HEATSET OFFSET

SYNOPSIS SHEET

Prepared in the framework of EGTEI

1. ACTIVITY DESCRIPTION AND EGTEI CONTRIBUTION - SUMMARY 3

2. EUROPEAN REGULATION 4

3. METHODOLOGY DEVELOPED WITHIN EGTEI TO REPRESENT THE SECTOR 4

3.1 DEFINITION OF REFERENCE INSTALLATIONS 4
3.2 DEFINITION OF EMISSION ABATEMENT TECHNIQUES 5
3.2.1 Primary measures 5
3.2.2 Secondary measures 6

4. COUNTRY SPECIFIC DATA TO BE COLLECTED 6

5. DEFAULT EMISSION FACTORS AND COST DATA DEFINED WITH THE EGTEI METHODOLOGY 6

6. RELEVANCE OF EGTEI INFORMATION FOR INTEGRATED ASSESSMENT MODELLING (IAM) 7

7. PERSPECTIVE FOR THE FUTURE 7

8. BIBLIOGRAPHY 8

A. COUNTRY SPECIFIC DATA COLLECTION AND SCENARIO CLE DEVELOPED 9

B. TRENDS IN EMISSIONS AND TOTAL COSTS OF THE CLE SCENARIO 10

1. Activity description and EGTEI contribution - summary

Offset is a printing process using an image carrier in which the printing and non-printing areas are on the same plane. The non-printing area is treated to attract water and thus reject the greasy ink. The printing area is treated to receive and transmit ink to a rubber coated cylinder and from there the surface to be printed. Heat set means an offset printing process where evaporation takes place in an oven where hot air is used to heat the printed material (most offset inks do not dry by evaporation, but by oxidation or absorption in the paper. Heat set inks are the exception. They are the unique offset ink drying largely through evaporation).

Emissions to air arise primarily from the organic solvents contained in inks. Solvents used in cleaning and dampening solutions (commonly isopropanol) are also important sources of VOC emissions. Solvents driven off through evaporation from the inks may be discharged untreated or destroyed via thermal oxidation. Cleaning techniques range from wiping over equipment with a solvent cloth to the use of enclosed cleaning units designed to recycle solvents.

NMVOC emissions from this sector may vary significantly from country to country according to the rate of use of thermal oxidisers. At a EU25 level for the year 2000 (according to the RAINS model: version CP_CLE_Aug04(Nov04)), NMVOC emissions were 40 kt representing 0.38% of total NMVOC emissions. Total activity being, 123.59 kt of ink, average emission factor is about 323.9 g NMVOC/kg of ink meaning that emissions from this sector are already well treated in EU25. These estimations could be modified in a near future due to information delivered by national experts during the bilateral consultation in 2005.

Heatset offset is addressed by the European Directive 1999/13/EC (SED) [1] related to the reduction of NMVOC emissions from the use of solvents in some industrial activities. In order to be able to better represent the impact of this Directive in term of emission reduction and costs, **this sector has been considered as an individual activity by EGTEI [2]**. This sector was also considered as an individual sector in the previous version of RAINS [4] but new measures and abatement costs have been defined in the EGTEI background document. The methodology for this sector was developed in close cooperation with the European Printing Association (Intergraf) [3] in 2003. Since the EGTEI background document was finalised, new information has been provided by industry. A meeting has been organised in Laxenburg in 2005 with representatives from Intergraf, IIASA and CITEPA. The most efficient technique has been modified to be consistent with new information available in the BREF document in preparation. This recent information will be introduced into the new RAINS version and used for the modelling work carried out in the scope of the revision of the Gothenburg Protocol and national emission ceiling Directive. The EGTEI background document will be updated in the coming weeks. **This synopsis sheet presents the first data set provided by EGTEI in 2003 as the updated one has not been fully finalised yet.**

The representative unit used is the amount of ink consumed annually (kt/year). The installation's size depends on the number of presses and on the amount of ink consumed. As costs of secondary measures are extremely size-dependent, four reference installations (RI) have been defined with Intergraf.

Three primary measures are considered based on different fugitive emission levels. Conventional ink (with a content of 45% mineral oils) is always used as no substitute exists. The consumption of solvents used in the dampening solution and as cleaning agents can be reduced. This leads to lower VOC fugitive emissions. These solutions allow being in compliance with the fugitive emission level defined in the SED but a thermal oxidiser is usually used to be in compliance with VOC emission limit value in the stack.

EGTEI provides default emission factors (EF) with abatement efficiencies, investments and variable and fixed operating costs (OC) as well as unit costs (€/t NMVOC abated and €/activity unit) for three primary measures and one secondary measure according to the installation size.

