IPCC Inventory Software

IPPU Sector: Mineral, Chemical and Metal Industry:

IPCC 2006 Guidelines, Mandatory Requirements and Flexibility Provisions (including Hands on exercise) Cover IPCC good practices and CRTs

ipcc
INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

Key categories in IPPU

- 2A1 Cement production (level, trend)
- 2C3 Aluminium production (PFCs- level and trend; CO2- trend)
- 2.A.2 Lime production (level)
- 2.E Production of halocarbons and SF6 (HCFC-22 production) (level, trend)
- 2.B.1 Ammonia production (trend)

- Note: 1.A.2.a Iron and Steel production is listed as a key category (6th largest source of emissions in India) but process emissions not estimated.

Applicable to all IPPU

- **Subdivision:** You may choose to provide data by Subdivision (e.g. region, company, technology specific). If you do not want to stratify, insert Unspecified

- Single EFs in worksheets sometimes seem to be modified (e.g. to account for CKD or N2O abatement)

    - **Remember:** If an IPCC default EF does not exist, the category is not considered "mandatory" .

- **Fiscal year versus calendar year.** Ideally, data should be calendar year but other 12-month period is acceptable as long as same allocation over time for a given category.
    - Example: in ceramics, conversion from FY to CY was done on AD. For ammonia, it was done on final emissions which would not work in *Software*. Adjustments to fiscal year data should be on the Activity Data

Applicable to all IPPU

- **Capture and storage or other reduction:** Worksheet optional, to be used only if country-specific data on capture available (generally not Tier 1). Default = 0
    - **Column A:** This is for CO_2 captured <u>and stored</u>.
    - **Column B:** This is for CO_2 that is not permanently stored, or reductions of other GHGs. These emissions will be subtracted from total emissions; so if not permanently stored/recovered/ destroyed they should not be excluded, or if excluded, be sure that they are included elsewhere in GHG inventory.
    - **Ensure that there is no double counting** in recovery in this tab and the other category-level worksheets.

Subdivision	Source	Amount CO2 captured and stored (tonne)	Other reduction (tonne)	Total reduction (tonne)	Total reduction (Gg)
S	SRC	A	B	C = A + B	C / 1000
Unspecified	Unspecified				
Total				0	0

- **Incorporating Tier 3 methods:** The *Software* can be used for all Tier 3 methods, to do this:
    - Tier 1 equations can be used to enter AD and Implied Emission Factor(s) (IEFs)
    - IEFs can be calculated by dividing the Tier-3 estimated GHG emission with the underlying AD required by the IPCC Tier 1 equation(s), to reproduce the estimated Tier 3 emissions.

Cement Production- CO2

Tier applied	Tier 2
Key category	Yes, level and trend (CO_2)

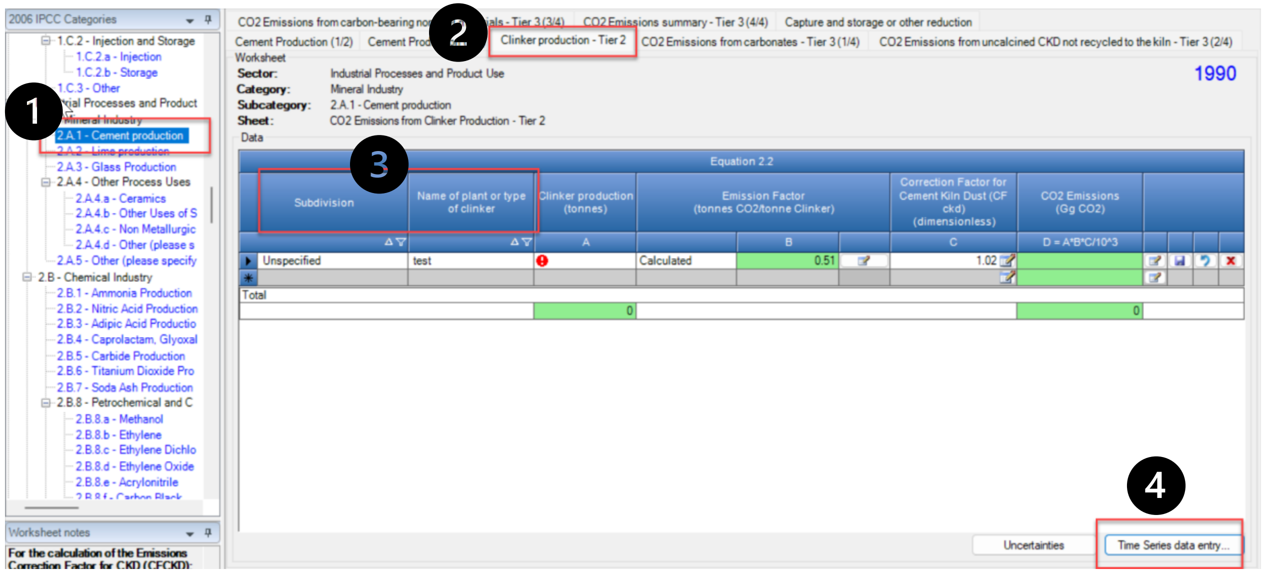
Data Needs – red requires country-specific data entry
Tier 2
Worksheet : Clinker production – Tier 2
• Name of plant or type of clinker • Clinker production (t) • CO_2 Emission Factor (Default available, with ability to overwrite) • Correction factor for CKD (Enter in default of 1.02 or calculate from requirements in sub-table)   • Note: If you enter in own data be sure to overwrite EF with your EF in Column B

