IST

Seminário PROJECTO EMPREGO CABO DELGADO

Lisboa, 24 de Junho de 2021

“O PAPEL GEOESTRATÉGICO do GÁS NATURAL NA TRANSIÇÃO ENERGÉTICA”

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Sumário

1. ***A Geopolítica da Energia e as Mudanças Estratégicas e Estruturais em Curso***

2. ***O Papel Geoestratégico do Gás Natural***

3. ***O Potencial de Moçambique***

1. A Geopolítica da Energia e as Mudanças Estratégicas e Estruturais em Curso

XXI CENTURY: THE KEY - GEOECONOMIC SPACES

- Cities
- Mega-cities
- Regions
- Hubs
- Ports
- Sea resources
- EEZ
- South Atlantic
- Indian Ocean
- Pacific Rim

HOW the FUTURE MIGHT EVOLVE?

"The World was always ruled by passion, irrationality and periodic evils"

Kant

TECHNOLOGY DISRUPTIONS

- Storage of electricity at grid scale
- Battery-driven world
- Growing electrification of world economy
- Automation / Virtualization
- Artificial Intelligence
- Robotics
- Nano-technologies
- Materials science
- Health science
- Big data
- Internet of things
- Deep ocean mining

THE ROBOTIC REVOLUTION

- Robots just in time to tackle "Ageing" and diminishing work force
- The "Dronization" of society
  - Industrial / Manufacturing
  - Energy
  - Cities
  - Goods transportation
  - War

GEOPOLITICS

- US technological / Military power anchored in Americas and Pacific RIM
- China emergence anchored in Asia Continental Belt, Indian Ocean and South Atlantic
- Russia balance Asia's/China/Europe or running to disaster and chaos?
- Middle East implosion or stabilization?
- Europe reinvention or growing irrelevance

WORLD TRANSPORTATION SYSTEM

- The electyric car emergence
- TESLA revolution?
- Electric/Hybrids/Fuel Cells
- The Self-driving car
- The car as a center for work, information, analysis, interaction as part of a dynamic network
- ICE motors running on gas with a new dynamics

WORLD ENERGY MATRIX

- More gas
- More renewables
- More electricity
- The digital revolution
- Smart grids
- Smart consumption
- Negawatt revolution
- The digital utilities

ROBOTS THAT TEACH EACH OTHER


UBR 708N

CONVERSATIONAL INTERFACES


MUNDO FÍSICO
• Veículos sem condutor
• Impressão 3D
• Robótica avançada
• Ciência de novos materiais
SÉCULO XXI
As IDEIAS QUE PODEM MUDAR O MUNDO
MUNDO DIGITAL
• Inteligência Artificial
• As Máquinas que aprendem
• A Internet das coisas
• O poder dos sensores
O MUNDO BIOLÓGICO
• A sequenciação do Genoma
• A Edição Genética e a Terapia
• A Técnica CRISPR
• A luta contra as doenças
• A Medicina com assistentes virtuais (robots)

Para onde vai o Século XXI?

Portugal na encruzilhada: como atuar no mundo de hoje?

A Geopolítica e a Economia

- Efeitos da globalização
- Declínio do Estado-Nação
- Emergência de novos atores
- Transferência parcial do poder financeiro
- Crise global do sistema capitalista

As ameaças globais

- Climática (migrações)
- Pandemias
- Terrorismo
- Ataques cibernéticos
- Estados falhados
- Colapso da ordem em zonas do Globo
- Proliferação nuclear
- Armas de destruição maciça
- Pirataria

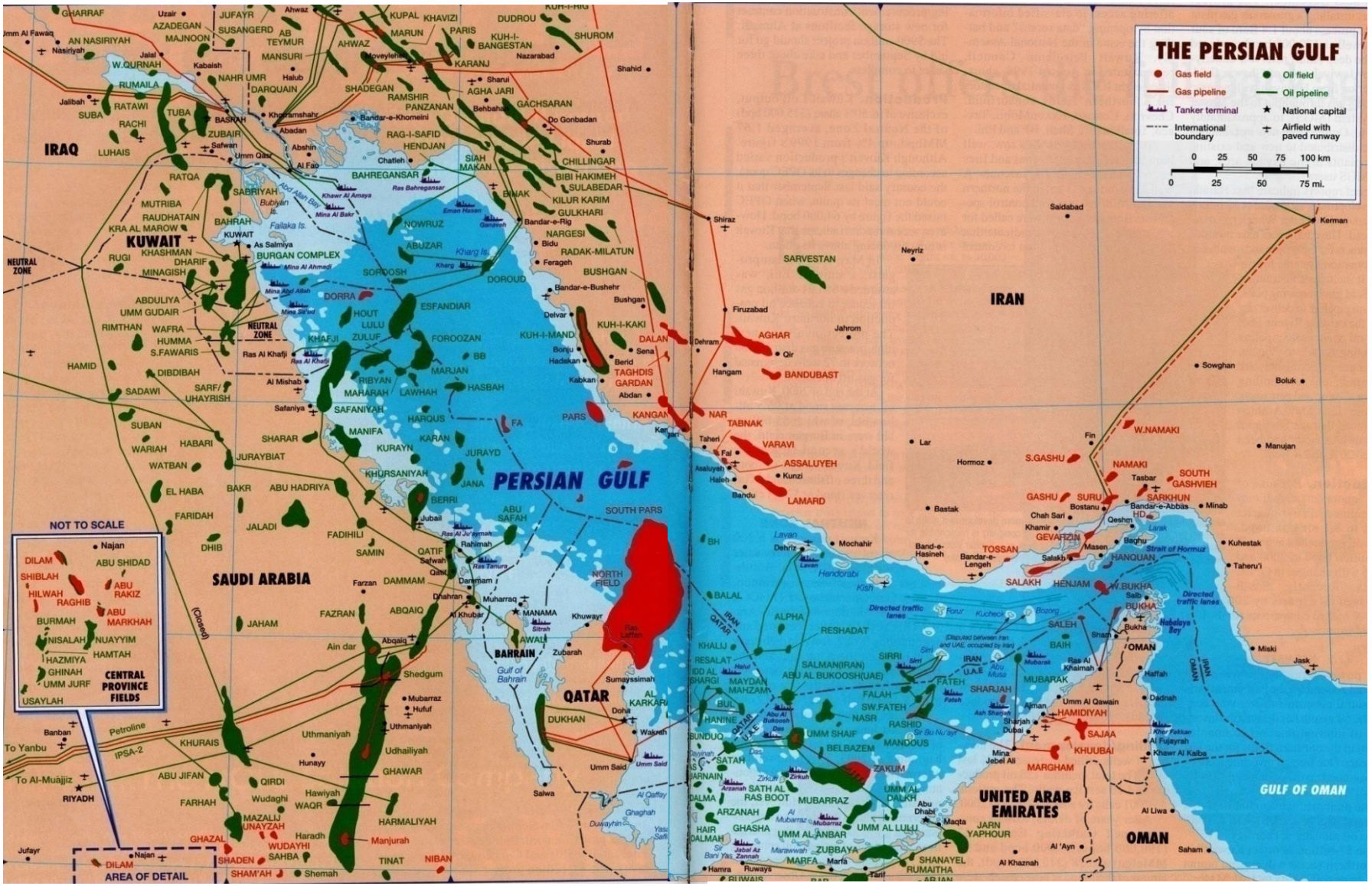
Os recursos

- Recursos cada vez mais escassos
- Intensificação da luta pelos recursos:
  - Minerais
  - Energéticos
  - Alimentares
  - Água
- Controle de matérias-primas estratégicas

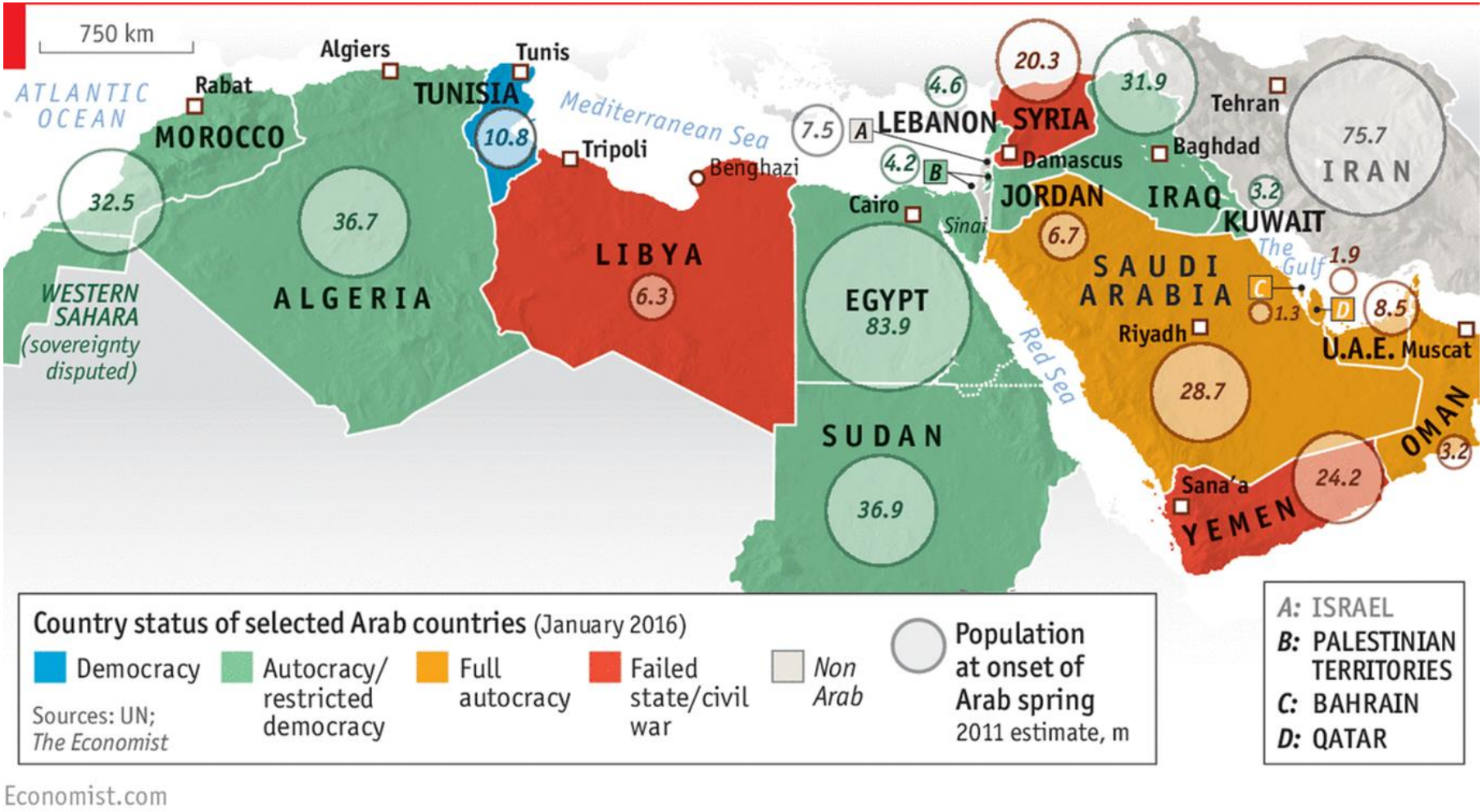
PRODUCTION of SELECTED COMMODITIES, 1950, 1975, and 2000 (in thousand metric tons, unless otherwise noted)

	PRODUCTION			PERCENT INCREASE 1950 - 2000
	1950	1975	2000	
Bauxite	8,370	25,401	135,000	1,513
Cobalt	7	30	33	371
Copper	2,645	6,960	13,200	399
Iron ore	250,000	887,389	1,061,148	324
Nickel	146	787	1,250	756
Titanium	814	3,298	5,187	537
Crude oil (billion barrels)	3,8	19,5	27,3	618
Natural gas (tillion cubic feet)	7,2	55,8	85,1	1,082

CONSTRAINTS ON OIL AND GAS FLOW FROM MIDDLE EAST



Arab Countries Status



Jihad in AFRICA
The Danger in the Desert

Source: The Economist, January 26th - February 1st

SEGURANÇA do ABASTECIMENTO

- PORTUGAL: 45% gás Argélia
  55% gás Nigéria
- Pipelines do Magrebe
- Instabilidade política MENA
- Dependência Energética do exterior 72%
- Europa: dependência da Rússia
- Papel da fachada Atlântica
- Segurança fluxos (pirataria)
- Cooperação geopolítica

SEGURANÇA ENERGÉTICA

SUSTENTABILIDADE AMBIENTAL

- Aposta nos recursos endógenos
- Mudança paradigma: do lixo para os recursos
- Economia Circular: design/reciclagem/produtos
- Papel das Energias Renováveis
- Controlo e declínio emissões CO_2
- COP 21 e mudança climática
- Ligação aos mecanismos do mercado (caso carvão exportado dos EUA para a Europa)

ESTABILIDADE e COMPETITIVIDADE dos PREÇOS

- Falhas Mercado Único Europeu de Energia
- Falhas liberalização /regulação dos mercados
- Fraquezas das Redes Europeias Energia (pipelines + redes eléctricas)
- Políticas Públicas desligadas dos mecanismos económicos do mercado

A SEGURANÇA NA BACIA DO ATLÂNTICO

Equador | Meridiano de Greenwich | Círculo Polar Árctico | Círculo Polar Antárctico | Trópico de Câncer | Trópico de Capricórnio

