

Roadmap for a jointly funded AU-EU Research & Innovation Partnership on Climate Change and Sustainable Energy (CCSE)

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PREAMBLE

Shared vision and common objectives between Africa and Europe regarding Research and Innovation laid the foundation within the framework of the *Joint Africa-EU Strategy (JAES,* 2007) for the emergence of a *High Level Policy Dialogue (HLPD) on Science, Technology and Innovation (STI)* in 2010. Similar to the process that led to the adoption of the Research & Innovation Partnership on Food and Nutrition Security and Sustainable Agriculture (FNSSA), the senior officials have asked the AU-EU HLPD Bureau in 2016 to develop a detailed initiative on global change for endorsement at the AU-EU Summit 2017. The proposal is to work towards a long-term, jointly funded and co-owned **AU-EU Research and Innovation (R&I) Partnership on Climate Change and Sustainable Energy (CCSE).**

Climate change is one of the most compelling challenges of our time, a challenge that due to its global nature can only be addressed through global collaboration and partnerships. Energy production and use can be regarded as major contributor to climate change while climate change in reverse has an impact on the energy sector. At the same time, access to sustainable energy is a key element of growth and development.

An effective and progressive response to climate change and a sustainable response to the access to energy challenge need to be based on the best available scientific knowledge. This new R&I Partnership on Climate Change and Sustainable Energy shall therefore boost our knowledge and practice with a focus on two areas of collaboration: Climate Action for adaptation and mitigation and Sustainable Energy with a focus on renewable energy and energy efficiency.

Global agreements, in particular the Paris Agreement (2015) and the 2030 Agenda for Sustainable Development (2015), provide the framework for this R&I Partnership, supporting a transition to low-carbon and climate resilient economies. Moving swiftly to the implementation of *Nationally Determined Contributions*, as well as of national adaptation plans and strategies (taking into account the *Cancun Adaptation Framework (2011*)) is also a top priority for the two continents. In addition to climate change, this Roadmap recognises the critical role that sustainable energy has to play in addressing multiple, inter-related challenges. Renewable Energy is an immediate

opportunity to remove carbon from the energy sector, and Energy Efficiency is identified as key to the transformation of energy and production systems.

The Partnership provides a long-term framework for cooperation on R&I for jointly-funded and co-owned climate and energy actions, and will boost the alignment and consolidation of relevant R&I activities. Its added-value will be in pooling a critical mass of national and international resources (in-kind and in-cash). Thereby, the Partnership seeks to go "one step further" and aims to have a catalytic role, building on existing initiatives between the AU and EU. In order to fulfil this role the activities of the Partnership will be based on the following criteria:

1. **Relevance** of the research domain to African and European priorities for CCSE (the joint research and innovation needs, as identified below)
2. Expected **impact** of research and likelihood of **uptake** of solutions by communities
3. **Capacity for joint research** in both African and European scientific communities, involving comparable and complementary expertise and resources
4. **Scalability** of R&I impact at national or regional scales (or cross-continent)
5. **Complementarity** to existing bilateral and multilateral collaboration.

I. An innovative initiative: rationale and objectives

Climate change (partially driven by human activity by the emission of greenhouse gases, GHGs, in the atmosphere) is a decisive challenge of the 21st century for the global community. If not urgently addressed, it has the potential to disrupt economies and societies, and negatively impact environment and ecosystems, with repercussions for global stability. Moreover, climate change is a serious threat multiplier, as it acts both as a contributor and a catalyst to destabilization and conflicts, notably in areas already characterized by underlying tensions. It brings more damage from natural disasters and disruption of farming systems and water resources to the point of destabilising entire countries and regions, causing, *inter alia*, massive forced displacement of populations due to loss of livelihood, new and emerging health threats, political instability and food insecurity. Its multifaceted impacts on development are clear and its importance to Europe's and Africa's internal and intercontinental dimensions of security and prosperity is becoming ever more obvious. Europe and Africa have thus much to gain from increased cooperation in combatting climate change, but also a lot to lose if they fail to act.

Climate Action

Commitments to transit to a climate resilient and low-carbon economy unite both the EU and AU. Although especially impactful in developing countries, climate change related phenomena like rising sea levels and increased droughts intensify disaster risk, food insecurity, cause water scarcity, deplete energy resources, ecosystems and migration, and thereby, affect countries all over the world. Africa's high vulnerability to the adverse consequences of climate change is an urgent call to adapt to its impacts. Firstly, in terms of understanding the impacts of climate change in all its dimensions. Secondly, in terms of strenghting climate change governance and disaster risk management. Other impacts of climate change and their implications for economic activities and livelihoods – such as changes in water availability and agriculture, heatwaves in urban settings, emergence of vector-borne infectious diseases, and of other health threats or desertification – also need to be understood, addressed, and monitored. We must take on the challenge of delivering the scientific knowledge required to support better planning, implementation and results/impacts monitoring of adaptation and mitigation measures in all sectors of the economy, and of promoting the use and development of vital climate services.

Even if African countries are not major GHG emitters, it is necessary to avoid lock-in development paths that are carbon-intensive. Addressing climate change can provide countless opportunities to ensuring a transition to low-carbon economies, inventing new and better ways to produce and consume, protecting lives, jobs, assets, ecosystems and livelihood opportunities, for the benefit of people and the planet. Today Africa is attracting more and more investment and, in order to unlock its potential for a low-carbon transition, it is important to fully understand the implications for African countries of different development paths. Supporting responsible investment can help foster development, while protecting the environment and contributing to climate objectives. The EU has more than two decades of experience in designing and implementing climate policies to drive the transition to a low GHG emission economy, while boosting growth and jobs.

Focusing climate action on improving our knowledge and stimulating innovation around low-carbon and low-emission development, technologies and strategies, climate resilience, social adaptation, adaptive capacity and reducing vulnerability, will help achieve the goals of Agenda 2030 for sustainable development (with focus on SDG 11 and 13), while also contributing to the goals of the Paris Agreement. The initial focus of this action will be on Climate Services to support, i.e., adaptation, planning and monitoring, as well as disaster risk reduction. More R&I areas related to climate adaptation and mitigation will be explored in the course of the Partnership, depending on emerging priorities and needs.