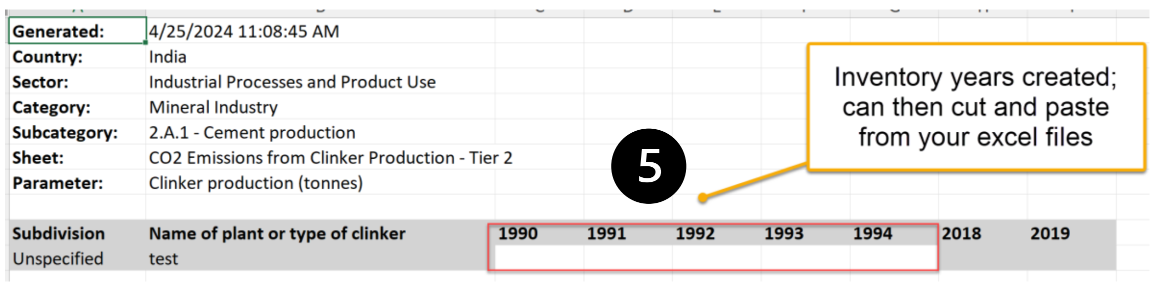
Cement Production

Worksheet: Clinker production – Tier 2

- ✓ To enter time series data, need to prepare all inventory years with basic data:
  - – From **Main menu** select **Inventory Year,** and then in dropdown menu select **Choose** (if all inventory years are already created in database) **or Create New** (if not)
  - – Need to populate relevant information in **Column |Subdivision|** and **Column |Name of plant or type of clinker|** for each inventory year
  - – Select **Time Series Data Entry**
  - – Paste in activity data from your excel worksheets

  OR
- ✓ Manually enter information for **Column |Subdivision|, Column |Name of plant or type of clinker| and Column |A|** year by year





Cement Production

Worksheet: Clinker production – Tier 2

✓ Select if your Emission Factor is **Calculated or Specified**

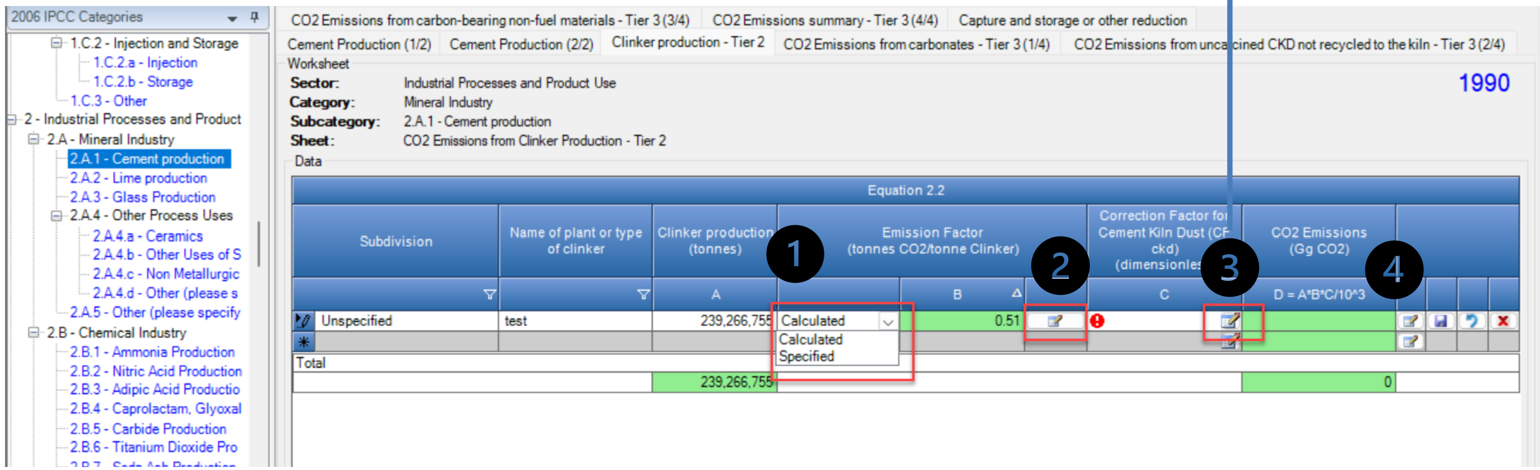
- Specified = direct entry

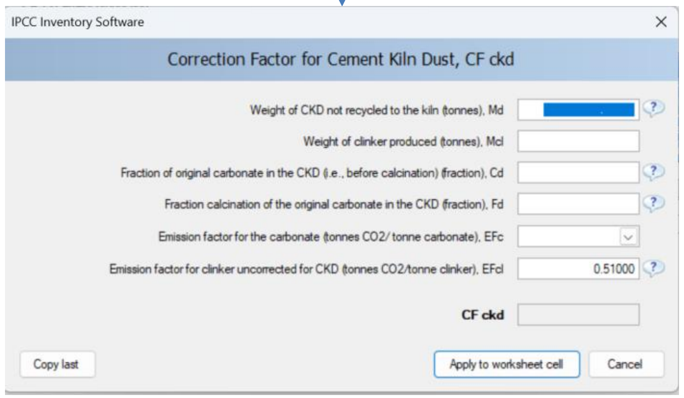
- Calculated = user can enter country-specific information on CaO content / % of non carbonate sources / % MgO by selecting the sub-table icon: 

Note: Currently India includes a single column for "EF" in calculation worksheet, including CKD correction factor. Not clear the CKD correction factor used (IPCC default would be 0.51*1.02 = 0.5202), but *Software* includes separate columns for EF and CKD.

