

The United Republic of Tanzania

# **The Project for Domestic Natural Gas Production and Supply System in Tanzania**

## **Report**

### **- Appendix -**

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## Appendix A: Gas Demand Estimation by Google Map

DNGPP Study Team conducted Regional Energy Demand Survey in 2018 (REDS 2018) as explained in Chapter 5. It covers seven cities, Morogoro, Dodoma, Tanga, Arusha, Moshi, Mbeya and Mwanza, with useful information on energy consumption and energy users in these cities. However, coverage is limited and outcome is not universal. To obtain a more comprehensive picture of energy demand for drafting a nationwide gasification plan, Study Team tried to read the Google Map and estimate the present energy consumption in cities and towns all over Tanzania that have concentration of buildings and houses to be deemed as object regions for city gas plan.

### A.1 Outline of Survey

#### A1.1 Objective Area

As candidate market for development of a mini-LNG based virtual pipeline system, cities and towns are picked up along the five main corridors as shown in Figure A.1-1:

- a. Central Corridor: from Dar es Salaam to Dodoma
- b. Northern Coastal Corridor: from Dar es Salaam to Tanga including periphery of DSM
- c. North East Corridor: from Korogwe to Arusha
- d. Great North Corridor: from Dodoma to Mwanza, Musoma, Bukoba and Kigoma
- e. TANZAM Corridor: from Morogoro to Mbeya and adjacent markets.



Figure A.1-1 Energy Markets Along Main Corridors

These corridors will be the main routes for LNG transport to regional markets. Once an automotive gas service network, or an LNG corridor, is developed along them, it will become possible to share these gas filling stations as satellites for local mini-girds to supply gas and, if appropriate, electricity. In this regard, several small towns are picked up along the corridors running the north eastern part of the country where the first phase of the DNGPP may start.

In this survey, only densely populated parts of cities and towns are enclosed for city gas plan reading the Google Map. Then, numbers of houses, factories, schools, hospitals and other remarkable facilities are counted. However, it is not possible from the satellite image to precisely identify for what purpose these buildings and facilities are used. Number of houses are roughly calculated assuming the ratios of spaces for road and public facilities and empty slot. Population is calculated assuming five (5) family members a house. Residential gas demand is calculated applying an annual consumption of 200kg LNG equivalent per house (15-20 kg per month), which would be too low for the people living on highland under mild/cool climate. Gas demands of industrial and business/commercial sectors are estimated assuming a ratio to the residential demand taking account of the number of these facilities.

### A.1.2 Outcome of Survey

Though estimation is made with arbitrary assumptions and rough calculations, it illustrates a more universal picture of energy markets compared with the REDS 2018. Important findings are as follows:

- 1) Houses and other facilities located in the densely populated areas along the main corridors and periphery are taken up as the priority target of the city gas/community gas plans under the DNGPP. The population in the enclosed areas is counted to be less than 10% of the total population of Tanzania.
- 2) The total gas demand of the densely populated areas is estimated to be about 154,000 tons LNG equivalent per year or about 420 tons per day. Per capita gas consumption may increase in future as people's income increases. On the other hand, local gas systems at scattered markets cannot be built over night. They will be developed stepwise over years before completion.
- 3) Purposes of buildings and facilities are difficult to identify on the satellite images. More precise information is necessary to estimate the energy demand of the business/commercial users such as hotels, restaurants, and shopping malls as well as features of energy use at factories.
- 4) In most cities, factories are put together in the industrial blocks; namely Morogoro, Dodoma, Tanga, Moshi, Arusha, Mwanza, Iringa and Mbeya. At these sites, integrated gas systems should be considered to collectively serve gas for the industrial park members. It will be efficient and economical and provide an anchor demand for developing a city gas system.
- 5) Energy demands are tiny at small towns and communities. They are several hundred tons and are much smaller compared with sales at a standard class gas filling station for NGVs, which would be 3,000 tons per year or more.

6) Construction of the Standard Gauge Railway (SGR) is progressing through to Dodoma. New stations are going to be built in new development areas in Morogoro and Dodoma. However, city development plans in consideration of the SGR development are not at hand.

The gas demand estimation as above is summarized in Table A.1-1 and detail information is provided on each site in the chapters below. Due to the simplicity assumptions, this estimation may have substantial variance. Actual demand may be greater as the numbers of restaurants and shops are not counted on the Google Map and the climate is cooler in upcountry.

This survey must be deepened with more precise data and information to establish a credible business plan. Information should be collected via local market research. In particular, through interviews with large energy users as listed in Appendix-B and administrative planners of major cities, their views, intentions on gas use and future plans should be asked for. A credible sales plan shall be compiled incorporating the outcome.

Table A.1-1 Summary of City Gas Demand by Corridor

Region	City/Town	Elevation	Distance from DSM	City Gas Coverage			Gas Demand					
				Area	Houses	Population	Residential	Biz/Com	Industry	Total	(rounded)	
<b>Central Corridor</b>												
12	Pwani	Kibaha	130	30	1600	7000	35000	1400	70	140	1610	1600
		Kibaha West	140	35	2,800	10,100	50,500	2020	60	100	2180	2200
		Visiga	130	55	300	1,300	6,500	260	10	10	280	300
		Mlandizi	70	60	1,400	7,400	37,000	1480	40	0	1520	1500
		Chalinze	210	100	300	1,300	6,500	260	10	0	270	300
	Morogoro	Morogoro	510	185	12200	52800	264000	10560	1060	5280	16900	16900
		Kilosa	490	280	600	2,300	11,500	460	20	0	480	500
		Dakawa	360	230	50	300	1,500	60	0	0	60	100
	Dodoma	Dumila	430	250	600	2,200	11,000	440	10	0	450	500
		Gairo	1290	315	500	2,000	10,000	400	10	0	410	400
		Chamwino	1100	415	200	1,000	5,000	200	10	0	210	200
		Dodoma	1140	440	15700	45500	227500	9100	1820	910	11830	11800
	<b>Total</b>				36,250	133,200	666,000	26,640	3,120	6,440	36,200	36,300
<b>Northern Coastal Corridor and DSM Periphery</b>												
7	Pwani	Bagamoyo	20	80	1300	5700	28500	1140	60	0	1200	1,200
		Kisarawe	220	15	100	600	3,000	120	0	0	120	100
		Msata	260	140	100	600	3,000	120	0	0	120	100
	Tanga	Serega	310	275	200	1,100	5,500	220	0	0	220	200
		Handeni	700	270	1,600	9,500	47,500	1,900	40	0	1,940	1,900
		Muheza	200	310	2,400	9,600	48,000	1,920	40	0	1,960	2,000
		Tanga	20	350	3,400	22,000	110,000	4,400	440	660	5,500	5,500
	<b>Total</b>				9,100	49,100	245,500	9,820	580	660	11,060	11,000
<b>North East Corridor</b>												
8	Tanga	Koroge	310	300	1,600	8,700	43,500	1,740	30	0	1,770	1,800
		Mombo	440	340	200	1,200	6,000	240	0	0	240	200
	Kilimanjaro	Same	850	455	400	1,900	9,500	380	20	0	400	400
		Mwanga	920	510	600	2,100	10,500	420	10	0	430	400
		Himo	800	540	500	4,100	20,500	820	40	0	860	900
		Moshi	850	560	5,900	20,400	102,000	4,080	410	1,220	5,710	5,700
		Ng'ombe	940	590	1,400	5,700	28,500	1,140	30	0	1,170	1,200
	Arusha	Arusha	1,400	640	14,600	57,400	287,000	11,480	1,150	1,720	14,350	14,400
	<b>Total</b>				25,200	101,500	507,500	20,300	1,690	2,940	24,930	25,000
<b>Great North Corridor</b>												
9	Singida	Singida	1510	690	2,500	8,000	40,000	1,600	80	80	1,760	1,800
	Shinyanga	Shinyanga	1130	970	4,300	12,300	61,500	2,460	50	120	2,630	2,600
		Kahama	1220	975	5,200	21,600	108,000	4,320	90	0	4,410	4,400
	Geita	Geita	1250	1100	3,800	15,900	79,500	3,180	60	0	3,240	3,200
	Mwanza	Mwanza	1150	1130	13,500	86,000	430,000	17,200	860	2,580	20,640	20,600
	Mara	Musoma	1140	1140/1250	2,500	15,600	78,000	3,120	90	160	3,370	3,400
	Kagera	Bukoba	1140	1370	2,400	13,700	68,500	2,740	80	50	2,870	2,900
	Tabora	Tabora	1200	820	5,800	32,000	160,000	6,400	130	640	7,170	7,200
	Kigoma	Kigoma	890	1240	7,800	44,300	221,500	8,860	180	0	9,040	9,000
	<b>Total</b>				47,800	249,400	1,247,000	49,880	1,620	3,630	55,130	55,100
<b>TANZAM Corridor</b>												
6	Morogoro	Iringa	1640	490	2,600	17,100	85,500	3,420	170	340	3,930	3,900
	Njombe	Makambako	1680	650	2,400	11,600	58,000	2,320	120	120	2,560	2,600
		Njombe	1920	710	2,400	11,100	55,500	2,220	110	0	2,330	2,300
	Mbeya	Mbeya	1150	940/1070	7,200	27,600	138,000	5,520	280	0	5,800	5,800
	Rukwa	Sumbawanga	1710	820	8,800	40,800	204,000	8,160	410	1,220	9,790	9,800
	Songea	Songea	1840	1140	4,900	12,500	62,500	2,500	130	0	2,630	2,600
	<b>Total</b>				28,300	120,700	603,500	24,140	1,220	1,680	27,040	27,000
42												
	<b>Total</b>				146,650	653,900	3,269,500	130,780	8,230	15,350	154,360	154,400



## A.2 Central Corridor

Starting from the seashore port in Dar es Salaam, the central corridor climbs up the eastern ark mountain ridge and connects to the interior highlands. Elevation above sea level is 250 m at Chalinze, 500 m at Morogoro, 1,300 m at the pass between Dumila and Gairo and 1,100 m at Dodoma. Climate changes from tropical in Dar es Salaam, tropical/temperate with rain in Morogoro and temperate-dry on the highland. Morogoro is surrounded by rich agricultural land and forests while Dodoma is amid arid dry savanna. The Standard Gauge Railway (SGR) is under construction along this route.

Along the central corridor through Dodoma, 12 cities and towns are picked up as shown in Figure A.2-1. Among them, Morogoro and Dodoma are by far the largest. Present gas demand is estimated by reading the Google Map with demarcation on aerial photo and summarized in Table A.2-1.



Figure A.2-1 Central Corridor

Table A.2-1 Potential Gas Demand Along the Central Corridor

	Kibaha	Kibaha West	Visga	Mlandizi	Chalinze	Morogoro Phase-1	Morogoro AI	Kibisa	Dakawa	Dumila	Gairo	Chamwino	NGC	Iyumbu	Dodoma CBD	Dodoma AI
Elevation(m)	130	140	130	70	210	510	-	490	360	430	1,290	1,100	(Pan)	-	1,140	-
Distance from DSM (km)	30	35	55	60	100	185	-	280	230	250	315	415	420	435	440	-
Area (ha)	1,600	2,800	300	1,400	300	1,600	12,200	600	50	600	500	200	700	100	600	15,700
Houses	7,000	10,100	1,300	7,400	1,300	9,900	52,800	2,300	300	2,200	2,000	1,000	37	91.3	2,600	45,500
Population (5/house)	35,000	50,500	6,500	37,000	6,500	49,500	264,000	11,500	1,500	11,000	10,000	5,000	300	4,600	13,000	227,500
Facilities																
Government Office	4	0	0	1	1	4	Several	1	0	1	1	0	26	0	50++	60
School	10	10	0	3	1	14	45	2	0	3	1	0	0	1	11	32
Hospital	2	1	0	0	1	3	14	1	0	0	0	1	2	0	5	5
Other Public Facility	1	0	0	1	0	0	2	0	0	0	0	0	Many	0	3	Many
Business Office	1	0	0	0	1	Several	Several	0	0	0	0	0	2	3	Many	Many
Factory	4	3	1	0	0	2	13	0	0	0	0	0	0	0	0	4
Shopping Centre, Market	2	0	0	0	1	3	10	2	0	0	2	0	Several	1	8++	Several
Hotel	6	4	1	2	2	6	15	0	1	0	0	0	2	1	3	6
Other	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Gas Demand	t	t	t	t	t	t	t	t	t	t	t	t	t	t	t	t
Residential	1,400	2,020	260	1,480	260	1,980	10,560	460	60	440	400	200	200	460	1,620	9,100
Public+ Biz/Com	70	60	10	40	10	200	1060	20	0	10	10	10	6,800	560	3,830	1,820
Industry	140	100	10	0	0	3960	5280	0	0	0	0	0	0	0	0	910
Total	1,610	2,180	280	1,520	270	6,140	16,900	480	60	450	410	210	7,000	1,020	5,450	11,830
Total (Round)	1,600	2,200	300	1,500	300	6,100	16,900	500	100	500	400	200	7,000	1,000	5,500	11,800
Residential (kg/fam)	200	200	200	200	200	200	200	200	200	200	200	200	As per detail plans	As per detail plans	As per detail plans	200
Public, BizCom Ratio	5%	3%	3%	3%	3%	10%	10%	5%	2%	2%	2%	5%	As per detail plans	As per detail plans	As per detail plans	20%
Industry Ratio	10%	5%	5%	0%	0%	200%	50%	0%	0%	0%	0%	0%	As per detail plans	As per detail plans	As per detail plans	10%

Source: Google Map, Elevation.maplogs.com

Since construction of city gas system in large cities takes time, it will progress only stepwise. Gas demand for the early stage is estimated for the priority areas of Morogoro and Dodoma. Factories are mostly located

in the industrial blocks. They may be considered collectively for an integrated gas supply system in each city. Such depot can become the core satellite terminal to develop city gas system and cover other smaller users such as hotels, restaurants, shops, hospitals, schools and households. Compared with these two cities, estimated gas demands at other towns are relatively small.

### 1) Kibaha

Kibaha is the capital of Pwani Region 30 km west of Dar es Salaam on Route A7 connecting to interior regions. There are national education centres, Tumbi regional referral hospital and some factories. No remarkable energy user is found. By quick reading of the Google Map, the city gas plan area will be 1,600 ha; there are about 7,000 houses with a population of 35,000. Estimated gas demand is 1,600 tons a year.

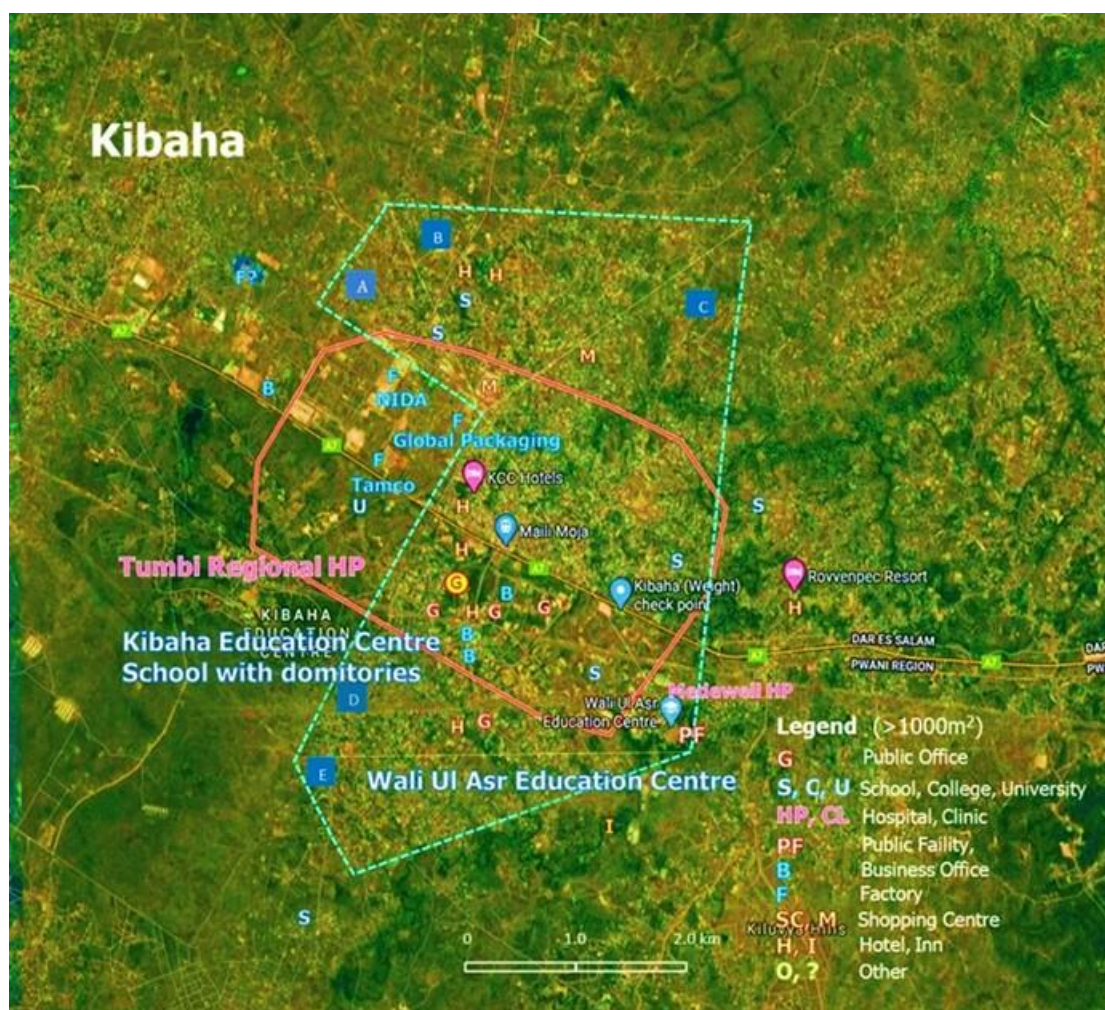


Figure A.2-2 Kibaha

### 2) Kibaha West

Kibaha town is extending 5 km to the west. There are three food processing factories that may use some fuel. By quick reading of the Google map, the community gas plan area will be 2,800 ha; there are about 10,000 houses with a population of 50,000. Estimated gas demand is 2,200 tons a year.

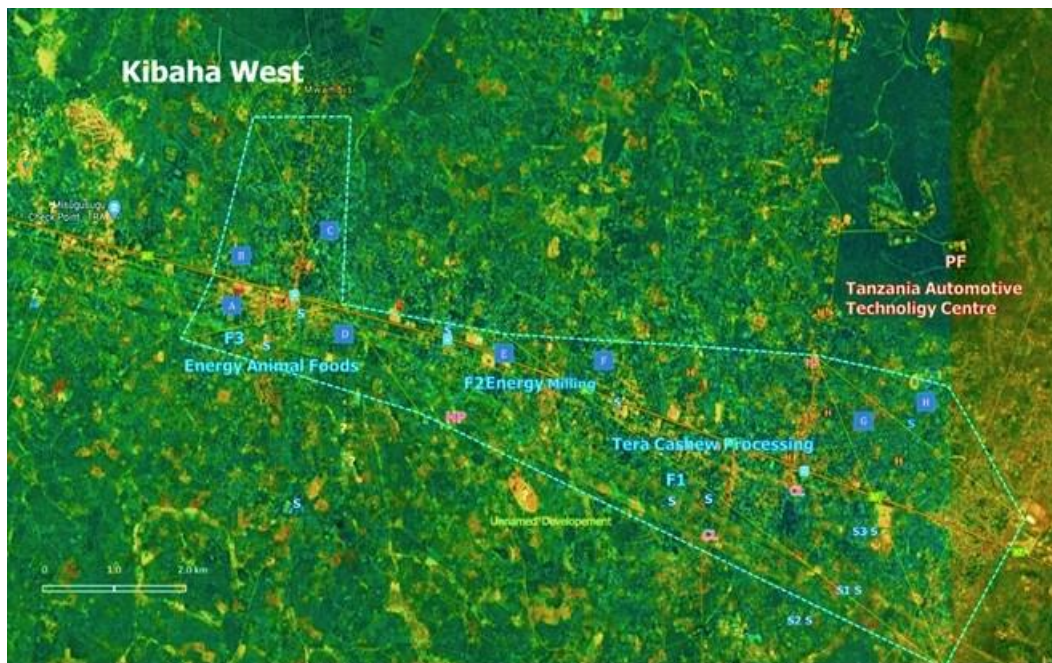


Figure A.2-3 Kibaha West

### 3) Visiga

Visiga is a small town west of Kibaha and 55 km from Kinyerezi. No remarkable energy user is found. Hon Yu Steel may be an independent target. By quick reading of the Google map, the community gas plan area will be 300 ha; there are about 1,300 houses with a population of 6,500. Estimated gas demand is 300 tons a year.

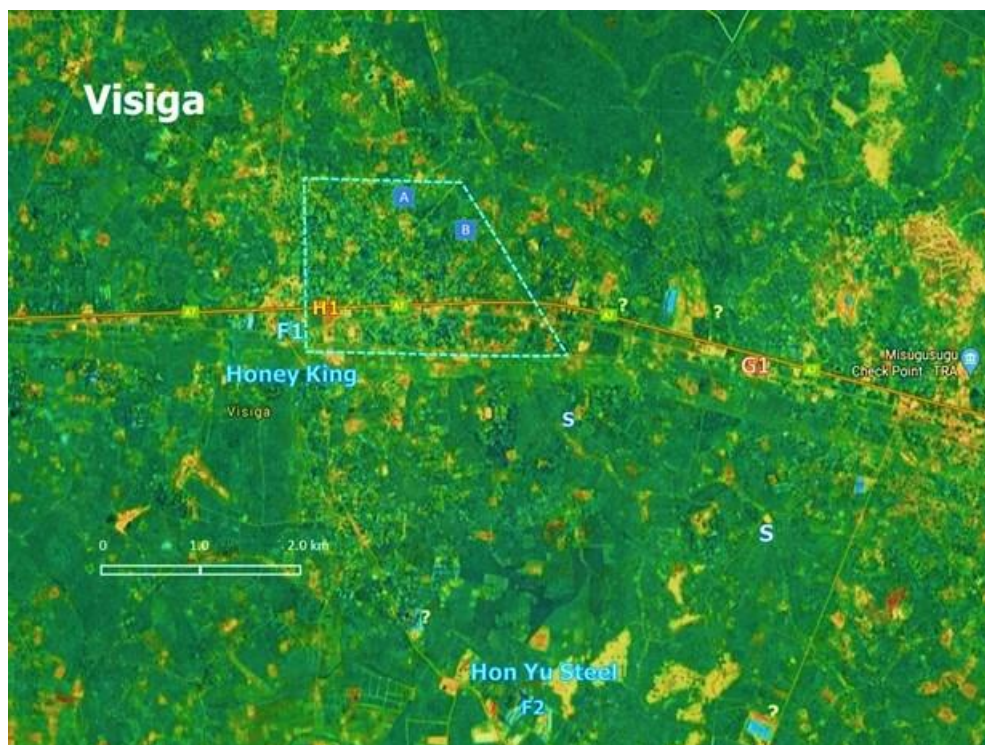


Figure A.2-4 Visiga

## 4) Mlandizi

Mlandizi is located 60 km west of Dar es Salaam on Route A7. A water processing plant of DAWASCO is located in the north of the town. JKB poultry farm is operating further north. No remarkable energy user is found. By quick reading, the community gas plan area will be 1,400 ha; there are about 7,400 houses with a population of 37,000. Estimated gas demand is 1,500 tons a year.

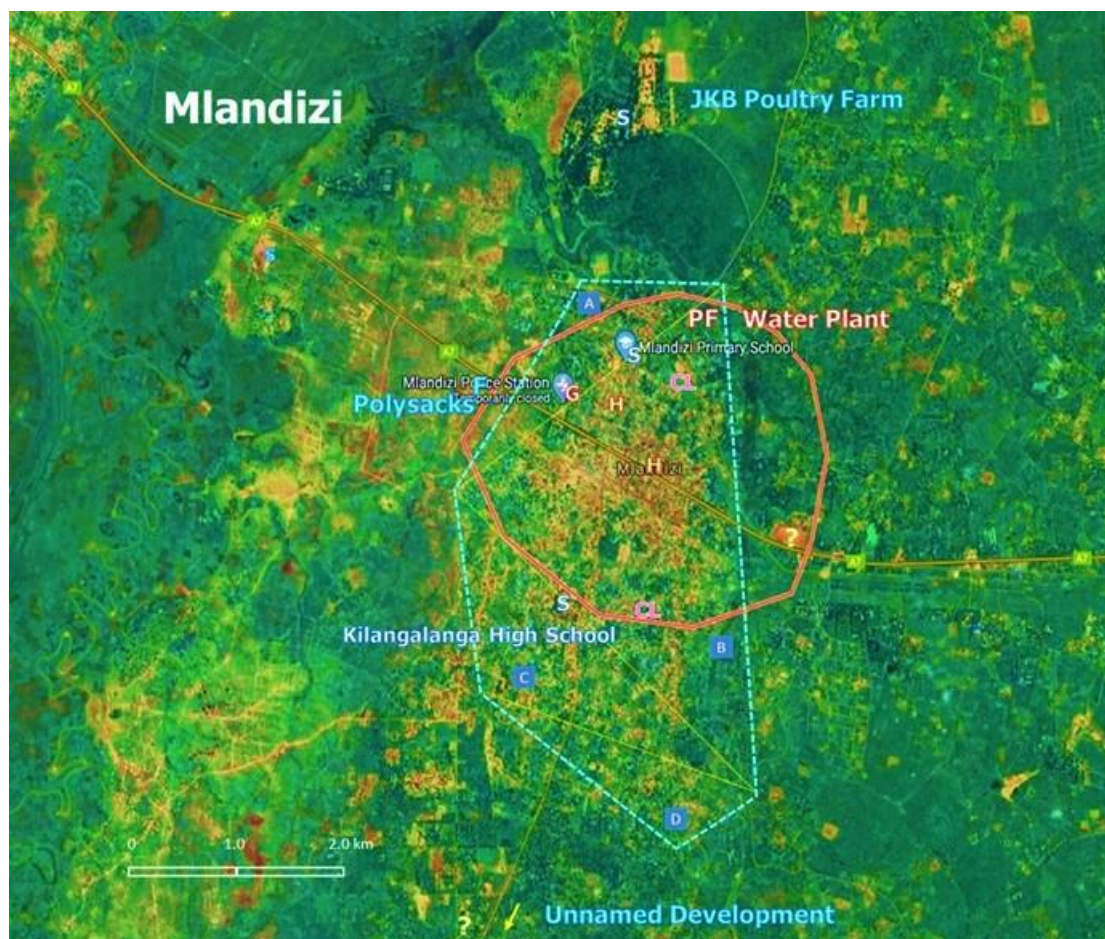


Figure A.2-5 Mlandizi

## 5) Chalinze

Chalinze is 100 km away from Dar es Salaam and a branching point on Route 7 to Route A14 going to the north, and hence is one of the candidate locations for gas filling station. It is a small town and no remarkable energy user is found. By quick reading of the Google map, the community gas plan area will be 300 ha; there are about 1,300 houses with a population of 6,500. Estimated gas demand is 300 tons a year.



Figure A.2-6 Chalinze

## 6) Morogoro

Morogoro is the 6<sup>th</sup> biggest city in Tanzania. According to the 2012 Census, population of Morogoro Urban was 318,857. It is 500 m above sea level with warm/hot climate at temperature of 20-30 degree C and annual precipitation of 890 mm. It is 190 km, by road, west of Dar es Salaam and at a middle point to Dodoma and at the foot of the slope going up to highland. It is an important junction of Route A7 going southwest through to Mbeya and Route B129 going west through Dodoma to Manyoni. As the city is within easy reach from Kinyezezi, it is an important pillar for the virtual pipeline system.

Table A.2-2 Industries in Morogoro

Location	User Name	Size	Notes(Fuel Consumption by REDS 2018)
Users in green column were visited at the 2018 Regional Energy Demand Survey.			
Industrial Area-A	A1	21 Century Textiles Limited	F M Coal 900t/M, HFO 1.6kL/M, Charcoal 250kg/M
	A1	TPM(1998) LTD	F S Subsidiary of 21 Century for sisal bags; diesel 475L/M
	A1	Mazava Fabric & Production E.A.L.	F M Diesel for boiler 2.8 kL/M
	A1	Intermech Engineering	F S Agricultural machines and spare parts
	A1	MW Rice Millers	F S
Industrial Area-B	A1	Inernational Tanfeeds Ltd	F S Soybean oil and animal feeds
	A2	Agriculture Seed Agency	F S Diesel 7.1 kL/M not for transport
	A3	Tanzania Tobacco Processors Limited	F L Diesel for drier 17.5kL/M, HFO 206kL/M
Industrial Area-C	C	Alliance One Tobacco Tanzania	F L Diesel 11.5kL/M, HFO 78.9kL/M, LPG 38t/M
	C	Mambo Coffee Company	F S
	C	SGR Workshop (CCECC)	F S

Morogoro is surrounded by vast agricultural land and forest. It is an important collecting centre of tobacco leaves and sisal. Two tobacco plants of Tanzania Tobacco Processors Limited (TTPL) and Alliance One Tobacco Tanzania Limited are operating there. 21 Century Textiles Limited and other factories are as listed

in Table A.2-1. In addition to them, Star City Development project including SEZ Industrial Park and Morogoro dry port was proposed in 2016 to develop 4,300 ha 4 km east of the city centre around AOTTL and SGR workshop. The Project has stalled for sometime but there is a movement to revive it.

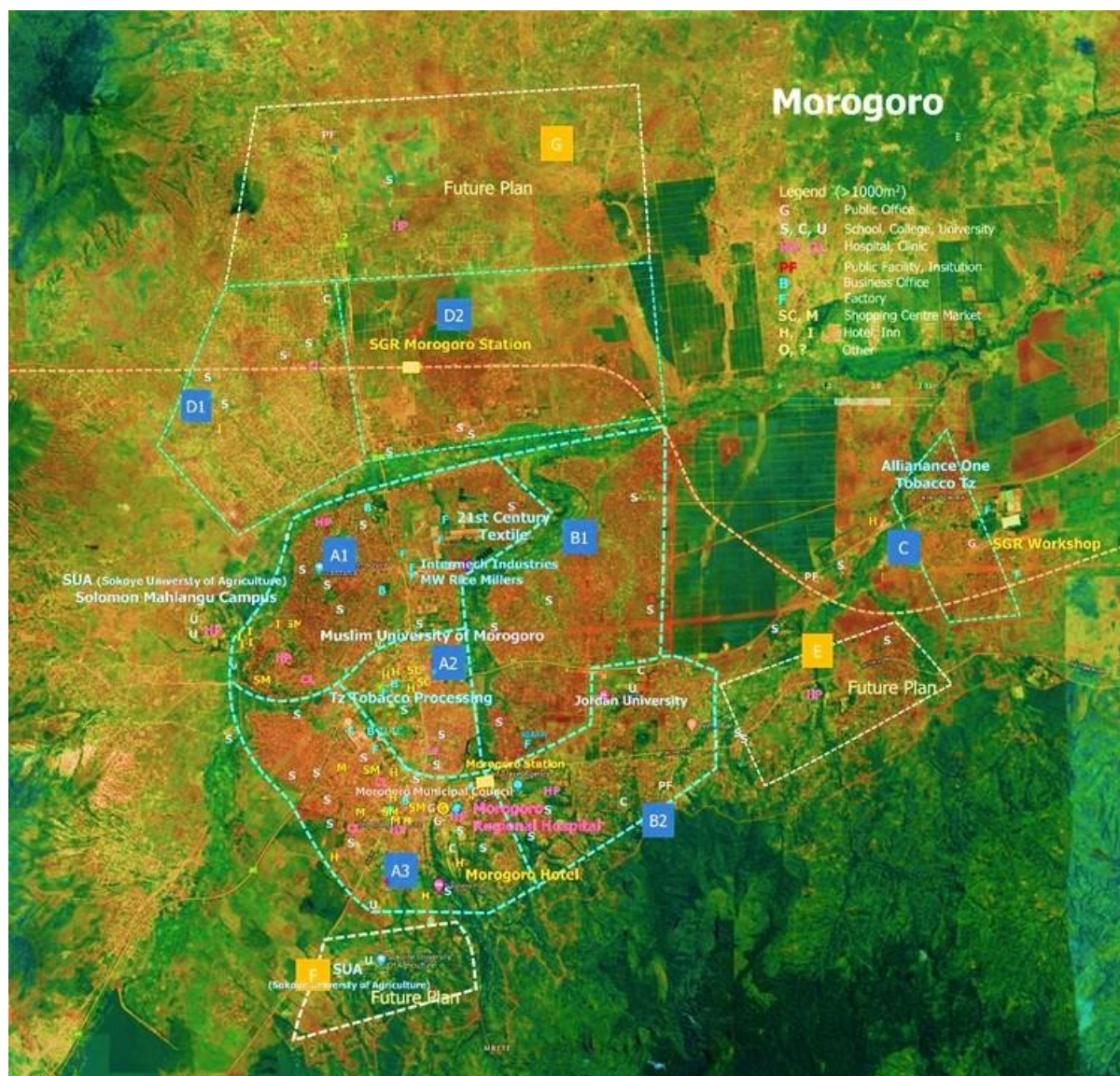


Figure A.2-7 Morogoro

In Morogoro, there are also many schools, hotels and hospitals including Sokoine University of Agriculture, Muslim University of Morogoro and Morogoro Regional Referral Hospital. By quick reading of the Google map, object population for the city gas plan is 12,200 ha and population 264,000. Estimated gas demand is 16,900 ton per year. Construction of the city gas system may start from the central part of the city; houses/buildings are counted to be 10,000 in Blocks A2 and A3 combined and 12,000 in block A1. Key for the city gas development is the industrial gas demand at factories that will decide the project size. Hospitals and hotels located there will also provide certain demand. Block C around Alliance One Tobacco plant may be developed as an independent community gas system at first. In addition, Block D2 is presently empty but will come up as a new centre for city development upon opening of the SGR station.

## 7) Kilosa

Kilosa is a city about 70 km west of Morogoro and 280 km away from Dar es Salaam. It is situated at the foot of the Eastern Arc mountain range and 500 m above sea level. The central line of the Tanzania Railways and the SGR under construction pass through Kilosa and climb up to Dodoma. Urban population of Kilosa was 126,229 according to the 2012 Census.

Kilosa District Hospital and Kilosa Clinical Officers Training Centre are the noticeable facilities. By quick reading of the Google Map, the community gas plan area will be 600 ha; there are about 2,300 houses with a population of 11,500. Estimated gas demand is 500 tons a year.



Figure A.2-8 Kilosa

## 8) Dakawa

Wami Dakawa is a small community about 40 km north of Morogoro and 230 km away from Dar es Salaam on the Route B129 through to Dodoma. It is situated 400 m above sea level. No noticeable energy user is seen. By quick reading of the Google map, community gas plan area will be 50 ha; there are about 300 houses with a population of 1,500. Estimated gas demand is less than 100 tons a year.

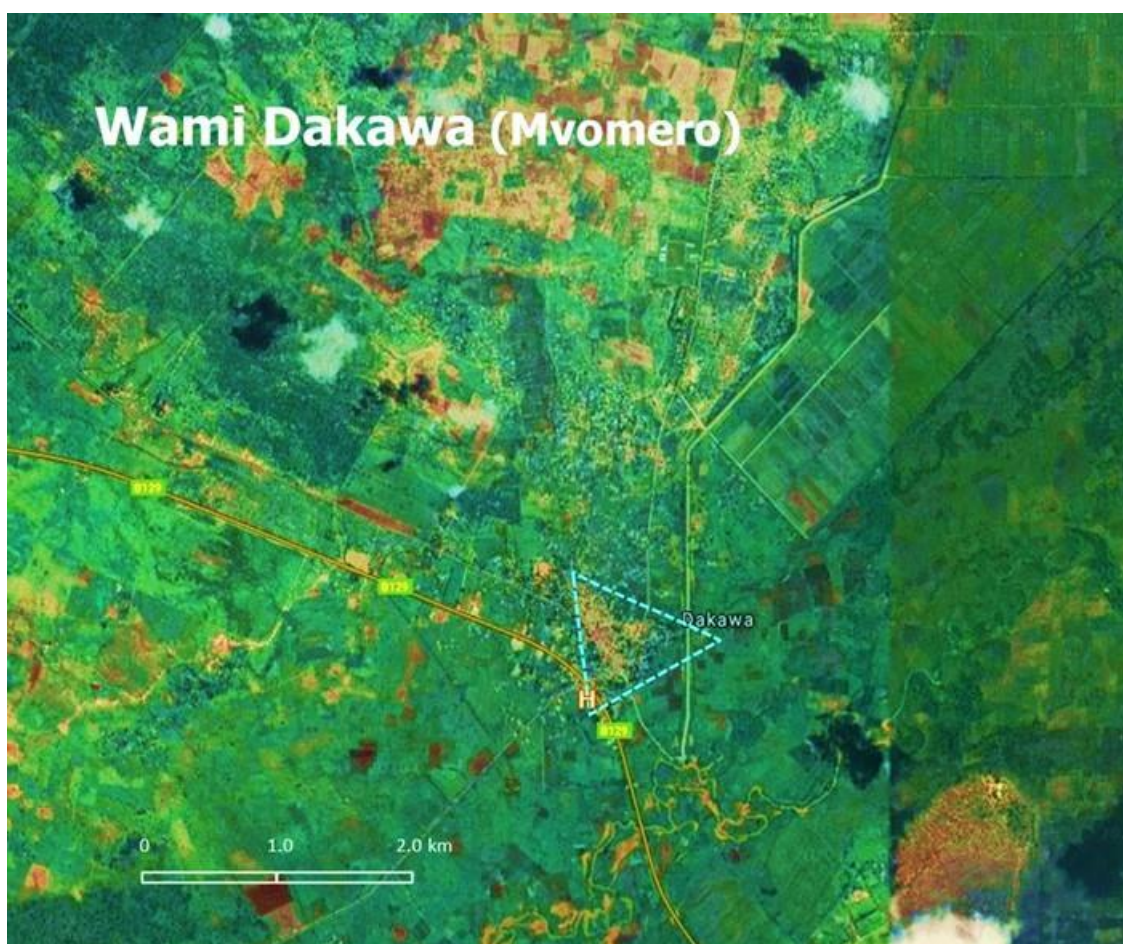


Figure A.2-9 Dakawa



## 9) Dumila

Dumila is situated at the foot of the Eastern Arc mountain range, 250 km away from DSM and 70 km from Morogoro, and 450m above sea level. It is the junction of the Route B129 and the Route B127 that runs north-south along the foot of the Eastern Arc mountain range. From here, Route B129 climbs up the pass above 1,300 m through to the highland. By quick reading of the Google map, the community gas plan area will be 600 ha; there are about 2,200 houses with a population of 11,000. Estimated gas demand is less than 500 tons a year.

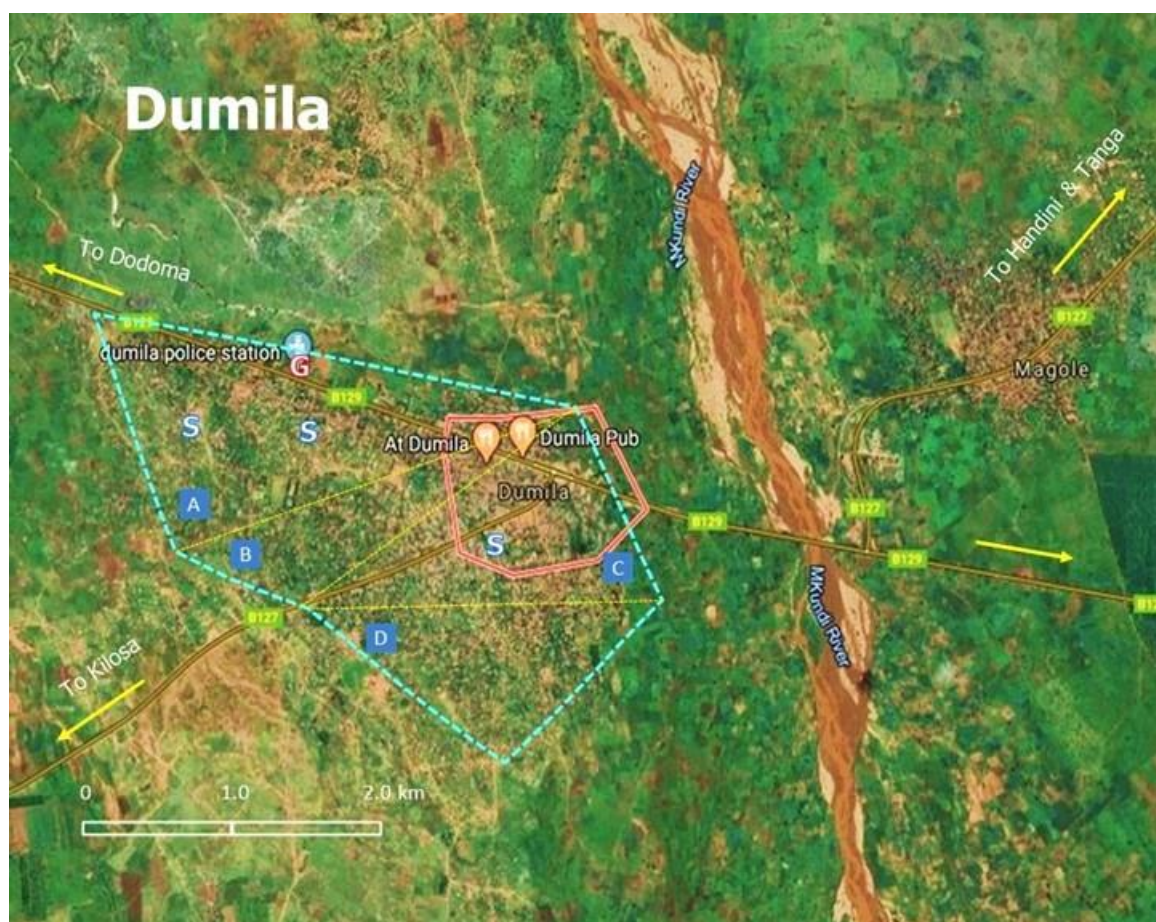


Figure A.2-10 Dumila

## 10) Gairo

Gairo is a small town on the Route B129 at the western edge of Morogoro Region after climbing up the pass to upland. It is 130 km from Morogoro and 320 km from DSM. By quick reading of the Google map, the community gas plan area will be 500 ha; there are about 2,000 houses with a population of 10,000. Estimated gas demand is 400 tons a year.

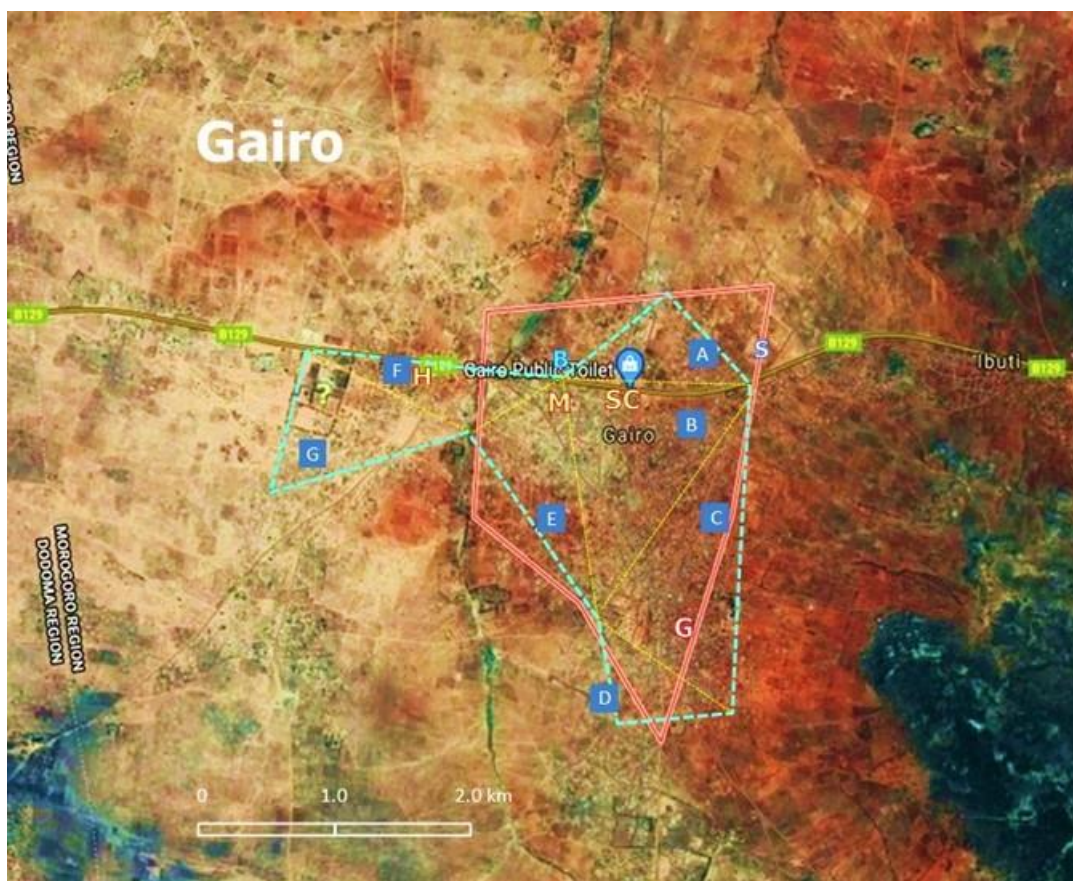


Figure A.2-11 Gairo

## 11) Chamwino

Chamwino is a small town about 4 km north of the Route B129, 40 km east of Dodoma and close to the New Government City (NGC). By quick reading of the Google map, the object area for community gas plan will be 200 ha; there are about 1,000 houses with a population of 5,000. Estimated gas demand is 200 tons a year.

