Energy Management

Project for implementation of remote monitoring system in IBEROL

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Abstract

This study aimed to prepare the implementation of a remote monitoring system in IBEROL, that provide all counts of fluids and electricity in a single server, for more control, faster analysis and energy optimization. For this, began by making a survey of the facilities points of IBEROL to be monitored, followed by the development of specifications according to the needs of the company.

Subsequently were contacted 9 suppliers, but only six, one of which presented two proposals, were considered eligible.

With the aid of pre-established technical and economic criteria, evaluated both technical and economic proposals that allowed for their hierarchy. To this end, it was developed a spreadsheet that the company may also use in future analyses. Thus, after analysis of seven proposals, pointed to D proposal ranked first with an investment of € 53,213, a NPV (Net Present Value) of € 99,210, an IRR (Internal Rate of Return) of 74% and a payback of 17.4 months. Secondly the proposal C had a total investment of € 65,152, an NPV of € 28,130, an IRR of 34% and a payback of 26.5 months. The proposal A came in third, with an investment of € 75,330, an NPV of € 71,439, an IRR of 46% and a payback of 26.2 months.

In this work still elaborated a tool that allows the monitoring and control of IBEROL's effluent.

Keywords: Energy management, Remote Monitoring System, Savings, Investment.

1. Introduction

The standard ISO 50001 – Energy Management, establishes the requirements that must have an energy management of an organization to help improve energy performance, increase energy efficiency and reduce environmental impacts, as well as to increase the competitiveness in the market, that organization operate, without affecting the productivity. To implement an energy management, organizations install a remote monitoring system, allowing the automation of data collection for monitoring and optimizing energy. This work will primarily focus on a project to install a remote monitoring system [2].

Qualitative benefits of monitoring consumption

Monitoring consumption, through manual collection of information, has a number of advantages as [2], [3]:

- Knowledge of energy / fluid consumption of the organization – why / how / where / when consuming energy / fluid, as it consumes energy / fluid;
- Analysis of energy consumption and fluid per cost center – to quantify the use of energy and fluids of a sector and allocating their cost;
- Detection of anomalies in consumption – Eliminate or minimize situations overspending of energy and fluids by malfunction, failure, ignorance or misuse of resources;
- Acquisition and Data Analysis – The analysis of the collected data allows to identify areas of potential savings;
- Benchmarking – Comparison of consumption, costs and results with other similar plants allows to quickly identify good practices that can be adopted;
- Creation of KPIs (Key Performance Indicators) - With the collected counts is possible to create reference indicators for consumption.

Qualitative benefits of installing a remote monitoring system

The implementation of a remote monitoring system will give benefits in the medium / long term. These benefits relate to the reduction of energy consumption and consequent improvement in efficiency and productivity of the process, promoting the rationalization of costs, and improving the organization's environmental performance. The benefits result are indirect, since the system helps to identify key places to intervene, and after the necessary intervention can monitor the measures applied and their reduction in consumption with greater facility.

The remote monitoring system not just potentiate the benefits of the topic <u>Qualitative benefits of monitoring consumption</u>, but can still provide the following benefits [2], [4]:

- Reduction of energy bill of organizations;
- Increase productivity of organizations;
- Increase competitiveness in internal and external markets;
- Know in detail the facilities and the cost of the processes;
- Contribute to an improvement in the allocation of operating costs and consequent cost planning;
- Contribute to reducing the negative impacts of energy consumption, including reducing greenhouse gas emissions;
- Reduce exposure of entities to external factors;
- Control the results of actions and investments to improve the energy performance;
- The constitution of a database of consumption enables planning interventions, optimizing the use of existing resources and reducing consumption and costs;
- Reduction of risks. The new system reduces the financial risks through the use of KPIs, accurate predictions, accumulation of charges, scenario analysis of tariffs and a strengthened further position when negotiating contracts for the supply of energy.

To graphically demonstrate the advantages of a remote monitoring system in relation to energy audit, next is illustrated in the first scenario with audit and subsequently with remote monitoring system.

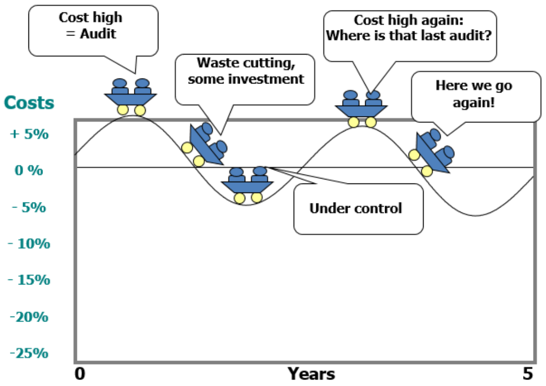

Figure 1 – Reduction cost with energy audit [5].