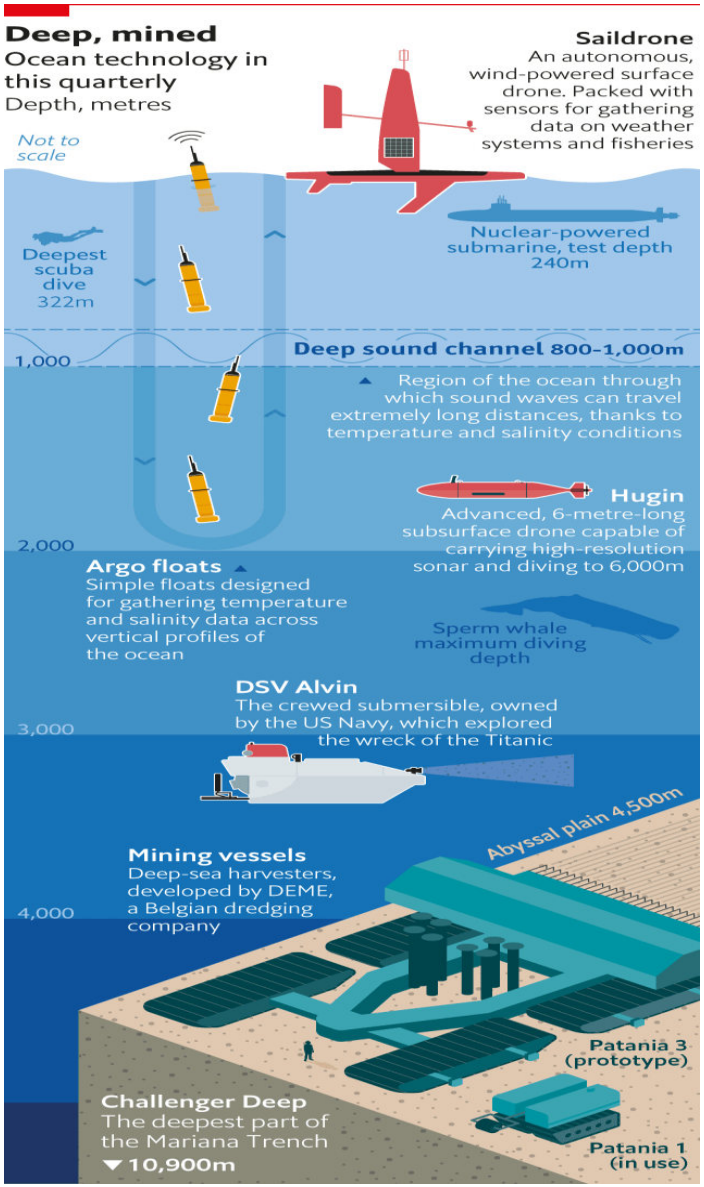
Dropped in the ocean

Operational Argo floats

February 12th 2018

Total: 3,887

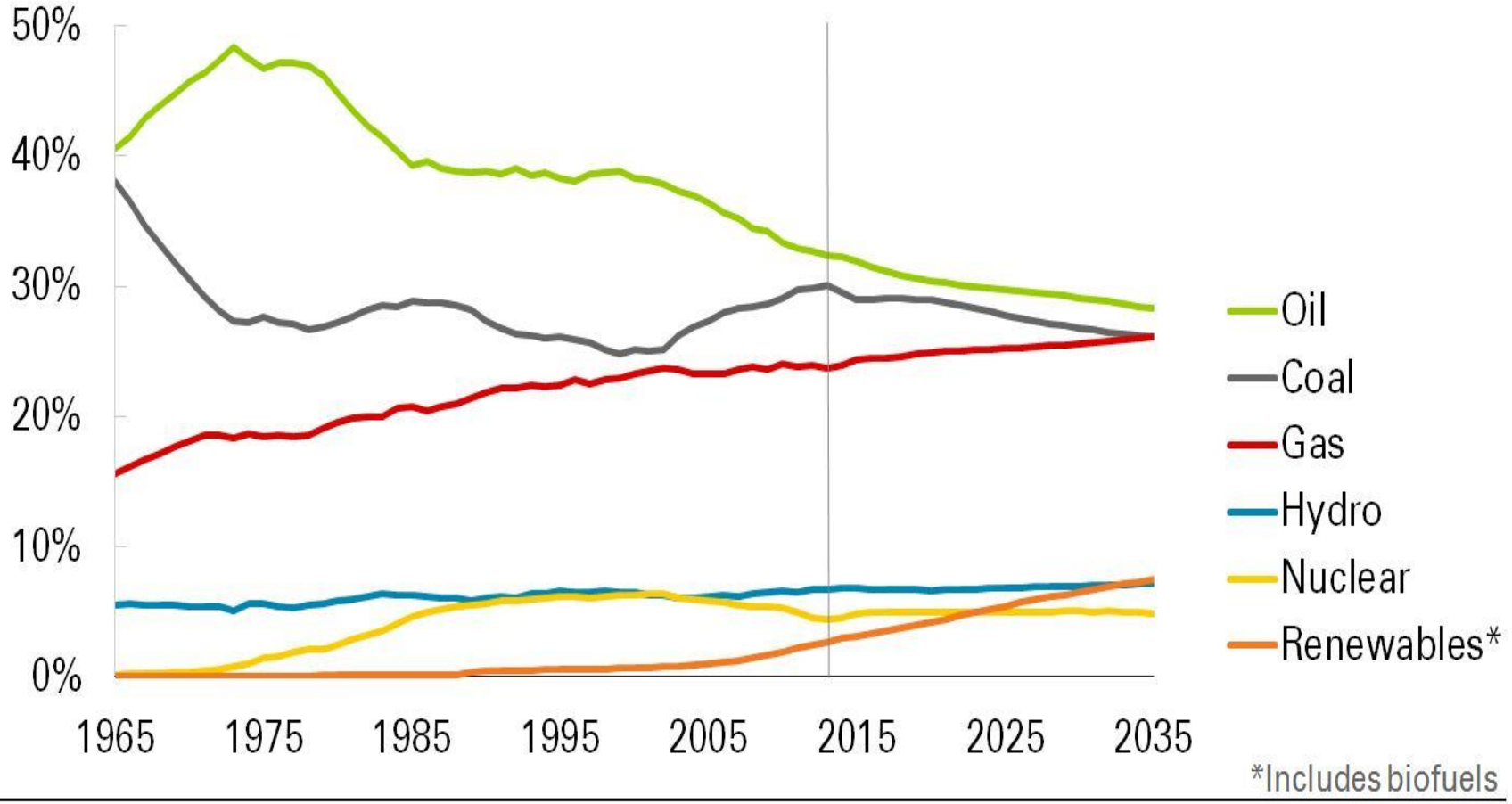
Source: International Argo Project



Source: The Economist, 10th March 2018

2. O Papel Geoestratégico do Gás Natural

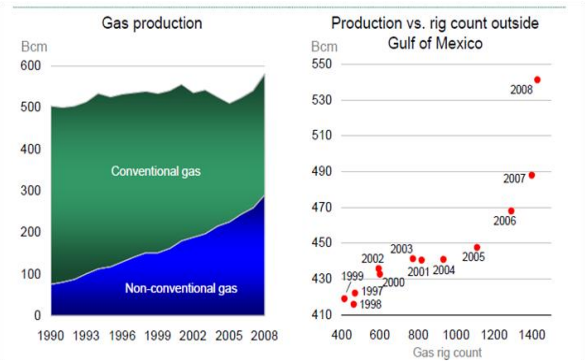
Shares of primary energy



Energy Outlook 2035

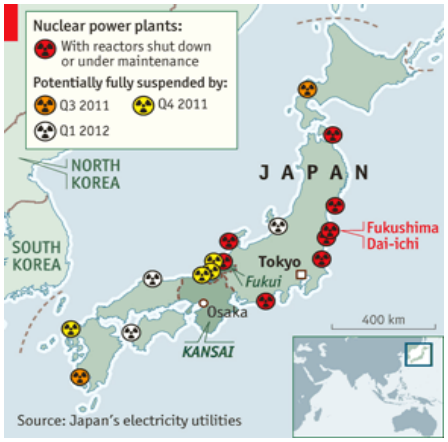
ENERGY GAME CHANGERS in XXI CENTURY

UNCONVENTIONAL GAS

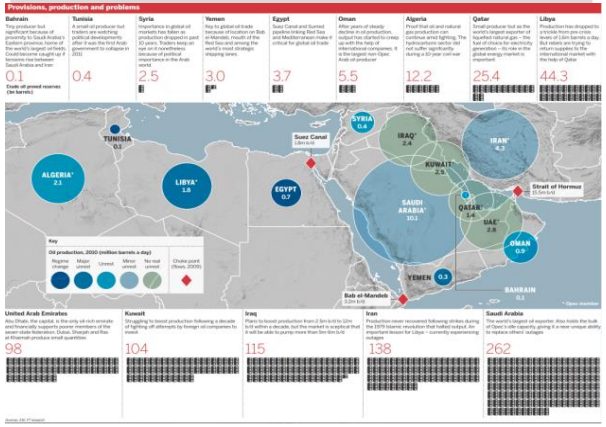


INDUSTRY CATASTROPHIC ACCIDENTS (e.g. OFFSHORE OIL Spills) and PUBLIC IMAGE

FUKUSHIMA NUCLEAR ACCIDENT



INSTABILITY in PRODUCING COUNTRIES and THREATS to SUPPLY

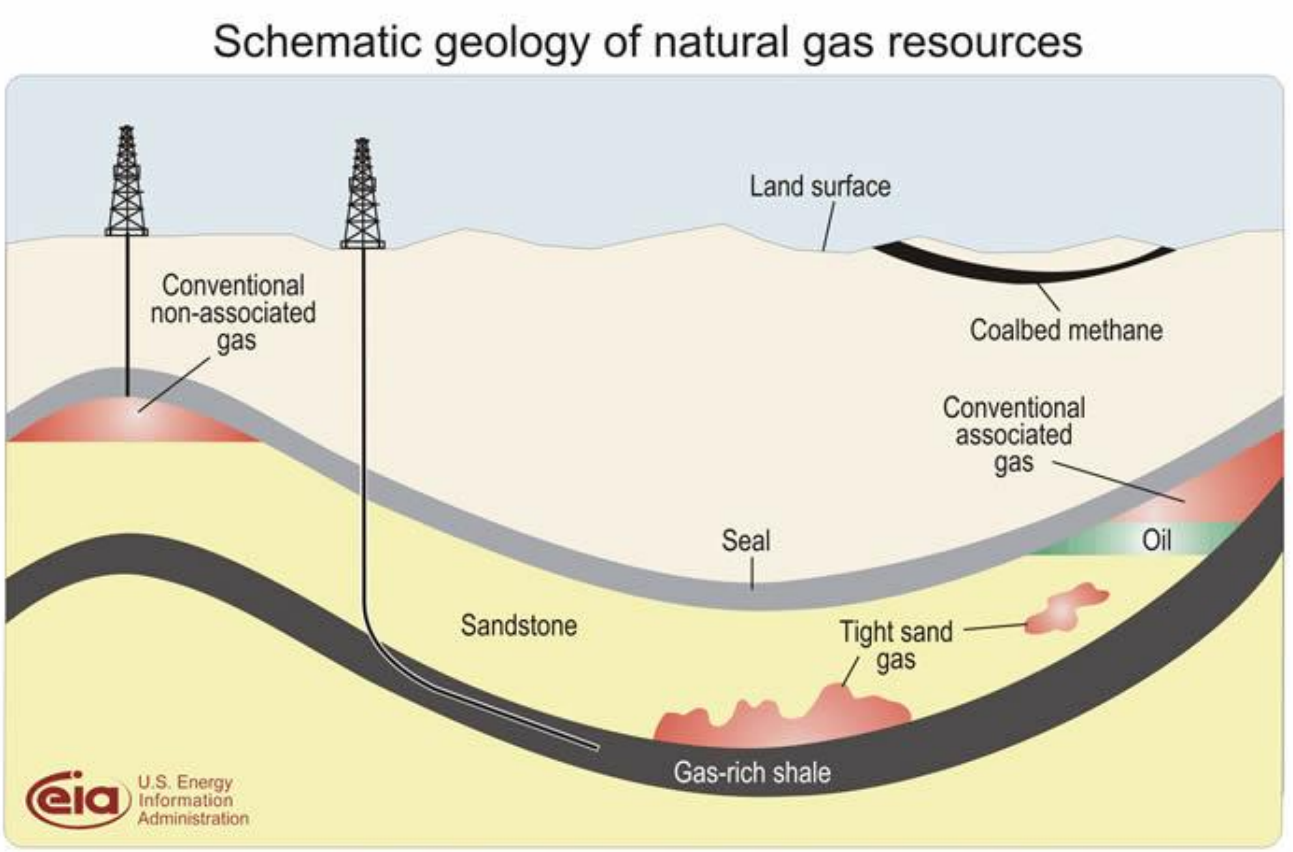


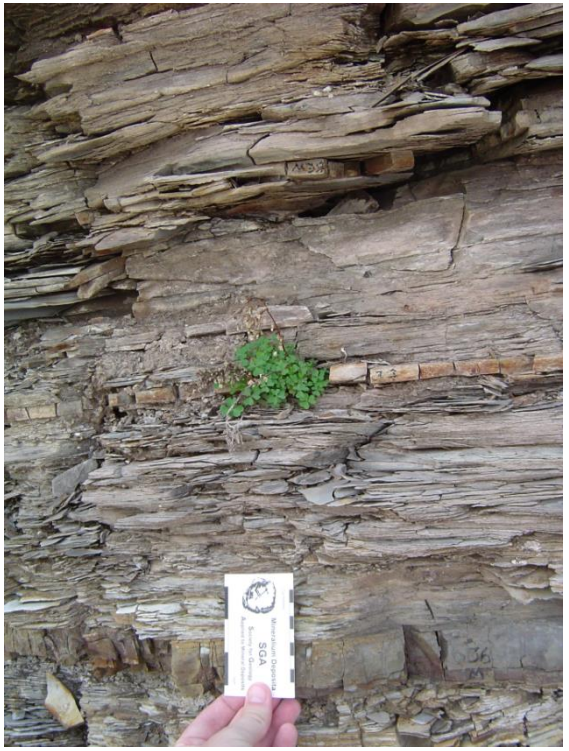
EMERGENCE of PACIFIC BASIN as TOP ENERGY CONSUMER

CLIMATE CHANGE and ENVIRONMENTAL REVOLUTION

- The Revolution of the SHALE GAS
- The Conceptual Innovation for Shale Production
- US Learning Curve
  - Footprint Concerns
  - Induced Seismicity
- Knowledge of Rocks and Evaluation of the Potential
- Can the US Shale Model be exported?

What is the SHALE GAS?



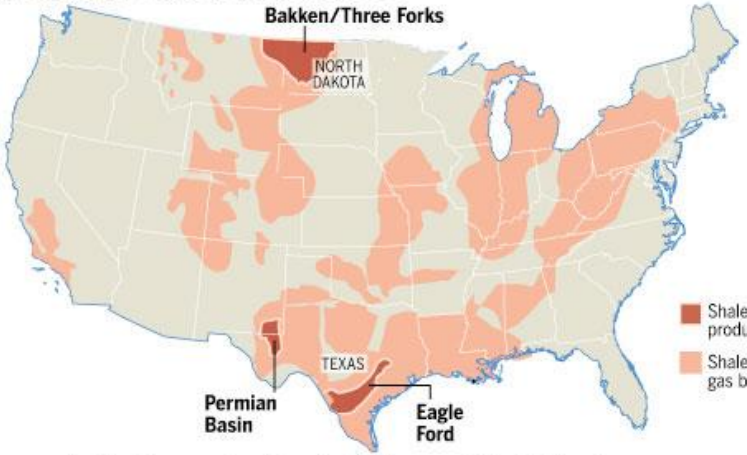


A world class source rock and a potential shale gas reservoir – the Devonian-Mississippian Woodford Shale

US OIL SHALE: TEXAS HEARTLAND HEADS THE US OIL REVIVAL

Re-energising America

Key oil and gas shale regions in the US

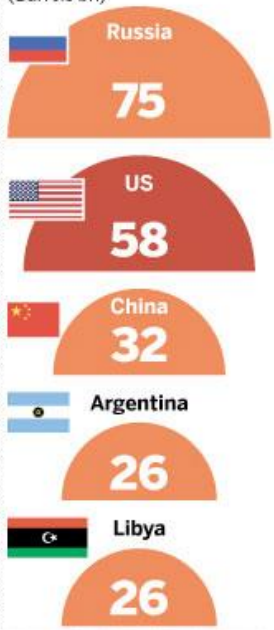


Companies leading exploration in Bakken and Eagle Ford

Bakken-Three Forks		Eagle Ford	
Continental Resources	ExxonMobil	EOG Resources	EP Energy
Whiting Petroleum	Marathon Oil	ConocoPhillips	Marathon Oil
Hess Corporation	Petro-Hunt	Chesapeake Energy	Murphy Oil
Statoil	Slawson Exploration	GeoSouthern Energy	Pioneer Natural Resources
EOG Resources	Kodiak Oil & Gas	Anadarko	
		Plains Exploration & Production	

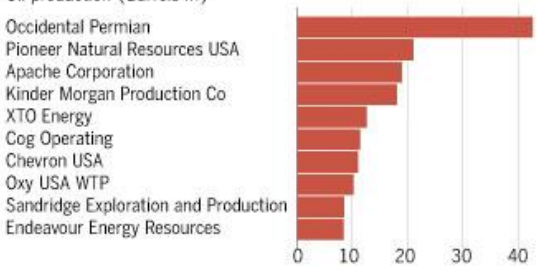
Top countries with shale oil resources

Technically recoverable (Barrels bn)



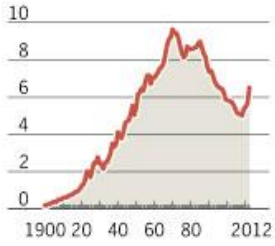
Top 10 Permian Basin operators, 2012

Oil production (Barrels m)



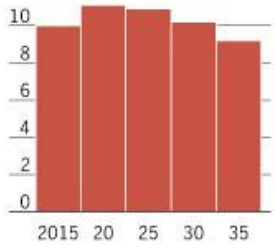
US oil production

Million barrels per day



US oil production forecasts

Million barrels per day



Sources: EIA; IEA

FT graphic Photo: Bloomberg

Source: FT, 8th July 2013

WORLD TOTAL GAS RESERVES

Source: The Economist, 6th August 2011

The IEA calculates that electricity prices for German industry have tripled since 2000

Fonte: The Economist, 14th June 2014

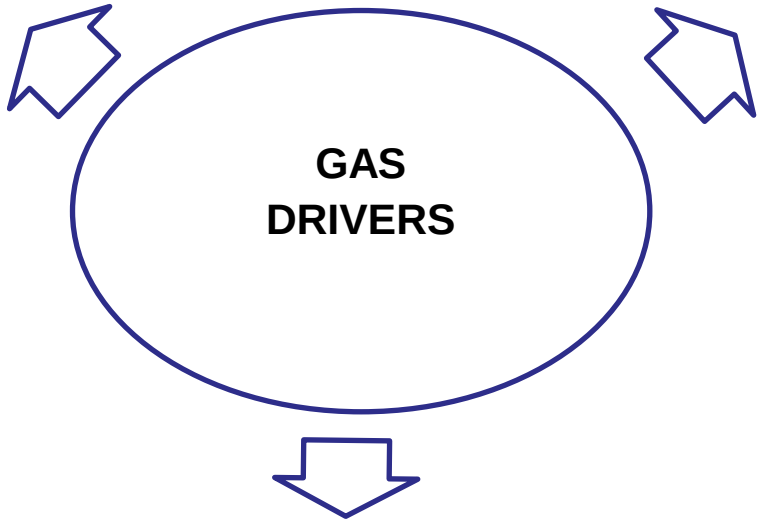
DRIVERS FOR FURTHER GAS DEVELOPMENTS

APPLICATIONS

- Gas is most versatile of fossil fuels
- Used both in power generation and transportation
- GTL may be competitive solution for transport in Medium Term

DECARBONIZATION OF ECONOMY

- Gas is the least poluent of fossil fuels
- May play key role in transition of energy paradigm



EFFECTS OF JAPAN NUCLEAR CRISIS

- Decision of some countries to slowdown nuclear power (Germany, Italy, Japan)
- Opens a more decisive role for Gas

DRIVERS FOR FURTHER GAS DEVELOPMENTS

Citizenship Issue

- **Mobilization**
- **Change of behaviour**
- **Global economy vs local governance**
- **Multilateral institutions**
- **Restructuring of world economy**

CLIMATIC CHANGE

- **Is an issue of Security and survival**

THE CLIMATIC THREAT

- Concentration of CO2 in atmosphere before the Industrial Revolution : 280 ppm
- Current concentration : 400 ppm
- Projection at the end of the XXI Century: 560 ppm ("Business as usual")
- Increase of Earth temperature: 3 – 4º C
- Instability of life on Earth

Need of action focused on polluter centers:

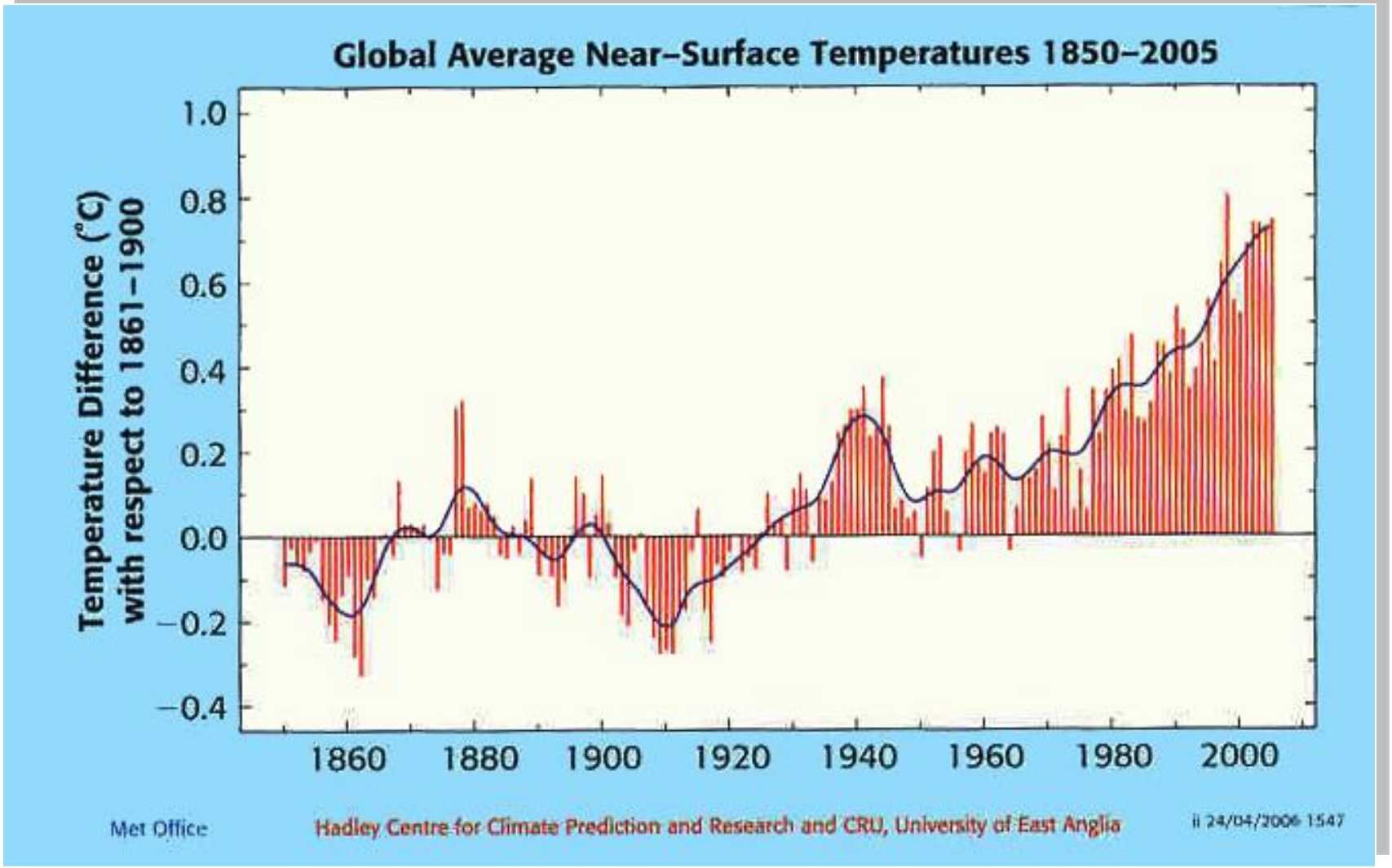
- **Power stations**
- **Electricity System**
- **Transport System**

Reduction of CO2 Emissions to be sucessful needs to be linked to MARKET mechanisms

