

# The importance of energy balances to estimate greenhouse gas emissions

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Mainstreaming Energy Sustainable Development Goals (SDGs), Targets and Indicators into Statistical Programmes in Select African Countries

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## What sectors drive GHG emissions?



Generally, energy-related CO<sub>2</sub> dominate GHG emissions

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# Even if the energy sector weight varies across countries....

#### Share of energy in total GHG emissions



Source: IEA / EDGAR estimates, 2015

### Always need to consider country circumstances



## ... The emissions from energy are predominantly CO<sub>2</sub>

#### CO<sub>2</sub> emissions from Fuel Combustion



Source: IEA CO<sub>2</sub> emissions from fuel combustion, 2015



# Why are energy balances relevant to estimate CO<sub>2</sub> emissions?



**Combustion Reaction** 

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# Estimating CO<sub>2</sub> emissions using IPCC methodologies: carbon conservation in combustion

1										
	MODULE ENERGY									
	CATEGORY									
	CATEGORY CODE	'EGORY CODE   1A (FOR EACH SOURCE CATEGORY)								
	SHEET	CO <sub>2</sub> , CH <sub>4</sub> AND N <sub>2</sub> – TIER 1	O FROM FUEL	COMBUSTION	ATEGORY					
		Ener	gy consump	tion	CO					
		А	В	С						
		Consumption (Mass, Volume or Energy unit)	Conversion Factor (TJ/unit)	Consumption (TJ)	CO <sub>2</sub> Emission Factor (Kg CO <sub>2</sub> /TJ)	CO <sub>2</sub> emissions (Gg CO <sub>2</sub> )				
				C=(AxB)		E=(CxD)				
En Col	ergy nsumption	× Calori × value	ific s	CO <sub>2</sub> emis factors	sion _	CO <sub>2</sub> Emis	sions			
	Other Kerosene									
	Gas/Diesel Oil			Source: 2	006 IPCC G	uideline	s			
	Residual Fuel Oil									

Note: all renewables sources - including biofuelsare not emitting (IPCC)

