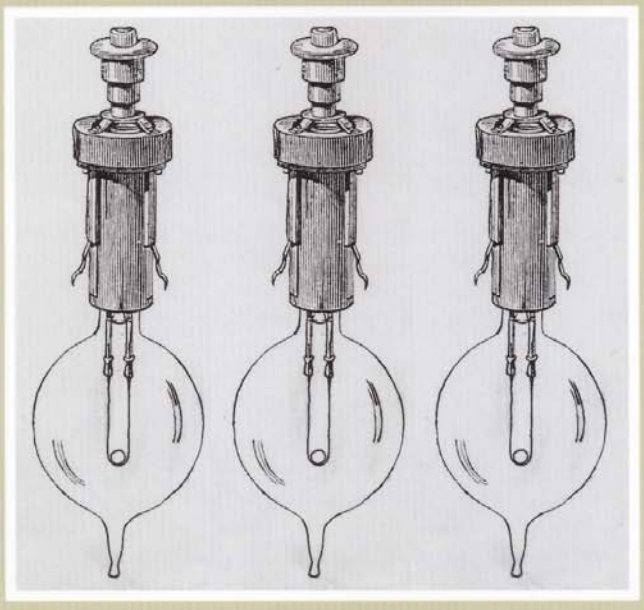
Energy Consumption in Italy in the 19th and 20th Centuries

A Statistical Outline

Paolo Malanima



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Istituto di Studi sulle Società del Mediterraneo

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FOREWORD

The purpose of this work is to provide statistical series on energy consumption in Italy in the last two centuries. Its main innovation is the inclusion of traditional sources along with modern ones.

After some introductory remarks on the purpose of my research and the definitions used therein (Ch. 1), I examine each carrier individually and explain the statistical methods I have employed for traditional (Ch. 2) and modern (Ch. 3) energy carriers. I also review some characteristics of energy consumption trends in Italy (Ch. 4) to set the statistical data within a wider economic context.

The statistical series are given in the Appendix.

This work is part of a more ambitious project undertaken by the research group "Energy, Growth, Pollution". Its aim is to quantify energy consumption in most European countries. I would like to thank the members of the group for their comments during the several meetings we had over the last few years. I am also grateful to Astrid Kander for her remarks to a previous draft, and especially to Silvana Bartoletto for collecting much of the data on which the series in this book are based.

1. The energy sources

1. Energy sources

1.1. The energy transition

The energy transition from traditional vegetable energy sources to modern fossil carriers marked a strong discontinuity in the availability and use of energy and was one of the main foundations of modern growth.[1] Yet our knowledge of this major transformation is far from clear. The available statistical information in European historical accounting only concerns modern sources. The lack in it of the traditional energy carriers or the inclusion only of firewood, and the lack of clarity about what traditional carriers actually are and the methods used to record them bias our perception of recent economic transformations. If we include traditional sources in our investigations, the interplay between the economy and energy becomes much more complex and interesting.

The purpose of the present research is to quantify all energy carriers over the long period of the Italian energy transition.[2] At the time of its political unification in 1861, Italy was still a *traditional economy,* an economy based, that is, primarily on the vegetable product of fields, pastures and forests. Its use of fossil sources was much lower than in north-western European countries, accounting for 7 percent of the total energy balance. In the following century, Italy, like other countries, witnessed a dramatic transformation in the structure of its energy consumption after a long-term

[1] See especially Cipolla (1962) and Wrigley (1988 and 2004).

[2] Works on energy in 19th- and 20th-century Italy completely disregard traditional sources and hence only give a partial image of the connections between energy and economy. See, for instance, Colombo (1991), Clô (1994), Toninelli (1999).

stability which had lasted several centuries. In 2000, only 7 percent of the country's overall energy consumption came from traditional sources. This energy transition went hand in hand with a rise of gross product and an expansion of the secondary and tertiary sectors.

Since "energy transition" means a replacing of the old with the new, its study may be a first step to throw light on the dynamics of energy consumption both in modern and in pre-modern economies.

1.2. Definitions

The aim of this investigation is to take into account every form of energy exploited by human beings yesterday and today.[3] The objective is to reconstruct the input of energy having a cost into the economic system; that is *to quantify primary sources of energy consumed yearly, at some cost, by human beings*.

I will look at the following energy sources, in chronological order:

1. *Food for human beings;*
2. *Firewood;*
3. *Feed for work animals;*
4. *Wind;*
5. *Water;*
6. *Fossil sources;*
7. *Primary electricity.*

These energy sources make up, so to speak, the successive layers on which our modern energy system is based.[4] The first

[3] I have already put forward this approach to energy quantification in preindustrial Europe in Malanima (1996 and 2001). The method is quite similar to that used for Sweden by Kander (2002).

[4] For some general information on the history of energy exploitation, see, among many others, Débeir, Deléage, Hémery (1986), Smil (1994),

energy source was food, which has remained the indispensable basis for any human activity ever since the dawn of the human species 4 or 5 million years ago. Later, between 1 million and 500,000 years ago, human beings gained mastery over fire and thus became capable of exploiting fuels, especially firewood, the second source, and, until recently, the main energy carrier. Feed for working animals was the third main source of energy to be exploited by human beings, ever since they began to harness oxen, horses, mules, camels, etc., for agricultural work or transportation. The exploitation of animals began at the start of the Neolithic agricultural revolution, and spread rapidly especially in the 4th millennium b.C., i.e., in the age of the first Near East agrarian empires. Wind had been exploited to propel sailing ships long before, but began to be widely used for this purpose only in the 4th millennium, and to drive mills from the 7th century A.D. onward. Water power began to be exploited for mills in the 1st century b.C.[5] For several millennia, all of these carriers together formed the energy basis of pre-modern agrarian civilizations. Ultimately derived from the Sun, they were the source of all human activities (Figure 1.1).

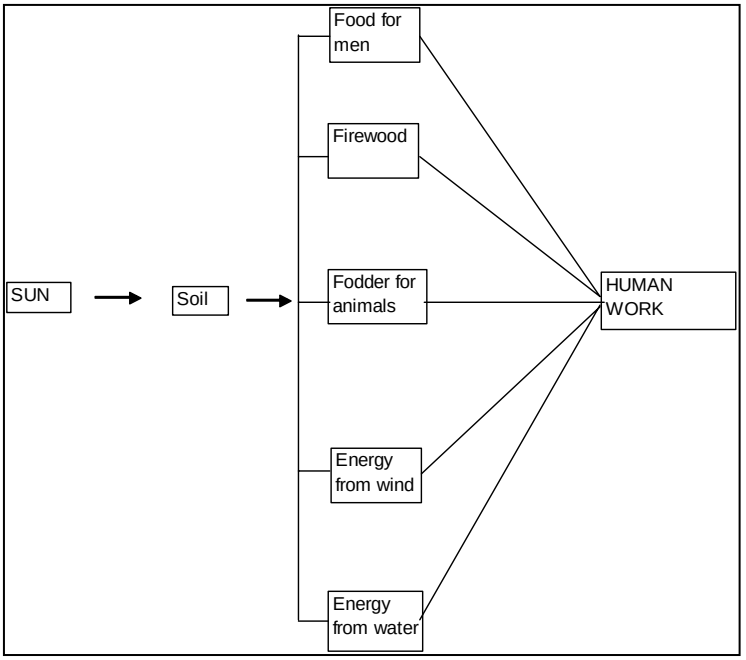
Two centuries ago, the massive introduction of fossil sources inaugurated a new age of change. These sources, while already known previously, began to be utilized on a large scale only at the turn of the 18th century, with the First Industrial Revolution.[6] Later, at the end of the 19th century, the spread of electricity and oil coincided with the so-called Second Industrial Revolution. Nuclear energy is a very recent addition to the energy basis.

Caracciolo-Morelli (1996), and, with specific reference to Europe, Malanima (1996).

[5] Although it has been recently suggested that the water-mill may have existed as early as the 3rd century b.C.: Wilson (2002).

[6] Malanima (2006).

Figure 1.1. *Sun, soil and traditional energy sources*



Military energy consumption for weapons, although important, is not included today in modern energy balances and is hence disregarded in the following calculations. Still, the military consumption of energy definitely calls for the historian's attention, and could become a stimulating subject for future research.

It is important to stress that in the following time series, I have only taken into consideration energy sources having a cost (not just in monetary terms) for human beings. I have disregarded free energy sources -e.g., solar light- sometimes included in similar studies examining the theme of energy from a biological, ecological, or physical point of view. Annual production of biomass not exploited by human beings or working animals as an energy source is not included either. Thus, I have not regarded as part of the energy balance the annual production of biomass not collected by human

beings in a forest (or collected for construction purposes), or the grass of a meadow not consumed by the animals exploited by human beings for food or work. On the contrary, the grass eaten by an ox used by peasants becomes part of human energy consumption, either as "fuel" for the animal, if the animal is used for work, or as food if it or its products are eaten (whether in the form of milk, cheese, or meat). Wind and flowing water are also included in my series because, although free, their exploitation is possible only by utilizing a machine, such as a ship or mill, which has a cost.

1.3. Primary sources

In the following time series, to avoid duplications –always a risk in reconstructions of this kind– only *primary energy* will be considered. By primary energy source, we mean *a source useful to human beings and exploited, at a cost, to be converted into heat or mechanical work*. A *secondary source of energy* is, on the contrary the transformation of a primary source. Thus, charcoal is a *secondary source* and as such excluded from the following series, whereas the firewood used to produce charcoal is included. The calories of charcoal are merely a transformation of the calories the firewood already possessed. For the same reason, electricity produced by means of coal and oil power plants is not included in the series, since they already include coal and oil. I have taken account, instead, of the hydraulic energy used to produce electricity.[7]

In many other cases it is less clear how one should recognize a primary source. Since bread was produced by means of cereals ground by exploiting the energy of a water mill, one may wonder whether we should not subtract the mill's

[7] Nevertheless, I present statistics on thermoelectricity in App. II, 7, although I have not included them in the aggregate figures on energy consumption in App. I.

energy from the calories of bread to avoid duplication. The gravitational energy of water is, indeed, already computed in the water energy series. Animal energy, too, could be regarded, in some ways, as being already included in the food we consume today, since this food still "contains" the energy used in the past to produce it. The same uncertainty could arise concerning human labour: the calories employed yesterday to produce food are, so to speak, included in the food we eat today. In all of these cases, however, we are not dealing with the same energy undergoing a transformation, as in the case of firewood-charcoal. Bread is a transformation of the calories of cereals, and not of the calories of the water driving the mill's waterwheel, or those burned by the muscles of the animal pulling the plough. Hence, we must include both the energy of the mill and the animals' muscle energy in our calculations, as well as the calories of the bread.

A similar case is that of the coal and oil burned to drive a turbine and produce electricity. We could opt for including as primary energy both the electricity and the energy content of coal and oil, since we are dealing with the different calories of fuels, on the one hand, and electricity, on the other. In this case, however, the electrons' movement can be seen merely as a transformation of the energy of the fuel. The fuel is, in this case, the primary energy carrier. The same is true of the electricity produced by the gravitational energy of water and by nuclear plants. Electricity is always a secondary form of energy. The expression "primary electricity" is merely a practical, although inaccurate, way of designating electricity not produced by means of fuels. Fuels used to produce electricity are included in our series of fossil carriers and the energy of water utilized to drive a turbine is included in our series of hydroelectricity or primary electricity.[8]

We may wonder whether manure should be included in our calculation, since it is the nourishment of many micro-

[8] More on this subject in the following pages.

organisms living in the soil, and hence a source of energy for human beings. These micro-organisms are, in a way, true work animals used for agriculture. However, I have not included manure among the energy sources analyzed in my time series, since its energy is already calculated in my statistics as working animals' feed (i.e., manure is definitely a secondary source).

My statistics detail the input of energy into the economic system, regardless of how efficiently that energy is exploited. Thus, I will estimate the calories consumed by human beings as food; the feed consumed by working animals; the flow of water driving a mill's wheel or a modern turbine. It will be interesting, at a later stage, to estimate how much energy consumed by human beings as food actually becomes useful work (mechanical energy employed for any kind of useful work) and productive work (work used to produce the commodities that make up the national GDP). But calculating the energy yield will be a later step in this statistical research. The first task is to quantify total energy consumption.

Inevitably, any research on pre-modern energy carriers is plagued with a high degree of uncertainty. The exploitation of the power of the wind and water courses, as we can imagine, is not easy to quantify. We will see, however, that it is indeed possible to determine a range of magnitudes, and thus evaluate the contribution of these carriers to pre-modern energy consumption. A range of magnitudes is already a good result for an attempt at quantifying pre-modern energy sources, a still untrodden terrain.

1.4. Territory and population

All of the time series of energy consumption in Italy available so far are within coeval borders. My estimates, on the contrary, always refer to the present national borders (unless otherwise stated) to allow comparisons over time. To convert

data from coeval to present borders, we can use conversion factors based either on the surface of Italy within its current borders, or the population living within current borders (Table 1.1). By multiplying the values within coeval borders by these coefficients we obtain values within present borders. Obviously, while this method can be applied to firewood or mills, it can not be used with sailing ships. In this case, we have to know the actual number of ships in Venice and Trieste's harbours during the period when they were not Italian. The conversion factor for sailing ships from the 1861-66 borders to present borders is based on the *Annuario statistico* by Correnti-Maestri.[9] The coefficient is 1.47.

Table 1.1. Conversion factors from coeval to present borders based on surface and population

Year	Surface of Italy within national borders (kmq)	Index (surface)	Conversion factor (surface)	Conversion factor (population)
1861-65	259,320	86.1	1.161	1.183
1866-70	274,527	91.2	1.097	1.058
1871-1918	286,610	95.2	1.051	1.029
1919-46	310,120	103.0	0.971	0.985
1947-	301,181	100.0	1.000	1.000

Since emigration from Italy was massive, especially from 1870 to 1970, to evaluate consumption I take into account the population actually living within the national borders at any time, rather than the official resident population.[10] Official residents who were living abroad at the date of a given census are hence excluded.[11] Between 1870 and 1970, more than 25 million Italians left the country (although often not

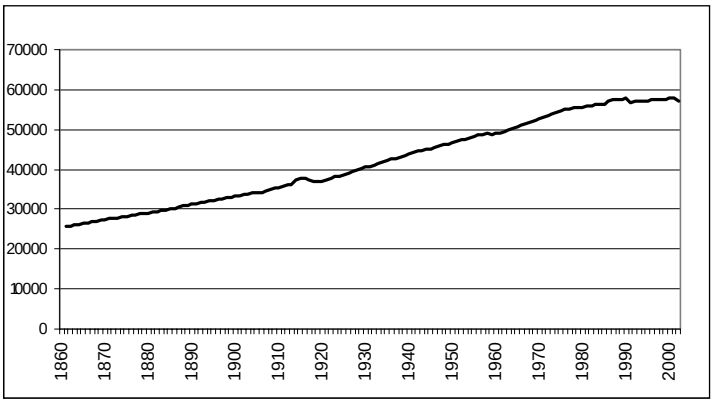
[9] Correnti-Maestri, II, (1864), p. 536.

[10] While the *actual population* is the number of inhabitants actually living in a particular country at the date of a given census, the *official (or resident) population* is the number of citizens of that country, whether they live in the country or not.

[11] The series of population is in App. I, 3, col. 2.

permanently).[12] From 1970 onward, because of the decline of Italian emigration,[13] the difference between actually present and officially resident population becomes negligible. On the other hand, immigrants to Italy, who live and consume energy in that country, ought to be included even if they lack official Italian citizenship and formally are not part of the national population. Unfortunately, while we have statistics on Italians who lived abroad in the past, we are not well informed on immigrants living in Italy today. From 1986 onward, our time series on population only include the officially resident population.[14] The series describes a continuous increase from its beginning until the 1980s, when it levels off asymptotically (Figure 1.2).

Figure 1.2. *Italian population 1860-2000 (present pop. 000)*



[12] Del Panta, Livi Bacci, Pinto, Sonnino (1996), p. 196.

[13] See data in tables A5.1 and A5.2, p. 160 in Baldi, Cagiano de Azevedo (1999).

[14] I used the same criteria to establish my statistics on per capita product in App. III, 2.

2. Traditional sources

2. Traditional sources

2.1. Methods

Statistical information on modern commercial sources is available for Italy as well as many other modern countries.[1] Time series of traditional sources, instead, need to be put together from scratch, or, when they do exist, need thorough revision. In this case, as in many others, we can proceed in our estimates either from the supply or the demand side. Let us examine, first of all, the main issues involved and the methods to be used to quantify food for human beings and animals, firewood, water, and wind. Specific technical aspects will be addressed in the subsequent sections devoted to the information available for each source. I will begin by calculating per capita consumption. I will then estimate aggregate figures by multiplying per capita figures by the population.

Calculating food consumption is easy when one looks at the question from the side of demand. Given the relatively low variability of food consumption in time and space –around 2,500-3,500 kcal per capita per day– all one needs to do is to determine a fixed annual coefficient to be multiplied by the population. For remote times, this method is the only one we can use, because of our lack of direct evidence. Fortunately, for the last two centuries, quantitative information on food

[1] See especially the statistics in ISTAT (1958, 1976, 1986), Barberi (1961), and Vitali (1991), pp. 235-36.

produced, imported, and exported is usually available in national statistics, and national institutes have already extrapolated food consumption from these primary data. In this case, the choice of the supply side viewpoint is preferable by far.

It is much harder to compile time series of traditional fuels. Since it is impossible to gather information on oil for lamps and wax for candles, and since, all considered, their contribution to the energy budget was negligible, the only fuel we should take into account is firewood, the most ancient source of heating and light. Charcoal being a secondary source, it must be converted into an equivalent quantity of firewood and added to the total estimate. As in the case of food, it would be preferable to approach the study of firewood consumption from the angle of supply. Studying demand only yields rough estimates. Multiplying a fixed figure, assumed as the average demand, by the population is an unsatisfactory solution, especially when dealing with the energy transition, when per capita consumption of traditional fuels diminished. On the other hand, reconstructing the supply is a difficult task, and sometimes a totally impossible one. As we shall see, in Italy as in most other European countries, it is far from easy to quantify firewood production. Hence, we must of a necessity combine a supply-oriented with a demand-oriented approach.

In the case of work animals, there is no choice but to approach the question of their energy consumption from the side of demand. In national agricultural accounting, statistics on the production of pastures are usually lacking or unreliable. On the other hand, we are interested, in this case, only in the fodder produced for the animals employed in agriculture or transportation; not the fodder used to feed all the animals in a given country. The time series of national statistical institutes, however, concern the total product of pastures. We can address the problem of animal energy by establishing, first of all, the number of working animals; then, the annual food intake of the average animal.

By multiplying these two values, we obtain the energy consumed by these animate "machines". Their fuel is the feed they convert into mechanical energy. It is, so to speak, the fuel the men use in their agricultural activity or transportation. It is part of human beings' daily energy consumption, just like the fuel used today to operate cars. Animals raised for their meat or milk enter our energy balance as food for human beings. Their energy contribution is already included in our estimates under the first heading: "food for human beings".

Apparently, the problem of quantifying water and wind energy is insoluble. Yet, by approaching the question from the supply side, a rough estimate is actually possible.[2] Some preliminary remarks, however, are due. Sometimes, in calculations about water and wind-energy consumption, some scholars employ the method of estimating the energy actually consumed indirectly, as if it were produced by means of modern energy carriers. This means that the water-energy consumption of a traditional mill is assumed to be equal, for the same volume of production, to that of a modern mill driven by fossil fuels or electricity -a technology which was obviously unavailable at the time. Actually, since combustion inevitably entails heavy losses, this method yields too high estimates of energy consumption; 5-6 times higher than those yielded by a direct estimation of water and wind-energy consumption;[3] the method, that is, employed in this book.

Both for water and wind, our only, or best, chance of estimating energy consumption is to base our calculations on the power of water or wind-driven machines. Italian sources provide information on the power of mills and other industrial engines. In the case of sailing ships and boats, their

[2] For an earlier attempt to solve the problem following the same guidelines, see Malanima (1996), pp. 91 ff.

[3] See, for Italy in particular, Bardini (1991 and 1998), whose estimates of water energy are far higher than mine.

power can be estimated indirectly. In order to estimate energy consumption from power, we have to know how long the engine -mill or ship- actually worked, since the energy consumed (E) is the result of power (P) multiplied by the hours actually worked in a year (h):

$$E = Ph$$

Thus, if a watermill with a power of 3 CV[4] worked at full power 10 hours a day, its everyday energy consumption was 30 CVh[5]. Multiplied by a yearly working calendar of 300 days, its yearly energy consumption would have been 9,000 CVh. Since 1 CVh is equal to 634 kcal, the total energy employed would have been 5,706,000 kcal.

To convert CV into HP:

1 CV = 735.4 W

1 HP (continental) = 736 W

1 HP (English) = 745.7 W

1 English HP = 1.0132 continental HP = 1.014 CV.

The problem, however, is not yet solved. Since we are interested in energy input -in the case of a mill, the energy of the water actually falling on the wheel- we have to multiply the previous result by a coefficient (≥ 1). Thus, if the efficiency or yield (output divided by input) of a watermill was 70 percent, that is 0.70 (a high efficiency, as in all cases when there is no passage through combustion), the coefficient would be 1.428 (1/0.70). This is a necessary step, since calculations concerning modern sources are also based on the energy input, not the output (i.e., the fuel actually put into the tank of a car, not its mechanical-energy output). For the sake of consistency, we need to employ the same method to estimate hydro-electric energy. What we are looking for is not the energy produced, but the energy of the falling water driving the turbines.

[4] Cavallo Vapore is the Italian measure of power, quite similar to the continental HP.

[5] Cavallo Vapore ora; a measure of energy similar to HPh.

Thus, the formula is the following:

$$E = P \cdot h \cdot \frac{1}{i}$$

Where:
E energy consumption;
P power;
h hours of exploitation per day or per year;
i engine efficiency (the ratio of energy output to input).

In our case, assuming that a watermill with a power (P) of 3 CV worked at full power 10 hours a day (h), as in the previous example, its daily energy consumption would have been 30 CVh. We must then multiply this figure by 1.428 ($1/i$). The result is 42.84 CVh per day. Even though this is only a theoretical example, as we shall see it is actually not so far removed from what the real energy consumption of Italian mills must have been. In the following time series of hydraulic energy, I have employed a coefficient of 1.428 to allow for the fact that the energy of the water driving the wheel is higher than that actually used by the mill. A similar formula, with a different coefficient, is used to derive the energy input of a water flow driving a turbine from the electricity produced by the turbine itself.

The same method can be used for sailing ships. Again, we determine the power of the sailing ship and multiply it by the hours this power is employed for during the year. The only difference is that, while mills usually worked at full power, ships worked at full power only when the wind was blowing with sufficient force and in the right direction. Hence, we need to add to the previous equation another coefficient, lower than 1. Its effect in the equation would be that of neutralizing, at least partially, the $1/i$ coefficient. In my calculation, in the case of ships, I have opted for the following simplified formula:

$$E = P \cdot h$$

All the data will be expressed in kcal and their multiples (toe), which are the standard units used today by international organizations. In Appendix II, the series are also expressed in joules and their multiples to facilitate comparisons with other series.

Now let us turn to our time series of energy sources. The series are arranged in chronological order: food, firewood, working animals, wind, water, fossil sources, primary electricity.[6]

2.2. Food[7]

Food for human beings is never included in current energy statistics. Two reasons are often invoked to account for this omission:

- The present contribution of food to the energy balance is negligible in quantitative terms, since it provides only 2,500-3,500 kcal per capita per day, whereas in advanced economies energy consumption per capita per day mainly ranges from 50,000 to 150,000 kcal;
- Food can be regarded as a secondary source of energy, since today many more calories are used up to produce and transport food than it actually supplies.[8]

The first of these two arguments is true, if we look at the modern energy system, but not if we look at pre-modern economies. The quantitative importance of food in traditional energy systems is remarkable. Since energy transition means the passage from the old to the new energy system, food must be included. As to the second argument, I have

[6] This order is also followed in the Appendices to maintain a correspondence between the text and the statistics.

[7] App. I, 1, col. 1, and App. II, 1.

[8] As stated by Martinez-Alier (1991), p. 54.

already discussed and disproved the second point above, in my discussion on the issue of duplications.[9]

Data on food in the 1861-1913 period have been recently re-examined by G. Federico in his revision of statistics on the Italian agricultural sector in national accounting.[10] His series are more reliable than those supplied by the ISTAT in the 1950s. I have used them in my own time series. Notably, there is a strong difference between the two series in the 1880s. For the period following 1913, I have used ISTAT data.[11] Since these data -expressed in kcal per capita per day- do not include alcohol, I have added data on wine and beer consumption and converted them into kcal.[12] The ISTAT data were put together using a supply-oriented approach. This approach involves collecting information on the production, exportation, and importation of any commodity used as food. The procedure on which the series I used are based is to estimate, first of all, domestic production as:

$$\sum_{i=1}^{n} m_i x_i = m_1 x_1 + m_2 x_2 \ldots + m_n x_n$$

Where:

m energy measurement unit (kcal) per weight unit;

x weight of any commodity used as food.

The same calculation must be performed on imported (*imp*) and exported (*exp*) human food (respectively added and subtracted) to obtain the total (*E*) energy consumed in the country in a year:

[9] See above, 1.2.

[10] Federico (2003 a, b, c).

[11] ISTAT (1958), p. 233, and (1986), p. 184, which provide decadal values. The ISTAT series on food consumption in kcal has been discontinued from 1973 on. I assumed for the following years 1973-2000 the same consumption as in 1973.

[12] Statistics on alcohol consumption are in ISTAT (1958), p. 232, and (1986), p. 183. I have assumed a caloric content of 300 kcal per liter of wine or beer.

$$E = \sum_{i=1}^{n} m_i x_i + \sum_{i=1}^{n} impm_i x_i - \sum_{i=1}^{n} expm_i x_i$$

Then we can divide the result by the population to calculate per capita consumption.

2.3. Firewood[13]

The issue of firewood consumption is especially controversial. All previous attempts at establishing annual series on a national scale are unsatisfactory. What's more, given the importance of firewood among traditional sources, an over- or underestimation can deeply affect our aggregate values. The same problem is encountered, as far as I know, when dealing with other European regions.

As to the magnitude of firewood consumption in early modern Italy, some estimates based on data from the demand side indicate that an average of about 1.5-2 kg per capita per day was more or less the norm. This estimate, like subsequent ones, includes the industrial uses of firewood as an energy carrier.[14] Some examples concerning Rome and Naples[15] in the 19th century confirm this assumption. The differences between the Alpine area and the Southern regions, however, were quite strong. In 18th-century Piedmont, firewood consumption was 2.3 kg per capita per day,[16] while in Sicily it hardly reached 1 kg. Since firewood yields about 3,000 kcal per kg., the Italian average daily consumption was presumably 4,500-6,000 kcal per capita. It appears that in early Modern Spain the average firewood consumption was more or less the same.[17] From the scanty available information, it is estimated that in Central Europe

[13] App. I, 1, col. 2, and App. II, 2.
[14] Wood used for construction (houses, ships) is excluded.
[15] Bartoletto (2004 a and b).
[16] Prato (1912).
[17] I refer to the series by Mar Rubio on Spain (forthcoming).

-Germany, Northern France, England, Denmark, The Netherlands- per capita fuel consumption ranged from 2 to 4 kg. of firewood per day (this estimate also includes the caloric content of coal and peat, converted into kilos of firewood). In 19th-century Sweden, fuel consumption was as high as 7-8 kg, and in Finland as high as 10.[18]

Often data on firewood and charcoal are expressed in volume. To convert volume into weight and then into calories, I have used the following coefficients:

1 cubic meter = 625 kg[19]

1 kg of firewood = 3,000 kcal

Kgs of firewood to produce 1 kg of charcoal = 5.5

1 kg of charcoal = 7,300 kcal.

An estimate for Italy, based on available data from the supply side, could be obtained by applying the following formula:

$$E = mF_a + mF_u + mA + mImp - mExp$$

where:

E gross energy consumption in kcal;

m unit of measurement to convert weight or volume units into kcal;[20]

F_a officially authorized cutting of firewood in the forests (in weight or volume);

F_u unauthorized cutting of firewood in the forests (in weight or volume);

A home consumption of self-procured firewood in rural areas (in weight or volume);

Imp importation of firewood (in weight or volume);

Exp exportation of firewood (in weight or volume).

[18] I collected information on this topic some years ago in Malanima (1996). For Sweden, see especially Kander (2002), pp. 22 ff.

[19] This is the coefficient for dry wood from coniferous trees: see *Energy Statistics* (1987). A coefficient of 450 kg is often used. Obviously the difference can deeply affect our statistics. The choice of a 625-kg coefficient is based on the trees mainly used for firewood in Italy. For other European areas, a different coefficient may be preferable.

[20] On measurement units for fuels, see also Pireddu (1990), p. 30.

Charcoal, being a secondary energy source, is converted into firewood using the above coefficients.

While data on officially authorized cutting of wood is more or less reliable, and imports and exports (negligible, all considered, for a heavy and relatively cheap commodity such as firewood) are also relatively well documented,[21] we lack direct information about unauthorized cutting and home consumption of non commercialized firewood. To indicate a general range of magnitude, we first need to look at earlier estimates.

Some estimates have been published by the ISTAT and, more recently, by G. Federico in his ongoing revision of national accounting for agriculture.[22] In the following table (2.1), Federico's estimates, in cubic metres per capita per year, are compared with those proposed by the ISTAT.

Table 2.1. Recent estimates of firewood consumption in Italy in 1891, 1911, 1938 and 1951 (m^3 per capita per year)

Year	Author	m^3 per capita per year
1891	Federico	0.965
	Istat	0.908
1911	Federico	0.703
	Istat	0.835
1938	Federico	0.455
	Istat	0.668
1951	Federico	0.434
	Istat	0.589

It is also interesting to look at some estimates of firewood production made from 1904 to 1938 by statisticians and economists, using different criteria. In table 2.2, some of the more reliable estimates are compared.[23]

[21] See Bardini (1991) for the 1870-1913 period.

