POTENTIAL FOR REGIONAL USE OF EAST AFRICA'S NATURAL GAS

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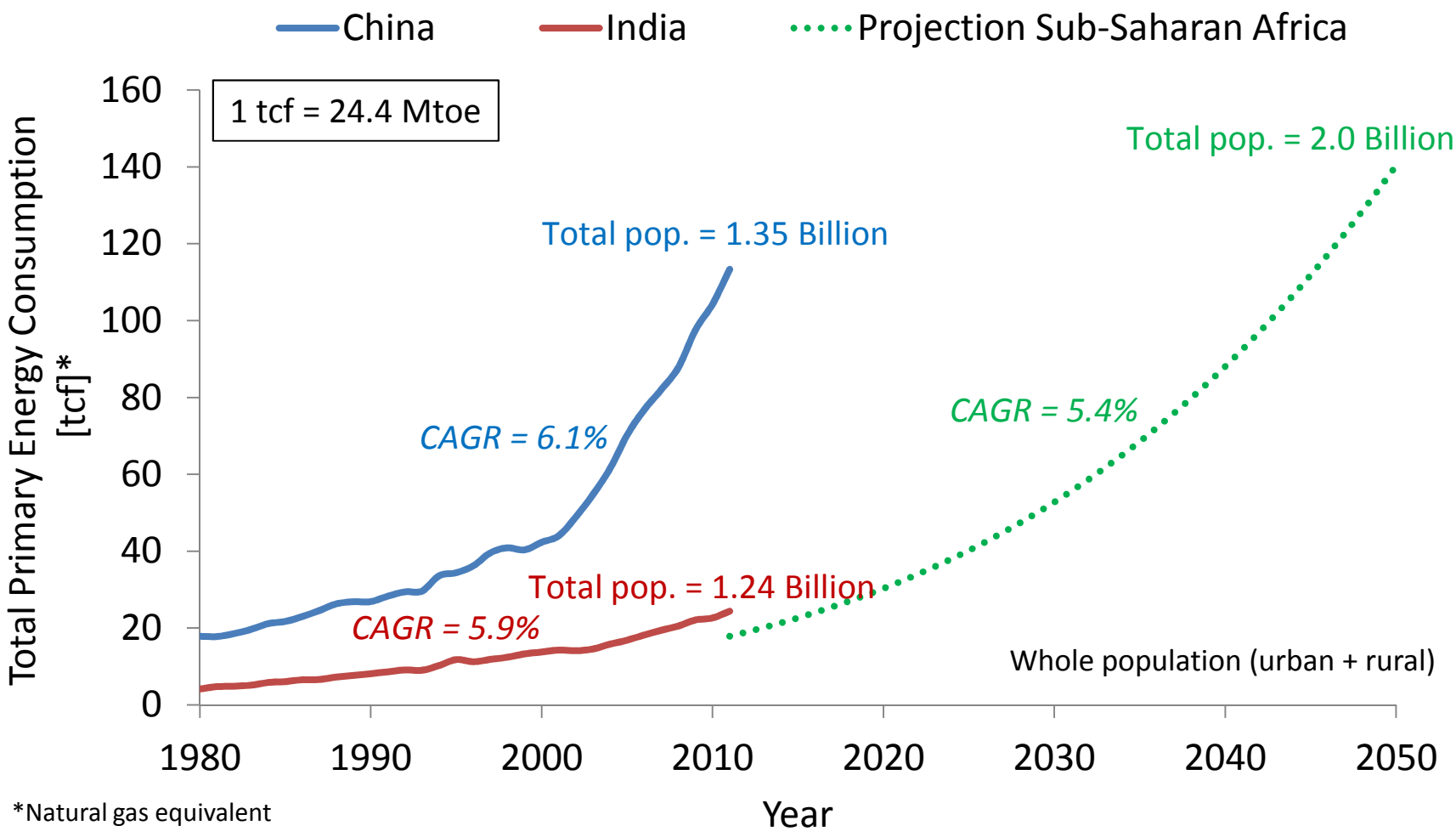
MOTIVATION

- Longer term view
- Substantial fuel needs in cooking, transport, fertilizer prod, industry, power
- Same time, large gas finds
- Also working on synergy with renewables
- Benefits from similar integration in power
- Shared prosperity: meeting domestic needs in parallel with export incomes

