ECRAN Regional Training Seminar on the Assessment of
GHG Inventories in the Energy and Industrial Processes Sectors
Activity 3.2: MMR - Task 3.2.2.A
Zagreb, Croatia, 19 November 2014

# Practical approach in handling the CRF tables - Industrial processes

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# Outline

- inventory preparation
  - ✓ AD collection - different sources
  - ✓ choice of method, EFs and AD
  - ✓ emission estimates
- **how to start working with CRF?**
- examples of spreadsheets
- preparation of “meta CRF table”
- **how to fill in the CRF tables?**

TACCC principles
- ✓ transparency
- ✓ accuracy
- ✓ completeness
- ✓ comparability
- ✓ consistency

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# Table 2(I)s1 - sectoral report for IPPU

**TABLE 2(I) SECTORAL REPORT FOR INDUSTRIAL PROCESSES AND PRODUCT USE**
**(Sheet 1 of 2)**

Year
Submission
Country

| GREENHOUSE GAS SOURCE AND SINK CATEG | $CO_2$ | $CH_4$ | $N_2O$ | HFCs [1] | PFCs [1] | Unspecified mix of HFCs and PFCs [1] | $SF_6$ | $NF_3$ | $NO_x$ | CO | NMVOC | $SO_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (kt) | | | $CO_2$ equivalent (kt) | | | (kt) | | | | | |
| **Total industrial processes** | | | | | | | | | | | | |
| **A. Mineral industry** | | | | | | | | | | | | |
| 1. Cement production | | | | | | | | | | | | |
| 2. Lime production | | | | | | | | | | | | |
| 3. Glass production | | | | | | | | | | | | |
| 4. Other process uses of carbonates | | | | | | | | | | | | |
| **B. Chemical industry** | | | | | | | | | | | | |
| 1. Ammonia production | | | | | | | | | | | | |
| 2. Nitric acid production | | | | | | | | | | | | |
| 3. Adipic acid production | | | | | | | | | | | | |
| 4. Caprolactam, glyoxal and glyoxylic acid production | | | | | | | | | | | | |
| 5. Carbide production | | | | | | | | | | | | |
| 6. Titanium dioxide production | | | | | | | | | | | | |
| 7. Soda ash production | | | | | | | | | | | | |
| 8. Petrochemical and carbon black production | | | | | | | | | | | | |
| 9. Fluorochemical production | | | | | | | | | | | | |
| 10. Other *(as specified in table 2(I).A-H)* | | | | | | | | | | | | |
| **C. Metal industry** | | | | | | | | | | | | |
| 1. Iron and steel production | | | | | | | | | | | | |
| 2. Ferroalloys production | | | | | | | | | | | | |
| 3. Aluminium production | | | | | | | | | | | | |
| 4. Magnesium production | | | | | | | | | | | | |
| 5. Lead production | | | | | | | | | | | | |
| 6. Zinc production | | | | | | | | | | | | |
| 7. Other *(as specified in table 2(I).A-H)* | | | | | | | | | | | | |

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# Table 2(I)s2 - sectoral report for IPPU