According to the figure above, when there is an increase in energy consumption and consequently increasing costs, the organization aims to decrease them so usually resorting to a service provider to perform an energy audit of the facility. Energy audit can result some measures, some of which can lead to an immediate cut in energy consumption, while some investment to decrease energy consumption for others is necessary. The process is under control for some time, but since there is continuous monitoring of the measures implemented earlier, consumption / energy costs increase again, returning a new audit to be necessary, creating an uninterrupted cycle that does not allow permanent savings.

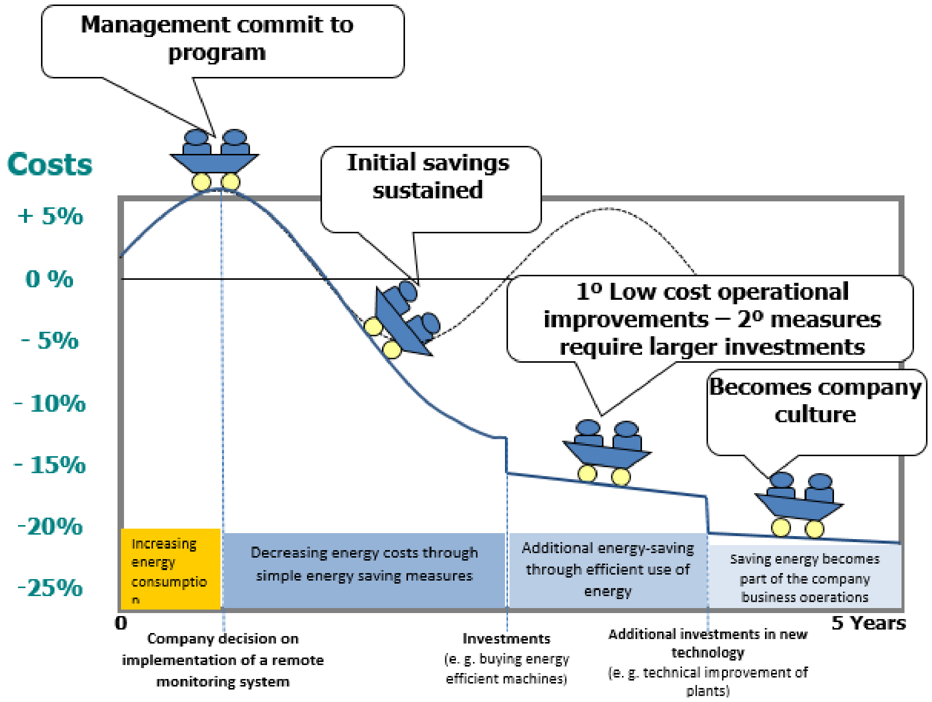

Figure 2 – Reducing cost with the installation of a remote monitoring system [5]

According to the figure 2, when the organization has a higher consumption / energy cost, implements a remote monitoring system, existing commitment by the administration to reduce the consumption of the organization. With the application of a remote monitoring system, only with the ability to monitor and control provided by this, it is possible to implement measures that allow the reduction of costs without any investment. Furthermore, with this system it is possible to perform the internal audit without the need to contract external services, this being much more effective due to their constant monitoring and during a higher period than energy audit, performed by external agents. Measures that follow from small operational adjustments resulting in small investments (e. g. variable speed) are required and measures that require higher levels of investment (e. g. electric motors high performance large capacity), which by being more efficient, leads to reduction of energy costs. With the commitment of all stakeholders the remote monitoring system becomes company culture leading to a permanent reduction of costs.

The importance of remote monitoring system for KPIs

In the industry there is a need to monitor the process and if it is within the established performance parameters, such indication is given by the KPIs (Key Performance Indicators). This type of indicator measures the performance of the process, and the remote monitoring system, is used primarily for energy issues. The main requirements for measuring energy efficiency include [6]:

- Indicators of energy efficiency to identify inefficiencies in energy use (e. g. energy consumption profiles.);
- Facilitate change control and improvements in energy efficiency;
- Measurement of energy efficiency directly into monetary values to communicate directly, where you can save money;

Quantitative advantages of a remote monitoring system

After the implementation of a remote monitoring system, are obtained reducing energy consumption. This economy is mainly by the application of energy efficiency measures, without the control and continuous monitoring of these, savings losses would have as noted in Figure 1.