# CO<sub>2</sub> emissions estimates rely on energy balances and underlying energy statistics quality

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**Transformation** 

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Final consumption

201 🔻	Indicators Balances Coal and Peat Electricity and Heat		d Heat	Natural Gas	s Oil	Renewables and Waste						
		Coal and peat	Crude oi	e Oil I products	Natural gas	Nuclear	Hydro	Geothermal, solar, etc.	Biofuels and waste	Electricity	Heat	Total <sup>×</sup>
Production		33658	173317	0	132349	24390	32309	901	12106	0	0	409029
Imports		5954	34510						759	1287	0	81260
Exports		-20076	-118761						70	-4430	0	-239722
International marine bunkers <sup>**</sup>		0	C		ner	gy	SO	urce	S o	0	0	-524
International . bunkers <sup>**</sup>	aviation	0	C	-1214					0	0	0	-1214
Stock changes	5	66	1064	-206	2092	0	0	0	0	0	0	3016
TPES		19603	90130	-8207	83569	24390	32309	901	12295	-3144	0	251845
Transfers		0	-3781	7993	0	0	0	0	0	0	0	4213
Statistical diff	erences	2329	4585	6 4579	2410	0	0	0	-1	0	-32	13872
Electricity pla	nts	-17629	0	-1820	-10824	-24390	-32309	-901	-2426	53814	0	-36484
CHP plants		0	0	-41	-2468	0	0	0	-39	958	544	-1047
Heat plants		0	0	0	0	0	0	0	-62	0	34	-28
Gasworks		0	0	0	0	0	0	0	0	0	0	0
Oil refineries		0	-91737	95461	-849	0	0	0	0	0	0	2875
Coal transform	nation	-1182	0	0	0	0	0	0	0	0	0	-1182
Liquefication	plants	0	802	2 0	-1940	0	0	0	0	0	0	-1138
Other transfor	mation	0	0	) 0	0	0	0	0	0	0	0	0
Energy indust	ry own use	-4	0	-7956	-13986	0	0	0	-1	-4019	0	-25966
Losses		0	0	) 0	0	0	0	0	0	-2984	0	-2984
Total final cor	nsumption	3117	C	90009	55912	0	0	0	9766	44625	546	203975
Industry		2450	C	6067	23876	0	0	0	5840	17698	545	56476
Transport		0	C	54404	2436	0	0	0	1637	331	0	58808
Other		33	C	8935	26208	0	0	0	2289	26596	0	64062
Residential		33	C	2647	14661	0	0	0	2279	13161	0	32782
Commercial a	nd public	0	C	3008	10823	0	0	0	10	12623	0	26464
	2011 V Production Imports Exports International bunkers <sup>xx</sup> International bunkers <sup>xx</sup> Stock changes TPES Transfers Statistical diff Electricity pla CHP plants Gas works Oil refineries Coal transform Liquefication Other transform Energy indust Losses Total final cor Industry Transport Other Residential Commercial a	2011 •IndicatorsProductionIndicatorsProductionImportsExportsInternational aviation bunkers**International aviation bunkers**International aviation bunkers**Stock changesImportsStock changesImportsStock changesImportsStock changesImportsStock changesImportsStock changesImportsStock changesImportsStock changesImportsChartistical differencesImportsGas worksImportsGas worksImportsGas worksImportsGoal transformationImportsLiquefication plantsImportsOther transformationImportsIndustryImportsIndustryImportsOtherImportsOtherImportsOtherImportsResidentialImportsCommercial and public	2011 ▼IndicatorsBalanceProduction33658Imports5954Exports5954Exports-20076International marine bunkers**-20076International aviation bunkers**0Stock changes66TPES19603Transfers2329Electricity plants2329CHP plants0Gas works0Oli refineries0Coal transformation0Coal transformation0Other transformation0Chargy industry own use0Cotal final consumption3117Industry2450Other33Residential33Commercial and public0Conserved33	2011 ▼   Indicators   Balances   Crude pead     Production   33658   173377     Imports   5954   34510     Exports   5954   34510     International marine bunkers**   2000   118761     International aviation bunkers**   2000   10064     Stock changes   6   1064     TPES   19603   90130     Statistical differences   2329   4586     Electricity plants   2320   4586     CAP plants   2320   4586     Gas works   0   0   0     Coal transformation   1182   0   0     Gas works   0   0   0   0     Coal transformation   1182   0   0   0     Coal transformation   0   0   0   0   0	2011 • •   Indicators   Balances   Coal and Peak     Production   33658   17337   01     Imports   5954   3457   0     Imports   -20076   11877   0     Exports   -20076   11877   0     International marine bunkers**   -20076   11877   0     International visition bunkers**   -20076   11877   0     Stock changes   6   00   -20076   11877   0     Stock changes   19603   00   -2007   12937   12933     Statistical differences   2329   4579   14579   14579     Electricity plants   -17629   0   -411     Heat plants   -17629   0   0   0     Gas works   0   0   0   0   0   0     Gas works   0   0   0   0   0   0   0     Gas works   0   0   0   0   0   0   0   0     Gas works   0   0   0   0 </td <td>Indicators   Balances   Coal and Peak   Returne     Imports   Sool   33668   17337   Imports   Imports   132349     Imports   5954   34510   Imports   Imports   123398   Imports   Imports   Imports   Imports   123398   Imports   Imp</td> <td>201: ▼   Indicators   Balances   Col and Peat   Electricity and Peat     Production   33668   173377   0   13234   24390     Imports   5954   3457   13234   24390     Imports   5954   3457   Imports   24390     Imports   5954   3457   Imports   24390     International