[22] In *I conti economici dell'Italia.* ISTAT estimates are from ISTAT (1958 and 1976).

[23] Lunardoni (1904), Carlucci (1923), Meliadò (1932), Associazione fra le Società Italiane per azioni (1939), De Vita (1939), Ferrari (1942), Istituto Centrale di Statistica (1939). Maroi's book (1946) is also useful.

Table 2.2. Estimates of firewood consumption in Italy from 1904 to 1938 (aggregate estimates are within coeval borders)

Year	Author	M^3 per year	m^3 per c. per year
1904	Lunardoni	32,000,000	1.000
1920-22	Carlucci	28,890,000	0.760
1928	Meliadò	20,000,000	0.495
1936-37	ASIPA* and De Vita	14,121,371	0.327
1937-38	Ferrari and ICS**	29,612,000	0.682

* ASIPA: Associazione fra le Società Italiane per azioni.
** ICS: Istituto Centrale di Statistica

As we can see, both the coeval series and the more recent estimates agree on a consumption level ranging from 0.300 to 1 m^3 per year, i.e., between 0.5 and 1.7 kg per capita per day with a clear long-run decline from 1900 to 1938.

In Italy as elsewhere, firewood remained the main source of energy until the second half of the 19th century. If we turn to consider its economic value, however, the outlook is quite different. Firewood was a negligible part of the gross domestic product and agricultural product. In 1911, the whole Italian consumption of wood as fuel amounted to less than 1 percent of the GDP and 2.3 percent of the total agricultural product.[24] After this date, its relative importance decreased even more.

From 1861 onward, we have two long-period series of firewood consumption:

1. The first series was compiled by the ISTAT.[25] Unfortunately, we know very little about the criteria employed.[26] The basis was certainly represented by authorized tree-cutting in the forests. Allowances were made for the peasants' use of firewood obtained through pruning and non-authorized cutting in the woods, even though no detailed information is available about these activities. Several experts on this

[24] *I conti economici dell'Italia* (1, 1991).
[25] ISTAT (1958 and 1976), and Barberi (1961).
[26] Some information can be found in Barberi (1961), pp. 95 ff.

topic, writing at the end of the 19th and in the first half of the 20th century, assumed that legally cut trees accounted for about one third of total firewood consumption. Thus, the issue of estimating this non-commercial part of the overall consumption is paramount.

2. A shorter series for the 1871-1913 period was established by C. Bardini in several studies published in the 1990s.[27] Bardini collected ample material on the subject from contemporary literature. In his publications he provides information on his statistical methods. He distinguishes between per capita urban and rural consumption, and takes account of price changes, changes in the extension of forests, and population movements (distinguishing between town and countryside). His time series differ from those of the ISTAT: +25 percent for the first decades after the Unification, between +5 and +10 percent for the years before World War I.

In the following series, I have used Bardini's data from 1871 to 1913.[28] I have added estimates for the 1861-71 period assuming the same yearly rate of increase as in 1871-80. Since the ISTAT series certainly underestimates firewood consumption (as recently pointed out by the ENEA in its report on firewood consumption in 1999),[29] for the 1913-1950 period I assume a 15-percent underestimation. I assume a similar underestimation for Bardini's series for the 1900-1913 period. The resulting series is close to the higher margin of the estimates we have just seen.[30]

While most traditional energy carriers decrease rapidly after 1950, this is not the case for firewood. A recent re-

[27] Bardini (1991, 1994, 1998). The results of these studies differ significantly.

[28] Bardini (1998).

[29] ENEA (2003).

[30] For a comparison with the evolution of woodland in Italy, see Agnoletti (2005), who discusses the reliability of the ISTAT's estimates of the extension of Italian forests.

search coordinated by the ENEA[31] has shown that, in 1999, 22.3 percent of Italian families still used vegetable fuels, mainly firewood and charcoal (although other fuels were often used as well). In regions such as Umbria, Sardinia, Abruzzo, and Trentino Alto Adige, the percentage of families relying partially or totally on firewood for domestic heating was higher than 35 percent. On the whole, 14,681,585 tons of firewood (i.e., 3,416,106 Toe) were consumed in Italy in 1999. To compare this datum with those just presented for previous periods, 23.5 million cubic metres of firewood were consumed in 1999: 0.250 per person per year. Firewood consumption in Italy decreased only slightly, in absolute figures, throughout the 20th century: from about 30 million cubic meters to 23.5. However, since population increased from 33 million in 1900 to 56 million in 2000, there was a sharp decline in per capita consumption. Thus, the per capita trend was declining, while the aggregate trend shows a long-run stability.

As was foreseeable, the ENEA investigation indicates that the Regional Energy Balances, on which the ISTAT series are based, heavily underestimate firewood consumption,[32] which actually appears to have been three times higher in 1999.[33] It seems from the ISTAT series that this heavy underestimation of firewood consumption increased during the 1960s. Since there is no way of establishing a reliable annual series for the half century following World War II, I used a linear interpolation to calculate the intermediary data from 1950 to 1999. The result is an almost stable level of firewood consumption in absolute figures and a gradual decline in per capita terms.

[31] ENEA (2001).

[32] A heavy underestimation is evident in the statistics proposed in ENI (1983, 1986, 1992).

[33] Because of the assumption of different conversion coefficients, our data in Toe differ from those put forward in the ENEA inquiry.

2.4. Animals[34]

Turning to working animals, a series for animals in agriculture was established by the ISTAT on the basis of animal censuses in post-Unification Italy.[35] G. Federico has recently turned out new data for bovines covering the 1861-1939 period. His estimates for the 1860's are higher by about 25 percent than those provided by ISTAT,[36] while they differ only slightly after 1880.[37]

Not all Italian oxen and cows actually worked. The contribution of animals to agricultural work and transportation was different in each European country. Thus, one needs to specify the percentage of actually working animals in each investigated area. The 1930 agricultural census informs us that in Italy only 29 percent of oxen and cows actually worked,[38] whereas horses, mules, and donkeys were all employed in agriculture and/or transportation. It seems reasonable to assume that the same percentage of oxen was employed in agriculture before 1930 as well. After all, in 1930 the Italian agriculture was still relatively backward, reliance on draught animals high, and the diffusion of tractors limited. I have assumed that working oxen began to diminish in 1951, and had gone down to 5 percent by 1965. From 1975 to 1984, I have assumed a gradual decline and finally the total disappearance of working animals in agriculture.[39] Unfortunately, as far as I know, there is no direct quantitative evidence for this declining trend. While young animals

[34] App. I, 1, col. 3, and App. II, 3.

[35] ISTAT (1958 and 1976). In my calculations I also used statistics provided by the MAIC (Ministero d'agricoltura, industria e commercio) (1875, 1876, 1882, 1887, 1910, 1934) and the *Annuario di statistiche zootecniche* ISTAT (1962, 1971, 1994).

[36] These statistics, not yet published, have been kindly supplied by G. Federico. I seize the occasion to thank him.

[37] See also SVIMEZ (1954 and 1961).

[38] ICS (1934), pp. 112 ff.

[39] I also used ISTAT statistics (1962, 1971, 1994).

are already excluded from the percentage (29 percent) of working bovines, it is not so in the case of horses, mules and donkeys. We know from animal censuses that one-two-year-old animals, not employed in work or transportation because too young, represented about 20 percent of the total.[40] Therefore I have subtracted this quota from the total of horses, mules and donkeys.

To estimate energy consumption, we now need to know the animals' daily caloric intake. For oxen, I have assumed a figure of 21,000 kcal per day; for horses, mules, donkeys, 24,000 kcal.[41] The reasonable assumption of a slow increase in animal feed consumption during the 20th century would hardly change the results of these series. I adopted the same per animal consumption along the whole period.

The formula for calculating the total energy consumption of working animals is the following:

$$E = c_h aH + c_o bO$$

Where:

- E energy consumption;
- c_h yearly feed consumption by a horse in kcal;
- a percentage of working horses, donkeys, and mules on the total (0.80, when young animals are excluded);
- H horses, donkeys, mules;
- c_o yearly feed consumption of an ox or cow in kcal;
- b percentage of oxen and cows employed in agriculture (0.29);
- O oxen and cows.

Dividing the result by the Italian population, we obtain the per capita consumption of energy by draught animals.

[40] Se the agricultural censuses, and especially those in MAIC (1882) and ICS (1934).

[41] The daily consumption is close to that proposed by Kander (2002), p. 46.

2.5. Wind[42]

Since the ISTAT provides a complete statistical series from 1862 onward detailing the number and tonnage of Italian merchant ships -distinguished in sailing ships and steamships-, we must necessarily use this information as our starting point. The series ends in 1975. For 1861, I have assumed the same datum as in 1862. We also have a series of sailboats for the same period.[43] They grew slowly until 1934 and declined thereafter. Their tonnage was 6 percent that of sailing ships in 1861, and this percentage was still the same in 1934. After 1934, the tonnage of sailboats declined more rapidly than that of sailing ships.

We know that, immediately after the unification of Italy (1861), the ratio of a steamship's tonnage to its power (expressed in CV) was 2.8.[44] Thus, power is the result of tonnage divided by 2.8. We are speaking here of net rather than gross tonnage, which also includes boilers, machines, motors, and the furniture of the crew's quarters.[45]

In the same period -the late 19th century- we know that, tonnage being equal, a sailing ship was usually estimated to have 1/3 of the power of a steamship.[46] Thus, to calculate the power of a sailing ship, all we need to do is divide its tonnage by $2.8 \cdot 3 = 8.4$.[47]

The next step is to estimate how much of this power was actually used. We lack any information whatsoever on this

[42] App. I, 1, col. 4, and App. II, 4.

[43] ISTAT (1958), p. 120, (1976), p. 87, (1986), p. 217.

[44] Correnti-Maestri, II, (1864), pp. 536-38.

[45] Supino (1918), p. 2. In Italy, the difference between gross and net tonnage was about 50 percent, as can be deduced from a change in tonnage that occurred in 1940, recorded in my series, based on ISTAT data (1958, p. 15, Table 75). I have taken account of this change in my processing of the data.

[46] Barberis (1908), II.

[47] Important technical information can be also found in Rossignoli (1922), pp. 34 ff., Baader, pp. 57 ff., and Rossi (1915).

matter. I have assumed that a ship's power was fully exploited 10 hours a day, 365 days a year. Since ships were not used every day and did not always travel at full speed, less than half a day at full power all year round seems a reasonable assumption. If an engine with a power of 1 CV works 10 hours, the energy consumed is 10 CVh. The final step is to convert CVh in calories or joules.

The trend is clearly declining for sailing ships from the 1870s onward, as contemporary observers already stressed. In the first half of the 19th century, the Italian merchant fleet, with a gross tonnage just short of 1,000,000 tons, was second only to the British fleet (more than 5 million tons). By the end of the century it had receded to fifth place,[48] a decline brought about by the transition to steam.

The importance of windmills in Italy was negligible. Only 78 are recorded in the 1878-82 period, as we shall see in the next section.

2.6. Water[49]

The first reliable national census of mills (not just watermills), within coeval borders, refers to 1878-82. Its results are summarized in Table 2.3.[50]

In 1869, there were 74,764 mills within the borders of the Italian Kingdom, i.e., 1 every 360 inhabitants.[51] The number of cereal mills diminished during the 1870s; by 1880, there were 57,408. This decline was brought about by the introduction of steam power and cylinders (more efficient than the traditional millstones). Since in 1880 the Italian population within coeval borders was 29,108,000, there was a ratio of 1 mill every 493 inhabitants and 1 watermill

[48] Supino (1918), pp. 12 ff.
[49] App. I, 1, col. 5, and App. II, 5.
[50] *Statistica industriale* (1889).
[51] Aliberti (1981).

every 962. A mill ground, on average, 1000 quintals per year; 380 quintals per 1 CV.

Table 2.3. Mills in 1878-82 and ground cereals per year (within coeval borders; power in CV and cereals in quintals)

Type of mill	Number	Power (CV)	Ground cereals (Q.ls)
Watermills	29,418	133,744	46,117,685
Steam-mills	918	16,103	9,356,183
Windmills	78	192	46,287
Animal-driven mills	26,994	…	1,390,245
TOTAL	57,408	150,039	56,910,400

Available industrial censuses[52] allow us to reconstruct the power of Italian watermills in several years, starting from 1869 (Table 2.4).

Table 2.4. Power of watermills between 1869 and 1937 (CV)

	CV
1869	145,090
1877	140,279
1882	133,744
1903	125,464
1911	115,249
1927	104,639
1937	126,381

To estimate the energy consumption of watermills (first in CVh then in kcal), we now need to know how long, on average, the power of a watermill was exploited per year. For the 1879-88 period, engineer Carlo Saldini -a great expert on watermills, and author of an important manual on watermill construction- published[53] a list of Italian watermills produc-

[52] For 1869, 1877 and 1882 MAIC (1889, 1905); for 1911 MAIC (1914), IV, pp. 508-09, 521-23; for 1927 ICS (1929), VI, p. 638; for 1937 ICS (1939), I, Part I, pp. 8-9, 40-41.

[53] Saldini (1878).

ing more than 100 quintals per day, divided by region.[54] The list specifies the quantities of cereals ground by each mill per working day (23 hours): 42,900 quintals ground by 152 mills (water or steam), with a total power of CV 14,518, exploited 23 hours a day. Thus, these larger mills ground 0.183 quintals per hour. These were, however, the most productive mills. In the same report, Saldini informs that it was commonly estimated that, to grind 1 quintal of cereals in 1 hour, a power of 6-8 CV was needed. Hence, on average 1 CV ground 0.140 quintals per hour. It seems that the difference in productivity between the best water and steam-mills, on the one hand, and other types of mills, on the other, was not particularly high if the larger steam and water-mills had a productivity of 0.183 quintals per hour, whereas the general average was 0.140. They were exploited 2,646 hours per year (that is 10 hours a day for 265 days).

We have no data on improvements in efficiency over the following years. After the period that Saldini describes as a period of change, when millstones were replaced with cylinders, we can assume a gradual increase in productivity, notably in the years 1880-1913 (from 0.120 quintals per hour in 1861 to 0.140 in 1880, and then to 0.200 in 1913).

As to water power exploited for other purposes than to grind cereals, the same source tells us that in 1877 the power of other industrial water engines was distributed among the different industrial branches as follows:

Paper mills		CV 14,000
Cotton mills	less than	CV 10,000
Silk industry	more than	CV 4,000

These figures represent only a part of the water power actually exploited by the industry. In fact, we know that in 1877 the industry used 450,831 CV of water power, and 479,029 in 1888.[55] Thus, in 1877, watermills accounted for

[54] Saldini (1889).
[55] *Statistica industriale* (1889), p. 22.

31 percent of the total available power, and in 1888 for 24 percent. In 1903, the total water power exploited was 418,258 CV.[56] (The water power exploited by the cereal mills is not included in these estimates).

For the year 1911, we can rely on the industrial census, where the power available in each branch of the industry is specified.[57] The power exploited by the whole industry in that year was 1,603,836 CV. Water power amounted to 942,652 CV: about 60 percent of the total. Part of this water power was converted into electricity (and hence is already included in my time series as primary electricity). Water power not converted into electricity was 257,143 CV (Table 2.5). As we can see, in the industry as a whole, water power was already declining, being 57 percent less than in 1877. It is also worthy of notice that, aside from the production of electricity, most water power was employed for grinding cereals in the food industry.

To estimate the exploited water power, I present two different series of calculations, one for watermills, the other for the rest of the industry.[58] In both series I have assumed a working time of 2,650 hours per year (i.e., 10 hours a day for 265 days), the same assumed for cereal mills. We know that in the industry the usual working time was 10 hours per 6 days per 50 weeks a year, i.e., 3,000 hours per year.[59] Again,[60] I have assumed an efficiency of 70 percent to take into account losses in the transformation of water falling onto the wheel into mechanical energy (*1/i* is equal to 1.428).

[56] Bardini (1991), p. 106.

[57] The 1911 census data are taken from the elaboration by Bardini (1994), p. 416, of MAIC (1914). See, on the topic, Barca (2005).

[58] For the years 1877-87, I took into account the Italian provinces missing in the mill censuses (cf. Bardini (1991), p. 105).

[59] Zamagni (1989), p. 113.

[60] See above, 2.1.

Table 2.5. Water power (in CV) exploited by the Italian industry in 1911 (not transformed into electricity)

Industrial Sectors	CV
Mining	1,403
Food and tobacco	124,716
Textiles	51,785
Clothing	191
Leather	1,794
Wood	11,418
Metalworking	14,738
Engineering	12,728
Non-metallic minerals	7,961
Chemicals, rubber	3,248
Paper, printing	24,217
Sundry manufactures	488
Construction	428
Utilities	2,028
TOTAL	257,143

The resulting equation is :

$$E = (Pm_c + Pm_e) \cdot h \cdot \frac{1}{i}$$

Where:

E energy consumption;
P power;
m_c number of cereal mills;
m_e number of water industrial engines (cereal mills excluded);
h hours of exploitation per year;
i efficiency (the ratio between energy output and input).

While the two series referring, respectively, to cereal mills and industrial mills share some features, there is a difference in the slope of the curves. For watermills, we have 7 estimates, from 1869 to 1937. Obviously, changes in the number of mills from a census to the subsequent one were quite slow. I merely smoothed the curve between an estimate and the following and assumed stable values between

1937 and 1950. I also assumed a gradual linear decline from 1950 until the total disappearance of watermills in 1970. For the rest of the industry, we have only 3 estimates for the same period (1869-1937). Since the last estimate already shows a strong decline, the series uses a linear interpolation until 1950; then a decline until the disappearance of watermills in 1970. By that time, the economic importance of water power for mills and other industrial uses had become negligible.

Our results differ from Bardini's.[61] In the 1860s and '70s, there is a difference of 1 to 5. This difference depends on the fact that Bardini estimated direct water energy in terms of the quantity of coal required to do the same work, i.e., precisely the kind of calculation I have rejected above.[62]

2.7. Consumption of traditional sources

Even though we still know very little on energy consumption in European traditional economies, we can assume that before the energy transition Italian energy consumption was probably close to that of the rest of the Euro-Mediterranean world, i.e., lower than that of Central and Northern Europe. The first reason for this difference depended on the relatively higher temperatures of Southern European regions, which resulted in lower firewood consumption: around 1.5 kg per capita per day in Italy as opposed to 2-3 kg in France, Germany, England, and more than 5 kg further up north. The second reason is the relatively lower number of animals employed in agriculture in Mediterranean regions such as Italy, because of the aridity prevailing in the summer months and the consequent difficulty of feeding numerous working animals.

[61] Bardini (1991 and 1998).
[62] See above, 2.1.

Following the methods described above, we can assume an average daily energy consumption of 15-20,000 kcal in Central-Northern Europe in the early Modern Age, whereas in Italy it was around 10,000, as in 1860-70, a period for which a direct estimate is possible.[63] We will see in the next chapter that, despite the spread of new energy carriers from the second half of the 19th century, Italy's level of energy consumption remained relatively lower than that of other European countries. Since the cost of modern sources of energy continued to be higher than in other countries, the Italian economy specialized in low-energy productions. Metal and chemical productions always had trouble catching on in Italy. This trend towards low-energy continued to characterize the Italian economy even after its industrial boom in the 1950s and 1960s.

[63] See the estimates in Malanima (1996).

3. Modern sources

3. Modern sources

3.1. From traditional to modern energy carriers

The traditional energy system, based that is on renewable vegetable sources, was sustainable in the long run, since it ultimately relied on solar light, an almost endless source of energy. In the short run, however, it was hardly able to keep the population supplied with food for human beings and animals, and with firewood, because of the frequent ups and downs of production and the inherent difficulty of extending the main converter of the system, that is, agricultural land (fields, pastures and forests). We know, conversely, that the modern system is unsustainable in the long run, since fossil fuels will eventually get exhausted. In the short run, however, it is quite easy to increase fuel availability to allow production to grow. Thus we have, on the one hand, a system that is sustainable in the long but not in the short run; on the other, a system that is unsustainable in the long run, but able to supply immense quantities of energy in the short. It is the discovery, or rather, the diffusion of the technology to transform heat into work that allowed the transition from one system to the other. The European traditional economies -based, that is, on the metabolism of vegetable products by men, animals and plants-, were transformed into fossil-based economies. While before the transition the main converters of energy into work had been biological engines, thereafter this function was taken over by machines.

Two technological discontinuities, viz., the exploitation of fossil fuels and the generation of work from heat, were the basis of -or the necessary condition for- Modern Growth. In Europe first, and subsequently in the rest of the world, consumption of energy from modern sources, population, and per capita availability of energy, kept growing together for a relatively long time; whereas in vegetable energy systems a contemporary increase of these three variables was an exceptional event and one that, at any rate, could only last for short periods. Per capita product in Western Europe grew 16-17 times from 1800 to 2000; in the same period, per capita energy consumption grew 10 times and population 3.5 times; hence, total energy consumption grew about 35 times (Table 3.1).

Table 3.1. Estimates of per capita energy consumption in Europe, per capita traditional energy carriers, the European population, total energy consumption, and per capita GDP 1800-2000

	Per c. kcal. per day	Per c. toe per year	Traditional Energies (%)	European Population	Energy Consumption	Per c. GDP (1990 int. $)
1800	14,750	0.54	87	146	79	1,200
1830	15,150	0.55	80	181	100	1,400
1900	37,590	1.37	25	295	404	3,000
1950	47,430	1.73	15	392	678	5,000
1970	89,560	3.27	5	460	1504	11,000
1989	106,700	3.89	5	497	1933	16,800
2000	141,900	5.18	5	523	2709	20,000

Sources: Data on energy are from Malanima (1996), p. 126; data on GDP in 12 Western European countries from Maddison (2003), pp. 58-65.

Note: Energy consumption is expressed in per c. kcal per day (2nd col.) and toe per c. per year (3rd col.); traditional energy consumption – food for human beings, feed for animals, firewood, energy from water and wind- is a percentage of total consumption (4th col.). The European population (Russia excluded) is expressed in millions (5th col.) and total energy consumption in millions of toe or Mtoe (megatoe; 1 Mtoe=1 million toe) (6th col). Per c. GDP (7th col.) is in 1990 int. Geary-Khamis dollars.

As energy production (modern carriers) on a world scale grew (from 200 kcal per capita per day in 1800 to 40,000 in 2000), Modern Growth conquered new regions (Table 3.2).

Table 3.2. World production of energy from modern carriers (kcal per c. per day) 1800-2000

1800	209	1910	12,216
1830	577	1913	14,136
1840	724	1928	14,790
1850	1,154	1938	14,746
1860	1,887	1950	19,190
1870	2,895	1960	26,396
1880	4,320	1970	36,417
1890	6,269	1980	39,621
1900	8,785	1990	38,290
		2000	46,575

Source: adapted from Etemad-Luciani (1991) until 1980, ONU data for 1990, and adapted from Martin (1990) for 1990.

The consumption of energy from traditional and modern sources is hard to estimate on a world scale. The figures in Table 3.3 are an attempt to provide an overview of this complex change. On a world scale, the transition has obviously been slower than in Europe, and started later.

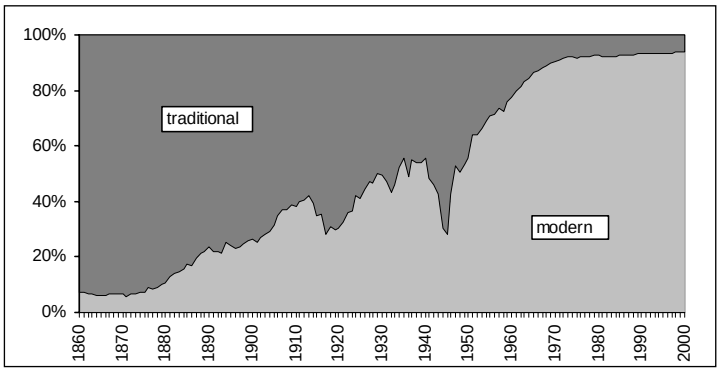
Table 3.3. Estimates of per capita energy consumption in the world, per capita traditional energy carriers, world population (000,000), total energy consumption, and per capita GDP 1800-2000

	Per c. kcal. per day	Per c. toe per year	Traditional carriers (%)	World population	Energy consumption	Per c. GDP (1990 int. $)
1800	5,225	0.2	95	954	180	
1850	5,770	0.2	80	1,241	261	
1880	8,640	0.3	50	1,480	466	
1900	13,510	0.5	45	1,634	806	1,250
1950	27,410	1.0	30	2,530	2,531	2,100
1970	45,520	1.6	20	3,637	6,043	3,700
1985	46,320	1.7	20	4,815	8,141	4,700
2000	52,250	1.9	15	6,000	11,440	6,000

Source and Note: as for Table 3.1.

In Italy, both the energy transition and the modernization of the economy came about relatively late. Modern sources provided 7 percent of the overall energy balance in 1861. From the 1880s onward, they increased to become 40 percent of the total on the eve of World War I, 50 percent on the eve of the World War II, and about 95 percent today (Figure 3.1).

Figure 3.1. *Modern and traditional sources of energy in Italy 1861-2000*



We could summarize this change by saying that in 1861 Italy was almost completely dependent on vegetable sources. Firewood still accounted for half of the total consumption, while food for human beings and animals represented about 20 percent each. Water and wind supplied only 1 percent of the total; coal, the only modern source, 7 percent (Table 3.4).

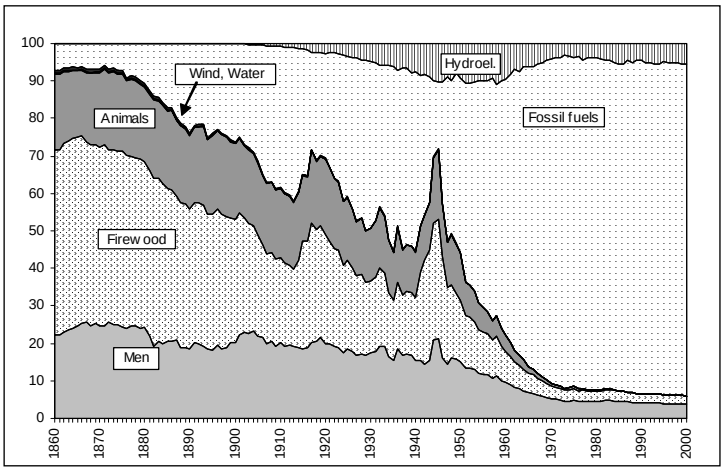
Table 3.4. Composition of energy consumption in Italy 1861-2000 (%)

	1861	1900	1950	2000
Food for human beings	22.92	20.48	15.37	3.89
Firewood	50.41	33.88	16.50	2.39
Feed for animals	18.32	18.31	11.62	0.00
Wind	0.24	0.15	0.00	0.00
Water	0.73	0.32	0.10	0.00
Fossil fuels	7.38	26.77	46.95	88.19
Primary electricity	0	0.09	9.46	5.53

Source: App. II, 2

The two main periods of change were 1880-1913 and 1950-70, whereas from 1913 to 1950 the growth of modern sources was continuous, but slower (Figure 3.2).

Figure 3.2. *Energy consumption in Italy 1861-2000 (%)*



Although we lack information on earlier periods, we can assume that for ages the Italian population relied on firewood for 50 percent of its energy, and on food for human beings and animals for the other 50 percent.

In Italy, the last decades of the 19th century were a period of important innovations in the exploitation of modern carriers. The importation of coal, from the first decades of the century, was increasing; oil was introduced in 1864; thermoelectricity in 1883; hydroelectricity in 1887; natural gas in 1896. At the beginning of the 20th century, geothermic sources too began to be exploited to produce electricity. These transitions to modern energy carriers occurred at about the same time as in the rest of Europe (Table 3.5).

Another much later innovation in Italy was the short-lived experience of nuclear electricity from 1963 to 1987. A very recent development was the introduction of wind, photovoltaic, and biomass electricity.

Table 3.5. Energy consumption in Europe from 1920 until 1970 per source (%)

	Coal	Oil	Natural Gas	Hydroel.	Nuclear
1920	96,5	2,6	-	0,9	-
1950	82,5	14,0	0,3	3,2	-
1970	29,2	60,2	6,6	3,5	0,5

Source: Brondel (1976).

As a plant-based economy, Italy, although not rich in arables and fertile land, was almost totally self-sufficient for its energy needs. Before the age of railways and steamships, self-sufficiency was crucial, because modern energy carriers, while cheaper than traditional ones, were still relatively expensive due to their high transportation costs. Some importation of cereals from abroad is attested in the late Middle Ages and, as we know, ancient Rome relied on imports from several Mediterranean regions for its alimentary sustenance. In the 16th-century Mediterranean world, however, it is estimated that such imports accounted for no more than 1 percent of total requirements.[1]

There is indeed evidence for some importation of firewood; on the whole, however, in 1863, 99.8 percent of the firewood and charcoal consumed in Italy was still produced within national borders.[2] In the same year, 90.5 percent of the small amount of coal consumed in Italy was imported.

The growing exploitation of fossil carriers determined an increasing dependence of Italy on foreign countries. In 1955, more than half of the energy consumed in Italy was imported (Table 3.6). At the end of the century, Italy was dependent on foreign sources for more than 80 percent of its energy, a datum mainly reflecting its massive petroleum imports.

[1] As stressed by Braudel (1949), 2, ch. III.
[2] Bardini (1991), p. 91.

Today, Italy produces less than 20 percent of its energy; the remaining 80 percent is imported. Hydroelectricity, always Italy's main native energy source, is still important. For a long time, Italy was the first producer of hydroelectricity in Europe. Only recently has it been overtaken by France and Norway. Italy also has a primate, ever since the beginning of the 20th century, in the production of geothermic electricity; actually, it is still the second geothermic electricity producer in the World after the USA. ENEL's nuclear programme has been halted in 1987. Natural gas also contributes significantly to the production of electricity, especially in the Po Valley.

