AFRIMETS ROADMAP

2011-2016

CONTENTS **Page**

1. INTRODUCTION

Accurate, internationally acceptable measurement is one of the cornerstones of quality assurance, for competitive manufacturing and trade. For many decades, Africa has been at a disadvantage with its trading partners and one of the reasons is the lack of a proper measurement infrastructure. Without such an infrastructure, it is difficult to manufacture to international specifications and tolerances, to ensure the integrity of export commodities and in general to apply quality control for the acceptance of fresh produce at the port of arrival. Without accurate measurement, effective health and environmental monitoring is also not possible.

Various programmes have been launched to develop quality infrastructure in countries in Africa, but prior to 2007 there was no pan-African project to improve the accuracy of measurement and ultimately the acceptance of test results generated in Africa. There was thus a reliance on calibration and test results from outside the continent, with associated high costs and the inability to effectively monitor processes leading up to the trade product.

This changed with the establishment of the Intra-Africa Metrology System (AFRIMETS). At its inception, more than 70% of the nations of Africa chose to belong to AFRIMETS, a figure that has since grown to over 90%. The effect on accurate measurement could be far reaching, from the benefit that could be derived by manufacturing in the more developed countries such as South-Africa, Egypt, Kenya and Tunisia, to the most basic measurement functions in countries classified by UNIDO as “least developed” or LDCs, of which most are in Africa (see figure 1).

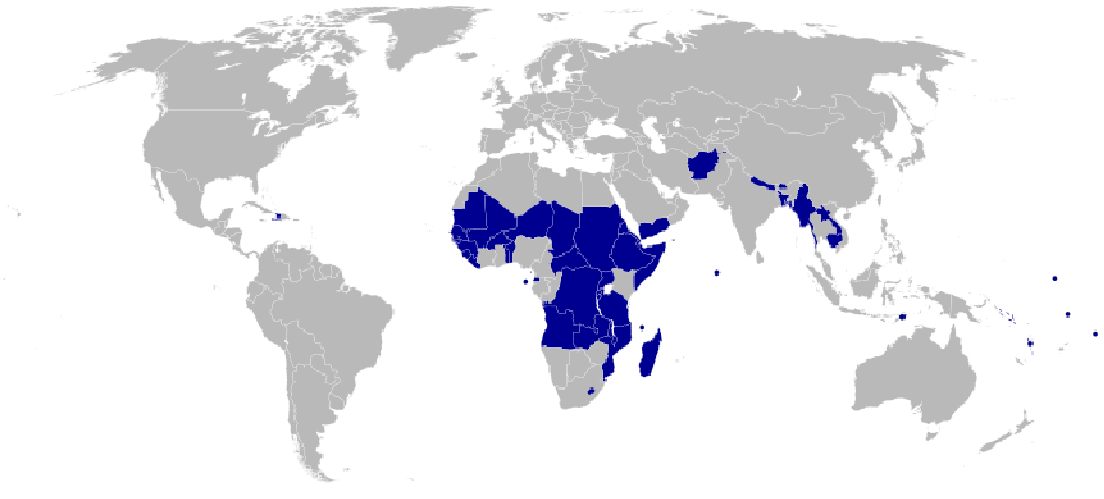


Figure 1: Least Developed Countries in the world [1]

The international linkage that AFRIMETS could provide to the analytical community is of inestimable value, and its impact on increasing trade and energy efficiency, and ultimately poverty reduction, could be huge.

A Roadmap for AFRIMETS was commissioned as part of the UNIDO project to strengthen AFRIMETS. The aim is to have a snapshot of the status of Scientific and Industrial and Legal Metrology in Africa at the start of the project, analyse the gaps in the Measurement Standards and Legal metrology

structures in the Sub-regions, proposes a model for an adequate, sustainable secretariat, and recommends approaches to improve the metrological infrastructure in Africa.

The Roadmap focuses on the provision of Traceability to the calibration and measurement capabilities in Africa and the harmonisation of Legal metrology activities. Although it identifies and comments on measurement and testing gaps, the establishment of a comprehensive testing infrastructure for Africa is beyond the scope of this study.

The Roadmap thus includes:

A. An Introduction to the history, infrastructure and members of AFRIMETS
B. A summary of the Sub-regional metrology organisations (SRMOs) and their Technical and Capability needs
C. An Infrastructure, Technology and Skills Development Strategy
D. Proposals of how to Ensure the Sustainability of AFRIMETS
E. Final Recommendations for Future Projects

It is assumed that the reader has knowledge of metrology and related concepts such as accreditation, standardisation and quality. References are given if basic concepts need to be understood before the Roadmap is perused, and readers are encouraged to visit the websites of the BIPM, OIML, AFRIMETS, the other RMOs such as EURAMET, APMP, SIM and COOMET, as well as the websites of the SRMOs in Africa, such as SADCMET/MEL and EAMET, for background information.

2. DEFINITIONS

Accreditation	-	means a procedure by which an authoritative body gives formal recognition that a body or person is competent to carry out specific tasks;
AEC	-	means the African Economic Community established in 1991 by the Organisation of African Unity heads of State and Government
AFRAC	-	means African Cooperation in Accreditation
ARSO	-	means African Regional Organisation for Standardisation;
AU	-	means African Union
BIPM	-	means International Bureau for Weights and Measures;
BIML		means International Bureau for Legal Metrology
CIML		means International Committee for Legal Metrology
Calibration	-	means the set of operations which establish, under specified conditions, the relationship between values indicated by a measuring instrument or measuring system, or values represented by a material measure, and the corresponding known values of a measure and;
CEMACMET	-	Economic and Monetary Community of Central Africa Metrology Cooperation
Certification	-	Any activity concerned with determining directly or indirectly that relevant requirements are fulfilled. *Note: Typical examples of conformity assessments activities are sampling, testing, and inspection; evaluation, verification and assurance of conformity (supplier's declaration, certification) registration, and approval as well as their combination*
Conformity Assessment	-	means the relevant combination of **inspection**, **testing** and **certification** concerned with determining directly or indirectly that relevant requirements are fulfilled.
CGPM	-	Means the General Conference of Weights and Measures, as introduced by the Metre Convention
CIPM	-	Means the International Committee for Weights and Measures
EAMET	-	East African Metrology Programme
ECOWAS	-	**The** Economic Community Of West African States
Harmonised Standards	-	means equivalent standards, **standards** on the same subject approved by different **standardising bodies**, that establish interchangeability of products, processes and services, or mutual understanding of test results or information provided according to these standards;
ILAC	-	means International Laboratory Accreditation Cooperation;

Inspection	-	Means examination of a product design, product, service, process or plant, and determination of their conformity with specific requirements or on the basis of professional judgement, general requirements
ISO	-	means International Organisation for Standardisation;
LDCs	-	Least Developed Countries (Countries that according to the United Nations, exhibits the lowest socioeconomic development)
Legal Metrology	-	means metrology relating to activities which result from statutory requirements and concern measurement, units of measurement, measuring instruments and methods of measurement and which are performed by competent bodies
Member State	-	means a Member of AFRIMETS
Metre Convention	-	the Metre Convention (*Convention du Mètre*) is a treaty that created the BIPM, an intergovernmental organisation under the authority of the CGPM and the supervision of the CIPM. *Note: the Metre Convention established a permanent organisational structure for member governments to act in common accord on all matters relating to units of measurement, thus the SI.*
MOU	-	means Memorandum of Understanding;
MRA	-	means Mutual Recognition Arrangement;
National Measurement Standard	-	means a standard recognised by a national decision to serve, in a country, as the basis for assigning values to other standards of the quantity concerned;
National Legal Metrology Body (NLMB)	-	means a body appointed by a national government to be responsible for legal metrology or any specified part of legal metrology in that country;
National Standard	-	means a **standard** that is adopted by a **national standards body** and made available to the public;
National Metrology institute (NMI)	-	means a **measurement institute** recognised at the national level, that is eligible to be the national member of the corresponding **international** and **regional metrology organisations**
NEWMET	-	North-Eastern and Western Africa sub-regional Metrology organisation
NSB	-	means National Standards Body;
NTB	-	means Non-tariff Barrier;
OIML	-	means International Organisation of Legal Metrology;
Quality	-	means the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs;

Quality Assurance	-	means all those planned and systematic actions necessary to provide adequate assurance that a product or service will satisfy given requirements for **quality**;
Quality Infrastructure (QS)	-	quality infrastructure relates to all fields of standardisation, metrology and testing, of quality management and conformity assessment, including certification and accreditation. In this document it is also abbreviated as SQMT;
Region	-	means the African region;
Regional Metrology Organisation (RMO)	-	means the regional body officially recognised by the CIPM to represent the region in matters related to the CIPM MRA
Rules of Procedure	-	means a set of formally adopted rules and/or guidelines for activities undertaken by constituted committees, subcommittees or working groups.
SADC	-	means Southern African Development Community;
SADCMEL	-	means SADC Cooperation in Legal Metrology;
SADCMET	-	means SADC Cooperation in Measurement Traceability;
Sanitary and Phytosanitary measures	-	measures necessary to protect human, animal or plant life or health, subject to the requirement that these measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between Members where the same conditions prevail or a disguised restriction on international trade;
Secondary (or transfer) Standard	-	means a measurement standard that is not a primary realisation of the SI, traceable to a primary (or fit-for-purpose secondary) measurement standard at another NMI or the BIPM, or in the case of least developed country NMIs, to accredited laboratories with fit-for-purpose artefact measurement standards, traceable to a NMI or the BIPM
Scientific and Industrial Metrology (S&I Metrology)	-	means (in the context of this Roadmap) the metrology activities at an NMI (or body responsible for metrology), to establish traceability to the SI and/or determine degrees of equivalence to other national and international standards, and disseminate this traceability to calibration laboratories and /or industry.
SI units	-	means a universal, practical system of units of measurement adopted by the General Conference on Weights and Measures, *Note : SI is the international abbreviation for Le Système International d'Unités*
SOAMET	-	means the "Secrétariat Ouest-Africain de Métrologie" or the Secretariat of Metrology of UEMOA (to be expanded to ECOWAS)

SQAM and SQMT	-	means Standardisation, Quality Assurance, Accreditation and Metrology. In this document it is also abbreviated as SQMT, where T stands for Testing. It is assumed that the Testing facilities is or will be Accredited.
Standard	-	means a document, established by **consensus** and approved by a **recognised body**, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.
Standardisation	-	means the activity of establishing, with regard to actual or potential problems, provisions for common and repeated use, aimed at the achievement of the optimum degree of order in a given context;
Standards Body	-	means a **standardising body** recognised at national, regional or international level, that has as a principal function, by virtue of its statutes, the preparation, approval or adoption of **standards** that are made available to the public;
Sub-regional Metrology Organisation (SRMO)		means the sub- regional metrology body based on an economic block in Africa, that is a Principle member of AFRIMETS
Supplier	-	means any organisation or person that brings a product or a service into circulation or onto the market place, irrespective of who the manufacturer is;
TBT	-	means Technical Barrier to Trade;
Technical Regulation	-	is a document which lays down product characteristics or their related processes and production methods, including the applicable administrative provisions, with which compliance is mandatory. It may also include or deal exclusively with terminology, symbols, and packaging, marking or labelling requirements as they apply to a product, process or production method.
Testing	-	means a technical operation that consists of the determination of one or more characteristics of a given product, process or service according to a specified procedure;
Third party	-	means a party independent from the supplier (first party) and the purchaser (second party) in the context of **conformity assessment**;
Top-level measurement standard	-	means a measurement standard of the highest metrological quality available for a quantity in a particular country, which does not have an official national measurement standard for that quantity;
Traceability	-	means the property of the result of a measurement or the value of a standard whereby it can be related to stated

		references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties;
UEMOA	-	The West African Economic and Monetary Union
WTO	-	means World Trade Organisation

3. STRENGTHENING OF THE INFRASTRUCTURAL CAPACITY OF AFRIMETS

A Quality infrastructure (QS) is a pre-requisite for consumer protection and trade. The main technical infrastructure pillars of a QS namely Standards, Accreditation and Metrology each is essential and the lack of, or inadequateness of any of the pillars can lead to the failure of a national health or law enforcement system, protection against unsafe local or imported products, limited access to export markets and an uncompetitive manufacturing industry.

Accurate measurement and the acceptance of measurement results internationally, can only be achieved through a proper, benchmarked national measurement system, with checks and balances in place such as verification and accreditation. Collectively this system is known as a national metrology system, and is divided into Scientific and Industrial metrology (S&I) and Legal metrology. Scientific metrology deals with the establishment of traceability to the International System of Units (SI) or internationally stated and accepted references, Industrial metrology with the process to disseminate the traceability to the testing level and to assure accurate measurement in all sectors but especially industry. Legal metrology means the part of metrology relating to activities which result from statutory requirements and concern measurement, units of measurement, measuring instruments and methods of measurement and which are performed by competent bodies. It includes technical regulations, type testing of measuring instruments, verification and inspection.

This Roadmap deals with both Scientific & Industrial and Legal Metrology on the African continent.

3.1 The Establishment of AFRIMETS

During 2005, a group of delegates from the Southern African Development Community Cooperation in Measurement Traceability (SADCMET), the National Metrology Institute of South Africa (NMISA), the Physikalisch Technische Bundesanstalt (PTB), Legal metrology at the National Regulator for Compulsory Specifications (NRCS), and the New Partnership for Africa's Development (NEPAD) came together to discuss the formation of an umbrella body to further metrology in Africa, and the idea of an "intra-Africa metrology system" was borne [2].

The first Intra-Africa Metrology System (AFRIMETS) workshop held in March 2006 [3] was attended by delegates from more than 25 African countries. A draft Memorandum of Understanding (MOU) was prepared and a second workshop was held in September 2006. The first General Assembly (GA) meeting was held in July 2007 at the premises of NEPAD at Midrand, South Africa. The MOU was finalised and signed by five sub-regional metrology organisations (SRMOs), namely (1) SADCMET, (2) East African Metrology Program (EAMET), (3) Economic and Monetary Community of Central Africa Metrology Cooperation (CEMACMET), (4) Secretariat for Metrology of the Economic Community of West African States (SOAMET), and (5) Maghreb Metrology Cooperation (MAGMET), representing 36 countries in Southern, Eastern, Central, Western and North Western Africa respectively. Four countries signed on as individual members. During 2009, Egypt united the four individual members, as well as Libya and Sudan, in a sixth sub-regional metrology organisation in North-Eastern and Western Africa (NEWMET). NEWMET officially joined AFRIMETS during July 2009. Mauritania then joined MAGMET and Sierra Leone joined as a country member, increasing the membership of AFRIMETS to 44 countries (as at June 2011).

Africa faces a huge challenge to stay abreast of technological developments, to be able to prove measurement equivalence and to provide analytical assurances for export products. Its economy is

resource and commodity based and relies heavily on metals, oil, diamonds and agricultural exports. As market access encompasses (i) intra-African trade, (ii) Africa's trade with other countries and regions, and (iii) the diversification of exports, the international linkages that AFRIMETS could provide to the analytical community is of inestimable value, and its impact on increasing trade could be huge.

3.2 AFRIMETS Mission and Vision

The primary aim of AFRIMETS is to harmonise scientific, industrial and legal metrology issues across Africa and to operate as a fully fledged RMO, fulfilling the obligations as stipulated in the Mutual Recognition Arrangement of the International Committee for Weights and Measures, the CIPM MRA. This leads to the secondary aim of fostering trade between African states and the rest of the world through the negation of technical barriers to trade.

The **Mission** statement of AFRIMETS is:

"Promote metrology and related activities in Africa with the view of facilitating intra–African and international trade and to ensure the safety, health, and consumer and environmental protection of its citizens"

Leading to its **Vision** of:

"Providing fit for purpose, comparable and internationally accepted metrology facilities in Africa"

The long term vision as approved at the 3rd AFRIMETS GA (2009) includes:

- The establishment of all structures within the organization of AFRIMETS that is necessary to fulfill the aims as set out in the MOU;
- To eventually become financially independent of sources outside Africa for the administration of AFRIMETS and thus ensure the future existence of AFRIMETS;
- To elevate the status of AFRIMETS so that it is fully accepted within the folds of the AU;
- The leverage of national and donor funding to apply towards the goals of AFRIMETS;
- The establishment of legal metrology and basic scientific and industrial metrology structures in all member states;
- The use of these structures to improve the measurement capabilities and harmonization of administrative and technical regulations in these countries, with the aim of facilitating intra-Africa and international trade.

The long term vision is reviewed annually at the AFRIMETS General Assembly meeting.

3.3 The Objectives, Goals and intended results

The overall Objectives of AFRIMETS are to:

a) Create awareness in Metrology in Africa at all levels of society and government;

b) Assist in the development and/or strengthening of the metrology infrastructure in each country/sub-region on the continent;

c) Contribute to the development of a conformity assessment and regulatory infrastructure as required and to promote equity in trade;

d) Foster competitiveness and quality in the manufacturing sector in order to promote trade and commerce;

e) Contribute to the development of the metrological infrastructure required to protect the environment and to promote the general well-being of the population, including its health, safety and the protection of consumers from fraudulent dealings where measurements are used as the basis for the transaction;

f) Develop a closer collaboration between Members;

g) Improve the level of metrology, and to assist members in gaining international recognition;

h) Improve the traceability of measurement standards within Africa to international standards as defined in the international system of units (SI), and to generally promote the International Committee of Weights and Measure's Mutual recognition Arrangement (CIPM MRA) and the objectives of the Metre Convention;

i) Encourage measurement traceability in Africa through recognised calibration services;

j) Promote the adoption of International Organisation of Legal Metrology (OIML) technical recommendations or other relevant international standards as technical regulations wherever possible and harmonize technical regulations in Africa in order to minimise technical barriers to trade.

This provides for the objectives of the Roadmap to;

a) Provide a snapshot of current metrological capabilities;
b) Define Strategies for the strengthening of the Infrastructural Capacity;
c) Design models for a sustainable AFRIMETS;
d) Determine the metrological needs of the continent;
e) Define how the need will be best met;
f) Define strategies to establish the necessary metrological infrastructure.

3.4 Current Infrastructural Arrangements and Membership

The structure of AFRIMETS with SRMOs as the Principal members (see figure 2) has been designed with the geographic spread, language blocks, limited road and air transport and free trade zones or customs unions in mind. It is difficult to transport artefacts or samples for comparisons or proficiency testing schemes (PTs) between custom zones in Africa, hence, the countries were asked to organise in SRMOs that closely resemble the economic trade communities or unions (AMU, CEMAC, EAC, UEMOA/ECOWAS, SADC). The exception is NEWMET that spans across 3 economic blocks, where language and trading partners were the overriding consideration,.

The sub-rmos have three main functions:

1) To establish confidence in measurements between neighbouring trading partners in economic blocks in support of intra-regional trade,
2) To participate in the activities of AFRIMETS to establish confidence in measurements at the international level, and
3) To adopt, establish and harmonise Legal metrology laws and regulations.

