Auditoría energética en el campus de la Universidad Técnica del Norte, ubicado en la ciudadela el Olivo, entre la panamericana norte y la avenida 17 de julio e implementación de un tablero didáctico para el laboratorio de la carrera de ingeniería en Mantenimiento Eléctrico

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Abstract.The present project was realized basedon the technical stu dy faced to theenergy efficiency in the central building, being a novel topic that in the last yearshas received importance, d ue to theconservation of the environment, it is forit for that it has tu rned out to benecessary to realize a diagnosis andevaluation of the electrical parametersin: the main assault, in each of thedistribution boards, in the electricalprotections and in the drivers who shapethe electrical circuits of each of theoffices, as also there was realized th ediagnosis and evaluation of the lightparameters of the central buil ding, theuse of electrical equipment withdecadent technology and t hat are notfriendly with the environment whatcauses an unnecessar y energyconsumption. For the analysis of theelectrical parameters t eams were usedas: network analyzer, luxómetro andtweezer amperi métrica, which allow areal analysis of: voltage, current,potency fac tor, harmonic, flicker, loadcurves, lighting level, between others.

INTRODUCTIÓN the present research work was realizedin order to verify the efficiency i n theelectric power consumption in thecentral building of the Tech nicalUniversity of the North.

There mentions of way contextual theorigin of the problem and of equal waythe formulation and the exposition ofthe same one; they decide the spatialand temporary delimitation inaccordance with the scope that wants tobe achieved by the audit. As soon as theproble m of investigation wasdetermined there is described thetheoretical frame, in which onementions to the processes to carry outthe energ y audit

. Theoretical foundation

The concepts that appear next areimportant for the development of theproject, subject-matters are analyzedlike: legal aspects, the energy in theeducation, energy audit, efficientlighting, electrical drivers, perturbationsbetw een others.

Legal aspects

For the present work investigativo it wasnecessary to know the leg al aspects thatgovern the execution of the same one, itis like that it breaks of the maximumLaw that exists in the country as it is theCo nstitution of the Ecuador, which inseveral of its articles refers to th eefficient use of the electric power, alsohe quotes the rights and dut ies of theelectrical companies and of the clients.

Constitution of the Ecuador

In the CONSTITUTION OF THEECUADOR, (2008), the chapter VII DIETOF THE GOOD ONE TO LIVE. The seventh section corresponding to thebiosphere, ecology and energy efficiency, belonging to the Art. 413says textually:

"The State will promotethe energy efficiency, the developmentand use of practices and technologiesambientalmente you clean and rec over,as well as of renewable, diversifiedenergies, of low impact an d that put inrisk neither the food sovereignty, theecological balance of the ecosystemsnor the right to the water" (p. 125).

The energy in the education

The program EDUCAREE, (2012), showsthat there encourage, in educational,cultural centers,

organisms of socialparticipation, companies andinternational organ izations, theformation of the individual
in the culture of the saving and efficientuse of the electric power, to contributewith a development sustentable.
It is of big importance to sensitize thepopulation, on the needs for a responsible and rational consumption ofthe electricity, which consi sts of sowingthe culture of the saving of electricpower and of the m echanisms that makethis possible. The education is importantto hel p to understand the importance ofthe use sustentable of the naturalr esources. To promote in cultural,educational centers, companies,or ganisms of social participation andinternational organizations, the humanformation in the culture of the savingand efficient use of the electric power,to contribute with a developmentsustentable, inform ing about theeconomic and environmental benefitsthat it bears the s aving of the electricpower, realizing workshops, courses,conferenc es, videos and days of savingof electric power; for which it isneces sary to facilitate teachingmaterials that promote the culture ofthe en ergy saving in the schools of basiceducation, average top and top at national level, in order to transmit andto offer training and consulta ncy toassociations, companies, cameras,governmental organisms a nd to all theusers of electric power. The energy auditmust be a part of the programs or plansof energy efficiency in the educationalesta blishments. These plans mustcomprise actions directed to obtain th emaximum efficiency in the consumptionof electric power, the ma ximum savingsand the knowledge of the energybehavior of the elec trical facilities. (p. 1-3)
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B. Optimization of the energy

The activities that achieve the efficientand balanced use of the ener gyresources are named an energyconservation, the energy saving is achieved by means of the efficiency intransformation and transport ation, upto not know where and how it is beingused and where its e fficiency can beimproved, the energy cannot be free; toreach the tar get of optimization ofenergy the first step is theimplementation of a n energy audit.