Projection of Primary Energy Demand

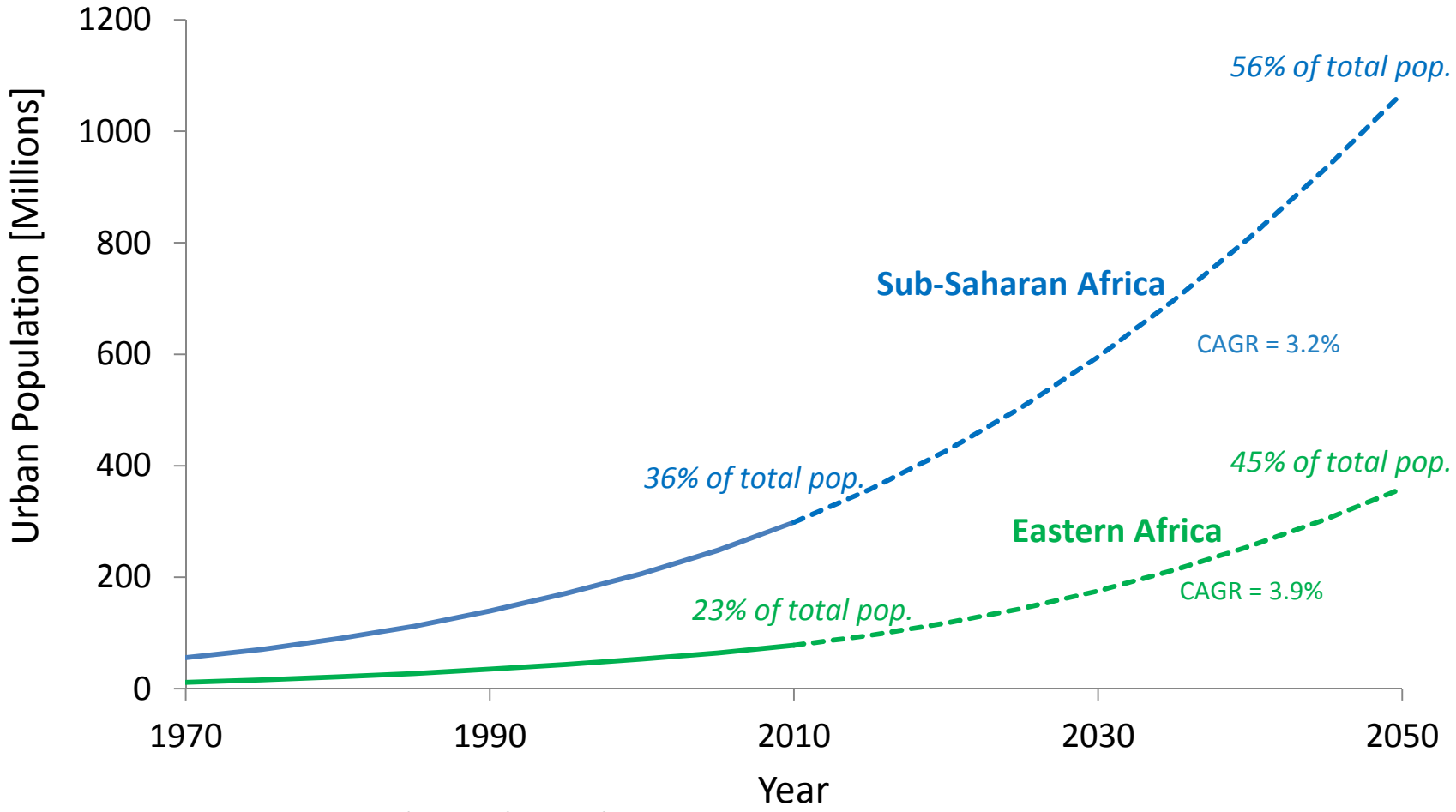


*Natural gas equivalent

Sources:
China's and India's consumption: EIA 2014
Sub-Saharan Africa's projection: own calculations

CAGR = Compound Annual Growth Rate

Urbanizing World: 45% of total by 2050
Eastern Africa (UN DESA definition)