Sustainable Energy

Both the EU and AU have committed to transitioning to a low carbon energy system. African countries have started to investigate and invest together with the private sector alternate energy production systems. As African countries' economies continue to grow, it will be important to build more reliable, resilient and sustainable energy systems to support this growth and to harness the great potential of a growing young population. Renewable and sustainable energy, in order to ensure energy supply and resilience, are thus of particular interest to both Europe and Africa. As R&I have high capability to provide solutions for the transition to a sustainable low carbon economy, the potential benefits from an increased AU-EU partnership in this field are clear.

Energy transition and decarbonisation policies also develop Europe's competitive edge in innovative products and services linked to sustainable and smart solutions. The costs for emerging energy technologies such as renewables, batteries and LEDs have fallen rapidly in recent years and may reach parity with conventional technologies as well as transforming how energy is produced and consumed. Renewable energy may also be part of the solution to provide sustainable and de-centralised access to energy, allowing Africa to increase access to energy, while doing so in a low-emission way. While Europe has expertise in high-technology and leading SMEs in the sector, expertise in frugal innovation and appropriate geographical conditions such as the abundance in sunlight is Africa's comparative advantage. The partnership between the EU and AU will also seek to co-develop some of the key strategic elements of an ecosystem needed, building on the experience and expertise that exist in both regions (including technologies, capacity, skills, data analytics, exchanges between SMEs, innovators, etc.). Therefore, whereas situational conditions and drivers differ, substantial convergence exists in the derived objectives for both the AU and EU to address those.

Boosting sustainable development

Sustainable development is a complex goal, covering many, often interdependent areas. It strives for joint action for people, planet and prosperity. Consequently, addressing sustainable development can only be done successfully by taking a holistic and systemic approach through an integrated knowledge system, involving all stakeholders. For instance, developing sustainable energy options also needs to take into consideration how these options (including technologies) are embedded in the surrounding societies; that they gain social acceptance by the user and how they contribute to creating and sustaining markets and livelihoods. This also takes into consideration the heterogeneity across and within both continents, Europe and Africa, regarding population density or geographical conditions. Just as much as there is no one approach fits all solution, there can be no disintegrated solution. The challenge of climate change adaption and the

creation of access to clean and affordable energy necessarily go hand in hand with other elements of sustainable development, such as equality, education, jobs and growth. In this regard, the launch of an AU-EU Research and Innovation Partnership on Climate Change and Sustainable Energy (CCSE) is an integrated means to consequently turn the common objectives with regard to the common challenge into common actions.

I. 1 Common Policy Framework

That climate change is a common challenge is acknowledged in several policy papers – at the global, EU and AU level. The Partnership reflects and builds on those policy papers, sharing the common objective of tackling climate change by adaptation and mitigation measures, taking full account:

- on the **global level** of the legally binding *Paris Agreement* (*UNFCCC, 2015*) and the targets set by the *Nationally Determined Contributions* and cooperation on enhancing action on adaptation (taking into account the *Cancun Adaptation Framework (2011)*), the *2030 Agenda for Sustainable Development (2015)* along with the *Sustainable Development Goals*, underscoring in particular the role of Renewable Energy as an immediate opportunity to remove carbon from the energy sector and Energy Efficiency being key to the transformation of energy and production systems, and the *Addis Ababa Action Agenda (2015),* as well as the *Sendai Framework for Disaster Risk Reduction (2015)*.

- on the **EU-level** of *The Road from Paris: assessing the implications of the Paris Agreement (2016)*, underscoring the Paris target of reducing EU-wide emissions by at least 40% by 2030 and delivering emission reductions in all sectors of the economy, prioritise energy efficiency and boost uptake of renewable energy, the *EU Global Strategy (2016)*, the *EU Energy Union (2015)*, its *Energy Union package (2015),* and its cooperation with third countries, including on RE and EE, the EP/Council *Directive on Energy Efficiency* (*2012*), the Council *Conclusions on an EU strategy on adaptation to climate change* (*2013*), the Council *Conclusions on energy and development* (*2016*), *Accelerating Clean energy innovation (2016),* the Communication on *Next steps for a sustainable European future (2016)* and the Communication on *A Strategic Approach to Resilience in the EU's External Action (2017),* the Communication on *the renewed impetus to the Africa-EU Partnership (2017),* and the *new European consensus on Development (2017).*

- on the **AU-level** of the *AU-Agenda 2063 (2015)*, the *African Union Science, Technology and Innovation Strategy for Africa 2024 (STISA, 2014*), the *Programme for development of Infrastructure in Africa* (*PIDA, 2012*), the *Africa Renewable Energy Initiative (AREI, 2016),* the *African Climate Conference 2013,* the *African Ministerial Conference on Environment (AMCEN),* its *2014 Draft African Union strategy on climate change,* the *Africa Climate Policy Centre* (*ACPC, 2011*), the *ClimDev-Africa* (*2012*) and the *African Space Policy and Strategy (2016)*.

- on the **EU and AU-level** of joint commitments to the *EU-Africa Ministerial Statement on Climate Change (2014)*, and the *Africa-EU Renewable Energy Cooperation Programme (RECP)*.

II. The basis for a jointly developed research and innovation agenda

The roadmap of the AU-EU R&I Partnership on Climate Change and Sustainable Energy can be prioritised in terms of three (3) phases, taking into consideration the goals and requirements of the Paris Agreement and the need to promote access to sustainable and affordable energy, in line with the Agenda 2030 and its Sustainable Development Goals:

- **First phase:** Establishment of enabling environment/capacity/regulations
  - Identification of priority for technology innovation, based on existing or new strategies
  - Human capital development
  - Education
  - Baseline assessments
  - Development of specific technology roadmaps
  - Identification of gaps in laboratory and research facilities
  - Laboratory and research facility benchmarking
  - Alignment or synergising protocols/working arrangements/standards
  - Exchange of experts south-south, and north-south

- **Second phase:** Conducting joint research in priority areas identified in the first Phase
  - Development of technologies and innovations
  - Adaptation of technology solutions
  - Exchange of experts

- **Third phase:** Commercialisation and utilisation of research results

The concept of Frugal Innovation will be considered through the actions of this partnership. This would help ensure 'more value from less resources for more people', taking into account the outcome of innovation, as well as the innovation process, and ensuring it is tailored to specific circumstances, needs, capacity and resources.