The analysis of the electrical network,
bearing in mind the current regulation,the knowledge of the infrastr ucture ofthe national electrical sector, the laws,regulations and curr ent norms, will allowto analyze, suggest and encourage theelectric power saving, as well as realizeenergy diagnoses for the saving of t heelectric power, know and use thedifferent teams of high efficienc y for itsapplication in the saving of the electricpower. The optimiza tion thinks abouthow to improve the general conditionsof an electri cal installation of any type,
but it is more used in the places wherethe efficiency of the electrica linstallation influences very much thegood functioning of the establ ishment.It will have to realize the analysis of thecurrent conditions of the electricalinstallation, and will propose to him thealternative of general progress, wherethere is guaranteed a reduction of theene rgy consumption and the value ofinvoicing, maintaining the samec onditions of lighting and charges.

Balcells,(2012). He affirms that “
anyaction that should tend to improve theenergy efficiency of the c harges,distribution means and everything whatrepresents a rational use of the energywill have important aftereffects on theeconomy of all” (p. 13).

For this, first it is necessary to realize alocal energy diagnosis, to a nalyzecarefully each of the obtainedinformation, by means of calcu lations, toraise the alternative of progress thatadapts itself to the ne eds of the usersand that does not represent anexcessive expense, th at is to say looksfor a minimal investment,
but that hasbig effects in the economy of the usersand that also rec overs the moneyinvested in the least possible time.

Although there exist big potentialities ofimprovement of efficiency of the use ofthe energy in the small and medium-
sized industry, the businessmen havenot implemented the necessar ymeasures; due to the technical andinstitutional obstacles that they face andits perception with regard to the slightlysignificant inciden

ce of the expense ofthe electricity in its entire costs;situation that al so is observed in theeducational institutions.

Energy audit Definition of energy audit

Flórez,

(2007), indicates that, theenergy audit is a review studysystematica lly and organized of the flowand the use of the energy by means oft he one that gathers information on thesupply of electric power, based onhistorical and punctual information,obtaining a sufficientl y trustworthyknowledge of the energy consumptionof a team or a s et of them in a globalprocess, of the building or of thecompany; to detect the factors that theyaffect to the above mentionedconsumpti on and to identify and toevaluate the possibilities of saving ofenerg y according to its profitability. Theenergy audit manages to predict theresult of a program of conservation ofenergy before investing m oney andlabor. The energy audit allows to achievethe energy effici ency in a building orindustrial plant, once this one has beenrealized , it is possible to be believed in atrue way, the costs and benefits th at theclient can obtain, in some cases theinvolved costs can be desp icable, inothers, can be considered to beadditional investments, to a chieve asuccessful program there is needed thesupport and the acti ve participation ofthe management and the personnel ofmaintenanc e of the same institution.The Energy Audit is a systematicalprocess by means of which there isobtained a sufficiently trustworthyknow ledge of the energy consumptionof the company to detect the factor sthat affect the energy consumption andto identify, to evaluate and to arrangethe different opportunities of saving ofenergy, according to its profitability, (p.15).

- Types of energy audits.

Basic audit methodology. _ is a generic,applicable study in small a nd medium-sized provisions, with description ofinventory, share-outs of consumptionsand proposals of progress.

Exhaustive audit methodology. _ talkseach other of the exhaustive study asfor: description of inventories, share-

outs of consumptions and definition ofproposals of progress.

In accordance with the informationearlier obtained, vé feasible thea pplication of the methodology that isdescribed next, to carry out to theenergy audit in the building centers

Exhaustive methodology of energy audit

The Andalusian Agency of Energy(2011), he proposes the followin gmethodology of energy audit:

Target

The energy audit takes as a target todiminish the energy consumpti on,analyzing the causes that reduce theyield of the energy systems. For which itis necessary to examine the productiveprocess and the entire use of theenergy.

Scope

The scope of the audit contemplates the following actions:

Analysis of the energy provisions. _exterior energy provisions.

