

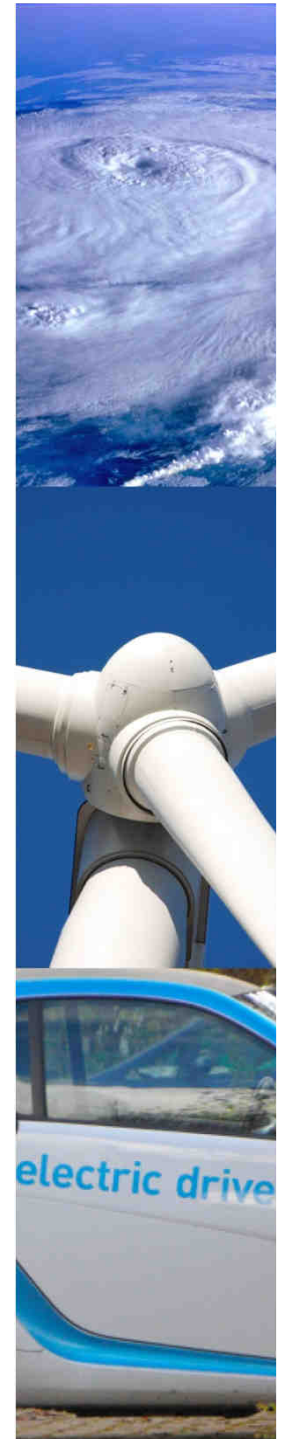


# Energy Balances for the estimation of GHG emissions

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Tirana, Albania – 16 - 17 March 2015

“ECRAN Modeling Workshop“



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- | The concept of energy balance
  
  - | Energy flows
  
  - | The principles of energy balance
  
  - | The estimation of GHG emissions based on energy balances
  
  
  - | Sources of information
    - International Recommendations for Energy Statistics by United Nations Statistics Division
    - Statistical Manual of the International Energy Agency
    - Energy Statistics Methodology by Eurostat

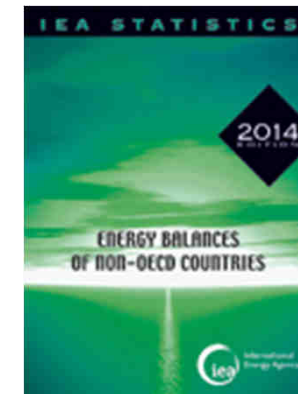
## Concept of energy balance



- | An energy balance is an accounting framework for compilation and reconciliation of data on all energy products entering, exiting and used within the national territory of a given country during a reference period.
  
- | The basis for an energy balance is energy commodity balances - balances compiled for individual energy commodities
  
- | The energy balance is based on the 1st law of thermodynamics
  - “The amount of energy within any closed system is fixed”

- | IPCC recommends using national energy balances for the estimation of GHG emissions
- | When national sources are not available, IPCC suggests using data from international organizations
- | National and international energy balances rely on different methodologies and the balance presentation

- | The main sources of international energy statistics
  
- | Prepared by United Nations Statistical Division – until 2011
  - Albania, Montenegro – available, Kosovo – not available
  - URL: <http://unstats.un.org/unsd/energy/balance/default.htm>
  
- | Prepared by International Energy Agency – until 2012
  - All countries
  - URL: <http://www.iea.org/statistics/statisticssearch/>
  
- | Prepared by EUROSTAT – until 2013
  - Albania, Montenegro – available, Kosovo – not available
  - URL: <http://ec.europa.eu/eurostat/web/energy/data/energy-balances>
  
- | All sources collect data from the national administrations of the member countries through questionnaires



| The scope of an energy balance is determined by:









