

# **Socio-Economic Analysis**

*Request for a Renewal of Exemption 39 under Directive 2011/65/EU (RoHS II)*

## **Contents**

Socio-Economic Analysis .....	1
<i>Request for a Renewal of Exemption 39 under Directive 2011/65/EU (RoHS II)</i> .....	1
Introduction .....	3
1. Health and Environmental Impacts .....	4
1.1 Health impacts .....	4
1.2 Environmental impacts .....	5
2. Economic impacts .....	8
Conclusions .....	11

## Introduction

The use of cadmium in II-VI colour converting material in displays can reduce the energy consumption of a TV by approximately 20%. The SEA shows that the economic benefits associated with this energy saving have been estimated at around 3 billion euro over 2014-2019<sup>1</sup>. The exemption is expected to benefit both environment, in terms of reduced CO<sub>2</sub> emissions and consumers, in terms of lower bills to pay. On the other hand, hazard assessment of cadmium shows that the risk is controlled during all recycling activities of LCD televisions.

The purpose of this analysis<sup>2</sup> is therefore to demonstrate that socio-economic benefits related to the renewal of the exemption 39<sup>3</sup>, under Directive 2011/65/EU of the European Parliament and Council, outweigh the risks to the human health and environment. The SEA has examined the expected health, environmental and economic impacts on the assumption that the renewal of the exemption 39 is granted.

As regards health impacts, the assessment of the hazards of cadmium and the exposure during recycling activities of LCD televisions shows that the risk is controlled, meaning that no effect on the health of the workers involved is to be anticipated when taking into account the operational conditions and adequate risk management measures<sup>4</sup>, and the OEL of 4 µg Cd/m<sup>3</sup> as recommended by SCOEL.

On environmental impacts, LED-displays and solid lighting systems with QDs go under the WEEE directive. It means that the waste has to be collected, treated and recycled. No negative environmental impacts are therefore expected if the exemption is granted.

In addition, important saving in cadmium emissions is expected if the renewal of exemption is granted because solid state lighting and displays system with Cd-QD consume less energy. An important part of the energy is indeed generated from coal, which contains cadmium<sup>5</sup>. Less energy consumption would then lead to less emission of CO<sub>2</sub> and cadmium. By adopting an extremely conservative approach, the total economic benefits associated with the estimated reduction of CO<sub>2</sub> emissions have been quantified at 65,165,348 euro.

Turning to economic impacts, the SEA shows how consumers will be able to benefit from TVs with Cd quantum dot down conversion material in displays, in terms of energy saving and therefore lower bills to pay.

It has been estimated that, under the granted renewal exemption scenario, the economic benefits to the EU consumers would range between 2,169,012,129 euro and 3,872,267,434 euro. The total economic benefits have been therefore quantified at around 3 billion euro over 2014-2019.

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<sup>1</sup> On assumption that the exemption renewal is granted.

<sup>2</sup> The analysis of the impacts has been performed following the general guidelines contained in the ECHA guidance on the preparation of the socio-economic analysis as part of an application for authorization. We have decided to apply the ECHA guidance since it covers all main types of impacts (health, environment and economic) that should be taken into account by policymakers when taking a decision.

<sup>3</sup> Use of cadmium in II-VI color converting material (< 10 µg Cd per mm<sup>2</sup> of light-emitting area) for LEDs for use in solid state illumination or display systems.

<sup>4</sup> Indicated in the Socio-Economic Analysis (Confidential version).

<sup>5</sup> Cd content in coal – low (1 ppm) and Cd content in coal – high (2 ppm).

# 1. Health and Environmental Impacts

## 1.1 Health impacts

With the purpose of analysing the expected health impacts on assumption that the renewal of the exemption 39 is granted the additional risk of cadmium in TV recycling has been assessed.

The first step in this risk evaluation is the hazard assessment of cadmium and proposal of a guidance value to be used in the risk evaluation. For this purpose, the recent Recommendation from the Scientific Committee on Occupational Exposure Limits for cadmium and its inorganic compounds (SCOEL/SUM/136) of February 2010 was taken into account. Furthermore, the information in the disseminated REACH dossier on cadmium was checked and available information was compared with the information available in the SCOEL-report.