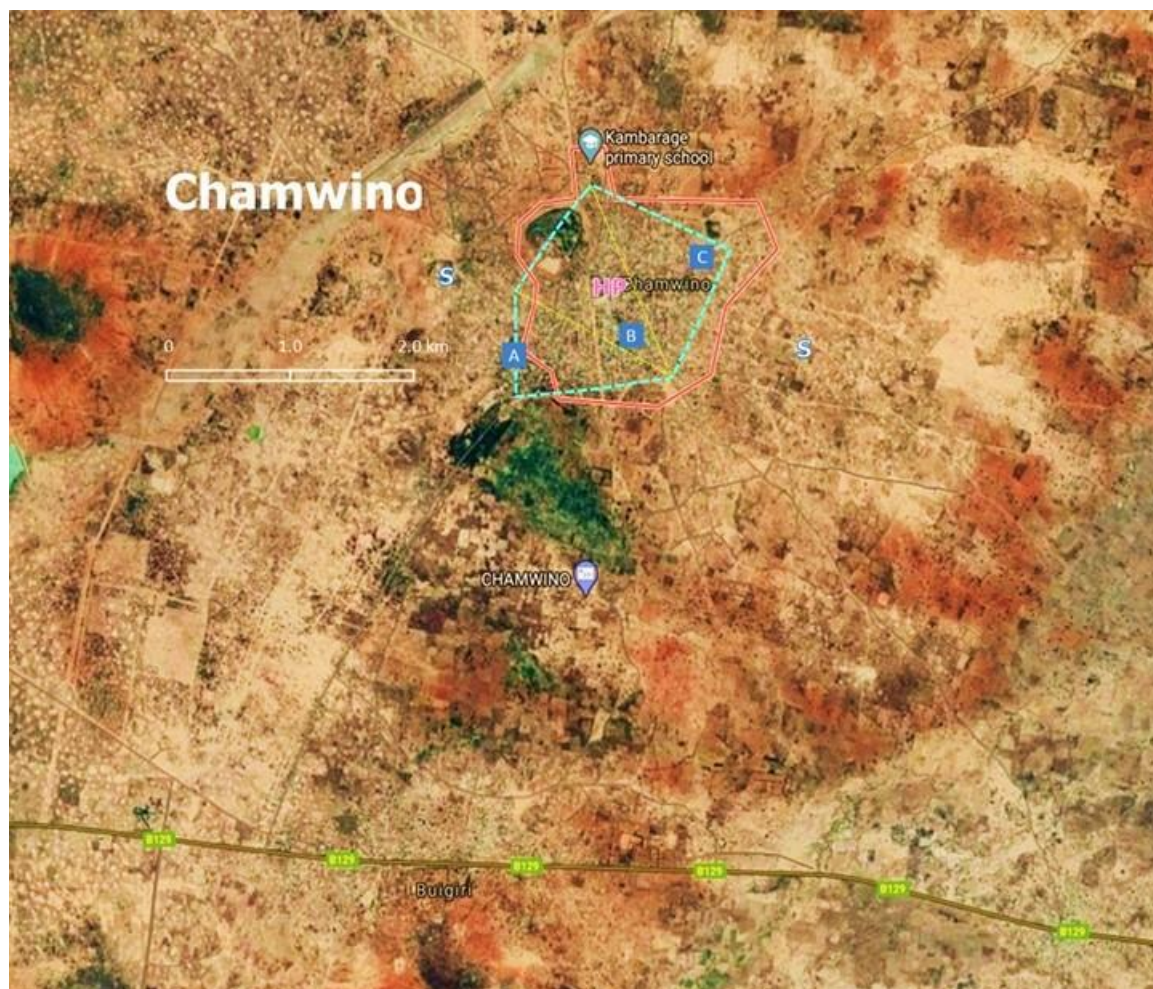


Figure A.2-12 Chamwino

## 12) Dodoma

Dodoma is the capital of Tanzania situated in the centre of the country. At an altitude of 1,100 m, the area is dry-savanna with temperature of 15 to 30 degree C and annual precipitation of merely 150 mm. According to the 2012 Census, population of Dodoma Council was 410,956 of which 213,636 were living in the urban area. Population of Dodoma is increasing rapidly since the government decided to move all its function from Dar es Salaam. According to quick reading, there are 45,000 houses with 225,000 people in the target areas for city gas construction. Present demand is estimated to be 11,800 tons per year.

City centre is the area south of the Dodoma airport and around the Dodoma railway station of the TRC central line. This area is named as Central Business District (CBD) in the Dodoma National Capital City Master Plan 2017 and is designated as the core area for city development. The inner ring road is being built along the eastern and southern boundaries and the SGR Dodoma station will be built southwest of the CBD. City gas system for the existing city centre may start from this area and expand to surrounding areas stepwise.

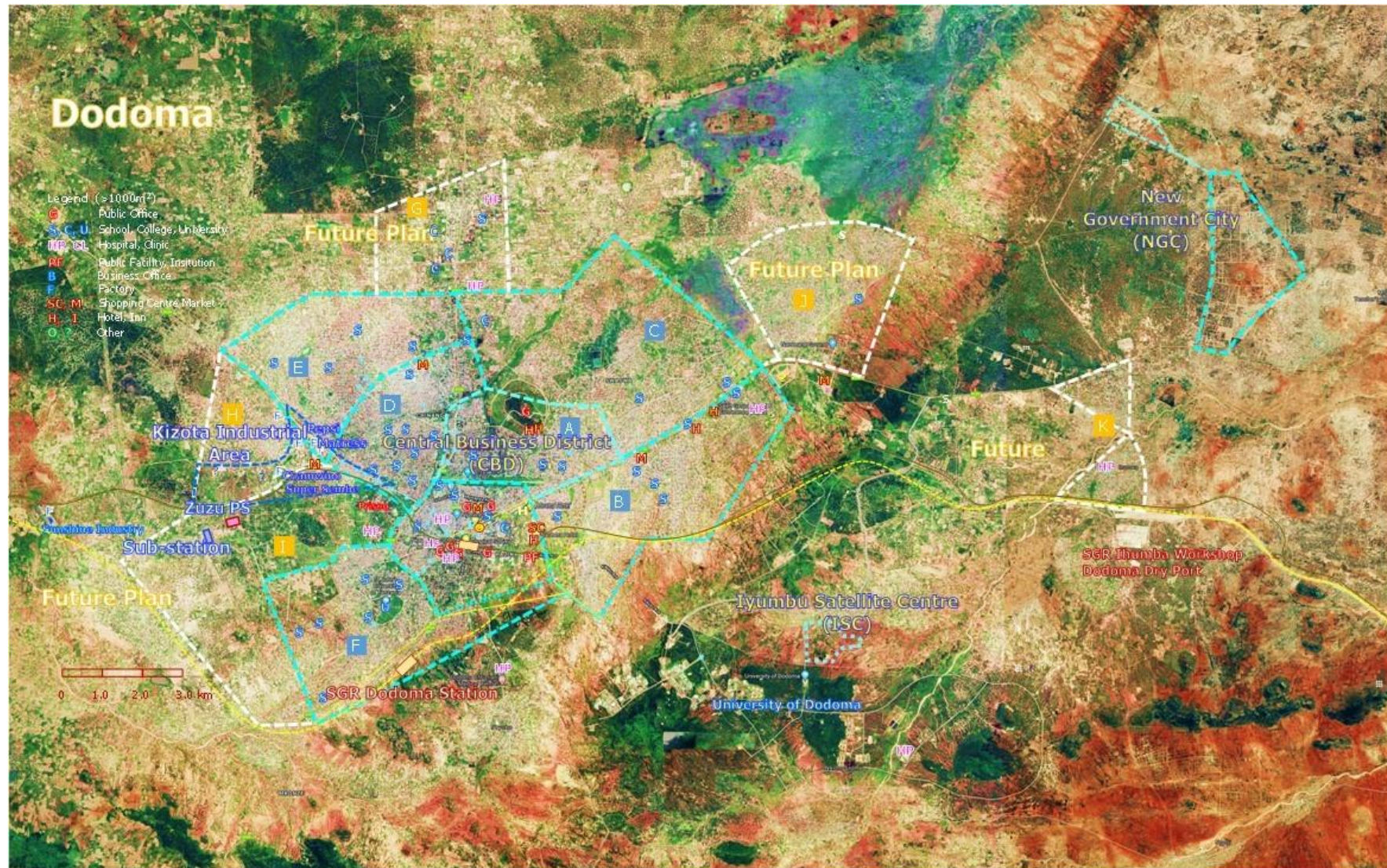


Figure A.2-13 Dodoma: Whole View

In addition, there are two important areas. At Ihumba, 17 km east of Dodoma City, New Government City (NGC) is under construction, which is designed as the administrative centre of the country. Between CBD and NGC, Iyumbu Satellite City is under construction, which is a new real estate development model. These three areas are deemed to be strategically important for the city gas development plan and their development plans are discussed in Chapter 11 of the principal report.

Factories and warehouses in Dodoma are being developed in the Kizota Industrial Park 5 km west of the city. In the south is the Zuzu industrial area where an obsolete diesel power station and the new sub-station are located; TANESCO keeps a wide area there for development of mega-solar power plant. This area may be considered as the location for the LNG satellite terminal to serve the city centre. The TRC central line crosses this area. Factories in the Kizota Industrial Park is as listed in Table A.2-3.

Table A.2-3 Industries in Dodoma

Kizota Industrial Area	Pepsi Industry	Soft drinks
do	Nduvini Autoworks	Garage
do	Dodoma Matress	Matress
do	Tanzania Meat Company	Abattoir
do	ALAF Limited	Matress, roof products,
do	NYEMO Investment Company	Ginnery/cooking oil
do	Nyanza Roadworks Ltd	
do	H Square Dodoma	
do	Chamwino Super Sembe Company Ltd	Maize flour milling
do	Pyxus Ariculture Tanzania	Vegetable Oil
do	Robert Paul Winery	Winery. Depot or warehouse?
Independent Location	Sunshine Industrial Co. Lted	Vegetable oil: currently using coal

In the east of the city, construction of the Dodoma dry port is planned in Ihumba, near the SGR camp 5 km south of the NGC. This area will also be developed extensively in the future. In particular, it is designed to be the hub for cargo distribution in the central and inner areas. It will be an ideal site for L-CNG station to serve long-haul fleets.

Historically government functions and business offices are concentrated in the CBD. This area is the immediate target of the city gas system. There are many schools, hospitals, hotels, restaurants and shops and the demand for modern energy such as city gas and electricity will be high. As its south eastern corner is relatively empty at present; substantial construction is expected to come up along the inner link road under construction. In the southwest of the district, the new railway station of SGR is coming up. Though relatively empty at present, this area will be the centre of the next city development. No information is yet available on development of the station square and periphery.

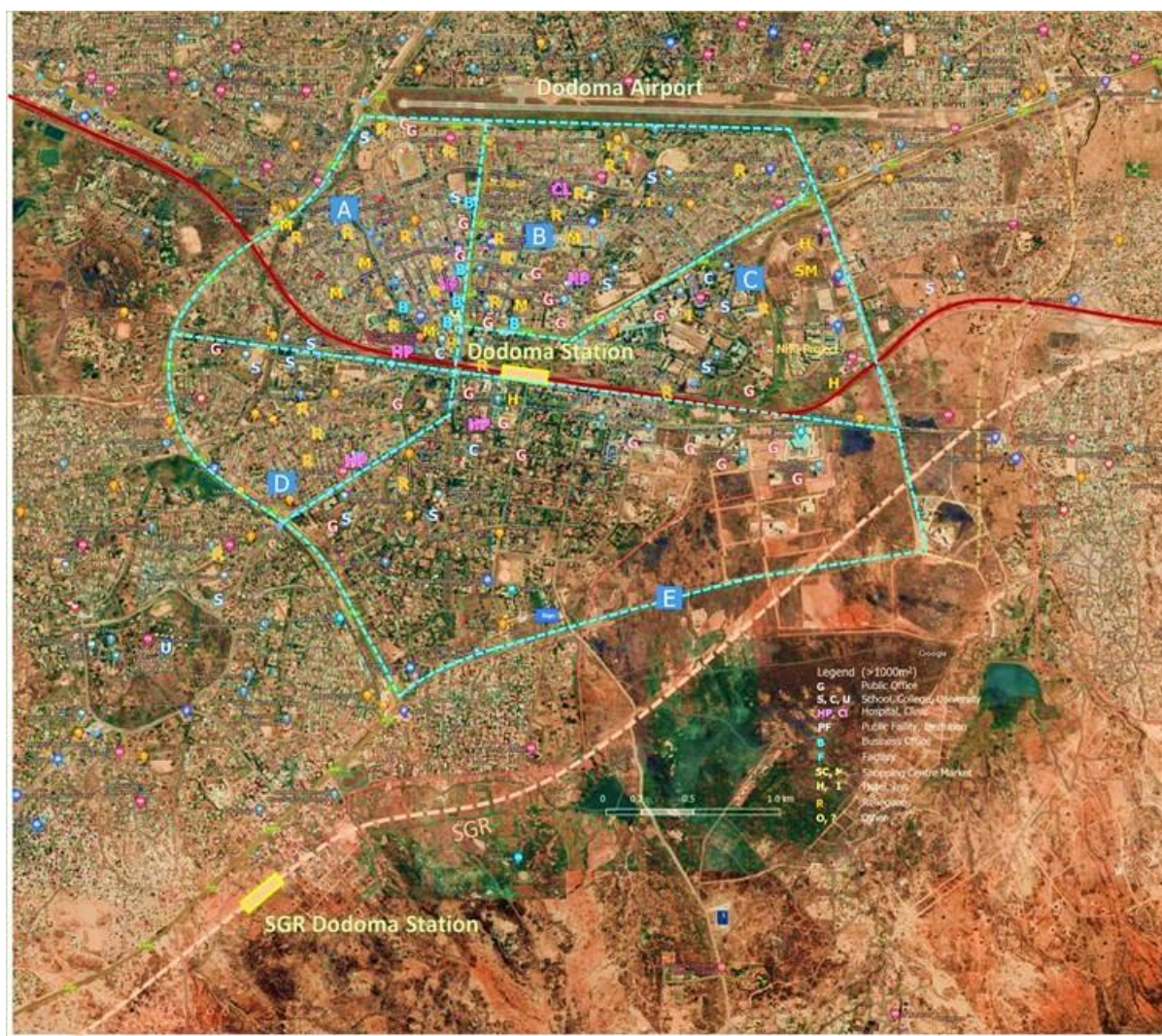


Figure A.2-14 Dodoma: Central Business District

### A.3 Northern Coastal Corridor and Periphery of Dar es Salaam

In the periphery of Dar es Salaam and along the Route A14 to Tanga, seven cities and towns are picked up, namely, Bagamoyo, Kisarawe, Msata, Segera, Handeni, Muheza and Tanga. Areas within Dar es Salaam and in the south will be covered by the existing Mtwara–DSM pipeline or its branch lines. These cities and towns are located within 200 km and delivery of LNG can be made by day trip. Bagamoyo and Tanga are old ports. Towns along Route A14 are situated at elevation of 200 – 300 m, while Handeni is an inland town at 700 m. Except for Tanga city, no remarkable industry development is found. The Bagamoyo Industrial Area plan is stalled while the new port plan is withheld. Small towns such as Msata and Segera may be considered as strategic point for LNG/CNG stations to serve long haul vehicles.

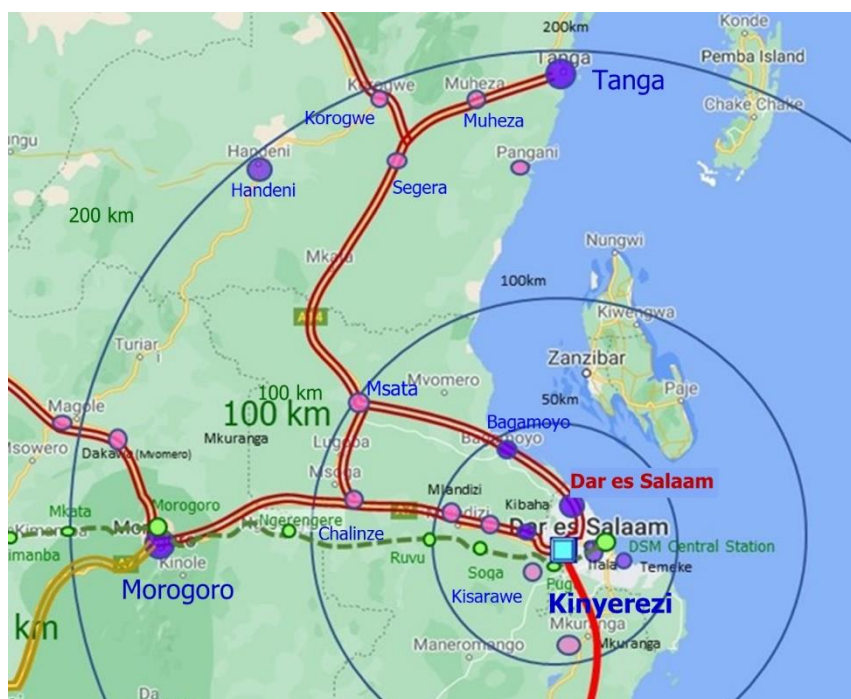


Figure A.3-1 Northern Coastal Corridor and Periphery of Dar es Salaam

Table A.3-1 Potential Gas Demand Along the Northern Coastal Corridor

	Bagamoyo	Kisarawe	Msata	Segera	Handeni	Muheza	Tanga	Total
Elevation(m)	20	220	260	310	700	200	20	-
Distance from DSM (km)	80	15	140	275	270	310	350	-
Area (ha)	1,300	100	100	200	1,600	2,400	3,400	9,100
Houses	5,700	600	600	1,100	9,500	9,600	22,000	49,100
Population	28,500	3,000	3,000	5,500	47,500	48,000	110,000	245,500
Facilities								0
Government Office	1	1	0	0	1	1	4	8
School	7	0	0	2	6	6	21	42
Hospital	2	1	1	0	1	1	5	11
Other Public Facility	1	0	0	0	0	1	2	4
Business Office	0	0	0	0	0	2	5	7
Factory	0	0	0	0	0	0	11	11
Commercial Facility	2	0	0	0	1	3	3	9
Hotel	3	0	0	0	8	6	36	53
Other		0	0	0	0	0	0	0
Gas Demand	t	t	t	t	t	t	t	0
Residential	1,140	120	120	220	1,900	1,920	4,400	9,820
Public+ Biz/Com	60	0	0	0	40	40	440	580
Industry	0	0	0	0	0	0	660	660
Total	1,200	120	120	220	1,940	1,960	5,500	11,060
Total (Round)	1,200	100	100	200	1,900	2,000	5,500	11,000
Residential (200kg/family)	200	200	200	200	200	200	200	kg
Public/Business/Commercial	5%	3%	2%	0%	2%	2%	10%	
Industry	0%	0%	0%	0%	0%	0%	15%	

## 1) Bagamoyo



Figure A.3-2 Bagamoyo

Bagamoyo is an old port town 80 km north of Dar es Salaam. According to the 2012 Census, its urban population was 74,788. Bagamoyo SEZ plan with a largest port in East Africa was proposed for the south east area of the town but is presently stalled. In the northern part of Bagamoyo, there are resort hotels, universities and hospitals. This area may be considered as the core area to start developing a community gas system. By quick reading of the Google Map, the community gas plan area will be 1,300 ha; there are about 5,700 houses with a population close to 30,000. With limited commercial activities, presently expected LNG demand is about 1,200 tons/year or 100 tons/month, which is considered marginal even for a small scale community gas system. Creation of a core demand bundling multiple customers will be necessary to establish a city gas project.



## 2) Kisarawe

Kisarawe is a small town located about 10 km south west of the Kinyerezi terminal. By quick reading of the Google Map, the community gas plan area will be 100 ha; there are about 600 houses with a population of 3,000. Estimated gas demand is 100 tons/year or 10 tons/month; it is too small even for a small community gas system.



Figure A.3-3 Kisarawe

## 3) Msata

Msata is a small community like Chalinze 140 km northeast of Dr es Salaam located at the junction where Route A14 and the Bagamoyo Road merge. By quick reading of the Google map, the community gas plan area will be 100 ha; there are about 600 houses with a population of 3,000. Local gas demand is estimated to be 120 tons/year or 10 tons/month. Because of its strategic location on the trunk road network, it can be considered as a site for an LNG/CNG station. Then, community gas system can be developed using the gas station as the satellite terminal.



Figure A.3-4 Msata

## 4) Segera

Segera is also a small town like Msata and is 275 km from Dar es Salaam located at the junction of Route A14 going to Tanga and Route B1 going to Kilimanjaro. Surrounding area is rich agricultural land famous for sisal and orange production. By quick reading of the Google map, the community gas plan area will be 200 ha; there are about 1,100 houses with a population of 3,000. Local gas demand is estimated to be 120 tons/year or 10 tons/month. Because of its strategic location on the North East Corridor linking coastal ports and upcountry, it can be considered as a site for an LNG/CNG station. Then, community gas system can be developed using the gas station as the satellite terminal.

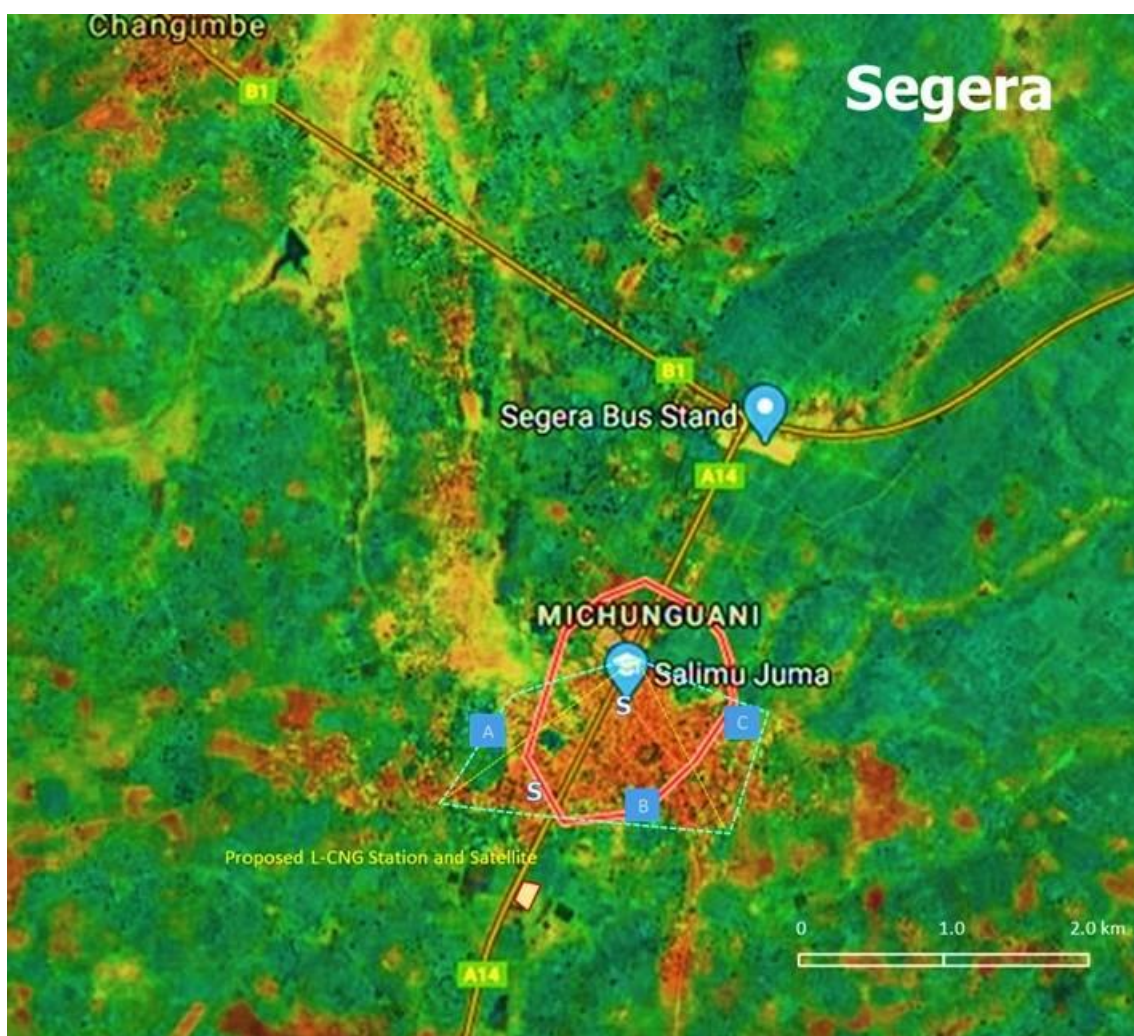


Figure A.3-5 Segera

## 5) Handeni

Handeni Town is one of the 10 districts of Tanga Region and located 50 km west of Segera and 275km from Dar es Salaam. It is situated in the centre of the plain at 700 m above the sea level surrounded by rich agricultural land. It is a strategic stop where the road from the west merges with Route B129 from south (Dumila/Magole, Morogoro Region). According to the 2012 Census, population in the urban area was 79,056. By quick reading of the Google map, the community gas plan area will be 1,600 ha; there are about 9,500 houses with a population of 47,500. Gas demand is expected to be 2,000 tons/year or slightly below 200 tons/month. No noticeable factory is found to provide a base demand. Because of its strategic location, the town may be considered as a site for an L-CNG station.

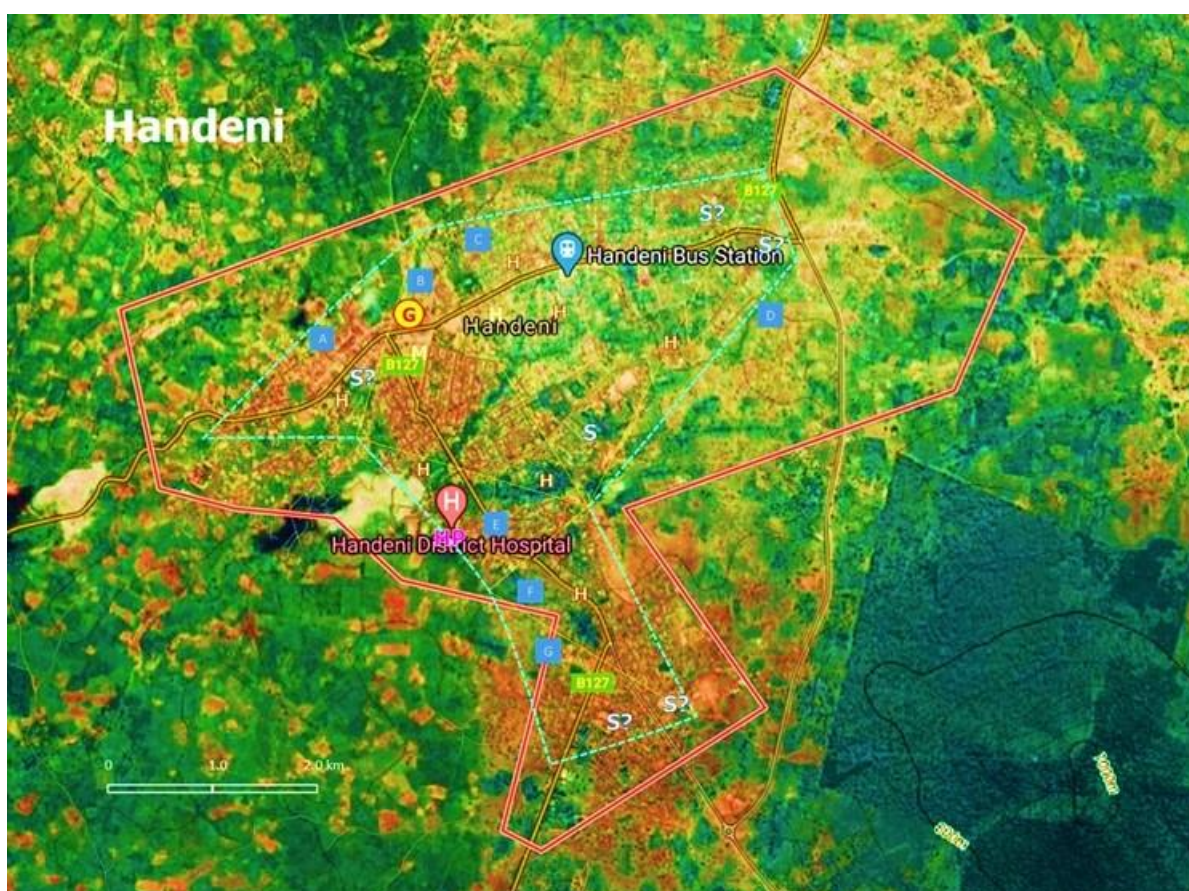


Figure A.3-6 Handeni

## 6) Muheza

Muheza is a town located about 20 km west of Tanga and 310 km from Dar es Salaam. By quick reading of the Google map, the community gas plan area will be 2,400 ha; there are about 9,600 houses with population of 48,000. Commercial facilities and hotels are located in its central part, but no noticeable factory is found in and around the town. Gas demand may be about 2,000 tons/year or below 200 tons/month.



Figure A.3-7 Muheza

## 7) Tanga

Tanga is located 350 km north of Dar es Salaam and is one of the three major ports in Tanzania; it is most northerly among them. It serves for export of sisal, coffee, tea, and cotton, and import of goods with road-link to Kilimanjaro and the African Great Lakes regions. The export terminal of the recently agreed Tanzania-Uganda Oil pipeline will be built in the deepwater offshore the present port.

According to the 2012 Census survey, urban population was 221,127. By quick reading of the Google Map, city gas plan area is about 3,400 ha extending for about 10 km east-west and 6 km north-south with 22,000 houses; target population will be about 110,000.



Figure A.3-8 Tanga

Endowed with rich limestone resource, cement and limestone industries are active in Tanga. These plants are located within a 5km range from the city centre. Fuel price matters for these users as they would provide a substantial anchor demand. They presently use low priced fuel such as coal and petro-coke. Though it is questionable if LNG can be competitive with these fuel, natural gas is indigenous and clean fuel. It is very important to confirm their intention.

In addition to them, there are several industries for food processing, chemical products, textile, etc. They are located together in the industrial areas east and west of the Tanga Airport. Therefore, an integrated gas supply system should be considered for the member of the industrial blocks collectively. The eastern industrial block is close to the city centre and the gas supply system can be shared with the city gas system. Cryogenic heat of LNG may also be utilised at a seafood processing factory and for supply of ice for fishery.

Table A.3-2 Industries In Tanga and Periphery

Gofu Chini Industrial Area	Asher Industries	Cosmetics	
do	Euro truck Parts	Automotive	
do	Tan Silica	Silica sand products	
do	Anjari Soda	Soft drinks (soda drinks), diesel for process 36L/M	
do	Mamujee Products	Cosmetics: bulk LPG 5 t/M, diesel for SBG 800 L/M	
do	Afritex	Textile	
do	Tanzania Autocraft Industrial	Automotive	
do	Alphakrust Ltd	Sea products (prown) processing; diesel for process 2 kL/M	
do	Tanga Pharmaical & Plastics	Cosmetics and chemical products	
Near the above	Tanga Fresh	Milk products, using LPG 25 t/M	
do	Pembe Flour Mills	Flour	LPG 15 kg/M
Bulk Service or city gas	Tanga Cement	Coal 13,183 t/M	
do	Kilimanjaro Cement	Coal 1224 t/M, using imported petro-coke	
do	Rhino Cement/Maweni Limestone Company	Subsidiary of ARM; bought by Huaxin Cement (Chinese).	
do	ARM Limestone Cmpnay (Rhino Cement)	Two plants are located back to back	
do	Shimba Lime Factory	Using imported petro-coke 8 t/day (250 t/M), diesel for SBG 4 kL/M	
do	Neekanth Limited Amboni Limestone Compnay	Using imported petro-coke 603 t/M, LPG 7.6 t/M	
Bulk Service	KATANI Limited	Sisal carpets	20km west of Tanga

There are several beach resort facilities, hospitals, schools and government offices in Tanga. These will collectively provide base demand for the city gas system. Presently estimated gas demand is 5,300 tons a year including fuel supply for light industries.

#### A.4 North East Corridor

The North East Corridor is an important route linking coastal ports (Dar es Salaam and Tanga) with Kilimanjaro and Arusha regions as well as interior countries. Along the Route B1 branching at Msata, elevation goes up from 300 m to 850 m in Moshi and 1,400 m in Arusha. In addition to the two big cities, six towns, namely, Korogwe, Mombo, Same, Mwangi, Himo and Ng'ombe are picked up as candidate location for L/CNG stations. There are two biomass based big plants. Kilimanjaro Biochem Industry in the north of Mwangi is producing ethanol and Tanganyika Planting Company (TPC) in the south of Moshi is producing sugar with big sugar cane plantation. After sugar cane is squeezed, bagasse is available as fuel for sufficient self-supply. No other noticeable industries are found at these towns and hence local fuel demand is limited. The old railway connecting Dar es Salaam and Tanga to Arusha has restored service recently after 30 years out of operation. There is a plan to construct SGR in place of them.

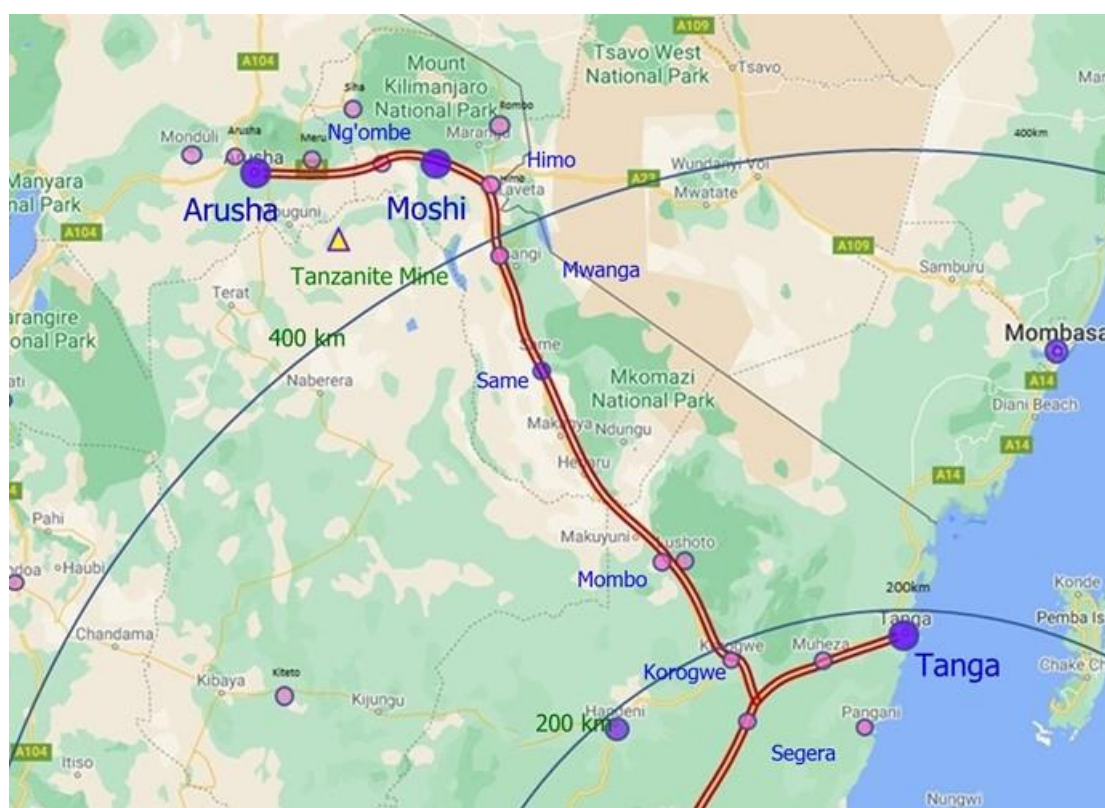


Figure A.4-1 North East Corridor

Moshi and Arusha are large cities. They are famous highland resort at the foot of Mt. Kilimanjaro and Mt. Meru, and also have certain industries, international institutions and education facilities. Arusha hosts the East African Community (AFC) headquarters.

At both cities, factories are located at the industrial blocks. Integrated gas supply systems for industries should be co-used as the core system for the city gas supply. As the cities are large, city gas system will be developed stepwise. Tanga Cement is reportedly planning to construct a plant in Arusha to serve the northern regions; the company is presently transporting cement by a freight train.



Table A.4-1 Potential Gas Demand Along the North East Corridor

	Korogwe	Mombo	Same	Mwanga	Himo	Moshi Phase-1	Moshi All	Boma Ng'ombe	Arusha Phase-1	Arusha All	Total
Elevation (m)	310	440	850	920	800	850	-	940	1,400	-	-
Distance from DSM (km)	300	340	455	510	540	560	-	590	640	-	-
Area (ha)	1,600	200	400	600	500	1,700	5,900	1400	2,500	14,600	25,200
Houses	8,700	1,200	1900	2100	4100	8,700	20,400	5700	13,800	57,400	101,500
Population	43,500	6,000	9,500	10,500	20,500	43,500	102,000	28,500	69,000	287,000	507,500
Facilities											0
Government Office	2	0	2	0	1	8	8	1	4	7	21
School	3	2	1	4	4	15	32	9	22	70	125
Hospital	1	0	1	0	1	4	5	1	8	9	18
Other Public Facility	0	0	0	0	0	1	1	0	4	5	6
Business Office	0	0	0	1	Some	Many	Many	1	Many	Many	XX
Factory	0	0	0	0	0	7	8	0	17	18	26
Commercial Facility	3	0	0	1	1	8	10	3	12	21	39
Hotel	1	2	3	0	0	3	6	1	32	131	144
Other	0	0	0	0	0	0	0	0	0	0	0
Gas Demand	t										0
Residential	1,740	240	380	420	820	1,740	4,080	1,140	2,760	11,480	20,300
Public+ Biz/Com	30	0	20	10	40	170	410	30	410	1,150	1,690
Industry	0	0	0	0	0	1,740	1,220	0	1,380	1,720	2,940
Total	1,770	240	400	430	860	3,650	5,710	1,170	4,550	14,350	24,930
Total (Round)	1,800	200	400	400	900	3,700	5,700	1,200	4,600	14,400	25,000
Residential(kg/haouse)	200	200	200	200	200	200	200	200	200	200	kg
PBC Ratio	2%	2%	5%	2%	5%	10%	10%	3%	15%	10%	
Industry Ratio	0%	0%	0%	0%	0%	100%	30%	0%	50%	15%	

### 1) Korogwe

Korogwe is an old town developed at the foot of the Usambara mountains at 300 above sea level. It is 300 km from DSM and a junction with Route B127 for Morogoro. The city gas plan areas read from the Google Map is 1,600 ha with 9,000 houses. City gas demand is around 2,000 tons a year.



Figure A.4-2 Korogwe

## 2) Mombo

Mombo is a town 440 above sea level and an entrance to a highland town Lushoto (Wilhelmstal) which is famous for large farms and plantations developed since the German colonial period for its pleasant mountain climate. Mombo itself is a small town 340 km away from Dar es Salaam. By quick reading of the Google map, the community gas plan area will be 200 ha; there are about 1,200 houses with a population of 6,000. Gas demand is expected to be 200 tons a year.

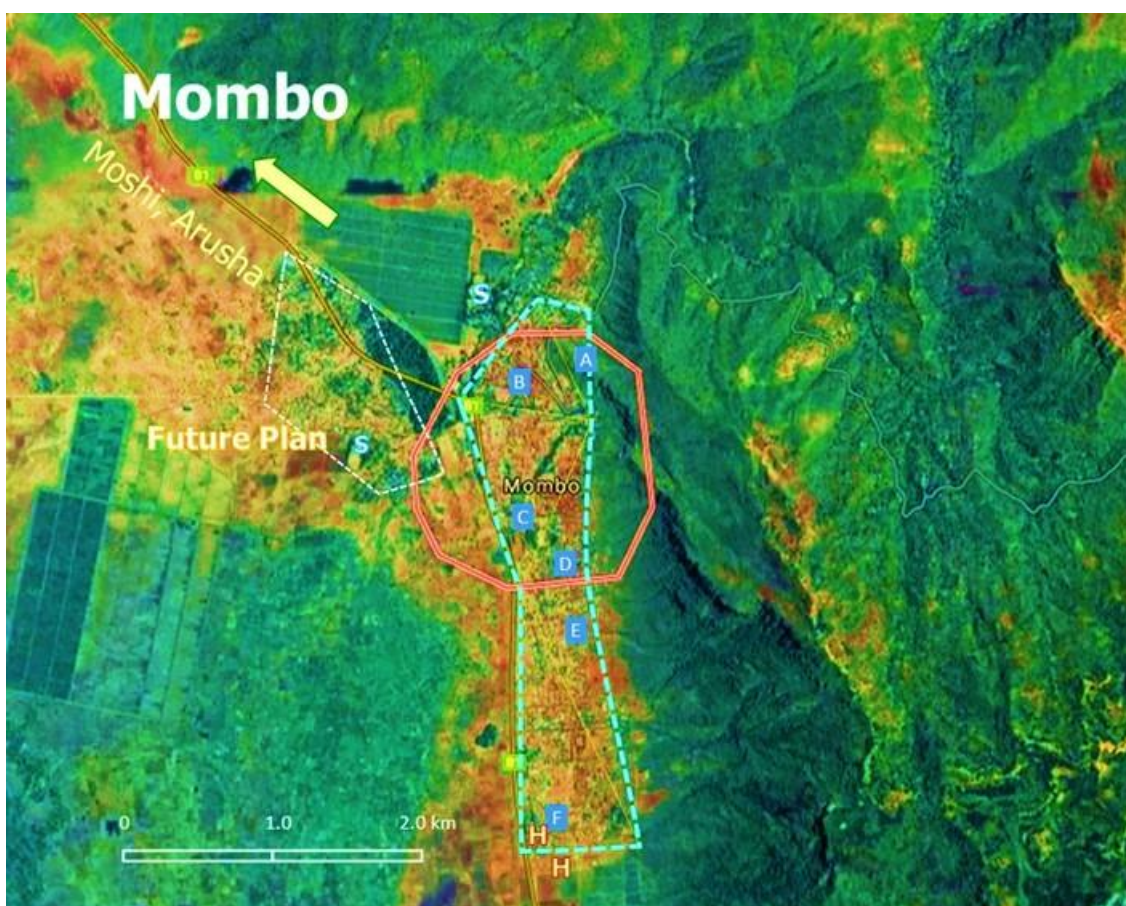


Figure A.4-3 Mombo

### 3) Same

Same is a town on the Route B1 located at a middle point between Segera and Moshi and is 450km from Dar es Salaam. It is 850 m above sea level and an entrance to the Mkomazi National Park. The town is divided in three sections; the town around the old railway station, the central town along the Route B1 and the southern town with sparse development. The central block is a small town with about 2,000 houses and the city gas demand is thought to be small at around 400 tons a year.

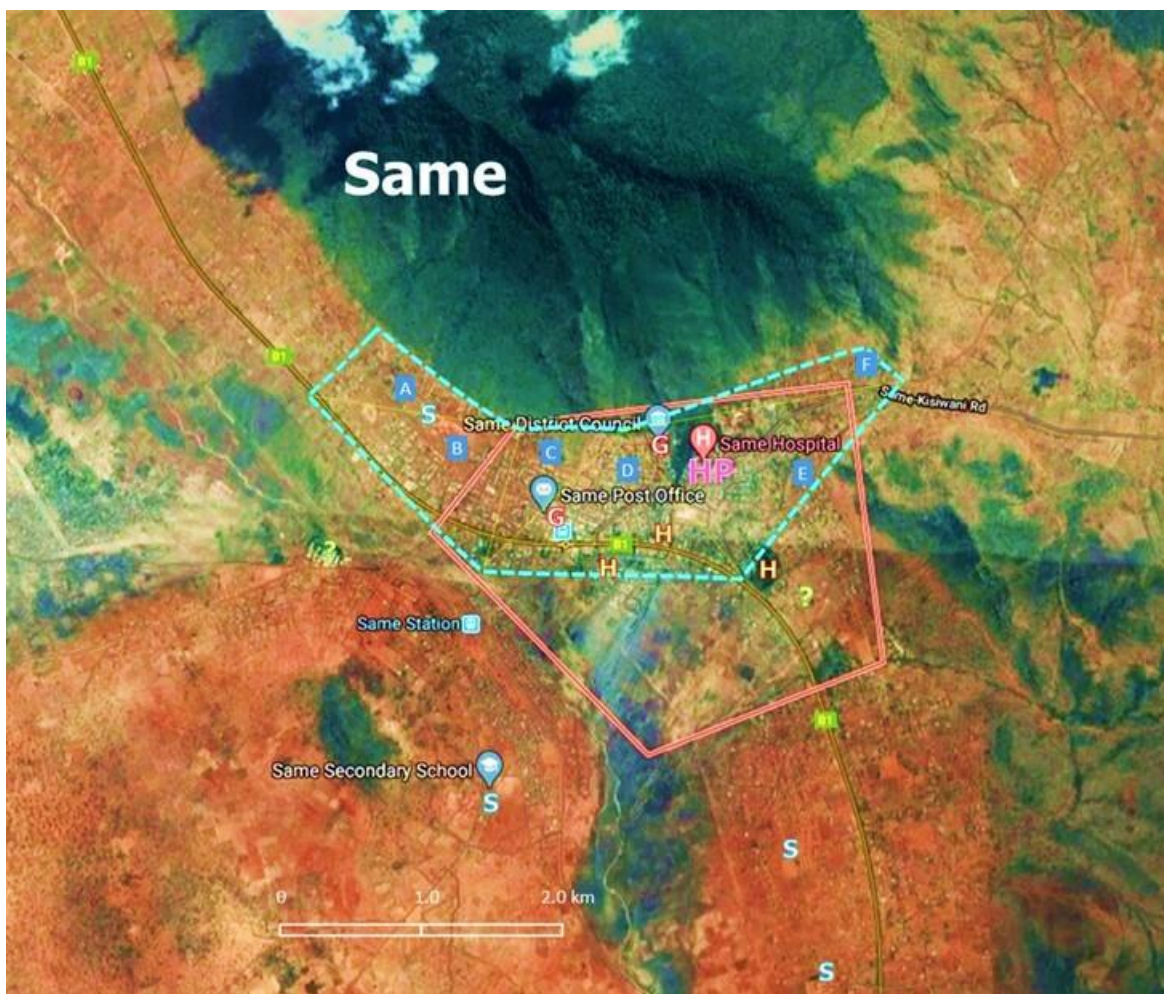


Figure A.4-4 Same

#### 4) Mwanga

Mwanga is another town on the Route B1 510km away from Dar es Salaam at the foot of the north Pare Mountains. By quick reading of the Google map, the community gas plan area will be 600 ha; there are about 2,100 houses with a population of 10,500. Annual gas demand is estimated to be 400 tons.

