Evaluation Report

for the

Materials Science and Solar Energy Network for Eastern and Southern Africa (MSSEESA)

(for the period of 2009-2017)

by

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Content

Abbreviations and acronyms

AC	Advisory Committee
AMSEN	African Materials Science and Engineering Network
CB	Coordinating Board
CO	Coordinating Office
COSTECH	Tanzanian Commission for Science and Technology
DAAD	German Academic Exchange Service
GERD	Gross Expenditure on Research and Development
ISP	International Science Programme
NGO	Non-governmental Organization
MAK	Makerere University
MDG	Millennium Development Goals
MSSEESA	Materials Science and Solar Energy Network for Eastern and Southern Africa
MoU	Memorandum of Understanding
NFAST	National Fund for the Advancement of Science and Technology (Tanzania)
R&D	Research and Development
SADC	Southern African Development Community
Sida	Swedish International Development Cooperation Agency
SDGs	Sustainable Development Goals
STEM	Science, Technology, Engineering, Mathematics
STI	Science, Technology and Innovation
S&T	Science & Technology
TWAS	The World Academy of Sciences
UDSM	University of Dar Es Salaam
UoE	University of Eldoret (formerly Moi University)
UoN	University of Nairobi
UNZA	University of Zambia

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Executive Summary

The Material Sciences and Solar Energy Network for Eastern and Southern African (MSSEESA) was supported by the International Science Programme since 2009. MSSEESA set its objectives to complement the support received at individual nodes at the physics departments of the University of Zambia, Makerere University, University of Dar Es Salaam, University of Eldoret, and University of Nairobi. The objectives comprise a) strengthening of postgraduate training and research, b) inter-university collaboration in teaching, research and training, c) promotion of gender equity and balance, d) increase of research capacities of individuals and organizations, and e) dissemination of research findings and information.

The network‘s conception reflected the need to cooperation to share expensive instrumentation available at the different nodes, foster exchange of junior researchers through travel grants, participation at conferences and workshops, and through the harmonization of study curricula across the participating universities, intensify the exchange of technicians among universities, and allowing for a regular exchange of senior scientists. Moreover, the expected results were higher visibility of the research to the academic, political and business communities as well as opportunities to attract funding for sustaining the network.

This report results from one year evaluation (October 2017 till October 2018) of the Material Sciences and Solar Energy Network for Eastern and Southern African (MSSEESA), commissioned by the International Science Programme (ISP) to assess the relevance, efficiency, effectiveness, impact and sustainability of the network in relation to its self-set objectives, the MSSEESA strategic plan and ISP’s reasons for supporting regional networks. The evaluation covers the period of 2009 till 2017 and builds on desk reviews, the analysis of self- and annual reports, on-site visits of all participating nodes as well as visits of the Swedish funding agencies, ISP and the Swedish International Development Agency (SIDA). The visits enabled the team to conduct interviews with all main academic stakeholders (students, technicians, lecturers, node coordinators, universities leadership, heads of national funding agencies, and executives at ISP and SIDA). To receive more comprehensive information for the assessment of the network’s monetary effectivity and efficiency, the evaluation team developed a further questionnaire. However, not all nodes provided all information as requested therein.

The network’s conception fostered the exchange of senior and of junior scientists in the region and laid the foundation for a strong South-South cooperation that promises even more impact in the future. Since most of the effects of strengthening research capacity must be attributed to the resources of individual nodes, including the support of Master theses and PhDs in local and sandwich-programmes, the network will need further communication and prioritizing of its activities to have a clear impact.

The evaluation of the MSSEESA network led to the following basic assessments:

1. The network has been unable to realise all the self-set goals and objectives, such as gender equity, harmonisation of curricula, publication of a newsletter, having a website, “real” complementary use of lab instruments due to acquisition of identical instruments at the different nodes, acquisition of additional third-party funding through joint-proposals, expansion within the sub-region.
2. Some of the realised goals were inefficiently accomplished, such as the training of technicians (technicians wished longer training period!).

3. Communication within and outside the network was inefficient due to lack of a network communication platform such as a website. Most students who joined the nodes were aware of the network only prior to network scientific meetings.
4. The greater share of the funding was spent on board meetings instead of students´ activities.
5. Students were not involved in the decision-making and felt not to be part of the network.
6. The 3 years rotatory chief coordination is inefficient (as confirmed by 3 of the 5 node coordinators). The non-continuity of network leadership explains the non-realisation of many self-set goals as mentioned under 1.
7. The financial and non-financial controlling inside the network and by ISP as funding agency was ineffective and error-prone.

Given this assessment, the evaluation team identifies two principal options for ISP: One basic option to withdraw from supporting the network and concentrating on the strengths of individual nodes. This support should include more strategic support for women and junior scientists. It could further include funds for travelling to partner universities.

The other basic option is to continue the network under the precondition of a revised strategy and implementation plan. This plan should consider the following recommendations:

Relevance

Build on the success of organizing academic and non-academic workshops and conferences to attract different sectors (government, industry, civil society) to regional events. Use conferences to attract new institutional members.

Facilitate access of network members to trainings that are organized by individual nodes in their respective countries.

Facilitate the integration of technicians and young scholars in the planning of network activities to increase the network's relevance for all participants.

Engage with administrations and governments to create common curricula for future exchange of master and doctoral students. Set incentives for young scholars to spend a minimum time of their studies at the member's laboratories.

Efficiency/Effectivity

Reconsider spending priorities within the network to allow for more mobility of junior scientists. Incentivise the exchange of junior scientists within the network.

Improve strategic planning of acquiring expensive instrumentation at different nodes to share limited resources. Strategic planning needs to include effective planning of travels and scholarships as well.

Plan for targeted funding of exchange of women scholars also to nodes, where only few women scholars are present. Consider stipends from the network-budget as an incentive for women to pursue research and training mobility.

Increase scientific exchanges of senior members and the training of young scholars by organizing lectures alongside the board meetings that are not taking place around workshops or conferences.

Reconsider the network governance to ensure the continuation and planning of activities across all nodes, for instance, by considering longer terms of offices or a permanent secretariat. Use controlling instruments to monitor the financial and non-financial degree of strategic target fulfilment as well as cost efficiency. Use these results to adjust strategic and operational planning. ISP should be stricter in budget controlling.

Impact

Increase the efforts to have more co-authored publications among the senior- and junior scientists of different nodes, either stemming from original research projects or from co-supervised dissertations.

Include doctoral students from the network in local solar academies and government consultations to expand the levels of experience of young scholars and to use their expertise in the training of solar technicians.

Focus on a comprehensive visibility and communication strategy to increase the network's impact within the national, regional and international academic and non-academic communities. This should include communication within the network and with its environment.

Sustainability

Build on shared network experiences to generate fund applications and broaden range of supporters, for instance, by attracting industry support.

Develop robust monitoring, evaluation and learning mechanisms to enable regular reflexions on the strengths and weaknesses, on achievements and planned goals. This can include the reporting mechanisms in place with ISP.

Include junior scientists from all nodes in the long-term planning and in task-sharing to assure that the network's ideas will continue.

Detailed Report

1. Introduction

1.1. The Evaluation

This report presents the results of a one-year study of the Material Sciences and Solar Energy Network for Eastern and Southern African (MSSEESA) to assess the relevance, efficiency, effectiveness, impact and sustainability of the network in relation to its objectives, the MSSEESA strategic plan and ISP's reasons for supporting regional networks (ToR, Appendix D). The evaluation was carried out with help of desk reviews of documents and self-reports and with help of interviews with the key participants of the network at the participating universities. These participants include the node coordinators, recent students at the departments, representatives from university administration and national funding bodies, including the Swedish funding side.

1.2. The role of material sciences in development

The material science research under review focuses on solar energy, which constitutes one of the most promising approaches to develop alternative energy sources. Renewable energy has become an important and rapidly evolving field of development policy in recent years (Brown *et al.*, 2018), which indirectly affects the role of material sciences. Renewable energy techniques are seen as instrument to tackle poverty in urban and moreover in rural areas by providing access to decentralized grids for the benefit of income-generating activities and for improving the access to cleaner energy resources for domestic use (Colenbrander et al., 2015; Karekezi and Kithyoma, 2004). Major development funders have set incentives to invest heavily into renewable energies as the solution to poverty, framed by global result agendas such as the MDGs and SDGs and the International Climate Change Conference-negotiations that call for more access to cleaner energy.

Research for cleaner energies and the adaptation of existing renewable energy techniques to local conditions in countries of the Global South are one among several activities of donors and private enterprises. Training of staff, provision of technical material and distribution of technologies among rural communities, and policy advice for legal and financial frameworks have become activities of national agencies, NGOs and small enterprises. Additionally, NGOs and expert networks have focused on providing scientific evidence for energy policies in their host countries to improve the endogenous capacities to adapt to low carbon energy modes. Beside the long-standing support of the International Science Programme (ISP), many other development-aid funders but also research funders have more recently developed programmes for energy-related interventions. Research for development (R4D) has been one instrument among the approaches chosen by donors to contribute to these goals.

The material science network MSSEESA hence not only contributes to the capacities of basic science and to the integration into the international research community. It also directly and indirectly strengthens the socio-economic development of the participating countries. Moreover, the network contributes to the several goals of the SDGs, such as the goal 7 "to foster the use of affordable and clean energy". Furthermore, the training aspects of the network, targeting different groups in solar science, -policy and adaptations add to SDG 13 as strengthening the use of renewable energy contributes to climate change measures in the participating countries. Regarding science, the approach of ISP contributes to the SDG 9, which demands from the states to build resilient infrastructures, promote inclusive and sustainable industrialization and foster innovation. All three aspects need a scientific infrastructure, which is one sub-target to reach the goal: “Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending.”[1]

Regional networks and associations such as the African Material Science and Engineering Network (AMSEN) reflect the increasing collaboration in the region and contribute to the activities of strengthening the research in renewable energies and especially solar energy. An increasing number of international funders such as the European Union in its Framework programme and within the EU-ACP partnership for Science, Technology and Innovation equally contribute to new research and innovation networks in the region and add to the resources that the individual countries designate for these fields.

2. Purpose, scope and methodology

2.1. Purpose and scope of the evaluation

The main purpose of the MSSEESA 2017 evaluation was to assess and analyse the network to provide MSSEESA and ISP with indications of the progress and development of the network as well as input and recommendations on improvements and future directions. According to the Terms of Reference, the following tasks can be summarized:

1) An overview of how MSSEESA functions, its activities and progress based on relevance, efficiency, effectiveness, impact and sustainability, where strengths and weaknesses are clearly outlined (3.1)

2) Recommendations and improvements (long and short term) to MSSEESA and to ISP, respectively, on future directions of the network and its activities, including outputs, outcomes and impact (3.2)

3) Tracer study of the graduate students and technicians trained by the network, where they are employed today, if and how they are contributing to the region, etc. (3.3) (see further Appendix D)

The analysis included the task to assess whether the network’s activities have contributed to the tasks of the individual nodes and have fulfilled the expectations that were formulated when developing the network since 2002. Given the centrality of the network’s own objectives and the expectations of ownership, the evaluation integrated the network’s objectives into the framework of analysis.

A. To strengthen postgraduate training and research,

B. To strengthen inter-university collaboration in teaching, research and training,

C. To promote gender equity and balance,

D. To strengthen research capacity,

[1] https://sustainabledevelopment.un.org/SDG9 (retrieved 14.11.2018).

E. To disseminate research findings and information (Strategic Plan, pp. 7-8, Constitution, pp. 2-3).

With these tasks at hand, the evaluation explicitly addresses the network members and ISP and recommends changes to all participants in chapter 6.

The evaluation covers the timeframe of 2009 to 2016. This is the period for which the most comprehensive data is available. Partially, the data integrates information about resource allocation, co-funding, events, and student support from 2017.

The structure of the network warrants a disclaimer: The network, as seen in the description below (see chapter 3.1.), grew out of the increasing demand to cooperate between nodes that received ISP funding before 2009. ISP has encouraged node coordinators in their wish to form a network that takes over several functions which are not easily to be organized by the nodes alone. This evaluation only covers the working and progress of the network. It is not meant to evaluate the nodes themselves. However, describing the network at some stages requires drawing from the activities and resources of the individual nodes. A certain overlap between nodes and network is hence unavoidable and will be marked where necessary.

2.2. Evaluation team

PD Dr. Daniel A. M. Egbe: is a habilitated organic chemist, designing semiconducting materials for organic solar cells. He researches at the Johannes Kepler University Linz, Austria, and at the same time coordinates the African Network for Solar Energy (www.ansole.org) and the platform BALE-WARE (Bridging Africa, Latin America and Europe on Water and Renewable Energies Application) (www.baleware.org). Between 2015 and 2017 he was an independent evaluator for the World Bank Group and the Association of African Universities on academic issues related to renewable energies.

PD Dr. Wichard Beenken: is an economical physicist habilitated in theoretical physics. He works at the Technische Universität Ilmenau, Germany on the field of organic solar cell materials doing quantum-chemical calculations. He was coordinator for the introduction of the master course "Renewable Energies" and is member of the study affairs committees for physics and chemistry courses.

Dr. Stefan Skupien is a social scientist and works in science policy studies and the sociology of science at the WZB Berlin Social Science Center, Germany. He has a background in political sciences, African Studies and philosophy and has worked in higher education management before starting a postdoctoral research project on the research environment for international scientific collaborations.

2.3. Methodology: desk study, field visits and interviews

2.3.1. Methodology

The methodology consisted of a multi-method approach with quantitative and qualitative parts to capture the elements of the network and of the theory of change that underlies the support by the ISP and by the participating nodes:

- A comprehensive desk review of given material by ISP and network members: tracing meetings, movements of graduates, quantitative financial assessment;

- A study of external factors that account for changes and help to reconstruct the history of the network and its overall working condition (desk review of general science indicators);
- In-depth individual interviews with coordinators (5) about the network's developments, self-evaluation according to objectives, perception of successes and challenges of parts of the network. The interviews built on the self-evaluations provided for the desk-review. (Questionnaire Appendix A.2.1);
- Interviews with graduates according to tracing study questions in the ToR (Appendix A.2.2.);
- Interviews with technicians according to the tracing study;
- Interviews with university administrative leadership to assess the position of the network within the university context and its funding in comparison to national and other international funding, to retrieve overall student enrolment in subjects, their changes over time and in disciplines (Appendix A.2.3.).
- In-depth interviews with ISP-staff to assess historical development, funding and collaboration motivation, administrative developments and challenges;
- Interviews with SIDA-staff to assess expectations and funding motivations during the funding period;
- Site visits to evaluate the technical equipment and placement in university environment
- Goal-oriented approach for determination of the effectiveness in respect of weighted objectives as given in the strategic plan and the corresponding efficiency based on cost centre, type, and object accounting.

The interviews and site visits at the nodes took place in November 2017 (University of Dar Es Salaam) and in February 2018 at the other nodes. Members of the evaluation team visited the ISP office in Uppsala and Sida's office in Stockholm in June 2018. The preliminary results were presented to the network's board an ISP in Nairobi on 28. September 2018 and a focus group discussion with the junior researchers took place on September 27th to elicit perspectives and proposals of how to improve the network's functioning from the next generation of researchers. The first draft was shared with the board and ISP in November to receive corrections of potential factual errors and lacking data. Comments are integrated into the final report.

2.3.2. Limited availability of data

Beside the interviews, the data from ISP and self-reports provided in 2017, the evaluation team required additional information for the cost-benefit analysis. Since in the annual reports the costs are only summaries and the self-evaluation reports contained mainly qualitative information about the performance of the nodes and the network, a cost objective accounting and other quantitative analyses were not possible on the available database. Therefore, the evaluators handed out a questionnaire (see appendix A.3.) for the quantitative analysis to all node coordinators concerning the following topics:

- Staff of the research group;
- Travelling by group members within the network, specifying costs and purposes of the visits;
- Events organized in the framework of the network;

- Former and present students fostered by the research group, in order to find out the influence of the network and other instruments in this framework on their success and career;
- Equipment available at the node, which could be used by other groups within the network by being complementary to their own;
- Publications.

From five nodes only three (University of Dar-es-Salaam, University of Nairobi, and University of Zambia) answered. The node coordinator at Makerere University regretted not to have received the necessary data from his predecessor. The University of Eldoret did not react despite repeated requests. The data from University of Nairobi came in late and were incomplete to fully take them into account in the quantitative analysis. In all cases the node coordinators lamented that the data were difficult to collect.

Due to this incomplete data set a comprehensive quantitative analysis is not possible for the total MSSEESA network. In particular the lack of information about costs does not allow a serious calculation of any kind of efficiency as requested amongst others in the ToR (see Appendix D). More critical, however, is the fact that incomplete data also rules out a quantitative determination of the effectivity of the network. A complete data set would have enabled us to assess whether problems of the network to fulfil its objectives resulted from a general lack of funding or a wrong allocation of in principle sufficient funding. Without such information, however, the assessment of good governance of any funded project is nearly impossible.

