Final Report

Vendor number: 135382

Date: 11 December 2014

MENA – Delivery Mechanisms and Institutions to Realize Energy Efficiency Potential

RCREEE

Regional Center for Renewable Energy and Energy Efficiency

المركز الإقليمي للطاقة المتجددة وكفاءة الطاقة

About the Study

As part of its sustainable energy development program, the World Bank (WB) has initiated a study entitled, "MENA – Delivery Mechanisms and Institutions to Realize Energy Efficiency Potential." The study aims to deliver a detailed survey to develop strategies for raising energy efficiency in the MENA region. There are several tasks envisioned during the course of the project, including: (1) screening/gap analysis and coordination with partners; (2) energy projections, efficiency potential and benefits; (3) lessons from scaling-up energy efficiency investments in other regions; (4) mapping of policies and delivery mechanisms; and (5) policy implications.

This report presents findings of the second task, a study on energy projections, efficiency potential and benefits.

Authors

Emmanuel Bergasse, Therese El Gemayel, Rana El-Guindy

Reviewers

Nurzat Myrsalieva, Adel Mourtada, Maged Mahmoud

Contributors

RCREEE would like to thank various stakeholders for their review of the initial planning for implementing this project, in addition to member countries representatives that provided their feedback on the output of this report:

- Mr. Sohbet Karbuz, Director of Hydrocarbons Division, Observatoire Méditerranéen de l'Energie (OME)
- Mr. Vladimir Kubecek, Energy Statistics Section, International Energy Agency
- Ms. Wafa Aboul Hosn, Head of Economic Statistics Section, UNESCWA
- Dr. Abdel Ali Dakkina, Directeur du Pôle de la Stratégie et du Développement, Agence Nationale ADEREE, Morocco
- Mr. Abdelaziz Bourahla, Energy, Environment and Statistics Expert
- Mr. Mohammed Al Badrawy, Energy Statistics Expert, independent Consultant
- Mr. Mongi Bida, Energy Officer, UNESCWA
- Mr. Nasser Al-Ruwaili, Advisor to H.E the Chief Executive of Electricity & Water Authority, Water and Electricity Authority, Bahrain
- Mr. Abdelhamid Khalafallah, Deputy Director of Energy Efficiency, Ministry of Industry and Technology / General Energy Dirtectory, Tunisia
- Mr. Fawzi Ben Zaid, Ministry of Energy & Mines, Algeria
- Mr. Ramy Aly Mohammed, Director Renewable Energy, Manager of Renewable Energy Department, Yemen
- Mr. Younes Ali, Deputy General Director, NERC, Syria
- Mr. Ziad El-Zein, Public Relations Officer, Lebanese Centre for Energy Concentration
- Mr. Yacoub Elias Marar, Head of Solar Energy Section, Ministry of Energy and Mineral Resources, Jordan

- Mr. Bassel Yassin, Director Energy Environmental Impact Department, Palestinian Energy and Environmental Research Center (PEC), Palestinian Energy Authority (PEA)
- Mr. Mohamed Sidon, Director of the Chairman Office of Renewable Energy Authority of Libya, Renewable Energy Authority of Libya
- Mr. Naseer Kareem Kasim, Head of Department, Renewable Energy and Environment Center, Iraq
- Mr. Sharf Eldin ElAgieb, Electricity Regulatory Authority ERA, Sudan
- Ms. Helen Naser, Consultant (GFA Group)
- Mr. Ali Abo Sena, Director of National Center for Cleaner Production, Egypt
- Ms. Ruba Al-Zubi, Clean Technology Sector Director at USAID "Jordan Competitiveness Program" (JCP)
- Mr. Tarek Saleh, Resource Efficiency and Cleaner Production Specialist, Egypt National Cleaner Production Center (ENCPC), Ministry of Trade, Industry and SMEs
- Mr. Habib El Andaloussi, Chief of Energy Section, Sustainable Development and Productivity Division, UNESCWA
- Mr. Rafik Missaoui, Energy Efficiency Consultant, Tunisia
- Mr. Mohammed Ahachad, National Coordinator of the EE Program in Building (CEEB)/UNDP, ADEREE, Morocco
- Ms. Dalia Abdelhalim El-Toukhy, KAHRA MAA, Qatar General Electricity & Water Corporation, Conservation and Energy Efficiency Department
- Mr. Mohamed Dabbas, Head of Energy Efficiency department, Ministry of Energy and Mineral Resources, Jordan
- Mr. Ihab Ismail, Head of the Planning Department, New Renewable Energy Authority, Egypt
- Mr. Tareq Akel, Financial advisor baker, AZI, Jordan
- Ms. Salma Aouinti, financial manager, ANME, Jordan
- Ms. Caroline Orjebin-Yousfaoui, project manager Water energy transport, IPEMED
- Mr. Steffen Erdle, Head of the Regional Project RE-ACTIVATE "Promoting Development and Employment through Renewable Energy and Energy Efficiency (RE/EE) in the Middle East and North Africa (MENA)", GIZ
- Ms. Rima le Coguic, Deputy Head of the Sustainable Energy and Transport Division, AFD
- Mr. Christian de Gromard, AFD
- Mr. Abdel Rahman A. Maali, Technical Advisor to the Ministry of Water, Resources and Electricity, Sudan
- Ms. Wafaa Mahmoud Al Obaidi, Senior Chief Engineer, Ministry of Oil, Iraq
- Mr. Dhahwi Al Hameli, Director of Emergency Electrical Networks Department, Ministry of Electricity and Water, Kuwait
- Ms. Sorina Mortada, Technical Consultant to Lebanese Center for Energy Conservation (LCEC)
- Mr. Sam Gouda, President and Lead Expert, Creara International LLC, Egypt
- Mr. Ezzedine Khalfallah, Independent Consultant, Tunisia
- Ms. Florentine Visser, Key Expert EE Building & Urban Planning, MED-ENEC

Contents

1 Introduction 8
2 Data, Methodology, and Key Assumptions 9
2.1 Data 9
2.2 Methodology and Key Assumptions 12
2.2.1 Energy Demand Projections 12
2.2.2 Energy Efficiency Potential 13
2.2.3 Cost of Conserved Energy 16
2.2.4 Reductions in Energy Expenditures and Avoided Investments 18
3 Results for the MENA Region 20
3.1 Overview of Energy Supply and Demand 20
3.2 Energy Demand Outlook 2020 20
3.3 Energy Demand Outlook 2025 21
3.4 Energy Efficiency Potential 23
3.4.1 Electricity 23
3.4.2 End-Use Sectors 23
3.4.3 Country Comparison 25
3.4.4 Projections for 2020 and 2025 26
3.4.5 CO_2 Emissions 27
4 Results by Country 29
4.1 Algeria 29
4.1.1 Overview of Energy Supply and Demand 29
4.1.2 Energy Demand Outlook 2020 30
4.1.3 Energy Demand Outlook 2025 30
4.1.4 Energy Efficiency Potential 32
4.1.5 Energy Efficiency Potential in 2020 and 2025 34
4.2 Bahrain 35
4.2.1 Overview of Energy Supply and Demand 35
4.2.2 Energy Demand Outlook 2020 36
4.2.3 Energy Demand Outlook 2025 36
4.2.4 Energy Efficiency Potential 37
4.2.5 Energy Efficiency Potential 2020 and 2025 40
4.3 Egypt 41
4.3.1 Overview of Energy Supply and Demand 41

4.3.2 Energy Demand Outlook 2020 42
4.3.3 Energy Outlook 2025 42
4.3.4 Energy Efficiency Potential 44
4.3.5 Energy Efficiency potential 2020 and 2025 46
4.3.6 Cost of conserved energy 46
4.3.7 Reduction in energy expenditures and avoided investment 48
4.4 Iraq 49
4.4.1 Overview of Energy Supply and Demand 49
4.4.2 Energy Demand Outlook 2020 50
4.4.3 Energy Outlook 2025 50
4.4.4 Energy Efficiency Potential 52
4.4.5 Energy Efficiency Potential 2020 and 2025 54
4.5 Jordan 55
4.5.1 Overview of Energy Supply and Demand 55
4.5.2 Energy Demand Outlook, 2020 56
4.5.3 Energy Demand Outlook 2025 56
4.5.4 Energy Efficiency Potential 58
4.5.5 Energy Efficiency Potential 2020 and 2025 60
4.5.6 Cost of Conserved Energy Curve 61
4.6 Kuwait 65
4.6.1 Overview of Energy Demand and Supply 65
4.6.2 Energy Demand Outlook, 2020 66
4.6.3 Energy Outlook 2025 66
4.6.4 Energy Efficiency Potential 68
4.6.5 Energy Efficiency Potential 2020 and 2025 70
4.7 Lebanon 71
4.7.1 Overview of Energy Supply and Demand 71
4.7.2 Energy Demand Outlook, 2020 72
4.7.3 Energy Demand Outlook 2025 72
4.7.4 Energy Efficiency Potential 74
4.7.5 Energy Efficiency potential 2020 and 2025 76
4.7.6 Cost of conserved energy 77
4.7.7 Reductions in energy expenditures and avoided investment 78
4.8 Libya 80

4.8.1 Overview of Energy Supply and Demand 80
4.8.2 Energy Demand Outlook, 2020 81
4.8.3 Energy Outlook 2025 81
4.8.4 Energy Efficiency Potential 83
4.8.5 Energy Efficiency Potential 2020 and 2025 85
4.9 Morocco 86
4.9.1 Overview of Energy Demand and Supply 86
4.9.2 Energy Demand Outlook, 2020 87
4.9.3 Energy Demand Outlook 2025 87
4.9.4 Energy Efficiency Potential 89
4.9.5 Energy Efficiency Potential 2020 and 2025 91
4.9.6 Cost of conserved energy 92
4.9.7 Reductions in energy expenditures and avoided investments 93
4.10 Oman 95
4.10.1 Energy Demand Outlook, 2020 96
4.10.2 Energy Demand Outlook 2025 96
4.10.3 Energy Efficiency Potential 98
4.10.4 Energy Efficiency Potential 2020 and 2025 100
4.11 Palestine 101
4.11.1 Overview of Energy Supply and Demand 101
4.11.2 Energy Demand Outlook 2020 102
4.11.3 Energy Outlook 2025 102
4.11.4 Energy Efficiency Potential 104
4.11.5 Energy Efficiency Potential 2020 and 2025 105
4.12 Qatar 107
4.12.1 Overview of Energy Supply and Demand 107
4.12.2 Energy Demand Outlook, 2020 108
4.12.3 Energy Demand Outlook 2025 108
4.12.4 Energy Efficiency Potential 110
4.12.5 Energy Efficiency Potential 2020 and 2025 112
4.13 Saudi Arabia 113
4.13.1 Overview of Energy Supply and Demand 113
4.13.2 Energy Demand Outlook, 2020 114
4.13.3 Energy Demand Outlook 2025 114

4.13.4 Energy Efficiency Potential 116
4.13.5 Energy Efficiency Potential 2020 and 2025 118
4.14 Sudan 119
4.14.1 Overview of Energy Supply and Demand 119
4.14.2 Energy Demand Outlook 2020 120
4.14.3 Energy Demand Outlook 2025 120
4.14.4 Energy Efficiency Potential 122
4.14.5 Energy Efficiency Potential 2020 and 2025 124
4.15 Tunisia 125
4.15.1 Overview of Energy Supply and Demand 125
4.15.2 Energy Demand Outlook 126
4.15.3 Energy Demand Outlook 2025 126
4.15.4 Energy Efficiency Potential 128
4.15.5 Energy Efficiency Potential 2020 and 2025 130
4.15.6 Cost of conserved energy 131
4.15.7 Reduction in energy expenditures and avoided investments 132
4.16 United Arab Emirates 134
4.16.1 Energy Demand Outlook, 2020 135
4.16.2 Energy Demand Outlook 2025 135
4.16.3 Energy Efficiency Potential 137
4.16.4 Energy Efficiency Potential 2020 and 2025 139
4.17 Yemen 140
4.17.1 Overview of Energy Supply and Demand 140
4.17.2 Energy Demand Outlook 141
4.17.3 Energy Demand Outlook 2025 141
4.17.4 Energy Efficiency Potential 143
4.17.5 Energy Efficiency Potential 2020 and 2025 145
List of figures 146
List of tables 149
Annex A: Data Sources 151
Annex B: EE Potential Sectoral Assumptions 154
Annex C: Budget Allocation Charts (BAC), 2020 (*Source:* MED-ENEC and MED-EMIP) 164
Annex D: Advisory group meeting results (Beirut and Marseille) 167

Abbreviations

AC	Alternating Current
AFEX	Arab Future Energy Index
BAU	Business as Usual
CFL	Compact Fluorescent Lamp
EE	Energy Efficiency
EEI	Energy Efficiency Indicator
EU	European Union
GCC	Gulf Cooperation Council
GCCSTAT	Statistical Centre for the Cooperation Council for the Arab Countries of the Gulf
GDP	Global Domestic Product
GWh	Gigawatt Hour
IEA	International Energy Agency
kgoe	Kilogram Oil Equivalent
KPI	Key Performance Indicator
ktoe	Thousand Tons of Oil Equivalent
kWh	Kilowatt Hour
LED	Light Emitting Diode
MAED	Model for Analysis of Energy Demand
MENA	Middle East and North Africa
Mtoe	Million Tons of Oil Equivalents
m^2	Square Meter
OAPEC	Organization of the Arab Petroleum Exporting Countries
OECD	The Organization for Economic Cooperation and Development
OME	Observatoire Méditerranéen de l'Energie
OPEC	Organization of Petroleum Exporting Countries
PWMSP	Paving the Way for the Mediterranean Solar Plan
RCREEE	Regional Center for Renewable Energy and Energy Efficiency
RE	Renewable Energy
SWH	Solar Water Heater
toe	Ton of Oil Equivalent
TWh	Terrawatt Hour
UAE	United Arab Emirates
UN	United Nations
UN-ESCWA	The United Nations Economic and Social Commission for Western Asia
WBG	World Bank Group

1 Introduction

The MENA region is one of the few energy abundant regions in the world with extensive oil and natural gas reserves. Countries have been extracting large quantities of hydrocarbons to be exported and used worldwide. The broad availability of hydrocarbons associated with universal subsidy schemes for energy consumption has hindered the use of new technologies to harvest renewable energy and energy efficiency potential. The production of energy from renewable sources is still extremely limited, even as solar and wind energy can be easily harvested due to the climate of the region. What is more, political revolutions and wars in the region greatly impacted several energy sectors. While some countries were affected more than others, energy sectors in the region are still growing and the economies of a large number of countries under review are extensively dependent on hydrocarbons.

The current report presents (1) a brief overview of current trends of energy supply and demand in the region and by country; (2) a "simple projection" of energy demand for 2020 and 2025 based on a historical trend of energy consumption; and (3) provides an estimate of technical energy efficiency potential. The main uses of energy in the future by major sectors will be assessed, the most important consuming sectors and uses will be identified by subsector, and potential energy savings will be highlighted. It is expected that socioeconomic structure and trends will remain unchanged over the projection period.

Countries under assessment are Algeria, Bahrain, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Palestine, Tunisia, Qatar, Saudi Arabia, Sudan, the United Arab Emirates, and Yemen.

2 Data, Methodology, and Key Assumptions

2.1 Data

A crucial step for each task is the data collection and appraisal to ensure sufficient relevance and internal coherence, as well as inter-country comparison. This will be done in order to perform the planned project tasks, in particular energy demand projections and estimations of energy efficiency potential. The project primarily relies on the recent RCREEE Energy Efficiency Indicator Study project, as well as on databases from the IEA and ESWCA, especially for the GCC countries.

Energy Demand Projections are primarily based on the energy balances series available from 2000 to 2012 prepared within the scope of the "RCREEE Energy Efficiency Indicators Study" project[1] and published data of IEA, UNESWCA, and other regional and international organizations including OPEC, OAPEC, and BP. The choice of the RCREEE Energy Efficiency Indicators Study was based on the cross checking and validation of data with national focal points and sources. The format chosen, although slightly altered, allows a suitable comparison of data over the selected period in the same table. Energy balances for the remaining countries, mainly GCC countries, was collected through desk review of available national and international sources.

The data sources differ according to each sub-region and are as follows:

- RCREEE member states (12): IEA and national sources with an extensive process of data consolidation on total and sectoral breakdown by national experts; and
- GCC countries (5): Based on national sources and complemented by regional and international organizations data.

This tailored approach was designed to ensure the most relevant and quality sources available were utilized. The following table provides a detailed data assessment by country and data sources. In addition, Annex **A** presents an extensive list of resources organized by country of the studies, reports, and statistical data sets used to complement the available data sources.

Table 1: Data Availability and Sources for Estimating Energy Demand Projections

	ENERGY BALANCES			SOCIOECOMIC & ENERGY INDICATORS	
	RCREEE (2000-2012)	UN ESCWA (2000-2012)	IEA BALANCE (2000-2012)	RCREEE INDICATORS	ESCWA
Algeria	X	No	XX	X	NO
Bahrain	X	X	X	X	X
Egypt	X	X	X	X	X

[1] The objective of this project was to design and implement a detailed and comparable set of indicators to monitor and assess energy efficiency performance and policies in RCREEE member states. The project offered a regular and consistent baseline data generation process. Information is used in regional benchmarking and decision-making support in designing energy efficiency policies.

Iraq	X	X	X	X	X
Jordan	X	X	X	X	X
Kuwait	No	X	X	No	X
Lebanon	X	X	X	X	X
Libya	X	X	X	X	X
Morocco	X	X	XX	X	X
Oman	No	X	X	No	X
Palestine	X	X	No	X	X
Qatar	No	X	X	No	X
Saudi Arabia	No	X	X	No	X
Sudan	X	X	X	X	X
Tunisia	X	X	XX	X	X
United Arab Emirates	No	X	X	No	X
Yemen	X	X	X	X	X
	XX: Detailed sectoral breakdown				

The lack of direct energy surveys among end-use sectors in the MENA region is a major barrier for energy balance coherence (since it is largely preventing to check supply data) and scope. The absence in these surveys also hampers an effective breakdown of energy consumption by subsectors/products and uses for the industrial, residential, and service sectors. Most countries still lack the tools necessary to collect energy demand data, which hinders the availability of reliable official statistics (*See Box 1 below*).

The lack of data revolves mainly around the breakdown of final energy consumption between economic activities. Despite the efforts made to elaborate more detailed and reliable energy balances, generally the repartition of the final consumption between the main sectors—industry, transportation, tertiary and residential—is problematic in most target countries. Thus, the distribution of the consumption between branches, by use or by mode within the sectors, is not available. This lack of information constitutes a real barrier to calculate indicators at a disaggregated level.

Some MENA countries have shown advancement in statistical surveys in several fields related to energy, industry, and agriculture sectors with the implementation of energy use surveys, whether in the household or transport sectors. However, a large number of countries still lack such advancement in statistics that hinders the availability of reliable official statistics.

Box 1: Energy Demand Data Collection

An effective and relevant energy data system should primarily rely on a solid and comprehensive data collection scheme, in particular on primary energy supply and transformation data from energy companies. For the final energy consumption by end-use sectors, energy supply sources are generally insufficient even to balance supply and demand in the annual energy balance according to international standards (as for the IEA/EUROSTAT/UNECE annual questionnaires).

Only sample surveys on final energy consumption by the end-use sectors (industry, residential, tertiary, transport, agriculture) are possible due to accurate, relevant, and detailed energy consumption data by subsectors and often by uses. This allows a breakdown of final demand in the energy balance. Additionally, direct demand surveys and associated databases have proven to be crucial tools to better understanding of the current and future energy demands and customer behaviors necessary for prospective and energy planning.

In the MENA region, only few countries Morocco have put in place regular direct demand surveys in the industrial, residential, and transport sectors, notably through existing surveys. The exceptions include Tunisia, which has since the late 1980s conducted a detailed household survey by the power utility STEG in collaboration with the Industry Ministry and ANME, and more recently Morocco. Nonetheless, despite those references, the support of EUROSTAT (MEDSTAT Energy) and ESCWA, their crucial function, relevance, and modest cost, direct demand surveys are still largely ignored by policymakers and thus remain neglected by national statistical offices and energy ministries.

A detailed review of the available surveys in the MENA countries under this study has been made to generate a list of the available surveys of the energy sector at the country level, as well as end-use sectors such as industry, residential, and agriculture. Table 2 below shows a summary of the available surveys and censuses consulted over the course of the study.

Table 2: Data Availability and Sources for Estimating Energy Savings Potential

	Sectors	Countries	Sources of Data	Relevant Reports
Energy Sector	Power generation	All countries, except for Palestine, Qatar	AUPTDE, national sources (statistical offices, ministries of electricity and energy)	Statistical Bulletin, statistical abstracts, electricity and water statistics
	Transmission and distribution losses	All countries, except for Palestine and Qatar	PWMSP, AUE, World Bank, national sources, AUPTDE	Statistical Bulletin
	Oil refineries	All countries except Lebanon and Palestine	OAPEC, OPEC, national sources (statistical offices, ministries of energy),	Statistical Bulletin, statistical abstracts
End-use Sectors	Industry	Algeria, Bahrain, Egypt, Iraq, Morocco, Oman, Qatar, Tunisia, Jordan, Saudi Arabia, Sudan, Yemen	National sources (statistical offices, ministries of industry), RCREEE Indicators Study	RCREEE Indicators Study, energy consumption surveys
	Residential	Algeria, Bahrain, Egypt, Iraq, Jordan, Kuwait, Lebanon, Palestine, Morocco, Qatar, Saudi	National sources (statistical offices)	Household consumption and expenditure surveys, energy consumption

		Arabia, Sudan, Tunisia, UAE		surveys
	Services	Bahrain, Egypt, Lebanon, Oman, Qatar, Morocco, Tunisia, UAE	National sources (statistical offices)	Tertiary surveys
	Transport	Kuwait, Palestine, Tunisia, Morocco	National sources (Statistical offices)	Transport Bulletin, Energy consumption surveys, surveys on transport sector
	Agriculture	All countries, except GCC	National sources (statistical offices)	Agriculture surveys

Table 3: Availability of EE Indicators for Energy Intensive Industrial Products 2000-2012

Specific Energy Consumption of the Selected Industrial Products	Country Where Data is Available	Unit
Cement	Algeria, Egypt, Jordan, Morocco, Sudan, Tunisia, Yemen	toe/t
Phosphate	Algeria, Egypt, Jordan, Morocco, Tunisia	toe/t
Steel	Algeria, Egypt, Jordan, Morocco, Sudan, Tunisia	toe/t
Paper	Algeria, Egypt, Jordan, Morocco, Tunisia	toe/t
Phosphoric Acid	Jordan, Morocco, Tunisia	toe/t
Sugar	Morocco, Sudan, Tunisia	toe/t
Data source: RCREEE EE Indicators Study		

Table 4: Availability of EE Indicators for Road Transport Sectors (Personal Cars) 2000-2012

Average Energy Unit Consumption	Country	Unit
All Cars	Algeria, Bahrain, Egypt, Jordan, Lebanon, Morocco, Sudan, Tunisia, Yemen,	kgoe/car/year
Gasoline Cars	Algeria, Jordan, Morocco, Tunisia, Yemen	kgoe /car/year
Diesel Cars	Algeria, Jordan, Morocco, Tunisia, Yemen	kgoe /car/year
Data source: RCREEE EE Indicators Study		

2.2 Methodology and Key Assumptions

2.2.1 Energy Demand Projections

Economic projection is defined as "a calculation of the way that something will change and develop in the future". It aims to give a picture of the future based on knowledge of the past. In other words, a projection is a prolongation of past trends over a selected period.

A large number of previous relevant studies and publications on different methodologies for estimating energy demand projections were reviewed to identify the most suitable methodology given the lack of detailed, comparable data sets in the MENA region. The question was whether to pursue energy demand estimations using detailed end-use methodologies (such as the MAED model[2]) or a simple econometric model. The latter option has been chosen due to the above-mentioned data constraints.

A thorough review of the data over the time series, by sector and fuel, of each country's energy balance was made. As such, the following data compilations and calculations were performed:

- Calculation of the average annual growth rate and average value for the period 2000-2012; and
- Projections for 2020 and 2025 based on average annual growth rate. For the period 2020-2025, the hypothesis is that the energy demand growth would be for some countries is less rapid than during the first period, owing to the results of EE policies and measures as well as energy-intensive economies. Such differential growth for this second period would rely on a quantitative and qualitative analysis of existing EE policies and notably its goals (NEEAP) and policy implementation.

The projection for the horizons 2020 and 2025 is based on a Business as Usual (BAU) or conservative scenario that implies that the socio-economic structure and energy consumption patterns remain unchanged over the projected period. It correlates with the objective of identifying energy consumption segments and will be the largest at those horizons with current consumption trends.

While such a strong assumption may be reasonable for countries with slow change in energy infrastructure and consumption patterns, it may not be relevant for other countries in rapid reforms and modernization such as Morocco and the UAE, especially due to their expanding energy infrastructure and more rapid socioeconomic development.

2.2.2 Energy Efficiency Potential

Energy savings and* energy *efficiency (EE) While both terms are used interchangeably, they are in fact different. Energy savings means using less energy, generally through a behavioural change (e.g. turn off the light or reduce its daily use). Energy efficiency (EE) means using energy more effectively and durably for the same level of service, product, or comfort based on technological, organisational, structural, or behavioural changes (e.g. change the incandescent bulb by a CFL or LED). Thus, less energy is used to produce the

[2] The MAED model computes energy demand at the subsector level and activity level. It evaluates future energy demand based on medium to long-term scenarios of socio-economic, technological and demographic developments. It relates systematically the specific energy demand for producing various goods and services identified in the model, to the corresponding social, economic and technological factors that affect this demand. The total energy demand for each end-use category is aggregated into four main "energy consumer" sectors: Industry (including agriculture, construction, mining and manufacturing), transportation, services and households. Finally, the model focuses exclusively on energy demand, and even more specifically on demand for specified energy services. It does require a detailed and reliable set of energy and socioeconomic data.

same service or good. According to the IEA,[3] "Something is more energy efficient if it delivers more services for the same energy input, or the same services for less energy input".

For this study, the term energy savings may be understood in a global sense and thus encompasses behavioural energy savings (as occurs through awareness campaigns) as well as EE, in particular through new investments in more efficient technologies. For simplification, in the rest of the report, the generic term of **energy efficiency** (EE) will be used.

Technical potential and techno-economic EE potential While technical potential covers all actions and investments that are technically feasible without the limitations of realisation costs, the techno-economic potential includes only those actions and investments with a payback time (as with the ratio between the economic savings and investment costs) considered as acceptable by most customers.

In most MENA countries, the existence of high universal energy subsidies for all customers proportionally reduces the value of those economic savings and thus the payback time and attractiveness of EE. Thus, for simplicity purposes, the technical potential for energy savings will be assessed in this study. The option to estimate the techno-economic potential would require acquiring much more data than is generally available and be based on weak assumptions.

Direct RE technology as energy savings A methodological issue is to either or not list direct renewable energy (RE) technologies, such as solar water heating (SWH) and Photovoltaic (PV), as energy savings technologies in the tertiary and residential sectors. In both cases, they reduce the use of grid or direct energy consumption including electricity and thus are energy savings technologies. On the other hand, as RE technology, they enter in the RE potential assessment. For this study, as SWH generally substitute fossil fuels such as LPG and fuel oil or electricity in the building itself and thus generate direct energy savings, they will be considered as part of the energy efficiency potential and technologies.

Primary and final EE potential Primary energy savings are realised in the energy sector (supply side), while final energy savings refer to energy savings in the end-use sectors (demand side). Final electricity savings can be converted in primary energy equivalent to take into account the transformation and transport losses. The usual coefficient to convert final electricity into primary energy is 2.58 (1 kWh final = 2.58 kWh primary), or a global efficiency of the electricity system (from the power plant to the consumer) of 38.5%. Based on the broad and in-depth data collection of the RCREEE Energy Efficiency Indicators Study project, reliable country-specific consumption of power generation (in toe/GWh) indicators are available for almost all countries. They are equivalent to a final electricity conversion to primary energy. Nevertheless, a statistical issue is that electricity consumption data in end-use sectors is generally available for the residential sector only.

[3] http://www.iea.org/aboutus/faqs/energyefficiency/

In a situation of scarce detailed data, especially on energy consumption at subsectoral and product levels as final energy breakdown remains limited in most countries, the use of existing EE indicators to estimate the EE potential appears the best methodological compromise. Generally, the unit consumption ratios are more accurate than relying on physical units, as they have less bias than energy intensities (with possible multiple fluctuations of the GDP and external reasons as exchange rate variations). Energy intensities measure first the energy content of products or services but not directly the physical efficiency of energy use. Thus, it does not necessarily reflect a high or higher EE and hence EE potential. The estimation of the energy efficiency potential by sector or subsector relies on the relative difference between the current level of one EE indicator or a set of EE indicators with references or benchmarks at country, regional or sub-regional levels (when relevant, international references are also mentioned). When detailed data is available by subsectors or products (i.e. for the seven industrial energy-intensive products, public lighting), or by energy uses (i.e. lighting, air conditioning, and motors), an estimation of EE technical potential has been further detailed.

The same methodology for EE potential estimation is applied to the electricity sector and end-use sectors, which rely on existing EE indicators. The technical EE potential is estimated for the latest data available year (in most cases, 2011 or 2012).

For sectoral EE indicators, benchmarks, and EE potential estimation, energy and socio-economic data availability and reliability at country and regional levels are crucial. While a sectoral EE indicator may be available for one country and considered reliable, the lack of sufficient indicators in other countries may prevent the establishment of a benchmark at country or regional levels that would inform an EE potential estimation. Additionally, final energy intensities (e.g. toe/unit of GDP) are generally too subject to specific structural conditions such as sectoral and product composition to be comparable between countries within the same sub-region.

Thus, specific energy consumption ratios such as toe/t and kWh/m^2 have been prioritized as generally not directly influenced by macroeconomics and variations and thus provide more accurate data. Nevertheless, these ratios require detailed and reliable energy and socio-economic data, which reduce the possibility of country comparisons and benchmarking.

The estimation of the EE potential relies on the following general assumptions:

- The reliability of the country EE indicators and the regional benchmarks is relevant between countries in the same sub-regions (i.e. the Mediterranean, the Gulf, and Africa) and is not influenced by structural parameter differences; and
- The use of regional benchmarks within the MENA region supposes that socio-economic and technology conditions are similar between the various countries within the same climatic zone and socio-economic categories for the residential sector.

Sector specific assumptions are presented in **Annex B**

2.2.3 Cost of Conserved Energy

The basic principle of the EE potential abatement cost is to associate the EE potential and the corresponding abatement cost in US dollars (USD) or euros per saved ktoe or GWh. Those abatement costs include all direct and related costs (including avoided energy costs) to study, install, and operate EE actions and technologies paid by the customers. They include annualized payments for the capital and operation expenses. In addition, the accumulated energy savings in economic terms (a measure based on customer's electricity bills) can also be associated.

The EE potential measures or technologies are ranked by abatement cost from the cheapest to the most expensive technology or action. This merit order by cost prioritizes technologies with the lowest cost, even if they have less potential. .

Uncertainty may be significant for estimates of the EE potential and abatement costs. It is linked with the effective implementation of EE measures and effective investment costs, respectively.

The associated reductions in energy expenditures consist of reduced energy expenses for customers while avoided investments include new capacities made unnecessary by reduced energy consumption.

The application of the EE potential abatement costs to a set of MENA countries relies first on the estimated EE potential carried out for the latest available year in the electricity sector and five end-use sectors: industry, transport, tertiary, residential, and agriculture and fishing. The estimated EE potential is also projected to the 2020 and 2025 to serve as framework data or the maximum technical EE potential.

An indispensable source of information used in this report is the Budget Allocation Chart (BAC) prepared by the MED-ENEC and MED-EMIP EU Southern Mediterranean regional projects for Egypt, Jordan, Lebanon, Morocco, and Tunisia for 2020. The cost abatement approach target electricity consumption and are built based on extensive data collection, compilation, and simulation both in the MENA region and the EU by using a set of EE&RE technologies, as well as their cost and impact on electricity consumption. These are based on an estimation of the electricity efficiency potential and abatement cost in both euro/kWh and total amount for the most promising EE&RE technologies in various subsectors and transversal uses, such as lighting – **Annex C**.

It combines the sectoral 2020 EE potential with selected EE technologies and solar water heating (SWH) within the industry, tertiary, and residential sectors to assess their electricity efficiency potential for 2020. Transport, agriculture, and fishing are not covered as they consume almost only fuels. The electricity efficiency potential is then expressed in final electricity. The abatement period starts from 2012 until the horizon 2020 for the industry, tertiary, and residential sectors. Tables 5 and 6 below show an example of the electricity efficiency potential abatement cost.

The unit investment costs (USD/toe) of EE technologies and measures are estimated based on existing international references and benchmarks and on the hypothesis that:

- 30 percent of the investments are realizable for an average cost of 100 USD/toe;
- 50 percent of the investments are realizable for an average cost of 200 USD/toe; and
- 20 percent of the investments are realizable for an average cost of 300 USD/toe, for an average total cost of 190 USD/toe (expert estimates based on previous studies and international benchmarks).

Table 5: Electricity Efficiency Potential Abatement Investment Cost, and Net Abatement Cost by End-use Sectors and EE Technologies

Sectors/EE Technologies	**Electricity Efficiency Potential**		**Investment Cost**		**Net abatement cost**
	Total of subsector	By EE technology			
	ktoe/y	ktoe/y	USD/toe	M USD/y	M USD/y
Industry					
Electric motors					
Compressed air					
Tertiary					
SWH					
Street lighting					
Thermal insulation					
Residential					
Efficient fridges					
Efficient lighting					
SWH					
Thermal insulation					
Lighting ballasts					
TOTAL					
Total without SWH					
% Total Electricity Efficiency Potential					

Table 6: Electricity Efficiency Potential, Investment Cost and Net Abatement Cost by EE Technologies

Electricity Sector / **EE Technologies**	**Electricity Efficiency Potential**	Net Abatement Cost
	ktoe/y	M USD/y
Electric motors		
Compressed air		

SWH		
Street lighting		
Thermal insulation		
Efficient fridges		
Efficient lighting		
SWH		
Thermal insulation		
Lighting ballasts		

2.2.4 Reductions in Energy Expenditures and Avoided Investments

The methodology is based on the electricity efficiency potential abatement and associated reductions in electricity expenditures for 2020 for a set of EE technologies. They represent the customer economic savings at a full realization of the electricity efficiency potential in 2020.

The avoided investments in capacity (MW) in the power sector are calculated with the assumption that the yearly average of electricity usage currently unavailable is similar to power plant time usage calculated for the total power capacity. The associated avoided investments in economic terms are based on an average investment cost of the combined cycle (CCGT) technology of 850 €/kW or 1,100 USD/kW. The CCGT has been selected as being the most energy efficient and the most common thermal power generation technology.

Table 7: Reductions in Electricity Expenditures and Avoided Power Investments

Period 2012-2020					
Sectors / **EE technologies**	**Electricity Efficiency Potential**		**Reductions in Electricity Expenditures**	**Avoidable Electricity Capacity Investments**	
	Total of Sub-Sectors	**By EE Technology**	**M USD/y**	**MW**	**M USD**
	ktoe/y	ktoe/y			
Industry					
Electric motors					
Compressed air					
Tertiary					
SWH					
Street lighting					
Thermal insulation					
Residential					
Efficient fridges					
Efficient lighting					
SWH					
Thermal insulation					
Lighting ballasts					

TOTAL					
Total without SWH					
% of total electricity efficiency potential / installed capacity					

3 Results for the MENA Region

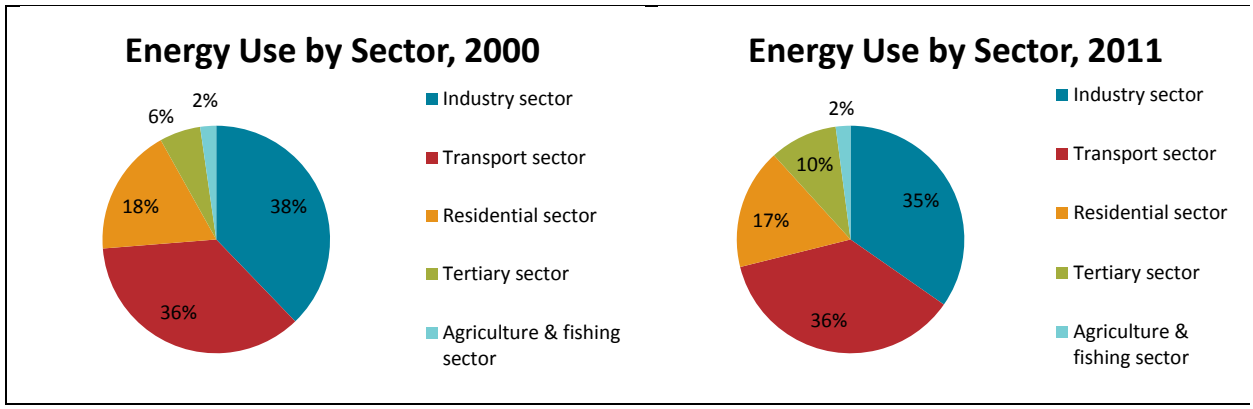
3.1 Overview of Energy Supply and Demand

The region relies heavily on oil, which makes up to 56 percent of its total primary energy supply, and natural gas, which makes up to 46 percent. An 83 percent increase in natural gas and a 16 percent increase in the share of oil products between 2000 and 2011 are reflected in this figure. Total electricity generation at the regional level increased from 484 TWh in 2000 to 925 TWh in 2012, with a total capacity of 193 TWh in 2011. Electricity was mainly generated from natural gas (59 percent) and crude oil and oil products (40 percent), with 0.2 percent of electricity generated from other fuels in 2012, mainly from renewable sources.

In 2011, final energy consumption was comprised of natural gas (17 percent), oil products (45 percent), electricity (15 percent), coal 90.4 percent) and other energies (2 percent). Total energy consumed by end use sectors amounted to 390 Mtoe in 2011 compared to 239 Mtoe in 2000.

Available statistics in the region shows that the largest energy-consuming sector was transport at 36 percent in 2011, followed by industry (35 percent) and residential (17 percent). Figure 1 sketches relative sectoral shares for 2000 and 2011.

Figure 1: Energy Use by Sectors, 2000 and 2011, Percentage



3.2 Energy Demand Outlook 2020

Total final energy consumed in the region is projected to amount to 623 Mtoe in 2020, compared to a total consumed energy of 390 Mtoe in 2011 and 217 Mtoe in 2000, an almost threefold increase. Total electricity generation increased from 428 TWh in 2000 to 861 TWh in 2011 and is estimated to reach 1,504 TWh in 2020, representing a twofold increase.

The largest energy-consuming sector in the region is expected to be the transport sector at 36 percent, followed by industry at 35 percent, residential at 17 percent, tertiary at 11 percent and agriculture and fishing at 1 percent.

In terms of physical units, the transport sector will consume 177 Mtoe in 2020 compared to 115 Mtoe in 2011; the industrial sector 175 Mtoe compared to 109 Mtoe; the residential sector 85 Mtoe compared to 54 Mtoe, the tertiary sector 53 Mtoe compared to 30 Mtoe, and agriculture and fishing 7.1 Mtoe compared to 7.1 Mtoe.

Figure 2: Projected MENA Final Energy Use by Sector, 2020

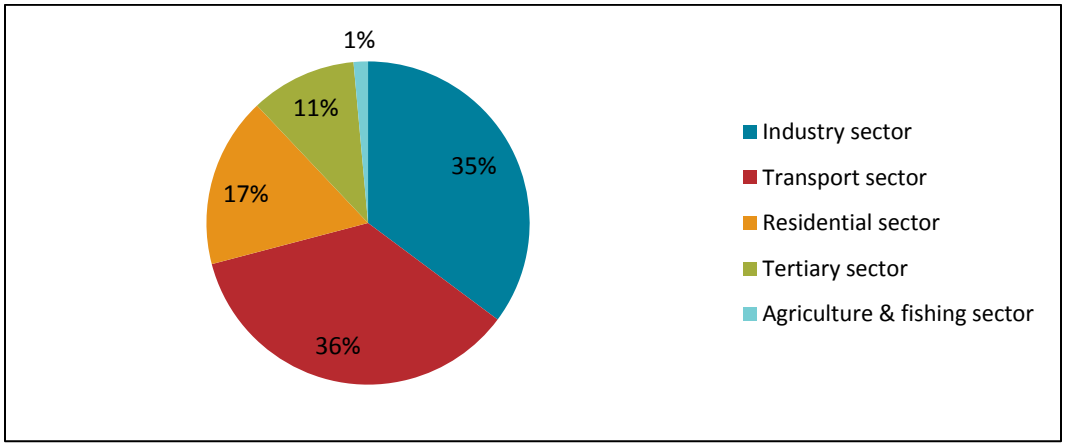
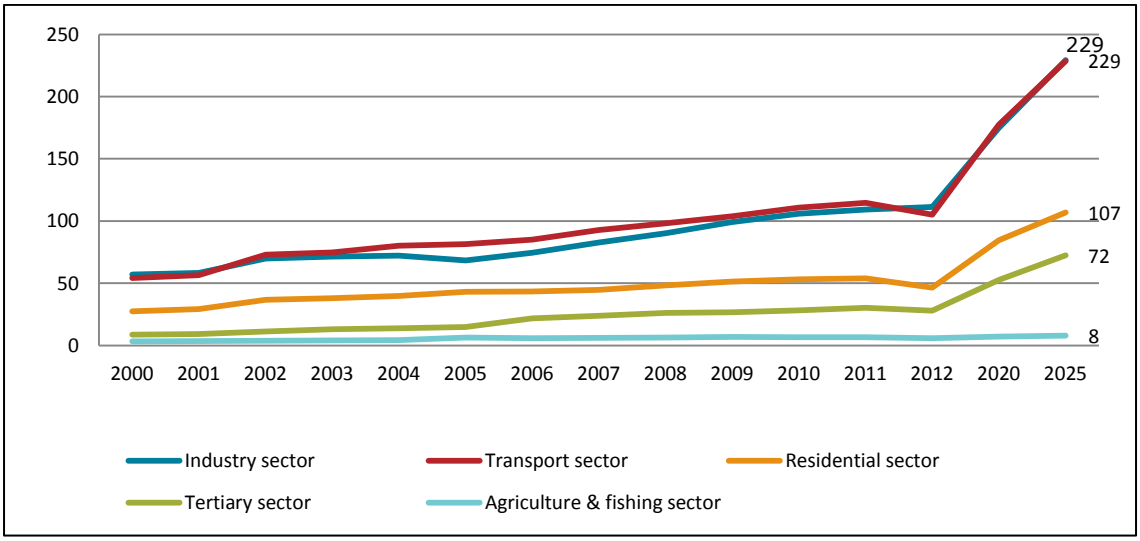


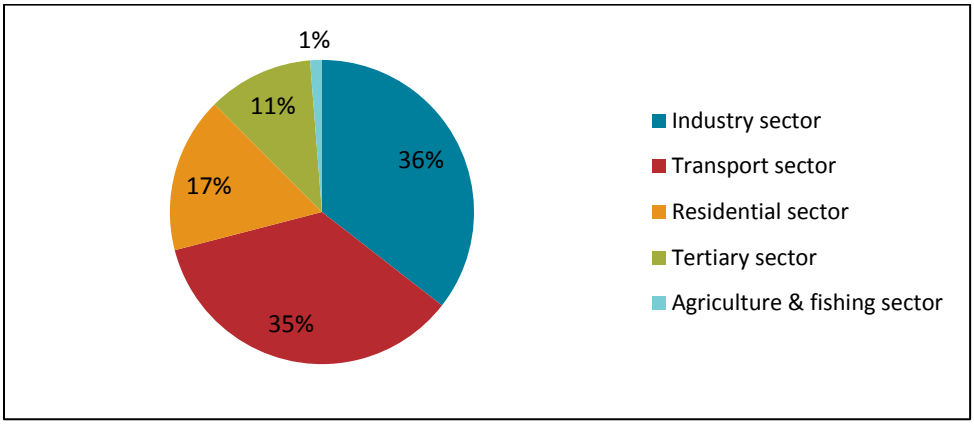
Figure 3: Final Regional Energy Consumption for End-Use Sector, Mtoe



3.3 Energy Demand Outlook 2025

Total final energy consumed in the region is projected to be 861 Mtoe in 2025, compared to a total consumed energy of 390 Mtoe in 2011 and 217 Mtoe in 2000. Total electricity generation is projected to double between 2011 and 2025.

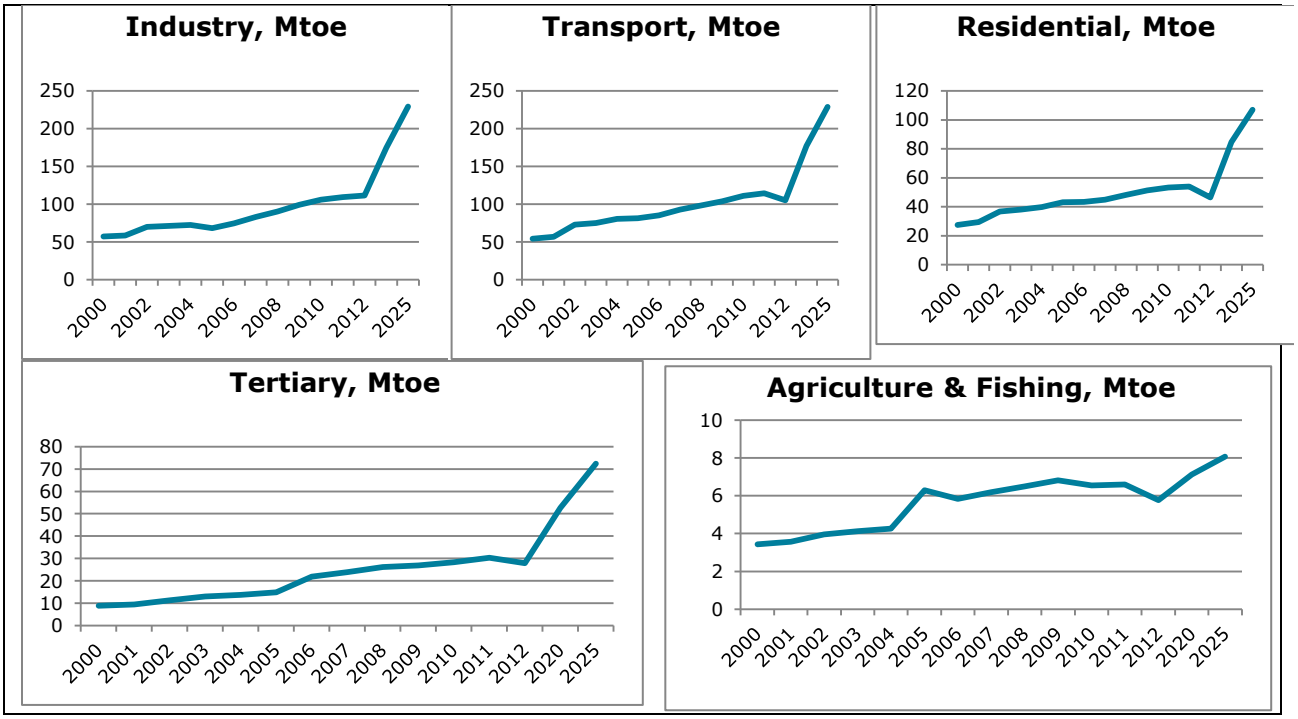
Figure 4: Energy Use by Sector, 2025



The largest energy-consuming sector on the regional sector is projected to be the industry sector at 36 percent, followed by transport at 35 percent, residential at 17 percent, tertiary at 11 percent, and agriculture and fishing at 1 percent.

In terms of physical units, the industry sector will consume 229.3 Mtoe in 2025 compared to 57 Mtoe in 2000, the transport sector 228.6 Mtoe compared to 54 Mtoe in 2000, the residential sector 107 Mtoe compared to 27 Mtoe in 2000, the tertiary sector to consume 72 Mtoe compared to 9 Mtoe in 2000, and the agriculture and fishing sector 8 Mtoe compared to 3 Mtoe in 2000.

Figure 5: Energy Consumption Trends by Sector



3.4 Energy Efficiency Potential

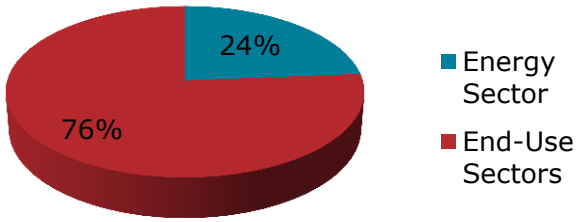
Energy is consumed in all economic sectors and socio-economic activities. Major energy consuming sectors in the MENA region are the oil refining and petrochemical sectors, electricity generation, and end-use sectors. In the MENA region, total primary energy supplied in 2012 amounted to 511 Mtoe, compared to 386 Mtoe in 2000, at an annual variation rate of 4.5 percent, of which 79 percent of total energy was consumed by the end-use sectors.

The total energy efficiency (EE) potential for the region amounted to 142 Mtoe[4]. The EE was comprised of 76 percent of end-use sectors and 24 percent of electricity sector. The total EE potential represented 28.1 percent of total energy consumed in 2012.

Table 8: MENA EE Potential

Sector	MENA EE Potential, ktoe, 2012
Electricity Sector	**33,748**
End-Use Sectors	**108,464**
Industry	34,994
Transport	25,261
Residential	29,825
Tertiary	17,158
Agriculture and Fishing	1,225
TOTAL	**142,212**
	28.1% of TPES

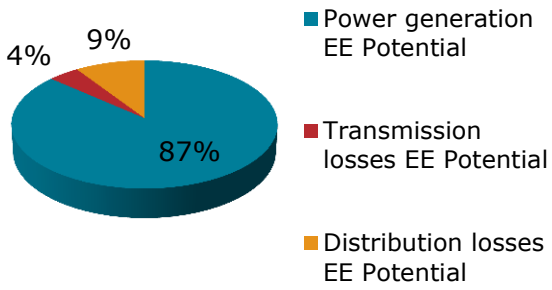
Figure 6: Total MENA EE Potential, 2012



3.4.1 Electricity

Total electricity generated amounted to 79,564 ktoe in 2012 at an annual variation of 6.1 percent since 2000. The EE potential was estimated for the electricity sector at 33,748 ktoe, of which 29,186 ktoe was for power generation EE potential, 1,412 ktoe for transmission losses EE potential, and 3,151 ktoe for distribution losses EE potential. Figure 7 across shows the distributional percentage of each component of the total EE potential of the electricity sector.

Figure 7: Electricity Sector EE Potential, 2012



3.4.2 End-Use Sectors

The total EE potential of end-use sectors was estimated at 108,464 ktoe in 2012. Within the end-use sectors, industry had the highest estimated potential at 32 percent, followed by

[4] Most data is based on 2012, while only Algeria, Palestine and Sudan data is based on 2011. This is due to the lack of updated data for three MENA countries.

residential at 28 percent, transport at 23 percent, tertiary at 16 percent and agriculture and fishing at 1 percent.

Beyond this quantitative estimation of the EE potential, a crucial element for EE policies for the effective deployment of EE is to assess, in each country, what are the priority EE potential sectors and measures/technologies that take into account a broad scope and interlinked factors for:

Customers

- Economic profitability through reduced and lasting energy bills and maintenance; and
- Attractiveness through customer awareness, adequate access to related information (technical economic and financial) and advice on the EE potential realization facilitating its effective realization.

Stakeholders (in particular the financial sector)

- Ease of the realization of EE potential through investment projects, grouping of projects, and economic and financial maturation.

State

- Socio-economic benefits, including for customers through reduced energy bills enhancing household's welfare and business competiveness, as well as establishing and developing an EE sector;
- Durable reduction of country energy consumption and imports, along with the associated subsidies for consumption and investment;
- Ease of the realization of the EE potential through investment size and maturation for an optimal use of eventual state incentives such as grants and loans for EE investment and support administration; and
- Deployment of low-cost transversal measures as compact fluorescent lamps (CFLs) and S&L.

3.4.2.1 Sectoral analysis

Industry

Beyond the large and energy-intensive industrial plants and companies for which EE investments are generally sizeable and relatively well identified for a relatively low unit management cost owing to the size and grouping of projects especially on utilities as boilers, motors, lighting or compressed air, it is necessary to analyse SMEs through a sectoral approach as these smaller-sized companies are diverse in terms of their processes, sectors, markets, and locations.

Tertiary

This sector includes subsectors and units with public administrations; private businesses for public such as hotels, commerce, and banks; and staff. Also diverse, the energy use of enterprises in this sector varies widely even if EE projects can be identified transversally for utilities and similar consumer types.

Residential

The residential sector comprises a large number of individual units, with great heterogeneity in terms of geography, society, economy, and level of urbanization, allowing for an effective and swift realization of EE potential. As such, the design of transversal and replicable measures applicable to most customer profiles is preferable.

Transport

This sector is particularly complex owing to the number and diversity of consuming units such as private and company cars, passenger and freight vehicles, and local and international vehicles. With an associated lack of reliable data, the design and implementation of EE measures requires a specific approach.

The following table provides a qualitative assessment of the deployment of EE technologies and measures by sector

Table 9: Assessment of EE Deployment of Technologies and Measures by Sector

Sector	Unit Consuming Concentration	Data Availability	EE Investment Size	Transversal (Utilities)
Industry	++	+	++	++
Tertiary	+	+	+	++
Residential	--	-	-	+
Transport	--	--	-	NR

3.4.3 Country Comparison

The MENA region is comprised of countries with varying energy needs and consumption patterns, available energy resources; size of economy; level of economic development; and population and land size. The above-mentioned factors play an important role in characterizing the magnitude of the EE potential. The table below shows a ranking of MENA countries from the largest estimated EE potential to the smallest.

Table 10: EE Potential in the MENA Region in 2012

Country	EE Potential (ktoe, 2012)	EE Potential (% of TPES)
Saudi Arabia	48,900	24
Egypt	19,809	25
UAE	18,045	27
Algeria (2011)	9,467	23
Kuwait	8,272	24
Iraq	7,064	16
Oman	6,128	23
Morocco	4,964	28
Qatar	4,442	12
Libya	3,650	21
Sudan (2011)	2,930	18

Tunisia	2,181	22
Lebanon	1,818	25
Jordan	1,612	22
Bahrain	1,578	10
Yemen	944	12
Palestine (2011)	407	28

The highest EE potentials were recorded in Saudi Arabia, Egypt, and the United Arab Emirates, where their estimated values are much higher than other countries in the region. Those differences is influenced by several factors, which include the size of the country, its level and type of production, energy consumption patterns, and the age and efficiency of the installed electricity system. The technical EE potential estimated for Saudi Arabia indicated that 48.9 Mtoe can be saved, or 24.4 percent of TPES; Egypt can save 20 Mtoe or 26 percent of TPES; and the United Arab Emirates can save 18 Mtoe, or 24 percent of TPES. These savings can be realized if technical improvements are implemented to increase the efficiency of the electricity sector and end-use sectors.

Yemen and Palestine are the countries with the lowest EE potential based on technical improvements of the electricity sector and end-use sectors. In Yemen, the energy sector is underdeveloped due to a low level of economic maturity and chronic financial difficulties. The lack and limited access to energy resources in Palestine has greatly impacted the consumption patterns of the population with no access to fossil fuels and limited electricity generation capacity, decreasing its EE potential.

3.4.4 Projections for 2020 and 2025

Based on 2000 – 2012 annual sectoral variation (percent/year), a simple projection was done in order to estimate the technical EE potential for the region in the years 2020 and 2025. The MENA total EE potential amounted to 222 Mtoe in 2020 and 297 Mtoe in 2025. The EE potential is projected to account 74 percent of end-use sectors in 2020 and 73 percent in 2025, as for the electricity sector, it should represent 26 percent in 2020 and 27 percent in 2025. The total EE potential represented 21.9 percent of total energy consumed in 2020 and 20.4 percent in 2025.

