ACADEMIE ROYALE DES SCIENCES D'OUTRE-MER
KONINKLIJKE ACADEMIE VOOR OVERZEESE WETENSCHAPPEN
Classe des Sciences techniques - Klasse voor Technische Wetenschappen

« Quelle énergie pour l'Afrique ? - une urgence et des défis »

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CRAOM

Webinaire, 29 avril 2021

en préparation de SE4A-2021, collaboration des académies béninoise ANSALB et belge ARSOM-KAOW (8 –11 novembre 2021, Cotonou, Bénin) - http://www.se4a.africa/)

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Les énergies en un coup d'œil (1/2)

L'énergie est présente partout sur notre Planète et sous de multiples formes : la chaleur et la lumière du soleil, l'eau ou l'air en mouvement, le bois ou les eaux chaudes souterraines, les gisements de charbon ou de pétrole ...

On appelle énergies primaires ces différentes sources d'énergie naturelles.

Mais dans bien des cas, nous ne pouvons pas utiliser directement ces énergies pour nos besoins.

Que peut-on faire d'un flacon de pétrole brut ? Il faut le transformer en carburant pour nos moteurs.

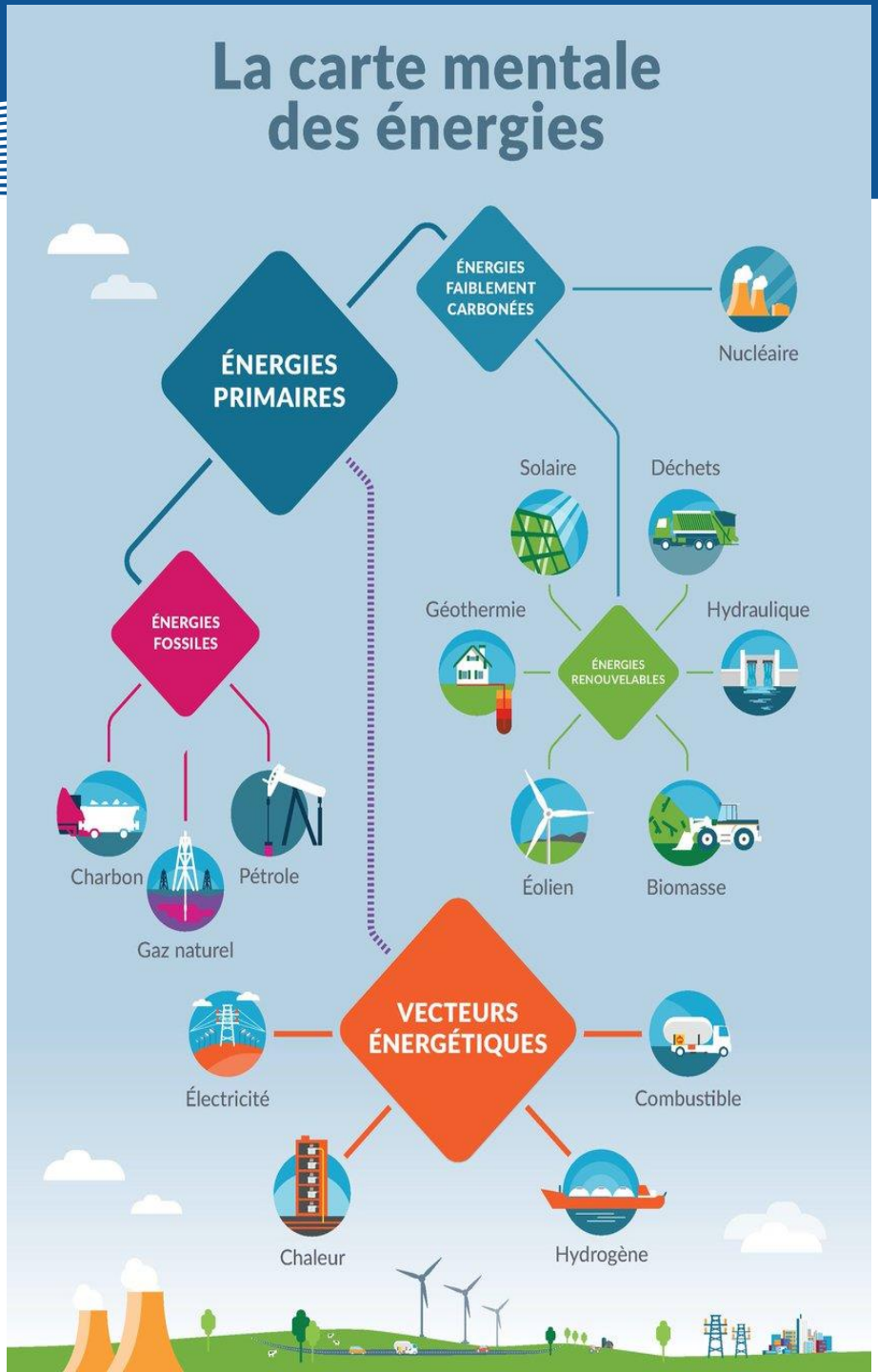
Que peut-on faire du courant d'une rivière ? Il faut installer un barrage pour créer une chute d'eau artificielle et produire de l'électricité.

Les formes d'énergie produites à partir des énergies primaires, comme l'électricité ou les carburants, sont appelées énergies secondaires ou vecteurs énergétiques.

Ce sont ces vecteurs énergétiques que nous utilisons dans notre vie au quotidien.

planete energies
An initiative by TOTAL FOUNDATION

https://www.planete-energies.com/fr/medias/infographies/la-carte-mentale-des-energies



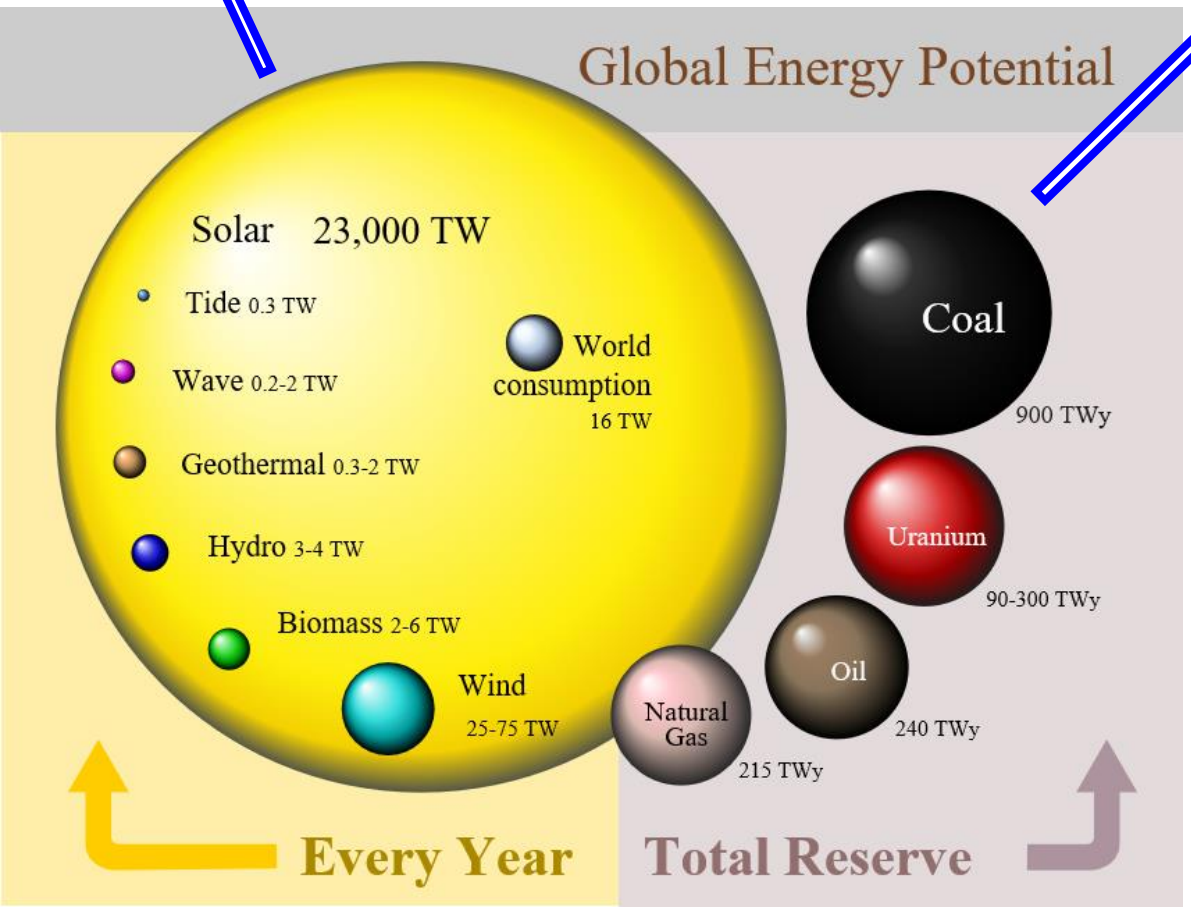
Les énergies en un coup d'œil (2/2)

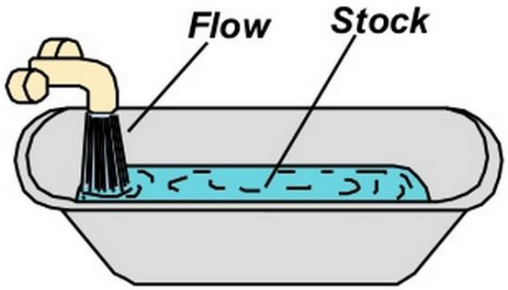
FLOW < = > STOCK

The sun powers almost everything on Earth, but … we do not know how to harness solar energy directly and efficiently (some progress is being made, however)

Energies de flux (vent, soleil): many renewable energy sources are intermittent, unpredictable and non-dispatchable

Energies de stock (charbon, gaz, pétrole, uranium) : réserves limitées dans le temps et l'espace





Grid stability = > Low carbon intermittent renewables ("flow") need a stable low carbon base ("stock")

Figure left. All the renewable sources of energy are depicted in this diagram as annual outputs (i.e. power, TW) .....whereas the non-renewables like fossils and nuclear are shown in their totality (i.e. energy, TWy).

Source 2015: http://waitbutwhy.com/2015/06/the-deal-with-solar.html

About 20 % of the world's energy is consumed in the form of electricity (IEA)

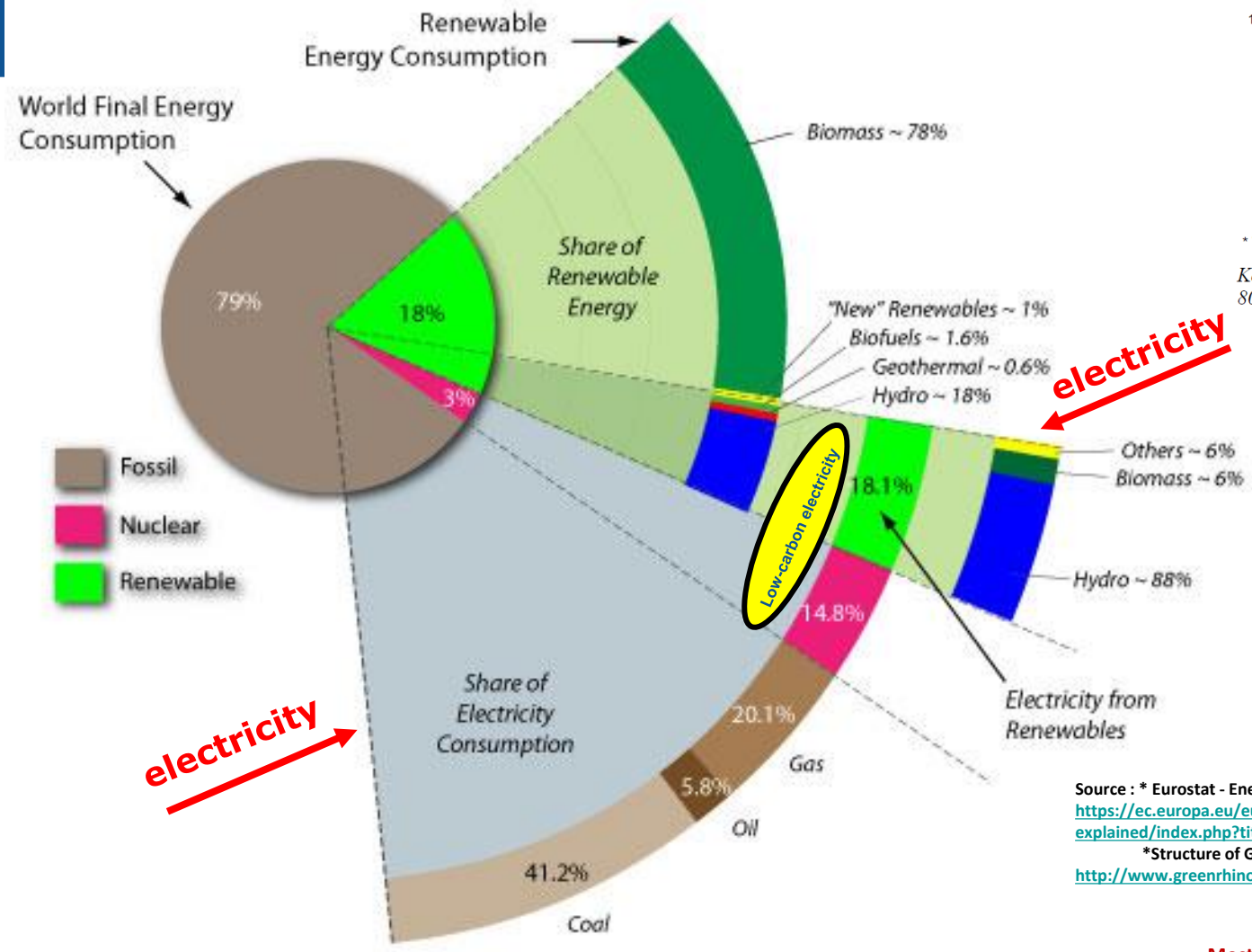
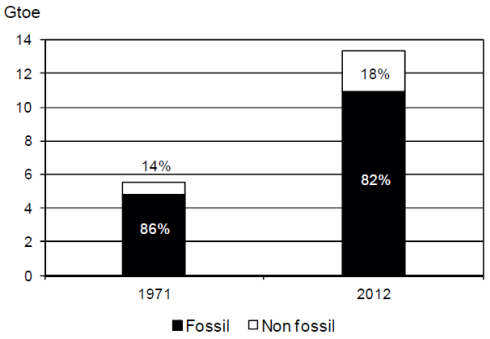


Figure 2. World primary energy supply*



* World primary energy supply includes international bunkers.

Key point: Fossil fuels still account for most – over 80% – of the world energy supply.

Source : * Eurostat - Energy statistics - an overview2020
https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Energy_statistics_-_an_overview
*Structure of Global Energy (2016) - Worldwide statistics -
http://www.greenrhinoenergy.com/renewable/context/uses_and_sources.php

National energy use is categorized in most countries world-wide in four broad sectors:

- transportation (passenger, freight, and pipeline)
- residential (heating, lighting, and appliances)
- industrial users (agriculture, mining, manufacturing, and construction)
- commercial (lighting, heating and cooling of buildings, and provision of water and sewer services)

Most of the energy used in the four broad sectors world-wide comes from fossil energy (about 80 %). It has been so over the last 50 years (above graph).

A small fraction of the primary energy sources - approximately 20 % - is consumed in the form of electricity but this fraction may grow dramatically in the coming decades because of the upcoming massive electrification of society (IEA outlook).

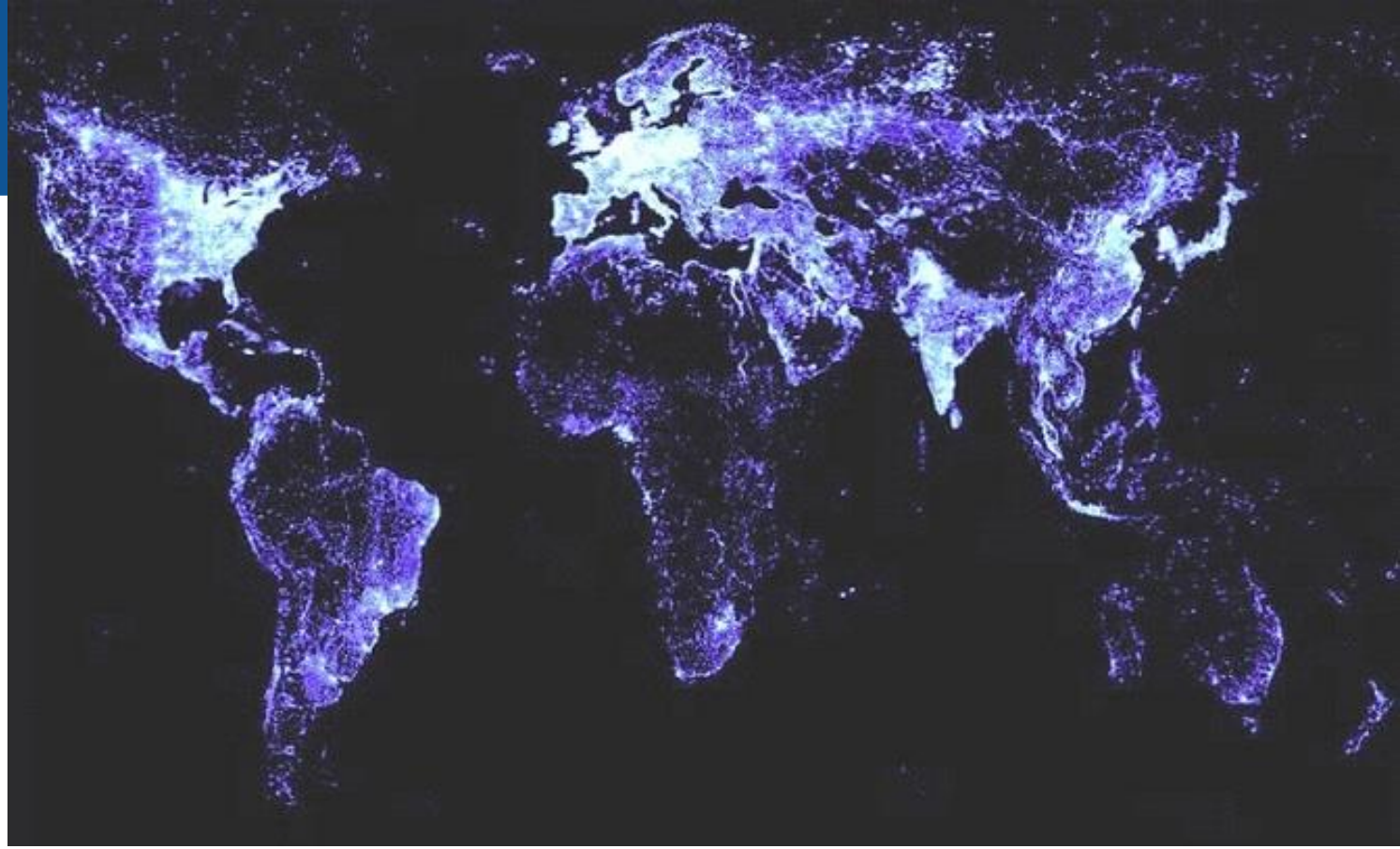
How electricity is distributed in the world

The amazing image right shows a picture of earth taken at night from outer space.

