

Sustainable African Electricity Sector Expansion: The Critical Role of Social Factors

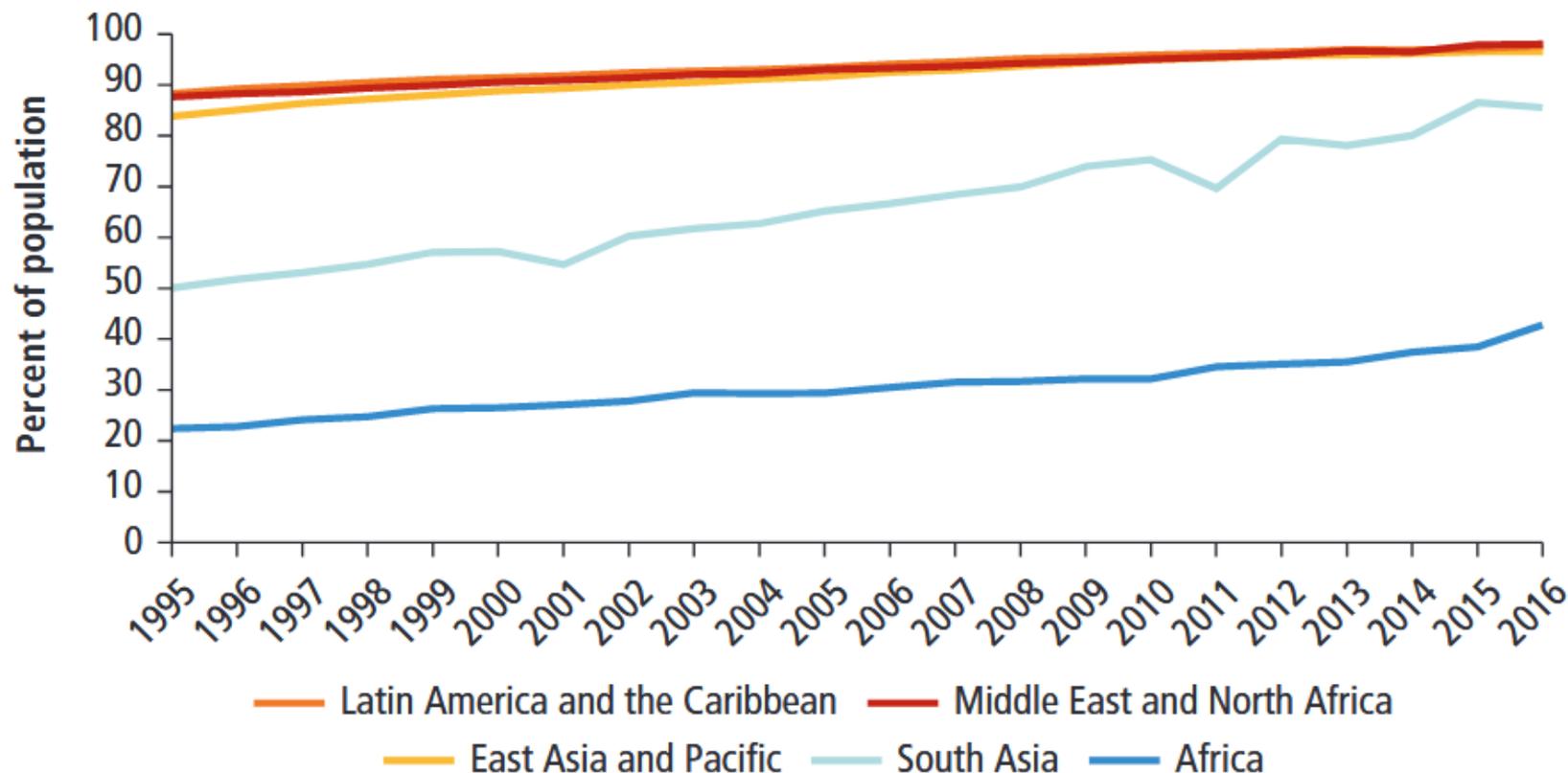
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April 23, 2021