Table 11: MENA EE potential 2020, 2025

Sector	EE saving potential, Ktoe, 2020	EE saving potential, Ktoe, 2025
Electricity Sector	**57,190**	**81,609**
End-Use Sectors	**165,490**	**215,735**
Industry	51,469	66,069
Transport	38,820	50,896
Residential	44,576	56,903

Tertiary	29,154	40,274
Agriculture and Fishing	1,471	1,593
TOTAL	**222,680**	**297,344**
% of TPES	**21.9%**	**20.4%**

Figure 9: Total MENA EE potential in 2020

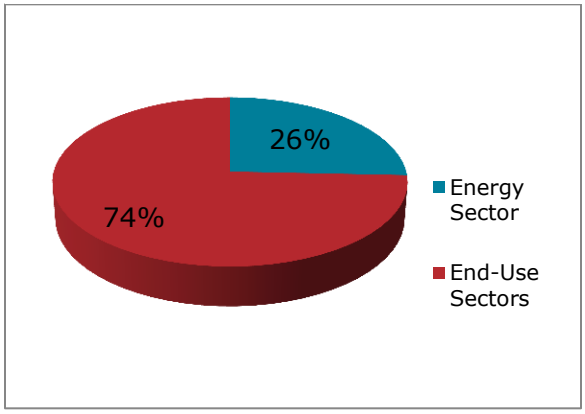
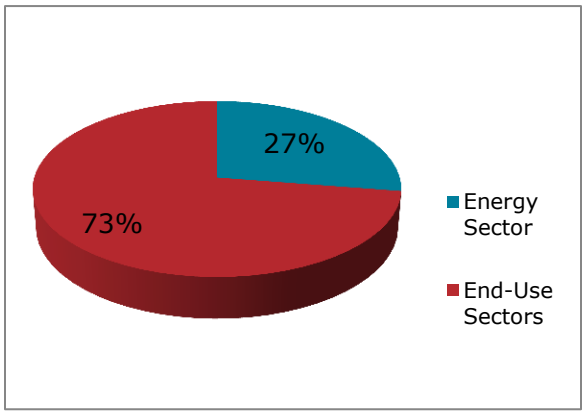
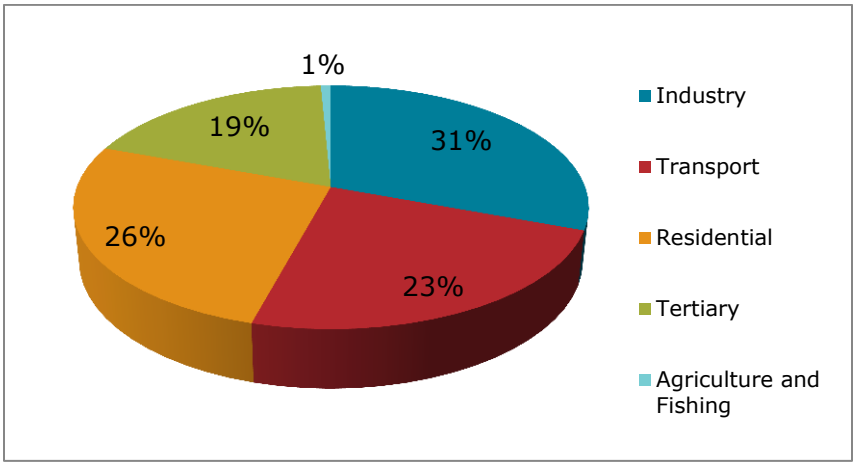


Figure 8: Total MENA EE potential in 2025



The EE potential for the electricity sector is projected to amount 57 Mtoe in 2020 and 82 Mtoe in 2025, as for the end-use sectors to reach 165 Mtoe in 2020 and 216 Mtoe in 2025. As shown in figure 10, industry will still account for the largest estimated potential at 31 percent, followed by residential at 26 percent, transport at 23 percent, tertiary at 19 percent and agriculture and fishing at 1 percent.

Figure 10: End-use sectors EE potential 2025



3.4.5 CO_2 Emissions

The average carbon dioxide emission for the MENA region from end-use sectors amounted to 1.5 $teCO_2$/1,000 USD. For non-GCC countries, this figure was 0.7 $teCO_2$/1,000 USD. For

GCC countries, this broke down to 3.6 teCO_2/1,000 USD. The highest CO_2 emission was recorded in the industry sector, where the average for the MENA region was 3.4 teCO_2/1,000 USD, compared to 1.2 teCO_2/1,000 USD for non-GCC and 7.5 teCO_2/1,000 USD for GCC countries. The residential sector was the second end-use sector with the high CO2 emissions at 1.6 teCO_2/1,000 USD for MENA region (specifically 0.8 teCO_2/1,000 USD for non-GCC and 5.8 teCO_2/1,000 USD for GCC region), followed by tertiary at 0.7 teCO_2/1,000 USD and 0.3 teCO_2/1,000 USD for transport.

4 Results by Country

4.1 Algeria

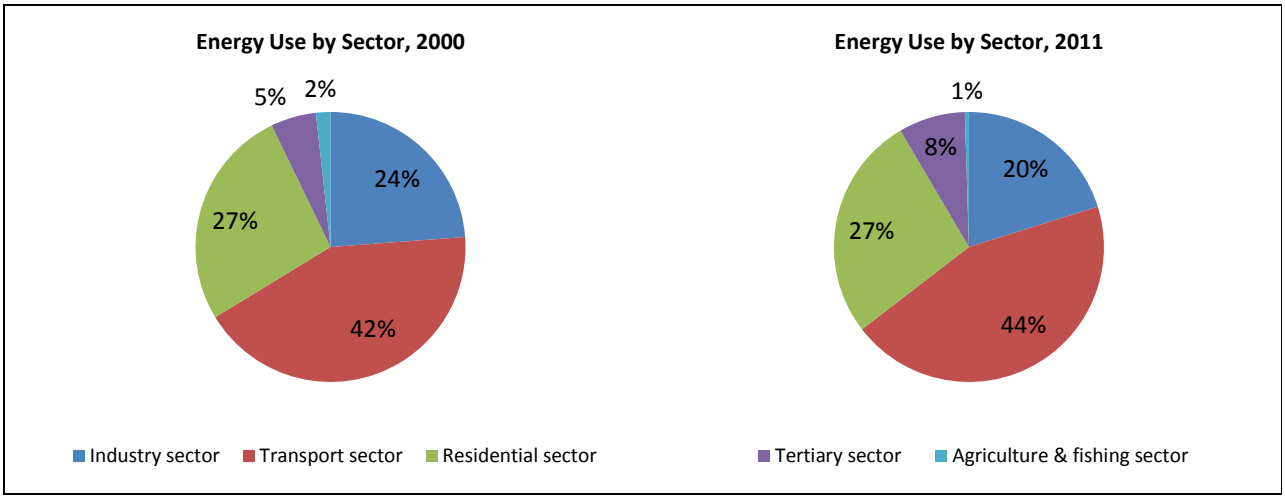
4.1.1 Overview of Energy Supply and Demand

Algeria's energy production amounted to 143,793 ktoe in 2011, mostly from natural gas and crude oil at an annual increase of 0.2 percent from 2000. Algeria relies heavily on exporting hydrocarbons, which decreased from 113,645 ktoe in 2000 to 104,419 ktoe in 2011, while its primary energy increased during the same period from 26,550 to 41,100 ktoe.

Final energy consumption amounted to 26,315 ktoe in 2012, compared to 15,894 ktoe in 2000, an increase of 66 percent. Final energy consumed in 2011 originated from oil products (53 percent), natural gas (28 percent), electricity (11 percent), and coal (0.2 percent). The largest contributor to electricity generation was natural gas at 93 percent in 2011, on the rest coming from oil products. Total electricity generated amounted to 4,936 ktoe in 2012, compared to 2,185 ktoe in 2000.

Figure 11 shows the energy consumed by sector in 2000 and 2011. The largest energy-consuming sector was transport, followed by residential and industry. There was a slight increase between 2000 and 2011 in the transport sector at 11,475 ktoe in 2011. This figure remained constant for the residential sector at 6,976 ktoe in 2011, decreased 4 percent for industry at 5,219 ktoe, and increased 3 percent for the tertiary sector at 2,065 ktoe in 2011.

Figure 11: Algeria Energy Use by Sector, 2000 and 2011, Percentage



4.1.2 Energy Demand Outlook 2020

Total final energy consumption by all end-use sectors is projected to reach 42,775 ktoe in 2020, compared to 27,771 ktoe in 2011. Generated electricity is expected to reach 94,771 GWh (8,150 ktoe) in 2020, compared to 51,221 GWh (4,405 ktoe) in 2011

The transport sector is to remain the largest energy-consuming sector in 2020, with a total estimated consumption of 18,979 ktoe, followed by residential at 11,303 ktoe, and the industrial sector at 7,373 ktoe.

The tertiary sector's consumption is projected to increase from 8 percent in 2011 to 10 percent in 2020 at 4,407 ktoe, while the agriculture and fishing sector is estimated to reduce to 0.43 percent at a value of 182 ktoe.

Figure 12: Algeria Energy Use by Sector 2020

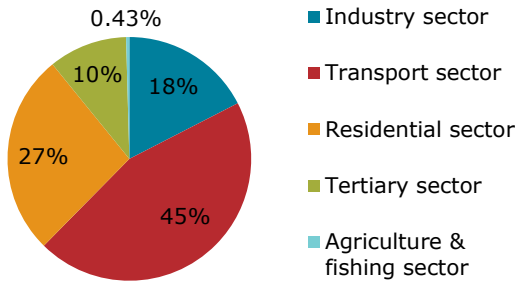
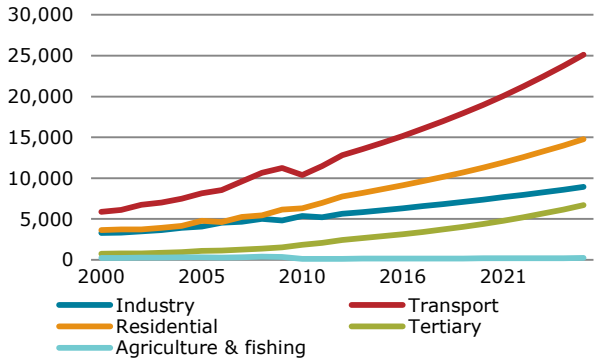


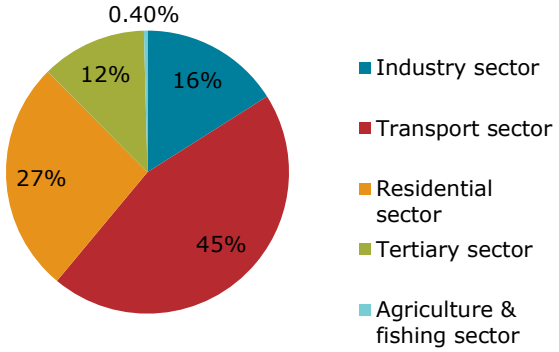
Figure 13: Algeria Final Energy Consumption of End-Use Sectors



4.1.3 Energy Demand Outlook 2025

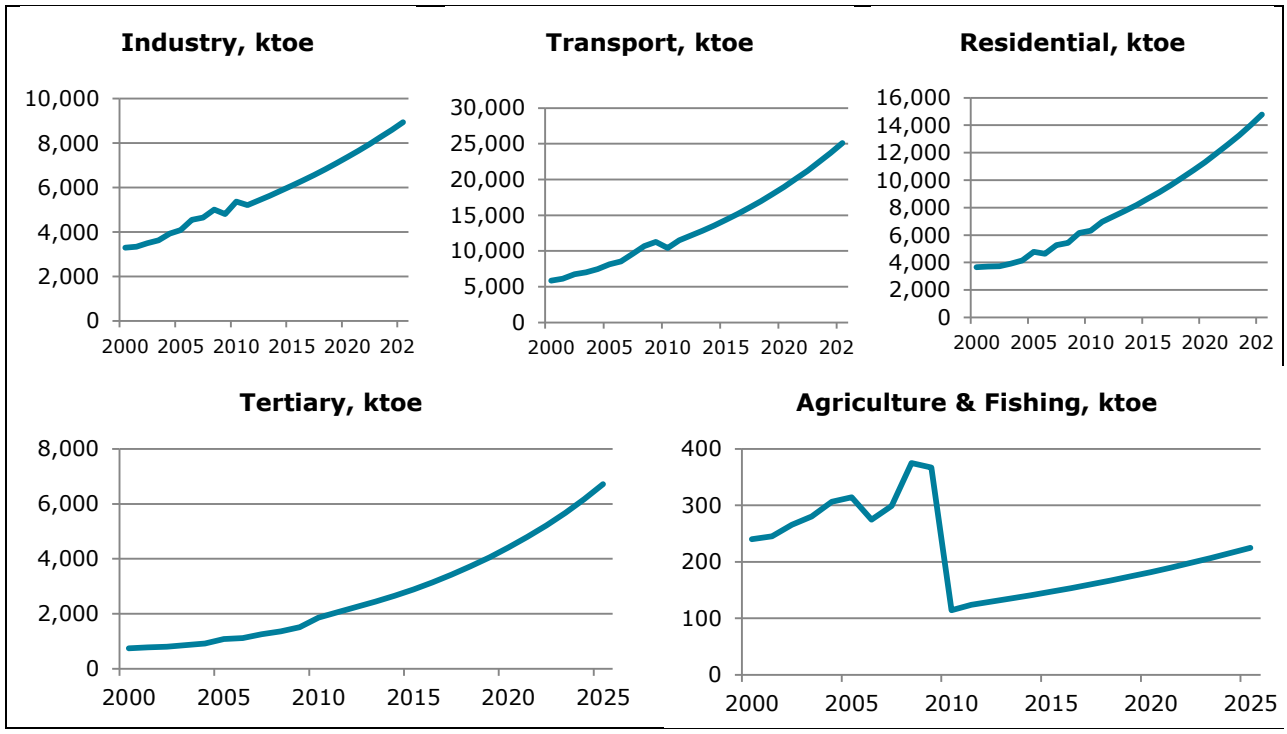
Final energy consumption by end-use sectors is expected to reach 56,199 ktoe in 2025, with electricity generation amounting to 129,658 GWh. The largest energy-consuming sector is expected to remain transport at 45 percent, followed by residential at 27 percent, industry at 16 percent, tertiary at 12 percent, and agriculture and fishing at 0.4 percent.

Figure 14: Algeria Energy Use by Sector 2025



Regarding total energy consumed, the transport sector will consume 25,100 ktoe in 2025 compared to 5,866 ktoe in 2000; the residential sector 14,779 ktoe compared to 3,666 ktoe; the industry sector 8,934 ktoe compared to 3,292 ktoe; the tertiary sector 6,715 ktoe; and the agriculture and fishing sector 225 ktoe from 240 ktoe.

Figure 15: Algeria Energy Consumption Trends by Sector



4.1.4 Energy Efficiency Potential

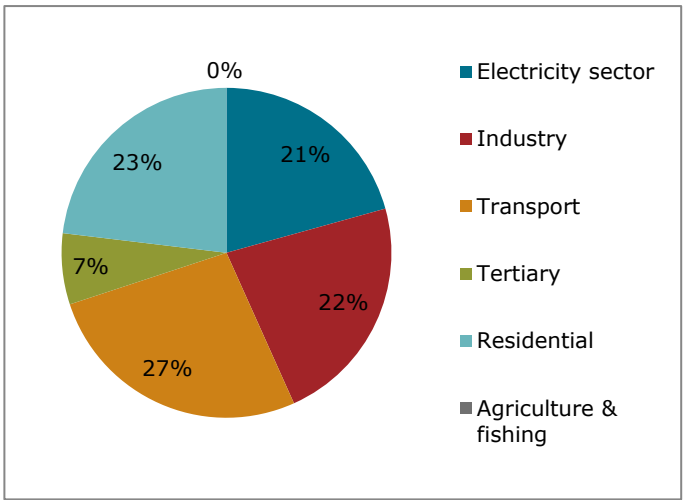
Total primary energy supplied in Algeria amounted to 41,100 ktoe in 2011, compared to 26,550 ktoe in 2000, of which 67 percent went to end-use sectors.

In 2011, total EE potential was estimated to be 9,467 ktoe,[5] of which 21 percent was in the electricity sector and 79 percent in end-use sectors. EE potential accounted for 23 percent of total primary energy supplied that year. Within the end-use sectors, transport has the largest EE potential (27 percent), followed by residential (23 percent), industry (22 percent), tertiary (7 percent), and agriculture and fishing (0.4 percent).

Table 12: Algeria EE Potential, 2011

Sector	EE Potential, ktoe, 2011
Electricity Sector	**1,958**
End-Use Sectors	**7,509**
Industry	2,141
Transport (2009)	2,523
Residential	2,187
Tertiary	659
Agriculture and Fishing	-0.3
TOTAL	**9,773**
	23% of TPES

Figure 16: Algeria EE Potential, 2011



4.1.4.1 Electricity Generation

Electricity generation amounted to 4,936 ktoe in 2012 with an annual variation rate of 6.5 percent between 2000 and 2012. The country's tailored benchmark for the power generation efficiency based on the power technology and mix was set at 53 percent, a 15 percent increase from 2011 at 1,636 ktoe. The specific consumption of power generation measured 220 toe/GWh.

The transmission and distribution losses of electricity were 19.3 percent in 2011, of which transmission losses were 5.2 percent and distribution losses 14.1 percent. The Maghreb benchmark was set at 4 percent for transmission losses and 8 percent for the distribution losses, estimating a total of 323 ktoe for total transmission and distribution losses EE potential, of which 53 ktoe for transmission losses and 270 ktoe for distribution losses.

The total EE potential for the electricity sector in terms of primary energy was 1,958 ktoe in 2011.

[5] Estimations for electricity sector are in terms of primary energy, estimations for transport and agriculture and fishing sectors are in terms of final energy, while estimations for industry, residential and tertiary sectors are in terms of primary and final energy.

4.1.4.2 End-Use Sectors

i. Industry

Final energy intensity of the industry sector amounted to 0.321 toe/1,000 USD in 2011, compared to 0.408 toe/1,000 USD in 2000. The EE potential for the industry sector for 2011 in terms of final energy was 1,483 ktoe, using an energy intensity efficiency country-tailored benchmark based on the structure of the sector, its evolution, and country performances. Within nine energy-intensive products, data was available only for cement, indicating an EE potential of 37 percent, or 741 ktoe.

Additionally, the final electricity efficiency potential of the sector converted in primary energy was equivalent to 658 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the industry sector at 2,141 ktoe.

The CO_2 intensity of the industry sector amounted to 1.17 $teCO_2$/1,000 USD for 2011, a decrease of almost 20 percent from 2000. In addition, the average emission factor was 3.65 $teCO_2$/toe in 2011, compared to 3.57 $teCO_2$/toe for 2000.

ii. Transport

The average energy consumption of gasoline cars was 1,309 kgoe/car/yr in 2009, with the total EE potential in terms of final energy estimated to be 2,523 ktoe, of which 718 ktoe is gasoline vehicles and 1,805 Ktoe diesel vehicles. The EE potential for transport covers only private cars within road transportation due to the scarcity of data for other transportation modes, which include railways, air and maritime.

The total CO_2 intensity for the transport sector was 0.42 $teCO_2$/1,000 USD and the average emission factor for the transport sector was calculated at 2.94 $teCO_2$/toe in 2011. The motorization rate amounted to 12.8 persons per vehicle in 2011, compared to 18 persons per vehicle in 2000.

iii. Tertiary

The final energy intensity of the tertiary sector was 0.065 toe/1,000 USD in 2011, compared to 0.046 toe/1,000 USD in 2000. Using an energy intensity country tailored benchmark,[6] surveys showed a potential of 18.6 percent with the EE potential in terms of final energy was 385 ktoe for the tertiary sector, using energy intensity.

In addition, the final electricity efficiency potential of the sector converted in primary energy was equivalent to 275 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 659 ktoe. On the other hand, the average emission factor was calculated at 4.4 $teCO_2$/toe and the total CO_2 intensity of the tertiary sector was calculated at 0.28 $teCO_2$/1,000 USD for 2011.

[6] Country tailored benchmark based on the Plan Bleu Study "Energy, Climate change and the Building sector in the Mediterranean: Regional Prospects" (2010).

iv. Residential

The energy intensity of the residential sector was 0.18 toe/1,000 USD for 2011, while the specific consumption of energy per unit area in 2009 was 11.58 kgoe/m^2/yr. The EE potential for the residential sector in terms of final energy using the specific consumption and country-tailored benchmark[7] was 1,795 ktoe in 2011.

The final electricity efficiency potential of the sector converted in primary energy was equivalent to 392 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 2,187 ktoe. The unit consumption of energy per dwelling amounted to 947 kgoe/Dw in 2011. The average emission factor was 3.3 teCO_2/toe and the total CO_2 intensity of the residential sector was 0.6 teCO_2/1,000 USD in 2011.

v. Agriculture and Fishing Sector

The final energy intensity of the agriculture sector was 0.013 toe/1,000 USD for 2011. An estimated -0.3 ktoe of EE potential, in terms of final energy, was measured based on an energy efficiency country benchmark for the agriculture sector and the energy intensity of the agriculture sector only.

4.1.5 Energy Efficiency Potential in 2020 and 2025

The technical EE potential projected for 2020 and 2025 amounts to 15,358 ktoe and 20,236 ktoe, respectively. The EE potential was based on the annual sectoral variation for the period 2000 to 2011. Based on the projected values of 2025, the total EE potential of 2025 represents 30 percent of TPES. Figure 17 shows the percentages of the subsectors with their projected EE potential while figure 18 shows the variation of the EE potential for 2011, 2020, and 2025.

Figure 17: Algeria Projected EE Potential, 2025

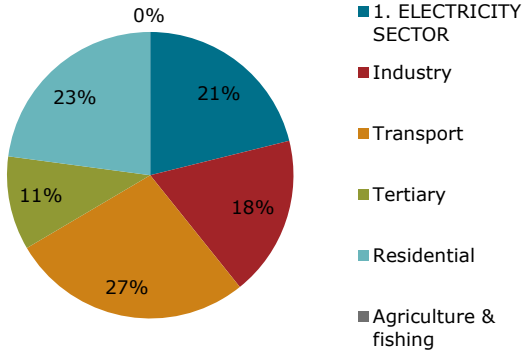
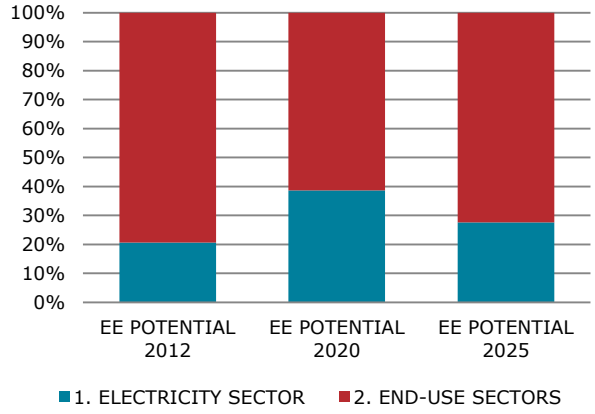


Figure 18: Algeria EE Potential, 2011-2025



[7] Based on the Plan Bleu study.

4.2 Bahrain

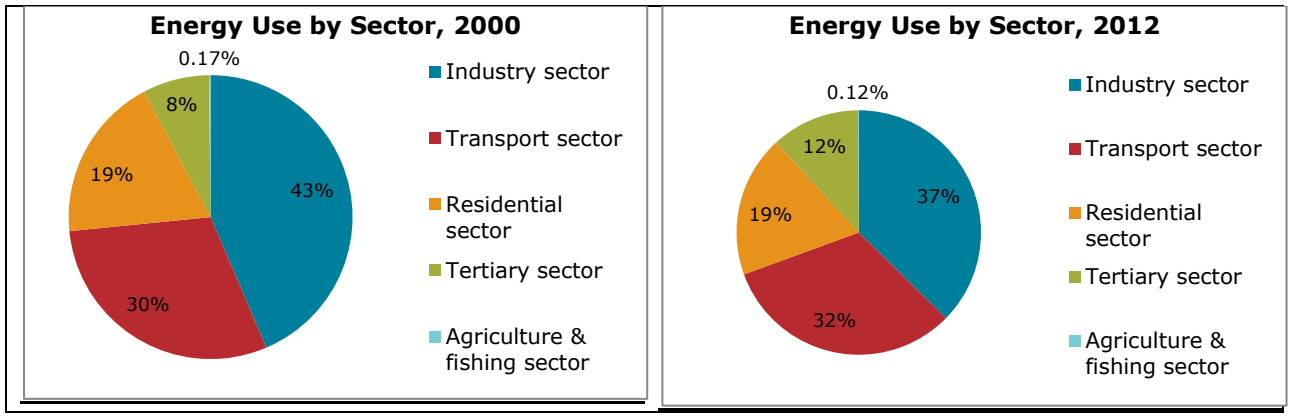
4.2.1 Overview of Energy Supply and Demand

The total production of energy in Bahrain reached 24,037 ktoe in 2012 compared to 19,736 ktoe in 2000. The country's production relies on natural gas, with a production value of 15,384 ktoe and crude oil at 8,653 ktoe in 2012. Bahrain also imports crude oil and transforms it to oil products, much of which is exported. Specifically, 6,387 ktoe of crude oil and 11,838 ktoe of oil products were exported in 2012, a decrease of 10.6 and 2.8 percent respectively since 2000.

Natural gas and oil products were the main energy sources for electricity generation in the country, with heavy input from natural gas. Total final energy consumption by sector consisted of 38 percent of energy consumed from electricity, 22 percent from oil products and 3 percent from electricity in 2012.

The consumption distribution by end use sector is illustrated in Figure 19. The major energy-intensive sector was industry, which consumed 75 percent of energy in 2012. The second intensive sector was transport, which consumed 19 percent in 2011, followed by the residential sector that consumed 12 percent. Due to the country's relatively small land area and arid climate conditions, the agricultural sector is limited and consumed only about 0.08 percent of total energy.

Figure 19: Bahrain Energy Use by Sector, 2000 and 2012, Percentage



4.2.2 Energy Demand Outlook 2020

Total energy consumption by end-use sectors will reach 5,135 ktoe in 2020, compared to 5,330 ktoe in 2012, a 4 percent decrease. Electricity generation will measure in at 35,402 GWh in 2020.

The industry sector, which is the largest energy-consuming sector, will comprise 34 percent of total energy consumed, at 1,699 ktoe.

The transport sector's energy consumption will drop by 1 percent in 2020 to 33 percent at a value of 1,676 ktoe. Residential will consume 18 percent, with a value of 936 ktoe, and agriculture and fishing sector consumption will fall from 0.12 percent in 2011 to 0.09 in 2020 at a value of 5 ktoe.

The tertiary sector is estimated to increase its consumption in 2020, subsequently amounting to 15 percent of total energy consumed at a value of 764 ktoe. This is an increase from 3 percent in 2012.

Figure 20: Bahrain Energy Use by Sector 2020

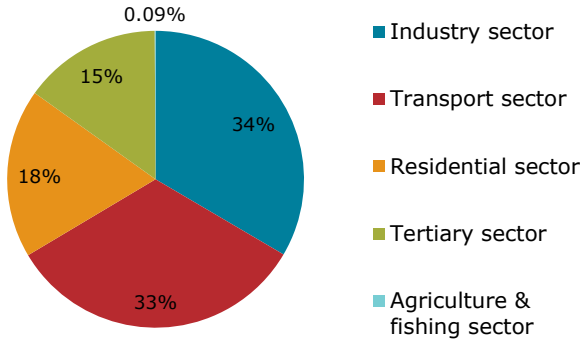
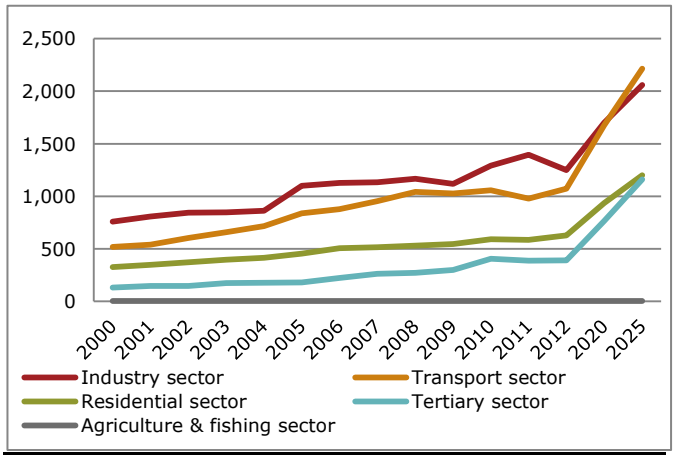


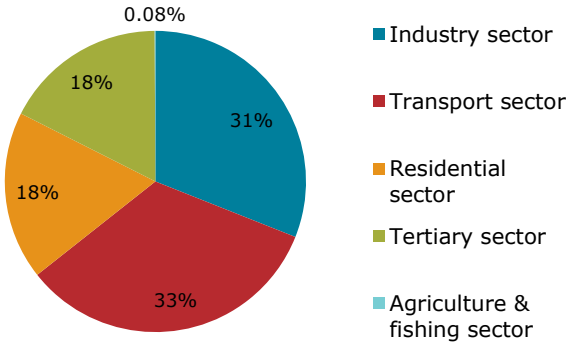
Figure 21: Bahrain Final Energy Consumption by End-Use Sectors, ktoe



4.2.3 Energy Demand Outlook 2025

Final energy consumption is expected to reach 6,833 ktoe in 2025, compared to 5,330 KTOE in 2012. Generated electricity is estimated to reach 44,257 GWh in 2025. The largest energy-consuming sector is estimated to be transport (33 percent), followed by industry (31 percent), residential (18 percent), tertiary (18 percent), and agriculture and fishing (0.08 percent).

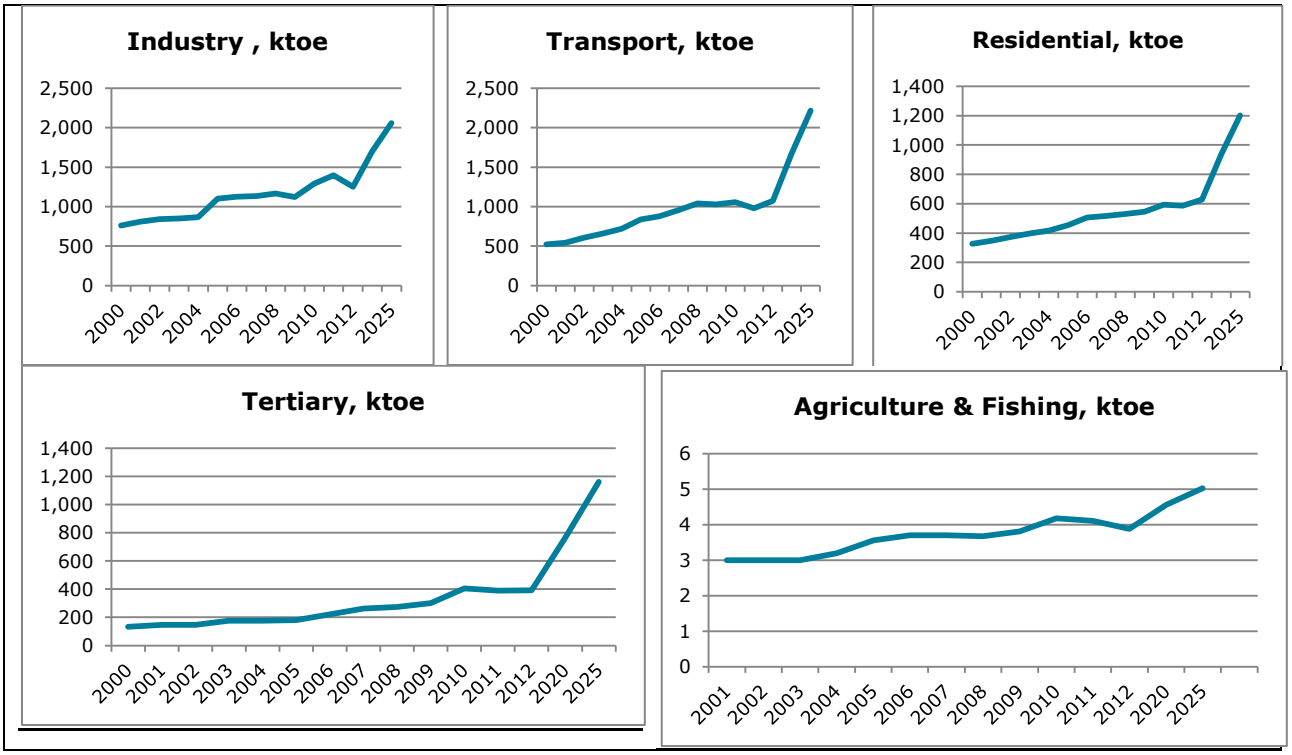
Figure 22: Bahrain Energy Use by Sector 2025



Compared to 2012, sectors are growing at different rates of energy consumption. The industrial sector is estimated to consume 2,059 ktoe in 2025, compared to 1,250 ktoe in 2012. The transport sector is estimated to consume 2,214 ktoe in 2025 from 1,073 ktoe in 2012. In 2025, the tertiary sector will consume 1,160 ktoe, compared to 391 ktoe in 2012. The residential

sector will consume 1,201 ktoe in 2025, compared to 628 ktoe in 2012, while the agriculture and fishing sector will increase by 1 ktoe to 5 ktoe in 2025.

Figure 23: Bahrain Energy Consumption Trends by Sector



4.2.4 Energy Efficiency Potential

Total primary energy supplied in Bahrain amounted to 16,249 ktoe in 2012, increasing by 51 percent from 2000, of which 33 percent was consumed by end-use sectors.

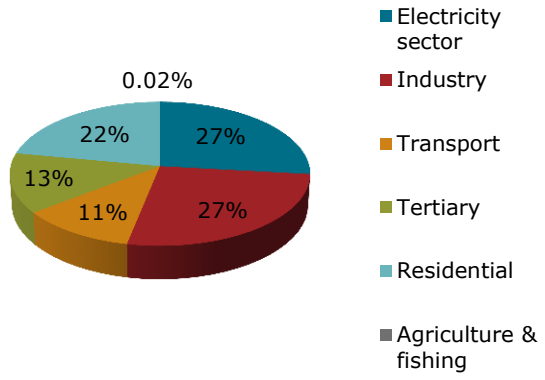
The total EE potential for 2012 was estimated at 1,578 ktoe,[8] of which 27 percent was allocated to the electricity sector and 73 percent to end-use sectors. The EE potential for end-use sectors was1,156 ktoe, of which 417 ktoe was from the industry sector (27 percent of total EE potential), 348 ktoe from the residential sector (22 percent), 212 ktoe from the tertiary sector (13 percent), 179 ktoe from transport (11 percent), and 0.4 ktoe from agriculture and fishing (0.02 percent). The total EE potential represented almost 10 percent of the total primary energy supplied for 2012.

[8] Estimations for electricity sector are in terms of primary energy, estimations for transport and agriculture and fishing sectors are in terms of final energy, while estimations for industry, residential and tertiary sectors are in terms of primary and final energy.

Table 13: Bahrain EE Potential, ktoe, 2012

Sector	EE Potential, ktoe, 2012
Electricity Sector	**422**
End-Use Sectors	**1,156**
Industry	417
Transport	179
Residential	348
Tertiary	212
Agriculture and Fishing	0.4
TOTAL	**1,578**
	10% of TPES

Figure 24: Bahrain EE Potential, 2012



4.2.4.1 Electricity Generation

Total electricity generation amounted to 2,130 ktoe in 2012, compared to 1,192 ktoe in 2000, with an annual variation of 4.6 percent since 2000. The power generation efficiency was 41 percent in 2012, compared to 49 percent in 2000. A country-tailored benchmark was set at 49 percent based on the sector situation and hypothesis,[9] regional,[10] and international references. This resulted in an estimated EE potential of 337 Ktoe for the power generation sector. The specific consumption of power generation was 170 toe/GWh in 2012.

Transmission and distribution losses amounted to 9 percent in 2012, of which 3 percent was transmission losses and 6 percent distribution losses. Using the sub-regional benchmark of 2 percent for transmission losses and 3 percent for distribution losses, the EE potential was 21 ktoe for transmission losses and 64 ktoe for distribution losses. The total EE potential of the electricity sector was estimated in terms of primary energy to be 422 ktoe for 2012.

4.2.4.2 End-Use Sectors

i. Industry

The final energy intensity of the industry sector was 2.2 toe/1,000 USD in 2012. A country-tailored benchmark based on the structure of the industrial sector, its evolution, and other country performances was 1.8 toe/1,000 USD, to estimate the EE potential in terms of final energy at 227 ktoe. The total EE potential represented 18 percent of total energy consumed by the industry sector.

The final electricity efficiency potential of the sector converted in primary energy was 190 ktoe. This potential added to the EE potential in final energy for a total EE potential of 417 ktoe. The average emissions factor for the sector was 7.6 $teCO_2$/toe while the CO_2 intensity of the sector was 16.6 $teCO_2$/1,000 USD.

[9] Switch of steam plants & GT to CCGT with 60 percent efficiency and of 20 percent of current CC to new CC with 60 percent efficiency.
[10] Qatari

ii. Transport

Total EE potential was in terms of final energy 179 ktoe in 2012, using the total energy consumed by the transport sector that year and based on the percentage of the EE potential of the transport sector of Jordan due to the proximity of the Jordan car fleet to Bahrain. The EE potential represents road transportation only due to the absence of data for other transportation means such as air, maritime, and railways.

The average emissions factor of the sector was 2.9 $teCO_2$/toe in 2012 while the CO_2 intensity of the sector was 0.14 $teCO_2$/1,000 USD. In addition, the motorization rate was 3.1 persons/vehicle that year, compared to 3.6 persons/vehicle in 2001.

iii. Tertiary

The energy intensity of the tertiary sector in terms of final energy was 0.51 toe/1,000 USD. The EE potential of the sector was 107 ktoe in 2012 using the country-tailored benchmark that was set at 0.37 toe/1,000 USD.[11] The EE potential represented 27 percent of total energy consumed by the tertiary sector.

In addition, the final electricity efficiency potential of the sector converted in primary energy was equivalent to 105 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 212 ktoe. The average emission factor amounted to 8.5 $teCO_2$/toe in 2012, while the CO_2 intensity of the tertiary sector was 4.3 $teCO_2$/1,000 USD the same year.

iv. Residential

The specific consumption of energy per unit area was calculated at 35 kgoe/m^2/yr in 2012, while the specific consumption of electricity per unit area was 352 Kwh/m^2/yr in the same year. The country-tailored benchmark was set at 24.5 kgoe/m^2/yr, based on comparisons with countries covered by the Plan Bleu study and expert analyses. The EE potential for the residential sector in terms of final energy was estimated to be 188 ktoe, or 30 percent of the total energy consumed by the sector.

In addition, the final electricity efficiency potential of the sector converted in primary energy was equivalent to 159 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 348 ktoe.

The unit consumption of energy per dwelling amounted to 3,151 kgoe/DW in 2012, while the unit consumption of electricity per dwelling was 31,678 Kwh/Dw. These values are estimated to be of the highest in the MENA region. The average emission factor was 7.7 $teCO_2$/toe in 2012.

v. Agriculture and Fishing Sector

The final energy intensity of agriculture amounted to 0.492 toe/1,000 USD in 2012. The country-tailored benchmark based on estimations was set at 0.45 toe/1,000 USD. The EE

[11] This was based on a regional study (Energy Efficiency Guidebook, A GOIC Publication for GCC Industries, 2013), building audits, and and the energy intensity of the sector.

potential in terms of final energy was estimated at 0.4 ktoe in 2012. The EE potential for fishing was not estimated due to unavailability of data.

4.2.5 Energy Efficiency Potential 2020 and 2025

The technical EE potential projected for 2020 and 2025 amounts to 2,411 ktoe and 3,168 ktoe, respectively. The EE potential was based on the annual sectoral variation for 2000 to 2012. Based on the projected values of 2025, the total EE potential of 2025 represents 14 percent of TPES. Figure 25 shows the percentages of the subsectors with their projected EE potential, while Figure 26 shows the variation of the EE potential for 2012, 2020, and 2025.

Figure 25: Bahrain Projected EE Potential, 2025

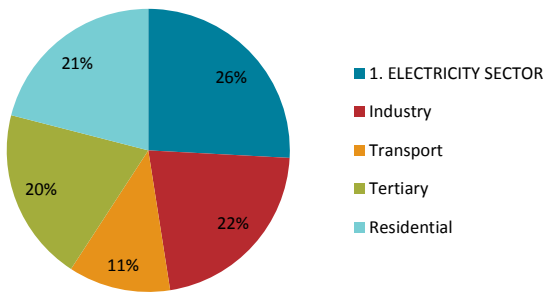
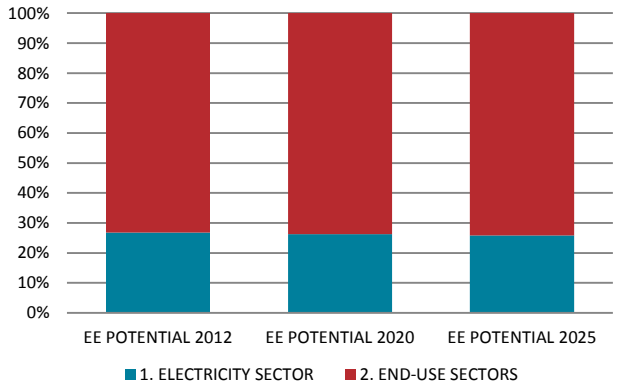


Figure 26: Bahrain EE Potential 2012-2025



4.3 Egypt

4.3.1 Overview of Energy Supply and Demand

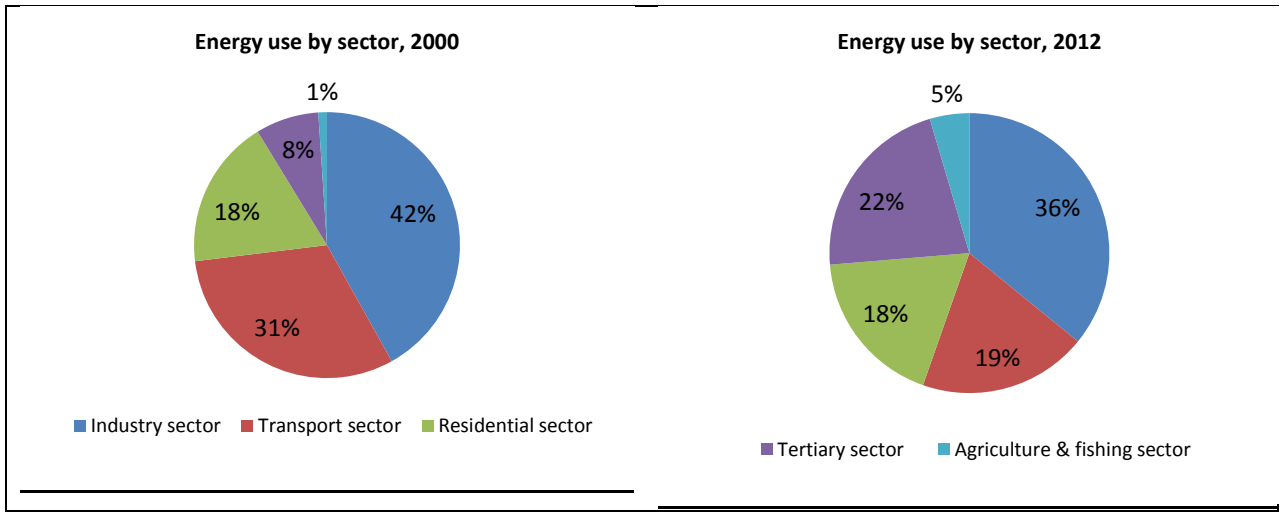
Egypt's total production of energy amounted to 87,178 ktoe in 2012, an increase of almost 39 percent from 2000. The country's main energy resources are natural gas, crude oil, hydropower and renewables. It is worth noting that the country has a production of combustible renewable and waste at the value of 1,617 ktoe and geothermal and solar energy at 168 ktoe for 2011.

Egypt imported 9,089 ktoe of oil products in 2011, a stark increase of 143 percent from 2000. It also imported 1,454 ktoe of coal, an increase of 21 percent over the same period. The total amount of electricity exports increased over time from 28 ktoe in 2000 to 139 ktoe in 2011.

Gross inland consumption in Egypt reached the amount of 78,129 ktoe in 2011, including all energy resources, both renewable and non-renewable. On the other hand, Egypt depended on natural gas and oil products to produce electricity, with 77 percent originating from natural gas and 23 percent from oil products in 2012.

Final energy consumption for 2012 amounted to 66,387 ktoe, with 44 percent from oil products, 28 percent from natural gas, and nearly 18 percent from electricity. The largest energy-consuming sector was industry, with a consumption increasing from 13,137 ktoe in 2000 to 21,278 ktoe in 2012. Industry was followed by tertiary sector, which increased from 2,407 ktoe to 12,907 ktoe over the same period. The transport sector reached 11,576 ktoe in compared to 9,771 ktoe, while the residential sector increased from 5,708 ktoe to 10,856 ktoe. The agriculture and fishing sector increased from 329 ktoe in 2000 to 2,707 ktoe in 2012.

Figure 27: Egypt Energy Use by Sector, 2000 and 2012, Percentage



4.3.2 Energy Demand Outlook 2020

Total energy consumption is estimated to reach 91,771 ktoe in 2020, compared to 66,387 ktoe in 2012. Electricity generation will increase in the same period to 246,296 GWh.

The distribution of energy consumed by sector is projected for 2020 is as follows:

- The industry sector is estimated be the highest energy consumption sector with 36 percent (28,631 ktoe in 2020);
- Tertiary follows at 24 percent (19,029 ktoe);
- Residential measures in at 20 percent (16,124 ktoe);
- Transport measures in at 12 percent for the transport sector (12,849 ktoe); and
- Agriculture and fishing measures in at 4 percent (3,651 ktoe).

Figure 28: Egypt Energy Use by Sector 2020

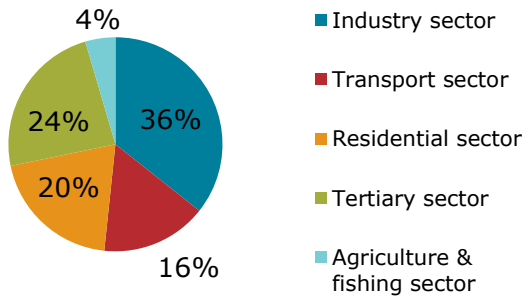
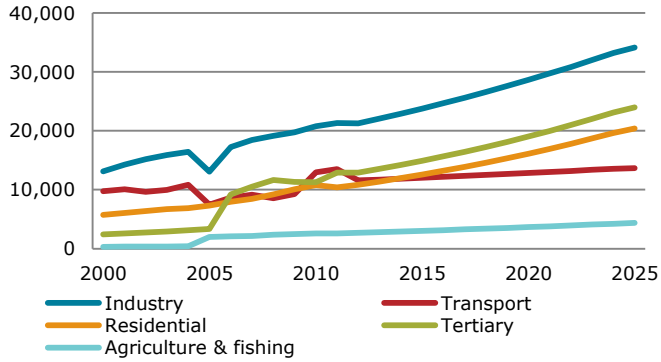


Figure 29: Egypt Final Energy Consumption by End-Use Sectors, ktoe



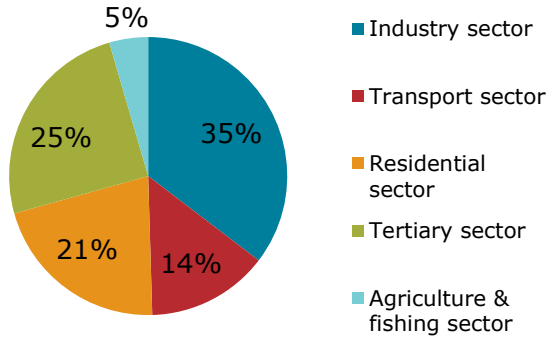
4.3.3 Energy Outlook 2025

Total energy consumed by end-use sectors is expected to reach 111,893 ktoe in 2025, compared to 66,387 ktoe in 2012, while electricity generation is estimated to rise to 319,437 GWh from 159,045 GWh over the same period.

The distribution of end-use sectors' energy consumption is projected for 2025, to be:

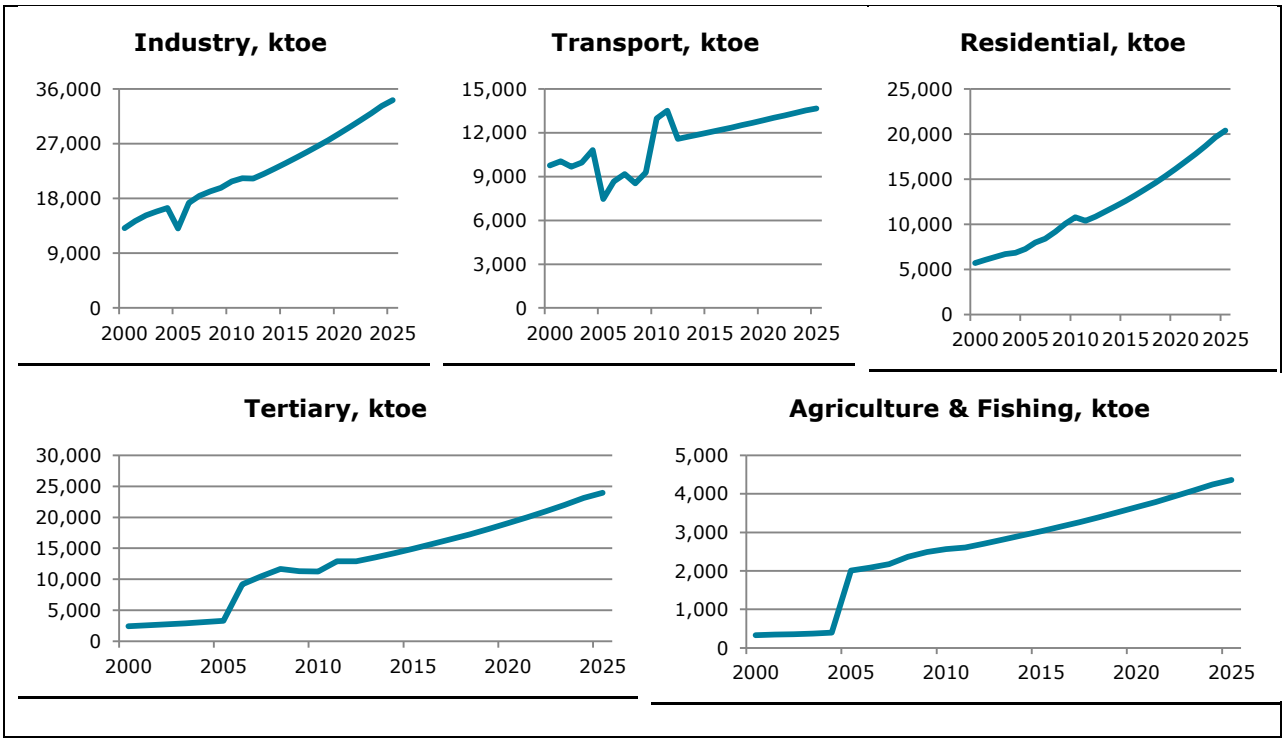
- 35 percent of total energy will be consumed by the industrial sector;
- 25 percent by tertiary sector;
- 21 percent by residential sector;
- 14 percent by transport sector; and
- 5 percent by the agriculture and fishing sector.

Figure 30: Egypt Energy Use by Sector 2025



The industrial sector will remain the largest energy consuming sector, reaching 34,154 ktoe in 2025, followed by the tertiary sector at 23,968 ktoe, 20,399 ktoe for residential, 13,670 ktoe for transport, and 4,360 ktoe for agriculture and fishing.

Figure 31: Egypt Energy Consumption Trends by Sector



4.3.4 Energy Efficiency Potential

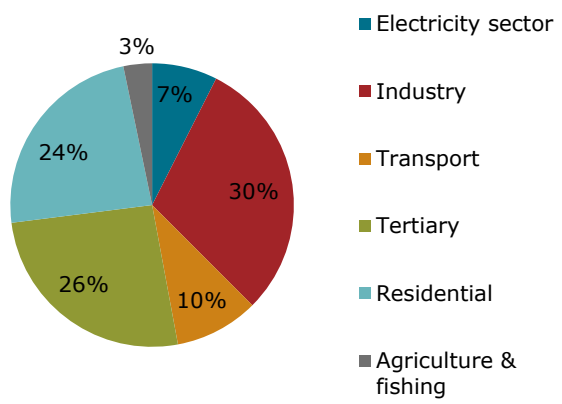
Total primary energy supplied in Egypt increased from 49,248 ktoe in 2000 to 78,129 ktoe in 2011, of which 87 percent was by end-use sectors.

Total EE potential was estimated at 19,808 ktoe[12] in 2012, with 7 percent for the electricity sector and 93 percent for end-use sectors. The industry sector, at 30 percent, has the highest EE potential among end-use sectors (5,948 ktoe), followed by tertiary at 26 percent (5,135 ktoe), residential at 24 percent (4,703 ktoe), transport at 10 percent (1,899 ktoe), and agriculture and fishing at 3 percent (645 ktoe). The total EE potential represented 25 percent of the TPES in 2011.

Table 14: Egypt EE Potential, ktoe, 2012

Sector	EE Potential, ktoe, 2012
Electricity Sector	**1,478**
End-Use Sectors	**18,330**
Industry	5,948
Transport	1,899
Residential	4,703
Tertiary	5,135
Agriculture and Fishing	645
TOTAL	**19,808**
	25% of TPES in 2011

Figure 32: Egypt EE Potential, 2012



4.3.4.1 Electricity Generation

Total generated electricity amounted to 13,678 ktoe in 2012, increasing from 6,720 ktoe in 2000 at an average annual variation of 5.6 percent. The country-tailored benchmark for power generation efficiency based on the electricity sector situation in 2000 was set at 46 percent, estimating the EE potential at 841 ktoe in 2012. The specific consumption of power generation was 200 toe/GWh in 2012.

Transmission and distribution losses amounted to 12.7 percent in 2012, of which 3.7 percent accounted for transmission and 9 percent for distribution. The sub-regional benchmark was set at 3 percent for transmission losses and the country-tailored benchmark was set at 5 percent for distribution losses, estimating the EE potential at 96 ktoe for transmission and 542 ktoe for distribution. Total electricity EE potential was estimated at 1,478 ktoe, in terms of primary energy, with 637 ktoe for the transmission and distribution losses.

4.3.4.2 End-Use Sectors

i. Industry

The final energy intensity of the industry sector was 1.237 toe/1,000 USD for 2012, an increase of 0.708 toe/1,000 USD for 2000. The EE potential for the industry sector in terms

[12] Estimations for electricity sector are in terms of primary energy, estimations for transport and agriculture and fishing sectors are in terms of final energy, while estimations for industry, residential and tertiary sectors are in terms of primary and final energy.

of final energy was 4,943 ktoe for 2012, using an energy-efficiency and country-tailored benchmark, as well as taking into account the energy intensity of the sector.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 1,006 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 5,948 ktoe.

The carbon dioxide intensity of the industry sector amounted to 3.8 teCO_2/1,000 USD for 2012, an increase of 69 percent from 2000. For comparison, the average emission factor of the industry sector was 3.1 teCO_2/toe for 2012, a decrease of 3 percent from 2000.

ii. Transport

The EE potential of the transport sector in terms of final energy was 1,898 ktoe in 2012, considering 16.4 percent of the total energy was consumed by the transport sector. Because of the absence of reliable data for the energy consumption of personal automobiles in Egypt, its EE potential was estimated using information from the closest car fleet of another country in the region. In this case, Tunisia has the closest car fleet and hence the EE potential estimation relied on Tunisia's EE potential for the transport sector.

The average emission factor for the transport sector was 2.86 teCO_2/toe for 2012 while the CO_2 intensity of this sector amounted to 0.13 teCO_2/1,000 USD. The motorization rate in 2012 was calculated at 29.5 persons per vehicle, compared to 48.9 persons per vehicle in 2000.

iii. Tertiary

The final energy intensity of the tertiary sector amounted to 0.54 toe/1,000 USD in 2012. Using a country-tailored benchmark of 0.37 based on the Plan Bleu study and energy intensity of the sector, the EE potential in terms of final energy was 4,122 ktoe.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 1,013 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 5,135 ktoe. The CO_2 intensity of the tertiary sector amounted to 1.8 teCO_2/1,000 USD, while the average emission factor was 3.3 teCO_2/toe in 2012.

iv. Residential

The total intensity of the residential sector amounted to 0.3 toe/1,000 USD in 2012, while the specific consumption of energy was 7.52 kgoe/m^2/yr. The total EE potential for the residential sector, in terms of final energy based on specific consumption, was 3,060 ktoe using a country-tailored benchmark of 5.4 based on the Plan Bleu study.[13]

In addition, the final electricity efficiency potential of the sector converted in primary energy was 1,643 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 4,703 ktoe.

The unit consumption of energy per dwelling amounted to 526 kgoe/Dw in 2012, while the unit consumption of electricity per dwelling was 2,747 Kwh/Dw. The CO_2 intensity of the residential sector in 2012 was 1.2 teCO_2/1,000 USD and the average emission factor was 4.2 teCO_2/toe.

[13] "Energy, Climate change and the Building sector in the Mediterranean: Regional Prospects" (2010).

v. Agriculture and Fishing Sector

The final energy intensity for agriculture amounted to 0.4 toe/1,000 USD in 2012. Due to lack of data regarding fishing, the total EE potential in terms of final energy using a country-tailored benchmark of 0.32 and energy intensity of the agriculture sector was 645 ktoe for the agriculture and fishing sector for 2012.

4.3.5 Energy Efficiency potential 2020 and 2025

The technical EE potential projected for 2020 and 2025 amounts to 27,818 ktoe and 32,794 ktoe, respectively. The EE potential was based on the annual sectoral variation for 2000 to 2012. Based on the projected values of 2025, the total EE potential of 2025 represents 20 percent of TPES. Figure 33 shows the percentages of the subsectors with their projected EE potential, while Figure 34 shows the variation of the EE potential from 2012, 2020, and 2025.

