

Geologic Carbon Capture and Storage (CCS) Economic Development opportunities for Africa

JOSEPH ESSANDOH-YEDDU

Energy Commission, Ghana

OVERVIEW

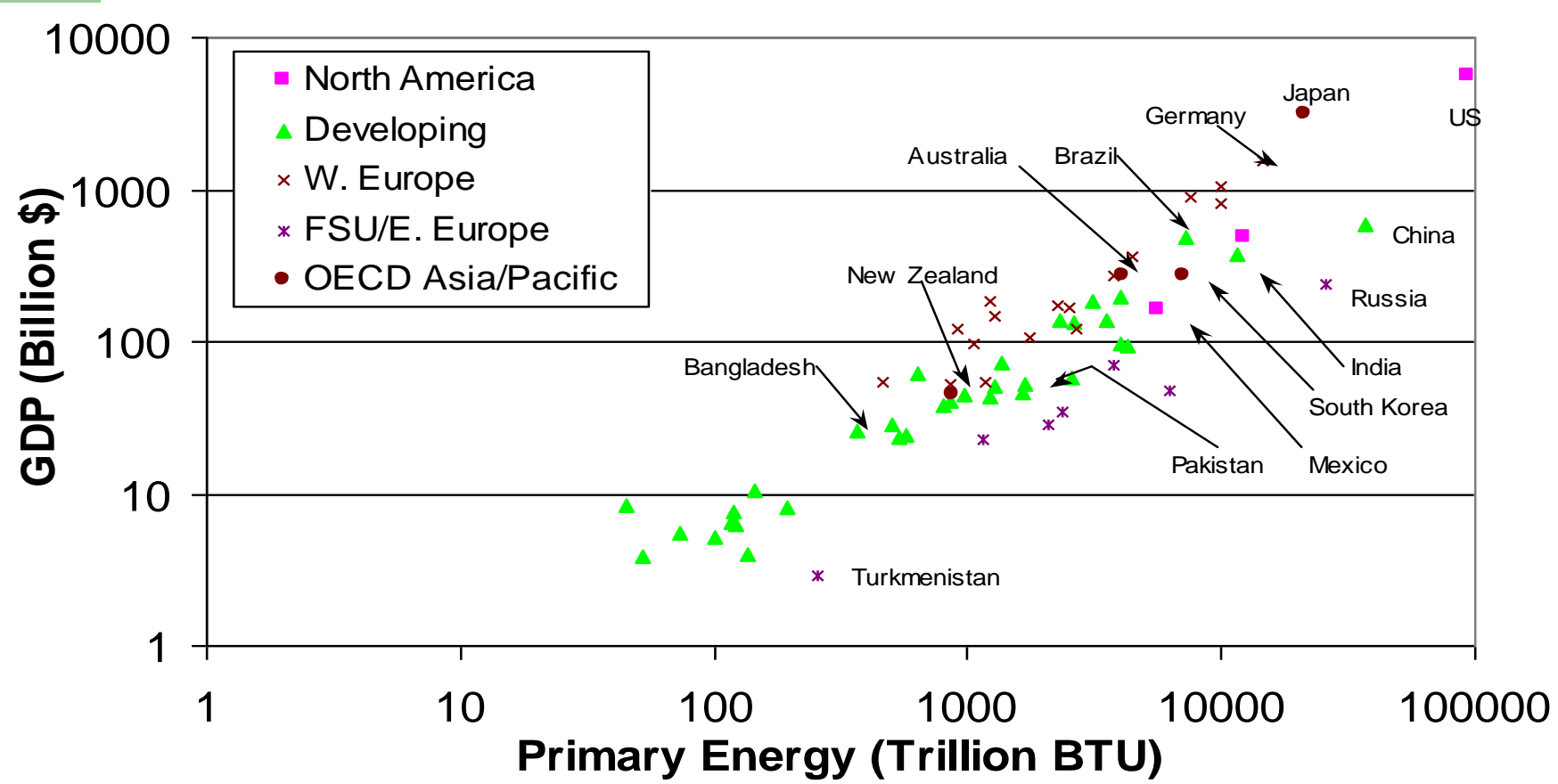
Africa's Population: present and future

- **Current Africa's population is about 1.2 billion**
 - Accounting for ~ 16% of world population
 - Over 80% in Sub Saharan Africa
 - *But 60-70%* live in rural and remote areas
 - Lower Level of Economic Development; *large rural agricultural sector*
- **population expected to hit about 2.5 billion by 2050**
 - Accounting for ~ 25-26% of world population in 2050
 - Over **50-60%** would live in urban areas.
 - Less than **50%** would remain in **rural and remote** areas.

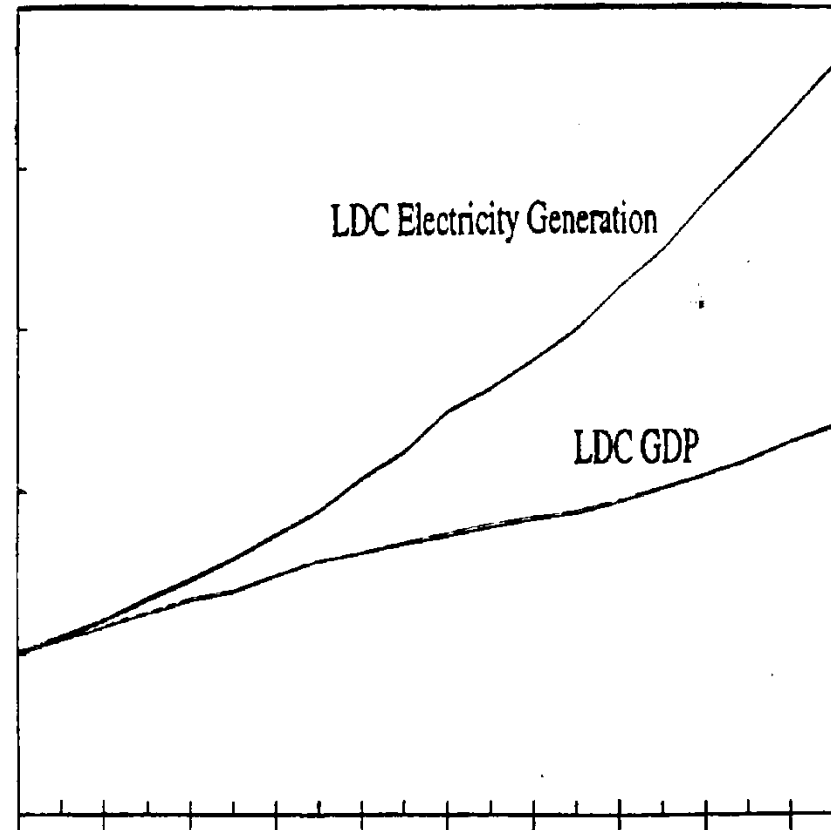
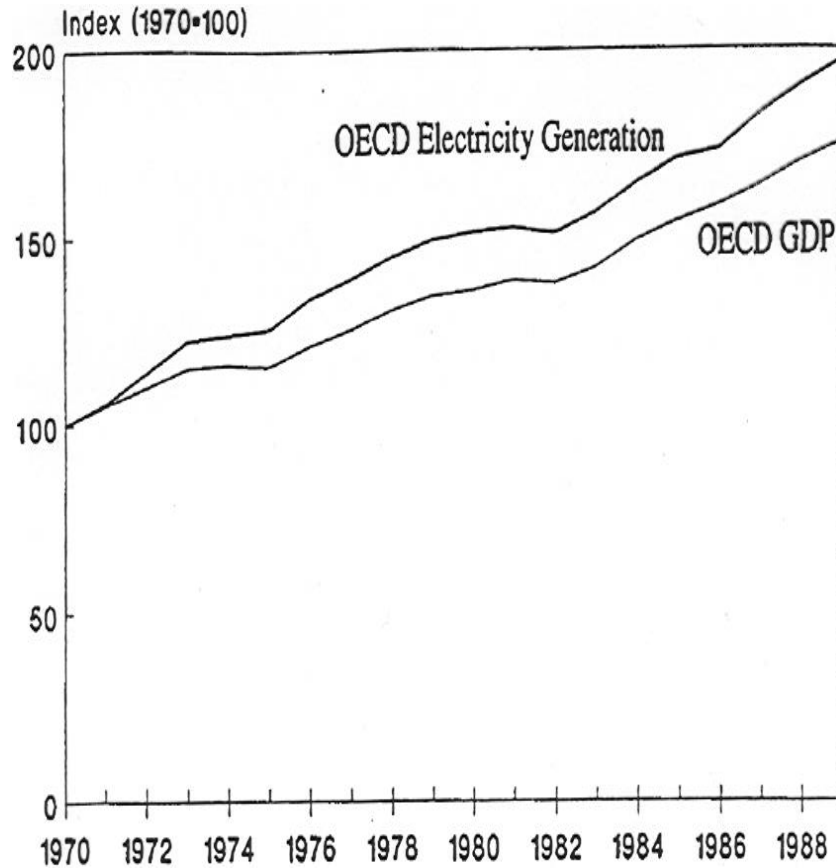
International Energy Agency – Africa Energy Outlook (IEA-AEO) 2014

