Energy conservation indicators in Southern Mediterranean countries

Country report for Morocco

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Preface

The design, the implementation and the monitoring of national energy policies require relevant indicators reflecting the energy use performances at macro and sector level. Moreover, for developing countries the implementation of information systems on energy and greenhouse gas emissions indicators will be a key condition for the development of new mitigation financing mechanisms (NAMAs, sectoral mechanism, etc.) currently under negotiations for the new international climate governance regime. In fact these mechanisms will need Measures, Reporting and Verification systems (MRV) to prove the integrity of these actions. Also, for the Arab League States Energy Efficiency Directive, such indicators are crucial for the monitoring and the assessment of the National Energy Efficiency Action Plans (NEEAPs). For these reasons and based on European experiences (ODYSSEE), PLAN BLEU, in cooperation with RCREEE and with the support of MED-ENEC, has launched the current Energy Efficiency Indicators Project in ten MENA countries, namely: Morocco, Algeria, Egypt, Lebanon, Syria, Jordan, Libya, Palestine, Tunisia and Yemen as a tenth member state of RCREEE. This project is aiming at i) strengthening the capacities of these countries in monitoring their energy policies by using the energy efficiency indicators approach ii) building and interpreting a range of basic common indicators for the region.

The project was carried out according to a two years process based on specific methodology including:

- A Participative approach associating national public and private experts
  - 4 workshops and working sessions held in Tunisia, Egypt, France and Morocco;
  - Selection, by the participants, of the common indicators to be developed in the project, based on the data availability and the relevancy for the country;
  - Technical assistance throughout the project provided by the regional coordination.
- Capacity building through " learning by doing" and experience exchanges
  - Data collection by the national experts with the support of RCREEE focal points, strengthening the cooperation between public and private experts;
  - Common development of a simplified calculation tool for data collection and indicators' calculation used by the experts;
  - Development of capacity for analysis and interpretation of energy indicators by national experts;
  - Country reports developed by the national teams.
- Dissemination of the results and the learned lessons
  - Organization of final seminar for the decision-makers in June 2012;
  - Publication and wide dissemination of the results recorded in flyers, national and regional reports.

The project was coordinated by:

- Plan Bleu: Ferdinand Costes, El Habib El Andaloussi
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The current work has needed a large set of socio-economic, energy and environment data that were not easy to collect. Some of them may not be accurate because were estimated on the base of own hypothesis. Hence, the author would like to draw the reader's attention to the necessity to use the results of this work with the required precaution.

I would like to thank Mrs Aicha Lâabdaoui, focal point of RCREEE, for the efforts she made for collecting data and for her valuable support to this work. My deep gratitude is also expressed to my colleagues of different departments for their assistance to data access. Finally, I would like to thank Plan Bleu and RCREEE for giving the opportunity to do this work, all the national experts and focal points for the mutual exchanges of experiences and knowledge and Alcor team for its assistance and guidance.

List of abbreviations

DW: Dwellings

GDP current price: Gross Domestic Product

GDP 1998: Gross Domestic Product constant price 1998

GWH: Gega Watt-hours

Goe: Gram Oil Equivalent

Kgoe: Kilogram Oil Equivalent

Ktoe: Kiloton Oil Equivalent

MAD: Moroccan Dirham

MWH: Mega Watt-hours

TCO_2: Ton Equivalent CO_2

TOE: Ton Oil Equivalent

TWH: Tera Watt-hours

US$: United States Dollars

I. Country general background

Morocco's population as of 2010 was 31,972 million, and is expected to grow to 33,353 million by 2015. Current (2010) unemployment in Morocco is 9.6%, down from almost 12% in 2005.

Morocco's economic growth is far more diversified, with new service and industrial centres such as Casablanca or Tangier. The agriculture sector is being rehabilitated, and in combination with good rainfall led to agricultural sector growth of over 17.1% in 2010.

In 2010, Morocco's GDP was US$ 91.702 billion, growing at 4% per year. Forecasts for 2015 predict Morocco's GDP to reach US$ 125.651 billion, growing about 7% per year between 2010 and 2015.

Consumption of primary energy in Morocco rises to 15 million tons of oil equivalent (TOE) in 2009 growing up with around 1.05% compared to 2008, driven by the increase in electricity consumption (3.5%).

Morocco is currently importing over 98% (98.6% in 2008 and 97.8% in 2009) of its total energy needs due to the scarcity of its own resources. Such dependence on outside combined with the upward trend in the prices of energy commodities, including oil, which accounts for nearly 60% of the total energy consumption, weighs heavily on the country's finances. The energy bill amounted to about MAD 21 billion in 2003, to MAD 52 billion in 2007 and to nearly MAD 70 billion in 2008 with soaring crude prices. Then, it dropped to 50.6 billion in 2009. The share of oil in the energy bill represents over 85% of these amounts.

To reduce the impact of escalating prices on consumers and the productive sectors, the Government's budget support to petroleum products has risen from about MAD 700 million in 2003 to over MAD 24.7 billion in 2008 before dropping to MAD 7.35 billion in 2009.

II. Strategies and objectives for renewable energies and energy efficiency

By 2030, primary energy demand would reach 35 to 40 million toe in case of no rigorous energy efficiency policy. It would fall in the range of 27-32 million Toe if all energy saving measures are applied. Meanwhile and taking into account the impacts of energy efficiency measures, power consumption, which was 22.4 TWh in 2009, could culminate to 52 TWh for the low scenario, 60 TWh average scenario or 70 TWh for a high scenario demand scenario.

To control the future of energy in Morocco, a new energy strategy was developed based on realistic economic and technological options. The Moroccan Energy Strategy, which is part of the comprehensive and integrated vision of sustainable development, aims at meeting the growing energy demand while preserving environment and reducing energy dependency of the country. It plans to build a diversified and balanced energy mix integrating significant share of renewables and focusing on energy efficiency.

Within this framework, Morocco launched two integrated renewable energy programs:

- The Moroccan Solar Plan which is aiming at establishing in 2020 a solar capacity of 2,000 megawatts, with an annual production capacity of 4,500 GWh.
- The wind program with the objective of 2,000 megawatts in of 2020, allowing an annual production of 6,600 GWh.

Upon completion of these 2 programs, the share of renewables in the total installed power generation capacity will be increased to 42% including solar (14%), wind (14%) and hydropower (14%). This objective may allow an annual saving of 2.5 Mtoe of primary energy and avoid 9 million MteCO_2 of GHG emissions.

For energy efficiency, the objective of the Moroccan Government is to achieve energy savings of 12% of primary energy consumption by 2020 and 15% in 2030 by improving efficiency at end use sectors. These measures will include mainly efficient lighting, solar water heater diffusion, energy building regulation, energy audits in industry and tertiary sectors, etc.

III. Data collection process

Publications of the Ministry of Energy, Mines, Water and Environment, in particular key statistics of Moroccan Energy Sector, the document of the energy strategy, annual progress reports of the Ministry and the assessment of solar water heaters development program are the main sources of information for this study. With regard to socioeconomic data, the sources are the statistical yearbooks of the High Commission for Planning and the Ministry of Economy and Finance.

The main sources of data collection are summarized in the following table.

