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Tunisian
"Nationally Appropriate Mitigation Action"
NAMAs

Preliminary Proposals

Draft for Discussion

Tunis
Workshop Proceedings 13 October 2010

STRUCTURE

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Part I
NAMA Development in Tunisia

Since Tunisia submitted Nationally appropriate mitigation actions (NAMAs) to the Copenhagen Accord in Mai 2010 major national stakeholders engaged in a process coordinated by the Ministry of the Environment with the aim of analysing promising national initiatives that have high potential to be developed into a NAMA for fast track financing. The following criteria were used to identify high potential NAMAs in the different sectors i.e. power, buildings, waste, industry, transport and agriculture/land use:

1.1.1 NAMA selection criteria

Based on our current expertise we have identified five key factors which are highly important when deciding on and developing a successful NAMA.

1. Local commitment is crucial. The NAMA needs to be developed within the country. The process to identify and select NAMAs should be led by the government. Broad involvement of relevant stakeholders in a participatory process is important to increase acceptance. A NAMA needs to be suited to the local conditions and fit the national implementation structure.
2. The NAMA needs to be measurable, reportable and verifiable (MRV). The NAMA should demonstrate GHG emission reductions for the short or the long-term. One advantage of the NAMA concept is that also long-term emissions savings can be considered. MRV can be done at the sector level for NAMAs with large boundaries or at the level of a project.[1]
3. Clear determination of financing needs – To obtain financing it is important to identify what part of the NAMA needs direct support for financing and from whom. This is important for the country to demonstrate the own contribution and for the donor countries to have a clear picture what financing is needed.
4. High leverage of private investments – It is one important aspect for international donors as well as for the government to engage with the private sector and leverage additional sources of money and trigger sustainable development. Therefore a good NAMA has the potential for leveraging private investments.
5. High sustainable development benefits – As specified in the Bali Action Plan, the NAMA should not only target GHG emission reductions, but shall significantly contribute to the countries sustainable development. That includes e.g. job creation, capacity building, less pollution, health benefits.

In a Workshop that took place in Tunis on 13 October 2010 these criteria where applied on five selected sectoral policies where basic requirements for further NAMA development were considered promising. This assessment is not yet comprehensive and was meant as a start into the NAMA identification process:

Table 1 Overview table of Tunisia NAMAs and the criteria

Sector	Transport	Building	Industry	Diverse	Waste
Description	Bus rapid transit	Energy audit for tertiary buildings	Promotion of cogeneration	Solar Plan: 40 public-private projects	Diversion of organic waste from land filling – Assessment
GHG reduction potential	very high	medium	high	very high	very high
Simplicity and basis of GHG calculation	low	high	high	high	medium
Non-GHG benefits	very high	medium	medium	high	very high
MRV metric	medium	medium	high	high	medium
Economic savings due to GHG reduction measures	high	medium	high	high	medium
Simplicity of determination of financing needs and split of unilateral and supported contributions	high	high	high	high	medium
Potential for leveraging private investments	medium	medium	high	high	medium
Donor attractiveness	high	high	high	high	high
Ongoing	no	yes	yes	no	yes

The proposed selection of NAMAs shows that for some of the selection criteria the variability is comparably large (e.g. GHG reduction potential varies from medium to very high), while in others the different proposals score very similar (e.g. simplicity of financing needs).

In the workshop the participants decided to focus on the waste sector and the Tunisian Solar Plan to develop two example NAMAs.

In each of the two groups, discussions took place on the scope and boundaries of the NAMAs. In the end two possible NAMAs were identified for which it was recommended to develop a NAMA proposal:

- Tunisian Solar Plan
- Diversion of organic waste from landfills

Tunisian Solar Plan

The main question was if the existing Tunisian Solar Plan should be considered as one NAMA including all projects or if each project should become a separate NAMA.
The following arguments were supporting the selection of the Tunisian Solar Plan as one NAMA.

- Better project management. One project management body could improve the implementation and monitoring of the single projects.

- High political support. The Tunisian Solar Plan is supported by the government there is the risk that if the TSP would be spilt into single projects it will lose its strength.

- Visibility. The total potential of green house gas emission reductions through the Solar Plan is high enhancing visibility of the Tunisian Solar Plan compared to single projects

- Important sustainable development benefits. The heterogeneous projects within the Tunisian Solar Plan bring up a variety of sustainable development benefits in different sectors and topics and makes it attractive for potential donors

- MRV approach. One overall MRV approach will lead to a transparent monitoring of all components of the Tunisian Solar Plan

Diversion of organic waste

For the waste sector two possibilitiesfor project based NAMAs were discussed.

- Diversion of organic waste from landfills
- Strengthening the eco-lef system

Different from for the Tunisian Solar Plan, for both NAMA options in the waste sector no project concepts exist and the NAMA would be developed specifically for this project.
The participants supported the approach of diverging organic waste from landfills. They agreed that approach should focus on organic waste produced in other sectors e.g. agriculture, clearing sludge. Households should not be included because if organic

waste from households was taken away from the landfills the basis for the CDM projects in landfills would be removed. Organic waste from other sectors is by law not permitted on landfills and is therefore suitable for composting plants. In the discussion group further details of this NAMA option were discussed for consideration in the NAMA proposal development.

Part II
The Tunisian Solar Plan

Summary

Tunisia investigates whether, and if so how, to implement its "Solar Plan" as Nationally Appropriate Mitigation Action (NAMA) under the UNFCCC and Copenhagen Accord.

This document is a NAMA preparation proposal, as it provides an overview of the different projects within the Tunisian Solar Plan and provides a first overview of what would be necessary to turn the plan into a NAMA. This NAMA preparation proposal outlines the potential of the Tunisian Solar Plan as a NAMA: it provides an overview of the national situation, emission reductions that can be achieved, indicators to measure, report and verify the actions and an indication of the domestic actions and the additional international financial needs to implement the actions.

Situation in Tunisia

Since 2000 Tunisia is depended on energy imports, despite this fact renewable energy currently plays still a minor role in Tunisia's power sector, although wind and hydropower are already fed into the grid. In addition, some solar home systems (PV) are used for rural electrification. The biggest share of emissions is attributed to the production of electricity and heat with 36%. The steady increase in energy demand requires increases in capacity.

The national agency for energy conservation developed a Solar Plan in 2009, to confirm the country's ambition to become an international hub for energy production and exportation and its commitment toward sustainable development.

The Solar Plan covers 40 projects in the following fields:

- Solar energy
- Wind energy
- Energy efficiency
- Biogas
- Studies

The 40 projects in the Solar Plan are in part already fully financed and have started, and in part require additional financing before implementation can start.

Emission reductions

The estimated emission reductions of the Tunisian Solar Plan represent 1.5 $MtCO_2e$ (Million tonnes of CO_2 equivalents) per year, compared to the current yearly emissions in Tunisia of 35 $MtCO_2e$ it depicts around 4%.

The plan is targeting an annual energy saving of 660 kTep, which is 22% of the overall forecast for Tunisia's energy consumption by 2016.

Measurement, reporting and verification of emissions reductions

Nationally Appropriate Mitigation Actions need to lead to measurable, reportable and verifiable emissions reductions.

The Tunisian Solar Plan defines SMART (specific, measureable, attributable, timely) outputs for the majority of the components. These are also very suitable as indicators to monitor the emission reductions of the NAMA. These include mostly energy related indicators such as Collector surface [m²] and Power installed capacity [MW].

Co-benefits

The actions included in the Tunisian Solar Plan have a variety of sustainable development benefits apart from the greenhouse gas emission reductions. These include the benefits supporting the development of a green economy such as creation of new jobs, development of a skilled work force and technology transfer and less dependence of fossil fuels. On the other hand improved health and improvements in buildings have a positive effect on the living conditions of the people.

Financing

Nationally Appropriate Mitigation Actions are to be supported internationally in a measurable, reportable and verifiable manner.

The 40 projects in the Solar Plan are in part projects that have secured finance. These could be considered as "unilateral" NAMAs. The remainder of the projects of the Solar Plan, for which international climate financing is required, would fall under the category of supported NAMAs.

A detailed estimate of the costs of the implementation of Tunisian Solar Plan exists for most activities. The costs are estimated per component and total to 1,852 Billion Euro between 2010 and 2016 for the implementation of all actions included the Tunisian Solar Plan. However not for all components of the Tunisian Solar Plan financing sources are defined and secured yet.

The costs covered domestically either trough private or domestic funding total to an amount of 1,472 Billion Euro. Funding that is already agreed to be covered by international donors totals to an amount of 9 Million Euro. The costs that are currently not secured total to 371 Million and for which Tunisia is seeking international climate finance. This is 20% amount of the total financing volume of the Tunisian Solar Plan.

In our analysis we found that the two main components for which international climate finance is required are solar electricity generating projects and wind projects. These type of actions are very much suitable for international climate financing because they match very well with the goals of a NAMA to leverage private investments and trigger technology transfer and innovation.

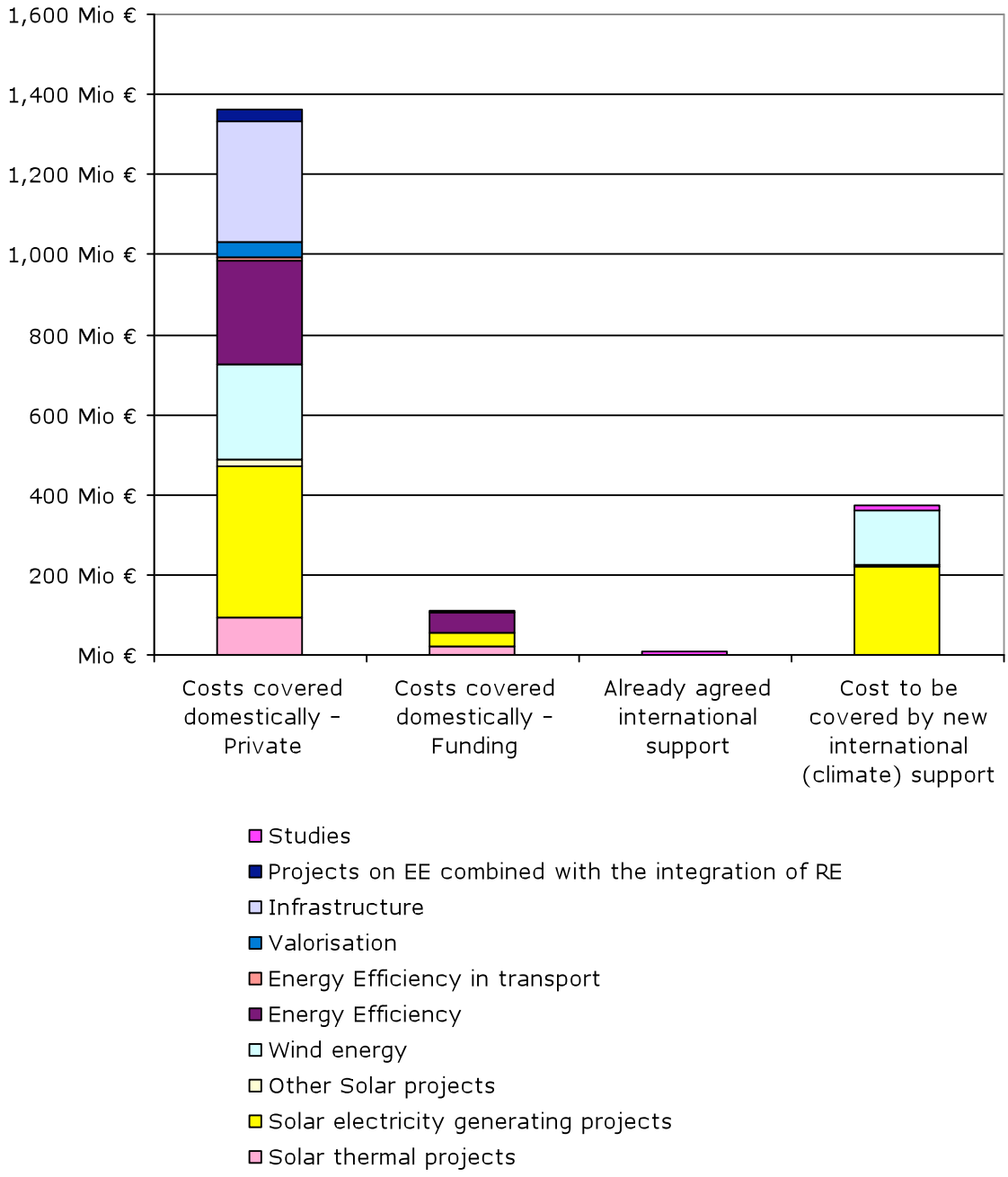


Figure 1: Financial sources of Tunisian Solar Plan in Mio €

Conclusions

The Tunisian Solar Plan is proposed as NAMA suitable for international support for various reasons:

- It is developed from within the country and fits national implementation structure
- It can demonstrate GHG reductions short term of and sets Tunisia on a path towards further emission reductions.
- It includes clear indicators to measure, report and verify emission reductions on a project by project basis.
- It demonstrates a high ownership by the country with provision of 80% of the financing needs domestically and requiring on 20% from additional international financing sources (372 Mln €).
- International NAMA financing complements the existing activities, closes gaps and advances quick development
- It provides high leverage of private investments (73%)
- It provides for high sustainable development benefits, including a yearly GHG reduction of ca. 1,5 Million tCO_2e

Nr	Component	Costs covered domestically - Private	Costs covered domestically - Funding	Already agreed international support	Cost to be covered by new international (climate) support	Estimated Yearly GHG reduction
				MEDREC +JAPON	*Already defined as intern cooperation and public*	*In Tons of CO2e per year*
1	Solar thermal projects	92 Mln €	20 Mln €			72,648
2	Solar electricity generating projects	380 Mln €	35 Mln €	1 Mln €	220 Mln €	204,870
3	Other Solar projects	18 Mln €			5 Mln €	1,430
4	Wind energy	235 Mln €			135 Mln €	528,530
5	Energy Efficiency	260 Mln €	50 Mln €	1 Mln €	1 Mln €	576,070
6	Energy Efficiency in transport	8 Mln €	6 Mln €			52,210
7	Valorisation	39 Mln €	Mln €			94,130
8	Infrastructure	300 Mln €				-
9	Projects on EE combined with the integration of RE	30 Mln €				12,370
10	Studies			7 Mln €	11 Mln €	235
Σ	**Subtotal in Euro**	1,362 Mln €	111 Mln €	9 Mln €	372 Mln €	
Σ	**Total in Euro**	**1,853 Mln €**				**ca. 1.500.000 tCO2e**

Structure

1 Context

1.1 Past and present situation of the country

The emissions of Tunisia have been constantly increasing since 1990; from around 20 Mt CO_2 eq. in 1990 to 35 Mt in 2007. The biggest share of emissions remains CO_2 emissions, followed by methane (CH_4) emissions which have approximately doubled. The amount of N2O emissions have been relatively stable, as can be seen in the following Figure 2.

