

CLIMATE CHANGE

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Implementation of Nationally Determined Contributions

Morocco Country Report

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Environmental Research of the
Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety

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Implementation of Nationally Determined Contributions

Morocco Country Report

by

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In cooperation with:

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Country specific support and review: El Mostafa Jamea
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On behalf of the German Environment Agency

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Introduction to the project

This country report is part of the “Implementation of Nationally Determined Contributions” (NDCs) project (FKZ 3716 4111 80), which considers NDC implementation in 10 countries: Colombia, Ethiopia, Georgia, Indonesia, Iran, Kenya, Marshall Islands, Morocco, Peru, and Viet Nam. This project places a special emphasis on identifying potential barriers to NDC implementation and mitigation potentials which could go beyond the current NDCs.

The country reports analyse the NDCs in terms of their robustness and coherence with other national or sectoral plans and targets, and put them into the context of additional mitigation potentials and other national circumstances. For countries where coal plays a critical role in consumption or national production, the analysis covers further details on this sector, including the economic relevance and local impacts of coal production or consumption. The content is based on available literature from research and public sector information on policies and institutions.

To be able to analyse the content in more detail, the authors focus the research on a number of relevant fields of action. The fields of action were selected based on historic and projected sectoral emissions development, comprehensive literature on GHG mitigation potentials, identified barriers and emissions reductions as well as feasibility, costs, and co-benefits.

The project was suggested and is financed by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, supervised by the German Environment Agency and carried out by independent think tanks - NewClimate Institute and Wuppertal Institute. The country reports are a continuation of similar previous efforts (project numbers 3713 41 102, 3711 41 120, 360 16 022, 364 01 003 and 363 01 128) and aim to inform policy makers and the interested public about the implementation of NDCs in individual countries. The choice of countries is based on developing countries with which Germany works closely on climate change topics.

The country reports are scientific in nature, and all suggestions are derived by the authors from careful analysis, having in mind the individual backgrounds of countries. They aim to increase knowledge about implementation of mitigation potentials to meet the globally agreed goal of staying within a temperature increase of 1.5°C or well below 2°C above preindustrial levels, without intending to prescribe specific policies.

Overview

Overview.....	6
List of Figures.....	7
List of abbreviations	9
1 Part I: Summary	11
1.1 Country background	11
1.2 Emissions trends	12
1.3 NDC and ongoing activities.....	13
1.4 Further mitigation potentials and barriers	14
1.5 Main fields of action	15
1.5.1 Urban environment.....	16
1.5.2 Mineral sector	16
1.5.3 Transport sector.....	17
2 Part II: Full country analysis.....	18
2.1 Country background	18
2.2 Institutional set up.....	25
2.3 MRV of GHG emissions	27
2.4 Description and evaluation of the (I)NDC.....	29
2.5 Climate change mitigation policies and strategies	30
2.6 Additional mitigation potential.....	33
2.6.1 Urban environment.....	35
2.6.2 Mineral industry.....	38
2.6.3 Transport sector.....	45
2.7 Assessment of the relevance and perspectives of coal use	49
2.8 Conclusions	53
3 References	55

List of Figures

Figure 1:	Morocco’s emissions profile.....	12
Figure 2:	Morocco’s energy profile.....	13
Figure 3:	Morocco’s projected emissions and NDC targets (incl. emissions from AFLOU).....	14
Figure 4:	Overview selection criteria for potential fields of mitigation action .	16
Figure 5:	Map of Morocco	18
Figure 6:	Morocco’s emissions profile.....	21
Figure 7:	Emissions and energy use intensity over time	22
Figure 8:	Morocco’s energy profile.....	23
Figure 9:	Flowchart of organisational setup.....	26
Figure 10:	Institutional set-up national Green House Gas Inventory System (GHG-IS) Morocco.....	28
Figure 11:	Morocco’s projected emissions and NDC targets (incl. emissions from AFLOU).....	29
Figure 12:	Comparison of mitigation potential and distribution efforts by sector by 2030	34
Figure 13:	Overview selection criteria for potential fields of mitigation action .	34
Figure 14:	Overview phosphate sector activities in Morocco and Western Sahara	39
Figure 15:	OCP carbon emissions 2007 - 2012	40
Figure 16:	Evolution of specific emissions from the cement sector in Morocco	43
Figure 17:	Stock of vehicles in circulation 2000 - 2014	45
Figure 18:	Modal share transport Casablanca 2012.....	47
Figure 19:	Share of total primary energy supply in Morocco 2015.....	49
Figure 20:	Domestic coal consumption 1990 - 2014	49
Figure 21:	Coal imports and production 1990 - 2014.....	50
Figure 22:	Fuel mix in electricity generation, 2014	51
Figure 23:	Electricity production 1990 - 2014	51

List of tables

Table 1:	Key socio-economic figures	19
Table 2:	[2014] emissions data from PRIMAP	21
Table 3:	[2000] emissions data from UNFCCC.....	21
Table 4:	Key emissions, energy and environmental data.....	22
Table 5:	[2014] total primary energy supply by fuel from IEA	24
Table 6:	Overview coal-fired power plants Morocco	52

List of abbreviations

4C Morocco	Moroccan Competence Center for Climate Change
AAA	African Agriculture to Climate Change Initiative
AFOLU	Agriculture, Forestry and Other Land Use
APC	Association Professionnelle des Cimentiers
BAU	Business as Usual
BRT	Bus Rapid Transit
BUR	Biennial Update Report
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CNCC	National Committee on Climate Change
CNEDD	National Charta for the Environment and Sustainable Development
CNST-CC	National Research and Technology Committee - Climate Change
COP	Conference of the Parties
DCCDBEV	Central Direction for Climate Change, Biodiversity and Green Economy
G77	Group of 77
GCF	Green Climate Fund
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GHG-IS	Greenhouse Gas Inventory System
GIZ	Gesellschaft für Internationale Zusammenarbeit
ICI	International Initiative for Climate
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
KfW	KfW Entwicklungsbank
LCDS	Low-Carbon Development Strategy
LEDS	Low Emission Development Strategy
LULUCF	Land Use, Land Use Change, and Forestry
MCCP	Moroccan Climate Change Policy
MGP	Morocco Green Plan
MENA	Middle East and North Africa
MRV	Monitoring, Reporting, and Verification System
MtCO_{2e}	Mega tonnes carbon dioxide equivalent
NAMA	Nationally Appropriate Mitigation Actions
NC	National Communication

NCESD	National Charta for Environment and Sustainable Development
NDC	Nationally Determined Contribution
NMM	New Market Mechanism
NSSD	National Strategy for Sustainable Development
PMR	Partnership for Market Readiness
PNRC	National Plan of Action against Climate Change
SNDD	National Strategy for Sustainable Development
SSSD	Secretary of State in Charge of Sustainable Development
UNFCCC	United Nations Framework Convention on Climate Change

1 Part I: Summary

1.1 Country background

The Kingdom of Morocco is located in the North-West of the African continent, bordering the Mediterranean Sea as well as the Atlantic Ocean. It is exposed to different climatic conditions. 93% of the country's territory already has an arid or semi-arid climate. Morocco is therefore known to be particularly vulnerable to the effects of climate change (Kingdom of Morocco 2014).

The country counted 34 million inhabitants in 2014, and it is projected that the size of the **population** will reach 41 million people by 2030 (UN DESA 2017). Next to the strong population growth, the urbanisation rate has also increased by 24% since 1990, reaching 60% in 2014 (Table 1). In regard to the **economy**, Morocco has experienced relatively stable annual GDP growth rates of about 5% in the past decade (NDC Partnership 2017b). However, growth rates are threatened by climatic conditions: In drought periods, they drop to around 2.8% on average, despite the diversification and the growing importance of the tertiary sector in the Moroccan economy (Government of Morocco 2016a). The most important sector of Morocco's economy in terms of GDP share is the tertiary sector (54.9%), followed by the secondary sector (accounting for 29.6% of GDP), and the primary sector with agriculture activities accounting for 15.5% of GDP (ibid.).

The **political system** in the Kingdom of Morocco is a constitutional monarchy with a dualist parliamentary system: The King (Mohammed VI.) is the head of the state and presides over the executive branch together with the head of government. Originally a strongly centralised monarchical system, Morocco has been evolving into a more democratic system over the last decades. In 2011, as a response to a series of protests across the Middle East and North Africa known as the "Arab Spring", the Constitution was revised and adopted by referendum. The Head of Government now selected from the political party with the highest vote share instead of being chosen by the King, and can appoint his cabinet himself. Furthermore, the new Constitution enshrines sustainable development as a right for all citizens (Government of Morocco 2016a).

Since 1992, Morocco has engaged in the international climate negotiations. It hosted the Conference of the Parties (COP) in 2001 and the 22nd session of the Conference of the Parties (COP 22) to the UN-FCCC in Marrakesh in 2016. Morocco is a member of several negotiation groups within the international climate regime: The African group, the Arab group as well as the G77.

In regard to bilateral cooperation with Germany, Morocco is one of the key partners and the largest recipient of German funding in the region. Development cooperation between Morocco and Germany is based on intergovernmental agreements, such as the 2013 Rabat Declaration, in which the foreign ministers of the two countries agreed on continuous cooperation and on deepening their dialogue in the political, economic and cultural spheres (BMZ 2017). In the energy sector, a bilateral energy partnership was established in 2012. The current priority areas for cooperation are water, energy, sustainable economic development as well as environment and climate change (GIZ 2012).

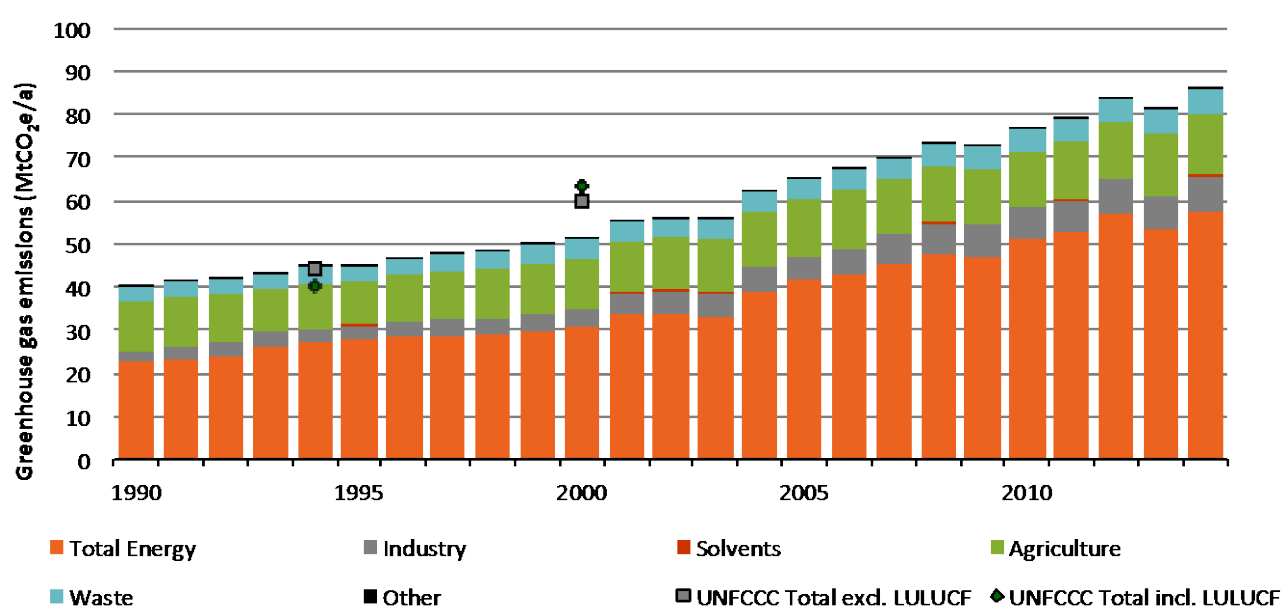
Climate change strategy	✓
Green growth strategy	✓
Energy strategy aligned with CC/GG strategy	✓
Institutional coordination on climate change	✓
Renewable energy targets	✓
Level of NDC ambition (CAT rating)	high
Reliance on coal (current)	high
Expected reliance on coal (2030)	high

1.2 Emissions trends

Morocco's greenhouse gas (GHG) emissions amounted to 86 MtCO₂e (excluding LULUCF) in 2014 and accounted for 0.1% of global emissions in 2012. The energy sector is responsible for 67% of these emissions, followed by agriculture (17%) and industry (10%). Emissions from the forestry sector are negligible. Even though Morocco's emissions are comparatively low, there has been a sharp increase since 1990. This emission growth is mainly attributable to the increase in energy-related emissions. In terms of per capita emissions, which reached 2.54 tCO₂e/cap in 2014, this corresponds to an increase of 58% compared to 1990. However, at the same time, the emissions intensity of the economy has considerably decreased, by 41%.

Figure 1: Morocco's emissions profile

Historical emissions by sector



Data sources: Gütschow et al. (2016a); UNFCCC (2016)

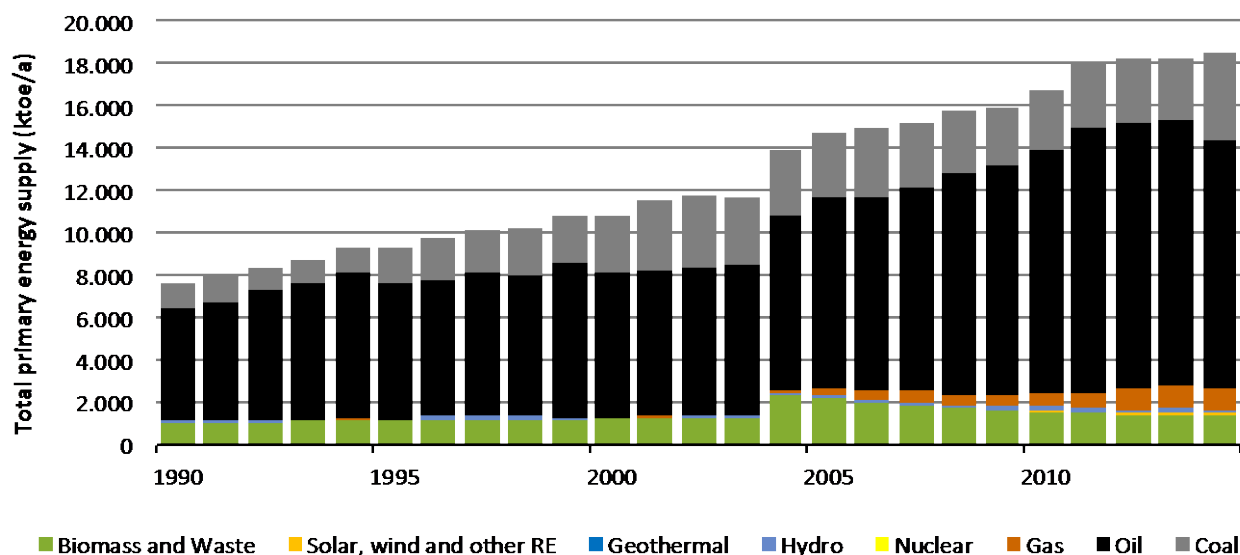
Morocco's primary energy demand is mainly covered by oil (64%) and coal (22%), followed by biomass and waste (7%) and gas (5%) (IEA 2016b). To meet its demand, Morocco is highly dependent on fossil fuel imports (95% in 2014), making the country the largest energy importer in the North African region. The reliance on fossil fuels and the high import dependency places a huge burden on both the national budget and the country's energy security. At the same time, the energy demand is growing as a result of population growth, urbanisation and economic development. The overall per capita electricity consumption has risen about 60% from an average of 358 kWh per year in 1990 to 901 kWh in 2014 (World Bank 2017a). To ensure a stable and affordable energy supply, the Moroccan government has taken steps to diversify its energy mix by making use of the country's significant renewable energy potentials, the most important renewable energy potentials being solar (200 GW) and onshore (25 GW) and off-shore wind resources (250 GW), followed by hydro power (38 GW) and biomass (1 GW) (L'Economiste 2017a; ONEE n.y). With its Solar Energy Plan and its Wind Energy Plan, the country aims to harness these potentials and install respectively 2,000 MW of solar and wind power capacity by 2020 (MASEN 2017).

Despite Morocco's impressive efforts in the renewable energy sector and the decreasing share of coal in the electricity mix, the absolute amount of coal used for electricity generation has increased strongly in the last two decades. Further expansion of coal-based power generation in Morocco is

planned or already under construction, showing that coal will remain an important energy source for Morocco in the future. This development is less prominently featured in the coverage of the energy sector developments than Morocco's ambitious renewable energy strategy.

Figure 2: Morocco's energy profile

Primary energy by energy carrier



Data sources: IEA (2016b)

1.3 NDC and ongoing activities

In 2016, Morocco submitted its NDC to the UNFCCC. The NDC is an improved version of the INDC developed in 2015. Compared to the INDC, the level of ambition has been raised in the NDC for both the unconditional and the conditional GHG emission reduction targets. Moreover, the NDC provides additional data on emissions reduction contributions from agriculture, forestry and other land use (AFOLU). Furthermore, in the NDC concrete measures to achieve the mitigation goals of the conditional and unconditional targets are specified, allowing to better evaluate the feasibility of Morocco's commitments (Government of Morocco 2015 and 2016c).

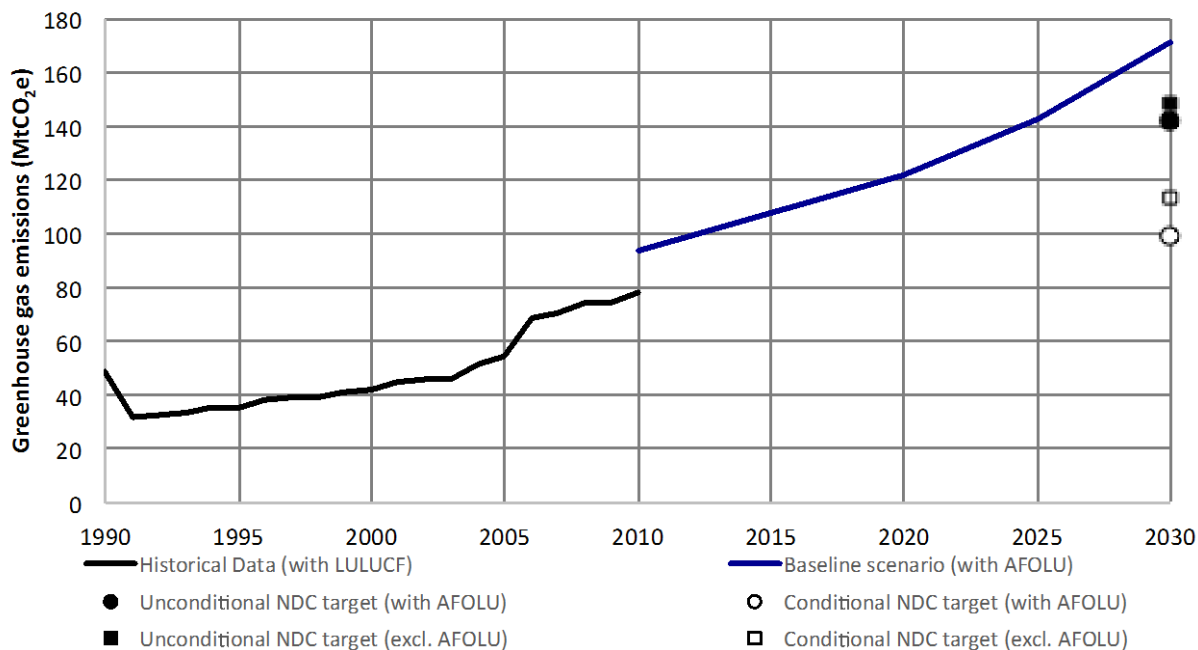
With its NDC, Morocco commits to an unconditional target of 17% reduction of GHG emissions by 2030 compared to a "business as usual" scenario. Conditionally, i.e. dependent on the availability of climate finance and support from the international community, Morocco pledges 42% GHG reductions by 2030. The funding required to reach these levels of reduction are estimated to be about USD 50 billion between 2010 and 2030, of which USD 24 billion are needed to meet the conditional target (Government of Morocco 2016c).