1. Main sources of data

Institution name	Address	Tel and fax	Email and Website
Agence Nationale de Développement des Energies Renouvelables et de l'Efficacité Energétique	Rue Abou Marouane Essaadi BP : Rabat Instituts 6208 - Haut Agdal - Rabat - Maroc	Tél: +212-537-68-88-57 Fax: +212-537-68-88-63	www.aderee.ma
Haut Commissariat au Plan	Ilot 31-3, HAY RIAD, RABAT – MAROC, BP : 178 – 10001	Tél : +212-537-76-57-29 Fax : +212-537-57-69-02	www.hcp.ma
Ministère de l'Energie, des Mines, de l'Eau et de l'Environnement	Rue Abou Marouane Essaadi BP : Rabat Instituts 6208 - Haut Agdal - Rabat - Maroc	Tél : +212-537-68-88-57 Fax : +212-537-68-88-63	www.mem.gov.ma
Ministère de l'Agriculture et de la Pêche Maritime	Avenue Mohamed V, Quartier Administratif-Place Abdellah Chefchaouni, BP: 607, Rabat	Tél : +212-37-76-01-02 Fax : +212-37-76-38-78	www.madrpm.gov.ma
Ministère de l'Industrie, du Commerce et des Nouvelles Technologies	Avenue Mohammed V, quartier Administratif ,10000 - RABAT- Chellah	Tél : +212 37-76-18-68	www.mcinet.gov.ma
Ministère de l'Economie et des Finances	Avenue Mohammed V, quartier Administratif, 10000 - RABAT - Chellah	Tél : +212-537-67-75-01/ 08 Fax : +212 -5 37-.67-75-26	www.finances.gov.ma
Ministère de L'équipement et du Transport	Boulevard Ma-Al-Ainine 10000 - RABAT	Tél : +212-537-67-91-04	www.mtpnet.gov.ma
Ministère de l'Habitat, l'Urbanisme et de l'Aménagement de l'Espace	Rues Al Jouaze & Al Joumaize Hay Ryad Secteur 16 - Rabat 10.000	Tél : +212-537-57-70-00 Fax : +212-537-57-73-73	www.mhu.gov.ma
Office National de l'Electricité	65, rue Othman Ben Affane 20000 Casablanca	Tél : +212-522-66-80-80 Fax :+212-522-22-00-38	www.one.ma

2. Data availability

The work required a relatively wide range of data that are not always available. To do this, there are data collected at the authorities concerned or through the available documentation, while others have been estimated. The following table provides an overview of the amount of collected data and their availability.

Sector	Energy data			Socio-economic data			Environmental data		
	Total* number of data	Available data**		Total number of data	Available data		Total number of data	Available data	
		Number	%		Number	%		Number	%
Macro	80	80	100	60	40	67	10	7	70
Transformation sector	140	100	71						
Transport sector	70	50	71	150	90	60	30	21	70
Tertiary sector	40	20	50	50	30	60	10	7	70
Residential sector	30	25	83	70	45	64	10	7	70
Industry sector	80	50	63	130	100	77	10	7	70
Agriculture & fishing	20	10	50	80	60	75			
Total	460	335	73	540	365	68	70	49	70

*: Total number of data expected by the sheet "Energy & socioeconomic data"
**: Total number of data (collected or estimated) filled in the sheet "Energy & socioeconomic data". One value for one year is considered as a data.

3. Major difficulties met during the data collection

Huge challenges remain to overcome for data collection in the country. The statistical system is in net improvement, but it remains quite fragile. We must recognize that general statistics exist in the departments of the concerned institutions, but requires big effort to gather and extract them. But more specific detailed data are not easy to find. Sometime, only estimation can help to complete some information, with the inevitable risk of error.

IV. Indicator's calculation

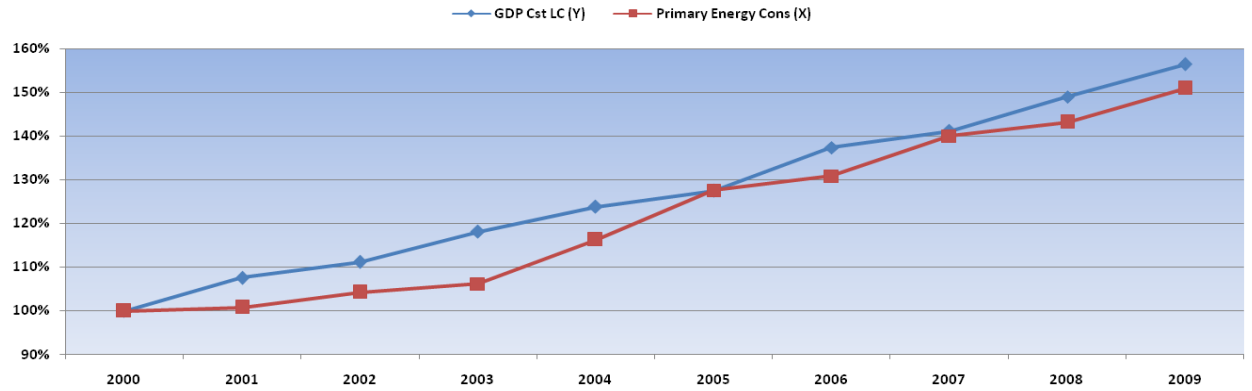
1. Macro level indicators

The indicators calculated by the tool model are given below:

Abbreviation	Indicators	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
EDR	Energy dependence Ratio	%	98.50%	98.50%	98.50%	98.10%	98.00%	98.50%	98.30%	98.50%	98.60%	97.80%
IPE	Intensity of Primary Energy	Toe/1000MAD	0.0254	0.0237	0.0238	0.0228	0.0238	0.0254	0.0242	0.0252	0.0244	0.0245
IFE	Intensity of Final Energy	Toe/1000 MAD	0.0185	0.0179	0.0181	0.018	0.0179	0.0188	0.0182	0.0185	0.0186	0.0182
RFEPE	Ratio of final energy consumption to primary energy	%	73%	75%	76%	79%	75%	74%	75%	73%	76%	74%
REB	Ratio of National Energy Bill to GDP	%	5.20%	4.10%	4.00%	3.90%	5.10%	7.10%	7.50%	7.70%	9.10%	5.70%
RPSE	Ratio of public subsidies for energy to GDP	%					0.70%	1.40%	1.30%	1.70%	3.60%	1.00%
AEF	Average emission factor	$TteCO_2/Toe$	3.37	3.48	3.47	3.39	3.35	3.34	3.29	3.25	3.18	3.11
ACEF	Average per capita emission factor	$TeCO_2/hab$	1.2	1.2	1.2	1.2	1.3	1.4	1.4	1.5	1.5	1.5
ICO2	Intensity of CO_2	$TeCO_2$ / 1000 MAD	0.085	0.083	0.082	0.077	0.08	0.085	0.08	0.082	0.077	0.076
AECH	Average Primary Energy Consumption per habitant	KToe/1000 hab	0.35	0.348	0.355	0.358	0.388	0.421	0.427	0.452	0.457	0.477
AELCH	Average Electricity Consumption per habitant	KWh/hab	444	461	479	512	546	584	631	666	694	710

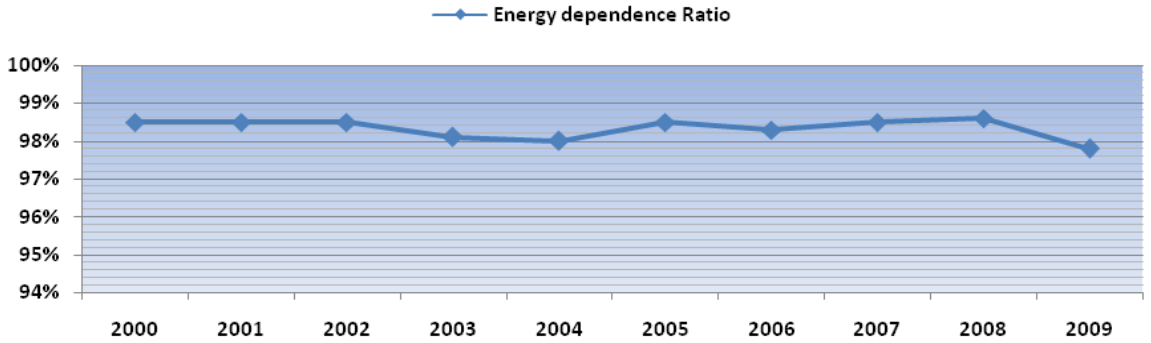
First, we can see during the study period a continuous evolution of GDP and consumption of primary energy with almost the same growth rate, as shown by the following chart (Figure 1). It's showing that economic growth continues to depend on the consumption of primary energy. This means that the decoupling between the two variables is not yet succeeded.

Figure 1 - Evolution of GDP & Primary Energy Consumption



Morocco is a non-producer of fossil fuel and imports most of its energy domestic needs. Therefore the dependency ratio is very high (Figure 2). This confirms the almost total dependence of Morocco on the import of energy products, particularly crude oil. A better recovery is seen in 2009 due to the contribution of wind energy and the contribution of hydropower.

