

ENERGY BALANCES AND BEYOND

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Presentation overview

- **Energy Statistics**
- **Energy Balances**
- **Fundamentals**
- **Exercise**

ENERGY STATISTICS

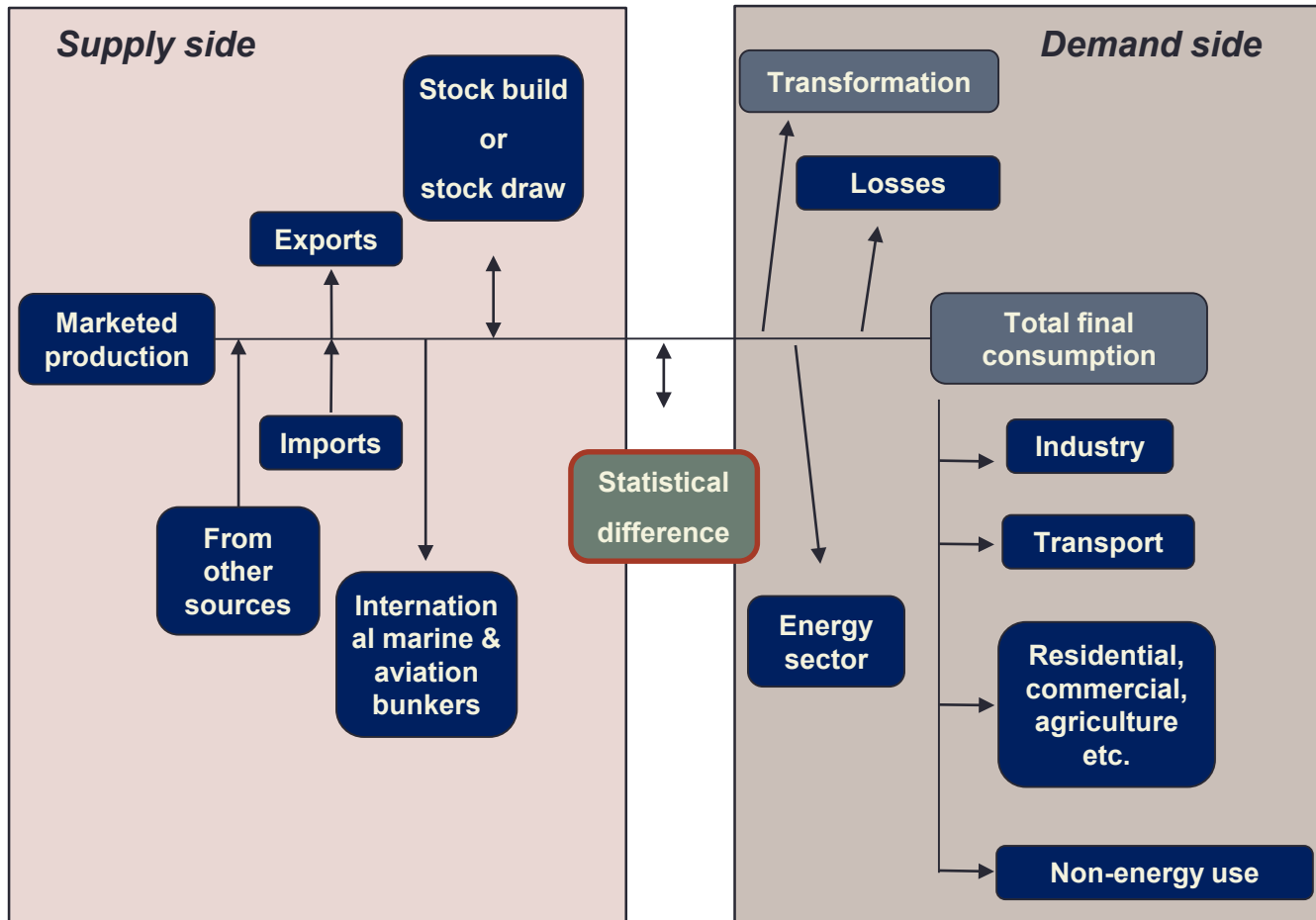
A general overview

Energy statistics

Aim to provide numerical values for all the flows (production and use) of energy commodities (fuels that are burnt and energy – heat and power) in a country (including trade)

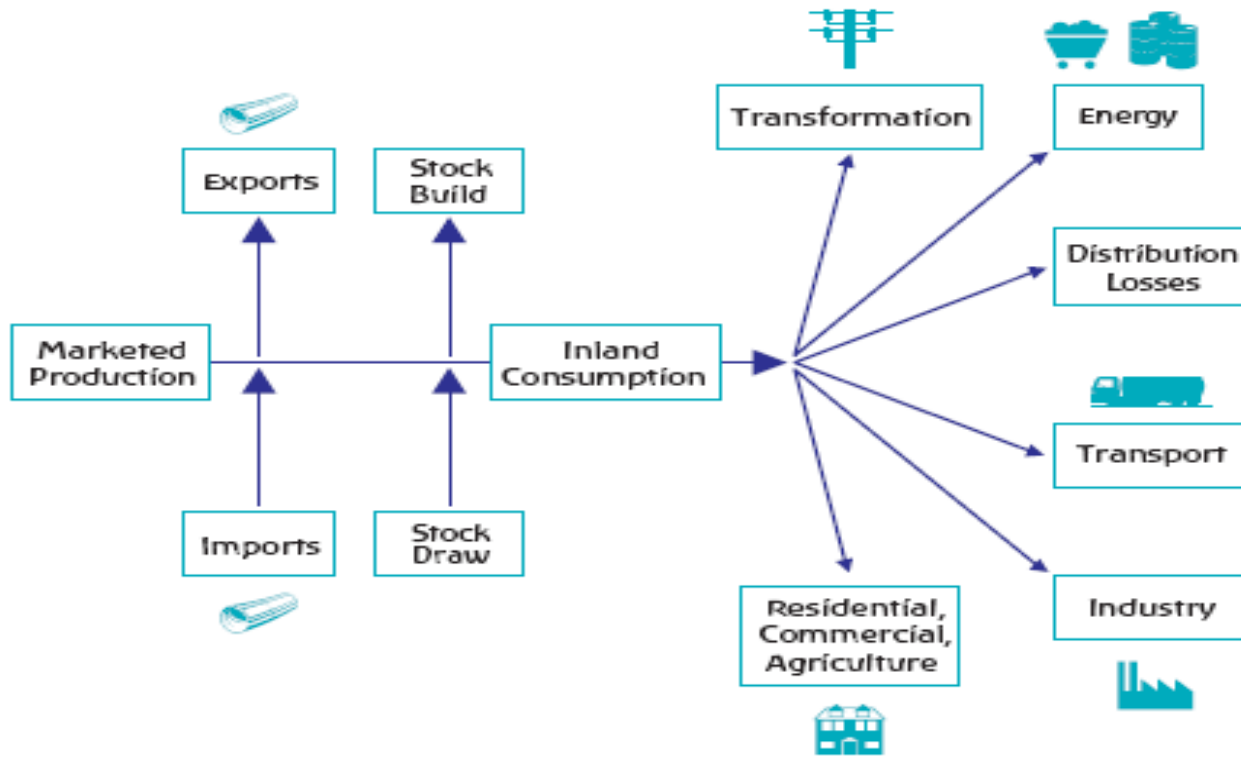
- Often presented as an energy commodity table and in individual or bespoke tables focusing on specific issues (fuel outputs from refineries, capacity, etc)
- Measured in “normal” units for the fuel – coal tonnes, electricity kWh, etc
- Data on use of energy traditionally very limited, hence need for additional work on uses for energy efficiency

