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Energy and Sustainable Development in Portugal

A report by

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By stimulating the growth of natural gas, the Portuguese Government has possibly provided a disincentive for further investment in renewable, endogenous sources.

Table of contents

Executive Summary

The current report is the application to the Portuguese energy system of the methodology for analysis of the relations between the energy system and the environment and society, developed by HELIO International for its project Sustainable Energy Watch (SEW). It is part of a number of similar exercises being conducted in Europe and other continents as a contribution to the debate on sustainable energy systems that will be a feature in the World Sustainable Development Summit of Johannesburg later this year.

This report review the past ten years of energy policy developments in Portugal and the achievements and failures within the period. This period coincides roughly with the period since the first negotiations that were to lead to the 1992 Rio Summit, and the report therefore provides a certain vision of the developments in the light of the commitments that nations took upon themselves at the time.

The Portuguese energy system has developd quite considerably throughout the period. In many respects, the energy sector can be said to have achieved some basic development progress, such as almost universal electricity coverage of the population, and some of the first, low-hanging fruits of environmental policy can be said to have been reaped in the decade, as with SO2 emissions (despite the simultaneous growth in other pollutants, stemming from other energy uses). Being a middle-to-high income country experiencing fast growth in a period of convergence and integration with Europe, Portugal failed in promoting in this period of growth the necessary requirements for transition to a more sustainable pattern of energy use. This is particularly patent in the developments of indicator 1 (per capita energy sector CO2 emissions). As with other sectors in the economy, the energy sector in Portugal demonstrated a lack of investment in more advanced energy technology, a general lack of concern with energy conservation and a low penetration rate of renewable technology. This pattern is further characterized by indicator 7, reporting on the energy intensity of production in Portugal. Unlike almost all of the other OECD members, including similar members (in relation to economic development) such as Greece and Mexico, energy intensity actually increased throughout the period.

	ind 1	ind 2	ind 3	ind 4	ind 5	ind 6	ind 7	ind 8
1990	0.96	1	1	0.95	1.034915	0.14	0.93	1.043596
1991	1.23	1.02	1	0.95	1.015794	0.16		1.044953
1992	1.16	1.17	1	0.95	1.007699	0.18		1.071588
1993	1.12	1.08	1	0.95	1.004126	0.17		1.050304
1994	1.13	1.05	1	0.95	0.966412	0.15		1.040814
1995	1.16	1.12	1	0.674779	1.03949	0.15		1.055819
1996	1.16	1.03	1	0.813777	0.969785	0.14		1.02215
1997	1.22	1.08	1	0.618172	0.985127	0.14	0.98	1.035851
1998	1.33	1.12	1	0.814309	0.981941	0.12	1.03	1.039933
1999	1.39	1.20						

The survey stops at 1998, for most indicators. Anecdotal evidence would indicate that most of the trends reported are still present today, with the notable exception of the boom in the expansion of renewable, in particular, wind energy capacity, policy induced by a lower administrative requirement and a higher feed-in tariff.

Introduction

This report was conducted in 2002, by Pedro Martins Barata of EURONATURA.
EURONATURA is a Portuguese non-governmental organisation, committed to the increasing of awareness of the Portuguese public and stakeholders in global environmental issues, in particular climate change and energy efficiency, trade and environment and international water conflicts. The author can be contacted via e-mail at pedro.barata@euronatura.pt, and by snail mail at Observatorio Astronomico de Lisboa, Tapada da Ajuda, 1349-018 LISBOA, Portugal.

Most of the data were provided by publications from the Energy Directorate, in particular a single publication "Informacao Energia n. 22/23". This publication seems, from a short survey conducted, to be the only available source of statistical information in detailed and abridged version on the Portuguese energy system with data spanning the entire decade. However, two issues arise with the use of this publication:

Firstly, the lack of independent verification of most of the numbers in it means that we cannot entirely vouch from the quality of these numbers. This is important to keep in the back of the mind when analysing indicators 3 to 8.

Secondly, and most importantly, in constructing indicator 7 with the numbers on this publication, the author arrived at absolutely non-sensical numbers, the non-sense of which has been corroborated by other authors of similar reports. In this case, we had to resort to other sources, namely data retrieved from the IEA/OECD database of energy indicators, and from the IEA Energy Policy Review of Portugal 2000.

Finally, one particular indicator was not available, namely the electricity coverage of Portuguese households. In the referred document, a graph indicates that this indicator is now extremely close to 100%, and it can be assumed that in the course of the decade Portugal has effectively reached universal coverage.