The street and house lights illuminate the countries and give an idea of how electricity is well or poorly distributed in the world.

Source 2001: The World Atlas of Artificial Night Sky Brightness, by P. Cinzano, F. Falchi (University of Padova) and C. D. Elvidge (NOAA National Geophysical Data Center, Boulder) - Royal Astronomical Society –

https://www3.astronomicalheritage.net/index.php/show-theme?idtheme=21



African Union

"The number of people without access to electricity declined from 1.2 billion in 2010 to 789 million in 2018, however, under policies that were either in place or planned before the start of the Covid-19 crisis, an estimated 620 million people would still lack access in 2030, 85% of them - that is : 530 million people - in Sub-Saharan Africa (SSA)."

Source : "Tracking SDG 7: The Energy Progress Report – 2020" - Summary (country results) in https://trackingsdg7.esmap.org/ by the Custodian Agencies – the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), the United Nations Statistics Division (UNSD), the World Bank (WB), and the World Health Organization (WHO).

Building bridges between science and the rest of the world

"It is indefensible that Africa's poorest people are paying among the world's highest prices for energy. A woman living in a village in northern Nigeria spends around 60 to 80 times per unit more for her energy than a resident of New York City, or of London."
Kofi Annan (UN SG 1997 - 2006), in his introduction to 2015 report from the Africa Progress Panel on energy use in Africa.

?

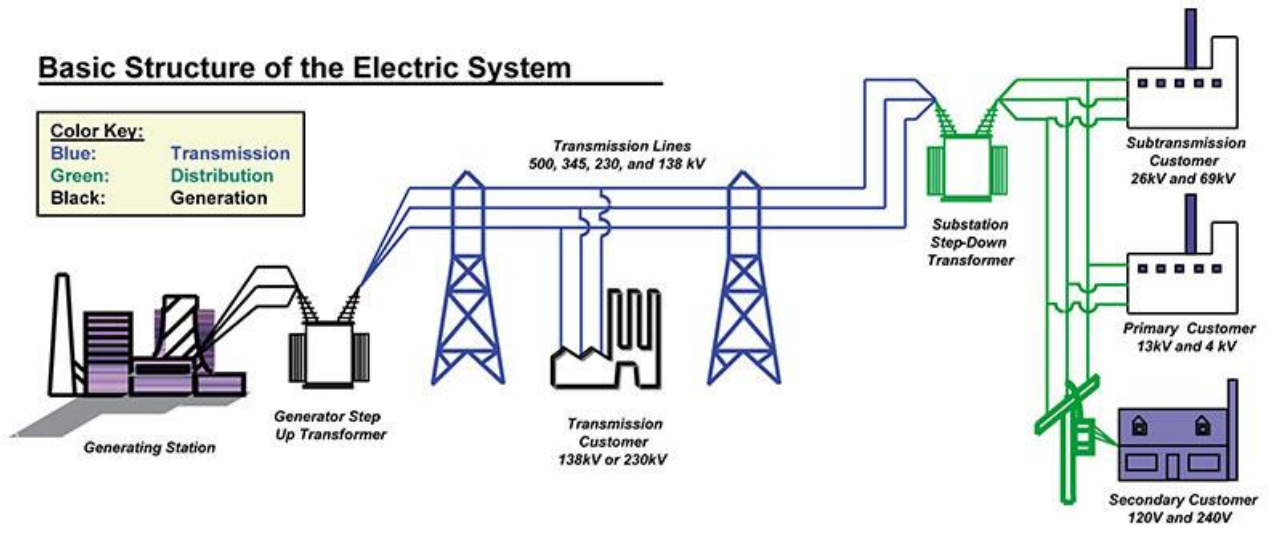
« Le sujet central pour le développement de l'Afrique, c'est l'énergie » (Jean-Louis Borloo, ministre FR 2002 - 2010)
L'urgence d'agir : "Si la croissance des pays africains passe de 5 % à 15 % par an, cela accroîtra la nôtre de 2 %. L'Afrique est, pour l'Europe en particulier, un relais de croissance formidable."

Traditional power grid and future smart grid:
paradigm change - from linear to more complex power generation

Today

Traditional centralized model of linear power generation and delivery through limited market or monopoly conditions

Linear : from "generation"
= > to "transmission"
=> to "distribution"

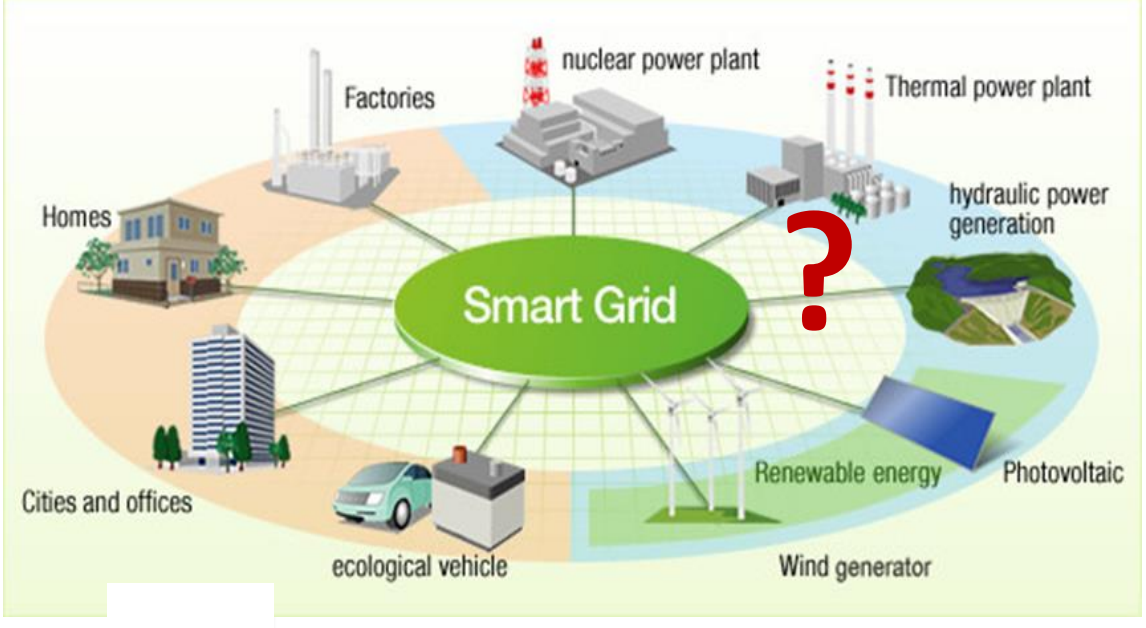


Energy (a primary driver) including electricity (reliable 24/7/365)

Tomorrow ?

A more diverse, dynamic and complex system with multiple actors and multilayered energy, information and money flows ?

Complex system with paradigm change :
from "supply follows load"
to "load follows supply"
(users become "prosumers"
= PROducer - conSUMER)



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Africa (and EU): demography (3 megacities)

How Africa meets the energy needs of a young, fast growing and increasingly urban population is crucial for the continent's – and the world's – economic and energy future.

Africa (54 countries) ranks number 2 among regions of the world (roughly equivalent to "continents"), ordered by population (1.34 billion people) and by land area (30.37 million sq km)

- **In 2018, Africa's population is 17 % of the world's population. The population density is 45 per sq km.**
- **The median age in Africa is 20 years while children under age 15 accounted for 41% of the population.**

According to UN estimates, the population of Africa may reach 2.5 billion by 2050 (about 26% of the world's total).

Almost 40 % of the population is urban (540 million people)

=> that includes an additional 500 million people who are expected to live in areas requiring some form of cooling.

*** Africa already has three megacities (i.e. > 10 million people): two in SSA (Kinshasa and Lagos) and another in North Africa (Cairo). There are another five large cities on the continent with a population of between 5 and 10 million each: Alexandria, Dar es Salaam, Johannesburg, Khartoum and Luanda (UNDESA). Of these, Dar es Salaam and Luanda are likely to become SSA's next megacities.**

=> profound implications for the energy sector (incl. air quality, etc)

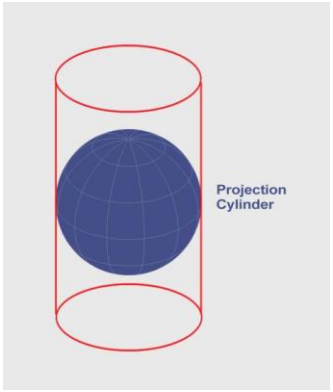
European Union (27 Member States)

- ***Population is 445 million people (compared to 1 340)***
- ***population density is 105 per sq km (compared to 45) ;***
- ***median age is 42 years (compared to 20)***
- ***land area is 4.08 million sq km (compared to 30.37)***

AFRICAN DEVELOPMENT BANK GROUP

Source : the World Bank's work in Africa https://www.worldbank.org/en/region/afr/overview and African Development Bank Group - https://www.afdb.org/en and AfDB 2020 "Energy Week" and "Energy & Power" - https://www.afdb.org/en/news-keywords/energy-power

The True Size of Africa
+ economy (GDP)



NB : Distance from Cape Town to Algiers = 8000 km (air line)

Mapped: The True Size of Africa

Despite the common perception that Africa is a large landmass, it's still one that is vastly underestimated by most casual map viewers.

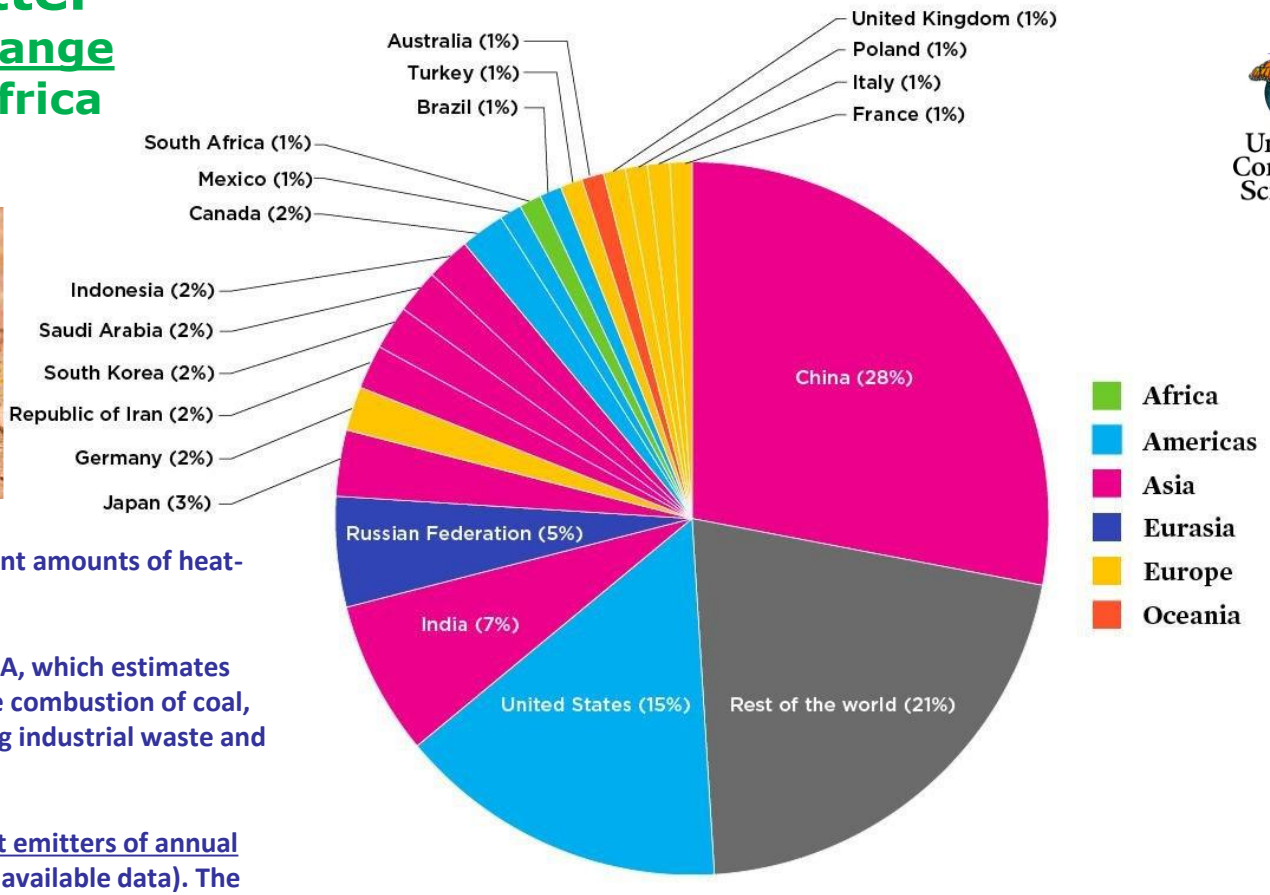
The reason for this is that the familiar Mercator (cylinder) map projection tends to distort our geographical view of the world in a crucial way — one that often leads to misconceptions about the relative sizes of both countries and continents.

The African continent has a land area of 30.37 million sq km — enough to fit in the U.S., China, India, Japan, Mexico, and many European nations, combined. *NB EU = 4.08 million sq km*

Source : "Mapped: Visualizing the True Size of Africa", Febr 2020 - https://www.visualcapitalist.com/map-true-size-of-africa/

Economy - Africa is the world's poorest and most underdeveloped continent with a continental Gross Domestic Product (GDP) that accounts for just 2.4 % of global GDP. GDP in U.S. dollars per capita in 2018 : 1 900 in Africa compared to 46 600 in developed economies (e.g. Belgium) ... but it is now the world's second-fastest growing economy.
Source : "UN World Economic Situation and Prospects 2019" - https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/WESP2019_BOOK-CH3-3-africa-en.pdf

Not a major emitter (4 %), but climate change matters greatly for Africa



Union of Concerned Scientists

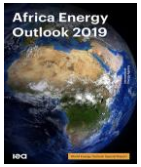
The world's countries emit vastly different amounts of heat-trapping gases into the atmosphere.

The chart shows data compiled by the IEA, which estimates carbon dioxide (CO2) emissions from the combustion of coal, natural gas, oil, and other fuels, including industrial waste and non-renewable municipal waste.

Picture right : we rank the top 20 highest emitters of annual carbon dioxide in 2018 (the most recent available data). The picture that emerges from these figures is one where—in general—developed countries and major emerging economy nations lead in total carbon dioxide emissions.

Africa accounts for a relatively small, but nonetheless growing share of the world's CO_2 emissions. In 2018, the continent accounted for 3.7% of global energy-related CO_2 emissions or around 1.2 gigatonnes (Gt) CO_2. North Africa accounted for the largest share with 40% and South Africa accounted for 35%.

Source : "Each Country's Share of CO2 Emissions", Union of Concerned Scientists, Aug 12, 2020 - https://www.ucsusa.org/resources/each-countrys-share-co2-emissions

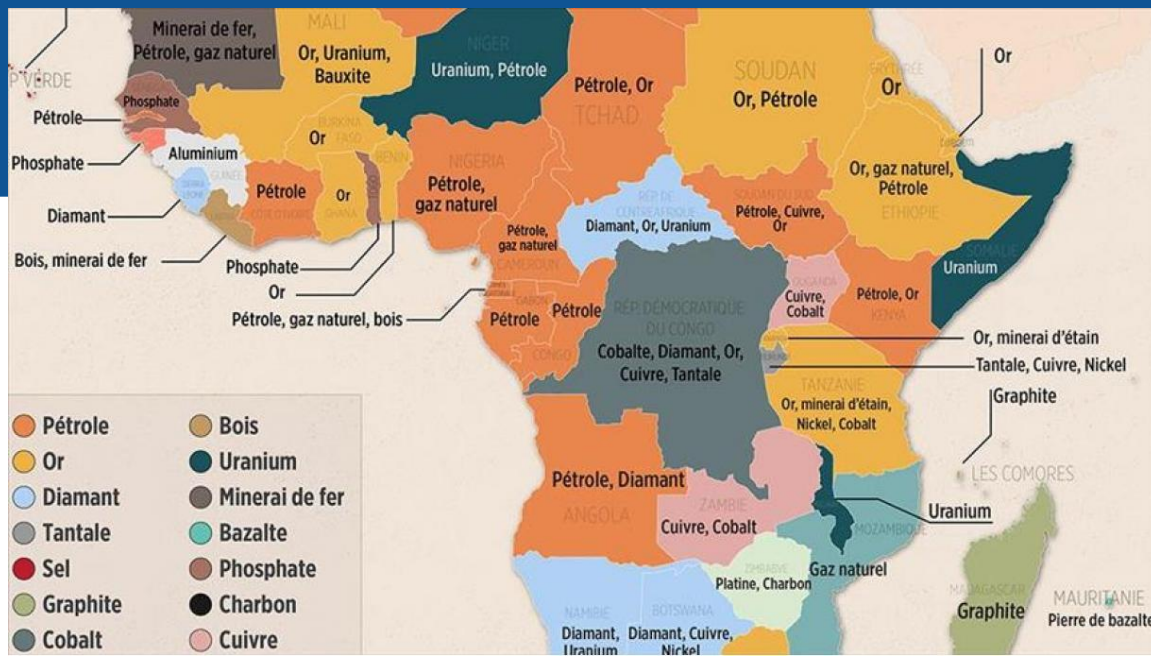


- Achieving the outcomes of the IEA Africa Case would be neither energy-intensive nor emissions-intensive thanks to stronger roles of energy efficiency and clean energies (source : Africa Energy Outlook 2019).

- Although not a major emitter, Africa is in the front line for the effects of a changing climate. Energy infrastructure planning must be climate-resilient.

NB Cumulated energy-related CO2 emissions:
** 1890-2018 : 2 % in Africa and 98 % in rest of the world*
** 1890 – 2040 (Stated Policies) : 3 % in Africa and 97 % in rest of the world*

Africa (and EU) 1/2 :
oil, mineral and natural resources



Thanks to natural resource endowments and technology improvements, Africa could pursue a much less carbon-intensive development model than many other parts of the world have.

The challenges and opportunities differ widely across a diverse continent.

- ***But renewables, together with natural gas in many areas, are poised to lead Africa's energy consumption growth as the continent moves away from the traditional use of biomass that currently accounts for almost half of final energy consumption.***
- **Africa has approximately 30% of the earth's remaining mineral resources.**

The continent has the largest reserves of precious metals with over 20% of the gold reserves (mainly in Ghana and ZA), over 60% of the cobalt (in DRC), and 70% of the platinum reserves (in ZA).

