



# Análise do Potencial Energético do Centro de Tecnologia da UFRJ

*Energy Potential Analysis Centro  
de Tecnologia - UFRJ*

**Energy Potential Analysis**  
**Centro de Tecnologia da**  
**Universidade Federal do**  
**Rio de Janeiro**

**Auftraggeber:**  
GIZ

**Ersteller:**  
EBF GmbH  
Kleine Bach 34  
64646 Heppenheim  
Telefon: 06252/1285-0  
Ansprechperson: Franz Schreier

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## 1 General

This report documents the results of the energy analysis performed for the

### **Centro de Tecnologia da Universidade Federal**

in

Rio de Janeiro.

An onsite inspection was carried out on Monday, 16<sup>th</sup> of March 2015.

Potentials for energy savings were evaluated.

In total 7 energy saving measures could be identified, which have the potential to reduce the energy consumption and the CO<sub>2</sub>-emissions economically.

These measures are as follows:

1. Reducing the number of connected Transformers
2. Reactive Power Compensation
3. Peak Load Management
4. Base Load Reduction
5. Switching-Off Equipment in unoccupied Rooms
6. Replacing T8 by LEDs
7. Maintaining Cooling Systems

Some of these measures could easily be realized in the frame of a demonstration project, which would finally characterize the building as a reference for energy savings.

The current status of the energy consumption as well as the mentioned measures are described on the following pages.

## 2 Current status of the energy consumption

The UFRJ is supplied with electricity from the medium voltage grid at a level of 13,8 kV.

In total 63 transformers are installed, with a total capacity of about 19.500 kVA.

The actual contracted power is 5,15 MW. The real active power demand is above that, around 6.584 kW.

The total energy consumption of the site was 18.073.877 kWh/year in 2013.

The respective cost have been around 5.689.341 R\$/year in total. The average energy price in 2013 has been 0,3148 R\$/kWh.

The actual power factor is around 0,5, which causes cost for reactive power consumption of about 117.482 R\$/year. These costs are included in the above mentioned total cost.

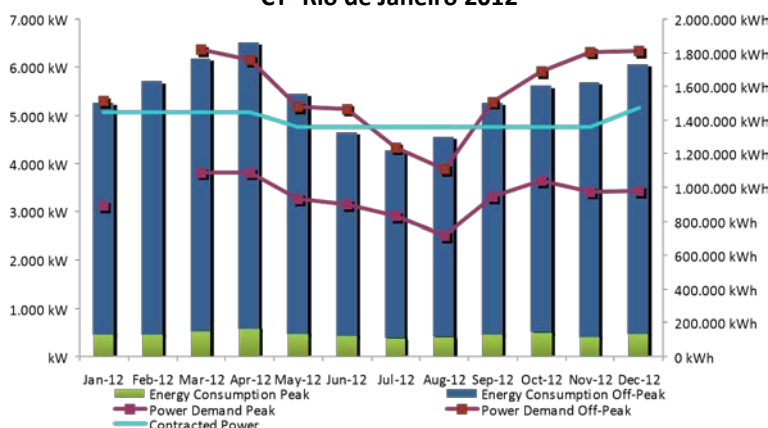
Due to the fact, that in early 2015 the energy prices increased by around 40 %, the actual average energy price is assumed to be around 0,4406 R\$/kWh. This price is the basis for the calculation of the cost savings of the measures below.

Further details can be seen in the following table.

