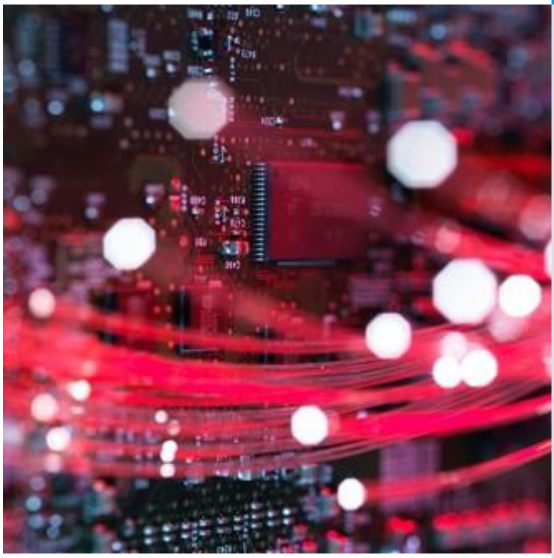
ICF



Study for the review of Commission Regulation 2019/424 (Ecodesign of servers and data storage products)

Task 7 Scenarios – DRAFT

June 2024

Submitted to:

Davide POLVERINI

Policy Officer,

DG GROW

Avenue d'Auderghem 45,

1040 Brussels,

Belgium

Task 7 Scenarios – Draft

A report submitted by ICF S.A.

Date: June 2024

Tom Lock
ICF S.A.
Avenue Marnix 17
Brussels
B-1000
Belgium
T +32 (0) 2 275 01 00
www.icf.com

Document Control

Document Title	Task 7 Scenarios – Draft
Prepared by	Manish Kumar, Abhishek Jathar, Todd Leddy
Checked by	Tom Lock
Date	June 2024

Contents

Table of Tables

Table of Figures

7 Introduction to Task 7 Scenarios

The aim of this task is to look at suitable policy means to achieve the potential improvement. For example, this could include implementing the Least Life Cycle Cost (LLCC) as a minimum requirement, using the environmental performance of the Best Available Technology (BAT) or Best Not Available Technology (BNAT) as a benchmark and using standards, labelling or incentives relating to public procurement.

This task also aims to draw together scenarios quantifying the improvements that can be achieved versus a Business-as-Usual (BaU) scenario and compares the outcomes with EU environmental targets and societal costs.

This task aims to estimate the impact on users and industry considering the typical design cycle in a product sector.

This task provides an analysis of which significant impacts may have to be measured under possible implementing measures and what measurement methods would need to be developed or adapted.

7.1 Policy Analysis

The objective of this sub-task is to identify policy options considering the outcomes of the previous tasks. The analysis will:

- Include a description of the main stakeholders' positions
- Discuss possible market and legislative barriers and opportunities for measures
- Be based on the exact definition of the products, according to subtask 1.1
- Provide Ecodesign requirements, such as minimum (or maximum) requirements
- Be complemented with (dynamic) labelling and benchmark categories
- Where appropriate, apply existing standards or propose needs/ generic requirements for harmonised standards to be developed
- Provide requirements on installation of the product or on user information

7.1.1 Stakeholders

Stakeholders have been engaged during this review and particularly at key junctures of the study. These have included the first stakeholder meeting, held on 29 March 2023; circulation of the Phase 1 Technical Analysis report; the second stakeholder meeting, held on 28 September 2023; and circulation of updated MEErP Tasks 1-4 reports and laterally Tasks 5-7. Comments have been collated and addressed during an ongoing iteration of the draft reports. Further direct engagement has been undertaken in order to strengthen the type and quality of information received, particularly in the Task 2 Markets report. Representatives from The Green Grid have supported the study with detailed feedback, quantitative data and sense checking of market estimates.

7.1.2 Barriers & Opportunities

As evidenced elsewhere within study, opportunities exist to strengthen the current energy efficiency requirements for servers. Opportunities also exist to expand the material efficiency requirements currently specified within Regulation 2019/424 in order to reflect the Commission's approach to improving the circular economy, using Ecodesign as a vehicle for that in line with its wider policy intentions.

7.1.3 Scope

The product scope for the proposed measures is in line with the categories and definitions for servers and data storage products presented within the Task 1 report.

7.1.3.1 Category definitions under existing scope

The following definitions apply to products in scope of the existing regulation 2019/424:

- '**server'** means a computing product that provides services and manages networked resources for client devices, such as desktop computers, notebook computers, desktop thin clients, internet protocol telephones, smartphones, tablets, tele-communication, automated systems or other servers, primarily accessed via network connections, and not through direct user input devices, such as a keyboard or a mouse and with the following characteristics:
  - it is designed to support server operating systems (OS) and/or hypervisors, and targeted to run user-installed enterprise applications;
  - it supports error-correcting code and/or buffered memory (including both buffered dual in-line memory modules and buffered on board configurations);
  - all processors have access to shared system memory and are independently visible to a single OS or hypervisor.
- **'resilient server'** means a server designed with extensive reliability, availability, serviceability and scalability features integrated in the micro architecture of the system, central processing unit (CPU) and chipset.
- '**multi-node server**' means a server that is designed with two or more independent server nodes that share a single enclosure and one or more power supply units. In a multi-node server, power is distributed to all nodes through shared power supply units. Server nodes in a multi-node server are not designed to be hot-swappable.
- **'network server'** means a network product which contains the same components as a server in addition to more than 11 network ports with a total line rate throughput of 12 Gb/s or more, the capability to dynamically reconfigure ports and speed and support for a virtualized network environment through a software defined network
- **'data storage product'** means a fully-functional storage system that supplies data storage services to clients and devices attached directly or through a network. Components and subsystems that are an integral part of the data storage product architecture (e.g., to provide internal communications between controllers and disks) are considered to be part of the data storage product. In contrast, components that are normally associated with a storage environment at the data centre level (e.g. devices required for operation of an external storage area network) are not considered to be part of the data storage product. A data storage product may be composed of integrated storage controllers, data storage devices, embedded network elements, software, and other devices.
- '**data storage device'** means a device providing non-volatile data storage, with the exception of aggregating storage elements such as subsystems of redundant

arrays of independent disks, robotic tape libraries, filers, and file servers and storage devices which are not directly accessible by end-user application programs, and are instead employed as a form of internal cache;

- **'online data storage product'** means a data storage product designed for online, random-access of data, accessible in a random or sequential pattern, with a maximum time to first data of less than 80 milliseconds;

7.1.3.2 Category definitions under proposed expanded scope

This section presents product categories considered for inclusion within the scope of the regulation. Unless otherwise specified below, other product category exclusions from Regulation 2019/424 remain.

As set out in Task 6, the following amendments to scope are proposed. For all three categories, it is proposed that they will be brought into scope of the regulation but kept out of scope of the energy efficiency requirements, as set out currently in Annex II point 2.1 and point 2.2 of Regulation 2019/424. The definitions are repeated below from Task 1 and Task 6 respectively.

- **Server appliance –** means a server that is not intended to execute user-supplied software, delivers services through one or more networks, is typically managed through a web or command line interface and is bundled with a pre-installed OS and application software that is used to perform a dedicated function or set of tightly coupled functions.
- **Fully fault tolerant server** – means a server that is designed with complete hardware redundancy (to simultaneously and repetitively run a single workload for continuous availability in mission critical applications), in which every computing component is replicated between two nodes running identical and concurrent workloads (i.e., if one node fails or needs repair, the second node can run the workload alone to avoid downtime).
- **Hyperconverged servers** – means a highly integrated server which contains the additional features of large network equipment and storage products.

Task 6 also considered the inclusion of large servers in scope of the revised regulation, which are currently defined in 2019/424:

- **Large servers** – means a resilient server which is shipped as a pre-integrated/pre-tested system housed in one or more full frame racks and that includes a high connectivity input/output subsystem with a minimum of 32 dedicated input/output slots.

Large servers are currently out of scope from SPEC SERT, EPEAT and IEC 21836:2020. They therefore do not have an energy measurement standard. Under Task 6 it was proposed to include large servers in the regulation but kept out of scope from the PSU requirements currently set out in Annex II point 1.1, the energy efficiency requirements set out in Annex II point 2.1 and point 2.2 of Regulation 2019/424. Most large servers would also be exempt from the information requirements from Annex II 3.1 as they generally meet the exemption criteria of being "*custom made servers, made on a one-off basis"* as currently set in the regulation. This addition however will ensure that large server providers must provide firmware support for 6 years, allow for part harvesting, provide availability of spare parts, disassemblability and repair, along with information provision on materials used.

7.1.4 Proposed Measures

The proposed measures for the servers and data storage product groups are presented and discussed below.

7.1.4.1 Stricter-active efficiency (servers)

Design Option 3 from Task 6, the stricter active efficiency measure for servers considers a scenario where 75% of the models from the SERT tool dataset from 2019 meet the requirement. The proposed limits are presented below in Table 7.1.

Table 7.1 Proposed server stricter-active efficiency thresholds

Number of sockets	Product type	Minimum Active efficiency
1	Rack	15.33
2	Rack	23.36
2	Blade or multi-node servers	21.09
4	Rack	20.32
4	Blade or multi-node	22.44

According to the SERT tool dataset which is comprised of models from 2019, the proposed thresholds presented in Table 7.1 would generate the following pass rates, as presented in Table 7.2.

Table 7.2 SERT 2019 dataset pass rate under stricter-active efficiency thresholds

Number of sockets	Product type	Pass rate (%)	Total sample size
1	Rack	75%	76
2	Rack	75%	152
2	Blade or multi-node servers[1]	75%	60
4	Rack	75%	24
4	Blade or multi-node	75%	10

7.1.4.2 Idle consumption to workload ratio (servers)

Design Option 4 from Task 6, the idle consumption to workload ratio for servers, considers a scenario where a new idle efficiency metric is proposed to ensure that idle consumption is being optimised for use in the market, but also to allow for servers with performance ratios to be included. The current ecodesign regulation 2019/424 sets maximum idle power consumption values for servers with a base allowance and an additional power allowance due to additional components. Under Task 6 it was determined that the current formulation of the requirement is having no effect, with a pass rate of 100% based upon the 2019 SERT Tool dataset.

$$Idle\ to\ workload\ ratio = \frac{idle\ power\ (in\ Watts)}{100\%\ SSJ\ workload\ power\ (in\ Watts)}$$

[1] for blade or multi-node servers, the "number of sockets" has been equated to "number of processors" in the dataset.

This metric ensures that the smaller the ratio, the smaller the idle power contribution compared to the SSJ workload contribution. The SSJ worklet chosen represents a worklet with both CPU processing and memory activities. Therefore, a smaller ratio will mean that the idle power consumption is scaled to be more efficient versus an active workload parameter. This metric therefore serves as a method to remove products which are operating inefficiently in idle versus their maximum power consumption. As this metric is a ratio that includes the SSJ workload, this includes insight into the specificities and components of the server, such as CPU power and memory, and hence doesn't require additional allowances to be included.

Applying this idle to workload ratio to servers on the market since 2019 within the SERT tool dataset, if a pass rate of needing the idle to workload ratio to be smaller than 0.38 was set, then 75% of the BC1 servers would pass the metric. And for BC2 if idle to workload ratio was set to be smaller than 0.16, then 75% of the BC2 servers would pass the metric.

7.1.4.3 Processor power management function (servers)

Design Option 5 from Task 6, mandating processor management functions, considers a scenario where servers shipped into the EU market shall have the following power management functions enabled by default: all processors must be able to reduce power consumption in times of low utilisation by reducing voltage and/or frequency through Dynamic Voltage and Frequency Scaling (DVFS). This feature allows for greater energy savings when switching to idle.

7.1.4.4 Improved disassembly, repairability and recycling for servers

Design Option 7 from Task 6, this measure considers multiple means to improve the overall disassembly, repairability and recycling of servers.