Supply and Demand



Energy flows for natural gas

Figure 3.1 • Simplified Flow Chart for Natural Gas



ENERGY BALANCES

A general overview

Why develop energy balances?

- To understand overall energy use in country, e.g.
 - compute the total energy use
 - assess relative contribution of different sources in energy mix / different sectors in energy demand
 - compute efficiencies of various transformation processes (e.g. electricity generation)
- To estimate high-level indicators e.g. self-sufficiency, intensity, CO₂ emissions from fuel combustion
- To assess data completeness and check quality of the various energy commodity balances



“...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.”

Energy balances in IRES

- The recommendations contained in IRES are focused on basic energy statistics and energy balances
- The basic energy statistics refer to statistics on energy stocks and flows, energy infrastructure, performance of the energy industries, and the availability of energy resources within the national territory of a given country during a reference period
- Energy balances are an accounting framework for compilation and reconciliation of data on all energy products entering, exiting and used within that territory

Basic concepts

- Total primary energy supply – the energy we produce and import (may not be in usable form)
- Transformation – changing format of energy
- Final energy consumption – the total energy we use in homes, business and transport
- Final energy consumers – people/businesses who ultimately use the energy

Basic concepts (2)

- Units – kWh, tonnes, L, m³
- But can't add tonnes to kWh so need toe (tonne of oil equivalent)
- Toes – a unit of energy (like a GJ)
- All numbers in an energy balance are in the same unit of energy.

An Energy balance

2016

SUPPLY AND CONSUMPTION	Thousand tonnes of oil equivalent (ktoe)										Total
	Coal	Crude oil	Oil products	Natural gas	Nuclear	Hydro	Geo-therm./Solar/etc.	Biofuels/Waste	Electrn-city	Heat	
Production	-	-	-	-	-	-	-	-	-	-	-
Imports	-	-	-	-	-	-	-	-	-	-	-
Exports	-	-	-	-	-	-	-	-	-	-	-
Intl. marine bunkers	-	-	-	-	-	-	-	-	-	-	-
Intl. aviation bunkers	-	-	-	-	-	-	-	-	-	-	-
Stock changes	-	-	-	-	-	-	-	-	-	-	-
TPES	-	-	-	-	-	-	-	-	-	-	-
Transfers	-	-	-	-	-	-	-	-	-	-	-
Statistical differences	-	-	-	-	-	-	-	-	-	-	-
Electricity plants	-	-	-	-	-	-	-	-	-	-	-
CHP plants	-	-	-	-	-	-	-	-	-	-	-
Heat plants	-	-	-	-	-	-	-	-	-	-	-
Blast furnaces	-	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-	-
Coke/pat. fuel/BKB/PB plants	-	-	-	-	-	-	-	-	-	-	-
Oil refineries	-	-	-	-	-	-	-	-	-	-	-
Petrochemical plants	-	-	-	-	-	-	-	-	-	-	-
Liquefaction plants	-	-	-	-	-	-	-	-	-	-	-
Other transformation	-	-	-	-	-	-	-	-	-	-	-
Energy industry own use	-	-	-	-	-	-	-	-	-	-	-
Losses	-	-	-	-	-	-	-	-	-	-	-
TFC	-	-	-	-	-	-	-	-	-	-	-
INDUSTRY	-	-	-	-	-	-	-	-	-	-	-
Iron and steel	-	-	-	-	-	-	-	-	-	-	-
Chemical and petrochemical	-	-	-	-	-	-	-	-	-	-	-
Non-ferrous metals	-	-	-	-	-	-	-	-	-	-	-
Non-metallic minerals	-	-	-	-	-	-	-	-	-	-	-
Transport equipment	-	-	-	-	-	-	-	-	-	-	-
Machinery	-	-	-	-	-	-	-	-	-	-	-
Mining and quarrying	-	-	-	-	-	-	-	-	-	-	-
Food and tobacco	-	-	-	-	-	-	-	-	-	-	-
Paper, pulp and printing	-	-	-	-	-	-	-	-	-	-	-
Wood and wood products	-	-	-	-	-	-	-	-	-	-	-
Construction	-	-	-	-	-	-	-	-	-	-	-
Textile and leather	-	-	-	-	-	-	-	-	-	-	-
Non-specified	-	-	-	-	-	-	-	-	-	-	-
TRANSPORT	-	-	-	-	-	-	-	-	-	-	-
Domestic aviation	-	-	-	-	-	-	-	-	-	-	-
Road	-	-	-	-	-	-	-	-	-	-	-
Rail	-	-	-	-	-	-	-	-	-	-	-
Pipeline transport	-	-	-	-	-	-	-	-	-	-	-
Domestic navigation	-	-	-	-	-	-	-	-	-	-	-
Non-specified	-	-	-	-	-	-	-	-	-	-	-
OTHER	-	-	-	-	-	-	-	-	-	-	-
Residential	-	-	-	-	-	-	-	-	-	-	-
Comm. and public services	-	-	-	-	-	-	-	-	-	-	-
Agriculture/forestry	-	-	-	-	-	-	-	-	-	-	-
Fishing	-	-	-	-	-	-	-	-	-	-	-
Non-specified	-	-	-	-	-	-	-	-	-	-	-
NON-ENERGY USE	-	-	-	-	-	-	-	-	-	-	-
in industry/transl./energy	-	-	-	-	-	-	-	-	-	-	-
of which: chem./petrochem.	-	-	-	-	-	-	-	-	-	-	-
in transport	-	-	-	-	-	-	-	-	-	-	-
in other	-	-	-	-	-	-	-	-	-	-	-
Electricity and heat output	-	-	-	-	-	-	-	-	-	-	-
Electr. Generated - GWh	-	-	-	-	-	-	-	-	-	-	-
Electricity plants	-	-	-	-	-	-	-	-	-	-	-
CHP plants	-	-	-	-	-	-	-	-	-	-	-
Heat generated - TJ	-	-	-	-	-	-	-	-	-	-	-
CHP plants	-	-	-	-	-	-	-	-	-	-	-
Heat plants	-	-	-	-	-	-	-	-	-	-	-