II.1 Research and Innovation pillar 1: Climate Action for adaptation and mitigation

The Partnership will initially focus on Climate Action in support of adaptation and mitigation planning and monitoring. It will be geared towards supporting countries in their efforts to implement the Paris Agreement and achieve its goals. As the Partnership evolves, the activities will be further refined and new areas will be considered, in line with new and emerging priorities and innovations.

The relationship between the actions proposed under Pillar I of the CCSE and the AU Agenda 2063 should be prioritised by establishing, in particular, how the actions will contribute, for example, to the targets of the first phase 2014-2023 of the AU agenda. Proposed actions should focus both on "Adaptation" and "Mitigation". African countries are amongst the most vulnerable to the impacts of climate change, calling for strengthened adaptation and enhanced resilience.

They have also brought forward, in the context of the Paris Agreement, (intended) Nationally Determined Contributions (NDCs) to achieve their mitigation and adaptation goals. There are significant opportunities for Africa to leapfrog towards low-emission and climate resilient development pathways, and the Climate Pillar of this partnership will support research and innovation that will aid in this regard. Priority should be given to actions that offer co-benefits for both adaptation and mitigation.

Three research and innovation domains are identified, the first two focusing on Climate Services, the third on an integrated approach that support informed decision making and implementation for a low-carbon and climate-resilient development. All actions are aligned with the Paris Agreement.

II.1.1. Generation and translation of climate-related data

Climate Services, although still a relatively new and specialised sector, have the potential of becoming a supportive and flourishing market, where public and private operators provide a range of services and products that can better inform decision-makers at all levels. The Paris Agreement (Article 7) recognises the importance of supporting adaptation efforts, including by strengthening scientific knowledge on climate, including through research, systematic observation of the climate system and early warning systems, to inform climate services and supports decision-making. The generation and analysis of climate related data and other socio-economic information can be instrumental, using the opportunities provided through such initiatives such as the Copernicus Climate Change Service and in line with the priorities for Africa identified by GFCS and further STI actors such as GEOSS. Valuable lessons should be learnt from Climate Service initiatives already existing in Africa and Europe[1], and these should be considered as high priority to go one step further in the EU-Africa Research and Innovation Partnership. This includes:

a) Promotion of monitoring tools, related technology and information management, delivered by **space-based earth observation technologies**. Such information is central to understanding changes on the planet and changes in the macro- and microenvironment. This wealth of climate information will be the basis for generating a wide variety of climate services aimed at supporting adaptation and mitigation policies and actions in Africa in a number of areas including (but not restricted to) disaster risk reduction and management, land and water management, energy, disease surveillance (prevalence and dynamics of disease vectors and hosts of zoonotic diseases) agriculture, forestry and biodiversity (establishing a strong link to the Partnership on FNSSA, as agriculture is highly exposed to climate change).

b) **In situ observations**, which are able to complement space-borne observations and enhance both monitoring and forecasting of climatic changes. There are limited *in-situ* ground-based observations in most of Africa, and this has consequences for our knowledge of regional climate modelling and weather forecasting. Developing ground-based observation systems across Africa, will enhance the reliability of decisions made from using space

observation and *in situ* measurements. *In situ* data are important not only to complement satellite observations, but also, to calibrate and to validate (ground-truthing) space observations. Whereas the modern scientific technological development proceeds, there is need to include traditional knowledge and citizen observations (citizen science) as a critical mix to fill knowledge gaps, especially in places where technology has not advanced. Lack of research infrastructure is a problem that has to be addressed in a holistic manner.

c) **Development and distribution of easy-to-use/low-maintenance technology** to measure *in situ* parameters related to climate change as crucial for the generation of basic data.

d) **Proper communication between space (e.g. satellites) and in situ observation stations to ensure the resilience and permanency of data generation**. Climate services for "planning" in the African perspective should help to build Shared Socioeconomic Pathways (SSPs) and socioeconomic scenarios on how Africa will respond to the different climate challenges in sectors such as disaster risk reduction and management, energy, health, water management, agriculture and forestry, and biodiversity as captured in Goal 7 of AU Agenda 2063: "The Africa We Want". For example, the various Copernicus Services, MESA and GMES for Africa services aim to deliver services by using both satellite data and data delivered by *in-situ* monitoring stations. This is also in line with SDG 9, as with initiatives such as Africa-Connect, funding connectivity in Africa and having the potential to facilitate digital communication for climate adaptation and mitigation. In particular, ICT technology and modelling, in terms of access to and maintenance of necessary and powerful ICT infrastructure/technology and capacities are mandatory to generate value out of the data and models to translate to risk information. The capacity needed for countries to be able to access the data, will be critical. Whilst improving connectivity and bandwidth to improve access to data, it is important to promote AU data centres or mirrors to EU data centres to enhance intra-Africa collaboration between centres and universities. Training of technicians and policy makers is of high necessity as well (cf. III.1 on capacity building). In this context, observation of land use and land use change is critical for both mitigation and adaptation purposes.

e) **Support capacity building of the Regional Economic Communities (RECs) and Regional Climate Centres and the national services:** there is a need to be more focused and to identify top priorities on climate services needed and build capacity of individuals and institutions (e.g. ACMAD, AGHRYMET, WASCAL, SASSCAL, SADEC, ICPAC, as well as national services that push for climate services in Africa) to support implementation of the said priorities. This would include, for instance, strengthening capacities to collect, analyse and evaluate climate-related data and meteorological information by re-pooling national meteorological services and observation network.

II.1.2. Applied technological and system solutions supporting data/information management, dissemination and networking, i.e. the development of Climate Services.

Climate Services cover the transformation of climate-related data - together with other relevant information - into customised products, tools and services, such as, projections, forecasts, information, trends, economic analysis, and assessments. As such, these services include data, information and knowledge that support adaptation, mitigation and disaster risk management. Through the provision (in a free and open access mode, cf. III.2) of a consistent layer of data, data products (including bespoke analysis), and model outputs, they can support the development of a market, in which public and private Climate Service operators develop a variety of customised high value-added services with and for users.

