TIRDO's Role in Development of Sustainable Energy Technologies for Supporting the Industrialization Process in Tanzania

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"Making industrialization work for socio-economic transformation"

TIRDO Role in Development of Sustainable Energy Technologies for Supporting the Industrialization Process in Tanzania

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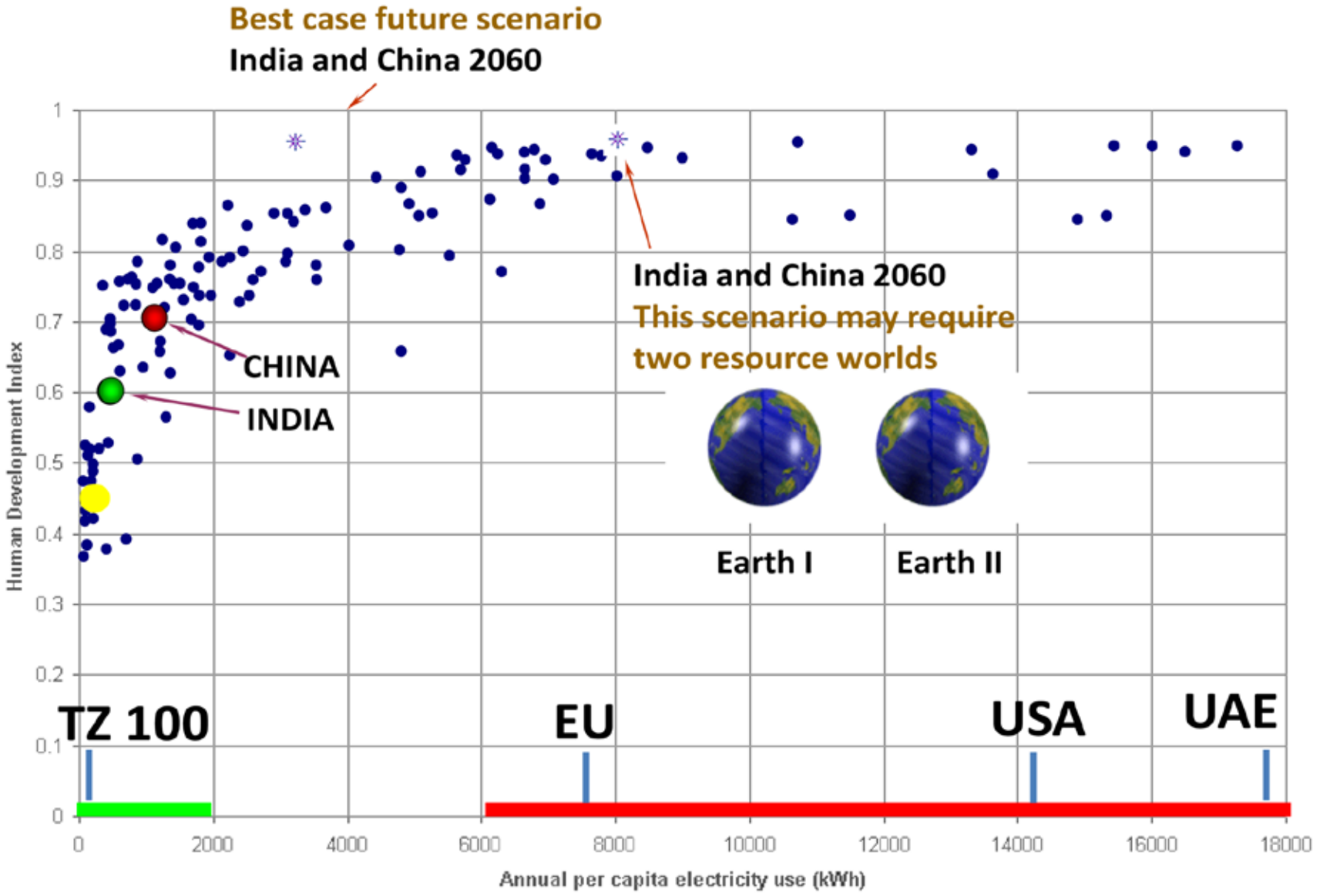
1: INTRODUCTION

1.1 Energy is prerequisite for development

A correlation between per capita energy use and real per capita income throughout the world economies

- Higher use implies higher income and vice versa
- Low per capita energy consumption in the developing countries is negatively affecting economic opportunities, and the provision of social services like health, education, and safe water.

