



Biofuels, Root Crops and Food Security in Africa

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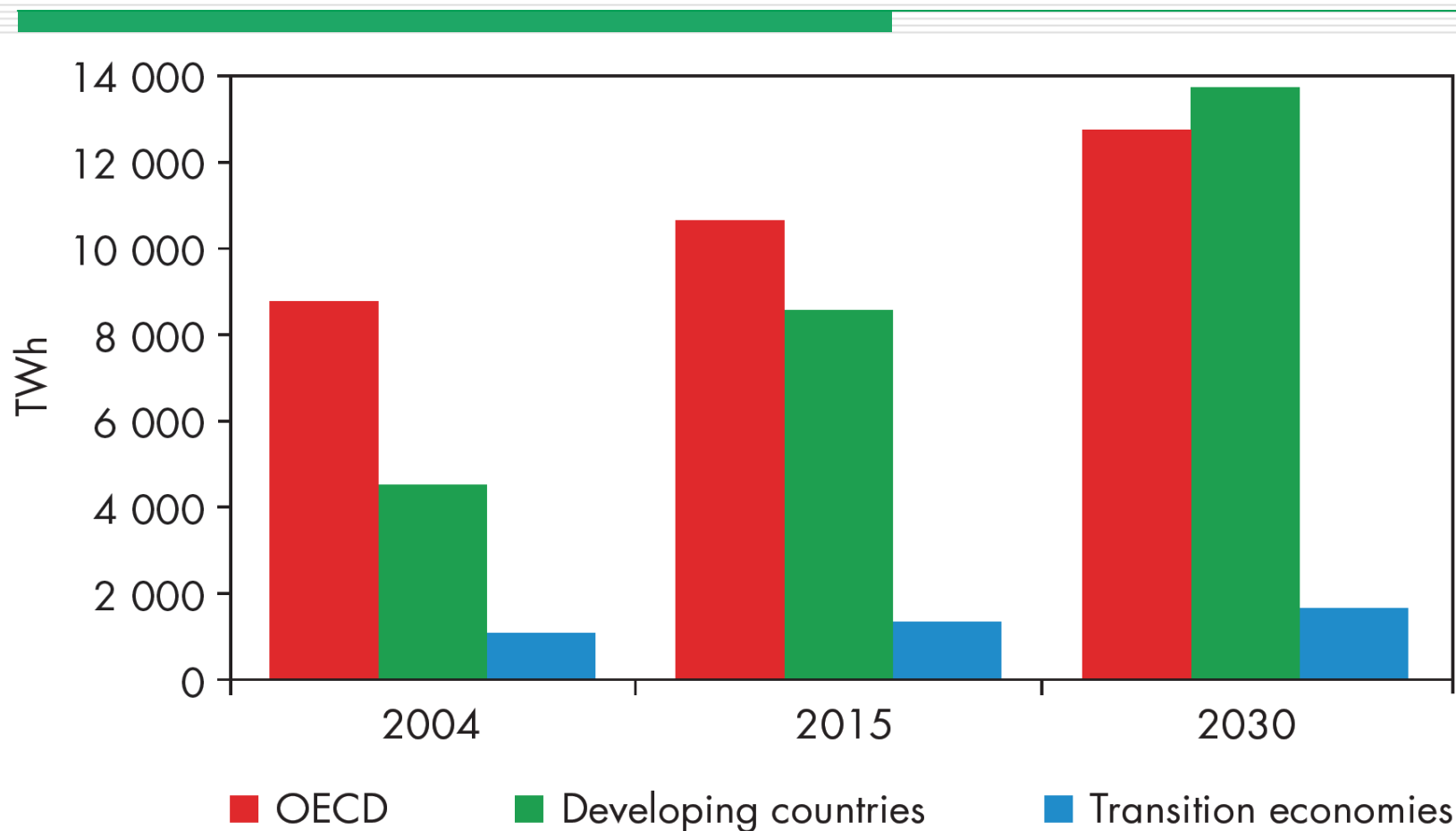
Population Increase in the World

- ❑ The world's population will rise to 9 billion by 2050
- ❑ The world's food production will have to double
- ❑ Energy needs may triple



World Electricity Demand by Region

(WEO 2006 Reference Scenario)



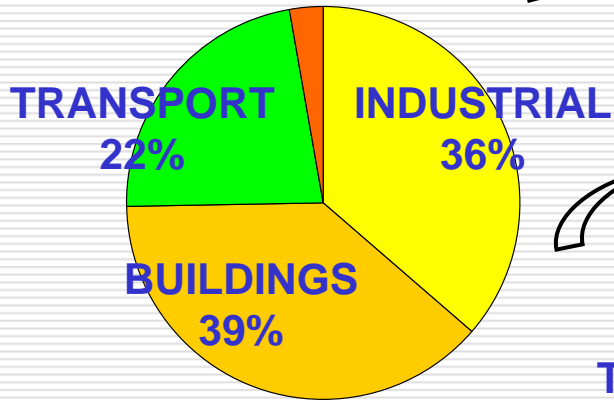
Source: IEA



Primary Energy Consumption 2000 & B2 Scenario Projections for 2030

(EJ)

