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ENERGY STATISTICS

The Use of Energy Statistics to Estimate CO_2 emissions

Joint Rosstat – IEA Energy Statistics Workshop
Moscow, 14-16 February 2012

International Energy Agency

Outline

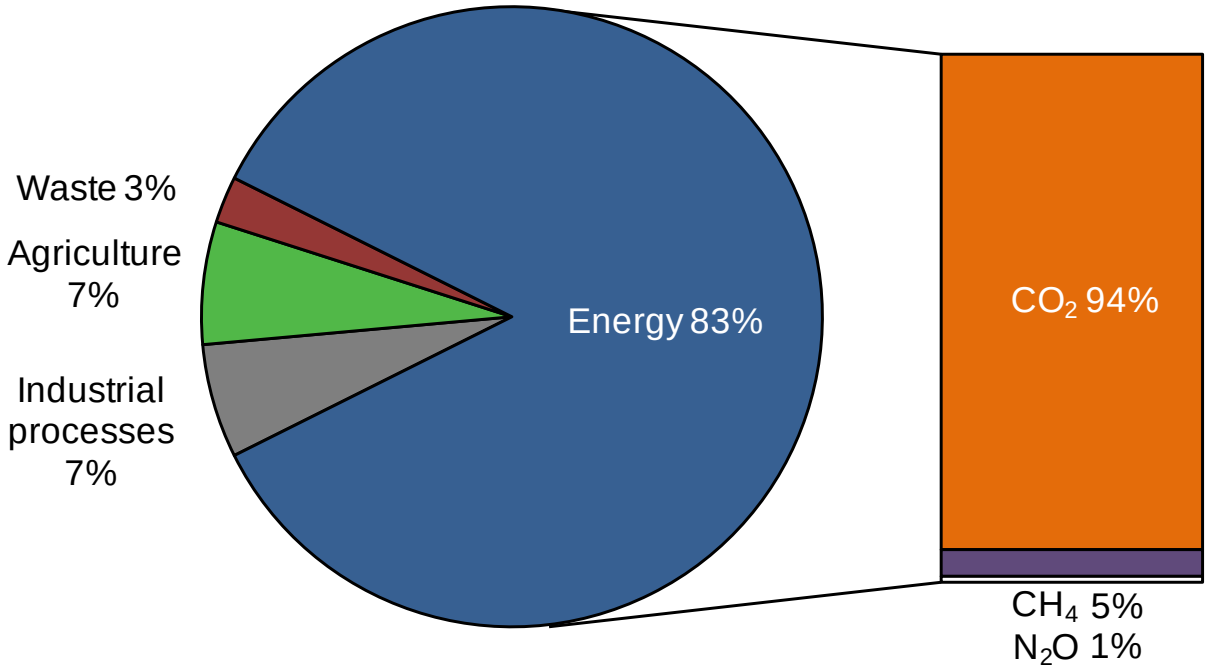
- International context
- IPCC methodologies (notes on bunkers and LULUCF)
- Estimation of CO_2 emissions by the IEA
- Differences between the *1996* and *2006 IPCC Guidelines*
- Data quality
- IEA estimates for Russia
- National policy options and the importance of energy statistics

International Context

Stabilisation of greenhouse gas concentrations in the atmosphere.

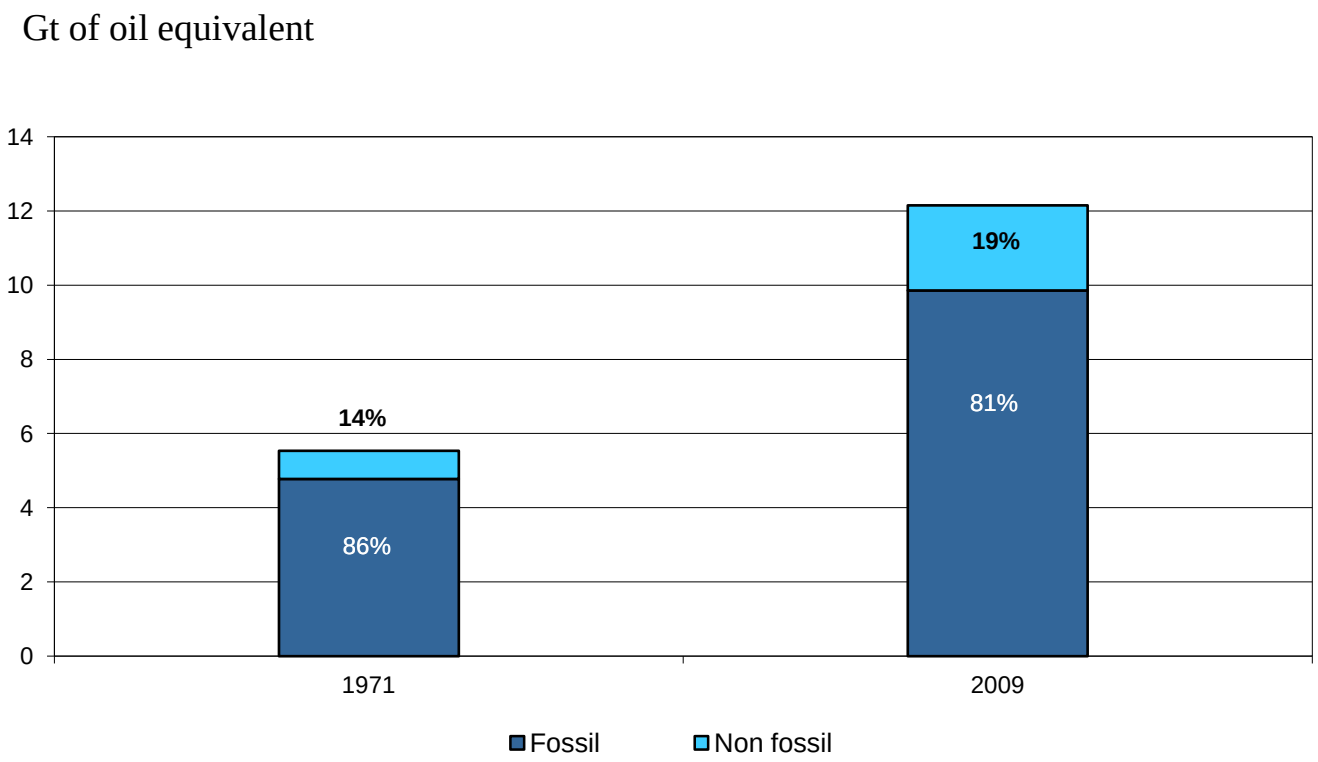
- **1992:** United Nations Framework Convention on Climate Change (UNFCCC) at Rio de Janeiro conference
- **1995 (1996):** *IPCC Guidelines for National Greenhouse Gas Inventories*
  Development of methodologies for gases not controlled by the Montreal Protocol.
- **1997:** Kyoto Protocol (entry into force 2005)
  Reduction of anthropogenic greenhouse gas emissions for the period 2008-2012 of about 5% compared to 1990.
- **2000:** *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.*
- **2006:** *2006 IPCC Guidelines for National Greenhouse Gas Inventories.*
- **2008-2012:** End of the first commitment period of the Kyoto Protocol

Share of energy in GHG emissions



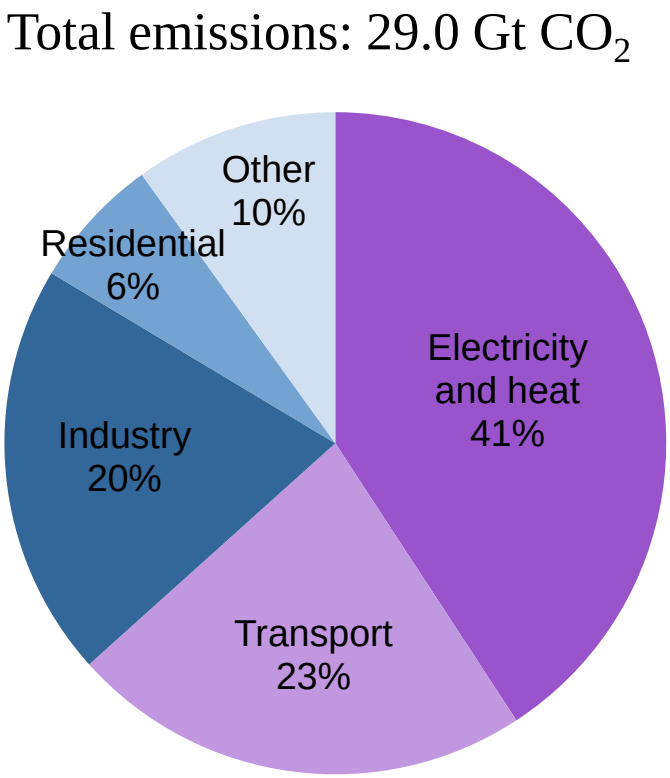
Key point: Accounting for the largest share of global GHG emissions, energy emissions are predominantly CO_2.