II.1.3. Taking on an integrated knowledge approach to climate action

The implementation of the Paris Agreement, including its ambition cycle, needs to be supported by knowledge and sound scientific results at national, regional and global level. Taking on an integrated knowledge approach to climate action, while ensuring their social embedding, is crucial. Therefore, R&I should also focus on how to support decision-making at a political, industrial and monitoring level. It is necessary to "talk the same language" as the users. Projects focus on increasing the integration of economic and impact model assessments – and increasingly social assessments – in support of adaptation and mitigation decisions. Monitoring societal patterns and social adaptation to climate change and climate-change related policies and products, that include, for example, education, capacity building and participative approaches for better appropriation of climate resilience and adaptation measures, are key to a systemic approach. Involving local communities and local decision makers in order to ensure integration, social embedding, as well as ownership, is a necessary condition to the success of any action. Transmitting knowhow is also presented as one of the cross-cutting issues in terms of capacity building (cf. III.1).

In this regard, **four areas for research and capacity building** are identified:

A. Co-development with advanced users of climate services for sustainable low emission energy development

- Conduct research for co-development of climate services (with users, intermediaries, and policy makers), including on climate adaptation, mitigation and disaster risk management as well as development of GIS user interface platform to support planning and policies. This could include, for instance, climate services to inform policies and strategies for disaster risk reduction, response and early warning systems using satellite information, ground observation and traditional knowledge systems; information on forest, land use and land use change policies for climate change mitigation and adaptation;
- Conduct research to enhance understanding of land-use based mitigation and adaptation options, assessing their potential and effectiveness in providing large-scale reductions of greenhouse gases and/or enhancing resilience of people and ecosystems, in the context of trade-offs and/or co-benefits (e.g., food and health security, energy and water security, biodiversity). This could include improving current methodologies

to estimate emissions and removals associated with land use measures, also by leveraging earth observations;

- Conduct climate change research relevant for the implementation of the Paris Agreement and, based on climate scenarios, build sustainable energy pathways, including identification of most suitable energy choices that are climate resilient as well as climate-adapted;
- Linked to above, support research initiatives and climate services for developing policies and strategies for renewable energy, as a means of realising Africa's NDCs and meeting the goals of the Paris Agreement.

B. Strengthening the knowledge base for developing climate policies, strategies and plans for supporting the implementation of the Paris Agreement

- Generate relevant scientific knowledge and capacity for the development and update of NDCs, the formulation of mid-century low emission strategies, and for informing the Global Stocktake of the Paris Agreement. This might include, but is not limited to, developing new or adapting existing modelling tools and enhancing capacity for their use;
- Enable enhanced participation of African science and scientists in international scientific fora relevant to advancing policy-relevant knowledge on climate change (such as the Intergovernmental Panel on Climate Change (IPCC) and Intergovernmental Platform on Biodiversity and Ecosystem Services);
- Strengthen the knowledge base for informed policies and legislative frameworks and their assessment, including on the design, requirements, governance and impacts of climate action, for the effective implementation of NDCs and adaptation action;
- Strengthen the knowledge base and the link to policy for enhancing the use of available climate services for policy design and monitoring of implementation to support decision making and long term planning at all levels of governance and in critical sectors (e.g. water, health, agriculture, land use, urban planning, etc.).

C. Promote climate strategies and action plans

Promote the development of strategies and action plans on research, development, innovation and technology transfer, including use of indigenous/traditional knowledge in climate change mitigation and adaptation, in line with the technology framework established by Article 10 of the Paris Agreement and in support of its implementation. Initiatives that offer co-benefits for adaptation and mitigation as well as other co-benefits, e.g. health and wellbeing more broadly, should be priorities. Such strategies and plans could:

- Strengthen cooperative action on technology development and transfer;
- Support the inclusion of gender and human development considerations in social and economic measures to address climate change e.g., ensuring early warning mechanisms are gender-responsive;
- Develop/implement climate change education programmes at all levels, including integration in the educational curricula;

- Raise awareness by conduct country wide sensitisation campaigns and popularize climate science.

D. Including society as an important stakeholder

i. Increasing public awareness and intensifying education for climate change action (mitigation and adaptation), e.g. ensuring citizens are aware of the steps needed to respond to weather extremes, or to reduce energy consumption;

ii. development of a holistic and participative approach to increasing acceptance of low-emission and climate-resilient transition by engaging the society (e.g. via agenda processes with all stakeholders and stakeholder empowerment tools); and

iii. development of feedback loops and assessment frameworks in order to evaluate the socio-economic impacts of climate action.

II.2. Research and Innovation pillar 2: Sustainable Energy

With more than 16% of the world population in 2017, Africa accounts only for 5% of the world's global primary energy use. Moreover, in most AU countries 70 to 80% of used energy is generated from traditional biomass (wood fuel). Africa has abundant energy resources (fossil and renewable energy). However, the main issue remains energy access. In sub-Saharan Africa, the average electrification rate is just 35%. In rural areas it is very low (below 20%).

The new partnership in order to succeed will be assisted by valuable lessons learned from existing projects. In the area of Sustainable Energy these include, *inter alia*., the *EUROSUNMED, REELCOOP, SOLPART, REDD, Carbon Credit Fund, GCCA-ACP Programme, ECOWREX, ENRICH, PRONOVABIO, etc.* For a full list of projects and an overview of their respective impact areas, see the Annex Matrix. This overview offers particularly a support to identify the gaps of research and cooperation activities, which is an issue of high priority to the AU-EU R&I Partnership.

Following Science, Technology and Innovation (STI) overarching goals for sustainable energy, this R&I Partnership will aim to support:

- Rational and sustainable use of energy sources (sustainable, adequate and appropriate energy mix) for energy supply (energy systems solutions);
- Developing and advancing resilient low-carbon energy systems to meet future energy demand;
- Supporting adoption of innovative low carbon energy solutions for energy supply; and
- Improving/increasing access to Sustainable Energy in rural and urban areas.

II.2.1 Renewable Energy

If not adequately planned, energy production and consumption can be a major contributor to climate change, but climate change will also have an impact on the energy sector – for instance, weather related extremes might impact energy infrastructure, while future climatic conditions may open/preclude renewable energy opportunities. Replacing fossil fuel-based energy supply by

renewable energy sources is a mitigation measure to climate change and a valuable sustainable solution to increasing energy access in Africa. Renewable energy can be collected from a wide variety of sources including solar, wind, hydro, sustainable biomass (including waste), geothermal, wave, and tidal.

Adequate mixes of the different renewable energy solutions may facilitate the energy transition which is already an urgent challenge that must be addressed by being aware of each specific context and general premises like:

- There is no single mix that would be ideal worldwide. The energy transition is specific to each region, country or group of countries and is strongly linked to the natural potential of the area.
- The general requirements for a stable and sustainable energy system are affordable cost, high local content, ease of integration / evolution from the existing systems, ease of offering distributed solutions, ease of offering flexible supply, and / or adapted to very different demand patterns.
- The energy transition requires technological and not technological breakthroughs, such as radical changes in energy behaviour by consumers.