… /Energy is prerequisite for development



1.2 Challenges of development

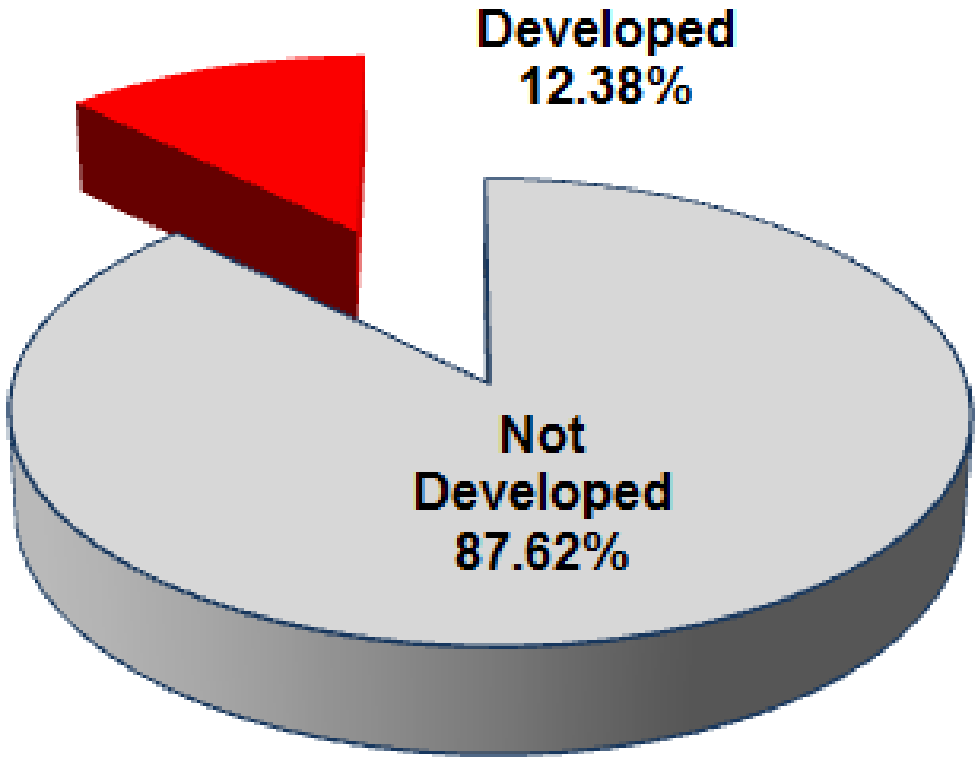
Various, which may base on:

- Low technological skills
- Low technological capacity
- Governance-based
- Mindset-based
- Resources-based
  - Tanzania has abundant energy resources are to include hydro, biomass, natural gas, coal, uranium, solar, wind and geothermal
  - Sustainable industrialization calls for an effective harnessing to these energy resources.

2. TANZANIA ENERGY RESOURCES

2.1 Hydropower

- The macro hydro potential is about 4.7GW
  - Only 565MW have been developed
- Micro hydro potential of about 350 MW
  - About 63.54 MW developed

