

# Executive summary

Africa does not need to replicate misleading trends of development, production and consumption which are now calling for strong efforts and Partnership at global level in order to set appropriate remedies, support the achievement of sustainable development while maintaining global Peace, reduce inequality among People and promote a more equitable Prosperity for all, including the Planet at large. Africa does not need to replicate misleading trends of development, production and consumption which are now calling for strong efforts and Partnership at global level in order to set appropriate remedies, support the achievement of sustainable development while maintaining global Peace, reduce inequality among People and promote a more equitable Prosperity for all, including the Planet at large. Africa does not need to replicate misleading trends of development, production and consumption which are now calling for strong efforts and Partnership at global level in order to set appropriate remedies, support the achievement of sustainable development while maintaining global Peace, reduce inequality among People and promote a more equitable Prosperity for all, including the Planet at large.

Africa is ready to **jump straight into the revolutionary frontiers which may represent the enabling environment for the transformative change requested by the 2030 Agenda**. Africa does not need to replicate misleading trends of development, production and consumption which are now calling for deep remedies. Indeed, strong efforts and **Partnership** at global level are requested to support the achievement of sustainable development while maintaining global **Peace**, reduce inequality among **People** and promote a more equitable **Prosperity** for all, including the **Planet** at large.

## THE POTENTIAL OF THE NEXT PRODUCTION REVOLUTION IN AFRICA

In this perspective, the **Next Production Revolution (NPR)** represents a potential opportunity and a big challenge for Africa and its socio economic development, also due to the traditional leapfrogging attitude that has already characterized the straight and successful diffusion of a number of smart or clean innovations in the continent. Indeed, NPR entails a **confluence of technologies** ranging from a variety of **digital technologies to new materials and processes**. Moreover, in the 2030 Agenda of the United Nation, the 5 clusters of **emerging technologies (bio-tech, digital-tech, nano-tech, neuro-tech and green-tech)** are considered crucial for the achievement of the Sustainable Development Goals (SDGs). Among the five clusters it emerges that **Digital and Green Tech** appear as the most relevant for the achievement of the SDGs like Health, Water, Energy, Ecosystem, Land, Ocean Management, Climate Change, Sustainable Production and Consumption patterns. Recognizing this relevance, Digital and Green Tech, broken down into digital infrastructure, sustainable energy infrastructure and smart mobility have become the core of ICA 2017.

**Physical** (e.g., telecommunication, energy, transport, water supply) and **social infrastructure** (e.g., health, education, banking, commercial services) are crucial for socio-economic development at country level. However, **infrastructure development** needs to cope with the new global framework. Indeed, only a **confluence of technological innovation matching political, institutional and social innovations** may have the power to trigger a transforming process that is requested for our society. From a **technological standpoint** - the OECD has just formalized the concept of Next Production Revolution which will have a very strong impact on productivity, work, skills, markets, poverty and inequality, well-being and environment. From a **political and institutional point of view**, the Paris Agreement on climate change, the 2030 Agenda for Sustainable Development and the Addis Ababa Action Agenda represent paramount innovative reference assets. However, **infrastructure development**, within the current production schemes, may represents a big burden for additional green-house gases emissions. Thus, long lasting effects of infrastructure need to be considered in order to avoid the risk of **technological lock-in** to a set of configurations that are able to meet 2030 or 2050 targets but that inevitably are due to fail in achieving the target beyond 2030.

Quality and reliable infrastructures are preconditions that may trigger access to different services pivotal for fighting poverty and boosting the local economy and entrepreneurship. **Africa needs to bridge a large infrastructural gap** in the **energy, transport and ICT assets** mainly due to **low population density, high concentration of landlocked countries and high share of rural settlements**. In the **energy sector, the infrastructure dearth** is largely manifest both from a quantitative and qualitative perspective. **Access to electricity and modern fuel** is still low in the Sub-Saharan region. Per capita electricity consumption, in the whole continent, is very low, less than **600 kWh/per capita per year** that represents less than 20% of the world average; **energy intensity**