Energy-Economy Nexus

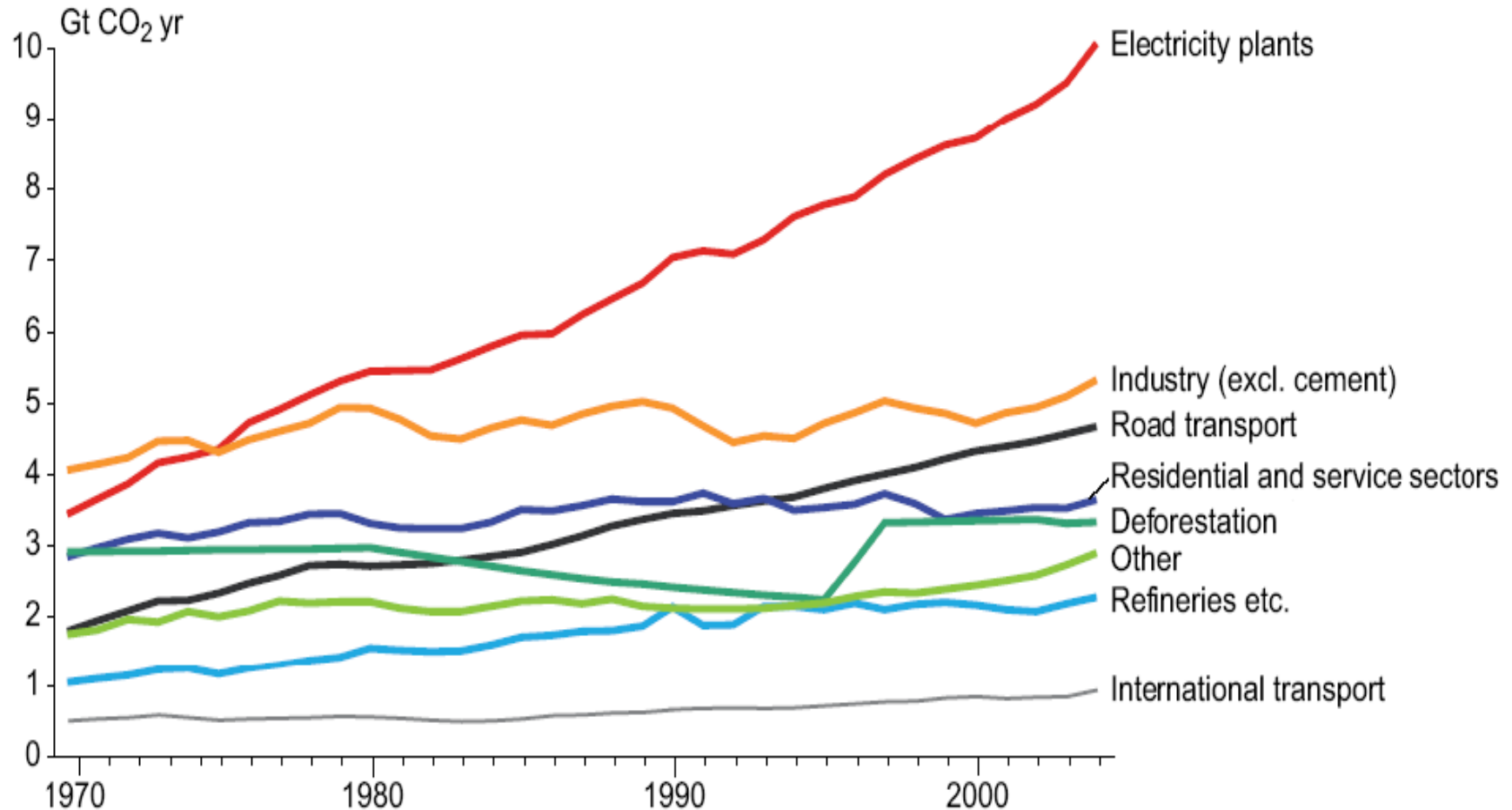
Poor countries have averagely low energy usage per capita



High Correlation between GDP growth and Electricity Consumption Growth rates in both Advanced (OECD) and Least Developing (LDC) countries