Renewable energy, which is an employment opportunity across the world, will give Africa the opportunity to leapfrog technology developments and develop cost-effective, locally adaptive and sustainable solutions. Energy transition towards renewable energy should go hand in hand with electrification efforts in Africa.

Some of the main R&I challenges to be addressed in order to accelerate Renewable Energy penetration both in Africa and Europe are:

- Improving the efficiency and, therefore, cost of RE technologies by reducing the cost of components and improving the installation, operation and maintenance procedures;
- Development of cheaper dispatchable solutions based on RE (such as hybridization schemes, heat and other forms of storage, batteries inclusions etc.); and
- Improving the electrical networks inter-regional connections to facilitate access to energy supply (deserted idea, etc.) and stability of the energy system;

Following a systemic approach, the following five (5) main action fields for joint research have been identified:

A. Development and Integration of renewable energy in the energy system

In order to properly develop and integrate renewable energy in the energy system supplying electricity, heat, cooling and fuels (including transport), the following measures needs to be taken:

i. development of Information and Communication Technologies (ICT) solutions to support the integration of renewables in the electricity grid (where available, e.g., smart grids, Internet of Things, big data), in heating/cooling systems and fuels distribution networks;

ii. development of decentralised systems (e.g., hybrid mini-grids);

iii. adaptation of existing technologies to weather and environmental conditions, adjustment of systems according to local needs and conditions;

iv. development of energy storage solutions, infrastructure and hardware solutions for managing renewable energy production, distribution and grid integration;

v. development of cost-effective and affordable renewable energy systems (e.g., increasing collection and conversion efficiencies or selection of appropriate technologies);

vi. creation of economic and programme development models adequate for the regional and national contexts;

vii. development and integration of waste-to-energy technologies;

viii. development of alternative sustainable fuel technologies and implementation mechanisms (e.g., for transport sector);

ix. development of mechanisms to consider environmental impacts of sustainable energy technologies;

x. development of integrated demand side management solutions, taking into account end-users, using the concept of smart development adjusted to local realities (e.g., mini-grids, island mode, customer-oriented solutions, as mobile payments, prosumers, market/consumer incentives).

B. Planning and modelling future sustainable energy systems

i. Development of models and tools in order to achieve a systemic view on energy demand, energy access and supply (electricity, heat, cooling and fuels - including transport) in regard of on-, weak and in particular, off-grid solutions. These include, e.g.:

- ✓ growth / demand projection tools,
- ✓ energy sector planning and optimization,
- ✓ (rural) electrification planning,
- ✓ renewable grid integration modelling.

ii. Development of new and adaptation of existing models and tools appropriate and adequate to local conditions (e.g., urban or rural structural locations, renewables integration in cities), different economic conditions (e.g., frugal or high-tech innovation), creation and sustainability of relevant markets and livelihoods. From the beginning potential applications have to be planned and modelled for a particular local, social and economic context (no “one approach fits all”);

iii. Development of open-access resources maps and project related data to facilitate the broad development of renewable energy projects and reapplication of successful experiences (e.g., an open-access Pan-African database on energy related data).

C. Including society as an important stakeholder

iv. Increasing public awareness and intensifying education for renewable energy by, e.g., integrating the gender and ethical dimensions and ensuring access to research results with reflection on the socio-economic impact of its deployment;

v. development of a holistic and participative approach to increase acceptance of energy transition by engaging the society (e.g., via agenda processes with all stakeholders and stakeholder empowerment tools); and

vi. development of feedback loops and assessment frameworks in order to evaluate the socio-economic impacts of renewable energy.

D. Market, pricing and business models for future sustainable energy systems

i. Development of policies and regulatory frameworks for the successful deployment of renewable energy technologies, costs and tariffs, subsidies and regulation of the energy systems (with attention to fossil fuel subsidies and their impact on the development of renewables);

ii. Development of systems or frameworks that create new revenue and creation of business models for decentralized technologies and innovations (e.g., for independent power producers (IPPs) or off-grid sector); and

iii. Development of sustainable operation models for utilities integrating renewable energy, which will support frameworks for inter-country / continent markets (e.g., Pan-African-European Energy Market and GHG emission certificate mechanism).

E. Strengthening basic research and technology development

In order to support renewable energy transition, STI cooperation in the following areas needs to be strengthened:

i. Photovoltaic Solar Energy Research (in particular, lifetime/behaviour/adaptation of solar panels in/to extreme conditions and related maintenance, and energy storage systems, photovoltaic system for water pumping (agricultural irrigation) and other environmental applications);

ii. Solar Thermal Energy Research (e.g., solar heating & cooling, concentrated solar power),

iii. Wind Power Research (e.g., decentralised use/stand-alone systems including energy storage, wind power modelling (meteorology by MESA/GMES), cost-efficiency, research on environmental impacts (migratory birds);

iv. Marine Energy Research (e.g., selection of sites with the best tide range allowing the implementation of tidal turbine pilot projects);

v. Geothermal Energy Research (e.g., environmental aspects related to the over exploitation of sources, geothermal cooling for food and beverage);

vi. Sustainable Bioenergy/biofuels Research (e.g., adaptation to local contexts and use of different substrates in Africa and Europe, valorisation of the organic fraction of urban solid waste, sustainable utilisation of biomass quantity estimated by Earth Observation

and thereby finding right balance for biomass exploitation, as it is most important energy source in Africa, use of non-food raw material and recycling in order to allow a sustainable added value);

vii. Renewable alternative fuel research (e.g., respectively technologies adapted to local conditions for transport and chemical storage of energy);

viii. Hydro-Electricity Research (e.g., choice of technologies and configurations adapted to local conditions); and

ix. Fuel Cells Research (e.g., as a replacement for diesel generators for stationary applications).

The key priorities for both basic research (low TLRs) and innovation activities (high TLRs), together with modelling needs, impact assessments, societal aspects will form the basis of an Integrated Roadmap for R&I in support of a Sustainable Energy Transition in Africa. Consultations with relevant stakeholders will allow defining a detailed Action Plan for specific areas mentioned above.