Figure 33: Egypt Projected EE Potential, 2025

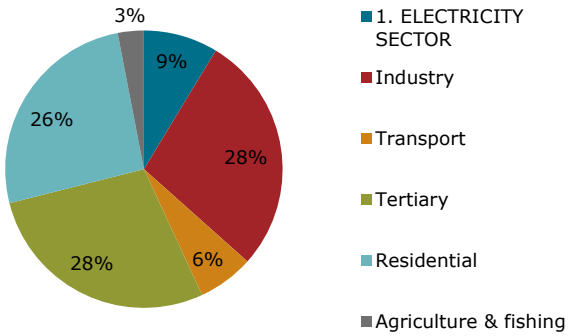
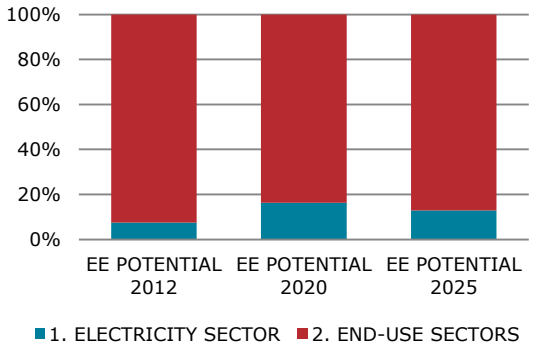


Figure 34: Egypt EE Potential 2012-2025



4.3.6 Cost of conserved energy

A set of the available data for the electricity efficiency potential abatement cost curve for Egypt in 2020 is represented in the table 15 below. It provides a combined estimation of electricity efficiency potential and net abatement cost by end-use sectors for a set of EE technologies.

The total cost-effective electricity efficiency potential (1,605 ktoe) accounts for a large share – Almost 48 percent – of the total identified electricity efficiency potential (3,289 ktoe). This indicates a relatively high concentration of the electricity efficiency potential on a set of EE technologies.

With almost 1,400 ktoe, the residential sector accounts for 87 percent of the total electricity efficiency potential while tertiary sector represents only 13 percent[14]. In terms of technologies, efficient lighting in the residential sector dominated the scene with 56 percent followed by efficient fridges at 26 percent and street lighting at 11 percent. SWH on the other hand accounted for a marginal share of only 2 percent in the electricity efficiency potential.

[14] Industry is not covered in the Budget Allocation Chart (BAC) for a lack of relevant data

The needed annual investment cost to realise this electricity efficiency potential is estimated to reach USD 139 million, with almost 78 percent coming from the residential sector. Efficient lighting and efficient fridges account for the largest shares of this cost with 35 percent and 32 percent, respectively. Over the period 2012 to 2020, the total investment cost of USD 1,112 million is largely compensated by the net (negative) abatement cost of USD 2,335 million.

Table 15: Electricity Efficiency Potential Abatement Investment Costs by End-Use Sectors and EE Technologies for Egypt over the Period 2012-2020

Sectors/EE technologies	**Electricity Efficiency Potential**			**Investment Cost (3)**	**Net abatement cost (2)**
	Total of subsector (1) ktoe/y	By EE technology (2)		M USD/y	M USD/y
		ktoe/y	USD/toe		
Tertiary	**1 248,6**	**208,1**		**30,2**	**-135,5**
SWH*		36,1	170	6,1	-69,68
Street lighting		172,0	140	24,1	-65,78
Residential	**2 040,0**	**1 396,6**		**108,5**	**-156,5**
Efficient fridges		411,1	120	49,3	-59,5
Efficient lighting		903,0	50	45,2	-79,69
Washing machines		82,6	170	14,0	-17,29
TOTAL	**3 288,6**	**1 604,8**		**138,7**	**-292,0**
Total without SWH		**1 568,6**			
% of total Electricity Efficiency Potential		**47,7%**			
* SWH is not listed in the EE potential estimation by subsector but covered here					
Sources					
(1) Study estimations for 2020 based on 2012-2020 annual variation (see Task on EE potential)					
(2) Data for 2020. Budget Allocation Chart (BAC), MED-ENEC and MED-EMIP, 2010					
(3) Energy efficiency in Building sector of the South Mediterranean countries, Plan Bleu, 2012					

Table 16: Electricity Efficiency Potential and Net Abatement Cost by EE Technologies for Egypt Over the Period 2012-2020

EE technologies	**Electricity Efficiency Potential**	**Net abatement cost**
	ktoe/y	M USD/y
SWH	36,1	-69,7
Street lighting	172,0	-65,8
Efficient fridges	411,1	-59,5
Efficient lighting	903,0	-79,7

Washing machines	82,6	-17,3
TOTAL	**1 604,8**	**-292,0**

4.3.7 Reduction in energy expenditures and avoided investment

In term of sectoral and technology reductions in electricity expenditures and avoidable electricity capacity investments, the main results are presented below in Table 17.

Table 17: Reductions in Electricity Expenditures and Avoided Power Investments for Egypt over the Period 2012-2020

Sectors/EE technologies	Electricity Efficiency Potential		Reductions in electricity expenditures (a)	Avoidable electricity capacity investments (b)	
	Total of subsector (1)	By EE technology (2)	M USD/y	MW	M USD (c)
	ktoe/y	ktoe/y			
Tertiary	**1 248,6**	**208,1**	**264,5**	**447,0**	**491,7**
SWH		36,1	48,8	77,6	85,3
Street lighting		172,0	215,7	369,4	406,4
Residential	**2 040,0**	**1 396,6**	**1 886,9**	**2 999,6**	**3 299,6**
Efficient fridges		411,1	555,4	882,9	971,2
Efficient lighting		903,0	1 220,0	1 939,4	2 133,4
Washing machines		82,6	111,5	177,3	195,0
TOTAL	**3 288,6**	**1 604,8**	**2 151,3**	**3 446,6**	**3 791,3**
Total without SWH		1 568,6			
% of total Electricity Efficiency Potential / Installed capacity		48,8%		11,9%	
Notes:					
(a) Based on average avoided electricity cost in 2020: low voltage: 0,087 €/kWh or 1,315 USD/toe; medium and high voltage: 0,083 €/kWh or 1,254 USD/toe (BAC Egypt, 2020)					
(b) Based on average electricity usage (hours/year)-without available data, hypothesis: similar to power plant time usage-around 5,000 h/y (2012)					
Power plant time usage (hours/year): 5 414					
(c) Based on average investment cost of combined cycle (CCGT) of 850€/kW or 1,100 USD/kW (sources: IEA ETSAP, Fraunhofer Institut)					

The main result that can be extracted from this above table is the fact that, for end-use customers, the electricity efficiency potential is almost equivalent to a reduction of USD 2,150 million of their electricity expenditures every year over the period 2012 – 2020. On the power generation side, the electricity efficiency potential corresponds to an avoidable capacity of 3,446 MW (2.6 times higher than the recently commissioned Ain Sokhna power plant, considered as one of the largest in the country with a capacity of 1,300 MW) almost around 12 percent of Egypt's existing installed power capacity. Such avoided new investment on power capacities would be equivalent to USD 3,800 million (using CCGT technology). Cumulating both electricity consumption and supply savings, Egypt should be saving every year more than USD 5,950 million representing almost 2.3 percent of its actual GDP at current price.

4.4 Iraq

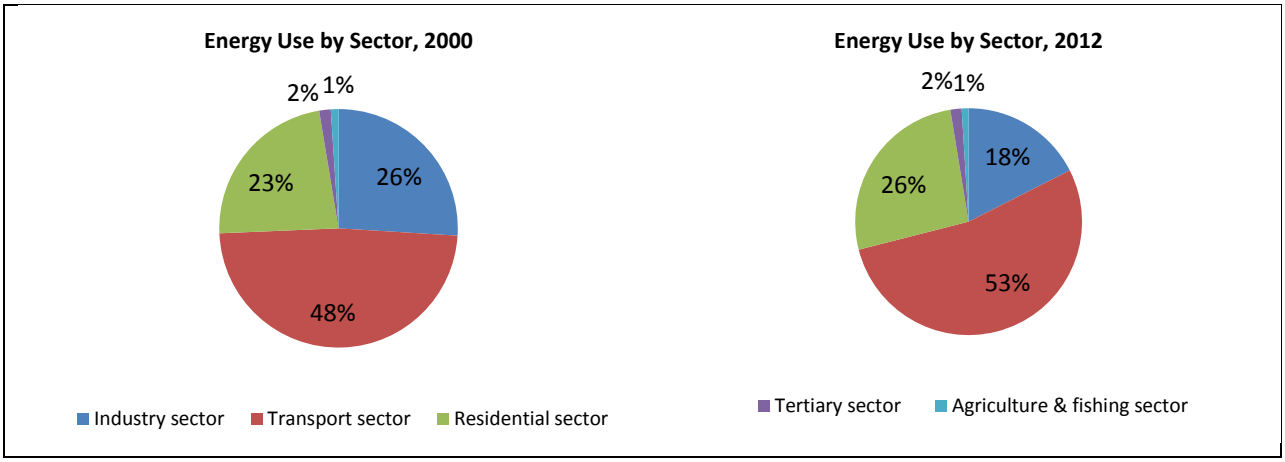
4.4.1 Overview of Energy Supply and Demand

The total energy production in Iraq consisted of 97 percent of crude oil in 2012 (compared to 98 percent in 2000), 3 percent of natural gas (compared to 1.9 percent), and less than 0.3 percent of hydropower (compared to 0.1 percent). The total production was 155,119 ktoe in 2012 compared to 134,909 ktoe in 2000. The country exported 82 percent of its crude oil production in 2012, while it imported oil products and electricity.

Electricity generation in Iraq relied mainly on natural gas, crude oil, and oil products. However, a portion of electricity was produced using other energies, mainly hydropower. Iraq imported increasing amounts of electricity since 2004, reaching 705 ktoe in 2012. Generated electricity almost doubled between 2000 and 2012, reaching 5,307 ktoe in 2012.

Final energy consumption in Iraq originated from electricity, oil products, natural gas, and other energies. In 2012, 86 percent of energy consumed in was generated from oil products (compared to 83 percent in 2000), followed by 9 percent from electricity (compared to 12 percent) and 1 percent from natural gas (compared to 7 percent). These different energy sources were used diversely between sectors, as shown in Figure 35. The transport sector is the largest energy-consuming sector. While the industrial sector used to be the second most intensive sector in 2000, residential sector consumption increased to become the second most intensive sector in 2012. Tertiary and agricultural and fishing sectors remained relatively stable at 2 and 1 percent, respectively, of total consumption.

Figure 35: Iraq Energy Use by Sector, 2000 and 2011, Percentage



4.4.2 Energy Demand Outlook 2020

Total energy consumption by end-use sectors is estimated to reach 25,904 ktoe in 2020, compared to 23,619 ktoe in 2012. The electricity generation is estimated to reach 92,605 GWh in 2020.

Transport sector is estimated to grow annually by 3 percent starting 2011, to reach 14,980 ktoe in 2020. The residential will increase by 2 percent, to 7,552 ktoe the same year.

The industrial sector will decrease by 5 percent to reach 3,626 ktoe in 2020, compared to 4,020 ktoe in 2012.

The tertiary and agriculture and fishing sectors are expected to have a steady growth at 2 percent and 1 percent, respectively, to amount to 468 ktoe and 295 ktoe in 2020, respectively.

4.4.3 Energy Outlook 2025

Final energy consumption will reach the value of 28,837 ktoe in 2025, compared to 19,121 ktoe in 2000. Electricity generation is estimated to nearly quadruple during the same period of time, to 119,354 GWh.

The transport and the residential sectors are estimated to grow by 9 and 6 percent, respectively, starting 2000 to reach 16,982 and 8,675 ktoe, respectively. While the tertiary and agriculture and fishing sectors are to remain steady, the industry sector is estimated to decrease consumption from 26 percent in 2000 to 11 percent in 2025 at a value of 3,400 ktoe.

Figure 36: Iraq Energy Use by Sector 2020

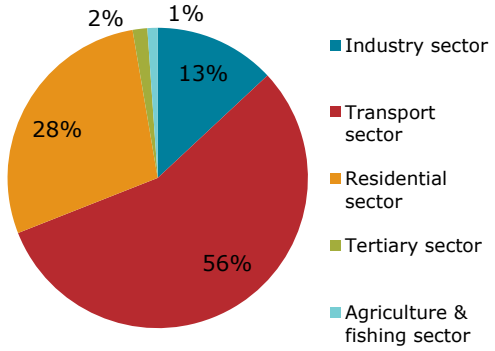


Figure 37: Iraq Final Energy Consumption by End-Use Sectors, ktoe

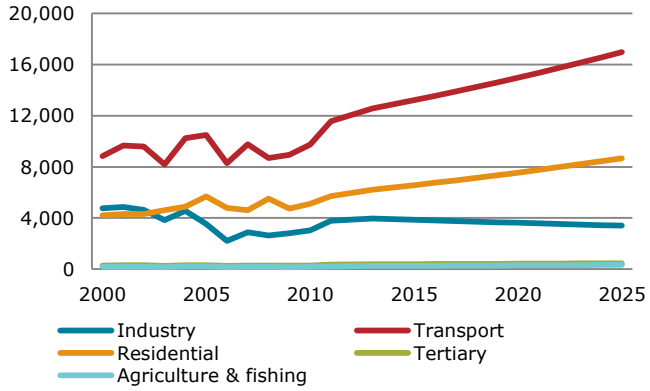
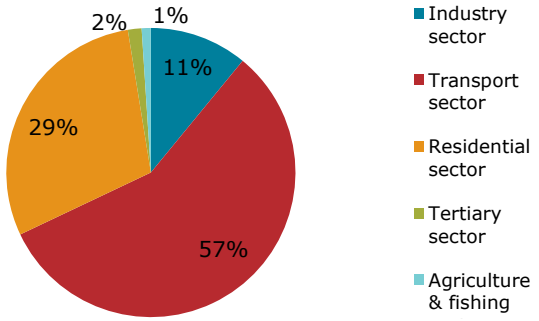
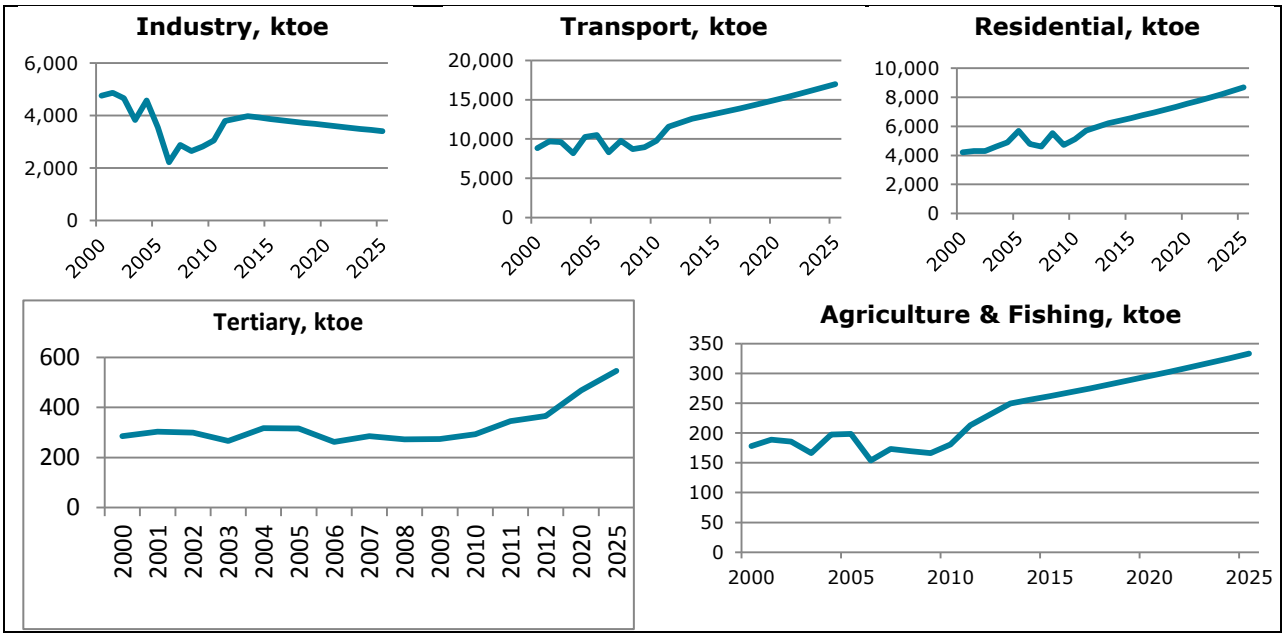


Figure 38: Iraq Energy Use by Sector 2025



In 2025, the transport sector will reach 16,982 ktoe, followed by residential at 8,675 ktoe, industrial at 3,400 ktoe, tertiary at 546 ktoe, and agriculture and fishing sector at 333 ktoe. In 2000, the transport sector amounted to 8,845 ktoe, followed by industry at 4,752 ktoe, residential at 4,218 ktoe, tertiary at 286 ktoe and agriculture and fishing at 190 ktoe.

Figure 39: Iraq Energy Consumption Trends by Sector



4.4.4 Energy Efficiency Potential

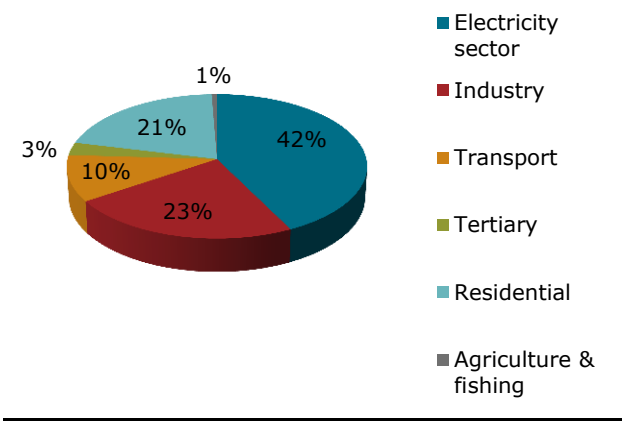
Iraq's total primary energy supplied amounted to 45,043 ktoe in 2012 compared to 25,936 ktoe in 2000, of which 52 percent was consumed by end-use sectors.

The total EE potential for 2012 was 7,064 ktoe,[15] of which 42 percent was for the electricity sector and 58 percent for end-use sectors. The industry sector had the highest EE potential at 1,622 ktoe (23 percent of total EE potential), followed by residential at 1,455 ktoe (21 percent), transport at 730 ktoe (10 percent), tertiary at 203 ktoe (3 percent), and 44 ktoe for agriculture and fishing (1 percent). The total EE potential represented 16 percent of total primary energy supplied in 2012.

Table 18: Iraq EE Potential, ktoe, 2012

Sector	EE Potential, ktoe, 2012
Electricity Sector	**3,009**
End-Use Sectors	**4,055**
Industry	1,622
Transport	730
Residential	1,455
Tertiary	203
Agriculture and Fishing	44
TOTAL	**7,064**
	16% of TPES

Figure 40: Iraq EE Potential, 2012



4.4.4.1 Electricity Generation

Total electricity generation in Iraq amounted to 5,307 ktoe in 2012, compared to 2,743 ktoe in 2000. The power generation efficiency was 27 percent for 2012. The country-tailored benchmark based on technological potential and fuel mix was set at 38 percent, which estimated the power generation EE potential to be 2,160 ktoe. The specific consumption of power generation was 318 toe/GWh in 2012.

The transmission and distribution losses amounted to 35 percent in 2012, without a clear indication whether commercial losses were taken into account, with 13 percent from transmission losses and 22 percent from distribution losses. Transmission losses country-tailored benchmark was set at 8 percent, while the distribution losses sub-regional benchmark was set at 11 percent. The EE potential for transmission and distribution losses was 265 ktoe for transmission and 583 ktoe for distribution losses.

The total EE potential for the electricity sector, in terms of primary energy, was 3,009 ktoe in 2012.

[15] Estimations for electricity sector are in terms of primary energy, estimations for transport and agriculture and fishing sectors are in terms of final energy, while estimations for industry, residential and tertiary sectors are in terms of primary and final energy.

4.4.4.2 End-Use Sectors

i. Industry

The final energy intensity of the industry sector was 0.247 toe/1,000 USD in 2012. A country-tailored benchmark based on the structure of the industrial sector, its evolution, and other country performances was set at 0.18 toe/1,000 USD. The EE potential for the industry sector based on the energy intensity in terms of final energy was 1,085 ktoe in 2012. The EE potential represented 27 percent of energy consumed by this sector.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 538 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 1,622 ktoe. The average emission factor of the industry sector amounted to 4.1 teCO2/toe, while the CO_2 intensity of the industry sector was 1.0 teCO2/1,000 USD in 2012.

ii. Transport

The total energy intensity of the transport sector was 0.594 toe/1,000 USD in 2012, while the average energy unit consumption of cars was 960 Kgoe/car/yr. The country-tailored benchmark of 1,000 kgoe/car/yr, along with an estimation of 30 percent of fuel smuggling that was unaccounted for in the average energy unit consumption of cars, led to an estimated EE potential in terms of final energy and based on the specific consumption of cars, for the transport sector at 730 ktoe in 2012. The EE potential represented 6 percent of total energy consumed by the transport sector.

The average emission factor of the transport sector was 2.94 $teCO_2$/toe in 2012, with a CO_2 intensity of the transport sector of 1.75 $teCO_2$/1,000 USD. The motorization rate was 8.5 persons/vehicle in 2012, including the Kurdistan area.

iii. Tertiary

The energy intensity of the tertiary sector was 0.057 toe/1,000 USD in 2012. A country-tailored benchmark based on the Plan Bleu Study was set at 0.045 toe/1,000 USD, which estimated the EE potential for the tertiary sector in terms of final energy based on energy intensity at 78 ktoe for 2012.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 125 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 203 ktoe.

iv. Residential

The total energy intensity of the residential sector was 0.65 toe/1,000 USD for 2012. The EE potential for the residential sector in terms of final energy was 941 ktoe in 2012, derived from energy intensity of the sector and on a country-tailored benchmark based on the Plan Bleu study. The EE potential represented 16 percent of total energy consumed by the sector in 2012.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 514 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 1,456 ktoe. The unit consumption of energy per dwelling amounted to 1,170 kgoe/Dw for 2012, with a unit consumption of electricity at 2,746 Kwh/Dw. The average emission factor of the residential sector was 3.9 $teCO_2$/toe while the CO_2 intensity of the sector was 2.5 $teCO_2$/1,000 USD in 2012.

v. Agriculture and Fishing Sector

The final energy intensity of the agriculture sector was 0.295 toe/1,000 USD in 2012, however, data on energy intensity of the fishing sector was unavailable. The country-tailored benchmark, based on Yemen, was 0.25 toe/1,000 USD, which estimated an EE potential, in terms of final energy, of 44 ktoe for 2012.

4.4.5 Energy Efficiency Potential 2020 and 2025

The technical EE potential projected for 2020 and 2025 are 11,372 ktoe and 18,071 ktoe, respectively. The EE potential was based on the annual sectoral variation for 2000 to 2012. Based on the projected values for 2025, the total EE potential of 2025 represents 11 percent of TPES. Figure 41 shows the percentages of the subsectors with their projected EE potential while Figure 42 shows the variation of the EE potential for 2012, 2020, and 2025.

Figure 41: Iraq Projected EE Potential, 2025

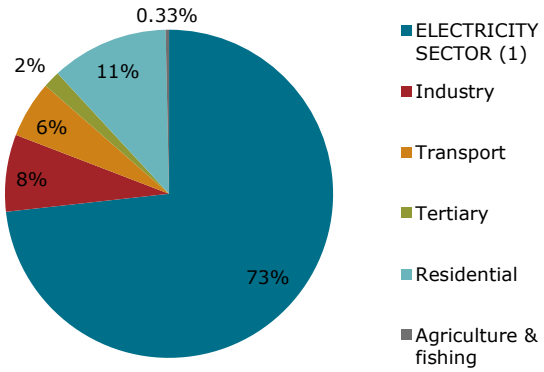
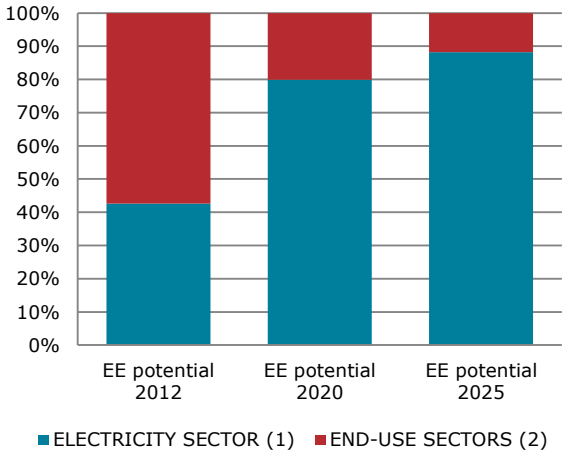


Figure 42: Iraq EE Potential 2012-2025



4.5 Jordan

4.5.1 Overview of Energy Supply and Demand

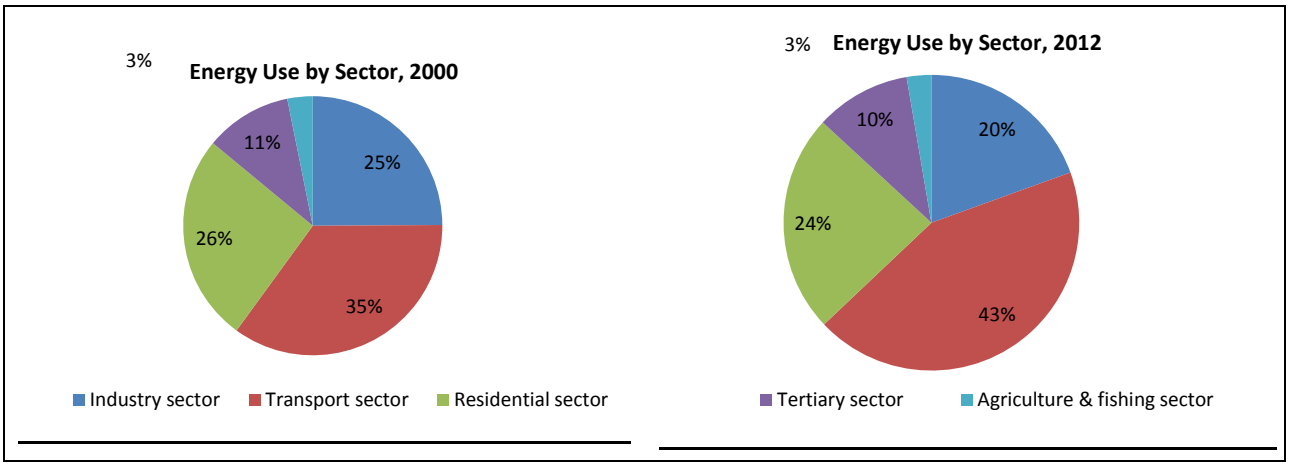
Energy production for Jordan was 268 ktoe in 2012, compared to 285 ktoe in 2000. Jordan produced natural gas at a rate of 121 ktoe in 2012 and geothermal and solar energies at 140 ktoe. The country relies mostly on imports of natural gas, crude oil, and oil products to meet its local demands. In 2012, imports amounted to 7,903 ktoe, an increase of 66 percent from 2000. Crude oil and oil products were largest share of imports, of which they constituted 91 percent of total imports in 2012. Jordan exported only electricity at varying rates, reaching 26 ktoe in 2012.

Total primary energy available amounted to 7,463 ktoe in 2012 compared to 4,805 ktoe in 2000. Crude oil and oil products amounted to 96 percent of total available primary energy. Electricity generation also depended heavily on oil products in 2012 at 81 percent and 19 percent for natural gas. Total electricity generated in Jordan reached 1,427 ktoe in 2012, compared to 634 ktoe in 2000.

Final energy consumption by end-use sectors as per fuel input amounted to 5,932 ktoe in 2012 and is allocated as follows: 4,448 ktoe for oil products; 1,228 ktoe for electricity; and 127 ktoe for other energies. This is in comparison to 2000, when the main energy sources were 2,817 ktoe for oil products, 527 ktoe for electricity, and 71 ktoe for other energies.

The largest energy-consuming sector was transport, with a consumption of 2,521 ktoe in 2012 (compared to 1,199 ktoe in 2000), followed by residential at 1,389 ktoe (compared to 887 ktoe), industry at 1,130 ktoe (compared to 851 ktoe), tertiary at 606 ktoe (compared to 370 ktoe) and agriculture and fishing at 156 ktoe (compared with 108 ktoe).

Figure 43: Jordan Energy Use by Sector, 2000 and 2012, Percentage



4.5.2 Energy Demand Outlook, 2020

The transport sector will remain the largest energy-consuming sector in 2020, with a consumption amounting to 49 percent of total energy consumed by end-use sectors at 3,983 ktoe. Residential will follow, with 22 percent (at 1,830 ktoe), 17 percent for industry (at 1,346 ktoe), 10 percent for tertiary (at 821 ktoe), and 2 percent for agriculture and fishing (at 196 ktoe).

Total energy consumed in 2020 will reach 8,137 ktoe, compared with 5,802 ktoe in 2012, while electricity generation will reach 27,342 GWh, an increase of almost 65 percent from 2012.

Figure 44: Jordan Energy Use by Sector 2020

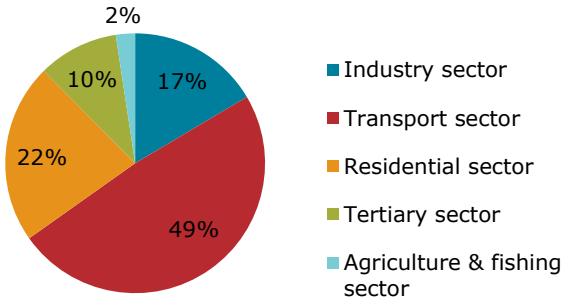
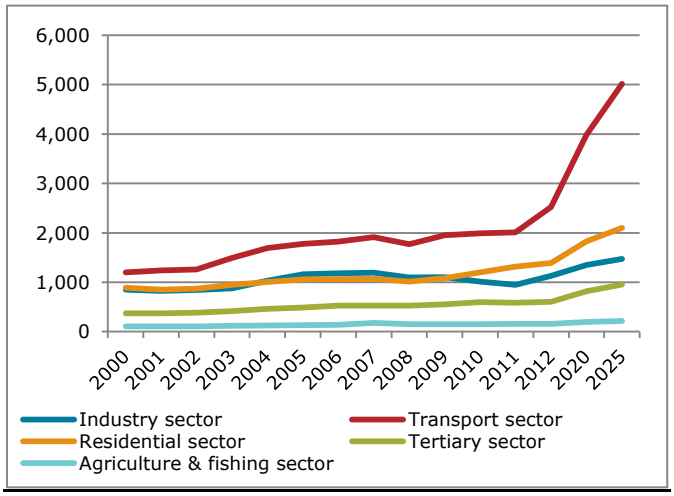


Figure 45: Jordan Final Energy Consumption by End-Use Sectors, ktoe

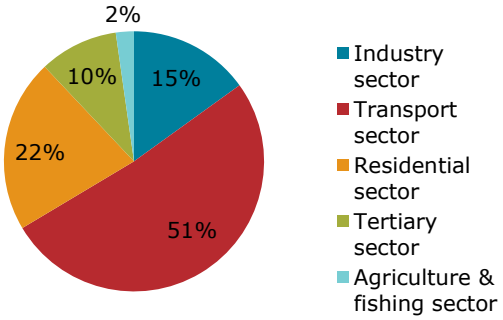


4.5.3 Energy Demand Outlook 2025

The transport sector is estimated to remain the largest energy-consuming sector with a consumption amounting to 51 percent of total energy consumed by end-use sectors, followed by 22 percent for residential, 15 percent for industry, 10 percent for tertiary and 2 percent for agriculture and fishing.

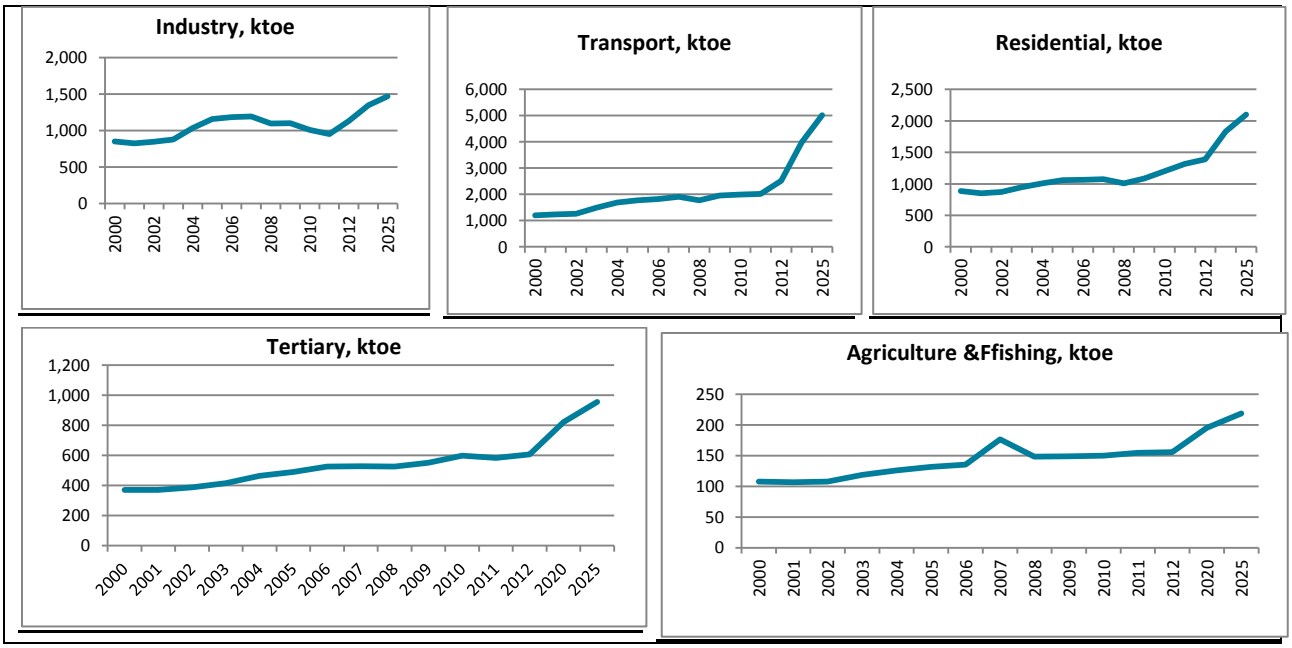
Total energy consumed is estimated to reach 9,884 ktoe in 2025, compared with 5,932 ktoe in 2012, while electricity generation is projected to reach 35,150 GWh, an increase from 16,595 GWh in 2012.

Figure 46: Jordan Energy Use by Sector 2025



Energy consumed by in 2025 will reach 5,013 ktoe for the transport sector, 2,101 ktoe for residential, 1,470 ktoe for industry, 956 ktoe for tertiary, and 219 ktoe for agriculture and fishing. This is in comparison to 2012, when the transport sector consumed 2,521 ktoe, followed by residential at 1,389 ktoe, industry at 1,130 ktoe, 606 ktoe for tertiary, and 156 ktoe for agriculture and fishing.

Figure 47: Jordan Energy Consumption Trends by Sector



4.5.4 Energy Efficiency Potential

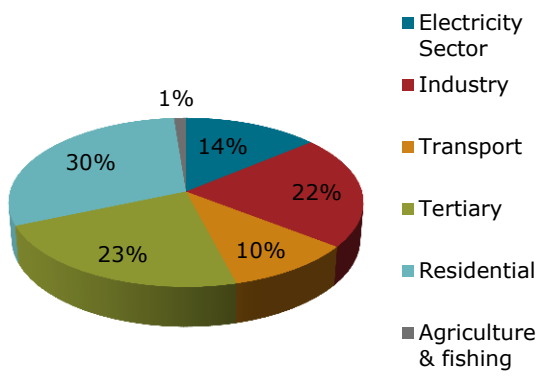
Total primary energy supplied amounted to 7,463 ktoe in 2012, an increase of 55 percent from 2000. Of the total primary energy supplied, 79 percent was consumed by end-use sectors.

Total EE potential for all energy-consuming sectors was 1,612 ktoe[16] in 2012. The electricity sector represented 14 percent of the total EE potential, while the end-use sector represented 86 percent. The EE potential amounted to 22 percent of total primary energy consumption for 2012. The residential sector has the highest EE potential within the end-use sectors at 30 percent, followed by tertiary at 23 percent, industry at 22 percent, transport at 10 percent, and agriculture and fishing at 1 percent.

Table 19: Jordan EE Potential, ktoe, 2012

Sector	EE Potential, ktoe, 2012
Electricity Sector	**224**
End-Use Sectors	**1,388**
Industry	348
Transport	169
Residential	486
Tertiary	365
Agriculture and Fishing	20
TOTAL	**1,612**
	22% of TPES

Figure 48: Jordan EE Potential, 2012



4.5.4.1 Electricity Generation

Total generated electricity amounted to 1,427 ktoe in 2012, increasing from 634 ktoe in 2000 at an average annual rate of 6.4 percent. The country tailored benchmark for power generation efficiency, based on the electricity sector situation and international references, was set at 44 percent. Using the power generation efficiency that was calculated at 40.2 percent for 2012, the EE potential was estimated to be 135 ktoe in 2012. The specific consumption of power generation was 214 toe/GWh in 2012.

The transmission and distribution electricity losses were 17.3 percent in 2012, of which 4 percent was for transmission losses and 13.3 percent for distribution losses. The sub-regional benchmarks were set at 3 percent for transmission and 8 percent for distribution, which resulted in an EE potential at 14 ktoe for transmission losses and 75 ktoe for distribution losses. The total EE potential for transmission and distribution was 89 ktoe. The total EE potential of the electricity sector, in terms of primary energy, was 224 ktoe in 2012.

[16] Estimations for electricity sector are in terms of primary energy, estimations for transport and agriculture and fishing sectors are in terms of final energy, while estimations for industry, residential and tertiary sectors are in terms of primary and final energy.

4.5.4.2 End-Use Sectors

i. Industry

The final energy intensity of the industry sector in Jordan was 0.41 toe/1,000 USD in 2012. A country-tailored benchmark based on the structure of the industrial sector, its evolution, and other country performances was set at 0.32 to estimate the EE potential in terms of final energy based on energy intensity at 250 ktoe in 2012. The EE potential for industry represented 22 percent of total energy consumed by this sector in 2012. In addition, out of the nine energy-intensive sectors, data suggests the EE potential for steel industries at 5 ktoe and the EE potential for paper industries at 3 ktoe.

The final electricity efficiency potential of the sector converted in primary energy was 98 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 348 ktoe.

The average emission factor of the industry sector was 4.1 teCO2/toe in 2012 while the CO2 energy intensity was 1.7 teCO_2/1,000 USD in 2012, a decrease of 3 percent from 2000.

ii. Transport

The average energy unit consumption of gasoline cars was 1,174 kgoe/car/yr in 2012, decreasing from 2,178 kgoe/car/yr in 2000. The EE potential for the transport sector, in terms of final energy was based on the consumption of road transport only due to lack of data for other transportation means, such as air, maritime and railways. The EE potential was 169 ktoe in 2012, based on a regional benchmark from three MENA countries. The EE potential represented 7 percent out of total energy consumed by this sector in 2012.

The average emission factor of the transport sector was 2.9 teCO_2/toe in 2012, constant in comparison with 2000. The CO_2 intensity of the sector was 0.7 teCO_2/1,000 USD in the same year, compared to 0.8 in 2000. The motorization rate in Jordan for 2012 was 7.7 persons per vehicle.

iii. Tertiary

The final energy intensity of the tertiary sector was 0.062 toe/1,000 USD in 2012. Based on the country-tailored benchmark from the Plan Bleu study that was set at 0.043, the EE potential for the tertiary sector, in terms of final energy and based on energy intensity, was 184 ktoe. The EE potential represented 30 percent of total energy consumed by this sector in 2012.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 182 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 365 ktoe.

The average emission factor for the tertiary sector in Jordan amounted to 5.9 teCO_2/toe in 2012, compared to 5.2 teCO_2/toe in 2000. The CO_2 intensity of the sector was 0.4 teCO_2/1,000 USD in the same year, compared to 0.4 in 2000.

iv. Residential

The energy intensity of the residential sector was 0.124 toe/1,000 USD for 2012, while the specific consumption of energy per unit area was 7.6 kgoe/m^2/yr. The EE potential for the residential sector in terms of final energy was 311 ktoe, based on country-tailored benchmark from the Plan Bleu study that was set at 5.9 Kgoe/m2/yr for the specific consumption of energy for this sector. The EE potential represented 22 percent out of total energy consumed by this sector in 2012.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 176 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 486 ktoe.

The unit consumption of energy per dwelling was 912 kgoe/Dw in 2012, while the unit consumption of electricity per dwelling was 4,024 Kwh/Dw in the same year. In addition, the average emission factor for the sector amounted to 4.4 $teCO_2$/toe while the CO_2 intensity was 0.5 $teCO_2$/1,000 USD.

v. Agriculture and Fishing Sector

The final intensity of the agriculture sector was 0.32 toe/1,000 USD in 2012. The country-tailored benchmark for the agriculture sector was set at 0.28 based on estimations, providing an EE potential in terms of final energy, at 20 ktoe based on energy intensity. There was no information available regarding the intensity of the fishing sector; therefore, it was not possible to provide an EE potential estimation for this subsector.

4.5.5 Energy Efficiency Potential 2020 and 2025

The technical EE potential projected for 2020 and 2025 amounts to 2,126 ktoe and 2,046 ktoe, respectively. The EE potential was projected based on the annual sectoral variation for 2000 to 2012. Based on the projected values of 2025, the total EE potential represents 13 percent of TPES. Figure 49 shows the percentages of the subsectors with their projected EE potential, while Figure 50 shows the variation of the EE potential for 2012, 2020, and 2025.

Figure 49: Jordan Projected EE Potential, 2025

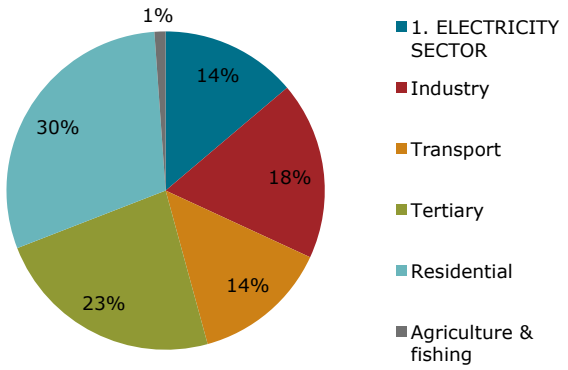
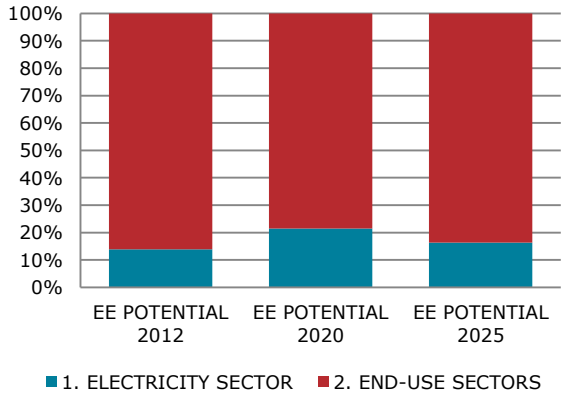


Figure 50: Jordan EE Potential 2012-2025



4.5.6 Cost of Conserved Energy Curve

The total cost-effective electricity efficiency potential – 206 ktoe – for a set of technologies shown in Table 20 below, accounts for only 19 percent of the total identified electricity efficiency potential. The main reason behind this fact is that there exist a lot of EE sectoral and transversal technologies and measures that are not listed in this assessment.

As there are more technologies listed in the residential sector than in other sectors, the coverage is higher in this sector (without SWH) and lower in the tertiary and industry. Furthermore, as fuels account for the largest share of total EE potential—up to 75 percent of total EE potential in Jordan—the need to undertake deeper research as the BAC expands the technology scope and also include fuel consumption is highlighted.

The residential sector dominates with 62 percent of the total EE potential, followed by tertiary at 23 percent and industry at 15 percent. In terms of technologies, SWH accounts for the largest share with 63 percent, while the shares of other technologies, such as electric motors at 10 percent and efficient lighting at 5 percent, are much lower.

The needed annual investment cost to realize this electricity efficiency potential is USD 36 million, mostly in the residential sector which represents 55 percent. SWH and building insulation account for the largest shares within the residential sector at 61 percent and 17 percent, respectively. Over the period 2012 to 2020, the total investment of USD 288 million will largely be compensated by net (negative) abatement cost savings of USD 4,705 million.

Table 20: Electricity Efficiency Potential Abatement Investment Costs by End-Use Sectors and EE Technologies for Jordan over the Period 2012-2020

Sectors/EE technologies	Electricity Efficiency Potential		Investment Cost (3)		Net Abatement Cost (2)
	Total of subsector (1)	By EE technology (2)			
	ktoe/y	ktoe/y	USD/toe	M USD/y	M USD/y
Industry	**78**	**30,4**		**6,7**	**-151,3**
Electric motors		21,5	220	4,7	-91,3
Compressed air		8,9	220	1,9	-60,06
Tertiary	**165**	**48,0**		**9,2**	**-151,7**
SWH (a)		38,7	170	6,6	-68,77
Street lighting		3,2	140	0,4	-70,33
Thermal insulation (b)		6,2	350	2,2	-12,61
Residential	**155**	**128,1**		**21,6**	**-285,0**
Efficient fridges		13,5	120	1,6	-29,8

Efficient lighting		10,7	50	0,5	-90,48
SWH*		90,3	170	15,4	-64,87
Thermal insulation**		11,5	350	4,0	-23,4
Lighting ballasts		2,2	50	0,1	-76,44
TOTAL	**399**	**206,5**		**37,5**	**-588,0**
Total without SWH		**77,5**		**15,6**	**-454,4**
% of total Electricity Efficiency Potential		**19,4%**			
(a) SWH is not listed in the EE potential estimation by subsector but covered here					
(b) EE potential shared between Residential (estimated at 65%) and Tertiary (est. at 35%)					
Sources:					
(1) Study estimations for 2020 based on 2012-2020 annual variation (see Task on EE potential)					
(2) Data for 2020. Budget Allocation Chart (BAC), MED-ENEC and MED-EMIP, 2010					
(3) *Energy efficiency in Building sector of the South Mediterranean countries*, Plan Bleu, 2012					

Table 21: Electricity Efficiency Potential and Net Abatement Cost by EE Technologies for Jordan over the Period 2012-2020

	Electricity Efficiency Potential	**Net Abatement Cost (2)**
	ktoe/y	M USD/y
Electric motors	21,5	-91,3
Compressed air	8,9	-60,1
SWH (tertiary)	38,7	-68,8
Street lighting	3,2	-70,3
Thermal insulation	6,2	-12,6
Efficient fridges	13,5	-29,8
Efficient lighting	10,7	-90,5
SWH (residential)	90,3	-64,9
Thermal insulation	11,5	-23,4
Lighting ballasts	2,2	-76,4
TOTAL	**206,5**	**-588,0**

4.5.6.1 Reductions in Energy Expenditures and Avoided Investment

The main results in terms of sectoral and technology reductions in electricity expenditures and avoidable electricity capacity investments are presented in Table 22.

Table 22: Reductions in Electricity Expenditures and Avoided Power Investments for Jordan over the Period 2012-2020

Sectors/EE technologies	Electricity Efficiency Potential		Reductions in Electricity Expenditures (c)	Avoidable Electricity Capacity Investments (d)	
	Total of subsector (1)	By EE technology (2)	M USD/y	MW	M USD (e)
	ktoe/y	ktoe/y			
Industry	**78**	**30,4**	**34,9**	**70,4**	**77,5**
Electric motors		21,5	24,7	49,9	54,9
Compressed air		8,9	10,2	20,6	22,6
Tertiary	**165**	**48,0**	**61,3**	**111,5**	**122,6**
SWH (a)		38,7	49,7	89,8	98,8
Street lighting		3,2	3,6	7,4	8,1
Thermal insulation (b)		6,2	7,9	14,3	15,8
Residential	**155**	**128,1**	**164,5**	**297,3**	**327,0**
Efficient fridges		13,5	17,3	31,3	34,5
Efficient lighting		10,7	13,7	24,7	27,2
SWH*		90,3	115,9	209,5	230,5
Thermal insulation**		11,5	14,7	26,6	29,3
Lighting ballasts		2,2	2,8	5,1	5,6
TOTAL	**399**	**207**	**261**	**479**	**527**
Total without SWH		77,5			
% of total Electricity Efficiency Potential / Installed capacity		19,4%		14,5%	
* SWH is not listed in the EE potential estimation by subsector but covered here					
** EE potential shared between residential (estimated at 65%) and Tertiary (est. at 35%)					
*** based on average avoided electricity cost in 2020: low voltage: 0,0841 €/kWh or 1,284 USD/toe; medium and high voltage: 0,076 €/kWh or 1,148 USD/toe (BAC Jordan, 2020)					
**** based on average electricity usage (hours/year)-without available data, hypothesis: similar to power plant time usage-around 5,000 h/y (2012)					

***** based on average investment cost of combined cycle (CCGT) of 850€/kW or 1,100 USD/kW (sources: IEA ETSAP, Fraunhofer Institut)

The main results include an estimated 480 MW of avoidable electricity capacity, which is equivalent to 14.5 percent of the existing installed capacity. Such avoided new investment of power capacities would be equivalent to USD 527 million (using CCGT technology). Added to the end-customers reductions in electricity expenditures of USD 261 million, Jordan would save above USD 790 Million, or over 2.30 percent of its actual GDP at the current price.

4.6 Kuwait

4.6.1 Overview of Energy Demand and Supply

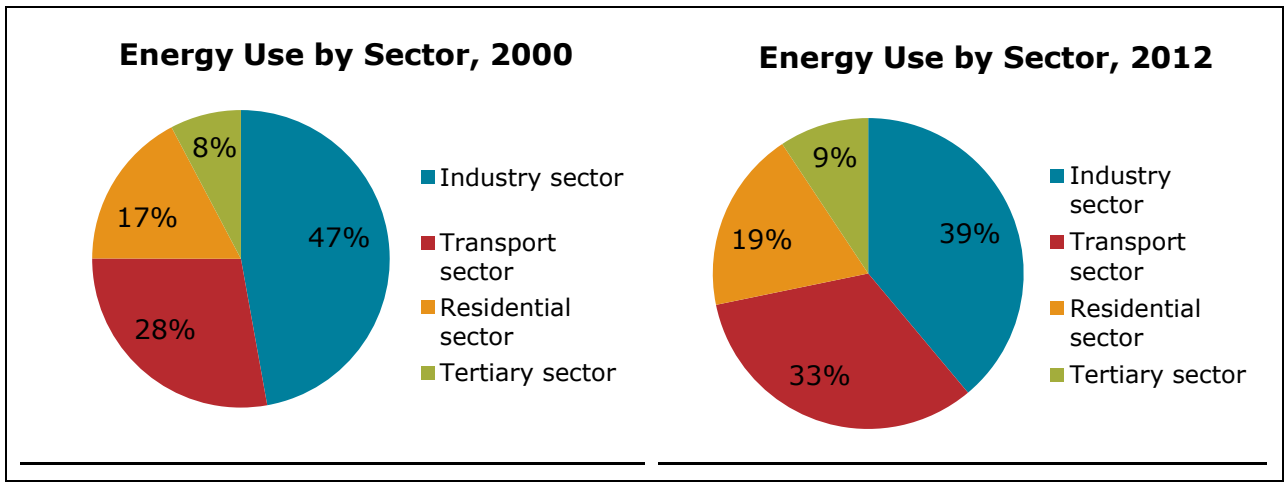
Total energy production in Kuwait increased from 114,317 ktoe in 2000 to 173,252 ktoe in 2012. This increase is due to the increase in the production of crude oil during the same period. Kuwait did not import energy until 2009, when natural gas importation started with 728 ktoe and reached 2,164 ktoe in 2012. However, the country exported almost 80 percent of its production in 2012 as crude oil and oil products.

Electricity is mainly generated from natural gas and oil products. An increase was recorded in the values of oil products from 4,494 ktoe in 2000 to 8,337 ktoe in 2012, while natural gas fuel input increased from 2,287 ktoe in 2000 to 5,573 ktoe in 2012. Crude oil values as fuel input to generate electricity amounted to 2,338 ktoe in 2012, compared to 1,803 ktoe in 2000. Total electricity generated reached 5,388 ktoe in 2012, compared to 2,780 ktoe in 2000.

In the petrochemicals sector, 18,428 ktoe was used in 2012, compared to 10,656 ktoe in 2000. The country used 11 percent of its production in this sector in 2012, while it amounted to 9 percent in 2000.

Final energy consumption by end-use sectors increased from 8,441 ktoe in 2000 to 16,787 ktoe in 2012, with a significant increase in the consumption of oil products. The consumption of energy by the industry sector was the highest in Kuwait, at 47 percent in 2000, decreasing to 39 percent in 2012. The transport sector increased by 5 percent to reach 33 percent in 2012. Residential and tertiary sectors slightly increased between the same period to reach 19 and 9 percent, respectively.

Figure 51: Kuwait Energy Use by Sector, 2000 and 2012, Percentage



4.6.2 Energy Demand Outlook, 2020

From 2012 to 2020, total energy consumption by sectors is estimated to increase from 16,787 ktoe to 18,798 ktoe. Generated electricity will increase during the same period to 94,141 GWh.

Although all sectors' consumption is estimated to increase with time, the industry sector will represent the slowest growth from 2012 to 2020, with a decrease of the sector's consumption out of total energy consumed (from 39 percent to 34 percent) to amount to 6,232 ktoe in 2020.

The transport sector is will increase from 33 to 36 percent from 2012 to 2020, while the residential and tertiary will each have a growth of 1 percent during the same period of time.

Figure 52: Kuwait Energy Use by Sector 2020

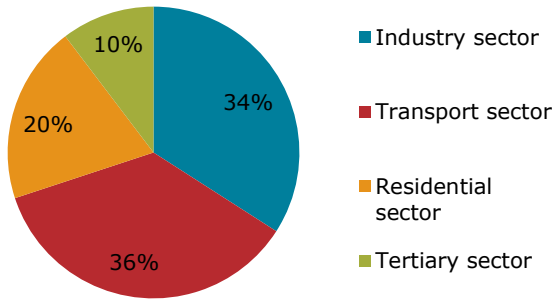
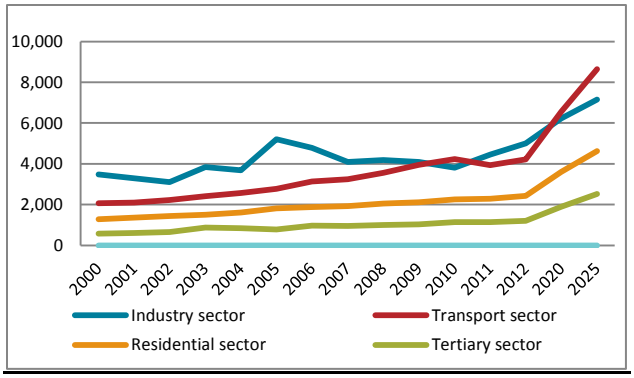


Figure 53: Kuwait Final Energy Consumption by End-Use Sectors, ktoe

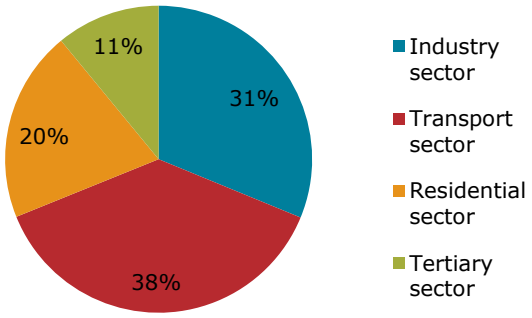


4.6.3 Energy Outlook 2025

Energy consumption by sector is estimated to reach 24,183 ktoe in 2025, compared to 16,787 ktoe in 2012. Electricity generated is estimated to almost double to 121,426 GWh during the same period.

In 2025, transport sector is estimated to consume 38 percent of total energy in Kuwait, followed by the industry sector at 31 percent, residential at 20 percent, and tertiary at 11 percent. Compared to 2012, all sectors are estimated to grow in energy consumption values, but the share of total energy consumption will grow for all sectors except the industrial sector, which will be reduced by 8 percent.

