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Page	:	1/54

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consultancy note

Modified Cable Sizing Strategies

Potential Savings vs Copper Usage

European Copper Institute

1. Index

1.1 Index of figures

1.2 Index of tables

2. Document control

2.1 Revision History

Date	Details	Author	Version
APR 29, 2011	First Draft for internal review	Bert Brouwers	A01
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2.2 Document distribution

Date	Details	Version
APR 29,2011 MAY 09; 2011	Internal project review	A01 A02
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3. Introduction

The European Copper Institute is a joint venture between the world's leading mining companies, custom smelters and semi-fabricators represented by the International Copper Association, and the European copper industry. The European Copper Institute is committed to the expansion and support of copper's end-use markets in Europe.
In this context the European Copper Institute aims to strengthen the awareness of copper and its values to society. To achieve this, the European Copper Institute facilitates research and engineering studies to consolidate facts and figures emerging from both fundamental and market research.

One particular topic currently being researched is the relationship between cable sizing in (industrial) electrical installations and rational use of energy. The general expectation is the energy saving potential would justify larger cross section cable dimensioning strategies for the design of electrical cable systems. As an element in the further development this business case, a study project is defined:

"Estimated energy saving potential as justification for modified cable sizing strategies through simulation of selected typical applications."

This document summarises the results of the engineering study.

3.1 Project Goal

The project goal is to:

- Identify and develop a number of simulated typical applications;
- Provide standard approach cable sizing and energy losses data as reference base line;
- Recalculate the typicals using modified cable sizing strategies and compare both copper content and energy losses relative to the base line.
- Quantify the energy impact of the modified strategies under study to allow extrapolation of the typical applications based on sectoral electricity consumption.

3.2 Project Approach

Based on our firm knowledge and experience in industrial application, electrical studies and automation systems, and taking into account the specific European Copper Institute knowledge on macro-economic data, a phased approach for achieving the project goals as defined above was followed.

<u>First phase: identification of typical applications and development of base line data</u>

- Development of the typical applications as base material for the further study four typical applications are selected:
  - Small office building (low voltage network connection)
  - Large office building (high voltage network connection, private transformer operation)
  - Small logistics handling plant (low voltage network connection)
  - Large industrial plant (high voltage network connection, private transformer operation)
- Each typical application is characterised by global data (e.g. installed (peak) power at the various levels of electricity distribution, simultaneity of consumption, day/week time load profile, average power load, …), within each of the application a small number of electrical consumers is worked out in detail, all others are represented by "dummy loads".
- Standard approach cable calculation according to legal requirements on electrical safety

This phase provides relevant and representative data, whilst keeping the simulation models limited for convenience of comparison. It is explicitly not the intention to end up with a huge report containing loads of inaccessible information, but to present a limited amount of data in an accessible format.
Information for the development of the typicals is extracted from:

- The Kitgoni report (a small subset of data from one of the office applications extensively documented in the report)
- Representative industrial applications from the Egemin group portfolio.

Second phase: Supplementary Calculations:

- The descriptive data of the base line solution is exported from the cable design software suite to a tailor made external spread sheet for supplementary calculations. The additional calculated information is:
  - Loss estimation per circuit
    - Based on a day time and night time load profile
    - Focussing on conductive joule losses in the
  - Copper usage
    - Estimated copper weight per circuit
  - 10 year horizon “economic optimum”
    - Accounting for the cost of avoidable energy losses over time and estimated cost of initial investment
  - 20 year horizon “carbon footprint”
    - Accounting for CO2 equivalent of avoidable energy losses over time and CO2 equivalent of total copper weight of the installed cable

Third phase: Recalculation according to modified sizing strategies:

- Starting from the exported descriptive data of the base line solution the alternative design approaches are defined in detail as:
  - One size up
    Selection of 1 standard calibre size up from the base line
  - Two sizes up
    Selection of 2 standard calibre sizes up from the base line
  - Economic optimum, 10 year investment horizon
    A cost minimisation algorithm is run balancing the cost represented by the energy losses over a 10 year investment horizon and the cost for initial purchase and installation of the cables
  - Energy loss minimisation (carbon footprint minimisation) 20 year horizon
    A minimisation algorithm is run balancing the CO2 equivalent of the energy losses over a 20 year lifetime horizon and the CO2 equivalent of copper production for the cables copper weight.
- The supplementary calculations are performed in parallel with the previous step
- Descriptive data for each alternative design and every model is re-entered into the cable design software for validation of the numbers
  - For the individual cases where a deviation exists between predicted figures from the external spread sheets and the model validation from the cable design software the above procedure is reiterated until numerical values are reconciled.

Fourth phase: Evaluation of results and conclusions:

The numerical results for the various models and design variants are evaluated, compared and presented in order to allow extrapolation of conclusions.

4. Study overview and findings

4.1 Identification of Typical Applications and Development of Base Line Data

Four electrical systems are defined in the cable design software suite, for ease of reference the models are indicated by a short descriptive denomination:

- Small office;
- Large office;
- Small logistics centre;
- Large industrial plant.

For all four models a number of common points of departure apply.

- The cable design is run for the nominal (full load) situation of the defined loads and consumers
- Load flow calculation pre-set is achieved through definition of dummy loads on various levels in the distribution system
- Load profiles are based on:
  - Number of hours per week “day time profile” – “night time profile”
  - Day time profile is assumed to be equal (or close to) nominal situation
  - Night time profile is defined as a percentage of the nominal load.
    Distinction is made between continuous running systems and “office hours related” systems

Additional data for use in the supplementary calculations:

Equivalent CO_2 emission per MWh is fixed at 395 kg CO_2 / MWh.

> Note: this figure is chosen as a representative average for the electricity market. The actual primary energy source mix for various member states will influence this ratio (e.g. more nuclear versus more coal fired plants). Even current day ‘special’ electricity supply contracts (so called ‘green current’ contracts) will influence this ratio.
> Such differences can result in a shift of the calculated optimum design, but general tendencies will remain unchanged.

Equivalent CO_2 emission per amount of copper produced is fixed at 2,95 $kgCO_2/kgCU$ produced.

> Note: this figure is chosen as a representative average for market. Specific differences in the production process such as the ratio of recycled copper to the amount of primary ore and the primary energy sources used for powering the production facilities will influence the precise figure.
> Such differences can result in a shift of the calculated optimum design, but general tendencies will remain unchanged.

Particulars for each model are presented in the next paragraphs.

4.1.1 Small office

The small office model's main characteristics are:

- Low voltage supply directly from the public distribution network
- One level of internal power distribution
- Circuits under study:
  - Power outlets for various office equipment
  - Lighting circuit (fluorescent lamp fixtures)
  - Power supply to HVAC unit

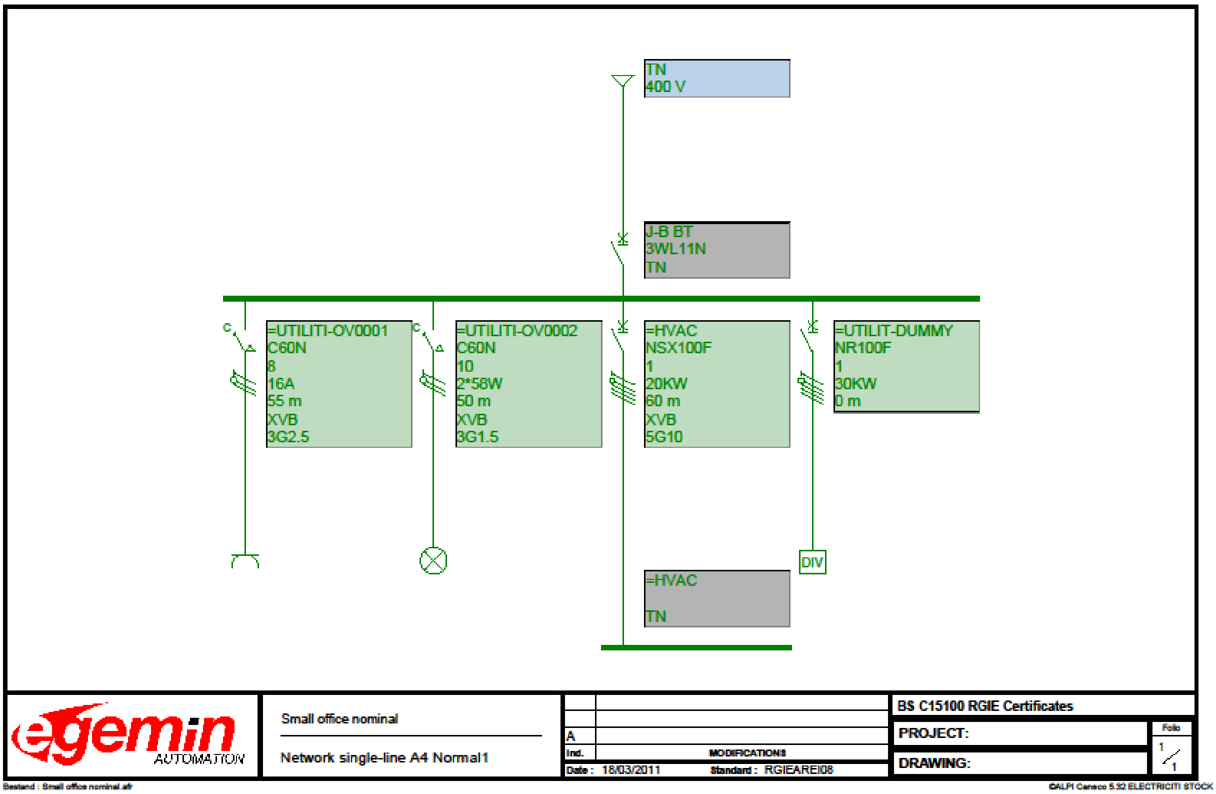

Figure 1 Network drawing model "Small Office"

Additional data applied for the supplementary calculations:

- Sectoral average electricity tariff: 0,194 EUR/kWh[1]
- Day time / Night time profile:
  - 50 hours of Day time load per week
  - Night time load on power outlets = 25% of day time (stand by consumption of various equipment + some ICT services such as file server, mail server, …)
  - Night time load on lighting = 25% of day time (emergency lighting + architectural accent lighting + neon signs, …)
  - Night time load on HVAC = 10% of day time (limited ventilation of selected rooms)

[1] Enerdata 2009 "price of electricity in industry A < 20 MWh"

4.1.2 Large office

The large office model's main characteristics are:

- High voltage supply from the public distribution network, privately operated power transformation
- Two levels of internal power distribution:
  - Main distribution towards building floors
  - Secondary distribution panel per floor towards consumers (individual floor is model similar to a small office)
- Circuits under study:
  - Power feeder to a building floor
  - Power outlets for various office equipment
  - Power outlets for ICT infrastructure & similar applications
  - Power supply to HVAC unit

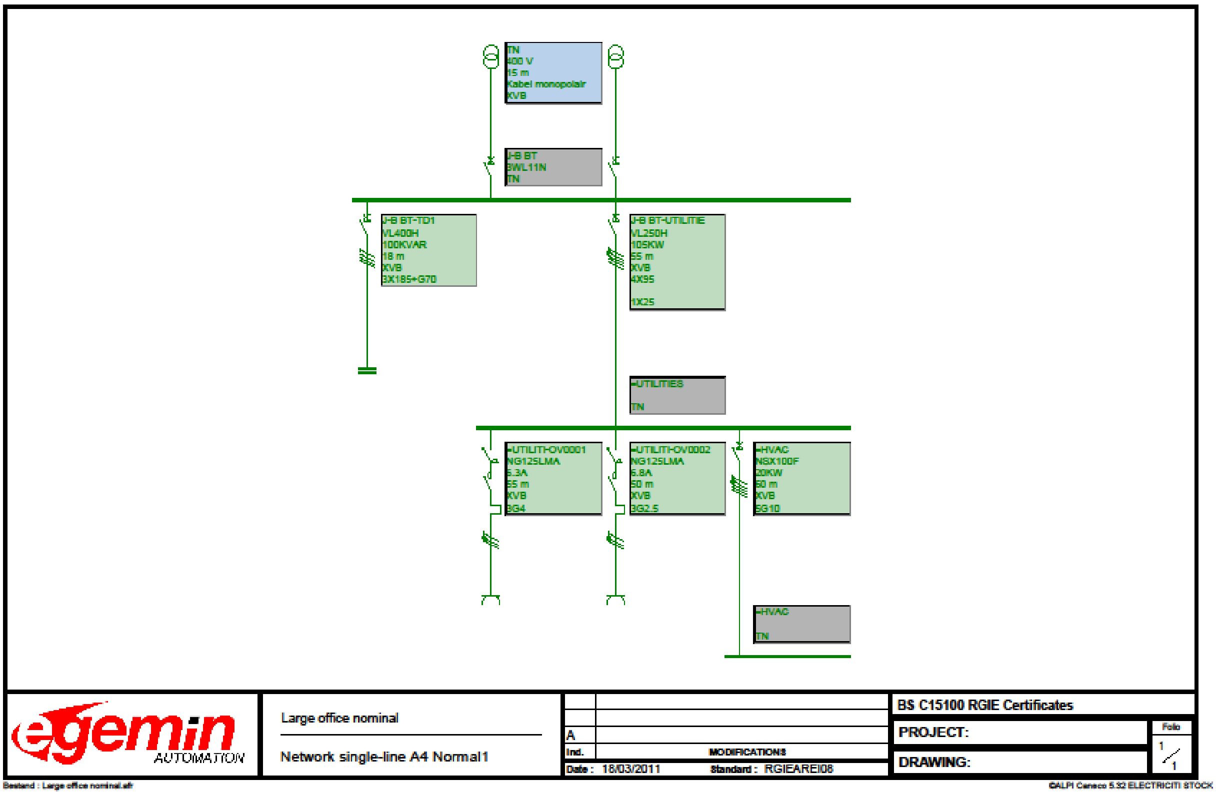

Figure 2 Network drawing model "Large Office"

Additional data applied for the supplementary calculations:

- Sectoral average electricity tariff: 0,148EUR/kWh[2]
- Day time / Night time profile:
  - 60 hours of Day time load per week
  - Night time load on power outlets various equipment = 10% of day time (stand by consumption of various equipment + DECT phone chargers & similar…)
  - Night time load on power outlets ICT infrastructure = 25% of day time (switches, routers, fibre to desk convertors, file server, mail server, … remain online, reduced network traffic)
  - Night time load on HVAC = 10% of day time (limited ventilation of selected rooms)

[2] Enerdata 2009 "price of electricity in industry B (>20MWh <500 MWh)"

4.1.3 Small logistics centre

The small logistics centre model's main characteristics are:

- Low voltage supply directly from the public distribution network
- Two levels of internal power distribution (general services, production area)
- Circuits under study:
    - Power outlets for various office equipment
    - Lighting circuit (fluorescent lamp fixtures)
    - Power feeder to the production area distribution
    - Small motor inverter fed
    - Small motor direct on line
    - Medium motor inverter fed
    - Medium motor direct on line

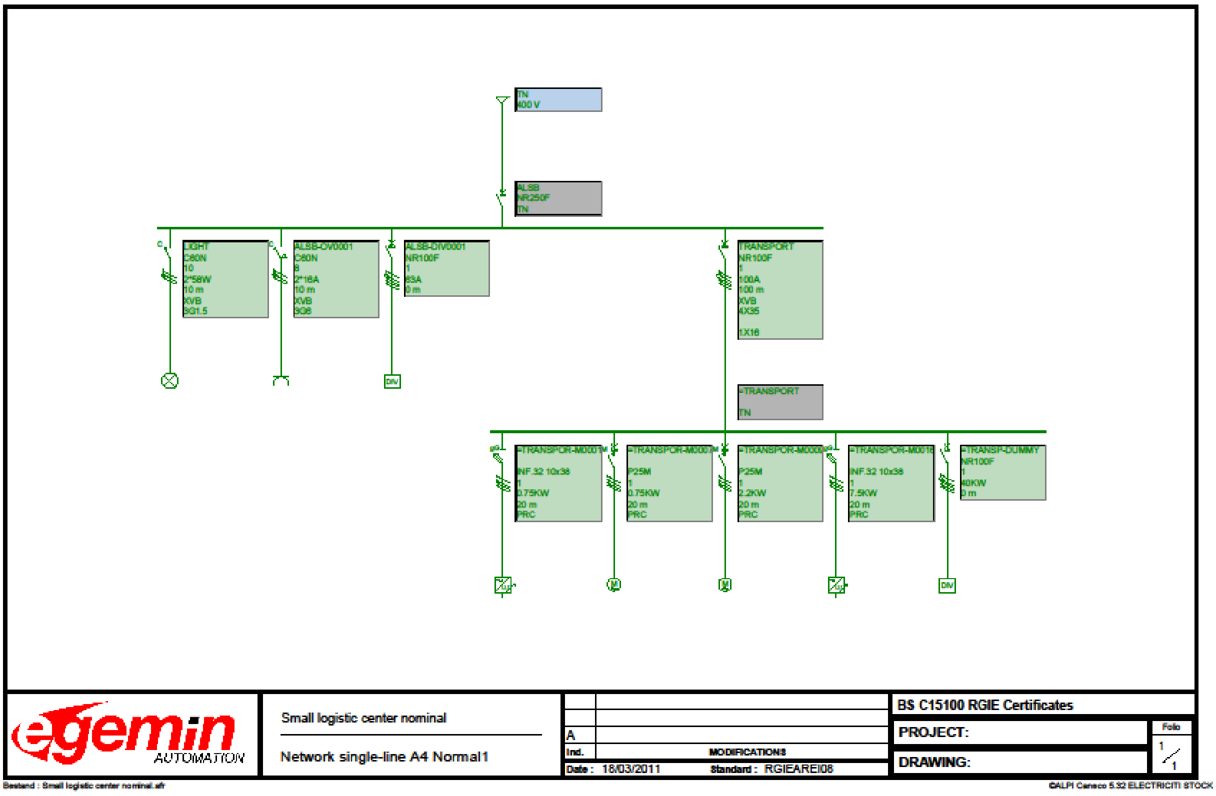

Figure 3 Network drawing model "Small Logistics Centre"

Additional data applied for the supplementary calculations:

- Sectoral average electricity tariff: 0,148EUR/kWh[3]
- Day time / Night time profile:
    - 60 hours of Day time load per week
    - Night time load on power outlets = 25% of day time (stand by consumption of various equipment + some ICT services such as file server, mail server, …)
    - Night time load on lighting = 10% of day time (mainly emergency lighting)
    - Night time load on production area = 10% of day time (stand by consumption of equipment, control systems, inverters, …)

[3] Enerdata 2009 "price of electricity in industry B (>20MWh <500 MWh)"

4.1.4 Large industrial plant

The large office model's main characteristics are:

- High voltage supply from the public distribution network, privately operated power transformation
- Three to four levels of internal power distribution
- Circuits under study:
  - Power outlets for various office equipment embedded in the process area
  - Lighting circuit (fluorescent lamp field lighting fixtures)
  - Power feeder to the production area distribution panels
  - Medium / large inverter fed motor (e.g. pump drive)
  - Electrical heat tracing circuit

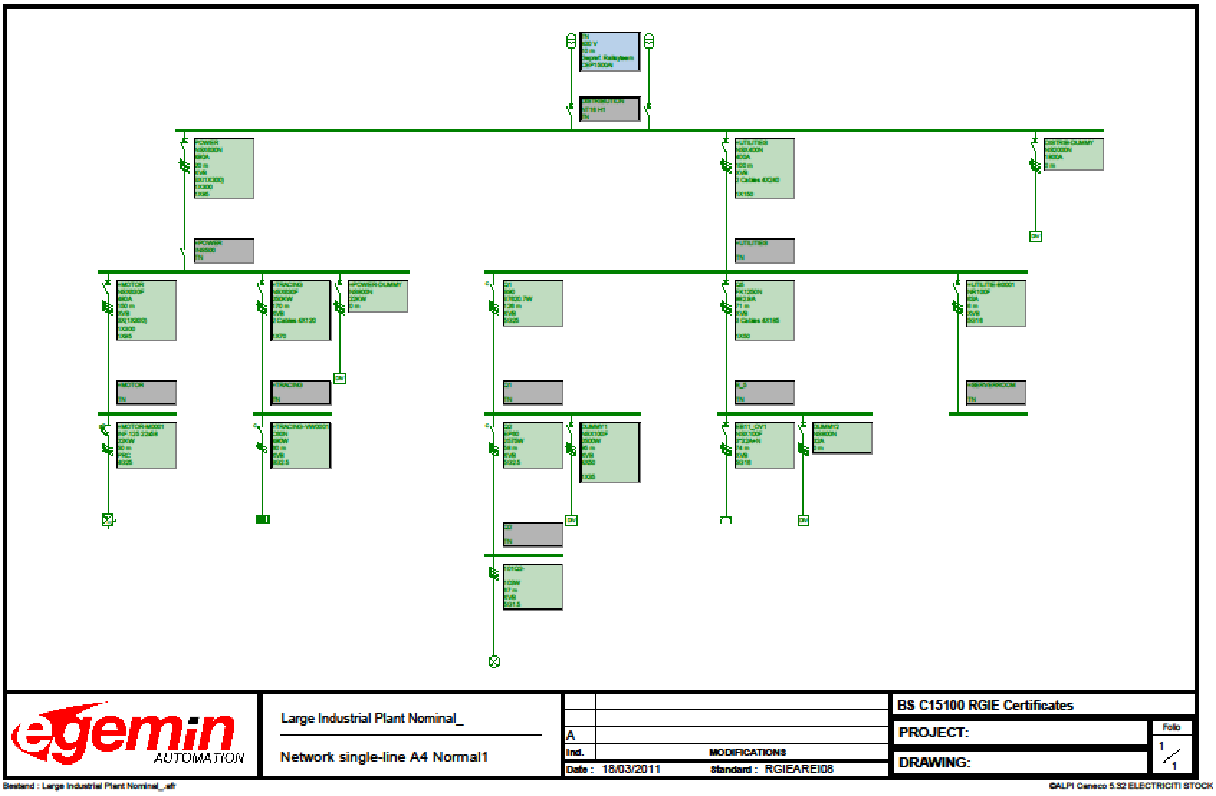

Figure 4 Network drawing model "Large Industrial Plant"

