The Hydrogen Economy – A move to a low Carbon Future

August 2014



GPM Working Group
Dar Es Salaam, Tanzania
13 August 2014

MITOCHONDRIA ENERGY COMPANY (Pty) Ltd

1 Introduction to Mitochondria Energy's Purpose, Vision and Structure

Mitochondria | Purpose, Vision and Mission

- Our Purpose is to contribute towards providing security of energy supply and eliminating energy poverty in South Africa and greater Africa respectively.
- The vision of the organization is:

"To be the respected, trusted, innovative, smart, sustainable and technology agnostic distributed energy solutions provider that adds value to all its stakeholders and to Africa's development challenge."

- The mission of the organization is:

"We shall accomplish our vision through smart collaborative partnerships and co-investment in selected emerging low carbon energy technologies."

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Mitochondria | Markets and Solutions

Mitochondria provides decentralized, distributed, on-site and grid connected single, co-generation, tri-generation and quattro-generation energy solutions and services to a variety of clients, customers, markets and industries including:

- Telecommunications
- Health Care, Data Centre's and other Critical Infrastructure
- Commercial
- Hotel and Hospitality
- Industrial
- Mining and
- Residential (Opportunity with small scale Fuel Cell)
- Outdoor and Recreation (Opportunity with small scale Fuel Cell)
- Consumer Electronics (Opportunity with small scale Fuel Cell)

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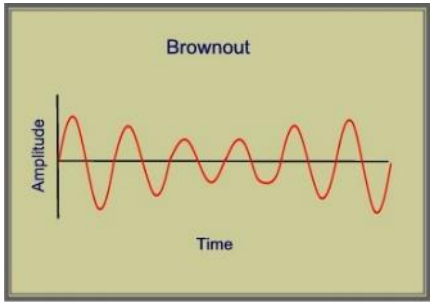


2 Energy in Telecoms

Operational challenges

Stability of National Power Grids

- Brown outs
- Black outs





Non Existence of National Grids

- Self provisioning of power

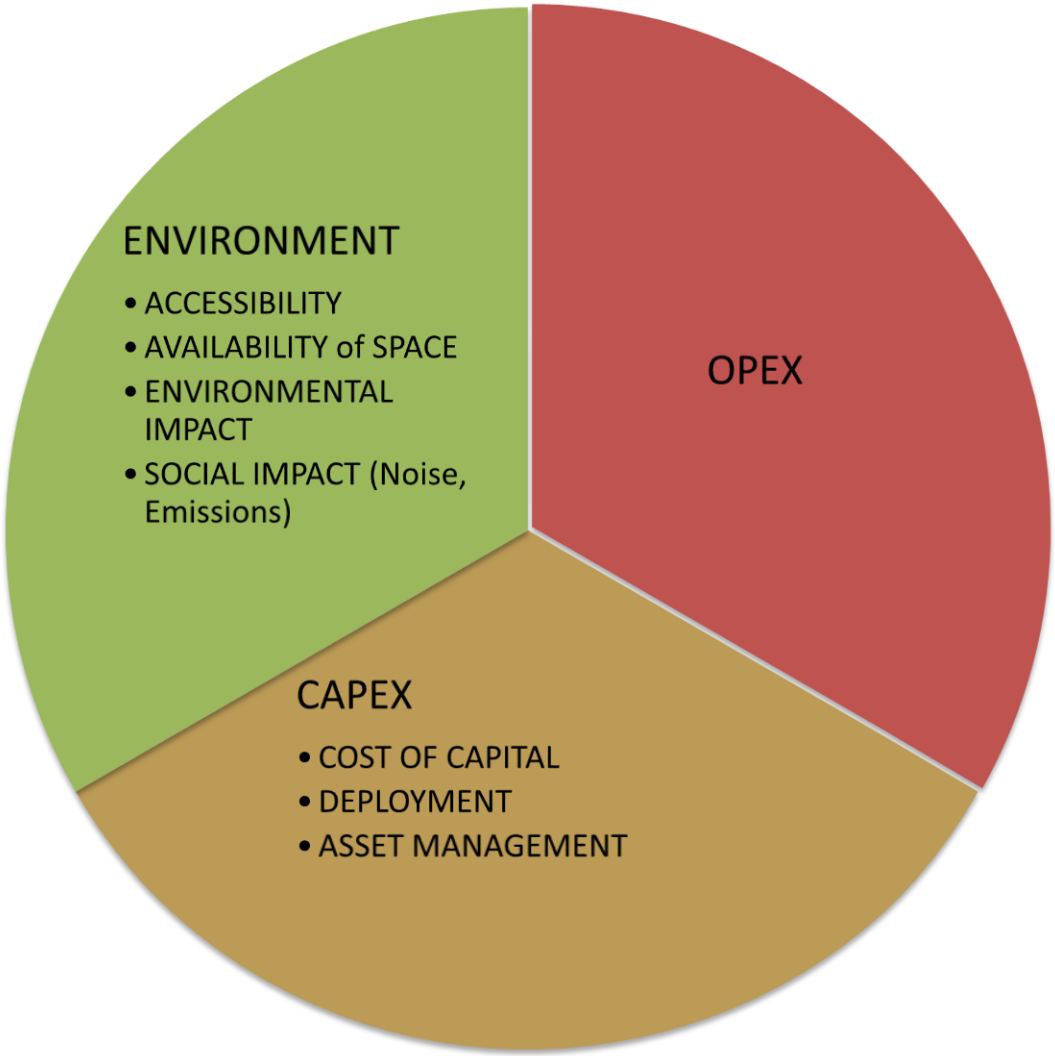


Challenges of self provision of power

- Access to site
- Fuel theft
- Battery theft
- Fuel logistics
- General theft and vandalism
- Ensuring competitive costs

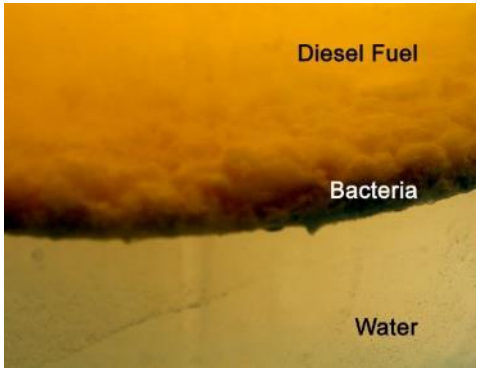


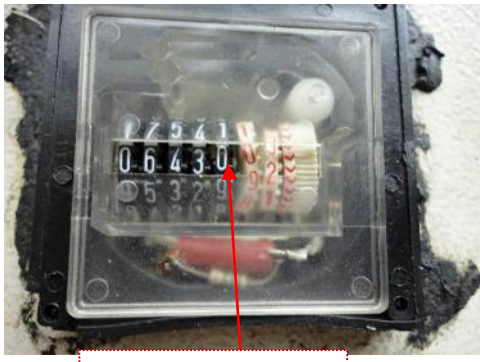
Business Challenges



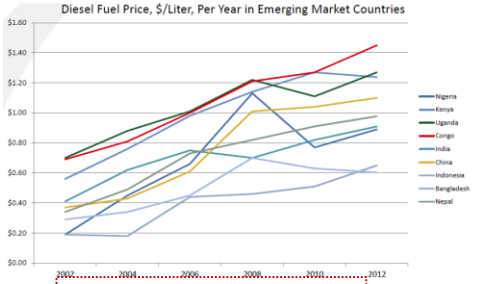
ASSUMPTIONS – Cost Drivers OPEX

RELIABILITY	• Penalties • Revenue Loss
OPERATIONAL INFO	• Usage • Run Hours • Efficiency
LOGISTICS	• Quality of fuel • Storage of fuel
LIFECYCLE COST	• Replacement Parts • Labor
UNPREDICTABLE COSTS	• Fuel Cost Volatility • Theft • Vandalism • Unscheduled Maintenance