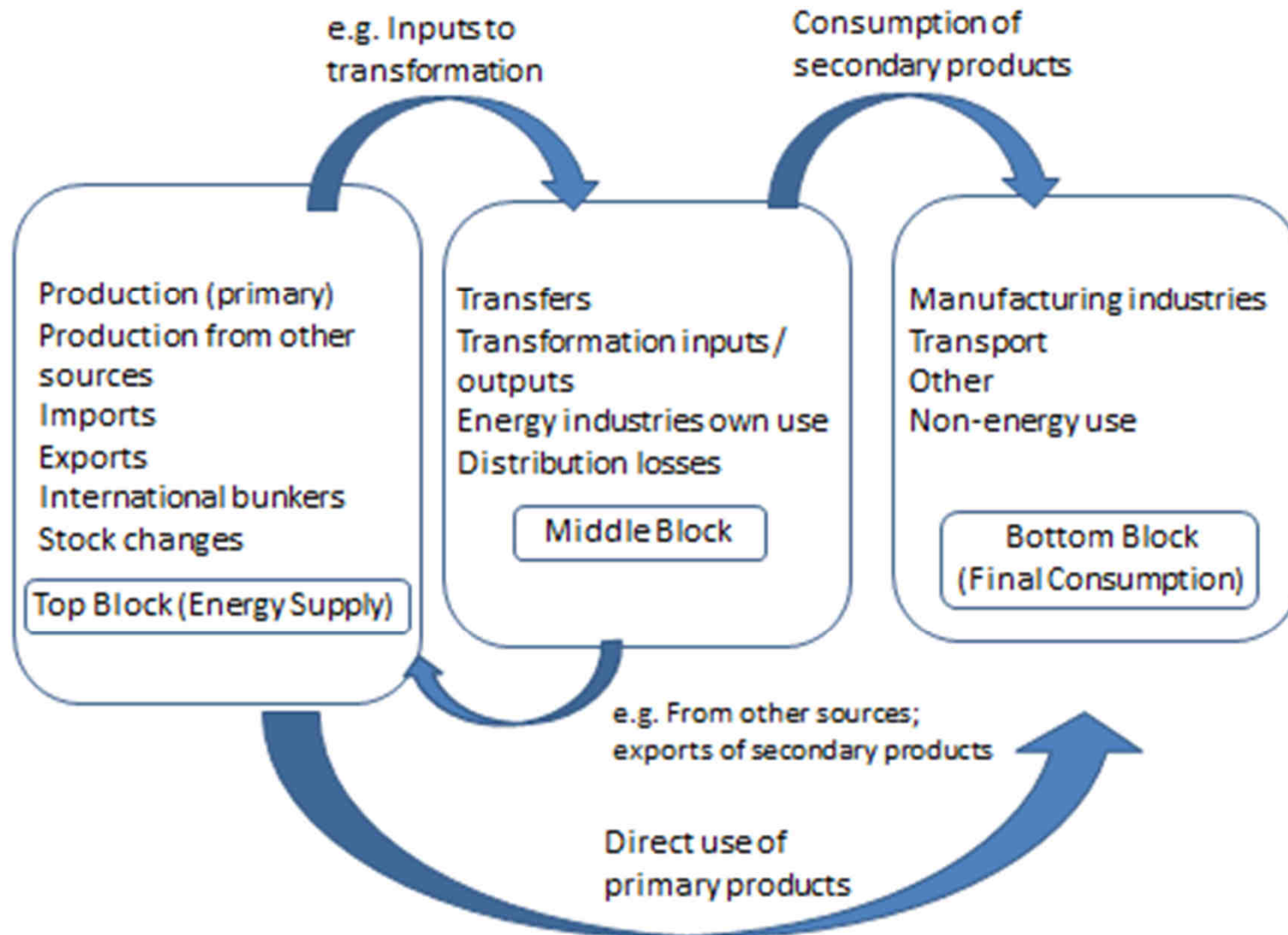


Usually, energy balances do not include:

- Passive energy such as the heat gain of buildings and solar energy falling on the land to grow crops, etc.
- Deposits of energy resources and reserves
- Extraction of any materials not covered in primary energy production
- Waste and biomass used for non-energy purposes

## Energy flows





## Top block: Energy supply



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### Total primary energy supply

+ *Primary production*

+ *Imports*

- *Exports*

+/- *Stock changes*

- *International marine bunkers*

- *International aviation bunkers*

## The middle block: Transformation



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### Net energy supply available for final consumption

-/+	<b><i>Transfers</i></b>
-/+	<b><i>Transformation input/output</i></b>
+/-	Electricity plants
+/-	CHP Plants
+/-	Heat plants
+/-	Gas works
+/-	Oil refineries
+/-	Coal transformation
+/-	Liquefaction plants
	Other transformation
-	<b><i>Energy sector own use</i></b>
-	<b><i>Transmission and distribution losses</i></b>