and CO<sub>2</sub> intensity are very high, thus giving evidence of a very low efficient and not clean energy supply chain. **Transport infrastructure**, in terms of both roads, rail lines, air transport and port, is another crucial pillar to foster sustainable development in Africa enabling local, regional and international trade. **Road transport contributes to 90% of passengers' mobility and more than 80% of goods' exchanges.** More than **50% of Africa's road network is unpaved** hindering the access to basic social services and burdening local economic activities, especially for rural population. **Air transport is still modest** compared to other macro regional aggregations. **Maritime transport**, despite being fundamental for trade, is also weakly developed. **Information and communication technologies** had a rapid growth in Africa which is now the second largest mobile phone market in the world. But the Africa penetration rate of **mobile phones varying from 71% to 111%** is still among the lowest compared to other macro-regional aggregations. Moreover, individual Internet access still scores very low, having a range between **20 and 39% of individuals using Internet.** Despite the positive trends, African ICT sector is still relatively immature as shown by the **low number of fixed broadband subscriptions**, and with **low impact of Internet on African GDP** (1.1% compared to 3.7% of developed economies).

**Filling the infrastructural gap of Africa** is urgent and in this perspective, additional resources are needed, but further value could be brought by cooping wise investments on quantitative **capacity** with a set of other strategies to improve **productivity** of current infrastructural asset use. At global, level ensuring a value of **infrastructure stock at around 70% of GDP**, a rise of annual baseline infrastructure investment from **\$2.6 trillion in 2013 up to \$4.5 trillion in 2030** would be required. Such an investment would not be enough to **fill the existing gaps** between developing countries and developed regions, to **address universal access to roads, clean water, sanitation, and electricity** and to consider extra investments required to tackle environmental stresses from climate change mitigation and adaptation. The additional amount to meet the need of Sustainable Development for developing countries is between **\$3.3 trillion and \$45 trillion** per year to be mainly allocated in the sector of basic infrastructure (roads, rail and ports; power stations; water and sanitation), food security (agriculture and rural development), climate change mitigation and adaptation, health, and education. Within this total amount, **physical infrastructures** would require from around \$1.6 trillion to \$2.5 trillion per year. This brings to evidence an estimated gap close to \$1-1.5 trillion per year when compared to current investments. As a global picture, investments in infrastructure in developing countries are estimated to be at **1.8% of global Gross Domestic Product (GDP)** while the investment gap should be between 2.4% and 4.2% of global GDP. **In 2015, investments for Africa's infrastructures amounted to \$83.4 billion** showing a 12% increase with respect to the previous year. **African national governments committed 34.1%** of total investments while the **private sector shared only 8.9%.** **Energy and transport** sector collected **more than 80%** roughly equally distributed among the two for a total investments sharing of \$69.4 billion. At regional scale, investments were mostly

allocated in **Eastern Africa** (23.1%). Investments from **private sector** were almost entirely focused in the **energy sector** and were mostly concentrated in South Africa (51.2%) followed by West Africa (17.2%) and North Africa (16.5%). In the whole Sub-Saharan Africa private sector investments were around **\$6.3 billion with the power sector sharing more than 95%** of it and the remaining allocated in **road construction and water infrastructure**. In the period from **2010 to 2015** most of private investments in Sub-Saharan Africa were allocated in **ICT infrastructure with few but big projects**. However, in the last three years a shift of private investments from **ICT to energy infrastructure** has been observed. **Private investments in transport sector are still very small** mainly concentrated in ports.

The share of **middle- and low-income countries** in global GDP (on purchasing parity terms) has increased from less than 40% to more than 50% since year 2000 and is expected to increase to two-thirds by 2030; these countries are coming to be the major drivers of investment and growth. This **unique transformation** calls for rapid technical progresses in digitalization, energy, transport and other spheres. At the same time, this progress needs to be carried out in compliance with the urgency of controlling impact on resources, environmental quality and on climate. **The Next Production Revolution** offers to developing countries and therefore to Africa the opportunity to achieve sustainable development goals provided the setting of an enabling infrastructure and a new generation of leaders able to manage such innovation. The early path towards low-carbon and quality infrastructure has already led to a **'leapfrogging' change of infrastructure system**, which needs to be more focused on a comprehensive **smart and integrated** approach including *functional, data integration and governance; a decentralized paradigm, a life cycle perspective and a new and pro-active role of users*.