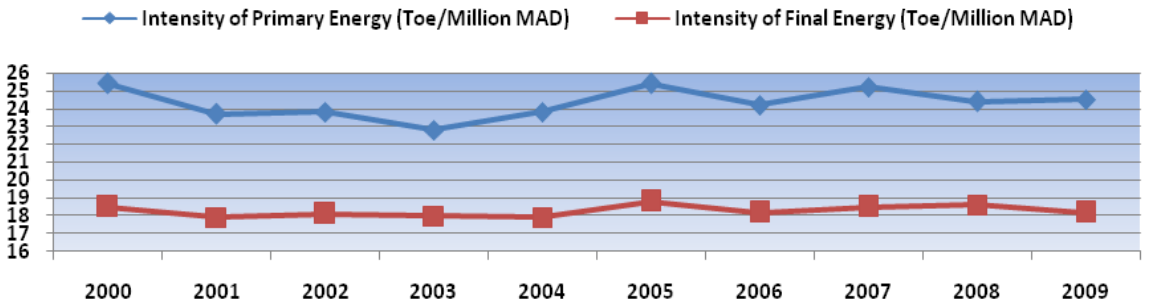
Figure 2 - Energy Dependence Ratio



On the other side, the Energy intensity witch obviously depends on some factors such the structure of the economy, the socio-economic level and the climate conditions (more it's colder, more we consume energy for heating for equal economic level) has recorded interesting levels.

Separately, the Intensity of Primary Energy[1] declined from 2000 to 2004, and then rebounded slightly in 2005, reaching 24.5 Toe/Million MAD. The Intensity of Final Energy is almost constant during the study period; its value is nearly about 18 Toe/Million MAD (Figure 3).

Figure 3 - Final &Primary Energy Intensities



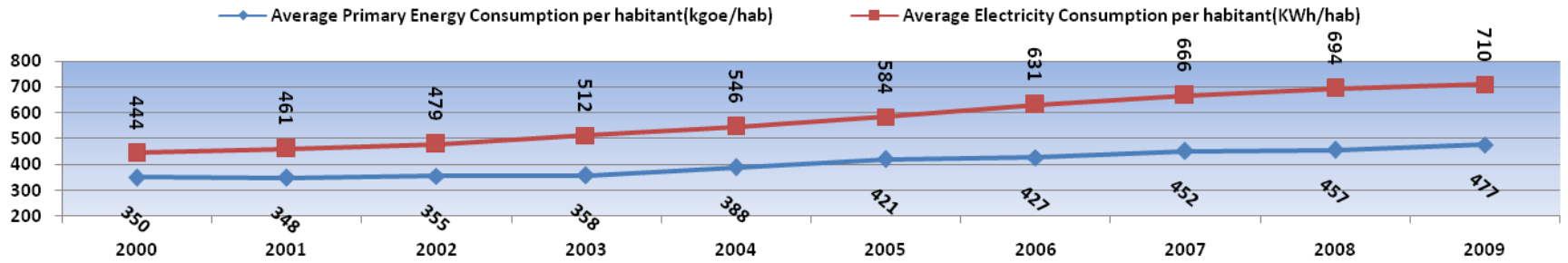
[1] GDP Constante price 1998.

The positive ratio of the final energy to the primary energy is mainly due to increased imports of refined products and electricity during the study period. The peak of 2003 could be attributed to the peak in imports following the great fire of Mohammedia refinery.

It should be noted that population continues to consume a lot of biomass that is not accounted in the official energy statistics. It shows to some extent why the energy intensities and also the energy consumption per capita are still relatively low. The former, has increased from 350 kgoe / capita in 2000 to 477 kgoe / capita in 2009, so an average annual increase of about 3.50%.

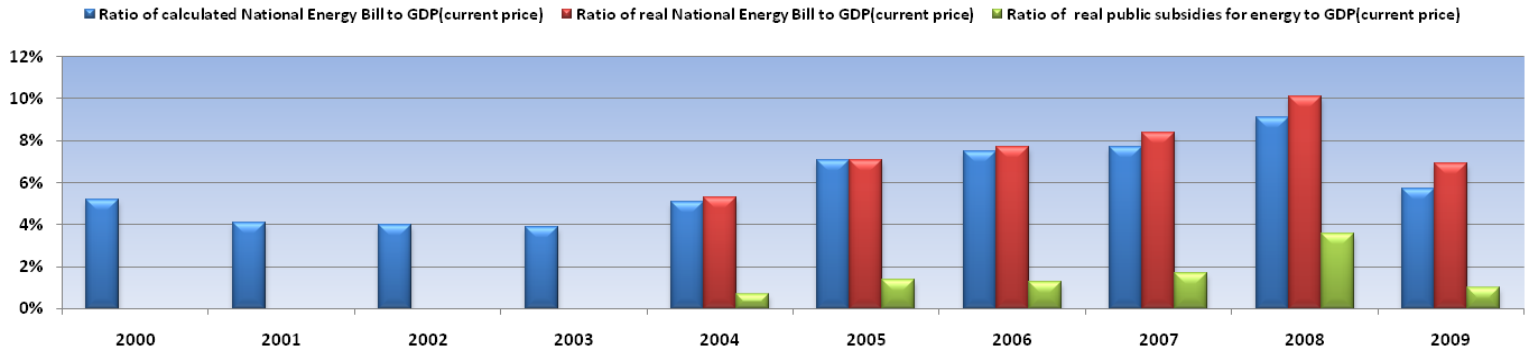
For the same period, the electricity has increased from 444 kWh /capita to 710 kWh /capita (Figure 4), corresponding to an average annual rate of nearly 5.4%. The electricity consumption per capita, despite its growth, because of widespread rural electrification, economic growth and urbanization tendency, remains relatively limited compared to other countries. High Electricity prices remain the major reason of the unitary consumption.

Figure 4 - Average Energy & Electricity Consumption per Capita



This energy Bill weighs heavily on the economy of the country and reached its peak in 2008. The Real National Energy Bill is shown in red from the year 2004, against the bill calculated by the model which is shown in blue throughout the study period. On the same chart, it's also postponed the share of subsidies reached 3.6% of GDP and are becoming a real problem for the state budget.

Figure 5 - Ratios of National Energy Bill & Public Subsidies to GDP



Finally, the average emission factor continues to decline between 2000 and 2009 from 3.37 to 3.11 $TeCO_2$/Toe. The value of 2009 is due mainly to the development of renewable energy. & hydro. CO_2 emissions per capita go from 1.2 in 2000 to 1.5 $TeCO_2$/ hab. in 2009, which is still low compared to world average ratio of around 4 $teCO_2$ per capita.

2. Energy transformation sector indicators

The indicators calculated by the tool model are given below:

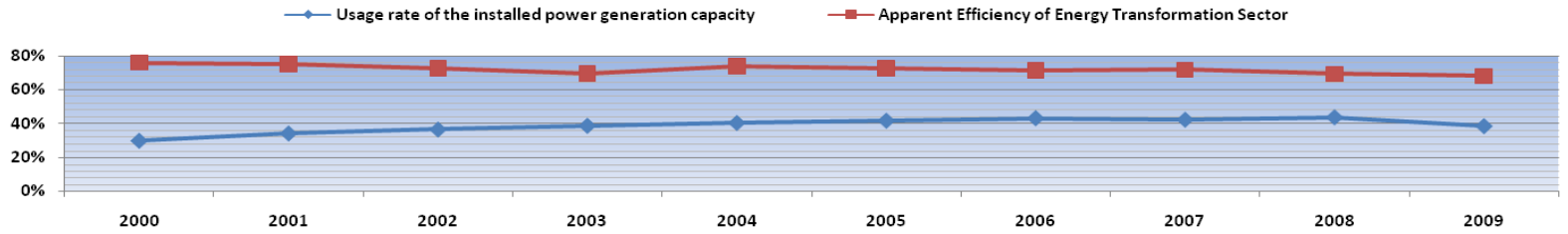
Abbreviation	Indicators	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
SREC	Share of installed RE electricity capacity	%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	2.3%	2.3%	4.6%
URIC	Usage rate of the installed power generation capacity	%	30.0%	34.3%	36.6%	38.8%	40.5%	41.8%	43.3%	42.4%	43.8%	38.6%
AETS	Apparent Efficiency of Energy Transformation Sector	%	75.9%	75.1%	72.7%	69.6%	73.9%	72.6%	71.3%	71.7%	69.1%	68.1%
PGEFF	Power generation efficiency of thermal plants	%	36.0%	36.5%	35.8%	35.5%	34.0%	34.3%	34.7%	35.1%	34.8%	35.4%
SCFFP	Specific Consumption of thermal power plants	Toe/GWh	239	236	240	242	253	251	248	245	247	243
PGF	Power generation efficiency	%	38.6%	39.7%	38.6%	39.7%	38.2%	37.5%	38.1%	38.2%	37.9%	42.2%
SCPG	Specific Consumption of Power Generation	Toe/GWh	223	217	223	216	225	229	226	225	227	204
TDEE	Transmission and Distribution Electricity system Efficiency	%	0.91	0.9	0.9	0.9	0.91	0.9	0.91	0.91	0.9	0.89
PGEF	Power Generation Emission Factor	$TeCO_2$/GWh	912	825	799	793	785	727	758	805	804	785
ESEF	Electricity Sector Emission Factor	$TeCO_2$/GWh	833	820	806	805	790	790	781	770	755	728

During the period 2003-2007, electricity demand grew by 8% annually, due to the almost generalized access to electricity and economic growth, producing a pressure on supply. As a result, the satisfaction of the electricity demand has become structurally dependent on the electrical interconnection with Spain.