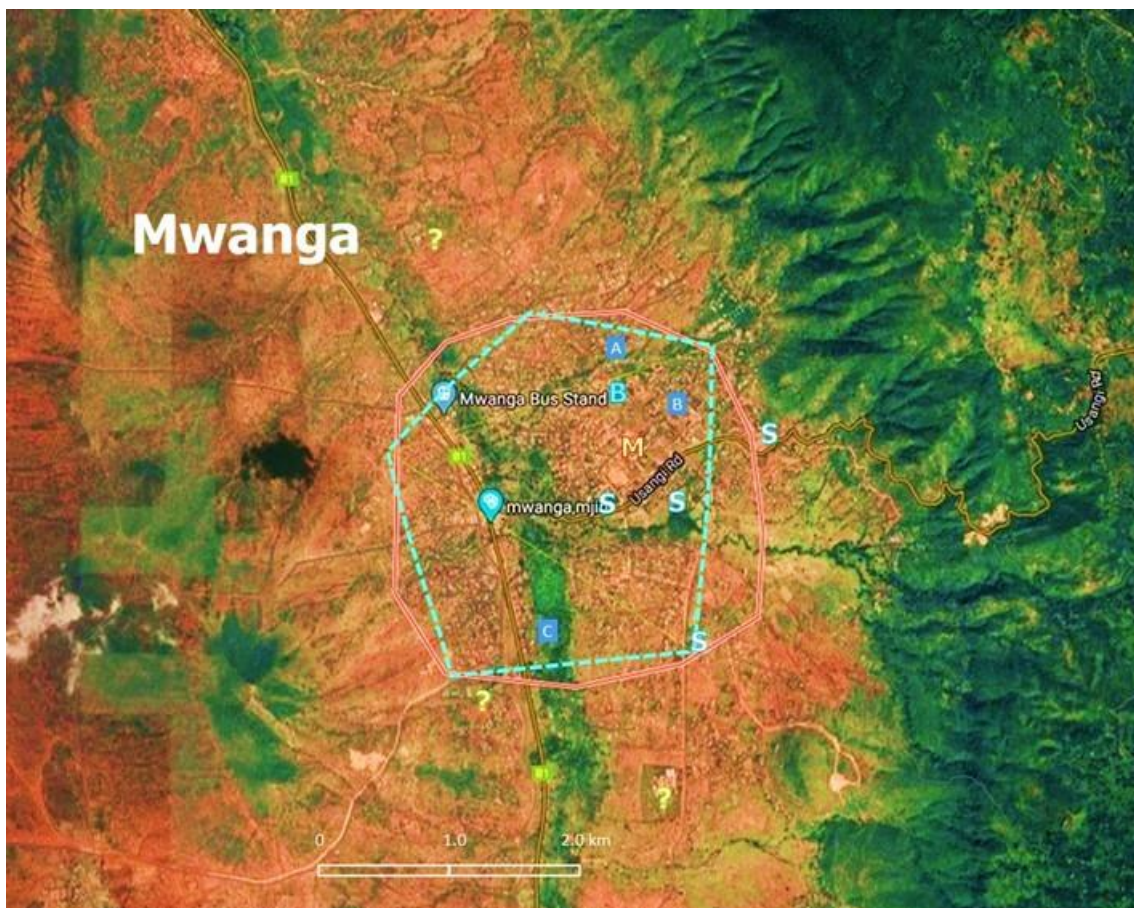


Figure A.4-5 Mwanga

## 5) Himo

Himo is a strategic stop with the junction to Moshi/Arusha and Kenya. It is 540km from Dar es Salaam, 300 km from Nairobi and 900 m above sea level. Town itself is not big. By quick reading of the Google map, the community gas plan area will be 500 ha; there are about 4,100 houses with a population of 20,500. Local gas demand will be small at around 900 tons a year.



Figure A.4-6 Himo

## 6) Moshi

Moshi is the capital of Kilimanjaro region 560 km away from Dar es Salaam. It is a tourism centre at the foot of Mt. Kilimanjaro and close to other national parks such as Serengeti and Ngorongoro. With temperate climate, coffee is grown on the higher slope of Mt. Kilimanjaro, while maize, beans and sugar canes are grown in lower land around Moshi. Tanganyika Planting Company (TPC) operates a large sugar cane plantation 20 km south of the city. Thus, there are many hotels/lodges, schools and administrative offices. Urban population was 184,292 according to the 2012 Census.

Reading Google Map, there are about 15,000 houses with a population of 70,000 in the city gas plan area of 1,700 ha. Factories are located in the south of the old Moshi airport. Big ones among them in terms of energy use are Serengeti Brewery and Bonite Bottlers. In view of their concentration, these factories combined will constitute a demand centre and a shared facility will support development of city gas system.



Figure A.4-7 Moshi

Table A.4-2 Industries in Moshi and Periphery

Kolongoni Industrial Estate	Serengetti Breweries	Beer	
do	Tanzania Breweries Limited Moshi Depot	Beer	
do	China Papers		
do	Merenga Millors Co.	Animal feeds	
do	Bonite Bottlers Limited	Lkilimanjaro Drinkig Water; Coca Cola, Kilimanjaro, etc.	
do	Tanzania Coffee Curing Compnay		
do	East-West Seed		
do	AFGRI	Agri Storage	
Bulk service	Harsho Group	Animal feeds, Agri-bags, etc.	10km west of Moshi
No demand	TPC Limited	Sugar plant: fuel may be self supplied	10km south of Moshi

Potential gas demand is estimated to be 5,700 tons a year, though there is certain upward potential of gas use for hot water service as the climate is mild but cool in morning and evening due to elevation of 700 to 1,000m. Considering the vast size of the objective area, city gas system will be developed stepwise.

### 7) Ng'ombe

Ng'ombe is a town at a junction to the north on the Route A23 between Moshi and Arusha. No specific industry is found. By quick reading of the Google map, the community gas plan area will be 1,400 ha; there are about 5,700 houses with a population of 28,500. Gas demand is expected to be 1,200 tons/year.



Figure A.4-8 Ng'ombe

## 8) Arusha

Arusha is the third largest city in Tanzania after Dar es Salaam and Mwanza; according to the 2012 Census, urban population was 416,442. It is 640 km by road from Dar es Salaam. Arusha is located 1,400m above sea level at the foot of Mt. Meru in the Great Rift Valley; climate is mild and cool. It is close to many national parks such as Mt. Kilimanjaro, Serengeti and Ngorongoro. It also hosts the East African Community and is home to famous Arusha International Conference Centre. Thus, there are many hotels, schools and government offices.

In addition, there are certain number of factories placed in three industrial blocks. They should be served with an integrated gas system that should also be shared with the city gas system. Large energy users are Tanzania Breweries, Monaban Trading and Farming, Spanish Tiles & Sanitary Wares, etc. A to Z Textile, a famous mosquito net producer, is located about 10 km west of the city and would be considered as an independent user.

Table A.4-3 Industries in Arusha and Periphery

Unga Limited Industrial Area	Monaban Trading and Farming	Maize and wheat milling	Diesel 660L/M for drier,
	Tanform Limited	Matress	No fuel consumption is
	Jandu Plambers Limited	Engineering & construction	
Themi Industrial Area-1	Tanzania Brewary Ltd	Beer	500t/y
do	Kilimanjaro Mills Ltd		
Themi Industrial Area-2	General Tyre	Tyre	
do	TANELEC Limited	Electric Equipment (transformaer, switch gear, etc.)	
do	Sunflag Tanzania	Textile, Garments	
do	Truckline	Road Haulage Services	
do	TATA Africa	Automotive	
do	Hanspaul	Automotive	
do	Spanish Tiles & Sanitary Wares	Ceramic	
do	Mount Meru Millers	Seed Crushing and animal feeds	
do	Darsh Industries	Tomato Products	
do	Monsant	Agri-chem & seeds	
Bulk service	A to z Textile	Textile, Moskito-net, garment,etc	Using package waste
Bulk service	Kilimanjaro Air port		40 km east of the city

By quick reading of the Google map, the city gas plan area is roughly 25,000 ha. There are about 96,000 houses with population of 480,000. Potential gas demand is estimated to be 24,000 tons a year; 19,000 tons for residential, 2,000 tons for business/commercial and 3,000 tons for industrial use. With mild/cool climate, there will be some upward potential of gas use.

Because of the vast city size, the city gas system will be developed stepwise.



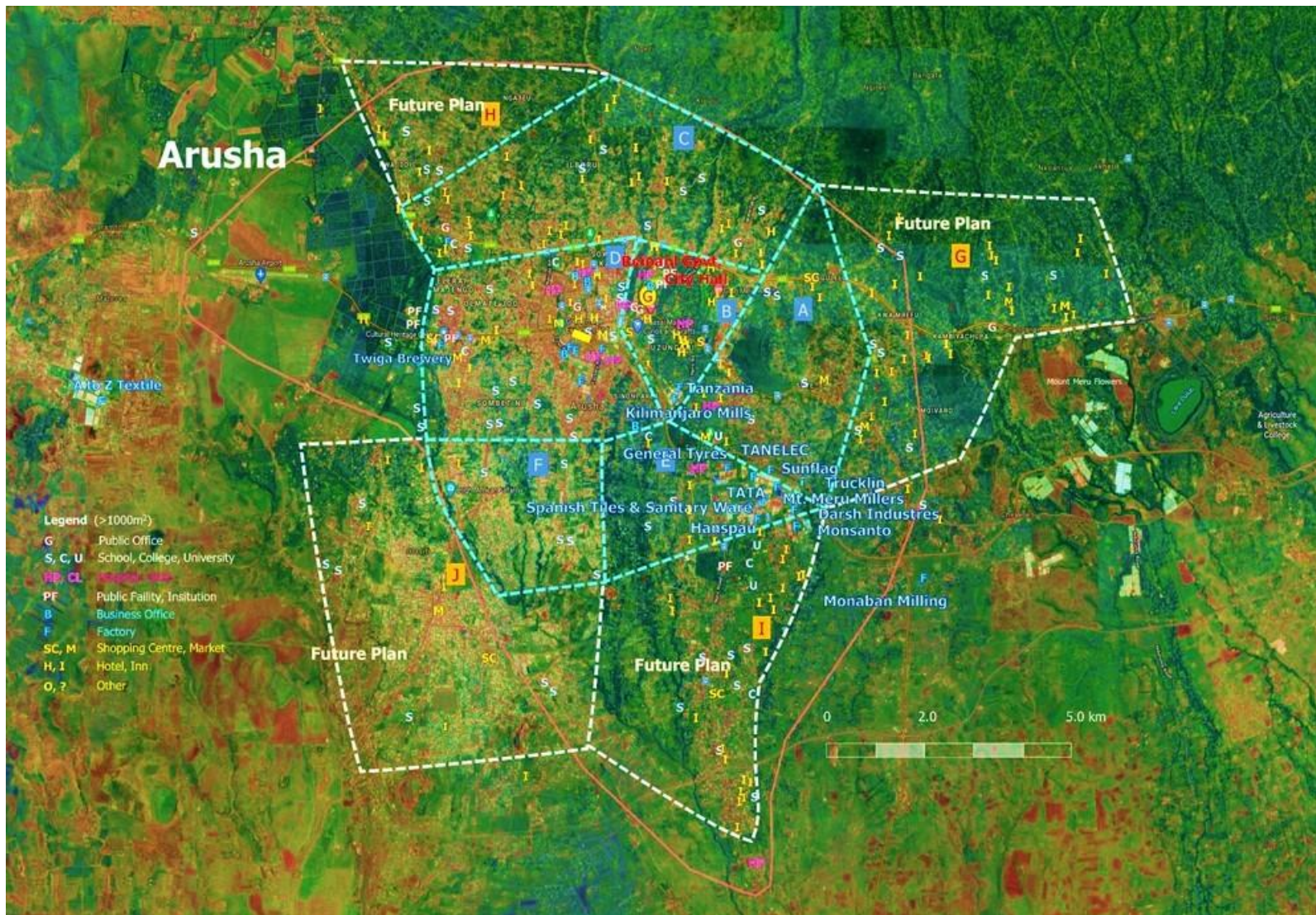


Figure A.4-9 Arusha

## A.5 Great North Corridor

From the north western regions beyond Dodoma, nine cities are picked up, namely, Singida, Shinyanga, Kahama, Geita, Mwanza, Musoma, Bukoba, Tabora and Kigoma. At elevation of 1,000 -1,500 m, climate is temperate or even cool. Industrial activities are high in Mwanza. Some factories are operating in Shinyanga, Kahama, Musoma and Tabora. There are many mines for gold and diamond in this region; Shinyanga, Kahama and Geita have developed with mining. At these mines, LNG can be considered to substitute diesel fuelling off-road vehicles and mining machines. No noticeable industrial activity is found in Bukoba and Kigoma.

As these cities are located far from Dar es Salaam, more or less 700km to 1,400km, they may be considered in the later stage of the DNGPP project.

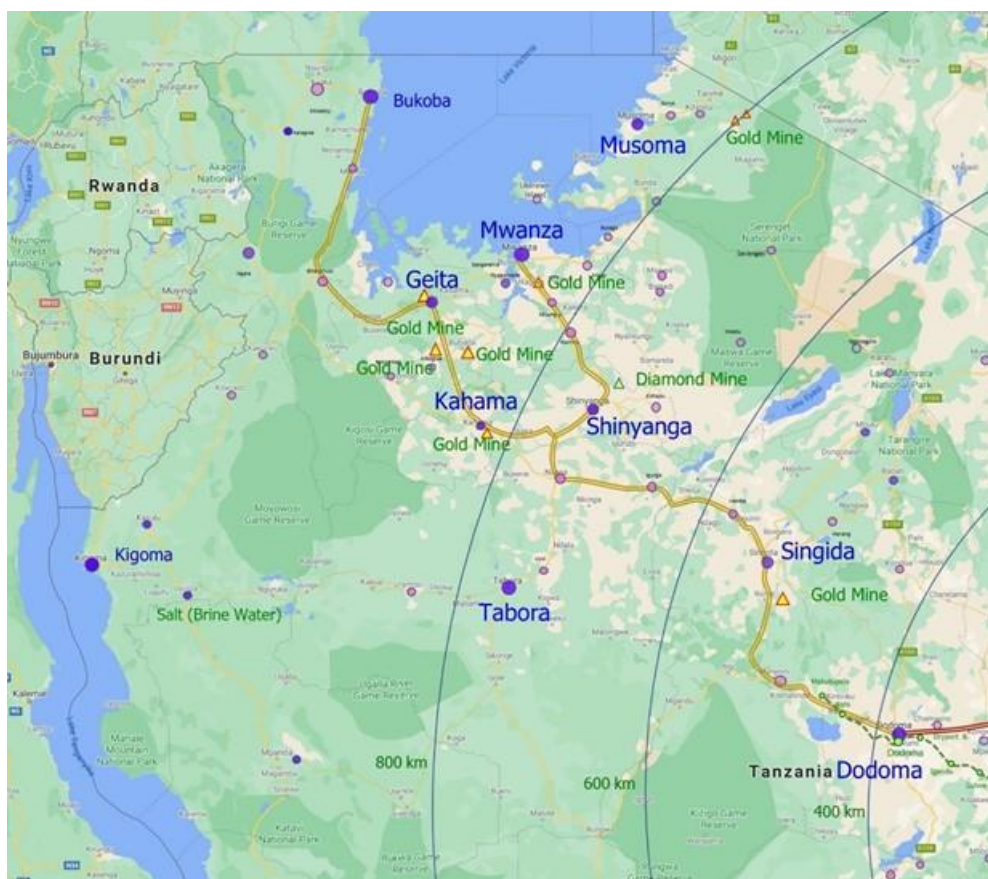


Figure A.5-1 Great North Corridor

Potential gas demand is estimated as shown in Table A.5-1. Among them, demand in Mwanza is by far the largest with certain concentration of demand for industrial use. As cities and towns are situated on the highland, climate is mild/cool and dry and even cold in evening and morning. Therefore, the estimated fuel demand may have upward potential for hot water supply and heating. Because of the very far distance from Dar es Salaam, effective transport system should be considered covering multiple cities by linkage of railway and truck-trailers.

Table A.5-1 Potential Gas Demand Along the Lake Corridor

	Singida	Shinyanga	Kahama	Geita	Mwanza	Musoma	Bukoba	Tabora	Kigoma	Total
Elevation (m)	1,510	1,130	1,220	1,250	1,150	1,140	1,140	1,200	890	-
Distance from DSM (km)	690	970	975	1100	1130	1140/1250	1370	820	1240	-
Area (ha)	2,500	4,300	5,200	3,800	13,500	2,500	2,400	5,800	7,800	47,800
Houses	8,000	12,300	21,600	15,900	86,000	15,600	13,700	32,000	44,300	249,400
Population (5/house)	40,000	61,500	108,000	79,500	430,000	78,000	68,500	160,000	221,500	1,247,000
Facilities										
Government Office	4	4	1	3	5	2	3	2	1	25
School	11	8	11	11	54	21	12	17	8	153
Hospital	2	4	1	3	15	5	1	5	4	40
Other Public Facility	2	0	0	0	5	2	3	1	3	16
Business Office	Some	Some	Some	Some	Many	Several	Some	Some	Some	XX
Factory	2	6	6	0	15	2	1	5	0	37
Commercial Facility	0	0	1	2	13	4	2	2	4	28
Hotel	9	1	3	3	6	4	6	4	4	40
Other	0	0	0	0	0	0	0	0	0	0
Gas Demand	t									
Residential	1,600	2,460	4,320	3,180	17,200	3,120	2,740	6,400	8,860	49,880
Public+ Biz/Com	80	50	90	60	860	90	80	130	180	1,620
Industry	80	120	0	0	2,580	160	50	640	0	3,630
Total	1,760	2,630	4,410	3,240	20,640	3,370	2,870	7,170	9,040	55,130
Total (Round)	1,800	2,600	4,400	3,200	20,600	3,400	2,900	7,200	9,000	55,100
Residential (kg/house)	200	200	200	200	200	200	200	200	200	200 kg
PBC Ratio	5%	2%	2%	2%	5%	3%	3%	2%	2%	
Industry Ratio	5%	5%	0%	0%	15%	5%	2%	10%	0%	
Mines in near location		Diamond	Gold	Gold		Gold				

### 1) Singida

Singida is the capital of Singida region located in the central Tanzania at 1,500m above sea level. It is 250 km by road northeast of Dodoma and 690 km from Dar es Salaam. Singida is a strategic junction of Route B141 coming from south and going to northeast and Route B3, which starts there connecting to the north western regions, and Route B143 connecting to the east. According to the 2012 Census, urban population of Singida Municipal was 85,242.

By quick reading of the Google map, the city gas plan area will be 2,500 ha; there are about 8,000 houses with a population of 40,000. Mount Meru Group has a plant on the west coast of the Lake Singida for production of vegetable oil and flour (?). No other noticeable factory is found. Potential gas demand is estimated to be 1,800 tons a year with some upward potential because of the high elevation.



Figure A.5-2 Singida

## 2) Shinyanga

Shinyanga is located 540 km northeast of Dodoma and 970 km from Dar es Salaam by road. It is on Route B6 connecting to Mwanza. It is the capital of Shinyanga region and the distribution centre of goods and local products; central town has developed around the railway station of the central line. According to the 2012 Census, urban population of Shinyanga Municipal was 103,795.

Industries are located in the Ibadakuli industrial area that is being developed about 5 km east of the city centre. There are many mines in the surrounding area exploiting gold and diamond, who may switch fuel for off-road vehicles and crushing machines from diesel to LNG.

Table A.5-2 Industries in Shinyanga and Periphery

Shinyanga			
Ibadakuli Industrial Area	Mount Meru Millers	Sun Flower Oil	
do	GAKI Investments	Cotton processing?	
do	Jambo Food Products Limited	Soft Drinks	
do	Musoma Foods Company	Processing rice	
Kolandoto: bulk service	Williamson Diamond Mine	LNG as fuel for mining machines and trucks	
Kahama			
Bulk service	Buzwaki Gold Mine	LNG as fuel for mining machines and trucks	
Nyahanga Industrial Area	Kahama Cotton	Cotton processing	Located west of the town
do	Nida Textile Mill (T) Ltd	Textile	
do	Namigogo Elution and Geo-chemical	Chemical Products	
Bulk service	KOM (Kahama Oil Mill) Group of Companies	Plastic Products	Located city centre west
Bulyanhulu: Bulk Service	Bulyanhulu Gold Mine		60 km north of Kahama

By quick reading of the Google map, the city gas plan area will be 4,300 ha; there are about 12,000 houses with a population of 60,000. Potential gas demand is estimated to be 2,600 tons a year.



Figure A.5-3 Shinyanga

### 3) Kahama

Kahama is a town developed with the Buzwagi gold mine. It is located 550 km northeast of Dodoma and 980 km away from Dar es Salaam by road; it is on Route B3 connecting to western regions. According to the 2012 Census, urban population of Kahama Town was 95,087.

In addition to the gold mine, there are two factories on the opposite side of the town.

By quick reading of the Google map, the city gas plan area will be 5,200 ha; there are about 22,000 houses with a population of 108,000. Pending fuel requirement at the gold mine, potential gas demand is estimated to be 4,400 tons a year.



Figure A.5-4 Kahama

#### 4) Geita

Geita is the capital of Geita region and has developed with the Geita gold mine. It is located 680 km northeast of Dodoma and 1,100 km away from Dar es Salaam by road; it is on Route B163 connecting to western regions. There are several gold mines between Kahama and Geita. According to the 2012 Census, urban population of Kahama Town was 167,160.

By quick reading of the Google map, the city gas plan area will be 3,800 ha; there are about 16,000 houses with a population of 80,000. There is no other noticeable factory. Pending fuel requirement at the gold mine, potential gas demand is estimated to be 3,200 tons a year.



Figure A.5-5 Geita

## 5) Mwanza

Mwanza is the second largest city in Tanzania after Dar es Salaam. It is located on the south eastern shore of the Lake Victoria at an altitude of 1,100m. In the old time when railway was the trunkline for transport, Mwanza was an important port connecting to towns around the Lake Victoria. It is 700km away by road from Dodoma and 1,100km from Dar es Salaam. Urban population of Nyamagana Municipal and Ilemela Municipal combined was 706,453 according to the 2012 Census.



Figure A.5-6 Mwanza

Administration/business/commercial centre develops around the railway station and the north port. Factories are distributed in three blocks; the south port area closest to the city centre, Pasiansi in the north of the city near the airport and Nyakato Industrial Area in the south east of the city. Two breweries in the north and Nyakato are large fuel users.



Table A.5-3 Industries in Mwanza and Periphery

Nyakato Industrial Area	Mwanza Textile	2nd largest textile factory in east Africa	Agr-residue 480 t/M
do	Sayona Drinks	Soft Drinks	HFO 120kL/M
do	Pepsi Industrial		
do	SIDO (Small Industries Development Organization)		
do	Nile Perch Fisheries	Fish processing	Diesel 5 kL/M HFO 15kL/M
do	Mwanza City Abattoir	Meat Processing	
do	Blue Coast Investment	Truck freight service	
do	Super Banko (T)	?	
do	Vitafoam T Limited	Matress for bed and sofa	
do	Serengetti Breweries Limited	Beer	HFO 1,43 kL/M
do	African Ginning	Cotton ginner	
do	Nyanza Bottling Company		Agri-residue 145 t/M
do	Nyakato Steel Mills	Iron bars	Kero, diesel & LPG
Igogo Industrial Area (South Port)	Falcon Packaging Limited		
do	Voil Industry	Vegetable oil company	
do	Victoria Mulders	Plastic items (pipe, chair, etc.) and bags	
do	Aluminium Africa (ALAF Limited Mwanza)		
Pasiansi : bulk service?	Tanzania Brewries Limited (Near airport)	Beer	
F4	Mwanza Quality Wines LTD		Firewoo 250kg/M
Usagara: bulk service	Sayona Steel		
Usagara: bulk service	Mining site?		

By quick reading of the Google map, the city gas plan area will be 13,500 ha; there are about 86,000 houses with a population of 430,000. The town further develops to the east and south, and the gas system will be extended to these suburban areas in the future. Potential gas demand is estimated to be 20,000 tons a year with some upward potential because of the mild/cool climate of the up-country. Fuel consumption pattern and fuel preference of large industrial users are yet to be confirmed. As the city centre is congested, the satellite terminal would be built in outer suburbs. The objective area is wide, and hence city gas system may be developed stepwise.

## 6) Musoma

Musoma is the capital of Mara region located at the eastern shore of the Lake Victoria and most northern part of the country. Altitude is 1,100 m. It is approximately 230 km, by road, northeast of Mwanza, and 1,140~1,250 km, pending the route, from Dar es Salaam. North Mara gold mine is operating 80 km east of the city. Urban population of Musoma Municipal was 134,327 according to the 2012 Census.

Administrative institutions are located at the cape. Two factories, Musoma Textile and Mara Oil Mills, are operating in the southeast of the city. By quick reading of the Google map, the city gas plan area will be 2,500 ha; there are about 15,000 houses with a population of 80,000. Estimated gas demand is 3,400 tons a year with some upward potential because of the mild and cool climate.



Figure A.5-7 Musoma

## 7) Bukoba

Bukoba is the capital of Kagera region, the most north-western region in Tanzania sharing the national border with Rwanda and Burundi. It is 1,370 km away from Dar es Salaam by road and is located at the western shore of Lake Victoria at an altitude of 1,150m. Climate is mild and cool though Bukoba lies only 1 degree south of the Equator; temperature is between 15 and 25 degree C and annual precipitation is 2,100mm. Urban population of Bukoba Municipal was 128,796 according to the 2012 Census.

It is a regional centre connecting to Mwanza by ferry and air. No large industrial activity is seen. By quick reading of the Google map, the city gas plan area will be 2,400 ha; there are about 14,000 houses with a population of 70,000. Estimated gas demand is 2,900 tons a year with some upward potential because of the mild and cool climate. A large sugar-cane plantation and sugar plant of Kagera Sugar Ltd are operating 70 km west of the city. The plant looks using coal while bagasse may also be used as fuel.

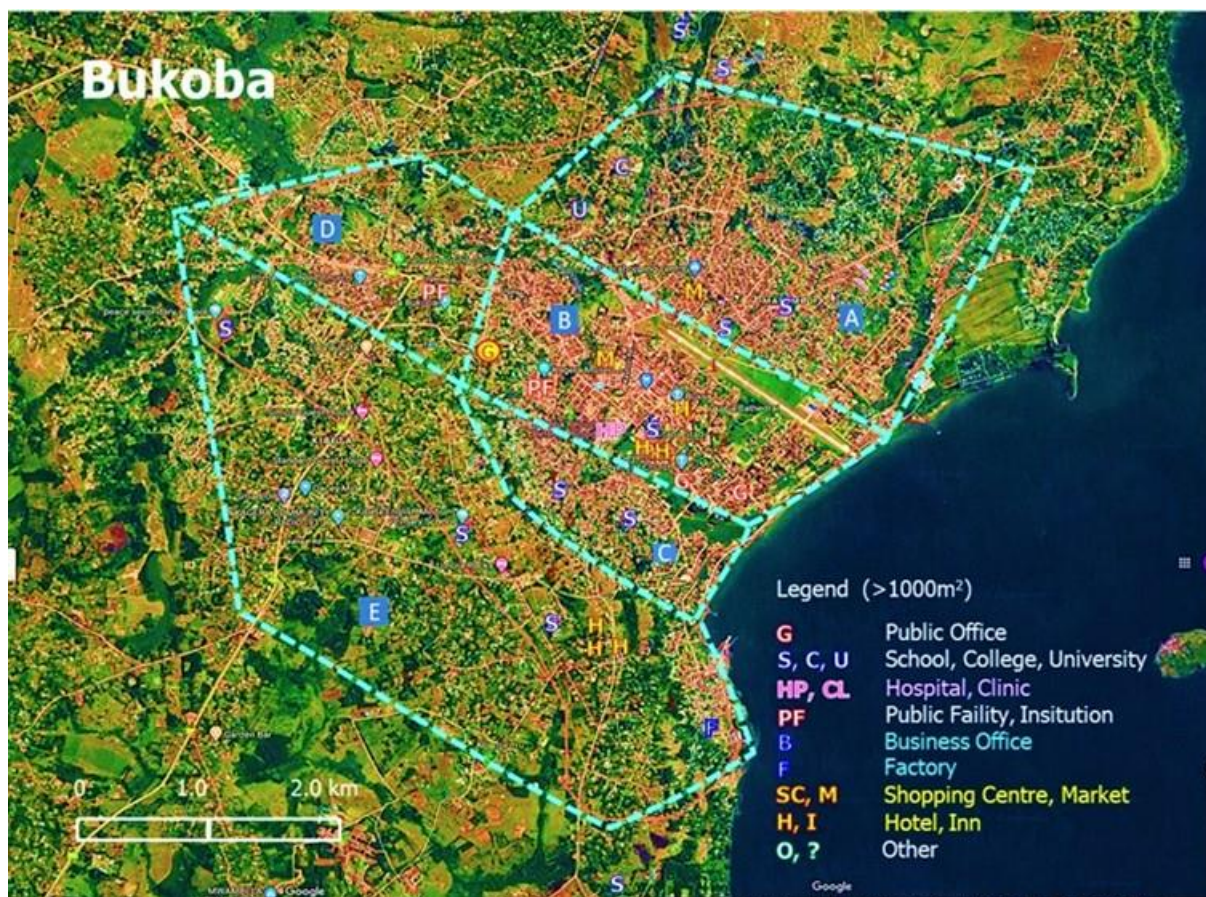


Figure A.5-8 Bukoba

## 8) Tabora

Tabora is the capital of Tabora region located in the central part of Tanzania. It has developed as the administrative centre of the central region. Central line of the national railway branches there to the north to Mwanza and to the west to Kigoma. It is 350 km, by road, away from Dodoma. Located at an altitude of 1,200 m, temperature is mild but climate is extremely dry with annual precipitation of only 88mm. Urban population of Tabora Municipal was 160,608 according to the 2012 Census.

Tabora is known as the fruit capital of Western Tanzania. There are some factories and warehouses in the central part of the city, but industrial activity is not very much apparent. By quick reading of the Google map, the city gas plan area will be 5,800 ha; there are about 32,000 houses with a population of 160,000. Estimated gas demand is 7,200 tons a year.

Table A.5-4 Industries in Tabora

Industrial Area	Universal Leaf Tobacco	Warehouse?
do	New Tabora Diaries	Milk Processing
do	DS Investment	?
do	JT International	Tobacco Leaf (Japanese)
do	Allaance One	Office



Figure A.5-9 Tabora

## 9) Kigoma

Kigoma is the capital of Kigoma region. It is the most western city in Tanzania sitting on the eastern shore of Lake Tanganyika. It is the terminal of the TRC central line and a lake port. It is 800 km, by road, away from Dodoma and 1,240 km from Dar es Salam. Located at an altitude of 800 m, temperature is mild/warm with annual precipitation of 930mm. Urban population of Kigoma Municipal was 215,458 according to the 2012 Census.

Kigoma is the western administration centre of Tanzania and lake resort but no apparent industrial activity is observed. By quick reading of the Google map, the city gas plan area will be 7,800 ha; there are about 44,000 houses with a population of 220,000. Estimated gas demand is 9,000 tons a year. In view of the vast area to be covered, city gas system will be developed stepwise.



Figure A.5-10 Kigoma

Role of Kigoma as a lake port has shrunk considerably due to deteriorated service of the central line with poor maintenance. There is a plan to revive the port function to transfer goods to the other side of the lake with rehabilitation of the existing central line or extension of the SGR.

## A.6 TANZAM Corridor

From the western regions beyond Morogoro along the TAZARA line, six cities are picked up, namely, Iringa, Makambako, Njombe, Mbeya and Sumbawanga. Industrial activities are high in Iringa and Mbeya but low in other cities. This area is rich in greens and thus biomass is fully used as fuel at the paper & pulp factory and other bio-chemical factories. Mbeya and adjacent areas are rich in coal resources and coal is exported to other regions from the Ngaka mine in Ruvuma region.

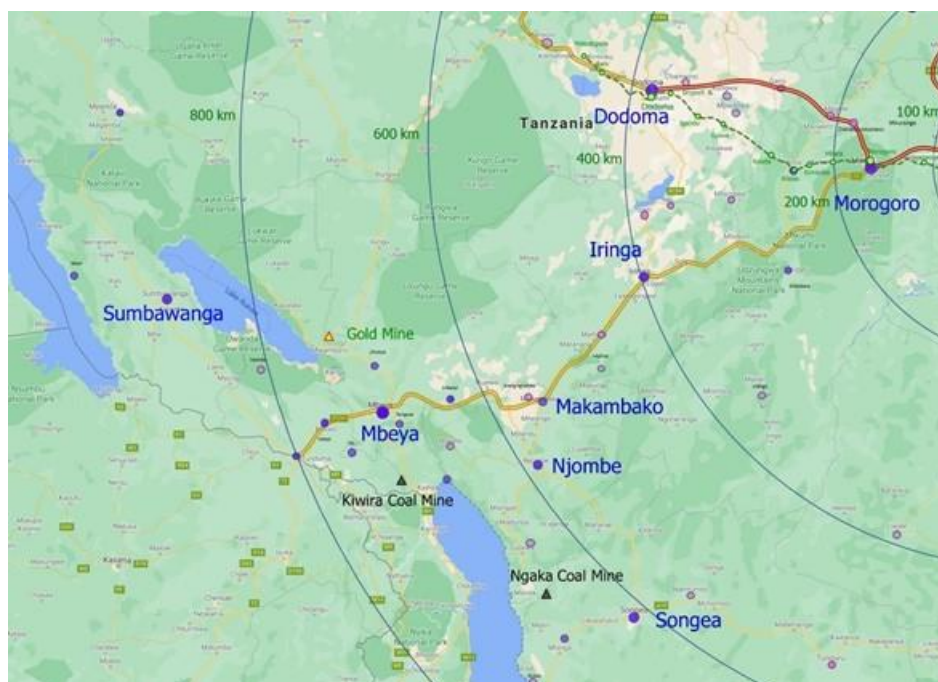


Figure A.6-1 TANZAM Corridor

Table A.6-1 Potential Gas Demand Along the TANZAM Corridor

	Iringa	Makambako	Njombe	Songea	Mbeya	Sumbawanga	Total
Elevation (m)	1,640	1,680	1,920	1,150	1,710	1,840	-
Distance from DSM (km)	490	650	710	940/1070	820	1140	-
Area (ha)	2,600	2,400	2,400	7,200	8,800	4,900	28,300
Houses	17,100	11,600	11,100	27,600	40,800	12,500	120,700
Population (5/house)	85,500	58,000	55,500	138,000	204,000	62,500	603,500
Facilities							0
Government Office	4	2	1	6	8	2	23
School	33	10	16	20	48	8	135
Hospital	4	2	2	4	5	4	21
Other Public Facility	3	0	0	0	3	0	6
Business Office	Several	Some	Some	Few	Many	Few	XX
Factory	4	3	1	1	11	1	21
Commercial Facility	4	1	4	2	4	1	16
Hotel	4	5	12	16	32	7	76
Other	0	0	0	0	0	0	0
Gas Demand	t	t	t	t	t	t	0
Residential	3,420	2,320	2,220	5,520	8,160	2,500	24,140
Public+ Biz/Com	170	120	110	280	410	130	1,220
Industry	340	120	0	0	1,220	0	1,680
Total	3,930	2,560	2,330	5,800	9,790	2,630	27,040
Total (Round)	3,900	2,600	2,300	5,800	9,800	2,600	27,000
Residential (kg/house)	200	200	200	200	200	200	
PBC Ratio	5%	5%	5%	5%	5%	5%	
Industry Ratio	10%	5%	0%	0%	15%	0%	

As these cities are located distant from Dar es Salaam, 500km to 1,000km, they may be considered in the later stage of the DNGPP project.

### 1) Iringa

Iringa is the capital of Iringa region located 300 km southwest of Morogoro and 490 km from Dar es Salaam via Route A7 and 250 km south of Dodoma via Route A104. Located at the junction, it is a strategic service point for long-haul trucks going to interior countries. Iringa is in the Udzungwa Mountains and about 1,600 m above sea level. Climate is warm with average temperature of around 20 degree C and annual precipitation 740 mm. Urban population of Iringa Municipal was 151,345 according to the 2012 Census.

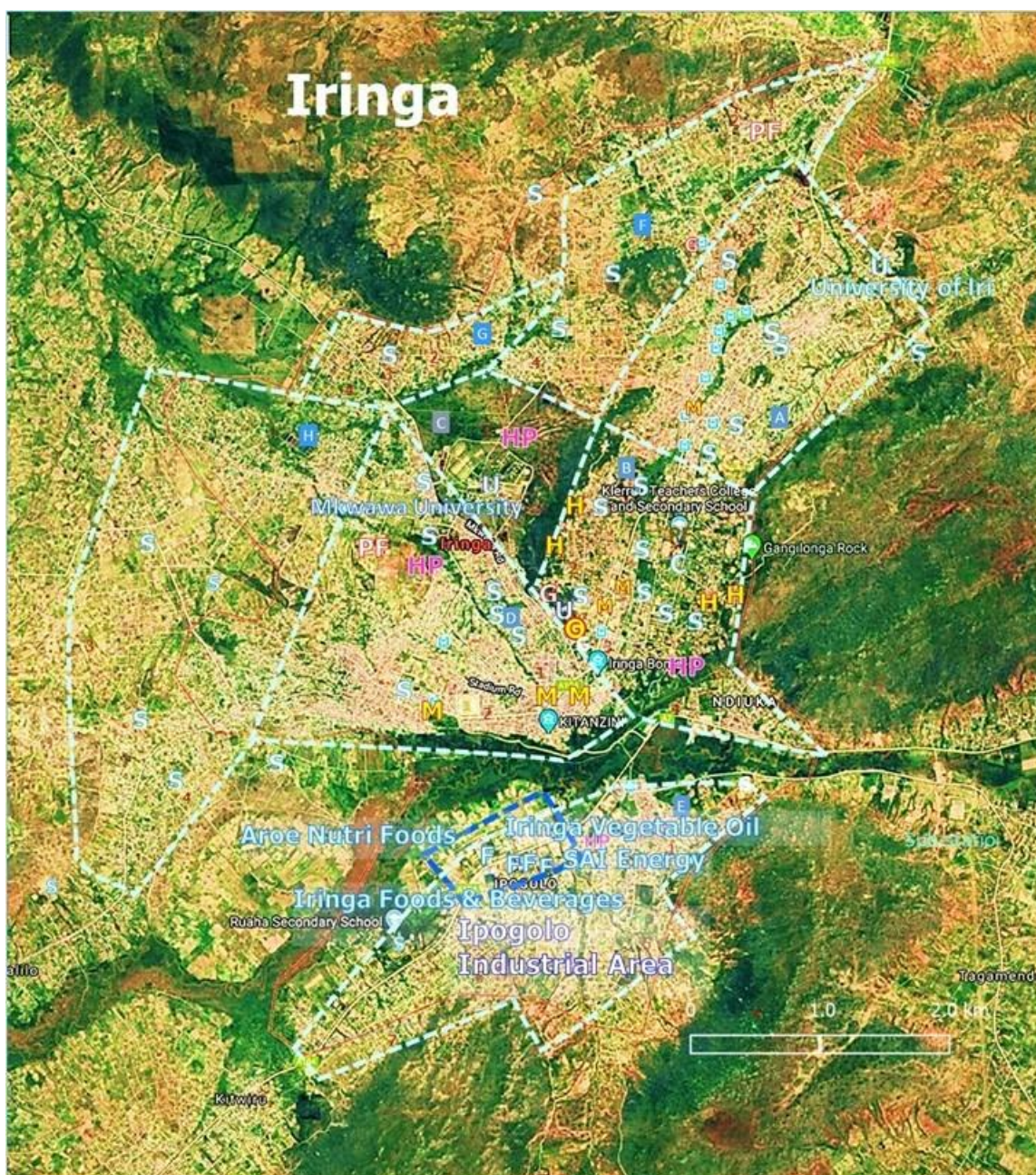


Figure A.6-2 Iringa

The town stretches along a hilltop overlooking the Little Ruaha River. There are two famous universities in the north of the city; University of Iringa and Mkwawa University. Ipogolo Industrial Area is developed on the southern bank of the river; factories there are producing food products, soft drinks, vegetable oils and bio-briquettes for fuel use.

Table A.6-2 Industries in Iringa

Ipogolo Industrial Area	Sai Energy and Logistics Services	Bio-briquette (for fuel use)
do	Iringa Vegetable Oils and Related	Vegetable oil
do	Iringa Foods & Beverages Ltd	Food processing
do	Are Nutri Foods	Food processing
do	Falahi Industries Limited	Confectionary
do	IVORI Iringa	Food & Beverage
do	Ivori Lollipops	Food & Beverage

By quick reading of the Google Map, the city gas plan area will be 2,600 ha; there are about 17,000 houses with a population of 86,000. Estimated gas demand is 3,900 tons a year.

2) Makambako



Figure A.6-3 Makambako



Makambako is located at the northern tip of Njombe region 460 km, by road, southwest of Morogoro and 650 km away from Dar es Salaam. It is a strategic transportation point connecting to the interior countries as well as north and south regions; Route A104, B4 and the TAZARA railway pass through the town. The altitude is 1,650m; the wet season is overcast, the dry season is mostly clear, and it is comfortable year round. Urban population of Makambako was 57,288 according to the 2012 Census.

No remarkable industrial activity is observed. By quick reading of the Google map, the city gas plan area will be 2,400 ha; there are about 12,000 houses with a population of 58,000. Estimated gas demand is 2,600 tons a year.

### 3) Njombe

Njombe is the capital of Njombe region 60 km south of Makambako and 710 km away from Dar es Salaam. It is located at nearly 2000 meters of altitude on the eastern edge of the Kipengere Range and has the reputation of being a cold town. Urban population of Njombe was 64,122 according to the 2012 Census.

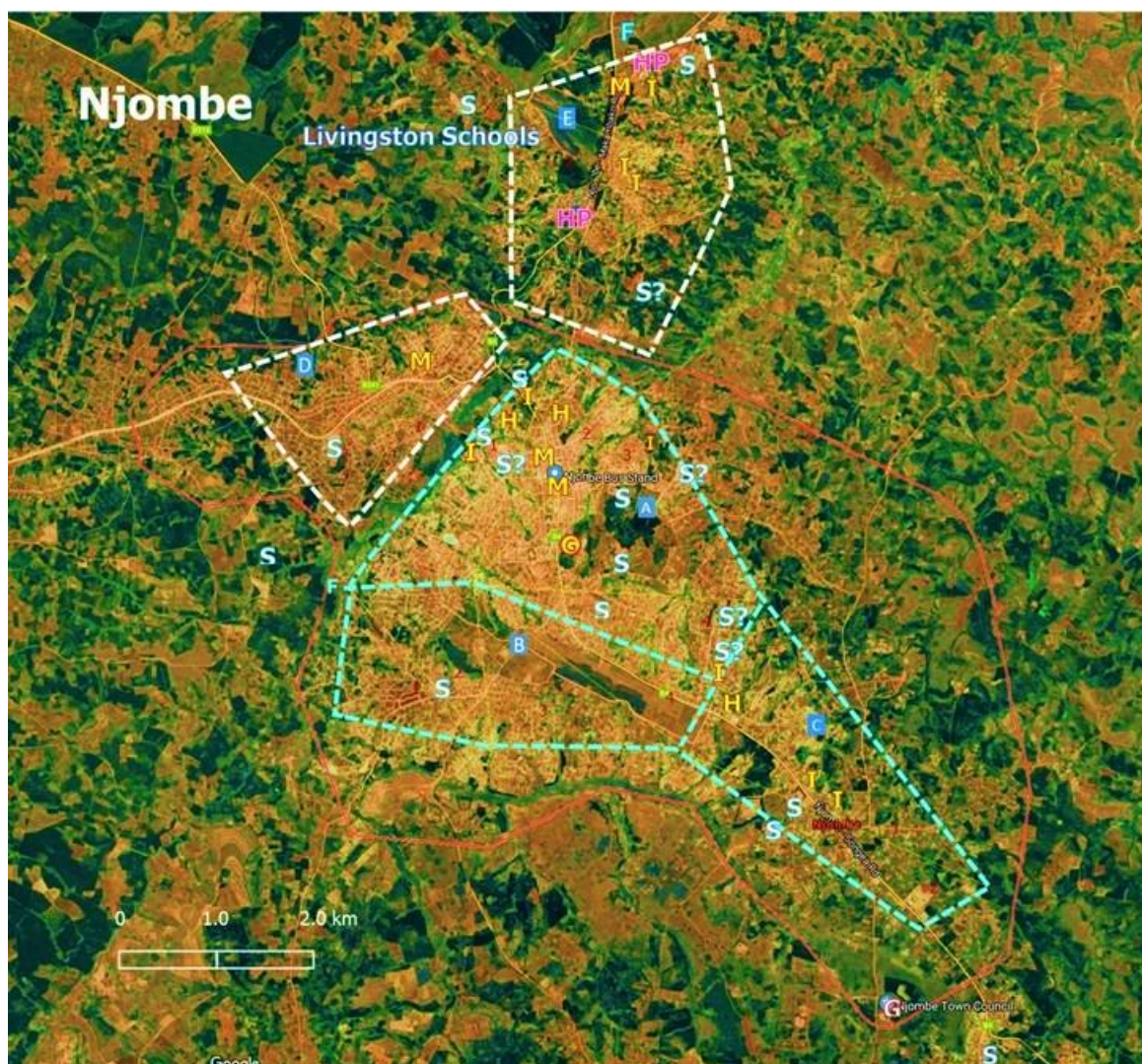


Figure A.6-4 Njombe

Tanwat factory is operating in the north of the town; it produces tannin from acacia tress from nearby plantation and uses saw dust as fuel. No other remarkable industrial activity is observed. By quick reading of the Google map, the city gas plan area will be 2,400 ha; there are about 11,000 houses with a population of 55,000. Estimated gas demand is 2,300 tons a year.

#### 4) Songea

Songea is the capital of Ruvuma region located 300 km, by road, south of Makambako via Route B4, 750 km south west of Morogoro, 160 km to Mbama Bay at the shore of Lake Nyasa (Lake Malawi). It is 650 km to Lindi and Mtwara and is 940 km via Morogoro and 1,070 km via Lindi from Dar es Salaam. It is situated just above 1,000 m above sea level and temperature is around 20 – 30 degree C. It is the largest town in Ruvuma region; urban population of Songea Municipal was 203,309 according to the 2012 Census.



Figure A.6-5 Songea

Songea is a regional administration and trade centre with many offices, schools and hospitals. Except for the National Milling plant, no other noticeable factory is found. By quick reading of the Google map, the city gas plan area will be 7,200 ha; there are about 28,000 houses with a population of 138,000. Estimated gas demand is 5,800 tons a year.