✓ **In Column |C|,** user can either directly enter the IPCC Default CF CKD or calculate it by selecting the sub-table icon

✓ Results are calculated in **Column |D|**





Cement Production

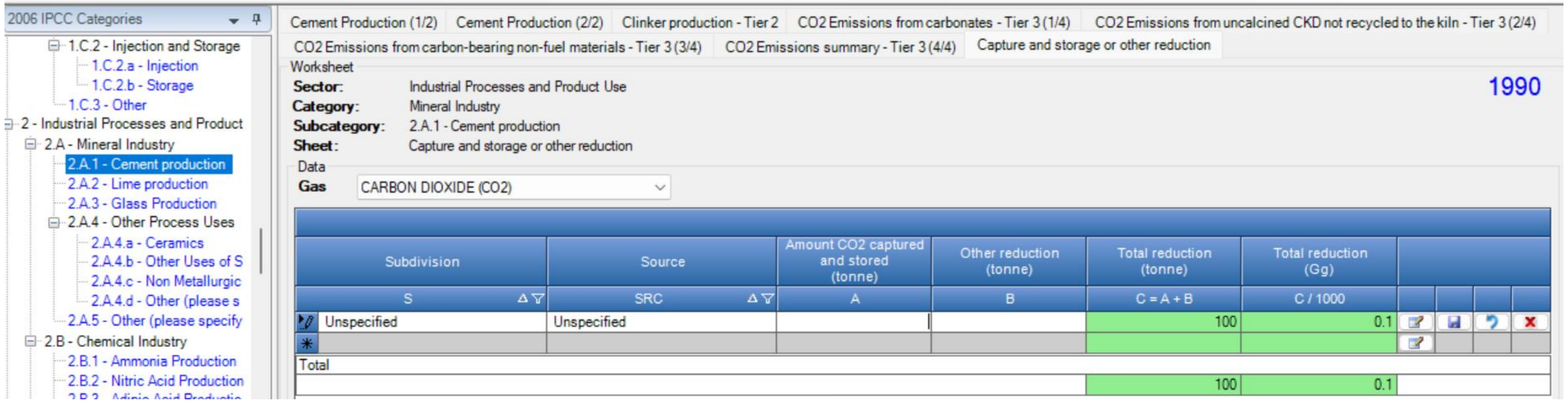
Worksheet: Capture and storage or other reduction

- ✓ Enter in this worksheet capture of CO_2 from cement production, referring to relevant information from 2006 IPCC Guidelines

> Should CO_2 capture technology be installed and used at a plant, it is *good practice* to deduct the CO_2 captured in a higher tier emissions calculation. The default assumption is that there is no CO_2 capture and storage (CCS) taking place. Any methodology taking into account CO_2 capture should consider that CO_2 emissions captured in the process may be both combustion and process-related. In cases where combustion and process emissions are to be reported separately, e.g. for cement production, inventory compilers should ensure that the same quantities of CO_2 are not double counted. In these cases the total amount of CO_2 captured should preferably be reported in the corresponding energy combustion and IPPU source categories in proportion to the amounts of CO_2 generated in these source categories. For additional information on CO_2 capture and storage refer to Volume 3, Section 1.2.2 and for more details on capture and storage to Volume 2, Section 2.3.4.

- ✓ Need to populate relevant information in **Column |Subdivision|** and **Column |Source|** for each inventory year
- ✓ Enter relevant information in **Column |Amount of CO2 captured and stored|** and/or **Column |Other reduction| .** The former column only includes CO2 that is captured and permanently **stored.**

Note: "Other reduction" could include other types of temporary recovery, but where this column is used, the actual emissions MUST be included elsewhere in the inventory, as the total reduction in column C will be subtracted from total emissions from cement production for purposes of reporting to the UNFCCC ETF Reporting Tool.



Ethylene Production

Tier applied	Unknown
Key category	Unknown

Data Needs – red requires country-specific data entry

IPCC Default Method	Tier 2
Worksheet: Ethylene production – Tier 1/2 CO_2 Emissions – Tier 1 CH_4 Emissions – Tier 1	**Worksheet :** Ethylene production – Tier 1/2 CO_2 Emissions – Tier 2

• Type of process (assume steam cracking)
• AD:
  • Amount Ethylene produced (t) OR
  • Feedstock used for Ethylene (t) and specific primary product factor (t product/t feedstock)
	• Type and amount of each feedstock used
	• Carbon content of feedstock
	• Carbon content of ethylene produced
	• Production and disposition of secondary produces from steam cracking (Table 3.25/ eqn 3.18) (defaults available, but actual AD preferred)
	• Carbon content of secondary products