- **Africa has the most extensive biomass burning in the world, yet only emits about 4% of the world's total carbon dioxide emissions.**

« Les pays africains possèdent une part importante des réserves mondiales de ressources naturelles » - Même si un développement notable est observé dans l'économie africaine grâce à l'exploitation des ressources naturelles, cela à très peu de retentissement sur le quotidien de la population (Source : Radio et Télévision de Turquie /TRT/ - 23.11.2020)
https://www.trt.net.tr/francais/economie/2017/07/30/les-pays-africains-possedent-une-part-importante-des-reserves-mondiales-de-ressources-naturelles-780120
See also : CIA The World Fact Book - https://www.cia.gov/the-world-factbook/countries/
and https://visual.ly/community/Infographics/economy/world-commodities-map-africa

Africa is rich in oil, mineral and natural resources
(Africa's enormous energy and agricultural potential is vastly untapped)

The natural resources in Africa are used practically in many industries and in many countries every day - https://www.miningafrica.net/natural-resources-in-africa/

European Union (27 Member States)

- ***Europe relies on foreign raw materials to power its green and digital future.***
- ***Now Europe wants to mine them at home. The EU plan in 2020 is to start mining in the EU itself, for battery-related raw materials such as lithium, nickel, cobalt, graphite, and manganese.***

NB : Coltan (short for columbite–tantalites) from which are extracted the elements niobium and tantalum. Tantalum from coltan is used to manufacture tantalum capacitors which are used for mobile phones, personal computers, automotive electronics, and cameras as well as in high-temperature alloys for jet engines (e.g. Airbus and the 787 Dreamliner). Le coltan est au cœur de la guerre en République démocratique du Congo depuis 2000, l'un des conflits les plus meurtriers depuis la Seconde Guerre mondiale avec plus de 5 millions de morts.

Africa map (2/2): minerals essential to modern energy transitions

Many of the minerals essential to modern energy transitions

Platinum-Group Metals (PGM):

- **Palladium for autocatalysts, electronics, dental and chemical reagents (South Africa and Ethiopia) ;**
- **Platinum for jewelry and for autocatalysts (South Africa and Zimbabwe) ;**
- **Rhodium for autocatalysts (South Africa an Zimbabwe) ;**
- **Iridium ; Osmium ; Ruthenium (South Africa**

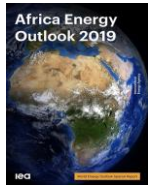
Cobalt is primarily used in lithium-ion batterie and in the manufacture of magnetic, corrosion/wear-resistant and high-strength alloys (e.g. for aircraft engine parts). (*"Le cobalt est le nouveau pétrole »)*

Cobalt is essential to many living creatures and is a component of vitamin B12.

Cobalt-60 is a commercially important radioisotope, used as a radioactive tracer and for the production of high-energy gamma rays.

For many African countries, mineral exploration and production constitute significant parts of their economies and remain keys to economic growth. Africa is richly endowed with mineral reserves and ranks first or second in quantity of world reserves of platinum-group metals (PGM) and cobalt, as well as bauxite, industrial diamond, phosphate rock, vermiculite, and zirconium. Many other minerals are present in quantity.

The 2012 share of world production from African soil was platinum 70% and cobalt 60%, followed by uranium 18% and copper 9%; and also chromite 38%; gold 20%; bauxite 7%; aluminium 5%; iron ore 2% (and steel 1%); lead (Pb) 2%; manganese 38%; zinc 1%; natural diamond 56%; graphite 2%; phosphate rock 21%; coal 4%; mineral fuels (including coal) and petroleum 47%.



Source : https://en.wikipedia.org/wiki/Mineral_industry_of_Africa and https://www.miningafrica.net/mining-countries-africa/

RD Congo, un énorme potentiel de matières premières "un véritable scandale géologique" (56% du tableau de Mendeleïev)

ÉLÉMENTS PRÉSENTS DANS LES MINÉRAUX DE LA RDC

A : nombre de masse
Z : numéro atomique
M : masse atomique en g.mol^{-1}

$^{A}_{Z}X$
Nom
M

RICHESSES NATURELLES DE LA RDC

Semaine de la Science et des Technologies

11 et 12 avril 2014, Institut de la Gombe

I	II										III	IV	V	VI	VII	VIII
^{1}H Hydrogène 1,01																^{4}He Hélium
^{7}Li Lithium 6,94	^{9}Be Béryllium 9,01										^{11}B Bore 10,8	^{12}C Carbone 12,0	^{14}N Azote 14,0	^{16}O Oxygène 16,0	^{19}F Fluor 19,0	^{20}Ne Néon 20,2
^{23}Na Sodium 23,0	^{24}Mg Magnésium 24,3										^{27}Al Aluminium 27,0	^{28}Si Silicium 28,1	^{31}P Phosphore 31,0	^{32}S Soufre 32,1	^{35}Cl Chlore 35,5	^{40}Ar Argon 39,9
^{39}K Potassium 39,1	^{40}Ca Calcium 40,1	^{45}Sc Scandium 45,0	^{48}Ti Titane 47,9	^{51}V Vanadium 50,9	^{52}Cr Chrome 52,0	^{55}Mn Manganèse 54,9	^{56}Fe Fer 55,8	^{59}Co Cobalt 58,9	^{58}Ni Nickel 58,7	^{63}Cu Cuivre 63,5	^{64}Zn Zinc 65,4	^{69}Ga Gallium 69,7	^{74}Ge Germanium 72,6	^{75}As Arsenic 74,9	^{80}Se Sélénium 79,0	^{79}Br Brome 79,9	^{84}Kr Krypton 83,6
^{85}Rb Rubidium 85,5	^{88}Sr Strontium 87,5	^{89}Y Yttrium 88,9	^{90}Zr Zirconium 91,2	^{93}Nb Niobium 92,9	^{98}Mo Molybdène 95,9	^{98}Tc Technétium 99,0	^{102}Ru Ruthénium 101,1	^{103}Rh Rhodium 102,9	^{106}Pd Palladium 106,4	^{107}Ag Argent 107,9	^{114}Cd Cadmium 112,4	^{115}In Indium 114,8	^{120}Sn Étain 118,7	^{121}Sb Antimoine 121,6	^{128}Te Tellure 127,5	^{127}I Iode 126,9	^{129}Xe Xénon 131,3
^{133}Cs Césium 132,9	^{138}Ba Baryum 137,3	57 à 71 lanthanides	^{180}Hf Hafnium 178,5	^{181}Ta Tantale 180,9	^{184}W Tungstène 183,9	^{186}Re Rhénium 186,2	^{192}Os Osmium 190,2	^{193}Ir Iridium 192,2	^{195}Pt Platine 195,1	^{197}Au Or 197,0	^{202}Hg Mercure 200,6	^{204}Tl Thallium 204,4	^{208}Pb Plomb 207,2	^{209}Bi Bismuth 209,0	^{210}Po Polonium 210	^{218}At Astate 210	^{222}Rn Radon 222
^{223}Fr Francium 223	^{226}Ra Radium 226,1	89 à 103 actinides															

Ra

lanthanides	^{139}La Lanthane 138,9	^{140}Ce Cérium 140,1	^{141}Pr Praséodyme 140,9	^{144}Nd Néodyme 144,2	^{145}Pm Prométhium 145	^{152}Sm Samarium 150,4	^{153}Eu Europium 152,0	^{158}Gd Gadolinium 157,3	^{159}Tb Terbium 158,9	^{163}Dy Dysprosium 162,5	^{165}Ho Holmium 164,9	^{166}Er Erbium 167,8	^{169}Tm Thulium 168,9	^{174}Yb Ytterbium 173,0	^{175}Lu Lutétium 176,0
actinides	^{227}Ac Actinium 227	^{232}Th Thorium 232,0	^{231}Pa Protactinium 231	^{238}U Uranium 238,0	^{237}Np Neptunium 237	^{242}Pu Plutonium 242	^{243}Am Américium 243	^{247}Cm Curium 247	^{247}Bk Berkélium 247	^{249}Cf Californium 249	^{254}Es Einsteinium 254	^{255}Fm fermium 255	^{256}Md Mendélévium 256	^{254}No Nobélium 254	^{257}Lw Lawrencium 257

Tous les métaux mentionnés dans le célèbre «tableau des éléments chimiques» du russe Mendeleïev se trouvent bel bien dans le sous sol de la République Démocratique du Congo (RDC).

C'est « un véritable scandale géologique » comme s'écrièrent les géologues belges au début des années 1900 (découvertes successives de cuivre, plomb, fer, or, platine, diamant, étain, charbon, cobalt, radium /1920-1940/, uranium, zinc, cadmium, germanium, manganèse, etc).

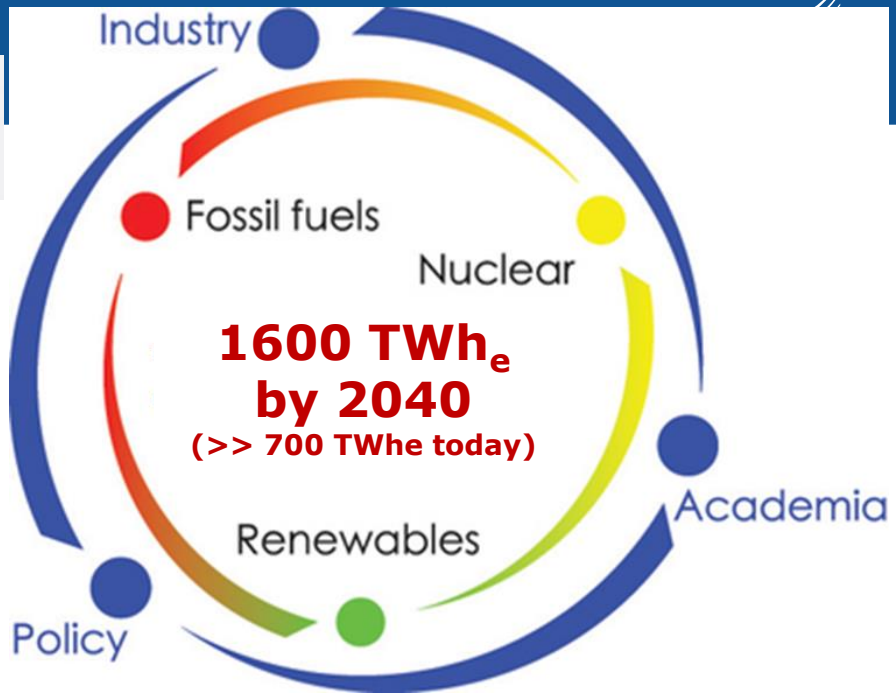
« Saviez-vous que près de 56% des éléments chimiques du tableau périodique de Mendeleïev se retrouvent sous forme de richesses naturelles en RDC ? Il n'y a probablement que la Russie qui fait mieux. Le tableau ci-joint, présenté lors de la première édition de la Semaine de la Science et des Technologies de Kinshasa en décembre 2014, reprend les éléments du tableau de Mendeleïev présents en RDC. »
Raissa Malu, Professeure de sciences, Ambassadrice du Next Einstein Forum (https://www.nexteinstein.org/).

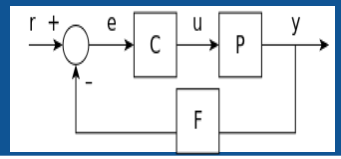
Source :
https://www.facebook.com/semainedelasciencerdc/photos/a.685820258116590.1073741827.685419751489974/860498713982076/?type=1&theater
* **African shapers** - https://africanshapers.com/raissa-malu-les-stim-ne-sont-pas-plus-difficiles-que-les-langues-leconomie-ou-les-sciences-humaines/

African Shapers

Africa SCIENCE WEEK
NEXT EINSTEIN FORUM

Africa in 2018 : total primary energy demand (21 x Belgium) including electricity demand (8 x)





In 2018, total primary energy demand (TPED) in Africa was more than 830 million tonnes of oil equivalent (Mtoe) /or 9650 TWh/.

IEA prospects in 2040 : TPED reaches 1350 Mtoe *//or 15700 TWh//* in the IEA "Stated Policies Scenario" (STEPS) and 1200 Mtoe /or 13950 TWh/ in the IEA "Africa Case" (AC)

NB : 2018 TPED in Africa = 21 times that in Belgium

including electricity demand in Africa which is today circa 700 terawatt-hours (TWhe), with the North African economies and South Africa accounting for over 70% of the total.

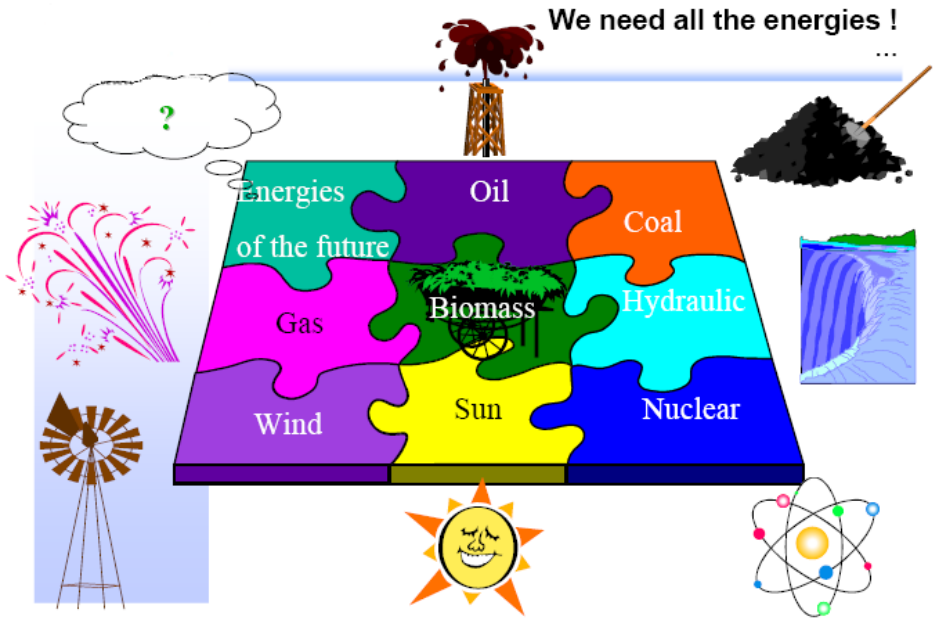
IEA prospects in 2040 : Electricity demand more than doubles in STEPS to over 1 600 TWhe, and reaches 2 300 TWhe in Africa Case (AC),

with most of the additional demand stemming from productive uses and emerging middle- and higher-income households.

NB : 2018 total electricity demand in Africa = 8 times that in Belgium.

NB : 2040 IEA prospect for total electricity demand in Africa = 15 times prospect for Belgium.

= > Electricity today accounts for less than 10 % of Africa's total final energy consumption.



Four power pools enabling SSA's transmission corridors - improve generation capacity and transmission infrastructure

SAPP, EAPP, CAPP and WAPP

Sub-Saharan Africa's power pools were established to improve generation capacity and transmission infrastructure for greater cross-border trade and ultimately address a cost-effective way of evacuating excess capacity between countries to offset peak demands.

NB The Comité Maghrébin de l'Electricité (COMELEC), also North African Power Pool (NAPP), is an association of five North African countries aiming at interconnecting the electricity grids of the member countries in order to facilitate the trading of electric power between the members.

NAPP is one of the five regional power pools in Africa (NAPP, SAPP, EAPP, CAPP and WAPP).

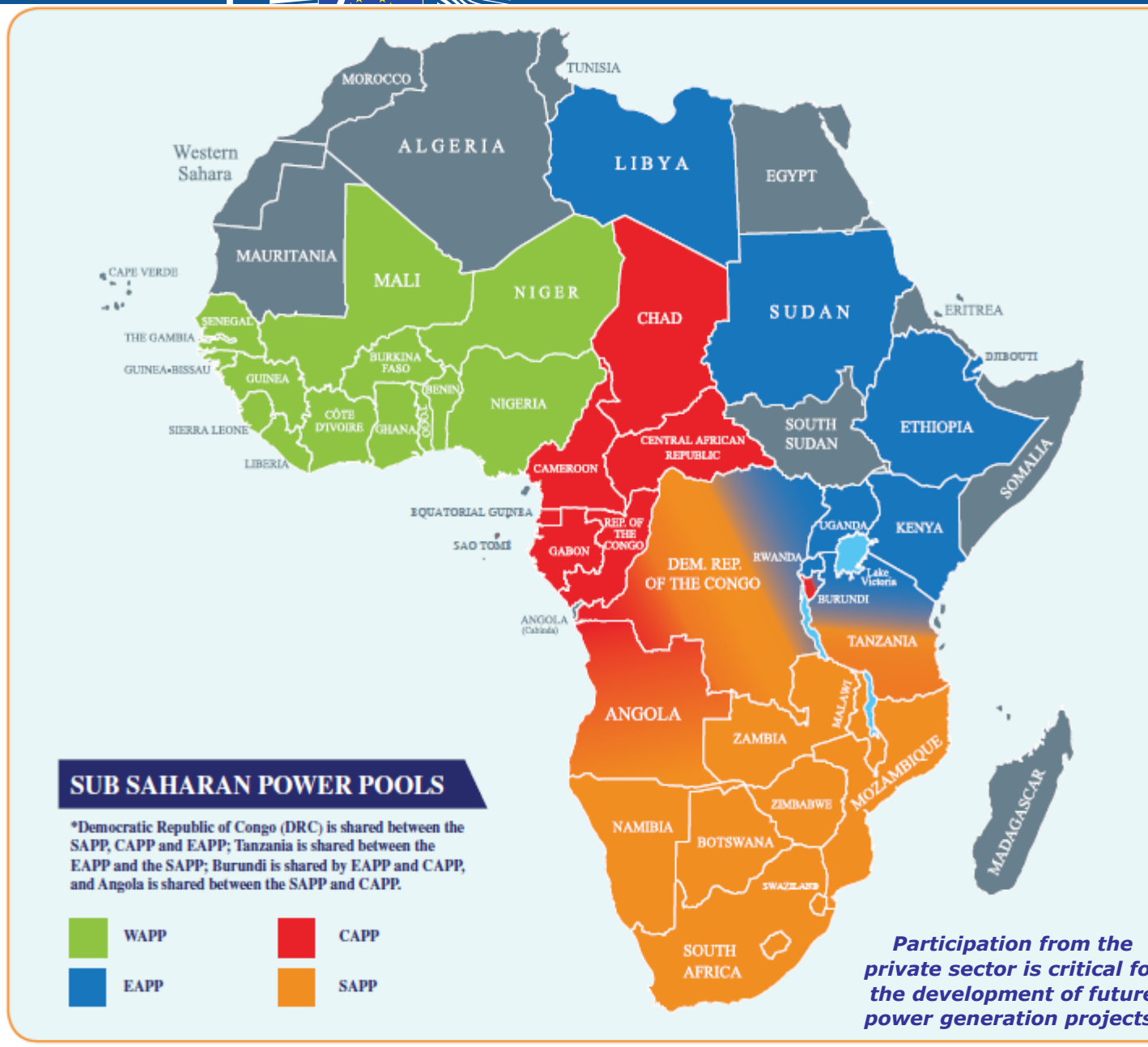
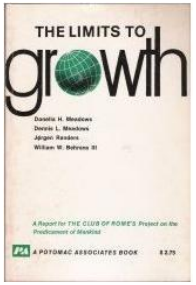


Table of contents

"Sustainable Development" (UN - Brundtland Report – 1987)

OUR COMMON FUTURE
THE WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT

SUSTAINABLE DEVELOPMENT GOALS



THE CLUB OF ROME

Sustainable Development

Original definition of sustainable development in the so-called Brundtland report :

- *[development that] meets the needs of the present without compromising the ability of future generations to meet their own needs;*
- *but sustainable development requires meeting the basic needs of all and extending to all the opportunity to fulfill their aspirations for a better life.*

On the first point, the report reads: «The concept of sustainable development does imply limits—not absolute limits but limitations imposed by the present state of technology and social organization on environmental resources and by the ability of the biosphere to absorb the effects of human activities.
But technology and social organization can both be managed and improved to make way for a new era of economic growth.»