NEED BUILD a Low-Carbon **ECONOMY**

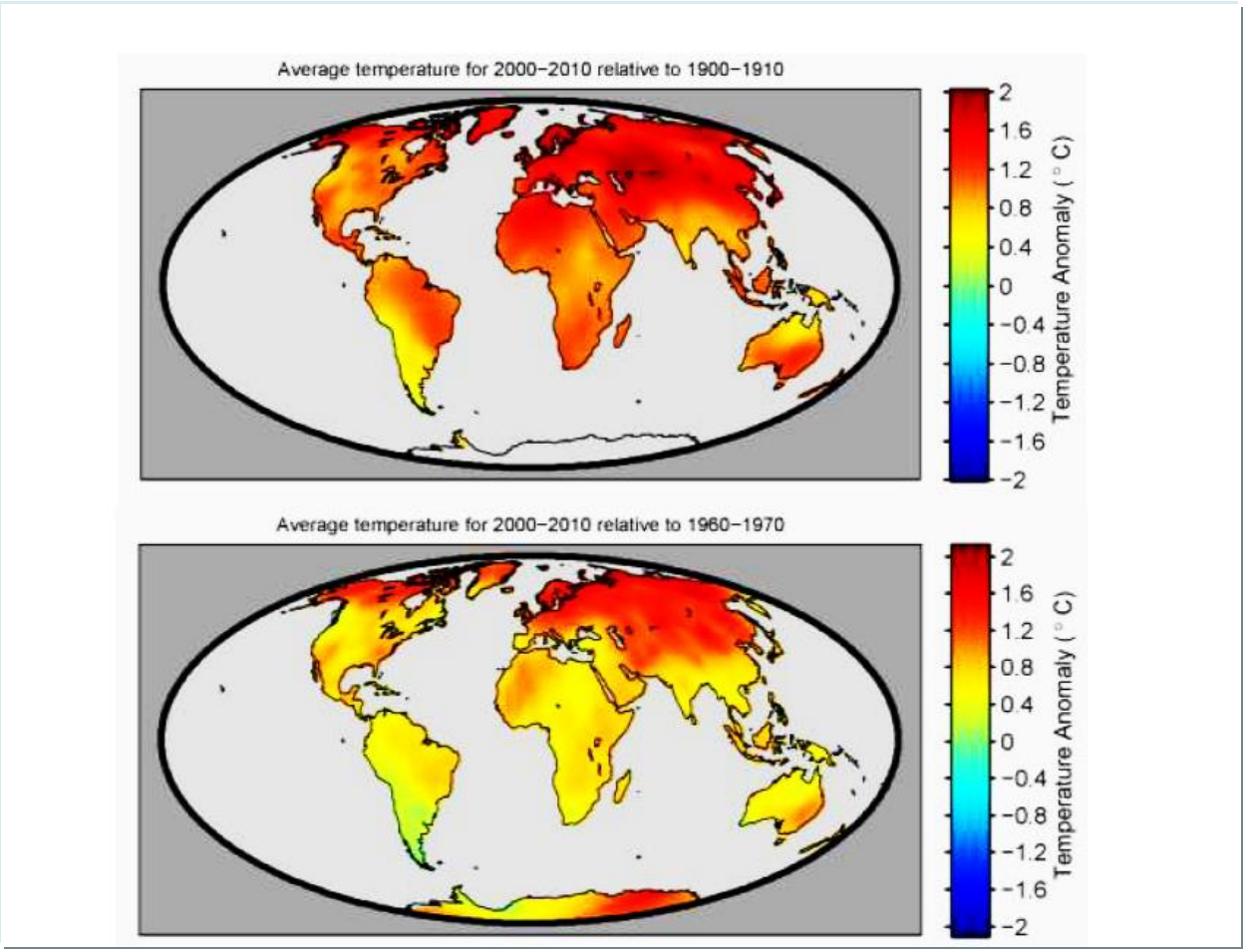
- **Till today action led to poor results**
- **New Action Plans**

The Earth has warmed 0.7ºC since around 1900



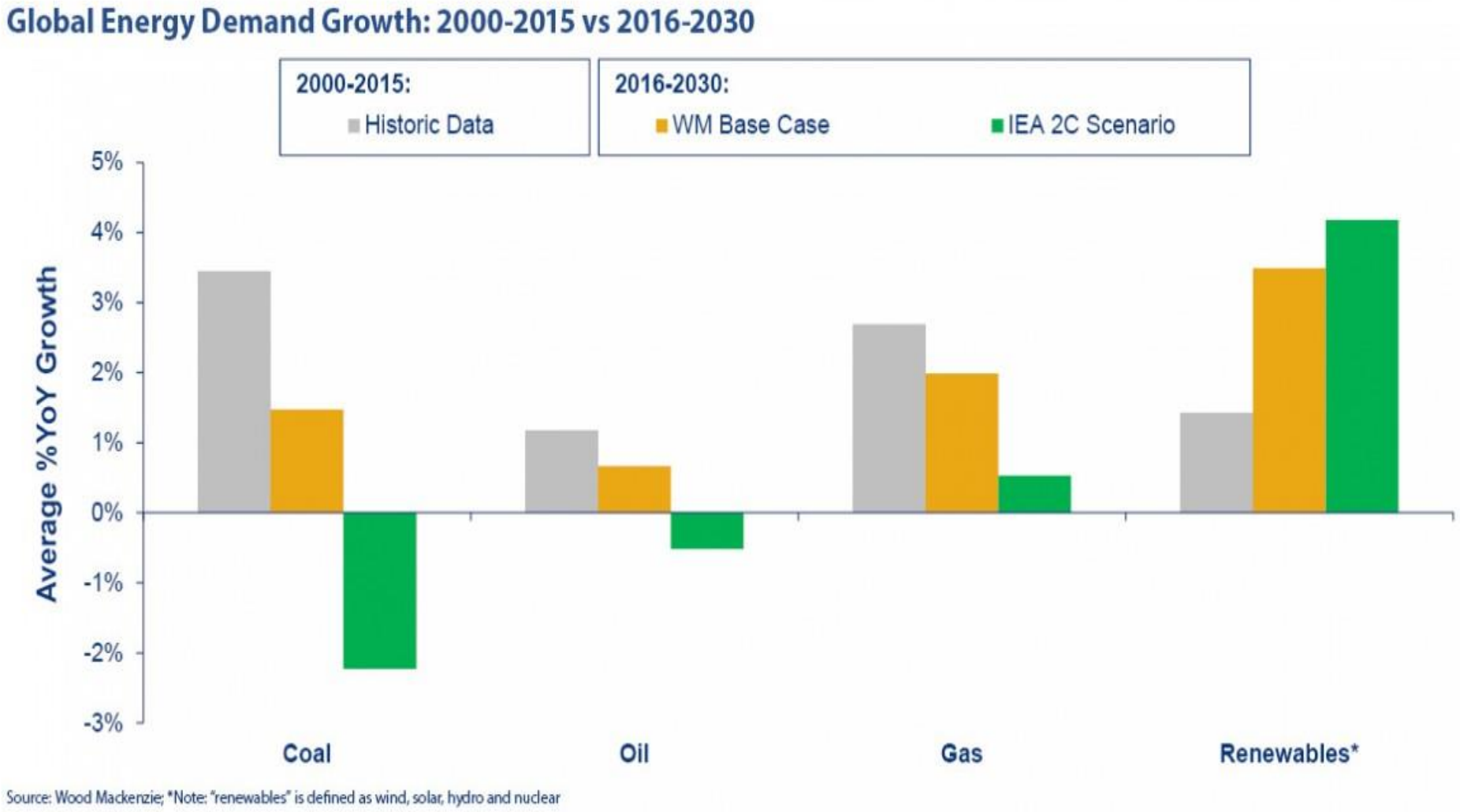
Fonte: Nicholas Stern / Brohan et al (2006)

BERKELEY EARTH TEMPERATURE STUDY
Prof. Richard A. Muller Team, November 2011



Maps showing the decadal average changes in land temperature field. In the upper plot, the comparison is drawn between the average tenperature in 1900 to 1910 and the average temperature in 2000 to 2010. In the lower plot, the same comparison is made but using the interval 1960 to 1970 as the starting point. We observe warming over all continents with the greatest warming at high latitudes and the least warming in southern South America

Paris COP 21 and Future Scenarios



TRANSPORTATION

- Penetration of gas in boats (LNG), trucks and taxi fleets (US)
- Growing share of electric cars
- Internal combustion engines fighting for survival
- Similar to telecommunications revolution
- Self-driving cars with technologies of information

WORLD ENERGY MATRIX

- More gas
- More renewables
- Less coal

OIL MARKET

- Declining oil share
- Ability to reduce and control costs
- How to compete in a low oil price world

POWER GENERATION

- Innovation and Emerging Technologies
- Distributed Generation
- Evolving power business models
- New services on demand response, supply, storage, energy efficiency
- Competition based on algorithms, sensors, processing power – the internet model

ENERGY 2030

- A VISION of the 2030 WORLD from the MANY "POSSIBLE WORLDS" CONTAINED in TODAY's REALITY
- 4 MAJOR TRENDS:
  - Electrification
  - Decarbonization
  - Optimization
  - Localization

GAS MARKET

- Ascension of gas
- LNG as a driving force of gas market globalization
- Gas less polluent of fossil fuels

RENEWABLES

- Growing share of world energy mix
- 5% in 2015 to 20/25% in 2050
- Solar costs reduced : 75% in 6 years
- Role of venture capital
- Ocean power: "a hidden" energy machine

TECHNOLOGIES and RISKS

- Disruptive technologies on storage, intelligent consumption, energy efficiency
- Batteries
- Cyber and Energy Infrastructure Security
- A New Face of Risks

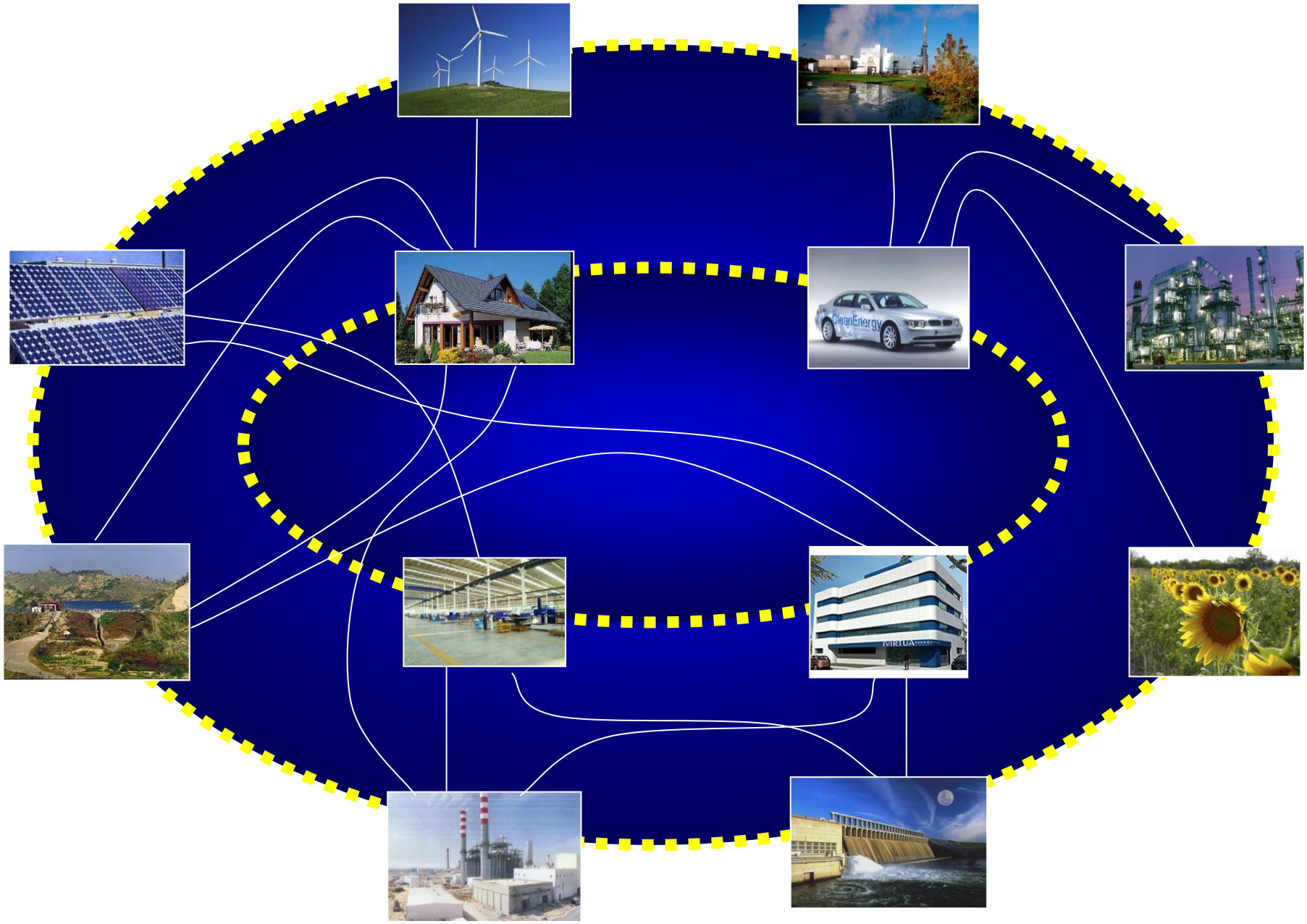
CLIMATE CHANGE

- Decarbonization
- Clean technologies
- Role of China
- Post-Paris
- Strategic responses to low carbon agenda

MARKETS and BUSINESS MODELS

- Globalization of gas market
- Improve capital efficiency
- Capital markets and Energy Investment

O NOVO PARADIGMA ENERGÉTICO



PIVOTAL ROLE of GAS in the ENERGY MIX

- The less pollutant of fossil fuels
- Win / win with renewables

STRONG CLUSTER of RENEWABLE ENERGIES

- Wind onshore and offshore
- Solar
- More and more competitive prices

BIOFUELS/BIOENERGY

- Conversion of biomass into fuels
- Reverse of paradigm
- Waste to resources
- Cellulosic algae
- Not compete with food crops

OTHER POWERFUL SOLUTIONS

- Natural carbon sinks
- Reforestation/Agriculture soils
- Carbon capture and sequestration
- Direct air capture
- Carbon mineralization

MULTIDIMENSIONAL RESPONSE to ENERGY TRANSITION

ELECTRICAL MOBILITY

- Change of the transportation system
- EV's for cities
- Plug-in's
- Hybrid fleet

HYDROGEN REVOLUTION

- Hydrogen from Natural Gas
- Competitive costs vs. water electrolysis
- Application in Fuel-cells and Batteries

DIGITALIZATION and OPERATIONAL EFFICIENCY

- Internet of Energy
- Streamlining of operations
- AI and ML for BIG Data processing
- Reduce emissions
- Reduce waste

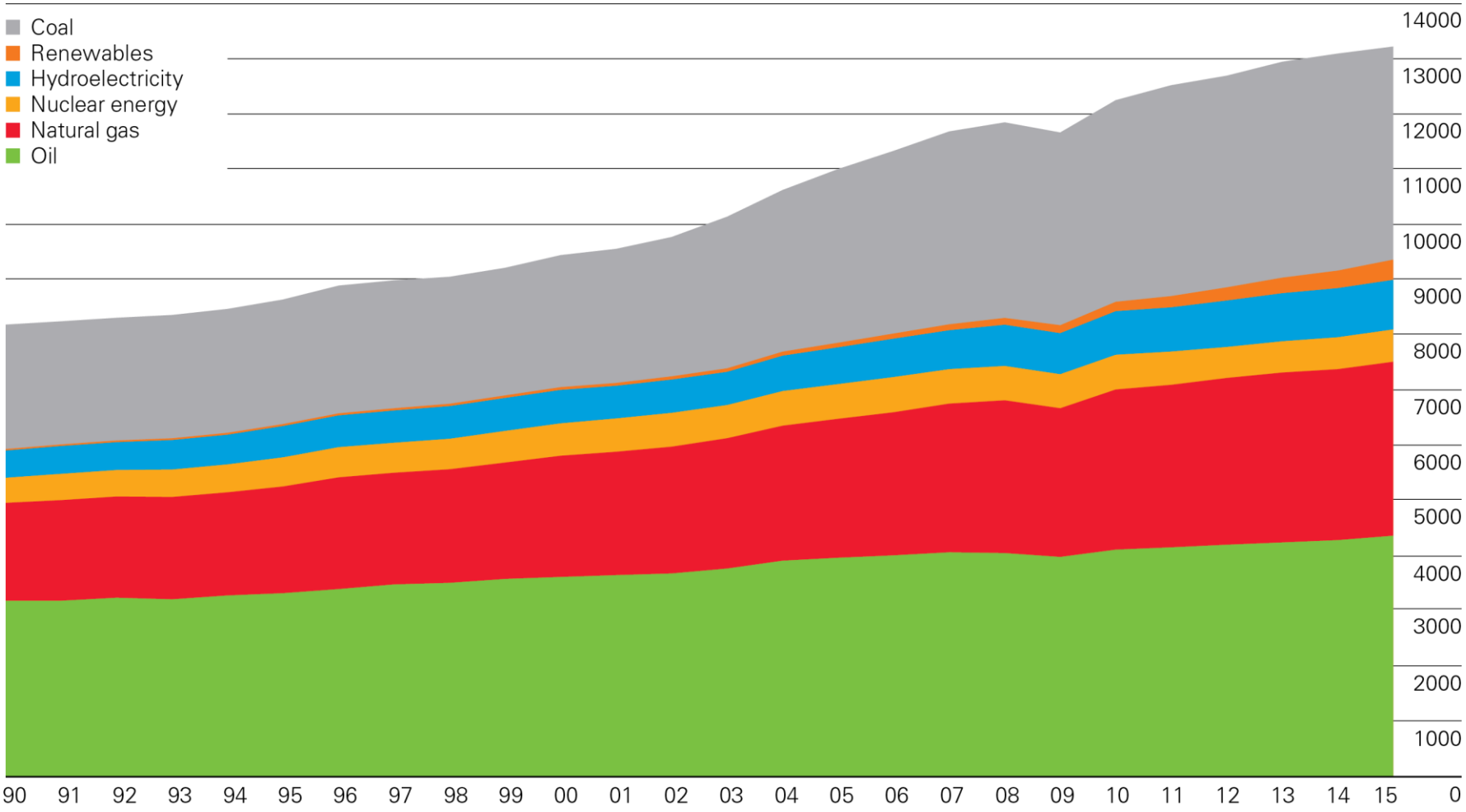
STORAGE

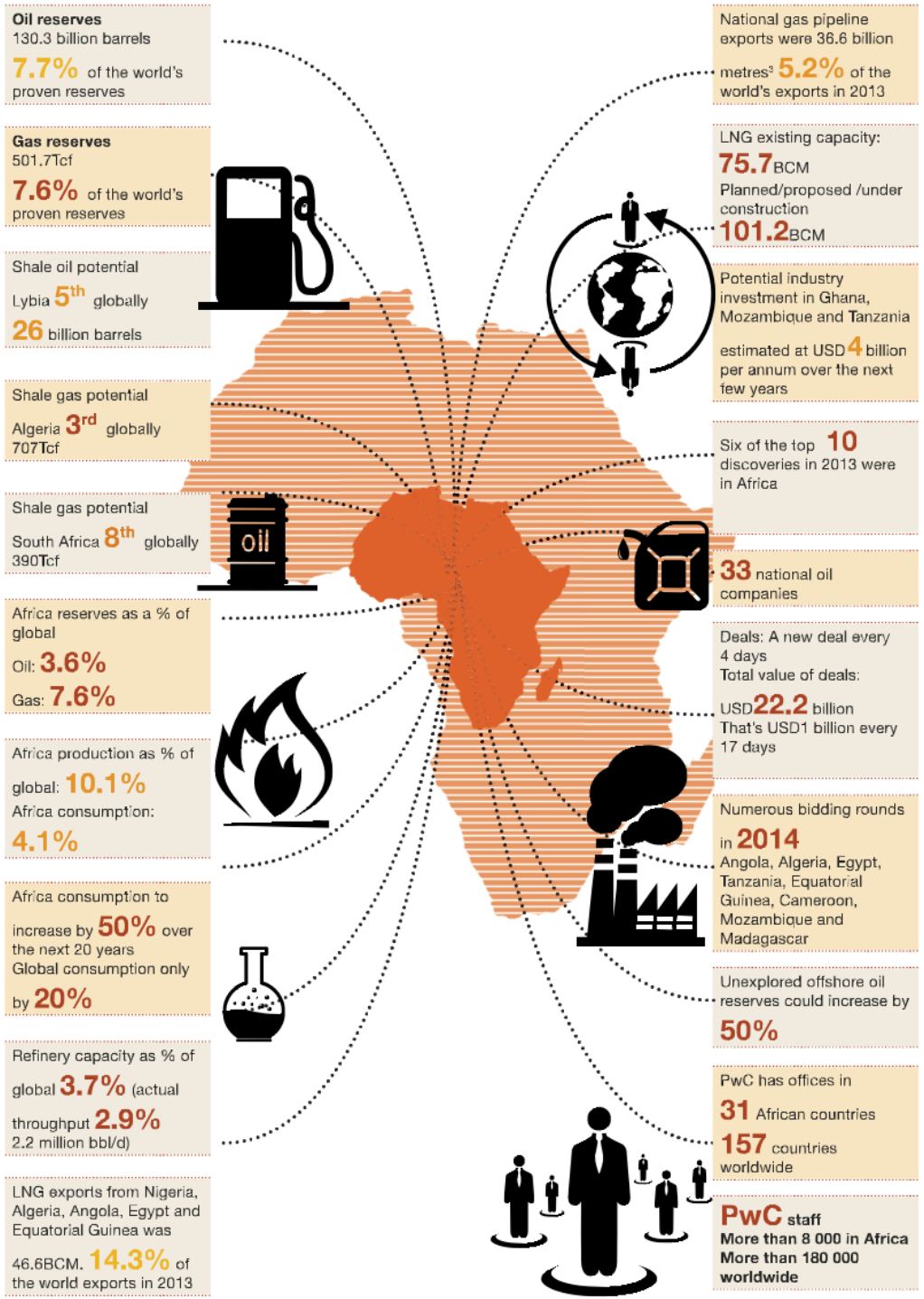
- Batteries at grid scale
- Invention of the Century
- Foster electrification of the economy