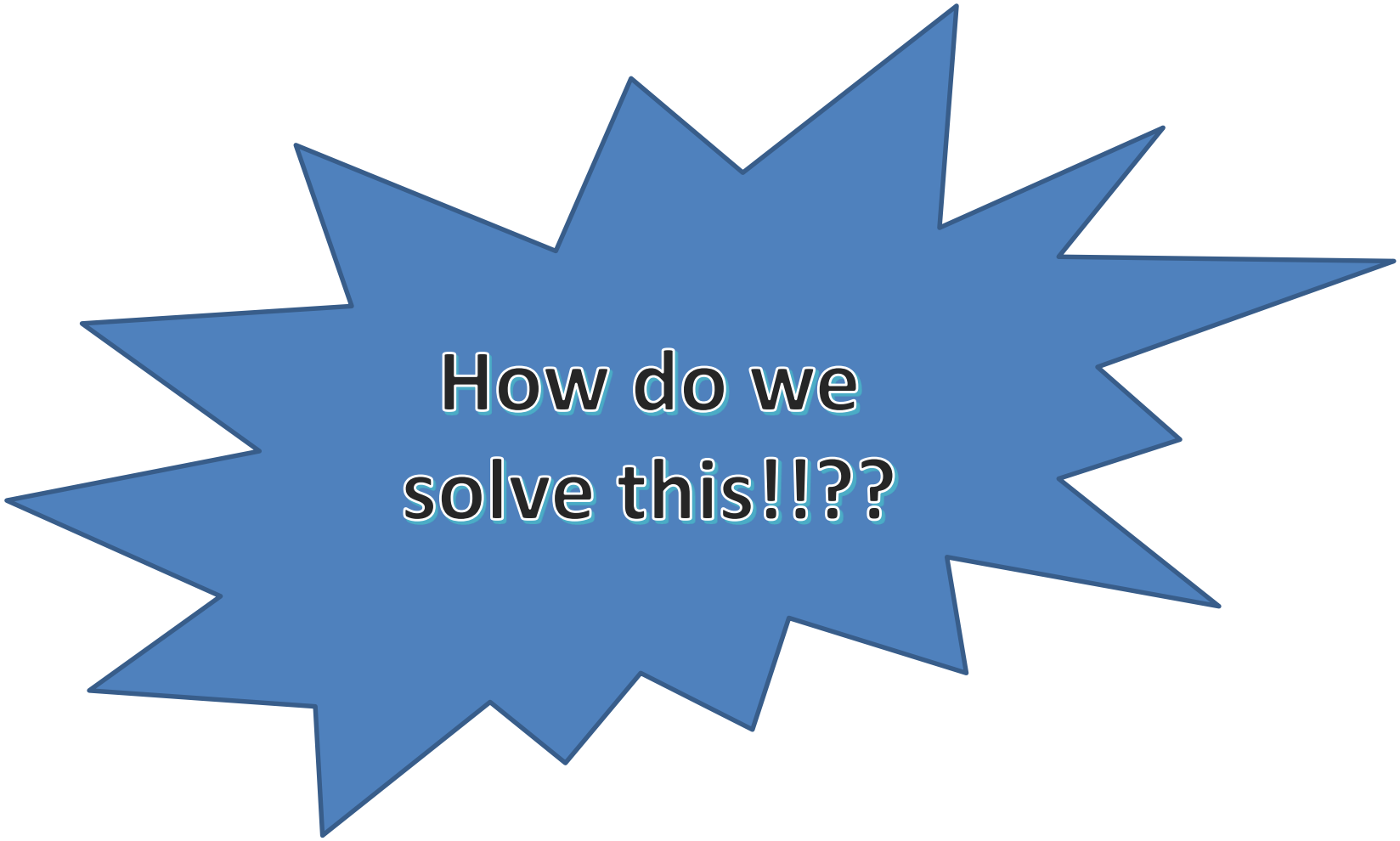




Tampered meter

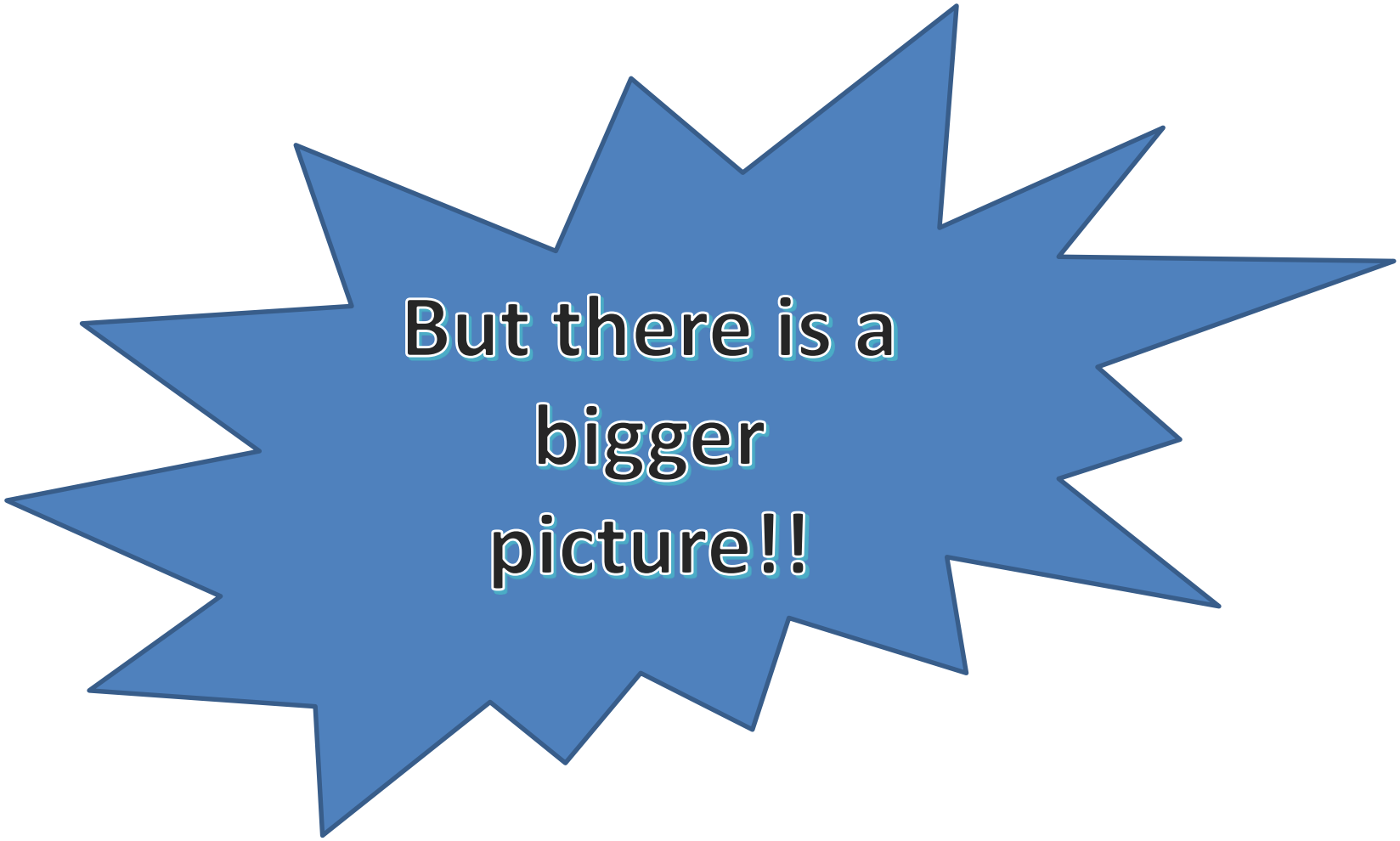


Diesel Cost Increases


How do we
solve this!!??

De-commoditization

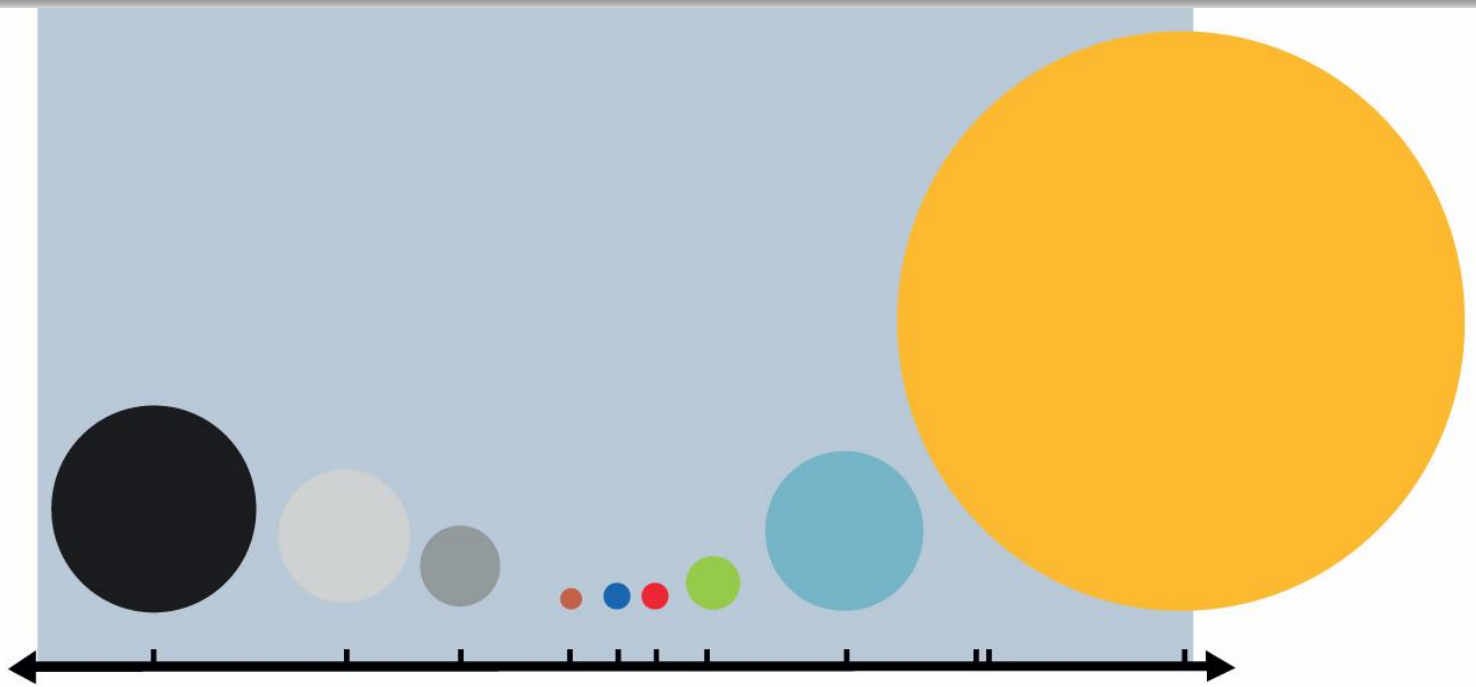
- Reduce amount of popular commodities on Base Station Sites:
  - Optimize site load and simplify site as an enabler for renewables/clean tech.
  - Replace Lead Acid Batteries with alternative storage media such as flow batteries
  - Implement reliable technologies that reduce the dependence on Batteries (fewer batteries)
  - Remove Diesel and Diesel Generators from sites by implementing alternative fuel generators such as fuel-cells
  - Harvest renewable energy resources where possible and feasible


But there is a bigger picture!!

3 Demand and Supply Dynamics: Africa and Energy Resources

The 2010 World Energy Council (WEC) report says that Africa's reserves of renewable energy resources are the highest in the world, and that the continent has enough renewable energy potential to meet future demand

Comparison of World Energy Resources



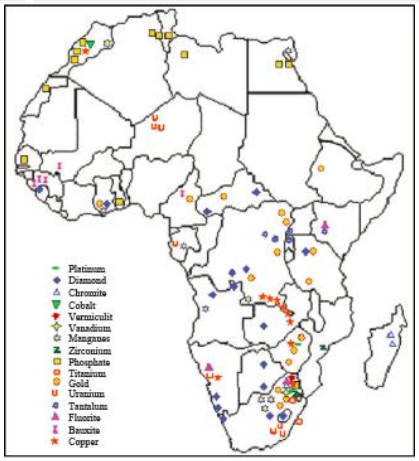
	Energy potential Reserves/Resources[2]	Thereof conventionally utilizable[2]
Coal	~ 135.000 EJ	
Natural gas	~ 60.400 EJ	~ 12.000 EJ
Crude oil	~ 23.000 EJ	~ 9.800 EJ

