Draft version

Contract N°. Specific contract 185/PP/ENT/IMA/12/1110333 implementing FC ENTR/29/PP/FC Lot 2

Report

Preparatory Studies for Product Group in the Ecodesign Working Plan 2012-2014: Lot 8- Power Cables

DRAFT Task 7 report - Scenarios (policy, scenario, impact and sensitivity analysis) (1st version)

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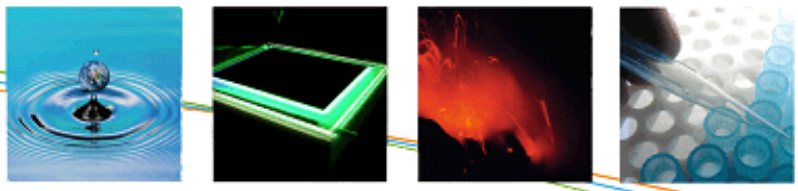

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EXECUTIVE SUMMARY

VITO is performing the preparatory study for the new upcoming eco-design directive for Energy-related Products (ErP) related to power cables, on behalf of the European Commission (more info http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/index_en.htm).

In order to improve the efficient use of resources and reduce the environmental impacts of energy-related products the European Parliament and the Council have adopted Directive 2009/125/EC (recast of Directive 2005/32/EC) establishing a framework for the setting Ecodesign requirements (e.g. energy efficiency) for energy-related products in the residential, tertiary, and industrial sectors. It prevents disparate national legislations on the environmental performance of these products from becoming obstacles to the intra-EU trade and contributes to sustainable development by increasing energy efficiency and the level of protection of the environment, taking into account the whole life cycle cost. This should benefit both businesses and consumers, by enhancing product quality and environmental protection and by facilitating free movement of goods across the EU. It is also possible to introduce binding information requirements for components and sub-assemblies.

The MEErP methodology (Methodology for the Eco-design of Energy-related Products) allows the evaluation of whether and to which extent various energy-related products fulfil the criteria established by the ErP Directive for which implementing measures might be considered. The MEErP model translates product specific information, covering all stages of the life of the product, into environmental impacts (more info http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/methodology/index_en.htm).

The tasks in the MEErP entail:
Task 1 - Scope (definitions, standards and legislation);
Task 2 – Markets (volumes and prices);
Task 3 – Users (product demand side);
Task 4 - Technologies (product supply side, includes both Best Available Technology (BAT) and Best Not Yet Available Technology (BNAT));
Task 5 – Environment & Economics (base case Life Cycle Assessment (LCA) & Life Cycle Costs (LCC));
Task 6 – Design options(improvement potential);
Task 7 – Scenarios (policy, scenario, impact and sensitivity analysis).
Tasks 1 to 4 can be performed in parallel, whereas 5, 6 and 7 are sequential.
Task 0 or a Quick-scan is optional to Task 1 for the case of large or inhomogeneous product groups, where it is recommended to carry out a first product screening. The objective is to re-group or narrow the product scope, as appropriate from an ecodesign point of view, for the subsequent analysis in tasks 2-7.

The preparatory phase of this study is to collect data for input in the MEErP model. An executive Summary of the complete study will be elaborated at completion of the draft final report.

Comment: This report is currently a working progress, as some parts of the study are missing comments and data from the stakeholders, therefore it shall not be viewed as a final report.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

BAT	Best Available Technology
BAU	Business As Usual
BC	Base Case
BNAT	Best Not (Yet) Available Technology
BOM	Bill Of Materials
CSA	conductor Cross-Sectional Area
Cu	Copper
EC	European Commission
EOL	End Of Life
GHG	GreenHouse Gas
GWP	Global Warming Potential
Kd	Distribution factor
Kf	Load Form Factor
LCA	(environmental) Life Cycle Assessment
LCC	Life Cycle Costs
LLCC	Least Life Cycle Cost
LV	Low Voltage
MV	Medium Voltage
NPV	Net Present Value
Pf	Power Factor
PVC	PolyVinyl Chloride
R	Resistance
TBC	To Be Confirmed
TBD	To Be Defined
VITO	Flemish institute for Technological Research
XLPE	Cross-Linked PolyEthylene

Use of text background colours

Blue: draft text
Yellow: text requires attention to be commented
Green: text changed in the last update

CHAPTER 7 TASK 7: SCENARIOS

The objective of this task is to look at suitable policy means to achieve the potential improvement, e.g. implementing Least Life Cycle Cost (LLCC) as a minimum requirement, the environmental performance of Best Available Technology (BAT) or Best Not (Yet) Available Technology (BNAT) as a benchmark, using dynamic aspects, legislative or voluntary agreements, standards, labelling or incentives, relating to public procurement or direct and indirect fiscal instruments. It draws up scenarios quantifying the improvements that can be achieved versus a Business As Usual (BAU) scenario and compares the outcomes with EU environmental targets, the societal costs if the environmental impact reduction would have to be achieved in another way, etc.

It makes an estimate of the impact on users (purchasing power, societal costs) and industry (employment, profitability, competitiveness, investment level, etc.), explicitly describing and taking into account the typical design cycle (platform change) in a product sector.

In addition, this final task provides an analysis of which significant impacts should be measured under possible implementation of measures, and which measurement methods are needed to be developed or adapted for that purpose.

Summary of Task 7:

This task report is currently a draft version with the purpose to collect views of stakeholders.

The proposed policy options in this task take into account the findings from previous tasks.

From Task 1 it was proposed to focus on 'losses in installed power cables in buildings', the power cable being the product put into service by the electrical installer in a circuit of an electrical installation in a building. As a consequence proposed policy measures focus on the power cables itself and/or the installed power cables in electrical circuits in buildings. Therefore, there is also no policy option proposed that would phase out all power cables with small cross-sectional areas (CSA) considered as products brought on the market, because they have their economic justified function in circuits with low loading and/or other applications such as machinery. By consequence most policy measures are formulated at electrical circuit or the system level, which is not directly in the 'product' scope of the ErP Directive (2009/125/EC). The policy options are mostly related to upgraded standardization, labelling and/or electrical installation codes.

By cross-checking the available data in Task 5, it was concluded that many circuits in the stock potentially have a low average load and/or load form factor or equivalent time of peak load. Therefore proposed policy options focuses on typical circuits with high load.

From Task 6 it was concluded that there is improvement potential in several of the design options that increase the CSA. For base cases representing circuits with a low

load, the 'environmental payback time' increased significantly up to almost the defined circuit lifetime. Therefore policy measures in this task are carefully chosen, not imposing an increased CSA for any circuit disregarding their loading and use. For some base cases the LLCC is the BAU, hence this is also taken into account for the proposed policy options.

This task also calculates scenarios on energy use, cost for BAT and LLCC with a sensitivity analysis on key parameters like discount rate, inflation rate, energy escalation rate, product lifetime and stock growth rate. This is useful to estimate the impact in the assumption that all proposed policy measures achieve their maximum impact. In the case of implementation of the BAT scenarios, the EU28 annual energy savings will be up to **15.75 TWh** in 2025, and in the case of LLCC scenarios a saving of **13.87 TWh** is possible.

A summary of the position of the stakeholders will be included and stakeholders are invited to provide input.

It is expected that the proposed measures will have a positive impact on the labour for installers, cable manufacturers and distributors. Stakeholders are invited to provide input on this section on socio-economic impact.

7.1 Policy analysis

7.1.1 Summary of stakeholders position

TBC (final version), stakeholder are invited to provide input.

Position papers are welcome and will be added in annex.

7.1.2 Opportunities for policy measures and barriers

As background for the selected policy options please also read the Task 7 summary section that discusses the findings of previous tasks and the consequences on proposed policy options.

7.1.2.1 Opportunities for policy measures and barriers at product level

7.1.2.1.1 Policy measures at product level by a generic ecodesign requirements on information

The enquiry[1] has demonstrated that installers and users are unaware of cable losses. The current information provided, such as CSA, expressed in mm^2, and the maximum current-carrying capacity in open air, expressed in Amperes [A], is therefore insufficient. A solution is to set a generic ecodesign requirement on the provision of cable loss information, for example:

[1] http://www.erp4cables.net/node/6, this questionnaire was sent to installers on the 30th of September, 2013 in the context of this study. A second questionnaire was sent on the 7th of July, 2014. The results were combined.

- Indication of the maximum DC ohmic resistance per kilometer at 20°C (R_{20} expressed in Ω/km) on the cable complementary to CSA;
- On the package and sales websites:
  - Cable losses per kilometer (VA/kilometer) at 50 % and 100% of the maximum current-carrying capacity of the cable in open air;
  - Indication of the real measured DC ohmic resistance according to the compliance check as described in paragraph 7 of IEC 60228 and Annex A of the standard. The DC ohmic resistance is measured on a cable sample of at least 1 meter at a given room temperature and corrected to 20°C and a length of 1 km (R_{20} expressed in Ω/km).

Notes:

- The measurement of the DC ohmic resistance of a sample of a cable must be carried out according to the requirements of the ISO 9001 (or ISO 17025) Quality Management System. This means that the measurement equipment has to be calibrated according to an (international) standard. Also the required accuracy of the measurement equipment shall be determined to guaranty an accurate measurement result.
- Information about the quality assurance of the production process including the technical procedures for testing of cable samples could/should be mentioned on the manufactures websites.

Stakeholders please provide input.

Remark: Policy measures for insulation material (PVC, XLPE, Halogen Free..)?? – recyclability, fire behavior …….

There are no barriers identified for this provision of information, because cables and packages are already marked with technical information. It only requires time to implement this in the manufacturing chain.

To be provided by manufacturers: how much time is needed?

Proposal for an exact definition of the cables within the scope of such a measure:

The above mentioned measures can be applied to single core and multi core Low Voltage (LV) cables that meet the following standards:

- IEC 60502-1: Power cables with extruded insulation and their accessories for rated voltages from 1kV up to 30 kV.
  Remark: restricted to cables with a rated voltage U0/U (Um) of 0.6/1 (1.2kV)

- EN 50525-1 Electric cables: LV energy cables of rated voltages up to and including 450/750 (U0/u).
  Remark: restricted to EN50525 cables for fixed wiring!

Stakeholders please provide input

7.1.2.1.2 Are electric circuits in buildings products?

This study does not consider electric circuits installed in buildings as products brought on the market nor their buildings. The rationale behind this is explained hereafter.

Electric circuits are elements or components of a building and so far were not considered as 'products' in European legislation. Even if they were considered as new 'products' brought on the market, they would not satisfy the minimum volume of sales requirement of article 15 (5) of the ErP regulation (2009/125/EC). Buildings and their electrical installations cannot be moved or relocated and the 'free movement of goods' is irrelevant issue in this context. For this reason, it is also unlikely that they would ever belong to the product categories of the CE product marking directive (93/68/EEC). By consequence new policy approaches are needed to address the identified improvement options in Task 6 and they are discussed in separate sections in this report.

7.1.2.1.3 Other policy measures at product level

Neither technical improvement options nor policy measures were identified at product level. Improvement options at installation level are discussed in the next sections. As explained before they are not considered as a product in the meaning of the ErP Directive (2009/125/EC).

7.1.2.2 Policy measures at installation level to reduce cable losses

7.1.2.2.1 Policy measures for cables installed in buildings and definition of scope

Task 6 identified significant improvement potential in cables installed in buildings (in the services and industry sector). In many cases, cables with a larger CSA will reduce cable losses economically for electric circuits of low voltage installations in buildings. It was also identified that installers and building owners are unaware of this and therefore even do not consider cables as a potential source for improvement. In the subsequent section specific and generic information requirements are proposed.

Proposal for an exact definition of the electric circuits within the scope of such installation measures:

The scope of this study is "installed Low Voltage power cables in buildings after the meter" (see Task 1, paragraph 1.1.3).

The focus for the policy measures will be on the electric circuits which transport the highest amount of electrical energy in the building. In general these are:

- Electric circuits between the transformer(s) and the main distribution board of the building, after the meter;
- Electric circuits between the main distribution board and the secondary distribution boards;
- Dedicated electric circuits from the main and secondary distribution boards to electrical consumers with a high load factor (large number of operating hours per year) (e.g. HVAC components and servers).

7.1.2.2.1.1 Specific ecodesign requirements to increase CSA and lower cable losses

Requiring minimum CSA above standard CSA levels for the above mentioned electric circuits, by means of:

- Requiring an economic analysis (Life Cycle Cost) for circuits that use the minimum CSA:

  - Similar to IEC 60287-3-2 Electric cables – Calculation of the current – part 3-2: sections on operating conditions – Economic optimization of power cable size;
  - Using economic optimization tool (e.g. Ecocalculator Nexans, Simaris Energy Efficiency optimization tool, etc.);
  - Mentioning a reference to this economic optimization tool on the cable package. This reference can be in the form of a textual URL and/or a QR-code. The reference could link to a web based tool on the sales website, to a commercial tool or to an app running on a smartphone or tablet. The QR-code should contain, besides the URL, the characteristics of the cable, which are automatically provided as input to the tool. For this, the installer has to provide additional information like circuit length and load (load factor and load form factor or equivalent operating time at maximum loss) of the circuit.
- Introduction of an extra correction factor based on the load factor of the electric consumer. HD 60364-5-52:2011 (IEC 60364-5-52:2009) defines two correction factors to determine the maximum allowable current-carrying capacity of an electric circuit; these are the method of installation and the ambient temperature. A third correction factor based on the load factor of the electrical load could be applied. Electrical loads with a high load factor (high amount of operating hours per year) would need cables with a higher CSA compared to the loads with a lower load factor. An alternative approach is to introduce more stringent voltage drop limitations in the standard. (TBD)
- Inclusion of cable losses in the standards for implementing the EPB Directive (2010/31/EU), especially taking into account dedicated building loads such HVAC components. In the framework of EPB it is also possible to add the electrical installation as one of the items of the building system in the guidelines[2] on cost optimal level calculations.

Note: it is proposed to include this in an updated prIEC 60364-8-1 and/or its EN equivalent. To include cable losses in the EPB Directive related standards needs to be updated, e.g. EN15603, and a new standard EN15XXX on the calculation of cable losses needs to be elaborated.

*7.1.2.2.1.2 Generic information requirements on the provision of information to decrease cable losses **before** commissioning of the electric circuit*

It is recommended that the following information is provided for each circuit:

- The unique reference number of the electric circuit;
- Denomination of the load (e.g. pump, server, socket outlets, etc.);
- The design current (Ib);
- The rated current of the circuit (In);
- The cable type and cable length;
- The (estimated) load factor of the electrical load of the circuit (amount of operating hours per year).

Based on this information, the cable losses (kWh per year) in each circuit can be calculated and optimized for circuits with a high load factor and/or long cable lengths.

[2] Guidelines accompanying Commission Delegated Regulation (EU) No 244/2012 of 16 January 2012 supplementing Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings by establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements (2012/C 115/01).

An economic analysis for circuits with a high load factor should be provided as part of the technical file of the electrical installation to be approved by the building owner. Therefore the section on economic optimization of power cable size (part 3-23 2) in standard IEC 60287-3-2 on 'Electric cables - Calculation of the current rating' could be used.

Note: it is proposed to include this in an updated prIEC 60364-8-1 and/or its EN equivalent. This could be aligned with the standard IEC 60287-3-2 that describes an economic optimization method.

*7.1.2.2.1.3 Generic information requirements on the provision of information to decrease cable losses **after** commissioning of the electric circuit*

This generic information may contain the following elements:

- Measure and indicate the loop impedance of electric circuits;
- Indicate circuit breakers of electric circuits with a label reflecting the loss in function of % of rated current of the circuit (In);
- The estimated loss (kWh) and assumed load (average load factor (LF)), load form factor (Kf) and/or equivalent time of peak load (h/y) for the electric circuit;
- A cable loss reduction indicator can be assigned to the intended circuits. This indicator is the ratio of the cable losses for the 'standard' electric circuit to the 'economically optimized' one.
- Remark: also a performance indicator of the complete installation, i.e. multiple circuits, could also be considered, e.g. taking into account the cables loss reduction indicators of each circuit and the ratio of circuits which are economically.

Note: it is proposed to include this in an updated prIEC 60364-8-1 and or its EN equivalent.

7.1.2.2.1.4 Requirements for monitoring of cable losses with BACS during operation of the building (Building Automation and Control Systems)

It is possible to promote and/or mandate the monitoring of power cable losses.

This would require sub-metering and monitoring of the targeted electric circuits. The monitoring system should calculate the load factor (LF) and load form factor (Kf) and/or equivalent or equivalent time of peak load and implement alarms when estimated values at commissioning are exceeded. It is recommended to include these cable loss monitoring functions in standard EN 15232 (2007) on 'Impact of Building Automation'. More specific it should therefore be defined as a building automation function and assigned to a certain efficiency class in Table 1 of the standard.

For consideration: monitor cable temperature instead of measuring the loading current.

7.2 Scenario analysis (unit stock/sale & environmental)

7.2.1 Scenario definition

BAU means 'do not change the regulatory framework' and is used as the baseline to compare all other scenarios.

In order to assess the effects of possible ecodesign requirements a calculation model has been developed. This spreadsheet-based model allows the calculation of impacts (on resource use, such as primary energy consumption, overall EU expenditure and GHG emissions) depending on inputs on the level and timing of energy efficiency requirements.

In the previous section it has been explained that it is extremely difficult to introduce ecodesign requirements at power cable level. Even at circuit level it is difficult as electric circuits cannot be defined as products.
Therefore the scenarios, described further on, are not selected based upon ecodesign regulatory options, but are based upon the improvement options defined in Task 6, in particular the BAT and LLCC option. On top of these scenarios, one additional scenario is selected. This scenario, called 'scenario IV' looks at the case where distribution and dedicated circuits in the services and industry sectors are improved by means of the D1 design option (i.e. S+1), showing the minimal case.

The input for the scenarios is based upon parameters and values defined in previous tasks. Due to the fact that this task looks at the total impact at EU28 level, the correction factors mentioned in section 5.5 of Task 5 are applied to the input data.

To distinguish a BAU electric circuit with an electric circuit designed according to a design option mentioned in Task 6, these latter circuits are called 'improved circuits' in this document.

The assumed start date for introducing 'improved' circuits is 2016 and is the same for all scenarios.

7.2.1.1 Baseline / business as usual scenario

All impacts and savings calculated will be referenced to a so-called baseline scenario (i.e. BAU), which describes the resource consumption and impacts assuming no new legislation is introduced. For each base case circuit the BAU option is selected (see Table 7-1).

Scenario BAU			BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8
design option		I	BAU	BAU	BAU	BAU	BAU	BAU	BAU	BAU

Table 7-1: BAU scenario design options selection

7.2.1.2 BAT scenario

In this scenario, the BAT improvement option is selected for each base case circuit, as calculated in Task 6. This selection is listed in Table 7-2.

Scenario BAT			BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8
design option		I	D3	D3	D2	D3	D3	D3	D3	D3

Table 7-2: BAT scenario design options selection

7.2.1.3 LLCC scenario

In this scenario, the LLCC improvement option is selected for each base case circuit, as calculated in Task 6. This selection is listed in Table 7-3.

Scenario LLCC			BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8
design option		I	D3	BAU	BAU	D3	D1	D1	D1	D3

Table 7-3: LLCC scenario design options selection

7.2.1.4 Scenario IV

In this scenario, the D1 improvement option is selected for the distribution and dedicated circuits in the services and industry sectors. This selection is listed in Table 7-4.