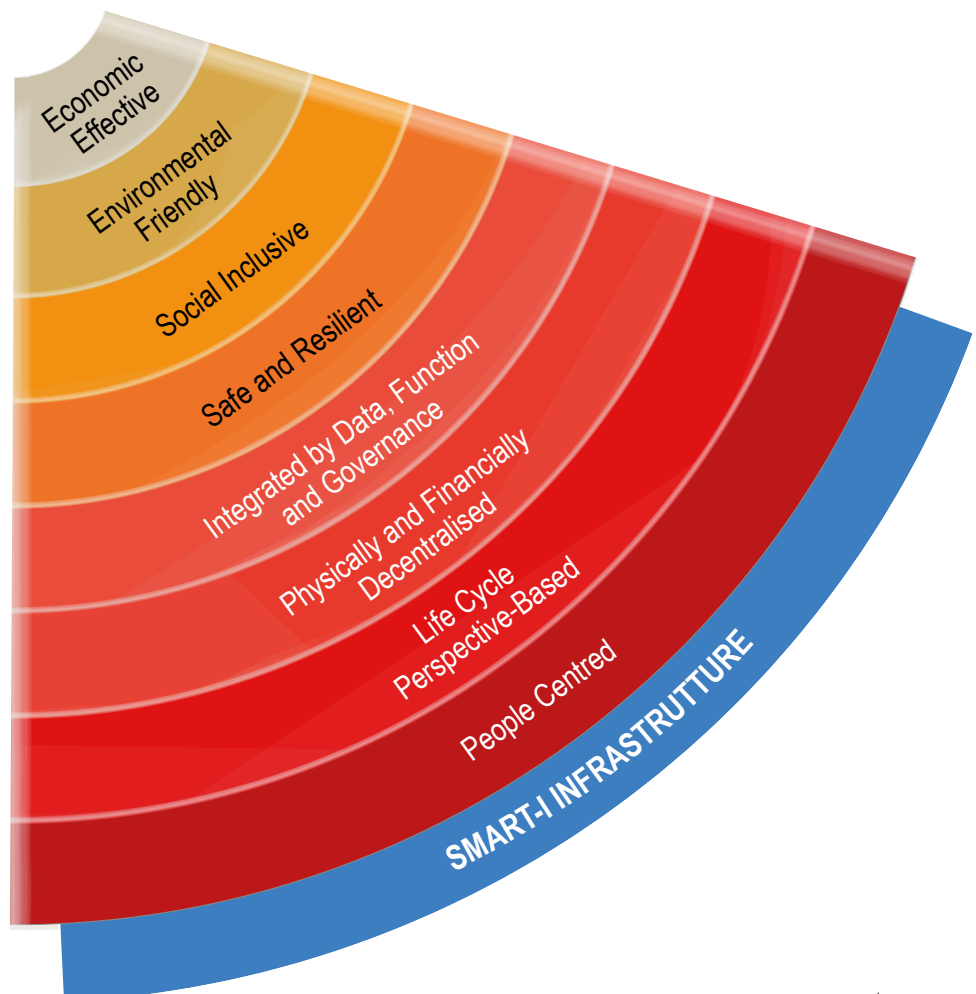
## SMART AND INTEGRATED INFRASTRUCTURE IN AFRICA

**Smart** refers to a massive penetration of digital technologies in the infrastructure sector to control, manage and optimize uses. **Integration** refers to the coping of functionality, data integration and sharing across sectors between physical infrastructure like energy, transport, telecommunication and digital technology including the use of Internet of Things, Artificial Intelligence, Big Data. Integrated infrastructures can therefore promote a new **infrastructure governance** able to foster an overarching approach to planning, delivery and management of infrastructure assets. In addition, integration leads to the promotion of **new technological nexus**, overlapping different sectors, such as waste, energy, transport, ICT, banking, financing. This implies that the development of, e.g., transport, energy and ICT, infrastructures should be seen as intertwined and synergic.

**Decentralization** is a crucial element in the transformative path for infrastructure: from **the physical perspective**, we assist to a capillary distribution of technologies more massively available to citizens; digital technologies (e.g. smart-phone) have increased the chance for everyone to get access to digital

services, energy and also transportation services. Additionally, technological advances have allowed the deployment of “local” digital services, which may stand regardless the availability of connectivity with centralized infrastructures. From **the financial perspective**, we are assisting to a parallel shift of capitals and infrastructure owners, from large creditworthy entities (e.g., large corporations and central governments) to smaller one (e.g., households, smallholders, emerging economy cities without good credit ratings, new project developers). In the same perspective, investments in infrastructure need to be more directed to solutions that aim at **optimizing resource use in a life cycle and system perspective** enabling the transition that is requested from now to 2030 but also casting the right seeds for the more challenging shift needed to 2050. Lastly, a new **people-centered perspective is envisaged**, where households and communities are engaged in new or adapted forms of distributed control, with demand-response approach.