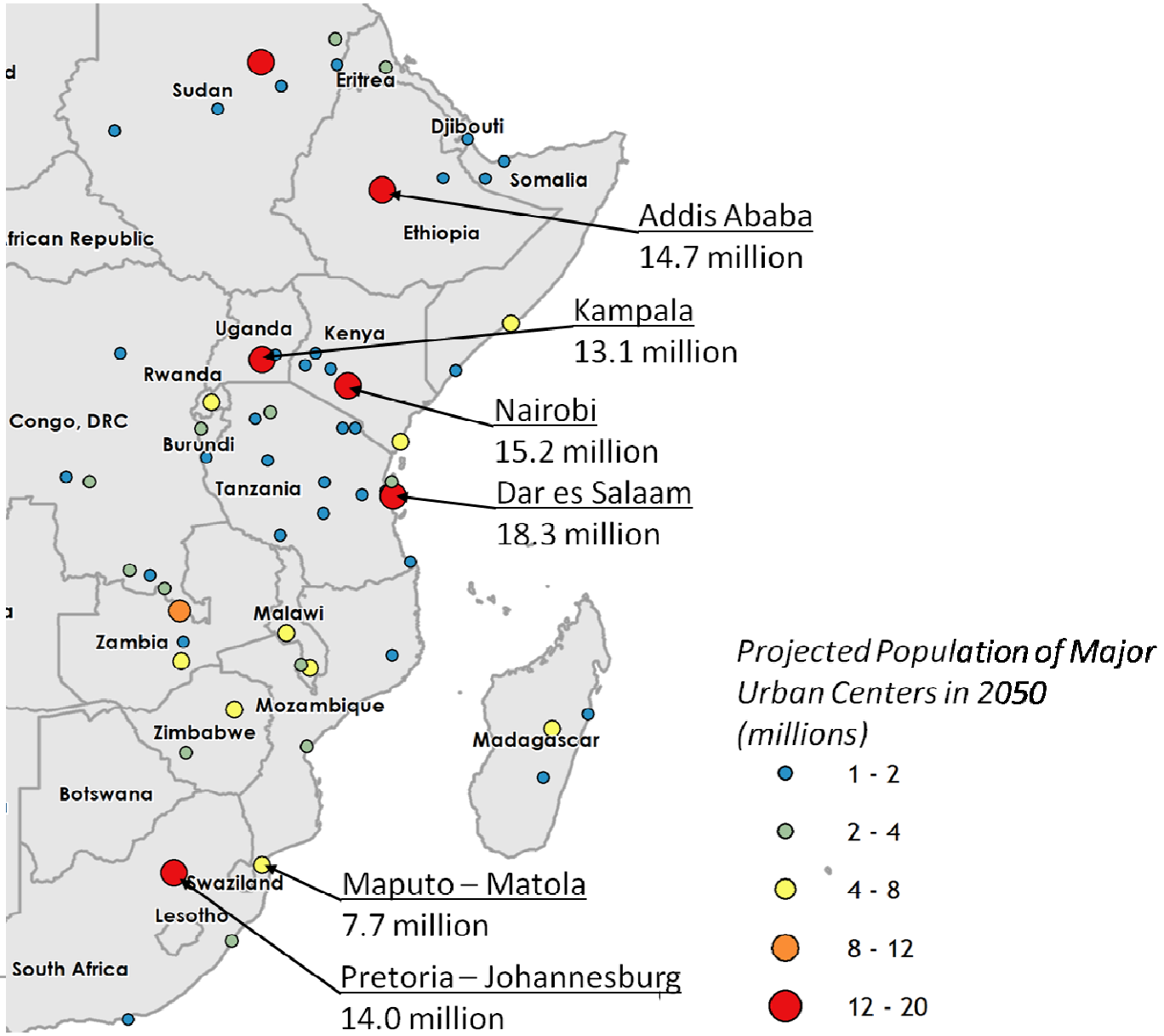


CAGR = Compound Annual Growth Rate

Major Urban Centers of the Region

In 2050

- 6 Cities with more than 12 million
- 16 Cities with more than 4 million



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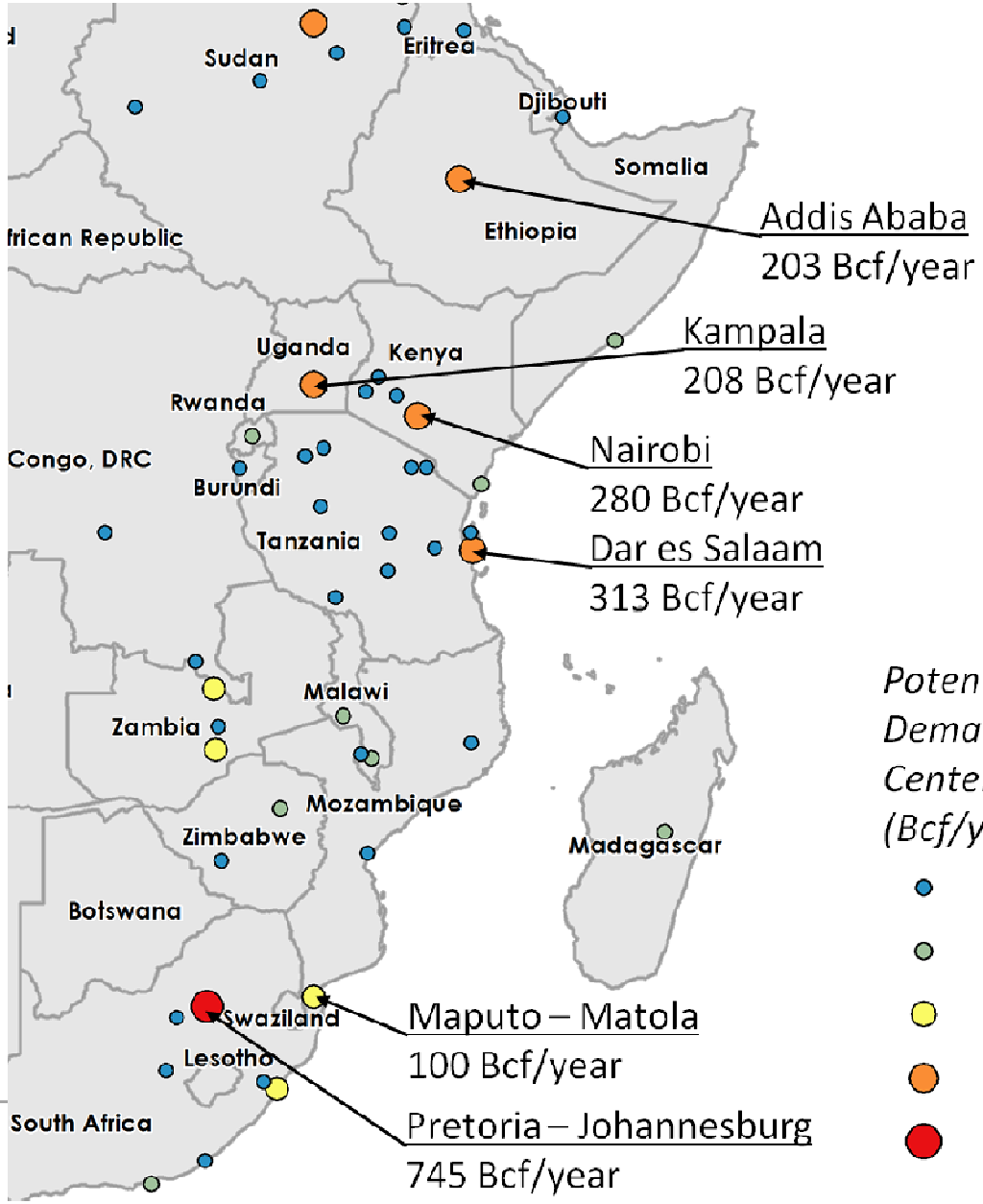
Potential City Gas Demand in the Region



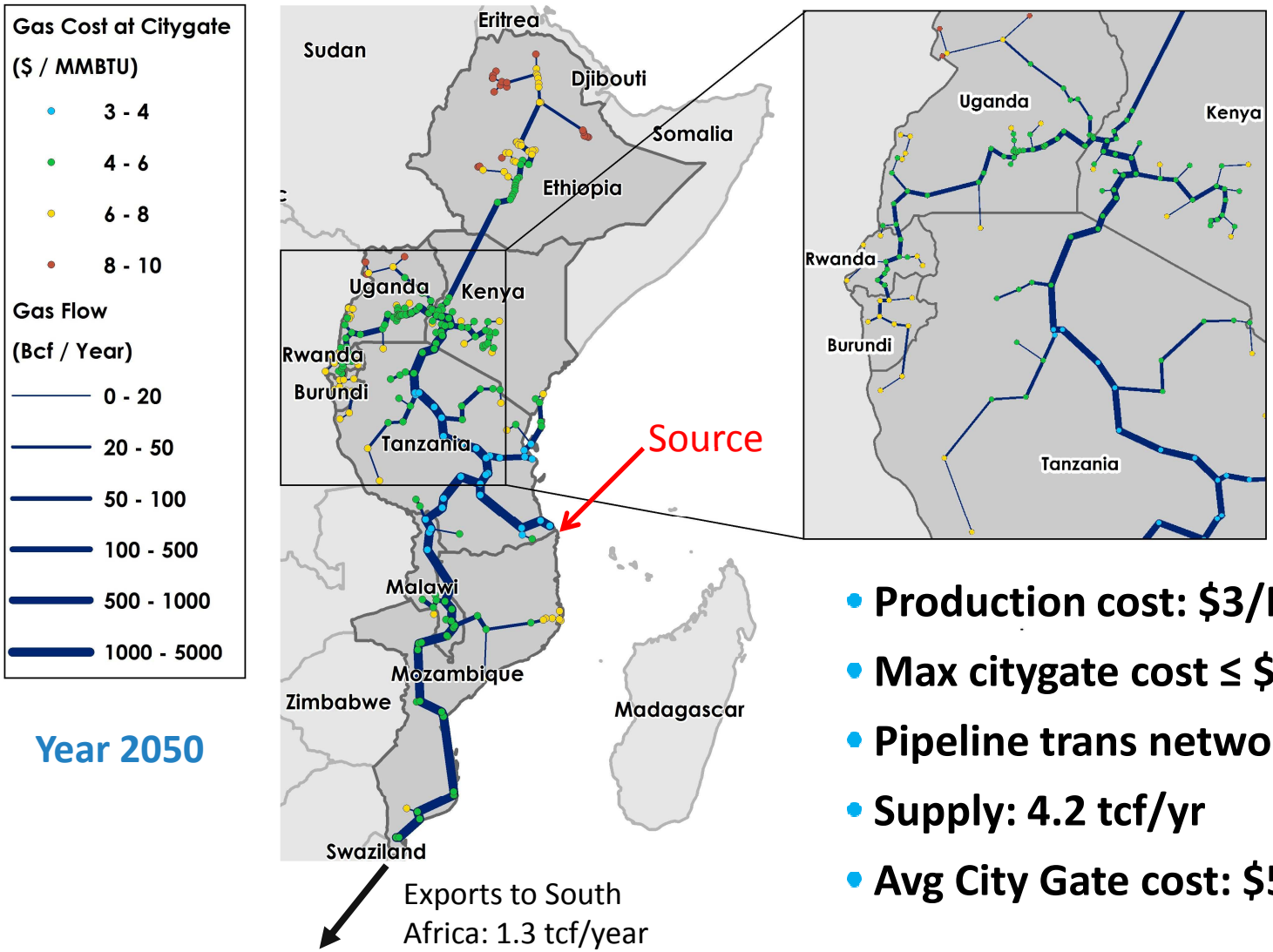
Natural Gas: Which Uses and at What Price?

	Est. Max Price at City Gate* [$/MMBtu]	Alternatives
Cooking	10 - 20	Retail Wood, Charcoal, Kerosene, LPG
Power generation	12 - 48	Existing dispatchable generation (from gas to diesel)
Transportation	25 - 52	Diesel, Gasoline
Fertilizer Production	14 - 24	Retail imported Price

* Maximum natural gas price at city gate to compete with existing altenatives. An additional $5/MMBtu is taken into account for distribution within the city (cooking) and an additional 25% is considered for CNG at refueling stations (transportation).