- Analysis of the productive system. _teams that take part in the p roductionprocess. Subprocesses: teams of littleconsumption that ta ke part in theproduction process. Big consumers:teams of major po tency that measurethemselves of independent form.
- Analysis of horizontal technologies. _facilities that do not belon g to theproductive process,

but that arenecessary for the development.

Necessary materials to realize the audit

- Analyzer of electrical networks

There are instruments of measurementof the following electrical pa rameters ofa network, normally of low voltage:voltage, intensity, p otency, energyactivates and reactivates, potencyfactor, as well as th e parameters ofelectrical quality that seek protection inthe regulatio n CONELEC 004/01;harmonic, interharmonic. These teamshave th e possibility of memorizing andof registering the above mentioned parameters by means of programmingfunctions.

- Luxómetro

It is an instrument that the iluminanciaor level of lighting allows to measure(lux) on a certain surface. There aresimple, light teams co mposed by theanalyzer and the photosensitive probe.

- Other teams of measurement

Depending on the scope there gives theaudit, can be useful the use of otherportable teams of measurement, forexample: anemometers, caudalímetros,pirómetros opticians, between others.

It is recommended to use a universalregistrar with several earnings andpossibilities of programming togetherwith the probes that is pre cise.

Toolbox

In the audit there can turn out to benecessary other materials and ha rdwareof common use:

Screwdrivers, pliers, scissors, electricalcables,

borneras, insulating tape,flexómetro, between others.

Phase 1, analysis of the energy structure

In the first phase is known how theenergy is received, how it transf orms,distributes and they consume theteams.

Activity and productive process

To realize a detailed study of theproductive process, emphatically i n theprocesses consuming energy, for whichone will be provided w ith informationfacilitated by the institution about thedistribution of work, shifts andschedules, planes of the institution,historical planes of lighting, inventory oflights, list of installed equipment,informati

ons of supply of electricity,schemes unifilares electrical, consumin genergy, distribution systems of energy,annual operation.

Structure of the energy consumption

To identify the services, teams and theareas of major importance fr om theenergy point of view, there will beanalyzed the information of the teamsof measurement and the possibledeviations will be stud ied in themeasured consumption.

Measurements

The measurements are realized toidentify the energy consumed in a team,in a part of the process or in the entireprocess, obtaining an e nergyconsumption of the team or a process.

Types of measurements

- Energy supply. _ measures the generalas sault of the plant
- Productive system

Subprocesses: one measures as a wholeall the elements of low cons umption ofthe same process.

Big consumers: it measures itself ofindividual form the big energyc onsumers.

- Horizontal technologies

Lighting: the consumption measuresitself in common of all the ligh ts that areinside the same sector.

Lighting levels: there measurethemselves the levels of lighting of t hewhole plant

Fase 2, analysis of energy efficiency

Energy efficiency in the energydistribution systems

The readings are analyzed obtained toknow the current conditions a nd to beable to optimize them, it is necessary toknow the legislatio n of the electricalmarket, to realize an efficiency study inthe energy distribution systems, theproposal of energy progress will beassocia ted with the decrease of losses orwith the progress of the conditions ofoperation. It will be a question of thefollowing way:

Balance of Charges

It consists of distributing the carryingcapacity between each of the circuitsthat have proved, which in turn aredistributed between the p hases. If theinstallation is two-

phase or trifásica fornorm it is necessary to do the respectivecharge s balance.

The balance of the charges is always anestimation, it is extremely c omplicatedto balance them and that are supportedin constant balan ce throughout 12 p. m.of the day, it is practically impossiblesince it s nature is variable,

but the loadbalance must be as near as possible tothe ideal balance.

Phase 3, evaluation of measurements ofenergy saving

The measurements proposed by theauditor must be analyzed techni callyand detail the economic value ofinvestment. As soon as there wereexamined all the possible alternatives ofenergy saving, one wil l consider with thefollowing methodology:

Type of measurements of energy saving

- Efficiency progress in the energy distribution
- Efficiency progress in the energy consumption of the teams

For every measurement it would benecessary to evaluate the energ y saving.