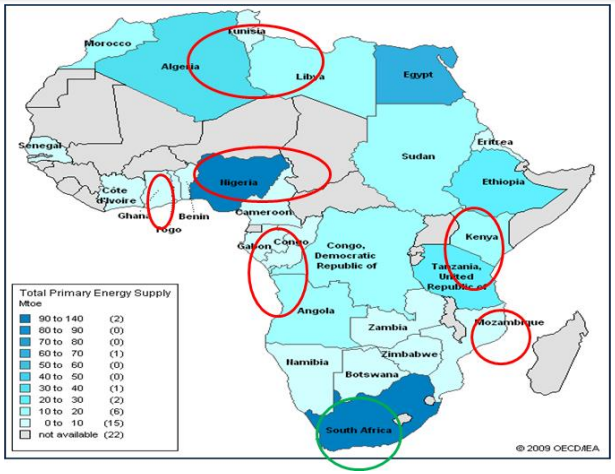
Global energy demand 2006: ~ 470 EJ

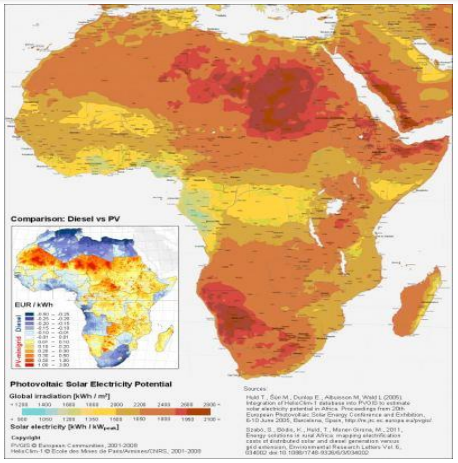
	Energy potential (amount of energy p. a.)[2]	technologically utilizable (state of the art)[2]
Solar radiation	~ 1.111.500 EJ	~ 1.482 EJ
Wind energy	~ 78.000 EJ	~ 195 EJ
Biomass	~ 7.800 EJ	~ 156 EJ
Geothermal	~ 1.950 EJ	~ 390 EJ
Hydro/tide power	~ 1.170 EJ	~ 78 EJ

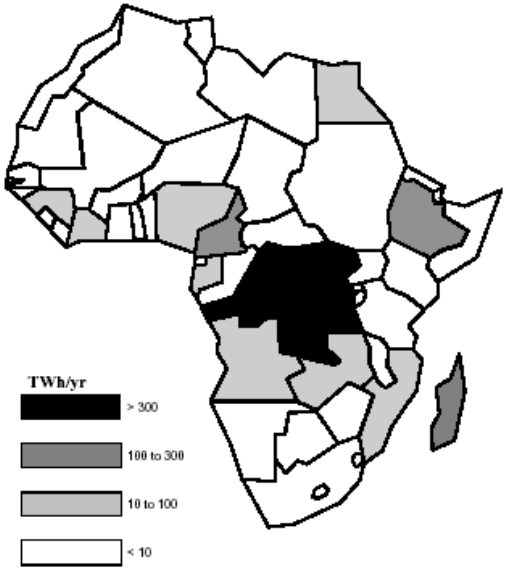
Source: EREC

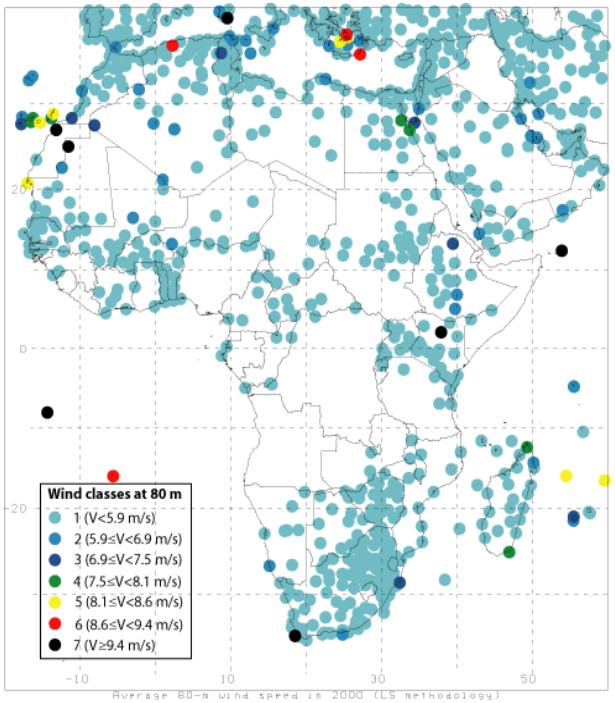
Africa is rich in Energy and Mineral resources

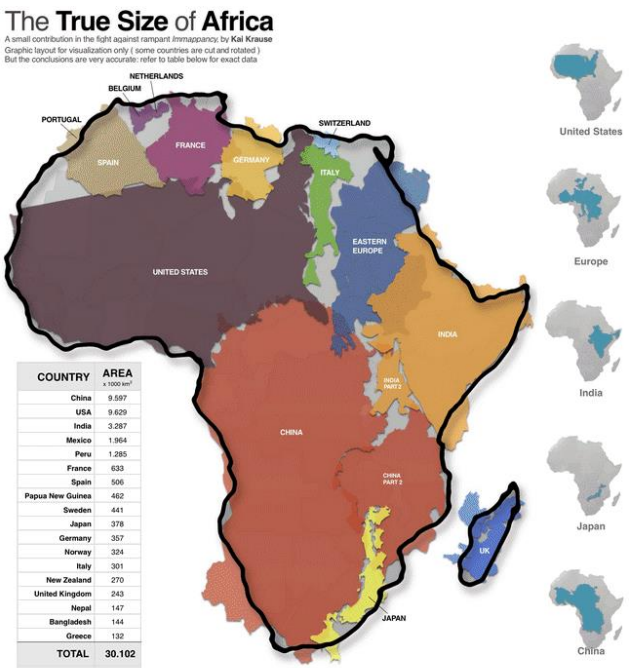












COUNTRY	AREA x 1000 km²
China	9.597
USA	9.629
India	3.287
Mexico	1.964
Peru	1.285
France	633
Spain	506
Papua New Guinea	462
Sweden	441
Japan	378
Germany	357
Norway	324
Italy	301
New Zealand	270
United Kingdom	243
Nepal	147
Bangladesh	144
Greece	132
TOTAL	30.102
AFRICA	30.221

Africa is rich in Energy and Mineral resources

- Africa has the largest reserves of Alumino-Silicates, Chromium Ore, Gold, Manganese Ore, PGM's, Titanium, Vanadium and Vermiculite
- Highest Hydro-power potential
- Southern Africa produces 80% of world's Platinum Group Metals
- Nigeria, Angola and Ghana combine have sufficient feedstocks with an attractive electricity demand profile, making them the top contenders for fuel cell export market selection. Feedstocks in Tanzania, Congo and Uganda look positive
- Very Good Solar Potential



4 The Changing Global Energy Landscape

Energy Market dynamics

- **The global energy landscape is decarbonising and hydrogenating:** over the past two hundred years the hydrocarbon energy landscape has simultaneously been reducing its carbon intensity and increasing in hydrogen content.

- **Gas is emerging as the next significant energy resource:** the surplus of gas globally will drive pricing downward and unlock the energy generation opportunity in markets. This is coupled with the focus on decarbonising the energy value chain.