Table 3.6. Italian dependency on foreign energy sources (%)

	IE/IC	IE/TI
1955	55.4	12.2
1960	59.8	13.9
1965	76.2	15.3
1970	82.3	14.3
1975	80.1	26.7
1980	82.3	27.8
1985	81.3	26.7
1990	82.7	10.7

Source: Spinelli (1993), p. 236.

Note: in column 2 dependency is computed as the export-import difference (IE) as to the internal energy consumption (IC); in column 3 the export-import difference (IE) is divided by the Italian total imports of goods (TI).

Italy today is one of the countries in the world that most depends on other countries for its energy supplies. In Europe, only Ireland, Portugal and, in a somewhat lesser measure, Spain, have an equally high degree of dependence; outside of Europe, Japan is another example of a developed country depending heavily on imported energy (Table 3.7).

Table 3.7. Dependency on foreign energy sources in Europe in 1990 and 2002 (%)

	1990	2002
Austria	67.4	67.9
Belgium	73.4	76.8
Denmark	45.0	-40.0
Finland	59.2	56.9
France	51.0	48.9
Germany	47.3	60.3
Greece	59.4	64.5
Ireland	65.6	90.9
ITALY	*82.8*	*84.1*
Netherlands	8.8	21.4
Portugal	83.5	88.7
Spain	61.9	76.1
Sweden	36.1	35.0
United Kingdom	2.0	-13.6

Source: ENEA (2004).

3.2. Fossil fuels[3]

Series on fossil fuels are computed, within current borders, as:

$$E=P+I-X+Ri-Rf$$

Where:

E energy consumed;
P internal production;
I import;
X export;
R_i availability at the beginning of the yearly cycle;
R_f availability at the end of the yearly cycle.

The data on fossil fuels have been recently revised by S. Bartoletto, whose series refers to coeval borders.[4] For the 1861-1870 period, I have replaced data missing in her series with data gathered by Barberi.[5] These series are the same as

[3] App. I, 1, col. 6, and App. II, 6.
[4] Data within coeval borders are in Bartoletto (2002) and (2005).
[5] Barberi (1961), pp. 240 ff.

those of the ISTAT, *Sommari di statistiche storiche.*[6] For the 1870-1913 period, Bartoletto's series is based on Bardini,[7] and subsequently on official ISTAT series, except for data on peat and oil, which she took from Bardini.[8] The difference between the ISTAT's series and those worked out by Bardini is negligible. For the 1914-21 period, Bartoletto's series is based on Barberi,[9] and then, from 1922 until 1954, on data on gross internal availability published in the *Bollettino del Comitato Carboni*.[10] Data for the 1955-70 period are based on annual energy balances published by the Ministry of Industry and Commerce.[11] The data from 1963 to 1977 have been cross-checked with the CNEN's reconstruction for the same period.[12] Data for 1944-45, which are lacking in the bulletins of the *Comitato Carboni*, were also taken from the CNEN publication. Data from 1977 to 2000 are from the *Bilanci energetici nazionali* published by the Ministry of Industry, Commerce and Crafts.[13] As regards the composition of fuel consumption, we can clearly distinguish three ages (Table 3.8). The first was dominated by coal.

Table 3.8. Composition of fossil fuel consumption in Italy 1870-2000 (%)

	Coal	Oil	Gas
1870	95	5	0
1900	98	2	0
1930	87	13	0
1950	58	39	3
1970	9	81	10
2000	8	54	38

[6] B. Barberi was at the time director of the Institute. The *Sommari* referred to are published by ISTAT (1957 and 1976).

[7] Bardini (1991).

[8] Bardini (1991).

[9] Barberi (1961).

[10] Pluchino (1956).

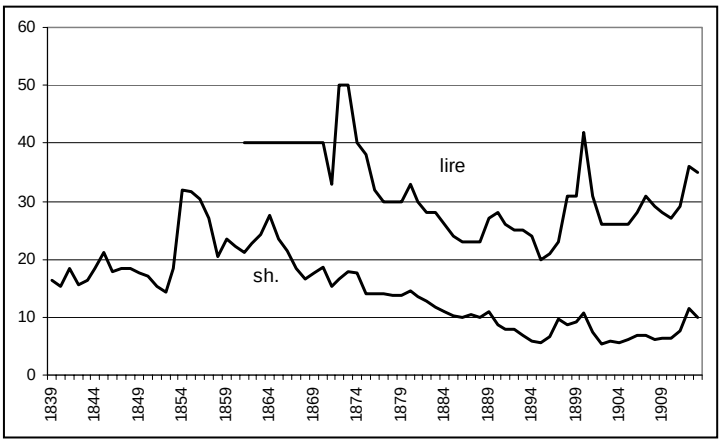
[11] MIC (1965) and MICA (1978).

[12] Pierantoni, Piacentini, Vestrucci (1980).

[13] See *Bilanci energetici nazionali,* ad annum and, for a control, ENEA (2003), 2, pp. 96-101.

Our information on the importation of coal into Italy before the Unification is scarce. Some coal began to be imported from England at the beginning of the 19th century, or even earlier. At the time when my series begin, coal imports, especially from Genoa, were increasing as a result of diminishing transportation costs (Figure 3.3).[14] The shipping of coal to Italian ports increased during the 1880s, when coal prices dropped quickly. After a period of stability, from 1861 until the end of the 1870s, our curve of coal consumption exhibits a rapid rise in the 1880s.[15]

Figure 3.3. *Coal price in Italy and transportation costs from Galles to Genoa 1839-1913 (sh. and lire per ton)*

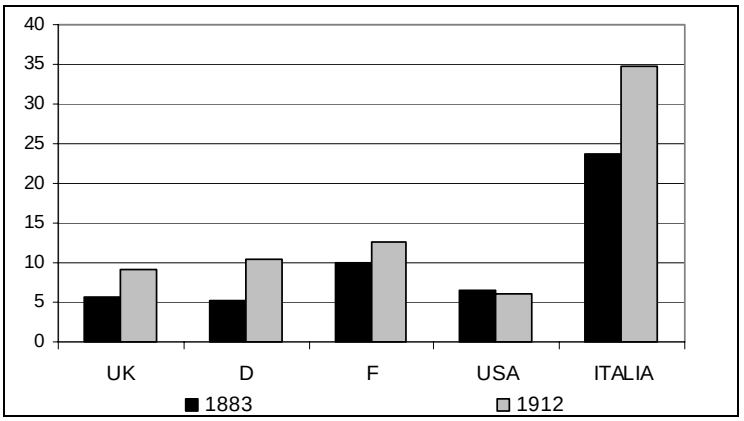


[14] Transportation costs from Wales are taken from Harley (1989). Coal prices from 1861 onward are found in ISTAT (1958 and 1976). For the previous period, they have been computed from a linear regression of prices on transportation costs for the period 1861-1913. While transportation costs are in English shillings, coal prices in Italy are in Italian lire.

[15] This rise in the 1880s is consistent with Fenoaltea's view of the growth of the Italian economy in the Eighties. See especially Fenoaltea (2002 and 2004).

Italian coal never represented more than 0.15 percent.[16] The country's scarcity of fossil fuels resulted in relatively high fuel costs, 3-5 times higher than in competing Western European economies (Figure 3.4).[17] In 1910, the United Kingdom produced about 270,000 tons of coal per year, Germany 150,000, and Italy only 3,000.[18] Italy almost totally lacks modern energy carriers. Some oil is produced in Sicily and the Po Valley, and poor-quality coal is quarried in Sardinia.

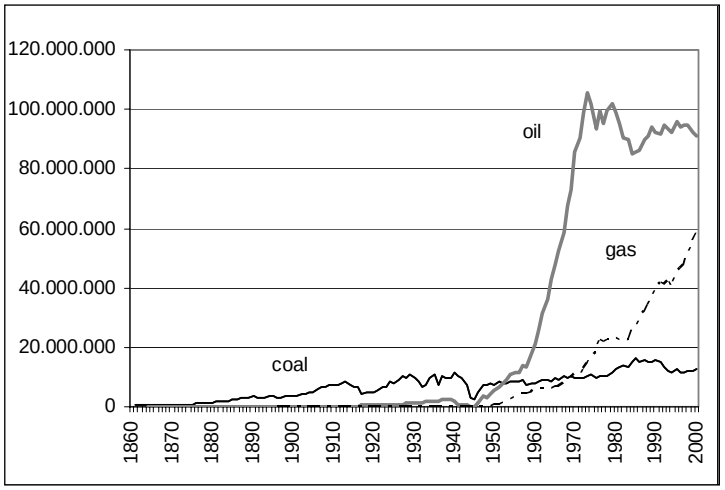
Figure 3.4. *Coal prices in 1883 and 1912 (in sh. per ton)*



Petroleum importation started in Italy in 1864. Its importance remained secondary until the 1950s, when it surpassed coal and rapidly increased until 1973, to slowly decline thereafter. Natural gas was already used at the end of the 19th century, but began to gain importance only in the 1950s, and eventually surpassed coal in the 1970s (Figure 3.5).

[16] The percentage of 0.15 was reached in 1945.
[17] These prices are from Bardini (1998), p. 52. See also Sapori (1981).
[18] From Bardini (1998), p. 32.

Figure 3.5. *Consumption of coal, oil and gas 1861-2000 (Toe)*



3.3. Primary electricity[19]

As we have seen, electricity is always a secondary form of energy and, as such, cannot be included in our time series, which only concern primary energy. Both thermal electricity –produced, that is, by means of coal or oil- and hydro-geo-nuclear-electricity are always secondary forms of energy. Hence, it is incorrect to speak of primary electricity. Usually, however, statistics on electricity make a distinction between "thermo-electricity" and "secondary electricity" produced by means of coal or oil, which is a duplication of the calories of the fuels used in thermal power plants, on the one hand, and "electricity" and "primary electricity", produced by means of carriers such as falling water or underground steam sources, on the other. For simplicity's sake, I have decided to maintain the definition "primary electricity", although incorrect, in my own statistics.

[19] App. I, 1, col. 7, and App. II, 7.

In June 1883, the power plant of Santa Radegonda in Milan began to produce the first 700,000 kwh from coal.[20] It was thermo-electricity, and as such I have not included it in my series.[21] Only from 1887 onward did the production of hydro-electricity begin.[22] Geo-electricity appears in the national series in 1916.

In App. II, 7, the time series of secondary electricity or thermo-electricity indicate the kwh produced, not the energy employed to produce them. Since we are interested in primary energy consumption, these series on secondary energy are not included in my final calculations in Appendix I.

As in the other cases considered here, I have included in my calculation energy losses in the production of hydro-geo-electricity, since our purpose is to establish the gross energy employed. Hence, primary electricity is computed as:

$$E = (H + G + N + W + P) \cdot \frac{1}{i} + I$$

Where:

E primary electricity in general;
H hydroelectricity;
G geoelectricity;
N nuclear electricity;
W wind electricity;
P photovoltaic electricity;
i efficiency in the production of hydro-geo-electricity (always $i < 1$);
I net electricity import.

The Italian national series of primary electricity also includes nuclear electricity – or nuclear-thermo-electricity – com-

[20] The *Storia dell'industria elettrica in Italia* contains a wealth of information on electricity in Italy.

[21] Mortara (1981), p. 357.

[22] In the ISTAT statistics (1957), until 1898 no distinction is made between thermo- and hydroelectricity. I took the figures on hydro- and thermo-electricity production from ENEA. The series in App. I and II are also taken from this source.

puted from the beginning of its production in 1962.[23] The role of nuclear energy in Italy has been negligible. The first nuclear power stations began to produce electricity in 1962 (Latina), 1963 (Garigliano), and 1964 (Trino Vercellese).[24] Italy's nuclear energy production ceased completely in 1987, as a consequence of the Chernobyl disaster in April 26th 1986, and a national referendum which rejected the ENEL nuclear program. A rapid increase in wind and photovoltaic electricity began in 1992. The raw data, in kwh, are shown in Appendix II.

Since it is consumption, rather than production, that we are interested in here, I have included statistics on imported electricity, from the same ENEA source. Italy has always been a net importer of electricity, except for a few years in the 1950s.[25]

To estimate energy consumption, we also need to take into account loss at the turbines. We know that in 1953 the efficiency of hydro-electric power-plants –i.e., the ratio of energy output to input-[26] was 0.78. I have assumed an efficiency of 75 percent until 1960 and 85 percent after that date.[27] As we can see in the above equation, the *i* coefficient is divided not only by hydroelectricity, but also by geo, nuclear, wind, and photovoltaic electricity. The use of different coefficients, reflecting the different efficiencies of different energy-producing methods, and their changes over time, while undoubtedly more correct, would complicate matters. I have therefore assumed, for all forms of electricity production, the same yield as hydroelectricity, by far the most important source of primary electricity in Italy. The use of different coefficients would result in quite similar figures.

[23] ISTAT (1986), p. 239.
[24] Silvestri (1989), p. 175.
[25] As we can see in App. II, 7.
[26] Bartoletto (2002), pp. 5-6.
[27] Eden, Posner, Bending, Crouch, Stanislaw (1981), pp. 161ff. See also Venikov-Putyatin (1981), pp. 109 ff.

The electricity used to pump water upstream during the night, when electricity consumption is lower, to exploit the downstream flow of water during the day, has not been subtracted, as is often done in similar statistical reconstructions. The consumption of electricity through this technology remained negligible -1 percent or less- until the 1990s when it rapidly grew to reach 24 percent of the electricity produced in 2003.

To estimate primary electricity production, some researchers use a coefficient of 2,200 kcal per kwh, computed from the kcal necessary to produce electricity by means of fossil fuels. Since I have rejected from the beginning this method of estimating energy consumption, I have always assumed the lower coefficient of 1 kwh=860 kcal.

The Second Industrial Revolution opened up new opportunities for Italy. While coal importation was rising, electricity, and especially the spread of hydroelectricity, increased the country's ability to produce work.[28] A wider range of modern carriers was becoming available. In the 1911 industrial census, the installed power in CV was 1,603,836 (Table 3.9).[29]

Table 3.9. Total power of Italian industry in 1911 (CV)

	CV
Steam	465,343
Water power	942,694
Gas	166,215
Oil	29,583
Total	*1,603,836*

Water power was mainly employed to produce electricity: 685,541 CV out of 942,694. Of the remaining 257,143 CV, which represented 16 percent of the total (1,603,836

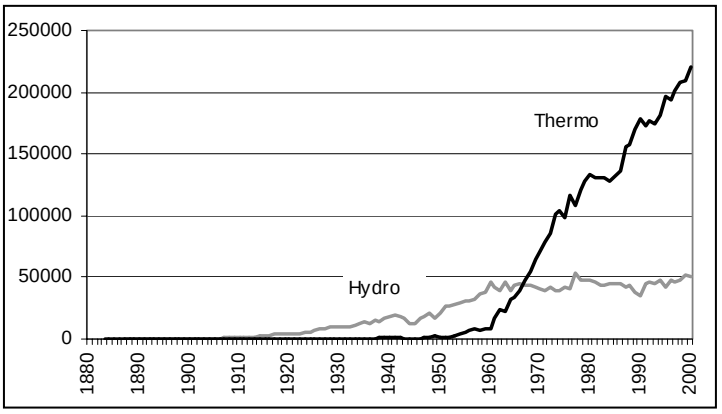
[28] See Barca (2005).

[29] MAIC (1914). The following data are taken from Bardini (1994), where the original figures are presented according to the current distribution of industrial sectors.

CV), 117,804 were used to grind cereals in watermills. Thus, only 139,339 CV, 8.7 percent of the total, were used outside of the food industry. Hence, much of Italy's industrial growth from 1861 to 1911 depended on the introduction of new sources of energy (especially hydroelectricity) and increases in power (in Italy, in 1860, steam power accounted only for 50 CV).[30]

Until the 1960s, hydroelectricity was more important than thermoelectricity in Italy (Figure 3.6). The low prices of fossil fuels in the 1950s and 1960s, together with the increasing national energy consumption, resulted in a growth of thermoelectricity, which surpassed hydroelectricity in 1966.

Figure 3.6. *Hydro- and thermoelectricity 1883-2000 (GWh)*



3.4. Consumption of modern sources

In 1985, the Italian per capita yearly consumption of commercial -i.e., modern- energy was about 70 percent that of France and Great Britain, and 30 percent that of the USA. It was 70 percent higher than the world average, but only 70 percent that of the European Community (Table 3.10).

[30] Landes (1969), ch. IV, Tab. 8.

Table 3.10. Commercial energy consumption in 1985 (kcal per capita per day)

	Kcal
Canada	240,219
USA	200,739
The Netherlands	133,972
Soviet Union	132,109
Fed. Rep. of Germany	122,794
Great Britain	98,410
France	96,876
Japan	83,753
Italy	*69,863*
EC (10 members)	98,465
OCSE	125,397
Developing Countries	11,123
World	*39,753*

Source: Ippolito (1989), p. 85.

If we look at the Italian position in the world hierarchy of energy consumption in a longer chronological perspective, we will find that in 1950 the Italian per capita consumption of modern energy carriers was 12 percent that of the United Kingdom, 24 percent that of France, and only 6 percent that of the USA (Table 3.11). In terms of per capita GDP, Italy was still lagging behind, but not as much as in energy consumption. Its per-capita GDP was 66 percent that of France and 50 percent that of the United Kingdom. The gap with the USA was wider. The Italian per capita GDP was 37 percent that of the USA, but, again, the gap in per capita energy consumption was even wider.

Even though its methods for calculating energy consumption are different from mine, a recent report confirms the relatively low level of per capita energy consumption in Italy for the last 20 years of the past century (Table 3.12), a level close to that of other North Mediterranean countries such as Spain and Portugal enjoying a similar climate.

Table 3.11. Per capita energy consumption of modern carriers in some advanced countries from 1950 until 1990 (Toe per year)

	1950	1960	1970	1980	1990
Italy	0.336	0.805	2.112	2.517	2.730
Japan	0.380	1.020	2.905	3.261	3.536
United Kingdom	2.768	3.446	4.137	3.854	3.675
France	1.379	2.083	3.228	3.881	3.845
Germany*	1.825	2.883	4.254	4.809	4.351
The Netherlands	1.405	2.206	4.640	5.415	4.459
Canada	3.876	5.970	7.799	9.348	10.009
USA	5.531	6.119	8.058	8.221	7.882
USSR	1.102	2.196	3.294	4.578	5.014
EC**	1.231	2.141	3.622	3.972	3.410
World	0.707	1.089	1.422	1.575	1.567

* Fed. Germany until 1980. In 1990 Dem. Germany is included.
** 9 countries until 1980; 12 countries in 1990.

Source: Spinelli (1993), p. 232.

Table 3.12. Per capita energy consumption of modern carriers in Western Europe from 1980 until 2000 (Toe per year)

	1980	1990	2000
Austria	3,7	3,8	4,3
Belgium	5,2	5,5	6,6
Denmark	4,2	3,8	4,1
Finland	5,1	5,4	5,9
Former Yugoslavia	1,9	2,3	–
France	3,9	4,1	4,6
Germany	–	–	4,4
Germany, East	5,4	5,2	–
Germany, West	4,6	4,6	–
Greece	2,0	2,6	3,1
Ireland	2,4	2,6	3,9
ITALY	*2,7*	*3,0*	*3,3*
Luxembourg	9,9	9,6	8,8
Netherlands	5,7	5,6	6,0
Norway	8,3	10,2	11,0
Portugal	1,1	1,9	2,7
Spain	2,1	2,6	3,4
Sweden	6,3	6,4	6,3
Switzerland	4,5	4,4	4,5
Turkey	0,6	0,9	1,2
United Kingdom	4,0	4,1	4,1
Western Europe	*3,4*	*3,5*	*3,7*

Source: www.eia.doe.gov

Assuming that these international estimates are reliable, it appears that, until the late Sixties, per-capita modern-energy consumption in Italy remained lower than the world average. The gap between Italy and the rest of the European Community was still about 20 percent. One also notices that in 1960, although below the world average and the average in advanced regions, the Italian position was already much stronger than that of the many backward countries of the world (Table 3.13).

Table 3.13. Per capita consumption of commercial energy in the world in 1960 (kcal. per c. per day)

ITALY	22,065	
World	26,926	
North America, Europe, Oceania		*86,378*
USA	153,405	
Canada	108,145	
Western Europe	49,249	
Oceania	58,301	
USSR and Eastern Europe		*55,597*
USSR	54,715	
Eastern Europe	57,515	
Latin America, Middle East, Africa, Asia		*7,939*
Caribbean	16,991	
Latin America (without the Caribbean)	9,627	
Middle East	5,120	
Africa	5,983	
Asia	7,786	
India	2,684	
Japan	22,380	
Communist Asia	11,506	

Source: adapted from Schurr (1963), p. 113

Italy's economic boom in the Fifties and Sixties raised it higher in the world hierarchy of energy consumption. Its three-fold increase in per-capita GDP from 1950 to 1973[31] went hand in hand with a 4.5 increase of overall energy consumption and a 7.5 times increase of modern energy consumption.

[31] See the GDP series in App. III.

What the data in Table 3.13 tell us, in a nutshell, is that modern energy consumption in Italy was still lower than in other European countries, and lower than the European average. Immediately after World War II, the Italian per capita consumption from modern sources was more or less the same as that of the developing regions of the World at the end of the previous century (Table 3.14).

Table 3.14. Modern energy consumption in 1950 and 1993 (kcal per c. per day)

	1950	1993
Canada	124,082	208,870
USA	144,030	207,410
The Netherlands	37,590	150,180
Germany	48,900	141,060
England	84,770	107,130
Czechoslovakia	56,770	105,460
France	38,930	104,100
Denmark	40,100	96,500
Japan	14,960	91,980
ITALY	7,611	77,270
India	1,920	6,770

Source: Maillet (1954) for 1950; ONU data for 1993.

While this pattern of low energy consumption distinguishes Italy from North and continental European countries, it resembles that of Mediterranean countries such as Greece, Portugal and Spain. In the 1970s, per capita energy consumption from modern sources was 50-60 percent higher in Italy than in Spain. The gap has been reduced since.[32]

[32] From Cook (1976), p. 245 (for 1972) and UN sources for 1988 and 1993.

4. Energy and product

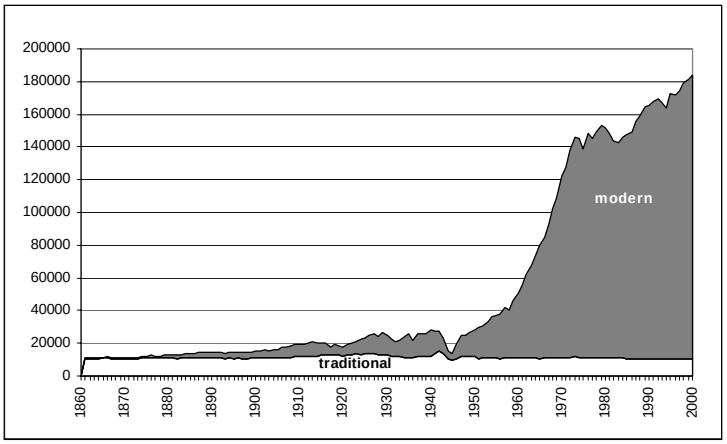
4. Energy and Product

4.1. The trend

On the basis of the foregoing reconstructions, the trend of energy consumption in Italy can be seen in a different light. Its movement clearly shows the existence of three phases (Figures 4.1 and 4.2):

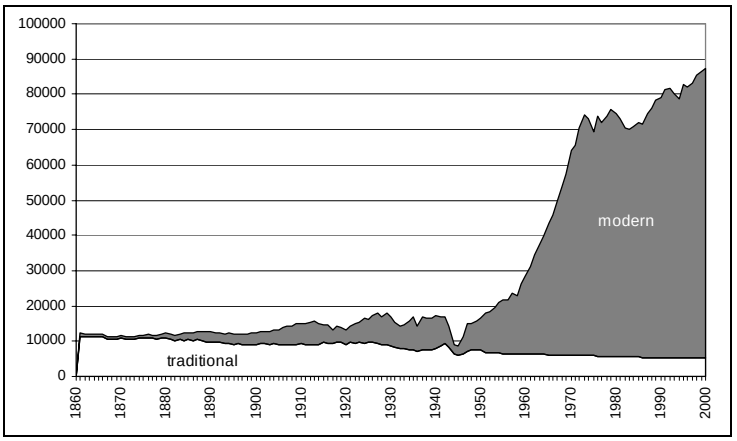
1. From the beginning until World War II: in about 80 years (1861-1938), total energy availability rose by slightly more than 1 percent a year.
2. From the end of the World War II to 1973: energy consumption rose at the astonishing rate of 5 percent per year.
3. From 1973 to the present: annual growth was lower than 1 percent.

Figure 4.1. *Energy consumption in Italy 1861-2000 (traditional and modern in Mtoe)*



While traditional sources slowly decreased, the rising trend was largely dependent on the growth of modern sources, which represented 7 percent at the beginning of our period and 93 at the end.

Figure 4.2. *Per c. energy consumption in Italy 1861-2000 (modern and traditional; kcal per day)*

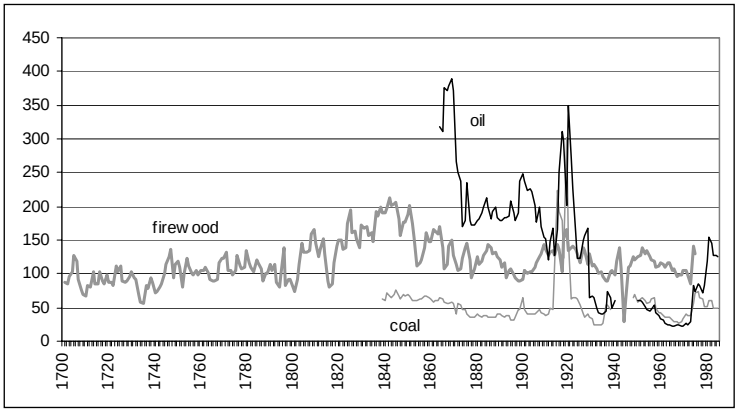


In the long run, the increase in energy usage was higher than these figures suggest. Efficiency in consumption - the ratio, that is, of the output of useful energy to the total input - certainly improved during the transition. It has been estimated that, while a subsistence agriculture exploits energy with an efficiency of about 10 percent, a more advanced pre-industrialization agrarian economy could even reach 25 percent.[1] This is probably an overestimation. We know that the efficiency of a working animal hardly reaches 10 percent, since most of the fodder is used for the animal's metabolism and hence does not produce mechanical energy. In the case of a human being, efficiency is higher: about 20 percent. Traditional fireplaces and stoves employing fire-

[1] Cook (1976), p. 135. For a more in-depth discussion of this issue, see Malanima (1996), pp. 119 ff.

wood usually had a very low efficiency, barely reaching 20 percent and in most cases not even 10. A weighted average of the yield of these three main energy sources results in an estimate of overall efficiency at around 20 percent, or perhaps even less. Today, modern energy systems are credited with an efficiency of about 35 percent. Thus, the transition to modern carriers and the exploitation of machines as converters ultimately resulted in higher efficiency. Biological (animal) converters of traditional vegetable sources are, on the whole, less efficient than inanimate machines.

Figure 4.3. *Real prices of firewood, coal, oil 1700-1985 (1911 prices; lire per Toe)*



Modern growth in Italy, but not only in Italy, coincided with a relatively long period of low energy prices. This becomes clear when we look at the evolution of energy prices in a long-term perspective (Figure 4.3).[2] If we compare firewood prices with those of coal and oil, we will see that modern sources replaced the old ones in the period when the consumption of the old sources was rapidly increasing.

[2] Data on coal, oil and firewood prices in 1861-1985 are from ISTAT (1976 and 1986). Data on firewood refer to Milan (1700-1861) and are from De Maddalena (1974).

Real prices of coal and oil were particularly low precisely in the period when Italy experienced its fastest GDP increase. It was then relatively cheap to produce work through mechanical converters.

4.2. Energy intensity and productivity of energy

As one could expect, the energy consumption trend closely follows the trend of production (Figure 4.4).[3] A widely used concept to evaluate the energy-product relationship is that of energy intensity (i); the ratio, that is, between energy consumption (E), measured in kcal or kj, and product (Y), measured in money:

$$i = \frac{E}{Y}$$

Energy intensity in Italy, as in many other European regions, has repeatedly been represented as increasing during the energy transition (Figure 4.5).[4] According to this general opinion, while in earlier, pre-modern economies, production required little energy, things changed during the energy transition: more and more energy was required for the same volume of product. This is a foregone conclusion when we only look at modern sources. The opposite is true, however, when we include traditional energies as well as modern carriers in our estimation. In this case, the trend of the curve is downward from the beginning (Figure 4.6). An upward shift occurs only in the 1960s, the age when energy was particularly plentiful and cheap. From 1973 onward, the curve resumes its downward trend, regaining its earlier intensity level. The series including traditional carriers suggests a totally different perspective from the one considering exclu-

[3] On GDP, energy intensity, and energy productivity, see App. III.

[4] See especially Clô (1994), on which Fig. 4.5 is based, Bardini (1998), p. 25, and Toninelli (1999).

sively modern carriers. The energy used in production has diminished. Its decline has been continuous from 1960 or even earlier. A strong increase followed in the 1960s and was sustained until 1973. Nowadays energy intensity seems to have regained the levels of the 1950s.