Additional data applied for the supplementary calculations:

- Sectoral average electricity tariff: 0,103EUR/kWh[4]
- Day time / Night time profile:
  - 60 hours of Day time load per week
  - Night time load on power outlets embedded office equipment = 50% of day time (stand by consumption of various equipment + part of equipment running 24/7, …)
  - Night time load on lighting = 50% of day time (process area remains fully lit, offices & similar are dimmed)
  - Night time load on process related items = 80% to 100% of day time (most actions run 24/7)

[4] Enerdata 2009 "price of electricity in industry B (>20 000MWh <70 000 MWh)"

4.2 Supplementary Calculations

4.2.1 Base line Solution

The cable design software generates the common and usual data for cable sizing and electrical system quantification in view of legal compliance and safety. This data provides a detailed description of the compliant solution obtained.
Some of this data is required to evaluate the conductive energy losses as addressed in this study (e.g. cable cross section, load current, …) Other data does not directly affect the elements under study (e.g. calculated direct and indirect contact voltage during fault condition, insulation type, …).
A selected set of data is exported for further calculation in an external spread sheet:

- Circuit reference tag
- Circuit type (3phase, single phase, …)
- Cable length
- Number of paralleled cables
- Cable cross section (phase, neutral & protective earth conductor)
- Load current
- Power factor (cosine phi)

From this information a number of figures are calculated, as described below:

- Instantaneous values
    - Conductive (joule) power loss per meter (W/m) in day time load
      The specific resistance of copper selected for the calculation is the Rho_1 value at operational temperature as defined in Cenelec R064-003.
      Theoretically varying the cable cross section in subsequent steps will influence the operational temperature, resulting in a slight decrease in resistance value, leading to second order effects. This will have a limited impact on the numerical values (up to a few percent). As a conservative approach – and to limit the complexity of the optimisation algorithm – these second order effects are not taken into account.
    - Conductive power loss per cable (W) in day time load
    - Indicative power of useful load (W & kW) in day time load
    - Indicative percentage of conductive power loss relative to useful load (day time load)
    - Conductive (joule power loss per meter (W/m) in night time load
    - Conductive power loss per cable (W) in night time load

- Cumulative values
    - Circuit energy loss per year in day time load, night time load and totalled (Wh & kWh))
    - Total energy loss per year (kWh)

    - Cost of circuit energy loss in day time load, night time load and totalled (EUR)
      Using sectorial average electricity prices as indicated in §**Error! Reference source not found.**.
    - Total cost of energy loss per year (EUR)

    - Equivalent amount of CO2 emission per year, for circuit energy loss per year in day time Load, night time load and totalled (kgCO2)
    - Total equivalent amount of CO2 emission per year (kgCO2)

- Investment related figures
    - Indicative circuit installation cost (EUR)
      Using base pricing tables destined for the cost calculation of cable delivery, installation and connection in ”reference circumstances” a cost estimate of the circuit is derived. In real

circumstances other factors such as installation height, location accessibility, … will influence the real installation cost. The cost formula allows a fast estimate of the order of magnitude of the cost, and shows sufficiently accurate behaviour to demonstrate the cost optimisation cable design approach.

  - Indicative total cabling cost (EUR)
    Costs related to the construction of distribution panels, cable ways and other related elements have not been considered in this exercise.

  - Circuit amount of copper (m^3 & kg)
  - Total amount of copper (kg)

  - Circuit equivalent amount of CO_2 emission for copper production (kgCO_2)
  - Total equivalent amount of CO_2 emission for copper production (kgCO_2)

- Investment analysis and numerical optimisation related figures
  - Circuit Cable Loss related Total Cost of Ownership (Circuit CLrTCO)
    Calculated as the cost incurred due to energy losses over an investment horizon of 10 year and the initial investment cost for the cable.
    A classic total cost of ownership would be calculated from the total energy bill and the total investment cost. Equipment efficiency and equipment are not the factors under study in this assessment. Thus for the scope of this study the energy used by the equipment is considered to be useful and invariable.
    In a way the CLrTCO can be considered as the cost of ownership related to elements that are not contributing to the desired operational result of the circuit.
    The concept of CLrTCO allows examining the economic / financial effect of the incremental investment of alternative cable sizing strategies compared to the base line solution.
  - Installation CLrTCO
    The numerical value of CLrTCO should be interpreted with due care. A minimal value of the CLrTCO corresponds to an optimal design within the boundary conditions outlined in the study. Comparison of CLrTCO between various solutions allows ranking the solutions from an economic point of view. Using the absolute figures of CLrTCO however is not a straightforward action (even though the theoretical unit of the value is euro).

  - Circuit Cable Loss related Carbon Footprint (Circuit CLrCFP)
    Calculated as the total amount of (equivalent) CO_2 linked to energy losses over a 20 year life time and the equivalent amount of CO_2 for the production of the copper within the circuit cables.
    Since efficiency of the equipment supplied with electricity is not the subject researched in this study, the load of the electrical system is considered to be useful and required.
    The CLrCFP can be considered as the portion of the classic carbon footprint that rises above the actual useful effort delivered.
    The concept of CLrTCO allows examining the ecologic (carbon footprint) effect of the incremental investment of alternative cable sizing strategies compared to the base line solution.
  - Installation CLrCFP
    The numerical value of CLrCFP should be interpreted with due care. A minimal value of the CLrCFP corresponds to an optimal design within the boundary conditions outlined in the study. Comparison of CLrCFP between various solutions allows ranking the solutions from an ecologic – carbon footprint – point of view. Using the absolute figures however is not a straightforward action.

All of the above parameters are calculated for each of the four models described in §4.1.

4.2.2 Recalculation According to Modified Sizing Strategies

Each model is recalculated according to the four modified cable sizing strategies:

- One size up:
  All cable cross sections obtained from the base line solution are simply increased by one standard calibre. The modification is done in the external spread sheet, and the supplementary calculations are performed for the new situation.
  The new cross sections are substituted into the original cable calculation model, and key information is compared in order to validate the data generated in the external spread sheet.
- Two sizes up:
  All cable cross sections obtained from the base line solution are simply increased by two standard calibres. The modification is done in the external spread sheet, and the supplementary calculations are performed for the new situation.
  The new cross sections are substituted into the original cable calculation model, and key information is compared in order to validate the data generated in the external spread sheet.
- Economic optimum:
  For each individual cable cross section obtained from the base line solution a non-linear optimisation algorithm is run to minimise both Circuit and installation CLrTCO.
  For reasons of stability of the optimisation algorithm maximal cable cross section is limited to 630mm², and the number of paralleled conductors is maintained equal to the base solution. In some cases this might limit the results of the optimisation, leading to a local sub-optimum. Where this effect influences the results this will be indicated in the result evaluation.
- Ecologic optimum:
  For each individual cable cross section obtained from the base line solution a non-linear optimisation algorithm is run to minimise both Circuit and installation CLrCFP.
  For reasons of stability of the optimisation algorithm maximal cable cross section is limited to 630mm², and the number of paralleled conductors is maintained equal to the base solution. In some cases this might limit the results of the optimisation, leading to a local sub-optimum. Where this effect influences the results this will be indicated in the result evaluation.

4.3 Numerical results

The detailed numerical results for all four models in all 5 design strategies are represented in §6 Addenda.

Some general guidance on the detailed results is to be referenced when reading the data:

- Lines indicating zero length are items introduced into the calculation model for simulation purposes. Loss calculation and other figures for these items do not represent realistic values
- One of the models includes a capacitor bank for power factor correction, since the active power associated with an (ideal) capacitor bank is zero, the loss percentage would be infinity. These values have been replaced by a double dash.

4.4 Evaluation of results and conclusions

Although the detailed numerical results of all design cases for the models under study contain a vast amount of data, and as such would be interesting material to expand upon, for the purpose of this research project more interesting information can be obtained by comparing selected pieces of information and totalised data between the various design cases.

For the purpose of this study the most interesting views and consolidated data are:

- Total copper usage per design strategy
- Energy losses and energy savings potential per design strategy
- Evolution of the total cost of ownership per design strategy
- Relation between total cost and initial investment
- Evolution of carbon footprint per design strategy
- Relation been carbon footprint and initial investment

4.4.1 Total copper usage per design strategy

4.4.1.1 Comparative summary tables

For each of the models the cross section of the phase conductor is presented as an indication of the impact of the alternative design strategy. The actual calculation takes into account the possible reduced cross sections of neutral and PE conductors for large cable cross sections.

As shown in the tables for some specific circuits in some of the models the difference between base line and optimised solutions is small. This can be explained by either of two possible causes:

- The circuit in question is a dummy circuit of zero cable length, and thus has no contribution to the energy losses calculated
- The base line solution has a considerable upward bias due to operational or electric safety requirements. This can occur in case of long cable lengths with relatively high loads. In these circumstances the operational requirement for limited voltage drop and the safety requirement of proper operation of short circuit protective devices in order to limit contact voltages for indirect exposure result in large cross sections for the base line solution.

Table 1 "Small office" evolution of cross section and copper usage

cross section (phase conductor as representative reference)					
	base	**S +1**	**S+2**	**Economic**	**Carbon**
reference	[mm²]	[mm²]	[mm²]	[mm²]	[mm²]
=UTILITI-OV0001	2,5	4	6	10	50
=UTILITI-OV0002	1,5	2,5	4	4	25
=HVAC	10	16	25	35	120
=UTILIT-DUMMY	16	25	35	16	16
Total CU Weight	32,5 kgCU	52,2 kgCU	81,3 kgCU	114,0 kgCU	429,1 kgCU
CU Weight ratio	**100,0%**	**160,4%**	**249,9%**	**350,5%**	**1319,6%**

The base line, one size up, two sizes up and economically optimised solutions are within a rather narrow range, the carbon footprint optimised solution is requires significantly larger cross sections.

Table 2 "Large Office" evolution of cross section and copper usage

cross section (phase conductor as representative reference)					
	base	**S +1**	**S+2**	**Economic**	**Carbon**
reference	[mm²]	[mm²]	[mm²]	[mm²]	[mm²]
J-B BT-TD1	185	240	300	185	500
J-B BT-UTILITIE	95	120	150	185	630
=UTILITI-OV0001	4	6	10	4	25
=UTILITI-OV0002	2,5	4	6	4	25
=HVAC	10	16	25	35	120
Total CU Weight	335,8 kgCU	441,5 kgCU	573,6 kgCU	708,8 kgCU	2343,4 kgCU
CU Weight ratio	**100,0%**	**131,5%**	**170,8%**	**211,1%**	**697,9%**

The J-B BT-TD1 circuit is a main feeder from the main distribution board to the local distribution panel of an individual floor in the office building. The length is considerable, and voltage drop requirements lead to significant sizing in the base line solution. The base line cross section actually is equal to the economic optimised solution for this particular circuit. For the =Utiliti-OV 0001 a similar condition applies.

This model also shows the significant difference between the carbon footprint optimisation and the other four design strategies.

Table 3 "Small Logistics Centre" evolution of cross section and copper usage

cross section (phase conductor as representative reference)					
	base	**S +1**	**S+2**	**Economic**	**Carbon**
reference	[mm²]	[mm²]	[mm²]	[mm²]	[mm²]
LIGHT	1,5	2,5	4	4	25
ALSB-OV0001	6	10	16	25	150
ALSB-DIV0001	16	25	35	16	16
TRANSPORT	35	50	70	95	400
=TRANSPOR-M0001	2,5	4	6	2,5	6
=TRANSPOR-M0007	2,5	4	6	2,5	2,5
=TRANSPOR-M0009	2,5	4	6	4	16
=TRANSPOR-M0016	2,5	4	6	10	50
=TRANSP-DUMMY	25	35	50	25	25
Total CU Weight	148,6 kgCU	215,9 kgCU	304,1 kgCU	446,0 kgCU	1888,2 kgCU
CU Weight ratio	**100,0%**	**145,3%**	**204,6%**	**300,1%**	**1270,4%**

As in the previous two situations the first four strategies are in rather close proximity and the carbon footprint optimisation is significantly larger.

The "M0001" and "M0007" circuits display a specific behaviour often encountered in machinery applications: the 2,5mm² requirement in the base line solution results from mechanical strength and vibration resistance requirements for the power supply to relative small motors. Cable sizing in strict view of current load would result in much smaller cross section (probably down to 1mm² or even 0,5mm²). Due to this effect the economic optimum is equal to the base line for these two circuits.

This clearly shows that from an investment analysis view the simple "one size up" or "two sizes up" strategies are not to be advised, especially not for machinery applications.

Table 4 "Large Industrial Plant" " evolution of cross section and copper usage

cross section (phase conductor as representative reference)					
	base	**S +1**	**S+2**	**Economic**	**Carbon**
reference	[mm²]	[mm²]	[mm²]	[mm²]	[mm²]
POWER	300	400	500	630	630
=UTILITIES	240	300	400	240	630
DISTRIB-DUMMY	400	500	630	400	400
=MOTOR	300	400	500	630	630
=TRACING	120	150	185	400	630
=POWER-DUMMY	240	300	400	240	240
=MOTOR-M0001	25	35	50	75	300
=TRACING-VW00	2,5	4	6	2,5	16
Q1	25	35	50	75	75
Q5	185	240	300	630	630
=UTILITIE-B0001	16	25	35	75	400
Q2	2,5	4	6	2,5	25
DUMMY1	50	70	95	50	240
101Q2-	1,5	2,5	4	1,5	10
EB11_OV1	16	25	35	50	240
DUMMY2	185	240	300	185	185
Total CU Weight	7282,3 kgCU	9419,3 kgCU	12035,5 kgCU	17124,9 kgCU	24859,3 kgCU
CU Weight ratio	**100,0%**	**129,3%**	**165,3%**	**235,2%**	**341,4%**

The high power main feeders in this model are limited to 630mm² in the economic and carbon foot print optimisation (due to optimisation algorithm limitations), this occurs on a number of circuits in this model, which indicates that the actual optimum is located at even larger cable sizes (or increased number of parallel conductors). This will show in the globalised results as "clipping" of the totalised values.

Some of the circuits show the machinery behaviour, others are base line biased due to operational and safety requirements, as discussed above.

4.4.1.2 Evaluation and summary graph

The graph shown in Figure 5 shows the total amount of copper used for the different design strategies. To allow comparison between the models the figures are normalised with the amount of copper in the base line solution defined as 100%

The graph allows to conclude that:

- "One size up" strategy results in an average increase in copper weight between about 30% and 60%, this ratio is purely defined by the spacing between standard cable cross sections. For small cross sections (such as in the small office model) the relative step is more important than for larger sections (such as in the large office model)
  Global average can be estimated at about 40%.
- "Two sizes up" strategy results in an average increase between 70% and 150%. These ratios are equally defined by the spacing between standard cable cross sections.
  Global average can estimated at about 90%, or close to doubling the actual copper usage.
- "Economic optimum" strategy results in multiplying the copper usage by a factor between 2 and 3. Global average can be estimated at an increase of about 150% of the base line copper usage (or approximately 2,5 times as much copper)
- "Carbon Footprint optimum" strategy results in a very wide range of ratios for the various models, (times 3 op to times 13), the very wide range of results is caused by:
    - Optimisation algorithm clipping in the large industrial plant model results in an under estimation of the optimal solution

  - The most important circuit in the "large office" model (the main feeder) has a large cross section in the base line solution due to operational and safety requirements (as explained above) because only a limited number of circuits are modelled this significantly skews the ratio on this model.
- A cautious estimate of the global average ratio of the carbon footprint copper usage ratio would be between 7 to 10 times the amount of copper of the base line solution.

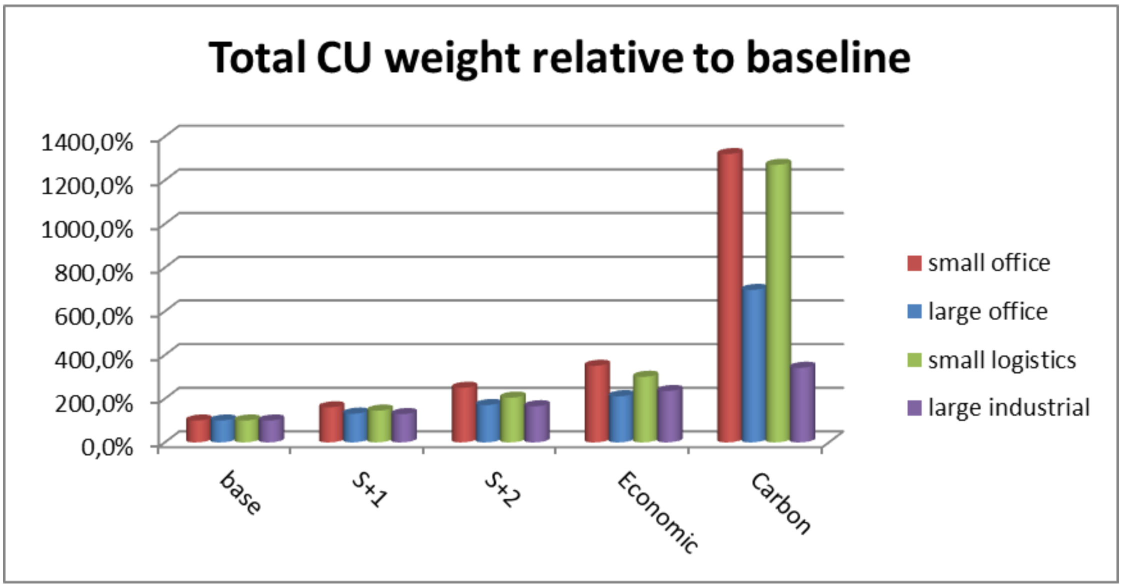

Figure 5 Total copper usage relative to base line

The very high cross sections resulting from the carbon footprint optimisation can often lead to practical implementation problems, and for that reason might be unrealistic. This subject will be discussed further on.

4.4.2 Energy losses and energy savings potential per design strategy

4.4.2.1 Comparative summary tables

The tables in this paragraph summarise the energy losses per circuit and for the complete model on a yearly basis. Next to the absolute calculated figures, the relative amount with respect to useful energy consumption of the load is calculated. (for the scope of this study the complete electrical consumption of the load is considered to be useful energy).
For the modified cable sizing strategies the reduction of the cable losses compared to the base line solution is presented to allow judging the effectiveness of the strategy.

