Nanoco Technologies Ltd.

Airborne cadmium emissions from coal fired electricity generation in the European Union

Report

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bipro

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1 Background and Objectives of the report

Background

BiPRO´s assistance was procured to provide Nanoco Technologies Ltd. [Client] a background to prepare a statement for the public consultation on extending Exemption 39 to the RoHS Directive, which is being conducted by the Öko Institut for the European Commission.

The Client´s aimed approach was to investigate the Applicant´s (QD Vision Inc.) response and Supplement Statement on Life Cycle Analysis based on the assumption that any savings in power consumption for displaying products using their cadmium technology will result in a net reduction of cadmium in the environment, by reducing the airborne emissions of cadmium from power generation, mainly from burning coal.

Objectives of the report

As per Client´s request, the objectives of the report include:

- to verify data and calculations in the QD Vision Inc. Supplement Statement on Life Cycle Analysis;
- to identify the European Union (EU) level relevant data; and
- to provide an overview of the forecast change in relation to the EU power generation mix and abatement standards future change prognosis.

2 Airborne cadmium emissions from coal fired electricity generation in the EU

2.1 Methodology

The analysis of the QD Vision Inc. Supplemental Statement on Life Cycle Assessment (LCA) showed that data and calculations presented in particular in Table 5 are not identified in any of publicly available databases.

The following step was to develop an approach to identify Cd emissions through the coal energy production and related CO_2 emissions. The relevant EU level data were identified and also data for single European Union Member States (EU-MS) with significant share of coal-fired electricity generation in their energy mix. The result is to be used to show the relation between the Cd emissions rates and Cd emissions reduction calculation in the QD Vision inc. LCA.

2.2 Identification of data for cadmium emission in the EU

In this step relevant data concerning the energy production, CO_2 and Cd emissions as well as electricity production mix were gathered.
Using the European Pollution Release and Transfer Register (E-PRTR) data, the relevant data for CO_2 and Cd emissions from coal fired power plants in the EU were identified (see Annex 1, chapter 5.1). This analysis has revealed that the E-PRTR contains the relevant data for one fifth on the big coal fired power plants in the EU, due to prescribed reporting requirements (see [1]). Corresponding calculations are presented below in Table 1.

Table 1 The EU level relevant data identified

Items	Data
Cd emissions in relation to CO_2 emissions [see Annex 1]	0.025 mg Cd/kg CO_2
EU-28 electricity production from coal fired plants [3]	27 %
Cd emissions/ kg CO_2 in relation to the EU-28 electricity production mix	0.00675 mg Cd/kg CO_2
Lifetime reduction of Cd emissions per CdSe QD TV [5]	**2,94 mg**

In the next step, focus was on the national level data for CO_2 and Cd emissions for countries with significant share in the total EU coal fired power plants capacities and available reliable emissions reporting data. To depict the complete picture in the EU context, countries with low and high performance in regard to Cd emissions, state of the art technology and related standards were selected including Germany, United Kingdom, Spain, Greece and Czech Republic.

Table 2 Overview lifetime reduction of Cd emissions for different EU countries

Items	Germany	UK	Spain	Greece	Czech Republic
Cd emissions in relation to CO_2 emission [mg Cd/kg CO_2]	0,0012[6]	0,002[7]	0,03[2]	0,033[2]	0,054[8]
Electricity production from coal fired plants [9] [10]	41,5%	27,6%	22%	55,3%	55%
mg Cd emissions/kg CO_2 in relation to EU electricity production mix	0,000498	0,000552	0,0066	0,018	0,029
Lifetime reduction of Cd emissions per CdSe QD TV	**0,22 mg**	**0,24 mg**	**2,88 mg**	**7,95 mg**	**12,9 mg**

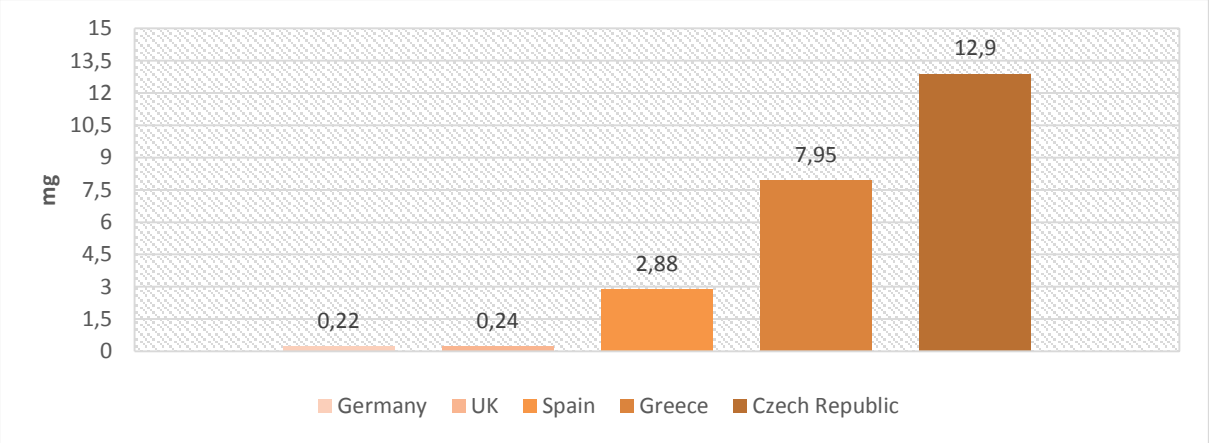

Figure 1 Lifetime reduction of Cd emissions per CdSe Qd TV in the EU context

2.3 Overview of the forecast change in relation to the EU electricity generation mix and abatement standards future change prognosis