3. Description of the MSSEESA network

The evaluation team decided to use the network's own goals as parameter for its assessment exercise, in addition to the ToR. To better understand the evolution of the goals and to answer questions of the ToR, the first part of this chapter focuses on the network's history, its motivations and objectives, its internal organization, and its scientific and organizational environment. The support of ISP is one important element of the organizational environment. The chapter also helps to situate the ISP support in a wider context (ToR: Q1, 8-9, 11, 19, 30). Furthermore, opportunities and constraints become visible which help to explain why some of the network's objectives have not been fully fulfilled by today.

The second part of the chapter assesses different objectives, such as resource allocation and cost-benefit-analysis, postgraduate training, research output, gender-questions, and activities for the network as well as for the socio-economic environment.

3.1. History of the MSSESA network

The MSSEESA evaluation includes as the founding chapters[2] University of Eldoret and University of Nairobi (Kenya), the University of Dar-es-Salaam (Tanzania) , Makerere University (Uganda) and the University of Zambia. The University of Addis Ababa in Ethiopia is not part of this evaluation, although it is a founding member of the network (Strategic Plan, p. 3).

According to the self-evaluations, the network idea was born out of a reference group meeting at Uppsala University in 2002 and was established in 2004 as MSSEESA after another round of consultations at the founding member's universities. Some of the member universities have research groups in solar energy, dating back to the 1970s. The Tanzanian node, for instance, is based on a solar energy group that was founded at the UDSM as early as in 1977.

A first step included formation of nodes of the network. Nodes were formed at the university departments and had to be formally registered in its host country. Additionally, each node had to sign a Memorandum of Understanding MoU with its host university. The Tanzania and Zambia nodes constituted their nodes in 2006, while the Kenyan node consisting of the University of Eldoret and the University of Nairobi could only register in 2011 due to the requirements of conformance with the Kenyan Laws.

Despite its early foundation, the MSSEESA network is funded by the ISP only since 2009. In 2008, the network was invited to apply for funds for a three-year period that support the objectives of the network for a period of four years. The following application for the funding period of 2013 to 2015 was rejected by the reference group and consequently by ISP in 2012 and a resubmission became necessary on the basis of recommendations given by the reference group. A budget for only 2013 was approved to continue the network's activities, especially the first conference for young scholars taking place in Nairobi. The second application for the period of 2014-2016 passed the review, as did the application for funding from 2017-2019.

While the research network on solar energy originates from ISP-funded departments and research groups, not all nodes received institutional support from ISP. The research group in Dar-es-Salaam

[2] The term "chapter" refers to the legal definition of becoming and/or being part of the association MSSEESA. The term "node" is used when analyzing the network outside the description of the legal framework as one part of the network. For reasons of simplicity we use the term 'node' for both meanings.

has been supported by ISP since 2004 but the institutional support has been terminated in 2009. This interruption of node funding has been criticized as limiting the impact of the network's activities.

The network started under difficult circumstances: While it was conceptualized and established by the prominent and senior researchers Prof. Kivaisi and Dr. Mbise, (University of Dar es Salaam), Prof. Bantikassegn (University of Addis Ababa), Prof. Otiti (Makerere University), Prof. Aduda (University of Nairobi), Dr. Chinyama (University of Zambia), Dr. Mwamburi (then of Moi University)), three of the founding persons - late Prof. Rogath Thomas Kivaisi and Dr. Godfrey Mbise (Tanzania), and Dr. Kaumba Chinyama (Zambia) - passed away, while Prof. Bantikassegn relocated to the United States of America shortly after the network's inauguration. The vision and management had to be promptly transferred to a new generation of researchers in the affected nodes.

3.2. Motivation and objectives of the network

The motivation for establishing the network was the underutilization of the Materials Science and Solar Energy's potential in the region. Three rationales were identified: (1) Translating the benefits of Material Science to support the value addition; (2) Using Materials Science to assist the formulation of standards for consumer protection; (3) Training highly skilled personnel in Materials Science (Strategic Plan, p. 3).

The program partners have drafted a constitution and developed a five-year rolling strategic plan for the establishment of a regional network in the field of materials science with focus on solar energy and its conversion into other usable forms of energy.

The network aimed at providing a platform to strengthen the sharing of research facilities; establishment of joint courses and programs, student and staff exchange; joint supervision of graduating students; information exchange and the organization of networking events (Strategic Plan, p. 7).

Accordingly, the network set five key objectives to foster and deepen the previous exchange across research units of the participating universities:

A. To strengthen postgraduate training and research
B. To strengthen inter-university collaboration in teaching, research and training
C. To promote gender equity and balance
D. To strengthen research capacity
E. To disseminate research findings and information (Strategic Plan, pp. 7-8, Constitution, pp. 2-3)

The strategic plan entails a differentiated approach with help of targets and activities for each of the five objectives (Strategic Plan, pp. 10-15). These objectives and the planned activities can therefore serve as guidelines for the quantitative and qualitative approach of the evaluation.

3.3. The Network's organizational structure

MSSEESA was formed as an association with a constitution in 2004 that describes the structure and processes of the network to put into action its objectives. University research groups in the Eastern and Southern region can become nodes of the network for research and related network activities.

Additionally, the nodes passed a rolling strategic plan that lays out the initiatives necessary to fulfil the network's aims.

The formal structure consists of the coordinating board (CB), the advisory committee (AC), and the coordinating office (CO). The CB comprises the university coordinators and the secretaries/treasurers as its members. Representatives of funding agencies may become ex-officio board members. The main functions of the CB can be summarized as agenda and policy oversight, rule-making and approval of financial reporting, and initiative for resources and the expansion of the network.

The AC was planned to comprise the Deans of relevant Faculties or Schools of participating universities and a representatives of funding agencies that support the network. Integrating the Deans and funders into the structures offers a wider support network of MSSEESA and to raise awareness for the network at their respective host universities. The AC was, however, not mentioned to the evaluators during the interviews and in any of the self-evaluations and seems to be non-functional at the moment.

MSSEESA's founders have decided to install a CO that rotates every three years between the participating network nodes. The coordinating office has amongst other the tasks to

- formulate and programme annual activities and budget,
- prepare reports, to coordinate scientific meetings,
- prepare and distribute the MSSEESA-newsletter and other publications and
- to oversee the planned MSSEESA website (Constitution: 6).

The office bearers of the CO are the chief coordinator and the secretary/treasurer. The former chief coordinators have been:

Year	Institution	Chief Coordinator
2009 – 2011	University of Dar-es-Salaam, Tanzania	Prof. R.T. Kiviasi
2012 - 2014	University of Zambia, Zambia	Dr. Sylvester Hatwaambo
2015 - 2017	Makerere University, Uganda	Prof. Tom Otiti
Since 2018	University of Nairobi, Kenya	Prof. Bernard O. Aduda

Table 1: Chief coordinators since 2009

While the chief-coordinator ensures the day-to-day working of the network, the coordinating board meets annually to oversee the process and set guidelines for the next years. Additionally, at each university the participating research members form a research group that meets at least four times per fiscal year to organize the country-level network activities (Constitution, pp. 9-10).

University coordinating officers at each member university are envisioned to oversee the implementation of network activities including meetings of research groups at each university and to report to the coordinating office annually (Constitution, p. 7). University coordinators are elected for the period of five years.

According to the network's constitution, the network is financed through membership fees of each node and through annual subscription fees, grants and donations from governmental and non-governmental organisations and through other sources as determined by the CB (Constitution, p. 10). Part of the budget has been scheduled for the annual meetings of the coordination board and part is reserved for the administration of the coordinating office (see further chapter 3.5.).

3.4. Organizational and funding environment

The network is situated in a complex national and international environment. The different individual, organizational and financial resources available determine the possible contributions to the network and to the impact it can have. High teaching loads and strikes at some of the universities, low availability of resources for teaching and research due to a lack of endogenous funding and subsequently persistent reliance on exogenous research funding, and low numbers of women applying for basic sciences are features that all participating countries and nodes share. Moreover, a lack of industries and businesses that support research and development of products leads to fewer resources available from private funders. This fact cannot be understated given the high amount of private investment of Research and Development (R&D) by private firms in OECD countries is at approximately 60% of annual investment in R&D. This implies that most expectations for financial and organizational support in developing countries such as Kenya, Uganda, Tanzania and Zambia focus on the government and its intermediary organizations as the major funder for research and training.

3.4.1. Sweden as funder

The MSSEESA network is funded by the International Science Programme (ISP) since 2009. ISP receives its main financial support from the Swedish International Development Cooperation Agency (Sida) and to lesser extent from the Uppsala University and Stockholm University. ISP exists since 1961 and aims at funding and supporting basic sciences (physics, chemistry and mathematics) through different instruments. The approach to support the fundamental and applied sciences within the basic sciences is also the framework for the MSSEESA-network.

ISP aims at an efficient contribution to increase scientific knowledge and capacity building. Through this approach the program expects to support the increase of social- and economic wealth. An increase of scientific knowledge is envisioned through assisting low-income countries to build and strengthen local research and teaching capacities for graduate and post-graduate education in the basic sciences. Its model bases on "long-term funding, coordination and mentoring to research groups and regional scientific networks at universities and research institutes in Africa, Asia and Latin America."[3]

The main instruments to realize the increase of scientific knowledge and capacity building are institutional and individual support. The individual support comprises PhD training, partly realised in sandwich-programmes, where students spend part of their training in Sweden or other European countries., Institutional support consists long-term support over several decades, a focus on local ownership of the research agenda and financial spending, flexible support according to local needs and strategies, establishment of regional and international research networks.

ISP as its core supports individual research groups and networks in the basic sciences in 12 focus countries chosen by the Swedish Government for long term cooperation through bilateral agreements.[4] Additionally, ISP supports research groups in Laos, Zimbabwe and Myanmar. As of November 2018, ISP supports 19 networks across physics (5), chemistry (11), and mathematics (3).

Beside its core programme, ISP is assigned by Sida as an agency to coordinate the Swedish activities in four bilateral cooperation programmes with Ethiopia, Mozambique, Tanzania and Uganda.

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[3] See: https://www.isp.uu.se/About-ISP/ (retrieved on 11.12.2018).
[4] These 12 countries comprise Bangladesh, Bolivia, Burkina Faso, Cambodia, Ethiopia, Kenya, Mali, Mozambique, Rwanda, Tanzania, Uganda and Zambia since 2009. See: http://www.isp.uu.se/what-we-do/bilateral-coordination/ (retrieved on 11.12.2018).

Sida as the main funder of ISP is also subject to changes as a government agency. This has repercussions for the funding of ISP and the environment under which the international collaborations take place. While the MSSEESA-network has not been affected directly in its funding, the Tanzanian node ceased to receive funding as a research group after the support was phased out in 2008, after 34 years of direct funding. This was due to a decision at the time by the Swedish government, according to which ISP could not support activities in countries where Sida had a bilateral program. This has now changed.

The long-term orientation of ISP, its geographic scope, and the will to hand ownership to the funded parties within Southern countries is quite unique in comparison to the funding landscape of other European countries. Supporting basic sciences fills a lacuna in the donor community, that is still mostly focused on applied-driven health, agriculture and geo-science, and enables the universities to build research and training capacities (as, for instance, visible in the training of PhDs, see chapter 3.6.).

The nodes's research environments are portrayed below with regard to their policy-priorities for renewable energies and the amount of funding available from government and other sources below (see ToR: Q11, 19). ISP support strengthens some of their national scientific systems, notably the human and organizational research capacities, which have direct and indirect effects for their energy and research policies. Many of the participating countries have technological and energy-related innovation and progress high on their national agendas. The ISP thus contributes to a number of priorities set by the governments of Kenya, Uganda, Zambia and Tanzania and can be deemed as highly relevant for the needs of the countries.

3.4.2. The policy and funding environment of Tanzania

Tanzania is seen by observers to have a “fairly elaborate and well-articulated Science and Technology (S&T) infrastructure, as indicated by it having a large number of research institutions” (Swanepol, n.d.). However, the country invests only few resources in R&D. The country has experienced a higher share of GDP for expenditure for R&D within the last decade, increasing from 0,34% in 2007 to 0.53% in 2013 (see Figure 1).

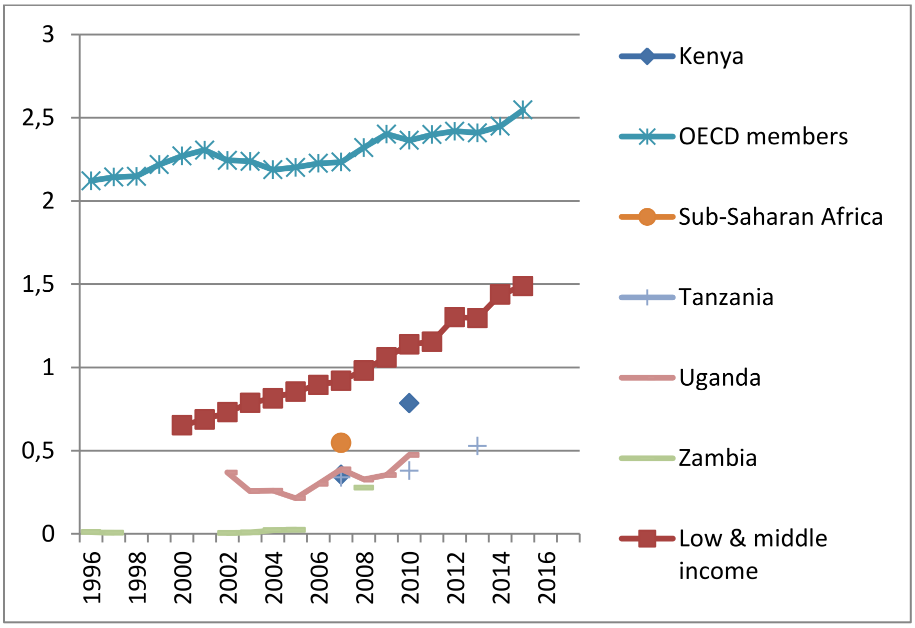

Figure 1: GDP-Expenditures for R&D from 1996-2015 (Source: Unesco Institute for Statistics)

The Tanzanian Commission for Science and Technology (COSTECH) is the government agency responsible for the funding of R&D and for the promotion of science and technology. The National Fund for the Advancement of Science and Technology (NFAST) was created in 1995 and received several times high amounts of funds to support science. However, local government and central government continued to support research aside the fund in a decentralized manner. Only the 2010 policy change to transform NFAST into a National Research Fund led to more centralization of available budgets. The fund still needs to become fully operational.

COSTECH is also responsible for setting research priorities. The "better use of energy including renewable energy" (Swanepol, n.d.) is among the seven identified economic sectors. Interviews with the staff at COSTECH reflect awareness for renewable energy and especially the research being done at the UDSM. However, the lack of resources for larger investments in laboratories was pointed out as well. Node representatives have expressed disillusionment with the national research funding as it remains too little and is often distributed to other areas than basic sciences.

The UNESCO 2015 report states that Tanzania is among the countries, where at least 40% of R&D comes from foreign sources (ibid, p. 512). The government spent 57.5%, the business sector 0.1% of total GERD in 2011. The overall GERD as % of GDP was 0.38% in 2011 (ibid, p. 513).

In 2010, Tanzania counted 69 researchers per million inhabitants (ibid). Of these, 25.4% were female researchers (ibid, p. 508).

3.4.3. The policy and funding environment of Uganda

Uganda's policy-makers acknowledged science, technology and innovation as one of their four priority areas in the Ugandan National Development Plan (2010-2014). Comparable to all other Science, Technology and Innovation (STI) policies of its neighbouring countries, Uganda expects STI to be an instrument to lift the country out of its current poverty through harnessing the available resources. Energy infrastructure is amongst the priorities, as is science, technology, engineering and innovation in general.

The Uganda National Council for Science and Technology (UNCST) coordinates the research activities of the country, using the Science, Technology and Innovation Fund as one of its instruments to disburse resources. The Council also developed the National, Science and Innovation Policy (Uganda 2009), whose priorities includes the creating of a critical mass of scientists and engineers.

In 2010, GERD was at 0.48% of total GDP, with Government accounting for 21.9% and Business of 13.7 of it. 57.3% of R&D resources came from abroad (UNESCO 2015, p. 513). 9.0% of these resources were invested in Natural Sciences (ibid, p. 512), the smallest group besides Engineering (12.2%), Medical and Health Sciences (18.1%), Agricultural Sciences (16.7%), Social Sciences (29.8%) and Humanities (14.1%).

In 2010, Uganda counted 83 researchers per million inhabitants (ibid). Of these, 24.3% were female researchers (ibid, p. 508).

3.4.4. The policy and funding environment of Zambia

The National Science and Technology Council is the main actor responsible to promote STI in the country. It is based under the Ministry for Education, Science, Vocational Training and Early Education. The organization was re-founded in 1999, after several reforms of former organizations. Its main objective is to promote STI to support the creation of wealth and to improve the quality of life in Zambia (Boshoff, n.d., pp. 11-12). More specifically, the council has the tasks to promote STI in the country, but also to promote research priorities, mobilize resources, promote the use of STI in industry, and to “ensure that gender concerns are integrated at all levels of S&T development” (ibid, p. 14).