Table 5 "Small Office" Yearly Energy use and Cable Losses

Energy per year	net usage	Energy loss per year													
		base		S+1			S+2			Economic			Carbon		
	[kWh]	[kWh]	rel. to load	[kWh]	rel. to load	reduction	[kWh]	rel. to load	reduction	[kWh]	rel. to load	reduction	[kWh]	rel. to load	reduction
=UTILITI-OV0001	9 763,1	479,0	4,91%	299,4	3,07%	-37,5%	199,6	2,04%	-58,3%	119,76	1,23%	-75,0%	23,95	0,25%	-95,0%
=UTILITI-OV0002	4 363,9	161,9	3,71%	97,1	2,23%	-40,0%	60,7	1,39%	-62,5%	60,70	1,39%	-62,5%	9,71	0,22%	-94,0%
=HVAC	64 214,0	1 390,5	2,17%	869,1	1,35%	-37,5%	556,2	0,87%	-60,0%	397,28	0,62%	-71,4%	115,87	0,18%	-91,7%
=UTILIT-DUMMY	123 793,6	0,0	0,00%	0,0	0,00%	--	0,0	0,00%	--	0,00	0,00%	--	0,00	0,00%	--
Total		2 031,4	2,59%	1 265,6	1,62%	-37,7%	816,5	1,04%	-59,8%	577,7	0,74%	-71,6%	149,5	0,19%	-92,6%

Table 6 "Large Office" Yearly Energy use and Cable Losses

Energy per year	net usage	Energy loss per year													
		base		S+1			S+2			Economic			Carbon		
	[kWh]	[kWh]	rel. to load	[kWh]	rel. to load	reduction	[kWh]	rel. to load	reduction	[kWh]	rel. to load	reduction	[kWh]	rel. to load	reduction
J-B BT-TD1	0,0	469,9	--	362,2	--	-22,9%	289,8	--	-38,3%	469,88	--	0,0%	173,86	--	-63,0%
J-B BT-UTILITIE	415 402,3	4 505,0	1,08%	3 566,5	0,86%	-20,8%	2 853,2	0,69%	-36,7%	2313,39	0,56%	-48,6%	679,33	0,16%	-84,9%
=UTILITI-OV0001	4 279,4	77,2	1,80%	51,5	1,20%	-33,3%	30,9	0,72%	-60,0%	77,21	1,80%	0,0%	12,35	0,29%	-84,0%
=UTILITI-OV0002	5 676,0	143,0	2,52%	89,4	1,57%	-37,5%	59,6	1,05%	-58,3%	89,37	1,57%	-37,5%	14,30	0,25%	-90,0%
=HVAC	73 565,5	1 659,5	2,26%	1 037,2	1,41%	-37,5%	663,8	0,90%	-60,0%	474,13	0,64%	-71,4%	138,29	0,19%	-91,7%
Total		6 854,6	1,37%	5 106,7	1,02%	-25,5%	3 897,2	0,78%	-43,1%	3 424,0	0,69%	-50,0%	1 018,1	0,20%	-85,1%

Table 7 "Small Logistics Centre" Yearly Energy use and Cable Losses

Energy per year	net usage	Energy loss per year													
		base		S+1			S+2			Economic			Carbon		
	[kWh]	[kWh]	rel. to load	[kWh]	rel. to load	reduction	[kWh]	rel. to load	reduction	[kWh]	rel. to load	reduction	[kWh]	rel. to load	reduction
LIGHT	4 999,5	38,6	0,77%	23,2	0,46%	-40,0%	14,5	0,29%	-62,5%	14,49	0,29%	-62,5%	2,32	0,05%	-94,0%
ALSB-OV0001	32 052,6	380,0	1,19%	228,0	0,71%	-40,0%	142,5	0,44%	-62,5%	91,20	0,28%	-76,0%	15,20	0,05%	-96,0%
ALSB-DIV0001	138 175,0	0,0	0,00%	0,0	0,00%	--	0,0	0,00%	--	0,00	0,00%	--	0,00	0,00%	--
TRANSPORT	203 782,6	6 063,7	2,98%	4 244,6	2,08%	-30,0%	3 031,8	1,49%	-50,0%	2233,98	1,10%	-63,2%	530,57	0,26%	-91,3%
=TRANSPOR-M00	3 629,9	6,1	0,17%	3,8	0,11%	-37,5%	2,6	0,07%	-58,3%	6,13	0,17%	0,0%	2,55	0,07%	-58,3%
=TRANSPOR-M00	3 629,9	6,1	0,17%	3,8	0,11%	-37,5%	2,6	0,07%	-58,3%	6,13	0,17%	0,0%	6,13	0,17%	0,0%
=TRANSPOR-M00	9 074,7	38,3	0,42%	23,9	0,26%	-37,5%	16,0	0,18%	-58,3%	23,94	0,26%	-37,5%	5,99	0,07%	-84,4%
=TRANSPOR-M00	29 956,0	366,9	1,22%	229,3	0,77%	-37,5%	152,9	0,51%	-58,3%	91,72	0,31%	-75,0%	18,34	0,06%	-95,0%
=TRANSP-DUMMY	147 131,1	0,0	0,00%	0,0	0,00%	--	0,0	0,00%	--	0,00	0,00%	--	0,00	0,00%	--
Total		6 899,7	2,40%	4 756,6	1,66%	-31,1%	3 362,8	1,17%	-51,3%	2 467,6	0,86%	-64,2%	581,1	0,20%	-91,6%

Table 8 "Large Industrial Plant" Yearly Energy use and Cable Losses

Energy per year	net usage	Energy loss per year													
		base		S+1			S+2			Economic			Carbon		
	[kWh]	[kWh]	rel. to load	[kWh]	rel. to load	reduction	[kWh]	rel. to load	reduction	[kWh]	rel. to load	reduction	[kWh]	rel. to load	reduction
POWER	2 064 767,0	7 181,2	0,35%	5 385,9	0,26%	-25,0%	4 308,7	0,21%	-40,0%	3419,63	0,17%	-52,4%	3419,63	0,17%	-52,4%
=UTILITIES	1 623 353,1	13 985,2	0,86%	11 188,2	0,69%	-20,0%	8 391,1	0,52%	-40,0%	13985,23	0,86%	0,0%	5327,71	0,33%	-61,9%
DISTRIB-DUMMY	7 584 858,5	0,0	0,00%	0,0	0,00%	--	0,0	0,00%	--	0,00	0,00%	--	0,00	0,00%	--
=MOTOR	2 022 628,9	51 683,2	2,56%	38 762,4	1,92%	-25,0%	31 009,9	1,53%	-40,0%	24611,07	1,22%	-52,4%	24611,07	1,22%	-52,4%
=TRACING	2 181 303,1	84 138,8	3,86%	67 311,0	3,09%	-20,0%	54 576,5	2,50%	-35,1%	25241,64	1,16%	-70,0%	16026,44	0,73%	-81,0%
=POWER-DUMMY	3 345 344,0	0,0	0,00%	0,0	0,00%	--	0,0	0,00%	--	0,00	0,00%	--	0,00	0,00%	--
=MOTOR-M0001	222 337,2	2 039,8	0,92%	1 457,0	0,66%	-28,6%	1 019,9	0,46%	-50,0%	679,95	0,31%	-66,7%	169,99	0,08%	-91,7%
=TRACING-VW00	4 271,4	42,0	0,98%	26,2	0,61%	-37,5%	17,5	0,41%	-58,3%	41,98	0,98%	0,0%	6,56	0,15%	-84,4%
Q1	328 029,6	13 206,7	4,03%	9 433,3	2,88%	-28,6%	6 603,3	2,01%	-50,0%	4402,22	1,34%	-66,7%	4402,22	1,34%	-66,7%
Q5	4 752 832,6	72 143,5	1,52%	55 610,6	1,17%	-22,9%	44 488,5	0,94%	-38,3%	21184,99	0,45%	-70,6%	21184,99	0,45%	-70,6%
=UTILITIE-B0001	304 637,8	868,8	0,29%	556,0	0,18%	-36,0%	397,2	0,13%	-54,3%	185,35	0,06%	-78,7%	34,75	0,01%	-96,0%
Q2	22 450,1	194,5	0,87%	121,6	0,54%	-37,5%	81,1	0,36%	-58,3%	194,53	0,87%	0,0%	19,45	0,09%	-90,0%
DUMMY1	190 042,8	1 733,8	0,91%	1 238,4	0,65%	-28,6%	912,5	0,48%	-47,4%	1733,82	0,91%	0,0%	361,21	0,19%	-79,2%
101Q2-	7 918,5	52,4	0,66%	31,4	0,40%	-40,0%	19,7	0,25%	-62,5%	52,40	0,66%	0,0%	7,86	0,10%	-85,0%
EB11_OV1	157 499,8	3 221,2	2,05%	2 061,6	1,31%	-36,0%	1 472,5	0,93%	-54,3%	1030,78	0,65%	-68,0%	214,75	0,14%	-93,3%
DUMMY2	2 099 997,3	0,0	0,00%	0,0	0,00%	--	0,0	0,00%	--	0,00	0,00%	--	0,00	0,00%	--
Total		250 491,2	1,80%	193 183,8	1,39%	-22,9%	153 298,5	1,10%	-38,8%	96 763,6	0,70%	-61,4%	75 786,6	0,55%	-69,7%

4.4.2.2 Evaluation and Summary graphs

Figure 6 shows the evolution of the cable conductive energy losses as a percentage of total useful energy consumption on a yearly basis.

Before drawing conclusions from this graph two important remarks must be made:

- The relative importance of the over dimensioned main feeder in the "large office" model (as explained above) significantly skews the results for this model, the energy losses in the base line model are under estimated due to this skewing
- The clipping of the optimisation algorithm for very large cross sections has serious impact on the carbon footprint solution which is in fact sub optimal for the "large industrial plant" model.

From the graph one can conclude:

- Conductive cable losses in a base line solution represent between 1,5% and 2,5% of the total yearly energy consumption of the installation. Correcting for the skewing in the large office model, it is safe to state that in a conventional cable design the conductive losses run up to about 2% of the total useful electricity consumption by the various loads.
- In a10 year investment horizon design (economic optimum) the losses are reduced to about 0,7% of the total energy consumption.
- A carbon footprint optimisation brings the losses further down to about 0,2% of the total energy consumption (neglecting the "clipped" result from the large industrial plant model)

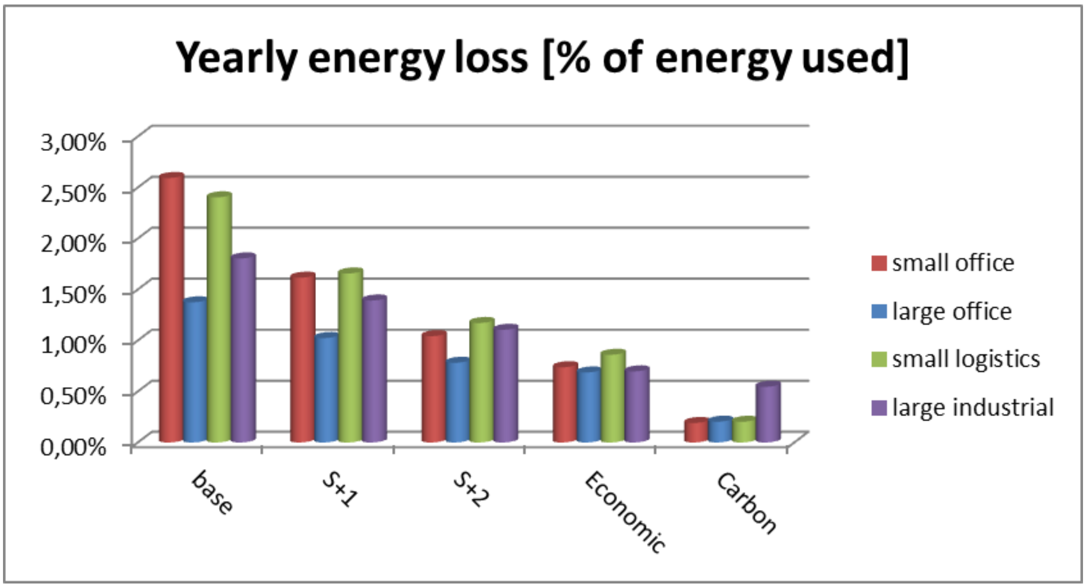

Figure 6 Yearly energy loss relative to useful consumption

To clearly illustrate the enormous impact of the achieved loss reduction Figure 7 portrays the achieved loss reduction of the alternative design strategies when compared to the conventional base line design.

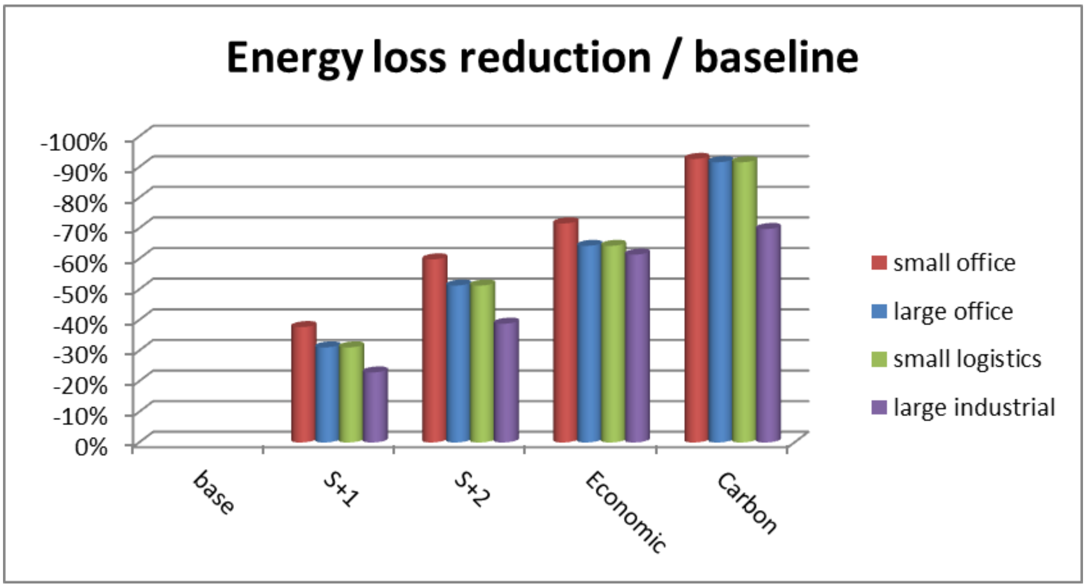

Figure 7 Energy loss reduction compard to base line

From this it is immediately clear that a small modification in design such as increasing cable cross section by one standard calibre immediately reduces cable losses by about 30% on average.

Designing the installation for low total cost of ownership – which would be interesting for any installation operator – results in a 60% cut in the conductive energy losses.

Optimising for carbon footprint actually means reducing the conductive losses by 90%, or virtually eliminating these losses. (Again neglecting the result for the large industrial plant, which is heavily influenced by optimisation algorithm clipping.)

4.4.3 Evolution of the total cost of ownership and initial investment per design strategy

Table 9 shows the calculated cable loss related total cost of owner ship and initial investment for all models and design strategies.
The absolute figures presented are relevant to the actual models only, the ratios comparing alternative design strategies to the base line are however quite reliable estimates of the effect of the various design strategies

Table 9 Evolution of CLrTCO & Initial investment

	CLrTCO evolution					Investment cost evolution				
Absolute	base	S +1	S+2	Economic	Carbon	base	S +1	S+2	Economic	Carbon
small office	€ 4.661,40	€ 3.432,02	€ 2.925,89	€ 2.795,77	€ 5.060,02	€ 720,47	€ 976,79	€ 1.341,88	€ 1.674,95	€ 4.769,91
large office	€ 14.310,69	€ 12.848,00	€ 12.365,49	€ 11.664,27	€ 18.195,73	€ 4.165,93	€ 5.290,12	€ 6.597,65	€ 6.596,78	€ 16.688,90
small logistics	€ 12.357,44	€ 9.840,66	€ 8.600,94	€ 8.006,54	€ 15.193,90	€ 2.145,83	€ 2.800,83	€ 3.624,07	€ 4.354,51	€ 14.333,87
large industrial	€ 330.945,17	€ 288.753,50	€ 266.604,99	€ 236.820,92	€ 263.662,63	€ 72.939,22	€ 89.774,15	€ 108.707,52	€ 137.154,44	€ 185.602,41
Relative to base line						base	S +1	S+2	Economic	Carbon
small office	100%	73,6%	62,8%	60,0%	108,6%	100%	135,6%	186,3%	232,5%	662,1%
large office	100%	89,8%	86,4%	81,5%	127,1%	100%	127,0%	158,4%	158,4%	400,6%
small logistics	100%	79,6%	69,6%	64,8%	123,0%	100%	130,5%	168,9%	202,9%	668,0%
large industrial	100%	87,3%	80,6%	71,6%	79,7%	100%	123,1%	149,0%	188,0%	254,5%

A quick glance at the figures reveals that for instance the one size up strategy reduces the total cost of ownership by 10% to 30%, for an increase in initial investment of about 30%.

Figure 8 and Figure 9 provide a more convenient view of the evolution of both total cost of ownership and initial investment.

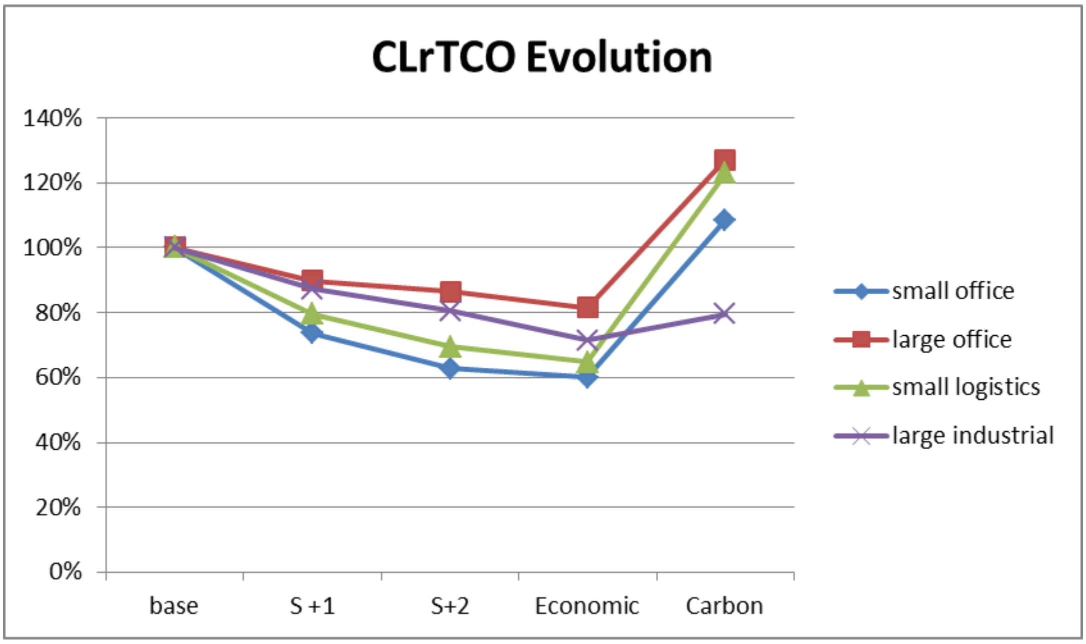

Figure 8 Evolution of CLrTCO across design strategies

From the graphs it shows that the economic optimised solution performs on average 30% better than the base line solution in terms of CLrTCO. (Again the skewing in the large office model must be considered when reading the graph)

When investment decisions are based on the economic optimum rather than the initial investment cost only, it is immediately clear that a serious benefit can result.

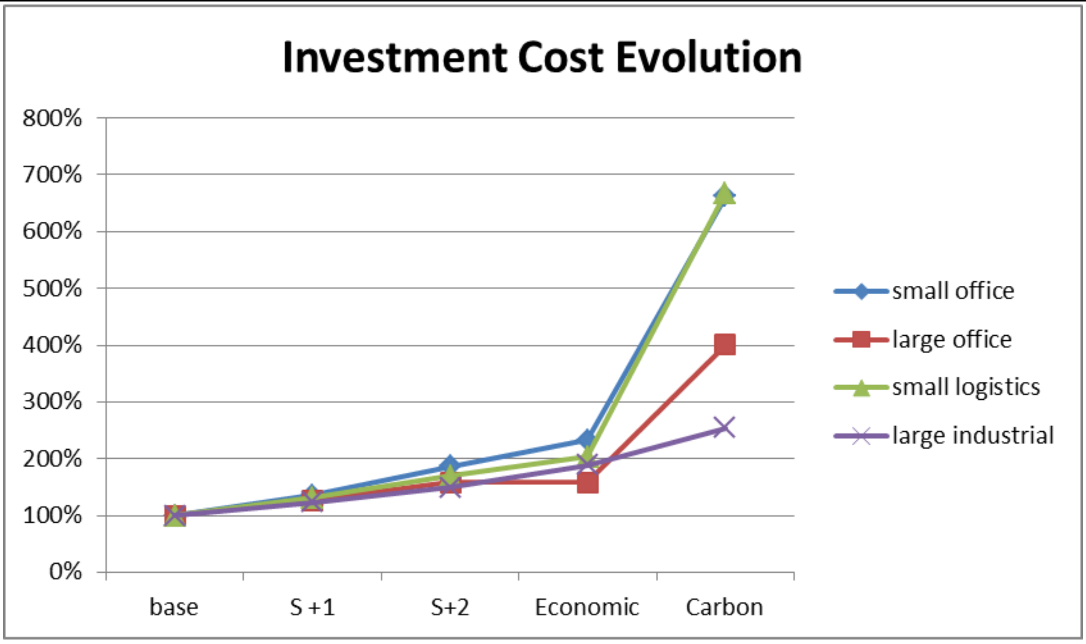

Figure 9 Evolution of initial investment across design strategies

The initial investment for an economic optimum design is about twice the investment for a base line solution. This might appear to be a vast increase in investment. However an electrical installation is never built as a stand-alone piece of equipment. The electrical installation is an integral part of a building, a processing plant, …
On average the cost of the electrical installation is often in the range of 5% to 10% of the total investment. Doubling the cost of the electrical wiring thus increases the total investment by less than 5% to 10% (the electrical system is more than just the wiring).
A rise in total initial investment by about 5%, which pays for itself in 10 years, and keeps on generating additional benefit after that period is definitely worth consideration.