In the unconditional case, realising the commitments would mean that the emission levels continue to increase until 2030, but more slowly than in the BAU scenario, whilst in case of the conditional targets, GHG emissions would not rise further but remain steady compared to today's level until 2030. Morocco's conditional target would represent a fair share of global emission reductions in line with the objectives of the Paris agreement (CAT 2017).

In Figure 3, the emissions development in the baseline scenario is displayed in comparison to the conditional and unconditional targets in 2030 (with and without AFOLU). The reference year for the baseline scenario (2010) has a higher emissions level than the historical data (with LULUCF) account for.¹

Figure 3: Morocco's projected emissions and NDC targets (incl. emissions from AFOLU)

Nationally Determined Contribution



Data sources: Gütschow et al. (2016a); UNFCCC (2016); Government of Morocco (2016c)

In its NDC, Morocco presents a list of 55 mitigation actions for 2030 to achieve the conditional and unconditional GHG emission reduction targets. The portfolio includes activities in all sectors of the economy. However, the most significant reductions are related to the transition of Morocco's energy sector. With ambitious targets both in the field of renewable energies (52% of power shall be generated from renewable sources by 2030, equalling an installed capacity of about 27GW) and energy efficiency (e.g. 15% energy savings by 2030), the National Energy Strategy is key for the implementation of Morocco's mitigation contributions (Government of Morocco 2016c).

1.4 Further mitigation potentials and barriers

Morocco is one of the leading countries in the MENA region when it comes to climate change mitigation and adaptation strategies. Especially climate change adaptation measures have always been in the centre of Morocco's considerations due to the country's vulnerability to climate change. International climate finance inflows are overwhelmingly focused on mitigation while most of the domestic support has been allocated to adaptation measures (Heinrich-Böll-Stiftung 2017).

¹ This difference is based on the fact that the Moroccan inventory for the BUR resulted in higher numbers than the used emission database. As no details on the way emissions have been calculated it was not possible to determine underlying causes of this differences

In terms of mitigation action, it is estimated that the highest potential in Morocco exists in the electricity sector (67%), followed by the industry sector (14%) and the waste sector (7%), while agriculture, transport, buildings and forest display smaller mitigation potential (PMR 2014). The portfolio of 55 mitigation actions presented in the country's NDC to achieve the conditional and unconditional GHG emission reduction targets by 2030 entail activities for all these sectors and are closely linked to the objectives of the different national sector strategies. Hence, Morocco's mitigation strategy already comprises very extensive and far-reaching measures coherent with the country's climate change commitments.

However, the mitigation actions also include measures focusing on the expansion of natural gas use. While natural gas is often described as a low-carbon energy source and the Government of Morocco sees natural gas as an option to back power generation from intermittent renewable energy sources, and power plants fuelled by natural gas have lower emissions compared to oil or coal, natural gas is still responsible for significant amounts of GHG emissions. Investments in new gas infrastructures entail the risk of technology and emission lock-ins that could create new dependencies on fossil fuels and hinder further GHG mitigation efforts.

With regard to the implementation of the country's climate change agenda including the mitigation and adaptation efforts, the number of involved stakeholders is growing. Accordingly, there is a need to coordinate between the different activities of these stakeholders in order to avoid miscommunication or doubling of efforts. The newly established Moroccan Competence Center for Climate Change (4C Morocco) is now mainly responsible for coordinating these exchanges and facilitating information sharing between government ministries, private sector institutions, and civil society associations.

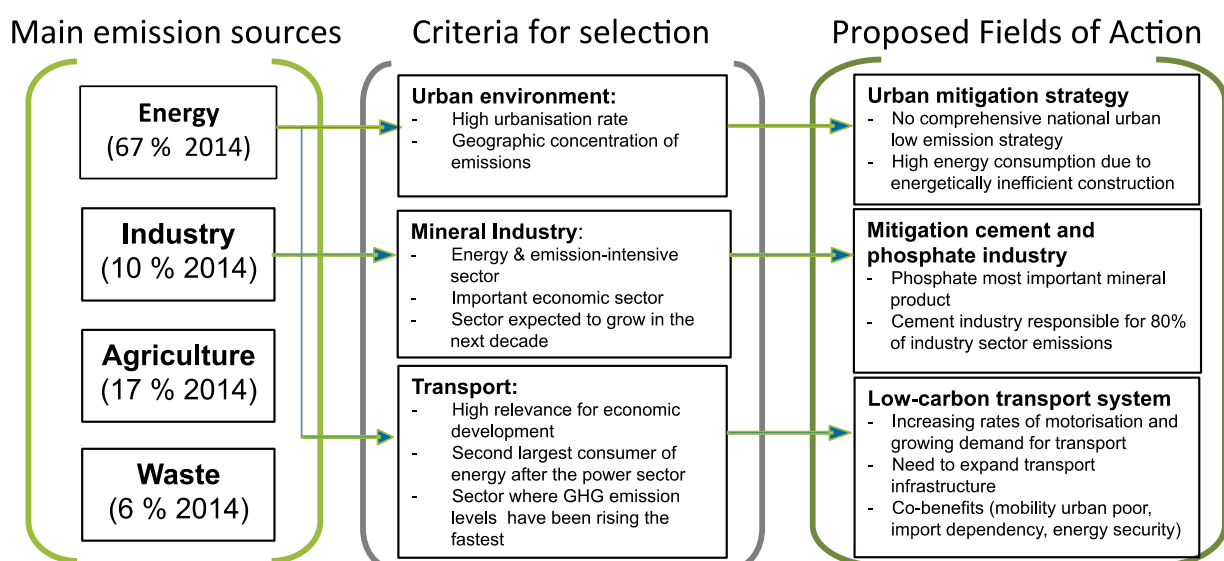
While Morocco will likely be able to meet its unconditional NDC targets under current policies, further efforts are required to achieve the conditional targets by 2030 as well (CAT 2017). Accordingly, the NDC Partnership lists the development of an NDC implementation roadmap and increasing political visibility and agenda setting as a key engagement area, next to the need to identify and secure financing and technical assistance to close the gap on resources needed to meet adaptation and mitigation targets (NDC Partnership 2017b).

1.5 Main fields of action

Morocco's mitigation strategy already constitutes very extensive and far-reaching measures coherent with the country's climate change commitments. Nevertheless, there are still some fields for mitigation actions that could potentially be specified in more detail or could be extended in order to overachieve the existing targets.

Accordingly, the integrated assessment of mitigation potential and actions explicitly includes an analysis of existing strategies and measures which would help to reach both the conditional and unconditional mitigation contribution. Based on these observations and after considering historic and projected sectoral emissions development; comprehensive literature on GHG mitigation potentials; identified barriers and emissions reductions; feasibility, costs, and co-benefits, the following fields of action were selected: urban environment, mineral sector and transport sector.

Figure 4: Overview selection criteria for potential fields of mitigation action



Source: authors

1.5.1 Urban environment

Cities account for a large share of GHG emissions due to their high levels of energy consumption. Morocco has a high mitigation potential in the urban environment as so far no national urban mitigation strategy is being implemented albeit the existence of individual measures and of planned activities within the country's NDC.

Therefore, two mitigation strategies have been identified: Implementing energy efficiency measures in public and private buildings, and fostering the cooperation between administrative levels, including municipalities, in order to elaborate a comprehensive sustainable urban development strategy. First, the Thermal Regulation of Construction in Morocco (RTCM), with a mitigation potential of 2.4 MtCO₂e between 2016 and 2035, needs to be effectively implemented. Though, so far this legal framework only applies to new constructions. Therefore, an expansion of energy efficiency measures to existing housing facilities is necessary. Second, Morocco's climate policy needs to be coherent on all levels, including the local administration. To achieve this, an involvement of local governments in the conceptualisation of national urban policy is of great importance.

1.5.2 Mineral sector

Within the industry sector, large amounts of GHG emissions can be allocated to mineral production and processing (4C Morocco 2014). Hence, the mineral sector is one of the industry segments with a sizeable potential for GHG emissions reductions in Morocco. Key segments of the mineral sector that are both energy- and emission-intensive and that are expected to grow further in the next decades are the phosphate and cement industry.

In 2012, the cement sector emitted between 7.9 – 9.5 MtCO₂e depending on the source (Government of Morocco 2016b, PMR 2014), compared to 3.2 MtCO₂e emitted during phosphate production and processing in 2016 (OCP 2016). Although the cement sector is smaller than the phosphate sector in terms of production, employees and revenues, it has a higher relevance when it comes to GHG emissions and mitigation potentials.

The cement sector is already actively involved in reducing its GHG emissions. Mitigation efforts are so far mainly concentrated on the indirect energy-related emissions from electricity consumption. However, these emissions represent only a small portion of emissions from the cement sector. It is therefore recommendable to explore mitigation options regarding emissions from direct energy use for heat generation to operate the kilns and the process emissions from the calcination process. Mitigation options in this regard include the use of alternative fuels (biomass or waste), efficiency measures, replacing a portion of the clinker by blending in waste materials or in the future capture and storage of carbon emissions (CCS).

1.5.3 Transport sector

The transport sector in Morocco has been growing rapidly and is expected to continue to grow further due to increasing rates of motorisation and growing demand for transport. Road transport is by far the main mode of transport and the vehicle fleet more than doubled from 1.6 million vehicles in 2000 to 3.4 million in 2014 (DEPF 2015; CTF 2009).

In 2012, the transport sector was responsible for about 14.7% of the direct net GHG emissions in Morocco and thereby ranked second behind the electricity sector (Government of Morocco 2016b). Even if the emissions growth was already lowered due to improvements of the overall emissions factor, transport is the sector in Morocco in which GHG emission levels have been rising the fastest. The already high share of GHG emissions and the rapid growth rates of the sector are making it evident that the transport sector is an important field for mitigation action.

Morocco has already implemented different urban transport projects and national measures and has listed further mitigation actions for the transport sector in its NDCs. The additional mitigation potential from these actions amounts to nearly 50 MtCO₂e. These activities include extensions of the Rabat, Sale and Casablanca tram, large taxi upgrades, a national strategy for the logistic development and the upgrade of utility vehicles (Government of Morocco 2016c). Next to these already implemented or planned measures, a low-carbon transport system in Morocco could be supported by modal shifts in passenger and freight transport and a fuel switch from fossil fuels to low-carbon fuels and energy carriers.

In regard to alternative fuels, with its unique renewable energy resources Morocco could also use its potential to strengthen research and development of synthetic fuels based on renewable energy power, which would not only provide potentials to decarbonise Morocco's transport sector, but also open opportunities to become an exporter to Europe in the future. Morocco is one of the countries in the Maghreb region that have the highest potential to produce and export carbon-neutral hydrocarbons most cost-effectively to Europe (Fasihi et al. 2017).

2 Part II: Full country analysis

2.1 Country background

Geography. The Kingdom of Morocco is located in the North-West of the African continent, bordering the Mediterranean Sea as well as the Atlantic Ocean. It is exposed to different climatic conditions: Its climate is Mediterranean in the North and semi-arid or arid in the South. It is therefore known to be particularly vulnerable to the effects of climate change (Kingdom of Morocco 2014). The Atlas Mountains, ranging from the country's North-East to the South-West, provide freshwater resources which are mainly used for agricultural irrigation (Heinrich-Böll-Stiftung 2017).

Figure 5: Map of Morocco



Source: Wikimedia Commons (2017)

Population. Morocco's population counted 34 million inhabitants in 2014. Since 1990 it has grown by 36%. Between 2004 and 2014, the country experienced an annual demographic growth rate of 1.25%, which has slightly decreased compared to the period of 1994-2004 (Government of Morocco 2016a). In 2030, its population is projected to reach 41 million people (UN DESA 2017). Next to the high population growth the Moroccan population is increasingly urban: In 2014, Morocco displays an urbanisation rate of 60%, having grown by 24% since 1990 (Table 1).

Economy. In 2014, Morocco's GDP amounted to USD 110 billion, which rates as a record high. Compared to 1990, the GDP increased by 265%. However, in 2016, it decreased again to USD 101 billion due to a poor agricultural season, while for 2017 the GDP has been rising again (World Bank 2017b). Over the past decade, Morocco has experienced relatively stable annual growth rates of about 5% (NDC Partnership 2017b). Yet, growth rates are subject to climatic conditions: In drought periods, they drop to around 2.8% on average, albeit the diversification and the growing importance of the tertiary

sector in the Moroccan economy help contain the volatility of economic growth rates (Government of Morocco 2016a).

The most important sector of Morocco's economy in terms of GDP share is the tertiary sector (54.9%), followed by the secondary sector (accounting for 29.6% of the GDP), and the primary sector with agriculture activities accounting for 15.5% of the GDP (Government of Morocco 2016a). Export rates have increased by 6.7%, which is largely attributable to the dynamics of the automobile, agro-alimentation and aeronautic sectors (Kingdom of Morocco 2014).

Table 1: Key socio-economic figures

Indicator	Morocco	% change since 1990	World	Germany	Year
Population [million]	34	+36	7261	81	2014
GDP [2017 billion USD]	110	+265	78630	3879	2014
GDP/Cap [2017 USD/cap]	3239	+168	10829	47903	2014
HDI [0 – 1]	0.63	+38	/	0.92	2014
Electrification rate [%]	100	+133	85	100	2012
GINI index [0 – 100]	40.7 (2006)	+3.8	/	30.1 (2011)	2006, 2011
Corruption index [1 – 6]	/	/	2.9	/	/
Urbanisation [% of total]	60	+23.99	53	75	2014

Data sources: ND-GAIN (2017); UNDP (2015); United Nations (2014); World Bank (2017a); GDP per capita calculated based on World Bank (2017a)

Political system. The Kingdom of Morocco is a constitutional monarchy with a dualist parliamentary system: The King (Mohammed VI.) is the head of the state and presides the executive branch together with the head of government (prime minister currently Saadeddine Othmani). The government is responsible before the Parliament, but also before the monarch (dualism). The Parliament is bicameral (Chamber of Representatives elected by universal direct suffrage for five years and the Chamber of Councillors elected indirectly for six years by local and national electoral colleges), under a multiparty system (Government of Morocco 2016a).

Originally a strongly centralised monarchical system, Morocco has been evolving into a more democratic system over the last decades. In 1996, a constitutional reform led to the establishment of a bicameral parliamentary system. Since 2001, a decentralisation process is slowly taking shape. Local governors are assigned by the King, while the presidents of the regions are elected by the local population (European Forum for Democracy and Solidarity 2014).

In 2011, as a response to the series of protest across the MENA region known as the “Arab Spring”, the Constitution was revised and adopted by referendum. Herein, Morocco declares to abide the international Human Rights and affirms its engagement in harmonising Moroccan legislation with the dispositions of international conventions and treaties the country is a signatory to (Government of Morocco 2016a). The Head of Government is now selected from the political party with the most votes instead of being chosen by the King, and can appoint his cabinet himself. In the 2011 elections, the moderately Islamist Justice and Development Party was voted into office (European Forum for Democracy and Solidarity 2014).

Furthermore, the new Constitution enshrines sustainable development as a right for all citizens (Government of Morocco 2016a). Most importantly, there has been a re-equilibration of powers (Melloni 2013). The respective roles of the government and the parliament have been strengthened (ibid.) and

the political opposition now benefits from a formal status (ibid.). Nevertheless, the King still exercises important powers, especially concerning the composition of the government. He can freely revoke ministers and issue Royal Decrees (ibid.). Although the King can still make these decisions, in practice key decisions are made by the council of ministers in which the King participates. Albeit its constitutional reform of 2011, Morocco's political system still qualifies as authoritarian (Hachemaoui 2012).

Position in the international climate negotiations. Morocco has engaged in international activities in favor of adaptation to climate change and mitigation efforts since 1992 (Heinrich-Böll-Stiftung 2017). It hosted the Conference of the Parties in Marrakech in 2001, which finalised provisions for the implementation of the Kyoto Protocol. Ever since the Copenhagen Climate Change Conference in 2009, the country has increasingly invested in preparatory measures concerning its annual participation in the global climate conferences (ibid.), culminating in its engagement as the host of the 22nd session of the Conference of the Parties (COP 22) to the UNFCCC, which took place in Marrakesh in 2016.

Morocco is a member in several negotiation groups within the international climate regime: The African group, the Arab group as well as the G77 plus China. Taking the diversity of these affiliations into account, Morocco's positions in the climate negotiations address different issues. Not least because of its interest in international support for its renewable energy deployment, Morocco engages in the further development of carbon markets within the climate regime.

With view to its vulnerability to the negative effects of climate change and its comparatively low GHG emissions, a strong focus lies upon adaptation measures rather than mitigation. Morocco is amongst a group of 48 countries that have joined forces within the Climate Vulnerable Forum (CVF) in 2016 and are committed to achieving 100% domestic renewable energy production as rapidly as possible. Furthermore, Morocco seeks to engage in programmes that help to preserve its strategic natural resources, to stabilise its socially and economically fragile territories and to increase the competitiveness of its green economy (Heinrich-Böll-Stiftung 2017). Morocco frequently stresses the need of financial investment, capacity building and technology transfer in order to face the effects of climate change. Embedding its climate policy in a regional context (notably African), it is aware of the necessity of a collaborative and global as well as local and regional approach to climate regulation (ibid.). In this context, Morocco contributed to the establishment of the Adaptation of African Agriculture to Climate Change (AAA) Initiative in 2016, a project aiming at the support of African countries in the implementation of their NDCs in the field of agriculture. The AAA encompasses 25 other African countries, the UNFCCC, FAO and various international development partners (NDC Partnership 2017b).

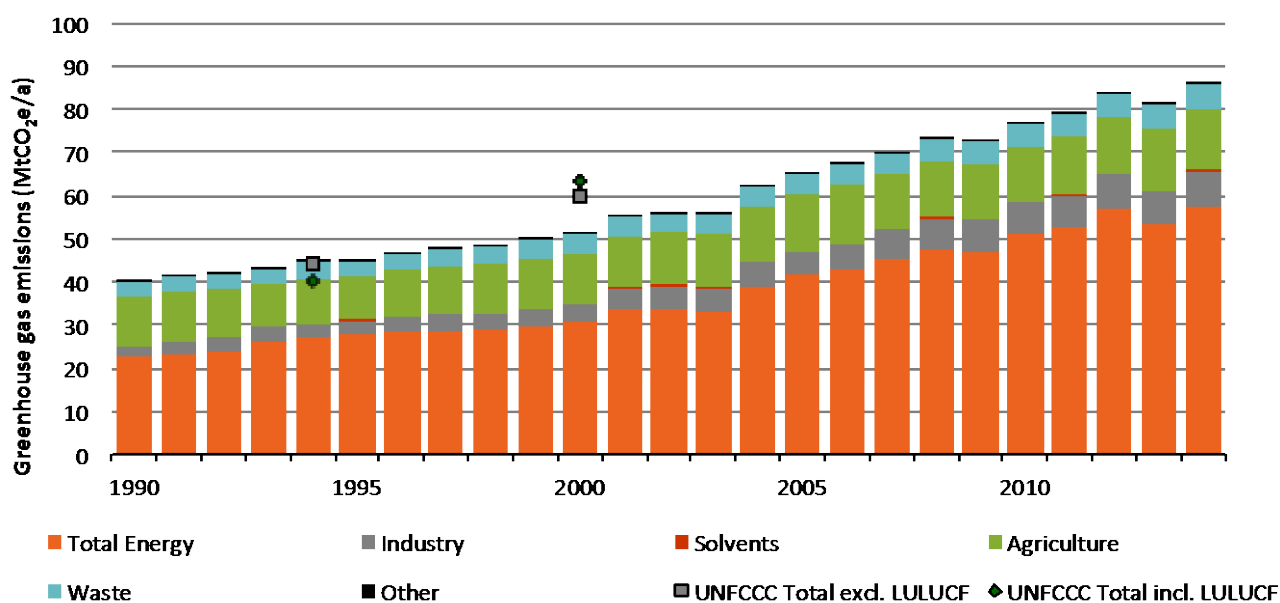
Emissions. Morocco's GHG emissions amount to 86 MtCO_{2e} (excluding LULUCF) in 2014 and account for 0.1% of global emissions in 2012. The energy sector is responsible for 67% of the emissions, followed by agriculture (17%) and industry (10%). Forestry is negligible. Even though Morocco's emissions are comparatively low, there has been a sharp increase since 1990. This emission growth is mainly attributable to the increase in energy-related emissions (from about 23 MtCO_{2e} in 1990 to 58 MtCO_{2e} in 2014). In terms of per capita emissions, which reached 2.54 tCO_{2e}/cap in 2014, this corresponds to an increase of 58% compared to 1990. However, the emissions intensity of the economy has at the same time considerably decreased, by 41%, from 1,329 tCO_{2e}/mln 2017 USD in 1990 to 783 tCO_{2e}/mln 2017 USD in 2014.

