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Energy balances as a first tool for informing policies: *Introduction to the energy balances*

Mafalda Silva and Charles Michaelis

Pretoria, 15 October 2019

IEA #energyefficientworld

- Overview

The importance of energy balances

- How to read an energy balance?
- Aggregated indicators from the energy balances
- Example of applications of aggregated indicators

Practical exercise

The importance of energy balances: bringing all information together

"…An accounting **framework** for compilation of data on **all energy products entering, exiting, and used** within the **national territory** of a given **country** during a reference period."

Source: International Recommendations on Energy Statistics (IRES), UNSD, 2011

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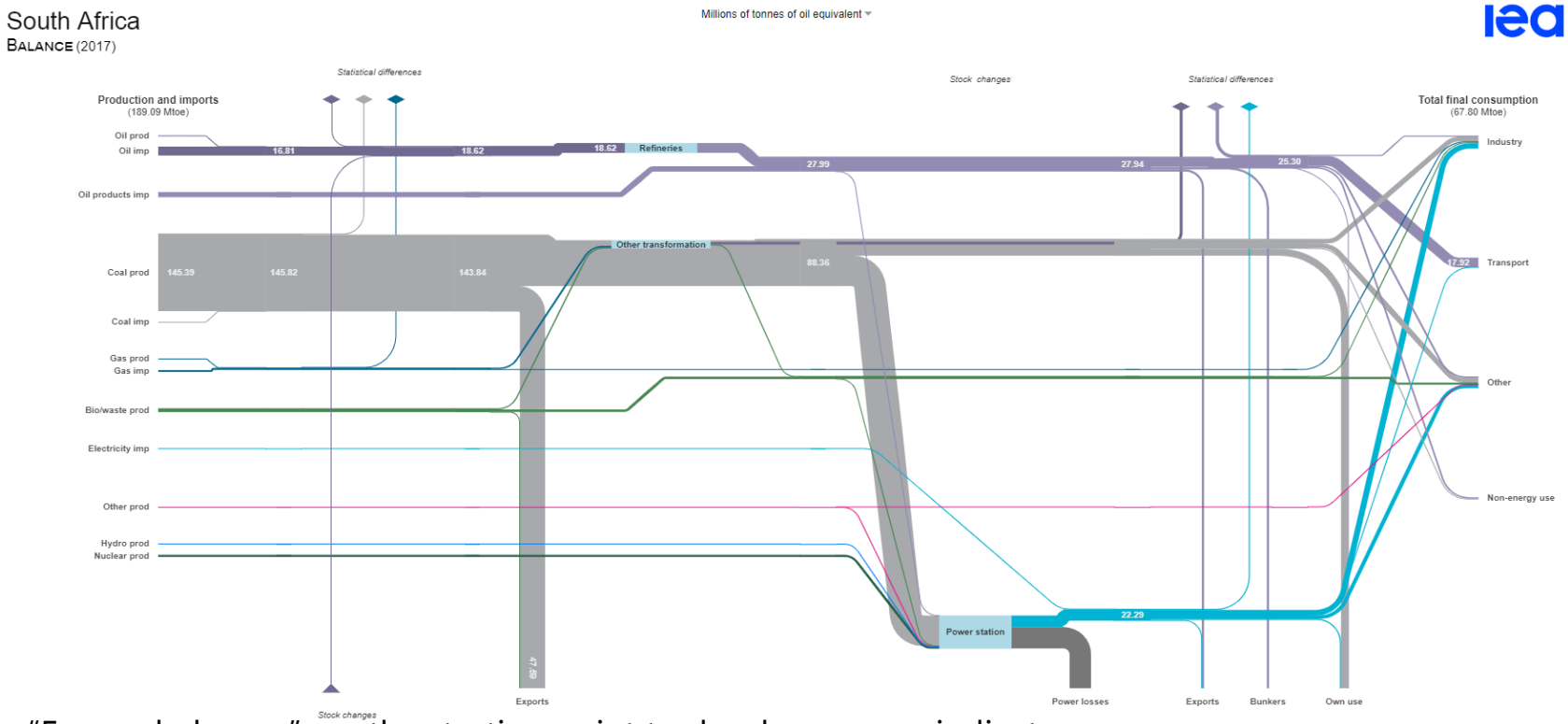
The complete picture – Sankey diagram example of energy balance



"Energy balances" are the starting point to develop energy indicators

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Why do we develop energy balances?

- **To understand overall energy use in country,** from supply, to transformation and final consumption sectors.
- **To estimate high-level indicators** and **CO_2 emissions** from the energy sector
- **To assess data completeness and check quality** of the various energy commodity balances

How to read an energy balance?