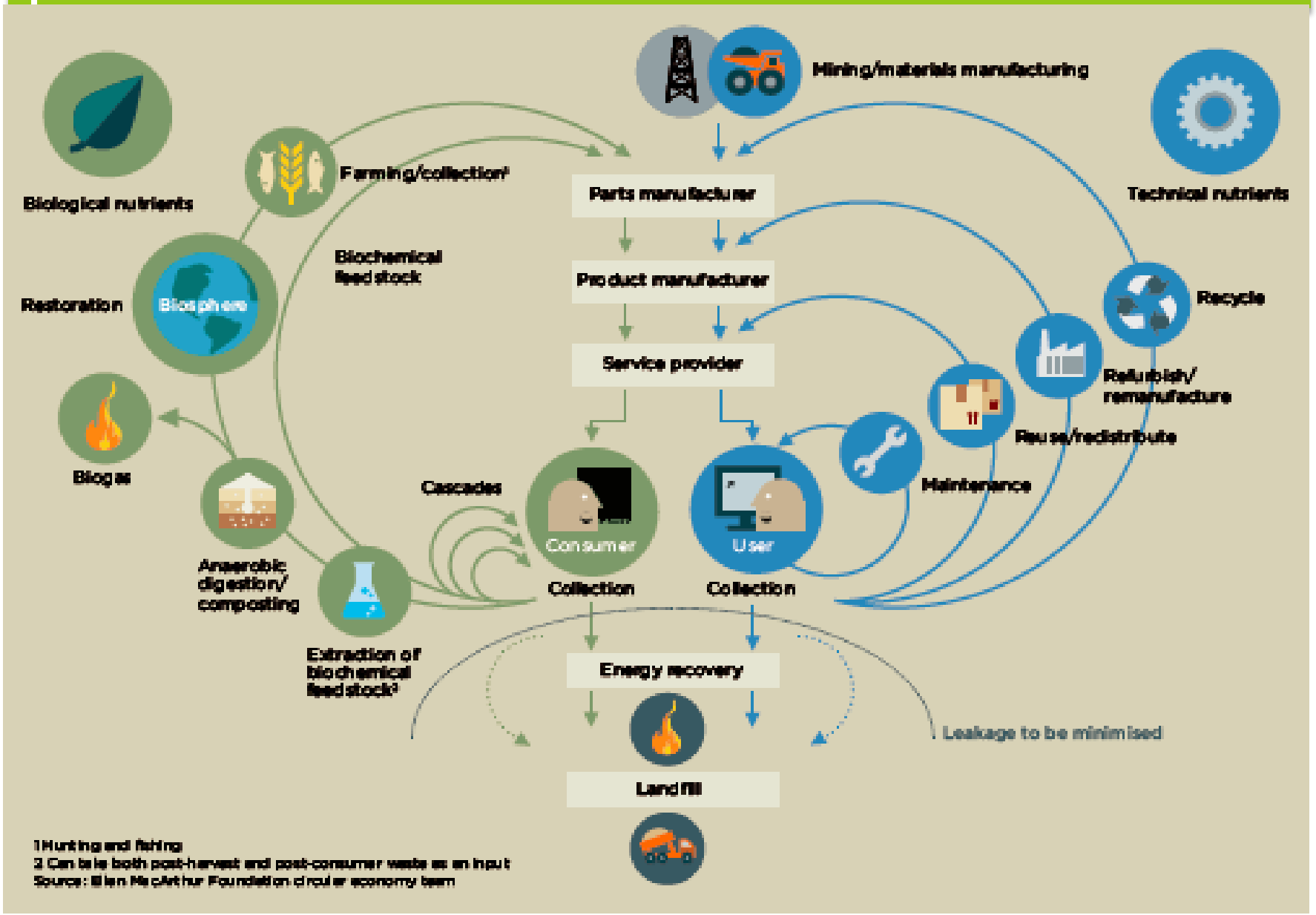
- **Decentralised, distributed energy solutions will dominate:** lack of distribution and transmission infrastructure and the focus on energy efficiency will encourage efficient, distributed technology solutions

- **High energy price growth:** increase in global energy prices are enabling the viability of alternate disruptive technologies

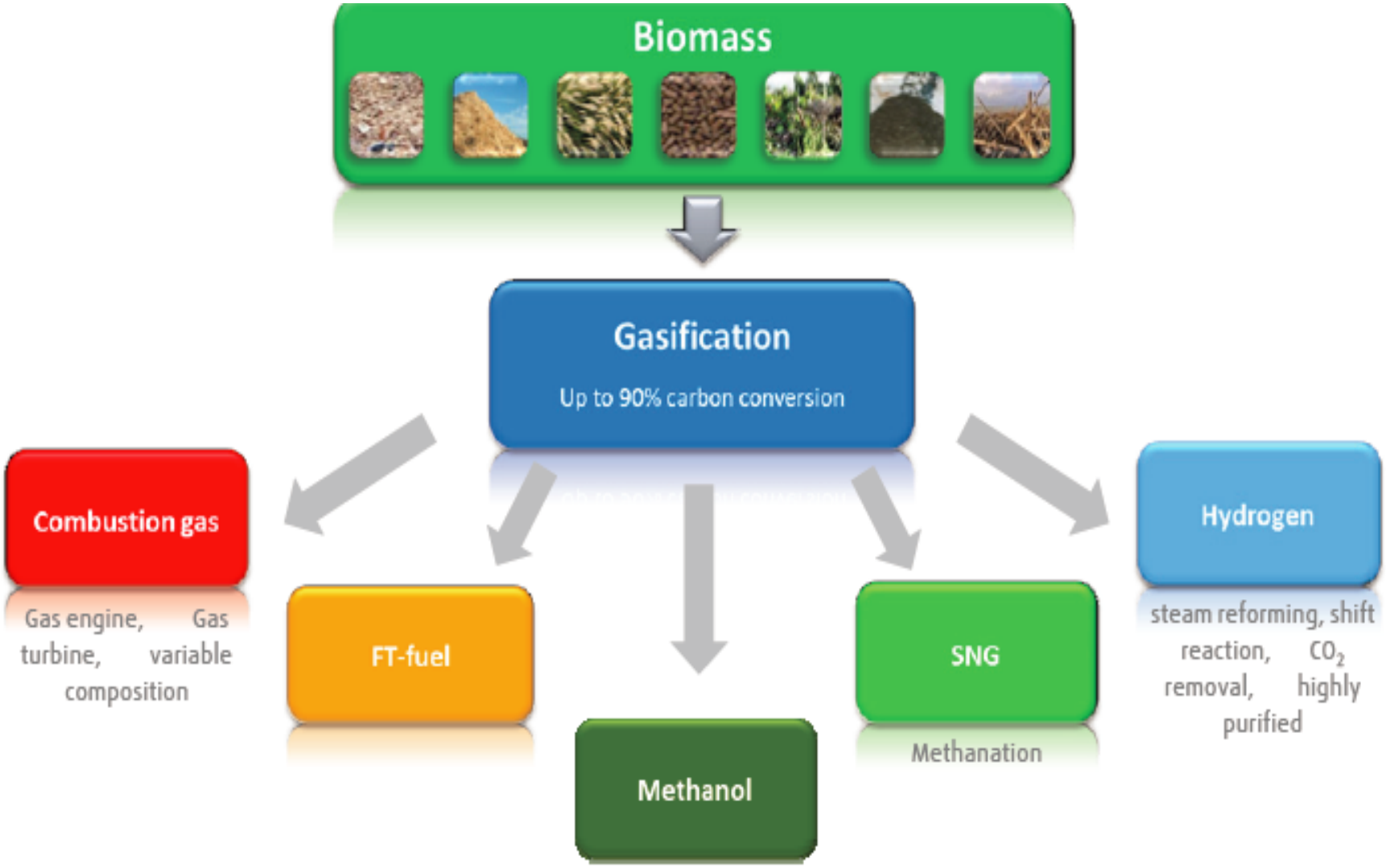
- **Climate change drives focus on carbon:** clean energy technologies will participate in the energy mix with price parity being achieved in various technologies.