Moroccan power system has an important hydroelectric capacity mobilized during the peak period only, that explain the level of the usage rate of the installed power generation capacity (Figure 6).

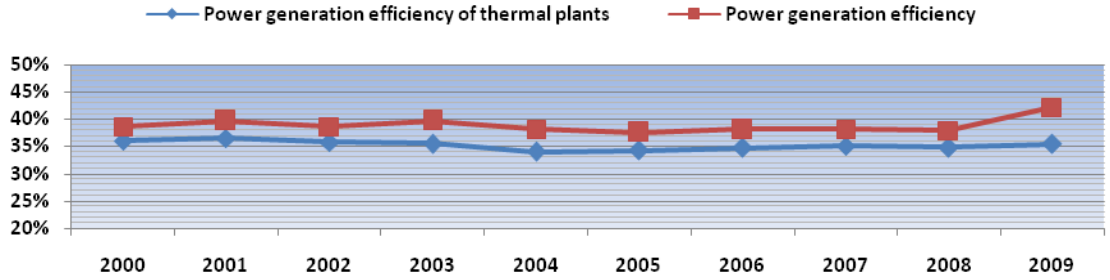
On the same graph, it's observed a fluctuation in Apparent of Efficiency of Energy Transformation Sector. In 10 years, there is a loss of about 8 points that can be explained by the oldness of the power generation means.

Figure 6 - Usage of the Installed Power Generation Capacity & Apparent Efficiency of Transformation Sector



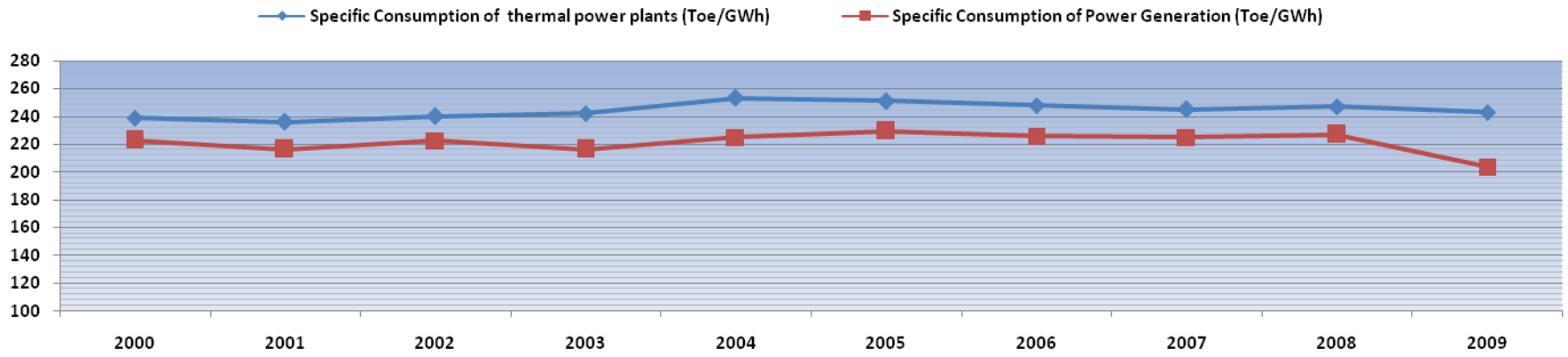
In term of operation, the performance of the Power Generation is around 38 %, except for 2009 when there was a significant increase notably following the significant electricity generation from renewable energy (hydro and wind). The performance of thermal power plants is between 34% and 36% (Figure 7).

Figure 7 - Power Generation Efficiency & Power Generation Efficiency of Thermal Plants



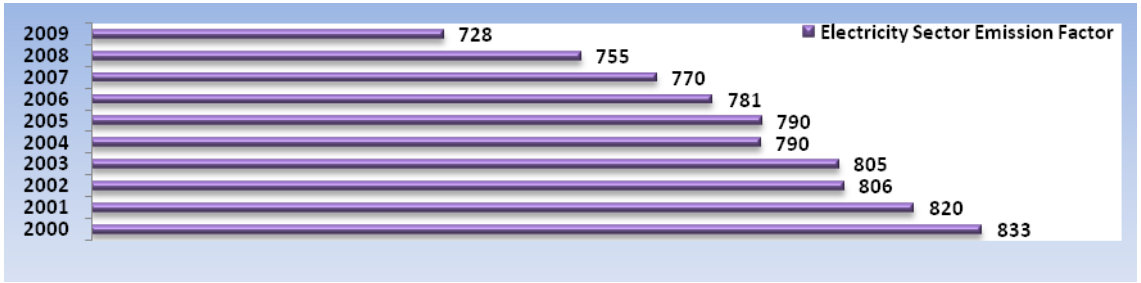
The Specific Consumption of Power Generation & Specific Consumption of Thermal Power Plants is represented in the following graph (Figure 8). For the Thermal Power Plants, the Specific Consumption in about on average 244 g/KWh, against a theoretical consumption of 213 g/KWh. This would mean that the operating system have relatively good performance.

Figure 8 - Specific Consumption of Power Generation & Specific Consumption of Thermal Power Plants



A sustained fall in CO_2 emissions per kWh electricity produced between 2000 and 2009, rising from 833 g / kWh in 2000 to 728 g / kWh in 2009 (Figure 9). This reduction is due to the development of renewable energies & Hydro in Morocco during this period.

Figure 9 - Electricity Sector Emission Factor



3. Industry sector indicators

The indicators calculated by the tool model are given below:

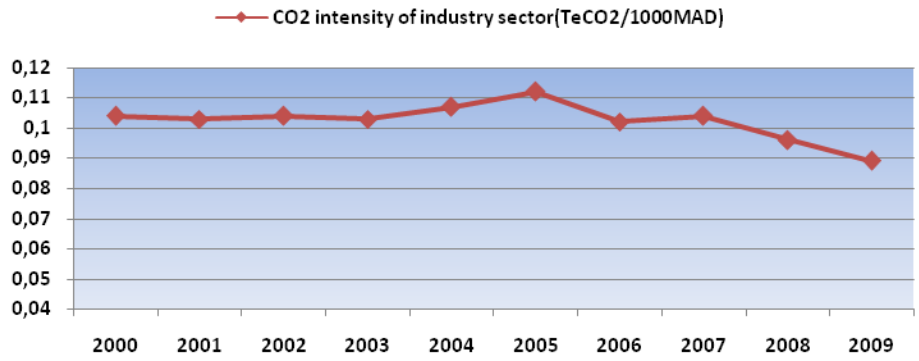
Abbreviation	Indicators	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BSEC	*Specific energy consumption for the Cement*	Toe/T	0.148	0.146	0.141	0.133	0.135	0.13	0.105	0.091	0.09	0.088
	Specific energy consumption for the Phosphate		0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
	Specific energy consumption for the Phosphoric acid		0.025	0.025	0.026	0.027	0.026	0.026	0.031	0.032	0.037	0.036
	Specific energy consumption for the T. Super Phosphate		0.026	0.025	0.028	0.03	0.033	0.035	0.034	0.036	0.046	0.045
	Specific energy consumption for the Steel		0.092	0.088	0.082	0.078	0.074	0.07	0.066	0.063	0.056	0.053
	Specific energy consumption for the Paper		0.496	0.494	0.491	0.492	0.49	0.494	0.488	0.494	0.495	0.498
	Specific energy consumption for the Sugar		0.173	0.174	0.185	0.183	0.177	0.184	0.187	0.179	0.182	0.189
FEIIS	Final Energy Intensity of Industry Sector	Toe/1000 MAD	0.019	0.019	0.019	0.02	0.02	0.021	0.019	0.02	0.019	0.018
IEBR	Ratio of Industry sector Energy Bill to Added Value	%	9%	10%	10%	11%	10%	10%	10%	9%	10%	10%
$IICO_2$	CO_2 intensity of industry sector	$TeCO_2$/ 1000 MAD	0.104	0.103	0.104	0.103	0.107	0.112	0.102	0.104	0.096	0.089
IAEF	Average emission factor of industry sector	$TeCO_2$/Toe	5.54	5.53	5.47	5.15	5.35	5.43	5.25	5.32	5.01	5.02

Potential available in Morocco are likely to enable the industry to play a locomotive role in economic growth. A business environment is constantly improving and closes to the European market. Support industrial sector has shown in recent years by enactment of the Charter Investment and Commercial Code, the revision of the Customs Code and indirect taxes, the establishment of commercial courts, etc.