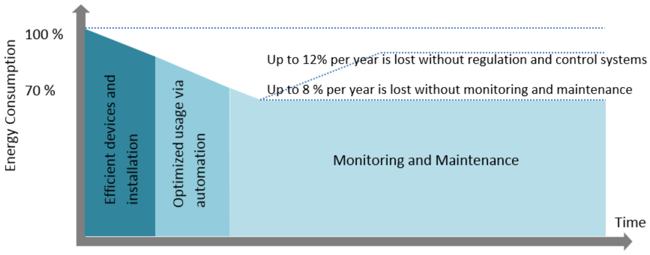

Figure 3 – Reduction in consumption by implementing energy efficiency measures [7].

Through the above figure you can see that the program of Monitoring and Maintenance, that fits the remote monitoring system, contributes to a reduction of losses in energy consumption which can vary between 2 and 8% on energy [7].

From Figure 2, it is observed that with remote monitoring system and applying some measures to reduce consumption, can be obtained gains of about 15% [5].

According to the ADENE -Agency for energy [8], with the experience gained in the implementation of remote monitoring system, the savings obtained exclusively from the remote monitoring process is 3% in electrical consumption and 5% for other forms of energy.

Then we present a small case study associated with the reality of IBEROL, which refers to the rounding of average monthly energy consumption. We present two visions of the possible savings through the implementation of a remote monitoring system without any additional investment, an optimistic view with a reduction of energy consumption by 3% ADENE suggested [8], and a pessimistic view considered this work is that it allows a reduction of half the reference value or above is 1.5% of energy consumption.

Table 1 – Case study of savings achieved with the implementation of a remote monitoring system in IBEROL.

		Monthly savings	
	Monthly consumption	**Optimistic vision (3 %)**	**Pessimistic vision (1,5 %)**
Gas	220,000 €	6,000 €	3,300€
Electricity	130,000 €	3,900 €	1,950 €
Total		10,500 €	5,250 €

The installation of a remote monitoring system

According to the Industrial Association of Aveiro [2], to make the remote monitoring system robust is necessary that it has the ability to make:

- Recording and analysis of physical parameters, such as energy consumption (electricity, heat, fuel), temperature, humidity, pressure, flow, production (outputs of production units);
- Creation by user dashboards freely, with graphs, charts (exportable to Excel) that behave metering functionality;
- Benchmarking across facilities;
- Generation of dashboards for analysis of consumption and costs and benchmarking;
- Aggregation of multiple sensors;
- Forecast of future invoices, based on estimates and weather data or forecast production;
- Accessible via web AA (Anytime / Anywhere);
- Obtaining reporting standards for installation;

- Ability to adapt the potential of software to the needs of each user, creating if necessary levels of access to this;
- Report with energy costs and simulation of invoices;
- Reporting and issuing alarms, automatic periodic emission reports (e. g. consumption profile of the previous day, peak load, contracted power, the energy consumed in a week or month).

For the installation of a remote monitoring system there are two components to analyse in greater detail the Hardware and Software.

- **Hardware**

In this component, briefly described by the following figure, is the entire physical infrastructure needed for gathering information for a remote monitoring system

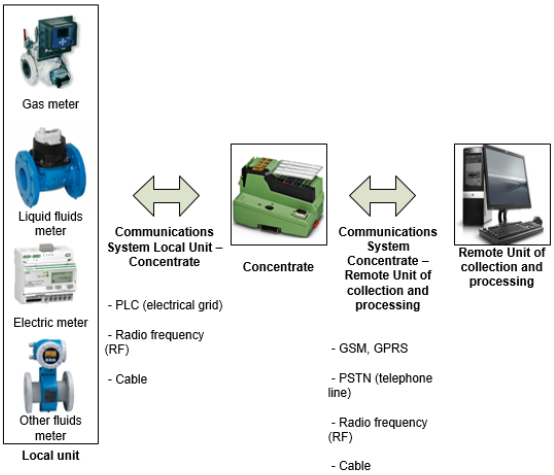

Figure 4 – Typical physical infrastructure of a remote monitoring system [1].