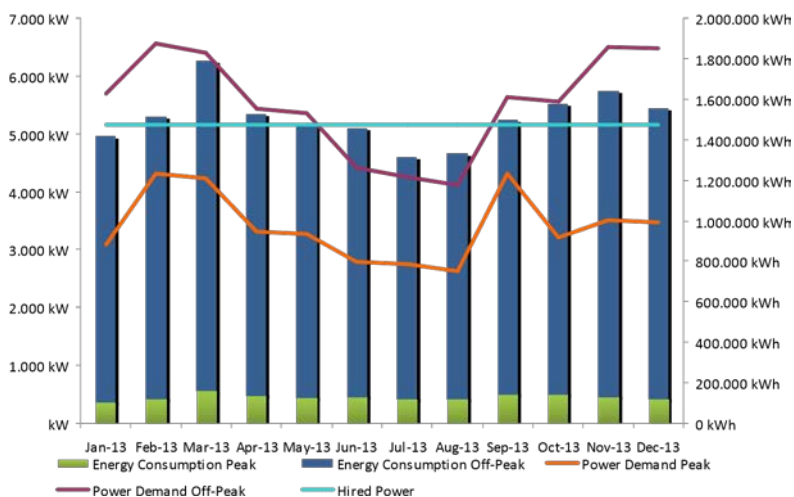
	<b>Energy/Power</b>	<b>Cost/Prices</b>
Contracted Power	5.150 kW	-
Peak Power	6.549 kW	994.372 R\$/year 151,83 R\$/kW year
Exceeding Power	1.399 kW	197.456 R\$/year
Active Energy (Peak)	1.566.077 kWh/year	1.848.584 R\$/year 1,18 R\$/kWh
Active Energy (Off-Peak)	16.507.800 kWh/year	2.531.358 R\$/year 0,153 R\$/kWh
Total Active Energy	18.073.877 kWh/year	4.379.941 R\$/year
Total Reactive Energy	743.169 kVAh/year	117.482 R\$/year
Full Load Hours	2.760 h/year	-
<b>Total Cost</b>	-	<b>5.689.341 R\$/year</b>

The following graphs are showing the energy consumption of the years 2012, 2013 and 2014.