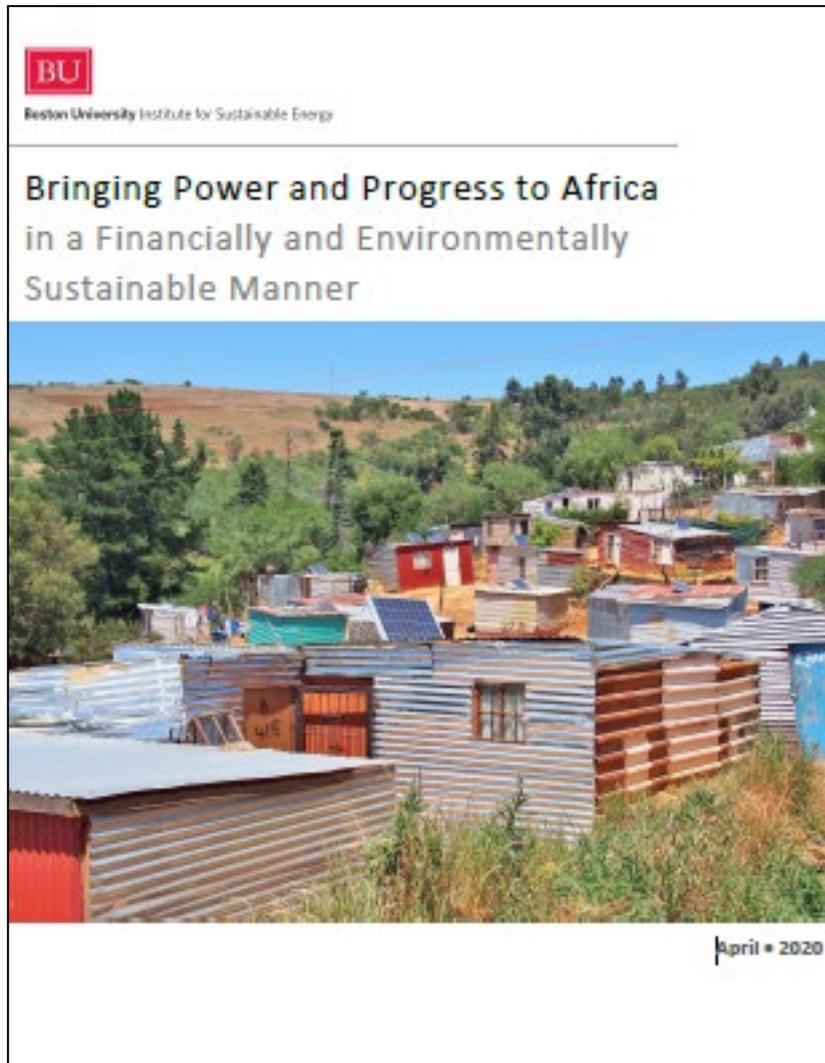


< 50% of Africans Have Access to Electricity



Source: [Brookings Institution](#)