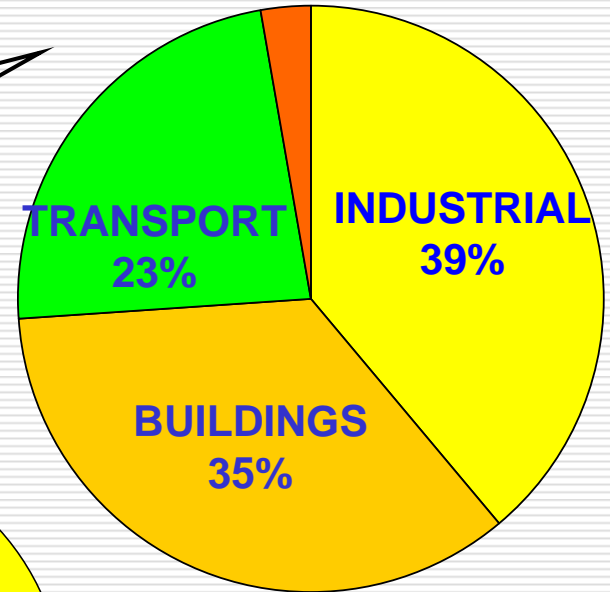
AGRICULTURE
3%



Total 384 EJ
2000

A1 - High Growth Scenario
B2 - Low Growth Scenario

A1



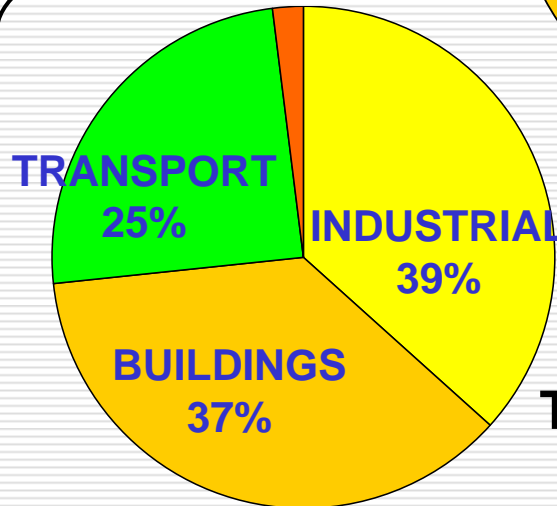
Total 892 EJ

2030

Total 648 EJ

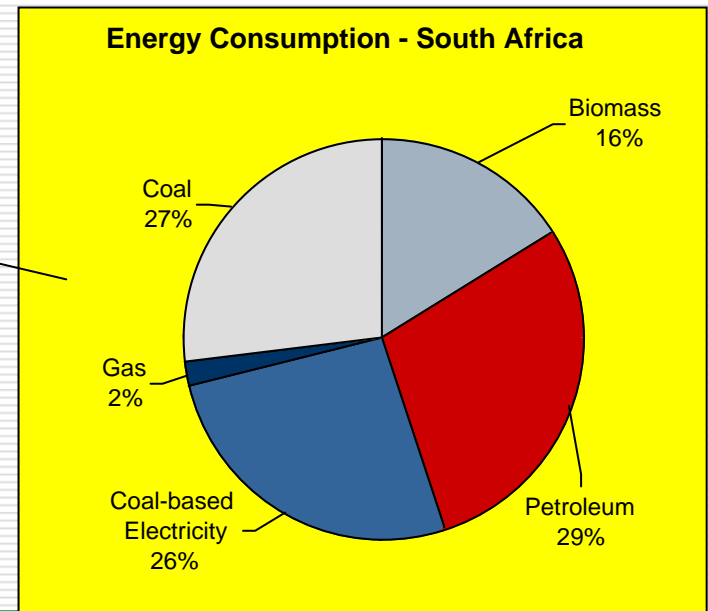
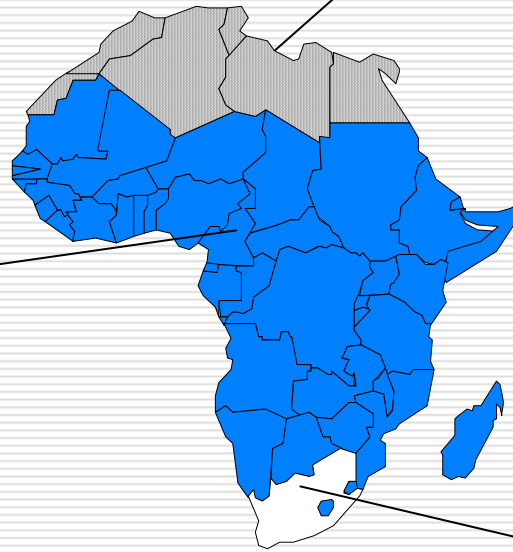
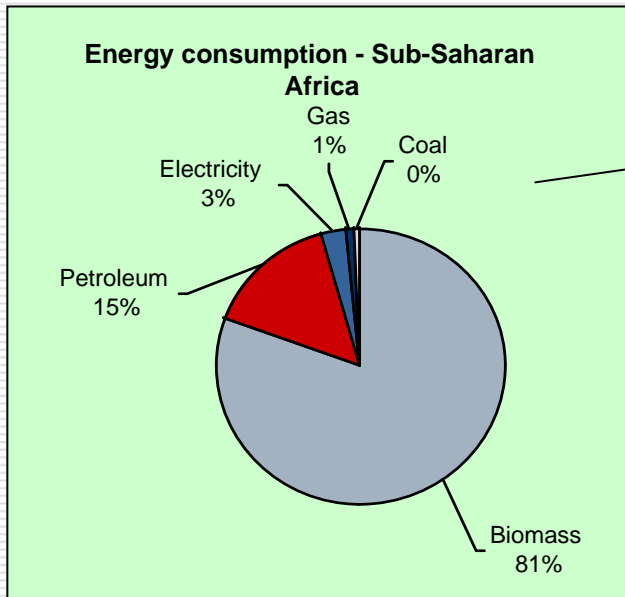
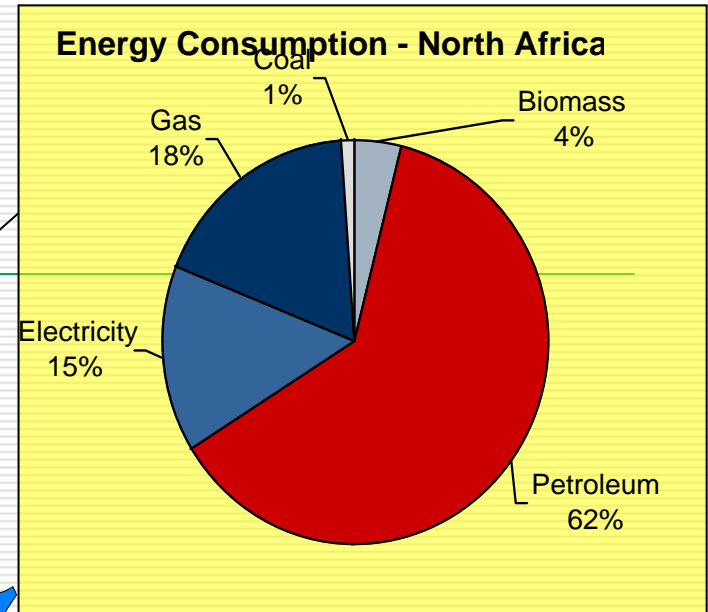
Source: IPCC

