



Taking energy into account(s)

The paper presents energy use data currently released by Istat in the framework of environmental satellite accounts as well as energy physical supply and use tables that are going to be developed in the near future

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Fare i conti con l'energia

Il paper illustra i dati sugli impieghi energetici diffusi dall'Istat nel contesto dei conti satellite dell'ambiente e le tavole delle risorse e degli impieghi di prodotti energetici in termini fisici, di prossima realizzazione

Introduction and background

Awareness of the crucial role played by energy in human and economic development and in society's well-being, spurred decades ago a clear demand for high quality energy statistics in response to which most countries set up statistical information systems describing the energy production and consumption stages.

At the same time, on an international level, efforts to reach a high level of standardisation in the domain of energy statistics led to the adoption, in 2011, of the *International Recommendations for Energy Statistics* (IRES), which aim at providing common standards and guidance to national compilers. Similarly to other countries, Italy can rely on a wide range of energy data; among them, a comprehensive framework is provided by the National Energy Balance (NEB) which records – for a wide range of energy products and with reference to a given year – three main sets of information:

- the amount of energy available for consumption

on the national territory, obtained by adding up flows of energy entering the national territory – production and imports – and subtracting flows of energy which are not available for consumption on the territory – exports, stock changes, international bunkers;

- the amount of energy which is transformed, used by energy industries for their own use and lost in distribution and transmission
- the amount of energy used up for final energy consumption and non-energy use.

This paper looks at a subset of energy statistics: those produced in the framework of environmental satellite accounts by the Italian National Institute of Statistics (Istat).

Paragraph 1 explains which kind of demand the energy data derived in an environmental accounting framework are able to meet, and the specific features that make them different from other energy statistics.

Paragraph 2 presents data currently produced and released by Istat: energy use data by household/production activity and by kind of use, while paragraph 3 explores recent developments in the demand at the European level that will bring up further energy data in the form of comprehensive supply and use tables.

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1. Energy data derived from environmental accounts: why do we need them?

The National energy balance, published annually in Italy since the '60s, is a regular and detailed source of data on energy production and consumption, as it covers more than 30 different energy products.

However, there are certain information needs for which the NEB cannot provide a full answer; they relate, typically, to the demand for energy statistics which can be linked to national accounts data for integrated energy environmental and economic analysis. The NEB, as other energy statistics was not originally meant to be fully consistent to economic accounts, (similarly to the case of environmental statistics).

Examples of inconsistencies between the NEB and economic accounts data are:

- economic accounts clearly split production activities and households' consumption activities while in the NEB households' energy consumption is not singled out, but rather is accounted for together with energy consumption occurring in certain production activities belonging to the service sector, such as wholesale and retail trade;
- economic data for a given production activity (e.g., output, value added), relate to its principal activity, to its ancillary activities and to any possible secondary activity¹; hence, in order to be consistent with economic data, energy data for a given production activity should cover the same range of activities encompassed by economic data. For example, since transport can in principle be performed as a secondary or ancillary activity by any production activity (beside those belonging to the 'transport' sector for which transport is the main activity), energy use for transport needs to be accounted for all production activities in which it occurs. By contrast, in the NEB energy consumption for transport is accounted for as a single process (split by mode of transport) and not broken down by activity.
- economic accounts require that all flows relate to the activities of 'residents units' (this is known as 'residence principle'): *an institutional unit is*

said to be resident within the economic territory of a country when it maintains a centre of economic interest in that territory - that is, when it engages, or intends to engage, in economic activities or transactions on a significant scale either indefinitely or over a long period of time, usually interpreted as one year. Some of the production of a resident institutional unit may take place abroad, while some of the production taking place within a country may be attributable to foreign institutional units. (Eurostat, 1996 § 1.30). Consistency with the residence principle requires that energy use data include residents' energy use in the rest of the world for road transport, air transport, water transport activities and exclude non residents' energy use on the domestic territory for road transport, air transport, water transport activities. By contrast, national energy balances worldwide account for all energy consumption by residents as well as non residents on the (national) geographic territory.