Scenario IV			BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8
design option		I	D1	BAU	BAU	D1	D1	BAU	BAU	D1

Table 7-4: LLCC scenario design options selection

7.2.2 Scenario analysis

Later on in this task this scenario analysis will be referenced as the 'default scenario analysis', to distinguish it from the sensitivity scenario analysis cases.

7.2.2.1 Main input parameters for the analysis

The main input parameters are the parameters that will be altered in the sensitivity analysis. The parameters for this scenario analysis are listed in Table 7-5.

Discount rate	4.0%
Inflation rate	2.0%
Energy Escalation rate	4.0%
Electricity rate (€/kWh)	0.11
Stock growth rate services sector	1.9%
Stock growth rate industry sector	2.9%
Sales growth rate services sector	3.2%
Sales growth rate industry sector	2.8%
Product lifetime services sector (years)	25
Product lifetime industry sector (years)	25

Table 7-5: Main input parameters

7.2.2.2 Stock

Figure 7-1 and Table 7-6 show the increase of circuit stock in units of circuits due to the building stock increase. Of course the increase of the amount of circuits stays the same for each scenario. Figure 7-2 and Table 7-7 shows that this is not the case for the quantity of conductor material used in each scenario. The BAT scenario, opting for the best design options in terms of electricity loss reduction, needs the largest quantity of conductor material, up to almost 2.5 times the quantity needed in the BAU scenario, in 2050. The surplus of conductor material in case of the LLCC scenario is about half of the surplus for the BAT scenario. In case of scenario IV a 28% surplus of conductor material is needed compared to the BAU scenario.

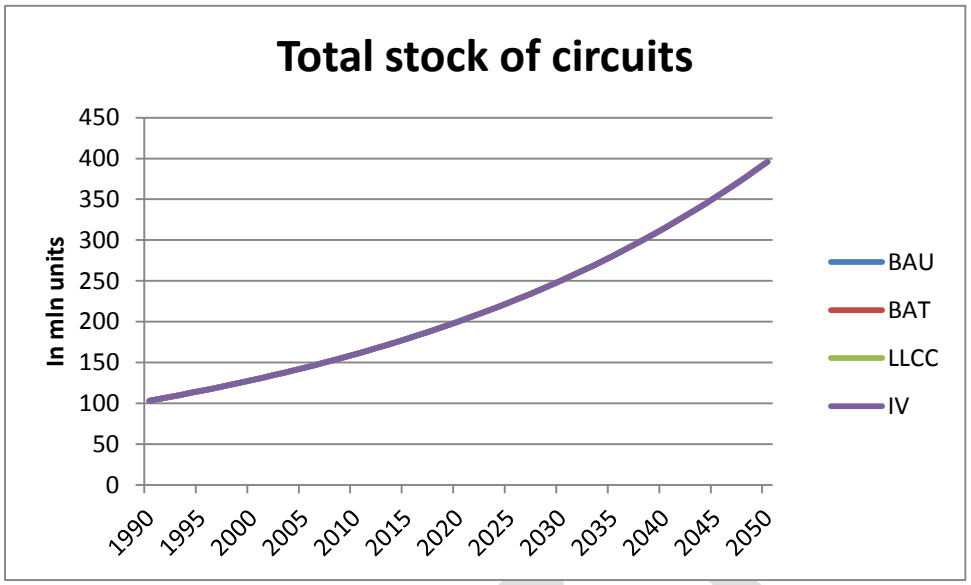


Figure 7-1: Total stock of circuits (in circuit units)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	103.22	115.11	128.44	143.38	160.15	178.97	200.12	223.89	250.62	280.70	314.57	352.73	395.75
BAT	103.22	115.11	128.44	143.38	160.15	178.97	200.12	223.89	250.62	280.70	314.57	352.73	395.75
LLCC	103.22	115.11	128.44	143.38	160.15	178.97	200.12	223.89	250.62	280.70	314.57	352.73	395.75
IV	103.22	115.11	128.44	143.38	160.15	178.97	200.12	223.89	250.62	280.70	314.57	352.73	395.75
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%

Table 7-6: Total stock of circuits (in circuit units)

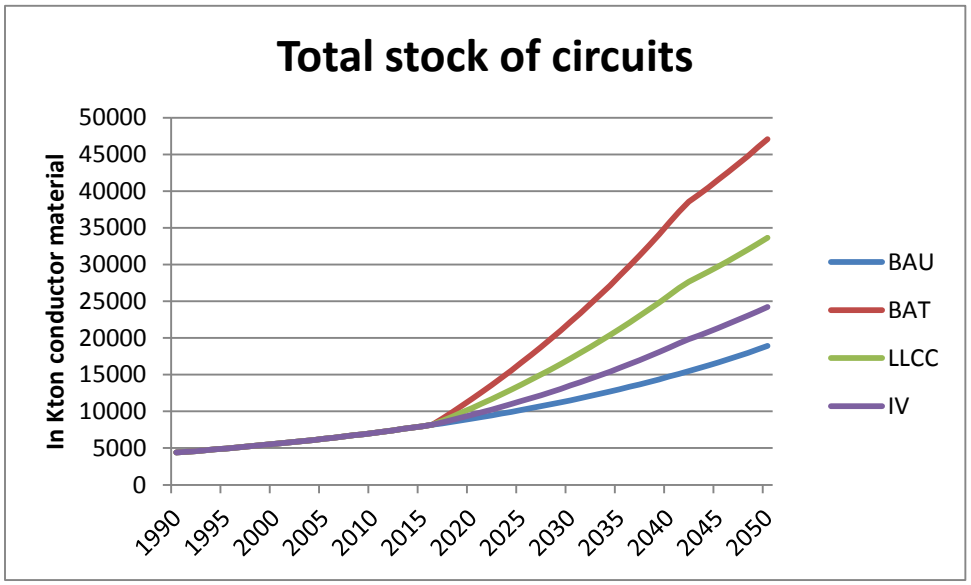


Figure 7-2: Total stock of circuits (in Kton conductor material)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	4389.84	4941.75	5566.35	6273.64	7075.00	7983.45	9013.85	10183.21	11510.98	13019.37	14733.85	16683.55	18901.83
BAT	4389.84	4941.75	5566.35	6273.64	7075.00	7983.45	11692.64	16604.61	22168.69	28474.98	35626.39	41552.11	47090.60
LLCC	4389.84	4941.75	5566.35	6273.64	7075.00	7983.45	10452.13	13619.80	17195.67	21234.71	25799.57	29759.70	33634.60
IV	4389.84	4941.75	5566.35	6273.64	7075.00	7983.45	9516.28	11388.57	13513.19	15925.42	18665.63	21371.90	24223.88
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	2678.79	6421.39	10657.72	15455.61	20892.53	24868.56	28188.78
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	1438.28	3436.59	5684.70	8215.34	11065.71	13076.15	14732.77
IV	0.00	0.00	0.00	0.00	0.00	0.00	502.43	1205.35	2002.21	2906.05	3931.78	4688.34	5322.05
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+29.7%	+63.1%	+92.6%	+118.7%	+141.8%	+149.1%	+149.1%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+16.0%	+33.7%	+49.4%	+63.1%	+75.1%	+78.4%	+77.9%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+5.6%	+11.8%	+17.4%	+22.3%	+26.7%	+28.1%	+28.2%

Table 7-7: Total stock of circuits (in Kton conductor material)

Figure 7-3, Figure 7-4, Table 7-8 and Table 7-9 show that the number of BAU circuits decreases when they are replaced by improved circuits. The decrease is the same in circuit numbers as in conductor material for all scenarios.

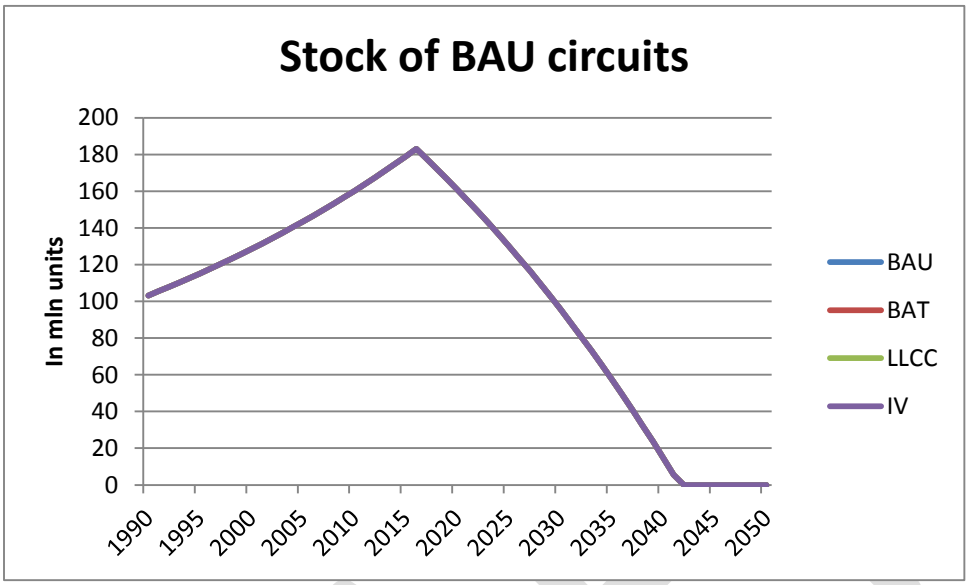


Figure 7-3: Stock of BAU circuits (in circuit units)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	103.22	115.11	128.44	143.38	160.15	178.97	160.77	130.06	95.76	57.43	14.57	0.00	0.00
BAT	103.22	115.11	128.44	143.38	160.15	178.97	160.77	130.06	95.76	57.43	14.57	0.00	0.00
LLCC	103.22	115.11	128.44	143.38	160.15	178.97	160.77	130.06	95.76	57.43	14.57	0.00	0.00
IV	103.22	115.11	128.44	143.38	160.15	178.97	160.77	130.06	95.76	57.43	14.57	0.00	0.00
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-	-
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-	-
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-	-

Table 7-8: Stock of BAU circuits (in circuit units)

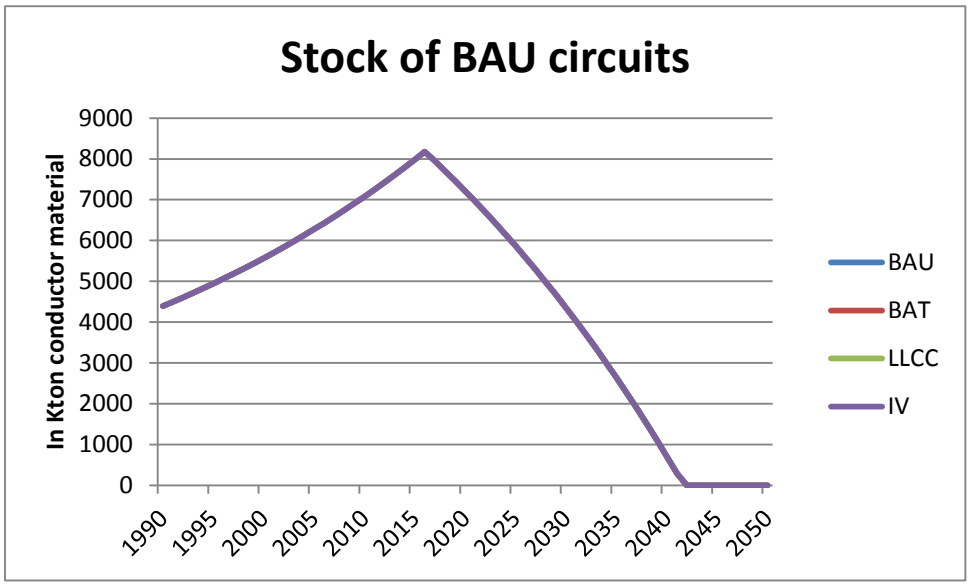


Figure 7-4: Stock of BAU circuits (in Kton conductor material)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	4389.84	4941.75	5566.35	6273.64	7075.00	7983.45	7213.68	5869.12	4352.75	2641.58	709.46	0.00	0.00
BAT	4389.84	4941.75	5566.35	6273.64	7075.00	7983.45	7213.68	5869.12	4352.75	2641.58	709.46	0.00	0.00
LLCC	4389.84	4941.75	5566.35	6273.64	7075.00	7983.45	7213.68	5869.12	4352.75	2641.58	709.46	0.00	0.00
IV	4389.84	4941.75	5566.35	6273.64	7075.00	7983.45	7213.68	5869.12	4352.75	2641.58	709.46	0.00	0.00
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-	-
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-	-
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-	-

Table 7-9: Stock of BAU circuits (in Kton conductor material)

Figure 7-5 and Table 7-10 show the number of circuits replaced by the 'improved' circuits. Figure 7-6 and Table 7-11 show the consequences for the amount of conductor material needed, as explained before for the total stock.

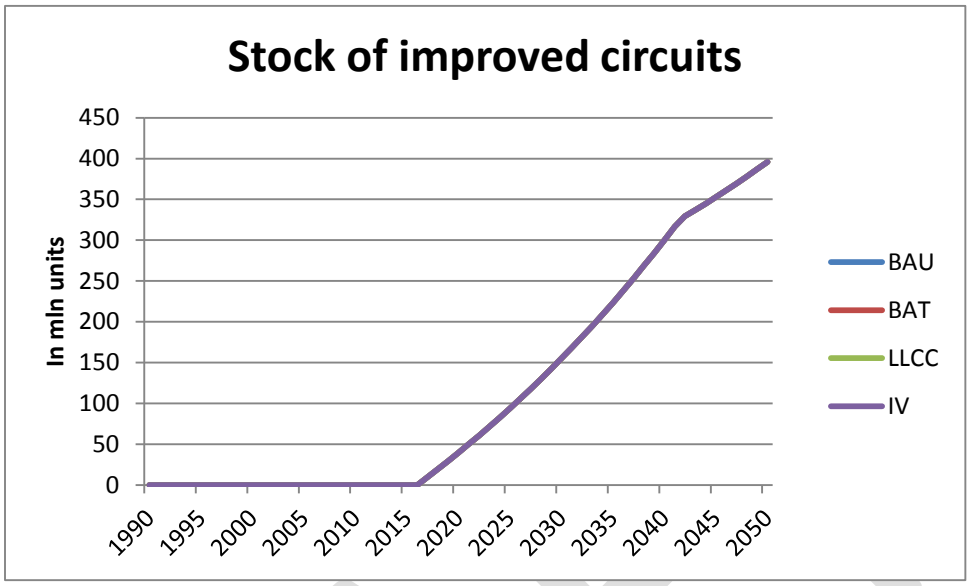


Figure 7-5: Stock of improved circuits (in circuit units)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	0.00	0.00	0.00	0.00	0.00	0.00	39.35	93.83	154.85	223.27	300.00	352.73	395.75
BAT	0.00	0.00	0.00	0.00	0.00	0.00	39.35	93.83	154.85	223.27	300.00	352.73	395.75
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	39.35	93.83	154.85	223.27	300.00	352.73	395.75
IV	0.00	0.00	0.00	0.00	0.00	0.00	39.35	93.83	154.85	223.27	300.00	352.73	395.75
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Relative difference to BAU													
BAT	-	-	-	-	-	-	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
LLCC	-	-	-	-	-	-	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
IV	-	-	-	-	-	-	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%

Table 7-10: Stock of improved circuits (in circuit units)

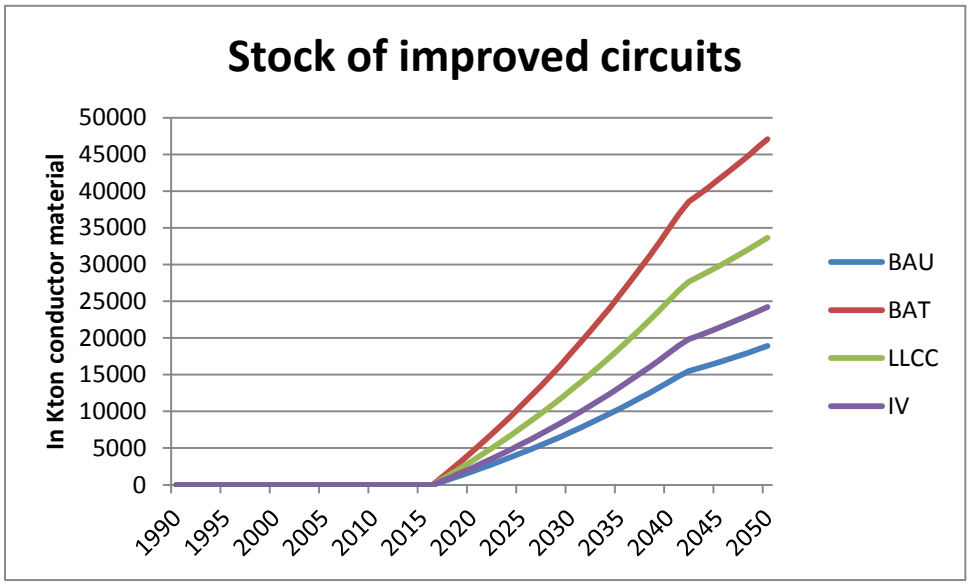


Figure 7-6: Stock of improved circuits (in Kton conductor material)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	0.00	0.00	0.00	0.00	0.00	0.00	1800.17	4314.09	7158.23	10377.80	14024.40	16683.55	18901.83
BAT	0.00	0.00	0.00	0.00	0.00	0.00	4478.96	10735.48	17815.95	25833.41	34916.93	41552.11	47090.60
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	3238.45	7750.68	12842.93	18593.13	25090.11	29759.70	33634.60
IV	0.00	0.00	0.00	0.00	0.00	0.00	2302.60	5519.44	9160.44	13283.84	17956.17	21371.90	24223.88
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	2678.79	6421.39	10657.72	15455.61	20892.53	24868.56	28188.78
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	1438.28	3436.59	5684.70	8215.34	11065.71	13076.15	14732.77
IV	0.00	0.00	0.00	0.00	0.00	0.00	502.43	1205.35	2002.21	2906.05	3931.78	4688.34	5322.05
Relative difference to BAU													
BAT	-	-	-	-	-	-	+148.8%	+148.8%	+148.9%	+148.9%	+149.0%	+149.1%	+149.1%
LLCC	-	-	-	-	-	-	+79.9%	+79.7%	+79.4%	+79.2%	+78.9%	+78.4%	+77.9%
IV	-	-	-	-	-	-	+27.9%	+27.9%	+28.0%	+28.0%	+28.0%	+28.1%	+28.2%

Table 7-11: Stock of improved circuits (in Kton conductor material)

7.2.2.3 Annual sales of circuits

The amount of sales in terms of number of circuits is displayed in Figure 7-7 and Table 7-12. There is no difference between the scenarios. The amount of sales in terms of conductor material differs between the scenarios starting at the introduction of the improved circuits in the stock, shown in Figure 7-8 and Table 7-13.