Acknowledgements :
The present report would not have been possible without the precious assistance of Goncalo Cavalheiro and Nuno Lacasta, to whom the author is indebted. Data on emissions has gently been provided in digital format by Luisa Basilio from the Portuguese Environment Institute. This has been a precious assistance which must be acknowledged here.

Finally, the push to finish this report, among other tasks, was given by a fortunate e-mail exchange with Matthias Duwe of Climate Network Europe, who was crucial in disentangling the mystery of indicator 7 on Portuguese energy intensity.

General Discussion

►Geography and Demography

Portugal is a small, peripheral country located in the South westernmost tip of Continental Europe. With a surface area of approximately 96,000 sq.kms, it enjoys a temperate climate, with relatively mild temperatures throughout the year.

Throughout the decade, the Portuguese population has stabilized at close to 10 million inhabitants. However, the decades-long process of urbanisation has proceeded, with most population centering around the two major cities of Lisbon (approx 2.5 million in the metropolitan area) and Oporto (approx. 1.5 million in the MA). This process of urbanisation has been set in motion since the early 1960s, as the process of industrialisation and mechanisation of agriculture proceeded. This process of urban growth has not been matched by a capacity to build infrastructure at the same pace, leading to the development of large suburbs. In fact, according to the latest Census Reports (2001), the third, fourth and fifth largest cities in the country are now suburbs of Lisbon and Oporto. Conversely, small and medium-size cities in Portugal have remained mostly stable, in some cases losing further population during the decade.

Demographically, two large movements must be referred to: the surge of emigration in the 1960s, reaching a peak of approximately 150,000 emigrants in 1970, which contributed to the development of the financial system and the internationalisation of the Portuguese economy, by providing a sustained source of foreign currency throughout the 1960s and 1970s. Most of these emigrants have established themselves in France, Luxembourg, and, to a lesser extent, South Africa, Venezuela and the United States.

The second important event in demographic terms has been the end of the colonial war and the independence of former colonies, which led to the influx in 1976 and 1977 of approximately 1 million inhabitants, some 10% increase in the population. This population increase, more than the rural exodus itself, has contributed to the very rapid growth of the metropolitan areas.

▸Economic Growth and Economic Structure

Portugal has experienced relatively rapid growth since the 1960s, partly interrupted in the 1970s, with the occurrence of the two oil shocks, the nationalisation of assets in the post-revolutionary period of 1974 and ensuing chaotic macro-management of the economy (Portugal negotiated two separate adjustment packages with the IMF in 1977 and 1982). This relative unsettled period came to a close in 1985. From 1985 until today, Portugal has generally experienced relatively high growth rates of 3-4% p.a., with the exception of two years in that period.

In 1986, Portugal joined the European Community, and has since been a recipient of Structural Funds. These funds have been used to cover the relative scarcity of capital in Portugal for infrastructural projects. The growth of infrastructure since 1985 has been impressive, in particular in the fields of transport infrastructure (particularly roads), but also in telecommunications, health care and general public services.

Despite these massive inflows of structural funds, Portugal has recovered only slowly from a century-long gap between GDP per capita levels. Nevertheless, GDP per capita has risen from approximately 55% to 75% of the EU15 average, over the period from 1985 to today. This progress was starkly made noticeable, when the European Commission announced that, in accordance with its own numbers, the area of Lisbon and the Tagus Valley (home to approximately 1/3 of the population) would, as of 2000, no longer qualify for Objective 1 assistance (underdeveloped areas), as its income was over 90% of the EU15 average.

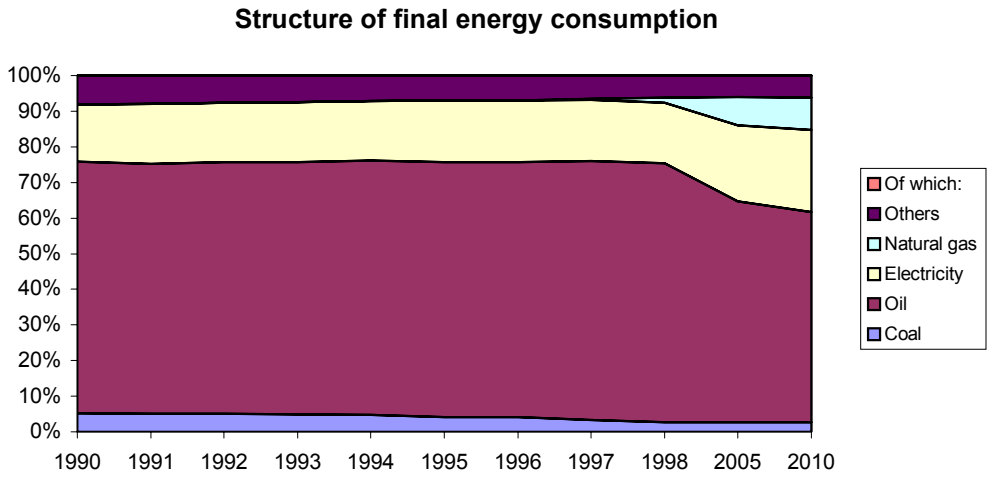
The rapid growth of the 1990s has resulted in increased wealth, but also in increased environmental stress. In many instances, the lack of appropriate planning regulations has led to extremely high stresses on local ecosystems, as well as to increased overall demands on energy and environmental inputs. In particular, the massification of road transport, and the under-investment in railways and public transportation systems (with the notable exceptions of the Lisbon underground and bus system), in conjunction with the consumption-led growth in welfare has led to a doubling of the number of cars in less than ten years, with an expectation that these rates of growth should maintain in the next decade. The resulting increase in CO2 emission is startling – approximately 70% more CO2 from cars since 1990.