## 5) Mbeya

Mbeya is the capital of Mbeya region. It is the largest city in the southwestern part of the country on the main route to Zambia, Malawi and Congo; Route A124 and TAZARA railway pass through the city. Mbeya is 630km west of Morogoro and 820 km from Dar es Salaam via Route A7 and A124. Mbeya is situated at an altitude of 1,700 m, and sprawls through a narrow highland valley surrounded by high mountains. Urban population of Mbeya City was 385,279 according to the 2012 Census.

Mbeya was founded as a gold mining town in the 1920s. Today Mbeya City is a growing metropolis and business centre for the southern regions and the neighbouring countries of Malawi, Zambia and Congo. Thanks to the mild weather, enough rainfall ( $-6^{\circ}\text{C}$  in the highlands and  $29^{\circ}\text{C}$  on the lowlands and annual precipitation of 850mm) and fertile soil, Mbeya is the country's largest producer of maize, rice, bananas, beans, potatoes, soya beans and wheat as well as high-value export and cash crops such as coffee, tea, cocoa, pyrethrum and spices. Animal husbandry, with dairy cattle, is also predominating.

The Iyunga industrial area is developed in the south of the railway station with TBL brewery, soft drinks producer of Coca Cola and Pepsi, CMG investment producing pole, etc. Mbeya University is located in the same area. Considering the long-haul of LNG containers by rail, an LNG satellite terminal will be built in this area and the city gas network will be developed eastward.

Table A.6-3 Industries in Mbeya and Periphery

<b>Mbeya</b>			
Mbeya	Industrial area is 5 km west of the old city centre		
Iyunga Industrial Area	Tanzania Breweries Limited	Beer	HFO 34 kL/M
do	Coca Cola Kwanza Limited Mbeya Plant	Soft Drinks, Electricity for air conditioning	Diesel for SBG 12kL/M
do	Marmo E Granito Mines		Diesel for SBG 280L/M
do	CMG Investment	Concrete poles	Firewood 500kg/M
do	Tembo Coffee Compnay Limited	Coffee	
do	SBC Tanzania: Pepsi Cola	2 sites across road	
Near to above	Mbeya University of Science and Technoby		
do	Makenda Health Centre		
<b>Songwe</b>			
10 km west of Mbeya	Mbeya Cemnt Company Limited	Using coal?	
Next to Mbeya Cement	Mbeyatex		
Luika: bulk service	New Luika Gold Mine	LNG for generators and off-road vehicles	Near Lake Rukwa, 100

By quick reading of the Google Map, the city gas plan area will be 8,800 ha; there are about 41,000 houses with a population of 204,000. Estimated gas demand is 9,800 tons a year.

About 10 km west of the city, there are Songwe airport and factories of Mbeya cement and Mbeya tex. As Mbeya region is rich in coal resources, these factories are using coal as fuel. A new gold mine, Shanta Gold New Luka Mine, was found 100 km north of Mbeya and started operation in 2012. It is a combination of open and underground pits. In addition to off-road vehicles, HFO based diesel generators are used to supply power for crushing and milling plant.

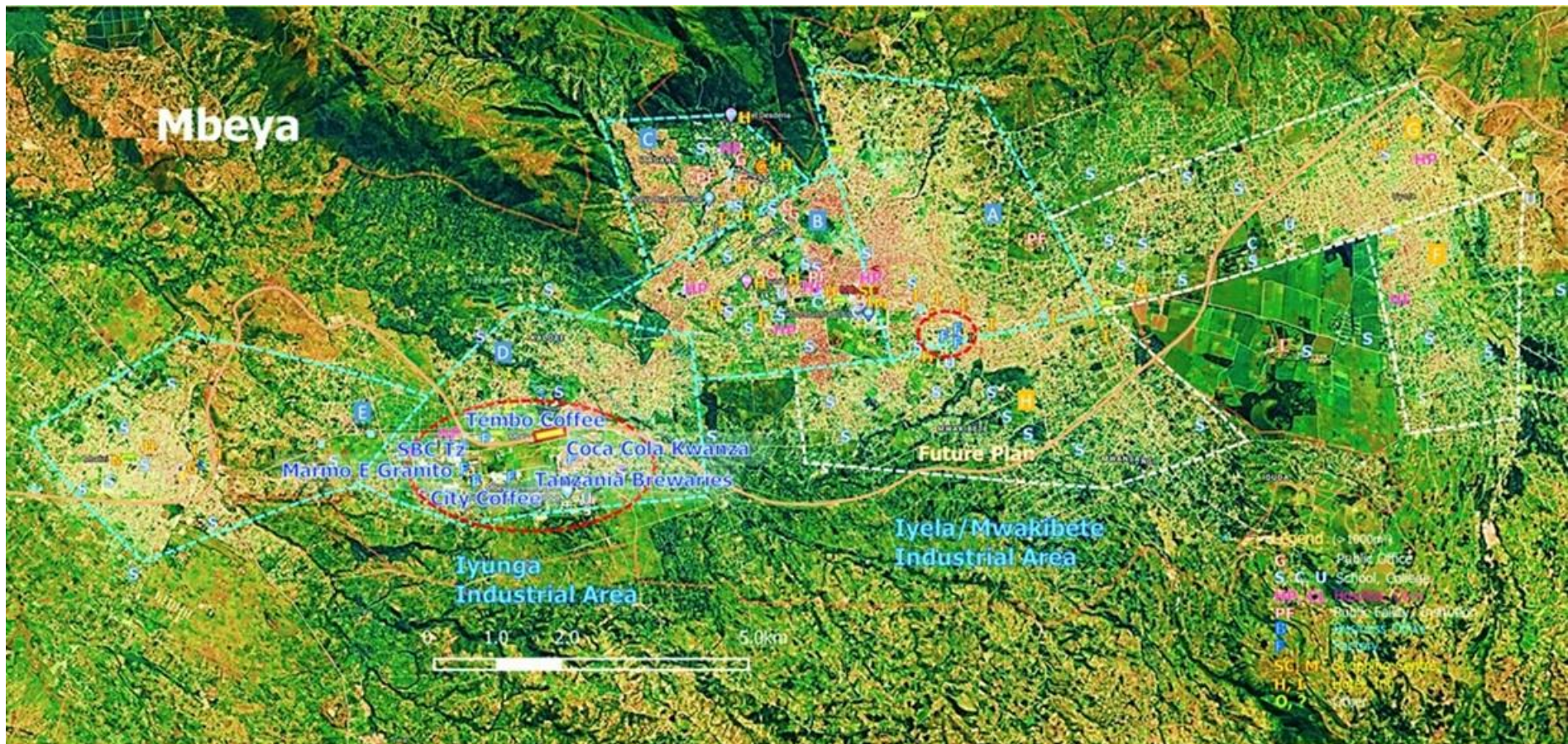


Figure A.6-6 Mbeya

## 6) Sumbawanga

Sumbawanga is the capital of Rukwa Region located 330 km, by road, northwest of Mbeya and 1,140 km from Dar es Salaam. It is situated at an altitude of 1,700 m. Temperature is 15 – 30 degree C with annual precipitation of 960mm. Urban population of Sumbawanga Municipal was 124,204 according to the 2012 Census. Major activities are agriculture (maize, rice, beans and drug plants), fishing in Lake Rukwa and beekeeping for honey. No noticeable industrial activity is found.

By quick reading of the Google Map, the city gas plan area will be 4,900 ha; there are about 12,500 houses with a population of 62,500. Estimated gas demand is 2,600 tons a year.

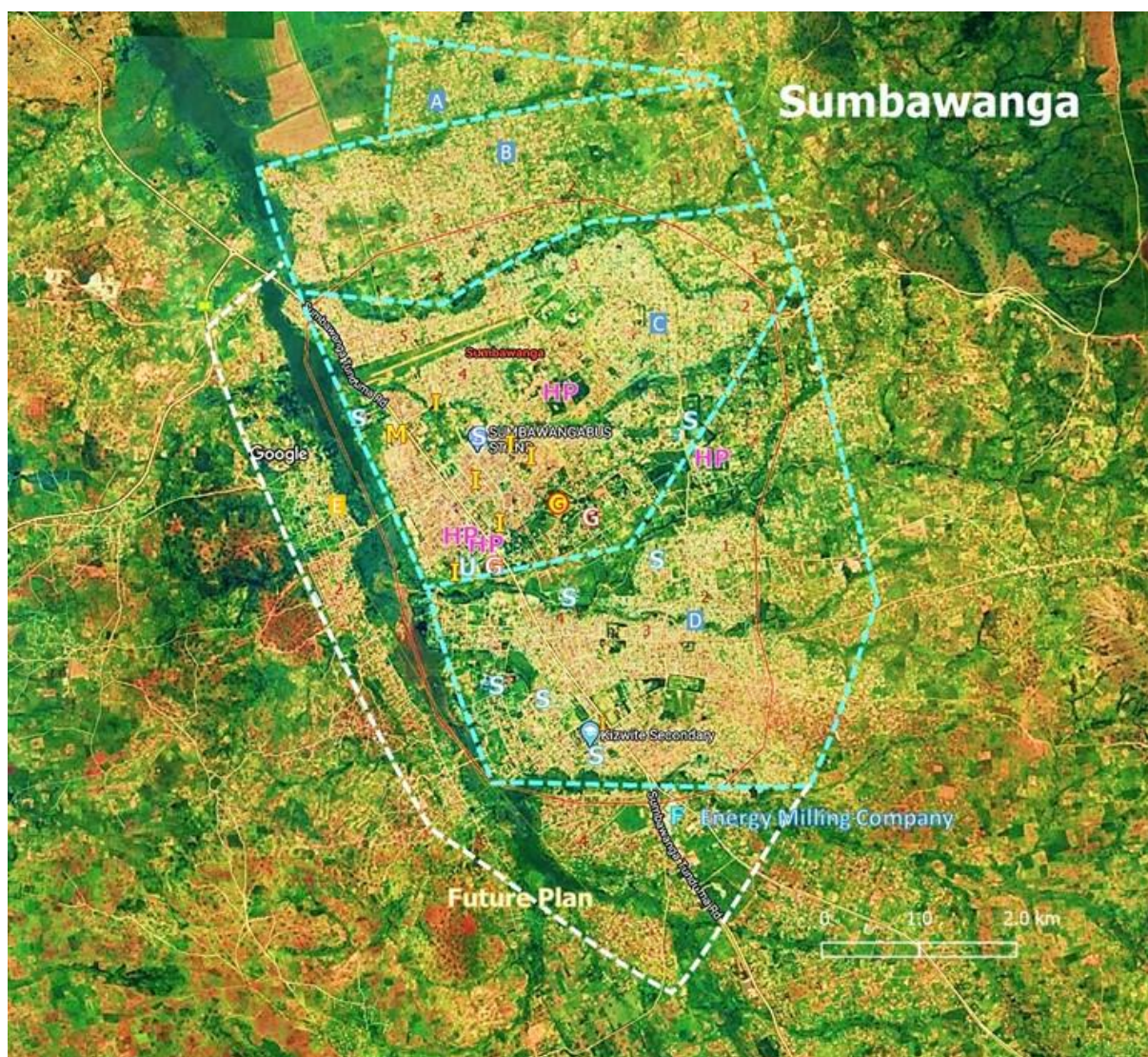


Figure A.6-7 Sumbawanga



## Appendix B: List of Large Energy Users by Google Map

Large energy users are the key for the DNGPP project. Even a small number of them will provide the base demand for the mini-LNG based virtual pipeline system. Those within the city gas service area will be supplied gas via pipe and provide a core demand for the system. Energy users of certain size located out of city gas service areas can receive LNG delivery by truck container. Their possibilities and intentions on gas use are fatal for this project. Therefore, Study Team tried to list potential large users by reading the Google Map. The satellite image, however, does not provide complete information. We should visit them to identify their features and conditions and to hear their views and future plans on gas use so to compile a credible sales plan.

### B.1 Outline of Survey

#### B.1.1 Objective Area

Potential large energy users are shortlisted reading the Google Map along the five main corridors and periphery as shown in Figure B.1-1:

- a. Central Corridor: from Dar es Salaam to Dodoma
- b. Northern Coastal Corridor: from Dar es Salaam to Tanga including periphery of DSM
- c. North East Corridor: from Korogwe to Arusha
- d. Great North Corridor: from Dodoma to Mwanza, Musoma, Bukoba and Kigoma
- e. TANZAM Corridor: from Morogoro to Mbeya and adjacent markets.



Figure B.1-1 Energy Markets Along Main Corridors

### B.1.2 Summary of Findings

Findings of the survey are as follows;

- 1) While the Regional Energy Demand Survey (REDS) was conducted in 2018, it was a sample survey. There are many (potentially large) energy users not covered by the REDS.
- 2) Factories are mostly put together in the industrial blocks in Morogoro, Dodoma, Tanga, Moshi, Arusha, Mwanza, Iringa and Mbeya. (Some of them enjoy the Special Economic Zone (SEZ) status such as 10 year tax holidays, etc.)

An integrated gas system should be considered that covers all the energy users from small to large collectively as it will be more efficient than individual supply. Such regional energy centre will provide a credible and stable anchor demand for developing a city gas system.

- 3) In Tanga, there are several limestone and cement companies that are using coal and/or petro-coke in a large volume.

It is questionable if LNG by road transport can compete with cheaper fuels. However, indigenous natural gas has benefits in terms of supply security, price stability and environment friendliness which are also essential for sustainable business operation.

- 4) Mines for gold, diamond and tanzanite are operating at independent locations on highland.

LNG could be used as fuel for off-road vehicles and electricity generators in place of diesel gas oil. Those mines not connected to the grid need electricity for crushing and milling the ore.

### B.1.3 Action Plan

Satellite images do not tell feature of energy use at potential large users and their intentions. It is necessary to obtain more precise information by interview. In addition, this survey does not cover new regional development plans. Present status of industrial estates and future plans should be identified with stakeholders such as Ministry of Industry and Trade (MIT), Export Processing Zones Authority (EPZA), Small Industry Development Organisation (SIDO) and local municipalities. Potential investors should also be interviewed to create a credible sales plan for formulation of the DNGPP project. Thus, the next action plan will be;

- 1) Meet MIT and municipalities and obtain precise information on industrial estates and their views on collective gas supply system for the industry park members; in particular for Morogoro, Dodoma, Tanga, Arusha and Moshi as a first batch.
- 2) Meet representative industries at industry parks and hear their views and opinions.
- 3) List potential large energy users at independent location and visit them for precise information.
- 4) Compile the outcome as the potential demand outlook and the gas sale plan.



## B2 Central Corridor

Along the Route A7 of the Central Corridor coming out of Dar es Salaam, several factories, hospitals and institutions are found up to Kibaha as DSM is expanding to the west. This area would be outside of the DSM city gas plan in its early stage. Then, any plan for development of industrial park, institutions, health care centre, etc. with fuel consumption of above 20 tons per month could be a target for independent gas supply by LNG bulk delivery. A list of the observed large factories/facilities along this corridor is summarised in Table B.2-1.

After Kibaha and Visiga, Morogoro and Dodoma are the large cities having industrial buildup, while no remarkable factory or facility is found in other areas. As Route A7 and B127 are the busiest corridor linking Dar es Salaam port with interior regions, the Central Corridor will be the most promising route for development of LNG/CNG supply network for vehicles.



Figure B.2-1 Central Corridor

### B.2.1 Morogoro

Morogoro is located 190 km, by road, west of Dar es Salaam and at a middle point to Dodoma. Morogoro is the sixth largest city in Tanzania with active industries and education/training facilities. LNG can be transported by truck-container as well as by rail. Thus, Morogoro will be an important inaugurate member for the DNGPP project.

Old town and administration centre have developed around the TRC Morogoro station. There are three big factories, Tanzania Tobacco Processing Limited (TTPL), Morogoro, 21st Century Textile and Alliance One Tobacco. TTPL is the largest fuel consumer located close to the city centre and be considered as a core user for the city gas plan. Alliance One is located at a distant location. Intensions of these large energy users should be confirmed as soon as possible.

Table B.2-1 Large Energy Users along the Central Corridor: Pwani and Morogoro

Region	Location	Name	Notes	Monthly Fuel Consumption by REDS 2018 (excluding use for transport)								Electricity		
				GSL	DGO	HFO	LPG	Coal	Chacoal	FW/Res		MWH	kW	
				kL	kL	kL	t	t	t	t	t			
			Users in green column were visited at the 2018 Regional Energy Demand Survey, while in blue were visited by Study Team.	Fuel for transport is excluded.								Daily operation: 15 hours ↓		
<b>Pwani</b>														
			<b>Independent Targets</b>											
			Visiga: Bulk service	Hong Yu Steel										
			Msata: Bulk service	Gulf Concrete and Cement Products										
			Kwenbe: Bulk Service?	MUHAS Mloganzila Campus and Hospital										
			<b>Others</b>											
			Kibaha: City Gas Area	Tumbi Special Hospital										
			<b>Bagamoyo</b>											
			Bagamoyo: City Gas area	St. Elithabeth Health Centre	•Hotels, schools and hospitals will provide the core demand for city gas system.									
			do	Stella Hostel/New Bagamoyo Beach Resort	•Should take note of industry park and real estate development plans									
<b>Morogoro</b>														
			<b>Priority Targets for District Gas System</b>											
			Industrial Area -A	21 Century Textiles Limited				1.6	900	0.3		16	35	
			do	TPM(1998) LTD				0.5				484	1,075	
			do	Mazava Fablic & Production E.A.L.				2.8				124	275	
			do	Intermech Engineering				0.0				0	1	
			do	MW Rice Millers										
			Industrial Area -B	Tanzania Tobacco Processors Limited				17.5	206.0			814	1,808	
			do	Agriculture Seeds Agency				7.1				1	2	
			do	Inernational Tanfeeds Ltd										
			Independent Area	Alliance One Tobacco Tanzania				11.5	78.9	38.0		688	1,529	
			do	Mambo Coffee Company										
			do	SGR Workshop										
			do	Star City Industrial Park (plan)										
			<b>Others</b>											
			City Gas Area	Sokoine University of Agriculture								260	579	
			City Gas Area	Muslim University of Morogoro								16	35	
			City Gas Area	Morogoro Regional Referral Hopspital				0.3		0.7		26	58	
			City Gas Area	Morogoro Hotel										
			City Gas Area	Mazimbu Hospital/SUA Campus										

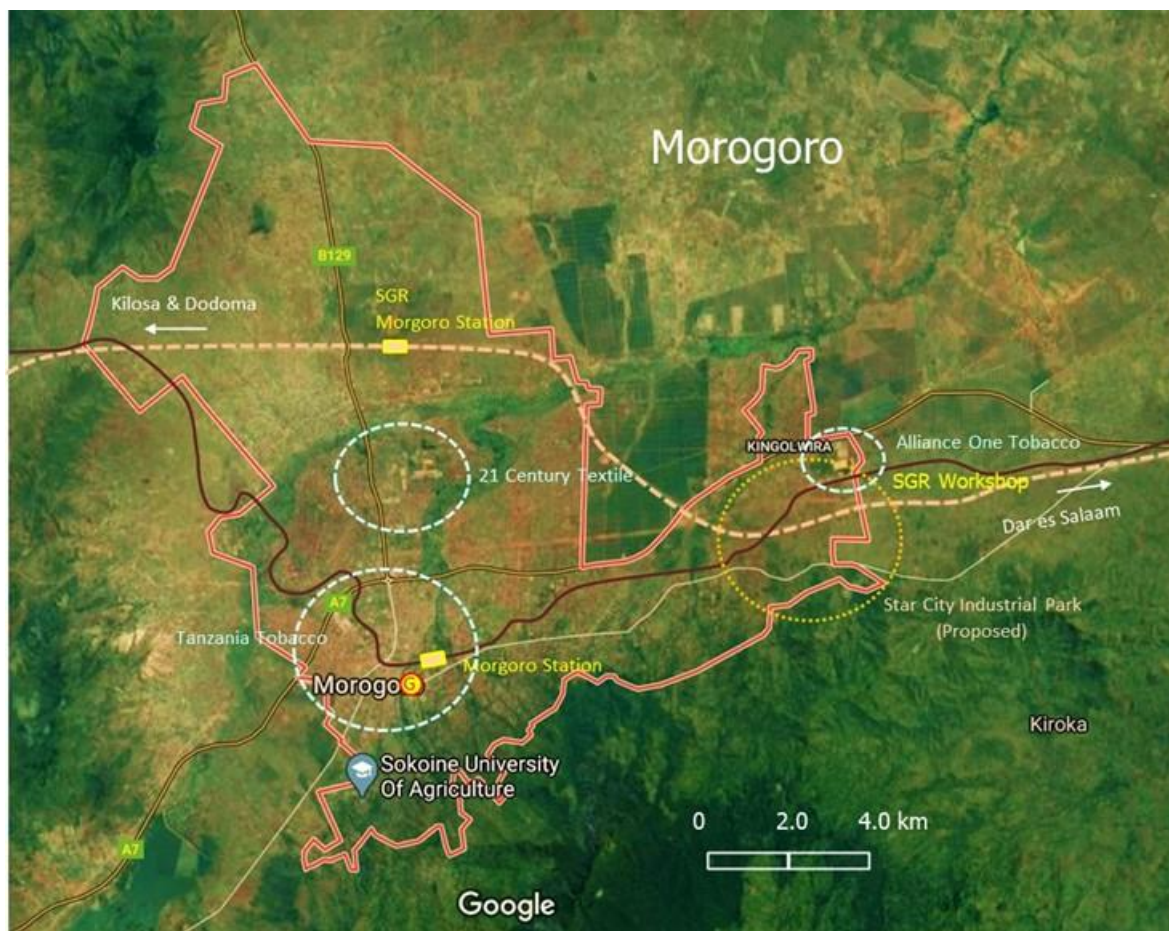


Figure B.2-2 Overview of Morogoro

In addition to them, there are many government and business offices, schools, hotels and hospitals in the central area. Though individual energy consumption would not be large, they will collectively provide certain base demand. With careful review of their energy use profile, the city gas development plan should be established through close collaboration with the Municipality. Designing the city gas network, proper plans should be identified relating to two important issues:

- New Morogoro station of SGR is coming up in the north of the Ngerengere river. Though this area is presently empty, it will become a new business/commercial centre.
- The Star City industrial park was proposed in 2016 in Tungi estate 4 km east of Morogoro town near Alliance One Tobacco. Morogoro dry port is also scheduled near the SGR workshop. As the city centre is congested, this area may be considered for the future industrial development.

The site plan for the city gas satellite terminal must be delineated carefully together with the future city development plan considering the congestion in the city centre, location of core industrial users and the Ngerengere river crossing the city.

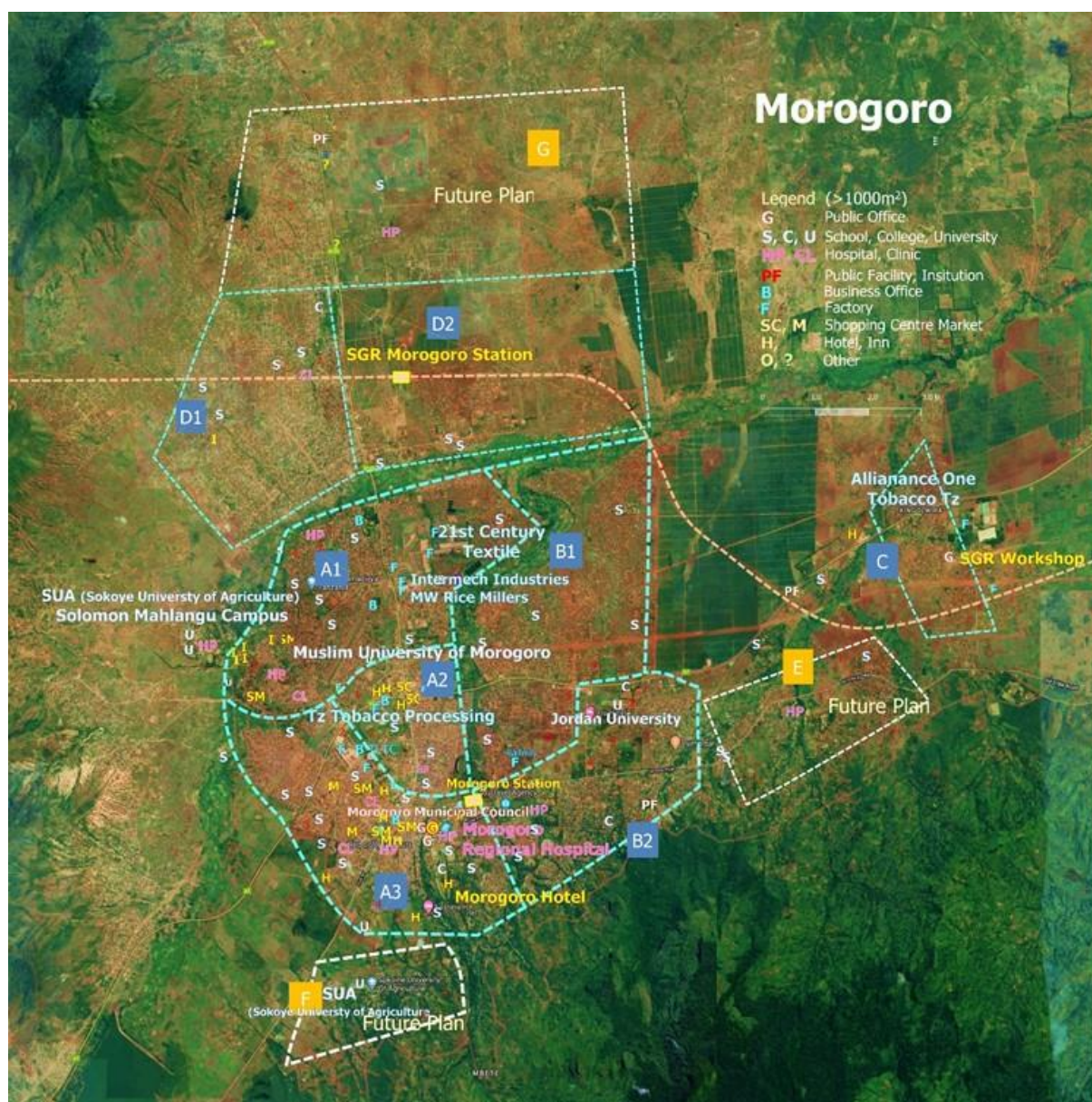


Figure B.2-3 Distribution of Energy Users in Morogoro

### B.2.2 Dodoma

In Dodoma, Kizota industrial estate is developed by SIDO in the west of the city and north of the Zuzu industrial area. If the satellite-B is built in Zuzu around the existing power station, most of the factories around there can be served from there. Seasonal change of operation is reported at the vegetable oil plant (Sunshine Industry) 4km from the Zuzu power station, which is presently using coal. Its energy consumption is relatively large.

Cold heat of LNG may be utilised at livestock processing plant and storage. Ice cube may be utilised at its delivery channel as well as sold for hotels and restaurants and at shops.

Table B.2-2 Large Energy Users along the Central Corridor: Dodoma

Region	Location	Name	Notes	Monthly Fuel Consumption by REDS 2018 (excluding use for transport)									
				GSL	DGO	HFO	LPG	Coal	Chacoal	FW/Res	Electricity		
				kL	kL	kL	t	t	t	t	MWH	kW	
			Users in green column were visited at the 2018 Regional Energy Demand Survey, while in blue were visited by Study Team.	Fuel for transport is excluded.				Daily operation:		15	hours ↓		
<b>Dodoma</b>													
			<b>Priority Targets for District Gas System</b>										
	Kizota Industrial Area	Pepsi Industry	Soft drinks										
	do	Nduvini Autoworks	Garage										
	do	Dodoma Matress	Matress		0.0		0.2				21	47	
	do	Tanzania Meat Company	Abattoir				4.0				81	181	
	do	ALAF Limited	Matress, roof products,								17	37	
	do	NYEMO Investment Company	Ginnery/cooking oil				0.0				3	7	
	do	Nyanza Roadworks Ltd											
	do	H Square Dodoma	?										
	do	Chamwino Super Sembe Company Ltd	Maize flour milling										
	do	Pyxus Ariculture Tanzania	Vegitable Oil										
	do	Robert Paul Winery	Winery. Depot or warehouse?										
			<b>Independent Targets</b>										
	Independent Location	Sunshine Industrial Co. Ltd	Vegitable oil: using coal for process 100 t/day	Pipe from Zuzu for 4km or bulk service.									
	Bulk Service	University of Dodoma	Using LPG by bulk but not reported		0.5						91	203	
			<b>Others</b>										
	City Gas Area	Dodoma Regional Referral Hospital	Diesel for stand-by generator		4.5						31	69	
	City Gas Area	St. John' s Univeristy of Tanzania											
	City Gas Area	New Dodoma Hotel					0.2				23	52	
	City Gas Area	Nashera Hotel			0.3		3.3				18	41	
	City Gas Area	Morena Hotel					1.5				23	52	
	City Gas Area	VETA (Vocational Education & Training Authority)											
	City Gas Area	City Secondary School			0.0				0.3		39	86	
	City Gas Area	DCT Mvumi Secondary School					0.0			12	60	133	
	City Gas Area	Martin Luther School Dodoma					0.2		2.5		83	185	
	City Gas Area	Alfa Super Market Dodoma			0.0						12	26	
	Hombolo: isolated location	Alko Vintage Winery: 40 km from Dodoma	No fuel needed as the process produces heat.		0.5						20	44	

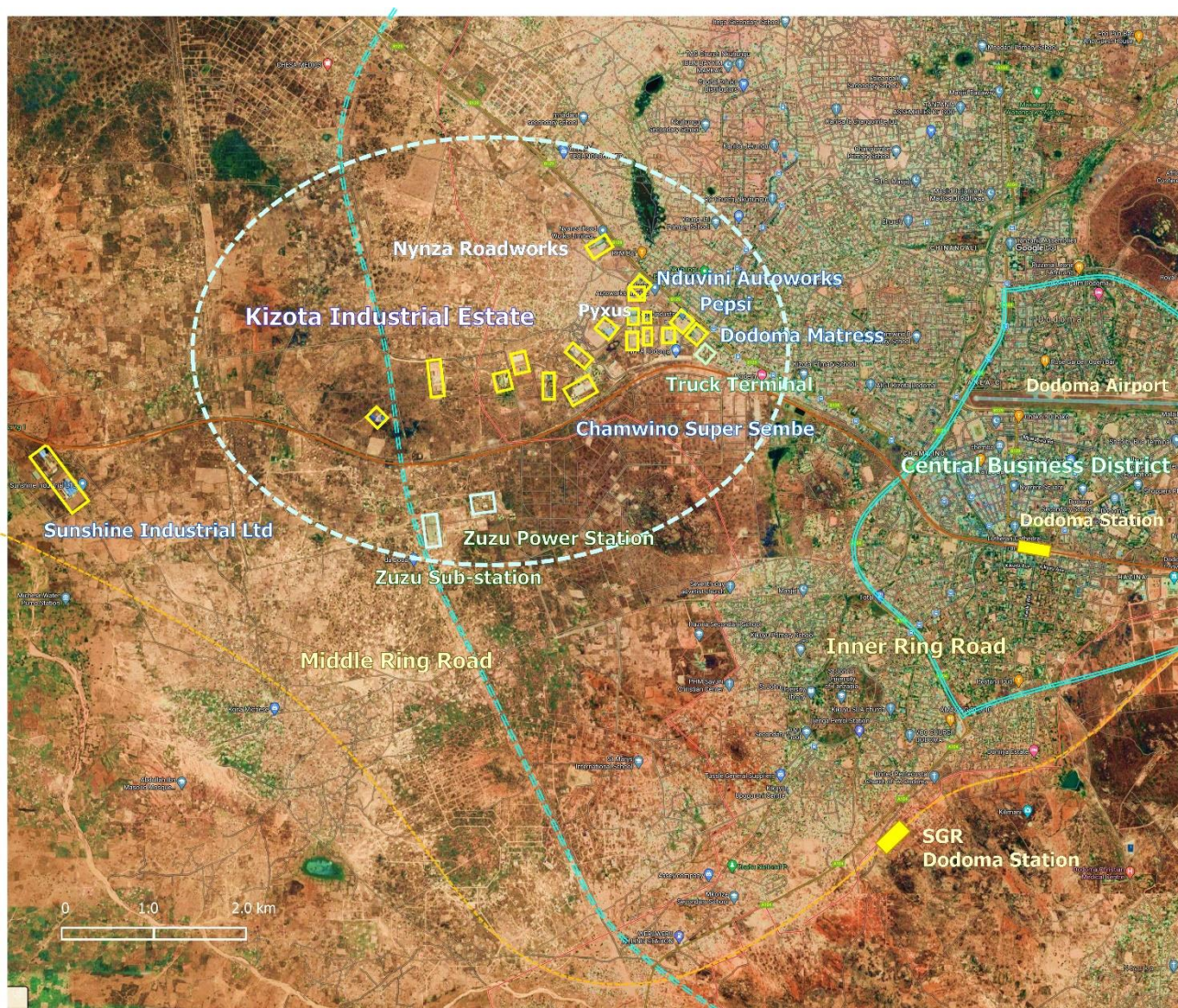


Figure B.2-4 Industrial Area in Dodoma

### B.3 Tanga

Industrial areas are located in the east and west of the Tanga airport. Gofu Chini industrial area is close to the city centre. An integrated system should be applied for gas supply covering industrial park members; it should be shared with the city gas system. At such system, cold heat of LNG may be utilised at a seafood processing plant and ice cube production for fishery and seafood businesses.

Large energy users such as Tanga Cement, Kilimanjaro Cement, Simba Line Factory and Amboni Limestone Company are located within 2-5km from this area. They presently use coal and petcoke; price competition would be harsh for LNG based gas supply.

In future when gas demand grows significantly, LNG may be transported by ship from Lindi, which will also be transferred to interior markets.

Table B.3-1 Large Energy Users along the Northern Coastal Corridor: Tanga

Region	Location	Name	Notes	Monthly Fuel Consumption by REDS 2018 (excluding use for transport)								
				GSL	DGO	HFO	LPG	Coal	Chacoal	FW/Res	Electricity	
			Users in green column were visited at the 2018 Regional Energy Demand Survey, while in blue were visited by Study Team.	kL	kL	kL	t	t	t	t	MWh	kW
				Fuel for transport is excluded.				Daily operation:		15 hours ↓		
<b>Tanga</b>												
	Priority Targets for District Gas System											
	Gofu Chini Industrial Area	Asher Industries	Cosmetics									
	do	Euro truck Parts	Automotive									
	do	Tan Sillica	Sillica sand products									
	do	Anjari Soda	Soft drinks (soda drinks), diesel for process		0.0						186	413
	do	Mamujee Products	Cosmetics: bulk LPG 5 t/M, diesel for SBG 800 L/M		0.8		5.0		2.0		135	300
	do	Afritex	Textile									
	do	Tanzania Autocraft Industrial	Automotive									
	do	Alphakrust Ltd	Sea products (prown) processing; diesel for process		2.0	Cold storage may be needed					5	11
	do	VETA Tanga		0.0		0.1		0	0.2	14	32	72
	do	Tanga Pharmaical & Plastics	Cosmetics and chemical products									
	Kange Heavy Industrial Area	Tanga Fresh	Milk products, using LPG 25 t/M		2.1		23.7				87	193
	do	Pembe Flour Mills	Flour				0.0				85	190
	do	Tanga University										
	Independent Targets											
	Bulk Service or city gas	Tanga Cement	These plants are located within 5km from the city centre.					13,183			9,203	20,451
	do	Kilimanjaro Cement	Fuel price matters for these users as they would provide a substantial anchor demand.					1,224			926	2,058
	do	Rhino Cement/Maweni Limestone Company	Subsidiary of ARM; bought by Huaxin Cement (Chinese).									
	do	ARM Limestone Cmpnay (Rhino Cement)	Two plants are located back to back									
	do	Shimba Lime Factory	Using imported petro-coke, diesel for SBG		4.0					250		
	do	Neelkanth Limited Amboni Limestone Compnay	Using imported petro-coke				7.6			603	5,687	12,638
	Ngomeni: Bulk Service	KATANI Limited	Sisal carpets. 20 km west of Tanga.									
	Others											
	City Gas Area	Bombo Regional Hospital							0.2		40	88
	City Gas Area	Makonge Hotel Tanga										
	City Gas Area	Tanga Beach Resort			0.5		0.9		0.1		29	64

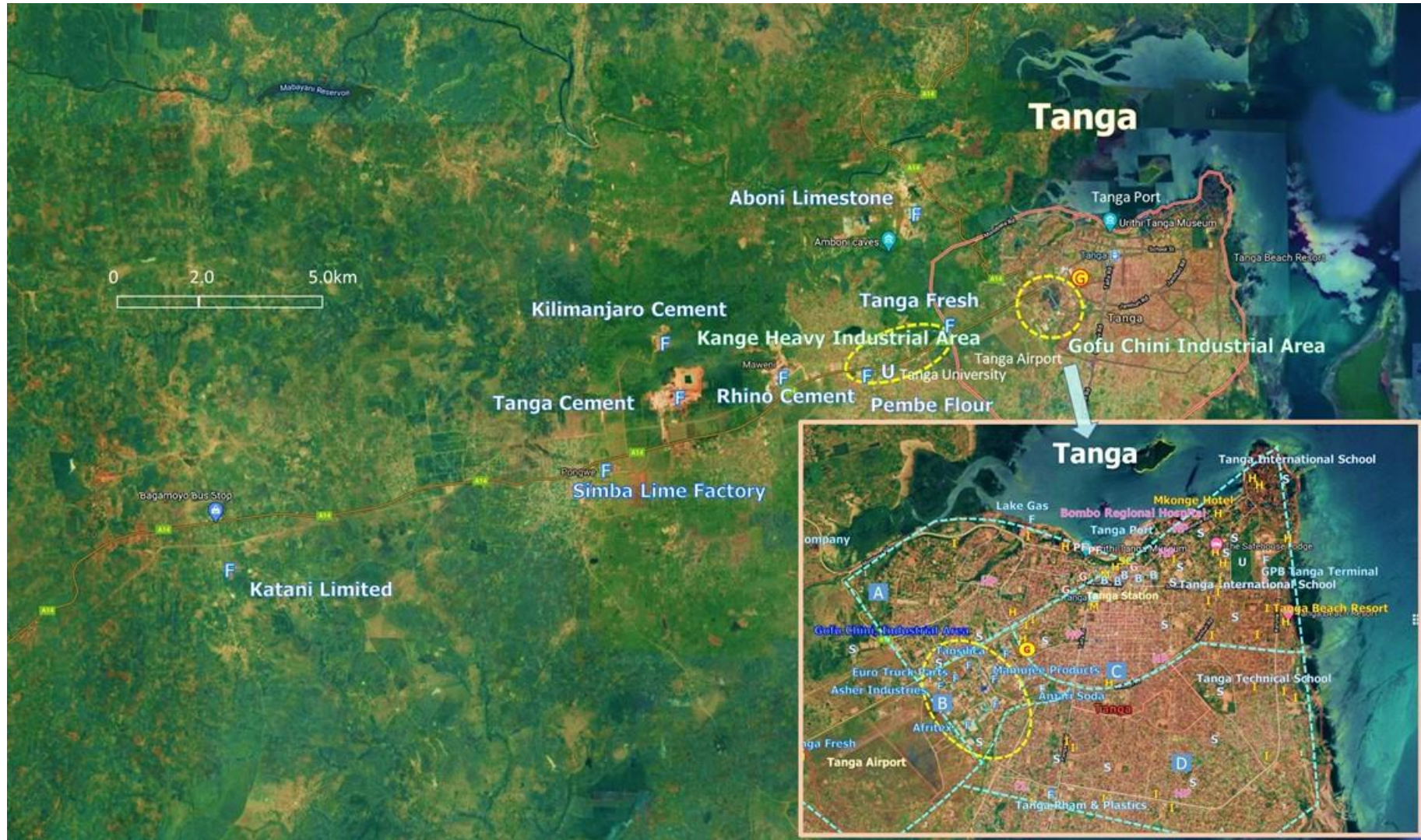


Figure B.3-1 Tanga



## B.4 North East Corridor

No remarkable industry is found along Route B1 between Segera and Himo. Moshi and Arusha are the main target along the North East Corridor.

Table B.4-1 Large Energy Users along the North East Corridor: Moshi

Region	Location	Name	Notes	Monthly Fuel Consumption by REDS 2018 (excluding use for transport)									
				GSL	DGO	HFO	LPG	Coal	Chacoal	FW/Res	Electricity		
				kL	kL	kL	t	t	t	t	MWH	kW	
			Users in green column were visited at the 2018 Regional Energy Demand Survey, while in blue were visited by Study Team.	Fuel for transport is excluded.				Daily operation:		15	hours ↓		
<b>North East Corridor</b>			No remarkable energy users are found along the corridor such as Koroge, Hendani, Mombo, Same, Mwanga, Himo and Hai.										
	Mwanga	Kilimanjaro Biochem Ltd	Bio-ethanol plant using sugar cane; bagasse for feul.										
<b>Moshi</b>													
			Priority Targets for District Gas System										
	Kolongoni Industrial Estate	Serengetti Brewaries	Beer										
	do	Tanzania Brewaries Limited Moshi Depot	Beer										
	do	China Papers											
	do	Merenga Millors Co.	Animal feeds										
	do	Tanzania Coffee Curing Compnay									28	63	
	do	Moshi Lether Ltd	Viwanda area		11.0		0.1			10	37	83	
	do	East-West Seed											
	do	AFGRI	Agri Storage										
	do	Bonite Bottlers Limited	Kilimanjaro Drinkig Water, Coca Cola, etc.			43.8	6.5				793	1,762	
			Independent Targets										
	Bulk service	Harsho Group	Animal feeds, Agri-bags, etc.										
	No demand	TPC Limited	2nd Largest sugar plant in Africa: fuel self-supplied										
	Bulk service	Kilimanjaro Air port	Air-conditioning and electricity										
	Bulk service	Tanzanite Mine	Off-road vehicles and generators for machines										
			Others										
	City Gas Area	Mawenzi Regional Hospital			3.0	0.0				1	80	178	
	City Gas Area	Kilimanjaro Christian Medical Hospital			4.0				0.1		164	365	
	City Gas Area	St. Joseph Hospital											
	City Gas Area	Coperative Univeristy of Moshi			0.4						43	95	
	City Gas Area	Kilimanjaro Christian Medical University College											
	City Gas Area	UWC East Afrca	(University of West Africa, Cape Town)										
	City Gas Area	Tanzania Police School					1.5			0	300	667	
	City Gas Area	Kilimanjaro Wonders Hotel			0.4		0.2		0.5		16	35	
	City Gas Area	Panama Garden Resort											

## B.4.1 Moshi

Factories are located south of the old Moshi airport. The area is close to the city centre. An integrated LNG satellite terminal should be considered to serve for these factories combined as well as the city gas system. Starting from this area, the city gas network will be expanded to outer areas. At independent locations, there are some factories, the Kilimanjaro airport and tanzanite mine to be considered for LNG bulk delivery.

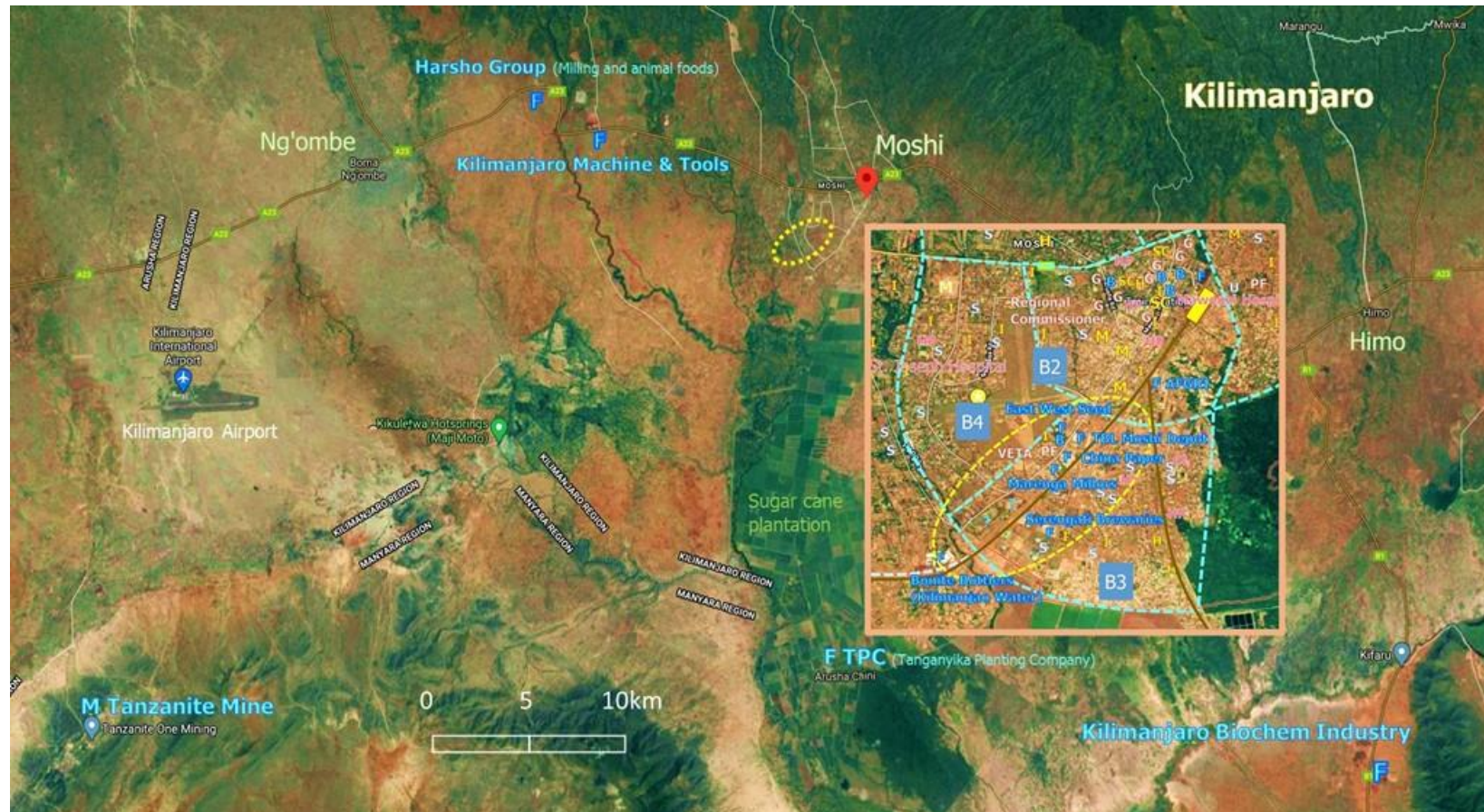


Figure B.4-1 Moshi

## B.4.2 Arusha

In addition to the old industrial area (Unga Limited Industrial Area) near the city centre, larger factories are located east and southeast of the city in 3 to 6 km. These industries may provide certain anchor demand. City gas system may be built with these industries as core users and starting from the city centre in the first phase. The system will be expanded to outer areas stepwise.