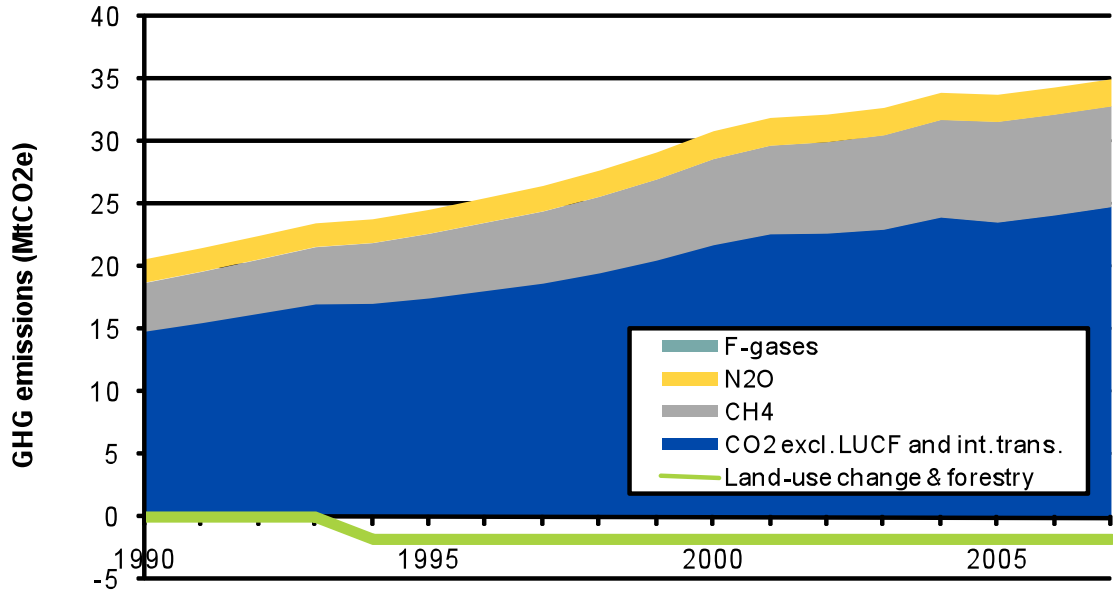


Figure 2: Greenhouse gas emissions in Tunisia, 1990-2007 (Source: „Factors underpinning future action – 60 country factsheets", Ecofys for UK DECC, www.ecofys.com)

In order to show the emissions that are caused in individual sectors in Tunisia, the emissions were broken down to the individual sectors electricity and heat production, industry, transport, households and services, agriculture and waste.

The biggest share of emissions is attributed to the production of electricity and heat with 36%. The second largest sector in terms of emission is industry (22%), followed by transport (15%) and households and services (12%).

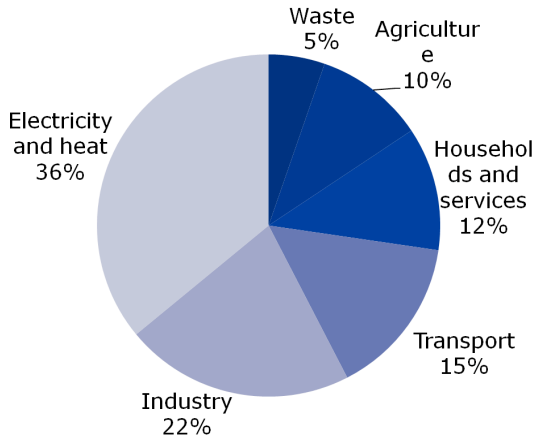


Figure 3: Emissions by sector in Tunisia, 2007 (Source: „Factors underpinning future action – 60 country factsheets", Ecofys for UK DECC, www.ecofys.com)

In the following Table 1, the greenhouse gas emissions per capita are indicated.

With 3.4 tCO_2eq per capita, Tunisia ranks at the lower end of per capita emissions worldwide, together with other countries in that region. The minimum emission per capita is 1 t, the maximum 28.

Table 1: Greenhouse gas emissions per capita, 2007 (Source: „Factors underpinning future action – 60 country factsheets", Ecofys for UK DECC, www.ecofys.com

	t CO2 eq. / cap
Minimum	1
India	2
Morocco	2.1
Egypt	3.1
Tunisia	**3.4**
Lebanon	4
Jordan	4.2
Developing country average	4.3
Algeria	4.9
World average	6.5
China	6.6
EU-27	10.2
Developed country average	15.6
USA	23.6
Maximum	28.2

However, these emissions have been growing steadily in the past from 2.5 t CO2 eq per capita in 1990 to the 2007 value of 3.4. This means an increase of 35% or almost 2% annual growth. At the same time energy intensity of the GDP has been decreasing.

1.2 Past and present situation of the relevant sector/sub-sector

In the following section we provide an overview of the present situation in the sectors power and buildings as they are related to the actions included in the Tunisian Solar Plan.

1.2.1 General description of the (sub-)sectors power and buildings

Power

In 2007, 14661 GWh of electricity were produced in Tunisia. This electricity was produced by STEG (The Tunisian Company of Electricity and Gas) in 20 power plants, independent power producers (IPPs) and auto producing industrial companies. The main source for power production in that year were gas (83%) and oil (16%), with wind and hydro power accounting for less than 1% each. The demand for electricity currently grows at a rate of around 5% per year. Until the liberalization of the electricity market in 1996, STEG held the monopoly for electricity production, and is with a market share of around 85% still the most important producer. In addition, apart from auto producers who may use STEG's grid to transport their produced electricity to the place of consumption, STEG operates as the sole buyer for electricity.

Renewable energies play a very minor role in Tunisia in the power sector, although wind and hydropower are already fed into the grid. In addition, some solar home systems (PV) are used for rural electrification.

Buildings

The building sector in Tunisia accounts for approximately 27% of Tunisia's final energy demand, as can be seen in the following Figure 4.

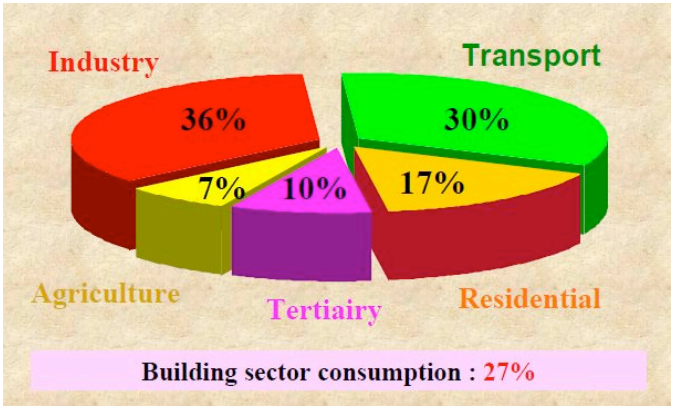


Figure 4 Sectoral distribution of final consumption in Tunisia (Source: ANME 2010)

The final energy consumption in this sector is expected to further grow significantly and, in 2030, become the largest energy consuming sector in Tunisia.

A large share of the previous growth in energy demand is due to the increasing use of air conditioning appliances: while in 1989, around 14,000 appliances were installed, this number has increased by a factor of more than nine to 130,000 in 2004

In contrast to the current share of final energy consumption, regarding the greenhouse gas emissions, the sector accounts for 12%. The amount of GHG emissions has increased by 69% from 1990 to 2007. The emissions per capita in this sector are at 0.4 tCO_2eq.

The energy sources used in the building sector are petroleum products (32%), combustible renewables and waste (38% - this category accounts for 50% of the energy sources in residential buildings), electricity (20%) and gas (10%).

Renewable energies like PV are still immature, quiet the contrary to solar thermal panels which are already introduced in the building sector for some years.

1.2.2 Emissions and reduction potentials

There are several strategies and policies in place to increase the use of renewable energies and energy efficiency in the electricity and building sector in Tunisia.

The political framework includes laws that allow auto producers to use STEG's transmission grid for the transport of electricity from the place of production to the place of consumption. Excess electricity can be sold to STEG at a fixed tariff.

In addition, in 2008 an energy conservation programme for the period 2008 to 2011 was introduced. It contains measures that are estimated to save 20% of energy use by the end of the programme. Through actions in energy efficiency and renewable energies, 8 $MtCO_2eq$ are planned to be saved by the end of 2011.

Furthermore, in 2006 the National Fund for Energy Conservation (FNME) was implemented, which financially supports energy conservation policies in Tunisia. This fund is fed by taxation of inefficient air-conditioning appliances and cars and supplies also other sectors like the industrial sector.

In addition to this legislation, support programmes are in place like the successfully Prosol (a subsidy scheme for the utilization of solar thermal panels in the residential sector) and others, while further programmes are planned.

Just recently, the Tunisian Solar Plan was introduced with the aim to save 1.3 Mt CO_2eq per year until 2016. The Tunisian Solar Plan (TSP) is the framework for the Tunisian energy policy; within this framework, numerous projects and measures are planned.

This plan will be in the following deeply investigated.

1.2.3 Analysis of barriers

Although emission reductions are of course possible in various fields and sectors, they do face several barriers when it comes to implementing adequate actions.

Projects in the field of renewable energies or energy efficiency face **rather high upfront costs**, especially if these areas are not yet well established in a country. This also leads

to **high transaction costs to deploy those technologies** into a new country. Energy efficiency projects will, for example, save fuel and thus money over their whole lifetime, but in the beginning, the investment has to be made and will be compared to the option not to invest anything. So in the long run, the energy efficiency will amortise, but if only the upfront costs are taken into account, this hinders such projects from being implemented.

To meet and alleviate these barriers, financing mechanisms like for example low interest loans or financing from thirds parties could be implemented. However, currently in Tunisia there are only **insufficient financing mechanisms for mitigation action** investment available.

A barrier that is more on the personal level is a **lack of awareness** of the need to take action soon and on a broad level. Without this awareness, new technologies and ideas will not be developed or implemented.

On the institutional level, two main barriers exist: on the one hand, the **public procedures** do not harmonise well with the needs and characteristics of the carbon market. Furthermore, there is a **lack of a domestic system for statistics, monitoring and evaluation**. The fact of limited information is a crucial barrier for the successful and broad implementation of CDM projects.

1.2.4 Relevant political and institutional framework

The Tunisian Solar Plan includes different types of projects in different sectors. In the following table we provide an overview of those regulations and institutions in the broad context of renewable energy and energy efficiency. We would like to highlight that due to the cross cutting nature of the Tunisian Solar Plan overall a large group of different actors (ministries, stakeholders, private sector) are involved and many different regulations are relevant. This listing is therefore not complete but provides a general overview.

In Tunisia following regulations exist in the context of renewable energy and energy efficiency:

Regulation/Policy/ Measure	Description of measure	Responsible government/entity	Planned entry into force	Duration in years
Order of 24 October 2005 relating to MEPs of refrigerators, freezers and combined equipments	Prohibition of the marketing of refrigerators, freezers and combined equipments pertaining to energy efficiency class 4 , from April 1 2009 .	ANME (National Agency for Energy Conservation)	2004	11
Creation of the National Fund for Energy Conservation (FNME)	Fund witch supports the energy conservation policy in Tunisia	MIT	2006	
Promotion of SWHs in the building sector	installation of 450 000 m² of SWHs in household and tertiary sectors	ANME	2008	4
Order of 27 October 2008 relating to labelling of refrigerators, freezers and combined equipments	Labelling and MEPs for refrigerators	ANME	2008	4

Regulation/Policy/ Measure	Description of measure	Responsible government/entity	Planned entry into force	Duration in years
Order of 21 April 2009 of Ministry of industry, energy and Small and Medium Enterprises and Ministry of trade and handicrafts	Obligation of the energy certification and energy labelling of the apparatuses of individual air-conditioning which cooling capacity is lower than 12kw	ANME	2009	/
Promoref acceleration of the replacement of not efficient existing refrigerators	Replacement of 400000 refrigerators of less than 300 liters and which age exceeds 10 years, by more energy efficient appliances	ANME	2009	8
Lighting efficiency programme	Diffusion of 8 million Low Consumption bulbs in The residential and tertiary sectors	ANME	2009	4
Joint order of 18 August 2010 of Ministry of Industry and technology and Ministry of trade and handicrafts	Prohibition of the distribution of the incandescent lamps for domestic use which capacity is higher or equal to 100 Watt and its tension higher or equal to 100 volts, from January 1, 2011.	Ministry of Industry and technology and Ministry of trade and handicrafts (MIT)	/	/

Regulation/Policy/ Measure	Description of measure	Responsible government/entity	Planned entry into force	Duration in years
The Decree 2009-2269 modifying decree 2004-20144	The establishments belonging to the tertiary sector which total energy consumption is higher or equal to five hundred tons oil equivalent are subjected to an obligatory and periodical energy audit			
Order of 11 June 2007 of Ministry of industry, energy and Small and Medium Enterprises	The new and extension projects in tertiary and residential sectors which total energy consumption is higher or equal to 200 TOE are subjected to the obligation of a preliminary consultation			
i) Joint order of 1 June 2009 of Ministry of Industry, energy and Small and Medium Enterprises and Ministry of equipment, housing and land planning	Setting of the minimal technical specification for the projects of construction of new buildings for office and residential use	Ministry of industry, energy and Small and Medium Enterprises		

Regulation/Policy/ Measure	Description of measure	Responsible government/entity	Planned entry into force	Duration in years
ii) Joint order of 23 July 2008 of Ministry of Industry, energy and Small and Medium Enterprises and Ministry of equipment, housing and land planning				
iii) Law 2007-72 modified and completed by Law 2009-7				
The Law 2009-7 (February 2009)	i) Possibility of sale of the surplus of electricity to National power utility according to a fixed tariff ii) Possibility of transport of electricity produced by auto-producers until the consumption point of the user through the National grid	MIT	2009	
The Decree 2009-362 (February 2009)				
Decree 2009-2773				

Regulation/Policy/ Measure	Description of measure	Responsible government/entity	Planned entry into force	Duration in years
Quadrennial Energy conservation program for the period 2008-2011	Identified actions in EE and RE aiming at 20% energy saving by the end of the program	ANME	2008	4
Electoral Presidential program 2009-2014	The chapter 21 of the electoral program	MIT/ANME	2009	
The Law 2009-7 (February 2009) modifying and extending Law 2004-72; The Decree 2009-362 (February 2009) modifying the incentive structure to investment in energy efficiency originally established in Decree 2005-2234.	Promotion of grid-connected PV systems in the building sector	STEG in partnership with ANME	2010	2
Promotion of grid-connected PV systems in the building sector	Installation of 15 MW PV grid-connected systems in the building sector	STEG in partnership with ANME	2010	2
Rural electrification of households in the isolated areas	electrification of rural households (3MW)	ANME in partnership with the regional authorities	2010	5

Regulation/Policy/ Measure	Description of measure	Responsible government/entity	Planned entry into force	Duration in years
The Tunisian solar plan for 2010-2016	A Tunisian program encompassing all relevant RE and EE activities. It is a official framework for the Tunisian policy	MIT/ANME	2010	6

2 Details

2.1 General description of the proposal

The background of the Tunisian solar plan is the European – Mediterranean initiative to formulate a Solar Plan for Europe, North Africa and the Middle East. The overall aim was to connect regions with high solar potential (and other renewable resources) to Europe. Other positive aspects like technology transfer, green house gas reductions, job creation were expected to follow. In this framework Tunisia formulated its own solar plan in order to implement 40 public-private projects scheduled over the 2010-2016 period, which are focussing on energy efficiency and renewable energies.