Local Unit – unit dedicated to reading

Concentrate – is the interface between the local units and the remote unit collection and processing. Aggregating readings of various local units.

Remote Unit of collection and processing – It is this drive that there is the main interface between the hardware and the software of the remote monitoring system, as well as the collection of data from the concentrator and registration in the database. The user interface may be performed locally or remotely. This interface also allows, if needed, manual data entry. After the data stored can be accessed through the software, which may be located in this unit or remotely (e. g. Cloud), processing them and making accessible analysis.

- **Software**

The software is connected to the remote unit for collecting and processing data, this can't be located, when the data needs to exist in its database.

According to the Industrial Association of Aveiro [2], the software from a remote monitoring system must:

- Allow analysis of energy consumption, providing every facility access to their consumption profile;
- Allow the monitoring of trends in consumption and costs, and establish a relationship between them and the equipment, processes and procedures;
- Provide all relevant information of each sector, to enable reduce energy consumption;
- Allow meet the specific consumption, thereby enabling internal benchmarking;
- Allow the allocation of energy costs in detail by sector / department;
- Provide the data in real time, with quick and easy access via the internet;
- Provide immediate reporting;
- Allow to prepare an unlimited number of custom panels (dashboards) defined by the user;
- Ability to easily identify the best practices that can be adopted;
- Allow the continuous demand for more efficient operation, maximizing profit margins, while simultaneously allowing a positive impact on the environment;
- Ensure the following vectors: Flexibility, Adaptability and accessibility via Internet.

2. Specifications

The framework of the necessity of achieving this specification for implementing a remote monitoring system was due mainly to two aspects. The first was the need for standardization of proposed solutions, as previously IBEROL had performed a consultation to the market, having obtained such a discrepancy in proposed solutions that it was not possible a technical comparison between them. The other aspect is due to the temporal distance between the current and previous consultations that led to need to update the previous proposals that have become obsolete.

3. Technical analysis of proposals

As mentioned in the preparation of the specifications referred to in topic 2, the proposals technically standardized so that all suppliers respond with comparable proposals with the required technology. Thus, the technical analysis of proposals corresponding to the hardware installation, will be held only at the level of small changes from the specifications, thus not being a differentiating factor.

Comparison of technical analysis of proposals

The analysis of the various proposals received has shown that the description of the software made by suppliers was quite diverse. Thus, it became necessary to establish a criterion for comparison of the various proposals.

In the standardization carried out it was decided that if the proposal altogether the item corresponding word will be "Yes"; If a limited number of options exist proposals appear "Yes conditioning" and finally, if not completely answer the item will be "No".

Due to its importance for the analysis and ranking of proposals and was prepared as for the software, created the following table for easier of analysis of general items of the various proposals.

Table 2 – Comparison of general items.

	Proposals						
	A	B	C	D	E	F	G
Total installation time (weeks)	12	14	14	10	16	12	28
Equipment Warranty (months)	24	24	24	12	12	12	24
Software Warranty (months)	24	60 (1)	60 (1)	12	3	12	24
Payment Terms	1,238 €	0 €	0 €	984 € (2)	2,471 €	2,057 €	3,989 €

Note:

(1) - The software is provided as a service, the supplier always being responsible for running this. We considered this premise for the whole evaluation of the project (5 years).

(2) - The supplier has not provided payment terms, assuming that the corresponding value would be all settled by the award of the project.

4. Economic analysis of proposals

Evaluation of investment

After setting the previous assumptions, it became possible to perform the evaluation of the investment, obtaining the following table.

Table 3 – Results obtained from the evaluation of Investment.

	Proposals						
	A	B	C	D	E	F	G
investment	75,330 €	63,465 €	63,465 €	53,213 €	174,929 €	118,515 €	89,108 €
NPV	71,439 €	47,696 €	28,131€	99,210 €	-75,151€	12,872 €	53,880 €
Payback (months)	26.2	24.6	26.5	17.4	(1)	52.4	32.9
IRR	45.5%	43.4%	34.3%	74.0%	-8.6%	15.8%	34.0%

Note:

(1) - Proposal has not Payback period of the project evaluation (5 years).

The analysis of the previous table allows to, check that, according to the indicators used, proposal

E has the lowest interest and D is the most interesting proposal. As this analysis resulting solely from the economic evaluation, it is still necessary to consider the technical part which will be paid in the next topic.

5. Ranking of proposals

Criteria

As economic criteria used to evaluate the investment with an overall weighting of 50%.