**Energy Consumption and Power Demand  
CT- Rio de Janeiro 2012**

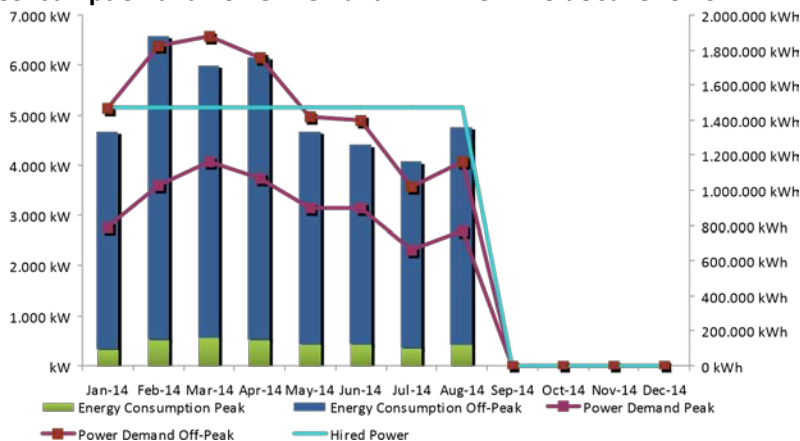


**Energy Consumption and Power Demand  
CT- Rio de Janeiro 2013**

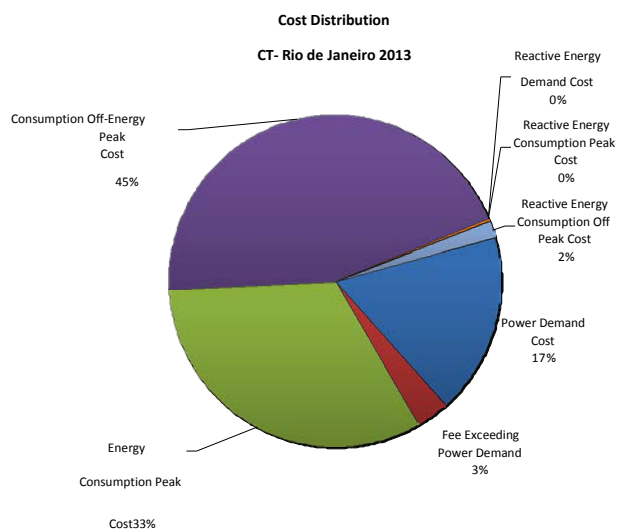


**Energy Consumption and Power Demand**

**CT- Rio de Janeiro 2014**

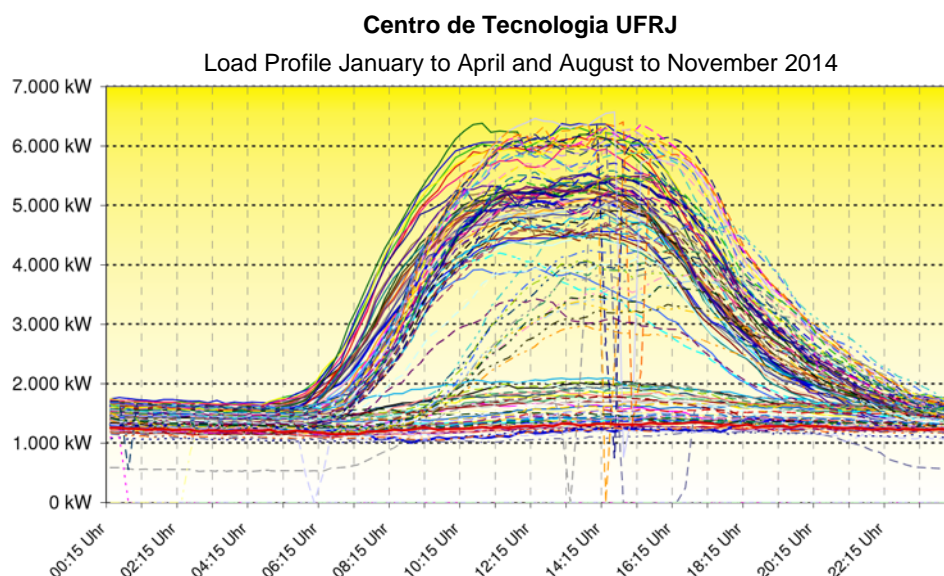


The total cost of 5.689.341,- R\$/year can be split into the separate part as shown in the following graph.

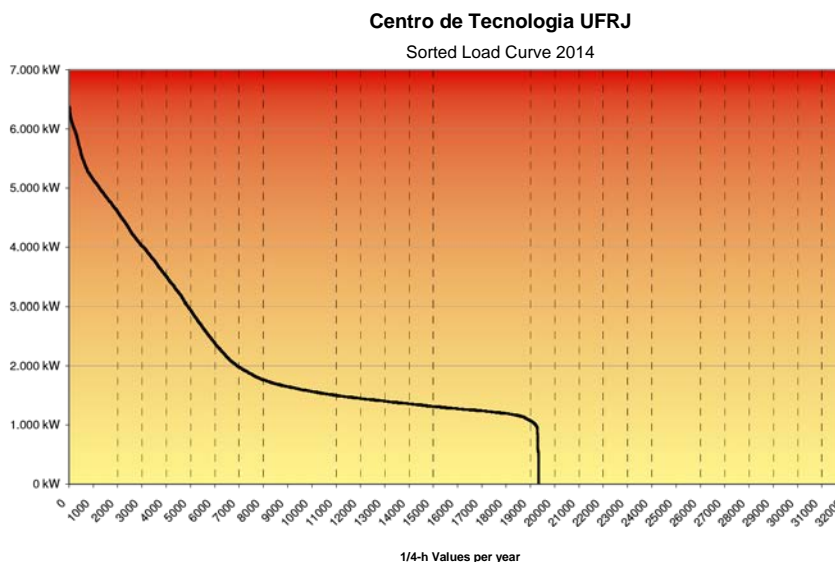


Based on 15-minutes loads date, provided by Light, a load profile analysis was executed. The following graph shows the actual “energetic fingerprint” of the

site. It can be seen, that base load is very high on weekends and in night-time, around 1.300 kW in average. The load starts increasing at 7:00 am and falls back to base load around midnight. The plateau is around 6.000 kW, with some peaks up to 6.500 kW.



To be able to analyse the number of peaks, the 15-minutes load data were sorted with decreasing value. This lead to the following graph (sorted load curve).



It can be seen, that a power demand of for example 6.000 kW is exceeded for only 200 15-minute-values. The minimum load is around 1.000 kW.

### 3 Energy saving measures

In total 7 energy saving measures could be identified.

These measures are:

1. Reducing the number of connected Transformers
2. Reactive Power Compensation
3. Peak Load Management
4. Base Load Reduction
5. Switching-Off Equipment in unoccupied Rooms
6. Replacing T8 by LEDs
7. Maintaining Cooling Systems