In regard to the future development of Morocco's GHG emissions, it is projected that emission levels (excluding LULUCF) reach 142 MtCO_{2e} for the unconditional NDC emission reduction target or 103 MtCO_{2e} for the conditional NDC emission target in 2030, corresponding respectively to reductions of 17% and 42% compared to the business as usual (BAU) emission level (CAT 2017).²

² In its communication to the UNFCCC about its NDC, Morocco reports targets on its emission levels including and excluding intended emission reductions from agriculture, forestry and other land use (AFOLU). Expecting an emission level of 171

Figure 6: Morocco's emissions profile

Historical emissions by sector



Data sources: Gütschow et al. (2016a); UNFCCC (2016)

Table 2: [2014] emissions data from PRIMAP³

Sector	Value	Unit	Share in 2014
Total (excluding LULUCF)	86	MtCO ₂ e/a	100%
Total energy	58	MtCO ₂ e/a	67%
Industry	8	MtCO ₂ e/a	10%
Solvents	0	MtCO ₂ e/a	0%
Agriculture	14	MtCO ₂ e/a	17%
Waste	6	MtCO ₂ e/a	6%
Other	0	MtCO ₂ e/a	0%

Data sources: PRIMAP database Gütschow et al. (2016)

Table 3: [2000] emissions data from UNFCCC

Sector	Value	Unit	Year
Total (excluding LULUCF)	60	MtCO ₂ e/a	2000

MtCO₂e in the BAU scenario in 2030, it would emit 149 MtCO₂e in the unconditional scenario and 113 MtCO₂e in the conditional scenario (respectively without AFOLU) (Government of Morocco 2016c).

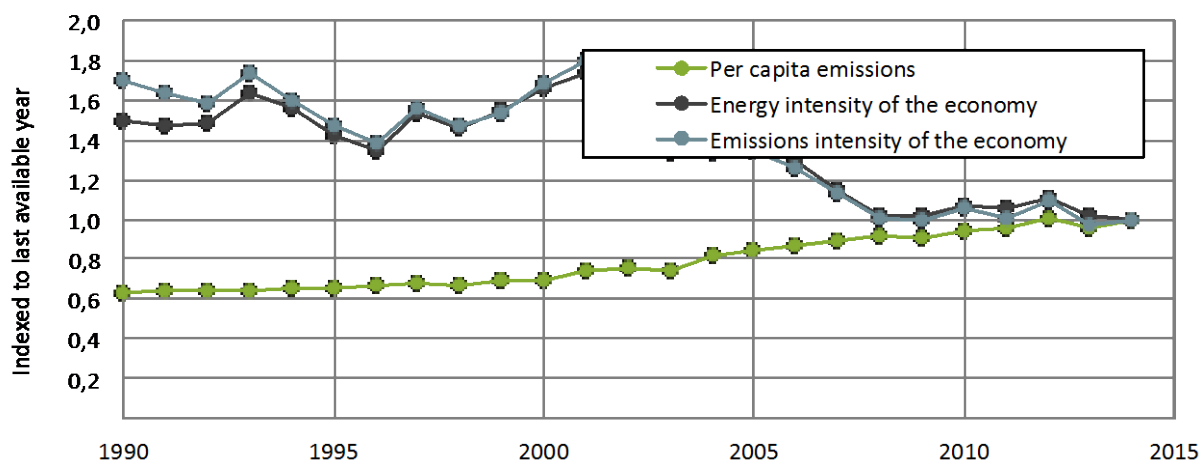
³The PRIMAP dataset is a time series based on a number of sources. Although national data is prioritised, it must meet certain requirements, and undergoes further processing. Therefore, UNFCCC and PRIMAP data do not always match. See Gütschow et al. (2016) for details.

Sector	Value	Unit	Year
LULUCF	4	MtCO ₂ e/a	2000

Data sources: UNFCCC database

Figure 7: Emissions and energy use intensity over time

Emissions and energy use indicators



Data sources: Gütschow et al. (2016b); IEA (2016a); World Bank (2017a)

Table 4: Key emissions, energy and environmental data

Indicator	Morocco	% change since 1990	World	Germany	Year
GHG/cap [tCO ₂ e/cap]	2.54	+58	6.42	10.76	2014
GHG/GDP [tCO ₂ e/mln 2017 USD]	783	-41	593	225	2014
Energy/GDP [ktoe/mln 2017 USD]	0.17	-33	0.17	0.08	2014
Global share of emissions [%]	0.1	+11	/	1.8	2012
Air pollution index (P2.5)	21 ug/m ³ *	-3	42 ug/m ³ *	14 ug/m ³ *	2014
Vulnerability index [0 – 1]	0.39	/	/	0.23	2014

Data sources: Gütschow et al. (2016b); IEA (2016a); ND-GAIN (2017); World Bank (2017a)

*annual mean concentr. of fine particulate matter <2.5 microns in diameter

Vulnerability to climate change. Morocco is highly vulnerable to both the long-term effects of climate change as well as to catastrophic events due to climate variability. The country's regions are already affected by negative impacts of climate change such as average temperature rise, droughts, desertification, heat waves, flooding, a rising sea level and changing rainfall patterns (Heinrich-Böll-Stiftung 2017; Government of Morocco 2016a).

On average, the temperature has already risen by 1°C in two thirds of the country's territory. The frequency of droughts has significantly increased and climate projections for Morocco indicate that this trend is expected to continue. Furthermore, 93% of the country's territory already has an arid or semi-arid climate with a rising tendency. Accordingly, spring precipitation is of crucial importance for the

cultivation of cereals and other crops, but has decreased by 47% from 1976 to 2006, thereby negatively affecting the agricultural sector, which is highly dependent upon climatic conditions. Moreover, two thirds of the beaches are already at risk of erosion and the threat of coastal storms is growing (Heinrich-Böll-Stiftung 2017; Government of Morocco 2016a).

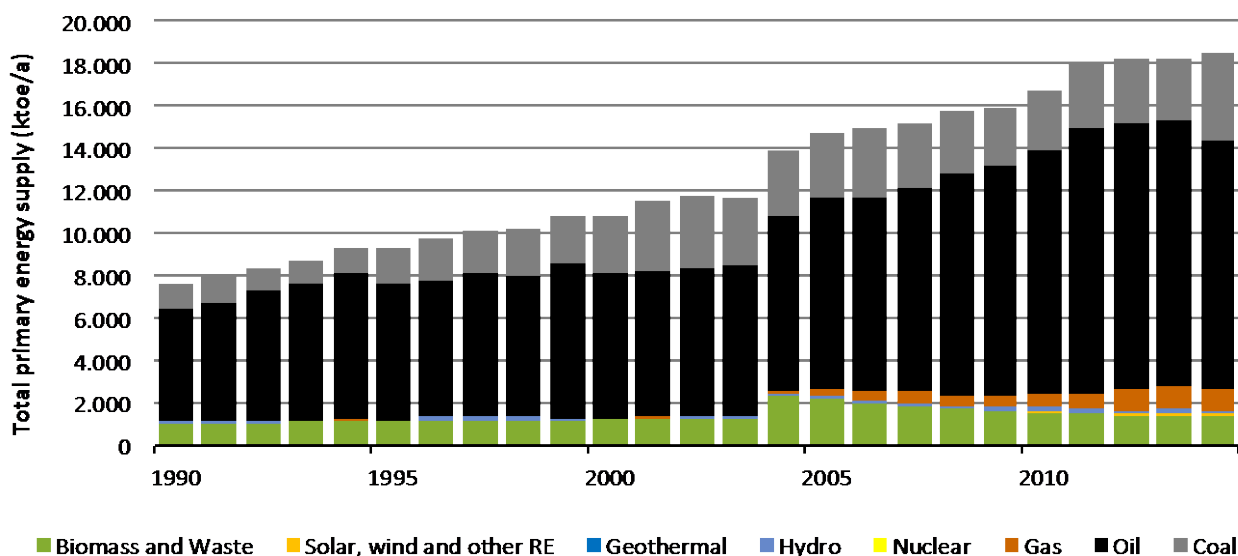
As a result, climate migration has already become a reality in Morocco. Climatic events are assumed to have an impact on mobility, causing rural migration and forcing nomadic shepherds to settle down. These trends will potentially increase the (resource) pressure on already damaged and vulnerable areas (Heinrich-Böll-Stiftung 2017; Government of Morocco 2016a).

Furthermore, there is an increasing pressure on the country’s scarce water resources. In certain regions of the South, water shortages are to be expected as of 2020. The country also suffers from increasing desertification. This constitutes a crucial constraint to Morocco’s development potential with view to its dependency on the economic sectors of agriculture, fishery and tourism, considering that these activities are highly water-intensive (Heinrich-Böll-Stiftung 2017; Government of Morocco 2016a).

Energy system. In 2014, the country’s primary energy demand was mainly met by oil (64%) and coal (22%), followed by biomass and waste (7%) and gas (5%) (IEA 2016b). To meet its demand, Morocco is highly dependent on fossil fuel imports (95% in 2014) being the largest energy importer in the MENA region (Heinrich-Böll-Stiftung 2017). The reliance on fossil fuels and the high import dependency places a huge burden on both, the national budget and the country’s energy security. At the same time, the energy demand is growing as a result of population growth, urbanisation and economic development. The increase in electricity demand was furthermore driven by the increased electrification rate, which reached 91.6% in 2014 (World Bank 2017a). In 2017, the electrification rate reached supposedly nearly 100% (L’Economiste 2017b). The overall per capita electricity consumption has risen about 60% from an average of 358 kWh per year in 1990 to 901 kWh in 2014 (ibid.)

Figure 8: Morocco’s energy profile

Primary energy by energy carrier



Data sources: IEA (2016b)

Table 5: [2014] total primary energy supply by fuel from IEA

Fuel	Value	Unit	Share in 2014
Biomass and waste	1366	ktoe	7%
Solar, wind and other RE	165.5	ktoe	1%
Geothermal	0	ktoe	0%
Hydro	141	ktoe	1%
Nuclear	0	ktoe	0%
Gas	1006	ktoe	5%
Oil	11750	ktoe	64%
Coal	4037	ktoe	22%

Data sources: IEA (2016b)

In regard to the economic sector, energy intensity has decreased by 33% compared to 1990 (World Bank 2017a), but Morocco's energy needs are expected to rise further, especially for energy-intensive industries like the chemical industry or the construction sector as well as in the tourism industry, and for the development of the country's infrastructure. Furthermore, the energy demand for desalination to meet the growing demand for supply drinking, irrigation and industrial water is expected to rise.

To ensure a stable and affordable energy supply, the Moroccan government has taken steps to diversify its energy mix. The deployment of renewable energy technologies on a large scale and the increase of energy efficiency are a major part of Morocco's strategy to transition to a more sustainable energy system. In regard to renewable energies, Morocco has set the most ambitious targets in the region aiming to increase the share of renewables in the installed electricity capacity to 42% by 2020 and 52% by 2030 (OECD/IEA 2014). Concerning energy efficiency, the government's target is to reduce energy consumption by 12% by 2020 and 15% by 3030 (ibid.).

To reach these targets, Morocco makes use of its significant renewable energy potentials, the most important being solar and wind resources, followed by hydro power. Morocco has an average of 2,800 to 3,400 hours of sunshine per year, corresponding to an average irradiation level of over 2,300 kWh/m²/year, among the highest rates worldwide (MASEN 2017). In addition to solar, Morocco also boasts ideal conditions for wind power, with the highest potential located along the 3,000 km of Atlantic coastline, where average wind speeds reach between 7.5-9.5 m/s in the South and 9.5-11 m/s in the North (EWEA 2012). Harnessing these renewable potentials, the country aims to install 2,000 MW of solar capacity and 2,000 MW of wind power capacity by 2020 (MASEN 2017).

Bilateral Cooperation with Germany. Germany has maintained diplomatic relations with Morocco since 1956 (Federal Foreign Office 2017). Within the Middle East/North Africa (MENA) region, Morocco is one of the key partners and the largest recipient of German funding, mainly in the form of concessional loans. Development cooperation between Morocco and Germany is based on intergovernmental agreements, such as the 2013 Rabat Declaration, in which the foreign ministers of the two countries agreed on continuous cooperation and to deepen their dialogue in the political, economic and cultural spheres (BMZ 2017). In the energy sector, a bilateral energy partnership was established in 2012, in order to coordinate the bilateral activities between Germany and Morocco, which includes the promotion of renewable energy (ibid.)

The current priority areas for cooperation are water, energy, sustainable economic development as well as environment and climate change. Accordingly, Germany's bilateral engagement in Morocco encompasses a variety of projects focusing on both climate change mitigation and adaptation efforts

(NDC Partnership 2016a). These projects provide financial or technical assistance as well as capacity building and are implemented by different partners, amongst which are GIZ and KfW (ibid.). One of the projects supported the establishment of a Competence Center for Climate Change (4C Morocco) in 2016. This center, which was developed in collaboration between the Moroccan National Observatory for Environment and the GIZ through Germany's International Climate Initiative (ICI), was founded in order to improve Morocco's capacity to adapt to climate change and to reduce GHG emissions. It consists of a platform for actors originating from different sectors aiming at the exchange of expert knowledge of climate change, ranging from public administration, regional and local authorities, private sector, research and education, to civil society actors (Heinrich-Böll-Stiftung 2017; 4C Morocco 2015a). Other projects provide/provided technical assistance and capacity building support, for example by helping to gain access to international funds and making effective use of climate finance (Climate Finance Readiness programme (CF Ready)), by supporting the development of legal frameworks and institutional conditions in the energy sector (Support for Morocco's energy policy (PAPEM)) or by supporting adaptation measures to climate change by helping with the implementation of the Nagoya Protocol, which is an international environmental agreement that was concluded within the context of the UN Convention on Biological Diversity (ACCN). Moreover, Germany contributes to the implementation of Morocco's renewable energy strategy by providing financing for example for the construction of the solar complex in Ouarzazate as well as for wind energy or sea water desalination projects.

Furthermore, Morocco and Germany cooperated in the establishment of the NDC Partnership in 2015, a platform for effective NDC implementation in developing countries (NDC Partnership 2017a).

2.2 Institutional set up

Morocco has set up a two-fold institutional system for climate governance, addressing the national and international level.

On the national level, Morocco has created a legal and institutional framework for the implementation of its engagements in the UNFCCC. In 2014, it enacted the Framework Law on the National Charter for Environment and Sustainable Development (NCESD), thereby setting a frame for its policies in these fields (NDC Partnership 2017b), one of its principles being the fight against climate change. The responsible institutions involved in Morocco's national climate governance are the following (Government of Morocco 2016a):

The **Secretary of State in Charge of Sustainable Development (SSSD)** within the Ministry of Energy, Mines, and Sustainable Development (former Ministry of Energy, Mines, Water and Environment) is the focal point for the national climate politics. It is a. o. responsible for the implementation of the National Strategy for Sustainable Development (NSSD) (NDC Partnership 2017b). A structural reorganisation within the Ministry has led to the creation of the Central Direction for Climate Change, Biodiversity and Green Economy (DCCDBEV), in charge of the following tasks: Integration of climate change and biodiversity data into policy, surveillance and implementation of Morocco's engagements, and the implementation of national governance structures for climate change and biodiversity (Heinrich-Böll-Stiftung 2017).

However, climate objectives concern not only these departments of that ministry, but are also of high relevance for other departments and ministries in Morocco. A cross-ministerial coordination is mainly guaranteed by the effort of the **Moroccan Competence Center for Climate Change (4C Morocco)**, established in the framework of the partnership between the SSSD and the German government. The 4C Morocco provides a platform for dialogue and cooperation between government ministries, five private sector institutions, and six civil society environmental associations, adopting a participatory, multi-stakeholder approach (NDC Partnership 2017a).

The **National Committee on Climate Change (CNCC)** assembles representatives of public institutions dealing with the issue of climate change in Morocco, as well as stakeholders from the private sector and civil society.

The **National Research and Technology Committee - Climate Change (CNST-CC)** is composed of national experts in science and technology in a climate change context embedded in public institutions, universities and counseling firms (Government of Morocco 2016a).

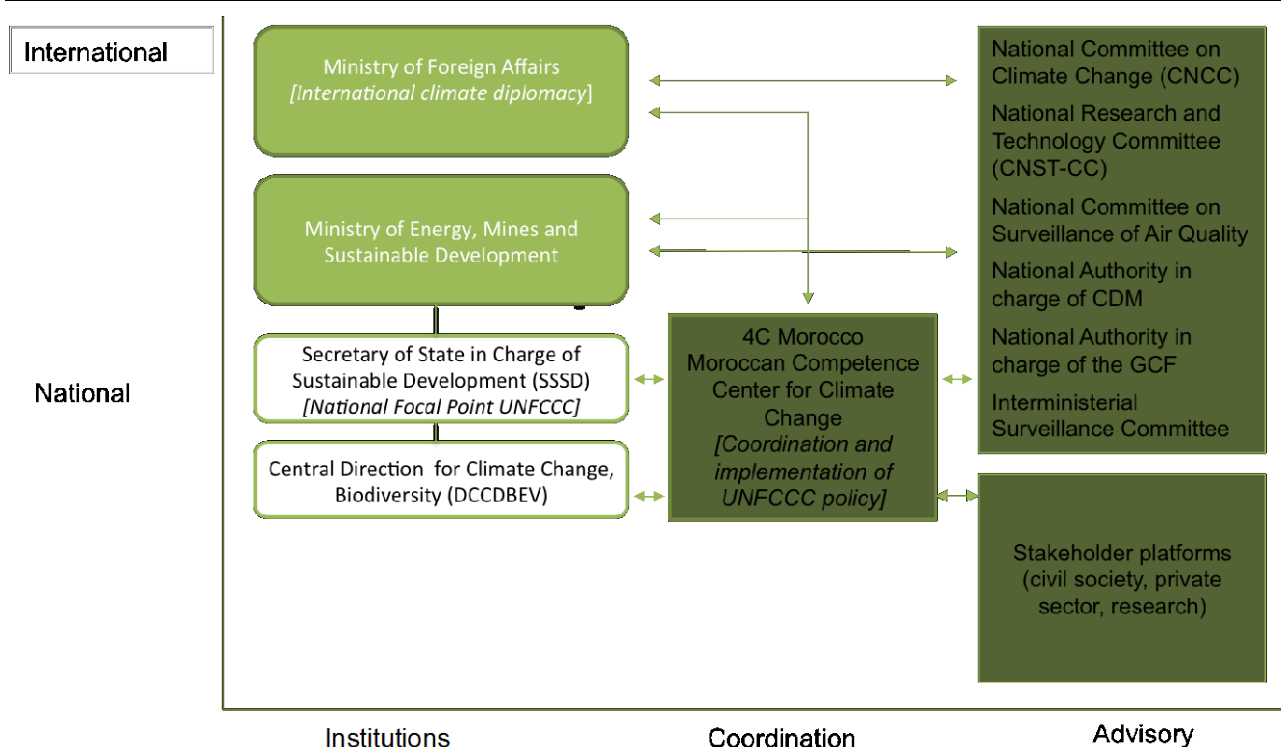
The Ministry Delegate in Charge of the Environment assures the secretariat and presidency of the **National Committee on Surveillance of Air Quality**. The latter is in charge of federating and harmonising all activities linked with the surveillance of air quality. Furthermore, regional committees are to be installed in every region in which an air quality surveillance network exists; so far there are four regional committees (SSMEMWE 2015).

The **National Authority in charge of the Clean Development Mechanism (CDM)** is entrusted with the task of examining national CDM projects in accordance with the Kyoto Protocol. It has to be noted that Morocco was one of the first countries to establish a National Authority in charge of CDM.

