ENERGY ANALYSIS OF A MICRO HYDRO STATION IN SRI LANKA

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ABSTRACT

Energy analysis of the Micro Hydro is taken into account at four different levels. The sensitivity of the energy analysis can be done using a computer software package. The main factors influencing sensitivity are life span, distance involved and the capacity of the Micro Hydro. In this project the basis of calculating the embedded energy is Tonnes of oil equivalent (TOE). Here Energy gain ratio is calculated using output to input usable energy of the Micro Hydro. Several assumptions were made in order to make it applicable to a typical Micro Hydro plant in Sri Lanka and by doing so we can determine the significance of each factor influencing energy efficiency of a Micro Hydro.

INTRODUCTION

Energy and environmental considerations are becoming increasingly important today. This is primarily because there is an appreciation of non-renewable and limited nature of many of our energy sources, and any sort of development inevitably consumes energy sources and may cause adverse environmental effects. It has been found through research that solar energy is not energy efficient. Hydropower generation is the most suitable source of energy for a tropical country like Sri Lanka and Micro Hydro power will be the best choice for rural areas where, electrification from National grid is very expensive. Energy gain ratio besides giving the efficiency of a particular Micro Hydro plant would also help in comparing the efficiency of different Micro Hydro plants.

In order for the professionals to make choices regarding the size of the Micro Hydro plants and to know the energy related consequences of their designs, an accurate database has to be developed to store all the energy related data of raw materials and the elements related to Micro Hydro. The embedded energy content of raw materials will vary from country to country depending on the sources of energy used for manufacturing.

In Sri Lanka for example there is a wide range of energy sources used for building a Micro Hydro, such as biomass, fossil fuel and electricity for cement production.

So there is a clear need for research to be carried out into energy content of a Micro Hydro and arriving at a value for energy efficiency. Process analysis is our approach in studying the Micro Hydro plant, but it involves use of energy contents of materials like cement, sand, timber etc. from the statistical information. Energy from raw materials analyzed in level 2 makes a significant contribution. The final result of our analysis thus depends on the extent of accuracy of the data collected. The same analysis can be extended to the materials too, but this is beyond our scope.

OBJECTIVES

The objective of this study is to find the energy content of a Micro Hydro station by performing "Cradle to Grave" analysis, which will ultimately derive the energy efficiency of a typical plant in Sri Lanka. The main aims are:

1. To arrive at a basic data regarding the energies of raw materials and elements.
2. To store information regarding embedded energies using a computerised database.
3. To convert all the energy into equivalent TOE.
4. To find the gross energy input.
5. To derive the energy efficiency of the station.

Methodology

ENERGY ANALYSIS

There are four commonly accepted methods of energy analysis, namely:

1.Process analysis
2.Input output analysis
3.Statistical analysis
4.Eco-energetics