## Bottom block: Final energy consumption



<b>Final energy use</b>	
<b>+</b>	<b><i>Final energy consumption</i></b>
	+ Industry
	+ Iron & steel industry
	+ Chemical and Petrochemical industry
	+ Non-ferrous metal industry
	+ Non-metallic Minerals (Glass, pottery & building mat. Industry)
	+ Transport Equipment
	+ Machinery
	+ Mining and Quarrying
	+ Food and Tabasco
	+ Paper, Pulp and Print
	+ Wood and Wood Products
	+ Construction
	+ Textile and Leather
	+ Non-specified (Industry)
	+ Transport
	+ Rail
	+ Road
	+ International aviation
	+ Domestic aviation
	+ Domestic Navigation
	+ Pipeline transport
	+ Non-specified (Transport)
	+ Other Sectors
	+ Services
	+ Residential
	+ Agriculture / Forestry
	+ Fishing
	+ Non-specified (Other)
<b>+</b>	<b><i>Non-energy use consumption</i></b>
	+ Non-Energy Use in Transformation sector
	+ Non-Energy Use in Energy sector
	+ Non-Energy Use in Industry sector
	+ Non-Energy Use in Transport sector
	+ Non-Energy Use in Other sectors
	+ Non-Energy Use in Industry, Transformation and Energy Sectors

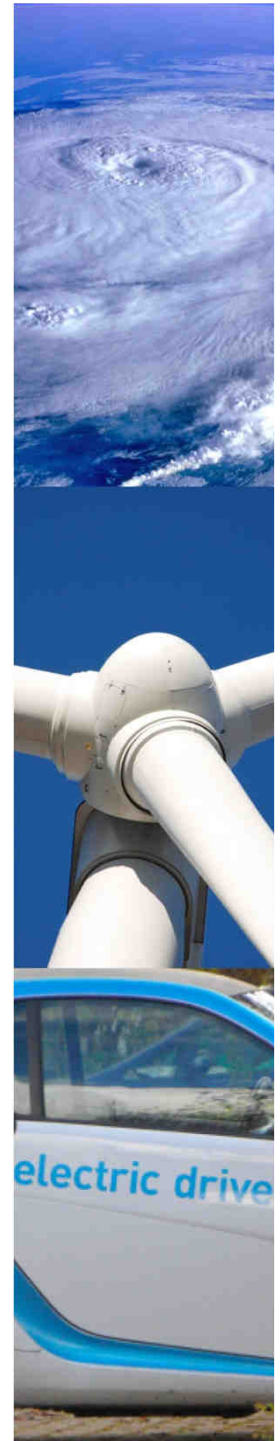
## Albania: Balances for 2012

*in thousand tonnes of oil equivalent (ktoe) on a net calorific value basis*

2012 ▾	Indicators	Balances	Coal	Electricity and Heat	Natural Gas	Oil	Renewables and Waste					
		Coal*	Crude oil*	Oil products	Natural gas	Nuclear	Hydro	Geothermal, solar, etc.	Biofuels and waste	Electricity	Heat	Total**
	Production	1	1031	0	13	0	406	12	206	0	0	1670
	Imports	161	0	984	0	0	0	0	0	218	0	1364
	Exports	0	-957	-18	0	0	0	0	0	0	0	-975
	International marine bunkers***	0	0	0	0	0	0	0	0	0	0	0
	International aviation bunkers***	0	0	-21	0	0	0	0	0	0	0	-21
	Stock changes	0	37	0	0	0	0	0	0	0	0	37
	<b>TPES</b>	<b>162</b>	<b>111</b>	<b>945</b>	<b>13</b>	<b>0</b>	<b>406</b>	<b>12</b>	<b>206</b>	<b>218</b>	<b>0</b>	<b>2075</b>
	Transfers	0	0	0	0	0	0	0	0	0	0	0
	Statistical differences	0	0	-1	0	0	0	0	0	24	0	23
	Electricity plants	0	0	0	0	0	-406	0	0	406	0	0



## Principles of energy balances



| All entries into the energy balance are expressed in one energy unit

### | Examples

- USA uses Mbtu
- IEA uses Mtoe
- UNSD uses terajoules
- EUROSTAT uses ktoe
- Russia and China use Mtce
- Albania uses ktoe
- Kosovo uses ktoe
- Montenegro uses terajoule

| Commercial units of the same fuel (e.g. tons of coal) could be converted into energy units using different conversion factors because caloric values of fuels may vary from country to country and sometimes by flow

- -> This could be a reason in difference in the same flow of the same country reported by different sources.