B2



African Energy Sector

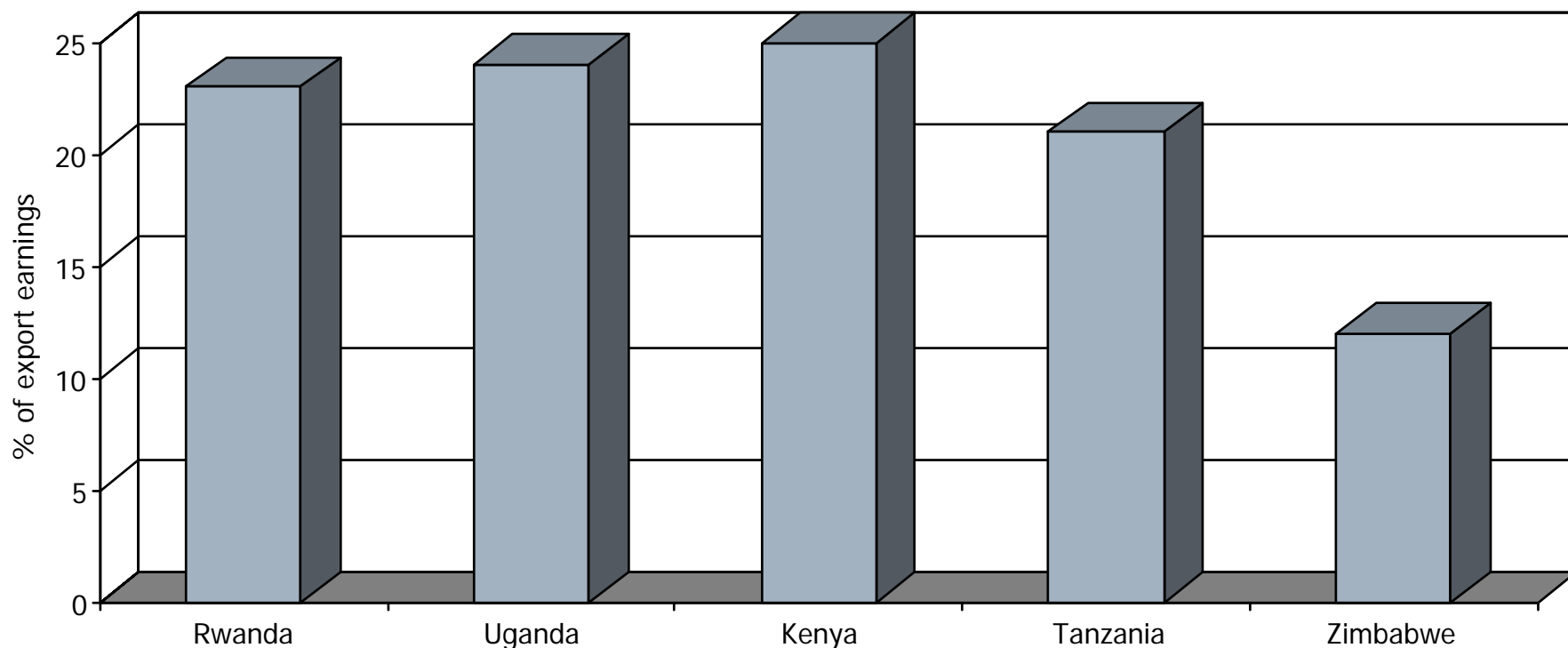
– 3 distinct regions



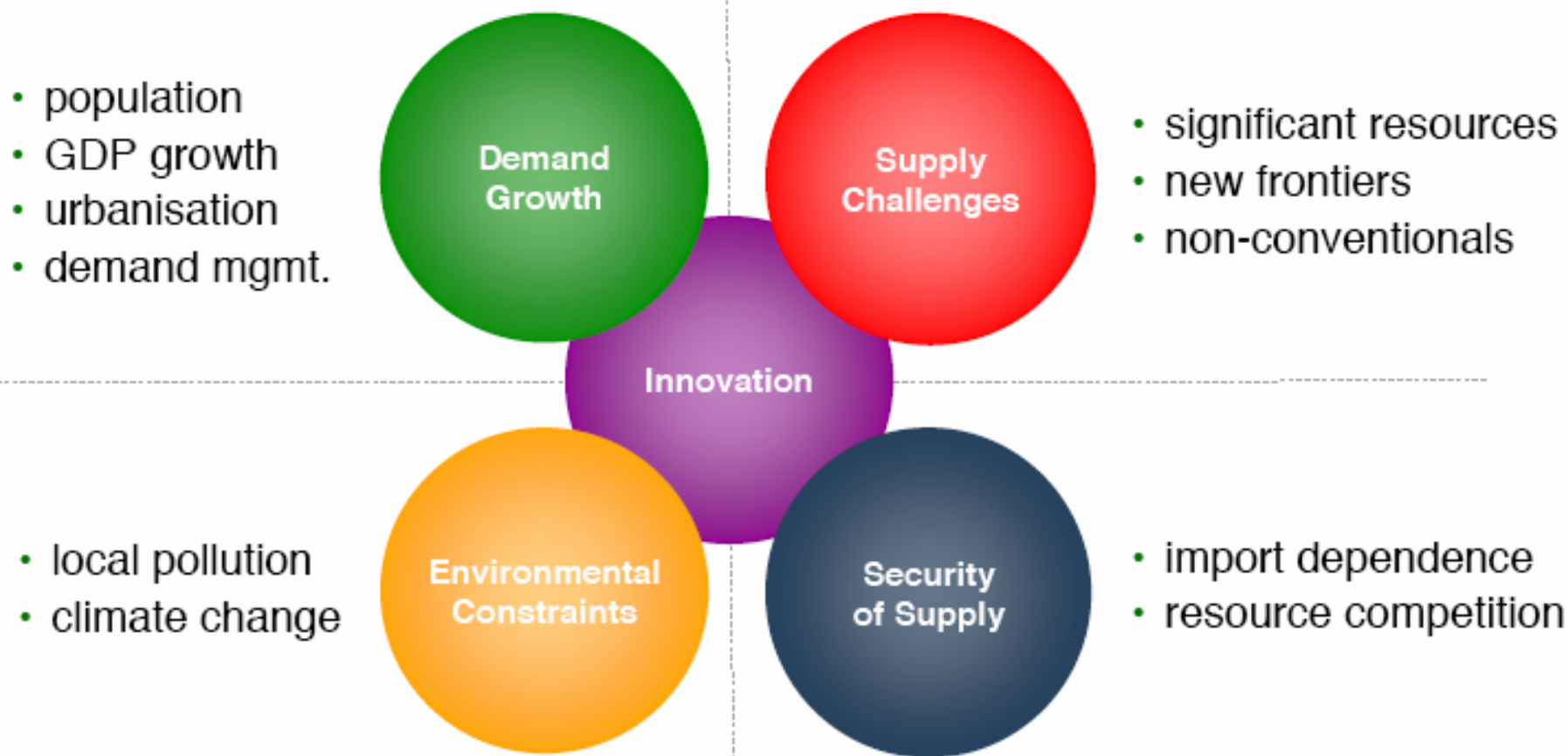


Africa spends too much on petroleum products

Percentage Share of Export Earnings Spent on Petroleum Products, 2000



Key drivers of the energy future



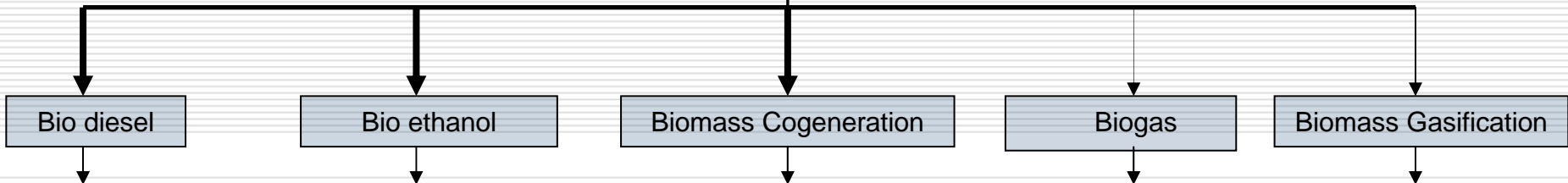
Drivers of Biofuels Development – African Context

- ❑ Africa has 13% of global population yet uses 3% of electricity used globally
- ❑ Only 1 in 4 people in Africa has access to electricity
- ❑ Under exploitation of available resources : 6% of hydroelectricity and 0.6% of geothermal potential exploited
- ❑ Abundance and decentralized availability of biomass resources
- ❑ Need to raise GDP growth rate from 3.5% to 8% if Africa is to meet the MDGs & means a corresponding increase in energy demand



AU's Strategy for biofuels

DRY LANDS/ WETLANDS



PROGRAMMES

- Enabling Policy and Institutional Framework
- Financing Mechanisms
- Resource Assessment – Feedstock Availability and Sustainability
- Strengthening Technical Expertise

KEY ACTORS AND ROLES
 African Governments (Technocrats and Policy Makers) – Ministries in charge of Agriculture, Energy, Industry, Finance; Environment; Agro-industries (Private and Public Sector); Research institutions, Regional Bodies (AU, UNIDO, UNDP, UNEP, ECA); International Organizations (World Bank and EU) Financial Institutions such as African Development Bank (AfDB); Other Stakeholders (Refineries and Fuel Distributors, Farmers Associations, Automobile Industry, Quality Standards Boards, Private Entrepreneurs and Banks, Media)