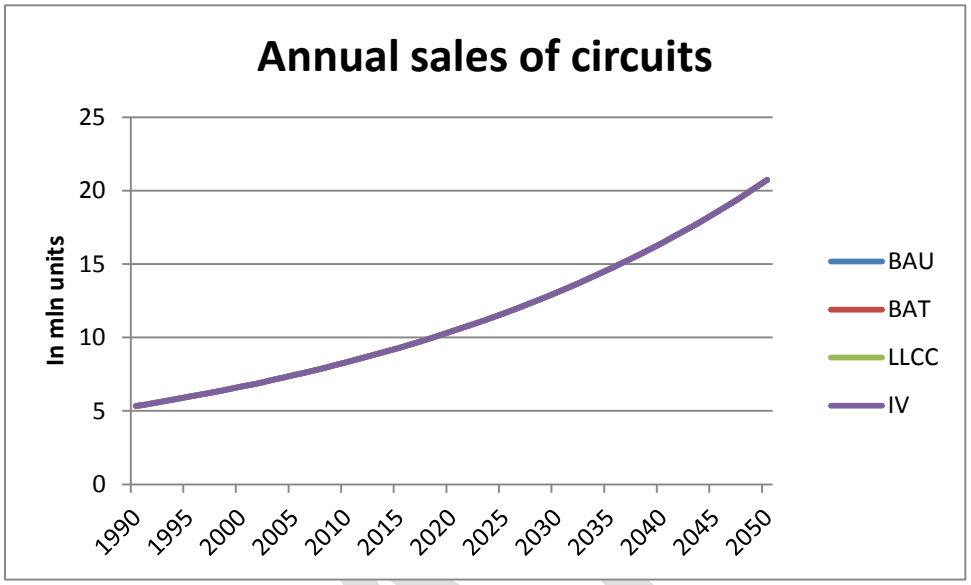


Figure 7-7: Annual sales of circuits (in circuit units)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	5.33	5.95	6.65	7.43	8.31	9.30	10.41	11.66	13.06	14.65	16.44	18.45	20.73
BAT	5.33	5.95	6.65	7.43	8.31	9.30	10.41	11.66	13.06	14.65	16.44	18.45	20.73
LLCC	5.33	5.95	6.65	7.43	8.31	9.30	10.41	11.66	13.06	14.65	16.44	18.45	20.73
IV	5.33	5.95	6.65	7.43	8.31	9.30	10.41	11.66	13.06	14.65	16.44	18.45	20.73
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%

Table 7-12: Annual sales of circuits (in circuit units)

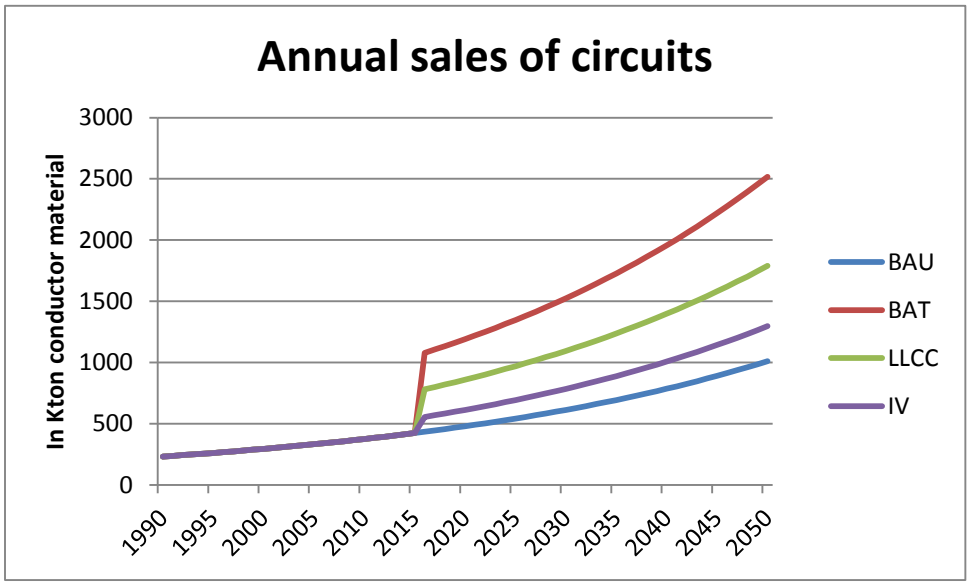


Figure 7-8: Annual sales of circuits (in Kton conductor material)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	231.25	260.64	293.95	331.71	374.54	423.15	478.34	541.05	612.33	693.38	785.61	890.60	1010.16
BAT	231.25	260.64	293.95	331.71	374.54	423.15	1190.33	1346.77	1524.65	1726.98	1957.26	2219.45	2518.13
LLCC	231.25	260.64	293.95	331.71	374.54	423.15	859.46	969.70	1094.73	1236.60	1397.68	1580.65	1788.60
IV	231.25	260.64	293.95	331.71	374.54	423.15	611.98	692.51	784.09	888.26	1006.84	1141.87	1295.71
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	711.99	805.73	912.32	1033.60	1171.64	1328.85	1507.97
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	381.11	428.65	482.40	543.22	612.07	690.06	778.44
IV	0.00	0.00	0.00	0.00	0.00	0.00	133.64	151.46	171.76	194.88	221.23	251.28	285.55
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+148.8%	+148.9%	+149.0%	+149.1%	+149.1%	+149.2%	+149.3%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+79.7%	+79.2%	+78.8%	+78.3%	+77.9%	+77.5%	+77.1%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+27.9%	+28.0%	+28.1%	+28.1%	+28.2%	+28.2%	+28.3%

Table 7-13: Annual sales of circuits (in Kton conductor material)

Table 7-14 and Figure 7-9 show the sales due to circuit replacement, in number of circuits. Table 7-15 and Figure 7-10 display the same replacement sales but expressed in amount of conductor material needed here for.

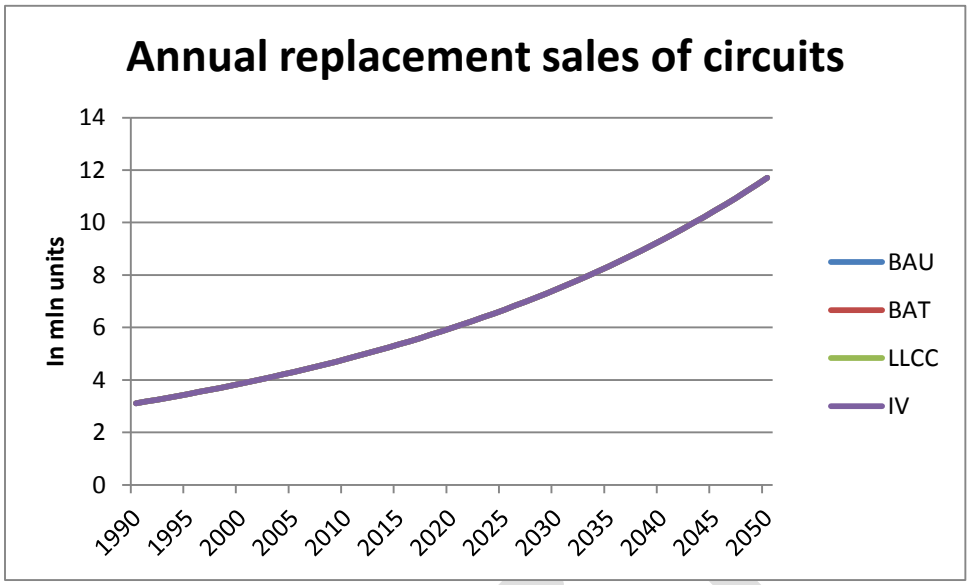


Figure 7-9: Annual replacement sales of circuits (in circuit units)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	3.11	3.46	3.86	4.30	4.80	5.35	5.98	6.68	7.46	8.34	9.34	10.45	11.71
BAT	3.11	3.46	3.86	4.30	4.80	5.35	5.98	6.68	7.46	8.34	9.34	10.45	11.71
LLCC	3.11	3.46	3.86	4.30	4.80	5.35	5.98	6.68	7.46	8.34	9.34	10.45	11.71
IV	3.11	3.46	3.86	4.30	4.80	5.35	5.98	6.68	7.46	8.34	9.34	10.45	11.71
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%

Table 7-14: Annual replacement sales of circuits (in circuit units)

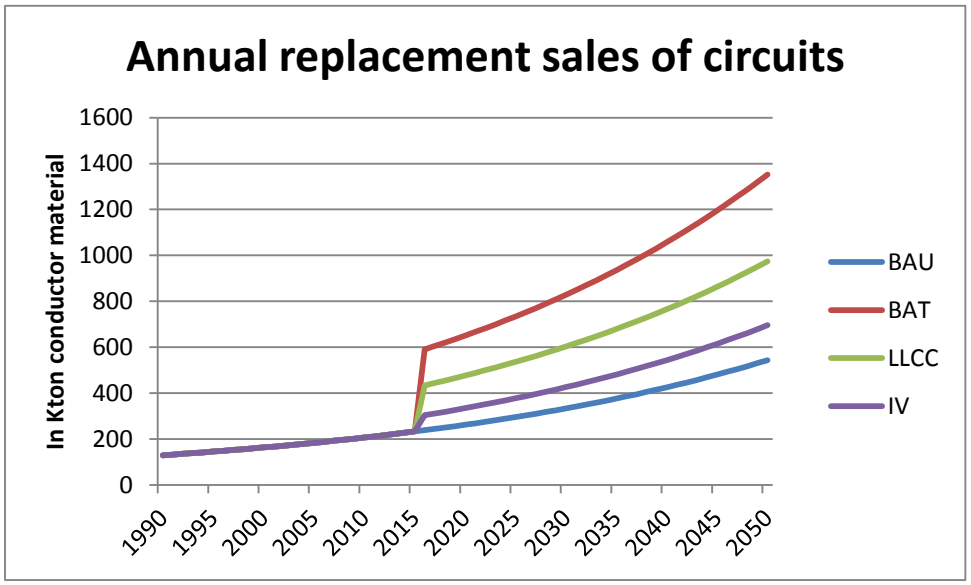


Figure 7-10: Annual replacement sales of circuits (in Kton conductor material)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	128.80	144.74	162.75	183.11	206.14	232.21	261.72	295.16	333.08	376.08	424.89	480.30	543.26
BAT	128.80	144.74	162.75	183.11	206.14	232.21	650.28	733.60	828.08	935.29	1056.98	1195.21	1352.28
LLCC	128.80	144.74	162.75	183.11	206.14	232.21	476.25	535.74	603.02	679.15	765.35	863.01	973.70
IV	128.80	144.74	162.75	183.11	206.14	232.21	334.08	376.95	425.56	480.72	543.35	614.49	695.34
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	388.56	438.44	495.01	559.20	632.10	714.90	809.02
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	214.53	240.58	269.94	303.07	340.47	382.70	430.44
IV	0.00	0.00	0.00	0.00	0.00	0.00	72.36	81.78	92.48	104.64	118.46	134.18	152.08
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+148.5%	+148.5%	+148.6%	+148.7%	+148.8%	+148.8%	+148.9%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+82.0%	+81.5%	+81.0%	+80.6%	+80.1%	+79.7%	+79.2%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+27.6%	+27.7%	+27.8%	+27.8%	+27.9%	+27.9%	+28.0%

Table 7-15: Annual replacement sales of circuits (in Kton conductor material)

7.2.2.4 Annual demand of electricity due to losses in circuits

Table 7-16 and Figure 7-11 show for the design option scenarios a significant diminution of electricity losses in the total stock of circuits thanks to the introduction of improved circuits compared to the BAU scenario. The decrease will take place for all design option scenarios although at a different pace. Compared to the BAU scenario the decrease starts at the introduction of the improved circuits and will carry on till all BAU circuits are replaced by improved circuits.

For the BAT scenario, this equates to a reduction of annual electricity losses of about 15.75 TWh in 2025. For the LLCC scenario, this equates to a reduction of annual electricity losses of about 13.87 TWh in 2025. For scenario IV, this equates to a reduction of annual electricity losses of about 7 TWh,, in 2025.

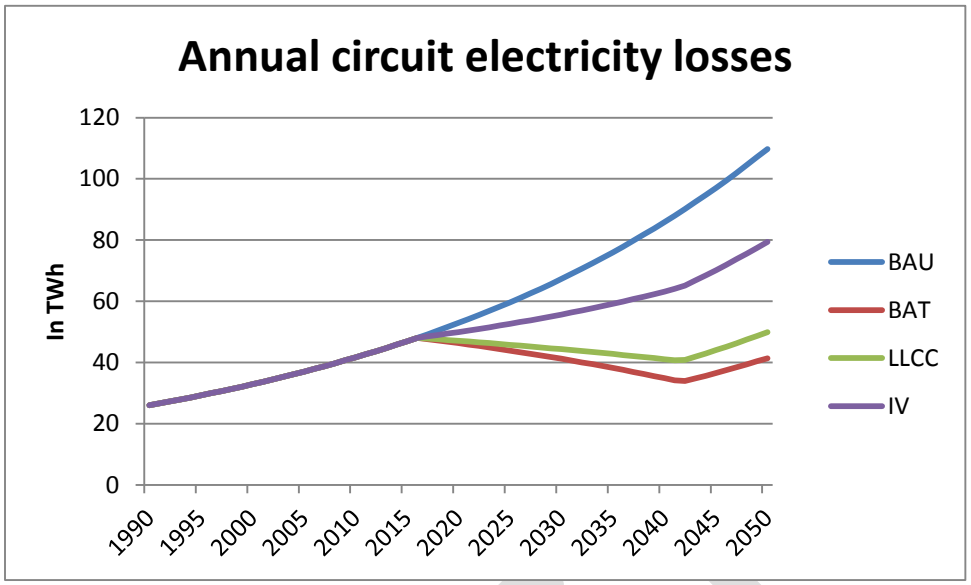


Figure 7-11: Annual circuit electricity losses (in TWh/yr)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	26.02	29.24	32.88	36.99	41.65	46.91	52.88	59.64	67.30	75.99	85.85	97.05	109.77
BAT	26.02	29.24	32.88	36.99	41.65	46.91	46.30	43.89	41.20	38.20	34.86	36.55	41.38
LLCC	26.02	29.24	32.88	36.99	41.65	46.91	47.08	45.77	44.33	42.77	41.06	44.01	49.92
IV	26.02	29.24	32.88	36.99	41.65	46.91	49.95	52.62	55.68	59.17	63.17	70.17	79.42
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	-6.58	-15.75	-26.10	-37.79	-50.99	-60.50	-68.39
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	-5.80	-13.87	-22.97	-33.22	-44.79	-53.04	-59.86
IV	0.00	0.00	0.00	0.00	0.00	0.00	-2.93	-7.02	-11.62	-16.82	-22.68	-26.88	-30.36
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-12.4%	-26.4%	-38.8%	-49.7%	-59.4%	-62.3%	-62.3%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-11.0%	-23.3%	-34.1%	-43.7%	-52.2%	-54.6%	-54.5%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-5.5%	-11.8%	-17.3%	-22.1%	-26.4%	-27.7%	-27.7%

Table 7-16: Annual circuit electricity losses (in TWh/yr)

7.2.2.5 Annual emissions of CO_2 eq.

Figure 7-12 and Table 7-17 show a considerable increase of GHG emissions for the design option scenarios starting at the introduction of the improved circuits in the stock. For the BAT scenario it means that the emissions due to production and distribution more than double.

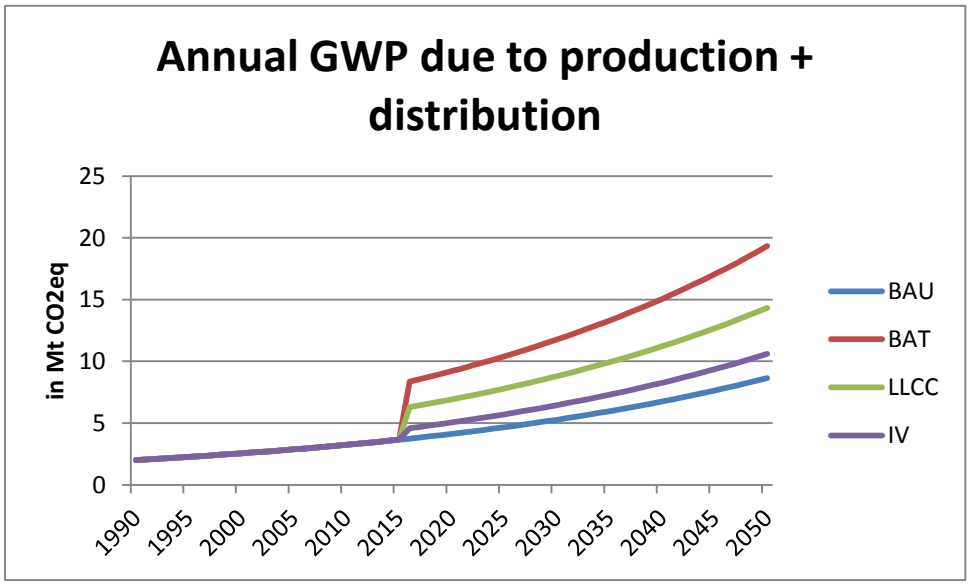


Figure 7-12: Annual GWP due to production + distribution (in Mt CO_2 eq.)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	2.01	2.26	2.55	2.87	3.24	3.66	4.13	4.66	5.27	5.96	6.74	7.64	8.65
BAT	2.01	2.26	2.55	2.87	3.24	3.66	9.20	10.40	11.76	13.30	15.06	17.05	19.33
LLCC	2.01	2.26	2.55	2.87	3.24	3.66	6.91	7.80	8.80	9.93	11.21	12.67	14.33
IV	2.01	2.26	2.55	2.87	3.24	3.66	5.05	5.71	6.45	7.30	8.27	9.36	10.61
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	5.08	5.74	6.49	7.34	8.31	9.42	10.68
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	2.79	3.13	3.53	3.97	4.47	5.04	5.68
IV	0.00	0.00	0.00	0.00	0.00	0.00	0.92	1.05	1.18	1.34	1.52	1.73	1.96
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+123.0%	+123.0%	+123.1%	+123.2%	+123.3%	+123.3%	+123.4%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+67.6%	+67.2%	+66.9%	+66.6%	+66.3%	+66.0%	+65.7%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+22.4%	+22.4%	+22.5%	+22.5%	+22.6%	+22.6%	+22.7%

Table 7-17: Annual GWP due to production + distribution (in Mt CO_2 eq.)

As expected, Figure 7-13 and Table 7-18 show the diminution of GHG emissions due to the lower electricity losses of the improved circuits. Compared to the BAU scenario, the decrease starts at the introduction of the improved circuits and will carry on till all BAU circuits are replaced by improved circuits, thus untill introduction date plus product lifetime. From then on the emissions of GHG due to electricity losses will again increase, due to stock increase, although at a slower pace as for the BAU scenario.