The **National Authority in charge of the Green Climate Fund (GCF)** has the function of the national coordination of the country's financial priorities.

The **Interministerial Surveillance Committee (CSI)** is responsible for the surveillance and validation of technical studies conducted by Morocco as a response to its engagements and obligations within the UNFCCC (for example the national communications, the INDCs etc.) (Government of Morocco 2016a).

Figure 9: Flowchart of organisational setup



Source: authors

Overall it can be stated that the number of stakeholders involved in planning and implementing Morocco's climate agenda is growing. Accordingly, there is a need to coordinate between the different activities of these stakeholders in order to avoid miscommunication or doubling of efforts. Especially, as there is not only a high number of stakeholders involved on the Moroccan side, but there are also

many active development partners in Morocco (NDC Partnership 2017b). The newly established Moroccan Competence Center for Climate Change (4C Morocco) is now mainly responsible to coordinate these exchanges and facilitate information sharing between different stakeholders. While the establishment of the 4C center is an important step towards efficient coordination of efforts from different stakeholders, so far the efforts have a strong focus on the governmental actors, while civil society actors and non-governmental organisations are only partly included.

On the international level, Morocco has established a governance system for its climate diplomacy. The main agents are the Ministry of Foreign Affairs and the Ministry of Energy, Mines, and Sustainable Development (Heinrich-Böll-Stiftung 2017). The Ministry of Foreign Affairs engages in monitoring activities and coordinates national diplomacy concerning Morocco's diverse engagements in international treaties, while the Secretary of State in Charge of Sustainable Development (SSSD) within the Ministry of Energy, Mines, and Sustainable Development acts as the national focal point to the UNFCCC and coordinates the national implementation of commitments made under the Paris agreement (Government of Morocco 2016a).

2.3 MRV of GHG emissions

Morocco submitted its first national communication (NC1) to the UNFCCC in 2001 and the second one (NC2) in 2010. The third national communication (NC3) was submitted in 2016 together with the country's first biennial update report (BUR I) (Government of Morocco 2016a and 2016b). The BUR was originally intended to be submitted by December 2014, but was delayed for undisclosed reasons (UNFCCC 2017).

Morocco recognises the need for a domestic MRV (Monitoring, Reporting, and Verification) system that will allow monitoring and evaluation on a continuous basis, but until now no overall national MRV system exists (UNFCCC 2017). However, Morocco has set up a National Green House Gas Inventory System (GHG-IS) and provides details on potential MRV systems for its five NAMAs.

The national Green House Gas Inventory System (GHG-IS) has been introduced in 2015 with support of the international climate initiative of the German Federal Ministry of Environment. The institutional set-up of this GHG-IS includes a National Inventory Committee, a National Inventory Unit, a National Coordinator as well as five sector coordinators and various industry focal points. The inventory is coordinated by the Competence Center for Climate Change (4C Morocco and GIZ Morocco 2017). Following a broad stakeholder consultation process the system was approved and a draft ministerial decree has been composed, which is in the process of being adopted. The GHG-IS has been applied to prepare the emissions inventory for 2010 and 2014. In 2017, a process was started to further improve the GHG-IS, by focusing on the implementation of priority actions in the sectors of agriculture, energy and land use, and forestry (4C Morocco and GIZ Morocco 2017).

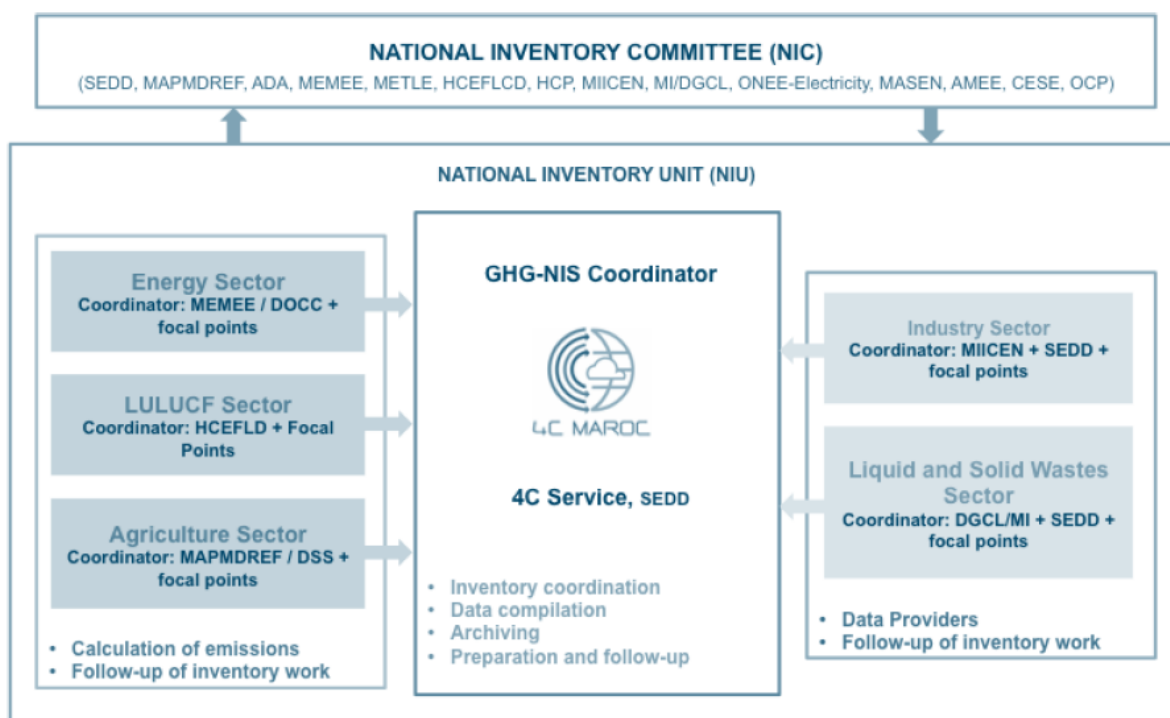
For the emission accounting the Tier 1 approach from the revised 1996 IPCC Guidelines was applied. While Morocco did not provide details on the methodologies used in the BUR I, additional information on the methodology and emission factors used was provided for the analysis by the UNFCCC team of technical experts. Based on this information, the team of technical experts recommends to improve the completeness of Morocco's GHG inventory by collecting activity data for specific emission sources, developing methodologies to better estimate emissions and developing country-specific emission factors (UNFCCC 2017).

Next to the national inventory system, Morocco proposes a detailed MRV system for the five NAMAs in the fields of solar pumps, solar photovoltaic systems, habitats (energy efficiency and renewable energy production in residential buildings), waste management and in the argan oil sector (for detailed de-

scription of NAMAs please see chapter 2.5) (Government of Morocco 2016b). The MRV systems presented in the BUR I include potential NAMA-specific indicators and list stakeholders responsible for the coordination and implementation of the MRV system. The level of detail presented in the report regarding the indicators and the institutional set-up varies across the different NAMAs. However, the MRV system proposed in the BUR I only constitutes a first version. Morocco plans to further develop and expand these MRV systems during the implementation phases of the NAMAs. As the NAMAs are intended to be supported internationally, it is suggested that the task of verification should be completed by a third party (UNFCCC 2017).

While the BUR I describes in detail the proposed MRV systems for the five NAMAs, no information has been made available on how an overall MRV system for other mitigation actions and programs should be designed and which steps the country intends to take to set up such a system, so far. According to the information provided by the analysis of the UNFCCC team of technical experts, setting up an MRV system is one of Morocco’s objectives for the country’s fourth national communication (NC4) (UNFCCC 2017).

Figure 10: Institutional set-up national Green House Gas Inventory System (GHG-IS) Morocco



Sources: 4C Morocco and GIZ Morocco (2017)

By joining the Partnership for Market Readiness (PMR), which is a forum providing funding and technical assistance to support capacity building to scale up climate change mitigation, Morocco received funding to prepare a Market Readiness Proposal (MRP), which was finalised in 2014. One of the objectives within the programme is to strengthen Morocco’s capacity in regard to GHG emissions data collection, management and processing at the national level as well as in the three sectors identified as target areas (electricity generation, cement production, and phosphate processing) to achieve GHG mitigation. The proposed activities include the design of an MRV system, and piloting of monitoring and reporting in the three selected sectors (PMR 2014 and 2016).

In addition, Morocco is piloting the first policy-level MRV infrastructure within the frame of the World Bank’s Transformative Carbon Asset Facility (TCAF). This is a first step towards developing a carbon

pricing structure aimed at policy impacts, instead of emission sources for Morocco (NDC Partnership 2017b).

2.4 Description and evaluation of the (I)NDC

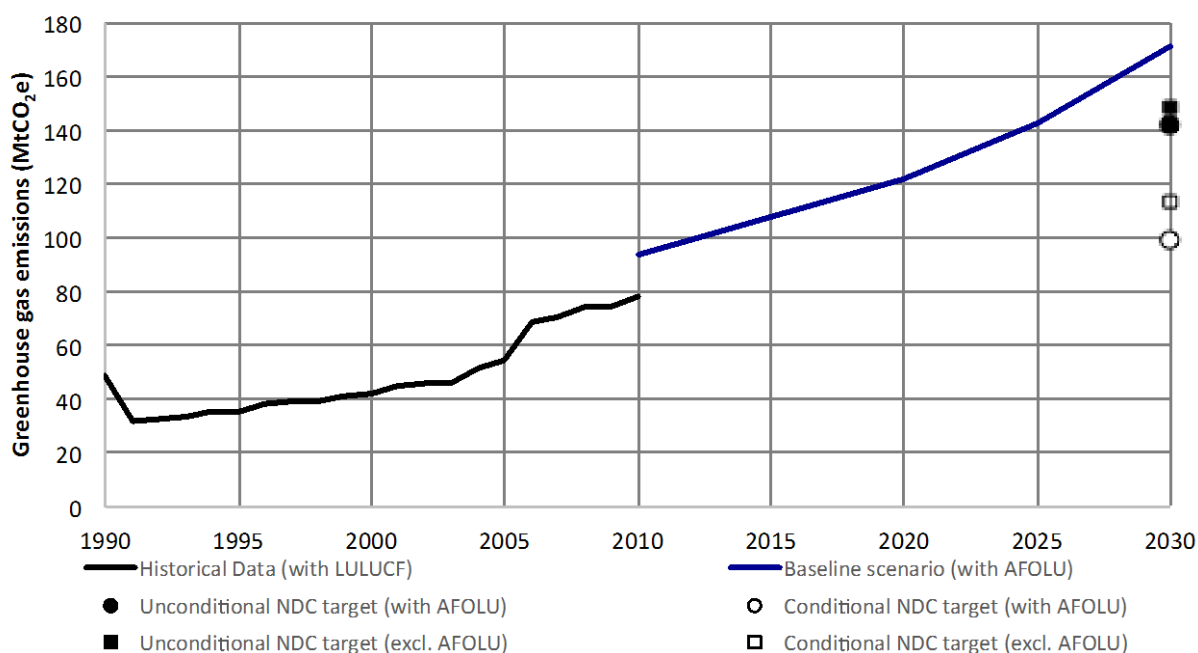
In 2016, Morocco submitted its NDC to the United Nations Framework Convention on Climate Change (UNFCCC). The NDC is an improved version of the 2015 INDC. The INDC was developed in an extensive, two-year stakeholder consultation process, which however did not include civil society representatives (Climate Action Network 2015). In 2015, the results of this process were presented in a conference chaired by the head of government that involved Moroccan stakeholders. After the adoption of the Paris Agreement, the NDC was developed by again engaging various stakeholders to ensure a broad level of support for the implementation of Morocco’s commitments (Government of Morocco 2016c).

Compared to the INDC the level of ambition has been raised in the NDCs for both the unconditional and the conditional GHG emission reduction targets by including emissions reduction from agriculture, forestry and other land uses (AFOLU) (CAT 2017). Furthermore, in the NDC concrete measures to achieve the mitigation goals of the conditional and unconditional targets are specified, allowing to better evaluate the feasibility of Morocco’s commitments (Government of Morocco 2015 and 2016c).

In the NDC, Morocco commits to an unconditional target of 17% reduction of GHG emissions by 2030 compared to a BAU scenario, with 4% coming from AFOLU actions. Accordingly, without AFOLU actions the unconditional reduction target is 13%. Conditionally, dependent on the availability of climate finance and support from the international community, Morocco pledges 42% GHG reduction below BAU emission levels by 2030, including AFOLU actions (34% without AFOLU). The funding required to reach these levels of reduction are estimated to be about USD 50 billion between 2010 and 2030, of which USD 24 billion are needed to meet the conditional part of the reduction target (Government of Morocco 2016c).

Figure 11: Morocco’s projected emissions and NDC targets (incl. emissions from AFLOU)

Nationally Determined Contribution



Data sources: Gütschow et al. (2016a); UNFCCC (2016); Government of Morocco (2016c)

The emission levels correspond to 171 MtCO_{2e} in the BAU scenario in 2030, which would be reduced to 149 MtCO_{2e} in the unconditional scenario and to 113 MtCO_{2e} in the conditional scenario (respectively without AFOLU) (Government of Morocco 2016c). Translating these numbers into emission levels excluding LULUCF, this corresponds to 142 MtCO_{2e} for the unconditional NDC emission reduction targets or 103 MtCO_{2e} for the conditional NDC emission targets in 2030 (CAT 2017). While both NDC and INDC refer to the same BAU emissions projections until 2030, the BUR I and NC3 both include a revised BAU scenario with slightly lower emission projections (ibid.). Another point that could prove to be critical is that the emissions reduction targets refer to the BAU scenario and not to a base year. Even though this approach is in line with the target setting of other developing countries, it entails the risk that the absolute reduction targets might differ if the development differs from the BAU projections. Considering the expected population growth, urbanisation rates and further economic development, this might not be an unlikely case (Climate Action Network 2015).

In the unconditional case, realising the commitments would mean that the emission levels would continue to increase until 2030, but more slowly than in the BAU scenario. While in case of the conditional targets, GHG emissions would not rise further but remain steady compared to today's level until 2030. According to calculations of the Climate Action Tracker, the conditional target would be in line with the country's climate change fair share in the global effort of holding global warming well below 2°C, and limiting it to 1.5°C, as agreed in the Paris Agreement (CAT 2017).

In its NDC, Morocco presents a list of 55 mitigation actions for 2030 to achieve the conditional and unconditional GHG emission reduction targets. The portfolio includes activities in all sectors of the economy; however, the most significant reductions are related to the transition of Morocco's energy sector. With ambitious targets both in the field of renewable energies (52% of the installed electrical power from renewable sources by 2030) and energy efficiency (e.g. 15% energy savings by 2030), the National Energy Strategy is key for the implementation of Morocco's mitigation contributions (Government of Morocco 2016c).

With the energy strategy and strategies in other sectors such as agriculture currently being implemented, it is anticipated that Morocco will likely be able to meet its unconditional NDC targets under current policies (CAT 2017). To achieve the conditional targets by 2030 would however require further policy efforts (ibid.). Accordingly, the NDC Partnership lists the development of an NDC implementation roadmap and increasing political visibility and agenda setting as a key engagement area, next to the need to identify and secure financing and technical assistance to close the gap on resources needed to meet adaptation and mitigation targets (NDC Partnership 2017b).

2.5 Climate change mitigation policies and strategies

Climate policy framework. The institutional background for Morocco's climate policy framework, as presented in chapter 2.2, is formed by the National Strategy for Sustainable Development (SNDD) from 2015, which operationalises the National Charta for the Environment and Sustainable Development (NCESD) from 2010, enacted in 2014. The SNDD is currently being implemented; evaluation activities and regional integration are planned. This policy framework is supposed to build upon already existing national strategies or plans, such as the National Water Strategy from 2009 or the National Energy Strategy from 2009. Part of its operationalisation is 2015's Green Investment Plan, which has been enacted in preparation of the Paris agreement and of the Moroccan presidency of COP 22 (Deutscher Bundestag 2016). This plan portrays a project portfolio for seven key areas (water, energy, urban planning, forestry, transport, agriculture, waste management) in order to force "green growth", to build a "Low Carbon Economy" and to establish a climate change-resilient economy. In order to put these projects into practice, investment in order of USD 38 billion over 15 years is needed (ibid.).

To date, Morocco has enacted two climate change policies (the National Plan of Action against Climate Change (PNRC) from 2009 and the Energy Security Plan from 2008) and a number of climate-related laws of which several have already been updated:

- ▶ Framework Law 99-12 on the NCESD from 2014;
- ▶ Law 47-09 on energy efficiency from 2011;
- ▶ Law 13-09 on renewable energy (2011), which was modified and completed by law 58/15 in 2015;
- ▶ Law 57-09 that created the Moroccan Agency for Solar Energy (MASEN) in 2010, which was modified and completed by the law 37/16. This law extends the responsibilities of MASEN to all forms of renewable energies (wind, solar, and hydro, biomass) and changed the name to Moroccan Agency for Sustainable Energy in 2016;
- ▶ Law 16-09 which created the Moroccan Agency for Development of Renewable Energy and Energy Efficiency (ADEREE) in 2010. This law was modified in 2016 into law 36/16, shifting the focus of the agency to energy efficiency and renaming it “Moroccan Agency for Energy Efficiency”.

The PNRC constitutes the overarching climate policy framework. It consists of a portfolio of governmental actions in the fields of mitigation and adaptation, while the focus lies on the latter. The mitigation measures draw upon the National Energy Strategy, mainly aiming at improvements of energy efficiency and the development of renewable energies (Nachmany et al. 2015).

The Moroccan Climate Change Policy (MCCP) from 2013 is an instrument for the coordination of different initiatives and measures to fight climate change and constitutes the mid- and long-term frame for Morocco’s climate change policy. MCCP is supposed to be understood as a dynamic and flexible policy tool, open for participation. Furthermore, the Competence Center for Climate Change (4C Morocco), already presented in chapter 2.2, was established in order to institutionalise and formalise the structures for Morocco’s climate policy. Amongst others, national climate experts are being trained in order to participate in the international dialogue on adaptation and mitigation (Deutscher Bundestag 2016).

Mitigation activities. In its NC3, Morocco developed a portfolio of 49 projects, falling into two categories: 1) Actions aimed at awareness-raising of private and public decision makers, as well as consumers; 2) Actions aimed at the reduction or even elimination of GHG emissions. Together, these actions require an investment amounting to USD 61.67 billion in order to reach the maximum mitigation potential accounting for 78.8 MtCO_{2e}/a. The listed projects cover the sectors of energy production, renewable energies and energy efficiency, household and tertiary sector, industry, transport, and agriculture. The NC3 clearly states that the realisation of these projects depends on massive foreign investment, as Morocco lacks the financial capital, and on technology transfer. The Moroccan government obtained a ranking of the proposed projects into three categories via multi-criteria analysis, ranging from “no regret”, “initial investment < USD 500,000,000” to “Yearly investment < USD 10,000,000”. Concentrating on the 27 “no regret” measures, 58.6% of the overall mitigation potential would be reached, while 48.7% of the initial investment would be consumed (Government of Morocco 2016a).

In its NDC (2016), Morocco enlists 55 economy-wide actions to reduce GHG emissions (see chapter 2.4). The coordination of these potential mitigation actions and the overarching mitigation targets will be ensured by a Low-Carbon Development Strategy (LCDS), which is still being drafted. Reaching Morocco’s mitigation targets presupposes especially an important transformation of the energy sector. Therefore, the government seeks to reduce the country’s dependence upon foreign energy sources and to simultaneously increase the share of renewable energy in the electricity production. These goals translate as follows:

- ▶ 52% installed electricity generation capacity from renewable sources by 2030
- ▶ reducing energy consumption by 15% by 2030

- ▶ substantially reducing public fossil fuel subsidies
- ▶ substantially increasing the use of natural gas, through infrastructure projects allowing liquefied natural gas imports (Government of Morocco 2016c).

Mitigation policy framework. The key sectoral strategies and targets for the implementation of Morocco's mitigation contribution include the National Energy Strategy, National Logistics Strategy, National Household and Similar Waste Program, National Liquid Sanitation and Wastewater Treatment Program, Morocco Green Plan, Preservation and Sustainable Forest Management Strategy as well as the Urban Public Transit Improvement Program (Government of Morocco 2016c).