World primary energy supply



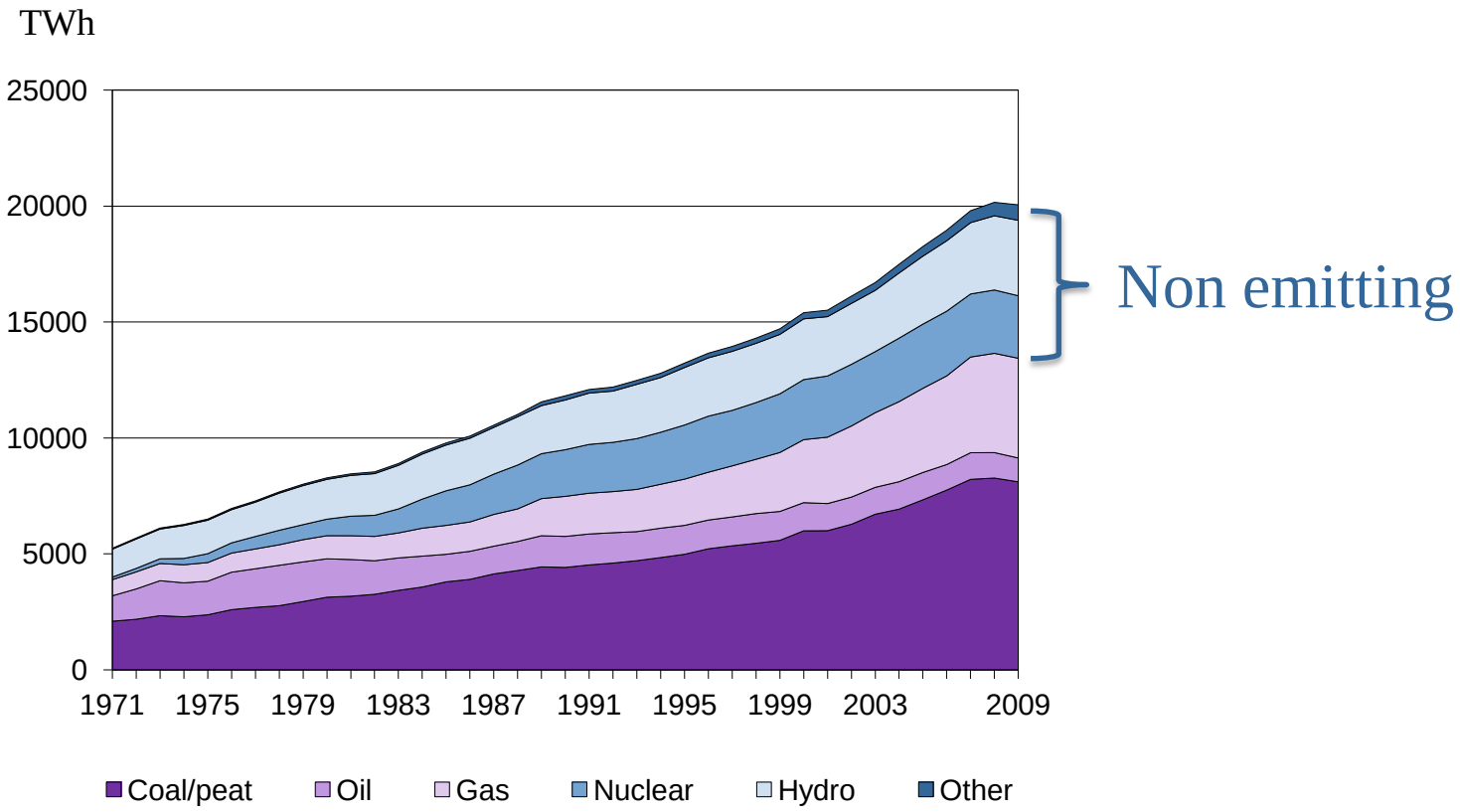
Key point: Despite growth in renewable energy, fossil fuels still satisfy most of the world's energy supply.

World CO_2 emissions by sector in 2009



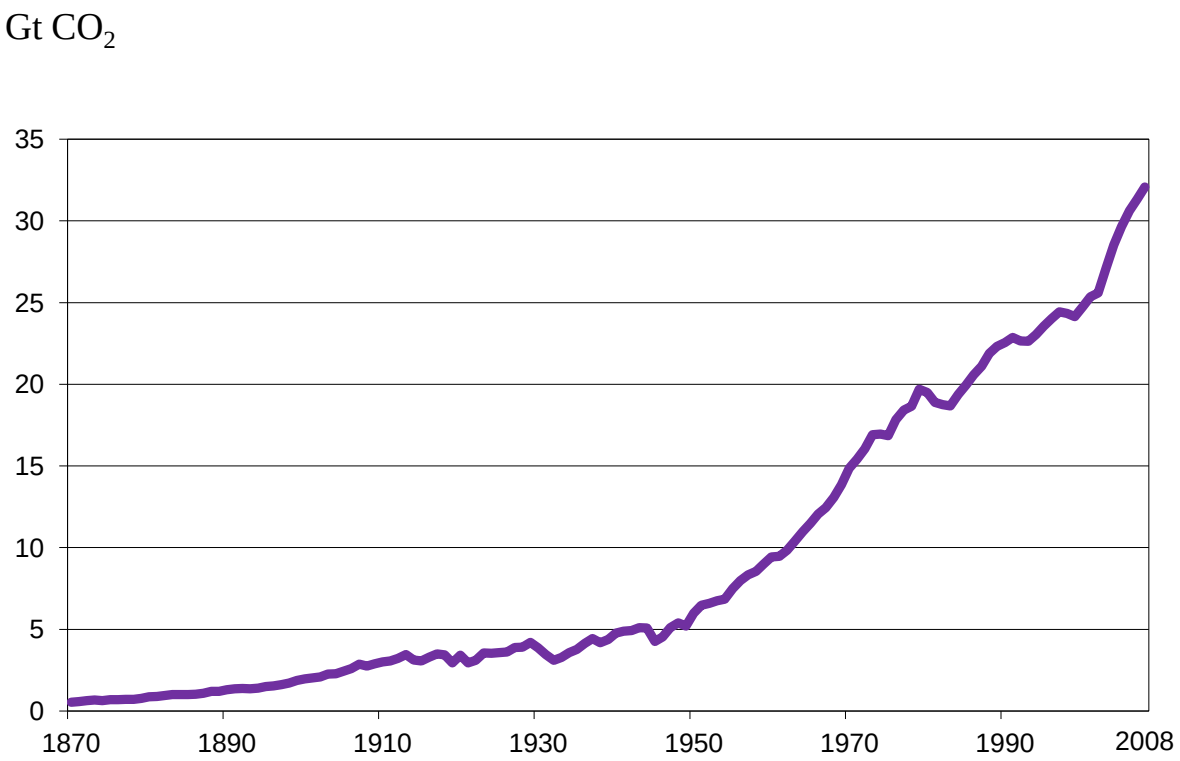
Key point: Between 1971 and 2009, the combined share of electricity and heat generation and transport shifted from 1/2 to 2/3 of global emissions.

World electricity generation by fuel



Key point: Although non- and low-emitting sources are growing, electricity generation is becoming more CO_2-intensive as a result of coal use.