Table B.4-2 Large Energy Users along the North East Corridor: Arusha

Region	Location	Name	Notes	Monthly Fuel Consumption by REDS 2018 (excluding use for transport)									
				GSL	DGO	HFO	LPG	Coal	Chacoal	FW/Res	Electricity		
			Users in green column were visited at the 2018 Regional Energy Demand Survey, while in blue were visited by Study Team.	kL	kL	kL	t	t	t	t	t	MWH	kW
<b>Arusha</b>				Fuel for transport is excluded.				Daily operation:		15	hours ↓		
	Priority Targets for District Gas System												
	Unga Limited Industrial Area	Monaban Milling Plant (under NMC)	Maize and wheat milling		0.7		0.1	60				4	9
		Tanform Limited	Matress: no fuel consumption is reported.									3	6
		Jandu Plambers Limited	Engineering & construction										
	Themis Industrial Area-1	Tanzania Brewery Ltd	Beer		9.0	36.3	0.5					253	562
	do	Kilimanjaro Mills Ltd											
	Themis Industrial Area-2	General Tyre	Tyre										
	do	TANELEC Limited	Electric Equipment (transformaer, switch gear, etc.)										
	do	Sunflag Tanzania	Textile, Garments										
	do	Truckline	Road Haulage Services										
	do	TATA Africa	Automotive										
	do	Hanspaul	Automotive										
	do	Spanish Tiles & Sanitary Wares	Ceramic										
	do	Mount Meru Millers	Seed Crushing and animal feeds										
	do	Darsh Industries	Tomato Products										
	do	Monsant	Agri-chem & seeds										
	Independent Targets												
	Bulk service or city gas	Monaban Milling Factory (in Moshono)	Maize and wheat milling, 2km east of the above.										
	Bulk service	A to Z Textile/Sumitomo Chemical	Textile, Moskitto-net, garment,etc. burning package waste.					18					
	Others												
	City Gas Area	Mt. Meru Regional Hospital											
	City Gas Area	AICC Hospital											
	City Gas Area	East African Community Office											
	City Gas Area	Arusha International Conference Centre											
	City Gas Area	Tanroads Arusha										822	1,826
	City Gas Area	Mt. Meru Hotel											
	City Gas Area	Gran Meria Arusha											
	City Gas Area	Naura Springs											
	City Gas Area	Sharaton											
	City Gas Area	Kibo Palace Hotel Arusha											
	City Gas Area	Gold Crest Hotel											

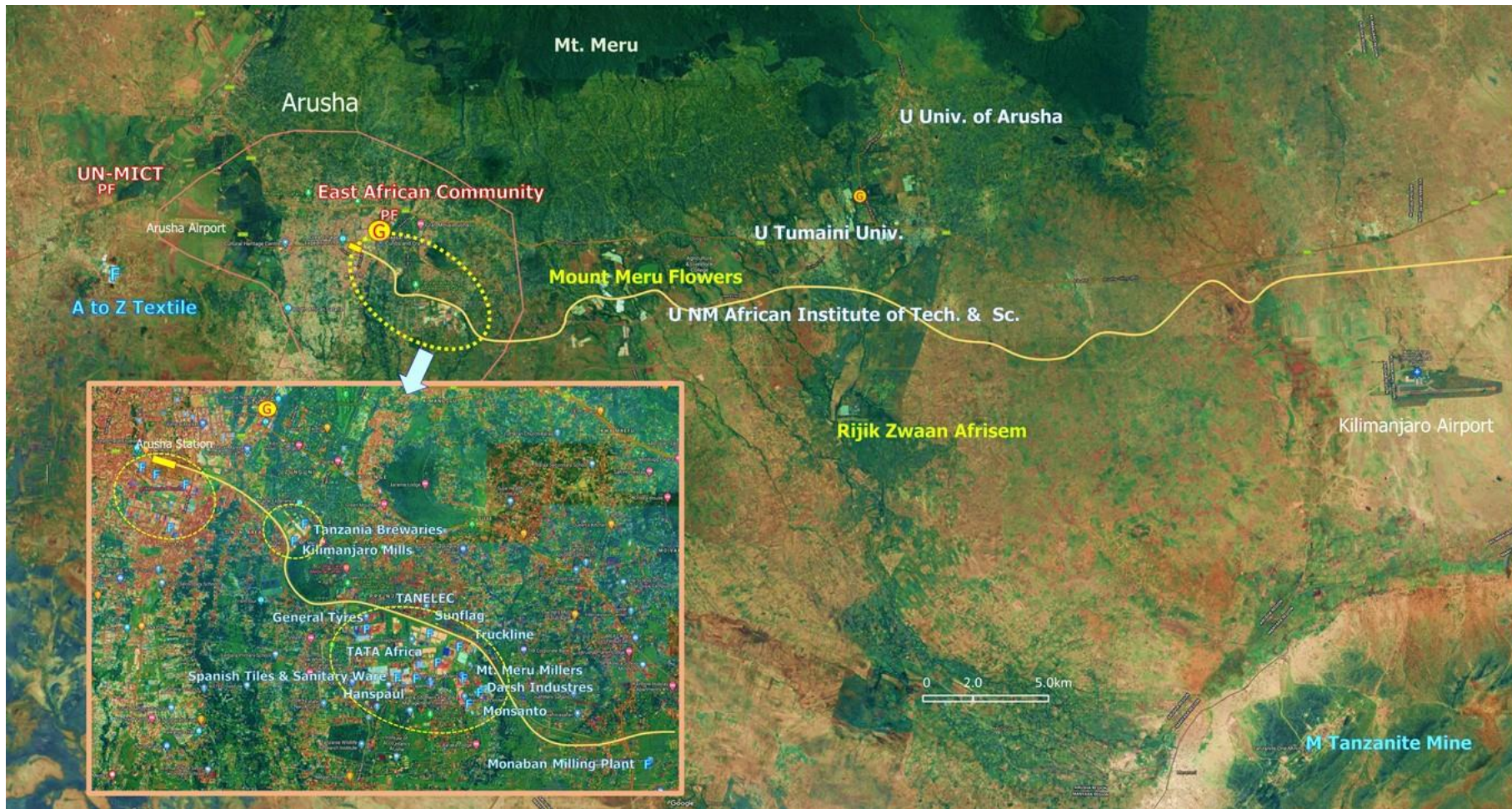


Figure B.4-2 Greater Arusha

## B.5 Great North Corridor

On the highland beyond Singida, there are many gold mines. Buzwagi gold mine at Kahama, Geita gold mine and North Mara Gold mine in Mara region are the most active ones. Some are in the late stage of exploitation while there are new exploration activities as well as activities to rive dormant mines. Large operators may switch their fuel for off-road vehicles and machines from diesel to LNG if stable supply is assured.

Except for Mwanza, industrial activities are relatively limited to processing of agriproducts such as flour mills, vegetable oil, tobacco leaves, and textile industry. No sizable factories are found in Bukoba and Kigoma.

Mwanza is the second largest city and have many active industries. As the old city centre is congested, new industrial estates are developing in the suburbs area.

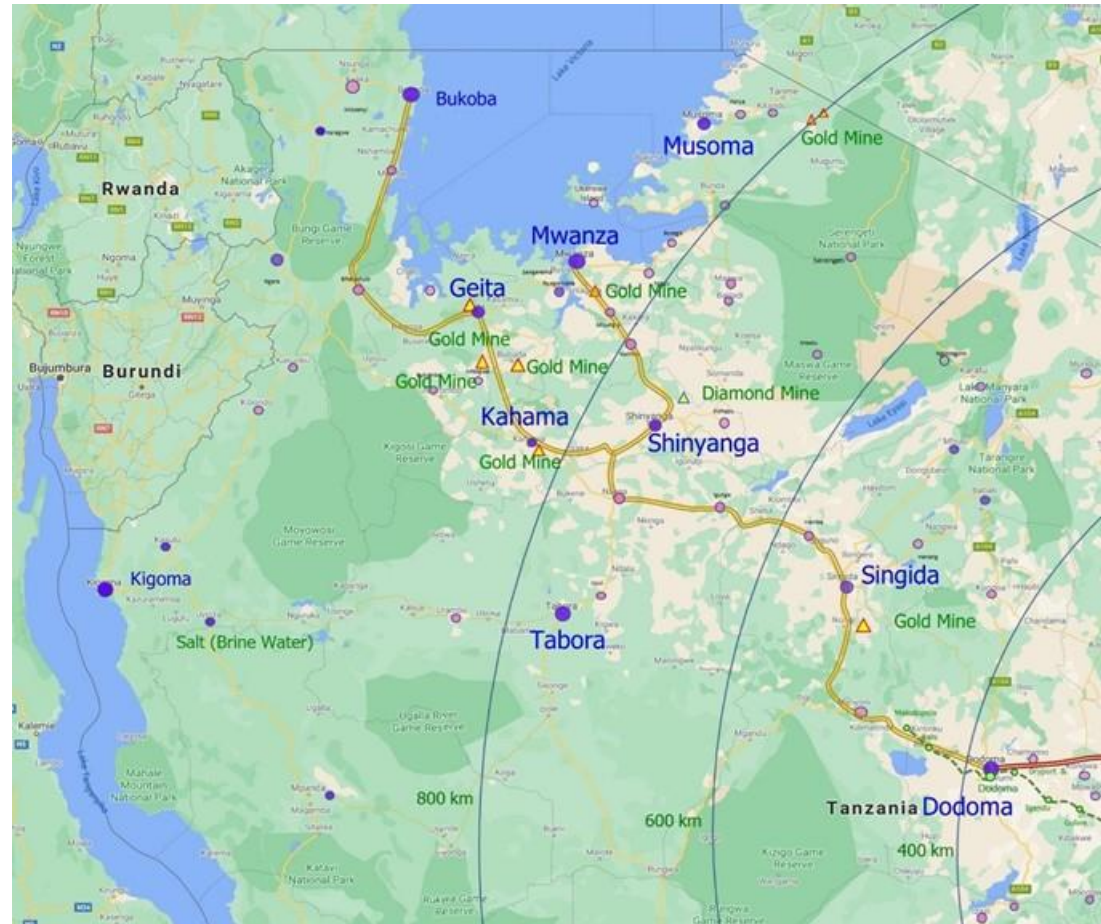


Figure B.5-1 Great North Corridor

## B.5.1 Singida, Shinyanga, Geita Regions

In addition to gold mines, some other industries are found in Singida, Shinyanga and Kahama. In Shinyanga the Ibadakuli industrial area is being developed 4 km east of the city. In Kahama factories are located in the opposite side of the Buzwaki gold mine about 10 km apart across the city.

Table B.5-1 Large Users along Great North Corridor: Singida, Shinyanga and Geita

Region	Location	Name	Notes	Monthly Fuel Consumption by REDS 2018 (excluding use for transport)									
				GSL	DGO	HFO	LPG	Coal	Chacoal	FW/Res	Electricity		
				kL	kL	kL	t	t	t	t	MWH	kW	
			Users in green column were visited at the 2018 Regional Energy Demand Survey, while in blue were visited by Study Team.	Fuel for transport is excluded.				Daily operation:		15	hours ↓		
<b>Singida</b>													
	Singida	Mount Meru Milling											
	Ikungi: bulk service	Shanta Gold: Shingida Gold Mine Project	80 km south of Singida										
<b>Shinyanga</b>													
	Shinyanga												
Priority Targets for District Gas System													
	Ibadakuli Industrial Area	Mount Meru Millers	Sun Flower Oil										
	do	GAKI Investments	Cotton seed oil; 10 KL per year.										
	do	Jambo Food Products Limited	Soft Drinks										
	do	Musoma Foods Company	Processing rice										
	do	2 factories coming up											
	City Centre	Shinyanga Regional Hospital											
	Kolandoto: bulk service	Williamson Diamond Mine	LNG as fuel for mining machines and trucks										
<b>Kahama</b>													
	Bulk service	Buzwagi Gold Mine	LNG as fuel for mining machines and trucks										
Targets for District Gas system: aggregate demand not so large?													
	Nyahanga Industrial Area	Kahama Cotton	Cotton processing	Located west of the town, opposite side of the gold mine									
	do	Nida Textile Mill (T) Ltd	Textile										
	do	Namigogo Elution and Geo-chemical	Chemical Products										
	Bulk service	KOM (Kahama Oil Mill) Group of Companies	Plastic Products	Located in city centre away from IA.									
	Bulyanhulu: bulk Service	Bulyanhulu Gold Mine		60 km north of Kahama									
<b>Geita</b>													
	Geita: bulk service	Geita Gold Mine	LNG as fuel for mining machines and trucks										
	Geita: bulk service	Buckreef-Busolwa Gold Mine project	Multiple locations around 20 km from Geita to revive dormant mines; production started in 2020.										

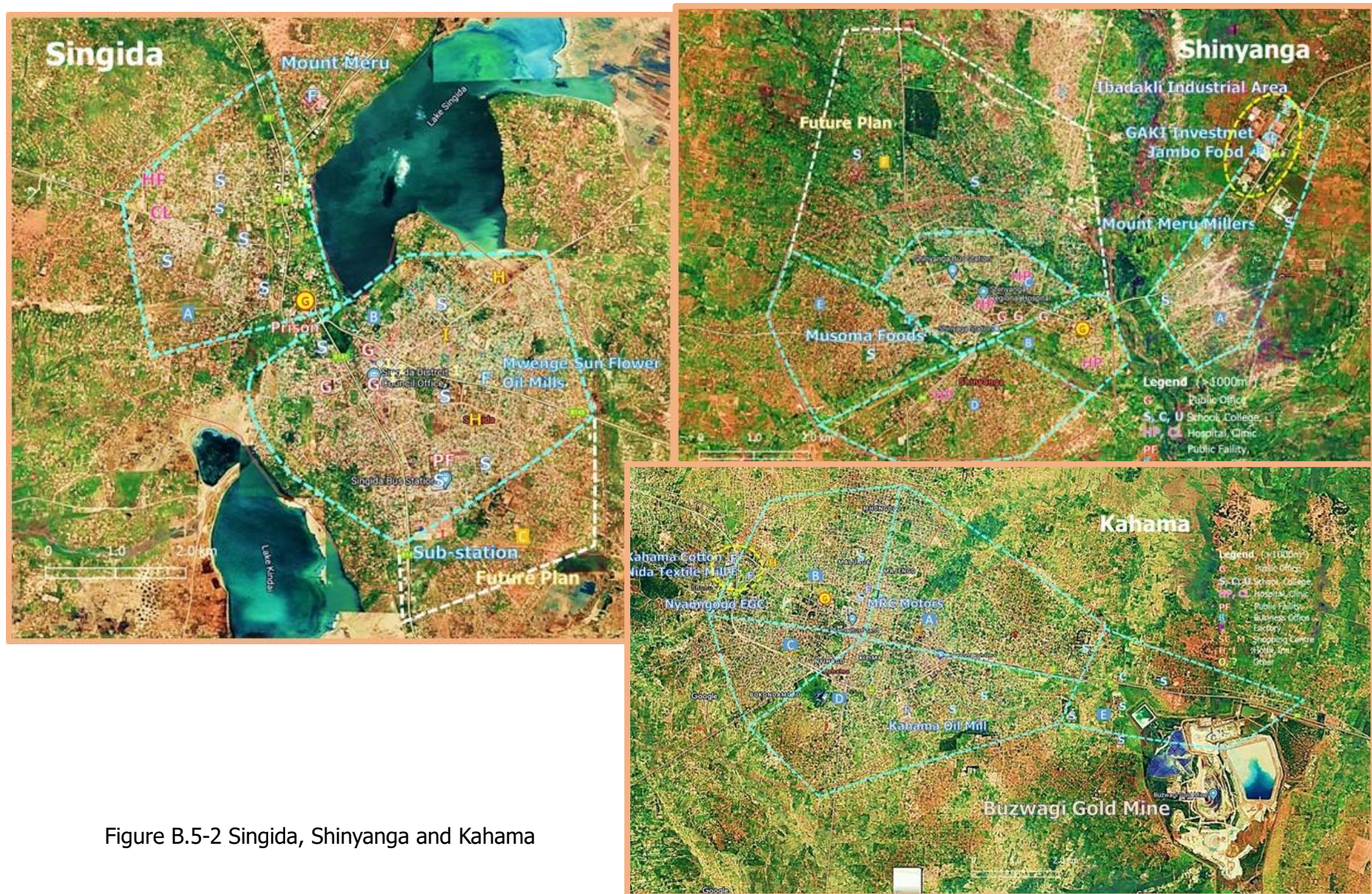


Figure B.5-2 Singida, Shinyanga and Kahama

## B.5.2 Mwanza, Musoma and Bukoba

Table B.5-2 Large Users along Great North Corridor: Mwanza

Region	Location	Name	Notes	Monthly Fuel Consumption by REDS 2018 (excluding use for transport)									
				GSL	DGO	HFO	LPG	Coal	Chacoal	FW/Res	Electricity		
				kL	kL	kL	t	t	t	t	MWh	kW	
			Users in green column were visited at the 2018 Regional Energy Demand Survey, while in blue were visited by Study Team.	Fuel for transport is excluded.				Daily operation:		15	hours ↓		
<b>Mwanza</b>													
		<b>Priority Targets for District Gas System</b>											
	Nyakato Industrial Area	Mwanza Textile	2nd largest textile factory in east Africa								480	150	333
	do	Sayona Drinks	Soft Drinks, Juice, etc.		7.5	120.0						54	120
	do	Pepsi Industrial											
	do	SIDO (Small Industries Development Organization)											
	do	Nile Perch Fisheries	Fish processing		5.0	15.0						400	889
	do	Ndiyo Bottling Compnay										205	456
	do	Veta Mwanza							0.1	1	6	13	
	do	Mwanza City Abattoir	Meat Processing										
	do	Blue Coast Investment	Truck freight service										
	do	Super Banko (T)	?										
	do	Vitafoam T Limited	Matress for bed and sofa										
	do	Serengetti Brewaries Limited	Beer		109.8	1,043.7						3,746	8,325
	do	African Ginning	Cotton ginner										
	do	Nyanza Bottling Company	Cocal Cola and Soft Drinks		209.5		0.0			148	489	1,086	
	do	Nyakato Steel Mills	Iron bars		0.6		1.3			0	1,290	2,866	
	Igogo Industrial Area	Falcon Packaging Limited											
	(South Port)	Voil Industry	Vegitable oil company										
	do	Victoria Mulders	Plastic items (pipe, chair, etc.) and bags										
	do	Alminium Africa (ALAF Limited Mwanza)											
		<b>Independent Targets</b>											
	Pasiansi : bulk service?	Tanzania Brewries Limited (Near airport)	Beer: near airport										
	do	Mwauwasa	Sewage Plant		0.2							28	63
	do	Mwanza Airport	Airport		2.4	0.0						33	74
	Location unknown	Unoplast (T) Mwanza	Domestic foam matress		36.5							1,096	2,436
	Usagara: bulk service	Sayona Steel	20 km southeast										
	Usagara: bulk service	Mining site?	20 km southeast										
	Others												
	F4	Mwanza Quality Wines LTD	2 km southwest of Nyakato IA							0	1	2	
	City Gas Area	Bugando Medical Centre											
	City Gas Area	Hindu Mendal Hospital Mwanza											
	City Gas Area	CF Hospital											
	City Gas Area	Sekou Toure Hospital			0.2				0.2		20	45	
	City Gas Area	Aga Kahn Medical Centre											
	City Gas Area	Rock City Mall			5.0		1.3				164	365	
	City Gas Area	Malaika Beach Resort							0.3	0	31	69	
	City Gas Area	Gold Crest Htel			0.5		1.1		0.4		42	94	
	City Gas Area	Ryan's Bay Hotel											
	South of the city	St. Augustine University of Tanzania			0.3				0.5	0	48	107	



Mwanza is the second largest city in Tanzania after Dar es Salaam. Its industrial areas are apart in three locations, namely, Nyakato Industrial Area, Igogo Industrial Area at South Port and TBL brewery in Pasiansi in the north near the airport. Land is tight in Mwanza and the satellite terminal plan should be carefully drafted considering demand distribution and supply priority by area.



Figure B.5-3 Greater Mwanza

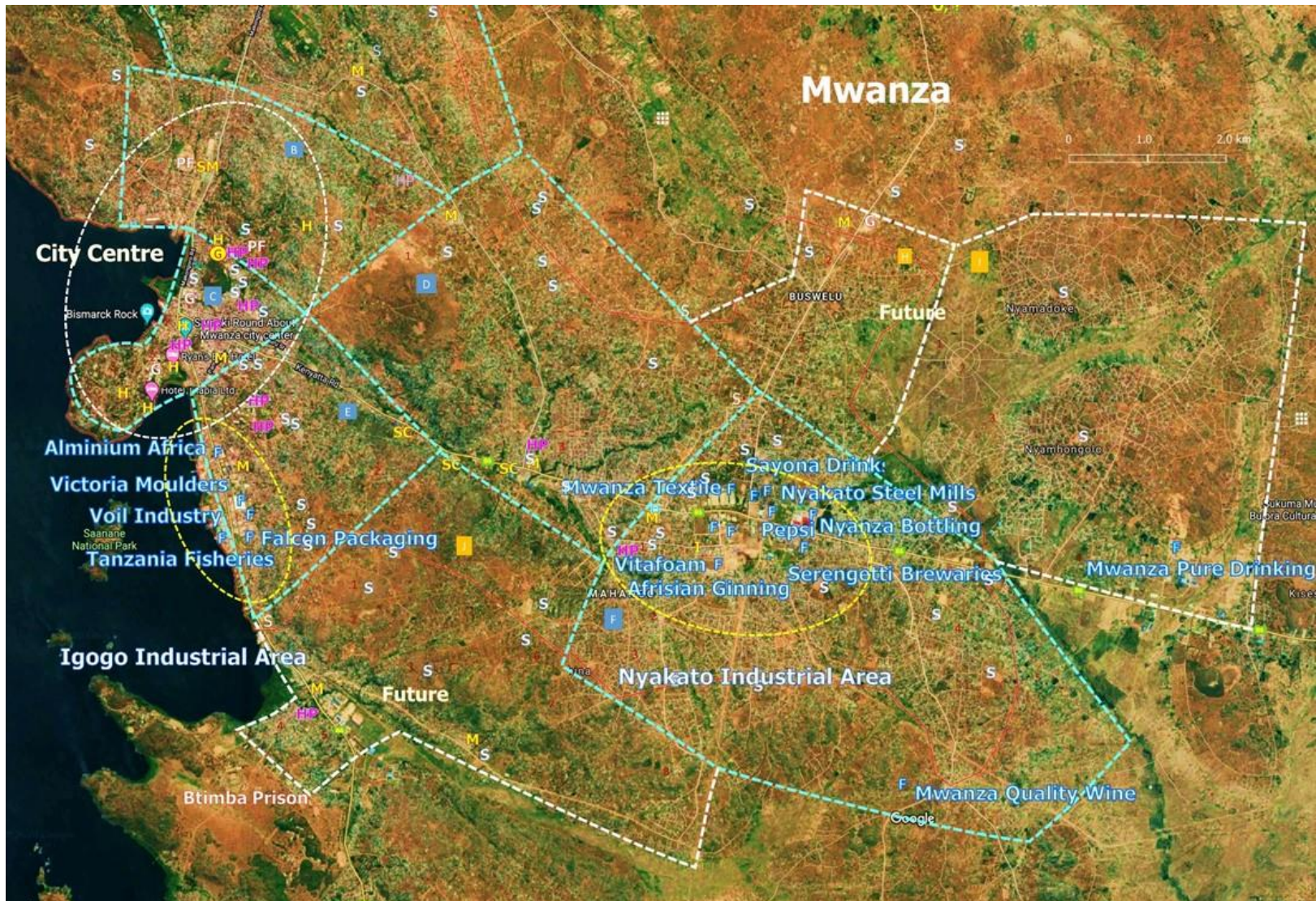


Figure B.5-4 Mwanza

No remarkable energy users are found in Musoma and Bukoba. North Mara Gold Mine located east of Musoma may be considered as an independent LNG user

Table B.5-3 Large Users along the Great North Corridor: Musoma, Bukoba

Region	Location	Name	Notes	Monthly Fuel Consumption by REDS 2018 (excluding use for transport)									
				GSL	DGO	HFO	LPG	Coal	Chacoal	FW/Res	Electricity		
				kL	kL	kL	t	t	t	t	MWH	kW	
			Users in green column were visited at the 2018 Regional Energy Demand Survey, while in blue were visited by Study Team.	Fuel for transport is excluded.			Daily operation:		15 hours ↓				
<b>Mara</b>													
	Musoma												
	Baruti	Musoma Textile											
	do	Mara Oil Milling	Vegitable oil company										
	Near to above	Mara Milk Manufactured Industry											
	Mukendo (city centre)	Le Grand Victoria Hotel											
	do	Afrilux Hotel											
	do	Musoma Hospital											
	Nyamongo: bulk service	North Mara Gold Mine	Two mines 90 km east of Musma										
<b>Kagera</b>													
	Bukoba	No remarkable energy users.											
		Kolping Hotel											
		Bukoba Regional Hospital											
	Usunga	Kagera Sugar Limited	Use bagasse as fuel?										



Figure B.5-5 Musoma and Bukoba

## B.5.3 Tabora and Kigoma

Two tobacco factories are located near the central part of Tabora. No remarkable energy user is found in Kigoma.

Table B.5-4 Large Users along the Great North Corridor: Tabora and Kigoma

Region	Location	Name	Notes	Monthly Fuel Consumption by REDS 2018 (excluding use for transport)									
				GSL	DGO	HFO	LPG	Coal	Chacoal	FW/Res	Electricity		
			Users in green column were visited at the 2018 Regional Energy Demand Survey, while in blue were visited by Study Team.	kL	kL	kL	t	t	t	t	MWH	kW	
				Fuel for transport is excluded.				Daily operation:		15	hours ↓		
<b>Tabora</b>													
		Priority targets for District Gas System											
	Industrial Area	Universal Leaf Tobacco	Warehouse?										
	do	New Tabora Diaries	Milk Processing										
	do	DS Investment	?										
	do	JT International	Tobacco Leaf (Japanese)										
	do	Allaiance One	Office										
	City Gas Area	Kitete Regional Hospital											
	Nzega Ndora:	Golden Pride Gold Mine	Closed										
<b>Kigoma</b>													
	Kigoma	No remarkable energy users to provide core demand.											
	City Centre	Sunset Vista Hotel											
	do	Kigoma Regional Hospital											
	Ubinza: bulk service	Ubnsa Salt	Salt production from brine water										

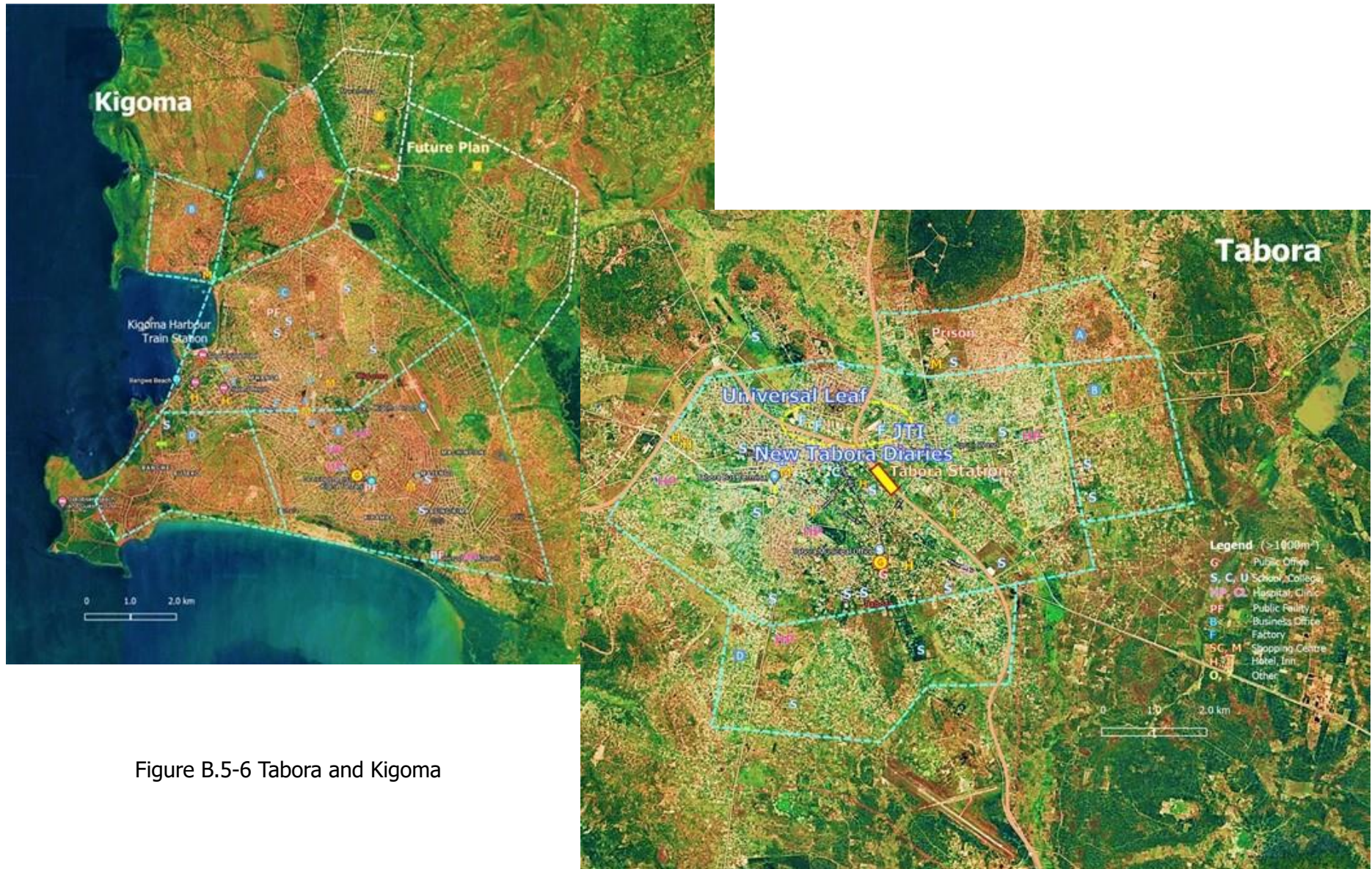


Figure B.5-6 Tabora and Kigoma

## B.6 TANZAM Corridor

### B.6.1 Iringa

Factories are located in the Ipogolo industrial area on the southern side of the city across the Little Ruaha River. City gas system may be constructed starting from here and the city centre.

With rich forestry industry in the area producing wood dust and waste, Sai Energy and Logistics is producing bio-briquettes for fuel use. Natural gas may have to compete with it. Therefore, city gas plan must be discussed carefully with city planners.

In the south of the Iringa region, there are Pyrethrum Company of Tanzania in Mafinga and Mufindi Paper Mill. They may also use bio-wastes and black liquor.



Figure B.6-1 Iringa

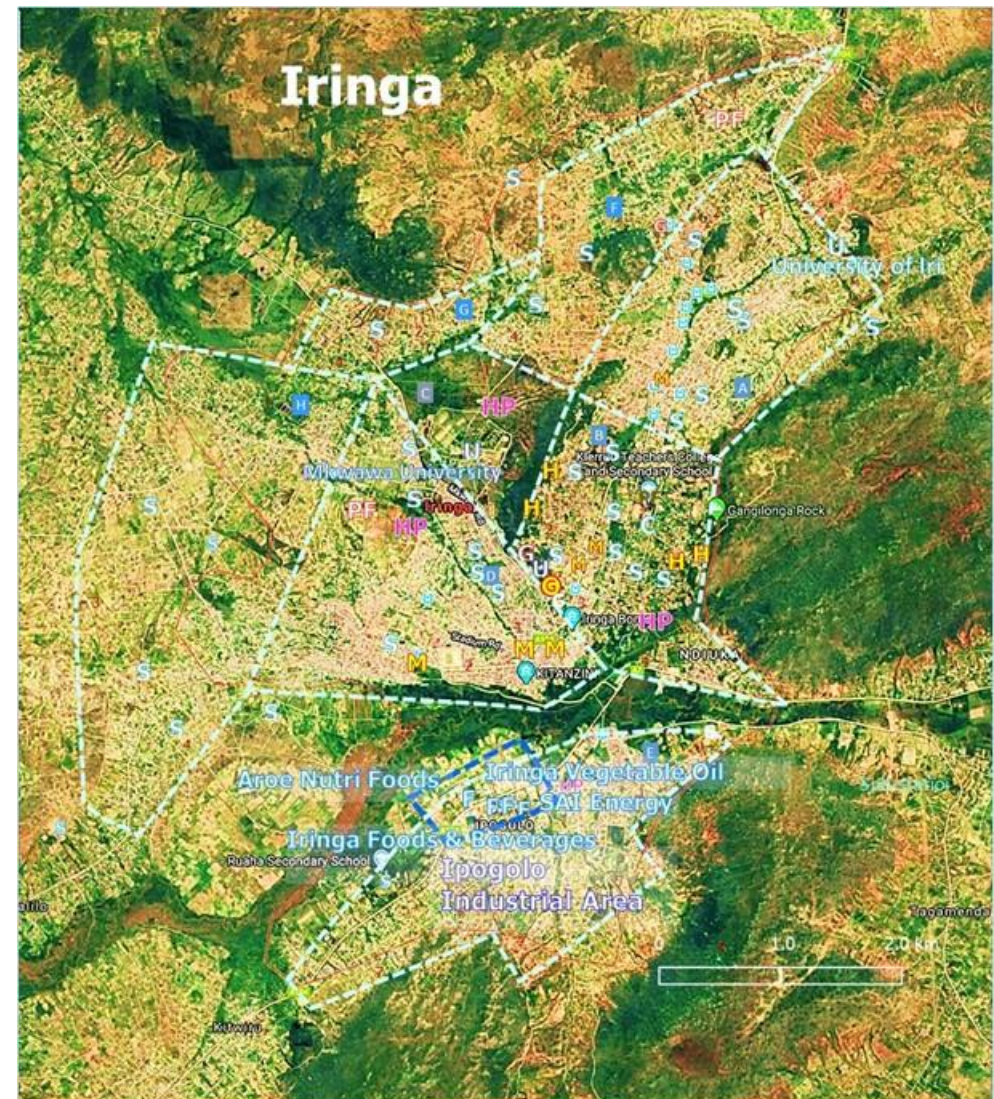


Table B.6-1 Large Users along the TANZAM Corridor: Iringa and Njombe

Region	Location	Name	Notes	Monthly Fuel Consumption by REDS 2018 (excluding use for transport)									
				GSL	DGO	HFO	LPG	Coal	Chacoal	FW/Res	Electricity		
				KL	KL	KL	t	t	t	t	MWH	kW	
			Users in green column were visited at the 2018 Regional Energy Demand Survey, while in blue were visited by Study Team.	Fuel for transport is excluded.						Daily operation:	15	hours ↓	
<b>Iringa</b>													
	Iringa												
Priority Targets for District Gas System													
	Ipogolo Industrial Area	Sai Energy and Logistics Services	Bio-briquette (for fuel use)										
	do	Iringa Vegetable Oils and Related	Vegetable oil										
	do	Iringa Foods & Beverages Ltd	Food processing										
	do	Are Nutri Foods	Food processing										
	do	Falahi Industries Limited	Confectionary										
	do	IVORI Iringa	Food & Beverage										
	do	Ivori Lollipops	Food & Beverage										
Others													
	City Gas Area	Mkawa University											
	City Gas Area	University of Iringa											
Mafinga													
		Pyrethrum Company of Tanzania											
		Sao Hill Industries	Wood dust/ waste										
Mufindi													
		Mufindi Paper Mill	Wsate of pulp production and black liquor may be used as fuel for plants.										
<b>Njombe</b>													
	Makambako	No remarkable energy users.											
	Njombe	No remarkable energy users.											



### B.6.2 Mbeya

Large factories are located in the Iyunga Industrial Area developed south of the Mbeya station about 5 km from the city centre. Mbeya University is in the same area. LNG in containers may be transported there by the TAZARA railway. City gas system will be extended from there toward northeast.

Mbeya Cement and Mbeyatex are located in Songwe Region 10 km west of Mbeya station. They may be using coal locally produced.

In further north, New Luika Gold Mine has started operation in 2012 near the Lake Rukwa. LNG can be used for power generation and off-road vehicles.

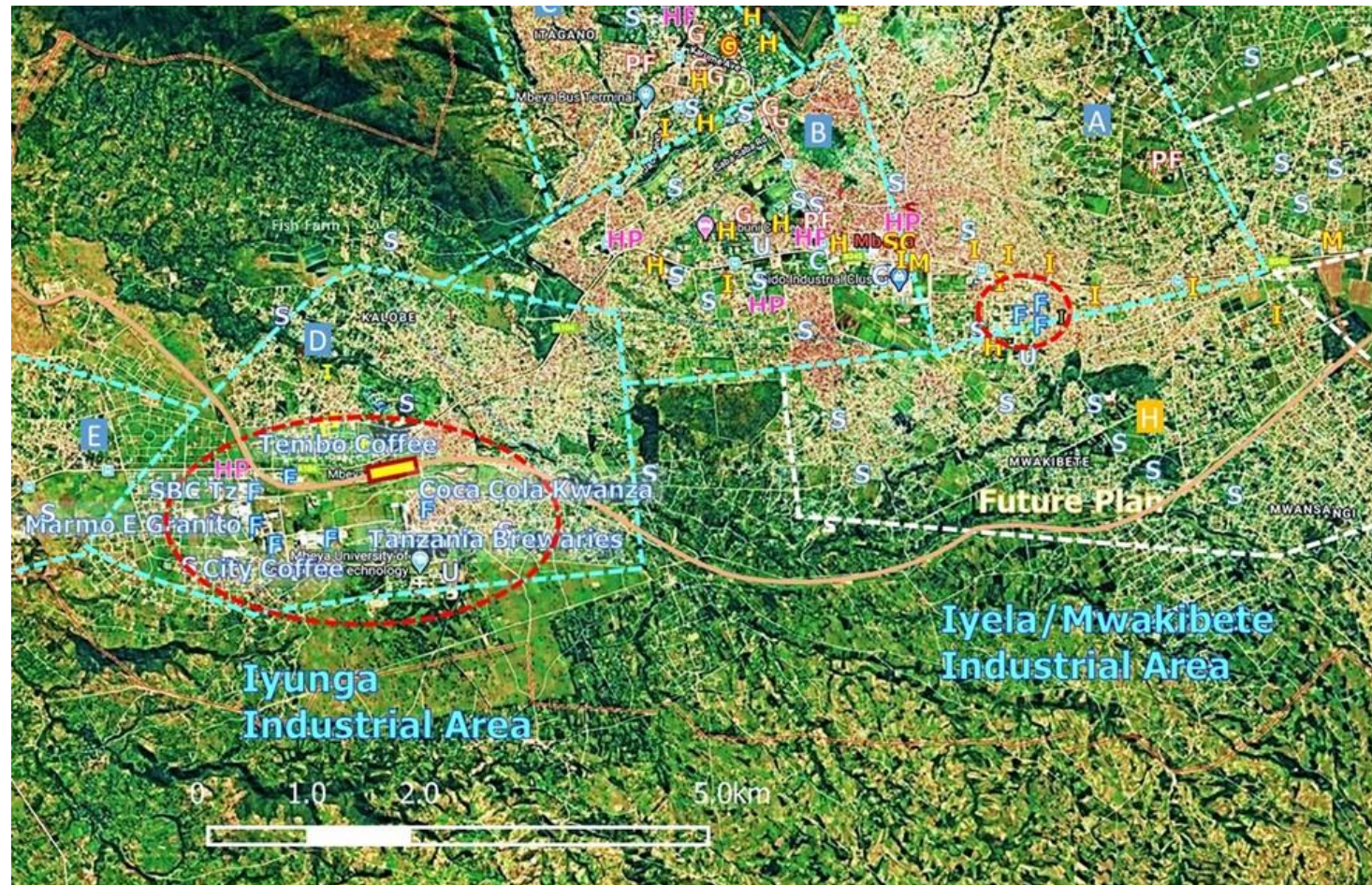


Figure B.6-2 Mbeya

## B.6.3 Rukwa, Njombe and Songea

No remarkable energy users are found in these cities.

Table B.6-2 Large Users along the TANZAM Corridor: Mbeya, Songwe, Sumbawanga and Songea

Region	Location	Name	Notes	Monthly Fuel Consumption by REDS 2018 (excluding use for transport)									
				GSL	DGO	HFO	LPG	Coal	Chacoal	FW/Res	Electricity		
			Users in green column were visited at the 2018 Regional Energy Demand Survey, while in blue were visited by Study Team.	kL	kL	kL	t	t	t	t	MWH	kWh	
				Fuel for transport is excluded.				Daily operation:		15	hours ↓		
<b>Mbeya</b>													
		Priority Targets for District Gas System		Industrial area is south of Mbeya station 5 km west of the old city centre									
	Iyunga Industrial Area	Tanzania Breweries Limited	Beer		1.2	34.0	0.5			0.0	155	344	
	do	Coca Cola Kwanza Limited Mbeya Plant	Soft Drinks, Electricity for air conditioning		12.0						194	430	
	do	Marmo E Granito Mines	Marble products such as onyx tile		0.3						4	9	
	do	CMG Investment	Concrete poles		0.9		0.1			0	323	718	
	do	Tembo Coffee Compnay Limited	Coffee										
	do	SBC Tanzania: Pepsi Cola	2 sites across road										
	Near to above	Mbeya University of Science and Technology											
	do	Makenda Health Centre											
<b>Others</b>													
	City Gas Area	Mbeya Zonal Referral Hospital			3.8						120	267	
	City Gas Area	Mbeya Regional Referral Hospital			0.3						15	33	
	City Gas Area	Hospital Ya Wazazi Meta											
	City Gas Area	Uyole Hospital											
	City Gas Area	Paradise Hotel			0.1						13	29	
	City Gas Area	Green City Hotel			0.2						19	42	
	City Gas Area	Mbeya Hotel											
	City Gas Area	Hotel Desderia											
	City Gas Area	Hills View Hotel											
	City Gas Area	Mbeya Open University			0.0						15	32	
	City Gas Area	Teofilo Kisanji University											
	City Gas Area	Tumaini University	East hill side.										
<b>Songwe</b>													
	10 km west of Mbeya	Mbeya Cemnt Company Limited	Using coal?										
	Next to Mbeya Cement	Mbeyatex											
	Luika: Bulk service	New Luika Gold Mine	100km north of Mbeya. LNG for generators and off-road vehicles										
<b>Rukwa</b>													
	Sumbawanga	No remarkable energy users.											
<b>Ruvuma</b>													
	Songea	No remarkable energy users.											

## Appendix D: Review of Energy Consumption Data

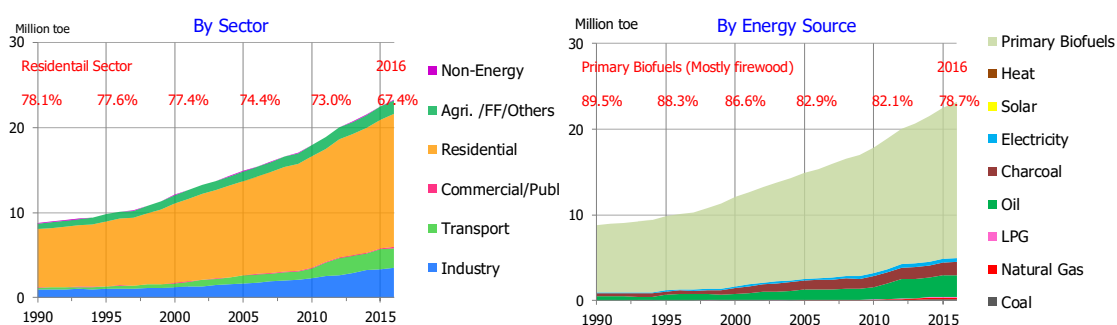
Kensuke Kanekiyo, Lead Author, JICA Study Team  
Councillor, The Institute of Energy Economics, Japan

Data and information on energy production and consumption in Tanzania is scarce. Comprehensive data compilation is found only in the IEA statistics. However, it is far from reality nor consistency. In this paper, we examined the available energy data and readjusted the IEA data for use as the basis for the energy demand projection. To supplement this, the JICA Study Team has conducted Regional Energy Demand Survey engaging a local consultant and its outcome is summarised in Section D.2. Incorporating the survey outcome, we have reviewed energy statistics for Tanzania as discussed in Section D.3.

After these pre-processing of data, several scenarios on the future energy trend have been developed and discussed in Chapter 5 of the principal report. Despite the substantial uncertainties contained herein, we trust the following data recompilation provides a more realistic basis for developing domestic energy demand forecast.

### D.1 Issues on the Existing Data

Comprehensive national energy statistics is not available in Tanzania. Although some energy related statistics are available at individual institutions such as TANESCO, TPDC, EWURA, etc., they are neither complete in light of international standard nor compiled in a comprehensive and coherent manner into an energy balance table. An integrated energy balance table can only be sought from the IEA statistics; however, it looks inaccurate as discussed below.



Source: IEA World Energy Balances 2018

Figure D.1-1 Final Energy Consumption Estimated by IEA

The historical evolution of final energy consumption in Tanzania is estimated by the IEA as shown in Figure D.1-1. According to this assessment, the household sector consumes more than two thirds of the final energy demand and 79% of the final energy is supplied with primary biomass, namely firewood and agroforestry residues.

According to the notes by the IEA, data sources are very limited for Tanzania and the biomass consumption is estimated by the IEA based on 1990 data from Energy Statistics Yearbook 1990, Southern African Development Community (SADC), Luanda, 1992.<sup>1</sup> However, the outcome looks questionable if we compare the largest energy consumption sector, namely, the residential sector of Tanzania with that of Japan. Figure D.1-2 shows the Japanese residential energy consumption per capita by use according to the IEEJ's assessment<sup>2</sup> and the Tanzanian residential sector energy use per capita by energy source according to the IEA assessment. The IEA's assessment for the Japanese residential energy consumption is slightly higher than the IEEJ's assessment.