**TABLE 2(I) SECTORAL REPORT FOR INDUSTRIAL PROCESSES AND PRODUCT USE**
**(Sheet 2 of 2)**

Year
Submission
Country

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | $CO_2$ | $CH_4$ | $N_2O$ | HFCs [1] | PFCs [1] | Unspecified mix of HFCs and PFCs [1] | $SF_6$ | $NF_3$ | $NO_x$ | CO | NMVOC | $SO_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (kt) | | | $CO_2$ equivalent (kt) | | | (kt) | | | | | |
| **D. Non-energy products from fuels and solvent use** | | | | | | | | | | | | |
| 1. Lubricant use | | | | | | | | | | | | |
| 2. Paraffin wax use | | | | | | | | | | | | |
| 3. Other | | | | | | | | | | | | |
| **E. Electronics industry** | | | | | | | | | | | | |
| 1. Integrated circuit or semiconductor | | | | | | | | | | | | |
| 2. TFT flat panel display | | | | | | | | | | | | |
| 3. Photovoltaics | | | | | | | | | | | | |
| 4. Heat transfer fluid | | | | | | | | | | | | |
| 5. Other *(as specified in table 2(II))* | | | | | | | | | | | | |
| **F. Product uses as substitutes for ODS [2]** | | | | | | | | | | | | |
| 1. Refrigeration and air conditioning | | | | | | | | | | | | |
| 2. Foam blowing agents | | | | | | | | | | | | |
| 3. Fire protection | | | | | | | | | | | | |
| 4. Aerosols | | | | | | | | | | | | |
| 5. Solvents | | | | | | | | | | | | |
| 6. Other applications | | | | | | | | | | | | |
| **G. Other product manufacture and use** | | | | | | | | | | | | |
| 1. Electrical equipment | | | | | | | | | | | | |
| 2. $SF_6$ and PFCs from other product use | | | | | | | | | | | | |
| 3. $N_2O$ from product uses | | | | | | | | | | | | |
| 4. Other | | | | | | | | | | | | |
| **H. Other (as specified in tables 2(I).A-H and 2(II))** [3] | | | | | | | | | | | | |

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# Table 2(II) - sectoral report for IPPU - emissions of HFCs, PFCs, $SF_6$ and $NF_3$

TABLE 2(II) SECTORAL REPORT FOR INDUSTRIAL PROCESSES AND PRODUCT USE - EMISSIONS OF HFCs, PFCs, $SF_6$ AND $NF_3$
(Sheet 1 of 1)

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | HFC-23 | HFC-32 | HFC-41 | HFC-43-10mee | HFC-125 | HFC-134 | HFC-134a | HFC-143 | HFC-143a | HFC-152 | HFC-152a | HFC-161 | HFC-227ea | HFC-236cb | HFC-236ea | HFC-236fa | HFC-245ca | HFC-245fa | HFC-365mfc | Unspecified mix of HFCs [1] | Total HFCs | $CF_4$ | $C_2F_6$ | $C_3F_8$ | $C_4F_{10}$ | $c\text{-}C_4F_8$ | $C_5F_{12}$ | $C_6F_{14}$ | $C_7F_{16}$ | $c\text{-}C_4F_8$ | Unspecified mix of PFCs [1] | Total PFCs | Unspecified mix of HFCs and PFCs [1] | $SF_6$ | $NF_3$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | kt | | | | | | | | | | | | | | | | | | | $CO_2$ equivalent kt | | kt | | | | | | | | | $CO_2$ equivalent kt | | $CO_2$ equivalent kt | kt | kt |
| Total carbon emissions of hydrocarbons by chemical and $SF_6$ [2] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B. Chemical industry | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Petrochemical products | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| By-product emissions | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fugitive emissions | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. Other | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C. Metal industry | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Ferrous products | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. Aluminium production | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3. Other | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E. Electronics industry | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Integrated circuit or semiconductor | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. TFT flat panel display | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3. Photovoltaics | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4. Heat transfer fluid | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5. Other, as specified in Table 2 (II) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F. Product uses as substitutes for ODS* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Refrigeration and air conditioning | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. Foam blowing agents | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3. Fire protection | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4. Aerosols | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5. Solvents | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6. Other applications | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| G. Other product manufacture and use | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Electron equipment | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. $SF_6$ and PFCs from other product use | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3. Other | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| H. Other (please specify) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | $CO_2$ equivalent kt | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total emissions * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B. Chemical industry | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C. Metal production | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E. Electronics industry | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| F. Product uses as substitutes for ODS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| G. Other product manufacture and use | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| H. Other | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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# Choice of method, EFs and AD

**Example: 2.A Mineral Industry/2.A.1 Cement Production**

- Tier 1 method
  - ✓ use of cement production data - national level
  - ✓ use of default EFs (CaO composition, correction factor for CKD)
- Tier 2 method
  - ✓ use of clinker production data - country/plant specific data
  - ✓ country/plant specific EFs
- Tier 3 method
  - ✓ use of carbonates input data - disaggregated plant specific data on compositions and quantities of carbonates
  - ✓ plant specific EFs - full accounting of carbonates (species and sources)