- | Countries use either net calorific values (NCVs) or gross calorific values (GCVs) for measuring the energy content of energy products.
- | The difference between NCV and GCV is the latent heat of vaporisation of the water produced during combustion
- | Using different basis to calculate caloric values of fuels could be another reason for differences in energy balances reported for the same countries by different sources
- | The corresponding conversion factors should be usually reported and countries should clearly identify which method is used for calculating its energy balance

## | Partial substitution method

- Represents the amount of energy necessary in conventional thermal plants
- Difficult to choose efficiency
- Not relevant for countries with a high share of hydro

## | Physical energy content method

- Most commonly used
- Uses physical energy content of the primary energy source

# Physical energy content vs. partial substitution

## Energy Balance of Russia : 2009

Using physical energy content method

Renewables = 3.4%

Thousand tonnes of oil equivalent											
SUPPLY AND CONSUMPTION	Coal & peat	Crude oil*	Oil products	Natural gas	Nuclear	Hydro	Geotherm. solar etc.	Biofuels & waste	Electricity	Heat	Total
Production	63640	493641	-	469561	42959	14980	399	64	-	-	18589
Imports	14530	1793	808	6675	-	-	-	-	264	-	24071
Exports	-68671	-25041	-10105	-13120	-	-	-	-	-1541	-	-552699
Intl. marine bunkers	-	-	-	-	-	-	-	-	-	-	-
Intl. aviation bunkers	-	-	-5858	-	-	-	-	-	-	-	-5858
Stock changes	-4228	-1635	451	5268	-	-	-	-	-43	-	-187
<b>TPES</b>	<b>86271</b>	<b>243668</b>	<b>-106734</b>	<b>360286</b>	<b>42959</b>	<b>14980</b>	<b>399</b>	<b>0.34</b>	<b>-1278</b>	<b>-</b>	<b>848816</b>
Electricity and Heat Output											
Eleo. generated - GWh	184112	17	18004	489034	183684	174183	488	2843	-	-	890046
Heat generated - TJ	1088666	27298	302619	3806801	13730	-	299726	118008	-	-	6863844

Using partial substitution method

Renewables = 6.8%

Thousand tonnes of oil equivalent											
SUPPLY AND CONSUMPTION	Coal & peat	Crude oil*	Oil products	Natural gas	Nuclear	Hydro	Geotherm. solar etc.	Biofuels & waste	Electricity	Heat	Total
Production	63640	493641	-	469561	36869	38908	104	64	-	-	189134
Imports	14530	1793	808	6675	-	-	-	-	264	-	24071
Exports	-68671	-25041	-10105	-13120	-	-	-	-	-1541	-	-552699
Intl. marine bunkers	-	-	-	-	-	-	-	-	-	-	-
Intl. aviation bunkers	-	-	-5858	-	-	-	-	-	-	-	-5858
Stock changes	-4228	-1635	451	5268	-	-	-	-	-43	-	-187
<b>TPER</b>	<b>86271</b>	<b>243668</b>	<b>-106734</b>	<b>360286</b>	<b>36869</b>	<b>38908</b>	<b>104</b>	<b>0.89</b>	<b>-1278</b>	<b>-</b>	<b>884481</b>
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## Estimating GHG emissions using energy balances





■ The methodological guidance on the estimation of national GHG emissions as a part of the preparation of national inventories is provided by the Intergovernmental Panel on Climate Change (IPCC)

■ The current basis for official national reporting of GHG inventories under the UNFCCC and the Kyoto Protocol includes

- Revised 1996 IPCC Guidelines for National GHG Inventories + Good Practice Guidance
- Uncertainty Management National GHG Inventories (2000)
- Good Practice Guidance for Land Use, Land- Use Change and Forestry (2003)



■ The 2006 IPCC Guidelines for National Greenhouse Gas Inventories were prepared and their adoption for reporting under UNFCCC is currently under discussion