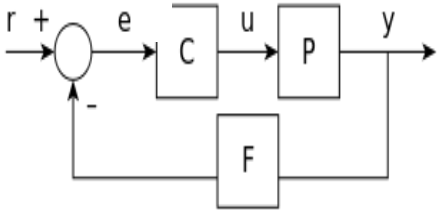
On the second point, the report makes clear that poverty eradication is as much part of sustainable development as the environmental part. Even stronger, «A world in which poverty is endemic will always be prone to ecological and other catastrophes.»

One could say that the first point addresses sustainability in time, i.e., intergenerational sustainability, whereas the second point emphasizes the importance of sustainability in space; i.e., more north-south equity and poverty.

1972 - mal traduit en français par l'interrogation « Halte à la croissance ? »

Ref : "Our Common Future", Gro Harlem Brundtland et al.

UN - World Commission on Environment and Development, Oxford University Press, NY 1987

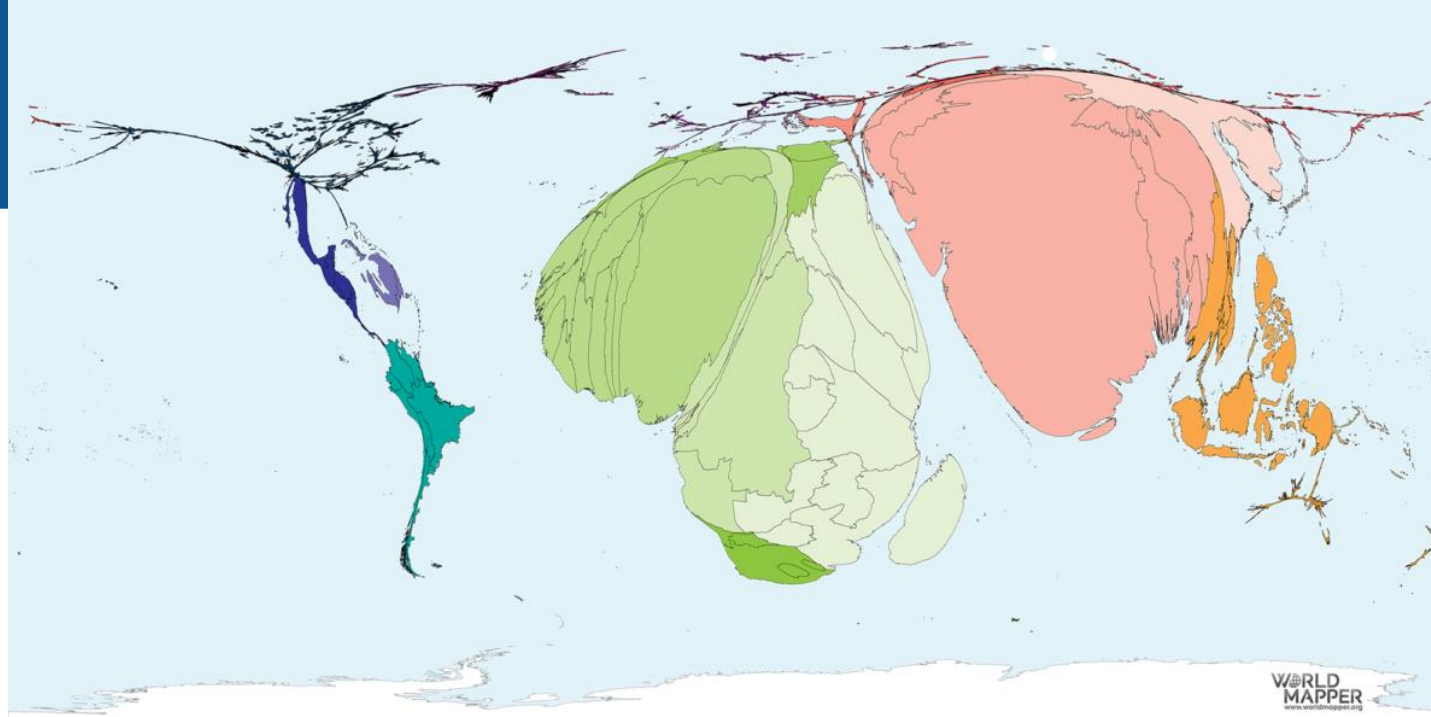


with distinct space & time horizons

ACCESS to "affordable, reliable, sustainable and modern energy for all"

This map (right) shows the proportion of all people on less than or equal to US$ 1.9 in purchasing power parity a day living there in 2016.

Half of the twenty poorest countries in the world are in sub-Saharan Africa (UNDP).



1 NO POVERTY

PROUDLY MADE IN AFRICA

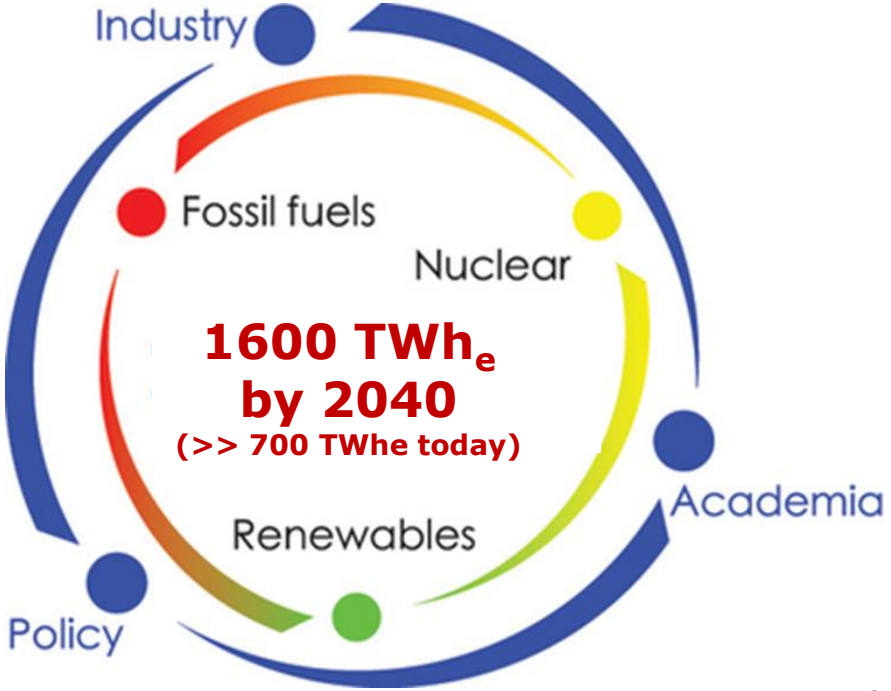
Une urgence

et des défis

7 AFFORDABLE AND CLEAN ENERGY

Integrating energy policy constraints

and energy value chain management



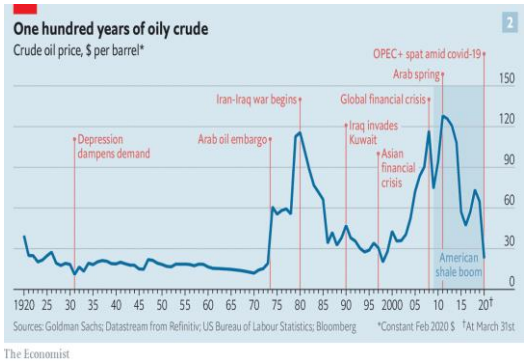
Integrating energy policy constraints and …

Energy Triangle

Integrating energy policy constraints

and energy value chain management

(2) Society
("leaving no one behind")



ENERGY MIX :

three constraints

(1) Economy
(performance)

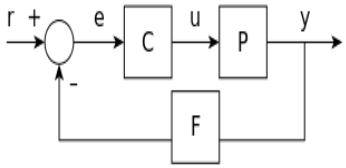
(3) Ecology
(footprint)

with distinct space & time horizons (e.g. economic goals (1) are local & urgent)

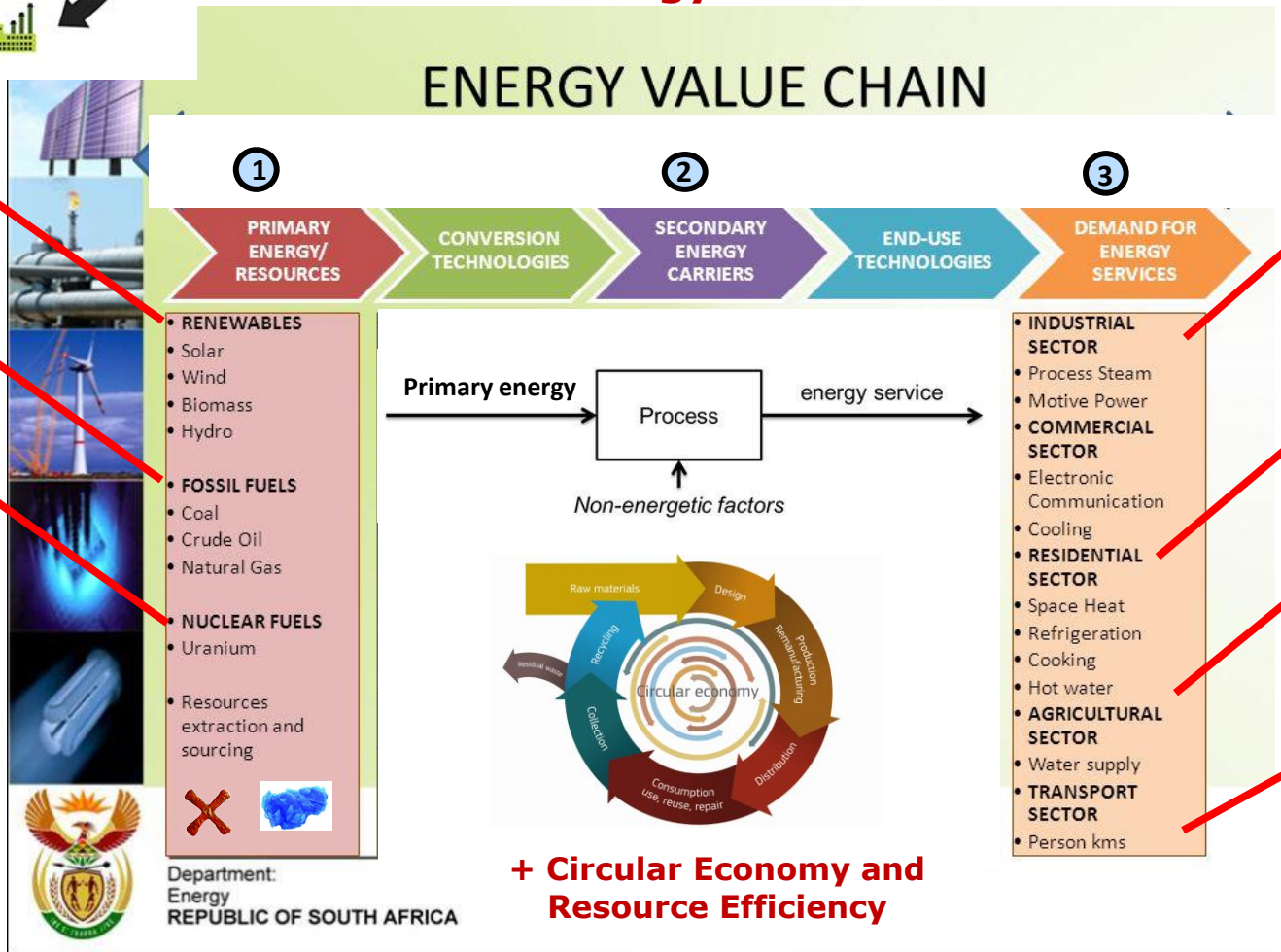
… energy value chain management (1/3)

7 AFFORDABLE AND CLEAN ENERGY

1 *Economy (performance)*



From primary energy sources to energy services



e.g. 20 years

e.g. 40 years

e.g. 60 years

+ Circular Economy and Resource Efficiency

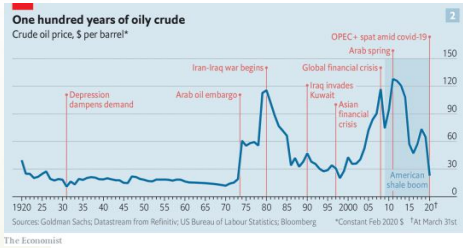
ENERGY VALUE CHAIN

Integrated energy planning seeks to consider all the key elements of the energy value-chain

Republic of South Africa

(1) Economy

PRIMARY ENERGY/ RESOURCES	CONVERSION TECHNOLOGIES	SECONDARY ENERGY CARRIERS	END-USE TECHNOLOGIES	DEMAND FOR ENERGY SERVICES
• **RENEWABLES** • Solar • Wind • Biomass • Hydro • **FOSSIL FUELS** • Coal • Crude Oil • Natural Gas • **NUCLEAR FUELS** • Uranium • Resources extraction and sourcing	• **POWER GENERATION** • Conventional Coal Plant • Nuclear • CCGT • OCGT • Solar • Wind • **FUEL PROCESSING** • Oil refineries • GTL • CTL • **REGASIFICATION**	• Electricity • Heat • Refined Petroleum Products **24/7/365**	• **INDUSTRY** • Steam boilers • Furnace • Machinery • **COMMERCE** • Air Conditioning • Light Bulbs • **HOUSEHOLDS** • Space Heaters • Refrigerators • Stoves • Geysers • **AGRICULTURE** • Irrigation pumps • **TRANSPORT** • Vehicles • Aircraft • Rail	• **INDUSTRIAL SECTOR** • Process Steam • Motive Power • **COMMERCIAL SECTOR** • Electronic Communication • Cooling • **RESIDENTIAL SECTOR** • Space Heat • Refrigeration • Cooking • Hot water • **AGRICULTURAL SECTOR** • Water supply • **TRANSPORT SECTOR** • Person kms



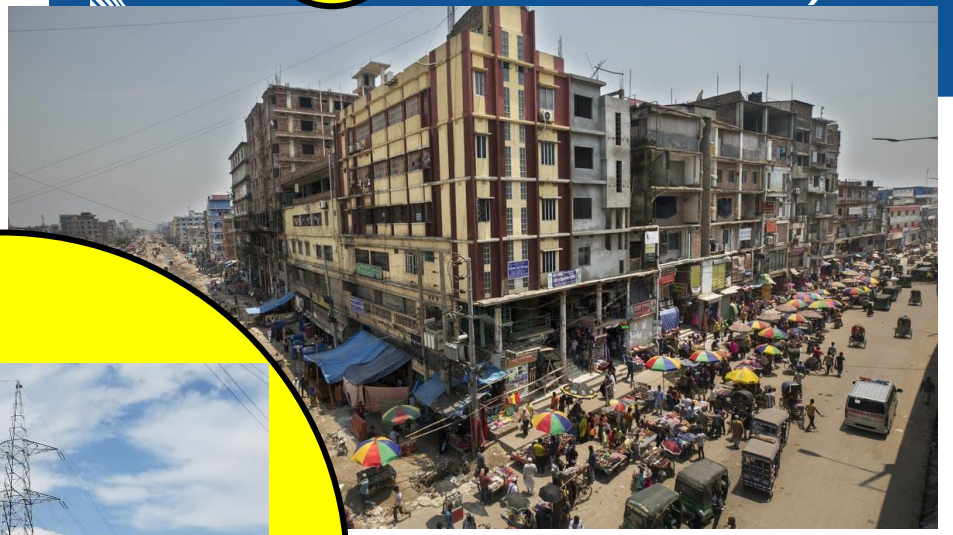
Department:
Energy
REPUBLIC OF SOUTH AFRICA

"The Energy Planning Framework considers all energy carriers, all technology options and all key national policy imperatives and proposes an energy mix and policy recommendations which ensures that the energy sector can help achieve these in the most optimal manner." (IEA)

Source : INTEGRATED ENERGY PLAN (IEP), Republic of South Africa, Dep't of Energy, 22 November 2016 - http://www.energy.gov.za/files/IEP/presentations/Integrated-Energy-Plan-22-Nov-2016.pdf and IEP Report, 20 August 2013 - http://slideplayer.com/slide/8307179/ - see also International Energy Agency (IEA, Paris) yearly "World Energy Outlook" projections

Despite its large and growing population, Africa accounts for a very small share of global energy sector investment. In 2018, around $100 billion was invested in the energy sector in Africa, or about 5.5% of the global total. Of this, $70 billion was invested in fossil fuels and $13 billion in renewables. Another $13 billion was spent on electricity networks.

… energy value chain management (2/3)



(1) Transportation - energy consumption for various transportation modes in kWh/p-km : airplane = 0.51 ; private car = 0.35 ; bus 20 passenger = 0.20 ; train = 0.077 (source : KTH Stockholm, 2006) (e.g. electricity in Belgium’s railway in 2018 : 1.6 TWhe)

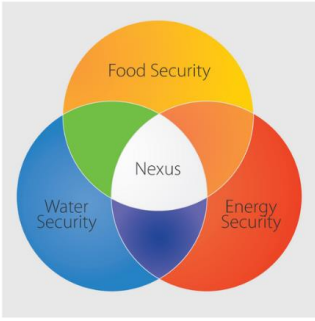
(2) Residential (e.g. space and water heating, space cooling, cooking, lighting and electrical appliances) – ww specific energy consumption = 110 kWh/sqm (ultimate goal = 15 - 30 at the passive house level)

(3) Industry : four major industrial subsectors: manufacturing (83%), mining (8%), construction (6%), and agriculture (3%) (% in the USA) (e.g. electricity consumption in Belgium’s chemistry in 2018 : 15 TWhe)

(4) Commercial and services (e.g. facility management /keeping spaces, structures and infrastructure in proper operating condition /; integrated heating, ventilation and air conditioning /HVAC/ systems ; possibly CHP cogeneration plants) - ww specific energy consumption = 120 kWh/sqm

”Energy, a primary driver for human development”

(2) Society



<u>The multiplier effect of energy access - Energy as an enabler</u>

<u>Energy</u> is an enabler to foster economic development, create jobs, facilitate education and health services, empower women, ensure <u>food</u> production and <u>water</u> supply and perform many other actions required for overall development of societies (<u>NEXUS</u>). The relationship of energy with "Human Development Index" (HDI) is well known and established.

SUSTAINABLE DEVELOPMENT GOALS
17 GOALS TO TRANSFORM OUR WORLD

UN Agenda-2030 (Sept 2015) : 17 “Sustainable Development Goals”
The proposed 17 “SDGs for people and planet” cut across all of the most critical <u>social</u>, <u>economic</u> and <u>environmental</u> issues of our time.

… energy value chain management (3/3)

3 *Ecology (footprint)*

The Electrification Situation

According to Power Africa, there is a long way to go to 100% electrification.