Figure 4.4. *Energy consumption and GDP 1861-2000*

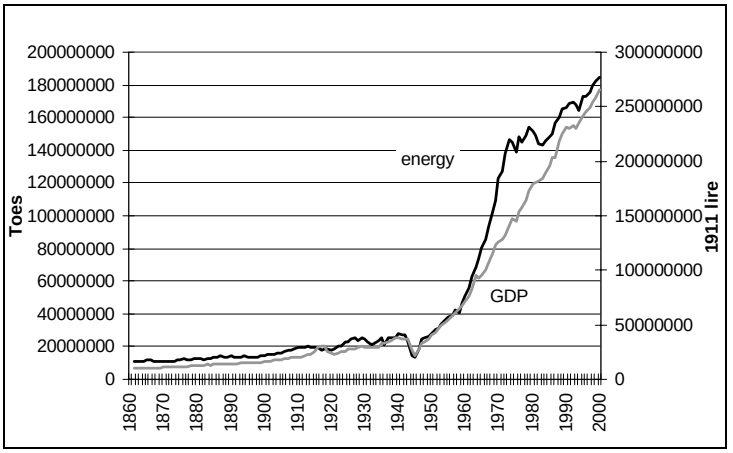


Figure 4.5. *Two views on energy intensity 1861-2000 (1970=1; decadal data)*

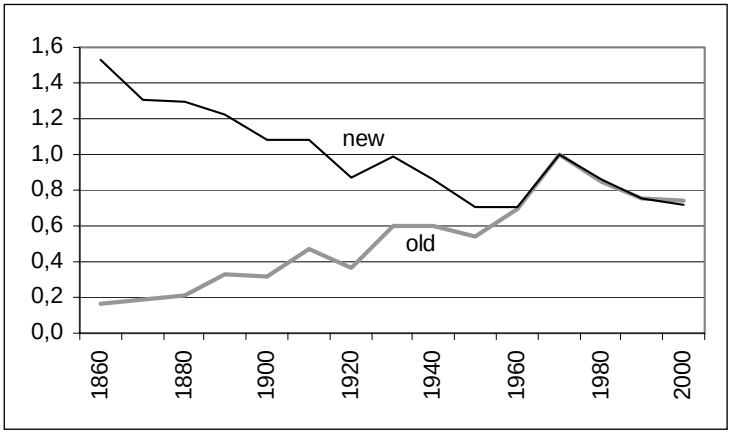
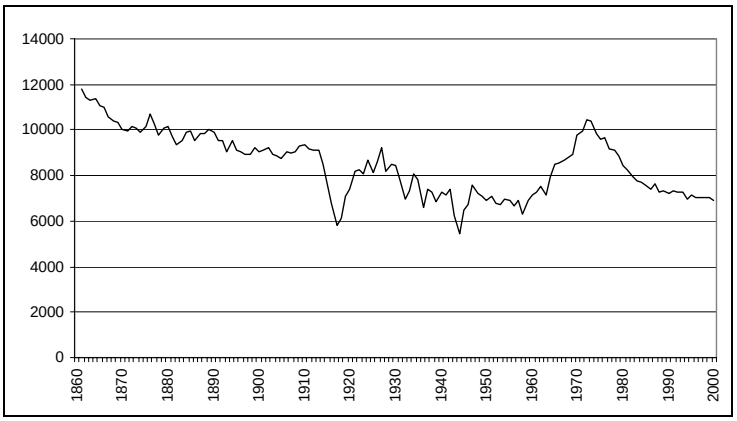


Figure 4.6. *Energy intensity 1861-2000 (kcal per lira 1911)*



It is interesting to look at the issue of energy intensity in a comparative perspective. In the last 30 years, a downward trend of energy intensity has characterized all European economies (Table 4.1). Italy, however, has one of the lowest energy intensities in the continent.

Table 4.1. Energy intensity in some European countries in 1985 and 1995 (koes per product in 1995 Euro PPP)

	1985	1995
Austria	0.220	0.192
Belgium	0.296	0.280
Denmark	0.208	0.185
Finland	0.355	0.360
France	0.231	0.229
Ireland	0.223	0.165
ITALY	*0.179*	*0.172*
Netherlands	0.276	0.248
Norway	0.287	0.257
Spain	0.190	0.195
Sweden	0.433	0.389
United Kingdom	0.262	0.221
European Community	*0.217*	*0.180*

Source: ENEA (2004).
Note: a koe is a 1 kg oil equivalent (kcal 10,000).

Low energy intensity characterizes the economies of several Mediterranean countries because of their high average temperatures. In Italy, it also depends on the specific character of the industrial system, which is dominated by light and/or small industries.

To examine the energy-product relationship, the concept of energy productivity (p), which is simply the reciprocal of energy intensity, can be perhaps more useful than that of energy intensity:

$$p = \frac{Y}{E}$$

As we can see (Figure 4.7), the productivity of energy increased continuously until the end of the 1950s. Then for a decade there was a decline, followed by a recovery up to the levels already attained in the 1950s. The decline in the productivity of energy took place precisely in the period when energy prices were reaching their lowest values. There was no point then in saving energy. Things changed after 1973, when the rise of energy prices put pressure on firms and households to save energy.

The link between energy and production becomes even clearer if we look at the GDP as a function of energy (Figure 4.8). The best interpolating curve of the scatter diagram is a third-degree polynomial curve.[5]

The inverted-S curve in the GDP-energy relation can be explained as follows:

- In a first phase, the replacement of biological converters with machines was the main reason for the increase in the productivity of energy. When the GPD level is low and energy prices relatively high, there is a tendency to save energy. Hence, the slope of the relationship is high (more or

[5] The equation of the curve is:

$$e = \alpha + \beta_1 y + \beta_2 y^2 + \beta_3 y^3 + \varepsilon$$

Where:

e is energy consumption per capita per year (in Toe); and

y is per capita GDP (in 1990 PPP international dollars).

less in a range of 0.5 to 0.9 toe per capita per year); the degree of elasticity of GDP to energy is high;

Figure 4.7. *Productivity of energy 1861-2000 (1911 Lire per toe)*

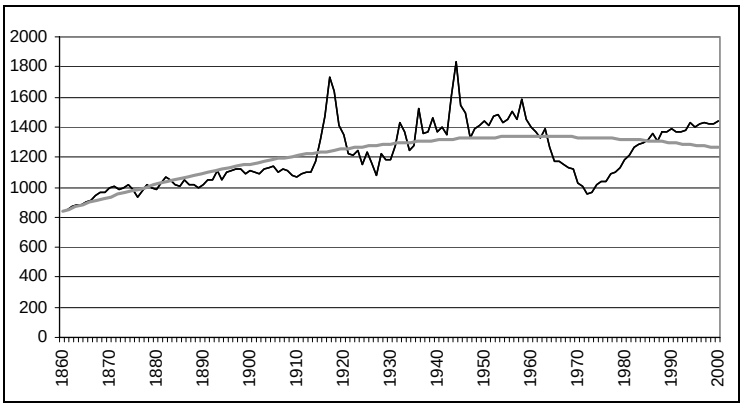
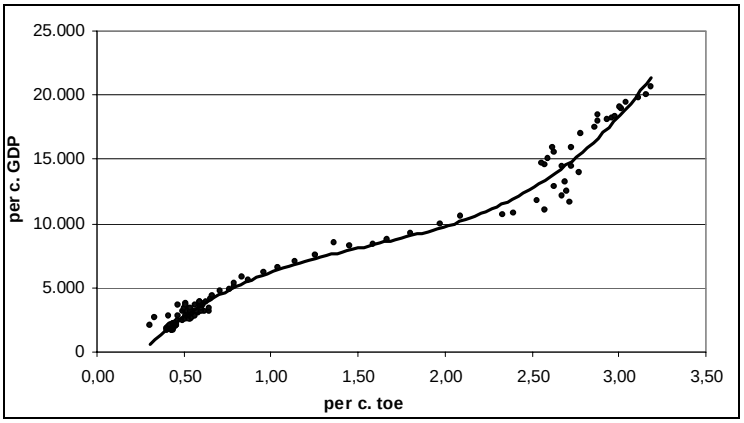


Figure 4.8. *Per c. GDP and energy consumption 1861-2000 ($1990 and toe)*



- In a second phase (the Italian economic miracle of the late 1950s and 60s), since energy was abundant and cheap, people's propensity to save diminished, and so does the slope of the curve (until 1973 and in a range of 0.9 to 2.8 toe); in this period, more energy than both before and later

was used to produce each additional unit of the GDP; the degree of elasticity diminished;

- In a third phase, when fossil fuels became expensive, a propensity to save energy spread again, so the slope of the curve rises. It is possible that the change in the elasticity of the curve derives, in part, from the structural change that was taking place in the economy, marked by the rising weight of services, which are usually less energy-intensive than industry.[6] This issue, however, would need to be investigated more in depth. At the moment, I can only observe that: 1. It is doubtful that the energy demand for services was lower than that of industry (in the particular case of Italy, where the heavy industry always played a minor role); 2. At the end of the 1990s, the productivity of energy regained the level of the 1950s, but the importance of services was higher than 60 percent in the second period and lower than 50 in the first.[7] If the rise of the services played such an important role in this process, we would expect a higher productivity of energy in the second period.

Another way of looking at the relationship between energy consumption and the economy is to break down energy consumption into its components. Energy consumption can be expressed as the result of population (*P*) multiplied by the per capita GDP (*GDP/P)* and energy intensity (*E/GDP)*:

$$E = P \cdot \frac{GDP}{P} \cdot \frac{E}{GDP}$$

A look at the growth rate of the components of gross energy consumption during the long period from 1861 to 2000 clearly shows the interplay between growth factors –population and GDP per capita- and energy intensity. The following figures refer to the annual compound rates of increase of total energy consumption (*e*), population (*p*), per capita GDP (*y*), and energy intensity (e_i). When *p*+y exceeds e_i energy

[6] See, however, the different opinion expressed by Kander (2004).
[7] See data on the Italian GDP in Appendix III, 1.

consumption increases. If we look at the following three periods - 1861-1938, 1950-1973, and 1973-2000 - the result is:

	e	p	y	e_i
1861-1938	1.07	0.67	1.03	-0.61
1950-1973	7.48	0.66	5.00	1.82
1973-2000	0.85	0.26	2.10	-1.50

As we can see, during the first phase the compound energy growth rate -1.07- depends primarily on the product increase, while population plays a minor role. The decline in energy intensity more or less neutralizes population growth. In the second period (1950-1973), the yearly rate of increase in energy consumption –7.48- derives almost totally from the growth of income, although the increase in energy intensity also plays a role. During the last, recent phase, the increase in energy consumption was relatively modest. Product per capita rose, but the decline in energy intensity had a curbing effect on the growth of energy consumption.

4.3. Conclusion

The main obstacle in the path of per capita growth in agricultural economies was their vegetable energy system. Energy sources were scarce and expensive. As a consequence, labour productivity and incomes were low. The energy transition rapidly changed this state of things. Energy sources became abundant and labour relatively scarce. Labour productivity rose, as did labour incomes. Economic growth went hand in hand with a growing availability of energy.

The existing time series of energy consumption provide only a partial view of the energy-growth relationship. New series including both traditional and modern energy sources are a first important step toward a comprehensive understanding of the relationship between energy and modern growth. They are not enough, obviously!

List of abbreviations

CNEN	Comitato Nazionale Energia Nucleare (National Commitee of Nuclear Energy)
ENEA	Ente per le Nuove Tecnologie, l'Energia e l'Ambiente (Institute of New Technologies, Energy and the Environment)
ENEL	Ente Nazionale per l'Energia Elettrica (National Institute of Electric Energy)
ENI	Ente Nazionale Idrocarburi (National Hydrocarbons Institute)
ICS	Istituto Centrale di Statistica (Central Institute of Statistics)
ISTAT	Istituto Centrale di Statistica (Central Institute of Statistics)
MAIC	Ministero di Agricoltura, Industria e Commercio (Ministry of Agriculture, Industry and Commerce)
MIC	Ministero dell'Industria e del Commercio (Ministry of Industry and Commerce)
MICA	Ministero dell'Industria, del Commercio e dell'Artigianato (Ministry of Industry, Commerce and Crafts)

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APPENDIX

I

Aggregate Series

Note: the following series are always expressed in kcal (kilocalories), kj (kilojoules), Toe (tons of oil equivalent) and Pj (petajoules).

1 kcal = 4,1868 kj
1 Toe = 10,000,000 kcal
1 Pj = 23,895 Toe

1. Energy consumption in Italy 1861-2000 (Toe)

	1	2	3	4	5	6	7	
	Food for men	**Firewood**	**Animals**	**Wind**	**Water**	**Fossil fuels**	**Primary Electricity**	**TOTAL**
1861	2,370,917	5,694,864	2,069,359	27,584	82,875	834,009		11,079,609
1862	2,393,836	5,738,715	1,989,171	27,607	83,395	739,776		10,972,500
1863	2,462,591	5,782,903	1,929,575	28,306	83,919	750,114		11,037,407
1864	2,578,307	5,827,431	1,883,172	24,791	84,449	728,935		11,127,085
1865	2,478,188	5,872,302	1,866,486	28,184	84,983	743,492		11,073,636
1866	2,329,851	5,917,519	1,870,202	29,766	76,487	736,988		10,960,813
1867	2,329,197	5,333,003	1,852,809	33,740	76,974	762,537		10,388,261
1868	2,371,795	5,374,067	1,895,099	30,533	77,466	779,359		10,528,321
1869	2,484,260	5,415,448	1,955,557	32,777	77,963	774,036		10,740,041
1870	2,496,338	5,457,147	2,044,097	34,668	78,355	795,280		10,905,885
1871	2,478,242	5,499,167	2,041,734	35,152	76,594	668,266		10,799,154
1872	2,540,107	5,307,170	2,103,566	35,205	76,985	805,104		10,868,138
1873	2,530,348	5,362,428	2,155,778	35,427	77,382	767,446		10,928,809
1874	2,583,998	5,488,686	2,194,851	34,713	77,784	853,542		11,233,574
1875	2,657,962	5,715,066	2,208,254	35,050	78,191	872,198		11,566,721
1876	2,646,974	5,798,106	2,222,394	36,232	78,604	1,144,024		11,926,334
1877	2,633,576	5,584,589	2,227,995	35,933	83,764	1,054,159		11,620,015
1878	2,695,432	5,498,359	2,234,398	34,518	84,075	1,078,355		11,625,137
1879	2,790,578	5,707,657	2,250,111	33,344	84,394	1,247,619		12,113,704
1880	2,772,974	5,777,629	2,280,398	32,912	84,721	1,399,140		12,347,773
1881	2,764,590	5,682,653	2,305,452	31,698	85,056	1,627,135		12,496,583
1882	2,808,574	5,619,781	2,361,628	31,840	85,398	1,760,606		12,667,826
1883	2,853,892	5,690,267	2,417,047	31,023	85,909	1,893,035		12,971,173
1884	2,874,451	5,675,244	2,467,904	30,452	86,426	2,087,216		13,221,693
1885	2,937,906	5,614,224	2,513,855	29,751	86,949	2,369,773		13,552,458
1886	3,010,932	5,539,519	2,550,016	28,865	87,478	2,338,406		13,555,215
1887	3,090,173	5,524,084	2,565,284	26,562	88,012	2,843,354	23	14,137,492
1888	3,035,517	5,530,258	2,563,299	25,460	83,541	3,047,181	57	14,285,312
1889	3,088,297	5,438,368	2,545,215	23,551	78,969	3,144,485	103	14,318,988
1890	3,057,225	5,382,185	2,509,112	23,248	74,731	3,428,090	114	14,474,705
1891	3,007,084	5,309,434	2,526,660	23,036	70,804	3,086,887	149	14,024,054
1892	3,110,898	5,344,832	2,541,421	22,557	67,164	3,067,149	343	14,154,363
1893	3,163,330	5,178,545	2,561,258	21,951	63,790	2,968,561	915	13,958,351
1894	3,140,109	5,230,613	2,584,973	21,425	60,663	3,698,038	1,144	14,736,964
1895	3,214,085	5,182,353	2,620,782	20,944	57,762	3,401,398	2,230	14,499,554
1896	3,293,507	5,120,716	2,639,408	20,068	55,073	3,226,443	2,516	14,357,730
1897	3,202,980	5,098,078	2,665,094	20,017	52,579	3,364,375	5,033	14,408,155
1898	3,354,913	5,023,784	2,681,975	20,544	50,266	3,494,121	7,549	14,633,152
1899	3,352,432	4,975,730	2,684,052	21,262	48,119	3,830,486	10,294	14,922,376
1900	3,318,812	4,957,928	2,679,139	21,612	46,128	3,918,432	12,582	14,954,633
1901	3,472,734	5,020,697	2,694,903	21,807	44,280	3,832,147	18,301	15,104,869
1902	3,548,168	4,800,800	2,708,995	21,671	42,565	4,256,804	25,164	15,404,165
1903	3,585,277	4,609,920	2,734,559	22,115	40,972	4,343,658	34,314	15,370,814
1904	3,545,479	4,494,878	2,769,621	21,708	41,392	4,620,203	40,033	15,533,314
1905	3,620,471	4,348,863	2,801,882	20,781	40,418	5,033,933	45,752	15,912,099
1906	3,717,984	4,270,762	2,881,649	19,557	39,474	6,008,644	62,909	17,000,979
1907	3,617,581	4,263,353	2,959,930	18,456	38,560	6,502,775	91,504	17,492,159
1908	3,580,046	4,338,881	3,029,210	17,989	37,674	6,649,933	111,521	17,765,254
1909	3,664,458	4,446,103	3,165,482	17,417	36,816	7,336,709	125,818	18,792,804
1910	3,839,307	4,417,497	3,197,544	17,233	35,984	7,357,207	142,975	19,007,746

(segue)

(segue)

	1	2	3	4	5	6	7	
	Food for men	Firewood	Animals	Wind	Water	Fossil fuels	Primary Electricity	TOTAL
1911	3,817,581	4,336,721	3,235,905	16,603	45,071	7,603,667	171,570	19,227,117
1912	3,942,010	4,311,819	3,273,705	15,395	44,006	7,963,385	200,165	19,750,485
1913	4,062,147	4,348,142	3,285,761	14,770	42,978	8,560,819	228,760	20,543,377
1914	3,795,063	4,686,776	3,293,676	14,535	41,984	7,689,478	265,934	19,787,446
1915	3,764,734	5,750,726	3,183,958	13,646	41,025	6,743,655	300,248	19,797,992
1916	3,783,953	5,732,266	3,099,922	10,575	40,098	6,729,608	370,248	19,766,669
1917	3,655,621	5,714,160	3,068,812	9,083	39,203	4,645,286	434,072	17,566,237
1918	3,905,883	5,693,215	3,110,216	8,355	38,337	5,459,564	471,360	18,686,931
1919	4,028,665	5,536,769	3,068,442	8,161	35,898	5,114,279	435,102	18,227,314
1920	3,522,841	5,237,383	3,203,210	8,316	35,124	4,938,191	517,798	17,462,862
1921	3,869,147	5,330,835	3,408,324	8,216	34,376	5,895,745	488,288	19,034,932
1922	3,895,067	5,334,233	3,455,130	8,050	33,653	6,839,802	503,272	20,069,207
1923	4,014,752	5,471,522	3,466,137	7,899	32,954	7,146,498	615,936	20,755,699
1924	4,011,265	5,373,313	3,453,850	7,858	32,278	8,938,858	705,381	22,522,805
1925	4,230,736	5,471,862	3,446,433	7,361	31,625	8,614,946	789,336	22,592,300
1926	4,385,988	5,500,747	3,401,504	7,122	30,992	9,917,932	945,351	24,189,636
1927	4,346,379	5,416,471	3,329,824	7,063	30,380	11,238,234	992,361	25,360,712
1928	4,194,846	5,198,303	3,276,939	6,760	30,229	10,266,939	1,105,826	24,079,841
1929	4,361,908	5,168,059	3,181,034	6,605	30,102	11,923,108	1,175,140	25,845,955
1930	4,310,961	4,796,630	3,106,057	6,396	29,999	11,039,150	1,205,680	24,494,872
1931	4,090,604	4,531,566	3,080,456	6,240	29,920	9,663,302	1,190,238	22,592,326
1932	4,081,064	4,396,656	3,050,874	6,248	29,864	8,005,784	1,198,588	20,769,078
1933	4,249,069	4,251,551	2,999,166	6,060	29,831	8,831,482	1,321,432	21,688,591
1934	3,963,170	4,215,529	2,966,103	6,048	29,820	11,280,171	1,435,355	23,896,195
1935	4,017,818	4,163,876	2,917,393	5,880	29,831	12,828,180	1,569,294	25,532,272
1936	4,073,615	3,881,481	2,866,012	5,761	29,863	9,088,669	1,551,908	21,497,309
1937	4,382,306	4,159,118	2,843,774	5,586	29,916	12,599,735	1,736,288	25,756,724
1938	4,421,731	4,362,673	2,864,536	5,469	29,586	12,240,330	1,718,788	25,643,114
1939	4,348,836	4,428,599	2,858,256	5,539	29,268	12,134,425	2,025,327	25,830,249
1940	4,316,188	4,721,189	3,052,115	5,442	28,962	13,401,570	2,137,305	27,662,770
1941	4,175,768	6,411,818	3,019,555	4,784	28,668	10,810,350	2,304,757	26,755,701
1942	3,950,769	7,647,422	3,010,169	4,637	28,385	10,456,870	2,237,959	27,336,210
1943	3,558,445	6,862,766	2,689,731	4,053	28,112	7,850,139	2,046,716	23,039,962
1944	3,150,178	4,667,157	2,366,554	3,144	27,850	3,033,016	1,509,587	14,757,486
1945	2,956,918	4,477,874	2,313,094	2,909	27,598	2,528,140	1,415,453	13,721,987
1946	3,024,413	5,167,039	2,396,568	3,693	27,356	6,162,800	1,933,594	18,715,463
1947	3,645,318	5,159,130	2,690,493	3,995	27,536	11,056,015	2,255,345	24,837,831
1948	4,113,355	4,932,810	3,086,525	3,860	27,308	10,394,605	2,506,981	25,065,443
1949	4,235,287	4,632,315	3,189,056	3,868	27,088	12,187,978	2,125,066	26,400,658
1950	4,277,729	4,591,950	3,234,553	3,819	26,878	13,065,480	2,632,113	27,832,521
1951	3,979,553	4,588,083	3,079,140	3,812	15,153	15,936,145	3,188,571	30,790,458
1952	4,138,980	4,584,220	2,986,153	3,784	8,550	16,466,531	3,309,471	31,497,688
1953	4,289,188	4,580,359	2,889,793	3,675	4,828	18,481,409	3,388,965	33,638,217
1954	4,330,492	4,576,502	2,798,601	3,494	2,729	21,318,880	3,518,901	36,549,599
1955	4,374,090	4,572,648	2,641,666	3,377	1,544	22,707,200	3,737,367	38,037,891
1956	4,433,442	4,568,798	2,429,564	3,141	874	23,331,400	3,808,625	38,575,845
1957	4,490,936	4,564,950	2,353,615	3,061	495	26,860,895	3,902,646	42,176,597
1958	4,570,185	4,561,106	2,264,482	3,038	281	24,884,000	4,348,728	40,631,820
1959	4,638,766	4,557,265	2,182,554	2,947	160	30,477,560	4,651,377	46,510,628
1960	4,838,576	4,553,427	2,100,692	2,811	91	34,557,990	4,879,361	50,932,948

(segue)

(segue)

	1	2	3	4	5	6	7	
	Food for men	**Firewood**	**Animals**	**Wind**	**Water**	**Fossil fuels**	**Primary Electricity**	**TOTAL**
1961	4,975,202	4,549,593	2,006,478	2,729	52	39,962,085	4,509,974	56,006,112
1962	5,132,447	4,545,761	1,915,834	2,708	29	46,432,235	4,351,361	62,380,376
1963	5,289,546	4,541,933	1,836,600	2,644	17	51,501,905	5,089,831	68,262,475
1964	5,368,677	4,538,109	1,781,883	2,588	10	57,172,370	4,592,883	73,456,518
1965	5,445,549	4,534,287	1,597,298	2,610	5	64,036,910	5,015,649	80,632,309
1966	5,591,043	4,530,469	1,453,328	2,597	3	68,653,980	5,242,355	85,473,775
1967	5,755,473	4,526,654	1,313,540	2,582	2	76,320,825	5,137,019	93,056,095
1968	5,940,100	4,522,842	1,190,922	2,582	1	85,749,360	5,161,577	102,567,384
1969	6,065,219	4,519,033	1,082,605	2,568	1	92,939,805	4,964,909	109,574,139
1970	6,259,775	4,515,227	966,031	2,577		106,266,880	5,192,326	123,202,817
1971	6,397,962	4,511,425	869,102	2,565		110,784,175	4,841,509	127,406,739
1972	6,491,809	4,507,626	792452	2,509		121,100,000	4,985,002	137,879,398
1973	6,678,755	4,503,830	727606	2,355		129,800,000	4,630,126	146,342,672
1974	6,741,722	4,500,037	666,023	2,199		128,600,000	4,825,475	145,335,457
1975	6,788,080	4,496,248	616,814	2,188		121,700,000	5,220,131	138,823,461
1976	6,826,009	4,492,461	540,742	2,047		131,800,000	4,907,674	148,568,933
1977	6,850,304	4,488,678	474,718	1,953		127,100,000	6,229,756	145,145,410
1978	6,872,615	4,484,898	416,556	1,867		131,700,000	5,729,662	149,205,599
1979	6,891,951	4,481,122	365,680	1,735		136,300,000	5,960,225	154,000,714
1980	6,898,769	4,477,348	320,818	1,497		134,170,000	5,933,942	151,802,374
1981	6,913,271	4,473,578	281,522	1,429		131,099,000	6,163,794	148,932,594
1982	6,940,664	4,469,810	246,636	1,375		126,610,000	6,167,143	144,435,628
1983	6,969,545	4,466,046	216,580	1,291		125,500,000	6,473,917	143,627,378
1984	6,983,923	4,462,285	180,871	1,212		126,760,000	7,717,655	146,105,948
1985	7,003,012	4,458,528		1,140		129,050,000	7,912,294	148,424,974
1986	7,092,629	4,454,773		1,072		130,490,000	7,931,981	149,970,456
1987	7,106,263	4,451,022		1,010		137,880,000	6,991,059	156,429,354
1988	7,119,898	4,447,273		951		140,330,000	7,903,770	159,801,893
1989	7,130,310	4,443,528		897		145,820,000	7,546,865	164,941,600
1990	7,157,703	4,439,786		847		147,410,000	7,403,575	166,411,911
1991	7,035,115	4,436,047		799		148,330,000	8,511,128	168,313,090
1992	7,060,277	4,432,312		755		149,580,000	8,579,931	169,653,276
1993	7,082,341	4,428,579		714		147,310,000	8,888,227	167,709,862
1994	7,098,578	4,424,850		675		144,200,000	9,006,857	164,730,961
1995	7,098,578	4,421,124		639		153,000,000	8,400,920	172,921,262
1996	7,122,377	4,417,401		605		152,000,000	8,956,828	172,497,211
1997	7,135,020	4,413,681		573		154,400,000	9,073,631	175,022,906
1998	7,141,218	4,409,964		543		158,500,000	9,391,771	179,443,496
1999	7,149,523	4,406,250		515		160,600,000	10,005,827	182,162,115
2000	7,169,851	4,406,250		489		162,600,000	10,200,871	184,377,461

2. The structure of energy consumption 1861-2000 (percentages)

	1	2	3	4	5	6	7
	Food for men	**Firewood**	**Animals**	**Wind**	**Water**	**Fossil fuels**	**Primary Electricity**
1861	21.40	51.40	18.68	0.25	0.75	7.53	
1862	21.82	52.30	18.13	0.25	0.76	6.74	
1863	22.31	52.39	17.48	0.26	0.76	6.80	
1864	23.17	52.37	16.92	0.22	0.76	6.55	
1865	22.38	53.03	16.86	0.25	0.77	6.71	
1866	21.26	53.99	17.06	0.27	0.70	6.72	
1867	22.42	51.34	17.84	0.32	0.74	7.34	
1868	22.53	51.04	18.00	0.29	0.74	7.40	
1869	23.13	50.42	18.21	0.31	0.73	7.21	
1870	22.89	50.04	18.74	0.32	0.72	7.29	
1871	22.95	50.92	18.91	0.33	0.71	6.19	
1872	23.37	48.83	19.36	0.32	0.71	7.41	
1873	23.15	49.07	19.73	0.32	0.71	7.02	
1874	23.00	48.86	19.54	0.31	0.69	7.60	
1875	22.98	49.41	19.09	0.30	0.68	7.54	
1876	22.19	48.62	18.63	0.30	0.66	9.59	
1877	22.66	48.06	19.17	0.31	0.72	9.07	
1878	23.19	47.30	19.22	0.30	0.72	9.28	
1879	23.04	47.12	18.57	0.28	0.70	10.30	
1880	22.46	46.79	18.47	0.27	0.69	11.33	
1881	22.12	45.47	18.45	0.25	0.68	13.02	
1882	22.17	44.36	18.64	0.25	0.67	13.90	
1883	22.00	43.87	18.63	0.24	0.66	14.59	0.00
1884	21.74	42.92	18.67	0.23	0.65	15.79	0.00
1885	21.68	41.43	18.55	0.22	0.64	17.49	0.00
1886	22.21	40.87	18.81	0.21	0.65	17.25	0.00
1887	21.86	39.07	18.15	0.19	0.62	20.11	0.00
1888	21.25	38.71	17.94	0.18	0.58	21.33	0.00
1889	21.57	37.98	17.78	0.16	0.55	21.96	0.00
1890	21.12	37.18	17.33	0.16	0.52	23.68	0.00
1891	21.44	37.86	18.02	0.16	0.50	22.01	0.00
1892	21.98	37.76	17.96	0.16	0.47	21.67	0.00
1893	22.66	37.10	18.35	0.16	0.46	21.27	0.01
1894	21.31	35.49	17.54	0.15	0.41	25.09	0.01
1895	22.17	35.74	18.07	0.14	0.40	23.46	0.02
1896	22.94	35.67	18.38	0.14	0.38	22.47	0.02
1897	22.23	35.38	18.50	0.14	0.36	23.35	0.03
1898	22.93	34.33	18.33	0.14	0.34	23.88	0.05
1899	22.47	33.34	17.99	0.14	0.32	25.67	0.07
1900	22.19	33.15	17.92	0.14	0.31	26.20	0.08
1901	22.99	33.24	17.84	0.14	0.29	25.37	0.12
1902	23.03	31.17	17.59	0.14	0.28	27.63	0.16
1903	23.33	29.99	17.79	0.14	0.27	28.26	0.22
1904	22.83	28.94	17.83	0.14	0.27	29.74	0.26
1905	22.75	27.33	17.61	0.13	0.25	31.64	0.29
1906	21.87	25.12	16.95	0.12	0.23	35.34	0.37
1907	20.68	24.37	16.92	0.11	0.22	37.18	0.52
1908	20.15	24.42	17.05	0.10	0.21	37.43	0.63
1909	19.50	23.66	16.84	0.09	0.20	39.04	0.67
1910	20.20	23.24	16.82	0.09	0.19	38.71	0.75