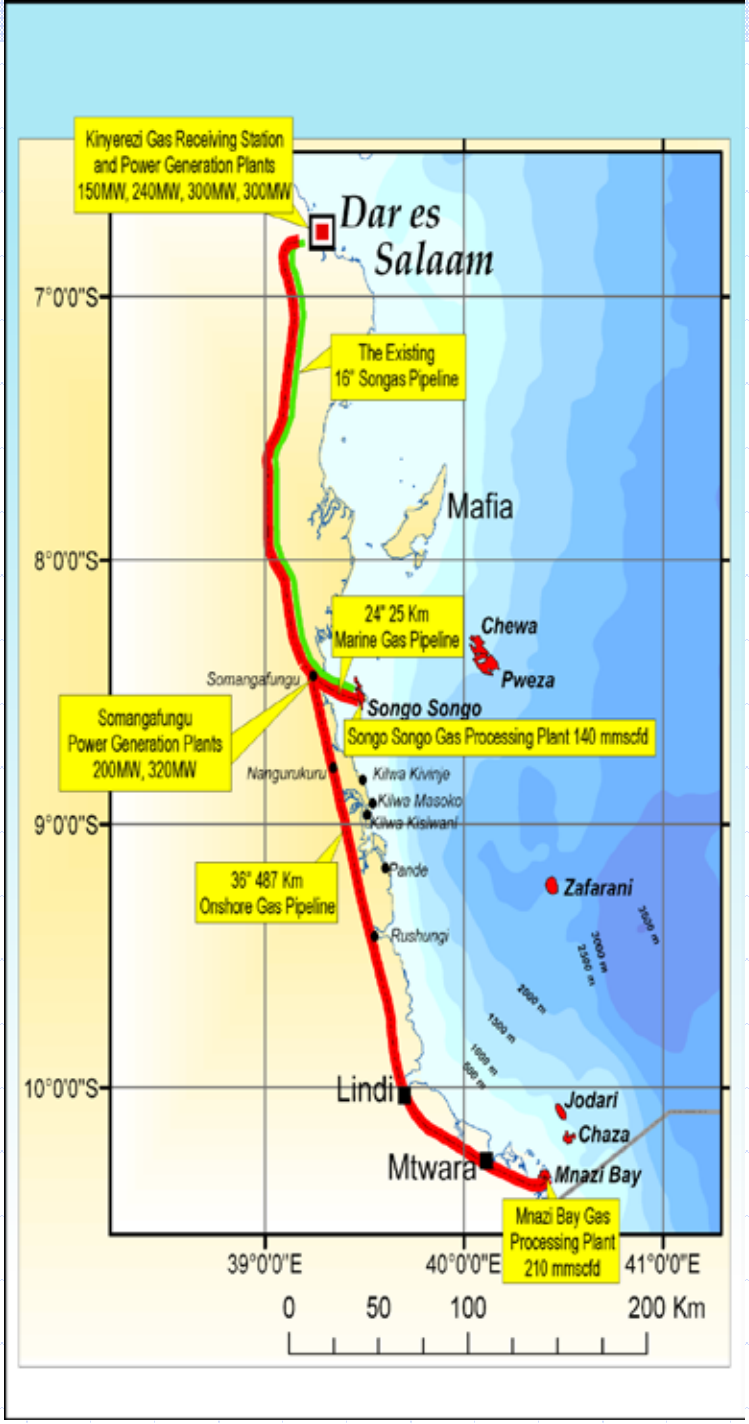


2.2 Natural gas

TPDC has discovered five offshore natural gas reserves (Songo Songo, Mnazi Bay, Mkuranga, Kiliwani and Ntorya) and eight deep sea discoveries (Chaza, Jodari, Zafarani, Pweza, Mzia, Chewa, Papa 1 and Lavani) - southeastern Tanzania

- Total natural gas reserve is 55.08 trillion cubic feet (TCF)
- 1.142 TCF is proven at Songo Songo and Mnazi Bay
- 20.68% of the proven natural gas reserve has been harnessed