As technical criteria used the general items such as general criteria with an overall weighting of 10% and the related software items, as criteria of the Software in its entirety to avail a global weighting of 40%.

The weight established for each item of economic criteria is presented in Table 4 As can be seen, it was considered an equal weighting to those items that are all equally important. Target column in shows the intended purpose, where "-" indicates that the item is intended to minimize and "+" indicates that aims to maximize the item.

Table 4 – Weighting of items of economic criteria.

Economic criteria	Weighting	Target
Investment	25%	-
NPV	25%	+
Payback (months)	25%	-
IRR	25%	+
Total	100%	

The weighting for each item set of general criteria is presented in Table 5.

Table 5 – Weighting of items of general criteria.

General criteria	Weighting	Target
Implementation time (weeks)	25%	-
Equipment Warranty (months)	25%	+
Software Warranty (months)	25%	+
Payment Terms	25%	-
Total	100%	

As shown in Table 4 for the economic criteria, it was considered the same weight for all items of general criteria due to the similarity between them. In fact, for warranties, for example, the remote monitoring system may either be unavailable by failure of the hardware or software level. The objective to be achieved for each item is displayed in the Target column.

In software criteria presented in Table 6 were defined four items. General characteristics, Dashboards, Reports and Alerts, contributing each with a weighting of 25% to the total.

Table 6 – Weighting of items of software criteria

Software criteria		Weighting	Target
General characteristics (25%)	Online platform:	20%	(1)
	Partial counts:	20%	(1)
	Weather data:	5%	(1)
	Process / business data:	15%	(1)
	HHV data daily:	10%	(1)
	Software is scalable:	15%	(1)
	Have limited number of users:	15%	(2)
	Total	100%	
Dashboards (25%)	Real Time - analysis and baselines:	18%	(1)
	Real Time - simple forecast consumption:	10%	(1)
	Real Time - forecast of optimal consumption:	10%	(1)
	Historical - Energy costs:	10%	(1)
	Historical - tariff simulation:	10%	(1)
	Historical - performance *tracking*:	10%	(1)
	Historical - KPIs specific consumption:	15%	(1)
	Custom Dashboards:	15%	(1)
	Mobile Dashboards:	2%	(1)
	Total	100%	
Reports (25%)	Sensitivity analysis of load profile:	20%	(1)
	Sensitivity analysis to the energy price:	20%	(1)
	Benchmark inter-client:	15%	(1)
	Benchmark intra-client:	15%	(1)
	Analysis of contracted power:	15%	(1)
	Custom:	15%	(1)
	Total	100%	
Alerts (25%)	Absence of consumption:	15%	(1)
	Null consumption:	15%	(1)
	Billing of reactive power:	20%	(1)
	Anomalous consumption:	20%	(1)
	High power:	15%	(1)
	Custom:	15%	(1)
	Total	100%	

Note:

(1) - Yes = 100%; Yes conditioning = 50%, No = 0%.

(2) - No = 100%; No conditioning = 50%, Yes = 0%.

Ranking

- Ranking using economic criteria

The following figure shows the results obtained in the evaluation of the economic criteria of the various proposals.

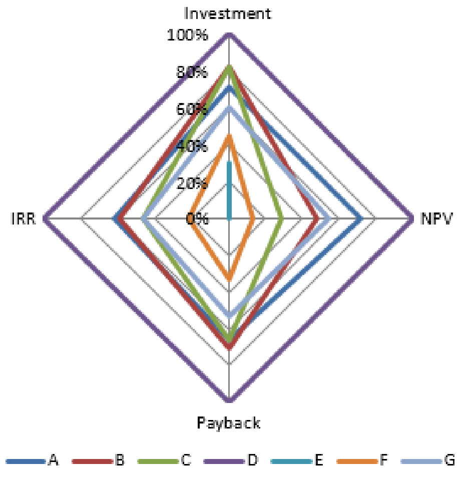

Figure 5 – Analysis of economic criteria of the proposals.

Through the analysis of the previous figure was observed that proposal D has the best indicators in all economic criteria, while the worst proposal is E. The latter does not present acceptable values within the project period for the criteria of payback, NPV and IRR and presents the most unfavourable investment.

Figure 6 shows the ranking of proposals based on economic criteria based on the weighting factors of each item presented in Table 4.