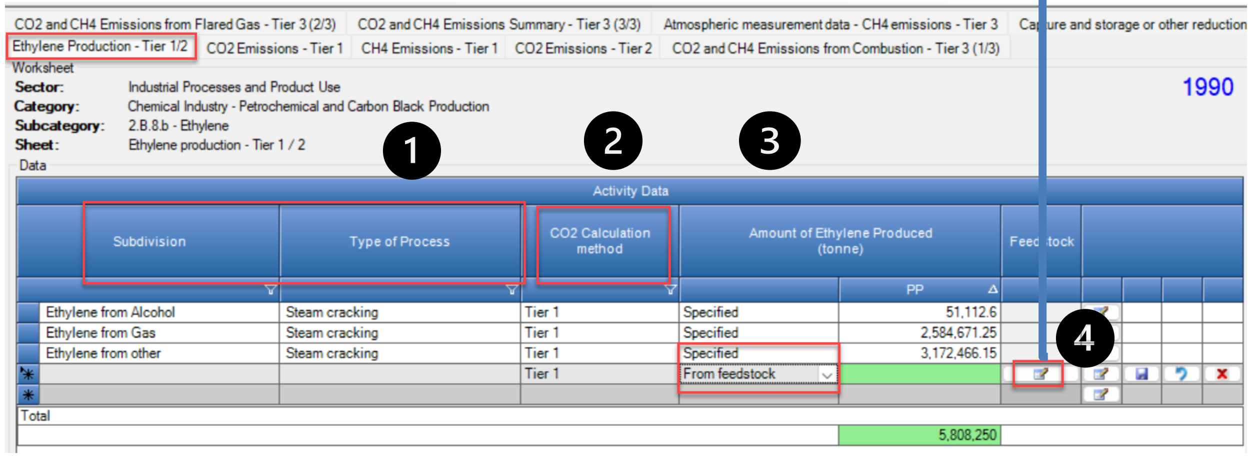
Ethylene Production

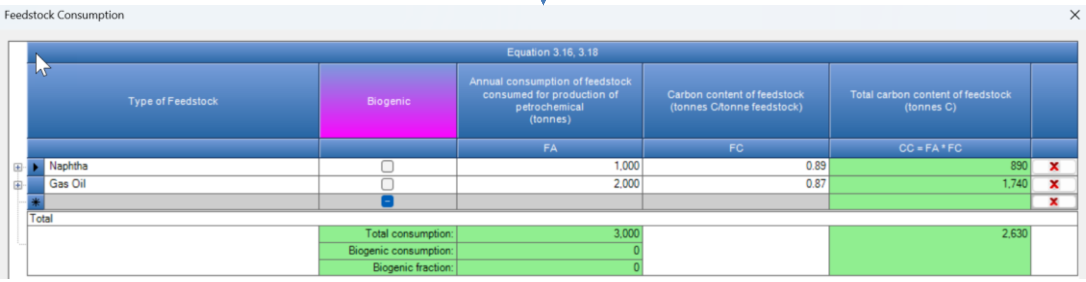
Worksheets for IPCC Default Method: Ethylene Production – Tier 1/2 ; CO2 Emissions-Tier 1 ; CH4 Emissions – Tier 1

- ✓ To enter time series data, need to prepare all inventory years with basic data:
  - – See series of steps in Cement production
  - – Need to populate relevant information in **Column |Subdivision|** and **Column |Type of Process|** for each inventory year for time series data entry, or manually enter data for each year.

- ✓ **Column |CO2 Calculation Method|** indicate whether Tier 1 or Tier 2 method used.

- ✓ **Column |Amount of Ethylene Produced|** decided whether you will **Specify** the amount (i.e. enter amount of ethylene produced directly in *Software)* or **Calculate the amount from feedstock.** When you calculate an amount from feedstock, a sub-table will be opened to enter further information.
  - *Note for India: Because India knows the types of feedstock, but AD statistics are based on the amount of ethylene produced and not feedstock consumed, I have created different subdivisions for ethylene produced from different feedstocks and specified corresponding amount of ethylene produced.*



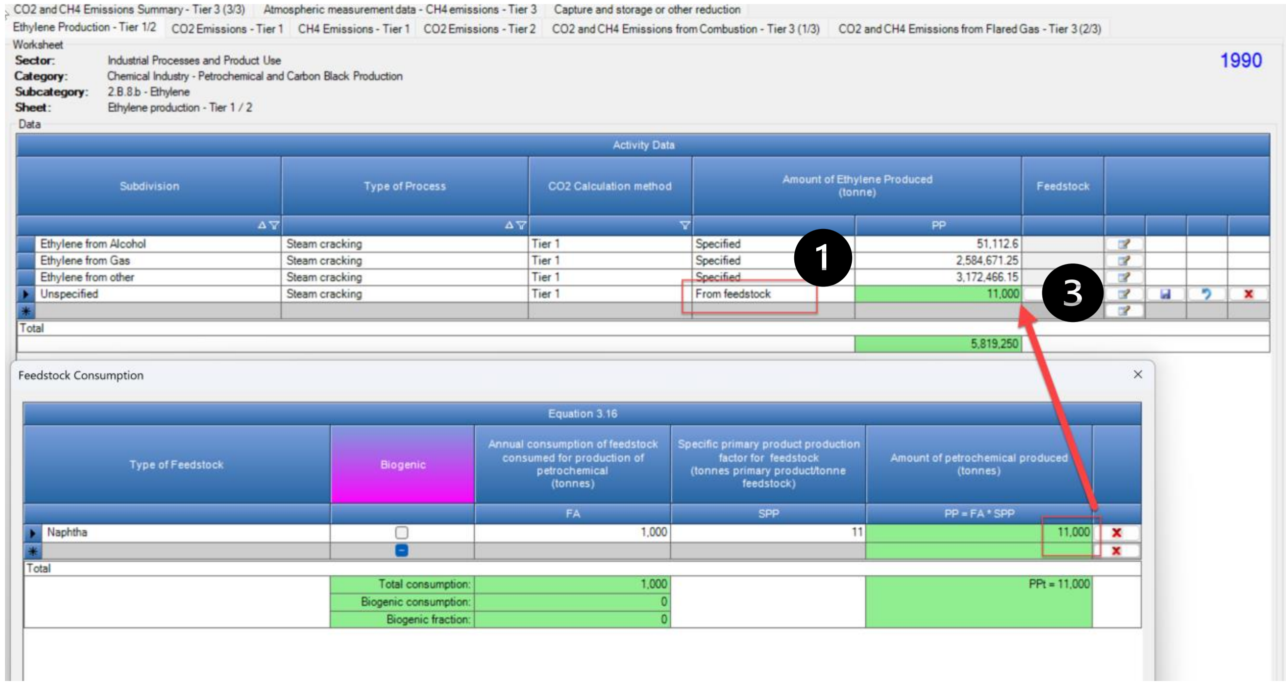


Note for India – allocation of production, by feedstock, does not equal total ethylene production, so I added a subdivision of "other"

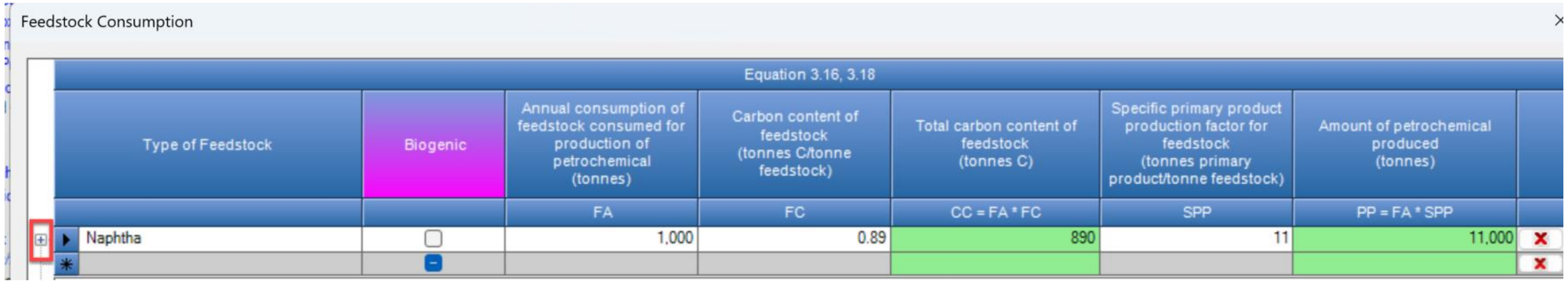
Ethylene Production

[Calculating ethylene production from feedstock consumption – sub-table]