More recently, in 2000 and 2001, the economy has declined sharply. Analysts relate this decline to structural deficiencies in the economy, namely the growth of the public administrative sector and the overhang of the public sector borrowing needs (public sector expenditure is now more than 50% of GDP, according to estimates, and, more importantly, the structural problems of low levels of factor productivity, in particular, energy and labour productivity.

In fact, despite compulsory education of 9 years, most of the current workforce is poorly equipped in terms of skills and Portugal has been criticized for not raising the levels of labour productivity (currently under the European average), in spite of the massive investments in infrastructure.

▸Energy System

The high growth experienced throughout the decade has been accompanied by a related increase in energy demand. In fact, energy intensity has, despite attempts (critics would say half-hearted ones) at establishing energy conservation guidelines, such as the RCCTE (regulation on building requirements) and the RGCE (general regulation on energy efficiency), increased, in contrast to almost all other nations in the OECD.



Electricity:

Following European energy directives, the electricity system has been decoupled between a "linked system" and an independent production system. The "linked system" provides the mainstay of the electricity grid, and has recently been further unbundled between the former electricity monopoly – Electricidade de Portugal (EDP) and REN (national grid). However, this separation has not yet resulted in different ownership, and it is widely acknowledged that EDP is, for most practical purposes, a powerful incumbent. ERSE, the regulator, has provided independent regulation, leading to increased downward pressure on prices, in particular to industrial consumers. This in turn has resulted in higher growth of electricity consumption, already sped up by the increased acquisition of electrical appliances (in particular, air conditioning systems). Electricity consumption has therefore grown at a higher rates than economic growth, at world-high levels.

The "linked system" produces electricity essentially from hydro electrical plants (in the revolutionary period of nationalisation, most independent hydro electrical plants were taken over by the newly formed EDP) and coal-fired power plants (Sines-900MW, Carregado-600MW, Pego-600MW). Over the past decade, capacity has grown essentially due to the opening of new hydro electrical plants (Lindoso, in the north, and the opening of a new coal-fired power plant in Pego. This latest plant does not form part of the "linked system" and is partly owned by the British company PowerGen.

Of particular interest to the national effort to limit greenhouse gas emissions has been the recent decision to adapt at least one generator in Carregado and the northern power plant at Tapada do Outeiro (near Oporto) to natural gas.

Natural Gas:
This intention has been stimulated by the very recent (in European terms) construction of the distribution network for natural gas. This is a recent addition to the Portuguese fuel mix. A large proportion of energy investment in the past few years has gone into the building of the natural gas infrastructure. The previous Government intended to supplement this support to the gas infrastructure with support to conversion of turbines and other end-use equipment to gas-fired uses. In particular, there is a general appreciation of the potential role that conversion of current co-generation facilities to natural-gas may have in improving energy performance in most sectors. The merging of the Algerian-Iberian with the EuroSiberian grid will in the future enlarge the diversity of origins of the natural gas. Natural gas consumption is expected to take off in the current decade, and the residential grid in metropolitan areas has in fact been upgraded (from LPG) ahead of schedule. The grid and the distribution networks are the property of Galpenergia, the Portuguese gas and oil holding, partly owned by the Portuguese government.

