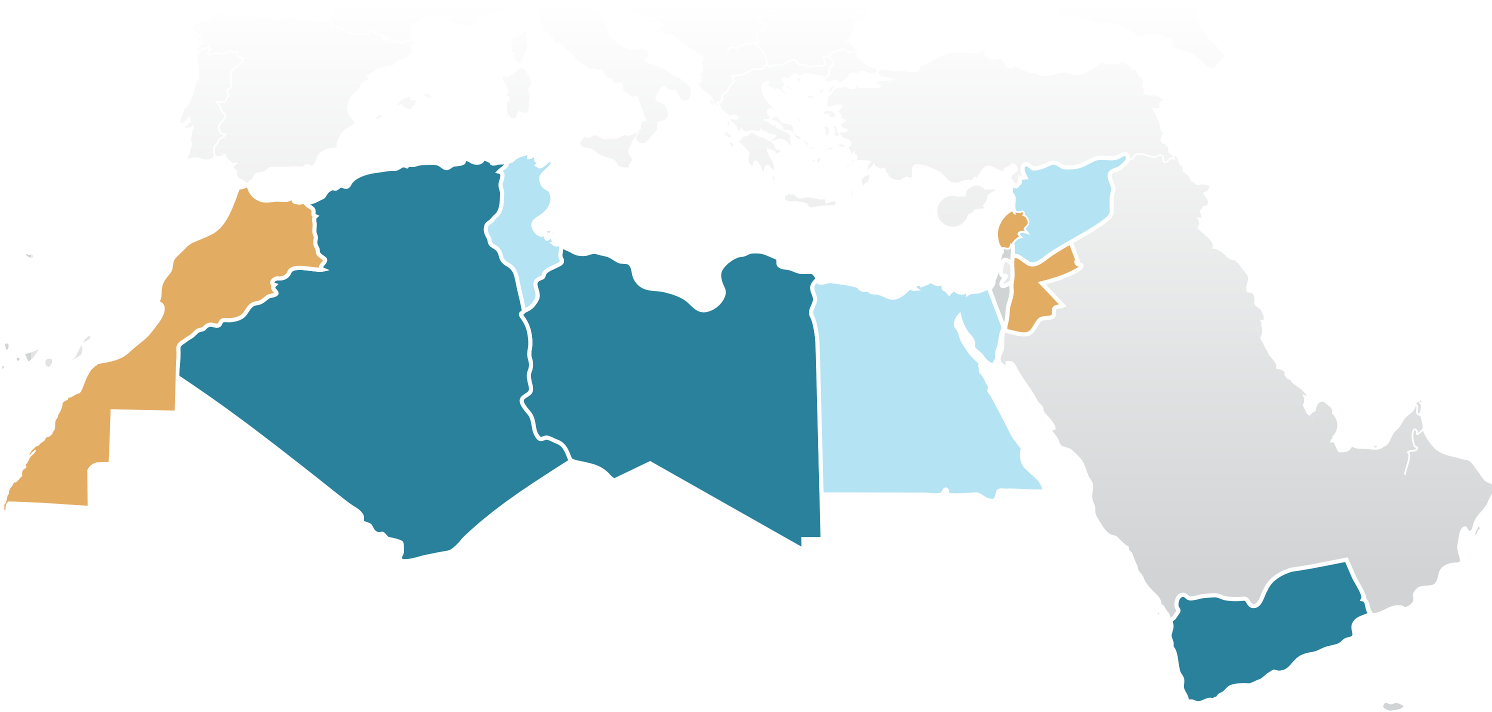

Energy efficiency indicators in the Southern and Eastern Mediterranean countries

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Regional report

October 2012

UNEP MAP plan bleu

RCREEE
Regional Center for Renewable Energy and Energy Efficiency
المركز الإقليمي للطاقة المتجددة وكفاءة الطاقة

MED-ENEC
Energy Efficiency in the Construction Sector in the Mediterranean

This project is funded by the European Union

Report realized under the direction of Hugues Ravenel, director of Plan Bleu, and can be downloaded from:

www.planbleu.org

www.rcreee.org

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The study is financed under the FEMIP Trust Fund. This Fund, which was established in 2004 and has been financed – to date – by 15 EU member States and the European Commission, is intended to support the development of the private sector via the financing of studies and technical assistance measures and the provision of private equity.

This study also benefited from the support of:

The analysis and conclusions expressed in this report do not necessarily reflect the views of the European Investment Bank, l'Agencia Española de Cooperación para el Desarrollo or the Agence Française de Développement

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Executive summary

Indicators: a vital approach for monitoring energy and climate policy

The adoption of a long-term energy efficiency and renewable energy development policy has become a vital need for Southern and Eastern Mediterranean countries, including energy-producing countries. The justification for this is socio-economic, strategic and environmental. From a socio-economic standpoint, the international oil market and predicted price rises will raise major challenges in terms of competitiveness, pressure on public finances and the vulnerability of the most deprived communities. From a strategic perspective, tensions in the international energy markets threaten the security of supply and hence countries' capacity to meet their basic energy needs. From an environmental viewpoint, it is now clear that if an average global temperature increase is to be stabilised at +2°C by 2100, a strong commitment is required from developing countries to reduce greenhouse gas emissions, alongside the efforts that must be made by developed countries.

To meet these challenges, some countries in the region have already announced ambitious medium- and long-term energy efficiency and renewable energy development targets, which should form part of appropriate strategies drawing together regulatory, institutional and economic measures in a coherent framework.

However, the design and implementation of such policies requires monitoring and assessment systems to be created, based on relevant indicators for decision-making. These systems will be even more vital for countries in the region that want to access new mitigation funding mechanisms in the context of current climate change negotiations. The implementation of such mechanisms requires greenhouse gas emissions reduction Measurement, Reporting and Verification (MRV) systems to be set up.

Disseminating an energy indicator culture within the region

Currently, there is little or no culture of monitoring and assessing energy programmes and policies through an indicator-based approach in the countries of the region, and even being non-existent in most of them. Competence in this area has therefore remained limited, both in the relevant public institutions and in the private sector.

This project, initiated by Plan Bleu in cooperation with the Regional Center for Renewable Energy and Energy Efficiency (RCREEE) has the principal aim of **kick-starting a new process** in the relevant countries, with several objectives:

- **Capacity building** among the relevant public- and private-sector stakeholders in calculating and interpreting energy and greenhouse gas emissions indicators,
- **Disseminating a culture** of indicators among policymakers in target countries,
- **Raising awareness among domestic policymakers** of the issues around availability and reliability of energy data and socio-economic data for developing indicators,
- **Promoting the sharing** of experience between countries in the region, with the aim of eventually creating a regional database similar to the ODYSSEE project in Europe,
- **Creating a network of regional experts** to design, calculate and analyse energy efficiency indicators, with the key aim of assessing energy efficiency policies in the countries of the region.

A participatory approach was used to meet these objectives, based on **learning by doing**. The learning process involved the active participation of national experts in the development of an array of macro-scale and sectoral indicators, which are based on international energy accounting standards. The indicators were selected through consultation with the countries.

The work drew together a working group of experts from the target countries, comprising national teams. Each national team was comprised of one focal point, a representative of the authority responsible for the country's energy policy, and an independent expert working in partnership to collect and validate data, calculate indicators and produce the national report. Technical assistance was provided to the country teams remotely and during four workshops organised throughout the duration of the project. capacity building focused mainly on:

- Energy accounting,
- Reading the energy balance and analysing the consistency of energy data,
- Economic variables (GDP, added value, etc.) and the structure of socio-economic data,
- Typical in-country and international data sources,
- Defining and calculating energy indicators,
- Interpreting the indicators within a country's economic and energy contexts.

In conclusion, the most important expected outcome from the project was not so much the calculated indicators and the country reports but the capacity-building process involving the public- and private-sector stakeholders and the dissemination of an indicator culture among the institutions working on energy policy in the countries of the region.

Major difficulties to overcome

The teams encountered significant difficulties in terms of availability and consistency of data during the process of collecting and validating the basic data. These problems included issues related to:

- The availability and reliability of energy balance figures, particularly with respect to final energy use (at the end use level).
- The disaggregation of sector-specific socio-economic data, such as figures on production in large-scale energy-consuming industries, figures from the transport sector and from the construction sector.
- The disaggregation of final energy consumption for different sectors, by usage, industry and energy product.
- The diversity of data sources and the lack of cooperation from data-holding institutions, making information-gathering a difficult and time-consuming affair.

The expert working group attempted to take into account the risks of unavailability of data at an early stage through their initial choices of indicators to be developed. In spite of these efforts, **some indicators could not be calculated** by all the countries due to a lack of data. Other indicators generated **incorrect values** because of insufficient data reliability.

The project thus highlighted major gaps in data availability and reliability in most countries in the region, which limited the scope of the calculated indicators, with respect to the time allocated to the experts in the project.[1] Policymakers in the countries of the region need to be aware of these gaps and correct them by gradually implementing the appropriate information systems that supply data required for calculating energy efficiency indicators at the lowest possible cost.

Progress to build on

Despite the difficulties, the project generated definite progress, with target countries – f**or the first time in the region** – being prepared to take a rational approach to monitoring and assessing their energy policies. The areas of progress include:

1 This corresponds to approximately one person-month per country, including the time spent on the four workshops.

- **Defining an energy performance baseline for countries in the region** by providing a snapshot of the current situation with regard to key energy performance indicators (energy intensity, specific consumption, renewable energy penetration rate, etc.). This baseline will be a starting point for future assessments of energy performance in the target countries.
- **Establishing recent trends in these energy performance indicators,** which will help define "business-as-usual" scenarios in the countries. These scenarios will form a benchmark with which future changes in indicator values can be compared.
- **Drawing together the first network of experts** in the region, and training them in the theory and practice of energy indicators, and more broadly in the top-down assessment of energy management policies. This also helped to **strengthen public-private partnerships** by creating mixed country-level teams of private-sector experts working alongside representatives of public-sector institutions.
- **Boosting in-country horizontal institutional cooperation** around the issue of energy indicators and the assessment of public energy policies.
- Using the network to open up possibilities for sharing experience and knowledge on energy indicators between target countries, with the aim of creating **harmonised indicator-calculation standards** across the region.
- **Raising awareness among in-country policymakers** of the importance of indicators in the design, monitoring and assessment of energy efficiency and renewable energy policies.
- Highlighting the financial issues related to energy consumption by developing **innovative indicators** relating to the true cost of – and subsidies paid for – conventional fuels.

Major energy challenges highlighted by the project

Analysis of the indicators developed as part of the project leads to the following assessment of the current situation:

- **A widespread trend towards energy dependence,** even for energy-producing countries, due to strong growth in primary energy demand, alongside a very slight increase, or stagnation in the production of oil and gas;
- **Poor penetration of renewable energies** in the electricity generation mix[2], estimated at an average of 11.4% of total capacity in 2009, or only 0.8% if hydroelectric power is excluded. In energy terms, the penetration rate of renewable energies in electricity generation[3] is approximately 6% if hydroelectric power is included, and less than 0.5% for all other renewables.
- **Significant potential for improving energy efficiency in the region,** highlighted when comparing average energy intensity in the region (0.460 toe/1000 $\$_{2000}$) with that of OECD countries (0.174 toe/1000 $\$_{2000}$), more than twice as much. Primary energy intensity varies widely between countries in the region, from 0.240 to 0.8 toe/1000 $\$_{2000}$.
- **Intensity of electricity consumption is increasing rapidly;** meanwhile electricity demand is growing at more than 7% per year in some countries. Growth is approximately 2% on average per year across the region.
- **Significant economic and financial issues relating to energy consumption,** with energy costs varying between 5 and 20% of GDP from country to country. In some cases, fuel subsidies may be as high as 12% of GDP. This situation creates problems of economic competitiveness and socio-economic vulnerability to fluctuating international energy prices for most countries in the region.
- **An illegal fuel trade** between countries in the region, outside the official energy accounting systems, making it difficult to accurately appraise and interpret energy indicators in these countries.

2 Installed renewable energy capacity divided by total installed electricity-generation capacity.
3 Electricity generated from renewable energies divided by total electricity generated.

Recommendations for taking the process further

This project should be considered as the starting point of a long process introducing a culture of monitoring and assessment of energy management policies through an energy indicator-based approach. This process should cover various aspects, including capacity-building and institutional strengthening **within and between countries** in the region. As the project comes to an end, therefore, various recommendations can be made, with respect to the continuation of this process and the long-term consolidation of the progess made:

1. **Continuing the process in-country.** In order to achieve this aim, countries are strongly advised to institutionalise the process by transferring responsibility for continuing work, based on the tools and approaches developed during the project, to a domestic institution that already exists, or that will be created. These institutions could either be energy management agencies, where applicable, or ministerial departments that are responsible for energy. Small but totally dedicated teams need to be created within these institutions to fulfil this mission, with a strong link to the relevant sectoral stakeholders. The project focal points and national experts should play a significant role, in order to pass on to these teams the know-how they have acquired from the project.

   However, most of these institutions would need occasional technical support to help with the training and creation of these dedicated teams. This technical assistance is likely to be fairly low-key, but needs to be specific to each country, with support provided to the local teams.

   Technical assistance should also focus on the development of centralised information systems for the compilation and periodical publication of energy efficiency and greenhouse gas emissions indicators in the countries.

   Some countries such as Algeria, Morocco and Lebanon currently receive technical assistance, for instance as part of the MEDENER project, to develop an information system for energy indicators. Tunisia has received assistance under a multi-year cooperation programme with the French Environment and Energy Management Agency (ADEME) to develop an information system, which is now up and running. These countries could transfer their knowledge to other countries in the region.

2. **Taking the work further.** The major obstacle in developing regional indicators was data availability and the reliability of disaggregated figures. However, unavailability of data varies from sector to sector and from country to country. It is recommended that **an advanced sectoral data-collection pilot project** should be launched, involving integration of existing records, field surveys and estimates, etc. in order to define and validate methodological approaches before rolling them out to other countries. In practical terms, three projects could be run in three different countries, focusing on developing specific disaggregated indicators in the fields of manufacturing industry, construction and transport. The findings could then be useful for other countries. These sectoral indicators would also serve as a benchmark for assessing the impact of the energy efficiency measures implemented under the League of Arab States guidelines on energy efficiency. This would also boost the **development of a bottom-up approach to assessment.**

3. **Gradually introducing regional cooperation on energy indicators.** A large body of socio-economic and energy data was collected in the countries participating in the project, compiled and processed in order to produce an initial array of standardised indicators on energy efficiency and greenhouse gas emissions in the region. These efforts should be used as starting point for region-wide institutional cooperation, involving the development of a regional database (similar to the European ODYSSEE project). This database, managed on a regional scale should be:

   - Updated regularly, through lasting links with the national focal points mentioned above,
   - Rolled out gradually to other countries in the region,
   - Improved continually and broadening to other more complex, more specific and more innovative indicators (structural effect, climate effect, technical effect, ODEX-type aggregate energy efficiency indicator, etc.),
   - Interfaced with other larger databases, especially in terms of methodology (e.g. International Energy Agency, World Bank, etc.)

4. **Consolidating and structuring the expert network** formed for the project. A big step forward was the establishment, for the first time, of a core team of regional experts in energy indicators. This network of around twenty public- and private-sector experts should be maintained, consolidated and strengthened. More specifically, it could be established as a regional network (as part of one or more other regional energy networks), with a role that would include the following:

   - Promoting the sharing of expertise and experience across the region,
   - Disseminating an indicator culture in countries across the region,
   - Gradually broadening the network to other Southern and Eastern Mediterranean countries and other Arab nations,
   - Initiating and strengthening cooperation with other networks, such as the ODYSSEE project in Europe,
   - Helping to complete and improve the work started by the project, by completing the missing indicators, where possible,
   - Contributing to the periodical publication of key indicators within the region.

5. **Promoting international cooperation and coordination with other initiatives.** Various initiatives directly or indirectly related to the topic of energy indicators are currently underway in the region. These projects include:
   - The MEDSTAT project, whose key objective is to help countries produce their energy balances according to the EUROSTAT format over the long-term,
   - The MEDENER technical assistance project on the development of energy management information systems in Tunisia, Algeria, Morocco and Lebanon,
   - The RCREEE project to compile a regional database on RE & EE initiated jointly with LAS.
   - The MED-ENEC project on the energy efficiency of buildings, etc.

Finally, it is strongly recommended that cooperation should be initiated with regional and international organisations with long experience in the field, such as the European Union and more specifically the ODYSSEE network, the International Energy Agency, Eurostat, the Observatoire méditerranéen de l'énergie (OME). There should be three aims for this cooperation:

- Transfer of knowledge about indicators to countries in the region,
- Harmonisation of indication-calculation methods and hypotheses with a view to international comparison,
- Gradual integration of regional data into these organisations' statistics about indicator

Acknowledgments

The Project was coordinated by ALCOR, namely Rafik Missaoui and Hassen Ben Hassine and Adel Mourtada, who would like to express their deep gratitude to the whole project team for their strong level of commitment and their invaluable support, which has allowed them to achieve the project targets:

- Plan Bleu, particularly Habib El Andalousi and Ferdinand Costes
- RCREEE, Amel Bida
- MED-ENEC, Florentine Visser
- The country teams including the national experts from the private sector and the RCREEE focal points as experts from the public sector.

The content of this report is based on the contribution of all country teams consisting of:

Table 1: List of project participants

	RCREEE focal points	National experts
Algeria	Abd Elrafik Belal Agency for Promotion of Rational Use of Energy	Fatiha Gherbi Djallal Boucheneb
Egypt	Dorria Abbas Mohamed Central Agency for Public Mobilization and Statistics	Mohamed Salah Elsobki
Jordan	Abdul-Motaleb Al Nugrush Ministry of Energy and Mineral Resources	Walid Shahin
Lebanon	Rani Al-Ashkar Lebanese Center for Energy Conservation	Ghassan DIB
Libya	Mohamed Sidon Renewable Energy Authority of Libya	Mohamed Ali Ekhalat
Morocco	Aicha Laabdaoui Ministry of Energy, Mines, Water and Environment	Mohammed Hmamouchi.
Palestine	Falah Demery Palestinian Energy and Environment Research Center	Mohanad Aqel
Syria	Jolnar Tanbaki Public Establishment for Electrical Generation and Transfer	Mohamad Kassem Kordab
Tunisia	Leila Bejaoui National Energy Agency for Energy Conservation	Rafik Missaoui, Hassen Ben Hassine
Yemen	Abdelkadir Obeid Basalah Ministry of Electricity and Energy	Ali Mohamed Al-Ashwal

I. Preface

The Energy Efficiency Indicators Project in the Southern and Eastern Mediterranean countries has been initiated by Plan Bleu, in partnership with RCREEE and with support of MED-ENEC. Its main aim is to enhance regional stakeholders' capacity to calculate and analyse energy efficiency indicators.

This project has been realized in a participatory way thanks to the participation of experts from the private and public sectors in each of the ten countries, member states of RCREEE[4]: Morocco, Algeria, Egypt, Lebanon, Syria, Jordan, Libya, Palestine, Tunisia and Yemen.

This project also benefited from the support of the European Investment Bank (EIB), under the energy program from Plan Bleu, as well as the financial contribution of RCREEE.

It needs to be kept in mind that this project coincided with the Arab Spring uprising. In fact the kick-off workshop was held in Tunisia on the 7th and 8th January 2011, a few days before the Tunisian revolution (14th January 2011). Despite the constraints resulting from the Arab Spring events that affected many of the project countries (Egypt, Libya, Syria, Tunisia and Yemen), the project team has been able to overcome these difficulties and achieve the project objectives.

Finally, several technical difficulties linked to access, availability and reliability of data in the countries have limited the original scope of this project, in terms of number of indicators that could be calculated and their level of detail. Hence, this project, with the learning process of designing and calculating energy efficiency indicators, has to be considered as the first step of a longer path that should be continued in the region.

4 At the start of the project in 2011

II. List of abbreviations

1. Units of measurement

GWh: gigawatt-hour
kg: kilogram
kgoe: kilogram of oil equivalent
km: kilometre
kWh: kilowatt-hour
Mtoe: million tons of oil equivalent
MW: megawatt
m^2: square metre
p.km: passenger-kilometre
toe: ton of oil equivalent
tCO_2e: ton of CO_2 equivalent
TWh: terawatt-hour

2. Currency and related symbols

$: US dollar
$\$_{2000}$: US dollar at constant value for the year 2000
LC: Local currency

3. Other abbreviations

ADEME: French Environment and Energy Management Agency
AETS: Apparent Efficiency of the Transformation Sector
ALG: Algeria
CFL: Compact Fluorescent Lighting
CIF: Cost, Insurance and Freight
CO_2: Carbon Dioxide
DW: Dwelling
EE: Energy Efficiency
EIB: European Investment Bank
EGY: Egypt
ESEF: Electricity Sector Emissions Factor
EU: European Union
FAO: Food and Agriculture Organization
GDP: Gross Domestic Product
GHG: Greenhouse Gas
GN: Guest - Night
IPP: Independent Power Producer
IPPC: Intergovernmental Panel on Climate Change
JOR: Jordan
LEB: Lebanon
LYB: Lybia
LNG: Liquefied Natural Gas
LPG: Liquefied Petroleum Gas
MED-ENEC: Mediterranean Energy Efficiency in the Construction sector
MEDENER: Association of Mediterranean Energy Conservation Agencies
MOR: Morocco
MRV: Measurement, Reporting and Verification
NAMA: National Appropriate Mitigation Action
NEEAP: National Energy Efficiency Action Plan
NG: Natural Gas
OECD: Organization for Economic Co-operation and Development
OME: Observatoire Méditerranéen de l'Énergie
PAL: Palestine
PPP: Power Purchasing Parity
RCREEE: Regional Centre for Renewable Energy and Energy Efficiency
RE: Renewable Energy
SCPG: Specific Consumption of Power
SYR: Syria
SWH: Solar Water Heater
TUN: Tunisia
UNFCCC: United Nations Framework Convention on Climate Change
YEM: Yemen

III. Introduction

1. Project framework

The design, implementation and monitoring of national energy policies requires relevant indicators reflecting energy use and performance at the macro and sector levels. Moreover, for developing countries, the implementation of information systems on energy and greenhouse gas emissions indicators is a key condition for the development of new mitigation financing mechanisms (like the National Appropriate Mitigation Actions (NAMAs), sectoral mechanisms, etc.), which are currently under negotiation as part of the new international climate governance policies. These mechanisms need Measurement, Reporting and Verification (MRV) methodologies to evaluate their impact. Also, for the League of Arab States Electricity Efficiency Directive, such indicators are crucial for the monitoring and assessment of their National Energy Efficiency Action Plans (NEEAPs). In fact, the electricity efficiency improvements targeted in the NEEAPS can be measured by comparing electricity consumption indicators for the target year to those of a selected reference year. Another assessment approach is to compare the performance of electricity consumption indicators in the energy efficiency scenario to the case of the business-as-usual scenario.

For these reasons and based on European experiences (like the ODYSSEE Project[5], etc.), Plan Bleu and RCREEE have initiated this ambitious project. MED-ENEC joined due to special interest in EE indicators in the building sector. The project covers ten countries in the Arab region: Morocco, Algeria, Egypt, Lebanon, Syria, Jordan, Libya, Palestine, Tunisia and Yemen. The project aims particularly at:

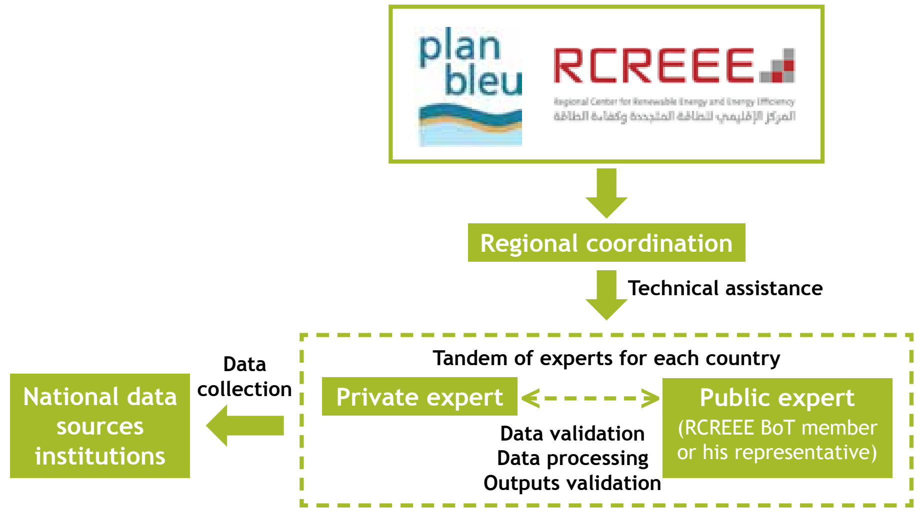
- Strengthening the capacities of public and private experts for the calculation and analysis of energy efficiency indicators;
- Disseminating a culture of indicators among policymakers in target countries;
- Raising awareness among national policymakers about difficulties related to access, availability and reliability of energy data and socio-economic data;
- Promoting the exchange of experiences and data between countries in the region in order to gradually develop a regional database similar to ODYSSEE in Europe;
- Creating a regional network of experts able to design, calculate and analyze energy efficiency indicators as a tool for evaluating the impact of energy efficiency policies in the region.

The project started in January 2011, with a kick-off workshop in Tunisia, and activities lasted for about 18 months.

With the objective of capacity building, teams were formed, consisting of a private national expert and a RCREEE focal point for each country. They were trained to collect data from national institutions, evaluate and process these data, and finally to calculate the indicators. The teams presented their results in national country reports including a first analysis of the indicators. Figure 1 illustrates the basic organizational structure for the project.

5 http://www.odyssee-indicators.org/

Figure 1: Project organization



ALCOR was responsible for the regional coordination of the project and provided technical assistance for country teams. This regional report reflects the results of the national teams was also developed by the regional coordinator.

2. Project methodology and process

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

- A participatory and active approach involving national public and private experts by:
  - Hosting four workshops and working sessions (in Tunisia, Egypt, France and Morocco).
  - Selection, by the participants, of the common indicators to be developed in the project, based on data relevance and availability for countries.
  - Technical assistance throughout the project provided by the regional coordinator.
- Capacity building through “learning by doing” and sharing experiences of:
  - Data collection by the national experts with the support of RCREEE focal points, to strengthen the cooperation between public and private experts.
  - Common development of a simplified calculation tool for data collection and calculating indicators to be used by the experts.
  - Analysis and interpretation of energy indicators by national experts.
  - Country reports developed by the national teams.
- Dissemination of the results and lessons learned by:
  - A final seminar for the decision-makers in November 2012.
  - Publication and wide dissemination of the results in a regional report and flyer, summarizing the results and conclusions of the report.
- Network building for energy data and indicators in the region to:
  - Continue the capacity building through information and experience exchanges.
  - Update the energy indicators.
  - Form a group of regional experts for future projects.

The data collection of the project can be grouped into four categories:

- **Energy data,** including macro and disaggregated data by sector, subsector, energy products from national energy balances and other sources (departments of energy, sector departments, professional associations, energy distributers, etc.),
- **Socio-economic data** provided by several sources including national statistic institutions and sector organizations,
- **Financial and economic data** including energy prices, budgets, energy bills, etc.
- **Environmental data** including mainly greenhouse gas emissions at different activity levels.

As mentioned above, the targeted indicators have been selected in a concerted way, in consultation with the country teams based on data availability and their relevance for each country's context. Table 2 presents the number of indicators to be calculated by sector for each country.

Table 2: Number of indicators by sector

Sectors	Number of indicators
Macro	10
Transformation	10
Transport	13
Tertiary	8
Residential	12
Industry	14
Agriculture & fishing	7
Total	74

The list of indicators and their definitions are presented in the Annex.

Depending on data availability in the countries, the indicators were calculated either for the period of 2000 to 2009 or from 2003 to 2009.

3. Data collection process

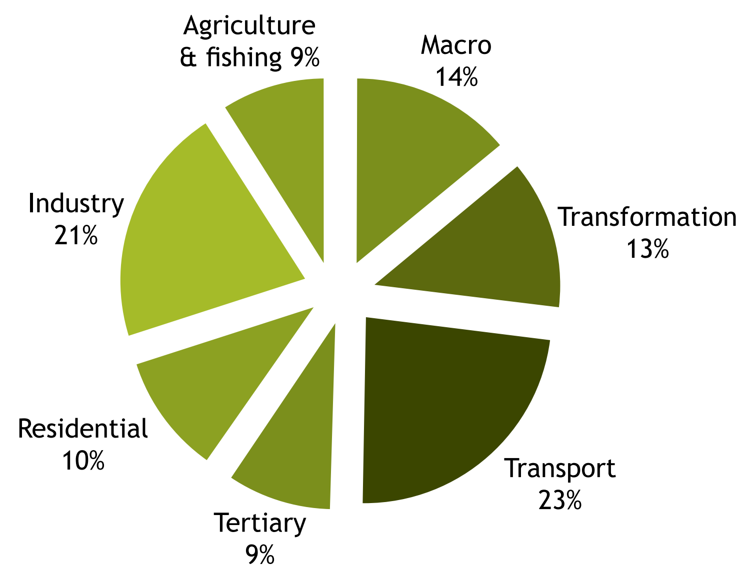
For each year of the reporting period, Table 3 shows by type the number of data required to calculate the above-mentioned indicators for each sector.