PLATFORM FOR IMPLEMENTATION - REGIONAL BIOFUELS NETWORK

Africa's Biofuels Potential

- ❑ Africa has 'vast' land resources and conducive climates
- ❑ Estimating exact potential is complex – many variables
- ❑ Several studies undertaken and converge on the following
 - Africa has a very large potential to produce biofuels
 - Under a high productivity scenario Sub Saharan Africa can produce biofuels with energy content up to 410 Exa J compared to global energy consumption of 440 Exa J (very optimistic)



Opportunities and Benefits of Biofuels in Africa

- ❑ **Sustainable use of Biofuels can lead to**
 - Reduction in oil importation bill
 - Revitalization of rural economies through higher farm incomes, creating jobs and enhance local energy security
 - Increased availability of cleaner burning fuel with both global and local environmental benefits
 - Reclaiming of degraded and marginal lands and opportunities for carbon sequestration.
-

Key issues, challenges and risks of biofuels include..

□ Environmental Challenges.

- Production chain and application should have positive energy and GHG balances.
 - Sustainable water use and no additional water contamination
 - Environmental responsibility and conservation of natural resources and biodiversity.
 - Minimize soil erosion and degradation
 - Minimum environmental emission from Bio fuels production technologies
-

Key issues, challenges and risks of biofuels include..