The Tunisian Solar Plan will allow an estimated CO_2 emission reduction of 1.5 Million tonnes per year. Targeting an annual energy saving of 660 kTep, which is 22% of the overall forecast for Tunisia's energy consumption reduction by 2016.

The Tunisian Solar Plan confirms the country's ambition to become an international hub for energy production and exportation and its commitment toward sustainable development.

The 40 projects cover following fields:

- Solar energy
- Wind energy
- Energy Efficiency
- Biogas
- Studies

2.2 Components

The Tunisian Solar Plan consists of more then 40 projects with different actions and technologies. We have grouped the 40 projects into ten components based on the technologies applied. While the majority of the projects are focusing on renewable energies and technology implementation there are few projects e.g. improvement of driving skills which address behavioural changes. It is therefore a comprehensive package of different types of measures that complement each other.

Nr	Component	Amount of Actions	Actions	Phase	Responsible institutions
1	Solar thermal projects	4	Solar thermal projects (1.1 – 1.4).	2010-2016	ANME partnering with Industry, Certication bodys, STEG…
2	Solar electricity generating projects	10	Photovoltaics (2.1 – 2.7).		
			CSP (2.8 – 2.10).		
3	Other Solar projects	3	Solar cooling (3.1). Solar drying (3.2). Production of PV panels (3.3)		
4	Wind energy	3	Wind parks (4.1 – 4.3)	2009-2016	ANME, STEG, MEDREC, Private sector
5	Energy Efficiency	5	Rational utilization of energy of appliances. buildings and industry (5.1 – 5.5)	2009-2016	ANME
6	Energy Efficiency in transport	2	Improve driving skills and the introduction of innovative information technology for public vehicle fleet (6.1 – 6.2)	2010-2015	ANME partnering with Ministry of Transport and Technical Agency of Transport
7	Valorisation	3	Valorisation of gas and other combustible resources (7.1 – 7.3)	2010-2014	ANME and private sector
8	Infrastructure	1	ELMED. electric interconnection linking Tunisia and Italy (8)	2010-2014	Private sector

9	Projects on energy efficiency combined with the integration of renewable energies	3	Three concrete projects for energy efficiency and renewable energy for buildings and districts (9.1 – 9.3)	2010-2016	ANME
10	Studies	6	Feasibility studies. project management and pilot projects(10.1 – 10.6)	2010-2016	ANME

2.3 Detailed actions

In Annex I we provide an description of the individual actions included in the Tunisian Solar Plan.

2.4 Objective and MRVable indicators

In the following table we provide an overview of possible indicators against which the implementation of each component can be assessed. For the majority of the components SMART (specific, measureable, attributable, timely) outputs are defined in the Tunisian Solar Plan. These are also very suitable as indicators to monitor the emission reductions of the NAMA. Most indicators are linked to installed technology e.g. the amount of collector surface installed. The amount of installed technology can be used as a proxy to estimated emission reductions of this action. Some of the proposed actions e.g. studies of certain aspects have no direct effect on the emission reductions but an indirect effect. For the purpose of the NAMA monitoring it is however possible to use indicators of implementation for this type of actions e.g. the number of studies conducted or the report produced.

There are several factors that can have an impact on the implementation of the different projects. For the technology based actions in the Tunisian Solar Plan these include e.g.

- Availability of finance to cover the high up front costs
- Availability and capacity of skilled work force to implement the projects
- Availability of technology and products in sufficient quantity and quality

The Tunisian Solar Plan implementation path is based on the assumption that e.g. capacity, technology finance are available.

Nr.	Component	Action	MRVable outcome/output indicator		Assumptions and risks
1	Solar thermal projects	1.1 Residential	1.000.000	Collector surface [m²] in 2014	The time frame is ambitious and will depend on private sector demand
		1.2 Multi-Family houses	10.000	Collector surface [m²] in 2014	Availability of project developers is a key success factor and if lacking it may create a bottle neck, technology for multi family houses is complex and needs specific expertise.
		1.3 Tertiary and Industry	60.000	Collector surface [m²] in 2014	Programs of this type have already been implemented and existing experience can be considered.
		1.4 Swimming Pool	5.700	Collector surface [m²] in 2014	Technology is available and no risks are foreseen
2	Solar electricity generating projects	2.1 Grid-connected PV	15	Power installed [MW] in 2011	High upfront costs, skilled work force required, availability of technology and products required, local market for expertise needs to be developed
		2.2 PV pumping	Not defined	Power installed [MW] in 2011	See above
		2.3 Rural energy	3	Power installed [MW] in 2014	See above
		2.4 PV public lighting	0.5	Power installed [MW] in 2015	See above
		2.5 PV for tank stations	Not defined	Power installed [MW] in 2014	See above
		2.6 PV for export	10	Power installed [MW] in 2016	See above
		2.7 PV plant	10	Power installed [MW] in 2016	See above
		2.8 ISCC	25	Power installed [MW] in 2014	High upfront costs, skilled work force required, availability of technology and products, innovative solution requiring technology transfer
		2.9 CSP	75	Power installed [MW] in 2016	See above
		2.10 ISCC	10	Power installed [MW] in 2014	See above
3	Other Solar projects	3.1 Solar cooling – food industry	10	Amount of realized pilot projects [-] in 2014	Already at least one pilot available (MEDISCO). Evaluation of existing project can support the development of further

					projects. Appropriate monitoring tools need to be available
		3.2 Solar dryer	1	Amount of realized pilot projects [-] in 2012	skilled work force needed, appropriate monitoring tools need to be available
		3.3 PV panel production	14	Yearly produced panels [MW] in 2014	Very high costs to set up production. Evaluation of market opportunities important pre-requisite for success.
4	Wind energy	4.1 Wind farm	60	Power installed [MW] in 2011	High up front costs and long planning time increase risk of delays.
		4.2 Wind farm	120	Power installed [MW] in 2014	High up front costs and long planning time increase risk of delays.
		4.3 Wind farm	100	Power installed [MW] in 2016	High up front costs and long planning time increase risk of delays.
5	Energy Efficiency	5.1 Refrigerators	400.000	Amount of exchanged refrigerators [amount] in 2014	Awareness rising to create acceptance and demand is key success factor.
		5.2 Positive energy buildings	Not defined		Skilled work force required, availability of technology and knowledge, innovative solution requiring technology transfer
		5.3 Insulation of roofs	1.000.000	Surface of insulated roofs [m²] in 2016	Awareness rising to create acceptance and demand is key success factor.
		5.4 Energy saving lamps	8.000.000	Amount of distributed EE light bulbs [amount] in 2011	Awareness rising to create acceptance and demand is key success factor.
		5.5 Industry	Not defined		
6	Energy Efficiency in transport	6.1 Driving skills	3.500	Number of monitored drivers [amount]	-
		6.2 Information device	Not defined	Number of installed information devices [amount]	Very innovative product, technology and availably may be bottle neck
7	Valorisation	7.1 Poultry	14.5	Power installed [MW] in 2012	
		7.2 landfill gas	10	Power installed [MW] in 2013	

		7.3 Biogas	1	Power installed [MW] in 2014	
8	Infrastructure	8 ELMED cable	Realized project [Yes. No]		High costs
9	Projects on energy efficiency combined with the integration of renewable energies	9.1 RE for oasis	Not defined	Power installed [MW] in 2016	High upfront costs, skilled work force required, availability of technology and products, innovative solution requiring technology transfer
		9.2 Eco-village	Not defined		See above
		9.3 Train-station	Not defined		See above
10	Studies	10.1 Training centre		Information material published and distributed and frequency of visitors/students	Availability of skilled work force required
		10.2 PV plant	0.25	Power installed [MW] in 2012	Availability of skilled work force required
		10.3 Helpdesk		Information material published and distributed	Availability of skilled work force required
		10.4 Study		Information material published and distributed; Study results published	Availability of skilled work force required
		10.5 Study		Information material published and distributed; Study results published	Availability of skilled work force required
		10.6 Helpdesk		Implement listed projects of the Plan Tunisian Solar	Availability of skilled work force required

2.5 Benefits

2.5.1 Estimated emission reductions

In the following table we present the estimated yearly CO_2 reductions per component as specified in the Tunsia Solar Plan.

The estimated emission reductions of the Tunisian Solar Plan represent 1.5 $MtCO_2e$ (Million tonnes of CO_2 equivalents) per year, compared to the current yearly emissions in Tunisia of 35 $MtCO_2e$ it depicts around 4%.

The plan is targeting an annual energy saving of 660 kTep, which is 22% of the overall forecast for Tunisia's energy consumption by 2016. There is an uncertainty in the quantification of the estimates of yearly emission reductions that depends on the method used to estimate the emission reduction.

Nr	Component	Estimated Yearly GHG reduction	Estimated uncertainty
	Study to detect cost-efficient measures for emission reduction in the commercial building sector (new buildings) with analyses under which conditions (reference buildings. climate. region. economics. client etc.) different measures are cost-efficient	*In Tons of CO2e per year*	
1	Solar thermal projects	72,648	Low
2	Solar electricity generating projects	204,870	Low
3	Other Solar projects	1,430	Low
4	Wind energy	528,530	Low
5	Energy Efficiency	576,070	High
6	Energy Efficiency in transport	52,210	High
7	Valorisation	94,130	Low
8	Infrastructure	-	-
9	Projects on energy efficiency combined with the integration of renewable energies	12,370	High
10	Studies	235	High
	Total	**ca. 1.500.000**	High

2.5.2 Other benefits

The actions included in the Tunisian Solar Plan have a variety of sustainable development benefits apart from the greenhouse gas emission reductions. These include the benefits supporting the development of a green economy such as creation of new jobs, development of a skilled work force and technology transfer and fuel independence. On the other hand improved health and living conditions have a positive effect on the living conditions of the people.

No	Component	Benefit	Description	Source of information
1	Solar thermal projects	Jobs; fuel independence, More work capacity;	Already in place and good experience; LPG is substituted, which had to be obtained from local supplier	Ecofys estimation
2	Solar electricity generating projects	Jobs ; Fuel independence ;	Creation of skilled work force	Ecofys estimation
3	Other Solar projects	Jobs ; Fuel independence; Market; Innovation	Creation of skilled work force; Export of PV panels	Ecofys estimation
4	Wind energy	Jobs ; Fuel independence;	Creation of skilled work force; Already in place and experience available	Ecofys estimation
5	Energy Efficiency	Innovation, testing; Comfort;	Improved indoor climate	Ecofys estimation
6	Energy Efficiency in transport	Fuel independence ; Less pollution;	Less fuel consumption with the help of better driving;	Ecofys estimation
7	Valorisation	Health, Re-using biomass; Jobs	Dung could be reused after valorisation for farming issues	Ecofys estimation
8	Infrastructure	Facilitating the export of "green" energy to Europe	Interconnection of Tunisia and Italy mandatory for	Ecofys estimation
9	Projects on energy efficiency combined with the integration of renewable energies	Innovation, testing; Comfort;	Real projects enhance visibility and technology transfer of RE and EE	Ecofys estimation
10	Studies	Technology transfer; Project management; Market intelligence; Statistics	In order to transfer knowledge facilities needs to be defined;	Ecofys estimation

2.6 Cost and financing

The 40 projects in the Solar Plan are in part projects that have secured finance. These could be considered as "unilateral" NAMAs. The remainder of the projects of the Solar Plan, for which international climate financing is required, would fall under the category of supported NAMAs.

The costs covered domestically either trough private or domestic funding total to an amount of 1,472 Billion Euro. Funding that is already agreed to be covered by international donors totals to an amount of 9 Million Euro. The costs that are currently not secured total to 371 Million and for which Tunisia is seeking international climate finance. This is 20% amount of the total financing volume of the Tunisian Solar Plan.

In our analysis we found that the two main components for which international climate finance is required are solar electricity generating projects and wind projects. These type of actions are very much suitable for international climate financing because they match very well with the goals of a NAMA to leverage private investments and trigger technology transfer and innovation.