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The energy balance table

World

2016

Million tonnes of oil equivalent

SUPPLY AND CONSUMPTION	Coal[1]	Crude oil[2]	Oil products	Natural gas	Nuclear	Hydro	Geotherm./ Solar/ etc.	Biofuels/ Waste	Electricity	Heat	Total
Production	3657.19	4473.27	-	3032.41	679.65	349.22	225.63	1344.87	-	1.76	13763.99
Imports	795.23	2379.32	1329.40	915.52	-	-	-	23.92	62.11	0.01	5505.50
Exports	-833.43	-2354.63	-1414.63	-932.53	-	-	-	-19.44	-62.25	-0.01	-5616.91
Stock changes	111.90	-15.32	-7.21	19.55	-	-	-	-0.06	-	-	108.86
TPES	**3730.89**	**4482.63**	**-92.43**	**3034.95**	**679.65**	**349.22**	**225.63**	**1349.29**	**-0.14**	**1.77**	**13761.45**
Transfers	-1.36	-233.00	262.09	-	-	-	-	-	-	-	27.73
Statistical differences	28.63	11.25	14.35	-11.26	-	-	0.09	0.84	-1.14	-0.35	42.41
Electricity plants	-1672.04	-40.48	-178.55	-868.18	-672.06	-349.22	-177.96	-120.97	1811.30	-0.72	-2268.88
CHP plants	-623.84	-0.01	-17.99	-314.57	-7.59	-	-2.56	-60.58	335.99	239.30	-451.86
Heat plants	-23.38	-0.83	-10.95	-61.70	-	-	-1.56	-13.13	-0.46	102.63	-9.39
Blast furnaces	-207.69	-	-0.05	-0.01	-	-	-	-0.04	-	-	-207.78
Gas works	-13.32	-	-2.17	5.42	-	-	-	-0.27	-	-	-10.34
Coke/pat.fuel/BKB/PB plants	-89.82	-	-2.32	-0.03	-	-	-	-0.12	-	-	-92.29
Oil refineries	-	-4246.76	4165.65	-	-	-	-	-	-	-	-81.11
Petrochemical plants	-	35.90	-35.37	-	-	-	-	-	-	-	0.53
Liquefaction plants	-12.08	15.16	-	-16.47	-	-	-	-	-	-	-13.40
Other transformation	-0.30	10.75	-0.54	-13.01	-	-	-	-90.54	-	-0.68	-94.32
Energy industry own use	-75.28	-11.24	-208.00	-296.17	-	-	-0.00	-13.46	-181.96	-36.50	-822.61
Losses	-4.91	-8.69	-0.47	-18.71	-	-	-0.01	-0.14	-169.65	-22.26	-224.84
TFC	**1035.50**	**14.68**	**3893.25**	**1440.26**	**-**	**-**	**43.63**	**1050.88**	**1793.94**	**283.18**	**9555.32**
Industry	826.95	6.66	299.71	537.77	-	-	0.92	198.33	746.69	135.57	2752.60
Transport	0.07	0.01	2533.20	101.89	-	-	-	81.97	30.73	-	2747.87
Residential	72.73	-	209.30	431.24	-	-	31.64	728.60	488.44	99.20	2061.15
Services	33.90	-	85.72	187.45	-	-	7.88	28.28	395.52	36.99	775.73
Agriculture/Forestry	16.08	0.01	104.20	9.66	-	-	2.07	9.84	52.79	3.21	197.87
Fishing	0.00	-	5.68	0.06	-	-	0.05	0.01	0.55	0.05	6.41
Non-specified other	30.08	0.01	18.27	3.42	-	-	1.06	3.84	79.21	8.16	144.05
Non-energy use	55.70	8.00	637.17	168.78	-	-	-	-	-	-	869.64

- Columns present the "commodity balances" for all products
- All data are comparable thanks to a common energy unit
- Total energy can be defined

Source: IEA 2018, World Energy Balances

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Quiz

- How to convert mass to energy units?

A. Density

B. Calorific value

C. Carbon content

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Answer

➢How to convert mass to energy units?

A. Density

B. Calorific value

C. Carbon content

Typically in units of energy per mass **(kJ/kg)**

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- Understanding the main energy flows

Supply

Transformation & own use

Final consumption

Rows present energy flows across energy products

Three main "blocks" of flows

World

2016

Million tonnes of oil equivalent

SUPPLY AND CONSUMPTION	Coal[1]	Crude oil[2]	Oil products	Natural gas	Nuclear	Hydro	Geotherm./ Solar/ etc.	Biofuels/ Waste	Electricity	Heat	Total
Production	3657.19	4473.27	-	3032.41	679.65	349.22	225.63	1344.87	-	1.76	13763.99
Imports	795.23	2379.32	1329.40	915.52	-	-	-	23.92	62.11	0.01	5505.50
Exports	-833.43	-2354.63	-1414.63	-932.53	-	-	-	-19.44	-62.25	-0.01	-5616.91
Stock changes											108.86
TPES											761.45
Transfers											27.73
Statistical differences											42.41
Electricity plants											268.88
CHP plants											451.86
Heat plants											-9.39
Blast furnaces	-207.69	-	-0.05	-0.01	-	-	-	-0.04	-	-	-207.78
Gas works	-13.32	-	-2.17	5.42	-	-	-	-0.27	-	-	-10.34
Coke/pat.fuel/BKB/PB plants	-89.82	-	-2.32	-0.03	-	-	-	-0.12	-	-	-92.29
Oil refineries	-	-4246.76	4165.65	-	-	-	-	-	-	-	-81.11
Petrochemical plants	-	35.90	-35.37	-	-	-	-	-	-	-	0.53
Liquefaction plants	-12.08	15.16	-	-16.47	-	-	-	-	-	-	-13.40
Other transformation	-0.30	10.75	-0.54	-13.01	-	-	-	-90.54	-	-0.68	-94.32
Energy industry own use											-822.61
Losses											224.84
TFC											555.32
Industry											2752.60
Transport	0.07	0.01	2533.20	101.89	-	-	-	81.97	30.73	-	2747.87
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1: Energy supply

World

2016

Million tonnes of oil equivalent

SUPPLY	Coal	Crude oil	Oil products	Natural gas	Nuclear	Hydro	Geother m./ Solar/ etc.	Biofuels/ Waste	Electricity	Heat	Total
Production	3657.19	4473.27						1344.87	-	1.76	13763.99
Imports	795.23	2379.32						23.92	62.11	0.01	5505.50
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Stock changes	111.90	-15.32						-0.06	-	-	108.86
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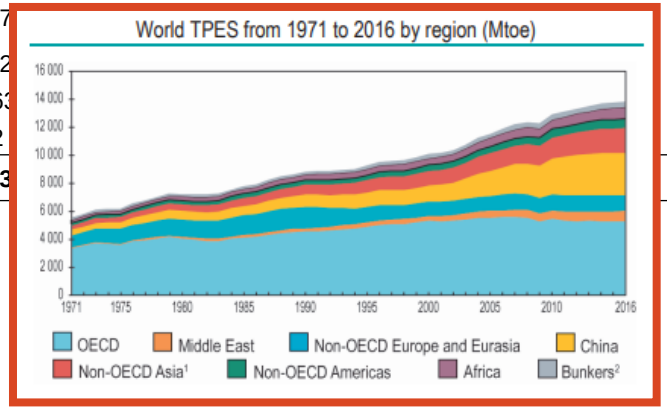