The sector contribution to GDP is about 24-25% and part of total of energy consumption is around 24-26%. Outside of some public institutions, the sector is virtually privatized.

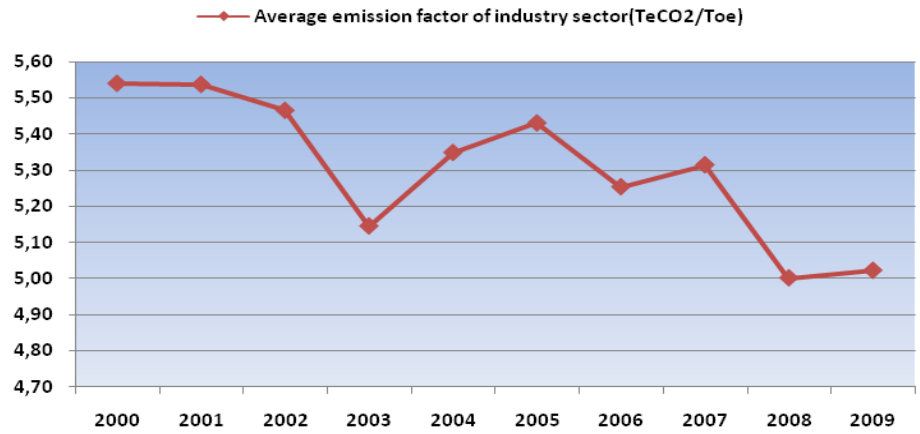
The final energy intensity of industry sector is relatively low; less than 0.02 Toe is enough to produce 1000 MAD of value added for the sector (Figure 10).

Figure 10 - CO_2 intensity of Industry Sector



On another level, the average emission factor is steadily declining. It went from 5.5 in 2000 to 5 TCO_2/toe in 2009, corresponding to an average annual decrease of almost less than 1.1% (Figure 11). The factor of technological change and the evolution towards high value added industries could be an explaining for this trend, in addition to the efforts related to achieving greater energy efficiency.

Figure 11 - Average Emission Factor of Industry Sector



In general, Moroccan industry is well managed by engineers and senior executives. For example, the cement industry, the OCP and the metallurgical, mechanical and electromechanical industries are competitive and adequately managing their consumption of energy.

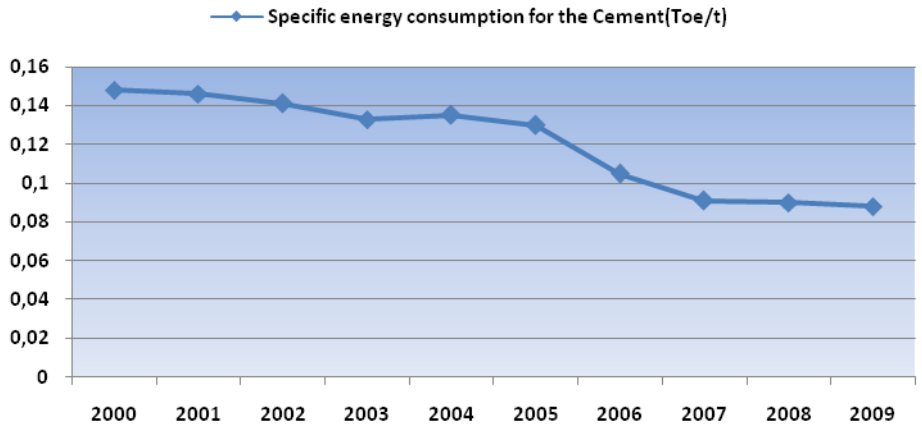
The cement industry in Morocco is a major player since it significantly contributes to the GDP. The sector, mainly in the hand of international groups, has seen major investments covering either the creation of new production units, either the expansion or refurbishment of existing facilities but also on improving the economic efficiency of all facilities for optimal management of resources.

The substantial efforts were made to have a rational use of raw materials and fuels, and a marked improvement in productivity and energy consumption ratios. In this regard, there has to be noted:

- The switch from heavy fuel oil and coal to petroleum coke;
- The improvement of the rate of additives in the cement (cements / clinker ratio);
- The use of waste and industrial by-products: fly ash, ash pyrrhotines, shredded tires, waste oil, etc;
- The organization and operation of the quarry rehabilitation,
- The introduction of self-electricity generation from renewable energy (wind energy farm of Lafarge).

These factors have contributed to significant reductions of energy consumption allowing passing specific consumption from 0,144 to 0,088 Toe/T (Figure 12).

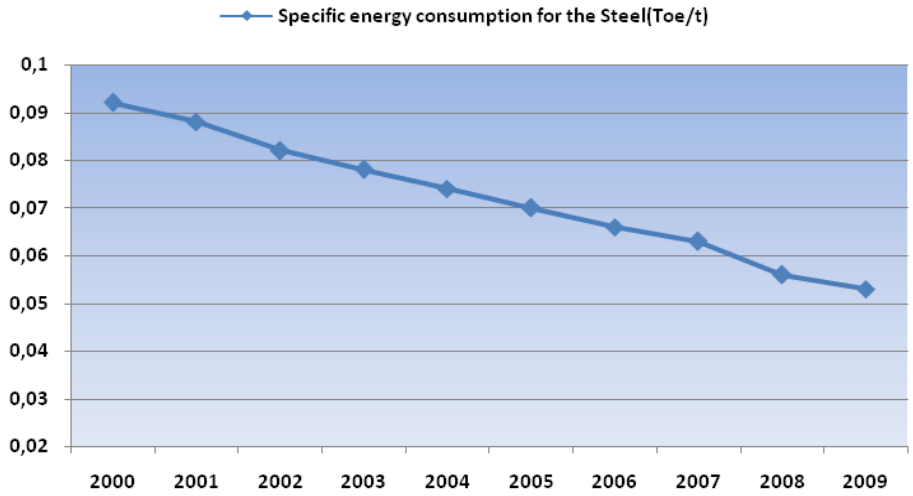
Figure 12 - Specific Energy consumption for the cement



The iron and steel market in Morocco have an annual increase of 10% due to the dynamics of the construction industry which remains among one of the largest consumers of iron for years. The sector is headed by a professional organization which oversees defend its interests (the Federation of metallurgical, mechanical and electromechanical).

The following graph (Figure 13) reflects the evolution of specific consumption of all the metallurgical, mechanical and ectro-mechanical industries (**IMME**). This specific consumption may seem relatively low compared to international benchmark, because of the previous precision. But it's also possible that the calculation takes account of annual sales instead of annual production.

Figure 13 - Specific Energy Consumption for the Steel (IMME)



Notes : Indicators of the phosphate industry are not represented nor discussed because of errors that may exist on the tonnage produced annually (errors relating to stock, for example). But also, biases may be committed on energy consumption, due to the fact that the OCP produces part of its consumption and that consumption of the energy needed to produce phosphoric acid and fertilizers is not ventilated. Ditto for sugar and paper.