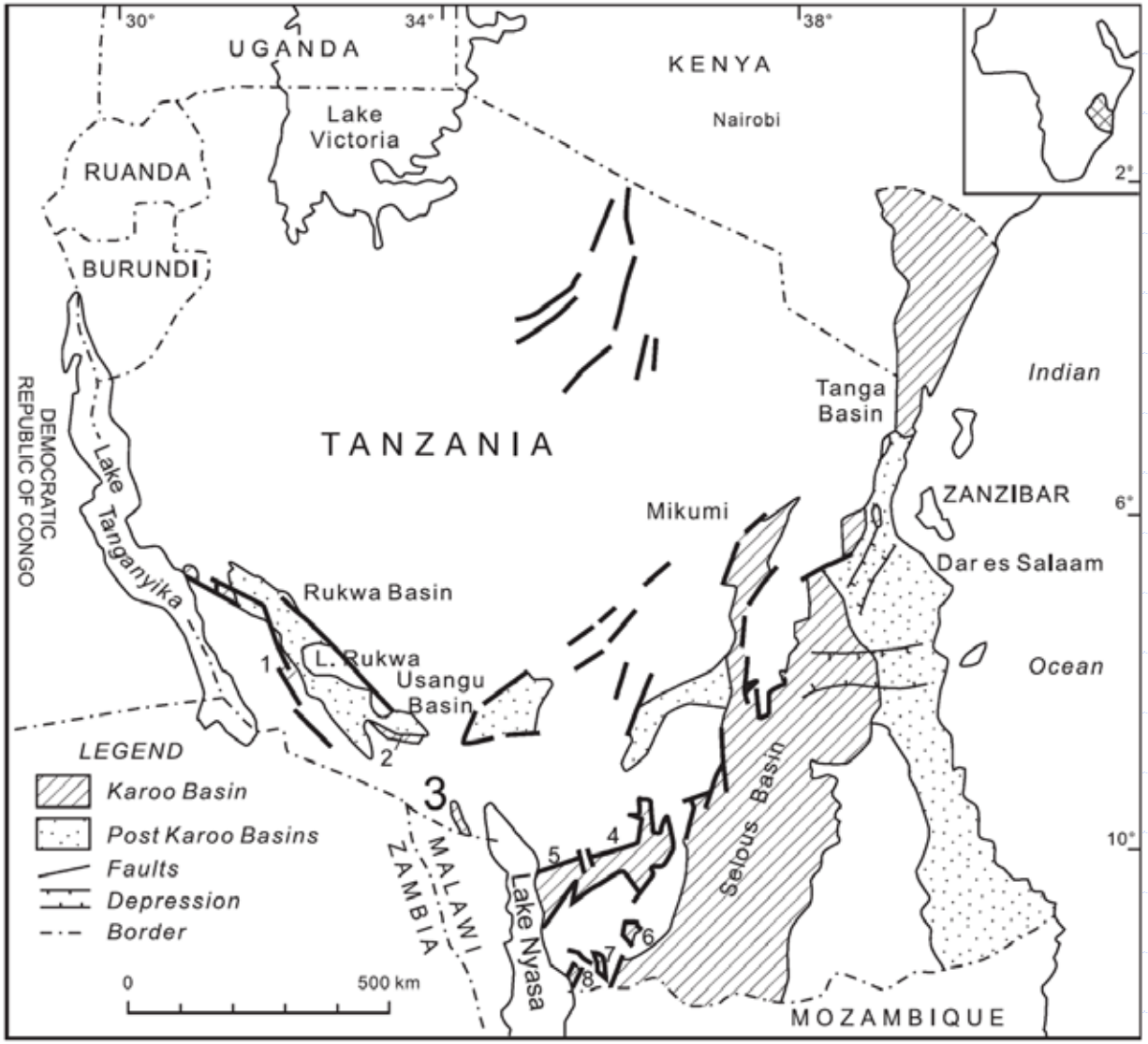
… / Natural gas


Kinyerezi Gas Receiving Station and Power Generation Plants 150MW, 240MW, 300MW, 300MW
Dar es Salaam
7°0'0"S
The Existing 16" Songas Pipeline
Mafia
8°0'0"S
24" 25 Km Marine Gas Pipeline
Chewa
Pweza
Somangafungu
Songo Songo
Songo Songo Gas Processing Plant 140 mmscfd
Somangafungu Power Generation Plants 200MW, 320MW
Nangurukuru
Kiwa Kivinje
Kiwa Masoko
Kiwa Kisiwani
9°0'0"S
36" 487 Km Onshore Gas Pipeline
Pande
Zafarani
Rushungi
Lindi
10°0'0"S
Jodari
Chaza
Mtwara
Mnazi Bay
Mnazi Bay Gas Processing Plant 210 mmscfd
39°0'0"E
40°0'0"E
41°0'0"E
0
50
100
200 Km

2.3 Coal reserve

- Coal reserves is about 1,500 million tons of which 496.11 million tons are proven
- Majority coal resource is within the Ruhuhu coalfield that contains reserves at Mhuhuru, Katewaka-Mchuchuma and Ngaka that contains almost 700 million tons of coal
- Other deposit is the Songwe-Kiwira coalfield
- Recent discoveries of deposits in the southwest part of Tanzania
  - The level of utilization is still low (0.51%) through one power plant and thermal applications