With the focus lying on the energy sector, the global investment needed to implement Morocco's Energy Program is estimated at USD 15 billion. The Energy Strategy is based on the mobilisation of national resources, a higher share of renewable energy in the energy mix and the establishment of energy efficiency as a national priority. In the medium and long term, energy consumption in buildings, industry and transport is to be reduced by 12% in 2020 and by 15% in 2030, whilst renewable energy should amount to 42% of the installed capacity in 2020 and 52% in 2030. The strategy is built upon two programs: The Morocco Solar Plan and the Wind Plan. Obstacles to the implementation of the Energy Program exist especially with respect to governance. The legal framework needs to be completed and the financial dispositions as well as fiscal incentives are insufficient (Government of Morocco 2016a).

NAMAs. In 2010, Morocco submitted a list of "Nationally Appropriate Mitigation Actions" (NAMAs) to the UNFCCC. These NAMAs are closely linked to the national policy strategies (i.e. the National Energy Strategy, the National Strategy for Development of Logistics Competitiveness, the National Pact for Industrial Emergence, the National Plan for Domestic Waste, the Morocco Green Plan (MGP), a. o.) and the country's Low Emission Development Strategy (LEDS), which includes the energy, transport, industry, waste, agriculture, and construction sector (Kingdom of Morocco 2014).

However, in its Third Communication to the UNFCCC, Morocco states that the implementation of these projects and actions is difficult due to a lack of financial resources in the country. Thus, five priority areas for NAMAs have been identified in collaboration with international partners: agriculture, housing, and waste, as well as solar pumping and solar PV as part of the energy sector (Government of Morocco 2016a).

The NAMA in agriculture addresses the promotion of the argan oil sector in the frame of the Morocco Green Plan. It is the only one having reached the stage of implementation (NAMA-database 2017). The other four areas are currently under development. The NAMA in housing is concerned with the improvement of energy efficiency and the use of renewable energy technologies in the residential sector. As of 2030, 983,000 solar thermal collectors and 4,450 thermal inertial refrigerators coupled with PV panels are to be installed. Furthermore, 136,400 buildings are supposed to be thermally insulated each year (2,000,000 residences over the whole period) (Government of Morocco 2016a), and 130 million fluorescent lamps are expected to be in use by then (NAMA-database 2017). As for the NAMA in the waste sector, alternatives to the current waste management, basically consisting of landfills, are aimed at (ibid.)

The priority NAMAs display the following mitigation potentials in the period of 2015-2030:

NAMA agriculture: 2.1 MtCO₂e

NAMA housing: 39.2 MtCO₂e, 11% compared to BAU

NAMA waste: 4 MtCO₂e, 54% compared to BAU

NAMA solar pumping: 1.4 MtCO₂e

NAMA solar PV: 18.9 MtCO₂e (Government of Morocco 2016a).

Other key activities. For agriculture, the mitigation potential of the main national strategy, the MGP (from 2009) has been evaluated. Actually, the majority of adaptation measures indicated in this strategy contribute directly to the mitigation of GHG emissions, as they improve the production conditions in arid or resource-poor areas. A study commanded in 2012 evaluated the impact of the MGP on emissions, taking the Regional Agriculture Plans as a basis. According to this study, the MGP contributes to the mitigation of 61.7 MtCO₂e in 2020 (Government of Morocco 2016a).

Other key activities with respect to mitigation efforts include carbon pricing. In 2012, Morocco obtained USD 350,000 under the World Bank Partnership for Market Readiness (PMR) to launch a pilot carbon market. Furthermore, it is planned to establish a domestic Emission Trading Scheme (ETS) and to install a system of carbon credits based on Morocco's NAMAs. The Moroccan government defined three main areas of action aimed at by market mechanisms: Electricity generation, cement production and phosphate extraction. These areas are the most emission-intensive sectors of the Moroccan economy (Nachmany et al. 2015). The Moroccan government plans to establish carbon pricing until 2020 (PMR 2014).

Morocco also engages in international cooperation for mitigation activities. The Delegation of the European Union in Morocco has not only supported the country during the preparation and organisation of COP 22, there is also a whole portfolio of partially EU-funded or -supported activities in the climate context (Delegation of the European Union in Morocco 2016).

CDM. Morocco was one of the first countries in Africa and the MENA region to engage in the Clean Development Mechanism (CDM). For the implementation of this mechanism, it established the Designated National Authority (DNA) in 2002, building the institutional grounds for the development and validation of CDM projects. In October 2013, there were 14 registered CDM projects, accounting for a total emissions reduction potential of 2.4 MtCO₂eq/a. These projects are mainly affiliated to the following sectors: Wind energy (Morocco has the first registered CDM wind farm in Africa), biomass energy, waste management, and solar energy. However, even though there is by now a non-negligible portfolio of CDM projects, their full mitigation potential has not yet been realised, as only part of them has been put into practice. The complexity of this mechanism, the alterations of its functioning, transaction costs and low capacities in Morocco requiring the consultation of external specialists are some of the reasons for the slow development of CDM activities (PMR 2014).

2.6 Additional mitigation potential

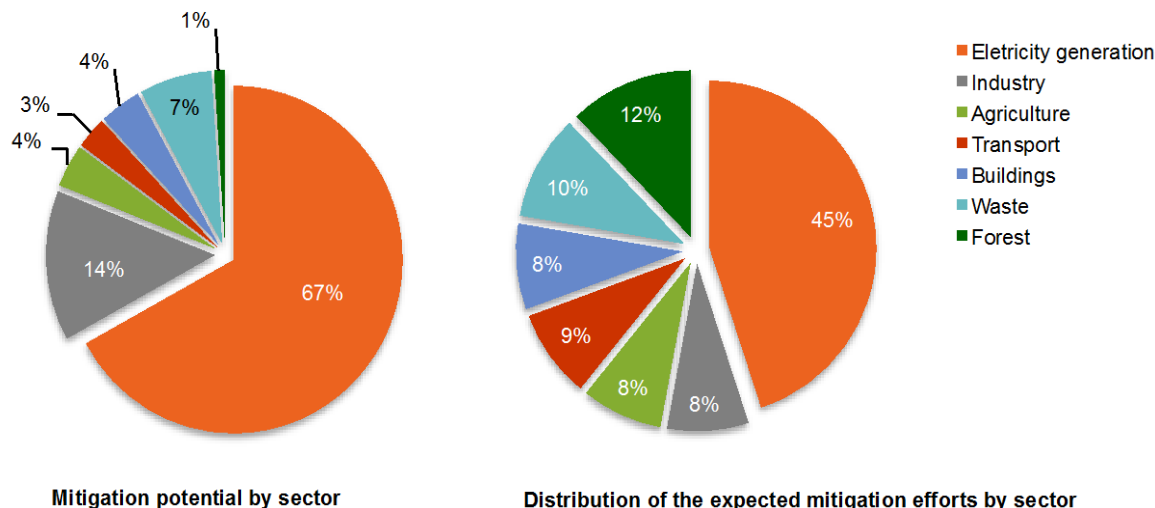
Morocco is one of the leading countries in the MENA region when it comes to climate change mitigation and adaptation strategies. Especially, climate change adaptation measures have always been in the centre of Morocco's considerations due to the country's vulnerability to climate change. Yet, international climate finance inflows are overwhelmingly focused on mitigation, while most of the domestic support has been allocated towards adaptation measures (Heinrich-Böll-Stiftung 2017). Furthermore, Morocco included a climate change adaptation section in its NDC, which involves several quantified sector-specific goals for 2020 and 2030. The country is developing a National Adaptation Plan (NAP) to improve its climate change resilience framework (Government of Morocco 2016c).

As outlined above, Morocco has listed a portfolio of 55 mitigation actions in its NDC to achieve the conditional and unconditional GHG emission reduction targets by 2030. The activities span all sectors (energy, agriculture, forest, transportation, waste, industry as well as actions in the residential and commercial sector) and are closely linked to the objectives of the different national strategies presented in the previous section.

Morocco's mitigation strategy thus already encompasses very extensive and far-reaching measures coherent with the country's climate change commitments. Nevertheless, there are still some fields for

mitigation actions that could potentially be specified in more detail or could be extended to even over-achieve the existing targets. Accordingly, the integrated assessment of mitigation potential and actions in this section explicitly includes an analysis of existing strategies and measures, which would help to reach both the conditional and unconditional mitigation contribution.

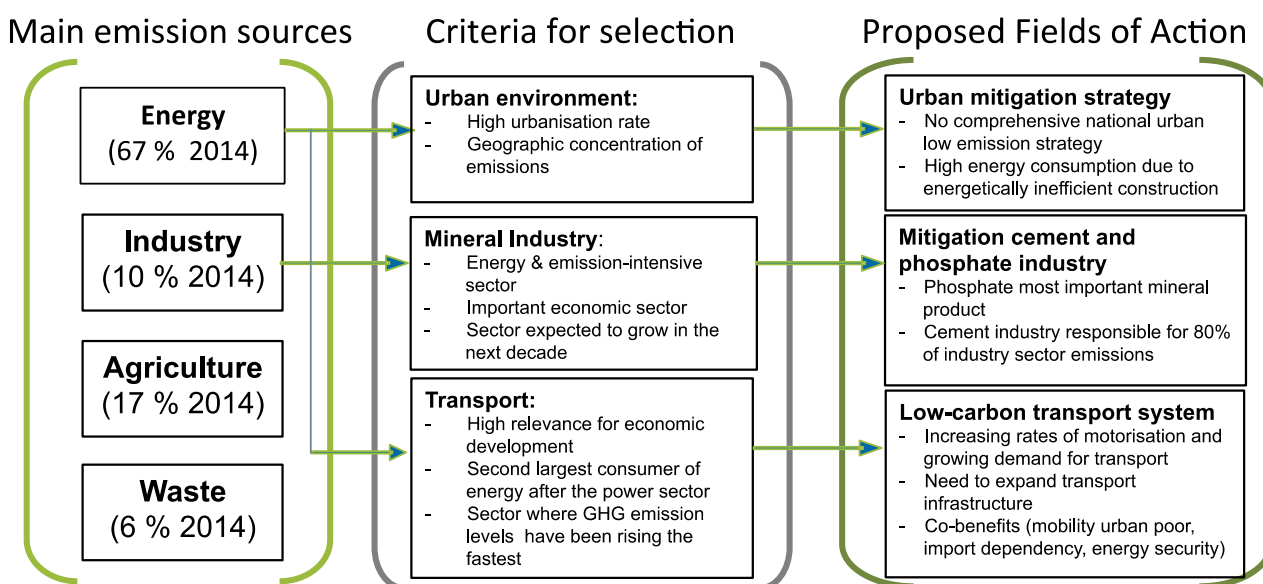
Figure 12: Comparison of mitigation potential and distribution efforts by sector by 2030



Data source: based on PMR (2014) and Government of Morocco (2016c)

A comparison of the mitigation potential in the different sectors and the distribution of the expected mitigation efforts per sector to achieve the conditional target (Figure 12) by 2030 shows that the most significant reduction potentials exists in the electricity sector and that correspondingly most mitigation efforts are directed towards this sector, which is also the major source of the country’s GHG emissions.

Figure 13: Overview selection criteria for potential fields of mitigation action



Source: authors

The comparison also shows that there is still potential for additional mitigation actions in the industry sector. Especially the mineral industries like cement production and the phosphate industry seem to offer a high replication potential for mitigation actions.

The mitigation actions outlined in the NDC address the urban environment only to a limited extent directly. Furthermore, so far no comprehensive, nation-wide strategy or programme to reduce GHG emissions in the urban environment exists. And also on a city level, sustainable urban development strategies are missing, leading to increasing levels of electricity consumption especially for heating and air conditioning. Here, a more focused analysis of the mitigation potential in the urban environment is useful.

Connected to the urban development but also beyond that, on a regional or national level, the transport sector represents a potential field for mitigation actions, especially with the rapidly increasing number of cars and demand for transport services, that could be harnessed by deploying clean transport strategies to a greater extent.

Based on these observations and after considering historical and projected sector emissions development; comprehensive literature on GHG mitigation potentials; identified barriers and emissions reductions; feasibility, costs, and co-benefits, the following fields of action were selected: urban environment, mineral sector and transport sector.

2.6.1 Urban environment

UN-Habitat views cities as a “concentration of economic activities, households, industries and infrastructures which are hotspots for energy consumption as well as key sources of greenhouse gases” (UN-Habitat 2016). Due to this concentration, it is easier and less cost-intensive to take mitigation actions in cities (ibid.). Considering that 60% of Morocco’s population live in urban areas, and with view to the rapid urbanisation rate the country experiences (having grown by 24% from 1990 to 2014) (see Table 1), the urban environment is a crucial field for mitigation activities.

Emissions. Unfortunately, there is no data on GHG emissions directly attributed to the urban environment in Morocco. Therefore, it would be an important first step to measure GHG emissions according to their sources in Moroccan cities, in order to respond by designing appropriate mitigation projects. The IPCC clusters four sections of drivers for urban GHG emissions: The economic geography and income level (generally measured by GDP); socio-economic factors (such as consumption habits, population size, age, etc.); technology (macro-level drivers, such as the technology of manufacturing and commercial activities); and infrastructure and urban form (patterns and spatial arrangements of land use) (Seto et al. 2014). More recent research on cities’ emissions in general suggests that the housing and transport sectors are crucial, regardless of the city’s location in a developing or developed country (PIK 2017).

On-going and planned actions. Despite the fact that local initiatives in distinct cities of Morocco have been advanced, there is no comprehensive, nation-wide strategy or programme to reduce GHG emissions in the urban environment. Morocco is currently elaborating a National Strategy for Urban Renovation, for whose implementation 15 cities have been identified as a pilot area in 2018. However, no explicit reference to climate change is made (Bennajah 2017).

Though, the country has made first steps in the direction of a sustainable urban development. The most prominent example of green cities is the so-called “Green City Mohammed VI”, an ecologically and technologically ambitious project launched in 2009, built outside of Benguerir and close to Marrakech (Tafline 2012; OCP n.y.). Green Mine Khouribga City, a project aimed at the transformation of an abandoned mine site into a new “ecological city”, displaying for instance buildings with optimised insulation, is another example of urban mitigation efforts (OCP n.y.). Other green cities include Green

Mazagan City (Sylla 2014; OCP n.y.), Cité Mohammed VI Tanger Tech (Khouja 2017), and the Eco City of Zenata (Société d'Aménagement Zenata n.y.). As a preparation for COP 22, Marrakech has seen some initiatives flourish, for example public lighting fuelled by solar energy, the establishment of a waste treatment site, or “green” transport options. Independently of COP 22, some local initiatives have emerged, such as the GIZ-funded “Green Mosques” initiative (HuffPost Maroc 2016). Since 2016, Morocco has, in a second attempt since the failed one in 2009, enforced a nation-wide ban on plastic bags. This constitutes an important step in view of the country’s problematic waste disposal situation and its position as second largest consumer of plastic bags after the USA (Alami 2016). Also, the city of Chefchaouen benefitted from European funding in order to conduct local projects, such as implementing a municipal system of electric bikes or institutionalising awareness-raising by creating an information point on energy efficiency in the city (AFP 2017).

Beyond the on-going urban mitigation activities, Morocco has planned further actions. In its NDC, Morocco listed a number of planned activities which explicitly address urban areas. Among the unconditional actions, the “Energy-Efficient Building Wraps” concern the implementation of the Code for Thermal Regulation for Housing in residential and tertiary housing, with estimated implementation costs of USD 18 million and a total emission reduction potential of 1.2 MtCO_{2e}. Another action concerns energy efficiency in the tourism sector, which is also partly linked to urban areas. This would also save 1.2 MtCO_{2e}, at estimated implementation costs of USD 83 million. Furthermore, Morocco seeks to build a “Low-Carbon City”, which would constitute an urban model for energy efficiency, transport and waste management. Morocco calculates USD 165 million for this action, with projected emission reductions of 1.2 MtCO_{2e} (Government of Morocco 2016c). The above-mentioned green cities projects are in line with this activity listed in Morocco’s NDC. However, no direct link between this NDC-related activity and the individual sustainable city projects is being made in the sources related to them.

Among the conditional actions, city-related projects figure, as well. The project of “low-energy lighting in residential housing” consists of installing 14,700,000 low-energy light bulbs in the residential sector. This measure would cost USD 18 million, with a potential to mitigate 13.9 MtCO_{2e}. There is also a “Public Lighting Energy Efficiency Program” aimed at large Moroccan cities. At implementation costs of USD 310 million, this measure allows to mitigate 0.7 MtCO_{2e}. The plan to recycle household waste through co-incineration and mechanical biological treatment would require an investment of USD 1,440 million in order to mitigate 58.8 MtCO_{2e} of GHG emissions. Concretely, Morocco cites a national strategy allowing to meet the mitigation targets in the urban waste sector, the “National Household and Similar Waste Program” (Government of Morocco 2016c), which builds upon the National Household and Solid Waste Management Programme (NHSWMP) launched in 2007 (EEA 2014). The National Household and Similar Waste Program aims at promoting the execution of the NHSWMP and proposing a direction for the next phase (2023-2038) (JICA n.y.). This strategy seeks to standardise household waste management for all the territorial entities in Morocco, to improve the collection of household waste to achieve an urban collection rate of 90% by 2020 and of 100% by 2030, to establish sanitary landfills and recycling centers by 2020, and to rehabilitate or close illegal landfills by 2020, among others (Government of Morocco 2016c). However, the exact process of the restoration of existing landfills is not specified. This constitutes a threat with view to the environment as landfills produce emissions and pollute the groundwater if not adequately closed and sealed. So far, municipalities have generally delegated waste management to private firms. For example, the City of Meknes commissioned the company SITA Atlas to rehabilitating its landfill site in January 2014. The latter opted for adding a vegetated cover, and drainage, leachate and rainwater collection systems to the site. As a further rehabilitation measure, it will equip the landfill with biogas capture wells in order to reduce emissions (WMW 2014).

However, so far, existing urban development strategies focus rather on resolving social issues, such as creating affordable housing options, reducing the growing demographic pressure on major agglomerations (such as the National Strategy for Urban Renovation, which is currently being established, with

its ambition to evaluate the urban land potential in order to find a better informed response to the challenges of job creation, access to housing and security (Bennajah 2017)), and dissolving slum areas (for example the 2004 program “Cities without slums” (MWN 2017)); or on fostering economic development, for example by improving infrastructures. But especially considering the need for economic development, it is important to have climate-friendly ways of fostering it in mind, thereby decoupling economic growth from GHG emissions.

Mitigation strategies. Thus, this leaves a wide range of potential mitigation activities in urban areas to be explored in Morocco. Instead of focusing on building new, ecologically friendly cities and thereby releasing pressure on existing urban agglomerations (UN-Habitat 2012), much could be done in order to make the latter more climate-friendly. As one potential mitigation strategy, energy efficiency measures in public as well as private buildings could be advanced in order to reduce GHG emissions. Seeing that air pollution attains alarming scopes in Morocco (AFP 2017) and knowing that the way buildings are conceived contributes to air pollution as they are not energetically efficient (UN-Habitat 2012), there needs to be a focus on increasing energy efficiency. This would mean an efficient implementation of the Energy Efficiency Code in Buildings (CEEB) whose main objective is the reduction of GHG emissions linked to fossil energy consumption by mastering energy demand in the housing sector. So far, the Thermal Regulation of Construction in Morocco (RTCM) constitutes the regulating framework, which foresees a mitigation potential of 2.4 MtCO_{2e} of GHG emissions between 2016 and 2035 (Government of Morocco 2016a). However, the RTCM only applies to new constructions, meaning that existing buildings are exempt of the aspirations of energy efficiency. Aside from that, there is a need to set up decrees and according administrative structures to ensure the effective implementation of the RTCM in new constructions. Furthermore, other aspects of this Code beyond the RTCM are not legally translated yet, such as energy equipment, urban development, etc. (ibid.).

This leaves a wide range of actions to be done, such as giving incentives to improve energy efficiency in existing buildings or integrate mitigation measures in urban development plans.