Secondary functions include the sharing of expertise, assistance with the establishment of metrology infrastructure in the region, assistance with type testing and verification, training and the creation of awareness of metrology at all levels of society.

The infrastructural arrangements of AFRIMETS, including the secretariat, were defined in the original MoU signed in July 2007 (See Appendix A). The main structures are summarized below:

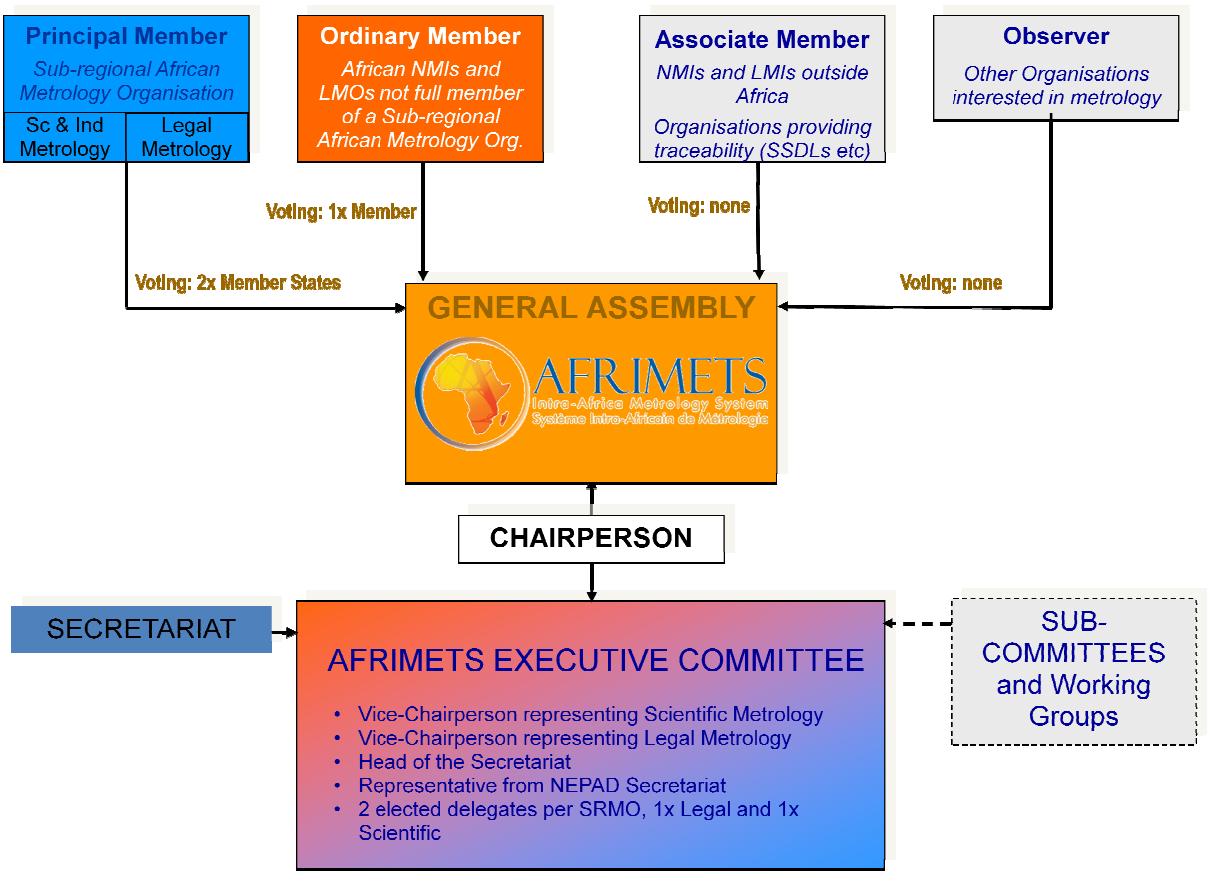


Figure 2. The Structure of AFRIMETS

3.4.1 Membership to AFRIMETS

There are four categories of membership, namely;

a) Principal members: Countries that are members of sub-regional Metrology Organisations (SRMOs) in Africa;

b) Ordinary members: Countries/Institutes responsible for Metrology in Africa who are not full members of a sub-regional metrology organisation;
c) Associate members: Institutes responsible for Metrology outside Africa, or institutes in Africa designated by the national metrology institute as responsible for specific parameter(s), for example Atomic energy institutes responsible for Ionising radiation;
d) Observer members: Other Organisations interested in metrology in Africa.

Only one category of membership is allowed.

At the inauguration of AFRIMETS, 36 countries signed the MOU as members of a SRMO and 4 countries became Ordinary members (Egypt, Ethiopia, Nigeria and Ghana). In 2009 the Ordinary members formed NEWMET and were joined by Libya and Sudan. There were thus no ordinary members left. New members will be encouraged to join through a SRMO, to ensure that the first objective of advancing intra-regional trade is met, and in 2009, Mauritania joined MAGMET. In 2010, Sierra Leone joined as an ordinary member, the reason being that the metrology structures in the ECOWAS region, especially of the countries not part of UEMOA, is still in a developmental phase. It is envisaged that in the future the ECOWAS countries will join an established SRMO such as SOAMET. The rules of AFRIMETS do not allow for interfering with national decisions, and it is up to the member countries to decide how to join AFRIMETS. It must however be noted that donor funding is focused on assistance to economic blocks, and it will be to the advantage of countries to follow economic groupings.

AFRIMETS now spans the continent with 44 members, as shown in figure 3. The individual members are shown in Table 1.

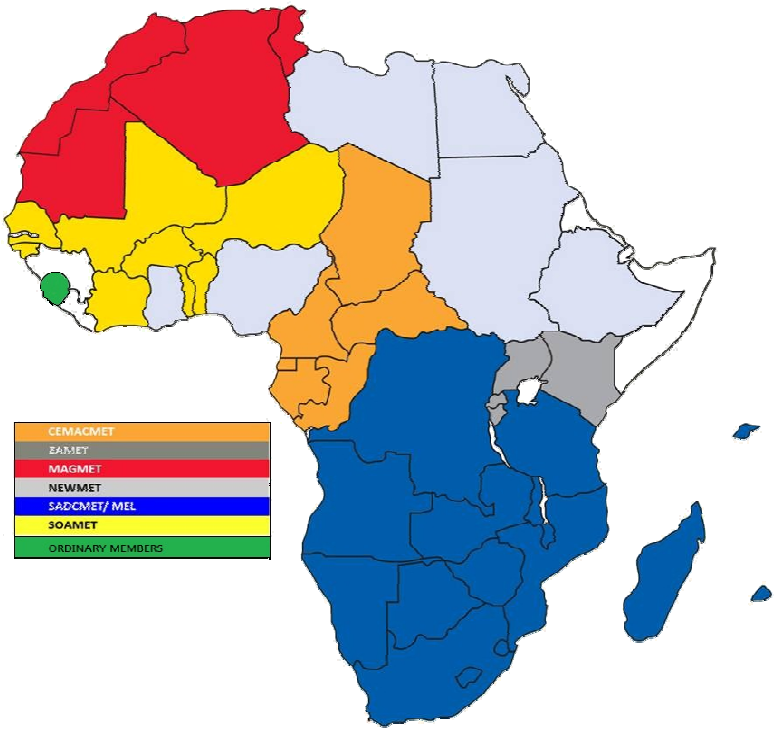


Figure 3. Map of the sub-regional metrology organisations of AFRIMETS

Table 1. The individual members of AFRIMETS in the SRMOs, and the Ordinary Members

SADCMET/ MEL	SOAMET	CEMACMET	EAMET	MAGMET	NEWMET	Ordinary Members
Angola Botswana DRC Lesotho Madagascar Malawi Mauritius Mozambique Namibia Seychelles South Africa Swaziland Tanzania Zambia Zimbabwe	Benin Burkina-Faso Guinea-Bissau Mali Niger Senegal Togo Côte-d'Ivoire	Cameroon Central African Republic (CAR) Chad Republic of the Congo Equatorial-Guinea Gabon	Kenya Uganda Rwanda Burundi	Morocco Algeria Tunisia Mauritania	Egypt Ethiopia Ghana Libya Nigeria Sudan	Sierra Leone

*Although Sudan indicated membership of NEWMET, they have not officially signed the MOU

Only Cape Verde, Comores, Eritrea, Djibouti, Gambia, Guinea, Liberia, São Tomé and Principe, and Somalia, most without any mentionable metrology infrastructure, have not yet joined AFRIMETS.

A concern is the participation of CEMACMET in AFRIMETS. There are no well established metrology institutes in any of the member countries, and although one of the founder members of AFRIMETS in 2007, there were no attendance from CEMACMET at the 2nd and 3rd AFRIMETS GA meetings, with limited attendance at the 4th. The AFRIMETS Executive committee (EXCOM) initiated a process to engage the Republic of the Congo, and an EXCO member (from the DRC) visited Brazzaville in December 2009 and made contact with the staff in government responsible for metrology. It is hoped that in future the Republic of the Congo can play a role in reviving metrology in CEMACMET.

In 2011, the PTB informed the AFRIMETS Secretariat that a process has started in CEMACMET to establish a SRMO structure. Consequently, a few individuals from 3 CEMACMET member countries indicated that they will attend the annual GA meeting in July 2011. This is encouraging and future developments will be eagerly anticipated (and be actively supported).

3.4.2 Membership of the BIPM and the OIML

One of the aims of AFRIMETS is to increase the membership of the BIPM [4] and associate membership of the GCPM), and membership and corresponding membership of the International Organisation of Legal Metrology (OIML) [5].

Scientific and industrial metrology

At the inception of AFRIMETS in 2007, only two countries had full (paid up) membership of the BIPM (thus were signatories to the Metre Convention), namely Egypt and South Africa. Cameroon is a signatory, but is currently suspended due to membership fees being in arrears. Kenya had associate membership of the CGPM. As of 23 October 2007 the Republic of Tunisia, and as of 17 September 2009 Ghana are Associates of the CGPM [6]. Kenya which has been an Associate of the CGPM since November 2002 acceded to the BIPM on 1 January 2010. In 2010, Seychelles, Mauritius, Zambia and Zimbabwe applied for Associate membership [7] and all were accepted by early 2011.This brought the number of members of the BIPM in Africa to three, and the Associates to the CGPM to six. Morocco indicated that an application for Associate membership will be submitted by end 2011.

The Member and Associate country coverage of the continent is shown in figure 4.

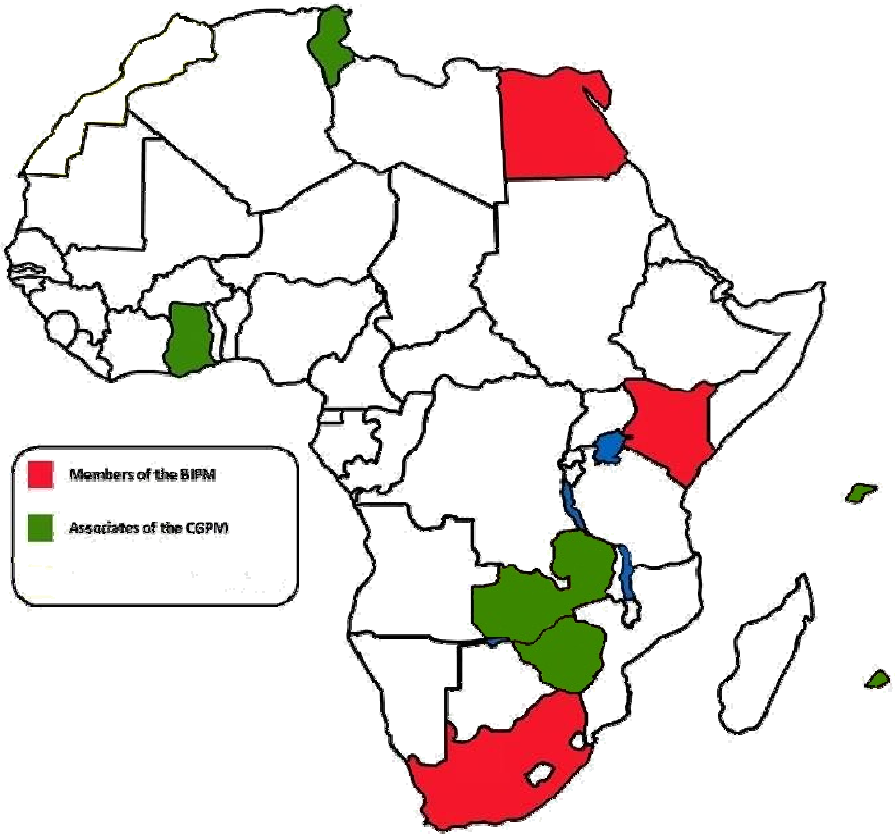


Figure 4. S&I Metrology: Members of the BIPM and Associates of the CGPM

Legal Metrology

As of middle 2011, there are 7 Members and 19 Corresponding members of the OIML in Africa [5]. The membership is well distributed across the SRMOs with Members (M) or corresponding members (CM) in SADCMET (2 M, 6 CM), EAMET (1 M, 1 CM), NEWMET (1 M, 3 CM), SOAMET (8 CM –UEMOA has membership as a block, and Benin and Burkina Faso has individual membership as well) and

MAGMET (3 M). CEMACMET has one corresponding member (Gabon). The distribution of the membership is shown in Figure 5.

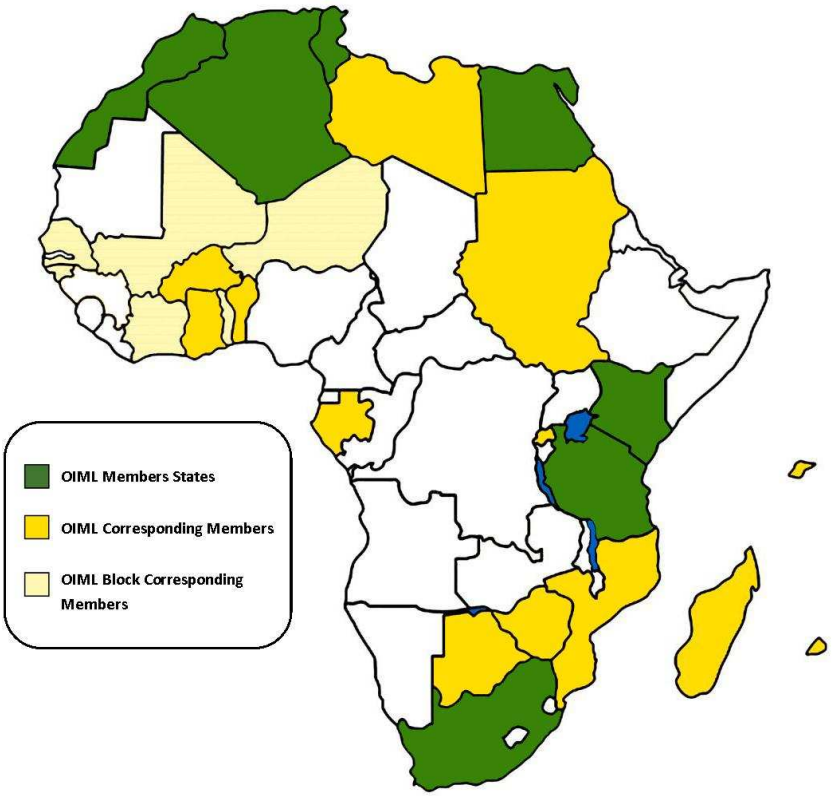


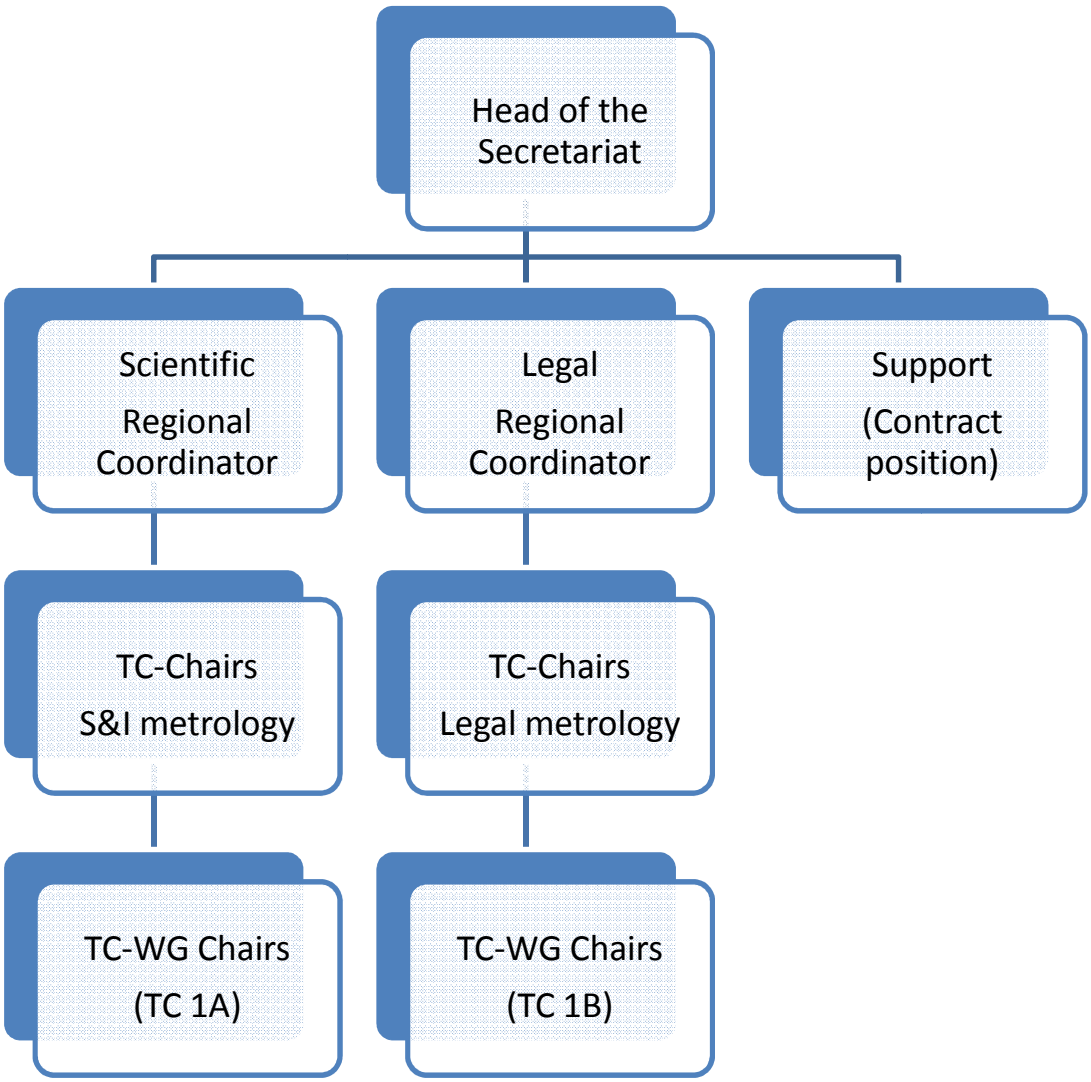
Figure 5. Legal Metrology: Members and Corresponding members of the OIML

3.4.3 The Rights and Obligations of Members (Article 5, MoU), The General Assembly (article 7, MOU) and Office Bearers

The rights and obligations of Members, the operation of the General Assembly and the definition and duties of the Office bearers are described in Article 5 and 7 of the MOU (Appendix A).