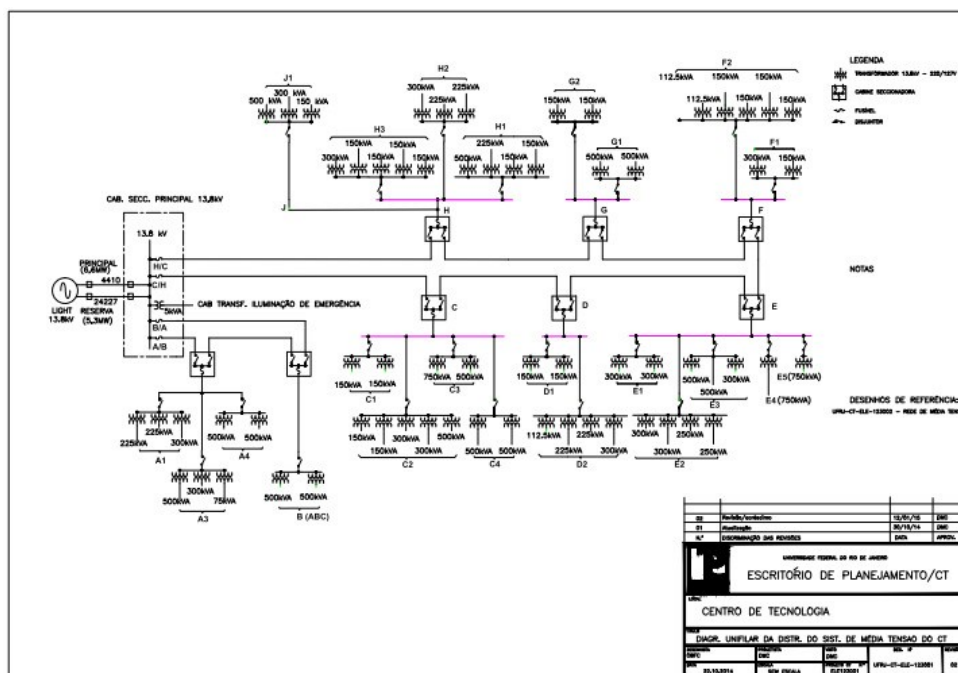
The measures are described in the following.



### 3.1 Reducing the number of connected Transformers

#### Actual situation:

The following sketch shows the architecture of the existing medium voltage system of the site.



Most of the 63 transformers are connected to the grid.

Assuming a power factor of 1, which is not the case yet, the load on the transformers is only about 33,8 %. Even with a power factor of 0,5, the load on the transformers is about 50,6 %.

The losses of the transformers are assumed to be 3% of the total energy consumption, which is around 550.000 kWh/year.

#### Measure:

It is recommended to switch of those transformers, which are less loaded and where the technical requirements allow that.

#### Saving potential:

It is assumed, that 20 % of the transformer losses can be avoided by this measure, which is about 100.000 kWh/year or 44.000,- R\$/year.

#### Economics:

It is assumed, that 20 % of the transformer losses can be avoided by this measure, which is about 100.000 kWh/year or 44.000,- R\$/year.

## 3.2 Reactive Power Compensation

### **Actual situation:**

Actually, the power factor of the site is about 0,5, which is a very low value. Thus the reactive power consumption is about 750.000 kVAhr.

The actual cost for reactive power are about 120.000 R\$/year.

### **Measure:**

It is recommended to install systems for reactive power compensation.

This measure needs further technical evaluation, analysis and planning.

### **Saving potential:**

It is assumed, that the power factor can be increased to 1,0, which would avoid completely any reactive power consumption. All the 750.000 kVAhr and respectively all the 120.000,- R\$/year can be avoided.

### **Economics:**

With all uncertainty, the investment can be cautiously estimated to be around 500.000 R\$.

The payback time will then be around 4,2 years.

### 3.3 Peak Load Management

#### Actual situation:

Actually, the power demand of the site is exceeding the contracted power by almost 1.400 kW.

Beside economical effects, this reaches the limits of the grid connection itself.

The actual cost for power is about 151,83 R\$/kW and year.

#### Measure:

It is recommended to install a peak load management systems for limiting the peak loads to a maximum of 6.000 kW. According to the previously shown sorted load curve (see page 6), limiting the peak load to 6.000 kW, would require a maximum temporary switch-off of equipment in the range of 550 kW during 200 to 300 15-minutes-periods per year.

This measure needs further technical evaluation, analysis and planning.

#### Saving potential:

It is assumed, that the power demand can be reduced by at least 550 kW. This would affect a cost reduction of about 83.000,- R\$/year.