Firstly, the measure specifies disassemblability requirements by a class B generalist, workshop environment class A, using tools from A, B or C nomenclature, and favours the repairability, reuse, refurbishment and recycling of servers: *Servers must be disassemblable by someone with generalist repair skills, in a workshop environment and not using proprietary tools. The definition of "disassembly" is marked as "a process whereby a product is taken apart in such a way that is could subsequently be reassembled and made operational". This is the process for replacement of parts.* Further details are presented in Task 6, section 6.1.3.1. Additionally, fasteners should all be reusable (class A) or removable (class B). This shall cover the following components: CPU, PSUs, data storage devices, memory, motherboard, graphic card, chassis, batteries, fans, integrated switch, RAID controllers and Network Interface Cards. For the PSU and storage drives, the tool requirement for removal and replacement/upgrade shall be only of class A. This measure has singled out PSUs and storage drives with a more stringent disassembly requirement, following the data from Task 3, section 3.3.4, that the most likely component failure is the PSU, motherboard and storage drives. As motherboards are connected to all components, these cannot be set at a higher stringency level. However, it is noted that PSUs and storage drives are typically set aside from the rest of the server design in order to facilitate upgrade. Hence, they are suitable for improved disassemblability requirements.

Secondly, the measure specifies that information shall be provided to professionals on how to disassemble, and thus repair, servers. The suite of information presented in Task 6, section 6.1.3.1 shall be made available on the manufacturer's website, indicating the process for professional repairers to register for access to information.

Thirdly, the measure specifies the availability of spare parts such that manufacturers, importers or authorised representatives of servers shall make available to professional repairers at least the following spare parts, for a minimum period of 5 years after placing the last unit of the model on the market: memory cards, CPU, motherboard, graphic cards, PSU, chassis, batteries, fans, integrated switch, RAID controllers and network interface cards.

Fourthly, the measure specifies that for serialised parts, the manufacturers shall provide non-discriminatory access for professional repairers to any software tools, firmware or similar auxiliary means needed to ensure the full functionality of those spare parts and of the device in which such spare parts are installed during and after the replacement. This measure shall cover CPU, PSUs, data storage devices, memory, graphic card, chassis, batteries, fans, integrated switch, RAID controllers and Network Interface Cards. A serialised part means a part which has a unique code that is paired to an individual unit of a device and whose replacement by a spare part requires the pairing of that spare part to the device by means of a software code to ensure full functionality of the spare part and the device.

Finally, the measure specifies that hardware components, performance capabilities and compatibility metrics are published by manufacturers to support the recycling industry to better target their recycling efforts to recover the materials. This product information datasheet should include a list of the components, their number codes and their material content (both bulk and targeted CRMs: cobalt, neodymium, silicon, germanium, silicon, tantalum, gold, dysprosium). The requirements shall cover the following components: CPU, PSUs, data storage devices, memory, motherboard, graphic card, chassis, batteries, fans, integrated switch, RAID controllers and Network Interface Cards.

7.1.4.5 Energy efficiency requirements for storage products

Design Option 6 from Task 6 considers a scenario where energy efficiency requirements are placed on data storage products, namely setting a SNIA performance level and capacity optimisation methods (COMs).

For SNIA, the measure aligns with the Energy Star criteria such that: each optimal configuration point submitted for a block I/O storage product or storage product family must meet the following applicable active state requirements in Table 7.3 for each workload type. For streaming workloads, the data storage product must meet either the sequential read or the sequential write requirement. The optimal configuration is defined as the products maximum peak energy efficiency performance (performance/watt) for a given workload type. This configuration is provided by the manufacturer and may be optimised for the transaction, streaming and composite workload types. Further information about specific workload test methods are provided in Task 6 section 6.1.2.1.

Table 7.3 Active state requirements for Block I/O Storage products

Workload Type Specific	Specific Workload Test	Minimum Performance/Watt Ratio	Applicable Units of Ratio
Transaction	Hot Band	28.0	IOPS/Watt
Streaming	Sequential Read	2.3	MiBS/Watt
Streaming	Sequential Write	1.5	MiBS/Watt

For capacity optimisation methods (COMs), a storage product shall make available to the end user configurable / selectable features listed in Table 7.4 in quantities greater than or equal to those listed in Table 7.5. COMs result in the reduction of actual data stored on storage devices through a combination of hardware and / or software. Further details are provided in Task 6 section 6.1.2.1.

Table 7.4 Recognised COM features[2]

Feature	Verification Requirement
COM: Thin Provision	SNIA Verification test, following ISO/IEC 24091:2019 standard
COM: Data Deduplication	SNIA Verification test, following ISO/IEC 24091:2019 standard
COM: Compression	SNIA Verification test, following ISO/IEC 24091:2019 standard
COM: Delta Snapshots	SNIA Verification test, following ISO/IEC 24091:2019 standard

Table 7.5 COM reqs for Disk Set & NVSS Disk Set Access Online 2, 3 & 4 Systems

Storage Product Category	Minimum number of COMs required to be made available
Online 2	1
Online 3	2
Online 4	3

7.1.4.6 Improved disassembly, repairability and recycling for data storage products

Design Option 8 from Task 6, this measure considers multiple means to improve the overall disassembly, repairability and recycling of data storage products.

Firstly, the measure specifies disassemblability requirements by a class B generalist, workshop environment class A, using tools from A, B or C nomenclature, and favours the repairability, reuse, refurbishment and recycling of data storage products: *Data storage products must be disassemblable by someone with generalist repair skills, in a workshop environment and not using proprietary tools. .* Further details are presented in Task 6, section 6.1.3.2. Additionally, fasteners should all be reusable (class A) or removable (class B). This shall cover the following components: CPU, PSUs, data storage devices, memory, motherboard, graphic card, chassis, batteries, fans, integrated switch, RAID controllers and Network Interface Cards. For the PSU and storage drives, the tool requirement for disassembly shall be only of class A. This measure has singled out PSUs and storage drives with a more stringent disassembly requirement, following the data from Task 3, section 3.3.4, that the most likely component failure is the PSU, motherboard and storage drives. As motherboards are connected to all components, these can't be set at a higher stringency level. However, it is noted that PSUs and storage drives are typically set aside from the rest of the device design in order to facilitate upgrade. Hence, they are suitable for improved disassemblability requirements.

[2] ISO/IEC 24091:2019(en), Information technology — Power efficiency measurement specification for data center storage

Secondly, the measure specifies that information shall be provided to professionals on how to disassemble, and thus repair, data storage products. The suite of information presented in Task 6, section 6.1.3.2 shall be made available on the manufacturer's website, indicating the process for professional repairers to register for access to information.

Thirdly, the measure specifies the availability of spare parts such that manufacturers, importers or authorised representatives of data storage products shall make available to professional repairers at least the following spare parts, for a minimum period of 5 years after placing the last unit of the model on the market: memory cards, CPU, motherboard, graphic cards, PSU, chassis, batteries, fans, integrated switch, RAID controllers and network interface cards.

Fourthly, the measure specifies that for serialised parts, the manufacturers shall provide non-discriminatory access for professional repairers to any software tools, firmware or similar auxiliary means needed to ensure the full functionality of those spare parts and of the device in which such spare parts are installed during and after the replacement. This measure shall cover CPU, PSUs, data storage devices, memory, graphic card, chassis, batteries, fans, integrated switch, RAID controllers and Network Interface Cards. A serialised part means a part which has a unique code that is paired to an individual unit of a device and whose replacement by a spare part requires the pairing of that spare part to the device by means of a software code to ensure full functionality of the spare part and the device.

Finally, the measure specifies that hardware components, performance capabilities and compatibility metrics are published by manufacturers to support the recycling industry to better target their recycling efforts to recover the materials. This product information datasheet should include a list of the components, their number codes and their material content (both bulk and targeted CRMs: cobalt, neodymium, silicon, germanium, silicon, tantalum, gold, dysprosium). The requirements shall cover the following components: CPU, PSUs, data storage devices, memory, motherboard, graphic card, chassis, batteries, fans, integrated switch, RAID controllers and Network Interface Cards.

7.1.5 Information sharing

7.1.5.1 Server real time utilisation and power consumption reporting

The following design option is considered:

A computer server must provide real-time data on input power consumption (W) and average utilisation of all logical CPUs. Data must be made available in a published or user-accessible format that is readable by third-party, non-proprietary management software over a standard network. For blade and multi-node servers and systems, data may be aggregated at the chassis level.

Processor utilisation: Average utilisation must be estimated for each logical CPU that is visible to the OS and must be reported to the operator or user of the computer server through the operating environment (OS or hypervisor); This should be reported under the ITEUSV ISO/IEC 30134-5:2017 metric.

Input power: Measurements must be reported with accuracy of at least ±5% of the actual value, with a maximum level of accuracy of ±10W for each installed PSU (i.e., power reporting accuracy for each power supply is never required to be better than ± 10 watts) through the operating range from Idle to full power;

This measure is estimated not to have any costs to include as this requires for updated software reporting to be included, which is irrelevant of the hardware used. It is also a requirement for Energy Star, making it a common requirement for all products to align with. The measure is expected to increase product utilisation and therefore decrease the total need for hardware.

7.1.5.2 Server thermal management and monitoring

The following design option is considered:

A computer server must provide real-time data on inlet air temperature (°C) monitoring and fan speed management capability that is enabled by default. Data must be made available in a published or user-accessible format that is readable by third-party, non-proprietary management software over a standard network. For blade and multi-node servers and systems, data may be aggregated at the chassis level.

Inlet air temperature: Measurements must be reported with an accuracy of at least ±2°C.

This measure is estimated not to have any costs to include as this requires for updated software reporting to be included, which is irrelevant of the hardware used. It is also a requirement for Energy Star, making it a common requirement for all products to align with. The measure is expected to improve datacentre facilities management and hence overall energy efficiency of the datacentre under the PUE. This is not expected to affect Base case consumption.

7.1.5.3 Data storage products performance reporting

The following design option is considered:

Data storage products with an Online 3 and Online 4 capability shall be capable of measuring and reporting the following;

- *Input Power, in watts. Input power measurements must be reported with accuracy within ±5% of the actual value for measurements greater than 200 W, through the full range of operation. For measurements less than or equal to 200 W, the accuracy must be less than or equal to 10 W multiplied by the number of installed PSUs; and*
- *Inlet Air Temperature, in degrees Celsius, with accuracy of ± 2°C.*

The data shall be made available in a published or user-accessible format that is readable by third-party, non-proprietary management systems. This data shall be available over a standard network for end users and third-party management systems.

This measure is estimated not to have any costs to include as this requires for updated software reporting to be included, which is irrelevant of the hardware used. It is also a requirement for Energy Star, making it a common requirement for all products to align with.

The measure is expected to improve datacentre facilities management and hence overall energy efficiency of the datacentre under the PUE. This is not expected to affect Base case consumption.

7.1.6 Labelling

As initially presented in Task 6, a Design Option for a mandatory energy label for servers is a scenario being modelled under Task 7. The Design Option specifies that servers shall be sold with an energy label which includes the following information:

- Server form factor
- Server active efficiency
- Server active Performance score
- Idle power consumption (in Watts)
- ASHRAE temperature range

For servers which are part of a server configuration family, the "typical server configuration" data should be reported.

This measure could also be considered to be run via a QR code set directly on the server which links to a webpage with the information.

This measure is expected to show benefits to encourage the purchase of more efficient servers over time.