- **Urbanisation in Africa is driving increasing demand for energy:**

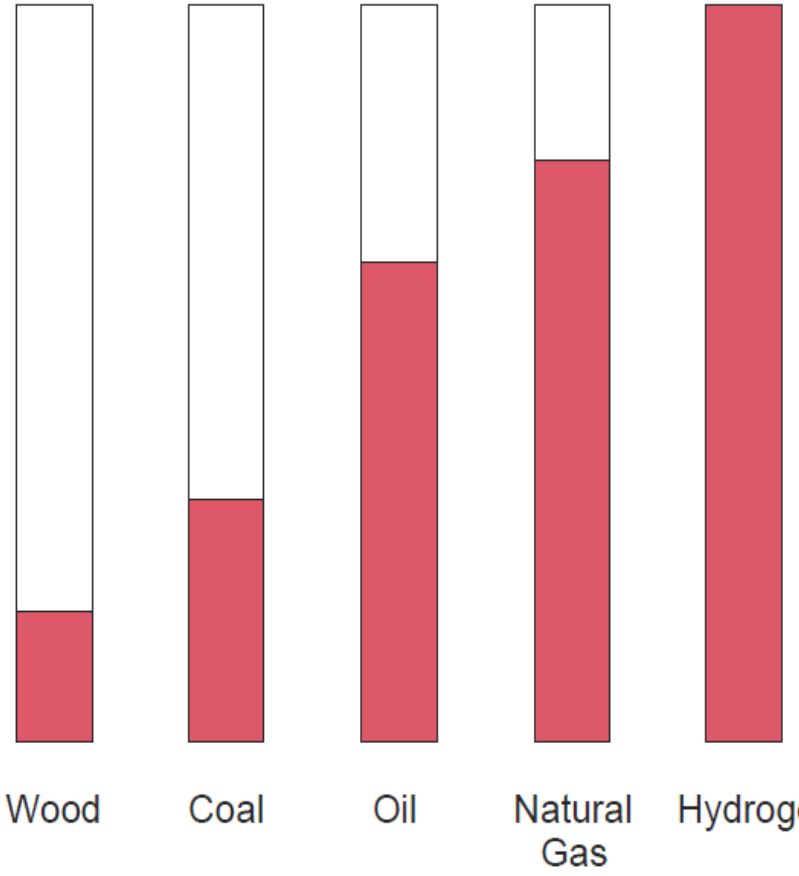
From Waste Streams to Value Streams: Waste as a Resource