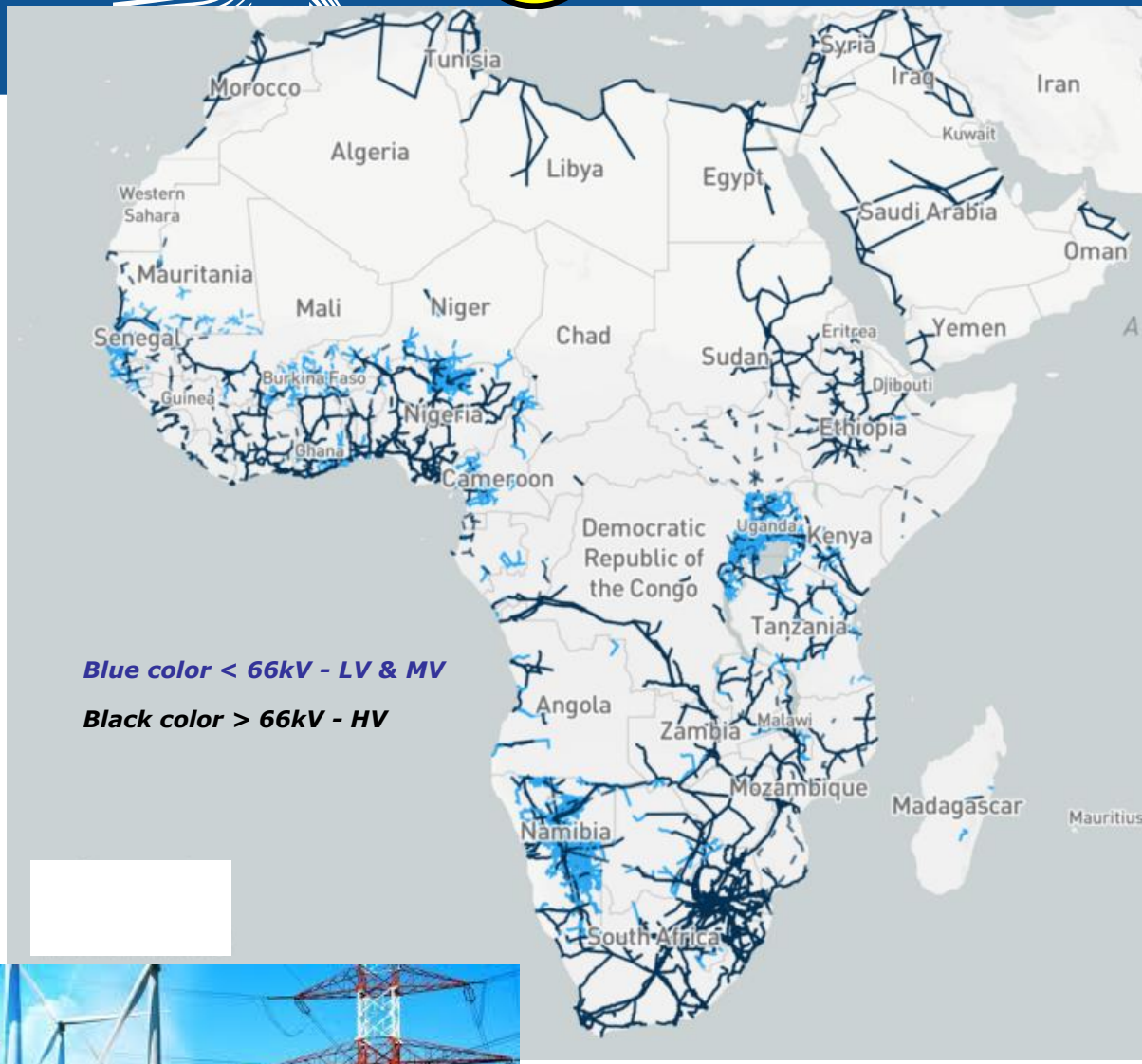
*** Kenya is only 65% electrified by the national grid, run by Kenya Power & Electric (KPLC); this percentage is significantly higher than neighboring countries…and still far from the Vision 2030 target of 100% of the population with electricity access**

*** In contrast, Nigeria (45%), Ethiopia (40%) and Rwanda (30%)**

*** South Africa takes the lead with 86% electrification**

*** At only 22%, Uganda has one of the lowest electrification rates in Africa.**

Source : "Electrifying Africa: A Brief Introduction to Solar & the Opportunities", Feb 7, 2019, I-DEV International - https://medium.com/i-dev-insights/electrifying-africa-a-brief-introduction-to-solar-the-opportunities-article-1-of-3-9604dc450301

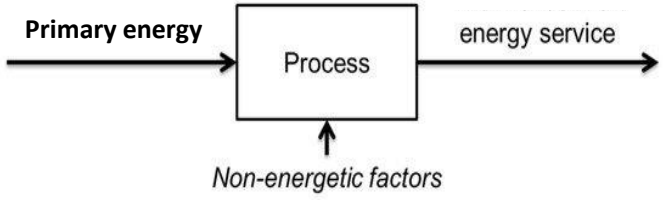


Blue color < 66kV - LV & MV

Black color > 66kV - HV

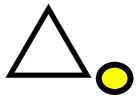
Source : Screenshot from the "Africa Electricity Grids Explorer", an innovation of the World Bank Group, mapping latest data on planned and existing electricity lines - http://africagrid.energydata.info/

Make a more informed decision, based on ecological footprint



In supplying society with energy, a balance must be struck between
(1) economy (performance, competitiveness),
(2) society ("leaving no one behind", security of supply)
(3) ecology (footprint, low-carbon and environment).

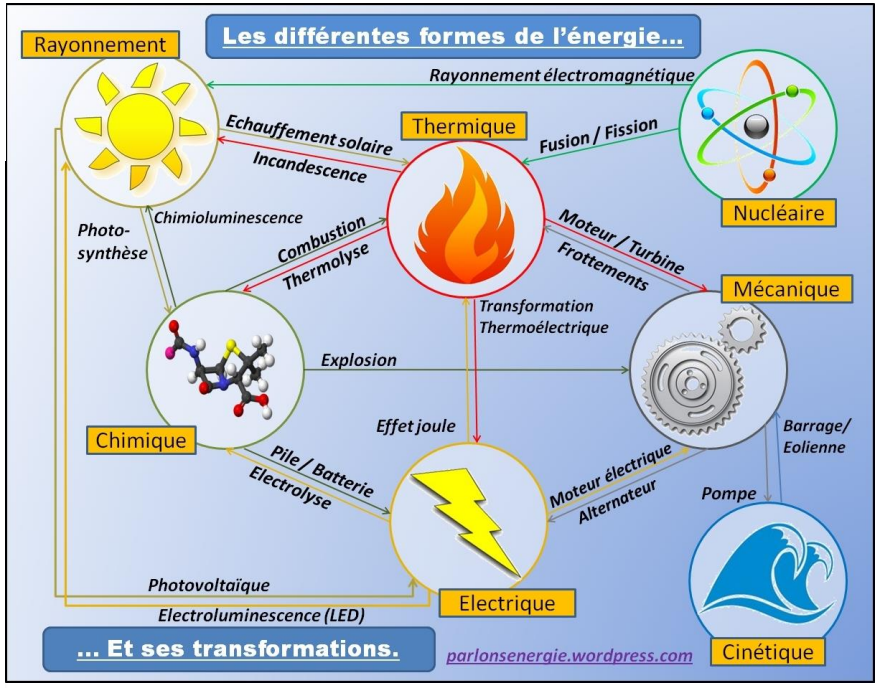
No single energy source is optimal from all dimensions (optimum within energy triangle).



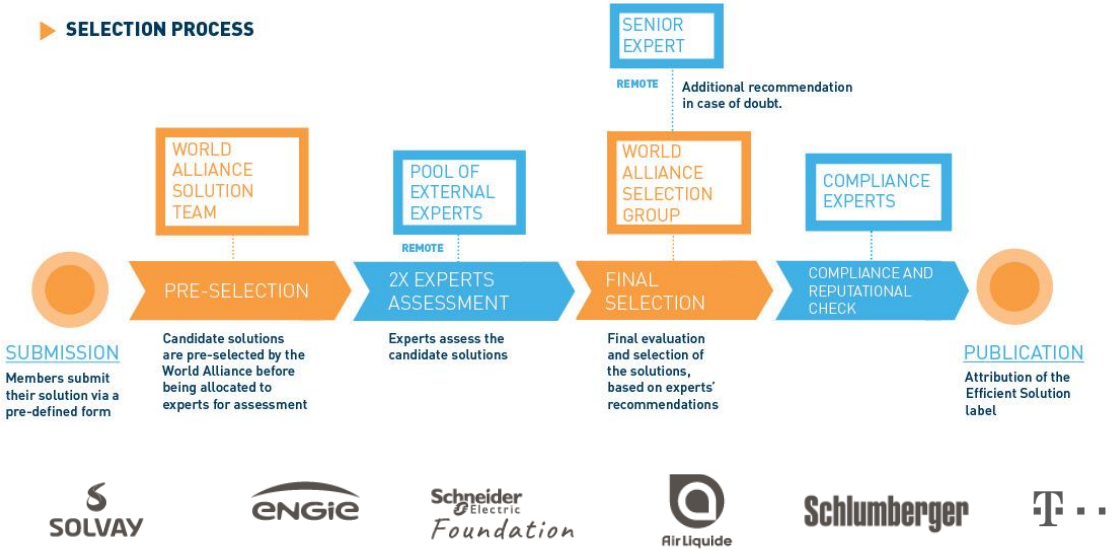
(3) Ecology

Figure ci-dessous - Différentes formes d' « énergies libres » (sept au total): gravitation ; cinétique ; thermique ; radiative ; chimique ; électrique ; nucléaire

Transformation de l'énergie d'une forme à l'autre
(loi de conservation de l'énergie – 1-er principe thermodynamique)



"Solar Impulse Efficient Solutions" : practical tools to reconcile ecology and economy



Bertrand Piccard (https://solarimpulse.com/)

A voice to encourage the implementation of solutions. A pioneering vision, considering ecology through the lens of profitability. As an influential voice on progress and sustainability, Bertrand Piccard is now working to develop collaborations with governments, institutions and large companies to give them practical tools to reconcile ecology and economy and prove that solving climate change – rather than an expensive problem – is a fantastic market opportunity.

See also : "Power up African green energy - introduce concrete solutions to Africa in support of Sustainable Development Goal 7" - United Nations Conference on Trade and Development – 3 December 2018 - https://unctad.org/news/solar-pioneer-piccard-and-unctad-power-african-green-energy

« Bertrand Piccard's Solar Impulse Foundation readies 1000+ profitable Solutions to fix climate change » – Lausanne, 13 april 2021 - https://solarimpulse.com/press/press-release/bertrand-piccard-s-solar-impulse-foundation-readies-1000-profitable-solutions-to-fix-climate-change#

For the first time a label proves the economic profitability of solutions that protect the environment. The Solar Impulse Foundation is selecting 1,000 solutions that protect the environment in a profitable way and awarding them the "Solar Impulse Efficient Solutions Label". https://solarimpulse.com/energy-crisis-solutions

Collaborating with independent experts and with renowned institutions, the World Alliance proposes to evaluate its members solutions free of charge. The "Solar Impulse Efficient Solutions" label will offer a competitive edge to innovators and a guarantee of quality to solution seekers (investors). WORLD ALLIANCE NETWORK - An ever-expanding network (3575 members including many in Africa) - https://solarimpulse.com/alliance-network

PROUDLY MADE IN AFRICA

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"Agenda 2063
the future that Africa wants"

In 2015, the Heads of State and Governments of the African Union adopted Agenda 2063.
It sets out a vision for "an integrated, prosperous and peaceful Africa, driven by its own citizens and representing a dynamic force in the international arena".
Closely linked to the United Nations "Sustainable Development Goals" (SDGs), it is an ambitious vision and one which will require significant political will if its goals are to be realised.

Agenda 2063, the continent's inclusive and sustainable vision for accelerated economic and industrial development

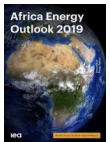
Agenda 2063 builds on previous Pan-African initiatives, but is distinct in many respects:

- it sets out clear goals, implementation plans and targets alongside elements of accountability;
- it identifies key flagship programmes as well as monitoring and review mechanisms;
- and it proposes a clear resource mobilisation strategy.

Successful delivery of Agenda 2063 is likely to depend on good governance, transparency and effective intra-African co-ordination, among other things.
It will also depend on resources being available to implement it and in particular on the mobilisation of private sector resources.

Energy-related targets contained in the framework for the first ten years include increasing access to electricity by at least 50% compared to 2013 levels and increasing the efficiency of household energy use by at least 30% before 2023.
As a reminder, the SDGs include full access to electricity and clean cooking by 2030 and a significant reduction in premature deaths related to pollution.

"Africa Energy Outlook 2019", World Energy Outlook special report, Nov 2019 - https://www.iea.org/reports/africa-energy-outlook-2019 and Press Release, Paris, 8 Nov. 2019 - https://www.iea.org/news/africas-energy-future-matters-for-the-world



"Sustainable Development Goals" (world) and "Agenda 2063" (Africa)

"Sustainable Development Goals" (17 SDGs)

1 End poverty in all its forms everywhere
2 End hunger, achieve food security and improve nutrition and promote sustainable agriculture
3 Ensure healthy lives and promote well-being for all at all ages
4 Ensure inclusive and equitable education and promote lifelong learning opportunities for all
5 Achieve gender equality and empower all women and girls
6 Ensure availability and sustainability management of water and sanitation for all
7 Ensure access to affordable, reliable, sustainable and modern energy for all
8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
10 Reduce inequality within and among countries
11 Make cities and human settlement inclusive, safe, resilient and sustainable
12 Ensure sustainable consumption and production patterns
13 Take urgent action to combat climate change and its impacts
14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development
15 Protect, restore & promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, & halt and reverse land degradation & halt biodiversity loss
16 Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
17 Strengthen the means of implementation and revitalize the global partnership for sustainable development

LEAVE NO ONE BEHIND

"Agenda 2063 Goals" (20 Goals)

1 A high standard of living, quality of life and wellbeing for all
2 Well educated citizens and skills revolution underpinned by science, technology & innovation
3 Healthy and well-nourished citizens
4 Transformed economies and job creation
5 Modern agriculture for increased productivity and production
6 Blue ocean economy for accelerated economic growth
7 Environmentally sustainable climate resilient economies and communities
8 United Africa (Federal or Confederate)
10 World class infrastructure criss-crosses Africa
11 Democratic values, practices, universal principles of human rights, justice & the rule of law entrenched
12 Capable institutions and transformed leadership in place at all levels
13 Peace, security and stability are preserved
16 African cultural renaissance is pre-eminent
17 Full gender equality in all spheres of life
18 Engaged and empowered youth and children
19 Africa as a major partner in global affairs and peaceful co-existence
20 Africa takes full responsibility for financing her development

Source : https://sdgcafrica.org/wp-content/uploads/2018/09/AFRICA-SDGS-2018-Report-WEB-V6-220818-1.pdf

Flagship projects of Agenda 2063 (1/2)

Agenda 2063
THE AFRICAN WE WANT

PROUDLY MADE IN AFRICA

The flagship projects of Agenda 2063 (15 in total) refers to key programmes and initiatives which have been identified as key to accelerating Africa's economic growth and development as well as promoting our common identity by celebrating our history and our vibrant culture. The Flagship projects encompass amongst others infrastructure, education, science, technology, arts and culture as well as initiatives to secure peace on the continent.

1. INTEGRATED HIGH SPEED TRAIN NETWORK
The project aims to connect all African capitals and commercial centres through an African High Speed Train Network thereby facilitating the movement of goods, factor services and people. The increased connectivity by rail also aims to reduce transport costs and relieve congestion of current and future systems.
Ref : The Department of infrastructure and energy - https://au.int/en/flagships/integrated-high-speed-train-network

2. FORMULATION OF AN AFRICAN COMMODITIES STRATEGY (raw materials, basic resources, etc)
The development of a continental commodities strategy is seen as key to enabling African countries to add value, extract higher rents from their commodities, integrate into the Global Value chains, and promote vertical and horizontal diversification anchored in value addition and local content development. The strategy aims to transform Africa from simply being a raw materials supplier for the rest of the world to a continent that actively uses its own resources to ensure the economic development of Africans.
Ref : The Department of Trade and Industry (DTI) - https://au.int/en/ti

6. IMPLEMENTATION OF THE GRAND INGA DAM PROJECT
The development of the Inga Dam is expected to generate 43,200 MW of power, to support current regional power pools and their combined service to transform Africa from traditional to modern sources of energy and ensure access of all Africans to clean and affordable electricity.
Ref : Department of Trade and Industry (DTI) - https://au.int/en/flagships/grand-inga-dam-project

"Le Grand Inga – 40 GW"

Hydro-electricity
(low-carbon, predictable and dispatchable … but …too big to be constructed ?)