A price at city gate < $10-15/MMBtu may allow a large penetration of natural gas

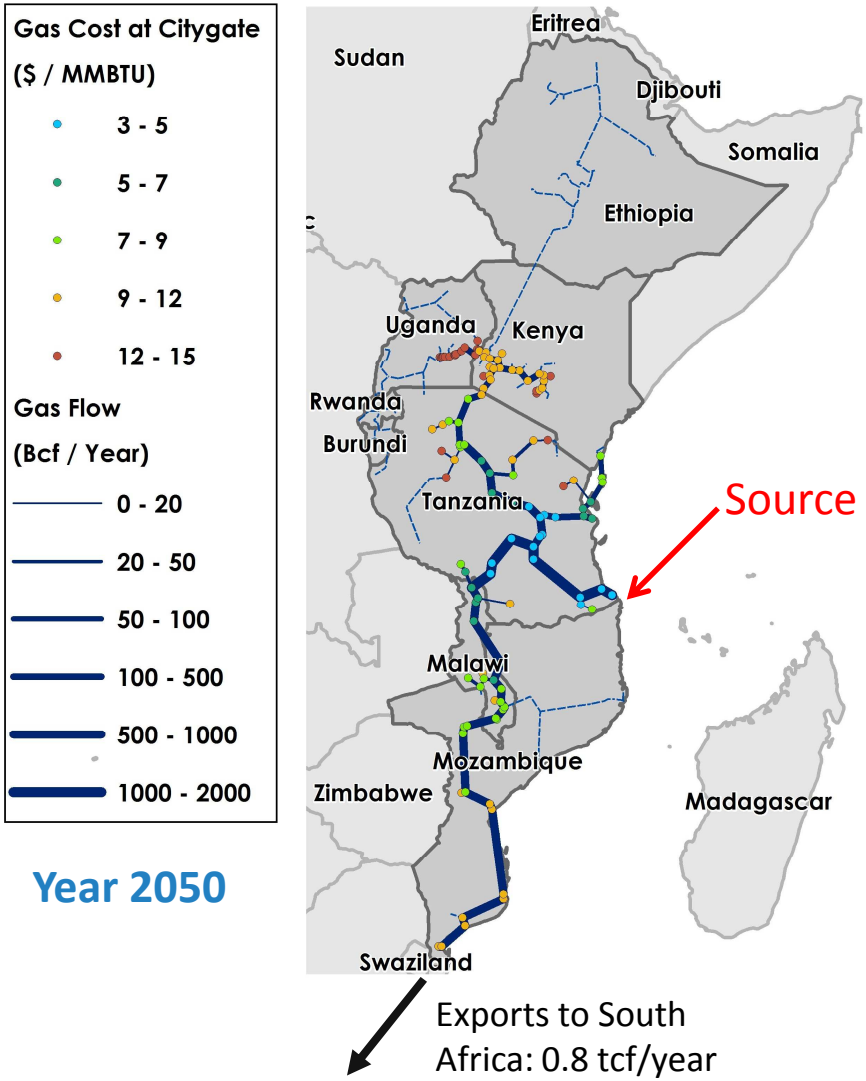
Transmission Network: Baseline Scenario



Year 2050

- **Production cost: $3/MMBtu**
- **Max citygate cost ≤ $10/MMBtu**
- **Pipeline trans network: $57 B**
- **Supply: 4.2 tcf/yr**
- **Avg City Gate cost: $5.2/MMBtu**

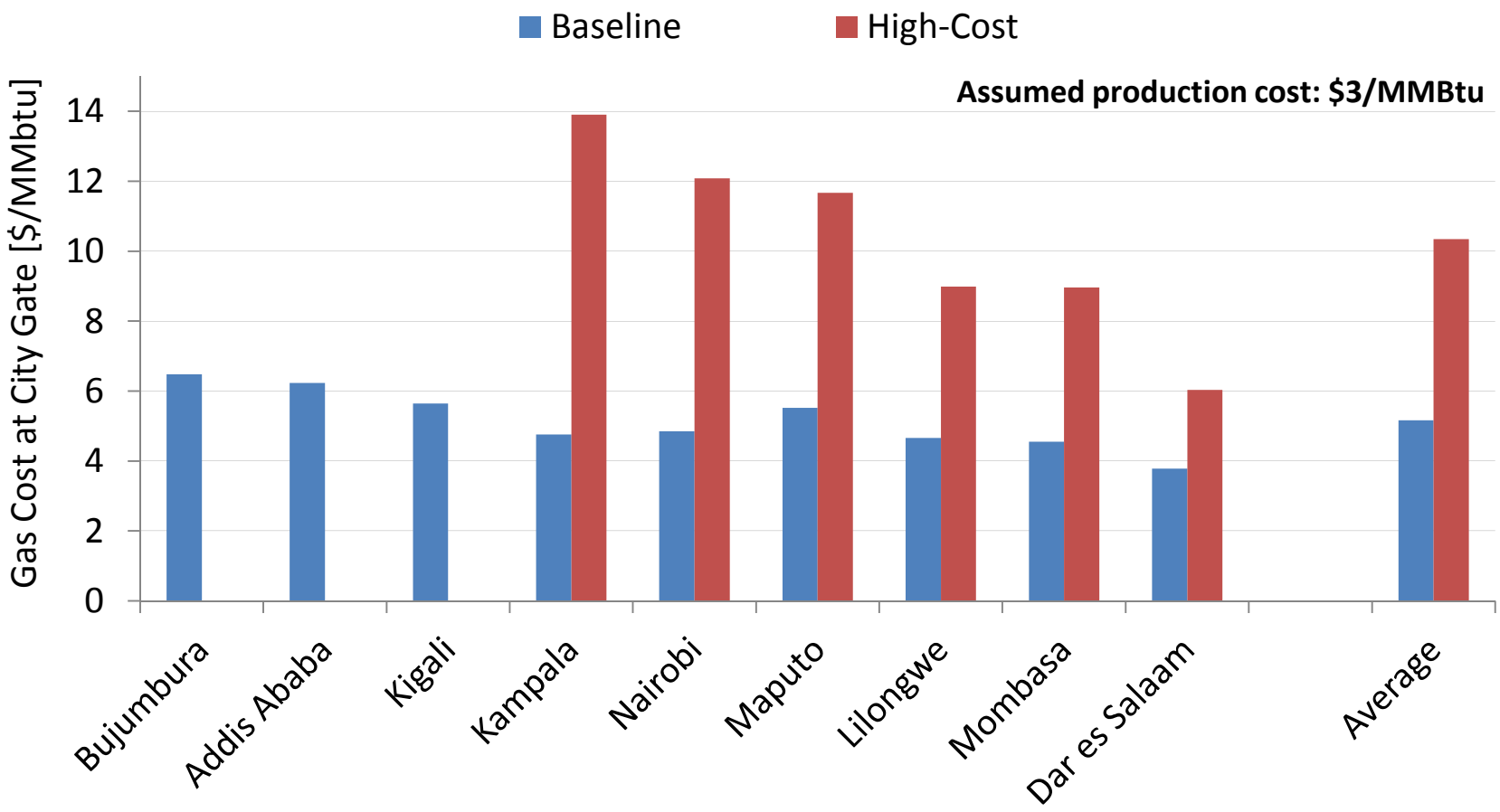
Transmission Network: High-Cost Scenario



Avg at City Gate: $10.3/MMBtu

- **Ethiopia, Rwanda, and Burundi not connected**

Delivered Gas Cost for the Major Cities



Bujumbura, Addis Ababa, and Kigali not connected in the high-cost scenario (delivered cost > $15/MMBtu)