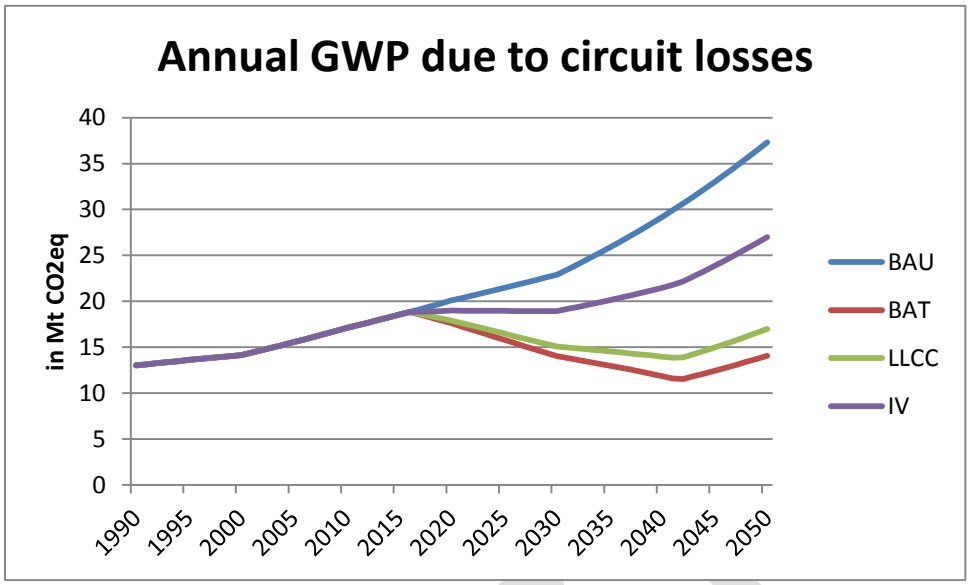


Figure 7-13: Annual GWP (total stock) due to circuit losses (in Mt CO_2 eq.)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	13.01	13.60	14.14	15.54	17.08	18.53	20.09	21.47	22.88	25.84	29.19	33.00	37.32
BAT	13.01	13.60	14.14	15.54	17.08	18.53	17.59	15.80	14.01	12.99	11.85	12.43	14.07
LLCC	13.01	13.60	14.14	15.54	17.08	18.53	17.89	16.48	15.07	14.54	13.96	14.96	16.97
IV	13.01	13.60	14.14	15.54	17.08	18.53	18.98	18.94	18.93	20.12	21.48	23.86	27.00
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	-2.50	-5.67	-8.87	-12.85	-17.34	-20.57	-23.25
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	-2.20	-4.99	-7.81	-11.30	-15.23	-18.03	-20.35
IV	0.00	0.00	0.00	0.00	0.00	0.00	-1.11	-2.53	-3.95	-5.72	-7.71	-9.14	-10.32
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-12.4%	-26.4%	-38.8%	-49.7%	-59.4%	-62.3%	-62.3%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-11.0%	-23.3%	-34.1%	-43.7%	-52.2%	-54.6%	-54.5%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-5.5%	-11.8%	-17.3%	-22.1%	-26.4%	-27.7%	-27.7%

Table 7-18: Annual GWP (total stock) due to circuit losses (in Mt CO_2 eq.)

Figure 7-14 and Table 7-19 show that 25 years, which equals the product lifetime, after the introduction of the improved circuits a considerable gain in emissions can be noted due to the recycling of the improved circuits, compared to the BAU scenario.

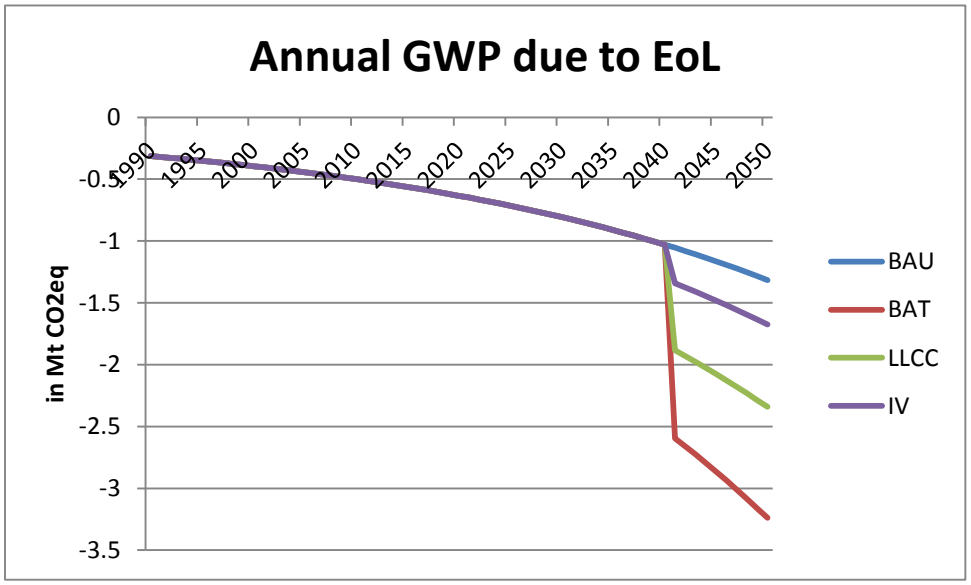


Figure 7-14: Annual GWP due to EoL (in Mt CO_2 eq.)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	-0.31	-0.35	-0.39	-0.44	-0.50	-0.56	-0.63	-0.72	-0.81	-0.91	-1.03	-1.16	-1.32
BAT	-0.31	-0.35	-0.39	-0.44	-0.50	-0.56	-0.63	-0.72	-0.81	-0.91	-1.03	-2.86	-3.24
LLCC	-0.31	-0.35	-0.39	-0.44	-0.50	-0.56	-0.63	-0.72	-0.81	-0.91	-1.03	-2.08	-2.34
IV	-0.31	-0.35	-0.39	-0.44	-0.50	-0.56	-0.63	-0.72	-0.81	-0.91	-1.03	-1.48	-1.68
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.70	-1.92
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.91	-1.03
IV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.32	-0.36
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+146.2%	+146.2%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+78.4%	+78.0%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+27.3%	+27.4%

Table 7-19: Annual GWP due to EoL (in Mt CO_2 eq.)

Figure 7-15 and Table 7-20 show at the start of the introduction of the improved circuits a considerable increase of GHG emissions due to the production and distribution of these circuits, compared to the BAU circuits. In case of the BAT scenario, it will take about 10 to 15 years before the total GHG emissions drop below emissions level of the BAU scenario. In case of the LLCC scenario, it will take about 5 to 10 years, and in case of scenario IV it will take less than 5 years before the total GHG emissions drop below emissions level of the BAU scenario.

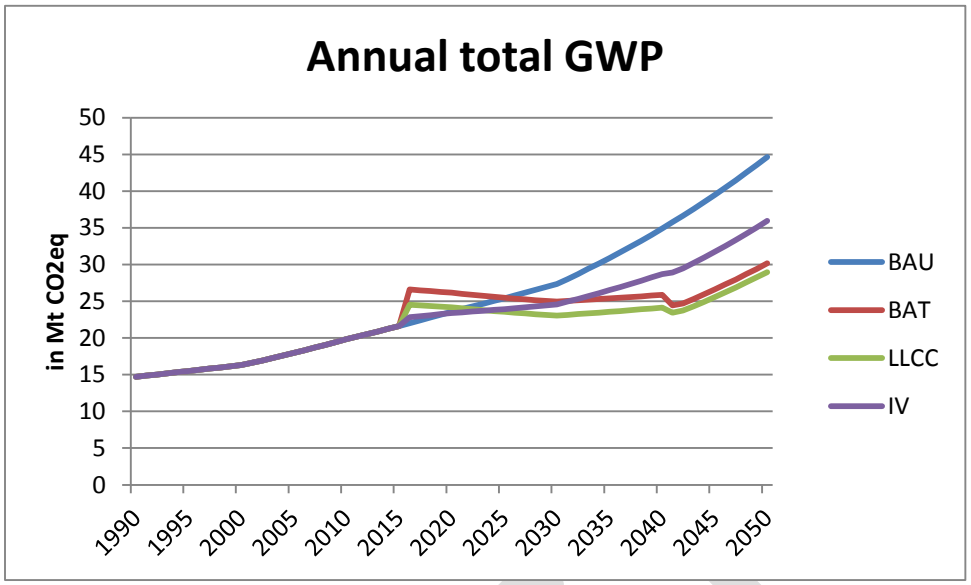
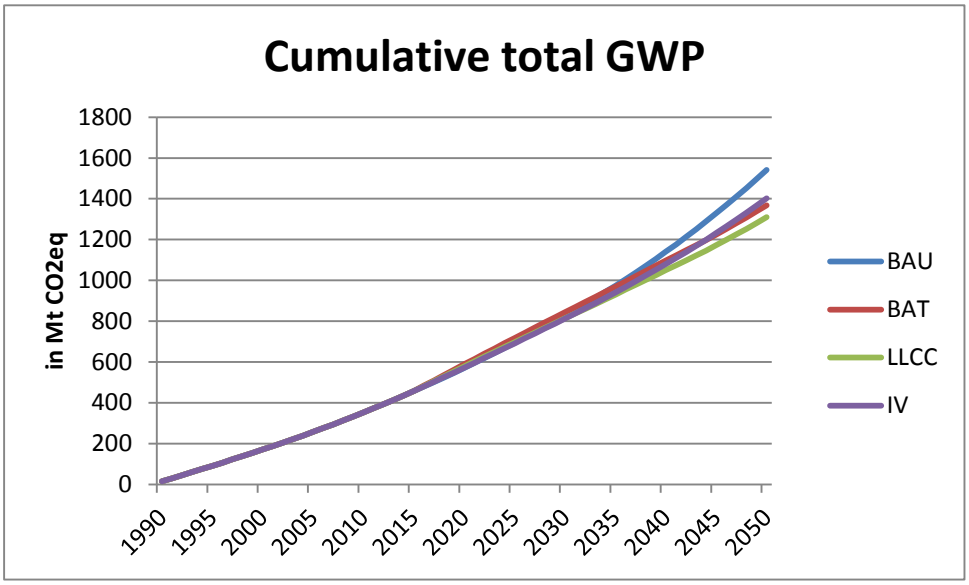


Figure 7-15: Annual total GWP (in Mt CO_2 eq.)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	14.71	15.51	16.29	17.97	19.82	21.62	23.59	25.42	27.34	30.88	34.90	39.47	44.66
BAT	14.71	15.51	16.29	17.97	19.82	21.62	26.16	25.48	24.96	25.38	25.88	26.62	30.16
LLCC	14.71	15.51	16.29	17.97	19.82	21.62	24.17	23.56	23.06	23.56	24.14	25.56	28.96
IV	14.71	15.51	16.29	17.97	19.82	21.62	23.40	23.94	24.58	26.51	28.71	31.74	35.94
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	2.58	0.07	-2.38	-5.50	-9.02	-12.85	-14.50
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	0.58	-1.86	-4.28	-7.33	-10.76	-13.91	-15.70
IV	0.00	0.00	0.00	0.00	0.00	0.00	-0.19	-1.48	-2.77	-4.38	-6.19	-7.73	-8.72
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+10.9%	+0.3%	-8.7%	-17.8%	-25.9%	-32.6%	-32.5%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+2.5%	-7.3%	-15.7%	-23.7%	-30.8%	-35.2%	-35.1%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-0.8%	-5.8%	-10.1%	-14.2%	-17.7%	-19.6%	-19.5%

Table 7-20: Annual total GWP (in Mt CO_2 eq.)

The figures in Table 7-21, illustrated by Figure 7-16, show that in case of the BAT scenario it will take 15 to 20 years to level out the increase of GHG emission due to the increase of GHG caused by production and distribution of the improved circuits. In case of the LLCC scenario, it will take 10 to 15 years, and in case of scenario IV it will take 5 to 10 years.



(in Mt CO_2 eq.)

Figure 7-16: Cumulative GWP (in Mt CO_2 eq.)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	14.71	90.66	170.57	256.99	352.30	456.74	570.69	694.07	826.89	974.06	1140.33	1328.32	1540.96
BAT	14.71	90.66	170.57	256.99	352.30	456.74	588.64	717.36	843.14	969.17	1097.53	1224.59	1368.11
LLCC	14.71	90.66	170.57	256.99	352.30	456.74	578.51	697.48	813.72	930.48	1049.99	1171.98	1309.81
IV	14.71	90.66	170.57	256.99	352.30	456.74	572.31	690.86	812.42	940.99	1080.03	1231.31	1402.38
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	17.96	23.29	16.25	-4.89	-42.80	-103.73	-172.85
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	7.82	3.41	-13.17	-43.57	-90.34	-156.34	-231.15
IV	0.00	0.00	0.00	0.00	0.00	0.00	1.62	-3.20	-14.47	-33.06	-60.30	-97.01	-138.59
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+3.1%	+3.4%	+2.0%	-0.5%	-3.8%	-7.8%	-11.2%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+1.4%	+0.5%	-1.6%	-4.5%	-7.9%	-11.8%	-15.0%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.3%	-0.5%	-1.8%	-3.4%	-5.3%	-7.3%	-9.0%

Table 7-21: Cumulative GWP (in Mt CO_2 eq.)

TBC

7.3 Socio-economic impact analysis

7.3.1 Annual expenditure

The next figures illustrate that initial investment costs for building owners will be higher but there is a return on investment. Building owners might need higher loans and therefore dedicated bank support might be needed and could be considered as a policy option.

In Figure 7-17 and Table 7-22 one can notice that after the introduction of improved circuits the sales at EU-28 level in terms of EURO (year 2010) increases with about 123% for the BAT scenario, about 59% for the LLCC scenario and about 20% in case of scenario IV. The increase in terms of EUROs does not only reflect the cable purchase cost increase, but also the installation cost (and connector cost) increase.
Stakeholders please provide the impact on sales (cable manufacturer, conductor material provider).

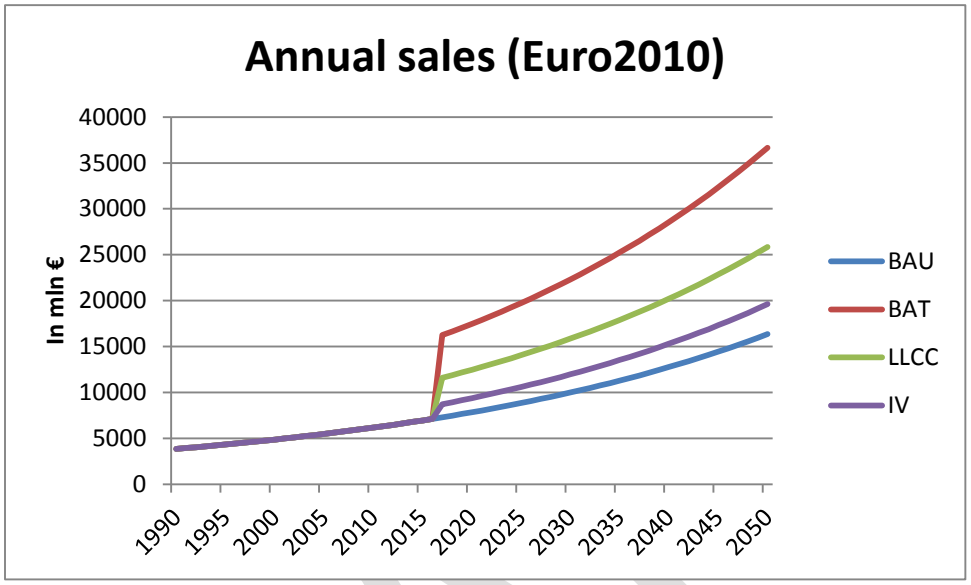


Figure 7-17: Annual sales (in mln. euro)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	3839.25	4317.59	4858.41	5470.25	6162.80	6947.17	7836.01	8843.81	9987.09	11284.77	12758.46	14432.92	16336.45
BAT	3839.25	4317.59	4858.41	5470.25	6162.80	6947.17	17468.02	19736.12	22311.68	25237.90	28564.21	32347.18	36651.63
LLCC	3839.25	4317.59	4858.41	5470.25	6162.80	6947.17	12466.33	14055.04	15855.62	17897.44	20214.08	22843.90	25830.83
IV	3839.25	4317.59	4858.41	5470.25	6162.80	6947.17	9372.16	10584.13	11959.81	13522.14	15297.36	17315.50	19610.94
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	9632.00	10892.31	12324.59	13953.14	15805.74	17914.26	20315.18
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	4630.32	5211.24	5868.53	6612.68	7455.61	8410.98	9494.38
IV	0.00	0.00	0.00	0.00	0.00	0.00	1536.15	1740.32	1972.72	2237.37	2538.90	2882.58	3274.49
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+122.9%	+123.2%	+123.4%	+123.6%	+123.9%	+124.1%	+124.4%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+59.1%	+58.9%	+58.8%	+58.6%	+58.4%	+58.3%	+58.1%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+19.6%	+19.7%	+19.8%	+19.8%	+19.9%	+20.0%	+20.0%

Table 7-22: Annual sales (in mln. euro)

Figure 7-18 and Table 7-23 show the stock value in terms of EURO (year 1020). The stock value at year N equals the summation of all precedent sales up to the year N minus the product lifetime period.

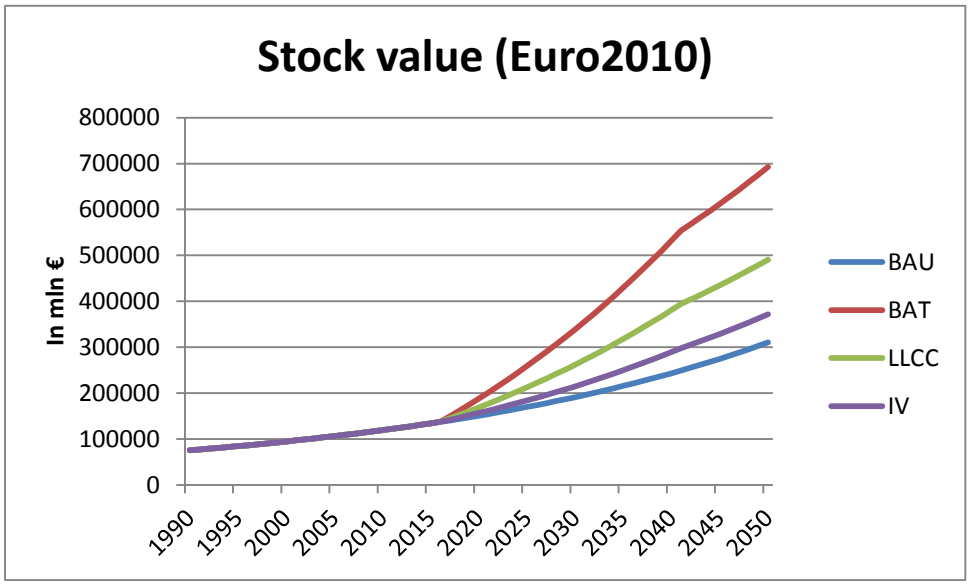


Figure 7-18: Stock value (in mln. euro)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	75178.39	84248.32	94490.25	106062.39	119145.11	133944.11	150694.12	169663.04	191156.81	215524.92	243166.77	274538.95	310163.63
BAT	75178.39	84248.32	94490.25	106062.39	119145.11	133944.11	187845.40	258690.93	338869.71	429662.63	532532.30	611998.18	692395.41
LLCC	75178.39	84248.32	94490.25	106062.39	119145.11	133944.11	168578.71	212413.34	261902.64	317808.84	381000.77	434584.59	490594.07
IV	75178.39	84248.32	94490.25	106062.39	119145.11	133944.11	156615.96	183867.59	214748.11	249760.01	289477.54	328635.40	371545.40
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	37151.28	89027.89	147712.89	214137.70	289365.53	337459.23	382231.78
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	17884.59	42750.29	70745.83	102283.92	137834.00	160045.64	180430.44
IV	0.00	0.00	0.00	0.00	0.00	0.00	5921.83	14204.55	23591.30	34235.08	46310.77	54096.45	61381.76
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+24.7%	+52.5%	+77.3%	+99.4%	+119.0%	+122.9%	+123.2%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+11.9%	+25.2%	+37.0%	+47.5%	+56.7%	+58.3%	+58.2%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+3.9%	+8.4%	+12.3%	+15.9%	+19.0%	+19.7%	+19.8%

Table 7-23: Stock value (in mln. euro)

At the benefit side Figure 7-19 and Table 7-24 show the gains due to lower electricity losses in case of improved circuits in net present value terms for the year 2010. From the introduction of the improved circuits, the end-user will have to spend less on electricity due to the higher energy efficiency of the improved circuits. In 2050 the total EU28 expenditure caused by energy losses in electric circuits will diminish by about 62% in case of the BAT scenario, by about 55% in case of the LLCC scenario and by about 28% in case of scenario IV.