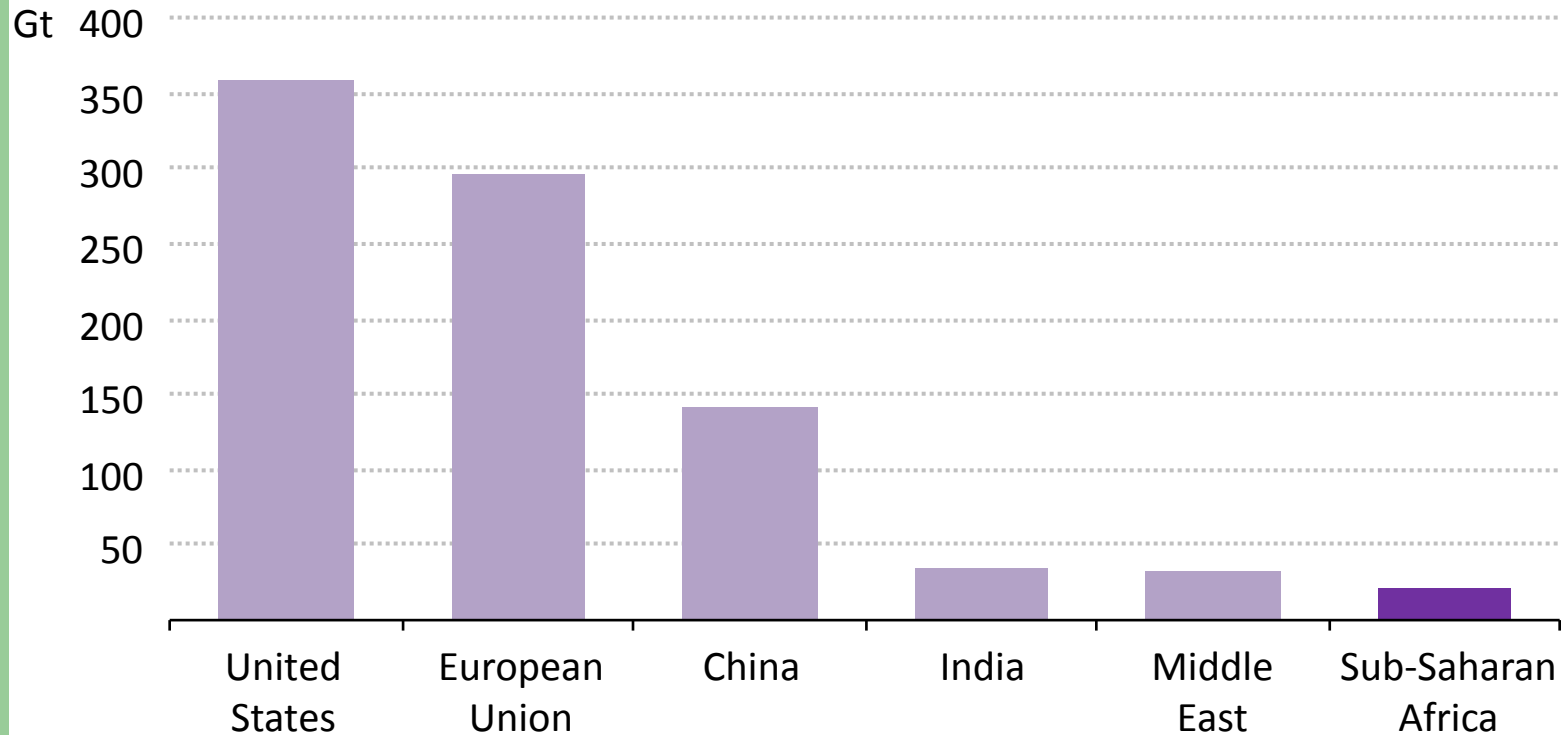
Sources of Global CO₂ emissions



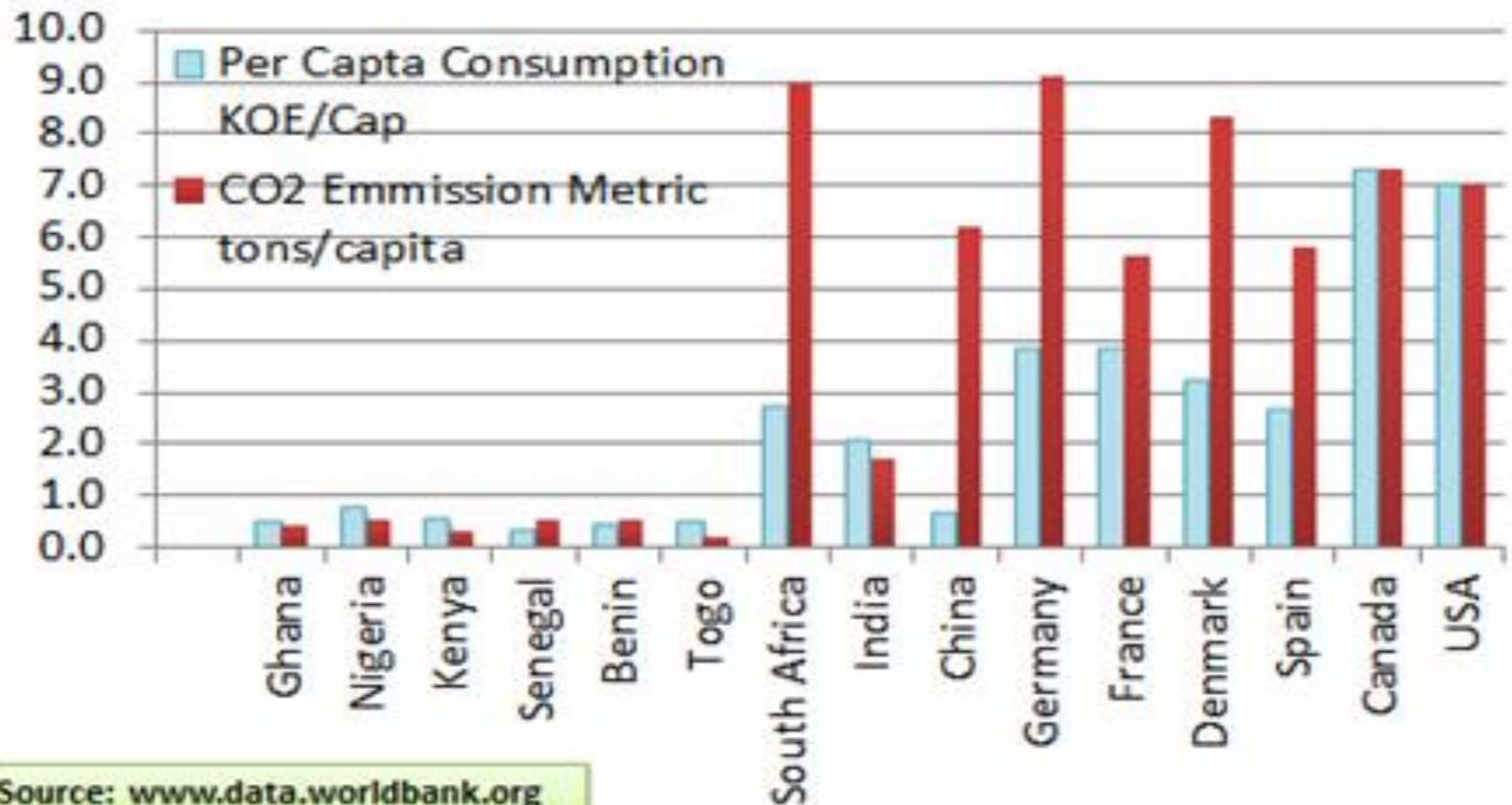
Sources: IPCC AR4, 2007

Africa is least CO₂ emitter

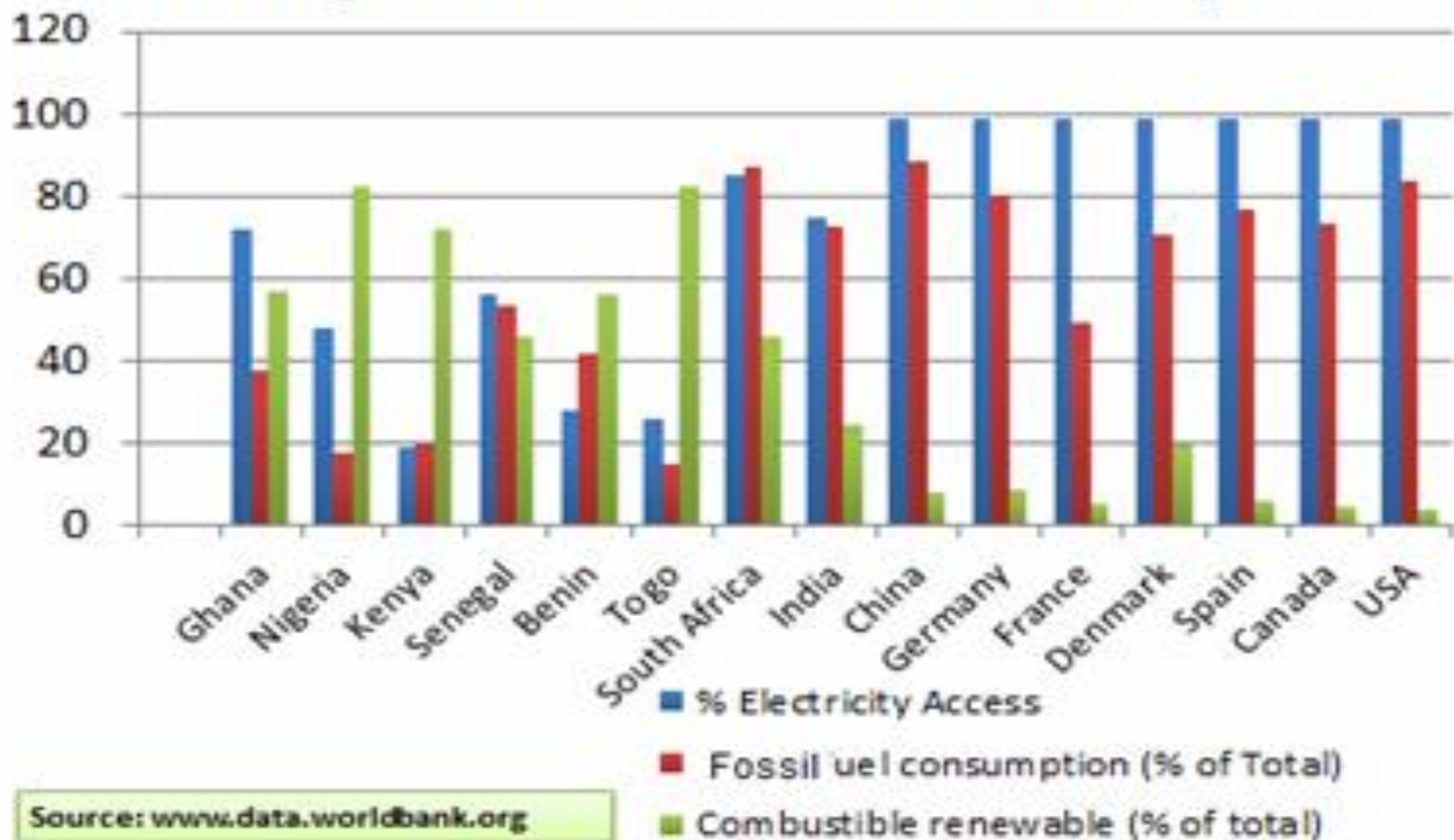
Cumulative energy-related CO₂ emissions, 1890-2012



Energy Consumption & CO2 Emission per Capita in Selected Countries - 2014



Electricity Access & Fossil Fuel Consumption



Is there hope? YES!

Africa, second fastest economic growth

Economic Region		Real GDP Growth 2013-2015
Global growth		3.6
Eurozone		1.2%
Central and Eastern Europe		2.8-3.7%
CIS		1.4-3.1%
North America		2.5-2.8%
	United States	2.8-3%
	Canada	2.2-2.5%
Latin America		2.5-3.1%
Africa		4.7-5.2%
East Asia		7.1-7.5%
Middle East		3%
New Zealand & Australia		2.6-3.6

Source: World Bank, IMF, Focus Economics (www.focus-economics.com)