Nr	Component	Costs covered domestically - Private	Costs covered domestically - Funding	Already agreed international support	Cost to be covered by new international (climate) support
				MEDREC +JAPON	*Already defined as intern cooperation and public*
1	Solar thermal projects	92 Mln €	20 Mln €		
2	Solar electricity generating projects	380 Mln €	35 Mln €	1 Mln €	220 Mln €
3	Other Solar projects	18 Mln €			5 Mln €
4	Wind energy	235 Mln €			135 Mln €
5	Energy Efficiency	260 Mln €	50 Mln €	1 Mln €	1 Mln €
6	Energy Efficiency in transport	8 Mln €	6 Mln €		
7	Valorisation	39 Mln €	Mln €		
8	Infrastructure	300 Mln €			
9	Projects on EE combined with the integration of RE	30 Mln €			
10	Studies			7 Mln €	11 Mln €
Σ	**Subtotal in Euro**	1,362 Mln €	111 Mln €	9 Mln €	372 Mln €
Σ	**Total in Euro**	**1,853 Mln €**			

In Figure 5 we provide an overview of the financing split per source. The two main components for which international climate finance is required are solar electricity generating projects and wind projects. These types of action are very much suitable for international climate financing because they match very well with the goals of a NAMA to leverage private investments and trigger technology transfer and innovation which makes them also attractive for donors.

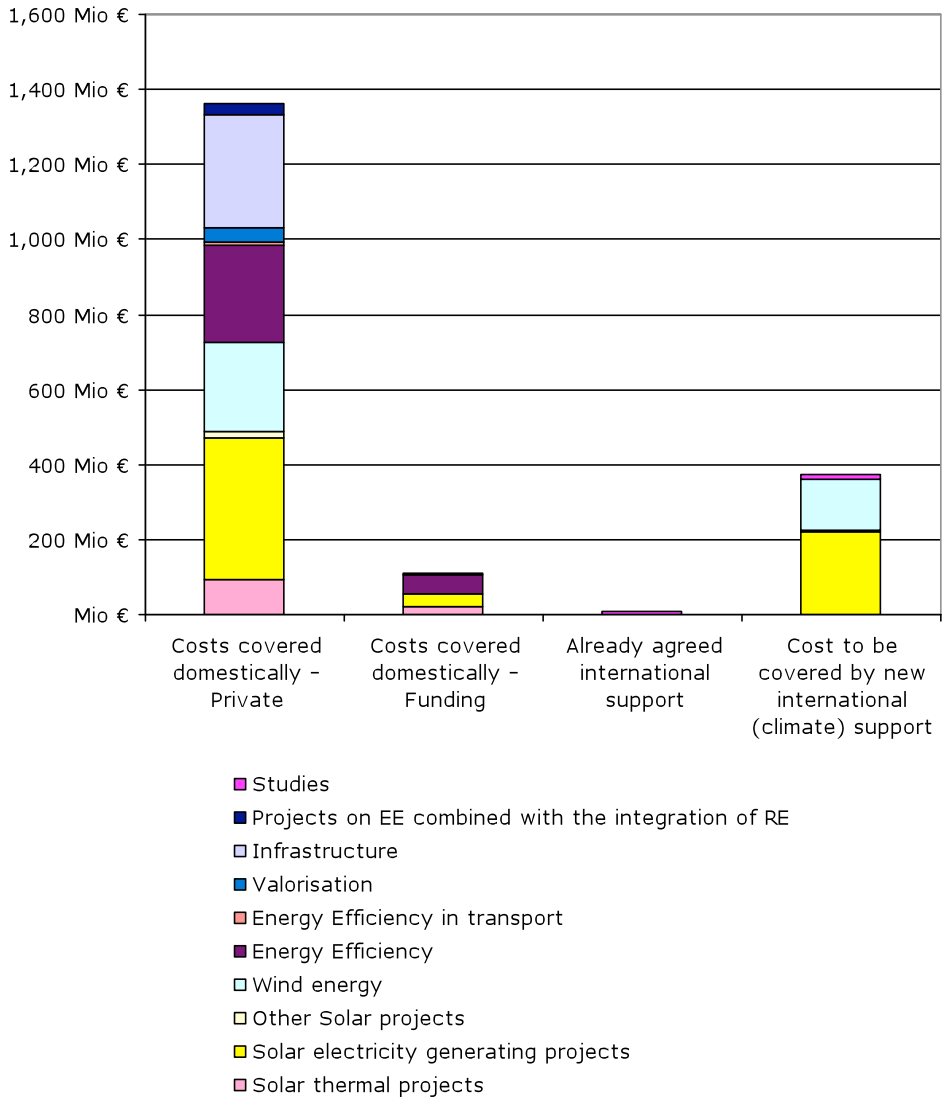


Figure 5: Financial sources of Tunisian Solar Plan in Mio €

Annex I Description of actions included in the Tunisian Solar Plan

The information is based on the Tunisian Solar Plan and the information the status of the project is based on interviews with experts from the ANME.

Nr	Actions	Description	Phase	Responsible institutions	Status Ongoing yes/no
1.1	Extension of the solar thermal collector surface up to 1.000.000 m² in the residential sector	The project maintains the development of the market knowledge gained of solar water heaters in Tunisia through the mechanisms established under the program PROSOL. Its aim is to reach a total stock of 1 million square meter installed by 2014. The project is also setting up quality labels for equipment and installation works.	2010-2014	National Agency for Energy Management (ANME) in partnership with manufacturers, laboratories. accreditation bodies and certification	yes
1.2	200 Multi-family houses should be equipped 10.000 m² of solar collectors till 2014	Multi-family houses are becoming increasingly important in Tunisia. The project is to promote the use of solar thermal for heating and domestic hot water, taking into account the socio-cultural. technological and economic aspects.	2010-2014	National Agency for Energy Management in partnership with property developers	Planned and not yet implemented
1.3	Installation of 60.000 m² solar collectors by 2014 in the tertiary and industrial sectors	The program Prosol in the tertiary sector and industry promotes collective solar thermal systems through the establishment of an attractive financial mechanism, strengthening of local expertise. the mobilization of international expertise and awareness rising actions for all institutions and companies belonging to industrial and tertiary sectors.	2010-2014	National Agency for Energy Management in partnership with hoteliers and industrialists	Implemented for tertiary and not yet for industry

1.4	Installation of 5.700 m² solar collectors on municipal indoor swimming pools	The project will cover the hot water demand for municipal indoor swimming pools covered by solar thermal.	2010-2014	National Agency for the Control of Energy's partnership with the Ministry of Youth. Sport and Physical Education. and municipalities	Implemented as pilot phase for demonstration and dissemination
2.1	Installation of grid-connected photovoltaic (PV) 15 MW	○ Installation of PV on 600 buildings and 6000 flats ○ Power to install: 15MW	2010 - 2011	Tunisian Company of Electricity and Gas with the partnership of the National Agency for Energy Management	No
2.2	PV pumping for agricultural irrigation (200 farms)	○ Equipment of 200 farms by photovoltaic pumping systems for water for irrigation in order to further dissemination of this large-scale technology; ○ Educate farmers about the benefits of substituting the use of diesel by solar energy for later broadcast broader technology.	2009-2011	National Agency for Energy Management in partnership with the Ministry of Agriculture and Water Resources.	No
2.3	Installation of equipment for rural electrification by renewable energy with a total capacity of 3MW	Electrification of households. farms and small projects in rural areas by photovoltaic. wind and hybrids to facilitate the energy supply in remote areas and improve the living conditions of the inhabitants of these regions	2010 - 2014	National Agency for Energy Management in partnership with regional authorities and project beneficiaries	No
2.4	Installation of PV public lighting (500 kW)	The project is to promote the use of photovoltaic energy needs for lighting in urban areas and / or remote areas of the national electricity grid.	2010 - 2015	National Agency for Energy Management in partnership with the Ministry of Equipment. Housing and Spatial Planning	No
2.5	Equipment of 100 service stations by solar photovoltaics	○ Involving oil companies in the national effort for sustainable development	2010 - 2014	Oil companies in partnership with the National Agency for Energy	Started with pilot installations (one by

		○ Operate service stations as a platform for public awareness on solar energy		Management	company)
2.6	Installation of photovoltaic plants with a total capacity of 10MW connected to the national grid (for export)	The generated electricity is foreseen for the export (partly or completely)	2010 - 2016	Private sector in partnership with the National Agency for Energy Management and the Tunisian Company of Electricity and Gas.	No
2.7	Implementation of a 10 MW photovoltaic plant by STEG	To promote the centralized production of photovoltaic electricity and contribute to the diversification of energy sources.	2010 - 2016	Tunisian Company of Electricity and Gas.	No
2.8	Realization of an integrated solar combined cycle (ISCC) - 25 MW solar / 125 MW gas.		2010 - 2014	Tunisian Company of Electricity and Gas.	No (prefeasibility)
2.9	Realization of a solar CSP for electricity generation with a capacity of 75 MW. by the private sector	The electricity generated in the southern part of Tunisia is foreseen for the export (partly or completely).	2010 - 2016	Private sector in partnership with the Tunisian Electricity and Gas	No
2.10	Realization of an integrated solar combined cycle (ISCC) - 10 MW solar / 30 MW gas.	The project involves the creation of a combined CSP plant of 40 MW (30 MW gas and 10 MW solar) in the resort of El Borma by an Italian-Tunisian petrol company.	2012-2014	Italian-Tunisian petrol company	MoU with Japaneese cooperation for 5 MW
3.1	The implementation of 10 food industry plants using solar cooling	○ Develop concepts for producing cold energy through solar thermal; ○ Realisation 10 pilot projects.	2009-2014	National Agency for Energy Management in partnership with the private sector and research institutions.	No

3.2	One solar dryer as a pilot project	The project is to design and build a prototype solar dryer for fruits and vegetables. used in small farms. The dryer should be simple to use. maintain and must adapt to the climate and region of implantation	2010 - 2012	National Agency for Energy Conservation Partnership with the private sector.	No
3.3	Production of PV panels (14 MW /a)	Manufacture of photovoltaic panels in Tunisia to a minimum annual production capacity of 14 MW.	2010 - 2014	Private sector	No
4.1	Wind farms for self-consumption of cement industry - 60 MW.	Wind park 60 MW	2010 - 2014	Settlements major electricity consumers in partnership with the National Agency for Energy Conservation and the Tunisian Company of Electricity and Gas	Under feasibility
4.2	Construction of a wind farm of 120 MW by STEG in the region of Bizerte	Realization of STEG a wind farm. Spread over two sites and sales Kchabta Metline in the Bizerte region. with a total capacity of 120 MW	2009-2011	Tunisian Company of Electricity and Gas	Implemented
4.3	Construction of a wind farm of 100 MW by the private sector	To encourage investors to generate power by exploiting the wind resource. important that Tunisia has the purpose of export to countries interested in energy from renewable sources.	2012 - 2016	Private sector (PPI) in partnership with the National Agency for Energy Management and the Mediterranean Renewable Energy Center (MEDREC) and the Tunisian Company of Electricity and Gas.	No
5.1	Replacement of 400.000 refrigerators older than 10 years with new ones of class 1 and 2	The goal is to reduce electricity bills for households and to create savings at the national energy balance	2009 - 2016	National Agency for Energy Management (ANME) in partnership with the private sector	Labeling in place and project not yet implemented
5.2	Positive energy building at public	Improving energy efficiency equipment to reduce energy	2010 - 2016	Competitive cluster of El Fejja and	No

	areas for a total area of 15.000 m²	consumption in order to undertake the production of this type of building to a larger scale		Monastir in partnership with the National Agency for Energy Management.	
5.3	Insulating terraced housing: 11 million m² of thermal insulation on house roofs	To improve the standard of thermal comfort inside buildings and reduce household energy bills by reducing energy consumption used for heating and air conditioning	2011 - 2016	National Agency for Energy Conservation in partnership with property developers and individuals	Mechanism under designing
5.4	Promotion and distribution of 5 million Energy Saving Lamps (LBC)	Aiming for a total elimination of the market for incandescent lamps and a reduction in electricity bills for households.	2009 - 2011	National Agency for Energy Conservation and the Tunisian Company of Electricity and Gas	Implemented
5.5	Energy Efficiency in the Industrial Sector	The project is to promote cogeneration and the shares of energy efficiency in industry by establishing an integrated mechanism for financing. assisting manufacturers in the different phases of their projects and building local expertise in this area.	2009 - 2014	National Agency for Energy Conservation in partnership with industry	Implemented
6.1	Training of 3500 trainers in economic driving and they will train 160.000 drivers	The project involves the integration of economic behaviour in terms of learning to drive and driving license tests and retraining of drivers belonging to departments and public enterprises. enterprises of passenger transport and transport companies merchandise.	2010 - 2015	National Agency for Energy Conservation Partnership with the Ministry of Transport and Land Transport Agency Technical	Implemented in a pilot phase
6.2	Promoting ICT for Management and Tracking Fleet Vehicles	The project is encouraging companies to equip their fleets with a means of monitoring and management to analyze the activity and vehicle performance and driver behaviour in real time to detect and engage overconsumption corrective actions to reduce consumption at its normal level.	2009 - 2014	National Agency for Energy Conservation in partnership the Ministry of Transport and Technology Agency of Land Transport	Implemented in a pilot phase