Source: IEA 2018, World Energy Balances; IEA 2018, Key World Energy Statistics

"High-level" information: **TPES, Totals, etc…**

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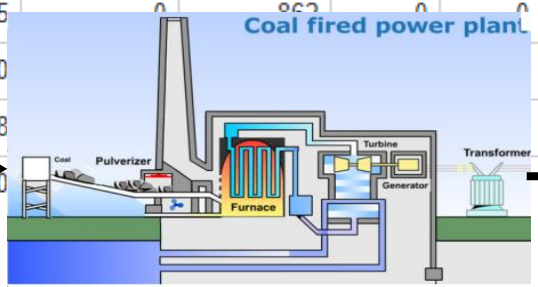
2: Transformation and own use

	Coal and peat	Crude oil	Oil products	Natural gas	Nuclear	Hydro	Geothermal, solar, etc.	Biofuels and waste	Electricity	Heat	Total*
Electricity plants	-355445	0	-31163	-119138	-20839	-27438	-31647	-21908	231911	0	-375667
CHP plants	-9940	0	-360	-178	0	0	0	0	3536	1068	-5875
Heat plants	0							0	0	0	0
Gas works	-30							0	0	0	-30
Oil refineries	0	-508585	501625	0	0	0	0	0	0	0	-6960
Coal transformation	-18358	0	0	0	0	0	0	0	0	0	-18358
Liquefication plants	0	465					0	0	0	0	-397
Other transformation	0	0					0	-16141	0	0	-16190
Energy industry		-628								-65	-62651
Losses		-200								-33	-36890

Transforming energy sources

Input (coal)



Output (electricity)

The concept of transformation efficiency = output / input

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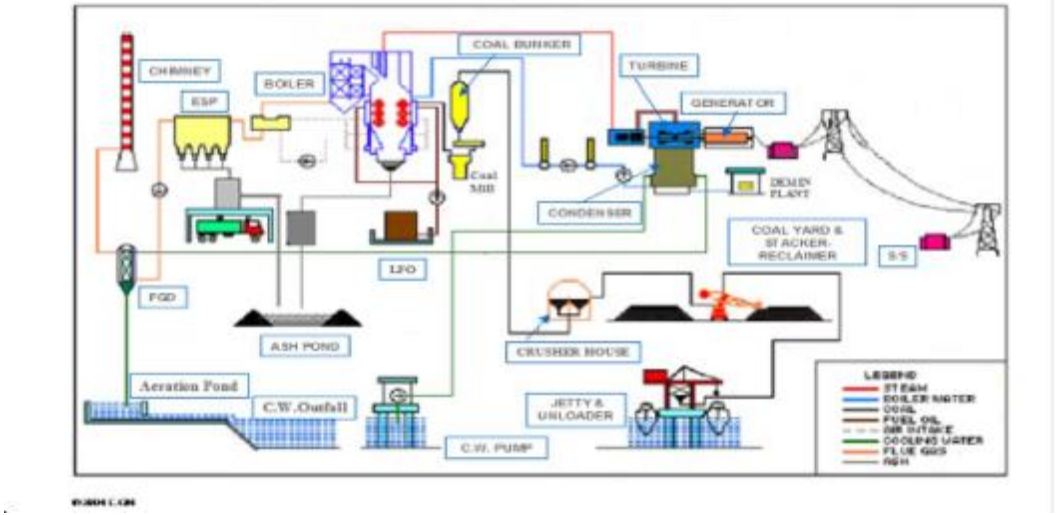
Quiz

➢ What is the average efficiency for a **coal electricity-only** power plant?

A. 37%

B. 52%

C. 65%



Source: IEA, World Energy Balances, 2018.

Answer

➢ What is the average efficiency for a **coal electricity-only** power plant?

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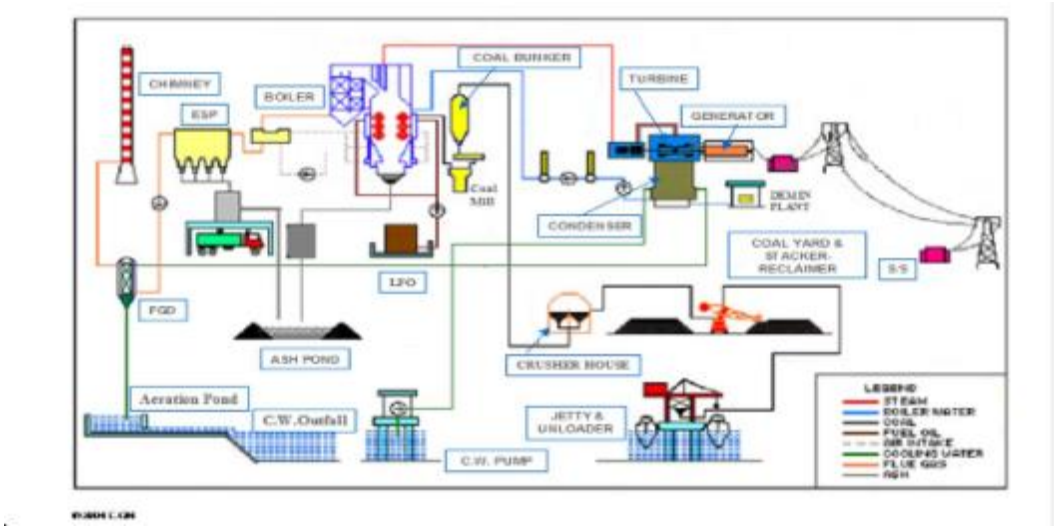

Source: IEA, World Energy Balances, 2018.

