Worked Examples – Fossil Fuels

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Table of Contents

Instructions

It is recommended that you watch the tutorial videos on DE of fossil fuels before using this workbook. You should then try to complete the example tasks using what you have learned there, before checking against the solutions provided. These examples are intended as reinforcement learning rather than the primary instruction tool.

For the following exercises, use any or all the data provided to try attempt to calculate the DE account elements you can derive from the information given. The solutions provided are not necessarily prescriptive, but should illustrate a reasonable way to proceed.

A.4 – All subcategories when already reporting to IEA

Example

Your country is reporting to the IEA. You have located the local agency responsible for this reporting and have obtained the data shown in Table 1 from them, for the most recent year (say 2020).

	Imports	Exports	Production	Aviation bunkers	Domestic supply	Transformation processes
Hard coal (if no detail) (kt)	0	0	0	0	0	0
Brown coal (if no detail) (kt)	0	0	0	0	0	0
Anthracite (kt)	361	0	0	0	361	0
Coking coal (kt)	2,491	-103	909	0	3297	1634
Other bituminous coal (kt)	956	0	206	0	1162	0
Sub-bituminous coal (kt)	0	0	0	0	0	0
Lignite (kt)	0	0	0	0	0	0
Patent fuel (kt)	1	0	0	0	1	0
Coke oven coke (kt)	56	-1	1157	0	1212	1189
Gas coke (kt)	0	0	0	0	0	0
Coal tar (kt)	0	0	42	0	41	0
BKB (kt)	0	0	0	0	0	0
Gas works gas (TJ-gross)	0	0	0	0	0	0
Coke oven gas (TJ-gross)	0	0	9195	0	9195	183
Blast furnace gas (TJ-gross)	0	0	13260	0	13260	6845
Other recovered gases (TJ-gross)	0	0	0	0	0	0
Peat (kt)	0	0	0	0	0	0
Peat products (kt)	0	0	0	0	0	0
Oil shale and oil sands (kt)	0	0	0	0	0	0
Natural gas (TJ-gross)	1,484,784	-6,158,113	23,625,565	0	18,952,239	8,914,945
Crude/NGL/feedstocks (if no detail) (kt)	0	0	0	0	0	0
Crude oil (kt)	10,877	-964,307	1,327,483	0	363,726	374,512
Natural gas liquids (kt)	0	-39,030	169,823	0	134,631	35,281
Refinery feedstocks (kt)	0	0	0	0	392	1,506
Additives/blending components (kt)	1,814	0	0	0	1,814	1,834
Other hydrocarbons (kt)	0	0	0	0	5,180	0
Refinery gas (kt)	0	0	7,187	0	7,187	0
Ethane (kt)	0	0	0	0	0	0
Liquefied petroleum gases (LPG) (kt)	1,646	-54,011	5,527	0	-46,974	0
Motor gasoline excl. biofuels (kt)	22,694	-11,915	56,300	0	67,824	0
Aviation gasoline (kt)	0	0	8	0	8	0

Table 1 Hypothetical data on fossil fuels provided by local agency reporting to the IEA.

You know that you will need to convert the natural gas from energy units to tonnes, and from the tutorial videos know that it is best to seek local conversion factors.

You have done some web searching, and found one relevant annual report from one major natural gas producer operating in your country. This gives their production for the year as 240,000 ktoe, and mentions that this gas comes from one large, isolated project characterised by relatively low energy content gas (mainly due to high CO2 content), which averages 38 GJ/tonne.

Extract the relevant data and use it to establish as much of your domestic extraction (DE) account as you can, using tool(s) from the Questionnaire if/where appropriate.

Solution

Firstly, the only flows relevant to DE are those in the "Production" column, as DE by definition includes only materials extracted directly from the environment on a nation's territory, and so is primary production.

Note that "Domestic supply" is not DE. It refers to the national availability of a product, and so includes both domestic production and imports, less exports, and is further adjusted for changes to stocks.

Next we can refer to the concordance table given on The Questionnaire's "Fossil fuels tool", to reduce to set of products relevant to DE. This concordance is reproduced in Table 2.