Another strategy to advance mitigation efforts could be to establish a closer cooperation between the different administrative levels, including municipalities, in order to conceptualise a sustainable urban development strategy. The Urban Low Emission Development Strategy (Urban LEDS) constitutes a framework for urban transition, created by UN-Habitat and the International Council for Local Environmental Initiatives (ICLEI). The goal is to integrate low-carbon strategies into urban development and planning. Stressing the importance of vertical integration, their activities include capacity building for local governments (Urban LEDS n.y.; UN-Habitat n.y. b). The GIZ also states that vertically integrated climate protection is necessary for it to be successful. This means that all state levels are included in the development and implementation of policies and programmes for climate change mitigation. Realising the subnational mitigation potential is highly dependent on the respective state design, decentralisation level and the distribution of competencies among national and subnational stakeholders (GIZ n.y.). As an example, the Indonesian city of Balikpapan participated in the Urban-LEDS programme. It thereby was able to get in touch with other levels of government and to collect information and discuss activities to reduce GHG emissions, thereby guaranteeing a greater coherence of the Indonesian climate policy on all levels (ICLEI 2016). For Morocco, it would also be useful to create a stronger link between its different administrative levels. In Morocco, the national Ministry of Housing, Equipment and Environment is responsible for important local programmes and projects (UN-Habitat 2012). So far, cities have not been included in the elaboration of potential (urban) mitigation activities; the Moroccan government rather relied on international experts (see chapter 2.2). Thus, it would be useful to establish decentralised climate change policies and plans which focus on the respective city’s or region’s challenges and opportunities. Though, the programme “Cities without Slums” from 2005 constitutes a positive example, which could set a base for climate-related issues: The government identified and upgraded 250 neighbourhoods in a participatory process with 25 cities (UN-Habitat 2012). Furthermore, 4C Morocco aims at including territorial levels of administration into climate

change governance. So far, two regional pilot observatories for the environment and sustainable development (OREDD) in the regions of Tanger-Tetouan and Marrakech-Tensift-El Haouz have been integrated into its structure. But it is planned to include the other OREDDs in the future, as well (4C Morocco 2015b). The latter would be a crucial step towards an effective participation of regional entities in Morocco's climate change governance. In order to decentralise the management of environmental information and data and in order to provide necessary information for regional and local decision-makers, a Regional Information System on the Environment (SIRE) has been set up. Though, the information is not yet accessible online (4C Morocco 2015c).

Barriers. There are, however, important obstacles to the implementation of the proposed mitigation actions in urban areas. Morocco suffers from significant pressure (demographic, migrational) on cities, which results in the current socio-economic priority setting in urban development strategies. Notwithstanding, as indicated in the proposed mitigation strategies above, Morocco's need to foster and shape urban development could be coupled with more climate-friendly ways of constructing, for example. However, in order to do so, the lack of information and transparency in urban land management has to be tackled, first (Kandil 2002). The Moroccan property and land market still faces the challenges revolving around a poor legal and practical framework for the land market, a lack of national standards, and a lack of published information, a.o. (Bajeddi 2017).

The UN-Habitat diagnoses a significant divergence in many countries between official statements about addressing climate change and concrete actions towards it. The nature of the obstacles to urban mitigation actions is manifold – institutional, technical, economic or even political (UN-Habitat 2016). Thus, Morocco's official communication shows a high willingness to tackle the issue of climate change mitigation in the urban environment as its NDC targets in this field show. However, the respective actions are so far only envisaged as their implementation currently fails because of a lack of financial resources. Most municipalities are unable to finance urban projects, which is why they delegate project implementation to the specialised national agency Al Omrane (UN-Habitat 2012). Institutionally, as shown in the previous section, Morocco lacks an effective participation of the communes in the conceptualisation of mitigation actions, thereby neglecting their respective views on urban priorities. In his speech on smart cities, Morocco's King mentions the necessity of institutional reform extending the competencies of regions and decentralised authorities in order to implement national urban strategies (MWN 2017). In this context, the fact that there is no national strategy for urban low emission development and thereby no comprehensive legal framework for this field is a hindrance to the implementation of Morocco's city-related NDC. Finally, mitigation actions have to take the reality of illicit buildings and informal neighbourhoods in Moroccan cities into consideration (UN-Habitat n.y. a), which makes it even more difficult to address the issue.

2.6.2 Mineral industry

The industry sector accounted for 30% of Morocco's end-use GHG emissions in 2009 while industrial processes accounted for about 10% of the direct net GHG emissions in 2012 (CTF 2009; Government of Morocco 2016b). Within the industry sector, large amounts of GHG emissions can be allocated to mineral production and processing (4C Morocco 2014). Hence, the mineral sector is one of the industry segments with a sizeable potential for GHG emissions reductions in Morocco.

The mineral sector is not only a major emitter of GHG emissions, but also plays an important role for Morocco's economy, accounting for about 10% of the GDP and for 30% of the national exports in 2014 (USGS 2017). Despite a significant shift in Morocco's exports in the last two decades towards emerging industries, like the automotive sector, the mineral sector still remains one of the major foreign exchange earners for the country (MEF 2016). Key segments of the mineral sector in Morocco are phosphate mining and processing and cement production. Both industries are expected to grow further in

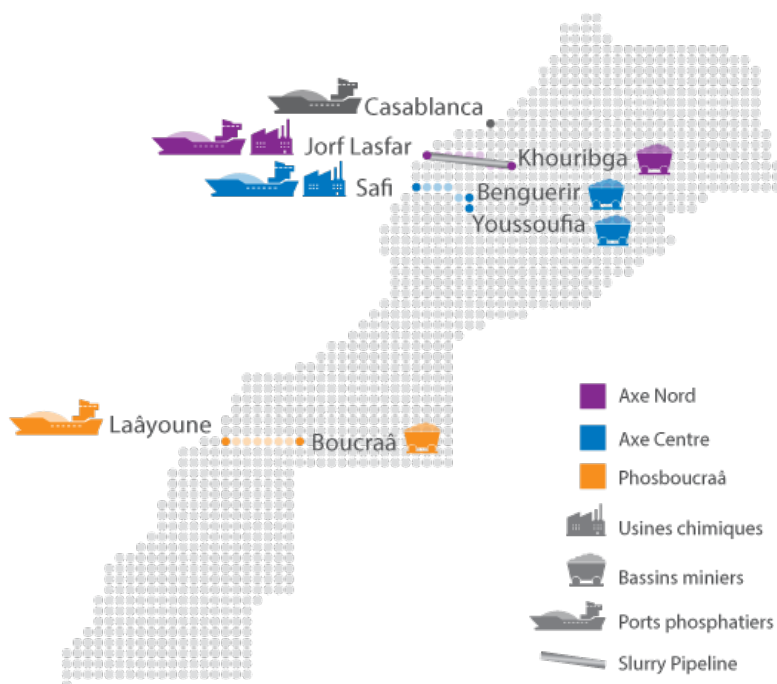
the next decades and they are energy- and emission-intensive, which makes them important fields for mitigation actions.

Phosphate

Phosphate is the most important mineral product of Morocco. Out of 28.92 Mt of mined products in 2016, 26.9 Mt were phosphates (ONHYN 2016). With 75% of the world’s phosphate reserves being located in Morocco, the country is the largest exporter of phosphates worldwide accounting for about 30% of phosphate exports, and the world’s second largest producer of phosphate rock, producing about 14% of the world’s output (USGS 2017). The sector employs nearly 21,000 people and created revenues of about 4,417 billion EUR in 2016 (OCP 2016). With phosphate being nearly exclusively used as a fertiliser in modern agriculture, the growing global food demand increases the worldwide demand for phosphate and phosphate-based fertilisers. Accordingly, the state-owned company OCP Group (Office Chérifien des Phosphates), which exclusively mines and processes phosphate in Morocco, has plans to significantly increase its mining and processing capacity (OCP 2016). It is expected that expansions of rock mines and processing facilities in Morocco will double the country’s production by 2020 (INN 2017).

OCP Group, which was formerly an public administration unit that was transformed to a shareholding company controlled by the state, is a monopolist on the Moroccan phosphate market, owned by Moroccan government, operating along the entire phosphate value chain, and running all four mining sites, two processing platforms and four phosphate ports in Morocco. In 2016, it produced 26.9 Mt of phosphate rock, 4.9 Mt of phosphoric acid and 7 Mt of phosphate fertilisers. The market share of OCP phosphate products on the European market was 30% in 2016. The production data for the recent years show that OCP is moving away from directly exporting phosphate rock towards the export of higher value phosphate derivatives (OCP 2016).

Figure 14: Overview phosphate sector activities in Morocco and Western Sahara



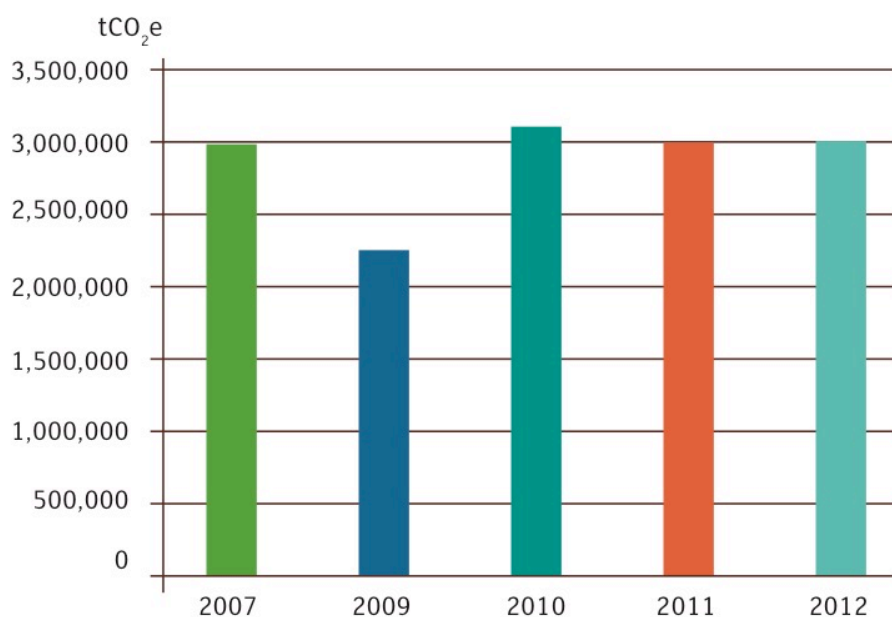
Source: OCP (2017)

Emissions. The main emission source during the phosphate production in Morocco is the phosphate rock processing, accounting for about three quarters of the emissions. This includes both process emissions as well as combustion-related GHG emissions from fuel to run the equipment necessary for the manufacturing process. Further emissions in the phosphate sector result from consumption of grid electricity (18%) and the transport of products and employees (7%) (PMR 2014).

Process emissions include CO₂ released by the phosphate rock itself when reacting with sulphuric acid in the phosphate fertiliser manufacturing process (EPA 2009). In addition to these gaseous emissions, the major emission sources are dryers, calciners, and grinders, which emit particulate matter during the processing in form of fine rock dust and atmospheric emissions, mainly sulphur dioxide (SO₂) (EPA 1995). Particulate matter has a measurable effect on the climate system. Therefore, one option to mitigate emissions is to eliminate or reduce dust emissions during the processing of phosphate rock. Additional emissions during rock processing stem from fuel consumption for the processing machines and the transport of the phosphate rock.

The GHG emissions associated with phosphate mining, processing, and transport in Morocco were 3.2 MtCO₂e in 2016 (OCP 2016). Due to several mitigation measures implemented in the sector, the emissions remained relatively stable over the last ten years despite an increase in phosphate production and processing.

Figure 15: OCP carbon emissions 2007 - 2012



Source: OCP (2015)

On-going and planned actions. OCP as a monopolist on the Moroccan phosphate market is active in limiting its GHG emissions. It has conducted a full carbon review of the sector's emissions and tracks the carbon footprint of its activities. Furthermore, in order to better monitor GHG emissions, CO₂ analysers were installed in two drying ovens in the Khouribga site in 2016 (OCP 2016).

Completed mitigation projects include the construction of a 235 km long slurry pipeline to transport washed phosphate in the form of pulp from Khouribga to Jorf Lasfar. The pipeline started operating in 2014 and reduced carbon emissions by 0.5 MtCO₂e in 2016. When used at full capacity, it is expected to reduce up to 0.93 MtCO₂e per year (OCP 2016). Another project that reduces emissions is the introduction of heat recuperation systems (HRS) in the two sulphuric acid plants Safi and Jorf Lasfar. The recovered heat is used to generate electricity, thereby reducing emissions of approximately 0.09

MtCO₂e per year in each of the two units Safi and Jorf Lasfar while simultaneously reducing energy consumption (PMR 2014; RCMDP 2004). In addition, OCP aims to increase the use of renewable energy to 95% in 2020 and reduce the energy demand by implementing energy efficiency measures, thereby aiming to achieving medium-term energy self-sufficiency. Moreover, to reduce sulphur dioxide emissions during the processing, OCP has implemented technology components at two chemical installations in Jorf Lasfar that reduce sulphur dioxide emissions from over 600 ppm to values below 15 ppm (OCP 2016).

The range of activities aiming at or contributing to GHG emission reduction along the phosphate value chain in Morocco shows that the sector is pro-active in reducing its emissions and has a significant experience in measuring its emissions and identifying and implementing mitigation measures (PMR 2014). However, as the emission data is not publicly available, it is not possible to compare the GHG emission intensity of the phosphate sector in Morocco with the average carbon intensity. According to IFA (2009) the world average GHG emissions from phosphate rock production are 0.02 tCO₂e per tonne of product. For a new plant with the best available technology these should be about 0.01 tCO₂e per tonne of product (IFA 2009). The world average emissions for the production of phosphoric acid (P₂O₅) are 0.34 tCO₂e per tonne of product, while new plants implementing the best available technology should only emit 0.08 tCO₂e per tonne of product (ibid.).

Barriers. One potential barrier to implement the best available technology that would be less emission-intensive is the long operational lifetime of the processing infrastructure. However, Morocco has a number of old acid plants from the 1970s and 1980s, and OCP plans to expand the processing of phosphate rock in Morocco. This could be an opportunity for technical upgrades, replacement or new construction implementing technologies with lower emission levels.

OCP attempted to register both the slurry pipeline and the heat recovery measures as CDM projects. But these projects as well as all other CDM applications from OCP since 2003 were rejected due to a lack of financial additionality (PMR 2014). To finance further mitigation action in the phosphate sector, the Moroccan government has considered the implementation of a crediting mechanism as an opportunity to encourage mitigation efforts (ibid.). To analyse the feasibility of market-based instruments for GHG emissions reductions, Morocco receives assistance from the World Bank's Partnership for Market Readiness (PMR), which is scheduled to provide final results by the end of 2018 (NDC Partnership 2017b). In the intermediary PMR report, internal capacity building programmes within the phosphate sector targeting operational staff were recommended to ensure that mitigation measures are implemented on a day-to-day basis (PMR 2014).

Cement

Apart from the phosphate sector, the cement sector is also an important industry in Morocco, producing 13.8 Mt of cement in 2017 (ICR 2018). Although the cement industry has been experiencing volatile growth rates in recent years after an all-time production high in 2011, with cement sales rising in 2016 and declining again by 2.5% in 2017, the industry is expected to grow in the long run in the coming decades due to the rapid urbanisation and continuing infrastructure developments in the country (OBGR 2016; Global cement 2016; ICR 2018).

The sector comprises four major companies, one of which is owned by the Moroccan state and three of which are subsidiaries of foreign firms. The largest player in the sector is LafargeHolcim Maroc (a merge of Lafarge Ciments and Holcim Maroc) with a capacity of 13.2 Mt per year. The second-largest company with a production capacity of 5.2 Mt per year is Ciments du Maroc, which is part of the Heidelberg Cement Group. Ciments d'Atlas is the Moroccan-owned company, which entered the sector at the end of 2010 and has currently a production capacity of 3.2 Mt per year. The fourth company, Asment de Témara, is a subsidiary of Portugal's Cimpor and has a capacity of 1.2 Mt per year (Heidelberg

Cement 2017b; Votorantimcimentos 2017; Global Cement 2016; OBGR 2016). The four companies are represented by the Association Professionnelle des Cimentiers (APC), a national cement association that acts as a lobby group for the cement industry (Maradan and Zein 2011).

Emissions. In comparison to the phosphate industry, the cement sector is smaller, but has a higher relevance when it comes to GHG emissions. In 2012, the cement industry was responsible for 7.9% of the country's overall GHG emissions, which corresponds to about 80% of the emissions from the industry sector (Government of Morocco 2016b). The share of the cement sector in regard to industrial process emissions is even higher with 88% (4C Morocco 2014). Emissions in the cement sector stem from direct emissions from decarbonising the raw material (60%) and indirect emissions from energy consumption in form of fuel and electricity (40%) (Abnay et al. 2017).

Due to the volatile development of cement consumption in recent years, the amount of emitted CO₂ by the sector fluctuated as well. Even the emission data for 2012 vary between different sources: according to the BUR I, 7.9 MtCO_{2e} were emitted during cement production in 2012 while the Association Professionnelle des Cimentiers (APC) reported higher emissions of 9.5 MtCO_{2e} (Government of Morocco 2016b and PMR 2014).

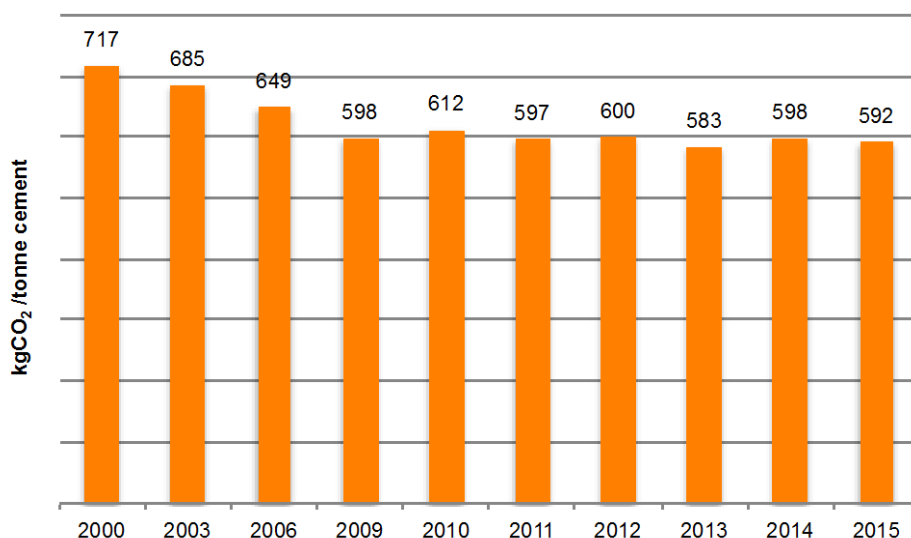
The major indirect emission source in the cement industry is the use of fuel to generate heat for the production of clinker. The use of electricity, needed for crushing and grinding raw materials and running pumps, vans and other technical equipment represents another important emission source. Further emissions result from the transport of raw material and products (IPP n.y.).

On-going and planned actions. The cement sector is actively involved in reducing its GHG emissions. Since 1997, Moroccan cement producers signed several national environmental conventions. The sector was already successful in reducing its direct and indirect CO₂ emissions per tonne of cement produced, from 717 kgCO₂ per tonne of cement in the year 2000 to 592 kgCO₂ per tonne of cement in 2015. Therewith, the Moroccan cement sector performs better than the world and the European average of respectively 634 and 632 kgCO₂ per tonne of cement (GNR 2015).

The emission reductions were mainly reached by the deployment of wind power to meet the cement sector's energy needs. According to ACP, Moroccan cement producers already source about 80% of their electricity from renewable energies (Cemnet 2017). This development is supported by the fact that energy costs represent a major share of the cement production costs and renewable energy sources are seen as a cost-effective alternative. Hence, the deployment of renewables is in the self-interest of cement companies.

The cement sector itself installed 37 MW of wind energy capacity and additionally sources renewable power from private energy producers. Lafarge has developed a 32 MW wind power facility at its Tetouan cement plant and signed an agreement for the consumption of wind power produced from a private wind park, and Ciments du Maroc has constructed a 5 MW wind farm (Choukri et al. 2017; PMR 2014). Furthermore, Ciments du Maroc has operated a 3 MW solar thermal pilot project in Ait Baha since 2014, which uses CSP technology to produce process heat (Global Cement 2018).