To calculate the energy saving of themeasurement proposal will ha ve to berealized, the analysis of the energyconsumption of the team and it must becompared with that of current use, thepotential savin g of the measurementbeing obtained.

Clear current value (GO)

The VAN allows to calculate the presentvalue of a certain number of future cashflows, caused by an investment. Itconsists of updatin g by means of avaluation all the cash flows of theproject. The form ula that the (VAN)allows us to calculate is:

$$VAN = \sum_{t=1}^{n} \frac{V_t}{(1+k)^t} - I_0$$

V_t represents the cash flows in everyperiod t.

I_0 is the value of the initial payment ofthe investment.

n is the considered number of periods.

k is the revenue valuation it fixes used.

Internal valuation of comeback (TIR)

The TIR of an investment is the interestrate with which the clear cu rrent value isequal to zero. There is an indicator ofthe profitability of a project, to majorTIR, a major profitability. It is used todecide t he acceptance or rejection of aproject.

Analytically the TIR decides like:

$$\boldsymbol{VAN = \sum_{t=1}^{n} \frac{V_F t}{(1+TIR)^t} - I_0 = 0}$$

In the equation it is observed that a longanalysis is needed to obtain the value ofthe TIR.

Recovery period

The period of recovery of the investment isthe measurement of ele mentary economicexpediency.

The period of simple recovery (PRS) in years will be:

$$PRS = \frac{Inversion\ capital}{Anual\ saving}$$

While less time the investment takes along time to recover with ref erence to thetime of life of the product, in which it isinvested, more feasible it is the project.

Relation cost benefit (RCB)

It is the relation between the clear currentvalue of the costs (VANC) and the clearcurrent value of the benefits (VANB).

$$RCB = \frac{VANB}{VANC}$$

So that a project is economically viablethe extreme values of the di fferentcriteria of evaluation are the followingones:

· Clear current value major than zero. 0GO > .

· Valuation interns of comeback majorthan discount rate. TIR > k

· Period of recovery of the investmentless than the useful life. PRS < n. · Relation cost / benefit less than 1.RCB < 1.

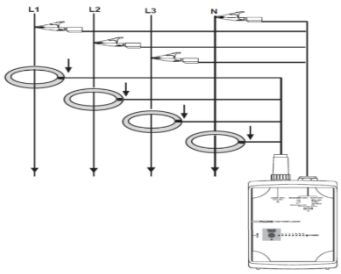
ENERGY AUDIT IN THE CENTRALBUILDING

Analysis and diagnosis of results

Target

To diminish the energy consumption,analyzing the use of the electr ic power.

Scope of the energy audit in the central building



Phase 1. Analysis of the energystructure of the central building

The central building is located in theuniversity citadel, in the Olive tree, between the avenue on July 17 and Pan-American north; the same one thatstocks up with electric power of thecircuit J1 of the electrical substationAjaví,

belonging to the authorization ofthe public enterprise EMELNORT E. Bymeans of a transformer trifásico of 37.

5kVA, located in a structure type "H",which is along with the centr al building.

In the preliminary information therewere obtained neither electrical planesnor planes of lighting of the building,only architectural sche mes arecontemplated.

Activity and productive process of thecentral building

In the central building there are carriedout administrative activities and thefunctioning of the radio and universitytelevision; all the ad ministrative areas,which contemplate the use of computerteams an d lighting have a function in period administrative areas, which contemplatethe use of computer teams and lightinghave a period of average functioning of9 daily hours be tween Monday to Fridaywith the exception of holiday andholidays.

The sets of radio, televisionand edition have an average ofoperatio n of 7 hours on the day ofMonday to Friday; the areasprogramming work 24 hours of the dayuninterruptedly, here there occurcompute r teams, audio, video andlighting.

Next there is realized the architecturaldescription of each of the are as thatshape the central building.

General description of the central building

The study of energy audit, it wasrealized in a building belonging to theeducational institutional sector, in theabove mentioned building there arecarried out administrative activities ofthe Technical Unive rsity of the North,one proceeds to realize the respectiveinventories of: architectural structure,computer teams and lights.