IEA to EW-MFA DE Concordance

IEA Name	EW-MFA Code	EW-MFA Name
Hard coal (if no detail) (kt)	A.4.1.2	Hard Coal
Brown coal (if no detail) (kt)	A.4.1.1	Brown Coal
Anthracite (kt)	A.4.1.2.1	Anthracite
Coking coal (kt)	A.4.1.2.2	Coking Coal
Other bituminous coal (kt)	A.4.1.2.3	Other Bituminous Coal
Sub-bituminous coal (kt)	A.4.1.1.2	Other Sub-Bituminous Coal
Lignite (kt)	A.4.1.1.1	Lignite (brown coal)
Peat (kt)	A.4.1.3	Peat
Oil shale and oil sands (kt)	A.4.3	Oil shale and tar sands
Natural gas (TJ-gross)	A.4.2.2	Natural gas
Crude/NGL/feedstocks (if no detail) (kt)	A.4.2.1	Crude oil
Crude oil (kt)	A.4.2.1	Crude oil
Natural gas liquids (kt)	A.4.2.3	Natural gas liquids

Table 2 Concordance of IEA products relevant to DE to EW-MFA categories.

This narrows the relevant information from Table 1 down to just the first two columns shown in Table 3. Conversion to the values required on The Questionnaire (given in the "DE default calc. (tonnes)" column do not even require further calculation beyond the simple addition of three zeros, as the original data was in thousands of tonnes.

The one exception is natural gas. The default conversion using the section provided for natural gas on the Fossil fuels tool has been done there then entered here.

	Production (IEA)	EW-MFA Code	EW-MFA Name	DE default calcs. (tonnes)
Hard coal (if no detail) (kt)	-	A.4.1.2	Hard Coal	-
Brown coal (if no detail) (kt)	-	A.4.1.1	Brown Coal	-
Anthracite (kt)	-	A.4.1.2.1	Anthracite	-
Coking coal (kt)	909	A.4.1.2.2	Coking Coal	909,000
Other bituminous coal (kt)	206	A.4.1.2.3	Other Bituminous Coal	206,000
Sub-bituminous coal (kt)	-	A.4.1.1.2	Other Sub-Bituminous Coal	-
Lignite (kt)	-	A.4.1.1.1	Lignite (brown coal)	-
Peat (kt)	-	A.4.1.3	Peat	-
Oil shale and oil sands (kt)	-	A.4.3	Oil shale and tar sands	-
Natural gas (TJ-gross)	23,625,565	A.4.2.2	Natural gas	472,511,300
Crude/NGL/feedstocks (if no detail) (kt)	-	A.4.2.1	Crude oil	-
Crude oil (kt)	1,327,483	A.4.2.1	Crude oil	1,327,483,000
Natural gas liquids (kt)	169,823	A.4.2.3	Natural gas liquids	169,823,000

Table 3 Initial calculation of DE from IEA format data using defaults.

Rather than show the simple default calculation for natural gas, let's now use the information you found indicating that 240,000 ktoe of this gas averages only 38 GJ/tonne.

The first thing to do here is convert the low energy gas onto the same energy basis. Using a conversion factor found online of 1 toe = 41.868 GJ, you estimate that 10,048,320 TJ should be allocated to the 38 GJ/tonne gas stream. For the remainder you assume the default energy content applies.

A snapshot of how you would enter this is the relevant section of the fossil fuels tool is provided in Table 4. As the original data was given in TJ, you only use the upper panel, which converts gas energy to mass, based on energy density.

	Default energy density (GJ/tonne)	*Alternative energy density (GJ/tonne)*	Density Used	Raw base Units	2020	Year2
Natural Gas 1	50		50	GJ	13,577,245,000	-
Natural Gas 2	50	*38*	38	GJ	10,048,320,000	
Calculated total A.4.2.2 Natural gas (tonnes)					**535,974,374**	**-**
	Default density (tonnes/bcf)	***Alternative Density (tonnes/bcf)***	**Density Used**	**Raw base Units**	**2020**	**Year2**
Natural Gas 1	21,000		21000	bcf		
Natural Gas 2	21,000		21000	bcf		
Natural Gas 3	21,000		21000	bcf		
Calculated total A.4.2.2 Natural gas (tonnes)					**-**	**-**

Table 4 Relevant section of Fossil fuels tool from The Questionnaire for converting common natural gas units to tonnes.

Split the gas production into two components. The 10,048,320 TJ of low-quality gas receives an alternative energy density in the grey cell provided for this purpose, with the remainder of the gas using the default factor unless you have further information. As tool uses GJ/tonne, it is necessary to multiply the original data given in TJ by 1000 prior to entry.

The result changes from less than 473 million tonnes of natural gas DE under the default energy density assumption to over 535 million tonnes.

Note: If you need additional rows for more different gas streams on the tool, simply highlight the last data row currently in the input section of the panel (Natural Gas 2 in this case), then copy and insert row in place.