"Le Grand Inga", méga-barrage, sur le deuxième fleuve du Monde, 40 GW (2 x le barrage chinois des Trois Gorges), coût total estimé à environ 80 milliards USD (including 10 billion USD, cost of the transmission lines needed to carry its power across Africa and potentially to Europe)

« Parmi toutes les énergies renouvelables, c'est l'hydro-électricité qui est la plus économique, car compétitive sans subventions couteuses, et sans problème d'intermittence ni de stockage pour les gestionnaires des réseaux électriques. Elle offre de plus des avantages uniques pour la gestion du réseau électrique (réglage de la fréquence et de la tension).
Par ailleurs les besoins en eau douce, en eau potable et en irrigation, vont aussi beaucoup augmenter, avec le changement climatique annoncé. …Les infrastructures de stockage d'eau sont considérées comme des outils indispensables à la fois pour le développement durable et pour l'adaptation au changement climatique.» Source : Henri Boyé, US-AID Electrification Advisor

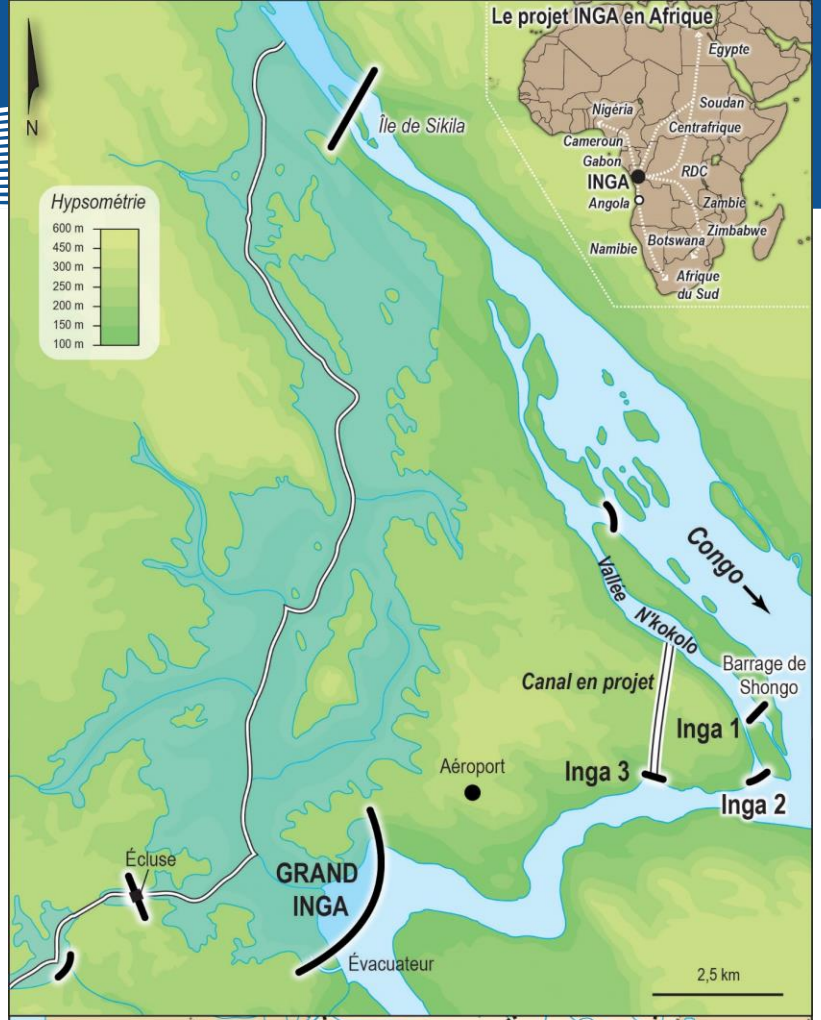
Voir également "RDC : L'hydrogène congolais, énergie de l'avenir pour l'UE. Mythe ou réalité ? (LLB 14 oct 2020) - https://afrique.lalibre.be/54836/rdc-lhydrogene-congolais-energie-de-lavenir-pour-lue-mythe-ou-realite/

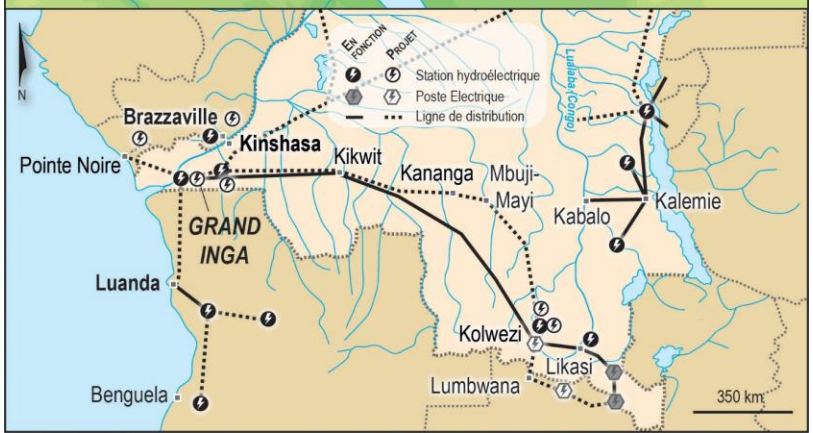
****

ABUNDANT RENEWABLE ENERGY RESOURCES
LOCATED CLOSE TO POTENTIAL DEMAND CLUSTERS

DRC has rich hydro resources distributed across the territory and some of this potential is in close proximity to extractive industries and population centers. The DRC hydrological technical potential is estimated to be around 100 GW among which 70 GW have already been specifically localized and most of this potential (64 GW) being concentrated in Bas Congo Province.
…… Unfortunately, the focus on expanding the Inga power plant has tended to delay the development of other hydro-power sites, especially smaller ones.

Source : "Increasing access to electricity in the Democratic Republic of Congo - Opportunities and challenges", Washington, DC - World Bank 2020 - http://documents1.worldbank.org/curated/en/743721586836810203/pdf/Increasing-Access-to-Electricity-in-the-Democratic-Republic-of-Congo-Opportunities-and-Challenges.pdf and https://www.petroleum-economist.com/articles/low-carbon-energy/energy-transition/2020/germany-eyes-drc-hydrogen-project





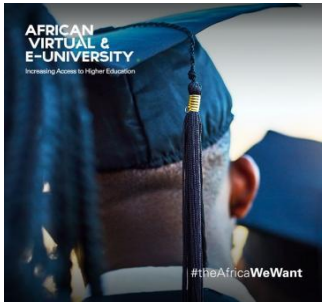
"Le Grand Inga et les projets de connexion internationale - https://dei.hypotheses.org/494
Lire aussi : "Inga III: Nous sommes en train de nous préparer pour que la première pierre soit posée par le président de la République en 2021", 16 novembre 2020 – Extrait : « Nous travaillons pour que l'énergie d'Inga III soit disponible (…) avant 2030. Inga III va générer 11.000 MW qui vont être repartis comme suit: 3.500 MW sont réservés à l'Afrique du Sud, 4000 MW reviendront à Aluminium corporation of China, une des plus grandes entreprises chinoises de production d'aluminium qui va produire, tout près d'Inga, dans le Bas-Fleuve, dans un premier temps, 1 million de tonnes d'aluminium pour un investissement de 6 milliards de dollars » - https://www.politico.cd/encontinu/2020/11/16/inga-iii-nous-sommes-en-train-de-nous-preparer-pour-que-la-premiere-pierre-soit-posee-par-le-oresident-de-la-republique-en-2021-bruno-kapandji.html/72218/

Flagship projects of Agenda 2063 (2/2)

incl. science, technology and innovation (STISA-2024)

10. THE PAN-AFRICAN E-NETWORK

This aims to put in place policies and strategies that will lead to transformative e-applications and services in Africa; especially the intra-African broad band terrestrial infrastructure; and cyber security, making the information revolution the basis for service delivery in the bio and nanotechnology industries and ultimately transform Africa into an e-Society. Ref : https://au.int/en/ie



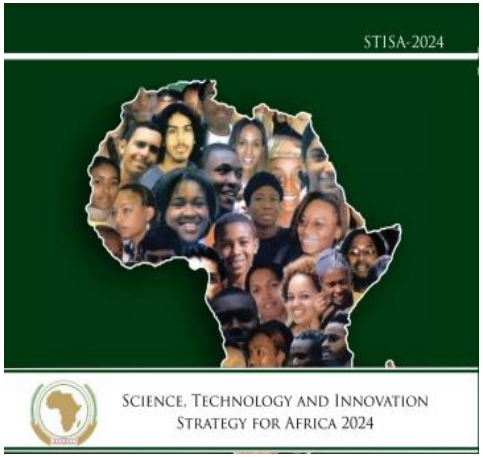
12. AN AFRICAN VIRTUAL AND E-UNIVERSITY

This project aims to use ICT based programmes to increase access to tertiary and continuing education in Africa by reaching large numbers of students and professionals in multiple sites simultaneously. It aims to develop relevant and high quality Open, Distance and eLearning resources to offer students guaranteed access to the University from anywhere in the world and anytime (24 hours a day, 7 days a week).
Ref : Human Resources, Science & Technology Department (HRST) : https://au.int/en/hrst

Source : Flagship Projects of Agenda 2063 (African Union) - https://au.int/agenda2063/flagship-projects

****

The STISA-2024 is the first of the ten-year incremental phasing strategies to respond to the demand for science, technology and innovation to impact across critical sectors such as agriculture, energy, environment, health, infrastructure development, mining, security and water among others.
The strategy is firmly anchored on six distinct priority areas that contribute to the achievement of the AU Vision.
These priority areas are: Eradication of Hunger and Achieving Food Security; Prevention and Control of Diseases; Communication (Physical and Intellectual Mobility); Protection of our Space; Live Together- Build the Society; and Wealth Creation.



"On the Wings of Innovation", the Science, Technology and Innovation Strategy for Africa (STISA-2024) – African Union

- adopted by the Heads of State and Government in June 2014 (56 pages) – with the support of regional institutions namely, the NEPAD Agency, the African Academy of Sciences, African Development Bank, International Council for Science Regional Office for Africa (ICSU-ROA), United Nations Economic Commission for Africa and United Nations Education Scientific and Cultural Organization.
https://au.int/sites/default/files/newsevents/workingdocuments/33178-wd-stisa-english_-_final.pdf

Backbone africain en fibre optique « Djoliba »

Djoliba ('fleuve Niger' en langue mandingue au Sénégal) est le nom définitif donné au projet BAFO – Backbone africain en fibre optique -, annoncé en novembre 2019, dont le consortium réunit SONATEL, Orange International Carriers, Orange Burkina Faso, Orange Mali et Orange Côte d'Ivoire. Orange est actuellement présent dans 18 pays d'Afrique et compte plus de 120 millions de clients.

How Djoliba will revolutionise the connectivity in Western Africa?

Djoliba se déploie à l'ouest du continent africain avec plus de 10 000 km de réseau terrestre à fibres optiques, couplé à 10 000 km de câble sous-marin. Il supporte des offres à très haut débit (jusqu'à 100 Gbit/s) et 99,99% de taux de disponibilité. Le backbone couvre 16 points de présence avec un maillage de 155 sites techniques, et relie 300 points de présence en Europe, en Amérique et en Asie.

Il s'agit du premier réseau unifié très haut débit permettant de fournir une connectivité sans couture, avec une meilleure disponibilité grâce à la redondance et la sécurisation du réseau, et une excellente qualité de service.

Dans un premier temps il couvre six pays, la Côte d'Ivoire, le Ghana, le Mali, le Burkina Faso, le Nigeria et le Sénégal, puis il s'étendra à la Guinée et au Liberia, pour servir près de 330 millions d'habitants. L'exploitation et la maintenance sont assurées par des équipes locales basées à Dakar.

Orange - opérateur de télécommunication présent dans 26 pays du monde - Novembre 2020 - https://www.orange.com/fr/newsroom/communiques/2020/orange-renforce-sa-position-de-leader-de-la-connectivite-en-afrique-0

See also : Submarine cable systems connecting West Coast of Africa to Asia, Europe and South America- https://www.submarinenetworks.com/euro-africa

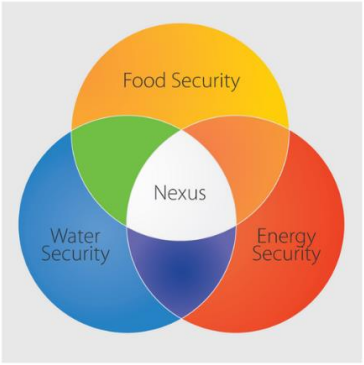
"Agenda 2063" - First Ten Year Implementation Plan (2013 – 2023) 1/3

Aspiration 1: A Prosperous Africa

African Union

The Seven Aspirations (https://au.int/agenda2063/aspirations)

- Aspiration 1: A prosperous Africa based on inclusive growth and sustainable development
- Aspiration 2: An integrated continent; politically united and based on the ideals of Pan-Africanism and the vision of Africa's Renaissance
- Aspiration 3: An Africa of good governance, democracy, respect for human rights, justice and the rule of law
- Aspiration 4: A peaceful and secure Africa
- Aspiration 5: An Africa with a strong cultural identity, common heritage, shared values and ethics
- Aspiration 6: An Africa, whose development is people-driven, relying on the potential of African people, especially its women and youth, and caring for children
- Aspiration 7: Africa as a strong, united, resilient and influential global player and partner.



Aspiration 1: A Prosperous Africa based on inclusive Growth and Sustainable Development:

- ending poverty, inequalities of income and opportunity;
- job creation, especially addressing youth unemployment;
- facing up to the challenges of rapid population growth and urbanization, improvement of habitats and access to basic necessities of life – water, sanitation, electricity;
- providing social security and protection;
- developing Africa's human and social capital (through an education and skills revolution emphasizing science and technology) and expanding access to quality health care services, particularly for women and girls;
- transforming Africa's economies through beneficiation from Africa's natural resources, manufacturing, industrialization and value addition, as well as raising productivity and competitiveness;
- radically transforming African agriculture to enable the continent to feed itself and be a major player as a net food exporter;
- exploiting the vast potential of Africa's blue/ocean economy;
- and finally putting in place measures to sustainably manage the continent's rich biodiversity, forests, land and waters and using mainly adaptive measures to address Climate change risks.

Source : "AGENDA 2063 - The Africa We Want - A Shared Strategic Framework for Inclusive Growth and Sustainable Development" – "First Ten Year Implementation Plan of Agenda 2063 (2013 – 2023)" - September 2015, AUC African Union Commission - https://au.int/en/agenda2063/ftyip and NEPAD (143 pages) - https://www.nepad.org/agenda-2063/publication/agenda-2063-first-ten-year-implementation-plan-2014-2023-0

"Agenda 2063" - First Ten Year Implementation Plan (2013 – 2023) 2/3

Aspiration 1 (cont'd): A Prosperous Africa

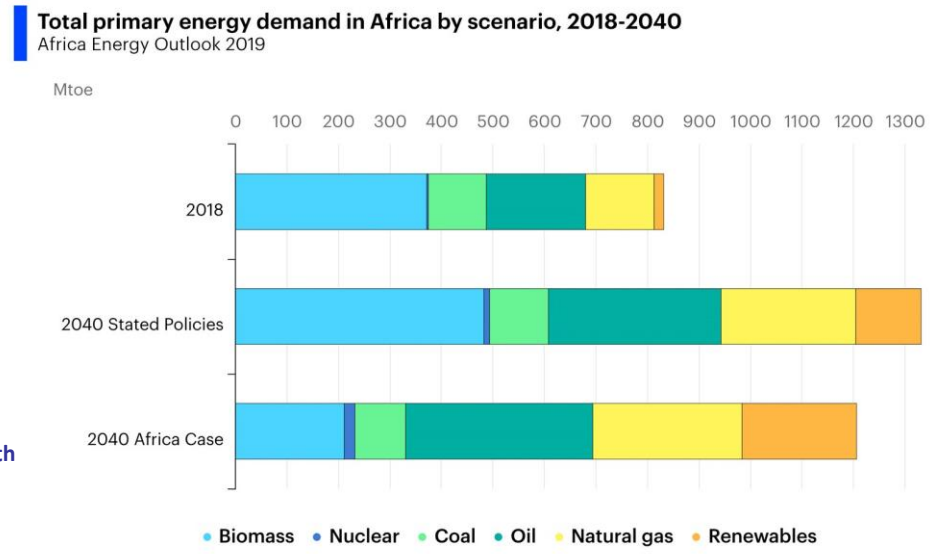


Figure - A major shift towards modern and efficient energy mix

Africa could be the first continent where renewables and gas play a prominent role in supporting a shift away from bioenergy and underpinning economic and industrial growth

Aspiration 1. A prosperous Africa based on inclusive growth and sustainable development

There are seven goals under this aspiration with seventeen priority areas.
The goals under this aspiration are numbered as goals 1-7 in the results framework.
……

Goal 7: Environmentally sustainable climate resilient economies and communities
(aligned with SDG 7 - Ensure access to affordable, reliable, sustainable and modern energy for all) ……

Priority area (3) : Climate Resilience and Natural Disasters and preparedness ……

2023 Target

4. Reduce proportion of fossil fuel in total energy production by at least 20%
5. All Cities meet the WHO's Ambient Air Quality Standards (AAQS) by 2025

……

Priority area (4) : Renewable Energy

2023 Target

1. Raise the share of renewable energy (wind, solar, hydro, bio and geothermal) in total energy production by at least 10%
2. At least 10% of all urban buildings are certified as energy smart
3. At least 15% of all urban mass transport operate on low renewable and low emissions fuel Indicative Strategies

Quantitative targets

To achieve the above targets, the following indicative strategies will have to be considered

1. Develop and implement policies, strategies and regulations to promote sustainable growth of the energy sector
2. Promote the development and dissemination of energy efficient technologies and use clean energy sources
3. Ensure financing of education, adoption and use of renewable energy technologies

"Agenda 2063" - First Ten Year Implementation Plan (2013 – 2023) 3/3

Aspiration 2: An integrated continent

Aspiration 2. An integrated continent, politically united and based on the ideals of Pan Africanism and vision of Africa's Renaissance

There are two goals under this aspiration with three priority areas.
The goals under this aspiration are numbered as goals 8-10 in the results framework……

Goal 10: World Class Infrastructure crisscrosses Africa

Priority Area (1) - Communications and Infrastructure Connectivity

2023 Target – Continental/Regional

1. Regional Power Pools fully operational by 2020
2. INGA Dam is commissioned by 2025

INGA Dam

1. ADEPI with mandate to develop and promote Grand Inga Dam is established in 2015; technical studies, preparation of tender documents and resource mobilization are also completed in the same year
2. Design work and field preparation is completed by 2016 with commencement of work in 2017
3. Commissioning is expected in 2024

Other PIDA Initiatives on Energy *(NB PIDA = Programme for Infrastructural Development in Africa)*

1. Increase in generation of electricity by 42,000 MW through hydro and renewable energy initiatives achieved by 2020
2. Additional 10,000 MW in partnership with Power Africa is attained by 2020
3. Feasibility Studies for PIDA 2021-2030 completed by 2020

Uganda–Tanzania East African Crude Oil Pipeline (EACOP) – TOTAL project
Lake Albert is an on-shore development in the north west of Uganda. The site has seen many significant discoveries and appraisals and is estimated to hold around 1.7 billion barrels of oil in place. The EACOP is a 1,443km, 24-inch diameter heated and buried crude oil pipeline that will start from Hoima in Uganda to Tanga in Tanzania. Albertine Graben Refinery Consortium (AGRC), is a consortium of international companies that have agreed with the government of Uganda, to invest in, construct, operate and co-own the Uganda Oil Refinery (60,000 b/d).

Quantitative targets

ANNEX 5: CRITICAL SUCCESS FACTORS, POTENTIAL RISKS AND MITIGATION STRATEGIES
…. 2. Risks, Threats and Mitigation Strategies …
…… External Shocks …Disruptive Technologies:

…For example in the area of oil, Africa still has the responsibility
- to provide power to homes, factories and offices;
- to provide petrol to the growing middle class that will be owning their own cars.

Africa can therefore in the medium term not be bothered by a declining demand for her oil by the rest of the world as a result of a replacement of oil through a disruptive technology.

Indicative Strategies

To achieve the above targets, the following indicative strategies have to be considered

National ……

7. Implement high capacity oil refinery and oil and gas pipeline strategy
8. Ensure provision of ICT infrastructure and alternative infrastructure roll out
9. Develop / implement renewable energy generation policy and increase generation capacity
10. Prepare/ implement geothermal projects to increase generation by 200% through GRMF
11. Implement Summit Decision on Africa Bio Energy Policy Framework and Guidelines and increase electricity generation in the bio-energy component in the African energy mix ……
13. Develop / implement policies for sustainable energy development / usage capacities, research and development and financing *(NB GRMF = Geothermal Risk Mitigation Facility)*

Continental / Regional

1. Promote Think Tanks for ICT and Energy …….
7. Develop/implement continental legal framework to promote integrated energy market ……

Table of contents

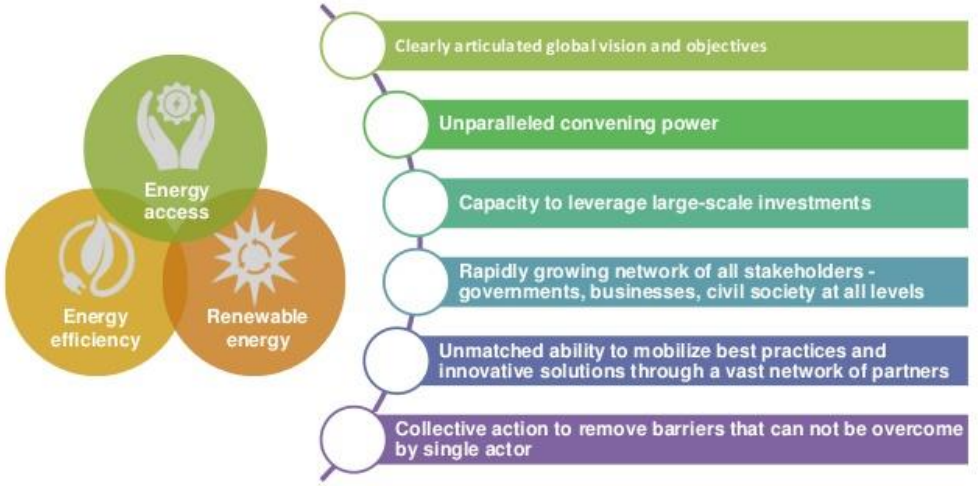
SDG-7 : Ensure universal access to affordable, reliable, and modern energy services 1/2

Goal 7:

Ensure access to affordable, reliable, sustainable and modern energy for all.