Figure 16: Evolution of specific emissions from the cement sector in Morocco



Data source: Based on L'Economiste (2016); PMR (2014)

While the cement industry in Morocco is already actively engaged in reducing its GHG emission levels, the efforts are so far mainly concentrated on the indirect energy-related emissions from electricity consumption. However, the latter represent only a small share of the sector's emissions. It is therefore recommendable to explore mitigation options for emissions from direct energy use for heat generation to operate the kilns, and the process emissions from the calcination process. As no detailed country analysis exists for these mitigation potentials, the following analysis also relies on non-country specific data.

Mitigation strategies. Mitigation actions to reduce emissions from direct energy use include fuel switch, which can potentially reduce overall cement emissions by 18-24%, and efficiency measures which are estimated to have a reduction potential of 20-40% (Rubenstein 2010). Alternative fuels include biomass or waste. Waste has already been used as a fuel in the cement production for the past 20 years in Europe, Japan, the United States, and Canada, but not yet in Morocco (Fischedick et al. 2014). Though, the cement producer Lafarge Maroc had already perused concrete steps to use waste as an alternative fuel by importing waste from Italy in 2016. But when the arrival of the Italian waste in Casablanca sparked public protests, it was sent back to Italy and the Moroccan government decided to ban the import of waste fuels (Global Cement 2017).

Potential efficiency measures can be of technical or mechanical nature, like using more efficient motors, or address the efficiency of the production process (Rubenstein 2010). Since kilns are already running on efficient dry processes in Morocco, there is no mitigation potential in switching from less efficient wet to dry kilns. According to Abnay et al. (2017), an efficiency measure applicable to the Moroccan cement industry would however be the recovery of exhaust gases coming from the clinker-burning process. The recovered heat could be converted to electricity, generating about 172.5 GWh, which would allow a minimum saving of 13% of cement plants' electricity consumption in Morocco, and a substantial reduction of CO₂ emissions of about 140 kt/year (ibid.).

To reduce emissions generated during the calcination process, opportunities exist to replace a portion of the clinker by blending in waste materials (CTF 2009). Blending in such materials could reduce CO₂ emissions by up to 20% and could furthermore increase fuel efficiency by improving the combustibility of the materials (Rubenstein 2010). In Morocco, fly ash, a by-product of coal-fired power plants, is one of the potential substitutes for clinker. The production of fly ash from thermal power plants in Mo-

rocco is estimated at 570,000 tonnes per year (Nabih et al. 2014), of which about 6% are currently being used (Bazzar et al. 2013), leaving significant potential for further clinker replacements and thus CO₂ emission reductions. Accordingly, repurposing fly ash within the building materials industry has been listed as one of the conditional mitigation measures in the NDC with an expected mitigation potential of 2.97 MtCO_{2e} (Government of Morocco 2016c).

However, besides the blending in of materials, there are only few options to reduce emissions from the calcination process, which accounts for 52-60 % of the emissions during the cement production (Abnay et al. 2017; Fishedick et al. 2014). A future option to mitigate these emissions could be the capture and storage (CCS) of these emissions. However, CCS is still in its initial stage and its application in the cement sector has yet to be piloted (ibid.). The estimated cost for CCS is around USD 75-100/tCO₂, which would significantly raise production costs and therefore require suitable financing mechanisms to be implemented on a larger scale (Rubenstein 2010).

Barriers. On the basis of the foregoing consideration, the main barriers to the implementation of further mitigation measures in the fields of efficiency, alternative fuel use, clinker substitution and CCS have been identified by IEA in cooperation with the World Business Council for Sustainable Development (WBCSD) and the Cement Sustainability Initiative (CSI). In regard to energy efficiency, the main barriers listed are high investment costs and an increase in energy demand due to environmental requirements or quality demands, but also the use of CCS to reduce emissions could increase the future energy demand (OECD/IEA 2009). Overall, the mitigation costs are estimated to increase nearly proportionally with the level of reduction ambitions, as Ba-Shammakh et al. (2008) have shown in their non-country-specific analysis. This means that for 10% emission reductions, the cement production costs would increase by 7.3% and CO₂ reductions of 50% would increase costs by about 55.4% (ibid.).

On the other hand, barriers in regard to alternative fuel use are mainly practical limitations like the physical and chemical properties of alternative fuels, but factors like national waste management legislation, local waste collection systems, costs of alternative fuels and social acceptance of using alternative fuels also play a part (OECD/IEA 2009). In Morocco, ACP has already reached an agreement on the use and import of alternative fuels with the Moroccan government in 2003, and since 2015 attempts are being made to agree on an industry regulation that sets standards for the use of all the appropriate kinds of special waste available in Morocco (EcoMENA 2016). However, when the potential use of waste as fuel in the Moroccan cement industry that was supposed to be recovered from Italy sparked public protests in 2016, the Moroccan government banned the import of waste fuels. Cement companies in Morocco now plan to focus on recovering local waste instead, although waste in Morocco is currently not yet available in the required form to be used as fuel in the cement sector (Global Cement 2017).

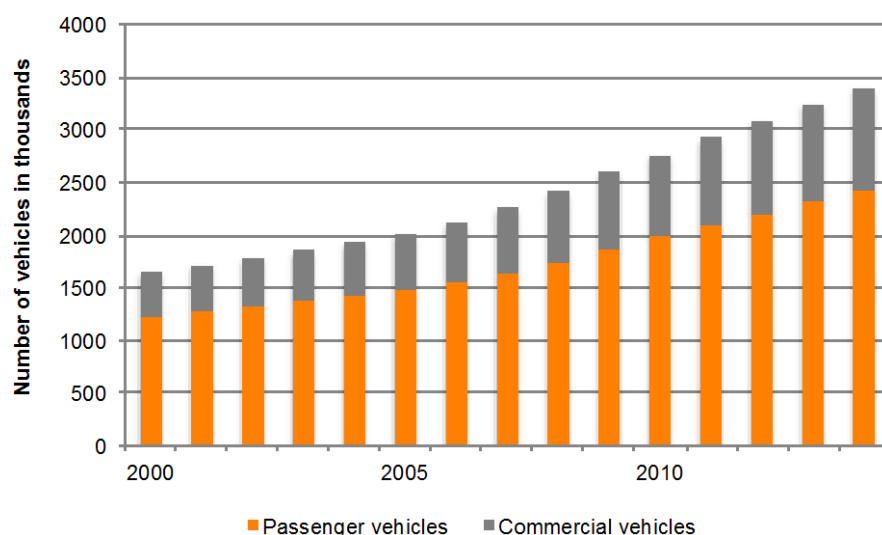
Concerning the blending of materials, the main challenges mentioned are the availability of substituting materials, the costs of the latter, but also national standards for cement composition (OECD/IEA 2009). In Morocco, the standard requires a minimum rate of clinker in the cement of between 65% and 95%. Depending on the cement type, in 2015, the average clinker amount was estimated to be about 72% (Abnay et al. 2017). Without the adaption of the existing standards, the margin of replacing clinker with other materials is therewith currently limited.

For the application of CCS, the state of technology development, demonstration and maturity of CCS for industry applications and the high costs are limiting factors for future implementations (Fishedick et al. 2014). So far, only limited work has focused on the potential of CCS technology for Morocco. Only a first assessment of the potential to deploy CCS in Morocco was conducted in the frame of a research project, identifying potential storage sites and available capacities (Boavida et al. 2013).

2.6.3 Transport sector

The transport sector in Morocco has been growing rapidly and is expected to grow even further due to increasing rates of motorisation and the growing demand for transport. Road transport is by far the main mode of transport and the vehicle fleet nearly doubled from 1.6 million vehicles in 2000 to 3.4 million in 2014 (DEPF 2015; CTF 2009). The majority of vehicles are passenger vehicles with a share of about 70% of the fleet in circulation (ibid.).

Figure 17: Stock of vehicles in circulation 2000 - 2014



Data source: DEPF (2015)

The majority of vehicles in Morocco run on diesel fuels, with diesel vehicles representing about 61% of the vehicle fleet in 2011 (IEA 2014). In 2011, about 40% of cars were older than ten years with an average consumption of 8.57 l/100 km compared to an average of 7.15 l/100 km in the European Union (Kharbach and Chfadi 2017). The increase in vehicle numbers can be directly related to the increase in energy consumption in the transport sector, which grew by more than 50%, equalling an average growth of 5.9% per year between 2004 and 2011 (IEA 2014). Road transport overwhelmingly relies on diesel (2011: 84%) (Kharbach and Chfadi 2017). While the growth rates in the freight sector have been lower compared to passenger transport, freight transport ranks first in terms of fuel consumption with a share of 41.2% in 2011, followed by individual transport and collective passenger transport with respectively 35.2% and 24% (GEF 2015).

Emissions. Overall, the transport sector was responsible for about 14.7% of the direct net GHG emissions in Morocco in 2012 (Government of Morocco 2016b), ranking second behind the electricity sector in terms of GHG emissions. The sector was furthermore the second largest consumer of energy after the power sector, being responsible for 26.1% of the direct GHGs attributable to energy consumption. Within the transport sector, the main emission source is road transport accounting for over 85% of the total transport GHG emissions, followed by air transport accounting for over 10% of GHG emissions (PMR 2014). Railway transport, on the other hand, accounted for about 2.6% of the transport sector's emissions whilst accounting for 8.5% of modal share (ONFC 2016). A major share of GHG emissions can be allocated to the urban areas, particularly to the metropolitan areas of Casablanca and Rabat where nearly half of the vehicles in Morocco are registered (Kharbach and Chfadi 2017; Van Breusegem and Souلامي 2011; CTF 2009).

Even if emissions growth has already been lowered by improvements of the overall emissions factor due to reduced fuel consumption of new vehicles, the transport sector in Morocco is the sector where

GHG emission levels have been rising the fastest. The average annual emission growth of the transport sector was about 4%, which was higher than the overall emission growth in Morocco of 3.1% between 1971 and 2011 (Kharbach and Chfadi 2017). Analyses have shown that the main drivers for the increase of GHG emissions in the transport sector are population growth and the increase in vehicle ownership (*ibid.*).

The already high share of GHG emissions stemming from the transport sector and the rapid growth rates of the sector, resulting in further increases of GHG emissions and energy consumption, are making it evident that the transport sector is an important field for mitigation action. Especially the need to expand the transport infrastructure in light of increasing demand for passenger and commercial vehicles and other transport services offers opportunities to implement measures and projects that avoid or reduce GHG emissions (CTF 2009).

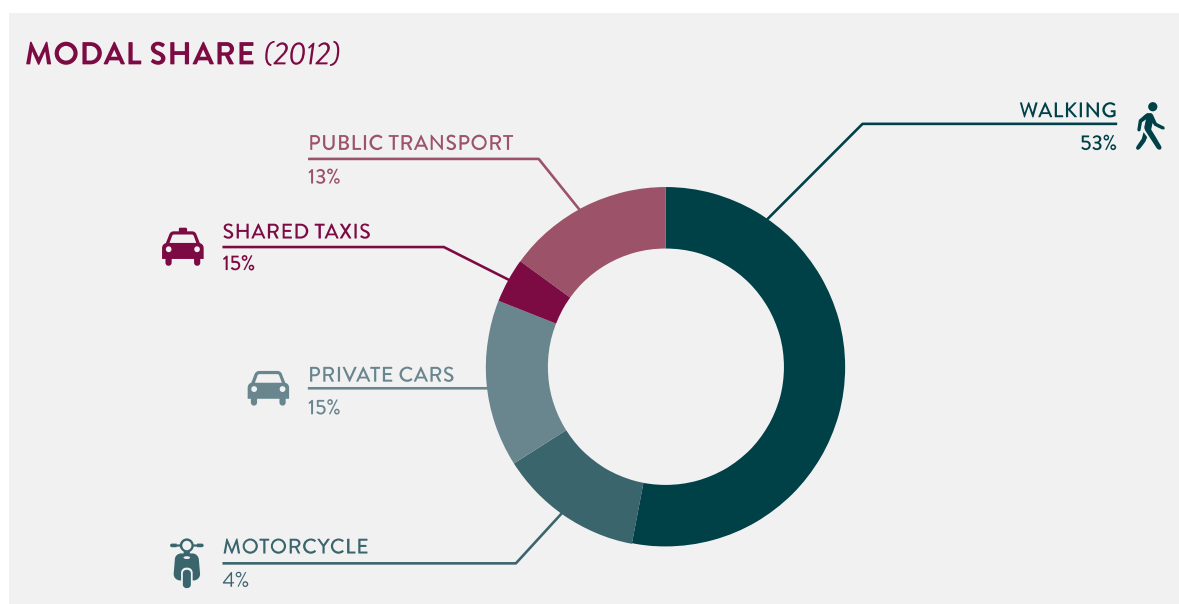
On-going and planned actions. Morocco has already implemented different urban transport projects and national measures. Urban transport projects include for example the introduction of public transport infrastructures such as the tram lines in Rabat, Sale and Casablanca or the Bus Rapid Transit (BRT) system under implementation in Marrakech and in planning for Agadir and Tangier. In Marrakech the installation of a 1 MW solar farm is planned to provide the buses with “clean” electricity (GEF 2015). On the national level, Morocco has also implemented different measures, for example the ban on imports of vehicles older than five years in order to rejuvenate the vehicle fleet (Coffin et al. 2016; IEA 2014), or the roll-out of logistics platforms in the frame of the National Logistics Strategy. The National Logistics Strategy, whose objective is to optimise the movement of goods in Morocco, aims to reduce CO₂ emissions from the freight sector by 35% (GEF 2015). Furthermore, Morocco, which previously had one of the highest sulphur levels in diesel (10,000 ppm) worldwide, introduced fuel standards that eliminate leaded gasoline fuel and introduce low-sulphur (50 ppm) diesel fuels nationally (CEDARE 2015). In the rail sector, Morocco has started to implement a high-speed rail project between Casablanca and Tangiers, which is currently tested and set to become Africa’s fastest rail link (OBGR 2016).

Mitigation strategies. In addition to these on-going and completed projects, the Moroccan government has listed further mitigation actions for the transport sector in the portfolio of mitigation actions itemised in its NDC. The additional mitigation potential from these actions amounts to nearly 50 MtCO_{2e}, of which 12.5 MtCO_{2e} stem from unconditional and 37.2 MtCO_{2e} from conditional actions. These activities include extensions of the Rabat and Casablanca tram, large taxi upgrades, a national strategy for logistics development and the upgrade of utility vehicles (Government of Morocco 2016c).

Yet, despite the already implemented projects and planned mitigation actions, the main mitigation focus of Morocco has so far been on large-scale GHG mitigation projects in the energy sector, while the transport sector has received less attention (GEF 2015). Hence, further potential exists in regard to the development of low-carbon transport systems. The main mitigation options in the transport sector consist of the avoidance of transport, modal shifts, reducing energy intensity and fuel carbon intensity (Sims et al. 2014). In developing and emerging economies, the provision of affordable, low-carbon transport options plays a more important role compared to mitigation options that aim at reducing the transport demand (*ibid.*). A low-carbon transport system in Morocco could therefore be supported by modal shifts in passenger and freight transport as well as a fuel switch from fossil fuels to low-carbon fuels and energy carriers. It is however difficult to quantify estimated emissions reductions from these measures, as they depend on the scale of the adoption.

Modal shifts in the Moroccan context do not only refer to shifting away from but also avoiding a shift towards cars and trucks as most energy-consuming transport modes to reduce and avoid GHG emissions. Because, as figure 18 shows for the case of Casablanca, currently the main mode of transport is still walking.

Figure 18: Modal share transport Casablanca 2012



Source: UITP/MDC (2015)

It is important to avoid a switch from walking to car transport, instead transport modes with a lower energy and carbon intensity, such as low-carbon transport and public transport need to be supported. While public transport running on conventional fuels still generates emissions, the energy consumption and emissions per passenger-kilometre are lower compared to private cars. Diesel buses for example emit about 15 gCO₂ per average passenger-kilometre while diesel cars have average passenger-kilometre emissions as high as 143 gCO₂ (GIZ 2014). One option to make public transport faster, more efficient and thus more attractive as a transport mode are bus rapid transit (BRT) systems, like the one that is currently under implementation in Marrakech or the ones planned in Agadir and Tangier.

Avoiding shifts to individual motorised transport modes and supporting and extending public and non-motorised options instead, can also generate co-benefits in addition to GHG emissions reductions. Better public transport can for example improve the mobility and the access to services or employment opportunities for the urban poor. Reducing the fossil fuel-intensity can decrease the demand and therewith the dependency on imports leading to an improvement of the national energy security. Furthermore, a shift towards mass and non-motorised transport can reduce air pollution, especially in urban areas.

Next to modal shift options, the reduction of fuel carbon intensity by switching or expanding to low-carbon fuels like electricity from renewables, hydrogen, CNG, biofuels, and other fuels represents another mitigation option that has so far received limited attention in Morocco. The electricity use in the transport sector has so far been marginal with a share of 1.2% in the total electricity demand, yet the share has been growing significantly in recent years due to the expansion of railway electrification (IEA 2014). In the future, a further extension of the railway system by 1,500 km of high-speed railway in Morocco is planned as of 2035. Thus, the electricity demand of this sector is expected to grow (Move 2017). Using electricity produced from renewable energies could further decrease the emissions in this field, and the National Railway Office (ONCF) is already planning to implement this idea, by developing a 50 MW wind farm to supply renewable electricity to the rail system (PMR 2014).

Regarding the use of electric cars, Morocco is supporting the introduction of electric vehicle technologies. With the Chinese electric car producer BYD planning to open a factory in Morocco to build battery-powered passenger cars, buses and trucks, this goal comes closer into reach. However, only limited infrastructure for charging electric vehicles exists, so far. But the number of stations is expanding

rapidly, since 2016 seven electric charging stations have been established in Marrakech, three in Casablanca and Agadir respectively, two in Tangier and one in Rabat (Chargemap 2018). Furthermore, the installation of 37 charging points at the 800 km long highway between Tangier and Agadir stated in 2017 (L'Economiste 2018a).

In addition, with its renewable energy resources, Morocco could also use its potential to strengthen research and development of synthetic fuels based on renewable energy power, which would not only contribute to decarbonising Morocco's transport sector, but also provide opportunities for Morocco to become an exporter to Europe in the future. As Fasihi et al. (2017) show, Morocco is one of the countries in the Maghreb region which have the potential to produce and export carbon-neutral hydrocarbons most cost-effectively to Europe.

Barriers. The transport sector plays a significant role for economic development and poverty reduction efforts. Reducing GHG emissions from the transport sector will therefore be challenging in a growing economy like Morocco due to continuing increases in passenger and freight transport. Unless transport emissions are decoupled from economic growth, the growing demand will potentially outweigh mitigation efforts (Sims et al. 2014).

Next to the growing demand, financing the mitigation measures in the transport sector also proves to be a challenge for Morocco as for most mitigation options, the investor and the recipient of the benefits of the investment differ (PMR 2014). This is especially critical as Morocco strongly focuses on a market-based approach to reduce GHG emissions.

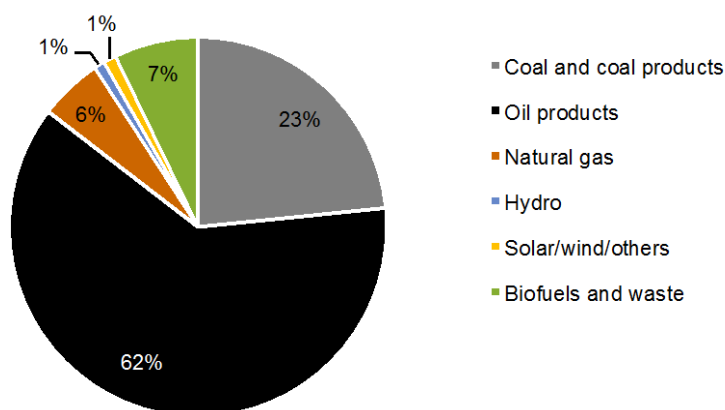
Next to financial barriers, in the urban areas the lack of comprehensive sustainable urban development strategies that include the local level decision making bodies (compare chapter 2.6.1) and the lack of urban mobility planning is hindering mitigation efforts in the transport sector.