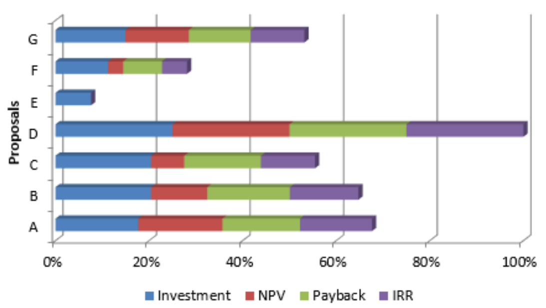

Figure 6 - Ranking to the economic criteria for each proposal.

As in Figure 6, it is observed that proposal D has a rating of 100% because it is the best bid on all the items d economic criteria. Second and third are proposals A and B which have a value of about 68% and 65%, respectively. The proposal with the worst classification corresponds to proposal E, with a value of about 8%.

- Ranking using general criteria

Figure 7 shows the results obtained in the evaluation of the general criteria of the various proposals.

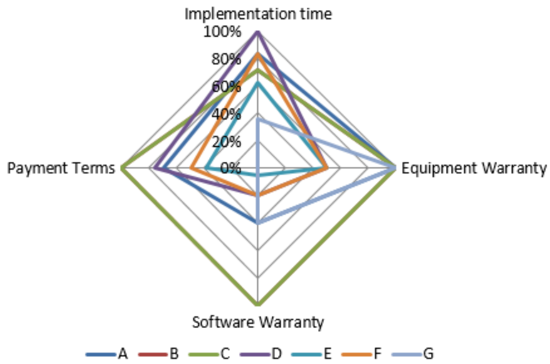

Figure 7 – Analysis of general criteria of the proposals.

Through the analysis of the previous figure we see that proposal B and C present the best rankings on all items of general criteria, with the exception of the implementation time by occupying the fourth position. The proposal G is the least satisfying items in terms of payment and time of implementation, and the proposal E the worst in terms of payment.

Using the weighting factors for each item of the general criteria presented in Table 5, we obtained the following figure.

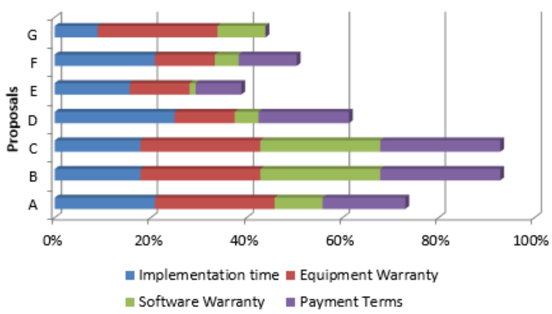

Figure 8 – Ranking to the general criteria for each proposal

The analysis of the previous figure shows that proposal B and C are the most satisfying yielding a value of 93% on overall criteria. Following is proposal A which had a value of compliance with general requirements of about 73%. The proposal which has the worst ranking general criteria corresponds to the proposal E, with the value of 39%.

- **Ranking using Software criteria**

The following figure shows the ranking of the proposed criteria in the evaluation of the Software.

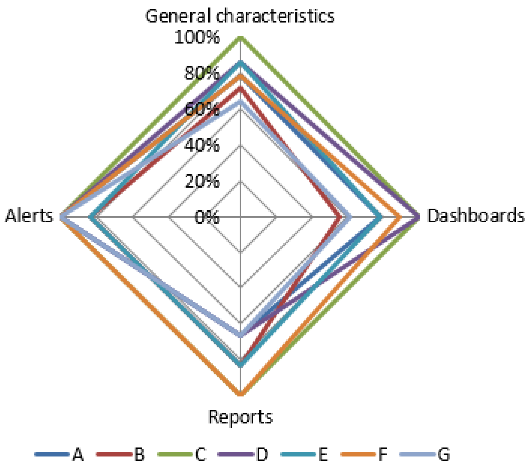

Figure 9 – Analysis of software criteria of the proposals.

Through the analysis of the previous figure it is found that the C proposal satisfies all of the criteria of Software items. By other hand, proposal G is the one that least meets the General Characteristics and Reports and proposal B is the worst in items Dashboards and alerts. Figure 10 presents the ranking of proposals after application of the weighting factors for each item of the criteria of the Software provided in Table 6.