3.4.4 The Secretariat

The structure of the Secretariat is shown in figure 6. All positions are non-paid voluntary positions elected from nominees or volunteers from the member states. One support person, sponsored by the PTB, is appointed on a yearly contract basis.



The Rules for the Secretariat is described in detail in section 7 of the MoU.

The Secretariat for AFRIMETS is provided by a member of a SRMO volunteering to host it at its own cost. In case of members from two or more SRMOs volunteering to host, the issue goes for elections in the GA. The Secretariat assists the Chairperson and the EXCOM in the administration of AFRIMETS and ensures that details of collaborations are circulated to all Representatives. The Secretariat maintains a complete set of AFRIMETS publications and AFRIMETS Member details and each retiring Secretariat need to ensure the efficient transfer of AFRIMETS material to the succeeding Secretariat. The term of Secretariat is three years and renewable, and the Member hosting the Secretariat should preferably not provide the Chairperson of AFRIMETS (this condition was wavered at the inception of AFRIMETS and currently both the Secretariat and Chair are provided by South Africa).

One of the aims of the Roadmap is to propose a sustainable model for a Secretariat. This is discussed in section 5.5.

3.4.5 The Roles of the RMO and the SRMOs

Due to the size of the continent and the difference in level of development of the NMIs, AFRIMETS was designed such that technical work (comparisons, proficiency testing, etc) can be conducted at two levels;

1) Key, subsequent and supplementary comparisons and other international benchmarking activities, as well as the harmonisation of Legal metrology regulations (where applicable) are conducted at the RMO (AFRIMETS) level. The SRMOs assist with the process by co-ordinating the participation of the institutes or laboratories in their regions,
2) Other comparisons, pilot studies, proficiency testing activities and the harmonisation of regulations within economic blocks are conducted within the SRMOs.

The SRMO structures do not need to "mirror" the structure of AFRIMETS, but must rather complement it. The main roles and responsibilities of the RMO vs the SRMO can be summarised as follows:

<u>AFRIMETS as the RMO for AFRICA</u>

- Represents the continent at the BIPM (through participation in the Joint Committee of the RMOs and the BIPM -the JCRB) and OIML (where applicable, as Legal metrology at international level do not currently have a "regional" structure);
- In terms of the CIPM MRA, all activities associated with the international benchmarking of the calibration and measurement capabilities of countries in Africa;
- The CMC submission process is therefore handled by AFRIMETS. This entails:
    1) Approval of the Quality systems of NMIs as stipulated by the CIPM MRA;
    2) The intra-regional peer review of CMCs;
    3) The submission of CMCs to the JCRB for inter-regional review.
- All official key, subsequent and supplementary comparisons conducted in Africa will be registered as "AFRIMETS" comparisons in the Key Comparison Data Base (KCDB) of the BIPM. Such comparisons will be piloted by a NMI in a sub-region, for example EAMET, SADCMET or NEWMET, but needs to be registered as an AFRIMETS comparison.
- The adoption of international laws and regulations by members is co-ordinated by the TC-Legal metrology.

<u>Sub-regional Metrology Organisations within AFRIMETS</u>

- Represents AFRIMETS in the sub-regions of Africa;
- Mostly involved with the promotion of metrology within sub-regions, based on economic blocks, within Africa;
- Assists fellow NMIs and LMIs with methodology, training, etc;
- Organises intra-regional benchmarking exercises and the harmonisation of technical regulations within an SRMO to assist intra-regional trade;
- Conduct fit-for-purpose proficiency testing within regions to improve the measurement capabilities and methodology;
- Generally assist neighbouring countries with advice and training in metrology;
- Assist with the distribution of samples and artefacts during AFRIMETS benchmarking exercises.

4. TECHNICAL AND CAPABILITY NEEDS

4.1 Profile of Africa, the Economic blocks and the associated Sub-Regional Metrology Organisations (SRMOs)

To understand the basic metrology requirements of Africa, a short background summary of the financial and industrial activities of Africa and its economic blocks are provided below, with a short introduction to the SRMOs.

Statistics given are 2009/2010 values that were sourced in October 2010. More detail on the economic activities of the members is available in Appendix B.

4.1.1 The Continent

Africa has a total GDP (Purchasing Power Parity) of US$ 2,200 trillion (2009 est.) and a total population of 922 million (2006 est.), living in 54 countries. 36.2% of its population is living on under $1 per day. According to the United Nations Development Report of 2003, 25 African nations ranked lowest amongst the nations of the World. The past decade, some positive signs emerged and the World Bank reported that the economy of Sub-Saharan African countries grew at rates that match global rates (end of 2007). The economies of the fastest growing African nations experienced growth above the global average, for example Mauritania (19,8%), Angola (17,6%), Mozambique (7,9%) and Malawi 7,8%) [8].

The recession of 2008-2009 resulted in a sharp decline in the export of commodities, the mainstay of the African export trade, but increased oil production and relatively high global food prices offset the negative effects to a certain extend. Manufacturing comes from a low base and even though global markets are depressed, further growth is not unrealistic, especially in processed foods.

The depressed global market does mean stiffer competition for African food exports, and accurate, traceable measurement is even more important in such a climate, as some market protection could be expected. Metrology is therefore becoming of increasing importance to Africa. It is here that AFRIMETS through its SRMO members plays an ever increasing role.

4.1.2 CEMAC and CEMACMET

<u>Important Statistics</u>

Total population: 41 million

Gross Domestic Product (Purchasing Power Parity): $ 123 billion

Main Products and Industries: Oil, diamonds, cotton, agro-food products, logs and timber, cassava, coffee, cocoa and minerals (manganese)

Main Exports: Oil, diamond and cotton

CEMAC (from its name in French, Communauté Économique et Monétaire de l'Afrique Centrale) is an organisation of states of Central Africa established to promote economic integration among countries that share a common currency, the CFA franc. CEMAC is the successor of the Customs and

Economic Union of Central Africa (UDEAC), which it completely superseded in June 1999 (through an agreement from 1994). Its member states are Cameroon, the Central African Republic, Chad, the Republic of the Congo (Brazzaville), Equatorial-Guinea and Gabon. The region shares a high dependence on oil and forestry, volatile economic growth patterns, weak intra-regional linkages and a lack of transportation infrastructure. The zone is dominated by Cameroon and Gabon whose economies account for more than two-thirds of the region's GDP. The main export products are oil, diamonds and cotton. Oil contributes 45% to GDP [9].

CEMAC's objectives are the promotion of trade, the institution of a genuine common market, and greater solidarity among peoples and towards under-privileged countries and regions. Currently CEMAC countries share a common financial, regulatory, and legal structure, and maintain a common external tariff on imports from non-CEMAC countries. In theory, tariffs have been eliminated on trade within CEMAC, but full implementation of this has been delayed [5] and trade is hampered by a large number of policies not harmonised in the region. Traditionally, the CEMAC markets have been sheltered from competition with high tariff and non-tariff barriers in all sectors other than unprocessed raw material [10]. CEMAC's intra-regional trade is relatively low (an estimated 3 % of total trade), and for example trade between France and CEMAC is more than 10 times the intra-regional trade.

Metrology infrastructure is weak in the region and although the Metrology Cooperation of the Economic Community of Central African States (CEMACMET) was established in 2008, no formal SRMO structures exist. In 2010/11 the PTB re-initialised initiatives to formalise the SRMO structures and some progress have been reported. The presence of a delegation from CEMACMET at the 5th AFRIMETS GA in July 2011 is a good start towards future positive developments.

4.1.3 The EAC and EAMET

Total combined population (excl. Tanzania):	94 million
Gross Domestic Product:	US$ 120 billion
Main Products and Industries:	Coffee, Tea, Fruit and flowers, Cotton, Sugarcane, Dairy and Meat products
Main Exports:	Coffee, Tea, Bananas, Cotton, Sugarcane, Dairy and Meat products, Cut flowers

The economy of the EAC with members Burundi, Kenya, Tanzania and Rwanda is heavily dependent on agricultural and horticultural exports, and most industries either support agriculture or are involved in value addition or food processing. Tourism is also a substantial contributor to the economies of Kenya and Tanzania, and to a lesser extent to Rwanda and Uganda.

The EAC Protocol on Standardisation, Quality Assurance, Metrology and Testing (2001) has mandated the East African Standards Committee with the coordination of regional SQAM activities. Four technical sub-committees have been created, one being the Metrology sub-committee or Metrology cooperation (EAMET), which is responsible for coordinating metrological activities in the

sub-region and assuring traceability to the SI. The chair and secretariat are held by one of the partner states on a rotational basis [12].

Metrology infrastructure is thus well established under EAMET, with its members (NMIs) Burundi (BBS), Kenya (KEBS and Kenya Weights and Measures), Rwanda (RBS) and Uganda (UNBS). Although a member of the EAC, Tanzania chose to participate in AFRIMETS through SADCMET, as it is also a member of SADC.

4.1.3 The AMU and MAGMET

Total combined population:	80 million
Gross Domestic Product:	US$ 427 billion
Main Products and Industries:	Agriculture (Dairy and meat products, olive oil, vegetables, Textiles). Oil and gas, fish products, automotive, minerals, services
Main Exports:	Oil and gas, Agro-food and fish products (Mauritania). Manufacturing (automotive, electronic), services (call centres, etc)

The Arab states of North Africa established the Arab Maghreb Union (AMU) in 1989 to promote cooperation and economic integration. Its members are Morocco, Algeria, Tunisia, Libya and Mauritania [13]. MAGMET was established in 2007/8. The membership of MAGMET does not include Libya, as Libya chose to participate in AFRIMETS through NEWMET.

The economy of Algeria is mostly reliant on petroleum and natural gas, whilst Morocco and Tunisia rely on Atlantic fisheries, textiles, fruit and vegetables, manufacturing and services. Morocco and Mauritania have thriving mining industries.

Due to a relatively large and well trained working force, nearly 50 % of exports from Morocco and Tunisia are intermediate and finished manufacture. The destination is mostly the EU region, with the USA second.

Tunisia and to a lesser extend Morocco have well established metrology infrastructure, although not yet internationally recognised. The SRMO structures of MAGMET are well established with Tunisia and Morocco as the main contributors, and an annual GA is held. A measurement infrastructure exists in Algeria, mostly based on Legal metrology. Mauritania recently joined MAGMET and not much is known about its capabilities. MAGMET started a project in 2010 to assist the metrology infrastructure in Mauritania and the situation is expected to improve.

4.1.4 The Environment of NEWMET

Total combined population:	391 million
Gross Domestic Product (2009 est):	$ 1129 billion

Main Products and Industries: Resources and Commodities; Oil and natural gas, potash, salt, gold, platinum, copper, manganese, iron ore, phosphates, limestone, gypsum, talk, asbestos, timber, bauxite, diamond. Agriculture (cotton, rice, onions, beans, citrus fruits, wheat, corn, barley, sugar, sesame, ground nuts, coffee, cereals, pulses, oilseeds, khat, meat, hides and skins), construction.

Main Exports: Oil and natural gas, textiles, coffee, processed foods, cement and hydroelectric power

NEWMET is not based on a single economic block and thus no summary is provided. Detail on the economies of the individual countries can be found in Appendix B.

During 2009, Egypt was instrumental in the establishment of a sixth SRMO amongst the ordinary members of AFRIMETS, mostly English/Arabic speaking countries in North-Eastern Africa and the English speaking countries in the Economic Community of West African States (ECOWAS). In June 2009, the NMIs of five African countries namely the National Institute for Standards of Egypt (NIS), the Standards Organisation of Nigeria (SON), the Ghana Standards Bureau (GSB), the Quality and Standards Authority of Ethiopia (QSAE) and The Libyan National Centre for Standardisation and Metrology (LNCSM) signed a MoU and officially established "NEWMET". In addition in August 2009, the Sudanese Standards & Metrology Organisation (SSMO) agreed to join NEWMET.

A first General Assembly meeting was held at NIS (Egypt) on 21 June 2009, and the delegates elected office bearers to take care of the affairs of NEWMET. The structures now include technical working groups and some benchmarking activities are already underway.

4.1.5 SADC and SADCMET/MEL

Total combined population (incl. Tanzania): 267 million

Gross Domestic Product: US$ 827 billion

Main Products and Industries: Agricultural (fruit, table grapes vegetable products, maize, wheat, meat, hides and skins), fish, prepared foodstuffs (beverages, spirits & vinegar, tobacco), mineral products (salt, sulphur, stone, lime and cement, mineral fuels, oil), precious metals (platinum, gold, silver) base metals and articles of base metals (iron and steel, copper, nickel, aluminium, lead, zinc, tin), natural and cultured pearls and precious and semi-precious stones, wood pulp and wood articles, chemicals, manufactured goods (automotive units and components, aircraft, vessels, textile articles).

Main Exports: mineral products (mineral fuels, oils), pearls and precious stones, metal products, agricultural (vegetable products, beverages, tobacco), prepared foodstuffs, chemical products, paper products, machinery, vehicles, textile products.

SADC was formed in 1992 [14]. It currently has fifteen member states, which are: Angola, Botswana, Democratic Republic of the Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, the Seychelles and Zimbabwe. The objectives of SADC include achieving active development and economic growth; alleviating poverty; enhancing the standard and quality of life of the people of Southern Africa; amongst others. Intra-SADC, intra-African and African global trade are well established, with South Africa leading the way. Exports by most countries focus on agricultural goods and commodities, with South Africa also exporting manufactured goods and services. SADC launched a free trade area in August 2008 [17]. This also paved the way for entry into the more competitive global market. While growing, intra-SADC trade is still low at around 25 % of total SADC trade and is concentrated in the Southern African Customs Union (SACU) region [14].

A SADC SQAM program was established to progressively eliminate technical barriers to trade (TBTs) in the region, as well as between SADC and other regions in the world. This program is overseen by the SADC Directorate Trade, Finance, Industry and Investment.

The SADC quality infrastructure was formed at the same time as SADC and includes several formal entities, established to perform specific functions of the SQAM program, including SADCMET and SADCMEL. It includes technical committee and working group structures [15].

The NMISA is the most prominent NMI in the region [16] and provides traceability to a large part of sub-Saharan Africa.

4.1.6 UEMOA and SOAMET

Total combined population:	97,8 million
Gross Domestic Product:	US$ 122,4 billion
Main Products and Industries:	Oil and natural gas, uranium, gold, other minerals, cocoa, coffee, fish products and cotton.
Main Exports:	Coffee, cocoa, cotton, gold and phosphate by-products, petroleum products, food commodities (rice, fruit), fish products.

The UEMOA country members are Benin, Burkina Faso, Côte d'Ivoire, Mali, Niger, Senegal and Togo. UEMOA countries account for only 0.1 % of global trade in manufactured goods, and intra trade is only 6 % of total trade. The main exports of the UEMOA countries are agro-food products, fish products and cotton. The main export market is the EU [18]. An ambitious strategy was implemented to pursue bio-energy in five areas, namely sustainable wood fuels, bio-ethanol, biodiesel, power generation and biogas [19]. In September 2001, to enhance the participation of the UEMOA countries in regional and international trade, the EU, United Nations Industrial Development Organisation (UNIDO) and UEMOA launched a Quality Program as part of the UNIDO Trade Capacity Building Initiative. The Programme assisted with establishment and/or strengthening of institutional and human capacities in laboratory accreditation; the development of product and material testing laboratories (chemical, microbiology, etc.) according to international standards; standards

formulation, adoption and dissemination; the development and implementation of quality policies; instituting quality awards; and the development of consumer protection laws and associations.

UEMOA countries realised for many years that it will be interesting to get a “common” view to deal with some fields of metrology and to be able to face the great challenges to support the regional industries. This was strongly support by UNIDO, which proposed different programmes to implement this approach. In 2007 the metrology secretariat for the West African Region was established (SOAMET). The goal of SOAMET is to determine the main priorities for the region in terms of metrology, but also to develop a common approach in the regions of regulations, standardisation, accreditation and quality insurance. It also has as goal to strengthen industries in the international and regional trade and commerce market.

Although the official structures of SOAMET are in place, intra-regional activities is still limited and mostly focuses on coordination and the accreditation of calibration facilities at NMIs in member countries.

4.2 Snapshot of the Metrology Infrastructure in Africa

To obtain a clear and comprehensive picture of the metrology infrastructure in Africa is a major task. The technologically more advanced countries have well described formal structures for SQAM and information on their capabilities is available from the internet. The smaller, less developed countries have some SQAM structures, but in most cases it is not well described, or when part of a standards body (>50% of countries in Africa), only the testing laboratories are explained on websites. In some cases, for the least developed countries, there is no mention of scientific, industrial or legal metrology, and correct information can only be gathered through country visits.

The information supplied has been gathered through a combination of website searches, the assistance of individuals from institutes or sub-regional metrology organisations, presentations at meetings and conferences, a workshop with the regional coordinators of the International Technical Cooperation of the PTB, discussion with UNIDO officials responsible for projects in Africa, and visits to sub-regions. It is not claimed to be 100% correct or comprehensive, but can be used as an indication of capabilities and the status of metrology per country as of early 2011.

A short summary of the infrastructure per sub-region is provided below. The Tables summarising the capabilities per parameter per sub-region and member country are included in Appendix C and a graphic summary of the metrological capabilities is provided in section 4.3. A table listing recent Quality Infrastructure projects in Africa is also supplied in Appendix C.

4.2.1 The Metrology Infrastructure in CEMACMET

The metrology infrastructure is extremely limited, with only Gabon and the Republic of the Congo with some basic metrology infrastructure (that could be ascertained in this study).

In all the sub-regions of Africa, the greatest immediate gain could arguably be realised with an investment in the SQMT and especially metrology infrastructure in this region, as starting from a

very low base, a relatively small investment can have a large noticeable impact. The flip side is that as political support for metrology is lacking and very little infrastructure exist it is difficult to start activities. The PTB [11] and UNIDO are active in programs to establish QS infrastructure in the region, but for measurement/metrology, the focus is on the establishment of basic testing facilities and the accreditation thereof. It is logical that the development of national or regional metrology facilities should follow to support traceability for the accredited testing facilities.