Trend in CO_2 emissions from fossil fuel combustion



Source: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, US

Key point: Since 1870, CO_2 emissions from fuel combustion have risen exponentially.

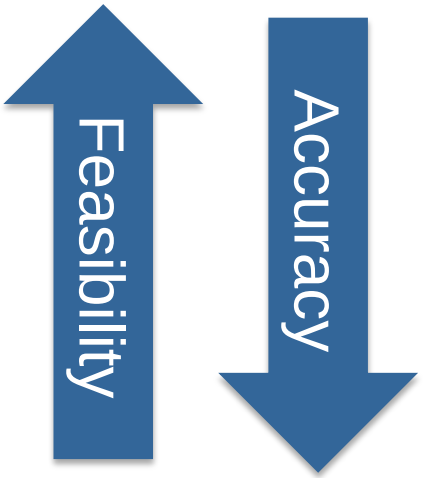
IPCC methodologies

- IEA CO_2 estimates are calculated using the *Revised 1996 IPCC Guidelines* although the IPCC published new Guidelines in 2006.
- Kyoto Protocol is based on the *Revised 1996 IPCC Guidelines*

Tier 1
- Simplest method
- Activity data available to all countries

Tier 2
- Country or technology-specific emission factor

Tier 3
- More detailed or country-specific methods



IPCC methodology: Tier 1

Basic computation for CO_2 emissions:

- CO_2 emissions by product: **Fuel Quantity x Emission Factor** (with corrections for stored and unoxidised carbon)
- Sum over all different products

Can be done from two independent sets of data:

Supply of fuels to the country **Reference Approach**	**Consumption** by end-use sectors **Sectoral Approach**

What is not covered in CO_2 from fuel combustion?

IPCC Guidelines: Biomass is **not included** in national totals for CO_2 emissions from fuel combustion.

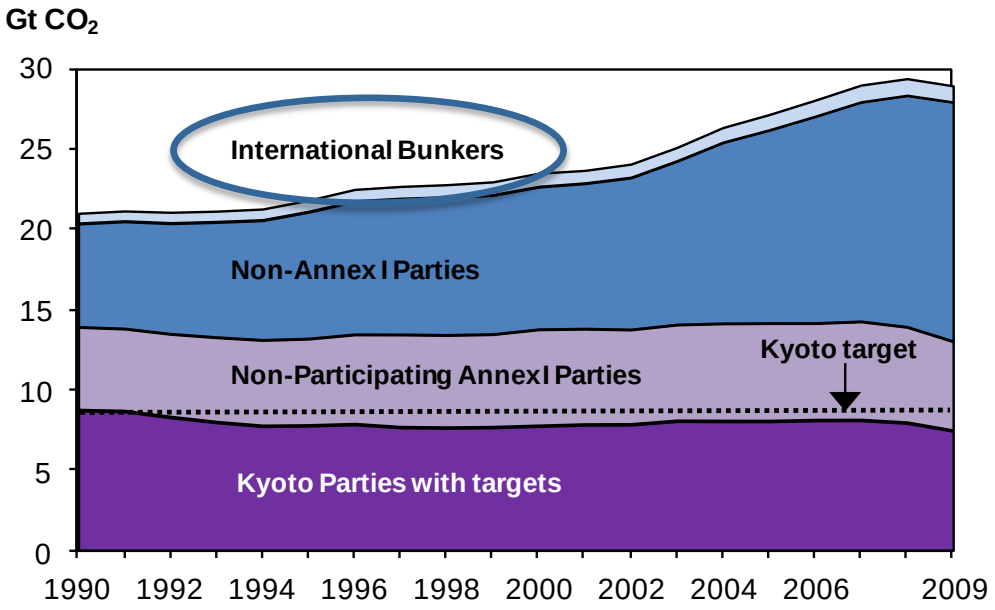
Biomass contains carbon, absorbed by plants through photosynthesis.

However, if biomass is sustainably grown, no additional CO_2 is considered as emitted into the atmosphere.

If there is a change in the biomass stocks, then the CO_2 is accounted for in LULUCF.

Note on international bunkers

IPCC Guidelines: International aviation and international marine bunkers are **not included** in national totals.



2009 World CO_2 emissions

Other only includes industrial waste and non-renewable municipal waste (not biofuels)

Residential only includes emissions from fuels actually combusted in households (hence its relatively small share), not electricity or heat consumption

We show both the reference approach and sectoral approach emissions (the difference coming from statistical differences, and losses and transformation)

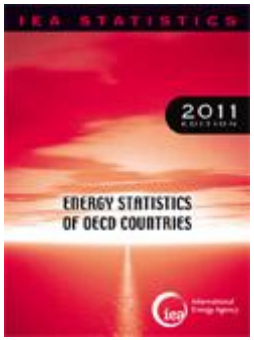
We show emissions for main activity and autoproducer plants separately (we don't have the required data to allocate autoproducers to their consuming sectors)

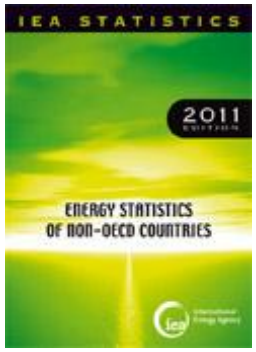
million tonnes	Oil			ge 09
Sectoral Apr			**28 999.4**	**38.3%**
Main activity p			10 796.1	63.1%
Unallocated autoproducers			1 031.0	16.2%
Other energy industry own use			1 464.1	45.6%
Manufacturing industries and constructior			5 870.9	29.5%
Transport			6 543.8	42.5%
of which: road			*4 876.6*	48.3%
Other			3 293.4	-1.1%
of which: residential				
Reference Approach				
Diff. due to losses and/or transformation	256.5	85.6		
Statistical differences	99.2	37.4		
Memo: international marine bunkers **	-	*592.2*		
Memo: international aviation bunkers **	-	*423.4*		

* Other includes industrial waste and non-renewable municipal waste.
** World includes international marine bunkers and international aviation bunkers.

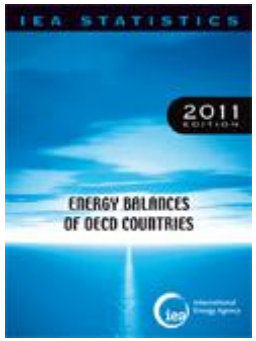
How IEA estimates CO_2 emissions from fuel combustion

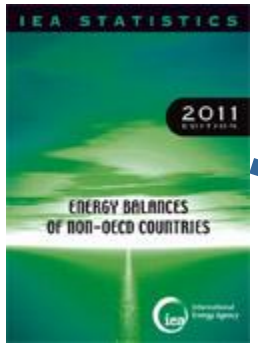
Energy Statistics

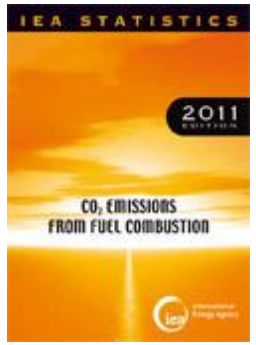




Energy Balances







CO_2 Emissions

IPCC Methodologies (Revised 1996 GLs)

Step 1: Estimating sectoral fuel consumption

Revised 1996 Guidelines

MODULE	ENERGY
SUBMODULE	CO_2 FROM FUEL COMBUSTION (TIER I SECTORAL APPROACH)
WORKSHEET	STEP BY STEP CALCULATIONS
SHEET	MANUFACTURING INDUSTRIES AND CONSTRUCTION

	STEP 1	STEP 2				
Manufacturing Industries and Construction	A Consumption					
Crude Oil						
Natural Gas Liquids						
Gasoline						
Jet Kerosene						
Other Kerosene						
Gas/Diesel Oil						
Residual Fuel Oil						
LPG						

Separate sheet filled out for each sector:

Main activity producer electricity and heat
Unallocated autoproducers
Other energy industries
Manufacturing industries and construction
Transport
of which: road
Other sectors
of which: residential

Units:
Could be in natural units (e.g. 1000 tonnes) or in energy units (e.g. TJ)