Energy balance – Supply and energy use

Thousand tonnes of oil equivalent (ktoe)

SUPPLY AND CONSUMPTION	Coal	Crude oil	Oil products	Natural gas	Nuclear	Hydro	Geo-therm./Solar/etc.	Biofuels/Waste	Electricity	Heat	Total
Production	-	-	-	-	-	-	-	-	-	-	-
Imports	-	-	-	-	-	-	-	-	-	-	-
Exports	-	-	-	-	-	-	-	-	-	-	-
Intl. marine bunkers	-	-	-	-	-	-	-	-	-	-	-
Intl. aviation bunkers	-	-	-	-	-	-	-	-	-	-	-
Stock changes	-	-	-	-	-	-	-	-	-	-	-
TPES	-	-	-	-	-	-	-	-	-	-	-
Transfers	-	-	-	-	-	-	-	-	-	-	-
Statistical differences	-	-	-	-	-	-	-	-	-	-	-
Electricity plants	-	-	-	-	-	-	-	-	-	-	-
CHP plants	-	-	-	-	-	-	-	-	-	-	-
Heat plants	-	-	-	-	-	-	-	-	-	-	-
Blast furnaces	-	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-	-
Coke/pat. fuel/BKB/PB plants	-	-	-	-	-	-	-	-	-	-	-
Oil refineries	-	-	-	-	-	-	-	-	-	-	-
Petrochemical plants	-	-	-	-	-	-	-	-	-	-	-
Liquefaction plants	-	-	-	-	-	-	-	-	-	-	-
Other transformation	-	-	-	-	-	-	-	-	-	-	-
Energy industry own use	-	-	-	-	-	-	-	-	-	-	-
Losses	-	-	-	-	-	-	-	-	-	-	-
TFC	-	-	-	-	-	-	-	-	-	-	-

Total Primary supply – energy available for use

Sources of **supply** (+ve and -ve)

Transformation

Energy sector own use and losses

Use of energy, but essential to provide it to final consumers

Total Final Consumption – energy available for **final use** in the domestic market

Energy balance - demand

Thousand tonnes of oil equivalent (ktoe)											
SUPPLY AND CONSUMPTION	Coal	Crude oil	Oil products	Natural gas	Nuclear	Hydro	Geotherm./Solar/etc.	Biofuels/Waste	Electricity	Heat	Total
TFC	-	-	-	-	-	-	-	-	-	-	-
INDUSTRY	-	-	-	-	-	-	-	-	-	-	-
Iron and steel	-	-	-	-	-	-	-	-	-	-	-
Chemical and petrochemical	-	-	-	-	-	-	-	-	-	-	-
Non-ferrous metals	-	-	-	-	-	-	-	-	-	-	-
Non-metallic minerals	-	-	-	-	-	-	-	-	-	-	-
Transport equipment	-	-	-	-	-	-	-	-	-	-	-
Machinery	-	-	-	-	-	-	-	-	-	-	-
Mining and quarrying	-	-	-	-	-	-	-	-	-	-	-
Food and tobacco	-	-	-	-	-	-	-	-	-	-	-
Paper, pulp and printing	-	-	-	-	-	-	-	-	-	-	-
Wood and wood products	-	-	-	-	-	-	-	-	-	-	-
Construction	-	-	-	-	-	-	-	-	-	-	-
Textile and leather	-	-	-	-	-	-	-	-	-	-	-
Non-specified	-	-	-	-	-	-	-	-	-	-	-
TRANSPORT	-	-	-	-	-	-	-	-	-	-	-
Domestic aviation	-	-	-	-	-	-	-	-	-	-	-
Road	-	-	-	-	-	-	-	-	-	-	-
Rail	-	-	-	-	-	-	-	-	-	-	-
Pipeline transport	-	-	-	-	-	-	-	-	-	-	-
Domestic navigation	-	-	-	-	-	-	-	-	-	-	-
Non-specified	-	-	-	-	-	-	-	-	-	-	-
OTHER	-	-	-	-	-	-	-	-	-	-	-
Residential	-	-	-	-	-	-	-	-	-	-	-
Comm. and public services	-	-	-	-	-	-	-	-	-	-	-
Agriculture/forestry	-	-	-	-	-	-	-	-	-	-	-
Fishing	-	-	-	-	-	-	-	-	-	-	-
Non-specified	-	-	-	-	-	-	-	-	-	-	-
NON-ENERGY USE	-	-	-	-	-	-	-	-	-	-	-
in industry/transf./energy	-	-	-	-	-	-	-	-	-	-	-
<i>of which: chem./petrochem.</i>	-	-	-	-	-	-	-	-	-	-	-
in transport	-	-	-	-	-	-	-	-	-	-	-
in other	-	-	-	-	-	-	-	-	-	-	-
Electricity and heat output											
Electr. Generated - GWh	-	-	-	-	-	-	-	-	-	-	-
<i>Electricity plants</i>	-	-	-	-	-	-	-	-	-	-	-
<i>CHP plants</i>	-	-	-	-	-	-	-	-	-	-	-
Heat generated - TJ	-	-	-	-	-	-	-	-	-	-	-
<i>CHP plants</i>	-	-	-	-	-	-	-	-	-	-	-
<i>Heat plants</i>	-	-	-	-	-	-	-	-	-	-	-