#### Economics:

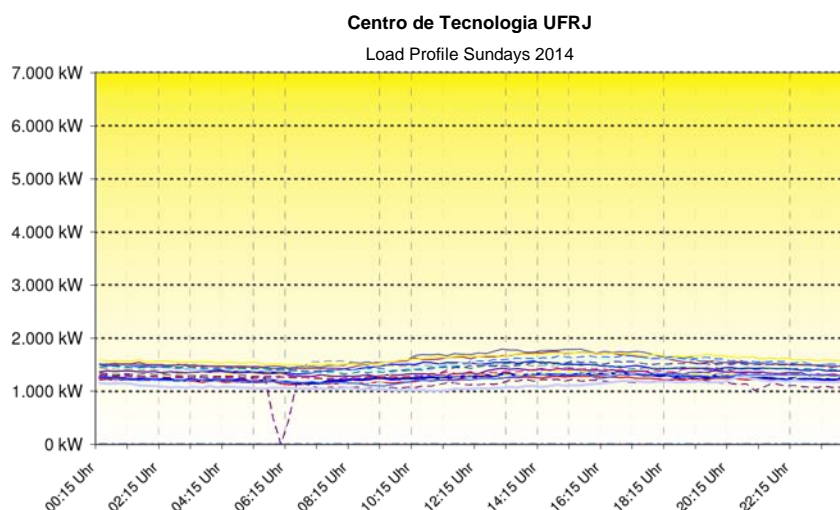
With all uncertainty, the investment for a peak load management system can be cautiously estimated to be around 150.000 R\$.

The payback time will then be around 2 years.

### 3.4 Base Load Reduction

#### Actual situation:

Actually, the power demand during night-time and on weekends is still around 1.300 kW. This fact is shown clearly with the following graph.



### Measure:

It is recommended to analyse the night-time and weekend power consumption.

Based on the gathered data, the personnel and the students have to be informed and motivated to switch-off unnecessary energy consumers during night-time and weekends.

In some cases, clock timers can be installed to limit the operation of the equipment to the office operation times.

This measure needs further technical evaluation, analysis and planning.

### Saving potential:

It is assumed, that the power demand can be reduced by at least 100 kW during night-time and weekends. This would affect an energy reduction of about 500.000 kWh/year and respectively cost reduction of about 100.000,- R\$/year. It is assumed, that about 400 clock timers have to be installed (each clock timer switches 250 W).

### Economics:

For this measure, only a low investment in clock switches is necessary, which would be around 40.000,- R\$.

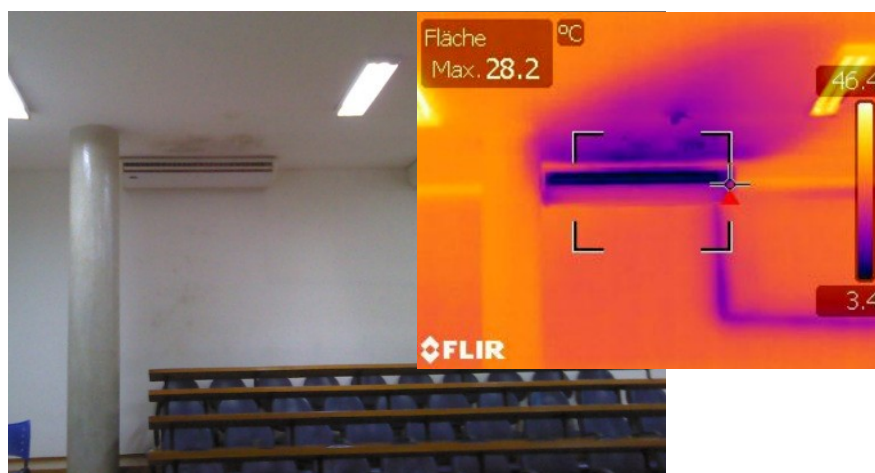
The payback time will then be around 0,4 years.

## 3.5 Switching-Off Equipment in unoccupied Rooms

### Actual situation:

It could be observed during the onsite inspection, that some class rooms where not in use, but all the equipment (lighting and air conditioning) was switched on.

This fact is documented with the following pictures.



**Measure:**

It is recommended to install a card system (like it is known from hotel rooms) with which, the professor only can activate the lighting and cooling system according to the schedule of the courses.

This would reduce the operation time of the equipment.

This measure needs further technical evaluation, analysis and planning.