Phase 2. Energy efficiency in the energydistribution system in the c entralbuilding

One proceeds to the analysis of themeasurements obtained by thein struments of measurement used in the assault, board of distribution andoffices of the central building, in order top ropose energy progress and todiminish the losses

Charges balance

Calculation to determine the chargesbalance in each of the distribut ion boardsof the central building and proposal ofprogress.

%D= (CM-cm) x 100/CM

Calculation of the balance loads of theboard of main distribution.

$$\%D = \frac{(CM-cm)\ x100}{CM} = \frac{(104{,}3-58{,}3)\ x100}{104{,}3} = 44{,}1\%$$

In this case it is necessary to re-accommodate the charges, up toobtaining a percentage inside 5 %.

He proposes to realize the adjustmentthat is described next so that t hecharges balance is inside the levelallowed by the regulation.

The main board is trifásico, in which it issuggested to connect to th e phase 1 theswitches of: (63, 80) amperes; in thephase 2 will connect the switch of: (80)amperes and in the phase 3 will go theswitches of: (80, 80) amperes; obtaininglike turned out entire currents of: (72,5;72,3; 72,6) amperes, in each of thephases of entry to the boar

d, applyingthe formula it is had:%D $= \frac{(CM-cm)\ x100}{CM} =$

$\frac{(72,6-72,3)\ x100}{72,6} = 4,13\%$

This way it remains verified thatstrengthen the change of the switc hesthat the percentage is inside 5 %admissible.

Drivers' change of the assault of thecentral building

He proposes to realize the change of thedrivers of the assault, due t o the variableof superheat of the electrical cables,which was the res ult of the realizedanalysis, the section increase in thedrivers consid ers an economic saving bymeans of the reduction of energy losses,t his helps to reduce the electricalinvoice, as well as diminish the ris ks dueto an inadequate dimensionamiento ofthe driver. It is possibl e to obtain anideal section the one that allows savingsfor losses of e nergy and this way itcompensates the costs associated at therate of section of the driver of theassault, for ends of energy efficiency.

Calculation of the driver

For the calculation of the driver of theassault of the central building , heproposes to install: assault trifásica, TTU# 3/0 AWG, with neut ral of nakedcopper # 3/0 AWG. At a 70 metersdistance, expiring at the level of fall ofvoltage of 2 % in the nourishing circuit.

Calculation:

It happens in the table 4, the driver'scaliber in accordance with the capacityof conduction of current of the cable.

In accordance with the table 4, thedriver TTU is chosen # 3/0 AW G, due tothe characteristic of isolation andtemperature of operation , one proceedsto correct the voltage fall, with thefollowing formula :$\Delta V = \frac{\sqrt{3}*Z*L*i}{Vff} * 100 = \frac{\sqrt{3}*0,213*0,070*91}{128,3} * 100 = 1,83\%$

$$Z = \mathbf{0,213}$$

The value of fall of voltage is inside thelimit of the regulation, this way there isconfirmed the proposal of change of thedriver.

Perturbations in the electrical feedingnetwork to the central buildin g

In accordance with the graphs of theperturbations earlier analyzed, onedetermines that the existingperturbations in the network are: fli cker,THDv and the factor of potency; thesame ones that until now are inside thelimits allowed by the regulation, atpresent the regulati on does not includethe analysis of harmonic of current but itis sugg ested that in the future therespective analysis to be realized.

Change of fluorescent lights for pipesled`s in the central building

He proposes to realize the change of thefluorescent pipes for pipes led's in thelights arranged in every department.Next the values of e nergy consumptionelectricity company are indicated in kWhfor one month, obtained of thecalculation of the existing lighting in thebuil ding, in which they get ready offluorescent lights of (3 x 32 W) and (2 x40 W).

Lighting system led

The target of the proposal is to reducethe consumption of electric p owerdestined for the fluorescent lighting, toachieve an economic sa ving, improvingalso the level of current lighting. Theinefficient lig hting systems wasteenergy and money proposes to change the 40 a nd32 W current fluorescent pipes to pipesled's of 16 W; also the ele ctromagnetictie will be eliminated, this changepresents a saving of 60 %, also the sameceiling rose survives and the currentemplaceme nt of the ceiling roses issupported in the roof.

Whole of fluorescent pipes for thechange = # of lamps for the num ber ofpipes.