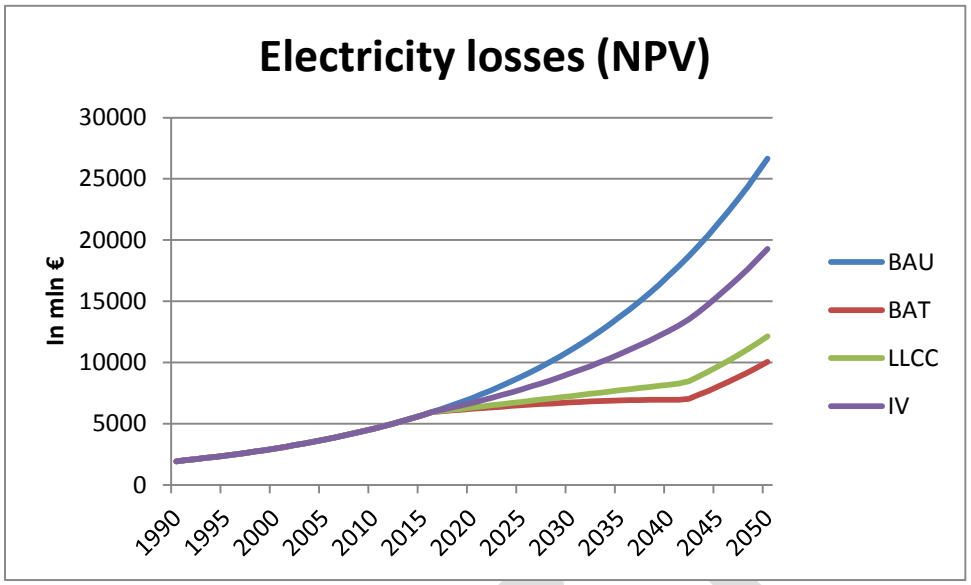


Figure 7-19: Annual expenditure due to electricity losses (in mln. euro)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	1926.23	2389.95	2967.08	3685.77	4581.27	5697.73	7090.50	8828.95	11000.16	13713.38	17105.84	21349.94	26662.42
BAT	1926.23	2389.95	2967.08	3685.77	4581.27	5697.73	6208.32	6497.61	6734.57	6894.41	6945.20	8040.72	10051.34
LLCC	1926.23	2389.95	2967.08	3685.77	4581.27	5697.73	6312.74	6775.36	7246.16	7717.88	8180.88	9682.42	12124.23
IV	1926.23	2389.95	2967.08	3685.77	4581.27	5697.73	6697.21	7790.15	9100.51	10678.28	12585.96	15436.32	19288.82
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	-882.18	-2331.34	-4265.59	-6818.97	-10160.64	-13309.22	-16611.08
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	-777.76	-2053.60	-3754.00	-5995.49	-8924.95	-11667.52	-14538.19
IV	0.00	0.00	0.00	0.00	0.00	0.00	-393.28	-1038.80	-1899.65	-3035.09	-4519.88	-5913.62	-7373.61
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-12.4%	-26.4%	-38.8%	-49.7%	-59.4%	-62.3%	-62.3%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-11.0%	-23.3%	-34.1%	-43.7%	-52.2%	-54.6%	-54.5%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-5.5%	-11.8%	-17.3%	-22.1%	-26.4%	-27.7%	-27.7%

Table 7-24: Annual expenditure due to electricity losses (in mln. euro)

7.3.2 Impact on workforce

The proposed policy option will lead to an increase in the need for human resources, and thus can lead to significant job creation within EU28 in the sector of local electrical contracting, local engineering.
More specific, the most important increase is expected in manual labour jobs at electrical contractors.

Stakeholders: please provide input and figures if possible

7.4 Sensitivity analysis

The analysis in this section investigates the sensitivity of the main outcomes for changes in the main calculation parameters. This sensitivity analysis is performed at scenario level. The sensitivity analysis in Task 6 is performed at base case level.

Selected sensitivity analysis cases are:

- Sensitivity case 1: the stock growth, replacement rate and product life are set according to the long product life value, listed in Task 3.
- Sensitivity case 2: the inflation and discount parameters are set to their low value, indicated by the MEErP guidelines.
- Sensitivity case 3: the energy escalation rate is set to a low value.

Per sensitivity analysis case only these parameters are changed. All other parameters values remain the same.

7.4.1 Sensitivity case 1: scenario analysis

In this sensitivity case, the stock growth, replacement rate and product life for the services and industry sector are set according to the long product life value, listed in Task 3.
The main calculation parameters for this analysis are listed in Table 7-25.

Discount rate	4.0%
Inflation rate	2.0%
Energy Escalation rate	4.0%
Electricity rate (€/kWh)	0.11
Stock growth rate services sector	1.0%
Stock growth rate industry sector	1.0%
Sales growth rate services sector	1.7%
Sales growth rate industry sector	1.4%
Product lifetime services sector (years)	40
Product lifetime industry sector (years)	40

Table 7-25: Sensitivity case 1 - Main input parameters

One should notice that the product life of improved circuits, being introduced in 2016, extends beyond 2050. This means the full potential of savings is not visible yet in 2050.

Sales (Figure 7-26 up to and including Figure 7-29, Table 7-32 up to and including Table 7-35) and stock (Figure 7-20 up to and including Figure 7-25, Table 7-26 up to and including Table 7-31), and associated economic figures (Figure 7-36, Table 7-42, Figure 7-37 and Table 7-43) are directly impacted by changing these parameters. As a result circuit losses will be lower, so the gains will also be lower (see Table 7-36 and Figure 7-30).
Although the amounts of GHG emissions are lower, it takes about the same period as for the default scenario analysis case to level out the increased GHG emission in production and distribution by the decreased GHG emission during the use phase (Figure 7-31 up to Figure 7-35, Table 7-37 up to Table 7-41).

A lower stock means lower electricity losses, and thus also a lower annual expenditure due to electricity losses (Figure 7-38, Table 7-44).

7.4.1.1 Stock

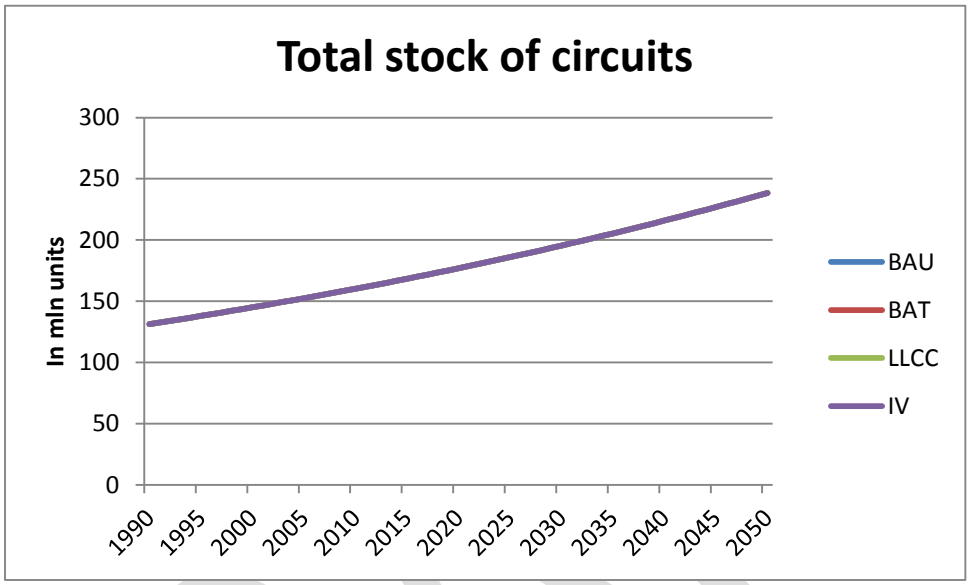


Figure 7-20: Sensitivity case 1 - Total stock of circuits (in circuit units)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	131.25	137.95	144.98	152.38	160.15	168.32	176.91	185.93	195.41	205.38	215.86	226.87	238.44
BAT	131.25	137.95	144.98	152.38	160.15	168.32	176.91	185.93	195.41	205.38	215.86	226.87	238.44
LLCC	131.25	137.95	144.98	152.38	160.15	168.32	176.91	185.93	195.41	205.38	215.86	226.87	238.44
IV	131.25	137.95	144.98	152.38	160.15	168.32	176.91	185.93	195.41	205.38	215.86	226.87	238.44
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%

Table 7-26: Sensitivity case 1 - Total stock of circuits (in circuit units)

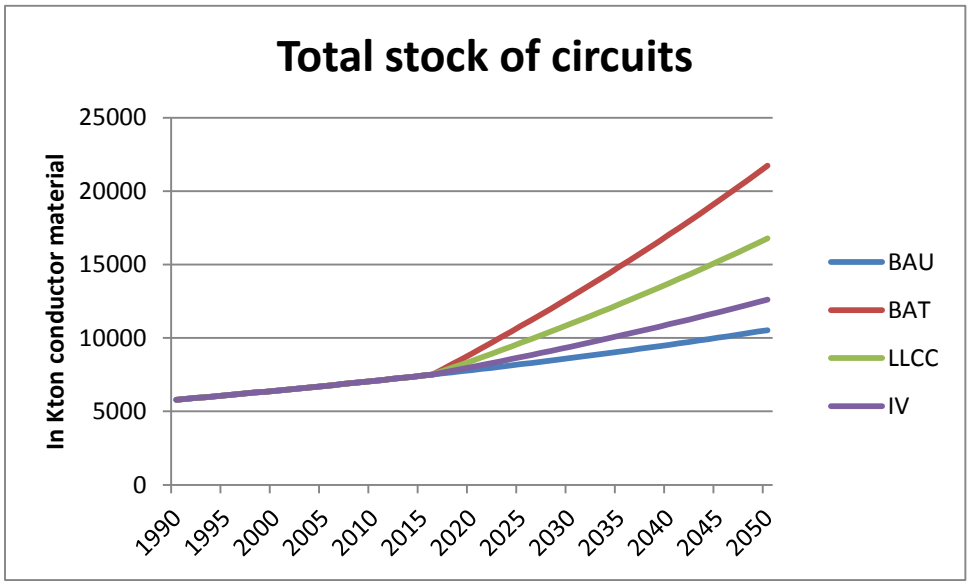


Figure 7-21: Sensitivity case 1 - Total stock of circuits (in Kton conductor material)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	5798.28	6094.05	6404.91	6731.62	7075.00	7435.90	7815.20	8213.86	8632.84	9073.21	9536.03	10022.46	10533.71
BAT	5798.28	6094.05	6404.91	6731.62	7075.00	7435.90	8944.48	10819.43	12790.02	14861.13	17037.89	19325.68	21730.18
LLCC	5798.28	6094.05	6404.91	6731.62	7075.00	7435.90	8445.39	9667.88	10952.74	12303.13	13722.41	15214.08	16781.84
IV	5798.28	6094.05	6404.91	6731.62	7075.00	7435.90	8024.93	8697.76	9404.90	10148.12	10929.26	11750.23	12613.09
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	1129.28	2605.57	4157.18	5787.92	7501.86	9303.22	11196.47
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	630.19	1454.03	2319.89	3229.92	4186.37	5191.61	6248.13
IV	0.00	0.00	0.00	0.00	0.00	0.00	209.73	483.90	772.06	1074.92	1393.22	1727.77	2079.38
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+14.4%	+31.7%	+48.2%	+63.8%	+78.7%	+92.8%	+106.3%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+8.1%	+17.7%	+26.9%	+35.6%	+43.9%	+51.8%	+59.3%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+2.7%	+5.9%	+8.9%	+11.8%	+14.6%	+17.2%	+19.7%

Table 7-27: Sensitivity case 1 - Total stock of circuits (in Kton conductor material)

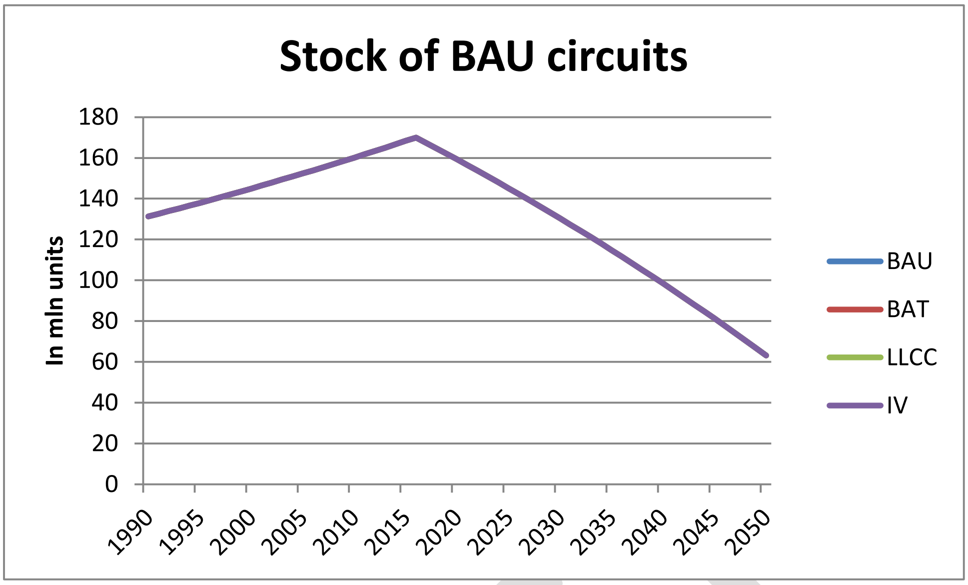


Figure 7-22: Sensitivity case 1 - Stock of BAU circuits (in circuit units)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
	131.25	137.95	144.98	152.38	160.15	168.32	159.23	145.14	130.33	114.77	98.41	81.22	63.16
	131.25	137.95	144.98	152.38	160.15	168.32	159.23	145.14	130.33	114.77	98.41	81.22	63.16
	131.25	137.95	144.98	152.38	160.15	168.32	159.23	145.14	130.33	114.77	98.41	81.22	63.16
	131.25	137.95	144.98	152.38	160.15	168.32	159.23	145.14	130.33	114.77	98.41	81.22	63.16
difference to BAU													
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ifference to BAU													
	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%

Table 7-28: Sensitivity case 1 - Stock of BAU circuits (in circuit units)

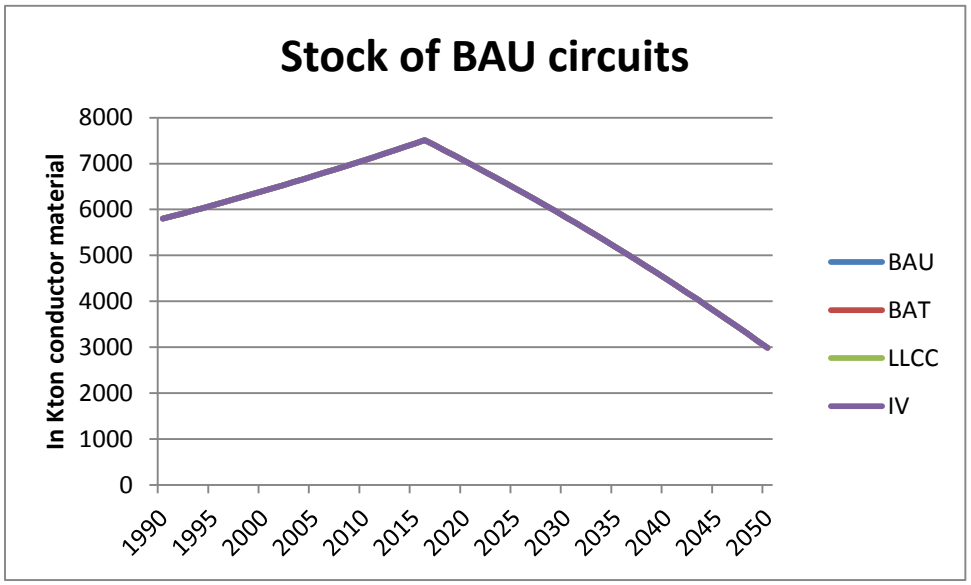


Figure 7-23: Sensitivity case 1 - Stock of BAU circuits (in Kton conductor material)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	5798.28	6094.05	6404.91	6731.62	7075.00	7435.90	7053.86	6457.23	5830.16	5171.10	4478.43	3750.42	2985.28
BAT	5798.28	6094.05	6404.91	6731.62	7075.00	7435.90	7053.86	6457.23	5830.16	5171.10	4478.43	3750.42	2985.28
LLCC	5798.28	6094.05	6404.91	6731.62	7075.00	7435.90	7053.86	6457.23	5830.16	5171.10	4478.43	3750.42	2985.28
IV	5798.28	6094.05	6404.91	6731.62	7075.00	7435.90	7053.86	6457.23	5830.16	5171.10	4478.43	3750.42	2985.28
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%

Table 7-29: Sensitivity case 1 - Stock of BAU circuits (in Kton conductor material)

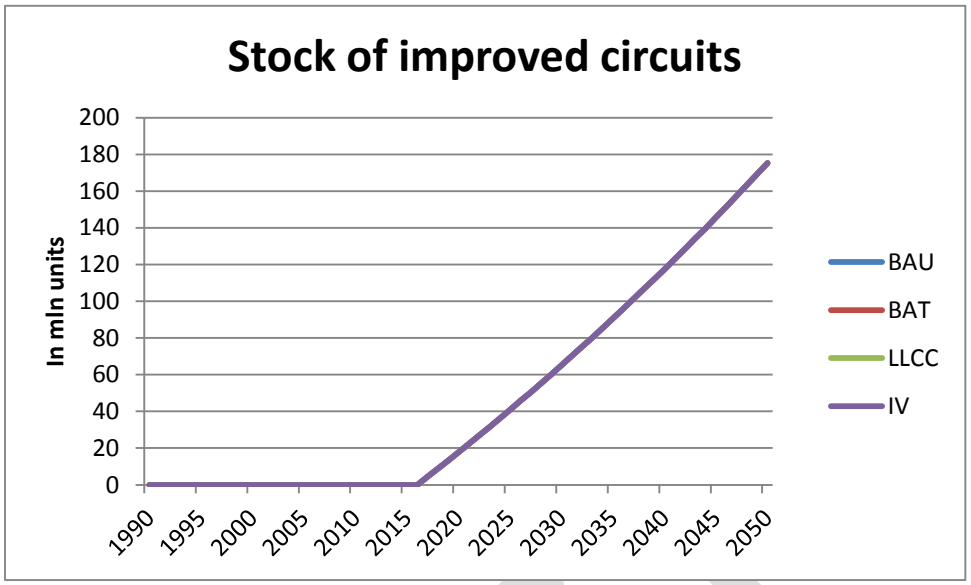


Figure 7-24: Sensitivity case 1 - Stock of improved circuits (in circuit units)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	0.00	0.00	0.00	0.00	0.00	0.00	17.68	40.79	65.08	90.61	117.45	145.65	175.29
BAT	0.00	0.00	0.00	0.00	0.00	0.00	17.68	40.79	65.08	90.61	117.45	145.65	175.29
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	17.68	40.79	65.08	90.61	117.45	145.65	175.29
IV	0.00	0.00	0.00	0.00	0.00	0.00	17.68	40.79	65.08	90.61	117.45	145.65	175.29
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Relative difference to BAU													
BAT	-	-	-	-	-	-	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
LLCC	-	-	-	-	-	-	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
IV	-	-	-	-	-	-	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%

Table 7-30: Sensitivity case 1 - Stock of improved circuits (in circuit units)