7.1.7 Standards

7.2 Scenario Analysis – Resource Use & Environmental Impacts

The objective of this sub-task is to create a stock-model between 2010 and 2050 and calculate resources use and environmental impacts in the following scenarios:

- BaU – Business as usual. This scenario assumes no new policy measures on the European level. According to the market analysis in Task 2 and stock development till 2050, resource use and environmental impacts are modelled.
- MEPS – Implementation of Minimum Energy Performance Standard, as proposed in Section 7.1.4. This scenario assumes implementing Design Option 9 from Task 6, for BC1 and BC2 from year 2024 with no further changes. For BC3, it is assumed implementing Design Option 10 from year 2024 with no further changes. According to the market analysis in Task 2 and stock development till 2050, resource use and environmental impacts are modelled. There is no difference between the BaU and the MEPS scenario between 2010 and 2023.
- Labelling – Implementation of an Energy Label, as proposed in Section 7.1.5. The Energy Label is assumed to be implemented in 2024. Between 2010 and 2023, there is no difference between the BaU and the Labelling scenario. From 2024 onwards, the Labelling system is assumed to accelerate improvements in efficiency over time. In the Labelling scenario a reduction of 6% has been assumed for the year when the label is implemented (2024). Subsequently, a further 6% reduction is accounted for in year 2 (2025) as the competitive market for energy issues takes hold followed by further 7% (in 2026) and 4% (in 2027) reductions. From 2028 onwards, the annual improvement rate of electricity consumption is set at 1%.

- MEPS + Labelling – Implementation of both MEPS and an Energy Label. In this scenario, both the MEPs and the Labelling system are assumed to be implemented in 2024. Between 2010 and 2023, there is no difference between the BaU and the MEPS + Labelling scenario. In 2024 a reduction of 3% has been assumed along with MEPS. Subsequently, a further 3% reduction is accounted for in year 2 (2025) as the competitive market for energy issues takes hold followed by further 4% (in 2026) and 2% (in 2027) reductions. From 2028 onwards, the annual improvement rate of electricity consumption is set at 1%.

7.2.1 Inputs & Assumptions

7.2.1.1 Stock & Sales

The stock and sales assumptions from Tasks 2 and 5 are used for modelling the BaU, MEPS, Labelling and MEPS+Labelling scenarios. In the Labelling scenario, the implementation of the Energy Label is assumed not to affect sales or stock. This means that figures used in the Labelling scenario are the same as those in the BaU scenario. The rationale behind this assumption is that the label does not directly affect the price of products on the market nor the consumer's decision to procure a server. Instead, the effect of the label is to improve the performance of a market average product by shifting sales to more efficient products.

In the MEPS and MEPS + Labelling scenarios, the total stock and sales figures are the same as those in the BaU scenario.

There is further detail on the assumptions used to model stock and sales in the Task 2 and Task 5 reports.

Table 7.6 Estimated stock of BC1, BC2 and BC3 in the EU between 2010 and 2050.

	BC1	BC2	BC3
Year	Stock (In thousands)		
2010	4757	937	36197
2015	5526	1088	64793
2020	5666	1116	106455
2025	6583	1296	128228
2030	6750	1329	205092
2035	6923	1363	340150
2040	7100	1398	582438
2045	7282	1434	1023942
2050	7468	1471	1837672

7.2.1.2 BaU Scenario

In the BaU scenario, the energy consumption in the use phase and the consequent environmental impacts are calculated considering the technical inputs used to model the Base Cases in Task 5. Environmental impacts are also calculated using the EcoReport tool 2024, as per Task 5.

7.2.1.3 MEPS Scenario

In the MEPS scenario, the energy consumption in the use phase and the consequent environmental impacts are calculated considering the technical inputs used to model the Base Cases in Task 5 and Design Option 9 in Task 6 for BC1 & BC2. For BC3, Design Option 10 in Task 6 is used. Environmental impacts are also calculated using the EcoReport tool 2024, as per task 5.

Between 2010 and 2023, there is no difference between the BaU and the MEPS scenario. The MEPS scenario comes into effect from 2024. The stocks and sales remain same as BaU scenario.

7.2.1.4 Labelling Scenario

The Energy Label is assumed to be implemented in 2024. Between 2010 and 2023, there is no difference between the BaU and the Labelling scenario. From 2024 onwards, the Labelling system is assumed to accelerate improvements in efficiency over time.

Table 7.7 compares the estimated yearly percentual reduction in the average electricity consumption used in the BaU and Labelling scenarios.

Table 7.7 Labelling-Estimated change in electricity consumption (%)

Year	BaU	Labelling
2010-2023	No change	Same as BaU
2024		6%
2025		6%
2026		7%
2027		4%
2028-2050		1%

Similar to the approach taken in BaU scenario, in the Labelling scenario the environmental impacts created have been calculated using the inputs for the Base Cases as per Task 5.

7.2.1.5 MEPS & Labelling Scenario

In this scenario, both the MEPs and the Labelling system are assumed to be implemented in 2024. Between 2010 and 2023, there is no difference between the BaU and the MEPS + Labelling scenario.

Table 7.8 compares the estimated yearly percentual reduction in the average electricity consumption used in the BaU and MEPS + Labelling scenarios.

Table 7.8 MEPS + Labelling – Estimated change in electricity consumption (%)

Year	BaU	Labelling
2010-2023	No change	Same as BaU
2024	MEPS	3%
2025		3%
2026		4%
2027		2%
2028-2050		1%

7.2.2 Results

The energy consumption of the stock of BC1, BC2 and BC3 in the EU for the four different scenarios were calculated.

7.2.2.1 Base Case 1

Figure 7.1 shows the Primary Energy Consumption for the four scenarios between 2010 and 2050 for EU27 for BC1.

Figure 7.1 BC1 Primary Energy Consumption, four scenarios, 2010-2050 (EU27)

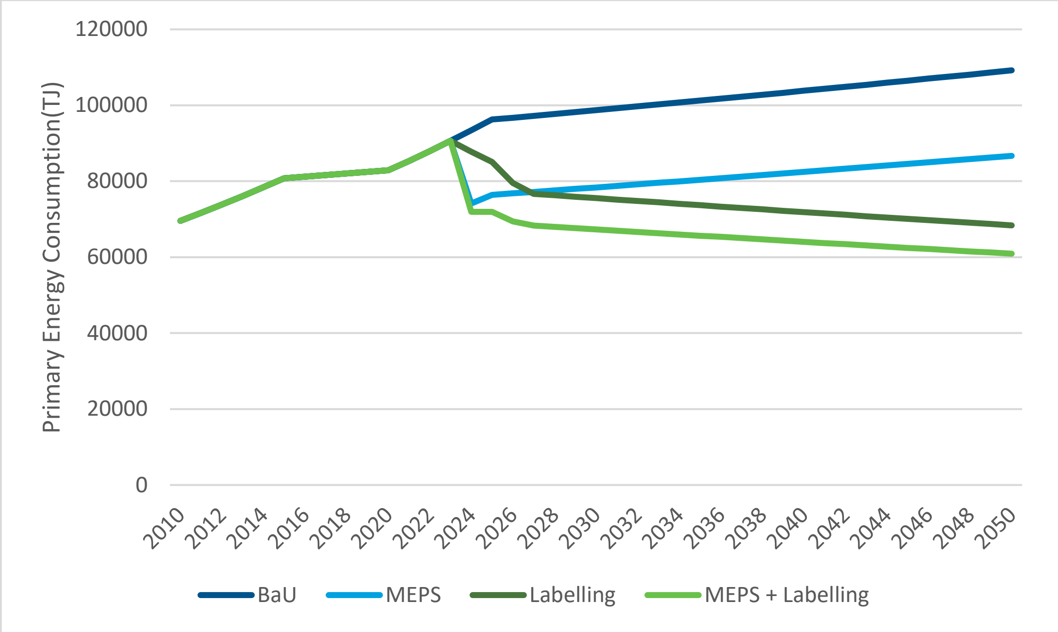


Figure 7.2 shows the Energy Cost for the four scenarios between 2010 and 2050 for EU27 for BC1.

Figure 7.2 BC1 Energy Cost for the four scenarios, 2010-2050 (EU27)

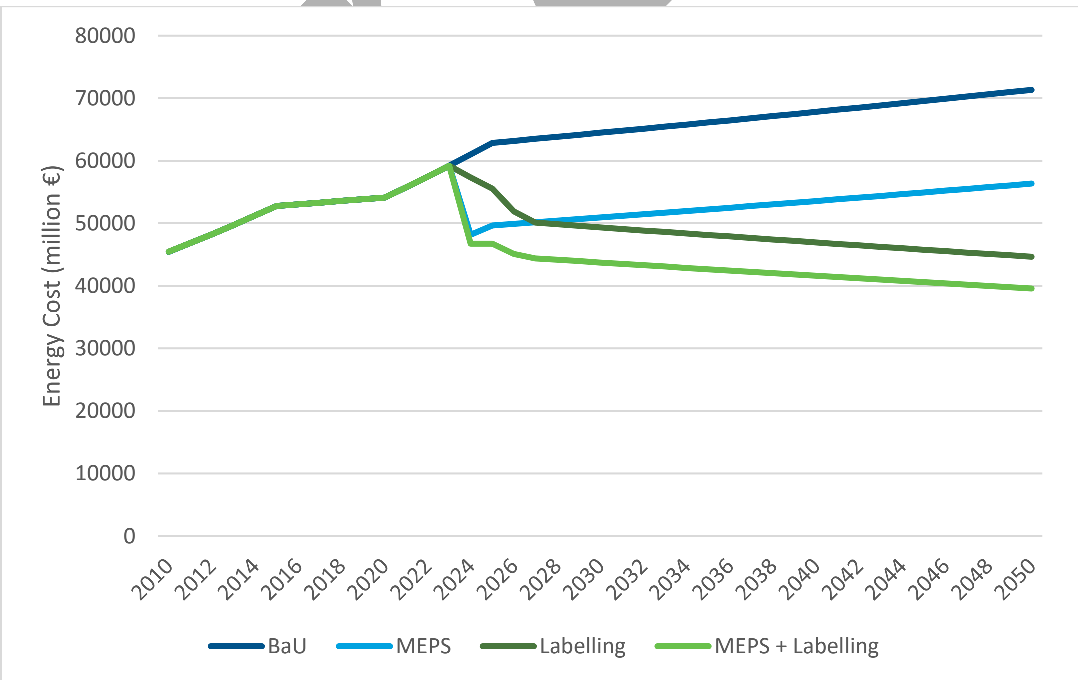
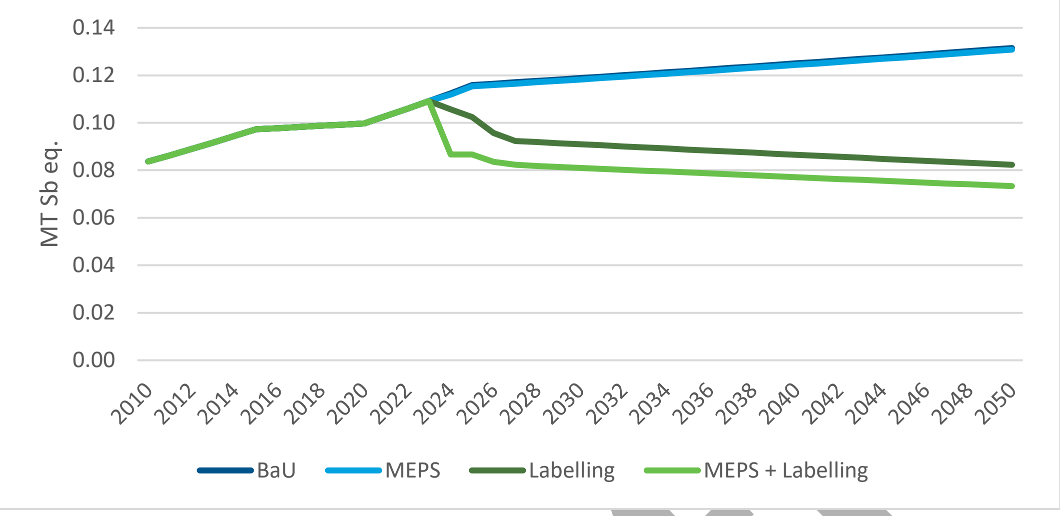


Figure 7.3 shows the Resource use (minerals & metals) for the four scenarios between 2010 and 2050 for EU27 for BC1.