## I Tier-1 methods

- Quantities of fuel combusted X emission factors
- Fuel combusted is usually taken from national energy statistics
- Emission factors are default

## I Tier-2 methods

- Quantities of fuel combusted X emission factors
- Fuel combusted is usually taken from national energy statistics (more detailed)
- Emission factors are country-specific
- More details than Tier -1

## I Tier-3

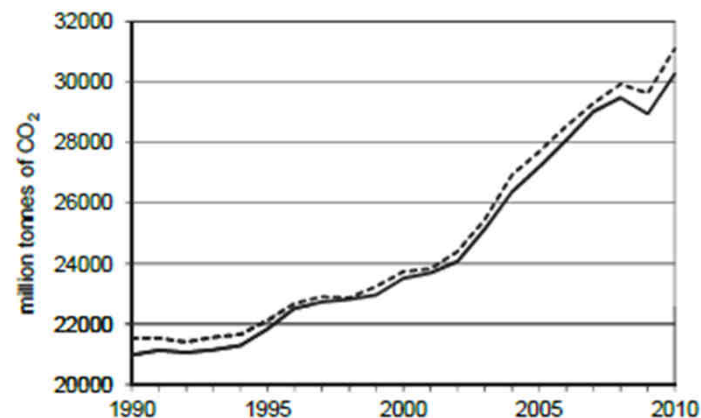
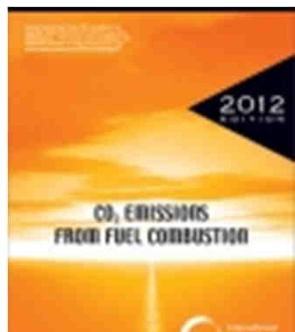
- Detailed country-specific emission models and inventory data are used
- Tier-3 is more detailed than Tier-2



■ The reference approach requires statistics on the production of fuels, on their external trade, as well as on changes in their stocks. It also requires some data on the consumption of fuels used for non-energy purposes.



# Reference vs sectoral: the world, 2010



se  
 — Total CO2 emissions - Sectoral Approach  
 - - - - - Total CO2 emissions - Reference Approach