3. O Potencial de Moçambique

Primary energy world consumption

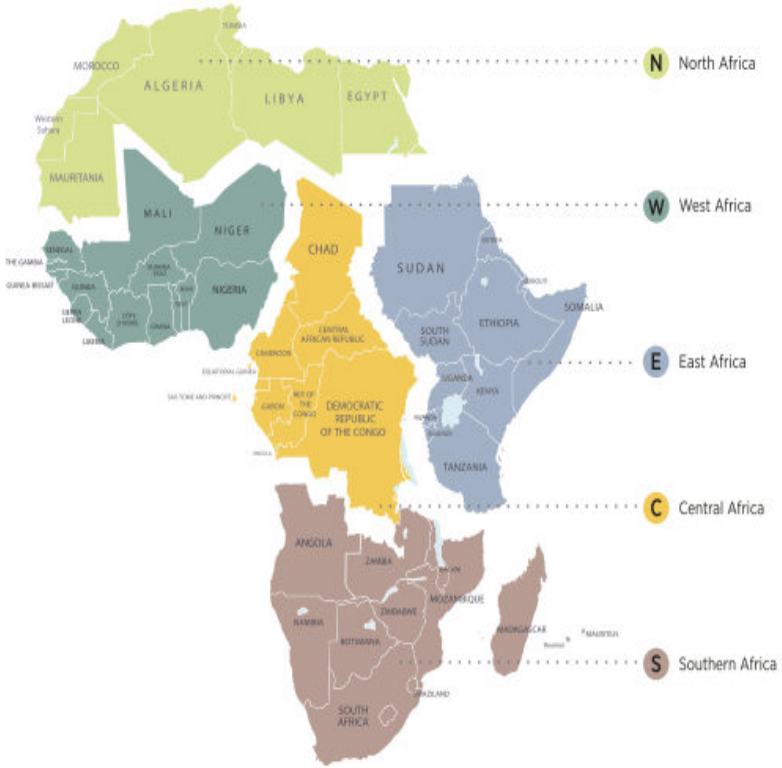
Million tonnes oil equivalent





Source: PWC, Report July 2014

Africa's energy landscape: Present*



	Population (million people)	GDP billion/yr (current international $)	Access to electricity (% population)	Electricity (KWh per capita)
N North Africa	175	1936	98%	1574
W West Africa	327	1310	47%	188
E East Africa	303	646	23%	91
C Central Africa	115	227	25%	167
S Southern Africa	177	1100	43%	2061

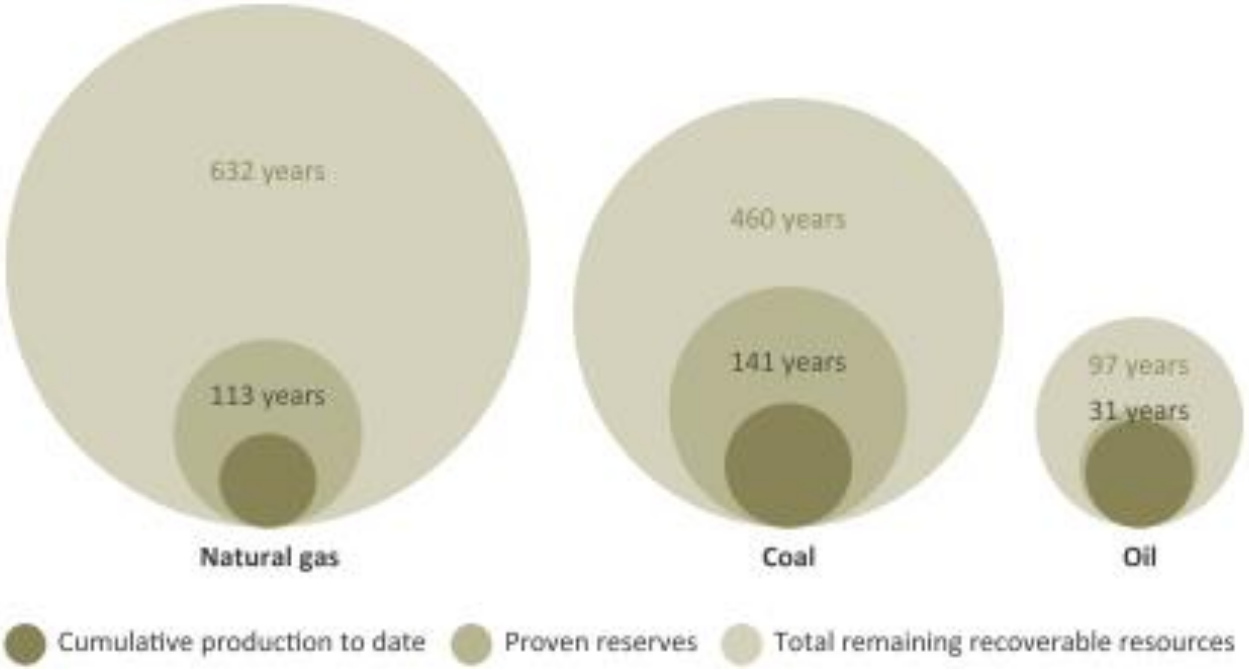
*Note: statistics refer to 2013, except for access to electricity which refers to 2012.

ENERGY IN AFRICA TODAY

- Since 2000 much of Sub-Saharan Africa expected rapid economic growth but the current state of the energy system is a huge threat to future economic hopes

- Energy demand grew by 45% from 2000 to 2012 but it is only 4% of world total
- More than 620 million people without access to electricity
- 730 million people rely on traditional use of sold biomass for cooking
- Grid power generation is 90 GW (50% in South Africa); 45% of this capacity is coal (mainly South Africa), 22% hydro, 17% oil and 14% gas (mainly Nigeria)
- Insufficient, unreliable or inaccessible grid supply results in large scale private oil fuelled generators

Sub-Saharan Africa Natural Gas, Coal, and Oil Reserves, end 2013

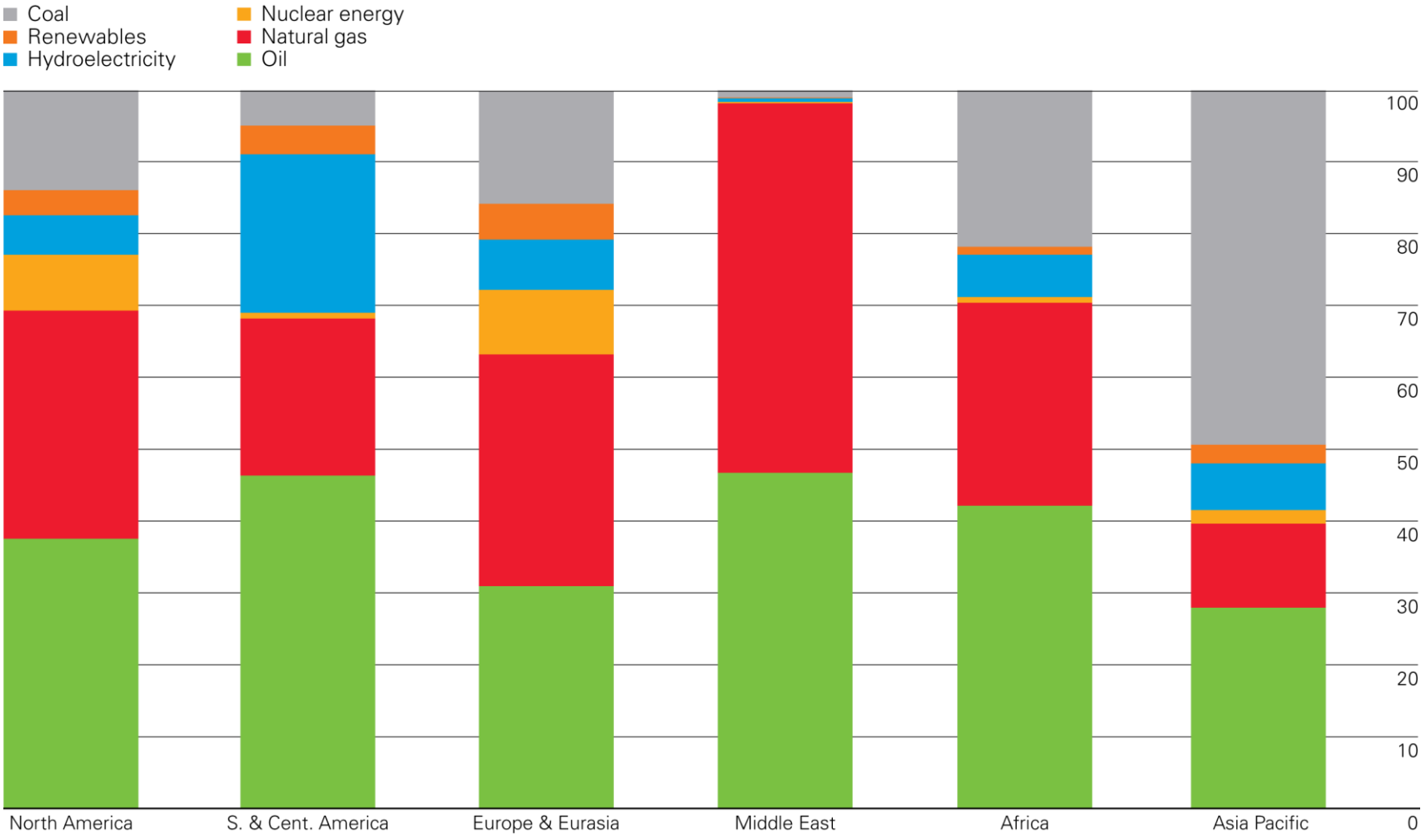


Notes: All bubbles are expressed as a number of years production based on estimated production levels in 2013. Production numbers for gas include flaring – if flaring were to cease today, there would be sufficient resources for around 960 years of production at 2013 production levels. Remaining recoverable oil and gas resource numbers include conventional and unconventional resources.

Sources: USGS (2000); USGS (2012a); USGS (2012b); Cedigaz (2013); BGR (2013); IEA analysis.

Primary energy regional consumption by fuel 2016

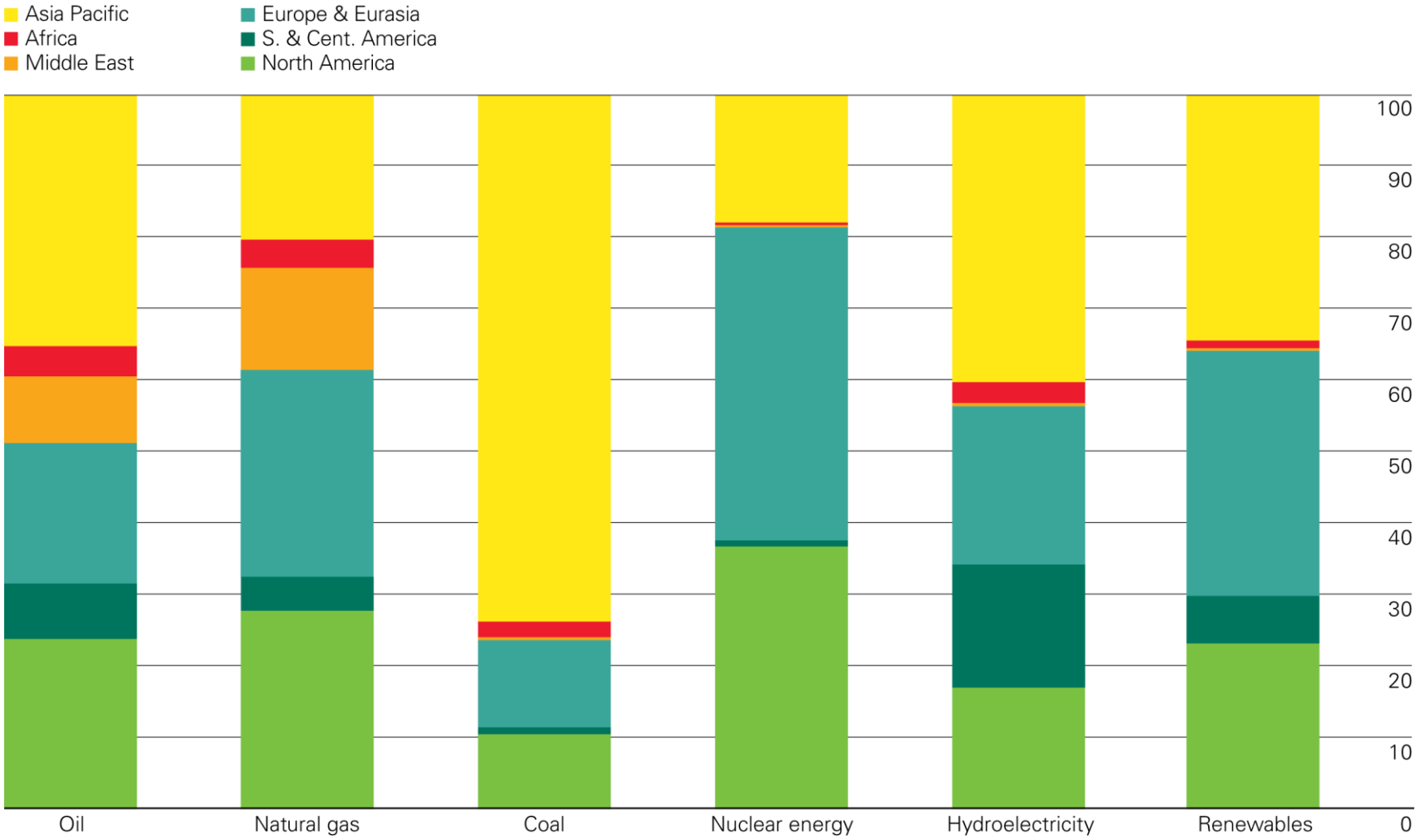
Percentage



Source: BP Review of World Energy 2017

Fuel consumption by region 2016

Percentage



Source: BP Review of World Energy 2017

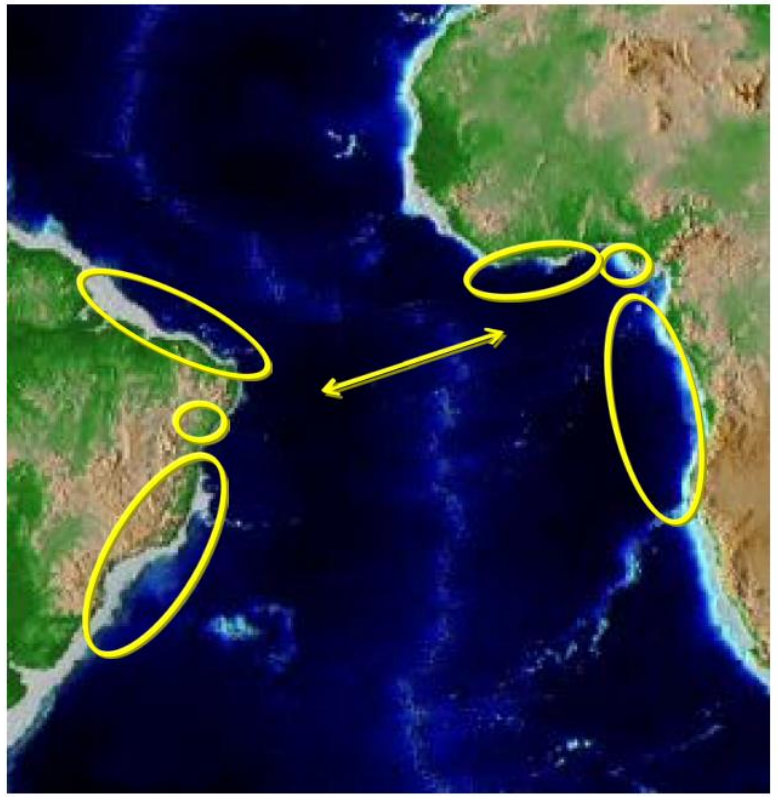
ENERGY IN AFRICA TODAY

- Sub-Saharan Africa produces 5.7 MB/D oil primarily Nigeria and Angola; while 5.2 MB/D of crude were exported around 1 MB/D of oil products were imported
- Natural gas: 27 bcm was exported; the same volume was flared
- Last 5 years 30% of world O&G discoveries made in Sub-Saharan Africa but challenge to turn these discoveries into production and the resulting revenues into public benefits is enormous
- Coal production (220 Mtce) is concentrated in South Africa
- Region accounts for 18% of world uranium supply