Smart and Integrated Infrastructures (SMART-I Infrastructure) need to become the driving element for the next investment generation in Africa and they are the essence of the taxonomy proposed for ICA 2017. They represent the natural evolution of the list of attributes for infrastructure development and complement the previous definition of **sustainable** and **quality** infrastructure.



## THE ROLE AND STATUS OF SMART AND INTEGRATED INFRASTRUCTURE FOR PROSPERITY IN AFRICA

### DIGITALISATION: THE NEW ERA OF INFRASTRUCTURE

To benefit fully from the digital economy, countries require a **smart and integrated digital infrastructure**. At its core, digital infrastructure includes telecommunications infrastructure, both fixed and mobile. Within the **Next Production Revolution (NPR)**, technologies such as **Internet of Things, Big Data and Cloud Computing** will play a crucial role. The IoT is going to generate a massive amount of data, so **Big Data** that require new, advanced analytic techniques. **Cloud Computing** enables ubiquitous, convenient, on-demand network access to a shared pool of memory and computing resources for data storage and processing. Among the large variety of applications that can benefit from the above technologies, some are of prominent importance to Africa:

- **Public transport.** Transport users can become fully informed about their travel options while at the same time providing information that enables transport authorities to plan and manage transport networks and services more efficiently.
- **Emergency management.** Massive amounts of data collected by public authorities as well as by people using specific digital applications (crowd-sourced data) can be effectively used to ensure swift response to and recovery from emergency situations such as natural disasters or energy grid failures.
- **Remote monitoring.** Users' smartphones can act as mobile sensors, gathering environmental and pollution data. Mobile apps further add the possibility for the users to report environmental data for the realization of smart city services, medical data, user habits (like smart meters).
- **E-learning.** Cloud computing, coupled with broadband wireless connectivity to the Internet, represents the ideal means to enable remote educational services and access to educational, training and learning material.

The future deployment and effectiveness of IoT, big data and cloud computing will depend on the availability, quality and security of the underlying infrastructure. Indeed, **high-data rate connectivity** (e.g., between the "things" or users and cloud computing servers), **ultra-low latency** (e.g., for robotics control applications in next-generation factories) and **data security and privacy** (e.g., user profiling or industrial data) are critical to the development of innovative services. In this context, mobile infrastructure represents an effective solution that can provide high capacity while avoiding the costs of fixed-broadband or satellite-broadband networks. In particular, the emerging **5G technology** can significantly help to mitigate the need for a high capacity, costly backhaul. Through virtualization, services can be deployed everywhere in the network, thus allowing the transition from a centralized, often costly cloud, to a distributed cloud.

In this regard, and despite the progress made in the last years, Africa still lags behind other regions in its access and use of digital infrastructures, digital technologies, and the Internet. The **broadband infrastructure gap, the related to**



**costs of services and devices, the lack of local content and low proficiency in digital skills** are among the critical barriers. Migration to mobile broadband is gaining momentum in Africa but still 600 million people do not have access to a mobile broadband service. On the side of fixed-broadband connection, Africa has the opportunity to advance quickly to **high-speed fibre broadband** as it has not made massive investments in old copper-based technologies.

The mentioned inter-dependent aspects must be addressed concurrently to **close the digital divide**, such as **infrastructure, affordability, local content, and skills development**. Digitalization has policy implications across different areas and, thus, maximizing its benefits requires more coordinated policies and regulation across sectors and authorities. To recognise the relevance of digitalisation, African leaders adopted the **“Agenda 2063” as the continent’s new long-term vision for the next 50 years**.

Since ICT is intertwined with the energy, transport, water sectors, just to name a few, deploying a **digital infrastructure** for Africa will bring a number of contributions to prosperity, characterizing the digital revolution as a new era of infrastructure contributing to the transformation of the African Socio-Economic asset toward the NPR adoption in the continent.

Internet contributes **1.1% to the African Gross Domestic Product**, which is low compared to **global average of 3.7% for developed economies**. The overall benefits of digitalization in emerging economies derive from the **effectiveness, efficiency and innovation gains** in processes, products, services and business models that accompany the digital transformation. Thanks to the expansion of connectivity and accessibility across Africa, a new ecosystem of digital entrepreneurs and start-ups can emerge and flourish. Beyond the leapfrogging to mobile phones a similar leapfrogging could happen with distributed manufacturers, at least at the urban scale, allowing start-ups or small businesses with little capital to begin manufacturing on a small scale.