Selected Major Regional drivers

Region	Country	Population (2011-2014)* million	GDP** (2011-2014)* US\$ billion	GDP growth %	Industry % GDP
Western Africa	Nigeria	162-170	478-510	7.1	26 <i>(oil)</i>
	Ghana	25-26	90-91	7-8	27 <i>(oil)</i>
	Cameroon	20-24	53	4.6-5	32 <i>(oil)</i>
	Angola	19-21	130-132	8.4	61.4 <i>(oil)</i>
Eastern Africa	Tanzania	47.1-47.5	73.5-73.9	6.5-6.9	22.6 <i>(oil)</i>
	Mozambique	24-25	26.7-28.2	7.5	23.9 <i>(oil)</i>
	Kenya	41.6-45.1	41.8-80	4-5	14.8
Horn of Africa	Ethiopia	84.7-97	118	6.9-7	14.5
Southern Africa	South Africa	50-54	391	2.6	31.6

Sources: IEA 2014 World Key Energy Statistics 2014; World Bank country data base; Wikipedia.

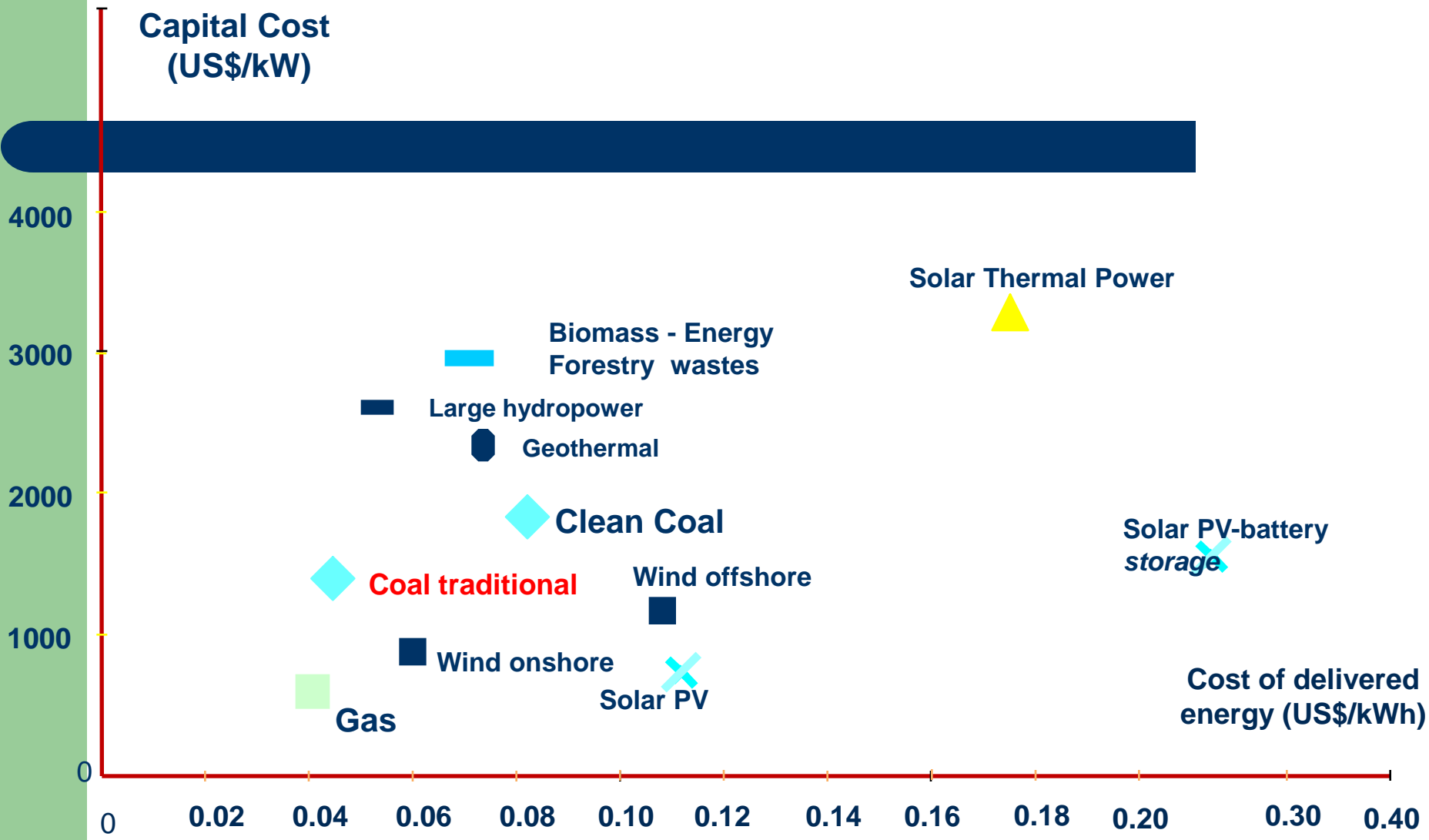
* Data provided for within 2011-2014. ** Nominal