7.1	Electricity generation (14.5 MW) in the recovery of poultry droppings	Establishment of two plants for the production of electricity from biogas with a total capacity of 14.5 MW	2010 - 2012	Private sector partnership with the National Agency for Energy Management	Prefeasibility studies
7.2	Electricity generation (10MW) in the recovery of landfill gas	Perform an installation of 10 MW at the Jebel Chakir landfill. The Jebel Chakir landfill is equipped with a unit of flaring of methane trapped in the discharge resulting from the anaerobic digestion of waste. The project is profitable these gases through energy recovery by producing electricity.	2010 - 2013	The discharge of Jebel Chakir partnership with the National Agency for Energy Conservation	Implemented
7.3	Self-generating electricity (1MW) from the recovery of organic waste	Promote energy recovery from organic waste into biogas to produce electricity.	2010 - 2014	National Agency for Energy Conservation	No
8	Electrical interconnection between Tunisia and Italy	The project is to install a submarine link between Tunisia and Italy with a capacity of 1000 MW in the project ELMED and 100 MW solar.	2010 – 2016	Private sector	Feasibility studies
9.1	Electrification of the oasis of Nafta by renewable energy	The electrification of the city of Nafta by renewable energy technologies and thereby converting it into a city totally independent of other energy sources	2010 - 2016	Local associations in partnership with the Agency for Energy Management	No
9.2	ECO-VILLAGE Zarzis-Djerba	The project involves the implementation of a fleet of renewable energy developments within the region of Zarzis. The park will include several components: research centres. a space for innovative companies. training institutions. a space for experimentation of new	2010 – 2016	Local associations in partnership with the National Agency for Energy Conservation	No

		technologies and an industrial area.			
9.3	Optimization of the development of the station Sousse	Improve the energy performance of the proposed development of the station Sousse through an architectural design consistent with the climate of the site. using different techniques and building materials. energy-efficient use of technical equipment by promoting energy efficient integration of renewable and conventional energy use the most appropriate way.	2010 - 2016	Society for Study and Development of Sousse	No
10.1	International Training Centre of Superior Renewable Energy and Energy Efficiency Technologies and International Laboratory of Solar Energy	The project involves the creation of an international training center for graduates of engineering schools and universities on renewable energy and energy efficiency and the creation of an international center of expertise in the technology field solar energy. The center will be equipped with a laboratory that specializes in solar thermal and solar photovoltaic.	2010 - 2011	Management Company of the Technopole of Borj-Cedria in partnership with the National Agency for Energy Management	Feasibility study
10.2	Photovoltaic power plant pilot in Borj-Cedria (250 KW)	The project consists of a photovoltaic experimental power plant of 250 kilowatts designed to serve as supply of new generation batteries for electricity storage. The goal is to test the performance technologies of storage batteries for electricity and the different technologies of PV production.	2010 - 2012	Management Company of the Technopole of Borj-Cedria in partnership with the National Agency for Energy Management	Under feasibility
10.3	STEG Renewable Energy	The project involves the creation of a society study. implementation. operation and maintenance of renewable energy installations. The goal is to provide expertise and know-how needed to develop the various sectors of renewable energy. the operation and maintenance of its facilities and those belonging to third parties.	2010 - 2011	Tunisian Company of Electricity and Gas in partnership with the private sector	

10.4	Strategic Study of the energy mix for electricity production in Tunisia in 2030	Studying the diversification of primary energy sources for electricity production and the choice of a strategy to meet key requirements of economic growth. security of supply and environmental friendliness	2010 - 2011	National Agency for Energy Conservation and Tunisian Company of Electricity and Gas	Implemented by the support of the German cooperation
10.5	Strategic study on electricity production from solar and wind	The determination of the potential recovery of significant wind and solar resources available to Tunisia for the production of electricity and other applications through various technologies such as photovoltaics. CSP and wind energy for domestic consumption (centralized or dispersed) and export to power up to 2000 MW. This study also covers feasibility studies. training and research.	2010 - 2012	National Agency for Energy Conservation and Tunisian Company of Electricity and Gas	No
10.6	Establishing a management unit of solar plan Tunisia	The management of the TSP will be assigned to a unit that will be implemented within the ANME. The main tasks of this unit include launching and monitoring the various projects of the TSP. coordinate between the various stakeholders. accompany the project sponsors for research funding.	2010 – 2016	National Agency for Energy Management with international cooperation	Implemented by the support of the German cooperation

Part III
Biowaste Treatment

Structure

Methane prevention through sustainable biowaste treatment in Tunisia

3 Summary

Based on a rough draft of bifa environmental institute (bifa) for a NAMA aimed at reducing methane emissions within the waste sector, experts from the most authorative Tunisian institutions related to waste management rated a more sustainable treatment of biowaste to best fit the NAMA principles and the conditions in Tunisia as well.

The rating took part during a workshop organized by the GTZ in Tunis on October 13 2010. In small working groups following the panel session, these experts worked out several essential aspects that can be seen the basis for a NAMA to be later accepted by the observers and negotiators within the international climate change regime and especially by potential donors from the public and the private financial sector as well.

A very important precondition for success of the proposed NAMA is, at least in the eyes of bifa, the conviction that separate treatment of biowaste opens up the door to a more sustainable waste management in the future than it is today. The NAMA should be eligible to fit into the overall concept of the Tunisian Government for the waste sector and so be harmonized with the CDM projects that were started in Tunisia in recent years or are now in the planning phase.

Since all of these CDM projects already target the methane emissions from household waste on landfills the Biowaste NAMA only includes biowaste from sources other than private households, for instance agricultural waste, gross markets' organic waste and sewage sludge. The distinction of the waste streams according to their origin constitutes a challenge not to be underestimated. But differentiation is important to reduce mutual influence on the respective baselines to a very limited extent.

The fundamental NAMA concept as it is being discussed globally gives the NAMA owners the chance not only to link the success of a certain NAMA to its quantitative emission reductions but also to the additional benefits that can be drawn from the realization of the components and their single actions. In the case of the Biowaste NAMA these additional benefits are manifold and of really big public interest as the separate treatment of biowaste reduces a lot of negative effects related to open dumps and disposal of sludge from waste water treatment.

The NAMA gives donors from the public as well as the private sector the opportunity to actively participate in the promoting and realization of an integrated approach for resource management since the NAMA helps close the material-cycle, save primary stockpiles and evolve a new technological branch in Tunisia. Energy and fertilizer from biowaste treatment represent highly valuable goods to be earned by the plants that would have to be build within this NAMA and guarantee the donors attractive possibilities to show their engagement in various regions of Tunisia through physical objects (the plants). This is also true to the accompanying campaigns for awareness building in various social fields and training of skilled personnel for the construction and operation of the plants.

4 Context

4.1 Past and present situation of the country

Tunisia is a country in Northern Africa bordering the north and east by the Mediterranean, the west by Algeria and the south-east by Libya. Tunisia is the easternmost of the Maghreb countries. The largest north-south extent is about 780 km and the largest east-west distance about 380 km. The Mediterranean coastline measures about 1,300 km in length and most of the bigger Tunisian cities border the sea. The growing population (about 1.2 % p.a.) in combination with strong economic growth (6 % in 2007, ~ 3.3 % in 2009) has led over the years to a more intensive use of natural resources. The pollution caused by sewage and waste at many places in Tunisia now reached a serious level. The cost of environmental damage in the country are estimated by the World Bank to be about 2.1% of GDP. The environmental protection is a priority in national policy with protection of drinking water resources and a more environmentally sound waste disposal requiring strong common engagement in politics and society. This makes Tunisia a role model for other countries in the MENA region.

Table 2: Basic data on Tunisia; sources [1], [2], [3]

Area	163,610 km²
Population	10.486 millions (2009)
Share of urban population	around 65 %
Gross domestic product (GDP) per capita	4,107 US$ (2009)
Municipal solid waste (MSW)	2,250,000 t p.a. (2009)
Per capita MSW	220 kg p.a. (ranging from 55 in rural to 300 kg in urban areas)
Emission intensity of the electricity mix	0.627 Kg CO_2/kWh

In planning of projects that include a treatment of organic waste the large climatic differences in Tunisia have to be taken into account. There is a clash of mediterranean and arid climate. Precipitation declines slightly from the north to the south and from the west to the east. With increasing distance from the Mediterranean its balancing influence gives way to a continental climate. The average temperatures are in January at 10 ° C and in August at 26 ° C (Tunis). South of the Atlas there prevails year-round hot dry desert climate with very irregular rainfall. The temperatures here reach maximum values up to 45 °C. Rain falls almost exclusively in the winter months. In summer there may, in exceptional cases be heavy rains, too. While in the north the annual precipitation is 500-1,000 mm in coastal areas and 1,500 mm in the mountains, in the South the evaporation is higher than the irregular rainfall of 200 mm per year at best.

Table 3: Climatic data at selected places

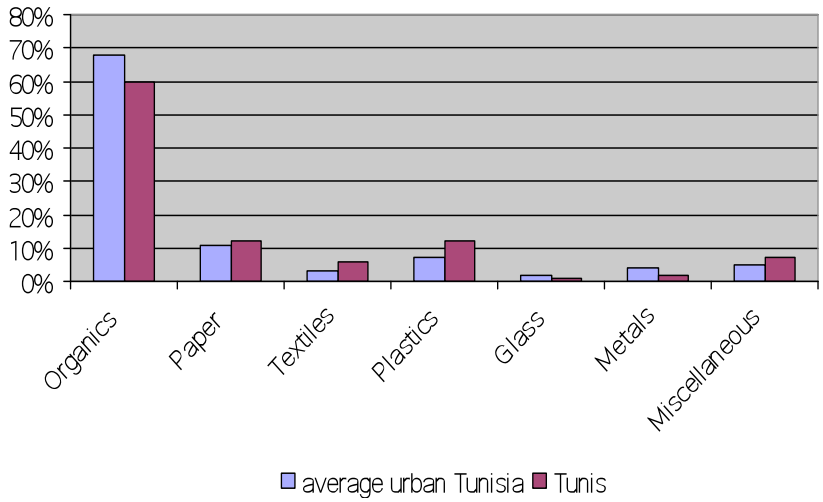
Place	Annual precipitation in mm / a	Average annual temperature in °C
Tunis	467	18,3
Gafsa	183	18,8

2.2 Past and present situation of the relevant sector/sub-sector

2.2.1 General description of the (sub-)sector

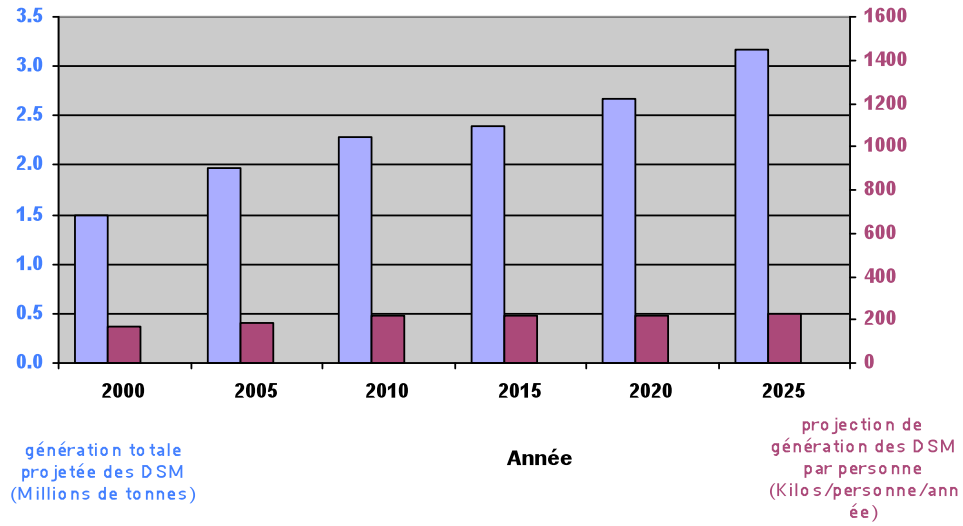
Biowaste considered in this NAMA is one important waste stream within the total waste volume of Tunisia. One big segment of this volume is called municipal solid waste (MSW). MSW made up about 2.25 millions of tons in 2009 and originated from households and commercial sites. The composition of MSW in Tunisia is shown in Figure 6.

Figure 6: Composition of municipal solid waste in Tunisa; source: bifa



Within a decade from now the amount of MSW from households and commercial sites is expected to reach around 3.5 million tons per year (Figure 7). This would mean an increase of more than 1 million tons within ten years causing a heavy burden for public authorities responsible for managing the landfills. But there are alternatives that lie beyond these methane spitting mountains of garbage and that have proven very effective in other places of the world: recycling and recovery.

Figure 7: Expected quantitative development of MSW in Tunisia; source: [2]



PRONAGDES (1995 to 2006) was the first strategic framework for waste management adopted by the Tunisian Government and it paved the way for a more environmentally sound waste management in country. With the experience and achievements made in its eleven year lifetime it was enriched by more ambitious elements in the field of recovery and recycling and in the promotion of an information system, better control costs and extended support to communities. Renamed as PRONGIDD and covering the period 2007-2016 it now includes monitoring as well as control achievements through a set of indicators and targets. Several quite important targets are presented in the table below.

Table 4: 2016 targets of PRONGIDD; source: [3]

Action	Target
Reduced source exploitation by changing consumption patterns	-20 %
Improving composting rate	+15 %
Improving recycling of household waste	+ 20 %
Landfilling of final waste not recoverable	98 %
Coverage of municipalities with transfer stations and landfills	100 %
Promoting private sector participation in collection/infrastructure investments	30 %
Promoting degassing of landfills under the CDM	100 %
Closure of wild dumps	70 %
Treatment of industrial waste and special	70 %

Responsibilities

Tunisia's top environmental agency, the Agence de l'Environnement (ANPE) is responsible for environmental impact assessments and controls. Moreover, it is in charge of the financial support under the Fonds de Dépollution Industrielle (FODEP) that pools and allocates investment capital to projects that intent to reduce environmental pollution.

A very important authority in the waste management field is the Agence Nationale de Gestion des Déchets (ANGED). It emerged in 2006 from the ANPE and is directly subordinate to the Ministry of Environment. It is responsible for actions of the recovery, treatment and proper disposal of waste as well as for implementation and monitoring of disposal and recycling activities. This authority is decentralized and has branches in different regions of Tunisia to carry out its monitoring function in the regions. ANGED is also responsible for the construction of facilities for waste treatment. The operation itself is in the hand private companies but ownership of the plant remains at the ANGED.

Locally, there have been committees established with representatives of the government, local authorities and the Ministry of Environment to support the ANGED at the regional level in the monitoring of operations. These committees are named Comité régional de suivi.

For the collection and transportation of waste the municipalities are responsible. The municipalities can get low-interest loans from the Caisse de prêt (CSPCL) that under the plan Communal d'investissement (PIC) finances the proper equipment for the garbage collection. The CSPCL is supported by AFD and the EIB with a credit line. With PRONGIDD the Tunisian Government also intends to increase the share of private sector participation in collection and transport from the current 10% to 20% by the end of 2011.

The peculiarities of biowaste in Tunisia

Biowaste consists of different kinds of organic waste. The environmentally sound treatment of this waste stream is becoming more and more an important issue in Tunisia as its recovery and development can not only help reduce greenhouse gas emissions but also bring along other environmental advantages, create jobs and promote new technologies. In other words, biowaste now constitutes a major challenge to waste management but bears a lot of chances to ecology and economy, too. The separate treatment of this category of waste has evolved rapidly especially in some countries in Western Europe. The recovery of such wastes should be acknowledged now as something that is pretty worth to be promoted in Tunisia through new market mechanisms being discussed within UNFCCC.