In summary

- Legal metrology
  - Gabon is a corresponding member of OIML;
  - law on legal metrology generally exists but it seems that there is a problem with legal metrology institutes not reaching the necessary requirement to be efficient enough.
- Scientific and industrial metrology
  - Cameroon is member of the Meter convention (although currently suspended), and has no scientific/industrial activity in metrology (at reference level);
  - if there are some NMIs (that could not be identified during this study), they are not accredited and do not deliver recognised calibration services;
  - no national or regional accreditation body active and internationally recognised (for calibration services);
  - some countries have industrial metrology activities and some have companies/laboratories able to propose calibration services (but not with a recognised accreditation).

4.2.2 The Metrology Infrastructure in EAMET

EAMET is well covered in both S&I and Legal Metrology. Legal metrology mostly precides under government ministries in the respective countries and S&I is part of the Bureaus of Standards.

Legal metrology is fairly well established and all countries except Burundi have Legal metrology Acts in place.

In S&I metrology, the provision of traceability for all basic parameters is in place in Kenya (KEBS), to a lesser degree in Uganda (UBS) and Rwanda (RBS) and at a very basic level in Burundi (BBS). KEBS is improving its traceability route with a development programme to replace secondary or transfer standards with primary standards, for example in Mass and Temperature.

Gaps still exist and the region needs to expand its metrology infrastructure, especially in metrology in chemistry (MiC), to fully support intra-regional and international trade in foodstuffs, environmental monitoring and manufacturing. Kenya recently opened an expanded capability in MiC in upgraded buildings. For physical metrology, some laboratories in the region still only have traceability to accredited laboratories in developed countries and the traceability chain needs to be improved (to NMIs) to shorten the traceability route and to improve uncertainty of measurement.

KEBS is the driving force behind most of the metrology programmes in the EAC, and undertakes activities such as managing the comparison measurements, hosting workshops and providing expertise in training and consultancy. The institute is well supported by the Kenyan government. KEBS has made a substantial contribution to the increase in trade of Kenyan and other EAC products

through the provision of internationally recognised measurement standards and accredited testing facilities.

In summary

- Legal metrology
  - Kenya is full member and Rwanda a corresponding member of OIML;
  - technical regulations and law on legal metrology exist in Kenya and Uganda, to a lesser extend in Rwanda, but is still limited in Burundi;
  - apart from Kenya, the region needs better equipped S&I laboratories.
- Scientific and industrial metrology
  - Kenya is a member of the BIPM and signatory to the CIPM MRA. It has good basic facilities, most of which are accredited by internationally recognised accreditation bodies. A process has been initiated to have primary standards, starting with Mass, Temperature and Time and Frequency);
  - Uganda and Rwanda have some accredited facilities and deliver recognised calibration and testing services;
  - the Legal and S&I capabilities in Burundi is very limited;
  - Kenya is in the process to establish a national accreditation body for calibration services;
  - comparisons in mass, pressure and temperature have been conducted in the sub-region;
  - Kenya is participating in AFRIMETS comparisons and CMCs are expected in the near future.

4.2.3 The Metrology Infrastructure in MAGMET

Since the inception of AFRIMETS, the metrology infrastructure in the member countries became more organised. Tunisia is moving towards international recognition of its measurement standards and services. It has a distributed system for metrology overseen by a public entity agency (the Tunisian National Agency for Metrology -ANM) created in 2008 under the responsibility of the Ministry in charge of Commerce. ANM manages the scientific, industrial and legal metrology. The main reference laboratories are LCAE (mass, pressure, length, temperature) and DEFNAT (electricity and time & frequency). Both are accredited for these quantities by internationally recognised NABs (COFRAC and the Tunisia National Accreditation -TUNAC). Tunisia has also some laboratories in chemistry that are on their way to include metrology in their activities.

In Morocco, industrial, scientific and legal Metrology is under the responsibility of the Ministry of Industry, Commerce and new technologies, Department of standardisation and promotion of quality. For industrial and scientific metrology, the national metrology laboratory in Morocco is the LNM at LPEE (*Laboratoire Public d'Essais et d'Etudes*), in charge of the metrology references in Morocco for temperature, electricity, dimensional, force, volume, pressure, mass and weighing. The LNM has a long experience in metrology, participated in many programmes in the frame of EU contracts. The LNM also organised some comparisons at regional level. Some activity exists in the field of chemistry, at the present time not really dealing with metrology, but with potential to expand into metrology.

Morocco achieved accreditation for most of the metrology laboratories from the national accreditation system (that is not currently a signatory of ILAC).

In Algeria, The metrology is under the responsibility of the ONML (National legal metrology organisation). ONML was created in 1986 (decree n°86-250) as a public administrative institute under the responsibility of the Ministry in charge of Industry, small and medium enterprises and promotion of investment. ONML deals mainly with legal metrology. No recognised Scientific metrology facilities exist, although in industgrial metrology one private company (Metrocal Algérie) has been accredited in the fields of pressure, mass and non-automatic weighing instruments.

In Mauritania metrology is under the responsibility of the Ministry of Mines and Industry. A dedicated service of technology and intellectual property is in charge of standardisation, metrology, promotion of quality and technological innovation. A recent law (April 2010) further formalised metrology in Mauritania. The main objective is to define the context of legal metrology (verification, repairing, utilisation) and to define the legal units which should be used. No Scientific metrology capability currently exists.

In summary:

- Legal metrology :
    - Tunisia and Morocco are members of OIML and has well established facilities;
    - Algeria has a formal Legal metrology institute and Mauritania has one activity in a government ministry.
- Scientific metrology :
    - Tunisia is an associate member to the CGPM and has signed the CIPM MRA. The LCAE and DEFNAT are the main “reference laboratories” for metrology, and most of their capabilities (CMCs) are accredited by an internationally recognised NAB;
    - the LNM at LPEE (NMI) is the national metrology laboratory and is accredited by the Moroccan accreditation body for calibration services;
    - Tunisia and Morocco are participating in AFRIMETS comparisons and CMCs are expected from Tunisia in the near future.

4.2.4 The Metrology Infrastructure in NEWMET

The original Ordinary members of AFRIMETS in the region had an established metrology infrastructure (both S&I and Legal metrology) at the time of the establishment of AFRIMETS. Since the inception of NEWMET, the region became more organised and Libya and Sudan joined. The heightened awareness of metrology benefits Libya and Sudan that are both now in the process of establishing scientific metrology facilities. Ghana and Ethiopia are improving their established facilities and traceability. Most members (except Sudan) have established Legal metrology.

In Egypt, Legal metrology is the responsibility of the National Legal Metrology Authority within the Egyptian Organisation for Standards and Quality (EOS). EOS also includes an Industrial metrology section with accredited laboratories for most physical metrology parameters. Traceability is obtained from the National Institute of Standards (NIS), responsible for primary standards. NIS provides traceability for all basic parameters through primary standards and in some cases traceable secondary standards. It has 11 CMCs accepted in the international key comparison database (KCDB). This is being increased every year. NIS can therefore assist the other SRMO members with traceability to the SI or internationally stated references.

In Ethiopia, Legal and S&I metrology was the responsibility of the Quality and Standards Authority of Ethiopia (QSAE). Recently, QSAE was re-organised in four different institutes, each responsible for one leg of the Quality infrastructure. The Ethiopian National Metrology Institute is responsible for establishing and maintaining Ethiopian measurement standards and ensuring that the national calibration service is used by the manufacturing industry. It is also responsible for providing independent evidence that testing and calibration laboratories, inspection agencies, and certification bodies are technically competent. It has good basic industrial metrology facilities, but for scientific metrology traceability is sourced from other NMIs (NIS, NMISA, KEBS and NMIs outside Africa).

In Ghana, both Legal and S&I metrology is the responsibility of the Ghana Standards Board (GSB). The Legal metrology system is well established and focuses on Oil marketing companies (service and fuel stations and weighing instruments for the cocoa and other industries). Industrial metrology is well established and focuses on Mass, Flow/volume and Force measurements. Scientific metrology undertakes the calibration of laboratory, medicine and other equipment. The temperature, mass and pressure laboratories are accredited. It is also responsible for the certification of all new weighing and measuring equipment in Ghana. Traceability is sourced from other NMIs (NIS, KEBS, NMISA and from Europe).

In Libya, metrology is the responsibility of the Libyan National Centre for Standardisation and Metrology (LNCSM). Libya is participating in the activities of NEWMET but a full picture of their capabilities is not available. The current status of LNCSM due to the hostilities is also not known.

In Sudan, metrology is the responsibility of the Sudanese Standards and Metrology Organisation, with 13 laboratories. Metrology activities are limited to the unification of measurement units in the country, the issue of measuring specifications, distribution nationally of international measurement information and technical supervision of scales. A new Scientific metrology laboratory is envisaged.

In Nigeria, metrology is the responsibility of the Standards Organisation of Nigeria (SON). It has well established industrial metrology laboratories focusing on mass, volume, dimensional, force, temperature and torque. The facility calibrates equipment. Traceability is sourced from other NMIs in NEWMET or SADCMET. A scientific metrology facility is planned.

In summary:

- Legal metrology :
    - Egypt is a full member and Ghana, Libya and Sudan are associated members of the OIML;
    - Egypt, Ghana, Ethiopia and Nigeria have well established structures for Legal metrology, but physical facilities are somewhat limited;
    - Libya and Sudan have organisations responsible for Legal metrology, but limited laboratory facilities.
- Scientific metrology :
    - Egypt is a full member of the BIPM, a signatory to the CIPM MRA and has CMCs in the international database;
    - Ethiopia and Ghana has industrial metrology facilities and some scientific metrology facilities;
    - Nigeria has industrial metrology facilities and limited scientific metrology facilities;
    - Libya and Sudan have organisations responsible for industrial metrology, but no identifiable scientific metrology activities.

4.2.5 The Metrology Infrastructure in SADCMET

Both S&I and Legal metrology infrastructure are well established in the region. A summary of the institutes responsible for metrology is provided in Appendix C.

All countries in SADC (except Lesotho) has a Legal metrology capability, or at least an identifiable entity or group within a government department responsible for Legal metrology. A group of countries (South Africa, Tanzania, Zimbabwe, Zambia, Seychelles, etc) have relatively expansive facilities, although many gaps have been identified through the SADC EU project.

S&I infrastructure closely follows the intra-African and global trade patterns, with those countries with limited global, but increasing intra-regional trade, focusing on basic metrology parameters such as mass, volume and temperature (for example Swaziland, Zambia and Namibia). Those participating more extensively in global trade established more advanced metrology and technical infrastructure (such as Botswana, Tanzania and South Africa) and are expanding into metrology in chemistry.

Although some level of S&I metrology is established in most of the countries, apart from South Africa, it is still at a basic level. As part of the SADC EU project, there was an extensive drive to accredit laboratories at NMIs in SADC and the basic parameter facilities (mass, volume, temperature) in a group of countries (Seychelles, Mauritius, Tanzania, Zimbabwe, Zambia and Botswana) have been accredited. Most of the other NMIs have at least one or two facilities accredited. These laboratories provide calibration or analysis at a national level. Another project under SADC EU strived to improve Traceability with the calibration of the secondary or transfer standards for the basic parameters at the NMISA.

Even though the NMISA has CMCs accepted for most parameters in the KCDB, and the region is more advanced in metrology than most other developing regions in the world, challenges remain as primary traceability is needed for some parameters, for example electricity (energy, power, resistance), flow (large diameter/volume) and reference materials and reference methods for specialised chemical analysis such as dioxins and mycotoxins.

Challenges exist to better harmonise Legal metrology in the region and to establish fit-for purpose facilities in countries such as Angola, Swaziland and Lesotho.

In summary:

- Legal metrology :
    - South Africa and Tanzania are full members and Botswana, Madagascar, Mauritius, Seychelles and Zimbabwe are Corresponding members of the OIML;
    - South Africa has well established laboratory facilities and the rest (except Angola and Lesotho) have some facilities, although not fit-for-purpose in all the countries;
    - SADCMEL is active to harmonise technical regulations in the region and provide training and general assistance to member LMIs.
- Scientific metrology :
    - South Africa is a full member of the BIPM and Mauritius, Seychelles, Zambia and Zimbabwe are Associates of the CGPM. All 6 are signatories to the CIPM MRA;
    - South Africa has CMCs in the international database (KCDB). For all physical parameters, as well as 25 in Chemistry (June 2011);
    - Most countries (except Lesotho, Angola and Namibia) have Scientific metrology facilities (for the basic parameters);

- traceability is sourced mostly from South Africa, in accordance with SADCMET strategies that not all countries need primary standards.

4.2.6 The Metrology Infrastructure in SOAMET

Since the establishment of SOAMET as the secretariat for metrology in the region, the organisation of metrology has improved substantially. Legal metrology structures and facilities exists in most of the members, but S&I metrology facilities are limited to a few countries such as Benin, Senegal and Burkina Faso. Cote d'Ivoire had a S&I facility, but it was destroyed during recent hostilities. There are plans to re-build the institute.

The increased organisation of the UEMOA region and the emphasis placed on quality infrastructure should accelerate the improvement of metrology infrastructure in the region. The possible future incorporation of the ECOWAS countries outside UEMOA in SOAMET could give the metrology activities in the region a further boost.

SOAMET has an interesting strategy for S&I metrology as it plans to spread the responsibility for traceability between the member countries. As an example, Benin has been earmarked to provide traceability to the region for Mass, and the laboratory received assistance to become accredited. Successful accreditation was obtained in 2011.

In Legal metrology, Benin is a corresponding member of the OIML. One laboratory is in charge of the legal metrology and of the industrial metrology in a department under the responsibility of the Ministry in charge of industry and trade *(Direction de la Métrologie et du Contrôle de la Qualité).*

Burkina Faso is a corresponding member of the OIML. One laboratory is in charge of the legal metrology and of the industrial metrology in a department under the responsibility of the Ministry in charge of industry (Direction Général de la Qualité et de la Métrologie). The laboratory has capabilities in the field of Mass.

In Cote d'Ivoire, one laboratory is in charge of industrial metrology, LANEMA (*Laboratoire national d'essais de qualité métrologique et d'analyses*). This laboratory is a public institute with commercial activities under the responsibility of the Ministry in charge of industry. LANEMA renders support to companies/laboratories for the industrial development, protection and security of consumers in the country. LANEMA performs calibration services, testing and analysis (chemical analysis). The last ten years, LANEMA faced some difficulties. In particular, lack of qualified staff due to a high turn-over of personnel. During the recent hostilities, the institute was totally destroyed. It has already been indicated that the institute will be re-build, and the existing expertise should still be available. Basic capabilities in mass, pressure, temperature, humidity and electrical metrology are planned.

Around 2005, Guinea-Bissau planned to create a department in charge of standardisation and metrology under the responsibility of the ministry in charge of the commerce and industry. No information was available on the project.

In Mali in 2010, a new project was proposed to take into account the impact of measuring instruments in the competitiveness of industries and in the international commerce and trade, and also the development of new technologies and commercial innovation. A department of commerce and trade (*DNCC: Direction Nationale du Commerce et de la Concurrence*) is in charge of the regulation (for commerce and trade), metrology, consumer protection and commercial innovation, within the ministry in charge of industry. The DNCC has a laboratory in charge of legal metrology,

with the responsibility of the verification of measuring instruments (mainly for mass, weighing instruments, volume). It is the official NMI for the country.

In Niger, a new project was proposed to take into account the impact of measuring instruments in the competitiveness of industries and in the international commerce and trade, and also the development of new technologies and commercial innovation. A department of Commerce and Trade (*DNCC : Direction Nationale du Commerce et de la Concurrence*) within the Ministry of Industry is in charge of the regulation (for commerce and trade), metrology, consumer protection and commercial innovation,. The DNCC has a laboratory in charge of legal metrology, with the responsibility of the verification of measuring instruments (mainly for mass, weighing instruments, volume). It is the official NMI for the country.

In Senegal, one laboratory in the Department of the Ministry of Internal Commerce is in charge of Legal and industrial metrology,. The laboratory is essentially focused on regulation and operates as a fraud squad. In 2005, it was also the national metrology institute, but was not able to provide calibration services and is currently not the official NMI. A private company has developed some activity in metrology in view to provide traceability to other private or public companies. This company, the LAME (*Laboratoire Africain de Métrologie*), implemented calibration services in mass, pressure, temperature, and liquid flow. LAME also provides testing activities and training. It should be noted that this laboratory was accredited for mass by COFRAC (French NAB).

In Togo, The Ministry of Commerce is in charge of the Legal metrology in Togo. A new project of law has been elaborated in 2009 which proposed the creation of a national legal metrology council in charge of the regulation and application of the law (including legal metrology linked to environment). A legal metrology laboratory (*Laboratorie national de métrologie et d'essais*) is implemented in the Department of Conditioning and Legal metrology.

In summary:

- Legal metrology :
    - Benin and Burkina Faso are corresponding members of OIML;
    - Many countries have a law on legal metrology, but without a legal metrology laboratory sufficient to answer to the industrial and trade requirements.

- Scientific and industrial metrology :
    - There are no members of the BIPM or Associates of the CGPM in the region;
    - only Benin is accredited for calibration services for mass;
    - no national or regional accreditation body active and internationally recognised (for calibration services);
    - not many companies /laboratories able to perform calibration services.

4.3 Graphic Presentation of the Metrology Infrastructure in Africa

The status of metrology in Africa will be summarised in three maps, showing:

A. Indication of Metrology Infrastructure through the existence of formal institutes or bodies for Scientific & Industrial and Legal Metrology. The criteria are shown in table 2A and the classification in table 2B.
B. Scientific Metrology capabilities: Divided into five categories of capabilities. The criteria are shown in table 3A and the classification in table 3B.
C. Legal Metrology capabilities: divided into five categories of capabilities. The criteria are shown in table 4A and the classification in table 4B.

Table 2A: Indication of the Existence of Metrology Institutes in AFRIMETS Member countries

Category	Criteria
1-Gold (Internationally Recognised Metrology Infrastructure)	-Official Institutes responsible for S&I and Legal Metrology -Member of BIPM/OIML -Capabilities in most areas of Metrology, or those critical for the country
2-Silver (Regionally Recognised Metrology Infrastructure)	-Official Institutes responsible for S&I and Legal Metrology -Associate of CGPM or Corresponding member of OIML -Capabilities in most areas of Metrology, or those critical for the country
3-Green (Established National Metrology Infrastructure)	- Official Institutes responsible for S&I and Legal Metrology -Associate of CGPM/OIML, or plans to become in the next 5 years -Capabilities in basic areas of Metrology, or those critical for the country
4-Yellow (Basic Metrology Infrastructure)	- Official Institutes or at least identifiable section with basic facilities within government department or other institute responsible for S&I and/or Legal Metrology -Capabilities in basic areas of Metrology, or those critical for the country
5-Red (Limited or No Metrology Infrastructure)	-No official institutes or identifiable bodies responsible for S&I and/or Legal Metrology -Very basic facilities in other institute not uniquely identified for metrology but performing some functions, or no capabilities at all

According to the criteria the countries are classified as follows (May 2011). Countries that are establishing facilities, or at least have designated contact points (even for one of the metrologies) and have identified the need to establish facilities, have been classified as yellow. It is debatable if Cameroon and Gabon should not be red, but at least there are identifiable institutes and contact points have been established.