Step 2: Converting to a common energy unit

Revised 1996 Guidelines

MODULE	ENERGY
SUBMODULE	CO_2 FROM FUEL COMBUSTION (TIER I SECTORAL APPR
WORKSHEET	STEP BY STEP CALCULATIONS
SHEET	MANUFACTURING INDUSTRIES AND CONSTRUCTION

	STEP 1	STEP 2		
Manufacturing Industries and Construction		B Conversion Factor (TJ/unit)	C Consumption (TJ)	
			C=(AxB)	
Crude Oil				
Natural Gas Liquids				
Gasoline				
Jet Kerosene				
Other Kerosene				
Gas/Diesel Oil				
Residual Fuel Oil				
LPG				

Country-specific NCVs for natural gas and coal are given explicitly in the *Revised 1996 IPCC Guidelines*

SELECTED NET CALORIFIC VALUES FROM THE 1996 GLS	
	Factors ($TJ/10^3$ tonnes)
Refined petroleum products	
Gasoline	44.80
Jet kerosene	44.59
Other kerosene	44.75
Shale oil	36.00
Gas/diesel oil	43.33
Residual fuel oil	40.19
LPG	47.31
Ethane	47.49
Naphtha	45.01
Bitumen	40.19
Lubricants	40.19
Petroleum coke	31.00
Refinery feedstocks	44.80
Refinery gas	48.15
Other oil products	40.19
Other products	
Coal oils and tars derived from coking coals	28.00
Oil shale	9.40
Orimulsion	27.50

Step 3: Multiplying by carbon emission factors

Revised 1996 Guidelines

MODULE	ENERGY
SUBM	I SECTORAL APPROACH)
WORK	
	ONSTRUCTION

CARBON EMISSION FACTORS (CEF)	
Fuel	*Carbon emission factor (t C/TJ)*
LIQUID FOSSIL	
Primary fuels	
Crude oil	20.0
Orimulsion	22.0
Natural gas liquids	17.2
Secondary fuels/products	
Gasoline	18.9
Jet kerosene	19.5
Other kerosene	19.6
Shale oil	20.0
Gas/diesel oil	20.2
Residual fuel oil	21.1
LPG	17.2
Ethane	16.8
Naphtha	(20.0)
Bitumen	22.0
Lubricants	(20.0)
Petroleum coke	27.5
Refinery feedstocks	(20.0)
Refinery gas	18.2
Other oil	(20.0)

	STEP 3		
Manufacturing Industries and Construction	D Carbon Emission Factor (t C/TJ)	E Carbon Content (t C)	F Carbon Content (Gg C)
		E=(CxD)	F=(E x 10-3)
Crude Oil			
Natural Gas Liquids			
Gasoline			
Jet Kerosene			
Other Kerosene			
Gas/Diesel Oil			
Residual Fuel Oil			
LPG			

Step 4: Calculating carbon stored

Revised 1996 Guidelines

MODULE	**ENERGY**
SUBMODULE	**CO_2 FROM FUEL COMBUSTION (TIER I SECTORAL APPROACH)**
WORKSHEET	**2 STEP BY STEP CALCULATIONS**
SHEET	**MANUFACTURING INDUSTRIES AND CONSTRUCTION**

	STEP 4			STEP 5		STEP 6
Manufacturing Industries and Construction	G Fraction of Carbon Stored	H Carbon Stored (Gg C)	I Net Carbon Emissions (Gg C)			
		H=(FxG)	I=(F-H)			
Crude Oil						
Natural Gas Liquids						
Gasoline						
Jet Kerosene						
Other Kerosene						
Gas/Diesel Oil						
Residual Fuel Oil						
LPG						

Default values: fraction of carbon stored

Naphtha*	0.8
Lubricants	0.5
Bitumen	1.0
Coal Oils and Tars	0.75
Natural Gas*	0.33
Gas/Diesel Oil*	0.5
LPG*	0.8
Ethane*	0.8

*When used as feedstocks

Step 5: Correcting for carbon unoxidised

Revised 1996 Guidelines

MODULE	**ENERGY**
SUBMODULE	**CO_2 FROM FUEL COMBUSTION (TIER I SECTORAL APPROACH)**
WORKSHEET	**2 STEP BY STEP CALCULATIONS**
SHEET	**MANUFACTURING INDUSTRIES AND CONSTRUCTION**

	STEP 4			STEP 5		STEP 6
Manufacturing Industries and Construction				J Fraction of Carbon Oxidised	K Actual Carbon Emissions (Gg C)	
					K=(IxJ)	
Crude Oil						
Natural Gas Liquids						
Gasoline						
Jet Kerosene						
Other Kerosene						
Gas/Diesel Oil						
Residual Fuel Oil						
LPG						

Default values: fraction of carbon oxidised

Coal	0.98
Oil and oil products	0.99
Gas	0.995
Peat for elec. Generation	0.99

Step 6: Converting to CO_2 emissions

Revised 1996 Guidelines

MODULE	**ENERGY**					
SUBMODULE	**CO_2 FROM FUEL COMBUSTION (TIER I SECTORAL APPROACH)**					
WORKSHEET	**2 STEP BY STEP CALCULATIONS**					
SHEET	**MANUFACTURING INDUSTRIES AND CONSTRUCTION**					
	STEP 4			**STEP 5**		**STEP 6**
Manufacturing Industries and Construction						L Actual CO2 Emissions (Gg CO2)
						L=(K x [44/12])
Crude Oil						
Natural Gas Liquids						
Gasoline						
Jet Kerosene						
Other Kerosene						
Gas/Diesel Oil						
Residual Fuel Oil						
LPG						

Multiply by 44/12

(the molecular weight ratio of CO_2 to C)

Differences between 1996 and 2006 Guidelines

Simplified estimation methodology

- Emission factors: Rather than separate carbon and CO_2 – estimate CO_2 directly
- Oxidation factors: Rather than differentiate oxidation based on fuels since almost no information is available on this, assume 100% oxidation – simplifies and is more conservative. Also, the oxidation factors are now included directly in the EFs.
- Non-energy use: Rather than include all energy and then make assumptions on stored carbon, the activity data explicitly exclude the non-energy use of fuels.
- Account for emissions where and when they occur: New methodologies for CO_2 captured and stored, new methodologies for CO_2 in agricultural soils, forests

Revised 1996 IPCC Guidelines: Sectoral Approach

Step 1: Estimating sectoral fuel consumption

Step 2: Converting to a common energy unit *(TJ)*

Step 3: Multiplying by carbon emission factors

Step 4: Calculating carbon stored

Step 5: Correcting for carbon unoxidised

Step 6: Converting to CO_2 Emissions *(tonnes of CO_2)*

2006 IPCC Guidelines: Sectoral Approach

Step 1: Estimating sectoral fuel consumption (Excludes non-energy use of fuels)

Step 2: Converting to a common energy unit *(TJ)* (Can use default or country-specific NCVs. Country-specific factors improves accuracy)

Step 3: Multiplying by carbon dioxide emission factors (conversion by 44/12 included, oxidation = 1)

Step 1: Estimating sectoral fuel consumption

2006 Guidelines

SECTOR	ENERGY
CATEGORY	FUEL COMBUSTION ACTIVITIES
CATEGORY CODE	1A
SHEET	1 OF 4 (CO_2, CH_4 AND N_2O FROM FUEL COMBUSTION BY SOURCE CATEGORIES – TIER 1)

	Energy consumption			C(		CH_4 (etc.)
	A Consumption (Mass.Volume or Energy unit)					
Liquid fuels						
Crude Oil						
Orimuls						
Natural Gas L						
Motor Gasoline						
Aviation Gasoline						
Jet Gasoline						
Jet Kerosene						
Other Kerosene						

Units:
Could be in natural units (e.g. 1000 tonnes) or in energy units (e.g. TJ)

Separate sheet filled out for each sector:

Main activity electricity and heat production, Petroleum Refining, Manufacture of Solid Fuels and Other Energy Industries, Iron and Steel, Non-Ferrous Metals, Chemicals, Pulp/Paper/Print, Food Processing/Beverages/Tobacco, Non-Metallic Minerals, Transport Equipment, Machinery, Mining (excl. fuels)/Quarrying, Wood/Wood Products, Construction, Textile/Leather, Non-specified Industry, Commercial/Institutional, Residential, Agriculture/Forestry/Fishing/Fish Farms, Non-specified Stationary

Step 2: Converting to a common energy unit

2006 Guidelines

Country-specific NCVs for natural gas and coal are given explicitly in the *Revised 1996 IPCC Guidelines*. The *2006 Guidelines* give one default value with upper and lower limits.