What makes this initiative different?

Sustainable Energy for ALL: 1 Goal & 3 Objectives



Importance of Sustainable Energy for Sustainable Development (2020)

- Globally, the number of people without access to electricity declined from 1.2 billion in 2010 to 789 million in 2018, however, an estimated 620 million people would still lack access in 2030, 85% of them – that is : 530 million people - in Sub-Saharan Africa.
- 2.8 billion people still (in 2018) burn wood, dung, coal and other traditional fuels inside their homes, mainly in Asia and Sub-Saharan Africa, resulting in 1.5 million deaths per year from breathing cooking smoke.
- Extensive energy use, especially in high-income countries, creates pollution, emits greenhouse gases and depletes non-renewable fossil fuels.
- Energy efficiency: global primary energy intensity improved by 1.7% in 2017. That is better than the 1.3% average rate of progress between 1990 and 2010 but still well below the original target rate of 2.6% and a marked slowdown from the previous two years.
- The scarcity of energy resources will grow ever greater - the share of renewable energy in the global energy mix is only inching up gradually.
- By 2050, when the planet reaches around 9 billion people, there will be 2 billion more people using more energy.

SDG-7 : Ensure universal access to affordable, reliable, and modern energy services 2/2

Goal 7:
Ensure access to affordable, reliable, sustainable and modern energy for all.

SDG-7 : Targets and Indicators

TARGETS

7.1 By 2030, ensure universal access to affordable, reliable, and modern energy services

7.2 By 2030, increase substantially the share of renewable energy in the global energy mix

7.3 By 2030, double the global rate of improvement in energy efficiency

7.A By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency, and advanced and cleaner fossil fuel technology, and promote investment in energy infrastructure and clean energy technology

7.B By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support

INDICATORS

7.1.1 Proportion of population with access to electricity

7.1.2 Proportion of population with primary reliance on clean fuels and technology for cooking

7.2.1 Renewable energy share in total final energy consumption

7.3.1 Energy intensity measured as a ratio of primary energy supply to gross domestic product

7.A.1 International financial flows to developing countries in support of clean energy research and development and renewable energy production, including in hybrid systems (NB : remember the original international commitment to mobilize up to 100 billion United States dollars per year starting in 2020 with a Financial Mechanism accountable to the COP – Paris Agreement 2015 – COP 21)

7.B.1 Investments in energy efficiency as a percentage of GDP and the amount of foreign direct investment in financial transfer for infrastructure and technology to sustainable development services

Source : https://sustainabledevelopment.un.org/sdg7

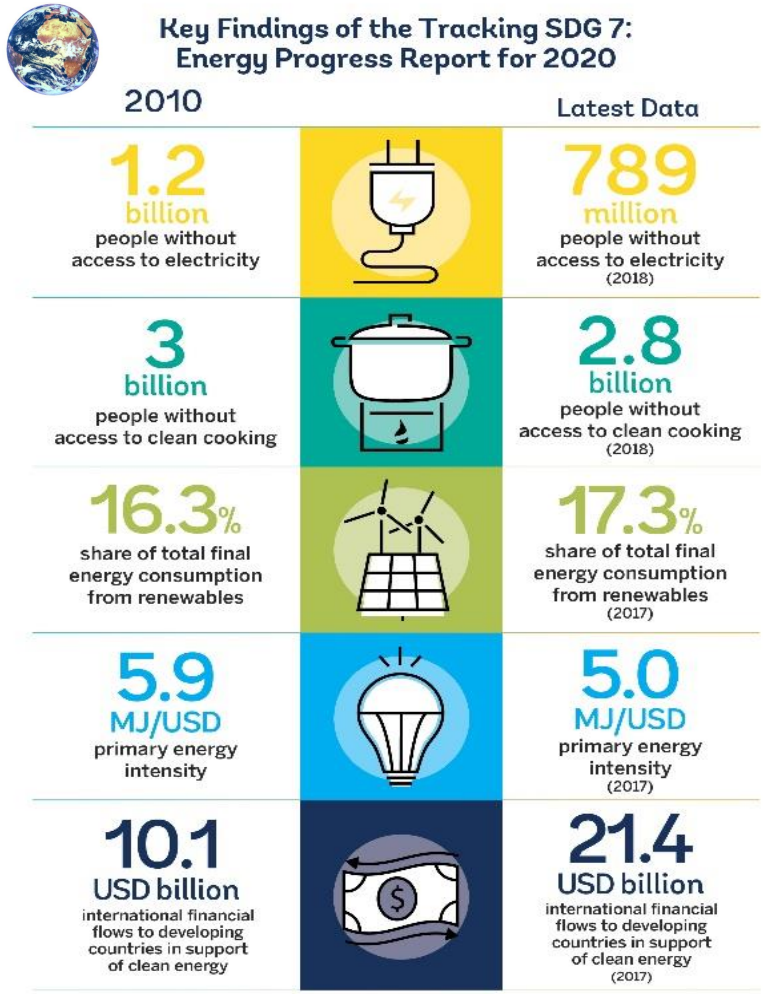
Source :"How data gaps affect global businesses in Africa", Kemdi Ebi, Versus Africa, CEO and Founder, October 16, 2019 - https://www.versus.africa/post/how-data-gaps-affect-global-businesses-in-africa-part-1-of-series

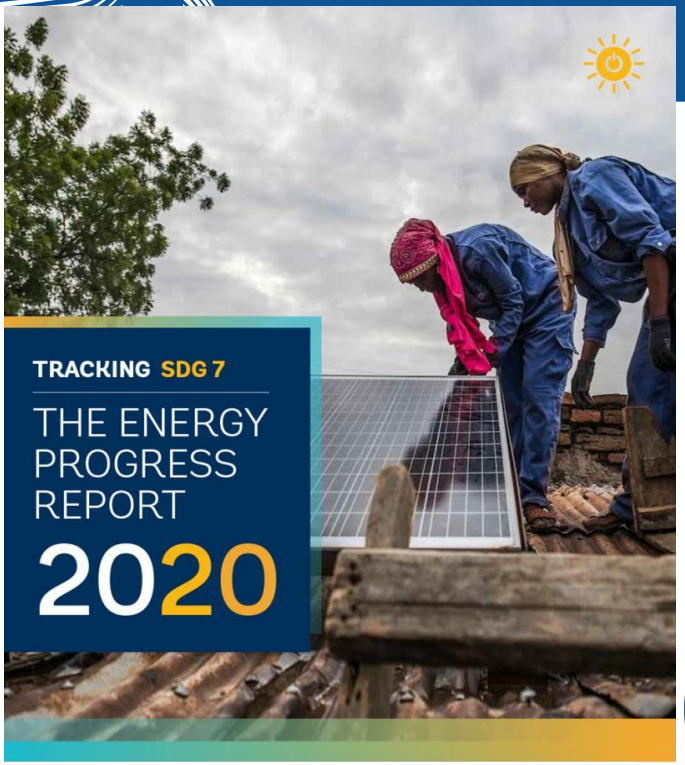
CHAPTER 6 - TRACKING SDG 7 PROGRESS ACROSS TARGETS: INDICATORS AND DATA
Comprehensive and accurate data are a prerequisite for making evidence-based decisions, monitoring trends, and tracking progress toward policy goals. In developed and developing countries alike, well-designed and appropriately resourced statistical systems play a fundamental role in monitoring progress toward Sustainable Development Goal 7 (SDG 7).
(Source : 2020 edition of "Tracking SDG 7: The Energy Progress Report" - p 145)

.....

Data gaps.
Weak statistical systems threaten achievement of SDGs in African countries in ensuring that no one is left behind, especially marginalized groups.
A review of the UN metadata revealed that data disaggregation is inadequate for vulnerable groups i.e. children, youth, persons with disabilities, people living with HIV, older persons, indigenous peoples, refugees, internally displaced persons and migrants.
In addition, some of the SDGs indicators still do not have a methodology. Despite limited updated data since the SDGs were adopted in 2015 globally, it is clear that the benefits of development are not equally shared among different sub-populations.

Tracking SDG 7 : Access to energy / Renewable energy / Energy efficiency / Access to clean cooking /International financial flows 1/2





International Energy Agency

United Nations Statistics Division

World Health Organization

IRENA
International Renewable Energy Agency

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

Source : The Energy Progress Report "Tracking SDG 7: The Energy Progress Report" 2020 - Summary (country results) in https://trackingsdg7.esmap.org/
by the Custodian Agencies – the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), the United Nations Statistics Division (UNSD), the World Bank, and the World Health Organization (WHO).
and website tracking - https://trackingsdg7.esmap.org/data/files/download-documents/tracking_sdg_7_2020-full_report_-_web_0.pdf and World Bank full report (6 chapters) May 2020 - https://www.worldbank.org/en/topic/energy/publication/the-tracking-sdg-7-report-the-last-decade-to-leave-no-one-behind

OUTLOOK FOR EFFICIENCY (SDG 7.3 - p 147). For purposes of SDG 7, energy efficiency is tracked as energy intensity, the ratio of total energy supply to economic output (MJ/USD). Recent world-wide estimates indicate that annual improvements in global energy intensity is low for 2018 (1.3 %) and 2019 (2.0 %), moving the world further from achieving SDG 7.3. Determining the total energy supply requires robust information on production of and trade in all types of energy. The supply information may be collected from administrative sources or by surveying the key energy suppliers. Reasonably good information on supplies of most energy sources is available in most countries, with the notable exception of supplies of solid biofuels in several countries. Thus, where solid biofuels are a significant part of the overall energy mix, estimates of total energy supply may be less certain.
To analyze sectoral progress in energy efficiency, countries are encouraged to monitor intensities at the end-use level, at least for priority sectors.
Examples of energy efficiency indicators include,

- **for transport, energy per passenger-kilometer (or tonne-kilometer for freight), by vehicle type;**
- **for buildings, energy for space heating and cooling as a function of area; and**
- **for industry, energy by quantity of physical production of a given good.**

Tracking SDG 7 : Access to energy / Renewable energy / Energy efficiency / Access to clean cooking / International financial flows 2/2

Goal 7:
Ensure access to affordable, reliable, sustainable and modern energy for all.

Focus on "Access to energy" (2020)

ACCESS TO ELECTRICITY

Tracking electrification efforts has been a complex process that has raised many challenges, the first being to devise a universally applicable and transparent approach. Measuring access to electricity requires tracking cumulative progress across interventions by a variety of players—governments, energy utilities, private sector companies, funding agencies, and development organizations at the national and international levels. Particularly challenging are the socioeconomic complexities of low-access countries. Measuring access also implicates a variety of technologies—not only national grids but mini grids and off-grid solutions, such as solar home systems. Finally, it requires assessing the number of people who actually benefit from these interventions, as well as the nature and degree of improvement they provide. But however difficult it may be, measuring access is critical to enable governments and practitioners to understand the current status of access, to identify bottlenecks to further electrification, and to achieve universal access goals in more efficient ways.

The definition and measurement of access to electricity should focus not only on the number of users benefitting from improved energy access, but also on the nature and degree of improvement across various attributes: capacity (adequacy), availability, reliability, affordability, quality, legality, health impact, safety, and convenience, among others. To provide this fuller picture, and to help prioritize investment and track progress, a set of international agencies joined together to produce a multi-tier framework (MTF) for household surveys. The MTF has been rolled out by national statistical offices and the World Bank in about 16 countries since 2016. Given the paucity of data for multi-tier metrics, however, standardized country-level surveys and supply-side data from governments and utilities must still be used to complement the MTF approach.

Additional methods of improving the tracking of access to electricity are:

- **(i) developing the capacity of national statistical offices to collect energy data (for example, through workshops organized by development partners on data collection and analysis for the energy sector);**
- **(ii) helping governments apply new technology and data analytics, since survey design can be challenging if the national census is outdated or if a census has never been conducted;**
- **(iii) improving and adapting the usability of existing datasets for energy practitioners;**
- **(iv) exploring the use of largescale open databases, such as satellite data.**

Most microdata (including household surveys, enterprise surveys, and agricultural surveys) contain information useful for energy practitioners and the ministries of energy. However, significant time and effort are usually required to extract from such sources data related to energy access, including socioeconomic status, electrification status, and village-level information. Data harmonization and standardization could help more end users access and use such datasets for project design and policy formulation.
(Source : 2020 edition of "Tracking SDG 7: The Energy Progress Report", p 146)

Africa-Europe Green Energy Initiative (March 2020)

EC Communication "Towards a comprehensive Strategy with Africa" (09.03.2020)

European Union
EXTERNAL ACTION

To strengthen the EU's strategic alliance with Africa, the European Commission and the High Representative of the Union are proposing to engage discussions with African partners in view of jointly defining at the upcoming EU-AU Summit a new comprehensive EU strategy with Africa that could be built on five partnerships:

1. **A partnership for green transition and energy access;**
2. **A partnership for digital transformation;**
3. **A partnership for sustainable growth and jobs;**
4. **A partnership for peace and governance; and**
5. **A partnership on migration and mobility.**

I. Partners for green transition and energy access

The fight against climate change and environmental degradation is this generation's defining task. Therefore, Europe and Africa are allies in the development of sustainable energy, transport solutions, farming, circular and blue economies which can underpin Africa's economic growth.
To achieve the Sustainable Development Goals, the EU and Africa alike need to opt for a low-carbon, resource efficient and climate-resilient future in line with the Paris Agreement. African countries are particularly vulnerable to climate change as it risks jeopardising ongoing progress on sustainable development……

I.1 Innovation is key to drive green transition.
Investments should therefore be geared towards strengthening scientific capacities in Africa by providing access and local adaptation to technologies. This will enable African countries to pursue a low-carbon, climate resilient and green growth trajectory, that avoids inefficient technologies and resists new investment in coal power generation, deploying instead new renewable energy sources and hydrogen production. Trade should also facilitate the adoption of innovative, sustainable business models and play a leading role to shape a climate-neutral future.

I.2 Africa is home to vast natural capital, unique biodiversity and ecosystems such as forests.
This offers significant opportunities for social and economic development and can contribute to lasting nature-based solutions to climate change mitigation and adaptation.
At the same time, there is a risk of overexploitation and depletion in addition to the threats posed by unsustainable fishing and management of water resources, pollution, desertification, and, in the case of coastal areas, rising sea levels.

I.3 A clean circular economy with sustainable and fair value chains will be key for the transition to a sustainable economic model.
This means that the value of products, materials and resources are maintained in the economy for as long as possible. It also implies that waste is minimised, while natural resources, wastewater and sanitation are managed in a sustainable way.
This requires enhanced cooperation between the EU and Africa on a responsible raw materials sector, secure and clean industrial value chains, respecting ambitious environmental and climate standards.

I.4 African cities have a key role to play in the green transition; the EU should support the development of green and smart urbanisation models and businesses in Africa, thereby tackling pollution.
To address the needs of its growing population and economy, Africa needs to double its energy supply by 2040 while ensuring access to electricity for 600 million people. This means putting the focus on resilient infrastructure, cleaner, more sustainable and secure energy access, maximising renewable energy sources, energy transition and efficiency across all value chains, as well as regional integration for energy security. The EU should build with Africa a strong partnership on sustainable energy for both rural and urban populations.

Source :"Africa-Europe Green Energy Initiative", laid out in the EC Communication 'Towards a comprehensive Strategy with Africa' JOIN(2020) 4 (09.03.2020) - https://ec.europa.eu/international-partnerships/system/files/communication-eu-africa-strategy-join-2020-4-final_en.pdf

EuropeAID - The EU is the largest donor in the world

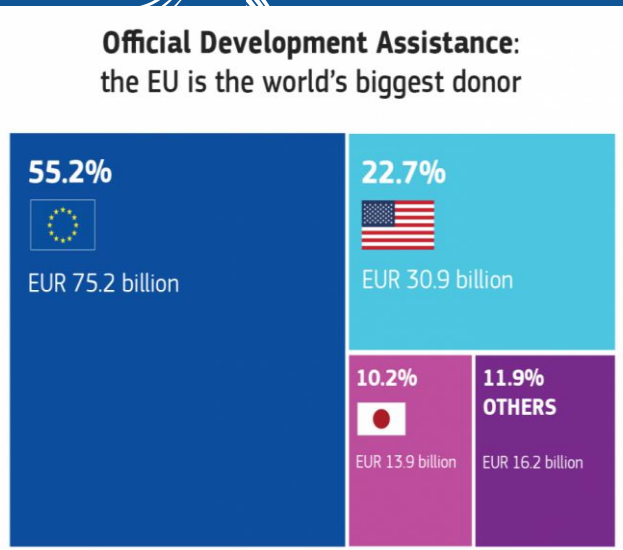
The European Union remains world's leading donor of Official Development Assistance with € 75.2 billion in 2019

NEWS 16 April 2020 Brussels
https://ec.europa.eu/international-partnerships/news/european-union-remains-worlds-leading-donor-official-development-assistance_en

The collective Official Development Assistance (ODA) from the European Union and its Member States amounted to € 75.2 billion in 2019, representing 55.2 % of global assistance, according to preliminary figures released today by the Organisation for Economic Co-operation and Development's Development Assistance Committee (OECD-DAC).

The EU's and its Member States collective assistance represented 0.46 % of EU Gross National Income (GNI), slightly lower than the 0.47 % in 2018, but remains significantly above the 0.21% average of the non-EU members of the DAC.

Source : EU Aid Explorer - a one-stop shop for funding information: it facilitates donor coordination, ensures transparency and improves accountability to citizens - https://euaidexplorer.ec.europa.eu/



EU BUDGET FOR THE FUTURE 2021-2027 : THE " *NEIGHBOURHOOD, DEVELOPMENT AND INTERNATIONAL COOPERATION INSTRUMENT* " (NDICI)

The European Union, with its Member States, is the world's biggest donor of development assistance and among the first global trading partners and foreign investors (*).
As a Union promoting peace, stability and a rules-based global order, it is faced with many challenges as well as opportunities in an increasingly complex and inter-connected world. Prosperity and peace in the EU's neighbourhood and beyond are crucial for the EU's own stability and security. This is why the European Union is proposing an increase in its current budget for the next Multiannual Financial Framework. The Commission's 2021-2027 budget proposal of May 2020 earmarks € 86 billion (in 2018 prices) for the "Neighbourhood, Development and International Cooperation Instrument" (NDICI) …, more than an 8% increase to the 2018 proposal. The NDICI will be the EU's main financial tool to contribute to eradicating poverty and promoting sustainable development, prosperity, peace and stability.