The efficiency of the council is limited by the fact that policies of 1996 were only reviewed after ten years in 2009, with the aim to update it after consultation and to draft a new S&T policy. A change in government halted the process of approval in 2011. Concurrently, the Southern African Development community’s efforts to draft a science and innovation strategy influenced the national S&T policy draft.

Despite the clear tasks laid out in the policy papers, the Ministry and the NSTC are not the only institutions to distribute funding for R&D. Other line ministries are also financing R&D through their portfolios, for instance, giving it to its research institutes on health or to the Institute for Energy. This leaves the STI-system fragmented and with limited oversight.

0.38% of GDP were dedicated to R&D (GERD) in 2008. (A differentiation according to sources is not available) (UNESCO 2015, p. 513). R&D is mostly carried out by higher education institutions (78%), while government agencies carry out 19% of the research activities (Boshoff, n.d., p. 7).

In 2008, Zambia counted 49 researchers per million inhabitants (ibid). Of these, 30.7% were female researchers (ibid, p. 508).

3.4.5. The policy and funding environment of Kenya

Kenya is host to two nodes and one of the scientifically strongest countries in the region, often following directly after South Africa with regard to measurements for expenditure for R&D. In 2010, 0.79% of GPD were used for R&D (GERD). It comes close to the average of expenditure in low and middle income countries as shown in figure 1 above. Government contributed 26.0%, Business 4.3%, Higher Education raised 19.0% of funds and 47.1% came from outside the country (UNESCO 2015, p. 513).

Similar to the other participating countries, Kenya's policy vision for STI is to contribute to poverty eradication, to the rise of welfare and to foster a technologically advanced society. The national "Vision 2030" gives STI a pivotal role in realizing these goals (Swanepol, n.y.). The science policy document of 2013-2017, outlining the roadmap, included the field of energy in the "National Priority Growth and Social Sectors".

The Ministry of Education, Science and Education is the principal organization in STI policies, overseeing the development of science-related policies. Until a reform in 2013, the National Council for Science and Technology (NACOSTI) has been the advising and coordinating body for STI. The reform of 2013 sought the establishment of a Kenya National Innovation Agency (KENIA) and a National Research Fund (NRF; Swanepol, n.d., p. 9).

In 2010, the country had 318 researchers per million inhabitants (ibid). Of these, 25.7% were female researchers (ibid, p. 508).

During the interviews and in September 2018, we were made aware that universities are often at risk of being interrupted by strikes from staff members. This results from demands for higher wages in a field that sees more students to take care of. Such strikes also affect the capacities for research, administration and exchange, and for the full and continuous participation in research networks such as MSSEESA.

3.5. Resource allocation, co-funding and financial sustainability

To estimate the cost and efficiency and partly the effectivity of the network from 2009 to 2017, the evaluation includes a comprehensive cost-benefit analysis (ToR: Q13). The analysis not only shows the priorities set during the funded period by the coordinating board but also reveals points of departure for further improvements.

3.5.1. Research allocation

MSSEESA has received funding from ISP over the period from 2009 to 2017. This funding needs to be viewed separately from the funding allocated to individual nodes. All nodes except the Tanzanian node have received separate funding from ISP since 2009 (see chapter 3.4.1.). However, Tanzania receives new funding as an individual node since 2017.

The total amount of US$ 403,616.52 has been allocated to the network from 2009 to 2017 (the year of the latest available, comprehensive data).[5] Of these, US$ 348,486.87 has been spent until 31.12.2017. This sum is shared among four categories, which were presented to the evaluators as: Training, Regional, Development and Exchange. Given the categorizations in the annual expenditure sheets, we as evaluators had to assign expenditures to the following categories, which are used by ISP:

- *Training:* comprises the costs for students' fees, teaching and exchange visit for training, including the travelling costs of researchers to participate at these trainings. Both conferences in 2013 and 2017 were categorized as training, including the the technician trainings.

[5] The information is assembled from the annual expenditure sheets from 2009 to 2017. These sheets were formulated in US$. The evaluators copied all available information into one sheet, however, without harmonizing the exchange rates.

- *Regional* expenditure: covers costs for exchange and research visits within the region, including the proposal writing meeting in 2015, the annual board meetings, and meetings to organize the transition of chief coordination between nodes in 2014 and 2017.
- *Development:* covers the costs for scientific consumables and equipment, including clearing costs for instruments and repair costs.
- *Exchange* expenditures: comprise travel costs for conferences and research visits abroad, outside the region or to other institutions than node members. While the Exchange Category remained empty in the expenditure sheets, a fifth category of administrative costs comprises the first design of a website (2009), banking and audit charges, and costs for local staff during the meetings, trainings and conferences.

Year	**Training**	**Regional**	**Development**	**Exchange**	**Administration**	**Total expenditures**	**Allocation from ISP**
2017	33375.00	12037.00	0.00	0.00	7790.00	53202.00	6000.00
2016	4347.00	11767.00	5000.00	0.00	1000.00	22114.00	36008.46
2015	8800.00	12032.00	0.00	0.00	3400.00	24232.00	33379.83
2014	1915.91	16409.27	7432.70	0.00	4094.55	29852.43	45517.54
2013	46835.87	19613.06	4700.00	0.00	8546.14	79695.07	64712.42
2012	0.00	12422.63	0.00	0.00	18.54	12441.17	46243.92
2011	14489.00	17458.00	6986.49	0.00	399.30	39332.79	76901.63
2010	8768.00	14610.00	27133.06	0.00	4063.00	54574.06	57500.70
2009	4895.70	14492.75	8774.90	0.00	4880.00	33043.35	37352.02
TOTAL	**123426.48**	**130841.71**	**60027.15**	**0.00**	**34191.53**	**348486.87**	**403616.52**
Percentage of total exp.	35%	38%	17%	0%	10%		

Table 2: Expenditure according to categories (in US$)

The funding and allocation pattern during the period reflect the network's objectives, investing in regional exchange and in the building of research capacities of laboratories (see chapter 4 for the detailed assessment). Training of students and visits to non-nodes have received the lowest contributions during the network's time. For containing the costs of board meetings, a big share of the expenditures in the category "regional" might be rather administration costs. For the higher level of aggregated data and a lack of more detailed data (see 2.3.2) the evaluators were not able to report these costs separately.

If one shares this allocation to five distinct categories, the analysis points to first conclusions. In general, the networking aspect of the node-leadership has received the biggest share, facilitating the exchange among the nodes for administrative and managing tasks. 17% have been allocated for the improvement of laboratories, for the most part at the University of Dar-es-Salaam. This adds to the strengthening of research capacity with regard to the instruments and opportunities to carry out experiments on spot (ToR: Q19).

3.5.2. Accrual accounting

The allocation from ISP minus the total expenditures by the network would results in US$ 11398,50 amount of balance end of 2017. The annual expenditure sheets of 2017, however, account only for US$ 3378.19.

Year	amount brought forward according expenditure sheets	Allocation from ISP	Total expenditures	Balance according expenditure sheets	Real amount to be forwarded	Real Balance	missing sum for Balance
2017	50580.29	6000.00	53202.00	3378.29	58600,5	11398,5	8020,21
2016	35612.83	36008.46	21041.00	50580.29	43633,04	58600,5	8020,21
2015	26464.00	33379.83	24232.00	35611.83	34485,21	43633,04	8021,21
2014	18820.10	45517.54	29852.43	34485.21	18820,1	34485,21	0,00
2013	33802.75	64712.42	79695.07	18820.10	33802,75	18820,1	0,00
2012	*	46243.92	12441.17	33802.75	*	33802.75	*
2011	7143.00	76901.63	39332.79	44711.84	7235.31	44804.15	92.31
2010	4308.67	57500.70	54574.06	7235.31	4308.67	7235.31	0.00
2009		37352.02	33043.35	4308.67		4308.67	0.00

Table 3: Accrual accounting (in US$) for the periods 2009-2011 and 2012-2017

*The balance of 2011 remained in Dar-es-Salaam for investments.

The balance of US$ 44.804,15 for end 2011 was not carried forward to 2012, but remained in Dar-es-Salaam for investments in scientific equipment according to a decision of the 5th Coordinating Board Meeting in 2012. Unfortunately, this was not documented in the expenditure sheets and maybe due to the renewed application for funds in 2011.

Unfortunately, since 2014 the balances were wrongly carried forward, resulting in an error in the balance end of 2017 of total US$ 8020.21 missing. This is by far too much to be explained by money transfer costs due to a move of the coordination office, but may be caused by the costs for the external audit in 2014 not accounted by ISP in the authorized expenditure sheets.

3.5.4. Co-funding

The network in its strategy planned to attract co-funding to support the network activities and to diversify the funding base of the regional network. The coordinating board has been assigned with the task to “solicit resources” (Constitution, p. 5). According to interviewed participants, a sub-committee was formed during the funding period to assess opportunities for funding of network opportunities. The committee met during 2015 to write grant proposal (Source: expenditure sheet 2015). However, common applications as a network to funders were not realized. This assessment touches on the question of sustainability (ToR: Q32 and 33). Any renewal of the strategic plan will have to include higher priorities for collecting funds for the network’s activities.

The majority of co-funding must therefore be attributed to the individual nodes, attracting for the events that have been organized in their departments. Additionally, funding was acquired to support PhD candidates through scholarships with the German Academic Exchange Service (DAAD) The World

Academy of Sciences (TWAS) and the Royal Society. These additional resources can be assumed to have contributed to the network indirectly.

Overall, most of additional funding has been attracted by the University of Nairobi that has received extra funding from the UoN, from the Africa Materials Science and Engineering Network (AMSEN), from foreign funders such as the Nuffic Trust (UK) and the Indian Government, as well as from the Leadership in Higher Education and Research. The German Academic Exchange Service DAAD has contributed with three PhD scholarships to the node. The Kenyan National Research Fund (NRF) has also contributed to the node's activities. Moreover, the Solar Academies as training opportunities have generated funding support and revenues. The funding amounts to SEK 2456950 from 2008 until 2016. The node at UNZA has acquired SEK 241900 from the National Research council between 2013 and 2016. In 2016, the Tanzanian node attracted TWAS scholarships for two MSc students worth US$ 23000. The node has furthermore attracted co-funding for the events in 2017 worth US9.222, benefiting the network's conference, board meeting and technician training as well as the locally organized 2nd outreach activity to attract female students to the basic sciences (see below chapter 3.9.). The Eldoret and Makerere nodes reported no additional funding.

3.5.3. Financial sustainability

We assume that funding for nodes has indirect effects for the network's activities and therefore benefits the network activities and opportunities. As nodes can extend their funding for material and solar energy research, they provide new opportunities for the network to exchange information and research and to work in a collaborative manner on subjects the network was founded for in the first place. Such funding from nodes complements the working of the network. However, it can only partially compensate for a long-term lack of funding of the network itself.

However, there have only been limited attempts to find direct funding for the network. Finding funding through national sources and personal or departmental international networks will be one opportunity to support the network in general. The wide networks of the members are a strength to explore for funding acquisition. Some of the successfully raised funds from non-academic training for SV-technicians could be another source. Finally, the chapters were supposed to pay an annual fee to the network, which could use for maintaining the chief coordination costs.

3.6. PhD training and research

Postgraduate-training and especially PhD-training is a central instrument in strengthening individual and organizational research capacities by training individual researchers, who then add to the capacities of their host-institutions. Many studies and reports by funding agencies across different fields emphasize the individual short-term and the organizational long-term positive effects of postgraduate training (see for example Akuffo et.al. 2014). One key objective of the network and of ISP is hence to support the PhD candidates through making available different instrumentation, offering training and research opportunities at the participating nodes and to foster the early exchange among junior researchers within the network (ToR: Q19). Furthermore, joint supervision of postgraduate students was considered another benefit of the network (Strategic Plan, p. 3). The analysis of the PhD-results contributes to the better understanding of one expected key network effect (ToR: Q14-16).

PhD training is mainly funded and carried out by the nodes themselves, which all have a PhD programme for physics in place. The programmes last 3-4 years and consist of research alone. The PhD candidate presents a thesis and has to pass oral examinations. Nevertheless, PhD candidates are encouraged to take specialised courses "relevant to the pertinent area of specialization, whenever desired and offered." (Strategic Plan, p. 5)

3.6.1. PhD graduates

Within the period of funding from 2009 to 2017, 19 PhD candidates have graduated; one person's year of graduation is unknown. Six students have taken up his PhD-course during the period of the network. Of three candidates the starting year is unknown. The low number of candidates and graduates is attributed to low numbers of MSc-students at nearly all nodes. There is only one female graduate. This low number is attributed to the even lower number of female MSc-students; nearly all graduates so far are male (1/18).

Group	**Grad year**	**Start year**	**Duration**	**Gender**	**University of graduation**	**Type of support RG or NW**	**SWH/LOC**
KEN:02	2008	2001	7	M	UoN	RG	SWH (Uppsala)
KEN:02	2009	2005	4	M	UoN	RG	SWH (Hahn-Meitner Institute Berlin)
KEN:02	2010	2004	6	M	UoN	RG	SWH (Uppsala)
KEN:02	2010	2004	6	M	UoN	RG	SWH (Hahn-Meitner Institute Berlin)
KEN:02	2015	2005	10	M	UoN	RG	SWH (Forschungszentrum Jülich Institut für Energieforschung, Germany)
KEN:02	2017	2012	5	M	UoN	RG	LOC
KEN:02	2017	2013	4	M	UoN	RG	LOC
KEN:02	2017	2014	3	F	UoN	RG	SWH (IIT, Mandi, India; University of Duisburg-Essen, Germany)
Ken:02	2017	2015	2	M	UoN	RG	LOC
KEN:03	2009	2006	3	M	Moi Univ.	RG	SWH (Uppsala)
KEN:03	2015	2007	8	M	UoE	RG	SWH (Uppsala)
TAN:01/2	2009	N/A	N/A	M	UDSM (Lic. Lund 2008)	N/A	SWH (Lund University)
TAN:01/2	2010	2005	5	M	UDSM	N/A	SWH (Uppsala)
TAN:01/2	2010	2005	5	M	UDSM	N/A	LOC (Institute of Marine Science)
TAN:01/2	2015	2011	4	M	UDSM	N/A	LOC (University of Dar Es Salaam)
TAN:01/2	2017	2012	5	M	UDSM	N/A	LOC
UGA:01	2012	N/A	N/A	M	MaK	N/A	SWH (Norway)
UGA:01	N/A	N/A	N/A	M	MaK	N/A	SWH (Norway)
ZAM:01	2009	2004	5	M	UNZA	RG	SWH (Lund University)

Table 4: PhD Graduates (RG=Research Group, NW=Network, SWH=Sandwich, LOC=Local PhD-Training)

Three observations are noteworthy. First, in the early generation of PhD trainings six graduates were fully trained at their universities. 13 graduates have been trained in the sandwich model and have spent significant time of their research in Sweden, Norway, Germany or India. When asked for their experiences in Sandwich-Models, most respondent pointed out the positive effects for their training and research networks, despite having had less opportunities to visit their host-institutions in the recent past (for instance from UNZA). All coordinators, themselves having benefitted from the Sandwich-Model, commend this form of PhD-training. The lasting relationships to the universities are also reflected in the conference proceedings, where partners are listed as co-authors. The positive assessment by the grantees resonates with earlier findings about the advantages of sandwich-models in comparison to local and fully external PhD-programmes (Zink 2016).

Secondly, the average time of graduates has been at 5,3 years with significant outliers in the Kenyan nodes, leading to the graduation only after 10, 8 and 7 years. The node coordinators have indicated that a high number of teaching obligations due to an increased number of student intake can be considered as an obstacle to a shorter graduation time (ToR: Q15). Some of the more recent PhD-graduates of the University of Nairobi, however, only needed three (3) years. This seems to reflect better research conditions, as confirmed by the node coordinator in his 2017-report.

Thirdly, 13 out of 19 have become researchers and lecturers in their fields and are in most cases employed by the institution from which they graduated or universities within the countries. This reflects the common academic career path, which is often taken after deciding for a PhD. And it reflects an amount of sustainability that the expertise remains at the institutes instead of finding employment outside of the region. The 13 researchers from table 4 above, that have become staff member at the universities add to the 11 PhD-holders already at their departments that have received their PhDs elsewhere and are today members of ISP-funded nodes. It can be said that this has led to a substantial increase in individual and organizational research capacities within the network (ToR: Q14, 19, 26). Accounting for two lectureships at other institutes of higher learning, the early PhD-training has also led to increased capacities in the broader academic and social environment of the host-countries.

3.6.2. PhD candidates

A different picture arises when turning to PhD candidates that have started their research during the funding-period since 2009 but have not graduated yet. According to the self-evaluations, the network nodes currently host 12 PhD candidates that are either member of staff or group members of individual nodes. They have commenced their research projects starting in 2014 and are expected to finish their thesis and oral defences until 2020.