EXPECTED COST-COMPETITIVE ELECTRICITY SUPPLY

ECONOMIC SECTOR	MAXIMUM PRICE /TARIFF RANGE	EXPECTED TOLERABLE QUALITY
Industry	2-6 US cents/kWh	Base-load, highly stable
Agriculture (irrigation) Poultry/livestock	4-6 US cents/kWh 6-9 US cents/kWh	Base – intermediate load, fairly stable
Commercial/ Services	7-9 US cents/kWh	Intermediate to peak load, fairly stable (<i>highly stable if peak</i>)
Homes/Residential	9-12 cents/kWh	Intermediate load fairly stable Peak load highly stable

- Africa of share of world primary energy use/ consumption ~3%
 - **Very low levels of Electrification <30%** (*Bad quality; very expensive often intermittent, if available*)

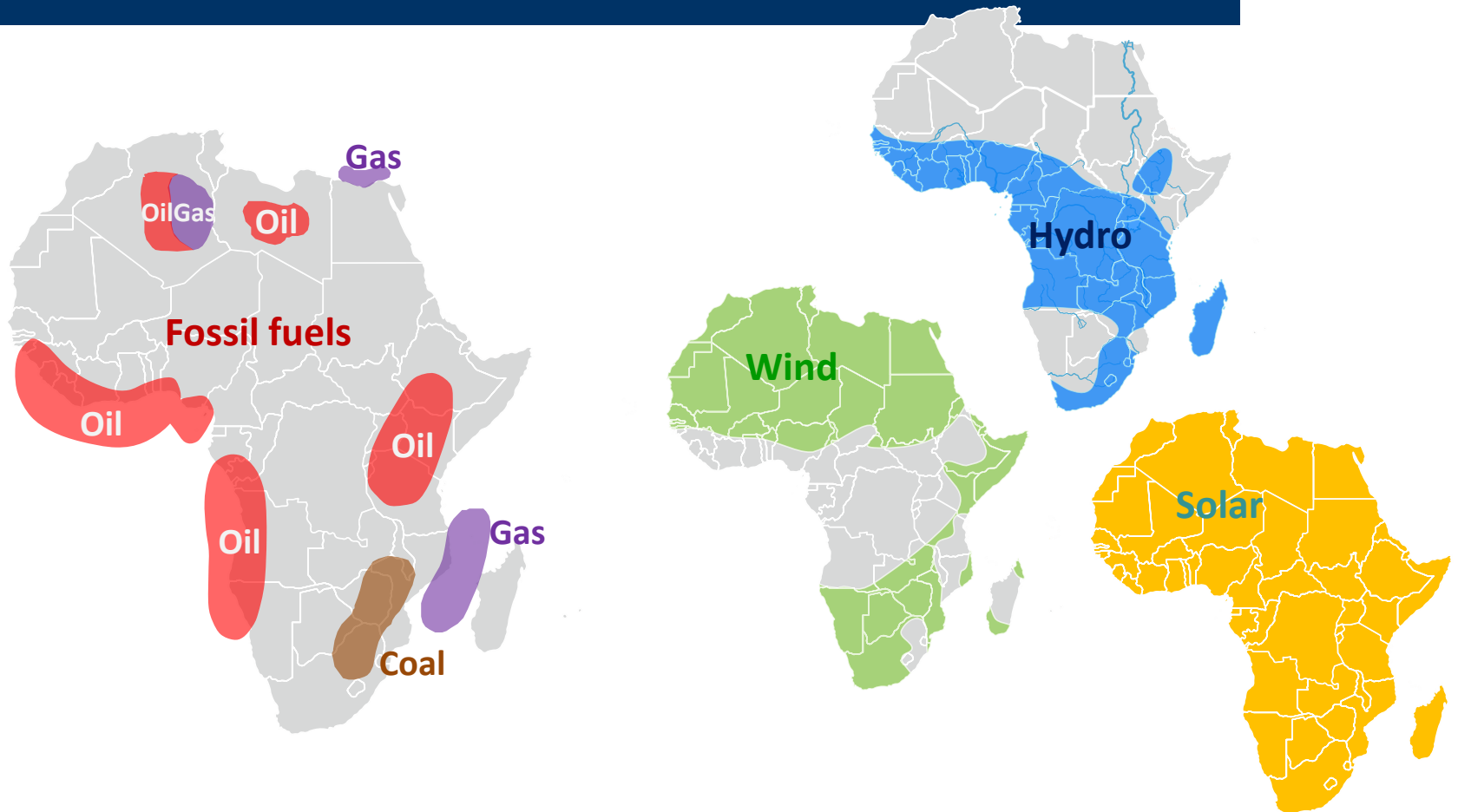
Projected Average Capital and Delivered Costs in Sub-Saharan Africa



Africa is RICH in energy resources

In the last 6 years, almost 30% of global oil & discoveries were in sub-Saharan Africa

IEA, 2014



Other Emissions into the Atmosphere

Should Africa not grow it economies?

Industries

- ✓ Oil Refining
- ✓ Aluminium smelting
- ✓ Iron and Steel
- ✓ Cement production
- ✓ others

● **Transport**

- ❖ Road , Rail ,
Water/Maritime, Air
- ❖ International

● **Commerce**

- ✓ Lighting
- ✓ Preservation

● **Homes and buildings**

- ✓ Lighting (*oil based*)
- ✓ Cooking (*gas/biomass*)
- ✓ Others

Other GHG sources into the Atmosphere

Should we stop developing Agriculture because of Climate change?