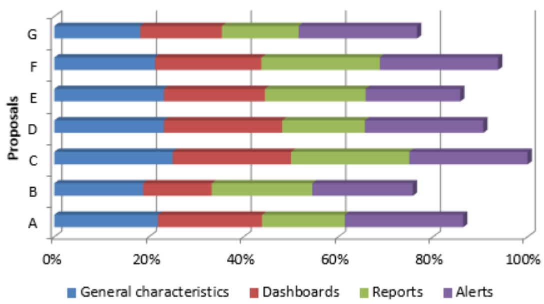

Figure 10 – Ranking to the software criteria for each proposal

Through the analysis of the previous figure was found that C is the proposal that best satisfies software criteria with a value of 100%. The second and third proposal best rating for the economic criteria correspond respectively to F and D proposals that have a value of about 94% and 91% respectively. The proposal with the worst ranking corresponds to proposal B, with a value of about 76%.

- **Ranking summary of all proposals**

As previously stated, the final evaluation of tenders was assigned a weighting of 50% of the economic criteria, 10% to general criteria and a weighting of 40% to the Software. Figure 11 shows the evaluation of proposals.

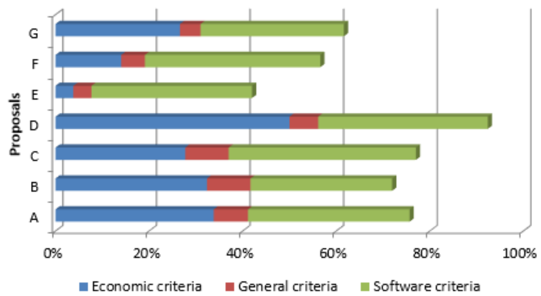

Figure 11 – The final ranking of proposals based on economic, general and software criteria.

After analysing the above figure it is clear that the proposal with the best overall assessment is proposed with a D value of 92%, with higher ranking on economic criteria. The second best proposal is C having a value of 77%. This proposal presents, as proposal B, the best ranking in the general criteria and is also the best proposal with regard to the criteria software criteria. The top 3 suppliers is complete with proposal A, which is the second best proposal on economic criteria. The proposal with the lowest classification corresponds to the proposal E, with the worst ranking in economic and general criteria.

The following figure shows the hierarchy of the proposals in the form of an inverted pyramid that allows better perception of the ranking.

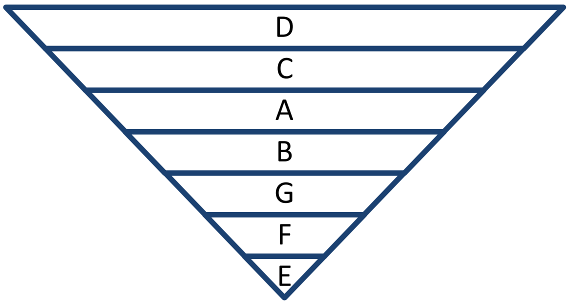

Figure 12 – Inverted pyramid with ranking the various proposals.

6. Conclusion and future work

This study aimed to prepare a project for implementing a remote monitoring system in IBEROL. This design contemplated the need for automation of data collection, in order to provide all counters of the fluids and electricity in a single server, for better control and energy optimization.

After reviewing the seven proposals received, the highlight was proposal D that had a score in the ranking of 92% (50% economic criteria, 6% general criteria and 36% software criteria), for an investment of € 53,213, an NPV of 99,210 €, an IRR of 74% and a payback of 17.4 months. Proposal C came in second place in the standings featuring a score in the ranking of 77% (28% economic criteria, 9% general criteria and 40% criteria software), for an investment of € 65,152, an NPV of € 28,130, an IRR 34% and a payback of 26.5 months. In third place was proposal A in the ranking with a score of 76% (34% economic criteria, 7% general criteria and 35% criteria software), with an investment of € 75,330, an NPV of € 71,439, one IRR of 46% and a payback of 26.2 months.

Another interesting task to do in case of implementation progress will follow the development of the remote monitoring system, locating the sites for implementation of measures to reduce consumption, keeping the quality parameters of the products made in IBEROL. The verification of savings resulting from measures taken will allow also confirm the values that were used to evaluate the investment.

Another activity to be developed in the future after the implementation of remote monitoring system and implementation of measures for energy optimization will be the implementation of an energy management according to ISO 50001.

This is because the system remote monitoring is a fundamental tool to aid the implementation of energy management. Thus, the remote monitoring system is a fundamental tool to aid the implementation of a system of energy management. That will allow IBEROL to be at the forefront of energy management, before the remaining players in the market.

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