When it comes to the concrete waste streams that could play a role in a “waste related” NAMA a cross-sectoral stakeholder workshop organized by the GTZ in Tunis on 13 October 2010 brought up the finding that concerted and well-coordinated action in the field of special kinds of biowaste might be a promising and really national ‘appropriate’ action to mitigate GHG emissions within a NAMA approach. Even when there are several options for treatment of biowaste composting and anaerobic digestion are the ones that have proven both to be appropriate for diverse kinds of biowaste and robust in terms of their organic degradation processes and technical procedures as well.

Composting

Composting allows a considerable reduction of the quantity of biodegradable wastes in the landfills and thus of the CH_4 emissions. The development of composting stations for organic waste requires, before hand, the set up of appropriate collection processes at the points of the waste generation. It also requires the development of a market for compost

that is close to the composting stations so as to ensure the financial viability of the composting facilities.

The potential for composting in Tunisia is currently hardly exhausted. There are, despite the organic content of at least 60 %, only about 0.1 % of household wastes composted. For the small amount of compost from organic waste, at present, there is no marketing strategy.

In the town of Beja a composting facility was built in 1992 with financing from KfW and GTZ. It is operated by ANPE and has an annual capacity of 2,000 tons. This plant shows, according to experts, that it is possible in Tunisia to produce a compost product that can be of high value. At present GTZ waste experts estimate that there were around 10 composting plants located in Tunisia, all of them of very poor performance. Mainly for cost reasons composting has not been spread widely over Tunisia.

Anaerobic digestion (production of biogas)

The valorization of CH_4 as the main component in the biogas produced from organic matter is a well-known technique applied in more and more parts of the world. The biogas can be used in engines to produce electricity from. The electricity can then be used for the facilities' own use, but most of it would be fed in the electric network.

The digestion of organic waste to produce electricity is has not been promoted in the recent years while Tunisia has in former times been a forerunner in this field. The first biogas plant in Tunisia was built in 1983 at the sugar production complex Ben Bechir. At present there is a rehabilitation program running to reopen the biogas plant. There are reports about 8 more biogas plants in Tunisia with one of them having been built at the wholesale market in Tunis. This plant is planned to take up the biowaste from all the markets in Tunis as well as from other markets in the surroundings of Tunis city.

2.2.2 Emissions and reduction potentials

2.2.2.1 National Communication to UNFCCC

Following the National Communication to UNFCCC waste and waste water made up around 3.6 % of Tunisia's GHG emissions in 1994. The table below illustrates how the Tunisian Government in 2001 considered the national GHG emissions to develop by the year 2020.

Table 5: Anticipated GHG emissions according to Tunisia's mitigation scenario (in 1,000 t CO_2e); source: National Cmmunication by the Republic of Tunisia (2001)

Sector	1997	2010	2020
Energy	17,010	24,245	36,151
Industrial Processes	3,265	7,409	12,068
Agriculture	6,440	7,522	6,913
LUC & Forest	-2,744	-8,321 -	-16,864
Forest-emissions	3,952	3,523	3,043
Forest-absorptions	-6,696	-11,844	-19,907
Waste*	**1,182**	**3,107**	**3,178**
TOTAL gross emissions	31,849	45,806	61,353
TOTAL net emissions	25,153	33,962	41,446

*) number includes all kinds of solid waste and waste water

2.2.2.2 Specific emission reductions of different options of biowaste treatment

Based on the relevant parameters of the Tunisian MSW management and on behalf of the German Federal Ministry for the Environment bifa in 2009 accomplished an ecobalance for different waste management practices. The results are shown below. Even though these scenarios do contain neither a mere composting nor a any biogas scenario the figure gives an indication that in Tunisia the use of compost as well as electric energy from biogas plants would lead to a net relief of GHG emissions because of the avoided use of primary fossil fuels. Moreover the calculation models are based on the input of 1 ton of MSW that contains also materials other than organics.

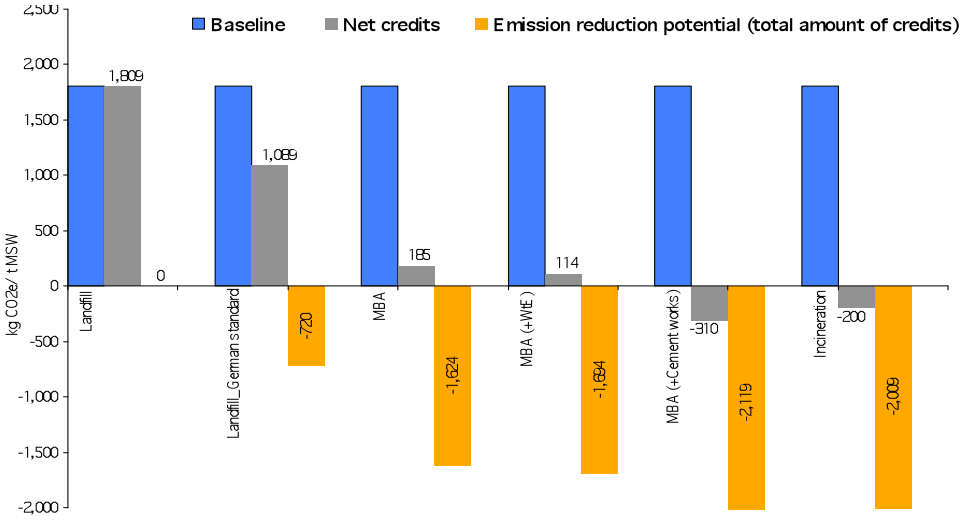


Figure 8: Specific emission reductions of different options of biowaste treatment; source: bifa 2009

2.2.2.3 Schematic emission scenario based on application of current and future support by financial and other means

The figure below illustrates how the situation in Tunisia concerning the emissions in the waste sector might be going to develop in the up-coming years. The figure takes into account that there are several landfill projects that will lead to reduction of emissions from MSW from private households. These landfill projects are either financed through grants from financial institutions such as the KfW or others or by selling the emerging CERs to contracting partners of Tunisia like for example the World Bank.

One can imagine that the entire Biowaste NAMA could be divided into a unilateral one (so as to continue national policies and measure) as well as a directly supported one.

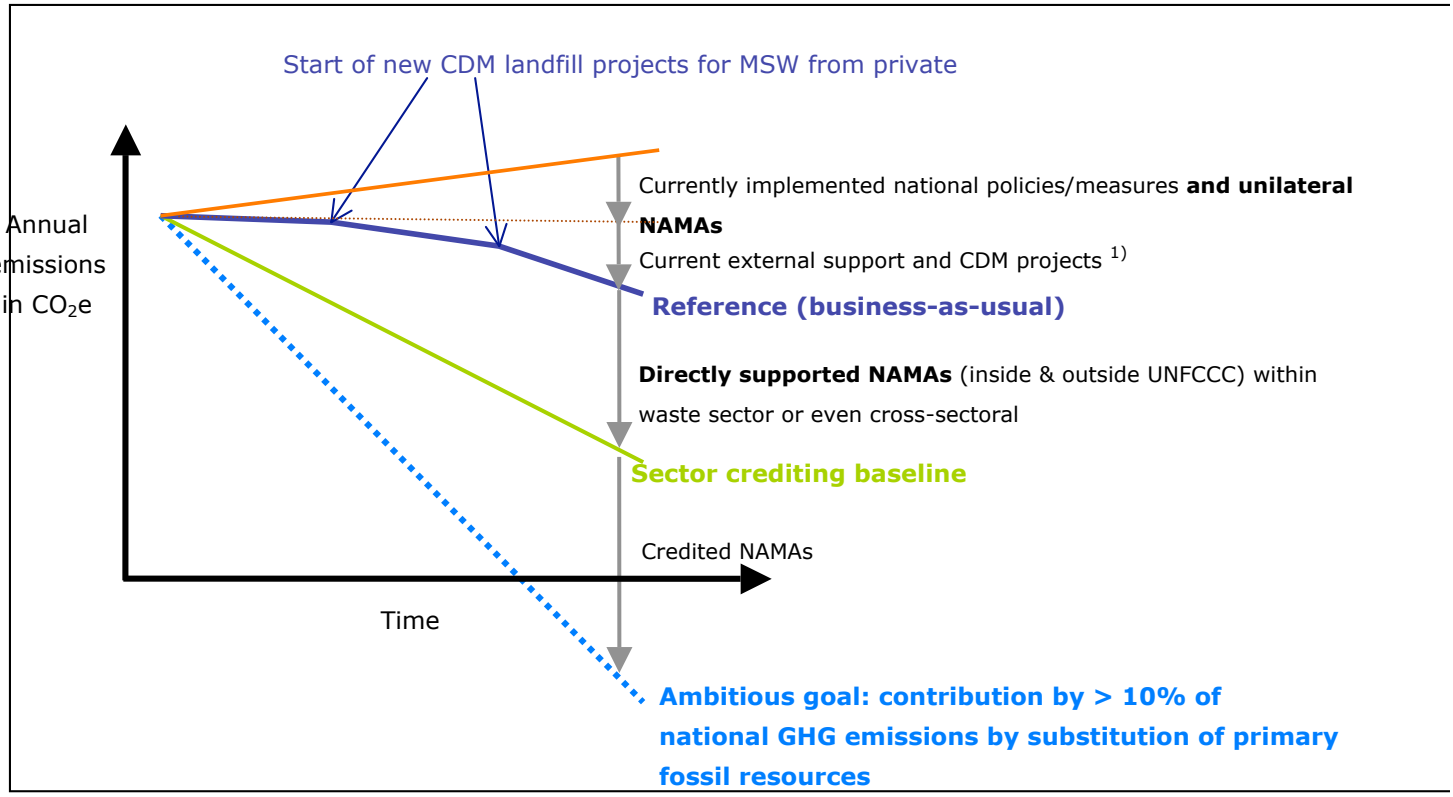


Figure 9: Schematic emissions scenario for the waste sector; source: based on ecofys, OECD, modified by bifa

1) For example Djebel Chekir Landfill: The annual average of estimated reductions over the crediting period (2006-2016) is 369,664 tons of CO_2e according to the PDD *Djebel Chekir Landfill Gas Recovery and Flaring Project – Tunisia*. The efficiency rate (representing „methane collection/destruction efficiency) was estimated 70 % [15].

Principles to be considered in calculation emission reductions

Regarding the data issue, CH_4 calculations should be made using IPPC methodology and IPCC Good Practice Guidance. These methodological tools are recommended by the Conference of Parties as they represent internationally accepted calculation models on landfills's emissions for the time being. The calculations should fully apply the

recommendations to use national data in priority, and if not available, to use default factors recommended by IPCC. To the best possible extent, specific data for Tunisia should be utilized. In fact, although acknowledging the uncertainties associated with these data, they better reflect Tunisian circumstances. On the other hand, conservative assumptions should be made to estimate emissions and emission reductions, where necessary.

2.2.3 Analysis of barriers

There are diverse factors that can be seen as barriers to the diffusion of the idea of separate biowaste treatment in Tunisia. These factors are as diverse as:

- Inadequate knowledge about biowaste streams and real potential for special treatment
    - For instance, there appears to be a big gap between the theoretical and real potential of agricultural biowaste since farmers are used to scatter it directly on fields.
- Insufficient capital for investment
- Low level of knowledge about capability of treatment processes such as composting and anaerobic digestion in terms of mitigation of greenhouse gas emissions
- Remuneration for electricity (from biogas) fed into the grid doesn't play-off the cost (At present there is a feed-in-tariff system missing.)
- Often, there are no techniques available that suit the actual demand in Tunisia; offered solutions from abroad are often too complex and maintenance and service are not available locally.
- The collecting activities are only selectively and not covering larger regions so that the amount of collected biowaste is often too less for operation of a plant.
- Lack of systematic marketing strategy for high-quality compost; at the time being there is no label that could promote compost of high quality.

2.2.4 Relevant political and institutional framework

A NAMA has to fit into the political and institutional framework of Tunisia. For instance, it would at least slow down the NAMA implementation if there was a political measure that made separate biowaste treatment nearly impossible or constituted relevant obstacles to the operation of treatment plants. Therefore Table 6the table in this section lists and describes legislation on national or sub-national level, other, non regulatory measures and programs which are in place that are of interest to the development of the Biowaste NAMA.

Regulation/Policy/Measure	Entry into force/duration	Responsible government entity	Related domestic financing (US$)	Related external[1] financial contribution		Brief summary of status/evaluation
				US$	Source	
PRONGIDD (Programme National de Gestion Intégrée et Durable des Déchets)	2007	MEDD, ANGED				The aim of PRONGIDD is that not only the technical aspects (construction of landfills), but also the necessary institutional and financial conditions for a sustainable operation of waste management be considered. Emphasis is placed on the financing, optimization of collection and transport, recycling, private sector involvement and cooperation between communities.
Loi n° 96-41 du 10 juin 1996 relative aux déchets et au contrôle de leur gestion et de leur élimination + Décrets d'application	1996	MEDD, ANGED				Defines in a concise form the principles of a national waste management. According to this law, the responsibility for waste management is shared between municipalities and the ministry of the environment and sustainable development. The guiding principles of the law are: - Waste prevention and reduction at source; - waste treatment if the forms of waste recycling and energy recovery;

[1] Only if applicable, i.e. if there exists approved external funding for the measure or funding approval is pending. Please mention all non-domestic sources (bilateral and multilateral aid, etc.)

Regulation/Policy/Measure	Entry into force/duration	Responsible government entity	Related domestic financing (US$)	Related external[1] financial contribution US$	Source	Brief summary of status/evaluation
						- indisposing at landfills after exhausting all recovery potentials. The law introduced: • the polluter pays principle; • the principle of product stewardship (responsibility of the producers, traders and transporters) and it contains 30 specific regulations.
Le décret 2005 – 2317 du 22 aout 2005 portant création de l'ANGED	2005	State Government				Established the ANGED and entrusted the task of the national management of waste through the development and implementation of plans, programs and projects related to waste management generally
Plan communal de gestion des déchets (PCGD)	?	Municipalities				Communities have to set up plans for municipal solid waste management.
Loi organique des communes n° 95-68	1995	Municipalities				Confers in article 129 the responsibility for the "collection, separate collection, treatment, transportation and disposal of waste in landfills" to the municipalities. Article 101 gives municipalities the opportunity to group and confers this implementation responsibility to a neighboring municipality or to a administrative union.
Law No. 30	1999	State Government				The "birth" of birth of organic agriculture in Tunisia.