Electricity generating capacity (in MW)

	31.12.96	31.12.97	31.12.98
Hydroelectricity	**4428**	**4438**	**4501**
- Public Sector	4276	4277	4332
- Independent producers	152	161	169
Thermal	**4942**	**4993**	**5275**
- Public Sector	4 165	4 169	4 393
- Independent producers	777	824	882
Wind (public sector)	**18**	**29**	**48**
Geothermal	**8**	**8**	**8**
Total	**9396**	**9468**	**9832**

The numbers on wind generating capacity are necessarily outdated due to the very recent increase in capacity currently at about 150MW, and expected to reach 3000 MW by the end of the current decade. Use of natural gas for electricity production has only taken off in 1999.

Renewable energy:
The development of renewable energy sources, despite the ambitions of successive governments, has been relatively small over the decade. Wind power has not seen any major increase in capacity, and the much expected boom in small scale hydro did not take place, partly because of environmental constraints (as with wind), but also due to the uncertain income.

RES has been supported since 1986 by a feed-in tariff remotely related to the amount of CO2 displaced from average capacity in the grid. Unfortunately, for most of the period, the "environmental premium" awarded to RES has been relatively small. The situation has improved considerably in the last two years, due to a strong administrative hike in the environmental premium, generally regarded to be the main driver behind the current boom in wind and small-scale hydro projects.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	2005	2010
% Domestic production in Primary Energy Consumption	12,37	12,25	9,33	11,26	11,62	9,57	12,65	11,07	10,45	10,18	
Coal	**0,70**	**0,67**	**0,51**	**0,46**	**0,33**						
Hydroelectricity	**4,88**	**4,76**	**2,46**	**4,30**	**5,12**	**3,82**	**6,72**	**5,54**	**5,19**	**5,22**	**5,11**
Other	**6,79**	**6,82**	**6,36**	**6,50**	**6,18**	**5,75**	**5,92**	**5,52**	**5,26**	**4,96**	**4,84**
Primary Energy Intensity(toe/10^9 PTE 95) (4)	1139	1119	1172	1171	1178	1213	1171	1220	1252	1025	937

Final Energy Consumption Total	12590	12744	13204	13308	13929	14345	15034	15963	17030	18256	19611
Coal	**658**	**656**	**663**	**647**	**657**	**600**	**632**	**526**	**448**	**500**	**536**
Oil	**8898**	**8935**	**9327**	**9426**	**9959**	**10263**	**10753**	**11595**	**12382**	**11324**	**11549**
Electricity(2)	**2014**	**2145**	**2206**	**2234**	**2318**	**2477**	**2600**	**2747**	**2911**	**3882**	**4529**
Natural gas								**49**	**238**	**1443**	**1795**
Others(3)	**1020**	**1008**	**1008**	**1001**	**994**	**1005**	**1049**	**1047**	**1051**	**1107**	**1202**
Of which:											
Final use as inputs	**1701**	**1296**	**1307**	**1223**	**1321**	**1469**	**1266**	**1425**	**1562**	**1300**	**1300**
Final Energy Intensity(toe/10^9 PTE 95) (6)	756	771	784	807	821	815	844	862	886	753	681
Population (´000 inhabitants)	9873	9865	9869	9892	9912	9921	9934	9957	9979	10112	10173
FEI/capita (toe/inhabitant)	1,66	1,68	1,80	1,77	1,82	1,93	1,92	2,07	2,19	2,28	2,48
Annual rate of change		1991/ /1990	1992/ /1991	1993/ /1992	1994/ /1993	1995/ /1994	1996/ /1995	1997/ /1996	1998/ /1997	2005/ /1998	20102005
GDP		**3,1**	**2,2**	**-1,4**	**2,5**	**2,9**	**3,2**	**3,5**	**3,5**	**3,7**	**3,6**
PEC		**1,2**	**7,1**	**-1,4**	**3,2**	**6,0**	**-0,4**	**7,8**	**6,2**	**0,8**	**1,8**
FEC		**1,2**	**3,6**	**0,8**	**4,7**	**3,0**	**4,8**	**6,2**	**6,7**	**1,0**	**1,4**

The Eight Indicators

►Indicator 1: Per Capita Energy Sector Carbon Emissions

	Per Capita Energy Sector Carbon Emissions
1990	0.957967
1991	1.231017
1992	1.159863
1993	1.114713
1994	1.128625
1995	1.151602
1996	1.164808
1997	1.219209
1998	1.327702
1999	1.390102

	Population	CO2('000 t)	C(Mt)	kgC/cap
1990	9877500	39721.62	1083316	1096.752
1991	9864900	47483.3	12949990	1312.734
1992	9869200	45467.31	12400175	1256.452
1993	9892200	44174.93	12047708	1220.738
1994	9912100	44766.89	12209151	1231.742
1995	9920800	45467.31	12400175	1249.917
1996	9934100	45908.78	12520576	1260.363
1997	9957300	47587.05	12978286	1303.394
1998	9979500	50833.35	13863640	1389.212
1999	9997600	52734.92	14382250	1438.57

Throughout the decade, albeit with an almost stagnating population, CO2 emissions from the energy sector have increased at alarming rates. This is partly to due with increased economic growth during the decade, but the fact already mentioned in the introduction that energy intensity has actually increased during the same period leads us to believe that a great part of the emission increase stems from economic growth not accompanied by the necessary de-linking from energy use. In the next years, as the coverage of the natural gas network extends, it is likely that per capita emissions relating strictly to the energy sector may decelerate or decline.