- ✓ **Enter Type of Feedstock** (including indicator if the fuel is biogenic)
- ✓ **In Column |FA|** enter annual consumption of feedstock consumed for petrochemical production (t)
- ✓ **In Column |SPP|** enter the Specific primary product production factor (t ethylene/tonne feedstock)



Note: Use of the Tier 2 (**Column | CO_2 Calculation method |** requires knowledge of all primary and secondary outputs. If you apply Tier 2, you must select the plus in the red box. This will open a sub-table to calculate carbon content of secondary products.

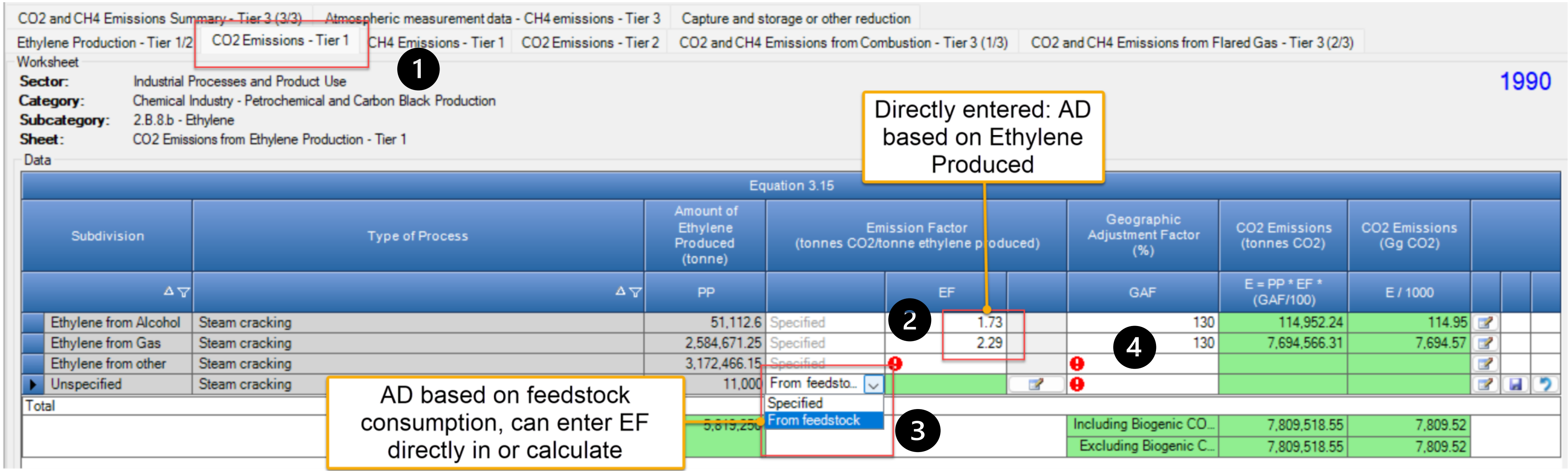


Ethylene Production

In worksheet: CO2 Emissions – Tier 1

- ✓ **In Column |EF| on Carbon Content of Fuel (kg C/GJ)**
  - ✓ Enter in the CO2 EF (t CO2/ t ethylene)
  - Where AD are based on amount of ethylene produced, you must directly enter in EF;
  - Where amount of ethylene produced was based on feedstock consumption, you may select the default from the dropdown or directly enter in EF
    - – Note: in calculation worksheets, India has applied factor of 2.17 (tCO2/t ethylene). If this is "gas oil" the default is 2.29, taking into account supplemental fuel use

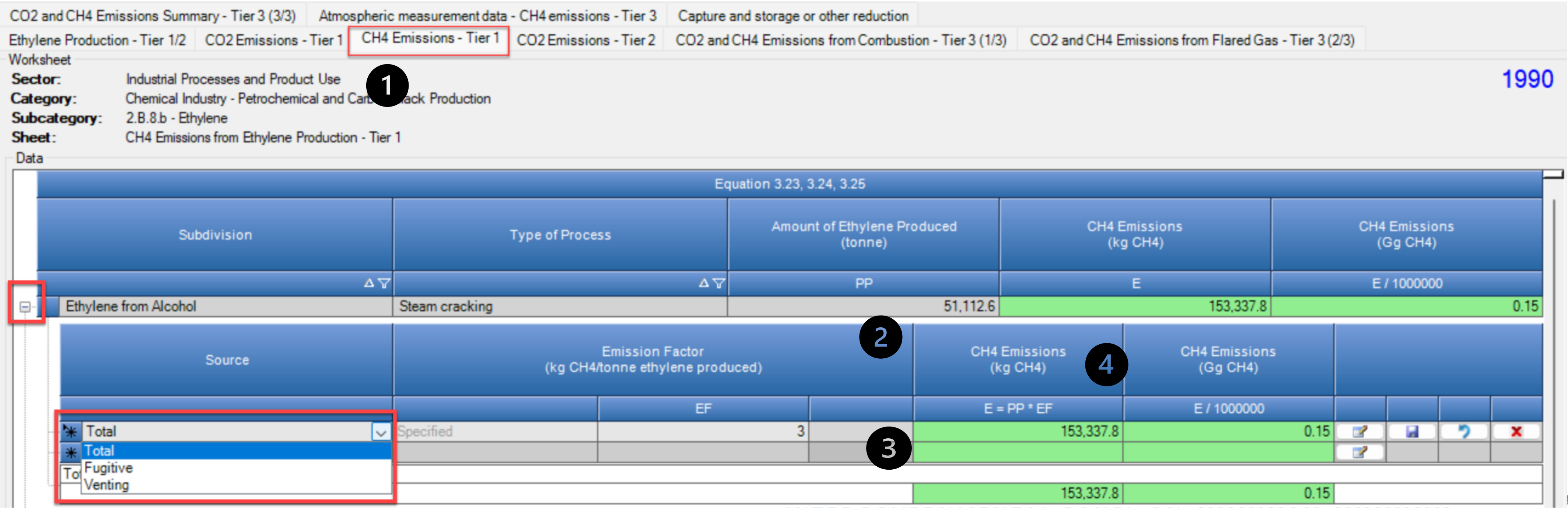
- ✓ **In Column |GAF| -** adjustment because 2006 GL are based on ethylene steam crackers in Western Europe