The use of a thermal oxidiser associated with reduced fugitive emissions enables compliance with the SED requirements. Abatement costs of the two corresponding techniques vary from 2.7 to 5.1 k€/t NMVOC abated or from 0.3 to 0.6 k€/t of ink consumed.

National experts have to collect only 3 country specific economic parameters (wages, electricity and natural gas costs) which can be very easily known. EGTEI provides default costs for country specific parameters which can be used if no better national data exist. National experts have also to provide

the trends in activity level from 2000 to 2020, the activity shares according to the different RI as well as the application and applicability rates of each abatement technique.

Even if the representation of this sector will be slightly modified in the new RAINS version compared to the current EGTEI proposal, it is recommended to national experts to complete ECODAT with country specific parameters which are not known from CIAM. These data can be a very good support to discuss this sector during the bilateral consultations.

The EGTEI background document and the synopsis sheet will be updated as soon as possible.

2. European regulation

As mentioned above, the European Directive 99/13/EC [1] applies to this sector (annex IIA, n°1).

Operators can conform to the Directive (SED) in either of the following ways:

by complying with the canalised and fugitive emission limit values,

by introducing a reduction scheme to obtain an equivalent emission level (in particular by replacing conventional products with a high solvent content with low-solvent or solvent-free products).

The SED applies to installations with a solvent consumption above 15 t per year. Emission limit values defined in the SED are presented in table 2.1. All obligations are not described in this chapter.

Table 2.1: Emission limit values for heatset offset

Solvent consumption threshold [t / y]	NMVOC emission limit value in residual gases [mg C / Nm^3]	Fugitive emissions [% of solvent input*]
15-25	100	30
> 25	20	30

* Solvent input: quantity of organic solvents used as input into the process in the time frame over which the mass balance is being calculated (purchased solvent) + quantity of organic solvents recovered and reused as solvent input into the process (recycled solvents are counted every time they are put back into the process cycle).

No information is provided in the SED for the respect of the reduction scheme. However, as explained in chapter 1, secondary measures will always be used to comply with the SED requirements.

The compliance date for existing installations is October 30th, 2007. Following the transcription of the Directive in Member States, this date can be different from country to country. For example, in France, the compliance date is October 30th, 2005.

3. Methodology developed within EGTEI to represent the sector

3.1 Definition of reference installations

Four reference installations (RI) were defined with Intergraf [3]. The representative unit used is the amount of ink consumed annually (t/year).

Table 3.1.1: Reference installations

Reference Installation Code RIC	Description	Technical characteristics
01	Small Reference Installation: 1 small press Ink consumption: 30 t / y	Full load hours: 1,600 h/y [NMVOC]: 1.8 g/m^3 Flow rate: 7,500 m^3/h Solvent input (I*): 21.8 t/y
02	Medium Reference Installation: 2 small presses Ink consumption: 100 t / y	Full load hours: 3,200 h/y [NMVOC]: 1.5 g/m^3 Flow rate: 15,000 m^3/h Solvent input (I*): 72.8 t/y
03	Large Reference Installation: 4 large presses Ink consumption: 400 t / y	Full load hours: 4,800 h/y [NMVOC]: 1.6 g/m^3 Flow rate: 30,000 m^3/h Solvent input (I*): 291.0 t/y
04	Very Large Installation: 8 large presses Ink consumption: 1,000 t / y	Full load hours: 4,800 h/y [NMVOC]: 2.0 g/m^3 Flow rate: 60,000 m^3/h Solvent input (I*): 727.5 t/y

* As mentioned in the Solvent Management Plan implemented by the SED [2], inputs of organic solvents (I) equal the quantity of organic solvents or their quantity in preparations purchased (I1) + the quantity of organic solvents recovered and reused as solvent input into the process (I2). In this sector, I = I1 because no solvent is recovered. All solvents consumed are assumed to be emitted when no add-on technique is used.

All installations defined in table 3.1.1 have a solvent consumption above the SED threshold (of 15 tonnes of solvents per year). Thus, they all have to comply with the Directive requirements.

3.2 Definition of emission abatement techniques

3.2.1 Primary measures

Three primary measures are defined.

Inks used within heatset offset printing consist of high boiling mineral oils as solvents (between 40 and 45 wt.-%). About 20% of the mineral oil remains in the paper, where once cooled to room temperature, no longer fall within the definition of VOC, and the rest evaporates during the drying stage, which occurs at high temperatures (200 to 300 °C). In this sector, only ink's emissions are always captured and generally routed to the thermal oxidiser. Cleaning agents are not captured for safety reasons and the dryer is usually turned off during cleaning periods (temperature of the dryer are too high and explosion might occur if the dryer is running). Some 10% of isopropanol emissions (dampening solution) are captured and routed to the dryer and then treated in the incinerator.