Digitalization can significantly contribute to mitigate environmental challenges to sustainable development, by enabling a more efficient use of energy and natural resources, and helping countries, cities and individuals to adapt to environmental threats with the improvement of monitoring and control. Digitalization may also contribute to social improvements through job creation and better access to basic services, such as health care and education.

In order to mitigate any future lock in, it is important to consider that digital technologies and infrastructures also contribute to the generation of Greenhouse Gas (GHG) emissions and e-waste, through the energy consumption involved in the lifecycle of digital infrastructure as well as the production, use and disposal of digital products and services. **Taking a lifecycle and circular economy perspective** and deploying systems to manage digital technologies is, therefore, crucial to minimize negative impacts. New business models are also characterised by an emphasis on high value-added services where people are at the centre of the stage and their role shift from being simple customers to become partners.

## DECARBONISATION: THE NEXUS ENERGY-CLIMATE-DEVELOPMENT

Africa is expected to become more and **more energy demanding** due to its growing population and growing economy both claiming access to reliable and affordable energy services and together with it, as remarked by PIDA, Africa wishes to confirm the **continent commitment to maintain its low contribution to global carbon emissions**. In this perspective, the challenge of NPR for Africa may allow some countries to leap-frog to more advanced stages of development in a number of sectors; energy being one of them. **Africa cannot lose momentum to investigate low carbon alternatives** for the long run in the path to decarbonisation and to the claimed decoupling among growth and greenhouse gases.

The energy paradox in Africa is nowadays fully recognised. Energy demand over the last decade has grown by more than 30% nevertheless, even if home for the **16% of the global population**, the continent accounts for only **6% of the total primary energy supply** at global level and the **3% of the total electricity demand** being responsible of the **5% of the CO<sub>2</sub> emission burden**. Africa still lags behind other regions: per capita availability of energy is very low while **energy and CO<sub>2</sub> intensity are higher** than other regions. These numbers, together with the **low levels of installed generation capacity per capita**, and per unit of GDP represent the evidence of underinvestment in Africa in terms of power generation infrastructure. Indeed, installed capacity is roughly around **150 GW** unevenly distributed in the continent. The capacity mix is mostly given by **thermal power plants** (80%) due to the size of the North African and South African systems, and **hydro plants** (20%) mainly located in the central and eastern regions of Africa. The energy situation in Africa is very diverse in term of generation capacity and mix in the different regions. Except for COMELEC and SAPP, the generation mix in the other regions does not mirror the local natural endowment, but it is more the evidence of **short sighted planning and lack of regional integration**. The existing African **transmission system** (defined as lines with a voltage equal or above 100 kV), with a total length of less than 90.000 km, is the major bottleneck for further energy system integration and networking among the power pool as again suggested by PIDA.

The current level of **annual investment** in the power sector (roughly \$10-11 billion per year) is inadequate and huge **increase of four times** is at least needed for supporting the boosting of the energy sector in term of installed capacity, transmission lines, quality of the service and universal and equitable access for all in the continent. The main challenge will be financing the large capital investment required by the transformation of the power sector, increasing private sector financing and sector cash flow by some 7-10 times their current levels. This big effort may be turned into a positive effect since no significant increase in average tariff may be required to finance the sector program, which would so remain around \$8-10 cents /kWh due to the large amounts of low cost hydro power which would become available.

**Africa sub-regions differ consistently** in their availability and use of the energy resources. Such differences bring about different sets of challenges



which have led in Africa to an evident **pluralism of actors** involved in the energy sector through several policies and action plans. Governmental agencies and international organizations, development banks and funds, power utilities associations, NGOs and others, undertake actions addressing energy-related challenges. The **fragmentation of the policies and action plans** and the lack of harmonization represent one of the main key points. Indeed, actors involved in this frame have priorities and roles that often differ or overlap even if some efforts of integration have appeared over the last decade by **AU, NEPAD, AFREC and AfDB** and the increasing coordination within **the Power Pools**. **Modern energy services**, though increasing, remains limited and diversified by regions in the continent. For instance, roughly 50% of Sub Saharan Africa population is without access to electricity, 80% of which leaving in rural area. On-grid solution stays the least-cost solution and provide access to the majority of those who gain it within 2030; renewable makes the 70% of the additional capacity to provide access. Reliable energy infrastructure with proper regulatory framework are crucial to transform the power sector and contribute to decarbonisation. **Bioenergy** in Africa, mainly fuelwood and charcoal, is still the dominant source of energy for Africa (a bit less than 80% of the population in SSA) affecting the health of hundred thousand people. In the areas where progress will occur, **LPG is the most common solution to clean cooking access**, with over half of those gaining access by 2030 relying on LPG. This is particularly crucial from an infrastructure perspective since a lack of proper distribution networks as well as adequate affordability of LPG may slow down progress in rural areas, where biomass alternative is often free of monetary costs. Beyond providing a short-term pathway to cleaner energy solutions, an LPG network and infrastructure can provide a platform for developing modern bioenergy solutions (e.g., biogas) towards a higher relevance of bioeconomy that is a pillar of the NPR.