II.2.2. Energy Efficiency

Together with renewable energy, energy efficiency is an important component of sustainable energy development. Energy efficiency is also a cost-effective strategy for development in Africa as it aims at decreasing energy consumption without hindering economic growth. It also has a huge potential on consumer side as it reduces costs for energy consumption (e.g., in households).

Due to population density and power consumption characteristics, energy efficiency is most effective in urban areas, both in Africa and Europe. However, its importance will also grow rapidly in rural areas, along with increasing demand for energy there. For African rural areas, energy efficiency gain from sustainable use of biomass, regarding the huge consumption of wood fuel (70-80% of used energy), will limit the problem of land degradation and deforestation.

Regarding energy efficiency strategy in AU-EU R&I in CCSE, joint research priorities are identified in the following areas:

- Identification of national baselines and characterise the national energy consumption patterns;

- Promotion of energy savings in:
  - ✓ Buildings and households (energy efficient buildings, thermal insulation, design, materials, appliances, heating and cooling);
  - ✓ Development of smart systems (demand side management, smart metering, smart micro-grids and small-scale energy storage);
  - ✓ Capacity building for research linked to the development of Energy Efficiency policies;
  - ✓ Industrial processes and in energy production;
  - ✓ Transport (multimodal, alternative propulsion); and
  - ✓ Agriculture and water infrastructure (energy efficient water pumping and water treatment);

- Development of efficient power production, transmission, distribution and storage;

- Promotion of technology diversity and the use of energy mix.

- Promotion of interdisciplinary approach covering societal impact, education and acceptance of technologies connected with energy efficiency, e.g., promoting Energy Efficiency in civil society, schools, etc.; and
- Development of communication and information tools for efficient energy products (solar water heater, low-energy lamps, and efficient air conditioning solutions).

II.3. Cross-cutting issues related to climate change and sustainable energy

Both targets, Climate Change (pillar1) and Sustainable Energy (pillar 2), share the objective of **Capacity Building** and **Open Access** to relevant data in their respective areas. In this regard, the EU-Africa R&I partnership in CCSE will take benefit of projects offering valuable lessons learnt include i.a. the *RTD study on RE capacities in SSA*, and the *DEVCO study on mapping SER*, the *Pan African University*, *WASCAL/SASSCAL* projects on capacity building and research, *AfricaCONNECT*, etc.

II.3.1 Capacity building

Capacity building is a cross-cutting issue of both STI in Climate Change and Sustainable Energy. Strengthening **collaboration** will help to build a broader engagement between African and European R&I communities, including common vision increasing trust and visibility. Taking a holistic approach to the Partnership, it should address – similar to the FNSSA-Partnership – the following needs:

II.3.1.1 Human capital development

Actions to strengthen research communities could include:

- Special support to young and promising researchers, in line with principles of gender equity and the inclusion of socially vulnerable groups;
- Extensive use of mentoring (identifying mentors both in EU and AU);
- Grants and Scholarships for local projects and researchers' mobility – in both directions (EU-AU) and inside Africa, including participation in conferences – in order to increase outreach of Climate Change (adaptation and mitigation) and Sustainable Energy knowledge;
- Double diploma curricula, students' exchange programmes (e.g. ERASMUS MUNDUS) and ECTS like system for joint AU – EU higher education;
- Development of dedicated trainings for graduates to enter Climate Change mitigation and adaptation fields, as well as Renewable Energy and Energy Efficiency labour market including Development of e-learning and MOOC allowing a better access to R&I and related know-how, in particular in terms of utilisation of Climate Services, Sustainable Energy, Renewable Energy and Energy Efficiency, Climate Change mitigation and adaptation modelling skills;
- Training of local workforce, e.g. for in-situ monitoring stations, including raising awareness and social embedding of climate adaptation and mitigation, renewable energy and energy efficiency should be provided;
- Increasing the transfer of research based knowledge to policy makers relevant for stakeholders and the public;

- Supporting the creation of job opportunities demanding high qualification (e.g. through interaction with public private partnerships) and recognise the relevance of higher education training for the regional labour market and entrepreneurial needs in terms of STI
- Valorisation of R&D findings into capacity building skills for stakeholders (national technical services, NGOs...)
- Introduction of short term trainings on utilisation, promoting of renewable energy and energy efficiency in schools and civil society;
- Introduction of short term trainings on climate risk and vulnerability assessment, which also link to disaster risk reduction trainings;
- Training of communities around the social dynamics and uptake of appropriate systems;
- Training of policy makers, including communication training and utilisation of Climate Services, skills to access big data and data analytics as provision for key decisions.

II.3.1.2.Infrastructural & institutional capacity building

- Development of curricula and graduate research programme dedicated to climate change and sustainable energy;
- Strengthening equipment and research capacity of laboratory and R&D institutions;
- Enhancing research capacity, e.g. by curricula development; capitalize on the training hubs as in the experience of the Pan African University (PAU) with its research and training thematic including Water, Energy Sciences and Climate Change, as well as the WASCAL/SASSCAL program with its research hub (Competence Center) and its capacity building program with ten (10) graduates programs dedicate to climate change and sustainable energy (energy, water resources, biodiversity, economics, agriculture, education, human security, disaster risk reduction,...);
- Exploring possible establishment of joint R&D centres between the AU and EU based on common research projects and assure training of appropriate skilled managers for that;
- Strengthening south-south, north-south and triangular cooperation on STI and transfer, networking and knowledge sharing by supporting existing channels of knowledge dissemination in regard to Climate Change and Sustainable Energy;
- Supporting the establishment of technical support and active communication and exchange between metadata and data providers, data analysts and end users.

II.3.1.3. Financial capacity building, funding tools and networking

- Provide trainings to financing institutions, enabling them to mobilise fresh money, and also boosting better articulation of existing financial support (incl. access to infrastructures and mobilization of human resources);
- Support to twinning, teaming and networking should be provided between the hubs of universities and research centres;
- Launch of excellence grants as means of joint capacity development, in form of targeted calls on Climate Change and Sustainable Energy;
- Enable better conditions for synergy between the African Union initiatives and European instruments for R&D support in Climate Change and Sustainable Energy. Explore

establishment of funding mechanisms in Africa (e.g. as done in Europe in form of the framework programmes) to strengthen research capacities, to provide an optimal research environment and to reinforce the international attractiveness of African universities and research institutions. These funds will foster partnering strategies within the framework of climatic change and sustainable energy based on African STI programs and networks and will contribute to address dispersion and the unequal distribution of competencies and to build a critical mass.