Population Benefitting in 2050 (baseline scenario)
National-level population: 614 Million (urban+rural)

Countries: Mozambique, Malawi, Tanzania, Kenya, Uganda, Burundi, Rwanda and Ethiopia

	Population Impacted	Assumptions
Power	461 million	75% access to electric grid 25% of electricity from gas
N Fertilizer needs	614 million	100% of urban + rural needs

Population Benefitting in 2050 (baseline scenario)
Urban population supplied by gas: 185 Million

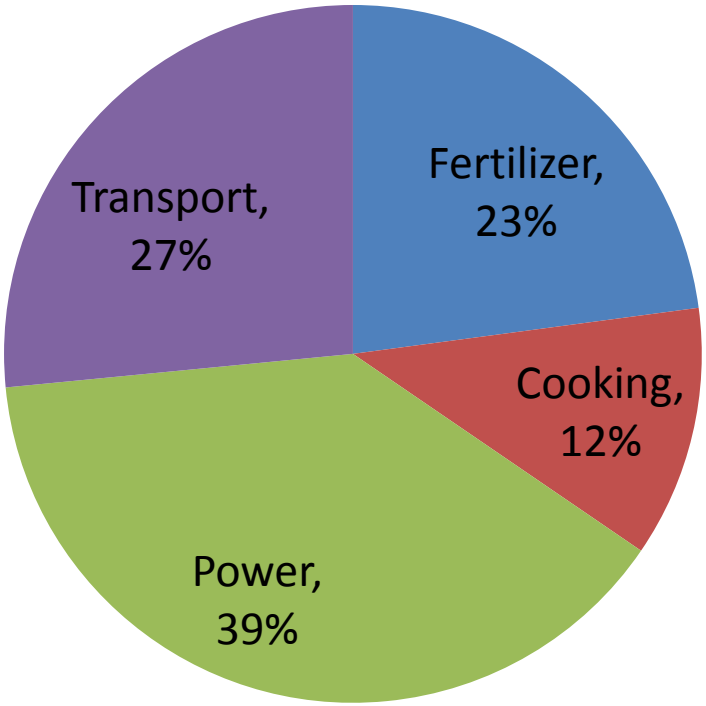
Countries: Mozambique, Malawi, Tanzania, Kenya, Uganda, Burundi, Rwanda and Ethiopia

	Population Impacted	Assumptions
Cooking	185 million	100% of the population in connected cities
URBAN Passenger transport	185 million	85% of LDV and Public transport in connected cities

Consumption by Sector in 2050

Baseline Scenario

Countries: Mozambique, Malawi, Tanzania, Kenya, Uganda, Burundi, Rwanda and Ethiopia