The actual risk of exposure to Cadmium by workers during the recycling activities was assessed using the CHEMical Safety Assessment and Reporting tool (CHESAR) of the European Chemicals Agency (ECHA) and the Advanced REACH Tool (ART) model for estimating inhalation exposure. First an overview was made of the activities that typically take place during the recycling of LCD screens from TVs. These activities were listed in Chesar by describing them in terms of the Use Descriptors System as included in the ECHA guidance document R.12. Subsequently the ART model was used to estimate the exposure to cadmium during the activities. A Risk Characterisation Ratio was calculated using the established DNEL for Cadmium.

The assessment of the hazards of cadmium and the exposure during recycling activities of LCD televisions shows that the risk is controlled, meaning that no effect on the health of the workers involved is to be anticipated when taking into account the operational conditions and risk management measures<sup>6</sup>, and the OEL of 4 µg Cd/m<sup>3</sup> as recommended by SCOEL.

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<sup>6</sup> Included in the Socio-Economic Analysis (Confidential version).

## 1.2 Environmental impacts

Important saving in CO<sub>2</sub> emissions is expected thanks to the reduced energy demand from TVs with QD Optic.

Coal represents 26% of the total EU production of electricity and 1 kg of coal can generate 3 kW-hr. By using a TV with QD it is possible to save 504 kW-hr. It means that, by using one TV with QD optic, it is possible to save 43.7 kg<sup>7</sup> of coal over the lifetime of the television.

The content of carbon in coal normally ranges from 60% to 80%<sup>8</sup>. The estimated reduction in CO<sub>2</sub> emissions over 2014-2019<sup>9</sup> has been estimated at 7,095,167 tonnes.

The analysis of the damage caused by incremental CO<sub>2</sub> emissions and relative economic cost are at the centre of the literature covering the monetization of the environmental impacts. Although the literature reveals the existence of a great number of models for estimating the economic benefits of reducing CO<sub>2</sub> emissions, the majority of them are based on the concept of social cost of carbon (SCC)<sup>10</sup>.

Since the social cost of carbon is an important indicator of how much the society is in theory willing to pay to avoid damage related to additional CO<sub>2</sub> emissions, it has been therefore considered appropriate to monetize benefits of the above estimated reduction in CO<sub>2</sub> by applying the concept SCC.

In order to find a reasonable estimate of the SCC a great number of studies have been consulted. In 2011, Nordhaus<sup>11</sup> estimated that the social cost of carbon is \$ 12/tonne in 2005 US\$ prices, while the existing literature proposes values from £ 35 to £ 140/tonne<sup>12</sup>.

In order to maintain a prudential approach we have decided to quantify the economic benefits related to estimated reduction in CO<sub>2</sub> emissions by applying the value of \$ 12/tonne (euro 10.5 /tonne)<sup>13</sup>. The value of £ 35 (euro 40.5 /tonne)<sup>14</sup> has been used for the central estimate while the value of £140/tonne (euro 162/tonne)<sup>15</sup> for the upper estimate.

In addition to that, we decided to apply a constant SCC over 2014-2019, even though it would be reasonable to think that SCC should increase over the time to take the increasing marginal impacts of additional CO<sub>2</sub> emissions into account.

In order to be consistent with the logic that SCC should be higher in the future, the economic benefits that are expected to occur over the life time of TVs have not been discounted. The

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<sup>7</sup> (504 kW-hr \* 0.26) /3 kW-hr/kg

<sup>8</sup> *Energy Information Administration, Quarterly Coal Report* (EIA, 1994).

<sup>9</sup> Assuming that the carbon content in coal is 70%.

<sup>10</sup> "Social cost of carbon is defined as the monetary value of the damage done by emitting one more tonne of carbon at some point of time" (Pearce, 2003)

<sup>11</sup> *Estimates of the social cost of carbon: background and results from the RICE-2011 model*, William Nordhaus (2011)

<sup>12</sup> *The social cost of carbon (SCC) Review – Final Report* (DEFRA, 2005).