The classification of the members according to the criteria is shown in table 2B and the map of Africa indicating the existence of Metrology Institutes is shown in figure 6.

Table 2B: Classification of Members in terms of Existence of Metrology Institutes/contact points

Category	Criteria
1-Gold	Egypt, Kenya, South Africa
2-Silver	Ghana, Tunisia, Seychelles, Mauritius, Zimbabwe
3-Green	Botswana, Ethiopia, Côte d'Ivoire, Morocco, Rwanda, Tanzania, Uganda, Zambia
4-Yellow	Algeria, Angola, Benin, Burkina Faso, Burundi, Cameroon, DRC, Gabon, Libya, Madagascar, Malawi, Mauritania, Mozambique, Namibia, Nigeria, Senegal, Sudan, Swaziland, Sierra Leone
5-Red	CAR, Chad, Equatorial-Guinea, Guinea-Bissau, Lesotho, Mali, Niger, Republic of the Congo, Togo

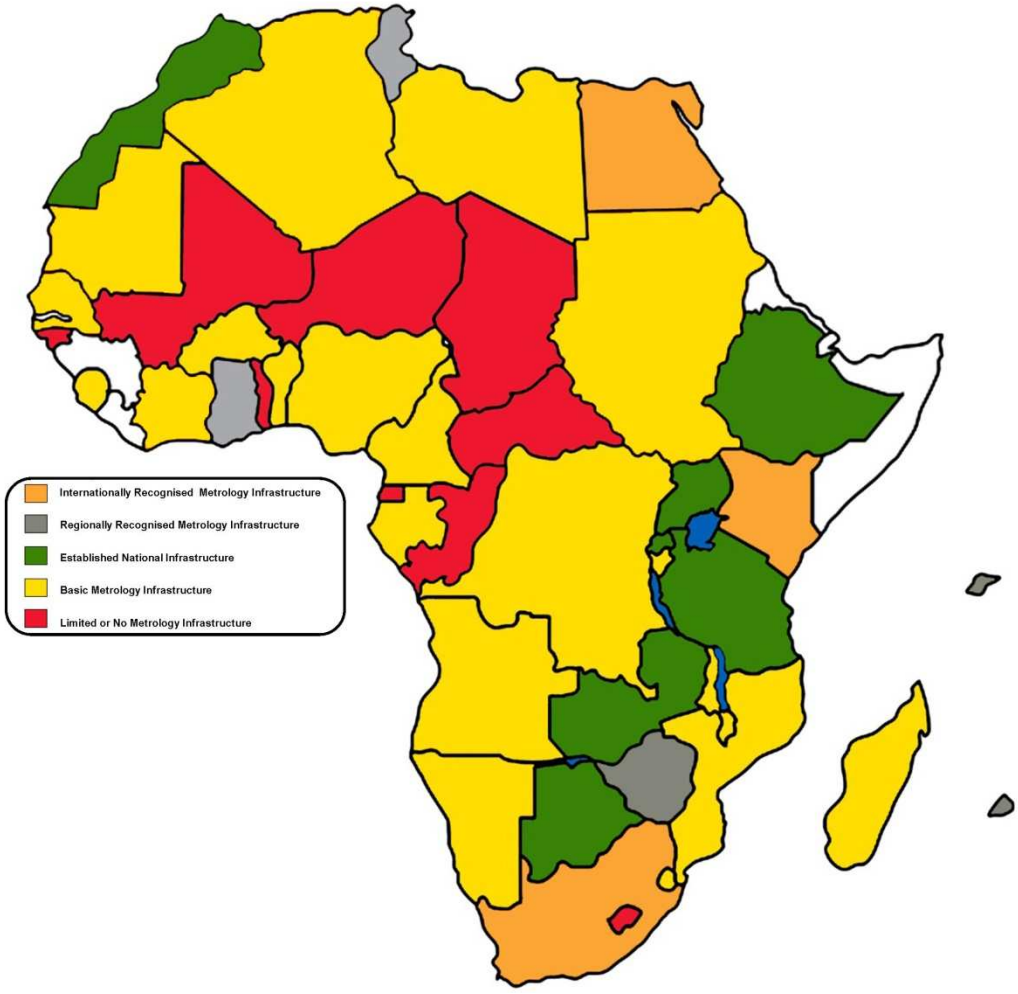


Figure 6: Indication of Existence of Metrology Institutes in Member countries

Table 3A: Status of S&I Metrology Capabilities in AFRIMETS Member countries

Category	Criteria
1-Gold (NMIs Participating in the CIPM MRA)	-Official Institutes responsible for S&I Metrology -Member of BIPM -Capabilities in most areas of Metrology, or those critical for the country -At least some in-house realisation of the SI -International Traceability in place for all national standards -AFRIMETS (or EURAMET) approved Quality system in place -Most laboratories Accredited or peer reviewed -CMC entries in KCDB, or imminent
2-Silver (NMIs Participating in RMO Activities)	-Official Institutes responsible for S&I Metrology - Associate of CGPM -Capabilities in most areas of Metrology, or those critical for the country -International Traceability in place for all or critical national standards -AFRIMETS (or EURAMET) approved Quality system in place, or imminent -Most laboratories Accredited or peer reviewed
3-Green (NMIs Providing National Traceability)	- Official Institutes responsible for S&I Metrology -Associate of CGPM, or plans to become in next 5 years -Capabilities in basic areas of Metrology, or those critical for the country -Traceability in place for critical national standards -Quality system in place -Critical laboratories Accredited or peer reviewed
4-Yellow (Basic Scientific Metrology Infrastructure)	- Official Institutes responsible for S&I Metrology -Capabilities in basic areas of Metrology, or those critical for the country -Traceability in place for some parameters -Quality system in place or being developed
5-Red (Limited or No Scientific Metrology Infrastructure)	-No official institute responsible for S&I metrology -Very basic facilities in a government department or related institute

Although the membership of AFRIMETS (44 members) suggests that the continent is covered by at least basic metrology infrastructure, the classification (table 3B) and map (figure 7) shows that a large part of the continent has no or very limited S&I metrology facilities. Also, it is debatable if the DRC should not also be classified as red.

At least with the renewed activities in the sub-regions, up to 7 countries are in the process to establish S&I metrology facilities and the situation should improve in the near future.

Table 3B: Classification of Status of S&I Metrology Capabilities in AFRIMETS Member countries

Category	Criteria
1-Gold	Egypt, Kenya, South Africa
2-Silver	Tunisia, Ghana
3-Green	Botswana, Ethiopia, Mauritius, Morocco, Tanzania, Uganda, Zimbabwe
4-Yellow	Benin, Burkina Faso, Burundi, Cameroon, Côte d'Ivoire, DRC, Madagascar, Malawi, Mozambique, Namibia, Nigeria, Rwanda, Seychelles, Zambia, Swaziland
5-Red	Algeria, Angola, CAR, Chad, Equatorial-Guinea, Gabon, Guinea-Bissau, Lesotho, Libya, Mali, Mauritania, Niger, Republic of the Congo, Senegal, Sierra Leone, Sudan, Togo

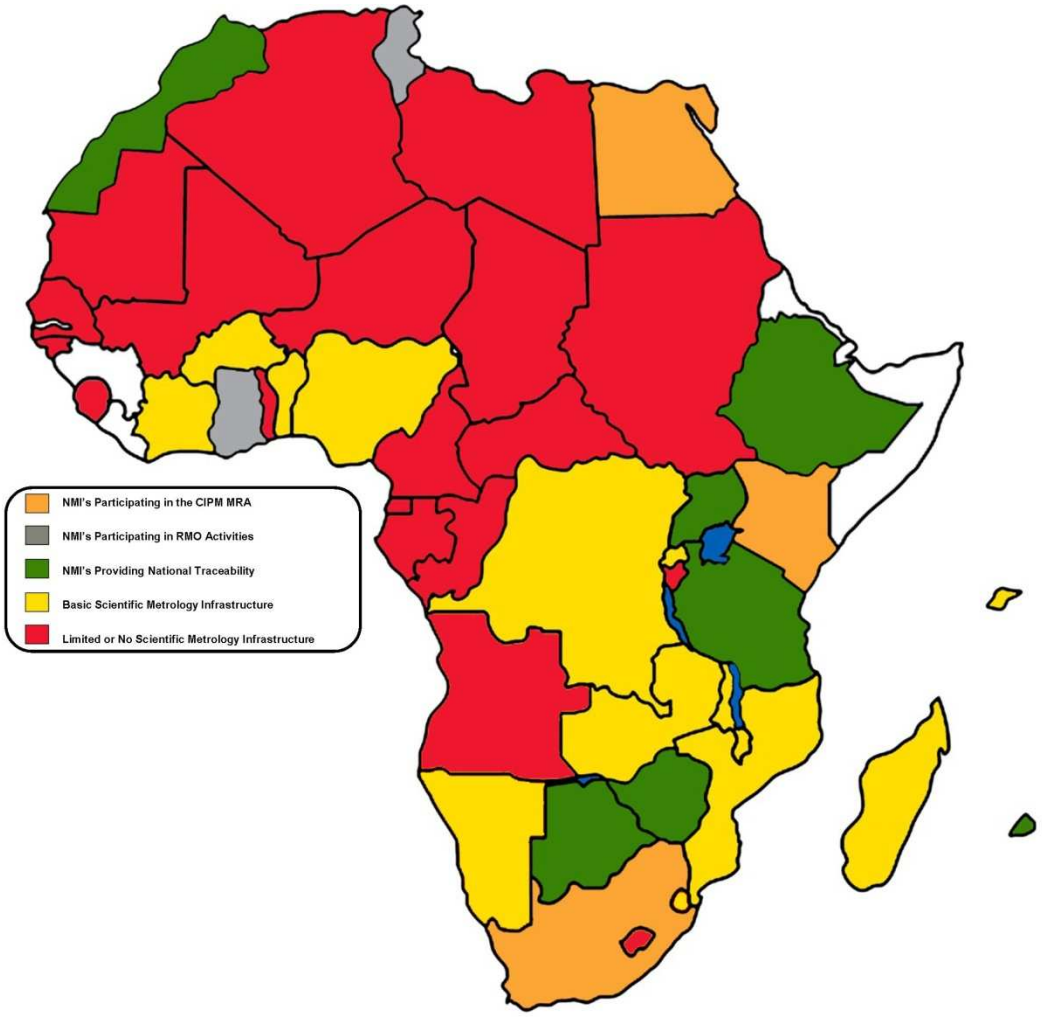


Figure 7: Indication of Scientific Metrology Infrastructure in Member countries

Table 4A: Classification of Legal Metrology Capabilities in AFRIMETS Member countries

Category	Criteria
1-Gold (Recognised LM system at national, regional and international levels)	-Official Institute responsible for Legal Metrology -Member of OIML -OIML MAA Signatory -Legal Metrology Act (including or with plans to include Health, Safety, Environment and Trade) -Facilities to carry out Technical Activities -Competent staff -Prepackages -Participation in OIML Technical Committees -Categories of Measuring instruments that fully support the scope -Approved Quality system in place, Accreditation or Certification
2-Silver (Imbedded LM system with regional and international participation)	-Official Institute responsible for Legal Metrology -Member of OIML -Legal Metrology Act (Minimum trade and plans to include Health, Safety, Environment and Trade) -Facilities to carry out Technical Activities -Competent staff -Prepackages -Participation in OIML Technical Committees -Categories of Measuring instruments that fully support the scope -Approved Quality system in place, Accreditation or Certification
3-Green (Organised LM system with sub-regional participation	-Official Institute responsible for Legal Metrology -Corresponding member of OIML -Legal Metrology Act (Minimum Trade) -Facilities to carry out Technical Activities -Competent staff -Prepackages -Categories that fully support the scope of the Act -Participation in sub-regional technical activities
4-Yellow (LM existence at National level with limited resources)	- Legal Metrology Act in place, or at least fit-for-purpose regulations for main national issues - Some facilities to carry out Technical Activities -Trained staff to support technical activities -Sub-regional participation -Technical instructions
5-Red (No official LM)	-No facility and/or Act/regulations

Table 4B: Classification of Legal Metrology Capabilities in AFRIMETS Member countries

Category	Criteria
1-Gold	None
2-Silver	South Africa, Tunisia
3-Green	Algeria, Egypt, Kenya, Morocco
4-Yellow	Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Côte d'Ivoire, DRC, Ethiopia, Gabon, Ghana, Libya, Madagascar, Malawi, Mauritania, Mauritius, Mozambique, Namibia, Nigeria, Republic of the Congo, Rwanda, Senegal, Seychelles, Swaziland, Sudan, Uganda, Tanzania, Togo, Zimbabwe Zambia
5-Red	Cameroon, CAR, Chad, Equatorial-Guinea, Guinea-Bissau, Lesotho, Mali, Niger,

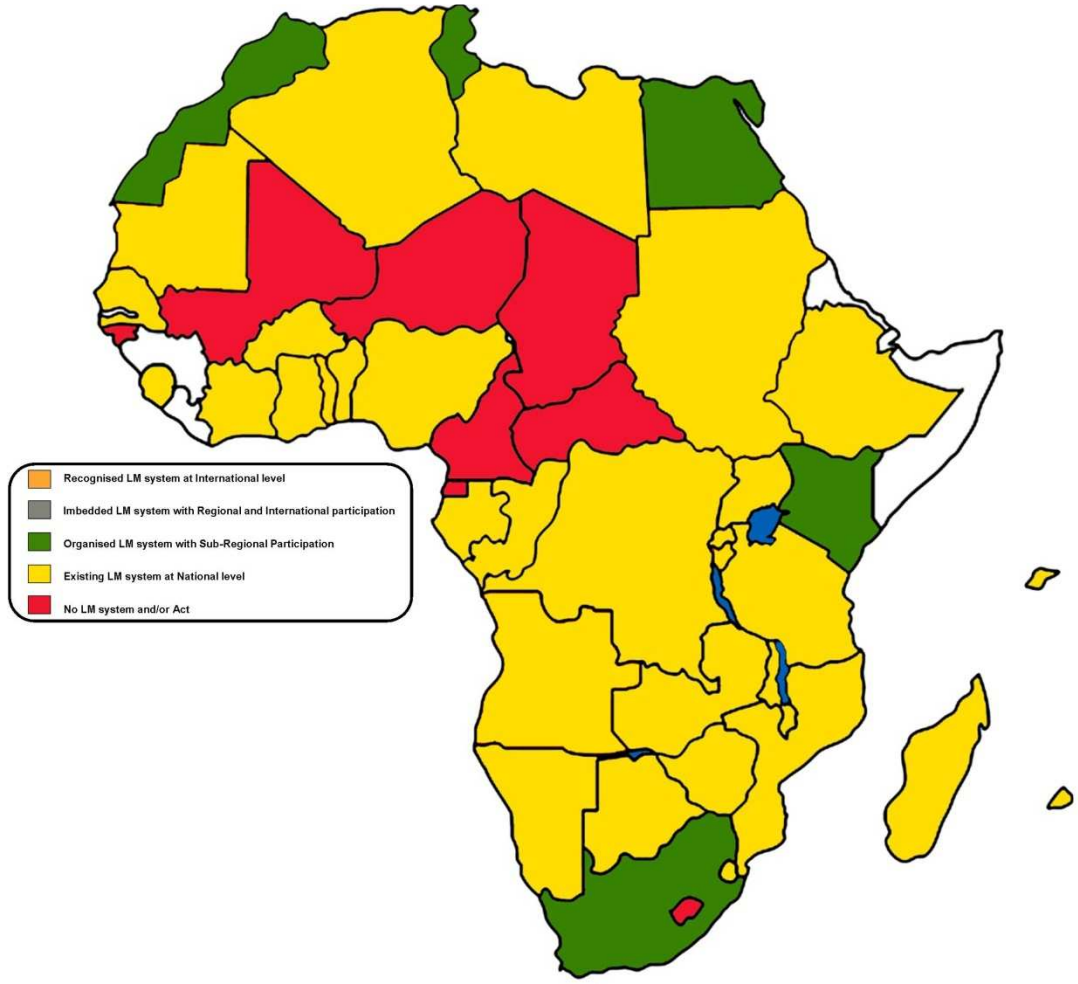


Figure 8: Indication of the level of Legal Metrology Infrastructure in Member countries

Figure 8 shows that although a large part of the continent is covered for Legal metrology, the level of the infrastructure is a concern, as well as the lack of infrastructure in the region immediately north of the equator.

The infrastructure maps can now be used to visually track the development of metrology in Africa.

4.4 Market Trends, Projections and Associated future Metrology traceability needs

To properly identify the current metrology infrastructure gaps in member countries, and even more importantly the infrastructure needed to meet future demands, a comprehensive study of the industry, industry projections and current analytical capabilities of each member country is needed. Only a preliminary investigation was done for the Roadmap and a summary of future trends is provided. It is one of the recommendations of this Roadmap that a comprehensive study be undertaken, especially for the sub-regions with less developed metrology infrastructure such as CEMACMET and SOAMET.

Weak infrastructure, poor transport systems, unreliable electricity supply and protracted customs procedures are some of the common challenges faced by international companies in Africa. The lack of quality information is arguably the biggest obstacle to doing business on the continent, especially in its poorest economies [20]. The same is true for identifying the analytical capabilities and level of traceability on the continent. More success was had with obtaining information on the market trends and projections of future industries and economic activity, since these studies are being compiled by international companies and entities interested in doing business with Africa, or summarising recent economic activity.

A summary of macro-trends for the continent and sub-regions is provided below as an indicator as to what metrology infrastructure need to be developed.

4.4.1 The Continent

From 1995-2005, there were indications that many African economies appear to have turned the corner and moved to a path of faster and steadier economic growth, with growth figures following that of the developed world [21]. This trend continued to 2007/2008, which growth rates above 5%, fuelled by high commodity prices (oil, minerals and food). The effects of the economic recession led to a severe slowdown as commodity prices came under pressure. However, there are some less negative indications for the economies of developing countries than that of the developed world. It appears that the extent of the downturn is less severe than that of the developed world. This can be attributed to a combination of factors: the African financial markets are relatively weakly integrated into global markets, thus the direct negative effects of the global financial crisis are moderate; the African economy is only lightly depended on the export of manufactured or high technology goods, that showed the biggest decline globally; although export of commodities fell due to lower demand and the oil price declined, oil production and export in Africa is on the increase and food prices increased worldwide (one of the main reasons be the increase in bio-fuel production in the USA). Some sectors did realise a severe decline in exports, such as mineral exports, and in the case of one or two more developed countries (such as South-Africa and Tunisia), automotive and automotive component export. In Southern Africa, the decline in income was offset to a certain extend with the increased tourism associated with South-Africa hosting the 2010 FIFA World Cup.