(segue)

(segue)

	1	2	3	4	5	6	7
	Food for men	**Firewood**	**Animals**	**Wind**	**Water**	**Fossil fuels**	**Primary Electricity**
1911	19.86	22.56	16.83	0.09	0.23	39.55	0.89
1912	19.96	21.83	16.58	0.08	0.22	40.32	1.01
1913	19.77	21.17	15.99	0.07	0.21	41.67	1.11
1914	19.18	23.69	16.65	0.07	0.21	38.86	1.34
1915	19.02	29.05	16.08	0.07	0.21	34.06	1.52
1916	19.14	29.00	15.68	0.05	0.20	34.05	1.87
1917	20.81	32.53	17.47	0.05	0.22	26.44	2.47
1918	20.90	30.47	16.64	0.04	0.21	29.22	2.52
1919	22.10	30.38	16.83	0.04	0.20	28.06	2.39
1920	20.17	29.99	18.34	0.05	0.20	28.28	2.97
1921	20.33	28.01	17.91	0.04	0.18	30.97	2.57
1922	19.41	26.58	17.22	0.04	0.17	34.08	2.51
1923	19.34	26.36	16.70	0.04	0.16	34.43	2.97
1924	17.81	23.86	15.33	0.03	0.14	39.69	3.13
1925	18.73	24.22	15.25	0.03	0.14	38.13	3.49
1926	18.13	22.74	14.06	0.03	0.13	41.00	3.91
1927	17.14	21.36	13.13	0.03	0.12	44.31	3.91
1928	17.42	21.59	13.61	0.03	0.13	42.64	4.59
1929	16.88	20.00	12.31	0.03	0.12	46.13	4.55
1930	17.60	19.58	12.68	0.03	0.12	45.07	4.92
1931	18.11	20.06	13.63	0.03	0.13	42.77	5.27
1932	19.65	21.17	14.69	0.03	0.14	38.55	5.77
1933	19.59	19.60	13.83	0.03	0.14	40.72	6.09
1934	16.58	17.64	12.41	0.03	0.12	47.20	6.01
1935	15.74	16.31	11.43	0.02	0.12	50.24	6.15
1936	18.95	18.06	13.33	0.03	0.14	42.28	7.22
1937	17.01	16.15	11.04	0.02	0.12	48.92	6.74
1938	17.24	17.01	11.17	0.02	0.12	47.73	6.70
1939	16.84	17.15	11.07	0.02	0.11	46.98	7.84
1940	15.60	17.07	11.03	0.02	0.10	48.45	7.73
1941	15.61	23.96	11.29	0.02	0.11	40.40	8.61
1942	14.45	27.98	11.01	0.02	0.10	38.25	8.19
1943	15.44	29.79	11.67	0.02	0.12	34.07	8.88
1944	21.35	31.63	16.04	0.02	0.19	20.55	10.23
1945	21.55	32.63	16.86	0.02	0.20	18.42	10.32
1946	16.16	27.61	12.81	0.02	0.15	32.93	10.33
1947	14.68	20.77	10.83	0.02	0.11	44.51	9.08
1948	16.41	19.68	12.31	0.02	0.11	41.47	10.00
1949	16.04	17.55	12.08	0.01	0.10	46.17	8.05
1950	15.37	16.50	11.62	0.01	0.10	46.94	9.46
1951	12.92	14.90	10.00	0.01	0.05	51.76	10.36
1952	13.14	14.55	9.48	0.01	0.03	52.28	10.51
1953	12.75	13.62	8.59	0.01	0.01	54.94	10.07
1954	11.85	12.52	7.66	0.01	0.01	58.33	9.63
1955	11.50	12.02	6.94	0.01	0.00	59.70	9.83
1956	11.49	11.84	6.30	0.01	0.00	60.48	9.87
1957	10.65	10.82	5.58	0.01	0.00	63.69	9.25
1958	11.25	11.23	5.57	0.01	0.00	61.24	10.70
1959	9.97	9.80	4.69	0.01	0.00	65.53	10.00
1960	9.50	8.94	4.12	0.01	0.00	67.85	9.58

(segue)

(segue)

	1	2	3	4	5	6	7
	Food for men	**Firewood**	**Animals**	**Wind**	**Water**	**Fossil fuels**	**Primary Electricity**
1961	8.88	8.12	3.58	0.00	0.00	71.35	8.05
1962	8.23	7.29	3.07	0.00	0.00	74.43	6.98
1963	7.75	6.65	2.69	0.00	0.00	75.45	7.46
1964	7.31	6.18	2.43	0.00	0.00	77.83	6.25
1965	6.75	5.62	1.98	0.00	0.00	79.42	6.22
1966	6.54	5.30	1.70	0.00	0.00	80.32	6.13
1967	6.18	4.86	1.41	0.00	0.00	82.02	5.52
1968	5.79	4.41	1.16	0.00	0.00	83.60	5.03
1969	5.54	4.12	0.99	0.00	0.00	84.82	4.53
1970	5.08	3.66	0.78	0.00	0.00	86.25	4.21
1971	5.02	3.54	0.68	0.00	0.00	86.95	3.80
1972	4.71	3.27	0.57	0.00	0.00	87.83	3.62
1973	4.56	3.08	0.50	0.00	0.00	88.70	3.16
1974	4.64	3.10	0.46	0.00	0.00	88.48	3.32
1975	4.89	3.24	0.44	0.00	0.00	87.67	3.76
1976	4.59	3.02	0.36	0.00	0.00	88.71	3.30
1977	4.72	3.09	0.33	0.00	0.00	87.57	4.29
1978	4.61	3.01	0.28	0.00	0.00	88.27	3.84
1979	4.48	2.91	0.24	0.00	0.00	88.51	3.87
1980	4.54	2.95	0.21	0.00	0.00	88.38	3.91
1981	4.64	3.00	0.19	0.00	0.00	88.03	4.14
1982	4.81	3.09	0.17	0.00	0.00	87.66	4.27
1983	4.85	3.11	0.15	0.00	0.00	87.38	4.51
1984	4.78	3.05	0.12	0.00	0.00	86.76	5.28
1985	4.72	3.00	0.00	0.00	0.00	86.95	5.33
1986	4.73	2.97	0.00	0.00	0.00	87.01	5.29
1987	4.54	2.85	0.00	0.00	0.00	88.14	4.47
1988	4.46	2.78	0.00	0.00	0.00	87.81	4.95
1989	4.32	2.69	0.00	0.00	0.00	88.41	4.58
1990	4.30	2.67	0.00	0.00	0.00	88.58	4.45
1991	4.18	2.64	0.00	0.00	0.00	88.13	5.06
1992	4.16	2.61	0.00	0.00	0.00	88.17	5.06
1993	4.22	2.64	0.00	0.00	0.00	87.84	5.30
1994	4.31	2.69	0.00	0.00	0.00	87.54	5.47
1995	4.11	2.56	0.00	0.00	0.00	88.48	4.86
1996	4.13	2.56	0.00	0.00	0.00	88.12	5.19
1997	4.08	2.52	0.00	0.00	0.00	88.22	5.18
1998	3.98	2.46	0.00	0.00	0.00	88.33	5.23
1999	3.92	2.42	0.00	0.00	0.00	88.16	5.49
2000	3.89	2.39	0.00	0.00	0.00	88.19	5.53

3. Per capita energy consumption 1861-2000

(in Toe per year, kcal per year, kjoules per year, kcal per day, kjoules per day)

	Population	Per c. consumption	Per c. consumption	Per c. consumption	Per c. consumption	Per c. consumption
	(000)	(Toe per year)	(kcal per year)	(kj per year)	(kcal per day)	(kj per day)
1861	**25,756**	0.43	4,301,758	18,010,602	11,786	49,344
1862	**25,933**	0.42	4,231,096	17,714,751	11,592	48,534
1863	**26,110**	0.42	4,227,272	17,698,741	11,582	48,490
1864	**26,289**	0.42	4,232,601	17,721,054	11,596	48,551
1865	**26,470**	0.42	4,183,467	17,515,338	11,462	47,987
1866	**26,652**	0.41	4,112,567	17,218,495	11,267	47,174
1867	**26,835**	0.39	3,871,161	16,207,777	10,606	44,405
1868	**27,019**	0.39	3,896,636	16,314,436	10,676	44,697
1869	**27,203**	0.39	3,948,109	16,529,942	10,817	45,288
1870	**27,390**	0.40	3,981,703	16,670,595	10,909	45,673
1871	**27,578**	0.39	3,915,858	16,394,915	10,728	44,918
1872	**27,748**	0.39	3,916,728	16,398,559	10,731	44,928
1873	**27,886**	0.39	3,919,102	16,408,497	10,737	44,955
1874	**27,982**	0.40	4,014,572	16,808,209	10,999	46,050
1875	**28,258**	0.41	4,093,255	17,137,641	11,214	46,952
1876	**28,428**	0.42	4,195,277	17,564,787	11,494	48,123
1877	**28,598**	0.41	4,063,226	17,011,916	11,132	46,608
1878	**28,768**	0.40	4,040,996	16,918,841	11,071	46,353
1879	**28,938**	0.42	4,186,089	17,526,318	11,469	48,017
1880	**29,108**	0.42	4,242,055	17,760,635	11,622	48,659
1881	**29,278**	0.43	4,268,250	17,870,311	11,694	48,960
1882	**29,493**	0.43	4,295,198	17,983,133	11,768	49,269
1883	**29,707**	0.44	4,366,369	18,281,115	11,963	50,085
1884	**29,921**	0.44	4,418,867	18,500,913	12,106	50,687
1885	**30,135**	0.45	4,497,248	18,829,079	12,321	51,587
1886	**30,350**	0.45	4,466,298	18,699,498	12,236	51,232
1887	**30,564**	0.46	4,625,537	19,366,199	12,673	53,058
1888	**30,779**	0.46	4,641,253	19,431,998	12,716	53,238
1889	**30,993**	0.46	4,620,072	19,343,316	12,658	52,995
1890	**31,207**	0.46	4,638,288	19,419,583	12,708	53,204
1891	**31,421**	0.45	4,463,274	18,686,837	12,228	51,197
1892	**31,637**	0.45	4,473,990	18,731,703	12,258	51,320
1893	**31,851**	0.44	4,382,390	18,348,191	12,007	50,269
1894	**32,065**	0.46	4,595,966	19,242,389	12,592	52,719
1895	**32,279**	0.45	4,491,946	18,806,881	12,307	51,526
1896	**32,493**	0.44	4,418,715	18,500,275	12,106	50,686
1897	**32,707**	0.44	4,405,221	18,443,778	12,069	50,531
1898	**32,921**	0.44	4,444,929	18,610,030	12,178	50,986
1899	**33,134**	0.45	4,503,645	18,855,859	12,339	51,660
1900	**33,343**	0.45	4,485,089	18,778,172	12,288	51,447
1901	**33,513**	0.45	4,507,167	18,870,607	12,348	51,700
1902	**33,695**	0.46	4,571,647	19,140,572	12,525	52,440
1903	**33,813**	0.45	4,545,830	19,032,480	12,454	52,144
1904	**34,071**	0.46	4,559,101	19,088,045	12,491	52,296
1905	**34,192**	0.47	4,653,749	19,484,317	12,750	53,382
1906	**34,355**	0.49	4,948,618	20,718,876	13,558	56,764
1907	**34,594**	0.51	5,056,414	21,170,194	13,853	58,001
1908	**34,930**	0.51	5,085,959	21,293,892	13,934	58,339
1909	**35,202**	0.53	5,338,561	22,351,489	14,626	61,237
1910	**35,560**	0.53	5,345,260	22,379,537	14,645	61,314

(segue)

(segue)

	Population (000)	Per c. consumption (Toe per year)	Per c. consumption (kcal per year)	Per c. consumption (kj per year)	Per c. consumption (kcal per day)	Per c. consumption (kj per day)
1911	**35,905**	0.54	5,354,997	22,420,302	14,671	61,425
1912	**36,181**	0.55	5,458,800	22,854,904	14,956	62,616
1913	**36,275**	0.57	5,663,233	23,710,823	15,516	64,961
1914	**37,241**	0.53	5,313,350	22,245,933	14,557	60,948
1915	**37,726**	0.52	5,247,837	21,971,646	14,378	60,196
1916	**37,713**	0.52	5,241,341	21,944,446	14,360	60,122
1917	**37,463**	0.47	4,688,956	19,631,722	12,846	53,786
1918	**36,849**	0.51	5,071,218	21,232,175	13,894	58,170
1919	**36,890**	0.49	4,940,991	20,686,940	13,537	56,677
1920	**37,122**	0.47	4,704,181	19,695,467	12,888	53,960
1921	**37,452**	0.51	5,082,487	21,279,358	13,925	58,300
1922	**37,796**	0.53	5,309,876	22,231,388	14,548	60,908
1923	**38,063**	0.55	5,452,986	22,830,560	14,940	62,549
1924	**38,351**	0.59	5,872,808	24,588,272	16,090	67,365
1925	**38,715**	0.58	5,835,542	24,432,246	15,988	66,938
1926	**39,044**	0.62	6,195,481	25,939,240	16,974	71,066
1927	**39,414**	0.64	6,434,443	26,939,724	17,629	73,807
1928	**39,801**	0.61	6,050,059	25,330,388	16,576	69,398
1929	**40,113**	0.64	6,443,286	26,976,751	17,653	73,909
1930	**40,473**	0.61	6,052,151	25,339,148	16,581	69,422
1931	**40,814**	0.55	5,535,435	23,175,761	15,166	63,495
1932	**41,152**	0.50	5,046,918	21,130,437	13,827	57,892
1933	**41,494**	0.52	5,226,922	21,884,078	14,320	59,956
1934	**41,842**	0.57	5,711,055	23,911,044	15,647	65,510
1935	**42,194**	0.61	6,051,162	25,335,004	16,579	69,411
1936	**42,503**	0.51	5,057,833	21,176,136	13,857	58,017
1937	**42,797**	0.60	6,018,348	25,197,619	16,489	69,035
1938	**43,154**	0.59	5,942,233	24,878,943	16,280	68,161
1939	**43,633**	0.59	5,919,888	24,785,388	16,219	67,905
1940	**44,047**	0.63	6,280,285	26,294,296	17,206	72,039
1941	**44,357**	0.60	6,031,900	25,254,361	16,526	69,190
1942	**44,580**	0.61	6,131,945	25,673,227	16,800	70,338
1943	**44,762**	0.51	5,147,214	21,550,358	14,102	59,042
1944	**44,890**	0.33	3,287,477	13,764,010	9,007	37,710
1945	**45,076**	0.30	3,044,189	12,745,411	8,340	34,919
1946	**45,497**	0.41	4,113,560	17,222,652	11,270	47,185
1947	**45,830**	0.54	5,419,557	22,690,602	14,848	62,166
1948	**46,177**	0.54	5,428,123	22,726,465	14,872	62,264
1949	**46,437**	0.57	5,685,263	23,803,061	15,576	65,214
1950	**46,768**	0.60	5,951,189	24,916,439	16,305	68,264
1951	**47,223**	0.65	6,520,225	27,298,877	17,864	74,791
1952	**47,411**	0.66	6,643,540	27,815,174	18,201	76,206
1952	**47,411**	0.66	6,643,540	27,815,174	18,201	76,206
1953	**47,655**	0.71	7,058,696	29,553,350	19,339	80,968
1954	**47,940**	0.76	7,624,030	31,920,288	20,888	87,453
1955	**48,185**	0.79	7,894,135	33,051,165	21,628	90,551
1956	**48,732**	0.79	7,915,917	33,142,359	21,687	90,801
1957	**48,589**	0.87	8,680,277	36,342,583	23,782	99,569
1958	**48,885**	0.83	8,311,715	34,799,490	22,772	95,341
1959	**48,604**	0.96	9,569,301	40,064,747	26,217	109,766
1960	**48,967**	1.04	10,401,484	43,548,934	28,497	119,312

(segue)

(segue)

	Population (000)	**Per c. consumption** (Toe per year)	**Per c. consumption** (kcal per year)	**Per c. consumption** (kj per year)	**Per c. consumption** (kcal per day)	**Per c. consumption** (kj per day)
1961	**49,156**	1.14	11,393,545	47,702,496	31,215	130,692
1962	**49,563**	1.26	12,586,077	52,695,389	34,482	144,371
1963	**49,936**	1.37	13,669,993	57,233,525	37,452	156,804
1964	**50,439**	1.46	14,563,437	60,974,197	39,900	167,053
1965	**50,840**	1.59	15,860,014	66,402,705	43,452	181,925
1966	**51,227**	1.67	16,685,298	69,858,004	45,713	191,392
1967	**51,664**	1.80	18,011,787	75,411,749	49,347	206,608
1968	**52,042**	1.97	19,708,578	82,515,876	53,996	226,071
1969	**52,376**	2.09	20,920,677	87,590,692	57,317	239,974
1970	**52,771**	2.33	23,346,690	97,747,921	63,964	267,803
1971	**53,124**	2.40	23,982,896	100,411,591	65,707	275,100
1972	**53,499**	2.58	25,772,332	107,903,599	70,609	295,626
1973	**53,882**	2.72	27,159,844	113,712,835	74,411	311,542
1974	**54,390**	2.67	26,720,989	111,875,435	73,208	306,508
1975	**54,764**	2.53	25,349,401	106,132,873	69,450	290,775
1976	**55,070**	2.70	26,978,197	112,952,317	73,913	309,458
1977	**55,266**	2.63	26,263,057	109,958,166	71,954	301,255
1978	**55,446**	2.69	26,910,074	112,667,100	73,726	308,677
1979	**55,602**	2.77	27,696,974	115,961,690	75,882	317,703
1980	**55,657**	2.73	27,274,624	114,193,395	74,725	312,859
1981	**55,774**	2.67	26,702,871	111,799,581	73,159	306,300
1982	**55,995**	2.58	25,794,380	107,995,908	70,670	295,879
1983	**56,228**	2.55	25,543,747	106,946,558	69,983	293,004
1984	**56,344**	2.59	25,931,057	108,568,150	71,044	297,447
1985	**56,498**	2.63	26,270,837	109,990,739	71,975	301,344
1986	**57,221**	2.62	26,208,989	109,731,795	71,805	300,635
1987	**57,331**	2.73	27,285,300	114,238,094	74,754	312,981
1988	**57,441**	2.78	27,820,179	116,477,527	76,220	319,117
1989	**57,525**	2.87	28,673,029	120,048,239	78,556	328,899
1990	**57,746**	2.88	28,817,911	120,654,832	78,953	330,561
1991	**56,757**	2.97	29,655,036	124,159,706	81,247	340,164
1992	**56,960**	2.98	29,784,634	124,702,306	81,602	341,650
1993	**57,138**	2.94	29,351,721	122,889,784	80,416	336,684
1994	**57,269**	2.88	28,764,421	120,430,877	78,807	329,948
1995	**57,269**	3.02	30,194,566	126,418,610	82,725	346,352
1996	**57,461**	3.00	30,019,876	125,687,218	82,246	344,349
1997	**57,563**	3.04	30,405,452	127,301,548	83,303	348,771
1998	**57,613**	3.11	31,146,355	130,403,560	85,332	357,270
1999	**57,680**	3.16	31,581,504	132,225,441	86,525	362,261
2000	**57,844**	3.19	31,874,950	133,454,041	87,329	365,628

II

The energy carriers

1. Food for men (Appendix I, 1, col. 1)

	Population (present) (x000)	**Food** per c. kcal per day	**Food** Per c. kjoules per day	**Total** Toe per year	**Total** Petajoules Per year
1861	25,756	2,522	10,559	2,370,917	99
1862	25,933	2,529	10,588	2,393,836	100
1863	26,110	2,584	10,819	2,462,591	103
1864	26,289	2,687	11,250	2,578,307	108
1865	26,470	2,565	10,739	2,478,188	104
1866	26,652	2,395	10,027	2,329,851	98
1867	26,835	2,378	9,956	2,329,197	97
1868	27,019	2,405	10,069	2,371,795	99
1869	27,203	2,502	10,475	2,484,260	104
1870	27,390	2,497	10,454	2,496,338	104
1871	27,578	2,462	10,308	2,478,242	104
1872	27,748	2,508	10,500	2,540,107	106
1873	27,886	2,486	10,408	2,530,348	106
1874	27,982	2,530	10,593	2,583,998	108
1875	28,258	2,577	10,789	2,657,962	111
1876	28,428	2,551	10,681	2,646,974	111
1877	28,598	2,523	10,563	2,633,576	110
1878	28,768	2,567	10,748	2,695,432	113
1879	28,938	2,642	11,062	2,790,578	117
1880	29,108	2,610	10,928	2,772,974	116
1881	29,278	2,587	10,831	2,764,590	116
1882	29,493	2,609	10,923	2,808,574	118
1883	29,707	2,632	11,020	2,853,892	119
1884	29,921	2,632	11,020	2,874,451	120
1885	30,135	2,671	11,183	2,937,906	123
1886	30,350	2,718	11,380	3,010,932	126
1887	30,564	2,770	11,597	3,090,173	129
1888	30,779	2,702	11,313	3,035,517	127
1889	30,993	2,730	11,430	3,088,297	129
1890	31,207	2,684	11,237	3,057,225	128
1891	31,421	2,622	10,978	3,007,084	126
1892	31,637	2,694	11,279	3,110,898	130
1893	31,851	2,721	11,392	3,163,330	132
1894	32,065	2,683	11,233	3,140,109	131
1895	32,279	2,728	11,422	3,214,085	135
1896	32,493	2,777	11,627	3,293,507	138
1897	32,707	2,683	11,233	3,202,980	134
1898	32,921	2,792	11,690	3,354,913	140
1899	33,134	2,772	11,606	3,352,432	140
1900	33,343	2,727	11,417	3,318,812	139
1901	33,513	2,839	11,886	3,472,734	145
1902	33,695	2,885	12,079	3,548,168	148
1903	33,813	2,905	12,163	3,585,277	150
1904	34,071	2,851	11,937	3,545,479	148
1905	34,192	2,901	12,146	3,620,471	152
1906	34,355	2,965	12,414	3,717,984	156
1907	34,594	2,865	11,995	3,617,581	151
1908	34,930	2,808	11,757	3,580,046	150
1909	35,202	2,852	11,941	3,664,458	153
1910	35,560	2,958	12,385	3,839,307	161

(segue)

(segue)

	Population (present) (x000)	**Food** per c. kcal per day	**Food** Per c. kjoules per day	**Total** Toe per year	**Total** Petajoules Per year
1911	35,905	2,913	12,196	3,817,581	160
1912	36,181	2,985	12,498	3,942,010	165
1913	36,275	3,068	12,845	4,062,147	170
1914	37,241	2,792	11,689	3,795,063	159
1915	37,726	2,734	11,447	3,764,734	158
1916	37,713	2,749	11,509	3,783,953	158
1917	37,463	2,673	11,193	3,655,621	153
1918	36,849	2,904	12,159	3,905,883	163
1919	36,890	2,992	12,527	4,028,665	169
1920	37,122	2,600	10,886	3,522,841	147
1921	37,452	2,830	11,850	3,869,147	162
1922	37,796	2,823	11,821	3,895,067	163
1923	38,063	2,890	12,099	4,014,752	168
1924	38,351	2,866	11,998	4,011,265	168
1925	38,715	2,994	12,535	4,230,736	177
1926	39,044	3,078	12,886	4,385,988	184
1927	39,414	3,021	12,649	4,346,379	182
1928	39,801	2,888	12,090	4,194,846	176
1929	40,113	2,979	12,473	4,361,908	183
1930	40,473	2,918	12,218	4,310,961	180
1931	40,814	2,746	11,497	4,090,604	171
1932	41,152	2,717	11,376	4,081,064	171
1933	41,494	2,806	11,746	4,249,069	178
1934	41,842	2,595	10,865	3,963,170	166
1935	42,194	2,609	10,923	4,017,818	168
1936	42,503	2,626	10,994	4,073,615	170
1937	42,797	2,805	11,746	4,382,306	183
1938	43,154	2,807	11,753	4,421,731	185
1939	43,633	2,731	11,433	4,348,836	182
1940	44,047	2,685	11,240	4,316,188	181
1941	44,357	2,579	10,799	4,175,768	175
1942	44,580	2,428	10,166	3,950,769	165
1943	44,762	2,178	9,119	3,558,445	149
1944	44,890	1,923	8,050	3,150,178	132
1945	45,076	1,797	7,525	2,956,918	124
1946	45,497	1,821	7,625	3,024,413	127
1947	45,830	2,179	9,124	3,645,318	153
1948	46,177	2,440	10,218	4,113,355	172
1949	46,437	2,499	10,462	4,235,287	177
1950	46,768	2,506	10,492	4,277,729	179
1951	47,223	2,309	9,667	3,979,553	167
1952	47,411	2,392	10,014	4,138,980	173
1953	47,655	2,466	10,324	4,289,188	180
1954	47,940	2,475	10,362	4,330,492	181
1955	48,185	2,487	10,413	4,374,090	183
1956	48,732	2,492	10,436	4,433,442	186
1957	48,589	2,532	10,602	4,490,936	188
1958	48,885	2,561	10,724	4,570,185	191
1959	48,604	2,615	10,948	4,638,766	194
1960	48,967	2,707	11,335	4,838,576	202

(segue)

(segue)

	Population (present) (x000)	**Food** per c. kcal per day	**Food** Per c. kjoules per day	**Total** Toe per year	**Total** Petajoules Per year
1961	49,156	2,773	11,610	4,975,202	208
1962	49,563	2,837	11,878	5,132,447	215
1963	49,936	2,902	12,150	5,289,546	221
1964	50,439	2,916	12,209	5,368,677	225
1965	50,840	2,935	12,286	5,445,549	228
1966	51,227	2,990	12,519	5,591,043	234
1967	51,664	3,052	12,779	5,755,473	241
1968	52,042	3,127	13,093	5,940,100	249
1969	52,376	3,173	13,283	6,065,219	254
1970	52,771	3,250	13,607	6,259,775	262
1971	53,124	3,300	13,815	6,397,962	268
1972	53,499	3,325	13,919	6,491,809	272
1973	53,882	3,396	14,218	6,678,755	280
1974	54,390	3,396	14,218	6,741,722	282
1975	54,764	3,396	14,218	6,788,080	284
1976	55,070	3,396	14,218	6,826,009	286
1977	55,266	3,396	14,218	6,850,304	287
1978	55,446	3,396	14,218	6,872,615	288
1979	55,602	3,396	14,218	6,891,951	288
1980	55,657	3,396	14,218	6,898,769	289
1981	55,774	3,396	14,218	6,913,271	289
1982	55,995	3,396	14,218	6,940,664	290
1983	56,228	3,396	14,218	6,969,545	292
1984	56,344	3,396	14,218	6,983,923	292
1985	56,498	3,396	14,218	7,003,012	293
1986	57,221	3,396	14,218	7,092,629	297
1987	57,331	3,396	14,218	7,106,263	297
1988	57,441	3,396	14,218	7,119,898	298
1989	57,525	3,396	14,218	7,130,310	298
1990	57,746	3,396	14,218	7,157,703	300
1991	56,757	3,396	14,218	7,035,115	294
1992	56,960	3,396	14,218	7,060,277	295
1993	57,138	3,396	14,218	7,082,341	296
1994	57,269	3,396	14,218	7,098,578	297
1995	57,269	3,396	14,218	7,098,578	297
1996	57,461	3,396	14,218	7,122,377	298
1997	57,563	3,396	14,218	7,135,020	299
1998	57,613	3,396	14,218	7,141,218	299
1999	57,680	3,396	14,218	7,149,523	299
2000	57,844	3,396	14,218	7,169,851	300

2. Firewood (Appendix I, 1, col. 2)

	Tons	Cubic Meters	Toe	Petajoules
1861	18,982,880	30,372,609	5,694,864	238
1862	19,129,049	30,606,478	5,738,715	240
1863	19,276,342	30,842,148	5,782,903	242
1864	19,424,770	31,079,632	5,827,431	244
1865	19,574,341	31,318,945	5,872,302	246
1866	19,725,063	31,560,101	5,917,519	248
1867	17,776,677	28,442,684	5,333,003	223
1868	17,913,558	28,661,692	5,374,067	225
1869	18,051,492	28,882,387	5,415,448	227
1870	18,190,489	29,104,782	5,457,147	228
1871	18,330,555	29,328,889	5,499,167	230
1872	17,690,568	28,304,909	5,307,170	222
1873	17,874,759	28,599,614	5,362,428	224
1874	18,295,620	29,272,992	5,488,686	230
1875	19,050,220	30,480,352	5,715,066	239
1876	19,327,021	30,923,234	5,798,106	243
1877	18,615,296	29,784,474	5,584,589	234
1878	18,327,862	29,324,579	5,498,359	230
1879	19,025,524	30,440,838	5,707,657	239
1880	19,258,764	30,814,022	5,777,629	242
1881	18,942,175	30,307,480	5,682,653	238
1882	18,732,602	29,972,163	5,619,781	235
1883	18,967,557	30,348,091	5,690,267	238
1884	18,917,479	30,267,966	5,675,244	237
1885	18,714,080	29,942,528	5,614,224	235
1886	18,465,062	29,544,099	5,539,519	232
1887	18,413,612	29,461,779	5,524,084	231
1888	18,434,192	29,494,707	5,530,258	231
1889	18,127,893	29,004,629	5,438,368	228
1890	17,940,615	28,704,984	5,382,185	225
1891	17,698,114	28,316,982	5,309,434	222
1892	17,816,106	28,505,770	5,344,832	224
1893	17,261,818	27,618,909	5,178,545	217
1894	17,435,376	27,896,602	5,230,613	219
1895	17,274,509	27,639,214	5,182,353	217
1896	17,069,052	27,310,483	5,120,716	214
1897	16,993,592	27,189,747	5,098,078	213
1898	16,745,946	26,793,514	5,023,784	210
1899	16,585,765	26,537,224	4,975,730	208
1900	16,526,426	26,442,282	4,957,928	207
1901	16,735,656	26,777,050	5,020,697	210
1902	16,002,665	25,604,264	4,800,800	201
1903	15,366,400	24,586,240	4,609,920	193
1904	14,982,926	23,972,682	4,494,878	188
1905	14,496,209	23,193,934	4,348,863	182
1906	14,235,872	22,777,395	4,270,762	179
1907	14,211,176	22,737,882	4,263,353	178
1908	14,462,938	23,140,701	4,338,881	182
1909	14,820,344	23,712,550	4,446,103	186
1910	14,724,990	23,559,984	4,417,497	185