The initial investment for a carbon footprint optimised design is significantly higher (four to six times the base line investment, when neglecting the clipped results of the large industrial plant).
Additionally the total cost of ownership on a 10 year horizon rises. Traditional investors will not be inclined to make such a decision.

Furthermore the extremely large sections resulting from the carbon footprint optimisation will introduce serious practical problems upon implementation, such as: equipment terminals not suited for the large cross sections, cableway congestion, increased project lead times due to difficult handling, … These factors will in general lead to advice against this design strategy.

4.4.4 Relation between total cost and initial investment

Figure 10 shows an alternative view on the relation between CLrTCO and initial investment. This graphical representation gives an insight in the economic yield from an alternative design strategy on the vertical (CLrTCO) axis and the effort required for implementing the strategy on the horizontal axis (investment).

To allow comparison between the various models all values are normalised such that the base line solution represents 100%.

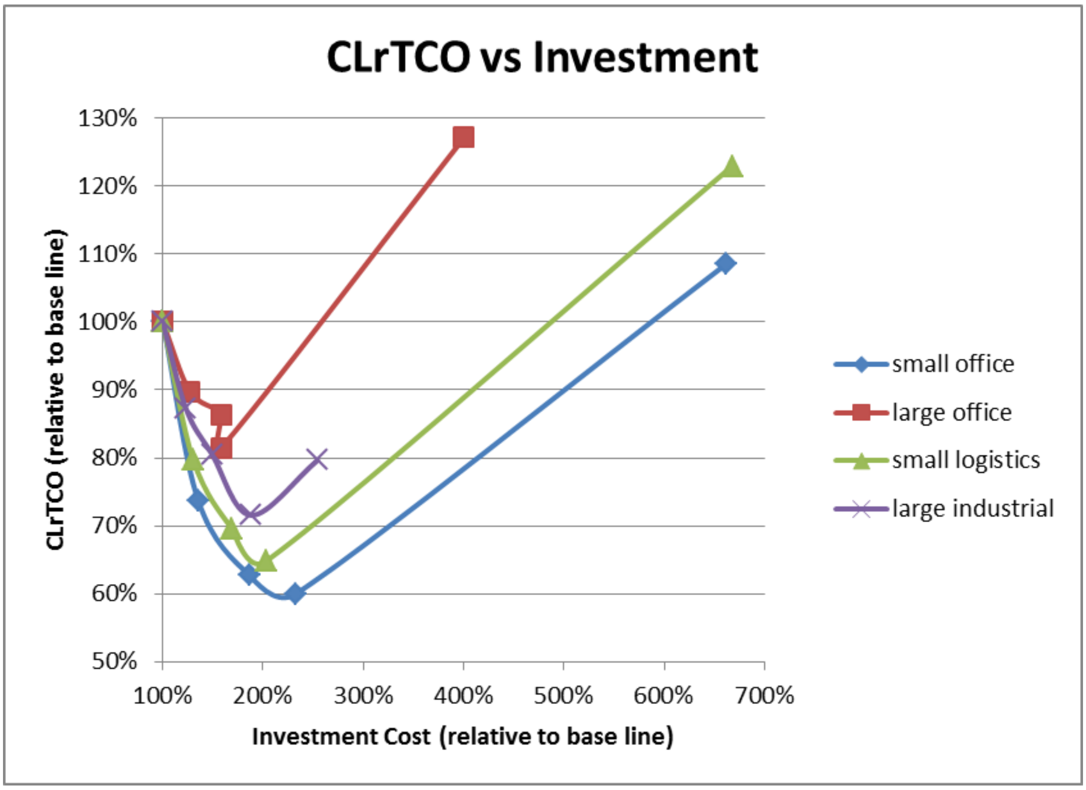

Figure 10 CLrTCO as a function of Initial Investment

From this representation it is immediately clear that the carbon footprint optimisation comes at a significantly higher investment cost, and higher total cost of ownership. (The apparent lower CLrTCO for the large industrial plant is cause by optimisation algorithm clipping.

The strange curve in the graph for the “large office model” is caused by the fact that the two sizes up and economic optimum solution for this particular model are almost identical.

The graph clearly shows the presence of a relatively sharp minimal point in the total cost of ownership curves.

4.4.5 Evolution of carbon footprint per design strategy

Table 10 shows the calculated cable loss related carbon footprint for all models and design strategies. The absolute figures presented are relevant to the actual models only, the ratios comparing alternative design strategies to the base line are however quite reliable estimates of the effect of the various design strategies

Table 10 Evolution of CLrCFP

CLrCFP evolution					
Absolute	base	S +1	S+2	Economic	Carbon
small office	**16 144,0 kgCO2**	**10 152,0 kgCO2**	**6 690,1 kgCO2**	**4 900,4 kgCO2**	**2 447,3 kgCO2**
large office	**55 141,7 kgCO2**	**41 645,2 kgCO2**	**32 479,9 kgCO2**	**29 140,5 kgCO2**	**14 956,2 kgCO2**
small logistics	**54 946,4 kgCO2**	**38 214,5 kgCO2**	**27 462,9 kgCO2**	**20 809,7 kgCO2**	**10 160,9 kgCO2**
large industrial	**2 000 363,3 kgCO2**	**1 553 939,3 kgCO2**	**1 246 563,0 kgCO2**	**814 950,6 kgCO2**	**672 049,2 kgCO2**
relative to base line					
small office	100%	62,9%	41,4%	30,4%	15,2%
large office	100%	75,5%	58,9%	52,8%	27,1%
small logistics	100%	69,5%	50,0%	37,9%	18,5%
large industrial	100%	77,7%	62,3%	40,7%	33,6%

A quick glance at the figures reveals that for instance the one size up strategy reduces carbon footprint by 25% to 40%. With as illustrate above an increase in initial investment of about 30%.

Figure 11 provides a more convenient graphical view of the evolution of both total cost of ownership and initial investment.

From this graph it is immediately clear that the design strategies introducing larger cross section lead to a long term reduction of carbon footprint of the installation without any exception.

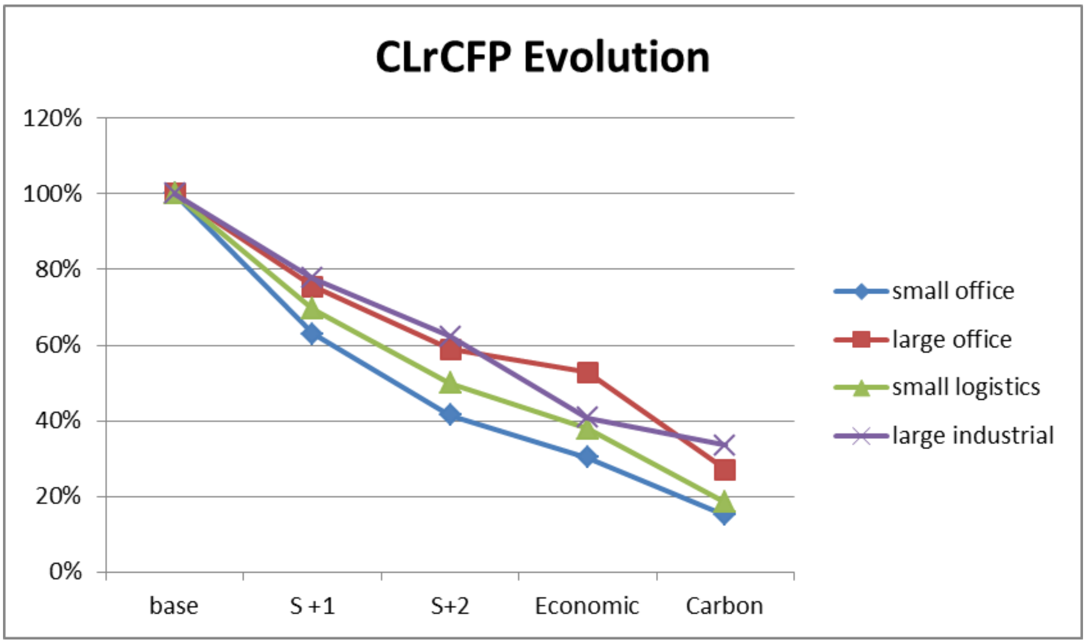

Figure 11 Evolution of CLrCFP across design strategies

4.4.6 Relation between carbon footprint and initial investment

When trying to decide on the right design strategy using Figure 11 as a reference, the carbon footprint optimum would appear to be best suited.

Figure 12 shows an alternative view on the relation between CLrCFP and initial investment. This graphical representation gives an insight in the ecological yield from an alternative design strategy on the vertical (CLrCFP) axis and the effort required for implementing the strategy on the horizontal axis (Investment).

To allow comparison between the various models all values are normalised such that the base line solution represents 100%.

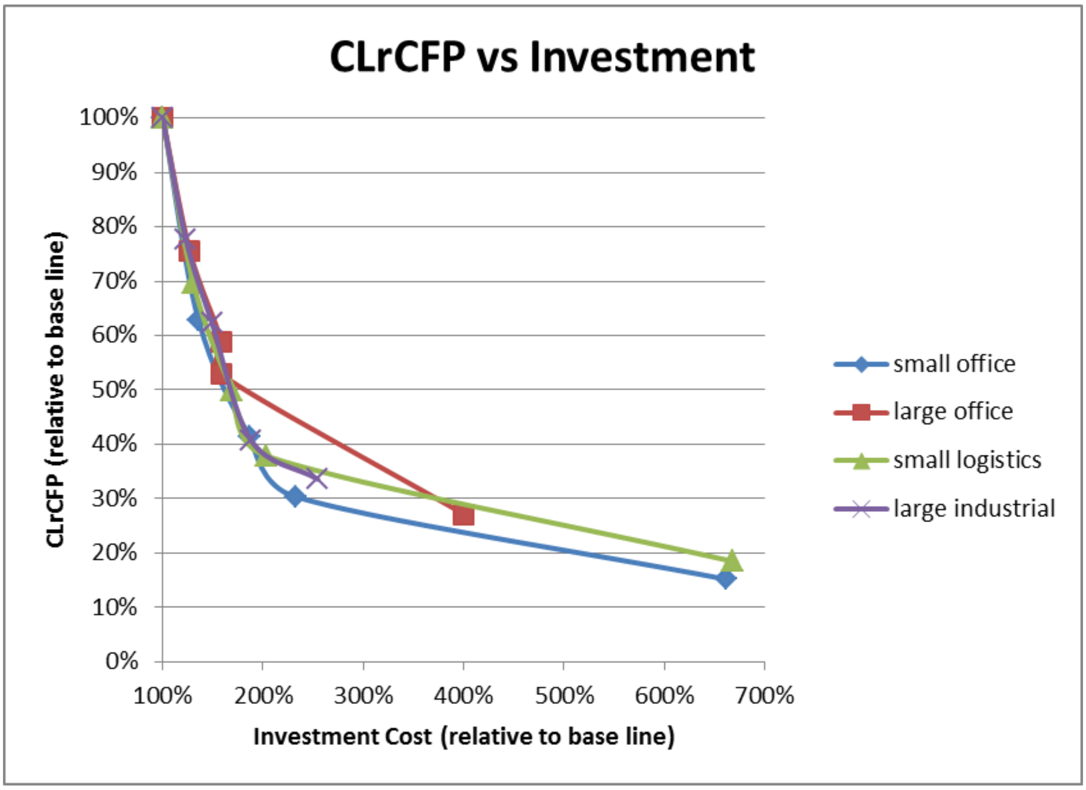

Figure 12 CLrCFP as a function of Initial Investment

When deciding on the design strategy to be applied it is immediately clear that the effort to reach the carbon footprint optimum is disproportional to the yield of this strategy. (Again the result for the large industrial plant is biased by optimisation algorithm clipping)

Based on the information presented in Figure 12 the positive ecological effect of an economic optimum design is considerable, and the effort needed to implement the design is within a reasonable range. Especially when considering the fact that the electrical wiring is only a relatively small part of an investment project (e.g. building or production plant).

The additional effort for a carbon footprint optimum design is considerable, and as indicated in 4.4.4 above, a number of factors advice against the use of this design strategy.

5. Summary/conclusions

Based on the calculated results for the various models and design strategies have been compared and evaluated against each other.

Table 11 presents global results for the five design strategies averaged across all four models. The values are normalised relative to the results for the base line solution.

- Economic yield in the table is defined as the reduction in cable loss related total cost of ownership over a 10 year investment horizon compared to the base line solution.
- Ecologic yield is defined as the reduction in cable loss related carbon footprint over a 20 year installation life time.
- Additional effort is defined as the increase in required initial investment.

Table 11 Yield and effort across strategies

	Averaged over all models					
Srategy	**CLrTCO**	**economic yield**	**investment**	**additional effort**	**CLrCFP**	**ecologic yield**
Base	100%	0%	100%	0%	100%	0%
S +1	83%	17%	129%	29%	71%	29%
S +2	75%	25%	166%	66%	53%	47%
Economic	69%	31%	195%	95%	40%	60%
Carbon	110%	-10%	496%	396%	24%	76%

Figure 13 represents the same values in a graphical format.

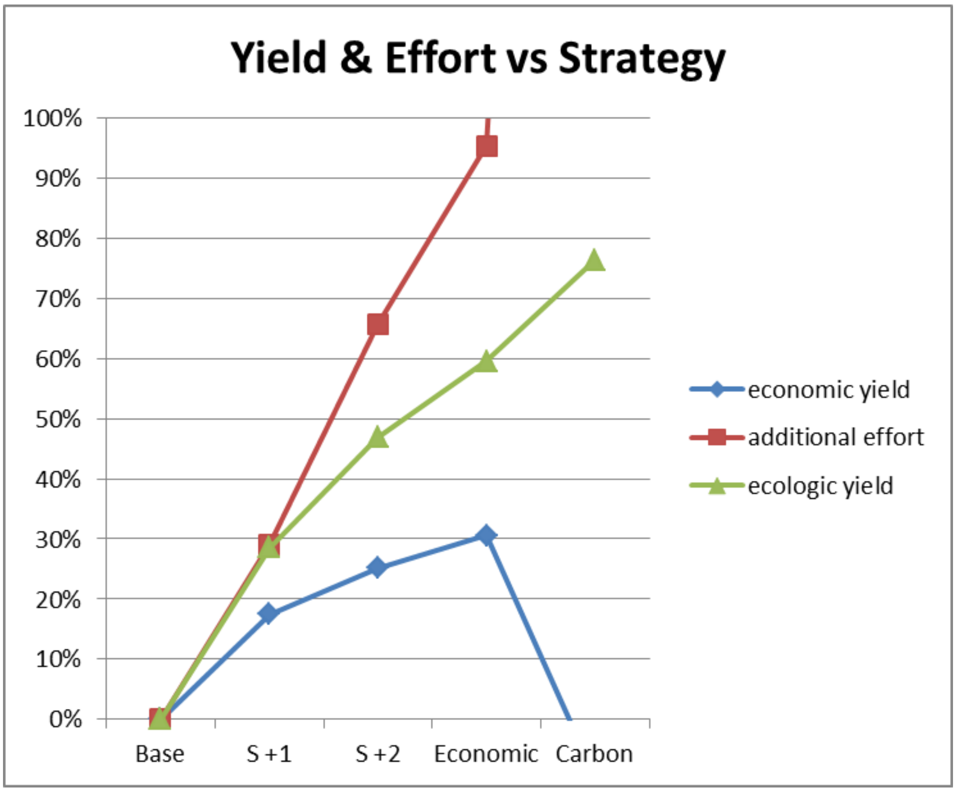

Figure 13 Yield and effort across strategies

From the graphical representation it is clear that the economic optimum can be considered as a best in class solution combining significant ecological improvement and minimal total cost of ownership with a reasonable additional effort. Especially when the additional effort is placed in view of the total investment

of the office building or production plant and the small portion of the total investment related to the electrical systems.
In general an increase in total project budget in the order of magnitude 5% is to be expected. When electricity prices remain stable over a 10 year period the additional investment pays for itself. When electricity prices go up – as can be expected in the future – the pay-back is attained even faster.

Implementation of an economic optimum design strategy would be feasible.

Implementing an ecologic (carbon footprint) optimum design strategy would present additional opportunites, but due to the extreme (off scale) additional effort, combined with the negative economic yield (i.e. higher total cost) over a 10 year horizon, it is very unlikely to find broad public or industry support for such an approach.

Having demonstrated the possible economic and ecological yield of a modified cable sizing strategy, and the related feasibility, an estimate of actual energy conservation impact averaged over the various models, as well as additional copper usage is presented to complete the picture.

Table 12 Impact on Energy losses & copper usage

	Averaged over all models			
Srategy	**Energy Loss**	**Loss reduction**	**CU weight**	**additional CU**
Base	2,04%	0,00%	100,0%	0,0%
S +1	1,42%	0,62%	141,6%	41,6%
S +2	1,02%	1,02%	197,7%	97,7%
Economic	0,75%	1,30%	274,2%	174,2%
Carbon	0,29%	1,76%	907,3%	807,3%

As can be read from the table the total amount of energy lost due to conductive cable losses in electrical installations is slightly over 2% of the total electric energy consumption. Or in a graphical format:

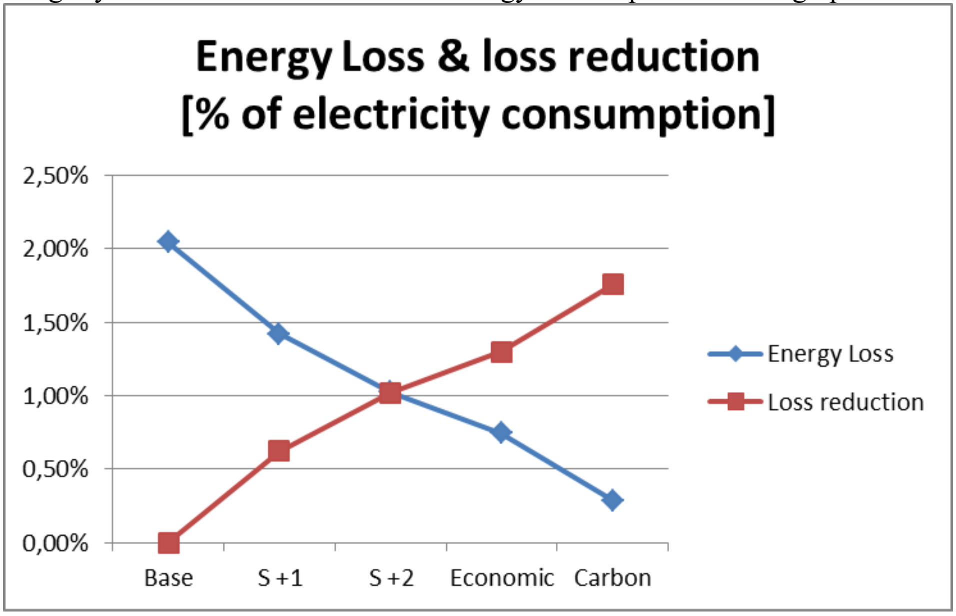

Figure 14 Energy Loss & possible loss reduction across design strategy

For any particular country or region, the energy savings potential can be estimated from these percentages.

For Europe, with a Europe wide electricity consumption of about 3 350 TWh[5] this would represent 67 000MWh of energy lost. The economic optimum design brings the loss back to 0.75% or 25 125MWh, or effectively saving a respectable 66 975MWh.

The additional copper usage is to be understood as percentage of the total amount of copper used for cable manufacturing.

The economic optimum design would lead to an 174% increase in copper usage (or a multiplication of the amount of copper by about 2.7) for the manufacture of low voltage power cables.

For 2007 the global copper demand was 24.2 million tonnes, of which 48% was used in the manufacture of electric cable[6], or about 11 million tonnes. Assuming an economic design strategy would be used instead of a conventional design in 1 out of 10 new projects, this would lead to an additional copper demand of 1.9 million tonnes.

Even though this study is based on detailed analyses of rather limited models, the conclusions show that significant opportunities are available in various fields:

- Significant reduction of the total cost of ownership for operators;
- Significant energy savings and associated reduction in carbon footprint;
- Significant increase in copper usage to attain the previous two goals.

Due to limitations in models due care is to be taken on using the exact figures, but tendencies and global conclusions hold for a wide range of applications.

Real world investment decisions need to be based on specific calculations for each individual case, but when averaged over a sufficiently large number of cases the values found are expected to be in close proximity to the results of this model based study.