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# Preparation of subsectoral spreadsheets (1)

## Plant-specific data, Tier 2 method

| Clinker and Cement Production | | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| Clinker bought | [t/yr] | 0 | 0 | 0 | 0 | 0 | 0 |
| Clinker sold | [t/yr] | 0 | 6,395 | 3,601 | 21,607 | 65,082 | 70,186 |
| Clinker send off | [t/yr] | 0 | 0 | 0 | 0 | 0 | 0 |
| Change in clinker stocks | [t/yr] | 10,752 | 25,252 | 511 | -20,281 | -10,388 | 32,614 |
| Total clinker consumed | [t/yr] | 486,730 | 443,919 | 402,820 | 348,667 | 350,254 | 307,713 |
| | | | | | | | |
| **Mineral components (MIC) used to produce blended cements (dry weight):** | | | | | | | |
| Gypsum | [t/yr] | 28,071 | 26,360 | 21,826 | 14,370 | 17,254 | 17,808 |
| Limestone | [t/yr] | 34,659 | 22,532 | 26,374 | 19,096 | 23,622 | 29,926 |
| Slag | [t/yr] | 82,822 | 62,924 | 56,335 | 35,488 | 43,729 | 38,333 |
| Fly ash (for blending) | [t/yr] | 56,201 | 65,409 | 38,276 | 34,826 | 42,676 | 33,473 |
| Puzzolana | [t/yr] | 0 | 0 | 0 | 0 | 0 | 0 |
| Others - kiln filter dust | [t/yr] | 20,424 | 16,607 | 13,363 | 11,109 | 7,507 | 7,210 |
| Total MIC consumed for blending | [t/yr] | 222,177 | 193,832 | 156,174 | 114,889 | 134,788 | 126,750 |
| | | | | | | | |
| **Production totals:** | | | | | | | |
| **Total cement** | [t/yr] | 708,907 | 637,742 | 558,994 | 463,565 | 485,042 | 434,464 |
| **Total cementitious products** | [t/yr] | 719,659 | 669,398 | 563,106 | 464,892 | 539,736 | 537,263 |
| **Direct CO2 Emissions** | | | | | | | |
| **CO2 from Raw Materials** | | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** |
| Calcination emission factor, corrected for CaO- and MgO imports | [kg CO2/ t cli] | 511 | 511 | 504 | 512 | 487 | 477 |
| Raw meal consumption | [t/yr, dry weight] | 783,536 | 749,016 | 640,918 | 551,255 | 637,793 | 646,558 |
| CO2 from calcination of clinker | [t CO2/yr] | 254,035 | 242,844 | 205,114 | 179,276 | 197,091 | 195,676 |
| CO2 from CKD not recycled (separate for cement mill, discarded, lost) | [t CO2/yr] | 5,081 | 4,857 | 4,102 | 3,586 | 3,942 | 3,914 |
| Total CO2 from raw materials | [t CO2/yr] | 259,116 | 247,701 | 209,216 | 182,861 | 201,033 | 199,590 |

CO2 emission | Calcination CO2

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# Preparation of subsectoral spreadsheets (2)