Whole of fluorescent pipes for thechange = [161 * (3 of 32 W)] + [106 * (2of 40 W)] = 695

The whole of fluorescent pipes for thechange is 695.

Additional advantages:

Table 26. Typical of pipes led's

It has instantaneous starter Eliminatesthe noise

Operation independent from the lampsDiminishes the weight of the team

It improves the useful life of the lamp aless operation temperature Exists

It has 1650 lm for pipe led

The useful life of the pipes of 16 W highefficiency is 30.

000 hours and itsguarantee is 5 years

Source: Master's degree Light

The development of this proposalconsists of the following thing:

Inventory of fluorescent lights in thecentral building, information o f badgeand estimation of time of use of thesystem to calculate the e maciatedenergy and level measurements

I save in the energy consumption

For the calculation there is taken intoconsideration only the differe ncebetween the energy consumption of theexisting system and the proposedsystem, the type of current lighting, themonthly cost of en ergy by dependence,taking into consideration:

106 existing lights have 2

40 Wfluorescent pipes, more 10 W of the tie,consume a 90 W activ e potency, whichevery pipe proposes to change to itselfinto pipes le d's of 16 W.

161 current lights have 3

32 Wfluorescent pipes, more 10 W of the tie,consume a 106 W acti ve potency; thosethat every pipe proposes to change toitself into pi pes led's of 16 W. Beingbased on the potency of the new systeman d under the same conditions of timeof use, the energy consumption iscalculated.

Energy 1 = # lamps whole * It Promotes* use time a month = 161 l amps * 48 W *180 h a month = 1. 391,04 kWh amonth.

Energy 2 = # lamps whole * It Promotes* use time a month = 106 l

amps * 32 W *180 h a month = 610,56 kWh a month.

Entire emaciated energy of theproposed system = Energy 1 + Ener gy 2 (kWh/mes)

Entire emaciated energy of theproposed system = 2. 001,6 kWh/me s

Financial analysis of the proposal of thenew system of lighting

Next there is described the comparisonof the potency of the system of existinglighting and proposed:

FINANCIAL ANALYSIS

useful life pipes led's = (30. 000) /(9*20*12) =14 years

ANNUAL REVENUE = $ 3. 344,9

INVESTMENT = $ 15. 488,75

$$VAN = \sum_{t=1}^{n} \frac{V_t}{(1+k)^t} - I_0$$

Vt = 3.344,9

IO = 15.488,75

n = 14

k = 12 %

VAN = -15.488,75 + 3.344,9 $[\frac{1}{(1+0,12)^1} + \frac{1}{(1+0,12)^2} + \frac{1}{(1+0,12)^3} + \cdots + \frac{1}{(1+0,12)^{14}}]$

VAN = -15.488,75 + (3.344,9 * 6,64)

VAN = 6.721,4

TIR

$$\boldsymbol{VAN = \sum_{t=1}^{n} \frac{V_F t}{(1+TIR)^t} - I_0 = 0}$$

VAN = -15.488,7 + 3.344,9 $[\frac{1}{(1+TIR)^1} + \frac{1}{(1+TIR)^2} + \frac{1}{(1+TIR)^3} + \cdots + \frac{1}{(1+TIR)^{14}}] = 0$

15.488,7 = 3.344,9 $[\frac{1}{(1+TIR)^1} + \frac{1}{(1+TIR)^2} + \frac{1}{(1+TIR)^3} + \cdots + \frac{1}{(1+TIR)^{14}}]$

4,6 = $[\frac{1}{(1+TIR)^1} + \frac{1}{(1+TIR)^2} + \frac{1}{(1+TIR)^3} + \cdots + \frac{1}{(1+TIR)^{14}}] = \alpha$

In Excel there exists the function "TIR

" thatcalculates straight the value of the InternalValuation of Com eback and needs likearguments only the clear box flow.

Años	beneficios netos
0	-15.489
1	3.349,90
2	3.349,90
3	3.349,90
4	3.349,90
5	3.349,90
6	3.349,90
7	3.349,90
8	3.349,90
9	3.349,90
10	3.349,90
11	3.349,90
12	3.349,90
13	3.349,90
14	3.349,90
TIR	20%

TIR = 20 %

PRS

$$PRS = \frac{Inversion\ de\ capital}{Anual\ savings}$$

$$PRS = \frac{15.488,75}{3.349,90} = 5\ YEARs$$

PRS = 5 años

RBC

$$\boldsymbol{RBC = \frac{VANB}{VANC}}$$

Next there is calculated the clear currentvalue of cost and benefit.