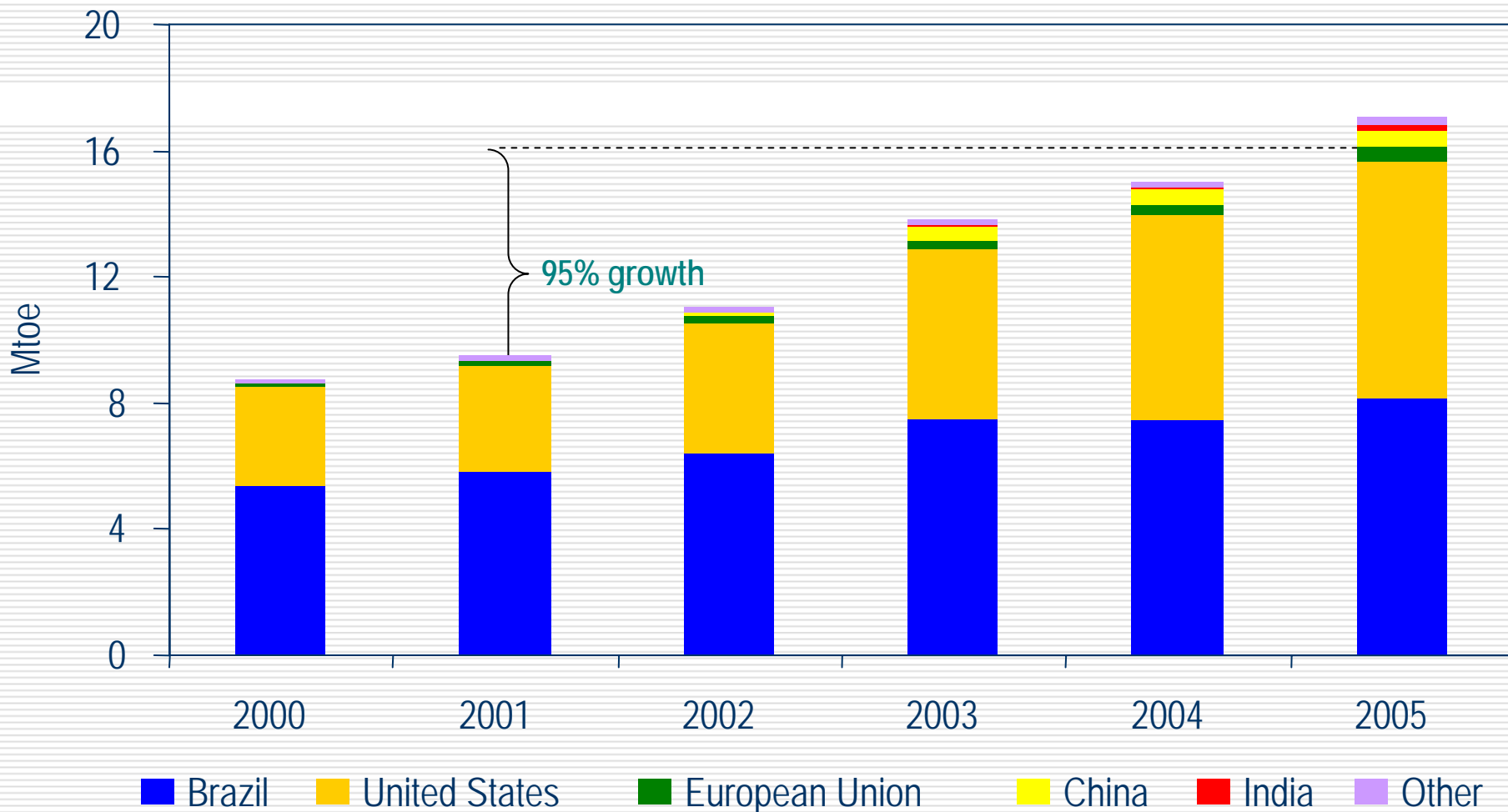
❑ **Socio-Economic Challenges**

- Reduce competition and strengthen synergies with food sector/land.
- Balancing between large-scale and small-scale production
- Production should lead to local and shared prosperity

❑ **Technology Challenges**

- Identifying appropriate plants for specific regions.
 - Appropriate technologies for communities and businesses.
 - Increasing production efficiency
-

Recent Trends in Ethanol Production



Ethanol production has almost doubled in 5 years, with the bulk of the increase coming from Brazil & the United States



Many African countries are already producing bio-ethanol

Ethanol production in ESA

Country	Cane crushed Tons (2002)	Ethanol production potential*, Liters (2002)
Kenya	5,904,108	413,288,000
Sudan	5,821,000	407,470,000
Tanzania	3,628,800	254,016,000
Malawi	2,095,065	146,655,000
Ethiopia	1,147,283	80,310,000
Uganda	1,707,000	119,490,000
Swaziland	6,861,600	480,312,000

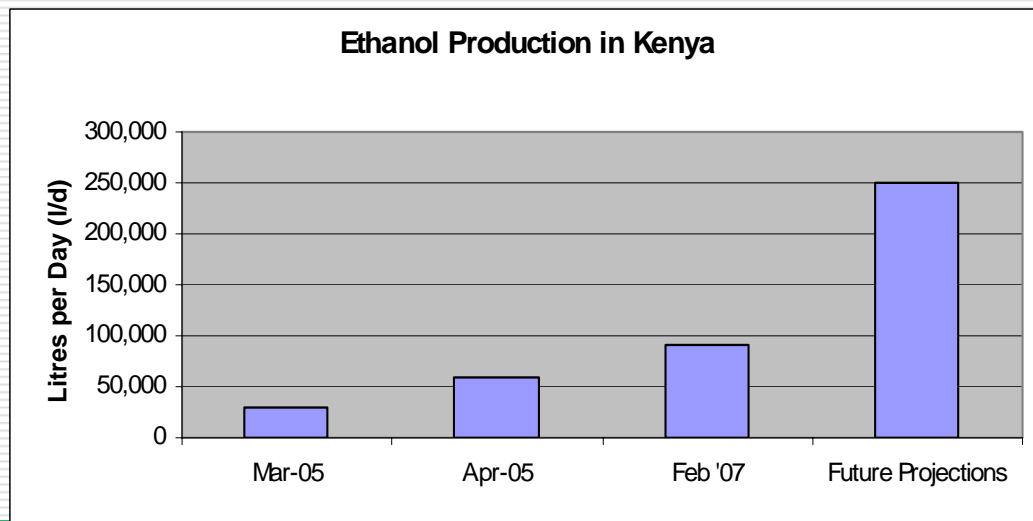
* Estimated ethanol potential assuming an average of 70 litres of ethanol produced per tonne of cane crushed and that all cane is used for ethanol production (*SEI, 2003; TaTEDO, 2006*)