## Plant-specific data

| Total clinker production and composition | | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| Clinker produced | [t/yr] | 497,482 | 475,566 | 406,932 | 350,003 | 404,948 | 410,513 |
| CaO content (incl. free lime) | [%] | 65.1 | 65.1 | 64.2 | 65.3 | 62.0 | 60.7 |
| MgO content | [%] | 1.9 | 1.7 | 0.6 | 1.8 | 0.7 | 0.9 |
| CaO amount | [t/yr] | 323,712 | 309,451 | 261,372 | 228,447 | 251,149 | 249,346 |
| MgO amount | [t/yr] | 9,303 | 7,942 | 2,482 | 6,195 | 2,916 | 3,859 |
| **Correction for non-carbonate sources of CaO, MgO found in clinker** | | | | | | | |
| **Total of raw materials** | | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** |
| Raw material consumed | [t/yr] | 783,536 | 749,016 | 640,918 | 551,255 | 637,793 | 646,558 |
| CaO content | [%] | 42.8 | 42.9 | 42.7 | 42.8 | 40.5 | 38.6 |
| MgO content | [%] | 1.1 | 1.1 | 0.4 | 1.2 | 0.5 | 0.6 |
| CaO amount | [t/yr] | 335,197 | 321,627 | 273,928 | 236,047 | 258,051 | 249,377 |
| MgO amount | [t/yr] | 8,776 | 8,014 | 2,820 | 6,395 | 3,125 | 3,879 |
| **CO2 emissions from raw material calcination** | | | | | | | |
| **Absolute CO2 emissions** | | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** |
| Uncorrected CO2 emissions, based on CaO- and MgO content of clinker | [t CO2/yr] | 264,048 | 251,378 | 207,708 | 185,938 | 200,163 | 199,778 |
| Correction for imports of CaO and MgO via raw materials etc. | [t CO2/yr] | 272,481 | 261,007 | 217,925 | 192,117 | 205,805 | 199,826 |
| Corrected, direct CO2 emissions | [t CO2/yr] | -8,432 | -9,630 | -10,217 | -6,179 | -5,642 | -47 |
| | | | | | | | |
| **Specific CO2 emissions per ton of clinker** | | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** |
| Calcination factor, uncorrected | [kg CO2/t cli] | 531 | 529 | 510 | 531 | 494 | 487 |
| **Calcination factor, corrected for CaO- and MgO imports (= input into CO2 inventory, line 35)** | [kg CO2/t cli] | -17 | -20 | -25 | -18 | -14 | 0 |
| | **Calcination EF** | **511** | **511** | **504** | **512** | **487** | **477** |

CO2 emission | Calcination CO2

spreadsheets “CO2 emission” and “Calcination CO2” are linked

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# Preparation of sectoral spreadsheets (1)

Aggregate plant-specific data - national level

| | PORTLAND | ALUMINATE | CRF activity data |
|---|---|---|---|
| | clinker production (t) | clinker production (t) | clinker production (kt) |
| 2007 | 3,046,209 | 114,311 | 3,160.520 |
| 2008 | 2,883,266 | 111,787 | 2,995.053 |
| 2009 | 2,355,148 | 83,911 | 2,439.059 |
| 2010 | 2,229,152 | 91,332 | 2,320.484 |
| 2011 | 1,965,307 | 106,353 | 2,071.660 |
| 2012 | 1,896,912 | 99,587 | 1,996.499 |

| | PORTLAND | ALUMINATE | |
|---|---|---|---|
| | actual clinker prod. (*CKD) (kt) | actual clinker prod. (*CKD) (kt) | actual clinker prod. (kt) |
| 2007 | 3,107.133 | 116.597 | 3,223.730 |
| 2008 | 2,940.931 | 114.023 | 3,054.954 |
| 2009 | 2,402.251 | 85.589 | 2,487.840 |
| 2010 | 2,273.735 | 93.159 | 2,366.894 |
| 2011 | 2,004.613 | 108.480 | 2,113.093 |
| 2012 | 1,934.850 | 101.579 | 2,036.429 |

Cement P | Lime P | Lime&Dol U | Soda Ash P&U | Mineral Prod P&U

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# Preparation of sectoral spreadsheets (2)