[5] CIA World Factbook, 2008
[6] Source www.eurocopper.eu > market data

6. Addenda

6.1 Addendum 1 : Numerical Results "Small Office"

6.1.1 Base line solution

Electric System Descriptive Data											
reference	circuit type	Length [m]	# parallel cond. [-] Ph	N	PE	Cross Section [mm²] Phase	N	PE	Load (daytime) Ib [A]	Cos(φ)	P [kW]
=UTILITI-OV0001	P+N+PE	55	1	1	1	2,5	2,5	2,5	12,8	0,80	2,36
=UTILITI-OV0002	P+N+PE	50	1	1	1	1,5	1,5	1,5	6,4	0,92	1,35
=HVAC	3P+N+PE	60	1	1	1	10	10	10	36,1	0,80	19,93
=UTILIT-DUMMY	3P+N+PE	0	1	1	1	16	16	16	54,1	0,80	29,86

Instantaneous values									
reference	Conductive losses (daytime) [W/m]	[W]	rel. to load	Load (night time) rel. to day	Ib [A]	P [kW]	Conductive losses (night time) [W/m]	[W]	rel. to load
=UTILITI-OV0001	2,911	160,13	6,80%	25%	3,2	0,59	0,182	10,01	1,70%
=UTILITI-OV0002	1,213	60,65	4,48%	25%	1,6	0,34	0,076	3,79	1,12%
=HVAC	8,684	521,04	2,61%	10%	3,6	1,99	0,087	5,21	0,26%
=UTILIT-DUMMY	12,189	0	0%	25%	13,5	7,47	0,762	0,00	0%

Cumulative Values				Investment related figures		
reference	Energy losses per year [kWh]	[EUR]	[kgCO2]	cost [EUR]	CU usage [kgCU]	equiv. CO2 [kgCO2]
=UTILITI-OV0001	479,05	€ 92,94	189,22	€ 167,70	3,69	10,88
=UTILITI-OV0002	181,46	€ 35,20	71,68	€ 115,82	2,01	5,93
=HVAC	1390,50	€ 269,76	549,25	€ 425,62	26,82	79,12
=UTILIT-DUMMY	0	€ -	0	€ 11,33	0	0
Total	**2051,0 kWh**	**€ 397,89**	**810,1 kgCO2**	**€ 720,47**	**32,5 kgCU**	**95,9 kgCO2**

Investment analysis figures		
reference	CLrTCO(10yr) [EUR]	CLrCFP(20yr) [kgCO2]
=UTILITI-OV0001	€ 1.097,05	3795,35
=UTILITI-OV0002	€ 467,84	1439,44
=HVAC	€ 3.123,18	11064,04
=UTILIT-DUMMY	€ 11,33	0
Total	**€ 4.699,41**	**16298,8 kgCO2**

6.1.2 One Size Up

Electric System Descriptive Data

reference	circuit type	Length [m]	# parallel cond. [-] Ph	N	PE	Cross Section [mm²] Phase	N	PE	Load (daytime) Ib [A]	Cos(φ)	P [kW]
=UTILITI-OV0001	P+N+PE	55	1	1	1	4	4	4	12,80	0,80	2,36
=UTILITI-OV0002	P+N+PE	50	1	1	1	2,5	2,5	2,5	6,40	0,92	1,35
=HVAC	3P+N+PE	60	1	1	1	16	16	16	36,10	0,80	19,93
=UTILIT-DUMMY	3P+N+PE	0	1	1	1	25	25	25	54,10	0,80	29,86

Instantaneous values

reference	Conductive losses (daytime) [W/m]	[W]	rel. to load	Load (night time) rel. to day	Ib [A]	P [kW]	Conductive losses (night time) [W/m]	[W]	rel. to load
=UTILITI-OV0001	1,820	100,08	4,25%	25%	3,2	0,59	0,114	6,25	1,06%
=UTILITI-OV0002	0,728	36,39	2,69%	10%	0,6	0,14	0,007	0,36	0,27%
=HVAC	5,428	325,65	1,63%	10%	3,6	1,99	0,054	3,26	0,16%
=UTILIT-DUMMY	7,801	0	0%	25%	13,5	7,47	0,488	0,00	0%

Cumulative Values

reference	Energy losses per year [kWh]	[EUR]	[kgCO2]
=UTILITI-OV0001	299,40	€ 58,08	118,26
=UTILITI-OV0002	97,12	€ 18,84	38,36
=HVAC	869,06	€ 168,60	343,28
=UTILIT-DUMMY	0	€ -	0
Total	**1265,6 kWh**	**€ 245,52**	**499,9 kgCO2**

Investment related figures

cost [EUR]	CU usage [kgCU]	equiv. CO2 [kgCO2]
€ 221,24	5,90	17,41
€ 153,00	3,35	9,89
€ 588,95	42,91	126,59
€ 13,60	0	0
€ 976,79	**52,2 kgCU**	**153,9 kgCO2**

Investment analysis figures

reference	CLrTCO(10yr) [EUR]	CLrCFP(20yr) [kgCO2]
=UTILITI-OV0001	€ 802,08	2382,70
=UTILITI-OV0002	€ 341,41	777,13
=HVAC	€ 2.274,93	6992,16
=UTILIT-DUMMY	€ 13,60	0
Total	**€ 3.432,02**	**10152,0 kgCO2**

6.1.3 Two sizes Up

Electric System Descriptive Data											
reference	circuit type	Length [m]	# parallel cond. [-] Ph	N	PE	Cross Section [mm²] Phase	N	PE	Load (daytime) Ib [A]	Cos(φ)	P [kW]
=UTILITI-OV0001	P+N+PE	55	1	1	1	6	6	6	12,80	0,80	2,36
=UTILITI-OV0002	P+N+PE	50	1	1	1	4	4	4	6,40	0,92	1,35
=HVAC	3P+N+PE	60	1	1	1	25	25	25	36,10	0,80	19,93
=UTILIT-DUMMY	3P+N+PE	0	1	1	1	35	35	35	54,10	0,80	29,86

Instantaneous values									
reference	Conductive losses (daytime) [W/m]	[W]	rel. to load	Load (night time) rel. to day	Ib [A]	P [kW]	Conductive losses (night time) [W/m]	[W]	rel. to load
=UTILITI-OV0001	1,213	66,72	2,83%	25%	3,2	0,59	0,076	4,17	0,71%
=UTILITI-OV0002	0,455	22,75	1,68%	10%	0,6	0,14	0,005	0,23	0,17%
=HVAC	3,474	208,42	1,05%	10%	3,6	1,99	0,035	2,08	0,10%
=UTILIT-DUMMY	5,572	0	0%	25%	13,5	7,47	0,348	0,00	0%

Cumulative Values				Investment related figures		
reference	Energy losses per year [kWh]	[EUR]	[kgCO2]	cost [EUR]	CU usage [kgCU]	equiv. CO2 [kgCO2]
=UTILITI-OV0001	199,60	€ 38,72	78,84	€ 302,25	8,85	26,11
=UTILITI-OV0002	60,70	€ 11,78	23,98	€ 201,85	5,36	15,82
=HVAC	556,20	€ 107,90	219,70	€ 820,78	67,05	197,80
=UTILIT-DUMMY	0	€ -	0	€ 17,00	0	0
Total	**816,5 kWh**	**€ 158,40**	**322,5 kgCO2**	**€ 1.341,88**	**81,3 kgCU**	**239,7 kgCO2**

Investment analysis figures		
reference	CLrTCO(10yr) [EUR]	CLrCFP(20yr) [kgCO2]
=UTILITI-OV0001	€ 689,48	1602,97
=UTILITI-OV0002	€ 319,61	495,35
=HVAC	€ 1.899,80	4591,76
=UTILIT-DUMMY	€ 17,00	0
Total	**€ 2.925,89**	**6690,1 kgCO2**

6.1.4 Economic Optimum

Electric System Descriptive Data												
reference	circuit type	Length [m]	# parallel cond. [-]			Cross Section [mm²]			Load (daytime)		
			Ph	N	PE	Phase	N	PE	Ib [A]	Cos(φ)	P [kW]
=UTILITI-OV0001	P+N+PE	55	1	1	1	10	10	10	12,80	0,80	2,36
=UTILITI-OV0002	P+N+PE	50	1	1	1	4	4	4	6,40	0,92	1,35
=HVAC	3P+N+PE	60	1	1	1	35	35	35	36,10	0,80	19,93
=UTILIT-DUMMY	3P+N+PE	0	1	1	1	16	16	16	54,10	0,80	29,86

Instantaneous values									
reference	Conductive losses (daytime)			Load (night time)			Conductive losses (night time)		
	[W/m]	[W]	rel. to load	rel. to day	Ib [A]	P [kW]	[W/m]	[W]	rel. to load
=UTILITI-OV0001	0,728	40,03	1,70%	25%	3,2	0,59	0,045	2,50	0,42%
=UTILITI-OV0002	0,455	22,75	1,68%	10%	0,6	0,14	0,005	0,23	0,17%
=HVAC	2,481	148,87	0,75%	10%	3,6	1,99	0,025	1,49	0,07%
=UTILIT-DUMMY	12,189	0	0%	25%	13,5	7,47	0,762	0,00	0%

Cumulative Values				Investment related figures		
reference	Energy losses per year			cost	CU usage	equiv. CO2
	[kWh]	[EUR]	[kgCO2]	[EUR]	[kgCU]	[kgCO2]
=UTILITI-OV0001	119,76	€ 23,23	47,31	€ 390,99	14,75	43,52
=UTILITI-OV0002	60,70	€ 11,78	23,98	€ 201,85	5,36	15,82
=HVAC	397,28	€ 77,07	156,93	€ 1.070,78	93,87	276,92
=UTILIT-DUMMY	0	€ -	0	€ 11,33	0	0
Total	**577,7 kWh**	**€ 112,08**	**228,2 kgCO2**	**€ 1.674,95**	**114,0 kgCU**	**336,3 kgCO2**

Investment analysis figures		
reference	CLrTCO(10yr) [EUR]	CLrCFP(20yr) [kgCO2]
=UTILITI-OV0001	€ 623,32	989,63
=UTILITI-OV0002	€ 319,61	495,35
=HVAC	€ 1.841,51	3415,46
=UTILIT-DUMMY	€ 11,33	0
Total	**€ 2.795,77**	**4900,4 kgCO2**

6.1.5 Ecologic optimum

Electric System Descriptive Data

reference	circuit type	Length [m]	# parallel cond. [-] Ph	N	PE	Cross Section [mm²] Phase	N	PE	Load (daytime) Ib [A]	Cos(φ)	P [kW]
=UTILITI-OV0001	P+N+PE	55	1	1	1	50	50	50	12,80	0,80	2,36
=UTILITI-OV0002	P+N+PE	50	1	1	1	25	25	25	6,40	0,92	1,35
=HVAC	3P+N+PE	60	1	1	1	120	120	120	36,10	0,80	19,93
=UTILIT-DUMMY	3P+N+PE	0	1	1	1	16	16	16	54,10	0,80	29,86

Instantaneous values

reference	Conductive losses (daytime) [W/m]	[W]	rel. to load	Load (night time) rel. to day	Ib [A]	P [kW]	Conductive losses (night time) [W/m]	[W]	rel. to load
=UTILITI-OV0001	0,146	8,01	0,34%	25%	3,2	0,59	0,009	0,50	0,08%
=UTILITI-OV0002	0,073	3,64	0,27%	10%	0,6	0,14	0,001	0,04	0,03%
=HVAC	0,724	43,42	0,22%	10%	3,6	1,99	0,007	0,43	0,02%
=UTILIT-DUMMY	12,189	0	0%	25%	13,5	7,47	0,762	0,00	0%

Cumulative Values / **Investment related figures**

reference	Energy losses per year [kWh]	[EUR]	[kgCO2]	cost [EUR]	CU usage [kgCU]	equiv. CO2 [kgCO2]
=UTILITI-OV0001	23,95	€ 4,65	9,46	€ 1.281,55	73,76	217,58
=UTILITI-OV0002	9,71	€ 1,88	3,84	€ 686,25	33,53	98,90
=HVAC	115,87	€ 22,48	45,77	€ 2.790,78	321,84	949,43
=UTILIT-DUMMY	0	€ -	0	€ 11,33	0	0
Total	**149,5 kWh**	**€ 29,01**	**59,1 kgCO2**	**€ 4.769,91**	**429,1 kgCU**	**265,9 kgCO2**

Investment analysis figures

reference	CLrTCO(10yr) [EUR]	CLrCFP(20yr) [kgCO2]
=UTILITI-OV0001	€ 1.328,02	406,80
=UTILITI-OV0002	€ 705,09	175,62
=HVAC	€ 3.015,58	1864,84
=UTILIT-DUMMY	€ 11,33	0
Total	**€ 5.060,02**	**2447,3 kgCO2**

6.2 Addendum 2 : Numerical Results "Large Office"

6.2.1 Base line solution

Electric System Descriptive Data												
reference	circuit	Length	# parallel cond. [-]			Cross Section [mm²]			Load (daytime)		
	type	[m]	Ph	N	PE	Phase	N	PE	Ib [A]	Cos(φ)	P [kW]
J-B BT-TD1	3P+PE	18	1	0	1	185	0	70	144,3	0,00	0,00
J-B BT-UTILITIE	3P+N+PE	55	1	1	1	95	95	25	189,4	0,80	104,55
=UTILITI-OV0001	P+N+PE	55	1	1	1	4	4	4	6,3	0,80	1,16
=UTILITI-OV0002	P+N+PE	50	1	1	1	2,5	2,5	2,5	6,8	0,80	1,25
=HVAC	3P+N+PE	60	1	1	1	10	10	10	36,1	0,80	19,93

Instantaneous values									
reference	Conductive losses (daytime)			Load (night time)			Conductive losses (night time)		
	[W/m]	[W]	rel. to load	rel. to day	Ib [A]	P [kW]	[W/m]	[W]	rel. to load
J-B BT-TD1	7,500	135,00	--	25%	36,1	0,00	0,469	8,44	--
J-B BT-UTILITIE	25,162	1383,91	1,32%	15%	28,4	15,68	0,566	31,14	0,20%
=UTILITI-OV0001	0,441	24,24	2,09%	10%	0,6	0,12	0,004	0,24	0,21%
=UTILITI-OV0002	0,822	41,08	3,28%	25%	1,7	0,31	0,051	2,57	0,82%
=HVAC	8,684	521,04	2,61%	10%	3,6	1,99	0,087	5,21	0,26%

Cumulative Values				Investment related figures		
reference	Energy losses per year			cost	CU usage	equiv. CO2
	[kWh]	[EUR]	[kgCO2]	[EUR]	[kgCU]	[kgCO2]
J-B BT-TD1	469,88	€ 69,54	185,60	€ 1.278,53	100,58	296,70
J-B BT-UTILITIE	4505,01	€ 666,74	1779,48	€ 2.087,55	199,14	587,46
=UTILITI-OV0001	77,21	€ 11,43	30,50	€ 221,24	5,90	17,41
=UTILITI-OV0002	142,99	€ 21,16	56,48	€ 153,00	3,35	9,89
=HVAC	1659,47	€ 245,60	655,49	€ 425,62	26,82	79,12
Total	**6854,6 kWh**	**€ 1.014,48**	**2707,6 kgCO2**	**€ 4.165,93**	**335,8 kgCU**	**990,6 kgCO2**

Investment analysis figures		
reference	CLrTCO(10yr)	CLrCFP(20yr)
	[EUR]	[kgCO2]
J-B BT-TD1	€ 1.973,95	4008,76
J-B BT-UTILITIE	€ 8.754,97	36177,07
=UTILITI-OV0001	€ 335,51	627,40
=UTILITI-OV0002	€ 364,63	1139,53
=HVAC	€ 2.881,63	13188,90
Total	**€ 14.310,69**	**55141,7 kgCO2**

6.2.2 One Size Up

Electric System Descriptive Data											
reference	circuit	Length	# parallel cond. [-]			Cross Section [mm²]			Load (daytime)		
	type	[m]	Ph	N	PE	Phase	N	PE	Ib [A]	Cos(φ)	P [kW]
J-B BT-TD1	3P+PE	18	1	0	1	240	0	95	144,30	0,00	0,00
J-B BT-UTILITIE	3P+N+PE	55	1	1	1	120	120	35	189,40	0,80	104,55
=UTILITI-OV0001	P+N+PE	55	1	1	1	6	6	6	6,30	0,80	1,16
=UTILITI-OV0002	P+N+PE	50	1	1	1	4	4	4	6,80	0,80	1,25
=HVAC	3P+N+PE	60	1	1	1	16	16	16	36,10	0,80	19,93

Instantaneous values									
reference	Conductive losses (daytime)			Load (night time)			Conductive losses (night time)		
	[W/m]	[W]	rel. to load	rel. to day	Ib [A]	P [kW]	[W/m]	[W]	rel. to load
J-B BT-TD1	5,781	104,06	--	25%	36,1	0,00	0,361	6,50	--
J-B BT-UTILITIE	19,920	1095,60	1,05%	15%	28,4	15,68	0,448	24,65	0,16%
=UTILITI-OV0001	0,294	16,16	1,39%	10%	0,6	0,12	0,003	0,16	0,14%
=UTILITI-OV0002	0,514	25,68	2,05%	25%	1,7	0,31	0,032	1,60	0,51%
=HVAC	5,428	325,65	1,63%	10%	3,6	1,99	0,054	3,26	0,16%

Cumulative Values				Investment related figures		
reference	Energy losses per year			cost	CU usage	equiv. CO2
	[kWh]	[EUR]	[kgCO2]	[EUR]	[kgCU]	[kgCO2]
J-B BT-TD1	362,20	€ 53,61	143,07	€ 1.636,35	131,15	386,89
J-B BT-UTILITIE	3566,47	€ 527,84	1408,76	€ 2.560,72	253,23	747,02
=UTILITI-OV0001	51,48	€ 7,62	20,33	€ 302,25	8,85	26,11
=UTILITI-OV0002	89,37	€ 13,23	35,30	€ 201,85	5,36	15,82
=HVAC	1037,17	€ 153,50	409,68	€ 588,95	42,91	126,59
Total	**5106,7 kWh**	**€ 755,79**	**2017,1 kgCO2**	**€ 5.290,12**	**441,5 kgCU**	**1302,4 kgCO2**

Investment analysis figures		
reference	CLrTCO(10yr)	CLrCFP(20yr)
	[EUR]	[kgCO2]
J-B BT-TD1	€ 2.172,40	3248,28
J-B BT-UTILITIE	€ 7.839,09	28922,12
=UTILITI-OV0001	€ 378,43	432,77
=UTILITI-OV0002	€ 334,12	721,85
=HVAC	€ 2.123,96	8320,21
Total	**€ 12.848,00**	**41645,2 kgCO2**

6.2.3 Two sizes Up

Electric System Descriptive Data											
reference	circuit	Length	# parallel cond. [-]			Cross Section [mm²]			Load (daytime)		
	type	[m]	Ph	N	PE	Phase	N	PE	Ib [A]	Cos(φ)	P [kW]
J-B BT-TD1	3P+PE	18	1	0	1	300	0	120	144,30	0,00	0,00
J-B BT-UTILITIE	3P+N+PE	55	1	1	1	150	150	50	189,40	0,80	104,55
=UTILITI-OV0001	P+N+PE	55	1	1	1	10	10	10	6,30	0,80	1,16
=UTILITI-OV0002	P+N+PE	50	1	1	1	6	6	6	6,80	0,80	1,25
=HVAC	3P+N+PE	60	1	1	1	25	25	25	36,10	0,80	19,93

Instantaneous values									
reference	Conductive losses (daytime)			Load (night time)			Conductive losses (night time)		
	[W/m]	[W]	rel. to load	rel. to day	Ib [A]	P [kW]	[W/m]	[W]	rel. to load
J-B BT-TD1	4,625	83,25	--	25%	36,1	0,00	0,289	5,20	--
J-B BT-UTILITIE	15,936	876,48	0,84%	15%	28,4	15,68	0,359	19,72	0,13%
=UTILITI-OV0001	0,176	9,70	0,84%	10%	0,6	0,12	0,002	0,10	0,08%
=UTILITI-OV0002	0,342	17,12	1,37%	25%	1,7	0,31	0,021	1,07	0,34%
=HVAC	3,474	208,42	1,05%	10%	3,6	1,99	0,035	2,08	0,10%

Cumulative Values			
reference	Energy losses per year		
	[kWh]	[EUR]	[kgCO2]
J-B BT-TD1	289,76	€ 42,88	114,46
J-B BT-UTILITIE	2853,18	€ 422,27	1127,00
=UTILITI-OV0001	30,89	€ 4,57	12,20
=UTILITI-OV0002	59,58	€ 8,82	23,53
=HVAC	663,79	€ 98,24	262,20
Total	**3897,2 kWh**	**€ 576,78**	**1539,4 kgCO2**

Investment related figures		
cost	CU usage	equiv. CO2
[EUR]	[kgCU]	[kgCO2]
€ 2.000,83	164,14	484,21
€ 3.109,55	319,61	942,83
€ 390,99	14,75	43,52
€ 275,50	8,05	23,74
€ 820,78	67,05	197,80
€ 6.597,65	**573,6 kgCU**	**1692,1 kgCO2**

Investment analysis figures		
reference	CLrTCO(10yr)	CLrCFP(20yr)
	[EUR]	[kgCO2]
J-B BT-TD1	€ 2.429,68	2773,31
J-B BT-UTILITIE	€ 7.332,25	23482,92
=UTILITI-OV0001	€ 436,70	287,51
=UTILITI-OV0002	€ 363,68	494,42
=HVAC	€ 1.803,18	5441,71
Total	**€ 12.365,49**	**32479,9 kgCO2**