Ethanol production in Malawi

Year	Ethanol	Rectified	Potable	Total	To date
2000	11,625,036	352,019	211,319	12,188,374	199,363,988
2001	11,167,122	546,707	271,879	11,985,708	211,349,696
2002	10,987,543	431,256	345,786	11,764,585	223,114,281
2003	8,375,761	610,399	230,660	10,222,767	233,337,048
2004	8,375,761	751,567	275,837	9,403,165	242,740,213

Source: *Tembo, 2006*

Ethanol production in Kenya



Source: *Ethanol Producer Magazine*

Potential Biofuels Projects in the ECOWAS Sub-Region

	Country	Biofuel	Plant Capacity, million litres	Raw Material	Investment, US\$'million
1	Benin	ethanol	20	cassava	14.0
2	Burkina Faso	ethanol	20	sugarcane	12.0
3	Côte d'Ivoire	ethanol	20	molasses	12.0
4	Ghana	biodiesel	50	jatropha	15.0
5	Guinea-Bissau	ethanol	10	cashew tree apples	9.0
6	Mali	ethanol	20	molasses	12.0
7	Niger	biodiesel	10	jatropha	6.0
8	Nigeria	ethanol	70	sugarcane	30.0
9	Senegal	ethanol	15	molasses	10.0
10	Togo	biodiesel	10	jatropha	6.0
			Total		126.0

Sources of Bio-ethanol

- ❑ **Sugarcane**
 - ❑ **Sweet sorghum**
 - ❑ **Sugar beet**
 - ❑ **Maize**
 - ❑ **Wheat**
 - ❑ **Rice**
 - ❑ **Potato**
 - ❑ **Cassava**
 - ❑ **Sweet potato**
-

Why cassava?

- ❑ Africa produces more than half the world cassava output but has the lowest yields
- ❑ As a raw material for industry, cassava would attract the necessary investments to drive up farm productivity
- ❑ Millions of farmers stand to benefit from a high demand for cassava as raw material for industry
- ❑ There is a wealth of research on cassava that has already been conducted and is awaiting adoption



Example of Optimized Cassava Growing Conditions in Cote d'Ivoire



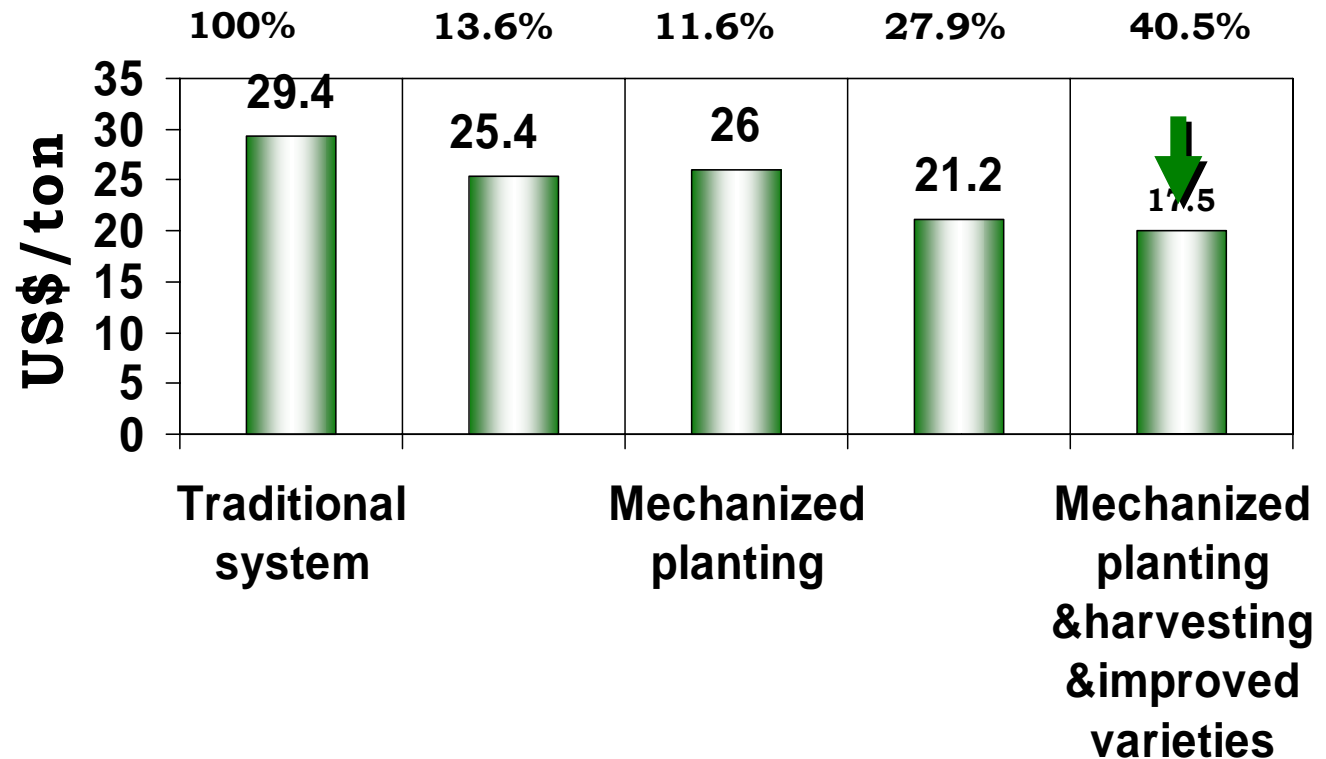
Meeting the Ethanol Demand using Cassava as Raw Material