To reduce VOC emissions, the more efficient solution is to reduce fugitive emissions especially from isopropanol and cleaning agents.

Three primary measures are presented hereafter: they are defined according to the fugitive emissions level.

Table 3.2.1.1: Primary measures

Primary Measure Code PMC	Description
00	Conventional heat set ink (content of 45 wt.-% mineral oils) and impregnation with isopropanol and solvent-based cleaning agents. Fugitive emission of 45% of solvent input
01	Conventional heat set ink (content of 45 wt.-% mineral oils) and reduced consumption of isopropanol and of cleaning agents with high flash points. Fugitive emissions of 30% of solvent input
02	Conventional heat set ink (content of 45 wt.-% mineral oils) and reduced consumption of isopropanol and of cleaning agents with high flash points. Fugitive emissions of 25% of solvent input

3.2.2 Secondary measures

Thermal oxidation is the unique secondary measure considered as it is very well adapted to the flow rates and NMVOC concentrations in exhaust gases encountered in this activity. It enables compliance with the SED.

Table 3.2.2.1: Secondary measures

Secondary Measure Code SMC	Description
00	No secondary measure
01	Thermal oxidiser

4. Country specific data to be collected

Different types of country specific data have to be collected to give a clear picture of the situation in each Party. EGTEI proposes default values for the economical parameters which can be modified by the national expert if better data are available.

For this activity as for all NMVOC sectors, country specific economical parameters are used to calculate variable operating costs. They are presented in table 4.1 as the default costs proposed by EGTEI (these costs are entered only once in ECODAT).

Table 4.1: Country specific economic parameters

Parameters	Default costs provided by EGTEI	Country specific costs
Electricity [€/kWh] (net of taxes)	0.0686	To be provided by national experts
Natural gas [€/GJ] (net of taxes)	5.926	To be provided by national experts
Wages [€/h]	25.9	To be provided by national experts

Default data are used to calculate variable and annual unit costs presented in table 5.1.

Information concerning activity levels from 2000 to 2020 as well as the description of the control strategy is also necessary (these data can be directly entered in the database ECODAT). A full definition of the work to be done by national experts is provided in the general EGTEI methodology [8].

National experts can also modify the default unabated emission factor proposed by EGTEI to represent the reference situation of the heatset offset for all Parties, in a range of ± 10%. If the modification is higher than 10%, then appropriate explanations are required.

Table 4.2: Unabated emission factor [g of NMVOC / kg ink]

Default emission factor	Country specific emission factor
727.5	To be provided by national expert

5. Default emission factors and cost data defined with the EGTEI methodology

Table 5.1 gives an overview of all data provided by EGTEI for heatset offset: default emission factors (EF) with abatement efficiencies, investments, and variable and fixed operating costs (OC) as well as unit costs per t NMVOC abated and unit costs per unit of activity.

Variable costs account for natural gas, electricity and labour when a thermal oxidiser is used. Fixed operating costs are only considered for secondary measures and correspond to 5% of the thermal oxidiser investment (for maintenance and insurance). As no data are available, it is assumed that fixed operating costs are the same for all primary measures so no additional costs are taken into account (that is why fixed operating costs appear as 0 costs in table 5.1).

Investments and variable operating costs of secondary measures presented in table 5.1 are calculated from the equations defined in the document “derivation of secondary measure costs: thermal oxidation” downloadable on EGTEI website [5]. Energy can be recovered from exhaust gases in some cases but this assumption is not considered in the variable cost calculation. Technical characteristics of the installations are given in table 3.1.1.

Table 5.1: Default emission factors (EF), abatement efficiencies and costs for each combination