4. Tertiary sector indicators

The calculation results of the different indicators are given in the following table:

Abbreviation	Indicators	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
FEITS	Final Energy Intensity of Tertiary Sector	Toe/1000 MAD	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.001
TDRSHR	Diffusion Rate of Solar Water Heaters in tertiary sector	m²/1000 hab	0.283	0.395	0.467	0.59	0.735	0.826	1.01	1.226	1.482	1.836
HECNG	Energy Consumption per night guest	Kgoe/Nigh Guest	3.102	3.363	3.688	3.956	3.992	3.945	4.038	4.144	4.34	4.495
$TICO_2$	CO_2 intensity of tertiary sector	$TeCO_2$/ 1000 MAD	0.5	0.49	0.48	0.46	0.5	0.5	0.52	0.53	0.47	0.47
TAEF	Average emission factor	$TeCO_2$/Toe	3.46	3.46	3.42	3.22	3.34	3.40	3.28	3.32	3.12	3.14

The tertiary sector includes all activities outside the primary and secondary sectors and which can be linked to activities provision of intangible assets for individuals, communities or businesses. This sector includes market services and non-market, including trade (wholesale and retail), business and auto

repair, rental and leasing real estate, posts and telecommunications, insurance, tourism, health services, and finally the services offered by the government. The tertiary sector generates near 50% of GDP.

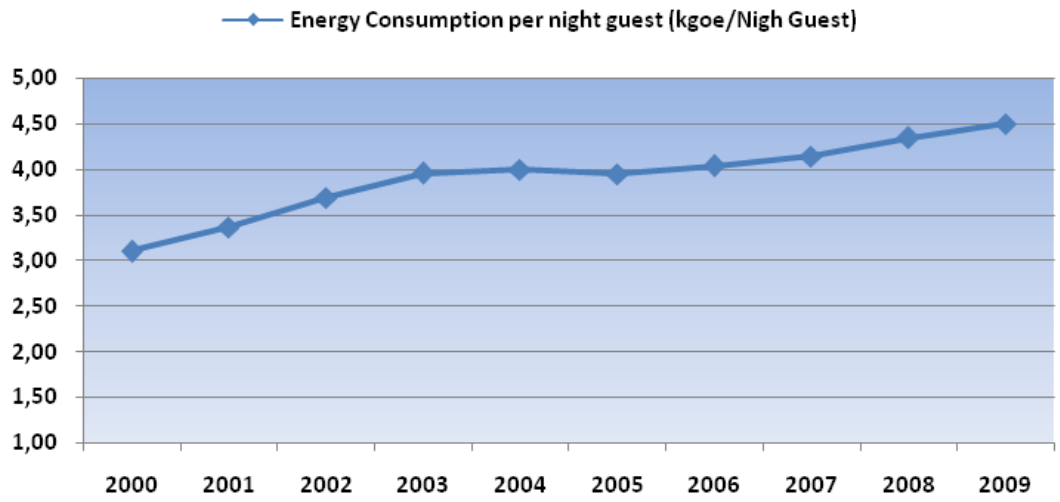
It seems that the energy intensity is relatively low. It does not exceed 1 kgoe to produce 1000 MAD of added value. Almost all of the energy consumption in the tertiary sector is electrical. Electricity consumption and the sector's activity increase with the same rate (6.3% for electricity consumption and 6% for the GDP).

The equipment rate in solar water heater is still low. This rate increased in 10 years of 0.28 to 1.84 m^2 per 1,000 inhabitants. This means that there is still large potential for development that must be seized.

On another level, the CO_2 intensity is continued decline from 5 in 2000 to 4.7 $kgeCO_2$ in 2009. The same trend is observed for the average emission factor which declined by 3.46 to 3.14 $TeCO_2$/Toe.

For the hotels branch where the trend was much more estimated on the basis of audit results, the consumption per night ranges from 3.1 to 4.5 kgoe/Nigh Guest (Figure 14). This indicator increasing by 4.2% per year can be attributed to several factors that included the decline in overnight stays, the increase of hotel units, increasing facilities of existing units, improving of the quality recessed with respect to the required standards.

Figure 14 - Energy Consumption per night guest



5. Residential sector indicators

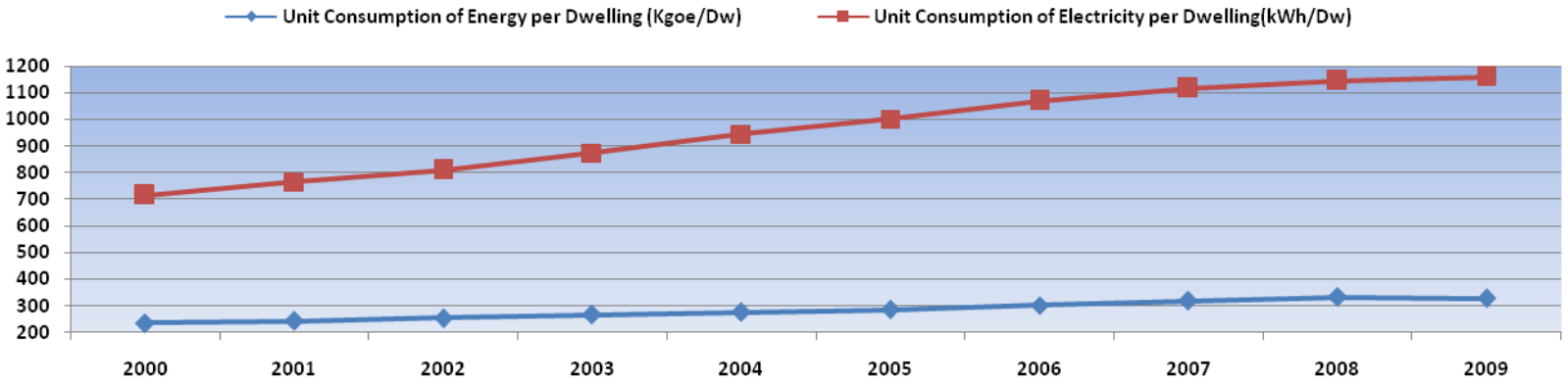
The calculation results of the different indicators are given in the following table:

Abbreviation	Indicators	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
UCED	Unit Consumption of Energy per Dwelling	Kgoe/Dw	235	243	254	267	277	286	302	319	332	329
SCEM²	Specific Consumption of Energy per area unit	Kgoe/m²	2.94	3.04	3.18	3.33	3.46	3.57	3.77	4.00	4.14	4.11
UEICD	Unit Consumption of Electricity per Dwelling	kWh/Dw	716	764	809	874	944	1001	1069	1117	1144	1160
SCEIM²	Specific Consumption of Electricity per m²	kWh/m²	8.9	9.6	10.1	10.9	11.8	12.5	13.4	14	14.3	14.5
RIPE	Intensity of Residential Sector	Kgoe/ 1000MAD	5.17	5.37	5.56	5.68	5.78	5.89	5.95	6.25	6.31	5.96
RAEF	Average emission factor	$TeCO_2$/Toe	3.46	3.46	3.42	3.22	3.34	3.39	3.28	3.32	3.13	3.14
$RICO_2$	CO_2 intensity of residential sector	$KgeCO_2$/ 1000 MAD	17.9	18.6	19	18.3	19.3	20	19.6	20.8	19.7	18.7
RDRSHR	Diffusion Rate of Solar Water Heaters in Residential sector	m²/1000 hab	1.1	1.6	1.9	2.4	2.9	3.3	4	4.9	5.9	7.3
ERACR	Equipment Rate of Air conditioning in Residential sector	Unit/Dw	0.05	0.06	0.06	0.06	0.07	0.08	0.09	0.1	0.12	0.14
ERFR	Equipment Rate of refrigerator in Residential sector	Unit/Dw	0.68	0.68	0.7	0.71	0.73	0.78	0.8	0.81	0.83	0.84

If the overall energy consumption of residential sector is up to 18-19%, the share of electricity consumption is much greater (around 33%). The level of individual consumption is still low, given the modest standard of living and the large number of the population. In the future, it is expected that the electricity consumption will increase rapidly because of the overseen evolution of urbanization in the country.

The Unit Consumption of Energy per Dwelling continue to increase, with an evolution rate of 3.8%/year. Despite this, consumption remains relatively low, around 315 Kgoe/Dw in 2009 (Figure 15). The same goes for the Specific Consumption of Energy per area unit which remains confined to a value of almost 4 kgoe/ m², in 2009.