Most remarkably is the observation that none of the 12 is reported as being in a sandwich programme. All PhD graduates are currently pursuing their studies locally. This reflects the increased research and training capacities of the staff that was trained one generation earlier. One could speak of a positive generation-effect, reflecting the increased capacities. While the first generation of graduates was male only, there are two female PhD candidates among the new generation of PhDs, both at Kenyan nodes. The nodes themselves report on different difficulties to adequately train post-graduates. One example is the Tanzanian node, where the coordinator reported in 2017 that graduates could not finish in time due to broken equipment (ToR: Q17). On the other hand, the University of Nairobi has recently experienced a shorter time until graduation. The coordinator explains this by the possibilities for students to either be freed from any teaching load or to have the opportunities to have research stays abroad (ToR: Q16).

3.7. M.Sc. training

All nodes have MSc programmes in place. Given the low number of master students that chose basic sciences and material sciences for their post-graduate studies, the network also aims at increasing and supporting MSc students, offering joint supervision, research stays at laboratories in the region. Moreover, the planning of a harmonized credit transfer system among the nodes is a further instrument to create a favourable environment for MSc students, of which some become future PhD candidates.

3.7.1. Graduated MSc

44 post graduate students received their MSc or MPhil during 2008 and 2016. According to the annual ISP reports there have been 2 female graduates and 42 male graduates. Both female students graduated from the Tanzanian node in 2009 and 2012. The only node without reported MSc graduates during the funding period is Makerere University. The largest batch of MSc students graduated in 2012 (16) and 2016 (10). In the framework of MSSEESA Tanzania's node has produced the highest output of master-degrees (19), followed by the University of Nairobi (10) and the University of Zambia (9).

3 MSc.-students that were part of the nodes before (2 Kenya, 1 Tanzania) had the opportunity to take up a PhD candidacy after their MSc graduation. Some units such as Makerere University, however, experience institutional bottlenecks to take up more graduates since all staff positions are filled and the department remains small, leaving very little room for recruitment of new staff members.

The higher numbers in MSc students on the topic of material sciences reflect the increased capacity for training within the research units. Some of the current PhD candidates have become members of staff and are currently pursuing their own PhD research. A future study should include all M.Sc. graduates for a follow-up study.

3.7.2. MSc candidates

According to the self-evaluations, there are currently 26 MSc candidates at the nodes, preparing a thesis partly since 2010 (MAK) and 2011 (UDSM). The new generation integrates 7 female students, which reflects the intake of more female students into the basic sciences and their choices to pursue a MSc in the field of material sciences.

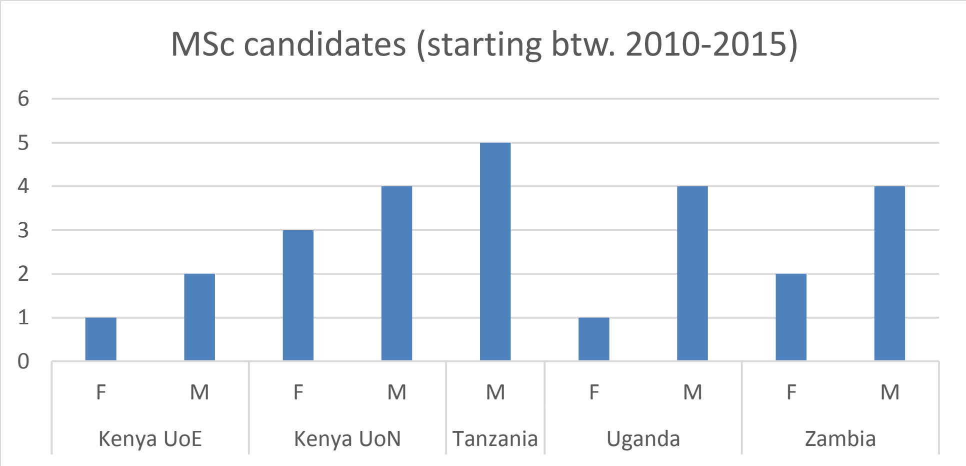

Figure 2: Number of MSc candidates at nodes according to gender

3.8. Strengthening departmental facilities

One of the objectives of the network was to strengthen the facilities in their technical abilities. Thereby the main idea was to complement each other by sending scientists or samples from a department, where specific instruments necessary for their research where not available to another, where the respective facilities exists (see also ToR: Q19). This of course requires that the different chapters have complementary equipment. The visitation of all chapters by the evaluators, however, revealed that all facilities are quite similar equipped with few exceptions. In this respect, it has to be mentioned, that independently from the network funding, ISP supported the acquisition of scientific equipment. It must be noted that the possession of similar core equipment by the nodes – which are part of independent universities - is not unexpected and often unavoidable for daily research. Furthermore, national universities also tend to follow national and organizational priorities of research Nevertheless, one of the aims of MSSEESA was to avoid duplicate purchase of very expensive equipment.

In what follows the equipment of the network facilities are listed without guarantee of completeness (see 2.3.2)

University of Dar es Salaam

Equipment type, model, and name of manufacturer	Funded or donated by whom?	Year acquired	Working
Vacuum Unit, Edwards Auto 306	ISP		Yes
Sputtering Unit, Balzers BAE 250	ISP		Yes
Corrosion Cell, Metrohm	ISP	2015	Yes
UV/VIS/NIR Spectrophotometer Lambda 9, Perkin Elmer	Sida		No, cannot be repaired and is substituted, used for spare parts
UV/VIS/NIR Spectrophotometer Lambda 9, Perkin Elmer	ISP & Royal Society, UK		Yes
FTIR Spectrometer, Spectrum BX, Perkin Elmer	ISP		Requires to new far IR source
Atomic Force Microscope, Nanoscope IIIP, VEECO	Sida/ISP		No, due to computer failure

Four and two point probes	Self-built		Yes
Surface profiler, Alpha Step IQ	Sida/ISP		Yes
Hall effect, HMS3000, Ecopia	ISP		Yes
I-V Tracker, ECO 107	ISP		Yes
Ultrasonic cleaner, FS300, Decon			Yes
UV-VIS-Spectrometer, U-2000, Hitachi	ISP		Yes
Jandel RM 3 – AR – Four point probe	ISP		Yes
SCK – 100 M Spin coater	Royal Society		Yes
Annealing System, RPT 1000 D4, NDBKJ	Heriot Watt University, UK		Yes

University of Nairobi

Equipment type, model, and name of manufacturer	**Funded or donated by whom?**	**Year acquired**	**Working**
Edwards Auto 306 Vacuum Unit	World Bank		Requires repair
Solar Simulator	ISP		Yes
Spin coater	ISP		Requires small pump
UV-VIS-NIR spectrophotometer	ISP		Yes
Spray pyrolysis	ISP		Yes
SILAR deposition unit	ISP		Yes
Surface Photovoltage Spectrometer	ISP		Requires repair
Photensiostat PGStat 204	ISP		Yes
Photentiostat PGStat 12	ISP		Yes
Alfastep surface profiler	ISP		Yes
Furnace Nebertherm	ISP		Yes
Tube furnace	ISP		Yes
Autoclave	ISP		Requires repair
Ultrasonic cleaner	ISP		Yes
Sonifier	ISP		Yes
Water distiller	ISP		Yes
Solar trainer	ISP		Yes

University of Eldoret

Equipment type, model, and name of manufacturer	**Funded or donated by**	**Year acquired**	**Working**

	whom?		
Spectrum analyzer (Model: Bentham 200, with TM300 monochromator)	WB	2000	Yes
Instrument Systems spectrum analyser (Model: Spectro 100/320 CD)	WB	2000	No, Aged and out of service
Edwards high vacuum sputter-ing/evaporation unit (Model: Auto 306) With chiller unit	WB/ISP	2000	Requires repair but spare parts are not readily available
Four Point Probe setup(Scientific equipment, Rookie; model DHE-21)	UOE	2000	Yes
Gaussmeter and Hall effect set-up(Scientific equipment, Rookie; model DFP-02)	UOE	2000	Yes
Solarimeters.	ISP	2002	Yes
2 CPC concentrators. 5 PV panels.	ISP	2002	Yes
Temperature sensors, multimeters and other accessories.	ISP	2006	Yes
Optical table 2.5 m x 1.5 m (Model: Melles Griot)	ISP	2002	Yes
GMW H- frame electromagnet +accessories (Model: 3472-70)	ISP	2006	Yes
200 MHz digital scope (Model:)	ISP	2004	Yes
PCB etch facility	ISP	2002	Yes
PV module test set-up + accessories	ISP	2002	Yes
Mini weather station WM-918	ISP	2006	No, aged and out of service
Hall effect setup	ISP	2006	Yes
Spray pyrolysis Oven	ISP	2006	Requires new heater
NI-PXI system 1042 series (with Scope, DMM, DAC and motor drive)	ISP	2008	Yes
TTi QL355TP Precision programmable power supply TTi Function generator	ISP	2008	Yes
Dual phase Lock-in amplifier	ISP	2010	Yes
Infinivar cfm-2 color video system Complete video inspection package for pc	ISP	2010	Yes
Keithley hall effect apparatus complete system.	ISP	2010	Yes
Laser beam induced current setup, complete system with optical bread-board	ISP	2010	Yes

Photocatalytic reactor set-up	ISP	2015	Yes

Makerere University

Equipment type, model, and name of manufacturer	Funded or donated by whom?	Year acquired	Working
Coating unit, AUTO 306 Edwards	ISP	1992	Yes
Four Point Probe, Jandel	ISP	2012	Yes
Surface profiler, Alpha – Step 500	ISP	2000	Not fully, requires service

University of Zambia

Equipment type, model, and name of manufacturer	Funded or donated by whom?	Year ac-quired	Working
High vacuum sputtering coating unit (BT10)	ISP	2016	Still under assembling
Carbolite Split tube furnace LHT5030, Labotec Ltd	ISP	2016	Yes
Carbolite 7L Ashing Furnace, Labotec Ltd	ISP	2016	Yes
UV/VIS Spectrophotometer, Labotec Ltd	ISP	2016	Yes
Spin processor (Model: WS-650Hz-8NPPB-UD-3)	ISP	2016	Yes
UV/VIS/NIR Perkin Elmer Lambda 19 spectrophotometer	ISP	Not known	Yes
Edwards High Vacuum Coating Unit, E306A	ISP	Not known	No, is obsolete now
Spray Pyrolysis Coating Unit	ISP	Not known	Yes, but has no heating rods
I-V tracker (>5A)	ISP	2009	Yes
Solarimeter	ISP	2009	Yes

By comparing these lists, the evaluators found only a few complementary instruments, which really motivate an exchange of scientists. In particular expensive vacuum equipment as sputter units was available or acquired at nearly all facilities. On the other hand, there are still no XRD or XPS setups available at least in one department, though these are very important for sample characterization that the scientists of all departments regularly send them to US or European facilities. Several interviewed node-coordinators have pointed to the lack of resources to obtain one of the XRD or XPS setups.

3.9. Network conferences, summer schools, teaching events

The chief coordinators organized a variety of events during the funding period, ranging from board meetings and conferences to seminars with a gender-specific approach and training for technicians. Overall, according to the available data, 28 events have been financed by MSSEESA-dedicated support:

Type of Meeting	Number of Meetings	approx. number of participants
Board Meetings	12	~10/each
Visits of Coordinators	1	2
Scientific Conferences and Workshops	4	209
Technical Training for Node Technicians	2	35
School Outreach with gender focus	2	61
Training on PV and Solar Technique for 3rd Parties	7	174

Table 5: Events during the funding period (2009-2016) (Source: Annual and self-reports)

Of these events, four have been co-funded by third parties. (For a detailed list of events see Appendix B.) The University of Nairobi organizes "Solar Academies" for a broad range of technicians in the PV field that raised participant fees and hence led to additional income.

Although some of the events were organized on the initiative of nodes rather than on the initiative of MSSEESA, all events can be considered to have contributed to the objectives of the network. While the coordinators have met officially at board meetings twelve times, other staff members and students had the occasion to meet at two designated conferences/workshops for young scholars of the network in 2013 and 2017. These meetings gave the participants the opportunities to present their research results and get to know their peers from other nodes. Interviewed students have pointed at the fact that they only learned on very short notice from these networking opportunities through announcements during lectures. Some of the conferences were announced on the university's websites and on the ISP-site, some other distributed through social media.

Moreover, technicians have profited from two workshops on instrumentations, which were organized around the time of both network conferences. In the self-descriptions and in interviews, it was remarked that although these workshops were met with great approval, the technicians would have wished for more time for learning and exchange.

Female students from secondary schools have profited from the networks expertise especially in Tanzania, where the coordinators organized two outreach seminars and noted that the feedback was very approving and that more need of such events became clear.

The last group profiting from network activities were third party, non-academic technicians, who were the target group of several workshops at either the university department or at locations throughout the country (see for example Tanzania). These workshops contributed to the visibility of solar energy research in all participating countries and led to further cooperation with other academic, government and civil-society partners (see below: Effects beyond teaching and academic research).

The network and more specifically the nodes have developed a variety of formats over the years (ToR: Q7). While the regular board meetings and the increasingly bigger conference on material sciences (2013, 2017 and 2018) contribute to a scientific exchange within the network, other formats distribute more clearly to national audiences. Technical training for university staff and other photovoltaic energy technicians has proven to be not only to serve a wider community but also to contribute to the network and individual nodes financially. The commendable initiative of outreach programmes for female students has begun and should be continued throughout the networks.

3.10. Gender equity

Female students in the basic sciences are of special concern to the network as expressed in their objective #3 to create gender equity and balance. ISP also strongly calls for this gender equity. As of 2017 the gender ratio among participants in the network and ISP nodes since 2008 were at 1 female to 5,13 males. The gender ratio, however, differs between the nodes as the following table shows. Kenya leads the gender quote with approx. 22% while Zambia and Uganda fall under 12%.

Node	F	M	Result	%
Kenya UoE	2	7	9	22,2
Kenya UoN	8	26	34	23,52
Tanzania UDSM	2	17	19	10,52
Uganda MAK	1	12	13	7,69
Zambia UNZA	2	15	17	11,76
Result	**15**	**77**	**92**	16,30

Table 6: MSSEESA participants according to gender

There are several reasons for these low numbers, which are representative for many African and Non-African countries, especially in the basic sciences such as physics. The UNESCO World Science Report 2015 estimated a 30% share of female researchers for Sub-Sahara Africa. The region follows the European Union (33,1%) and leads before West Asia (27,2%). However, the participating countries show different percentages of female researchers. The following table gives a general overview regardless of the field of research:

Country (latest source)	Percentage of female researchers
Zambia (2008)	30,4
Kenya (2010)	25,7
Tanzania (2010)	25,4
Uganda (2010)	24,3

Table 7: Percentage of female researchers in participating countries (UNESCO 2015)

According to the UNESCO Science Report (2015), several countries have acted to integrate more female labour in STI. Kenya is among the countries nodes of MSSEESA that has drafted its policy “Mainstreaming Gender in the National STI Policy of Kenya” that serves as an addition to the ‘draft National Science, Technology and Innovation Policy of 2012’ (UNESCO 2015: 508).

Following the individual careers from entry into higher education to the end of postgraduate studies, several bottlenecks became visible during the interviews: First, all coordinators, administrators and policy-makers pointed out at the lower numbers of female students choosing to study natural sciences at the undergraduate level. UDSM has dedicated a large part of its available funding to attracting female high school students to the field of natural sciences and physics in particular by offering outreach programs at secondary schools. Second, it does not follow automatically that female students chose a Master-degree after having obtained a BSc in related subjects. UNZA has initiated programmes that are designed to attract more undergraduate students to Master-courses and choices for research careers. Finally, not all students find sufficient means to pursue a PhD degree in the field of renewable energy. This affects all participating universities, which cannot always provide PhD-scholarships to candidates.

Interviews with female network members have revealed that most are eager to pursue an academic career or to become a bridge between academia and business to improve their livelihood. Some have remarked that cultural reasons prevent women from pursuing a time-intensive academic career, being perceived and judged more as mothers and caring members for their families than as successful professionals.

3.11. Research output

Research output is usually measured in journal articles and dissertations. The latter often form the basis of publications in journals. Some universities of the nodes even incentivize the publication of journal articles before completing the dissertation. Most of the post-graduate students have published before their graduation.

Based on the list of MSc and PhD theses and the list of publications, the MSSEESA network covers all research aspects of Materials Science for/and Solar Energy with strong focus on thin film technologies (2nd and 3rd generation photovoltaics) except in the synthesis of materials for organic photovoltaics (OPV), which requires a synthetic chemist equipped with a good synthesis lab (ToR: Q18). To remedy this problem, Dr Munyati of the Zambian node either purchases organic materials or obtain materials from collaborators outside the Network to carry out his research on OPV. His research is, moreover, strongly dependent on collaboration with labs in South Africa, due to lack of a glovebox and other necessary accessories to effectively conduct OPV research at the University of Zambia or at any university within the Network. The integration of the synthetic group from Ethiopia (which was present at the MSSEESA 2017 Dar es Salaam Meeting) to the network will be a way forward.