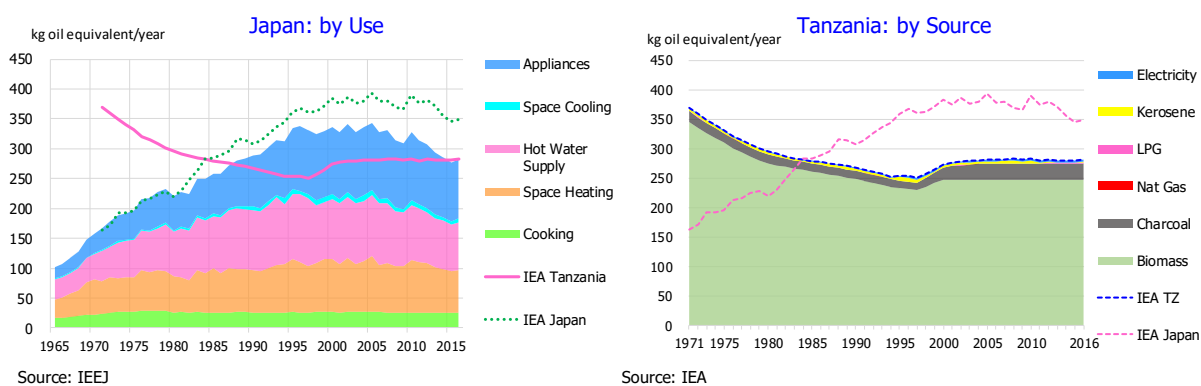


Figure D.1-2 Per-capita Energy Consumption, Residential Sector: Japan and Tanzania

According to the IEA's assessment, Japanese and Tanzanian households are using almost same amount of energy at home on per person basis. As the statistics for Tanzania does not have breakdown by use, direct comparison is not possible. However, it seems quite peculiar with regard to the following viewpoints:

- a In most part of Tanzania, space heating would not be necessary thanks to its hot/milder climate while a significant amount of energy is consumed for heating in Japan during winter time.
- b Japanese are known to be fond of taking hot water bath while it is not customary among Tanzanians. Generally, hot water is used one quarter at kitchen and three quarters for bath and shower in Japan.
- c Home appliances are powered mostly by electricity. Penetration of energy-consuming home appliances is still low among Tanzanians, though electricity supply is gradually increasing through grid development and penetration of photovoltaics (PV).

Energy may be similarly used for cooking in both countries, while Japanese energy consumption for cooking has been levelling off at around 25kg per person per year since the 1970s. Energy efficiency in Tanzania may be lower because primary biomass is mainly used for cooking at lower efficiencies. Even so, the energy consumption assessed by the IEA, i.e. 282kg per person for 2016, looks significantly overshooting the reality. To investigate the issue, we compared the above with the IEA statistics for other

<sup>1</sup> According to the IEA "WORLD ENERGY BALANCES: DATABASE DOCUMENTATION (2018 edition)," statistics on fossil fuel and electricity consumption are compiled from documents of various sources and interviews with relevant institutions including Ministry of Energy and Minerals, Ministry of Finance, TANESCO, EWURA, etc., but not from one integrated statistics.

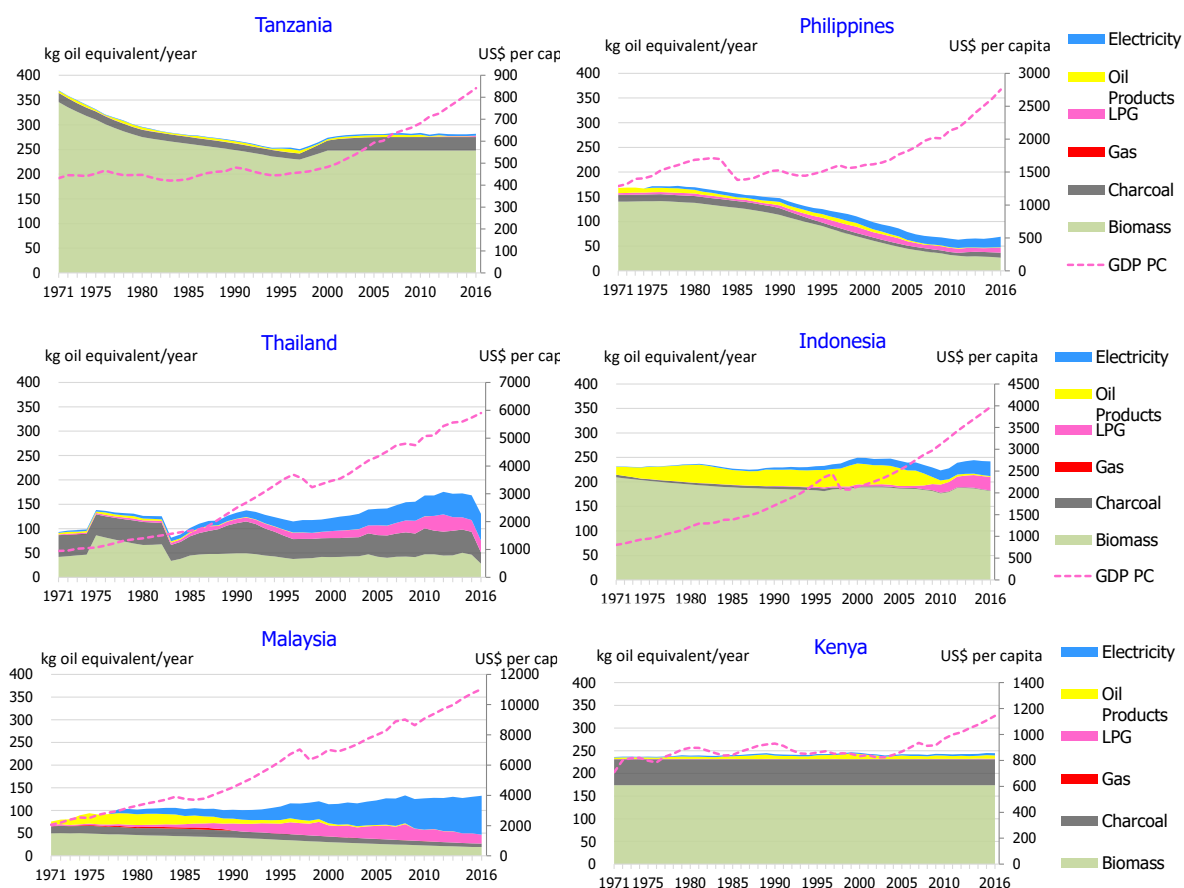
<sup>2</sup> IEEJ, "Handbook of Japan's and World Energy and Economic Statistics (2018)"

developing countries in the tropical area.

In the following exercise, four Asian developing countries located in the tropical zone with similar climate with Tanzania, namely Malaysia, Indonesia, the Philippines and Thailand, plus neighbouring Kenya are picked up to compare the per capita energy consumption by sector except for the transportation sector.

### 1) Residential Sector

Per capita energy consumption by energy source in the residential sector according to the IEA statistics is shown in Figure D.1-3 and Table D.1-1 for the selected countries.



Source: IEA World Energy Balances 2018

Figure D.1-3 Residential Sector Energy Consumption (per capita): Selected Countries

At a glance, it is observed that:

- Per capita energy consumption significantly varies among these countries and is much higher for Tanzania, Kenya and Indonesia compared with other countries mainly due to different estimation on the consumption of traditional biofuels.
- For Tanzania, primary biomass consumption per capita is kept constant at 249kg per year since 2000 and charcoal at 27.5kg per year since 2006.
- For Kenya, both primary biomass and charcoal consumption per capita are kept constant at 176.1kg and 57.8kg per person throughout the data period.

- d. For Indonesia, primary biomass consumption is kept at around 185kg per person during the data period, while it is assumed to be declining in the Philippines.

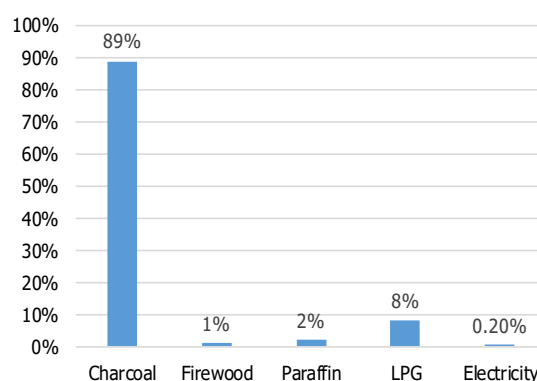
Biomass consumption at household in these tropical countries may mostly represent the use for cooking. Japanese household energy consumption for cooking is around 25kg per person. Given that energy efficiency is much higher, for example 50-60% for modern gas cooking stove used in Japan while it is 25-35% for firewood and charcoal stoves, this equates to roughly 50kg per person of biomass consumption a year. This translates to 200kg a year, or 16kg per month for a family of four. According to the Regional Energy Demand Survey as discussed in the next section, household energy consumption was 73kg oil equivalent per year per person or monthly 25kgoe per family of four. This figure is slightly high compared to the Japanese experience in the old days but looks more realistic than the IEA estimation.

Table D.1-1 Residential Sector Energy Consumption (per capita) in 2016

	Unit:kgoe						
	Tanzania	Thailand	Malaysia	Philippines	Indonesia	Kenya	Japan
Nat Gas	0.0	0.0	0.0	0.0	0.1	0.0	69.2
LPG	2.2	24.4	19.3	10.1	27.6	1.4	35.0
Oil Products	0.8	0.0	0.1	0.8	1.6	7.2	60.0
Biomass	247.7	28.0	19.5	26.8	181.6	174.0	0.0
Charcoal	27.3	23.1	7.8	9.9	1.1	57.1	0.1
NRE	0.0	0.0	0.0	0.0	0.0	0.0	1.8
Electricity	3.9	54.9	85.9	21.3	29.9	4.8	182.4
<b>Total</b>	<b>281.9</b>	<b>130.4</b>	<b>132.5</b>	<b>69.0</b>	<b>241.9</b>	<b>244.5</b>	<b>348.6</b>
GDP per capita	842	5,902	11,027	2,753	3,974	1,143	47,674

Note: total for Japan includes Solar PV. Source: IEA World Energy Balances 2018

There are similar observations. According to the recent study by Lokina and Mapunda<sup>3</sup>, almost 90% of the households in Dar es Salaam was using charcoal as the main cooking fuel while only 1% was using firewood. It also reports that, “More importantly, it is observed that low income households using charcoal as their main cooking fuel consists of 80 percent, while middle income households using charcoal as a primary fuel consists of only 18 percent, and only 2 percent of those using charcoal as a primary fuel are high income households. This suggests that charcoal use is an important source of energy among the poor households.”



Source: Lokina and Mapunda, "Willingness to Change from Charcoal", Tanzanian Economic Review, 2015

Figure D.1-4 Cooking Fuel in Dar es Salaam

<sup>3</sup> Razack Lokina & Gloria Mapunda, "Willingness to Switch from Charcoal to Alternative Energy Sources in Dar es Salaam, Tanzania," Tanzanian Economic Review, Vol. 5 Nos. 1 & 2, 2015

Table D.1-2 Household Energy Consumption in Morogoro and Songea

District	Stratum	Households surveyed	Firewood	Charcoal	Electricity	Kerosene	Crop Residue	Natural Gas	Solar
			%	%	%	%	%	%	%
Morogoro	Rural	167	87	44	2.4	74	14	-	-
	Peri-urban	115	83	71	10.4	87	36	0.9	-
	Urban	82	70	92	34	74	1.2	-	-
	Overall	364	82	64	12	78	18	0.3	-
Songea	Rural	91	97	29	1.1	90	21	-	-
	Peri-urban	62	95	37	3.2	97	21	-	1.6
	Urban	51	31	98	70	80	-	-	-
	Overall	204	80	49	19	90	16	-	0.5
Pooled	Rural	258	90.3	38.8	1.9	80	16	-	-
	Peri-urban	177	87	59	7.9	90	30.5	0.6	0.6
	Urban	133	55	94	48	77	0.8	-	-
	Overall	568	81	58	14.6	83	17	0.2	0.2

Source: Lusambo LP, "Household Energy Consumption Patterns in Tanzania", Journal of Ecosystem & Echography, 2016,S5

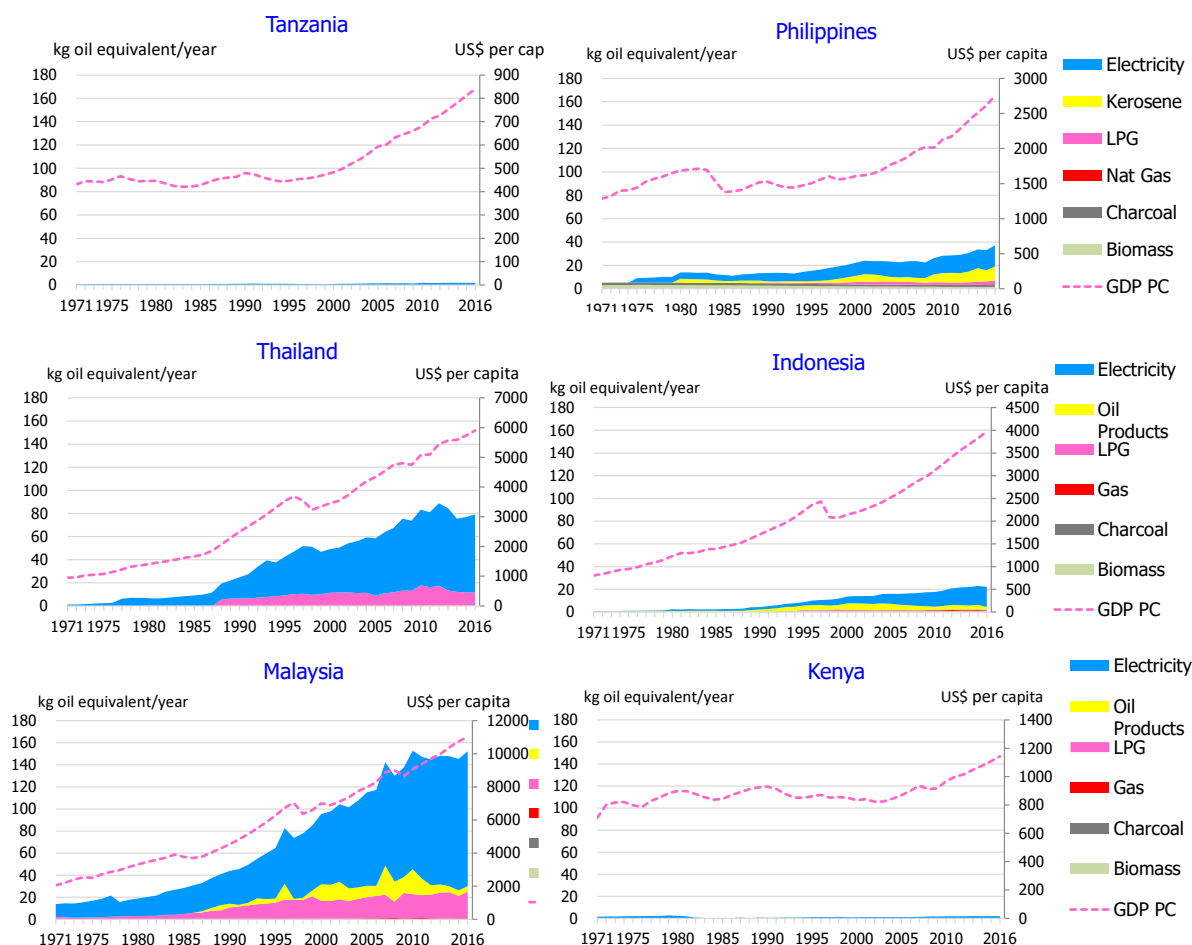
Another research on the rural side indicates, as shown in Table D.1-2, that charcoal, kerosene and electricity are used at household together with firewood and agroforestry residue and that use of biomass shifts to modern energies in urban areas.

From the above observations, it may be deduced that household energy consumption in Tanzania is much less than that estimated in the IEA statistics and that fuel switching from traditional biomass to more convenient charcoal and modern fuels is occurring along with income growth and urbanisation.

## 2) Commercial and Services Sector

Per capita energy consumption by energy source in the commercial and services sector according to the IEA statistics is shown in Figure D.1-5 and Table D.1-3 for the selected countries. As can be seen in the graph and table, the IEA compilation on the commercial sector is somewhat incomplete for developing countries. It picks up only electricity for Tanzania and Kenya. Charcoal is picked up only for the Philippines, and primary biomass for the Philippines and Indonesia. It would be difficult to collect meaningful data on biomass and charcoal consumption in the small-scale commercial sector. However, it is true that charcoal is the major cooking fuel at restaurants and hotels in developing countries. In addition, LPG is penetrating rapidly in this sector. For 2016, all the 120 ktoe LPG consumption of Tanzania is allocated for the residential sector use and, for Kenya, LPG consumption is allocated with 68 ktoe for the residential sector and 62 ktoe for the industrial sector. According to the Regional Energy Demand Survey to be discussed later in section D.2, charcoal and LPG are used as main fuel in this sector except for schools.

On the other hand, electricity is mainly used for lighting in the early development stage and will be increasingly used for electric appliances as living standard improves and finally for air conditioning.



Source: IEA World Energy Balances 2018

Figure D.1-5 Commercial Sector Energy Consumption (per capita): Selected Countries

Table D.1-3 Commercial Sector Energy Consumption (per capita) in 2016

	Tanzania	Thailand	Malaysia	Philippines	Indonesia	Kenya	Japan
Gas	0.0	0.0	0.8	0.0	0.7	0.0	94.8
LPG	0.0	11.6	24.4	3.6	0.8	0.0	8.2
Oil Products	0.0	0.0	4.9	12.2	2.2	0.0	83.5
Biomass	0.0	0.0	0.0	1.7	0.8	0.0	4.5
Charcoal	0.0	0.0	0.0	1.6	0.0	0.0	0.0
NRE	0.0	0.0	0.0	0.2	0.0	0.0	0.2
Electricity	1.9	67.5	122.3	18.1	17.9	2.1	225.3
<b>Total</b>	<b>1.9</b>	<b>79.2</b>	<b>152.4</b>	<b>37.4</b>	<b>22.2</b>	<b>2.1</b>	<b>421.9</b>
GDP per capita	842	5,902	11,027	2,753	3,974	1,143	47,674

Note: Total for the Philippines includes bio-diesel and that for Japan coke, solar PV and heat.

Source: IEA World Energy Balances 2018

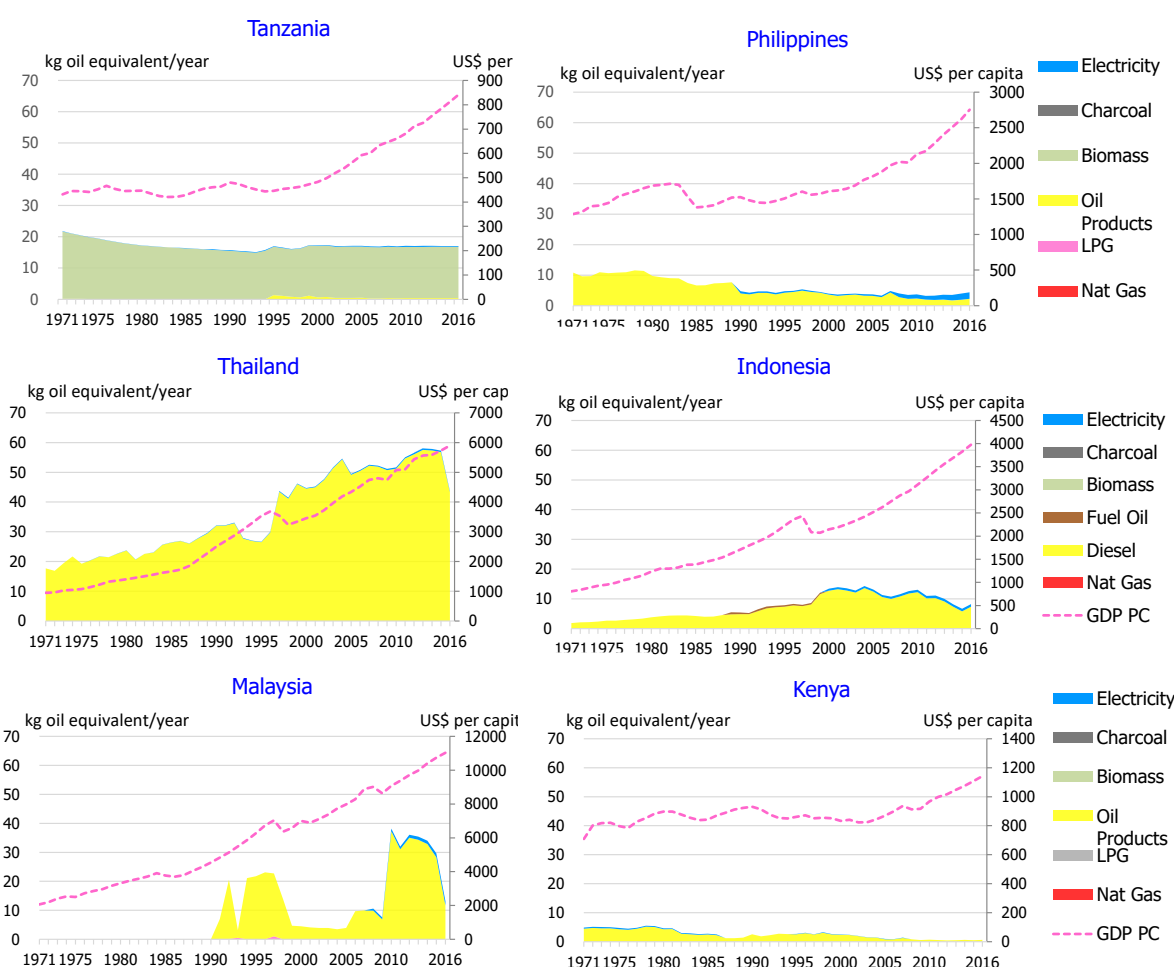
### 3) Agriculture, forestry and Fishery Sectors

The IEA statistics for these sectors are random and diverse among countries as shown in Figure D.1-6 and Table D.1-4. This may be due to lack of coherence in definition and assessment methods of data for these sectors.



From general observation, typical energy use in agriculture, forestry and fishery sectors may be as follows:

- a. Power sources for driving vehicles (truck, tractor, lift, cultivator, planter, seeder, combine, heavy duty vehicle, fishing boat, etc.), pumps, machines (threshing machine, washer, packing machine, bottling machine, etc.), and tools (chain saw, grass cutter, etc.), which are mainly petroleum products such as gasoline, kerosene and diesel, and electricity.
- b. Fuels for heating (greenhouse, drying machine, fishpond, building, warehouse, etc.) and light culture, which are mainly gas, LPG, petroleum products and electricity.
- c. Fuels for incineration or disposal of wastes, where waste itself should not be considered as fuel consumption.



Source: IEA World Energy Balances 2017

Figure D.1-6 Agriculture and Fishery Sector Energy Consumption (per capita)

In the old days, bagasse and firewood were used to drive steam locomotives to collect sugar canes and timbers. Except for such use, it is inconceivable that primary biomass is used in the agricultural and forestry activities in a large quantity. The IEA statistics reports that, among 146 countries and areas compiled for 2015 energy consumption estimation, primary solid biomass was used in 50 countries,

totalling 9,429 ktoe. No consumption is listed for countries with enormous agricultural sector such as China, India, Indonesia, Thailand and Vietnam. For Tanzania, it is estimated at 881 ktoe or 9.3% of the world total, highly questionable, while it is 949 ktoe for the United States and 86 ktoe for Russian Federation.

If woods and grasses were burnt for slash-and-burn farming or cultivation, it should be considered just as incineration or disposal of wastes but not “energy” required for agroforestry activities though the residue may serve as fertiliser. Firewood, crop residue and saw dusts used for charcoal production is energy for transformation but not the final demand. For Tanzania, primary biomass consumption of 16.5kg per person is given throughout the data period. However, no such agroforestry activities specifically using large quantities of solid biomass are identified in the country.

Table D.1-4 Agriculture and Fishery Sector Energy Consumption (per capita) in 2016

	Unit:kgoe						
	Tanzania	Thailand	Malaysia	Philippines	Indonesia	Kenya	Japan
Nat Gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LPG	0.0	0.0	0.0	0.0	7.4	0.0	0.0
Oil Products	0.4	43.4	11.7	2.2	0.0	0.6	35.4
Biomass	16.4	0.0	0.0	0.0	0.0	0.0	0.0
Charcoal	0.0	0.0	0.0	0.0	0.0	0.0	0.6
Electricity	0.3	0.3	1.5	2.1	0.9	0.0	2.1
<b>Total</b>	<b>17.1</b>	<b>43.8</b>	<b>13.2</b>	<b>4.4</b>	<b>8.3</b>	<b>0.6</b>	<b>38.1</b>
GDP per capita	842	5,902	11,027	2,753	3,974	1,143	47,674

Note: Total for Japan includes geothermal. Source: IEA World Energy Balances 2018

Consumption of a small amount of oil products and electricity is listed for Tanzania, which may be deemed reasonable.

In addition to the above, primary solid biomass consumption for non-specified sector is assumed to be 11.2 kg per person constant since 2000. This is also a puzzling assumption.

#### 4) Non-specified Sector

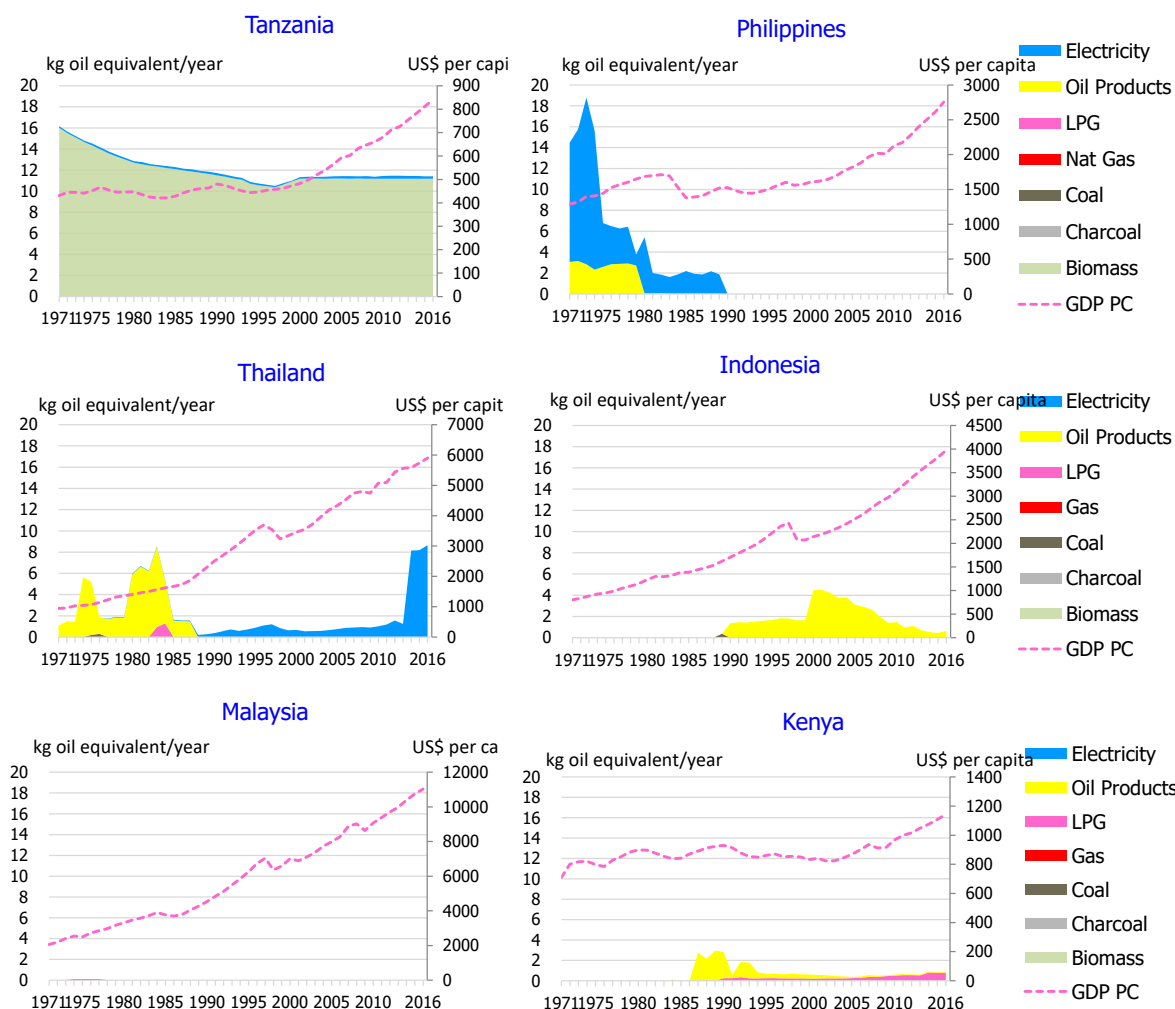
Except that military energy use is classified in this sector, this sector is something like an error term in statistics. Listed numbers are generally small and fluctuate irregularly.

Table D.1-5 Non-specified Energy Use (per capita) in 2016

	Unit:kgoe						
	Tanzania	Thailand	Malaysia	Philippines	Indonesia	Kenya	Japan
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LPG	0.0	0.0	0.0	0.0	0.0	0.8	0.0
Oil Products	0.0	0.0	0.0	0.0	0.7	0.1	0.0
Biomass	11.2	0.0	0.0	0.0	0.0	0.0	8.3
Charcoal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NRE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	0.2	8.7	0.0	0.0	0.0	0.0	0.0
<b>Total</b>	<b>11.4</b>	<b>8.7</b>	<b>0.0</b>	<b>0.0</b>	<b>0.7</b>	<b>0.9</b>	<b>8.3</b>
GDP per capita	842	5,902	11,027	2,753	3,974	1,143	47,674

Source: IEA World Energy Balances 2018

For Tanzania, biomass consumption of 11.2 kg per year per person is slated since 2000, which constantly declines from 16.0kg in 1971. The Tanzanian military has about 27,000 personnel<sup>4</sup>, which is only 0.05% of the total population. Given that fuel is needed to prepare meals for them, such a large amount would not be necessary. On the other hand, oil consumption is not counted while it is necessary to drive military vehicles.



Source: IEA World Energy Balances 2018

Figure D.1-7 Non-specified Use of Energy (per capita)

### 5) Industrial Sector

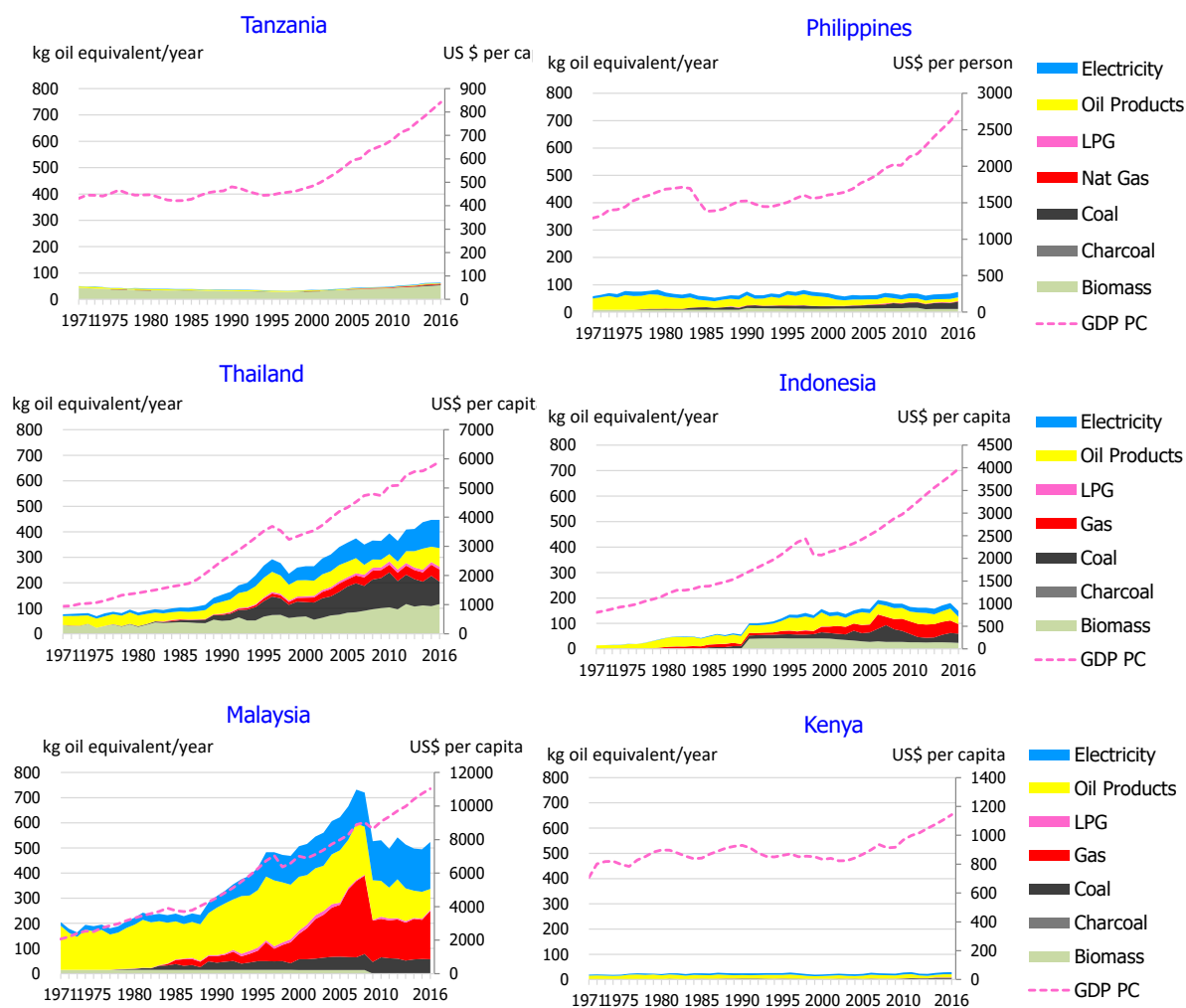
Industrial sector energy consumption on a per capita basis compiled in the IEA statistics is shown in Figure D.1-8 and Table D.1-6 for the selected countries.

For Tanzania, a very small amount of energy consumption is recorded for the industrial sector, which may reflect the present industrialisation status. From general comparison of per capita industrial energy

<sup>4</sup> [https://en.wikipedia.org/wiki/Tanzania\\_People%27s\\_Defence\\_Force](https://en.wikipedia.org/wiki/Tanzania_People%27s_Defence_Force)

consumption among the countries, several questionable features are noted as follows:

- a. A substantially large amount of primary biomass consumption is recorded for Tanzania, while it is not recorded for Kenya as shown in Table D.1-6. Thus, total per capita industrial energy consumption for Tanzania is more than double that of Kenya.
- b. The primary biomass consumption is ten (10) times greater than the consumption of coal and natural gas; the latter being mainly used by cement industry.
- c. The total industrial energy consumption per capita for Tanzania almost compares to that of the Philippines. This is doubtful considering the industrialisation status of the two countries.



Source: IEA World Energy Balances 2018

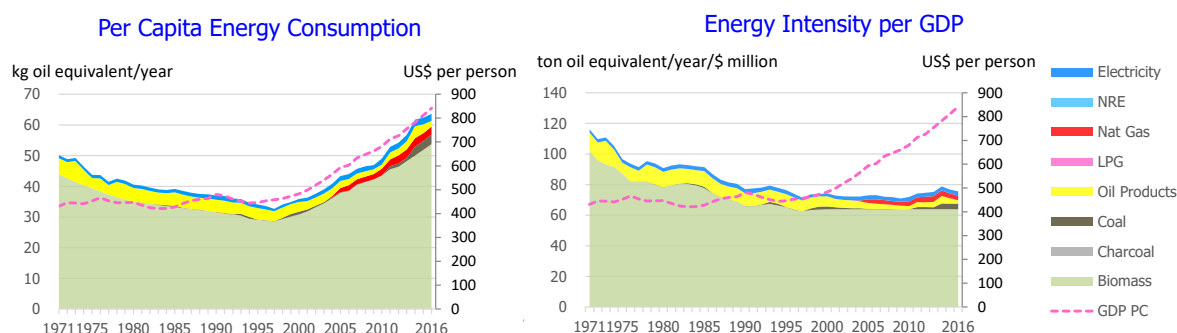
Figure D.1-8 Industrial Sector Energy Consumption (per capita): Selected Countries

Table D.1-6 Industrial Sector Energy Consumption (per capita) in 2016

	Tanzania	Thailand	Malaysia	Philippines	Indonesia	Kenya	Japan
	Unit: kgoe						
Coal	3.1	88.0	57.2	26.6	36.3	7.1	94.6
Gas	2.6	47.9	192.0	1.5	37.6	0.0	156.6
LPG	0.0	10.4	4.4	1.3	0.4	1.3	12.3
Peroleum Products	1.8	73.0	83.7	12.8	28.2	12.9	126.5
Biomass	53.8	116.7	0.0	11.3	23.7	0.0	31.1
Charcoal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NRE	0.0	8.7	0.0	0.1	0.0	0.0	0.0
Electricity	2.3	111.0	186.7	20.1	22.4	7.8	233.5
<b>Total</b>	<b>63.6</b>	<b>455.7</b>	<b>524.0</b>	<b>73.7</b>	<b>148.7</b>	<b>29.1</b>	<b>661.3</b>
GDP per capita	842	5,902	11,027	2,753	3,974	1,143	47,674

Note: Total for Thailand includes biogas and the Philippines biodiesel. Source: IEA World Energy Balances 2018

Investigating further, it is noted that the per capita industrial consumption of primary biomass has been increasing in Tanzania since 2000 which means industrialisation is proceeding burning more firewood. However, this phenomenon is caused by the fact that the intensity of primary biomass consumption per GDP has been kept constant since 2000. During the field survey conducted in January 2018, A to Z Textile in Arusha told that they use waste wood from packaging materials for cooking stoves to prepare meals for the employees. In Morogoro some factories are using firewood as fuel. At any rate, however, energy consumption at these factories is much smaller than that of cement factories.



Source: IEA World Energy Balances 2018

Figure D.1-9 Industrial Sector Energy Consumption: Tanzania

In general observation, industrial energy consumption evolves along with economic development and industrialisation. In the early stage of development, some fuel may be used at bakeries and blacksmiths, while waterwheel is used to run flouring mills and sawmills, to be replaced by petrol and electricity at a later development stage. Then brickworks and cement plants appear as main users of firewood, charcoal and coal. Mining industry uses diesel and electricity to drive heavy vehicles, crushers and conveyers. If sugarcane is abundant, bagasse is used for generation of steam and power.

Tanzania is yet in the early stage of industrialisation, and its industrial energy consumption looks rather limited. However, the high biomass consumption in the industrial sector listed in the IEA statistics, equating more than double that of the Philippines and Indonesia on a per capita basis, is questionable, whereas no biomass consumption is accounted for Kenya. Cement plants in Tanzania are located in

Tanga, Dar es Salaam and Mtwara and are using coal, petro-coke and natural gas as fuel. Metallurgy is still in infant stage. Compared with these plants, it is doubtful if there are many more industrial plants in the country that consume ten times more fuel than the cement industry.

From these observations, it is necessary to improve the energy statistics for Tanzania with more realistic data and assessment.

## D.2 Regional Energy Demand Survey

To formulate a domestic natural gas supply plan, we need to know potential energy demand by region. In Tanzania, energy consumption survey was carried out at the occasion of the Population Census in 2002 and 2012, and then the Energy Access Situation Survey was conducted in 2016. All of these surveys concentrate on the household energy consumption and energy sources for lighting and cooking. Whereas the 2016 survey offers in-depth information on household energy needs, no such surveys have been conducted to cover energy use in other sectors.

Under the circumstance, the Study Team conducted Regional Energy Demand Survey to collect basic information relating to regional energy consumption at industries, commercial and public facilities and households in the selected regions as the objective of the DNGPP study, namely Morogoro, Dodoma, Tanga, Arusha, Moshi, Mbeya and Mwanza. This section provides outcomes of the sample survey on regional energy consumption.

Later in 2020 and 2021, the Study Team conducted additional survey on demand; demand reading from Google Map and Market Research by a team of Ministry of Energy. Outcome of these additional research is discussed in Chapter 5 of the principal report.

### D.2.1 Outline of Regional Demand Survey

The survey was conducted from February through June by the Dar es Salaam Institute of Technology as the local consultant. Outline of the survey is as follows;

- a. Schedule-1: compilation of existing statistics for all regions on regional economic indicators available from various institutions covering items such as population, number of households, GDP, energy consumption, energy prices, etc.
- b. Schedule-2: research on present economic activities and future development plans for selected regions, namely Morogoro, Dodoma, Tanga, Arusha, Moshi, Mbeya and Mwanza, on items such as number and size of factories, commercial and public facilities, etc.
- c. Schedule-3: sample survey by interviews on factories, commercial/public facilities and households for selected regions with regard to their energy consumption.

In particular, the survey team conducted interviews with 58 factories, 150 commercial and public entities and 442 households as shown in Table D.2-1. Though the number of samples was limited, the

carefully designed survey has provided us with in-depth information on the energy consumption patterns in various sectors.

Table D.2-1 Samples Covered by the Regional Energy Demand Survey

	Arusha	Dodoma	Mbeya	Morogoro	Moshi	Mwanza	Tanga	Total
<b>Factories (Employees)</b>								
Large	1	1	3	5	3	6	5	24
Medium (<100)	1	1	1	1	2	4	2	12
Small (<25)	6	3	3	5	0	1	4	22
<b>Total</b>	<b>8</b>	<b>5</b>	<b>7</b>	<b>11</b>	<b>5</b>	<b>11</b>	<b>11</b>	<b>58</b>
<b>Commercial/services</b>								
Hospitals	2	5	4	5	3	5	3	27
Hotels	5	7	6	4	9	5	4	40
Shops	1	5	1	4	2	4	4	21
Public Facilities	3	0	4	4	4	7	2	24
Schools	2	5	8	5	8	6	4	38
<b>Total</b>	<b>13</b>	<b>22</b>	<b>23</b>	<b>22</b>	<b>26</b>	<b>27</b>	<b>17</b>	<b>150</b>
<b>Household</b>								
Families	53	50	82	70	64	66	57	442
Family Members	406	324	453	352	305	620	525	2,985

## D.2.2 Industrial Sector

For the industrial sector, 58 factories were interviewed. In addition to them, two factories are added which the study team visited during its field survey in February and June 2018. The study team understands that the survey outcome summarized in Table D.2-2 covers most of the industrial activities in the objective regions. The total industrial energy consumption inferred from the survey is 162 thousand tonnes oil equivalent (ktoe) per year, of which;

- More than 60% is consumed in Tanga Region where energy intensive cement and lime factories are located.
- Of the total consumption, 78.4% was fuel and 21.6% was electricity
- Consumption of traditional biomass (firewood, agriculture residue and charcoal) comprises a relatively small share of 6.6% though it includes a sugar factory in Moshi where bagasse is used intensively as boiler fuel.
- Excluding Tanga, the share of electricity goes up to 27.5%
- Cement and lime industries use coal and petro-coke.

While the IEA statistics state that the Tanzanian industries heavily depend on biomass, it is not the case. A small-scale pulp and paper plant is operating in Iringa with an annual capacity of 60,000 tonnes. Because of the unique process of pulp production, it may consume biomass fuel of 20,000 toe. Apart from this, no other large plant using biomass is found in Tanzania. Biomass would not be a convenient energy except for sugar and pulp plants where they are available at a cheap cost, and most of other industries prefer modern fossil fuels that are easy to use and control.