According to the European Commission electricity generation mix trend in the European Union, generation from solid fuels declines significantly throughout the projection period, in particular in the period 2030-2050 [4]. The coal/lignite electricity generation will decrease significantly from 24% in 2010 to 7% in 2050 (see Figure 2).

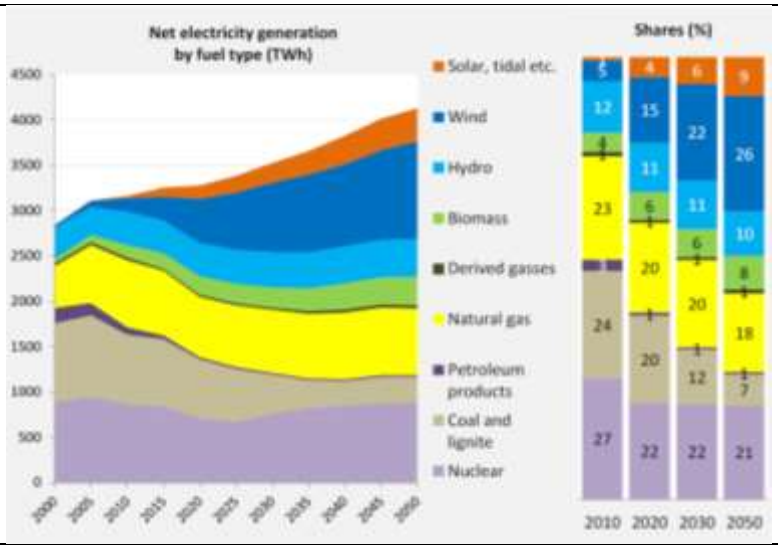

Figure 2 Structure of electricity generation in the EU 2010-2050 [4]

3 Concluding remarks

Based on our calculation Cd emissions from the electricity production in the EU from coal fired power stations considering the EU-28 electricity generation mix in 2013 equals to 0,00675 mg Cd/kg CO_2. The QD LCA report claims 436 kgCO_2 reduction per TV lifetime with CdSe QD technology, resulting in 2,94 mg Cd emissions reduction per TV lifetime with CdSe QD technology.

Further the country level data analysis result presented in Figure 1 shows the difference between the EU-MS which can be explained by different state of the practices and technologies used in the coal fired power plants across the EU, with Germany and the UK being at the advanced level.

According to all stated above, we can estimate based on the analysed data that the Cd emission reduction of CdSe QD TV per its lifetime in the EU context, is in the range between 13 mg and 0,22 mg with the average being around the EU level figure.

In order to forecast the potential change in Cd emissions reduction related to the energy trends at the EU level several drivers should be considered including electricity production trends, energy technology progress and related stricter emissions standards and limit values integrated in the energy policies.

Figure 2 shows the EU electricity production trends which indicate that in for example 2030 CdSe QD TV will potentially have Cd emissions reduction potential of 1,3 mg.

The energy technology progress analysed in the EU Reference Scenario 2013 predicts the penetration of new technologies (supercritical coal plants and carbon capture and storage (CCS) technologies) leading to changes in the energy mix alongside other drivers prices and costs, policies, market trends [4]. For example, the UK Department for Department of Energy and Climate Change, as part of a plan to decarbonize the power sector by 2030, announced in 2009 a policy that would ban new coal-fired power plants without carbon capture and storage (CCS). New plants would be required to capture and store CO_2 equal to at least 300 megawatts of CO_2 emissions from the day they go online, and to capture all their CO_2 emissions by 2025 [14]. Further, the German coal phase out trend is driven by the German government target to increase the share of renewables in power generation to 40-45 percent by 2025 and 55-60 percent by 2035 and to phase out nuclear power by 2023. However, in the short term and connected with phasing out of nuclear power, Germany plans to commission new coal-fired power plants [11].The projections predict that in 2030 Germany will reach 28-33% [12] share in generation of electricity from solid fuel (coal and lignite) [13].

Public policies at EU and national level, through information campaigns, industrial policy, R&D support, taxation and other means, aim at pushing more rapid adoption of new technologies by removing or compensating uncertainties associated with their use. In this way, the technologies themselves reach maturity more rapidly as a result of “learning-by-doing” effects and economies of scale [4]. In the end, this should lead to more equal application of new technologies across the EU and contribute to reduction in the average emission rate of cadmium per kg of CO_2.