Regulation/Policy/Measure	Entry into force/duration	Responsible government entity	Related domestic financing (US$)	Related external[1] financial contribution		Brief summary of status/evaluation
				US$	Source	
						Under the provisions of this Act, a series of incentives and support has been implemented in order to promote the sector while taking into account its specificity. Following these measures, the organic farming sector in Tunisia has experienced a relatively large development. Thus, the number of producers in the sector increased from 141 in 1999 to 580 in 2004, and organic areas have more than quadrupled between 1999 (15,036 ha) and 2004 (87,000 ha).
??						
??						

5 Details

5.1 General description of the proposal

To identify streams of biowaste that could fit into a *Biowaste NAMA* experts of the ANGED (National Waste Authority) as well as of a supporting program of the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) were asked to provide information and data.

Since there have been concrete plans and strategies adopted how to deal with organic waste contained in the MSW from private households this waste stream is not considered within this NAMA proposal. But there are other important streams of biowaste for which no sustainable treatment or recovery is in sight and which are disposed at landfills and wild dumps at present.

Table 6: Waste streams in the scope of the NAMA proposal; source: [5]

Types of Waste	Waste subtype	Quantity (tons per year)
Communal biowaste[2]	Residuals from vegetables, fruits and other foodstuffs based on private markets and whole sale areas	17,500
	Residuals from public parks (leafs, grass and wooden material)	31,500
Agroindustry / food processing	Canning plants for vegetables and fruits	39,500
	Residuals from oilmills	2,090,000
	Residuals from wineries (mainly marc)	10,557
	Residuals from slaughter-houses including poultry slaughterhouses	29,250 + 47,580 76,830
Waste from hotels and restaurants	Waste from food preparation	68,600
Organic waste and by-products from agricultural production	Crop remains	4,426,760
	Manure from animal production	2,246,837
	Poultry manure	606,000
Residuals from wood processing	sawdust and shavings	64,500
Waste water treatment plants	Sewage sludge from waste water	175,000 (solid mass)

[2] The wording „Communal" is used to avoid confusion with the "municipal" solid waste which is the total amount with communal biowaste being only one fraction of it.

5.1.1 Communal biowaste

About 80 percent of municipal biowaste stems from governmental whole sale areas in the bigger cities of the country. Hot spot is the Council of Tunis where almost 6,000 t municipal biowaste is produced per year.

It is estimated that there are about 3 t residuals per hectare of public parks. Taking into account the approximately 10,000 ha of park areas in Tunisia, there are about 31,500 t/a of park residuals (wood, grass) in total. Main area in this field is the Council of Tunis, where about 10,000 t residuals from public parks are generated every year. The total quantity of municipal biowaste and residuals from public parks is expected to increase from 49,000 t/a in 2009 to 55,000 t/a in 2020. At present the communal biowaste is mainly being disposed at landfills and open dumps. A smaller part is composted.

5.1.2 Agroindustry and food processing

The largest segments in which biowaste emerges in Tunisia are:

- Grain-processing (18%) with 1.5 millions of tons as straw
- Slaugthering (22%)
- Oilmills: 15%

Because of bumper crops, agricultural GDP in the first 9 months of 2009 grew by 6% compared to the same period in 2008 In particular, the wheat crops have been good. The Tunisian press reported the second highest harvest in the last ten years. It is said that not only the good seasonal conditions might have contributed to the high yields, but also the promotion of the sector by provision of low-interest loans through the Agricultural Bank of Tunisia, a price guarantee and other measures.

In the following sections the biowaste that emerges in this sector is presented more in detail.

5.1.2.1 Canning plants for vegetables and fruits

The canning of vegetables and fruits is an important branch in Tunisia. The most important fruit is the tomato, which represents around 90 percent of the canning activities. The production accounts for 8,000 up to 11,000 tons per year. The quantity of organic wastes is estimated 39,500 tons per Year. Most of the organic-production waste appears in the regions of Nabeul, Tunis and Béja.

5.1.2.2 Residuals from oil mills

Beside the liquid residuals which are separated from the pressed oil, there occurs an amount of about 650,000 t/a marc and about 120,000 up to 170,000 t/a of production sludge (In the production of olive oil an amount of 0,458 t marc by pressing 1 t olives arises). At present it is reported that sludge is dried in huge basins and composted or disposed at landfills. Moreover there is an amount of some 70,000 t of leafs from olive trees per year which are used for animal feed or raw material for composting. About 1600 mills are located throughout the country producing the annual quantities of vegetable (liquid by-product) ranging from 600,000 to 1,200,000 tons per year depending on the season with nearly 60 % of the total amount being concentrated in the Sahel region of Tunisia.

The total quantity of organic waste from oil production is estimated to be about 2.09 millions tons a year.

5.1.2.3 Residuals from wineries

The production of wine was growing up the last years. The marc, the main residual in terms of quantity, appears with an amount of 10,557 t/a. Marc at present is mainly used for composting purpose, partly as animal feed or burning material.

5.1.2.4 Residuals from slaughter-houses including poultry slaughterhouses

In Tunisia there is an amount of about 29,250 t /a of solid waste from slaughterhouses and an additional amount of about 47,580 t/a waste from poultry slaughterhouses.

5.1.2.5 Waste from hotels and restaurants

Organic wastes from catering locations, especially oils and fats from food preparation exist in an amount of 68,600 t/a. These sorts of waste accrue at hotels, restaurants or canteens in hospitals, schools or universities.

5.1.2.6 Residuals from wood processing

There is a lot amount of wooden residuals in the chain of processing and production of wooden materials and furniture production. The annual amount of wooden waste is estimated some 64,500 tons per year.

5.1.2.7 Manure from animal production

Solid manure is often used directly as fertilizer, partly used for input in digestion plants. Manure generally is very important for fertilize soils and input mould. The total production is 2,246,837 t/a.

Poultry manure.

- 400,000 t/a liquid manure
- 206,000 t/a solid manure

5.1.2.8 Crop remains

Totally 4,426,760 t/a

5.1.2.9 Waste Water and Sewage sludge

In the year 2007 there was a volume of about 260 millions of m^3 of waste water reported for whole Tunisia with about 225 millions of m^3 that were treated in wastewater plants. After dewatering the sludge naturally (sun drying) or by means of mechanical support there remained an outcome of 175,000 t/a of solid mass. It is expected that this mass will rise up to 300,000 t in the year 2020.

Sewage sludge is used as fertilizer in cropping, is given added to co-composting-processes or is digested in the fermenters of wastewater treatment plants. In newer times the digestion of sewage sludge is coming up because of the possibility to produce biogas for energetical use.

The highest amounts of sewage sludge will occur in the bigger cities along the coast-line of Tunisia, namely Tunis, Nabeul, Sousse and Bizerte.

5.2 Treatment of organic waste streams

In chapter 5.1 biowaste streams being suitable for biological treatment in Tunisia have been presented including quantitative numbers. The next table represents a proposal how the waste streams could be allocated to either aerobic (composting) or anaerobic (fermentation) treatment according to technical considerations by bifa. Generally there are three adequate technical-biological treatments for organic-wastes: aerobic treatment (composting), anaerobic treatment (digestion) or a combination of digestion and composting. There are different types of digestion and composting processes available. For example, the wet and dry digestion or when it comes to composting the out door or inhouse composting.

Table 7: Waste streams and appropriate actions

Types of Waste	Waste subtype	Composting	Anaerobic digestion
Communal biowaste[3]	Residuals from vegetables, fruits and other foodstuffs based on private markets and whole sale areas	X	X
	Residuals from public parks (leafs, grass and wooden material)	X	
Agroindustry / food processing	Canning plants for vegetables and fruits	X	X
	Residuals from oilmills		X
	Residuals from wineries (mainly marc)	X	X
	Residuals from slaughter-houses including poultry slaughterhouses		X
Waste from hotels and restaurants	Waste from food preparation		X
Organic waste and by-products from agricultural production	Crop remains		X
	Manure from animal production	X (dry)	X (wet)
	Poultry manure	X (dry)	X (wet)
Residuals from wood processing	sawdust and shavings	X	
Waste water treatment plants	Sewage sludge from waste water		X

"X": Suitability of the subtype to composting / anaerobic digestion is given

[3] The wording „*Communal* waste" is used to avoid confusion with "*Municipal* solid waste (MSW)".

Recommendations with respect of allocating the waste streams the best:

- If any kind of biowaste should be allocated better to a composting or a anaerobic digestion plant depends on the characteristics of the organic waste (humidity, presence of high molecular weight organic substances like carbohydrates, fats and proteins that could be divided by exo-enzymes in low-molecular dimers and monomers).
- Liquid waste with little parts of wooden materials should better be digested.
- Digestion process should be preferred in case there is need of electrical and – even more – thermal energy (e.g. at canning plants)
- In case there is free capacity, organic waste should be added to the digestion process in wastewater treatment plants.
- Consider the energy content of each of the biowaste subtypes when thinking of energetic use:

  The quality and quantity of biogas produced per ton of waste depends on its composition as the following examples show:
  - Fat: 900 m³ biogas per ton
  - Food waste: about 265 m³ biogas per ton
  - household waste (50% organic): 70 to 150 m³ biogas per ton

  Note: Methane content is 55 % on average.

5.3 Components

Core part of the Biowaste NAMA is the assembly of measures which in their entirety should lead to reduced emissions from the degradation of biowaste in landfills. These measures are called “components” in the Ecofys’ NAMA logic. Beside the realization of technical components there might also be diverse accompanying “soft” measures such as training and awareness building being important so as to create an environment in which the technique can fulfill the expectations.

Component	Action(s)	Phase	Responsible government institution(s)
Study to detect cost-efficient measures for emission reductions in the field of biowaste with analyses under which conditions the different measures (composting, anaerobic digestion or combinations of both) are the most cost-efficient ones in the different regions of Tunisia	• Determine the scope of such a study (e.g. statistical data, …) • Preparation of tender for the development of a study • Tendering of the project • Development of study by the contractor • Evaluation of study results	2011	ANGED (and other relevant bodies)
Scientific research on degradation processes for different kinds of waste composition	• Elaborate a coordinated research program that addresses all relevant issues • Invite international science community to integrate into the research program and promote exchange of knowledge and experiences with other countries.	2011	ANGED (and other relevant bodies)
Development of a detailed and well-coordinated national concept on biowaste treatment	• Start a well-designed stakeholder process • Allocation of waste streams to a preferred treatment option from a technical point of view • Check feasibility from an environmental and social point of view • Review current legislative framework and the need for improvement • Develop regulations • Elaborate and evaluate scenarios for the organisation of the collection of different	2012-2013	ANGED (and other relevant bodies)

Component	Action(s)	Phase	Responsible government institution(s)
	biowaste streams • Set up financial plans		
Review (or study) on feed-in of electricity :	• Determine the scope of such a study (e.g. technical and/or organisational barriers to the feed-in, net capacity, etc.) • Preparation of tender for the development of a study • Tendering of the study • Development of study by the contractor • Evaluation of study result with important stakeholders	2012	MEDD together with Ministry of Industry and Technology and Energy Agency (Agence Nationale pour la Maîtrise de l'Energie (ANME); (and other relevant bodies)
Construction of composting and anaerobic digestion plants	• Identify appropriate locations • Start stakeholder process and environmental impact assessment • Initiate tenders and approve eligible bids for o BOT models (Build, Operate, Transfer) o Commission and finance construction by municipalities and operation by private o Fully in public hand • Elaborate logistics for collection • Develop infrastructure for use of residual heat and electricity from anaerobic digestion plants	2013-2016	Municipalities
Awareness Building	Identify relevant multiplicators, e.g. o Primary and Secondary Schools o Environmental NGOs o Scouts Clubs o The Union of Tunisian Women o The neighbourhood committees across	2013-2016	MEDD, ANGED (and other relevant bodies)

Component	Action(s)	Phase	Responsible government institution(s)
	municipalities		
Capacity building and training	• Strengthen capabilities at the ANGED so that it can fully assume and fulfil its duties • Create an environment of expertise to assist ANGED in developing various national plans and programs • Set up special training programs for specific target groups such as: o farmers o food industry o slaughterhouses	2012-2016	ANGED (and other relevant bodies)
Norming and standardization	• Review norms and standards • Adapt existing norms and standards to changed conditions • Adopt new norms and standards	2013-2016	MEDD and Ministry of Industry and Technology as well as concerned non-state organisations

5.4 Detailed action(s)

Elaboration of detailed steps for realising the suggested actions must be subject to decisions of a governmental body that will be responsible for the NAMA after having a principle agreement on this proposal.

One **example** regarding realisation of composting plants:

From an emissions related point it is recommended to enclose composting plants from an annual capacity of 20,000 t upwards to avoid relevant leakage emissions.

5.5 Objective and MRVable indicators

The table below shows indicators against which implementation can be assessed for each component. The indicators should follow the SMART logic, i.e. should be as far as possible: specific, measurable, attributable, realistic and timely. Wherever possible assumptions are expressed that were made for achieving the outcomes and the risks involved that could threaten the success of the proposed measures.