Furthermore, it needs to be noted that besides infrastructure investments and technology developments, behavioural change often plays a more important role for achieving emission reductions in the transport sector. Cultural and social barriers could prevent or slow down such behavioural changes. Chachdi et al. (2017), for example, showed for the acceptance of electric vehicles in Morocco that consumers have reservations regarding the costs and autonomy of electric cars. Furthermore, the lack of infrastructure in Morocco, like charging stations for electric vehicles, will limit the growth potential for low-carbon fuels at least in the short term. Other barriers in Morocco consist in the complexity of the transport sector due to the large number of actors and the lack of data and capacity to establish an efficient MRV system (PMR 2014). General barriers for mitigation in the transport sector that are also relevant for Morocco include high investment costs to build low-emission transport systems and the slow turnover of stock and infrastructure (Sims et al. 2014).

2.7 Assessment of the relevance and perspectives of coal use

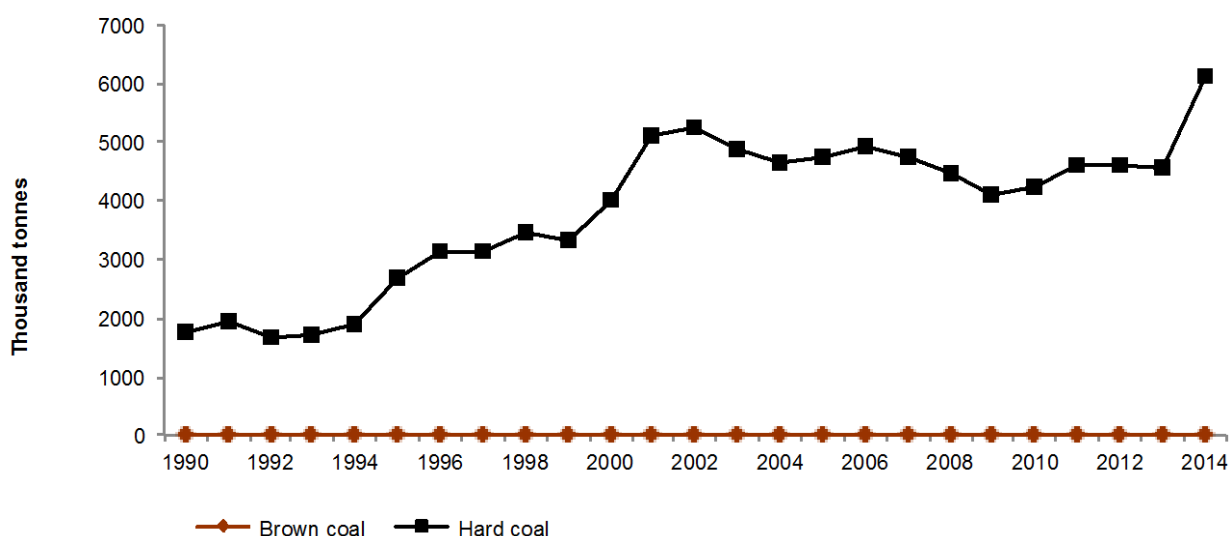
Morocco is highly dependent on fossil fuel imports. While oil products represent the largest share of the primary energy supply with 62% in 2015, Morocco is the only country in the MENA region that also strongly relies on coal to meet its primary energy demand (23%). Despite the very low coal reserves in the region, the country promotes coal as a key strategy to meet the growing energy demand (APICORP 2017). Since 1990, the domestic coal consumption in Morocco has rapidly increased, tripling from 1.8 million tons in 1990 to 6.1 million tons in 2014.

Figure 19: Share of total primary energy supply in Morocco 2015



Data source: IEA (2016)

Figure 20: Domestic coal consumption 1990 - 2014



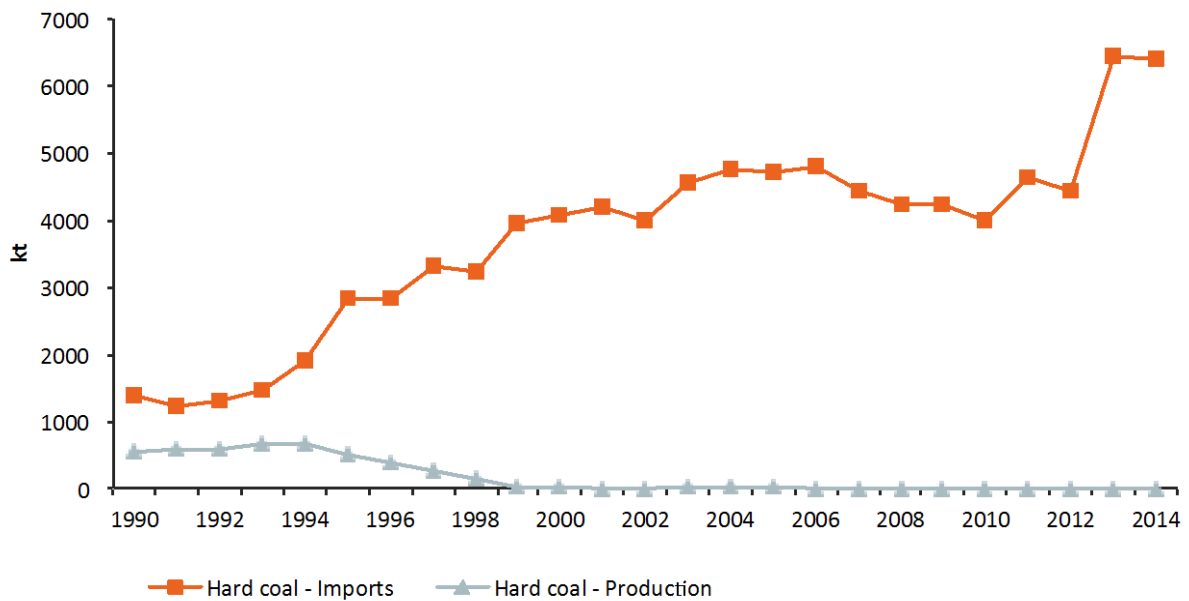
Data source: IEA (2016)

Morocco itself has small coal deposits in the North-East of the country, most of them about 600 m below the surface (Boum and Park 2016). The remaining coal potential is estimated to be about 96 Mt, constituted by 14 Mt coal reserves and 82 Mt of coal resources (BGR 2016).

From 1927 to 2001, small amounts of high quality coal, containing primarily anthracite with 2-5% of pyrite, were mined around the city Jerada (Addou et al. 2017). In the late 1990s, it was decided to end coal extraction at the Jerada coal mines because the production was not economically viable any more as importing coal became cheaper. Although, the coal mines were officially closed, local residents have continued to illegally extract minor amounts of coal in the abandoned mines (Babas 2017).

Today, Morocco is fully dependent on coal imports. Until 2008, the main supplier of coal to Morocco was South Africa; today, the majority of coal is imported from the USA (54%) and Russia (19%) (DEPF 2016).

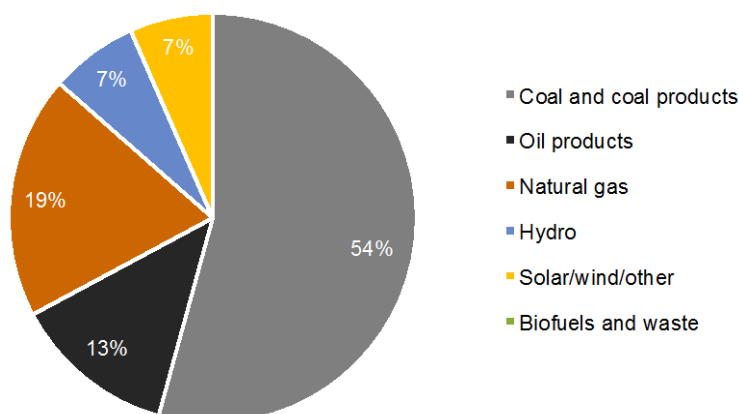
Figure 21: Coal imports and production 1990 - 2014



Data source: EIA (2017)

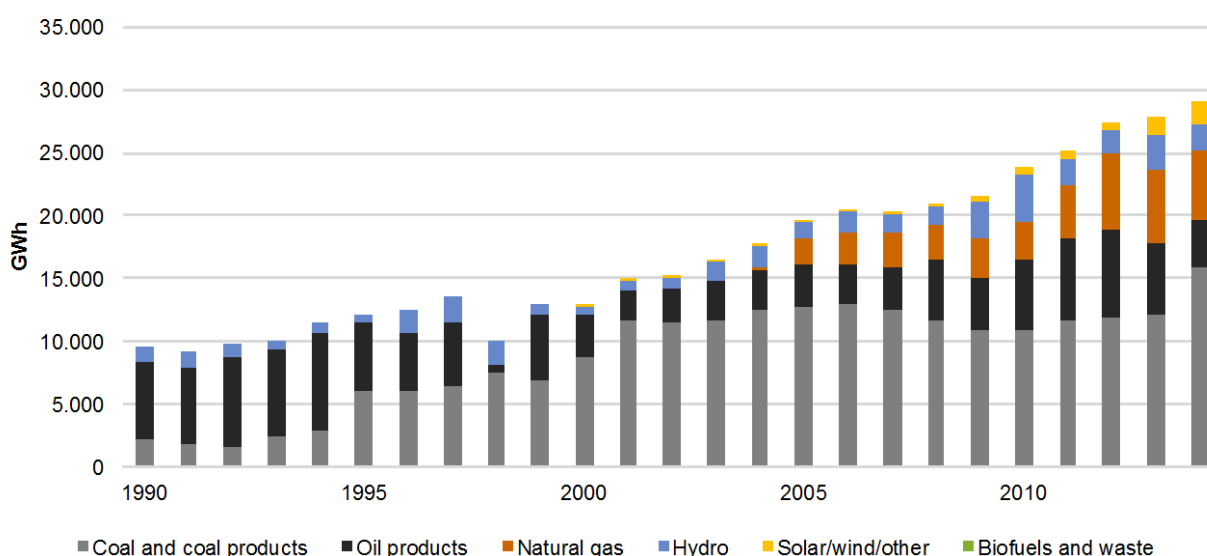
The imported coal is nearly exclusively used for power generation. Although the electricity portfolio has changed over the last decade, coal and coal products remain a major fuel source for electricity generation with 54% in 2014. While the share of coal in the electricity mix has decreased due to the use of natural gas as well as renewable energies like wind and solar power, the absolute use of coal for electricity generation has strongly increased in the last two decades. Only between 2006 and 2012, the amount of coal used to generate electricity experienced a slight decline.

Figure 22: Fuel mix in electricity generation, 2014



Data source: IEA (2016)

Figure 23: Electricity production 1990 - 2014



Data source: IEA (2016)

The electricity from coal is currently generated in three coal-fired power stations. The oldest plant, which started operating in 1971, is the Jerada power station consisting of three units with a respective capacity of 55 MW. The Mohammedia power station, which is situated in the Casablanca region and is operating since 1986, is a two-unit coal-fired power plant with a total capacity of 300 MW. The third operational coal power plant is the Jorf Lasfar power station located in the Casablanca-Settat region with a total capacity of 2,056 MW. The Jorf Lasfar power plant consists of six units of which the first four units started operating between 1994 and 2011, while units 5 and 6 started operating in 2014 with a capacity of 350 MW each (Global Energy Observatory 2017).

Table 6: Overview coal-fired power plants Morocco

Power Plant	Total Capacity (MW)	Units	Unit Capacity (MW)	Year completed	Status
Jerada	515	Jerada I	55	1971	Operational
		Jerada II	55	1971	Operational
		Jerada III	55	1972	Operational
		Jerada IV	320	expected 2018	Under construction
		Jerada V	350	planned 2022	In planning
Mohammedia	300	Unit 1	150	1984	Operational
		Unit 2	150	1985	Operational
Jorf Lasfar	2056	Unit 1	330	1994	Operational
		Unit 2	330	1994	Operational
		Unit 3	348	2000	Operational
		Unit 4	348	2001	Operational
		Unit 5	350	2014	Operational
		Unit 6	350	2014	Operational
Safi	1386	Unit 1	693	planned mid 2018	Under construction
		Unit 2	693	planned mid 2018	Under construction
Nador	1320	Unit 1	660	planned 2021	In planning
		Unit 2	660	planned 2021	In planning

Data source: L'Economiste (2018b); Global Energy Observatory (2017); MAP (2017); LE MATIN (2015); SAFIEC (2014)

Next to these existing coal-fired power plants, further extensions as well as the construction of new plants are already on-going or planned in the future. A 320 MW extension of the Jerada power station is nearly operational and was supposed to go online at the end of 2017 and another extension of 350 MW is in the planning stage for 2022 (MAP 2017). In Cap Ghir Safi, the Safi power plant is under construction, which will comprise two units with a capacity of 693 MW each, amounting to an overall capacity of 1,386 MW when completed. The Safi power plant started to be constructed in 2015 and is currently tested to become operational in mid 2018 (SAFIEC 2014). Another coal-fired power plant in the planning stage is Nador, which is planned to have a capacity of 1,320 MW and to start operating in 2021 (LE MATIN 2015).

The extensions of the existing power plants Jerada and Jorf Lasfar and the new power plants under construction or in planning of Safi and Nador, are so-called clean coal power plants that utilise technologies aimed at improving energy efficiency and reducing emissions of pollutants and GHG (OBGR 2016; BYMARO 2014). The Safi power plant is furthermore the first power plant in Africa that uses the ultra-supercritical technology, which is supposed to further reduce CO₂ emissions by raising the efficiency levels (Heidelberg Cement 2017a).

The listed expansion of coal-based power generation in Morocco shows that coal will not only remain an import energy source but will even gain importance in the future. It is expected that in 2030, 21% of an installed capacity of 25 GW will be coal-fired power plants (Hamane 2016). Accordingly, the coal

consumption and therewith the dependence on imports will rise even further in the future. This development is less prominently featured in the coverage of the energy sector developments in Morocco than the country's ambitious renewable energy strategy.

Both coal mining and its use for power generation can have negative impacts on the environment. Even though no coal is produced in Morocco anymore, the former mines in Jerada still have negative environmental impacts on air, soil and groundwater quality in the region due to large waste piles or acid mine drainages (Addou et al. 2017). Not only the production of coal but also its use for electricity generation can have negative effects on the environment and population. Coal combustion generates large masses of solid waste like fly ash and bottom ash. Until 1997, these solid wastes were pumped into the Atlantic Ocean. Today, the waste is stored in long-term ash disposal sites and parts are sold to cement companies (Boukhair et al. 2016).

To follow-up on Morocco's pledge to meet 100% of its domestic electricity needs with renewable energies in the future, the exit from coal-fired energy generation can be seen as a necessity. Yet, Morocco is currently the only country in the MENA region that promotes coal as a key strategy to meet the growing energy demand, despite the fact that Morocco has very limited coal reserves. In order to promote the exit from coal-fired power generation, Morocco would need to go beyond its already extensive commitments and further increase and accelerate its efforts in the renewable energy sector to meet the growing electricity demand (García and Leidreiter 2016). In order to do so, Morocco would on the one hand need to extend and improve the grid infrastructure to balance an increasing share of intermittent renewable energies. On the other hand, next to the large-scale renewable projects Morocco would also need to support small- and medium-sized renewable energy projects to ensure the participation of self-producers (ibid.). This would require extensive financial, institutional and technical support from the international community as well as on a bilateral level.

2.8 Conclusions

Morocco is one of the leading countries worldwide when it comes to climate change mitigation and adaption strategies. The Kingdom has not only set itself ambitious targets but it has also established policies that support its climate change agenda and it is also implementing it in a timely fashion. In regard to mitigation actions the country has far-reaching plans. In its NDC, Morocco provided a comprehensive list of 55 activities to achieve the conditional and unconditional GHG emission reduction targets by 2030. The listed activities span across all sectors (energy, agriculture, forest, transportation, waste, industry as well as actions in the residential and commercial sector) and are closely linked to the objectives of the different national strategies. Therewith, Morocco's mitigation strategy already constitutes very extensive and far-reaching measures coherent with the country's climate change commitments.

Yet, despite Morocco's ambitious climate strategy, potential challenges continue to exist in achieving the set objectives. On the one hand, Morocco currently has a very low GHG emission rate, which is anticipated to increase significantly in the coming decades in course of the country's continuing economic development. To limit the GHG emission increase, the country will need substantial financial support as shown by conditional targets that depend on the availability of climate funding and support from the international community.

On the other hand, Morocco is currently highly dependent on fossil fuel imports. Especially, the continuing relevance of coal to meet the country's primary energy demand and the strategy to expand natural gas use could become critical. The country is the only country in the MENA region that promotes coal as a key strategy to meet the growing energy demand, despite the fact that Morocco has only very limited coal reserves. Currently, the country's coal-based power generation capacities are being ex-

panded with new power plants under construction or in planning. These expansions of fossil-fuel infrastructures entail the risk of technological and therewith also carbon-lock-ins. However, this development is less prominently featured in the coverage of the energy sector developments in Morocco than the country's ambitious renewable energy strategy.

Fortunately, Morocco has additional potential to even further extend its already far-reaching efforts and strategies for a low-carbon development. A promising approach could be the focus on the urban centres as administrative entities. Major shares of GHG emissions are geographically concentrated in urban agglomerations, yet institutionally the development of mitigation strategies is so far strongly based on the national level. But also at the national level no comprehensive strategy or programme to reduce GHG emissions in the urban environment exists. Therefore, Morocco's mitigation efforts could benefit from creating more coherent climate policies for the different administrative levels, including the local administration. To achieve this, an involvement of local governments in the conceptualisation of national urban policy is of great importance. Another option to tap the mitigation potential in the urban environment could be the implementation of energy efficiency measures in public and private buildings. As a first step in this direction, the Thermal Regulation of Construction in Morocco (RTCM), with a mitigation potential of 2.4 MtCO_{2e} between 2016 and 2035, needs to be effectively implemented. Though, so far this legal framework only applies to new constructions. Therefore, further potential exists to expand energy efficiency measures to existing housing facilities. Major barriers to exploit the mitigation potential in urban areas reside in the lack of a comprehensive sustainable urban development strategy, the demographic pressure on cities and insufficient financial resources for the implementation of Morocco's NDC, including the Energy Efficiency Code in Buildings (CEEB). Furthermore, urban planning faces the challenge of dealing with illicit buildings and informal neighborhoods.

Another sector with a sizeable additional potential for GHG emissions reductions in Morocco is the energy- and emission-intensive mineral sector. Key segments of the mineral sector, which are expected to further expand their activities in the coming decades, are the phosphate and cement industry. Although the cement sector is smaller than the phosphate sector in terms of production, employees and revenues, it has a higher relevance when it comes to GHG emissions and mitigation potentials. The mitigation efforts in the cement industry are so far mainly concentrated on the indirect energy-related emissions from electricity consumption. However, these emissions represent only a small portion of emissions from the cement sector. It is therefore recommendable to explore mitigation options regarding emissions from direct energy use for heat generation. Mitigation options in this regard include the use of alternative fuels (biomass or waste), efficiency measures, substituting clinker by blending in waste materials or in the future capture and storage of carbon emissions (CCS). To realise these potentials, various obstacles including regulative, practical and financial barriers have to be overcome.

In addition, mitigation potential exists in the transport sector, which has been the sector with the fastest growing emission rate, representing the second largest source of emissions in Morocco behind the electricity sector. Accordingly, Morocco has already implemented different urban transport projects and national measures and has listed further mitigation actions for the transport sector in its NDC. However, in light of the needed extensions due to increasing demand for passenger and commercial transport, further opportunities exist for the development in the direction of a low-carbon transport system. Supporting modal shifts away from cars and trucks as the most energy-consuming transport modes to transport modes with a lower energy and carbon intensity is one option. Another could be the use of alternative fuels with a lower carbon intensity like electricity from renewables, hydrogen, CNG, biofuels, and other fuels. Especially, with its high renewable energy potential Morocco could focus on research and development of synthetic fuels based on renewable energy power, which would not only provide potentials to decarbonise Morocco's transport sector, but also open opportunities to become an exporter to Europe in the future.

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