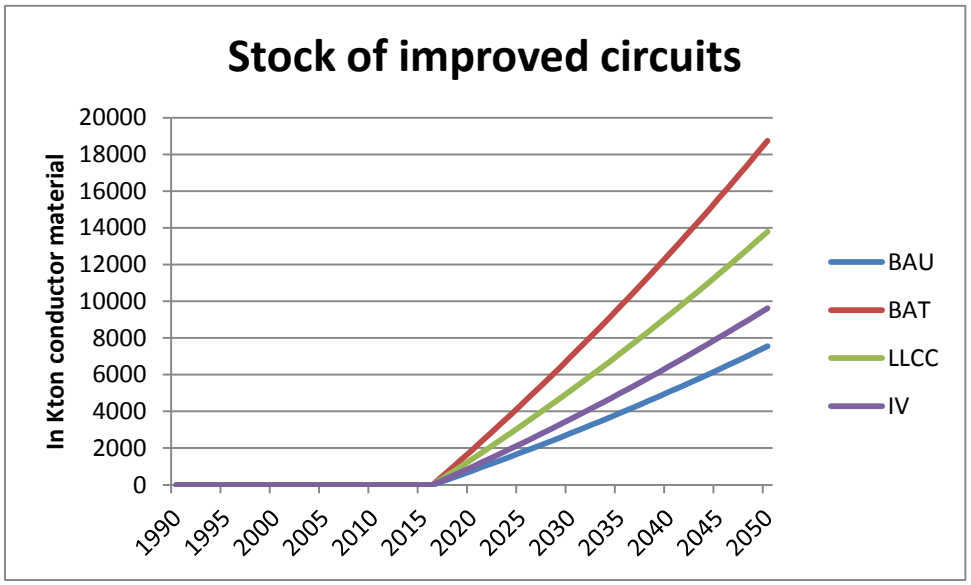


Figure 7-25: Sensitivity case 1 - Stock of improved circuits (in Kton conductor material)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	0.00	0.00	0.00	0.00	0.00	0.00	761.34	1756.63	2802.68	3902.10	5057.60	6272.04	7548.43
BAT	0.00	0.00	0.00	0.00	0.00	0.00	1890.62	4362.20	6959.86	9690.03	12559.46	15575.26	18744.90
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	1391.52	3210.65	5122.57	7132.02	9243.97	11463.66	13796.56
IV	0.00	0.00	0.00	0.00	0.00	0.00	971.06	2240.53	3574.74	4977.02	6450.82	7999.81	9627.81
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	1129.28	2605.57	4157.18	5787.92	7501.86	9303.22	11196.47
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	630.19	1454.03	2319.89	3229.92	4186.37	5191.61	6248.13
IV	0.00	0.00	0.00	0.00	0.00	0.00	209.73	483.90	772.06	1074.92	1393.22	1727.77	2079.38
Relative difference to BAU													
BAT	-	-	-	-	-	-	+148.3%	+148.3%	+148.3%	+148.3%	+148.3%	+148.3%	+148.3%
LLCC	-	-	-	-	-	-	+82.8%	+82.8%	+82.8%	+82.8%	+82.8%	+82.8%	+82.8%
IV	-	-	-	-	-	-	+27.5%	+27.5%	+27.5%	+27.5%	+27.5%	+27.5%	+27.5%

Table 7-31: Sensitivity case 1 - Stock of improved circuits (in Kton conductor material)

7.4.1.2 Annual sales of circuits

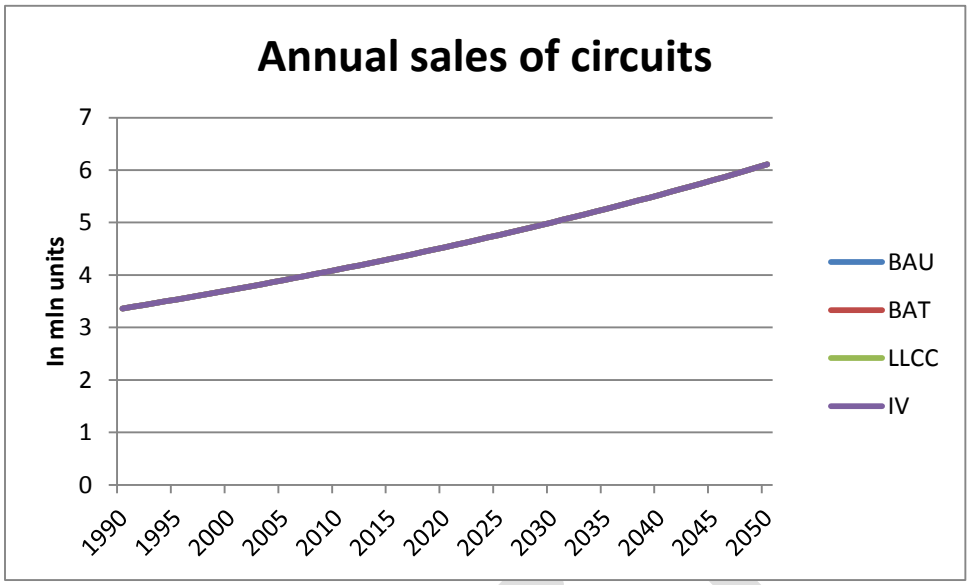


Figure 7-26: Sensitivity case 1 - Annual sales of circuits (in circuit units)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	3.36	3.53	3.71	3.90	4.10	4.31	4.53	4.76	5.00	5.26	5.53	5.81	6.11
BAT	3.36	3.53	3.71	3.90	4.10	4.31	4.53	4.76	5.00	5.26	5.53	5.81	6.11
LLCC	3.36	3.53	3.71	3.90	4.10	4.31	4.53	4.76	5.00	5.26	5.53	5.81	6.11
IV	3.36	3.53	3.71	3.90	4.10	4.31	4.53	4.76	5.00	5.26	5.53	5.81	6.11
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%

Table 7-32: Sensitivity case 1 - Annual sales of circuits (in circuit units)

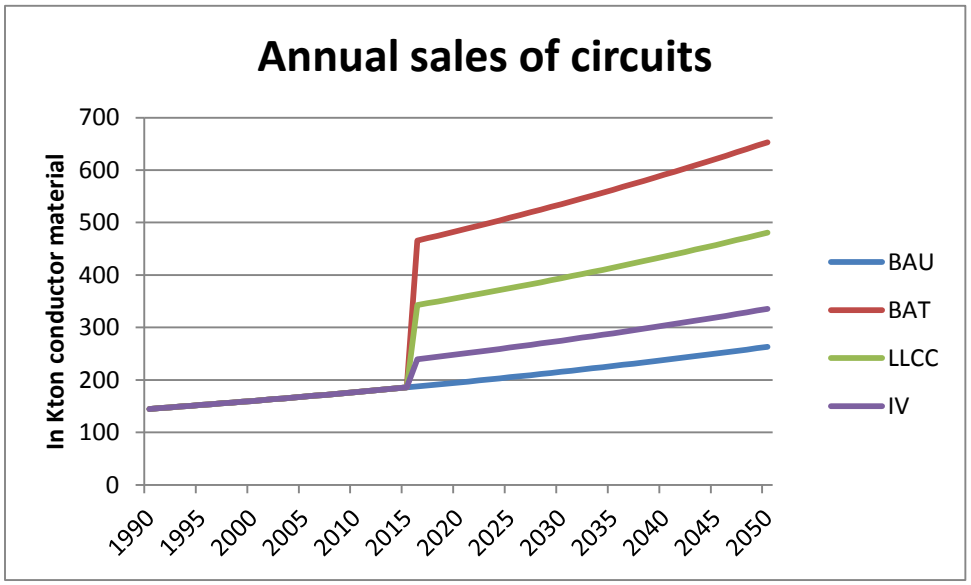


Figure 7-27: Sensitivity case 1 - Annual sales of circuits (in Kton conductor material)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	144.76	152.15	159.91	168.06	176.64	185.65	195.12	205.07	215.53	226.52	238.08	250.22	262.99
BAT	144.76	152.15	159.91	168.06	176.64	185.65	484.53	509.24	535.22	562.52	591.22	621.38	653.07
LLCC	144.76	152.15	159.91	168.06	176.64	185.65	356.62	374.81	393.93	414.03	435.15	457.34	480.67
IV	144.76	152.15	159.91	168.06	176.64	185.65	248.87	261.56	274.90	288.92	303.66	319.15	335.43
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	289.41	304.18	319.69	336.00	353.14	371.15	390.08
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	161.51	169.74	178.40	187.50	197.07	207.12	217.68
IV	0.00	0.00	0.00	0.00	0.00	0.00	53.75	56.49	59.37	62.40	65.58	68.93	72.45
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+148.3%	+148.3%	+148.3%	+148.3%	+148.3%	+148.3%	+148.3%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+82.8%	+82.8%	+82.8%	+82.8%	+82.8%	+82.8%	+82.8%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+27.5%	+27.5%	+27.5%	+27.5%	+27.5%	+27.5%	+27.5%

Table 7-33: Sensitivity case 1 - Annual sales of circuits (in Kton conductor material)

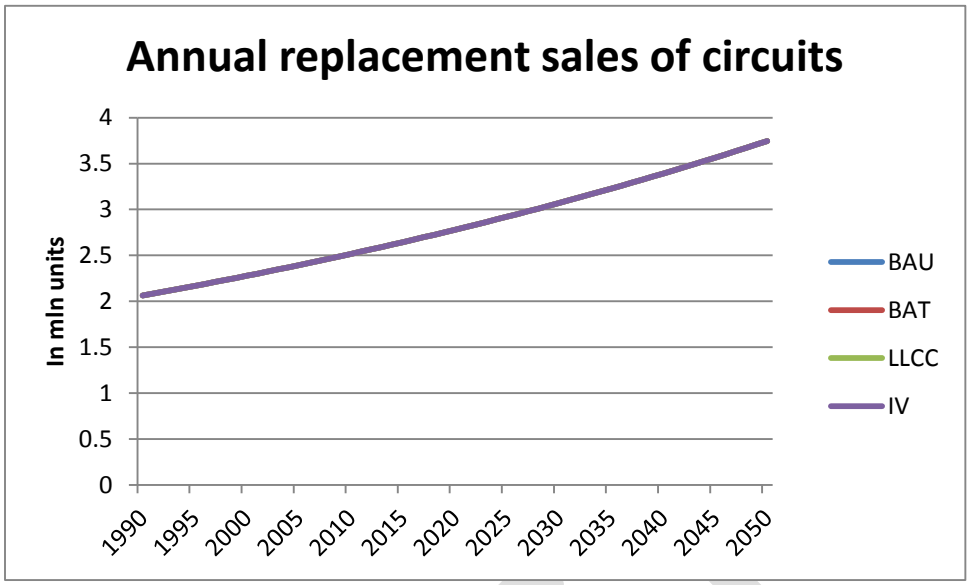


Figure 7-28: Sensitivity case 1 - Annual replacement sales of circuits (in circuit units)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	2.06	2.17	2.28	2.39	2.52	2.64	2.78	2.92	3.07	3.23	3.39	3.56	3.75
BAT	2.06	2.17	2.28	2.39	2.52	2.64	2.78	2.92	3.07	3.23	3.39	3.56	3.75
LLCC	2.06	2.17	2.28	2.39	2.52	2.64	2.78	2.92	3.07	3.23	3.39	3.56	3.75
IV	2.06	2.17	2.28	2.39	2.52	2.64	2.78	2.92	3.07	3.23	3.39	3.56	3.75
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%

Table 7-34: Sensitivity case 1 - Annual replacement sales of circuits (in circuit units)

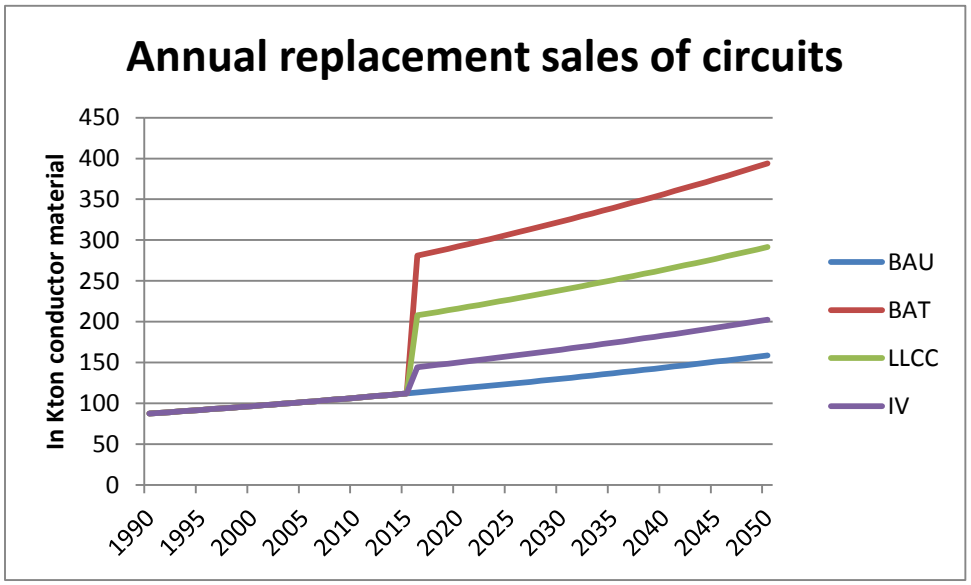


Figure 7-29: Sensitivity case 1 - Annual replacement sales of circuits (in Kton conductor material)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	87.35	91.81	96.49	101.41	106.59	112.02	117.74	123.74	130.06	136.69	143.66	150.99	158.69
BAT	87.35	91.81	96.49	101.41	106.59	112.02	292.22	307.12	322.79	339.26	356.56	374.75	393.86
LLCC	87.35	91.81	96.49	101.41	106.59	112.02	216.15	227.18	238.77	250.95	263.75	277.20	291.34
IV	87.35	91.81	96.49	101.41	106.59	112.02	150.05	157.70	165.75	174.20	183.09	192.43	202.25
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	174.48	183.38	192.73	202.57	212.90	223.76	235.17
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	98.41	103.43	108.71	114.26	120.08	126.21	132.65
IV	0.00	0.00	0.00	0.00	0.00	0.00	32.31	33.96	35.69	37.51	39.43	41.44	43.55
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+148.2%	+148.2%	+148.2%	+148.2%	+148.2%	+148.2%	+148.2%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+83.6%	+83.6%	+83.6%	+83.6%	+83.6%	+83.6%	+83.6%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+27.4%	+27.4%	+27.4%	+27.4%	+27.4%	+27.4%	+27.4%

Table 7-35: Sensitivity case 1 - Annual replacement sales of circuits (in Kton conductor material)

7.4.1.3 Annual demand of electricity due to losses in circuits

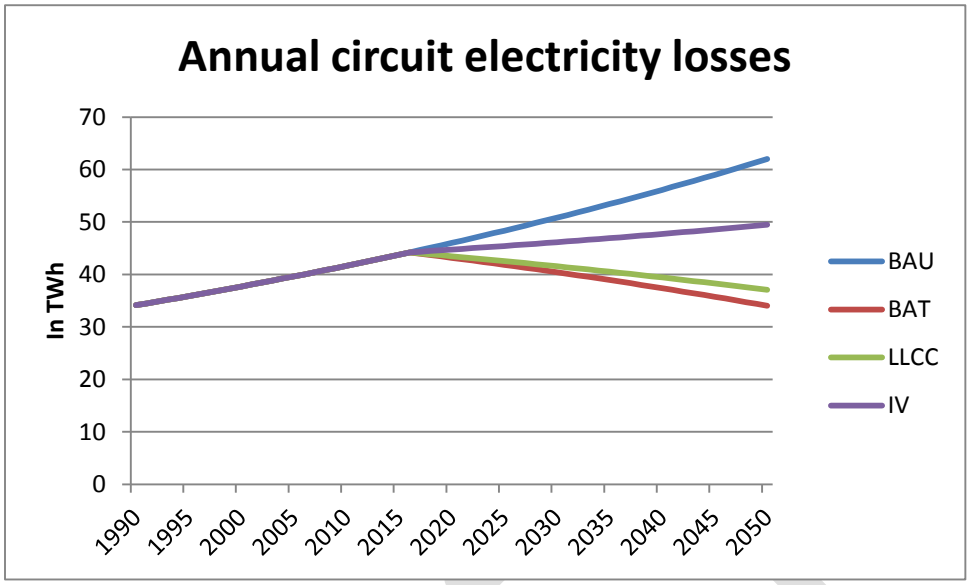


Figure 7-30: Sensitivity case 1 - Annual circuit electricity losses (in TWh/yr)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	34.13	35.87	37.70	39.63	41.65	43.77	46.01	48.35	50.82	53.41	56.14	59.00	62.01
BAT	34.13	35.87	37.70	39.63	41.65	43.77	43.18	41.84	40.42	38.94	37.38	35.74	34.02
LLCC	34.13	35.87	37.70	39.63	41.65	43.77	43.49	42.55	41.56	40.52	39.43	38.28	37.07
IV	34.13	35.87	37.70	39.63	41.65	43.77	44.74	45.43	46.16	46.92	47.72	48.57	49.45
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	-2.82	-6.51	-10.39	-14.47	-18.76	-23.26	-27.99
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	-2.52	-5.80	-9.26	-12.89	-16.71	-20.72	-24.94
IV	0.00	0.00	0.00	0.00	0.00	0.00	-1.27	-2.92	-4.66	-6.49	-8.41	-10.43	-12.56
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-6.1%	-13.5%	-20.5%	-27.1%	-33.4%	-39.4%	-45.1%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-5.5%	-12.0%	-18.2%	-24.1%	-29.8%	-35.1%	-40.2%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-2.8%	-6.0%	-9.2%	-12.2%	-15.0%	-17.7%	-20.2%

Table 7-36: Sensitivity case 1 - Annual circuit electricity losses (in TWh/yr)

For the BAT scenario, this equates to a reduction of annual electricity losses of about 6.51 TWh in 2025. For the LLCC scenario, this equates to a reduction of annual electricity losses of about 5.80 TWh in 2025. For scenario IV, this equates to a reduction of annual electricity losses of about 2.92 TWh in 2025.