Pie Chart: 2.4 tcf

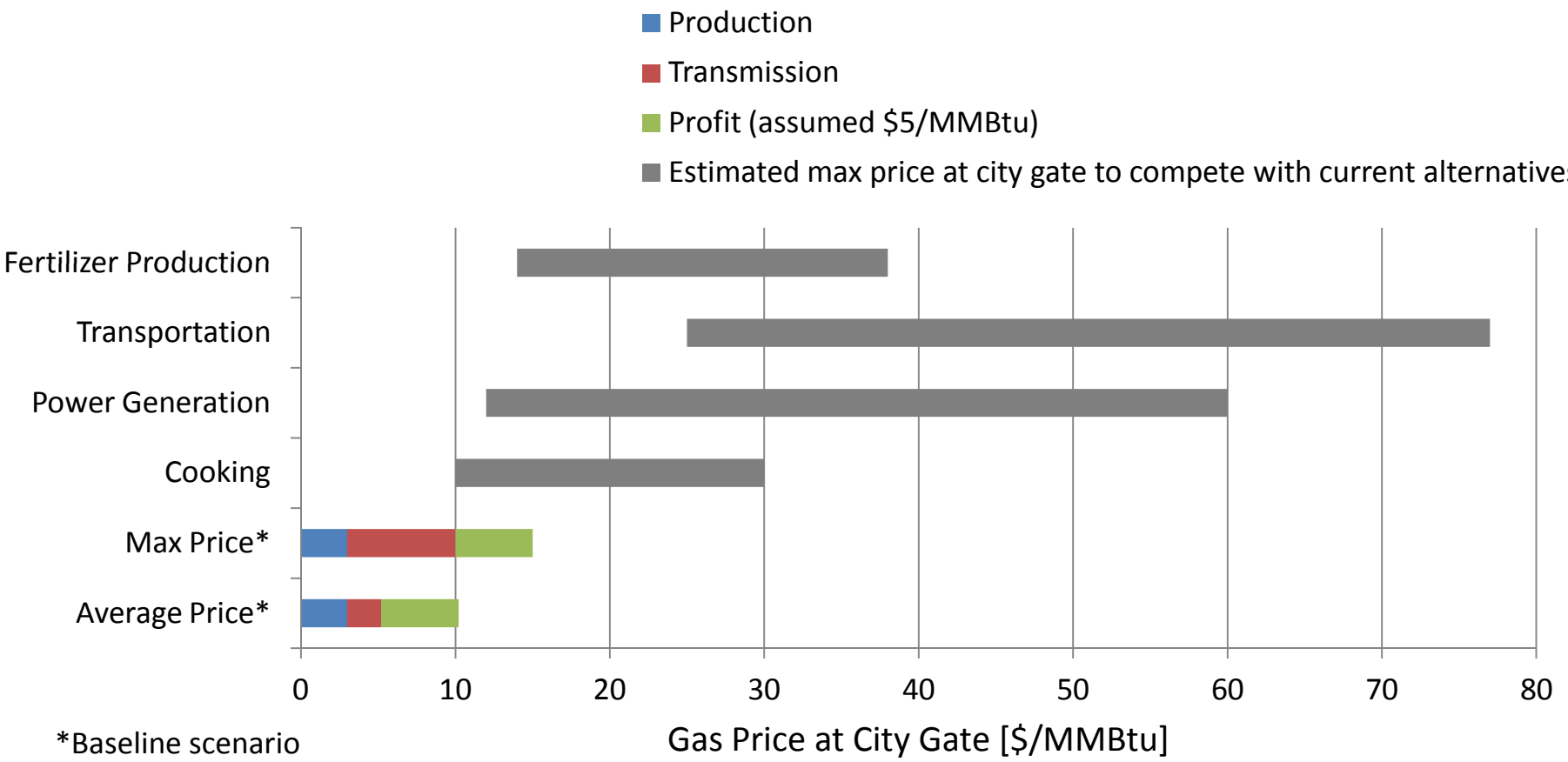
Other indus/commercial: 0.5 tcf

Exports to South Africa 1.3 tcf

TOTAL: 4.2 tcf/yr

Similar Profits than with LNG exports

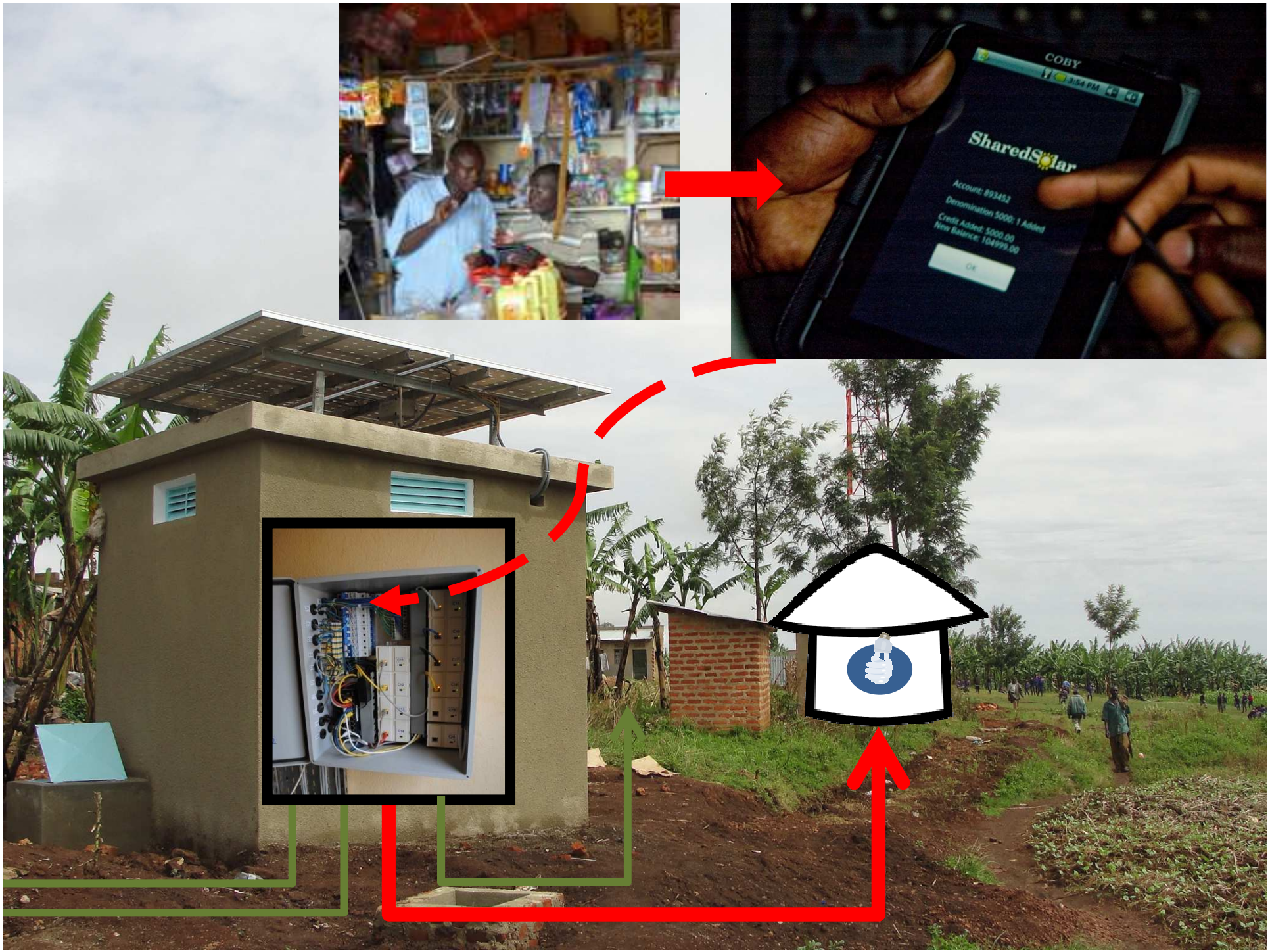
- Estimated profit for LNG exports to Japan (medium term): $1-7/MMBtu
- Assuming $5/MMBtu profit for the domestic market, natural gas would still be a very affordable alternative

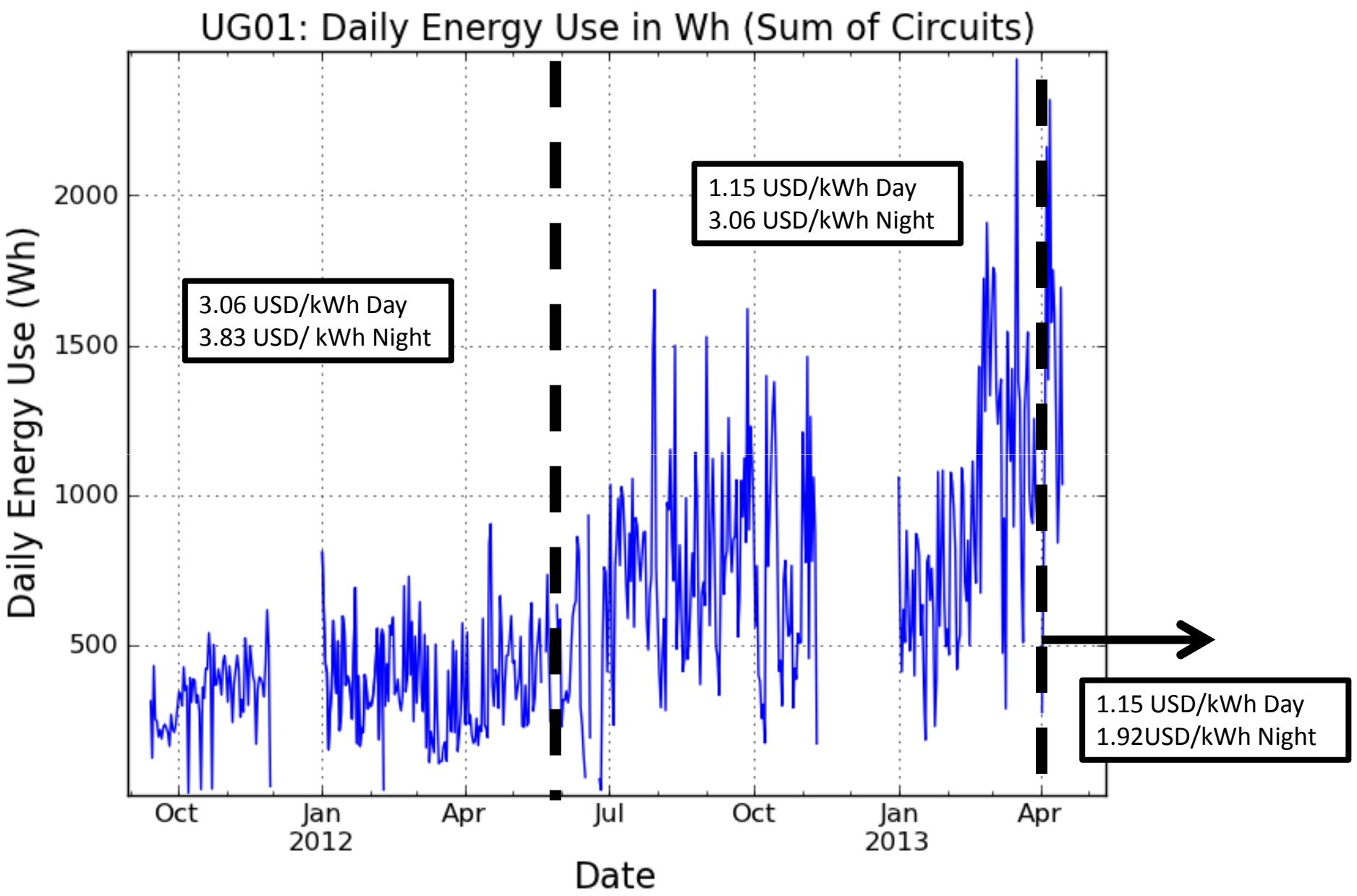


*Baseline scenario

CAN THE POOR PAY FOR ENERGY SERVICES?