II.3.2 Open Data & Open Access

Open Access to data will be the key to the support of implementing the roadmap. It shall guarantee the practice and principle of Open Science. It is now widely recognised that making research results more accessible to all societal actors contributes to better and more efficient science, and to innovation in the public and private sectors. Capacity to face the challenge of Big Data should be provided.

Taking a holistic approach, the R&I Partnership should address the following needs in order to foster knowledge development and exchange:

- **Availability and Access**
  - ✓ Enable free flow of data and protecting the right to information as data technologies and services are essential stimulators for R&I;
  - ✓ Foster Open Data and knowledge management:
    - to enhance and facilitate the development of Climate Services
    - to promote Public-Private-Partnerships
    - to improve tools for decision making for addressing climate change
  - ✓ Develop Open Science and Open innovation policies, e.g. in terms of off-grid developments or smart intellectual property rights management.

- **Reuse and Redistribution**
  - ✓ Explore the synergies and links between the data/information developed under specific programmes to generate Climate Services (e.g. Copernicus, MESA, GMES for Africa, the new intra-ACP Climate Services programmes under definition and Digital for Development initiative, European and African Research Clouds),
  - ✓ Implement citizen reporting and rapidly provide the data at their disposal,
  - ✓ Develop open science clouds and other flagship projects that will allow researchers to work efficiently. The European Commission is anticipating the development of a European Open Science Cloud that will service the researchers and policy makers in its Member States. An African Data Intensive Research Cloud will be a counterpart to the European Science Cloud. This would enable collaboration on major strategic big data science projects that involve the EU and AU.

- **Universal participation**
  Ensure free access to all published data and publications and promote shared research infrastructures to:

✓ boost collaboration between research communities and when appropriate, involve non-scientific stakeholders,

✓ exchange climate information and knowledge to both public and private stakeholders, and to provide opportunities for co-design, co-production and co-delivery of climate services with the involvement of users, providers/purveyors and researchers,

✓ foster transdisciplinarity between sectors, research areas and stakeholder groups.

III. Implementation of the AU-EU Research and Innovation Partnership on Climate Change and Sustainable Energy

III.1 Lessons learnt for the Research and Innovation Partnership

The landscape of Africa-Europe STI collaboration comprises a diversity of initiatives, which offer valuable lessons for the AU-EU R&I Partnership on CCSE, as mentioned in the respective chapters. It is of high importance in order to "go one step further" to build on these lessons. Apart from the specific projects mentioned above, some studies such as the *HLPD Mapping study*, the *RTD STI evaluation,* the *DEVCO STI evaluation*, and the *HLPD WG1 study from UK and SA on implementation*, DEVCO and AUC projects as MESA and GMES, as well as the example of the EDCTP as a long-term cooperation partnership, may offer a more general advice to this Research and Innovation Partnership. Those studies state the following challenges:

- the hitherto **absence of an established joint funding mechanism** or of co-financing arrangements is the most prominent gap, particularly at the political level (*HLPD mapping study*);
- the **dependence on a skewed funding landscape**, contributing to a slew of issues linked to access to financing and the suitability of instruments (*HLPD mapping study*);
- **missing synergies and coordination** between different programmes (*RTD STI evaluation of 2016*);

These challenges lead to the following key recommendations, constituting a **defragmentation of multiple initiatives** (national, bilateral, multilateral):

- **Optimise** and **align** policies and programmes between Africa and Europe on CC and SE, by building trust between actors;
- Building-up an **all-encompassing** R&I framework, bringing visibility and opportunities;
- Overcome donor-recipient relationship: **jointly developed, owned, governed and funded** R&I framework;
- Support and encourage
  - higher participation of SMEs;
  - increasing industry-academia relationship;
  - translational as well as cross-cutting activities and links of STI policy to other domains, notably higher education;
  - investment in partnerships;
  - **the establishment** of a core of group of funders/partners sharing a common vision of CCSE needs and measures, and **finalising a common agenda** with shared set of

indicators that would strengthen the Partnership's funding bases and ensure impact on the ground (*WG1 of Bureau-Report*).

III.2 Short, medium and long term actions and instruments

In and across the priority areas, the R&I Partnership will provide short- to medium-term solutions to challenges in African and European contexts, while also building the relevant R&I capacities for achieving longer-term objectives. Hence, short, medium and long-term actions are envisaged in developing the AU-EU R&I Partnership on CCSE. Thereby,

- short-term actions mainly concern the joint **development** of a strategic framework for collaboration on STI in support of CCSE (by 2017- 2018), building on the *CAAST-NET+* and *RINEA* initiatives and potentially future Horizon 2020 and bilateral projects.
- medium-term actions mainly refer to the **consolidation**, investing in reducing fragmentation in the R&I landscape. This includes fostering co-ownership of a range of stakeholders of the value chain and financing mechanism (by 2019- 2020) and joint programming process for better alignment between funding agencies or research performing organizations (e.g. LEAP-Agri within FNSSA-R&I Partnership, JPI Climate/ERA4CS on Climate Services, Belmont Forum, EDCTP partnership on infectious diseases). Thereby, the Partnership will build synergies in clustering, attracting and pooling a critical mass of national resources to a joint effort at achieving economies of scale.

  Work continues on jointly developing a research agenda and reflections start on long-term options for the R&I Partnership. Best practices and conditions for success distilled from earlier bi-regional initiatives will serve as models for future activities and for organisational modalities. Initiatives of a medium and longer term nature, addressing capacity building together will remain of particular focus.
- long-term actions focus on the complete **establishment and integration** into the landscape of the R&I Partnership, supported by its fully operational organisational/governance structure (2020 and beyond). The formal structure would continue the steps started in the short and medium term phases, carrying forward the R&I Partnership's activities, while simultaneously assuring that the key conditions are met and maintained. The process of agenda-setting, established in the short term, continues in the longer term via a dedicated team under the formal organisational structure, assuring legitimacy through broad participation and extensive consultation. This goes hand in hand with the support of further deployment of knowledge in Climate Action and Sustainable Energy.