The power sector is often weakly reliable in the African countries due to severe and frequent power shortages which happen in poorly maintained networks. On average, roughly 5% of **annual sales** are estimated to be lost due to electrical outages; electricity tariffs are, in many cases, among the highest in the world and the frequent recourse to emergency back-up oil-fuelled generators or captive power has induced consequences on the **electricity costs** for the final user (across businesses and households) and affect **product competitiveness**. Time and cost to get electricity connection affects **business development**. As a general consideration, since GDP growth of more than 5% per year in Africa has been achieved despite poor electricity supply, it is not difficult to forecast the impact of a more reliable and affordable energy infrastructure on the economic and social development. A higher quality power network is expected to raise the productivity of African companies: every additional \$1 invested in the power sector may generate more than \$15 in incremental GDP. According to different scenarios and forecasts, the power demand will increase from the current value up to **three or four times** to 2040, and therefore, installed power generation capacity must rise from present levels to almost 400-600 GW by 2040. Forecasting different penetration of renewable energies will also imply

a different level of investment. PIDA suggests that Africa will **save on electricity production costs** through power interconnectors among the Power Pools to enable large-scale hydropower projects while increasing access to power in the low generating area through inter-regional trade. In this configuration, the role of regional smart and integrated infrastructure will be crucial as suggested also by IRENA and IEA. Both of them include deeper regional co-operation and integration to facilitate new large-scale generation. **Integration will also call for stronger inter-sectorial synergies, high coordination and multi-sectorial governance as well as a life cycle perspective** in order to mitigate long term CO<sub>2</sub> lock in and allocate responsibility for energy consumptions among national economies and their productive sectors including trades.

The **debate between top-down or bottom-up approach** is going to be overcome in the perspective of providing universal access giving space to both approaches in order to mitigate the rural-urban divide. In the perspective of increasing further the quality and level of access for household, beyond the basic needs, and promote productive uses for community services, agriculture or rural industries, the contribution of distributed (off-grid) and decentralised generation (mini-grid) increases from covering the 17% for the new access of the New Policy Scenario to the 42% of the new access in the Universal Access Scenario. Reduction of costs and greater attention to energy efficiency, social entrepreneurial promotion, disruptive penetration of digital technology will be crucial for the future relevance that distributed generation may gain. Distributed Energy infrastructure may better respond to the needs, capacities, and aspirations of people and be absorbed within the local culture, adapted and later improved by the local people to sustain local ownership, promote economic growth and ensure long term impact.

## **MOBILITY: THE GOAL OF CONNECTING PEOPLE AND GOODS**

Transport of goods and people is a prerequisite for a prospering economy **shaping mobility patterns, contributing to innovation and productivity while triggering economic, environmental and social benefits**. Transport infrastructure enables the connection of people to jobs, education and health services. It spurs the interactions among people that generate knowledge and visions for long-term development.

Future transport systems need to comply with many constraints in terms of quality and affordability, social and environmental impacts. Transport accounts for about 64% of global oil consumption, 27% of primary energy demand and 23% of total anthropogenic GHGs emissions. In 2040, for each barrel of oil no longer used in Europe, almost one barrel more will be used in the Africa. Africa has the primacy for the risk of a road traffic death resulting in about one-fifth of total fatalities from road crashes worldwide although the share of global registered vehicles is only 2%. Noteworthy, road accidents cause economic losses equal of up to 5% of GDP.

Future trends suggest that global transport volume for passengers and goods will double as result of fast-growing population and emerging economies with a

consequent strain on the global transportation system. As a result, **significant investment will be required in the transportation infrastructure to increase capacity and improve productivity**. Similarly, there will be the need of more **efficient and reliable vehicles** relying on more sustainable fuel sources.