} Final consumption by sector and subsector

} Non-energy use as raw materials

} Electricity and heat by input fuel

Energy Balances

Jersey Energy Balance 2005

	Coal and Other Solid Fuel	Petroleum products	Gas	Electricity	total	
						tonnes of oil equivalent
Production				1,471	1,471	
Imports	2,340	141,327		55,883	199,549	
stock change		-5,894		0	-5,894	
Primary supply	2,340	135,433		57,354	195,126	
Transfers						
Electricity generation		-3,779		1,054	-2,725	
Gas supply		-10,942	10,746		-197	
Available supply	2,340	120,711	10,746	58,407	192,204	
Energy industry own use and losses			161	5,381	5,543	
Consumption						
Industry and government		27,827	4,413	27,555	59,796	
Air and marine		19,607			19,607	
Road		43,116			43,116	
Domestic	2,340	30,162	6,171	25,471	64,143	
Final consumption	2,340	120,711	10,585	53,026	186,661	

-ve stocks means a stock build (use) ie closing level higher than opening

-ve means fuel used to produce electricity

Source:

States of Jersey Statistics Unit

UK Energy Balance - slightly more complex!

	Thousand tonnes of oil equivalent									
	Coal	Manufactured fuel(1)	Primary oils	Petroleum products	Natural gas(2)	Renewable & waste(3)	Primary electricity	Electricity	Heat	Total
Supply										
Indigenous production	11,376	-	83,958	-	80,013	3,579	17,742	-	-	196,668
Imports	32,617	682	64,872	29,335	20,983	497	-	884	-	149,870
Exports	-342	-120	-54,875	-31,474	-10,369	-	-	-238	-	-97,417
Marine bunkers	-	-	-	-2,486	-	-	-	-	-	-2,486
Stock change(4)	-814	-152	-391	-917	-553	-	-	-	-	-2,827
Primary supply	42,838	410	93,564	-5,543	90,073	4,076	17,742	646	-	243,808
Statistical difference(5)	-125	-9	-127	+65	+33	-	-	+7	-	-155
Primary demand	42,962	419	93,691	-5,608	90,040	4,076	17,742	639	-	243,963
Transfers	-	-105	-2,835	+2,869	-5	-	-760	+760	-	-75
Transformation	-41,389	1,801	-90,856	89,769	-28,592	-3,473	-16,982	33,159	1,347	-55,217
Electricity generation	-35,775	-967	-	-692	-26,686	-3,473	-16,982	33,159	-	-51,416
Major power producers	-34,869	-	-	-277	-23,915	-729	-16,982	30,445	-	-46,327
Autogenerators	-906	-967	-	-415	-2,771	-2,744	-	2,714	-	-5,089
Heat generation	-288	-51	-	-61	-1,906	-	-	-	1,347	-961
Petroleum refineries	-	-	-90,856	90,760	-	-	-	-	-	-96
Coke manufacture	-4,315	4,282	-	-	-	-	-	-	-	-33
Blast furnaces	-816	-1,665	-	-238	-	-	-	-	-	-2,719
Patent fuel manufacture	-194	202	-	-	-	-	-	-	-	8
Other	-	-	-	-	-	-	-	-	-	-
Energy industry use	3	871	-	4,986	6,839	-	-	2,426	72	15,197
Electricity generation	-	-	-	-	-	-	-	1,597	-	1,597
Oil and gas extraction	-	-	-	-	5,954	-	-	47	-	6,001
Petroleum refineries	-	-	-	4,986	221	-	-	380	71	5,659
Coal extraction	3	-	-	-	10	-	-	89	-	102
Coke manufacture	-	414	-	-	23	-	-	8	-	446
Blast furnaces	-	457	-	-	53	-	-	44	-	554
Patent fuel manufacture	-	-	-	-	-	-	-	-	-	-
Pumped storage	-	-	-	-	-	-	-	92	-	92
Other	-	-	-	-	578	-	-	169	-	746
Losses	-	177	-	-	1,033	-	-	2,659	-	3,869
Final consumption	1,571	1,067	-	82,044	53,572	603	-	29,474	1,275	169,606