Table 3: Number of data items according to the type and sector

Sectors	Energy	Socio-economic	Environ-mental	Total
Macro	8	6	1	15
Transformation	14	0	0	14
Transport	7	15	3	25
Tertiary	4	5	1	10
Residential	3	7	1	11
Industry	8	13	1	22
Agriculture & fishing	2	8	0	10
Total	46	54	7	107

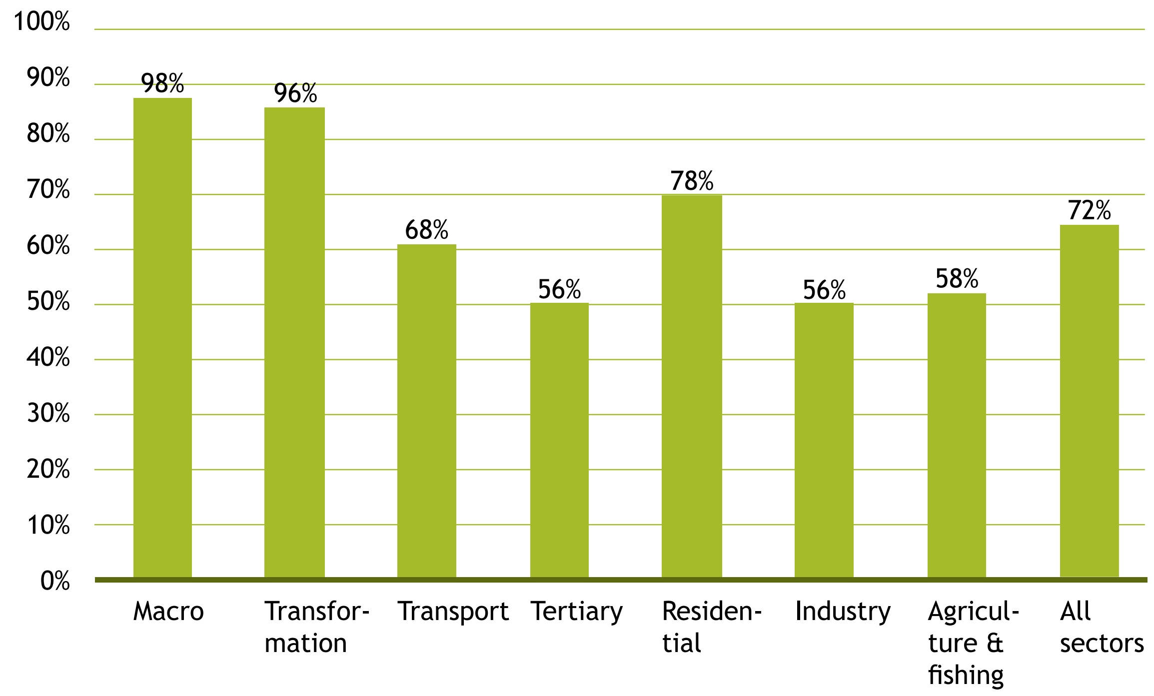
The share of required data by sector is presented in Figure 2. It clearly shows that the transport and industry sectors required the largest amounts of data to calculate the indicators.

Figure 2: Percentage of required data by sector for development of indicators



The data availability rate, defined as the ratio between the number of available data collected during the reporting period, and those initially indicated to be collected, is around 72% on average. It rises to 74% for energy data, 64% for socio-economic and 71% for environmental data. As shown by Figure 3, the data availability rate is the highest for the macro and transformation sectors, whilst the data in the industry, agriculture and tertiary sectors have the lowest availability.

Figure 3: Data availability by sector



The process of data collection depends on availability and quality of existing information systems both for activity data (demography, economy, etc.) and energy data. This requires strong relations between energy policy institutions and national statistic providers in order to facilitate data connections and analysis.

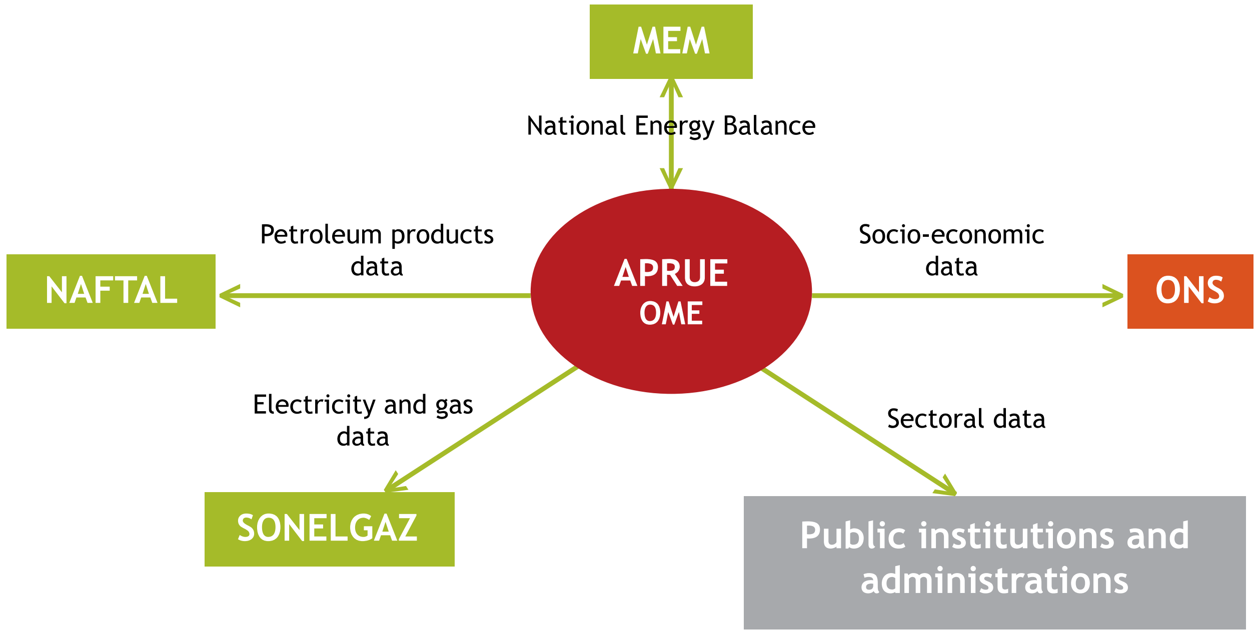
Among key stakeholders, we may mention:

- The ministries in charge of energy;
- Observatories responsible for energy balance development;
- Electricity utilities and independent power producers;
- Oil and gas companies;
- Energy efficiency and renewable energy agencies;
- Major energy intensive consumers;
- Statistic institutes for demographic and socio-economic data;
- Central banks for macroeconomic aggregates;
- Sectoral departments and agencies (transport, housing, agriculture, etc.);
- International institutions holding relevant databases (International Energy Agency, World Bank, etc.).

The development of indicators requires an information system based on sustainable relationships of information exchange between these organizations and the developer of the indicators. The system should also provide procedures for the collection, verification, validation and compilation of data to ensure their reliability.

The following example in Figure 4 shows the configuration of the system of data collection in the case of Algeria.

Figure 4: Institutions and public administrations in Algeria



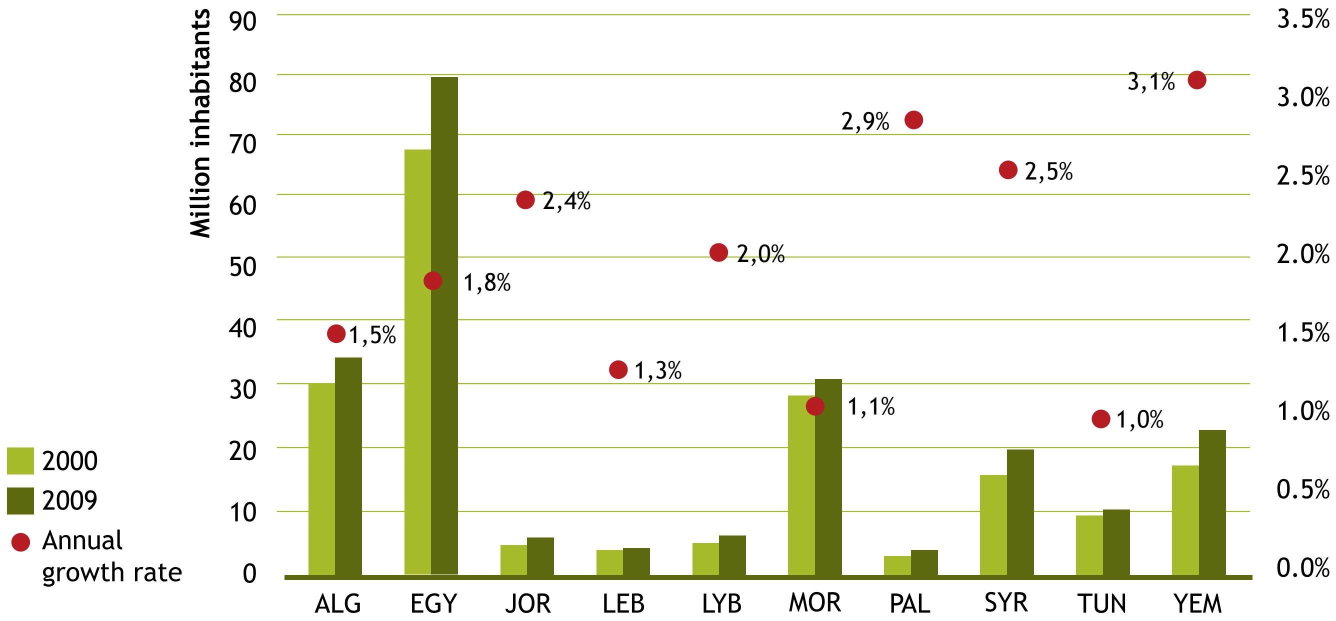
IV. Target countries background

1. Socio-economic context

The studied region (i.e. the 10 countries) is a heterogeneous area with great disparities in terms of demography, income and level of economic development, which makes comparison between the various countries quite complex and less relevant overall.

Over the past decade (2000 to 2009) the population increased from about 187 million to over 220 million inhabitants with an annual average growth rate of about 1.8%, ranging from 1% in Tunisia to more than 3% in Yemen, as shown by Figure 5.

Figure 5: Demography development from 2000 to 2009



Source: World Bank

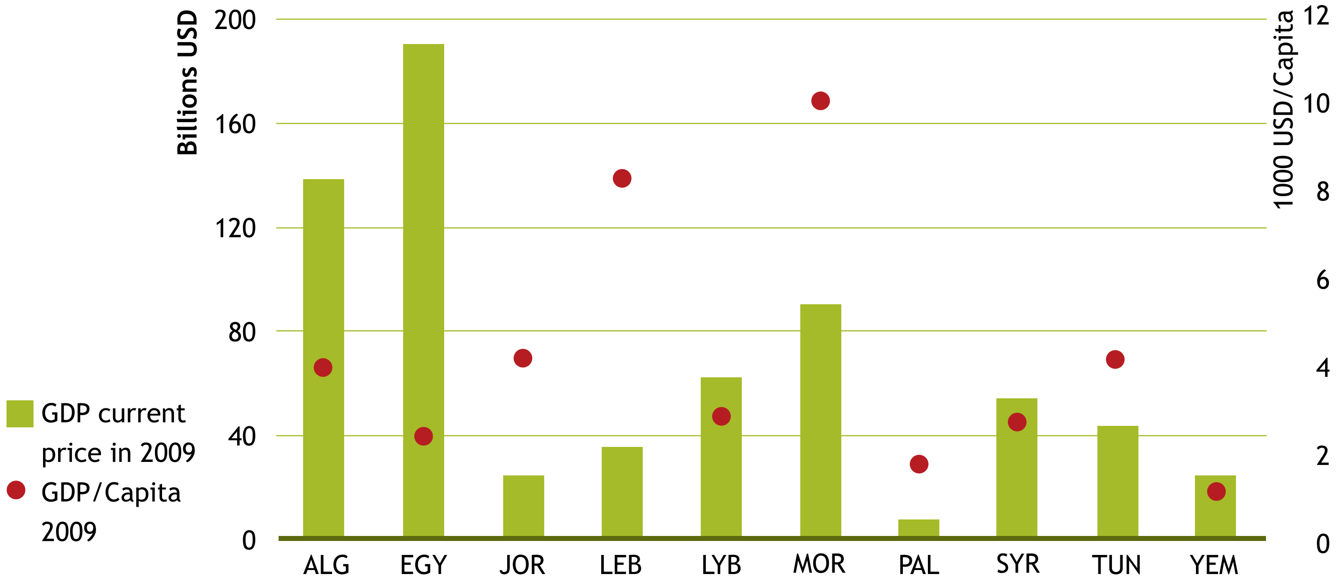
This demographic trend, combined with other phenomena like rapid urbanization and improvement in living standards is putting increasing pressure on natural resources and, in particular, energy needs.

The region also shows a large diversity of economy types, ranging from some monoculture economies based on large hydrocarbon exports such as Libya and Algeria, to diversified economies like Tunisia, Jordan, Lebanon, Egypt and Morocco.

Based on income per capita in 2009, the countries could be classified into three groups (Figure 6):

- High income countries: Libya and Lebanon
- Upper middle income countries: Tunisia, Algeria, Morocco, Jordan, Syria and Egypt
- Lower middle income countries: Yemen and Palestine

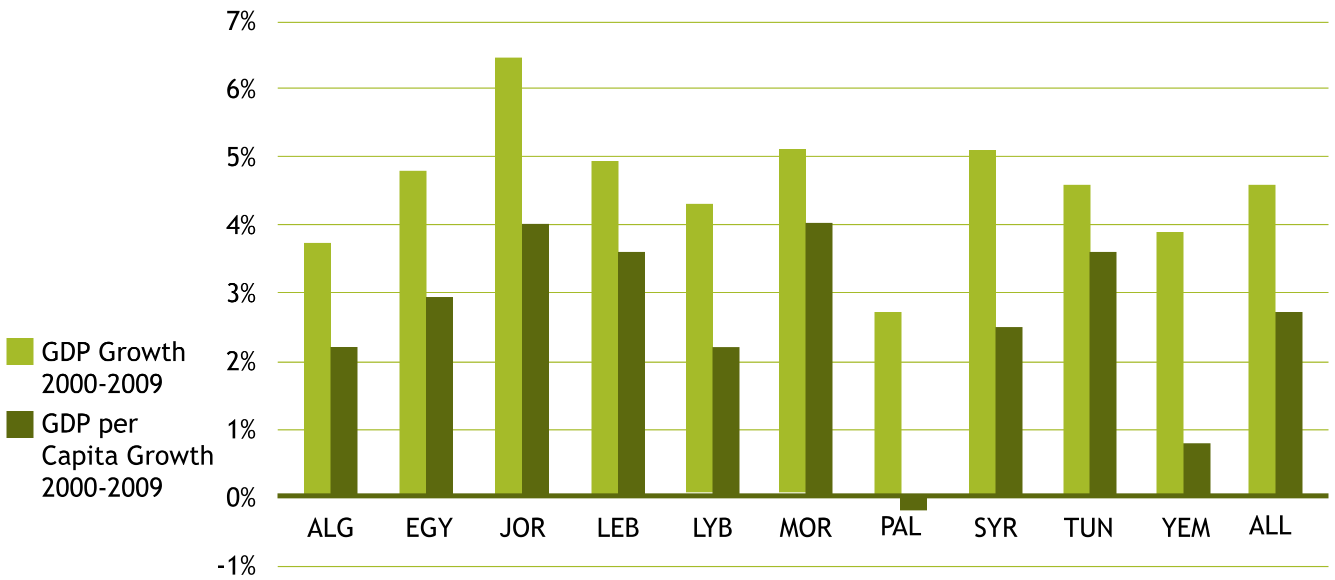
Figure 6: GDP and GDP per capita in 2009



Source: World Bank

Over the last decade, the region has experienced consistent economic growth, with an average annual increase in gross domestic product (GDP) of 4.6%, ranging from 6.5% (Jordan) to 2.7% (Palestine), as shown in Figure 7. However, oil revenues have largely contributed to this growth and therefore the use of decarbonised GDP[6] provides a more realistic analysis.

Figure 7: Growth of GDP at 2000 constant price, from 2000 to 2009



Source: World Bank

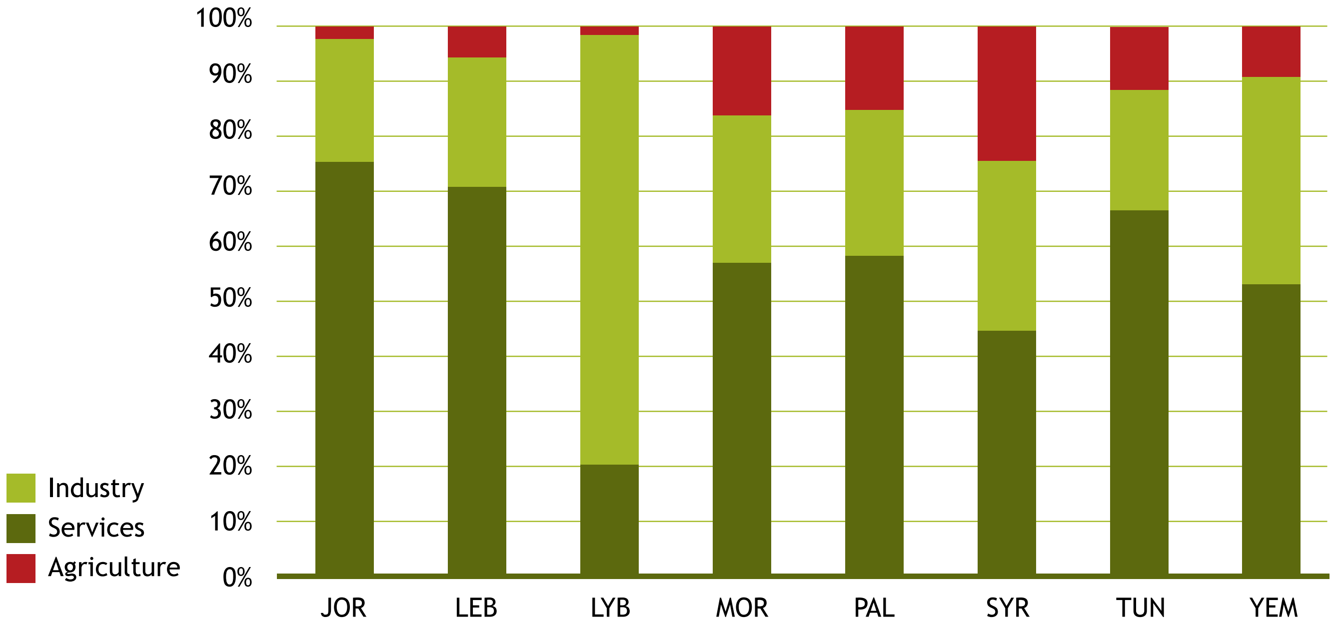
These high GDP growth rates have not been reflected in GDP per capita, which indicates that economic growth has not maintained the same pace as population growth.

In fact, economic growth during 2000 to 2009 averaged 4.6%, whereas average GDP per capita growth was only 2.7%.

6 GDP excluding hydrocarbon revenues

The economic structure is an important parameter determining the level of the final energy consumption of a given country. Thus, it is relevant to analyse contributions of the main economic sectors (tertiary, industry and agriculture) in the GDP of the project countries. These values for the year 2009 are shown in Figure 8.

Figure 8: Value added structure by economic sector in 2009



Sources: Official countries data & World Bank

Based on economic structure, the target countries can be grouped into three categories:

- **Countries with low diversified economies** are those essentially depending on gas and oil extraction, such as Algeria, Libya and Yemen. Their exports strongly focus on the energy products and derivatives sector.
- **Countries with more diversified economies** (Tunisia, Morocco, and Egypt) have achieved a good level of development in both manufacturing and service sectors, with the tourism sector playing a leading role.
- **Countries with service oriented economies** (Jordan, Lebanon): intensive economic and financial relations with foreign countries have helped the development of financial services (including emigrant worker remissions, deposits held by emigrant workers and Gulf countries' financial investments), and other services depending on trade.

We should also mention the importance of the agricultural sector, in particular in Morocco and Syria, which contributes significantly to their GDP composition.

These differences in economy structures, combined with other technical effects, have a significant impact on primary and final energy demand levels.

2. Energy background

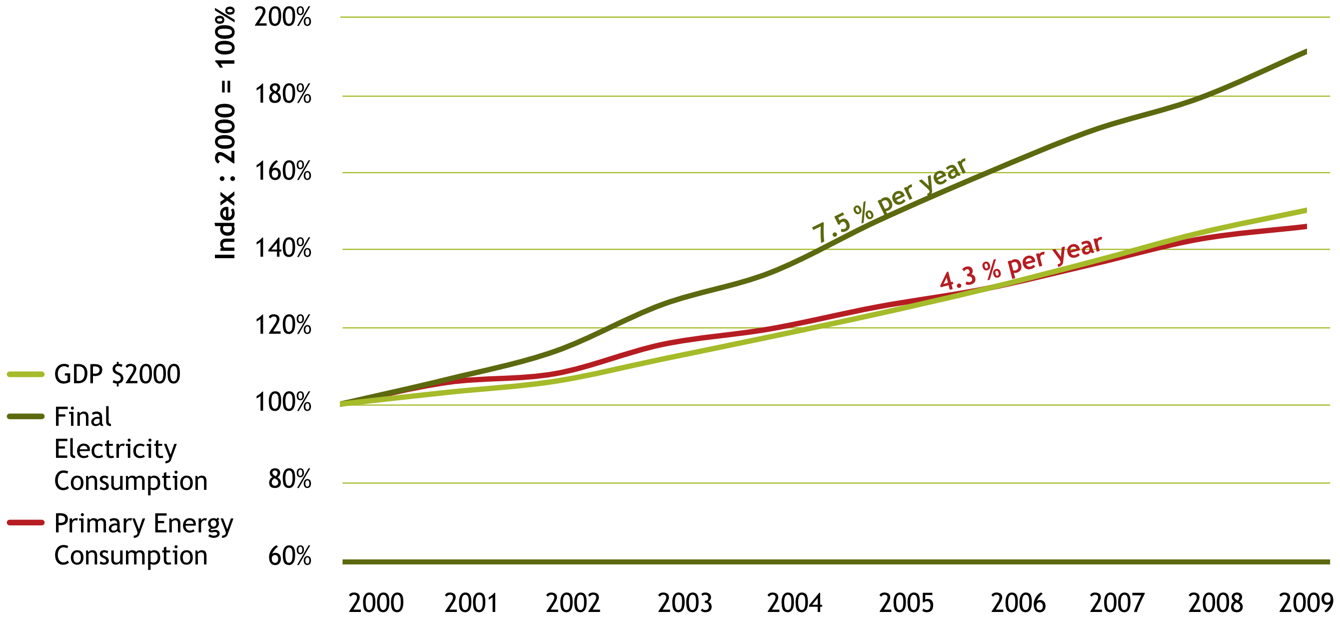
2.1. Energy consumption

Demographic trends and economic growth in the target countries have contributed to an increase in energy demand and the need for related infrastructure. Between 2000 and 2009, primary energy consumption in the region grew from 144 to 210 Mtoe, increasing by 46% over the period. Primary energy consumption per capita was about 770.6 kgoe in 2000 compared with 955 kgoe in 2009, representing a rise of about 24% during this period.

Electricity consumption in the region has increased from 154 TWh in 2000 to 294 TWh in 2009, about 90% overall during the period. The average annual electricity consumption has risen from 824 to 1338 kWh per capita, increasing by 62% over the period.

As shown by the data in Figure 9, there has been no decoupling between economic growth and primary energy demand in the region during the last decade. The average annual growth of GDP is around 4.3% per year, which is roughly equivalent to the growth rate of primary energy consumption.

Figure 9: Development of primary energy consumption, electricity final consumption and GDP



Sources: Official countries data and World Bank

However, this regional trend hides significant disparities between the target countries. For net energy exporter countries in particular, GDP – based mainly on oil revenues – has increased faster than primary energy consumption during the last decade. This is due to the large increase in international crude oil prices.

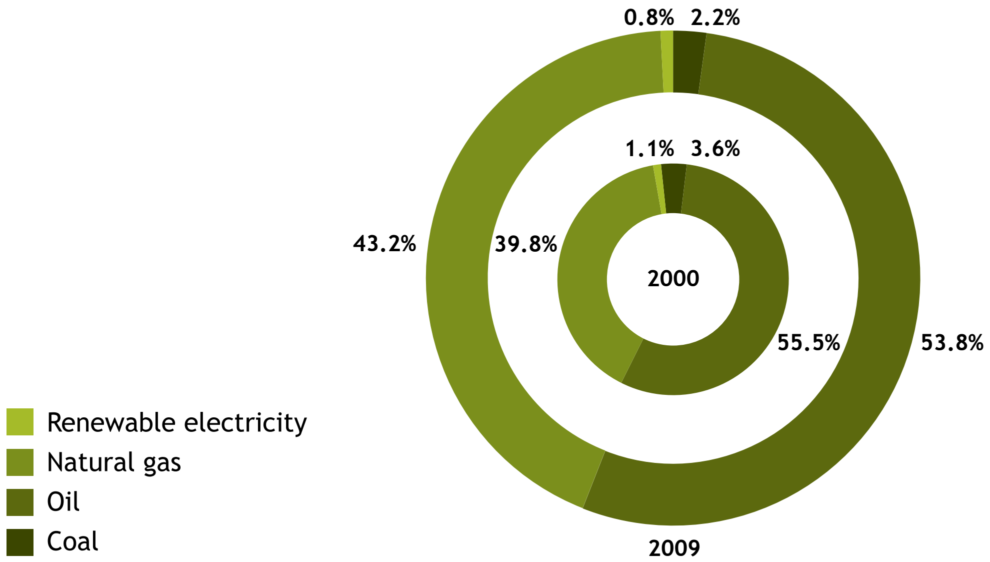
The situation for electricity is different, where demand has increased much faster than economic growth, with demand growing at an average annual rate of about 7.5%. This tendency reflects a major shift in energy consumption patterns of households in the target countries. In fact, improvement in living standards and lower-priced electrical appliances in these countries have been the main drivers of increased electricity demand in the residential sector.

This trend has been implicitly encouraged by governments through low electricity tariffs, in particular for poor households, in order to facilitate access to electricity for the wider population.

2.2. Energy mix

The energy mix in the region is still dominated by oil and petroleum products, which in 2009 represent more than half of all consumption, as shown by Figure 10.

Figure 10: Primary energy consumption mix in 2000 (inner ring) and 2009 (outer ring)



The penetration rate of natural gas has increased significantly from 40% to 45% over the period. Such natural gas penetration rate is mainly explained by the fuel switch in the power electricity generation.

Excluding biomass, the share of renewable energy is still very low, at less than 1% in 2009. Of course, the situation varies from one country to another, depending mainly on hydro resources and establishment of renewable energy policies.

Finally, there should be a substantial contribution of biomass, mainly in rural areas; unfortunately, this form of energy is difficult to estimate as it is not recorded in official statistics. In Tunisia and Morocco, the share of firewood in primary energy consumption is estimated to be 12% and over 20%, respectively.

2.3. Energy production

Energy production in the region was around 384 Mtoe in 2009 against 339 Mtoe in 2000, representing an annual average growth rate of 1.4%, which is well below the increase in the rate of primary energy consumption. The region produces mainly crude oil (60%) and natural gas (39%).

Around 90% of the energy produced in the region is produced by three countries: Algeria (39%), Egypt (25%) and Libya (23%).

2.4. Energy dependency

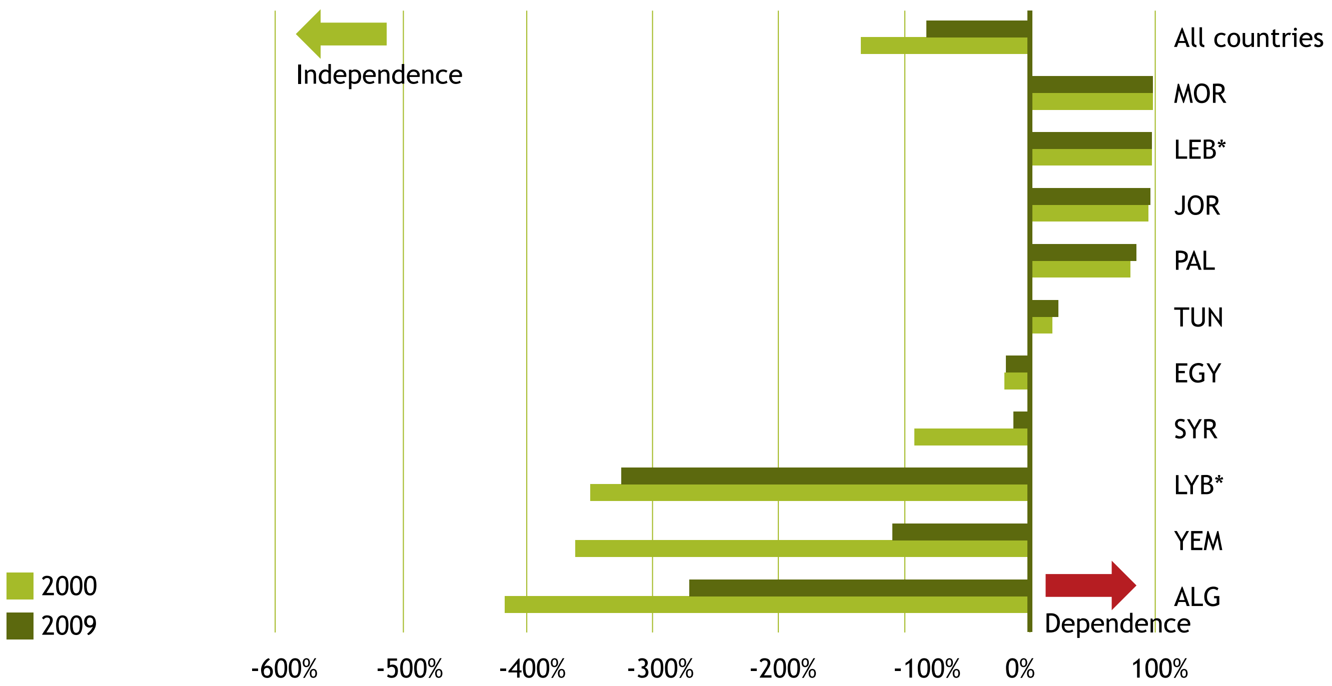
The Energy Dependency Indicator is defined as:

EDI = 1 – (Energy production / Primary energy consumption)

The higher the ratio, the more dependent a country is on supply from other countries to meet its energy needs. For net exporters, this ratio is negative.

Figure 11 presents the energy dependency ratio changes for the project countries from 2000 to 2009.

Figure 11: Energy dependency ratios in 2000 and 2009



*Source: IEA

Three country groups are distinguished:

- **Net energy exporting countries** (Algeria, Libya, Yemen)
- **Countries in transition** from being an exporter to being an importer of energy (Syria, Egypt and Tunisia)
- **Countries fully dependent** on imports for their energy supply (Morocco, Lebanon, Jordan and Palestine)

It shows also that the general trend for all the countries is moving towards greater energy dependence, including the net exporting states. Indeed, even in the largest energy producing countries, such as Algeria and Libya, the primary energy demand is increasing much faster than energy production, thus reinforcing the tendency towards energy dependence.

The largest decline in "energy supply autonomy" is registered in Syria, which exported the equivalent of its domestic consumption in 2000 and barely covered its needs in 2008, as mentioned in the country report.

In the future, the region may face high tensions in energy supply and bigger socio-economic vulnerability to oil price shocks.

The challenge for most of the target countries is to manage their social and economic vulnerability to shocks in international energy prices as a result of their inevitable dependency on foreign oil and gas markets. They urgently need to start the implementation of energy efficiency policies and a transition process to increase the share of renewable energy in their mix.

Good policy framework is needed to decouple energy consumption and economic growth.

V. Macro level indicators analysis

The energy efficiency indicators are calculated at a macro-economic level using energy and socio-economic aggregated data, with all sectors included. They allow for provision of general energy features, trends and a comprehensive diagnosis.