The infrastructure dearth of Africa in the field of transport is evident from the very low total intra-African trade in 2011 that was only 11% of African trade with the rest of the world, stating the poor internal connection among the countries and the region. More in detail, Africa's terrain variety has an impact on critical transport and in general, there is a **huge range of maturity in terms of infrastructure**. For example, Angola has just 4 km of roads per 100 square kilometers of land; Ghana's road density is more than 10 times as high, while South Africa has 62 km of roads per 100 square kilometers.

**Roads** represent the main mode of goods transport in Africa; however, most of continent's roads are unpaved or in poor condition and quality tends to reduce in case of non-international truck roads. Formally speaking a network of **trans-African highways** exists, to potentially permit people and goods travelling across African countries, but their impact is limited by the poor quality of some of them. Indeed, where road infrastructure is adequate, road maintenance is a worrying problem reducing dramatically the percentage of road in good or fair condition.

Africa's **rail** networks have severe infrastructural problems and deficiencies: generally, rail lines date back to colonial period and are poorly maintained. These network densities are lower than Europe's range of 200 to 1,000 km per million people. It is also notable that African exports are largely bulky primary commodities, which could be transported more efficiently and at lower cost by rail than by road, therefore, **rail development holds huge opportunities for investors**.

**Maritime transport**, despite fundamental for trade is also weakly developed. **Ports** are the most important transportation mode to access African continent especially for goods. Nevertheless, ports are not enough to handle existing traffic. Africa operates 64 ports but they **share only around 5% of global traffic**. South Africa, Morocco, Egypt and Cameroon contribute to around 68% of the regional maritime traffic.

There exist several **international airports** for passenger traffic while air transportation of goods is not enough developed. Generally, there is a **lack of physical connections and coordination between the different transport infrastructure and terminals**.

Several policies related to transportation and logistics are already in place sustained by the Programme for Infrastructure Development in Africa (PIDA). Overall, PIDA aims at developing a functional African Regional Transport Infrastructure Network (ARTIN) at the least economic cost, with priority for landlocked countries, while minimizing the environmental impact and including gateway ports and air transport services, increasing efficiency, cost, reliability and safety. It is urgent to increase the **infrastructure capacity** of Africa to sustain economic growth since a positive correlation between real income per capita and road and rail density exists originated by the increased opportunity of connecting people to jobs and goods to markets. Introducing digital technologies into existing transport infrastructure can also **increase productivity, expanding the connections of**

**existing assets while predicting and avoiding disruption**, thus changing old paradigms basing solely on capacity. Finally, intermodal transport solutions can be promoted thus increasing the productivity of the whole transport and logistic value chain.

Beyond productivity of infrastructure, integrated and intelligent transport network is able to sense demand, measure performance and monitor the health of physical assets thus enabling **radical new ways of monitoring and maintaining the roads, track and runways**. Cognitive technology can improve automation and safety of vehicles. Finally, connected and automated vehicles are likely to lead to modifications in terms of security, safety, emissions reduction and time management while travelling on roads. All these measures promise to reduce the actual burden of poor transport infrastructure in Africa's economies. Smart transport and logistics infrastructure enable the Next Production Revolution by the digitisation and **integration of vertical and horizontal value chains, the development of new digital business models and customer access platforms**. Overall, digitalization has a high potential to improve internal operations of companies in a wide variety of areas including **asset management and the delivery of new investments**.

The implementation of smart transport and logistics solutions can stimulate more **decentralized and small business offering a greater flexibility that could overcome financial barriers**.

Transport infrastructure needs to shift for speeding up the disrupting change coming from the new mobility landscape with a major trend in shared mobility. Cities have been indicated as the most relevant segmentation dimension that will determine mobility behaviour and, thus, the pace of transport changes. Shared mobility solutions will provide **user-centered mobility services** empowering people and changing the approach to operations and planning based on users' choice and priorities.

A people-centered approach is also required to develop capacity and skills that drive transformation as the lack of **digital culture** has been recognized as a major barrier for the implementation of smart transport infrastructure. Finally, crowdsourcing give empowerment to people in a global perspective by changing the **granularity of measures, monitoring and planning**.

Remarkably, smart and integrated infrastructure can promote sustainable mobility ensuring more inclusive and healthy transport services. Furthermore, electrification of transport could promote the **integration of transport and energy infrastructure** and can give momentum to more efficient and reliable vehicles relying on more sustainable fuel sources and carriers thus helping the penetration of renewable energy in a final sector with a strong lock-in with carbon-based fuels. On the other hand, using electric vehicles as power grid infrastructure for energy storage options provide a higher flexibility of the energy system as a whole helping a higher penetration of renewable power sources.