The answer to the demand for consistent energy and economic information comes from energy accounts, which belong to the broader framework of environmental satellite accounts. Environmental satellite accounts were born with the specific purpose to integrate economic and environmental information in a standardised accounting framework, which adopts national accounts principles, definitions and classifications. At present, both in Italy and Eu-wide, the production of environmental accounts is relatively mature in three areas that historically proved to be those where suitable statistical data sources existed, namely economy-wide material flow accounts, air emission accounts (a.k.a. Namea²-air), environmental protection expenditure accounts and environmental taxes. In order to meet policy demand for regular and standardised environmental accounts data, Regulation 691/2011 of the European Parliament and the Council on European environmental economic accounts makes it compulsory to produce economy-wide material flow accounts, air emission accounts and environmental taxes; for all three modules, nation-wide and yearly time series will be made available for all

Member States from 2013 onwards.

In the medium term, a second round of the Regulation will probably include three additional modules: environmental protection expenditure, environmental goods and services and energy accounts.

Paragraph 3 will provide a comprehensive presentation of energy accounts; with focus on energy flow accounts in physical terms. Before that, next paragraph looks at energy data currently produced and released by Istat within environmental accounts.

2. Which energy data consistent with an energy accounts framework have we got already?

In 2011, Istat released energy use time series 1990-2008 by type of use and economic activity: production activities and households' consumption (see <http://seriestoriche.istat.it/>)³. Throughout the paper, consistently with the satellite accounts terminology, "economic activity" indicates both production activity (production of goods and services classified by industry, according to the NACE – the statistical classification of economic activities in the European Community) and households' consumption (use of products purchased by final users).

The source of the released figures is a more detailed framework: the EUTs (energy use tables by type of use), traditionally produced within environmental satellite accounts as input for air emission accounts, and recently become an independent output. EUTs data, in physical units (tonne, Mmc, MWh), comply with the residence principle (see above) and are broken down by energy product, type of use and economic activity⁴.

Data cover the following *energy products*: coal, lignite, peat, natural gas, crude oil, semi-finished products, waste (only waste used as fuel for the production of electricity or heat), electricity, coke, coke oven gas, non-energy coal products, lpg (liquid propane gas or liquefied petroleum gas), refinery gas, naphtha, motor gasoline, jet fuel, kerosene, gas work gas, blast furnace gas, diesel oil, fuel oil, petroleum coke, white spirit, bitumes, lubricating oil, chemicals, other non-energy oil products;

Type of use includes "energy use with combus-

tion", "energy use without combustion" and "non-energy use" (see also Table 1 below).

Energy use with combustion is in turn divided into: "heating" (dwellings, shops, offices, factories, etc.),

"transport" (road and off-road transport, including by rail, air and sea, in addition to all the operations of ships, boats, tractors, construction machinery, lawnmowers, military and other equipment; household transport is considered separately; for production activities, transport can be performed as a main, secondary and ancillary activity consistently with economic accounts)

"transformation into electricity"

"other energy use with combustion" (transformation with combustion into energy products other than electricity, for example the transformation of coke into blast furnace gas; use of energy products by production activities in production processes in a strict sense, excluding heating, transport and transformation; use of energy products by households for cooking and hot water production).

Energy use without combustion includes the transformation without combustion of energy products into other energy products (for example, the transformation of crude oil into motor gasoline) and the use of electricity for any use.

Non-energy use includes the transformation of energy products into non-energy producing products (for example, the transformation of crude oil into plastic) and the use of energy products for non-energy uses (degreasing, dry cleaning, lubrication, etc.).

The figures presented are *gross of transformations*, in that the energy incorporated in the products used to be transformed into other energy products is also counted in the various uses of the derivative products. In principle, therefore, "total use of energy products" is affected by double counting since:

- a) energy incorporated in products used for electricity production is also counted in the phase in which electricity itself is used;
- b) energy incorporated in the products transformed by combustion into other energy prod-

PURPOSES	includes:			
	PRODUCTION ACTIVITIES		HOUSEHOLDS	
Energy use with combustion	Heating use		heating (office building, factory, ...)	heating (home)
	Transport use	Road transport	road transport carried out both as principal and secondary activity and as ancillary activity (own account)	road transport by households (own account)
		Off-road transport	railway, air and maritime transport as well as all operations of ships, boats, tractors, construction machinery, lawn mowers, military and other equipment	off-road transport by household (mainly operations of boats and lawn mowers)
	Transformation into energy products	Electricity	energy products used to produce electricity (transformation into electricity)	
		Other energy products	energy products used to produce energy products other than electricity (transformation with combustion into energy products other than electricity)	
Other energy use with combustion		energy products used in production processes (excluding heating, transport and transformation)	energy products used in cooking and for hot water	
Energy use without combustion		energy products used to produce other energy products (transformation without combustion into energy products); use of electricity	use of electricity	
Non-energy use		energy products used to produce non-energy products (transformation into non-energy products); energy products used for non energy purposes (degreasing, dry cleaning, ...)	energy products used for non energy purposes (degreasing, lubrication, ...)	