3.11.1. A tentative benchmark for journal publications

The latest UNESCO Science Report (2015) gives some indications for the amount of publications in the basic sciences in MSSEESA’s participating countries. The field of material sciences and especially physics is still underrepresented, when for example measured against the number of publication in the life and medical sciences, agriculture or geo-sciences. The UNESCO report lists the overall number of publications from 2005-2014 by drawing from the Web of Science database, with all countries showing an upward trend in the number of publications. Between 2008 and 2014, the Web of Science shows for MSSEESA-relevant fields of physics, chemistry and engineering the following publication counts:

Country	Overall Number (2005-2014)	Physics (2008-2014)	Chemistry (2008-2014)	Engineering (2008-2014)
Kenya	1374	68	91	90
Tanzania	770	23	41	80
Uganda	757	13	12	36
Zambia	245	12	13	14

Table 8: Publications according to the UNESCO Science Report 2015, pp. 514-515, 544-545.

However, the Web of Science data needs to be read with care: The database does not include all publications due to language and selection biases. Some journals enter the database, while other leave it due to the fulfilment or lack of compliance with journal standards, which the Web of Science defines and changes. This approach, hence, comes with restricted reliability when constructing benchmarks for publications.

3.11.2. The number of publications from the network

The data available from the network's annual reports (2008-2017) reveal a sum of 163 publications, including a few popular publications such as government and a company reports:

Nodes/Network	MPh theses	MSc theses	PhD theses	Popular pub.	Sci Journal	Sum
KEN:02		12	8	2	54	76
KEN:02 & KEN:03					4	4
KEN:03	3	3	3		19	28
MSSEESA		3		1	6	10
TAN:01/2		20	5		2	27
ZAM:01		9	1	1	7	18
Sum	3	47	17	4	92	163

Table 9: Number of Node/MSSEESA Publications

Most of the publications originate from the work of individual nodes, with only few journal papers reported to include authors from more than one node. This marks a similar attribution problem as with the funding. Notably, many publications cannot be attributed to the research funding of the network for lack of acknowledgment stating the funding organization.

The majority of the scientific articles are published in journals with good to excellent international visibility (ToR: Q20). Only ten are in journals of only African media penetration (see Appendix C). The 92 scientific publications in nine years by 9 to 18 scientists seem to contribute to the national trends outlined in the UNESCO Report. The biggest growth is in Kenya, which is also reflected in the publication output of the ISP-funded nodes.

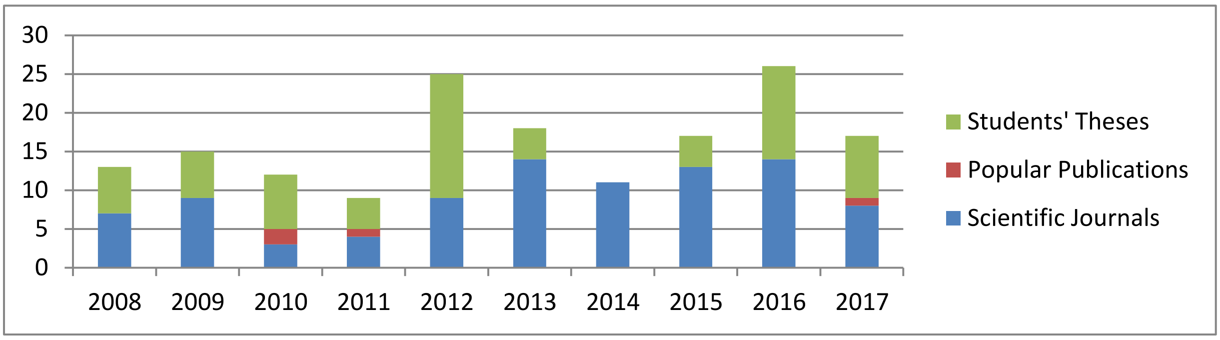

Figure 3: Number of publications per year by all MSSEESA members

The yearly number of publications rose after 2012 but not very persistently. Whether this was an effect of the network could not be clarified. A comprehensive bibliometric analysis could give clearer indications and also benchmarks when compared to other fields and within the region.[6]

3.11.3. Conference publications

The limited analytical power of these bibliometric numbers calls for additional measurements. The network's objectives state that common research and exchange for training are equally highly valued. The bibliometric indicators hence need to be read together with the number of PhD and MSc-dissertations, which were partly supported through the exchange between the nodes (see chapters 3.6.-3.7. above). However, during the evaluation, only a very few co-supervisions between the nodes became apparent. Moreover, they have not generated many co-publications with members from at least two nodes.

Conference and workshop proceedings could be another indicator for collaborative publications. Two conference proceedings of the network are available (2013, 2017). The conference of 2013 consisted of 45 presentations by network members and other scholars. The composition of abstract authors shows that most research is done nationally, often cooperating with other universities from within the node's countries. Other international co-authors included Germany, Botswana, and South Africa. The second conference in 2017 included 28 presenters and 10 poster-sessions. The abstracts of 20 presentations reveal the same patterns as in 2013, showing much collaboration within departments (13) and between departments, such as physics and chemistry departments at UNZA (1). Interuniversity-collaboration within the country (1) and exclusively within the network (1) as well as with international partners from Taiwan, Sweden, and Ethiopia (3) and with other than nodes (1) are in the minority. The posters on the other hand revealed further collaboration between the Kenyan and the Ugandan nodes and between Kenya and South African collaborators.

3.12. Effects beyond teaching and academic research

Given the rise in PV distribution, the discussions about renewable energies and the intensified material science developments during the last decade within the region, the network also started with the objective to contribute to the socio-economic development of its societies. Providing training for students who eventually become part of the emerging and growing industries as experts as well as providing training to technicians for PV systems is one key contribution. Hence the expected effects

[6] A bibliometric analysis for benchmarks and contextualization of the network's output was planned but not executed due to time and data (?) constraints.

for industry, government and society at large can be used as indicators for the evaluation (see ToR: Q23-26, 27).

3.12.1. Non-Academic Training

As shown above in chapter 3.9., the network provided several training opportunities for students and technicians. Moreover, several nodes organized larger scale academies and technical trainings to improve the practice of PV technicians and entrepreneurs. Given the high number of participants at the Solar Academies and training workshops organized by the network members (approx. 179), a wide number of persons have received new skills that can be applied. The effect is expected to be scalable once the trained persons become trainers in their countries themselves.

Additionally, outreach programmes to schools helped to sensitize for studies in the STEM subjects and promise to affect the individual choices of future students that again might affect their societies as increased expertise.

3.12.2. Policy-making

Further cooperation at the level of individual nodes included policy-making, standardization and control of solar panel import (UNZA, UDSM). The training of staff helped to recognize faulty panels that are currently imported and hence increases the protection for customers and of the environment, if non-functional solar panels are disposed without appropriate care. This adds to new collaborations with government-agencies such as the Tanzanian Rural Energy Association in PV training, Tanzania Bureau of Standard for Solar PV standard (Self-Description of UDSM, 2017) and the Zambia Bureau of Standards. Given the established and strengthened expertise, the nodes and network directly and indirectly contributed to the policy-making as one stake-holder among others (ToR: Q24).

3.13. Communication via website and newsletter

A website is nowadays an essential instrument to become known to a larger group of colleagues, industries and policy-makers. Websites and social media have become standards that promise gains for the network's integration and for its presence outside the universities. They have also become obligatory to guarantee a minimum of visibility with effects for distributing information and for attracting potential cooperation partners and students. Supplying regular activities also helps to provide information for students who wish to take part in activities of the network. Announcements for conferences and workshops have, however, been shared through the ISP- and university-websites and also through social media (fb).

The network in the beginning proposed to develop a website, whose administration was to be overseen by the coordination office. Moreover, a regular "Network Newsletter" was planned to support the distribution of information and activities (Constitution: 6). A website was planned during the first year but has not been realized so far (see expenditure sheet 2009). A new approach is underway during the current coordinating office being at the University of Nairobi creating a website in the second half of 2018. Young scholars of the network indicated that they founded a social-media group to share information among their peers.

4. Quantitative analysis from the questionnaire

This chapter assesses the networks based on the questionnaire mentioned in part 2.3.2. Together with the factual development listed in chapter 3 it forms the basis for our recommendations in chapter 6 below. This assessment includes a quantitative approach to estimate the efficiency and effectivity of the funds spent. Due to the noted lack of information from the expenditure sheets, further information where asked for but only received partially. The assessment therefore remains incomplete.

4.1. Quantitative analysis for the node at the University of Zambia

For the node at the University of Zambia the questionnaire was partly usable for some analyses. For this node we will focus our analysis on the period from 2013 to 2016.

- ***Travelling:*** According to the travelling sheet of the questionnaire, in the year 2014 the node coordinator spent US$ 2136 in order to "handover notes to the MSSEESA Uganda node" and US$ 150 to attend the "*All African Nanoscience Nanotechnology Workshop*". This shows clearly a low performance of scientific compared to administrative activities within the network. In particular the intended exchange of students between the nodes is missed as one of the main goals of the *Five Year Rolling Strategic Plan for MSSEESA*.
- ***Events:*** The Zambian node organized the *5th,6th,* and *7th MSSEESA Coordinating Board Meeting* in Lusaka for total US$ 23041 which is half the administrative costs budget of the SEK 510000 ≈ US$ 55500 for three years according to the Grant Application for 2013-2015. Furthermore, in 2013 the financial support of US$40'000 for the "*1st International MSSEESA Conference" with* 79 participants and of US$ 15155 for a workshop for training of technicians with 18 participants in Kenya was administrated by the Zambian node as network coordinator. This is more than the SEK 80000 ≈ US$ 8700 per year the network applied for in 2012. Even if one considers that the next conference of this size happened in Dar-es-Salaam in 2017 (see below), which means that this expenditure has to be compared with the conference budget for 4 years, i.e. SEK 360000 ≈ US$ 38800, the conference activities seems to have been quite adequate to the Five Year Rolling Strategic Plan for MSSEESA. However, in the opinion of the evaluators, already in the grant application was a clear misbalance between administrative and scientific conference activities compared to other programmes of this kind.
- ***Students support:*** With US$ 45143 support for 14 master students (2 female) between 2008 and 2016 this activity in the framework of MSSEESA was OK, but not part of the MSSEESA budget. From the planned MSSEESA budget for support of students of SEK 16800 ≈ US$ 1900 per annum and node nothing has been used. The main financial supports were obviously allowances from ISP or other sources in Sweden to the students. Thus, the students support may be only seen as a side effect of the network activities. That more direct support of students is necessary is indicated by the quite long time, partly more than 4 years, they needed to accomplish their master studies (see chapter 3.7). It has to be noted that the first female student in the group started in 2015.
- ***Equipment:*** One of the main ideas of the MSSEESA network was to install complementary specific equipment at the nodes used by the network via exchange of scientists and samples for measurement. The inspection of equipment by the evaluators first showed that the uni-

versities are equipped for basic sciences on their own. Contrary to one of the key objectives of the network, however, all nodes have more or less equivalent equipment. Even for expensive new special equipment there are duplications (see below). For the year 2014 data for usage by own and MSSEESA users as well as breaks and costs for maintenance were to be gathered.

4.2. Quantitative analysis for the node at the University of Dar-Es-Salaam

The data sent in by the node at the University of Dar-Es-Salaam were less complete than those from the University of Zambia but still usable for some analyses.

- ***Travelling:*** With three senior scientists and six students the node participated on the *"1st Young Scientist MSSEESA Conference on Materials Science and Solar Cell Technology"* in Nairobi, Kenya in 2013 (no data about costs given). Furthermore, there was one participant for the "*1st MSSEESA Technical Training Workshop on Instrumentation"* at the same location one day before the conference.

- ***Events:*** The node in Dar-Es-Salaam was quite active in organizing conference and workshops, from the *"1st International Conference on Solar Energy Material Research"* in 2009 (no detailed data available) to the *"Workshop on Solar Energy Materials for Energy Need in Africa …"* in 2017 with 70 participants, which costs US$ 38275 refunded with US$ 45595 by MSSESA and US$ 7320 by other sources. For funding of US$ 4050 by MSSESA and US$ 666 by other sources the retention of the difference between costs and funding for this activity should be clarified as well. The costs for the *11th MSSEESA Board Meeting*, which was organized by the node and ensuing the conference, was with US$ 3384 normal, though it could have been cheaper, if it weren't added but included into the conference. Also, in this case the retention of the difference between costs and funding should be clarified. Between the two big conferences the node organized several smaller workshops. In respect to the gender issues formulated in the *Five Year Rolling Strategic Plan for MSSEESA* the two "*Advanced Level Science Camps for Female Students…"* in 2016 and 2017 have to be emphasized. With 20 and 30 female participants and total costs of US$ 2454 and US$ 2985, respectively, they were efficient activities. Since the funding for the latter was US$ 3283 by MSSESA and US$ 298 by other sources, the retention of the difference between costs and funding should be clarified as well. Although the participants seem to be mainly local students from Dar-es-Salaam but not from the other MSSEESA nodes, this activity should be supported in future – maybe as a separate project outside of MSSEESA, which should be by definition an exchange program.

- ***Students support:*** From 2009 till 2016, 13 students graduated for MSc and one for PhD. With 2½ years duration the master studies are quite normal, whereas the 6 years for the PhD-student are quite long as compared to international standards. However, this may be a singular case though in the interviews a systemic problem of lack of sufficient financial support or excess of teaching workload for PhD student could be identified. With only US$ 3240 for two cases, the financial support by MSSEESA was marginal. The activities of the node to encourage female students (see above) at least had the effect that after more than 12 years of only male MSc-students two female MSc students joined the group in 2016 and 2017, respectively.

- ***Equipment:*** The equipment at the node in Dar-es-Salaam is quite limited and almost worn out compared to that at the University of Zambia. The latter can be seen in the mean outage time of 80 days in 2016 mainly caused by long replacement time for spare parts. The low quality and reliability of equipment may explain why other nodes are not enthusiastic in using the facilities at the University of Dar-es-Salaam. On the other hand, the group in Dar-Es-Salaam had severe problems in using the equipment at other nodes by exchanging scientists. There is no other reason than this lack of exchange of information to explain, but not to justify, why the University of Dar-es-Salaam purchased an AFM for self-use, though there was a quite similar AFM at the University of Zambia. Coordination in acquisition and cooperation in usage of this device between the nodes would have saved US$ 120000 of funding, which could have been used for exchange and other urgently needed equipment. The low workload of 52 days per year for the AFM in Dar es Salaam, which means that there might have been a lot of time for measurements by members of other nodes, demonstrates also exemplarily that the MSSEESA network didn't work on the level of merging complementary facility capacities by exchange of scientists or samples. Of course, every node is free in its acquisition policy, but then pops up the question: What is the purpose of the objective 4 in the MSSESA strategic plan?

4.3. Quantitative analysis for the node at the University of Nairobi

The node at the University of Nairobi provided only data concerning students and equipment, which both are very incomplete. Therefore, the informative value was quite limited.

- ***Students support:*** From 2012 till 2017 the node supported 16 MSc (5 female) and 8 PhD (3 female) students. None of them were directly supported by MSSEESA. With the exception of one case each MSc students got US$ 2400 by other sources. Two MSc students received additional support from Swedish foundations of US$ 4800 each. 4 PhD-students received US$ 18000 allowance from other sources but none from MSSEESA or other Swedish foundations.

  8 MSc and 5 PhD students have graduated between 2012 and 2017. Though the node in Nairobi has the highest quota of female MSc students of all nodes, it must be pointed out that none of these female MSc students are yet to graduate, although three of them started their studies already in 2013.

- ***Equipment:*** The facilities at the University of Nairobi are in good shape, although the visit of the laboratory has shown that many of the equipment are not as "top" as stated by the node coordinators in previous reports. Nevertheless, there was a problem with maintenance even for quite new equipment. In 2016 the vacuum sputter coater (investment US$ 178354) was not available for 270 days due to the long time needed to finance the repair costs of US$ 14439. Some of the equipment at the node of Nairobi was used in 2016 for 21 days by members of the node at the University of Dar-es-Salaam.

5. Identifying limiting and supporting factors for the functioning of the network

The observations from the diverse elements of the network in chapter 3 and the quantitative analysis of the budget in chapter 4 give an overall impression of the network's expenditure and development. The interviews with node coordinators, technicians, students and administrators have revealed different explanations for the low output of the network and fulfilment of indicators. Both, qualitative and quantitative analyses reveal a lower effectiveness in the proceedings of the network than expected. This affects the efficiency of the MSSEESA network as measured by the self-set objectives in the Five Year Rolling Strategic Plan. The summary of the observations follows the five (5) key objectives and identifies current weaknesses and potentials. It is suggested that some of the realization of objectives is interdependent and to some extent not to be reduced to financial support only. Recommendations for the further development will be presented in chapter 6.

Objective 1: To strengthen postgraduate training:

When seen from the perspective of the network–the primary task of the evaluation–there was no direct support of postgraduates by allowance and only very few participations of students at conferences or visits to other nodes for scientific exchange and experiments. Most of the successes of postgraduate training must be attributed to the work of the nodes.

However, the network's activities have provided further opportunities for students to present their work at conferences and workshops, to increase their individual skills in research and to partly travel for experiments elsewhere. As shown in chapter 3.7. the newest generation of post-graduate students, who chose to pursue their degree in their home-country, profit from the earlier generation of training of supervisors. The postgraduate training was hence also strengthened because more supervision capacities were built up between 2000 and 2015. The individual decision of many of the graduates to remain in academy has contributed to these increased capacities.