## SMART AND INTEGRATED INFRASTRUCTURE IN AFRICA: RACOMANDATION FOR AN ACTION AGENDA

Deploying SMART-I Infrastructure for Africa needs to be recommended to promote Prosperity. Some of ten key recommendations emerges from the data and policy analysis in the different sector of digitalisation, decarbonisation and smart mobility are:

1. *Broadband penetration needs to be widen in the continent to support sustainable development.*
2. *Digital transformation is crucial to enable a new asset for African manufacturing and productivity.*
3. *Digital Technologies can boost people engagement and empowerment.*
4. *Renewable Energy & Efficiency need to be top priorities to unleash access to modern services.*
5. *Increased power capacity and reliability need to boost local economy and business development.*
6. *Interconnections and Networking of energy system cannot wait longer to increase trade and savings.*
7. *Distributed energy system may complement on grid option to increase inclusion and empowerment.*
8. *Smart transport infrastructure is prodromal of prosperity in Africa.*
9. *DigitalWization of transport and logistics spurs African manufacturing and productivity.*
10. *Systemic integration and effective resource management need to be on top of the Africa Agenda to unveil the potential of Smart-I Infrastructure.*

The attributes of SMART-I Infrastructure also complement and characterise the needed transformation of the African Socio-Economic asset toward the NPR adoption in the continent:

**Economic Effective:** The positive impact of broadband penetration opens a new era for the infrastructure development and an innovative asset for the national economy contributing to business development, annual sales saving, operational costs reduction, productivity and competitiveness, affecting national GDP by taking profit from the positive correlation with income boosted by the opportunity of connecting people, jobs, goods and markets.

**Environmental Friendly:** Africa cannot lose momentum to investigate low carbon and efficient alternatives in order to prepare the long term future beyond 2030. Digitalised energy infrastructure and shared mobility with proper regulatory framework allow cleaner energy services and avoid lock in in the transportation sector, and enable a more efficient use of energy and natural resources.

**Social Inclusive:** SMART-I Infrastructure needs to act on the social divide allowing different services to be available for all in order to meet basic needs,

community expectations like health and education, productive uses in the industrial or agricultural sector. In addition, the reliability of services supports fair conditions for business development by reducing the upfront cost of investment that otherwise could be met only by higher income categories.

**Safe and Resilient:** SMART-I Infrastructure for distribution networks (electricity, roads...) are crucial for reducing the divide among rural and urban area and to fasten the adoption of modern, healthy and safe services. Data collected from sensors, machines and vehicles enable rapid decision-making and improve productivity, operational safety and maintenance and a new engagement by people is expected by the introduction of new digital products and services that allows customer-specific solutions.

**Integrated by data, function & governance:** Introducing digital technologies and proper governance into existing infrastructure increases productivity thus changing old paradigms based only on capacity and giving more relevance to efficiency. Inter-sectorial synergies are crucial: energy, water, ICT, transport, so that governance needs to be the backbone of SMART-I Infrastructure. New ways of interaction and cooperation with suppliers and customers enable open innovation and crowdsourcing.

**Physically and Financially Decentralised:** A new ecosystem of digital entrepreneurs needs to flourish associated to new business models like distributed manufacturers, starting with little capital and using the earnings to finance expansion. Distributed solutions, boosted by cost reduction, energy efficiency, social entrepreneurship, disruptive digital technology, bring the double advantages of increasing renewable energies and reducing investment. The implementation of smart transport and logistics solutions can stimulate more decentralized and small business offering a greater flexibility that could overcome financial barriers.

**Life Cycle Perspective-Based:** Life cycle and circular economy perspective need to be a new paradigm on which SMART-I Infrastructure development is promoted for assessing a fair allocation of resource's consumption and synergies and trades among different economic sectors and economies. A new paradigm of consumption-based accounting is thus requested to define effective policies.

**People Centred:** New products and services as well as new business models are characterised by an emphasis on high value-added digital technology where people are the centre of the stage. Decentralised solutions need to be driven by local needs, respond to capacities, and aspirations of people and be absorbed within the local culture, adapted and improved by local people. So, empowerment driven by capacity development (technical, managerial, institutional) can increase ownership and avoid lock-in solution for the long run while facilitating the NPR promotion as stated at the G7 Africa Outreach in Taormina 2017.