Major Oil and Gas Discoveries in the Atlantic

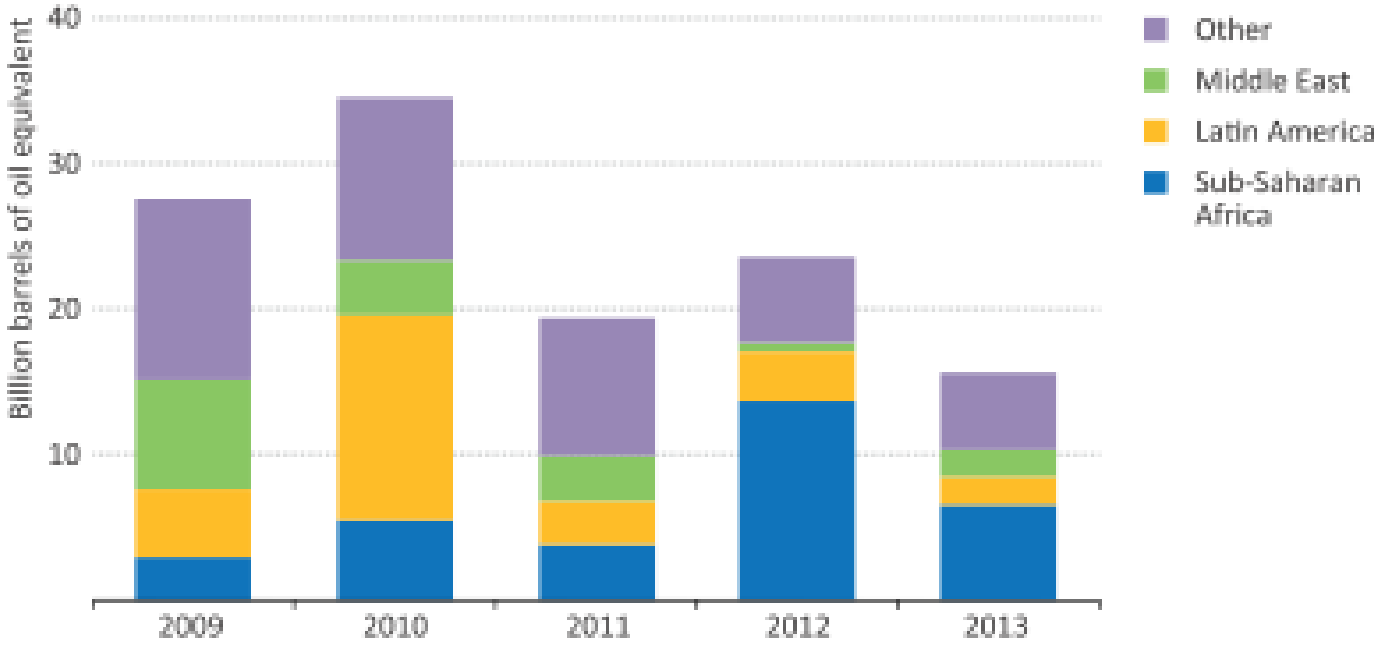
PETROBRAS

West Africa: Pre Salt



Source: 21st World Upstream Conference Global Pacific & Partners

Global Discoveries of Oil and Gas



Sources: Rystad Energy AS; IEA analysis.

AFRICAN GAS EXPORTS

CONTINENTAL SHARE		*DESTINATION OF LNG*	
Algeria	72%	EUROPE	88%
Nigeria	13%	USA	11%
Egypt	9%	ASIA	1%
Libya	6%		

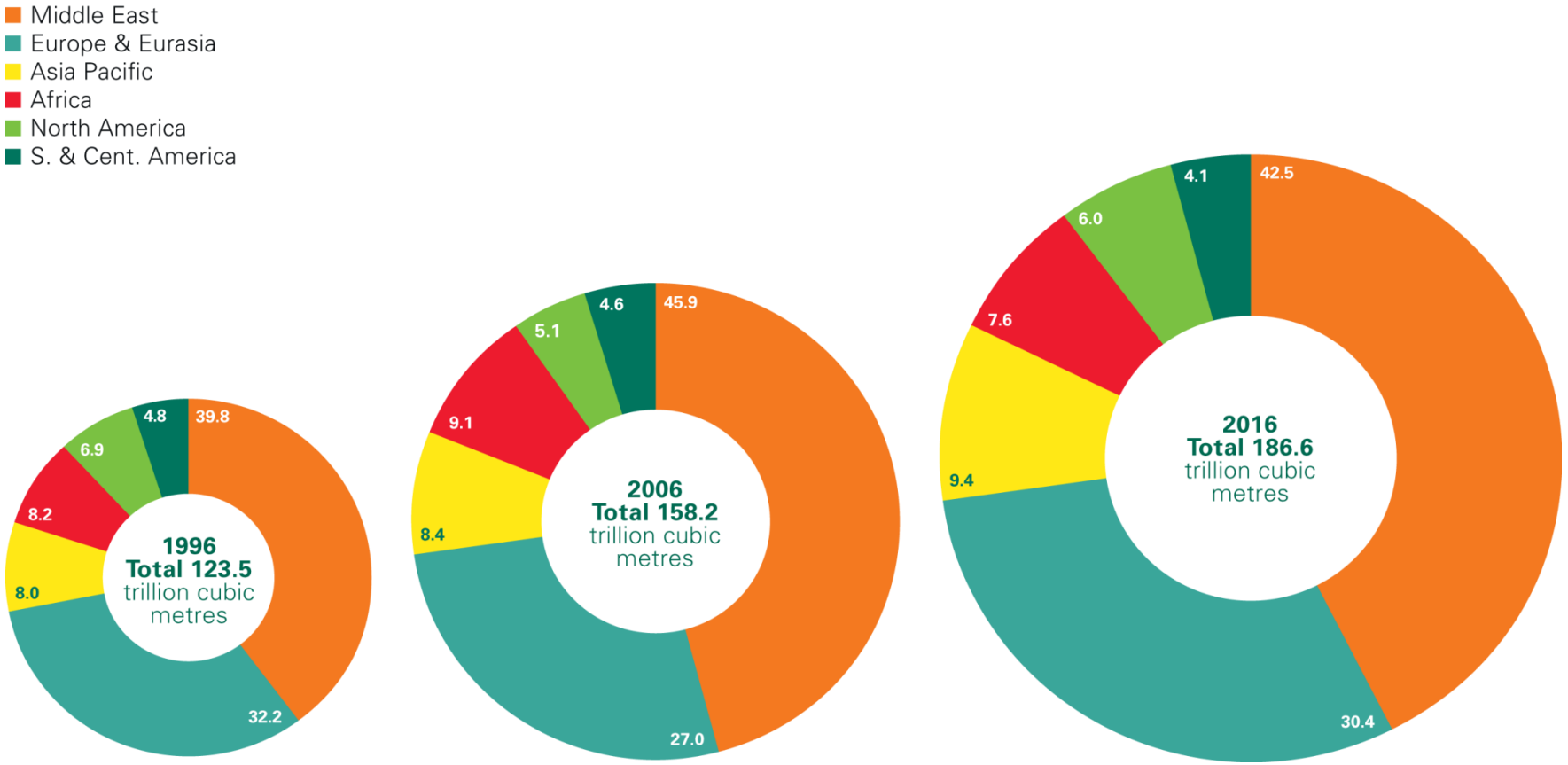
AFRICAN OIL EXPORTS

DESTINATION OF OIL	
EUROPE	35%
USA	32%
CHINA	10%
JAPAN	2%
ASIA (others)	12%

RISE of AFRICAN ENERGY CONSUMER BRINGS a NEW BALANCE to OIL and GAS

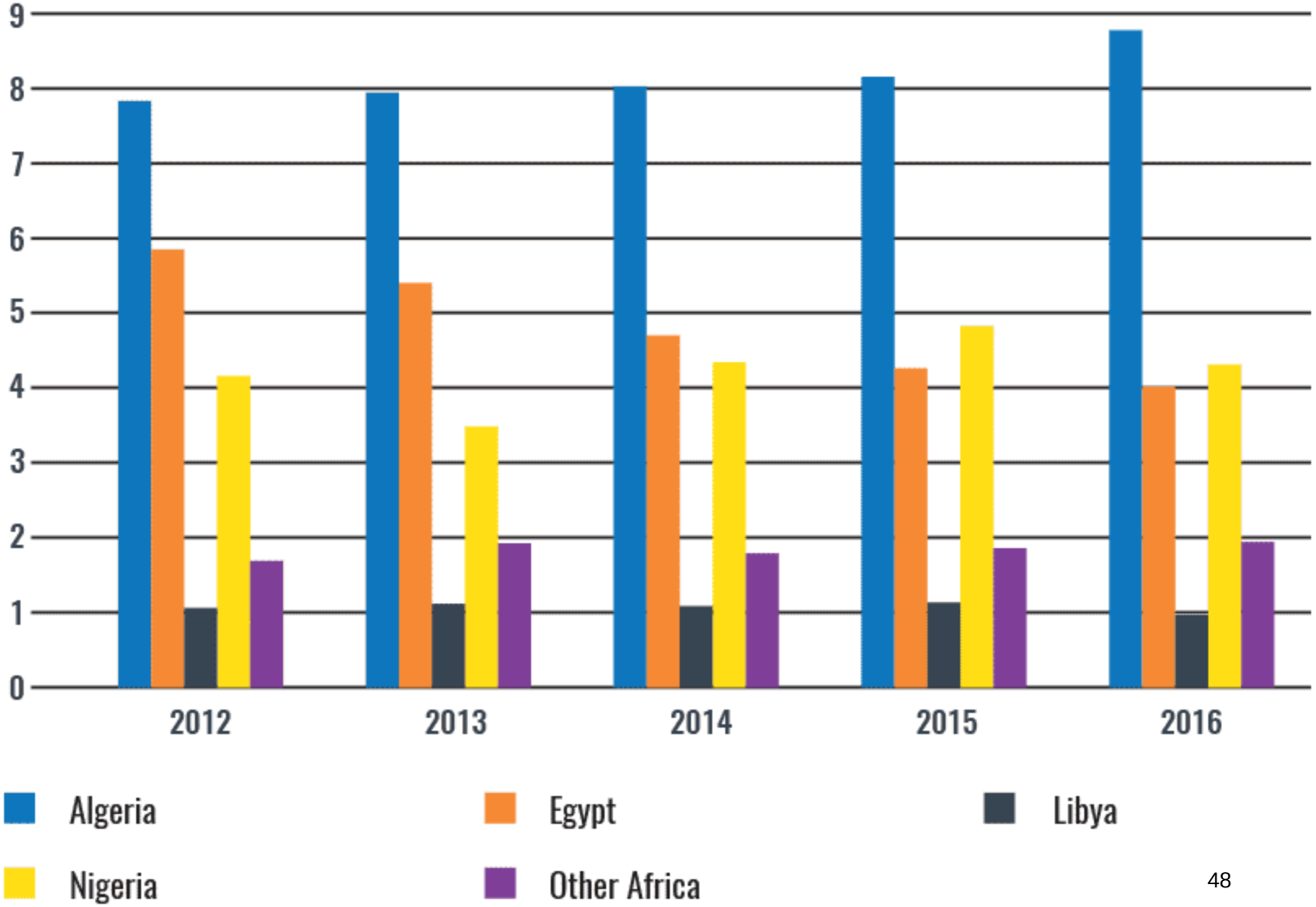
- 30% of global oil and gas discoveries made over last 5 years have been in Sub-Saharan Africa
- Growing appetite for African resources
- Nigeria is the richest resource centre of oil sector but regulatory uncertainties, militant activities and oil theft in the Niger Delta are deterring investment and production (150,000 B/D of oil theft amounting to 5 billion/year)
- Angola may overtake Nigeria as the region's largest producer of crude oil
- Host of smaller producers (South Sudan, Niger, Ghana, Uganda, Kenya) see rising output
- Late 2020's production in most countries, excepting Nigeria, in decline
- By 2020 Regional production to fall from 6 MB/D to 5.3 MB/D but demand for oil products doubling to 4 MB/D; trend amplified by subsidised prices; future contribution to oil balance will decline

NATURAL GAS PROVED RESOURCES
TCM



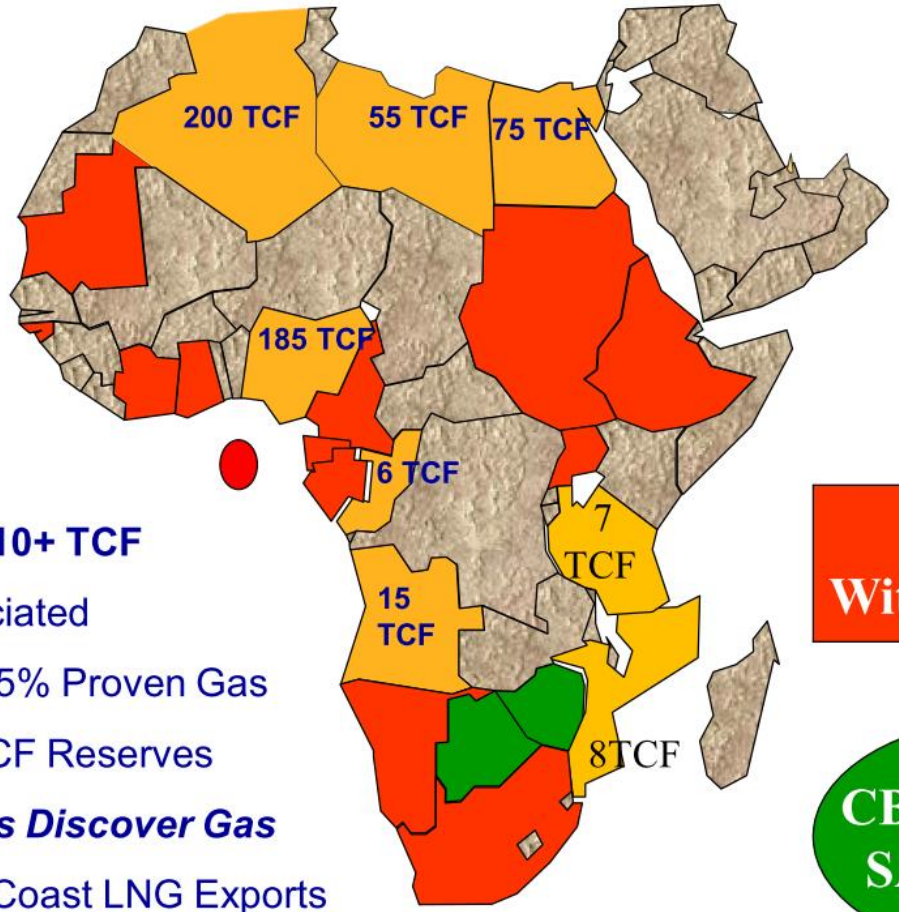
Source: BP Review of World Energy 2017

AFRICA GAS PRODUCTION 2012-2016 (BCF/D)



Africa: Proven Gas Reserves

Africa
Long Gas Future



Global Pacific & Partners
London • The Hague • Johannesburg • Nicosia • Rio de Janeiro

