New work to update costs for LCP and refineries

SO$_2$, NO$_x$ and PM abatement techniques

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Work plan of EGTEI

(d) Progress on the update of the methodology on LCP, proposed by the Expert Group;
(e) Continue to cooperate with the European Integrated Pollution Prevention and Control Bureau, including the updating of cost data in BAT reference documents for some industry sectors, such as steel and LCP;

Report_of_EGTEI_18th_meeting_Lyon_Nov.2010.pdf Informal doc for the 48th session of WGSR
LCP and refineries

Current Methodology

Set of representative power plants

Standard cost functions $f (\text{size}, \text{technique})$

- Investment
- Annualised capital cost
- Fixed operating cost
- Variable operating cost
Cost assessment of abatement techniques

- specific investment amount (€/kW\textsubscript{th})
- specific operating cost (€/kW\textsubscript{th}/y)
- cost effectiveness (€/ton pollutant abated)
- cost of moving from option \((i)\) to \((i+1)\)

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### Current Methodology

Set of representative power plants

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<th>Existing plants</th>
<th>Capacity (MW\textsubscript{th})</th>
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\(^1\) Lower heating value used for France.
**Investment function**

\[
INV_{\text{tot}}[\text{€}] = \\
\sum_i \left[ (INV_{C,i} \times BS + INV_{V,i}) \times \vartheta \times \left( 1 + \frac{\text{Retro}-\%_i}{100} \right) \right] \times 1,000
\]

\(i = \) installed technique  
\(BS = \) Boiler size in MW\(_{\text{th}}\)  
\(INV_{C,i} = \) variable cost component of technique \(i\)  
\(INV_{V,i} = \) fixed cost component of technique \(i\)  
\(\text{Retro}-\%_i = \) Cost factor for retrofit difficulty  
\(\vartheta = \) relative flue gas volume (hard coal = 1)

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**Investment function**  
example: wet FGD retrofit to a HC3 unit

\[
INV_{\text{tot}}[\text{€}] = \\
\sum_i \left[ (INV_{C,i} \times BS + INV_{V,i}) \times \vartheta \times \left( 1 + \frac{\text{Retro}-\%_i}{100} \right) \right] \times 1,000
\]

\(i = 1\)  
\(BS = 1,622\) MW\(_{\text{th}}\)  
\(INV_{C,1} = 33.65\) €/kW\(_{\text{th}}\)  
\(INV_{V,1} = 0\) €  
\(\text{Retro}-\%_1 = 30\%\)  
\(\vartheta = 1\)

\[
INV_{\text{tot}}[\text{€}] = \left( 33.65 \frac{\text{€}}{\text{kW}_{\text{th}}} \times 1,622\text{MW}_{\text{th}} + 0\text{€} \right) \\
\times \left( 1 + \frac{30}{100} \right) \times 1,000 \frac{\text{kW}_{\text{th}}}{\text{MW}_{\text{th}}} = 70,9 \times 10^6 \text{€}
\]
**Annualised capital cost**

Annualised capital cost = \( f \) (investment, lifetime, interest rate)

\[
ACC \ [\text{€}] = INV_{tot} \times \frac{(1 + \frac{i}{100})^t}{(1 + \frac{i}{100})^t - 1} \times \frac{i}{100}
\]

Currently used:
Lifetime \( t \) = 20 years (technical lifetime)
Interest rate \( i \) = 4% p.a.

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**Fixed operating cost**

Fixed operating cost = \( f \) (investment)

Currently used:
4% p.a. of total investment (\( INV_{tot} \))
Variable operating cost

Technique and pollutant specific

Parameters:
- labour demand,
- electricity consumption,
- chemicals demand,
- byproduct cost/ profit,
- …

Fields of improvement

- General Assumption
**Annualised capital cost**

Annualised capital cost = f (lifetime, interest rate)

\[
ACC = INV_{tot} \frac{(1 + \frac{i}{100})^t}{(1 + \frac{i}{100})^t - 1} \times \frac{i}{100}
\]

Lifetime \( t \) = 25-30\? years (technical lifetime)

Interest rate \( i = 4\% \) p.a.? (social planners)

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\(^1\) Lower heating value. National input, here France.
Unabated emission factors

<table>
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<tr>
<th>Fuel</th>
<th>TSP-EF (t TSP/PJ)</th>
<th>Fraction PM10 (%)</th>
<th>Fraction PM2.5 (%)</th>
<th>Sulphur content (%)</th>
<th>SO₂-EF (t SO₂/PJ)</th>
<th>NOₓ-EF (t NOₓ/PJ)</th>
</tr>
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<tr>
<td>HC1</td>
<td>3,500¹</td>
<td>23</td>
<td>12</td>
<td>0.9</td>
<td>735</td>
<td>260</td>
</tr>
<tr>
<td>HC2</td>
<td>4,337</td>
<td>23</td>
<td>12</td>
<td>0.8</td>
<td>627</td>
<td>333</td>
</tr>
<tr>
<td>HC3</td>
<td>4,337</td>
<td>23</td>
<td>12</td>
<td>1.2</td>
<td>941</td>
<td>315</td>
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<td>23</td>
<td>12</td>
<td>1.0</td>
<td>941</td>
<td>315</td>
</tr>
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<td>HF</td>
<td>15.5</td>
<td>85</td>
<td>60</td>
<td>2.79</td>
<td>1,423</td>
<td>238</td>
</tr>
<tr>
<td>GAS</td>
<td>0.1</td>
<td>100</td>
<td>100</td>
<td>0.01</td>
<td>50</td>
<td>80</td>
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(1) 3,500 and 4,500 t TSP/PJ both have been stated as emission factors.

Fields of improvement

- Extension of the range of installations covered
  > 50 MWth instead of > 500 MWth
Fields of improvement

Reduction techniques

Selection of techniques

• PM:
  - Now: Cyclone, i.e. ESP, ESP, FF
  - Future: replace current ESPs by 2-, 3-, 4-field ESP?

• SO₂:
  - Now: Wet FGD, HE-Wet-FGD
  - Future: ?

• NOₓ:
  - Now: PM, SCR
  - Future: add SNCR? Differentiate PM?
Individual techniques

• Selected abatement efficiency appropriate?

• Consider maximum achievable emission limit? (~BAT-AEL?)

• Consumption figures (electricity, reagent) up to date?

• Wet FGD: include saleable byproducts (gypsum)?

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Fields of improvement

- Cost functions
Questions about cost data

• Is modeling with a single investment function appropriate?
  o splitting investment function into a partially continuous function (acc. to size range)?
  o defining variable and fix part of function acc. to characteristics
  o defining range of possible scaling

• Thermal input or volume flow as basis?

• Retrofit cost factors appropriate?

• How to include inflation? CEPCI?

Defining the cost of moving from one option to another

• Uprading by investment + retrofit factor?

• Building a completely new unit?

• Starting point: zero or a BAT for this option?
Proposed work programme

• Target: one year to complete the work (May 2012)

• Development of cost functions on the basis of collected information for installation larger than 500 MWth

• Extend to 50 to 500 MW installations

• Undertake the update of operating costs when necessary

• Hold a first meeting in the beginning of October to discuss the first results and define the following steps (representation of the sector for estimation of total costs for one activity)

• Inform the secretariat before end of June 2011 for experts to be involved in the work (LCP and refineries)