RIC PMC SMC	NMVOC EF [g NMVOC / kg ink]	Abatement efficiency [%]	Investment [k€]	Variable Operating Costs [k€ / year]	Fixed Operating Costs [k€/y]	Unit cost [k€/t NMVOC abated]	Unit cost [k€/t]
01 00 00	727.5	0	0	0.0	0.0	-	0.0
01 00 01	376.5	48.2	442	2.8	22.1	7.5	2.6
01 01 00	541	25.6	10	0.0	0.0	0.2	0.0
01 01 01	203	72.1	452	2.8	22.1	5.1	2.7
01 02 00	510	29.9	10	0.0	0.0	0.4	0.1
01 02 01	173.6	76.1	452	2.8	22.1	4.9	2.7
02 00 00	727.5	0	0	0.0	0.0	-	0.0
02 00 01	376.5	48.2	647	9.7	32.3	3.5	1.2
02 01 00	541	25.6	20	0.0	0.0	0.1	0.0
02 01 01	203	72.1	667	9.7	32.3	2.4	1.2
02 02 00	510	29.9	20	0.0	0.0	0.2	0.0
02 02 01	173.6	76.1	667	9.7	32.3	2.3	1.3
03 00 00	727.5	0	0	0.0	0.0	-	0.0
03 00 01	376.5	48.2	950	30.5	47.5	1.4	0.5
03 01 00	541	25.6	80	0.0	0.0	0.1	0.0
03 01 01	203	72.1	1,030	30.5	47.5	1.0	0.5
03 02 00	510	29.9	80	0.0	0.0	0.2	0.0
03 02 01	173.6	76.1	1,030	30.5	47.5	1.0	0.5
04 00 00	727.5	0	0	0.0	0.0	-	0.0
04 00 01	376.5	48.2	1,390	52.1	69.5	0.8	0.3
04 01 00	541	25.6	160	0.0	0.0	0.1	0.0
04 01 01	203	72.1	1,550	52.1	69.5	0.6	0.3
04 02 00	510	29.9	160	0.0	0.0	0.2	0.0
04 02 01	173.6	76.1	1,550	52.1	69.5	0.6	0.3

Investments correspond to the update of the press to reduce isopropanol consumption and the thermal oxidiser cost when appropriate.

Unit costs [k€/ t of NMVOC abated] are obtained by dividing the annual total additional cost of a measure by the amount of NMVOC abated (costs and emissions are compared to the uncontrolled measure PMC 00/SMC 00).

6. Relevance of EGTEI information for Integrated Assessment Modelling (IAM)

In the previous version of RAINS [4], heatset offset was studied as a separate sector. Control options such as the use of solvent free inks were studied but this technique seems to be not technically applicable to this sector. New reduction techniques with corresponding emission factors have been defined.

EGTEI provides now an approach to consider this sector and test the impact of the current legislation as well as the maximum achievable reduction. The approach has been developed in close cooperation with industry.

Data provided by EGTEI (emission factors and costs) were not implemented in the 2004 RAINS version [6] because of the tight timing. Following a meeting held in Laxenburg in March 2005 with representatives from Intergraf, IIASA and CITEPA, EGTEI proposals [2] and the new information provided by industry will be introduced in the new RAINS version. The background document and the synopsis sheet will be updated consequently.

For this activity, data provided by national experts through ECODAT will still be of interest for the completion of RAINS.

7. Perspective for the future

In a near future, the EGTEI background document will be modified to take into account the updated information defined in cooperation with IIASA and the industry representative: one of the improvements concerns the definition of the best available techniques (BATs) to define the MFR scenario.

8. Bibliography

[1] Council Directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations.
[2] EGTEI background document. http://citepa.org/forums/egtei/heat_set_offset.pdf
[3] European Printing Industry Association. https://www.intergraf.org/
[4] KLIMONT; M. AMANN; J. COFALA. Estimating costs for Controlling Emissions of Volatile Organic Compounds (NMVOC) from Stationary Sources in Europe. Interim Report IR-00-51. IIASA. August 1. 2000. http://www.iiasa.ac.at/~rains/voc_review/voc_ir-00-51.pdf
[5] http://citepa.org/forums/egtei/thermal_oxidation_costs_170603.pdf
[6] Review of data used in RAINS-VOC model
http://www.iiasa.ac.at/web-apps/tap/RainsWeb/
[7] Rapport d'inventaire national au format UNECE/NFR et NEC
Rapport d'étude du CITEPA - Décembre 2003
[8] Methodology: http://citepa.org/forums/egtei/egtei_index.htm
[9] CITEPA: National reference centre for emission inventories

ANNEXE: Example of data collection and use of EGTEI data – Case of France

A. Country specific data collection and scenario CLE developed

The French national expert has been able to complete ECODAT for the heatset offset with the help of CITEPA [9] and consultation of the French printing association.

All collected data have been provided to CIAM for the bilateral consultation France – CIAM in March 2004.

Country specific economic parameters

Country specific parameter costs have been defined from costs encountered in the medium size industry which are monthly published by official French statistic organisations.

Table A.1: French specific economic parameters

Parameters	French specific costs
Electricity [€/kWh] (net of taxes)	0.05
Natural gas [€/GJ] (net of taxes)	5.33
Wages [€/h]	23.4

Activity level

The trend of heatset offset activities from 2000 to 2020 comes from data provided by the French national expert and reviewed by the printing association.