marine bunkers**   -20078   11874   Imports   24390     International aviation bunkers**   -20078   100   Imports   2092   0     Stock changes   668   1064   -2068   2092   0     Transfers   19603   90150   83569   24390     Transfers   19603   -2017   83569   24390     Stock changes   19603   -2017   83569   24390     Transfers   19603   -2017   8457   2419   0     Stock changes   19603   -2117   7993   2419   0     Statistical differences   2329   458   4679   2419   0     Gas worke   0   &lt;</td> <td>201: ▼   Indicators   Balances   Coal and peat   Electricity and text     Production   33668   173 31   0   132349   24390   32309     Imports   55954   345 10   132349   24390   32309     Imports   -20076   -118761   Imports   24390   32309     International marine bunkers**   -20076   -118761   Imports   100   1000</td> <td>201 · V   Indicators   Balances   Coal and Peak   Electricity and Heat   Natural Gai     Production   3368   17317   0   13234   Q4300   22309   901     Imports   3368   17317   0   13234   Q4300   22309   901     Imports   5964   34510   112761   13234   Q4300   22309   901     Imports   -20076   -118761   -20076   -118761   Feak   24300   22309   901     International aviation bunkers**   -20076   -118761   Feak   -20076   118761   100   0<!--</td--><td>201 ·  Indicators Balances Coal and Peat Belectricity and Heat Natural Gas Oil   Production 3366 173 37 0 132349 24390 32309 901 12106   Imports 56964 34810 24390 32309 901 12106   Imports 56964 34810 24390 32309 901 12106   International marine bunkers** -20076 118761 Imports 6666 1007 12007 24390 32309 901 12106   International marine bunkers** -20076 118761 Imports 666 1007 12070 12070 12070 12070 12000 12000 12000   International marine bunkers** -20076 118761 11870 11870 11870 11870 12000 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-20078   11874   Imports   24390     International aviation bunkers**   -20078   100   Imports   2092   0     Stock changes   668   1064   -2068   2092   0     Transfers   19603   90150   83569   24390     Transfers   19603   -2017   83569   24390     Stock changes   19603   -2017   83569   24390     Transfers   19603   -2017   8457   2419   0     Stock changes   19603   -2117   7993   2419   0     Statistical differences   2329   458   4679   2419   0     Gas worke   0   <	201: ▼   Indicators   Balances   Coal and peat   Electricity and text     Production   33668   173 31   0   132349   24390   32309     Imports   55954   345 10   132349   24390   32309     Imports   -20076   -118761   Imports   24390   32309     International marine bunkers**   -20076   -118761   Imports   100   1000	201 · V   Indicators   Balances   Coal and Peak   Electricity and Heat   Natural Gai     Production   3368   17317   0   13234   Q4300   22309   901     Imports   3368   17317   0   13234   Q4300   22309   901     Imports   5964   34510   112761   13234   Q4300   22309   901     Imports   -20076   -118761   -20076   -118761   Feak   24300   22309   901     International aviation bunkers**   -20076   -118761   Feak   -20076   118761   100   0 </td <td>201 ·  Indicators Balances Coal and Peat Belectricity and Heat Natural Gas Oil   Production 3366 173 37 0 132349 24390 32309 901 12106   Imports 56964 34810 24390 32309 901 12106   Imports 56964 34810 24390 32309 901 12106   International marine bunkers** -20076 118761 Imports 6666 1007 12007 24390 32309 901 12106   International marine bunkers** -20076 118761 Imports 666 1007 12070 12070 12070 12070 12000 12000 12000   International marine bunkers** -20076 118761 11870 11870 11870 11870 12000 100 10000 112100   International marine bunkers** -20076 118770 2007 2007 12000 100 10000 112100   International marine bunkers** -20076 118700 2007 2007 2007 2007 2007 2007 2007 2007 2007 2007 2007 2007 2007 2007 2007 2007</td> <td>201 · •     Indicators     Balances     Coal and Peak     Electricity and Heat     Natural solar     Natural solar&lt;</td> <td>201 · •     Indicators     Balances     Coal and Peak     Below is and Peak     Number of the set of the set</td>	201 ·  Indicators Balances Coal and Peat Belectricity and Heat Natural Gas Oil   Production 3366 173 37 0 132349 24390 32309 901 12106   Imports 56964 34810 24390 32309 901 12106   Imports 56964 34810 24390 32309 901 12106   International marine bunkers** -20076 118761 Imports 6666 1007 12007 24390 32309 901 12106   International marine bunkers** -20076 118761 Imports 666 1007 12070 12070 12070 12070 12000 12000 12000   International marine bunkers** -20076 118761 11870 11870 11870 11870 12000 100 10000 112100   International marine bunkers** -20076 118770 2007 2007 12000 100 10000 112100   International marine bunkers** -20076 118700 2007 2007 2007 2007 2007 2007 2007 2007 2007 2007 2007 2007 2007 2007 2007 2007	201 · •     Indicators     Balances     Coal and Peak     Electricity and Heat     Natural solar     Natural solar<	201 · •     Indicators     Balances     Coal and Peak     Below is and Peak     Number of the set