● Biomass

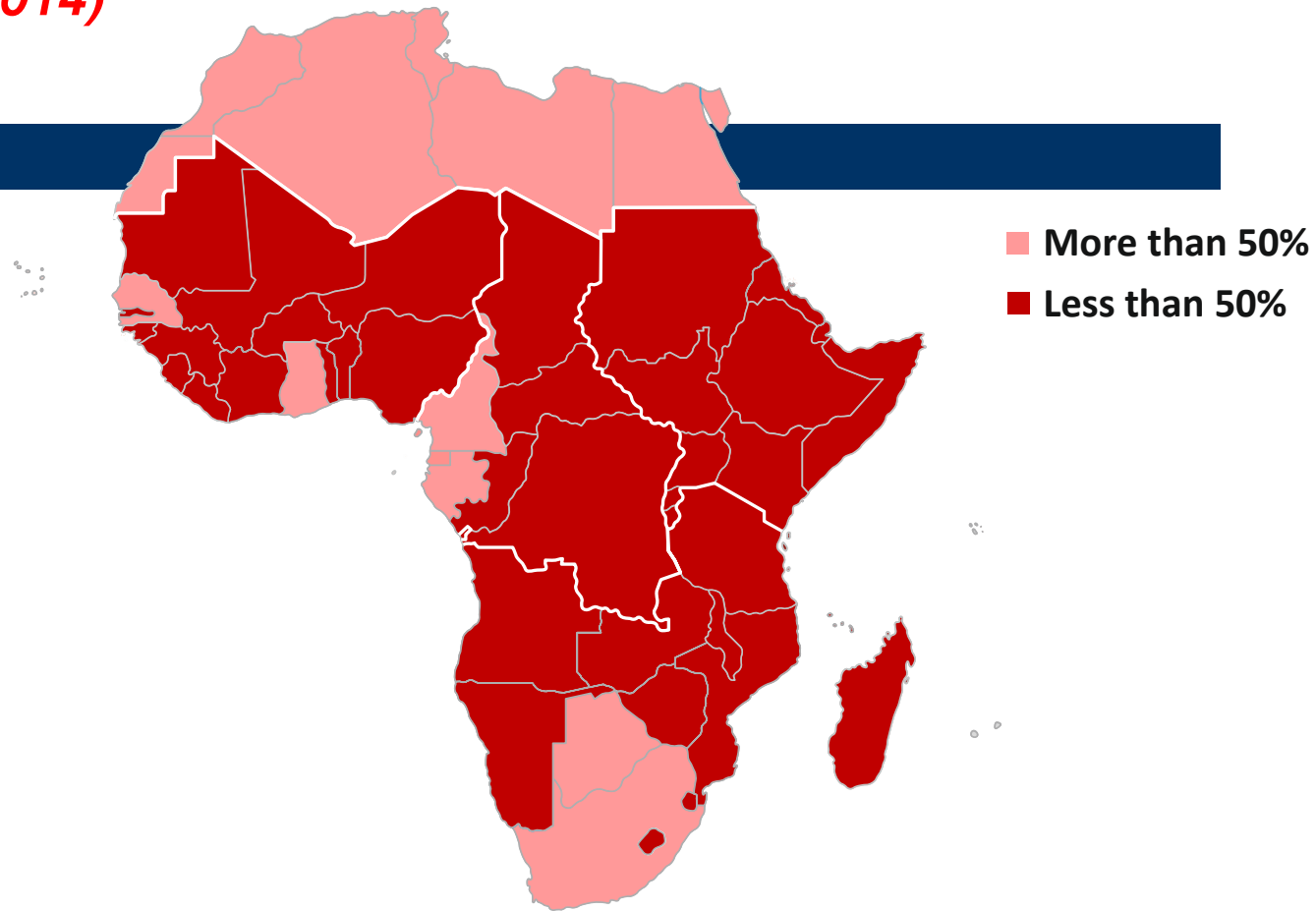
- Peat, wetlands, soils
- Bush burning / bush fires
- Charcoal production
- Deforestation and Forest Degradation
- Land Use and Land-use change
- Sewages

● Agriculture

- Rice plantations
(emitting methane)
- Fertilizer applications.
(emitting methane)
- Livestock – Cattle ranches
(emitting methane)

Africa Rich in energy resources, but poor in energy supply

*Share of population with access to grid/public electricity
(IEA-AEO,2014)*



In sub-Saharan Africa, 620 million people – two-thirds of the population – live without electricity. Only a handful of countries have electrification rates above 50%

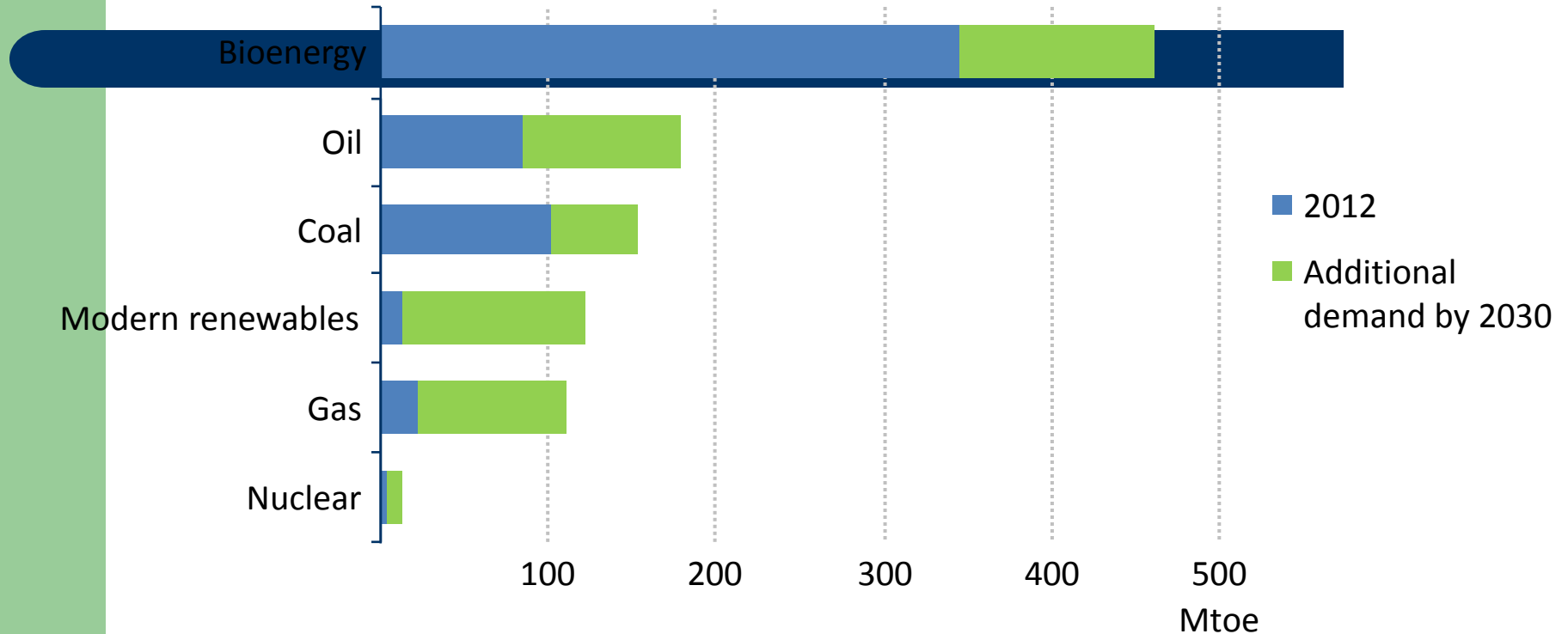
OVERVIEW: Africa's Commercial Energy Use (Consumption)

- Oil consumption
 - North Africa 30-31%
 - South Africa 20%
 - Rest 50%
 - Natural gas
 - North Africa 73%
 - Coal
 - South Africa 80%
 - Nuclear
 - Only South Africa
- The rest is largely BIOMASS**
- Urban & Rural share of Public/grid Electricity
 - North Africa >90%
 - >Urban 99%; > Rural 80%
 - Sub Saharan 20-60%
(excluding South Africa)
 - >Urban 50-70%; Rural <15%
 - South Africa 80-90%
 - >Urban 99%; Rural 60-70%*

