TRENDS OF ENERGY AND GREENHOUSE GAS EMISSIONS

PRACTICAL EXERCISE

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It is intended the student get to know:
i) How to find and explore energy statistics and emissions of greenhouse gas (GHG) emissions for Europe and Portugal;
ii) How to make energy conversions;
iii) How to build indicators and charts with added value;
iii) How to analyze economic sectors, and interpret their performance in terms of energy consumption and greenhouse gas emissions.

Guidelines:

1. Energy Unit Conversion

A first reading can be accessed herein:
http://www.aps.org/policy/reports/popa-reports/energy/units.cfm

Joule (J) is the basic energy unit of the International System of Units (SI). It is desirable that all energy units should be presented in J.
James Prescott Joule was a self-educated British physicist and brewer whose work in the middle of the 19th century contributed to the establishment of the energy concept. The international unit of energy bears his name.

"1 Joule [J] refers to the energy needed to raise a 102-g-apple 1 m."

Watt (W) is a unit of power (energy per unit time). Power units can be converted to energy units through multiplication with seconds [s], hours, [h], or years [yr]. For example, 1 kWh [kilowatt hour] = 3.6 MJ [MegaJoule].

Calories and/or kilocalories [**cal** and/or kcal] were commonly used to measure heat (energy) in the past and are still used sometimes today. Heating a gram of water 1 ⁰C requires 1 cal.

Normally, you should prefer to use The International System of Units. However, there are many other energy units. A still very frequent unit used in the energy business is "ton of oil equivalent" (toe). 1 toe equals 11630 kWh. It means that the energy content in one tonne of oil is the same as in 11 630 kWh.

The best option to manage energy units is through the use of converters. There are several online energy unit converters you may use. Here is one with many options: https://www.unitjuggler.com/energy-conversion.html

Also, you need to be familiar with the prefix used to manage energy numbers, as presented in the next table.

Table 2.2 Prefixes commonly used

Factor	Prefix name	Symbol
Multiple		
10^{18}	Exa	E
10^{15}	Peta	P
10^{12}	Tera	T
10^{9}	Giga	G
10^{6}	Mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10^{1}	deka	da
Submultiple		
10^{-1}	deci	d
10^{-2}	cents	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

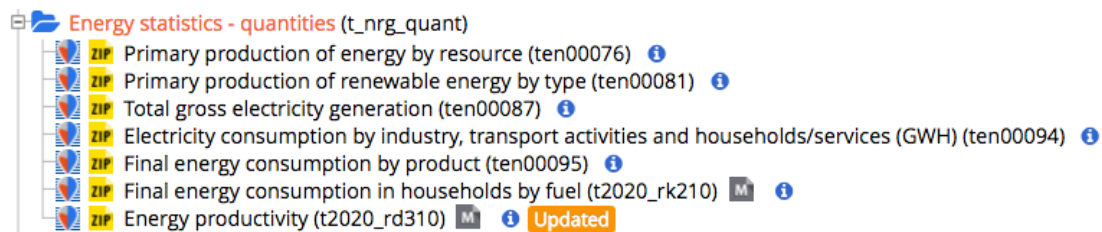## 2. Explore statistics of energy at:

SELECT JUST ONE CASE TO WORK: 2.1 (EUROPE) OR 2.2. (PORTUGAL)

2.1. European Energy Statistics: EUROSTATS
http://ec.europa.eu/eurostat/web/energy/data/main-tables

Select

Download the file by clicking over the symbol

Analyze the **Primary Production of energy by resource**: select a country of your interest and take a look at the consumption of natural gas and oil - note the units, you may explore the graph option.

Analyze the **Electricity consumption by industry, transport activities and households/services**: select a country of your interest and take a look at the different sectors of consumption, you may explore the graph option.

To manage the data, you may click over the sign (at the upper right) and,

in the next table, you may download the table by clicking here

Now you may select the Excel format, and an excel file will be generated. Open the file in your excel program.

a. Convert to the IS units (J)

b. Decide a couple of indicators you find useful to explore (e.g. how has been evolved the energy consumption in industry in Portugal in the last decade, in comparison with Spain and the European Union?)

2.2. Portuguese Energy statistics: http://www.dgeg.pt/
Página inicial» à Direita **Estatísticas e Preços »Balanços e Indicadores Energéticos**

Download the following files:
- *Balanços Energéticos (excel files in portuguese)*
- *Indicadores Energéticos (table with numbers on inidicators in Portuguese)*
- *Energia em Portugal - Principais Números (organized document in Portuguese)*

Alternatively, you may access summarized Portuguse energy data at https://www.observatoriodaenergia.pt . Note that at the bottom of the graph you've selected, you may also export it for an excel file.

Based on these files, answer the following questions, building displays and / or graphics:
2.2.1. What is the average annual rate of primary energy consumption, considering the last 10 years?
2.2.2. Choose a specific sector of activity - Agriculture and Fisheries, Industry, Transport, domestic, or Services-, and assess:
   i.   How the energy mix of the final energy consumption in that sector (consider the main forms of final energy such as petroleum products, natural gas, electricity) has changed in the last 10 years (consider only the initial and the final years)?
   ii. How much the total final energy consumption has increased or decreased in this period in that sector?

3. Explore Greenhouse gas emission data go:
http://www.apambiente.pt/
Página inicial»Instrumentos» Inventário Nacional de Emissões Atmosféricas (INERPA)

Submissões no âmbito da Convenção Quadro das Nações Unidas sobre Alterações Climáticas (UNFCCC):
- Download the file **Common Report Format (CRF)[1]. The last version is the one available (Versão de 15.03.2019).**

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[1] CRF is a common format for all countries to submit emissions report to the UNFCCC.

This file includes a large excel file set that corresponds to the yearly emissions inventories since 1990. Open the one corresponding to the last year 2017: PRT_2017_2017_xxx.xls. Since the excel file contains a huge number of worksheets, the following table guides you through the most important for this exercise, but you may want to explore the other worksheets.

Table1s1, e Table1s2	Emissions by type of greenhouse gas in the combustion activities
Table1.A(a)s1 a s4	energy consumption and implicit emission factors in combustion activities
Table 1.C	International Bunkers (fuels consumed in the international shipping and aircrafts)
Table10s1 a Table10s3	Trends of GHG emissions 1990 to 2013 by sector and activity subcategories
Table10s5.1 a Table10s5.3	Summary of GHG emissions 1990-2013 by major activity sectors
Summary2	Consolidated balance sheet of 2013 emissions

Based on these worksheets (mostly **Table1s1, e Table1s2)**, answer the following questions, by building adequate indicators and graphics:

3.1. What is the annual average rate of GHG emissions in the period 1990-2017? How to relate with the energy indicator obtained in 2.2.1?

3.2. Choose the sector of activity you chose for 2.2.2. - Agriculture and Fisheries, Industry, Transport, domestic, or Services - and answer the following questions:
  i.   What was the evolution of GHG emissions from 1990 to 2017 for that sector?
  ii.   how is the representativeness of your selected sector in the total national emissions for 1990 and for 2017? Has it increased or decreased?
  iii. how the evolution of emissions compares with the energy consumption you assessed in 2.2.2. for the last 10 years?