Figure 7.3 BC1 Resource use, four scenarios, 2010-2050 (EU27)



7.2.2.2 Base Case 2

Figure 7.4 shows the Primary Energy Consumption for the four scenarios between 2010 and 2050 for EU27 for BC2

Figure 7.4 BC2 Primary Energy Consumption, four scenarios, 2010-2050 (EU27)

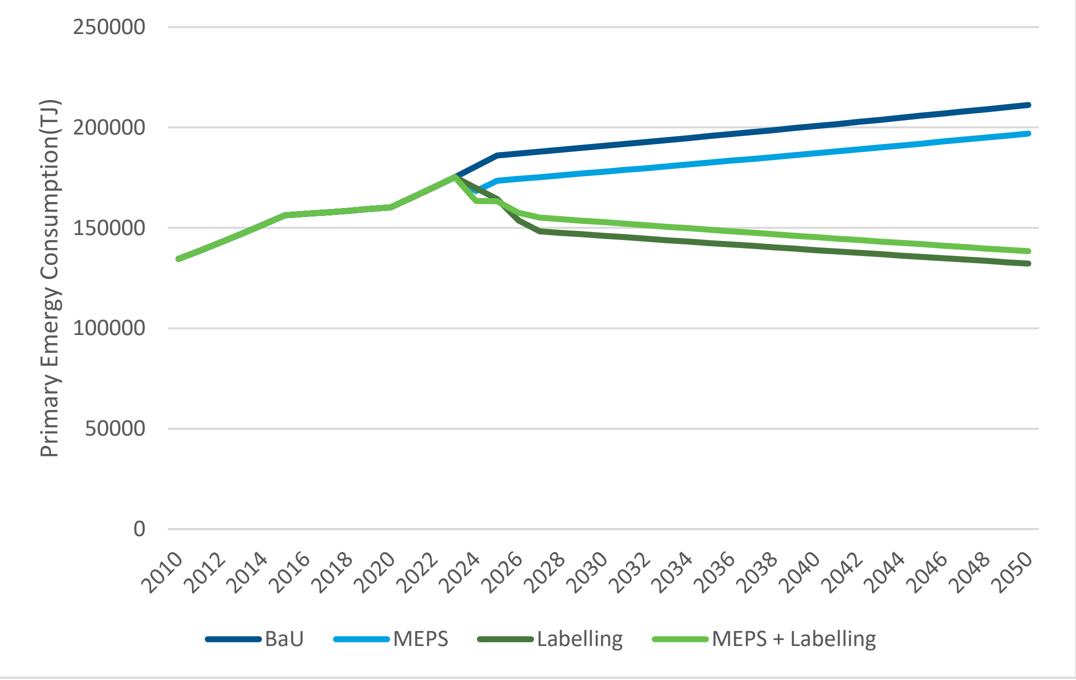


Figure 7.5 shows the Energy Cost for the four scenarios between 2010 and 2050 for EU27 for BC2

Figure 7.5 BC2 Energy Cost, four scenarios, 2010-2050 (EU27)

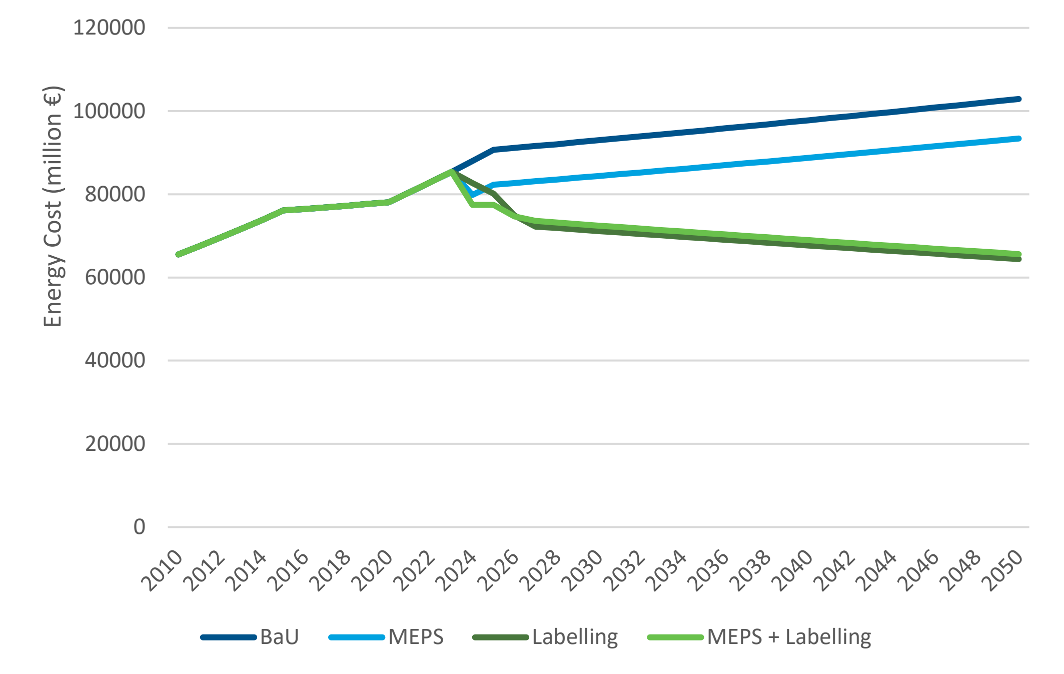
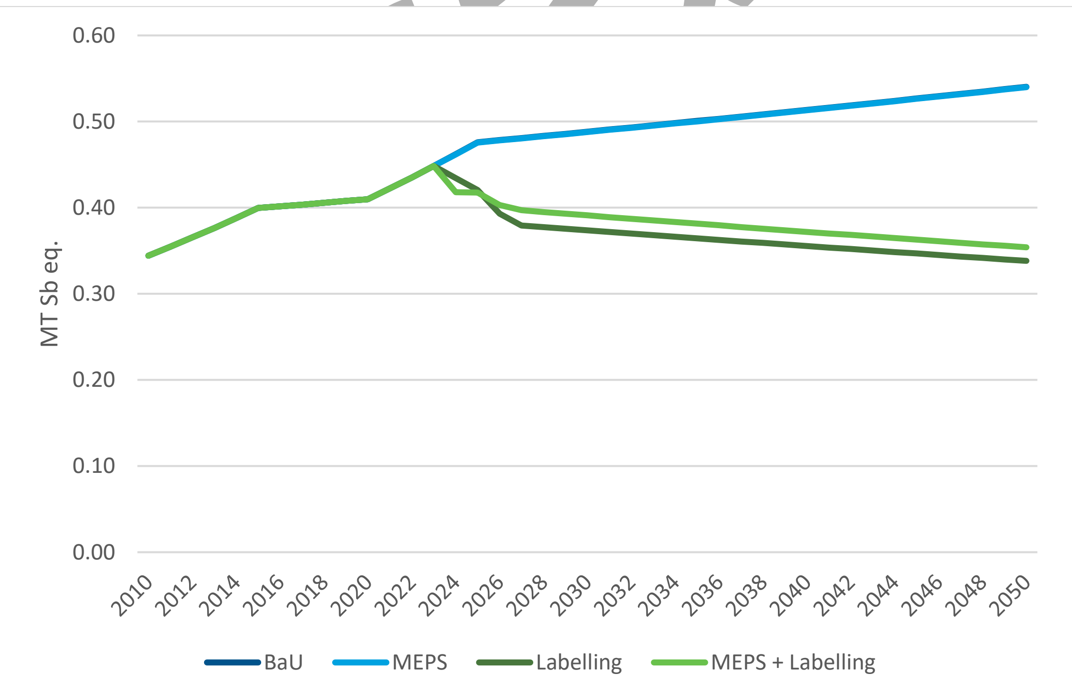


Figure 7.6 shows the Resource use (minerals & metals) for the four scenarios between 2010 and 2050 for EU27 for BC2

Figure 7.6 BC2 Resource use, four scenarios, 2010-2050 (EU27)



7.2.2.3 Base Case 3

Figure 7.7 shows Primary Energy Consumption for all fours scenarios between 2010 and 2050 for EU27 for BC3.

Figure 7.7 BC3 Primary Energy Consumption, four scenarios, 2010-2050 (EU27)

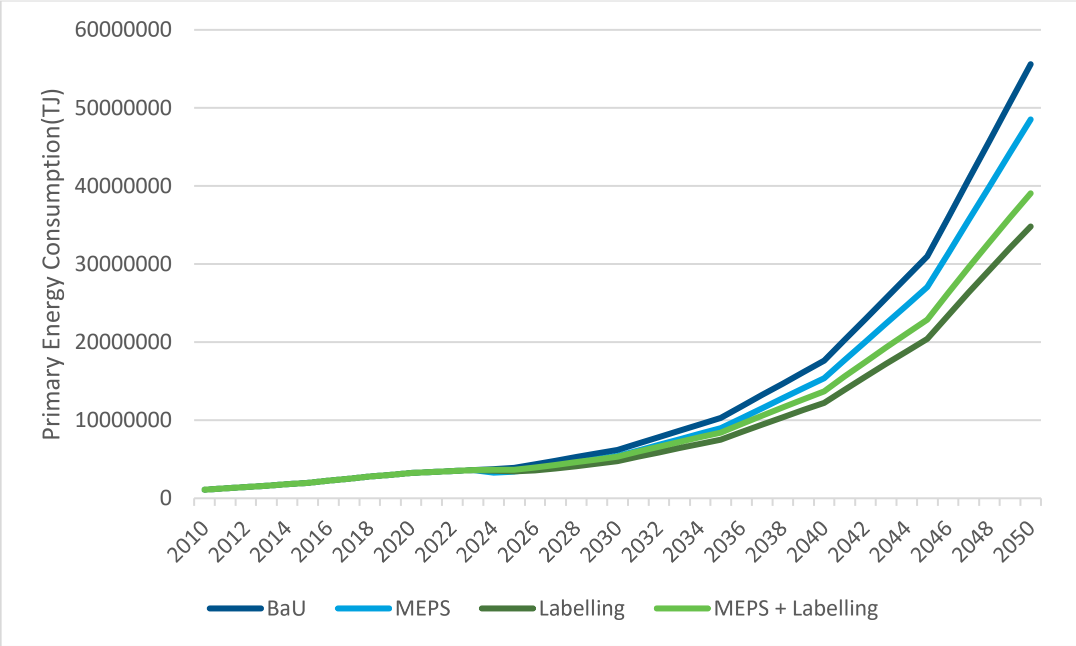


Figure 7.8 shows the Energy Cost for the four scenarios between 2010 and 2050 for EU27 for BC3.