**Saving potential and economics:**

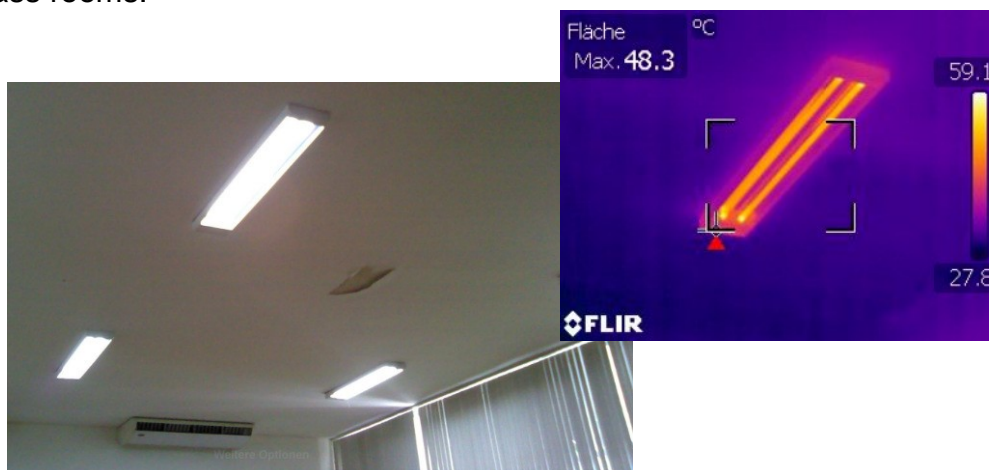
Yet, the saving potential and the economics of this measure cannot be estimated.

**3.6 Replacing T8 by LEDs**

**Actual situation:**

It is estimated, that actually a lighting capacity of about 500 kW is installed onsite. It is also estimated, that the average operation time is 2.000 hours per year. This causes an energy consumption of 1.000.000 kWh/year.

The following pictures show a typical installation of the lighting systems in the class rooms.



**Measure:**

It is recommended to replace the T8 lamps by LEDs.

Either a complete replacement of the T8 luminaries or just a replacement of the lamp by an LED adapter is possible.

This measure needs further technical evaluation, analysis and planning.

**Saving potential:**

It is assumed, that the power demand of the lighting system can be reduced by at least 200 kW. This would affect an energy reduction of about 400.000

kWh/year and respectively cost reduction of about 176.000,- R\$/year. It is assumed, that about 6.500 LED adapters have to be installed.

**Economics:**

For this measure, 650.000 R\$ have to be invested.

The payback time will then be around 4 years.

**3.7 Maintaining Cooling Systems**

**Actual situation:**

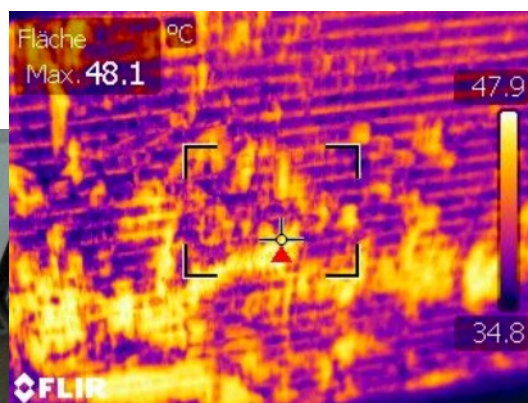
A lot of the installed cooling systems are in a bad state and are thus operated inefficiently.

The following pictures are documenting this fact.

Ice at the refrigerant gas pipe!



Corroded condensers!



It is estimated, that actually a cooling capacity of about 1.500 kWel is installed on the site. It is also estimated, that the average operation time of the cooling systems is 3.000 hours per year.

This causes an energy consumption of 4.500.000 kWh/year.

### **Measure:**

It is recommended to implement a maintenance procedure for the cooling systems.

Some of the cooling systems have to be replaced, due to the damage of the condensers.

This measure needs further technical evaluation, analysis and planning.

### **Saving potential:**

It is assumed, that the power demand of the cooling systems can be reduced by at least 20%. This would affect an energy reduction of about 900.000 kWh/year and respectively cost reduction of about 396.000,- R\$/year.

### **Economics:**

For this measure, the costs have to be evaluated after a detailed analysis of the situation.

From experience, the payback time will short-term.