TABLE 1 The split by type of use in the Istat's Energy Use Tables
Source: adapted from Eurostat (2010)

ucts is also counted in the various uses of those products;⁵

c) energy incorporated in the products transformed without combustion into other energy products is also counted in the various uses of those products (for example, the energy counted in crude oil used to produce motor gasoline is recounted in the use of motor gasoline for transport).

The following cases can be distinguished as regards double counting:

- for *production activities as a whole*, double counting does not occur in energy use for “heating”, “transport”, “transformation into electricity” and “non-energy use”; double counting does occur, albeit marginally, in the case of “other energy use with combustion” and “energy use without combustion”. Total use of energy products is, by contrast, strongly affected by double counting;

- in the case of *individual production activities*, the same considerations as for production activities as a whole apply, but the activity breakdown considerably mitigates the extent to which double counting occurs;
- *households data* are not affected by double counting as households do not perform any type of transformation of energy products⁶.

3. What next: full energy supply and use tables

Energy accounts feature as one of the areas for the medium-long term development of environmental accounts identified by Eurostat, with priority being given to energy flow accounts in physical terms. Energy flow accounts in physical terms are only one of the modules foreseen within the comprehensive worldwide accounting framework for energy which is being developed by the United Nations in

the field of energy accounts: the *System of Environmental-Economic Accounting for Energy (SEEA-E)*. SEEA-E encompasses the whole spectrum of energy accounts, i.e., energy asset accounts and energy flow accounts, both in physical and monetary terms, energy-related air emission accounts and hybrid energy accounts, whereby: energy asset accounts are asset accounts for energy resources and describe the opening and closing stocks of energy resources and the changes therein; energy flow accounts describe the supply of energy products and their use by economic categories in the economic territory of a country; hybrid energy accounts are combined physical and monetary accounts. Energy accounts are conceived in full compliance with the environmental accounting principles and accounting frameworks outlined in the UN handbook *System of Integrated Environmental and Economic Accounting (SEEA)*⁷ and, more generally, with the *System of National Accounts (SNA)*, as regards economic concepts, definitions, classifications and accounting rules.

Physical Flow Accounts in the EU will be developed by adopting the framework of Physical Supply and Use Tables (PSUTs). The supply and use framework is widely used in National Accounts as it allows to present in detail the monetary value of products by producing industry and the use of products by industries (intermediate use) and by several final use categories such as final consumption expenditure, gross capital formation and exports.

Figure 1 presents the basic structure of Physical Supply and Use Tables for energy flows (energy PSUTs). All flows are quantified in physical natural units (tonnes, cubic metres, etc.) as in energy statistics.

The Physical Supply Table represented in Figure 1 shows the origin of all energy flows (row headings) that can occur between the economy and the environment: by definition natural resources can only be supplied by the Environment whereas products and residuals⁸ can only be supplied by the economy, either the domestic industry, households or the Rest of the World (RoW) in the form of imports. In the full tables each flow category is broken down according to a suitable existing classification, For resources the classification of energy resource

assets proposed in the draft SEEA-E and shown in Table 2 will be used.

Products will be broken down according to the classification of energy products applied in Eurostat's energy statistics, presented in Table 3.

The supply from the national economy will be broken down according to the standard industry classification (Nace).

The Physical Use Table shows - row-wise - the uses of available energy flows by: industries for intermediate consumption, final uses including households, RoW (for exports) and the Environment.

The matrices in Figure 1 show *gross* supply and *gross* use of energy products by economic activities, the term "gross" indicating that "double counting" can occur, i.e., the same energy embodied in different products at different stages is counted more than once. This mainly occurs in the case of primary energy products, which are transformed into secondary energy products: energy embodied in both stages is accounted for in the tables.