.../Coal reserve



- Estimated at 1,500 mill. tons; 304 mil. tons proven
- Ruhuhu (Mhuhuru, Katewaka-Mchuchuma and Ngaka) has 700 mil. tons

1 Namwele-Nkomolo coa, Muze coalfield
2 Galula coalfield
3 Songwe-Kiwira coalfield
4 Ruhuhu basin
5 Katewaka/Mchuchuma coalfield
6 Njuga coalfield
7 Mhukuru coalfield
8 Mbamba Bay coalfield

…/Characteristics of Tanzania coal

Tanzania coal reserve has received spatial assessment (Mpanju et. Al. 1991; Mbede, 1991; Cairncross, 2001; Semkiwa et al., 2003; Wilson and Iddi, 2014)

- It is bituminous
- Reported ash of up to 25%
- Calorific value of between 15 and 35 MJ/kg
- Potential applications include:
  - Thermal processes
  - Low temperature carbonization
  - Hydrogenation
  - Blending for iron and steel industry

2.4 Biomass energy potential

Agricultural waste (tons)	**12,000,000**
Forestry waste (m^3)	205,400
Forestry waste (tons)	**143,780**
Potential energy forest land (ha)	19,000,000
Yield (m^3/ha - yr.)	10.4
Potential forest biomass (m^3)	197,600,000
Potential forest biomass (tons)	**138,320,000**
Total potential biomass resource (tons)	**150,463,780**
Taking 1 kg biomass = 0.43 kg oil equivalent	
Gross energy potential (TOE)	**64,699,425**
Net energy in liquid or gaseous form	
at 75% conversion efficiency (TOE)	**48,524,569**
At 25% realistic proven potential (TOE)	**12,131,142**

.../Commercial biomass energy production

(1) Small Power Producers Connected to the National Grid			
SNO.	**STATION**	**INSTALLED CAPACITY (MW)**	**FUEL TYPE**
1	Tanganyika Planting Corporation Ltd-TPC	17	Bagasse
2	Tanganyika Wattle co Ltd-TANWAT	2.7	Biomass
3	Kilombero Sugar Company Ltd	10.6	Bagasse
4	Mtibwa Sugar Estate Ltd	13	Bagasse
5	Tanzania Sisal Board, Tanga	0.5	Biomass
	Subtotal:	**43.8**	**Biomass**
(2) Small Power Producers not Connected to the National Grid			
1	Ngombeni Power Ltd, Mafia	2.5	Biomass
2	Kagera Sugar Estate Ltd	5	Bagasse
3	Saohill Saw Mills, Mafinga	15	Bio-mass
4	Symbion-KMRI, Tunduru	0.3	Bio-mass
5	Symbion-Kigoma	3.3	Bio-mass
	Subtotal:	**25.1**	Biomass
	Total biomass:	**69.9**	**Biomass**

2.5 Solar energy potential

- Tanzania lies between 10 and 11^0 South of the Equator, with long sunshine hours of between 2800 and 3500 hours per year
- The average potential of solar energy in country is approximated to be 187 Wm^{-2}
  - Is an opportunity for installing solar photovoltaic (PV) and solar thermal energy systems
  - Todate there is a limited harnessing of the solar resource as only about 6 MWp of PV