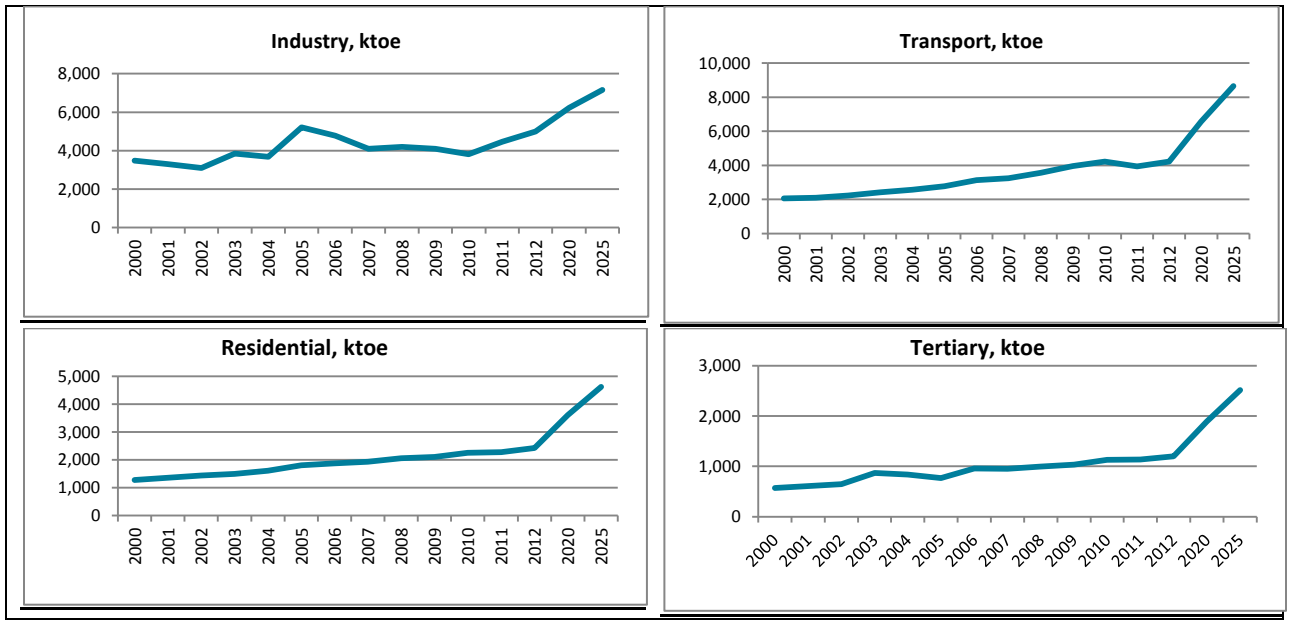
Figure 54: Kuwait Energy Use by Sector 2025



Total energy consumption by end-use sectors for 2025 will be as follows: 8,641 ktoe for the transport sector; 7,157 ktoe for the industrial sector; 4,625 ktoe for the residential sector; and 2,513 ktoe for the tertiary sector.

The agriculture and fishing sector is not included in the percentage of the total energy consumption by sector as data on the energy consumption of this sector was not available.

Figure 55: Kuwait Energy Consumption Trends by Sector



4.6.4 Energy Efficiency Potential

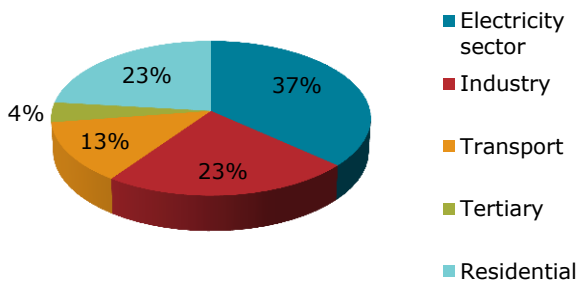
Total primary energy supplied in Kuwait increased from 18,807 ktoe in 2000 to 34,613 ktoe in 2012, of which 48 percent was consumed by end-use sectors.

The total EE potential in 2012 was 8,272 ktoe,[17] of which 37 percent was for the electricity sector and 63 percent for end-use sectors. In the end-use sectors, residential and industry have the highest EE potential at 23 percent, followed by transport at 13 percent, and tertiary at 4 percent. Data for the agriculture and fishing sector was not available for review in this study. The total EE potential represented 24 percent of total primary energy supplied in 2012.

Table 23: Kuwait EE Potential, ktoe, 2012

Sector	EE Potential, ktoe, 2012
Electricity Sector	**3,028**
End-Use Sectors	**5,244**
Industry	1,919
Transport	1,063
Residential	1,919
Tertiary	342
Agriculture and Fishing	…
TOTAL	**8,272**
	24% of TPES

Figure 56: Kuwait EE Potential, 2012



4.6.4.1 Electricity Generation

Total electricity generated in Kuwait in 2012 amounted to 5,388 ktoe, increasing from 2,780 ktoe in 2000. The power generation efficiency was 33 percent in 2012. The country-tailored benchmark based on the sector situation and international references was set at 49 percent. The EE potential for power generation was 2,574 ktoe in 2012. The specific consumption of power generation was 259 toe/GWh in 2012.

The total transmission and distribution electricity losses were 14.2 percent in 2012, with 5.6 percent for transmission losses and 8.6 percent for distribution losses. Sub-regional benchmarks were used to estimate the EE potential of transmission losses at 178 ktoe and 277 ktoe for distribution losses. The total EE potential for the electricity sector was estimated, in terms of primary energy, to be 3,028 ktoe in 2012.

[17] Estimations for electricity sector are in terms of primary energy, estimations for transport and agriculture and fishing sectors are in terms of final energy, while estimations for industry, residential and tertiary sectors are in terms of primary and final energy.

4.6.4.2 End-Use Sectors

i. Industry

The energy intensity of the industry sector was 0.8 toe/1,000 USD in 2012, compared to 0.98 toe/1,000 USD in 2000. The EE potential for the industry sector, in terms of final energy and based on a country-tailored benchmark of 0.55 toe/1,000 USD, was 1,568 ktoe based on the energy intensity of the sector. The EE potential represented 31 percent of total energy consumed by this sector during 2012.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 351 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 1,919 ktoe.
The average emission factor of the sector was 3.02 $teCO_2$/toe in 2012, while the CO_2 intensity was 2.4 $teCO_2$/1,000 USD.

ii. Transport

The final energy intensity of the transport sector was 0.044 toe/1,000 USD in 2012, increasing from 0.038 toe/1,000 USD in 2000. The country-tailored benchmark of 0.033 toe/1,000 USD, or the equivalent of 25 percent of total energy consumed by this sector, estimated the EE potential in terms of final energy at 1,063 ktoe. The EE potential includes road transportation only due to data unavailability for other transportation means, such as maritime and air.

The average emission factor of the transport sector was 2.9 $teCO_2$/toe in 2012 and the CO_2 intensity of the sector was 0.13 $teCO_2$/1,000 USD in 2012, compared to 0.11 $teCO_2$/1,000 USD in 2000. The motorization rate was 2.4 persons per vehicle in 2012, decreasing from 3.1 persons per vehicle in 2000.

iii. Tertiary

The EE potential, in terms of final energy, was -337 ktoe in 2012, using the country-tailored benchmark of 0.018 toe/1,000 USD based on the GIOC study[18] and the final energy intensity of the tertiary sector at 0.025 toe/1,000 USD.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 680 ktoe. This added to the EE potential in final energy estimated the total EE potential for the sector at 342 ktoe.

The average emission factor of the tertiary sector was 7.4 $teCO_2$/toe in 2012 and the CO_2 intensity of the tertiary sector was 0.19 $teCO_2$/1,000 USD.

iv. Residential

The total EE potential for the residential sector in Kuwait, in terms of final energy, was 704 ktoe in 2012, based on a country-tailored percentage benchmark based on set of GCC individual audits, studies and expert analysis, and the total consumption of energy by the residential sector. Data for energy intensity for the residential sector was unavailable; hence the percentage was used to estimate the total EE potential.

[18] Energy Efficiency Guidebook, A GOIC Publication for GCC Industries, 2013.

In addition, the final electricity efficiency potential of the sector converted into primary energy was 1,216 ktoe. This added to the EE potential in final energy estimated the total EE potential for the sector at 1,919 ktoe.

Based on available data, the unit consumption of energy per dwelling was 4,704 kgoe/Dw in 2011, when the unit consumption of electricity per dwelling was 49,858 Kwh/Dw. The average emission factor was 7 $teCO_2$/toe in 2012.

v. Agriculture and Fishing Sector

Statistical data related to the energy intensity of the agriculture and fishing sector was unavailable for Kuwait, and the EE potential was not estimated as such.

4.6.5 Energy Efficiency Potential 2020 and 2025

The technical EE potential projected for 2020 and 2025 amounts to 12,108 ktoe and 15,428 ktoe, respectively. The EE potential was projected based on the annual sectoral variation for 2000 to 2012. Based on the projected values of 2025, the total EE potential of 2025 represents 26 percent of TPES. Figure 57 shows the percentages of the subsectors with their projected EE potential, while Figure 58 shows the variation of the EE potential for 2012, 2020, and 2025.

Figure 57: Kuwait Projected EE Potential, 2025

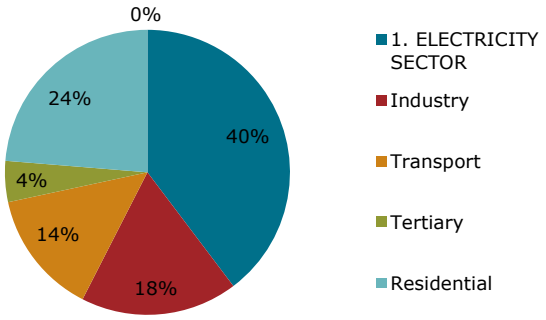
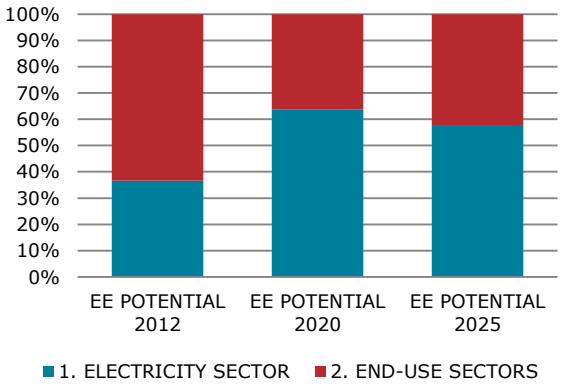


Figure 58: Kuwait EE Potential 2012-2025



4.7 Lebanon

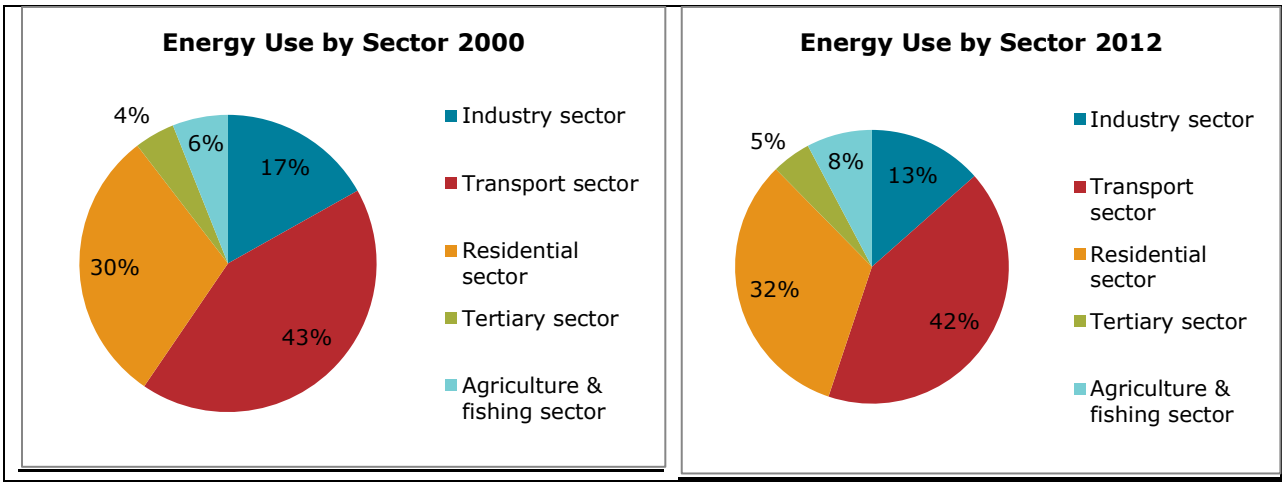
4.7.1 Overview of Energy Supply and Demand

Lebanon is one of the two MENA countries under review that does not have energy production from conventional sources through 2012. Energy was produced solely from hydro power and renewable sources, at a value of 87 ktoe in 2012, compared to 39 ktoe in 2000. Energy production from combustible renewable and waste amounted to 119 ktoe in 2012, compared to 130 ktoe in 2000, and geothermal and solar amounted to 20 ktoe in 2012, compared to 4 ktoe in 2000. Lebanon imports coal, oil products, and electricity, amounting to 7,190 ktoe in 2012. The largest quantities in 2012 are for oil products at 6,997 ktoe (97 percent of total imports), 165 ktoe for coal (about 2 percent) and 28 ktoe for electricity. Lebanon does not export energy products.

Total primary energy available for consumption was about 7,149 ktoe in 2012, compared to 4,906 ktoe in 2000, comprising mainly of oil products, coal, hydro power, renewable electricity, and combustible renewable and waste. Total electricity generated was about 1,275 ktoe in 2012, increasing by almost 52 percent from 2000.

Final energy consumed for 2012 was 4,386 ktoe, compared to 3,289 ktoe in 2000. In 2006, Israel launched a one-month war on Lebanon, affecting the energy sector by striking a power plant and industries, causing a decrease in the total energy available for consumption and energy consumed during that year. Transport sector was the largest energy-consuming sector, with 43 percent in 2000 and growing to 42 percent of total energy available for consumption in 2012 at 1,839 ktoe. Residential was the second most energy-consuming sector in 2000 at 30 percent and increased to 32 percent in 2012 at 1,434 ktoe. The industry sector decreased from 17 percent of total energy consumption to 13 percent in 2012 at 595 ktoe. Finally, tertiary, and agriculture and fishing sectors consumed 4 and 6 percent, respectively, in 2000 and increased to consume 5 and 8 percent in 2012, at 342 ktoe and 204 ktoe, respectively.

Figure 59: Lebanon Energy Use by Sector, 2000 and 2012, Percentage



4.7.2 Energy Demand Outlook, 2020

Final energy consumption by sectors will reach 5,271 ktoe in 2020, while electricity generation will reach 19,180 GWh in 2020, up from 14,826 GWh in 2012.

Transport consumed 42 percent of energy, residential 35 percent, industry 12 percent, tertiary 5 percent, and agriculture and fishing 6 percent.

In physical units, the transport sector amounted to 2,197 ktoe in 2020 (compared to 1,839 ktoe in 2012); 1,825 ktoe for residential (compared to 1,434 ktoe in 2012); 298 ktoe for agriculture and fishing sector (compared to 342 ktoe in 2012); 255 ktoe for tertiary (compared to 204 ktoe for 2012); and 629 ktoe for the industrial sector (compared to 595 ktoe in 2012).

Figure 60: Lebanon Energy Use by Sector 2020

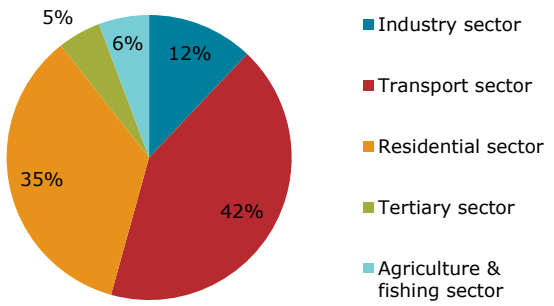
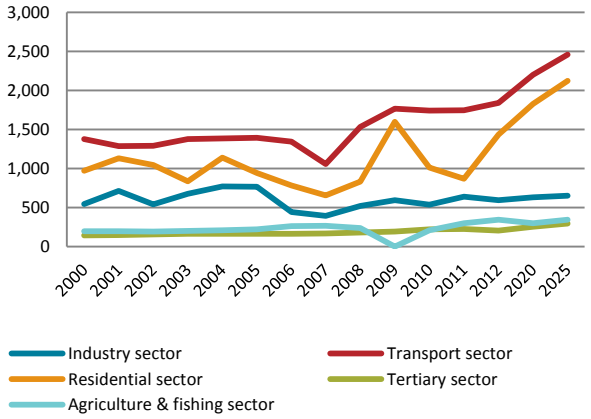


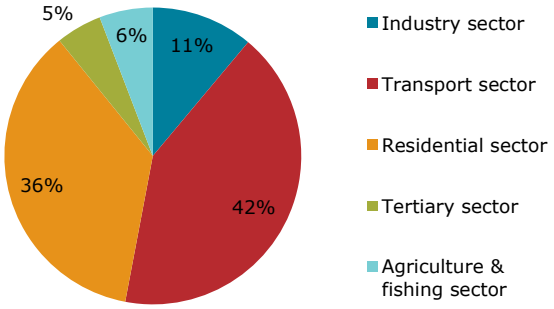
Figure 61: Lebanon Final Energy Consumption for End-Use Sectors, ktoe



4.7.3 Energy Demand Outlook 2025

Electricity generation will reach 22,530 GWh in 2025, compared to 14,826 GWh in 2012. Total energy consumption by sectors is estimated to reach 5,927 ktoe, allocated as follows: 2,456 ktoe for transport, 2,122 ktoe for residential, 342 ktoe for agriculture and fishing, 293 for tertiary, and 651 ktoe for industry sector.

Figure 62: Lebanon Energy Use by Sector 2025

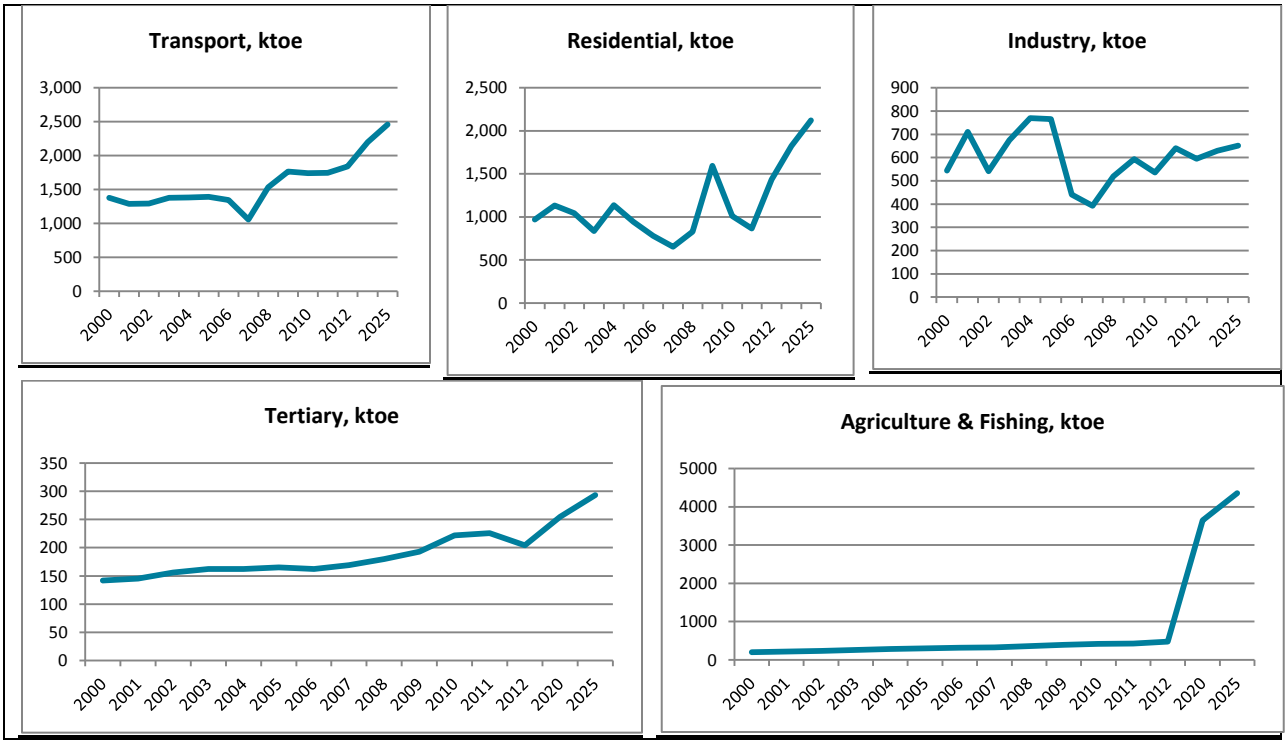


Energy-consuming sectors are estimated to evolve as follows: transport sector to stabilize at 42 percent in 2012 and 2025, residential sector to increase from 32 percent in 2012 to 36 percent in 2025, industry sector to decrease from 13 percent in 2012 to 11 percent in 2025, the agriculture and fishing sector to grow by 2 percent in 2025, and the tertiary sector to stabilize at 5 percent.

Comparing the estimated energy consumption in 2000, the transport sector will grow from 1,377 ktoe to 2,456 ktoe in 2025, the residential sector to increase from 969 ktoe to 2,122 ktoe, the agriculture and fishing sector to increase from 195 ktoe to 342 ktoe, the tertiary

sector from 142 ktoe to 293 ktoe, and the industry sector will increase from 544 ktoe to 651 ktoe.

Figure 63: Lebanon Energy Consumption Trends by Sector



4.7.4 Energy Efficiency Potential

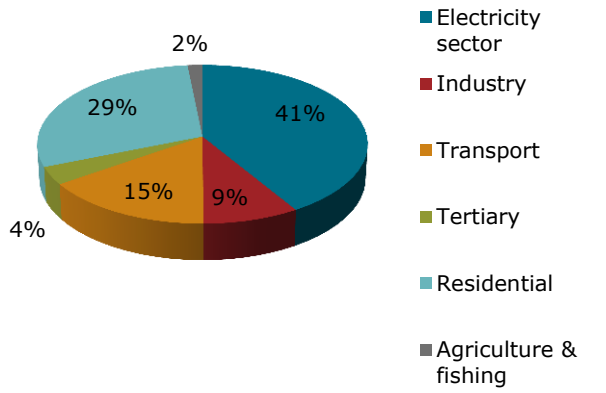
Total primary energy supplied in Lebanon amounted to 7,149 ktoe in 2012, compared to 4,906 ktoe in 2000, of which 61 percent was consumed by end-use sectors.

The total EE potential in 2012 for Lebanon was 1,818 ktoe,[19] of which 41 percent was for the electricity sector and 59 percent for end-use sectors. In the end-use sector, the highest EE potential was estimated to be residential at 537 ktoe, followed by transport at 280 ktoe, industry at 157 ktoe, tertiary at 66 ktoe, and agriculture and fishing at 29 ktoe. The EE potential consisted of 25 percent of total primary energy supplied in 2012.

Table 24: Lebanon EE Potential ktoe, 2012

Sector	EE potential, ktoe, 2012
Electricity Sector	**751**
End-Use Sectors	**1,067**
Industry	157
Transport	280
Residential	537
Tertiary (2011)	66
Agriculture and Fishing	29
TOTAL	**1,818**
	25% of TPES

Figure 64: Lebanon EE Potential, 2012



4.7.4.1 Electricity Generation

Total electricity generated in Lebanon in 2012 was 1,275 ktoe, with an average annual increase of 3.3 percent from 2000. The power generation efficiency in the country was estimated at 33 percent in 2012, excluding electricity imports. The country-tailored benchmark was set at 50 percent, which estimated the EE potential at 649 ktoe in 2012. The specific consumption of power generation was 235 toe/GWh in 2012.

The total transmission and distribution electricity losses amounted to 45 percent in 2012. However, according to PWMSP, 26 percent of the losses were due to non-payment of electricity bills, while the technical distribution losses were estimated at 14 percent and transmission losses at 5 percent. Using the sub-regional benchmark of 3 percent for transmission losses and 8 percent for distribution losses, the transmission and distribution EE potential was 102 ktoe, of which 26 ktoe for transmission and 76 ktoe for distribution.

The total EE potential for the electricity sector, in terms of primary energy, was 751 ktoe for 2012.

[19] Estimations for electricity sector are in terms of primary energy, estimations for transport and agriculture and fishing sectors are in terms of final energy, while estimations for industry, residential and tertiary sectors are in terms of primary and final energy.

4.7.4.2 End-Use Sectors

i. Industry

The final energy intensity of the industry sector was 0.099 toe/1,000 USD in 2012. The EE potential for the industry sector in terms of final energy was 82 ktoe using the country-tailored benchmark of 0.085 based on the structure of the industry sector, its evolution, and other country performances. The EE potential consisted of 14 percent of the total energy consumed by the industry sector in 2012.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 74 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 157 ktoe.

The average emission factor of the industry sector amounted to 9.9 teCO_2/toe in 2012, while the CO_2 intensity was 0.98 teCO_2/1,000 USD for the same year.

ii. Transport

The final energy intensity of the transport sector, including road transportation only, amounted to 0.06 toe/1,000 USD in 2012, while the average energy unit consumption of cars amounted to 793 kgoe/car/yr. The inaccuracy of data has led to estimating the EE potential, in terms of final energy, at 20 percent of total energy consumed by the sector in 2012, which corresponds to 280 ktoe.

The average emission factor for this sector was 2.9 teCO2/toe in 2012, while the CO2 intensity of the sector was 0.17 teCO2/1,000 USD in the same year (compared to 0.22 in 2000), and a motorization rate of 2.22 persons per vehicle.

iii. Tertiary

The final energy intensity of the tertiary sector amounted to 0.013 toe/1,000 USD in 2011. The country-tailored benchmark of 0.012 toe/1,000 USD based on the Plan Bleu study estimates the EE potential for the tertiary sector in terms of final energy to be 25 ktoe in 2011.

In addition, the final electricity efficiency potential of the sector converted into primary energy was 41 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 66 ktoe.

The average emission factor was 7.8 teCO_2/toe in 2012, while the CO_2 intensity of the sector amounted to 0.1 teCO_2/1,000 USD the same year.

iv. Residential

The EE potential, in terms of final energy, was 347 ktoe in 2012, using the specific consumption of energy per unit area (8.18 kgoe/m^2/yr for 2010), the country-tailored benchmark (which is 6.2 kgoe/m2/yr based on the Plan Bleu study), and total energy consumed by the sector in 2012. The energy intensity of the residential sector was 0.055 toe/1000 USD, compared to 0.051 toe/1,000 USD in 2000.

In addition, the final electricity efficiency potential of the sector converted in primary energy was equivalent to 190 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 537 ktoe.

The unit consumption of energy per dwelling was 1,273 kgoe/Dw in 2012, an increase of 42 percent from 2000. On the other hand, the average emission factor of the residential sector was 0.6 $teCO_2$/toe in 2011 and the CO_2 intensity was 0.03 $teCO_2$/1,000 USD.

v. Agriculture and Fishing Sector

The final energy intensity of agriculture was 0.179 toe/1,000 USD in 2012. Due to lack of data for the energy intensity of fishing, the total EE potential for the agriculture and fishing sector, in terms of final energy, was estimated at 29 ktoe in 2012 using the country benchmark based on estimations.

4.7.5 Energy Efficiency potential 2020 and 2025

The technical EE potential projected for 2020 and 2025 is 2,242 ktoe and 2,434 ktoe, respectively. The EE potential was projected based on the annual sectoral variation for 2000 to 2012. Based on the projected values of 2025, the total EE potential represents 33 percent of TPES. Figure 65 shows the percentages of the subsectors with their projected EE potential, while Figure 66 shows the variation of the EE potential for 2012, 2020, and 2025.

Figure 65: Lebanon Projected EE Potential, 2025

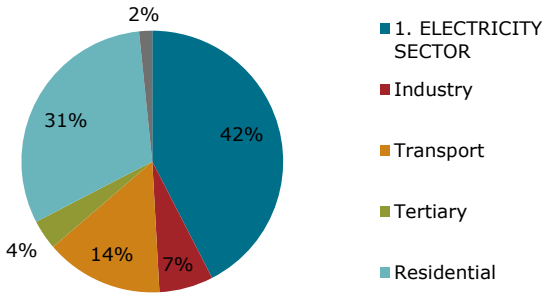
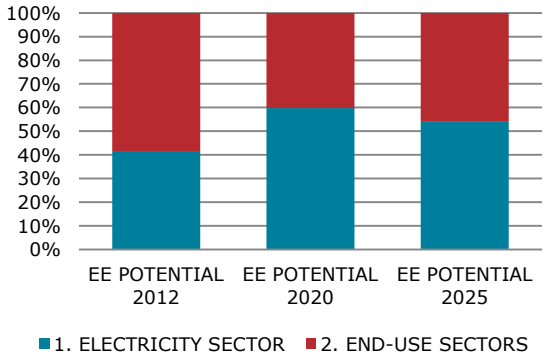


Figure 66: Lebanon EE Potential 2012-2025



4.7.6 Cost of conserved energy

Table 25 below lists the available data related to the electricity efficiency potential abatement cost curve for Lebanon in 2020. It provides a combined estimation of electricity efficiency potential and net abatement cost by end-use sectors for a set of EE technologies.

The total cost-effective electricity efficiency potential (93 ktoe) accounts for a significant share reaching 39 percent of the total identified electricity efficiency potential. With almost 1,400 ktoe, the residential sector accounts for almost 51 percent of the total the electricity efficiency potential followed by the industrial sector representing 38 percent and tertiary only 12 percent. In terms of technologies, efficient lighting and housekeeping in the residential sector represent together over 51 percent followed by efficient compressed air at 38 percent. SWH accounts here for a marginal share of 2 percent in the electricity efficiency potential but is not covered in the residential sector.

The needed annual investment cost to realise this electricity efficiency potential is estimated to 5.8 million USD, mostly in the residential sector with 70 percent. Over the period 2012 to 2020, the total investment cost of USD 46.4 million is largely compensated by the net (negative) abatement cost of USD 2,300 million.

Table 25: Electricity Efficiency Potential Abatement Investment Costs by End-Use Sectors and EE Technologies for Lebanon over the Period 2012-2020

Sectors/EE technologies	**Electricity Efficiency Potential**		**Investment Cost (3)**		**Net abatement cost (2)**
	Total of subsector (1)	By EE technology (2)			
	ktoe/y	ktoe/y	USD/toe	M USD/y	M USD/y
Industry	**45,4**	**35,0**			**-70,3**
Efficient compressed air		35,0	220	7,7	-70,3
Tertiary	**29,7**	**9,6**		**1,6**	**-90,6**
SWH*		9,6	170	1,6	-90,6
Residential	**139,2**	**48,4**		**4,1**	**-217,6**
Housekeeping		24,5	120	2,9	-100,5
Efficient lighting		23,9	50	1,2	-117,1
TOTAL	**214,3**	**93,1**		**5,8**	**-378,6**
Total without SWH		**83,4**		**4,1**	**-288,0**
% of total Electricity Efficiency Potential		**38,9%**			
Notes:					
* SWH is not listed in the EE potential estimation by subsector but covered here					
Sources:					
(1) Study estimations for 2020 based on 2012-2020 annual variation (see Task on EE potential)					
(2) Data for 2020. Budget Allocation Chart (BAC), MED-ENEC and MED-EMIP, 2010					

(3) *Energy efficiency in Building sector of the South Mediterranean countries*, Plan Bleu, 2012

Table 26: Electricity Efficiency Potential and Net Abatement Cost by EE technologies for Lebanon over the Period 2012-2020

Sectors/EE technologies	Electricity Efficiency Potential	Net abatement cost
	ktoe/y	M USD/y
Efficient compressed air	35,0	-70,3
SWH	9,6	-90,6
Housekeeping	24,5	-100,5
Efficient lighting	23,9	-117,1
TOTAL	**93,1**	**-378,6**

4.7.7 Reductions in energy expenditures and avoided investment

The main results in terms of sectoral and technology reductions in electricity expenditures and avoidable electricity capacity investments are presented in Table 27.

Table 27: Reductions In Electricity Expenditures and Avoided Power Investments for Lebanon over the Period 2012-2020

Sectors/EE technologies	Electricity Efficiency Potential		Reductions in electricity expenditures (a)	Avoidable electricity capacity investments (b)	
	Total of subsector (1)	By EE technology (2)	M USD/y	MW	M USD (c)
	ktoe/y	ktoe/y			
Industry	**45,4**	**35,0**	**64,5**	**79,0**	**87,0**
Efficient compressed air		35,0	51,8	62,0	68,2
Tertiary	**29,7**	**9,6**	12,7	17,1	18,8
SWH		9,6	**108,0**	**129,2**	**142,1**
Residential	**139,2**	**48,4**	71,7	85,7	94,3
Housekeeping		24,5	36,3	43,4	47,7
Efficient lighting		23,9	172,5	208,2	229,0
TOTAL	**214,3**	**93,1**	**148,9**	**181,9**	**200,0**
Total without SWH		83,4			

% of total Electricity Efficiency Potential	38,9%		8,1%	
Notes				
(a) based on average avoided electricity cost in 2020: low voltage: 0,098 €/kWh or 1,481 USD/toe; medium voltage: 0,087 €/kWh or 1,315 USD/toe (BAC Lebanon, 2020)				
(b) based on average electricity usage (hours/year)-without available data, hypothesis: similar to power plant time usage-around 5,000 h/y (2012)				
Power plant time usage: 6 566 (hours/year)				
(c) based on average investment cost of combined cycle (CCGT) of 850€/kW or 1,100 USD/kW (sources: IEA ETSAP, Fraunhofer Institut)				

The electricity efficiency potential would materialise for end-customers in a reduction of their electricity expenditures of USD 149 million every year over the period 2012-2020. On the power generation side, the electricity efficiency potential corresponds to an avoidable capacity of 182 MW or around 8 percent of Lebanon's existing installed power capacity (without private generation). Such avoided new investment on power capacities would be equivalent to USD 200 million (using CCGT technology). Cumulating both consumption and supply savings, Lebanon would then save every year above USD 350 million or 1.1% of its actual GDP at current price.

4.8 Libya

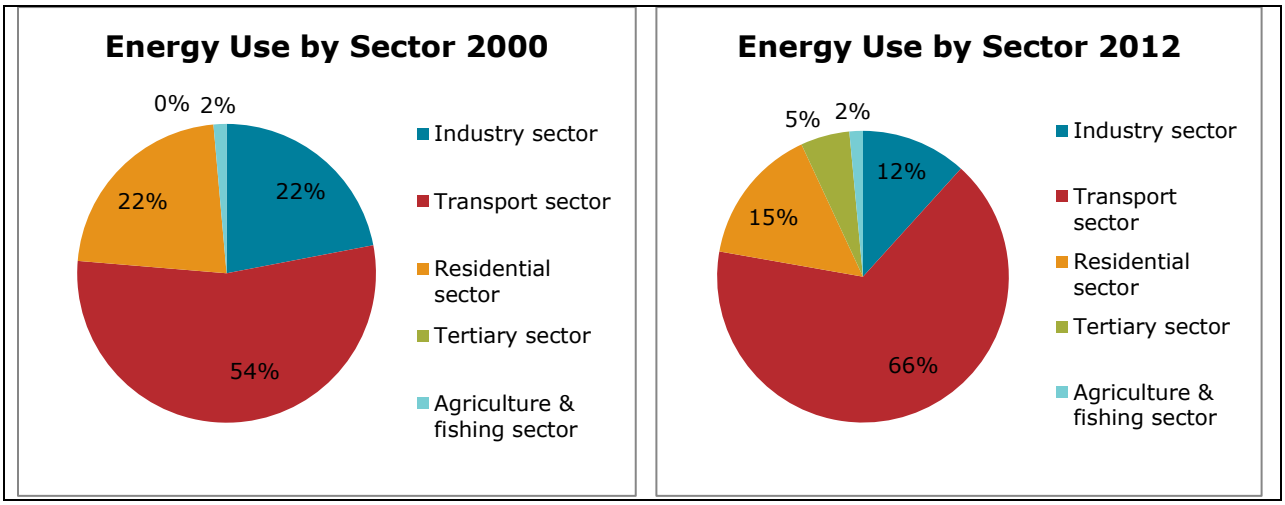
4.8.1 Overview of Energy Supply and Demand

Libya produces natural gas and crude oil, with a significantly higher proportion of crude oil. Most of the crude oil produced is exported (88 percent in 2012 compared to 73 percent in 2000). Libya imports oil products and a relatively small quantity of electricity, while its exports include crude oil, natural gas, and oil products. It is worth mentioning that during the Libyan revolution in 2011, the oil industry witnessed a sudden drop in production and exports of crude oil and natural gas due to security issues. However, the sector quickly recovered in 2012 with the resumption of production and exports, albeit at a lower level than in 2010. Primary energy available for consumption in Libya amounted to 17,144 ktoe in 2012 compared to 15,903 ktoe in 2000.

The main fuels used for electricity generation are natural gas and oil products. Available data shows a steady increase in the use of natural gas between 2000 and 2012, where its use increased from 860 ktoe in 2000 to 3,401 ktoe in 2012. On the other hand, electricity generation doubled between in that period to reach 2,922 ktoe.

Final energy consumed in Libya by end-use sectors depends on oil products, electricity, and natural gas. Although the variation is minimal between 2000 and 2012 (9,388 ktoe in 2000 and 10,461 ktoe in 2012), we can say that the political situation shift in 2011 had a significant impact on the energy use sector. Figure 67 shows the variation between the various sectors and their energy consumption intensity between 2000 and 2012. The largest energy-consuming sector in Libya was the transport sector (increasing from 54 percent in 2000 to 66 percent in 2012), followed by residential (decreasing from 22 percent to 15 percent in 2012), industrial (decreasing from 22 to 12 percent in 2012) and tertiary and agriculture and fishing sectors representing 5 and 2 percent, respectively.

Figure 67: Libya Energy Use by Sector, 2000 and 2011, Percentage



4.8.2 Energy Demand Outlook, 2020

Total energy consumption will decrease from 10,461 ktoe in 2012 to 10,220 in 2020. Electricity generation is projected to increase during the same period to reach 55,090 GWh.

Energy consumption by end-use sectors will be allocated in 2020, as follows: 76 percent for transport, 10 percent for residential, 8 percent for industrial, 5 percent for tertiary, and 1 percent for agriculture and fishing.

The transport sector is estimated to consume a total of 7,451 ktoe in 2020 (compared to 5,642 ktoe in 2012), residential 1,033 ktoe (compared to 1,307 ktoe in 2012), industrial 779 ktoe (compared to 1,001 ktoe in 2012), tertiary 524 ktoe (compared to 464 ktoe for 2012) and agriculture and fishing 65 ktoe (compared to 128 ktoe in 2012).

4.8.3 Energy Outlook 2025

Energy consumption by the end-use sectors is estimated to increase slightly between 2012 and 2025, from 10,461 ktoe to 11,652 ktoe, while electricity generation is estimated to increase during the same period to 74,512 ktoe.

A large shuffle in the sectoral breakdown of energy consumed in Libya is estimated to occur by 2025. The energy consumption of the transport sector is expected to increase by 4 percent in 2012, industrial and residential sectors to decrease by 2 percent each, and tertiary and agriculture and fishing sector are to remain stable.

Figure 68: Libya Energy Use by Sector 2020

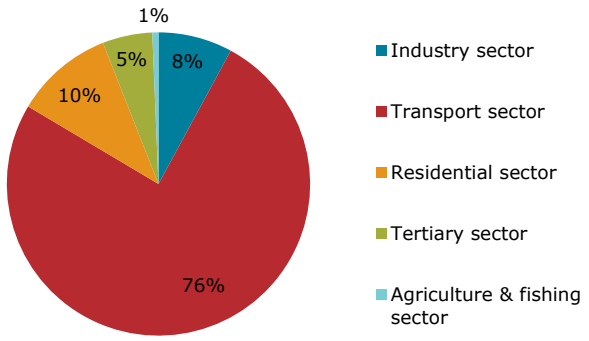


Figure 69: Libya Final Energy Consumption for End-use Sectors, ktoe

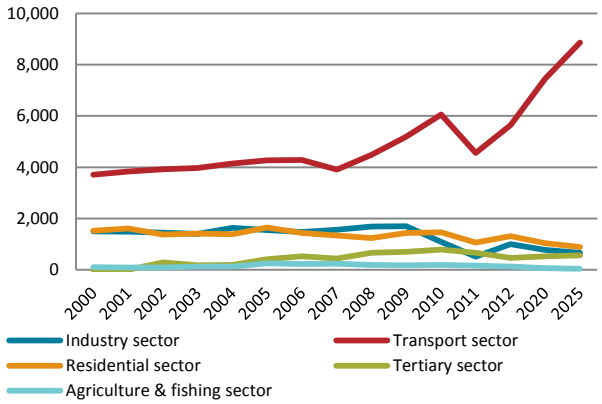
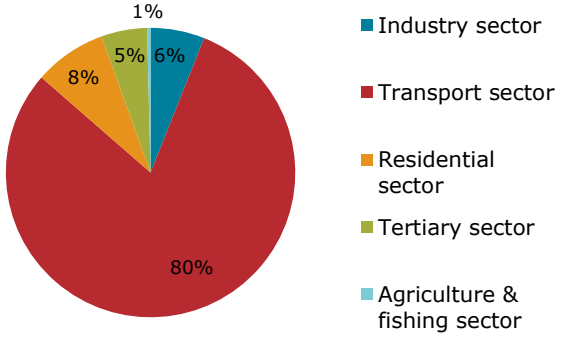


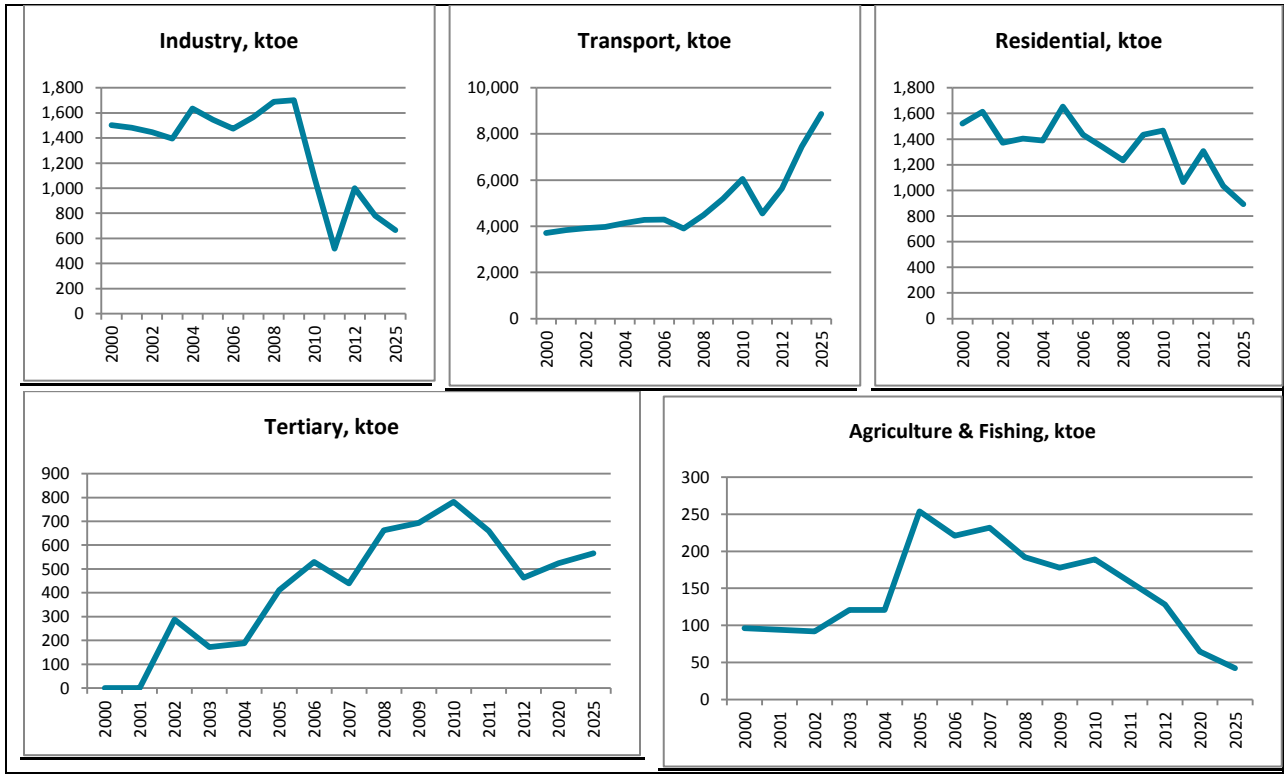
Figure 70: Libya Energy Use by Sector 2025



In terms of energy consumption in physical units, the transport sector will slightly increase from 5,642 ktoe in 2012 to 8,866 ktoe in 2025. The industry sector energy consumption will decrease from 1,001 ktoe in 2012 to 667 ktoe in 2025, and the residential sector will also

decrease from 1,231 to 961 ktoe. The tertiary sector will increase from 464 ktoe to 565 ktoe in 2025 and the agriculture and fishing sector will decrease from 128 to 42 ktoe.

Figure 71: Libya Energy Consumption Trends by Sector



4.8.4 Energy Efficiency Potential

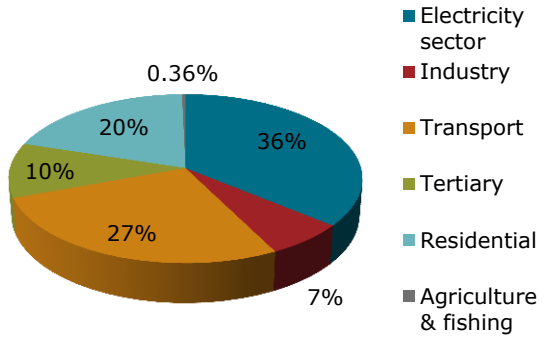
Total primary energy supplied amounted to 17,144 ktoe in 2012, compared to 15,903 ktoe in 2000, of which 61 percent was consumed by end-use sectors.

The total EE potential for Libya for 2012 was 3,650 ktoe,[20] of which 36 percent was for the electricity sector and 64 percent for the end-use sectors. The highest EE potential in the end-use sectors was transport at 27 percent, followed by residential at 20 percent, tertiary at 10 percent, industry at 7 percent, and agriculture and fishing at 0.4 percent.

Table 28: Libya EE Potential, ktoe, 2012

Sector	EE Potential, ktoe, 2012
Electricity Sector	**1,313**
End-Use Sectors	**2.336**
Industry	239
Transport	982
Residential	720
Tertiary	383
Agriculture and Fishing	13
TOTAL	**3,650**
	21% of TPES

Figure 72: Libya EE Potential, 2012



4.8.4.1 Electricity Generation

Total electricity generation amounted to 2,922 ktoe in 2012, at an annual increase of 6.2 percent since 2000. Power generation efficiency was 37 percent for 2011. The country-tailored benchmark was set at 49 percent based on the sector situation, hypothesis (switch of oil-fuelled steam and CC plants to CCGT with 60 percent efficiency), and international references, which estimated the EE potential of 874 ktoe. The specific consumption of power generation was 207 toe/GWh in 2012.

The transmission and distribution electricity losses were 26 percent for 2012, with 8 percent for the losses of transmission and 18 percent for distribution losses. Sub-regional benchmarks were used to estimate the EE potential for the transmission losses at 146 ktoe in 2012 and 293 ktoe for distribution losses during the same year.

The EE potential for the electricity sector was estimated, in terms of primary energy, at 1,313 ktoe for 2012.

4.8.4.2 4.8.2 End-Use Sectors

i. Industry

The final energy intensity of the industry sector was 0.52 toe/1,000 USD in 2012. Due to lack of specific energy consumption of industries, the EE potential in terms of final energy, was 192 ktoe for 2012, using a country-tailored benchmark based on the structure of the

[20] Estimations for electricity sector are in terms of primary energy, estimations for transport and agriculture and fishing sectors are in terms of final energy, while estimations for industry, residential and tertiary sectors are in terms of primary and final energy.

sector, its evolution, and country performances. The EE potential consists of almost 19 percent of total energy consumed by the industry sector.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 47 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 239 ktoe.

The average emission factor was 3.7 $teCO_2$/toe in 2012, decreasing from 3.9 $teCO_2$/toe in 2000. The CO_2 intensity of the industry sector was 2 $teCO_2$/1,000 USD in 2012, compared to 3.2 $teCO_2$/1,000 USD in 2000.

ii. Transport

The EE potential in terms of final energy was 982 ktoe in 2012 for the transport sector (road transport data available only), using a benchmark based on Jordan's percentage of the EE potential for the transport sector. The EE potential consisted of 17 percent of total energy consumed by the transport sector in 2012.

The average emission factor was 2.91 $teCO_2$/toe in 2012 while the CO_2 intensity was 0.3 $teCO_2$/1,000 USD in 2012.

iii. Tertiary

The energy intensity of the tertiary sector was 0.042 toe/1,000 USD in 2012. The EE potential of the tertiary sector in terms of final energy, based on energy intensity, and the country-tailored benchmark from the Plan Bleu study, estimated the EE potential to be 130 ktoe in 2012, 28 percent of total energy consumed in the tertiary sector.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 253 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 383 ktoe.

iv. Residential

The energy intensity of the residential sector amounted to 0.094 toe/1,000 USD in 2012 and the specific consumption of energy per unit area was 13.1 kgoe/m^2/yr in 2012. Using the specific consumption of energy per unit area and the country-tailored benchmark set by the Plan Bleu study, the EE potential for the residential sector, in terms of final energy, was 452 ktoe, 35 percent of total energy consumed by the residential sector.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 270 ktoe. This added to the EE potential in final energy estimated the total EE potential for the sector at 722 ktoe.

The unit consumption of energy per dwelling was 1,182 kgoe/Dw (down from 1,688 kgoe/Dw in 2000) while the unit consumption of electricity per dwelling amounted to 4,229 Kwh/Dw in 2012. The average emission factor was 4.9 $teCO_2$/toe in 2012 while the CO_2 intensity was 0.5 $teCO_2$/1,000 USD the same year.

v. Agriculture and Fishing Sector

The EE potential of the agriculture and fishing sector in terms of final energy was 13 ktoe in 2012, using the energy intensity of agriculture of 0.22 toe/1,000 USD in 2010, a country-tailored benchmark based on estimations at 0.2 toe/1,000 USD, and energy consumption of

the sector for 2012. Data for fishing was not available to inform in the EE potential for Libya. The EE potential represented 10 percent of total energy consumed by the agriculture and fishing sector in 2012.

4.8.5 Energy Efficiency Potential 2020 and 2025

The technical EE potential projected for 2020 and 2025 was 4,409 ktoe and 5,125 ktoe, respectively. The EE potential was based on the annual sectoral variation for 2000 to 2012. Based on the projected values of 2025, the total EE potential represents 37 percent of total TPES. Figure 73 shows the percentages of the subsectors with their projected EE potential while Figure 74 shows the variation of the EE potential for 2012, 2020, and 2025.

Figure 73: Libya Projected EE Potential, 2025

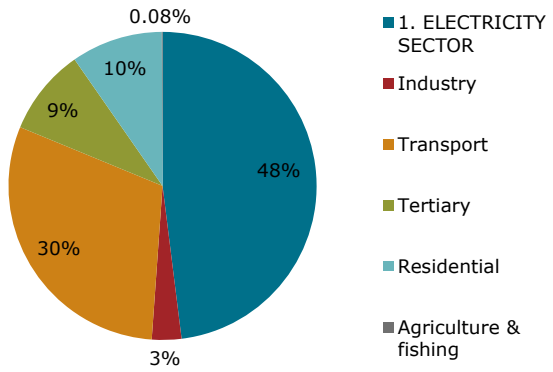
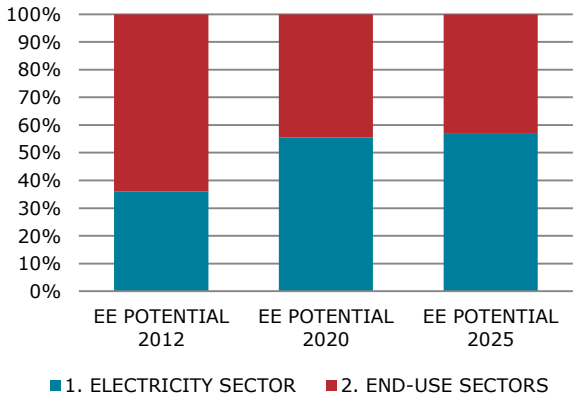


Figure 74: Libya EE Potential 2012-2025



4.9 Morocco

4.9.1 Overview of Energy Demand and Supply

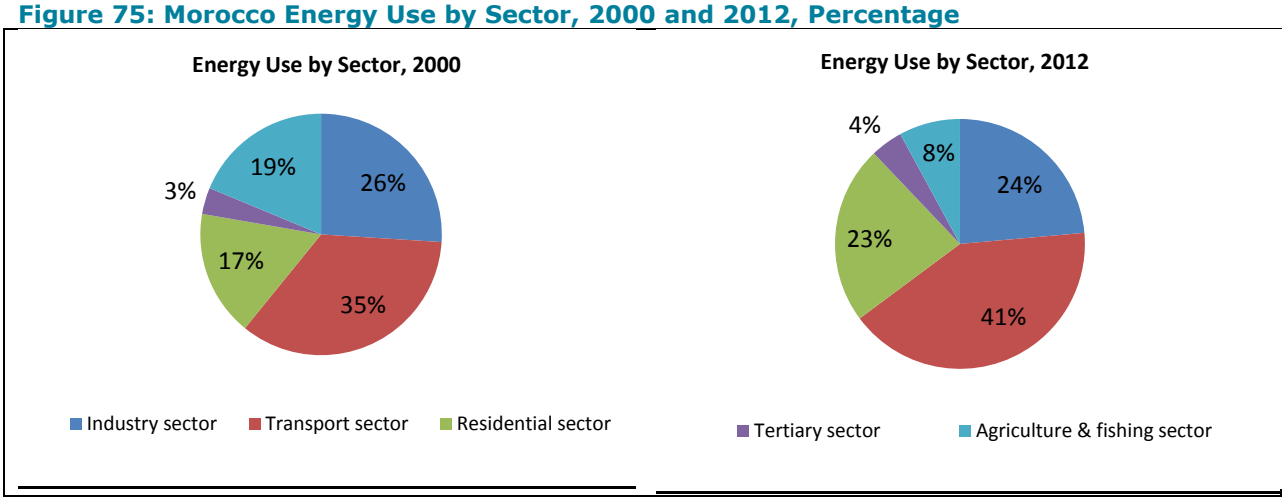
Total energy production in Morocco was 285 ktoe in 2012, mainly from natural gas, crude oil, hydropower, and renewable electricity. The country heavily relies on imports of coal, natural gas, crude oil, oil products, and electricity. Total imports amounted to 19,301 ktoe in 2012, compared to 11,282 ktoe in 2000. The largest imports are those of oil products, amounting to almost 48 percent of total imports in 2012, followed by crude oil at 28 percent, 16 percent for coal, 5.7 percent for natural gas, and 2.5 percent for electricity. The country exported oil products only during the period under review, where exports decreased from 1,472 ktoe in 2000 to 1,056 ktoe in 2012.

In 2012, fuel input for electricity generation came from coal (54 percent of total fuel consumed for electricity generation), from oil products (28 percent), and from natural gas (18 percent).

Final energy consumed amounted to 14,032 ktoe in 2012, an increase of 80 percent from 2000. The most used energy by end-use sectors in 2012 was oil products at 75 percent, followed by electricity at 17 percent, natural gas at 0.5 percent, and coal at 0.1 percent.

The largest energy-consuming sector was the transport sector at a consumption rate of 5,334 ktoe in 2012, compared to 2,528 ktoe in 2000, followed by industry at 3,051 ktoe in 2012 compared to 1,887 ktoe in 2000; residential at 2,985 ktoe in 2012, compared to 1,224 ktoe in 2000; agriculture and fishing at 1,025 ktoe in 2012, compared to 1,359 ktoe; and tertiary at 540 ktoe in 2012, compared to 257 ktoe in 2000. Of the end-use sectors, 41 percent of total energy was consumed by the transport sector, 24 percent by industry, 23 percent by residential, 8 percent by agriculture and fishing, and 4 percent by tertiary.

Figure 75: Morocco Energy Use by Sector, 2000 and 2012, Percentage



4.9.2 Energy Demand Outlook, 2020

Total electricity generation will reach 43,480 GWh in 2020, compared to 27,337 GWh in 2012. Total energy consumption by end-use sectors is estimated to reach 21,115 ktoe in 2020 with the following distribution by sector: 44 percent for transport, 27 percent for residential, 21 percent for industry, and tertiary, and agriculture and fishing at 4 percent each.

The transport sector will consume 8,445 ktoe in 2020 compared to 5,334 ktoe in 2012, while residential will consume 5,167 ktoe in 2020 compared to 2,985 ktoe, industry consume 4,101 ktoe compared to 3,051 ktoe, and tertiary 853 ktoe compared to 540 ktoe. The agriculture and fishing sector is estimated to decrease consumption from 1,025 ktoe in 2012 to 862 ktoe in 2020.