1. Energy intensities

Many economy-wide energy efficiency indicators have been developed and applied for evaluating, monitoring and explaining differences in energy performance between countries. Among them, the most widely used monetary indicator is energy intensity, defined as the quantity of energy required to produce one unit of GDP. It is considered to be a good measure of the energy performance of an economy. The use of energy intensities allows countries to set overall targets independent of economic growth or the level of future energy demand.

Simple energy intensity cannot be used to compare the energy performance of countries. However it can show changing patterns in energy efficiency of a given economy over the years. Indeed, the differences reflect the features of their productive structures and other differences (size and efficiency of the energy transformation sector, climate, suppressed demand, cost of factors, etc.) that could be corrected by using a set of economic methods.

Because of the lack of required data to adjust the energy intensity (like degree days, final energy consumption of subsectors, etc.), we have used **simple energy intensity defined as energy consumption divided by gross domestic product (GDP).**

For the purpose of the regional report and in order to harmonise the calculation methods, the energy intensities were calculated by using GDP at constant price expressed in U.S. dollars for the base year 2000 ($\$_{2000}$) and purchasing power parity (PPP), from World Bank database. The energy consumption data are collected by national experts and focal points[7] in the countries.

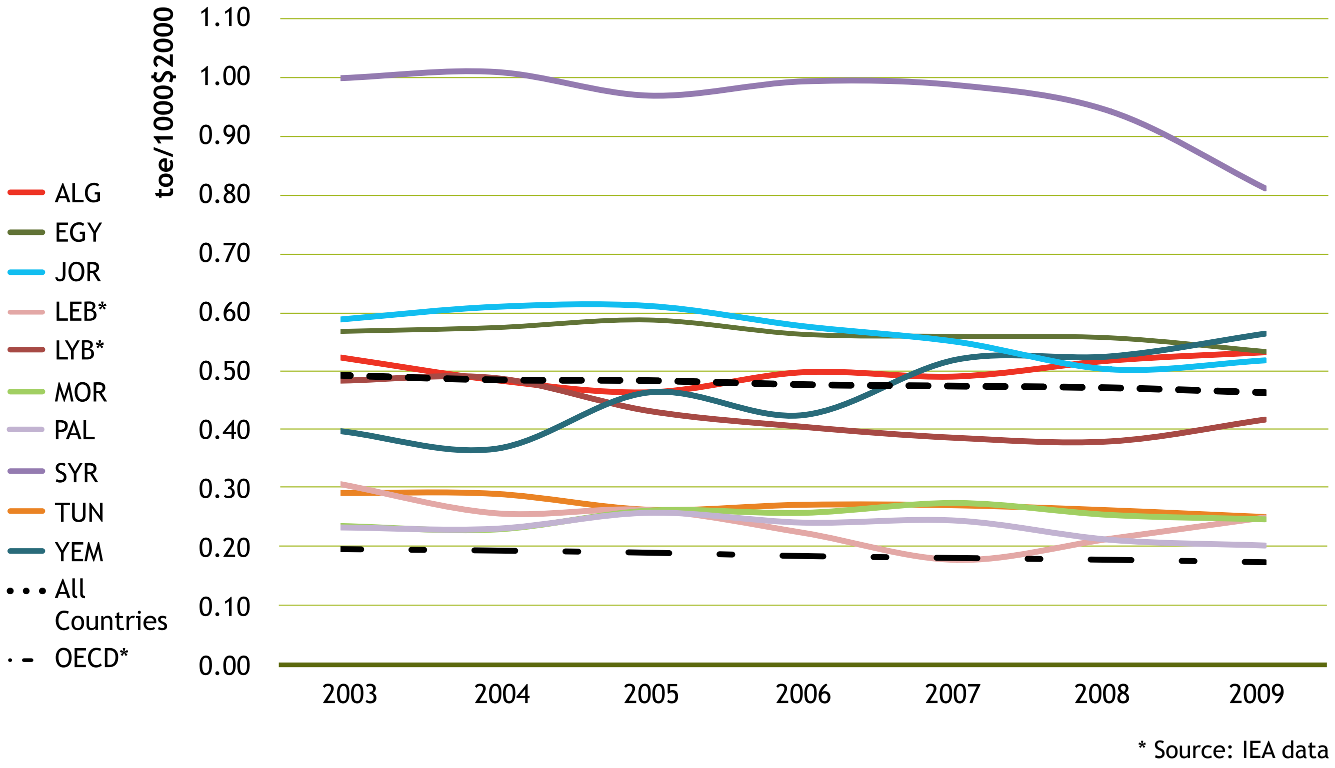
1.1. Primary energy intensity

Primary energy intensity is defined as the primary energy consumption divided by the GDP at constant price. It aims to measure the overall energy efficiency of the economy.

Figure 12 presents the development of primary energy intensities during the period 2003 to 2009.

7 Except for Libya and Lebanon where the 2009 data was retrieved from IEA database. Renewable energy and wastes are not included in the total primary energy supply, except those used for power generation (hydro and wind).

Figure 12: Primary energy intensities from 2003 to 2009



The average intensity in the region is about 0.459 Toe/1000 $$_{2000}$ in 2009, more than double the OECD average of 0.174 Toe/1000 $$_{2000}$. **Hence, among target countries, there is a huge potential for energy efficiency improvement in the region.**

Primary energy intensity of GDP varies considerably among the target countries, and we can identify three groups as shown in Table 4.

Table 4: Country groups according to the primary energy intensity in 2009

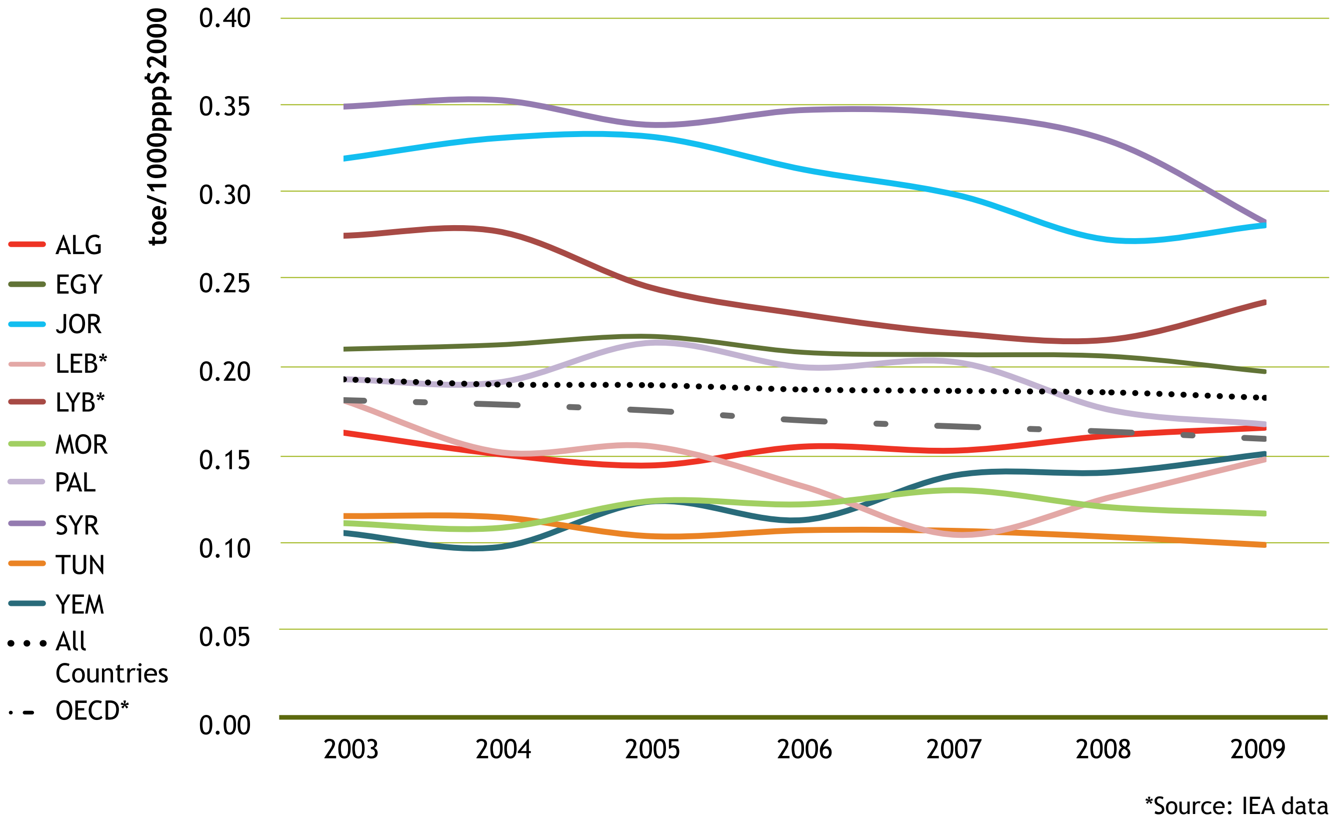
Intensity level	Range of intensity in 2009	Countries
1-Low	Less than 0.3 Toe/1000 $$_{2000}$	Lebanon – Morocco – Palestine - Tunisia
2-Medium	From 0.3 to 0.6 Toe/1000 $$_{2000}$	Algeria – Egypt - Libya - Jordan – Yemen
3-High	More than 0.6 Toe/1000 $$_{2000}$	Syria

For the first group, the low intensity can be mainly explained by an economic structure dominated by the tertiary sector[8]. Moreover, for Morocco and Palestine, the high weight of the agricultural sector in the economy has an effect of lowering the primary energy intensity. Finally, for Tunisia, the long-term energy efficiency policy, initiated in the early eighties, has played a major role in lowering the energy intensity.

For the second group, the relatively high intensity for Algeria, Egypt, Libya and Yemen can be explained primarily by the economic structure, based mainly on energy production and transformation industry. Secondly, it can be explained by the lack of major energy efficiency policies and programmes. For Jordan, the explanation is more difficult, because there is a very developed services sector and relatively high energy tariffs that encourage energy efficiency measures. The high intensity can be explained, however, by the presence of energy intensive heavy industries that have low economic value added (like cement, phosphate and derivatives, steel, and paper production).

Finally for Syria, the main causes of its high primary energy intensity are the economic structure, dominated by old industries, and the low energy tariffs, discouraging efficient use of energy. On the other hand, in order to take into account the cost of living, which is very different among the target countries, the study proposes analysis of the primary energy intensity calculated with GDP expressed in PPP, as presented by Figure 13.

Figure 13: Primary energy intensities at PPP from 2003 to 2009



In PPP terms, the average primary energy intensity of the target region is not far from OECD. Morocco, Tunisia, Lebanon and Yemen show the lowest intensities, even below the OECD average. Egypt, Palestine and Libya are around the average of the region, at about 0.18 toe/1000 $ppp 2000. Syria and Jordan show the highest intensities when expressed in PPP.

Finally, it is very important to highlight that these explanations should be treated with caution, for the following reasons:

- The informal energy market is not reflected in statistics and can have an impact on reducing the energy intensity. For example biomass, which represents a substantial portion of rural household energy consumption, particularly in Yemen, Morocco (20% to 30%) and Tunisia (around 12%), is not included in the energy intensity calculation;
- Cross-border smuggling of petroleum products in the region can cause energy intensities to be over- or under-estimated. In fact, significant illegal trade of oil products exists between Syria and Lebanon, Syria and Jordan, Iraq and Jordan, Yemen and Saudi Arabia, Morocco and Algeria, Tunisia and Algeria, Libya and Tunisia, and Egypt and Palestine. That activity is not reflected in official energy

8 See above IV.1

statistics. To illustrate this point, in 2008 the Syrian government significantly increased the internal prices of gasoline and gasoil (by more than three times), and the illegal import of these products was no longer profitable for the Lebanese traders. In 2009, we consequently observed a sudden decrease in primary energy intensity in Syria against an increase in Lebanon, which cannot be explained by a sudden improvement in the economies' performances;

- The suppressed demand is due to the lack of energy supply (e.g. in Yemen and Palestine) and also the lack of electrical appliances in households in some countries such as Yemen, Palestine and to a lesser extent Egypt and Morocco, and makes it meaningless to compare energy intensity between the project countries.

1.2. Final energy intensity

Final energy intensity aims at measuring the efficiency of energy consumption at end use level. Final energy intensity is defined as final energy consumption divided by the GDP at constant price.

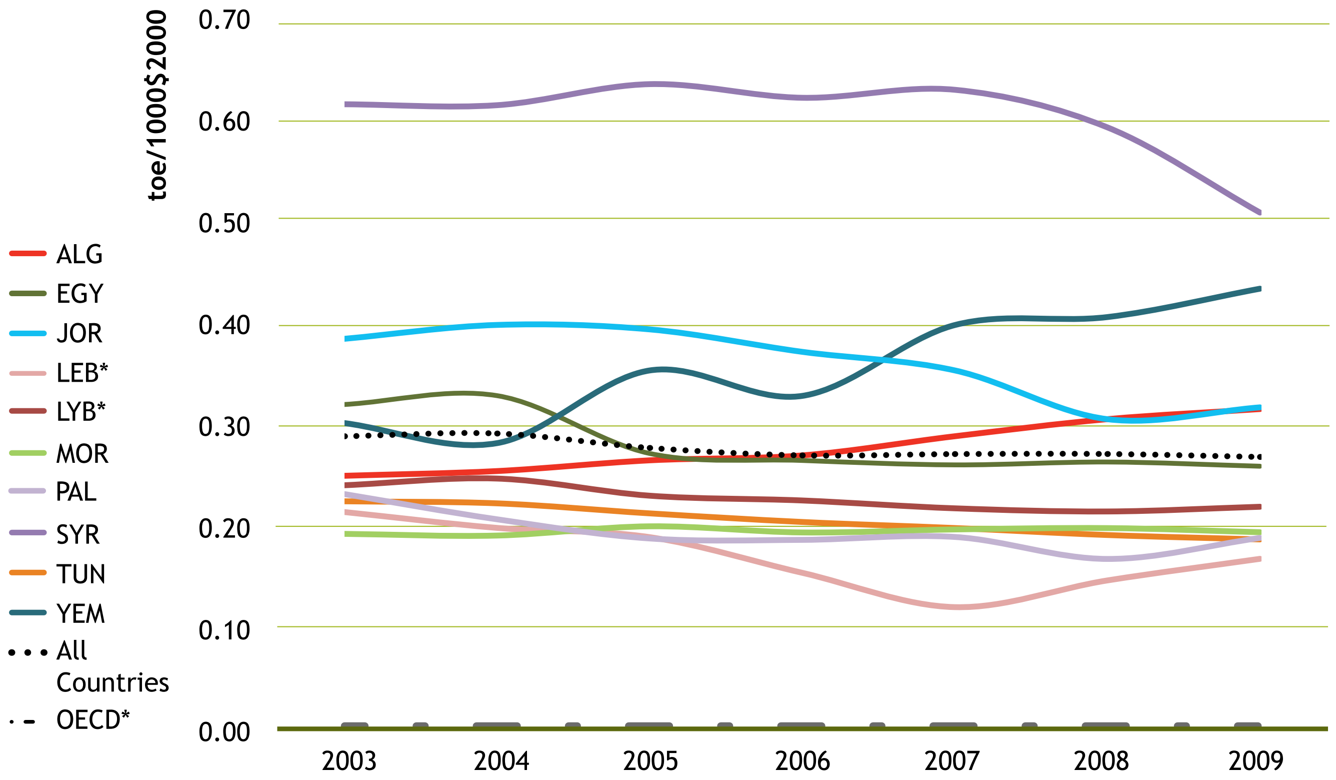
On average, the final energy intensity of the region is estimated at 0.268 toe/1000 $\$_{2000}$ in 2009 compared with an average for OECD countries estimated at 0.108 toe/1000 $\$_{2000}$.

In terms of PPP, the region's average intensity is around 0.108 toe/1000 $ppp 2000, whilst it accounted for 0.110 toe/1000 $ppp 2000 for the OECD countries.

The ratio between final and primary intensities reflects the performance of the overall energy transformation sector. In 2009, this ratio was on average about 59% for the entire region, compared with 68% for OECD countries.

For final energy intensity, the differences between countries are smaller than those observed for primary energy intensities. However, countries with low primary intensity also maintain lower final intensity, as shown by Figure 14.

Figure 14: Final energy intensities at constant price from 2003 to 2009



* Source: IEA data

The analysis allows for distinguishing two groups of countries:

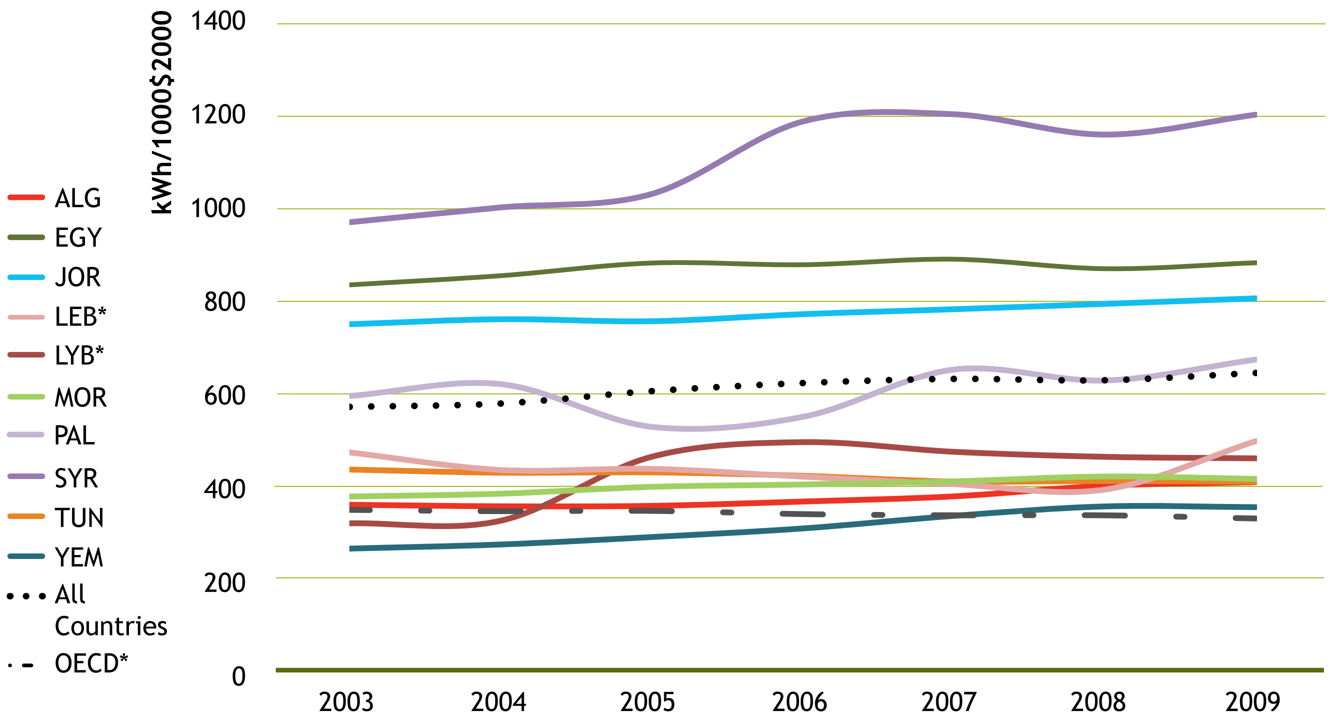
- Countries with intensities ranging between OECD and region averages: Palestine, Lebanon, Tunisia, Libya, Morocco and Egypt
- Countries with intensities beneath the region average: Jordan, Yemen and Syria.

1.3. Electricity intensities

Electricity intensity measures, at aggregate economic level, the quantity of final electricity required to produce one unit of GDP.

In 2009, the average electricity intensity in the region was around 642 kWh/1000 $\$_{2000}$, which is double the OECD average intensity of 324 kWh/1000 $\$_{2000}$. Figure 15 summarises these results for the 2003 to 2009 period.

Figure 15: Electricity intensities at constant price from 2003 to 2009



* Source: IEA data

On the basis of electricity intensity levels in the region, two main country groups are identified:

- A group with low intensity (349 to 493 kWh/1000 $\$_{2000}$) compared with the region average including: Yemen, Tunisia, Morocco, Algeria, and Libya. The low intensity in the case of Yemen does not really reflect high efficiency in energy use, but essentially the low electrification rate (less than 70% of the territory) and non-supplied demand. For Libya and Algeria, the intensities were reduced by the reduction of hydrocarbon activity in the GDP.
- A group of high electricity intensity countries above the region average including Syria, Egypt and Jordan.

1.4. Trends analysis

On average, the final energy intensity of the region has decreased slightly, by 7% from 2003 to 2009, at an average rate of 1.2% per year.

There was also an improvement of the final energy intensity for all regional countries between 2003 and 2009, except Algeria, Yemen and to a lesser extent Morocco.

The explanation for this drop in the energy intensity varies between countries. This drop cannot be explained by changes in the structure of the end use sectors, because of the short period of analysis. However, it can be explained by the general tendency towards improved efficiency in appliances sold on the regional market (fridge, TV, lighting, cars, etc.).

In the exceptional case of Syria, the drop accelerated since 2008 because of the high increase in internal energy prices, which has encouraged more energy efficient behaviour and has also reduced the smuggling of fuel to Lebanon and Jordan.

In the case of Tunisia, in addition to the general tendency towards efficiency in electrical appliances, the energy efficiency policy and programmes have largely contributed to the improvement of the final energy intensity. According to the bottom-up energy saving evaluation carried out by the National Agency for Energy Conservation[9], these programmes have allowed savings of around 3550 ktoe cumulatively over the period of 2005 to 2011. These programmes contribute around 80% of the energy intensity reduction whilst the remaining 20% could be explained by the other effects (structure, general tendencies, etc.).

Change in primary energy intensity has various sources. It may come from the efficient process of transforming primary energy into final energy. It may also be the result of more efficient use of final energy at end use level. Assessing the relative importance of these factors is useful for analytical purposes and for formulating policy recommendations.

Intensity reduction in the energy transformation sector can be achieved either by increasing the efficiency of energy conversion processes (electricity generation, oil transformation, etc.) or re-orienting the electricity mix towards more renewable energy.

However, reducing final energy intensity requires sustainable policy making in order to implement, on a large scale, energy efficiency measures in the different economic sectors (building, industry, transport, etc.).

Figure 16 presents the changes of the primary, final and transformation intensities between 2003 and 2009.

9 In cooperation with the French Agency of Energy Conservation and Environment (ADEME), 2011

Figure 16: Variation of intensities from 2003 to 2009

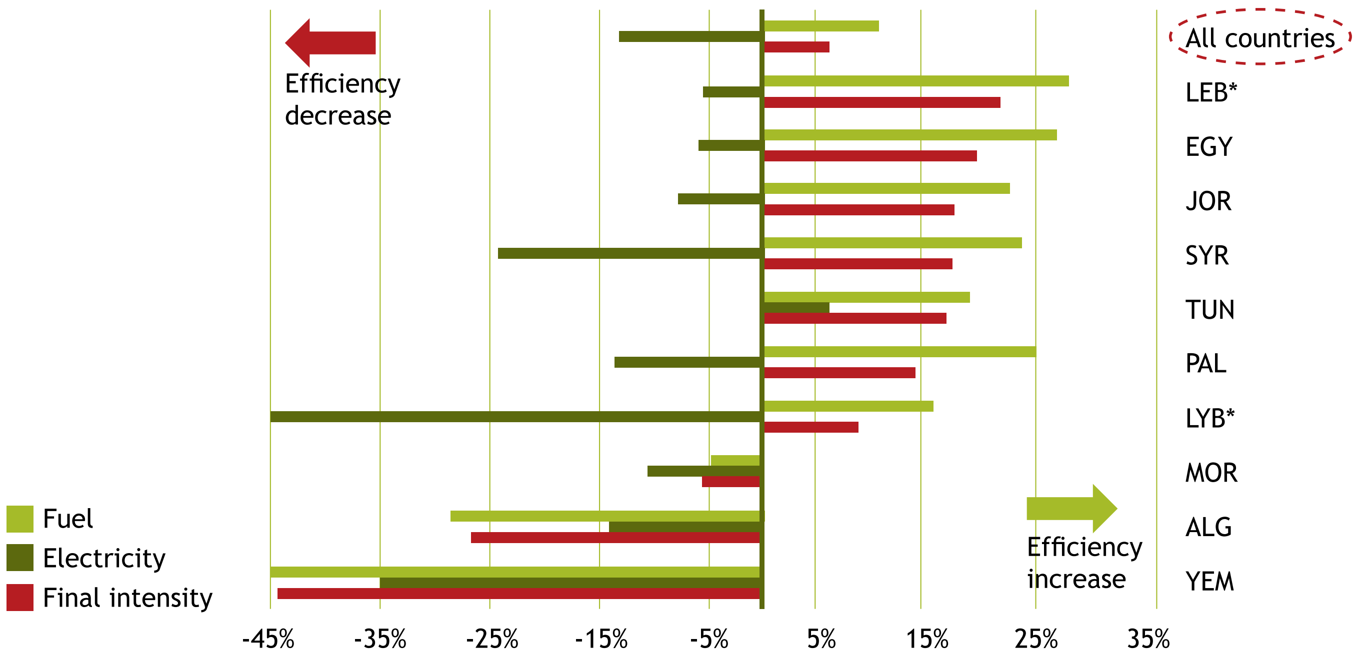
At the regional level, the primary energy intensity is reduced by 6% during the period. This means that the energy efficiency of the economies increased. The reasons are both, the increase of the transformation sector efficiency (4.7%) and the decrease of the final energy intensity (6.8%).

It is possible to distinguish 4 country groups:

- Countries where the reduction of primary energy intensity has been supported by efficiency increase in both the transformation sector and at end-use level. These countries include Syria, Lebanon, Tunisia, Libya and Jordan.
- Countries where primary energy intensity reduction comes solely from the increase in efficiency at end use level (decrease of final intensity). This improvement has been compensated by the reduction of the efficiency in the transformation sector: Egypt and Palestine.
- Countries where the efficiency increase in energy transformation has not been enough to compensate the increase of the final intensity. As a consequence, primary energy intensity has increased during the period. These countries are Algeria and to a lesser extent Morocco.
- Finally, in Yemen, both the efficiency at transformation level and end use level has been declining.

In order to analyse the sources of changes of the final energy intensities in the target countries, it is relevant to compare the respective contribution of electricity and fuel to this variation, as shown in Figure 17.

Figure 17: Variation of final energy intensities from 2003 to 2009



As mentioned previously, electricity demand in the target countries is increasing faster than the GDP. Hence, the average electricity intensity in the region has increased by 13% between 2003 and 2009, at an average annual rate of 2%. Fortunately, this growth does not totally cover the fuel energy intensity reduction, which results in an overall final energy intensity reduction. However, there is no real decrease of fuel energy intensity. Due to switching to electricity in some countries (as result of low electricity prices) gives the impression that the fuel consumption decreases. However this is not caused by efficiency increase, but due to the 'energy-switch', like for space heating and hot water.

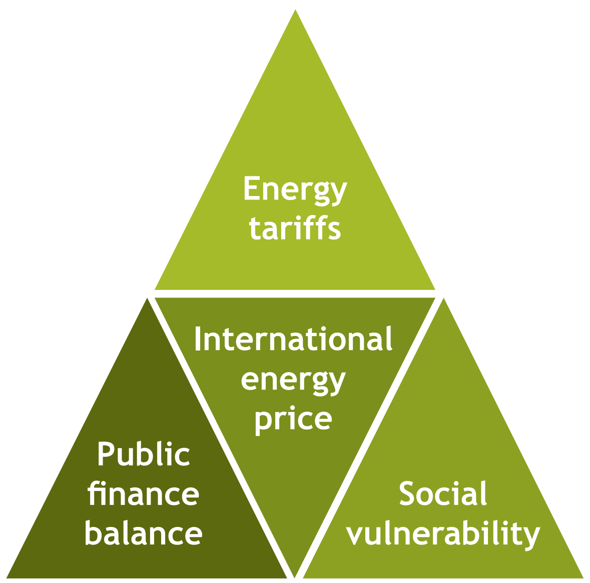
For all countries except Tunisia there was an increase in the electricity intensity within the studied period. The biggest increases in electricity intensity are noted in Libya, Yemen and Syria, as shown in Figure 17. This phenomenon is explained mainly by the rapid growth in electricity demand in the residential sector, in line with the increase in the appliance ownership. Moreover, the appliances sold on the local market are usually cheap and with low energy efficiency, which accelerates the upward trend in electricity intensity. In some cases, like Jordan, the differences between electricity tariffs and fuel prices encourage consumers to switch some energy usage (like heating) to electricity.

Reduction of electricity intensity requires a stable policy for electricity demand side management, including implementation of energy efficiency measures in the different sectors and minimum energy performance standards for appliances, efficient lighting programmes, appropriate electricity tariffs, building regulation, etc. Since they are members of the League of Arab States, the project countries should work actively on the implementation of energy efficiency measures in the framework of the NEEAP as recommended by the Arab Ministerial Council for Electricity, through the energy efficiency guidelines launched in November 2010.

2. Energy bill and subsidies

In addition to the strategic issue of the security and continuity of national energy supply, the energy sector in most countries of the region arises as an important issue in terms of socio-economic vulnerability to increases in international energy prices. This vulnerability can be analysed through three main aspects:

- Expensive energy bills for these countries in comparison with the performance of their economies, which can reduce their economic competitiveness.
- The great need for foreign currency to pay these energy bills.
- The pressure on public finances caused by the large amount of subsidies on domestic energy prices, justified by the protection of the poor.



In the short term, after the Arab Spring movements, any cost-effective energy tariff policy including high increase in domestic energy prices would not be socio-politically acceptable. Governments thus often face a dilemma between the need to protect the poorest social classes and the need to preserve the balance of their public finances against a continual increase in international energy prices.

For net energy exporting countries, the situation is for the moment less critical. However, we have seen that even for the large energy producers the energy dependency ratio is getting higher because of the quick increase in the internal demand and the stagnation (or low rate of increase) in gas and oil production.

For these reasons we have thought it is useful to integrate in this work some indicators on energy bill and energy subsidies, although we are aware of the difficulty of such exercise. We have introduced two indicators:

- Ratio of energy bill to GDP at current price
- Ratio of energy subsidies to GDP at current price

2.1. Method

The precise calculation of the energy bill and public subsidies to energy in a country often raises serious methodology issues.

First, the concepts of energy bill and subsidies must be defined.