Major Gas Reserves

Countries With Proven Gas

CBM Potential SA Shale Gas

Proven Gas: **510+ TCF**

50% Non Associated

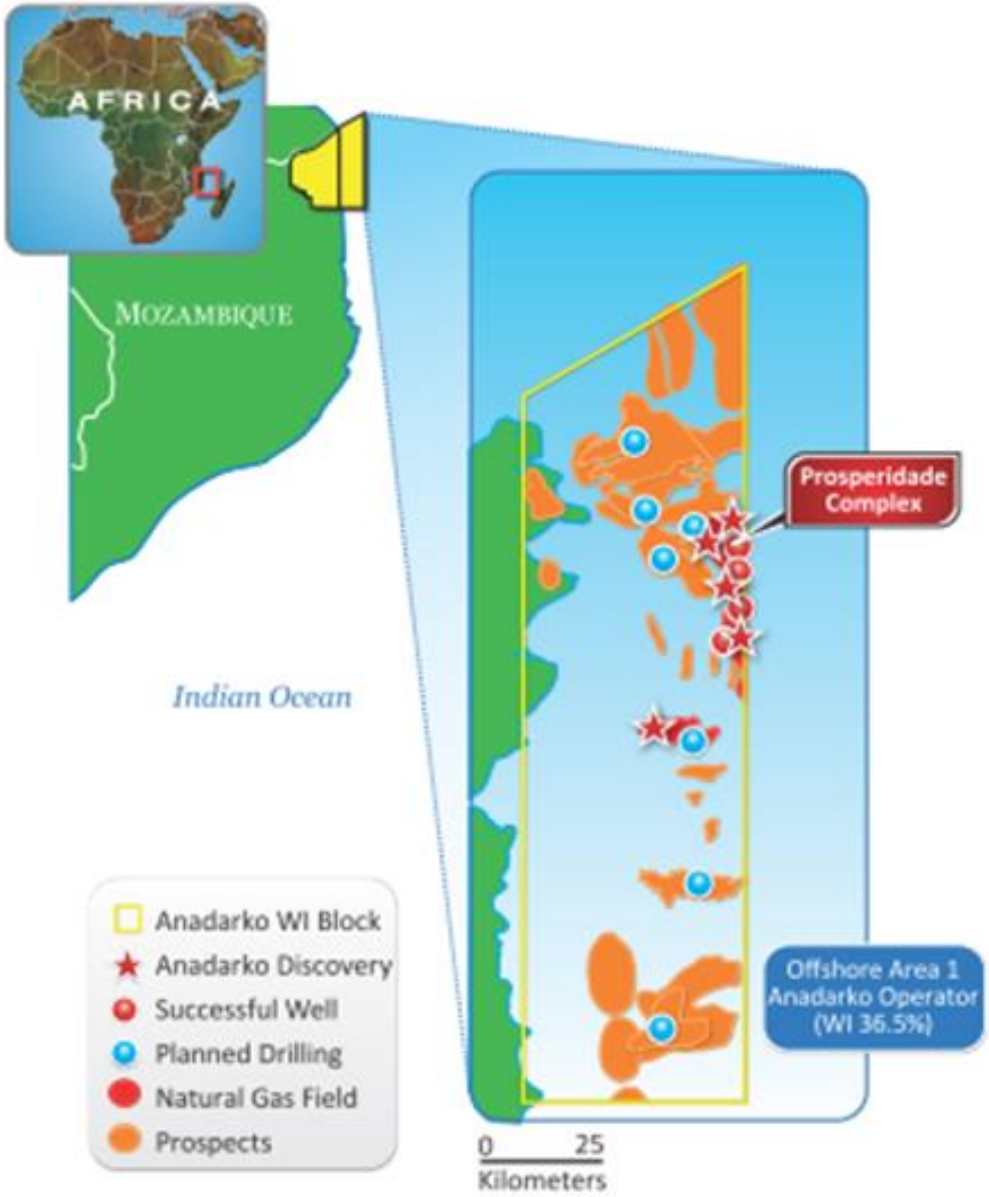
6 Countries = 95% Proven Gas

Cut Off > 5.0 TCF Reserves

More Countries Discover Gas

Atlantic + East Coast LNG Exports

Source: 21st World Upstream Conference Global Pacific & Partners

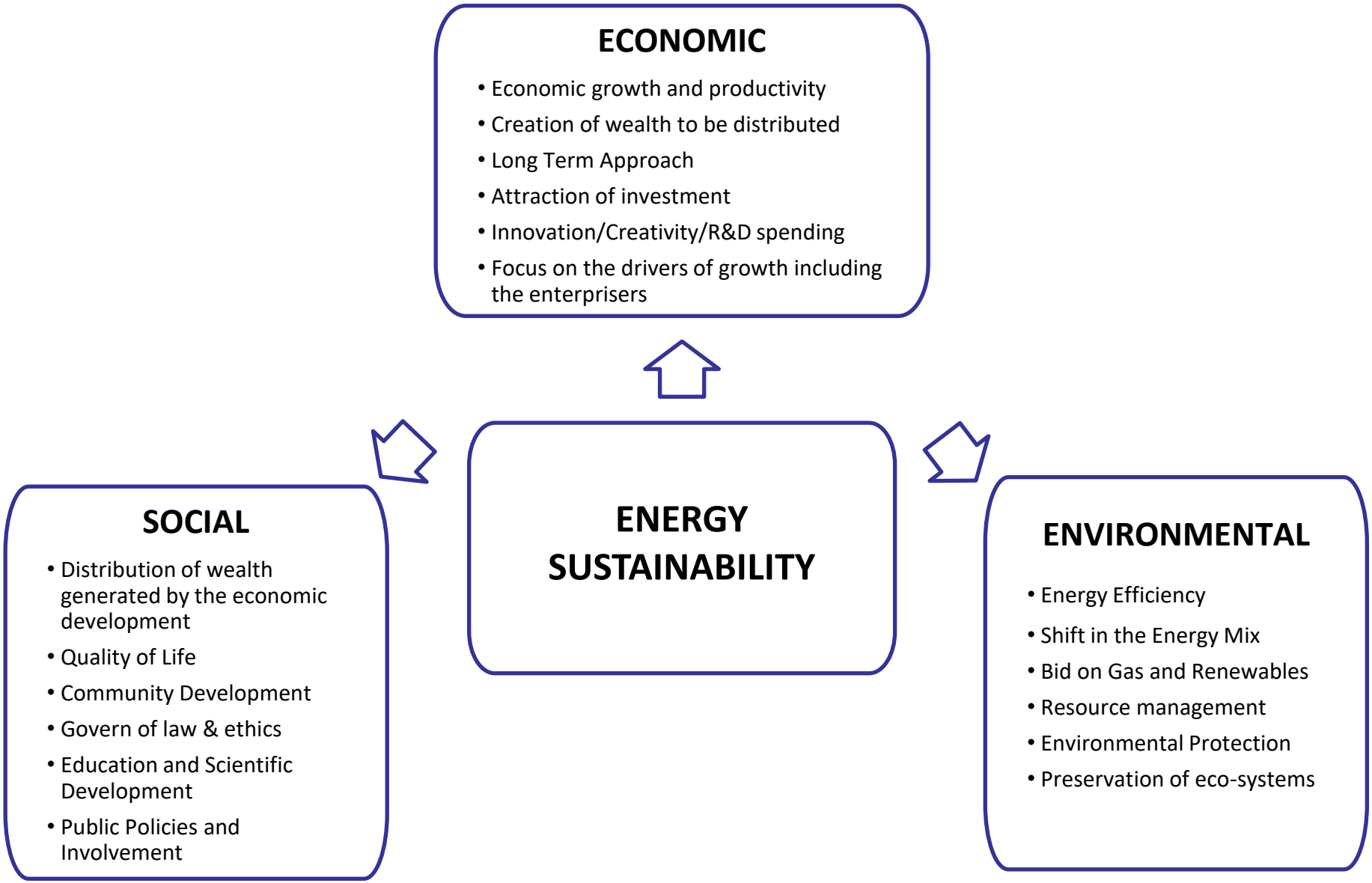

AFRICA
MOZAMBIQUE
Indian Ocean
Prosperidade Complex
Offshore Area 1
Anadarko Operator
(WI 36.5%)
Anadarko WI Block
Anadarko Discovery
Successful Well
Planned Drilling
Natural Gas Field
Prospects
0 25
Kilometers

THE FUTURE OF NATURAL GAS

Gas should make the world a cleaner, safer place

Source: The Economist, 6th August 2011


Maritime Shipping Routes and Strategic Locations
Bosporus
Gibraltar
Suez
Hormuz
Bab el-Mandab
Panama
Malacca
Good Hope
Magellan
Shipping Density
High
None
Dr. Jean-Paul Rodrigue
Dept. of Global Studies & Geography, Hofstra University
Source: Shipping density data adapted from National Center for Ecological Analysis and Synthesis, A Global Map of Human Impacts to Marine Ecosystems.


ECONOMIC
• Economic growth and productivity
• Creation of wealth to be distributed
• Long Term Approach
• Attraction of investment
• Innovation/Creativity/R&D spending
• Focus on the drivers of growth including the enterprisers
SOCIAL
• Distribution of wealth generated by the economic development
• Quality of Life
• Community Development
• Govern of law & ethics
• Education and Scientific Development
• Public Policies and Involvement
ENERGY SUSTAINABILITY
ENVIRONMENTAL
• Energy Efficiency
• Shift in the Energy Mix
• Bid on Gas and Renewables
• Resource management
• Environmental Protection
• Preservation of eco-systems

NATURAL GAS

- Natural Gas can power Domestic economic development and boost export revenues but only if the RIGHT REGULATION, PRICES, and INFRASTRUCTURE are in place

- More than 1 tcm of gas has been wasted through flaring over the years; this volume would be enough to meet current Sub-Saharan electricity needs for more than 10 years

- East Coast of Africa and huge gas offshore discoveries in Mozambique and Tanzania may provide 75 bcm boost to annual regional output to reach 230 bcm by 2040

- East Coast LNG export is helped by proximity to Asia importing markets

ECONOMIAS AFRICANAS EXPORTADORAS de PETRÓLEO e COMMODITIES

- ANGOLA/NIGÉRIA
- GRANDE DEPENDÊNCIA DO PETRÓLEO
- FRACA CAPACIDADE DOS SECTORES NÃO-PETROLÍFEROS
- QUE ESTRATÉGIA

PERÍODOS de "BOOM" dos PREÇOS

- Acumular Reservas Financeiras
- Apostar noutros sectores da economia

EVITAR o EFEITO do CUSTO MARGINAL de PRODUÇÂO

- Diversificar oferta dos projectos petrolíferos
- Evitar concentração no deep-offshore
- ANGOLA: papel do onshore/Bacias interiores como Kuando-Kubango
- Papel do "Shale Gas" e do "Shale Oil" (rocha-mãe)
- Reavaliar coluna litológica angolana
- Papel dos grandes deltas
- Novos métodos: Sísmica 3D combinada com electromagnetismo
- Atenção ao gás
- Política de incentivos para atrair novos investimentos: regime fiscal

DIVERSIFICAÇÃO DA ECONOMIA

- Explorar a cadeia de valor
- Não exportar "raw materials" mas refinados
- Promover a indústria nacional
- Em vez da dependência do petróleo usar o petróleo para criar sectores adjacentes
- Industria petroquímica
- Ciência dos materiais
- "Local content" nas políticas públicas
- Redes de cooperação: multinacionais/Universidades/R&D

POLÍTICA ENERGÉTICA com VISÃO de LONGO PRAZO

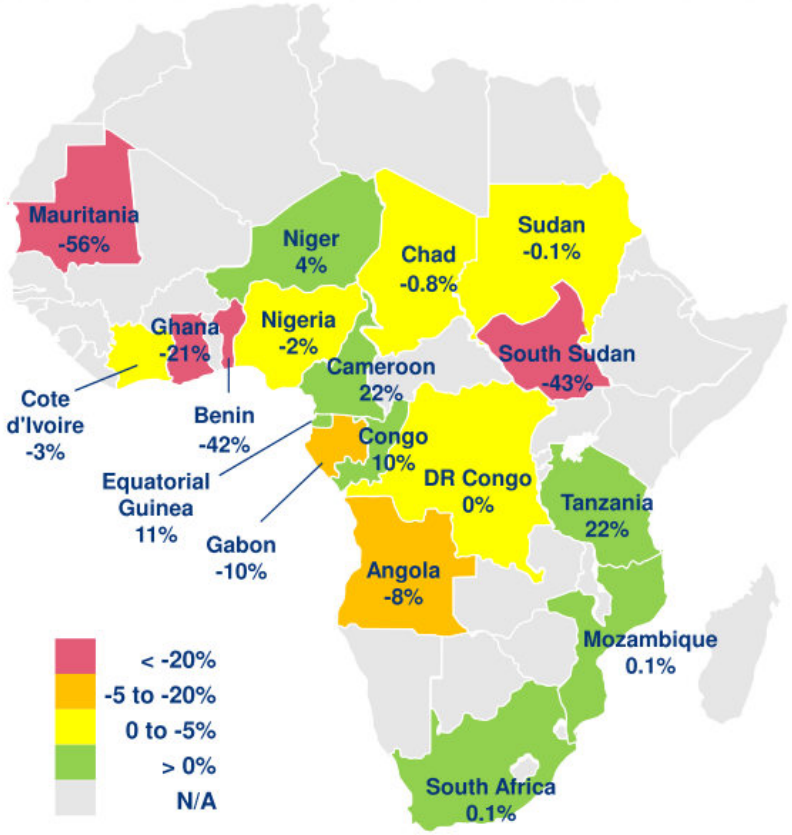
- Aumento de 40% na procura mundial da Energia nos próximos 35/40 anos
- Reservas deep-offshore vão ser necessários
- Indústria é cíclica
- Optimizar consumo doméstico de petróleo e gás e exportar o máximo
- Eficiência energética e estimular o uso dos recursos endógenos

DESENVOLVER e OPTIMIZAR OUTROS RECURSOS ENDÓGENOS

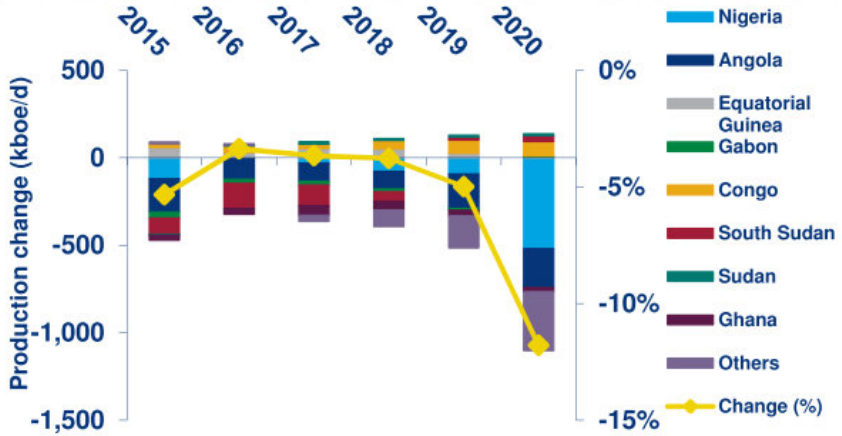
- Energias Renováveis: mapear e desenvolver o potencial local
- Apostar na eficiência energética e optimizar consumo doméstico
- Mapear outros recursos minerais: diamantes, ferro, cobre, fosfatos, etc.
- Não esquecer o sector agrícola e sua dinamização (indústria local de fertilizantes)

Sub Saharan Africa production

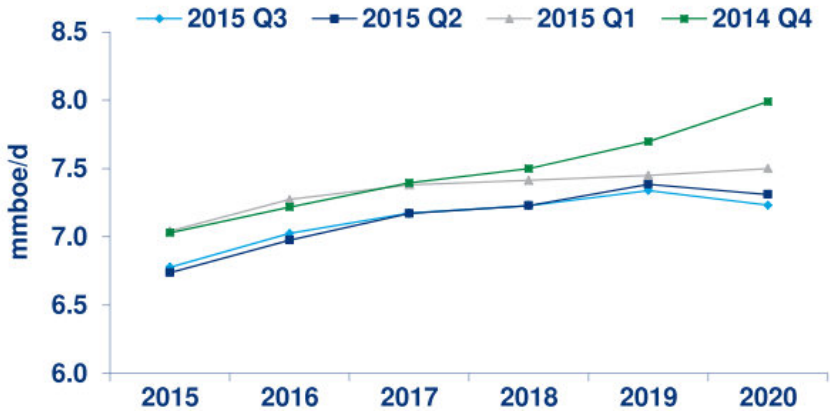
Changes to forecast since Q3 2014 (2015-2016)



Changes to forecast since Q3 2014 (2015-2020)



Production forecasts – last four quarters



Source: Wood Mackenzie

RENT SEEKING AND CONFLICTS

LOOSE ECONOMIC POLICIES

DUTCH DISEASE

- Economic policies focused more on the booming sector
- Competitiveness of other sectors affected
- Agriculture/Manufacturing
- Price appreciation of currency during booms

CORRUPTION and UNDERMINED POLITICAL INSTITUTIONS

THEORY of the RESOURCE COURSE

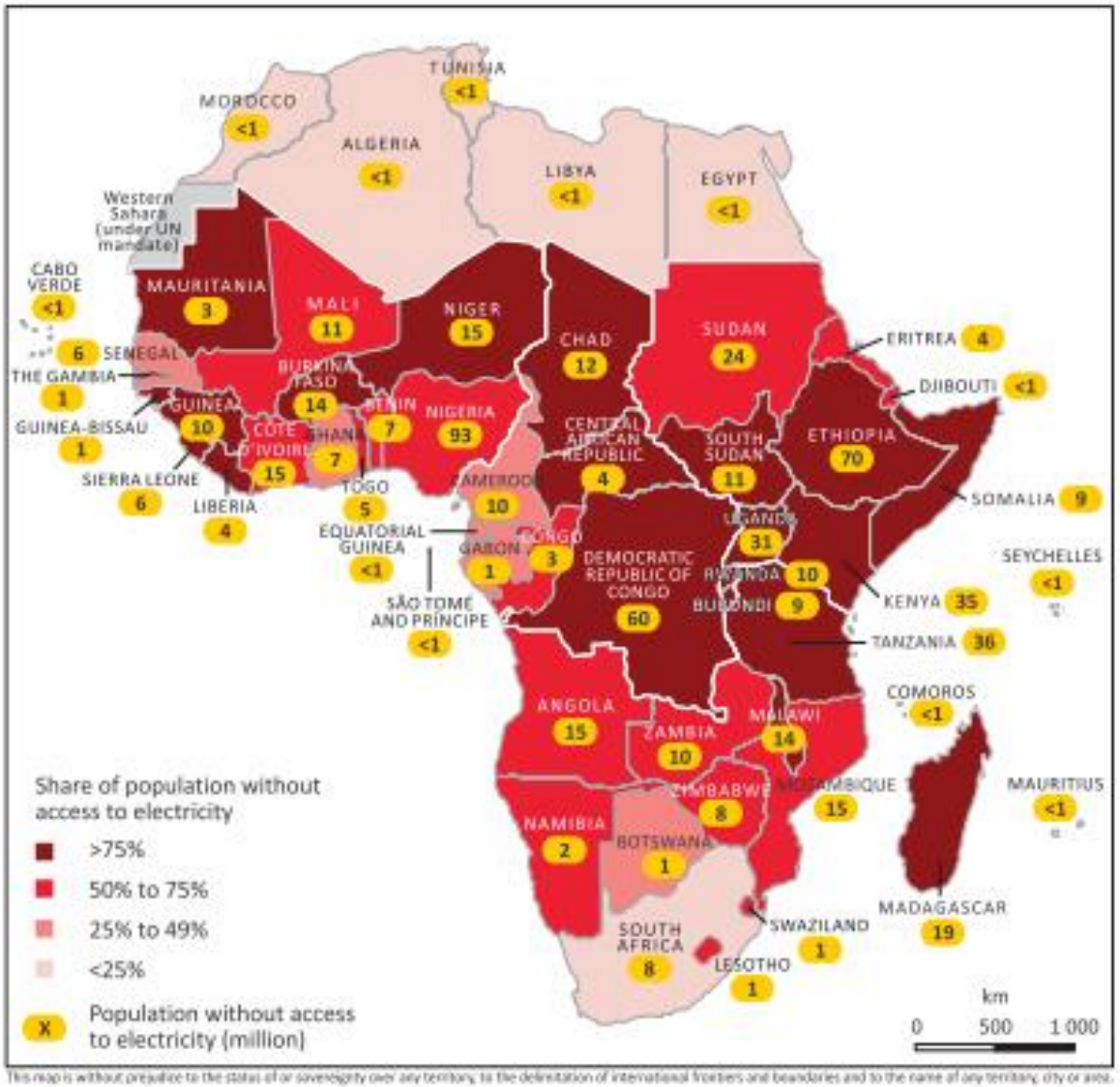
- Resource Abundant Economies
- Tend to grow less rapidly
- More prone to conflict

Insufficient Economic Diversification

HOW to ESCAPE the PITFALLS of RESOURCE COURSE

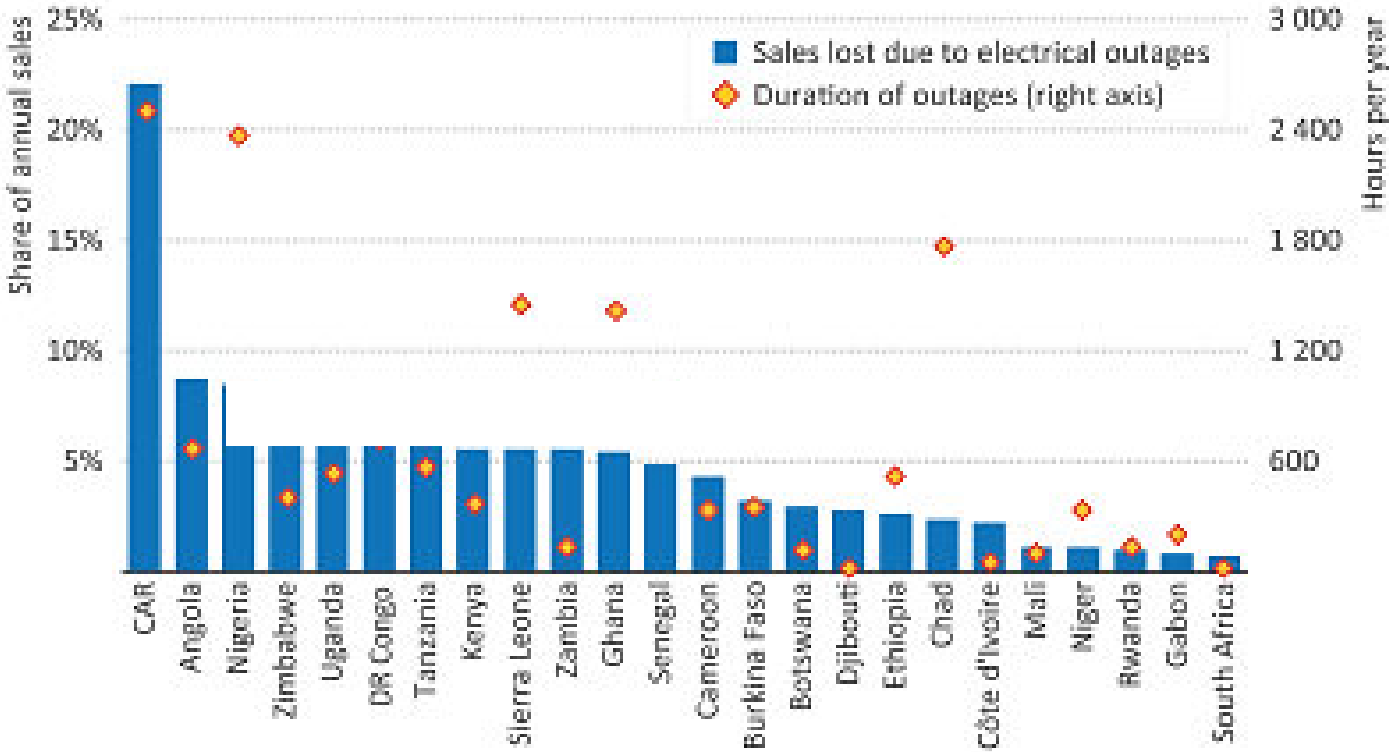
- Ensure stable growth
- Save its wealth for use by future generations
- <u>Pursue economic diversification</u>
  (create business friendly environment/ structures and incentives to improve business capacity/stability of financial sector/initiatives to support diversification like promotion of privatization/support agriculture, manufacturing, tourism)
- De-link expenditure from revenues to render it less susceptible to alternation in revenue
- Investment on Education and Health systems
- Rank of investments: avoid low-return and ambitious projects
- National development plan and sustainable fiscal policy
- Botswana example
- Good Governance (accountability/Government effectiveness/Market-friendly regulation/Anti-corruption policies)