## 2010 CO<sub>2</sub> emissions by sec

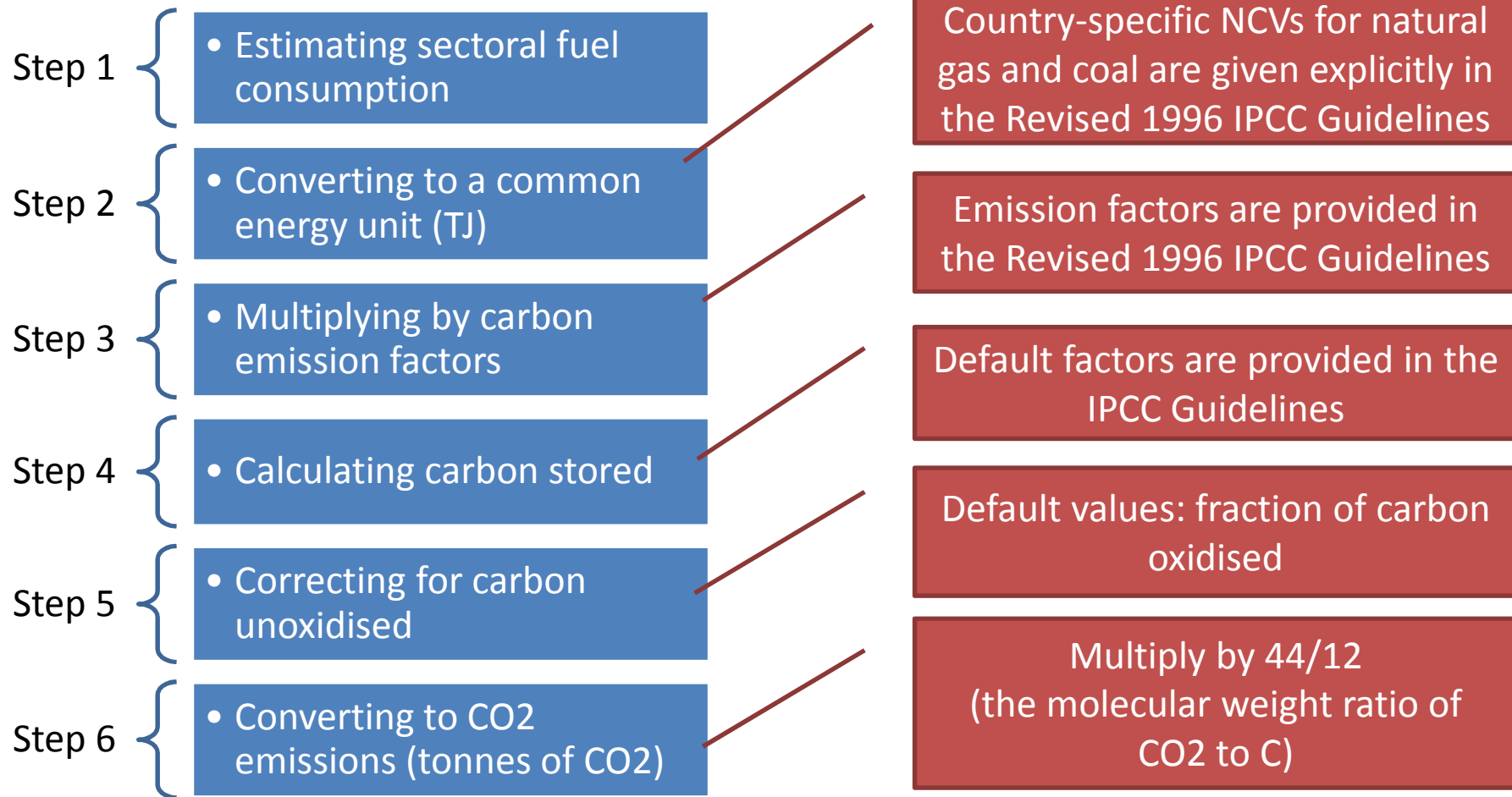
<i>million tonnes of CO<sub>2</sub></i>	Coal/peat	Oil	Natural gas	Other *	Total	% change 90-10
<b>Sectoral Approach **</b>	<b>13 065.9</b>	<b>10 890.5</b>	<b>6 179.1</b>	<b>140.6</b>	<b>30 276.1</b>	<b>44.4%</b>
Main activity producer elec. and heat	8 449.2	702.2	2 169.2	40.9	11 361.4	71.5%
Unallocated autoproducers	489.4	156.9	411.3	61.5	1 119.1	26.3%
Other energy industry own use			8.2	0.9	1 570.8	55.4%
Manufacturing industries and construction			0.0	32.5	6 186.4	36.6%
Transport **			2.1	-	6 755.8	47.0%
<i>of which: road</i>			0.6	-	4 972.1	51.1%
Other			8.3	4.9	3 282.6	-1.3%
<i>of which: residential</i>	301.0	595.3	984.1	0.0	1 880.4	3.2%
<b>Reference Approach **</b>	<b>13 700.9</b>	<b>11 007.0</b>	<b>6 253.8</b>	<b>140.6</b>	<b>31 102.3</b>	<b>44.4%</b>
Diff. due to losses and/or transformation	308.2	99.0	81.3	0.0	488.6	
Statistical differences	326.8	17.4	-6.6	-0.0	337.6	
<i>Memo: international marine bunkers</i>	-	643.7	-	-	643.7	77.6%
<i>Memo: international aviation bunkers</i>	-	455.3	-	-	455.3	78.3%