SOLAR MINIGRID DEPLOYMENTS IN UGANDA AND MALI.
PAY-AS-YOU-GO SMART MODULAR MINIGRIDS

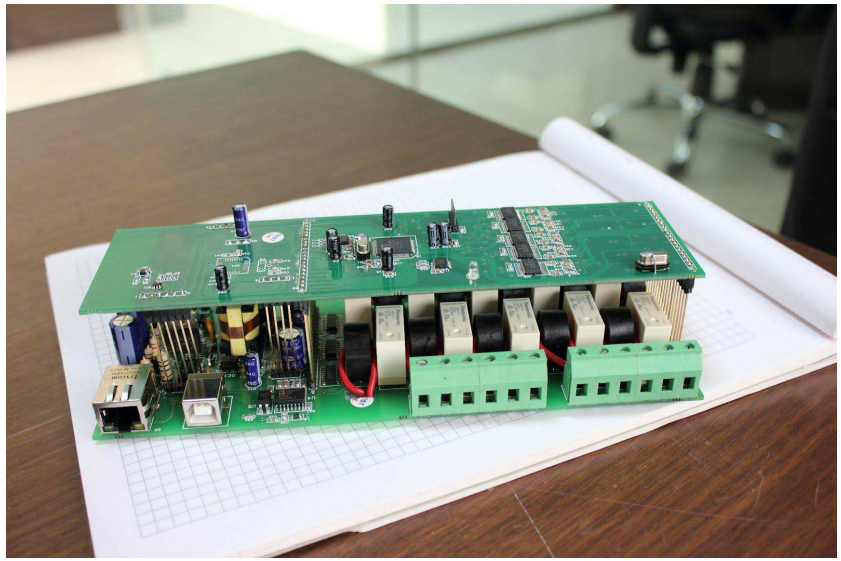

COBY
3:54 PM
SharedSolar
Account: 893452
Denomination 5000: 1 Added
Credit Added: 5000.00
New Balance: 104999.00
OK


UG01: Daily Energy Use in Wh (Sum of Circuits)
Daily Energy Use (Wh)
2000
1500
1000
500
Oct
Jan
2012
Apr
Jul
Oct
Jan
2013
Apr
Date
3.06 USD/kWh Day
3.83 USD/ kWh Night
1.15 USD/kWh Day
3.06 USD/kWh Night
1.15 USD/kWh Day
1.92USD/kWh Night

10 Consumer System: Metering + Communications

Meter Enclosure

Version 1: 40 cm x 30 cm x 20 cm



Version 2: 15 cm x 7 cm x 7 cm

Needed Investment by Sector by 2050

Baseline Scenario

Countries: Mozambique, Malawi, Tanzania, Kenya, Uganda, Burundi, Rwanda and Ethiopia

Needed investments in the 4 main sector to develop the demand in addition to the $57 Billion for the transmission system

	Investments [Billion $]
Distribution Networks within Urban Centers	13.9
Power Plants	43.9
CNG Refueling Stations	9.3
Fertilizer Plants	33.2
Total	**100**

GUJARAT, INDIA: A CASE STUDY IN GAS AND GAS INFRASTRUCTURE FOR DOMESTIC GROWTH

Mr. Pandian
Additional Chief Secretary
Sec, Energy and Petrochemicals

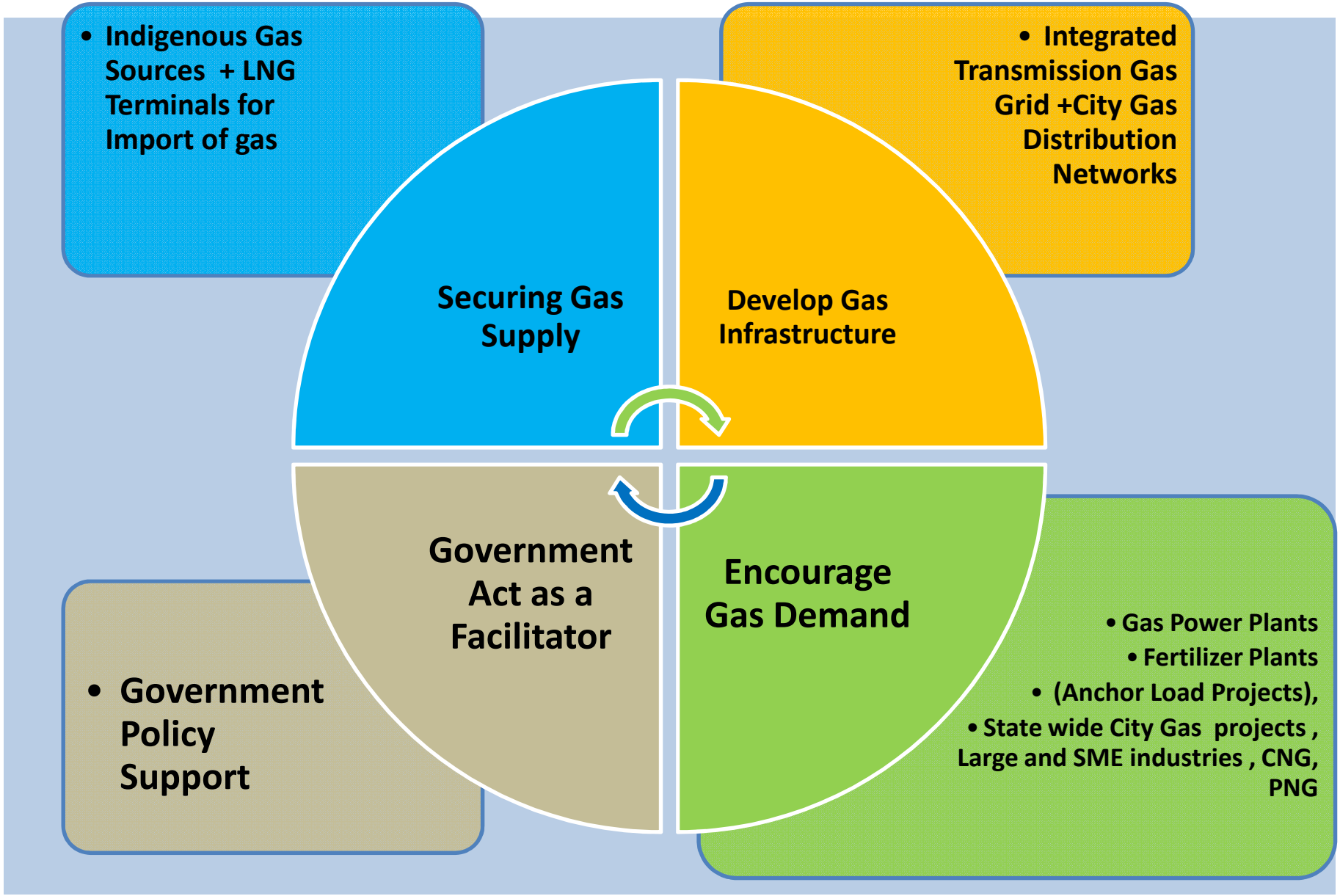
CHICKEN AND EGG PROBLEM

- No market demand without infrastructure
- No infrastructure without market demand
- Infrastructure and Market demand useless without assured gas supply!