<sup>13</sup> US GDP deflator has been used for adjusting data to the price level of 2013 (116/101.3). The value has been converted into euro applying the average exchange rate covering the period from 9<sup>th</sup> July to 9<sup>th</sup> August 2013: 1.3172 (Source: ECB)

<sup>14</sup> The value has been converted into euro applying the average exchange rate covering the period from 9<sup>th</sup> July to 9<sup>th</sup> August 2013: 1.1576 (Source: ECB)

<sup>15</sup> The value has been converted into euro applying the average exchange rate covering the period from 9<sup>th</sup> July to 9<sup>th</sup> August 2013: 1.1576 (Source: ECB)

discounting has been done only to take into account the year in which the TVs are expected to be sold.

**Table No. 1:** Economic benefits related to estimated reduction in CO2 emissions over 2014-2019 (lower estimate)

<b>Years</b>	<b>Estimated reduction in CO2 (tonnes)</b>	<b>Economic benefits related to estimated reduction in CO2 emissions (euro)</b>	<b>Present value (at 2014)<sup>16</sup> (euro)</b>
<b>2014-2019</b>	7,095,167	74,499,253	<b>65,165,348</b>

By applying the upper estimate of SCC of euro 162/tonne CO2, the economic benefits in terms of avoided damage to the environment because of reduced CO2 emissions, have been quantified at euro 1,005,408,224. The central estimate has been quantified at euro 251,352,056.

**Table No. 2:** Central, upper and lower estimate

<b>Lower estimate (euro)</b>	<b>Central estimate (euro)</b>	<b>Upper estimate (euro)</b>
65,165,348	251,352,056	1,005,408,224

The above analysis shows that the economic benefits of the expected reduction in CO2 emissions range from euro 65,165,348 to euro 1,005,408,224. In order to maintain a prudential approach we have decided to bring forward the lower estimate, keeping in mind that in reality the benefits can be much higher.

One should bear in mind the estimation of SCC is characterized by a high level of uncertainty given that:

- Estimates of SCC are based on different models
- SCC strictly depends on the choice of the discount rate
- There is no a common approach to dealing with accumulative impacts of CO2<sup>17</sup>
- There are impacts that have not been yet quantified and valued<sup>18</sup>
- The literature proposes a range of values from £ 35/tonne to £ 140/tonne<sup>19</sup>.

Finally it is important to remind that there are alternative methods for measuring damage caused by CO2 emissions, like:

- Shadow price of carbon and (SPC)
- The marginal abatement cost (MAC).

<sup>16</sup> Impact Assessment guidelines, EU Commission (2009). 4% is the average real yield on long term bonds in the EU since 1980's and it is considered an appropriate indicator of the social time preference.

<sup>17</sup> See Cumulative Carbon Emissions and Climate Change: Has the Economics of Climate Policies Lost contact with the Physics, J. Rhys (The Oxford Institute for Energy Studies, 2011).

<sup>18</sup> *The Social cost of carbon (SCC) Review – Methodological approach for using SCC Estimates in Policy Assessment* (DEFRA, 2005)

<sup>19</sup> *The Social cost of carbon (SCC) Review – Methodological approach for using SCC Estimates in Policy Assessment* (DEFRA, 2005)

SPC is a concept strictly related to SCC and has been indicated by the UK Department for Environment, Food and Rural Affairs (DEFRA), as an important tool in cost & benefits analysis. SPC is based on SCC but differs from the SCC since it includes a stabilization target.

Finally the marginal abatement cost (MAC), by adopting a different perspective, estimates the costs related to reducing CO<sub>2</sub> instead of being focused on damage caused by those emissions. McKinsey estimated that MAC for reducing CO<sub>2</sub> ranges from 25 to 40 euro per tonne (in 2007 prices).

## 2. Economic impacts

Residential information and communication appliances play an important role in households' electricity consumption. Televisions are responsible for the highest share in energy consumption and therefore they are an important potential source for saving.<sup>20</sup> Furthermore, the stock of televisions and other information and communication technologies (ICTs) have been increasing over the last years<sup>21</sup>. It is clear that this increase in demand will lead to the increased demand for energy.