Energy flows	SUPPLY Economy			Environment
	Industries	Households	RoW	
(i) resources				
(ii) products				
(iii) residuals				

Energy flows	USE Economy				Environment
	Industries (intermediate consumption)	Final uses			
		Households (final consumption)	Changes in inventories	RoW	
(i) resources					
(ii) products					
(iii) residuals					

■ = not applicable

FIGURE 1 Basic structure of Physical Supply and Use Tables for energy flows
Source: adapted from Eurostat (2010)

level (hierarchy)	code	label
1	A	RESOURCE FLOWS (NATURAL INPUTS)
2	AA	Non-Renewables
3	AA.5100	Uranium ores (resource)
3	AA.2115	Anthracite (resource)
3	AA.2116	Coking coal (resource)
3	AA.2117	Bituminous coal (resource)
3	AA.2118	Sub-bituminous coal (resource)
3	AA.2210	Lignite (resource)
3	AA.2310	Peat (resource)
3	AA.311x	Natural bitumen, extra heavy oil, shale oil, sand oil and others n.e.c. etc.
3	AA.3110	Crude Oil (resource)
3	AA.4100a	Natural Gas (resource)
3	AA.4100b	Natural Gas Liquid (NGL) (resource)
2	AB	Renewables
3	AB.5510	Hydro (resource)
3	AB.5520	Wind (resource)
3	AB.5532	Solar Heat (resource = solar radiation)
3	AB.5534	Photovoltaic (resource = solar radiation)
3	AB.5535	Tide, Wave and Ocean (resource)
3	AB.5550	Geothermal (resource)
3	AB.554x	Biomass for energy use

TABLE 2 Proposed classification of energy resources (full version)
Source: adapted from Eurostat (2010)

Both in monetary and in physical SUTs the following equality holds:

$$\text{Supply} = \text{Use}$$

i.e.

$$\text{domestic production} + \text{imports} = \text{intermediate consumption} + \text{final consumption} + \text{gross capital formation} + \text{exports}$$

In addition to adopting the supply and use framework and the existing international classifications where they apply (such as in the case of industries, which are classified by Nace), consistency with national accounts implies that energy use in energy accounts has to be related to residents units (see paragraph 1); this means converting data from the geographic definition of a country which is adopted in energy statistics and balances to the definition based on the residence principle which forms the basis for National Accounts' aggregates such as output or value added⁹. Statistics needed to make the required corrections include, for example: physical data on fuel purchases abroad by tourists as well as by lorries, aircrafts, ships belonging to resident companies, and the same purchases by non-residents on the country's territory. As fuel purchase data in many countries are likely not to include all the details needed, other statistical

level (hierarchy)	code	label
1	B	PRODUCTS
2	B_CPA.01	Products of agriculture, hunting and related services
2	B_CPA.02	Products of forestry, logging and related services
2	B_CPA.10	Coal and lignite; peat
2	B_CPA.11	Crude petroleum and natural gas; services incidental to oil and gas extraction excluding surveying
2	B_CPA.12	Uranium and thorium ores
2	B_CPA.20	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials
2	B_CPA.21	Pulp, paper and paper products
2	B_CPA.23	Coke, refined petroleum products and nuclear fuels
2	B_CPA.24	Chemicals, chemical products and man-made fibres
2	B_CPA.40	Electrical energy, gas, steam and hot water
2	B_CPA.90	Sewage and refuse disposal services, sanitation and similar services

TABLE 3 Proposed classification of energy products (reduced version)
Source: adapted from Eurostat (2010)

sources such as transportation statistics or monetary figures can be used to estimate the needed distinction between resident units and non-resident units operating on the domestic territory.

Another important step in the implementation of energy accounts relates to the breakdown of each flow category by the supply and use categories and - within each category - by its own specific classification, e.g., Nace classification in the case of industries. Since the breakdown by 'industrial sector' of energy statistics/balances does not match the Nace classification, a re-assignment of energy supply/use from the classification used in energy statistics/balances to the classification employed in National Accounts is needed.

Istat's EUTs described in paragraph 2 provide a very good basis as the starting point for compiling the intermediate consumption and final consumption sections of the forthcoming Eurostat's EUT; although, in order to obtain a robust full desired breakdown by energy product and by Nace, further refinement of data is needed.