Aggregate plant-specific data - national level

| | EF (kg $CO_2$/t cli) - PORTLAND | | | | EF (kg $CO_2$/t cli) - ALUMINATE |
|---|---|---|---|---|---|
| | Plant A | Plant B | Plant C | AVERAGE | Plant D |
| 2007 | 493 | 518 | 511 | **507** | **310** |
| 2008 | 493 | 518 | 511 | **507** | **311** |
| 2009 | 513 | 480 | 504 | **499** | **310** |
| 2010 | 509 | 522 | 512 | **515** | **309** |
| 2011 | 520 | 517 | 487 | **508** | **306** |
| 2012 | 514 | 512 | 477 | **501** | **301** |

| | PORTLAND $CO_2$ (Gg) | ALUMINATE $CO_2$ (Gg) | CRF emission $CO_2$ emission (Gg) | CRF emission $SO_2$ emission (Gg) |
|---|---|---|---|---|
| 2007 | 1576.395 | 35.485 | 1611.880 | 1.299 |
| 2008 | 1492.073 | 34.794 | 1526.867 | 1.626 |
| 2009 | 1198.057 | 26.117 | 1224.174 | 1.424 |
| 2010 | 1169.927 | 28.333 | 1198.260 | 1.031 |
| 2011 | 1017.688 | 32.673 | 1050.361 | 0.831 |
| 2012 | 968.910 | 29.961 | 998.871 | 0.782 |

**ahublin:** emissions were taken from Collecter (CLRTAP)

Cement P | Lime P | Lime&Dol U | Soda Ash P&U | Mineral Prod P&U | Ammonia P | Nitric Acid P | Other Chemical P | Iron&St

cells in the spreadsheets are linked

Tier 2 method is used for $CO_2$ emission calculation (2006 IPCC GLs)

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# Preparation of “meta CRF table”

Exported table from CRF Reporter Inventory Software

[2. Industrial Processes and Product Use][2.A Mineral Industry][2.A.1 Cement Production]

| [2. Industrial Processes and Product Use] | Unit | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|
| **Activity data** | | | | | | | | |
| (specify - cement or clinker production ) | kt | 3,160.520 | 2,995.053 | 2,439.059 | 2,320.484 | 2,071.660 | 1,996.499 | |
| Method | | | | | | | | |
| CO2 | | | | | | | | |
| **Emission factor information** | | | | | | | | |
| CO2 | | | | | | | | |
| **Emissions** | | | | | | | | |
| CO2 | kt | 1,611.880 | 1,526.867 | 1,224.174 | 1,198.260 | 1,050.361 | 998.871 | |
| SO2 | kt | 1.299 | 1.626 | 1.424 | 1.031 | 0.831 | 0.782 | |
| **Recovery** | | | | | | | | |
| CO2 | kt | NO | NO | NO | NO | NO | NO | |
| **Implied emission factor** | | | | | | | | |
| CO2 | t/t | | | | | | | |
| **Documentation box** | | | | | | | | |

2. | 2.A | 2.A.1 | 2.A.2 | 2.A.3 | 2.A.4 | 2.A.4.a | 2.A.4.b | 2.A.4.c | 2.A.4.d | 2.B | 2.B.1 | 2.B.2 | 2.B.3 | 2.B.4 | 2