3: Final consumption

World

2016

Million tonnes of oil equivalent

FINAL CONSUMPTION	Coal	Crude oil	Oil products	Natural gas	Nuclear	Hydro	Geother m./ Solar/ etc.	Biofuels/ Waste	Electricity	Heat	Total
TFC	**1035.50**	**14.68**	**3893.25**	**1440.26**	**-**	**-**	**43.63**	**1050.88**	**1793.94**	**283.18**	**9555.32**
Industry	826.95	6.66	299.71	537.77	-	-	0.92	198.33	746.69	135.57	2752.60
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Non-energy use	55.70	8.00	637.17	168.78	-	-	-	-	-	-	869.64

Delivery of energy products to all final consumers (sectors)

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Quiz

➢ What is the largest energy-consuming sector globally?

- **Buildings**

- **Transport**

- **Industry**

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Answer

➢ What is the largest energy-consuming* sector globally?

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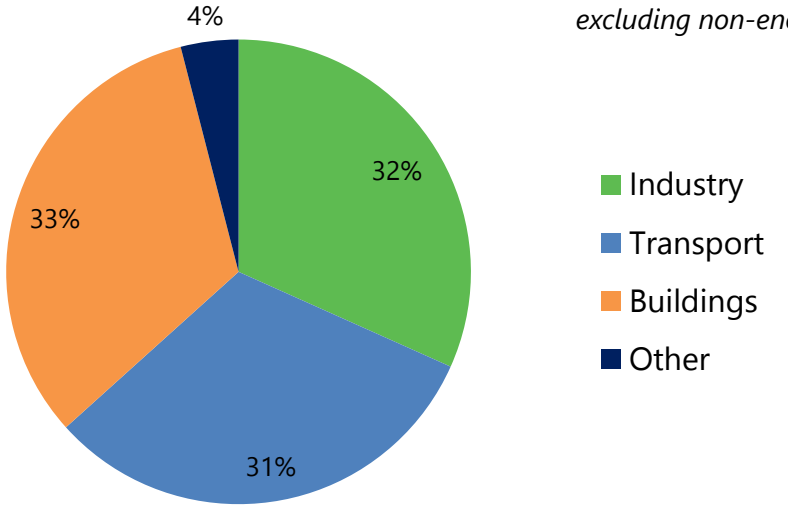

** Total Final Consumption excluding non-energy uses*

Source: IEA, World Energy Balances, 2018

Aggregated indicators from the energy balances

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From energy balances we derive high-level information

Supply →

Transformation →

Final consumption →

World

2016

Million tonnes of oil equivalent

SUPPLY AND CONSUMPTION	Coal[1]	Crude oil[2]	Oil products	Natural gas	Nuclear	Hydro	Geotherm./ Solar/ etc.	Biofuels/ Waste	Electricity	Heat	Total
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CHP plants	-623.84	-0.01	-17.99	-314.57	-7.59	-	-2.56	-60.58	335.99	239.30	-451.86
Heat plants	-23.38	-0.83	-10.95	-61.70	-	-	-1.56	-			
Blast furnaces	-207.69	-	-0.05	-0.01	-	-	-				
Gas works	-13.32	-	-2.17	5.42	-	-	-				
Coke/pat.fuel/BKB/PB plants	-89.82	-	-2.32	-0.03	-	-	-				
Oil refineries	-	-4246.76	4165.65	-	-	-	-				
Petrochemical plants	-	35.90	-35.37	-	-	-	-	-	-	-	0.53
Liquefaction plants	-12.08	15.16	-	-16.47	-	-	-	-	-	-	-13.40
Other transformation	-0.30	10.75	-0.54	-13.01	-	-	-	-90.54	-	-0.68	-94.32
Energy industry own use	-75.28	-11.24	-208.00	-296.17	-	-	-0.00	-13.46	-181.96	-36.50	-822.61
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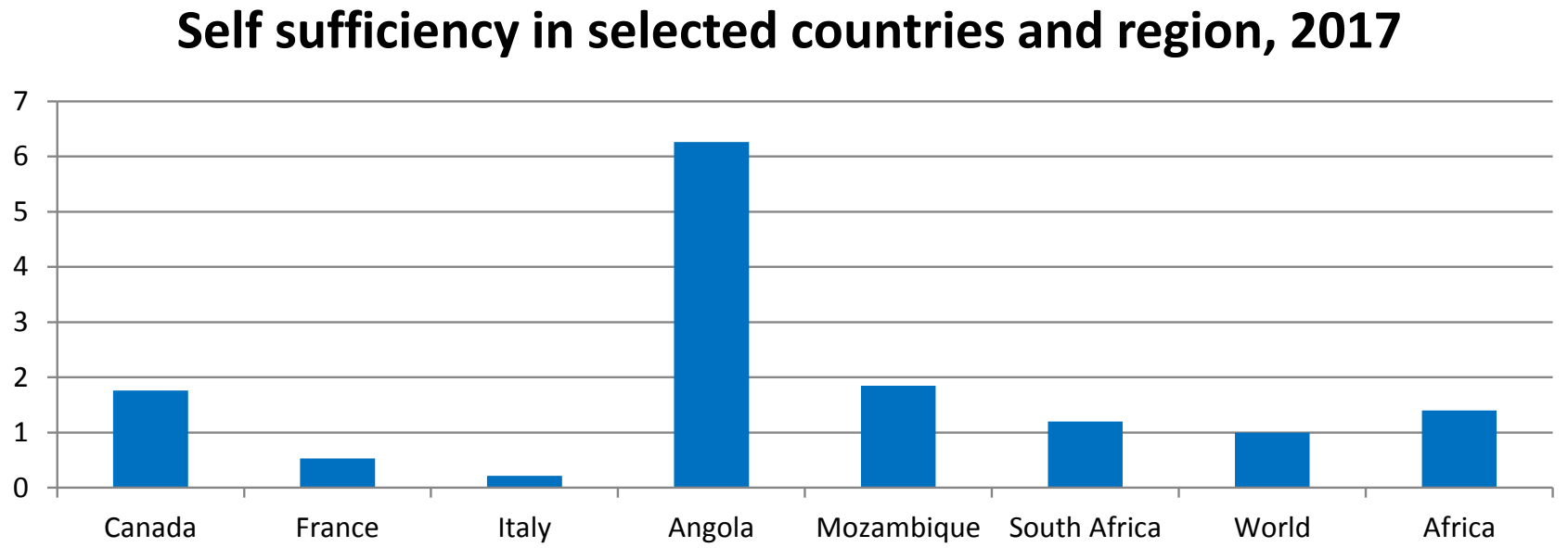
Transport	0.07	0.01	2533.20	101.89	-	-	-	81			
Residential	72.73	-	209.30	431.24	-	-	31.64	72			
Services	33.90	-	85.72	187.45	-	-	7.88	28			
Agriculture/Forestry	16.08	0.01	104.20	9.66	-	-	2.07	9			
Fishing	0.00	-	5.68	0.06	-	-	0.05	0			
Non-specified other	30.08	0.01	18.27	3.42	-	-	1.06	3.0			
Non-energy use	55.70	8.00	637.17	168.78	-	-	-	-	-	-	869.64