Energy bill, or the cost of energy supply for the community, is made up of two components:

- The cost of the quantity of consumed primary energy produced locally
- The cost of the quantity of primary energy imported from abroad

So, the cost of imported energy, the national energy bill, can be expressed as:

National energy bill= $\sum_i Qi \times PCi + \sum_j Qj \times IPj$

Qi: Consumed quantity of the primary energy product (i) produced locally
PCi: Local production cost of the primary energy product (i)
Qj: Consumed quantity of the primary energy product (j) imported from abroad
IPj: CIF[10] import price of the primary energy product (j)

The calculation of the public energy subsidy is more complex. For a given product, the subsidy is equal to

10 Cost, insurance and freight.

the price at which a state sells to energy distributors (in case of administered prices) minus the supply cost of the product (CIF import price or production cost or local processing) plus taxes collected by the state on the product.

However, in most countries of the region the parameters for calculating the real costs of energy supply and especially the amount of public energy subsidy are very often not available. For example, this is the case for the real energy production costs and the average import prices that heavily depend upon energy supply sources and trade agreements, etc. Even in countries where such data exists, they are often considered as highly confidential and inaccessible.

For these reasons we, in agreement with the experts' working group, adopted a **simplified method** (see paragraph 2.1.2 energy sector subsidies) that does not provide accurate values of the bill and energy subsidies. However the method should give a good approximation, sufficient for policy decisions.

The values calculated by the proposed method should not be considered as the real costs, such as those established by public accounting of the financial flows of energy (when they exist).

2.1.1. Energy bill calculation

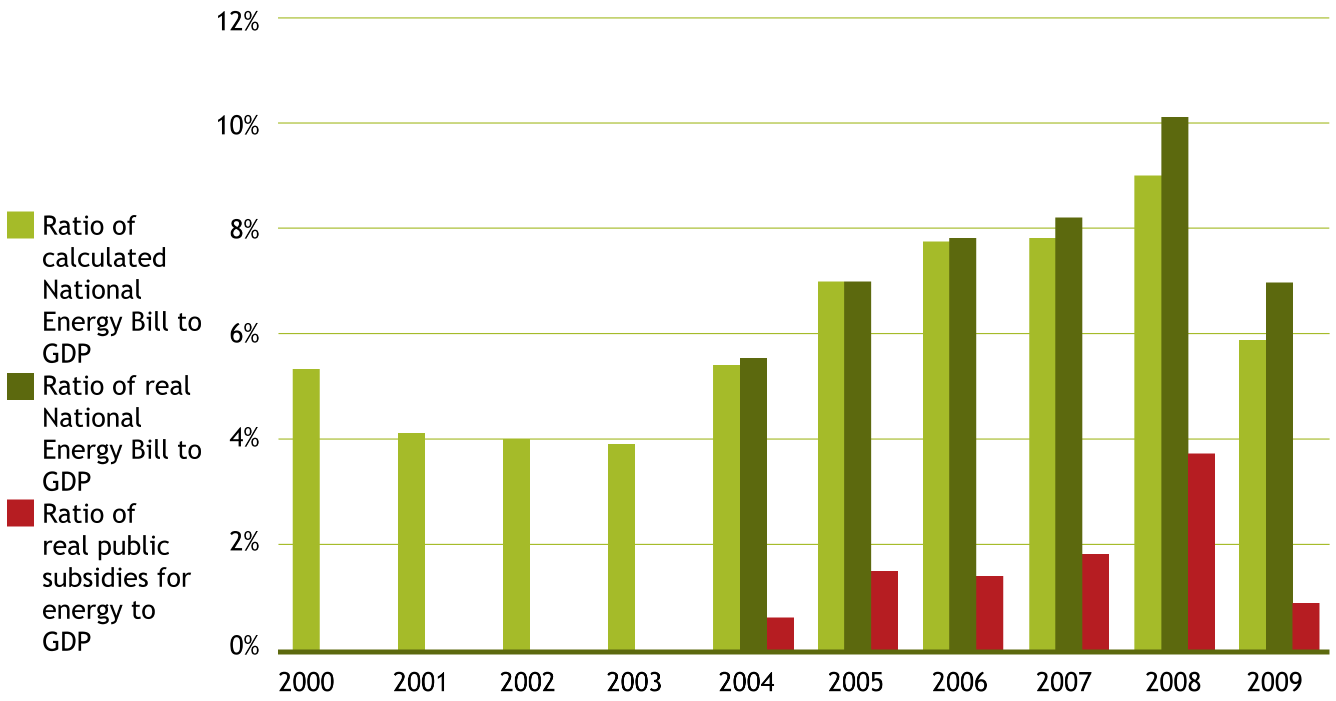
For the energy bill, the simplified method proposes the following definition: sum of the quantities of consumed primary energy products multiplied by their international prices.

This definition raises two important issues:

- International prices used for bill calculation are the annual average price on the Mediterranean market provided by PLATTS[11] database. These prices do not accurately reflect the real import prices paid by countries, which depend on several factors (quantities purchased, purchase dates, bilateral trade agreements, etc.).
- For importing countries, the bill calculated under this method is quite close to the real bill paid by the country. However, for (even partially) exporting countries, the method reflects the value of local energy consumption on the international market. Figure 18 illustrates this situation for Morocco.

11 www.platts.com

Figure 18: Ratio of national energy bill to GDP in Morocco



2.1.2. Energy sector subsidies

According to the simplified method, the energy subsidies can be considered as the difference between the **national energy bill and energy sales value in the local market.**

Local energy sales value is calculated as the sum, for all products, of final energy quantities consumed multiplied by the average prices in the domestic market.

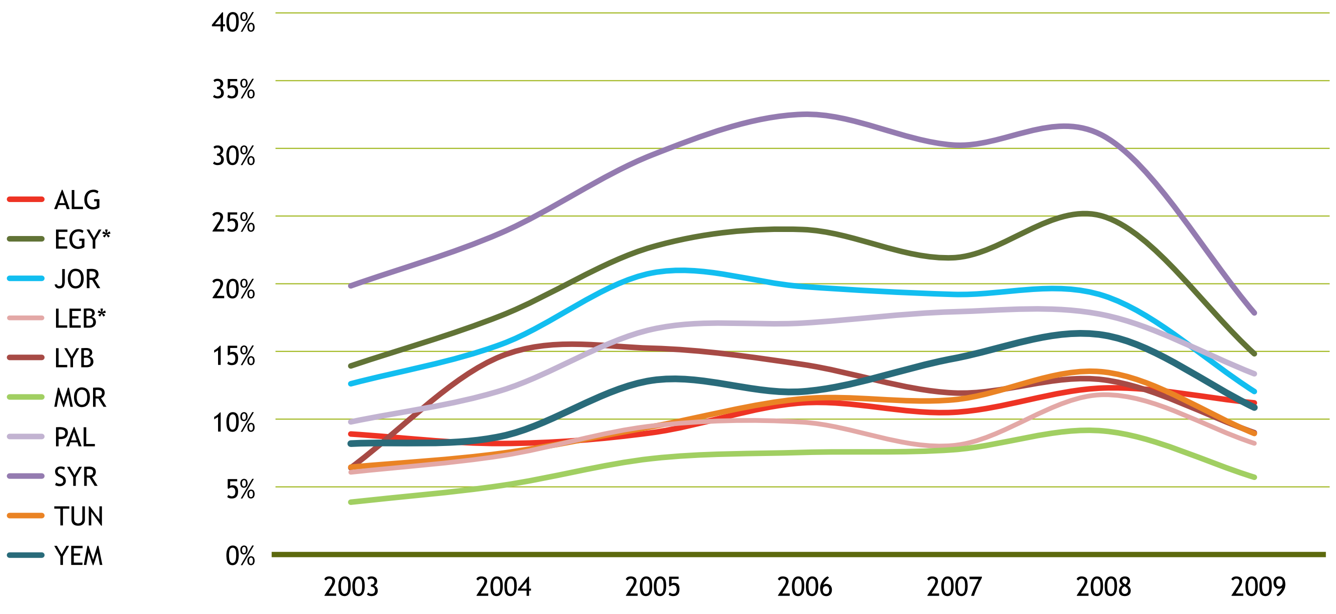
This definition must be used with great caution. In fact, there are fundamental differences between exporting and importing countries. Once again, for total importing countries like Morocco, Lebanon and Jordan, the subsidies calculated according to the proposed method should be close to the real subsidy paid by the government for conventional energy. However, in the case of net exporters, particularly Algeria and Libya, it is recommended to talk about a lost opportunity cost for the country than a subsidy bill.

2.2. Results

2.2.1. The national energy bill

Figure 19 presents the evolution of the energy bill as calculated using the method discussed above.

Figure 19: Ratio of national energy bill to GDP from 2003 to 2009



*Source: IEA

It should be kept in mind that from 2005 until 2008, international energy prices increased greatly, peaking in 2008. For this reason, the target countries' energy bills reached the highest rates in 2008, mainly for net importer countries, (ranging from 8% to 32% of GDP). For large energy exporter countries, the ratio was mitigated by the increase in GDP because of the increased value of their hydrocarbon exports.

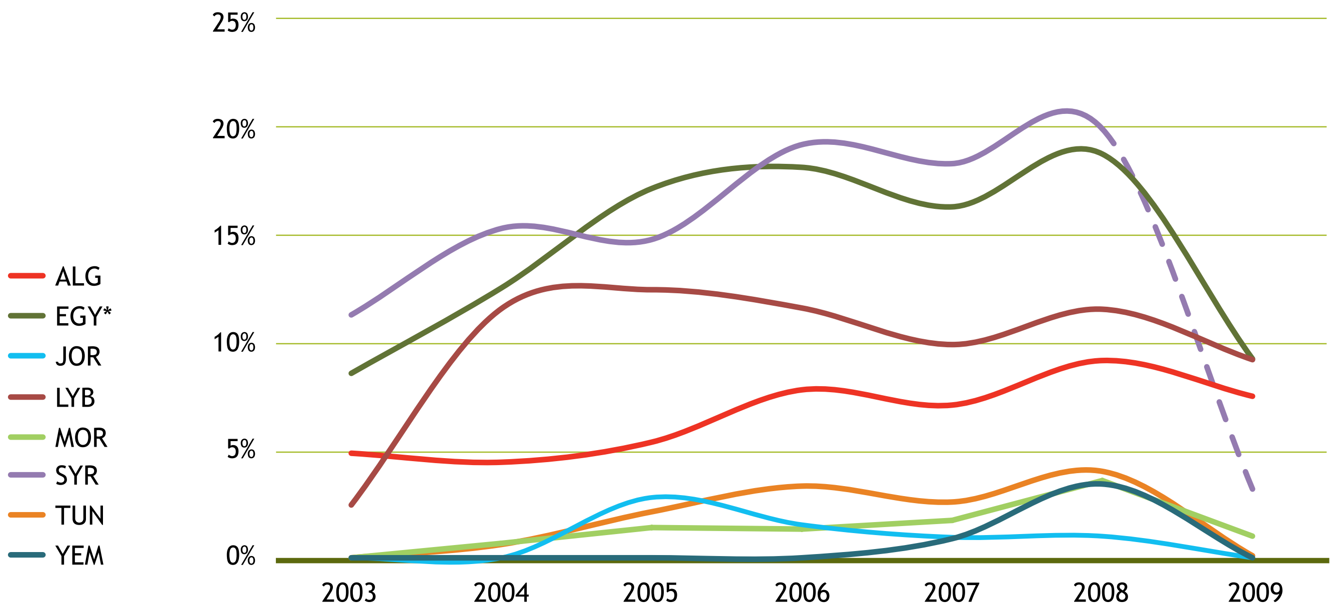
The analysis shows that, in general, countries with low primary energy intensity have a relatively low ratio of energy bill to GDP. For 2009, it is possible to identify three levels:

- First level with lowest ratio: Morocco (5%)
- Intermediate level with ratio of energy bill ranging from 9% to 12%: Lebanon, Tunisia Libya, Algeria, Yemen and Jordan
- Level with high ratio, including Syria, Palestine and Egypt (around 18%).

2.2.2. Energy subsidies

Figure 20 presents the ratio of energy subsidies to GDP for the target countries between 2003 and 2009.

Figure 20: Ratio of energy subsidies to GDP for 2003 to 2009



*Source: IEA for Energy Data

In addition to the energy performance of the economy, this indicator depends heavily on the country's energy tariff system. On the basis of these criteria, two country groups can be distinguished:

- Countries with a socially-oriented energy tariff system with heavy subsidies, such as Egypt, Syria, Algeria, Libya and, to a lesser extent, Lebanon. In 2008, the subsidies for Egypt and Syria accounted for about 23% and 20% of GDP, respectively. In 2009, with the drop in international energy prices, the share of subsidies in relation to GDP fell to 12% in Egypt and 3.2% in Syria. For the latter, this important drop of the ratio can be explained by the sharp increase in domestic fuel prices and also the consequent reduction of fuel smuggling to Lebanon and Jordan. For Algeria and Libya the indicator was mitigated with the high GDP of the countries based mainly on hydrocarbon exports. In 2009, the ratio was 7.5% and 9.2%, respectively.
- Countries with controlled and low subsidy of energy tariffs like Tunisia, Jordan, Morocco, Palestine and Yemen. For this group the ratio was ranging from 0% (Palestine) to 4% (Tunisia) in 2008 and less than 1% for Tunisia in 2009, with the decrease in international energy prices.

3. CO_2 emission indicators

At the macro level, two main indicators are calculated:

- Energy sector CO_2 emissions per capita: Total quantity of CO_2 emissions due to fuel combustion[12] divided by the population.
- CO_2 intensity: Total quantity of CO_2 emissions due to fuel combustion divided by GDP in $\$_{2000}$.
- It should be mentioned that for all countries except Tunisia[13] there is no formal greenhouse gas emission inventory of the energy sector for the year 2009. GHG emission inventories were developed within the 1st, 2nd and 3rd National Communication to the UNFCCC for the years of 1994, 2000

12 This quantity does not include fugitive emissions

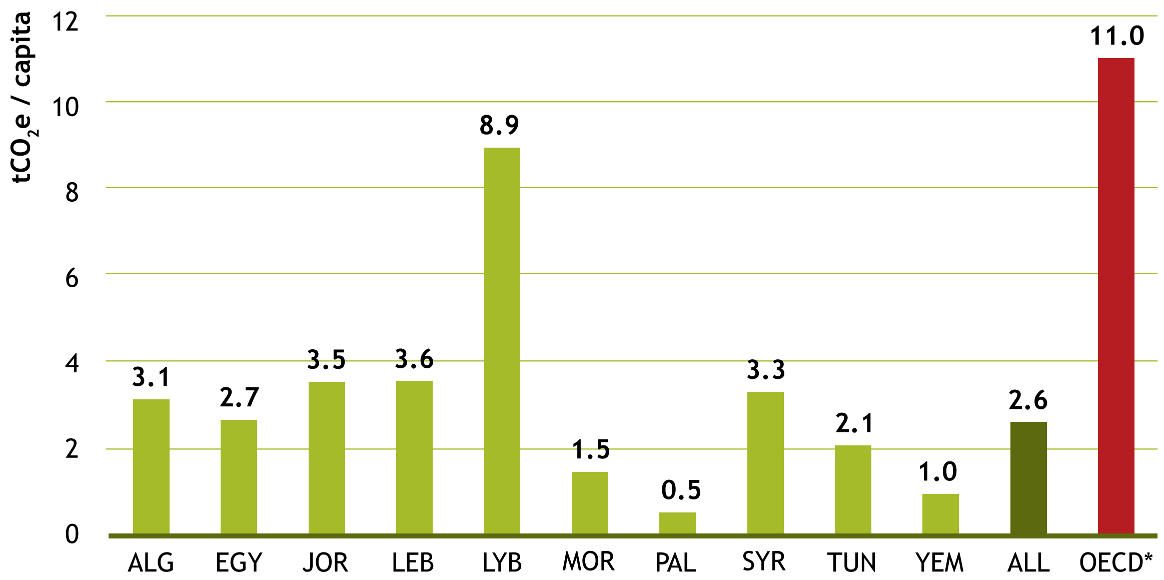
13 Which elaborates yearly its GHG inventory

and 2005, but not for 2009. For that reason, IPCC guidelines were not used for calculating countries' GHG emissions. A simplified method was used by the experts for estimating these emissions: the quantity of CO_2 emissions is equal to the sum of consumed primary energy products multiplied by their emission factors. Therefore, this quantity does not include fugitive emissions (that is emissions other that from combustion, like gas losses).

3.1. Emissions per capita

- The average emissions per capita in the region are around 2.6 tCO_2e per capita, which is far below the OECD average of 11 tCO_2e per capita.

Figure 21: Energy sector CO_2 emissions per capita



*Source: World Bank

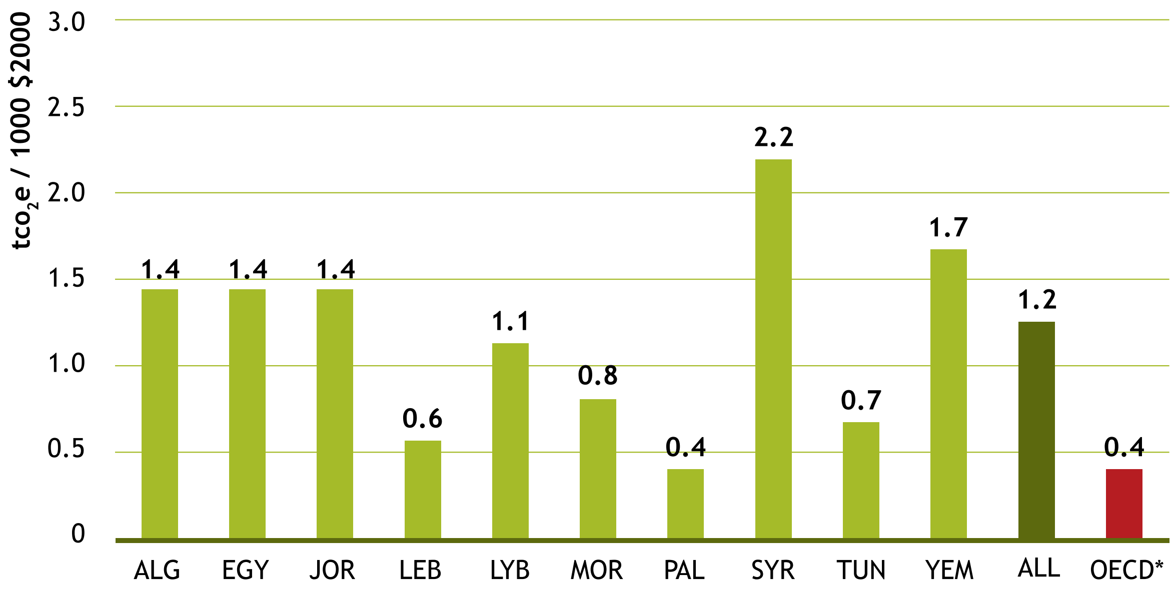
As illustrated in Figure 21, Libya has by far the highest emissions per capita. This is due primarily to the high level of primary energy consumption per capita (more the 3 toe/capita). For Yemen and Palestine the ratio is very low because of the low primary energy consumption. In addition, for Palestine, the import of all electricity leads to the reduction of emissions.

For the other countries, the figures are close with small variation due to the differences of fuel mix.

3.2. CO_2 intensity

The average CO_2 intensity (1.2 tCO_2e /1000 $\$_{2000}$) is about three times more than the OECD average (0.4 tCO_2e /1000 $\$_{2000}$), as shown in Figure 22.

Figure 22: CO_2 intensities from fuel combustion in 2009



*Source: OECD

The CO_2 intensities are strongly correlated with primary energy intensities. Syria, Yemen, Algeria, Egypt, Libya and Jordan therefore show the highest CO_2 intensities in the region in 2009. Although they had the same primary energy intensity as Morocco and Tunisia in 2009, Palestine and Lebanon show much lower CO_2 intensities. This can be explained mainly by the fact that a large portion of their electricity consumption is imported, so the electricity sector emissions are not recorded.

VI. Energy transformation sector

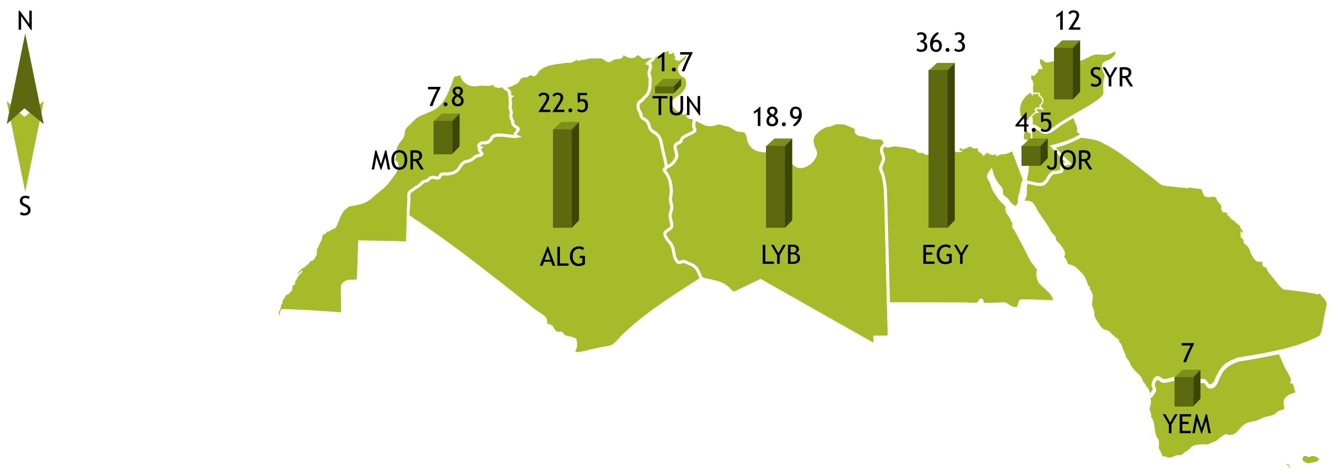
1. Main features of the transformation sector in the region

The energy transformation sector in the region is mainly composed of crude oil refineries and power generation capacities. In addition, there are some LPG and LNG facilities, mainly in Algeria and Egypt.

1.1. Oil transformation

The total refinery capacity in the region in 2012 is estimated at 110 million tons per year; 80% of this capacity is located in 4 countries: Egypt, Algeria, Libya and Syria. Some smaller, older refineries exist in the other countries like Tunisia and Jordan, Figure 23.

Figure 23: Refinery capacities in the project countries in 2012



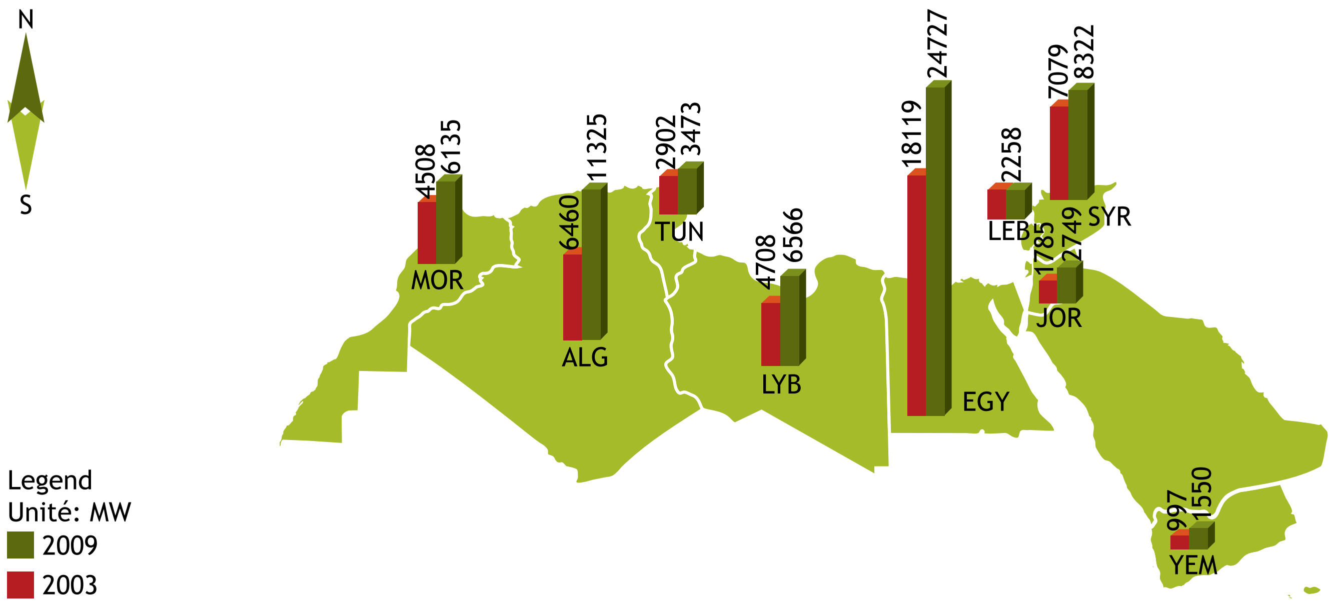
Source: US EIA, 2012

1.2. Electricity sector

In most countries in the region, the generation, transmission and distribution of electricity are still the monopoly of state-owned companies. However, liberalization initiatives in this sector have started in some countries like Jordan, Morocco and, to a lesser extent, Tunisia and Egypt by allowing private generation through independent power producers (IPP). However, in general, the power sector in the region is still largely state-administered in terms of sector investment, tariff setting, etc.

The total installed generating capacity in the region has risen from 49 TW to 61.5 TW with an average growth rate of 3.8% per year, over the period 2003 to 2009. Four countries alone – Egypt, Algeria, Libya and Syria – represent about 75% of the regional capacity, see Figure 24.

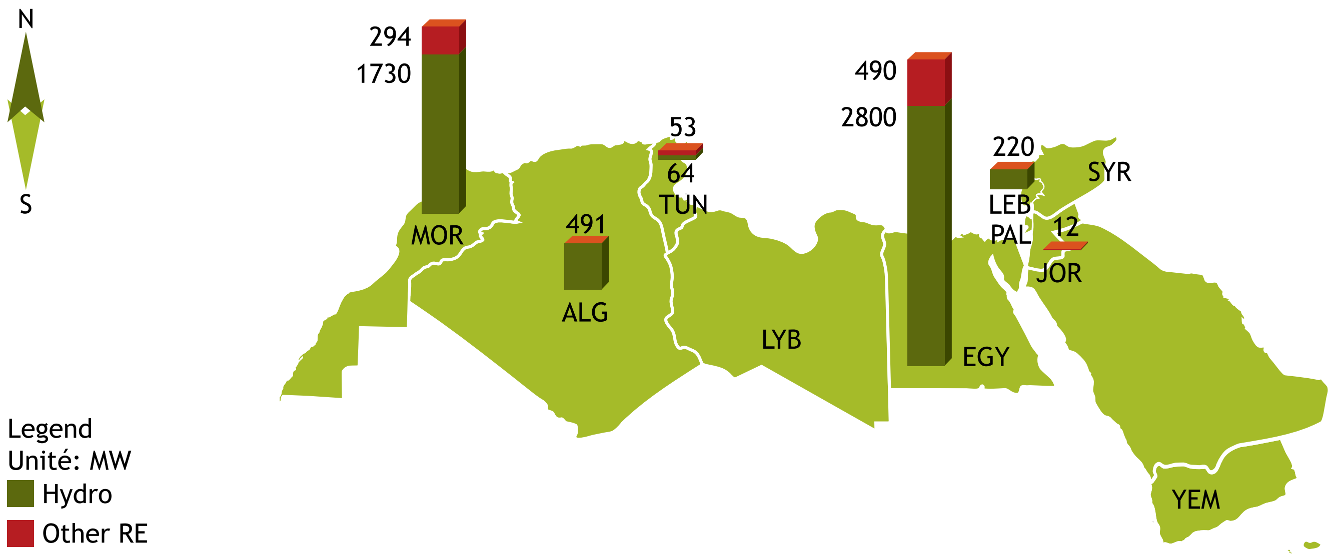
Figure 24: Installed power generation capacity in the project countries in 2003 and 2009



Source: Countries sources

The share of renewable energy (RE) in the power generation capacity is estimated at around 11.4% in 2009 including hydro (7683 MW). Excluding hydro, the renewable energy share is about 1.2% (840 MW).

Figure 25: Installed renewable power generation capacity in the project countries in 2009

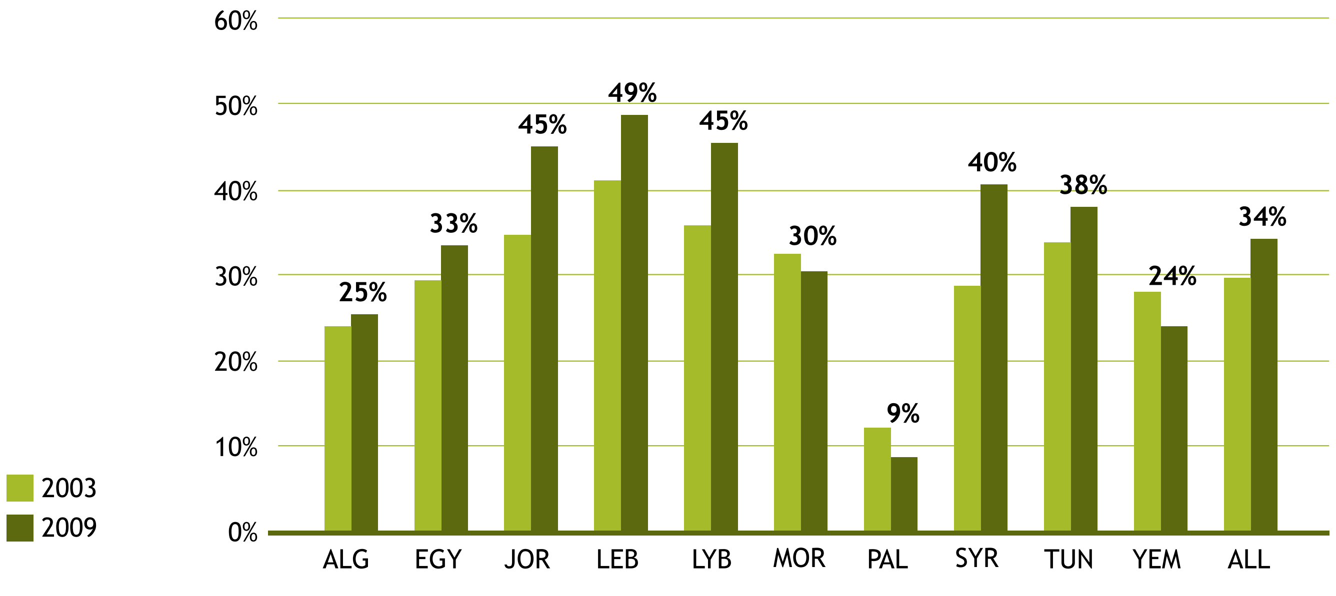


Source: Countries sources

Figure 25 shows that the most important RE capacity is installed in Egypt with about 2800 MW of hydro and 490 MW of wind energy, followed by Morocco with 1730 MW of hydro and 294 MW from other RE sources.