Table D.2-2 Regional Demand Survey: Industrial sector

	Coal	LPG	Gasoline	Kerosene	Diesel	Fuel Oil	Petro-coke	Firewood	Agri-residue	Charcoal	Electricity	Smables
<b>Original</b>	ton	ton	kltr	kltr	kltr	kltr	ton	ton	ton	ton	MWh	
Arusha	60	1	0	0	20	36	0	46	0	0	262	8
Dodoma	0	4	0	0	3	0	0	0	0	0	142	5
Mbeya	0	1	14	0	37	34	0	5	0	18	688	7
Morogoro	900	38	9	0	40	287	0	0	0	250	2,144	11
Moshi	0	7	1	0	238	44	0	10	250	0	1,092	5
Mwanza	0	1	4	0	540	1,179	0	400	628	50	7,449	11
Tanga	14,407	37	1	0	280	0	603	483	0	2	16,619	11
<b>Total</b>	<b>15,367</b>	<b>88</b>	<b>30</b>	<b>1</b>	<b>1,159</b>	<b>1,579</b>	<b>603</b>	<b>944</b>	<b>878</b>	<b>320</b>	<b>28,395</b>	<b>58</b>
<b>Adjusted Original</b>	ton	ton	kltr	kltr	kltr	kltr	ton	ton	ton	ton	MWh	
Arusha	78	1	0	0	20	36	0	56	0	35	5,762	9
Dodoma	900	4	0	0	3	0	0	0	0	0	292	6
Mbeya	0	1	14	0	37	34	0	5	0	18	688	7
Morogoro	900	38	9	0	40	287	0	0	0	250	2,144	11
Moshi	0	7	1	0	238	44	0	10	250	0	1,092	5
Mwanza	0	1	4	0	540	1,179	0	400	628	50	7,449	11
Tanga	14,407	37	1	0	280	0	603	483	0	2	16,619	11
<b>Total</b>	<b>16,285</b>	<b>88</b>	<b>30</b>	<b>1</b>	<b>1,159</b>	<b>1,579</b>	<b>603</b>	<b>954</b>	<b>878</b>	<b>355</b>	<b>34,045</b>	<b>60</b>
<b>Oil Equivalent</b>	kcal/kg	kcal/kg	kcal/ltr	kcal/ltr	kcal/ltr	kcal/ltr	kcal/kg	kcal/kg	kcal/kg	kcal/kg	kcal/kWh	Total
Net Calorific Value	4,129	11,313	7,826	8,179	8,348	9,137	7,809	3,523	3,535	6,800	860	
<b>Monthly Consumption</b>	toe	toe	toe	toe	toe	toe	toe	toe	toe	toe	toe	toe
Arusha	32	1	0	0	17	33	0	20	0	24	496	622
Dodoma	372	5	0	0	2	0	0	0	0	0	25	404
Mbeya	0	1	11	0	31	31	0	2	0	12	59	147
Morogoro	372	43	7	0	33	262	0	0	0	170	184	1,071
Moshi	0	7	1	0	199	40	0	4	88	0	94	433
Mwanza	0	1	3	0	451	1,077	0	141	222	34	641	2,570
Tanga	5,949	42	1	0	234	0	471	170	0	1	1,429	8,297
<b>Total</b>	<b>6,724</b>	<b>99</b>	<b>23</b>	<b>0</b>	<b>968</b>	<b>1,443</b>	<b>471</b>	<b>336</b>	<b>310</b>	<b>242</b>	<b>2,928</b>	<b>13,545</b>
<b>Annual Consumption</b>	toe	toe	toe	toe	toe	toe	toe	toe	toe	toe	toe	toe
Arusha	386	8	0	0	205	398	0	237	0	286	5,946	7,466
Dodoma	4,459	55	0	0	29	0	0	0	0	2	301	4,847
Mbeya	0	7	136	0	370	373	0	21	0	147	710	1,764
Morogoro	4,459	516	86	0	397	3,142	0	0	0	2,040	2,212	12,852
Moshi	0	90	10	0	2,389	480	0	42	1,060	0	1,127	5,197
Mwanza	0	18	35	4	5,412	12,923	0	1,691	2,663	408	7,688	30,841
Tanga	71,386	499	14	1	2,810	0	5,650	2,042	0	16	17,151	99,569
<b>Total</b>	<b>80,691</b>	<b>1,192</b>	<b>281</b>	<b>5</b>	<b>11,611</b>	<b>17,315</b>	<b>5,650</b>	<b>4,033</b>	<b>3,723</b>	<b>2,899</b>	<b>35,135</b>	<b>162,535</b>
<b>Composition</b>	<b>49.6%</b>	<b>0.7%</b>	<b>0.2%</b>	<b>0.0%</b>	<b>7.1%</b>	<b>10.7%</b>	<b>3.5%</b>	<b>2.5%</b>	<b>2.3%</b>	<b>1.8%</b>	<b>21.6%</b>	<b>100.0%</b>
<b>Excluding cement and lime factories in Tanga</b>												
	9,305	1,192	281	5	11,611	17,315	0	4,033	3,723	2,899	19,139	69,503
<b>Composition</b>	<b>13.4%</b>	<b>1.7%</b>	<b>0.4%</b>	<b>0.0%</b>	<b>16.7%</b>	<b>24.9%</b>	<b>0.0%</b>	<b>5.8%</b>	<b>5.4%</b>	<b>4.2%</b>	<b>27.5%</b>	<b>100.0%</b>

Table D.2-3 Summary of Annual Industrial Fuel Consumption by Type

	Motor Fuel	Fuel for heat				Electricity	Total
		Fuel Oil LPG	Coal+ Petro-coke	Biomass	Total		
	toe	toe	toe	toe	toe	toe	toe
Arusha	205	406	386	522	1,315	5,946	7,466
Dodoma	29	55	4,459	2	4,516	301	4,847
Mbeya	506	380	0	168	548	710	1,764
Morogoro	483	3,657	4,459	2,040	10,157	2,212	12,852
Moshi	2,398	569	0	1,103	1,672	1,127	5,197
Mwanza	5,447	12,945	0	4,761	17,706	7,688	30,841
Tanga	2,823	500	77,036	2,058	79,594	17,151	99,569
<b>Total</b>	<b>11,892</b>	<b>18,513</b>	<b>86,341</b>	<b>10,654</b>	<b>115,508</b>	<b>35,135</b>	<b>162,535</b>
	<b>7.3%</b>	<b>11.4%</b>	<b>53.1%</b>	<b>6.6%</b>	<b>71.1%</b>	<b>21.6%</b>	<b>100.0%</b>
<b>Excluding cement and lime in Tanga</b>	<b>11,892</b>	<b>18,507</b>	<b>9,305</b>	<b>10,654</b>	<b>29,162</b>	<b>19,139</b>	<b>69,503</b>
	<b>17.1%</b>	<b>26.6%</b>	<b>13.4%</b>	<b>15.3%</b>	<b>42.0%</b>	<b>27.5%</b>	<b>100.0%</b>

The outcome can be summarized by fuel type as in Table D.2-3. Coal and petro-coke are intensively used at cement and lime factories. But they are cheap fuels; natural gas cannot compete against them



unless at a substantially discounted price. Gasoline and diesel are used mainly for transport. Consequently, potential industrial fuel demand in seven regions inferred from the survey may be about 29,000 tonnes oil equivalent per year.

### D.2.3 Commercial and Services Sector

The survey team interviewed 150 entities covering hospitals, hotels, restaurants, offices and schools. It is unclear as to what extent the survey covers the overall commercial and services sector activities in the objective regions. However, the outcome has given us informative data on energy consumption patterns in these entities. Although the original survey outcome includes substantial quantities of gasoline and diesel oil consumption, they should be classified as transport fuel. Thus, the result is recompiled excluding them except for those noted as used for power generation.

Table D.2-4 Regional Demand Survey: Commercial and Services Sector

	Coal	LPG	Gasoline	Kerosene	Diesel	Fuel Oil	Firewood	Agri-residue	Charcoal	Other	Electricity	Samples
<b>Original</b>	ton	ton	kltr	kltr	kltr	kltr	ton	ton	ton	ton	MWh	
Arusha	0	1	0	0	77	0	0	0	5	0	908	13
Dodoma	0	6	0	0	16	0	12	0	4	0	519	22
Mbeya	0	0	0	0	17	0	81	0	0	0	266	23
Morogoro	0	3	1	0	6	0	0	0	1	0	409	22
Moshi	0	3	1	0	39	0	82	0	2	1	679	26
Mwanza	0	4	6	0	29	0	21	0	1	0	458	27
Tanga	0	2	2	0	4	0	1	0	3	0	141	17
<b>Total</b>	<b>0</b>	<b>18</b>	<b>11</b>	<b>0</b>	<b>188</b>	<b>0</b>	<b>199</b>	<b>0</b>	<b>15</b>	<b>1</b>	<b>3,379</b>	<b>150</b>
<b>Original excluding transport</b>		ton	kltr	kltr	kltr	kltr	ton	ton	ton	ton	MWh	
Arusha	0	1	0	0	5	0	0	0	5	0	908	13
Dodoma	0	6	0	0	7	0	12	0	4	0	519	22
Mbeya	0	0	0	0	8	0	81	0	0	0	266	23
Morogoro	0	3	0	0	0	0	0	0	1	0	409	22
Moshi	0	3	0	0	14	0	82	0	2	1	679	26
Mwanza	0	4	0	0	10	0	21	0	1	0	458	27
Tanga	0	2	0	0	2	0	1	0	3	0	141	17
<b>Total</b>	<b>0</b>	<b>18</b>	<b>0</b>	<b>0</b>	<b>46</b>	<b>0</b>	<b>199</b>	<b>0</b>	<b>15</b>	<b>1</b>	<b>3,379</b>	<b>150</b>
<b>Oil Equivalent</b>	kcal/kg	kcal/kg	kcal/ltr	kcal/ltr	kcal/ltr	kcal/ltr	kcal/kg	kcal/kg	kcal/kg	kcal/kg	kcal/kWh	Total
Net Caloric Value	4,129	11,313	7,826	8,179	8,348	9,137	3,523	3,535	6,800	7,809	860	
<b>Monthly Consumption</b>	toe	toe	toe	toe	toe	toe	toe	toe	toe	toe	toe	toe
Arusha	0	1	0	0	4	0	0	0	3	0	78	87
Dodoma	0	6	0	0	6	0	4	0	3	0	45	64
Mbeya	0	0	0	0	6	0	29	0	0	0	23	58
Morogoro	0	3	0	0	0	0	0	0	0	0	35	39
Moshi	0	4	0	0	12	0	29	0	2	1	58	105
Mwanza	0	5	0	0	9	0	7	0	1	0	39	61
Tanga	0	2	0	0	2	0	1	0	2	0	12	18
<b>Total</b>	<b>0</b>	<b>21</b>	<b>0</b>	<b>0</b>	<b>39</b>	<b>0</b>	<b>70</b>	<b>0</b>	<b>10</b>	<b>1</b>	<b>291</b>	<b>432</b>
<b>Annual Consumption</b>	toe	toe	toe	toe	toe	toe	toe	toe	toe	toe	toe	toe
Arusha	0	13	0	0	50	0	0	1	37	0	937	1,039
Dodoma	0	75	0	0	72	0	51	0	32	0	535	765
Mbeya	0	0	0	0	76	0	344	0	0	0	274	695
Morogoro	0	34	0	0	5	2	1	0	4	0	422	468
Moshi	0	44	0	0	139	2	348	0	19	10	701	1,263
Mwanza	0	57	1	0	104	0	90	0	10	0	472	734
Tanga	0	25	0	0	18	0	6	0	22	0	146	217
<b>Total</b>	<b>1</b>	<b>249</b>	<b>2</b>	<b>0</b>	<b>464</b>	<b>4</b>	<b>839</b>	<b>1</b>	<b>125</b>	<b>10</b>	<b>3,487</b>	<b>5,181</b>
<b>Composition</b>	<b>0.0%</b>	<b>4.8%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>9.0%</b>	<b>0.1%</b>	<b>16.2%</b>	<b>0.0%</b>	<b>2.4%</b>	<b>0.2%</b>	<b>67.3%</b>	<b>100.0%</b>
<b>Excluding Mbeya and Mwanza</b>	0	0	0	0	0	0	0	0	0	0	0	0
	1	192	1	0	284	3	406	1	114	10	2,740	3,752
<b>Composition</b>	<b>0.0%</b>	<b>5.1%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>7.6%</b>	<b>0.1%</b>	<b>10.8%</b>	<b>0.0%</b>	<b>3.1%</b>	<b>0.3%</b>	<b>73.0%</b>	<b>100.0%</b>

Excluding the motor fuel, the aggregate amount of annual energy consumption covered by the survey is 5,200 toe, of which:

- 67.3% was electricity and 32.7% was fuel consumption;
- Biomass consumption was 18.6% where firewood is intensively used in Mbeya and Moshi;

- c. LPG and charcoal are the main fuel in other areas.

Table D.2-5 Energy Consumption by Sub-sector

	Hospital	Hotel	Shop	Public Office	School	Total	Composition
	toe	toe	toe	toe	toe	toe	%
Coal	0	0	0	0	0	1	0.0
LPG	12	169	47	0	21	249	4.8
Gasoline	1	0	0	1	0	2	0.0
Kerosene	0	0	0	0	0	0	0.0
Diesel	206	99	91	62	6	464	9.0
Fuel Oil	2	1	0	0	0	4	0.1
<b>Sub-total</b>	<b>221</b>	<b>270</b>	<b>138</b>	<b>63</b>	<b>27</b>	<b>719</b>	<b>13.9</b>
Firewood	4	3	2	9	822	839	16.2
Agri-residue	0	0	0	1	0	1	0.0
Charcoal	6	65	10	5	39	125	2.4
Others	10	0	0	0	0	10	0.2
<b>Sub-total</b>	<b>20</b>	<b>68</b>	<b>12</b>	<b>14</b>	<b>861</b>	<b>975</b>	<b>18.8</b>
<b>Fuel Total</b>	<b>242</b>	<b>338</b>	<b>150</b>	<b>77</b>	<b>888</b>	<b>1,694</b>	<b>32.7</b>
Electricity	591	570	575	1,426	321	3,483	67.3
<b>Total</b>	<b>832</b>	<b>909</b>	<b>724</b>	<b>1,503</b>	<b>1,209</b>	<b>5,177</b>	<b>100.0</b>
	16.1%	17.6%	14.0%	29.0%	23.3%	100.0%	
Consumption per sample							
Samples	27	40	21	24	38	150	
Fuel	8.9	8.5	7.1	3.2	23.4	11.3	32.7
Electricity	21.9	14.3	27.4	59.4	8.4	23.2	67.3
<b>Total</b>	<b>30.8</b>	<b>22.7</b>	<b>34.5</b>	<b>62.6</b>	<b>31.8</b>	<b>34.5</b>	<b>100.0</b>
Excluding Tanroad (Arusha)							
Samples	27	40	21	23	38	149	
<b>Fuel</b>	<b>8.9</b>	<b>8.5</b>	<b>7.1</b>	<b>3.2</b>	<b>23.4</b>	<b>11.3</b>	<b>39.1</b>
Electricity	21.9	14.3	27.4	24.1	8.4	17.6	60.9
<b>Total</b>	<b>30.8</b>	<b>22.7</b>	<b>34.5</b>	<b>27.3</b>	<b>31.8</b>	<b>28.9</b>	<b>100.0</b>

Energy consumption by sub-sector is summarized in Table D.2-4. Among the samples, Tanroads Office in Arusha consumes a large amount of electricity; excluding it, average energy consumption per sample is mostly similar at about 30 toe a year. Except for schools, electricity is consumed mainly and up to three quarters of the total energy consumption. Schools are using firewood heavily, mainly to prepare meals for students. Hotels and shops are using LPG and charcoal. Diesel gas oil is used widely for stand-by generators.

#### D.2.4 Household Sector

A total of 442 households were interviewed by the survey team covering the family members of 2,985. The following are the notes on the outcome:

- There are substantial variances in individual response, which may reflect character and knowledge of interviewers and interviewees. It should be noted that the data was collected by a single hearing by an interviewer, but not by measurement of actual consumption.
- Use of solar PV is reported widely, but the amount of energy provided is not known as no measuring system is available. Therefore, they are counted assuming the average capacity of 100W, insolation of 10 hours per day and utilization of 50%; that is, generation capacity is 1kWh per day and annual utilisation is 182.5kWh.

- c. Dry battery is counted as 5 Ah x 1.5 V per piece; that is, 7.5 watt-hour per piece.
- d. Candle is counted as 50g a piece and one piece is used for three days.
- e. Use of biogas or solar water heater was not reported.

Table D.2-6 Regional Demand Survey: Household Sector

		Annual energy consumption in original units							Total
		Arusha	Dodoma	Mbeya	Morogoro	Moshi	Mwanza	Tanga	
Families		53	50	82	70	64	66	57	442
Family members		406	324	453	352	305	620	525	2985
<b>In Original Units</b>									
<b>Traditional fuel</b>									
Firewood	kg	1,140	420	59,532	2,855	13,848	21,036	18,340	117,171
Agri. Residue	kg	0	0	0	0	0	1,504	0	1,504
Charcoal	kg	20,388	27,772	27,021	26,473	18,829	25,980	48,793	195,256
Sub-total		21,528	28,192	86,553	29,328	32,677	48,520	67,133	313,931
<b>Fossil Fuels</b>									
Coal	kg	0	0	0	0	0	360	0	
LPG	kg	4,521	2,289	2,737	2,890	4,892	4,946	8,299	30,574
City Gas	kg/m <sup>3</sup>	0	0	0	0	0	0	0	
Gasoline	liter	0	234	0	0	0	0	0	234
Kerosene	liter	3,572	24	630	588	2,726	1,482	1,293	10,315
Diesel	liter	0	0	0	0	0	0	0	0
Other (candle)	piece	0	0	0	0	0	1,500	0	1,500
Sub-total		8,093	2,547	3,367	3,478	7,618	8,288	9,592	42,983
<b>Electricity</b>									
From grid	kWh	29,708	54,497	33,704	68,925	48,300	37,413	69,729	342,275
Generator	kWh	0	0	0	0	0	169	0	169
Solar PV	kWh	366	183	512	548	183	2,799	365	4,954
Battery	kWh	0	0	0.0	2.0	0.0	2.1	5.0	9
Other (specify)	kWh	0	0	0	0	0	0	8.7	9
Sub-total		30,074	54,680	34,215	69,475	48,483	40,383	70,108	347,416
Biogas		m <sup>3</sup>							
Solar water heater		m <sup>3</sup>							
Other (specify)									
<b>Total</b>		<b>59,695</b>	<b>85,419</b>	<b>124,135</b>	<b>102,281</b>	<b>88,778</b>	<b>97,191</b>	<b>146,833</b>	<b>704,330</b>

The survey outcome is standardized for per capita energy consumption as shown in Table D.2-6, where the consumption of gasoline and diesel is excluded as transport fuel unless indicated as fuel for power generation. The gist of the outcome is as follows:

- a. The average energy consumption per capita is calculated to be 83kg oil equivalent, which is significantly smaller than 282kgoe reported in the IEA statistics.
- b. Fuel comprises 87.9% of the total energy consumption, whereas electricity a mere 12.1%.
- c. Among fuels, traditional biomass comprises 70.4%; where charcoal is preferred to firewood possibly because it is more convenient and less harmful for health.
- d. LPG appears penetrating fast, and being used much more frequently than kerosene.

Table D.2-7 Household Sector Energy Consumption per Capita

	Arusha	Dodoma	Mbeya	Morogoro	Moshi	Mwanza	Tanga	Total	
Traditional fuels	kgoe	kgoe	kgoe	kgoe	kgoe	kgoe	kgoe	kgoe	
Firewood	1.0	0.5	46.3	2.9	16.0	12.0	12.3	13.8	16.7%
Agri. Residue	-	-	-	-	-	0.9	-	0.2	0.2%
Charcoal	34.1	58.3	40.6	51.1	42.0	28.5	63.2	44.5	53.6%
Sub-total	35.1	58.7	86.9	54.0	58.0	41.3	75.5	58.5	70.4%
Fossil Fuels	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0%
Coal	-	-	-	-	-	0.2	-	0.0	0.1%
LPG	12.6	8.0	6.8	9.3	18.1	9.0	17.9	11.6	14.0%
City Gas	-	-	-	-	-	-	-	-	-
Gasoline	-	0.6	-	-	-	-	-	0.1	0.1%
Kerosene	7.2	0.1	1.1	1.4	7.3	2.0	2.0	2.8	3.4%
Diesel	-	-	-	-	-	-	-	-	-
Other (candle)	-	-	-	-	-	0.1	-	0.0	0.0%
Sub-total	19.8	8.6	8.0	10.7	25.5	11.3	19.9	14.5	17.5%
Fuel Total	54.9	67.4	94.8	64.7	83.4	52.6	95.4	73.0	87.9%
Composition	75%	92%	130%	89%	114%	72%	131%	100%	
Electricity									
From grid	6.3	14.5	6.4	16.8	13.6	5.2	11.4	9.9	11.9%
Generator	-	-	-	-	-	0.0	-	0.0	0.0%
Solar PV	0.1	0.0	0.1	0.1	0.1	0.4	0.1	0.1	0.2%
Battery	-	-	-	0.0	-	0.0	0.0	0.0	0.0%
Other (specify)	-	-	-	-	-	-	0.0	0.0	0.0%
Sub-total	6.4	14.5	6.5	17.0	13.7	5.6	11.5	10.0	12.1%
Total	61.3	81.9	101.3	81.6	97.1	58.2	106.9	83.0	100.0%
Ratio to average	74%	99%	122%	98%	117%	70%	129%	100%	
Adjusted the variance to the average down to a half									
Traditional Fuel	46.8	58.6	72.7	56.2	58.2	49.9	67.0	58.5	70.4%
Fossil Fuel	17.2	11.6	11.3	12.6	20.0	12.9	17.2	14.5	17.5%
Fuel Total	64.0	70.2	83.9	68.8	78.2	62.8	84.2	73.0	87.9%
Electricity	8.2	12.3	8.3	13.5	11.8	7.8	10.7	10.0	12.1%
Total	72.2	82.5	92.2	82.3	90.1	70.6	95.0	83.0	100.0%
Ratio to average	87%	99%	111%	99%	108%	85%	114%	100%	

### D.3 Revision of the IEA Energy Data

In view of the above observation, it is necessary to review the energy statistics for Tanzania before we consider the future energy picture of the country, particularly with regard to the treatment of traditional biomass consumption. Without consistent and reliable statistics, this would require many bold assumptions to estimate it. Without any other measures we have made such a bold approach by sector as discussed below, while keeping the IEA statistics for the transport sector intact:

#### 1) Residential Sector

Starting from the IEA statistics, residential energy consumption is revised as follows:

- Electricity consumption is replaced with the statistics adopted for the Power System Master Plan (PSMP) 2016 Update, which was compiled by reviewing the TANESCO data. They are considered as the grid-based electricity.
- Penetration of solar PV as an independent source for lighting is newly considered.
- Kerosene has been used for lighting and cooking, but its consumption is decreasing fast being

replaced by solar PV and LPG.

- d. LPG and biomass are used as home fuel. Biomass consumption is totally revised as discussed below.
- e. For the fossil fuel consumption, namely LPG and kerosene, the IEA statistics are adopted.

#### Fuel for Cooking and Heat

In Tanzania, charcoal is widely used as the main home fuel. According to the household survey in 2012, charcoal was used for cooking by about a quarter of all private households in Tanzania (25.7 percent). Urban areas heavily rely on charcoal as their main source of energy for cooking; 73.5 percent of all private households in Dar es Salaam Region, 52.1 percent in Mjini Magharibi Region (Zanzibar) and 32.5 percent in Mwanza Region. On the other hand, less than 10% of households used charcoal in seven other regions. Meanwhile, the Energy Access Situation Report 2016 reports that much more households are now using charcoal as cooking fuel, in particular in the urban area as shown in Table D.3-1.

Table D.3-1 Sources of Energy for Cooking :2016

	Household Reporting			Standardized		
	Total	Urban	Rural	Total	Urban	Rural
	%	%	%	%	%	%
Kerosene	5.0	13.3	0.9	4.1	9.3	0.8
Charcoal	37.0	79.3	16.3	30.6	55.7	14.8
Firewood	71.2	28.4	92.0	58.8	20.0	83.3
Gas	7.2	20.0	0.9	6.0	14.1	0.8
Electricity	0.3	1.0	0.1	0.2	0.7	0.1
Other	0.3	0.3	0.3	0.2	0.2	0.3
Total	121.0	142.3	110.5	100.0	100.0	100.0

Source: NBS/REA, "Energy Access Situation Report, 2016 – Tanzania Mainland"

The Regional Energy Demand Survey conducted at this time also revealed that charcoal was widely used at home; 61% of the combustible fuel and 76% of the traditional fuel. From these observations, we roughly assume for the traditional fuel use including firewood and charcoal that;

- a. The charcoal use ratio among the traditional fuel for urban households was at 60% for 2012 and 80% for 2016. Including Dar es Salaam, the ratio may be higher than the average of 76% for the selected cities surveyed at this time.
- b. For rural households it was 15% for 2012 and 25% for 2018.

Multiplying the urbanisation ratio for these years, i.e. 29.5% and 33.73%, overall charcoal use ratio is estimated at 28.3% for 2012 and 43.5% for 2018. Retroactively, we assume the charcoal use for 2000 was at 50% for urban and 5% for rural households. Values for intermediate years are interpolated as shown in Table D.3-2 below.

Table D.3-2 Estimation of Charcoal Use Ratio at Urban and Rural Households

	2000	2005	2010	2012	2018
Urbanization Ratio	22.3%	24.8%	28.1%	29.5%	33.7%
Charcoal Use Ratio					
Urban	50.0%	54.2%	58.3%	60.0%	80.0%
Rural	5.0%	9.2%	13.3%	15.0%	25.0%
Average	15.0%	20.3%	26.0%	28.3%	43.5%

Note: Urbanisation ratio is cited from the World Bank WDI. Ratio for 2018 is estimated by Author.

Of fossil fuels, we assume that 1) 5% of the total LPG consumption is used by industrial sector, 10% by commercial and services sector and 85% at household, 2) a half of the kerosene is used for cooking and the rest for lighting, and 3) the balance is allocated as the estimated consumption of primary biomass. Then, fuel use efficiencies are assumed for each fuel and applied for converting to an oil equivalent demand to energy consumption by fuel type.

Table D.3-3 Fuel Consumption Efficiency and Conversion Factor

	LPG	Kerosene	Charcoal	Biomass
Fuel Efficiency	50.0%	50.0%	35.0%	25.0%
Conversion Factor	100%	100%	143%	200%

Source: IEEJ

In place of the large number allotted in the IEA statistics, we use 75kg oil equivalent per person per year as the basis for household fuel consumption for 2018 as observed in the Regional Energy Demand Survey (Table D.2-6). Applying the above efficiency calculation, this reduces to 45kgoe in terms of the modern energy equivalent. Compared with the Japanese statistics, this can be roughly divided into 30kgoe for cooking, slightly higher than 25kgoe for Japan, and 15kgoe, or one-half of it, used for making hot water. We further assume that home fuel consumption has increased in line with a growth of per capita personal consumption at the elasticity of 0.3. A summary of the residential sector fuel consumption estimation is shown in Table D.3-7 below.

#### Energy for Lighting and Electricity

Table D.3-4 summarises the outcome of a survey on the sources for lighting for the mainland Tanzania. According to the survey, the grid connection ratio remains low. Kerosene lamps are still widely used, while solar power and rechargeable lamps were getting more popular.

Table D.3-4 Sources for Lighting: Mainland Tanzania

Survey	Kerosene	Candle	Firewood	Electricity	Solar Power	Rechargeable Lamps	Generator	Charcoal	Others	Total
	%	%	%	%	%	%	%	%	%	%
2012 Population and Housing Survey	40.6	1.3	2.0	18.9	1.4	14.9				79.1
2016 Energy Access Situation Survey	22.3	3.8	1.0	25.1	8.1	45.2	0.1	0.2	5.2	111.0
Rural	24.3	1.0	1.4	6.6	10.5	54.4	0.0	0.2	6.3	104.7
Urban	18.1	9.7	0.1	63.1	3.1	26.6	0.2	0.2	2.9	124.0

Source: NBS/REA, "Energy Access Situation Survey 2016"

In other table, composition of electricity sources is shown in Table D.3-5.

Table D.3-5 Electrification and Its Source

	Connected Ratio	Composition			Electrification by Source		
		Grid	Solar	Other	Grid	Solar	Other
	%	%	%	%	%	%	%
Urban	65.3	96.4	3.4	0.2	62.9	2.2	0.1
Rural	16.9	34.5	64.8	0.6	5.8	11.0	0.1
<b>Total</b>	<b>32.8</b>	<b>74.9</b>	<b>24.7</b>	<b>0.3</b>	<b>24.6</b>	<b>8.1</b>	<b>0.1</b>

Source: NBS/REA, "Energy Access Situation Survey 2016"

Incorporating these survey outcomes, we assume that:

- A half of kerosene is used for lighting while the rest is used for cooking as discussed above;
- Rechargeable lamps are charged with grid electricity and solar PV at the ratio of 30:70;
- Electricity consumption at a family using PV or rechargeable is 1/5 of that of a family connected to the grid in light of their weak generation power; and
- Candles and firewood can be neglected.

Thus, electricity consumption supplied by solar PV is estimated as follows. For 2015, the average electricity consumption per person connected to the grid is calculated to be 23.6kgoe or 275kWh per year in 2015 as the quotient of 190.7kgoe or 2,217GWh of electricity consumption divided by the population of 48.8 million and grid connection ratio of 16.6%. In a rough calculation, this equates to 1,129 kW of electricity consumption for three hours a day for a family of 4.5 persons. For a family depending on a weak power source such as PV or rechargeable, electricity consumption level may be 1/5 of a grid connected family. We further assume that the use of PV started around 2005 and has been accelerated recently thanks to the national rural electrification efforts and significant cost reduction of PV being experienced worldwide.

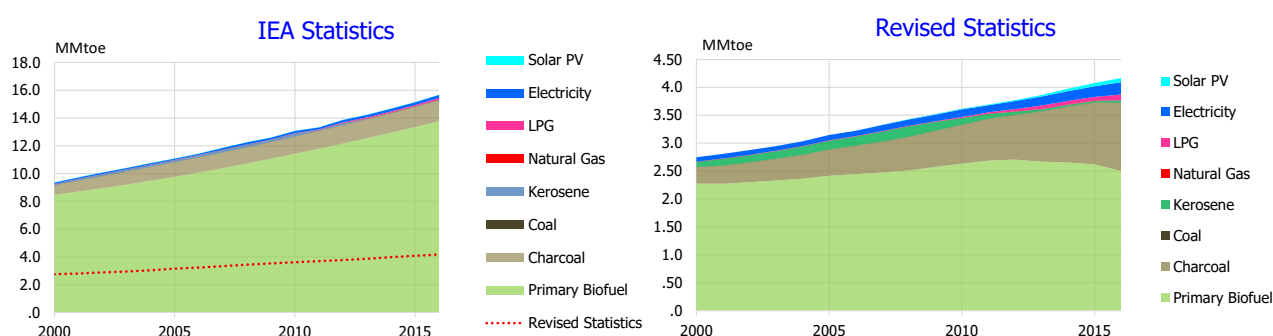
Table D.3-6 Estimated Electricity Consumption Supplied by PV

		2000	2005	2010	2012	2015
Population						
Rural	million	25.5	28.3	30.8	31.7	33.3
Urban	million	7.3	9.3	12.0	13.3	15.4
Total	million	32.8	37.6	42.8	44.9	48.8
Per capita Electricity Consumption						
Grid	kg oe	24.5	21.5	21.5	21.0	23.6
	kWh/year	285	250	250	244	275
3 hours for a family of 4.5	W	1,173	1,029	1,029	1,003	1,129
PV Penetration						
Rural	%	0.0%	0.0%	0.7%	4.2%	8.7%
Urban	%	0.0%	0.0%	0.0%	0.5%	1.5%
Total	%	0.0%	0.0%	0.5%	3.1%	6.4%
Rechargeable	%	0.0%	0.0%	7.5%	10.4%	26.3%
PV Supplied						
Rural	ktoe	0.0	0.0	0.9	2.7	13.7
Urban	ktoe	0.0	0.0	0.0	0.0	1.1
Rechargeable	ktoe	0.0	0.0	9.6	13.8	42.5
Total	ktoe	0.0	0.0	10.5	16.4	57.3

Source: Study Team

The above assumptions give us a guesstimate of solar energy supply in 2015 to be 75 ktoe, which is very close to the quantity of LPG imported in the same year. Major calculation factors are given in Table 5.3-6 above. Numbers for intermediate years are interpolated applying the milestone year estimates.

Summing up the above calculation, revised estimates of the residential sector energy consumption are shown in Figure D.3-1 and Table D.3-7. While the primary biomass still dominates, the total residential energy consumption per capita is 1/5 of the IEA estimation and indicates an increasing use of more convenient fuels such as charcoal and electricity. The revised estimation incorporating the outcome of the 2012 Population and Housing Census, the 2016 Energy Access Situation Survey and the Regional Energy Demand Survey would be much closer to the reality and more reasonable in view of the international comparison.



Source: Study Team

Figure D.3-1 Comparison of Residential Sector Energy Consumption

Table D.3-7 Revised Estimates of Residential Sector Energy Consumption.

	2000	2005	2010	2016	Composition				Growth Rate		
					2000	2005	2010	2016	00-->05	05-->10	10-->16
<b>IEA Statistics</b>	ktoe	ktoe	ktoe	ktoe	%	%	%	%	%	%	%
Coal	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Natural Gas	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
LPG	3	7	20	121	0.0	0.1	0.2	0.8	18.5	23.4	35.0
Kerosene	91	158	218	46	1.0	1.4	1.7	0.3	11.7	6.6	-22.8
Primary Biofuel	8,466	9,763	11,420	13,766	90.5	88.1	87.4	87.9	2.9	3.2	3.2
Charcoal	699	1,066	1,257	1,516	7.5	9.6	9.6	9.7	8.8	3.4	3.2
Electricity	91	83	150	215	1.0	0.7	1.1	1.4	-1.8	12.6	6.2
Solar PV	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
<b>Total</b>	<b>9,350</b>	<b>11,077</b>	<b>13,065</b>	<b>15,664</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>3.4</b>	<b>3.4</b>	<b>3.1</b>
<b>Per Capita (kg)</b>	<b>285</b>	<b>295</b>	<b>305</b>	<b>312</b>					<b>0.7</b>	<b>0.7</b>	<b>0.4</b>
<b>Revised Statistics</b>	ktoe	ktoe	ktoe	ktoe							
Coal	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Natural Gas	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
LPG	3	6	17	103	0.1	0.2	0.5	2.5	18.5	23.4	35.0
Kerosene	91	158	120	46	3.3	5.0	3.3	1.1	11.7	-5.4	-14.8
Primary Biofuel	2,274	2,415	2,633	2,500	82.8	76.8	72.8	60.0	1.2	1.7	-0.9
Charcoal	300	472	699	1,223	10.9	15.0	19.3	29.3	9.5	8.2	9.8
Electricity	79	95	136	220	2.9	3.0	3.8	5.3	3.7	7.5	8.3
Solar PV	0	0	11	76	0.0	0.0	0.3	1.8	-	-	39.0
<b>Total</b>	<b>2,747</b>	<b>3,146</b>	<b>3,615</b>	<b>4,168</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>2.7</b>	<b>2.8</b>	<b>2.4</b>
<b>Per capita (kg)</b>	<b>84</b>	<b>84</b>	<b>84</b>	<b>83</b>					<b>-0.0</b>	<b>0.2</b>	<b>-0.3</b>

Source: Study Team



## 2) Commercial and Services Sector

The IEA statistics discuss only electricity consumption for the commercial/services sector. However, there should be other energies consumed at restaurants, hotels, schools and other institutions for making meals, hot water supply and air conditioning.

Fuels in this sector are mainly used to prepare meals in the early stage of development. Figure D.3-2 shows the distribution of energy consumption among sub-sectors and evolution of per capita fuel consumption for cooking in Japan in the residential and commercial sectors. The residential sector fuel consumption has stayed almost at the same level since 1970s, while that for the commercial sector per urban population rose constantly until it reached about 35kg per year around the year 2005. This may represent changes in the Japanese life style to eat out or purchase prepared meals more frequently as people get richer and more women prefer to work out of home. Accordingly, more cooking fuel is consumed today in the services sector than at home. Among others, electricity consumption for appliances has risen sharply as a result of development of intellectual technology.

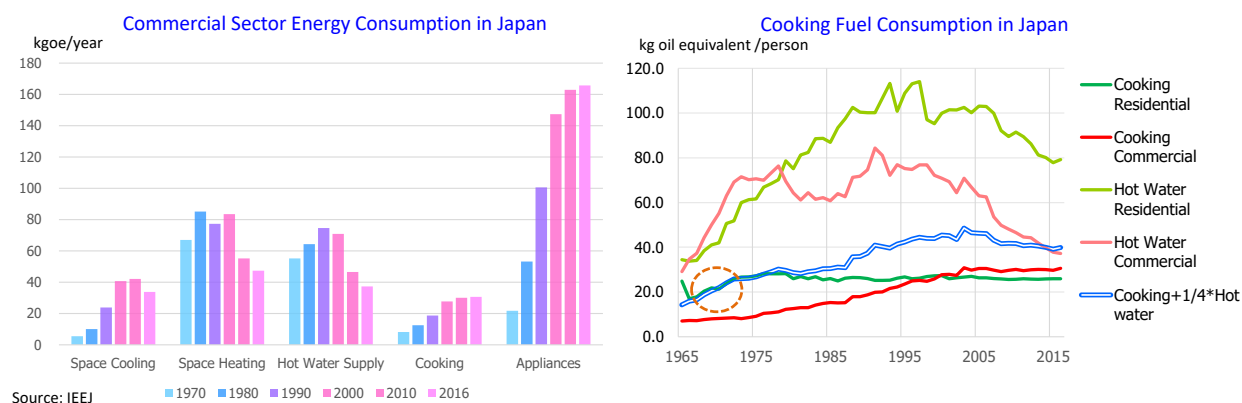


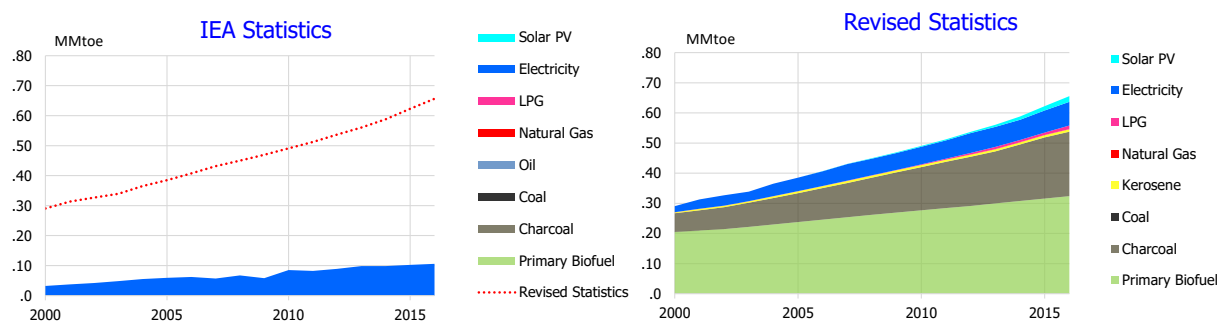
Figure D.3-2 Fuel Consumption of Commercial Sector and Cooking in Japan

In our guesstimation for Tanzania, we assume 20kg per urban population fuel consumption for cooking for 2016 applying the figures experienced in early 1970s in Japan, that is, 10kgoe for cooking and 1/5 of 50kgoe for hot water as climate is milder in Tanzania. We also assume that a half of the fuel was supplied by firewood from the outcome of the Regional Energy Demand Survey, which may have been at 70% in 2000. According to the Regional Energy Demand Survey, a certain amount of LPG is consumed in this sector. Hence, we assume that a 10% of the LPG consumption listed in the IEA statistics was made in the commercial and services sector. The balance is allotted to charcoal, and the data for intermediate years are interpolated.

As for the electricity demand which is mainly used for lighting, air conditioning and hot water supply, the figures used for the PSMP 2016 are adopted, which are listed as the commercial sector demand and the power transmission amount for Zanzibar, while we reclassify the amount recorded as electricity consumption at the state owned gold mine into industrial use. These figures are deemed as the demand for the grid. In addition, solar PV is being increasingly used at schools, hospitals and tourist

accommodations in remote locations. It is presumed that such quantity may amount to a quarter of the household use.

The commercial/services sector energy consumption thus estimated is compiled in Figure D.3-3 and Table D.3-8 below. It includes the small amount of natural gas delivered to hotels in Dar es Salaam under an experimental CNG project.



Source: Study Team

Figure D.3-3 Comparison of Energy Consumption of Commercial and Services Sector

Table D.3-8 Revised Estimates of Commercial/Services Sector Energy Consumption

	2000	2005	2010	2016	Composition				Growth Rate		
					2000	2005	2010	2016	00-->05	05-->10	10-->16
<b>IEA Statistics</b>	ktoe	ktoe	ktoe	ktoe	%	%	%	%	%	%	%
Coal	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Natural Gas	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
LPG	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Kerosene	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Primary Biofuel	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Charcoal	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Electricity	32	59	85	106	100.0	100.0	100.0	100.0	13.0	7.6	3.7
Solar PV	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
<b>Total</b>	<b>32</b>	<b>59</b>	<b>85</b>	<b>106</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>13.0</b>	<b>7.6</b>	<b>3.7</b>
<b>Per Capita (kg)</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>2</b>					<b>10.0</b>	<b>4.8</b>	<b>1.1</b>
<b>Revised Statistics</b>	ktoe	ktoe	ktoe	ktoe							
Coal	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Natural Gas	0	0	0.2	0.3	0.0	0.0	0.0	0.0	-	-	7.6
LPG	0	1	2	12	0.1	0.2	0.4	1.8	18.5	23.4	35.0
Kerosene	3	6	7	8	1.0	1.6	1.4	1.2	15.0	3.1	2.1
Primary Biofuel	205	238	277	324	70.6	61.8	56.5	49.4	3.0	3.1	2.7
Charcoal	62	96	143	214	21.5	24.9	29.2	32.6	9.0	8.4	6.9
Electricity	20	45	59	79	6.8	11.6	12.0	12.0	17.6	5.7	5.0
Solar PV	0	0	3	19	0.0	0.0	0.5	2.9	-	-	39.0
<b>Total</b>	<b>290</b>	<b>385</b>	<b>491</b>	<b>656</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>5.8</b>	<b>5.0</b>	<b>5.0</b>
<b>Per capita (kg)</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>13</b>					<b>3.0</b>	<b>2.3</b>	<b>2.2</b>

Source: Study Team

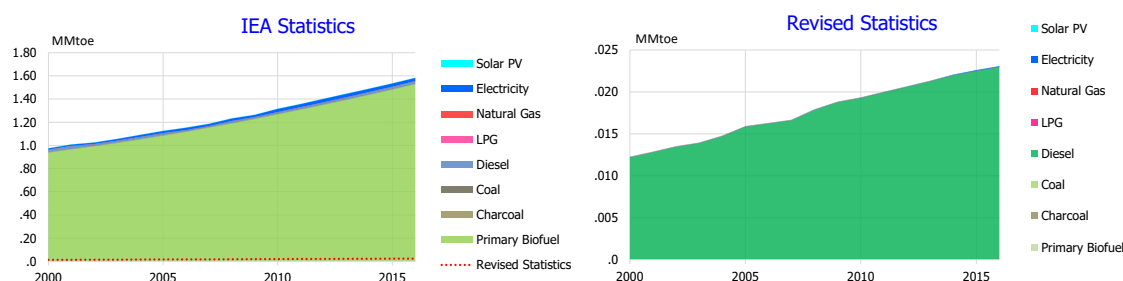
### 3) Agriculture and Others

For the agriculture, forestry and fishery sectors and non-specified energy consumption, we have revised the IEA statistics as below in view of the discussion in Section D.1.

- Reject the primary biomass consumption data listed in the IEA statistics.
- Assume that diesel consumption for 2016 in the IEA statistics, i.e. 23 ktoe, has increased proportionately with the increase of agricultural GDP.
- Adopt the very small amount of electricity consumption data in the PSMP 2016 Update, which

was provided by TANESCO.

Although the military sector may use energy, if we consider the active force of 27,000, fuel needed to prepare meals may be 1 ktoe or so a year. Therefore, the energy use in the non-specified sector is not considered in this study.



Source: Study Team

Figure D.3-4 Comparison of Energy Consumption of Agriculture and Other Sector

Table D.3-9 Revised Estimates of Agricultural and Other Sector Energy Consumption

	2000	2005	2010	2016	Composition				Growth Rate		
					2000	2005	2010	2016	00-->05	05-->10	10-->16
<b>IEA Statistics</b>	ktoe	ktoe	ktoe	ktoe	%	%	%	%	%	%	%
Coal	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Natural Gas	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
LPG	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Oil	22	19	17	23	2.3	1.7	1.3	1.5	-2.9	-2.2	5.2
Primary Biofuel	942	1,087	1,271	1,532	96.6	96.6	96.6	96.8	2.9	3.2	3.2
Charcoal	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Electricity	11	19	28	28	1.1	1.7	2.1	1.8	11.6	8.1	0.0
Solar PV	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
<b>Total</b>	<b>975</b>	<b>1,125</b>	<b>1,316</b>	<b>1,583</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>2.9</b>	<b>3.2</b>	<b>3.1</b>
Per Capita (kg)	30	30	31	32					0.1	0.5	0.5
<b>Revised Statistics</b>	ktoe	ktoe	ktoe	ktoe							
Coal	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Natural Gas	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
LPG	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Kerosene	12	16	19	23	100.0	100.0	100.0	99.6	5.4	4.0	3.0
Primary Biofuel	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Charcoal	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Electricity	0	0	0	0	0.0	0.0	0.0	0.4	43.1	12.9	43.1
Solar PV	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
<b>Total</b>	<b>12</b>	<b>16</b>	<b>19</b>	<b>23</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>5.4</b>	<b>4.0</b>	<b>3.0</b>
Per capita (kg)	0	0	0	0					2.5	1.3	0.3

Source: Study Team

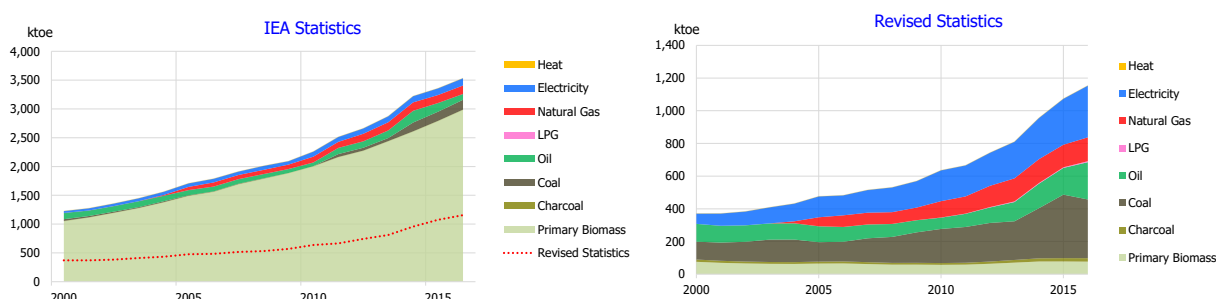
Note here that the most radical decision made is to exclude primary biomass from energy consumption. A substantial quantity of woods and agricultural residues may be being burnt not as energy but just for disposal of them. In the future, however, energy-driven machines will replace cattle and horses and more fishing boats will be motorised. Only the energy required for such activities should be considered for the future energy planning.

As the diesel consumption data in the IEA statistics is very small, i.e. 20 ktoe per year or so, and shows erratic movements, the figures are smoothed out considering the growth of agricultural value added.

## 4) Industrial sector

For the industrial sector, the IEA data has been revised as discussed below:

- Adopt the IEA statistics for natural gas and oil consumption, and, for LPG, allocate 5% of the total LPG consumption.
- For the cement industry, it is assumed that 0.1 ktoe of energy is required to produce 1 tonne of cement, with 5% of which being electricity. The IEA statistics are adopted for natural gas consumption in the cement industry, and the balance is deemed to be supplied with coal.
- Adopt the PSMP 2016 Update data on electricity consumption for industry and the government owned gold mine, while redefine it for cement industry as discussed above and the rest for general industries.
- Primary biomass is used generally among food and tobacco industry, paper and pulp industry, and wood and wood products industry. Such industries are not so predominant in Tanzania<sup>5</sup>. Accordingly, the biomass consumption data is redefined applying the outcome of the Regional Energy Demand Survey. It is assumed that their share against the total fossil fuel consumption is 10% for firewood and 5% for charcoal in 2018. On top of this, 20 ktoe is added as biomass consumption at the Iringa pulp and paper plant. The calculated total biomass consumption in the industrial sector is 98ktoe for 2016 or just 3% of 2,989 ktoe estimated by the IEA. It is further assumed that these ratios have evolved from 30% and 10%, respectively for firewood and charcoal in 2000 and improved to the present figures as above.