Energy intensity, Self-sufficiency …

Efficiencies of transformation sector

Shares of energy consumption by sector

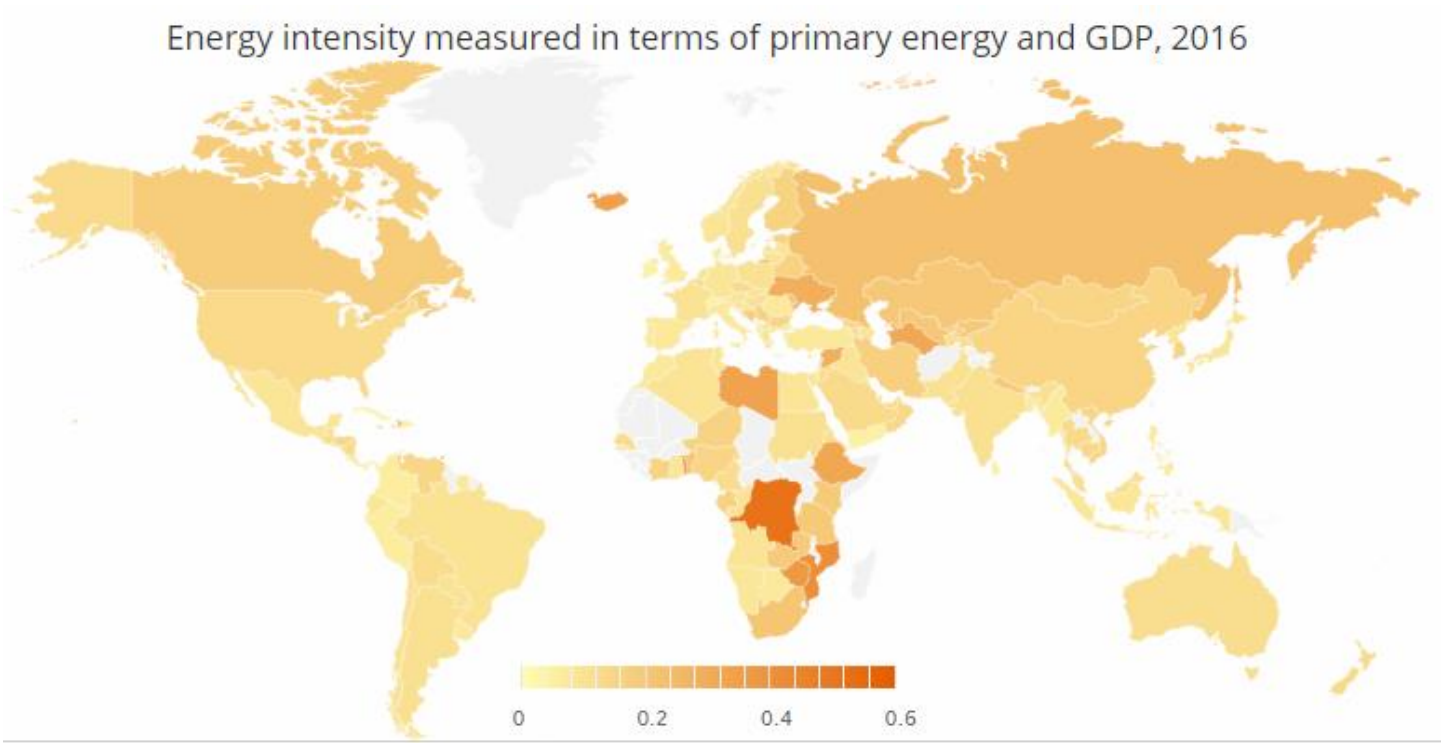
Examples of high level indicators: self-sufficiency