So what does the future hold for the continental economy? The market potential is there, especially in the energy, consumer goods, telecommunication, industrial equipment, logistics and services sectors [22]. Oil export is on the increase, especially from countries such as Angola and Libya, and (relative) newcomers Equatorial-Guinea, Cameroon, Sao Tome, Uganda, DRC, Tunisia, Egypt and Mauritania [23]. Commodity exports are under pressure and will remain so until the developed world comes out of the recession. Coming from a very low base, there is a slow but steady increase in the export of some manufactured goods, especially processed foods. If world food prices remain high, it may have a positive effect on some African economies, although it may lead to instability in

domestic markets. An increase in stability in some regions (Sudan, the DRC, Zimbabwe, etc) could also lead to substantial future economic growth (coming from a very low base).

Africa can also benefit from participation in a few niche markets. Domestic production of organic products in developed countries is expected to rise within the next few years (there is usually a time-lag of three years between conversion and production of certified organic produce), but it is unlikely to meet demand for most products. Consumers' preference for locally or regionally produced organic fruit and vegetables indicates that the best opportunities are in counter-seasonal fresh organic temperate zone produce and non-temperate zone products. Especially the countries along the Mediterranean such as Morocco and Egypt could benefit [24].

There may also be some opportunities in seasonal produce which is short in supply and in processed fruit and vegetables. This will benefit economic blocks such as the EAC, UEMOA, CEMAC and the AMU.

In the south, South-Africa has embarked on an ambitious Industrial Policy Action Plan (IPAP), with as aim the creation of jobs through increased industrialisation and value addition to commodities. This will be created through the development of specific industry sectors (Automotive, metal beneficiation, chemicals, agro-processing, advanced technologies (bio and nano), etc). This will place an increased demand on metrology to provide traceability for measurements and analysis in the manufacturing process, and to provide acceptable certificates of analysis and testing for export products.

The African Union has formed the African Economic Community (AEC) that endeavours to promote cooperation and integration among African countries economies, and regional economic blocks [25]. In future this may be a further stimulus to trade on the continent.

Although the global recession has a severe negative effect on the economies of poorer countries in Africa, there are thus some positive drivers and should the political situation allow stability, growth rates may constantly outstrip that of the developed world.

4.4.2 The Sub-regions

To identify what metrology traceability would be needed in future, it is necessary to estimate the main future trends in each metrology sub-region. The trends can then be used to suggest future metrology needs. This is not a comprehensive analysis of the future metrology needs, but only a high level indication of what could be needed in each sub-region. To obtain the full picture, each sub-region will have to perform a proper future needs study (such studies are proposed for the sub-regions in the final recommendations in this document). It must also be decided what level of infrastructure is needed in each member country, and what can be shared or provided by the leading NMI in the sub-region.

In the tables, the following abbreviations are used:

T	-	The need to be Traceable to the SI at NMI level, suitable for CMC submission
t	-	The need to be traceable at least to an internationally recognised source of traceability, can be to an accredited laboratory at appropriate level
nt	-	The need is for in-house traceability only

4.4.2.1 CEMACMET

Oil production will increase, with the resultant export in petroleum products. An increase in the manufacturing of processed foods is foreseen. The anticipated future metrology needs include:

Main Products and Exports (CEMACMET)	Future Industries	Current Metrology Offerings	Future Anticipated Metrology needs
-Oil -agro-food products -logs and timber -cassava -cotton -coffee -cocoa -diamonds -minerals (manganese)	Petroleum products, processed foods, furniture	Mass (nt) Temperature (nt)	Mass and Volume (T) Pressure (t) Flow (t) Length (Dimensional) (t) Temperature (t) MiC (t) - Inorganic, Organic, Bio, Gas

4.4.2.2 EAMET

The EAC region exports mostly agricultural products and need the measurement infrastructure for traceable certificates of analysis. In turn, it imports manufactured goods and need measurement infrastructure to support compliance testing.

The export of processed fruit juice is on the increase, with Kenya as the main supplier. The basic measurement traceability infrastructure is in place to support this industry. Although accredited chemical testing or analysis facilities are in place or being established, traceability is lacking and needs attention. Metrology in Chemistry is being established in Kenya and to a lesser degree in Uganda. For Kenya, it is expected that the major export growth will be in the processed foods and cut-flower sectors, as well as an increase in the export of manufactured goods to neighbouring sub-regions.

Future manufacturing includes soap and plastics. Uganda and Rwanda are the largest intra-Comesa exporters of plastic and products thereof, whilst Kenya is the largest intra-importer [26]. Kenya and Uganda are the major exporters of soap in the region. Export to outside the EAC and COMESA regions are limited, but expected to grow.

Oil production is on the increase in Uganda, a relative newcomer to the oil producing countries in Africa. This could in future lead to a petroleum based industry.

Regular technical Metrology sub-committee meetings are held. At the 13th meeting in Arusha, Tanzania on 4-5 May 2009 [12], it was noted that TBS (Tanzania) received additional equipment in the areas of Electricity, Dimensional and Pressure measurements, and the areas submitted formal applications for accreditation. Kenya reported that it was awaiting a DKD assessment for the Force laboratory. Uganda reported that it has earmarked accreditation in the Mass area. The formal application was going to be submitted in June. Rwanda reported that it has earmarked accreditation in Mass and Temperature. Training of staff was done but the quality manuals and other documents still had to be prepared.

The table below gives an indication of the future needs in the region. All the highest current metrology offering traceability status is in Kenya, although some of the other NMIs do have (T) traceability for some parameters. The detail of what traceability needs exist in the other NMIs in the region is given in Appendix C.

Main Products and Exports (EAMET)	Future Industries and Exports	Current Metrology Offerings	Future anticipated Metrology needs
Cut Flowers Coffee Tea Bananas Cotton Sugarcane Dairy and Meat products	Fruit Pyrethrum products Garments Processed foods - Dairy - Fruit juice - beer Manufactured products - Soap - Plastics/rubber - Petroleum - Horticultural - Textiles and fibres - Pharmaceuticals	Mass (T -Kenya) Volume/flow (T) Density (t) Temperature (T) Dimensional (Length - t) Pressure (T) Force (T) Ionising radiation (Dosimetry -T) MIC (t) Time (T) Density/viscosity (t) Photometry (t) Acoustics/Vibration (t) Electrical (ac/dc -T)	Photometry (T) Acoustics/Vibration (T) Length (T) Ionising radiation (T) Density/Viscosity (T) MiC (T) - Inorganic - Organic - Bio - Gas

4.4.2.3 NEWMET

The countries in NEWMET span three major economic regions in Africa (AMU, ECOWAS and COMESA). Libya is a member of the AMU, Ethiopia of COMESA and Nigeria and Ghana of ECOWAS. Sudan and Egypt does not belong to well defined economic blocks or trade areas within Africa, but Egypt has close ties with the AMU. ECOWAS is a member of the AEC and signed a free trade agreement with MERCOSUR [27]. Sudan has indicated that it wants to join the EAC [28].

The AMU, thus including Libya, exports mainly to Europe, with very little intra-trade. In fact, internal exchanges present only 3% of total local exports [22]. Libya, Egypt and Nigeria rely on oil and gas production. Sudan is also increasingly relying on oil and gas. One can therefore expect that petroleum products will play a bigger role in future in these economies, resulting in the need for specialised metrology. The Egyptian furniture industry is showing a rapid growth, and in fact is one of the country's fastest growing and most promising industries [29].

In Ethiopia the major export products of Ethiopia include coffee, livestock products (leather, live animals and meat), oil seeds and pulses, fruits, vegetables and flowers, textiles, natural gum, spices and mineral products. In addition to the efforts underway to increase the export supply of these products and to improve their quality, investments in other currently unexploited, higher value-added, export sectors is highly encouraged (such as pharmaceutical). Other export products on the increase are fruit, vegetables and flowers and mineral products such as granite and marble. This will place additional demands on MIC, mass and dimensional metrology.

In Ghana, traditional exports such as Bolga baskets are re-capturing markets in Europe [30]. The export of hard woven textiles is also on the increase. The industries that would require advances in metrology in future are the growing oil exports, food processing (value addition to cocoa and coffee products, as well as fruit juices etc), wood products, horticulture and if the ailing cotton industry could be revived.

The region as a whole has primary traceability in place for most parameters, but most is in Egypt. Many gaps exist in individual countries and as they are not neighbouring or part of the same economic block, secondary or even primary traceability may be needed in most of the other countries. The main anticipated needs in the other countries are therefore shown.

Main Products and Exports (NEWMET)	Future Industries and Exports	Current Metrology Offerings	Future anticipated Metrology needs
Resources and Commodities; - Oil and natural gas - Minerals - Gold - Diamond Agriculture; - cotton, rice, onions, beans, citrus fruits, wheat, corn, barley, sugar, sesame, ground nuts, coffee, cereals, pulses, oilseeds, khat, meat, hides and skins Industry; - textiles - processed foods - construction - cement - hydroelectric power	Petroleum products Furniture and wood products Pharmaceutical Food processing Horticulture Textiles	Mass (T) Volume (T) Density (T) Pressure (T) Force (T) Dimensional (T) Temperature (T) Ionising radiation (T) Electricity)T) MIC (T,t) (Most of these are in Egypt that could provide traceability to the region, but selected offerings will have to be established in countries such as Nigeria, Ethiopia, Sudan and Ghana)	Egypt: Flow (T) MIC: Gas, Inorganic, Organic (T) Ghana: Needs are known and basic parameters in place, expanding into MIC (t) Inorganic, Organic Nigeria: Proper needs analysis need to be conducted, but probably Mass, Volume, Density, Flow, MIC: Gas, Inorganic, Organic Libya and Sudan: Proper needs analysis need to be conducted. Ethiopia: Basic parameters in place, probably need to improve traceability route and establish MiC

4.4.2.4 MAGMET

The AMU is a leading economic region in Africa. Its proximity to Europe across the Mediterranean sea and to Asia with their common border with the Middle East Area, endows the region with many strategic advantages due to its position. GDP per capita varies across the MAGMET member countries, with Algeria in the lead, thanks to its energy reserves. Mauritania has one of the fastest growing economies in Africa. Morocco has signed a FTA with the US (2004) and Tunisia signed the first total free trade area agreement with the EU in 2008.

With a growing population and rising GDP, opportunities exist for growing intra-trade demand in numerous sectors such as consumer goods, healthcare, transport, construction and telecommunications. This will place an increased demand on mechanical and electromagnetic

metrology. Organic agriculture production is expected to increase, both for local consumption and export, increasing the importance of MIC.

Main Products and Exports (MAGMET)	Future Industries and Exports	Current Metrology Offerings	Future Metrology needs (T level)
Resources and Commodities; - Oil and natural gas - Minerals Agriculture; - Textiles, vegetables, Olive oil	Refined energy products Food processing Construction Pharmaceuticals Organic agriculture	Mass (t) Volume (t) Density (t) Pressure (t) Force (t) Dimensional (t) Temperature (T) Ionising radiation (t) Electricity (t) MIC (t) (Most of these are in Tunisia and Morocco that could provide traceability to the region, but selected offerings will have to be established in Algeria and Mauritania)	Algeria: Probably Mass and Volume (t), Pressure (t) Flow (t) Electrical AC/DC MIC: Gas, Organic, Inorganic (t) Morocco: Basic parameters at (T) level Mauritania: To be explored Tunisia: Mass and related quantities (T) Electricity (T) level, MIC: Gas, Organic, Inorganic (T)

4.4.2.5 SADCMET

The main market driver for the future will be the increased oil and gas production in the region (Angola, Mozambique), increased food production and fish exports. An increase in industrial projects in the aluminium, gas, titanium and coal industries in Mozambique is foreseen. If stability improve in the DRC, the export of its natural resources will and increase. An increase in manufacturing output from South Africa is anticipated due to the IPAP. High-technology projects such as the Square Kilometre Array project [31], micro satellite production, solar energy generation, nano-technology projects and bio-fuel production will also exert pressure to improve existing metrology infrastructure in Southern Africa.

Future Metrology needs can be divided into two groups;
A: the improvement of basic metrology infrastructure in the SADC countries excl. South-Africa and;
B: primary or advanced metrology facilities in South-Africa.

Main Products and Exports (SADCMET)	Future Industries and Exports	Current Metrology Offerings	Future Metrology needs (T level)
Resources and Commodities; - Oil and natural gas - Coal - Mineral products (salt, sulphur, stone, lime and cement, mineral fuels - Precious metals (Platinum, Gold, Silver) - Base metals (iron and steel, copper, nickel, aluminium, lead, zinc, tin) - Natural and cultured pearls - Precious and semi precious stones - Wood pulp Agriculture; - coffee, cocoa, cotton, gold and phosphate by-products, petroleum products, food commodities (rice, fruit), fish products	Pharmaceuticals, Organic agriculture, Bio-fuels, Value added mineral/metal products, High technology products (solar energy, satellites, products enhanced by nano-technology, Automotive and aviation components)	Mass (T) Volume (T) Density (T) Pressure (T) Force (t) Dimensional (T) Temperature (T) Ionising radiation (t) Radioactivity Standards (T) Electricity (T,t) MIC (T) (All the T level is in South-Africa. Selected offerings at t level exist at other institutes. SADCMET did a comprehensive study of what need to be established in individual member countries)	South-Africa: Force (T), Ionising radiation (T), Resistance, power and energy (T), Large Flow (T) MiC; High resolution MS facility for POPS (Dioxin/furan) analysis and CRMs, Food matrix CRMs. Other countries; Basic fit for purpose metrology parameters as identified by SADCMET (see appendix A and B).

4.4.2.6 SOAMET

In addition to the efforts at national level to improve metrology infrastructure, member States of UEMOA have opted for a common strategy in order to capitalise on the synergy arising from national potential to better promote the productive sector, derive benefits from the opportunities offered by the world economy and to achieve a high standard of living for their citizens. The bedrock of this common strategy is the enhancement of the economic integration process initiated within UEMOA since 1994 [32]. In the industrial sector, a common industrial policy (CIP) has been adopted to pool resources in the region with as aim the increase in industrial output. The Union's Agricultural Policy (UAP) tends to increase cash crop production. Growth is not currently following the predictions or targets, in part due to the global recession. Specific economic development strategies to make the vision a reality include the processing of cotton fibre, the development of the textile industry, fish farming and a programme to improve competitiveness of small industry (SMEs etc).

An average GDP growth of 6% is forecast for Cote d'Ivoire for until 2013 [33]. The growth is based (in part) on the active promotion of exports. Specific sectors mentioned are Food production, export

Agriculture (cocoa, cotton) and oil and gas exploration. Mining is also expected to increase (iron ore, nickel, bauxite, gold).

Main Products and Exports (SOAMET)	Future Industries and Exports	Current Metrology Offerings	Future Metrology needs (T level)
Resources and Commodities; - Oil and natural gas, uranium, gold, other minerals, Agriculture; - cocoa, coffee, fish products and cotton	Textile industry Processed cotton fibre Fish farming Mineral beneficiated products Petroleum products Processed foods	Mass (t) Volume (nt) Density (nt) Temperature (nt) Electricity (nt)	Mass (T) Length (T) Volume (t) Density (t) Temperature (t) Electricity (t) MIC (t)

5. The Way Forward

5.1 An overall Strategy to Advance Metrology in Africa

The establishment of fit-for-purpose metrology in Africa is a momentous task. It not only involves the provision of traceability for existing analytical, measurement and calibration services, but in many cases the establishment of a measurement structure and facilities at all levels (weights and measures, testing, calibration, traceability, accreditation, international benchmarking) for the country.

The snapshot of the status of Metrology in Africa, the status of the economies and future trends indicate that the metrology system can be improved at three distinct levels namely national (basic infrastructure), sub-regional (hubs to provide fit-for-purpose traceability and harmonisation of regulations for regional trade) and continental (a few advanced NMIs and LMIs that could provide the linkage to the international measurement system).

In summary, the strategy is to:

A. Establish fit-for-purpose basic legal and industrial metrology in the least-developed countries;
B. Strengthen existing Legal and S&I metrology capabilities in developing countries in the sub-regions to provide in the needs of intra-regional trade and finally;
C. Elevate the level of metrology in more technologically advanced countries to an internationally acceptable level.

A crucial part of the strategy is that S&I metrology for basic parameters and harmonisation of Legal metrology issues will be developed at a fit-for purpose level in all member countries, but that the responsibility for traceability and international acceptance of measurement results and will be shared amongst member countries rather than to try and establish everything in each country.

5.2 Implementation of the Strategy

The strategy can be implemented as follows:

A) Firstly, in support of the basic metrology needs in the countries, establish basic metrology infrastructure in all member countries and improve the overall level of awareness of metrology at the sub-regional level. The following steps are proposed:
   a. Obtain the political by-in at national and/or regional level,
   b. strengthen the sub-regional institutional metrology infrastructure,
   c. motivate and assist members to adopt metrology legislation at national level, or at least technical regulations for the most important national/regional issues,
   d. develop fit-for-purpose training programmes and provide basic training in metrology (the SADC EU project in SADCMET and SADCMEL can be used as an example [35);
   e. develop fit-for-purpose basic Weights and Measures metrology infrastructure in member countries. This should include the establishment of enforcement capabilities and basic measurement infrastructure,
   f. develop fit-for-purpose industrial metrology laboratories for the basic parameters that can later be improved to include scientific metrology. The focus should be on providing traceability to existing measurement capabilities in the country, in support of weights and measures, or where very little exist, to operate as an accredited measurement facility for the country. This could either be at national level or as in the case of SOAMET, can be shared amongst the members. Where very little measurement infrastructure currently exists, as in CEMACMET, it is an advisable option.
   g. obtain third party accreditation for the laboratories.

B) Secondly, in support of intra-regional trade, health diagnostics, consumer protection, environmental monitoring and law enforcement in member countries, improve the status of both Legal and S&I metrology in the more advanced countries in the sub-regions. Where possible, leading sub-regional NMIs can provide traceability to all top-level measurement standards or national measurement standards of members, or provide a link between national institutes and institutes regionally or internationally that can provide traceability to the SI. This process should be overseen by a sub-regional metrology infrastructure that will harmonise legal metrology issues and organise and manage benchmarking exercises. The following steps can be followed:
   a. Improve the status of the NLMBs in each country to fit-for-purpose level,
   b. establish S&I metrology at a fit-for-purpose (national) level that is at least recognised in the sub-region,
   c. assist the leading institution(s) in sub-regions to provide leadership in Legal metrology issues and a traceability link to regional members,
   d. assist the leading institutions to pilot benchmarking exercises in the sub-region.