A.4.2 Detailed (when no centralised reporting agency)

Example

Your country does not report to either the IEA or UNSD. You know from making enquiries and web searching that your country does have at least some production of fossil fuels.

Looking at the EIA website, you find that they have separate data for crude oil, NGL, and natural gas production. Unfortunately, their data ends in 2019, and you are trying to construct DE accounts to at least 2020, preferably 2021.

Your web searches only found one significant producer operating in your country (Company A), and this is the only source listed in the EIA's "Sources" section. Their corporate "Annual Report 2020" is available online, and that report contains the following table:

LNG Production	Value
LNG (mmscm)	3,242
Gas to power (mmscm)	14
Domestic gas (mmscm)	18
Condensate ('000 bbls)	3,056
Oil production ('000 bbls)	
Field A	1,534
Field B	1,051
Field C	11
Field D	23

Table 5 Production summary for 2020 from hypothetical company Annual Report

We have no further information on the gas or the condensates.

We do have additional information indicating that Field A is a distinct, heavy crude for which we have an API gravity value of 20. Field C is very close to Field A, while Fields B and D are close together in a different petroleum producing province far distant from A and C.

Solutions

Solution for A.4.2.2

Table 5 gives three streams of natural gas in millions of standard cubic metres (mmscm).

As we have no data indicating that these gas streams vary from the default density used in our tool, we can simply add these gas streams together initially – 3274 mmscm.

As the tool assumes volume units of bcf, we must first adjust our mmscm basis summation. This is done by dividing by 1000 (millions to billions), then applying a conversion from cubic metres to cubic feet ($1m^3 = 35.32ft^3$).

Enter the result of 115.6 bcf in the lower panel in the natural gas panel, and we get our DE estimate for entry on the Questionnaire for natural gas production – 2,427,600 tonnes, see Table 6.

	Default energy density (GJ/tonne)	*Alternative energy density (GJ/tonne)*	Density Used	Raw base Units	2020	Year2
Natural Gas 1	50		50	GJ	-	-
Natural Gas 2	50	*38*	38	GJ	-	
Calculated total A.4.2.2 Natural gas (tonnes)					-	-
	Default density (tonnes/bcf)	*Alternative Density (tonnes/bcf)*	**Density Used**	**Raw base Units**	**2020**	**Year2**
Natural Gas 1	21,000		21000	bcf	115.6	
Natural Gas 2	21,000		21000	bcf		
Natural Gas 3	21,000		21000	bcf		
Calculated total A.4.2.2 Natural gas (tonnes)					**2,426,970**	-

Table 6 Relevant section of Fossil fuels tool from The Questionnaire for converting common natural gas units to tonnes.

Solution for A.4.2.1 and A.4.2.3

Next we have the Condensates/NGLs and Crude oil values. These have been provided in thousand barrels per year. The units expected for input on their section of the tool are thousand barrels per day, so divide all by 365.25 prior to input.

We have the additional data indicating that Field A and probably Field C yield heavy crudes of API gravity value around 20.

In this situation, it should be simple to find an API -> SG converter to derive the SG units used on the tool, in this case API 20 -> 0.934 SG. As Fields A and C are likely exploiting similar oil sources, it would be reasonable to sum them together and apply this SG to both.

	Default density (S.G.)	*Alternative Density (S.G.)*	Density Used	Raw base Units	Conv. Fact m^3/year	Conversion Tonnes/year	2020	Year2
Crude Oil 1 - Fields A + C	0.8581	*0.934*	0.934	Mb/d	58,074.75	54,242	4.23	
Crude Oil 2 - Fields C + D	0.8581		0.8581	Mb/d	58,074.75	49,834	2.94	
Calculated total A.4.2.1 Crude Oil and condensate (tonnes)							**375,976**	-
NGL 1 - Condensates	0.75		0.75	Mb/d	58074.75	43,556	8.37	
NGL 2	0.75		0.75	Mb/d	58074.75	43,556		
Calculated total A.4.2.3 Subtotal NGLs (tonnes)							**364,428**	-

Table 7 Relevant section of Fossil fuels tool from The Questionnaire for converting Crude oil and Condensate/NGLs volumes to tonnes.

For the condensate, and the crude oil production from fields remote from Field A (i.e. B and D), it is probably best to leave the default density assumptions in place. Given this, we can add production from Fields B and D together as one entry.

The filled in section of the tool is shown in Table 7, with the conversion to tonnes required for The Questionnaire executed automatically.