Figure 76: Morocco Energy Use by Sector 2020

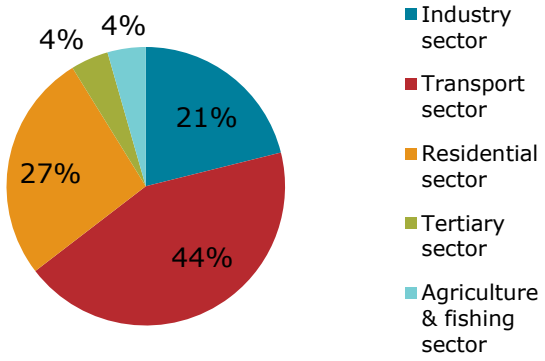
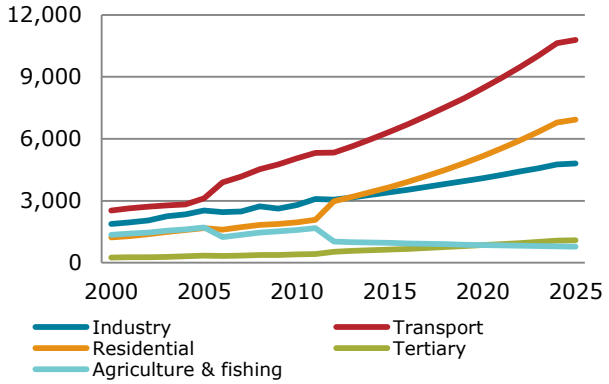


Figure 77: Final Energy Consumption for End-use Sectors

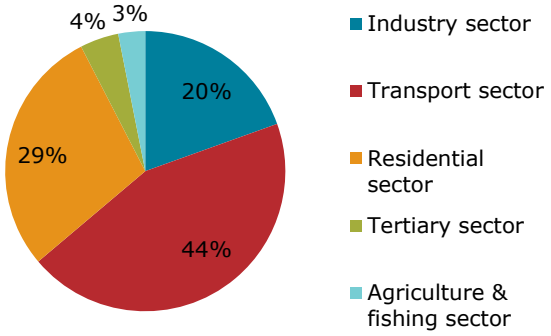


4.9.3 Energy Demand Outlook 2025

Energy consumption by end-use sectors is estimated to reach 27,226 ktoe in 2025, compared to 14,032 ktoe in 2012. Electricity generation is projected to reach 57,296 GWh in 2025, compared to 27,337 in 2012.

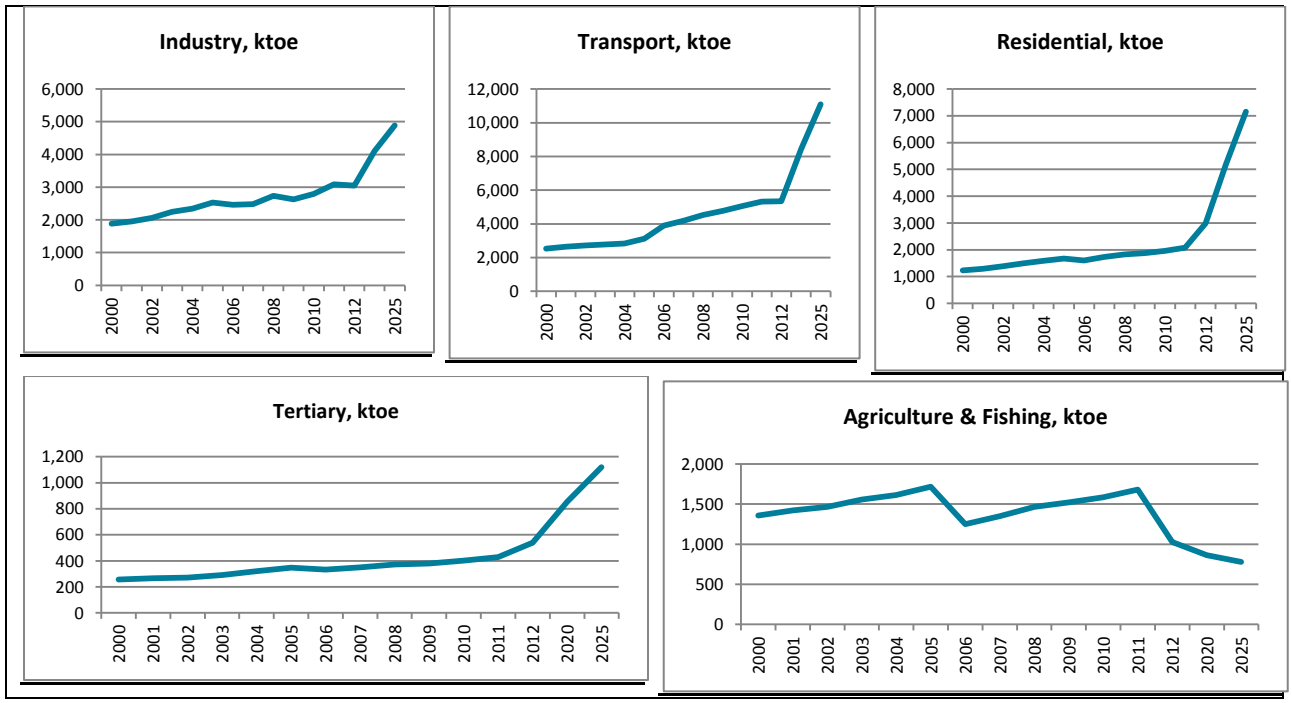
Sectoral energy consumption is expected to be distributed in 2025 as follows: 44 percent for transport (compared to 41 percent in 2012), 29 percent for residential (compared to 23 percent), 20 percent for industry (compared to 24 percent), 4 percent for tertiary (compared to 4 percent), and 3 percent for agriculture and fishing (compared to 8 percent).

Figure 78: Morocco Energy Use by Sector 2025



In physical units, total energy consumed in 2025 will be 11,099 ktoe for transport, 7,160 ktoe for residential, 4,888 ktoe for industry, 1,119 ktoe for tertiary, and 777 ktoe for agriculture and fishing. In 2012, sectoral energy consumption was 5,334 ktoe for transport, 3,051 ktoe for industry, 2,985 ktoe for residential, 1,025 ktoe for agriculture and fishing, and 540 ktoe for tertiary.

Figure 79: Morocco Energy Consumption Trends by Sector



4.9.4 Energy Efficiency Potential

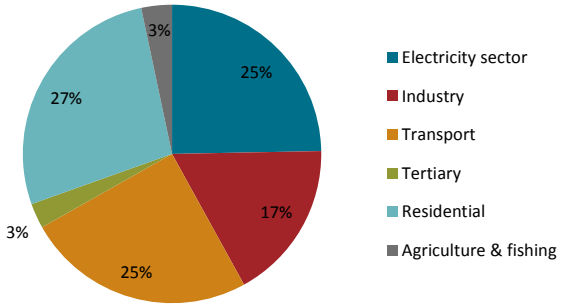
Total primary energy supplied increased from 9,689 ktoe in 2000 to 17,522 ktoe in 2012, with an annual increase of 4.7 percent, of which 80 percent was consumed by end-use sectors.

The total EE potential was 4,890 ktoe[21] in 2012, with 25 percent of EE potential for the electricity sector and 75 percent for the end-use sector. The EE potential represented 28 percent of total primary energy supply in 2012. The end-use sector with the most EE potential was the residential sector (27 percent), followed by the transport sector (25 percent), industry (17 percent), agriculture and fishing (3 percent) and tertiary (3 percent).

Table 29: Morocco EE Potential, ktoe, 2012

Sector	EE Potential, ktoe, 2012
Electricity Sector	**1,226**
End-Use Sectors	**3,738**
Industry	858
Transport (2011)	1,233
Residential	1,347
Tertiary	135
Agriculture and Fishing	165
TOTAL	**4,964**
	28% of TPES

Figure 80: Morocco EE Potential, 2012



4.9.4.1 Electricity Generation

Electricity generation amounted to 2,351 ktoe in 2012, at an annual variation of 6.0 percent since 2000. The power generation efficiency was 35 percent in 2012. Using a country-tailored benchmark of 56 percent, the EE potential was 1,160 ktoe for power generation in 2012. The specific consumption of power generation was 204 toe/GWh in 2012.

The transmission and distribution losses were 12.8 percent, of which 4 percent for transmission losses and 8.8 percent for distribution losses. A sub-regional benchmark was used for the transmission losses (3 percent) while a country-tailored benchmark was used for distribution losses based on the progress made in grid investment and management (7 percent). The EE potential was 66 ktoe for transmission and distribution losses in 2012, of which 24 ktoe for transmission and 42 ktoe for distribution losses, respectively.

The total EE potential for the electricity sector in terms of primary energy was 1,226 ktoe in 2012.

[21] Estimations for electricity sector are in terms of primary energy, estimations for transport and agriculture and fishing sectors are in terms of final energy, while estimations for industry, residential and tertiary sectors are in terms of primary and final energy.

4.9.4.2 End-Use Sectors

i. Industry

Final energy intensity of the industry sector was 0.167 toe/1,000 USD in 2012. A country-tailored benchmark based on the structure of the industrial sector, its evolution, and other country performances, was set at 0.135 toe/1,000 USD. This estimated the EE potential in terms of final energy at 578 ktoe for the industry sector, which represented 19 percent of total energy consumed by this sector. Out of the nine energy-intensive sectors, data was only available for cement, with the EE potential estimated at 266 ktoe in 2009.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 280 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 858 ktoe.

The average emissions factor of the industry sector was 4.8 teCO2/toe in 2012, compared to 4.2 teCO2/toe in 2000. In addition, the CO_2 intensity of the industry sector was 0.8 $teCO_2$/1,000 USD for 2012, a decrease of 9 percent from 2000.

ii. Transport

The final energy intensity of the transport sector was 0.07 toe/1,000 USD in 2011, while the average energy unit consumption of gasoline cars was 1,405 kgoe/car/yr in 2011 and 1,954 kgoe/car/yr in 2011. Using the EE regional benchmark based on three MENA countries and specific consumption of gasoline and diesel cars data, the EE potential in terms of final energy was 1,233 ktoe, with 289 ktoe for the average energy unit consumption of gasoline cars and 944 ktoe for the average unit consumption of diesel cars. The EE potential represented 23 percent of total energy consumed by the sector in 2011.

The average emissions factor for the transport sector was 2.9 teCO2/toe in 2011, while the CO2 intensity of the transport sector amounted to 0.2 $teCO_2$/1,000 USD for 2011. The motorization rate in Morocco was 15.3 persons per vehicle in 2011.

iii. Tertiary

The final energy intensity of the tertiary sector was 0.014 toe/1,000 USD in 2011. The country-tailored benchmark was 0.013, and the total energy consumed by this sector in 2012, the estimation of the EE potential, in terms of final energy, was 12 percent, or 65 ktoe for the tertiary sector.

In addition, the final electricity efficiency potential of the sector converted in primary energy was equivalent to 71 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 135 ktoe.

The average emission factor of the tertiary sector was 6.4 $teCO_2$/toe in 2011, while the CO_2 intensity of the sector was 0.1 $teCO_2$/1,000 USD the same year.

iv. Residential

The intensity of the residential sector was 0.046 toe/1,000 USD in 2011, while the specific consumption of energy per unit area at 4.02 kgoe/m2/yr, Based on the Plan Bleu study, a

country-tailored benchmark was set at 2.7, and the total energy consumed by this sector in 2012, the estimated EE potential in terms of final energy was 982 ktoe for the residential sector based on the specific consumption of energy.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 365 ktoe. This added to the EE potential in final energy, estimated as the total EE potential for the sector at 1,347 ktoe.

In Morocco, the consumption of energy per dwelling was 322 kgoe/Dw in 2011 while the consumption of electricity per dwelling was 1,305 Kwh/Dw. In addition, the CO_2 intensity of the residential sector amounted to 0.2 $teCO_2$/1,000 USD in 2011, while the average emission factor was 4.4 $teCO_2$/toe.

v. Agriculture and Fishing Sector

The EE potential for the agriculture sector was 146 ktoe in 2012, based on a country-tailored benchmark drawn from estimations and energy intensity of agriculture. This figure was 19 ktoe for 2010 for the fishing sector based on country-tailored benchmark and specific consumption for fishing. The total EE potential for the agriculture and fishing sector, in terms of final energy, was 165 ktoe in 2012.

4.9.5 Energy Efficiency Potential 2020 and 2025

The technical EE potential projected for 2020 and 2025 amounts to 7,770 ktoe and 10,362 ktoe, respectively. The EE potential was based on the annual sectoral variation for 2000 to 2012. Based on the projected values of 2025, the total EE potential represents 19 percent of TPES. Figure 81 shows the percentages of the subsectors with their projected EE potential, while Figure 82 shows the variation of the EE potential for 2012, 2020, and 2025.

Figure 81: Morocco Projected EE Potential, 2025

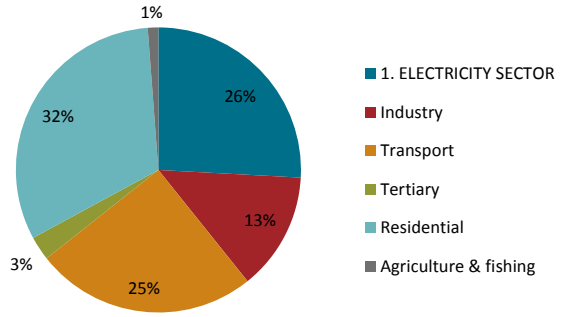
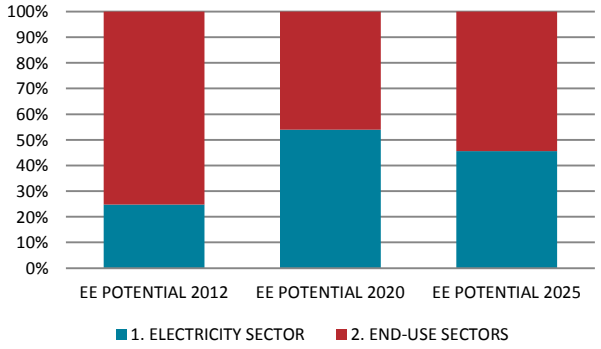


Figure 82: Morocco EE Potential 2012-2025



4.9.6 Cost of conserved energy

Table 30 below lists the available data on the electricity efficiency potential abatement cost curve for Morocco in 2020. It provides a combined estimation of electricity efficiency potential and net abatement cost by end-use sectors for a set of EE technologies.

The total cost-effective electricity efficiency potential (293 ktoe) accounts for 36 percent of the total identified electricity efficiency potential. The residential sector accounts for 47 percent of this total with 4 EE technologies and SWH. Tertiary with street lighting and SWH is the second largest sector with 30 percent followed by the industry with 23 percent (with only one technology: compressed air).

The needed annual investment cost to realise this electricity efficiency potential is estimated to USD 41 million, mostly in the residential sector with 46 percent. Compressed air would account for the largest share of this investment cost with 36 percent of total. Over the period 2012 to 2020, the total investment cost of USD 328 million is largely compensated by the net (negative) abatement cost of USD 3,116 million.

Table 30: Electricity Efficiency Potential Abatement Investment Costs by End-Use Sectors and EE Technologies for Morocco over the Period 2012-2020

Sectors/EE technologies	**Electricity Efficiency Potential**		**Investment Cost (c)**		**Net abatement cost (b)**
	Total of subsector (a)	By EE technology (b)			
	ktoe/y	ktoe/y	USD/toe	M USD/y	M USD/y
Industry	**263,5**	**67,9**		**14,9**	**-58,2**
Compressed air		67,9	220,0	14,9	-58,2
Tertiary	**66,4**	**87,7**		**7,0**	**-61,4**
Street lighting		67,1	**140,0**	**3,5**	-3,5
SWH*		20,6	170	3,5	-57,9
Residential	**343,6**	**137,4**		**19,0**	**-385,1**
Housekeeping		24,9	120	3,0	-76,4
Efficient lighting		30,9	120	3,7	-51,4
Efficient washing machines		24,1	170	4,1	-198,0
Efficient fridges		26,6	170	4,5	-2,1
SWH*		31,0	120	3,7	-57,2
TOTAL	**673,5**	**293,1**		**41,0**	**-504,7**
Total without SWH		**241,5**		**33,8**	**-389,6**
% of total Electricity Efficiency Potential		**35,9%**			
Notes					
* SWH is not listed in the EE potential estimation by subsector but covered here					
Sources					

(a) Study estimations for 2020 based on 2012-2020 annual variation (see Task on EE potential)
(b) Data for 2020. Budget Allocation Chart (BAC), MED-ENEC and MED-EMIP, 2010
(c) *Energy efficiency in Building sector of the South Mediterranean countries*, Plan Bleu, 2012

Table 31: Electricity Efficiency Potential and Net Abatement Cost by EE Technologies for Morocco over the Period 2012-2020

EE technologies	Electricity Efficiency Potential	Net abatement cost
	ktoe/y	M USD/y
Compressed air	67,9	-58,2
Street lighting	67,1	-3,5
SWH	20,6	-57,9
Housekeeping	24,9	-76,4
Efficient lighting	30,9	-51,4
Efficient washing machines	24,1	-198,0
Efficient fridges	26,6	-2,1
SWH (residential)	31,0	-57,2
TOTAL	**293,1**	**-504,7**

4.9.7 Reductions in energy expenditures and avoided investments

The main results in terms of sectoral and technology reductions in electricity expenditures and avoidable electricity capacity investments are presented in Table 32.

Table 32: Reductions in Electricity Expenditures and Avoided Power Investments for Morocco over the Period 2012-2020

Sectors/EE technologies	Electricity Efficiency Potential		Reductions in electricity expenditures (a)	Avoidable electricity capacity investments (b)	
	Total of subsector (1)	By EE technology (2)	M USD/y	MW	M USD (c)
	ktoe/y	ktoe/y			
Industry	**263,5**	**67,9**	**59,5**	**193,4**	**212,7**
Compressed air		67,9	59,5	193,4	212,7
Tertiary	**66,4**	**87,7**	**320,8**	**1 032,1**	**1 135,3**
Street lighting		67,1	58,8	190,9	210,0
SWH		20,6	18,1	58,8	64,6
Residential	**343,6**	**137,4**	120,4	391,2	430,3
Housekeeping		24,9	22,6	71,0	78,1

Efficient lighting		30,9	28,0	87,9	96,7
Efficient washing machines		24,1	21,8	68,5	75,4
Efficient fridges		26,6	24,1	75,6	83,2
SWH		31,0	27,1	88,1	96,9
TOTAL	**329,9**	**293,1**	**380,3**	**1 225,4**	**1 348,0**
Total without SWH		194,2			
% of total Electricity Efficiency Potential / Installed capacity		**58,9%**		18,3%	
Notes					
(a) based on average avoided electricity cost in 2020: low voltage: 0,06 €/kWh or 906 USD/toe; medium voltage: 0,058 €/kWh or 876 USD/toe (BAC Morocco, 2020)					
(b) based on average electricity usage (hours/year)-without available data, hypothesis: similar to power plant time usage-around 5,000 h/y (2012)					
Power plant time usage (hours/year): 4 085					
(c) based on average investment cost of combined cycle (CCGT) of 850€/kW or 1,100 USD/kW (sources: IEA ETSAP, Fraunhofer Institut)					

The table above indicates that the electricity efficiency potential for end-customers would be equivalent to an annual reduction of USD 380 million of their electricity bills over the period 2012-2020. On the power generation side, the electricity efficiency potential corresponds to an annual avoidable capacity of 1,225 MW (equivalent to the projected coal-fired power plant of Safi of 1,320 MW and thus to be one the largest in the country) or around 12 percent of Morocco's existing installed power capacity. Avoiding such new investment on power capacities would annually save USD 1,350 million (using CCGT technology). Cumulating both consumption and supply savings, Morocco would then save every year above USD 1,730 million or 1.9 percent of its actual GDP at current price.

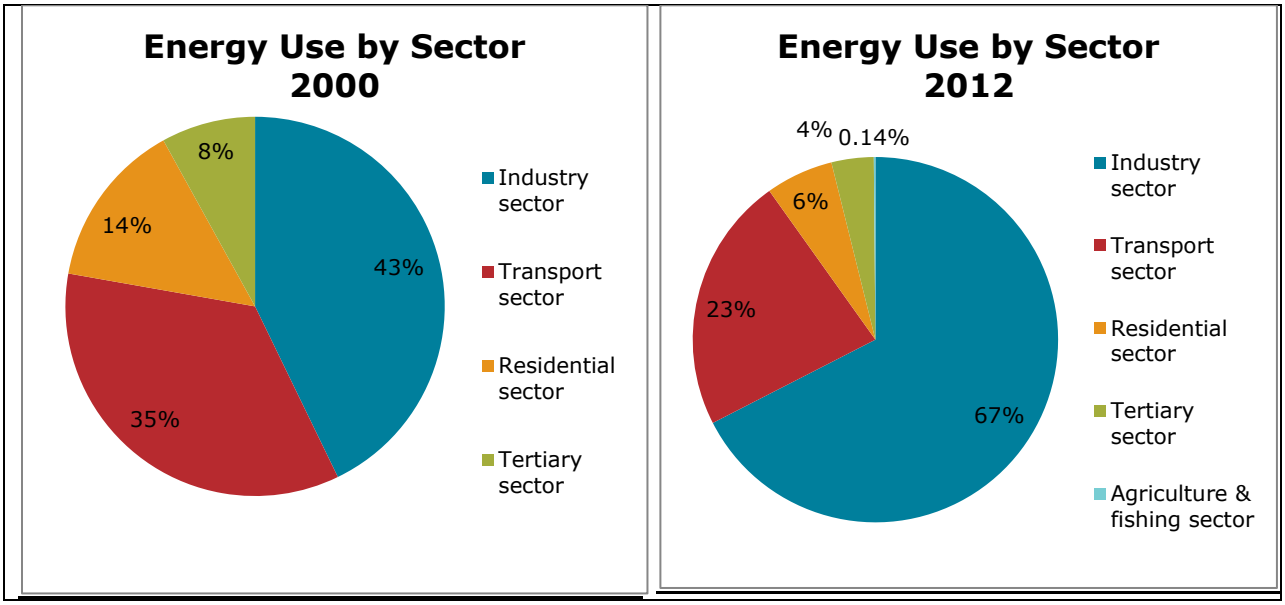
4.10 Oman

Total energy production was 75,774 ktoe in 2012, compared to 60,451 ktoe in 2000. Energy was produced from natural gas and crude oil sources, with 65 percent from crude oil and 35 from natural gas. Oman imported oil products only up through 2008, when the country started importing natural gas. Natural gas amounted to 1,735 ktoe in 2012. Eighty seven percent of the energy production was exported in 2000, a figure that decreased to 70 percent in 2012.

The main electricity-producing fuels are natural gas and oil products, with 98 percent from natural gas and 2 percent from oil products in 2012. Total electricity generated increased from 784 ktoe in 2000 to 2,151 ktoe in 2012.

Final energy consumption by end-use sectors increased from 2,614 ktoe in 2000 to 19,205 ktoe in 2012. In 2000, the largest energy-consuming sector was industry, followed by transport, residential, and tertiary, respectively. In 2012, the industry sector was the largest energy-consuming sector, followed by transport, residential, tertiary, and agriculture and fishing, respectively (Figure 83).

Figure 83: Oman Energy Use by Sector, 2000 and 2012, Percentage



4.10.1 Energy Demand Outlook, 2020

The distribution of energy consumption sectors for 2020 is as follows: 68 percent for the industry sector (compared to 67 percent in 2012), 24 percent for transport sector (compared to 23 percent), 5 percent for residential sector (compared to 6 percent), and 3 percent for tertiary sector (compared to 4 percent).

The total energy consumption by end-use sectors will increase from 19,205 ktoe in 2012 to 44,671 ktoe in 2020. The energy consumption by sector for 2020 will be 25,760 ktoe for industry, 9,094 ktoe for transport, 1,841 ktoe for residential, 1,221 ktoe for tertiary, and 48 ktoe for agriculture and fishing.

The generation of electricity will also increase, from 25,012 GWh in 2012 to 46,562 GWh in 2020.

Figure 84: Oman Energy Use by Sector 2020

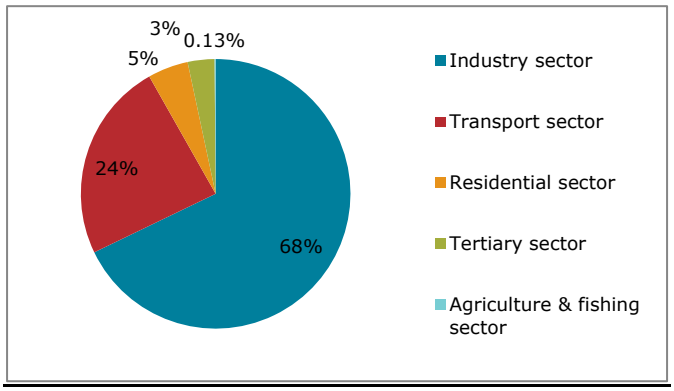
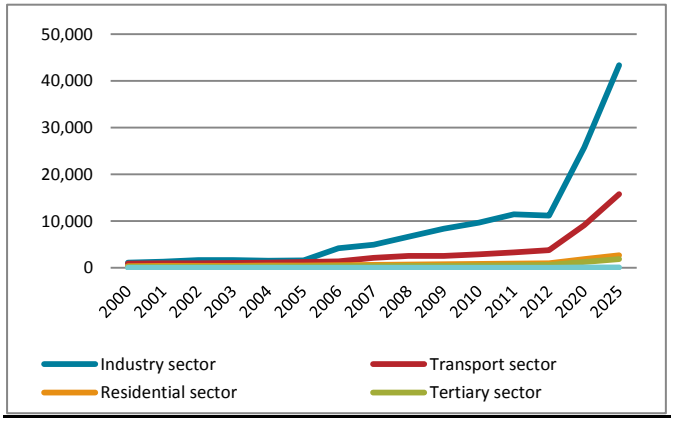


Figure 85 : Oman final Energy Consumption for End-use Sectors, ktoe



4.10.2 Energy Demand Outlook 2025

The total energy consumption by the end-use sector will reach 75,895 ktoe in 2025, compared to 19,205 ktoe in 2012, while electricity generation is estimated to reach 68,662 GWh in 2025.

The distribution of energy consumption by sectors is projected for 2025 to be 68 percent for industry, 25 percent for transport, 4 percent for residential, 3 percent for tertiary, and 0.12 percent for agriculture and fishing.

Total energy consumed for the transport sector is projected to reach 43,363 ktoe in 2025, compared to 11,196 ktoe in 2012, 15,786 ktoe for industry compared to 3,763 ktoe, 2,709 ktoe for residential compared to 993 ktoe, and 1,866 ktoe for the tertiary sector compared to 620 ktoe.

Figure 86: Oman Energy Use by Sector 2025

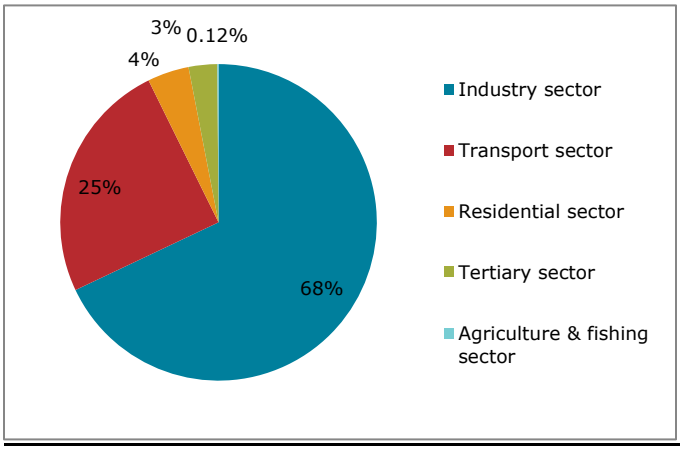
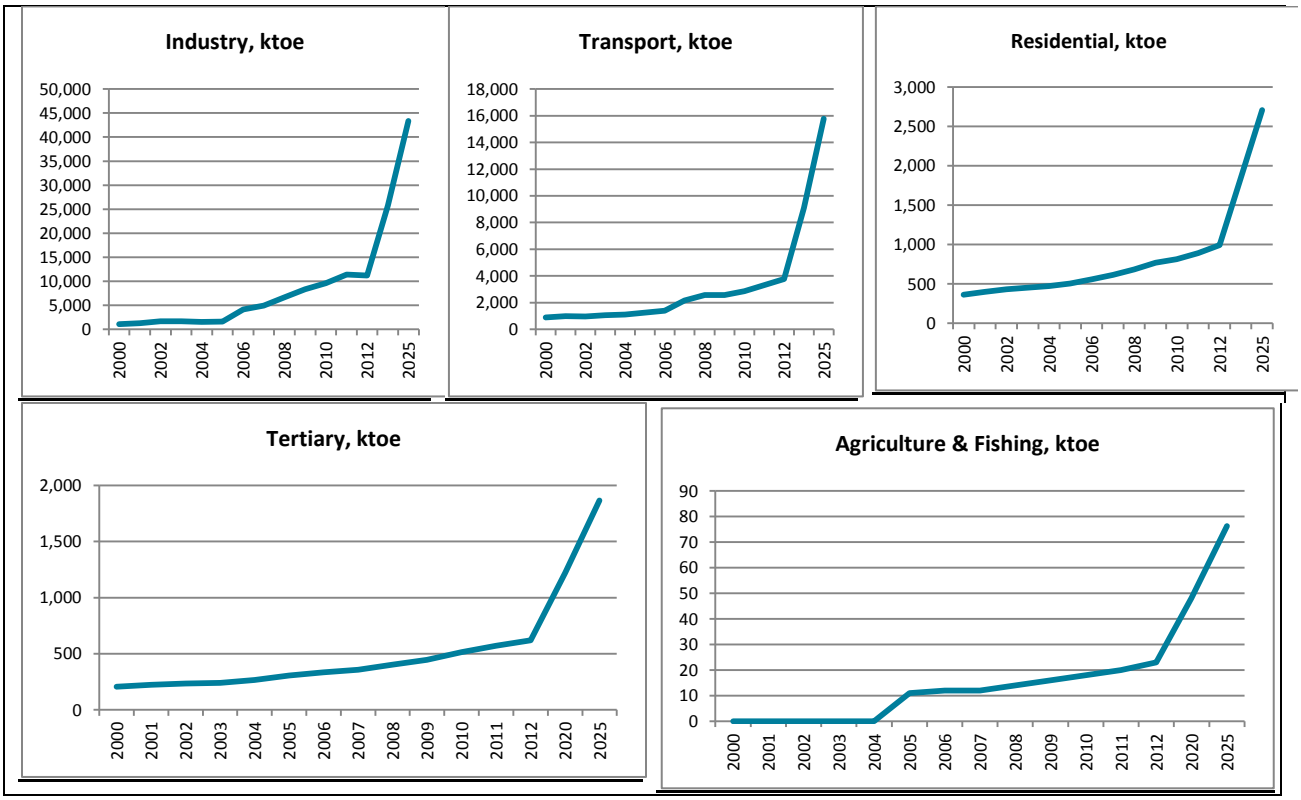


Figure 87: Oman Energy Consumption Trends by Sector



4.10.3 Energy Efficiency Potential

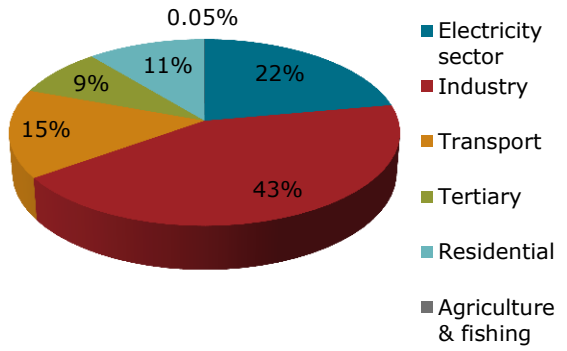
The total primary energy supplied in Oman was 26,320 ktoe in 2012, compared to 7,701 ktoe in 2000, a threefold increase during the above-mentioned period, of which 73 percent of energy was consumed by end-use sectors.

The total EE potential for Oman was 6,128 ktoe[22] in 2012, of which 22 percent was for the electricity sector and 78 percent for the end-use sector. The industry sector has the highest estimated EE potential at 43 percent, followed by transport at 15 percent, 11 percent for residential, 9 percent for tertiary, and 0.05 percent for agriculture and fishing. The total EE potential represented 23 percent of total primary energy supplied in 2012.

Table 33: Oman EE Potential, ktoe, 2012

Sector	EE potential, ktoe, 2012
Electricity Sector	**1,361**
End-Use Sectors	**4,767**
Industry	2,633
Transport	940
Residential	674
Tertiary	516
Agriculture and Fishing	3
TOTAL	**6,128**
	23% of TPES

Figure 88: Oman EE Potential, 2012



4.10.3.1 Electricity Generation

Total electricity generated in Oman increased from 784 ktoe in 2000 to 2,151 ktoe in 2012. The power generation efficiency amounted to 34 percent in 2012. A country-tailored benchmark was set at 52 percent based on the sector situation, hypothesis (switch of steam plants & GT to CCGT with 60 percent efficiency), and international references, which estimated the EE potential for power generation at 1,176 ktoe. The specific consumption of power generation was 256 toe/GWh in 2012.

The total transmission and distribution losses were calculated at 13.6 percent in 2012, with 4.5 percent for transmission losses and 9.1 percent for distribution losses. Based on the sub-regional benchmarks, the EE potential is 54 ktoe for transmission losses and 186 ktoe for distribution losses.

The total EE potential for the electricity sector, in terms of primary energy, was 1,361 ktoe in 2012.

4.10.3.2 End-Use Sectors

i. Industry

[22] Estimations for electricity sector are in terms of primary energy, estimations for transport and agriculture and fishing sectors are in terms of final energy, while estimations for industry, residential and tertiary sectors are in terms of primary and final energy.

The total energy intensity of the industry was 2.447 toe/1,000 USD in 2012. The EE potential in 2012, in terms of final energy, was 2,503 ktoe based on the country-tailored benchmark of 1.9 toe/1,000 USD and the energy intensity of the sector. The EE potential represented 22 percent of total energy consumed by the industry sector in 2012.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 130 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 2,633 ktoe.

The average emission factor for the sector was 2.7 $teCO_2$/toe in 2012, while the CO_2 intensity was 6.6 $teCO_2$/1,000 USD.

ii. Transport

The total EE potential for the transport sector, in terms of final energy, was 25 percent of total energy consumed by the sector, amounting to 941 ktoe in 2012. The average emissions factor of the sector was 2.9 $teCO_2$/toe while the CO_2 intensity of the sector was 0.24 $teCO_2$/1,000 USD in 2012.

iii. Tertiary

The energy intensity of the tertiary sector was 0.032 toe/1,000 USD in 2011. A country-tailored benchmark was set at 0.023 toe/1,000 USD, based on a regional study and building audits. The EE potential for the sector in terms of final energy was 174 ktoe, using energy consumed by the sector in 2012.

In addition, the final electricity efficiency potential of the sector converted in primary energy was equivalent to 343 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 516 ktoe.

The average emission factor of the sector was 10.9 $teCO_2$/toe in 2012 and the CO_2 intensity was 0.38 $teCO_2$/1,000 USD.

iv. Residential

The EE potential for the residential sector, in terms of final energy, was 25 percent of the total energy consumed by the sector at 248 ktoe in 2012, based on set of GCC and individual audits, studies, and expert analysis. Data for the energy intensity and specific consumption of the sector were not available.

The final electricity efficiency potential of the sector converted in primary energy was 426 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 674 ktoe. The average emission factor of the sector was 9.8 $teCO_2$/toe in 2012.

v. Agriculture and Fishing Sector

The total EE potential for the agriculture and fishing sector in terms of final energy was 3 ktoe in 2012, using the energy intensity of agriculture in 2011 at 0.055 toe/1,000 USD, the country-tailored benchmark based on estimations at 0.048 toe/1,000 USD, and the total energy consumption of the sector for 2012. Data for fishing was unavailable to inform the EE potential.

4.10.4 Energy Efficiency Potential 2020 and 2025

The technical EE potential projected for 2020 and 2025 was 13,063 ktoe and 21,115 ktoe, respectively. The EE potential was based on the annual sectoral variation for 2000 to 2012. Based on the projected values of 2025, the total EE potential represents 28 percent of total TPES. Figure 89 shows the percentages of the subsectors with their projected EE potential, while Figure 90 shows the variation of the EE potential for 2012, 2020, and 2025.

Figure 89: Oman Projected EE Potential, 2025

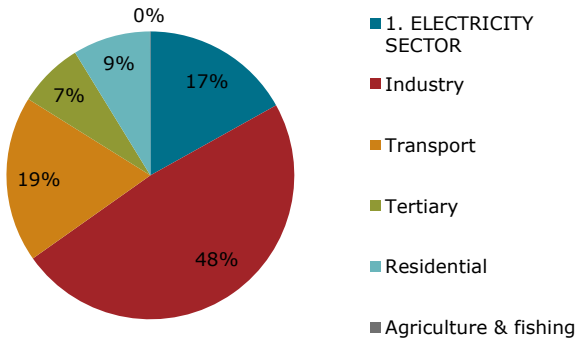
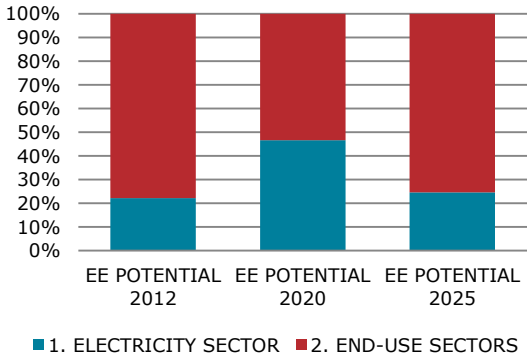


Figure 90: Oman EE Potential 2012-2025



4.11 Palestine

4.11.1 Overview of Energy Supply and Demand

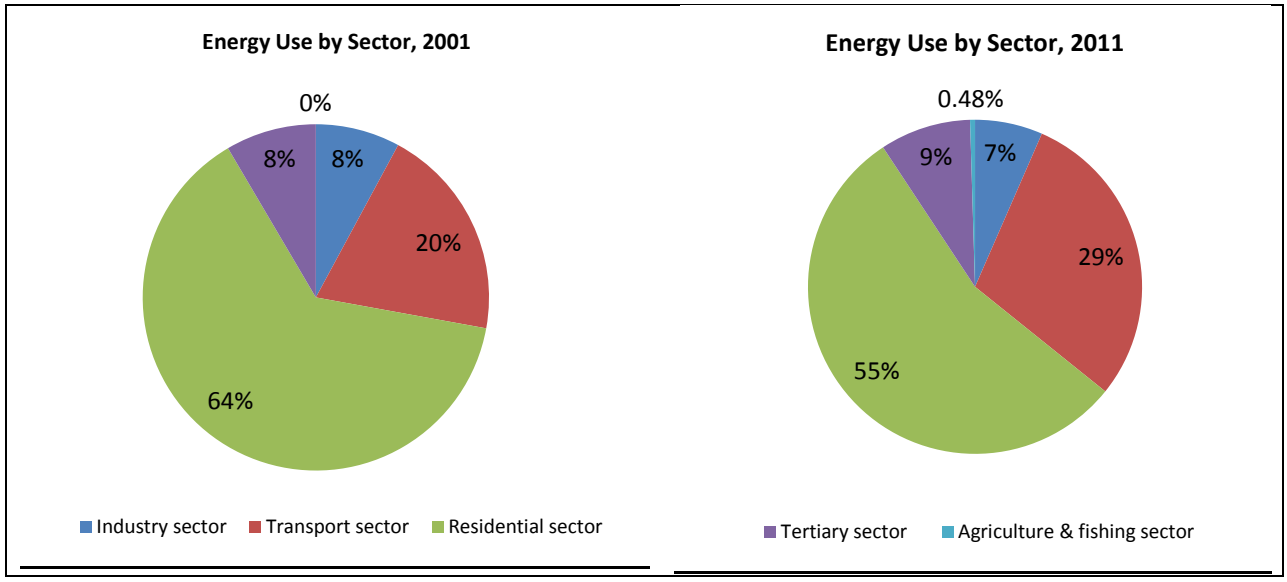
Palestine is the second MENA country under review that did not have production of energy from fossil sources until 2012, and now produces only geothermal and solar energy. This production amounted to 118 ktoe in 2012, compared to 102 ktoe in 2001. Total imports were 1,142 ktoe, compared to 656 ktoe in 2001. Since energy production is very limited, Palestine relies heavily on the imports of energy, which consists of more than 82 percent of the total primary energy available for consumption.

Energy available for consumption amounted to 1,181 ktoe in 2012, while electricity generated in the same year amounted to 40 ktoe, in addition to 422 ktoe of electricity imported. The main conventional source of fuel for electricity production was oil products, of which 137 ktoe were consumed to generate electricity in 2012, compared to 8 ktoe in 2001.

Final energy consumed by end-use sectors amounted to 1,297 ktoe in 2012, a 100 percent increase from 2001. The distribution of energy consumed by sector remained relatively stable, with the residential sector consuming the largest quantity of fuel, followed by transport, tertiary, industry, and agriculture and fishing. Total energy consumed in the residential sector in 2011 amounted to 574 ktoe, transport to 305 ktoe, tertiary to 92 ktoe, industry to 68 ktoe, and 5 ktoe for the agriculture and fishing sector.

In 2001, residential sector consumed 412 ktoe, transport 129 ktoe, tertiary 55 ktoe, and industrial 51 ktoe.

Figure 91: Palestine Energy Use by Sector, 2001 and 2011, Percentage



4.11.2 Energy Demand Outlook 2020

Palestine will consume around 1,552 ktoe of energy in 2020, an increase of 49 percent from 2011, while electricity generation is expected to amount to 585 GWh in the same year, compared to 569 GWh in 2011.

In 2020, the residential sector will become the largest energy-consuming sector with 47 percent of energy consumption (754 ktoe), followed by transport at 39 percent (617 ktoe), tertiary at 9 percent (141 ktoe), industry at 5 percent (87 ktoe), and 0.3 percent for agriculture and fishing (5 ktoe).

Figure 92: Palestine Energy Use by Sector 2020

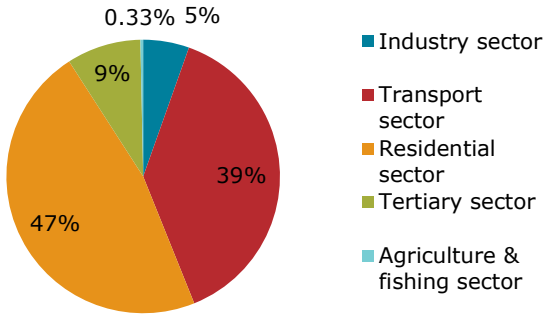
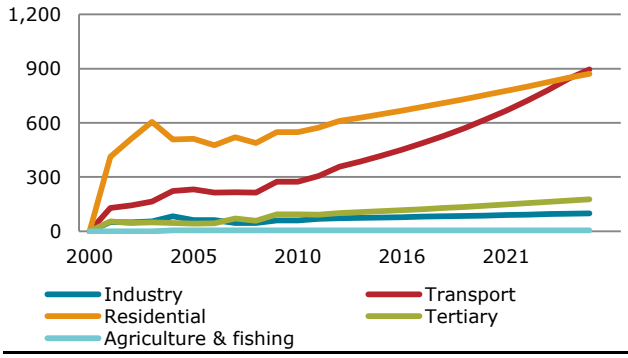


Figure 93 : Final Energy Consumption for End-use Sectors, ktoe

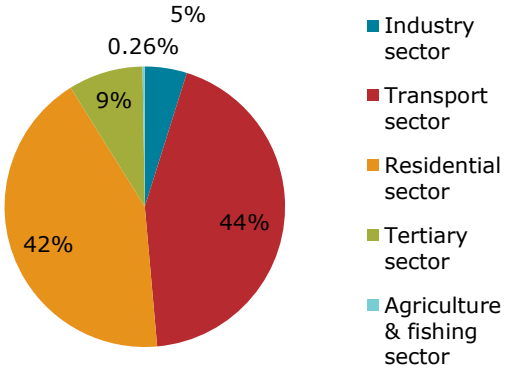


4.11.3 Energy Outlook 2025

Total energy consumed by the end-use sector will increase by 85 percent between 2011 and 2025, while electricity generation is projected to increase by 18 percent.

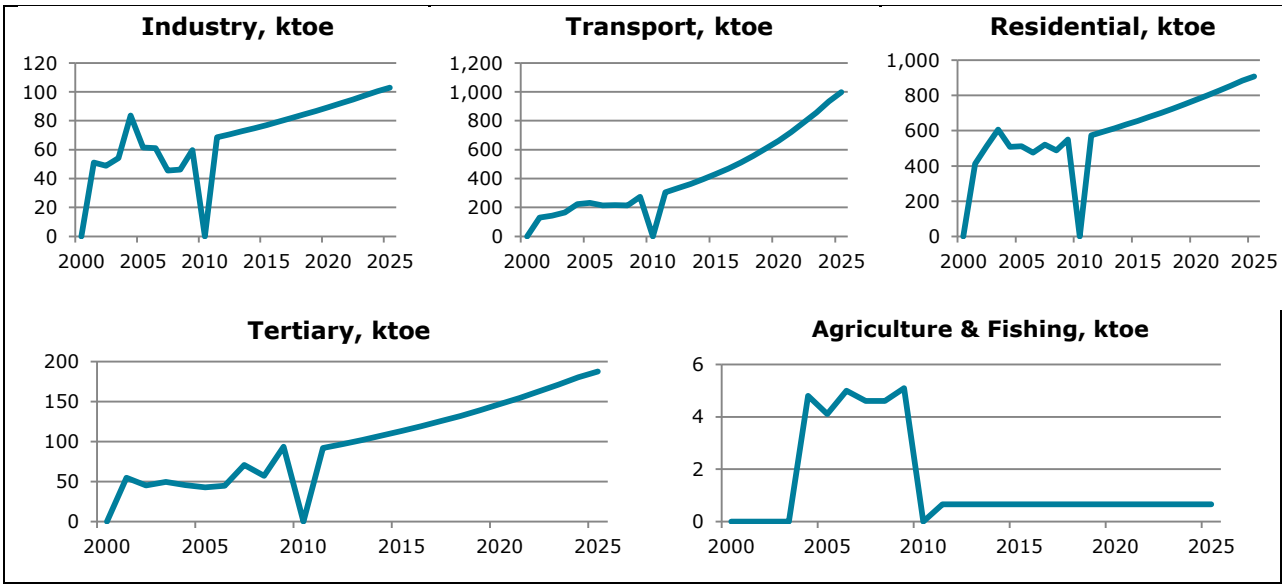
The transport sector is expected to continue growing, consuming 44 percent of total energy, followed by residential at 42 percent, 9 percent for tertiary, 5 percent for industrial and 0.3 percent for agriculture and fishing.

Figure 94: Palestine Energy Use by Sector 2025



The transport sector is estimated to grow from 305 ktoe in 2011 to 895 ktoe in 2025. Also projected to increase over that period are residential from 574 ktoe to 870 ktoe, tertiary from 92 ktoe to 176 ktoe, and industry from 68 ktoe to 99 ktoe in 2025. The agriculture and fishing sector is expected to remain stable at 5 ktoe.

Figure 95: Palestine Energy Consumption Trends by Sector



4.11.4 Energy Efficiency Potential

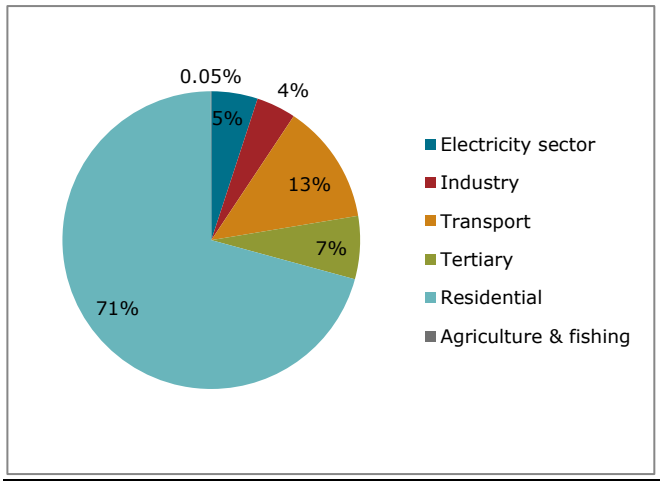
Total primary energy supplied in Palestine was 1,181 ktoe in 2012, compared to 640 ktoe in 2001, of which almost 100 percent was consumed by end-use sectors.

The total EE potential in 2011 was 407 ktoe,[23] of which 5 percent was for the electricity sector and 95 percent for the end-use sectors. The EE potential consisted of 28 percent of total primary energy supplied in 2011. The end-use sector with the largest EE potential was the residential sector (71 percent), followed by the transport sector (13 percent), tertiary (7 percent), industry (4 percent), and agriculture and fishing (0.05 percent).

Table 34: Palestine EE Potential, ktoe, 2011

Sector	EE potential, ktoe, 2011
Electricity Sector (2012)	**21**
End-Use Sectors	**388**
Industry	18
Transport	53
Residential	288
Tertiary	28
Agriculture and Fishing	0.2
TOTAL	**407**
	28% of TPES

Figure 96: Palestine EE Potential, 2011



4.11.4.1 Electricity Generation

Palestine generated 40 ktoe of electricity in 2012, at an average annual variation of 11 percent since 2002. The power generation efficiency was 29 percent in 2012. The country-tailored benchmark was set at 40 percent, estimating a power generation EE potential of 15 ktoe in 2012. The specific consumption of power generation was 296 toe/GWh in 2012.

Total transmission and distribution loss of electricity was 25 percent in 2012; 6 percent for transmission losses and 19 percent for distribution losses. The sub-regional benchmarks set at 3 percent for transmission losses and 11 percent for distribution losses, have estimated the EE potential at 1 ktoe for the transmission losses and 5 ktoe for the distribution losses. The total EE potential of the electricity sector, in terms of primary energy, was 21 ktoe in 2012.

4.11.4.2 End-Use Sectors

i. Industry

The final energy intensity of the industry sector was 0.088 toe/1,000 USD in 2011. The country-tailored benchmark was set at 0.066 toe/1,000 USD, based on the structure of the industry sector, its evolution, and other country performances. This benchmark provides an estimation of the EE potential for the industry sector, in terms of final energy, at 18 ktoe in

[23] Estimations for electricity sector are in terms of primary energy, estimations for transport and agriculture and fishing sectors are in terms of final energy, while estimations for industry, residential and tertiary sectors are in terms of primary and final energy.

2011. This EE potential represented 26 percent of the sector's total energy consumption in 2011.

The average emissions factor of the industry sector was 0.72 $teCO_2$/toe in 2011 while the CO_2 intensity emissions factor was 0.06 $teCO_2$/1,000 USD the same year.

ii. Transport

The final energy intensity of the transport sector was 0.047 toe/1,000 USD in 2011. Using the benchmark based on the total energy consumption of the transport sector and Jordan's EE potential for personal car share of 17.4 percent, the EE potential for the transport sector, in terms of final energy, was estimated at 53 ktoe for 2011, based solely on road transport information due to missing data regarding maritime and air transports.

The average emissions factor of the transport sector was 2.9 $teCO_2$/toe in 2011 while the CO_2 intensity emission factor was 0.14 $teCO_2$/1,000 USD the same year.

iii. Tertiary

The final energy intensity of the tertiary sector was 0.213 toe/1,000 USD in 2009. The EE potential, in terms of final energy, was 28 ktoe using the percentage of the EE potential of Jordan due to lack of reliable data on the value-added of the tertiary sector and the total energy consumption of the sector in 2011.

The average emissions factor amounted to 0.59 $teCO_2$/toe in 2009 and the CO_2 intensity of the tertiary sector was 0.125 $teCO_2$/1,000 USD in the same year.

iv. Residential

The intensity of the residential sector was 0.094 toe/1,000 USD in 2012, while the specific consumption of energy per unit area was 11.83 kgoe/m^2/yr the same year. Using the country-tailored benchmark based on Jordan EE potential percentage of the residential sector set at 50 percent and the total energy consumption of the residential sector of 2011, the EE potential, in terms of final energy was estimated to be 288 ktoe in 2012.

The unit consumption of energy per dwelling was 592 kgoe/Dw in 2012, while the unit consumption of electricity per dwelling was 2,206 Kwh/Dw. The average emissions factor amounted to 1 $teCO_2$/toe in 2012 while the CO_2 intensity of the residential sector was 0.183 $teCO_2$/1,000 USD.

v. Agriculture and Fishing Sector

The final energy intensity of the agriculture sector was 0.014 ktoe in 2011; however, data was not available for the fishing sector. The EE potential for the agriculture and fishing sector in terms of final energy was 0.8 Ktoe using the percentage of the Jordan EE potential for the agriculture energy intensity.

4.11.5 Energy Efficiency Potential 2020 and 2025

The technical EE potential projected for 2020 and 2025 was 576 ktoe and 671 ktoe, respectively. The EE potential was projected based on the annual sectoral variation for 2011 to 2011. Based on the projected values of 2025, the total EE potential represents 21 percent of TPES. Figure 97 shows the percentages of the subsectors with their projected EE potential, while Figure 98 shows the variation of the EE potential for 2011, 2020, and 2025.

Figure 97: Palestine Projected EE Potential, 2025

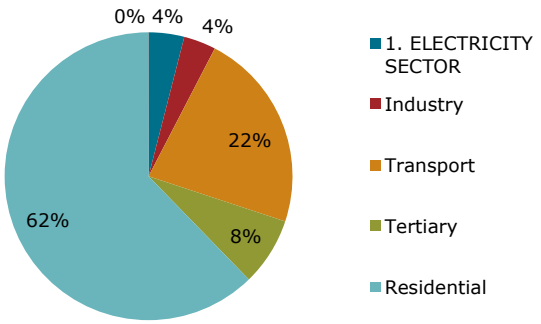
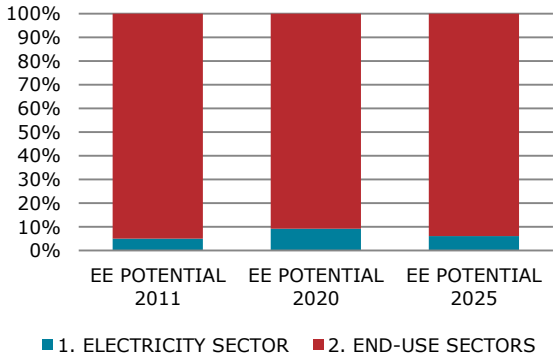


Figure 98: Palestine EE Potential 2011-2025



4.12 Qatar

4.12.1 Overview of Energy Supply and Demand

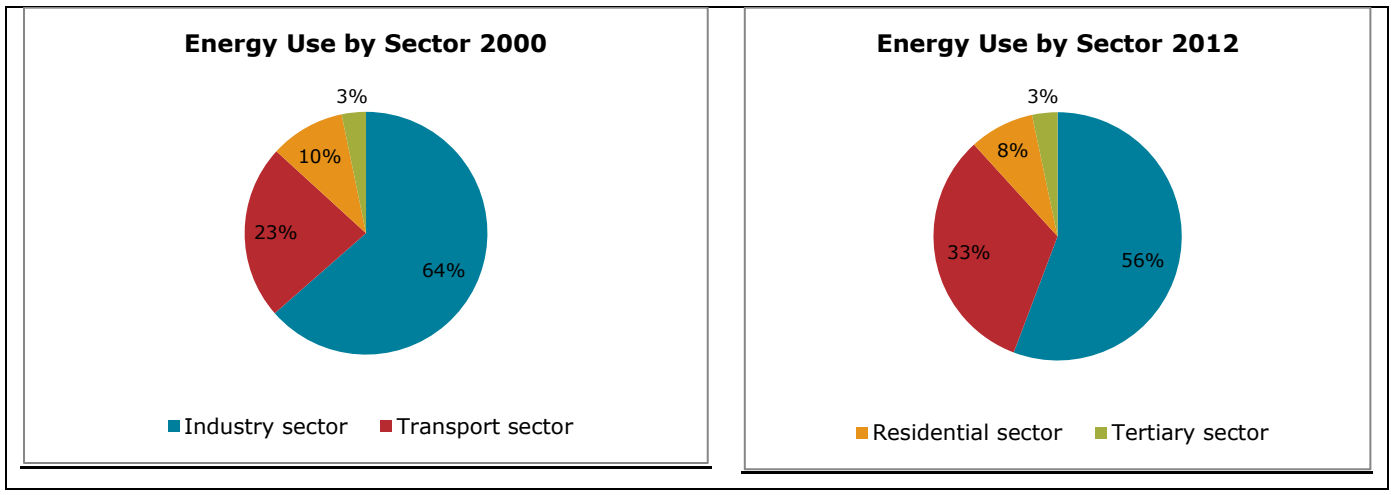
Total energy production was 220,380 ktoe in 2012, 64 percent of which from natural gas and 36 percent from crude oil. Qatar is one of two MENA countries that did not import energy products until 2006, when the country started imported small quantities of oil products. Being one of the largest natural gas (LNG) exporting countries in the world, Qatar exported 75 percent of its natural gas production in 2012, or 105,565 ktoe. In 2012, crude oil exports increased by 53 percent to 52,459 ktoe and oil products exports increased to 22,831 ktoe.

The total available primary energy for consumption was 37,922 ktoe in 2012, triple that in 2000. A large quantity of oil produced is used in the petrochemical sector, amounting to almost 9 percent of total production. In addition, 4,381 ktoe was used in 2012 for non-energy purposes compared to 2,216 ktoe in 2000, mainly as feedstock in the petrochemical processes.