The importance of accurate energy data and calorific values by product and by sector (three blocks)



## What is an energy balance?



Source: IEA, World Energy Balances, 2015

### The overall description of energy supply and use in a country



		г	201. V Indicators	Balanc	es Co	al and Pea	t Elec	stricity an	d Heat	Natural Gas	ral Gas Oil Renewables		s and	Waste
				Coal and peat	Crude oil	Oil products	Natural gas	Nuclear	Hydro	Geothermal, solar, etc.	Biofuels and waste	Electricity	Heat	Total*
		)	Production	33658	173317	0	132349	24390	32309	901	12106	0	0	409029
	Su	upply 🛛	Imports	5954	34510	12790	25960	0	0	0	759	1287	0	81260
			Exports	-20076	-118761	-19053	-76831	0	0	0	-570	-4430	0	-239722
			International marine bunkers <sup>##</sup>	0	0	-524	0	0	0	0	0	0	0	-524
		L	International aviation bunkers <sup>sx</sup>	0	0	-1214	0	0	0	0	0	0	0	-1214
		Г	Stock changes	66	1064	-206	2092	0	0	0	0	0	0	3016
_			TPES	19603	90130	-8207	83569	24390	32309	901	12295	-3144	0	251845
			Transfers	0	-3781	7993	0	0	0	0	0	0	0	4213
Tr	Transformation		Statistical differences	2329	4585	4579	2410	0	0	0	-1	0	-32	13872
	ansionnat		Electricity plants	-17629	0	-1820	-10824	-24390	-32309	-901	-2426	53814	0	-36484
			CHP plants	0	0	-41	-2468	0	0	0	-39	958	544	-1047
			Heat plants	0	0	0	0	0	0	0	-62	0	34	-28
			G as works	0	0	0	0	0	0	0	0	0	0	0
			Oil refineries	0	-91737	95461	-849	0	0	0	0	0	0	2875
			Coal transformation	-1182	0	0	0	0	0	0	0	0	0	-1182
			Liquefication plants	0	802	0	-1940	0	0	0	0	0	0	-1138
			Other transformation	0	0	0	0	0	0	0	0	0	0	0
	Einal		Energy industry own use	-4	0	-7956	-13986	0	0	0	-1	-4019	0	-25966
	Fillal		Losses	0	0	0	0	0	0	0	0	-2984	0	-2984
	-		Total final consumption	3117	0	90009	55912	0	0	0	9766	44625	546	203975
	consumpt	tion	Industry	2450	0	6067	23876	0	0	0	5840	17698	545	56476
	•		Transport	0	0	54404	2436	0	0	0	1637	331	0	58808
			Other	33	0	8935	26208	0	0	0	2289	26596	0	64062
			Residential	33	0	2647	14661	0	0	0	2279	13161	0	32782
			Commercial and public services	0	0	3008	10823	0	0	0	10	12623	0	26464
			Agriculture / forestry	0	0	3280	724	0	0	0	0	812	0	4816
			Fishing	0	0	0	0	0	0	0	0	0	0	0
			Non-specified	0	0	0	0	0	0	0	0	0	0	0
			Non-energy use	634	0	20603	3392	0	0	0	0	0	0	24629
			-of which petrochemical	0	0	12022	3392	0	0	0	0	0	0	15415

# 1: Energy supply

### Ethiopia: Balances for 2013



Sources: IEA World Energy Balances, 2015 IEA CO<sub>2</sub> emissions from fuel combustion, 2015

Basis for "reference approach" emissions ("top-down") and quick indicator of overall trends (few data needed)

# Carbon intensity of the energy supply



CO2/TPES: How much CO<sub>2</sub> for a given unit of energy supply?

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### Carbon intensity varies depending on the energy mix



Total CO<sub>2</sub>/TPES Weighted average across supply sources

Source: IEA CO<sub>2</sub> emissions from fuel combustion, 2015

### Need accurate supply data for all fuels – including solid biofuels!



## 2: Transformation sector



Need accurate input/output data by product type (e.g. electricity generation)



## Carbon intensity of electricity (CO2/kWh)

**United Republic of Tanzania** 



CO2/kWh: how much CO2 per unit of total electricity generated? Total CO2 emissions / total electricity output (including output from non emitting sources)

# "carbon intensity of electricity" depends on the electricity mix and on the efficiency of generation

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### Need accurate data on amounts of combusted fuels and of electricity generated, by source



## **3: Final consumption**

	Coal and peat	Crude oil	Oil products	Natural gas	Nuclear	Hydro	Geothermal, solar, etc.	Biofuels and waste	Electricity	Heat	Total*
fotal final consumption	3117	0	90009	55912	0	0	0	9766	44625	546	203975
Industry	2450	0	6067	23876	0	0	0	5840	17698	545	56476
Transport	0	0	54404	2436	0	0	0	1637	331	0	58808
Other	33	0	8935	26208	0	0	0	2289	26596	0	64062
Residential	33	0	2647	14661	0	0	0	2279	13161	0	32782
Commercial and public services	0	0	3008	10823	0	0	0	10	12623	0	26464
Agriculture / forestry	0	0	3280	724	0	0	0	0	812	0	4816
Fishing	0	0	0	0	0	0	0	0	0	0	0
Non-specified	0	0	0	0	0	0	0	0	0	0	0
Non-energy use	634	0	20603	3392	0	0	0	0	0	0	24629

Basis for "Sectoral approach" (official) emissions estimates ("bottom-up") – different levels of detail possible



### "Demand" indicators: shares by sector



## What sectors (and end uses) drive national emissions? The importance of demand side data

# A set of indicators can be computed at sectoral and sub-sectoral level



Source: IEA, CO<sub>2</sub> emissions from fuel combustion, 2015

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# A data quality assessment example: reconciling supply and demand sides



Generally, indicators are a tool to enhance data quality