Source: IEA, World Energy Balances, 2019

Self-sufficiency: production/total primary energy supply

…calculate aggregated energy intensities and other indicators



Energy (TPES) per unit of GDP: Tracking SDG 7.3 at global level

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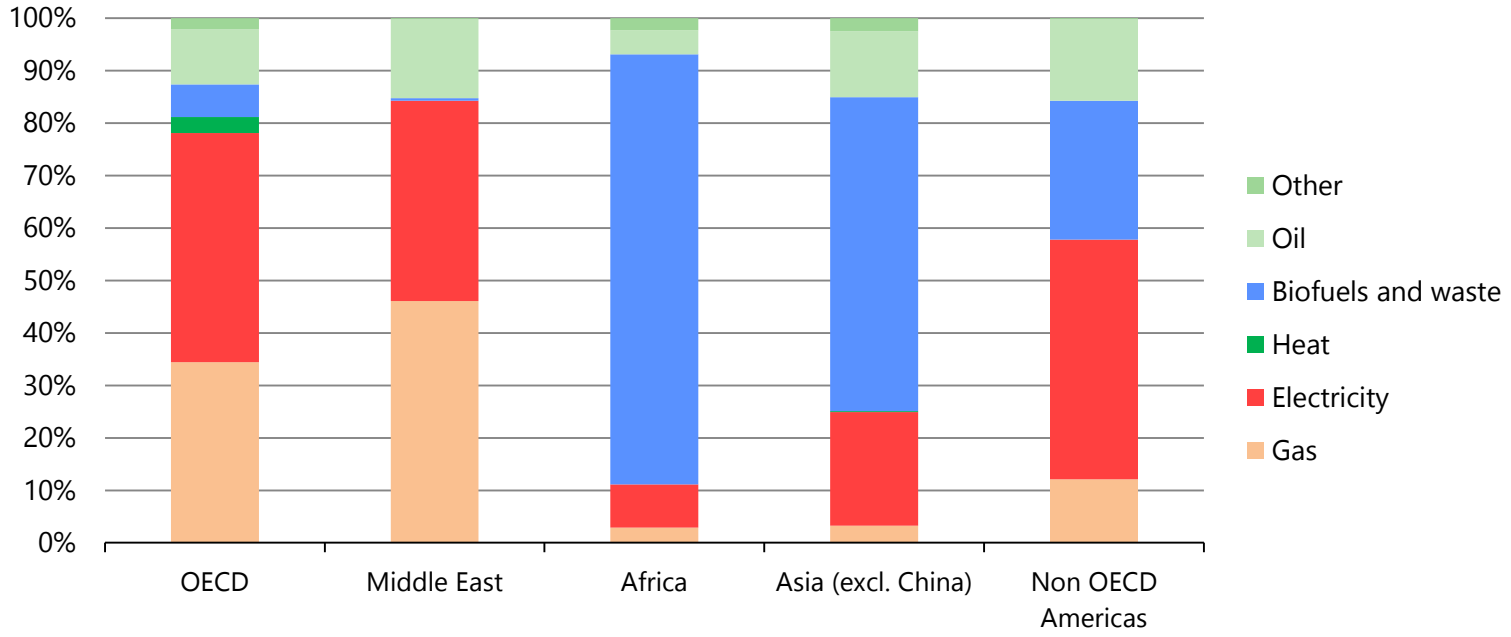
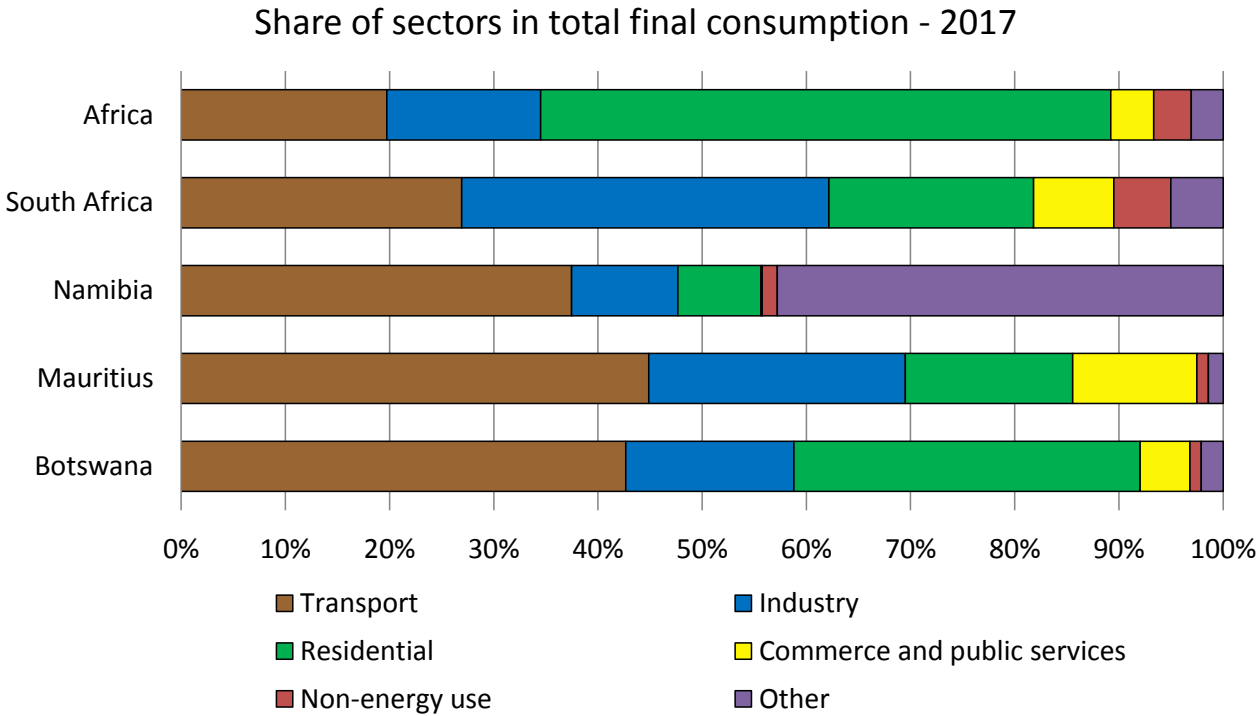
Understanding regional patterns