Figure 7.8 BC3 Energy Cost, four scenarios, 2010-2050 (EU27)

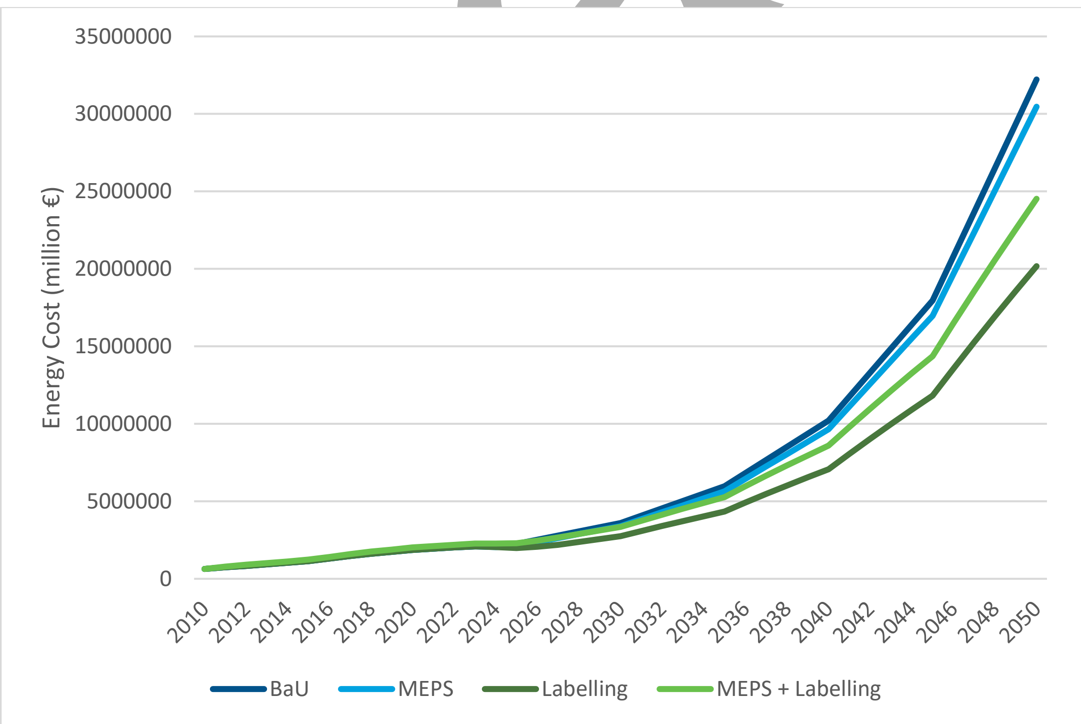
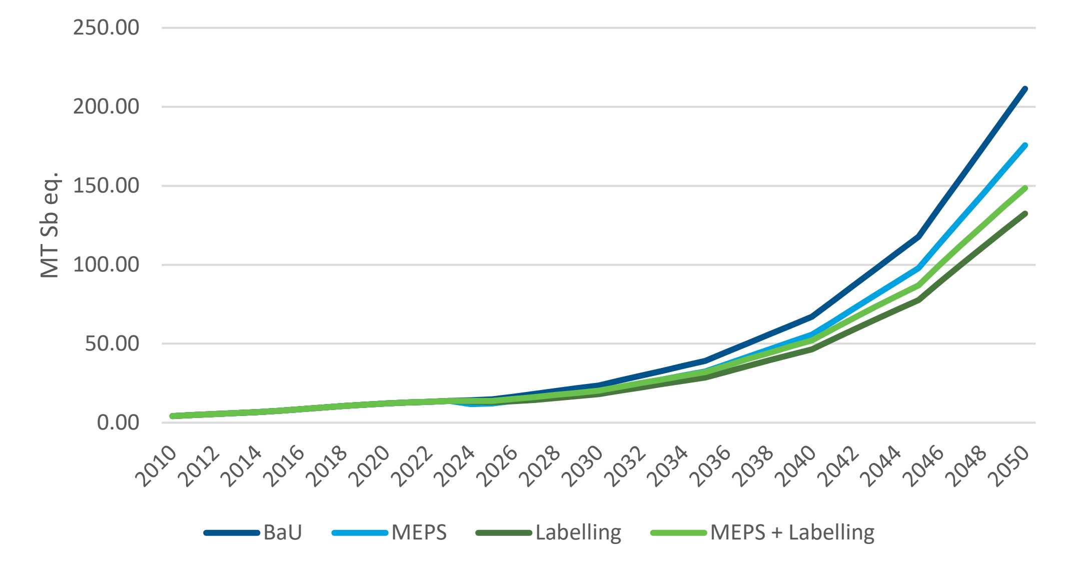


Figure 7.9 shows the Resource use (minerals & metals) for the four scenarios between 2010 and 2050 for EU27 for BC3.

Figure 7.9 BC3 Resource use, four scenarios, 2010-2050 (EU27)



7.2.2.4 All Base Case (BC1 + BC2 + BC3)

Figure 7.10 shows Primary Energy Consumption for all fours scenarios between 2010 and 2050 for EU27 for all BCs.

Figure 7.10 All BCs Primary Energy Consumption, four scenarios, 2010-2050 (EU27)

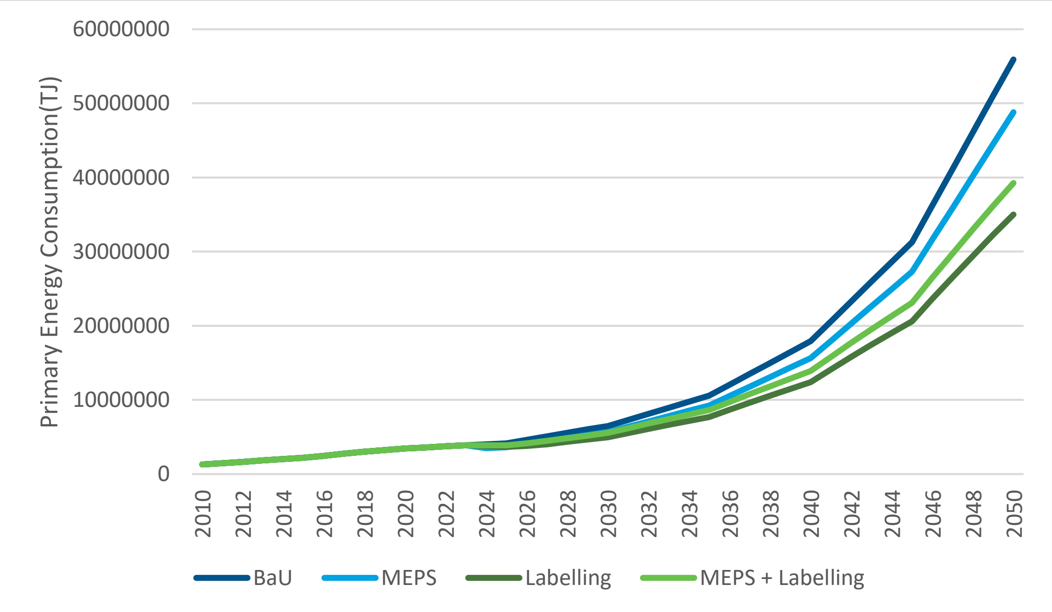


Figure 7.11 shows the Energy Cost for the four scenarios between 2010 and 2050 for EU27 for all BCs.

Figure 7.11 All BCs Energy Cost, four scenarios, 2010-2050 (EU27)

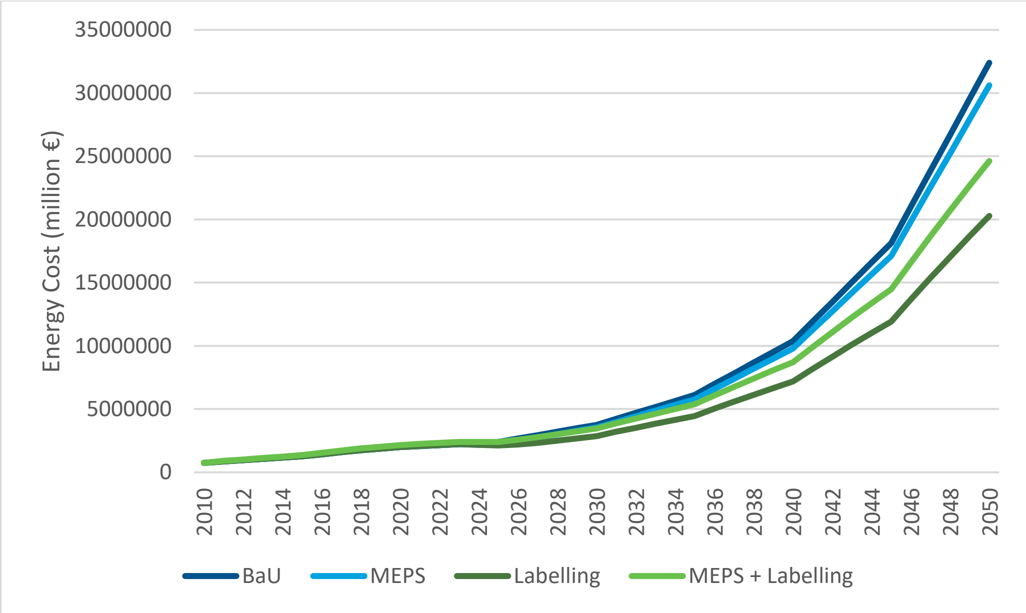
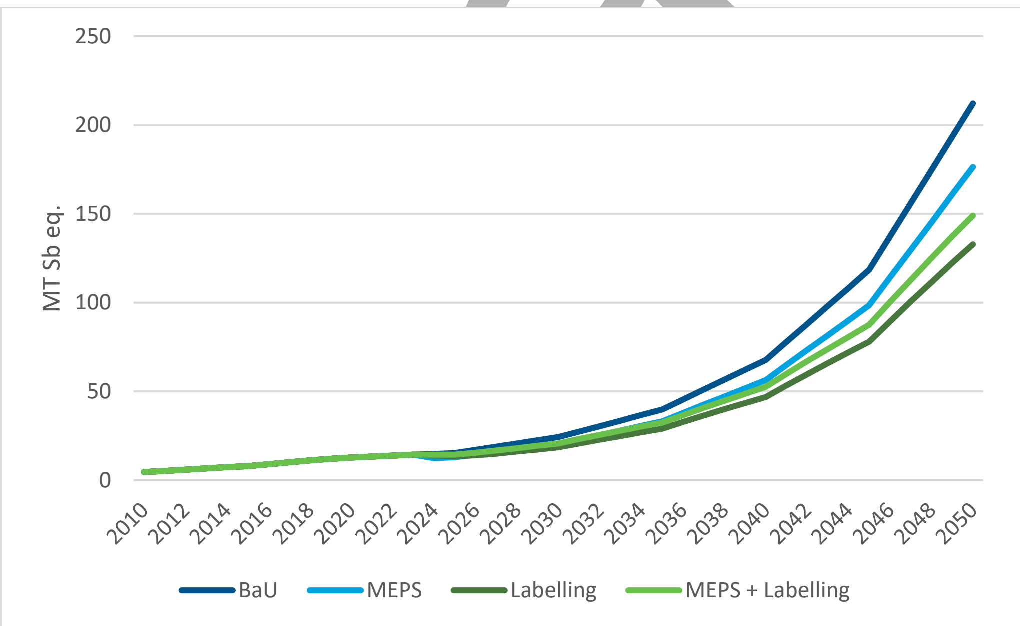


Figure 7.12 shows the Resource use (minerals & metals) for the four scenarios between 2010 and 2050 for EU27 for all BCs.

Figure 7.12 All BCs Resource use, four scenarios, 2010-2050 (EU27)



7.3 Scenario Analysis – Socio-Economic Impacts

The objective of this sub-task is to discuss the socio-economics impacts created by the different policy scenarios proposed (i.e. BaU, MEPS, Labelling and MEPS + Labelling).

The same sales and stock model used previously to calculate resource use and environmental impacts is used to estimate the following outputs in all four scenarios:

- Consumer expenditure with purchase and installation.

- Running costs to the consumer, cost of electricity, cost of repair, and maintenance cost.
- Societal costs of the environmental impacts created.

The inputs and assumptions used in the modelling as well as the results are presented in the following sub-sections.

7.3.1 Inputs & Assumptions

7.3.1.1 Purchase price

The purchase price inputs for the BaU scenario were used as per the Base Case models from Task 5 for the whole 2010-2050 period.

In the Labelling scenario, the purchase prices of units are similar to those in the BaU scenario. The rationale behind this assumption is that the label per se does not directly affect the price of products on the market.

In the MEPS and the MEPS + Labelling scenarios, the average price per unit is expected to increase in 2024 for all Categories due to the proposed measures as described in Task 6 for DO9 (BC1, BC2) and DO10 for BC3.