Figure 15 - Unit Consumption of Energy & Electricity per Dowelling



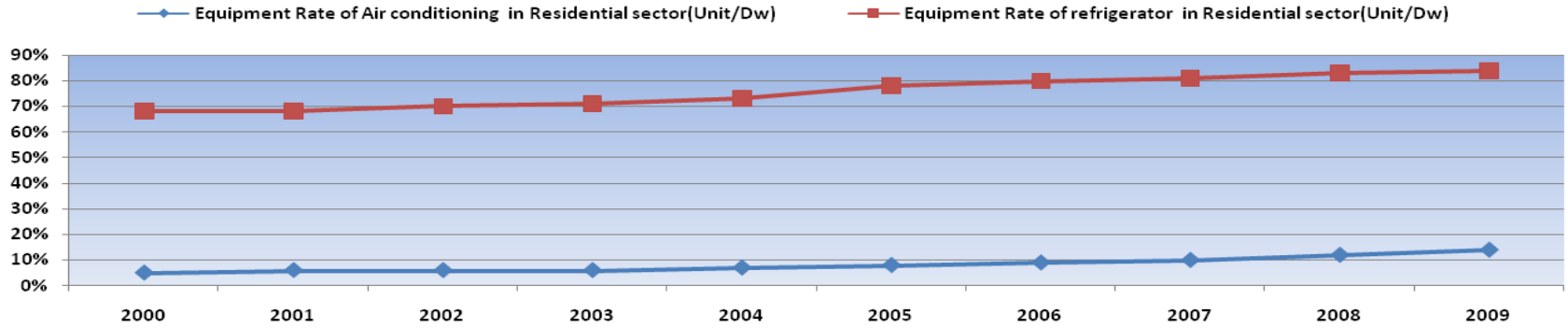
First, it's clear that electricity consumption per household is obtained by the ratio of electricity consumption in the residential sector to the number of households. It should be noted that from 2004, year of the last population census, the number of households is only estimated. And it's possible that there are differences between our calculations and those that the reader is referred to in other studies.

At this level, it's difficult to see the effects related to energy efficiency, due to the overall indicator. The increase in demand for households already equipped and who aspire to other comforts with the arrival of an additional annual demand for new households from the new towns mask the effect of energy efficiency efforts initiated by the government to the attention of the residential sector. Hence, there is a crucial need to monitor the future development of such indicators.

Actually, the Moroccan households remain generally under-equipped:

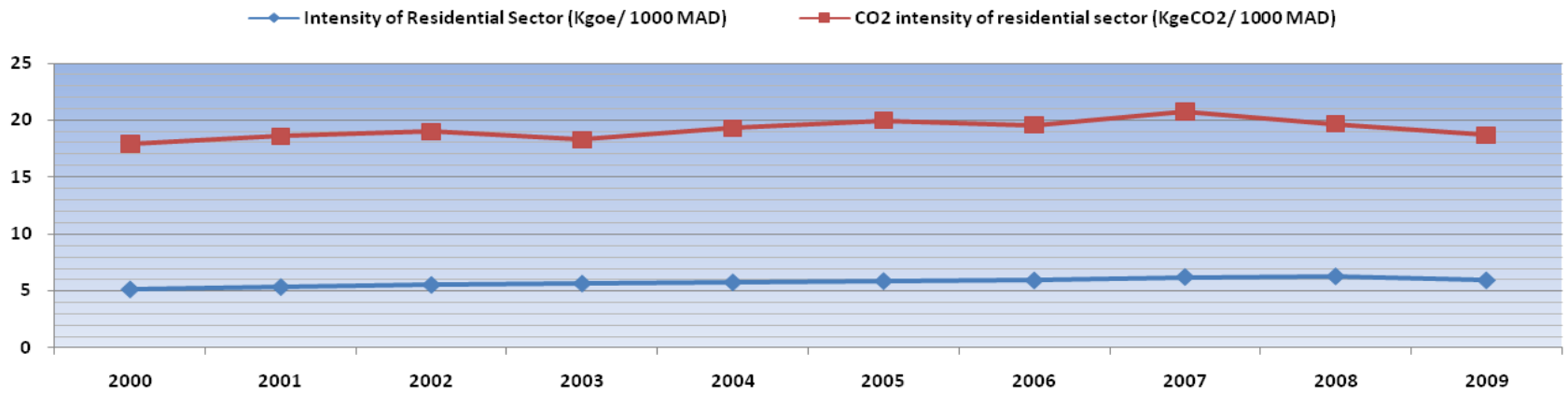
- The Diffusion Rate of Solar water Heaters remains low, only 1.1 m²/1000 hab in 2000 and 7.3 in 2009. The development is significant, but big efforts are still needed. For this, energy strategy provides a program to ensure a wide distribution of Solar water Heater (1.4 million m² in 2020).
- The level of equipment of refrigerator is relatively satisfactory; almost all households have this appliance (Figure 16).
- The equipment Rate of air conditioning is still also low, mainly because of the temperate climate in Morocco, but also because of the limited purchasing power of the Moroccan citizen. However, the development of market of air conditioning is growing quickly the last years (around 150000 units in 2010 because of the decrease of the prices of the imported appliances. This can impact significantly the electricity load demand, particularly when the appliances on the local marked are usually low efficient.

Figure 16 - Equipment Rate



The same pattern of evolution is observed for the energy intensity of households calculated by the ratio of household energy consumption at their expenses at constant dirham, the same trend is observed for the emission intensity, with a slight decrease from of 2008 (Figure 17).

Figure 17 - Residential Sector Intensities



6. Transport sector indicators

The calculation results of the different indicators are given in the following table:

Abbreviation	Indicators	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
TrFEI	Final Energy Intensity of transport sector	toe/1000MAD	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.007	0.007
STEHE	Share of household expenditure for transport	%	4.86%	4.07%	3.82%	4.05%	4.36%	4.46%	4.08%	4.58%	4.94%	5.10%
EUCC	Average Energy Unit Consumption of Cars	Kgeo/car/year	1166	1179	1200	1204	1217	1219	1230	1252	1281	1292
EUCC G	Average Energy Unit Consumption of gasoline Cars	kgeo/car/year	436	436	452	436	436	421	420	452	501	517
EUCC D	Average Energy Unit Consumption of diesel Cars	Kgeo/car/year	2008	2006	2004	2001	1999	1996	1993	1991	1989	1988
SCPC	Specific consumption for private cars	Toe/car/year	1.6	1.6	1.6	1.6	1.5	1.6	1.7	1.6	1.7	1.7
AEFTS	Average emission factor of transport sector	$TeCO_2$/Toe	5.61	5.94	5.47	5.25	5.34	5.81	5.77	6.05	5.38	5.21
MR	Motorization rate	persons / Vehicle	17.50	17.12	16.77	16.47	16.12	15.79	15.41	15.03	14.65	14.19
ICO_2	CO_2 intensity of transport sector	$TeCO_2$/1000MAD	0.036	0.037	0.034	0.031	0.034	0.038	0.036	0.039	0.036	0.035
SCRW	Specific consumption for Rail ways	Goe/ p.km	9.1	9	8.9	8.8	8.8	7.8	7.1	6.5	6.3	5.8
SCAT	Specific consumption for air transport	Goe/ p.km	26	25	24	23	22	21	20	19	18	17
SCMT	Specific consumption for maritime transport	Goe/ t.km	56	54	53	52	50	50	48	46	44	42

The importance of the transport sector can be appreciated through its place in economic and social development. All modes, transportation accounts for over 33-34% of final energy consumption. It employs nearly 10% of the urban labour force.

Road transport in Morocco provides 90% of the mobility of people and 75% of the flow of goods out of phosphate. For its part, the railway transports annually over 32 million tonnes of cargo and nearly 30 million passengers.

Enjoying a long coastline of 3500 km spread over the Atlantic Ocean and the Mediterranean Sea, Morocco has 27 ports and 30 port cities plus the port of Tangiers-Med, ensuring traffic of nearly 70 Million tons and transporting 4 million people.

Morocco has moreover fifteen airports at both national and international transport ensure annually 13 million passengers and 62 million tons of cargo.

The Final energy Intensity of transport sector is approximately constant; it's around 6 Kgoe per MAD 1000 of the GDP at constant price. Another important element is the fact that the Moroccan citizen spends only 4-5% of their income on transport. On the other hand, the average annual consumption of a private car is from 1166 to 1292 Kgoe, which is a reasonable monthly expense, estimated at about 1200 to 1300 MAD. But in terms of energy efficiency, we see some deterioration. The loss in efficiency for road transport has increased by 1.14% per year. The use of old cars and the congestion may partly explain this trend.