The interviews have also shown that some members of the network are still having low numbers of students in the BSc and MSc, a common feature in the developing countries for a number of reasons. The nodes have taken actions to attract students to natural sciences, research and solar energy – actions to be recommended and strengthened. A higher visibility of the network online and in social media and continuous outreach programmes to school could positively affect the choice of students to study material sciences and basic sciences in general.

Objective 2: To strengthen inter-university collaboration in teaching, research and training:

The research facilities available to the network were seldom used by the network. Staff exchange and training was limited to short workshops without real possibility for exchange of deep knowledge. Interviews with technicians have shown that also technicians would have profited from more frequent learning opportunities and exchanges with colleagues.

There were no attempts to get funding for sustainable research activity by cooperation of the members of the network although some efforts were taken, and some board meetings were dedicated to drafting proposals as a network.

While the network initially planned to work toward a harmonization of credit transfer between the universities to facilitate and incentivize the exchange of postgraduate student, this plan has been delayed due to a lack of support from the political and administrative side and due to the complexity of different specialised courses. This remains a promising target but is yet a weaker spot of the network's achievements.

Objective 3: To promote gender equity and balance:

Except for the commended two "*Advanced Level Science Camps for Female Students…"* organized by the Dar-es-Salaam node and for examples of outreach initiatives from UNZA in interviews we could not find any direct efforts to improve gender equity and balance within the network.

Nevertheless, there is a positive trend due to a rising number of female students, which should be further supported. Most nodes have taken in female students who will develop further into future researchers and contributors to their social, academic, and economic environment. Tellingly, one female postgraduate student indicated that she would not only want to have an academic degree but also the skills to develop a business outside of academy and to contribute to larger society.

Objective 4: To strengthen research capacity:

Research capacity building targets individuals and organizations. The difficulty remains to attribute the overall increase in research capacity to specific activities of the network. The postgraduate training at the node-level and the, however few, exchange opportunities at conferences for the coordinators and the young researchers have improved overall, as seen in the increasing numbers of PhD-intakes at mostly all universities and the stronger supervision capacities at the local levels of the first generation of network graduates.

There were few attempts to enhance human technical capacity by specialized workshops, which could be extended especially for the training of university technicians to better support the research activities. Without a clearer commitment by the network, it remains it is questionable, whether they will be sustainable.

The strengthening of the research facilities by equipment was less a result of MSSEESA-coordinated funding than rather of direct funding of the single nodes. Overall, the network spent 17% of its available budget for pursue and repair costs of equipment. This sustained and strengthened the research capacities of nodes, especially of the University of Dar-es-Salaam. The granted access to the equipment for network members and other researchers from universities is an indicator that some side-effects due to the existence of the network must be acknowledged, given the sometimes dire circumstances of availability and costs of import of instrumentations.

However, the research capacity needs to be complemented by capacities to manage complex projects, for which an adequate environment is necessary. The evaluation has shown several critical points: The inconsequent monitoring and evaluation practices and reporting practices among the nodes and harmonized financial statements can be considered avoidable and non-financial obstacles to a more effective and sustainable development of the network. A strong management and ready-made financial oversights would have it easier to convince further funders to support the network.

Objective 5: To disseminate research findings and information:

One key area of manage capacities are the dissemination efforts beside the academic publication opportunities in journals. There is still no online presence of the MSSEESA network, despite the early expenditure for the development of a website in 2009. The chief coordinators have also not formulated a newsletter that could have been produced at nearly no costs at all. Both facts pose severe limitations to the wider visibility of the network, which had and has effects for the integration of further nodes, for the information of students that could choose the field for their studies, and most importantly for potential funders and donations to strengthen the commendable idea of a South-South research network.

The evaluators appreciated that there were several conferences and workshops that helped to give visibility to the research and training at the different nodes. However, their participants reach was almost limited to the nodes and groups already related to them, not fostering a broader network with physics departments in the region. They were by no means comparable with Pan-African conferences as organized e.g. by the ANSOLE network.

The academic publication activities were normal and contributed to the scientific development of the region (see above, chapter 3.11.). However, due to only a few network-acknowledgements and due to the fact that articles by co-authors from two or more nodes were quite rare (10 out of 163), the number of publications can only be attributed indirectly to the network.

Several reports for governments and industries were produced from the nodes, which generally add to the outputs outside the academic realm. However, it remains unclear what the specific relation is to the network's activities.

Comment on the satisfiability of the objectives

Measured against the financial support the broad range of objectives might have been too ambitious, also given the sometimes difficult research and teaching environments. The more pragmatic and realistic selection of more feasible objectives would have been necessary after the first period of funding in 2013 in order to concentrate on particularly promising activities. While some activities of the network have been fulfilled and put in place strengthened research capacities and some visibility (such as the conferences and training opportunities, the outreach-programmes to schools), other objectives have visibly not been reached (such as an effective communication within the network and with its environment through a website and similar tools).

As noted in chapter two (2), this evaluation exercise works on the premise that the network should be measured against its own objectives to avoid biases and the application of exogenous objectives. We suggest that some of the inefficiencies and ineffectiveness of the network can be attributed to the chosen forms of governance as a non-financial attribute of the network. The absence of effective monitoring and evaluation instruments and their rigorous application throughout the board-meetings strongly contributed to the exposed weakness of the network. Moreover, a lack of communication and coordination between the nodes outside the board-meetings seemed to have limited the overall development as a network. As a consequence, the network tended to remain inefficient and ineffective, when measured against its own objectives as a network. This impression does not extend to the individual nodes, which need to be evaluated separately.

6. Recommendations

Given the preceding analysis of the network over the course of nine years, there seems to be two fundamental options for the future of the network that the evaluators would like to recommend to ISP for further consideration (ToR: 3.2.):

1) The first option is to stop the MSSEESA network for being too ambitious in its objectives. It might be better to continue to support the nodes directly for specific activities by separate well defined projects. These may be in particular:
   - More allowances for female MSc and PhD students including the sandwich model. Given the attempts at the UDSM and UNZA to target more female researchers, ISP should give preference to female candidates. This would add to closing the gap between male and female colleagues in science in general and in physics in particular. Also, a lack of fellowships has been mentioned during the interviews at all nodes as one reason for not providing more opportunities.
   - Maintenance funds for financing and/or direct sending of spare parts.
   - Courses for technicians in solar energy technology, in particular quality control.
   - Financial support for specific conferences and workshops in the region, at which the ISP nodes and other interested parties participate as hosts and speakers.

2) The second option for ISP and the nodes is to continue funding the network in a fundamentally changed way, but to build on the strengths and potentials of the network and its nodes. This concerns all aspects of administration, constitution, and strategy of the network. In particular changes are needed in respect of
   - **Controlling:** First of all the network has to establish a financial controlling system following international standards in budgeting, accounting, and reporting. This system should follow more than just GAAP and be externally certified by an external auditor. Furthermore, the controlling system should include a monitoring of the target compliance for non-monetary objectives. Payments-out of new instalments by ISP should depend on complete reports for the correct and target-oriented usage of the previous payment.
   - **Leadership**: A reconsideration of the rotating principle of chair of coordinators, when the handing over between chief coordinators becomes too inefficient and has detrimental effects for the network. If the decision is to keep the rotating principle of chief coordination, at least there could be installed a permanent and stationary executive secretary for coordination, accounting and reporting network activities and to support the activities of the chief coordination. Several node-coordinators have suggested this in interviews. Membership fees of the chapters, as planned in the guiding documents, could contribute to the maintenance of the secretary.
   - **Strategic Planning:** The strategy-plan has to be revised in respect of feasibility in respect of personal and financial resources resulting in objectives with realistic perspectives to follow upon. This requires a common understanding between the chapters and ISP about either a drastic reduction of the objectives listed in the prior strategic plans or a significant increase of funding. Investment in scientific equipment should be better coordinated between the chapters.

- **Internal Communication**: A more efficient communication process between the board and the chapters with more robust and frequent coordination of planned activities within the chapters and between them, including a timely and comprehensive reporting-mechanism.
- **External Communication**: A rigorous public dissemination practice first of all by installing an online presence. This includes a possible distribution of tasks among the chapters concerning public communication via a website and frequent newsletters to stay informed within the network and to communicate the networks activities to the broader public and to potential partners and funders.

  This online presence may also serve the internal communication as well as improve the exchange of information about equipment and research stays. The network members have to ensure that the network is acknowledged in all scientific and non-scientific publications, which are related to network activities.
- **Funding:** An acquisition of additional funders is necessary for the network to become less dependent on one funding source only. Some first funding successes were made possible by individual nodes. The potential of the network, however, remains to be leveraged on. Universities in the region provide services to search for funding, such as the University of Nairobi that has subscribed to the funding information platform Research Professional Africa.
- **Supporting Young Scholars:** An active and early inclusion of junior researchers into the network to attract talents for the future leadership of the network. Such inclusion can benefit the network when junior researchers identify with its goals and contribute with own initiatives. Junior researchers have shown an outspoken interest to contribute to the network by exchanging information and to take responsibility for certain tasks.
- **Gender equality:** All activities of the network should enforce gender equality. Allowances should be granted in particular to female MSc and PhD students. Furthermore, female scholars should be encouraged on all levels up to self-responsible project managing or node-coordination.

7. Literature

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Appendix A Interviews and questionnaires

A.1. List of Interviews

We are thankful to the many interlocutors for their patient and thorough responses to our questions.

Institution	Date	Interlocutors
University of Dar Es Salaam	November 2017	Prof. Dr. Margaret Emmanuel Samiji (Node coordinator) Dr. Najat Mohamed (Head of Physics Department) Dr. Georges Shemdoe (COSTECH) Students
Makerere University	February 2018	Prof. Dr. Tom Otiti (node coordinator) Dr. Denis Okello (node secretary) (Head of Physics Department) Prof. Dr. Ernest Okello Ogwang (Deputy Vice-Chancellor for Academic Affairs) Students
University of Zambia	February 2018	Dr. Sylvester Hatwamboo (node coordinator) Prof. Dr. Onesmus Munyati (node secretary) Prof. Dr. Prem C. Jain (member of staff) Mr. Bellingtone Changwe Chief Technician Prof. Dr. H.V.Mweene (Dean School of Natural Sciences) Dr. Alfred J. Sumani (Executive Secretary) and Mr. Filipo Zulu (National Science and Technology Council) Students
University of Nairobi	February 2018	Prof. Bernard Aduda (Department of Physics) Dr. Julius Mwankondo Mwaora (Head Department of Physics) Dr. David Otwoma, NACOSTI (December 2017) Dr. Eric Mwangi, Ministry for Higher Education and Research (December 2017) Students
University of Eldoret	February 2018	Prof. Mghendi Mwamburi (Node coordinator, Head Department of Physics, Director for University's Strategic Planning and Performance contracting) Students
ISP	June 2018	Prof. Dr. Carla Puglia, Prof. Dr. Ernst van Groningen, Ms. Rebecca Andersson Dr. Afzal Sher and Dr. Nils Ohlanders (Project officers at SIDA) Prof. Dr. Thomas Rosswell (Chair of SIDA Scientific Advisory Board)
University of Nairobi	September 2018	Focus Group Discussion with M.Sc. and PhD students connected to MSSEE-SA/Nodes

A.2. Standardized interview questions

A.2.1. Interview questions: Node Coordinator

General Questions

1. What is, in your opinion, the most important contribution of MSSEESA to your institution that you couldn't have achieved without the MSSEESA support?
2. What is the position of the network in your university?
3. Are your network activities part of the university's priorities?
4. How has the university supported your node?

A SWOT-Analysis

5. What are the strengths and weaknesses (a.k.a. engineering topics) of your institution? What would you see strengthened? How could MSSEESA help in accomplishing this?
    1. Could we get a list of the equipment of your laboratory? What is the use-rate of the instruments?
    2. Which equipment from other partners have you used in the past? Which would you still need?
    3. What is the amount of time per week you have to invest in teaching?
    4. How do you attract students to the physics department?
    5. Is there a gender programme in your institution? (→ Self-Evaluations: Science Camps)
    6. How is the, if any, bilateral program funded by Sida affecting your activity at department level and within MSSEESA? - WHY no funding? How often applied? Which effects?

PhD-Training

6. How did the PhD training profit from the network?
7. Are further PhDs planned? Were there interested persons
8. Is the sandwich model, as it is planned, a proper way for your department to use? YOU SEE POSSIBILITIES FOR IMPROVEMENTS?
9. Can you see that the PhD-students from the sandwich program can benefit from their studies after graduation at department level? In what way?

Publications

10. Why are there only XX journal articles in the list?
11. Which of your publication contain an acknowledgement of ISP-funding?
12. Which publications are results of cooperation within the network?
13. Why is the master theses list not complete in the self-evaluation?

Networking

14. How effectively does the organizational structure of the network operate from your point of view? What organizational changes would you welcome?
    1. Example: Rotation of network coordination office? Positive or negative?
15. Are organizational meetings sufficient and productive?
    1. At how many meetings did you take part?
    2. Do you think the network meetings can be more productive if more often via skype?
    3. Were relevant set goals discussed during the meetings?
    4. In your opinion, was there sufficient trust and transparency to discuss problems within the network? Can you give examples?
16. Your strategy included a website and newsletters? What have you undertaken so far to fulfill this aim? What are obstacles?
17. Have you tried to include further institutions into the network?
    1. Where there interesting parties? Is there a contact person for interested parties?
    2. Does your institution cooperate with private industry? If yes, does this support your research?
18. Have you developed funding projects together within the network? Do you have examples of rejected proposals?
19. Objectives of the network strategy plan

Future

20. Is your node interested in continuing the network? If yes, under which conditions?
21. If no, what is your exit plan?
22. Which effects do you expect if the network will not be continued?

A.2.2. Interview questions: Junior researcher

1. Describe your career so far and positions held
2. Describe the state of your current research
3. Give your opinion about the sandwich model (if appropriate) or course(s) attended with MSSEESA support.
4. What are your aims in your future career?
5. (If returning to home institution) Will you be able to join a research group, or will you have colleagues in related fields of research, at your home institution?

A.2.3. Interview questions: Research environment (HoD, university leadership, research councils)

1. What impact has the MSSESA-node have had on your university's research so far?
2. How has your institution supported the network in the past decade?

3. Can you name networks or international collaborations at you universities with similar effects and impacts?
4. How would you describe the engineering research environment in your country in regard to training, research & innovation and transfer of knowledge to society?
5. How would you describe the general access to funding for research and training in your country in regard to national and international sources and in regard to the development of access over the last 10 years?
6. Could you describe the access of women to science and technological studies at your universities/your country and its development over the last 10 years?

A.3. Questionnaires

In what follows we show the headers of the questionnaires sent to the nodes (see 2.3.2) in order to improve the quantitative analysis:

A.3.1. Questionnaire concerning staff

Ordinary Staff of	*University, Institute, Group*							
Employee's				Period		Function		Financed by ❾
name ❶	graduation ❷	citizen ❸	gender ❹	entry ❺	exit ❻	category ❼	description ❽	

⓿ from 2015 till 20017					
Previous employment ❿			Subsequent employment ⓭		
function ❼	category ⓫	institution ⓬	function ❼	category ⓫	institution ⓬

A.3.2. Questionnaire concerning students

PhD, MSc, and BSc Students at			*University, Institute, Group*				⓿	
Student's			Graduation				Thesis	
name ❶	citizenship ❷	gender ❸	entry ❹	defense ❺	degree ❻	success ❼	title	published ❽

from 2015 till 20017								
	Stipendium in US$ financed by			MSSESA support			Sandwich model	
costs in US$ ❾	own state ❿	Sweden ⓫	others ⓬	financial in US$ ⓭	cooperations ⓮	acknowledged ⓯	⓰	host ⓱

A3.3. Questionnaire concerning travelling

Travelling of members of				*University, Institute, Group*	
Dates ❶	Traveler's			Destination	
Start End	Status ❷	Name ❸	Gender ❹	institution, city, country ❺	distance ❻ ❼

⓿ from 2015 till 2017							
Purpose		Travelling costs in US$ for				MSSESA	
category ❽	description ❾	transport ❿	accommodation ⓫	allowance ⓬	overhead ⓭	reimbursed ⓮	acknowledged in ⓯

A.3.4. Questionnaire concerning events

Events organized by	*University, Institute, Group*		⓿ from 2015 till 2017	
Dates ❶	Venue		Subject	
Start End	type ❷	name ❸ country ❹	category ❺	title

Participants ❻	Event costs in US$ for				Funding in US$ by				
male female inter	rents ❼	print work ❽	speakers ❾	overhead ❿	hosting state ⓫	MSSEESA ⓬	industry ⓭	NGOs ⓮	others ⓯

A. 3.5. Questionnaire concerning equipment

Equipment at	*University, Institute, Group* ⓿						from 2015 till 2017
Device			Investment				
Name ❶	Manufacturer ❷	used for ❸	date ❹	costs in US$ ❺	funding ❻	paid by ❼	

Maintenance in 2016		Utilization in 2016				Usability status	Decommissioning	
days ❽	costs in US$ ❾	days in total ❿	by MSSEESA ⓫	MSSEESA visitors ⓬	costs in US$ ⓭	end 2017 ⓮	date ⓯	revenue ⓰

A. 3.5. Questionnaire concerning publications

Publications of members of	*University, Institute, Group*								⓿
Date	Journal				Authors'				
❶	abbreviation ❷	volume	first page	DOI, ISSN or ISBN ❸	names ❹	affiliations ❺	male	female	inter ❻

from 2015 till 2017							
Title	Publication	MSSESA			Citations		
	costs in US$ ❼	reimbursement ❽	cooperations ❾	acknowledged ❿	WoS ⓫	other ⓬	sources ⓭

For each questionnaire we sent an instruction set how to fill them out field by field (encircled numbers).