UK Energy Balance 2006 con't

Final consumption	1,571	1,067	-	82,044	53,572	603	-	29,474	1,275	169,606
Industry	1,138	845	-	7,220	12,362	159	-	10,000	836	32,561
Unclassified	-	227	-	3,019	5	159	-	-	-	3,409
Iron and steel	-	618	-	20	703	-	-	503	-	1,843
Non-ferrous metals	24	-	-	53	275	-	-	661	-	1,013
Mineral products	691	-	-	200	1,051	-	-	686	-	2,628
Chemicals	88	-	-	193	3,372	-	-	1,787	406	5,846
Mechanical engineering etc	9	-	-	106	731	-	-	736	3	1,585
Electrical engineering etc	4	-	-	85	358	-	-	630	-	1,077
Vehicles	37	-	-	124	797	-	-	502	-	1,460
Food, beverages etc	17	-	-	283	2,374	-	-	1,050	1	3,725
Textiles, leather etc	50	-	-	131	556	-	-	299	-	1,036
Paper, printing etc	99	-	-	59	1,018	-	-	1,162	22	2,360
Other industries	119	-	-	2,774	902	-	-	1,844	405	6,045
Construction	-	-	-	174	220	-	-	141	-	535
Transport (6)	-	-	-	59,047	-	-	-	733	-	59,780
Air	-	-	-	13,999	-	-	-	-	-	13,999
Rail	-	-	-	726	-	-	-	-	-	726
Road	-	-	-	42,509	-	-	-	-	-	42,509
National navigation	-	-	-	1,812	-	-	-	-	-	1,812
Pipelines	-	-	-	-	-	-	-	-	-	-
Other	433	222	-	4,779	40,394	444	-	18,740	438	65,451
Domestic	416	222	-	3,251	31,346	263	-	10,013	52	45,563
Public administration	6	-	-	489	4,201	87	-	1,891	378	7,053
Commercial	4	-	-	393	2,947	-	-	6,481	8	9,834
Agriculture	3	-	-	306	173	74	-	355	-	912
Miscellaneous	3	-	-	340	1,726	20	-	-	-	2,089
Non energy use	-	-	-	10,997	817	-	-	-	-	11,814

IRES equivalent presentation of an Energy Balance, as used by the IEA

ENERGY

1.1 Aggregate energy balance 2011

Gross calorific values

Thousand tonnes of oil equivalent

	Coal	Manufactured fuel(1)	Primary oils	Petroleum products	Natural gas(2)	Bioenergy & waste(3)	Primary electricity	Electricity	Heat sold	Total
Supply										
Indigenous production	11,580	-	56,902	-	45,288	5,751	17,468	-	-	136,990
Imports	21,399	35	62,917	24,942	50,251	1,890	-	747	-	162,180
Exports	-370	-357	-36,910	-30,300	-15,794	-184	-	-212	-	-84,127
Marine bunkers	-	-	-	-2,413	-	-	-	-	-	-2,413
Stock change(4)	+535	-385	667	+210	-1,945	-	-	-	-	-919
Primary supply	33,144	-707	83,577	-7,562	77,799	7,457	17,468	535	-	211,711
Statistical difference(5)	+25	-14	-326	-111	-145	-	-	-27	-	-598
Primary demand	33,119	-693	83,903	-7,451	77,544	7,457	17,468	562	-	212,310
Transfers	-	+5	-2,370	+2,356	-5	-	-1,843	+1,843	-	-14
Transformation	-31,427	2,342	-81,533	80,525	-28,455	-4,906	-15,625	29,532	1,365	-48,182
Electricity generation	-26,020	-640	-	-900	-26,420	-4,906	-15,625	29,532	-	-44,978
Major power producers	-25,221	-	-	-344	-23,697	-1,264	-15,625	26,839	-	-39,311
Autogenerators	-798	-640	-	-556	-2,723	-3,642	-	2,693	-	-5,667
Heat generation	-291	-51	-	-68	-2,035	-	-	-	1,365	-1,079
Petroleum refineries	-	-	-81,533	81,490	-	-	-	-	-	-42
Coke manufacture	-4,121	3,788	-	-	-	-	-	-	-	-333
Blast furnaces	-759	-980	-	-	-	-	-	-	-	-1,739
Patent fuel manufacture	-236	225	-	-	-	-	-	-	-	-10
Other	-	-	-	-	-	-	-	-	-	-
Energy industry use	3	660	-	5,189	5,161	-	-	2,171	94	13,277
Electricity generation	-	-	-	-	-	-	-	1,415	-	1,415
Oil and gas extraction	-	-	-	571	4,571	-	-	50	-	5,192
Petroleum refineries	-	-	-	4,618	378	-	-	387	94	5,474
Coal extraction	3	-	-	-	7	-	-	73	-	83
Coke manufacture	-	386	-	-	-	-	-	7	-	393
Blast furnaces	-	274	-	-	39	-	-	22	-	334
Patent fuel manufacture	-	-	-	-	-	-	-	-	-	-
Pumped storage	-	-	-	-	-	-	-	81	-	81
Other	-	-	-	-	168	-	-	138	-	306
Losses	-	151	-	-	1,251	-	-	2,423	-	3,825
Final consumption	1,690	844	-	70,241	43,071	2,551	-	27,344	1,271	147,011
Industry	1,111	628	-	4,526	10,701	535	-	8,804	839	27,144
Unclassified	-	184	-	2,404	2	535	-	-	-	3,125
Iron and steel	38	443	-	5	495	-	-	330	-	1,311
Non-ferrous metals	14	-	-	23	231	-	-	599	-	867
Mineral products	697	-	-	142	1,387	-	-	603	-	2,828
Chemicals	50	-	-	105	2,321	-	-	1,505	420	4,401
Mechanical engineering etc	8	-	-	67	571	-	-	634	-	1,279
Electrical engineering etc	3	-	-	32	298	-	-	550	-	883
Vehicles	37	-	-	78	666	-	-	446	-	1,227
Food, beverages etc	32	-	-	200	1,987	-	-	976	2	3,197
Textiles, leather etc	45	-	-	75	465	-	-	257	-	843
Paper, printing etc	71	-	-	38	1,312	-	-	938	1	2,358
Other industries	110	-	-	1,247	772	-	-	1,834	417	4,380
Construction	6	-	-	112	193	-	-	132	-	444
Transport (6)	11	-	-	53,698	-	1,128	-	351	-	55,187
Air	-	-	-	12,802	-	-	-	-	-	12,802
Rail	11	-	-	652	-	-	-	340	-	1,012
Road	-	-	-	38,646	-	1,128	-	2	-	39,775
National navigation	-	-	-	1,597	-	-	-	-	-	1,597
Pipelines	-	-	-	-	-	-	-	-	-	-
Other	568	216	-	4,040	31,677	889	-	18,189	431	56,010
Domestic	540	216	-	2,681	25,191	567	-	9,595	52	38,842
Public administration	18	-	-	366	2,680	112	-	1,591	376	5,144
Commercial	4	-	-	433	2,399	21	-	6,663	3	9,524
Agriculture	1	-	-	303	157	187	-	339	-	988
Miscellaneous	5	-	-	258	1,250	-	-	-	-	1,513
Non energy use	-	-	-	7,977	693	-	-	-	-	8,669

(1) Includes all manufactured solid fuels, benzole, tars, coke oven gas and blast furnace gas.