M FUEL COMBUSTION BY SOURCE CATEGORIES – TIER 1)

	rgy consumption			CO_2		CH_4 (etc.)
	A	B Conversion Factor (TJ/unit)	C Consumption (TJ)			
Liquid fuels						
Crude Oil						
Orimulsion						
Natural Gas Liquids						
Motor Gasoline						
Aviation Gasoline						
Jet Gasoline						
Jet Kerosene						
Other Kerosene						

SELECTED NET CALORIFIC VALUES FROM THE 2006 GLS

	Net calorific value (TJ/Gg)	Lower	Upper
Crude oil	42.3	40.1	44.8
Orimulsion	27.5	27.5	28.3
Natural Gas Liquids	44.2	40.9	46.9
Motor Gasoline	44.3	42.5	44.8
Aviation Gasoline	44.3	42.5	44.8
Jet Gasoline	44.3	42.5	44.8
Jet kerosene	44.1	42.0	45.0
Other kerosene	43.8	42.4	45.2

Step 3: Multiplying by CO_2 emission factors

2006 Guidelines

SECTOR	ENERGY
CATEGORY	FUEL COMBUSTION ACTIVITIES
CATEGORY CODE	1A
SHEET	1 OF 4 (CO_2, CH_4 AND N_2O FROM FUEL COMBUSTION BY SOURCE CATEGORIES – TIER 1)

	Energy consumption			CO_2		CH_4 (etc.)
				D CO_2 Emission Factor (kg CO_2/TJ)	E CO_2 Emissions (Gg CO_2) **E=C*D/10^6**	
Liqui						
Crude						
Orimu						
Natur						
Motor						
Aviati						
Jet Ga						
Jet Ke						
Other Kerosene						

DEFAULT EFFECTIVE CO_2 EMISSION FACTORS FROM THE 2006 GLS

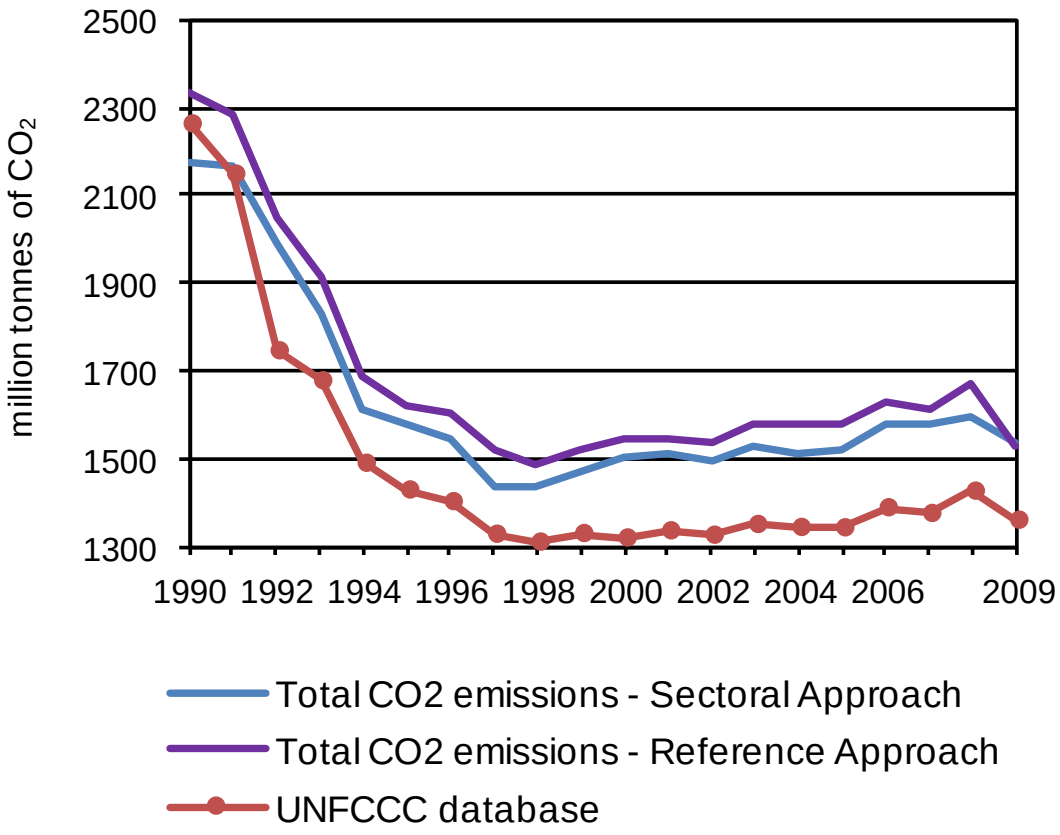
	CO_2		
	Default emission factor	**Lower**	**Upper**
Crude oil	73 300	71 100	75 500
Orimulsion	77 000	69 300	85 400
Natural Gas Liquids	64 200	58 300	70 400
Motor Gasoline	69 300	67 500	73 000
Aviation Gasoline	70 000	67 500	73 000
Jet Gasoline	70 000	67 500	73 000
Jet kerosene	71 500	69 700	74 400
Other kerosene	71 900	70 800	73 700

Data quality: comparing IEA and UNFCCC data

A comparison is done on an annual basis between IEA and UNFCCC emissions inventories, in order to highlight and minimise potential errors. There can be many (often legitimate) reasons for differences between the two datasets, including:

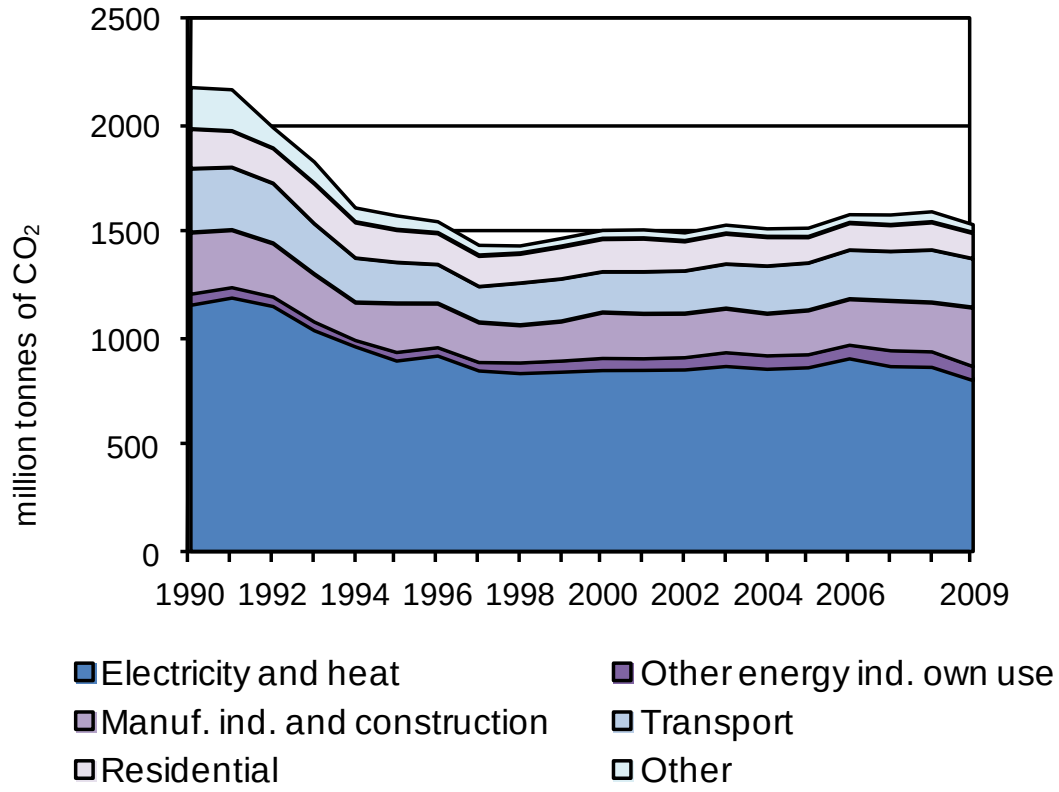
- The IEA uses a Tier 1 Method
- The IEA still uses the *1996 Guidelines*
- Underlying energy data can be different (multiple official sources)
- The IEA uses average NCVs
- The IEA uses average CEFs
- The IEA has no detailed info on carbon stored
- Autoproducers are unallocated in the IEA data
- Military emissions can be treated differently
- IEA data include emissions from coke inputs to blast furnaces
- Units can be different