Qatar relies on natural gas for electricity generation, using 2,992 ktoe in 2012 to produce electricity. Electricity constituted 13 percent of total energy consumed in the country that year, along with 32 percent for oil products and 26 percent for natural gas. In 2000, natural gas constituted the most-commonly used energy at 36 percent; 15 percent of electricity was produced from oil products and 10 percent from electricity.

Energy consumption by sector went through a large change in the most-consuming sectors. While in 2000 industry was the largest energy-consuming sector at 2,220 ktoe, followed by transport at 812 ktoe, residential at 349 ktoe, and tertiary 113 ktoe, energy consumed in 2012 followed the same trend with the transport sector consuming around 3,522 ktoe, industrial at 6,043 ktoe, residential at 916 ktoe and tertiary at 359 ktoe.

Figure 99 : Qatar Energy Use by Sector, 2000 and 2012, percentage



4.12.2 Energy Demand Outlook, 2020

Qatar's total energy consumption by end-use sectors will be 24,434 ktoe in 2020, increasing from 15,221 in 2012 and increasing from 5,710 ktoe in 2000. Total electricity generation is estimated to reach 79,228 GWh in 2020.

Final energy consumption by these sectors is estimated to increase in 2020. The transport sector will reach 11,191 ktoe, industry 5,476 ktoe, residential 1,659 ktoe, tertiary and 513 ktoe.

It is worth noting that data for energy consumption by the agriculture and fishing sector was unavailable. As such, this sector is not under review for this country in this study.

Figure 100: Qatar Energy Use by Sector 2020

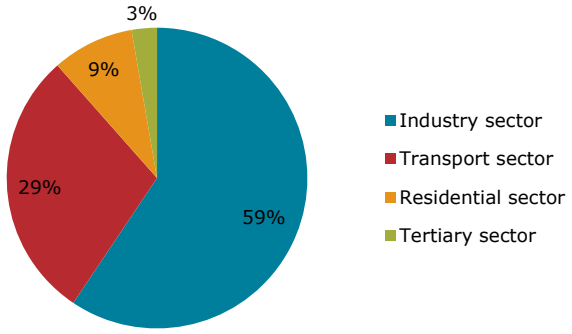
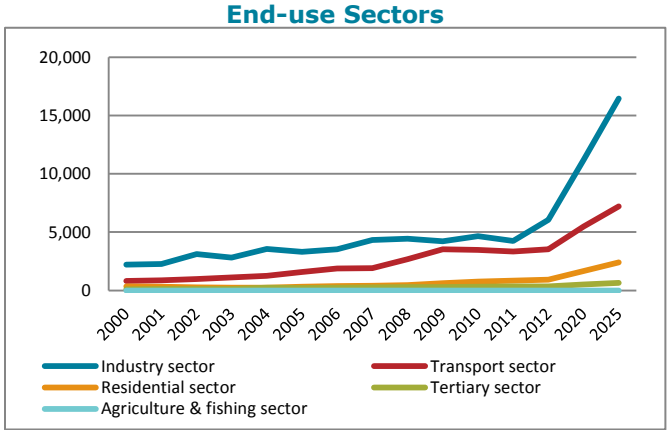


Figure 101: Qatar Final Energy Consumption for End-use Sectors

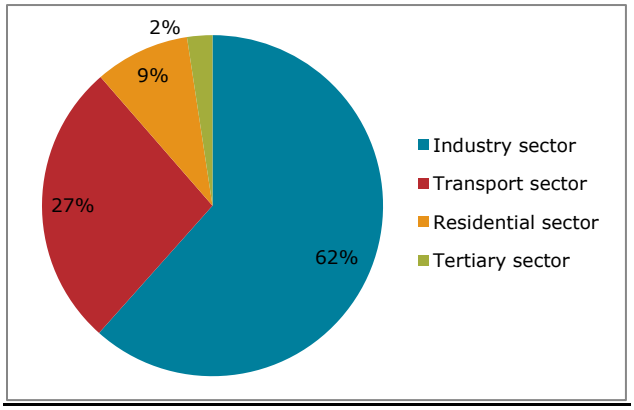


4.12.3 Energy Demand Outlook 2025

Qatar's total energy consumption is projected to reach 42,255 ktoe in 2025, when its electricity production is expected to reach 132,515 GWh.

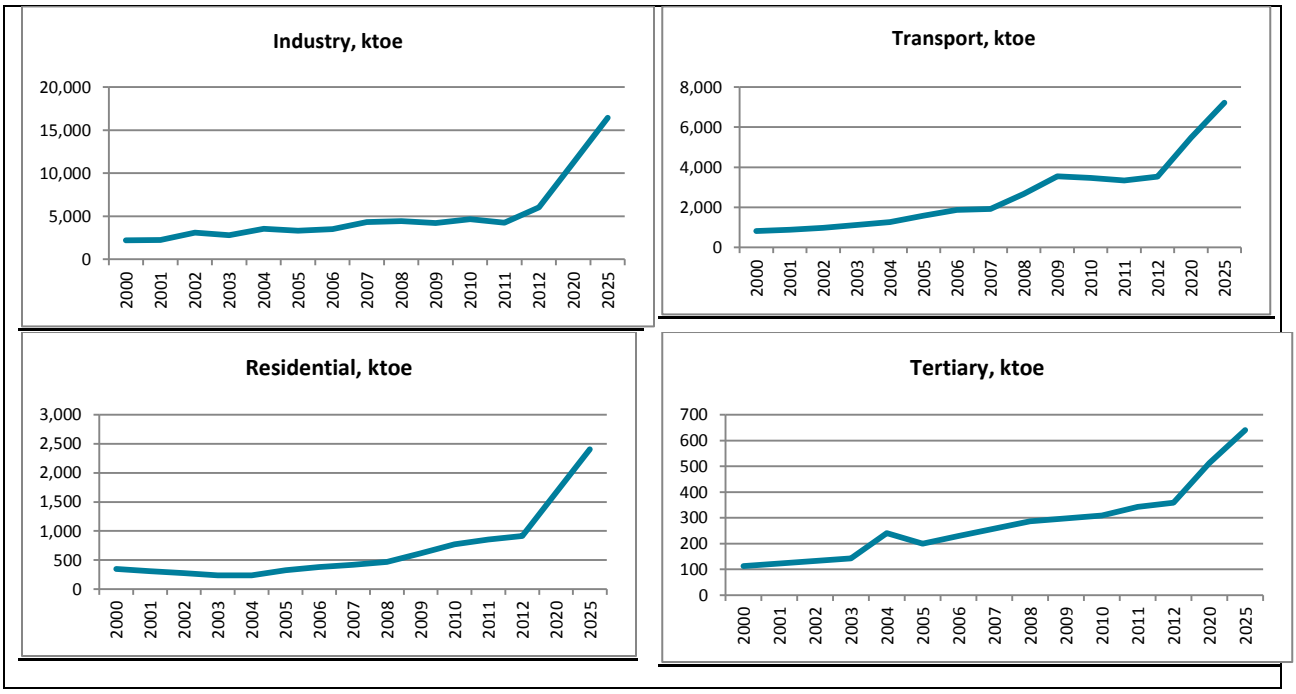
The industry sector is estimated to become the largest energy-consuming sector, amounting to 62 percent of total energy consumed, followed by 27 percent for transport, 9 percent for residential, and 2 percent for tertiary.

Figure 102: Qatar Energy Use by Sector 2025



The industry sector is projected to amount to 16,449 ktoe in 2025, 7,215 ktoe for transport, 2,404 ktoe for residential, and 640 ktoe for tertiary. This is in comparison to 2012, when transport consumed 3,522 ktoe, industrial 6,043 ktoe, residential 916 ktoe, and tertiary 359 ktoe.

Figure 103: Qatar Energy Consumption Trends by Sector



4.12.4 Energy Efficiency Potential

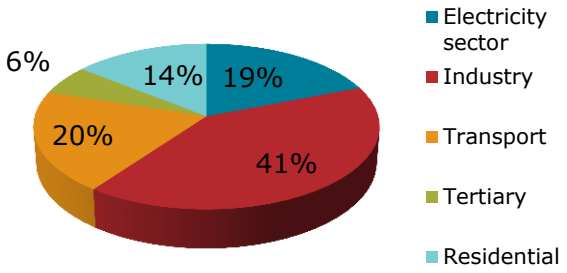
Total primary energy supplied in Qatar was 37,922 ktoe in 2012, increasing from 10,921 ktoe in 2000, of which 40 percent was consumed by end-use sectors.

The total EE potential in 2012 was 4,442 ktoe,[24] of which 19 percent was for the electricity sector and 81 percent for end-use sectors. Out of the end-use sectors, the highest EE potential was for industry at 41 percent. The EE potential for the rest of the sectors was 20 percent for transport, 14 percent for residential and 6 percent for tertiary. Data for agriculture and fishing sector was not available to estimate EE potential. The EE potential represented 12 percent of total primary energy supplied in 2012.

Table 35: Qatar EE potential, ktoe, 2012

Sector	EE Potential, ktoe, 2012
Electricity Sector	**847**
End-Use Sectors	**3,595**
Industry	1,822
Transport	881
Residential	635
Tertiary	258
Agriculture and Fishing	…
TOTAL	**4,442**
	12% of TPES

Figure 104: Qatar EE Potential, 2012



4.12.4.1 Electricity Generation

Total electricity generated in Qatar increased from 786 ktoe in 2000 to 2,992 ktoe in 2012. The power generation efficiency was 41 percent in 2012. The country-tailored benchmark was set at 51 percent, based on the sector situation and international references. The power generation EE potential was 750 ktoe in 2012. The specific consumption of power generation was 211 toe/GWh in 2012.

The total transmission and distribution electricity losses amounted to 6.2 percent in 2012, with 4.5 percent for transmission losses and 1.7 percent for distribution losses. The set sub-regional benchmark for transmission losses and the country-tailored benchmark for distribution losses estimated the EE potential to be 75 ktoe for transmission losses and 22 ktoe for distribution losses.

The total EE potential for the electricity sector was estimated, in terms of primary energy, to be 847 ktoe in 2012.

[24] Estimations for electricity sector are in terms of primary energy, estimations for transport and agriculture and fishing sectors are in terms of final energy, while estimations for industry, residential and tertiary sectors are in terms of primary and final energy.

4.12.4.2 End-Use Sectors

i. Industry

The final energy intensity of the industry sector was 0.63 toe/1,000 USD in 2012. The EE potential in terms of final energy was 1,515 ktoe based on the energy intensity and the country-tailored benchmark derived from the GIOC study, the structure of the sector, its evolution, and other country performances. The EE potential represented 25 percent of total energy consumed by the sector in 2012.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 307 ktoe. This potential added to EE potential in final energy estimated the total EE potential for the sector at 1,822 ktoe.

The average emissions factor of the sector was 3.1 $teCO_2$/toe in 2012, compared to 2.65 $teCO_2$/toe in 2000, while the CO_2 intensity of the industry sector was 1.95 $teCO_2$/1,000 USD in 2012, compared to 2.08 $teCO_2$/1,000 USD in 2000.

ii. Transport

The EE potential of the transport sector in terms of final energy was 881 ktoe in 2012, based on an estimated EE potential of 25 percent of total energy consumed by the transport sector. The EE potential includes road transport only due to the absence of data for other transportation means (i.e. maritime, air, and railways).

The average emissions factor of the transport sector was 2.91 $teCO_2$/toe in 2012 while the CO_2 intensity of the sector was 0.08 $teCO_2$/1m000 USD the same year.

iii. Tertiary

The energy intensity of the tertiary sector was 0.009 toe/1,000 USD in 2012, decreasing from 0.015 toe/1,000 USD in 2000. A country-tailored benchmark was set at 0.007 toe/1,000 USD based on GIOC study, which estimated the total EE potential in terms of final energy to be 105 ktoe for the sector. The EE potential represented 29 percent of total energy consumed by the sector in 2012.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 153 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 256 ktoe.

The average emission factor of the tertiary sector was 6.9 $teCO_2$/toe in 2012, while the CO_2 intensity of the sector was 0.06 $teCO_2$/1,000 USD the same year.

iv. Residential

The EE potential of the residential sector in terms of final energy was 281 ktoe in 2012 based on a country-tailored benchmark of 0.004 toe/1,000 USD[25] and energy intensity of 0.006 toe/1,000 USD in 2007. The EE potential represented 31 percent of total energy consumed by the sector in 2012.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 354 ktoe. This potential added to the EE potential in final energy estimated the total EE

[25] Figure derived froma set of GCC and Qatar individual audits, studies, and expert analysis.

potential for the sector at 635 ktoe. The average emissions factor of the sector was calculated at 6.4 teCO_2/toe in 2012.

v. Agriculture and Fishing Sector

Statistical data related to the energy intensity of the agriculture and fishing sector was unavailable for Qatar. As such, the EE potential could not be assessed.

4.12.5 Energy Efficiency Potential 2020 and 2025

The technical EE potential projected for 2020 and 2025 was 8,176 ktoe and 12,079 ktoe, respectively. The EE potential was based on the annual sectoral variation for 2000 to 2012. Based on the projected values of 2025, the total EE potential represents 6 percent of TPES. Figure 105 shows the percentages of the subsectors with their projected EE potential, while Figure 106 shows the variation of the EE potential for 2012, 2020, and 2025.

Figure 105: Qatar Projected EE Potential, 2025

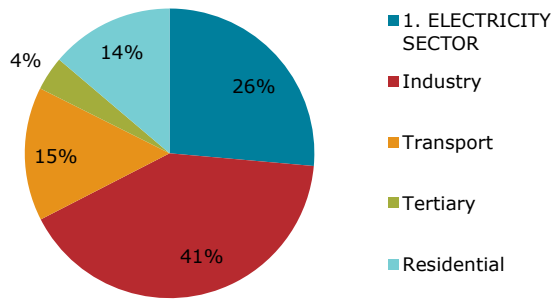
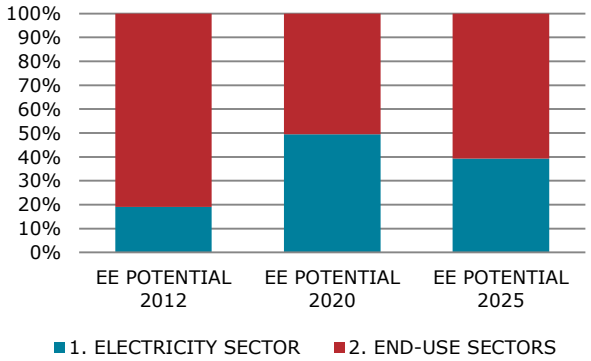


Figure 106: Qatar EE Potential 2012-2025



4.13 Saudi Arabia

4.13.1 Overview of Energy Supply and Demand

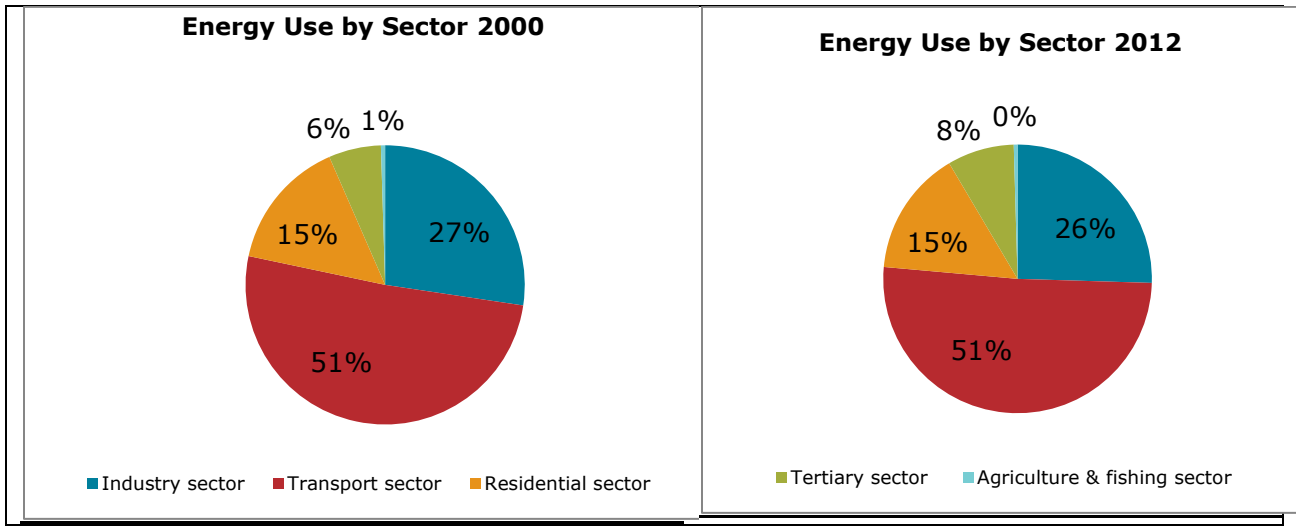
Saudi Arabia is one of the largest crude oil producing countries, with a total production of 558,780 ktoe in 2012, increasing from 445,057 ktoe in 2000. In addition to crude oil production, the country produced around 66,224 ktoe of natural gas, double from 2000. A large quantity of its crude oil and oil products production is exported (74 percent in 2012). The country imports oil products in relatively low quantities. The country consumed around 67,099 ktoe in the petrochemical sector, an increase of 95 percent in 12 years.

Primary energy available for consumption was at 00,249 ktoe for 2012, compared to 97,853 ktoe in 2000. The country does not produce or consume energy from coal or renewable sources. Electricity generation relies on natural gas, crude oil, and oil products. The total fuel input for electricity generation was 73,254 ktoe in 2012, of which 45 percent was from natural gas, 30 percent from crude oil, and 25 percent from oil products.

The main energy sources consumed in the country are oil products and electricity. Out of a total consumption of 133,106 ktoe, 59,349 ktoe was from oil products and 19,780 ktoe from electricity in 2012. This is in comparison with 2000, when the country energy consumption was 31,469 ktoe from oil products and 8,513 ktoe from electricity. Saudi Arabia also consumed 53,977 ktoe for non-energy purposes, compared to 23,532 ktoe in 2000.

The transport sector was the largest energy-consuming sector, with a 40,303 ktoe consumed in 2012, compared to 20,372 ktoe in 2000, followed by the industrial sector at 20,164 ktoe in 2012 (compared to 10,938 ktoe), residential sector at 11,933 ktoe in 2012 (compared to 6,053 ktoe), tertiary at 6,369 ktoe in 2012 (compared to 2,423 ktoe), and agriculture and fishing at 360 ktoe in 2012 (compared to 195 ktoe).

Figure 107: Saudi Arabia Energy Use by Sector, 2000 and 2012, Percentage



4.13.2 Energy Demand Outlook, 2020

The total energy consumption by end-use sectors is projected to reach 210,865 ktoe in 2020, compared to 63,514 ktoe in 2000.

Total energy used by these sectors is estimated to be as follows: 51 percent for the transport sector, 24 percent for industry, 15 percent for residential, 10 percent for tertiary, and 0.4 percent for agriculture and fishing.

In terms of physical units, 61,331 ktoe is estimated to be consumed by the transport sector in 2020, 29,379 ktoe by industry, 18,119 ktoe by residential, 11,544 ktoe by tertiary and 525 ktoe by agriculture and fishing.

4.13.3 Energy Demand Outlook 2025

Total energy consumption is projected to amount to 281,644 ktoe in 2025, compared with 63,514 ktoe in 2000.

The transport sector will consume nearly 50 percent of total energy consumed in 2025 (compared to 51 percent in 2000), followed by the industrial sector at 24 percent in 2025 (compared to 27 percent), tertiary sector at 11 percent (compared to 6 percent), and residential steady at 15 percent (compared with the year 2000) and the agriculture and fishing sector at 0.42 percent (compared to 1 percent).

Total energy consumption is projected in 2025 to be divided by sector as follows: 79,734 ktoe for the transport sector, 37,170 ktoe for industry, 23,523 ktoe for residential, 16,740 ktoe for tertiary, and 665 ktoe for agriculture and fishing.

Figure 108: Saudi Arabia Energy Use by Sector 2020

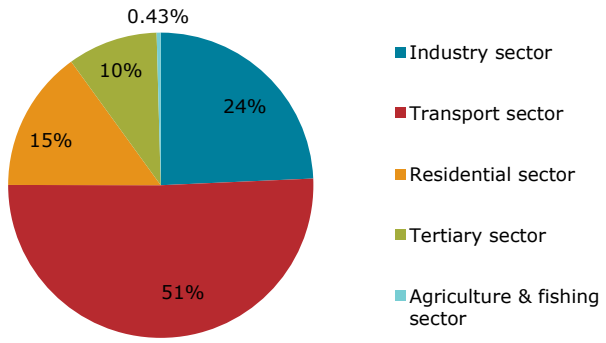


Figure 109: Saudi Arabia Final Energy Consumption by End-use Sector

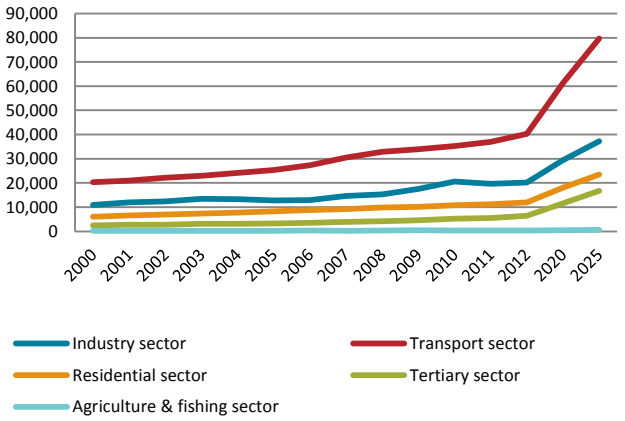


Figure 110: Saudi Arabia Energy Use by Sector 2025

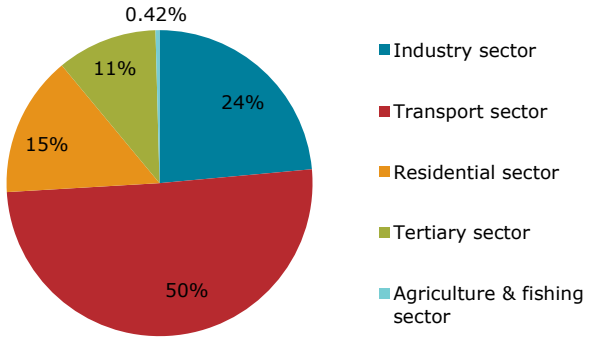
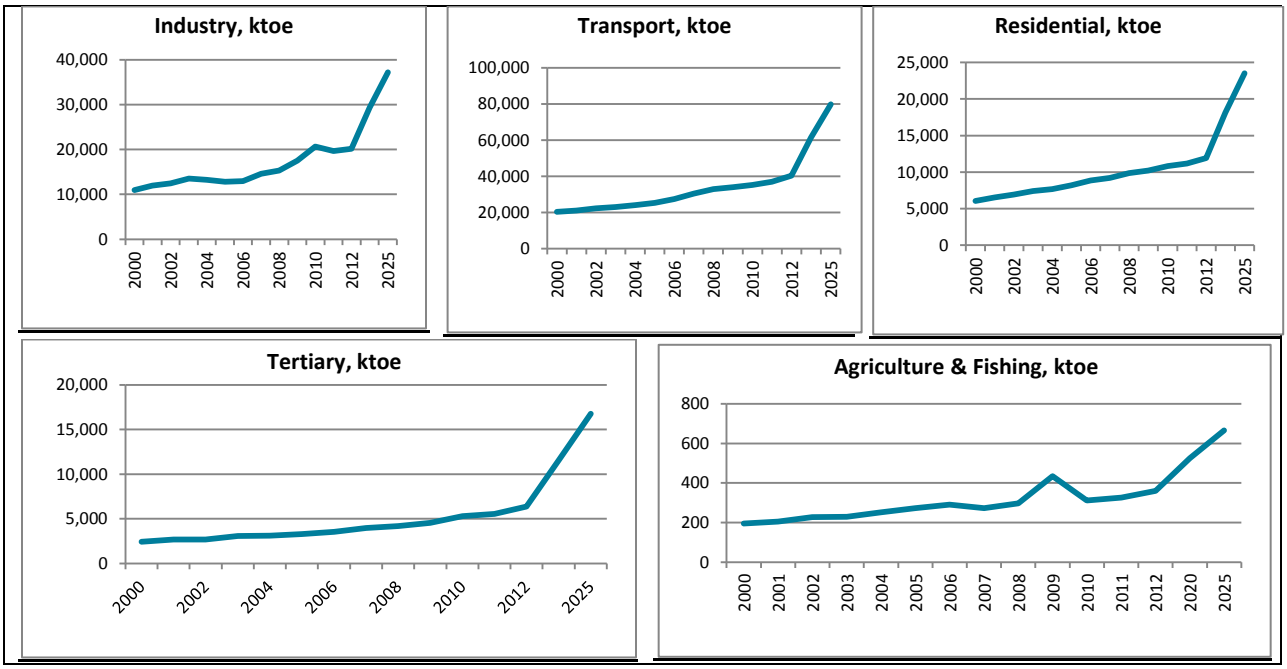


Figure 111: Saudi Arabia Energy Consumption Trends by Sector



4.13.4 Energy Efficiency Potential

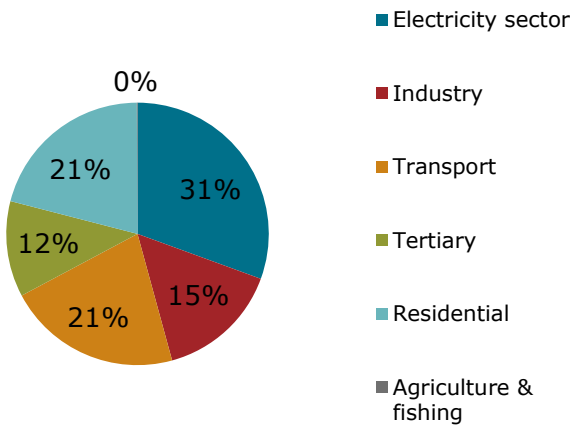
Saudi Arabia is the largest energy-producing, -consuming and -exporting MENA country. Its total primary energy supply reached 200,249 ktoe in 2012, compared to 97,853 ktoe in 2000. The final energy consumption for end-use sectors reached 133,106 ktoe in 2012 and accounts for over 30 percent of that of the entire MENA region.

Saudi Arabia's total EE potential was estimated for 2012 to be 48,900 ktoe,[26] of which 31 percent is used by the electricity sector and 69 percent by end-use sectors. The EE potential accounted for 24.4 percent of total primary energy consumption. Within the end-use sectors, transport, and residential account for 23 percent each, industry 16 percent, tertiary 13 percent, and agriculture and fishing 0.1 percent.

Table 36: Saudi Arabia EE potential, ktoe, 2012

Sector	EE Potential, ktoe, 2012
Electricity Sector	**14,946**
End-Use Sectors	**33,954**
Industry	7,425
Transport	10,495
Residential	10,219
Tertiary	5,773
Agriculture &Fishing	42
TOTAL	**48,900**
	24 % of TPES

Figure 112: Saudi Arabia 2012 Total EE Potential



4.13.4.1 Electricity Sector

In 2012, electricity generation amounted to 23,364 ktoe for a fuel input of 73,254 ktoe with a power mix made at 45 percent natural gas, 30 percent crude oil and 25 percent oil products. Power generation efficiency was 32 percent during the same year. The country-tailored benchmark for power generation based on best available power technologies and mix (in particular switch from crude oil to natural gas) was 51 percent (or a 19 percent increase), indicating an EE potential for 2012 at 14,069 ktoe. The specific consumption of power generation was at 270 toe/GWh.

The transmission and distribution losses of electricity were estimated to be 8.8 percent in 2012, of which transmission losses were 3.5 percent and distribution losses were 5.3 percent. The GCC benchmark was set at 2 percent for transmission losses and 3 percent for the distribution losses, representing an EE potential of 351 ktoe for transmission and 526 ktoe for distribution losses.

The EE potential for the electricity sector in terms of primary energy was 14,946 ktoe in 2012, or 31 percent of the total EE potential.

[26] Estimations for electricity sector are in terms of primary energy, estimations for transport and agriculture and fishing sectors are in terms of final energy, while estimations for industry, residential and tertiary sectors are in terms of primary and final energy.

4.13.4.2 End-Use Sectors

i. Industry

The final energy intensity of the industry sector was 0.364 toe/1,000 USD in 2012, compared to 0.494 toe/1,000 USD in 2000. The EE potential for the sector for 2012 in terms of final energy was 5,746 ktoe, using an energy intensity efficiency, country-tailored benchmark based on the structure of the sector, its evolution and country performances as well as national and GCC references.[27] Additionally, the final electricity efficiency potential in the industry sector once converted in primary energy was 1,679 ktoe, making the total EE potential for the industry sector 7,425 ktoe.

The average emissions factor of the sector was 11.8 $teCO_2$/toe in 2012, compared to 11.9 $teCO_2$/toe in 2000, while the CO_2 intensity of the industry sector was 4.3 $teCO_2$/1,000 USD in 2012, compared to 5.9 $teCO_2$/1000 USD in 2000.

ii. Transport

While the final energy intensity of the transport sector was 0.081/1,000 USD in 2012, compared to 0.079 toe/1,000 USD in 2000, no detailed data is available on the number and average energy consumption of private automobiles, information necessary for the indicator average energy unit consumption of cars.

The EE potential for transport is based on an overall estimation of the improvement of fuel efficiency standards of 26 percent.[28] The total EE potential of the transport sector is 10,495 ktoe. The average emissions factor of the transport sector was 2.9 $teCO_2$/toe in 2012 while the CO_2 intensity was 0.24 $teCO_2$/1,000 USD the same year.

iii. Tertiary

The final energy intensity of the tertiary sector was 0.033 toe/1,000 USD for 2012, compared to 0.027 toe/1,000 USD in 2000. Using an energy-intensity, country-tailored benchmark,[29] an EE potential of 28.4 percent was estimated in terms of final energy, equivalent to 1,810 ktoe for the tertiary sector.

In addition, the final electricity efficiency potential in the tertiary sector once converted in primary energy is equivalent to 3,963 ktoe. The total EE potential for the tertiary sector is 5,773 ktoe in 2012. The average emission factor of the tertiary sector was 9.3 $teCO_2$/toe in 2012 while the CO_2 intensity of the tertiary sector was 0.3 $teCO_2$/1,000 USD.

iv. Residential

Information on the energy intensity of the residential sector is only available for 2006, when it was 0.064 toe/1,000 USD. Based on various national and regional references,[30] the country-tailored benchmark indicates a potential EE gain of 30 percent. Using the sector

[27] "Saving Oil and Gas in the Gulf" (Chatham House, 2013) and "Regional Case Study: An Energy Guide Book for Industries in the GCC "(Gulf Organization for Industrial Consulting (GIOC), 2013)
[28] "Saving Oil and Gas in the Gulf" (Chatham House, 2013)
[29] Study: "An Energy Guide Book for Industries in the GCC" (GIOC, 2013) and building audits
[30] "GCC and SA individual residential building audits and Saving Oil and Gas in the Gulf" (Chatham House, 2013)

final energy consumption in 2012, the EE potential is estimated at 3,523 ktoe in terms of final energy.

In addition, the final electricity efficiency potential in the residential sector once converted in primary energy is equivalent to 6,696 ktoe. In total, the EE potential for the residential sector is 10,219 ktoe. The CO_2 intensity of the residential sector was 0.5 $teCO_2$/1,000 USD in 2006, while the average emissions factor was 8.2 $teCO_2$/toe for the same year.

v. Agriculture and Fishing Sector

The final energy intensity of the agriculture sector was 0.029 toe/1,000 USD in 2012. An estimated 41 ktoe of EE potential in terms of final energy is based on an EE country benchmark[31] for the agriculture sector only.

4.13.5 Energy Efficiency Potential 2020 and 2025

The technical EE potential projected for 2020 and 2025 was 76,962 ktoe and 102,418 ktoe, respectively. The EE potential was based on the annual sectoral variation for 2000 to 2012. Based on the projected values of 2025, the total EE potential represents 25 percent of TPES. Figure 113 shows the percentages of the subsectors with their projected EE potential, while Figure 114 shows the variation of the EE potential for 2012, 2020, and 2025.

Figure 113: Saudi Arabia Projected EE Potential, 2025

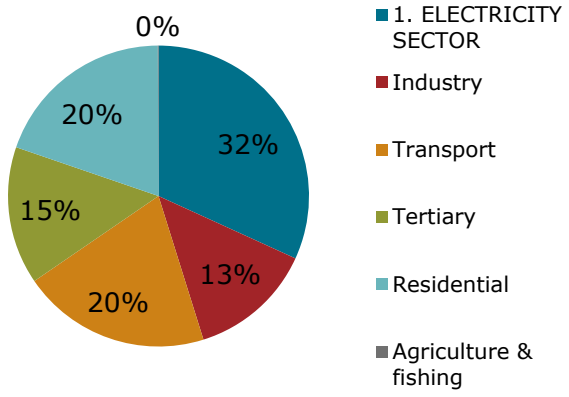
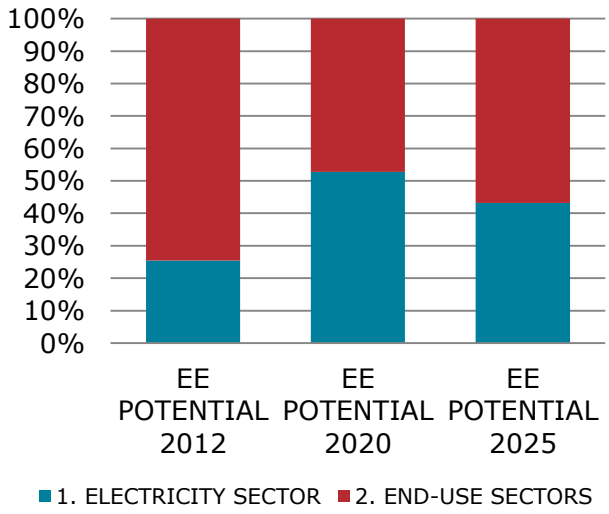


Figure 114: Saudi Arabia EE Potential 2012-2025



[31] National and MENA references (Jordan)

4.14 Sudan

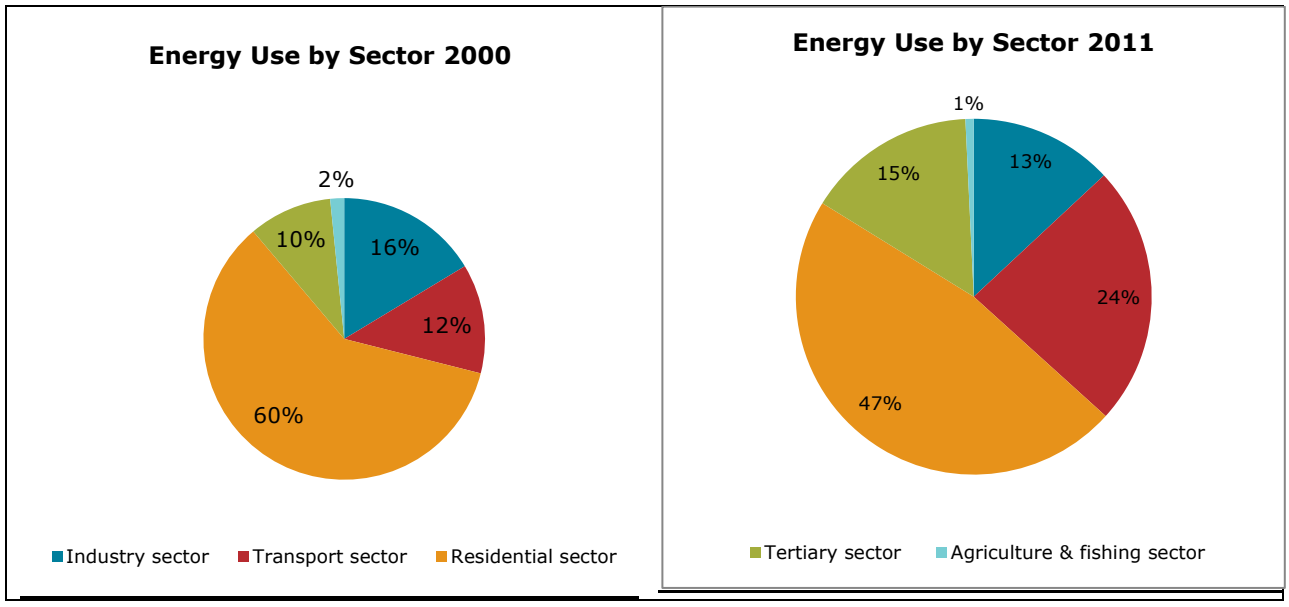
4.14.1 Overview of Energy Supply and Demand

Sudan's energy production was 34,756 ktoe in 2011, mainly from crude oil, hydro, and combustible renewable and waste, up 74 percent from 2000. It is worth noting that the energy production for Sudan for 2012 decreased to 17,320 ktoe due to the situation between South Sudan and Sudan that led to a halt in energy production. Sudan relies heavily on exporting its oil products; exports increased from 7,297 ktoe in 2000 to 18,991 ktoe in 2011. Energy available for consumption increased during the same period, from 13,308 to 16,605 ktoe.

Final energy consumption amounted to 10,989 ktoe in 2011, compared to 7,332 ktoe in 2000. Final energy consumed in 2011 came from other energies (61 percent) mainly combustible renewable and waste, oil products (32 percent), and electricity (5 percent). Electricity generation was 100 percent dependent on oil products in 2011. Total electricity generated amounted to 727 ktoe in 2011, compared to 221 ktoe in 2000.

Figure 115 shows the energy consumed by sectors between 2000 and 2011. The largest energy-consuming sector was residential, followed by transport, industry, tertiary and agriculture and fishing. The evolution between 2000 and 2011 saw a decrease by 14 percent in the residential sector (at 5,061 ktoe in 2011), an increase by 10 percent in the transport sector (at 2,540 ktoe), an increase by 5 percent for tertiary (at 1,659 ktoe), a decrease of 1 percent for the agriculture and fishing sector (at 81 ktoe), and a steady industry sector at 15 percent (at 1,581 ktoe).

Figure 115 : Sudan Energy Use by Sector, 2000 and 2011, Percentage



4.14.2 Energy Demand Outlook 2020

The total final energy consumption by all end-use sectors is estimated to reach 16,428 ktoe in 2020,[32] compared to 10,989 ktoe in 2011. Generated electricity is expected to reach 20,989 GWh in 2020, compared to 8,453 GWh in 2011.

In 2020, the residential sector will remain the largest energy-consuming sector, with a total estimated consumption of 5,723 ktoe, followed by transport at 5,521 ktoe, and tertiary at 3,215 ktoe.

The industrial sector consumption will increase from 24 percent in 2011 to 34 percent in 2020 for an estimated value of 1,604 ktoe, while the agriculture and fishing sector will reduce consumption, from 0.7 percent to 0.38 percent at a value of 62 ktoe.

Figure 116: Sudan Energy Use by Sector 2020

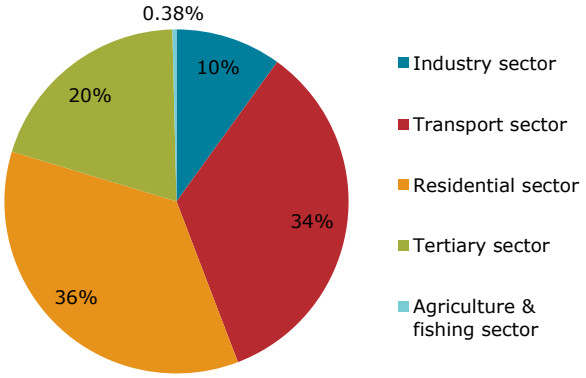
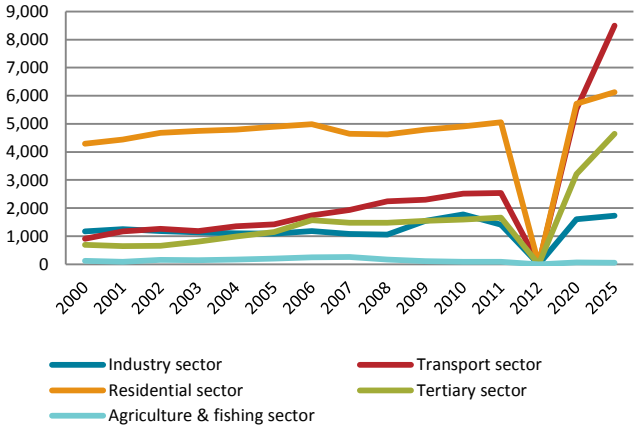


Figure 117: Sudan Final Energy Consumption for End-use Sectors

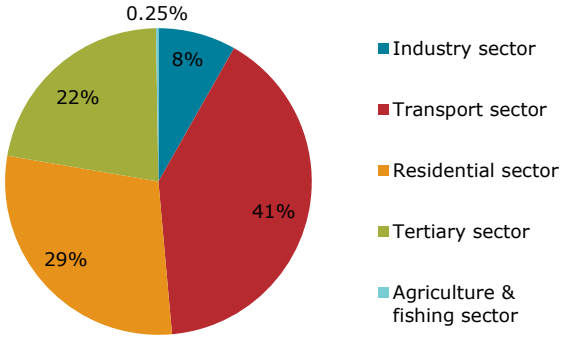


4.14.3 Energy Demand Outlook 2025

Final energy consumption by end-use sectors is expected to reach 21,415 ktoe in 2025, with electricity generation amounting to 34,606 GWh. The largest energy-consuming sector will be transport at 41 percent, followed by residential, which is estimated to reach 29 percent.

In 2025, the tertiary sector (22 percent) will consume more energy than the industrial sector (8 percent), while agriculture and fishing sector is estimated to fall to 0.26 percent of total energy consumed in Sudan.

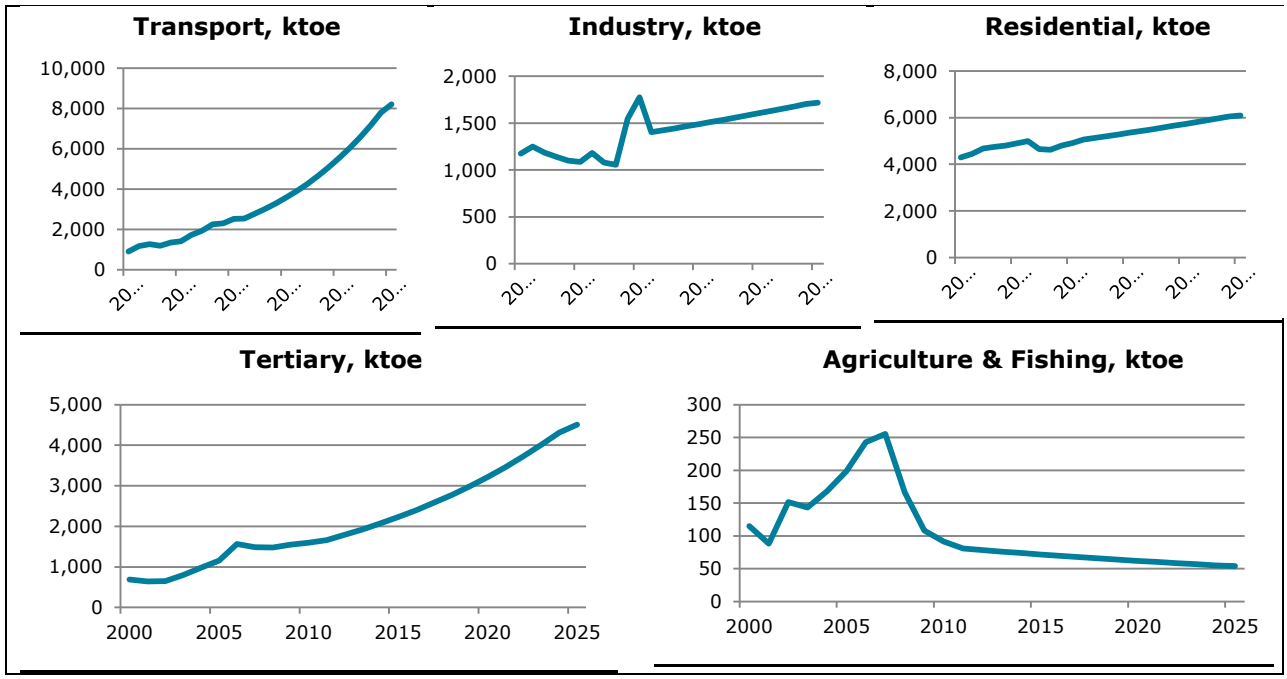
Figure 118: Sudan Energy Use by Sector 2025



Out of the total energy consumed, the transport sector will consume 8,500 ktoe in 2025 (compared to 902 ktoe in 2000), the residential sector 6,127 ktoe compared to 4,296 ktoe, tertiary sector 4,643 ktoe compared to 687 ktoe, while the industrial sector will consume 1,728 ktoe. The agriculture and fishing sector will decrease from 115 ktoe in 2000 to 53 ktoe in 2025.

[32] For Sudan as it was in 2010 (South Sudan and Sudan)

Figure 119: Sudan Energy Consumption Trends by Sector



4.14.4 Energy Efficiency Potential

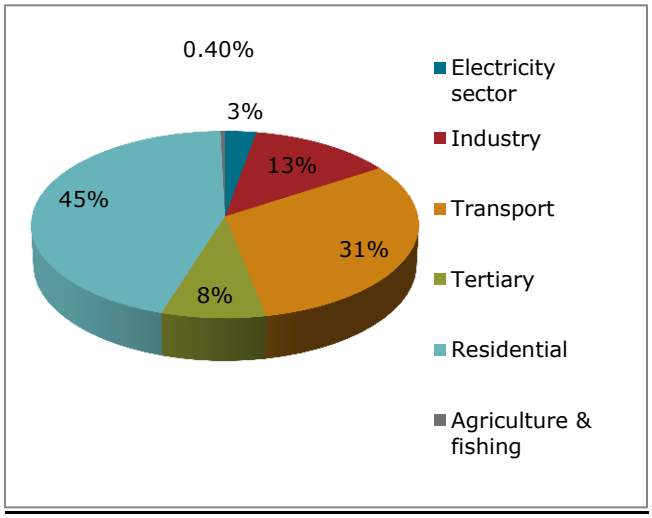
The total primary energy supplied in Sudan for 2011 was 16,605 ktoe, an increase of 25 percent from 2000, of which 66 percent was consumed by the end-use sectors.

Total EE potential was 2,930 ktoe[33] in 2011, of which 3 percent was from the electricity sector and 97 percent from end-use sectors. The end-use sectors accounted for 97 percent of the total EE potential, of which 45 percent was from residential, 31 percent from transport, 13 percent from industry, 8 percent from tertiary, and 0.4 percent from agriculture and fishing. The total EE potential represented 18 percent of the total primary energy supplied in 2011.

Table 37: Sudan EE Potential, ktoe, 2011

Sector	EE Potential, ktoe, 2011
Electricity Sector (2010)	**83**
End-Use Sectors	**2,847**
Industry	381
Transport	909
Residential	1,310
Tertiary	235
Agriculture and Fishing	12
TOTAL	**2,930**
	18% of TPES

Figure 120: Sudan EE Potential, 2011



4.14.4.1 Electricity Generation

Total electricity generation amounted to 811 ktoe in 2012 with an annual variation of 10.5 percent from 2000. The power generation efficiency was 56 percent in 2010, which is considered high, as the capacity of thermal plants in Sudan is low. The country-tailored benchmark of 60 percent estimated the EE potential for the power generation at 47 ktoe for 2010. The specific consumption of power generation was 64 toe/GWh in 2012.

The transmission and distribution electricity losses in Sudan were s 23 percent for 2010, with 7 percent from transmission and 16 percent from distribution. The sub-regional benchmark used estimated the EE potential of the transmission losses at 7 ktoe and 30 ktoe for distribution losses. The total EE potential for the electricity sector in terms of primary energy was 83 ktoe in 2010.

[33] Estimations for electricity sector are in terms of primary energy, estimations for transport and agriculture and fishing sectors are in terms of final energy, while estimations for industry, residential and tertiary sectors are in terms of primary and final energy.

4.14.4.2 End-Use Sectors

i. Industry

The EE potential of the industry sector in terms of final energy was 363 ktoe in 2011, based on the final energy intensity of 0.405 toe/1,000 USD in 2011 and using the sub-regional benchmark of 0.3 toe/1,000 USD. The EE potential represented almost 26 percent of total energy consumed by the industry sector in 2011.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 18 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 381 ktoe.

The average emission factor of the industry sector was 1.5 $teCO_2$/toe in 2011, while the CO_2 intensity of amounted to 0.6 $teCO_2$/1,000 USD for 2011.

ii. Transport

The EE potential of the transport sector in terms of final energy was 909 ktoe in 2011 based on estimations from Yemen EE potential for the transport sector. The total EE potential represented 36 percent of total energy used by this sector in 2011. The average emissions of the transport sector were 2.9 $teCO_2$/toe, while the CO_2 intensity of the sector was 0.2 $teCO_2$/1,000 USD in 2011.

iii. Tertiary

The EE potential for the tertiary sector in Sudan in terms of final energy was 218 ktoe in 2011, using the final energy intensity of the tertiary sector (0.104 toe/1,000 USD in 2011) and the country-tailored benchmark based on the comparison with Mediterranean countries, such as Lebanon. The EE potential represented 13 percent of the total energy consumed by the tertiary sector in 2011.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 17 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 235 ktoe.

iv. Residential

The specific consumption of energy per unit area was 12.76 kgoe/m^2/yr in 2011. A country-tailored benchmark was set at 9.6 kgoe/m^2/yr, based on the comparison with Mediterranean countries such as Algeria and Libya. The EE potential for the residential sector in terms of final energy was 1,253 ktoe in 2011. The EE potential consisted of 25 percent of the total energy consumed by the residential sector in 2011.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 57 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 1,310 ktoe.

The unit consumption of energy per dwelling was 893 kgoe/Dw in 2011, compared to 829 kgoe/Dw in 2000 while the unit consumption of electricity per dwelling was 600 Kwh/Dw in 2011. The average emission of the residential sector was 0.6 $teCO_2$/toe in 2011.

v. Agriculture and Fishing Sector

The final energy intensity of agriculture was 0.007 toe/1,000 USD in 2011. The country-tailored benchmark was set at 0.006 toe/1,000 USD based on estimations and estimated

the EE potential at 12 ktoe in 2011. Due to lack of data for fishing, the EE potential for agriculture and fishing in terms of final energy was estimated at 12 ktoe. The EE potential represented 15 percent of total energy consumed by the agriculture and fishing sector.

4.14.5 Energy Efficiency Potential 2020 and 2025

The technical EE potential projected for 2020 and 2025 was 4,709 ktoe and 6,375 ktoe, respectively. The EE potential was based on the annual sectoral variation for 2000 to 2011. Based on the projected values of 2025, the total EE potential represents 19 percent of TPES. Figure 121 shows the percentages of the subsectors with their projected EE potential, while Figure 122 shows the variation of the EE potential for 2011, 2020, and 2025.

Figure 121: Sudan Projected EE Potential, 2025

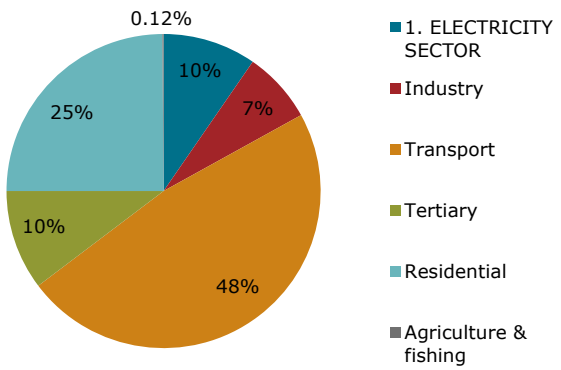
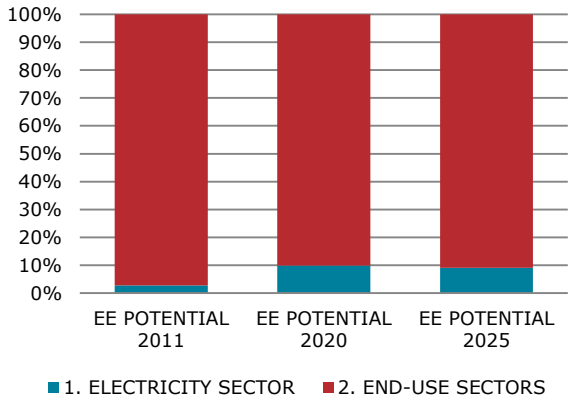


Figure 122: Sudan EE Potential 2011-2025



4.15 Tunisia

4.15.1 Overview of Energy Supply and Demand

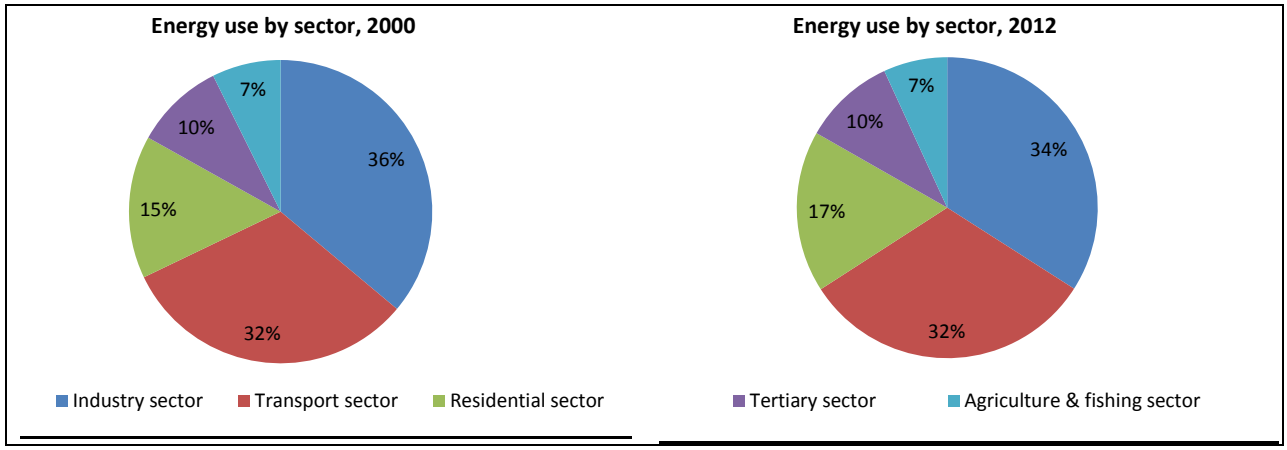
Tunisia produced a total of 5,844 ktoe of energy in 2012, mainly from natural gas and crude oil, an increase of 6 percent from 2000. Energy exports increased from 3,577 ktoe in 2000 to 3,710 ktoe in 2012, while its imports increased in the same period from 4,390 ktoe to 6,712 ktoe. Tunisia used to import coal but stopped in 2003. Energy available for national consumption increased from 6,298 ktoe in 2000 to 11,796 ktoe in 2012.

Final energy consumption was 6,052 ktoe in 2012 compared to 5,285 ktoe in 2000, representing the slowest final energy consumption increase in the region at 15 percent. Final energy consumed in 2012 came from oil products (59 percent), natural gas (21 percent), and electricity (21 percent). The largest contributor to electricity generation was natural gas at 99.95 percent in 2012, while the rest relied on other fuels and renewables. Total electricity generated amounted to 1,547 ktoe in 2012, compared to 911 ktoe in 2000.

Figure 123 shows the energy consumed by sectors between 2000 and 2012. The largest energy-consuming sector was industry, followed by transport, residential, tertiary, and agriculture and fishing. The evolution between 2000 and 2012 saw a slight decrease in the industrial sector (at 2,008 ktoe in 2012), constant for transport (at 1,878 ktoe in 2012), an increase by 2 percent for residential (at 1,024 ktoe in 2012) and constant for tertiary and agriculture and fishing (at 583 ktoe and 405 ktoe, respectively, in 2012).

It is worth mentioning that the political revolution in 2010 to 2011 had little impact on the energy sector in terms of production, imports, exports, and consumption.

Figure 123: Tunisia Energy Use by Sector, 2000 and 2012, Percentage



4.15.2 Energy Demand Outlook

Total final energy consumption by all end-use sectors is estimated to reach 6,602 ktoe in 2020, compared to 6,052 ktoe in 2012, representing the lowest increase in the region at 17 percent. Generated electricity is expected to reach 24,918 GWh in 2020 compared to 17,988 GWh in 2012.

In 2020, the industrial sector will remain the largest energy-consuming sector with a total projected consumption of 2,119 ktoe, followed by transport at 2,056 ktoe and residential sector at 1,214 ktoe.

Tertiary sector's estimated consumption will remain constant at 10 percent in 2020 with an estimated value of 651 ktoe, while the agriculture and fishing sector is estimated to fall 7 percent to 6 percent at a value of 425 ktoe.