  As it expands over the next 10 years, the R&I Partnership will also evolve organisationally. A Partnership of variable geometry, without entry and exit barriers, allows the institutional agility to support an array of activities. A consistent approach to governance and to the relationship with the formal HLPD process, supported by a rigorous administrative and managerial structure that includes project management capacity is also necessary.

III.3 Funding mechanisms

A core feature of the CCSE-Partnership is that of **co-funding** and the **co-ownership,** ensuring engagement of stakeholders and participants for the success of the measures. While individual initiatives may not necessarily all meet the criterion of co-funding, it would be essential to find an overall balance in the R&I Partnership. Not only fresh money should be taken into account, but also mobilization of human resources, infrastructures and facilities (in-kind concept).

IV. Monitoring and Evaluation (M&E) of the Research and Innovation Partnership

Similar to the FNSSA-Partnership, as well as to the input of *HLDP WG2* on M&E done by Portugal and Burkina Faso, as a dynamic tool the M&E plan will evolve with the Partnership in response to changing circumstances and exigencies, based on the following (non-exclusive) M&E criteria (being general Partnership criteria):

1. **Advancement** of knowledge;
2. Conduct of **capacity building** and targeted research activities;
3. **Uptake** of research outputs to scale;
4. Improved **coordination** of European and African R&I activities;
5. **Effectiveness of multi-disciplinary teams** in mobilizing stakeholders and sourcing funds;
6. **Operationalization** of capacity and mechanisms for knowledge and innovation mobilization.
7. Institutional and technical **evolution** of the R&I Partnership;
8. **Enhancement** of collaborative capacities of European and African Research and Innovation communities;
9. **Impact** of research on communities;
10. **Capacity** to inform and influence policy and decision making;
11. **Dissemination and usefulness** of knowledge.

The process thus integrates ex-ante, ad-interim and ex-post evaluation processes adapted to the R&I Partnership, its thematic programmes and diverse individual activities, across their varying temporal scales. External stakeholder input should be foreseen, with key M&E outputs being regular reporting and proposals for corrective measures.

V. Conclusions

Addressing climate change is of common interest to Africa and Europe. Therefore, the HLPD chose Climate Action and Sustainable Energy as its second priority for the R&I Partnership. Since 2016 the AU-EU HLPD Bureau with the support of several experts from Europe and Africa has worked on laying the basis for a truly jointly developed, governed, managed and co-funded AU-EU R&I Partnership on CCSE, building on and leveraging existing initiatives between the continents. The Partnership on CCSE is fully in line with and guided by the global policy framework. It commits itself to the fulfilment of the five quality criteria, mentioned in the Preamble (relevance, impact, capacity, scalability and complementarity).

Responding to the high vulnerability to the adverse consequences of climate change, and aiming at providing tools to harness the growth and development potential of a low-carbon economy, this Roadmap provides considerable support to climate action for adaptation and mitigation measures. In particular, the development and deployment of climate services contributes to inform decision makers and help them in their risk governance and management. It will also support a new and flourishing market, boosting innovation and public private partnerships.

The Roadmap will help implement targets of the global policy framework. It supports fulfilling commitments to transit to a climate resilient and low-carbon economy, both in the EU and AU. It contributes to building resilient and sustainable energy systems to support economic growth

demands in Africa and to harness the great potential of a growing youth generation. It allows enhancing industry-driven technological innovation and employment opportunity across the world, in particular, further deepening Europe's expertise in high-technology and leading SMEs.

The Roadmap takes an integrated approach by focusing on the entire research to innovation chain as well as the building of capacities of individual researchers, institutions and research infrastructure. Regarding the deployment of renewable energy technologies and energy efficient solutions, social embedding and ownership are key conditions of the Roadmap from the beginning. Social integration by involving local stakeholders and providing open access to data will ensure the success of this Roadmap.

The next steps are to focus on aligning and co-funding of joint activities. Aside from developing this Roadmap, an important example will be the launch of targeted calls in the third Work Programme of Horizon 2020. Substantial co-funding is expected from African and European countries through these Horizon 2020 calls and African Union Research Grants.

Synergies with the first AU-EU R&I Partnership on FNSSA and other existing and future initiatives in the field are expected to further underscore the goal of consolidation and defragmentation of the AU-EU R&I landscape.

Longer term success relies on the complete establishment and integration into the landscape of the R&I Partnership, supported by its fully operational organisational/governance structure and generating locally relevant innovation and exchangeable knowledge and know-how.

The complete establishment of the R&I Partnership should occur after 2020 with an operational life well beyond that.

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Acronyms

AAI Africa Adaption Initiative
ACP Africa-Caribbean-Pacific
AEEP Africa-EU Energy Partnership
AMCEN African Ministerial Conference on Environment
AU African Union
AURG African Union Research Grants
C3S Copernicus Climate Change Service
CAAST-NET Plus Science, Technology and Innovation Cooperation between Sub-Saharan Africa and Europe
CCSE Climate Change and Sustainable Energy
DEVCO DG International Cooperation and Development, European Commission
EDCTP European & Developing Countries Clinical Trials Partnership
EU European Union
ERAfrica coordination platform between European and African research funders initiated by the EU's seventh framework programme
ERANET COFUND Horizon 2020 initiated ERANET action between Europe and Africa with focus on R&I Partnership on food and nutrition security and sustainable agriculture.
ESASTAP Coordination and support action on Strengthening Technology, Research and Innovation Cooperation between Europe and South Africa
FNSSA Food and Nutrition Security and Sustainable Agriculture
GEOSS Global Earth Observation System of Systems
GFCS Global Framework for Climate Services
GMES Global Monitoring for Environment and Security
HLPD High Level Policy Dialogue
ICT Information and Communication Technology
JAES Joint Africa EU Strategy
JPI Joint Programming Initiative
M&E Monitoring and Evaluation
MESA Monitoring for Environment and Security in Africa
PUMA Preparation for Use of the MSG (Meteosat Second Generation) in Africa
R&I Research and Innovation
RE Renewable Energy
RECP Africa-EU Renewable Energy Cooperation Programme
RINEA Research and Innovation Network Europe and Africa
RTD DG Research & Innovation, European Commission
SASSCAL/WASCAL Southern African/West African Science Service Centre for Climate Change and Adaptive Land Management
SDG Sustainable Development Goal
SER Sustainable Energy Research
SSA Sub-Saharan Africa
STI Science, Technology and Innovation
STISA African Union Science, Technology and Innovation Strategy for Africa
WG Working Group