Source: Study Team

Figure D.3-5 Comparison of Energy Consumption of Industrial Sector

The above calculation results in the industrial sector energy consumption of 23kgoe per person in 2016, which is roughly 1/5 of that for the Philippines and Indonesia in the same year, while the per capita GDP of Tanzania is about 1/4 of the average per capita GDP of these two countries.

The outcome of the above revision is shown in Figure D.3-5 and Table D.3-10. With the above approach, primary biomass consumption in the industrial sector remains almost the same between 2000 and 2016. This looks more realistic than the IEA estimation which suggests that the Tanzanian industry has developed mainly depending on the biomass consumption (over 80%) which almost trebled between

<sup>5</sup> Mufindi Paper Company operating in Iringa with an annual production capacity of 60,000 tonnes is one of such plants identifiable in Tanzania. As there is no information on its energy consumption, its annual energy consumption may be in the range of 20 ktoe or so applying 15,000MJ or .35 oil tonne per paper tonne as a benchmark

2000 and 2016. Thus, the total industrial energy consumption in 2016 is calculated to be about 1/3 of the IEA estimate, while the annual growth rate is higher at 7.4% instead of 6.8% and it is accelerating in recent years.

Table D.3-10 Revised Estimates of Industrial Sector Energy Consumption

	2000	2005	2010	2016	Composition				Growth Rate		
					2000	2005	2010	2016	00-->05	05-->10	10-->16
<b>IEA Statistics</b>	ktoe	ktoe	ktoe	ktoe	%	%	%	%	%	%	%
Coal	30	7	0	170	2.4	0.4	0.0	4.8	-25.3	-100.0	-
Natural Gas	0	55	100	146	0.0	3.2	4.4	4.1	-	12.7	6.5
LPG	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Oil	109	90	64	102	8.9	5.3	2.8	2.9	-3.8	-6.6	8.1
Primary Biomass	1055	1494	2007	2,989	86.0	87.5	88.8	84.6	7.2	6.1	6.9
Charcoal	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Combustible Fuel Total	1194	1646	2171	3,407	97.3	96.4	96.1	96.4	6.6	5.7	7.8
Electricity	33	62	89	127	2.7	3.6	3.9	3.6	13.4	7.5	6.1
Electricity Ratio	2.7%	3.6%	3.9%	3.5%					6.2	1.6	-2.0
Heat	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Total	1227	1708	2260	3,534	100.0	100.0	100.0	100.0	6.8	5.8	7.7
Per Capita (kg)	37.4	45.4	52.8	71.6					4.0	3.0	5.2
GDP Intensity	0.074	0.072	0.071	0.075					-0.3	-0.3	0.8
<b>Revised Statistics</b>											
Coal	109	119	209	359	29.4	25.0	32.8	31.1	1.7	11.9	9.5
Natural Gas	0	55	100	146	0.0	11.6	15.7	12.7	-	12.7	6.5
LPG	0	0	1	6	0.0	0.1	0.2	0.5	18.5	23.4	35.0
Oil	109	97	69	228	29.4	20.4	10.9	19.8	-2.3	-6.6	22.0
Primary Biomass	76	69	66	77	20.4	14.6	10.3	6.6	-1.7	-1.1	2.6
Charcoal	14	12	12	21	3.8	2.6	1.8	1.8	-2.2	-1.4	10.5
Combustible Fuel Total	308	348	447	837	83.0	73.1	70.3	72.6	2.5	5.1	11.0
Electricity	63	128	189	317	17.0	26.9	29.7	27.4	15.2	8.1	9.0
Electricity Ratio	17.0%	26.9%	29.7%	26.2%					9.6	2.0	-2.1
Heat	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Total	371	476	636	1,154	100.0	100.0	100.0	100.0	5.1	6.0	10.4
Per Capita (kg)	11.3	12.7	14.8	23.4					2.3	3.2	7.9
GDP Intensity	0.022	0.020	0.020	0.024					-1.9	-0.1	3.4
<b>Cement Industry</b>											
Coal	79	93	178	199	95.0	67.9	76.8	60.2	3.2	13.9	1.9
Natural Gas	0	37	42	40	0.0	27.1	18.2	12.1	-	2.6	-0.8
Oil Products	0	0	0	75	0.0	0.0	0.0	22.7	-	-	-
Electricity	4	7	12	17	5.0	5.0	5.0	5.0	10.4	11.1	6.1
Total	83	137	231	331	100.0	100.0	100.0	100.0	10.4	11.1	6.1
<b>General Industry</b>											
Coal	30	26	31	160	10.4	7.7	7.7	19.4	-2.6	3.4	31.4
Natural Gas	0	18	58	106	0.0	5.3	14.3	12.9	-	26.4	10.6
LPG	0	0	1	6	0.1	0.1	0.2	0.7	18.5	23.4	35.0
Oil	109	97	69	153	37.9	28.6	17.1	18.6	-2.3	-6.6	14.2
Primary Biomass	76	65	57	77	26.3	19.1	14.1	9.3	-3.0	-2.5	5.0
Charcoal	14	12	11	21	4.8	3.5	2.7	2.6	-3.0	-1.8	11.7
Combustible Fuel Total	229	218	227	523	79.6	64.3	56.2	63.5	-0.9	0.8	14.9
Electricity	59	121	177	300	20.4	35.7	43.8	36.5	15.6	7.9	9.2
Electricity Ratio	20.4%	35.7%	43.8%	36.5%					11.8	4.2	-3.0
Heat	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Total	287	339	404	823	100.0	100.0	100.0	100.0	3.4	3.6	12.6

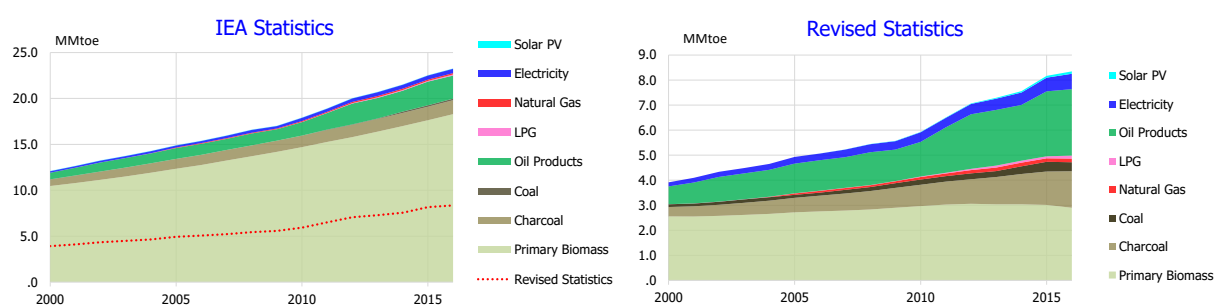
Source: Study Team

## 5) Summary

The outcome of the above analysis is summarized in Figure D.3-6 and Table D.3-11. The final energy consumption for 2016 is revised downward from 23,233 ktoe to 8,347 ktoe or by 14,886 ktoe, where consumption of primary biomass is reduced by 15,444 ktoe.

Under the revised statistics, the share of the traditional fuels (primary biomass and charcoal) among the total final energy consumption falls from 85% estimated in the IEA statistics to almost 52%, while charcoal's share becomes much higher though its absolute quantity is estimated lower. Coal consumption becomes higher than the IEA estimates as the cement production in Tanzania has been

adopted as the basis for estimation.



Source: Study Team

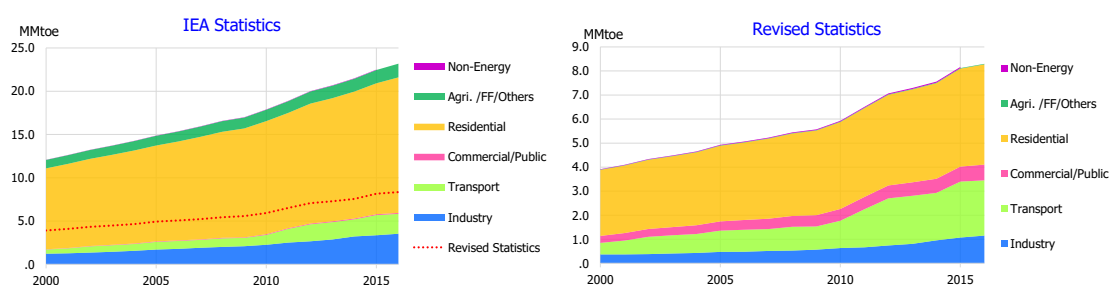
Figure D.3-6 Comparison of Total Final Energy Consumption

Table D.3-11 Revised Estimates of Final Energy Consumption

	2000	2005	2010	2016	Composition				Growth Rate		
					2000	2005	2010	2016	00-->05	05-->10	10-->16
<b>IEA Statistics</b>	ktoe	ktoe	ktoe	ktoe	%	%	%	%	%	%	%
Coal	30	7	0	170	0.2	0.0	0.0	0.7	-25.3	-100.0	-
Natural Gas	0	55	100	146	0.0	0.4	0.6	0.6	-	12.7	6.5
LPG	3	7	20	121	0.0	0.0	0.1	0.5	18.5	23.4	35.0
Oil Products	718	1,175	1,466	2,517	5.9	7.9	8.2	10.8	10.4	4.5	9.4
Primary Biomass	10,463	12,344	14,698	18,287	86.6	83.0	82.1	78.7	3.4	3.6	3.7
Charcoal	699	1,066	1,257	1,516	5.8	7.2	7.0	6.5	8.8	3.4	3.2
Combustible Fuel Total	11,913	14,654	17,541	22,757	98.6	98.5	98.0	98.0	4.2	3.7	4.4
Electricity	167	223	352	476	1.4	1.5	2.0	2.0	6.0	9.6	5.2
Solar PV	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
Heat	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
<b>Total</b>	12,080	14,877	17,893	23,233	100.0	100.0	100.0	100.0	4.3	3.8	4.4
Per capita (kg)	368	396	418	463					1.5	1.1	1.7
Traditional Fuel	11,162	13,410	15,955	19,803	92.4	90.1	89.2	85.2	3.7	3.5	3.7
<b>Revised Statistics</b>											
Coal	109	119	209	359	2.8	2.4	3.5	4.3	1.7	11.9	9.5
Natural Gas	0	55	100	146	0.0	1.1	1.7	1.8	-	12.7	6.5
LPG	3	7	20	121	0.1	0.1	0.3	1.4	18.5	23.4	35.0
Oil Products	711	1,185	1,382	2,651	18.2	24.0	23.3	31.8	10.7	3.1	11.5
Primary Biomass	2,555	2,718	2,967	2,901	65.2	55.1	50.0	34.8	1.2	1.8	-0.4
Charcoal	376	579	853	1,458	9.6	11.7	14.4	17.5	9.0	8.0	9.4
Combustible Fuel Total	3,754	4,663	5,531	7,636	95.9	94.6	93.3	91.5	4.4	3.5	5.5
Electricity	162	267	384	616	4.1	5.4	6.5	7.4	10.5	7.5	8.2
Solar PV	0	0	13	95	0.0	0.0	0.2	1.1	-	-	39.0
Heat	0	0	0	0	0.0	0.0	0.0	0.0	-	-	-
<b>Total</b>	3,916	4,931	5,928	8,347	100.0	100.0	100.0	100.0	4.7	3.8	5.9
Per capita (kg)	119	131	138	166					1.9	1.1	3.1
Traditional Fuel	2,931	3,297	3,820	4,359	74.8	66.9	64.4	52.2	2.4	3.0	2.2

Source: Study Team

The new estimation by sector is summarized in Figure D.3-7 and Table D.3-12. The share of the residential sector is revised downward; for 2000 from 77% to 70% and for 2016 from 67% to 50%. The share of the agriculture sector is revised to below 1%, since biomass disposal should not be considered as energy consumption. Instead, the commercial sector share is found to be around 8%. The transport sector energy consumption is now 1/3 of the total final energy consumption and is growing fast. It should be noted that the IEA statistics for the transport sector is adopted here. However, it does not include jet fuel, consumption of which is increasing rapidly in recent years.



Source: Study Team

Figure D.3-7 Comparison of Final Energy Consumption by Sector

Table D.3-12 Revised Estimates of Final Energy Consumption by Sector

	2000	2005	2010	2016	Composition				Growth Rate		
					2000	2005	2010	2016	00-->05	05-->10	10-->16
<b>IEA Statistics</b>	ktoe	ktoe	ktoe	ktoe	%	%	%	%	%	%	%
Industry	1227	1708	2260	3534	10.2	11.5	12.6	15.2	6.8	5.8	7.7
Transport	479	884	1135	2297	4.0	5.9	6.3	9.9	13.0	5.1	12.5
Commercial/Public	32	59	85	106	0.3	0.4	0.5	0.5	13.0	7.6	3.7
Residential	9350	11077	13065	15664	77.4	74.5	73.0	67.4	3.4	3.4	3.1
Agri. /FF/Others	975	1125	1316	1583	8.1	7.6	7.4	6.8	2.9	3.2	3.1
Non-Energy	17	24	32	49	0.1	0.2	0.2	0.2	7.1	5.9	7.4
<b>Total</b>	<b>12080</b>	<b>14877</b>	<b>17893</b>	<b>23233</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>4.3</b>	<b>3.8</b>	<b>4.4</b>
<b>Revised Statistics</b>											
Industry	371	476	636	1,154	9.5	9.7	10.7	13.8	5.1	6.0	10.4
Transport	479	884	1,135	2,297	12.2	17.9	19.1	27.5	13.0	5.1	12.5
Commercial/Public	290	385	491	656	7.4	7.8	8.3	7.9	5.8	5.0	5.0
Residential	2,747	3,146	3,615	4,168	70.1	63.8	61.0	49.9	2.7	2.8	2.4
Agri. /FF/Others	12	16	19	23	0.3	0.3	0.3	0.3	5.4	4.0	3.0
Non-Energy	17	24	32	49	0.4	0.5	0.5	0.6	7.1	5.9	7.4
<b>Total</b>	<b>3,916</b>	<b>4,931</b>	<b>5,928</b>	<b>8,347</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>4.7</b>	<b>3.8</b>	<b>5.9</b>

Source: Study Team

We believe the above analysis is closer to the reality than the IEA estimation. However, it is still far from a realistic analysis. In Tanzania, either systematic approach to collect comprehensive energy data or trial to formulate consistent energy balance table is yet to be challenged. Under the circumstance, the Study Team conducted Regional Energy Demand Survey in order to obtain basic data and information. The survey has brought us a lot of realistic information, but the outcome is still insufficient as discussed in Section D.2. In order to prepare a reliable data base for policy making, it is desired to periodically conduct comprehensive energy surveys.

Three years have passed since the above assessment was made. In these years, IEA has made significant downward revisions on estimates of primary biomass and charcoal consumption in industry and household sectors as shown in Table D.3-13. Even so, the revised statistics look still involving substantial over-estimate. This is simply inferred by the fact that per capita energy consumption in the revised statistics show steady decline in the long run since 2005. It is impossible that per capita energy consumption keeps declining over decades in an economy that is steadily growing at annual 7%.

Table D.3-13 Changes in IEA Statistics

	IEA 2018				IEA 2021					Changes			
	2000	2005	2010	2016	2000	2005	2010	2016	2019	2000	2005	2010	2016
<b>IEA Statistics</b>	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe
Coal	30	7	0	170	30	7	0	170	439	0	0	0	0
Natural Gas	0	55	100	146	0	55	100	146	148	0	0	0	0
LPG	3	7	20	121	3	7	20	121	145	0	0	0	0
Oil Products	718	1175	1466	2517	703	1179	1417	2018	1839	-15	4	-49	-499
Primary Biomass	10463	12344	14698	18287	10463	12337	13583	14499	14775	0	-7	-1115	-3788
Charcoal	699	1066	1257	1516	699	824	966	1156	1222	0	-242	-291	-360
Combustible Fuel Total	11913	14654	17541	22757	11898	14409	16086	18110	18568	-15	-245	-1455	-4647
Electricity	167	223	352	476	167	223	352	462	574	0	0	0	-14
Solar PV	0	0	0	0	0	0	0	0	0	0	0	0	0
Heat	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Total</b>	<b>12080</b>	<b>14877</b>	<b>17893</b>	<b>23233</b>	<b>12065</b>	<b>14632</b>	<b>16438</b>	<b>18572</b>	<b>19142</b>	<b>-15</b>	<b>-245</b>	<b>-1455</b>	<b>-4661</b>
Per capita (kg)	368	396	418	463	369	389	384	365	342	1	-7	-34	-99
Traditional Fuel	11162	13410	15955	19803	11162	13161	14549	15655	15997	0	-249	-1406	-4148
Industry	1227	1708	2260	3534	1227	1316	1412	1756	2009	0	-392	-848	-1778
Transport	479	884	1135	2297	479	906	1162	1753	1637	0	22	27	-544
Commercial/Public	32	59	85	106	32	59	85	97	157	0	0	0	-9
Residential	9351	11077	13065	15664	9351	11039	12259	13239	13562	0	-38	-806	-2425
Agri. /FF/Others	975	1125	1316	1583	975	1306	1502	1607	1634	0	181	186	24
Non-Energy	17	24	32	49	17	24	33	50	59	0	0	1	1
<b>Total</b>	<b>12081</b>	<b>14877</b>	<b>17893</b>	<b>23233</b>	<b>12081</b>	<b>14650</b>	<b>16453</b>	<b>18502</b>	<b>19058</b>	<b>0</b>	<b>-227</b>	<b>-1440</b>	<b>-4731</b>

Source: IEA World Energy Balances 2018 and 2021

Hence, we adopted the same modification as explained in this section as shown in Table D.3-14. Oil consumption in the IEA statistics show irregular movement, so it is modified by the study team applying several assumptions, while it still includes high uncertainties. Compared with the IEA statistics, primary biomass consumption is revised downward significantly for industry and residential sectors, and, as a result, the total final energy consumption is now about a half of the IEA estimation. Nevertheless, evolution of per capita energy consumption looks much more realistic. This data is applied for estimation of the post-COVID-19 energy outlook of Tanzania as discussed in Section 5.2 of the principal report.

Table D.3-14 Revised Statistics on Final Energy Consumption

	IEA 2021					JICA Study Team 2021					Changes				
	2000	2005	2010	2016	2019	2000	2005	2010	2016	2019	2000	2005	2010	2016	2019
<b>IEA Statistics</b>	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe
Coal	30	7	0	170	439	109	100	178	302	439	79	93	178	132	0
Natural Gas	0	55	100	146	148	0	55	100	146	182	0	0	0	0	34
LPG	3	7	20	121	145	3	7	20	121	145	0	0	0	0	0
Oil Products	703	1,179	1,417	2,018	1,839	721	1,202	1,438	2,783	3,255	18	23	21	765	1,416
Primary Biomass	10,463	12,337	13,583	14,499	14,775	2,515	2,689	2,909	2,988	2,974	-7,948	-9,648	-10,674	-11,511	-11,801
Charcoal	699	824	966	1,156	1,222	398	600	868	1,497	1,893	-301	-224	-98	341	671
Combustible Fuel Total	11,898	14,409	16,086	18,110	18,568	3,746	4,653	5,514	7,837	8,888	-8,152	-9,756	-10,572	-10,273	-9,680
Electricity	167	223	352	462	574	162	267	384	667	853	-5	44	32	205	279
Solar PV	0	0	0	0	0	0	0	11	65	94	0	0	11	65	94
Heat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Total</b>	<b>12,065</b>	<b>14,632</b>	<b>16,438</b>	<b>18,572</b>	<b>19,142</b>	<b>3,908</b>	<b>4,920</b>	<b>5,909</b>	<b>8,570</b>	<b>9,835</b>	<b>-8,157</b>	<b>-9,712</b>	<b>-10,529</b>	<b>-10,002</b>	<b>-9,307</b>
Per capita (kg)	369	389	384	365	342	120	131	138	168	176	-250	-258	-246	-196	-167
Traditional Fuel	11,162	13,161	14,549	15,655	15,997	2,913	3,289	3,777	4,485	4,866	-8,249	-9,872	-10,772	-11,170	-11,131
Industry	1227	1316	1412	1756	2009	369	442	592	1104	1372	-858	-874	-820	-652	-637
Transport	479	906	1162	1753	1637	479	905	1162	2435	2892	0	-1	0	682	1255
Commercial/Public	32	59	85	97	157	287	385	500	683	771	255	326	415	586	614
Residential	9351	11039	12259	13239	13562	2733	3144	3605	4274	4716	-6618	-7895	-8654	-8965	-8846
Agri. /FF/Others	975	1306	1502	1607	1634	22	19	17	23	25	-953	-1287	-1485	-1584	-1609
Non-Energy	17	24	33	50	59	17	24	33	50	59	0	0	0	0	0
<b>Total</b>	<b>12081</b>	<b>14650</b>	<b>16453</b>	<b>18502</b>	<b>19058</b>	<b>3908</b>	<b>4920</b>	<b>5909</b>	<b>8570</b>	<b>9835</b>	<b>-8173</b>	<b>-9730</b>	<b>-10544</b>	<b>-9932</b>	<b>-9223</b>

Source: JICA Study Team



Due to outbreak of the COVID-19 pandemic, JICA Study Team could not visit Tanzania since January 2020. During this period, Study Team tried to deepen the energy demand analysis on the areas surveyed by the 2018 Regional Energy Demand Survey using the Google Earth satellite images (see Appendix-A and B). In addition, the team asked Ministry of Energy to conduct market research in 2021 on these cities to obtain latest and more affirmative information. We discuss its outcome in Chapter 5 of the principal report. It is still under analysis at the time of this report, but shows similar trends found by the 2018 REDS as discussed in Section D.2. With a limited number of survey and research, it is still a challenging issue in Tanzania to formulate a credible energy statistics. We hope that these activities will be expanded so that a credible information base will be developed for support of policy makers.



## Appendix E: Japanese Legislation on Gas Operation

### E.1 Japanese Legislation relating to LNG

Japan is the largest importer of LNG in the world. Japanese engineering companies have built more than 80% of LNG plants in the world. But Japan has only one small LNG plant in the country producing LNG from natural gas and several small ones reproducing LNG from boil-off gas at LNG receiving terminals.

#### E.1.1 Japanese Laws on LNG

Japan does not have any law specifically prepared for LNG plants. LNG plants, as well as other refineries, chemical plants and high pressure gas plants are operated under a bunch of relevant laws. Japanese law system is not very smart; there are old general laws and new specific laws to be observed for construction of an LNG plant as below:

- 1) Basic Laws
  - a. Fire Service Act (1948)
  - b. Factory Location Act (1959)
  - c. Basic Act on Energy Policy (2002)
  - d. Mining Act (1950)
  - e. Basic Environment Law and Air Pollution Control Act (1993/1968)
  - f. Environmental Impact Assessment Act (1997)
- 2) Specific Laws relating to LNG Plants
  - a. High Pressure Gas Safety Act (1951)
  - b. Act on the Prevention of Disaster in Petroleum Industrial Complexes and Other Petroleum Facilities (1975)
  - c. Petroleum Pipeline Business Act (1972)
  - d. Act on Improvement of Pollution Prevention Systems in Specified Factories (1971)
  - e. Gas Business Act (1954)
  - f. Act on the Securing of Safety and the Optimization of Transaction of Liquefied Petroleum Gas (LP Gas Act) (1967)
  - g. Act concerning Supervising Installation Work of Specified Gas Appliance (1979)

The Fire Service Act is the baseline for treatment of hazardous materials. But it is old (re-set in 1948 after the World War II) and refers to only solid and liquid materials (gas is not covered). Therefore, the High Pressure Gas Safety Act (1951) is the baseline for oil and gas complex, which was later reinforced by the Act on the Prevention of Disaster in Petroleum Industrial Complexes and Other Petroleum Facilities (1975). The Gas Business Act (1954) mainly refers to city gas business. The LPG Act was set out only in 1967 to cover bottled service of LPG.

As far as gas pipeline is concerned, the Mining Act covers pipeline construction and operation dedicated for upstream operation (including gas supply to final users), the Gas Business Act covers piped city gas supply and the LPG Act covers mini-gas grid such as community gas using LPG.

## E.1.2 Japanese Law system

- 1) Japanese law system is as follows:
  - Laws and Acts ..... approved at Parliament
  - Cabinet Order ..... announced by Cabinet
  - Ministerial Order or Ordinance ... announced by Ministry
  - Regulations ..... announced by Ministry
  - Guidelines ..... announced by Ministry
  - Public Notice ..... announced by Ministry
- 2) Bills and draft orders are in principle consulted at designated committees and sub-committees comprising representatives from academies, industries and consumers (government officers act as secretaries but not members of these committees) before finalization.
- 3) Study on standards, inspections and examinations for certificates are carried out by specifically established institutes and usually announce by Ministerial Ordinance.

## E.2 Japanese Regulations on Gas Pipelines

### E.2.1 Gas Business Act

#### Revised Gas Business Act

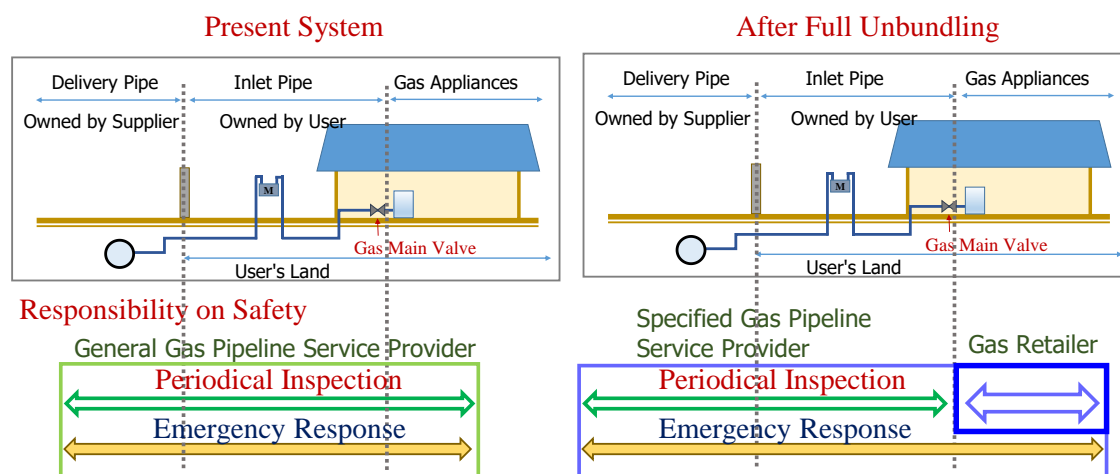
The Gas Business Act is a law stipulating various provisions for businesses that supply gas via pipeline (city gas service) for the purpose of ensuring safety and protecting the interests of gas users. The Act, which came into effect in 1954, was partially amended in 2015 and thereafter put into effect on April 1, 2017. The points of the above amendment related to the pipeline service business in the revised Gas Business Act are discussed below:

1. Enhancement of gas pipeline network:
  - a. The current system of regional monopoly and tariff regulation applying to general gas pipeline service providers are preserved to ensure a stable supply.
  - b. All gas pipeline service providers are required to make efforts to interconnect respective pipelines.
  - c. For the purpose of expanding interconnection of pipelines, a system has been established allowing the government to instruct and arbitrate consultations between relevant business entities.
2. Ensuring safety and supply security
  - a. Legal obligations are imposed upon gas pipeline service providers such as conventional city gas service providers concerning safety of pipeline networks as well as inspections and emergency safety measures covering the internal piping owned by small-scale users. Costs of such safety endeavours will be secured systematically by means of the provisions in the transportation service agreements, etc., to ensure such costs will be recovered without fail.

- b. In preparation for cases where a gas retailer becomes unable to supply gas, general gas pipeline service providers are required to make the last resort supply available.
3. Legal unbundling of pipeline business sector and restrictions on business practices:
- a. For the purpose of enhancing the neutrality of gas pipeline service business, as a regulation targeted specifically at the three major gas companies (namely, Tokyo Gas, Osaka Gas, and Toho Gas), as defined in terms of the total controlled pipeline length, will be prohibited in principle from conducting the hitherto approved LNG terminal and retail businesses concurrently with the gas pipeline service business (hereinafter referred to as the “legal unbundling” of gas pipeline service business). Meanwhile, gas suppliers excluding the three major companies mentioned above shall maintain the "account unbundling" system of bookkeeping.
  - b. Relevant restrictions shall be placed on business practices such as personnel management and accounting, so that pipeline companies do not undermine the neutrality and fairness of competition by giving preferential treatment to retail business units within the respective business group.
  - c. The legal unbundling of the gas pipeline service business comes into effect on April 1, 2022.
4. Other points of note:
- a. Those who provide gas supplies through transportation service within the licensed service area are administered as the "general gas pipeline service provider" (applicable to the license system), and conventional gas pipeline service providers that supply gas to specified service points through transportation service are administered as the "specified gas pipeline service provider" (applicable to the notification system).
  - b. The responsibilities for the safety of gas pipes (pipelines and internal piping) according to the Gas Business Act after its revision are to be assigned as shown in the Fig. 1 schematic diagram: The gas retailer will be responsible for carrying out regular inspections from the gas main valve (excluding) to the consumer equipment in the dwelling unit, whereas the general gas pipeline service provider will be responsible for the periodic inspections on pipelines owned by itself as well as the portion of the internal piping drawn into the customer premises up to the gas main valve (including).
  - c. However, in emergencies, the general gas pipeline service provider shall be responsible for entire safety measures covering the facility extending beyond the gas main valve<sup>1</sup>.

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<sup>1</sup> The gas retailer shall also cooperate with the general gas pipeline service provider, for instance by acting as a contact point for customers.



Source: METI

Figure E-1 Safety Responsibility Sharing

Between General Gas Pipeline Service Providers and Gas Retailers

[Reference] Major laws and regulations concerning the gas pipeline service business and the gas pipeline service provider:

## 1) Law:

Gas Business Act (Law No. 51 of 1954, Amendment: Law No. 41 of 2017)<sup>2</sup>

## 2) Cabinet Order:

Gas Business Act Enforcement Ordinance (Cabinet Order No. 68 of 1954, Amendment: Cabinet Order No. 40 of 2017)<sup>3</sup>

## 3) Ministerial Ordinance:

- Gas Business Act Enforcement Regulations (Ministry of International Trade and Industry Ordinance No. 97, 1970, Amendment: March 30, 2018 Ministry of Economy, Trade and Industry Ordinance No. 8)
- Ministerial Ordinance Establishing Technical Standards for Gas Facilities (Ministry of International Trade and Industry Ordinance No. 111, 2000, Amendment: Ministry of Economy, Trade and Industry Ordinance No. 8, 2018)

Regulations concerning gas pipelines and technical standards for the design and maintenance of related facilities other than those stipulated in the Gas Business Act will be described in the section "3. Other related regulations and technical standards".

## E.2.2 Latest movements and discussions on the Gas Business Act and gas pipeline businesses

The following issues are noteworthy as the latest movements and discussions held on laws and regulations related to the gas pipeline business since the 2015 revision of the Gas Business Act:

<sup>2</sup> <http://www.japaneselawtranslation.go.jp/law/detail/?id=3331&vm=04&re=01&new=1>

<sup>3</sup> <http://www.japaneselawtranslation.go.jp/law/detail/?id=2333&vm=04&re=01&new=1>

1. Legal unbundling of pipeline service as applied to the three major gas companies:

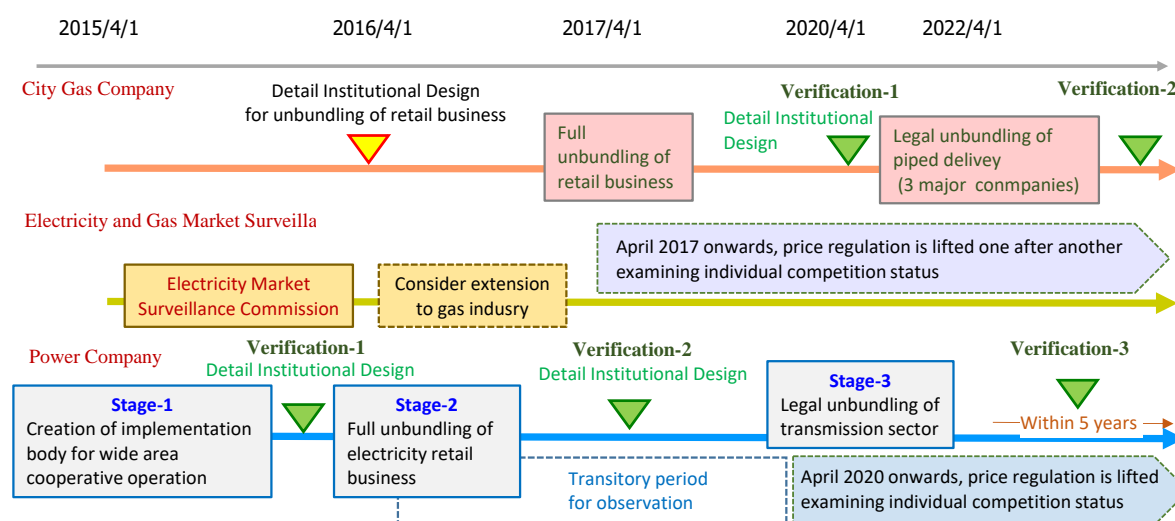
Pursuant to the 2015 revision of the Gas Business Act, prohibition of conducting retail or manufacturing businesses concurrently with the pipeline service business (“legal unbundling”), as well as restrictions on certain business practices related to personnel management, subcontracting, etc., will be introduced starting from April 1, 2022. The foregoing rules apply to gas pipeline service providers falling under the category as defined by the government ordinance based on parameters such as the length of pipeline under their control.

Behind the above mandates have been historical developments in which safeguarding of the neutrality of the pipeline sector became an issue in the full liberalization of gas retailing. Such circumstances arose because of acts on the part of pipeline operators, such as a discriminately treatment of new entrants or inappropriate use of information obtained by a pipeline service provider being shared with a limited number of gas retailers.

Under the current Gas Business Act, regulations such as the "account unbundling" (Article 53) and the "information barrier" (Article 54) have been introduced. In the former ruling, if a general gas pipeline service provider engages in a business other than its principal line of business, it must separate the bookkeeping for the pipeline service business and related activities, and publicize the results.

However, from the perspective of ensuring neutrality, fairness, and transparency, as well as curtailing unfair advantages in competition, based on the assessment that the conventional account unbundling alone will not suffice for such objectives, the legal unbundling of the pipeline sector will be introduced for the general gas pipeline service business owned by the three major companies (i.e., Tokyo Gas, Osaka Gas, Toho Gas).

Note that similarly in the electricity business, full liberalization of electricity retailing started in April 2016, or one year prior to the full liberalization of gas retailing in April 2017. In the case of the electricity business, its distribution sector had been legally unbundled since April 2020.



Source: METI

Figure E-2 Timeline toward the legal unbundling and related events in the pipeline sector.

The provisions related to the legal unbundling and business practice restrictions stipulated in the Gas Business Act are as follows:

Gas Business Act<sup>4</sup> (Law No. 51 of 1954, Amendment: Law No. 41 of 2017)

(Note) Provisions under the following articles will come into effect as of April 1, 2022:

Article 54 (Prohibited Acts)

Article 54-2 (Restriction on Concurrent Business)

Article 54-3 (Organs of Special General Gas Pipeline Service Provider<sup>5</sup>)

Article 54-4 (Restriction on Concurrent Holding of Positions by Directors or Executive Officers of a Special General Gas Pipeline Service Provider)

Article 54-5 (Prohibited Conduct for a Special General Gas Pipeline Service Provider)

Article 54-6 (Restriction on Assignment of an Employee of a Special General Gas Pipeline Service Provider to Engage in Work as an Employee of a Specified Related Service Provider of the Special General Gas Pipeline Service Provider by the Specified Related Service Provider)

Article 54-7 (Prohibited Acts for a Specified Related Service Provider of a Special General Gas Pipeline Service Provider)

Article 54-8 (Development of Systems for Ensuring Proper Competitive Relationship among Gas Supply Service Providers)

Note: Similar provisions as above apply to the specified gas pipeline service provider, as set forth in Articles 80 to 80-8 of the Gas Business Act.

The criteria for the applicable enterprises for the legal unbundling of the pipeline sector was debated in the Gas System Reform Subcommittee of the Ministry of Economy, Trade and Industry, and the principles on categorizing the target enterprises were reported in the minutes of the committee.

In Japan, there are about 200 general gas pipeline service providers, of which about 80% are small-to-medium enterprises with 100 or less employees. Meanwhile, as a peculiar character of city gas service in Japan, the gas pipeline networks have been developed based on LNG receiving terminals as the originating point. However, in a pipeline network with substantially large-scale where multiple LNG terminals are connected, there is a possibility that the method of sending out gas from each of LNG terminals involved may vary.

Based on the above analysis, it was concluded that the target enterprises for applying the legal unbundling should be those who own: (a) a pipeline system extending to a total length accounting for approximately 10% or more of the national total, and (b) a plural number of LNG terminals operated by different business entities are connected with the pipelines under their control. Eventually, a Cabinet Order specifying the enterprise (termed as the “special general gas pipeline service provider”) applicable for the legal unbundling was promulgated in August 2020 as described below:

<sup>4</sup> <http://www.japaneselawtranslation.go.jp/law/detail?id=3331&vm=04&re=01&new=1>

<sup>5</sup> The “Special General Gas Pipeline Service Provider” refers to a “service provider whose pipelines used for the general gas pipeline service business have an overall scale equal to or larger than that specified by Cabinet Order and who falls under other conditions as set forth by Cabinet Order” (Gas Business Act :Law No. 51 of 1954, Amendment: Law No. 41 of 2017, Supplementary Provisions: Act No. 47 of June 24, 2015 [Extract])



“Cabinet Order for Partial Revision of the Gas Business Act, and of the Cabinet Order Concerning Transitional Measures upon Enforcement of the Act for Partial Revision of the Electricity Business Act”

[Date of Promulgation] August 13, 2020

[Date of Enforcement] April 1, 2022

## Summary

### 1) Partial Revision of Order for Enforcement of the Gas Business Act:

Pipeline service providers who fall under the two sub-items below shall become subject to the legal unbundling (Note).

- a. The total length of owned pipelines is 26,000 kilometres or more;
- b. Two or more LNG terminals are connected to owned pipelines (limited, however, to the case where the terminals are operated and maintained by two or more different parties).

(Note) There are only three pipeline service providers that meet both (a) and (b) above, namely, Tokyo Gas, Osaka Gas, and Toho Gas. (As of August 7, 2020)

### 2) Partial Revision of the Cabinet Order Concerning Transitional Measures upon Enforcement of the Act for Partial Revision of the Electricity Business Act

- In order to reduce the tax burden associated with the legal unbundling, the pipeline service provider applicable to the provision 1) above is exempt from the registration and license tax (i.e., taxation related to record-keeping or registration associated with the legal unbundling).
- This Cabinet Order comes into effect as of the date of promulgation.

## 2. Deliberations on judgment criteria for change or suspension orders concerning the pipeline redundancy regulation

The pipeline redundancy regulation refers to a system applicable in a case where the service point of a specified gas pipeline service business according to the relevant notification is included in the service area of a general gas pipeline service provider. In such a case, if the government finds that such business undertaking is likely to harm the interests of gas users in the service area of the general gas pipeline service provider, the government is authorized to order the person who has given the notification to change the content of the notification or suspend its performance of the specified gas pipeline service business thereof. (Gas Business Act, Article 72)

Note: Similar provisions are stipulated applying to the notification pertaining to a specified gas pipeline service business conducted by connecting the pipelines used therefor to the pipelines used for its general gas pipeline service business. (Gas Business Act, Article 55)

The purpose of the pipeline redundancy regulation is to utilize efficiently the existing pipeline network, to suppress the increase in pipeline utilization cost in the service area of the general gas pipeline service business, and to promote the formation of an efficient pipeline network. More specifically, the

objective is to prevent the interests of all pipeline users from being impaired due to escalation in the transportation service charge reflecting an increase in the pipeline utilization cost.

Judgment on the issuance of a change or suspension order in the pipeline redundancy regulation is made through the following two steps:

#### 1) Categorization of notification types

In this exercise, the contents filed with the notification on the specified gas pipeline service business are examined and determined as to which of the following three categories the notification in question falls under: i.e., "types that do not require a change or suspension order", "types that require a change or suspension order", and "types for which the necessity of a change or suspension order is judged by the assessment on potential harm on consumer interests based on the amount of demand to be gained by the business according to the notification".

The above judgment is made from the viewpoint of: (a) whether the supplied gas related to the notification in question cannot be supplied via the transportation service using the pipeline of the general gas pipeline service provider, and (b) whether the gas user is actually being supplied with gas via the pipeline of the general gas pipeline service provider.

#### 2) Assessment of potential harm on consumer interests based on the amount of demand to be gained:

The necessity of issuing a change or suspension order is judged with regard to the specified gas pipeline service business that seeks to capture the "existing demand" that is currently being supplied with gas via the pipeline of the general gas pipeline service provider. The above judgement shall be made against the criteria dictating that "in principle, acquisition of existing demand equivalent to 4.5% of network demand is allowed for the period covering three fiscal years following the full liberalization of gas retailing."

Since the criteria for issuing a change or suspension order related to the current pipeline redundancy regulation was organized as a system applicable for the period of FY2017-2019, the Gas Business System Review Working Group of Ministry of Economy, Trade and Industry discussed in 2019 the criteria applicable for FY2020 and beyond. The outcomes of the discussion are summarized below:

- a. In order to enhance the business predictability for new entrants the new criteria should clarify that the point of time slated for the intended demand gain by the notification for the specified gas pipeline business should be defined as the "time of notification".
- b. For the period from FY2006 to 2018, in which statistics are made available for each service area of general gas pipeline service providers, assuming an average annual growth rate of network demand is defined as  $a\%$ , a theoretical value of  $\frac{1}{a}$  years and  $3a\%$  shall be used to calculate the benchmark (hereinafter referred to as the "allowable demand gain") for the potential harm on consumer interests for the three year-period from FY2020 to 2022.

After that, the assessment of potential harm on consumer interests shall be carried out based on the latest available growth rates of network demand projected for the subsequent three-year period, whereas a residual portion of the percentage allotted for the previous period, if any, will not be carried over to the said period.

In addition, in order to improve the business predictability of new entrants, the government, upon request, shall disclose the allowable demand gain not later than half a year before the start of the new period (i.e., by the end of September).

- c. By shifting to the new system that calculates the allowable demand gain for each service area, a situation may arise where the allowable demand gain allotted for the period beginning from April 2020 becomes less than the remainder of the FY2017-2019 benchmark level (i.e., 4.5%). For such areas, in consideration of the business predictability of new entrants, the said residual portion shall be treated as the allowable demand acquisition applicable only to the FY2020-2022 period as a measure to mitigate drastic changes.

### E.2 3. Other regulations and technical standards

In addition to the Gas Business Act, there are other laws and regulations applicable to gas pipelines in Japan including the "Electricity Business Act" and the "High Pressure Gas Safety Act". In Japan, applicable laws and regulations differ depending on the business operator, e.g., the "Gas Business Act" is applied to gas companies, and the "Electricity Business Act" governs the electric power utilities.

As most of the gas pipelines in Japan are installed under the road, the "Road Act" is used to regulate such instances. In addition, the "River Act" applies to pipelines installed in river areas, and, when the gas pipeline is passing through agricultural land, forests, wilderness, or privately owned properties, various regulations apply to gas pipelines for each section where the right of way is granted. High-pressure gas pipelines are sometimes laid in mountainous areas across the country, in which case the "Mining Act" and the "Mine Safety Act" may be applied.

As large-scale earthquakes have occurred recurrently in Japan since early times, the seismic standards for pipelines have been repeatedly reviewed and updated. In recent years, for instance, "The 1995 South Hyogo Prefecture Earthquake" (a.k.a. "The Great Hanshin-Awaji Earthquake") caused a huge impact on the Kansai metropolitan area. Although no serious damage was made to the high-pressure gas pipelines by this earthquake, which registered a maximum seismic intensity of 7, triggered by the experience, the "Seismic Design Code for High-Pressure Gas Facilities" was revised in 2000, in which the soil response speed to be used as the seismic computation input has been raised up to approximately four times that of the previous level. In the same year, performance requirement for related equipment and fitting was stipulated by the "Ministerial Ordinance Establishing Technical Standards for Gas Facilities" regulating gas facilities such as gas generators, pipelines, and so forth. This made it possible for gas companies to establish individual design specifications based on their own needs and responsibility.

In 2000, the High Pressure Gas Safety Association published the "Guideline for the Seismic Design of

the High Pressure Gas Facilities" in which the wavelength of ground vibration was amended with a smaller figure. In 2001, the Japan Gas Association published the "High Pressure Gas Pipeline Seismic Design Code for Liquefaction", bringing the lateral flow of the ground into consideration as a parameter in the seismic design and addressing the longstanding issue since the 1964 Niigata Earthquake.

#### Principal applicable legislation

- Gas Business Act
- Electricity Business Act (Act No. 170 of 1964)
- High Pressure Gas Safety Act (Act No. 204 of 1951)
- Road Act (Law No. 180 of 1952)
- River Act (Act No. 167 of 1964)
- Mining Act (Act No. 289 of 1950)
- Mine Safety Act (Act No. 70 of 1945)

#### Principal technical standards for construction and maintenance of gas facilities

- Ministerial Ordinance Establishing Technical Standards for Gas Facilities (Ministry of Economy, Trade and Industry Ordinance No. 15 of 2017)
- Japanese Industrial Standards (Japanese Standards Association)
- High Pressure Pipeline Guidelines (2014) (Japan Gas Association<JGA>)
- Seismic Design Code for High-Pressure Gas Pipeline (2013) (JGA)
- High Pressure Gas Pipeline Seismic Design Code for Liquefaction (2016) (JGA)
- Specifications for Highway Bridges with Interpretation (2017) (Japan Road Association)
- A Guide to “Cabinet Order to Establish Technical Standards for River Management Facilities” (2000) (Japan Institute of Country-ology and Engineering)
- Standard Specification for Tunneling-2016 (2016) (Japan Society of Civil Engineers)
- Architectural Infrastructure Design Guidelines (2019) (Architectural Institute of Japan <AIJ>)
- AIJ Standard for Allowable Stress Design of Steel Structures (2019) (AIJ)

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