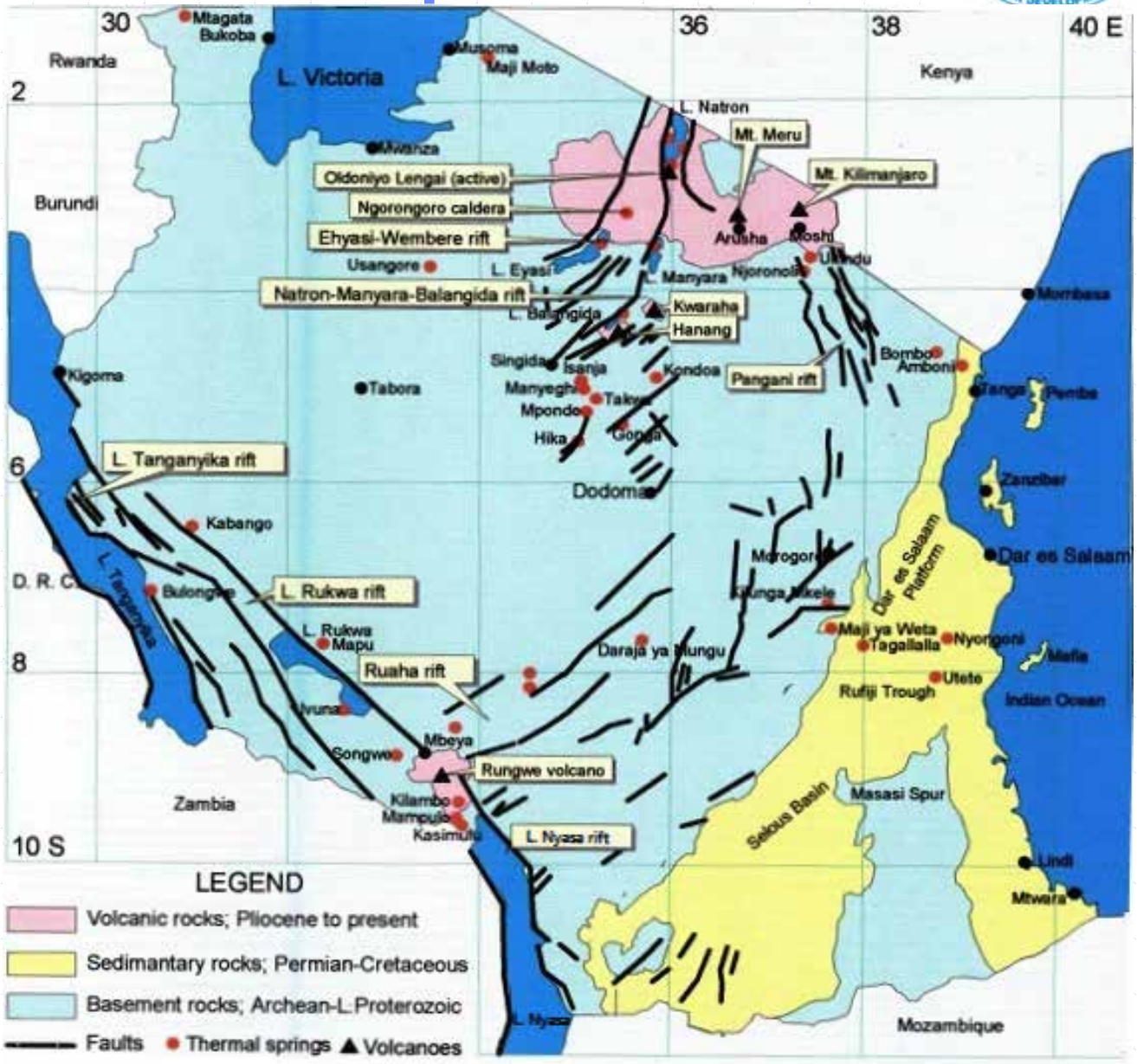
2.6 Wind energy potential

SITE	10 m WIND SPEED m/s	30 m WIND SPEED m/s
Makambako	7.6	8.7
Singida	8.2	9.4
Karatu (Arusha)	4.9	5.5
Mkumbara (Tanga)	4.14	4.9
Gomvu (Kigamboni)	3.56	4.28
Litembe (Mtwara)	3.21	4.47