(https://ec.europa.eu/international-partnerships/system/files/factsheet-mff-multiannual-financial-framework-v08-clean_0.pdf **)**

EUROPEAID

USAID FROM THE AMERICAN PEOPLE

*(*) **Sustainable investments - Public and private investments are crucial to stimulating entrepreneurship and sustainable economic diversification.** ….*

*With a foreign direct investment stock reaching EUR 222 billion, **the EU is the largest investor in Africa**, well ahead of the United States (EUR 42 billion) or China (EUR 38 billion). Under the umbrella of the **Africa-Europe Alliance for Sustainable Investment and Jobs**, EU instruments, such as the External Lending Mandate, the African, Caribbean and Pacific Investment Facility and, more recently, the European External Investment Plan, have unlocked considerable investments in Africa. These include investments in **transport**, **clean energy** and **agricultural sectors** and in **private sector development**. (Source : :"Africa-Europe Green Energy Initiative")*

Enabel au Bénin (programme 2019 – 2023) : priorité pour secteurs agroalimentaire et portuaire

Enabel
Agence belge de développement
enabel.be

À propos d'Enabel

Enabel est l'Agence belge de développement. Elle exécute et coordonne la politique belge de développement international, et travaille principalement pour le compte de l'État belge. L'Agence met également en œuvre des actions pour d'autres organisations nationales et internationales. Avec 1.500 collaborateurs·rices, dont plus de 70 % de personnel local, Enabel gère quelque 150 projets, essentiellement dans des États fragiles d'Afrique.

Bureaux à l'étranger : Bénin ; Burkina Faso ; Burundi ; RD Congo ; Guinée ; Mali ; Maroc ; Mozambique ; Niger ; Palestine ; Rwanda ; Sénégal ; Tanzanie ; Ouganda.

Enabel au Bénin (présente à Cotonou depuis 1999)

Programme de coopération gouvernementale
Belgique – Bénin 2019-2023

Active depuis plus de vingt ans au Bénin, Enabel se focalise sur l'appui au développement des secteurs de l'agriculture et de la santé. Dans ce pays, le programme de coopération 2019-2023 dispose d'un budget total de soixante millions d'euros. La Belgique y met également en œuvre des projets pour le compte d'autres bailleurs, pour un montant avoisinant les vingt millions d'euros. Le programme de coopération privilégie le partenariat, le transfert de compétences, la durabilité et l'innovation.

Le programme de coopération conclu entre la Belgique et le Bénin pour la période 2019-2023 rejoint les priorités et orientations du Bénin, en particulier la stimulation du développement économique focalisé sur le secteur de l'agroalimentaire et de l'activité portuaire, ainsi que le droit à la santé sexuelle et reproductive. (representation.benin@enabel.be)

https://www.enabel.be/sites/default/files/enabel_au_benin_web.pdf

(1) Développement des chaînes de valeur et de l'entrepreneuriat dans l'agroalimentaire (42 % des engagements financiers de Enabel)

Objectif : Meilleurs revenus pour 50 PME de transformation, 60 entreprises de commercialisation, 100 entreprises de services (transport, emballage) et 3.000 producteurs et productrices.

(2) Appui au développement du secteur portuaire (17 % des engagements financiers de Enabel)

Le Port de Cotonou est l'un des plus grands ports de l'Afrique de l'Ouest. Enabel l'appuie dans sa modernisation pour le rendre plus compétitif et performant. L'ambition est de renforcer son positionnement concurrentiel en facilitant les investissements, en renforçant les compétences de différents acteurs du port et en travaillant sur l'aspect environnemental.

Objectifs : * Évolution du nombre d'emplois décents parmi les emplois précaires : de 20 à 60 %
**** Evolution du tonnage global traitées par le port : augmentation de 20 % d'ici fin 2023 (base line 10 millions de tonnes).***

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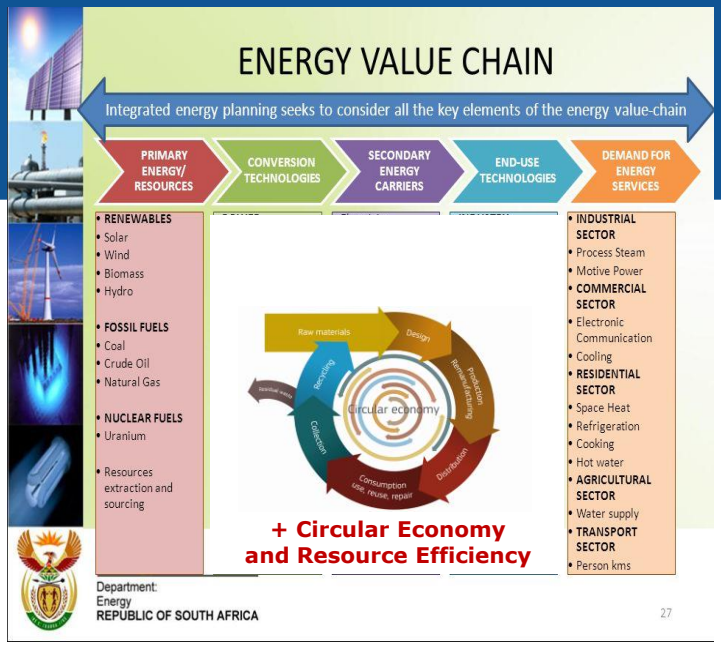
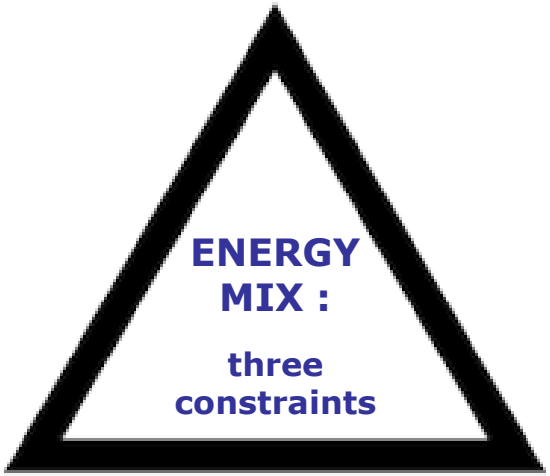
Conclusion



PROUDLY MADE IN AFRICA

Research and education in Africa to better manage the energy value chain



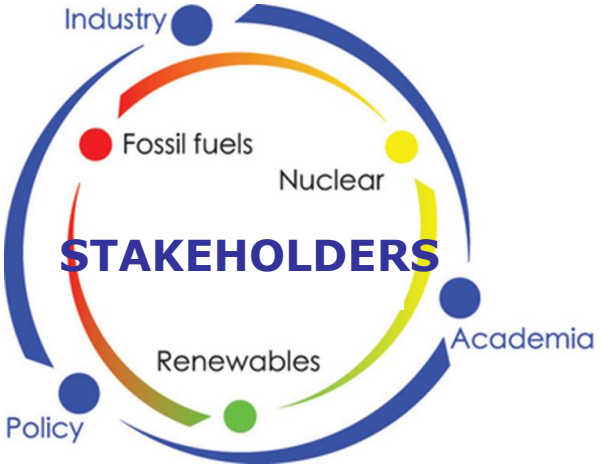
1 NO POVERTY

Une urgence

et des défis

7 AFFORDABLE AND CLEAN ENERGY

#AFRICA CAN

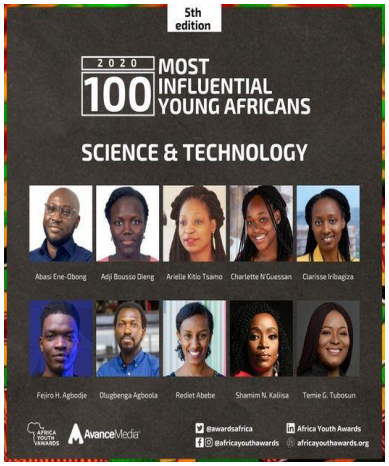


Integrating <u>energy policy constraints</u>

and energy value chain management

Recherche, innovation et formation en / avec l'Afrique - une partie de la solution 1/2

"Scientific African" is owned by the Next Einstein Forum (NEF) and operated by the NEF Community of Scientists - https://www.journals.elsevier.com/scientific-african/



"the next Einstein would be from Africa"

"My wish is that you help us unlock and nurture scientific talent across Africa, so that within our lifetimes we are celebrating an African Einstein", said Neil Turok. https://blog.ted.com/the-next-einstein-forum-begins/ and https://www.nexteinstein.org/

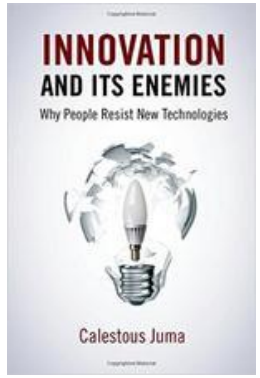
"Can you imagine a thinker who combines the brilliance of Einstein and the compassion of Mandela?" - TED 2008 talk (February 2008, 25 min duration, with transcript in 27 languages) : https://www.ted.com/talks/neil_turok_makes_his_ted_prize_wish

Neil Turok (1958 -), founded in 2003 the "African Institute for Mathematical Sciences" (AIMS) in Muizenberg (a small seaside suburb of Cape Town, South Africa). AIMS centre of excellence offers a creative STEM education to African students and aims to improve the statistic that less than 1% of global research is done in Africa. Since then, through the AIMS Next Einstein Initiative (AIMS-NEI), AIMS centres have opened in Sénégal (2011), Ghana (2012), Cameroon (2013), Tanzania (2014) and Rwanda (2016). "Our goal is to have 15 AIMS centres of excellence in operation across Africa by 2023."

****

"Innovation and Its Enemies: Why People Resist New Technologies"

Calestous Juma (1953-2017, Harvard Kennedy School from 2002) was a Kenyan professor and an internationally recognised authority in the application of science and technology to sustainable development worldwide. Juma created in 1988 the African Centre for Technology Studies (ACTS) in Nairobi. He set out the threats of modern biotechnology and its potential for solving food insecurity, especially in developing nations. His book "Innovation and Its Enemies: Why People Resist New Technologies" (Oxford Univ. Press, 2016) charted the battle between "innovation and incumbency" throughout human history. Also co-chair of the AU strategy report 2014 "On the Wings of Innovation", the Science, Technology and Innovation Strategy for Africa (STISA-2024).



Recherche, innovation et formation en / avec l'Afrique - une partie de la solution 2/2

Towards a joint AU-EU (ERASMUS like) programme to support research, education, training, culture, youth and sport ?

Picture from EU Horizon 2020 project : IGD-TP 3rd MIND Annual Project Meeting, 7-9 May 2018, Lausanne, Switzerland (15 countries involved)
https://igdtp.eu/event/3rd-mind-annual-project-meeting/

"South Up Map" - Main message : maps influence how people see the world and they reflect the political, economic and cultural interests of the people who make and sponsor them. Source : Maps (June 2011) : https://www.transpacificproject.com/index.php/maps/

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(2) "2020 Africa SDG Index and Dashboards Report (leave no one behind)", UN Sustainable Development Solutions Network, Sep 30, 2020 (248 pages) https://sdgindex.org/reports/2020-africa-sdg-index-and-dashboards-report/

(3) "Tracking SDG 7: The Energy Progress Report", World Bank full report (6 chapters) May 2020 - https://www.worldbank.org/en/topic/energy/publication/the-tracking-sdg-7-report-the-last-decade-to-leave-no-one-behind

(4) "Sustainable Energy: Without the Hot Air", Sir David Mackay, 2009, UIT Cambridge (download pdf file for free / read translations in 15 languages) - www.withouthotair.com

(5) « Energie : Economie et politiques » de Jean-Pierre Hansen (Auteur), Jacques Percebois (Auteur), Marcel Boiteux (Préface), Jean Tirole (prix Nobel d'économie 2014, Introduction), Editions De Boeck, 2010, ré-éditions 2015 et 2019 - 756 pages

(6) « L'électricité au coeur des défis africains - manuel sur l'électrification en Afrique », Christine Heuraux, EDF 2010

(7) « La guerre des métaux rares : La face cachée de la transition énergétique et numérique », Guillaume Pitron, 2018 (293 pages)

SE4A 2021 - « Sustainable Energy for Africa »

2021, November 8-11, National Academy ANSALB, Cotonou, Benin

You're invited

SE4A 2021 - International Conference organized jointly by

- **ANSALB (National Academy of Sciences, Arts and Letters of Benin) and**
- **RAOS (Royal Academy for Overseas Sciences of Belgium)**

Sustainable Energy for Africa
Cotonou, 8-11 Nov. 2021
mail : contact@se4a.africa
http://www.se4a.africa

- ***Energy is crucial for achieving the Sustainable Development Goals in Africa : "Agenda 2030", UN 2015 and "AGENDA 2063 - The Africa We Want", AU 2015) - Energy systems that are secure, sustainable, competitive and affordable for all - how can Africa's natural resources benefit all citizens ?***

- ***Energy value chain (including conversion and end-use technologies) : Power and storage technologies, aiming at providing energy services for all - Development and economics of power system***

- ***Research, innovation & education in connection with the energy-intensive sectors : Exploring the role of scientific resources and capacity building as a response to the needs of emerging countries in the sectors of transport, residential, industry, services.***

Two seminars

1 - Solar energy - tapping into solar energy resources to drive electricity access in Sub-Saharan Africa
2 - Innovative financing mechanisms in Africa for projects related to energy access, including circular economy.

Main organisers from RAOS and ANSALB:

- **Dr. Ir. Georges VAN GOETHEM (georges.m.vangoethem@gmail.com)**
- **Prof. Dr. Philippe De Maeyer, Permanent Secretary of RAOS**

+ Bernard MAIRY (Ir - SEII) and Marc LOBELLE (Prof. Dr Ir Emeritus UCL)
Website: http://www.kaowarsom.be/en/home
E-mail: contact_raos@kaowarsom.be

+

- **Prof. Dr. Mahouton Norbert HOUNKONNOU, Past President of ANSALB**
- **Prof. Dr. med. Hippolyte AGBOTON, Secrétaire Perpétuel de ANSALB**

+ Mr Arnaud Y. ZANNOU (UC/PDER) and Dr. Thierry d'ALMEIDA (Sèmè city)
Website: https://academie-sciences.bj/
E-mail: ansalb@academie-sciences.bj

« Quelle énergie pour l'Afrique ? - Une urgence et des défis » (Webinaire CBL-ACP, 10 novembre 2020)

WEBINAIRE :
Quelle énergie pour l'Afrique ?
10/11/2020 – 4PM
(Belgian time)

Rappel de la conférence précédente pour la chambre de commerce belgo-africaine sur le même theme (10/11/2020)

« Quelle énergie pour l'Afrique ? - Une urgence et des défis » (10 novembre 2020)

Georges Van Goethem (Dr Ir)

Royal Academy for Overseas Sciences of Belgium (ARSOM – KAOW)
Formerly with EC DG Research and Innovation / Energy (Brussels)
(georges.m.vangoethem@gmail.com)

Webinaire CBL-ACP, 10 novembre 2020, organisé par : Chambre de Commerce d'Industrie et d'Agriculture Belgique - Luxembourg / Afrique – Caraïbes – Pacifique
- https://cbl-acp.be/webinaire-quelle-energie-pour-lafrique/

- **Accès pour revisionner le webinaire (1h11min): https://www.youtube.com/watch?v=vldEmRQbHSE**

- **Accès à l'exposé sous format PDF (104 PPT slides) et téléchargeable :**
https://mcusercontent.com/742e822301b71be0f41d1e762/files/56dd70a6-490e-49ec-aac6-5ce85498d870/Quelle_%C3%A9nergie_pour_l_Afrique_2_Une_urgence_et_des_d%C3%A9fis_G_Van_Goethem_expos%C3%A9_ppt_webinaire_10_novembre_2020_compress%C3%A9.pdf

- **Accès aux questions/réponses sous format PDF (11 pages) et téléchargeable :**
https://mcusercontent.com/742e822301b71be0f41d1e762/files/27c15e75-9265-4d3b-9d53-4e882a4d78c4/Quelle_%C3%A9nergie_pour_l_Afrique_Une_urgence_et_des_d%C3%A9fis_G_Van_Goethem_QR_webinaire_10_novembre_2020.pdf

ACADEMIE ROYALE DES SCIENCES D'OUTRE-MER
KONINKLIJKE ACADEMIE VOOR OVERZEESE WETENSCHAPPEN
Classe des Sciences techniques - Klasse voor Technische Wetenschappen

29.IV.2021 à 14h30 (heure en Belgique)

« Quelle énergie pour l'Afrique ? - Une urgence et des défis »

Georges VAN GOETHEM

MOTS-CLES. — Énergie durable pour l'Afrique (SE4A 2021), IEA 2019, accès à l'énergie

RESUME — L'accès à l'énergie en Afrique est une urgence dans la lutte contre la pauvreté et pour le développement économique. L'Afrique du Nord bénéficie d'un accès quasi-universel à l'électricité, mais plus de la moitié de la population subsaharienne – environ 530 millions de personnes - n'ont pas d'accès à une électricité fiable. Cette situation en Afrique subsaharienne empêche la fourniture de nombreux services de base (santé, éducation, etc).

En 2018 en Afrique, la demande totale d'énergie primaire – utilisée e.a. pour produire de l'électricité - était de plus de 830 millions de tonnes équivalent pétrole (ou 9650 TWh), càd 21 fois celle de la Belgique. La demande d'électricité en Afrique est d'environ 700 TWhe, càd 8 fois celle de la Belgique - les économies d'Afrique du Nord et l'Afrique du Sud représentant plus de 70% du total. L'Afrique subsaharienne consomme 225 TWhe (comme l'Espagne).

Source : "Africa Energy Outlook 2019", IEA special report, 2019 - https://www.iea.org/reports/africa-energy-outlook-2019

Les défis soulevés par cette urgence énergétique seront traités plus en détails dans une conférence organisée par nos académies béninoise ANSALB et belge ARSOM-KAOW (8 –11 novembre 2021, Cotonou, Bénin) - http://www.se4a.africa/ .

Curriculum Vitae (1 minute)

Notre confrère Georges VAN GOETHEM est ingénieur civil mécanicien (1974) et docteur en sciences appliquées (1979) de l' Ecole Polytechnique de Louvain (Louvain-la-Neuve), auteur de nombreux articles scientifiques sur l'énergie.

Il a travaillé quelques années pour l'industrie belge et ensuite a fait toute sa carrière dans la recherche internationale à la Commission Européenne : moitié, dans un laboratoire européen en Italie (Ispra) et moitié au quartier général de la « DG Recherche et Innovation, Direction Energie » à Bruxelles. Il a géré de nombreuses collaborations scientifiques internationales entre laboratoires universitaires et centres de recherche industriels autour de thèmes liés à l'énergie.

Depuis sa retraite en 2015, il donne cours en Belgique et en France (« Ecole des Mines de Nantes » et « Université de Reims Champagne-Ardenne »). Il est également actif dans des associations citoyennes intéressées par le mix énergétique.