Conclusions

Data collection on energy data, organized in a PSUT framework by Eurostat from National Statistical Institutes (NSIs), will likely start in 2012. Although the process will take place on a voluntary basis at least for the first period, we can expect it to provide a significant incentive for NSIs to make Energy Accounts an autonomous product in the framework of Satellite Accounts.

As energy PSUTs will mainly be populated with existing physical energy statistics and balances,

which were not traditionally designed to be consistent with monetary economic accounts, the exercise will be challenging for NSIs which do not regularly produce energy accounts yet, or which do so in a way not close to the proposed Eurostat standard. Once the exercise will be completed in all member states and regular data will be produced, the availability of standardized EU-wide statistical information on economy and energy by means of energy accounts will allow a consistent and thorough statistical representation of the interactions among the two domains. Furthermore, full comparability will also be ensured between energy accounts and other physical aggregates of environmental accounting, such as air emissions accounts, thus allowing the integration of different dimensions within a single accounting framework and significantly expanding the scope for joint economic, energy and environmental analysis.

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Notes

- [1] Economic data follow accounting rules established by the European System of Accounts (ESA95, (see Eurostat 1996). ESA95 distinguishes three main types of activities: 1) Principal: the principal activity of a producing unit is the activity whose value added exceeds that of any other activity carried out within the same unit (Eurostat 1996, §3.10). 2) Secondary: a secondary activity is an activity carried out within a producing unit in addition to the principal activity. The output of the secondary activity is a secondary product (ibidem, § 3.11). 3) Ancillary: an ancillary activity is not undertaken for its own sake but purely in order to provide supporting services for principal or secondary activities. The output of an ancillary activity is not intended for use outside the enterprise. Typical ancillary activities that may be carried out are transporting, storing, marketing, various kinds of financial and business services, computing, communications, training, security, maintenance, etc. Ancillary activities are not isolated to form distinct recording entities, i.e., they are recorded together with the associated principal and/or secondary activity (ibidem, §3.12 – 3.13).
- [2] Namea (national accounting matrix including environmental accounts) is an accounting system, adopted on a European level, representing the interaction between economy and the environment in such a way as to ensure the comparability of the economic and social data (output, income, occupation, etc.) with data on the stress posed by human activities on the natural environment (environmental pressure).
- [3] This is the first release of energy use data in physical units consistent with national accounts since the early 1990s. At that time figures were broken down by economic activity and households as well as by purpose or type of use (transport, heating, non-energy use, other energy use) and by origin of supply (domestic output, imports).
- [4] In detail: 27 energy products, 8 types of use and 102 economic activities, of which 101 production activities plus end users, i.e., households. The main data sources for EUTs are the energy use tables in physical units by economic activity and by energy product (but not by type of use) annually produced by the Istat National Accounts as input for the Supply and use Table in monetary terms, the NEB, the energy use data used as inputs for the Corinair national air emissions inventory annually produced by the Institute for Environmental Protection and Research (ISPRA).
- [5] In practice the only case in which this does take place is when the energy incorporated in coke is used in blast furnaces to produce blast furnace gas, which in turn is used both for the production of electricity and for industrial steel-working processes and in cokeries.
- [6] In the original data source, the EUTs, the three-dimensional nature of the data (by energy product, type of use and economic activity) – and its layout (27 x 8 x 102) – ensures that no figure is affected by double counting; by contrast, in the data released, energy use is summed up across all products and this implies a certain - although limited - degree of double counting of the same energy in different phases (substantially in the production/transformation phase or consumption phase) as explained in the text.
- [7] The SEEA-E is currently being revised and expected to be elevated to the formal status of an international statistical standard. SEEA-E is expected to be adopted by the United Nations Statistical Commission decision, upon recommendation of the United Nations Committee of Experts on Environmental-Economic Accounting.
- [8] The category ‘residuals’ will not be dealt with in the remainder of the work.
- [9] Consistency with national accounts Monetary Supply and Use Tables is also behind other theoretical features of energy accounts, some of which are still under discussion within the Eurostat expert groups. See Eurostat (2010). Many issues are very technical, they concern, for example, the treatment of losses and “flaring”, “venting” and “re-injection”, or the recording of secondary production energy industry’s intermediate use of its own output and will not be discussed in this context.