Solid biomass remains at the centre of the sub-Saharan energy mix

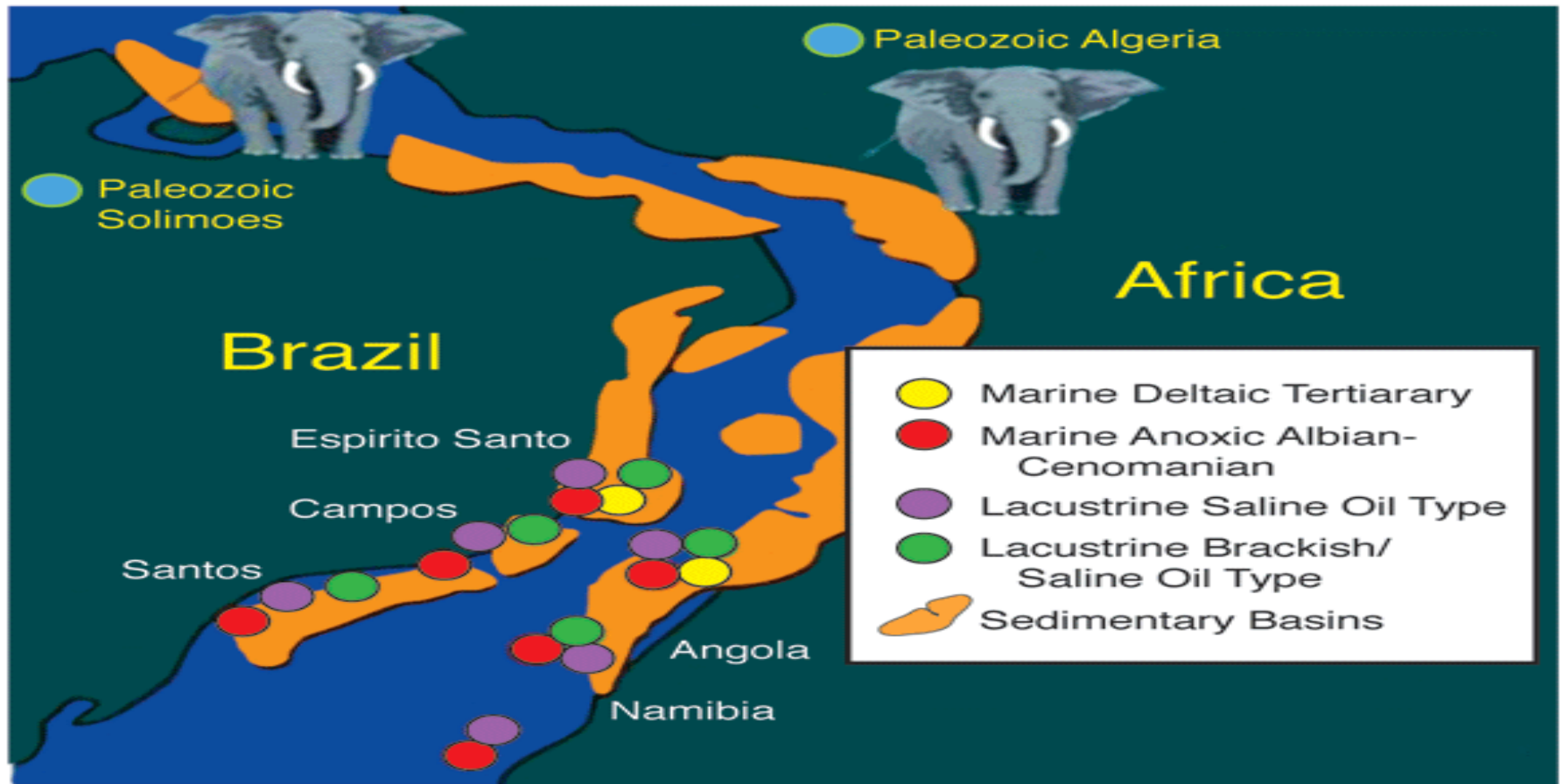
Total primary energy demand in sub-Saharan Africa, *IEA-AEO 2014*

18



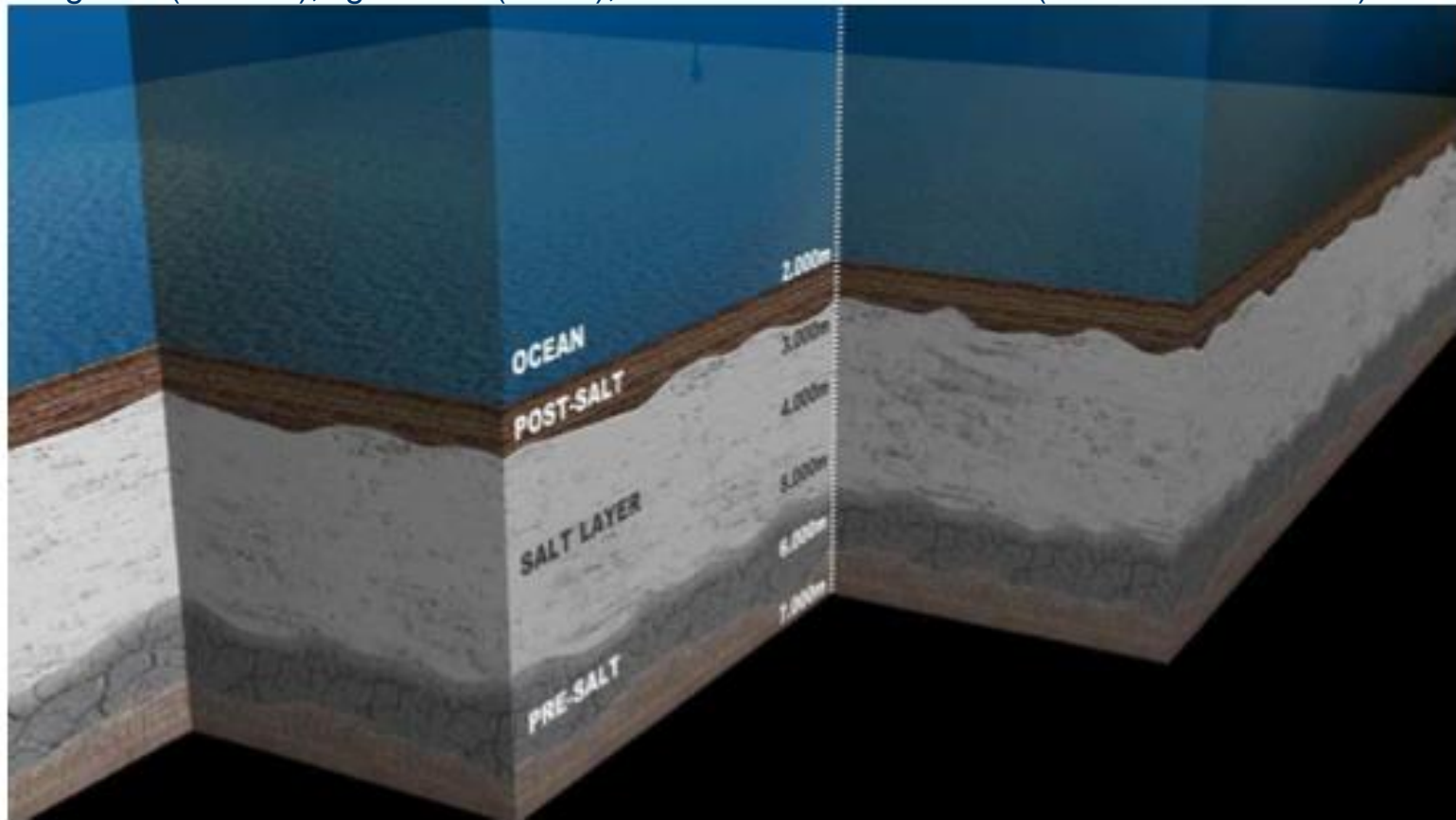
Traditional biomass still accounts for 60-90% of primary energy use in homes. Reliance on fuelwood & charcoal remains high, even as incomes grow; 650 million people would still cook with biomass in an inefficient & hazardous way by 2030. IEA-AEO 2014

Geological similarities with Brazil's pre-salt attract investments to Western Africa