- Gujarat had domestic gas so a study was carried out to use domestic gas

- Even with R-LNG it is viable today in Gujarat
- Of course with domestic piped gas is much better

STATE GOVT. GROWTH STRATEGY FOR GAS



IN WHAT ORDER WAS IT DONE? WITHIN A DECADE

Anchor Loads

- Power (State and Private)
- Fertilizer (State actors to support agriculture)
- Industry (Private, eg ceramic industry)

City Gas Distribution

- Started with CSR demo. near LNG terminal
- Domestic cooking (state and Private)
- Public Transport (state)

GSPL GAS GRID

CGD COVERAGE IN GUJARAT

Sr. No.	Name of CGD	No of Ind. Cust.	No of Domestic Cust.	No of Com. Non-Com. Cust.	No of CNG Stations	CNG Sales tons/Day	No of CNG Vehicle/Day	Daily Gas* Sales (MMSCMD)
1	GSPC Gas	1,892	490,000	1,893	159	445	90,000	5.00
3	GGCL	794	440,000	8,951	57	275	64,000	2.60
5	Adani Gas	760	190,000	1,460	52	320	62,300	0.88
Total		**3,789**	**1.3 Million**	**15K**	**331**	**1200**	**254K**	**9.90**

STATE URBAN POPULATION 3 Million HH

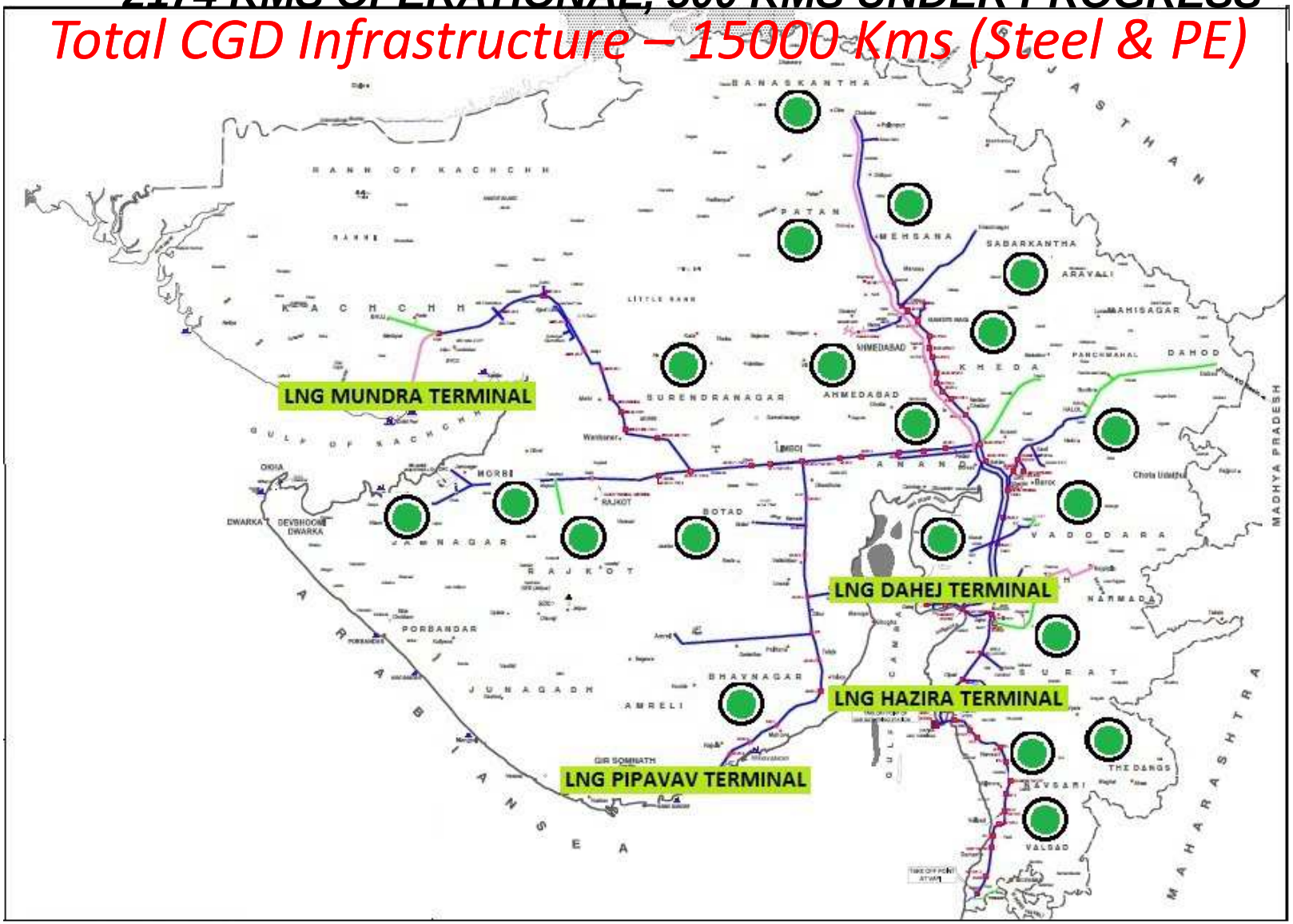
Done in 10 years

HOW?

GAS TRANSMISSION NETWORK IN GUJARAT

2174 KMS OPERATIONAL, 500 KMS UNDER PROGRESS

Total CGD Infrastructure – 15000 Kms (Steel & PE)



CITY DISTRIBUTION

- Typical CNG+PNG city network
- Cost Rupees 250-300 crores ($50 million) to supply 1.5 MMSCMD of gas
- $5M/yr for 15 Million MMBTU/yr
- With O&M and profit: $4/MMBTU
- Large cities could be $3.50


EMERGENCY CONTACT NO
079-27
NO SMOKING
NO FIRE
ADANI
PNG


AGL
90 mm
1:70
Dist. mt.
Em. Cont. no.
079-27
3264
GAS

ADDED NEW PUBLIC TRANSPORT CAPACITY

CNG BUSES and RICKSHAWS
ANCHOR PUBLIC DEMAND

Facts File : Ahmedabad BRTS
Operationl Corridor – 63 kms.
Corridor under Implementation – 25 kms.
BRT stations – 104
Buses–127

TODAY:

HH of 5 spends $6/month on cooking

CAN BE DONE

Took Political Will and Administrative skill

Thank you