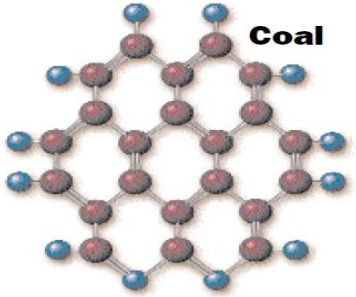
From Biomass and Waste to Value Streams

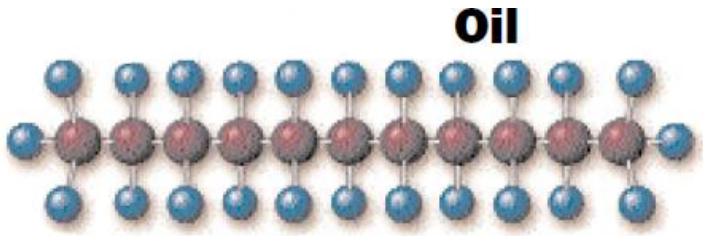


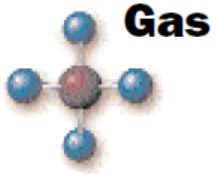
Decarbonization & Hydrogenation



Source: Barreto, L., Makihira,A., & Riahi, K. 2003



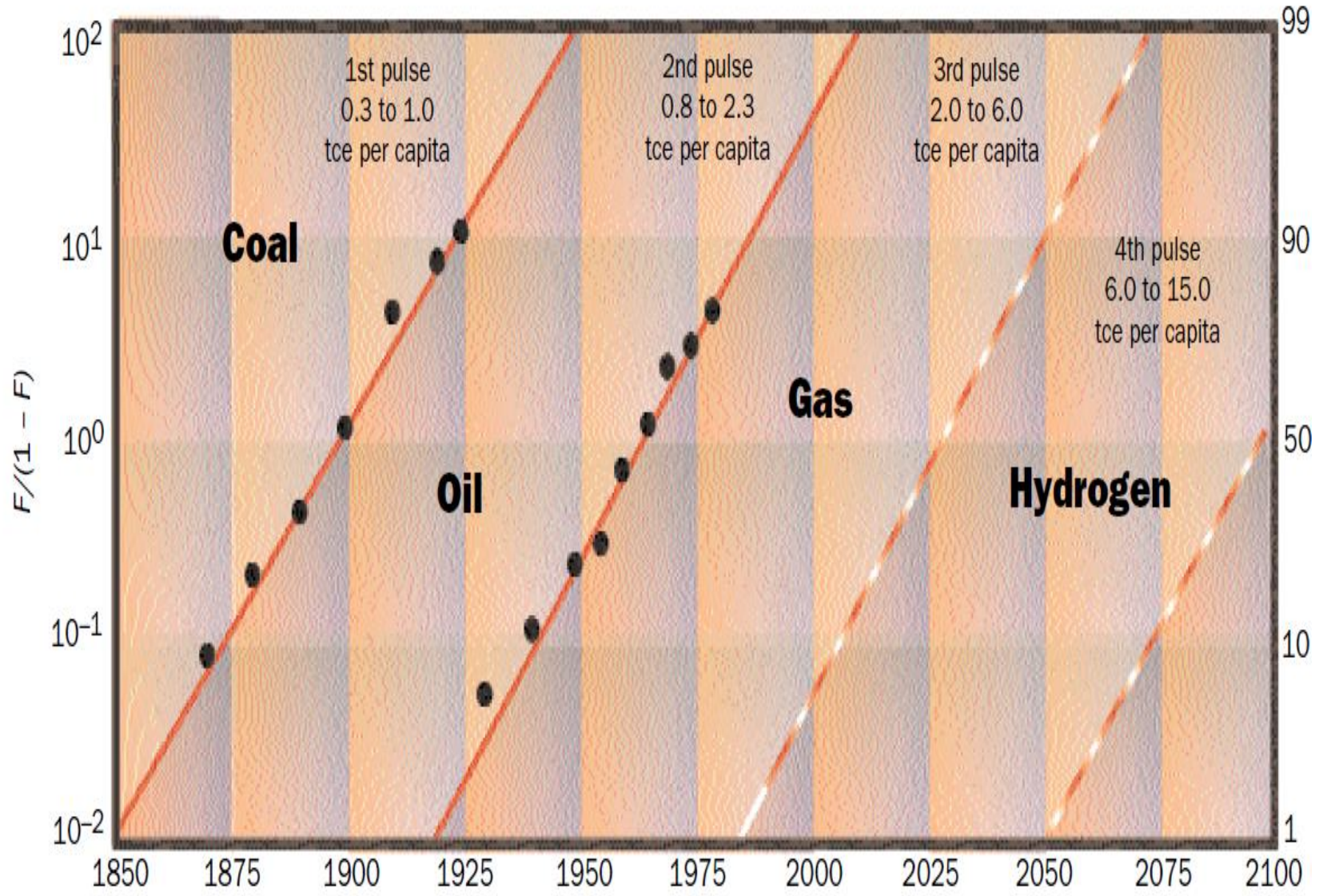




Asubel, J.H. 2000

Emerging Energy Paradigm: Portfolio of Energy Resources

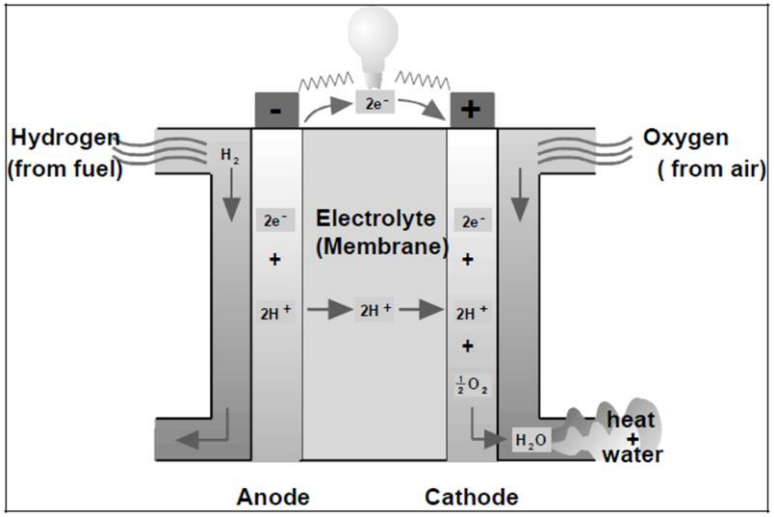
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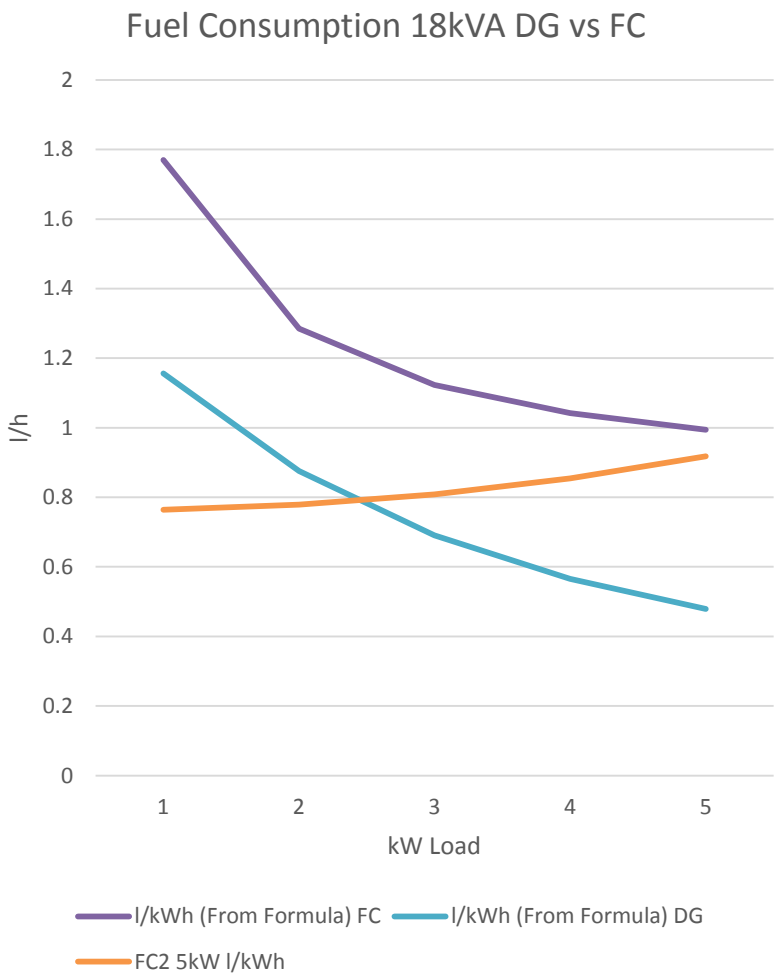
Source: Asubel, J.H. 2000.

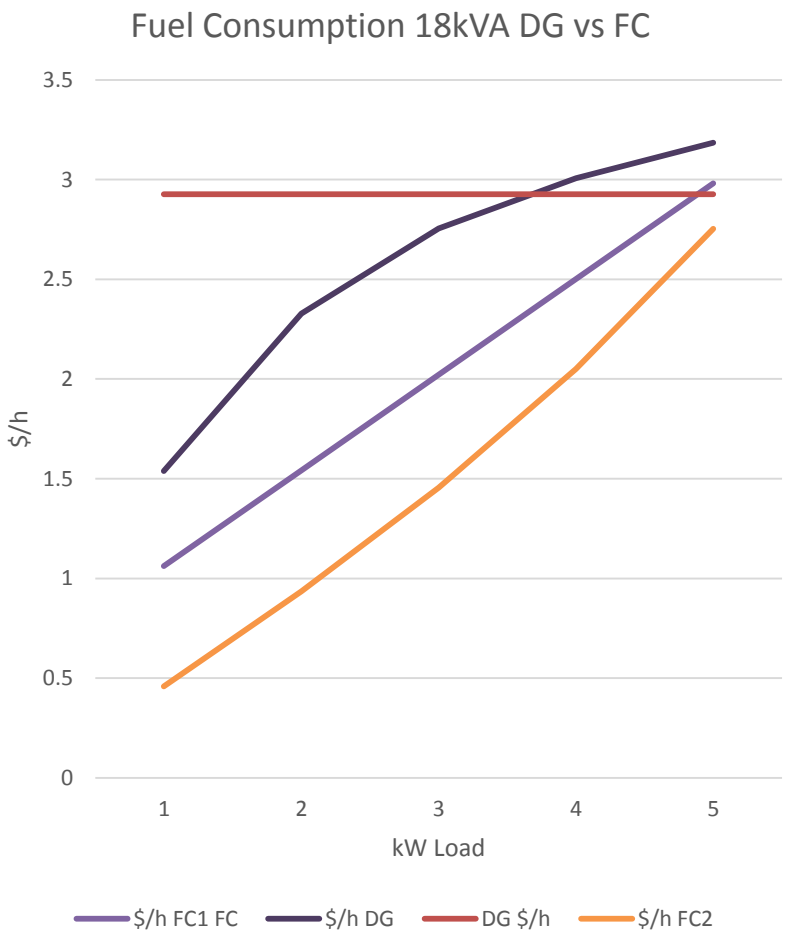
Fuel Cells

- Fuel Cells a good fit to harness Africa's resources:
  - Africa can produce fuels from Hydro Power Electrolysis, Methane gas (methanol or reformation based Hydrogen), Waste etc.
  - Use PGM's to produce fuel cell stacks
- Fuel Cells can run for several months without servicing
- Combined Heat and Power possibilities
- Low commodity value
- Small footprint
- Rapid Deployment
- Low CO_2, almost no NOx, SOx and particulate matter
- Low skill requirement