6.2.4 Economic Optimum

Electric System Descriptive Data											
reference	circuit type	Length [m]	# parallel cond. [-]			Cross Section [mm²]			Load (daytime)		
			Ph	N	PE	Phase	N	PE	Ib [A]	Cos(φ)	P [kW]
J-B BT-TD1	3P+PE	18	1	1	1	185	185	185	144,30	0,00	0,00
J-B BT-UTILITIE	3P+N+PE	55	1	1	1	185	185	185	189,40	0,80	104,55
=UTILITI-OV0001	P+N+PE	55	1	1	1	4	4	4	6,30	0,80	1,16
=UTILITI-OV0002	P+N+PE	50	1	1	1	4	4	4	6,80	0,80	1,25
=HVAC	3P+N+PE	60	1	1	1	35	35	35	36,10	0,80	19,93

Instantaneous values									
reference	Conductive losses (daytime)			Load (night time)			Conductive losses (night time)		
	[W/m]	[W]	rel. to load	rel. to day	Ib [A]	P [kW]	[W/m]	[W]	rel. to load
J-B BT-TD1	7,500	135,00	--	25%	36,1	0,00	0,469	8,44	--
J-B BT-UTILITIE	12,921	710,66	0,68%	15%	28,4	15,68	0,291	15,99	0,10%
=UTILITI-OV0001	0,441	24,24	2,09%	10%	0,6	0,12	0,004	0,24	0,21%
=UTILITI-OV0002	0,514	25,68	2,05%	25%	1,7	0,31	0,032	1,60	0,51%
=HVAC	2,481	148,87	0,75%	10%	3,6	1,99	0,025	1,49	0,07%

Cumulative Values				Investment related figures		
reference	Energy losses per year			cost	CU usage	equiv. CO2
	[kWh]	[EUR]	[kgCO2]	[EUR]	[kgCU]	[kgCO2]
J-B BT-TD1	469,88	€ 69,54	185,60	€ 1.278,53	148,85	439,11
J-B BT-UTILITIE	2313,39	€ 342,38	913,79	€ 3.824,39	454,82	1341,73
=UTILITI-OV0001	77,21	€ 11,43	30,50	€ 221,24	5,90	17,41
=UTILITI-OV0002	89,37	€ 13,23	35,30	€ 201,85	5,36	15,82
=HVAC	474,13	€ 70,17	187,28	€ 1.070,78	93,87	276,92
Total	**3424,0 kWh**	**€ 506,75**	**1352,5 kgCO2**	**€ 6.596,78**	**708,8 kgCU**	**2091,0 kgCO2**

Investment analysis figures		
reference	CLrTCO(10yr) [EUR]	CLrCFP(20yr) [kgCO2]
J-B BT-TD1	€ 1.973,95	4151,18
J-B BT-UTILITIE	€ 7.248,20	19617,47
=UTILITI-OV0001	€ 335,51	627,40
=UTILITI-OV0002	€ 334,12	721,85
=HVAC	€ 1.772,50	4022,57
Total	**€ 11.664,27**	**29140,5 kgCO2**

6.2.5 Ecologic optimum

Electric System Descriptive Data											
reference	circuit type	Length [m]	# parallel cond. [-]			Cross Section [mm²]			Load (daytime)		
			Ph	N	PE	Phase	N	PE	Ib [A]	Cos(φ)	P [kW]
J-B BT-TD1	3P+PE	18	1	1	1	500	500	500	144,30	0,00	0,00
J-B BT-UTILITIE	3P+N+PE	55	1	1	1	630	630	630	189,40	0,80	104,55
=UTILITI-OV0001	P+N+PE	55	1	1	1	25	25	25	6,30	0,80	1,16
=UTILITI-OV0002	P+N+PE	50	1	1	1	25	25	25	6,80	0,80	1,25
=HVAC	3P+N+PE	60	1	1	1	120	120	120	36,10	0,80	19,93

Instantaneous values									
reference	Conductive losses (daytime)			Load (night time)			Conductive losses (night time)		
	[W/m]	[W]	rel. to load	rel. to day	Ib [A]	P [kW]	[W/m]	[W]	rel. to load
J-B BT-TD1	2,775	49,95	--	25%	36,1	0,00	0,173	3,12	--
J-B BT-UTILITIE	3,794	208,68	0,20%	15%	28,4	15,68	0,085	4,70	0,03%
=UTILITI-OV0001	0,071	3,88	0,33%	10%	0,6	0,12	0,001	0,04	0,03%
=UTILITI-OV0002	0,082	4,11	0,33%	25%	1,7	0,31	0,005	0,26	0,08%
=HVAC	0,724	43,42	0,22%	10%	3,6	1,99	0,007	0,43	0,02%

Cumulative Values				Investment related figures		
reference	Energy losses per year			cost	CU usage	equiv. CO2
	[kWh]	[EUR]	[kgCO2]	[EUR]	[kgCU]	[kgCO2]
J-B BT-TD1	173,86	€ 25,73	68,67	€ 2.885,15	402,30	1186,79
J-B BT-UTILITIE	679,33	€ 100,54	268,33	€ 9.573,20	1548,86	4569,12
=UTILITI-OV0001	12,35	€ 1,83	4,88	€ 753,52	36,88	108,79
=UTILITI-OV0002	14,30	€ 2,12	5,65	€ 686,25	33,53	98,90
=HVAC	138,29	€ 20,47	54,62	€ 2.790,78	321,84	949,43
Total	**1018,1 kWh**	**€ 150,68**	**402,2 kgCO2**	**€ 16.688,90**	**2343,4 kgCU**	**6913,0 kgCO2**

Investment analysis figures		
reference	CLrTCO(10yr) [EUR]	CLrCFP(20yr) [kgCO2]
J-B BT-TD1	€ 3.142,46	2560,25
J-B BT-UTILITIE	€ 10.578,60	9935,81
=UTILITI-OV0001	€ 771,80	206,39
=UTILITI-OV0002	€ 707,41	211,86
=HVAC	€ 2.995,45	2041,91
Total	**€ 18.195,73**	**14956,2 kgCO2**

6.3 Addendum 3 : Numerical Results "Small logistics centre"

6.3.1 Base line solution

Electric System Descriptive Data

reference	circuit type	Length [m]	# parallel cond. [-] Ph	N	PE	Cross Section [mm²] Phase	N	PE	Load (daytime) Ib [A]	Cos(φ)	P [kW]
LIGHT	P+N+PE	10	1	1	1	1,5	1,5	1,5	6,4	0,92	1,35
ALSB-OV0001	P+N+PE	10	1	1	1	6	6	6	38,4	0,80	7,07
ALSB-DIV0001	3P+N+PE	0	1	1	1	16	16	16	63	0,80	34,78
TRANSPORT	3P+N+PE	100	1	1	1	35	35	16	100	0,80	55,20
=TRANSPOR-M0001	3P+PE	20	1	0	1	2,5	0	2,5	1,9	0,75	0,98
=TRANSPOR-M0007	3P+PE	20	1	0	1	2,5	0	2,5	1,9	0,75	0,98
=TRANSPOR-M0009	3P+PE	20	1	0	1	2,5	0	2,5	4,75	0,75	2,46
=TRANSPOR-M0016	3P+PE	20	1	0	1	2,5	0	2,5	14,7	0,80	8,11
=TRANSP-DUMMY	3P+N+PE	0	1	1	1	25	25	25	72,2	0,80	39,85

Instantaneous values

reference	Conductive losses (daytime) [W/m]	[W]	rel. to load	Load (night time) rel. to day	Ib [A]	P [kW]	Conductive losses (night time) [W/m]	[W]	rel. to load
LIGHT	1,213	12,13	0,90%	10%	0,6	0,14	0,012	0,12	0,09%
ALSB-OV0001	10,918	109,18	1,55%	25%	9,6	1,77	0,682	6,82	0,39%
ALSB-DIV0001	16,530	0,00	0,00%	15%	9,5	5,22	0,372	0,00	0,00%
TRANSPORT	19,039	1903,89	3,45%	10%	10,0	5,52	0,190	19,04	0,34%
=TRANSPOR-M0001	0,096	1,92	0,20%	10%	0,2	0,10	0,001	0,02	0,02%
=TRANSPOR-M0007	0,096	1,92	0,20%	10%	0,2	0,10	0,001	0,02	0,02%
=TRANSPOR-M0009	0,601	12,03	0,49%	10%	0,5	0,25	0,006	0,12	0,05%
=TRANSPOR-M0016	5,760	115,19	1,42%	10%	1,5	0,81	0,058	1,15	0,14%
=TRANSP-DUMMY	13,895	0,00	0,00%	10%	7,2	3,99	0,139	0,00	0,00%

Cumulative Values / **Investment related figures**

reference	Energy losses per year [kWh]	[EUR]	[kgCO2]	cost [EUR]	CU usage [kgCU]	equiv. CO2 [kgCO2]
LIGHT	38,63	€ 5,72	15,26	€ 26,90	0,40	1,19
ALSB-OV0001	379,99	€ 56,24	150,10	€ 61,50	1,61	4,75
ALSB-DIV0001	0,00	€ -	0,00	€ 11,33	0,00	0,00
TRANSPORT	6063,66	€ 897,42	2395,15	€ 1.773,30	139,46	411,42
=TRANSPOR-M0001	6,13	€ 0,91	2,42	€ 64,80	1,79	5,27
=TRANSPOR-M0007	6,13	€ 0,91	2,42	€ 64,80	1,79	5,27
=TRANSPOR-M0009	38,31	€ 5,67	15,13	€ 64,80	1,79	5,27
=TRANSPOR-M0016	366,88	€ 54,30	144,92	€ 64,80	1,79	5,27
=TRANSP-DUMMY	0,00	€ -	0,00	€ 13,60	0,00	0,00
Total	**6899,7 kWh**	**€ 1.021,16**	**2725,4 kgCO2**	**€ 2.145,83**	**148,6 kgCU**	**438,5 kgCO2**

Investment analysis figures

reference	CLrTCO(10yr) [EUR]	CLrCFP(20yr) [kgCO2]
LIGHT	€ 84,08	306,40
ALSB-OV0001	€ 623,89	3006,69
ALSB-DIV0001	€ 11,33	0,00
TRANSPORT	€ 10.747,51	48314,32
=TRANSPOR-M0001	€ 73,87	53,69
=TRANSPOR-M0007	€ 73,87	53,69
=TRANSPOR-M0009	€ 121,49	307,90
=TRANSPOR-M0016	€ 607,79	2903,65
=TRANSP-DUMMY	€ 13,60	0,00
Total	**€ 12.357,44**	**54946,4 kgCO2**

6.3.2 One Size Up

Electric System Descriptive Data											
reference	circuit type	Length [m]	# parallel cond. [-]			Cross Section [mm²]			Load (daytime)		
			Ph	N	PE	Phase	N	PE	Ib [A]	Cos(φ)	P [kW]
LIGHT	P+N+PE	10	1	1	1	2,5	2,5	2,5	6,40	0,92	1,35
ALSB-OV0001	P+N+PE	10	1	1	1	10	10	10	38,40	0,80	7,07
ALSB-DIV0001	3P+N+PE	0	1	1	1	25	25	25	63,00	0,80	34,78
TRANSPORT	3P+N+PE	100	1	1	1	50	50	25	100,00	0,80	55,20
=TRANSPOR-M0001	3P+PE	20	1	0	1	4	0	4	1,90	0,75	0,98
=TRANSPOR-M0007	3P+PE	20	1	0	1	4	0	4	1,90	0,75	0,98
=TRANSPOR-M0009	3P+PE	20	1	0	1	4	0	4	4,75	0,75	2,46
=TRANSPOR-M0016	3P+PE	20	1	0	1	4	0	4	14,70	0,80	8,11
=TRANSP-DUMMY	3P+N+PE	0	1	1	1	35	35	35	72,20	0,80	39,85

Instantaneous values									
reference	Conductive losses (daytime)			Load (night time)			Conductive losses (night time)		
	[W/m]	[W]	rel. to load	rel. to day	Ib [A]	P [kW]	[W/m]	[W]	rel. to load
LIGHT	0,728	7,28	0,54%	10%	0,6	0,14	0,007	0,07	0,05%
ALSB-OV0001	6,551	65,51	0,93%	25%	9,6	1,77	0,409	4,09	0,23%
ALSB-DIV0001	10,579	0,00	0,00%	15%	9,5	5,22	0,238	0,00	0,00%
TRANSPORT	13,327	1332,72	2,41%	10%	10,0	5,52	0,133	13,33	0,24%
=TRANSPOR-M0001	0,060	1,20	0,12%	10%	0,2	0,10	0,001	0,01	0,01%
=TRANSPOR-M0007	0,060	1,20	0,12%	10%	0,2	0,10	0,001	0,01	0,01%
=TRANSPOR-M0009	0,376	7,52	0,31%	10%	0,5	0,25	0,004	0,08	0,03%
=TRANSPOR-M0016	3,600	72,00	0,89%	10%	1,5	0,81	0,036	0,72	0,09%
=TRANSP-DUMMY	9,925	0,00	0,00%	10%	7,2	3,99	0,099	0,00	0,00%

Cumulative Values				Investment related figures		
reference	Energy losses per year			cost	CU usage	equiv. CO2
	[kWh]	[EUR]	[kgCO2]	[EUR]	[kgCU]	[kgCO2]
LIGHT	23,18	€ 3,43	9,16	€ 35,40	0,67	1,98
ALSB-OV0001	228,00	€ 33,74	90,06	€ 79,27	2,68	7,91
ALSB-DIV0001	0,00	€ -	0,00	€ 13,60	0,00	0,00
TRANSPORT	4244,56	€ 628,20	1676,60	€ 2.313,40	201,15	593,39
=TRANSPOR-M0001	3,83	€ 0,57	1,51	€ 85,54	2,86	8,44
=TRANSPOR-M0007	3,83	€ 0,57	1,51	€ 85,54	2,86	8,44
=TRANSPOR-M0009	23,94	€ 3,54	9,46	€ 85,54	2,86	8,44
=TRANSPOR-M0016	229,30	€ 33,94	90,57	€ 85,54	2,86	8,44
=TRANSP-DUMMY	0,00	€ -	0,00	€ 17,00	0,00	0,00
Total	**4756,6 kWh**	**€ 703,98**	**1878,9 kgCO2**	**€ 2.800,83**	**215,9 kgCU**	**637,0 kgCO2**

Investment analysis figures		
reference	CLrTCO(10yr) [EUR]	CLrCFP(20yr) [kgCO2]
LIGHT	€ 69,71	185,11
ALSB-OV0001	€ 416,70	1809,08
ALSB-DIV0001	€ 13,60	0,00
TRANSPORT	€ 8.595,35	34125,42
=TRANSPOR-M0001	€ 91,21	38,70
=TRANSPOR-M0007	€ 91,21	38,70
=TRANSPOR-M0009	€ 120,97	197,58
=TRANSPOR-M0016	€ 424,91	1819,92
=TRANSP-DUMMY	€ 17,00	0,00
Total	**€ 9.840,66**	**38214,5 kgCO2**

6.3.3 Two sizes Up

Electric System Descriptive Data

reference	circuit type	Length [m]	# parallel cond. [-] Ph	N	PE	Cross Section [mm²] Phase	N	PE	Load (daytime) Ib [A]	Cos(φ)	P [kW]
LIGHT	P+N+PE	10	1	1	1	4	4	4	6,40	0,92	1,35
ALSB-OV0001	P+N+PE	10	1	1	1	16	16	16	38,40	0,80	7,07
ALSB-DIV0001	3P+N+PE	0	1	1	1	35	35	35	63,00	0,80	34,78
TRANSPORT	3P+N+PE	100	1	1	1	70	70	35	100,00	0,80	55,20
=TRANSPOR-M0001	3P+PE	20	1	0	1	6	0	6	1,90	0,75	0,98
=TRANSPOR-M0007	3P+PE	20	1	0	1	6	0	6	1,90	0,75	0,98
=TRANSPOR-M0009	3P+PE	20	1	0	1	6	0	6	4,75	0,75	2,46
=TRANSPOR-M0016	3P+PE	20	1	0	1	6	0	6	14,70	0,80	8,11
=TRANSP-DUMMY	3P+N+PE	0	1	1	1	50	50	50	72,20	0,80	39,85

Instantaneous values

reference	Conductive losses (daytime) [W/m]	[W]	rel. to load	Load (night time) rel. to day	Ib [A]	P [kW]	Conductive losses (night time) [W/m]	[W]	rel. to load
LIGHT	0,455	4,55	0,34%	10%	0,6	0,14	0,005	0,05	0,03%
ALSB-OV0001	4,094	40,94	0,58%	25%	9,6	1,77	0,256	2,56	0,14%
ALSB-DIV0001	7,557	0,00	0,00%	15%	9,5	5,22	0,170	0,00	0,00%
TRANSPORT	9,519	951,94	1,72%	10%	10,0	5,52	0,095	9,52	0,17%
=TRANSPOR-M0001	0,040	0,80	0,08%	10%	0,2	0,10	0,000	0,01	0,01%
=TRANSPOR-M0007	0,040	0,80	0,08%	10%	0,2	0,10	0,000	0,01	0,01%
=TRANSPOR-M0009	0,251	5,01	0,20%	10%	0,5	0,25	0,003	0,05	0,02%
=TRANSPOR-M0016	2,400	48,00	0,59%	10%	1,5	0,81	0,024	0,48	0,06%
=TRANSP-DUMMY	6,947	0,00	0,00%	10%	7,2	3,99	0,069	0,00	0,00%

Cumulative Values / **Investment related figures**

reference	Energy losses per year [kWh]	[EUR]	[kgCO2]	cost [EUR]	CU usage [kgCU]	equiv. CO2 [kgCO2]
LIGHT	14,49	€ 2,14	5,72	€ 46,77	1,07	3,16
ALSB-OV0001	142,50	€ 21,09	56,29	€ 107,60	4,29	12,66
ALSB-DIV0001	0,00	€ -	0,00	€ 17,00	0,00	0,00
TRANSPORT	3031,83	€ 448,71	1197,57	€ 2.972,30	281,61	830,75
=TRANSPOR-M0001	2,55	€ 0,38	1,01	€ 115,00	4,29	12,66
=TRANSPOR-M0007	2,55	€ 0,38	1,01	€ 115,00	4,29	12,66
=TRANSPOR-M0009	15,96	€ 2,36	6,30	€ 115,00	4,29	12,66
=TRANSPOR-M0016	152,87	€ 22,62	60,38	€ 115,00	4,29	12,66
=TRANSP-DUMMY	0,00	€ -	0,00	€ 20,40	0,00	0,00
Total	**3362,8 kWh**	**€ 497,69**	**1328,3 kgCO2**	**€ 3.624,07**	**304,1 kgCU**	**897,2 kgCO2**

Investment analysis figures

reference	CLrTCO(10yr) [EUR]	CLrCFP(20yr) [kgCO2]
LIGHT	€ 68,21	117,62
ALSB-OV0001	€ 318,50	1138,39
ALSB-DIV0001	€ 17,00	0,00
TRANSPORT	€ 7.459,41	24782,20
=TRANSPOR-M0001	€ 118,78	32,83
=TRANSPOR-M0007	€ 118,78	32,83
=TRANSPOR-M0009	€ 138,62	138,75
=TRANSPOR-M0016	€ 341,24	1220,32
=TRANSP-DUMMY	€ 20,40	0,00
Total	**€ 8.600,94**	**27462,9 kgCO2**

6.3.4 Economic Optimum

Electric System Descriptive Data											
reference	circuit	Length	# parallel cond. [-]			Cross Section [mm²]			Load (daytime)		
	type	[m]	Ph	N	PE	Phase	N	PE	Ib [A]	Cos(φ)	P [kW]
LIGHT	P+N+PE	10	1	1	1	4	4	4	6,40	0,92	1,35
ALSB-OV0001	P+N+PE	10	1	1	1	25	25	25	38,40	0,80	7,07
ALSB-DIV0001	3P+N+PE	0	1	1	1	16	16	16	63,00	0,80	34,78
TRANSPORT	3P+N+PE	100	1	1	1	95	95	95	100,00	0,80	55,20
=TRANSPOR-M0001	3P+PE	20	1	0	1	2,5	2,5	2,5	1,90	0,75	0,98
=TRANSPOR-M0007	3P+PE	20	1	0	1	2,5	2,5	2,5	1,90	0,75	0,98
=TRANSPOR-M0009	3P+PE	20	1	0	1	4	4	4	4,75	0,75	2,46
=TRANSPOR-M0016	3P+PE	20	1	0	1	10	10	10	14,70	0,80	8,11
=TRANSP-DUMMY	3P+N+PE	0	1	1	1	25	25	25	72,20	0,80	39,85