The level of car ownership is still low, but clearly increasing. In 10 years, private car ownership increased from 18 to 14 people per vehicle. If we take into account the transport of government, this indicator is expected to be around 11 to 12 people per vehicle. The average unit consumption per vehicle has remained relatively constant over the period: from 1.6 to 1.7 Toe / vehicle. CO_2 emissions for the entire sector were relatively flat. But between the two extreme dates of the period, the gain in efficiency has increased by 0.8% per year (going from 5.61 to 5.21 $TeCO_2$/Toe).

Passenger transport by rail has also gained efficiency. Thus consumption of rail transport has decreased from 9 grams of oil equivalent for a passenger over one kilometre in 2000 to 5.8 goe in 2009. This evolution can be explained by the introduction of appropriate trains for destinations targeted, leading to improved traffic and occupancy rates. However, the rail freight becomes less efficient in energy consumption from 2005.

For the air and maritime transport we faced difficulties to have data, the calculation has not really been done. For the calculation of such indicators the accuracy is problematic. Already for maritime transport, an analysis should be differentiated according to the types of ships and types of goods transported. It would be difficult to treat in the same way a crude oil pipeline and the carriage of a passenger ferry. It would be good to have indicators that address these criteria types of ships, cargo, but also of vessel sizes, in order to best reflect the traffic of goods to or from the territory of Morocco.

Therefore, the figures for these two modes of transport (air and maritime transport) are given in the table above for guidance only.

7. Agriculture and fishing sector indicator

The following table shows the general trend of the indicators calculated by the model.

Abbreviation	Indicators	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
FEIA	Final Energy Intensity of agriculture	Toe/ 1000MAD	0.0294	0.0253	0.0241	0.0206	0.0203	0.025	0.0204	0.027	0.0251	0.0248
FEIF	Final Energy Intensity of fishing	Toe/ 1000MAD	0.0143	0.0139	0.0176	0.0184	0.0204	0.0176	0.0186	0.0225	0.0229	0.0203
SCF	Specific consumption for fishing	Toe/ Ton	0.0875	0.0682	0.0729	0.0678	0.0716	0.0695	0.0589	0.0609	0.0648	0.0543
SDCA	Share of Dry cultivated area	%	89%	88%	88%	87%	87%	86%	85%	84%	84%	84%
SICA	Share of Irrigated cultivated area	%	11.50%	11.90%	12.40%	12.60%	12.90%	14.50%	14.60%	16.50%	16.00%	16.40%
SEWMP	Share of equipped wells with Moto pumps	%	59%	60%	59%	59%	58%	58%	59%	58%	58%	57%
SEWEIP	Share of equipped wells with electro pumps	%	41%	40%	41%	41%	42%	42%	41%	42%	42%	43%

Reform of agriculture is considered as a major challenge for the future. This sector which employs 46% of the labour force and sustains 80% of the rural world, remains vulnerable to recurrent droughts and marked by methods of operation often traditional, very low productivity, lack of diversification and a suboptimal use of resources.

Dualism in agriculture is manifested through a modern agriculture unevenly competitive and traditional agriculture uninvolved. Much of the potential of the modern sector is still dominated by one mode of operation annuitant. The importance of the Moroccan agricultural sector could be assessed through: Its economic weight: Added value (14% of GDP), 7 billion in exports (4%) its social weight: 1.5 million farms- Nearly half of households in the country depends for 80% of agriculture.

The data for this sector come mainly from the Ministry of Agriculture. This department conducts annual agricultural survey for the determination of cultivated areas and yields of major crops. The cultivated area represents approximately 80% of total arable land.

In absence of other relevant characteristics of the past period, the cultivated area is taken as a decisive factor for this sector. The hypothesis of evolution of this factor takes into account land development requiring the driving force.

For marine fisheries, the number of boats exceeds 3000. The capacity of the fleet is growing continuously. The share of coastal fisheries in quantity in the total fish production approaches 90%. In value, the offshore fishery dominates.

The energy intensity in agriculture is around 0.025 Toe / 1000 MAD, apart from 2004 and 2009, when the weather was wetter. For sea fishing, this indicator recorded a minimum of 0.014 Toe/1000 MAD in 2000 and began to grow from the year 2003 -2004, where production began to decline due to the lengthening of biological rest periods for certain species.

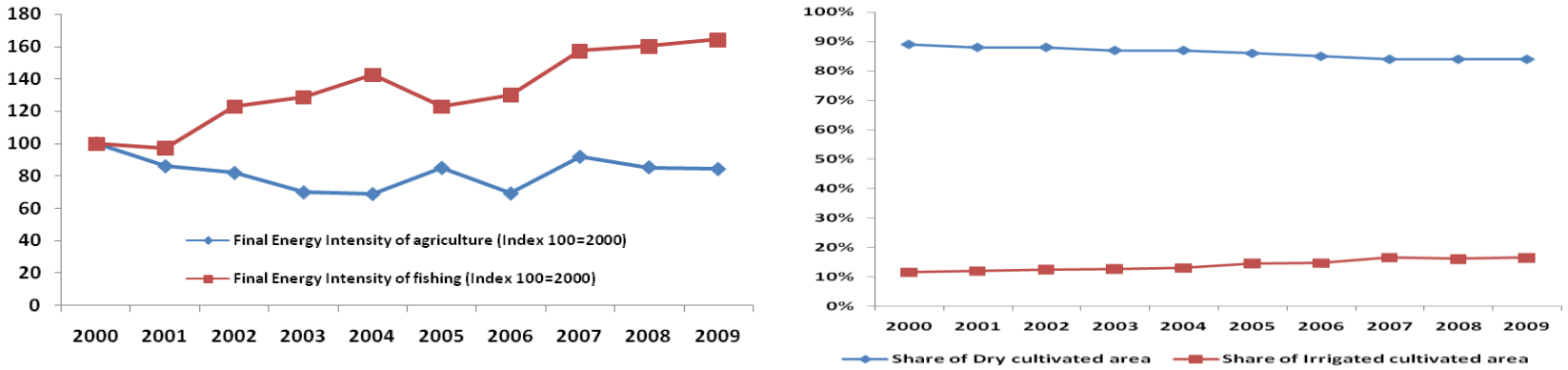
Moreover, we note that the rate of irrigated area is much improved from 11% in 2000 to 16% in 2009. Performances of the agricultural sector due to the importance of this indicator currently represent nearly one-fifth of the total area under cultivation, but also by the rate of equipment in pumping means.

Regarding energy intensities evolution (see Figure 18), this indicator is decreasing for the agricultural sector. It goes from an index of 100 in 2000 to an index 84 in 2009. The rainfall factor can partly explains this trend, but other factors come into play. Can be cited as an example, the use of a roundabout

way of LPG in the agricultural pumping, the new introduction technologies such as the system of drip irrigation to low pressure which can increase yields and diversify crops, there is also the effect of price and the and population management provided by the Ministry of Agriculture and institutions that depend. It is likely that energy efficiency in agriculture will intend it deserves with the implementation of government policy: 'Plan Vert'.

However, for the fisheries, we see a continuing increase of the intensities.

Figure 18 - Final Energy Intensities of Agriculture & Fishing –Share of dry cultivated area- Share of irrigated cultivated area



V. Conclusion

The exercise performed is of particular importance for our country. Even though collecting data was not an easy task and the necessary information is not always available, experts who have been involved in this exercise have learned a lot through the experience exchanges, the data assessment, the indicators' calculation and interpretation.

If it were still required to prove, this work has enabled us to perceive that in general the national statistical system has undergone tremendous progress, but efforts are still needed for the establishment of databases sufficiently developed for the assessment and the analysis of energy efficiency indicators. For that, the actions initiated by the Ministry of Energy, Mines, Water and Environment should continue in order to improve and update the energy consumption data in important sectors such as the transportation, the residential, the tertiary, the Industry and Agriculture.

For us, this work should be seen as the beginning of a long process that the public authorities should continue in order to set up a powerful energy information system that allows energy efficiency policy monitoring and assessment in the various socio-economic activities. This also must necessarily pass through the strengthening of cooperation between the concerned institutions within an appropriate framework.

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