Reference vs Sectoral Approach: Russian Federation



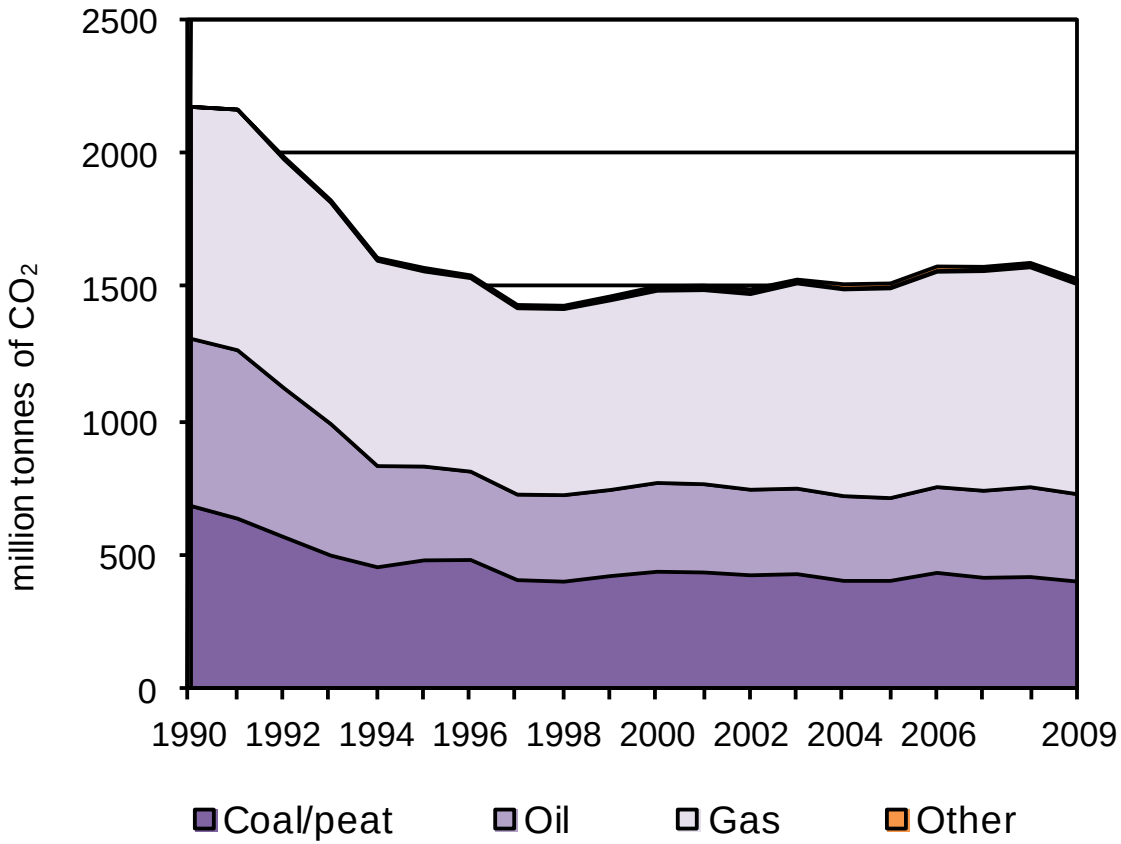
Key point: CO_2 emissions estimated by the IEA track closely the emissions reported to the UNFCCC.

CO_2 emissions by sector: Russian Federation



Key point: Most CO_2 emissions come from the generation of electricity and heat.

CO_2 emissions by fuel: Russian Federation



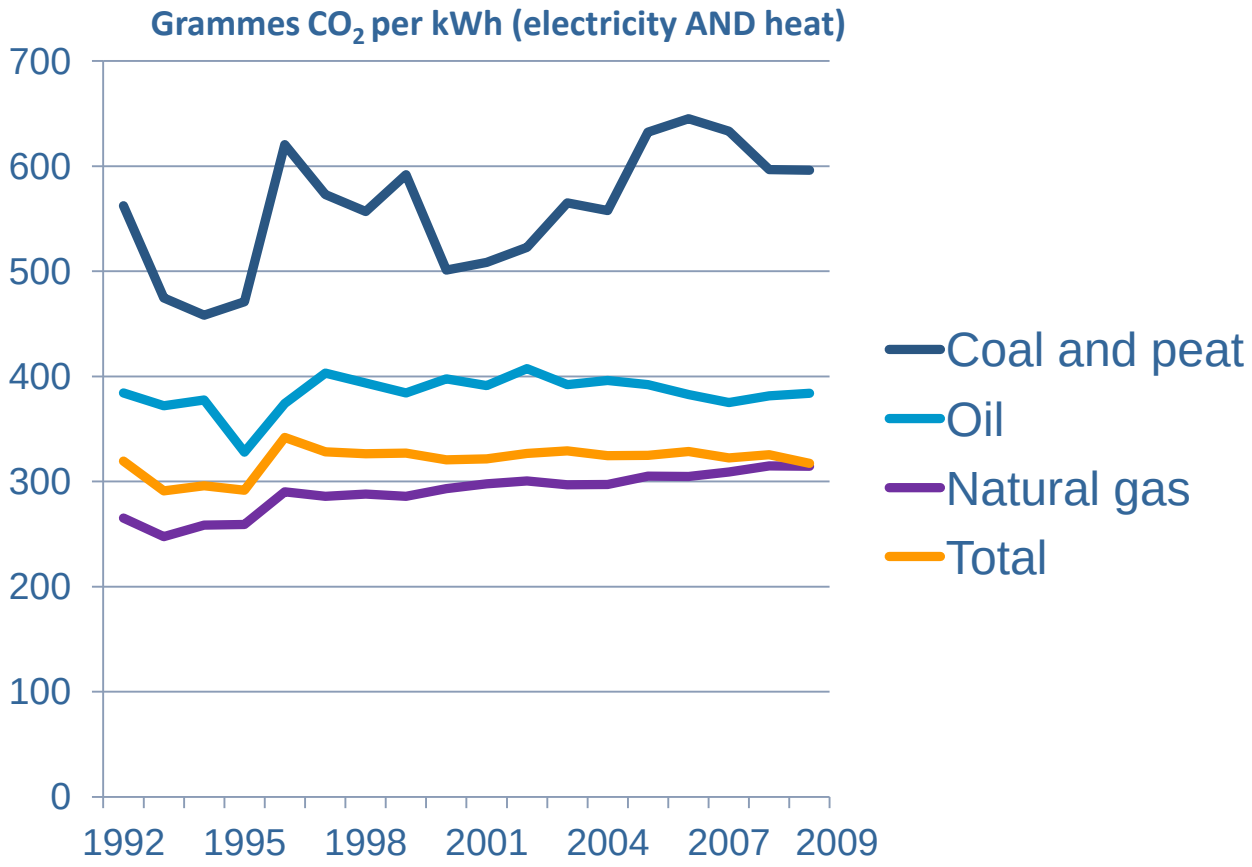
Key point: Since gas plays an important role, CO_2 emissions are less carbon intensive than they might have been.