(2) Includes colliery methane.

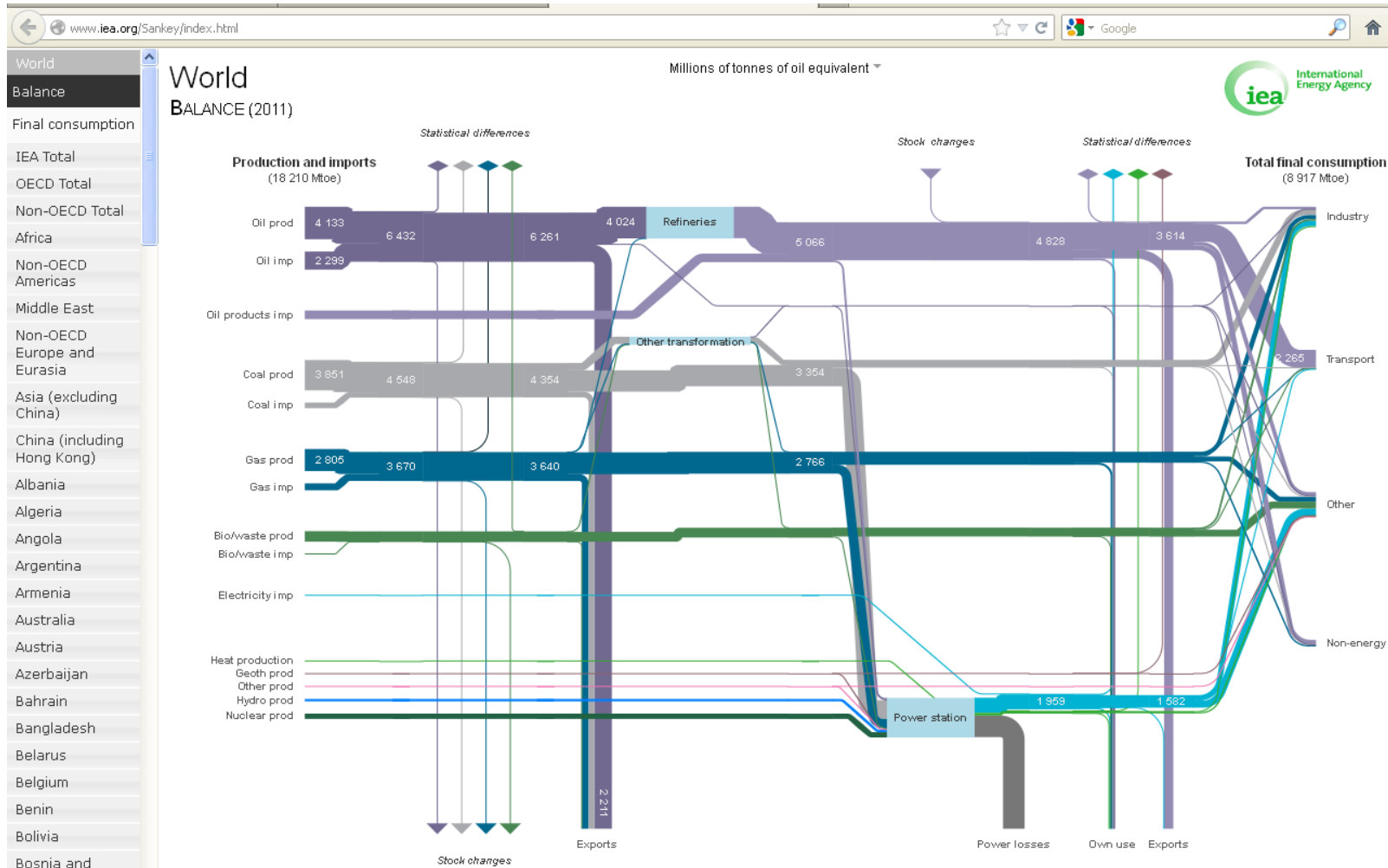
(3) Includes geothermal and solar heat.

(4) Stock fall (+), stock rise (-).

(5) Primary supply minus primary demand.

(6) See paragraphs 5.11 regarding electricity use in transport and 6.24 regarding renewables use in transport.