Pre-Salt

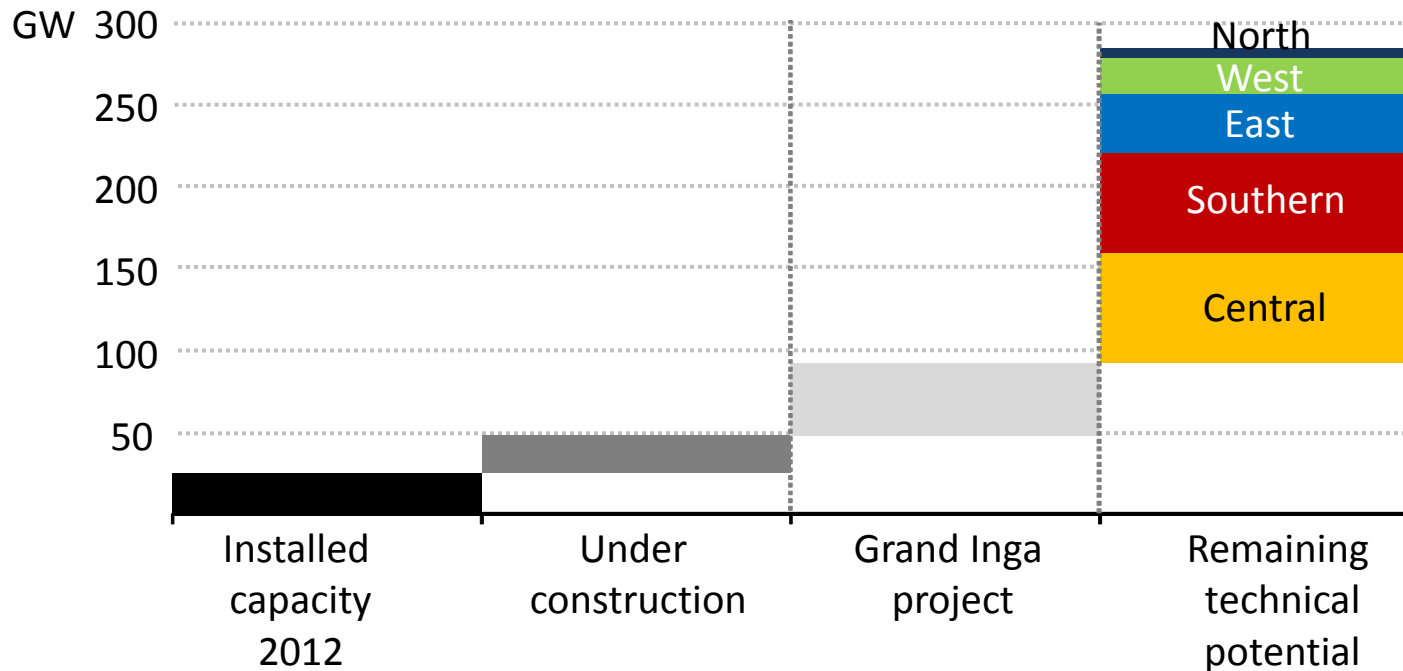
- Huge reservoirs (carbonates) of oil and natural gas (recoverable reserves of 8.3 billion BOE);
- Between 5,000m and 7,000 m below sea level;
- ~ 300 km off the coast;
- Water depth ~ 2,000 m;
- Salt layer with more than 2,000 m thick, in some areas;
- Light oil (30° API), light GOR (> 200), and variable CO2 content (between 1 and 20%)



Hydropower

potential for base-load is huge & largely untapped

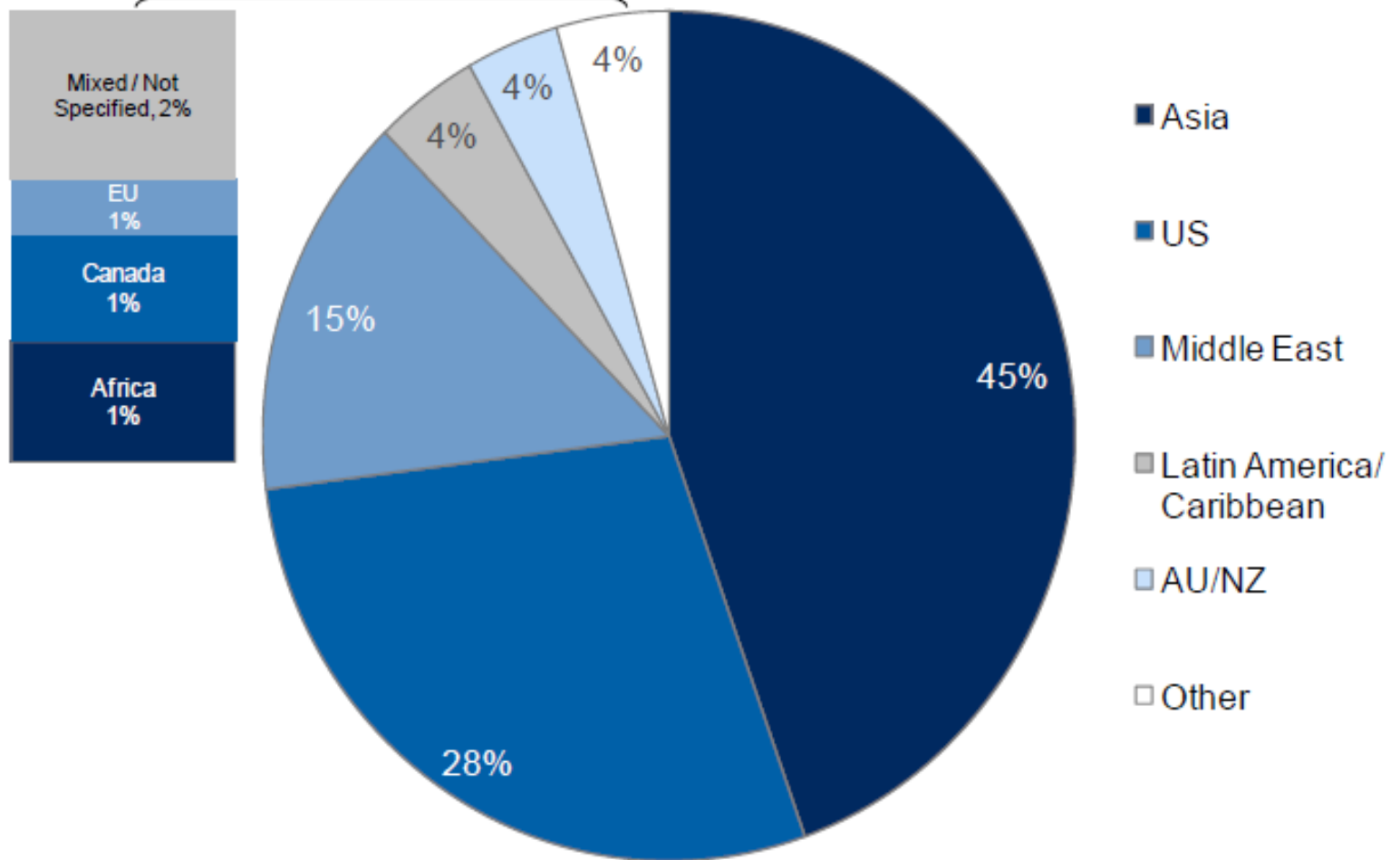
Existing hydropower capacity & technical potential in Africa, IEA-AEO 2014



Less than 10% of Africa's hydropower potential has been tapped; Central Africa has the largest remaining potential but significant resources remain across the region

Africa *hardly* benefited from Carbon Market under Kyoto

Transaction Volume by Project Location, OTC 2008



Source: Ecosystem Marketplace, New Carbon Finance.

1. Opportunities for *better carbon trade* under new carbon market mechanism

2. Opportunities for knowledge transfer

- Deep sub-surface geology mapping and technology
 - *Deep storage*
 - *Pre-salt depth for resource as well.*
- Super-critical fluid mechanics
 - *Material science and engineering*
- Carbon Capture technologies
 - *For geologic storage*
 - *Industrial applications – confectionary, chemical, etc.*