To illustrate the impact of electricity generation on the primary energy needs, the following chart compares between 2003 and 2009 the share of fuel input for electricity generation in the countries' primary consumption.

Figure 26: Share of fuel input for electricity generation in total primary energy consumption for 2003 and 2009



Source: Countries

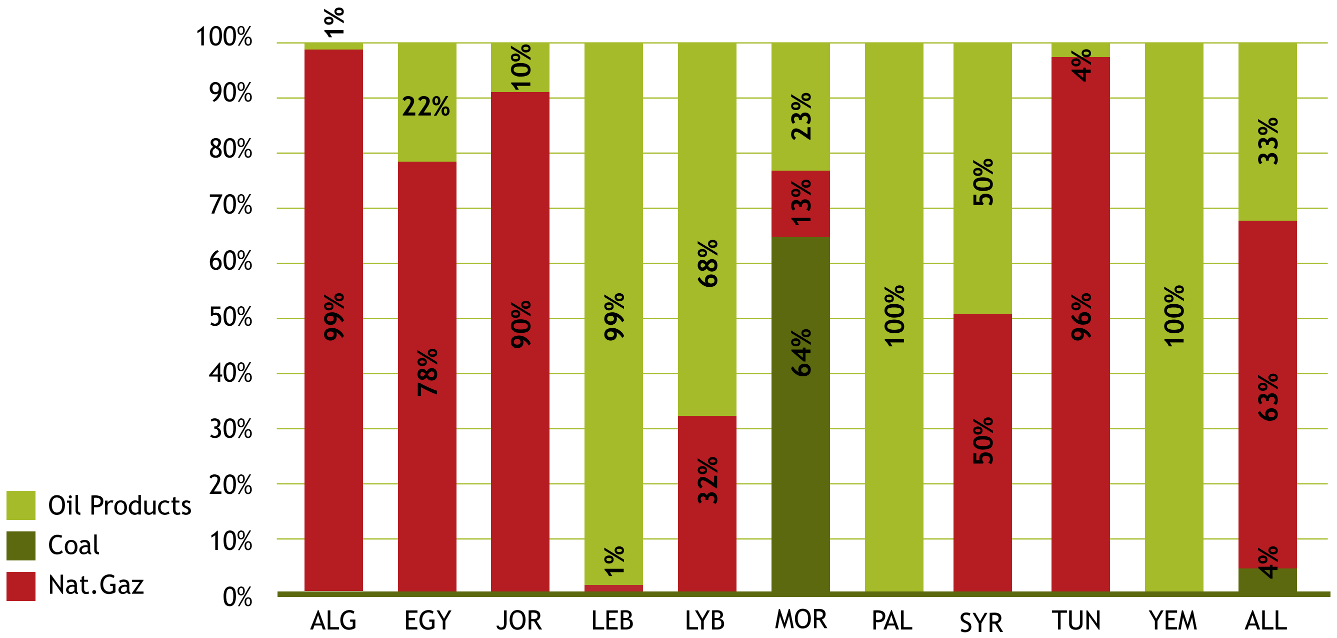
The share of energy consumption for power generation in primary energy consumption is increasing and has risen from 30% in 2003 to 34% in 2009. Lebanon, Jordan, Libya and Syria show the highest ratio, with 49%, 45% and 40% respectively, see Figure 26.

It is therefore important to highlight the target countries' need to monitor this sector carefully and in particular to develop the required energy efficiency measures in generation, transmission and distribution of electricity.

Palestine, Morocco and Yemen are the only countries that have slightly reduced this share. However Morocco and Palestine have increased their shares of imported electricity (Morocco from Spain and Palestine from Israel) from 1% to 3% of total primary energy, between 2003 and 2009. For Yemen, the decreasing share of fuel for electricity generation in the primary energy consumption can be explained by the unmet electricity demand due to the shortage in development of generation capacity.

In the region, natural gas remains the most important energy form in the conventional electricity generation mix, with a share of about 62%. The other sources are mainly oil products (32%), and to a lesser extent coal used only in Morocco, as shown by Figure 27.

Figure 27: Primary conventional energy mix for electricity generation in 2009



It is important to highlight the high level of dependency of some countries on natural gas for electricity generation, such as Algeria (99%), Tunisia (97%), and Jordan (90%). Whilst this dependency is not an important issue for Algeria since it is a large natural gas producer, it could be a serious concern for the other two countries with low natural gas resources.

2. Main indicators analysis

Ten indicators were selected to provide an initial diagnosis of the energy transformation sector's efficiency:

- Share of installed RE electricity capacity
- Usage rate of the installed power generation capacity
- Apparent efficiency of energy transformation sector
- Power generation efficiency of thermal plants
- Specific consumption of thermal power plants
- Power generation efficiency
- Specific consumption of power generation
- Electricity transmission and distribution system efficiency
- Power generation emission factor
- Electricity sector emission factor

By using these indicators it will be possible for decision makers to:

- Assess the overall effectiveness of all energy transformation sub-sectors (electricity production, refining, LPG and LNG processing, etc.);
- Get a preliminary diagnosis of power generation efficiency in terms of technology, energy mix, and management of existing power plants;
- Assess the impact of renewable energy on the global efficiency measures of the energy transformation sector, etc.

In this report, and according to available data, we present three key indicators that are the most used in international practice:

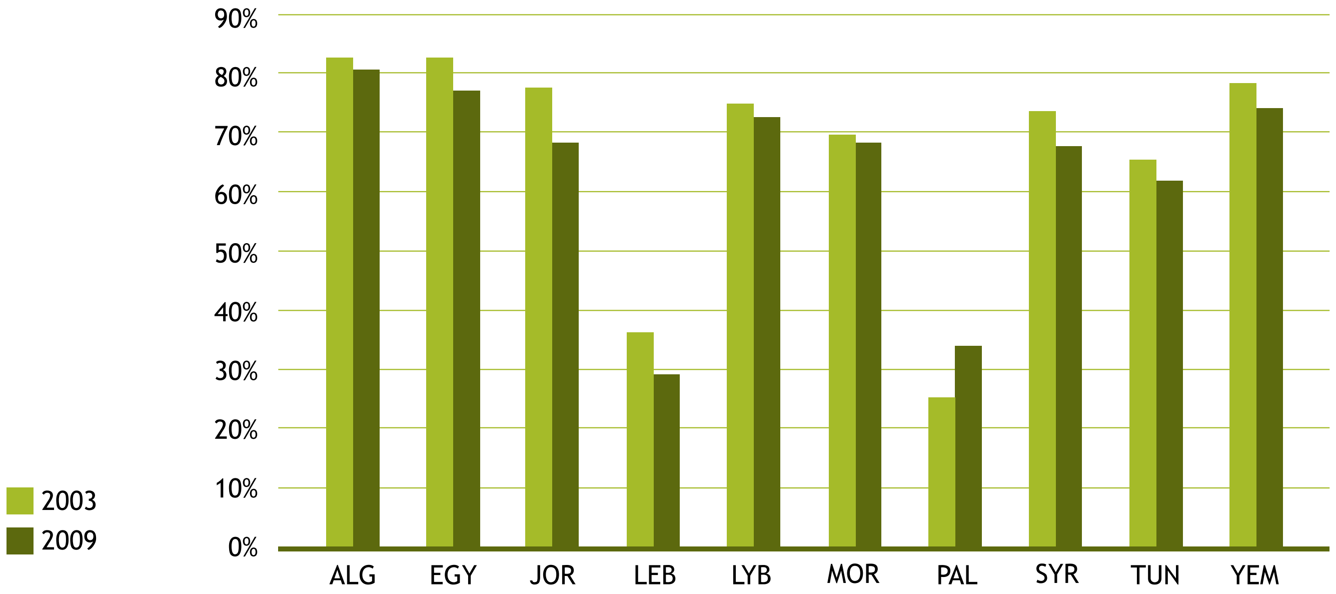
- Apparent Efficiency of Transformation Sector (AETS)
- Specific Consumption of Power Generation (SCPG)
- Electricity Sector Emission Factor (ESEF)

2.1. The apparent efficiency of transformation sector

The AETS can be defined as the total energy output of the transformation sector (excluding renewables) divided by the total input of primary energy to the process. Therefore, it measures the efficiency of the overall energy transformation sector including all types of processing.

The development of the indicator between 2003 and 2009 is presented in Figure 28:

Figure 28: Apparent efficiency of transformation sector for 2003 and 2009



Source: Countries

AETS varies widely among countries due to many factors, particularly the efficiency level of electricity generation. Analysis of the apparent efficiency data allows the following comments to be made:

- Lebanon shows the lowest value for this indicator, with an average of 29% in 2009. In the case of Lebanon this indicator refers exclusively to the power generation sector efficiency, because there is no refining industry in this country.
- Except Lebanon and Palestine, the AETS does not vary greatly between countries and ranges between 60% and 80%.
- In general, the efficiency of the energy transformation sector tends towards decline, except the particular case of Palestine. This may be due to several key concomitant factors: aged plants, operation quality, equipment condition, shape of the electricity load curve, etc.

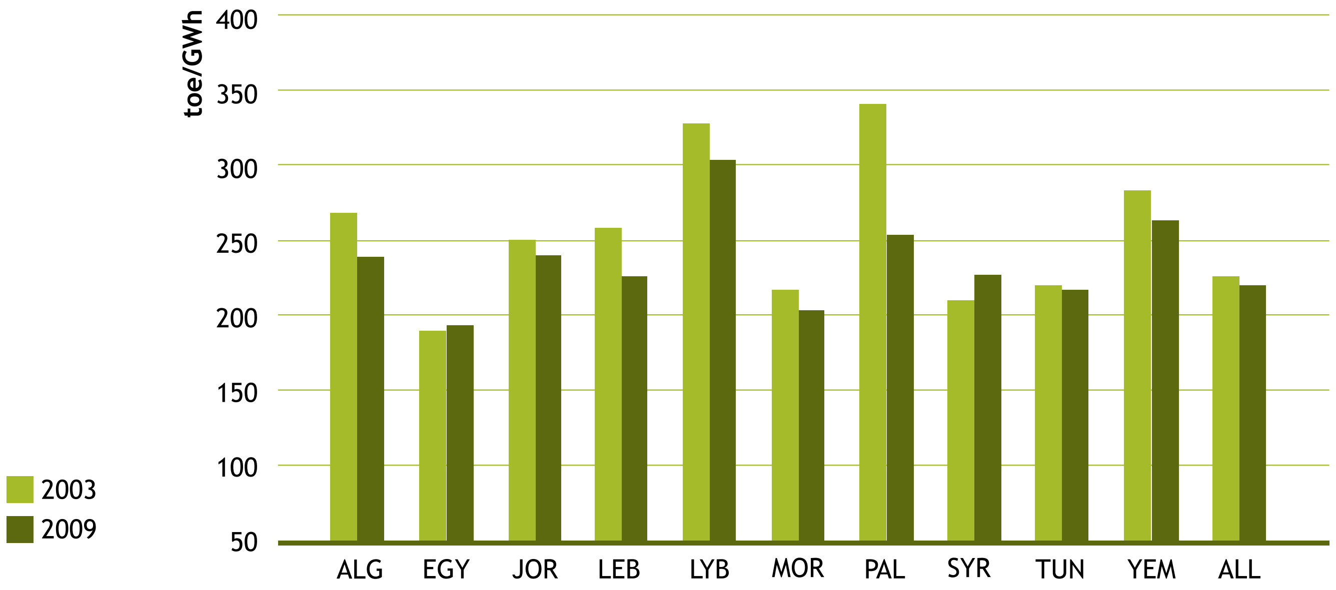
2.2. The specific consumption of power generation (SCPG)

The SCPG indicator measures the efficiency of installed power generation capacity. Its level depends on the following main parameters:

- Power generation technology mix
- Obsolescence of the plants
- Renewable energy share
- Fuel mix for power generation
- Efficiency of plant operation and maintenance
- Shape of the load demand curve, etc.

The average specific consumption for the region has decreased slightly from 224 toe/GWh in 2003 to 220 toe/GWh in 2009. The variations per country are shown in Figure 29.

Figure 29: Specific consumption of electricity generation for 2003 and 2009



Source: Countries

Taking into account renewable electricity generation, Egypt and Morocco have the lowest specific consumption in 2009, at 193 toe/GWh and 204 toe/GWh respectively. Among other factors, hydropower electricity has contributed significantly to reducing the specific consumption.

Excluding renewable electricity generation, the SCPG in these two countries would increase to 240 toe/GWh and 243 toe/GWh respectively. It clearly shows the role of renewable energy in increasing the efficiency of electricity generation in a given country.

On the other hand, Libya and Yemen, which still do not have renewable generation, present the highest specific consumptions with 303 toe/GWh and 263 toe/GWh respectively in 2009.

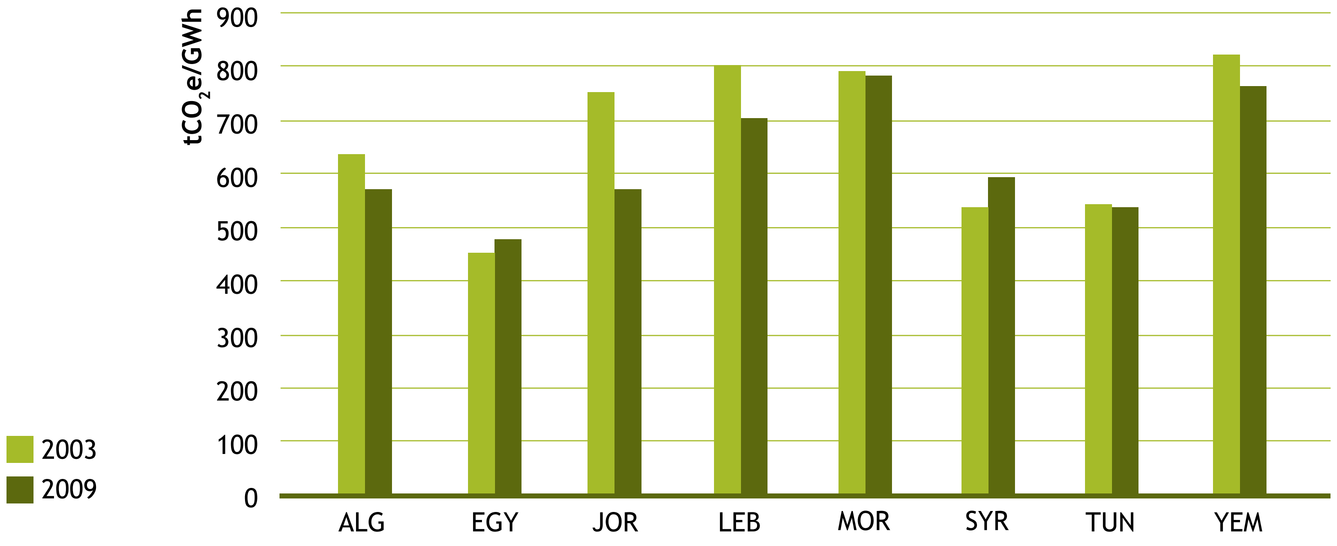
3. GHG emission performances

Fossil-fuelled power generation is responsible for major greenhouse gas emissions worldwide in the energy sector. GHG mitigation should therefore focus on this sector.

The environmental performance of the power generation sector measured by the emission factor is defined as the emitted quantity of CO_2 equivalent per unit of generated electricity.

Egypt has the lowest emission factor due to the significant role of renewable energy, as shown in Figure 30. However a trend towards higher emissions is observed because of the growing share of fossil fuel in the electricity mix.

Figure 30: Power generation emission factors for 2003 and 2009



Source: Countries

Despite its significant share of renewable electricity, Morocco has maintained a high emission factor level due to the high share of coal in power generation. The emission factor should decrease in the future according to the country's new energy strategy focusing on accelerated development of renewable energy and with switching to natural gas for fossil fuel-fired plants.

Yemen also has a high emission factor compared with other countries in the region because of the electricity mix based exclusively on use of oil products.

The biggest emission factor decline was recorded in Jordan which decreased by 23% between 2003 and 2009. The fuel mix is changing significantly in favour of natural gas, with the share of natural gas fuel for generation increasing from 22% in 2003 to 90% in 2009.

VII. Industry sector

1. Main features of the sector

The industrial sector in the region represents around 30% of the value-added in the economic structure (see Figure 8). However, the economic value added of the industrial sector varies greatly between the countries: it is very high in energy producing countries like Libya (78%) and Algeria (62%) and low in service-oriented economies like Tunisia, Jordan or Lebanon (around 22%).

The structure of the industry sector is also very different in each of the countries in the region, especially between countries with diversified economies, and hydrocarbon based economies.

In terms of number of establishments, the statistics are sparse and incoherent because of the lack of a universal definition (enterprise size, activities, etc.). Table 5 gives the number of industrial consumers for some of the target countries.

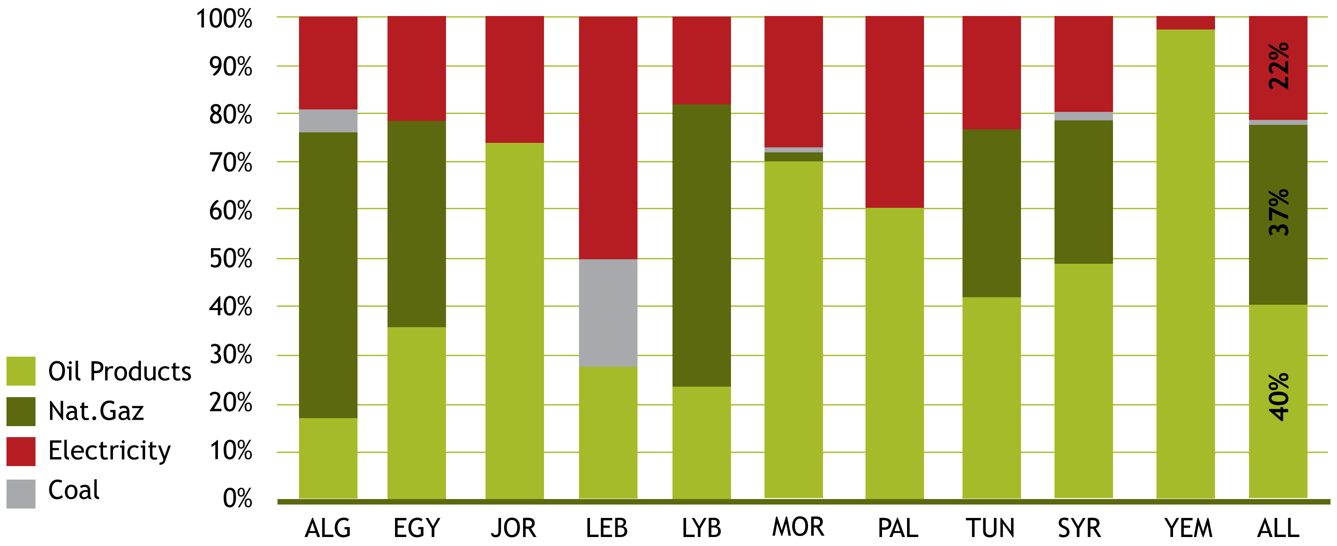
Table 5: Number of industrial consumers in some of the project countries in 2008

Country	Number of industrial consumers
Egypt	42 000
Algeria	28 350
Morocco	8 000
Tunisia	5 700
Yemen	3 700

Source: UNIDO

On average, up to 41% of the industry sector's energy needs in 2009 were met by oil products and 35% by natural gas (Figure 31). Electricity represented around 22% of the final energy consumption of the sector, as shown in Figure 31.

Figure 31: Final energy consumption structure in industry by energy product in 2009



Source: Countries

However, the gas penetration rate is much higher in some countries, like Algeria (60%), Libya (58%), Egypt (42%), Tunisia and Syria (around 30%). These countries with varying levels of natural gas resources have energy policies based on the valorisation of local energy resources in energy intensive activities.

The importance of the share of oil products in the other countries makes their industry activities more sensitive to fluctuations in international oil prices. Energy efficiency policies in the region should give priority to the usage of products oils in the industry sector. Energy audits and energy performance contracts should be two of the measures to be implemented in this sector. It is also recommended to extend the Arab EE Guideline to energy efficiency for fuel products which represents 76% of the final energy in the industrial sector, besides what it's already done for the electricity (22% of sector consumption).

2. Indicators analysis

Initially, the project group selected the following indicators for calculation and analysis:

- Final energy intensity of industry sector
- Specific energy consumption for main intensive industry (cement, phosphate, steel, paper, sugar, etc.)
- Ratio of industry sector energy bill to value added
- Ratio of public subsidies to value added
- Ratio of public subsidies for energy to government budget
- CO_2 intensity of industry sector
- Average emission factor of industry sector

However, industry sectors in most of the target countries suffer from a critical lack of available and reliable data, for both economic and energy data. This has greatly limited the possibilities of developing the selected indicators, particularly at sub-sector level and for energy intensive industries. Nonetheless, some intensive industries like cement, steel, etc. can represent an important energy issue for the countries. For example, in Tunisia some 55 energy intensive companies alone account for more than 40% of the whole industry sector. These energy intensive companies should be monitored through regular surveys and energy audits, in order to provide relevant data for decision making at both operational and strategic levels.

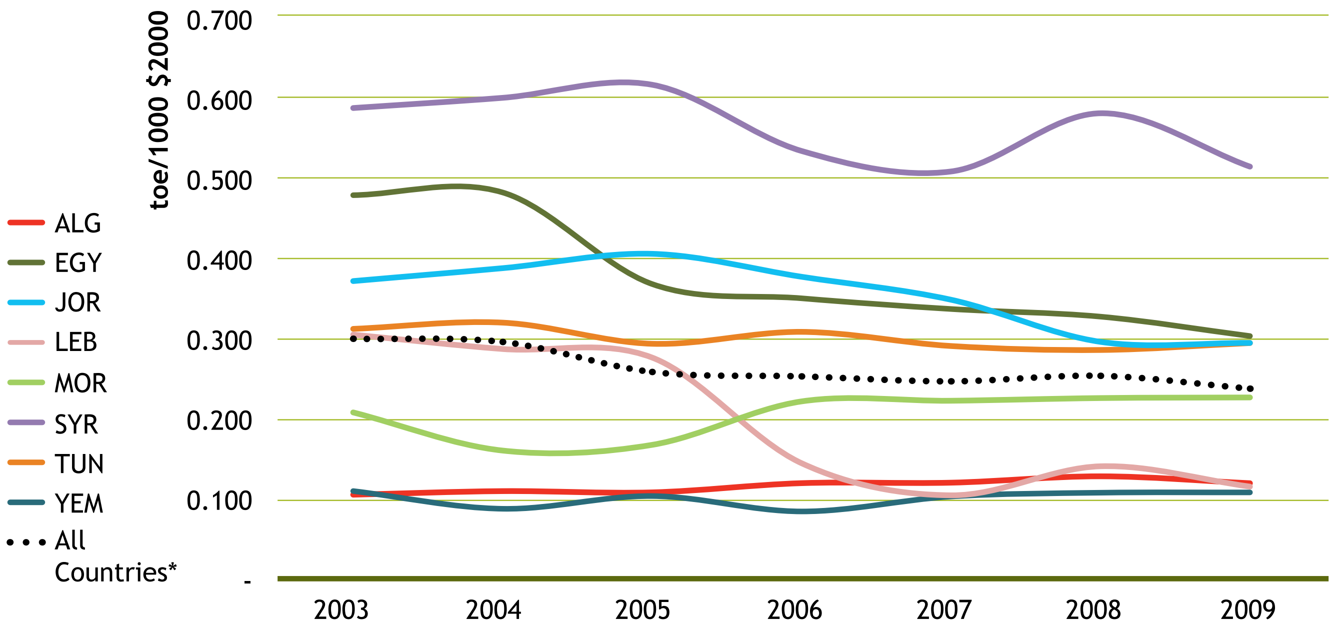
For the regional report, two key indicators were analysed, taking in account data availability in the target countries and international practices:

- Final energy intensity of the sector
- Specific consumption for some common energy intensive branches

2.1. Final energy intensity

The average final energy intensity for industry in the region was about 0.24 toe/1000 $\$_{2000}$ in 2009, compared with 0.30 toe/1000 $\$_{2000}$ in 2003, with an average annual rate of decrease of 3.8%.

Figure 32: Final energy intensity of industry sector from 2003 to 2009



Syria presents the highest energy intensity for industry in the region, mainly because of the outdated industry systems and the predominance of state-owned factories.

Egypt, Jordan, Tunisia and Morocco have similar intensities because of the similar industry structure in these countries, moving more and more towards less energy intensive industries, and with higher value added.

Algeria has the lowest intensity, at around 0.12 toe/1000 $\$_{2000}$, in 2009. This low intensity is mainly due to the predominance of the hydrocarbon industry characterised by low energy consumption and high value added, at a time when international oil and gas prices were high.

Lebanon's energy intensity is also low and can be explained by its diversified and low energy consumption industries.

The positive trend observed in Syria and Egypt should be highlighted: they have experienced a significant decrease in their intensities over the last years, from 0.59 to 0.51 toe/1000 $\$_{2000}$ and from 0.48 to 0.30 toe/1000 $\$_{2000}$ respectively.

Finally, in Yemen the industry sector is undeveloped and based mainly on crafts with little mechanization and low energy consumption. Some cement factories were commissioned recently after 2009.

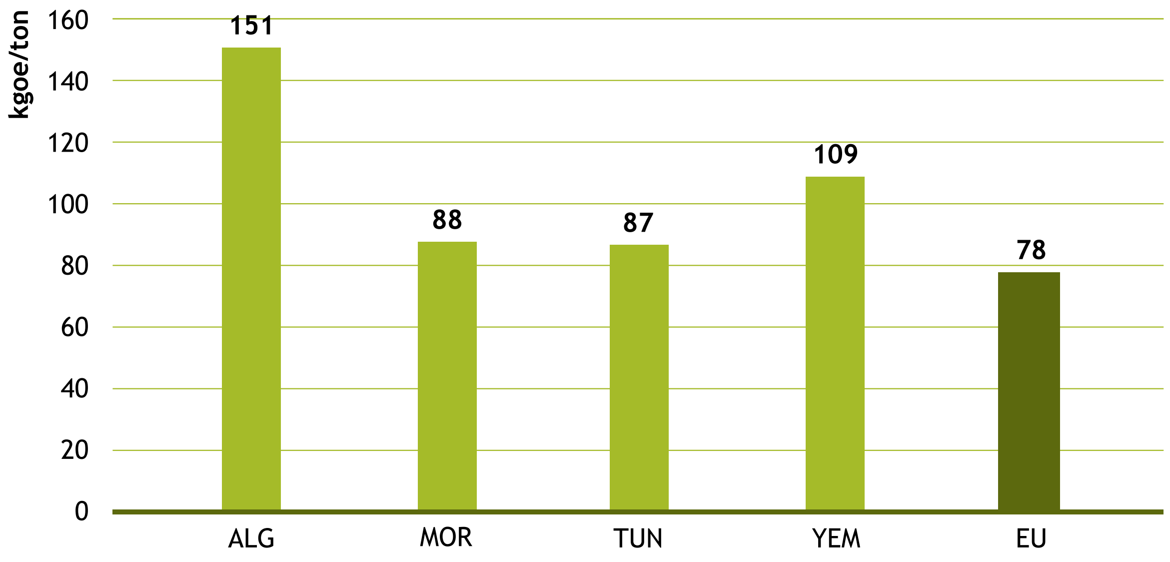
2.2. Energy specific consumption

The specific consumption of a given product is defined as the final quantity of energy required to produce one physical unit of the product. It is a relevant indicator, usually used to measure the energy performance of energy intensive processes like cement, sugar, steel, paper, phosphate, etc.

It should be noted that national statistics provide only limited coverage of these sub-sectors in terms of both energy and activity data, which did not allow national experts to calculate these indicators for the majority of the energy intensive products. The cement sector remains the most covered by production and energy consumption statistics.

Figure 33 presents the specific consumption of the cement industry in the countries where data is available and consistent.

Figure 33: Specific consumption of cement sector in 2009



The consumptions of the cement sectors in Morocco and Tunisia are close to the European average in terms of specific consumption (88 kgoe/ton and 87 kgoe/ton compared with EU average of 78 kgoe/ton in 2009). In fact, most cement factories in these countries belong to international groups – mainly European – which have made significant efforts in energy optimisation to meet international standards for energy consumption and local air pollutants.

However, Algeria and Yemen present the highest specific consumptions within the cement branches, with 151 and 109 kgoe/ton respectively. In these two countries, there is significant energy saving potential in this sector.

Phosphate extraction is an important activity in the region – mainly in Morocco, Tunisia, Jordan, and, to a lesser extent, Algeria. The specific consumption of phosphate extraction depends on many factors such as the type of extraction process, field topography, the physicochemical characteristics of the minerals, etc. As shown by Table 6, the specific consumption ranges from 6 to 17 kgoe/ton of extracted phosphate in 2008.

Table 6: Specific consumption of extracted phosphate in 2008 kgoe/ton

Country	Specific consumption
Algeria	13
Morocco	17
Tunisia	7
Jordan	6

For the processing of phosphate to phosphoric acid the specific consumption is higher than the extraction, as shown in Table 7.

Table 7: Specific consumption of phosphoric acid production in 2008 kgoe/ton

Country	Specific consumption
Morocco	21
Tunisia	27
Jordan	36

VIII. Building sector

1. Building sector outlook in the target countries

The building sector (residential and tertiary or service sector), also known as the construction sector, accounts for about one third of final energy consumption in the region. Final energy consumption of buildings in the region increased from 27 Mtoe in 2003 to about 37 Mtoe in 2009, with an average annual growth rate of 5.4%.

Energy consumption in the construction sector is dominated by residential activity with a share of 23% of the total final energy demand in the region. The tertiary buildings represent only 7% of this total consumption.

Although the timescale of the study did not allow for the observation of structural changes, we may well argue that the service sector will probably notice an increase in its energy share in the future, at the expense of the other sectors.

New and existing building stock is steadily growing because of rapid urbanization and growth in household incomes in the region.

Tertiary sector data for the building stock does not exist in any of the project countries. However, in the residential sector, the building stock has quickly increased from around 40 million dwellings in 2003 to more than 46 million dwellings in 2009, with an annual average growth rate of 2.4% representing an addition of roughly 1 million dwellings per year.

The increase in the number of dwellings has been accompanied by a significant decrease in the average number of occupants per dwelling. For example, in Algeria and Tunisia, the average household size fell, respectively, from 5.8 and 4.2 in 2000 to 4.9 and 3.6 in 2009.