cells in “meta CRF table” are linked with sectoral spreadsheets

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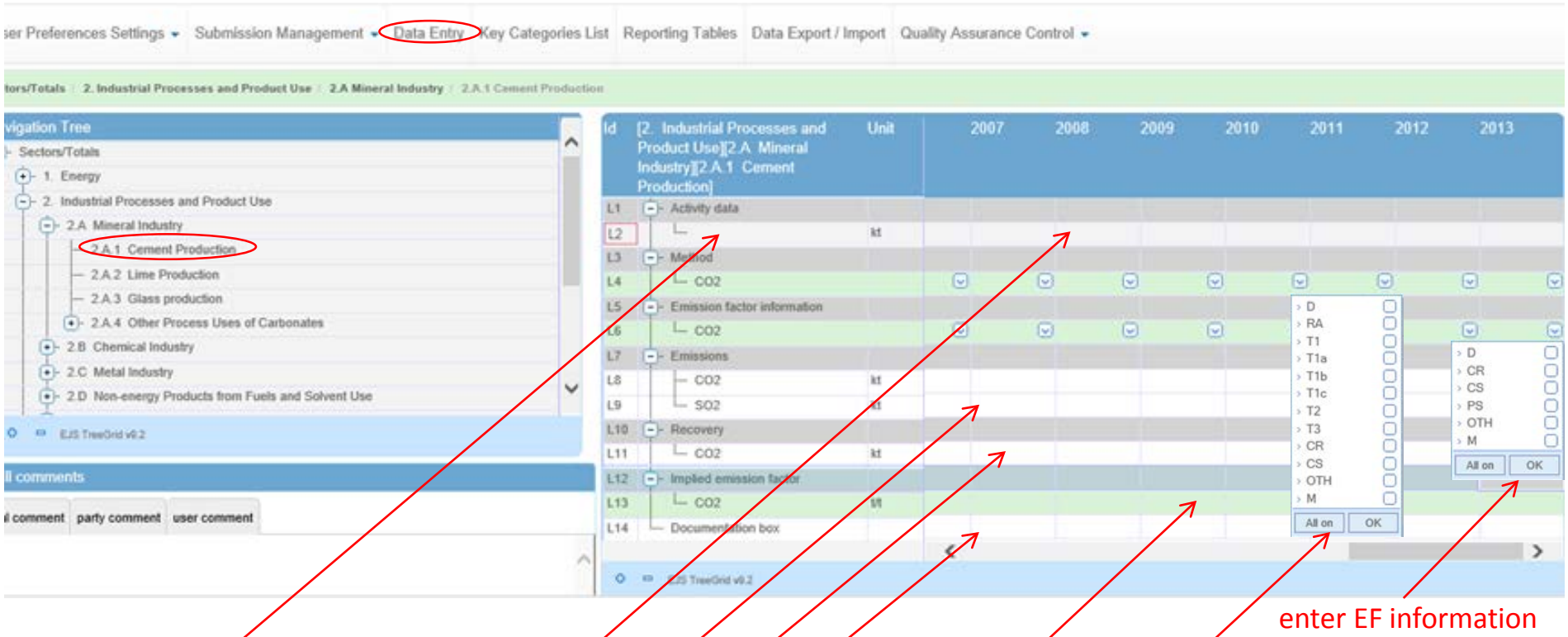
# CRF Reporter Inventory Software (1)

United Nations
Framework Convention on
Climate Change




specify - cement or clinker production

imported data from “meta CRF table”