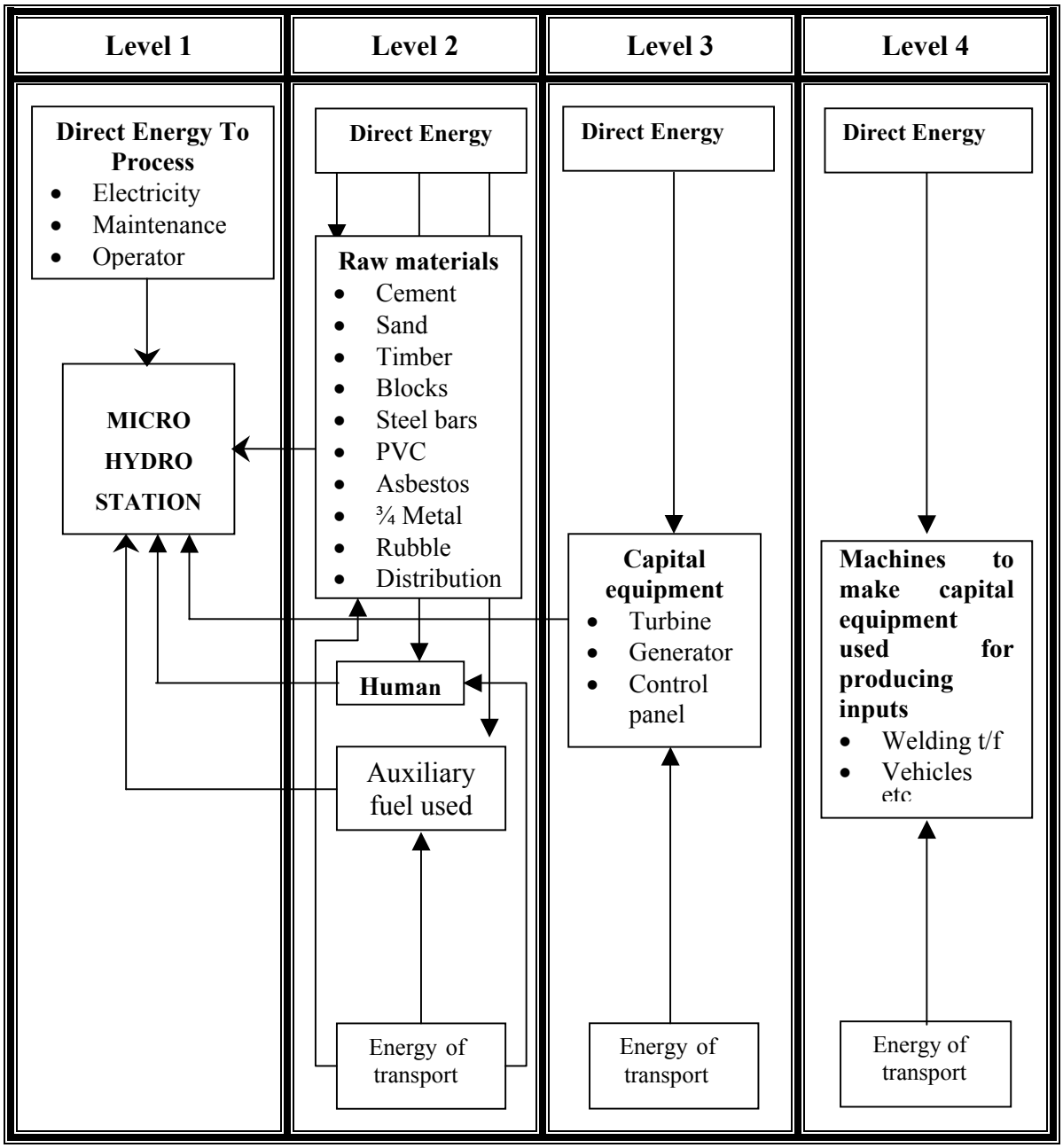

Fig 1-levels in the definition of system boundaries.

Process analysis is more suited to specific products or manufacturing chains for which physical flows of goods and services are easy to trace. This begins by identifying one particular product as the object of study; this may be either a good or a service. By examining the process, which makes the product the energy requirements are determined from all the materials, equipment and energy inputs to that process. This method goes tracking back from the target product through each stage of the production process.

Each successive step typically identifies smaller and smaller energy inputs, and all these energy inputs are summed to obtain the target product. Performing a process analysis requires extensive data on production of the target product.

ASSUMPTIONS

1. Twenty-year life span is assumed for the Micro Hydro plant.

2. Since the methods for assessing the contribution of human labour are not yet satisfactorily resolved, human energy is not considered in this calculation.
3. Colombo is considered as the reference city when considering transportation and traveling.
4. Monthly maintenance is neglected.
5. The electricity consumption to the process after commissioning the project is neglected.
6. Load profile is taken as 10% during off-peak hours and 90% during peak-power demand.
7. Due to seasonal variation of water flow it is assumed that the plant is not operated for two months.
8. For calculation purposes it is assumed that there is a quarry within 20 Km from the Micro Hydro plant.

SYSTEM BOUNDARIES

The boundary for energy contribution has been limited to the national boundary of Sri Lanka. The method of analysis and the system boundaries are as shown in Fig 1.

DATABASE AND SOFTWARE PACKAGE

Computerized database is a readily acceptable extension of the calculation of energy gain ratio of Micro Hydro. The end result of this attempt is software named "en-MIC". The database is implemented using a relational database management system (RDBMS) and Microsoft office access, well-known database creating application package. The software package was coded using Visual Basic-6, which supports list processing, object orientation and event handling capabilities, which are essential features in the process of energy analysis with complex database.

STRUCTURE OF THE DATABASE

There are two databases named: Energy and Evaluation input, one is dedicated to the inherent energies while the other is allocated to the evaluation of inputs when calculating the energy gain ratio.

This database includes several tables, the tables used in Evaluation of input database are Main, LOC, level 1 etc. and Energy database such as energy source, production, description and total energy.

Maincode, Code are the key fields in database Evaluation input and Energy respectively.

Use of key fields assist to optimize the database according to RDBMS.

Table 1
Energy Breakdown - Description

code	descreption	Qty
1	Abestos fibre	1 1Mt
2	Asbestos sheet	1 Mt
3	Blocks 4*8*16	1000 Nos
4	Blocks 6*8*16	1000 Nos
5	Blocks 8*8*16	1000 Nos
6	Blockwork4"	10m^2
7	Blockwork 6"	10m^2

Table 2
Energy Breakdown – Total Energy

code	tminenergy	tavgenergy	tmaxenergy
1	15680	15680	15680
2	4359	4476	4594
3	3571	3855	4140
4	5879	6138	6397
5	6070	6341	6612
6	519	558	597

CONCLUSIONS

The Energy Gain ratio between total input energy and out put energy ranges from 5.5 to 6.
The energy contribution from raw materials amounts to 70%.
The energy contribution from transportation is around 30%.

The Following figures show the results obtained for the Kahabhili Oya Micro Hydro project.

LEVEL	ENERGY CONTENT (TOE)
1	0.448
2	9.3063
3	0.0561
4	0

Fig 2- Total energy input

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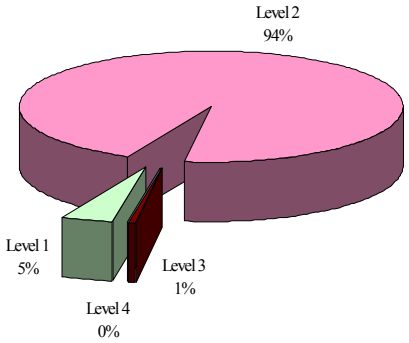

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