Promoting innovative and efficient technologies is the cornerstone of the EU legislations on energy saving<sup>22</sup>. The European Commission also underlined the importance of developing energy efficient technologies in the Energy Roadmap 2050<sup>23</sup>, pointing out that “products and appliances will have to fulfil highest energy efficiency standards”.

For IT appliances, switching to a more efficient technology is an important option for saving energy<sup>24</sup>. The use of cadmium in II-VI colour converting material for LEDs for use in display systems can reduce the energy consumption of a television by approximately 20%<sup>25</sup>, when compared to alternative technologies.

The following analysis is therefore aimed at showing that if the renewal for exemption 39 is granted, consumers will gain important benefits from an economic point view, in terms of lower bills to pay thanks to the expected energy saving.

As regards the scope of the analysis:

- The analysis concerns the European Union market
- The time horizon of analysis is 5 years (period for which the renewal of exemption is requested)
- The product category analysed is TV
- The quantification of economic benefits is based on applicant's projected sales<sup>26</sup>
- The price of electricity does not include taxes<sup>27</sup>
- The economic benefits are discounted over 10 years<sup>28</sup> (30.000 hours)<sup>29</sup> at 4%.

The cost-benefits analysis is focused on differences in terms of energy saving between TVs with QD optic and TVs produced with alternative technologies.

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<sup>20</sup> *Study on the Energy Saving Potentials in EU Member States, Candidate Countries and EEA Countries*, Final Report for the European Commission, EC Service Contract Number TREN/D1/239-2006/S07.66640 (2009).

<sup>21</sup> *Energy Efficiency Trends of IT Appliances in Households (EU 27)*, (Fraunhofer ISI, 2009)

<sup>22</sup> Eco-Design (2005/32/EC) and Energy Labelling (92/75/EEC) Directives and their recast.

<sup>23</sup> *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions* (2011).

<sup>24</sup> *Study on the Energy Saving Potentials in EU Member States, Candidate Countries and EEA Countries*, Final Report for the European Commission, EC Service Contract Number TREN/D1/239-2006/S07.66640 (2009).

<sup>25</sup> Based on the input from the applicant.

<sup>26</sup> The analysis considers the market at 15<sup>th</sup> October 2013, when to our knowledge there were no credible third party projections.

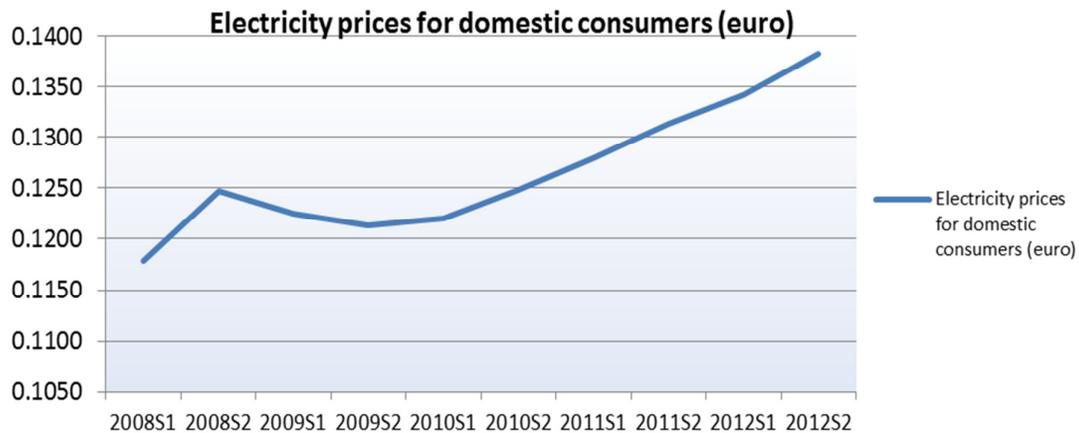
<sup>27</sup> Considering that they are not a cost for the society but a transfer of values between different sections of society.

<sup>28</sup> Average lifetime of a TV with QD. However it can be higher.

<sup>29</sup> The assumption is based on the fact that a typical TV user keeps the set on approximately 4-6 hours/day.