Energy balance as a Sankey chart

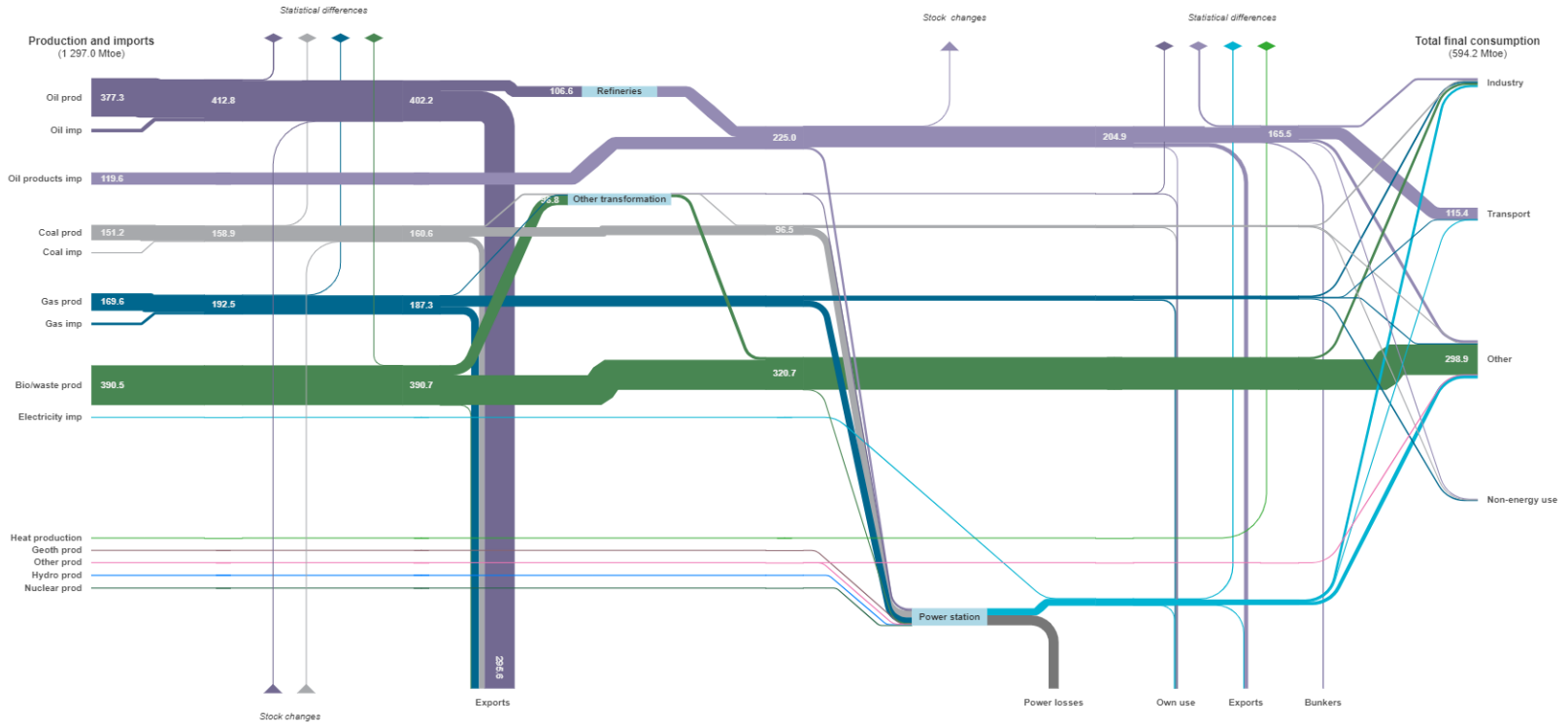


<http://www.iea.org/Sankey/index.html>

The Sankey diagram for Africa

Africa
BALANCE (2016)

Millions of tonnes of oil equivalent



Statistical difference

- A recognition that as supply and demand are measured from different sources they won't match exactly
- To calculate as defined in IRES it's: supply (all kinds) – use
- Can be considered the error or uncertainty term
- Correct to have a Statistical difference – as all statistics have an element of uncertainty
- Ideally less than 5% of TFC
- Should not include stock change, losses, bunkers, etc

How do we develop energy balances?

Annual Questionnaires
OR
National publications, websites

Commodity Balances

SUPPLY AND CONSUMPTION	Coal (kt)						Coal gases (TJ)		
	Coking coal	Other bit. coal / anth.	Sub-bit. coal	Lignite	Coke / tar	Pat. fuel / BKB	Gas works gas	Coke oven gas	Recovered gases ¹
Production									
From other sources									
Imports									
Exports									



Energy balance

SUPPLY AND CONSUMPTION	Thousand tonnes of oil equivalent (ktoe)										
	Coal	Crude oil	Oil products	Natural gas	Nuclear	Hydro	Geo-therm./ Solar/ etc.	Biofuels/ Waste	Electricity	Heat	Total
Production	-	-	-	-	-	-	-	-	-	-	-
Imports	-	-	-	-	-	-	-	-	-	-	-
Exports	-	-	-	-	-	-	-	-	-	-	-
Intl. marine bunkers	-	-	-	-	-	-	-	-	-	-	-
Intl. aviation bunkers	-	-	-	-	-	-	-	-	-	-	-
Stock changes	-	-	-	-	-	-	-	-	-	-	-
TPES	-	-	-	-	-	-	-	-	-	-	-
Transfers	-	-	-	-	-	-	-	-	-	-	-
Statistical differences	-	-	-	-	-	-	-	-	-	-	-
Electricity plants	-	-	-	-	-	-	-	-	-	-	-
CHP plants	-	-	-	-	-	-	-	-	-	-	-
Heat plants	-	-	-	-	-	-	-	-	-	-	-
Blast furnaces	-	-	-	-	-	-	-	-	-	-	-
Gas works	-	-	-	-	-	-	-	-	-	-	-
Coke/pat. fuel/BKB/PB plants	-	-	-	-	-	-	-	-	-	-	-
Oil refineries	-	-	-	-	-	-	-	-	-	-	-

Coal

Oil

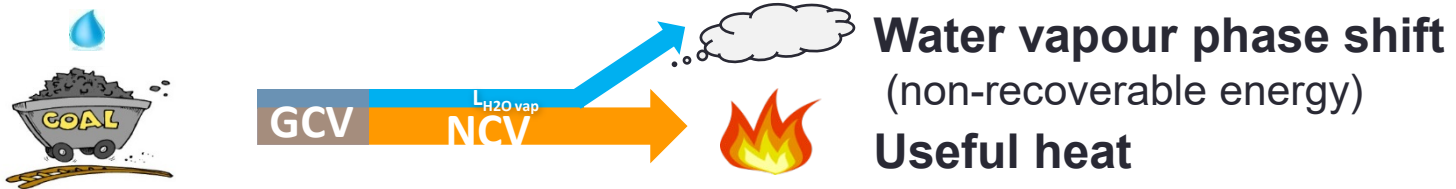
Natural gas

Renewables

Electricity & Heat

Calorific values

- When a fuel is combusted, water vapor is produced, but its energy rarely can be used for energy purposes