- ❑ **Total demand 400m LPY**
- ❑ **1 ton cassava chips --> 400L**
- ❑ **==> Total chips demand: 1m tons**
- ❑ **==> Fresh roots demand: 3m tons**

- ❑ **Total cassava production: 15m tons/year**
 - Use for ethanol: 20%
 - With cassava productivity increases expected from farm-industry linkages, the percentage of cassava going to ethanol will decrease.

- ❑ **A cassava-based ethanol industry will require increasing cassava root yields**

The Challenge: Reducing the Cost of Production



Cassava agro industries will begin to grow in Nigeria when root prices are low and available (<N3500/t) and will lose to the traditional market when root prices are high.



Number of farmers benefiting

- ❑ **3m tons roots/year**
 - ❑ **Assumptions:**
 - Cassava yield: 10 ton/ha
 - Average farm size: 0.5ha
 - ❑ **Need 600,000 farms/year**
 - Opportunities for farm clustering to introduce farm mechanization, best management practices to drive productivity up
-



Number of factories required if target is 1 million LPD

Scale of ethanol plant operation			
	Small	Medium	Large
LPD	30,000	120,000	350,000
Number	35	9	3

Scale of cassava chips plant operation			
	Small	Medium	Large
Ton chips/day	0.5	2.5	10
Number	17,000	1,500	350

Opportunities for equipment manufacturing

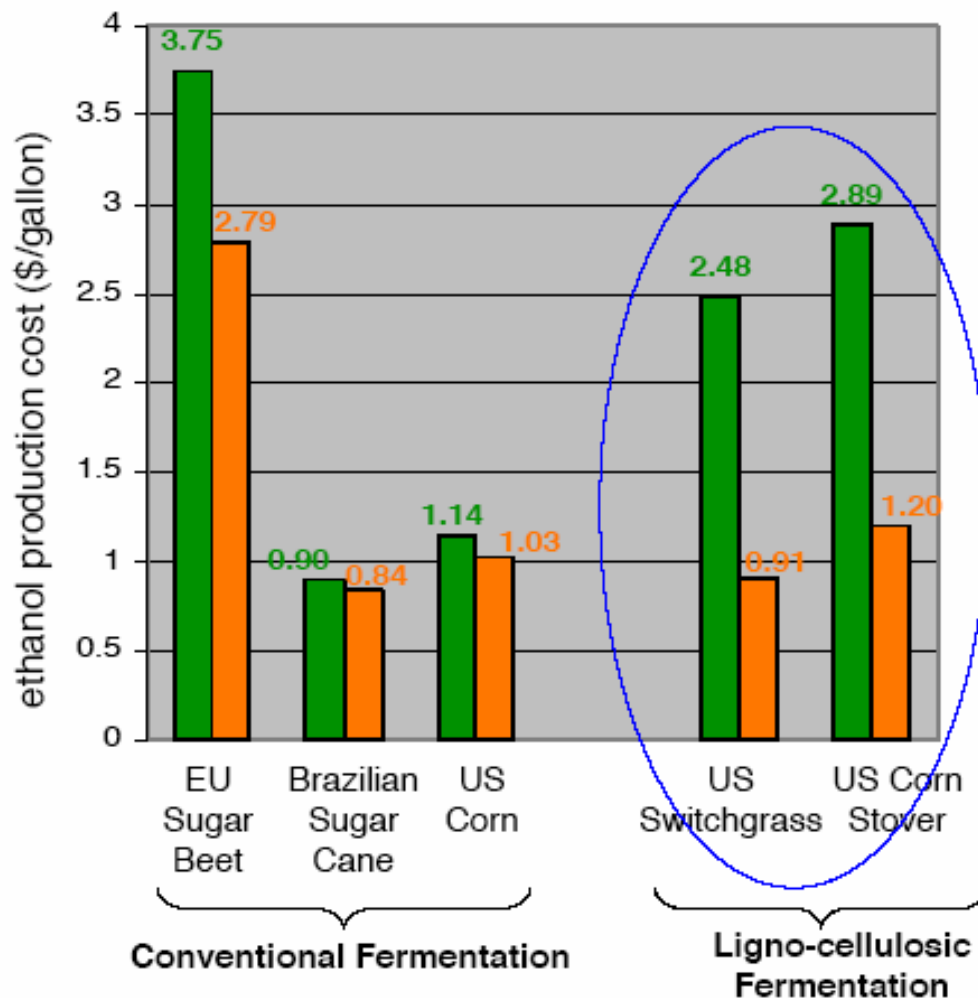
- ❑ **The high number of cassava chips factories present an added opportunity for equipment manufacturing in Africa rather than importing**
 - ❑ **To be competitive, a cassava-based ethanol industry needs to be backed by a capable maintenance and repair industry**
 - ❑ **AATF is working with Brazilian and African equipment manufacturers to facilitate the transfer of equipment fabrication, maintenance and repair know-how**
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Technology trends

- ❑ The conversion of simple sugars (sugarcane) and starchy substrates (maize, cassava, potato) to ethanol is a short term approach
 - ❑ In the long term:
 - ligno-cellulosic fermentation
 - C5/C6 fermentation
 - Production of **butanol** rather than **ethanol**
-



The Industry is investing in Ethanol conversion costs reduction



Technologies needed:

- energy crops
- pre-treatment technologies
- enzymatic hydrolysis
- C5/C6 fermentation
- alternative molecules