IEF is calculated by software

enter method

enter EF information

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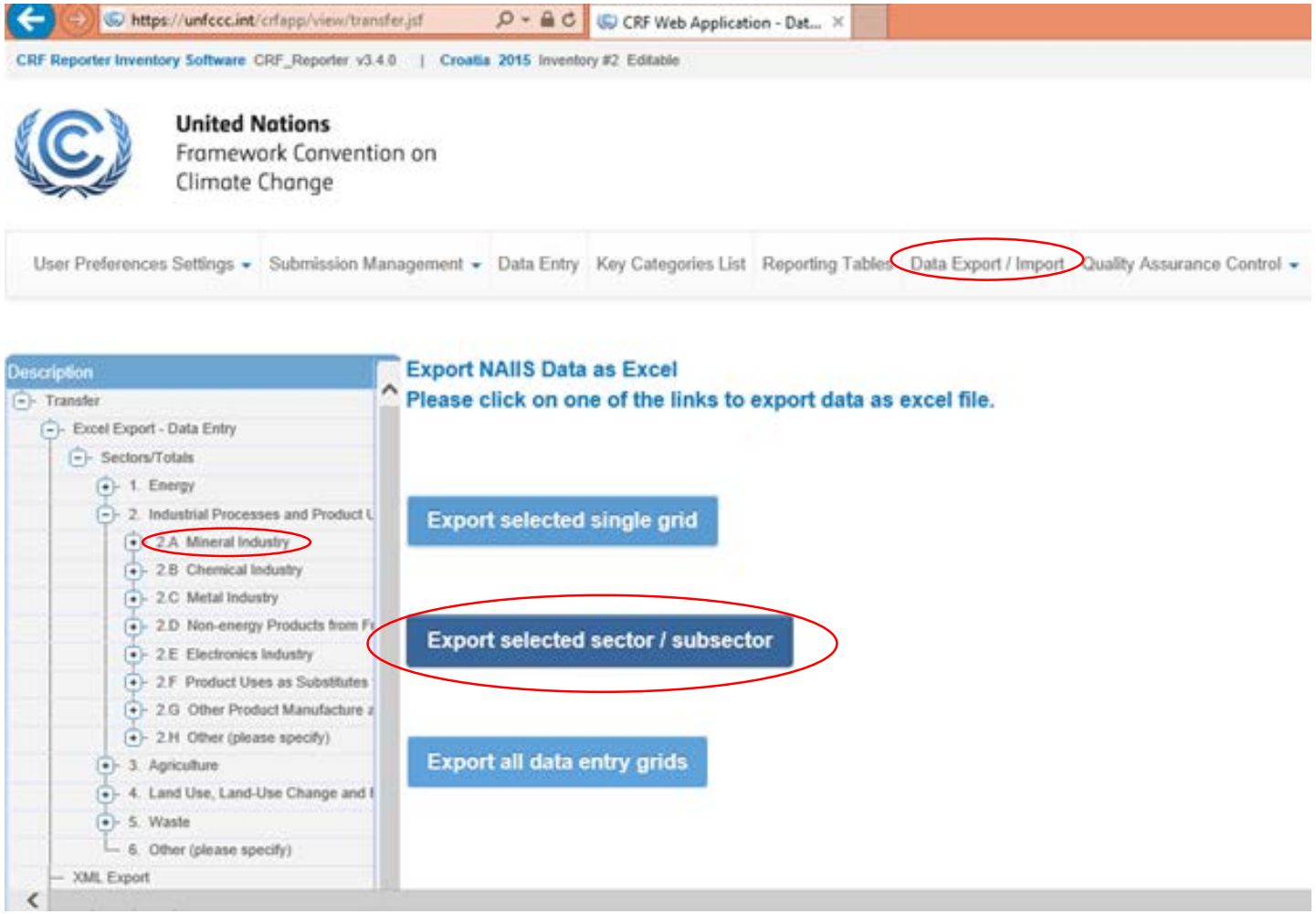
# CRF Reporter Inventory Software (2)