The same trend was observed in one of the key sub-sectors of the tertiary sector: tourism. The number of overnight guests in Tunisia, Jordan, Egypt and Syria increased by 93% between 2003 and 2009 with an average annual growth rate of 12%. This increase contributes simultaneously to increasing hotel occupancy rates but also to strengthening the capacity in new hotels.

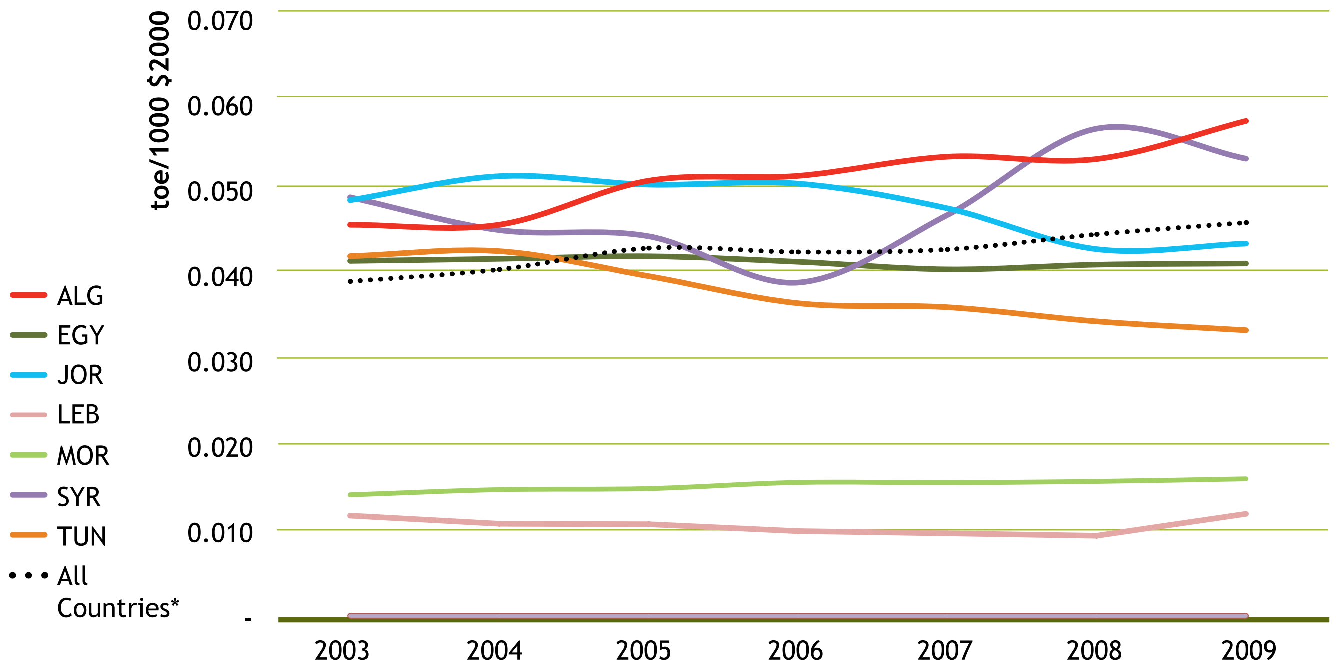
2. Tertiary sector

The tertiary sector covers a very diverse range of activities including hotels, commerce, banks, administration, etc. This is one of the main reasons explaining why energy and activities data are not readily available. In the best case, the energy balance provides only energy consumption of the entire sector, but not disaggregated consumption by sub-sector. Because of the great heterogeneity, activity data are either non-existent or scattered among many institutions, which make it hard to collect them, especially within the time frame of the project. Also in the project countries, there is a significant lack of specific studies and surveys dedicated to the main tertiary sub-sectors, which could at least provide timely and relevant data.

The main indicator developed for the tertiary sector is the final energy intensity[14], as presented by Figure 34.

14 Final energy consumption of the sector divided by its value added at constant price

Figure 34: Final energy intensity of tertiary sector from 2003 to 2009



The energy intensity of the tertiary sector can be influenced by many factors, including the climate of the country and the structure of the sector. For that reason, a simple comparison between countries may not lead to accurate conclusions.

The average intensity in the region accounted for 46 kgoe/1000 $\$_{2000}$ in 2009 compared with 39 kgoe/1000 $\$_{2000}$ in 2003, with a increasing rate of 2.7% per year.

Lebanon and Morocco, where bank activity is well developed among the tertiary sector, present the lowest intensities (12 and 16 kgoe/1000 $\$_{2000}$ in 2009). In fact, banks have very high value added with low energy consumption compared with other activities like hotels or administration.

For the other countries, the intensities range from 33 to 57 kgoe/1000 $\$_{2000}$.

Development of some specific indicators was attempted, such as the unitary consumption by night-guest in the hotels. However, data required for the calculation was available only in three countries (Tunisia, Morocco and Jordan). This indicator depends on many factors, mainly the occupancy rate of the hotels, the type of tourism (seaside, urban, desert, etc.), hotel categories (number of stars), etc.

The figures between the 3 countries are rather divergent and difficult to explain without a deep knowledge of the hotel sector in each country and without confidence in data reliability. In 2009, for Morocco, Tunisia and Jordan the specific energy consumption per guest night (GN) was, respectively, 4.5 kgoe/GN, 4.2 kgoe/GN and 14.2 kgoe/GN.

3. Residential sector

The residential sector is a major consumer of energy in project countries, which is characterised by specific patterns of consumption. Moreover, residential energy consumption and particularly electricity is significantly rising in these countries. The annual growth rate of total energy consumption of the sector between 2003 and 2009 was around 5%. This increase is indicative of larger homes, a higher level of comfort and increased usage of household appliances.

The penetration of electricity and modern fuels vary widely between countries and this variation has a significant impact on household energy consumption. For example a large proportion of the Yemeni population rely heavily on biomass, while the rate of electricity penetration is relatively low compared with other countries.

For this report and taking into account data availability and reliability, we have selected a set of indicators to illustrate the major trends:

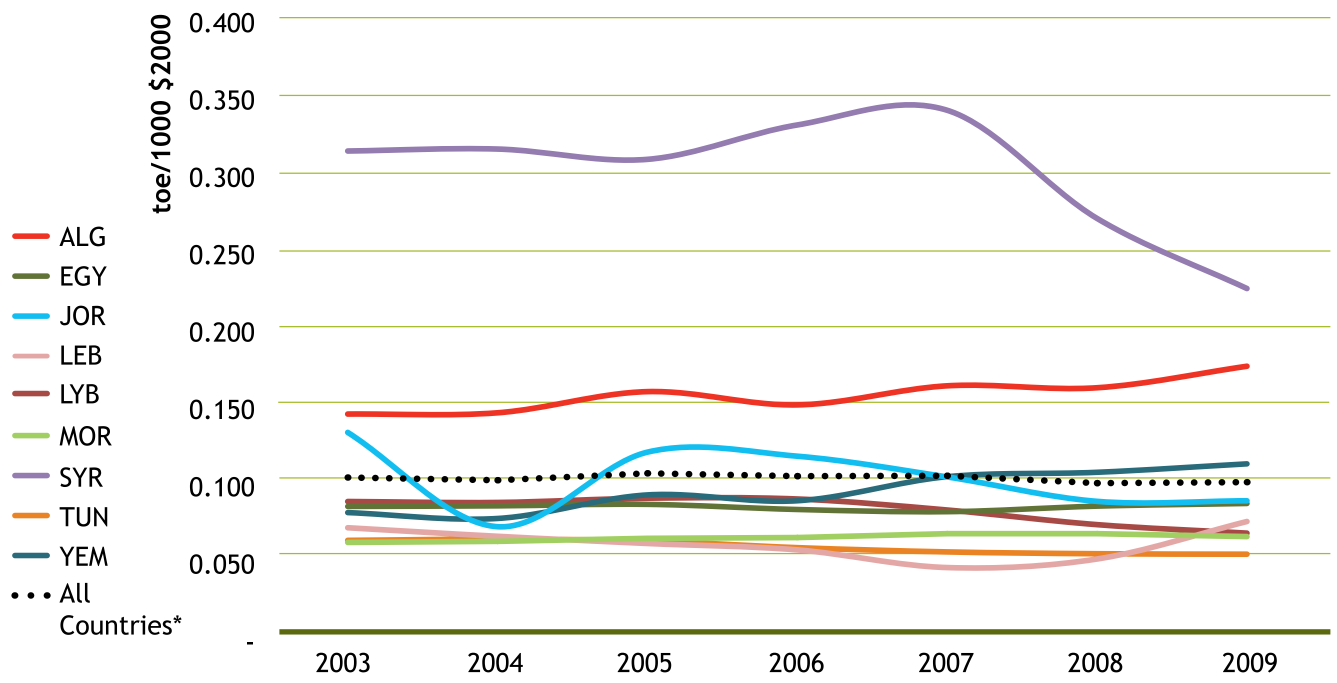
- Final energy intensity
- Specific consumption
- Penetration of household energy consumer appliances
- Penetration of solar water heaters

3.1. Final energy intensity

For the residential sector, final energy intensity is defined as the ratio between the final energy consumption of the sector and the private consumption of households at constant price (total household expenses), see Figure 35.

Except in Syria and Algeria, final energy intensities of the residential sector have ranged between 50 and 100 kgoe/1000 $\$_{2000}$, over the period 2003 to 2009. Algeria and Syria have the highest intensities with 225 kgoe/1000 $\$_{2000}$ and 174 kgoe/1000 $\$_{2000}$, respectively, in 2009.

Figure 35: Energy intensities of residential sector for 2003 to 2009



In Algeria there was a sharp increase in final energy intensity with an average growth rate of around 3% per year. However, Syria has experienced the strongest decrease in intensity with an annual average rate of -5%.

In the case of Syria, this decrease can also be explained by the reduction of the trade in smuggled oil products with Lebanon and Jordan, which was accounted for as internal consumption before the high domestic price increase in 2008.

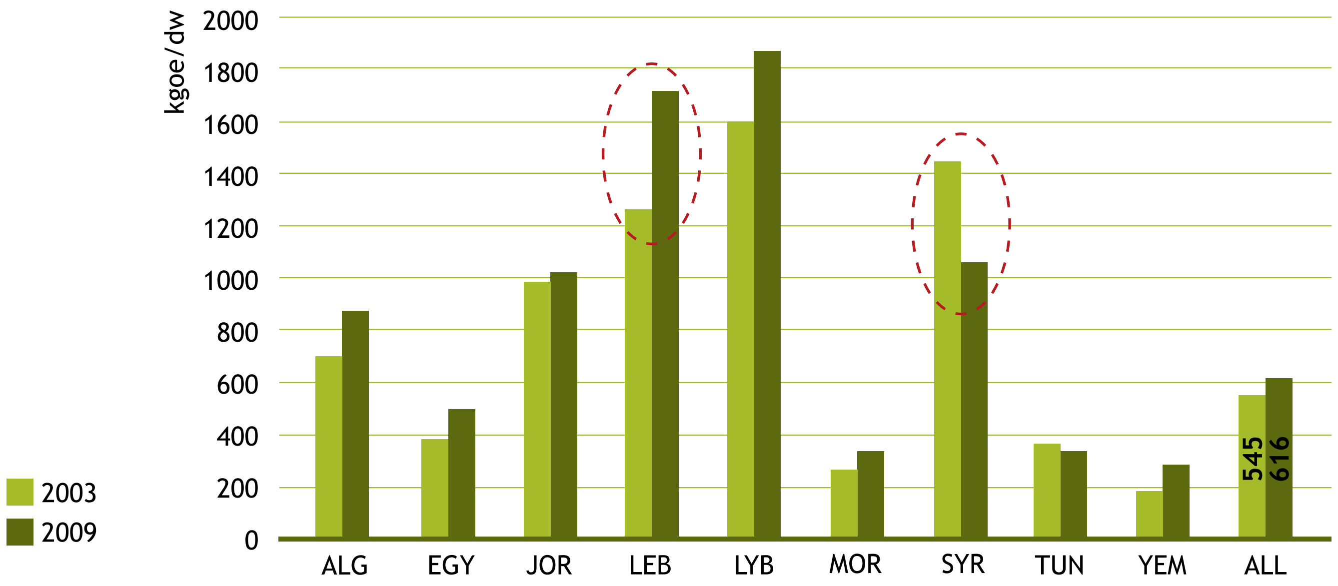
It is worth highlighting that the comparison of countries' performances in terms of residential final intensity has to be considered carefully, because of the diversity of the country contexts. In fact, this indicator is very sensitive to some key factors such as:

- Climate,
- Construction mode,
- Level of appliance ownership,
- Fuel mix,
- Penetration rate of renewables (solar water heater), etc.

3.2. Unit consumption of energy per dwelling

On average the unit consumption per dwelling in the region was around 616 kgoe in 2009, compared with 545 kgoe/dw in 2003, representing an average increase of 2% per year, as shown in Figure 36.

Figure 36: Final energy consumption per dwelling for 2003 and 2009



Source: Countries

Yemen shows the lowest rate (283 kgoe/dw) followed by Morocco, then Tunisia. The low rate observed in Yemen can be explained by the lower wealth level and correlated low modern energy (electricity) use.

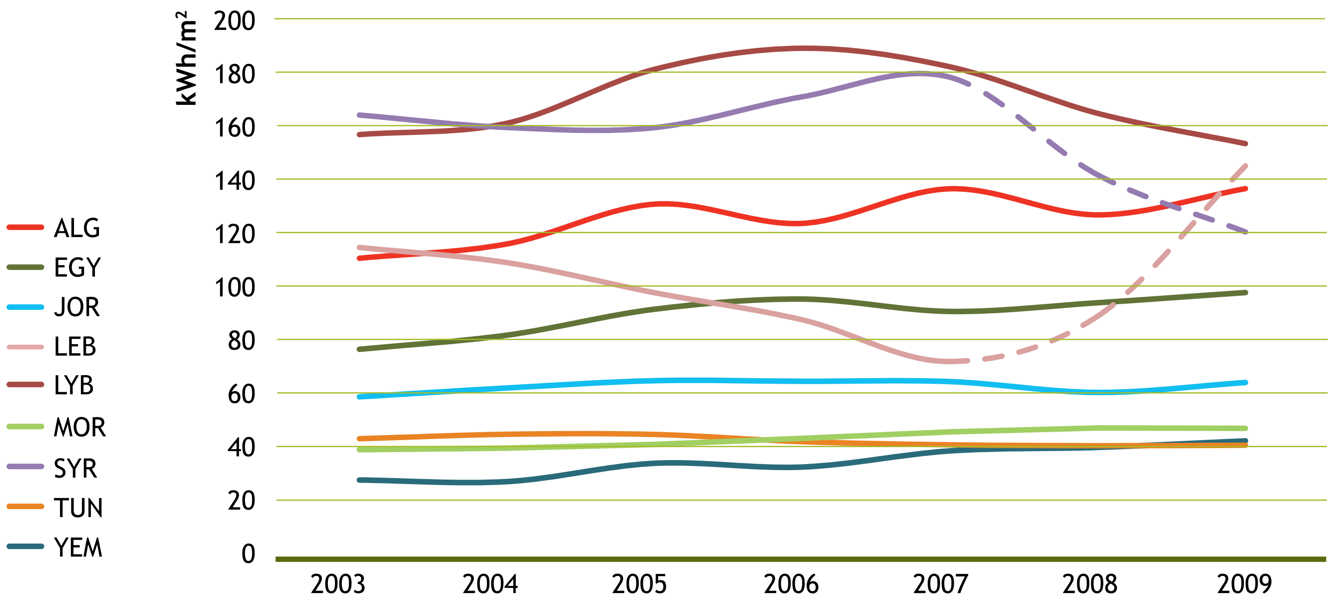
On the other hand, Libyan households seem to be the biggest energy consumers in the region, consuming over 6 times more than the Yemeni families (1860 kgoe/dw in 2009). Libya is followed by Lebanon, then Syria, with 1710 and 1060 kgoe/dw, respectively. It should be highlighted that Syria has seen a decline in consumption, while Lebanon has seen a significant increase between 2003 and 2009. This can be explained by the significant reduction in the trade in smuggled oil products from Syria to Lebanon after the increase in Syrian energy domestic prices in 2008.

3.3. Energy specific consumption per unit area of dwelling

Specific consumption of energy per unit area of dwelling is simply the ratio between the final energy consumption of the residential sector and the total area of the dwellings. The latter is not recorded in most of the project countries and the main sources of data are usually the national census or some specific household surveys. In some cases, the national teams had no other choice than to propose their own hypothesis, for the calculation of the energy specific consumption based on their knowledge of the local context.

When including all energy sources (like electricity, fuel, diesel, LPG and NG), the specific energy consumption varies widely between countries and in 2009 ranges from 40 to 151 kWh/m², see Figure 37.

Figure 37: Specific energy consumption of residential sector from 2003 to 2009



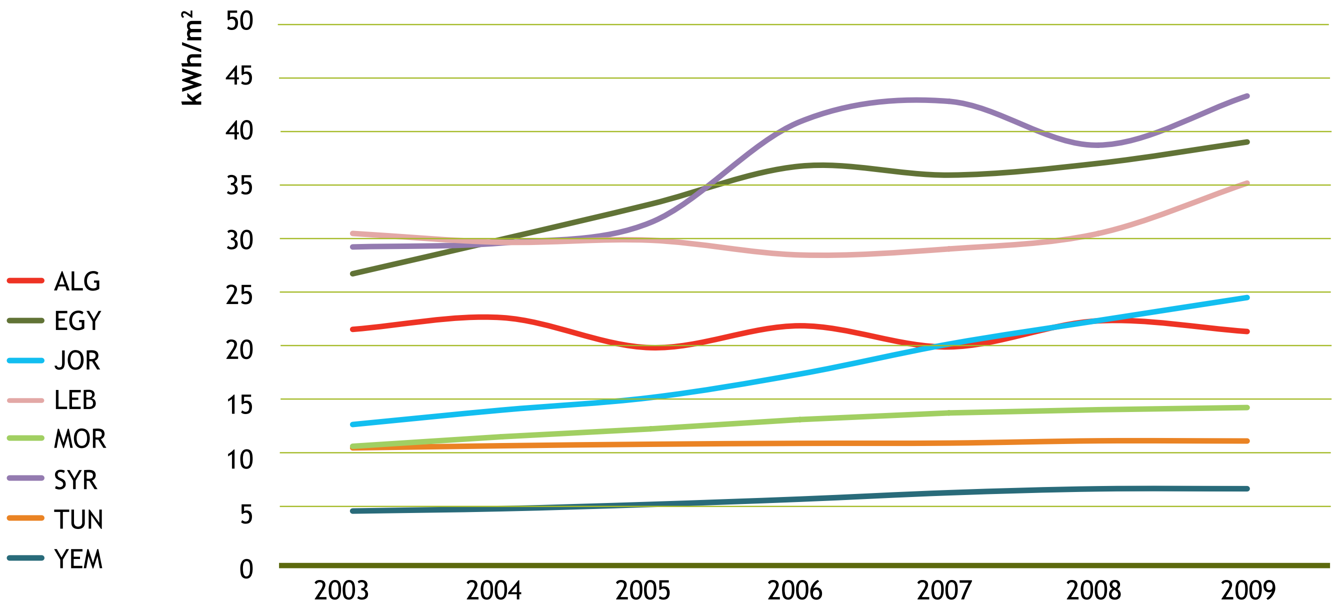
The general trend is towards an increase in the specific consumption of households in all countries. Libya has the highest levels of specific energy consumptions, then Syria with a strong decrease since 2007. The decrease in Syria's specific consumption is offset by an increase in Lebanon, according to the same phenomena as explained above.

Yemen, Tunisia and Morocco show the lowest specific energy consumption rate, around 40 kWh/m². It is worth pointing out that low specific consumption does not necessarily mean greater efficiency, but sometimes an unmet demand. The case of Yemen is a good illustration of this kind of situation.

Also, all else being equal, dwelling area and household size determine the demand for energy (space heating and cooling, lighting, etc.) and, by relation, the specific consumption. As discussed earlier, household size is decreasing in major countries and this induces a higher level of appliance ownership.

For electricity, we also calculate the specific consumption per unit (m² built area), as presented in Figure 38.

Figure 38: Specific consumption of electricity in residential sector from 2003 to 2009

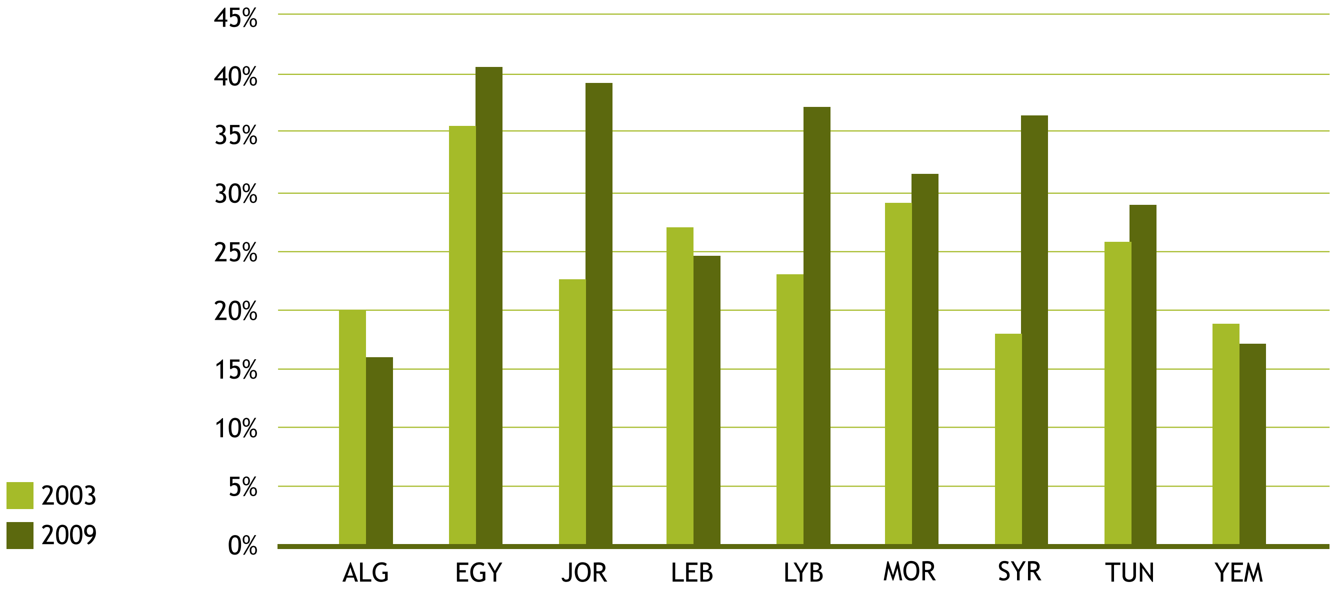


The indicator shows a clear rising trend of electricity consumption, reflecting the high electricity demand in the residential sector in the region.

The situation is highly variable between countries. In 2009, the ratio ranged between 7 kWh/m² (Yemen) and 43 kWh/m² (Syria). For this indicator, the rate of access to electricity is a key determining factor; that is why the figures for Yemen are very low (the electrification rate in Yemen is less than 70%).

The share of specific electricity consumption compared with the total specific household consumption confirms the general increasing trend of electricity weighting in household consumption, as shown in Figure 39.

Figure 39: Share of specific electricity consumption per total energy consumption in household sector for 2003 and 2009



This trend is particularly significant in Jordan and Syria with increasing shares, respectively, from 35% and 29% in 2003 to 45% and 40% in 2009. With the sharp rise in oil product prices in these two countries, households switched from oil products to electricity. In general, electricity in project countries is subsidised for low income customers, with tariffs usually lower than real electricity supply cost.

3.4. Energy expenses of households

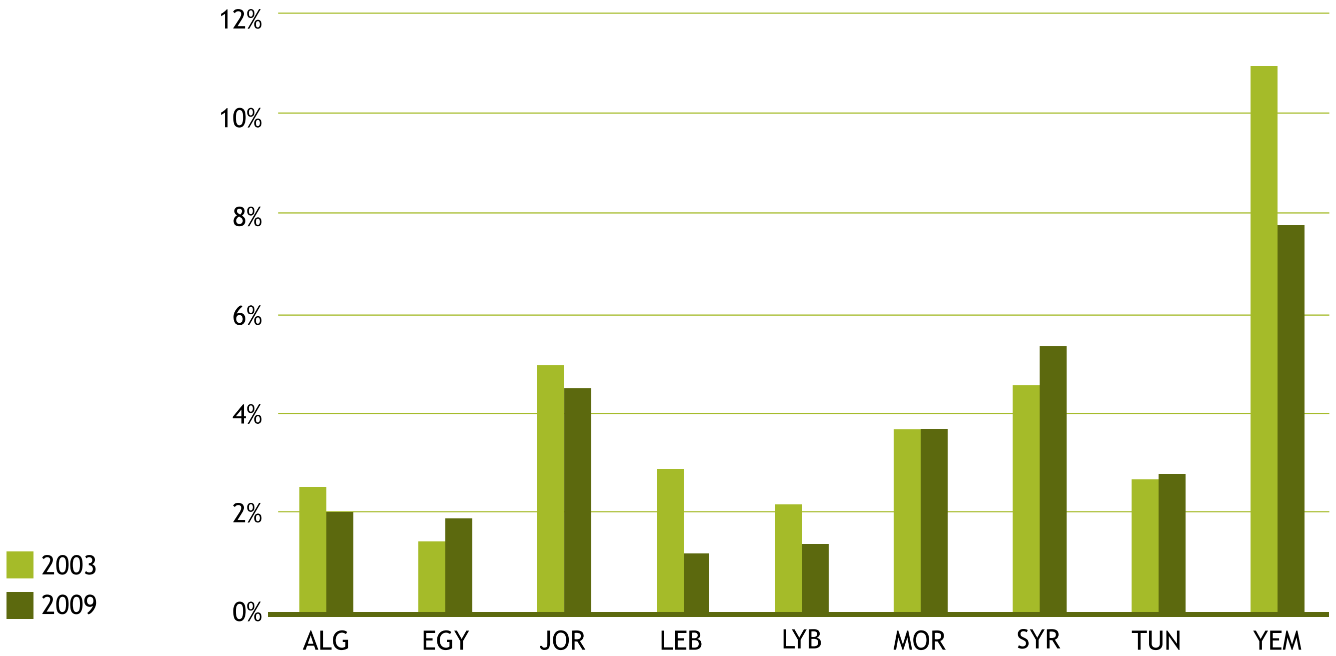
The energy expenses of households are expressed as the share of energy expenses in households' total expenditures. Energy expenses are the sum of each consumed energy product multiplied by its local price.

This share is affected mainly by three factors:

- The local energy prices, and the availability of public subsidies on energy
- The household income level
- The living standard of households, which affects the level of energy consumption of households

Figure 40 presents the results for the project countries, according to the above calculation method. It should be noted that transport expenditure are not included in household energy expenses.

Figure 40: Share of energy expenses in households' expenditures for 2003 and 2009



In 2009, the share of energy in household expenditures ranged from 1.2% in Lebanon to 7.7% in Yemen. Lebanon, where household incomes are among the highest in the region, shows the lowest ratio. The large energy producing countries like Algeria, Libya and Egypt show low indicators due to the highly subsidised local energy prices. Yemen presents the highest ratio, essentially because of the high energy prices and the particularly low household income.

3.5. Penetration rate of energy consuming appliances

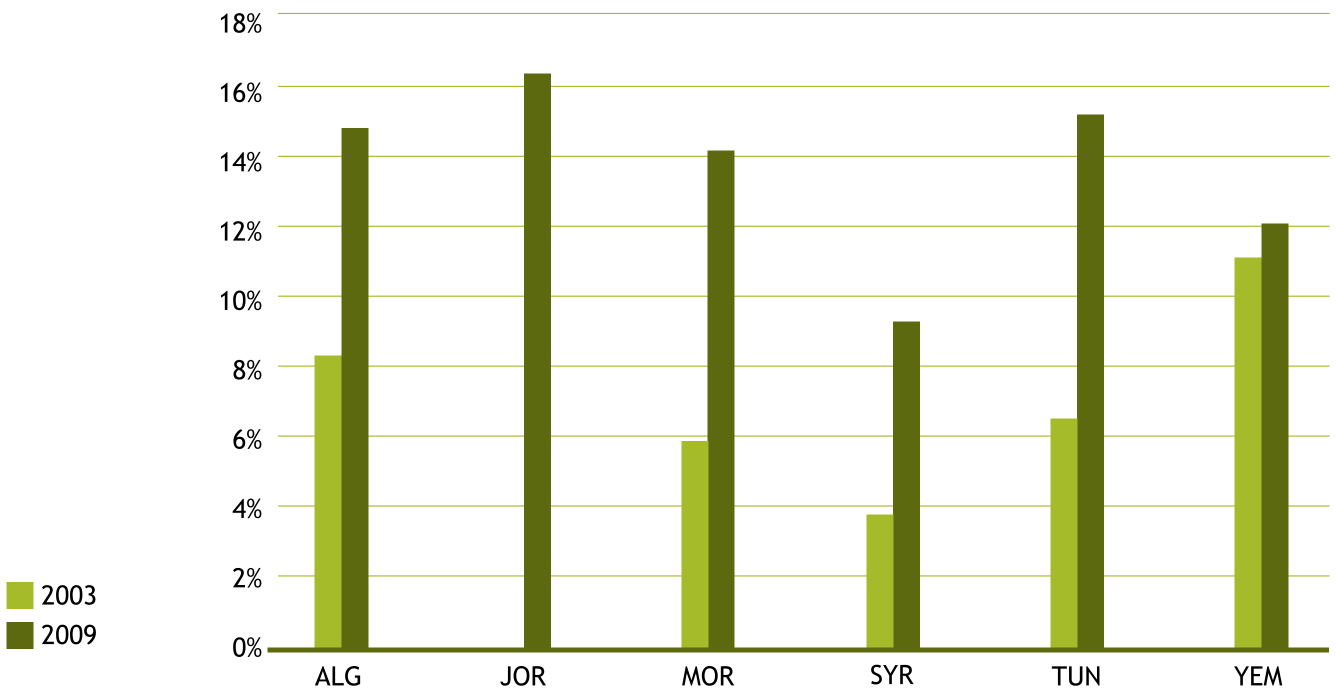
Electricity consumption in the project countries is determined by some key appliances such as refrigerators, lighting and TV sets. The use of air conditioning is expanding rapidly in the region, although the penetration rate is still low in the target countries.

In the following study the focus is on two main appliances: refrigerators and air conditioners, since they are the biggest electricity consumers within most households. The diffusion rate of these appliances is defined as the total number of appliances in the country divided by the total number of dwellings.