Ethylene Production

In worksheet: CH4 Emissions – Tier 1

- ✓ **To** estimate CH4 emissions click the box with the plus sign on the left hand side
- ✓ **In <u>Column |Source| </u>** select from the dropdown whether you are estimating fugitive emissions only, venting emissions only, or total. Default EFs reflect ‘Total’
- ✓ **In <u>Column |EF </u>** enter CH4 EF in kg CH4/t ethylene
  - ✓ *Note; India estimate is based on defaults for Naphtha; but based on calculation worksheets, other feedstocks are relevant (e.g. should factor of 6 kg CH4/t ethylene be applied for portion of ethylene produced from ethane/propane gas?*



Aluminium Production – CO2

Tier applied	Unknown
Key category	Yes, CO_2 (trend)

Data Needs – red requires country-specific data entry	
IPCC Default Method	**Tier 2**
Worksheet : CO_2 emissions from Aluminium production	**Worksheets:** CO_2 emissions from prebake anode Cons. – Tier 2/3; CO_2 emissions from pitch volatiles Comb. (Prebake)- Tier 2/3; CO_2 emissions from bake furnace packing material (Prebake) Tier 2/3 CO_2 emissions from paste consumption (SØderberg)-Tier 2/3
- Type of technology (Pre-bake / Soderberg) - Aluminium production by technology type (tonnes)	
• Emission factor (default, may be overwritten)	**Prebake process (by smelter):** - Net prebaked anode consumption per t aluminium, (t C/ t Al) - Sulphur content (default, may be overwritten) - Ash (default, may be overwritten) - Initial weight of green anodes (t green anode/year) - H content of green anode (default, may be overwritten) - Baked anode production (t/year) - Waste tar collected (default available) **Søderberg(by smelter) (See Tables 4.14):** - Paste consumption (t/t Al) - Other impurities (defaults, may be overwritten)

Aluminium Production – PFCs

Tier applied	Unknown
Key category	Yes, PFCs (trend)

Data Needs – red requires country-specific data entry	
IPCC Default Method	**Tier 2**
Worksheet : PFC emissions from Aluminium production	**Worksheets :** PFC emissions from Aluminium production – Slope method Tier 2/3 PFC emissions from Aluminium production – Overvoltage Tier 2/3
• Type of technology (CWPB, SWPB, HSS, VSS)	
• Aluminium prod. by technology type (t) • Emission factor (default, may be overwritten)	**Slope method** Slope coefficient for CF_4 (default, may be overwritten) Anode effect minutes per cell-day (AE-Mins/cell-day) Aluminium production (t) Weight fraction of C_2F_6/CF_4 (default, may be overwritten) **Overvoltage method** Overvoltage coefficient for CF_4 (default, may be overwritten) Anode effect overvoltage (mV) CE = aluminium production process current efficiency (%) Aluminium production (t) Weight fraction of C_2F_6/CF_4 (default, may be overwritten)

Data collection challenge for India in the worksheets appears to be breakdown of CWPB, SWPB, HSS and VSS

Magnesium Production – CO2

Tier applied	Unknown
Key category	No

Data Needs – red requires country-specific data entry	
IPCC Default Method	**Tier 2**
Worksheet : CO2 emissions from Magnesium Production	**Worksheets :** CO2 emissions from Magnesium Production
• Raw Material Used • National Magnesium Production (tonnes) • Emission factor (defaults available in dropdown)	• Raw Material Used in each company • Plant-level Magnesium Production (tonnes) • Company specific emission factor

No issues identified for India

Magnesium Production –PFCs

Tier applied	Unknown
Key category	No

Data Needs – red requires country-specific data entry	
IPCC Default Method	**Tier 2**
Worksheet : SF6 emissions from Magnesium Casting	**Worksheets :** SF6 emissions from Magnesium Casting
• By type of casting process, if known. • National Magnesium Produced/ Casted (tonnes) • Emission factor (defaults available in dropdown)	• Consumption of SF6 in Mg foundries and smelters

The default EF in India (21kgSF6/tonne Mg) is based on a 1999 study; is higher than the default. This may be reasonable as the 2006 GL note that the value varies, but it could be checked.

Lead–CO2

Tier applied	Unknown
Key category	No

Data Needs – red requires country-specific data entry	
IPCC Default Method	**Tier 2**
Worksheet : Lead Production	**Worksheet :** Lead Production
Source and furnace type (default available in dropdown) Amount of lead production (t) CO2 EF (defaults are available for some furnace types –	Type of production process (primary or secondary) Furnace type Type of reducing agent or other process input CO2 EF (defaults are available for some furnace types –

Any country specific source and furnace type may be written in, along with the corresponding EF.