C) Thirdly, in support of all trade and measurement issues of continental and international concern, obtain international recognition for Calibration and Measurement capabilities. This

could be done through the establishment (or strengthening) of regional centres of excellence. The following steps are foreseen:

a. Strengthen the AFRIMETS institutional infrastructure,
b. assist AFRIMETS with liaison with international organisations such as OIML/CIML, BIPM/CIPM, RMOs, the JCRB and technical interaction such as with Legal metrology forums and Consultative committee meetings and workshops;
c. initiate a process of harmonisation of legal metrology legislation and regulatory control and trade relevant measurement capacity of NLMBs upgraded according to international standards,
d. assist leading LMNBs with linkages to international Legal metrology structures and to obtain membership of the OIML,
e. assist leading NMIs to provide and improve the traceability route through membership (or associates) of the BIPM, accreditation and or peer review of facilities and the approval of Quality systems,
f. establish what parameters should be elevated to international recognition level (taking into account the needs of Legal metrology as well), and in which member countries it should be done. Sharing of this responsibility amongst sub-regional members is highly recommended,
g. get CMCs accepted in the international key comparisons database for all parameters critical for the sub-region,
h. identify what capabilities do not exist on the continent, identify NMIs that can operate as regional centres of excellence to establish these capabilities, and define strategies to obtain funding to establish the capabilities.

Overarching, a training strategy is crucial for the effective implementation of the strategy proposed. It is acknowledged that many training exercises had been conducted previously as part of individual member or sub-regional donor projects, and the training strategy will focus on generic training in metrology at a basic level for least-developed countries, and specific training for countries more advanced in metrology.

A technology development strategy will also be developed for the continent to lessen future dependence on other regions and to develop more fit-for-purpose measurement standards for Africa.

The political recognition of AFRIMETS by the AU is covered by the Pan-African Quality Infrastructure project sponsored by the PTB. This process is continuing since 2009 when a Quality Infrastructure representative was sponsored by the PTB to assist the process through NEPAD. In April 2011, with the help of NEPAD and coordinated between the pan-African structures representing Standardisation (ARSO and AFSEC), Metrology (AFRIMETS) and Accreditation (SANAS), an official request was submitted to the AUC for the recognition of the four bodies as representing the pillars of the Quality Infrastructure in Africa. Subsequently, a request for information on the structures was received from the AU. AFRIMETS forwarded its constituting MoU and information on its membership as contained in this Roadmap. A representative of the AU was also invited to attend the AFRIMETS

GA. The process to receive recognition will continue under the guidance of the PTB pan-African project, and assistance from UNIDO.

To achieve the proposed strategy to develop the metrological infrastructure in the countries and sub-regions, specific steps are proposed for each category (A,B and C). Interested donors can then choose the appropriate project to get involved in. The proposed projects are summarised in Table 5 and the detail is given in section 5.4.

Category A: Least developed countries with very little or no metrological infrastructure. Establish basic Weights and Measures (Legal metrology) and fit-for-purpose Industrial metrology, with the option to expand to Scientific metrology with secondary or transfer standards. In parallel, develop some SRMO institutional structures.

This category applies to CEMACMET, and from Step 4 for most countries in SOAMET, Mauritania in MAGMET, Sudan and Libya in NEWMET and Burundi in EAMET. Step 4 have been completed in SADCMET and to a large extend in EAMET, and their models of how it was done could be adopted by the other SRMOs.

Step 1: Make contact with local government and get approval to perform a comprehensive study of the measurement needs in the country. This should include:

-measurements and traceability needed for weights and measures;
-the main local and export industries and their measurement needs;
-health and environmental measurement and monitoring needs;
-measurement needed in support of law enforcement;
-future economic and market trends and associated measurement needs;
-existing measurement infrastructure, including:
-testing and calibration laboratories (private and public) and the tests/analysis/calibrations performed;
-accreditation status;
-the level of traceability needed.

Step 2: Get the approval of local government on the best model to achieve the required basic measurement infrastructure and consensus from the economic block on the sub-regional approach. This should include:

-a decision on what level of traceability will be established nationally, and what will be sourced sub-regionally, regionally and internationally;
-if applicable legislation is in place and if not, the process to establish;
-where the capability should be established;
-future sustainability, support from national government and the regional economic block.

Step 3: Establish a SRMO institutional structure to assist the process in the region, and act as a contact point.

Step 4: Develop a detailed plan with costing of how to develop the infrastructure. This should include:

-the main parameters to be established;
-must the parameter be established for national or regional needs;
-future parameters that provision must be made for;
-the building infrastructure with specific focus on environmental conditions;
-list and costing of equipment;
-staff requirements;
-training and skills plan;
-operational funding requirements.

Step 5: Obtain funding from a combination of national, regional or donor sources to implement.

Category B: Developing countries with basic metrological infrastructure. Here a Sub-regional approach is proposed to establish fit-for-purpose traceability to sub-regional NMIs and Legal metrology structures that is benchmarked regionally

For this category, the basic principles of a metrological infrastructure are understood, but basic metrological infrastructure in member countries need to be improved. The focus should be to formalise the methodology for a sub-regional approach, identify what parameters and level of traceability must be established at sub-regional hubs, and what parameters and level of traceability should be established in individual countries. This category includes SOAMET and to a certain extend MAGMET and NEWMET. The process is already followed in EAMET and has been finalised in SADCMET/MEL.

Step 1: Obtain consensus on the sub-regional approach from the SRMO secretariat and structures within the economic block (for example UEMOA, ECOWAS, EAC, AMU).

Step 2: Perform a comprehensive study of the measurement needs in the sub-region. The regions with an established sub-regional secretariat structure will have such information available, but it may entail Category A studies for individual countries (for example MAGMET: Mauritania, SOAMET: Guinea-Bissau, Mali, Niger and Togo; EAMET: Burundi; NEWMET: Libya, Sudan).

Step 3: At the national level, obtain approval from local government on the best model to achieve the required basic measurement infrastructure, as in Category A. This should include:

-agreement on what level of traceability will be established nationally and what will be sourced sub-regionally, regionally and internationally.
-if applicable legislation is in place and if not, the process to establish
-where the capability should be established.
-future sustainability and government support.

Step 4: Prioritise and divide into individual projects to establish the required parameters and levels of traceability at individual NMIs or LMIs.

Category C: Provision of internationally benchmarked traceability to the sub-regions by more advanced NMIs and internationally accepted Legal metrology by LMIs.

This category includes Egypt, South-Africa, Kenya and for the future, Tunisia, Ghana, Ethiopia, Seychelles, Zambia, Zimbabwe, Mauritius and Côte d'Ivoire. The methodology is to identify what gaps exist in the provision of internationally benchmarked traceability to the sub-regions, and which parameters must be strengthened to improve the level of traceability. The basic information is available in this Roadmap, but needs to be investigated in more detail.

It is proposed that this category be designed on the basis of a network of higher level NMIs and LMIs in Africa that could provide internationally benchmarked traceability to the continent. For Scientific & Industrial, this will be for secondary measurement standards as established at the sub-regional or individual member NMIs. For Legal metrology, the LMIs would be able to provide guidance and assistance to member countries of how to establish fit-for-purpose Legal metrology structures, development of regulations and assist with training of inspectors.

Step 1: Obtain a detailed picture of:

-the offerings at the individual NMIs, including the level, uncertainty of measurement and the status of international acceptance;

-identify the gaps;

-reach consensus on which NMIs will focus on primary realisation of which units, including agreement at the national government level.

Step 2: Prepare a schedule of which parameters will be established where and when;

-obtain a full costing to improve/establish the parameter. This should include equipment, staff, training, participation in benchmarking exercises (pilot studies, comparisons) and operational costs.

Step 3: Prepare proposals for individual projects and publish in a schedule on the AFRIMETS website. Donors can then assist with individual projects

It must be stressed that this category is one of the most important categories for the advancement of AFRIMETS. In the past, donor agencies were inclined towards assistance to least-developed countries. The risks associated with the establishment of basic metrological infrastructure in these countries are huge. The projects must be planned thoroughly, with the sustainability issue properly addressed. Even then an inadequate local infrastructure, the loss of key personnel, political instability and in general isolation can easily render investments useless. Investments in more advanced and politically stable countries that can assist neighbouring countries with metrology issues are thus an important part of the strategy.

5.3 Barriers to implement the strategy

The Barriers to establish metrology infrastructure is well known. The main factors are:

- Political instability
- Lack of political support for Metrology
- Lack of regional/national infrastructure

- Lack of proper buildings, poor environmental conditions
- Lack of artefacts/instrumentation
- Lack of trained personnel/metrologists
- Lack of services (electricity, water, gas, liquid nitrogen/helium, consumables)
- Lack of technical support for instrumentation –most of the time must be sourced from overseas

It is beyond the scope of this Roadmap to comment on the barriers per member or to suggest solutions for the barriers. It is sufficient to state that strategies for the institutional strengthening and to improve the metrological infrastructure in Africa should take cognisance of the barriers. Where specific barriers are identified in a sub-region, it is stated in the final recommendation of a strategy to improve metrological infrastructure in the sub-regions.

5.4 Sub-Regional Strategies

The information already gathered in this Roadmap can be used as the basis for the studies proposed for the sub-regions. It is however important that comprehensive, in-depth studies be conducted per member country where the information is not available. For EAMET and SADCMET, most of the information is already available.

The studies should take cognisance of the findings in the report from the UNIDO Expert Group on "Standards Compliance and Conformity Assessment for the Development of Sustainable Trade in Africa" on "Assessing the Specific Needs of African Countries in the Field of Quality Infrastructure with a Focus on Key Export Sectors". It is important that the investment in metrology infrastructure supports the key export sectors.

As an output of all the studies, a comprehensive list of S&I capabilities to be established will be developed according to three distinct levels of sophistication. It will be summarised as High level capabilities at CMC level, medium level capabilities per region and fit-for-purpose capabilities per country (see Table 11 in Appendix C).

5.4.1 CEMACMET

It is proposed that a category A study be conducted for CEMACMET, including the establishment of a sub-regional structure. This should be followed by some elements of a Category B study.

Three distinct projects are proposed:

<u>First project (C 1): Basic Scoping Study</u>

Step 1: Make contact with local governments in the region and get approval to perform a comprehensive study of the measurement needs in the countries of CEMAC, and conduct the study;

Step 2: Get the approval of local governments on the best model to achieve the required basic measurement infrastructure and consensus from CEMAC on the sub-regional approach;

Step 3: Establish a SRMO institutional structure for CEMACMET to assist the process in the region, and act as a contact point. It must again be emphasised that the sub-regional structure only

need to be a central contact point or points for Scientific & Industrial and Legal Metrology, and when more mature, can assist with coordination of metrology activities in the sub-region.

The cost for the study should be based on the appointment of three experts (economical/market studies and metrology -both legal and Scientific & Industrial) for 15-20 working days each, visits to the 8 member countries and a comprehensive report.

Second Project (C2): Detailed Infrastructure Costing

Step 4: Develop a detailed plan with costing of how to develop the infrastructure, including the sequence in which it will be implemented in the member countries;

Step 5: Motivate for funding from a combination of national, regional or donor sources to implement.

The cost for such a study should be based on the appointment of 2 metrology experts (Legal and S&I) for at least 25-30 workdays each, with provision for 2-3 follow-up visits to some members

Third Project (C3): Infrastructure Development

Step 6: Develop technical infrastructure in members starting with the most developed countries in CEMAC. From this point, the establishment of facilities in each member country will be a project on its own, although it will follow the strategic plan as defined in step 4.

5.4.2 EAMET

It is proposed that a category A study be conducted for Burundi, elements of a category B study for Rwanda and a category C study for Uganda and Kenya. As the SRMO is well established, most information is already available. It is also recommended that the projects be conducted either by, or under the supervision, of the EAMET Executive.

Three projects are proposed:

First Project: (E 1): Scoping Study Burundi

Step 1: Get approval from the Burundi government to perform a comprehensive study of the measurement traceability needs (Legal metrology is already established) and perform study;

Step 2: Reach consensus with the Burundi government on the best model to achieve the required basic S&I measurement infrastructure and to improve the Legal metrology infrastructure, in consensus with EAMET as a sub-regional approach;

Step 3: Develop a detailed plan with costing of how to develop the S&I infrastructure and to improve the Legal metrology infrastructure in Burundi;

Step 4: Motivate for funding from a combination of national, regional or donor sources to implement;

The cost for the study should be estimated on the appointment of two experts from EAMET for 15-20 working days each, and at least 3 visits to Burundi.

Second Project (E2): S&I Infrastructure development Rwanda

Step 1: Obtain approval from the Rwandan government to conduct a study on the traceability needs of Rwanda, and conduct the study;

Step 2: Develop a detailed plan with costing of how to further develop the S&I infrastructure in Rwanda;

Step 3: Motivate for funding from a combination of national, regional or donor sources to implement.

The cost for the study should be estimated on the appointment of one expert from EAMET and 2 visits. The next step will be to develop S&I technical infrastructure in Rwanda, with the cost as determined in Step 2.

Third Project (E 3): Infrastructure Improvement at UNBS and KEBS

Step 1: Update the detailed of the offerings (including uncertainty of measurement) at UNBS, KEBS and Kenya Weights and Measures and reach consensus on who will focus on primary realisation of which units, including agreement at the EAMET Executive level;

Step 2: Prepare a schedule of which parameters will be established where and when;

Step 3: Prepare proposals for individual projects and publish in a schedule on the AFRIMETS website. Donors can then assist with individual projects.

The cost for the study will be estimated according to the appointment of two experts from EAMET and 2 visits.

5.4.3 MAGMET

It is proposed that a category A study be conducted for Mauritania, a category B study for Algeria and a category C study for Morocco and Tunisia.

Three distinct projects are proposed:

First Project: (M 1): Scoping Study: Mauritania

(It is proposed that the projects be conducted under the guidance and through the MAGMET Executive):

Step 1: Make contact with the Mauritanian government and get approval to perform a comprehensive study of the measurement needs in Mauritania and perform study;

Step 2: Get the approval from the Mauritanian government on the best model to achieve the required basic measurement infrastructure, in consensus with MAGMET on the sub-regional approach;

Step 3: Develop a detailed plan with costing of how to develop the infrastructure in Mauritania;

Step 4: Motivate for funding from a combination of national, regional or donor sources to implement.

The costing should be estimated on the appointment of two metrology experts for 10-15 working days each and 2 visits.

Second Project (M 2): Infrastructure Development Algeria

Step 1: Obtain approval from the Algerian government to conduct a study on the traceability needs of Algeria and conduct the study;
Step 2: Develop a detailed plan with costing of how to develop the infrastructure in Algeria;
Step 3: Motivate for funding from a combination of national, regional or donor sources to implement;

The costing should be estimated on the appointment of one metrology expert for 20-25 working days and 2 visits.

Third Project (M 3): Infrastructure Development Morocco and Tunisia

Step 1: Obtain a detailed picture of the offerings at the individual NMIs in Morocco and Tunisia and reach consensus on which NMIs will focus on primary realisation of which units, including agreement at the national government and MAGMET Executive level;
Step 2: Prepare a schedule of which parameters will be established where and when;
Step 3: Prepare proposals for individual projects and publish in a schedule on the AFRIMETS website. Donors can then assist with individual projects.

The costing should be estimated on the appointment of one metrology expert for 20-25 working days and 2 visits.

5.4.4 NEWMET

It is proposed that a category A study be conducted for Sudan, a category B study for Nigeria, a verification of activities in Libya and a category C study for the rest of the region. It is proposed that the projects be conducted under the guidance and through the NEWMET Executive.

For Sudan it is proposed that a category A study be undertaken once the political situation has stabilised, and the secession of South-Sudan has been finalised. The first step should then be to confirm the participation of both North- and South-Sudan in NEWMET. If South Sudan chose to participate in EAMET, the study can be conducted under the auspices of the EAMET Executive.

Three distinct projects are proposed:

First Project (N 1): Scoping Study Sudan

Step 1: Make contact with both Sudanese governments and get approval to perform a comprehensive study of the measurement needs in North and South Sudan and perform study;
Step 2: Get the approval from the Sudanese government son the best model to achieve the required basic measurement infrastructure, in consensus with EAMET on the sub-regional approach;
Step 3: Develop a detailed plan with costing of how to develop the infrastructure in North and South Sudan;

Step 4: Motivate for funding from a combination of national, regional or donor sources to implement.

The cost should be estimated on the appointment of 4 experts (2 from NEWMET and 2 from EAMET) for 15-20 days each, and 4 visits.

Second Project (N 2): Infrastructure Development Nigeria

Step 1: Assist SON to conduct a study on the traceability needs of Nigeria;
Step 2: In partnership with SON, develop a detailed plan with costing of how to develop the S&I infrastructure in Nigeria;
Step 3: Motivate for funding from a combination of national, regional or donor sources to implement;

Most of the information should be available from SON. It is envisaged that one expert from NEWMET could assist SON with the study and the costs should be based on one expert for 10-15 days and one visit.

Third Project: (N 3): Infrastructure development Libya

The Libyan National Centre for Standardisation and Metrology (LNCSM) is well known to NEWMET, but the institute had very little interaction with AFRIMETS. It is proposed that once the political situation has stabilised, NEWMET conduct a study to determine the metrology offerings in LNCSM and to identify any future projects in the country. The costs can be estimated on the appointed of a S&I expert and will include a visit to Libya by the NEWMET secretariat.

Fourth Project (N 4): Infrastructure development in Ethiopia, Ghana and Egypt

Step 1: Update the picture of the offerings at the individual NMIs in Ethiopia, Ghana and Egypt. Reach consensus on which NMIs will focus on primary realisation of which units, including agreement at the national government and NEWMET Executive level;
Step 2: Prepare a schedule of which parameters will be established where and when;
Step 3: Prepare proposals for individual projects and publish in a schedule on the AFRIMETS website. Donors can then assist with individual projects

Due to the level of development of NEWMET, the cost should be minimal, although it could include a joint meeting of the three institutes to finalise the proposal. The cost can be estimated as assistance for the meeting (travel of at least 4 individuals intra-regionally).

Projects already identified:

Egypt

1) The expansion of the metrology in chemistry section to include the preparation of primary gas mixtures and an Organic and Bio- analysis section.
2) Improve the traceability chain for time and frequency, temperature, pressure, dosimetry etc. Project proposals will be invited from NIS.

5.4.5 SADCMET

SADCMET/MEL has a comprehensive strategy to develop metrology at a basic level in the region, as defined in the SADC-EU project and SADC-PTB interactions.

As part of the SADC EU project, SADCMEL conducted a Legal metrology landscape study for 7 countries [35]. SADCMET performed measurement needs studies in most of the region and has a comprehensive database of the current offerings at NMIs and future needs for traceability (see Appendix D).