Instantaneous values									
reference	Conductive losses (daytime)			Load (night time)			Conductive losses (night time)		
	[W/m]	[W]	rel. to load	rel. to day	Ib [A]	P [kW]	[W/m]	[W]	rel. to load
LIGHT	0,455	4,55	0,34%	10%	0,6	0,14	0,005	0,05	0,03%
ALSB-OV0001	2,620	26,20	0,37%	25%	9,6	1,77	0,164	1,64	0,09%
ALSB-DIV0001	16,530	0,00	0,00%	15%	9,5	5,22	0,372	0,00	0,00%
TRANSPORT	7,014	701,43	1,27%	10%	10,0	5,52	0,070	7,01	0,13%
=TRANSPOR-M0001	0,096	1,92	0,20%	10%	0,2	0,10	0,001	0,02	0,02%
=TRANSPOR-M0007	0,096	1,92	0,20%	10%	0,2	0,10	0,001	0,02	0,02%
=TRANSPOR-M0009	0,376	7,52	0,31%	10%	0,5	0,25	0,004	0,08	0,03%
=TRANSPOR-M0016	1,440	28,80	0,35%	10%	1,5	0,81	0,014	0,29	0,04%
=TRANSP-DUMMY	13,895	0,00	0,00%	10%	7,2	3,99	0,139	0,00	0,00%

Cumulative Values				Investment related figures		
reference	Energy losses per year			cost	CU usage	equiv. CO2
	[kWh]	[EUR]	[kgCO2]	[EUR]	[kgCU]	[kgCO2]
LIGHT	14,49	€ 2,14	5,72	€ 46,77	1,07	3,16
ALSB-OV0001	91,20	€ 13,50	36,02	€ 148,13	6,71	19,78
ALSB-DIV0001	0,00	€ -	0,00	€ 11,33	0,00	0,00
TRANSPORT	2233,98	€ 330,63	882,42	€ 3.771,00	424,65	1252,72
=TRANSPOR-M0001	6,13	€ 0,91	2,42	€ 64,80	1,79	5,27
=TRANSPOR-M0007	6,13	€ 0,91	2,42	€ 64,80	1,79	5,27
=TRANSPOR-M0009	23,94	€ 3,54	9,46	€ 85,54	2,86	8,44
=TRANSPOR-M0016	91,72	€ 13,57	36,23	€ 148,54	7,15	21,10
=TRANSP-DUMMY	0,00	€ -	0,00	€ 13,60	0,00	0,00
Total	**2467,6 kWh**	**€ 365,20**	**974,7 kgCO2**	**€ 4.354,51**	**446,0 kgCU**	**1315,7 kgCO2**

Investment analysis figures		
reference	CLrTCO(10yr)	CLrCFP(20yr)
	[EUR]	[kgCO2]
LIGHT	€ 68,21	117,62
ALSB-OV0001	€ 283,10	740,25
ALSB-DIV0001	€ 11,33	0,00
TRANSPORT	€ 7.077,29	18901,15
=TRANSPOR-M0001	€ 73,87	53,69
=TRANSPOR-M0007	€ 73,87	53,69
=TRANSPOR-M0009	€ 120,97	197,58
=TRANSPOR-M0016	€ 284,29	745,69
=TRANSP-DUMMY	€ 13,60	0,00
Total	**€ 8.006,54**	**20809,7 kgCO2**

6.3.5 Ecologic optimum

Electric System Descriptive Data											
reference	circuit	Length	# parallel cond. [-]			Cross Section [mm²]			Load (daytime)		
	type	[m]	Ph	N	PE	Phase	N	PE	Ib [A]	Cos(φ)	P [kW]
LIGHT	P+N+PE	10	1	1	1	25	25	25	6,40	0,92	1,35
ALSB-OV0001	P+N+PE	10	1	1	1	150	150	150	38,40	0,80	7,07
ALSB-DIV0001	3P+N+PE	0	1	1	1	16	16	16	63,00	0,80	34,78
TRANSPORT	3P+N+PE	100	1	1	1	400	400	400	100,00	0,80	55,20
=TRANSPOR-M0001	3P+PE	20	1	0	1	6	6	6	1,90	0,75	0,98
=TRANSPOR-M0007	3P+PE	20	1	0	1	2,5	2,5	2,5	1,90	0,75	0,98
=TRANSPOR-M0009	3P+PE	20	1	0	1	16	16	16	4,75	0,75	2,46
=TRANSPOR-M0016	3P+PE	20	1	0	1	50	50	50	14,70	0,80	8,11
=TRANSP-DUMMY	3P+N+PE	0	1	1	1	25	25	25	72,20	0,80	39,85

Instantaneous values									
reference	Conductive losses (daytime)			Load (night time)			Conductive losses (night time)		
	[W/m]	[W]	rel. to load	rel. to day	Ib [A]	P [kW]	[W/m]	[W]	rel. to load
LIGHT	0,073	0,73	0,05%	10%	0,6	0,14	0,001	0,01	0,01%
ALSB-OV0001	0,437	4,37	0,06%	25%	9,6	1,77	0,027	0,27	0,02%
ALSB-DIV0001	16,530	0,00	0,00%	15%	9,5	5,22	0,372	0,00	0,00%
TRANSPORT	1,666	166,59	0,30%	10%	10,0	5,52	0,017	1,67	0,03%
=TRANSPOR-M0001	0,040	0,80	0,08%	10%	0,2	0,10	0,000	0,01	0,01%
=TRANSPOR-M0007	0,096	1,92	0,20%	10%	0,2	0,10	0,001	0,02	0,02%
=TRANSPOR-M0009	0,094	1,88	0,08%	10%	0,5	0,25	0,001	0,02	0,01%
=TRANSPOR-M0016	0,288	5,76	0,07%	10%	1,5	0,81	0,003	0,06	0,01%
=TRANSP-DUMMY	13,895	0,00	0,00%	10%	7,2	3,99	0,139	0,00	0,00%

Cumulative Values				Investment related figures		
reference	Energy losses per year			cost	CU usage	equiv. CO2
	[kWh]	[EUR]	[kgCO2]	[EUR]	[kgCU]	[kgCO2]
LIGHT	2,32	€ 0,34	0,92	€ 148,13	6,71	19,78
ALSB-OV0001	15,20	€ 2,25	6,00	€ 598,10	40,23	118,68
ALSB-DIV0001	0,00	€ -	0,00	€ 11,33	0,00	0,00
TRANSPORT	530,57	€ 78,52	209,58	€ 12.700,03	1788,00	5274,60
=TRANSPOR-M0001	2,55	€ 0,38	1,01	€ 115,00	4,29	12,66
=TRANSPOR-M0007	6,13	€ 0,91	2,42	€ 64,80	1,79	5,27
=TRANSPOR-M0009	5,99	€ 0,89	2,36	€ 203,87	11,44	33,76
=TRANSPOR-M0016	18,34	€ 2,71	7,25	€ 479,00	35,76	105,49
=TRANSP-DUMMY	0,00	€ -	0,00	€ 13,60	0,00	0,00
Total	**581,1 kWh**	**€ 86,00**	**229,5 kgCO2**	**€ 14.333,87**	**1888,2 kgCU**	**5570,2 kgCO2**

Investment analysis figures		
reference	CLrTCO(10yr)	CLrCFP(20yr)
	[EUR]	[kgCO2]
LIGHT	€ 151,56	38,09
ALSB-OV0001	€ 620,60	238,76
ALSB-DIV0001	€ 11,33	0,00
TRANSPORT	€ 13.485,28	9466,10
=TRANSPOR-M0001	€ 118,78	32,83
=TRANSPOR-M0007	€ 73,87	53,69
=TRANSPOR-M0009	€ 212,73	81,04
=TRANSPOR-M0016	€ 506,15	250,41
=TRANSP-DUMMY	€ 13,60	0,00
Total	**€ 15.193,90**	**10160,9 kgCO2**

6.4 Addendum 1 : Numerical Results "Large industrial plant"

6.4.1 Base line solution

Electric System Descriptive Data											
reference	circuit	Length	# parallel cond. [-]			Cross Section [mm²]			Load (daytime)		
	type	[m]	Ph	N	PE	Phase	N	PE	Ib [A]	Cos(φ)	P [kW]
POWER	3P+N+PE	20	1	1	1	300	300	95	490	0,80	270,48
=UTILITIES	3P+N+PE	100	2	2	1	240	240	150	400	0,80	220,80
DISTRIB-DUMMY	3P+N+PE	0	3	3	1	400	400	400	1800	0,80	993,60
=MOTOR	3P+N+PE	150	1	1	1	300	300	95	480	0,80	264,96
=TRACING	3P+N+PE	170	2	2	1	120	120	70	451,1	0,80	249,01
=POWER-DUMMY	3P+N+PE	0	2	2	1	240	240	150	793,9	0,80	438,23
=MOTOR-M0001	3P+PE	50	1	0	1	25	0	25	41,8	0,88	25,38
=TRACING-VW0001	P+N+PE	60	1	1	1	2,5	2,5	2,5	2,12	1,00	0,49
Q1	3P+N+PE	126	1	1	1	25	25	25	67	0,81	37,45
Q5	3P+N+PE	71	3	3	1	185	185	50	982,9	0,80	542,56
=UTILITIE-B0001	3P+N+PE	6	1	1	1	16	16	16	63	0,80	34,78
Q2	3P+N+PE	58	1	1	1	2,5	2,5	2,5	3,79	0,98	2,56
DUMMY1	3P+N+PE	95	1	1	1	50	50	35	45,1	0,80	24,90
101Q2-	3P+N+PE	67	1	1	1	1,5	1,5	1,5	1,97	0,98	1,33
EB11_OV1	3P+N+PE	74	1	1	1	16	16	16	48	0,80	26,50
DUMMY2	3P+N+PE	0	2	2	1	185	185	95	640	0,80	353,28

Instantaneous values									
reference	Conductive losses (daytime)			Load (night time)			Conductive losses (night time)		
	[W/m]	[W]	rel. to load	rel. to day	Ib [A]	P [kW]	[W/m]	[W]	rel. to load
POWER	53,331	1066,62	0,39%	80%	392,0	216,38	34,132	682,64	0,32%
=UTILITIES	22,212	2221,20	1,01%	75%	300,0	165,60	12,494	1249,43	0,75%
DISTRIB-DUMMY	179,917	0,00	0,00%	80%	1440,0	794,88	115,147	0,00	0,00%
=MOTOR	51,176	7676,47	2,90%	80%	384,0	211,97	32,753	4912,94	2,32%
=TRACING	56,499	9604,89	3,86%	100%	451,1	249,01	56,499	9604,89	3,86%
=POWER-DUMMY	87,498	0,00	0,00%	80%	635,1	350,59	55,999	0,00	0,00%
=MOTOR-M0001	4,657	232,86	0,92%	100%	41,8	25,38	4,657	232,86	0,92%
=TRACING-VW0001	0,080	4,79	0,98%	100%	2,1	0,49	0,080	4,79	0,98%
Q1	11,965	1507,61	4,03%	100%	67,0	37,45	11,965	1507,61	4,03%
Q5	115,994	8235,56	1,52%	100%	982,9	542,56	115,994	8235,56	1,52%
=UTILITIE-B0001	16,530	99,18	0,29%	100%	63,0	34,78	16,530	99,18	0,29%
Q2	0,383	22,21	0,87%	100%	3,8	2,56	0,383	22,21	0,87%
DUMMY1	2,711	257,52	1,03%	80%	36,1	19,92	1,735	164,81	0,83%
101Q2-	0,172	11,55	0,87%	50%	1,0	0,67	0,043	2,89	0,43%
EB11_OV1	9,596	710,07	2,68%	50%	24,0	13,25	2,399	177,52	1,34%
DUMMY2	73,768	0,00	0,00%	50%	320,0	176,64	18,442	0,00	0,00%

Cumulative Values				Investment related figures		
reference	Energy losses per year			cost	CU usage	equiv. CO2
	[kWh]	[EUR]	[kgCO2]	[EUR]	[kgCU]	[kgCO2]
POWER	7181,22	€ 739,67	2836,58	€ 2.214,26	231,55	683,06
=UTILITIES	13985,23	€ 1.440,48	5524,17	€ 17.665,33	1850,58	5459,21
DISTRIB-DUMMY	0,00	€ -	0,00	€ 400,00	0,00	0,00
=MOTOR	51683,24	€ 5.323,37	20414,88	€ 16.086,95	1736,60	5122,96
=TRACING	84138,81	€ 8.666,30	33234,83	€ 15.704,42	1565,39	4617,91
=POWER-DUMMY	0,00	€ -	0,00	€ 113,33	0,00	0,00
=MOTOR-M0001	2039,84	€ 210,10	805,74	€ 686,25	44,70	131,87
=TRACING-VW0001	41,98	€ 4,32	16,58	€ 182,40	4,02	11,87
Q1	13206,67	€ 1.360,29	5216,63	€ 1.708,68	140,81	415,37
Q5	72143,48	€ 7.430,78	28496,67	€ 14.775,89	1440,86	4250,54
=UTILITIE-B0001	868,81	€ 89,49	343,18	€ 69,10	4,29	12,66
Q2	194,53	€ 20,04	76,84	€ 176,52	6,48	19,12
DUMMY1	1733,82	€ 178,58	684,86	€ 2.198,75	199,59	588,78
101Q2-	52,40	€ 5,40	20,70	€ 153,61	4,49	13,25
EB11_OV1	3221,20	€ 331,78	1272,37	€ 723,73	52,92	156,13
DUMMY2	0,00	€ -	0,00	€ 80,00	0,00	0,00
Total	**250491,2 kWh**	**€ 25.800,59**	**98944,0 kgCO2**	**€ 72.939,22**	**7282,3 kgCU**	**21482,7 kgCO2**

Investment analysis figures		
reference	CLrTCO(10yr) [EUR]	CLrCFP(20yr) [kgCO2]
POWER	€ 9.610,92	57414,69
=UTILITIES	€ 32.070,12	115942,53
DISTRIB-DUMMY	€ 400,00	0,00
=MOTOR	€ 69.320,69	413420,56
=TRACING	€ 102.367,39	669314,50
=POWER-DUMMY	€ 113,33	0,00
=MOTOR-M0001	€ 2.787,28	16246,58
=TRACING-VW0001	€ 225,64	343,48
Q1	€ 15.311,54	104748,03
Q5	€ 89.083,67	574183,99
=UTILITIE-B0001	€ 963,97	6876,27
Q2	€ 376,88	1555,88
DUMMY1	€ 3.984,58	14285,95
101Q2-	€ 207,58	427,22
EB11_OV1	€ 4.041,56	25603,58
DUMMY2	€ 80,00	0,00
Total	**€ 330.945,17**	**2000363,3 kgCO2**

6.4.2 One Size Up

Electric System Descriptive Data												
reference	circuit	Length	# parallel cond. [-]			Cross Section [mm²]			Load (daytime)		
	type	[m]	Ph	N	PE	Phase	N	PE	Ib [A]	Cos(φ)	P [kW]
POWER	3P+N+PE	20	1	1	1	400	400	120	490,00	0,80	270,48
=UTILITIES	3P+N+PE	100	2	2	1	300	300	185	400,00	0,80	220,80
DISTRIB-DUMMY	3P+N+PE	0	3	3	1	500	500	500	1800,00	0,80	993,60
=MOTOR	3P+N+PE	150	1	1	1	400	400	120	480,00	0,80	264,96
=TRACING	3P+N+PE	170	2	2	1	150	150	95	451,10	0,80	249,01
=POWER-DUMMY	3P+N+PE	0	2	2	1	300	300	185	793,90	0,80	438,23
=MOTOR-M0001	3P+PE	50	1	0	1	35	0	35	41,80	0,88	25,38
=TRACING-VW0001	P+N+PE	60	1	1	1	4	4	4	2,12	1,00	0,49
Q1	3P+N+PE	126	1	1	1	35	35	35	67,00	0,81	37,45
Q5	3P+N+PE	71	3	3	1	240	240	70	982,90	0,80	542,56
=UTILITIE-B0001	3P+N+PE	6	1	1	1	25	25	25	63,00	0,80	34,78
Q2	3P+N+PE	58	1	1	1	4	4	4	3,79	0,98	2,56
DUMMY1	3P+N+PE	95	1	1	1	70	70	50	45,10	0,80	24,90
101Q2-	3P+N+PE	67	1	1	1	2,5	2,5	2,5	1,97	0,98	1,33
EB11_OV1	3P+N+PE	74	1	1	1	25	25	25	48,00	0,80	26,50
DUMMY2	3P+N+PE	0	2	2	1	240	240	120	640,00	0,80	353,28

Instantaneous values									
reference	Conductive losses (daytime)			Load (night time)			Conductive losses (night time)		
	[W/m]	[W]	rel. to load	rel. to day	Ib [A]	P [kW]	[W/m]	[W]	rel. to load
POWER	39,998	799,97	0,30%	80%	392,0	216,38	25,599	511,98	0,24%
=UTILITIES	17,770	1776,96	0,80%	75%	300,0	165,60	9,995	999,54	0,60%
DISTRIB-DUMMY	143,934	0,00	0,00%	80%	1440,0	794,88	92,118	0,00	0,00%
=MOTOR	38,382	5757,35	2,17%	80%	384,0	211,97	24,565	3684,70	1,74%
=TRACING	45,199	7683,91	3,09%	100%	451,1	249,01	45,199	7683,91	3,09%
=POWER-DUMMY	69,999	0,00	0,00%	80%	635,1	350,59	44,799	0,00	0,00%
=MOTOR-M0001	3,327	166,33	0,66%	100%	41,8	25,38	3,327	166,33	0,66%
=TRACING-VW0001	0,050	2,99	0,61%	100%	2,1	0,49	0,050	2,99	0,61%
Q1	8,547	1076,86	2,88%	100%	67,0	37,45	8,547	1076,86	2,88%
Q5	89,412	6348,24	1,17%	100%	982,9	542,56	89,412	6348,24	1,17%
=UTILITIE-B0001	10,579	63,47	0,18%	100%	63,0	34,78	10,579	63,47	0,18%
Q2	0,239	13,88	0,54%	100%	3,8	2,56	0,239	13,88	0,54%
DUMMY1	1,936	183,94	0,74%	80%	36,1	19,92	1,239	117,72	0,59%
101Q2-	0,103	6,93	0,52%	50%	1,0	0,67	0,026	1,73	0,26%
EB11_OV1	6,141	454,45	1,72%	50%	24,0	13,25	1,535	113,61	0,86%
DUMMY2	56,863	0,00	0,00%	50%	320,0	176,64	14,216	0,00	0,00%

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Cumulative Values				Investment related figures		
reference	Energy losses per year			cost	CU usage	equiv. CO2
	[kWh]	[EUR]	[kgCO2]	[EUR]	[kgCU]	[kgCO2]
POWER	5385,91	€ 554,75	2127,44	€ 2.646,67	307,54	907,23
=UTILITIES	11188,18	€ 1.152,38	4419,33	€ 21.502,60	2310,99	6817,42
DISTRIB-DUMMY	0,00	€ -	0,00	€ 720,00	0,00	0,00
=MOTOR	38762,43	€ 3.992,53	15311,16	€ 18.983,38	2306,52	6804,23
=TRACING	67311,05	€ 6.933,04	26587,86	€ 19.055,40	1968,14	5806,02
=POWER-DUMMY	0,00	€ -	0,00	€ 160,00	0,00	0,00
=MOTOR-M0001	1457,03	€ 150,07	575,53	€ 895,15	62,58	184,61
=TRACING-VW0001	26,24	€ 2,70	10,36	€ 240,62	6,44	18,99
Q1	9433,33	€ 971,63	3726,17	€ 2.229,94	197,13	581,52
Q5	55610,60	€ 5.727,89	21966,19	€ 18.862,88	1872,48	5523,82
=UTILITIE-B0001	556,04	€ 57,27	219,64	€ 94,32	6,71	19,78
Q2	121,58	€ 12,52	48,02	€ 232,87	10,37	30,59
DUMMY1	1238,44	€ 127,56	489,18	€ 2.824,89	280,27	826,79
101Q2-	31,44	€ 3,24	12,42	€ 202,98	7,49	22,09
EB11_OV1	2061,57	€ 212,34	814,32	€ 1.009,12	82,70	243,95
DUMMY2	0,00	€ -	0,00	€ 113,33	0,00	0,00
Total	**93183,8 kWh**	**€ 19.897,93**	**76307,6 kgCO2**	**€ 89.774,15**	**9419,3 kgCU**	**27787,1 kgCO2**

Investment analysis figures		
reference	CLrTCO(10yr) [EUR]	CLrCFP(20yr) [kgCO2]
POWER	€ 8.194,16	43455,95
=UTILITIES	€ 33.026,43	95204,08
DISTRIB-DUMMY	€ 720,00	0,00
=MOTOR	€ 58.908,69	313027,44
=TRACING	€ 88.385,78	537563,29
=POWER-DUMMY	€ 160,00	0,00
=MOTOR-M0001	€ 2.395,89	11695,12
=TRACING-VW0001	€ 267,64	226,25
Q1	€ 11.946,27	75104,85
Q5	€ 76.141,79	444847,53
=UTILITIE-B0001	€ 667,04	4412,49
Q2	€ 358,09	991,07
DUMMY1	€ 4.100,48	10610,49
101Q2-	€ 235,36	270,47
EB11_OV1	€ 3.132,53	16530,32
DUMMY2	€ 113,33	0,00
Total	**€ 288.753,50**	**1553939,3 kgCO2**