HCFC-22 production– HFC-23

Tier applied	IPCC default method (with country-specific EF)
Key category	Yes, HFCs (level and trend)

Data Needs – red requires country-specific data entry	
IPCC Default Method	**Tier 2**
Worksheet : HFC-23 Emissions from HCFC-22 Production	**Worksheets** HFC-23 Emissions from HCFC-22 production – Tier 2
• Total amount of HCFC-22 produced (kg) • Emission factor (default available for global average or by technology type, can be overwritten)	- Minimum plant-level amount of HCFC-22 produced (kg) - Fraction of the year this stream released to atmosphere untreated, fraction - Carbon balance efficiency (%) - Factor to assign efficiency loss to HFC-23 - Fluorine balance efficiency (%) - Factor to assign efficiency loss to HFC-23

Minerals

Reporting in India's TNC		2019 Calculation worksheet	*Software* with full population of defaults	*Notes/ Reason for difference?*
Cement	CO_2	126,619.97	124, 574.15	Can recreate, but…calculation worksheets do not separate EF and CKD, which is needed for Tier 2. The combined EF in worksheets is higher than the defaults. Perhaps India has CAO content or national CKD factor?
Lime	CO_2	30,643	? (don't know actual lime production data)	This is total lime production, including lime used in cement mfg. In worksheets, lime for cement is subtracted out. This category should include ALL lime production (including intermediate lime production), but not carbonates used , for example, for. cement and iron and steel).
.Glass	CO_2	379.08	379.08	"Sheet" in worksheets ="Float" in Software" "bottles" in worksheets = "container (flint)" I could overwrite type of glass, so worked
Ceramics	CO2	23.46	24.02	India multiplies EF by .95According to GL "If data are only available on carbonate rock, a default purity of 95 percent can be assumed." The AD should be adjusted before entering into the Software to reflect pure carbonates.

Chemicals

Reporting in India's TNC		2019 Calculation worksheet	*Software* with full population of defaults	*Reason for difference?*
Ammonia	CO_2	6805.69		In worksheets conversion from FY to CY was done on emissions, not AD Carbon content of NG was used for all fuels in worksheet For Software, would need to assign the urea production to a fuel type(s) The technology process is not clear from worksheets – so used Unspecified and overwrote fuel requirement
Nitric acid	N2O	11.52	11.78	Cell reference error in excel (AL39 should be AL30). Methodology specifically accounts for destruction factor and abatement system utilization. Not clear if EFs are pre or post abatement?
Caprolactam	N2O	0.78	0.78	.
HCFC-22 production	HFC-23	2.39	2.39	Matches when I used India CS-factor.; India also estimates other fugitives (CFC-11, CFC-12, CFC-113, but these covered by Montreal Protocol)

Chemicals- cont.

Reporting in India's TNC		2019 Calculation worksheet (Gg)	*Software* with full population of defaults (Gg)	Can I recreate?	*Reason for difference?*
Calcium carbide	CO_2	89.98	89.16	Yes, but	Check the EF applied; I believe the EF in worksheets is for use of CaC2, not for CaC2 produced
Titanium dioxide	CO_2	71.16	71.17	Yes	India has averaged the IPCC defaults for different processes; this can be accommodated in the *Software*
Soda Ash Production	CO_2	1075.99	459.71	?	Need to examine this; the worksheets indicate Solvay process used, but then refer to "natural soda ash produced" Emissions are significantly higher than default for natural soda ash production, unsure of Solvay process. Are combustion-related emissions included here? Perhaps subdivisions needed?
Carbon black	CO_2	516.8	1,895.03	Yes, but	There is an error in the calculation worksheets, need to multiply by 44/12 to convert "C" to "CO2"
	CH_4	14.3	14.69	Yes, but	India has used a value (28.0) slightly lower than IPCC default (28.7), not clear if this was intentional or typographical error

Chemicals- cont.

Reporting in India's TNC		2019 Calculation worksheet (Gg)	*Software* with population of defaults (Gg)	*Reason for difference?*
Methanol	CO_2	134.01	134.01	Will want to identify type of process; based on EF India selected, seems the default process applicable.
	CH_4	0.46	0.46	
Ethylene	CO_2	5,697.16	7,809.52	Activity data – breakdown by feedstock ≠ 100% so may be missing AD in calculations.. EF – have used 2.17 for gas oil, but the "gas" seems to be split of ethane / propane according to TNC. EF – note factor uses should be "Total" not just feedstock Note that no geographic adjustment factor applied
	CH_4	17.42	25.18	Calculation worksheets used 3 kg/CH4 /t ethylene for time series, but that is for naphtha. Default of 6 for at least part of production may be more applicable based on notes in calculation worksheet; there is 0 naphtha in 2019

Chemicals cont.

Reporting in India's TNC		2019 Calculation worksheet (Gg)	*Software* with population of defaults (Gg)	*Reason for difference?*
Ethylene Dichloride/Vinyl Chloride Monomer Production	CO2	319.27	319.27	India estimates based on amount of EDC produced, and separately based on amount of VCM produced. Based on the GL (p.3.76) and footnote 3 to the worksheet, seems only one should be selected. However, with that said, IPCC *Software* set up the same way as India has done and I can match estimates.
	CH4	-	0.02	The GL include default for CH4 for integrated facilities, but it is not included in calculation worksheets (0.0226 kg CH4/tonne VCM table 3.19)
Ethylene Oxide	CO2	245.07	245.07	
	CH4	0.51	0.51	
Acrylonitrile	CO2	21.32 (2000)	26.98 (2000)	Indicated use of process "secondary products burned…." but default applied was for Acetonitrile and Hydrogen Cyanide Recovered as Product. Category is declining in recent years, but earlier in time series more significant- the difference for 2000 shown.
	CH4	0.005	0.005	

Metals

Reporting in India's TNC		2019 Calculation worksheet (Gg)	*Software* with population of defaults (Gg)	*Reason for difference?*
Iron and steel	CO2			Combustion related emissions a key category…consider?
	CH4			
Ferroalloys	CO2	1204.8	1204.8	
	CH4	.49	?	They indicate use of defaults from 2006 GL (table 4.7), but production according to CO2 is ferrochromium and there is no CH4 default for ferrochromium. Time series also abrupt in 2010/2011.
Aluminium	CO2	5879	5878.71	Only issue is rounding…generally have two decimal places in tables/reports.
	PFCs	4.88 (CF4) 1.33 (C2F6)		Don't know breakdown of CWPB, SWPB, HSS and VSS; CF4 Efs of CWPB , SWPB and HSS and VSS have been added up to give prebaked and Soderberg CF4 Efs This is a key category (level and trend….work towards tier 2?
Mg	CO2	.57	.57	
	SF6	.0042	0.0002	The default EF in India (21kgSF6/tonne Mg) is based on a 1999 study; is higher than the default. This may be reasonable as the 2006 GL note that the value varies, but it could be checked.