Share of energy consumption in the residential sector

Source: IEA, World Energy Balances, 2019

…understand the shares of sectors in total final consumption

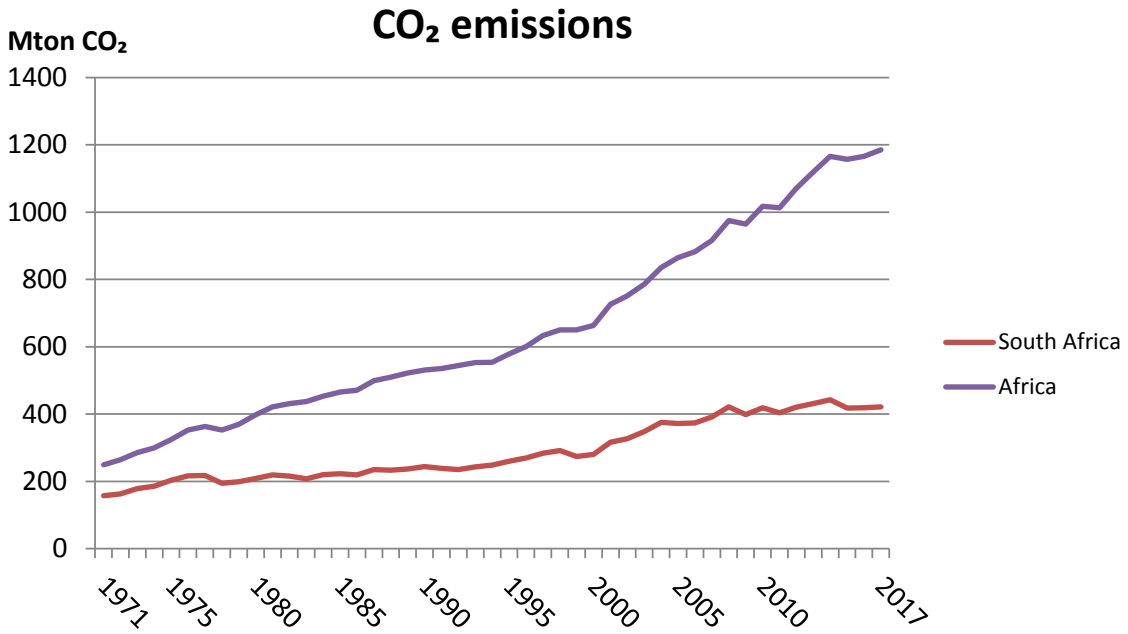


** Total Final Consumption excluding non-energy uses*

Source, IEA World Energy Balances, 2018

Key to understand where energy is used and to define policy priorities

… estimate CO_2 emissions from fuel combustion



Source: IEA, World CO_2 Emissions from Fuel Combustion, 2018

Based on energy balances and IPCC methodologies

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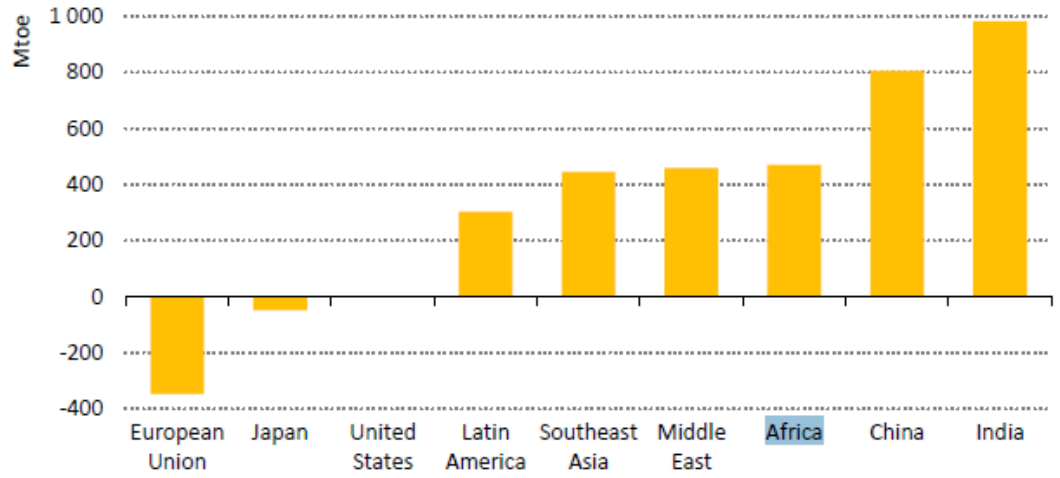
… project energy demand across countries

Figure 1.1 ▷ Change in total primary energy demand in selected regions in the New Policies Scenario, 2017-2040



Source: IEA, World Energy Outlook (WEO)

Comparability of energy statistics across countries is key

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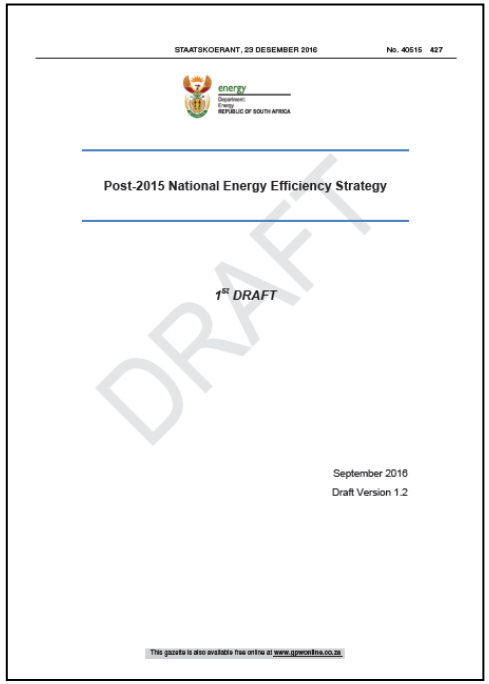
Example of applications of aggregated indicators

South Africa: targets for different sectors

Department of Energy: *post 2015 National Energy Efficiency Strategy (draft) with targets up to 2030*