Air conditioning

Penetration of air conditioning is still moderate in most target countries. The highest rate is observed in Jordan (16%), Tunisia (15%) and Morocco (14%). The potential growth is significant in other countries with low rates, as shown in Figure 41 (not all countries are shown due to lack of data).

Figure 41: Diffusion rate of air conditioning 2003 and 2009

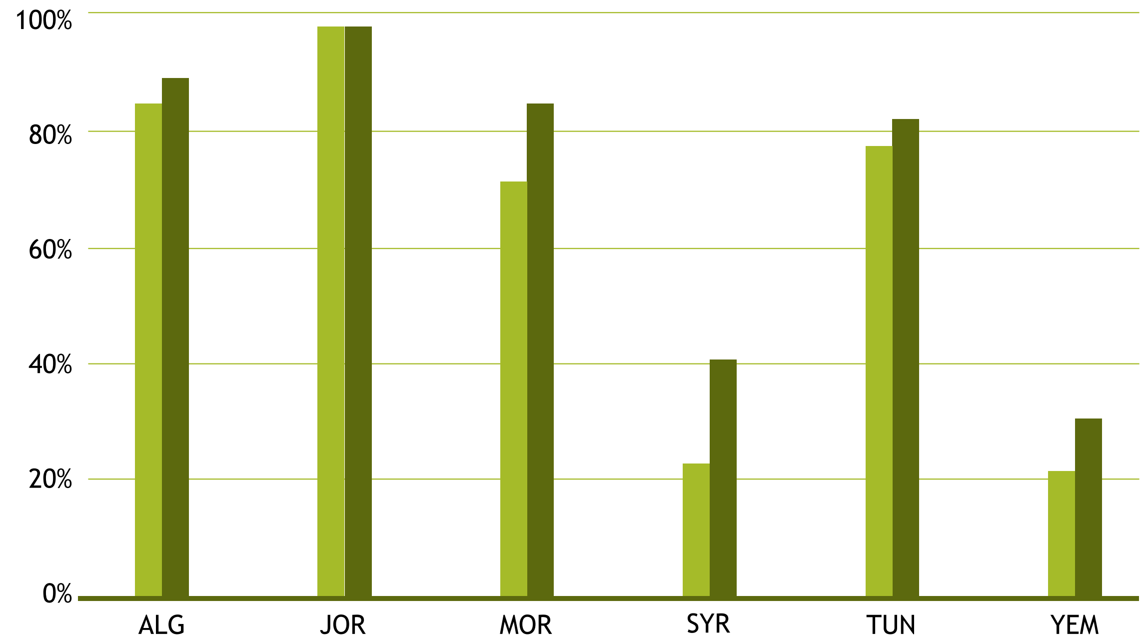


In the absence of specific regulations (labelling and minimum performance standards), the rapid development of the air conditioning market in the target countries will constitute a big issue in terms of power peak load demand. Governments will hence face more constraints in terms constructing additional power generation capacity and the required investments and financing.

Refrigerators

In a more saturated market like that of refrigerators, the penetration rate remains very high for almost all countries, except Yemen and Syria, see Figure 42

Figure 42: Diffusion rate of refrigerators 2003-2009

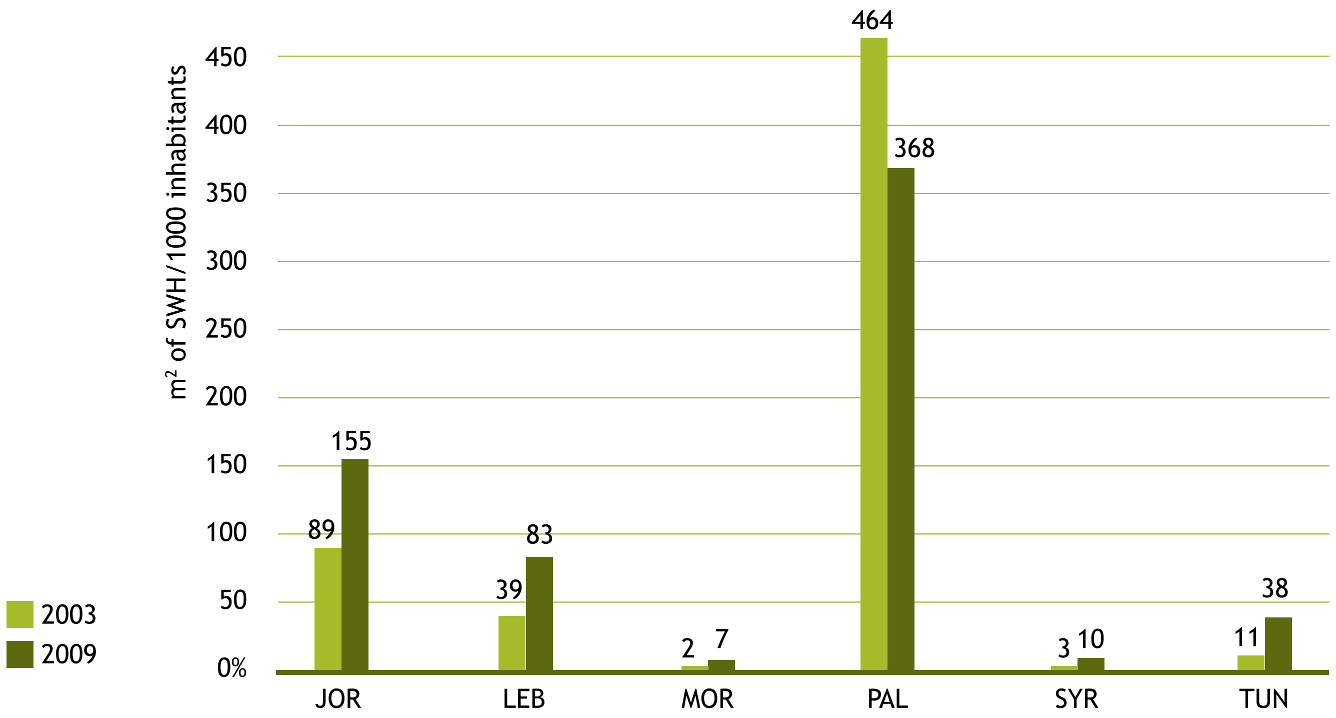


Given the rapid development of the appliance market in the countries of the region, governments should promptly issue regulations regarding labelling and minimum energy performance standards for appliances. Some countries have already implemented regulations for refrigerators and air conditioners. For example, in Tunisia a law was issued to gradually remove from the market the lowest energy performance refrigerators and air conditioning, since 2004. In this country, only refrigerators with an energy performance class less than 3 (on a scale of 8) are allowed on the local market, and below class 4 for air conditioners.

Solar water heater diffusion rate

The penetration of solar water heaters (SWH) in a country is measured in terms of collector area per 1000 inhabitants. As a reminder, an average of 2 to 4 m² of good quality collector to supply a household could be assumed in the Southern and Eastern Mediterranean countries. Figure 43 presents the indicator for countries where there was significant development of the solar water heater market.

Figure 43: Diffusion rate of SWH in some countries of the region for 2003 and 2009

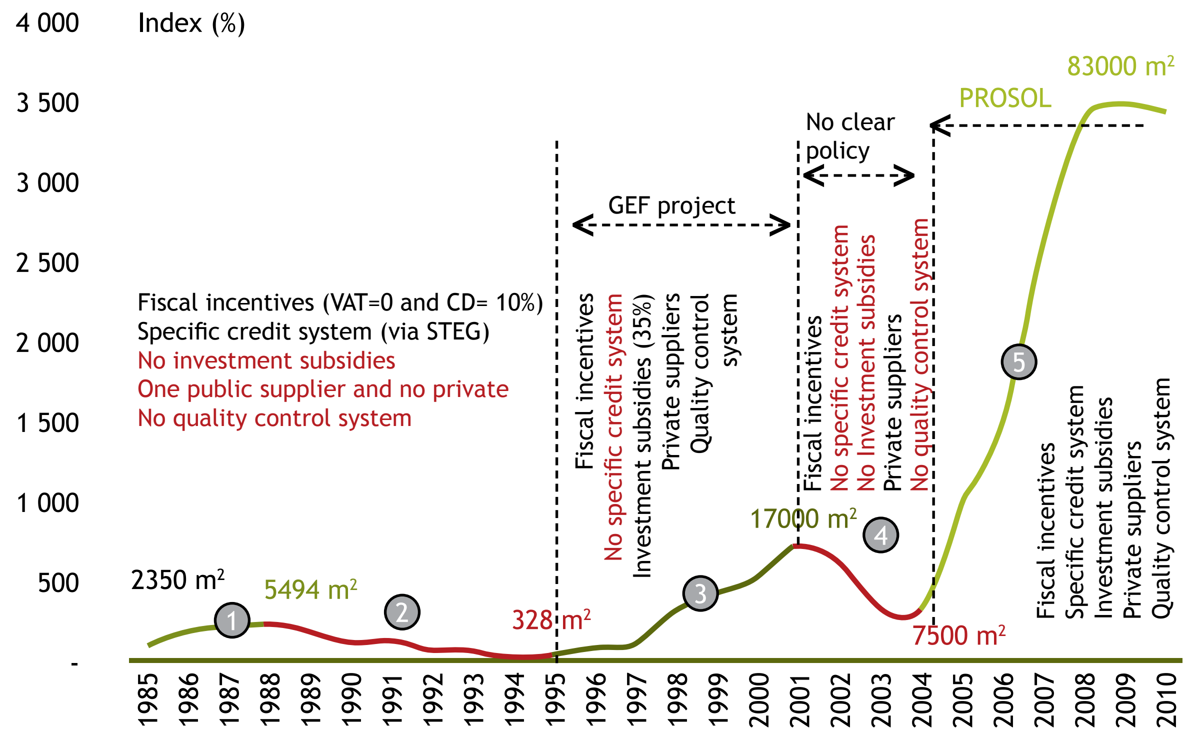


Palestine and Jordan are leading countries for SWH penetration in the region, followed by Lebanon. The development of SWH in these countries is mainly explained by the high tariffs for energy used for water heating (electricity and LPG).

Some SWH markets are emerging in the region, such as Tunisia, Morocco and to a lesser extent Syria. However, the differences between North African countries and Middle East ones should be moderated by the fact that the solar water heater sizing is different. The latter uses more collector area for the same storage capacity (4 m² instead of 2 m² for 200 litre SWH).

Finally, the trend of SWH market development in the region is positive since the penetration rate is significantly increasing. In Syria, Morocco, and in particular Tunisia this development is due to specific, supported public programmes. For instance, Tunisia has implemented, since 2004, a special programme (PROSOL[15]) based on a win-win financial mechanism coupling public subsidies and loan to the user repaid on the electricity bill. This mechanism has transformed the market (7,000 m² in 2004 to 80,000 m² per year currently) and allowed the creation of an important local industry. Figure 44 presents, for the purposes of illustration, the SWH market transformation in Tunisia.

Figure 44: Evolution of installed thermal solar collector index - base 1985



Rafik Missaoui, 2011

15 Tunisian solar programme

IX. Transport sector indicators

Despite the fact that transport is a key energy consuming sector in the target countries, the energy efficiency policies of the region are not paying sufficient attention to this sector. This situation is ascribed primarily to the lack of reliable data, the complexity of the sector, the large number of stakeholders involved and the lack of awareness and resources to conduct specific studies and surveys.

The transport sector includes four main modes which are road, rail, air and maritime. The road constitutes the main issue in the region in terms of energy consumption, because of its size and lack of organization. Additionally, energy consumption in the road sector depends on the quality and traffic organization of the infrastructure in the country, as well as the performance and age of the vehicle fleet. Hence, the comparison of performance indicators between countries can be meaningless, if the local contextual differences are not taken into account.

The transport sector is the primary energy consumer in the region. Its share of total final energy has slightly increased from 33% in 2003 to 34% in 2009. Its total consumption has risen from 32.4 Mtoe in 2003 to about 41.8 Mtoe in 2009, with an average annual growth rate of 4.4%. For some countries, the increase is particularly sharp, such as Algeria (10.6%) and Yemen (8.3%).

This increase is mainly explained by the rapid development of the sector in the region as a result of economic growth, rapid urbanisation, congestion and large proportion of populations shifting to private cars in the absence of good quality public transport.

In addition to these energy characteristics, the transport sector in the region has some specific features:

- Increasing rates of vehicle ownership (50% increase between 2003 and 2009, i.e. 7% per year);
- Obsolescence of car stocks in most of the target countries;
- Limited share and poor quality of public transportation services;
- Predominance of road transport for goods compared to rail and waterways.

Taking into account data availability, three main indicators are analysed within this report:

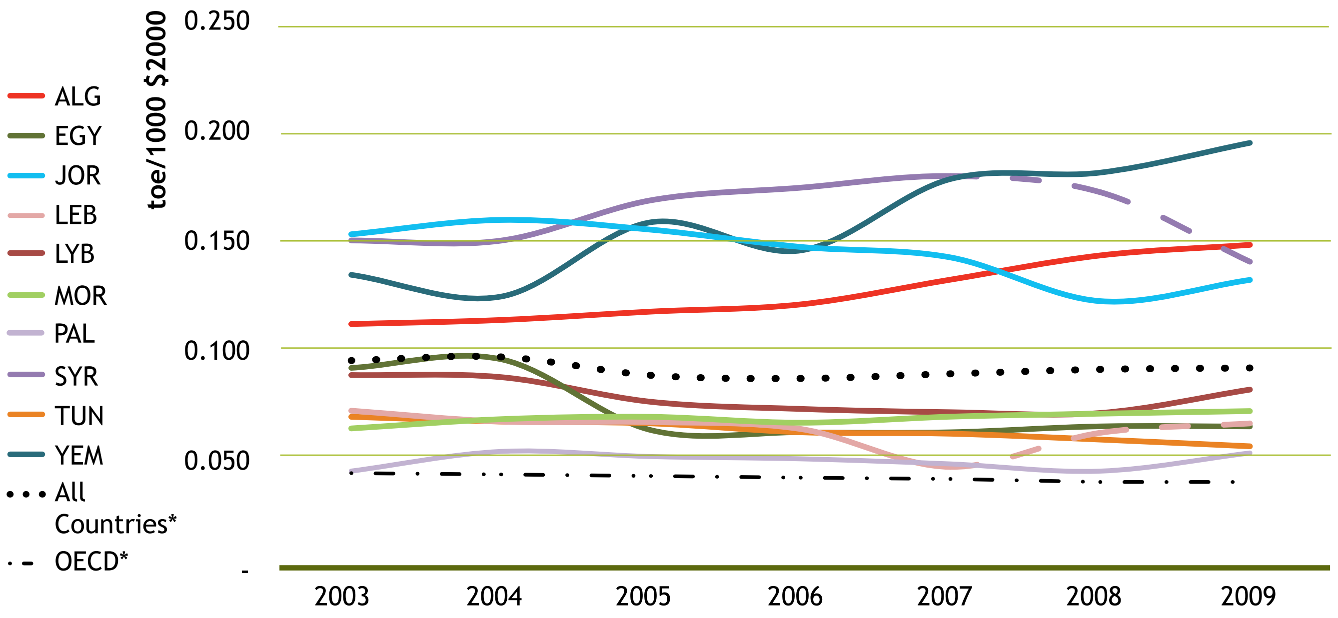
- Energy intensity of the sector
- Motorisation rate
- Specific consumption of private cars

1. Energy intensity of transport sector

As transport is a horizontal activity contributing to the functioning of all economic sectors, the energy intensity is defined as the ratio between total final energy consumption of the sector and GDP at constant price.

Figure 45 presents the development of the transport sector energy intensity in the target countries between 2003 and 2009.

Figure 45: Final energy intensity of transport sector from 2003 to 2009



The benchmark of energy intensity should be analysed with great caution because of the significant differences between the countries' contexts. Intensity can be affected by various factors such as country size and topography, urbanisation rate, infrastructure development and traffic organisation, modal structure in the country, public transport development, fuel tariffs, vehicle stock situations, etc.

In 2009, the average intensity of the region was around 91 kgoe/1000 $\$_{2000}$, which is about double the OECD average estimated to be 39 kgoe/1000 $\$_{2000}$. This demonstrates the huge potential for saving energy in the transport sector in the studied countries.

- Interpreting the chart, countries can be divided into two categories:
- Relatively low intensity, less than the regional average: Palestine (52 kgoe/1000 $\$_{2000}$), Tunisia (55), Egypt (64), Lebanon (66), Morocco (71) and, Libya (81).
- High intensity, above the average of the region: Yemen (194), Algeria (147), Syria (140) and Jordan (131 kgoe/1000 $\$_{2000}$).

On average in the region, the intensity of the transport sector has almost been stable over the period (95 kgoe/1000 $\$_{2000}$ in 2003 to 91 in 2009). However, some countries like Algeria and Yemen have an upward trend of final intensities with an annual growth rate of 4.8% and 6.4%, respectively, over the period.

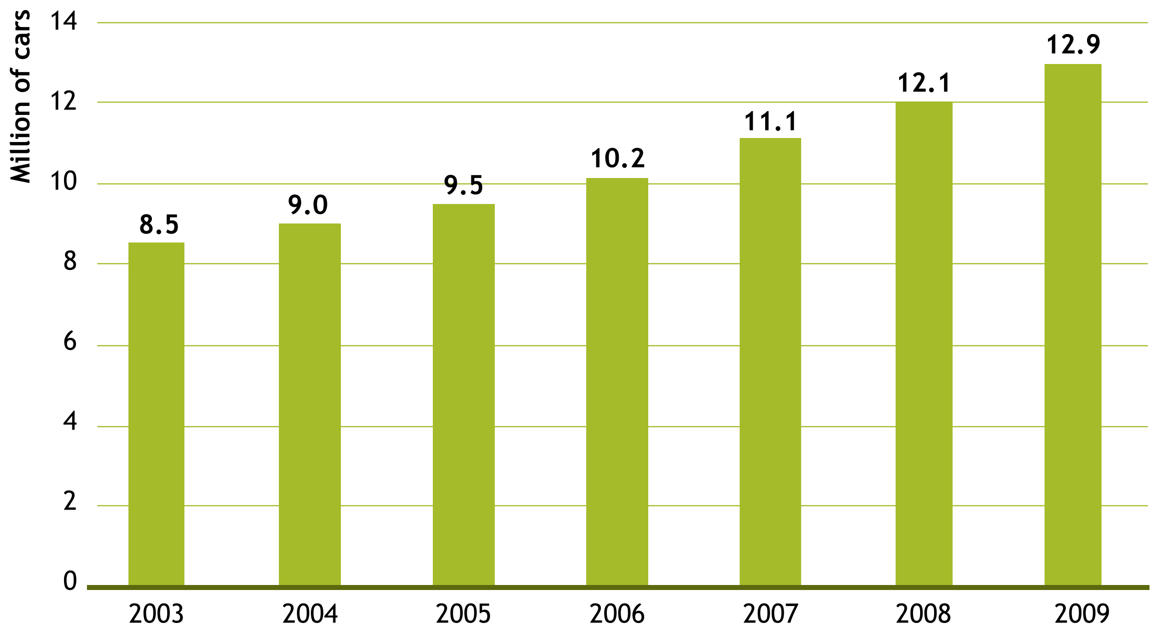
The decrease in final energy intensity of Syria is partially offset by an increase in Lebanon, due to the same phenomena of reducing smuggling of oil products between the two countries.

2. Vehicle ownership rate

The motorization rate is defined as the number of cars, or more generally vehicles, available per 100 inhabitants in the country.

The total number of cars in the region, see Figure 46, has increased from 8.7 million cars in 2003 to 13.1 million cars in 2009, resulting in a growth rate of 7% per year.

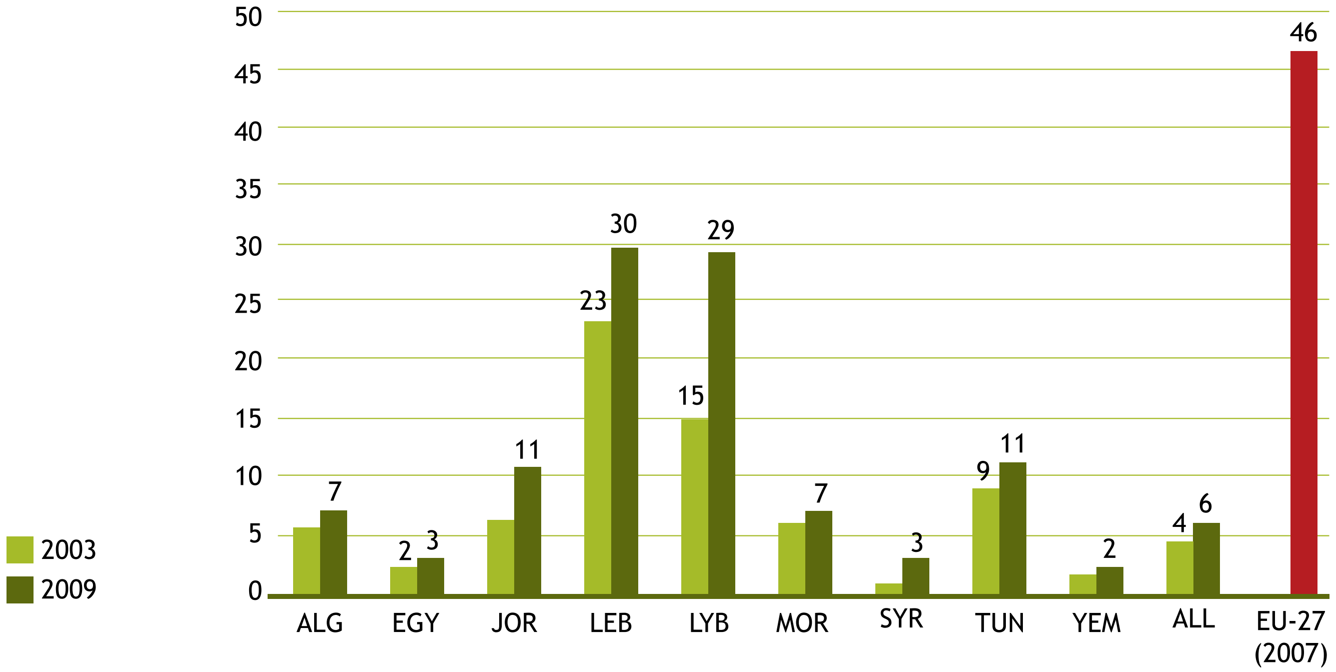
Figure 46: Total private car stock in the region from 2003 to 2009[16]



Source: Countries

As shown in Figure 47, the motorization rates in the region are still very far from the EU average level (6 cars in the region against 46 cars per 100 EU inhabitants). However, some countries like Lebanon and Libya have close rates (36 and 39 cars per 100 inhabitants). The lowest rates are in Yemen, Egypt and Syria, not exceeding 3 cars per 100 inhabitants.

Figure 47: Vehicle ownership rate in project countries for 2003 and 2009



Sources: Countries and Eurostat for EU

16 Excluding Palestine

Nevertheless, the observed trend in the region is characterised by the sharp increase in motorization rate, estimated at around 50% over the period (or more than 7% per year). If this trend persists in the future, the countries will face critical issues in terms of energy needs, local pollution, congestion and investment in road infrastructure.

Finally, it should be highlighted that data for car stocks are provided by car registration services in the countries. However, the recorded data may include old registered cars that are already retired (out of use), which may exaggerate the motorization ratio. In some countries like Tunisia, the retired cars are empirically estimated at 30% of the car stock.

3. Specific consumption of private cars

The specific consumption of private cars indicator is defined as the ratio between the total energy consumption of private cars and total number of private cars. It can be also calculated, if relevant, separately for diesel-fuelled and gasoline-fuelled cars.

In 2009, the average specific consumption of private cars in the region was around 1.62 toe/car/year compared with 1.28 toe/car/year in EU countries. Once again, there is big potential in the region for energy saving in road transport if EU performances are targeted in the long term.

Figure 48: Specific energy consumption of private cars for 2003 and 2009

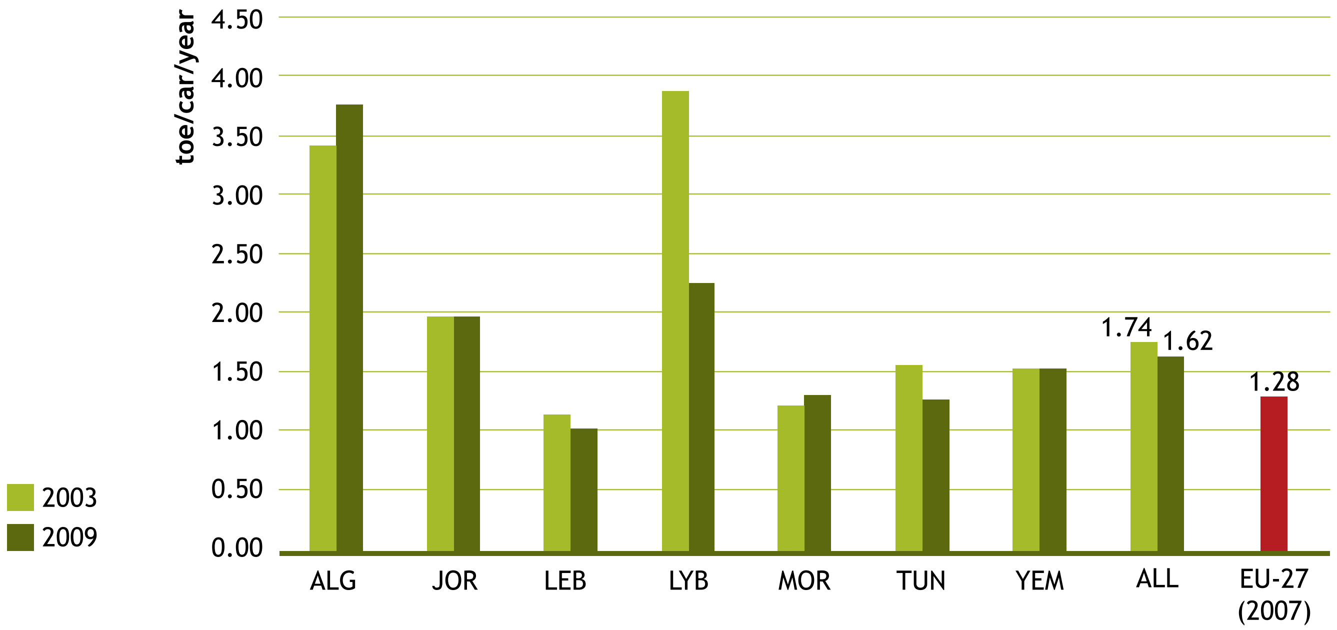


Figure 48 shows that countries such as Lebanon and Morocco are below the European specific consumption level; however, substantial energy savings are possible in private transport.

The general tendency in the region is the improvement of specific energy consumption, which has fallen from 1.74 toe/car/year to 1.62 toe/car/year, about 8% decrease over the six year comparison period. This progress is mainly ascribed to the general tendency towards energy performance improvements in new cars. Particularly in Libya, the lifting of the embargo has largely contributed to rapid growth in the car fleet and improvement of its performance.

Moreover, it is worth noting that the decrease in specific consumption in Tunisia (as shown in Figure 48) is due to the use of small cars as per the Tunisian government regulation to not charge customers importation fees for small cars. It was a measure adopted for both energy conservation purposes and socio-economic support to the middle class.

The comparison between countries should take into account many factors that determine the average specific consumption of cars, such as:

- The size of the country and geography which affect the average distance driven by consumers
- The behaviour of the consumer in terms of mobility, which can itself be affected by the fuel tariffs, car taxes, parking cost, etc.
- Congestion level, which affects car energy performance on the road (real consumption per 100 km)
- Intrinsic car performances as published by the manufacturers
- Quality of the road network, etc.

Finally, some cases such as Lebanon should be treated with caution because of the influence of fuel smuggling between neighbouring countries.

X. Agriculture and fishing sector indicators

The agriculture and fishing sector in the region is not energy intensive, with a share of total consumption among the countries ranging between 5% and 10%. On the other hand, this sector remains poorly represented in terms of energy data availability. Hence, despite the limited amount of data required in the present study, statistical coverage of the agricultural and fishing sector is very limited from both national and international sources.

Although the energy consumption of the sector remains low in the national balances, it can constitute a major socio-economic challenge. Indeed, with the increase in domestic prices of gasoil and electricity, the energy component in crop production cost becomes very high, creating difficulties for a large group of small-scale farmers and fishermen. Moreover, for socio-political reasons, many governments provide direct subsidies to energy used for agriculture and fishing, in addition to the common energy tariff subsidies. This practice has an important impact on the public finance balance.

Many indicators were selected by the project expert group, namely:

- Final energy intensity of agriculture
- Final energy intensity of fishing
- Specific consumption for fishing
- Share of dry cultivated area
- Share of irrigated cultivated area
- Share of equipped wells with motor pumps
- Share of equipped wells with electro pumps

However scarcity of data prevented many country teams from developing these indicators. In the present report we develop some of those indicators according to data availability.

1. Final energy intensity

The final energy intensity is defined as the energy consumption of the agriculture and fishing sector divided by the value added of the sector. Since the disaggregation of energy consumption between agriculture and fishing is very often not possible in most target countries, we were obliged to treat both sectors together.

For agriculture, the energy intensity depends on several key factors, such as:

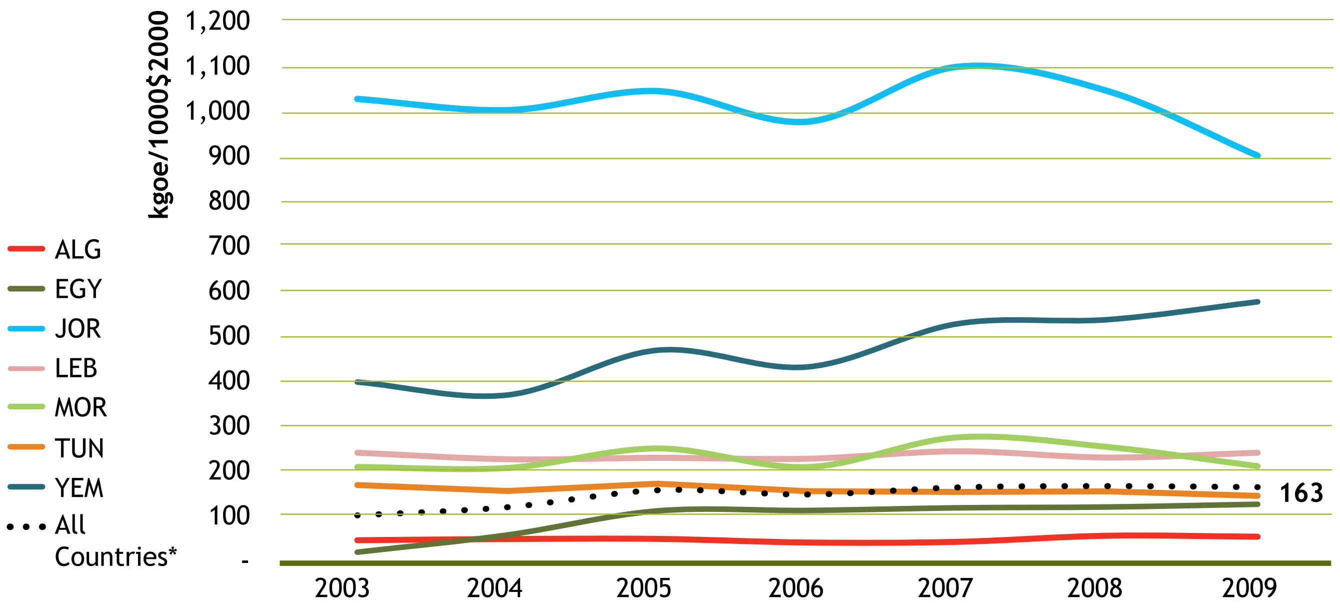
- Degree of agriculture mechanization
- Type of cultivated crops
- Share of irrigated area in total cultivated space
- Mode of irrigation and type of water resources used for irrigation (surface water or groundwater)
- Rainfall , which usually fluctuates and determines the farm yields
- Agricultural yields, etc.