The purchase price of units used in the scenarios are detailed in Table 7.9 below.

Table 7.9 Purchase price of units used in the four scenarios

Base Case	BaU and Labelling purchase price (€)	MEPS and MEPS + Labelling purchase price (€)
BC1	23,420	25,762
BC2	8,435	9,279
BC3	24,400	26,840

7.3.1.2 Installation cost

The installation cost inputs were used as per the Base Case models from Task 5 for the whole 2010-2050 period in all four scenarios.

The installation cost of units used in the scenarios are detailed in Table 7.10 below,

Table 7.10 Installation cost of units used in the four scenarios

Base Case	All 4 scenarios installation cost (€)
BC1	340
BC2	340
BC3	425

7.3.1.3 Maintenance & repair

The repair and maintenance cost inputs for the BaU scenario were used as per the Base Case models from Task 5

The repair and maintenance cost of units used in the scenarios are detailed in Table 7.11 below.

Table 7.11 Repair and maintenance cost of units used in the four scenarios

Base Case	All 4 scenarios repair and maintenance cost (€)
BC1	400
BC2	400

BC3	220

7.3.1.4 Inflation

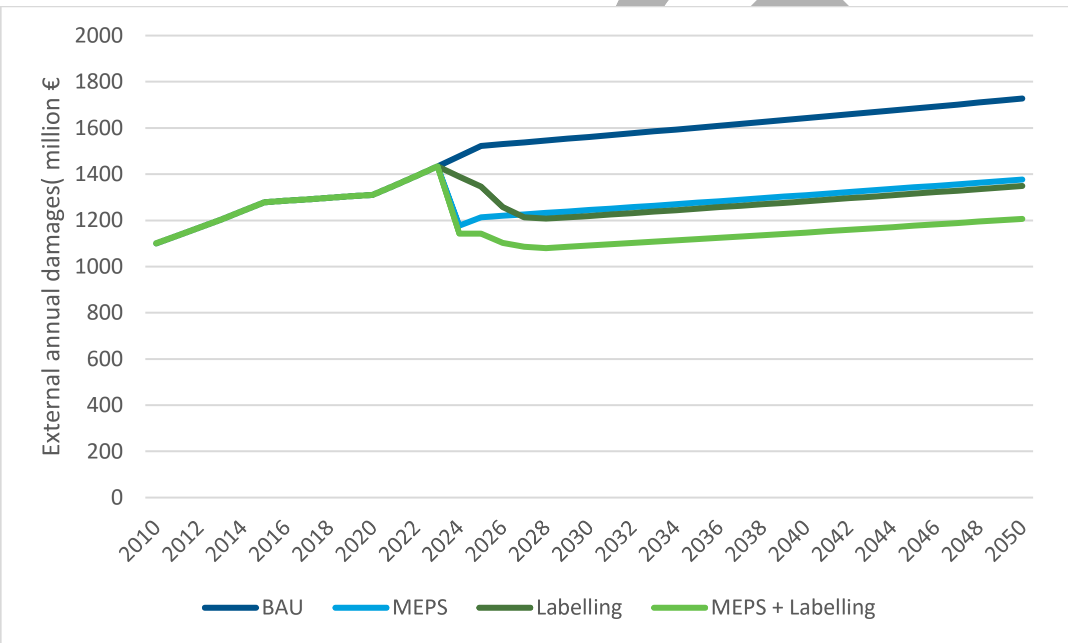
Socio-economic impacts were first calculated in terms of real value (i.e. current €) for an analysis of the effect of the assumptions and policies.

7.3.2 Results

7.3.2.1 Base Case 1

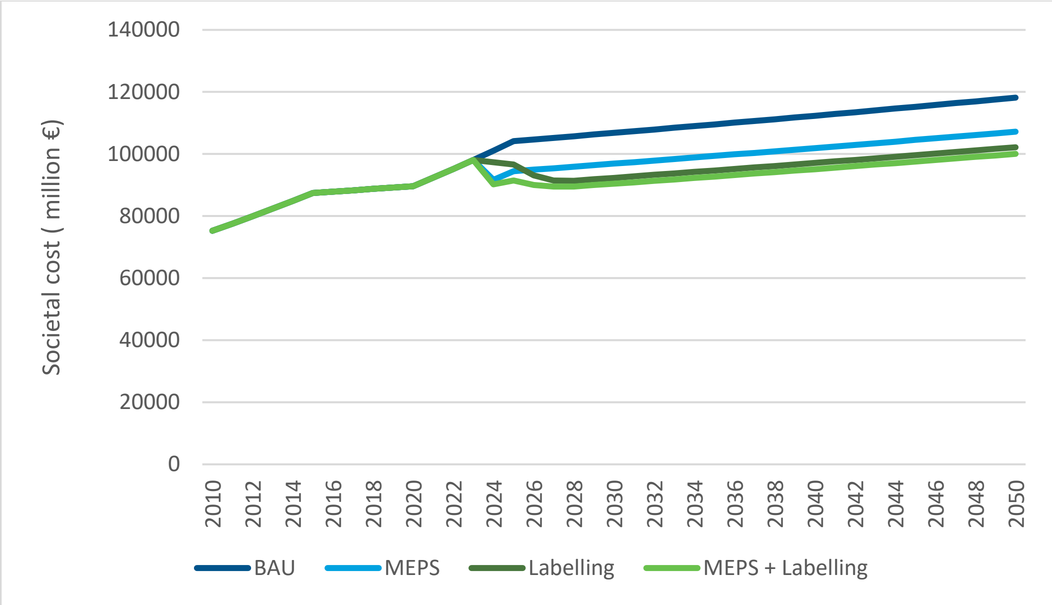
Total annual external damages of the stock between 2010 and 2050 in the EU for the four different scenarios is presented in Figure 7.13Figure 7.13 below.

Figure 7.13 BC1 External annual damages, EU27



Total societal cost of the stock between 2010 and 2050 in the EU for the four different scenarios is presented below in Figure 7.14.

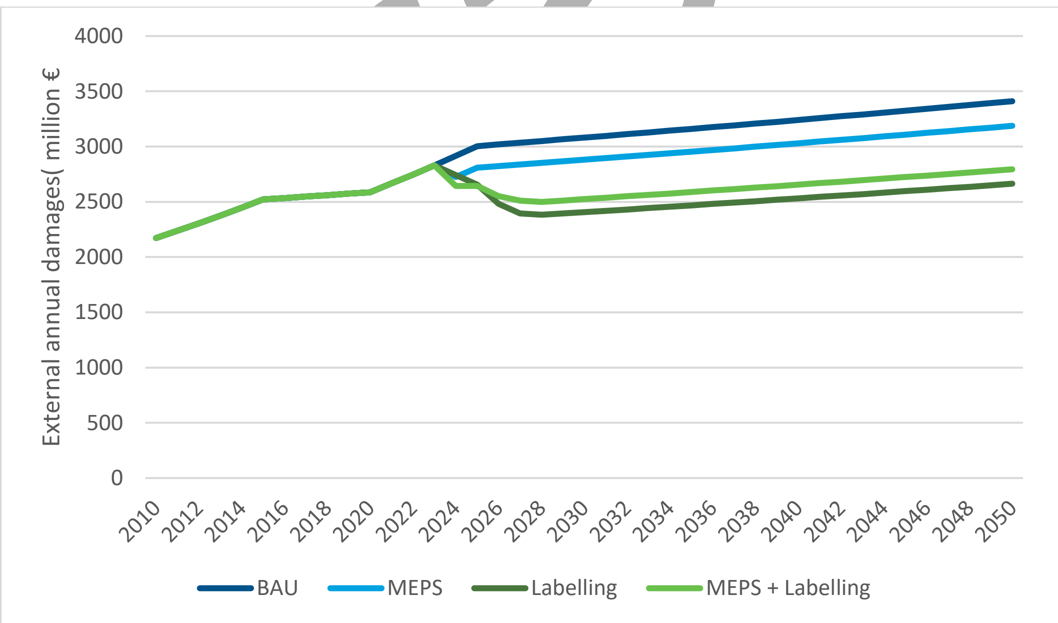
Figure 7.14 BC1 Total Societal cost, EU27



7.3.2.2 Base Case 2

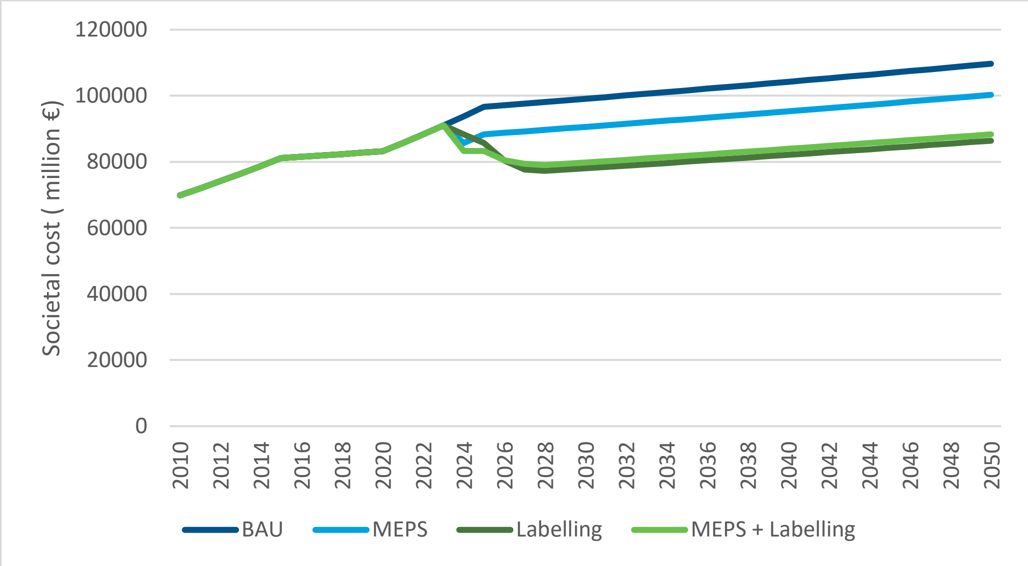
Total annual external damages of the stock between 2010 and 2050 in the EU for the four different scenarios is presented in Figure 7.15.

Figure 7.15 BC2 External annual damages, EU27



Total societal cost of the stock between 2010 and 2050 in the EU for the four different scenarios is presented below in Figure 7.16.