7.4.1.4 Annual emissions of CO_2 eq.

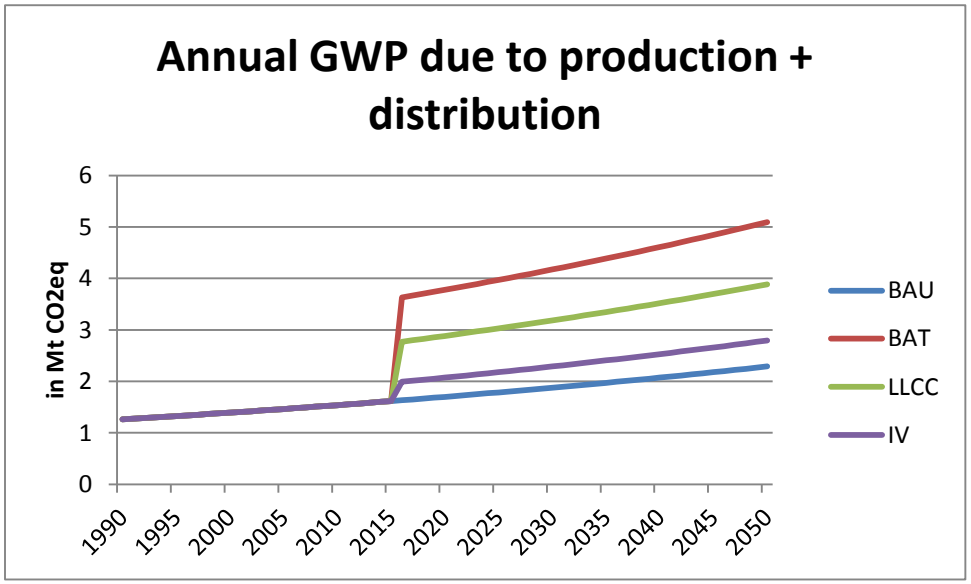


Figure 7-31: Sensitivity case 1 - Annual GWP due to production + distribution (in Mt CO_2 eq.)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	1.26	1.32	1.39	1.46	1.54	1.62	1.70	1.78	1.88	1.97	2.07	2.18	2.29
BAT	1.26	1.32	1.39	1.46	1.54	1.62	3.78	3.97	4.17	4.39	4.61	4.84	5.09
LLCC	1.26	1.32	1.39	1.46	1.54	1.62	2.88	3.03	3.18	3.35	3.52	3.70	3.89
IV	1.26	1.32	1.39	1.46	1.54	1.62	2.07	2.18	2.29	2.41	2.53	2.66	2.79
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	2.08	2.19	2.30	2.41	2.54	2.67	2.80
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	1.18	1.24	1.31	1.38	1.45	1.52	1.60
IV	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.39	0.41	0.43	0.46	0.48	0.50
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+122.5%	+122.5%	+122.5%	+122.5%	+122.5%	+122.5%	+122.5%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+69.7%	+69.7%	+69.7%	+69.7%	+69.7%	+69.7%	+69.7%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+22.0%	+22.0%	+22.0%	+22.0%	+22.0%	+22.0%	+22.0%

Table 7-37: Sensitivity case 1 - Annual GWP due to production + distribution (in Mt CO_2 eq.)

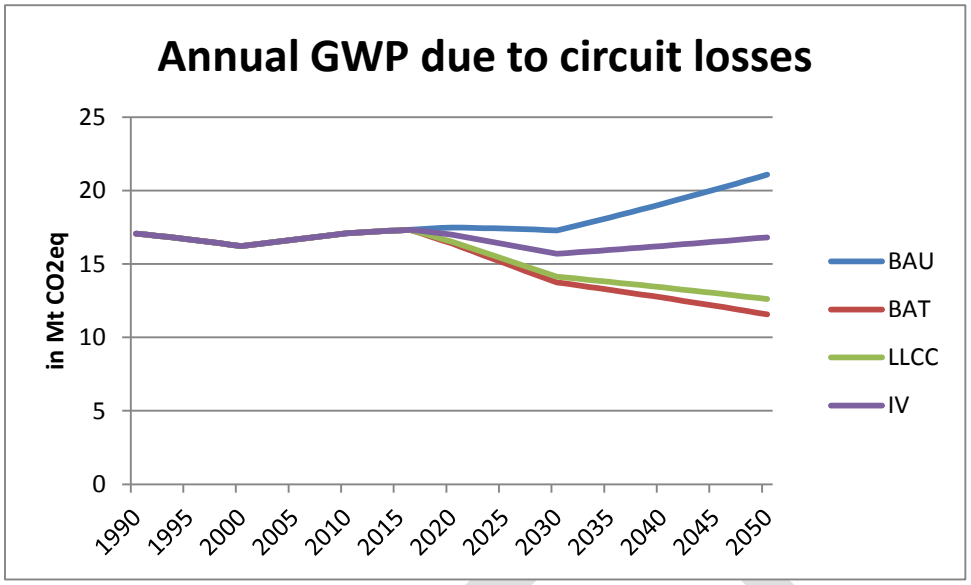


Figure 7-32: Sensitivity case 1 - Annual GWP (total stock) due to circuit losses (in Mt CO_2 eq.)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	17.07	16.68	16.21	16.64	17.08	17.29	17.48	17.41	17.28	18.16	19.09	20.06	21.08
BAT	17.07	16.68	16.21	16.64	17.08	17.29	16.41	15.06	13.74	13.24	12.71	12.15	11.57
LLCC	17.07	16.68	16.21	16.64	17.08	17.29	16.53	15.32	14.13	13.78	13.40	13.01	12.60
IV	17.07	16.68	16.21	16.64	17.08	17.29	17.00	16.35	15.69	15.95	16.23	16.51	16.81
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	-1.07	-2.35	-3.53	-4.92	-6.38	-7.91	-9.52
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	-0.96	-2.09	-3.15	-4.38	-5.68	-7.05	-8.48
IV	0.00	0.00	0.00	0.00	0.00	0.00	-0.48	-1.05	-1.59	-2.21	-2.86	-3.55	-4.27
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-6.1%	-13.5%	-20.5%	-27.1%	-33.4%	-39.4%	-45.1%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-5.5%	-12.0%	-18.2%	-24.1%	-29.8%	-35.1%	-40.2%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-2.8%	-6.0%	-9.2%	-12.2%	-15.0%	-17.7%	-20.2%

Table 7-38: Sensitivity case 1 - Annual GWP (total stock) due to circuit losses (in Mt CO_2 eq.)

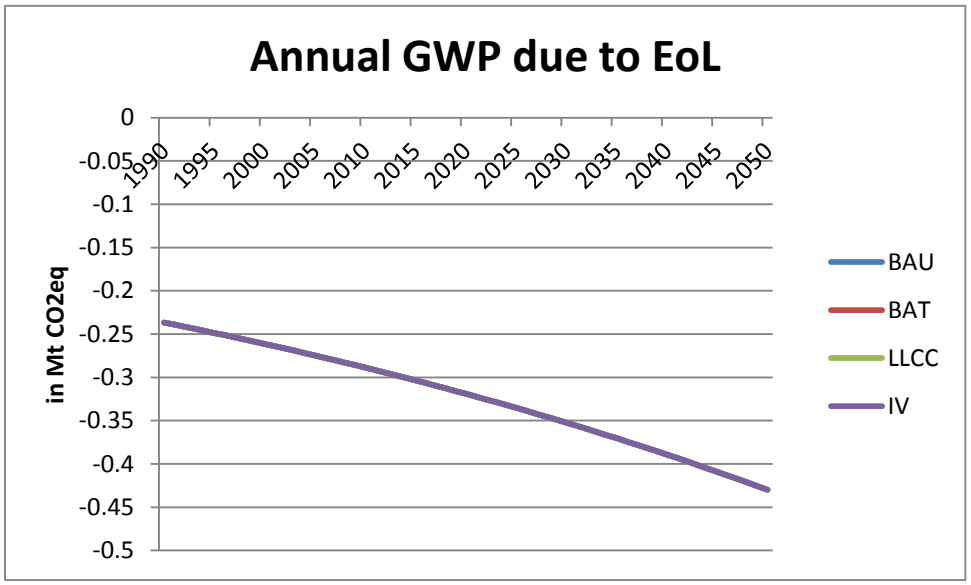


Figure 7-33: Sensitivity case 1 - Annual GWP due to EoL (in Mt CO_2 eq.)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	-0.24	-0.25	-0.26	-0.27	-0.29	-0.30	-0.32	-0.34	-0.35	-0.37	-0.39	-0.41	-0.43
BAT	-0.24	-0.25	-0.26	-0.27	-0.29	-0.30	-0.32	-0.34	-0.35	-0.37	-0.39	-0.41	-0.43
LLCC	-0.24	-0.25	-0.26	-0.27	-0.29	-0.30	-0.32	-0.34	-0.35	-0.37	-0.39	-0.41	-0.43
IV	-0.24	-0.25	-0.26	-0.27	-0.29	-0.30	-0.32	-0.34	-0.35	-0.37	-0.39	-0.41	-0.43
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%

Table 7-39: Sensitivity case 1 - Annual GWP due to EoL (in Mt CO_2 eq.)

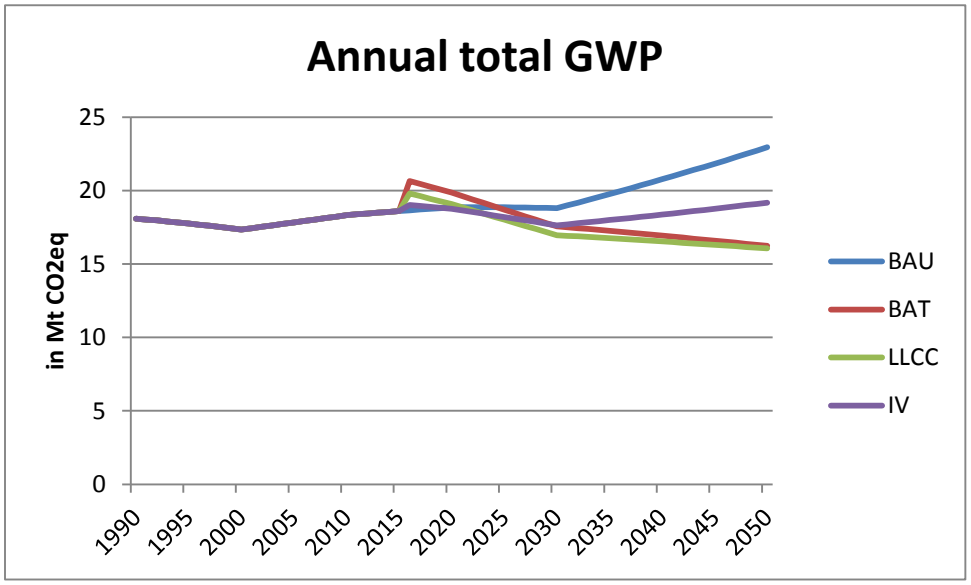
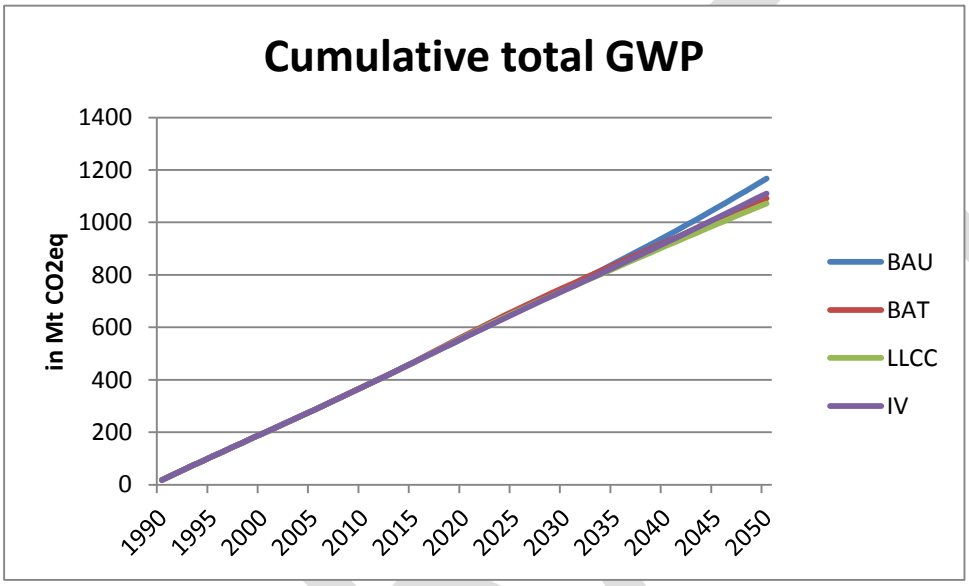


Figure 7-34: Sensitivity case 1 - Annual total GWP (in Mt CO_2 eq.)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	18.09	17.76	17.34	17.83	18.32	18.60	18.86	18.86	18.80	19.76	20.77	21.83	22.94
BAT	18.09	17.76	17.34	17.83	18.32	18.60	19.87	18.70	17.57	17.26	16.93	16.59	16.23
LLCC	18.09	17.76	17.34	17.83	18.32	18.60	19.09	18.01	16.96	16.75	16.53	16.30	16.06
IV	18.09	17.76	17.34	17.83	18.32	18.60	18.75	18.20	17.63	17.99	18.36	18.76	19.18
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	1.01	-0.16	-1.24	-2.51	-3.84	-5.24	-6.71
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	0.23	-0.84	-1.84	-3.01	-4.24	-5.53	-6.88
IV	0.00	0.00	0.00	0.00	0.00	0.00	-0.11	-0.66	-1.17	-1.77	-2.40	-3.07	-3.77
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+5.3%	-0.8%	-6.6%	-12.7%	-18.5%	-24.0%	-29.3%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+1.2%	-4.5%	-9.8%	-15.2%	-20.4%	-25.3%	-30.0%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-0.6%	-3.5%	-6.2%	-9.0%	-11.6%	-14.1%	-16.4%

Table 7-40: Sensitivity case 1 - Annual total GWP (in Mt CO_2 eq.)



(in Mt CO_2 eq.)

Figure 7-35: Sensitivity case 1 - Cumulative GWP (in Mt CO_2 eq.)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	18.09	107.57	195.15	283.32	373.96	466.42	560.22	654.53	748.67	845.54	947.34	1054.35	1166.81
BAT	18.09	107.57	195.15	283.32	373.96	466.42	567.72	663.53	753.61	840.51	925.82	1009.45	1091.31
LLCC	18.09	107.57	195.15	283.32	373.96	466.42	563.63	655.83	742.73	826.92	910.03	992.01	1072.80
IV	18.09	107.57	195.15	283.32	373.96	466.42	560.84	652.95	742.24	831.46	922.52	1015.53	1110.57
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	7.50	9.01	4.94	-5.02	-21.53	-44.90	-75.50
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	3.41	1.31	-5.93	-18.61	-37.31	-62.34	-94.01
IV	0.00	0.00	0.00	0.00	0.00	0.00	0.63	-1.58	-6.43	-14.08	-24.82	-38.82	-56.24
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+1.3%	+1.4%	+0.7%	-0.6%	-2.3%	-4.3%	-6.5%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.6%	+0.2%	-0.8%	-2.2%	-3.9%	-5.9%	-8.1%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.1%	-0.2%	-0.9%	-1.7%	-2.6%	-3.7%	-4.8%

Table 7-41: Sensitivity case 1 - Cumulative GWP (in Mt CO_2 eq.)

7.4.1.5 Annual expenditure

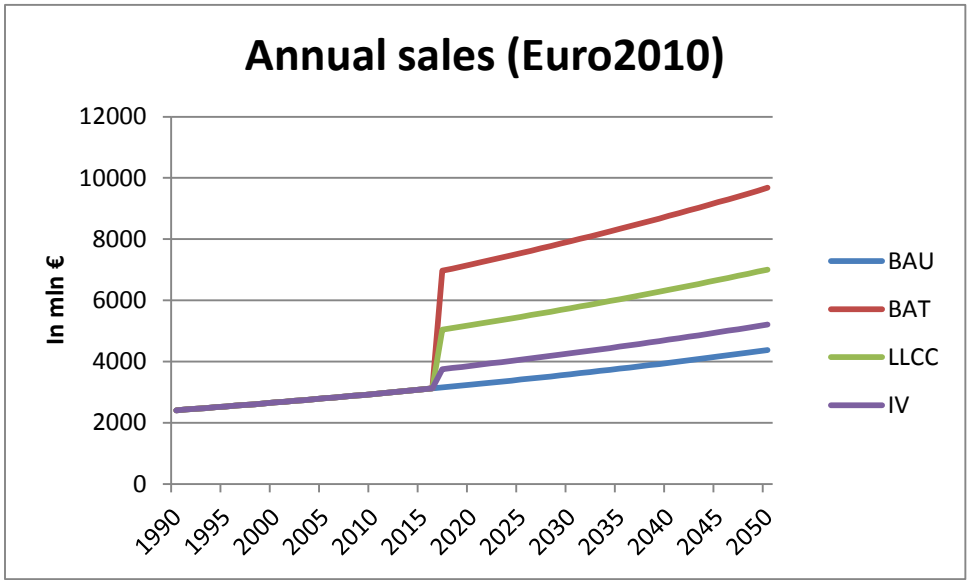


Figure 7-36: Sensitivity case 1 - Annual sales (in mln. euro)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	2407.40	2530.20	2659.26	2794.91	2937.48	3087.32	3244.81	3410.32	3584.29	3767.12	3959.28	4161.24	4373.51
BAT	2407.40	2530.20	2659.26	2794.91	2937.48	3087.32	7179.58	7545.82	7930.73	8335.27	8760.46	9207.33	9677.00
LLCC	2407.40	2530.20	2659.26	2794.91	2937.48	3087.32	5198.57	5463.75	5742.46	6035.38	6343.25	6666.82	7006.89
IV	2407.40	2530.20	2659.26	2794.91	2937.48	3087.32	3864.42	4061.55	4268.73	4486.48	4715.33	4955.86	5208.66
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	3934.78	4135.49	4346.44	4568.16	4801.18	5046.09	5303.49
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	1953.77	2053.43	2158.18	2268.26	2383.97	2505.57	2633.38
IV	0.00	0.00	0.00	0.00	0.00	0.00	619.62	651.22	684.44	719.36	756.05	794.62	835.15
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+121.3%	+121.3%	+121.3%	+121.3%	+121.3%	+121.3%	+121.3%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+60.2%	+60.2%	+60.2%	+60.2%	+60.2%	+60.2%	+60.2%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+19.1%	+19.1%	+19.1%	+19.1%	+19.1%	+19.1%	+19.1%

Table 7-42: Sensitivity case 1 - Annual sales (in mln. euro)

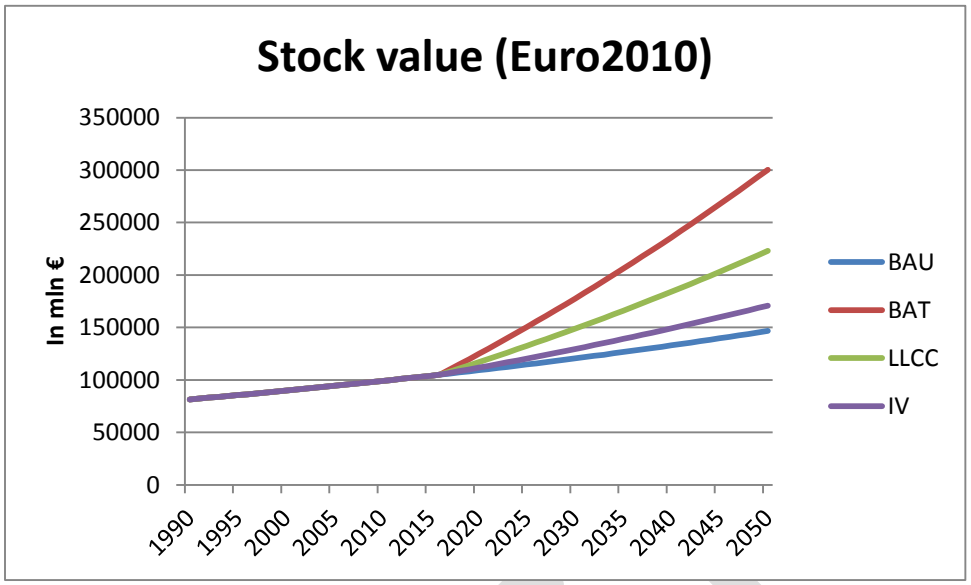


Figure 7-37: Sensitivity case 1 - Stock value (in mln. euro)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	81453.50	85525.96	89806.17	94304.71	99032.71	104001.90	109224.56	114713.63	120482.70	126546.05	132918.69	139616.40	146655.75
BAT	81453.50	85525.96	89806.17	94304.71	99032.71	104001.90	124731.46	150492.57	177567.75	206024.03	235931.88	267365.32	300402.19
LLCC	81453.50	85525.96	89806.17	94304.71	99032.71	104001.90	116924.33	132479.24	148827.61	166009.91	184068.68	203048.63	222996.75
IV	81453.50	85525.96	89806.17	94304.71	99032.71	104001.90	111666.46	120347.81	129472.00	139061.61	149140.38	159733.28	170866.52
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	15506.90	35778.94	57085.05	79477.99	103013.19	127748.93	153746.43
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	7699.77	17765.61	28344.91	39463.87	51150.00	63432.24	76340.99
IV	0.00	0.00	0.00	0.00	0.00	0.00	2441.90	5634.18	8989.30	12515.56	16221.70	20116.88	24210.77
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+14.2%	+31.2%	+47.4%	+62.8%	+77.5%	+91.5%	+104.8%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+7.0%	+15.5%	+23.5%	+31.2%	+38.5%	+45.4%	+52.1%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+2.2%	+4.9%	+7.5%	+9.9%	+12.2%	+14.4%	+16.5%