Figure 124: Tunisia Energy Use by Sector 2020

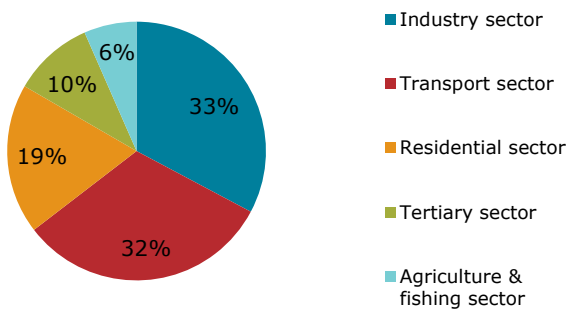
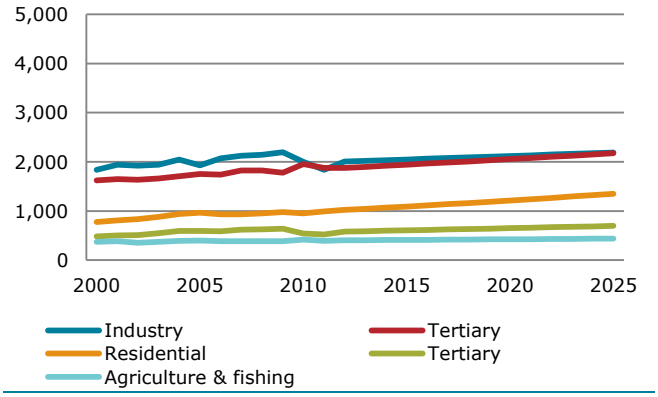


Figure 125: Tunisia Final energy Consumption for End-use Sectors

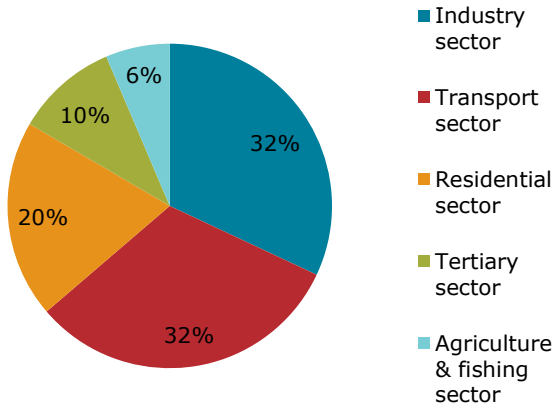


4.15.3 Energy Demand Outlook 2025

Final energy consumption by end-use sectors is expected to reach 6,981 ktoe in 2025, with electricity generation amounting to 30,547 GWh. The industry and transport sectors are estimated to be the most two intensive sectors (both at 32 percent), followed by residential (at 20 percent), tertiary (at 10 percent).

In 2025, the tertiary sector will still consume more energy than agriculture and fishing, which is estimated to represent 6 percent of total energy consumed in Tunisia.

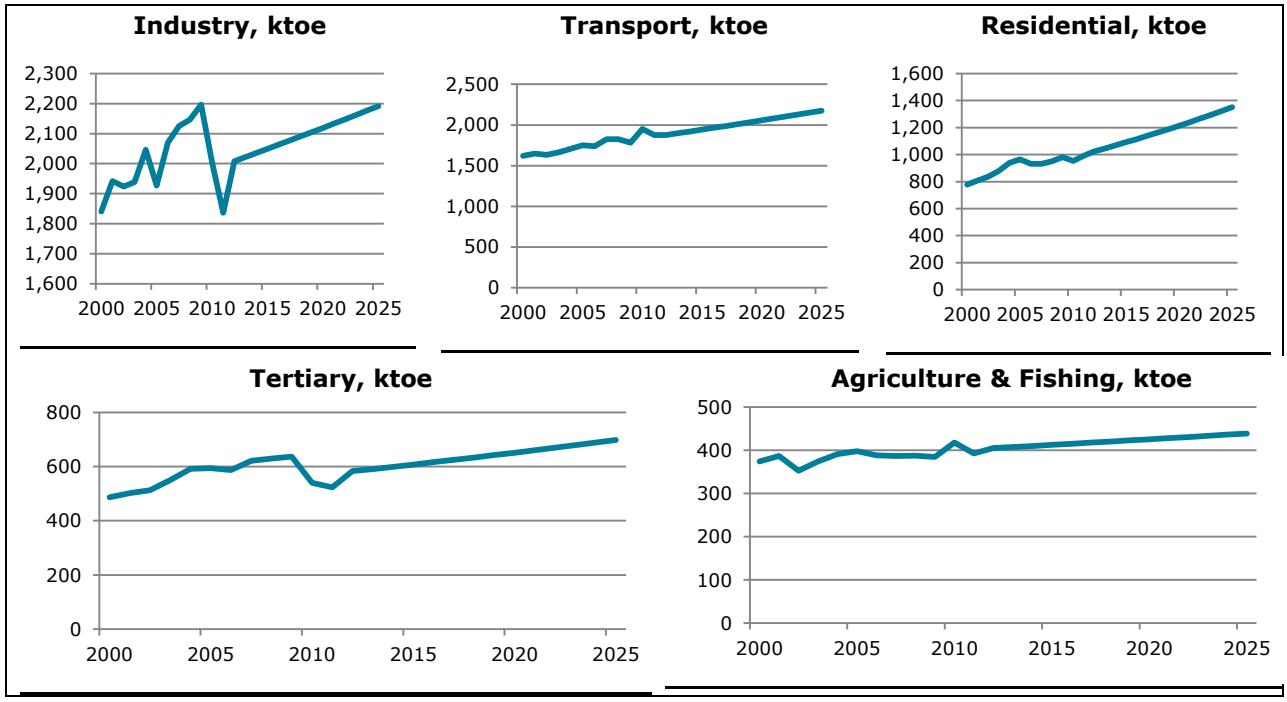
Figure 126: Tunisia Energy Use by Sector 2025



Out of the total energy consumed, the industrial sector will consume 2,192 ktoe in 2025, compared to 1,840 ktoe in 2000. The transport sector will consume 2,176 ktoe compared to 1,621 ktoe in 2000, residential sector will consume 1,351 ktoe compared to 777 ktoe, and the tertiary sector will consume 698

ktoe. The agriculture and fishing sector consumption will increase from 374 ktoe in 2000 to 439 ktoe in 2025.

Figure 127: Tunisia Energy Consumption Trends by Sector



4.15.4 Energy Efficiency Potential

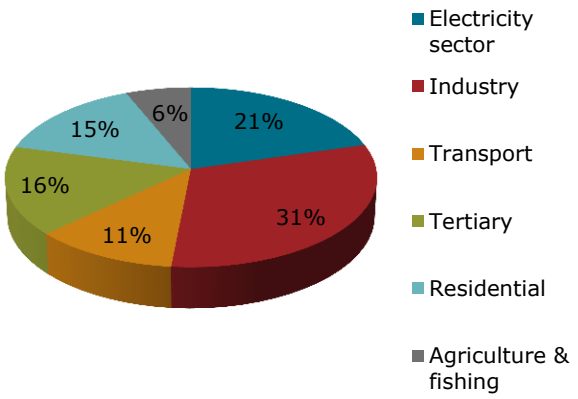
Total primary energy supplied in Tunisia was 9,966 ktoe in 2012, compared to 7,304 ktoe in 2000, of which 61 percent consumed by end-use sectors.

The total EE potential for Tunisia in 2012 was 2,181 ktoe,[34] with 21 percent from the electricity sector and 79 percent from end-use sectors. The end-use sector with the highest EE potential was industry at 677 ktoe (31 percent), followed by tertiary at 349 ktoe (16 percent), residential at 321 ktoe (15 percent), transport at 251 ktoe (11 percent), and agriculture and fishing at 135 ktoe (6 percent). The EE potential represented 22 percent of total primary energy consumption for 2012.

Table 38: Tunisia EE Potential, ktoe, 2012

Sector	EE Potential, ktoe, 2012
Electricity Sector	**448**
End-Use Sectors	**1,734**
Industry	677
Transport	251
Residential	321
Tertiary	349
Agriculture and Fishing	135
TOTAL	**2,181**
	22% of TPES

Figure 128: Tunisia EE Potential, 2012



4.15.4.1 Electricity Generation

Electricity generation in Tunisia for 2012 was 1,547 ktoe, with an annual increase of 4.2 percent from 2000. The power generation efficiency amounted to 40 percent in 2012. Using the country-tailored benchmark based on sector situation, a hypothesis,[35] and international references set at 52 percent, the EE potential of the power generation sector is estimated to be 396 ktoe. The specific consumption of power generation was 196 toe/GWh in 2012.

The transmission and distribution electricity losses were 14.3 percent, of which 4 percent came from transmission and 10.3 percent from distribution in 2011. A sub-regional benchmark was set at 3 percent for transmission and 8 percent for distribution losses estimated the EE potential at 16 ktoe for transmission and 36 ktoe for distribution in 2011. The entire electricity generation sector has an estimated EE potential of 448 ktoe for 2012 in terms of primary energy.

[34] Estimations for electricity sector are in terms of primary energy, estimations for transport and agriculture and fishing sectors are in terms of final energy, while estimations for industry, residential and tertiary sectors are in terms of primary and final energy.

[35] Switch of steam and GT plants to CCGT with 60 percent efficiency.

4.15.4.2 End-Use Sectors

i. Industry

The final energy intensity of the industrial sector was 0.604 toe/1,000 USD in 2012. A country-tailored benchmark of 0.45 toe/1,000 USD was set based on the structure of the industry sector, its evolution, and other country performances. This benchmark estimated the EE potential of the industry sector in terms of final energy at 511 ktoe in 2012, 26 percent of the total energy consumed by the sector. Out of the nine energy-intensive industries, data was only available for cement, which has an estimated potential based on specific energy at 398 ktoe in 2012.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 165 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 677 ktoe.

The average emissions factor of the industry sector was 2.27 $teCO_2$/toe in 2012, a decrease of almost 9 percent since 2000. The CO_2 intensity was 1.37 $teCO_2$/1,000 USD, a 28 percent decrease since 2000).

ii. Transport

The final energy intensity of the transport sector was 0.09 toe/1,000 USD for 2012 while the average energy unit consumption of cars was 1,136 kgoe/car/yr. EE potential in terms of final energy was 251 ktoe for the transport sector based on the energy unit consumption of cars and using a country-tailored benchmark of 950 Kgoe/car/yr. The EE potential for the transport sector was based on road transport only due to lack of data for railways, air, and maritime transport. The total EE potential represented 13 percent of total energy consumed by this sector in 2012.

The average emissions factor for the transport sector was 3.6 teCO2/toe in 2012, and CO_2 intensity of 0.33 $teCO_2$/1,000 USD, down from 0.45 in 2000. On the other hand, the motorization rate in Tunisia decreased from 12.74 persons per vehicle in 2000 to 8.01 persons per vehicle in 2012.

iii. Tertiary

The final energy intensity of the tertiary sector in 2012 was 0.053 toe/1,000 USD. Using the country-tailored benchmark based on the Plan Bleu study set at 0.035 toe/1,000 USD, the EE potential in terms of final energy was estimated to be 195 ktoe in 2012. The EE potential represented 33 percent of total energy consumed by this sector in 2012.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 155 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 349 ktoe.

The average emission factor was 1.8 $teCO_2$/toe in 2012, compared to 2 $teCO_2$/toe in 2000. The CO_2 intensity of the tertiary sector was 0.1 $teCO_2$/1,000 USD, compared to 0.2 $teCO_2$/1,000 USD in 2000.

iv. Residential

The energy intensity of the residential sector was 0.077 toe/1,000 USD in 2012, down from 0.101 toe/1,000 USD in 2000. The specific consumption of energy per unit area was 3.27 kgoe/m^2/yr in 2012, increasing from 3 kgoe/m^2/yr in 2000. The reference indicator—a chosen-specific consumption of energy per unit area—combined with a country-tailored benchmark based on the Plan Bleu study estimated the EE potential in terms of final energy to be 209 ktoe in 2012. The total EE potential represented 20 percent of total energy consumed by this sector in 2012.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 112 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 321 ktoe.

The unit consumption of energy per dwelling decreased from 344 kgoe/Dw in 2000 to 327 kgoe/Dw in 2012. On the other hand, the average emissions factor was 2.1 teCO_2/toe and the CO_2 intensity of the residential sector was 0.2 teCO_2/1,000 USD in 2012.

v. Agriculture and Fishing Sector

The final energy intensity of the agriculture sector was 0.18 toe/1,000 USD in 2012, while the specific energy consumption for fishing was 0.88 toe/ton. The EE potential in terms of final energy was 135 ktoe for 2012 for the agriculture and fishing sector using a country-tailored benchmark based on estimations (0.14 for agriculture and 0.7 for fishing, respectively).

4.15.5 Energy Efficiency Potential 2020 and 2025

The technical EE potential projected for 2020 and 2025 was 2,562 ktoe and 2,412 ktoe, respectively. The EE potential was based on the annual sectoral variation for 2000 to 2012. Based on the projected values of 2025, the total EE potential represents 14 percent of TPES. Figure 129 shows the percentages of the subsectors with their projected EE potential, while Figure 130 shows the variation of the EE potential for 2012, 2020, and 2025.

Figure 129: Tunisia Projected EE Potential, 2025

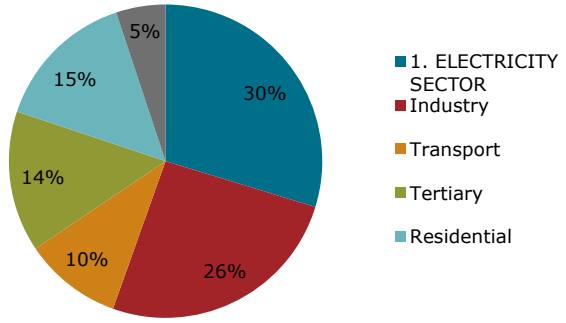
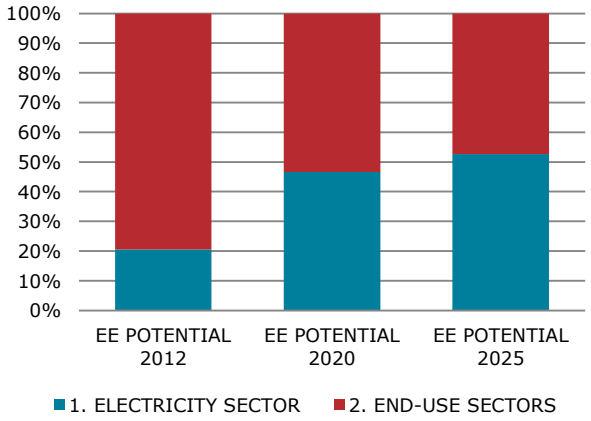


Figure 130: Tunisia EE Potential 2012-2025



4.15.6 Cost of conserved energy

Table 39 below lists the available data on the electricity efficiency potential abatement cost curve for Tunisia in 2020. It provides a combined estimation of electricity efficiency potential and net abatement cost by end-use sectors for a set of EE technologies.

The total cost-effective electricity efficiency potential (659 ktoe) has been mostly identified in the residential sector reaching 71 percent of the total identified electricity efficiency potential[36]. Two technologies, efficient space heating in new buildings and efficient fridges, accounted respectively for 39 percent and 50 percent of the total electricity efficiency potential. The SWH contribution accounted for a small share of only 7 percent in the total electricity efficiency potential which highlights the fact that is already greatly penetrated in both sectors.

The needed annual investment cost to realise this electricity efficiency potential is estimated to USD 64 million, most of it in the residential sector with 78 percent. Efficient space heating and efficient fridges account for the largest shares of this cost with 20 percent and 62 percent, respectively. Over the period 2012 to 2020, the total investment cost of USD 695 million is largely compensated by the net (negative) abatement cost of USD 4,024 million.

Table 39: Electricity Efficiency Potential Abatement Investment Costs by End-Use Sectors and EE Technologies for Tunisia over the Period 2012-2020

Sectors/EE technologies	Electricity Efficiency Potential			Investment Cost (3)	Net abatement cost (2)
	Total of subsector (1)	By EE technology (2)			
	ktoe/y	ktoe/y	USD/toe	M USD/y	M USD/y
Tertiary	**116,9**	**7,7**		**1,3**	**-60,8**
SWH*		7,7	170	1,3	-60,8
Residential	**90,2**	**651,2**		**62,4**	**-442,1**
Efficient lighting		24,3	120	2,9	-75,0
Efficient space heating in new buildings		255,4	140	35,8	-66,8
Efficient washing machines		3,4	170	0,6	-236,7
Efficient fridges		329,4	120	39,5	-3,6
SWH*		38,7	170	6,6	-59,9
TOTAL	**207,2**	**658,9**		**86,7**	**-503,0**
Total without SWH		**612,5**			
% of total Electricity Efficiency Potential		**295,7%**			

[36] The industrial sector is not covered in the Budget Allocation Chart (BAC) owing to a lack of relevant data in this sector. At the contrary, the availability and quality of detailed data in the residential sector BAC allowed to identify and detail various EE&RE technologies, resulting in a higher coverage (ratio up to 3) of the total identified electricity efficiency potential.

Notes:
* SWH is not listed in the EE potential estimation by subsector but covered here
Sources
(1) Study estimations for 2020 based on 2012-2020 annual variation (see Task on EE potential)
(2) Data for 2020. Budget Allocation Chart (BAC), MED-ENEC and MED-EMIP, 2010
(3) *Energy efficiency in Building sector of the South Mediterranean countries*, Plan Bleu, 2012

Table 40: Electricity Efficiency Potential and Net Abatement Cost by EE Technologies for Tunisia over the Period 2012-2020

Sectors/EE technologies	Electricity Efficiency Potential	Net abatement cost
	ktoe/y	M USD/y
SWH (tertiary)	7,7	-60,8
Efficient lighting	24,3	-75,0
Efficient space heating in new buildings	255,4	-66,8
Efficient washing machines	3,4	-236,7
Efficient fridges	329,4	-3,6
SWH (residential)	38,7	-59,9
TOTAL	**658,9**	**-503,0**

4.15.7 Reduction in energy expenditures and avoided investments

The main results in terms of sectoral and technology reductions in electricity expenditures and avoidable electricity capacity investments are presented in Table 41.

Table 41: Reductions in Electricity Expenditures and Avoided Power Investments for Tunisia over the Period 2012-2020

Sectors/EE technologies	Electricity Efficiency Potential		Reductions in electricity expenditures (a)	Avoidable electricity capacity investments (b)	
	Total of subsector (1)	By EE technology (2)	M USD/y	MW	M USD (c)
	ktoe/y	**ktoe/y**			
Tertiary	**116,9**	**7,7**	**8,3**	**20,3**	**22,3**
SWH		7,7	8,3	20,3	22,3
Residential		**651,2**	**747,6**	**1 709,4**	**1 880,4**
Efficient lighting		24,3	27,9	63,9	70,3
Efficient space heating in new buildings	**90,2**	255,4	293,2	670,5	737,5

Efficient washing machines		3,4	3,9	8,8	9,7
Efficient fridges		329,4	378,1	864,6	951,1
SWH		38,7	44,4	101,6	111,7
TOTAL	**207,2**	**658,9**	**755,9**	**1 729,7**	**1 902,7**
Total without SWH		612,5			
% of total Electricity Efficiency Potential / Installed capacity		**295,7%**		42,6%	
Notes:					
(a) based on average avoided electricity cost in 2020: low voltage: 0,076 €/kWh or 1,148 USD/toe; medium voltage: 0,071 €/kWh or 1,073 USD/toe (BAC Tunisia, 2020)					
(b) based on average electricity usage (hours/year)-without available data, hypothesis: similar to power plant time usage-around 5,000 h/y (2012)					
Power plant time usage (hours/year): 4 430					
(c) based on average investment cost of combined cycle (CCGT) of 850€/kW or 1,100 USD/kW (sources: IEA ETSAP, Fraunhofer Institut)					

According to these results, the electricity efficiency potential over the period 2012-2020 would be equivalent for end-customers to an annual reduction of almost USD 756 million of their electricity expenses. On the power generation side, the realisation of the electricity efficiency potential would avoid to use a capacity of 1,730 MW or almost 43 percent of Tunisia's current existing installed power capacity. This would then avoid new investment of almost USD 1,900 million (based on CCGT technology). Those savings consumption and supply sides would then amount to USD 2,660 million or 12.7 percent of Tunisia's actual GDP at current price.

4.16 United Arab Emirates

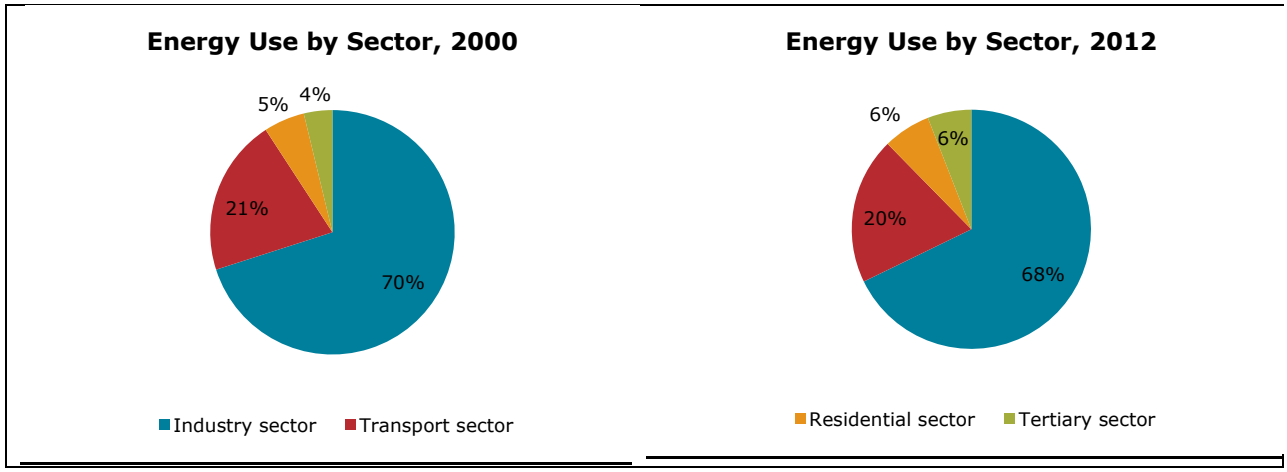
The total energy production of the United Arab Emirates (UAE) amounted to 194,348 ktoe in 2012, compared to 156,403 ktoe in 2000. Much of this was due to an increase of crude oil production from 123,013 ktoe in 2000 to 150,380 ktoe in 2012 and a parallel increase from 33,390 ktoe of natural gas production in 2000 to 43,968 ktoe in 2012. The country imports and exports large quantities of fuel; for instance, the UAE imported natural gas (15,656 ktoe), oil products (17,628 ktoe) and coal (1,685 ktoe) in 2012 and exported crude oil (120,593 ktoe), natural gas (6,154 ktoe), oil products (15,896 ktoe), and electricity (3 ktoe). Eight percent of produced energy was allocated for use in the petrochemicals sector, compared to 5 percent in 2000, while 10 percent of produced energy was used for international bunkers in the same year, up from 8 percent in 2000.

Total primary energy available for consumption was 67,402 ktoe for 2012, almost doubling from 2000. Electricity generation relied on natural gas and oil products as fuel input, with 98 percent from natural gas and 2 percent from oil products. In 2000, 97 percent of electricity generation was from natural gas and 3 percent from oil products. Total electricity generated amounted to 8,680 ktoe in 2012, compared to 3,435 ktoe in 2000.

Total energy consumed in the UAE was 49,964 ktoe for 2012, an increase of 100 percent from 2000. The main energy sources in 2012 were natural gas (29,015 ktoe), oil products (10,990 ktoe), electricity (6,433 ktoe), and coal (1,685 ktoe).

The largest energy-consuming sector in 2012 was industry at 32,627 ktoe (compared to 16,614 ktoe in 2000), followed by transport at 14,372 ktoe (compared to 4,922 ktoe), residential at 3,089 ktoe (compared to 1,284 ktoe), and tertiary at 2,852 ktoe (compared to 896 ktoe). Energy consumed for non-energy purposes was 1,841 ktoe in 2012, double that in 2000.

Figure 131: UAE Energy Use by Sector, 2000 and 2012, Percentage



4.16.1 Energy Demand Outlook, 2020

Energy consumption by end-use sector is expected to reach 84,533 ktoe in 2020, double the energy consumed in 2000.

The industrial sector will remain the largest energy-consuming sector at 66 percent in 2020 (compared to 70 percent in 2000), followed by transport at 19 percent (compared to 21 percent), tertiary at 8 percent (compared to 4 percent), and residential at 7 percent (compared to 5 percent).

Total energy consumption in the UAE is projected in 2020 to reach 49,426 ktoe by industry, 14,372 ktoe by transport, 5,814 ktoe by tertiary, and 5,301 ktoe by residential.

Figure 132: UAE Energy Use by Sector 2020

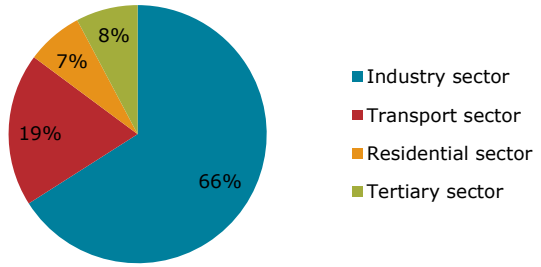
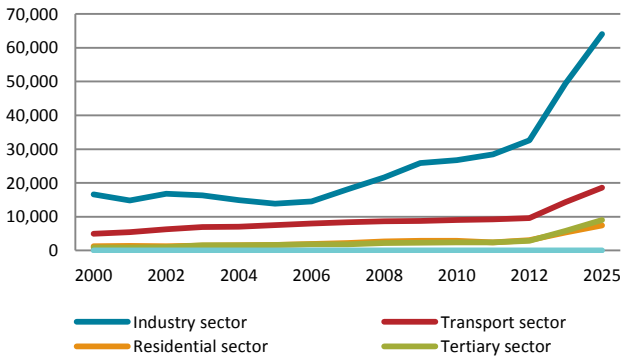


Figure 133: UAE Final Energy Consumption for End-use Sectors

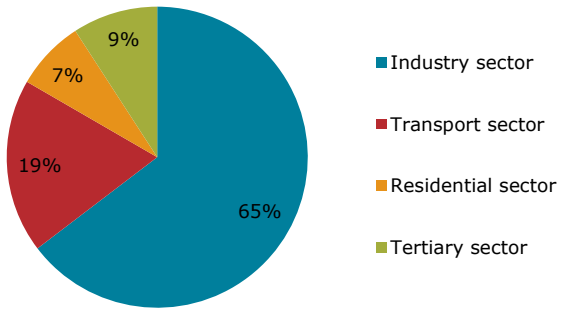


4.16.2 Energy Demand Outlook 2025

Total energy consumption by end use sectors is estimated to be 143,493 ktoe for 2025, compared with 24,596 ktoe for 2000.

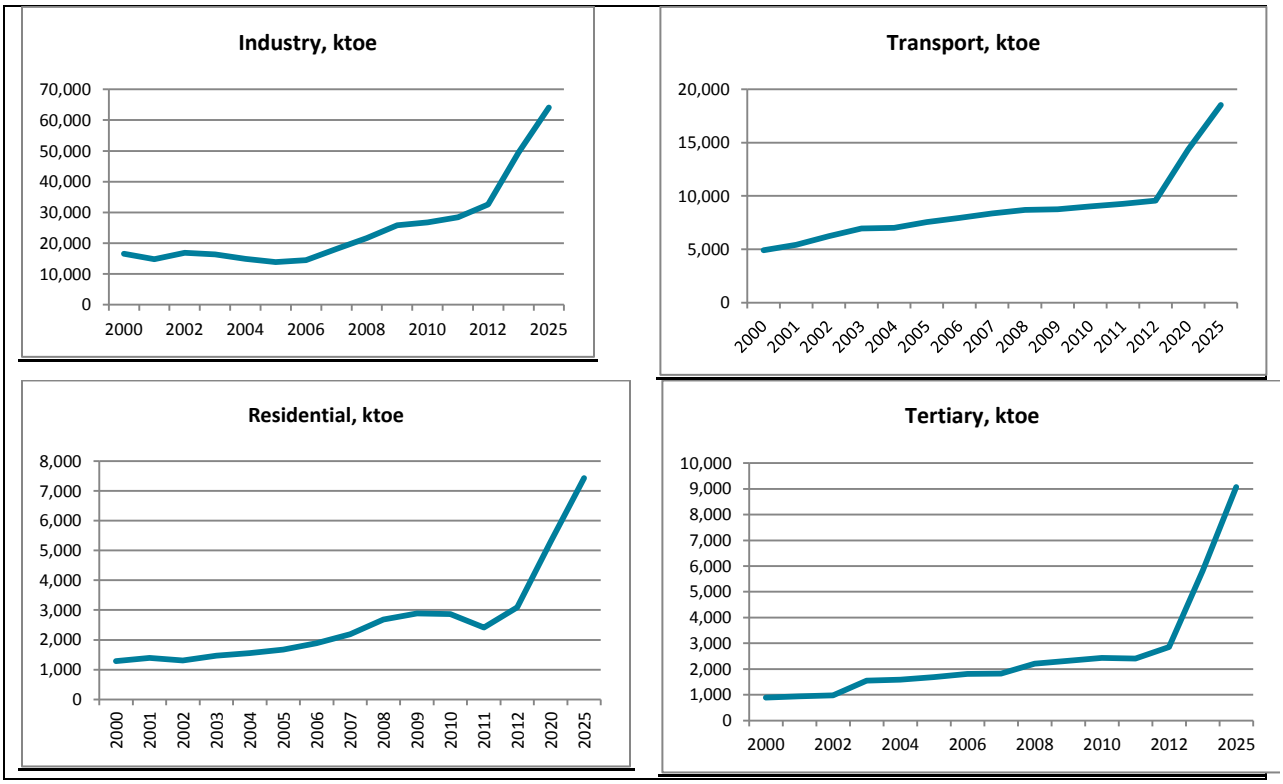
The percentage of each sectors' energy consumption out of total energy consumption between 2000 and 2015 is as follows: a decrease from 70 percent to 65 percent for industry, a decrease by 2 percent for the transport sector to 19 percent, an increase from 5 percent to 9 percent for the tertiary sector, and an increase of 2 percent for the residential sector to 7 percent.

Figure 134: UAE Energy Use by Sector 2025



Out of the total 143,493 ktoe of estimated energy consumed in 2025, the industrial sector will consume 64,075 ktoe, the transport sector 18,549 ktoe, tertiary 9,075 ktoe, and residential 7,430 ktoe.

Figure 135: UAE Energy Consumption Trends by Sector



4.16.3 Energy Efficiency Potential

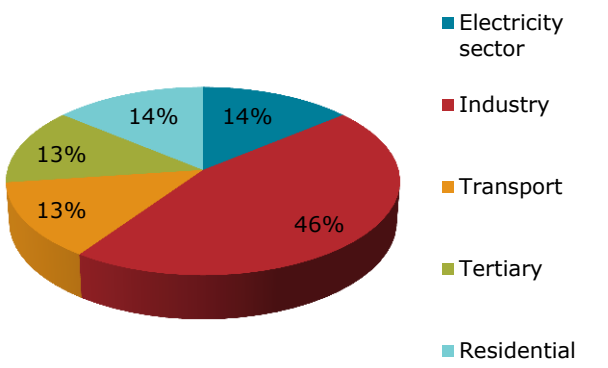
Total primary energy supplied was 67,402 ktoe in 2012, compared to 33,927 ktoe in 2000, a twofold increase of which 66 percent was from energy consumed by end-use sectors.

The total EE potential in the UAE in 2012 was 18,045 ktoe,[37] of which 14 percent was from the electricity sector and 86 percent from the end-use sectors. The end-use sector with the highest EE potential is industry at 8,238 ktoe, followed by 2,527 ktoe for residential, 2,388 ktoe for transport, and 2,366 ktoe for tertiary sector. The total EE potential represented 27 percent of total energy consumed by end-use sectors in 2012.

Table 42: UAE EE Potential, ktoe, 2012

Sector	EE Potential, ktoe, 2012
Electricity Sector	**2,527**
End-Use Sectors	**15,519**
Industry	8,238
Transport	2,388
Residential	2,527
Tertiary	2,366
Agriculture and Fishing	…
TOTAL	**18,045**
	27% of TPES

Figure 136: UAE EE Potential, 2012



4.16.3.1 Electricity Generation

Total electricity generation increased from 3,435 ktoe in 2000 to 8,680 ktoe in 2012. The power generation efficiency was 34 percent in 2012. The country-tailored benchmark was set at 43 percent, based on the situation of the sector and international references. This benchmark estimated the EE potential for power generation at 2,338 ktoe. The specific consumption of power generation was 254 toe/GWh in 2012.

The total transmission and distribution electricity losses amounted to 7.2 percent, with 3 percent from transmission and 4.2 percent from distribution. Sub-regional benchmarks were used to estimate an EE potential of 87 ktoe for transmission losses and 102 ktoe for distribution. The total EE potential for the electricity sector in terms of primary energy was 2,527 ktoe in 2012.

4.16.3.2 End-Use Sectors

i. Industry

The final energy intensity of the industry sector was 1.452 toe/1,000 USD in 2012. The country-tailored benchmark was 1.1 toe/1,000 USD based on the structure of the industry sector, its evolution, and other country performances based on a regional study.[38] The EE

[37] Estimations for electricity sector are in terms of primary energy, estimations for transport and agriculture and fishing sectors are in terms of final energy, while estimations for industry, residential and tertiary sectors are in terms of primary and final energy.

[38] "Energy Efficiency Guidebook, A GOIC Publication for GCC Industries," 2013.

potential in terms of final energy based on the energy intensity was 7,907 ktoe in 2012. The EE potential represented 24 percent of energy consumed by the industry sector in 2012.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 331 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 8,238 ktoe.

The average emission factor of the industry sector was 13.3 $teCO_2$/toe in 2012, compared to 13.2 $teCO_2$/toe in 2000, while the CO_2 intensity of the sector was 19.4 $teCO_2$/1,000 USD in 2012, increasing from 14.3 $teCO_2$/1,000 USD in 2000.

ii. Transport

The EE potential, in terms of final energy was 2,388 ktoe in 2012, based on an estimation of a 25 percent reduction of energy consumed. The EE potential for the transport sector takes into account only road transport due to lack of data for other means of transportation, such as maritime, air, and railways. The average emissions factor of the transport sector was 2.9 $teCO_2$/toe and the CO_2 intensity of the sector was 0.1 $teCO_2$/1,000 USD in 2012.

iii. Tertiary

The final energy intensity of the tertiary sector was 0.049 toe/1,000 USD in 2012. A country-tailored benchmark was set at 0.035 toe/1,000 USD based on a regional study. The EE potential, in terms of final energy, was estimated at 802 ktoe in 2012, which represented almost 28 percent of total energy consumed by the tertiary sector in that year.

In addition, the final electricity efficiency potential of the sector converted in primary energy was equivalent to 1,564 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 2,366 ktoe.

The average emission factor was 10.9 $teCO_2$/toe in 2012, while the CO_2 intensity of the tertiary sector amounted to 0.5 $teCO_2$/1,000 USD for the same year.

iv. Residential

The EE potential for the residential sector, in terms of final energy, was estimated at 896 ktoe in 2012 based on a country-tailored benchmark derived from a set of GCC and UAE individual audits, studies, and expert analysis (29 percent reduction of total energy consumed by the sector).

In addition, the final electricity efficiency potential of the sector converted in primary energy was 1,631 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 2,527 ktoe. The average emission factor was 11.1 $teCO_2$/1,000 USD in 2012.

v. Agriculture and Fishing Sector

Statistical data related to the energy intensity of the agriculture and fishing sector was unavailable for the United Arab Emirates. The EE potential was not estimated due to the lack of data for this sector.

4.16.4 Energy Efficiency Potential 2020 and 2025

The technical EE potential projected for 2020 and 2025 was 29,897 ktoe and 41,339 ktoe, respectively. The EE potential was based on the annual sectoral variation for 2000 to 2012. Based on the projected values of 2025, the total EE potential represents 25 percent of TPES. Figure 137 shows the percentages of the subsectors with their projected EE potential, while Figure 138 shows the variation of the EE potential for 2012, 2020, and 2025.

Figure 137: UAE Projected EE Potential, 2025

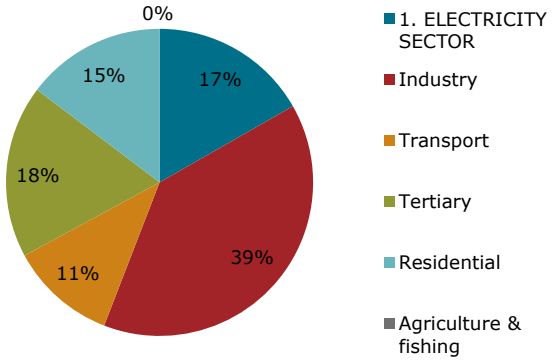
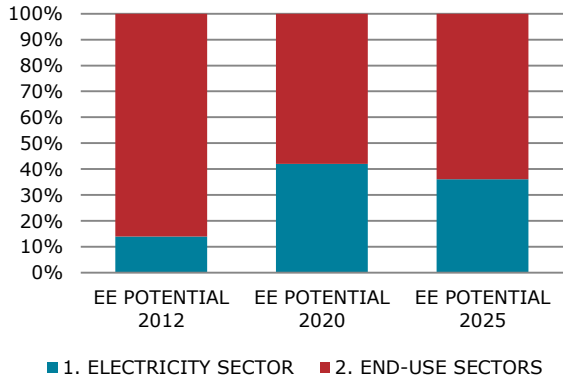


Figure 138: UAE EE Potential 2012-2025



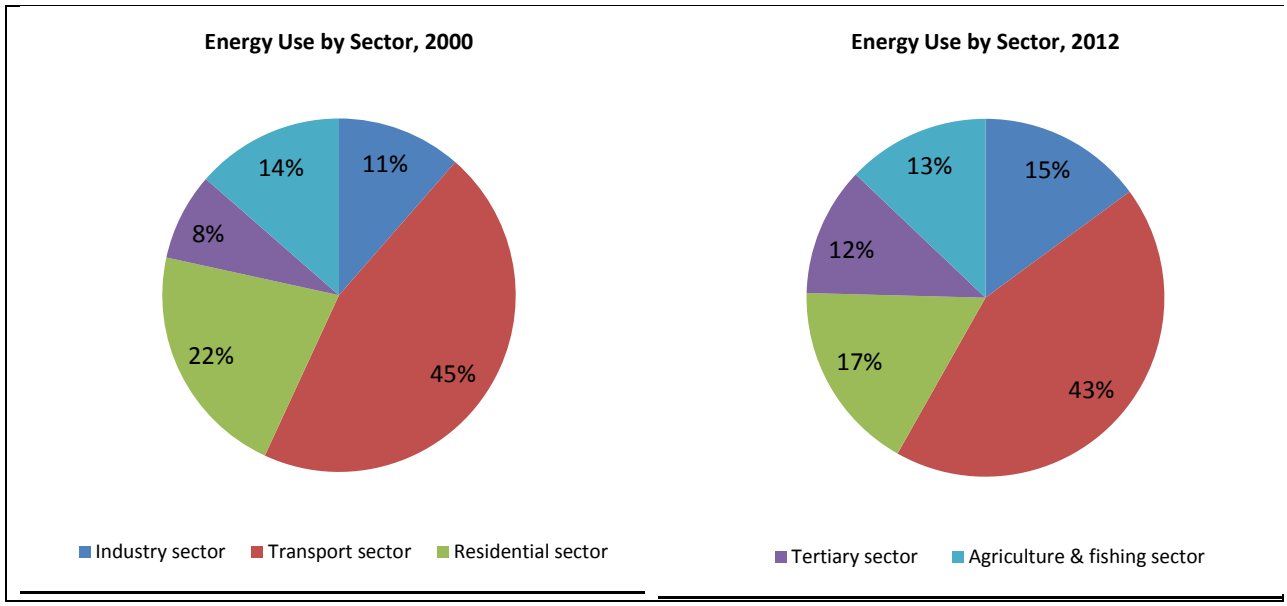
4.17 Yemen

4.17.1 Overview of Energy Supply and Demand

The production of energy in Yemen mainly relied on crude oil until 2009, when the country started producing natural gas, reaching a total of 8,604 ktoe in 2011. The production of crude oil decreased from 21,952 ktoe in 2000 to 8,229 ktoe in 2012. Yemen imported 3,117 ktoe of oil products in 2012. The country exported crude oil and oil products until 2009, when the export of natural gas started.

Electricity generated in Yemen is based on oil products only with a variation from 294 ktoe in 2000 to 566 ktoe in 2012. Oil products were heavily consumed by end-use sectors, representing about 90 percent of the total in 2012. Figure 139 represents the variation of the energy consumed by end-use sectors between 2000 and 2012. The transport sector consumed 45 percent of total energy available in 2000 and 43 percent in 2012, followed by the residential sector from 22 percent in 2000 to 17 percent in 2012. Agriculture and fishing sector decreased from 14 percent in 2000 to 13 percent in 2012.

Figure 139: Yemen Energy Use by Sector, 2000 and 2012, Percentage



4.17.2 Energy Demand Outlook

The proportion of the total energy consumed by end-use sector in 2020 will be 41 percent for the transport sector, 17 percent for industry, 15 percent for both residential and tertiary sector, and 12 percent for agriculture and fishing.

Total energy consumption will reach 4,157 ktoe in 2020, an increase of 10 percent from 2012. In addition, electricity generation is estimated to increase to 9,844 GWh in 2020.

Energy consumption by sectors in physical units is estimated for 2020 to be 1,711 ktoe for the transport sector, 715 ktoe for industry, 601 ktoe for tertiary, 613 ktoe for residential, and 510 ktoe for agriculture and fishing.

Figure 140: Yemen Energy Use by Sector 2020

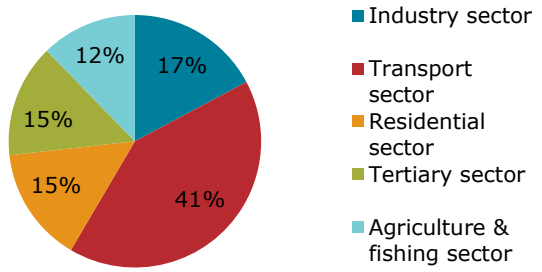
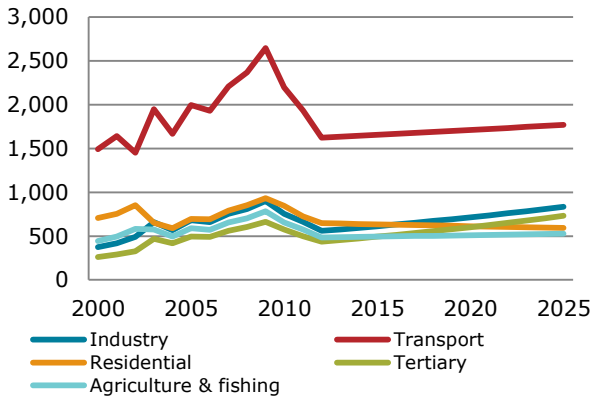


Figure 141: Yemen Final Energy Consumption for End-use Sectors, ktoe

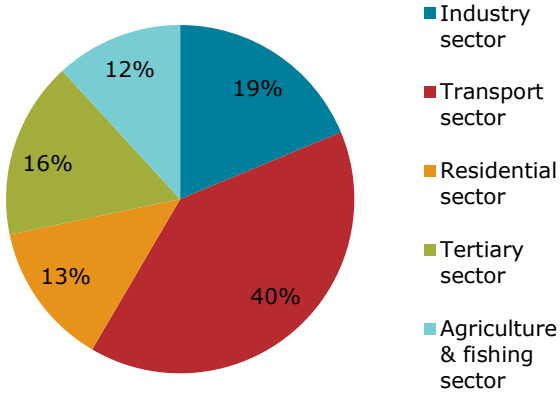


4.17.3 Energy Demand Outlook 2025

Total electricity generation will amount to 12,663 GWh in 2025, compared to 6,579 GWh in 2012, while energy consumption by end-use sectors will increase from 3,765 ktoe in 2012 to 4,458 ktoe in 2025.

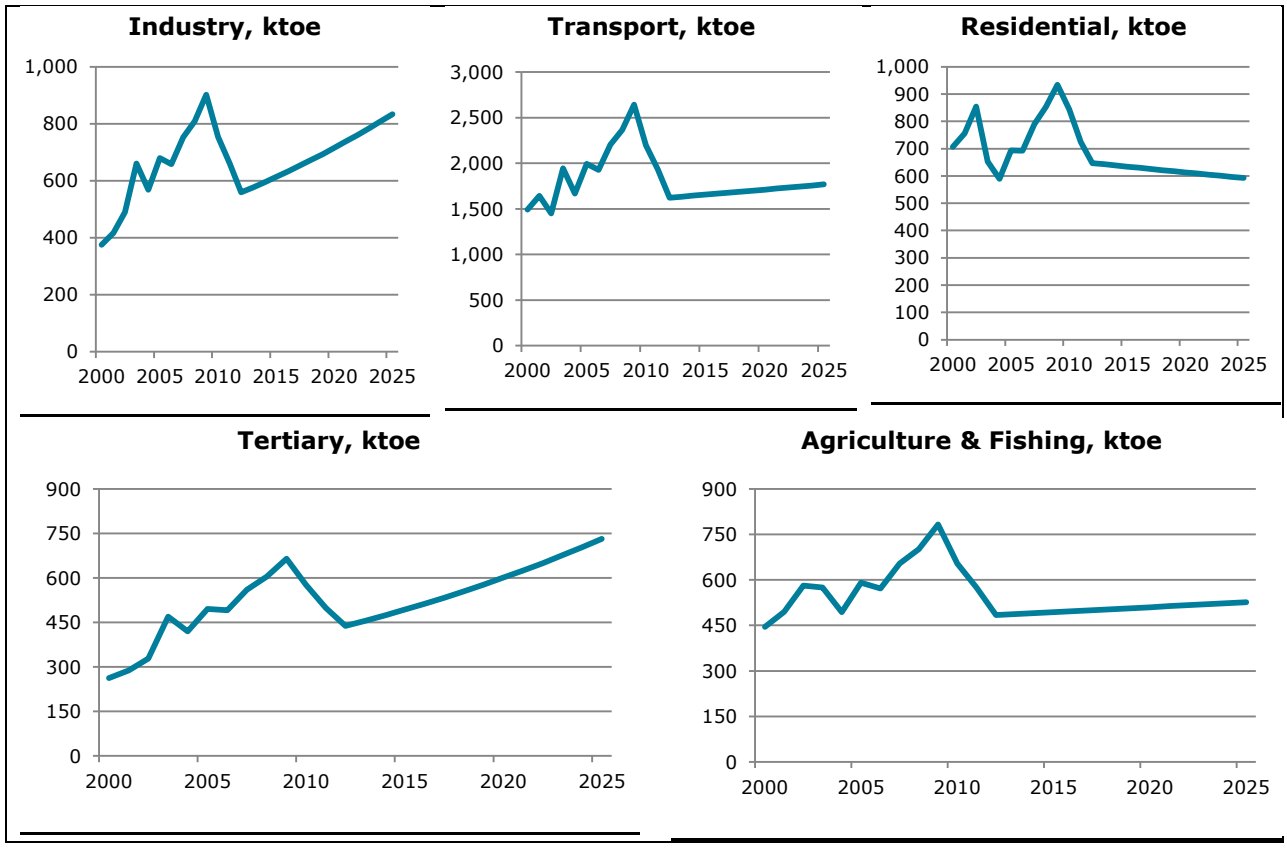
The distribution of total energy consumed by sector shows an increase of 4 percent for both the industrial and tertiary sectors, with a decrease of 3 percent, 4 percent, and 1 percent for the transport, residential and agriculture and fishing sectors respectively, for 2025 compared to 2012.

Figure 142: Yemen Energy Use by Sector 2025



Total energy consumed will be divided at 1,769 ktoe for the transport sector in 2025, 834 ktoe for the industry sector, 732 ktoe for the tertiary sector, 593 ktoe for the residential sector, and 527 ktoe for the agriculture and fishing sector.

Figure 143: Yemen Energy Consumption Trends by Sector



4.17.4 Energy Efficiency Potential

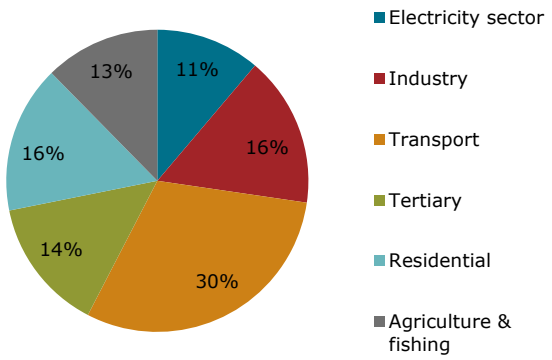
Total primary energy supplied was 7,890 ktoe in 2011, an increase of 66 percent from 2000, of which 60 percent of energy was consumed by end-use sectors.

Total EE potential was 944 ktoe[39] in 2012, of which 11 percent was for the electricity sector and 89 percent for end-use sectors. The total EE potential represented 12 percent of total primary energy supplied for 2011. The end-use sector with the highest EE potential was transport at 30 percent, followed by 16 percent for industry, 16 percent for residential, 14 percent for tertiary, and 13 percent for agriculture and fishing.

Table 43: Yemen EE Potential, ktoe, 2012

Sector	EE Potential, ktoe, 2012
Electricity Sector	**106**
End-Use Sectors	**838**
Industry	152
Transport	286
Residential	149
Tertiary	134
Agriculture and Fishing	117
TOTAL	**944**
	12% of TPES of 2011

Figure 144: Yemen EE Potential, 2012



4.17.4.1 Electricity Generation

Total electricity generation increased from 294 ktoe in 2000 to 566 ktoe in 2012, an annual increase of 5.2 percent. The EE potential for the power generation efficiency was 30 ktoe using the calculated power generation efficiency of 43 percent and the country-tailored benchmark of 45 percent for 2012. The specific consumption of power generation was 226 toe/GWh in 2012.

Transmission and distribution losses amounted to 27.4 percent for 2012, based on estimated data[40], where transmission losses were 3 percent and distribution losses 24.4 percent. The sub-regional benchmarks used were 3 percent for transmission losses and 11 percent for distribution. The EE potential for the transmission and distribution losses was estimated at 76 ktoe, with no EE potential for transmission and 76 ktoe for the distribution. The total EE potential for the electricity sector in Yemen in terms of primary energy was 106 ktoe for 2012.

[39] Estimations for electricity sector are in terms of primary energy, estimations for transport and agriculture and fishing sectors are in terms of final energy, while estimations for industry, residential and tertiary sectors are in terms of primary and final energy.

[40] Calculated from the energy balance data for 2011. Data for 2013 from AUPTDE indicates transmission losses at 2.5 percent and distribution losses at 33 percent. In addition, CSO Yemen statistics indicate a total transmission and distribution losses of 36 percent. Based on AUPTDE, the estimated commercial losses for 2012 were 8.3 percent

4.17.4.2 End-Use Sectors

i. Industry

The final energy intensity of the industry sector was 0.054 ktoe/1,000 USD in 2012. The country-tailored benchmark was set at 0.04 ktoe/1,000 USD, based on the structure of the industry sector, its evolution, and other country performances. The EE potential for the industry sector, in terms of final energy based on energy intensity was 146 ktoe in 2012. The EE potential represented 26 percent of the total energy consumed by the industry sector in 2012. Out of the nine energy-intensive industries, data was available for cement industries only, which had an estimated potential of 222 ktoe in 2012.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 6 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 152 ktoe.

The average emissions factor of the industry sector was 3 $teCO_2$/toe for 2012 while the CO_2 intensity of the industry sector was 0.17 $teCO_2$/1,000 USD.

ii. Transport

The final energy intensity of the transport sector was 0.139 toe/1,000 USD in 2012, while the average energy unit consumption of gasoline cars was 1,755 kgoe/car/yr. The average unit consumption of gasoline cars was selected for estimating the EE potential of the transport sector due its accuracy. Using the regionally tailored benchmark of 970 kgoe/car/yr, and the average unit consumption of gasoline cars, the EE potential in terms of final energy was 286 ktoe for 2012, 18 percent of total energy consumed by the transport sector. The EE potential represented road transport only due to lack of data for air and maritime transport.

The average emissions factor of the transport sector was 2.9 $teCO_2$/TOE in 2012, while the CO_2 intensity of the transport sector was 0.4 $teCO_2$/1,000 USD. The motorization rate in Yemen was 52 persons per vehicle in 2012.

iii. Tertiary

The energy intensity of the tertiary sector was 0.35 toe/1,000 USD in 2012. The EE potential for the tertiary sector in terms of final energy was 101 ktoe in 2012, using the country-tailored benchmark based on the comparison with Mediterranean countries of 0.27 toe/1,000 USD. The EE potential represented 23 percent of total energy consumed by the sector in 2012.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 34 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 134 ktoe.

iv. Residential

The energy intensity of the residential sector was 0.421 toe/1,000 USD in 2012, while the specific consumption of energy per unit area was 2.62 kgoe/m^2/yr. A country-tailored

benchmark of 2.2 kgoe/m2/yr based on the Plan Bleu study estimated the EE potential of this sector in terms of final energy to be 103 ktoe, which was 16 percent of the total energy consumed by the residential sector for 2012.

In addition, the final electricity efficiency potential of the sector converted in primary energy was 46 ktoe. This potential added to the EE potential in final energy estimated the total EE potential for the sector at 149 ktoe.

The unit consumption of energy per dwelling amounted to 183 kgoe/Dw in 2012 compared to 265 kgoe/Dw in 2000, while the unit consumption of electricity per dwelling was 719 Kwh/Dw for 2012. The average emission factor of the residential sector was 4.5 $teCO_2$/toe in 2012 and the CO_2 intensity 1.9 $teCO_2$/1000 USD.

v. Agriculture and Fishing Sector

The final energy intensity of the agriculture sector was 0.308 ktoe in 2012, compared to 0.368 ktoe in 2000. On the other hand, the specific consumption for fishing was 0.082 toe/ton in 2012, compared to 0.13 toe/ton in 2000. Two country-tailored benchmarks were used for agriculture and for fishing to estimate the EE potential of 113 ktoe for agriculture and 3.4 ktoe for fishing, for a total of 117 ktoe in 2012, which represented 24 percent of total energy used by the sector.

4.17.5 Energy Efficiency Potential 2020 and 2025

The technical EE potential projected for 2020 and 2025 was 1,121 ktoe and 1,271 ktoe, respectively. The EE potential was based on the annual sectoral variation for 2000 to 2012. Based on the projected values of 2025, the total EE potential represents 23 percent of total TPES. Figure 145 shows the percentages of the subsectors with their projected EE potential, while Figure 146 shows the variation of the EE potential for 2012, 2020, and 2025.