The figures are taken from the IPCC submitted national inventories. Energy sector emissions relate to all emissions from energy generation activities.

►Indicator 2: Local energy-related pollutants

	Population	SO_2(kilos)	SO_2/cap	Nox(kilos)	NOx/cap	indicador2(Nox/SO_2)
1990	9877500	322950000	32.69552	275420000	27.883574	1
1991	9864900	316070000	32.03986	290500000	29.44784	1.02
1992	9869200	376780000	38.17736	310980000	31.510153	1.17
1993	9892200	334400000	33.80441	305980000	30.931441	1.08
1994	9912100	311020000	31.37781	310090000	31.283986	1.05
1995	9920800	342850000	34.5587	320720000	32.328038	1.12
1996	9934100	298370000	30.03493	315690000	31.77842	1.03
1997	9957300	314550000	31.58989	325120000	32.651422	1.08
1998	9979500	314550000	31.51962	346360000	34.70715	1.12
1999	9997600	346660000	34.67432	363250000	36.33372	1.20

Sulphur dioxide and nitrous oxides are two particularly important local pollutants from the energy sector. It must be noted that local pollution from energy production has not, to date, been a major concern for the Portuguese environmental authorities. This is partly due to the low levels of pollution and the high levels of dispersion of pollutants in the vicinity of most power stations. Furthermore, upgrading of facilities at most power stations has led to a relative decrease of sulphur emissions. NOx emissions stem mostly from fossil-fuel combustion in transportation systems. The marked rise of NOx as a local pollutant can be observed and is directly related to the growth in car ownership. Moreover, transportation-related pollution from the Lisbon area (ozone and NOx) has now been measured in concentrations in excess of legally allowable limits as far away as Santiago do Cacem (rural area approximately 120 kms south of Lisbon center). It was decided therefore that a more accurate picture of the evolution of local pollution would be given by incorporating both SO_2 and NOx in the calculations.
The indicator is calculated as a weighted (0.5 each) average of per capita values for SO_2 and NOx.

►Indicator 3: Households with Access to Electricity

No information was obtained on percentages of households with access of electricity. However, it is generally believed that there is now almost universal coverage by the electricity grid, with only isolated instances in the most remote areas of inland Northern Portugal, where small villages have not yet been connected. For practical purposes, it can be assumed that the coverage was near 100%.

►Indicator 4: Investment in Clean Energy

	ind 4
1995	0.726724217
1996	0.681724748
1997	0.608872703
1998	0.611663724

The reason this indicator is only presented from 1995 onwards relates to the fact that no statistics were available on clean energy investments, prior to the implementantion of the Second Community Support Framework, i.e. the second structural plan presented to the European Commission for funding. Under this CSF, Programme ENERGIA in particular funded the development of endogenous resources and the development of the links to the international natural gas grid. This results in the fact that we have assumed that prior to the implementation of that programme no investment was being made in clean energy in Portugal. This is a crude assumption, but it nevertheless remains true that ENERGIA was the spur of all public and private investments in renewable resources from the period from 1995 to 1999. Data on investment in other energy sub-systems is also presented (data from the Energy Directorate).

Anos	Electricity	Oil	Coal	Gas	Energy Sector	Total FCGF	%
unit: billion PTE current							
	(1)	(2)	(3)	(4)	(5)=(1)+(2)+(3)+(4)	(6)	(7)=(5)/(6)
1990	105328	35454	129	641	141552	2719800	5.2%
1991	125238	48953	72	1744	176007	2966500	5.9%
1992	135952	91573	53	3935	231513	3194000	7.2%
1993	124719	103405	16	2961	231101	3146600	7.3%
1994	125928	43763	0	48432	218123	3438600	6.3%
1995	139756	50370	0	39776	229902	3742700	6.1%
1996	124080	61158	0	46024	231262	4005100	5.8%
1997	124841	76998	0	42578	244417	4515600	5.4%
1998(*)	98726	75225	0	50187	224138	4992100	4.5%