The average price of electricity in the EU is 0.1265 euro kW-hr.

Source: Eurostat Database<sup>30</sup>



The chart shows that the average price of electricity in the EU has had an upper trend over the last years. Any energy saving would clearly benefit consumers.

The table below summarizes total economic benefits taking into account the time period over which they will materialize:

- The second column reports the total benefits discounted over 10 years<sup>31</sup>
- The last column reports the present value of the total benefits at 2014.

**Table No.3:** Total benefits over 2014-2019 (annual benefits and discounted values)

Year	Total economic benefits (values discounted over 10 years at 4%) (euro)	Discounting factor	Present value (at 2014) <sup>32</sup> (euro)
2014	62,054,193	-	62,054,193
2015	258,559,136	0.961538462 <sup>33</sup>	248,614,554
2016	517,118,271	0.924556213 <sup>34</sup>	478,104,911
2017	672,253,753	0.888996359 <sup>35</sup>	597,631,138
2018	827,389,234	0.854804191 <sup>36</sup>	707,255,785

<sup>30</sup> [http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg\\_pc\\_204&lang=en](http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_pc_204&lang=en)

<sup>31</sup> TV's lifetime

<sup>32</sup> Total economic benefits discounted over 10 years \* discounting factor

<sup>33</sup>  $(1.04)^{-1}$

<sup>34</sup>  $(1.04)^{-2}$

<sup>35</sup>  $(1.04)^{-3}$

<sup>36</sup>  $(1.04)^{-4}$

2019	930,812,888	0.821927107 <sup>37</sup>	765,060,344
			<b>2,858,720,924</b>

One should bear in mind that an important element of uncertainty is related to variations in prices that are possible to observe across the EU<sup>38</sup>. France is among the cheapest countries, while Ireland is one of the most expensive, together with Cyprus<sup>39</sup>. In order to have a better overview of how the benefits may vary across the EU, it has been considered appropriate to calculate the economic benefits also using following prices:

- Average price in France<sup>40</sup> (0.09598 euro kW-hr), as lower bound
- Average price in Ireland<sup>41</sup> (0.17135 euro kW-hr), as upper bound

**Table No.4:** Total benefits under lower, central and upper estimates (euro)

<b>Lower bound estimate</b>	<b>Central value</b>	<b>Upper bound estimate</b>
2,169,012,129 euro	2,858,720,924	3,872,267,434

By bringing forward the central estimate, the economic benefits associated with the expected energy saving have been quantified at euro 2,858,720,924.

<sup>37</sup> (1.04)<sup>-5</sup>

<sup>38</sup> [http://www.e-control.at/portal/page/portal/medienbibliothek/presse/dokumente/pdfs/HEPI\\_Juni\\_englisch\\_Final.pdf](http://www.e-control.at/portal/page/portal/medienbibliothek/presse/dokumente/pdfs/HEPI_Juni_englisch_Final.pdf)

<sup>39</sup> [http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg\\_pc\\_204&lang=en](http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_pc_204&lang=en)

<sup>40</sup> From 2008 to 2012

<sup>41</sup> From 2008 to 2012

## Conclusions

The above analysis demonstrates that the risk during the recycling activities of LCD televisions is controlled and this means that no effect on the health of workers involved is to be anticipated, when taking into account the operational conditions and risk management measures<sup>42</sup>.

In the meantime, SEA shows that both environmental and economic benefits are expected if the exemption renewal is granted. From an environmental point of view, important saving in CO<sub>2</sub> emissions are foreseen because the use of cadmium in II-VI colour converting material in displays can reduce the energy consumption of a TV by around 20%. Taking the high external cost of greenhouses gas emissions into account, the economic benefits in terms of avoided damage to the environment have been estimated at 65,165,348 euro. In addition to that, consumers also will gain important advantages thanks to the expected energy saving. These economic benefits in terms of lower bills to pay have been quantified at 2,858,720,924 euro.

In summary, no effect on health workers is expected, while the net economic benefits associated with reduced energy consumption have been quantified at around 3 billion euro over 2014-2019.

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<sup>42</sup> As indicated in the section 1.1 (SEA – confidential version).