(segue)

(segue)

	Tons	Cubic meters	Toe	Petajoules
1911	14,455,735	23,129,176	4,336,721	181
1912	14,372,729	22,996,366	4,311,819	180
1913	14,493,808	23,190,093	4,348,142	182
1914	15,622,587	24,996,139	4,686,776	196
1915	19,169,087	30,670,539	5,750,726	241
1916	19,107,552	30,572,084	5,732,266	240
1917	19,047,202	30,475,523	5,714,160	239
1918	18,977,384	30,363,814	5,693,215	238
1919	18,455,896	29,529,433	5,536,769	232
1920	17,457,943	27,932,709	5,237,383	219
1921	17,769,449	28,431,119	5,330,835	223
1922	17,780,777	28,449,243	5,334,233	223
1923	18,238,408	29,181,452	5,471,522	229
1924	17,911,043	28,657,669	5,373,313	225
1925	18,239,541	29,183,265	5,471,862	229
1926	18,335,824	29,337,319	5,500,747	230
1927	18,054,902	28,887,844	5,416,471	227
1928	17,327,677	27,724,283	5,198,303	217
1929	17,226,862	27,562,979	5,168,059	216
1930	15,988,766	25,582,026	4,796,630	201
1931	15,105,221	24,168,354	4,531,566	190
1932	14,655,520	23,448,831	4,396,656	184
1933	14,171,835	22,674,936	4,251,551	178
1934	14,051,764	22,482,822	4,215,529	176
1935	13,879,586	22,207,337	4,163,876	174
1936	12,938,271	20,701,233	3,881,481	162
1937	13,863,727	22,181,964	4,159,118	174
1938	14,542,245	23,267,591	4,362,673	183
1939	14,761,998	23,619,197	4,428,599	185
1940	15,737,296	25,179,673	4,721,189	198
1941	21,372,727	34,196,363	6,411,818	268
1942	25,491,406	40,786,250	7,647,422	320
1943	22,875,886	36,601,418	6,862,766	287
1944	15,557,189	24,891,502	4,667,157	195
1945	14,926,247	23,881,995	4,477,874	187
1946	17,223,464	27,557,542	5,167,039	216
1947	17,197,100	27,515,360	5,159,130	216
1948	16,442,700	26,308,320	4,932,810	206
1949	15,441,050	24,705,680	4,632,315	194
1950	15,306,500	24,490,400	4,591,950	192
1951	15,293,610	24,469,776	4,588,083	192
1952	15,280,731	24,449,170	4,584,220	192
1953	15,267,863	24,428,581	4,580,359	192
1954	15,255,006	24,408,010	4,576,502	191
1955	15,242,160	24,387,455	4,572,648	191
1956	15,229,324	24,366,919	4,568,798	191
1957	15,216,499	24,346,399	4,564,950	191
1958	15,203,685	24,325,897	4,561,106	191
1959	15,190,882	24,305,412	4,557,265	191
1960	15,178,090	24,284,944	4,553,427	191

(segue)

(segue)

	Tons	Cubic meters	Toe	Petajoules
1961	15,165,308	24,264,493	4,549,593	190
1962	15,152,537	24,244,060	4,545,761	190
1963	15,139,777	24,223,644	4,541,933	190
1964	15,127,028	24,203,245	4,538,109	190
1965	15,114,289	24,182,863	4,534,287	190
1966	15,101,561	24,162,498	4,530,469	190
1967	15,088,844	24,142,151	4,526,654	189
1968	15,076,138	24,121,820	4,522,842	189
1969	15,063,442	24,101,507	4,519,033	189
1970	15,050,757	24,081,211	4,515,227	189
1971	15,038,082	24,060,932	4,511,425	189
1972	15,025,419	24,040,670	4,507,626	189
1973	15,012,766	24,020,425	4,503,830	188
1974	15,000,123	24,000,197	4,500,037	188
1975	14,987,492	23,979,986	4,496,248	188
1976	14,974,870	23,959,793	4,492,461	188
1977	14,962,260	23,939,616	4,488,678	188
1978	14,949,660	23,919,456	4,484,898	188
1979	14,937,071	23,899,313	4,481,122	187
1980	14,924,492	23,879,187	4,477,348	187
1981	14,911,924	23,859,079	4,473,578	187
1982	14,899,367	23,838,987	4,469,810	187
1983	14,886,820	23,818,912	4,466,046	187
1984	14,874,283	23,798,853	4,462,285	187
1985	14,861,758	23,778,812	4,458,528	187
1986	14,849,242	23,758,788	4,454,773	186
1987	14,836,738	23,738,780	4,451,022	186
1988	14,824,243	23,718,790	4,447,273	186
1989	14,811,760	23,698,816	4,443,528	186
1990	14,799,287	23,678,859	4,439,786	186
1991	14,786,824	23,658,919	4,436,047	186
1992	14,774,372	23,638,995	4,432,312	185
1993	14,761,930	23,619,088	4,428,579	185
1994	14,749,499	23,599,199	4,424,850	185
1995	14,737,078	23,579,325	4,421,124	185
1996	14,724,668	23,559,469	4,417,401	185
1997	14,712,268	23,539,629	4,413,681	185
1998	14,699,879	23,519,806	4,409,964	185
1999	14,687,500	23,500,000	4,406,250	184
2000	14,687,500	23,500,000	4,406,250	184

3. Animals (Appendix I, 1, col. 3)

	Number Bovine an. (000)	Number Bovine an. Working	Number Horses (000)	Number Horses Working	Consumption Work. Bov. Toe per year	Consumption Work.Horses Toe per year	Total Toe	Total Petajoules
1861	4,657	1,351	1,476	1,181	1,035,237	1,034,122	2,069,359	87
1862	4,717	1,368	1,342	1,074	1,048,617	940,555	1,989,171	83
1863	4,775	1,385	1,239	991	1,061,433	868,142	1,929,575	81
1864	4,793	1,390	1,167	933	1,065,476	817,697	1,883,172	79
1865	4,846	1,405	1,126	901	1,077,266	789,220	1,866,486	78
1866	4,896	1,420	1,116	893	1,088,304	781,897	1,870,202	78
1867	4,673	1,355	1,162	929	1,038,674	814,135	1,852,809	78
1868	4,700	1,363	1,213	971	1,044,831	850,268	1,895,099	79
1869	4,710	1,366	1,297	1,037	1,046,862	908,695	1,955,557	82
1870	4,745	1,376	1,412	1,129	1,054,680	989,417	2,044,097	86
1871	4,576	1,327	1,462	1,170	1,017,205	1,024,528	2,041,734	85
1872	4,616	1,339	1,538	1,230	1,026,007	1,077,559	2,103,566	88
1873	4,668	1,354	1,595	1,276	1,037,709	1,118,069	2,155,778	90
1874	4,722	1,369	1,634	1,307	1,049,530	1,145,321	2,194,851	92
1875	4,712	1,367	1,656	1,325	1,047,465	1,160,788	2,208,254	92
1876	4,766	1,382	1,660	1,328	1,059,396	1,162,998	2,222,394	93
1877	4,838	1,403	1,645	1,316	1,075,308	1,152,686	2,227,995	93
1878	4,876	1,414	1,642	1,313	1,083,922	1,150,477	2,234,398	94
1879	4,927	1,429	1,648	1,318	1,095,215	1,154,896	2,250,111	94
1880	5,007	1,452	1,666	1,333	1,112,981	1,167,417	2,280,398	95
1881	5,027	1,458	1,695	1,356	1,117,412	1,188,040	2,305,452	96
1882	5,078	1,472	1,759	1,407	1,128,659	1,232,969	2,361,628	99
1883	5,168	1,499	1,810	1,448	1,148,724	1,268,323	2,417,047	101
1884	5,281	1,531	1,847	1,477	1,173,802	1,294,102	2,467,904	103
1885	5,418	1,571	1,869	1,495	1,204,286	1,309,570	2,513,855	105
1886	5,557	1,612	1,876	1,501	1,235,291	1,314,725	2,550,016	107
1887	5,646	1,637	1,870	1,496	1,254,978	1,310,306	2,565,284	107
1888	5,703	1,654	1,849	1,479	1,267,724	1,295,575	2,563,299	107
1889	5,731	1,662	1,814	1,451	1,273,946	1,271,269	2,545,215	107
1890	5,724	1,660	1,765	1,412	1,272,460	1,236,652	2,509,112	105
1891	5,750	1,668	1,781	1,425	1,278,223	1,248,437	2,526,660	106
1892	5,764	1,671	1,798	1,439	1,281,200	1,260,221	2,541,421	106
1893	5,807	1,684	1,813	1,450	1,290,725	1,270,533	2,561,258	107
1894	5,867	1,701	1,828	1,462	1,304,128	1,280,844	2,584,973	108
1895	5,985	1,736	1,841	1,473	1,330,363	1,290,419	2,620,782	110
1896	6,029	1,748	1,854	1,483	1,340,150	1,299,258	2,639,408	110
1897	6,108	1,771	1,866	1,492	1,357,734	1,307,360	2,665,094	112
1898	6,148	1,783	1,877	1,502	1,366,513	1,315,462	2,681,975	112
1899	6,127	1,777	1,887	1,509	1,361,961	1,322,091	2,684,052	112
1900	6,075	1,762	1,896	1,517	1,350,419	1,328,720	2,679,139	112
1901	6,067	1,759	1,921	1,537	1,348,506	1,346,397	2,694,903	113
1902	6,057	1,757	1,944	1,555	1,346,394	1,362,600	2,708,995	113
1903	6,106	1,771	1,965	1,572	1,357,227	1,377,331	2,734,559	114
1904	6,204	1,799	1,984	1,587	1,379,032	1,390,589	2,769,621	116
1905	6,296	1,826	2,001	1,601	1,399,508	1,402,374	2,801,882	117

(segue)

(segue)

	Number Bovine an. (000)	Number Bovine an. Working	Number Horses (000)	Number Horses Working	Consumption Work. Bov. Toe per year	Consumption Work.Horses Toe per year	Total Toe	Total Petajoules
1906	6,360	1,844	2,095	1,676	1,413,723	1,467,926	2,881,649	121
1907	6,447	1,870	2,179	1,743	1,433,081	1,526,849	2,959,930	124
1908	6,530	1,894	2,251	1,801	1,451,540	1,577,670	3,029,210	127
1909	6,944	2,014	2,314	1,851	1,543,619	1,621,863	3,165,482	132
1910	6,926	2,009	2,366	1,893	1,539,591	1,657,953	3,197,544	134
1911	6,966	2,020	2,408	1,926	1,548,490	1,687,415	3,235,905	135
1912	7,037	2,041	2,439	1,951	1,564,194	1,709,511	3,273,705	137
1913	7,028	2,038	2,459	1,967	1,562,256	1,723,505	3,285,761	138
1914	7,031	2,039	2,470	1,976	1,562,806	1,730,871	3,293,676	138
1915	7,064	2,049	2,303	1,842	1,570,197	1,613,761	3,183,958	133
1916	7,024	2,037	2,196	1,756	1,561,288	1,538,634	3,099,922	130
1917	7,033	2,040	2,148	1,719	1,563,322	1,505,489	3,068,812	128
1918	7,179	2,082	2,161	1,729	1,595,888	1,514,328	3,110,216	130
1919	7,299	2,117	2,063	1,651	1,622,429	1,446,013	3,068,442	128
1920	7,516	2,180	2,187	1,749	1,670,776	1,532,434	3,203,210	134
1921	7,876	2,284	2,365	1,892	1,750,682	1,657,641	3,408,324	143
1922	8,062	2,338	2,373	1,898	1,792,045	1,663,085	3,455,130	145
1923	8,062	2,338	2,389	1,911	1,792,164	1,673,973	3,466,137	145
1924	7,937	2,302	2,411	1,929	1,764,227	1,689,624	3,453,850	145
1925	7,812	2,265	2,440	1,952	1,736,395	1,710,038	3,446,433	144
1926	7,496	2,174	2,476	1,981	1,666,288	1,735,216	3,401,504	142
1927	7,238	2,099	2,456	1,965	1,608,898	1,720,926	3,329,824	139
1928	7,141	2,071	2,411	1,929	1,587,315	1,689,624	3,276,939	137
1929	6,930	2,010	2,341	1,873	1,540,404	1,640,630	3,181,034	133
1930	6,893	1,999	2,246	1,797	1,532,114	1,573,943	3,106,057	130
1931	6,937	2,012	2,195	1,756	1,541,898	1,538,558	3,080,456	129
1932	6,954	2,017	2,148	1,718	1,545,659	1,505,215	3,050,874	128
1933	6,865	1,991	2,102	1,682	1,525,934	1,473,232	2,999,166	126
1934	6,848	1,986	2,060	1,648	1,522,131	1,443,972	2,966,103	124
1935	6,754	1,959	2,021	1,617	1,501,321	1,416,072	2,917,393	122
1936	6,639	1,925	1,984	1,587	1,475,798	1,390,214	2,866,012	120
1937	6,610	1,917	1,961	1,569	1,469,211	1,374,563	2,843,774	119
1938	6,706	1,945	1,960	1,568	1,490,654	1,373,883	2,864,536	120
1939	6,730	1,952	1,944	1,555	1,495,941	1,362,315	2,858,256	120
1940	8,003	2,321	1,817	1,453	1,778,943	1,273,172	3,052,115	128
1941	8,254	2,394	1,691	1,352	1,834,845	1,184,710	3,019,555	126
1942	8,142	2,361	1,713	1,370	1,809,808	1,200,361	3,010,169	126
1943	7,114	2,063	1,582	1,265	1,581,235	1,108,497	2,689,731	113
1944	6,067	1,759	1,453	1,162	1,348,560	1,017,993	2,366,554	99
1945	5,885	1,707	1,434	1,147	1,308,147	1,004,947	2,313,094	97
1946	6,229	1,806	1,444	1,155	1,384,613	1,011,955	2,396,568	100
1947	7,277	2,110	1,531	1,225	1,617,568	1,072,925	2,690,493	113
1948	7,848	2,276	1,915	1,532	1,744,493	1,342,032	3,086,525	129
1949	8,180	2,372	1,956	1,565	1,818,291	1,370,765	3,189,056	133
1950	8,350	2,422	1,967	1,574	1,856,080	1,378,474	3,234,553	135
1951	8,395	1,259	1,935	1,548	1,723,092	1,356,048	3,079,140	129
1952	8,708	1,306	1,892	1,514	1,660,239	1,325,914	2,986,153	125
1953	9,008	1,351	1,842	1,474	1,598,919	1,290,874	2,889,793	121
1954	8,831	1,325	1,795	1,436	1,540,665	1,257,936	2,798,601	117

(segue)

(segue)

	Number Bovine an. (000)	Number Bovine an. Working	Number Horses (000)	Number Horses Working	Consumption Work. Bov. Toe per year	Consumption Work.Horses Toe per year	Total Toe	Total Petajoules
1955	8,686	1,303	1,652	1,322	1,483,944	1,157,722	2,641,666	111
1956	8,495	1,274	1,427	1,142	1,429,523	1,000,042	2,429,564	102
1957	8,665	1,300	1,393	1,114	1,377,401	976,214	2,353,615	98
1958	9,078	1,362	1,338	1,070	1,326,812	937,670	2,264,482	95
1959	9,417	1,413	1,290	1,032	1,278,522	904,032	2,182,554	91
1960	9,845	1,477	1,241	993	1,230,999	869,693	2,100,692	88
1961	9,551	1,433	1,170	936	1,186,542	819,936	2,006,478	84
1962	9,189	1,378	1,103	882	1,142,852	772,982	1,915,834	80
1963	8,649	1,297	1,049	839	1,101,461	735,139	1,836,600	77
1964	9,226	1,384	1,029	823	1,060,759	721,123	1,781,883	75
1965	9,429	471	958	766	925,932	671,366	1,597,298	67
1966	9,546	477	921	737	807,891	645,437	1,453,328	61
1967	9,583	479	867	694	705,947	607,594	1,313,540	55
1968	10,070	504	820	656	616,266	574,656	1,190,922	50
1969	9,612	481	777	622	538,083	544,522	1,082,605	45
1970	8,776	439	708	566	469,865	496,166	966,031	40
1971	8,669	433	655	524	410,078	459,024	869,102	36
1972	8,805	440	620	496	357,956	434,496	792,452	33
1973	8,487	424	592	474	312,732	414,874	727,606	30
1974	8,243	561	412	449	272,874	393,149	666,023	28
1975	8,529	540	426	432	238,382	378,432	616,814	26
1976	8,813	475	354	380	207,722	333,020	540,742	23
1977	8,568	418	294	335	181,661	293,058	474,718	20
1978	8,724	368	244	294	158,666	257,891	416,556	17
1979	8,008	324	202	259	138,737	226,944	365,680	15
1980	8,836	285	168	228	121,107	199,711	320,818	13
1981	8,904	251	139	201	105,777	175,745	281,522	12
1982	9,127	221	116	177	91,980	154,656	246,636	10
1983	9,221	194	96	155	80,483	136,097	216,580	9
1984	9,206	171	80	137	61,106	119,766	180,871	8

4. Wind (Appendix I, 1, col. 4)

	Tonnage Sailships	Tonnage Sailboats	Tonnage Total	Power (CV)	Toe	Petajoules
1861	946,601	54,677	1,001,277	119,200	27,584	1,15
1862	946,601	55,509	1,002,109	119,299	27,607	1,16
1863	971,114	56,354	1,027,468	122,318	28,306	1,18
1864	842,666	57,212	899,878	107,128	24,791	1,04
1865	964,974	58,084	1,023,058	121,793	28,184	1,18
1866	1,021,531	58,969	1,080,500	128,631	29,766	1,25
1867	1,164,872	59,867	1,224,739	145,802	33,740	1,41
1868	1,057,470	50,856	1,108,326	131,944	30,533	1,28
1869	1,138,165	51,630	1,189,795	141,642	32,777	1,37
1870	1,205,479	52,954	1,258,433	149,813	34,668	1,45
1871	1,222,512	53,489	1,276,001	151,905	35,152	1,47
1872	1,221,283	56,616	1,277,899	152,131	35,205	1,47
1873	1,227,375	58,613	1,285,988	153,094	35,427	1,48
1874	1,204,808	55,248	1,260,056	150,007	34,713	1,45
1875	1,214,244	58,052	1,272,296	151,464	35,050	1,47
1876	1,255,200	60,006	1,315,206	156,572	36,232	1,52
1877	1,242,460	61,871	1,304,331	155,278	35,933	1,50
1878	1,188,582	64,377	1,252,959	149,162	34,518	1,44
1879	1,147,966	62,407	1,210,373	144,092	33,344	1,40
1880	1,134,240	60,436	1,194,676	142,223	32,912	1,38
1881	1,101,292	49,327	1,150,618	136,978	31,698	1,33
1882	1,088,901	66,853	1,155,754	137,590	31,840	1,33
1883	1,065,034	61,073	1,126,107	134,060	31,023	1,30
1884	1,043,906	61,469	1,105,375	131,592	30,452	1,27
1885	1,019,447	60,494	1,079,941	128,564	29,751	1,25
1886	985,659	62,127	1,047,787	124,736	28,865	1,21
1887	900,968	63,206	964,174	114,783	26,562	1,11
1888	858,458	65,704	924,162	110,019	25,460	1,07
1889	789,937	64,940	854,877	101,771	23,551	0,99
1890	780,003	63,885	843,888	100,463	23,248	0,97
1891	769,749	66,443	836,192	99,547	23,036	0,96
1892	750,080	68,711	818,791	97,475	22,557	0,94
1893	723,570	73,229	796,799	94,857	21,951	0,92
1894	703,074	74,631	777,706	92,584	21,425	0,90
1895	683,350	76,896	760,246	90,505	20,944	0,88
1896	648,891	79,553	728,444	86,720	20,068	0,84
1897	647,997	78,607	726,604	86,500	20,017	0,84
1898	661,300	84,444	745,744	88,779	20,544	0,86
1899	686,616	85,189	771,804	91,881	21,262	0,89
1900	698,842	85,663	784,505	93,393	21,612	0,90
1901	707,505	84,062	791,567	94,234	21,807	0,91
1902	701,596	85,030	786,626	93,646	21,671	0,91
1903	718,594	84,152	802,746	95,565	22,115	0,93
1904	701,537	86,430	787,966	93,806	21,708	0,91
1905	665,640	88,678	754,318	89,800	20,781	0,87
1906	619,010	90,901	709,910	84,513	19,557	0,82
1907	576,469	93,482	669,951	79,756	18,456	0,77
1908	557,589	95,387	652,975	77,735	17,989	0,75
1909	541,127	91,106	632,234	75,266	17,417	0,73
1910	532,209	93,323	625,531	74,468	17,233	0,72

(segue)

(segue)

	Tonnage Sailships	Tonnage Sailboats	Tonnage Total	Power (CV)	Toe	Petajoules
1911	505,519	97,147	602,666	71,746	16,603	0,69
1912	461,047	97,765	558,812	66,525	15,395	0,64
1913	437,834	98,295	536,130	63,825	14,770	0,62
1914	429,220	98,395	527,615	62,811	14,535	0,61
1915	408,682	86,645	495,327	58,968	13,646	0,57
1916	321,976	61,891	383,867	45,698	10,575	0,44
1917	268,753	60,962	329,715	39,252	9,083	0,38
1918	255,315	47,949	303,264	36,103	8,355	0,35
1919	242,549	53,695	296,244	35,267	8,161	0,34
1920	230,422	71,427	301,849	35,934	8,316	0,35
1921	218,901	79,337	298,238	35,504	8,216	0,34
1922	207,956	84,244	292,200	34,786	8,050	0,34
1923	197,558	89,154	286,712	34,132	7,899	0,33
1924	191,182	94,066	285,248	33,958	7,858	0,33
1925	168,255	98,957	267,212	31,811	7,361	0,31
1926	154,809	103,697	258,506	30,775	7,122	0,30
1927	151,793	104,593	256,386	30,522	7,063	0,30
1928	143,952	101,413	245,365	29,210	6,760	0,28
1929	135,383	104,385	239,768	28,544	6,605	0,28
1930	127,583	104,569	232,152	27,637	6,396	0,27
1931	120,741	105,784	226,525	26,967	6,240	0,26
1932	119,837	106,968	226,805	27,001	6,248	0,26
1933	115,820	104,154	219,974	26,187	6,060	0,25
1934	112,249	107,303	219,552	26,137	6,048	0,25
1935	108,531	104,921	213,452	25,411	5,880	0,25
1936	103,576	105,540	209,116	24,895	5,761	0,24
1937	101,606	101,153	202,759	24,138	5,586	0,23
1938	98,699	99,830	198,529	23,634	5,469	0,23
1939	99,352	101,696	201,048	23,934	5,539	0,23
1940	99,283	98,269	197,552	23,518	5,442	0,23
1941	95,055	78,615	173,670	20,675	4,784	0,20
1942	91,263	77,043	168,306	20,036	4,637	0,19
1943	73,923	73,191	147,114	17,514	4,053	0,17
1944	59,877	54,239	114,116	13,585	3,144	0,13
1945	48,426	57,163	105,589	12,570	2,909	0,12
1946	72,850	61,192	134,042	15,957	3,693	0,15
1947	79,492	65,513	145,005	17,263	3,995	0,17
1948	81,114	59,008	140,122	16,681	3,860	0,16
1949	81,494	58,906	140,400	16,714	3,868	0,16
1950	76,983	61,655	138,638	16,505	3,819	0,16
1951	78,672	59,704	138,376	16,473	3,812	0,16
1952	79,296	58,071	137,367	16,353	3,784	0,16
1953	76,423	56,989	133,412	15,882	3,675	0,15
1954	71,823	55,013	126,836	15,100	3,494	0,15
1955	70,284	52,301	122,585	14,593	3,377	0,14
1956	66,808	47,215	114,023	13,574	3,141	0,13
1957	66,170	44,938	111,108	13,227	3,061	0,13
1958	64,634	45,659	110,293	13,130	3,038	0,13
1959	62,295	44,672	106,967	12,734	2,947	0,12
1960	60,238	41,782	102,020	12,145	2,811	0,12

(segue)

(segue)

	Tonnage Sailships	Tonnage Sailboats	Tonnage Total	Power (CV)	Toe	Petajoules
1961	58,798	40,255	99,053	11,792	2,729	0,11
1962	58,302	39,999	98,301	11,703	2,708	0,11
1963	56,630	39,330	95,960	11,424	2,644	0,11
1964	55,514	38,414	93,928	11,182	2,588	0,11
1965	57,397	37,361	94,758	11,281	2,610	0,11
1966	57,654	36,609	94,263	11,222	2,597	0,11
1967	57,788	35,952	93,740	11,160	2,582	0,11
1968	56,958	36,762	93,720	11,157	2,582	0,11
1969	57,287	35,925	93,212	11,097	2,568	0,11
1970	58,447	35,103	93,550	11,137	2,577	0,11
1971	58,163	34,950	93,113	11,085	2,565	0,11
1972	57,945	33,135	91,080	10,843	2,509	0,11
1973	53,328	32,147	85,475	10,176	2,355	0,10
1974	48,925	30,893	79,818	9,502	2,199	0,09
1975	48,387	31,035	79,422	9,455	2,188	0,09
1976	46,255	28,036	74,291	8,844	2,047	0,09
1977	44,216	26,693	70,909	8,442	1,953	0,08
1978	42,268	25,491	67,759	8,066	1,867	0,08
1979	40,405	22,582	62,987	7,498	1,735	0,07
1980	38,624	15,732	54,356	6,471	1,497	0,06
1981	36,922	14,957	51,879	6,176	1,429	0,06
1982	35,295	14,612	49,907	5,941	1,375	0,06
1983	33,739	13,105	46,844	5,577	1,291	0,05
1984	32,253	11,754	44,006	5,239	1,212	0,05
1985	30,831	10,541	41,373	4,925	1,140	0,05
1986	29,472	9,454	38,927	4,634	1,072	0,04
1987	28,174	8,479	36,653	4,363	1,010	0,04
1988	26,932	7,605	34,537	4,112	951	0,04
1989	25,745	6,820	32,566	3,877	897	0,04
1990	24,610	6,117	30,728	3,658	847	0,04
1991	23,526	5,486	29,012	3,454	799	0,03
1992	22,489	4,920	27,410	3,263	755	0,03
1993	21,498	4,413	25,911	3,085	714	0,03
1994	20,551	3,958	24,508	2,918	675	0,03
1995	19,645	3,550	23,195	2,761	639	0,03
1996	18,779	3,184	21,963	2,615	605	0,03
1997	17,952	2,855	20,807	2,477	573	0,02
1998	17,160	2,561	19,721	2,348	543	0,02
1999	16,404	2,297	18,701	2,226	515	0,02
2000	15,681	2,060	17,741	2,112	489	0,02

5. Water (Appendix I, 1, col. 5)

	Mills %	Others %	Toe	Petajoules
1861	35	65	82,875	3.47
1862	35	65	83,395	3.49
1863	35	65	83,919	3.51
1864	35	65	84,449	3.53
1865	34	66	84,983	3.56
1866	34	66	76,487	3.20
1867	34	66	76,974	3.22
1868	34	66	77,466	3.24
1869	34	66	77,963	3.26
1870	33	67	78,355	3.28
1871	33	67	76,594	3.21
1872	33	67	76,985	3.22
1873	32	68	77,382	3.24
1874	32	68	77,784	3.26
1875	32	68	78,191	3.27
1876	31	69	78,604	3.29
1877	31	69	83,764	3.51
1878	31	69	84,075	3.52
1879	30	70	84,394	3.53
1880	30	70	84,721	3.55
1881	29	71	85,056	3.56
1882	29	71	85,398	3.57
1883	29	71	85,909	3.60
1884	29	71	86,426	3.62
1885	28	72	86,949	3.64
1886	28	72	87,478	3.66
1887	28	72	88,012	3.68
1888	28	72	83,541	3.50
1889	29	71	78,969	3.30
1890	31	69	74,731	3.13
1891	32	68	70,804	2.96
1892	34	66	67,164	2.81
1893	36	64	63,790	2.67
1894	37	63	60,663	2.54
1895	39	61	57,762	2.42
1896	41	59	55,073	2.30
1897	43	57	52,579	2.20
1898	44	56	50,266	2.10
1899	46	54	48,119	2.01
1900	48	52	46,128	1.93
1901	50	50	44,280	1.85
1902	52	48	42,565	1.78
1903	54	46	40,972	1.71
1904	53	47	41,392	1.73
1905	53	47	40,418	1.69
1906	54	46	39,474	1.65
1907	55	45	38,560	1.61
1908	55	45	37,674	1.58
1909	56	44	36,816	1.54
1910	57	43	35,984	1.51

(segue)

(segue)