Key sources: Russian Federation (2009)

IPCC source category	CO_2 emissions (Mt of CO_2)	% change 90-09	Level assessment (%) **	Cumulative total (%)
Main activity prod. elec. and heat - gas	304.0	-12.4%	13.0	13.0
Main activity prod. elec. and heat - coal/peat	186.7	-46.3%	8.0	21.0
Unallocated autoproducers - gas	176.1	-4.8%	7.6	28.6
Road - oil	136.6	-8.8%	5.9	34.5
Manufacturing industries - gas	109.9	5.3%	4.7	39.2
Manufacturing industries - coal/peat	103.2	6.4%	4.4	43.6
Residential - gas	97.4	-11.6%	4.2	47.8
Unallocated autoproducers - coal/peat	91.1	8.3%	3.9	51.7
Other transport - gas	64.3	-16.4%	2.8	54.4
Manufacturing industries - oil	60.2	-30.0%	2.6	57.0
Other energy industry own use - oil	34.7	-10.2%	1.5	58.5
Memo: total CO_2 from fuel combustion	*1 532.6*	*-29.7%*	*65.7*	*65.7*

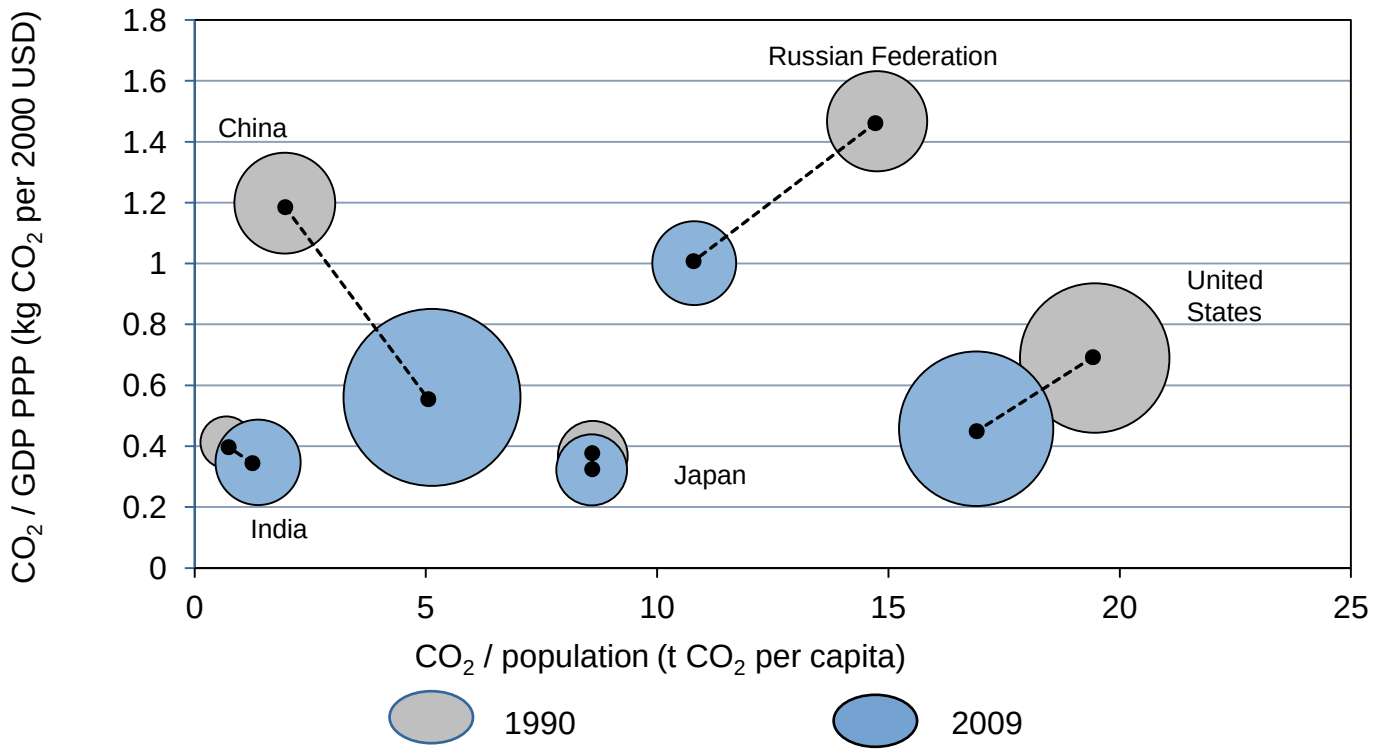
Key point: Key source analysis can help identify which sectors would benefit from better quality data, NCVs and emission factors.

CO_2 emissions per kWh: Russian Federation



Key point: Total emissions of CO_2 per kWh will also depend on the share of non-fossil sources such as nuclear, hydro, etc.

CO_2 intensities of major countries



Key point: Various CO_2 indicators can be used to track countries with different economies against each other.

Dealing with climate change: national policy options

- Emit less (be more efficient, restructure economy)
- Emit differently (switch fuels or processes to deliver same outcome)
- CO_2 capture and storage
- Do without (change behaviour)
- Adapt (learn to live with it)

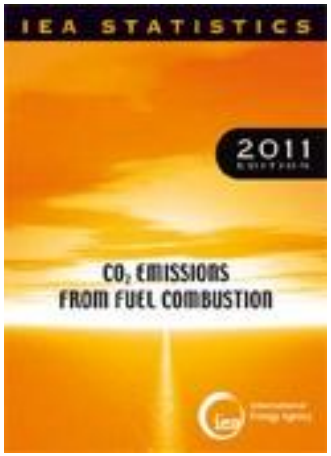
A need for energy statistics to be able to monitor progress of the various policies

Concluding remarks:

- Fossil fuel combustion is the single largest human influence on climate change.
- Two sectors, both growing rapidly, represent the bulk of CO_2 emissions from fuel:
  - electricity and heat generation
  - transport
- Effective emissions mitigation will require all countries, regardless of energy demand and infrastructure, to use energy in a sustainable manner.
- Up-to-date and accurate information on energy use and GHG emissions is essential for countries to monitor their progress in reducing GHG emissions.

good energy statistics are crucial for estimating GHG emissions

CO_2 Emissions from Fuel Combustion (2011 Edition) is available now.



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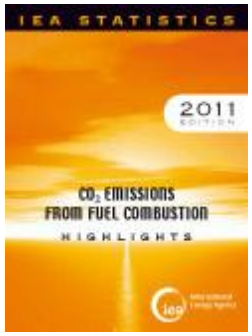
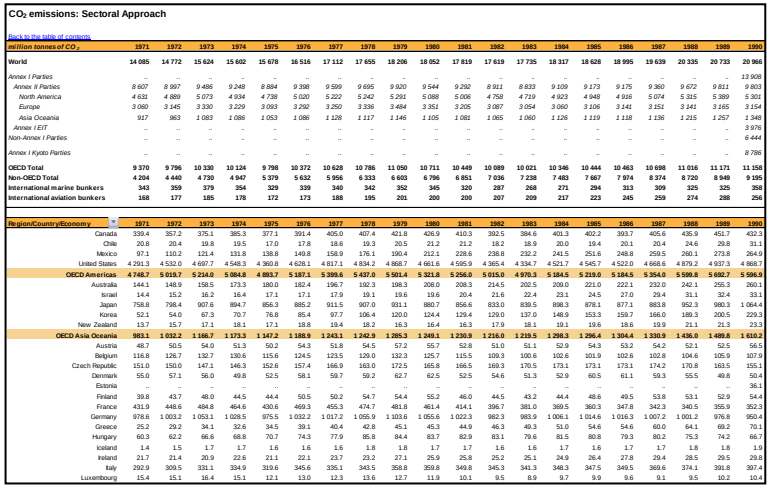