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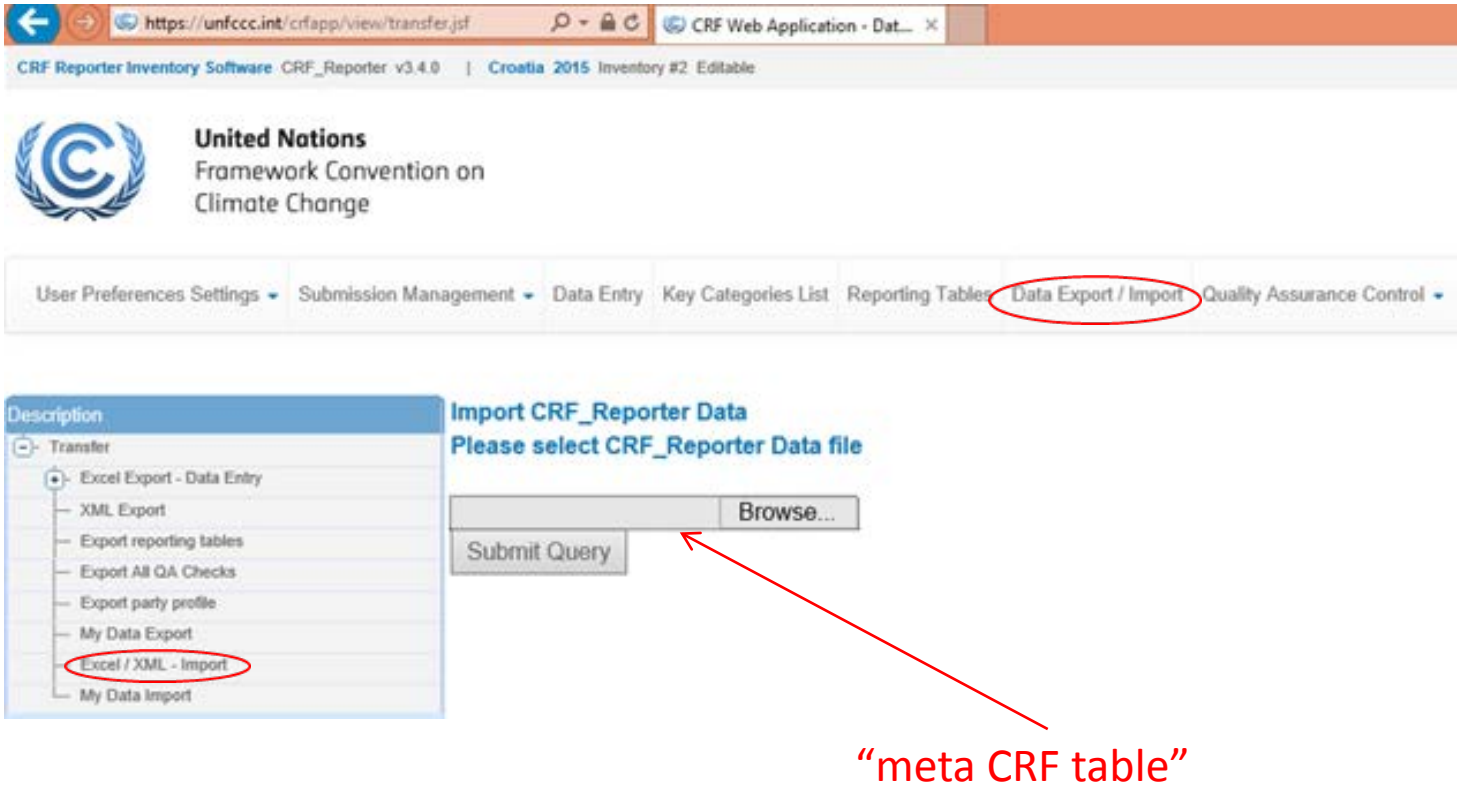
# CRF Reporter Inventory Software (3)

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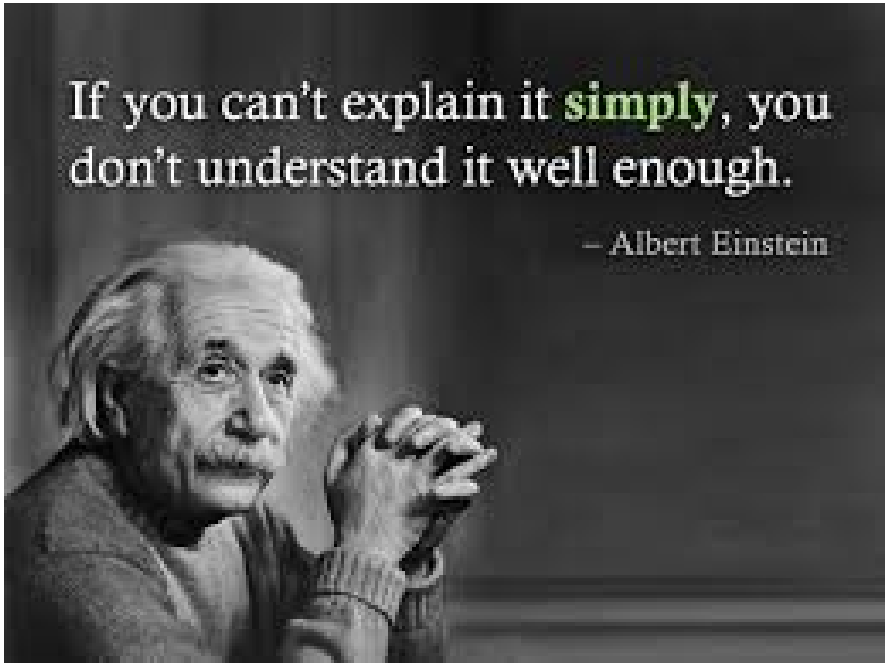


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