As can be seen, investment in coal has disappeared, as the last remaining mines were shut down in 1994. Gas amalgamates natural gas and other gases. Nevertheless, the boom in investment in the natural gas infrastructure can be seen, starting from 1994. Finally, the relatively high levels of investment in the electricity sector throughout the period refer to both upgrading of the general grid, but also to investments in auxiliary services (costumer service, etc..). For good measure, the numbers of public support for alternative, endogenous sources of energy is reflected in the accompanying table (also in billion PTE):

1995	60110
1996	29928
1997	77049
1998	28893

The current boom in wind development and the commitments under the Renewables Directive will have, since 1998, changed somewhat the picture.

►Indicator 5: Energy trade – Economic Resilience

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Primary Energy Consumption	**16410**	**16604**	**17781**	**17529**	**18083**	**19165**	**19087**	**20581**	**21863**
Coal	2760	2906	2950	3142	3328	3604	3430	3513	3232
Oil	11731	11767	13148	12479	12637	13649	13147	14445	15624
Electricity	804	798	552	768	1001	811	1379	1390	1159
Natural gas	0	0	0	0	0	0	0	96	698
Others	1115	1133	1131	1139	1117	1102	1130	1137	1150
Domestic production	**2030**	**2034**	**1659**	**1973**	**2102**	**1834**	**2414**	**2278**	**2285**
Coal	115	111	91	81	60				
	0								
Electricity from RES	800	790	437	753	925	732	1284	1141	1135
Others	1115	1133	1131	1139	1117	1102	1130	1137	1150
Net imports	**15501**	**15426**	**16706**	**16232**	**16358**	**18243**	**17024**	**19023**	**20255**
Coal	2991	2721	2840	3059	3220	3813	3357	3692	3268
Oil	12507	12697	13750	13158	13061	14351	13572	14972	16266
Electricity	3	8	115	15	77	79	95	249	24
Natural gas	0	0	0	0	0	0	0	110	697
Inputs for electricity generation	**5109**	**5383**	**5900**	**5675**	**5369**	**6222**	**5493**	**5724**	**6711**
Coal	2027	2159	2208	2419	2578	2918	2710	2893	2688
Oil	2113	2200	3046	2275	1658	2382	1323	1466	2303
Renewables (incl. Large hydro)	800	790	437	753	925	732	1284	1141	1135
Natural gas								27	375
Others	169	214	209	228	209	190	176	197	210
Losses	**3820**	**3860**	**4577**	**4221**	**4154**	**4820**	**4053**	**4618**	**4975**
Final Energy Consumption Total	12590	12744	13204	13308	13929	14345	15034	15963	17030
non-renewable imports	15498	15418	16590	16217	16281	18164	16929	18774	20231
non-renewable consumption	14491	14673	16098	15621	15965	17253	16577	18054	19554
Vector calculation	**1.07**	**1.05**	**1.03**	**1.04**	**1.02**	**1.05**	**1.02**	**1.04**	**1.03**

The data from the table above, taken from a publication from the Energy Directorate in Portugal, turn out an awkward result – non-renewable energy imports were, over the decade, higher than the actual consumption of non-renewable energy. This is no doubt due to statistical errors. What is relevant in the calculation, nevertheless, is the very high degree of dependency of Portugal on foreign non-renewable energy sources, both as fuel imports and as inputs into electricity generation. This dependency will not be mitigated by the expansion of the natural gas. In fact, by stimulating the growth of natural gas, the Portuguese Government has possibly provided a disincentive for further investment in renewable, endogenous sources.

►Indicator 6: Burden of Energy Investment

	Electricity	Oil	Coal	Gas	Energy Sector	Total Fixed Capital Formation	GDP	%	Ind 6
unit: million PTE									
	(1)	(2)	(3)	(4)	(5)=(1)+(2)+(3)+(4)	(6)		(7)=(5)/(6)	
1990	105328	35454	129	641	141552	2719800	9838000	5.2%	0.14
1991	125238	48953	72	1744	176007	2966500	11306700	5.9%	0.16
1992	135952	91573	53	3935	231513	3194000	12743200	7.2%	0.18
1993	124719	103405	16	2961	231101	3146600	13445500	7.3%	0.17
1994	125928	43763	0	48432	218123	3438600	14616900	6.3%	0.15
1995	139756	50370	0	39776	229902	3742700	15802100	6.1%	0.15
1996	124080	61158	0	46024	231262	4005100	16808700	5.8%	0.14
1997	124841	76998	0	42578	244417	4515600	17858500	5.4%	0.14
1998(*)	98726	75225	0	50187	224138	4992100	19245700	4.5%	0.12

►Indicator 7: Energy Intensity

As reported previously in the Introduction, one of the most difficult exercises has been to retrieve credible figures for the indicator on energy productivity. The report that has been used as the main source of information provided us with totally inconsistent figures, that showed Portugal to have the highest energy intensity of the EU by far. While this could eventually be the case, the numbers did not seem credible. We therefore resorted to using numbers provided in the IEA Energy Policy Review of 2000. Unfortunately, this report only provides us with numbers with respect to the years 1997 and 1998 (and the base-year 1990). The numbers are provided below, along with the vector calculation.