Component	Phase	MRVable outcome/output indicator	Assumptions and risks
Study to detect cost-efficient measures for emission reductions in the field of biowaste with analyses under which conditions the different measures (composting, anaerobic digestion or combinations of both) are the most cost-efficient ones	2011	• Study commissioned: yes/no • Study finalised: yes/no	Assumptions: The description in the pre-study "Options stratégiques pour la promotion de la Valorisation des Déchets Organiques VDO en Tunisie" published by GTZ is accepted by the Tunisian Government as a farsighted and very informative basis so that now the details can be elaborated. Risks: Results of the GTZ study are not accepted.
Scientific research on degradation processes for different variants of waste composition	2011	• Research program set up with international exchange of knowledge and best practices: yes/no • Research program started: yes/no • Proportion of issues addressed by the research program: o e.g.: humus reproduction efficiency of organic carbon differs between in different organic fertilizers. o other important issues	Assumptions: There has not been an extensive research program on the diverse organic compositions that can be found in the biowaste. Risks: Research is hindered due to missing laboratories or specific equipment.
Development of a detailed and well-coordinated national concept on biowaste treatment	2012-2013	• Consent on promotion of biowaste strategy is reached within the Tunisian Government • Appropriate locations for future plants are identified and stakeholder process has been started • Appropriate technology (wet vs. dry digestion) is elected for every biowaste stream that is to be digested • Monitoring program for leakage emissions from composting	Assumptions: There is a common understanding prevailing that current disposal practices should be changed. Risks: o The tasks (components) of phase 2011

Component	Phase	MRVable outcome/output indicator	Assumptions and risks
		and anaerobic digestion has been developed: yes/no • Activity areas of public respectively private organisation are in alignment with the Government's and sectoral strategies: yes/no	are not finalised on time. o There is only weak acceptance for changes within the population.
Review (or study) on feed-in of electricity	2012	• Study commissioned: yes/no • Study finalised: yes/no • Results communicated throughout the state ministries and agencies: yes/no	Assumptions: Energy agency does have the interest to use energy from biogas plants. Risks: -
Construction and operation of composting and anaerobic digestion plants	2013-2016	• Appropriate locations identified: yes/no • Stakeholder process and environmental impact assessment done: yes/no • Tenders initiated and eligible bids approved; yes/no • Logistical system for collection elaborated: yes/no • Procedures for improvement of infrastructure for use of residual heat and electricity from anaerobic digestion plants initiated: yes/no	Assumptions: The construction works have been well prepared in the years before 2012. Risks: o Companies having won the tenders can't fulfil their promises or don't have sufficient capabilities or qualifications. o Operation cost can not fully be covered by selling energy and natural fertilizer.
Awareness Building	2013-2016	• Relevant multiplicators identified: yes/no • Specific communication campaigns developed: rate of multiplicators affected by campaigns	Assumptions: It is necessary to find organizations and people that transport the ideas behind the biowaste concept. Risks: The identified multiplicators show only less interest in supporting the concept.

Component	Phase	MRVable outcome/output indicator	Assumptions and risks
Capacity building and training	2012-2016	• Numbers of eco-experts being qualified	Assumptions: The qualifications needed to operate biowaste treatment plants and keep degradation processes stable are not available in Tunisia at present to a sufficient degree. Risks: Only a few suitable experts are available or show their interest in being trained in biowaste treatment.
Norming and standardization	2013-2016	• Review process started: Study commissioned: yes/no • Coverage of issues to be addressed by norms and standards (degree of coverage)	Assumptions: The fundamentals for developing and applying norms and other standards are well known and accepted throughout Tunisia. Risks: The contrast between different ideas and interests is quite big so as preventing the adoption on time.

5.6 Benefits

5.6.1 Estimated emission reductions

Estimated emissions through composting and anaerobic digestion

The order of magnitude of emissions reduction from methane prevention doesn't differ between composting and anaerobic digestion of any biowaste. This part of emission reductions drawn from the baseline "Disposal at landfills" outweighs the reductions by substitution of fossil fuels through the utilization of fertilizer or electric power to lengths. For a rough prognosis bifa sees both the composting and the anaerobic digestion to be about equal.

Therefore the amount of emission reductions possible through a holistic approach in biowaste treatment by composting and anaerobic digestion is estimated by bifa for Tunisia between

550,000 and 800,000 tons CO_2e per year.

The estimated range of emission reductions is based on the following assumptions:

1. Mass of biowaste of the origins listed in Table 7 that is recommended and seen realizable for separate treatment: 2,000,000 t per year
2. Share of biowaste under assumption 1 that is scattered in the landscape (especially agricultural waste) and therefore doesn't cause methane in landfills or other accumulations of waste : 80 %
3. The parameters used by bifa in its 2009 eco-balance of different waste treatment options for MSW in Tunisia (corrected for 100 % organic content in biowaste instead the 68 % for MSW used in the eco-balance)
4. Only small traces of methane are emitted by leaky installations.

A more precise prognosis seems not to be possible because of several uncertainties. These **uncertainties** are due to:

- Baseline for the biowaste affected by the NAMA
    - Diversion of biowaste from landfills might cause changes to the methane production within the landfills over time → adaption of baseline needed in later years
    - Existing and planned CDM projects (degasification, gas burning) might influence the baseline scenario.
- Insufficient knowledge about the exact amount of biowaste on the different categories and on the proportion that could be acquired for separate treatment in special facilities.
- Exact composition of the biowaste
    - A high share of structural material improves compost quality but reduces the amount of biogas that could be obtained from the same material.
    - E.g.: Green matter, like grass clipping, is high in nitrogen and could improve compost quality.
    - Humus reproduction efficiency of organic carbon differs between in different organic fertilizers.
- Behavior of the different biowaste categories in terms of degradation in the Tunisian climate and in combination with each other.

- Non GHG credits because of substitution of artificial fertilizer (A carbon footprint of artificial fertilizer is recommended.)
- Power consumption of the facilities (composting and fermentation plants): An emission factor for electricity in Tunisia 0.627 tCO_2e/MWh is usually assumed in CDM projects like Djebel Chekir, taking into consideration that the electricity generation is mainly based on natural gas in Tunisia.

5.6.2 Other benefits

Beside its contribution to reduction of GHG emissions, this NAMA intends to help foster and accelerate the sustainable development of Tunisia. There are both short- and long-term benefits that could be achieved through the measures suggested within this NAMA. The most important addtitional benefits can be drawn from **Table** 8.

Table 8: Benefits of the Biowaste NAMA that go beyond emission reductions

Benefit	Description
Landfill capacities	The capacities of the landfills could be extended since less biowaste would be landfilled.
Production of valuable fertilizer from compost	Compost is an organic fertilizer and mulch. Production of high quality compost could contribute to a strategy of the Tunisian government to promote organic agriculture. Organic agriculture is a production method that draws its originality from the use of farming practices and livestock committed to respecting the natural balance. This method excludes the use of pesticides and chemical fertilizers. It can produce high quality food, foster working in accordance with natural ecosystems, maintain and improve soil fertility and prevent pollution. In Tunisia, organic farming is relatively young. Its development was driven by strong growth in international demand particularly for olive oil. In order to take advantage of new opportunities in the international market for organic products (especially olive oil) and enhance the benefits of Tunisia in this area (climate, early production, competitive prices, proximity to European markets) the Tunisian government has paid special attention to the development of organic agriculture and its supply chain organization.
Health benefits and human safety	Typical problems of landfills are avoided, especially: o Undesirable odour especially for the human establishments surrounding the landfill area. o Safety and health risks to landfill staff due to generation of methane concentration above safe limits as well as explosions and fires at the landfill site. o A very small percentage of volatile organic compounds (VOCs) is usually also found in landfill gas contributing to undesirable odour. VOCs emissions are photochemically reactive and result in the formation of tropospheric ozone. The latter might cause adverse effects to the respiratory system such as breathing difficulty and aggravated Asthma, and damages to crops and plants. VOCs are also known for their toxicity and carcinogenic effect from chronic exposure. However, since

Benefit	Description
	volatilorganic compounds comprise very small percentage of the landfill gas, impact on air quality is expected to be minimal.
Air and water quality	The waste prevention will help improve the ambient air quality in the vicinity of landfills. Indirectly (because of less waste being landfills) it will also help reduce impacts on water and environmental resources because of fewer leachate. Reducing the disposal of biowaste in the landscape leads to a decreased input of nutrients into the watercourses and prevents formation of algae.
Creation of new job opportunities	The construction and even more the operation of composting and anaerobic digestion plants require specific qualifications that require a comprehensive and consistent training program so that Tunisian personnel can be employed from the beginning. It seems likely that Tunisia could avoid long-term dependence on services by companies from abroad and therefore could create a relevant number of jobs for skilled (planning, engineering, operation of plants) as well for unskilled (operation of logistics and supply of raw material) workers. Approx. number of employees for operating a composting plant in Germany (capacity 10,000 tons per year): 10
Landscape ecology and esthetics	Reduced biowaste scattered in the urban and rural areas improves the landscape ecology as the waste can no longer influence the functional effect structure between the resident organisms and the their environment. It also contributes to better appearance of the landscape and city scenery.
Additional revenues	The local communities could receive local taxes from private organizations running the plants.

5.7 Cost and financing

Cost

The cost of the biowaste NAMA mainly depend on:

a. the number and capacity of composting plants anaerobic digestion plants and
b. the organization of the collection and the distances between the collection points and the places of final treatment.

A fair cost planning requires a detailed plan that is seen as an important step of an in-depth study that is to be conducted as one action within this NAMA. The following table gives an exemplary indication on the investment cost of one single composting plant.

Composting example: Investment cost for a composting plant with an annual capacity of about 14,000 tons of biowaste (German standard vs. estimates for Tunisia)

Position	Specific investment cost in € per ton of annual capacity	
	German standard	Estimates for Tunisia
Components	70-00	
Machinery	110-140	
total	**180-240**	**30-70**

Note: If there is a secondary air treatment similar to the German standard required, additional cost such as the construction of an RTO have to be taken into account.

Biogas example: There are investment cost for anaerobic digestion reported for Tunisia that lay between 70 and 100 € per ton of annual capacity. This is pretty much more than for a composting plant and makes, in reality, necessary that the additional cost would have to be covered by the sale of the energy and the fertilizer produced in the biogas plant.

Financing

However, the government revenue from the “ecotaxe” on plastics and some other products (“Filières”) are not sufficient to cover the full amount of landfill costs, so that general grants are necessary even to cover present landfilling activities. In 2006 for example the deficit was 1.6 million TND, which was about 10% of the total cost related to the landfills. And what is more, the deficit of FODEP, another potential source of financial means for covering the investment cost partially, amounts to 36.8 million for the years 2006-2016 DNT.

An additional problem is the coverage of the cost that arise from the operation of the separate biowaste collection and treatment.

Table 9: Financial plan to realize the Biowaste NAMA

Component	Cost	Cost covered domestically		Already agreed international support	Cost to be covered by new international (climate) support		Type of financing
	Range of estimated cost	**Private**	**Funding**		**unilateral**	**supported**	
Study to detect cost-efficient measures for emission reductions in the field of biowaste	200,000					200,000	a) Grant b) Twinning Project with German expert financed by Germany
Scientific research on degradation processes for different variants of waste composition	500,000 €					500,000	
Development of a detailed and well-coordinated national concept on biowaste treatment	800,000				800,000		a) Grant b) Twinning Project with German expert financed by Germany
Review (or study) on feed-in of electricity	80,000 €					80,000	Grant
Construction and operation of composting and anaerobic digestion plants	Investment cost of plants: ~ 135,000,000 € Operation cost:		FODEP can cover up to 20 % of the investment	Measures supported by South Korea and	Investment: 95,000,000	Investment: 40,000,000	Funding

Component	Cost	Cost covered domestically	Already agreed international support	Cost to be covered by new international (climate) support		Type of financing
	XX €/a	cost	German KfW (€ XX)	Operation: XX €/a		
Awareness Building	500,000			250,000	250,000	
Capacity building and training	600,00				600,000	a) Grant b) Training through GTZ, InWEnt or other organizations
Norming and standardization	400,000			400,000		

5.8 'National appropriateness'

The proposed Biowaste NAMA is in alignment with national strategies and plans concerning the waste sector. It contributes in a special way to PRONGIDD's goals "Improving composting rate" and "Promoting private sector participation in collection/infrastructure investments". The NAMA helps spur privatization since it a) states the demand of investing additional capital in treatment facilities and b) needs very competent and skilled personnel to operate these plants; experiences in developed countries show that operating composting and anaerobic digestion plants is a task that is quite appropriate to be done be private entities.

6 Bibliography and annexes

Nr.	Title	Organisation/ author	Date	Comment or link
1	Information about Tunisia available on reputable sites on the internet			
2	Rapport pays sur la gestion des dechets solides en Tunisie	Sweep-Net/ AMRA-Consulting	2010	
3	Collection of laws and other legislation related to environmental issues	République Tunisienne - Ministère de l'Environnement et du Développement Durable	2010	
4	PDD Djebel Chekir Landfill Gas Recovery and Flaring Project – Tunisia	ANGED	2004	
5	Options stratégiques pour la promotion de la Valorisation des Déchets Organiques VDO en Tunisie	Labeyrie, Pierre; Chakchouk, Mehrez	2009	Study on behalf of the GTZ
6	Information by authorities	ANGED	2010	
7	Utilization of the CDM in Waste Management - Guide to Foreign Investment Projects	bifa	2009	Guide for applying CDM in waste projects, bifa on behalf of the German Federal Ministry for the Environment; available´: http://bmu-jiko.de/english/service/doc/845.php

Part IV

Outlook

Tunisia NAMAs in the international context

Comparing the identified options for Tunisia with the NAMAs which are currently under development in other countries we identified that there are similarities in the type of NAMAs discussed. For example Tunisia has planned a bus rapid transit line which is considered in Mexico as a NAMA. The Solar plan has a focus on renewable energy which is also in Peru and South Africa a focus sector. We expect that the methodological questions for NAMAs in specific sectors will be similar in the different countries and this provides the opportunities for South-South exchange on methodological questions.

In addition we see opportunities for exchange between countries on the identification and selection process of NAMAs including process related questions such as stakeholder involvement and capacity building.

NAMAs in the Tunisia context

The overview of the situation on green house gas emissions in Tunisia shows that there are high emission reduction potentials. It has also shown that many activities and programs are planned an ongoing in the different sectors. Our first screening for potential NAMAs has identified several possibilities for NAMAs in the different sectors. While NAMAs provide new opportunities for financing it is important to develop them as part of the national and sector strategies.

Hence, in order to develop successful NAMAs it is crucial, that all relevant stakeholders are involved in an early stage and heading towards the same (overall) goal. Tunisia already started this process with a stakeholder workshop and it will be important to continue and extend the involvement of key stakeholders in future NAMA development activities.

NAMA financing for Tunisia

Tunisia has the opportunity to benefit from the fast track financing because Tunisia is one of the leading countries with the development of concrete NAMA proposals. One key challenge that Tunisia and other developing countries are facing is that the process to receive NAMA financing is still unclear.

There is a chance that a fund to support NAMA development will be established during the Conference of the Parties of the UNFCCC (COP 16 Cancun). It will however take time until this fund would become operational. In the meantime Tunisia will start to seek climate financing using the two NAMA preliminary proposals to establish contacts with possible bi-lateral donors and position itself as a leading country in NAMA development. The COP 16 in Cancun provides a good platform for this activity.