Number and Share of People without access to Electricity by Country 2012



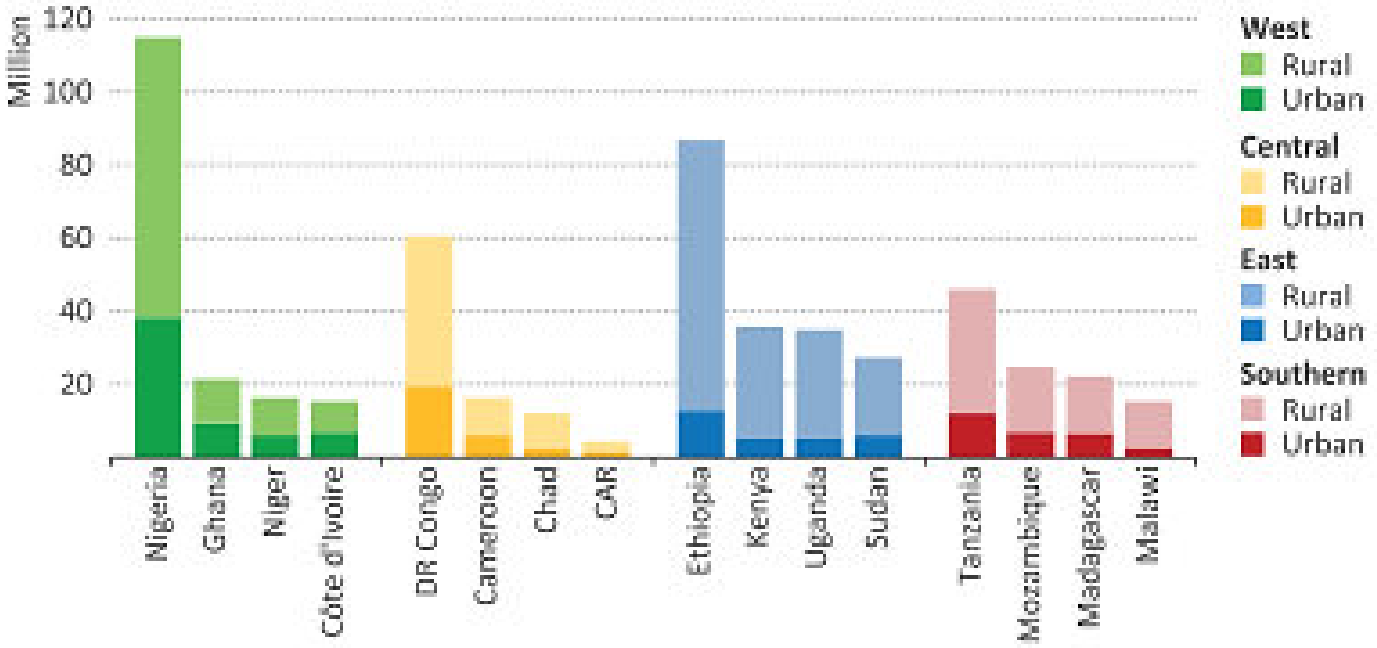
This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Duration of Electrical outages and impact on business sales in selected countries



Notes: CAR = Central African Republic. Data is from the latest available business survey for a given country.
Sources: World Bank (2014b); IEA analysis.

Largest Populations Relying on the Traditional Use of Solid Biomass for Cooking in Sub-Saharan Africa Region, 2012



Note: CAR = Central African Republic.

Sources: World Health Organization; IEA databases and analysis.

AFRICA NON-RENEWABLE RESOURCES

- About 30% of the world known reserves of minerals.
- About 10% of oil and 8% of gas resources.
- Largest cobalt, diamonds, platinum, and uranium reserves in the world.
- Comparably low level of exploration.
- In 2012, mining, oil and gas accounted for 28% of the continent's GDP.

AFRICA MINERAL RESOURCES

AFRICA SHARE OF WORLD PRODUCTION

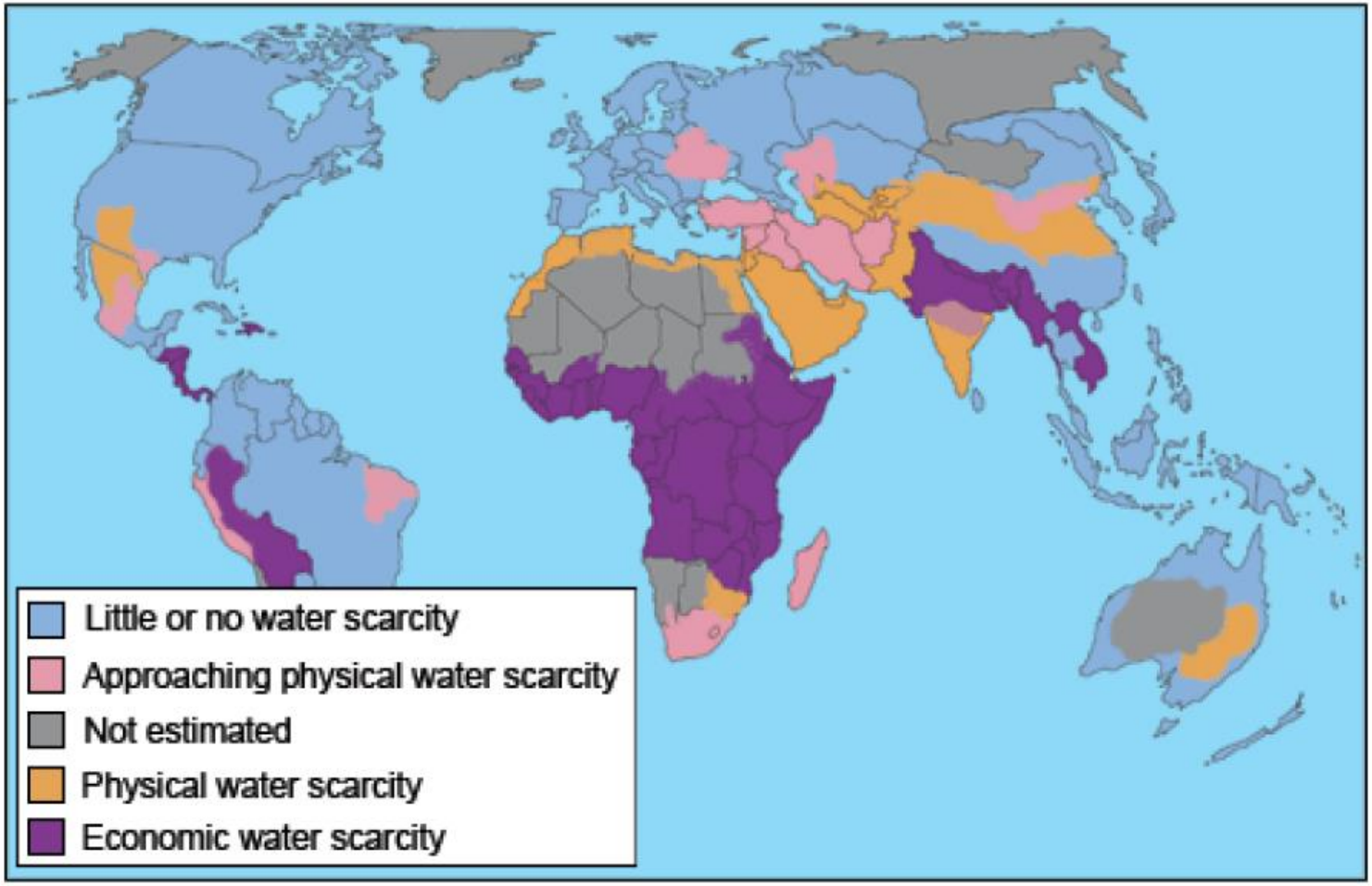
AFRICA MINERALS	*Share of World Production (%)*
BAUXITE	9%
ALUMINUM	5%
CHROMITE	44%
COBALT	57%
COPPER	5%
GOLD	21%
IRON ORE	4%
STEEL	2%
COAL	13%
URANIUM	16%
MANGANESE	39%
ZINC	2%
CEMENT	4%
NATURAL DIAMONDS	46%
GRAPHITE	2%
PHOSPHATE	31%

AFRICA RENEWABLE RESOURCES

- Close to 20 million people employed in the USD 24 billion fisheries sector.
- 90 million depend on fisheries for livelihood.
- Africa is home to the second largest tropical forest.
- Over 70 percent of the Sub-Saharan population depend on forests and woodlands for livelihood.
- Land in Africa is an economic development asset as well as a social, cultural and ontological resource.
- It defines the social identity, the organisation of religious life, culture, gender, ethnicity and nationality.
- Water resources are contrasted across the continente.
- Africa is home to some of the highest annual rainfall in the heart of the Congo basin.
- It is also the second world's driest continent.

One Of The Most Water-Deprived Regions On Earth

Global - Availability of Water



Source: International Water Management Institute, BMI

AFRICA ENERGY STATUS

- Sub-Saharan Africa is rich in energy resources but very poor in energy demand
- (13% of world population but only 4% of world energy demand)

- Since 2000 Sub-Saharan Africa has seen rapid economic growth and energy
- use has risen by 45%

- Inadequate energy infrastructure risks putting a brake on needed improvements
- in living standards

- A severe shortage of essential electricity infrastructure is constraining efforts to achieve more rapid social and economic development

- Sub-Saharan Africa grid-based generation capacity is very low today: 90 Gw (50% in South Africa)

- Need to build on successful examples of electrification programs (Ghana and Ruanda) with mini-grid and off-grid system providing electricity in rural areas

ACCELERATING TOWARDS an Africa Century?

- 3 actions in the Energy sector accompanied by Governance reforms can boost Sub-Saharan economy by 30% in 2040:

  i. Additional 450 billion US$ in Power Sector investment, reducing power outages by 50% and achieving universal electricity access in urban areas

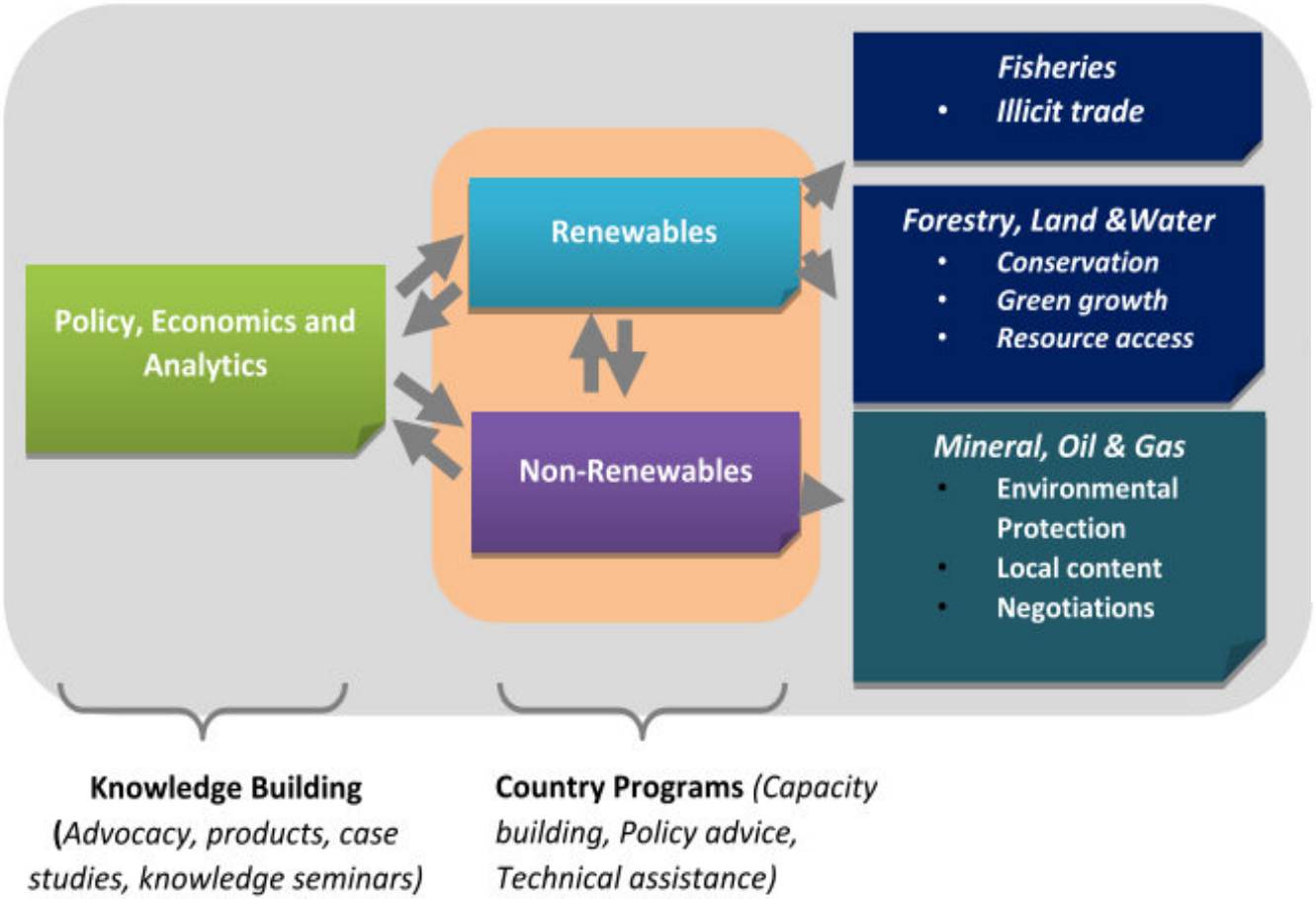
  ii. Deeper Regional Cooperation and Integration, facilitating new large-scale generation and transmission projects and further enabling cross-border trade

  iii. Better Management of Resources and Revenues adopting robust and transparent processes that allow more effective use of O&G Revenues

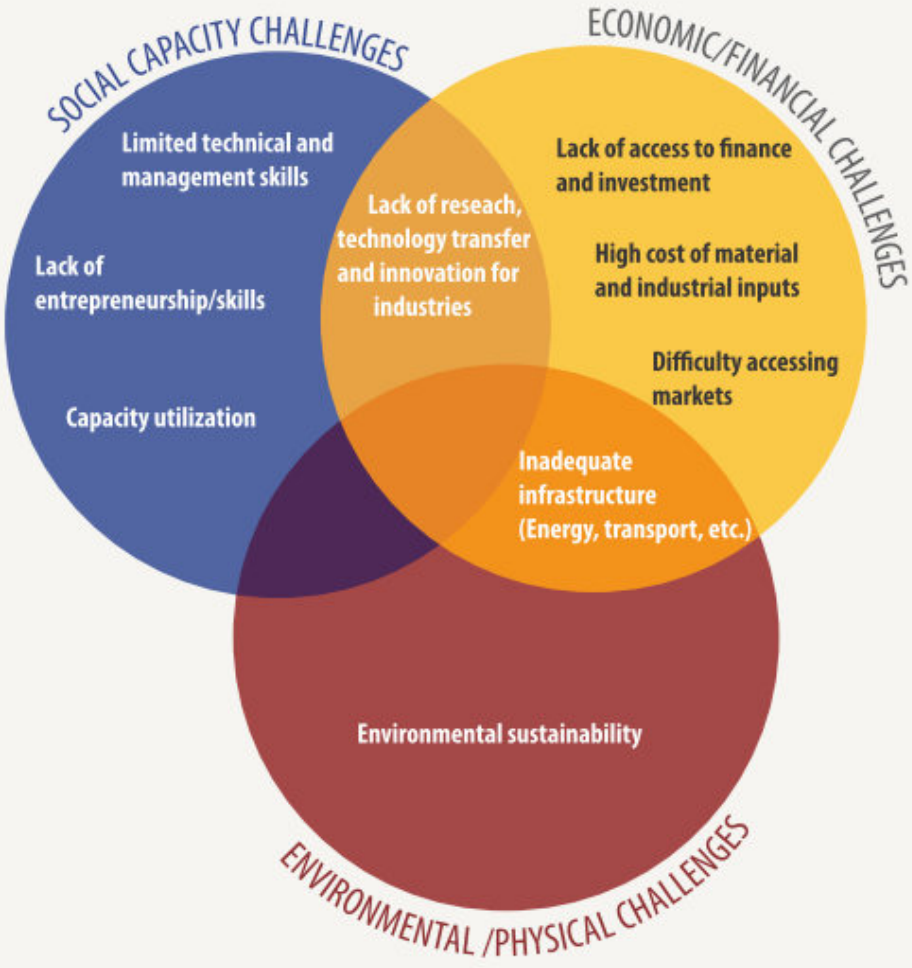
Estímulos e Bloqueios para o Futuro

- **A Boa "Governance" dos Recursos Naturais**
- **A Inteligência de Políticas Públicas**
- **Instituições Inclusivas vs. Instituições Extractivas**