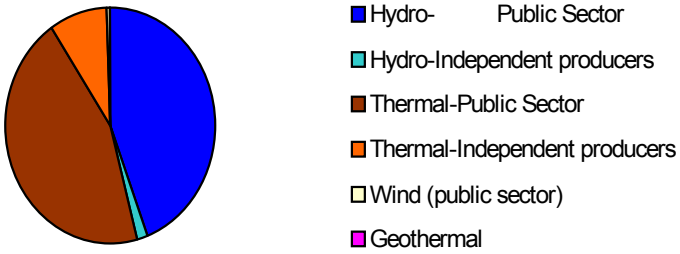
	TPES	GDP	TPES/GDP	MJ/ US$	Ind 7
1990	16.42	69.13	0.24	9.94	0.93
1997	20.16	80.63	0.25	10.47	0.98
1998	21.85	83.8	0.26	10.92	1.03

The numbers reflect the fact that, over the decade, Portugal has increasingly had a bad performance in the energy sector, in particular with relation to energy conservation. While the absolute figure per se might not look disturbing, its trend is staggering – a 10% increase in the energy requirements per unit of output.

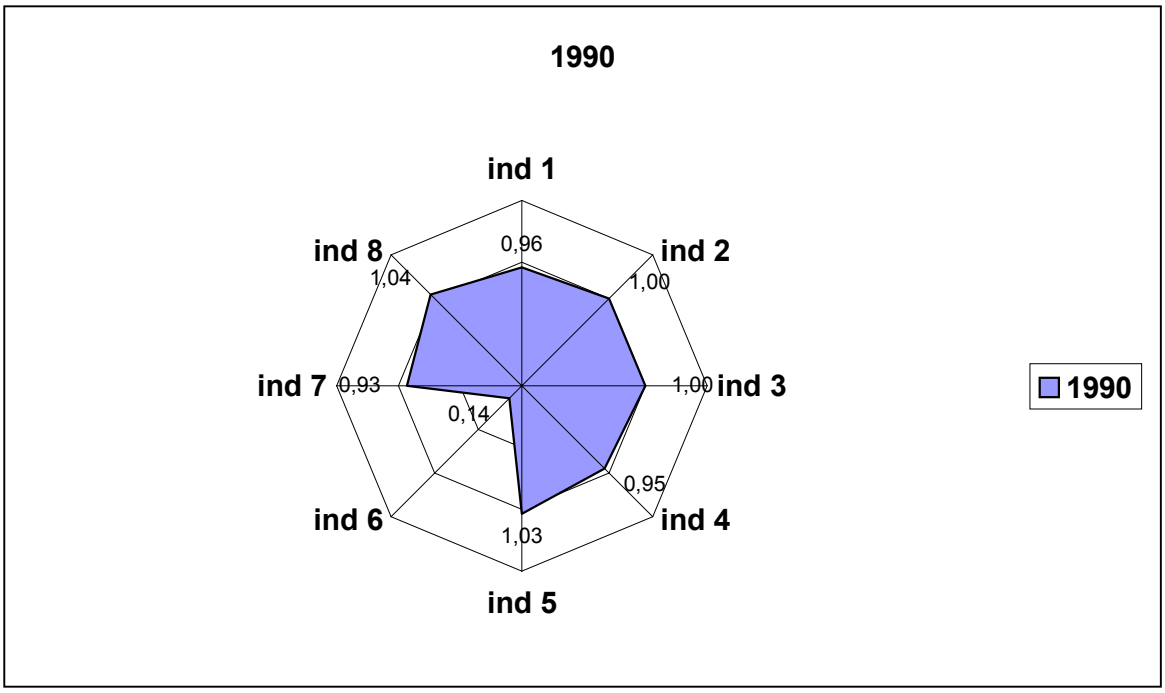
▸Indicator 8: Deployment of Renewables

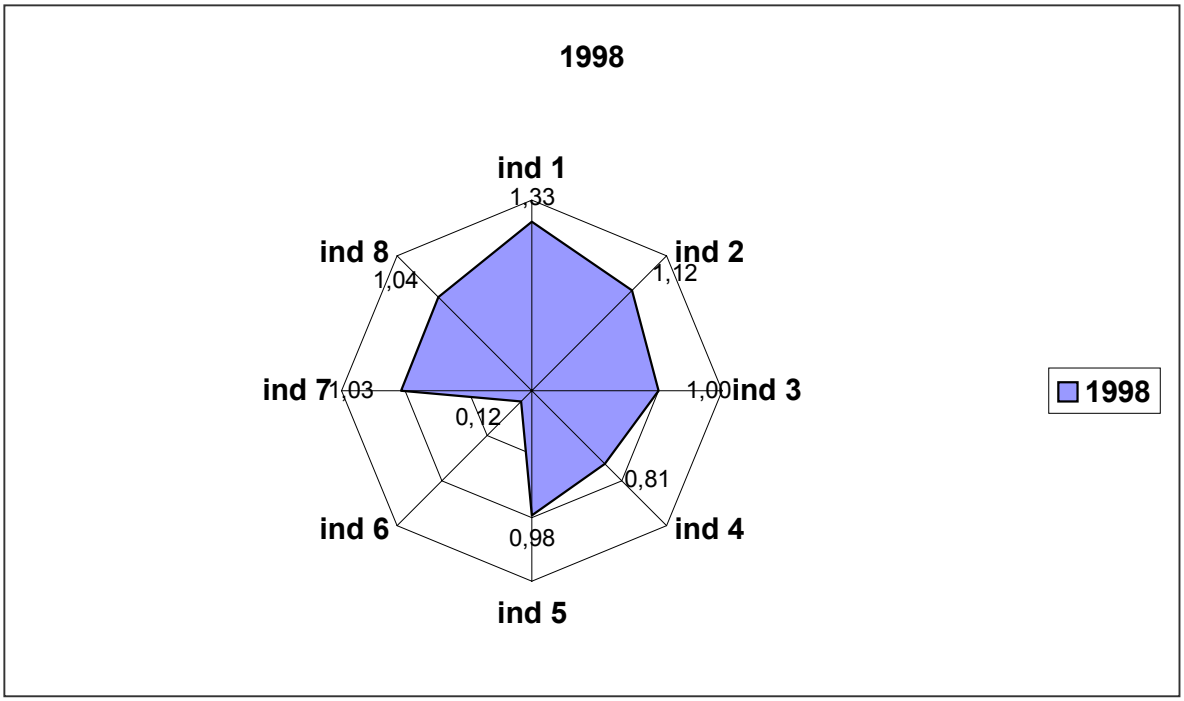
	Primary Energy Consumption	Renewable Energy Production		ind 8
	(in ktoe)	(in ktoe)		
1990	16410	800	0.05	1.043596
1991	16604	790	0.05	1.044953
1992	17781	437	0.02	1.071588
1993	17529	753	0.04	1.050304
1994	18083	925	0.05	1.040814
1995	19165	732	0.04	1.055819
1996	19087	1284	0.07	1.02215
1997	20581	1141	0.06	1.035851
1998	21863	1135	0.05	1.039933

The figures above include large hydroelectrical power stations. It was not possible to get a breakdown of hydroelectrical power plants into small and large-hydro. It can be safely assumed that "new renewables constitute only a tiny fraction of the total, as is patent in the graph included in the General Discussion. The graph below exemplifies the situation at the end of 1998, in terms of established generation capacity:



Portugal Star





Conclusions

The current report tries to portray, in abridged form, the challenge of sustainability for the Portuguese energy system. It is clear from what has been reported that the Portuguese energy system, far from being sustainable, has in fact, diverged from sustainable patterns over the period researched. Energy intensity increased (almost uniquely in the OECD), per capita emissions grew at unprecedented pace, and the switch to more sustainable forms of energy production, to put it simply, did not take place.
Current developments, while encouraging, have certainly not changed the overall picture as reflected in these eight indicators. This picture, far from being an environmental, marginal concern, should be at the core of every policy in Portugal in the coming years. It is now clear that consumption patterns in Portugal, in particular, the transport sector and the services sector must somehow face up to the challenge of sustainability.

Sources

- All statistics, except those for Indicator 7 from:

DGE(1997) – Informacao Energia n.22/23, Direccao-Geral de Energia, Lisbon, Portugal

-Information on Indicator 7 (energy intensity) from:

IEA Energy Policy Review 2000 – Portugal