6.4.3 Two sizes Up

Electric System Descriptive Data											
reference	circuit	Length	# parallel cond. [-]			Cross Section [mm²]			Load (daytime)		
	type	[m]	Ph	N	PE	Phase	N	PE	Ib [A]	Cos(φ)	P [kW]
POWER	3P+N+PE	20	1	1	1	500	500	150	490,00	0,80	270,48
=UTILITIES	3P+N+PE	100	2	2	1	400	400	240	400,00	0,80	220,80
DISTRIB-DUMMY	3P+N+PE	0	3	3	1	630	630	630	1800,00	0,80	993,60
=MOTOR	3P+N+PE	150	1	1	1	500	500	150	480,00	0,80	264,96
=TRACING	3P+N+PE	170	2	2	1	185	185	120	451,10	0,80	249,01
=POWER-DUMMY	3P+N+PE	0	2	2	1	400	400	240	793,90	0,80	438,23
=MOTOR-M0001	3P+PE	50	1	0	1	50	0	50	41,80	0,88	25,38
=TRACING-VW0001	P+N+PE	60	1	1	1	6	6	6	2,12	1,00	0,49
Q1	3P+N+PE	126	1	1	1	50	50	50	67,00	0,81	37,45
Q5	3P+N+PE	71	3	3	1	300	300	95	982,90	0,80	542,56
=UTILITIE-B0001	3P+N+PE	6	1	1	1	35	35	35	63,00	0,80	34,78
Q2	3P+N+PE	58	1	1	1	6	6	6	3,79	0,98	2,56
DUMMY1	3P+N+PE	95	1	1	1	95	95	70	45,10	0,80	24,90
101Q2-	3P+N+PE	67	1	1	1	4	4	4	1,97	0,98	1,33
EB11_OV1	3P+N+PE	74	1	1	1	35	35	35	48,00	0,80	26,50
DUMMY2	3P+N+PE	0	2	2	1	300	300	150	640,00	0,80	353,28

Instantaneous values									
reference	Conductive losses (daytime)			Load (night time)			Conductive losses (night time)		
	[W/m]	[W]	rel. to load	rel. to day	Ib [A]	P [kW]	[W/m]	[W]	rel. to load
POWER	31,999	639,97	0,24%	80%	392,0	216,38	20,479	409,58	0,19%
=UTILITIES	13,327	1332,72	0,60%	75%	300,0	165,60	7,497	749,66	0,45%
DISTRIB-DUMMY	114,233	0,00	0,00%	80%	1440,0	794,88	73,109	0,00	0,00%
=MOTOR	30,706	4605,88	1,74%	80%	384,0	211,97	19,652	2947,76	1,39%
=TRACING	36,648	6230,20	2,50%	100%	451,1	249,01	36,648	6230,20	2,50%
=POWER-DUMMY	52,499	0,00	0,00%	80%	635,1	350,59	33,599	0,00	0,00%
=MOTOR-M0001	2,329	116,43	0,46%	100%	41,8	25,38	2,329	116,43	0,46%
=TRACING-VW0001	0,033	2,00	0,41%	100%	2,1	0,49	0,033	2,00	0,41%
Q1	5,983	753,81	2,01%	100%	67,0	37,45	5,983	753,81	2,01%
Q5	71,529	5078,59	0,94%	100%	982,9	542,56	71,529	5078,59	0,94%
=UTILITIE-B0001	7,557	45,34	0,13%	100%	63,0	34,78	7,557	45,34	0,13%
Q2	0,160	9,25	0,36%	100%	3,8	2,56	0,160	9,25	0,36%
DUMMY1	1,427	135,54	0,54%	80%	36,1	19,92	0,913	86,74	0,44%
101Q2-	0,065	4,33	0,33%	50%	1,0	0,67	0,016	1,08	0,16%
EB11_OV1	4,387	324,60	1,23%	50%	24,0	13,25	1,097	81,15	0,61%
DUMMY2	45,490	0,00	0,00%	50%	320,0	176,64	11,373	0,00	0,00%

Cumulative Values				Investment related figures		
reference	Energy losses per year			cost	CU usage	equiv. CO2
	[kWh]	[EUR]	[kgCO2]	[EUR]	[kgCU]	[kgCO2]
POWER	4308,73	€ 443,80	1701,95	€ 3.179,06	384,42	1134,04
=UTILITIES	8391,14	€ 864,29	3314,50	€ 25.400,07	3075,36	9072,31
DISTRIB-DUMMY	0,00	€ -	0,00	€ 960,00	0,00	0,00
=MOTOR	31009,94	€ 3.194,02	12248,93	€ 22.282,95	2883,15	8505,29
=TRACING	54576,52	€ 5.621,38	21557,73	€ 23.474,38	2431,68	7173,46
=POWER-DUMMY	0,00	€ -	0,00	€ 266,67	0,00	0,00
=MOTOR-M0001	1019,92	€ 105,05	402,87	€ 1.166,90	89,40	263,73
=TRACING-VW0001	17,49	€ 1,80	6,91	€ 329,00	9,66	28,48
Q1	6603,33	€ 680,14	2608,32	€ 2.909,58	281,61	830,75
Q5	44488,48	€ 4.582,31	17572,95	€ 22.969,87	2345,36	6918,82
=UTILITIE-B0001	397,17	€ 40,91	156,88	€ 122,38	9,39	27,69
Q2	81,05	€ 8,35	32,02	€ 318,30	15,56	45,89
DUMMY1	912,54	€ 93,99	360,45	€ 3.583,95	382,19	1127,45
101Q2-	19,65	€ 2,02	7,76	€ 267,76	11,98	35,34
EB11_OV1	1472,55	€ 151,67	581,66	€ 1.316,66	115,77	341,53
DUMMY2	0,00	€ -	0,00	€ 160,00	0,00	0,00
Total	**153298,5 kWh**	**€ 15.789,75**	**60552,9 kgCO2**	**€ 108.707,52**	**12035,5 kgCU**	**35504,8 kgCO2**

Investment analysis figures		
reference	CLrTCO(10yr)	CLrCFP(20yr)
	[EUR]	[kgCO2]
POWER	€ 7.617,05	35173,02
=UTILITIES	€ 34.042,94	75362,30
DISTRIB-DUMMY	€ 960,00	0,00
=MOTOR	€ 54.223,19	253483,86
=TRACING	€ 79.688,20	438328,00
=POWER-DUMMY	€ 266,67	0,00
=MOTOR-M0001	€ 2.217,42	8321,09
=TRACING-VW0001	€ 347,01	166,66
Q1	€ 9.711,01	52997,08
Q5	€ 68.793,00	358377,79
=UTILITIE-B0001	€ 531,46	3165,34
Q2	€ 401,78	686,21
DUMMY1	€ 4.523,86	8336,49
101Q2-	€ 288,00	190,58
EB11_OV1	€ 2.833,39	11974,65
DUMMY2	€ 160,00	0,00
Total	**€ 266.604,99**	**1246563,0 kgCO2**

6.4.4 Economic Optimum

Electric System Descriptive Data											
reference	circuit	Length	# parallel cond. [-]			Cross Section [mm²]			Load (daytime)		
	type	[m]	Ph	N	PE	Phase	N	PE	Ib [A]	Cos(φ)	P [kW]
POWER	3P+N+PE	20	1	1	1	630	630	300	490,00	0,80	270,48
=UTILITIES	3P+N+PE	100	2	2	1	240	240	120	400,00	0,80	220,80
DISTRIB-DUMMY	3P+N+PE	0	3	3	1	400	400	195	1800,00	0,80	993,60
=MOTOR	3P+N+PE	150	1	1	1	630	630	300	480,00	0,80	264,96
=TRACING	3P+N+PE	170	2	2	1	400	400	195	451,10	0,80	249,01
=POWER-DUMMY	3P+N+PE	0	2	2	1	240	240	120	793,90	0,80	438,23
=MOTOR-M0001	3P+PE	50	1	0	1	75	75	35	41,80	0,88	25,38
=TRACING-VW0001	P+N+PE	60	1	1	1	2,5	2,5	2,5	2,12	1,00	0,49
Q1	3P+N+PE	126	1	1	1	75	75	35	67,00	0,81	37,45
Q5	3P+N+PE	71	3	3	1	630	630	300	982,90	0,80	542,56
=UTILITIE-B0001	3P+N+PE	6	1	1	1	75	75	35	63,00	0,80	34,78
Q2	3P+N+PE	58	1	1	1	2,5	2,5	2,5	3,79	0,98	2,56
DUMMY1	3P+N+PE	95	1	1	1	50	50	25	45,10	0,80	24,90
101Q2-	3P+N+PE	67	1	1	1	1,5	1,5	1,5	1,97	0,98	1,33
EB11_OV1	3P+N+PE	74	1	1	1	50	50	25	48,00	0,80	26,50
DUMMY2	3P+N+PE	0	2	2	1	185	185	95	640,00	0,80	353,28

Instantaneous values									
reference	Conductive losses (daytime)			Load (night time)			Conductive losses (night time)		
	[W/m]	[W]	rel. to load	rel. to day	Ib [A]	P [kW]	[W/m]	[W]	rel. to load
POWER	25,396	507,91	0,19%	80%	392,0	216,38	16,253	325,07	0,15%
=UTILITIES	22,212	2221,20	1,01%	75%	300,0	165,60	12,494	1249,43	0,75%
DISTRIB-DUMMY	179,917	0,00	0,00%	80%	1440,0	794,88	115,147	0,00	0,00%
=MOTOR	24,370	3655,46	1,38%	80%	384,0	211,97	15,597	2339,49	1,10%
=TRACING	16,950	2881,47	1,16%	100%	451,1	249,01	16,950	2881,47	1,16%
=POWER-DUMMY	87,498	0,00	0,00%	80%	635,1	350,59	55,999	0,00	0,00%
=MOTOR-M0001	1,552	77,62	0,31%	100%	41,8	25,38	1,552	77,62	0,31%
=TRACING-VW0001	0,080	4,79	0,98%	100%	2,1	0,49	0,080	4,79	0,98%
Q1	3,988	502,54	1,34%	100%	67,0	37,45	3,988	502,54	1,34%
Q5	34,062	2418,38	0,45%	100%	982,9	542,56	34,062	2418,38	0,45%
=UTILITIE-B0001	3,526	21,16	0,06%	100%	63,0	34,78	3,526	21,16	0,06%
Q2	0,383	22,21	0,87%	100%	3,8	2,56	0,383	22,21	0,87%
DUMMY1	2,711	257,52	1,03%	80%	36,1	19,92	1,735	164,81	0,83%
101Q2-	0,172	11,55	0,87%	50%	1,0	0,67	0,043	2,89	0,43%
EB11_OV1	3,071	227,22	0,86%	50%	24,0	13,25	0,768	56,81	0,43%
DUMMY2	73,768	0,00	0,00%	50%	320,0	176,64	18,442	0,00	0,00%

Cumulative Values				**Investment related figures**		
reference	**Energy losses per year**			**cost**	**CU usage**	**equiv. CO2**
	[kWh]	**[EUR]**	**[kgCO2]**	**[EUR]**	**[kgCU]**	**[kgCO2]**
POWER	3419,63	€ 352,22	1350,75	€ 3.684,80	504,22	1487,44
=UTILITIES	13985,23	€ 1.440,48	5524,17	€ 17.665,33	1823,76	5380,09
DISTRIB-DUMMY	0,00	€ -	0,00	€ 400,00	0,00	0,00
=MOTOR	24611,07	€ 2.534,94	9721,37	€ 25.556,00	3781,62	11155,78
=TRACING	25241,64	€ 2.599,89	9970,45	€ 42.993,45	5159,72	15221,18
=POWER-DUMMY	0,00	€ -	0,00	€ 113,33	0,00	0,00
=MOTOR-M0001	679,95	€ 70,03	268,58	€ 1.498,15	116,22	342,85
=TRACING-VW0001	41,98	€ 4,32	16,58	€ 182,40	4,02	11,87
Q1	4402,22	€ 453,43	1738,88	€ 3.738,86	377,36	1113,20
Q5	21184,99	€ 2.182,05	8368,07	€ 36.795,12	4989,06	14717,72
=UTILITIE-B0001	185,35	€ 19,09	73,21	€ 200,90	17,97	53,01
Q2	194,53	€ 20,04	76,84	€ 176,52	6,48	19,12
DUMMY1	1733,82	€ 178,58	684,86	€ 2.198,75	191,09	563,72
101Q2-	52,40	€ 5,40	20,70	€ 153,61	4,49	13,25
EB11_OV1	1030,78	€ 106,17	407,16	€ 1.717,22	148,85	439,11
DUMMY2	0,00	€ -	0,00	€ 80,00	0,00	0,00
Total	**96763,6 kWh**	**€ 9.966,65**	**38221,6 kgCO2**	**€ 137.154,44**	**17124,9 kgCU**	**50518,3 kgCO2**

Investment analysis figures		
reference	**CLrTCO(10yr)**	**CLrCFP(20yr)**
	[EUR]	**[kgCO2]**
POWER	€ 7.207,02	28502,50
=UTILITIES	€ 32.070,12	115863,41
DISTRIB-DUMMY	€ 400,00	0,00
=MOTOR	€ 50.905,40	205583,21
=TRACING	€ 68.992,34	214630,15
=POWER-DUMMY	€ 113,33	0,00
=MOTOR-M0001	€ 2.198,49	5714,42
=TRACING-VW0001	€ 225,64	343,48
Q1	€ 8.273,15	35890,76
Q5	€ 58.615,66	182079,13
=UTILITIE-B0001	€ 391,80	1517,25
Q2	€ 376,88	1555,88
DUMMY1	€ 3.984,58	14260,90
101Q2-	€ 207,58	427,22
EB11_OV1	€ 2.778,93	8582,30
DUMMY2	€ 80,00	0,00
Total	**€ 236.820,92**	**814950,6 kgCO2**

6.4.5 Ecologic optimum

Electric System Descriptive Data											
reference	circuit type	Length [m]	# parallel cond. [-]			Cross Section [mm²]			Load (daytime)		
			Ph	N	PE	Phase	N	PE	Ib [A]	Cos(φ)	P [kW]
POWER	3P+N+PE	20	1	1	1	630	630	300	490,00	0,80	270,48
=UTILITIES	3P+N+PE	100	2	2	1	630	630	300	400,00	0,80	220,80
DISTRIB-DUMMY	3P+N+PE	0	3	3	1	400	400	400	1800,00	0,80	993,60
=MOTOR	3P+N+PE	150	1	1	1	630	630	300	480,00	0,80	264,96
=TRACING	3P+N+PE	170	2	2	1	630	630	300	451,10	0,80	249,01
=POWER-DUMMY	3P+N+PE	0	2	2	1	240	240	120	793,90	0,80	438,23
=MOTOR-M0001	3P+PE	50	1	0	1	300	300	150	41,80	0,88	25,38
=TRACING-VW0001	P+N+PE	60	1	1	1	16	16	16	2,12	1,00	0,49
Q1	3P+N+PE	126	1	1	1	75	75	35	67,00	0,81	37,45
Q5	3P+N+PE	71	3	3	1	630	630	300	982,90	0,80	542,56
=UTILITIE-B0001	3P+N+PE	6	1	1	1	400	400	185	63,00	0,80	34,78
Q2	3P+N+PE	58	1	1	1	25	25	25	3,79	0,98	2,56
DUMMY1	3P+N+PE	95	1	1	1	240	240	120	45,10	0,80	24,90
101Q2-	3P+N+PE	67	1	1	1	10	10	10	1,97	0,98	1,33
EB11_OV1	3P+N+PE	74	1	1	1	240	240	120	48,00	0,80	26,50
DUMMY2	3P+N+PE	0	2	2	1	185	185	95	640,00	0,80	353,28

Instantaneous values									
reference	Conductive losses (daytime)			Load (night time)			Conductive losses (night time)		
	[W/m]	[W]	rel. to load	rel. to day	Ib [A]	P [kW]	[W/m]	[W]	rel. to load
POWER	25,396	507,91	0,19%	80%	392,0	216,38	16,253	325,07	0,15%
=UTILITIES	8,462	846,17	0,38%	75%	300,0	165,60	4,760	475,97	0,29%
DISTRIB-DUMMY	179,917	0,00	0,00%	80%	1440,0	794,88	115,147	0,00	0,00%
=MOTOR	24,370	3655,46	1,38%	80%	384,0	211,97	15,597	2339,49	1,10%
=TRACING	10,762	1829,50	0,73%	100%	451,1	249,01	10,762	1829,50	0,73%
=POWER-DUMMY	87,498	0,00	0,00%	80%	635,1	350,59	55,999	0,00	0,00%
=MOTOR-M0001	0,388	19,40	0,08%	100%	41,8	25,38	0,388	19,40	0,08%
=TRACING-VW0001	0,012	0,75	0,15%	100%	2,1	0,49	0,012	0,75	0,15%
Q1	3,988	502,54	1,34%	100%	67,0	37,45	3,988	502,54	1,34%
Q5	34,062	2418,38	0,45%	100%	982,9	542,56	34,062	2418,38	0,45%
=UTILITIE-B0001	0,661	3,97	0,01%	100%	63,0	34,78	0,661	3,97	0,01%
Q2	0,038	2,22	0,09%	100%	3,8	2,56	0,038	2,22	0,09%
DUMMY1	0,565	53,65	0,22%	80%	36,1	19,92	0,361	34,34	0,17%
101Q2-	0,026	1,73	0,13%	50%	1,0	0,67	0,006	0,43	0,07%
EB11_OV1	0,640	47,34	0,18%	50%	24,0	13,25	0,160	11,83	0,09%
DUMMY2	73,768	0,00	0,00%	50%	320,0	176,64	18,442	0,00	0,00%

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Cumulative Values												
reference	Energy losses per year					Investment related figures					
	[kWh]		[EUR]	[kgCO2]		cost [EUR]		CU usage [kgCU]		equiv. CO2 [kgCO2]	
POWER	3419,63	€	352,22	1350,75	€	3.684,80		504,22		1487,44	
=UTILITIES	5327,71	€	548,75	2104,44	€	34.288,00		4773,96		14083,18	
DISTRIB-DUMMY	0,00	€	-	0,00	€	400,00		0,00		0,00	
=MOTOR	24611,07	€	2.534,94	9721,37	€	25.556,00		3781,62		11155,78	
=TRACING	16026,44	€	1.650,72	6330,44	€	57.841,60		8115,73		23941,41	
=POWER-DUMMY	0,00	€	-	0,00	€	113,33		0,00		0,00	
=MOTOR-M0001	169,99	€	17,51	67,14	€	5.415,65		469,35		1384,58	
=TRACING-VW0001	6,56	€	0,68	2,59	€	588,95		25,75		75,95	
Q1	4402,22	€	453,43	1738,88	€	3.738,86		377,36		1113,20	
Q5	21184,99	€	2.182,05	8368,07	€	36.795,12		4989,06		14717,72	
=UTILITIE-B0001	34,75	€	3,58	13,73	€	887,34		95,75		282,45	
Q2	19,45	€	2,00	7,68	€	793,87		64,82		191,20	
DUMMY1	361,21	€	37,20	142,68	€	8.393,87		917,24		2705,87	
101Q2-	7,86	€	0,81	3,10	€	474,11		29,95		88,35	
EB11_OV1	214,75	€	22,12	84,82	€	6.550,91		714,48		2107,73	
DUMMY2	0,00	€	-	0,00	€	80,00		0,00		0,00	
Total	**75786,6 kWh**	**€**	**7.806,02**	**29935,7 kgCO2**	**€**	**185.602,41**		**24859,3 kgCU**		**73334,9 kgCO2**	

Investment analysis figures			
reference	CLrTCO(10yr) [EUR]		CLrCFP(20yr) [kgCO2]
POWER	€	7.207,02	28502,50
=UTILITIES	€	39.775,54	56172,07
DISTRIB-DUMMY	€	400,00	0,00
=MOTOR	€	50.905,40	205583,21
=TRACING	€	74.348,83	150550,28
=POWER-DUMMY	€	113,33	0,00
=MOTOR-M0001	€	5.590,74	2727,48
=TRACING-VW0001	€	595,71	127,77
Q1	€	8.273,15	35890,76
Q5	€	58.615,66	182079,13
=UTILITIE-B0001	€	923,13	557,00
Q2	€	813,91	344,88
DUMMY1	€	8.765,92	5559,45
101Q2-	€	482,20	150,44
EB11_OV1	€	6.772,10	3804,23
DUMMY2	€	80,00	0,00
Total	**€**	**263.662,63**	**672049,2 kgCO2**