For fishing, the intensity will depend on:

- Type of fishing (inshore fishing, light fishing, trawling, etc.)
- Quality and age of the fishing fleet
- Power of the fleet
- Availability of fisheries resources, etc.

Figure 49 displays the evolution of energy intensities of the agriculture and fishing sector in the target countries.

Figure 49: Energy intensity of agriculture and fishing sector from 2003 to 2009



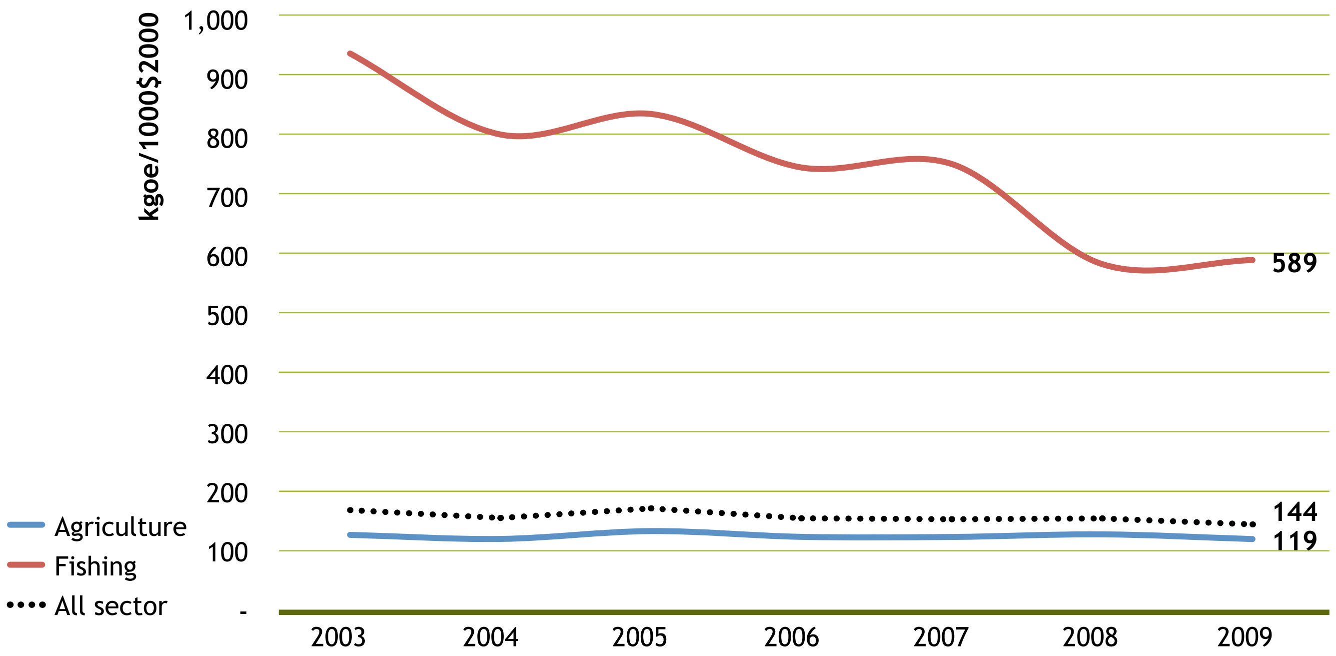
Source: countries

The average intensity of the agriculture and fishing sector was around 163 kgoe/1000 $$_{2000}$ in 2009 and has significantly increased since 2003 (101 kgoe/1000 $$_{2000}$), equivalent to more than 8.4% per year. This increase can be explained by mechanization and the development of pumping in agricultural activities. In some cases (like Mediterranean countries), this can also be due to the increased sailing distances for fishing, as a consequence in the decline of fishery resources.

Jordan shows, by far, the highest intensity with around 900 kgoe/1000 $$_{2000}$ in 2009, followed by Yemen (575 kgoe/1000 $$_{2000}$) and Lebanon (240 kgoe/1000 $$_{2000}$). Morocco, where agriculture and fishing are key sectors for the economy, the intensity is around 210 kgoe/1000 $$_{2000}$. Algeria has the lowest intensity, at around 53 kgoe/1000 $$_{2000}$.

For disaggregation of agriculture and fishing, we present the case of Tunisia – where adequate data was available – as an illustration, see Figure 50.

Figure 50: Energy intensity of agriculture and fishing sectors in Tunisia from 2003 to 2009



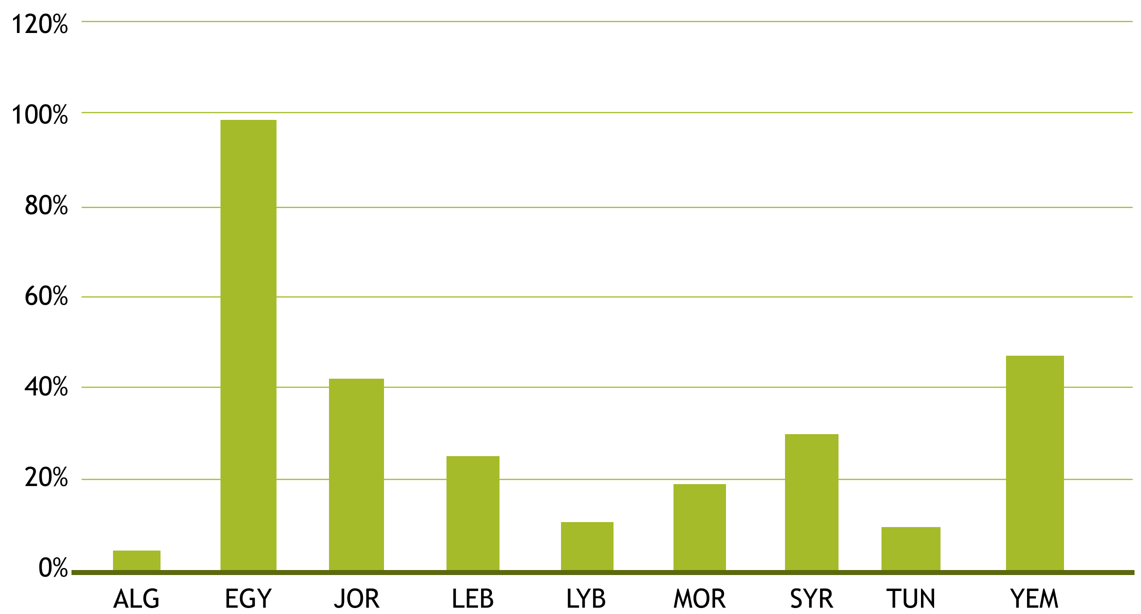
Source: Strategic study on energy conservation in agriculture and fishing sector in Tunisia, Alcor 2010

Fishing is about 5 times more energy intensive than farming per unit of GDP. However, total energy consumption in agriculture is higher because of greater activity, so the energy intensity for the two sectors together is pulled down to 144 kgoe/1000 $$_{2000}$.

2. Share of irrigated area

Figure 51, from the Food and Agriculture Organization (FAO) shows the share of irrigated land in the total cultivated area.

Figure 51: Share of irrigated area in total cultivated area



Source: FAO database

In agriculture, irrigation is very often the greatest energy consuming activity. Therefore, the share of irrigated land can partly explain the agriculture energy intensity. This is the case for Jordan and Algeria, which show the highest and lowest intensities of the sector, respectively. The intensity in Jordan is amplified by the topography of the country (mainly Amman), where high pressures for pumping are required.

The irrigated share also explains the positions of Yemen, Lebanon and Morocco among the other countries in terms of agriculture and fishing energy intensity.

For Egypt, whilst all the agriculture area is irrigated, the energy intensity remains rather low. In fact, almost all water irrigation is coming from the Nile River, with requires very low hydraulic pressure for pumping.

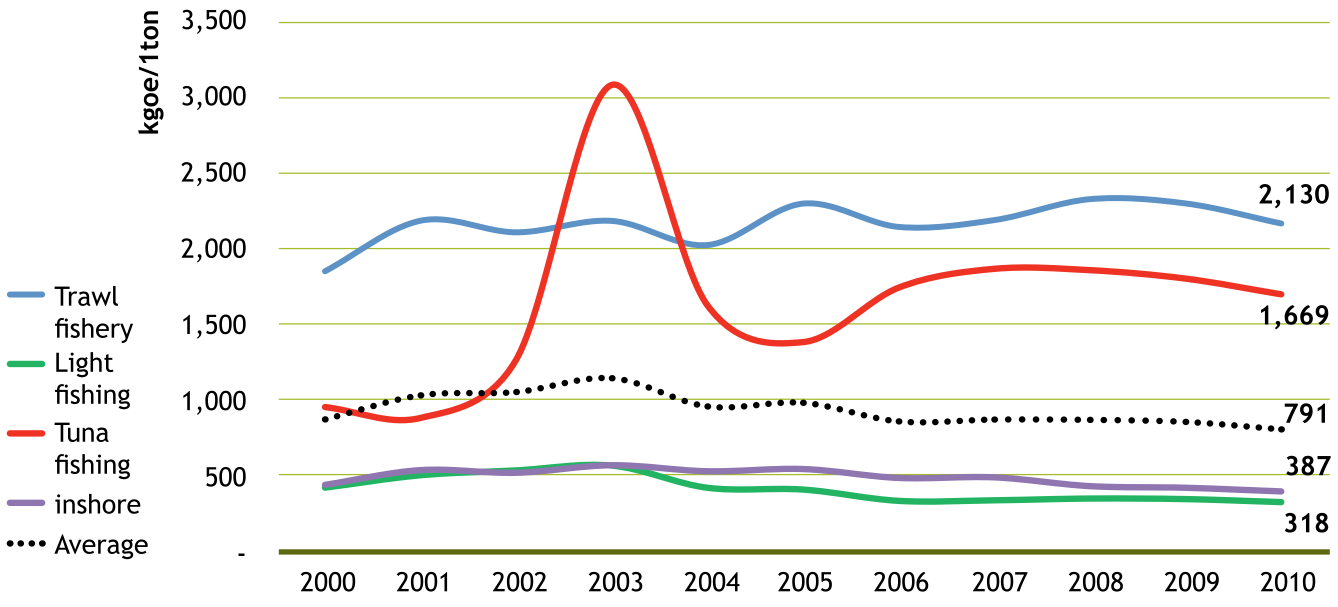
3. Specific consumption

Although calculating specific consumption in the agriculture and fishing sector is not very common, we think that it is important to do so at least for countries where these sectors are economically important like Morocco, Tunisia, Yemen, and Egypt. Unfortunately, because of lack of data, this was possible only for Tunisia, for which we present the results for illustration.

For fishing, the indicator is calculated as the ratio between energy consumption of the sector and total produced quantity of fish products expressed in physical value.

For Tunisia, Figure 52 announces an alarming situation.

Figure 52: Specific energy consumption of fishing products in Tunisia from 2000 to 2010

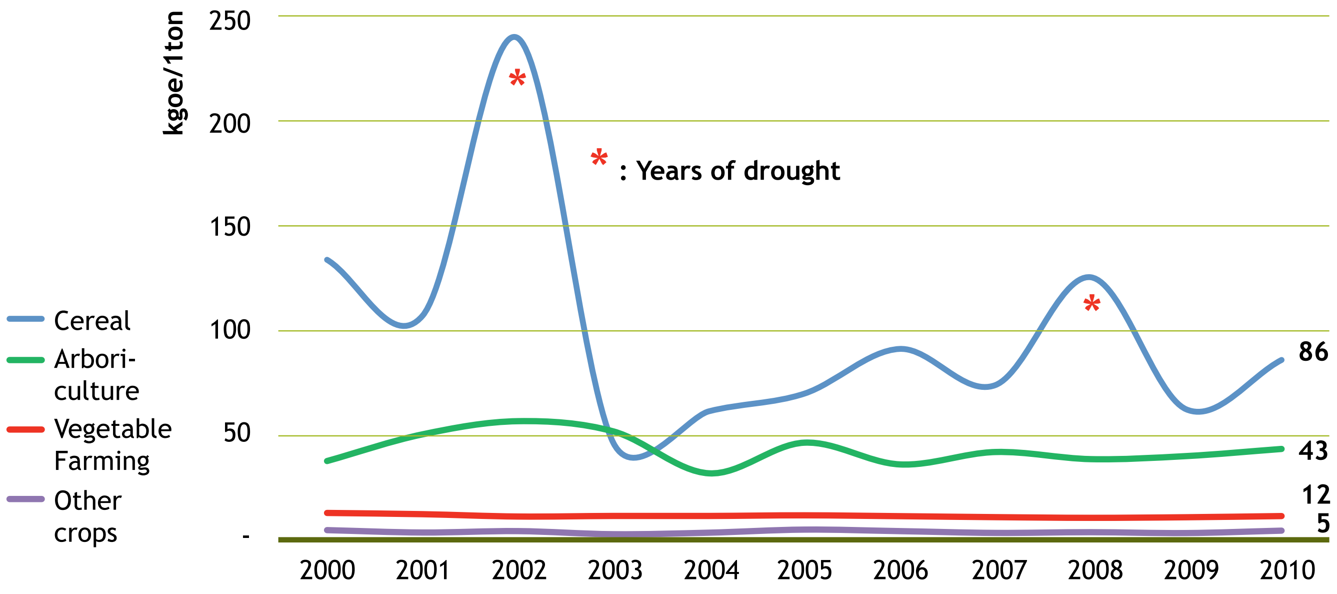


Source: Strategic study on energy conservation in agriculture and fishing sector in Tunisia, Alcor 2010

Indeed, a ton of fish products needs, on average, an energy input of 0.8 toe. The situation is particularly worrying for products like tuna and trawling fishery which require in average respectively 2.1 and 1.7 toe per ton. Both products also have a general trend to increased energy consumption, probably reflecting a growing depletion of fisheries resources, requiring longer sailing travel.

For agriculture, the specific consumption of cereal is largely dependent on amount of rainfall, as shown in Figure 53.

Figure 53: Specific energy consumption of agriculture products in Tunisia from 2000 to 2010



Source: Strategic study on energy conservation in agriculture and fishing sector in Tunisia, Alcor 2010

In 2002, the energy content of one ton of cereal produced in Tunisia was approximately 238 kgoe, against only 86 kgoe in 2010. The energy content of tree products appear to be less sensitive to climatic hazards, whilst vegetables are very stable because cultivation is practiced almost exclusively under irrigation.

XI. Recommendations

Recommendations for taking the process further

This project should be considered as the starting point of a long process of introducing a culture of monitoring and assessment of energy management policies through an energy indicator-based approach. This process should cover various aspects, including capacity-building and institutional strengthening **within and between countries** in the region. As the project comes to an end, therefore, various recommendations can be made, with respect to the continuation of this process and the long-term consolidation of the advances made:

1. **Continuing the process in-country.** In order to achieve this aim, countries are strongly advised to **institutionalise the process** by transferring responsibility for continuing work, based on the tools and approaches developed during the project, to a domestic institution that already exists, or that will be created. These institutions could either be energy management agencies, where applicable, or ministerial departments that are responsible for energy. Small but totally dedicated teams need to be created within these institutions to fulfil this mission, with a strong link to the relevant sectoral stakeholders. The project focal points and national experts should play a significant role, in order to pass on to these teams the know-how they have acquired from the project.

   However, most of these institutions would need occasional technical support to help with the training and creation of these dedicated teams. This technical assistance is likely to be fairly low-key, but needs to be specific to each country, with support provided to the local teams.

   Technical assistance should also focus on the development of centralised information systems for the compilation and periodical publication of energy efficiency and greenhouse gas emissions indicators in the countries.

   Some countries such as Algeria, Morocco and Lebanon currently receive technical assistance, for instance as part of the MEDENER project to develop an information system for energy indicators. Tunisia has received assistance under a multi-year cooperation programme with the French Environment and Energy Management Agency (ADEME) to develop an information system, which is now up and running. These countries could transfer their knowledge to other countries in the region.

2. **Taking the work further.** The major obstacle in developing regional indicators was data availability and the reliability of disaggregated figures. However, unavailability of data varies from sector to sector and from country to country. It is recommended that **an advanced sectoral data-collection pilot project** should be launched, involving integration of existing records, field surveys and estimates etc. in order to define and validate methodological approaches before rolling them out to other countries. In practical terms, three projects could be run in three different countries, focusing on developing specific disaggregated indicators in the fields of manufacturing industry, construction and transport. The findings could then be useful for other countries. These sectoral indicators would also serve as a benchmark for assessing the impact of the energy efficiency measures implemented under the League of Arab States guidelines on energy efficiency. This would also boost the **development of a bottom-up approach to assessment.**

3. **Gradually introducing regional cooperation on energy indicators.** A large body of socio-economic and energy data was collected in the countries participating in the project, compiled and processed in order to produce an initial array of standardised indicators on energy efficiency and greenhouse gas emissions in the region. These efforts should be used as starting point for region-wide institutional cooperation, involving the development of a regional database (similar to the European ODYSSEE project). This database, managed on a regional scale should be:

   - Updated regularly, through lasting links with the national focal points mentioned above.
   - Rolled out gradually to other countries in the region.
   - Improved continually and broadening to other more complex, more specific and more innovative indicators (structural effect, climate effect, technical effect, ODEX-type aggregate energy efficiency indicator, etc.).
   - Interfaced with other larger databases, especially in terms of methodology (e.g. International Energy Agency, World Bank, etc.).

4. **Consolidating and structuring the expert network formed for the project.** One of the biggest advances was the establishment, for the first time, of a core team of regional experts in energy indicators. This network of around twenty public- and private-sector experts should be maintained, consolidated and strengthened. More specifically, it could be established as a **regional network** (as part of one or more other regional energy networks), with a role that would include the following:

   - Promoting the sharing of expertise and experience across the region.
   - Disseminating an indicator culture in countries across the region.
   - Gradually broadening the network to others Southern and Eastern Mediterranean countries and other Arab nations.
   - Initiating and strengthening cooperation with other networks, such as the ODYSSEE project in Europe.
   - Helping to complete and improve the work started by the project, by completing the missing indicators, where possible.
   - Contributing to the periodical publication of key indicators within the region.

5. **Promoting international cooperation and coordination with other initiatives.**Various initiatives directly or indirectly related to the topic of energy indicators are currently underway in the region. These projects include:

   - The MEDSTAT project, whose key objective is to help countries produce their energy balances according to the EUROSTAT format over the long-term.
   - The MEDENER technical assistance project on the development of energy management information systems in Tunisia, Algeria, Morocco and Lebanon.
   - The RCREEE project to compile a regional database on RE & EE initiated jointly with LAS.
   - The MED-ENEC project on the energy efficiency of buildings.

Finally, it is strongly recommended that cooperation should be initiated with regional and international organisations with long experience in the field, such as the European Union and more specifically the ODYSSEE network, the International Energy Agency, Eurostat, the **Observatoire méditerranéen de l'énergie** (OME), etc. There should be three aims for this cooperation:

- Transfer of knowledge about indicators to countries in the region.
- Harmonisation of indication-calculation methods and hypotheses with a view to international comparison.
- Gradual integration of regional data into these organisations' statistics about indicators.

XII. References and data sources

- Energy conservation indicators in Southern and Eastern Mediterranean country reports for Algeria, Egypt, Jordan, Lebanon, Libya, Morocco, Palestine, Syria, Tunisia, Yemen, 2012.
- National statistics offices in Algeria, Egypt, Jordan, Lebanon, Libya, Morocco, Palestine, Syria, Tunisia, Yemen.
- Nation's accounts, Central banks in Algeria, Egypt, Jordan, Lebanon, Libya, Morocco, Palestine, Syria, Tunisia and Yemen.
- European Commission — Eurostat: http://europa.eu.int/comm/eurostat/
- International Energy Agency: http://www.iea.org/statist/
- World Bank: www.worldbank.org/data/
- World Energy Council: www.worldenergy.org
- FAO Food and Agriculture Organization: www.fao.org
- ENERDATA database: http://www.enerdata.net
- Organization for Economic Co-operation and Development: www.stats.oecd.org
- ODYSSEE Programme: http://www.odyssee-indicators.org
- U.S. Energy Information Administration: www.eia.gov

XIII. Annex: List of selected indicators

MACRO LEVEL INDICATORS

Abbreviation	Indicators	Unit	Definition
EDR	Energy dependence ratio	%	1- (energy production/gross inland energy consumption)
IPE	Intensity of primary energy	toe/1000 LC	Ratio between primary energy consumption and GDP
IFE	Intensity of final energy	toe/1000 LC	Ratio between final energy consumption and GDP
RFEPE	Ratio of final energy consumption to primary energy	%	Ratio between final energy consumption and primary energy consumption
REB	Ratio of national energy bill to GDP	%	Ratio between national energy bill and GDP
RPSE	Ratio of public subsidies for energy to GDP	%	Ratio between national public subsidies and GDP
AEF	Average emission factor	teCO_2/toe	Ratio between the total Green House Gas emission of the energy sector and the Gross Inland Consumption
ICO2	Intensity of CO_2	teCO_2 / 1000 LC	Ratio between the total Green House Gas emission of the energy sector and the GDP at constant price
AECH	Average primary energy consumption per inhabitant	ktoe/1000 inhab	Ratio between primary energy consumption and population
AELCH	Average electricity consumption per inhabitant	MWh/inhab	Ratio between total electricity consumption and population

TRANSFORMATION SECTOR INDICATORS

Abbreviation	Indicators	Unit	Definition
SREC	Share of installed RE electricity capacity	%	Ratio between installed RE electricity capacity (excluding hydro) and total installed generation capacity
URIC	Usage rate of the installed power generation capacity	%	Ratio between total produced electricity (all sources included) and total installed generation capacity
AETS	Apparent efficiency of energy transformation sector	%	Ratio between total energy output of the overall transformation sector (before distribution losses) and the total energy input to the energy transformation sector
PGEFF	Power generation efficiency of thermal plants	%	Ration between total generated electricity by thermal plants and fossil fuel input of thermal plants
SCFFP	Specific consumption of thermal power plants	toe/GWh	Ratio between total energy input of all thermal power plants in the country and total electricity produced by those power plants
PGF	Power generation efficiency	%	Ration between total generated electricity plants and fossil fuel input of thermal plants
SCPG	Specific consumption of per generation	toe/GWh	Ratio between total energy input of all power plants in the country and total electricity produced by those power plants
TDEE	Transmission and distribution electricity system efficiency	%	Ratio between total electricity output of the transmission and Distribution system and total electricity input of the transmission and distribution system
PGEF	Power generation emission factor	$teCO_2$GWh	Ratio between the total Green House Gas emission due to national power generation system and total produced electricity, all technologies and all resources included
ESEF	Electricity sector emission factor	$teCO_2$/GWh	Ratio between the total Green House Gas emission due to national power generation system and total electricity output of the transmission and distribution system

INDUSTRY SECTOR INDICATORS

Abbreviation	Indicators	Unit	Definition
BSEC	Specific energy consumption for the cement	toe/ton	Ratio between the final energy consumption of the cement branch and total production of the cement value added branch.
	Specific energy consumption for the phosphate		Ratio between the final energy consumption of the phosphate branch and total production of the phosphate branch.
	Specific energy consumption for the phosphoric acid		Ratio between the final energy consumption of the phosphoric acid branch and total production of the phosphoric acid branch
	Specific energy consumption for the T. super phosphate		Ratio between the final energy consumption of T. super phosphate branch and total production of T. super phosphate branch
	Specific energy consumption for the steel		Ratio between the final energy consumption of the steel branch and total production of the steel
	Specific energy consumption for the paper		Ratio between the final energy consumption of the paper branch and total production of the paper branch
	Specific energy consumption for the sugar		Ratio between the final energy consumption of the sugar branch and total production of the sugar branch
FEIIS	Final energy intensity of industry sector	toe/1000 LC	Ratio between the final energy consumption for the industrial sector and value added of industry sector at constant prices.
IEBR	Ratio of industry sector energy bill to value added	%	Ratio between the energy bill for the industrial sector and value added of industry sector
IESR	Ratio of public subsidies to value added	%	Ratio between the public subsidies for the industrial sector and value added of industry sector
IESRGB	Ratio of public subsidies for energy to government budget	%	Ratio between the public subsidies for the energy sector and government budget
IELSR	Ratio of public subsidies for electricity to value added	%	Ratio between the public subsidies for electricity sector and value added of industry sector
IICO2	CO_2 intensity of industry sector	$teCO_2$/1000 LC	Ratio between the total Green House Gas emission of the energy sector and value added of industry sector at constant prices.

TERTIARY SECTOR INDICATORS

Abbreviation	Indicators	Unit	Definition
FEITS	Final energy intensity of tertiary sector	toe/1000 LC	Ratio between the final energy consumption for the tertiary sector and value added of tertiary sector at constant prices.
TDRSHR	Diffusion rate of solar water heaters in tertiary sector	m²/1000 hab	Ratio between total solar water heater area in tertiary sector and population
TEBR	Ratio of energy bill to value added in tertiary sector	%	Ratio between the energy bill for the tertiary sector and value added of tertiary sector
TELSR	Ratio of public subsidies for energy to value added	%	Ratio between the public subsidies for the energy sector and value added of tertiary sector
TESRGB	Ratio of public subsidies for energy to government budget	%	Ratio between the public subsidies for the energy sector and government budget
HECNG	Energy consumption per night guest	kgoe/GN	Ratio between Total energy consumption of hotel sector and total number of night guests
TICO2	CO_2 intensity of tertiary sector	$teCO_2$/ 1000 LC	Ratio between the total Green House Gas emission of the tertiary sector and value added of tertiary sector at constant prices
TAEF	Average emission factor	$teCO_2$/toe	Ratio between the total Green House Gas emission of tertiary the sector and final energy consumption for the tertiary sector

RESIDENTIAL SECTOR INDICATORS

Abbreviation	Indicators	Unit	Definition
UCED	Unit energy consumption per dwelling	kgoe/dw	Ratio between total final energy consumption for households sector and total number of dwelling
SCEM²	Specific energy consumption per area unit	kgoe/m²	Ratio between total final energy consumption for households sector and total area of households
UEICD	Unit electricity consumption per dwelling	kWh/dw	Ratio between the total yearly electricity consumption for households sector and total number of dwelling
SCEIM²	Specific electricity consumption per m²	kWh/m²	Ratio between the total yearly electricity consumption for households sector and total area of households
RIPE	Intensity of residential sector	toe/ 1000 LC	Ratio between the final energy consumption for the residential sector and the private consumption of households at constant prices.
RELSR	Ratio of public subsidies for energy to private consumption	%	Ratio between the public subsidies for the residential sector and private consumption at constant price
RESRGB	Ratio of public subsidies for energy to Government Budget	%	Ratio between the public subsidies for the residential sector and government budget
RAEF	Average emission factor	$teCO_2$/toe	Ratio between the total Green House Gas emission of residential the sector and final energy consumption for the residential sector
$RICO_2$	CO_2 intensity of residential sector	$teCO_2$/ 1000 LC	Ratio between the total Green House Gas emission of the residential sector and value added of residential sector at constant prices
RDRSHR	Diffusion rate of solar water heaters in residential sector	m²/1000 inhab	Ratio between total solar water heater area in residential sector and population
ERACR	Equipment rate of air conditioning in residential sector	Unit/dw	Ratio between total number of air conditioning units and number of dwelling
ERFR	Equipment rate of refrigerator in residential sector	Unit/dw	Ratio between total number of refrigerators units and number of dwelling

TRANSPORT SECTOR INDICATORS

Abbreviation	Indicators	Unit	Definition
TrFEI	Final energy intensity of transport sector	toe/1000 LC	Ratio between the final energy consumption for the transport sector and value added of transport sector at constant prices.
STEHE	Share of household expenditure for transport	%	Ratio between the average of household expenses for transport and the average of the total households expenditures
EUCC	Average energy unit consumption of cars	kgeo/car/year	Ratio between final energy consumption of private cars and total number of private cars
EUCC G	Average energy unit consumption of gasoline cars	kgeo/car/year	Ratio between final energy consumption of gasoline cars and total number of gasoline cars
EUCC D	Average energy unit consumption of diesel cars	kgeo/car/year	Ratio between final energy consumption of diesel cars and total number of diesel cars
AEFTS	Average emission factor of transport sector	tCO_2e/toe	Ratio between the total Green House Gas emission of the transport sector and final energy consumption for the transport sector
MR	Motorization rate	persons/Vehicle	Ratio between the total population and the total number of private cars
ICO2	CO2 intensity of transport sector	tCO_2e/1000 LC	Ratio between the total Green House Gas emission of the transport sector and value added of transport sector at constant prices
SCRW	Specific consumption for rail ways	kgoe/ p.km	Ratio between total energy consumption of trains per total number of passengers of trains and total number of km's operated of train
SCAT	Specific consumption for air transport	kgoe/ p.km	Ratio between total energy consumption of air transport per total number of passengers of air transports and total number of km's operated of air transport
SCMT	Specific consumption for maritime transport	kgoe/ t.km	Ratio between total energy consumption of maritime transport per total number of tons operated by maritime transport and total number of km's operated of maritime transport
SEAT	Specific emission factor for air transport	$KgeCO_2$/p.km	Ratio between the total Green House Gas emission of air transport per total number of passengers of air transport and total number of km's operated of air transport
SEMT	Specific emission factor for maritime transport	$kgeCO_2$/t.km	Ratio between the total Green House Gas emission of maritime transport per total number of tons operated by maritime transport and total number of km's operated of maritime transport