Metals

Reporting in India's TNC		2019 Calculation worksheet (Gg)	*Software* with population of defaults (Gg)	*Reason for difference?*
Lead	CO_2	72.23	72.23	
Zinc	CO_2	32.56	32.56	There is no difference; good that India includes description of the zinc produced from the hydrometallurgical process to assist in the assessment of completeness, even though emissions from this furnace type /process are zero.

Questions?

Additional slides

Ethylene Production - Methods

IPCC Default Method

- Method requires only AD for the amount of product produced; it does not require AD for the consumption of each carbon-containing feedstock. But, India knows types of feedstock.
- Default method/ steam cracking
- Note that as indicated in Table 3.11, the default feedstock for steam crackers operating in for India would be naphtha.
- CO2 emissions from both feedstock consumption and supplemental energy consumption are to be reported in IPPU
- Default EFs in Table 3.14 provide total CO_2 emissions from steam cracking, not only CO_2 emissions associated with ethylene production from steam cracking.
- CO2 EFs do not include flaring

EQUATION 3.15
TIER 1 CO_2 EMISSION CALCULATION

$$ECO2_i = PP_i \bullet EF_i \bullet GAF / 100$$

Where:

$ECO2_i$ = CO_2 emissions from production of petrochemical *i*, tonnes

PP_i = annual production of petrochemical *i*, tonnes

EF_i = CO_2 emission factor for petrochemical *i*, tonnes CO_2/tonne product produced

GAF = Geographic Adjustment Factor (for Tier 1 CO_2 emission factors for ethylene production, See Table 3.15), percent

If activity data for annual primary product production are not available, primary product production may be estimated from feedstock consumption, as shown in the Equation 3.16:

EQUATION 3.16
PRIMARY PRODUCT PRODUCTION ESTIMATE CALCULATION

$$PP_i = \sum_k \left(FA_{i,k} \bullet SPP_{i,k}\right)$$

Where:

PP_i = annual production of petrochemical *i*, tonnes

$FA_{i,k}$ = annual consumption of feedstock *k* consumed for production of petrochemical (i), tonnes

$SPP_{i,k}$ = specific primary product production factor for petrochemical *i* and feedstock *k* ,tonnes primary product/tonne feedstock consumed

Ethylene Production - Methods

Tier 2

- This approach is applicable in cases where activity data are available for both feedstock consumption and primary and secondary product production and disposition.
- Activity data for all carbon flows are required to implement the Tier 2 methodology.
- Need information on the amount of secondary products produced;
- In the event that activity data are not available for all secondary products, the Tier 1 method can be applied instead of the Tier 2 method.

EQUATION 3.17
OVERALL TIER 2 MASS BALANCE EQUATION

$$ECO2_i = \left\{ \sum_k \left(FA_{i,k} \bullet FC_k\right) - \left[PP_i \bullet PC_i + \sum_j \left(SP_{i,j} \bullet SC_j\right) \right] \right\} \bullet 44/12$$

Where:

$ECO2_i$ = CO_2 emissions from production of petrochemical *i*, tonnes

$FA_{i,k}$ = annual consumption of feedstock *k* for production of petrochemical *i*, tonnes

FC_k = carbon content of feedstock *k*, tonnes C/tonne feedstock

PP_i = annual production of primary petrochemical product *i*, tonnes

PC_i = carbon content of primary petrochemical product *i*, tonnes C/tonne product

$SP_{i,j}$ = annual amount of secondary product *j* produced from production process for petrochemical *i*, tonnes
[The value of $SP_{i,j}$ is zero for the methanol, ethylene dichloride, ethylene oxide, and carbon black processes because there are no secondary products produced from these processes. For ethylene production and acrylonitrile production, see secondary product production Equations 3.18 and 3.19 below to calculate values for $SP_{i,j}$.]

SC_j = carbon content of secondary product *j*, tonnes C/tonne product

For ethylene production and acrylonitrile production there are both primary and secondary products produced by the process. If activity data are not available for the amount of secondary products produced by these processes, the amount of secondary products produced may be estimated by applying default values to the primary feedstock consumption, as shown in Equations 3.18 and 3.19:

EQUATION 3.18
ESTIMATE SECONDARY PRODUCT PRODUCTION FROM PRIMARY PRODUCT [ETHYLENE] PRODUCTION

$$SP_{Ethylene,j} = \sum_k \left(FA_{Ethylene,k} \bullet SSP_{j,k}\right)$$

Where:

$SP_{Ethylene,j}$ = annual production of secondary product *j* from ethylene production, tonnes

$FA_{Ethylene\ k}$ = annual consumption of feedstock *k* consumed for ethylene production, tonnes

$SSP_{j,k}$ = specific secondary product production factor for secondary product *j* and feedstock *k*, tonnes secondary product/tonne feedstock consumed

Excerpt

TABLE 3.25
ETHYLENE STEAM CRACKING FEEDSTOCK-PRODUCT MATRIX

Product / Feedstock	kg product/tonne feedstock					
Product **Feedstock**	**Naphtha**	**Gas oil**	**Ethane**	**Propane**	**Butane**	**Others**
High Value Chemicals	**645**	**569**	**842**	**638**	**635**	**645**
Ethylene	324	250	803	465	441	324
Propylene	168	144	16	125	151	168
Butadiene	50	50	23	48	44	50