PUBLIC POLICIES AND OPERATING MODEL

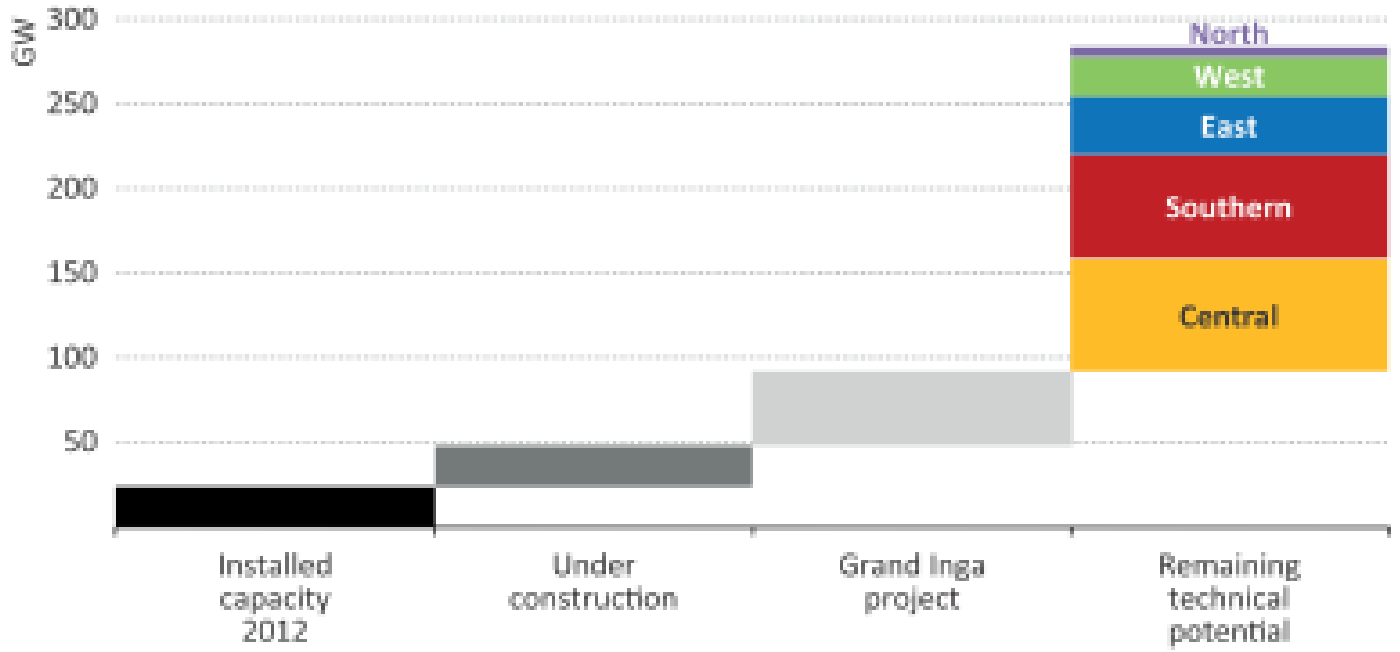


CHALLENGES FOR INDUSTRIAL POLICY



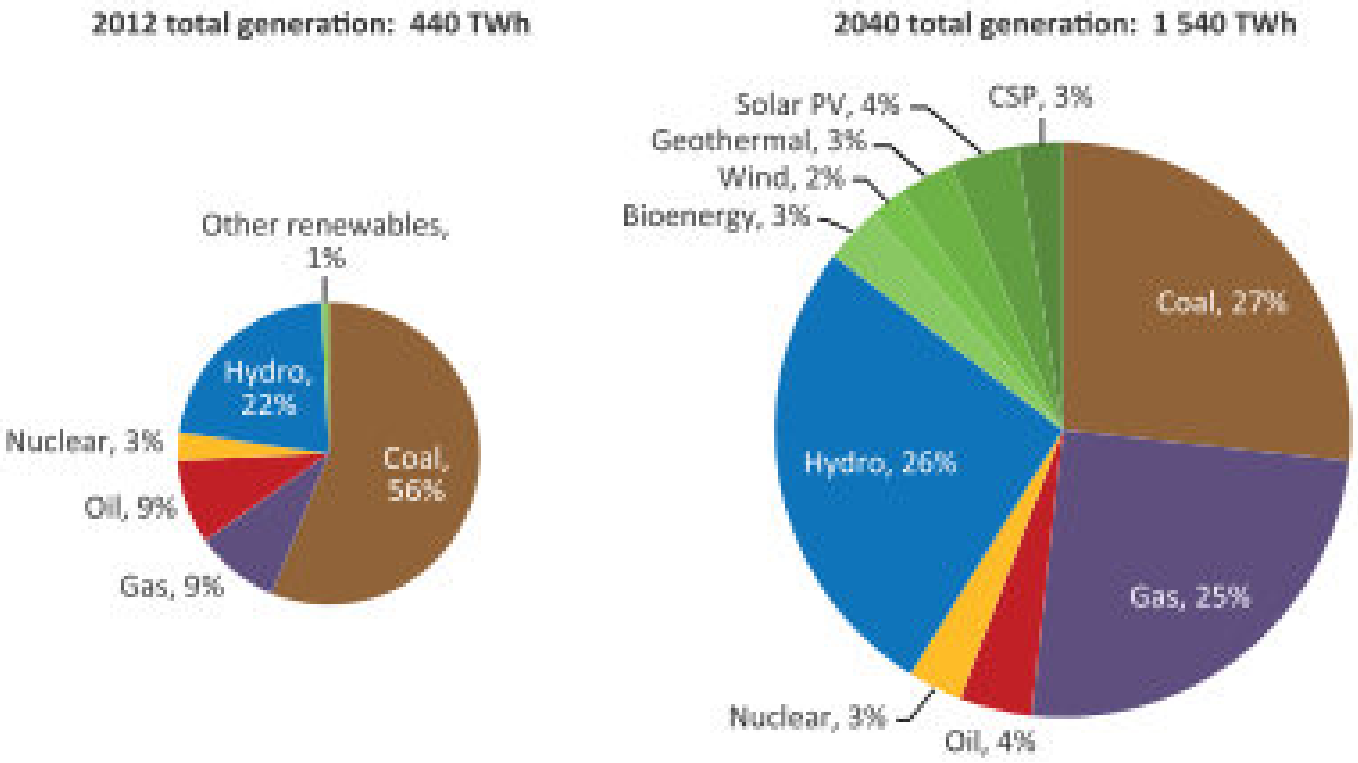
Source: Compiled from Ministry of Trade and Industry et al. (2011) and interviews with respondents.

Existing Hydro Power Capacity and Potential in Africa



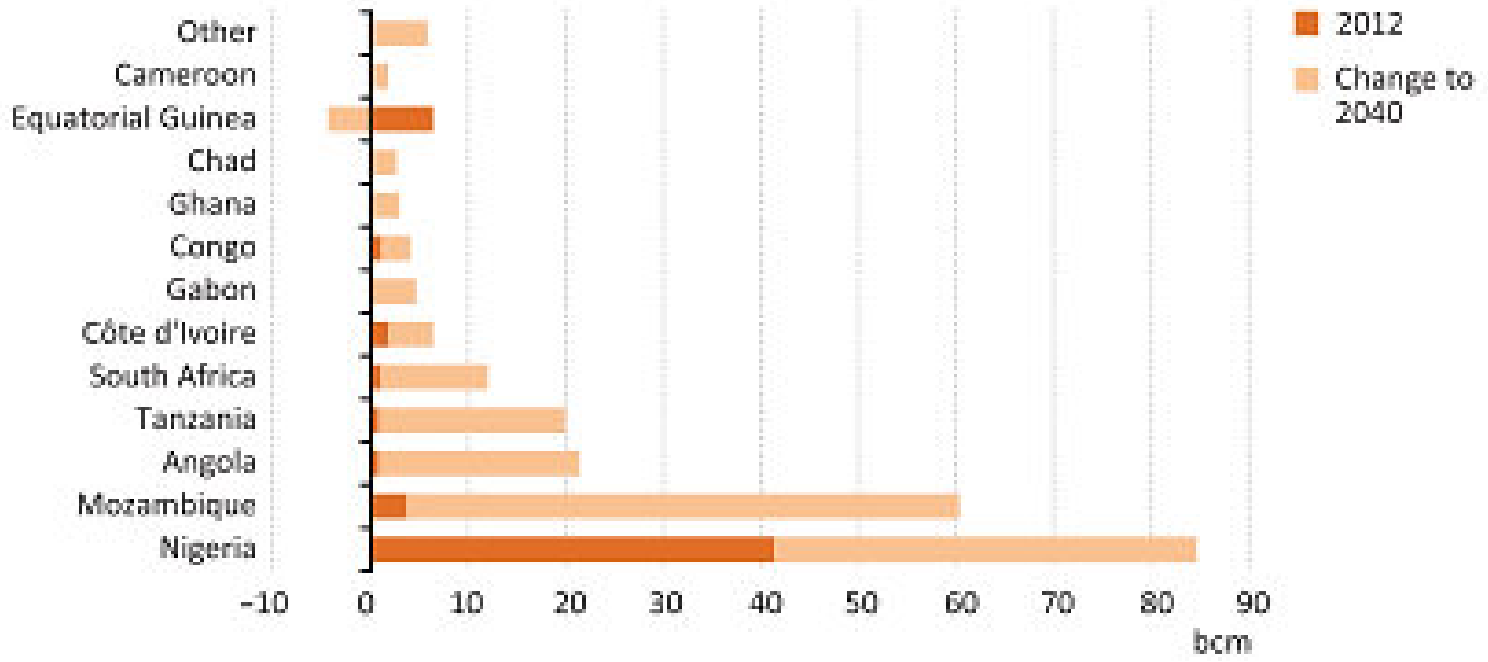
Sources: IPCC (2011); IJHD (2009) and (2010); IEA analysis.

Electricity Generation by Fuel in Sub-Saharan Africa in the New Policies Scenario, 2012 and 2040



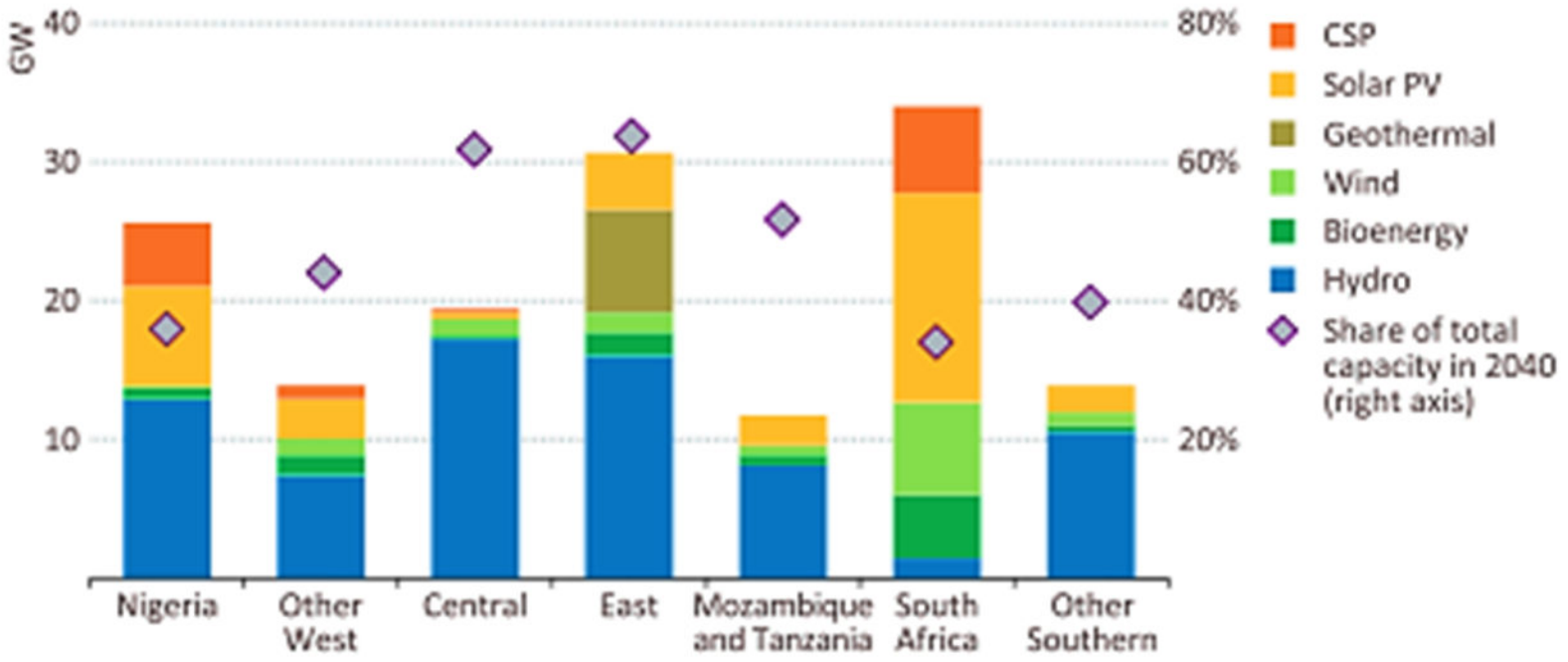
Source: World Energy Outlook 2015

Natural gas production in Sub-Saharan countries in 2012 and change to 2040 in the New Policies Scenario



Note: Production in Equatorial Guinea is 3 bcm in 2040, declining by around 3 bcm from 2012.

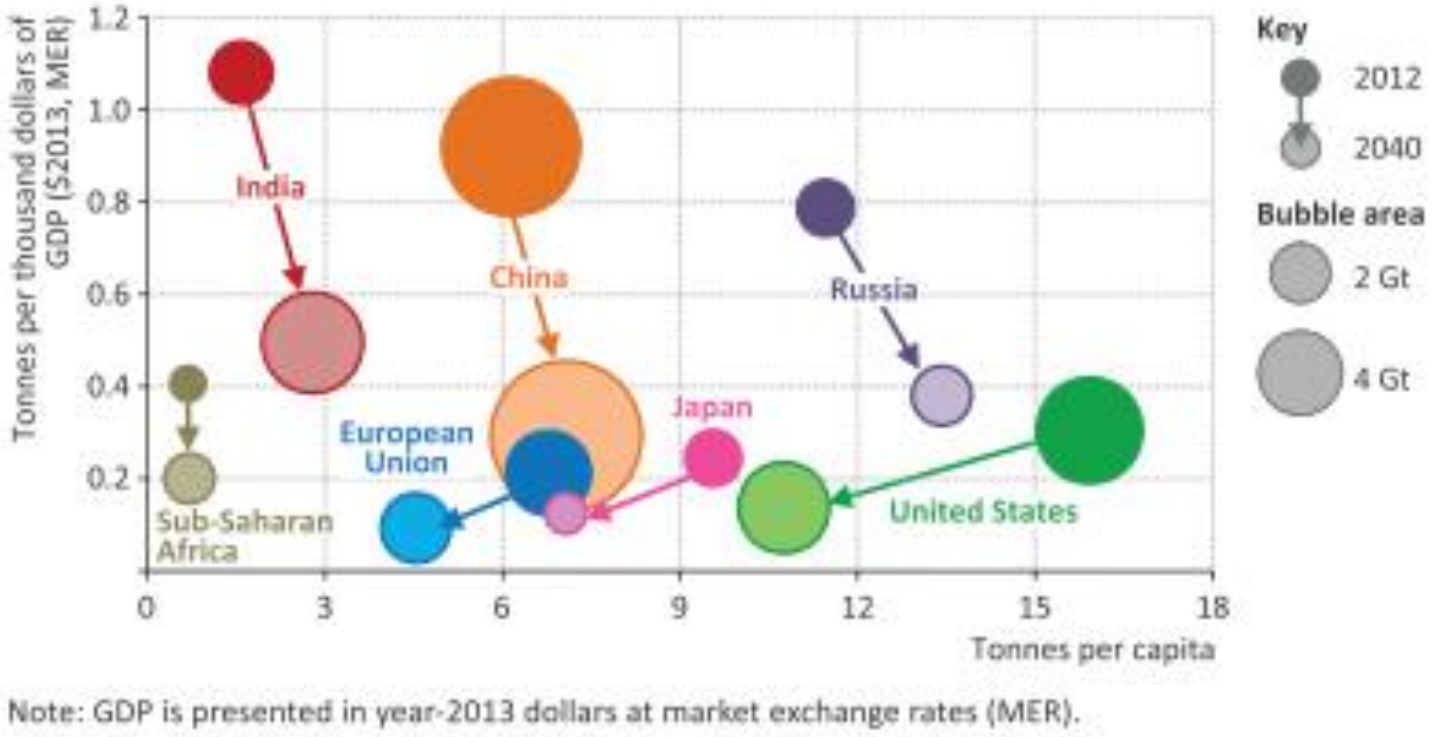
Increase in Renewables-based capacity by Sub-Region and type in Sub-Saharan Africa in the New Policies Scenario



➢ *AFRICA ENERGY STATUS*

- Sub-Saharan Africa is starting to unlock its vast renewable energy resources with 50% of growth in electricity generation to 2040 coming from renewables
- Hydropower provides today 20% of power supply but less then 10% of the estimated technical potential has been used
- Solar in South Africa and Geothermal in East Africa (Kenya and Ethiopia) are booming; as technical costs decrease attraction of renewable systems vs. diesel generators grow
- Bioenergy use (fuelwood and charcoal) outweighs demand for all other forms of energy combined (4 out of 5 people in Sub-Saharan Africa rely on solid biomass for cooking)

Energy-related CO2 emissions by selected country and region in the New Policies Scenario



Note: GDP is presented in year-2013 dollars at market exchange rates (MER).

Source: World Energy Outlook 2015

Way ahead for Africa

	+	-	Solution
People	More primary energy to sustain growth	No infrastructure, little money	Local decentralized solar & gas
Energy mix	Move away from coal	Storage	Gas as a transitional fuel and FSRU for storage
Governments	Skills transfer. LNG could kick start domestic gas production	Links with electric incumbent	Need to demonstrate a robust simple plan
Gas companies	Need to find additional demand	Profitable not too small projects	Concentrate on power plant for demand with FSRU
Infrastructure companies	Geographical monopoly	Visibility of revenues	Bundled or unbundled?
International organisations	UN 2030 Agenda - Sustainable Development Goal n°7: Affordable and Clean Energy	Fast tracking new projects	Grants & loans New business models with cheaper solutions

FUTURE of AFRICA ENERGY to 2040

- Sub-Saharan energy system will expand rapidly to 2040 but so do the demand
- Projections show economy to increase in size 4 times, population nearly doubles (to 1.75 billion) and energy demand grows by around 8%
- Many of existing energy challenges (capacity, efficiency and access to modern energy services) are only partly overcome
- Bioenergy demand grows by 40% placing stress on the forestry stock but share of bioenergy in the energy mix may decline from 60% today to below 40% and share of modern fuels may increase
- Oil demand more than doubles to 4 MB/D in 2040 and become the second largest fuel, overtaking coal
- Natural gas use grows nearly 6% per year to reach 135 bcm

FUTURE of AFRICA ENERGY to 2040 *(cont.)*

- Sub-Saharan power system expands rapidly with generating capacity increasing 4 times to 385 GW; the power mix becomes more diverse with coal (South Africa) and hydro (all regions), being joined by greater use of gas (Nigeria, Mozambique, Tanzania), solar (mainly in South Africa and Nigeria) and Geothermal (East Africa)

- The share of renewables in total capacity more than doubles to 44%

- Total power sector investment averages 46 billion US$ per year (50% for transmission and distribution)

- Oil production rises above 6 MB/D by 2020 but declines to 5.3 MB/D in 2040; Nigeria and Angola remain the dominant producers

- Gas production rises to 230 bcm in 2040 led by Nigeria and the expansion of output from Mozambique (60 bcm in 2040), Angola and Tanzania (each 20 bcm)

FUTURE of AFRICA ENERGY to 2040 *(cont.)*

- Coal supply grows by 50% to reach 325 Mtce still concentrated in South Africa but joined increasingly by Mozambique
- Sub-Saharan energy expands more towards Asian markets
- Rising output from Mozambique and Tanzania brings LNG export to 100 bcm by 2040
- Sub-Saharan Africa makes a contribution to global energy-related CO_2 emissions accounting for 3% of total in 2040 but is in the front line in terms of climate change impacts; hydropower may be affected by changing partners of rainfall
- Fuelwood and charcoal operate largely outside the formal economy and policy makers have few levers to promote sustainable forestry

OBRIGADO