Comparison of Technology Fuel Consumption curves





- Based on 5kW Fuel Cells and 18kVA Gensets
- Cost based on run-hours
- Based on $1.33 per liter Diesel Cost and $0.66 per liter for Methanol based fuel

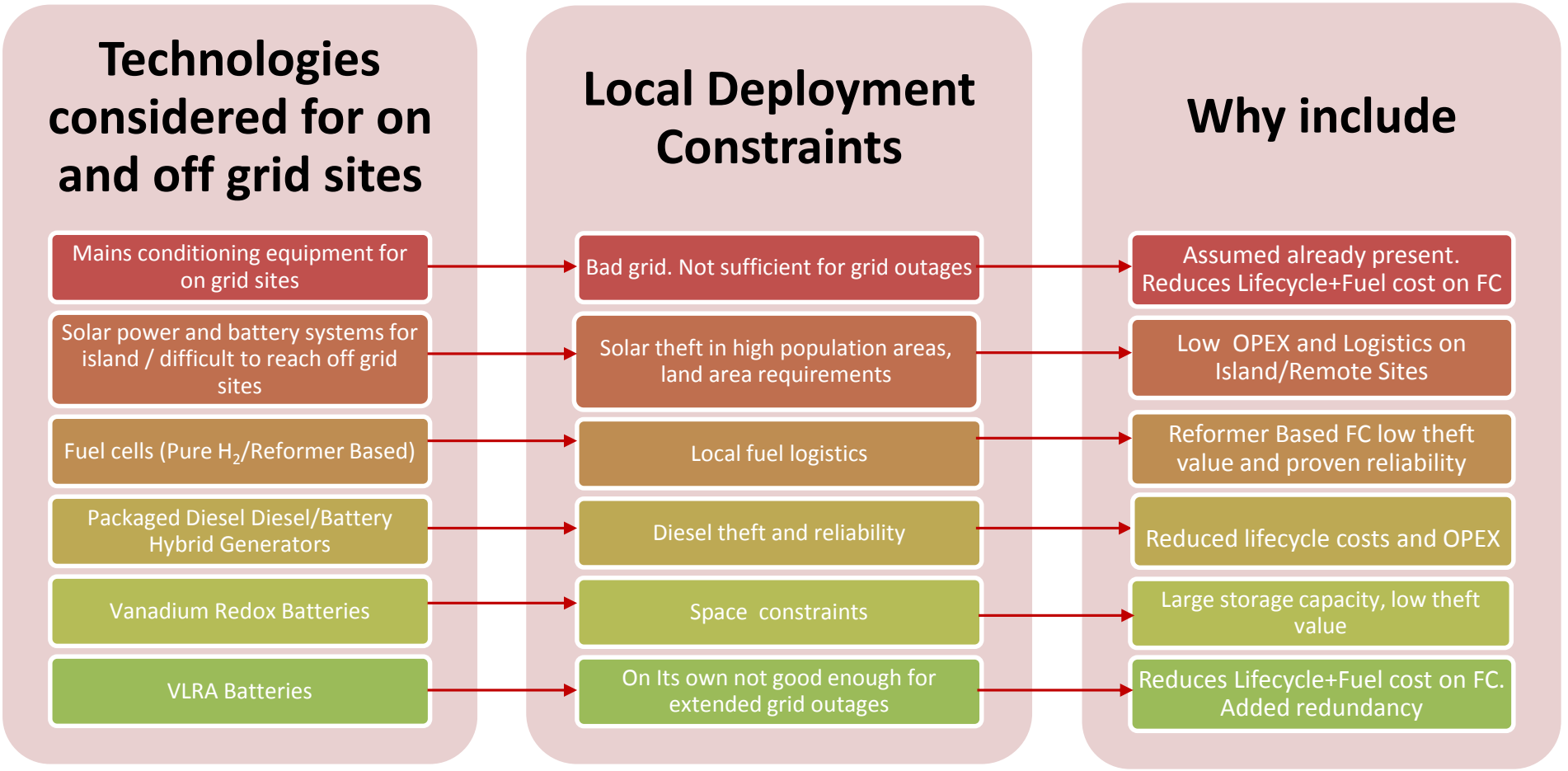
Private and Confidential

5 Outsourced Energy using Green Tech

No Silver Bullet!!!!

- An in-depth assessment is necessary to find the right technology mix:
  - Technology applicability and optimisation
  - Logistics
  - Financial
  - Commercial
  - Strategic

Technology evaluation - overview



Execution process

Conceptual / Desktop Evaluation

- Preliminary proposal for discussion based on available information provided by Infrastructure Operator
- Detailed TCO assessment across multiple technologies
- Technology, logistics and execution strategy design
- Business case evaluation resulting in saving potential

Business Model Validation

- Validation of hypothesis and assumptions
- Site audit data key input into evaluation
- Baseline costing finalisation
- Detailed design and costing
- Business case finalisation
- POC design development and contractual terms

Proof of Concept Assessment

- Validation of business model in real world operation
- Testing and validation of logistics systems and methodologies
- Sign off of the business case
- Contractual finalisation (SLA, PPA etc)
- Finalise funding structures

National roll-out

- Execution and delivery within agreed terms
- Operation and maintenance
- SLA management and monitoring

Mitochondria's Proposition

- Mitochondria's business proposition is to sell power, to key clients in the African market.
- Extensive development and engineering design is conducted to determine the appropriate optimal energy solution that provide the client with a cost advantage from the current base.
- Mitochondria remains technology agnostic but due to extensive expertise across technologies enables a sustainable approach to the definition of solutions.
- Mitochondria will fund the capital expenditure, operate and maintain the equipment within a long term power supply agreement between the company and the client.
- This has been enabled through its lead investor, the Industrial Development Corporation ('IDC'), who acts as a shareholder and project investor in Mitochondria.

Mitochondria's Proposition cont....

- Mitochondria has an extensive level of expertise in this value proposition proposed and offers the client an opportunity to:
  - Diversify the energy mix from traditional diesel technologies thereby decoupling the business from risks associated in the market and due to theft
  - Reduce the carbon footprint of the network
  - Renew the power offering to the client with no capital expenditure
  - Reduce the cost of power provision
- This solution enables:
  - stable and predictable cash flows,
  - the opportunity to access greener funds and
  - a low / no risk solution (client can decide when to redeploy assets).
- Critical Mass around 500 BTS sites

Conclusion

- Africa is able to reduce it’s dependence on Oil Diesel and Coal while harnessing Africa’s resources and creating sustainable development of the continent
- New technologies can be introduced in calculated way, while minimizing risk, reducing total cost and with minimum capital investment through PPA agreements.
- All this while also significantly reducing Africa and specifically Telecom Infrastructure Operators'’ Carbon emissions.