Figure 145: Yemen Projected EE Potential, 2025

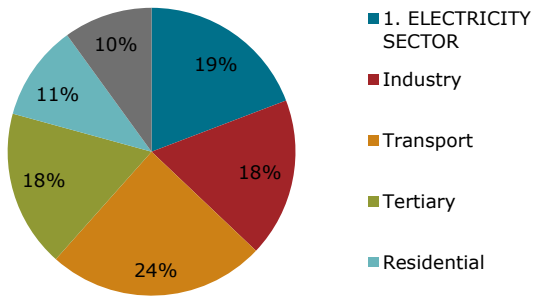
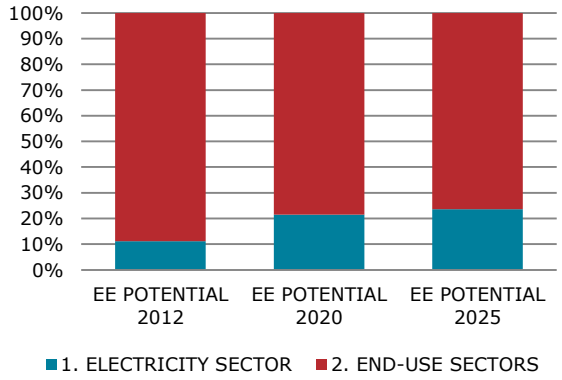


Figure 146: Yemen EE Potential 2012-2025



List of figures

Figure 1: Energy Use by Sectors, 2000 and 2011, Percentage....20
Figure 2: Projected MENA Final Energy Use by Sector, 2020....21
Figure 3: Final Regional Energy Consumption for End-Use Sector, Mtoe....21
Figure 4: Energy Use by Sector, 2025....22
Figure 5: Energy Consumption Trends by Sector....22
Figure 6: Total MENA EE Potential, 2012....23
Figure 7: Electricity Sector EE Potential, 2012....23
Figure 10: Total MENA EE potential in 2025....27
Figure 9: Total MENA EE potential in 2020....27
Figure 10: End-use sectors EE potential 2025....27
Figure 11: Algeria Energy Use by Sector, 2000 and 2011, Percentage....29
Figure 12: Algeria Energy Use by Sector 2020....30
Figure 13: Algeria Final Energy Consumption of End-Use Sectors....30
Figure 14: Algeria Energy Use by Sector 2025....30
Figure 15: Algeria Energy Consumption Trends by Sector....31
Figure 16: Algeria EE Potential, 2011....32
Figure 17: Algeria Projected EE Potential, 2025....34
Figure 18: Algeria EE Potential, 2011-2025....34
Figure 19: Bahrain Energy Use by Sector, 2000 and 2012, Percentage....35
Figure 20: Bahrain Energy Use by Sector 2020....36
Figure 21: Bahrain Final Energy Consumption by End-Use Sectors, ktoe....36
Figure 22: Bahrain Energy Use by Sector 2025....36
Figure 23: Bahrain Energy Consumption Trends by Sector....37
Figure 24: Bahrain EE Potential, 2012....38
Figure 25: Bahrain Projected EE Potential, 2025....40
Figure 26: Bahrain EE Potential 2012-2025....40
Figure 27: Egypt Energy Use by Sector, 2000 and 2012, Percentage....41
Figure 28: Egypt Energy Use by Sector 2020....42
Figure 29: Egypt Final Energy Consumption by End-Use Sectors, ktoe....42
Figure 30: Egypt Energy Use by Sector 2025....42
Figure 31: Egypt Energy Consumption Trends by Sector....43
Figure 32: Egypt EE Potential, 2012....44
Figure 33: Egypt Projected EE Potential, 2025....46
Figure 34: Egypt EE Potential 2012-2025....46
Figure 35: Iraq Energy Use by Sector, 2000 and 2011, Percentage....49
Figure 36: Iraq Energy Use by Sector 2020....50
Figure 37: Iraq Final Energy Consumption by End-Use Sectors, ktoe....50
Figure 38: Iraq Energy Use by Sector 2025....50
Figure 39: Iraq Energy Consumption Trends by Sector....51
Figure 40: Iraq EE Potential, 2012....52
Figure 41: Iraq Projected EE Potential, 2025....54
Figure 42: Iraq EE Potential 2012-2025....54
Figure 43: Jordan Energy Use by Sector, 2000 and 2012, Percentage....55
Figure 44: Jordan Energy Use by Sector 2020....56

Figure 45: Jordan Final Energy Consumption by End-Use Sectors, ktoe 56
Figure 46: Jordan Energy Use by Sector 2025 56
Figure 47: Jordan Energy Consumption Trends by Sector 57
Figure 48: Jordan EE Potential, 2012 58
Figure 49: Jordan Projected EE Potential, 2025 60
Figure 50: Jordan EE Potential 2012-2025 60
Figure 51: Kuwait Energy Use by Sector, 2000 and 2012, Percentage 65
Figure 52: Kuwait Energy Use by Sector 2020 66
Figure 53: Kuwait Final Energy Consumption by End-Use Sectors, ktoe 66
Figure 54: Kuwait Energy Use by Sector 2025 66
Figure 55: Kuwait Energy Consumption Trends by Sector 67
Figure 56: Kuwait EE Potential, 2012 68
Figure 57: Kuwait Projected EE Potential, 2025 70
Figure 58: Kuwait EE Potential 2012-2025 70
Figure 59: Lebanon Energy Use by Sector, 2000 and 2012, Percentage 71
Figure 60: Lebanon Energy Use by Sector 2020 72
Figure 61: Lebanon Final Energy Consumption for End-Use Sectors, ktoe 72
Figure 62: Lebanon Energy Use by Sector 2025 72
Figure 63: Lebanon Energy Consumption Trends by Sector 73
Figure 64: Lebanon EE Potential, 2012 74
Figure 65: Lebanon Projected EE Potential, 2025 76
Figure 66: Lebanon EE Potential 2012-2025 76
Figure 67: Libya Energy Use by Sector, 2000 and 2011, Percentage 80
Figure 68: Libya Energy Use by Sector 2020 81
Figure 69: Libya Final Energy Consumption for End-use Sectors, ktoe 81
Figure 70: Libya Energy Use by Sector 2025 81
Figure 71: Libya Energy Consumption Trends by Sector 82
Figure 72: Libya EE Potential, 2012 83
Figure 73: Libya Projected EE Potential, 2025 85
Figure 74: Libya EE Potential 2012-2025 85
Figure 75: Morocco Energy Use by Sector, 2000 and 2012, Percentage 86
Figure 76: Morocco Energy Use by Sector 2020 87
Figure 77: Final Energy Consumption for End-use Sectors 87
Figure 78: Morocco Energy Use by Sector 2025 87
Figure 79: Morocco Energy Consumption Trends by Sector 88
Figure 80: Morocco EE Potential, 2012 89
Figure 81: Morocco Projected EE Potential, 2025 91
Figure 82: Morocco EE Potential 2012-2025 91
Figure 83: Oman Energy Use by Sector, 2000 and 2012, Percentage 95
Figure 84: Oman Energy Use by Sector 2020 96
Figure 85 : Oman final Energy Consumption for End-use Sectors, ktoe 96
Figure 86: Oman Energy Use by Sector 2025 96
Figure 87: Oman Energy Consumption Trends by Sector 97
Figure 88: Oman EE Potential, 2012 98
Figure 89: Oman Projected EE Potential, 2025 100
Figure 90: Oman EE Potential 2012-2025 100

Figure 91: Palestine Energy Use by Sector, 2001 and 2011, Percentage 101
Figure 92: Palestine Energy Use by Sector 2020 102
Figure 93 : Final Energy Consumption for End-use Sectors, ktoe 102
Figure 94: Palestine Energy Use by Sector 2025 102
Figure 95: Palestine Energy Consumption Trends by Sector 103
Figure 96: Palestine EE Potential, 2011 104
Figure 97: Palestine Projected EE Potential, 2025 106
Figure 98: Palestine EE Potential 2011-2025 106
Figure 99 : Qatar Energy Use by Sector, 2000 and 2012, percentage 107
Figure 100: Qatar Energy Use by Sector 2020 108
Figure 101: Qatar Final Energy Consumption for End-use Sectors 108
Figure 102: Qatar Energy Use by Sector 2025 108
Figure 103: Qatar Energy Consumption Trends by Sector 109
Figure 104: Qatar EE Potential, 2012 110
Figure 105: Qatar Projected EE Potential, 2025 112
Figure 106: Qatar EE Potential 2012-2025 112
Figure 107: Saudi Arabia Energy Use by Sector, 2000 and 2012, Percentage 113
Figure 108: Saudi Arabia Energy Use by Sector 2020 114
Figure 109: Saudi Arabia Final Energy Consumption by End-use Sector 114
Figure 110: Saudi Arabia Energy Use by Sector 2025 114
Figure 111: Saudi Arabia Energy Consumption Trends by Sector 115
Figure 112: Saudi Arabia 2012 Total EE Potential 116
Figure 113: Saudi Arabia Projected EE Potential, 2025 118
Figure 114: Saudi Arabia EE Potential 2012-2025 118
Figure 115 : Sudan Energy Use by Sector, 2000 and 2011, Percentage 119
Figure 116: Sudan Energy Use by Sector 2020 120
Figure 117: Sudan Final Energy Consumption for End-use Sectors 120
Figure 118: Sudan Energy Use by Sector 2025 120
Figure 119: Sudan Energy Consumption Trends by Sector 121
Figure 120: Sudan EE Potential, 2011 122
Figure 121: Sudan Projected EE Potential, 2025 124
Figure 122: Sudan EE Potential 2011-2025 124
Figure 123: Tunisia Energy Use by Sector, 2000 and 2012, Percentage 125
Figure 124: Tunisia Energy Use by Sector 2020 126
Figure 125: Tunisia Final energy Consumption for End-use Sectors 126
Figure 126: Tunisia Energy Use by Sector 2025 126
Figure 127: Tunisia Energy Consumption Trends by Sector 127
Figure 128: Tunisia EE Potential, 2012 128
Figure 129: Tunisia Projected EE Potential, 2025 130
Figure 130: Tunisia EE Potential 2012-2025 130
Figure 131: UAE Energy Use by Sector, 2000 and 2012, Percentage 134
Figure 132: UAE Energy Use by Sector 2020 135
Figure 133: UAE Final Energy Consumption for End-use Sectors 135
Figure 134: UAE Energy Use by Sector 2025 135
Figure 135: UAE Energy Consumption Trends by Sector 136
Figure 136: UAE EE Potential, 2012 137

Figure 137: UAE Projected EE Potential, 2025 139
Figure 138: UAE EE Potential 2012-2025 139
Figure 139: Yemen Energy Use by Sector, 2000 and 2012, Percentage 140
Figure 140: Yemen Energy Use by Sector 2020 141
Figure 141: Yemen Final Energy Consumption for End-use Sectors, ktoe 141
Figure 142: Yemen Energy Use by Sector 2025 141
Figure 143: Yemen Energy Consumption Trends by Sector 142
Figure 144: Yemen EE Potential, 2012 143
Figure 145: Yemen Projected EE Potential, 2025 145
Figure 146: Yemen EE Potential 2012-2025 145

List of tables

Table 1: Data Availability and Sources for Estimating Energy Demand Projections 9
Table 2: Data Availability and Sources for Estimating Energy Savings Potential 11
Table 3: Availability of EE Indicators for Energy Intensive Industrial Products 2000-2012 .. 12
Table 4: Availability of EE Indicators for Road Transport Sectors (Personal Cars) 2000-2012 12
Table 5: Electricity Efficiency Potential Abatement Investment Cost, and Net Abatement Cost by End-use Sectors and EE Technologies 17
Table 6: Electricity Efficiency Potential, Investment Cost and Net Abatement Cost by EE Technologies 17
Table 7: Reductions in Electricity Expenditures and Avoided Power Investments 18
Table 8: MENA EE Potential 23
Table 9: Assessment of EE Deployment of Technologies and Measures by Sector 25
Table 10: EE Potential in the MENA Region in 2012 25
Table 11: MENA EE potential 2020, 2025 26
Table 12: Algeria EE Potential, 2011 32
Table 13: Bahrain EE Potential, ktoe, 2012 38
Table 14: Egypt EE Potential, ktoe, 2012 44
Table 15: Electricity Efficiency Potential Abatement Investment Costs by End-Use Sectors and EE Technologies for Egypt over the Period 2012-2020 47
Table 16: Electricity Efficiency Potential and Net Abatement Cost by EE Technologies for Egypt Over the Period 2012-2020 47
Table 17: Reductions in Electricity Expenditures and Avoided Power Investments for Egypt over the Period 2012-2020 48
Table 18: Iraq EE Potential, ktoe, 2012 52
Table 19: Jordan EE Potential, ktoe, 2012 58
Table 20: Electricity Efficiency Potential Abatement Investment Costs by End-Use Sectors and EE Technologies for Jordan over the Period 2012-2020 61
Table 21: Electricity Efficiency Potential and Net Abatement Cost by EE Technologies for Jordan over the Period 2012-2020 62
Table 22: Reductions in Electricity Expenditures and Avoided Power Investments for Jordan over the Period 2012-2020 63
Table 23: Kuwait EE Potential, ktoe, 2012 68
Table 24: Lebanon EE Potential ktoe, 2012 74

Table 25: Electricity Efficiency Potential Abatement Investment Costs by End-Use Sectors and EE Technologies for Lebanon over the Period 2012-2020 77
Table 26: Electricity Efficiency Potential and Net Abatement Cost by EE technologies for Lebanon over the Period 2012-2020 78
Table 27: Reductions In Electricity Expenditures and Avoided Power Investments for Lebanon over the Period 2012-2020 78
Table 28: Libya EE Potential, ktoe, 2012 83
Table 29: Morocco EE Potential, ktoe, 2012 89
Table 30: Electricity Efficiency Potential Abatement Investment Costs by End-Use Sectors and EE Technologies for Morocco over the Period 2012-2020 92
Table 31: Electricity Efficiency Potential and Net Abatement Cost by EE Technologies for Morocco over the Period 2012-2020 93
Table 32: Reductions in Electricity Expenditures and Avoided Power Investments for Morocco over the Period 2012-2020 93
Table 33: Oman EE Potential, ktoe, 2012 98
Table 34: Palestine EE Potential, ktoe, 2011 104
Table 35: Qatar EE potential, ktoe, 2012 110
Table 36: Saudi Arabia EE potential, ktoe, 2012 116
Table 37: Sudan EE Potential, ktoe, 2011 122
Table 38: Tunisia EE Potential, ktoe, 2012 128
Table 39: Electricity Efficiency Potential Abatement Investment Costs by End-Use Sectors and EE Technologies for Tunisia over the Period 2012-2020 131
Table 40: Electricity Efficiency Potential and Net Abatement Cost by EE Technologies for Tunisia over the Period 2012-2020 132
Table 41: Reductions in Electricity Expenditures and Avoided Power Investments for Tunisia over the Period 2012-2020 132
Table 42: UAE EE Potential, ktoe, 2012 137
Table 43: Yemen EE Potential, ktoe, 2012 143
Table 44: Final Energy Intensity Benchmarks for the Tertiary Sector in Various MENA Countries (in kgoe/1,000 USD 2000) 158
Table 45: Final Energy Intensity Benchmarks for the Residential Sector in Various MENA Countries (in kgoe/1,000 USD 2000) 159
Table 46: Specific Consumption of Energy Benchmarks for the Residential Sector in Various MENA Countries- Horizon 2025 (kgoe/m^2/y) 159
Table 47: Detailed Table Explaining the Approach by Sector 161

Annex A: Data Sources

National

Algeria
Office National des Statistiques, *Economic Statistics*
Ministry of Energy and Mines, *Statistical Report*
Sonelgaz, *Annual Report*

Bahrain
Central Informatics Organization, Directorate of Statistics, *Statistical Abstract*; and *Bahrain in figures*
National Oil and Gas Authority, *Annual Reports*
Bahrain Petroleum Company, *Annual Review*

Egypt
Central Agency for Public Mobilisation and Statistics (CAPMAS),
Ministry of Electricity and Energy, Egyptian Electricity Holding Company, *Annual Report*

Iraq
Central Organization for Statistics and Information Technology, *Annual Abstract of Statistics*
Ministry of Oil, *Annual Report*

Jordan
Department of Statistics, *Statistical Yearbook*.
Ministry of Energy and Mineral Resources, *Energy facts and figures*; and *Annual Report*

Kuwait
Central Statistical Bureau, *Statistical Bulletin*
Ministry of Oil, *Oil Documents, Facts and Figures*
Ministry of Electricity and Water, *Statistics*

Lebanon
Central Administration for Statistics, *Statistical Bulletin*; and *Statistical Yearbook*

Morocco
Haut Commissariat au Plan, *Statistical Reports*
Ministry of Energy, Mines, Water and Environment, *Annual Reports, Energy Balances*

Oman
Ministry of National Economy, *Statistical Yearbook*
Authority for Electricity Regulation, Oman, *Annual Report*

Palestine
Palestinian Central Bureau of Statistics, *Household Energy Survey; Palestine in Figures; Statistical Abstract of Palestine; Energy Consumption Report;* and *Population, Housing and Establishments Census*

Qatar
Statistics Authority, *Annual Statistical Abstract* and *Qatar in Figures*
Ministry of Energy and Industry,

Saudi Arabia
Central Department of Statistics, *Statistical Yearbook*
Ministry of Industry and Electricity, *Electricity & Development in the Kingdom of Saudi Arabia*
Saudi Electric Company, *Annual Report*
Ministry of Petroleum and Mineral Resources, *Oil and Gas statistics*

Sudan
Central Bureau of Statistics, *Statistical Yearbook* and *The Sudan in Figures*

Tunisia
National Institute of Statistics, *Energy Statistics*
STEG, *Electricity and Natural Gas Statistics*
L'Entreprise Tunisienne d'Activités Pétrolières, *Annual Reports*
STIR, *Annual Reports*
Agence Nationale pour la Maitrise de L'Energie, *Chiffres Clés*
United Arab Emirates
National Bureau of Statistics, *Annual Abstract*
Federal Electricity and Water Agency, *Annual Reports, Statistics*

Yemen
Ministry of Planning and International Cooperation, Central Statistical Organization, *Statistical Yearbook*
National Information Centre, *Electricity, Oil and Gas Data and Indicators*
Ministry of Oil and Minerals, *Statistical Data*

Regional

- Regional Centre for Renewable Energy and Energy Efficiency (RCREEE), *RCREEE Indicators Database (2012 – 2013)*
- Economic and Social Commission for Western Asia (ESCWA), *Statistical Abstract*
- International Energy Agency
- Energy Statistics of Non-OECD Countries; Energy Balances for non-OECD countries (2000-2012)
- IEA World Energy Statistics and Balances, http://www.oecd-ilibrary.org/statistics;jsessionid=1662shtur3mrp.x-oecd-live-01
- World energy outlook
- Organization of Petroleum Exporting Countries (OPEC), *Annual Statistical Bulletin*
- Organization of Arab Petroleum Exporting Countries (OAPEC), *Annual Statistical Report*
- OAPEC on-line database: http://oapecdb.oapecorg.org:8085/apex/f?p=112:8
- British Petroleum, *Statistical Review of World Energy*

- League of Arab States, Arab Industrial Development and Mining Organization, *Electrical Energy Database*

- *Unified Arab Economic Report*

- Arab Union of Producers, Transporters and Distributors of Electricity, *Statistical Bulletin*

- Budget Allocation Chart (BAC), MED-ENEC and MED-EMIP (Annex C)

- Study Pathways for a low-carbon economy, Mc Kinsey for WWF, 2009

- Levelized cost of electricity renewable energy technologies study, Fraunhofer Institut for solar energy systems, ISI, November 2013

- Combined Heat and Power, ETSAP, IEA, May 2010

Other sources

- US Energy Information Administration
- International Energy Statistics : http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm#
- Earth Trends Database
- Arab Petroleum Research Centre, *Arab Oil and Gas Directory*

Annex B: EE Potential Sectoral Assumptions

Energy sector: While data availability is generally higher in the MENA energy sectors, in particular in the electricity sectors including in the GCC, the existence of EE indicators is less common despite the significant or event dominant share of the sector in primary energy consumption for hydrocarbon exporting countries. EE indicators measure the efficiency of complex energy transformation processes of a relatively limited number of units such as power plants and oil refineries. In most MENA countries, the energy sector accounts for a large share of the primary energy consumption and is dominant in hydrocarbon exporter countries.

Power generation: A synthetic and common EE indicator for this subsector is the power generation efficiency, or the ratio between total fuel input and generated electricity, including RE sources. It indicates the overall efficiency of the power generation system, not only of thermal power plants.

While this indicator is relevant for an overall regional and international comparison of thermal power generation, the specific structure (i.e. technology and fuels), base load, age of the power plants stock, national power mix, and data and methodological issues such as accounting of plant energy consumption accounted make difficult to adopt a regional benchmark as a reference to estimate each country EE potential. This synthetic or aggregated EE indicator as benchmark is more relevant when the structure and conditions are comparable between countries. For instance, relatively high power generation efficiency in a relatively new power generation sector, few large units, and stable base load may not be a relevant benchmark for a sector with different structural characteristics.

Thus, country-tailored benchmarks for power generation efficiency have been set and are based on the characteristics of the existing domestic generation system with a focus on the most important or representative plants and its technical potential for improvements, including fuel mix.

Electricity transmission and distribution: In a similar way, the electricity transmission and distribution losses (i.e. the ratio between electricity generated or injected to the grid and delivered) are frequently calculated and used. Nonetheless, some issues exist whether to utilize this indicator as commercial losses or unpaid electricity may result in an erroneous assessment and comparisons between countries. What is more, data may not be available for transmission and distribution losses, although the respective EE potential and related abatement measures are quite different.

While the characteristics of the electricity transmission, distribution systems, and load use may differ between MENA countries in regards to power generation, the comparison of the level of transmission and distribution losses is an effective measure to assess the grid efficiency and its potential for improvements. Thus, instead of a MENA regional benchmark based on the most performing system, it appears preferable to refine it by sub-region or sub-groups. A first group may include relatively small and recent power grids (e.g. GCC)

while a second one would include established and developed medium to large power grids (Maghreb countries).

In the case of Jordan, its electricity transmission and distribution losses reached 2.2 TWh or 199 ktoe in 2012, 17.3 percent of electricity generated. The actual transmission losses are at 4 percent, while the sub-regional benchmark considered in this second group of countries was set at 3 percent. The actual distribution losses were 13.3 percent while the benchmark was set at 8 percent. This potential gain of 6.3 percent corresponds in 2012 to an EE potential of 14.3 ktoe and 75.3 ktoe respectively.

An assumption in this case is that the EE potential applies simultaneously for the transmission and distribution systems, as the gains on transmission shall increase the electricity volumes injected to the distribution grid and thus the EE potential.

Oil refineries and gas treatment plants: The assessment of energy flows in an oil refinery or a gas treatment plant for LNG differs considerably from the power sector. First, processes of those units are much more complex and include for refineries multiple output products. Additionally, auto-consumption of by-products and recovery of heat allow oil refineries to reach total efficiency of around 95 percent while international data indicates up to 97-98 percent in MENA and OECD countries. If the refinery purchases natural gas, then the efficiency can reach up to 99 percent. The oil refining efficiency is generally estimated based on the input crude oil and feedstock and oil product output derived from calorific values. It is usually not available by oil product, which would inform deeper analysis of the EE and thus its potential.

Further to the generic data uncertainty for narrow relative gains (95 percent to 96 percent even if for significant energy input) and considering the diversity of refineries (size, age, maintenance), of crude oil types and of oil outputs profiles in the MENA region, it seems hazardous to make a comparable estimation of their efficiency and thus of EE potential. Thus, it seems to be not possible to include this subsector in this transversal study with insufficient data and methodological basis while it remains included in the energy balance.

For a precise assessment on this subsector, individual in-depth energy audits of oil refineries gas and treatment plants are more appropriate tools to assess how energy is consumed and thus its EE potential by energy use and products.

Energy end-use sectors: At the difference of the energy sector, EE indicators in end-use sectors assess the efficiency of energy used by a large number of consuming units such as households and individual cars for a broad range of products and services, providing a high number of possible monetary and physical references but also potentially making complex their elaboration and interpretation.

Industrial: A first EE indicator for the industry is the final energy intensity of the sector, which consists of the ratio of total industrial energy consumption and total industrial added value. While data availability is generally good in most MENA countries and it includes the whole sector, this EE indicator appears too subject to the variations of the production value and types of products (more or less energy intensive) to be reliably comparable over time and between countries (owing to those structural sectoral differences). For instance, a light-

oriented industry would consume relatively less energy than heavy industry for generally higher added value, translating into lower energy intensity. Nevertheless, it does not indicate which industry uses energy more efficiently (at a thermodynamic level). Actually, the heavy industry may be more energy efficient as energy accounts for a large share of its costs and is used in large facilities (with economy of scale).

Such physical or thermodynamic efficiency is better assessed by the specific energy consumption (generally in toe/ton of products). The RCREEE EE Indicators Study project already identified seven energy-intensive and relatively standard products: cement, steel, paper, sugar phosphate, super phosphate and phosphoric acid, the last three being more specific to the South Mediterranean region. Two additional products are also considered in this study: chemicals and glass. While specific energy consumption is a more reliable tool to assess EE over time series and between individual plants and countries) they require detailed data both on specific production and related energy consumption, which is rarely available in multi-product plants. Data availability and the limited energy consumption scope are the constraints of this indicator in this sector.

In Jordan, the specific energy consumption for steel was 0,067 toe/ton of steel in 2009. A regional benchmarking indicates a target value of 0,055 toe/ton (based on three countries only), or a potential gain of 18.1 percent or an EE potential of 4.7 ktoe.

Transport: Assessing EE in the transport sector is particularly complex owing to the number and diversity of consuming units such as private and company cars, passenger and freight vehicles, and local and international vehicles, as well as the lack of associated direct and reliable metering of both energy consumption and services realized (e.g. number of passengers and freight transported).

The final energy intensity of the transport sector has, as in the industry, the advantage of covering the whole sector and modes but is constrained by similar weaknesses (evolution of monetary values independently of the energy consumption, strong differences in transport structure system between countries). Furthermore, the available final energy intensities are related to total GDP (not total transport sector added value). Thus, the final energy intensity of the transport sector appears as an insufficiently reliable indicator for this exercise at national level and for country comparison purposes.

With road transport being the most important energy consumption and fastest growing subsector, specific energy consumption ratios were prepared with a focus on personal or private cars as data on commercial trucks and buses appear hardly available or reliable in the MENA region. This ratio of the average energy unit consumption of cars (in kgoe/car/year) include both gasoline and diesel private cars. Nonetheless, usually the related gasoline and diesel are total data that also include consumption of commercial vehicles, especially diesel for taxi, buses and trucks. Thus, as the diesel consumption is not ventilated between those vehicle types, in some countries the average diesel unit consumption of private cars may be significantly above the one for gasoline cars. Also, in various countries, fuel smuggling can have significant and impacts consumption data (underestimating when fuels illegally enter the country or the opposite when fuels are smuggled abroad).

Despite those statistical limitations, a regional benchmark of 1,100 kgoe/car/year based on five MENA countries and the EU average (750 kgoe/car/year) is proposed. This translates in the case of Jordan for a potential gain of 17.4 percent and an EE potential of 169 ktoe in 2012 (equivalent to USD264 million).

For other transport modes as railways, air transport, and maritime transport for passenger and freight, specific energy consumption ratios may also be prepared. Nevertheless, low availability and reliability of data in MENA reduce its utility.

Tertiary: The definition of the tertiary sector in this study is based on the International Classification of Industrial Statistics revision 4 (ISIC rev.4), which includes wholesale, retail trade, restaurants, hotels (ISIC G-H), transport, storage, communication (ISIC I) and other activities (ISIC J-P). For this reason, subsectoral energy data and activities are hardly available without specific surveys. The energy balance provides energy consumption of the entire sector, without disaggregation by branches. Because of this great heterogeneity, activity data are either non-existent or scattered among a large number of institutions. Also, there is clearly a significant lack of specific studies and surveys dedicated to the main tertiary sector branches, which causes the partiality of available data.

The main indicator developed for the tertiary sector is the final energy intensity. In this sector, the output is generally measured in monetary terms. Nonetheless, energy intensity of the tertiary sector is influenced by many factors, including climate of the country and the structure of the sector. For that reason, no firm conclusions are to be drawn from comparisons between countries.

According to the study "Energy, Climate change and the Building Sector in the Mediterranean: Regional Prospects" (Plan Bleu, 2010), the average intensity of the tertiary sector for the southern Mediterranean region was 54 kgoe/1,000 USD 2000 in 2009 compared with 48 kgoe/1,000 USD 2000 in 2003, at an annual decreasing rate of 2 percent.

Lebanon, where bank activity is highly developed in the tertiary sector, presents the lowest intensity (12 kgoe/1,000 USD of GDP[41] in 2009). Banks have notably high added value with low energy consumption compared with other activities, such as hotels or commerce. On the opposite side of the spectrum, Morocco seems to have the highest energy intensity at 48 kgoe/1,000 USD of GDP in 2009. For the other countries, the intensities range from 33 to 57 kgoe/1,000 USD of GDP also in 2009.

Based on a 2 percent annual decrease of energy intensity of the tertiary sector with the assumption that it may be uniform within this sub-region, the following country-tailored benchmarks are proposed over the projection period in the following table:

[41] Constant year PPP, 2000

Table 44: Final Energy Intensity Benchmarks for the Tertiary Sector in Various MENA Countries (in kgoe/1,000 USD 2000)

	2012	2020	2025
Algeria	53	46	41
Egypt	37	32	29
Jordan	40	34	31
Lebanon	12	10	9
Morocco	37	32	29
Tunisia	30	26	24

Source: Plan Bleu

For Jordan, the country-tailored benchmark of 40 kgoe/1,000 USD 2000 indicates a potential gain of 27 percent, which when applied to a tertiary consumption of 0.6 Mtoe indicates an EE potential of 164 ktoe in 2012.

In a complementary way, specific energy consumption ratios based on total or subsectoral surface (kWh/m^2/y) for the residential sector and on the number of employees ((kWh/emp/y) may be developed, taking into consideration the availability of related energy and physical data. Sectorally, other specific energy consumption ratios have been developed for specific sectors as for the hotels (kgoe/nigh guest) for several countries. Within the specific energy consumption ratios for public lighting and water utilities (generally under the administration responsibility or under concession) may also be prepared if coherent data are accessible.

Residential: The residential sector generally includes as a large number of individual units, which make complex effective and representative data collection.

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 prices (i.e. total households expenses). As for the other energy intensities, this sectoral indicator has clear limitations as it is also influenced by external factors, this case being the evolution of total household expenses, which are rarely connected with energy consumption. On the energy side, this indicator is also influenced by climate conditions, building type, appliance equipment rate, energy mix, or use of renewable energy. Thus, comparisons over time and between countries of residential final energy intensities have to be carefully reviewed.

Similarly as the tertiary sector and based on the same regional study, a set of country-tailored energy intensity benchmarks for the residential sector is proposed in the following table:

Table 45: Final Energy Intensity Benchmarks for the Residential Sector in Various MENA Countries (in kgoe/1,000 USD 2000)

	2012	2020	2025
Algeria	102	144	130
Egypt	45	64	58
Jordan	47	65	59
Lebanon	43	60	54
Libya	41	58	53
Morocco	34	48	43
Tunisia	28	40	36
Yemen	47	66	59

Source: Plan Bleu

In addition, the specific consumption of energy per area unit is also used to assess the EE potential (i.e. the ratio between the final energy consumption of the sector and the total area of the dwellings). Based on four climatic zones and three socio-economic categories developed by the study "Energy, Climate change and the Building sector in the Mediterranean: Regional Prospects" (Plan Bleu, 2010), the following country-tailored energy specific consumption country-tailored benchmarks for the residential sector are listed in this table:

Table 46: Specific Consumption of Energy Benchmarks for the Residential Sector in Various MENA Countries- Horizon 2025 (kgoe/m^2/y)

Algeria	**8.6**
Egypt	5.4
Jordan	4.6
Lebanon	4.8
Libya	8.6
Morocco	2.5
Tunisia	2.8
Yemen	2.2

Source: Plan Bleu

In the case of Jordan, the country-tailored benchmark implies a potential gain of 39.5 percent, which when applied to a residential consumption of 1.4 Mtoe indicates an EE potential of 548 ktoe.

Agriculture and fisheries: For this relatively fragmented sector and multiple production types, the use of final energy intensity appears as a good option to estimate the EE potential. Final energy intensities of agriculture and fishing are based on those two sector's added values.

Additionally, when data is available and coherent, specific energy consumption for fishing is a valuable indicator but only few countries have such detailed data.

Carbon dioxide intensity: The CO_2 intensities of each sector and their average emission factors are also included. The calculations are based on the IPCC emission factors for primary energy sources such as crude oil, oil products, coal, and natural gas, while the CO_2 emissions of the electricity sector are calculated through country electricity emission factors ($kgCO_2/kWh$) from the technical paper on electricity-specific emission factors for grid electricity.[42] For specific countries, such as Tunisia, CO_2 emission data was provided by a national organization. The purpose of calculating CO_2 emissions of each sector is to identify the impact of using energy on the economy and the environment.

[42] Ecometrica, 2011.

Table 47: Detailed Table Explaining the Approach by Sector

Sector/subsector	Indicators	Unit	Country Coverage	Regional/international benchmark	Estimated Energy Savings Potential for Jordan in 2012*		Excel Sheet*	Comments
1. Energy Sector					%	KTOE		
1.1 Electricity								
1.1.1 Generation								
	Average generation efficiency	%	All	Country-tailored benchmark- Jordan: 42%	3.8	135	Power indicators & EE Pot	Country-tailored benchmark based on the characteristics of the existing domestic generation system and other countries' performance.
	Technology [2]	% and toe/MWh	All	Power generation BAT				According to power plants' age, technology and structure
	Fuel mix		All with focus on GCCC					Fuel mix: with target little efficient fuels (as crude oil) that may be replaced by other fuels as NG or RE (no transformation losses)
1.1.2 Transmission and istribution (T&D) losses	Average losses broken down between T&D and technical and commercial	%	All (with various levels of details and reliability)	Sub-regional benchmarks: Small/modern power systems: T: 3% D: 4% Medium-large power systems: T: 5% D: 8%	T: 1% D: 5.3%	T: 75 D: 89.5		Complementary data search and checking on T&D-technical and commercial losses at sub-regional levels. The EE potential only applies on the technical losses (not the commercial losses).
1.2. Oil refining	Average efficiency of refining	%	All except LEB, PAL, OMA	Regional benchmark: NA	NA	NA	Oil refining indicat. & EE Po	Considering the diversity of refineries (size, age, maintenance), of crude oil types and of oil outputs profiles in the MENA region, it seems hazardous to make a comparable estimation of their efficiency and thus of their EE potential.
2. End-use sectors								
2.1 Industry	Final Energy Intensity of Industry Sector	TOE/1,000$ of added value	All	Country-tailored benchmark- Jordan:0.320 TOE/1,000$	22	249.8	Industry indicators & EE Pot	Indicator too subject to structural differences (sectoral and product composition) between countries. Set a country-tailored-benchmark based on the structure of the industrial sector, evolution and other countries' performance

	Average Energy Unit Consumption of selected industrial products	TOE/t	Inception Report's Table 5 (7+2 energy-intensive products)	Regional benchmarks: TOE/t (7 industrial products+ chemicals and glass)				Assess 9 intensive product's share in total industry's energy consumption (e.g. JOR: 4%) Regional benchmark proposed
2.2 Transport	Final Energy Intensity of transport sector	TOE/1,000$ of GDP	All				Transport indicators & EE Pot	Assess fuel data consumption series and estimate share of illegal fuel trading (export & imports)
	Average Energy Unit Consumption of personal Cars	kgoe/car/year	IR's Table 6	Regional benchmark for all personal cars: 1,100 kgoe/car/year	17.4	168.7		Regional benchmark proposed (all personal cars: diesel and gasoline)
	Specific Energy consumption for railways	kgoe/p.km						Low data availability and reliability.
	Specific Energy consumption for air transport	kgoe/p.km						
	Specific Energy consumption for maritime transport	kgoe/t.km						
2.3 Tertiary/services	Final Energy Intensity of Tertiary Sector	TOE/1,000$ of added value	All	Country-tailored benchmark-Jordan: 40 TOE/1,000$ of added value	27	163.9	Tertiary indicators & EE Pot	Country-tailored benchmark based on based on an in-depth regional study on the building sector[43]
	Specific Energy Consumption per tertiary area unit or per employee	kgoe/m²/y or kgoe/empl./y						According to data availability: data on total Tertiary/services' surface (in million sq. m) or number of employees, and total electricity consumption to be collected
2.3.1 Public lighting	Specific Energy Consumption of public lighting	MWh/1,000 km of lighted streets			NA	NA		Data on lighted streets length (km) to be collected (data may be hardly comparable between urban and rural, and between countries) Regional benchmark to be proposed
2.3.2 Water utilities	Specific Energy	MWh/hm			NA	NA		Data on drinking and irrigation water

[43] "Energy, Climate change and the Building sector in the Mediterranean: Regional Prospects" (Plan Bleu, 2010)

	Consumption of water pumping	3						pumping volumes (hm3) to be collected Regional benchmark to be proposed
2.4 Residential	Final Energy Intensity of Residential Sector	TOE/1,000$ of private consumption		Country-tailored benchmark- Jordan: 65 TOE/1,000$			Residential indicators & EE Pot	Country-tailored benchmark based on regional study on the building sector[44].
	Specific Energy Consumption per residential area unit	kgoe/m²/y		Country-tailored benchmark- Jordan: 4.6 kgoe/m²/y	47.7	662.6		Country-tailored benchmark based on an in-depth regional study on the building sector[45] (with 1 climatic zone and 3 socio-economic categories)
2.5 Agriculture & Fishing	Final Energy Intensity of Agriculture	TOE/1,000$ of added value		Country-tailored benchmark- Jordan: 0.28 TOE/1,000$ of added value	12.8	20	Agricult. & Fish indic. & EE	According to data availability, Country-tailored benchmark to be proposed
	Final Energy Intensity of Fishing	TOE/1,000$ of added value		Country-tailored benchmark	NA	NA		
TOTAL					**20.3**	**1,650,7**		

[44] "Energy, Climate change and the Building sector in the Mediterranean: Regional Prospects" (Plan Bleu, 2010)
[45] "Energy, Climate change and the Building sector in the Mediterranean: Regional Prospects" (Plan Bleu, 2010)

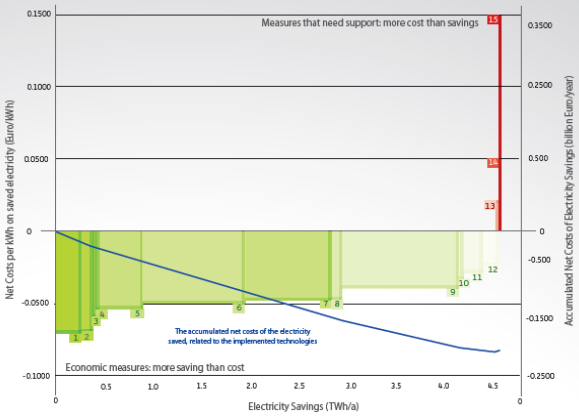
Annex C: Budget Allocation Charts (BAC), 2020 (*Source:* MED-ENEC and MED-EMIP)

Budget Allocation Chart (BAC)

Jordan untill 2020

www.med-enec.com | www.medemip.eu

	Measures: EE & RE Technologies	Electricity savings in TWh/year	Net electricity cost variation in billion EUR
1	EE 2.5 Energy efficient electric motors	0.2501	- 0 .0702
2	EE 1.13 Lighting – replacing incandescent lamps by CFL	0.1246	- 0 .0696
3	EE 3.8 Lighting – electronic ballasts	0.0255	- 0 .0588
4	EE 3.10 Street lighting – high pressure sodium	0.0369	- 0 .0541
5	RE 3.1 Solar Water Heaters (SWH) - commercial sector	0.4500	- 0 .0529
6	RE 1.1 Solar Water Heaters (SWH) - residential sector	1.0500	- 0 .0499
7	RE 4.2 Concentrated Solar Power (CSP) – power sector	0 .9000	- 0 .0469
8	EE 2.9 Energy efficient compressed air	0 .1030	- 0 .0463
9	RE 4.1 Wind energy – power sector	1 .2000	- 0 .0383
10	EE 1.31 Lighting – electronic ballasts	0 .0452	- 0 .0329
11	EE 1.3 Thermal insulation of buildings	0 .2025	- 0 .0277
12	EE 1.11 Food cooling – most efficient fridges	0 .1573	- 0 .0229
13	RE 4.7 Biogas and biomass for CHP – power sector	0 .0400	0 .0205
14	RE 2.4 Solar desalination – utilities/services	-	0 .0823
15	RE 1.4 PV on roofs – residential, commercial, public sectors	-	0 .1644
	Total	**4 .5851**	**- 0 .3033**



The BAC chart compares different major technologies for Energy Efficiency (EE) and Renewable Energy sources (RE).
It shows horizontal (x-axis) their potential for electricity savings in the country per year and vertical (y-axis) their economic attractiveness, compared to the avoided cost of electricity generated by fossil fuel.
The electricity saving potential of the technologies below the 0-line can be achieved with combined cost savings, those above the line need additional funding to compensate for the balance of electricity cost saved and cost of the technologies.
The data research and calculations for the BAC have been conducted in cooperation with the National Energy Research Center (NERC) of Jordan.

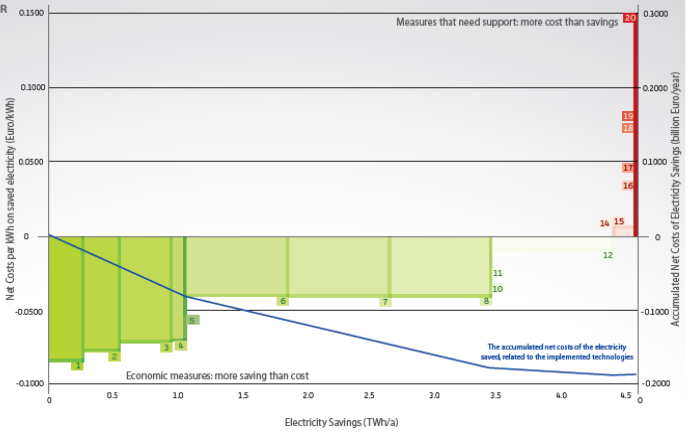
www.giz.de

Electricity Savings (TWh/a)

The BAC chart compares different major technologies for Energy Efficiency (EE) and Renewable Energy sources (RE).
It shows horizontal (x-axis) their potential for electricity savings in the country per year and vertical (y-axis) their economic attractiveness, compared to the avoided cost of electricity generated by fossil fuel.
The electricity saving potential of the technologies below the 0-line can be achieved with combined cost savings, those above the line need additional funding to compensate for the balance of electricity cost saved and cost of the technologies.
The data research and calculations for the BAC have been conducted in cooperation with the National Renewable Energy Authority (NREA) of Egypt.

Budget Allocation Chart (BAC)
Lebanon untill 2020

	Measures: EE & RE Technologies	Electricity savings in TWh/year	Net electricity cost variation in billion EUR
1	EE 1.13 Lighting – replacing incandescent lamps by CFL	0.2649	- 0.0838
2	EE 3.10 Public lighting – LED	0.0002	- 0.0807
3	EE 2.14 Heating and cooling – programmable thermostats	0.2845	- 0.0773
4	EE 2.9 Energy efficient compressed air	0.4066	- 0.0541
5	RE 3.1 Solar Water Heaters (SWH) – commercial sector	0.1125	- 0.0697
6	EE 1.1 Low energy buildings	0.0000	- 0.0682
7	RE 4.3 Grid connected PV – power sector	0.8000	- 0.0400
8	RE 4.2 Concentrated Solar Power (CSP) – power sector	0.8000	- 0.0400
9	RE 4.1 Wind energy – power sector	0.8000	- 0.0400
10	RE 4.6 Geothermal energy – power sector	-	- 0.0316
11	EE 2.3 Efficient ball mill - cement industry	0.0000	- 0.0213
12	RE 4.5 Large hydropower – power sector	0.9456	- 0.0094
13	RE 2.2 Municipal solid waste incineration	-	0.0001
14	EE 3.8 Lighting – electronic ballasts	0.0133	0.0050
15	RE 4.7 Biogas and biomass for CHP – utilities/services	0.1650	0.0063
16	RE 2.1 Municipal landfill gas – utilities/services	-	0.0161
17	RE 3.7 PV facades – commercial/public sector	0.0011	0.0240
18	EE 3.1 Energy efficient "green" buildings	0.0000	0.0707
19	RE 2.6 PV street lighting – utilities/services	0.0001	0.0764
20	RE 6.4 PV for water pumps - agriculture	0.0000	0.1512
	Total	4.5940	- 0.2835

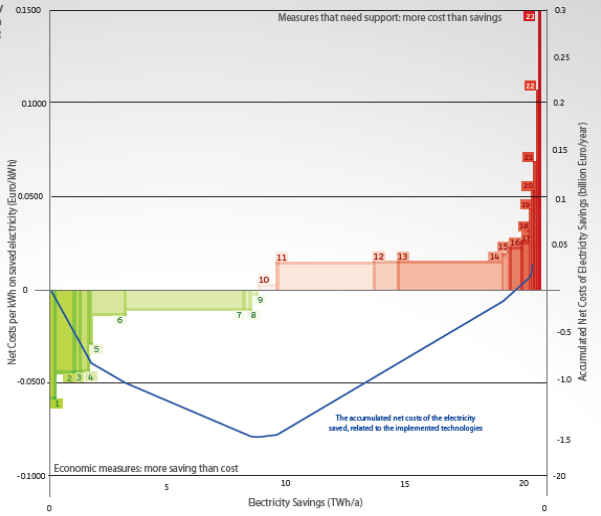


The BAC chart compares different major technologies for Energy Efficiency (EE) and Renewable Energy sources (RE).
It shows horizontal (x-axis) their potential for electricity savings in the country per year and vertical (y-axis) their economic attractiveness, compared to the avoided cost of electricity generated by fossil fuel.
The electricity saving potential of the technologies below the 0-line can be achieved with combined cost savings, those above the line need additional funding to compensate for the balance of electricity cost saved and cost of the technologies.
The data research and calculations for the BAC have been conducted in cooperation with the Lebanese Center for Energy Conservation (LCEC) of Lebanon.

www.lcec.org.lb www.giz.de

Budget Allocation Chart (BAC)
Morocco untill 2020

	Measures: EE & RE Technologies	Electricity savings in TWh/year	Net electricity cost variation in billion EUR
1	1 EE 3.9 Buildings – optimized setting for air circulation	0.2896	- 0.0588
2	EE 2.9 Energy efficient compressed air	0.7900	- 0.0448
3	RE 3.1 Solar water heaters (SWH) – commercial sector	0.2400	- 0.0445
4	RE 1.1 Solar water heaters (SWH) – residential sector	0.3600	- 0.0440
5	EE 2.10 Daylight sensor for lighting	0.0937	- 0.0293
6	RE 4.6 Geothermal energy – power sector	1.4400	- 0.0136
7	RE 4.5 Large hydropower – power sector	5.0000	- 0.0109
8	EE 1.13 Lighting - replacing incandescent lamps by CFL – residential sector	0.2695	- 0.0102
9	EE 1.11 Energy efficient refrigerators	0.3092	- 0.0016
10	EE 3.10 Street lighting – high pressure sodium lamps	0.7785	0.0027
11	RE 4.1 Wind energy - power sector	4.1000	0.0147
12	RE 4.3 PV Grid Connected - power sector	1.0000	0.0149
13	RE 4.2 Concentrated solar power - power sector	4.4000	0.0150
14	RE 2.2 Municipal solid waste incineration – utilities/services	0.2500	0.0189
15	RE 2.4 Solar desalination – utilities/services	0.1000	0.0197
16	RE 6.1 Biomass for power generation – agriculture	0.4800	0.0228
17	RE 4.7 Biogas and biomass for CHP – power sector	0.3200	0.0257
18	RE 1.4 PV on roofs – residential and commercial sector	0.0380	0.0314
19	RE 2.1 Landfill gas – utilities/services	0.0400	0.0436
20	RE 3.7 PV on facades – utilities/services	0.0400	0.0528
21	RE 6.9 Small hydropower – agriculture	0.0400	0.0688
22	RE 2.6 PV for street lighting – utilities/services	0.0020	0.1069
23	EE 1.12 Promotion A++ class for washing machines	0.0283	0.1523
	Total	20.4088	0.3325



The BAC chart compares different major technologies for Energy Efficiency (EE) and Renewable Energy sources (RE).
It shows horizontal (x-axis) their potential for electricity savings in the country per year and vertical (y-axis) their economic attractiveness, compared to the avoided cost of electricity generated by fossil fuel.
The electricity saving potential of the technologies below the 0-line can be achieved with combined cost savings, those above the line need additional funding to compensate for the balance of electricity cost saved and cost of the technologies.
The data research and calculations for the BAC have been conducted in cooperation with the Agence Nationale pour le Développement des Energies Renouvelables et de l'Efficacité Energétique (ADEREE) of Morocco.

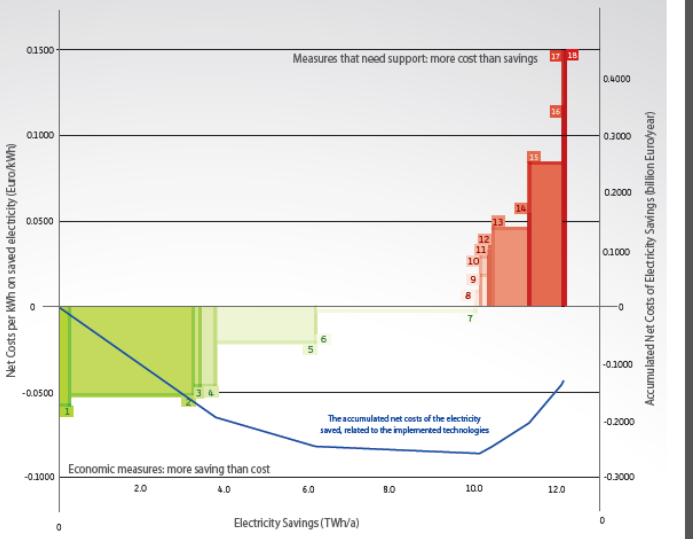
www.aderee.ore.ma www.giz.de

Zoom out (Ctrl+Minus)

Budget Allocation Chart (BAC)

Tunisia untill 2020

	Measures: EE & RE Technologies	Electricity savings in TWh/year	Net electricity cost variation in billion EUR
1	EE 1.13 Lighting – replacing incandescent lamps by CFL	0.2835	- 0.0577
2	EE 3.1 Energy efficient heating in new buildings	2.9703	- 0.0514
3	RE 3.1 Solar Water Heaters (SWH) - commercial sector	0.0900	- 0.0468
4	RE 1.1 Solar Water Heaters (SWH) - residential sector	0.4500	- 0.0461
5	RE 4.1 Wind energy – power sector	2.4000	- 0.0211
6	RE 4.6 Geothermal energy – power sector	-	- 0.0121
7	EE 1.11 Food cooling – most efficient refrigerators	3.8365	- 0.0028
8	RE 4.5 Large hydropower - power sector	0.1240	0.0089
9	RE 2.2 Municipal solid waste incineration	-	0.0243
10	RE 4.3 Grid connected PV – power sector	0.2000	0.0294
11	RE 4.7 Biogas and biomass for CHP – power sector	-	0.0298
12	RE 1.4 PV on roofs – residential	0.0700	0.0350
13	RE 2.1 Municipal landfill gas - utilities/services	0.9000	0.0462
14	RE 3.7 PV facades – commercial and public sectors	-	0.0580
15	RE 4.2 Concentrated Solar Power (CSP) – power sector	0.8000	0.0840
16	RE 2.6 PV street lighting - utilities/services	-	0.1156
17	EE 1.12 Energy efficient washing machines – A++ class	0.0391	0.1821
18	RE 6.4 PV for water pumps - agriculture	0.0018	0.1985
	Total	12.1652	0.5738



The BAC chart compares different major technologies for Energy Efficiency (EE) and Renewable Energy sources (RE).
It shows horizontal (x-axis) their potential for electricity savings in the country per year and vertical (y-axis) their economic attractiveness, compared to the avoided cost of electricity generated by fossil fuel.
The electricity saving potential of the technologies below the 0-line can be achieved with combined cost savings, those above the line need additional funding to compensate for the balance of electricity cost saved and cost of the technologies.
The data research and calculations for the BAC have been conducted in cooperation with the Agence Nationale pour la Maîtrise de l'Énergie (ANME) of Tunisia.

www.anme.nat.tn

www.giz.de

Annex D: Advisory group meeting results (Beirut and Marseille)

1- Comments on the methodology, assumptions and interim results (energy projections and EE potential):

On data and definitions:

- Definition of "tertiary" sector has to be clearly explained that it includes commercial sector as well;
- Sources of data need to be clearly indicated in the final product;
- Meaning of "EE potential for 2012" needs to be better explained;
- The term "energy sector" in estimation of EE potential is misleading and needs to be replaced by more clear terminology to properly reflect power generation, transmission and distribution;

On methodology and assumptions:

- On the results of EE potential, it would be more valuable to have break-down of sectors into more detailed subsectors and products;

- It is important to look at the technical potential, but it is also important to see who is willing to pay for this potential;

- Why 2025? That's not long enough, perhaps it is better to stretch projections to 2030 as most infrastructure projects are long term;

- Energy demand projections should take into account policy developments in the country;

- It is important to have coherence in estimation of EE potential. It needs to be specified whether the potential is estimated using bottom-up or top-down approach;

- Conversion or transformation sector seems to be missing in EE potential, which is an important sector. Production of fertilizers and liquefied natural gas is quite significant in our countries. All these two transformation industries used the natural gas as feedstock and as fuel. There are new industry processes to improve the auto consumption in these two obsolete technologies in some oldest plants. There are 18 countries that produce and export LNG worldwide, and 7 of them are in our region as in Algeria, Egypt, Qatar, UAE, Libya, Oman and Yemen.

- Theoretically, the gas auto-consumption of an LNG plant is about 12%. In Algeria it's reached 25% to produce LNG before the launching of the revamping program in the 90s to improve EE in the existing LNG plants. This need to be followed in all LNG producers. In the other hand, the specific consumption to produce a ton of fertilizer is decreasing of -30% (from more1000 m3 to about 650-700 m3 by ton of fertilizer including feedstock and fuel).

- Assumption on realization of EE targets in NEEAP in estimation of EE potential is invalid at least for Jordan because not much has been done and thus the potential might be underestimated.

On interim results:

- The results for Tunisia are somehow close to similar assessment done for the country. This study should not be granted the scope larger of what it actually is;

- EE potential in the residential sector of Egypt is probably underestimated because of large amount of unofficial/informal settlements that are not reflected in the official statistics;

- The estimations for the Iraq are reasonable as they are based on the IEA data and all IEA data comes from the official statistics;

- In Maghreb region, a study on ''Planification energetique dans l'Union du Maghreb Arabe - UMA'' was performed in 1997 with the support of ESMAP program. The study covered Algeria, Tunisia and Morocco (named AL.TU.MA study). This study was based on MEDEE-Sud model and gave EE potential by country and by sector by 2000-2010-2020. For Morocco for example, the EE potential was estimated to 5.3 Mtoe by 2020 (23 Mtoe energy demand in BAU scenario compared to 17.7 Mtoe for alternative scenario). This result is not far from present estimation;

- The results for Morocco are more or less similar with similar studies carried out for the country with difference of minus/plus 3-4%. Using results of the local studies for benchmarking would be a good thing.

2- Which sectors and why should be prioritized in your country for designing delivery mechanisms?

3- For the identified priority sectors, what are the challenges for unlocking the projected potential?

Country	Identified Priority Sector	Challenges Highlighted
Jordan	- Sectors that are paying higher energy prices e.g. **commercial** segments (hotels, banks, hospitals etc) - 1) **Construction sector** is a priority sector. 2) **Industrial sector** and 3) **Agriculture**, especially off-grid uses of energy;	- Lack of understanding of EE by industry groups - building codes lack EE specifications by building types, there is lack of national capacity to work on these issues - Lack of compulsory EE building code for retrofitting existing buildings - Inefficient tendering processes, lack of enforcement and compliance tools - No clear champion to lead and implement EE measures - Lack of coordination between government and private sector - Lack of financing mechanisms for EE

Tunisia	- If we take into account potential of energy saving, it appears that the leading sectors are residential and tertiary. If we take specific consideration, e.g. government policy of reducing subsidies, then we must help industrial sector and **industrial sector** becomes a priority. Payback period is also attractive for EE measures in industrial sector. - There is a solid regulatory framework for EE in place. We need to launch different actions in **different sectors in parallel**, although some sectors are more difficult to address.	
Kuwait	- It is easier to target **industrial, commercial and governmental sectors**. Targeting residential sector is somewhat challenging due to very strong parliament in the country. - From appliances, the biggest energy consuming product is **air conditioners** that largely contribute to peaks.	
Egypt	- The priority for EE is **residential sector**, especially **lighting**, because electricity consumption accounts for 42%. Also electricity sector is the sector with best available data. - **industrial sector** is a priority sector (**cement and petrochemical**)	- Inefficiency and difficulty of the government structures. - Lack of enforcement and compliance mechanisms. - Components of appliances are not regulated. - Weak EE governance and institutions

Sudan	In Sudan priority sectors identified in NEEAP includes only electricity, although transport is a very large energy consuming sector. In NEEAP target sectors are **network losses** and **buildings.** The buildings have been chosen mainly for appliances (**lighting and appliances**). The peak is completely influenced by **AC**.	
Iraq	Rehabilitation of **energy production sector** is a priority for Iraq.	
Lebanon	In Lebanon priority sector is **residential because** we have growing market of real estate and this what we are doing with NEEREA, we are targeting **SWH**.	
Morocco	Priority sectors: **manufacturing** and **construction** sectors because regulatory framework is in place and prices are high. **Home appliances** are also priority (standards and appliances).	- Morocco issued a lot of laws for EE, but these laws are general, and Morocco still needs application decrees/bylaws to bring into effect specifications of those laws. This legal gap is a real challenge that will further delay implementation of EE in the country. - Capacity building: training domain is not in line with the ambitions and objectives
Qatar	Priority sector is **commercial sector**	- Lack of detailed data and benchmarking - Heavy energy subsidies

4- General comments on priority sectors:

- Regardless of the identified priority sector, the focus should be on business case to make the priority happen;
- Sectors should be prioritized based on the pay-back time. In industrial sector there are many low-hanging fruits with short pay-back time;
- Appliances are easy to target and implement in the building sector through import regulations;
- Power generation (utility) sector should be a priority

5- General comments on challenges:

- Overall poor quality of data and lack of detailed data by sectors and subsectors
- Lack of one single focal point in some countries for data collection
- Lack of demand for EE services, and very little EE on the ground
- Regulatory and institutional frameworks are fragile and incomplete
- Lack of legal robust framework with sanctions and more targeted use of financial support to foster innovation in EE
- Transport remains a sector where actions are difficult to implement because there is no reliable good public transport alternative, also the climatic zone are too hot which definitely requires AC in the car and increases the use of energy. Transport is a biggest energy consuming sector, but it is at the same time difficult sector to tackle.
- Another sector with high EE potential is tourism sector. But this sector currently receives little attention in terms of policy and financial support
- Low awareness about benefits of EE, today we are still on a short term vision
- High initial capital costs and payback period is not sufficiently attractive
- Lack of technical professional trained to the needs of industries