Key:

- Base case
- 10 year plausible technology stretch



Implications for a cassava-to-ethanol industry

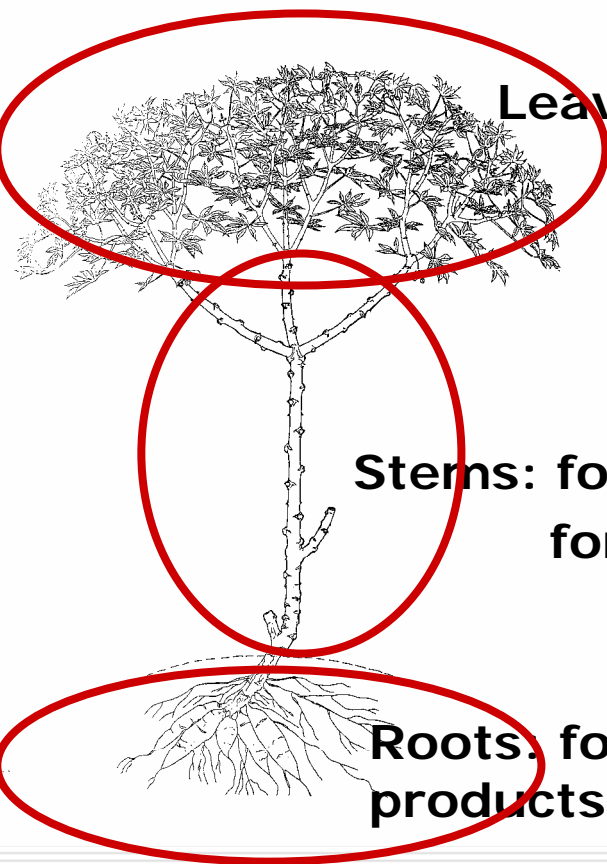
- ❑ **Ethanol plants will need to adapt to new raw materials and new processes: relatively easy**
 - ❑ **Cassava chips factories will need to find new outlets: there are multiple uses for cassava**
-

The multiple uses of cassava in industries



- ❑ **In food products**
 - Pie fillings, cream pudding, confectioneries, baby foods...
- ❑ **In the production of adhesives**
 - gums for envelopes, postage stamps, bottle labeling, lined cardboards, wood adhesives ...
- ❑ **In paper manufacturing**
 - internal sizing, filler retention, surface sizing, paper coating, toilet paper, disposable diapers, feminine products, ...
- ❑ **In textile manufacturing**
 - warp sizing, fabric finishing, printing
- ❑ **In the cosmetic and pharmaceutical industry**
 - dusting powder, make-up products, soap filler/extender, tablet binder/dispersing agent, pill coating, ...
- ❑ **As a lubricant in the oil drilling process**

Complete utilization of cassava



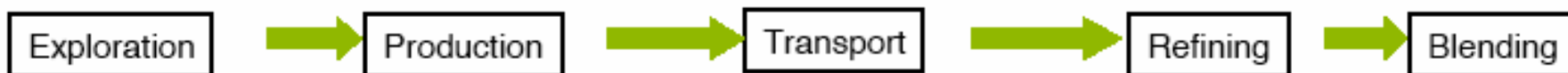
Leaves: proteins for food and feed

Stems: for ligno-cellulosic fermentation
for ethanol and butanol

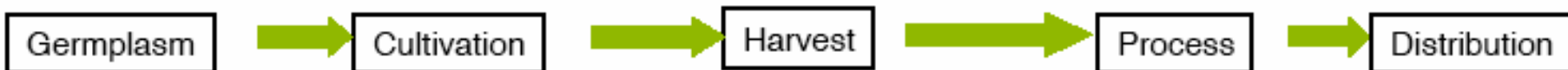
Roots: for food, feed and industrial
products

Optimizing biofuels requires fusing the petroleum and agricultural value chains

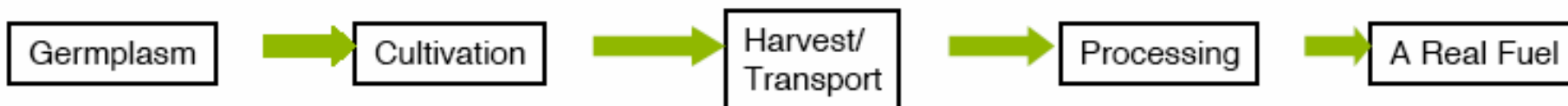
Petroleum Value Chain:



Agricultural Value Chain:



Biofuels Value Chain:



What Strategy for African R&D?

□ Energy Bioscience Intelligence Unit

- Include experts from various ministry
 - Energy, Agriculture, Industry, Infrastructure, Transportation, Lands, Science and Technology, Higher Education
 - Access and archive all open information
 - Establish partnerships to access proprietary technology when needed
 - Identify areas of the value chain for national focus and specialization
 - Fund local applied research by universities and research institutes with strategic partnerships (maybe through a bio-energy levy)
-

What Strategy for African R&D?

❑ Researchable issues

- Technology development
 - Check information in the scientific public domain, especially patent literature
- Technical and economic feasibility
- How to access intellectual property owned by others
- Value chain management and benefit sharing systems
- New uses of bio-energy: how to solve the problems of access to energy by the vast majority of Africans
- Smart subsidies
- Land tenure systems
- Environmental impact

❑ Need to be guided by national and regional Bio-Energy Strategies

Conclusion

- ❑ **The world needs more and cleaner energy: biofuels are here to stay**
- ❑ **Like any new technology, early adopters will derive more benefits (e.g. Brazil)**
- ❑ **Biofuels are a great opportunity to promote agro-industrial development, drive increases in agricultural productivity and encourage investment in infrastructure that serves agriculture and trade of agricultural products**
- ❑ **R&D efforts should focus on innovations in agricultural and energy value chains, access to IP, wealth creation and benefit sharing**



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