Excel



CO_2 emissions: Sectoral Approach

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million tonnes of CO_2	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
World	**14 085**	**14 772**	**15 624**	**15 602**	**15 678**	**16 516**	**17 112**	**17 655**	**18 206**	**18 052**	**17 819**	**17 619**	**17 735**	**18 317**	**18 628**	**18 995**	**19 639**	**20 335**	**20 733**	**20 966**
Annex I Parties	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*13 908*
Annex II Parties	*8 607*	*8 997*	*9 496*	*9 248*	*8 884*	*9 398*	*9 599*	*9 695*	*9 920*	*9 544*	*9 292*	*8 911*	*8 833*	*9 109*	*9 173*	*9 175*	*9 360*	*9 672*	*9 811*	*9 803*
North America	*4 631*	*4 889*	*5 073*	*4 934*	*4 738*	*5 020*	*5 222*	*5 243*	*5 291*	*5 088*	*5 006*	*4 758*	*4 719*	*4 923*	*4 948*	*4 916*	*5 074*	*5 315*	*5 389*	*5 301*
Europe	*3 060*	*3 145*	*3 330*	*3 229*	*3 093*	*3 292*	*3 250*	*3 336*	*3 484*	*3 351*	*3 205*	*3 087*	*3 054*	*3 060*	*3 106*	*3 141*	*3 151*	*3 141*	*3 165*	*3 154*
Asia Oceania	*917*	*963*	*1 083*	*1 086*	*1 053*	*1 086*	*1 128*	*1 117*	*1 146*	*1 105*	*1 081*	*1 065*	*1 060*	*1 126*	*1 119*	*1 118*	*1 136*	*1 215*	*1 257*	*1 348*
Annex I EIT	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*3 978*
Non-Annex I Parties	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*6 444*
Annex I Kyoto Parties	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*8 786*
OECD Total	**9 370**	**9 796**	**10 330**	**10 124**	**9 798**	**10 372**	**10 628**	**10 786**	**11 050**	**10 711**	**10 449**	**10 089**	**10 021**	**10 346**	**10 444**	**10 463**	**10 698**	**11 016**	**11 171**	**11 158**
Non-OECD Total	**4 204**	**4 440**	**4 730**	**4 947**	**5 379**	**5 632**	**5 956**	**6 333**	**6 603**	**6 796**	**6 851**	**7 036**	**7 238**	**7 483**	**7 667**	**7 974**	**8 374**	**8 720**	**8 949**	**9 195**
International marine bunkers	**343**	**359**	**379**	**354**	**329**	**339**	**340**	**342**	**352**	**345**	**320**	**287**	**268**	**271**	**294**	**313**	**309**	**325**	**325**	**358**
International aviation bunkers	**168**	**177**	**185**	**178**	**172**	**173**	**188**	**195**	**201**	**200**	**200**	**207**	**209**	**217**	**223**	**245**	**259**	**274**	**288**	**256**

Region/Country/Economy	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Canada	339.4	357.2	375.1	385.3	377.1	391.4	405.0	407.4	421.8	426.9	410.3	392.5	384.6	401.3	402.2	393.7	405.6	435.9	451.7	432.3
Chile	20.8	20.4	19.8	19.5	17.0	17.8	18.6	19.3	20.5	21.2	21.2	18.2	18.9	20.0	19.4	20.1	20.4	24.6	29.8	31.1
Mexico	97.1	110.2	121.4	131.8	138.8	149.8	158.9	176.1	190.4	212.1	228.6	238.8	232.2	241.5	251.6	248.8	259.5	260.1	273.8	264.9
United States	4 291.3	4 532.0	4 697.7	4 548.3	4 360.8	4 626.1	4 817.1	4 834.2	4 868.7	4 661.6	4 595.9	4 365.4	4 334.7	4 521.7	4 545.7	4 522.0	4 668.6	4 879.2	4 937.3	4 868.7
OECD Americas	**4 748.7**	**5 019.7**	**5 214.0**	**5 084.8**	**4 893.7**	**5 187.1**	**5 399.6**	**5 437.0**	**5 501.4**	**5 321.8**	**5 256.0**	**5 015.0**	**4 970.3**	**5 184.5**	**5 219.0**	**5 184.5**	**5 354.0**	**5 599.8**	**5 692.7**	**5 596.9**
Australia	144.1	148.9	158.5	173.3	180.0	182.4	196.7	192.3	198.3	208.0	208.3	214.5	202.5	209.0	221.0	222.1	232.0	242.1	255.3	260.1
Israel	14.4	15.2	16.2	16.4	17.1	17.1	17.9	19.1	19.6	19.6	20.4	21.6	22.4	23.1	24.5	27.0	29.4	31.1	32.4	33.1
Japan	758.8	798.4	907.6	894.7	856.3	885.2	911.5	907.0	931.1	880.7	856.6	833.0	839.5	898.3	878.1	877.1	883.8	952.3	980.3	1 064.4
Korea	52.1	54.0	67.3	70.7	76.8	85.4	97.7	106.4	120.0	124.4	129.4	129.0	137.0	148.9	153.3	159.7	166.0	189.3	200.5	229.3
New Zealand	13.7	15.7	17.1	18.1	17.1	18.8	19.4	18.2	16.3	16.4	16.3	17.9	18.1	19.1	19.6	18.6	19.9	21.1	21.3	23.3
OECD Asia Oceania	**983.1**	**1 032.2**	**1 166.7**	**1 173.3**	**1 147.2**	**1 188.9**	**1 243.1**	**1 242.9**	**1 285.3**	**1 249.1**	**1 230.8**	**1 216.0**	**1 219.5**	**1 298.3**	**1 296.4**	**1 304.4**	**1 330.9**	**1 436.0**	**1 489.8**	**1 610.2**
Austria	48.7	50.5	54.0	51.3	50.2	54.3	51.8	54.5	57.2	55.7	52.8	51.0	51.1	52.9	54.3	53.2	54.2	52.1	52.5	56.5
Belgium	116.8	126.7	132.7	130.6	115.6	124.5	123.5	129.0	132.3	125.7	115.5	109.3	100.6	102.6	101.9	102.6	102.8	104.6	105.9	107.9
Czech Republic	151.0	150.0	147.1	146.3	152.6	157.4	166.9	163.0	172.5	165.8	166.5	169.3	170.5	173.1	173.1	173.1	174.2	170.8	163.5	155.1
Denmark	55.0	57.1	56.0	49.8	52.5	58.1	59.7	59.2	62.7	62.5	52.5	54.6	51.3	52.9	60.5	61.1	59.3	55.5	49.8	50.4
Estonia	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	36.1
Finland	39.8	43.7	48.0	44.5	44.4	50.5	50.2	54.7	54.4	55.2	46.0	44.5	43.2	44.4	48.6	49.5	53.8	53.1	52.9	54.4
France	431.9	448.6	484.8	464.6	430.6	469.3	455.3	474.7	481.8	461.4	414.1	396.7	381.0	369.5	360.3	347.8	342.3	340.5	355.9	352.3
Germany	978.6	1 003.2	1 053.1	1 039.5	975.5	1 032.2	1 017.2	1 055.9	1 103.6	1 055.6	1 022.3	982.3	983.9	1 006.1	1 014.6	1 016.3	1 007.2	1 001.2	976.8	950.4
Greece	25.2	29.2	34.1	32.6	34.5	39.1	40.4	42.8	45.1	45.3	44.9	46.3	49.3	51.0	54.6	54.6	60.0	64.1	69.2	70.1
Hungary	60.3	62.2	66.6	68.8	70.7	74.3	77.9	85.8	84.4	83.7	82.9	83.1	79.6	81.5	80.8	79.3	80.2	75.3	74.2	66.7
Iceland	1.4	1.5	1.7	1.7	1.6	1.6	1.6	1.8	1.8	1.7	1.7	1.6	1.6	1.7	1.6	1.7	1.7	1.8	1.8	1.9
Ireland	21.7	21.4	20.9	22.6	21.1	22.1	23.7	23.2	27.1	25.9	25.8	25.2	25.1	24.9	26.4	27.8	29.4	28.5	29.5	29.8
Italy	292.9	309.5	331.1	334.9	319.6	345.6	335.1	343.5	358.8	359.8	349.8	345.3	341.3	348.3	347.5	349.5	369.6	374.1	391.8	397.4
Luxembourg	15.4	15.1	16.4	15.1	12.1	13.0	12.3	13.6	12.7	11.9	10.1	9.5	8.9	9.7	9.9	9.6	9.1	9.5	10.2	10.4

A large amount of data is available for free at the following address:
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Thank you. emissions@iea.org