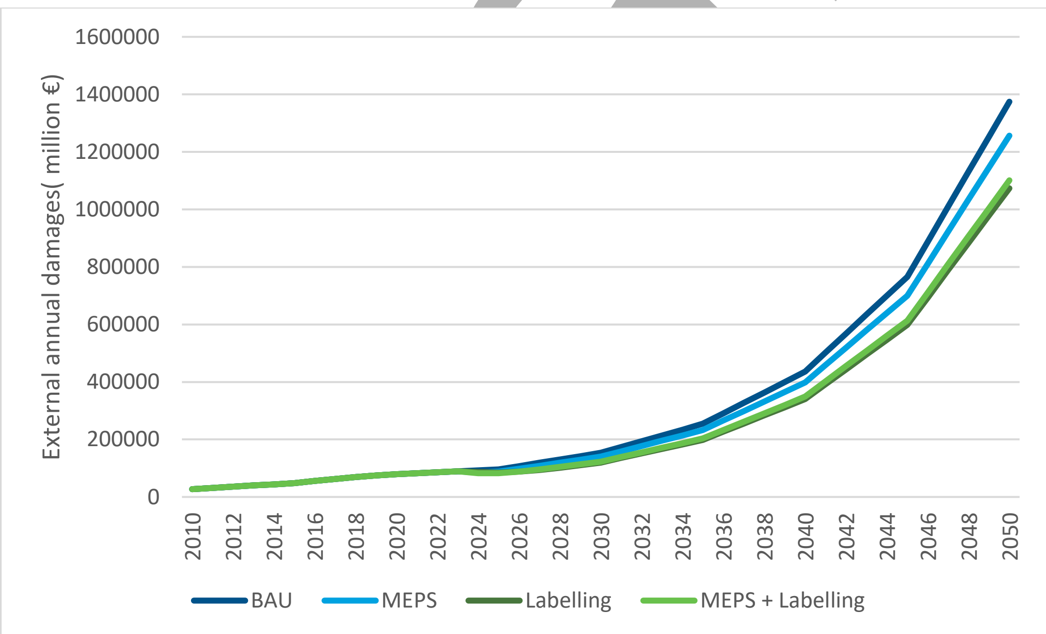
Figure 7.16 BC2 Total societal cost, EU27



7.3.2.3 Base Case 3

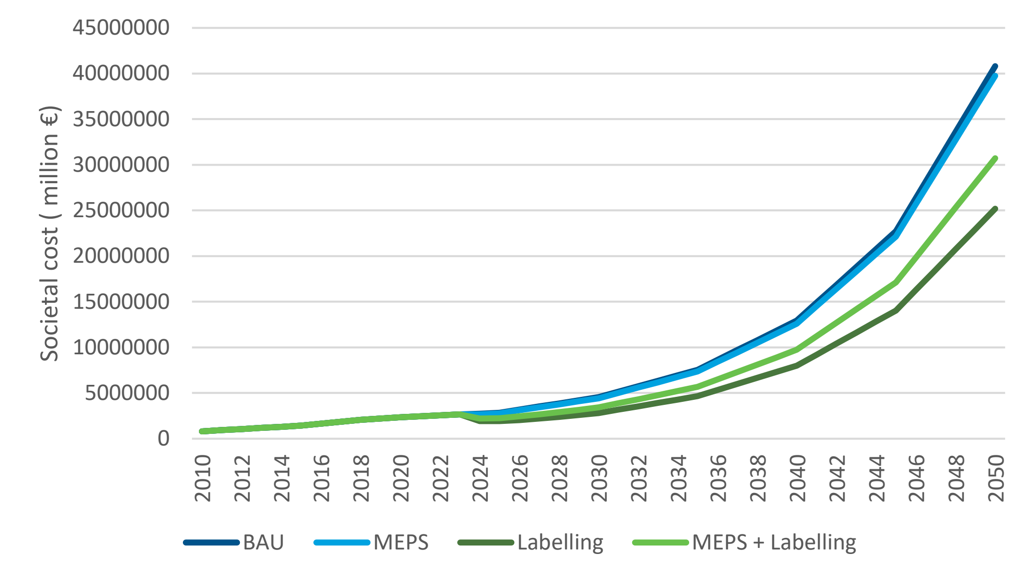
Total annual external damages of the stock between 2010 and 2050 in the EU for the four different scenarios is presented in Figure 7.17.

Figure 7.17 BC3 External annual damages, EU27



Total societal cost of the stock between 2010 and 2050 in the EU for the four different scenarios is presented below in Figure 7.18.

Figure 7.18 BC3 Total Societal cost, EU27



7.4 Sensitivity Analysis

The objective of this sub-task is to conduct a sensitivity analysis of the four scenarios i.e. BaU, MEPS, Labelling and MEPS + Labelling with DO3 (for BC1 & BC2) and DO6 (for BC3) and present its outputs in comparison to the four scenarios. BaU is the existing regulation scenario, MEPS is the DO9 which is combination of DO3, DO4, DO5 & DO7. Labelling scenario is BaU with efficiency improvements as defined in 7.2.1.4. MEPS + Labelling scenario is DO9 with efficiency improvements as defined in 7.2.1.5.

7.4.1 Base Case 1

Figure 7.19 shows Primary Energy Consumption for all fours scenarios vs DO3 between 2010 and 2050 for EU27 for BC1.

Figure 7.19 BC1 Primary Energy Consumption, four scenarios vs DO3, 2010-2050 (EU27)

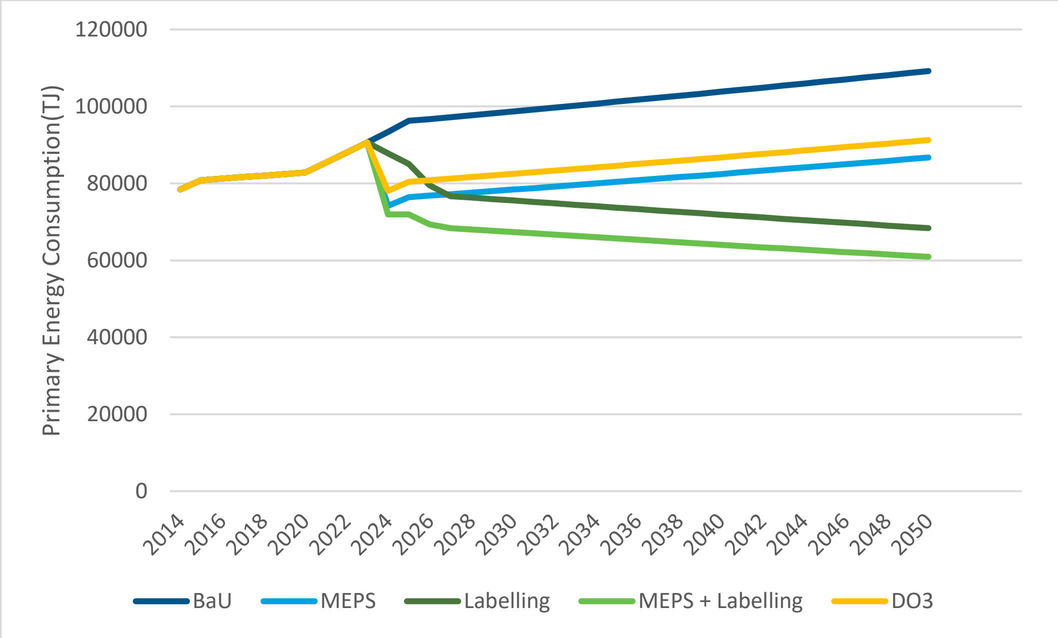


Figure 7.20 shows the Energy Cost for the four scenarios vs DO3 between 2010 and 2050 for EU27 for BC1.

Figure 7.20 BC1 Energy Cost, four scenarios vs DO3, 2010-2050 (EU27)

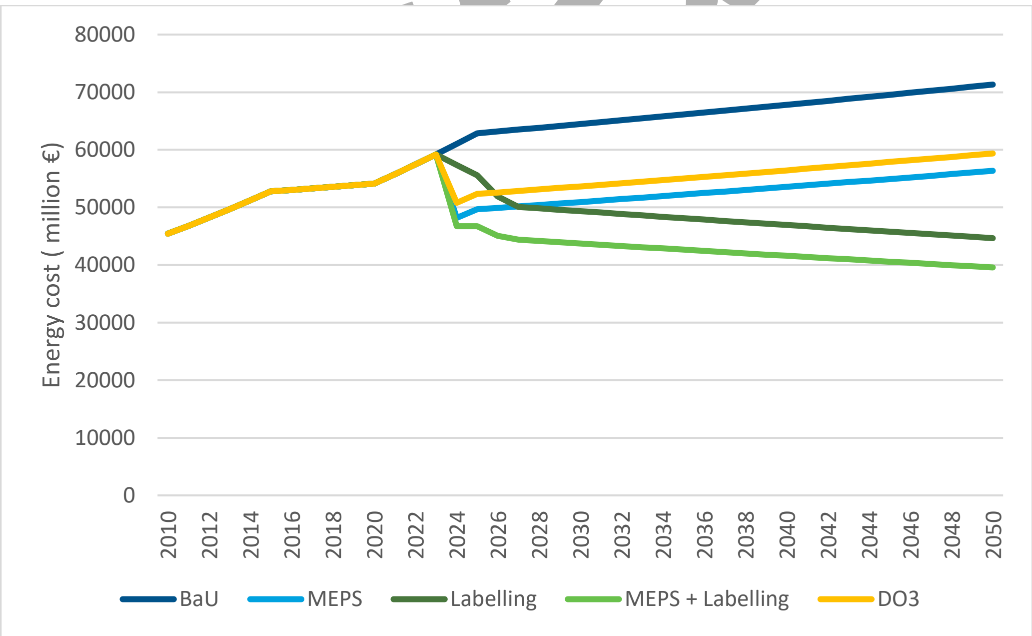
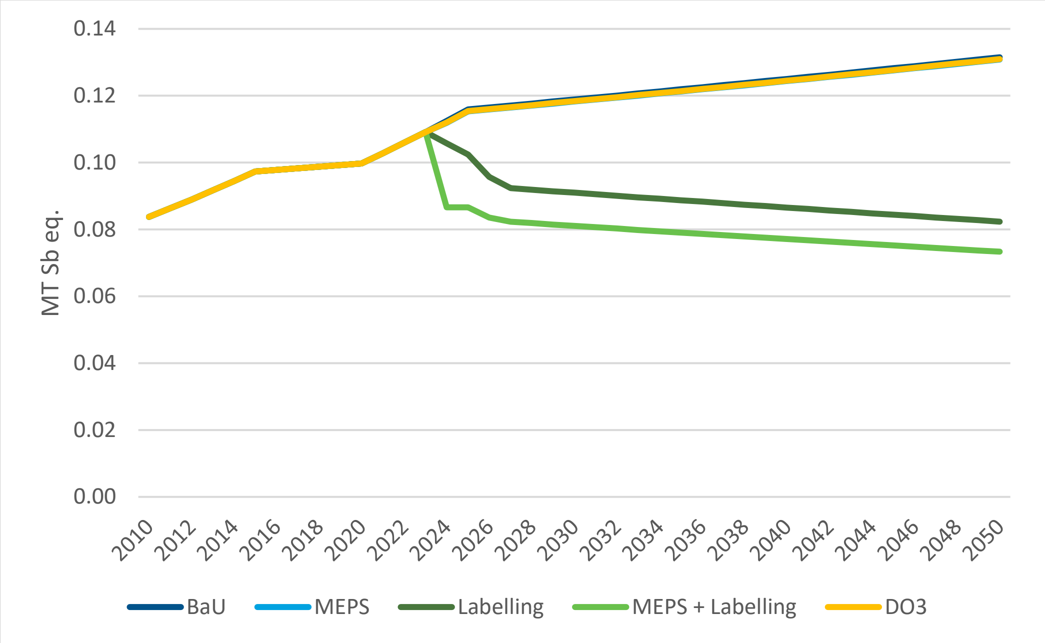


Figure 7.21 shows the Resource use (minerals & metals) for the four scenarios vs DO3 between 2010 and 2050 for EU27 for BC1.

Figure 7.21 BC1 Resource use, four scenarios vs DO3, 2010-2050 (EU27)



7.4.2 Base Case 2

Figure 7.22 shows Primary Energy Consumption for all fours scenarios vs DO3 between 2010 and 2050 for EU27 for BC2.