- Difference between GCV and NCV approximately:
 - NCV = **90%** of GCV for **natural gas**
 - NCV = **95%** of GCV for **oil**
 - NCV = **95%** of GCV for **coal**

Moving from energy statistics to energy balances

For combustible fuels the Value in energy balance (energy) = function of its value in energy statistics (natural) and a Calorific Value (CV)

$$EB_{ij} = f(ES_{ij} * CV_{ij}) \text{ (for each flow } i \text{ and product } j)$$

A calorific value:

- is the amount of heat obtained from one unit (mass or volume) of the fuel.
- is the only way to convert a fuel quantity from natural units (mass or volume) into energy units (e.g. ktoe)
- Recommended to use Net - excludes water vapour
- CVs needed for each combustible flow in the energy balance
- Can change over time and across regions/countries and by use
- If flow comes from a variety of sources – need a weighted average CV

- EG if there are 3 producing mines in your country, the weighted CV is:
- $CV_w = \frac{(\text{Production1} * CV1) + (\text{Production2} * CV2) + (\text{production3} * CV3)}{(\text{Production1} + \text{Production2} + \text{Production3})}$

Calorific values - example

- A country produces 2 bcm of Natural Gas
- Its GCV is 38000 kJ/m³
- What is its gross energy content?
- First, we convert the GCV to more convenient units:

$$38000 \frac{\text{kJ}}{\text{m}^3} = 38000 \frac{10^9 \times \text{kJ}}{10^9 \times \text{m}^3} = 38000 \frac{\text{TJ}}{\text{bcm}}$$

- Then:

$$2 \text{ bcm} \times 38000 \frac{\text{TJ}}{\text{bcm}} = 76000 \text{ TJ} \quad (\text{gross energy content})$$

- Or:

$$76000 \text{ TJ} \times 90\% = 68400 \text{ TJ} \quad (\text{net energy content})$$

Example calculation - wrong

	Statistics		Balance
	Original units (kt)	TJ/kt	TJ
Production	30	24.00	720
Imports	50	26.00	1300
Exports	10	23.00	230
Supply	70		1790
Stats diff	0		-110
Input to Elec Gen	40	24.00	960
			0
Final use	30	24.00	720
SD % supply		0%	-6%

Example calculation - correct

	Statistics		Balance
	Original units (kt)	TJ/kt	TJ
Production	30	24.00	720
Imports	50	26.00	1300
Exports	10	25.25	252.5
Supply	70		1767.5
Stats diff	0		-7.5
Input to Elec Gen	40	24.50	980
			0
Final use	30	26.00	780
SD % supply		0%	0.004%

Basic conversions

Remember!

Kilo-	10^3
Mega-	10^6
Giga-	10^9
Tera-	10^{12}

- 1 kt = 1 000 ton
- 1 ton = 1 000 kg
- 1 kt = 1 000 000 kg

Always True!

- 1 bbl \approx 159 L
- 1 m³ = 1000 L
- 1 GWh = 3.6 TJ
- 1 ktoe = 41.868 TJ
- 1 ktce = 0.7 ktoe

<http://www.iea.org/statistics/resources/unitconverter/>

Primary energy equivalents for non-combustible sources?

- Combustible sources are burnt so input fuel is measurable
- But for nuclear, geothermal, solar, wind, wave the output is clear (electricity, heat), but what is the input?
- Taken to be the first energy form downstream for which multiple energy uses are practical and measurable
- Standard is to take the Input using the Physical energy content method
- Implied efficiencies are.
 - When primary energy form = heat
 - nuclear 33%
 - geothermal
 - 10% (electricity)
 - 50% (heat)
 - When primary energy form = electricity
 - Solar PV, hydro, wind, etc. 100%

Example

South Africa

Electricity production 2015 (GWh)

Nuclear 12237

Hydro 801

GWh to ktoe conversion x 0.08598

Electricity production 2015 (ktoe)

Nuclear 1052

Hydro 69

Efficiency (%)

Nuclear 33 (ie two-thirds of energy is lost)

Hydro 100

Production (ktoe) (output/efficiency)

Nuclear 3188 Heat

Hydro 69 Electricity

Electricity input row in transformation section of the energy balance (ktoe)

Nuclear -3188

Hydro -69

Extract from South Africa Energy Balance 2015

IEA WORLD
ENERGY
BALANCES (2017
edition) - II.337

South Africa

2015

Thousand tonnes of oil equivalent

SUPPLY AND CONSUMPTION	Nuclear	Hydro	Geotherm./ Solar/ etc. <i>etc.</i>	Biofuels/ Waste	Total
Production	3189	69	496	16078	167410
TPES	3189	69	496	15782	142026
Transfers	-	-	-	-	357
Statistical differences	-	-	-	-	4838
Electricity plants	-3189	-69	-383	-107	-44232
Other transformation	-	-	-	-4118	-4118
Energy industry own use	-	-	-	-	-13676
Losses	-	-	-	-	-1711
TFC	-	-	113	11557	74791
INDUSTRY	-	-	-	2002	27884
TRANSPORT	-	-	-	-	18175
OTHER	-	-	113	9555	24231
NON-ENERGY USE	-	-	-	-	4501

Electricity and Heat Output

Electr. generated - GWh	12237	801	4453	310	246736
<i>Electricity plants</i>	12237	801	4453	310	246736
<i>CHP plants</i>	-	-	-	-	-

Non-energy use of energy products

- Reminder: fuels used as **raw materials** and not consumed as a fuel or transformed into another fuel (e.g. asphalt, plastics, fertilizers)



- But for biomass commodities:

- only the amounts **specifically used for energy purposes** are included in the energy statistics to start with
- Non-energy use of biomass is not taken into consideration within the energy balance



Exercise

- On the worksheet there are questions about energy balances from 2 real countries.
- In pairs work through the questions for around 20 mins
- Then can go through answers

**Thank you for listening
– Any Questions**



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