Table 7-43: Sensitivity case 1 - Stock value (in mln. euro)

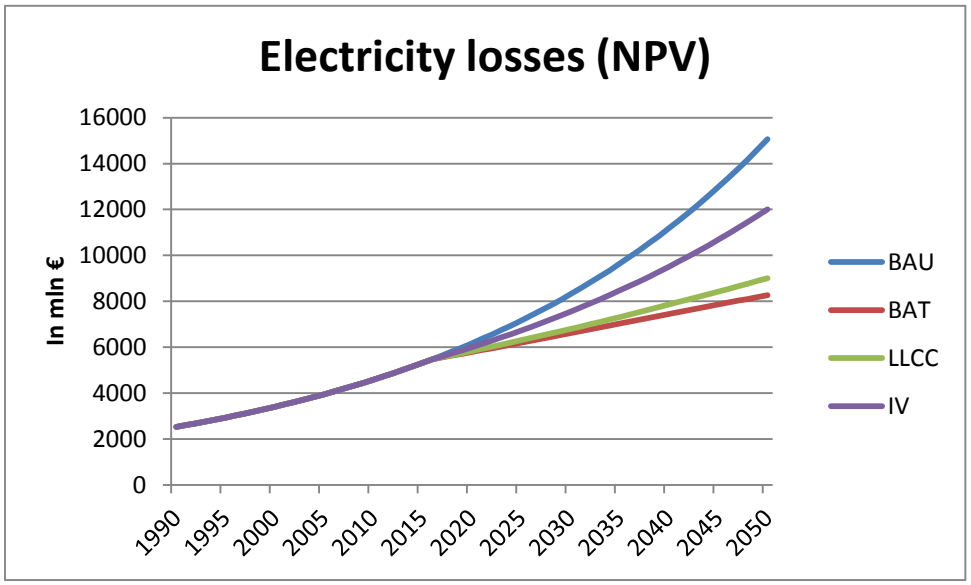


Figure 7-38: Sensitivity case 1 - Annual expenditure due to electricity losses (in mln. euro)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	2526.71	2931.99	3402.28	3948.01	4581.27	5316.10	6168.81	7158.28	8306.47	9638.83	11184.90	12978.96	15060.78
BAT	2526.71	2931.99	3402.28	3948.01	4581.27	5316.10	5790.23	6193.88	6607.63	7027.41	7447.89	7862.26	8261.89
LLCC	2526.71	2931.99	3402.28	3948.01	4581.27	5316.10	5831.54	6299.12	6793.01	7312.37	7855.68	8420.60	9003.80
IV	2526.71	2931.99	3402.28	3948.01	4581.27	5316.10	5998.99	6725.69	7544.44	8467.45	9508.62	10683.81	12011.06
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	-378.58	-964.40	-1698.84	-2611.42	-3737.01	-5116.70	-6798.89
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	-337.27	-859.16	-1513.46	-2326.46	-3329.22	-4558.35	-6056.98
IV	0.00	0.00	0.00	0.00	0.00	0.00	-169.81	-432.59	-762.03	-1171.38	-1676.28	-2295.15	-3049.72
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-6.1%	-13.5%	-20.5%	-27.1%	-33.4%	-39.4%	-45.1%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-5.5%	-12.0%	-18.2%	-24.1%	-29.8%	-35.1%	-40.2%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-2.8%	-6.0%	-9.2%	-12.2%	-15.0%	-17.7%	-20.2%

Table 7-44: Sensitivity case 1 - Annual expenditure due to electricity losses (in mln. euro)

7.4.2 Sensitivity case 2: scenario analysis

In this sensitivity analysis, the inflation and discount rate are set to their lowest value defined by the MEErP guidelines. Changing these parameters has only impact on the economic results, therefore only the economic charts and tables are shown in the next section.
The parameters for this analysis are listed in Table 7-45.

Discount rate	2.5%
Inflation rate	1.0%
Energy Escalation rate	4.0%
Electricity rate (€/kWh)	0.11
Stock growth rate services sector	1.9%
Stock growth rate industry sector	2.9%
Sales growth rate services sector	3.2%
Sales growth rate industry sector	2.8%
Product lifetime services sector (years)	25
Product lifetime industry sector (years)	25

Table 7-45: Sensitivity case 2 - Main input parameters

7.4.2.1 Annual expenditure

The sales and stock value are expressed in euro2010 value; as a result these values will not alter.

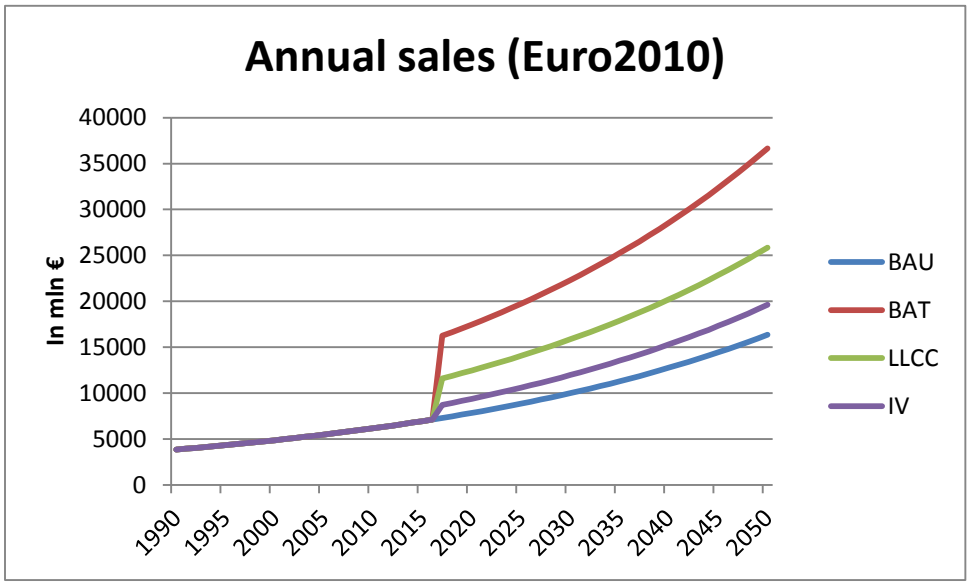


Figure 7-39: Sensitivity case 2 - Annual sales (in mln. euro)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	3839.25	4317.59	4858.41	5470.25	6162.80	6947.17	7836.01	8843.81	9987.09	11284.77	12758.46	14432.92	16336.45
BAT	3839.25	4317.59	4858.41	5470.25	6162.80	6947.17	17468.02	19736.12	22311.68	25237.90	28564.21	32347.18	36651.63
LLCC	3839.25	4317.59	4858.41	5470.25	6162.80	6947.17	12466.33	14055.04	15855.62	17897.44	20214.08	22843.90	25830.83
IV	3839.25	4317.59	4858.41	5470.25	6162.80	6947.17	9372.16	10584.13	11959.81	13522.14	15297.36	17315.50	19610.94
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	9632.00	10892.31	12324.59	13953.14	15805.74	17914.26	20315.18
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	4630.32	5211.24	5868.53	6612.68	7455.61	8410.98	9494.38
IV	0.00	0.00	0.00	0.00	0.00	0.00	1536.15	1740.32	1972.72	2237.37	2538.90	2882.58	3274.49
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+122.9%	+123.2%	+123.4%	+123.6%	+123.9%	+124.1%	+124.4%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+59.1%	+58.9%	+58.8%	+58.6%	+58.4%	+58.3%	+58.1%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+19.6%	+19.7%	+19.8%	+19.8%	+19.9%	+20.0%	+20.0%

Table 7-46: Sensitivity case 2 - Annual sales (in mln. euro)

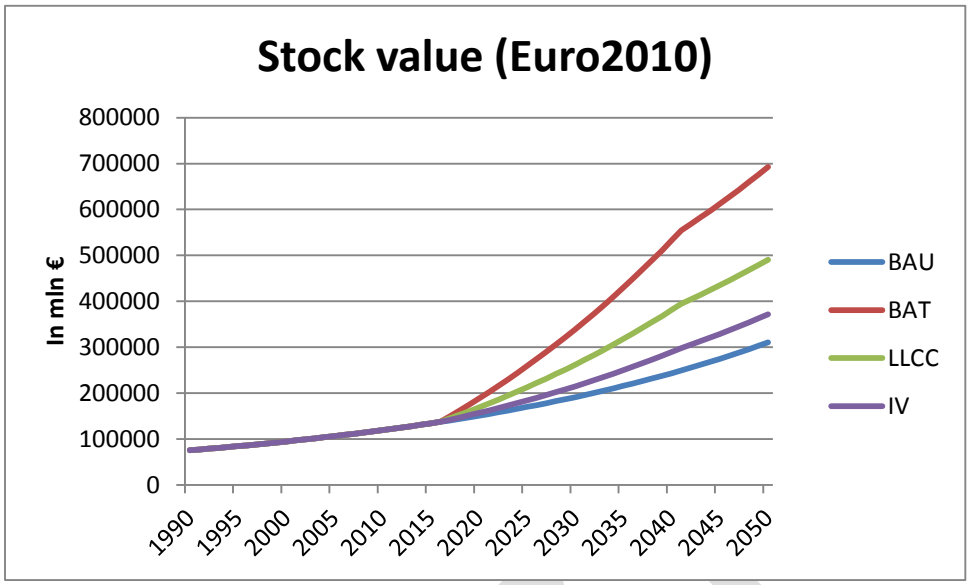


Figure 7-40: Sensitivity case 2 - Stock value (in mln. euro)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	75178.39	84248.32	94490.25	106062.39	119145.11	133944.11	150694.12	169663.04	191156.81	215524.92	243166.77	274538.95	310163.63
BAT	75178.39	84248.32	94490.25	106062.39	119145.11	133944.11	187845.40	258690.93	338869.71	429662.63	532532.30	611998.18	692395.41
LLCC	75178.39	84248.32	94490.25	106062.39	119145.11	133944.11	168578.71	212413.34	261902.64	317808.84	381000.77	434584.59	490594.07
IV	75178.39	84248.32	94490.25	106062.39	119145.11	133944.11	156615.96	183867.59	214748.11	249760.01	289477.54	328635.40	371545.40
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	37151.28	89027.89	147712.89	214137.70	289365.53	337459.23	382231.78
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	17884.59	42750.29	70745.83	102283.92	137834.00	160045.64	180430.44
IV	0.00	0.00	0.00	0.00	0.00	0.00	5921.83	14204.55	23591.30	34235.08	46310.77	54096.45	61381.76
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+24.7%	+52.5%	+77.3%	+99.4%	+119.0%	+122.9%	+123.2%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+11.9%	+25.2%	+37.0%	+47.5%	+56.7%	+58.3%	+58.2%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+3.9%	+8.4%	+12.3%	+15.9%	+19.0%	+19.7%	+19.8%

Table 7-47: Sensitivity case 2 - Stock value (in mln. euro)

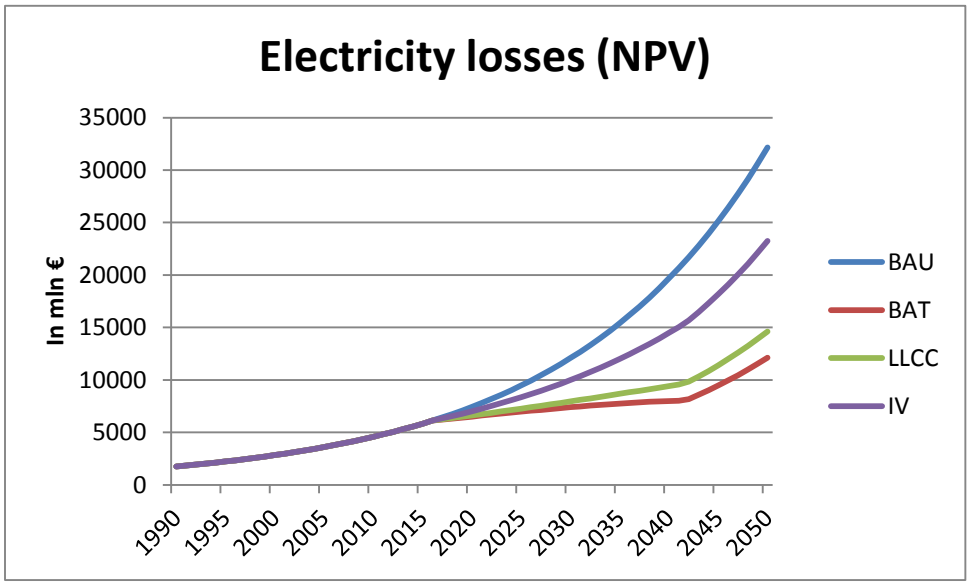


Figure 7-41: Sensitivity case 2 - Annual expenditure due to electricity losses (in mln. euro)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	1754.26	2228.07	2831.54	3600.60	4581.27	5832.51	7429.91	9470.42	12078.48	15413.86	19681.79	25146.08	32145.98
BAT	1754.26	2228.07	2831.54	3600.60	4581.27	5832.51	6505.50	6969.70	7394.74	7749.33	7991.07	9470.41	12118.56
LLCC	1754.26	2228.07	2831.54	3600.60	4581.27	5832.51	6614.92	7267.62	7956.49	8674.91	9412.83	11404.01	14617.78
IV	1754.26	2228.07	2831.54	3600.60	4581.27	5832.51	7017.80	8356.15	9992.62	12002.41	14481.27	18180.99	23255.87
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	-924.41	-2500.73	-4683.74	-7664.53	-11690.72	-15675.68	-20027.42
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	-814.99	-2202.80	-4121.99	-6738.94	-10268.96	-13742.07	-17528.20
IV	0.00	0.00	0.00	0.00	0.00	0.00	-412.11	-1114.27	-2085.87	-3411.45	-5200.52	-6965.10	-8890.11
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-12.4%	-26.4%	-38.8%	-49.7%	-59.4%	-62.3%	-62.3%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-11.0%	-23.3%	-34.1%	-43.7%	-52.2%	-54.6%	-54.5%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-5.5%	-11.8%	-17.3%	-22.1%	-26.4%	-27.7%	-27.7%

Table 7-48: Sensitivity case 2 - Annual expenditure due to electricity losses (in mln. euro)

7.4.1 Sensitivity case 3: scenario analysis

The parameters for this analysis are listed in Table 7-49. Compared to the default scenario analysis only the energy escalation rate has been altered. The impact of this parameter is limited to the electricity cost. As a result only the chart and table showing 'annual expenditure due to electricity losses' are listed in this section.

Discount rate	4.0%
Inflation rate	2.0%
Energy Escalation rate	1.0%
Electricity rate (€/kWh)	0.11
Stock growth rate services sector	1.9%
Stock growth rate industry sector	2.9%
Sales growth rate services sector	3.2%
Sales growth rate industry sector	2.8%
Product lifetime services sector (years)	25
Product lifetime industry sector (years)	25

Table 7-49: Sensitivity case 3 - Main input parameters

7.4.1.1 Annual expenditure due to electricity losses

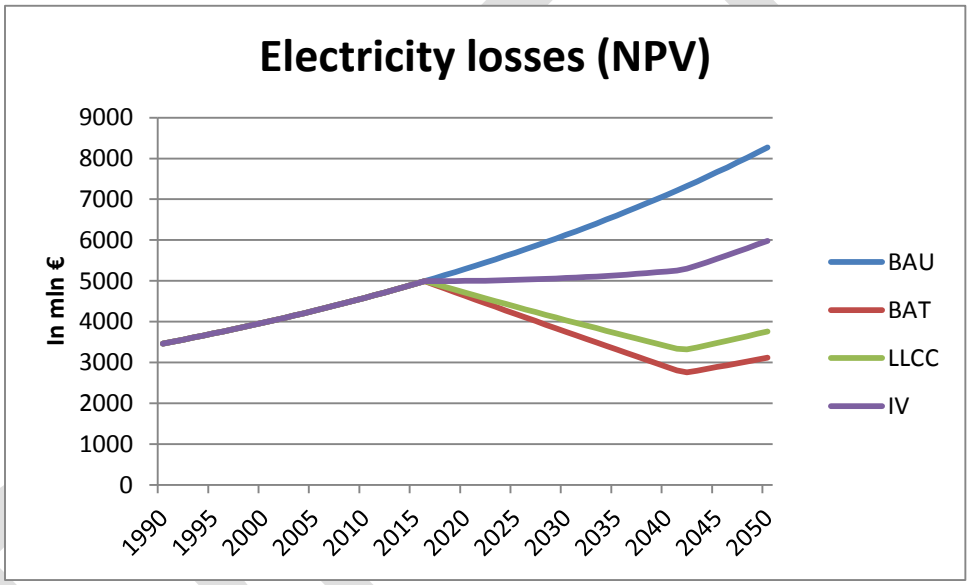


Figure 7-42: Sensitivity case 3 - Annual expenditure due to electricity losses (in mln. euro)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	3458.97	3707.40	3976.03	4266.66	4581.27	4922.00	5291.23	5691.54	6125.75	6596.98	7108.62	7664.40	8268.39
BAT	3458.97	3707.40	3976.03	4266.66	4581.27	4922.00	4632.92	4188.65	3750.34	3316.64	2886.19	2886.53	3117.06
LLCC	3458.97	3707.40	3976.03	4266.66	4581.27	4922.00	4710.84	4367.70	4035.23	3712.78	3399.70	3475.88	3759.89
IV	3458.97	3707.40	3976.03	4266.66	4581.27	4922.00	4997.75	5021.88	5067.88	5136.91	5230.31	5541.47	5981.73
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	-658.32	-1502.89	-2375.42	-3280.35	-4222.43	-4777.86	-5151.33
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	-580.40	-1323.84	-2090.52	-2884.20	-3708.92	-4188.51	-4508.50
IV	0.00	0.00	0.00	0.00	0.00	0.00	-293.49	-669.66	-1057.87	-1460.07	-1878.31	-2122.93	-2286.66
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-12.4%	-26.4%	-38.8%	-49.7%	-59.4%	-62.3%	-62.3%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-11.0%	-23.3%	-34.1%	-43.7%	-52.2%	-54.6%	-54.5%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-5.5%	-11.8%	-17.3%	-22.1%	-26.4%	-27.7%	-27.7%

Table 7-50: Sensitivity case 3 - Annual expenditure due to electricity losses (in mln. euro)

7.5 Summary

TBC

7.6 Annex

Questionnaires and aggregated results have to be inserted.

Some qualitative remarks on the questionnaires indicate that:

- electro-installers are unaware of the losses in circuits;
- calculation of the losses is not performed when designing an installation. Mostly only voltage drop and safety restrictions are taken into account;
- In the vast majority of investment projects the supplier for the electrical system is selected according to the lowest cost of investment. As a consequence electrical contractors offer the cheapest legal solution as a response to quotation requests.

TBC