Figure 7.22 BC2 Primary Energy Consumption, four scenarios vs DO3, 2010-2050 (EU27)

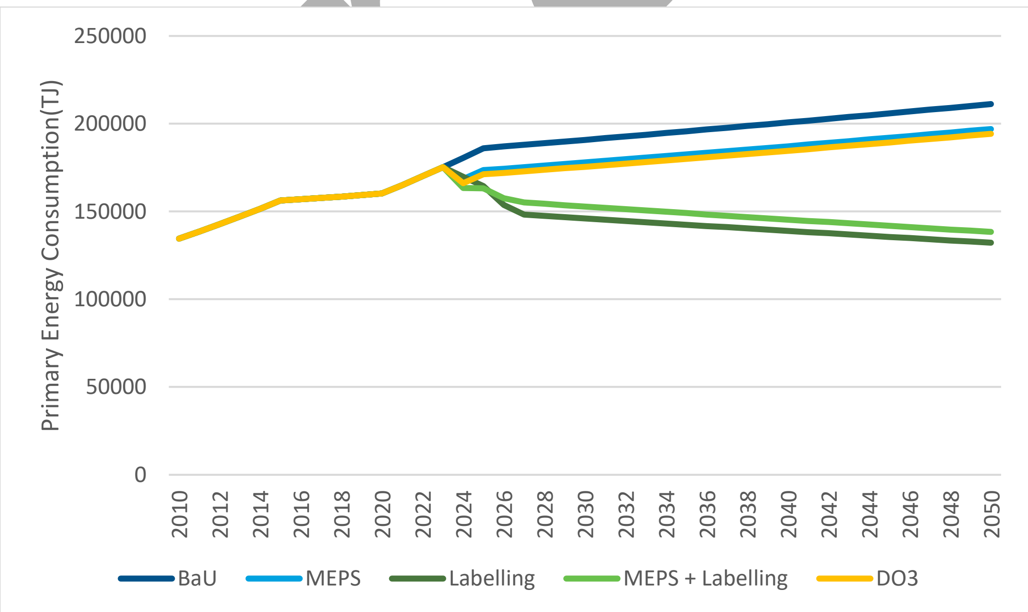


Figure 7.23 shows the Energy Cost for the four scenarios vs DO3 between 2010 and 2050 for EU27 for BC2.

Figure 7.23 BC2 Energy Cost, four scenarios vs DO3, 2010-2050 (EU27)

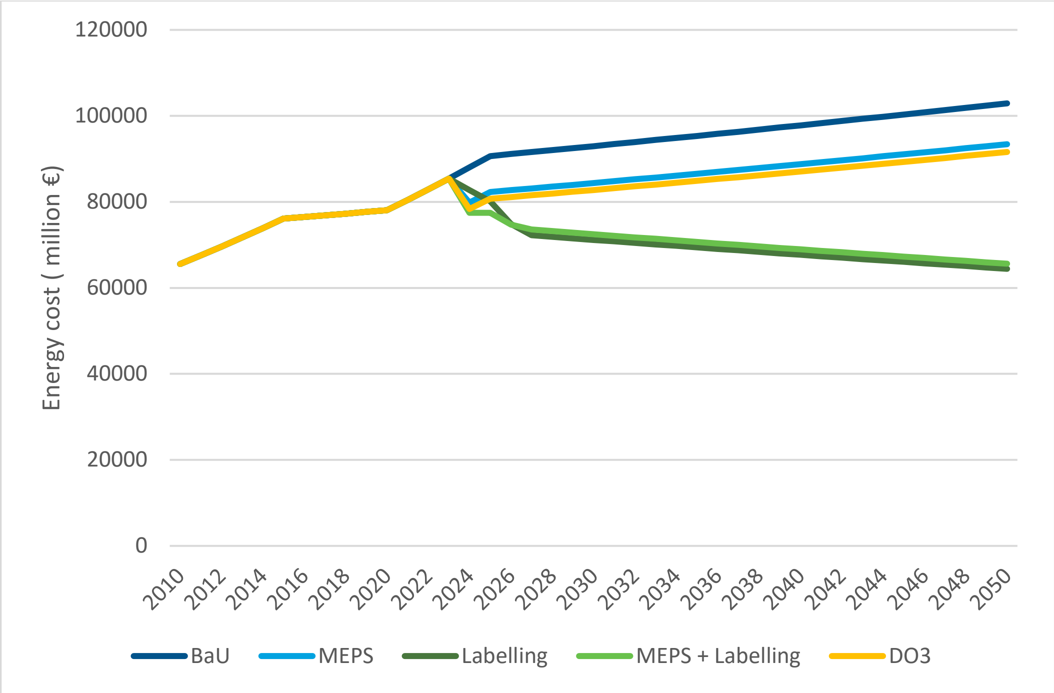
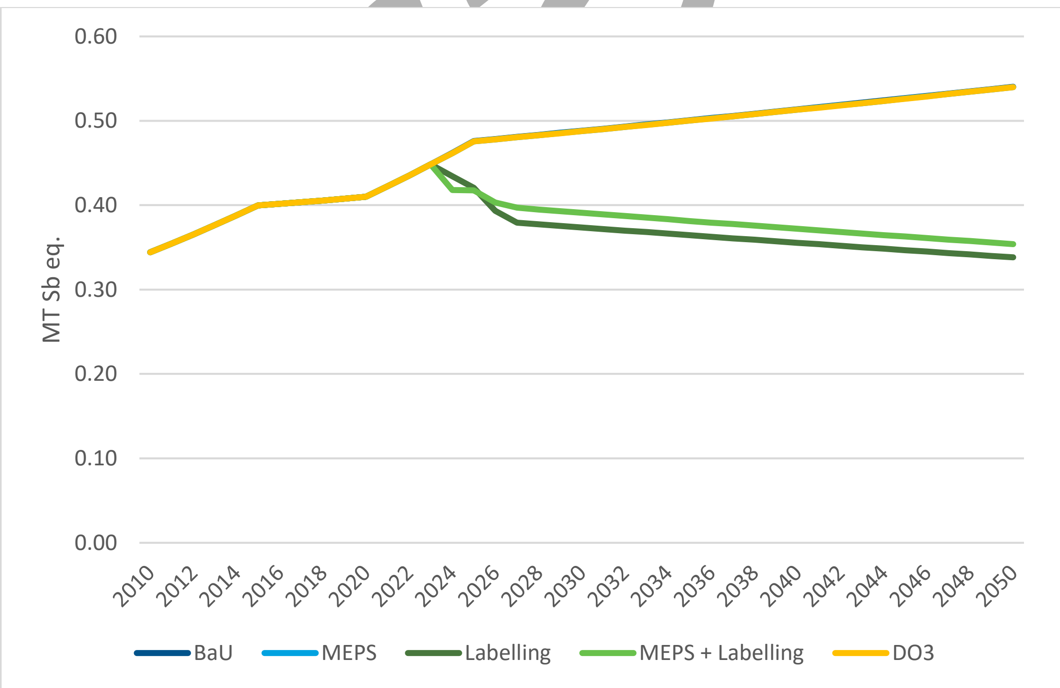


Figure 7.24 shows the Resource use (minerals & metals) for the four scenarios vs DO3 between 2010 and 2050 for EU27 for BC2

Figure 7.24 BC2 Resource use, four scenarios vs DO3, 2010-2050 (EU27)



7.4.3 Base Case 3

Figure 7.25 shows Primary Energy Consumption for all fours scenarios vs DO6 between 2010 and 2050 for EU27 for BC3.

Figure 7.25 BC3 Primary Energy Consumption, four scenarios vs DO6, 2010-2050 (EU27)

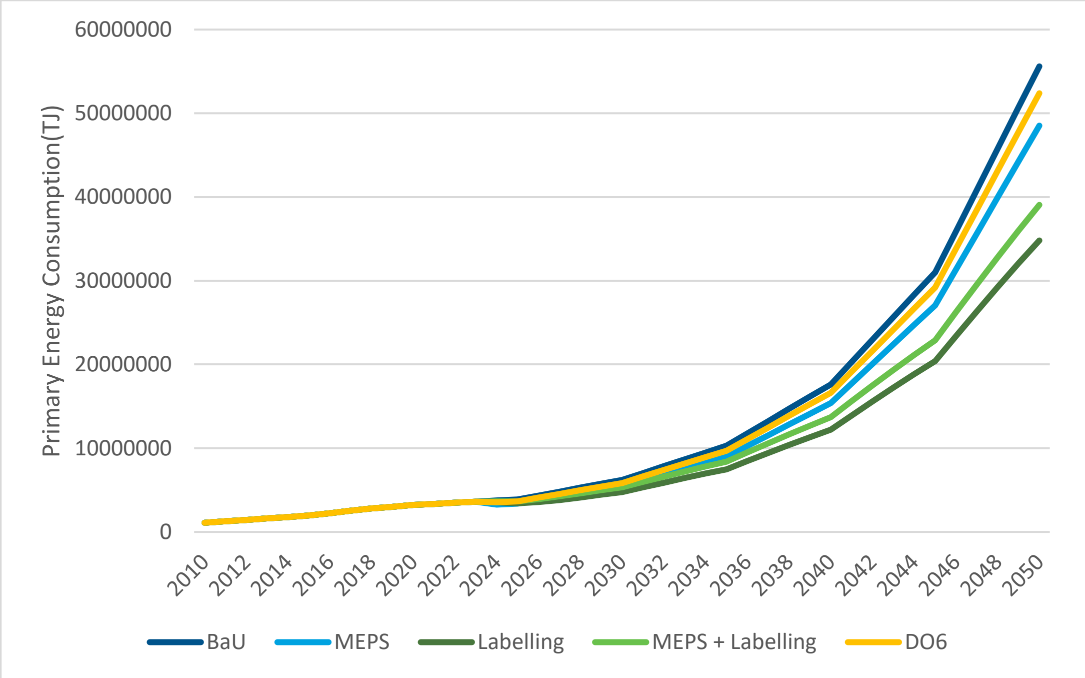


Figure 7.26 shows the Energy Cost for the four scenarios vs DO6 between 2010 and 2050 for EU27 for BC3.

Figure 7.26 BC3 Energy Cost, four scenarios vs DO6, 2010-2050 (EU27)

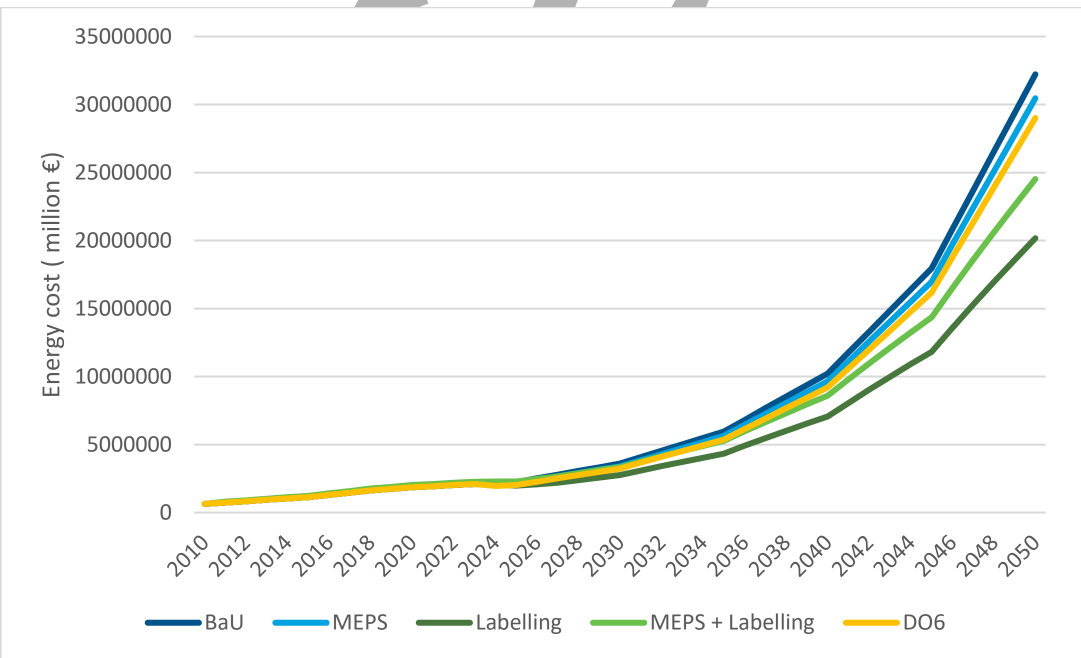


Figure 7.27 shows the Resource use (minerals & metals) for the four scenarios vs DO6 between 2010 and 2050 for EU27 for BC3.

Figure 7.27 BC3 Resource use, four scenarios vs DO3, 2010-2050 (EU27)