	Mills %	Others %	Toe	Petajoules
1911	45	55	45,071	1.89
1912	46	54	44,006	1.84
1913	46	54	42,978	1.80
1914	47	53	41,984	1.76
1915	48	52	41,025	1.72
1916	49	51	40,098	1.68
1917	50	50	39,203	1.64
1918	51	49	38,337	1.60
1919	51	49	35,898	1.50
1920	52	48	35,124	1.47
1921	53	47	34,376	1.44
1922	54	46	33,653	1.41
1923	55	45	32,954	1.38
1924	55	45	32,278	1.35
1925	56	44	31,625	1.32
1926	57	43	30,992	1.30
1927	58	42	30,380	1.27
1928	59	41	30,229	1.27
1929	61	39	30,102	1.26
1930	62	38	29,999	1.26
1931	63	37	29,920	1.25
1932	65	35	29,864	1.25
1933	66	34	29,831	1.25
1934	67	33	29,820	1.25
1935	68	32	29,831	1.25
1936	70	30	29,863	1.25
1937	71	29	29,916	1.25
1938	72	28	29,586	1.24
1939	72	28	29,268	1.22
1940	73	27	28,962	1.21
1941	74	26	28,668	1.20
1942	75	25	28,385	1.19
1943	75	25	28,112	1.18
1944	76	24	27,850	1.17
1945	77	23	27,598	1.15
1946	78	22	27,356	1.14
1947	78	22	27,536	1.15
1948	79	21	27,308	1.14
1949	79	21	27,088	1.13
1950	80	20	26,878	1.12
1951	79	21	15,153	0.63
1952	78	22	8,550	0.36
1953	77	23	4,828	0.20
1954	75	25	2,729	0.11
1955	74	26	1,544	0.06
1956	73	27	874	0.04
1957	71	29	495	0.02
1958	70	30	281	0.01
1959	68	32	160	0.01
1960	67	33	91	0.00

(segue)

(segue)

	Mills %	Others %	Toe	Petajoules
1961	65	35	52	0.00
1962	64	36	29	0.00
1963	62	38	17	0.00
1964	60	40	10	0.00
1965	59	41	5	0.00
1966	57	43	3	0.00
1967	55	45	2	0.00
1968	53	47	1	0.00
1969	52	48	1	0.00
1970	50	50	0	0.00

6. Fossil fuels (App. I, 1, col. 6)

	Coal	Coal	Oil	Oil	Gas	Gas	Totals	Total
	Toe	Pjoules	Toe	Pjoules	Toe	Pjoules	Toe	Petajoules
1861	834,009	35					834,009	35
1862	739,776	31					739,776	31
1863	750,114	31					750,114	31
1864	727,342	30	1,593				728,935	31
1865	733,934	31	9,559				743,492	31
1866	723,447	30	13,541	1			736,988	31
1867	742,623	31	19,914	1			762,537	32
1868	741,125	31	38,234	2			779,359	33
1869	742,173	31	31,862	1			774,036	32
1870	753,859	32	41,421	2			795,280	33
1871	622,650	26	45,616	2			668,266	28
1872	760,538	32	44,566	2			805,104	34
1873	731,348	31	36,097	2			767,446	32
1874	806,826	34	46,717	2			853,542	36
1875	824,401	35	47,797	2			872,198	37
1876	1,096,978	46	47,046	2			1,144,024	48
1877	1,000,754	42	53,405	2			1,054,159	44
1878	1,034,283	43	44,072	2			1,078,355	45
1879	1,184,675	50	62,944	3			1,247,619	52
1880	1,337,358	56	61,781	3			1,399,140	59
1881	1,563,337	65	63,798	3			1,627,135	68
1882	1,694,688	71	65,918	3			1,760,606	74
1883	1,820,758	76	72,277	3			1,893,035	79
1884	2,008,374	84	78,842	3			2,087,216	87
1885	2,270,896	95	98,877	4			2,369,773	99
1886	2,262,949	95	75,457	3			2,338,406	98
1887	2,763,658	116	79,696	3			2,843,354	119
1888	2,972,784	124	74,397	3			3,047,181	128
1889	3,069,029	128	75,457	3			3,144,485	132
1890	3,352,427	140	75,662	3			3,428,090	143
1891	3,008,487	126	78,400	3			3,086,887	129
1892	2,984,571	125	82,577	3			3,067,149	128
1893	2,885,984	121	82,577	3			2,968,561	124
1894	3,616,520	151	81,517	3			3,698,038	155
1895	3,324,151	139	77,247	3			3,401,398	142
1896	3,148,912	132	77,278	3	253	0.01	3,226,443	135
1897	3,288,933	138	75,189	3	253	0.01	3,364,375	141
1898	3,416,390	143	77,309	3	422	0.02	3,494,121	146
1899	3,752,503	157	77,309	3	675	0.03	3,830,486	160
1900	3,837,822	161	79,429	3	1,181	0.05	3,918,432	164
1901	3,755,777	157	75,189	3	1,181	0.05	3,832,147	160
1902	4,179,321	175	76,218	3	1,266	0.05	4,256,804	178
1903	4,267,588	179	74,129	3	1,941	0.08	4,343,658	182
1904	4,540,762	190	77,247	3	2,194	0.09	4,620,203	193
1905	4,948,730	207	82,588	3	2,616	0.11	5,033,933	211
1906	5,922,337	248	81,497	3	4,810	0.20	6,008,644	251
1907	6,399,552	268	98,414	4	4,810	0.20	6,502,775	272
1908	6,526,871	273	117,409	5	5,653	0.24	6,649,933	278
1909	7,196,564	301	133,142	6	7,003	0.29	7,336,709	307
1910	7,213,552	302	136,229	6	7,425	0.31	7,357,207	308

(segue)

(segue)

	Coal	Coal	Oil	Oil	Gas	Gas	Totals	Total
	Toe	Pjoules	Toe	Pjoules	Toe	Pjoules	Toe	Petajoules
1911	7,394,574	309	201,499	8	7,594	0.32	7,603,667	318
1912	7,735,733	324	221,914	9	5,738	0.24	7,963,385	333
1913	8,310,762	348	244,995	10	5,063	0.21	8,560,819	358
1914	7,472,516	313	211,984	9	4,978	0.21	7,689,478	322
1915	6,498,943	272	239,819	10	4,894	0.20	6,743,655	282
1916	6,444,303	270	280,495	12	4,810	0.20	6,729,608	282
1917	4,325,829	181	313,804	13	5,653	0.24	4,645,286	194
1918	5,071,082	212	382,829	16	5,653	0.24	5,459,564	228
1919	4,800,097	201	307,074	13	7,108	0.30	5,114,279	214
1920	4,588,623	192	343,430	14	6,139	0.26	4,938,191	207
1921	5,582,832	234	306,532	13	6,381	0.27	5,895,745	247
1922	6,454,535	270	379,855	16	5,412	0.23	6,839,802	286
1923	6,674,754	279	466,171	20	5,573	0.23	7,146,498	299
1924	8,311,035	348	622,412	26	5,412	0.23	8,938,858	374
1925	7,911,055	331	698,237	29	5,654	0.24	8,614,946	361
1926	9,180,305	384	732,781	31	4,846	0.20	9,917,932	415
1927	10,392,901	435	840,648	35	4,685	0.20	11,238,234	470
1928	9,355,067	392	906,702	38	5,169	0.22	10,266,939	430
1929	10,790,840	452	1,126,613	47	5,654	0.24	11,923,108	499
1930	9,633,965	403	1,398,158	59	7,027	0.29	11,039,150	462
1931	8,237,050	345	1,416,479	59	9,773	0.41	9,663,302	404
1932	6,555,324	274	1,440,040	60	10,419	0.44	8,005,784	335
1933	7,174,657	300	1,645,679	69	11,146	0.47	8,831,482	370
1934	9,516,972	398	1,751,084	73	12,116	0.51	11,280,171	472
1935	10,948,162	458	1,870,003	78	10,015	0.42	12,828,180	537
1936	7,370,061	308	1,708,108	71	10,500	0.44	9,088,669	380
1937	10,238,489	428	2,348,969	98	12,277	0.51	12,599,735	527
1938	9,816,450	411	2,410,068	101	13,812	0.58	12,240,330	512
1939	9,545,949	399	2,572,160	108	16,316	0.68	12,134,425	508
1940	11,676,159	489	1,702,957	71	22,454	0.94	13,401,570	561
1941	10,164,827	425	611,439	26	34,085	1.43	10,810,350	452
1942	9,741,875	408	670,815	28	44,181	1.85	10,456,870	438
1943	7,308,300	306	497,415	21	44,424	1.86	7,850,139	329
1944	2,966,601	124	26,595	1	39,820	1.67	3,033,016	127
1945	2,472,628	103	21,670	1	33,843	1.42	2,528,140	106
1946	4,979,106	208	1,132,001	47	51,693	2.16	6,162,800	258
1947	7,461,225	312	3,518,120	147	76,670	3.21	11,056,015	463
1948	7,233,279	303	3,065,550	128	95,776	4.01	10,394,605	435
1949	7,787,520	326	4,195,950	176	204,508	8.56	12,187,978	510
1950	7,514,958	315	5,132,650	215	417,872	17.49	13,065,480	547
1951	8,317,609	348	6,826,170	286	792,366	33.16	15,936,145	667
1952	7,733,849	324	7,557,950	316	1,174,732	49.16	16,466,531	689
1953	7,724,561	323	8,872,570	371	1,884,278	78.86	18,481,409	773
1954	8,196,178	343	10,676,970	447	2,445,732	102.35	21,318,880	892
1955	8,364,990	350	11,368,070	476	2,974,140	124.47	22,707,200	950
1956	8,279,000	346	11,390,400	477	3,662,000	153.25	23,331,400	976
1957	8,931,955	374	13,838,780	579	4,090,160	171.17	26,860,895	1,124
1958	7,158,000	300	13,482,000	564	4,244,000	177.61	24,884,000	1,041
1959	7,542,210	316	17,918,590	750	5,016,760	209.95	30,477,560	1,275
1960	8,138,430	341	21,133,020	884	5,286,540	221.24	34,557,990	1,446

(segue)

(segue)

	Coal	**Coal**	**Oil**	**Oil**	**Gas**	**Gas**	**Totals**	**Total**
	Toe	Pjoules	Toe	Pjoules	Toe	Pjoules	Toe	Petajoules
1961	8,665,325	363	25,669,100	1,074	5,627,660	235.52	39,962,085	1,672
1962	9,286,495	389	31,282,740	1,309	5,863,000	245.37	46,432,235	1,943
1963	9,277,605	388	36,264,540	1,518	5,959,760	249.42	51,501,905	2,155
1964	8,271,940	346	42,639,730	1,784	6,260,700	262.01	57,172,370	2,393
1965	9,650,720	404	47,899,990	2,005	6,486,200	271.45	64,036,910	2,680
1966	9,091,770	380	52,647,150	2,203	6,915,060	289.40	68,653,980	2,873
1967	10,057,355	421	58,714,550	2,457	7,548,920	315.92	76,320,825	3,194
1968	9,576,230	401	67,369,610	2,819	8,803,520	368.43	85,749,360	3,589
1969	10,053,225	421	73,077,330	3,058	9,809,250	410.52	92,939,805	3,890
1970	9,756,720	408	85,880,860	3,594	10,629,300	444.84	106,266,880	4,447
1971	9,404,075	394	90,488,450	3,787	10,891,650	455.82	110,784,175	4,636
1972	9,900,000	414	98,600,000	4,126	12,600,000	527.31	121,100,000	5,068
1973	10,200,000	427	105,300,000	4,407	14,300,000	598.46	129,800,000	5,432
1974	10,900,000	456	101,700,000	4,256	16,000,000	669.60	128,600,000	5,382
1975	9,800,000	410	93,600,000	3,917	18,300,000	765.86	121,700,000	5,093
1976	10,200,000	427	99,500,000	4,164	22,100,000	924.89	131,800,000	5,516
1977	10,000,000	419	95,400,000	3,992	21,700,000	908.15	127,100,000	5,319
1978	10,000,000	419	99,200,000	4,152	22,500,000	941.63	131,700,000	5,512
1979	11,300,000	473	102,100,000	4,273	22,900,000	958.37	136,300,000	5,704
1980	12,540,000	525	98,830,000	4,136	22,800,000	954.18	134,170,000	5,615
1981	13,550,000	567	95,459,000	3,995	22,090,000	924.47	131,099,000	5,486
1982	14,130,000	591	90,450,000	3,785	22,030,000	921.96	126,610,000	5,299
1983	13,240,000	554	89,670,000	3,753	22,590,000	945.39	125,500,000	5,252
1984	15,070,000	631	85,110,000	3,562	26,580,000	1,112.37	126,760,000	5,305
1985	16,140,000	675	85,640,000	3,584	27,270,000	1,141.25	129,050,000	5,401
1986	15,300,000	640	86,310,000	3,612	28,880,000	1,208.63	130,490,000	5,461
1987	15,850,000	663	89,890,000	3,762	32,140,000	1,345.06	137,880,000	5,770
1988	15,100,000	632	91,080,000	3,812	34,150,000	1,429.18	140,330,000	5,873
1989	14,980,000	627	93,970,000	3,933	36,870,000	1,543.01	145,820,000	6,103
1990	15,800,000	661	92,540,000	3,873	39,070,000	1,635.08	147,410,000	6,169
1991	15,060,000	630	91,750,000	3,840	41,520,000	1,737.61	148,330,000	6,208
1992	13,550,000	567	94,910,000	3,972	41,120,000	1,720.87	149,580,000	6,260
1993	11,970,000	501	93,240,000	3,902	42,100,000	1,761.89	147,310,000	6,165
1994	11,400,000	477	92,100,000	3,854	40,700,000	1,703.30	144,200,000	6,035
1995	12,500,000	523	95,700,000	4,005	44,800,000	1,874.88	153,000,000	6,403
1996	11,300,000	473	94,300,000	3,946	46,400,000	1,941.84	152,000,000	6,361
1997	11,700,000	490	94,900,000	3,972	47,800,000	2,000.43	154,400,000	6,462
1998	12,100,000	506	94,900,000	3,972	51,500,000	2,155.28	158,500,000	6,633
1999	12,200,000	511	92,400,000	3,867	56,000,000	2,343.60	160,600,000	6,721
2000	12,900,000	540	91,300,000	3,821	58,400,000	2,444.04	162,600,000	6,805

7. Primary electricity (Appendix I, 1, col. 7)

	Hydro	Geo	Nuclear	Aeolic Photov.	Import	Total (without thermoel.)	Total (without thermoel.)	Thermo
	KWh 10^6	KWh 10^6	KWh 10^6	KWh 10^6	KWh 10^6	TOE	Petajoules	KWh 10^6
1883								1
1884								2
1885								3
1886								3
1887	0.2					23	0.001	3
1888	1					57	0.002	5
1889	1					103	0.004	5
1890	1					114	0.005	7
1891	1					149	0.006	14
1892	3					343	0.014	19
1893	8					915	0.038	20
1894	10					1,144	0.048	23
1895	20					2,230	0.093	26
1896	22					2,516	0.105	28
1897	44					5,033	0.211	31
1898	66					7,549	0.316	34
1899	90					10,294	0.431	50
1900	110					12,582	0.527	50
1901	160					18,301	0.766	60
1902	220					25,164	1.053	80
1903	300					34,314	1.436	100
1904	350					40,033	1.675	100
1905	400					45,752	1.915	150
1906	550					62,909	2.633	150
1907	800					91,504	3.829	150
1908	975					111,521	4.667	175
1909	1,100					125,818	5.265	200
1910	1,250					142,975	5.984	250
1911	1,500					171,570	7.180	300
1912	1,750					200,165	8.377	250
1913	2,000					228,760	9.574	200
1914	2,325					265,934	11.129	250
1915	2,625					300,248	12.565	300
1916	3,225	12				370,248	15.495	188
1917	3,775	20				434,072	18.166	205
1918	4,100	21				471,360	19.726	179
1919	3,790	14				435,102	18.209	196
1920	4,520	7				517,798	21.670	163
1921	4,250	19				488,288	20.435	271
1922	4,380	20				503,272	21.062	330
1923	5,360	25				615,936	25.777	225
1924	6,140	27				705,381	29.520	283
1925	6,870	31				789,336	33.034	359

(segue)

(segue)

	Hydro	**Geo**	**Nuclear**	**Aeolic Photov.**	**Import**	**Total** (without thermoel.)	**Total** (without thermoel.)	**Thermo**
	KWh 10^6	KWh 10^6	KWh 10^6	KWh 10^6	KWh 10^6	TOE	Petajoules	KWh 10^6
1926	8,000	42			223	945,351	39.563	348
1927	8,430	51			195	992,361	41.530	259
1928	9,380	59			229	1,105,826	46.279	191
1929	9,970	60			244	1,175,140	49.180	350
1930	10,320	57			164	1,205,680	50.458	293
1931	10,180	53			173	1,190,238	49.811	237
1932	10,260	50			169	1,198,588	50.161	280
1933	11,300	76			177	1,321,432	55.302	274
1934	12,270	73			206	1,435,355	60.070	257
1935	13,420	82			218	1,569,294	65.675	298
1936	13,261	93			214	1,551,908	64.947	294
1937	14,861	125			194	1,736,288	72.664	444
1938	14,580	203			244	1,718,788	71.931	761
1939	17,006	488			213	2,025,327	84.760	923
1940	17,898	536			252	2,137,305	89.446	996
1941	19,270	649			231	2,304,757	96.454	842
1942	18,426	893			247	2,237,959	93.659	914
1943	16,794	909			191	2,046,716	85.655	544
1944	12,888	279			31	1,509,587	63.176	378
1945	12,276	92			7	1,415,453	59.237	280
1946	16,590	239			76	1,933,594	80.921	656
1947	18,904	672			142	2,255,345	94.386	998
1948	20,853	877			188	2,506,981	104.917	964
1949	17,383	1,056			140	2,125,066	88.934	2.343
1950	21,605	1,278			129	2,632,113	110.154	1.798
1951	26,354	1,585			-62	3,188,571	133.442	1.284
1952	27,105	1,839			-10	3,309,471	138.501	1.899
1953	27,797	1,880			-48	3,388,965	141.828	2.942
1954	29,217	1,881			-333	3,518,901	147.266	4.476
1955	30,800	1,859			16	3,737,367	156.409	5.465
1956	31,318	1,779			201	3,808,625	159.391	7.495
1957	31,848	1,812			460	3,902,646	163.326	9.066
1958	35,953	1,930			137	4,348,728	181.994	7.609
1959	38,398	2,079			189	4,651,377	194.660	8.873
1960	46,106	2,104			-128	4,879,361	204.201	8.030
1961	41,982	2,292			168	4,509,974	188.742	16.291
1962	39,264	2,346			1.269	4,351,361	182.104	23.249
1963	46,107	2,427	323		1.299	5,089,831	213.009	22.478
1964	39,328	2,527	2,402		1.002	4,592,883	192.212	32.482
1965	43,008	2,576	3,510		331	5,015,649	209.905	33.874
1966	44,321	2,633	3,863		842	5,242,355	219.393	39.176
1967	42,949	2,610	3,152		1.910	5,137,019	214.984	48.118
1968	43,477	2,694	2,576		2.116	5,161,577	216.012	55.264
1969	42,001	2,765	1,679		2.480	4,964,909	207.781	64.002
1970	41,300	2,725	3,176		3.965	5,192,326	217.299	70.222

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	Hydro	**Geo**	**Nuclear**	**Aeolic Photov.**	**Import**	**Total** (without thermoel.)	**Total** (without thermoel.)	**Thermo**
	KWh 10^6	KWh 10^6	KWh 10^6	KWh 10^6	KWh 10^6	TOE	Petajoules	KWh 10^6
1971	40,019	2,664	3,365		1.661	4,841,509	202.617	78.812
1972	42,715	2,582	3,626		200	4,985,002	208.622	86.338
1973	39,125	2,480	3,142		879	4,630,126	193.771	100.771
1974	39,346	2,502	3,410		2,293	4,825,475	201.946	103.647
1975	42,576	2,483	3,800		2,581	5,220,131	218.462	98.474
1976	40,943	2,523	3,807		1,088	4,907,674	205.386	116.277
1977	52,726	2,501	3,385		2,777	6,229,756	260.715	107.933
1978	47,413	2,494	4,428		2,126	5,729,662	239.786	120.706
1979	48,212	2,500	2,628		5,393	5,960,225	249.435	127.924
1980	47,511	2,672	2,208		6,083	5,933,942	248.335	133.350
1981	45,736	2,664	2,707		9,632	6,163,794	257.955	130.549
1982	44,080	2,737	6,804		7,151	6,167,143	258.095	130.823
1983	44,216	2,714	5,783		11,082	6,473,917	270.933	130.167
1984	45,434	2,840	6,887		20,890	7,717,655	322.984	127.508
1985	44,595	2,681	7,024		23,669	7,912,294	331.130	131.440
1986	44,531	2,760	8,758		22,114	7,931,981	331.953	136.281
1987	42,585	2,986	174		23,146	6,991,059	292.576	155.627
1988	43,547	3,082			31,256	7,903,770	330.773	156.932
1989	37,484	3,155			33,729	7,546,865	315.836	170.111
1990	35,079	3,222			34,655	7,403,575	309.840	178.590
1991	45,606	3,182			35,082	8,511,128	356.191	173.253
1992	45,786	3,459		3	35,300	8,579,931	359.070	176.995
1993	44,482	3,667		5	39,432	8,888,227	371.972	174.634
1994	47,731	3,417		8	37,599	9,006,857	376.937	180.648
1995	41,907	3,436		14	37,427	8,400,920	351.579	196.123
1996	47,072	3,762		39	37,389	8,956,828	374.843	193.551
1997	46,552	3,905		124	38,832	9,073,631	379.731	200.881
1998	47,365	4,214		237	40,732	9,391,771	393.046	207.970
1999	51,777	4,403		409	42,010	10,005,827	418.744	209.068
2000	50,900	4,705		569	44,347	10,200,871	426.906	220.455

Note: data on themo-electricity are not included in our total of primary energy in Appendix I.

III

Product and energy intensity

Note on the GDP series

The standard reconstruction of Italian National Accounting was published in 1957 by the Italian National Institute of Statistics (ISTAT).[1] It covered quite a long period, from Italy's unification in 1861 to 1956. It has long been the foundation of all discussions on the beginnings and evolution of Italian economy. Still, lack of information on the criteria used by the statisticians who collated these data has hindered historians from exploiting their full potential. Since its publication, this statistical basis of Italian national accounting has undergone several revisions. These revisions, however, only introduced marginal improvements.[2] At the end of the 1980s, a completely new reconstruction of Italian national accounting, based on direct information, was promoted by the Banca d'Italia.[3] The scholars involved in this still ongoing work include Giovanni Federico for agriculture, Stefano Fenoaltea for the industry, and Vera Zamagni for services. Other collaborators are statisticians like Guido Rey and Ornello Vitali, and historians like Carlo Bardini and Patrizia Battilani. At the moment, 4 volumes have been published, devoted, respectively, to 4 benchmark years: 1891, 1911, 1938 and 1951.[4] The revision for these 4 years has highlighted some weaknesses in ISTAT's reconstruction. Compared to the ISTAT series, the new results for the 4 benchmark years are higher, respectively, by 1.9, 10.7, 1.1 and 15.4 percent. Some important changes have been introduced in the relative weight of the 3 sectors. Other major results of this revision have been presented in a congress specifically devoted to this work in progress held at Brescia in 2003. The proceedings have been published in an issue of the *Rivista di Storia Economica*,[5] and in essays by Federico and Fenoaltea in a volume of the *Storia economica d'Italia*, edited by P. Ciocca and G. Toniolo.[6] In the latter publication, S. Fenoaltea provides a complete revision of industrial production in the 1861-1913 period,[7] and G. Federico does the same for agriculture, for the same period, basing his time series on the main 10 agricultural products.[8] Neither Fenoaltea nor Federico's time series are final, although those for the industry are in a more advanced state of completion than those for agriculture. As to the tertiary sector, all we have is the reconstruction for the 4 benchmark years. Still, the two series for agriculture and industry provide enough information to allow us to reconsider Italian economic growth in its most controversial period, i.e., the beginning of Modern Growth in the second half of the 19th century. The new provisional results show a more continuous

[1] ISTAT (1957). On the evolution of national statistics in Italy see the fine essay by Carreras (1999).

[2] See the very useful history of national accounting in Italy by Carreras (1999).

[3] On this revision in progress and its first results see now especially Toniolo (2003) and Rey (2003).

[4] *I conti economici.*

[5] 3 (2003).

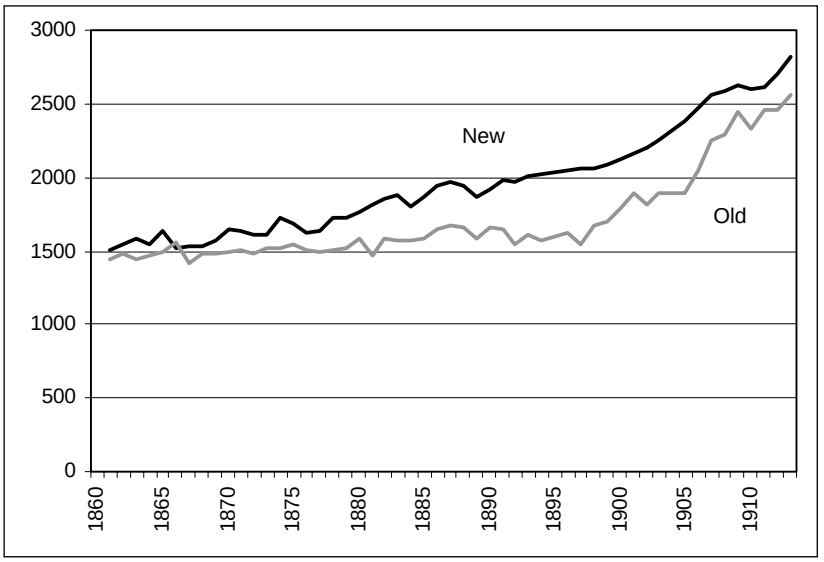
[6] Vol. 3 (2003).

[7] Fenoaltea (2003 b).

[8] Federico (2003 b).

upward trend from the Unification onward, particularly during the 1880s, precisely the years when the ISTAT series indicate a period of crisis (Figure). For the later period, the ongoing revision shows a slower growth between the two wars. In the ISTAT series, per capita product was almost stable until 1896. The series supported the view of Italian Modern Growth as a sudden take off from pre-industrial stability. The new emerging profile indicates, on the contrary, a gradual rise. This rising trend can actually be traced backward at least as early as 1820, as the recent GDP reconstruction for the previous period shows.[9]

Figure. *Two series of per c. GDP 1861-1913 (1990 int. Dollars)*



Today, we can no longer use the standard ISTAT series, particularly for the 1861-1913 period, because of their evident weakness. On the other hand, we cannot yet rely on the revised series, since they are still incomplete. We know, however, how research on energy consumption needs reliable data on the GDP. This is the reason for the new, open reconstruction I provide here, which incorporates the most recent results. Here is the documentary basis of my series, within present borders and at 1911 prices (at factor cost):

Recently S. Fenoaltea (2005a and 2005b) tried to build a comprehensive series covering the period 1861-1913 and to fill the still existing gap of the tertiary sector. I adopted the series by Fenoaltea with some changes: current borders instead of 1911 borders and at factor cost. The rest of the series is that of Maddison (2003), controlled on: Maddison (1991) Ercolani (1969), Rossi, Sorgato, Toniolo (1993), ISTAT (1976 and 1986).

[9] Malanima (2003).

The distribution in three sectors is the standard one:

First sector: Agriculture, Forestry and Fishing;

Second sector: Mining, Manufacturing, Construction, Electricity together with Gas and Water;

Third sector: Transport and Communication, Trade, Finance and Insurance, Miscellaneous services, Housing, Public Administration.

The series is also presented in International 1990 Geary-Khamis dollars to allow comparisons with other countries.

Here as elsewhere, I have estimated per capita GDP by dividing the GDP by the present population, rather than the official, resident population. What we are interested in is the availability of goods and services produced in Italy by the population actually living there.