Clear current value benefits (VANB)

$$\boldsymbol{VANB = \sum_{t=1}^{14} \frac{V_t}{(1+k)^t}}$$

VANB = 0 + 3.349,9 $[\frac{1}{(1+0,12)^1} + \frac{1}{(1+0,12)^2} + \frac{1}{(1+0,12)^3} + \cdots + \frac{1}{(1+0,12)^{14}}]$

VANB = 3.349,9 * 6,64

VANB = 22.246,3

(VANC)

$$\boldsymbol{VANC = I_0 + \sum_{t=1}^{14} \frac{V_t}{(1+k)^t}}$$

VANC = 15.488,75 + 0

VANC = 15.488,75

$$RBC = \frac{VANB}{VANC} = \frac{22.246,3}{15.448,75}$$

RCB = 1,4

ANALICE

- VAN > 0.
- TIR > 20 %.
- PRS < 5 años.
- RCB > 1,4

According to the results of the financialanalysis, this one proposed is attractiveeconomically since it expires with all theevaluated requ isites.

CONCLUSIONS

The most significant load in the centralbuilding is the lighting that's why it isconsidered to be the best option ofsaving of energy, the su bstitution of thefluorescent lamps to pipes led's.

With the installation of the proposedsystem of lighting, the installe d lightingpotency comes down of 27,242 kW to11,120 kW, what c onstitutes a decreaseof 59. 18 %.

The replacement of friendly computerteams with the environment f or the(ancient) teams in use, they drink to usminor consumo de energía eléctrica, mayor aprovechamiento de los recursos, aceleran los procesos informáticos, más versatilidad logrando trabajos eficientes; (impresión, escaneo, copiado y fax). Sin embargo su financiamiento es elevado por lo que no es rentable.

It has become possible to implement adidactic board, which allows to thestudent to realize laboratory practices.The module is of easy c omprehensionand operation, managing to create afriendly environ ment towards thepractice, with the target to complementthe educati on to the students of thecareer of Engineering in ElectricalMainten ance.

With the exposition and execution ofplans of maintenance predicti vo andpreventive in the electrical and lightcircuits of the central bu ilding, one willmanage to maintain and prolong theuseful life of the electrical facilities.

RECOMMENDATIONS

The driver's change of the assault isrecommended, as well as theim plementation of a main board ofcontrol and force which allows to r ealizelocal and remote monitorings; with theintention of preparing flaws in theelectrical system and if it is the case tocorrect them.

At the moment of re-
adapting orimplementing significantly areas,departments or electric al equipment, itis necessary to realize in advance astudy to determi ne the availability, andof being the case to balance the chargesin ea ch of the phases of the electricalfeeding system, so that this one re mainsbalanced.

It is advisable to locate a centralizedpoint or specific area in every apartmentof the building; for the use of coffeepots, microwave, ice boxes betweenothers.

To stimulate the development andinvestigation of programs that fa cilitatethe process automation, in order toimplement and to improv e thefunctioning of the electrical system ofthe institution, as there c an be theapplication of computer processes.

The Technical University of the Northshould realize orientation ca mpaigns toall the users and to the community, inorder to recommen d technicalmeasurements of energy saving,applicable in the enviro nment in whichdesembuelven; by means of the massmedia as they are: UTV and Radio(UTN), in order to concientizar theenergy savi ng in the users of theTechnical University of the North andthe com munity.

It is suggested to realize and to maintainupdated a database of the whole loadinstalled in the central building, withwhich it will be eas ier to realize a loadraising.

To select appropriately the electricalengines of the elevators (type a nd itpromotes), since thesobredimensionamiento provokes lossof e nergy.

To extinguish the computer during theperiods of meetings or simila r activitiesof duration superior to one hour, at theend of the workin g day and during theweekends or days of absence of the job.

To make use to the maximum of thenatural light to diminish the en ergyconsumption in lights.

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