Appendix B Meetings, Conferences, and Workshops

Dates	Organized by	Title	Venue	# Participants male/female	Costs in US$
13-15. October 2009	UDSM	The 1st International Conference on Solar Energy Material Research	Belinda Oceanic Resort, Dar es Salaam	No information	n/a
16-20. November 2009	UDSM	Local Training on Domestic Photovoltaic systems	Lindi Region, Tanzania	12	n/a
8-9. July 2010	UoN	Conference on "Opto-Electronic Devices: Their potential for sustainable development"	Department of Physics, UoN, Kenya	60	n/a
4-15. October 2010	UDSM	Training Veta Instructors on PV-Systems	Moshi, Tanzania	16	n/a
16-27. April 2012	UoN	1st Solar Academy 2012	Department of Physics, UoN, Kenya	41	n/a
28-29. July 2012	UNZA	5th MSSEESA Coordinating Board Meeting	Cosmic Executive Lodge, Lusaka, Zambia	9/1	7042.00
13-24. August 2012	UoN	2nd Solar Academy 2012	Department of Physics, UoN, Kenya	23	n/a
18-28. April 2013	UNZA	Visits to MSSEESA Nodes for Consultations	United Kenya Club, Kenya, Land Mark Hotel, Tanzania, Makerere Guest House, Uganda	2/0	5482.00
24-25. August 2013	UNZA	6th MSSEESA Coordinating Board Meeting	Cool-Breeze and Lodges, Lusaka, Zambia	10/0	7826.50
26-27. November 2013	UNZA	1st International MSSEESA Conference	United Kenya Club, Nairobi, Kenya	79	40000.00
28.-29. November 2013	UNZA	Training of Technicians workshop	United Kenya Club, Nairobi, Kenya	18	15155.00
25-26. January 2014	UNZA	7th MSSEESA Coordinating Board Meeting	Cool-Breeze and Lodges, Lusaka, Zambia	10/0	8172.00
August 2014	MU	4th Training Workshop on PV installation and maintenance	n/a	~35	n/a
August 2015	MU	5th Training Workshop on PV installation and maintenance	n/a	~35	n/a
7-11. November 2015	UDSM	PV training workshop for technicians	Physics Department, UDSM, Tanzania	12	n/a
11-15. November 2016	UDSM	1st Advanced Level Science Camp for Female students Taking Physics and Mathematics	Physics Department University of Dar es Salaam, Tanzania	5/20	2454.00
31.10.-2.11. 2017	UDSM	Workshop on Solar Energy Materials for Energy Need in Africa,	Blue Pearl Hotel, Dar es Salaam, Tanzania	55/15	52915.00 Of which co-funding: 7320.00

3. November 2017	UDSM	11th MSSEESA Board Meeting	Physics Department, University of Dar es Salaam, Tanzania	12/1	4716.00 Of which co-funding: 666.00
4-8. December 2017	UDSM	2nd Advanced Level Science Camp for Female Students taking Physics and Mathematics	Science Complex Building, University of Dar es Salaam, Tanzania	6/30	3581.00 Of which co-funding: 298.00
12. December 2017	UDSM	2nd MSSEESA Technical Training Workshop on Instrumentation	Physics Department, University of Dar es Salaam,	13/4	13298.00 Of which co-funding: 938.00

Appendix C List of number of publications of MSSEESA-members

Journal titles / Dissertations	Number
(The) African Reviews of Physics	1
Advanced Nanotechnology	1
Advances in Materials	1
Advances in Materials	2
Advances in Materials Physics and Chemistry	1
Advances in Materials Science and Engineering	1
Africa Journal of Physical Sciences	2
Africa Journal of Science and Technology	1
African Journal of Pure and Applied Chemistry	1
AIP Advances	1
American Journal of Energy Research	1
American Journal of Materials Science	1
American Journal of Materials Science	1
American Research Journal of Physics	1
Applied Optics	1
Applied Physics Letters	1
Australian Journal of Basic and Applied Sciences	1
Chemical Communications	1
Coatings	3
Company report	1
East African Journal of Engineering, Science and Technology	1
Elixir International Journal Chemical Physics	1
Elixir Thin Film Technology	2
Energy and Environ. Sci	1

Energy and Environmental Science	1
Energy Procedia	3
European Physical Journal Applied Physics	2
Experimental Mechanics	1
Gov report	1
IEEE Transactions on Magnetics	1
International Advanced Research Journal in Science, Engineering and Technology	1
International Advanced Research Journal in Science, Engineering and Technology (IARJSET)	1
International Journal for Innovation Education and Research	1
International Journal of Advanced Renewable Energy Research (IJARER)	1
International Journal of Applied and Natural Sciences	1
International Journal of Emerging Technology and Advanced Engineering	1
International Journal of Energy Engineering	2
International Journal of Energy, Environment, and Economics	1
International Journal of Innovative Research in Advanced Engineering	1
International Journal of Innovative Science, Engineering and Technology	1
International Journal of Material Science	1
International Journal of Materials Science and Applications	1
International Journal of Remote Sensing	1
International Journal of Renewable Energy Research (IJRER)	1
International Journal of Science, Technology and Society	1
International Journal of Thin Films Science and Technology	1
IOSR Journal of Applied Physics	1
Journal of Alloys and Compounds	1
Journal of Basic and Applied Scientific Research	1
Journal of Chemical Engineering and Materials	1
Journal of Electroanalytical Chemistry	2
Journal of Energy and Power Engineering	1
Journal of Energy Technologies and Policy	1
Journal of Environmental Engineering	1
Journal of Magnetism and Magnetic Materials	1
Journal of Materials Physics and Chemistry	1
Journal of Materials Science	1
Journal of NonCrystalline Solids	1
Journal of Optoelectronics and Advanced Materials	1

Journal of Semiconductor science and technology	1
Journal of Solar Energy Materials & Solar Cells	1
Kabarak Journal of Research and Innovation	1
Material Science Research India	1
Materials Sciences and Applications	2
Materials Sciences in Semiconductor Processing	1
Mphil thesis	3
MSc thesis	47
Optik-International Journal for Light and Electron Optics	1
PhD thesis	17
Phys. Status Solidi A	1
Physica Status Solidi A	1
Physica Status Solidi C	1
Proceedings	1
Renewable Energy	1
Report	1
Solar Energy Materials & Solar Cells	2
Solar Energy Materials and Solar Cells	2
Surface Review and Letters	1
Surface Reviews and Letters	1
Tanzania Journal of Natural and Applied Sciences	1
The African Review of Physics	1
The African Review of Physics	1
The International Journal of Science & Technology	1
Thin Solid Films	2
Vacuum	1
Sum	**163**

Publication type	Publication name
Mphil thesis	J. Kanule, “Effect of Non-Uniform Illumination on the Solar Cell Output Parameters for a CPC/PV”, 2008
Mphil thesis	G. Makateto, ”Automation of Heat Transfer and Vapour Flow-Rate in Thin Film Deposition of Tin Oxide using the Atmospheric Pressure Chemical Vapour Deposition Technique”, 2008
Mphil thesis	R. Koskey, “Modelling and Characterization of a 15X Parapolic Concentrator /PV System”, 2008
MSc thesis	Kahuthu Wambugu, “Transport Phenomena of Photo-Injected Electrons in Dye Sensitized Solar Cells”, 2008
MSc thesis	Joseph Olwendo, “Studies on Mobility of Photo-Injected Carriers in an Open Circuit Condition in DSSC”, 2008
MSc thesis	Yohana Msambwa; (male), Investigation towards improved power output of the Compound Parabolic Concentrator Photovoltaics (CPC-PV).
MSc thesis	Grace, Kinunda (female) Immobilization of invertase enzyme on large pore micelle templated silica.
MSc thesis	Jovin Emmanuel (male). Synergistic Effects of Halide ions on the Corrosion Inhibition of Mild Steel by Acacia senegalgum in Sulphuric Acid Solution. IPPS MSSEESA, MSc, local)
MSc thesis	Sijaona C. Msigara (male). Base Catalytic Properties of Organoamino-silica Hybrids Prepared using cashewnut shell liquid components as templates. (IPPS MSSEESA, MSc, local)
MSc thesis	Joseph Makene (male). Preparation of Cashew Nut Shell Liquid Templated Thiol-Silica Composites and Their Application in Heavy Metal Adsorption from Aqueous Solution. (IPPS MSSEESA, MSc, local)
MSc thesis	Given Kalonga (M) Optimization and characterization of organic solar cells based on region-P3HT and C_{60}- PCBM blends,
MSc thesis	Justin K. Pondo (M) In Situ real-time Rutherford back-scattering spectroscopy study of Ni/Ge interaction,
MSc thesis	Joseph Simfukwe (M),Design and evaluation of a low cost Photovoltaic system using structured aluminum reflectors.
MSc thesis	Elias Phiri (M) Solutions of the Landau problem and some uses of the Density Functional Theory (DFT) in Materials Science.
MSc thesis	Alex Afred Ntilakigwa (M). Effects of O_2 Partial Pressure and Substrate Temperature on Optical Properties of DC Magnetron Sputtered $CuCrO_2$ and $CuYO_2$ Thin Films.
MSc thesis	Charles Opiyo Ayieko (M). Effect of Nitration of TiO2 Thin Film Window Layer on the Performance of TiO2/In(OH)xSy/Pb(OH)xSy Composite Solar Cell.
MSc thesis	Paul Ajuoga (M). Effect of Concentration of Dopant States on Photoreactivity of Nb-doped TiO_2.
MSc thesis	Raphael Makokha (M). Performance and Characterization of Dye sensitized Photovoltaic Module under Tropical Weather Conditions: The case of Nairobi,

	Kenya.
MSc thesis	Calvince Okuna (M). The effect of Al doping on the electrical and optical properties of tin oxide thin films.
MSc thesis	Stellamaris Lydia Kioko (F). Modelling of artifacts and the effect of temperature on the ouput characteristics of a monocrystalline solar cell using the Laser Beam induced current/ voltage (LBIC/LBIV) technique.
MSc thesis	Ambonisye Sultan (M). Luminous Transmittance and Transition Temperature Of VO_2:Ce Thin Films Prepared by Reactive Magnetron Sputtering.
MSc thesis	Andrew Minu (M). Preparation of Palladium (II) Supported on Castor Oil Based MTS Catalyst for Peroxide Promoted Catalytic Wet Oxidation of Phenols as Model of Breweries Effluents.
MSc thesis	Emmanuel Ollotu (M). Investigation of Optical Properties of Nb doped TiO_2 Thin Films Prepared by DC magnetron sputtering.
MSc thesis	Fina Lesafi (F). The Effect Of Anacardic Acid On The Formation And Properties Of Cadmium Sulfide (CdS) Nanomaterials Prepared at the Water-Toluene Interface.
MSc thesis	Gervas Charles (M). Preparation of Sunflower Oil-Templated Organo-Silica Composites for Removal of Chromium Ions from Tanneries Wastewater.
MSc thesis	James Mgaya (M) Preparation of Castor Oil Porous Organosilica Composites for immobilization of Trypsin Enzyme.
MSc thesis	M Nathanael Komba (M). Preparation and Characterization of Organic Conducting Polymer Films from Cardanol: A Component of Cashew Nut Shell Liquid.
MSc thesis	Pholds Lwitiko (M). Structural, Electrical and Optical Properties of ZnO:B Films Prepared by DC Magnetron Sputtering.
MSc thesis	Wilson Joseph (M). Synthesis of 2,4,6-triamino-3-pentadecylphenol based polymers for adsorption of heavy metal ions from aqueous solutions.
MSc thesis	Prospery Simpemba (M). Growth and Characterization of Spray Pyrolytic Doped Zinc and Aluminium Oxides Spectral Selective Thin Films.
MSc thesis	Mannase Kitui (M). Design of TiO_2 based multilayer optical filters. (IPPS KEN:03, Local)
MSc thesis	Alinanuswe Mwakalesi (M). The potential of Terminalia catappa seed oil extract as a green corrosion inhibitor for carbon steel in sea water.
MSc thesis	Samwel Bernard (M). The effect of target composition on optical constants of DC sputtered ZnO:Al thin films. (IPPS MSSEESA, Local)
MSc thesis	Daniel Chilukusha (M). Study of Nickel-Germanium Interactions in Lateral Diffusion Couples and Thin Films.
MSc thesis	Jefarasio Ndungu (M). Nanoporous Ceramics for Water Filtration.
MSc thesis	Esekon James Ikai (M). Application of the Quantum Espresso Code to study the Structural and Electronic Properties of Titanium Dioxide.
MSc thesis	Jorim O. Obila (M). Characterization of Cu_2ZnSnS_3 (CZTS) thin films deposited by potentiostatic CZT elem-ental deposition followed by chemical bath in sodium sulphide solution.

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MSc thesis	Ogwe Odede (M). Representation of Quantum Mechanics in the Formulations of Special Relativity.
MSc thesis	Alphonce Dominick (M). Electrochemical Investigations on Corrosion Inhibition of Mild Steel in Portable Water Using Persea americana Seed Extract.
MSc thesis	John Justine (M). Optimization of zinc to tin ratio in a sol gel precursor solution on the growth and characterization of CZTS thin films.
MSc thesis	Mussa Mohamed (M). Determination of aluminium tungsten and Hall Effect
MSc thesis	Said J. Said (M). Investigation of the effect of sputtering power and argon flow rate on the optical and electrical properties of DC sputtering ZnO:Mg thin films .
MSc thesis	Gilbert Samukonga (M). Construction and evaluation of a PV/T collector using the batch method.
MSc thesis	Mwansa Mbayoni (M). Design, Construction and Evaluation of a parabolic Con-centrator-Photovoltaic System with Improved efficiency.
MSc thesis	Dennis Silungwe (M). Computational Modelling of the Electronic Properties of Chalcopyrite-type and Platinum Group Transition Metal (PGM) Chalcogenide Semiconductors.
MSc thesis	Justine Sageka Nyarige (M). Deposition and Characterization of Antimony (Sb) and Phosphorous (P) co-doped Zinc Oxide (ZnO) Films for Opto-electronic Ap-plications. (MSc)
MSc thesis	Kibet Too Philemon (M). Carbon Dioxide Capture capabilities of calcium Oxide and carbon nanotube: An ab Initio Study. (MSc)
MSc thesis	Aggrey H. Rodgers (M). Corrosion Inhibitione of Mild Steel by Gum Exudates from Acacia Melacocephala and Acacia Drepanolobium in Acidic Medium. MSc
PhD thesis	Sebastian Waita (male) Dye Sensitized Solar Cells Fabricated from Obliquely Sputtered Nanoporous TiO2 Thin Films: Characterization, Electron Transport and Lifetime Studies, PhD Thesis, University of Nairobi (2008)
PhD thesis	Robinsson Juma Musembi (male) Fabrication and Characterization of In(OH)xSy Modified Highly Structured TiO2/Pb(OH)xSy/PEDOT:PSS eta Solar Cell, and Study of its Transport Mechanism, PhD Thesis, University of Nairobi, 2009
PhD thesis	Christopher Maghanga (male). Preparation & Characterization of a spectrally selective reflector surface based on Ti02:Nb thin films.
PhD thesis	Joseph P. Yoeza. N/A
PhD thesis	Sylvester Hatwaambo (male). Comparative study of low concentrating photo-voltaic systems using low-cost reflector. Sandwich PhD with Lund University, Sweden.
PhD thesis	Alex A. Ogacho (male). Passivation of Ultrathin nanoporous TiO2 for Photovol-taic Applications. (IPPS KEN:02/MSSEESA, PhD, local)
PhD thesis	Justus Simiy (male). Characterization of Anthocyanin Dyes and Investigation of