Current or recent activities include a measurement needs study completed for Swaziland and one in progress for Namibia. UNIDO sponsored QS projects are currently being conducted in Mozambique and Zambia.

The only country in the region with no metrology infrastructure is Lesotho. Due to the small size of the economy of Lesotho and its proximity to the NMISA where it can source traceability from, the proposed strategy is to update the measurement needs and investigate the option of a mobile metrology laboratory (MML). Maintenance and calibration of equipment can be performed in SA.

Madagascar is currently excluded from activities in SADC due to the political situation. Most information regarding measurement and metrology needs are known, and it is possible to design a strategy to establish missing parameters without a comprehensive study.

Although some information is available for the DRC, it needs to be updated and a study may be necessary. This could be performed as part of the extension of the SADC EU project (anticipated for 2012 onwards).

The SADCMET/MEL strategy does not include a category C intervention, and the recommendation is to focus on a category C study for the more advanced NMIs and NLMBs in SADC. An overarching project is thus proposed specifically to improve the international standing of the leading NLMBs and NMIs:

<u>First Project (SD1): Infrastructure Development at sub-regional level</u>

Step 1: Update the picture of the status of the NLMBs and NMIs in South Africa, Mauritius, Seychelles, Zambia and Zimbabwe. Reach consensus on which NMIs will focus on primary realisation of which units, including agreement at the national government and SADCMET/MEL Executive level. For NLMBs, reach consensus on what interventions are needed to fill the gaps as identified in Table 4, and elevate the member countries to a higher level;

Step 2: Prepare a schedule of which parameters will be established where and when, and what interventions are necessary;

Step 3: Prepare proposals for individual projects and publish in a schedule on the AFRIMETS website;

Donors can then assist with individual projects.

The study could be conducted by the SADCMET and SADCMEL secretariats. The cost can be based on 4 visits and one joint meeting.

Projects already identified:

SD 2.1; Establishment of a Regional Reference facility for POPS analysis

Establish a regional (AFRIMETS) Persistent Organic Pollutant laboratory in Organic chemistry, with the focus to perform dioxin screening for export from the region. The idea is to establish this laboratory in South Africa at the highest level possible, with state-of-the art equipment rendering internationally recognised environmental analysis, and then to provide assistance to a network of lower level POPs laboratories at the leading sub-regional NMIs, thus Kenya, Egypt, Ghana and Cote d'Ivoire. The cost for this project is estimated at € 3,5 million.

SD2.2; Shorten the Traceability route for Electrical parameters

Shorten the traceability chain for electrical parameters with the establishment of primary systems for resistance, ac power and capacitance (quadrature bridge). The realisation will be implemented in the countries as identified in 1.

SD2.3; Equip established NLMBs in the region with fit-for-purpose equipment.

Built on the successes of the SADC EU project and equip well established NLMBs with the necessary equipment as identified in the project. It is proposed to start with Mauritius, Seychelles and Zimbabwe. Bi-lateral programmes are running in Mozambique, Namibia and Zambia.

5.4.6 SOAMET

It is recommended that category A studies be conducted for Guinea-Bissau, Mali, Niger and Togo. A category B study should be conducted for Benin, Burkina Faso and Senegal. A combination of a category B and C study should be conducted for Côte d'Ivoire.

The study could be conducted under the auspices of the SOAMET secretariat with external expert input.

In summary:

First project (S 1): Scoping study SOAMET

Step 1: Make contact with local governments in Guinea-Bissau, Mali, Niger and Togo and get approval to perform a comprehensive study of the measurement needs;

Step 2: Update the metrology offerings from Benin, Burkina-Faso, Côte d'Ivoire and Senegal and confirm gaps;

Step 3: Get the approval of local governments on the best model to achieve the required basic measurement infrastructure and consensus from SOAMET Secretariat on the sub-regional approach.

The cost should be estimated on two experts for 30-40 days each and 8 visits. This study could be combined with the CEMACMET study and the studies for Mauritania and Burundi (all French speaking).

Second Project (S2): Infrastructure development at National level

Step 4: Develop a detailed plan with costing of how to develop the basic infrastructure, including the sequence in which it will be implemented in the member countries;

Step 5: Motivate for funding from a combination of national, regional or donor sources to implement.

Third Project (S 3): Infrastructure development at Regional level

Step 6: Improve the traceability link in members starting with the most developed metrology institutes (Benin, Burkina Faso). From this point, the establishment of facilities in each member country will be a project on its own, although it will follow the strategic plan as defined in step 4.

5.4.7 Summary of Proposed SRMO Projects

The summary of the SRMO projects with an indication of what should be taken into account when costing the projects is given in Table 5 on page 61.

Table 5: Summary of Proposed Projects in Sub-regions

No	Sub-RMO	Category	Project Description	Cost to be Based On
C1	**CEMACMET**	**A**	Basic Scoping Study	3 Experts- 15-20 days each 8 visits each for 3 experts = 24
C2		**A**	Infrastructure Costing	2 Experts for 25-30 days each 4-6 visits to members
C3		**A**	Infrastructure Development	As per recommendation from C1-2
E1	**EAMET**	**A**	Scoping Study Burundi	2 Experts 15-20 days each 3-4 visits to Burundi
E2		**B**	Infrastructure development Rwanda	2 Experts 15-20 days each 2 visits to Rwanda
E3		**C**	Infrastructure Improvement: Uganda and Kenya	2 Experts 15-20 days each 2 intra-regional visits
M1	**MAGMET**	**A**	Basic Scoping Study Mauritania	2 Experts 15-20 days each 2 intra-regional visits
M2		**B**	Infrastructure Development Algeria	1 Expert 20-25 days 2 intra-regional visits
M3		**C**	Infrastructure Development Morocco and Tunisia	2 Experts 15-20 days each 2 visits
N1	**NEWMET**	**A**	Scoping Study Sudan	2 experts 15-20 days each 4 intra-regional visits
N2		**B**	Infrastructure Development Nigeria	1 Expert for 5 days 1 visit
N3		**B**	Infrastructure Development Libya	2 Experts for 10 days each 2 visits
N4		**C**	Infrastructure Development Ethiopia, Ghana, Egypt	4 visits (joint meeting for 2 days)
SD1	**SADCMET**	**C**	Infrastructure Development at sub-regional level	4 visits and one joint meeting
SD2.1		**C**	Develop POPS regional facility	To be costed. Will be published on website
SD2.2		**C**	Develop primary traceability for Electrical quantities	To be costed. Will be published on website
SD2.3		**C**	Equip NLMBs in the region with fit-for-purpose equipment	To be costed. Will be published on website
S1	**SOAMET**	**A**	Scoping study Guinea-Bissau, Mali, Niger and Togo	2 Experts for 30-40 days each 8 visits
S2		**B**	Infrastructure Development at National level	To be estimated from study S1.
S3		**C**	Infrastructure development at Regional level	To be estimated from S2.

5.5 Strengthening the AFRIMETS institutional infrastructure

Since the inception of AFRIMETS in 2007, the institutional arrangements (and meetings), as well as marketing material have been sponsored by the PTB, NMISA and to a lesser extend the NCRS. S&I metrology benchmarking exercises are mostly sponsored by the NMISA and the PTB. NEPAD assisted with the first GA. The SADC EU project also contributed to AFRIMETS through sponsorships to SADCMET and SADCMEL. The PTB and UNIDO also contribute to the general activities of the SRMOs through individual projects in support of economic blocks or individual countries. Since the start of the UNIDO/AFRIMETS project in 2009, UNIDO is assisting with training, attendance of some meetings, marketing, a metrology school and assistance with benchmarking exercises.

The NMISA, NRCS and PTB contribute to the Secretariat. PTB sponsors a contract administrative person, as well as individually motivated projects and marketing material. The NMISA and NRCS provide all further Secretariat functions.

Technical activities such as comparisons and proficiency testing schemes are funded mostly by the pilot laboratory (up to now NMISA), with assistance from the PTB for the transport of artefacts and evaluation meetings. UNIDO, through the Project, also assists with the purchasing of artefacts needed for benchmarking exercises.

Projects to strengthen the institutional infrastructure and to ensure a more effective system are proposed below. A summary of the projects and associated costs are given in Tables 11.

5.5.1 The Secretariat and ensuring a Sustainable AFRIMETS

Various models for a Secretariat were investigated. Most RMOs follow a rotation system where members host the Secretariat for defined periods. Most of the costs are funded by the host institution. Most RMOs charges a membership fee and contributes an amount to the Secretariat for travel of Secretariat members for RMO activities, marketing and to manage information systems.

The exception is the European Association of National Metrology Institutes (EURAMET). What sets EURAMET apart from the other RMOs is funding from the EU that can be accessed by NMIs on a 50/50 basis for joint research projects in metrology. It is called the European Metrology Research Programme (EMRP). EURAMET was established as a legal entity from its predecessor EUROMET.

The EURAMET Secretariat is still hosted by an NMI (currently PTB), but most of the Secretariat personnel is appointed by the RMO and funded from a combination of membership fees and a participation fee in the EMRP. In practise, some of the costs are still shared by the host NMI.

A full cost analysis was done for

1) A “permanent”, fully sponsored secretariat;
2) A Secretariat hosted by a member country with partial funding from membership fees or donors, and;
3) A secretariat hosted and sponsored by a member country.

After much deliberation and discussion with role players, it was decided that due to the RMO role as defined internationally and the associated skills base needed, that a “permanent” fully paid

secretariat is not an option. A secretariat hosted and fully sponsored by a host country can become a financial burden to such an extent that member countries will be reluctant to host the secretariat.

For AFRIMETS, a Secretariat hosted by a member country with partial funding from membership fees or donors is thus proposed. The estimated costs are shown in table 5.

Table 6: The costs for a partially sponsored Secretariat (calculated at 2011 rates. This should be escalated with 5% per year)

Topic	Description	Estimated cost per annum (Euro)
Accommodation and services	Accommodation is currently provided by the NMISA	To be provided by the host
Head of the secretariat	Currently provided by the NRCS	To be provided by the host
Technical Human resources	Currently provided by the NRCS (Legal) and the NMISA (S&I)	To be provided by the host and members
Resource person -Admin -ICT	Currently sponsored by PTB for a half day. A full day person is recommended. It is assumed that further resources would be provided by the host country	40-80 000
Travel of Executive members -EXCOM meetings (2-3 p/a) -JCRB meetings (2 p/a) -RMO meetings (2-3 p/a) -Miscellaneous (CIML?)	The PTB is currently assisting with travel to Executive committee meetings, And UNIDO sponsored 2 RMO GA attendants	30 – 60 000
Upkeep of website	Currently jointly provided by NMISA and the PTB	10 – 20 000
Promotional material and marketing	Currently provided by PTB, NMISA and UNIDO	15 – 30 000

There are two models to obtain the funding.

1) Sponsored by a donor;
2) From membership fees.

It is not recommended at this stage to introduce a membership fee for AFRIMETS, as it could provide an entry barrier to the remaining non-members. It can also not be recovered from non-active members at the moment, for example all members of CEMACMET and many members of SOAMET. The issue of membership fees to the SRMO versus membership fees to AFRIMETS will also have to be resolved first.

It is recommended that this issue be thoroughly discussed and planned over the next five years. A membership fee could be introduced once all SRMOs are fully operationable. It is envisaged that a five tier membership fee could then be levied:

Table 7: Proposed Future Membership Fees (Based on classification in table 2)

Category	Examples with numbers	Proposed Fees (€ p/a)	Total Income (€ p/a)
A. Top level NMIs/NLMBs participating at International Level	4	5 000	20 000
B. Middle level NMIs/NLMBs, leading in sub-regions	6	2 500	15 000
C. Other well established NMIs/NLMBs	8	1 500	12 000
D. NMIs/NLMBs from LDCs participating at SRMO level only	14	1 000	14 000
E. Observers (aspiring members)	4	500	2 000
	Total		**63 000**

It is questionable if the full amount could be recovered the first 1-3 years, and some external sponsorship will be needed in the interim. The fees could then be increased over a five year period, until it fully covers the costs. It is also envisaged that the active membership will increase with the implementation of the strategy for CEMACMET and SOAMET.

The desired sponsorship is thus:

Table 8: External sponsorship necessary for a fully operational AFRIMETS Secretariat, hosted by a member country

Year (starting 2011)	Sponsorship (€)	Membership fee (€)
2011	73 000	0
2012	76 500	0
2013	80 000	0
2014	84 000	0
2015	88 000	0
2016	40 000	52 000
2017	30 000	70 000

5.5.2 Approval of Quality systems and assistance to benchmarking exercises

The CIPM MRA stipulates that RMOs must have a process in place to approve the Quality Systems of the member NMIs, as a pre-requisite for the acceptance of CMCs into the KCDB. In AFRIMETS, the responsibility is delegated to the TC-QS (Technical Committee for Quality). The procedure stipulates an on-site visit. The cost associated with the time spent at the NMI is absorbed by the host NMI, but the preparation by the TC-QS and flights to the host country are not covered. In other RMOs there are enough high level NMIs that the cost can be shared between the committee members, that rotates between the member countries. In AFRIMETS, technical experts were trained (UNIDO) to assist with peer-review, but only the NMISA and NIS currently have the capability to oversee the

approval of the Quality systems. This places a financial burden on the two institutes, and the travel costs of the technical assessors (only for parameters not third party accredited) must be covered.

Sponsorship, based on 2 such visits per year (for 2011, Kenya and Tunisia) is estimated at €11 000.

One of the most important activities of a RMO is benchmarking exercises. In AFRIMETS, these exercises are conducted at two distinct levels;

1) SRMO pilot studies and proficiency testing;
2) AFRIMETS pilot studies, proficiency testing, Supplementary and Key comparisons.

The costs of SRMO exercises will be borne by the members. Funding is requested for AFRIMETS studies, with as priority Supplementary and Key comparisons to support CMC claims.

A schedule of benchmarking exercises (2011-2012) is attached in Appendix E. The schedule will be expanded to 2013-2015 as benchmarking needs are identified through the proposed studies.

The total estimated costs for the period are:

Table 9: Estimated costs for sponsorship of Quality system approval and benchmarking exercises

Category	Sponsorship 2011 (€)	Sponsorship 2012 (€)	Total (€)
Quality System approval	13 000-15 000	15 000-17 000	**27 000-31 000**
Supplementary and Key Comparisons -Development of scopes (comparisons p/a)	22 000-25 000	35 000-38 000	**57 000-63 000**
Supplementary and Key Comparisons -Artefacts	30 000-33 000	40 000-44 000	**70 000-77 000**
Supplementary and Key Comparisons -Logistics	5 000-6 000	7 000-8 000	**12 000-14 000**
		Total	**166 000-185 000**

5.7 Strategies for Alternative Technologies and Skills development

5.6.1 Alternative Technologies and Measurement Standards

Some of the oldest examples of accurate measurement standards were found in Africa, but the development of modern day measurement standards and measurement technologies originates from Europe, the United States and Asia Pacific (Japan). The recent development of scientific metrology in Africa followed the example set by the developed world. The advantage is that

resources do not need to be spent to re-invent the wheel, and technologies and standards can be imported from developing countries. The disadvantage is that the technologies in many cases are not suited to African conditions.

Also, often the methods prescribed in European Union regulations are not readily available or accessible in Africa, due to the high cost of the equipment, cost and availability of reference materials for the methods, or the high level of specialisation required to operate it.

The strategy is to form a metrology interest group amongst the more advanced NMIs and NLMBs in Africa to develop robust, fit-for-purpose measurement standards and methods, based on technologies adapted to Africa.

South Africa and Tunisia are already conducting research into a robust optical clock that could form the backbone of an African time network. To comply to European Union regulations in Africa, the Organic group at NMISA is developing and validating equivalent methods for persistent organic pollution analysis on instruments widely available in laboratories in South Africa, and at NMIs in Africa.

It is proposed that South Africa, Egypt, Kenya and Tunisia form the interest group (with observer status for any other interested party) to formulate future projects for the development of measurement standards and methods for Africa.

5.6.2 Skills Development

Various sub-regional and bilateral QS development programmes and donor projects in Africa had general training as a main thrust area. It is therefore acknowledged that basic training in QS and specifically metrology will be conducted at the sub-regional level, sponsored through regional donor programmes.

For AFRIMETS, it is proposed that the skills development strategy revolves around pan-African events such as the Metrology school and AFRIMETS GA. The Metrology school can be held every second or third year. Specific technical training programmes can be organised to coincide with the annual General Assembly and associated technical working group meetings. The TC-WGs will be tasked to develop schedules of technical training.

For Legal metrology, it is proposed that the training Strategy of the SADC EU project be adopted for AFRIMETS. The main components are:

- Theoretical and practical training was provided at different levels. The institutions used to provide the training were carefully selected and the courses were performed in different countries of the region, where it was possible to gain first-hand experience of the relevant trade metrology issues. National experts from the region and international experts from Europe worked together with the participants from the region.
- A number of participants were selected to receive additional “train the trainer” instruction in presentation skills and related issues, so that they can be available to meet future requests for training in the region.
- The technical training courses covered such areas as
    - typical non compliances;

- labelling and accuracy of packing of products;
- automatic and non-automatic weighing instruments;
- automatic weighing instruments;
- calibration of Mass, Length and Volume Standards;
- dynamic measuring systems;
- uncertainty of measurement;
- verification of fuel dispensers; and
- beam balances and mechanical counter scales.

- Specific coaching was provided in
  - Length (Taximeter);
  - Mass (Hopper and Belt Weighers); and
  - gravimetric filling instruments.

It is proposed that such programmes be conducted in each SRMO.

The metrology schools are proposed to follow the schedule below.

Table 10: Proposed Schedule for Metrology Schools

No	Proposed Parameter	2012	2013	2014	2015	2016
1	Metrology in Chemistry	X			X	
2	Physical Metrology		X			X
3	Ionising Radiation			X		

5.7 Summary of Proposed AFRIMETS Infrastructural Improvement Projects

The projects for the strengthening of AFRIMETS, the Quality reviews, Technical Comparisons and Training are summarised in Table 11. The costs have been estimated and should be cost properly when a Project is selected for funding.

Table 11: Summary of Infrastructure Improvement Projects at AFRIMETS level

No	AREA	Project Description	Estimated Cost 2011 (x1000)	Estimated Cost 2012 (x1000)
A1	**Secretariat**	Support a Secretariat hosted by a member country	€95-190	€100-200
A2	**Quality Systems**	Perform Peer review evaluation of Quality Systems of NMIs ready to submit CMCs	€13-€15	€15-€17
A3	**Technical Comparisons**	Supplementary and Key Comparisons -Development of scopes (comparisons p/a) -Provision of Artefacts -Logistics (movement of Artefacts)	€57-€64	€82-€90
A4	**Metrology Schools**	As proposed in table 10	To be cost by donor	To be cost by donor