1. Gross domestic product 1861-2003 (1911 prices; thousands lire; present territory)

	Agriculture	Industry	Services	GDP Total	Agriculture %	Industry %	Services %
1861	4,618,152	1,613,472	3,324,699	9,556,323	48.3	16.9	34.8
1862	4,753,980	1,639,197	3,382,323	9,775,500	48.6	16.8	34.6
1863	4,906,272	1,665,951	3,452,295	10,024,518	48.9	16.6	34.4
1864	4,794,111	1,674,183	3,467,730	9,936,024	48.2	16.8	34.9
1865	5,122,362	1,713,285	3,554,166	10,389,813	49.3	16.5	34.2
1866	5,274,654	1,680,357	3,620,022	10,575,033	49.9	15.9	34.2
1867	5,066,796	1,660,806	3,632,370	10,359,972	48.9	16.0	35.1
1868	5,154,261	1,647,429	3,694,110	10,495,800	49.1	15.7	35.2
1869	5,306,553	1,678,299	3,773,343	10,758,195	49.3	15.6	35.1
1870	5,634,804	1,724,604	3,878,301	11,237,709	50.1	15.3	34.5
1871	5,482,512	1,756,503	3,925,635	11,164,650	49.1	15.7	35.2
1872	5,338,452	1,816,185	3,977,085	11,131,722	48.0	16.3	35.7
1873	5,258,190	1,893,360	4,044,999	11,196,549	47.0	16.9	36.1
1874	5,746,965	1,925,259	4,128,348	11,800,572	48.7	16.3	35.0
1875	5,642,007	1,886,157	4,163,334	11,691,498	48.3	16.1	35.6
1876	5,370,351	1,904,679	4,199,349	11,474,379	46.8	16.6	36.6
1877	5,450,613	1,931,433	4,264,176	11,646,222	46.8	16.6	36.6
1878	5,834,430	1,968,477	4,352,670	12,155,577	48.0	16.2	35.8
1879	5,827,227	1,979,796	4,404,120	12,211,143	47.7	16.2	36.1
1880	5,963,055	2,062,116	4,516,281	12,541,452	47.5	16.4	36.0
1881	6,083,448	2,171,190	4,615,065	12,869,703	47.3	16.9	35.9
1882	6,194,580	2,273,061	4,701,501	13,169,142	47.0	17.3	35.7
1883	6,251,175	2,361,555	4,792,053	13,404,783	46.6	17.6	35.7
1884	5,891,025	2,434,614	4,824,981	13,150,620	44.8	18.5	36.7
1885	6,066,984	2,524,137	4,890,837	13,481,958	45.0	18.7	36.3
1886	6,395,235	2,622,921	5,000,940	14,019,096	45.6	18.7	35.7
1887	6,475,497	2,698,038	5,053,419	14,226,954	45.5	19.0	35.5
1888	6,363,336	2,721,705	5,128,536	14,213,577	44.8	19.1	36.1
1889	6,075,216	2,679,516	5,139,855	13,894,587	43.7	19.3	37.0
1890	6,331,437	2,685,690	5,208,798	14,225,925	44.5	18.9	36.6
1891	6,666,891	2,654,820	5,261,277	14,582,988	45.7	18.2	36.1
1892	6,643,224	2,614,689	5,282,886	14,540,799	45.7	18.0	36.3
1893	6,851,082	2,645,559	5,369,322	14,865,963	46.1	17.8	36.1
1894	6,851,082	2,704,212	5,416,656	14,971,950	45.8	18.1	36.2
1895	6,971,475	2,710,386	5,465,019	15,146,880	46.0	17.9	36.1
1896	7,035,273	2,747,430	5,537,049	15,319,752	45.9	17.9	36.1
1897	7,019,838	2,819,460	5,630,688	15,469,986	45.4	18.2	36.4
1898	7,003,374	2,904,867	5,705,805	15,614,046	44.9	18.6	36.5
1899	6,971,475	3,037,608	5,798,415	15,807,498	44.1	19.2	36.7
1900	7,163,898	3,094,203	5,915,721	16,173,822	44.3	19.1	36.6
1901	7,267,827	3,178,581	6,028,911	16,475,319	44.1	19.3	36.6
1902	7,355,292	3,298,974	6,174,000	16,828,266	43.7	19.6	36.7
1903	7,483,917	3,433,773	6,318,060	17,235,750	43.4	19.9	36.7
1904	7,700,007	3,572,688	6,468,294	17,740,989	43.4	20.1	36.5
1905	7,812,168	3,784,662	6,556,788	18,153,618	43.0	20.8	36.1
1906	7,939,764	4,060,434	6,768,762	18,768,960	42.3	21.6	36.1
1907	8,204,217	4,309,452	6,926,199	19,439,868	42.2	22.2	35.6
1908	8,147,622	4,572,876	7,119,651	19,840,149	41.1	23.0	35.9
1909	8,115,723	4,802,343	7,321,335	20,239,401	40.1	23.7	36.2
1910	7,907,865	5,013,288	7,503,468	20,424,621	38.7	24.5	36.7

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	Agriculture	Industry	Services	GDP Total	Agriculture %	Industry %	Services %
1911	8,003,562	5,097,666	7,738,080	20,839,308	38.4	24.5	37.1
1912	8,284,479	5,360,061	7,982,982	21,627,522	38.3	24.8	36.9
1913	8,836,023	5,392,989	8,275,218	22,504,230	39.3	24.0	36.8
1914	8,202,459	5,203,793	9,827,662	23,233,915	35.3	22.4	42.3
1915	7,401,217	6,251,284	12,355,188	26,007,690	28.5	24.0	47.5
1916	7,881,163	6,273,107	14,888,437	29,042,707	27.1	21.6	51.3
1917	7,796,301	5,550,960	16,991,844	30,339,106	25.7	18.3	56.0
1918	7,941,209	5,300,279	17,423,038	30,664,525	25.9	17.3	56.8
1919	7,556,333	5,427,747	12,764,046	25,748,126	29.3	21.1	49.6
1920	8,149,451	5,457,227	9,953,712	23,560,391	34.6	23.2	42.2
1921	7,981,608	5,045,975	10,200,148	23,227,731	34.4	21.7	43.9
1922	8,452,582	5,703,443	10,240,130	24,396,155	34.6	23.4	42.0
1923	9,247,471	6,280,656	10,272,996	25,801,122	35.8	24.3	39.8
1924	8,798,380	6,927,651	10,289,131	26,015,162	33.8	26.6	39.6
1925	9,372,801	7,866,241	10,504,731	27,743,773	33.8	28.4	37.9
1926	9,821,110	8,358,398	9,847,926	28,027,433	35.0	29.8	35.1
1927	8,495,206	7,768,359	11,178,551	27,442,116	31.0	28.3	40.7
1928	9,239,682	8,523,880	11,686,079	29,449,642	31.4	28.9	39.7
1929	10,439,568	9,620,669	10,378,019	30,438,256	34.3	31.6	34.1
1930	8,533,720	8,621,064	11,819,012	28,973,795	29.5	29.8	40.8
1931	8,862,761	7,874,551	12,070,066	28,807,377	30.8	27.3	41.9
1932	9,707,534	7,847,542	12,207,678	29,762,755	32.6	26.4	41.0
1933	8,747,113	8,365,286	12,470,151	29,582,550	29.6	28.3	42.2
1934	8,255,984	8,387,204	13,064,281	29,707,470	27.8	28.2	44.0
1935	8,997,816	9,176,966	14,411,898	32,586,680	27.6	28.2	44.2
1936	9,138,537	10,117,665	13,381,428	32,637,630	28.0	31.0	41.0
1937	9,757,382	10,802,816	14,287,595	34,847,793	28.0	31.0	41.0
1938	9,829,882	10,883,084	14,393,756	35,106,722	28.0	31.0	41.0
1939	10,323,403	11,955,406	15,412,029	37,690,838	27.4	31.7	40.9
1940	9,866,082	12,304,706	15,704,772	37,875,559	26.0	32.5	41.5
1941	9,676,388	11,861,719	15,809,617	37,347,724	25.9	31.8	42.3
1942	9,150,310	11,139,507	16,556,643	36,846,460	24.8	30.2	44.9
1943	9,297,419	10,175,921	17,523,547	36,996,888	25.1	27.5	47.4
1944	8,242,904	5,783,364	13,098,668	27,124,936	30.4	21.3	48.3
1945	7,367,539	4,153,592	9,733,494	21,254,625	34.7	19.5	45.8
1946	8,154,965	8,280,001	11,492,065	27,927,031	29.2	29.6	41.2
1947	8,732,759	10,486,027	13,612,464	32,831,249	26.6	31.9	41.5
1948	9,087,579	11,117,890	14,494,366	34,699,835	26.2	32.0	41.8
1949	9,299,124	13,390,739	14,506,634	37,196,497	25.0	36.0	39.0
1950	10,045,224	14,465,123	15,670,550	40,180,898	25.0	36.0	39.0
1951	10,826,487	15,590,142	16,889,320	43,305,950	25.0	36.0	39.0
1952	9,995,544	16,736,724	19,758,633	46,490,901	21.5	36.0	42.5
1953	11,156,316	17,630,963	21,017,702	49,804,980	22.4	35.4	42.2
1954	10,831,422	18,941,907	22,552,381	52,325,710	20.7	36.2	43.1
1955	11,165,867	19,899,564	24,211,136	55,276,567	20.2	36.0	43.8
1956	11,153,651	20,796,912	26,141,370	58,091,934	19.2	35.8	45.0
1957	10,920,587	22,146,218	27,942,060	61,008,864	17.9	36.3	45.8
1958	11,892,327	23,077,542	29,312,979	64,282,848	18.5	35.9	45.6
1959	11,324,394	24,671,002	31,411,712	67,407,108	16.8	36.6	46.6
1960	10,518,361	26,935,533	33,616,114	71,070,008	14.8	37.9	47.3

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	Agriculture	Industry	Services	GDP Total	Agriculture %	Industry %	Services %
1961	11,835,752	29,435,670	35,584,113	76,855,535	15.4	38.3	46.3
1962	12,451,838	31,876,704	38,683,709	83,012,250	15.0	38.4	46.6
1963	13,217,730	36,990,627	44,883,228	95,091,585	13.9	38.9	47.2
1964	12,414,630	35,576,255	44,655,611	92,646,496	13.4	38.4	48.2
1965	12,604,081	35,537,821	46,625,621	94,767,523	13.3	37.5	49.2
1966	12,676,146	37,429,564	49,706,461	99,812,172	12.7	37.5	49.8
1967	13,608,451	40,611,046	52,933,659	107,153,157	12.7	37.9	49.4
1968	12,903,621	44,872,052	58,473,166	116,248,840	11.1	38.6	50.3
1969	13,643,958	48,184,069	61,090,516	122,918,543	11.1	39.2	49.7
1970	11,953,503	51,085,499	62,787,350	125,826,352	9.5	40.6	49.9
1971	11,540,880	50,266,945	66,424,178	128,232,003	9.0	39.2	51.8
1972	10,695,063	51,494,750	69,848,006	132,037,819	8.1	39.0	52.9
1973	12,510,800	56,931,167	71,128,816	140,570,782	8.9	40.5	50.6
1974	12,086,280	62,789,698	72,517,680	147,393,658	8.2	42.6	49.2
1975	12,411,763	59,316,679	72,594,379	144,322,821	8.6	41.1	50.3
1976	12,305,317	65,371,995	76,139,147	153,816,459	8.0	42.5	49.5
1977	12,656,078	66,286,208	79,258,688	158,200,974	8.0	41.9	50.1
1978	13,128,232	68,102,702	82,871,963	164,102,897	8.0	41.5	50.5
1979	13,534,020	72,354,955	87,624,106	173,513,082	7.8	41.7	50.5
1980	12,927,058	75,048,756	91,566,664	179,542,479	7.2	41.8	51.0
1981	12,101,389	72,247,099	96,269,259	180,617,748	6.7	40.0	53.3
1982	11,833,105	71,908,871	98,305,798	182,047,775	6.5	39.5	54.0
1983	12,745,869	71,302,975	100,673,889	184,722,733	6.9	38.6	54.5
1984	11,947,179	72,441,627	105,248,960	189,637,766	6.3	38.2	55.5
1985	11,332,133	73,268,100	110,781,368	195,381,601	5.8	37.5	56.7
1986	9,893,858	68,583,954	125,019,334	203,497,146	4.9	33.7	61.4
1987	10,020,688	68,973,485	124,894,170	203,888,343	4.9	33.8	61.3
1988	9,987,697	75,345,781	133,418,681	218,752,159	4.6	34.4	61.0
1989	10,061,124	77,672,440	137,632,774	225,366,337	4.5	34.5	61.1
1990	9,636,315	79,269,475	142,199,795	231,105,585	4.2	34.3	61.5
1991	10,361,401	78,178,403	141,754,596	230,294,400	4.5	33.9	61.6
1992	10,487,159	78,501,396	143,498,992	232,487,547	4.5	33.8	61.7
1993	10,267,435	77,639,768	142,489,291	230,396,494	4.5	33.7	61.8
1994	10,581,123	76,403,024	148,408,454	235,392,602	4.5	32.5	63.0
1995	10,741,757	79,520,203	151,607,662	241,869,622	4.4	32.9	62.7
1996	10,802,214	81,735,107	152,426,913	244,964,234	4.4	33.4	62.2
1997	11,007,908	82,022,697	156,732,187	249,762,791	4.4	32.8	62.8
1998	11,129,832	83,425,972	159,720,771	254,276,574	4.4	32.8	62.8
1999	11,756,338	84,544,692	162,148,561	258,449,591	4.5	32.7	62.7
2000	11,453,352	85,093,051	169,392,947	265,939,350	4.3	32.0	63.7

2. Per capita product 1861-2000 (1911 and 1951 prices; lire and 1990 International PPP $)

	GDP	GDP	Per capita GDP	Per capita GDP	Per capita GDP
	1911 lire 000	Index 1911=100	1911 lire	1990 Int. dollars	Index 1911=100
1861	9,556,323	45.9	371	1,660	63.9
1862	9,775,500	46.9	377	1,687	64.9
1863	10,024,518	48.1	384	1,718	66.1
1864	9,936,024	47.7	378	1,691	65.1
1865	10,389,813	49.9	393	1,757	67.6
1866	10,575,033	50.7	397	1,776	68.4
1867	10,359,972	49.7	386	1,728	66.5
1868	10,495,800	50.4	388	1,738	66.9
1869	10,758,195	51.6	395	1,770	68.1
1870	11,237,709	53.9	410	1,836	70.7
1871	11,164,650	53.6	405	1,812	69.8
1872	11,131,722	53.4	401	1,795	69.1
1873	11,196,549	53.7	402	1,797	69.2
1874	11,800,572	56.6	422	1,887	72.7
1875	11,691,498	56.1	414	1,852	71.3
1876	11,474,379	55.1	404	1,806	69.5
1877	11,646,222	55.9	407	1,822	70.2
1878	12,155,577	58.3	423	1,891	72.8
1879	12,211,143	58.6	422	1,888	72.7
1880	12,541,452	60.2	431	1,928	74.2
1881	12,869,703	61.8	440	1,967	75.7
1882	13,169,142	63.2	447	1,998	76.9
1883	13,404,783	64.3	451	2,019	77.7
1884	13,150,620	63.1	440	1,967	75.7
1885	13,481,958	64.7	447	2,002	77.1
1886	14,019,096	67.3	462	2,067	79.6
1887	14,226,954	68.3	465	2,083	80.2
1888	14,213,577	68.2	462	2,067	79.6
1889	13,894,587	66.7	448	2,006	77.2
1890	14,225,925	68.3	456	2,040	78.5
1891	14,582,988	70.0	464	2,077	80.0
1892	14,540,799	69.8	460	2,057	79.2
1893	14,865,963	71.3	467	2,089	80.4
1894	14,971,950	71.8	467	2,090	80.4
1895	15,146,880	72.7	469	2,100	80.8
1896	15,319,752	73.5	471	2,110	81.2
1897	15,469,986	74.2	473	2,117	81.5
1898	15,614,046	74.9	474	2,122	81.7
1899	15,807,498	75.9	477	2,135	82.2
1900	16,173,822	77.6	485	2,171	83.6
1901	16,475,319	79.1	492	2,200	84.7
1902	16,828,266	80.8	499	2,235	86.0
1903	17,235,750	82.7	510	2,281	87.8
1904	17,740,989	85.1	521	2,330	89.7
1905	18,153,618	87.1	531	2,376	91.5

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	GDP 1911 lire 000	GDP Index 1911=100	Per capita GDP 1911 lire	Per capita GDP 1990 Int. dollars	Per capita GDP Index 1911=100
1906	18,768,960	90.1	546	2,445	94.1
1907	19,439,868	93.3	562	2,515	96.8
1908	19,840,149	95.2	568	2,542	97.9
1909	20,239,401	97.1	575	2,573	99.1
1910	20,424,621	98.0	574	2,570	99.0
1911	20,839,308	100.0	580	2,597	100.0
1912	21,627,522	103.8	598	2,675	103.0
1913	22,504,230	108.0	620	2,776	106.9
1914	23,233,915	111.5	624	2,792	107.5
1915	26,007,690	124.8	689	3,085	118.8
1916	29,042,707	139.4	770	3,446	132.7
1917	30,339,106	145.6	810	3,624	139.5
1918	30,664,525	147.1	832	3,724	143.4
1919	25,748,126	123.6	698	3,123	120.3
1920	23,560,391	113.1	635	2,840	109.4
1921	23,227,731	111.5	620	2,775	106.9
1922	24,396,155	117.1	645	2,889	111.2
1923	25,801,122	123.8	678	3,033	116.8
1924	26,015,162	124.8	678	3,036	116.9
1925	27,743,773	133.1	717	3,207	123.5
1926	28,027,433	134.5	718	3,212	123.7
1927	27,442,116	131.7	696	3,116	120.0
1928	29,449,642	141.3	740	3,311	127.5
1929	30,438,256	146.1	759	3,396	130.7
1930	28,973,795	139.0	716	3,204	123.3
1931	28,807,377	138.2	706	3,159	121.6
1932	29,762,755	142.8	723	3,237	124.6
1933	29,582,550	142.0	713	3,190	122.8
1934	29,707,470	142.6	710	3,177	122.3
1935	32,586,680	156.4	772	3,456	133.1
1936	32,637,630	156.6	768	3,436	132.3
1937	34,847,793	167.2	814	3,644	140.3
1938	35,106,722	168.5	814	3,641	140.2
1939	37,690,838	180.9	864	3,866	148.8
1940	37,875,559	181.8	860	3,848	148.2
1941	37,347,724	179.2	842	3,768	145.1
1942	36,846,460	176.8	827	3,699	142.4
1943	36,996,888	177.5	827	3,699	142.4
1944	27,124,936	130.2	604	2,704	104.1
1945	21,254,625	102.0	472	2,110	81.2
1946	27,927,031	134.0	614	2,747	105.8
1947	32,831,249	157.5	716	3,206	123.4
1948	34,699,835	166.5	751	3,363	129.5
1949	37,196,497	178.5	801	3,585	138.0
1950	40,180,898	192.8	859	3,845	148.0
1951	43,305,950	207.8	917	4,104	158.0
1952	46,490,901	223.1	981	4,388	169.0
1953	49,804,980	239.0	1,045	4,677	180.1
1954	52,325,710	251.1	1,091	4,884	188.1
1955	55,276,567	265.3	1,147	5,134	197.7

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	GDP 1911 lire 000	GDP Index 1911=100	Per capita GDP 1911 lire	Per capita GDP 1990 Int. dollars	Per capita GDP Index 1911=100
1956	58,091,934	278.8	1,192	5,335	205.4
1957	61,008,864	292.8	1,256	5,619	216.3
1958	64,282,848	308.5	1,315	5,885	226.6
1959	67,407,108	323.5	1,387	6,206	238.9
1960	71,070,008	341.0	1,451	6,495	250.1
1961	76,855,535	368.8	1,564	6,997	269.4
1962	83,012,250	398.3	1,675	7,495	288.6
1963	95,091,585	456.3	1,904	8,522	328.1
1964	92,646,496	444.6	1,837	8,220	316.5
1965	94,767,523	454.8	1,864	8,342	321.2
1966	99,812,172	479.0	1,948	8,719	335.7
1967	107,153,157	514.2	2,074	9,281	357.3
1968	116,248,840	557.8	2,234	9,996	384.9
1969	122,918,543	589.8	2,347	10,502	404.3
1970	125,826,352	603.8	2,384	10,670	410.8
1971	128,232,003	615.3	2,414	10,802	415.9
1972	132,037,819	633.6	2,468	11,045	425.2
1973	140,570,782	674.5	2,609	11,675	449.5
1974	147,393,658	707.3	2,710	12,127	466.9
1975	144,322,821	692.6	2,635	11,793	454.1
1976	153,816,459	738.1	2,793	12,499	481.2
1977	158,200,974	759.1	2,863	12,810	493.2
1978	164,102,897	787.5	2,960	13,245	509.9
1979	173,513,082	832.6	3,121	13,965	537.7
1980	179,542,479	861.6	3,226	14,436	555.8
1981	180,617,748	866.7	3,238	14,492	558.0
1982	182,047,775	873.6	3,251	14,549	560.2
1983	184,722,733	886.4	3,285	14,702	566.0
1984	189,637,766	910.0	3,366	15,062	579.9
1985	195,381,601	937.6	3,458	15,476	595.8
1986	203,497,146	976.5	3,556	15,915	612.7
1987	203,888,343	978.4	3,556	15,915	612.7
1988	218,752,159	1049.7	3,808	17,042	656.1
1989	225,366,337	1081.4	3,918	17,532	675.0
1990	231,105,585	1109.0	4,002	17,910	689.5
1991	230,294,400	1105.1	4,058	18,158	699.1
1992	232,487,547	1115.6	4,082	18,265	703.2
1993	230,396,494	1105.6	4,032	18,045	694.7
1994	235,392,602	1129.6	4,110	18,394	708.2
1995	241,869,622	1160.6	4,223	18,900	727.7
1996	244,964,234	1175.5	4,263	19,078	734.5
1997	249,762,791	1198.5	4,339	19,417	747.6
1998	254,276,574	1220.2	4,414	19,751	760.4
1999	258,449,591	1240.2	4,481	20,052	772.0
2000	265,939,350	1276.1	4,598	20,574	792.1

3. Product and energy intensity 1861-2000 (GDP in 1911 prices)

	Energy Consumption (Toe)	GDP 1911 lire (000)	Energy Intensity (kcal/lira)	Energy Intensity (kj/lira)	Productivity of energy (lire/toe)
1861	11,079,609	9,556,323	11,594	48,542	863
1862	10,972,500	9,775,500	11,224	46,995	891
1863	11,037,407	10,024,518	11,010	46,098	908
1864	11,127,085	9,936,024	11,199	46,887	893
1865	11,073,636	10,389,813	10,658	44,624	938
1866	10,960,813	10,575,033	10,365	43,395	965
1867	10,388,261	10,359,972	10,027	41,982	997
1868	10,528,321	10,495,800	10,031	41,998	997
1869	10,740,041	10,758,195	9,983	41,797	1,002
1870	10,905,885	11,237,709	9,705	40,632	1,030
1871	10,799,154	11,164,650	9,673	40,497	1,034
1872	10,868,138	11,131,722	9,763	40,877	1,024
1873	10,928,809	11,196,549	9,761	40,867	1,024
1874	11,233,574	11,800,572	9,520	39,856	1,050
1875	11,566,721	11,691,498	9,893	41,421	1,011
1876	11,926,334	11,474,379	10,394	43,517	962
1877	11,620,015	11,646,222	9,977	41,774	1,002
1878	11,625,137	12,155,577	9,564	40,041	1,046
1879	12,113,704	12,211,143	9,920	41,534	1,008
1880	12,347,773	12,541,452	9,846	41,221	1,016
1881	12,496,583	12,869,703	9,710	40,654	1,030
1882	12,667,826	13,169,142	9,619	40,274	1,040
1883	12,971,173	13,404,783	9,677	40,514	1,033
1884	13,221,693	13,150,620	10,054	42,094	995
1885	13,552,458	13,481,958	10,052	42,087	995
1886	13,555,215	14,019,096	9,669	40,483	1,034
1887	14,137,492	14,226,954	9,937	41,605	1,006
1888	14,285,312	14,213,577	10,050	42,079	995
1889	14,318,988	13,894,587	10,305	43,147	970
1890	14,474,705	14,225,925	10,175	42,600	983
1891	14,024,054	14,582,988	9,617	40,263	1,040
1892	14,154,363	14,540,799	9,734	40,755	1,027
1893	13,958,351	14,865,963	9,389	39,312	1,065
1894	14,736,964	14,971,950	9,843	41,211	1,016
1895	14,499,554	15,146,880	9,573	40,079	1,045
1896	14,357,730	15,319,752	9,372	39,239	1,067
1897	14,408,155	15,469,986	9,314	38,994	1,074
1898	14,633,152	15,614,046	9,372	39,238	1,067
1899	14,922,376	15,807,498	9,440	39,524	1,059
1900	14,954,633	16,173,822	9,246	38,712	1,082
1901	15,104,869	16,475,319	9,168	38,385	1,091
1902	15,404,165	16,828,266	9,154	38,325	1,092
1903	15,370,814	17,235,750	8,918	37,338	1,121
1904	15,533,314	17,740,989	8,756	36,658	1,142
1905	15,912,099	18,153,618	8,765	36,698	1,141
1906	17,000,979	18,768,960	9,058	37,924	1,104
1907	17,492,159	19,439,868	8,998	37,673	1,111
1908	17,765,254	19,840,149	8,954	37,489	1,117
1909	18,792,804	20,239,401	9,285	38,876	1,077
1910	19,007,746	20,424,621	9,306	38,964	1,075

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	Energy Consumption (Toe)	GDP 1911 lire (000)	Energy Intensity (kcal/lira)	Energy Intensity (kj/lira)	Productivity of energy (lire/toe)
1911	19,227,117	20,839,308	9,226	38,629	1,084
1912	19,750,485	21,627,522	9,132	38,234	1,095
1913	20,543,377	22,504,230	9,129	38,220	1,095
1914	19,787,446	23,233,915	8,517	35,657	1,174
1915	19,797,992	26,007,690	7,612	31,871	1,314
1916	19,766,669	29,042,707	6,806	28,496	1,469
1917	17,566,237	30,339,106	5,790	24,241	1,727
1918	18,686,931	30,664,525	6,094	25,514	1,641
1919	18,227,314	25,748,126	7,079	29,639	1,413
1920	17,462,862	23,560,391	7,412	31,032	1,349
1921	19,034,932	23,227,731	8,195	34,310	1,220
1922	20,069,207	24,396,155	8,226	34,442	1,216
1923	20,755,699	25,801,122	8,044	33,681	1,243
1924	22,522,805	26,015,162	8,658	36,248	1,155
1925	22,592,300	27,743,773	8,143	34,094	1,228
1926	24,189,636	28,027,433	8,631	36,135	1,159
1927	25,360,712	27,442,116	9,242	38,692	1,082
1928	24,079,841	29,449,642	8,177	34,234	1,223
1929	25,845,955	30,438,256	8,491	35,551	1,178
1930	24,494,872	28,973,795	8,454	35,396	1,183
1931	22,592,326	28,807,377	7,843	32,835	1,275
1932	20,769,078	29,762,755	6,978	29,216	1,433
1933	21,688,591	29,582,550	7,332	30,696	1,364
1934	23,896,195	29,707,470	8,044	33,678	1,243
1935	25,532,272	32,586,680	7,835	32,804	1,276
1936	21,497,309	32,637,630	6,587	27,577	1,518
1937	25,756,724	34,847,793	7,391	30,946	1,353
1938	25,643,114	35,106,722	7,304	30,582	1,369
1939	25,830,249	37,690,838	6,853	28,693	1,459
1940	27,662,770	37,875,559	7,304	30,579	1,369
1941	26,755,701	37,347,724	7,164	29,994	1,396
1942	27,336,210	36,846,460	7,419	31,062	1,348
1943	23,039,962	36,996,888	6,228	26,073	1,606
1944	14,757,486	27,124,936	5,441	22,779	1,838
1945	13,721,987	21,254,625	6,456	27,030	1,549
1946	18,715,463	27,927,031	6,702	28,058	1,492
1947	24,837,831	32,831,249	7,565	31,674	1,322
1948	25,065,443	34,699,835	7,224	30,243	1,384
1949	26,400,658	37,196,497	7,098	29,716	1,409
1950	27,832,521	40,180,898	6,927	29,001	1,444
1951	30,790,458	43,305,950	7,110	29,768	1,406
1952	31,497,688	46,490,901	6,775	28,366	1,476
1953	33,638,217	49,804,980	6,754	28,278	1,481
1954	36,549,599	52,325,710	6,985	29,245	1,432
1955	38,037,891	55,276,567	6,881	28,811	1,453
1956	38,575,845	58,091,934	6,640	27,802	1,506
1957	42,176,597	61,008,864	6,913	28,944	1,447
1958	40,631,820	64,282,848	6,321	26,464	1,582
1959	46,510,628	67,407,108	6,900	28,889	1,449
1960	50,932,948	71,070,008	7,167	30,005	1,395

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	Energy Consumption (Toe)	GDP 1911 lire (000)	Energy Intensity (kcal/lira)	Energy Intensity (kj/lira)	Productivity of energy (lire/toe)
1961	56,006,112	76,855,535	7,287	30,510	1,372
1962	62,380,376	83,012,250	7,515	31,462	1,331
1963	68,262,475	95,091,585	7,179	30,055	1,393
1964	73,456,518	92,646,496	7,929	33,196	1,261
1965	80,632,309	94,767,523	8,508	35,623	1,175
1966	85,473,775	99,812,172	8,563	35,854	1,168
1967	93,056,095	107,153,157	8,684	36,360	1,151
1968	102,567,384	116,248,840	8,823	36,941	1,133
1969	109,574,139	122,918,543	8,914	37,323	1,122
1970	123,202,817	125,826,352	9,791	40,995	1,021
1971	127,406,739	128,232,003	9,936	41,599	1,006
1972	137,879,398	132,037,819	10,442	43,720	958
1973	146,342,672	140,570,782	10,411	43,587	961
1974	145,335,457	147,393,658	9,860	41,283	1,014
1975	138,823,461	144,322,821	9,619	40,273	1,040
1976	148,568,933	153,816,459	9,659	40,440	1,035
1977	145,145,410	158,200,974	9,175	38,413	1,090
1978	149,205,599	164,102,897	9,092	38,067	1,100
1979	154,000,714	173,513,082	8,875	37,160	1,127
1980	151,802,374	179,542,479	8,455	35,399	1,183
1981	148,932,594	180,617,748	8,246	34,523	1,213
1982	144,435,628	182,047,775	7,934	33,218	1,260
1983	143,627,378	184,722,733	7,775	32,554	1,286
1984	146,105,948	189,637,766	7,704	32,257	1,298
1985	148,424,974	195,381,601	7,597	31,806	1,316
1986	149,970,456	203,497,146	7,370	30,855	1,357
1987	156,429,354	203,888,343	7,672	32,122	1,303
1988	159,801,893	218,752,159	7,305	30,585	1,369
1989	164,941,600	225,366,337	7,319	30,642	1,366
1990	166,411,911	231,105,585	7,201	30,148	1,389
1991	168,313,090	230,294,400	7,309	30,600	1,368
1992	169,653,276	232,487,547	7,297	30,552	1,370
1993	167,709,862	230,396,494	7,279	30,476	1,374
1994	164,730,961	235,392,602	6,998	29,300	1,429
1995	172,921,262	241,869,622	7,149	29,933	1,399
1996	172,497,211	244,964,234	7,042	29,482	1,420
1997	175,022,906	249,762,791	7,008	29,339	1,427
1998	179,443,496	254,276,574	7,057	29,546	1,417
1999	182,162,115	258,449,591	7,048	29,510	1,419
2000	184,377,461	265,939,350	6,933	29,027	1,442

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A Statistical Outline

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