- No commercial wind farm

2.7 Geothermal potential

- existing geothermal potential is 650 MW.
- No commercial harnessing

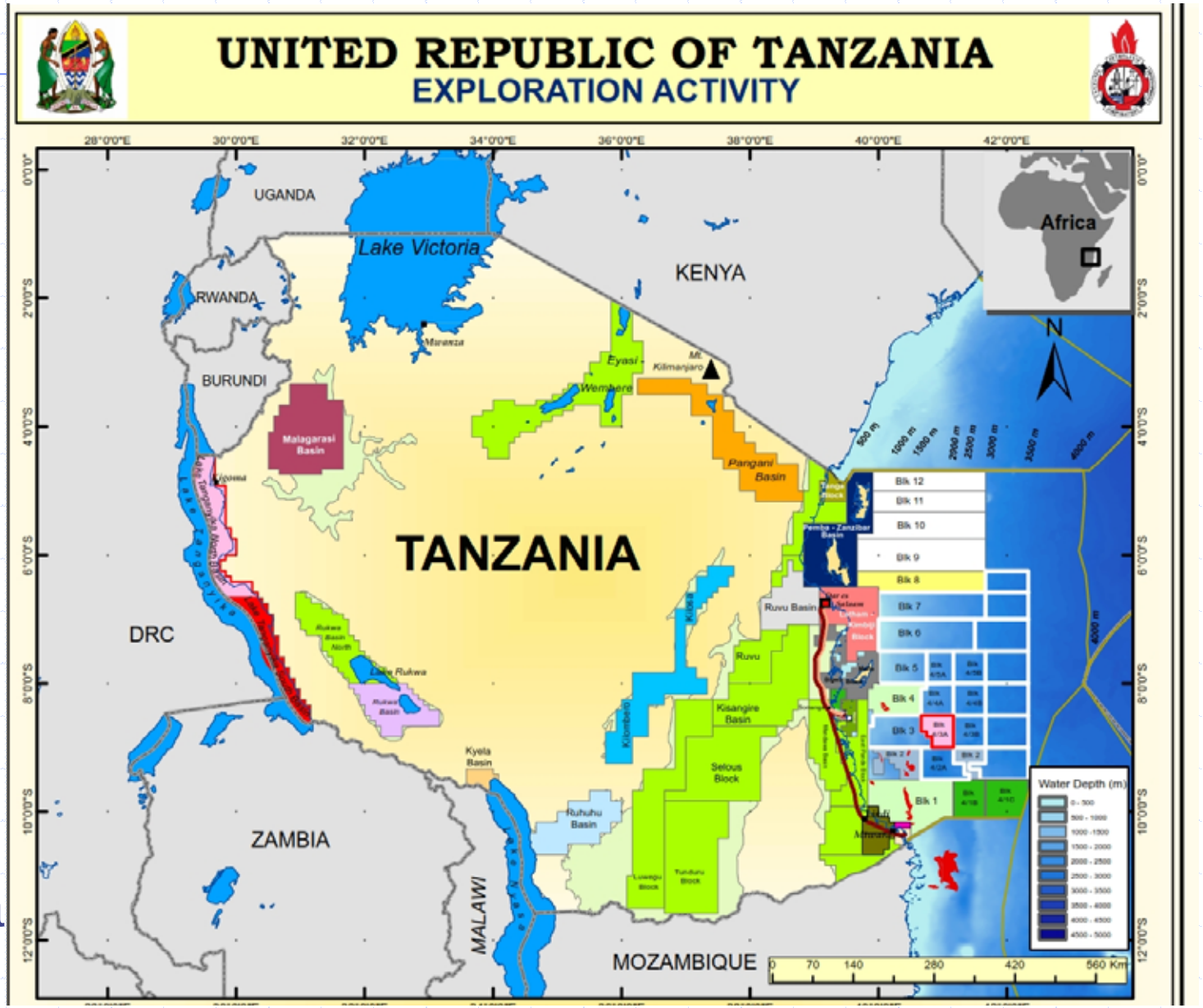


2.8 Tidal and Wave

- Eastern Tanzania is a 1,424 km coastal strip along the Indian Ocean. This strip including those along the Zanzibar and Mafia Islands constitute a potential energy source for tidal, wave, and ocean thermal energy conversion (OTEC) technologies.
- Lack of full feasibility assessments and technological capacity has led to the limited deployment.