	Charge Transport in TiO2 Dye Sensitized Solar Cells. (IPPS KEN:02/MSEESA, PhD, local)
PhD thesis	Nuru Mlyuka (male). Vanadium Dioxide based Thin Films Enhanced performance for smart window applications. (IPPS MSSEESA, PhD, local)
PhD thesis	Johnson Wilfred (male) Local student
PhD thesis	Thomas Nyangonda (M). Electrical, structural and thermal properties of microcrystalline silicon by aluminum induced crystallization.
PhD thesis	Maxwell Mageto (M). Electromagnetic Properties of Titanium-Oxide-based thin films: Electrical and optical performance of TiO_2:Nb and magnetic performance of TiO_2. (IPPS KEN:03, Sandwich)
PhD thesis	James Mutasingwa (male) Local
PhD thesis	Charles Opiyo Ayieko (M). Characterization of spectrally selective $FeMnCuO_4$ solar absorber paint on textured aluminum substrates for solar thermal collector applications at temperatures under 200 ^{o}C. (PhD)
PhD thesis	John Njagi Nguu (M). Fabrication and Characterization of TiO_2/Nb_2O_5 Composite Photo-Electrodes Deposited Using Electrophoretic Technique for Application in Dye Sensitized Solar Cells. (PhD)
PhD thesis	Zipporah Wanjiku Muthui (F). Study of the Structural, Electrical and Magnetic Properties of Heuslers Alloys of Type Mn_2VZ(Z=Al, In) for Spinstronic Application. (PhD).
PhD thesis	Luka Dinfa Domtau (M). Pore Size Enhancement in TiO_2 Thin Films for Applications in Dye-Sensitized Solar Cells. (PhD).
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Sci Journal	C.M. Muiva, J.M. Mwabora, S. Sathiaraj & J. King (2016). Optical and Dielectric properties of amorphous ternary $Se_{90-X}In_{10}Sb_X$ thin films. J ALLOY COMPD, 689:432-438. DOI: 10.1016/j.jallcom.2016.07.299
Sci Journal	D.L. Domtau, J. Simiyu, E.O. Ayieta, B. Muthoka & J.M. Mwabora (2016). Optical and Electrical Properties Dependence on Thickness of Screen-Printed TiO_2 Thin Films. J. Mat. Phys. Chem., 4(1)1-3.
Sci Journal	A. Ogacho & B.O. Aduda (2016). Structural, optical and photoelectrochemical properties of cuprous oxide synthesized by low temperature thermal oxidation. Mat. Sci. Res. India, 13(1)1-6.
Sci Journal	J.Y.N. Philip, J. Buchweshaija & A.Mwakalesi (2016). Corrosion inhibition of amino pentadecylphenols (APPs) derived from cashew nut shell liquid on mild steel in acidic medium. Mat. Sci. Appl., 7:396-402. DOI: 10.4236/msa.2016.78036
Sci Journal	D.L. Domtau, J. Simiyu, E.O. Ayieta, B. Muthoka, L.O. Nyakiti, J.M. Mwabora (2016). Effects of Film Thick-ness and Electrolyte Concentration on the Photovoltaic Performance of TiO_2. SURF REV LETT, 0:1750065 (7 pp.). DOI:

	10.1142/S0218625X17500652
Sci Journal	Francis Nyongesa, Bernard Aduda, **(2017)**. Electrophoretic Deposition of Titanium Dioxide Thin Films for Photocatalytic Water Purification Systems
Sci Journal	Muthui Zipporah, Pathak Rohit, Musembi Robinson, Mwabora Julius, Skomski Ralph and Kashyap Arti (2017): First Principle Investigation of Structural, Electronic and Magentic Properties of Co_2Vin and CoVIn Heusler Compounds
Sci Journal	Zipporah W. Muthui, Robinson J. Musembi, Julius M. Mwabora, Ralph Skomksi and Arti Kashyap (2017). Structural, Electronic and Magnetic Properties of the Heusler Alloy Mn2Vin: A Combined DFT and Experimental Study
Sci Journal	Justine Sageka Nyarige, Sebastian Waita, Justus Simiyu, Silas Mureramanzi and Benard Aduda, (2017), Structural and Optical Properties of Phosphorous and Antimony doped ZnO thin films Deposited by Spray Pyrolysis: A Comparative Study
Sci Journal	Muthui Zipporah, Musembi Robinson, Mwabora Julius and Kashyap Arti (2017). Perpendicular Magnetic Anisoptropy in nearly Fully Compensated Ferrimagnetic Heusler Alloy Mn0.75Co1.25Vin: An ab initio Study
Sci Journal	Henry Barasa Wafula, **Robinson Juma Musembi**, Albert Owino Juma, Patrick Tonui, **Justus Simiyu**, Thomas Sakwa, Deo Prakash, K.D. Verma (2017). Compositional Analysis and Optical Properties of Co doped TiO_2 Thin Films fabricated by Spray Pyrolysis Method for Dielectric and Photocatalytic Applications
Sci Journal	D. L. Domtau, J. Simiyu, E. O. Ayieta, L. O. Nyakiti, **B. Muthoka and J. M. Mwabora**, Effect of TiO_2 film thickness and electrolyte concentration on photovoltaic performance of dye-sensitized solar cell
Sci Journal	Ignatius Nakhoywa Barasa, ‚Justus Simiyu, Sebastian Waita, Denis Wekesa and Bernard Aduda, (2017), Automobile Battery Monitoring System using Arduino Uno R3 Microcontroller Board

Appendix D Terms of Reference of the evaluation

UPPSALA UNIVERSITET

International Science Programme (ISP)

Terms of Reference

MSSEESA Evaluation

Contents

1. BACKGROUND

1.1 Information about ISP

International Science Programme (ISP) at Uppsala University assists low-income countries to build and strengthen their domestic research capacity and postgraduate education in the basic sciences – chemistry, mathematics and physics. ISP provides support to research groups and regional scientific networks at universities and institutes in Africa, Asia and Latin America. ISP consists of three subprograms:

- International Programme in the Physical Sciences (IPPS), from 1961,
- International Programme in the Chemical Sciences (IPICS), from 1970,
- International Programme in the Mathematical Sciences (IPMS), from 2002.

ISP has supported scientific regional networks since the early 1980's. The current reason for supporting regional scientific networks, given in the ISP Strategy Plan 2013-2017, is that "*Regional cooperation generates scientific cooperation and complementary activities, gives access to advanced equipment, and contributes the human capital needed for good postgraduate education*".

ISP's main donor is the Swedish Government through the Swedish International Development Cooperation Agency (Sida). For more information visit: www.isp.uu.se

1.2 Information about MSSEESA

ISP has funded the Materials Science and Solar Energy Network for Eastern and Southern Africa (MSSEESA) since 2004 as part of the ISP supported research group at University of Dar es Salaam (TAN: 01/2), and since 2008 as an independent network.

The network consists of research groups based at five university nodes (University of Nairobi, University of Eldoret, University of Dar es Salaam, Makerere University, and University of Zambia) in Kenya, Tanzania, Uganda and Zambia, respectively (see Appendix 1). The Coordinating Office rotates between the network members (every three years) and is currently located at Makerere University, Uganda, headed by Prof Tom Otiti**.** There is a coordination board consisting of two staff members from each node meeting once every year. In addition to the network support, all research groups, besides the one at University of Dar es Salaam, receive direct support from ISP for their activities.

The main objective of MSSEESA is "*To develop human and infrastructure capacity in advanced research in materials science and solar energy in the East and Southern Africa region".*

The Specific objectives for 2017–2019 are (from the 2016 application to ISP):

(i) To strengthen graduate training for advanced research in materials science

(ii) To strengthen research capacity through shared infrastructure and equipment

(iii) To facilitate dissemination of research findings, publications and exchange of information

See the MSSEESA Strategic Plan and Constitution for more information about the network (available at: http://www.isp.uu.se/evaluations/msseesa)

2. EVALUATION PURPOSE AND SCOPE

2.1 Purpose

The purpose of the evaluation is to analyze and assess the MSSEESA network and its nodes (also referred to as research groups) in order to provide MSSEESA and ISP with indications of the progress and development of the network, and input and recommendations on improvements and future directions.

2.2 Scope

The evaluation should cover the period **2008-2016** and include the activities of the MSSEESA network and its involved nodes (see Appendix 1).

The scope of the evaluation is to analyze and assess the relevance, efficiency, effectiveness, impact, and sustainability of the MSSEESA network and its nodes in relation to MSSEESA's stated main and specific objectives (listed under section 1.2), the MSSEESA Strategic Plan (available at: http://www.isp.uu.se/evaluations/msseesa) and in relation to ISP's stated reason for supporting scientific regional networks as given in the ISP Strategy Plan 2013-2017 (and stated in section 1.1).

3. THE EVALUATION ASSIGNMENT

The evaluation should ultimately result in:

1) **An overview of how MSSEESA functions, its activities and progress** based on relevance, efficiency, effectiveness, impact and sustainability, where strengths and weaknesses are clearly outlined (3.1)
2) **Recommendations and improvements** (long and short term) to MSSEESA and to ISP, respectively, on future directions of the network and its activities, including outputs, outcomes and impact (3.2)
3) **Tracer study** of the graduate students and technicians trained by the network, where they are employed today, if and how they are contributing to the region, etc. (3.3)

3.1 Overview of MSSEESA, its activities and progress

The evaluation should result in an overview of how the MSSEESA network functions, and its activities and progress from 2008 until today. In general, it should provide a history and organizational and operational overview and analysis of the network and account for how far MSSEESA has come in achieving its stated specific goals and objectives. It should result in an assessment of the overall relevance and scientific quality of the research and postgraduate education, and of the efficiency and impact of MSSEESA. Strengths and weaknesses of each of these aspects should be clearly outlined. The sustainability of the network should also be evaluated.

The following topics and questions should be addressed in the evaluation report.

History and network collaboration

1) Provide an historical overview of the MSSEESA network, its activities and its developments.

2) Provide an overview of the organizational structure and governance of the network including communication, meetings, decision-making processes, planning and implementation of activities.

3) Analyze how the network collaboration functions and how the nodes influence each other. What works well and what can be improved? Outline the main strengths and weaknesses of the network.

4) Does the network carry out joint research projects resulting in joint publications?

5) Does the network collaboration result in joint applications for research funds?

6) Has the network facilitated and promoted student and staff exchange among the nodes, joint supervision of students, and thesis reviews prior to degree examination? How can this be improved?

7) How have other joint activities like conference organization, workshops and trainings for students and technicians evolved over time?

8) What have been the main challenges/difficulties facing the network and its nodes since the start to date? How are these challenges addressed?

9) In addition to the network support, most MSSEESA groups also receive direct support from ISP. Describe and analyze the relation and difference between the two types of support, including how the funding is used, and the potential gains and losses.

10) How does the difference in strength among the research groups affect and impact on the network collaboration and organization? Have the differences between the node institutions evolved over time?

Relevance

11) Are the MSSEESA network objectives and activities consistent with the needs and priorities of the network countries, node institutions and ISP's reason for supporting regional scientific networks? Describe.

12) To what extent and how has the MSSEESA network contributed to increase the relevance of materials science and solar energy research in the network countries and at the node institutions?

Cost and Efficiency

13) Describe and analyze the efficiency of the MSSEESA network and the development since the start of the network (2008) (i.e. what has come out of the network given what has been put in, in terms of funding).

Effectiveness

14) To what extent and how has the program been successful in delivering outputs such as the number of students enrolled and the number of graduated PhD and MSc students?

15) What is the average time needed for completion of MSc and PhD studies?

16) If the sandwich model is used, is this an effective way of achieving results? Exemplify.

17) Does each node have the requirements (e.g. adequate number of supervisors, researchers, infrastructure etc.) for meeting the national demand for MSc and PhD degree holders in physics through local programs? If no, how can the situation be improved? Are these issues handled within the network?

18) How are the major areas of materials science and solar energy represented within the network? If certain research areas are missing or weak, how could the network cooperation improve this situation?

19) If and how has MSSEESA contributed to the strengthening of the research environments, research capacity and academic quality at the node institutions?

20) What is the scientific quality of the research conducted within the MSSEESA network, in terms of publications in high-quality scientific journals and other journals and contributions to scientific conferences? Have there been any improvements in quality since the start of the collaboration? (The number of publications with North-South collaboration and South-South collaboration could be included here.)

21) How has MSSEESA facilitated the dissemination of research findings, publications and exchange of information?

22) How do MSSESSA and its nodes work with gender related issues?

Impact

23) What is the impact and influence of the MSSEESA network and its activities in the region? If possible, give examples on how activities and outcomes have strengthened, benefited or impacted on stakeholders in the region.

24) Have MSSEESA and its nodes had any influences on policies and practices in the node countries and/or region in any way?

25) Describe any influence and collaboration with universities outside the network and with public institutions, industry or civil society.

26) Where are MSSEESA graduates employed today? Are they contributing with their knowledge and skills to the society in any way?

27) What are the effects of the organized solar academies and training of solar technicians? Are their knowledge and skills contributing to the society in any way?

28) What are the positive and negative unintended effects, i.e. “spin-offs” resulting from the MSSEESA network and its activities?

29) How are the groups and the network viewed by other departments at their universities? Has there been any significant improvement in their academic status vis-á-vis the university administration and the government?

30) In general, what has the ISP support contributed to?

Sustainability

31) Describe the planning for sustainability of research capacity building and of postgraduate education in the network and at the node level.

32) Describe the network's and nodes' efforts and ability to attract sufficient financial support, other than from ISP.

33) What will happen with MSSEESA if it would be phased out from ISP support? Describe possible exit strategies on the network and node level.

3.2 Recommendations and improvements

The evaluation should result in recommendations on the future direction of the network and on improvements of its activities including outputs, outcomes and impact.

The recommendations should be based on the findings and headings in 3.1 Overview of MSSEESA, its activities and progress. The recommendations should be directed both to MSSEESA and to ISP.

3.3 Brief tracer study

In addition to 3.1 and 3.2, the evaluation could include a brief tracer study of the graduate students and technicians trained by the network. The tracer study should answer questions like where they are employed today, if and how they are contributing to the region, etc.

4. METHODOLOGY

The evaluation should include both preparatory desk studies and field visits (2-3 weeks) to the node institutions. Each node institution should be visited by the evaluation team (preferably by at least two members). Field visits could be paid in connection to the MSSEESA conference to be held in Dar es Salaam, Tanzania on 30 October - 2 November 2017**.** Interviews could be held with the following persons involved in the network activities:

- The overall MSSEESA Network Coordinator
- The Node Coordinators
- Staff members at the node institutions involved in the network
- Relevant people in university management at node intuitions
- PhD and MSc students
- PhD graduates and trained technicians
- Director and Deputy Director of the Physics Program (IPPS) at ISP
- Some of the IPPS reference group members
- Sida representatives
- Other relevant stakeholders

Interviews should be at least semi-structured, but templates might be adapted to the interviewed category.

5. TIMEFRAME, REPORTING & COST COVERAGE

5.1 Timeframe and reporting

- **Start and end.** The assignment of the evaluation team will start **in May 2017** and be completed in **March 2018,** if nothing else is agreed upon.
- **Inception report.** The evaluation team should provide ISP with an inception report including a preparatory desk study covering relevant areas of the ToR, methodology and feasibility of the ToR given the time and resources by **September 2017.** (Separate instructions for the inception report will be provided)
- **Briefing seminar. If feasible,** a briefing seminar covering preliminary findings can be held with involved partners in connection to the MSSEESA conference in Dar es Salaam, Tanzania on **30 October - 2 November 2017**.
- **Draft report.** A draft of the evaluation report should be sent to ISP for commenting by **January 2018.**
- **Final Report.** The revised, finalized version of the evaluation report should be sent to ISP in **March 2018**. Including a separate **brief (2-3 pages) summary** of the final report for dissemination to a wider audience.

5.2 Cost coverage

ISP will fully cover the costs for the evaluation team for the field visits to the network nodes as well as for participation in the conference in Dar es Salaam, including costs for visa, vaccinations, etc. In addition, the members of the evaluation team will each receive net honorarium of 1,500 USD plus travel allowance, according to Swedish rules and regulations.

NOTE: Only flights in economy class are reimbursed.

6. AVAILABLE DOCUMENTS

ISP will provide the evaluation team with the necessary documents to carry out the desk study and evaluation. In addition, the evaluation team will be provided with self-evaluations filled out by the network nodes. All documents will be available via http://www.isp.uu.se/evaluations/msseesa.

Appendix 1

List of the members of the MSSEESA network.

Name of Institute: Dept. of Physics, University of Nairobi
Location: Kenya
Node coordinator: prof. Bernard O. Aduda
Email: boaduda@uonbi.ac.ke
Telephone: +254 721 267 858

Name of Institute: Dept. of Physics, University of Eldoret
Location: Kenya
Node coordinator: prof. M. Mghendi Mwamburi
Email: mghendi@yahoo.com
Telephone: +254 (0) 722 375 112

Name of Institute: Physics Department, University of Dar es Salaam
Location: Tanzania
Node coordinator: Dr. Samiji Margaret
Email: samiji@udsm.ac.tz, esamiji@gmail.com, esamiji@yahoo.com
Telephone: +255 784 481 889

Name of Institute: Dept of Physics, Makerere University
Location: Entebbe, Uganda
Node and network coordinator: Prof. Tom Otiti
Email: totiti@cns.mak.ac.ug
Telephone: +256 772 509655

Name of Institute: Dept. of Physics, University of Zambia
Location: Zambia
Node coordinator: Dr. Sylvester Hatwaambo,
Email: shatwamb@gmail.com
Telephone: +260 977 117 931