STAATSKOERANT, 23 DESEMBER 2016 No. 40515 427

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Post-2015 National Energy Efficiency Strategy

1st DRAFT

DRAFT

September 2016
Draft Version 1.2

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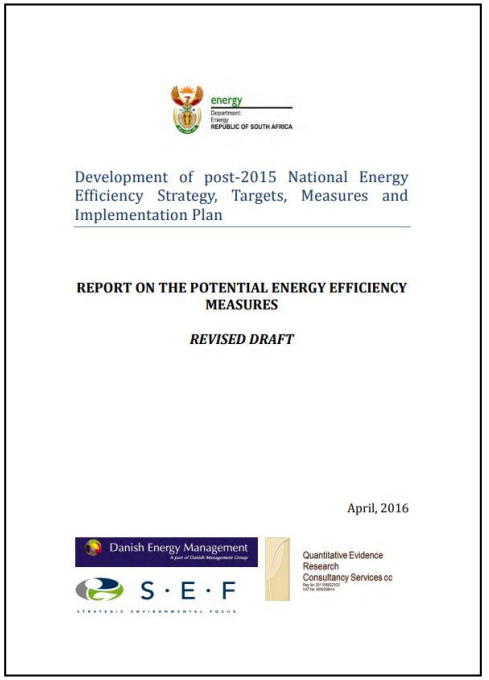

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Development of post-2015 National Energy Efficiency Strategy, Targets, Measures and Implementation Plan

REPORT ON THE POTENTIAL ENERGY EFFICIENCY MEASURES

REVISED DRAFT

April, 2016

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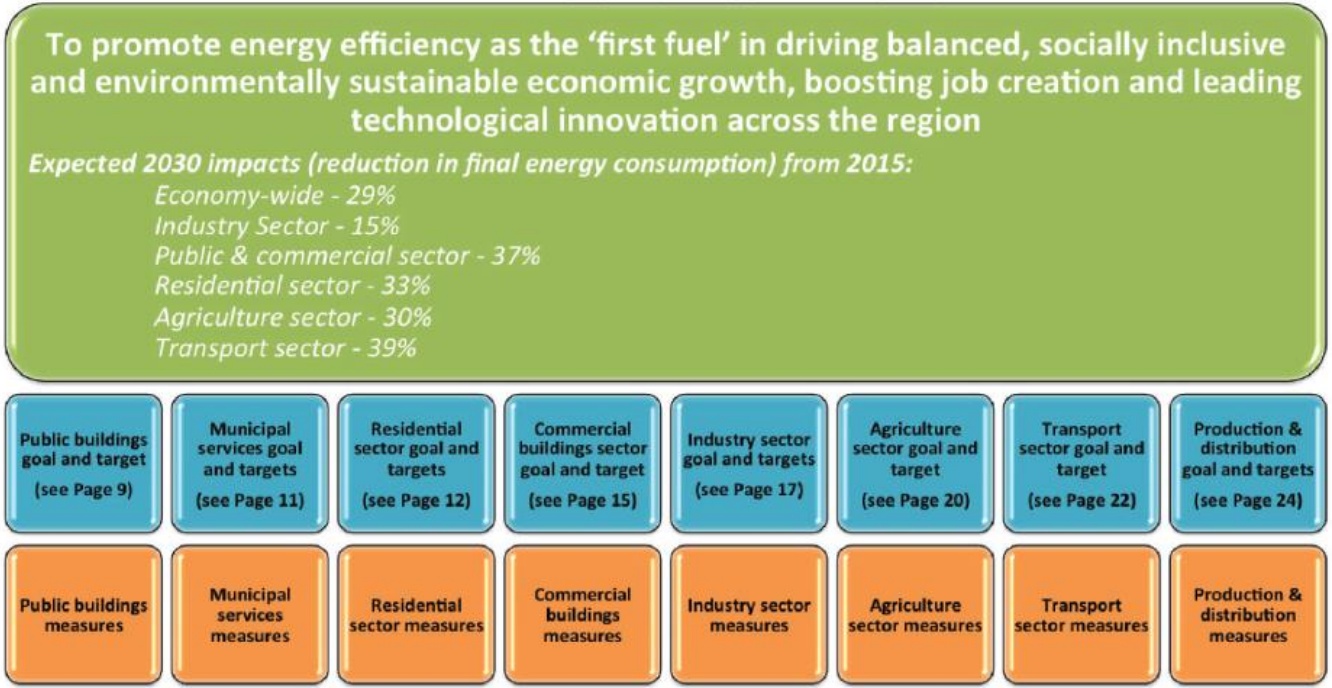
South Africa: targets for different sectors

Department of Energy: *post 2015 National Energy Efficiency Strategy (draft) with targets up to 2030*



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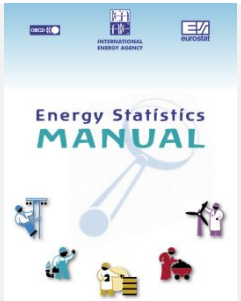
Resources on Energy Statistics

The IEA produced a comprehensive Energy Statistics Manual covering most of our data collection methodologies, consistently with the IRES framework.

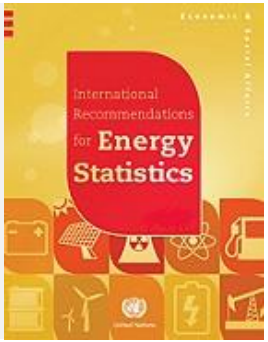
A comprehensive Energy Statistics Manual available in 10 languages.

Click on the manual to download it free of charge!



*Visit the **IEA's Statistics website** to access additional resources, including our questionnaires, glossary and documentation related to our data collection methodologies.*

To learn more about the international framework for energy statistics, please refer to the United Nations' International Recommendations for Energy Statistics (IRES).



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