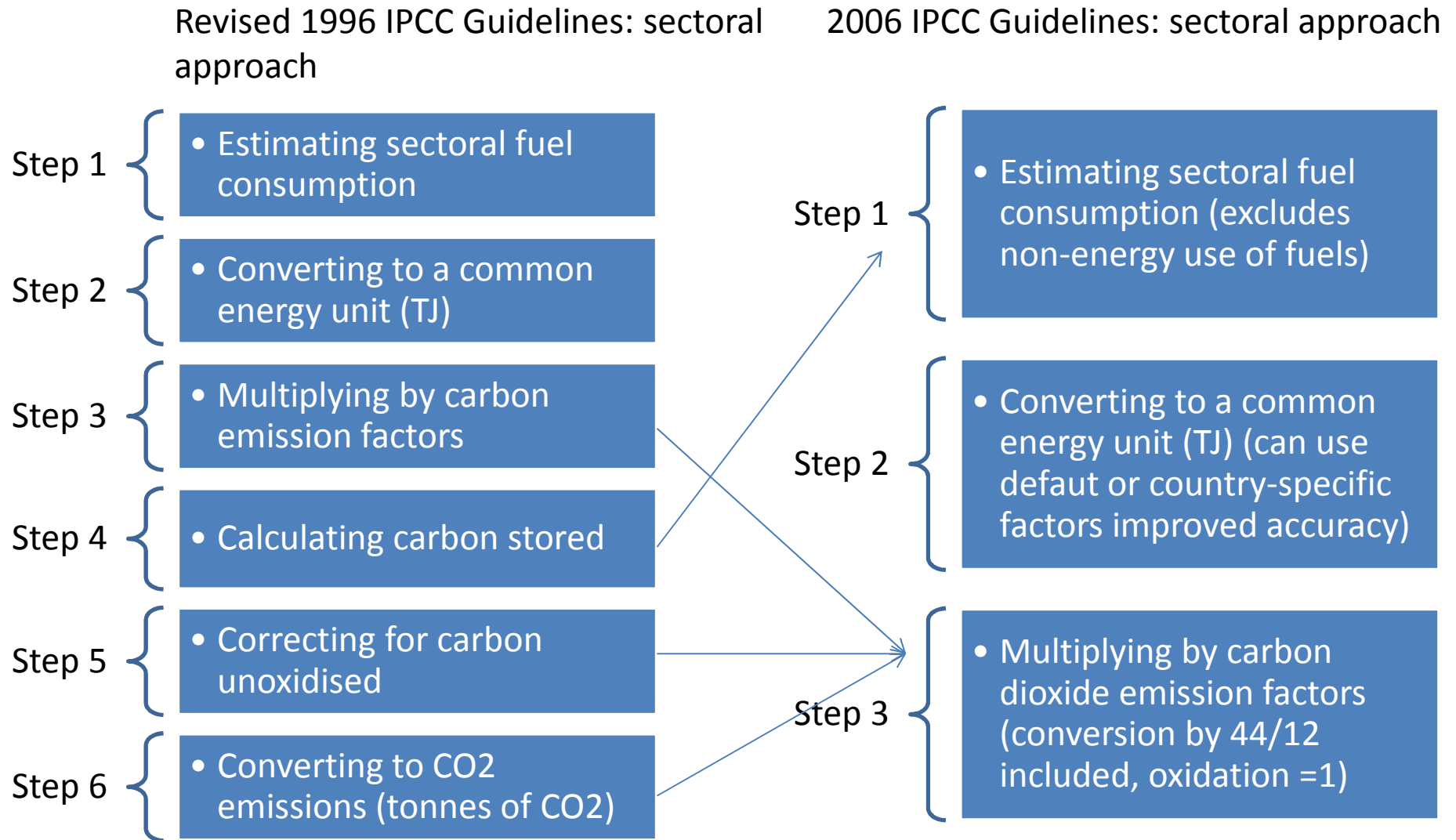
Residential only includes emissions from fuels actually combusted in households (hence its relatively small share), not electricity or heat consumption

\* Other includes industrial waste and non-renewable municipal waste.

\*\* World includes international marine bunkers and international aviation bunkers.

## Revised 1996 IPCC Guidelines: sectoral approach







## | Transformation Sector

- Eurostat balances show the transformation input separately from the transformation output. IEA balances show the inputs as negative numbers and the outputs as positive numbers on the same line.

## | Transfers of nuclear, hydro and wind to the electricity column

- Eurostat balances transfer the nuclear in the transformation input and transformation output sectors. For hydro and wind, the “interproduct transfers” row is used. The IEA balances treat nuclear, hydro and wind in the same way as other transformation processes, i.e. the inputs as negative numbers and the outputs as positive numbers.

## | Definition of Supply

- Eurostat balances subtract international marine bunkers out of supply, but international aviation bunkers are included with domestic air transport in final consumption. The IEA balances have just been changed as a result of the work done by InterEnerStat so that both the international marine and the international aviation bunkers are treated in the same way and both are now subtracted out of supply.

There can be many 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 information 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

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