4 Bibliographic references

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5 Annex

5.1 Annex 1: Data extract from the European Pollutant Release and Transfer Register (E-EPRT) [2]

The table below includes all coal fired power plants (57) reported to the E-PRTR and 2013 data for CO_2 and Cd emissions reported accordingly. Based this data, the average for Cd/CO_2 relation at the European level was calculated (0,025 mg Cd/ kgCO_2).

Facility	Country	CO_2 emissions [t]	Cd emission [kg]	mg Cd/kgCO_2
Dhekelia Power	CY	1410000	21,4	0,015
Elektrárny Tušimice	CZ	4550000	61,4	0,013
Elektrárny Chvaletice	CZ	3020000	13	0,004
Elektrárny Opatovice	CZ	2220000	30,7	0,014
Elektrárna Mělník	CZ	2290000	14	0,006
Elektrárny Prunéřov	CZ	4860000	16,1	0,003
Teplárny Hodonín	CZ	1480000	12,8	0,009
Elektrárna Počerady	CZ	5400000	21,1	0,004
Teplárna Náchod	CZ	0	18,3	n/a
Balti elektrijaam	ES	2250000	112	0,050
Eesti elektrijaam	ES	10700000	493	0,046
EDF BLENOD	FR	2390000	25	0,010
E.ON Centrale Emile Huchet	FR	3680000	13,5	0,004
EDF Centre de Production de La Maxe	FR	1450000	11,6	0,008
Centrale thermique du Vazzio	FR	433000	11,4	0,026
Centrale de Jarry-Nord	FR	512000	13	0,025
Centrale de Bellefontaine	FR	489000	12,9	0,026
Veltheim GmbH	GER	1230000	10,4	0,008
Schloven	GER	1020000	32	0,031
RWE Power AG	GER	18800000	23	0,001
Mark-E Aktiengesellschaft	GER	2210000	11	0,005
Lippendorf	GER	11800000	614	0,052
Schwarze Pumpe	GER	11400000	43	0,004
PPC S.A. SES AGIOY DHMHTRIOY	GR	13100000	75,2	0,006
PPC S.A. SES PTOLEMAIDAS	GR	3410000	432	0,127
PPC S.A. SES KARDIAS	GR	8910000	147	0,016
PPC S.A. SES AMYNTAIOY	GR	4200000	54,7	0,013
PPC S.A. SES MELITIS	GR	1450000	29,4	0,020
PPC S.A. SES RODOY	GR	524000	13,8	0,026
PPC S.A. SES LINOPERAMATON	GR	687000	18,2	0,026
PPC S.A. SES ATHERINOLAKKOY	GR	694000	18,4	0,027
Enel Produzione SpA Ventrale di Torrevaldaliga	IT	9730000	11,6	0,001
CENTRALE TERMOELETTRICA Federico II (BR SUD)	IT	11800000	63,8	0,005
ISAB ENERGY Impianto IGCC	IT	3110000	65,2	0,021

ERG Power Impianti Nord	IT	1380000	32,6	0,024
Centrale Teromoelettrica di Fiume Santo	IT	3490000	11	0,003
Delimara Power station	MT	1260000	17	0,013
Elektrownia Połaniec Spółka Akcyjna	PL	5570000	44,5	0,008
EDF Polska S.A.Oddział w Rybniku	PL	8380000	29,6	0,004
Repsol-Produção de Electricidade e Calor - ACE	PT	169000	41	0,243
Central Termoeléctrica do Caldeirão	PT	128000	16	0,125
Central Termoeléctrica do Belo Jardim	PT	119000	16	0,134
FINANCIERA MADERERA, S.A.	ES	0	13	n/a
FINSA-OREMBER; CONOSOL-OURENSE	ES	0	21	n/a
CENTRAL TERMICA DE ANDORRA	ES	3630000	16	0,004
UPT COMPOSTILLA	ES	2410000	11	0,005
ENERGYWORKS VILLARROBLEDO S.L.	ES	0	18,4	n/a
MOSTOS VINOS Y ALCOHOLES S.A.	ES	146000	26,2	0,179
ACEITES DEL SUR COOSUR S.A. (OLCESA REFINERÍA)	ES	0	15,7	n/a
CENTRAL TÉRMICA ALCÚDIA	ES	2520000	10,8	0,004
CENTRAL TÉRMICA LITORAL DE ALMERÍA	ES	5300000	14,2	0,003
CENTRAL TÉRMICA LOS BARRIOS	ES	2530000	14	0,006
CENTRAL TÉRMICA GRANADILLA	ES	1730000	11,3	0,007
Lynemouth Power Limited, Lynemouth Power Station	UK	2280000	16	0,007
Fiddlers Ferry Power Station	UK	9060000	26,4	0,003
Rwe Npower Plc, Tilbury Power Station	UK	0	10,1	n/a
Unit 2 Churchill Industrial Estate	UK	0	22	n/a
Average amount		**3531772**	**53**	**0,025**

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