Respective shares (t ink consumed/y) of total activity level carried out on each reference installation in 2000, 2005, 2010, 2015, 2020 are derived from the same enquiry. The trends in heatset offset activity and shares of the activity are presented in table A.2.

Table A.2: Activity levels on Reference Installations (t of ink / year)

RIC	2000	2005	2010	2015	2020
01	166.2	188.0	212.7	212.7	212.7
02	4,015.3	4,542.9	5,140.0	5,140.0	5,140.0
03	8,556.8	9,681.0	10,953.4	10,953.4	10,953.4
04	1,107.7	1,253.2	1,417.9	1,417.9	1,417.9
Total (t)	13,846.0	15,665.0	17,724.0	17,724.0	17,724.0

Unabated emission factor

Default emission factors are adapted to the French situation.

Current legislation control scenario (CLE)

In the current legislation control scenario (CLE), the application rates of the different abatement techniques depend on the regulation implemented and on the dates of compliance.

In 2000, secondary measures are already used in a large majority of companies because this sector is already well regulated in France. Only 6% of the activity is not controlled yet. These shares have been developed in collaboration with the French printing association. From 2005 onwards, all companies will be equipped with a thermal oxidiser to comply with the SED requirements.

The application rates and applicability factors for the CLE scenario are presented in table A.3.

Table A.3: Definition of the CLE scenario

RIC PMC SMC	Application rate in 2000 [%]	Application rate in 2005 [%]	Appl. [%]	Application rate in 2010 [%]	Appl. [%]	Application rate in 2015 [%]	Appl. [%]	Application rate in 2020 [%]	Appl. [%]
01 00 00	6	0	100	0	100	0	100	0	100
01 00 01	14	0	100	0	100	0	100	0	100
01 01 00	0	0	100	0	100	0	100	0	100
01 01 01	0	0	100	0	100	0	100	0	100
01 02 00	0	0	100	0	100	0	100	0	100
01 02 01	80	100	100	100	100	100	100	100	100
Total RIC 01	**100**	**100**	**-**	**100**	**-**	**100**	**-**	**100**	**-**
02 00 00	6	0	100	0	100	0	100	0	100
02 00 01	14	0	100	0	100	0	100	0	100
02 01 00	0	0	100	0	100	0	100	0	100
02 01 01	0	0	100	0	100	0	100	0	100
02 02 00	0	0	100	0	100	0	100	0	100
02 02 01	80	100	100	100	100	100	100	100	100
Total RIC 02	**100**	**100**	**-**	**100**	**-**	**100**	**-**	**100**	**-**
03 00 00	6	0	100	0	100	0	100	0	100
03 00 01	14	0	100	0	100	0	100	0	100
03 01 00	0	0	100	0	100	0	100	0	100
03 01 01	0	0	100	0	100	0	100	0	100
03 02 00	0	0	100	0	100	0	100	0	100
03 02 01	80	100	100	100	100	100	100	100	100
Total RIC 03	**100**	**100**	**-**	**100**	**-**	**100**	**-**	**100**	**-**
04 00 00	6	0	100	0	100	0	100	0	100
04 00 01	14	0	100	0	100	0	100	0	100
04 01 00	0	0	100	0	100	0	100	0	100
04 01 01	0	0	100	0	100	0	100	0	100
04 02 00	0	0	100	0	100	0	100	0	100
04 02 01	80	100	100	100	100	100	100	100	100
Total RIC 04	**100**	**100**	**-**	**100**	**-**	**100**	**-**	**100**	**-**

Appl.: applicability factor

B. Trends in emissions and total costs of the CLE scenario

Data shown in the table below are directly provided by ECODAT and based on input parameters defined in chapter A.

Table B.1 presents NMVOC emissions from 2000 to 2020 and total annual costs of emissions reduction for the CLE scenario.

Table B.1: Trends in emissions and total annual costs of emission reductions in the CLE scenario

	2000	2005	2010	2015	2020
NMVOC emissions	**t NMVOC**	**t NMVOC**	**t NMVOC**	**t NMVOC**	**t NMVOC**
CLE scenario	3,257	2,719	3,077	3,077	3,077
Annual total costs	**k€/year**	**k€/year**	**k€/year**	**k€/year**	**k€/year**
CLE scenario	9,780	11,885	13,448	13,448	13,448

Emissions shown in table B.1 for the year 2000 according to the CLE scenario have been calculated with EGTEI emission factors. Emissions defined in the French inventory for the year 2000 are 3,250 tonnes of VOC [7].

EGTEI approach allows representing very well NMVOC emissions from heatset offset.