2.9 Petroleum exploration

- Active petroleum system - in deep sea and along Lake Tanganyika



2.10 Uranium exploration

Mkuju River Project (MRP) by Australian company, Mantra Resources Limited

- Results show an average annual production of 3.7 million pounds of uranium grade U_3O_8 at a minimum initial mine lifetime of twelve years
- Requires more definitive feasibility studies

2.11 Harnessing level summary

SNO	ENERGY RESOURCE	PROVEN POTENTIAL	RESERVE	UTILIZATION
1	Hydropower, MW	5,050	5,050	12.38
2	Natural gas, BCF	1,142	55,080	20.68
3	Biomass, '000 TOE	12,131	64,699	0.37
4	Coal (proven), Mil. Tons	304	1,200	0.57
5	Solar	Not estimated	Not estimated	Not estimated
6	Wind	Not estimated	Not estimated	Not estimated
7	Geothermal, MW	> 650	Not estimated	Not utilized
8	Tidal and wave	Not estimated	Not estimated	Not estimated
9	Petroleum	Under exploration	Under exploration	Under exploration
10	Uranium	Under exploration	Under exploration	Under exploration

3. TIRDO INTERVENTION

Developed coal program aiming at **coal characterization** and **coal technologies development**

- Collaborators
  - Government through the Commission of Science and technology (COSTECH)
  - High Commission of India in Tanzania, the program is receiving technical support from the Council of Scientific and Industrial Research (CSIR)
- Coal laboratory at TIRDO is already equipped to undertake coal resource quality assessment

3.1 Coal characterization

characterize coal deposit available in Tanzania for developing coal utilization technologies

Specifically:

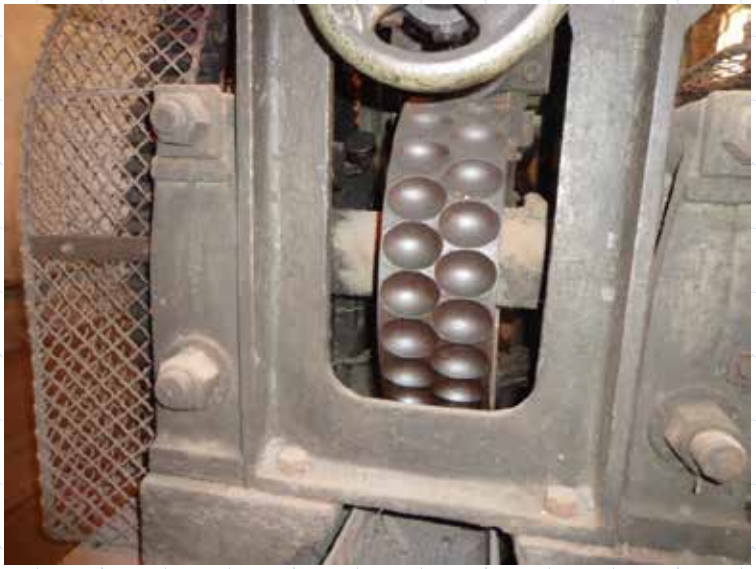
- Identify all coal deposit available in Tanzania
- Characterize the coal through chemical and physical analysis to establish proximate, ultimate and coking characteristics
- Ranking the coal
- Provide technical advice on coal utilization technology
- Develop coke for domestic and industrial applications to include SMEs

.... / Coal Characterization

3.2 Development of coal utilization technologies

For supporting

- Iron and steel industry
- Other energy intensive sectors like cement
- Chemical industry
- Households



3.3 Coal Bed Methane Energy Technology Development

Objectives

To develop the coal bed methane (CBM) production technology in Tanzania by undertaking gassing assessment of available coal seams

Specific objectives

- Mapping selected coal bed methane reservoirs
- Establishing specific factors that influence reservoir heterogeneity and permeability
- Determining hydrological and geological factors that control storage and release of methane in Tanzania coal seams
- Establishing critical reservoir parameters that control production
- Confirming reserves and making long-term production forecasts
- Developing technologies for harnessing the coal bed methane

Outcomes and impacts

- Introduction of coal bed methane power plant(s) and contribute to electrification
- To increase access to indigenous commercial energy by industrialists and households
- Increase coal mining safety
- Add value to Tanzania coal mining operations
- Mitigate greenhouse gases from gassing coal mines

4. CONCLUSION AND RECOMMENDATIONS

- Coal is among the abundant energy resources for Tanzania
- Due to its products' diversity, the sustainable harnessing of this resource has a significant contribution to the country's industrial development
  - This calls for increasing local capacity in acquiring niche skills in undertaking coal resource quality assessment and in developing coal utilization technologies
  - Benchmarking of coal resource quality is mandatory for supporting the development of coal utilization technologies and in quality assurance of the traded coal

THANK YOU

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