April 2020 Report on African Electricity Sector Expansion

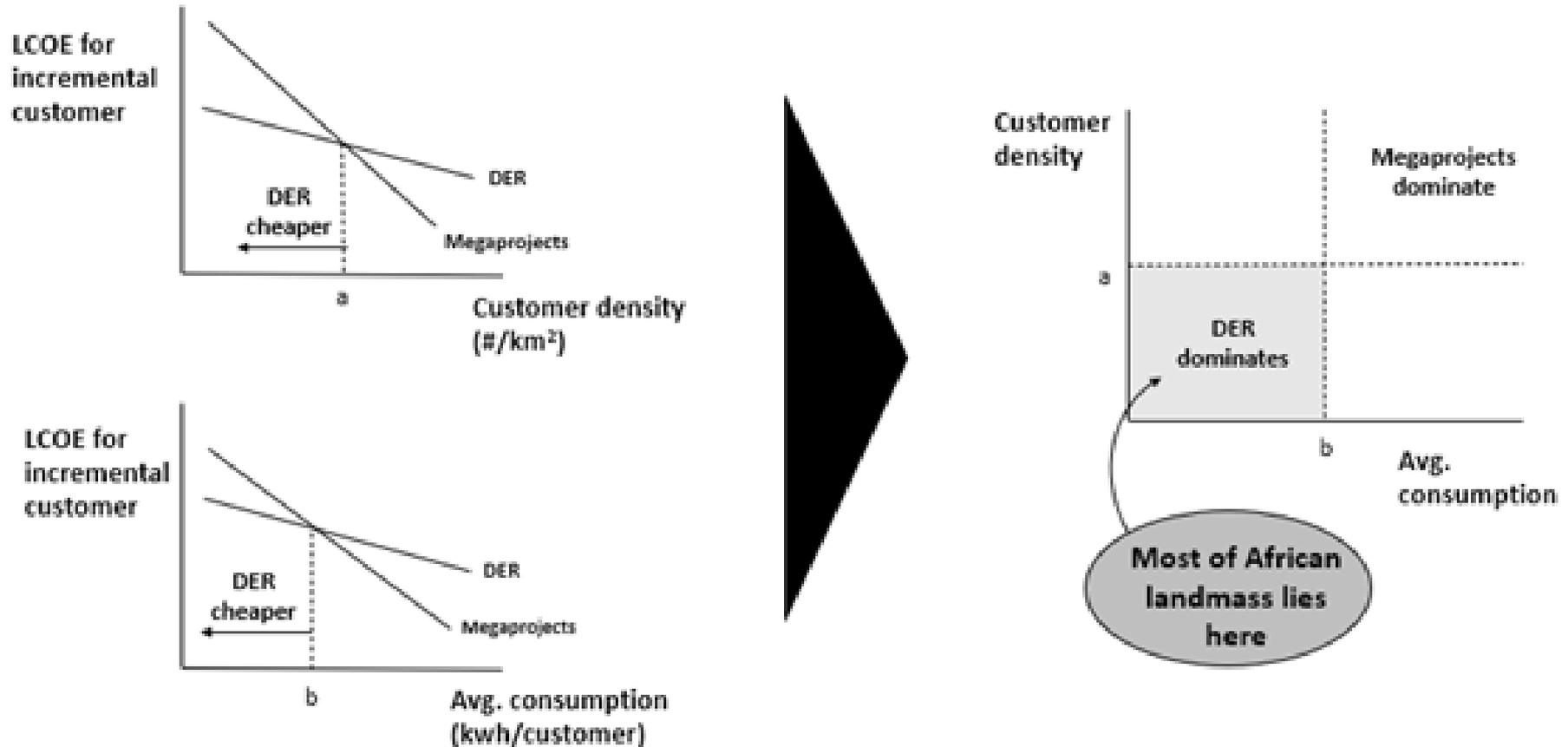


Available at
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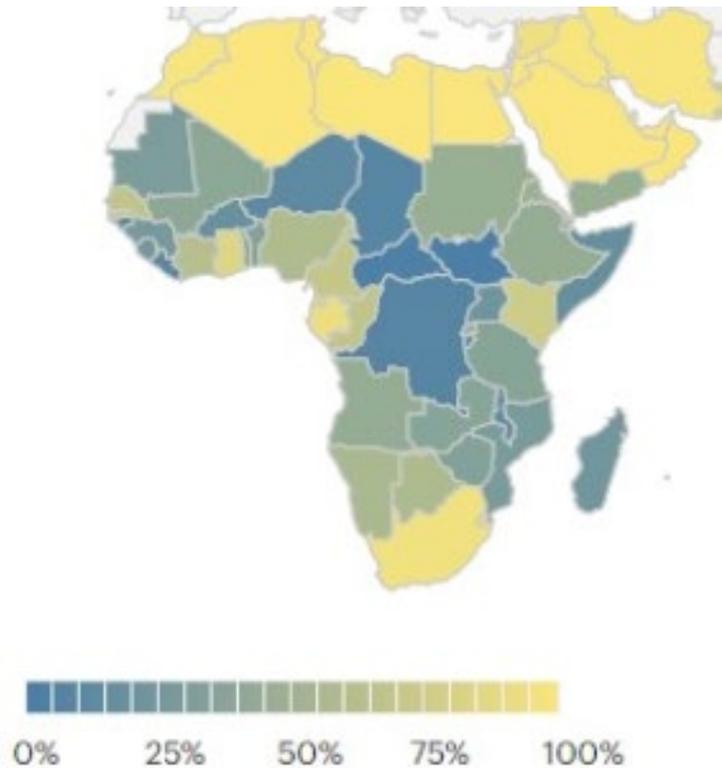
Conclusions from April 2020 Report

- ~\$1 trillion of new investment in electricity infrastructure over next few decades to bring universal energy access across Africa
- New capacity additions must be mostly renewables rather than fossil (especially not coal) if CO₂ emissions growth to be limited
- Weakness of African transmission network and challenges in multinational coordination limit ability for utility-scale power projects
- Increasing opportunities for lower capital/risk DER-based grids, especially in rural areas where minimal access exists
- No “one-size-fits-all” answer will be optimal across Africa; a hybrid “grid-of grids” likely to emerge
- Trustworthy in-country partners and better local data required for effective interventions

Where and When DER Will Be More Advantageous

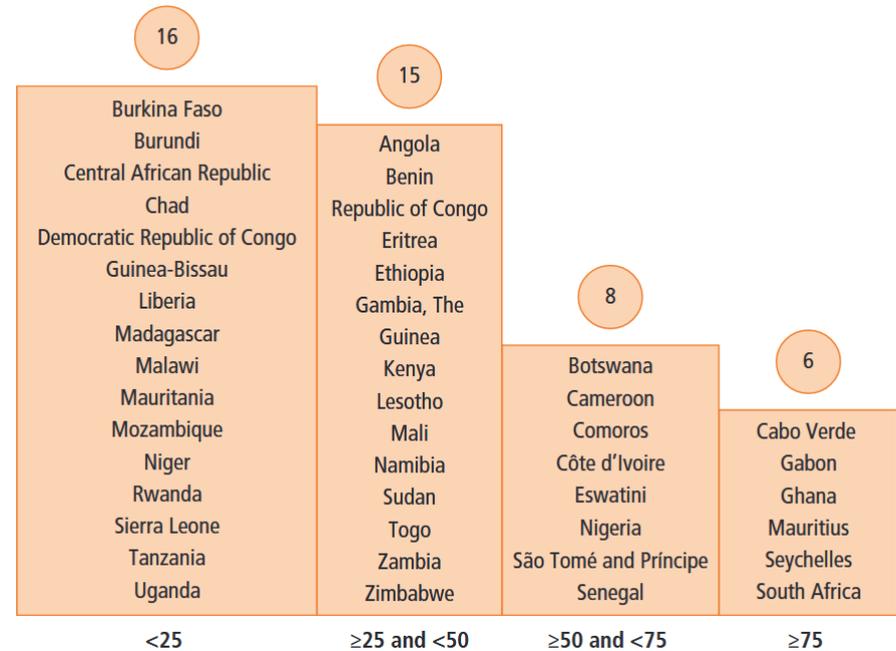


Low Electricity Access, But High Variability Across Countries



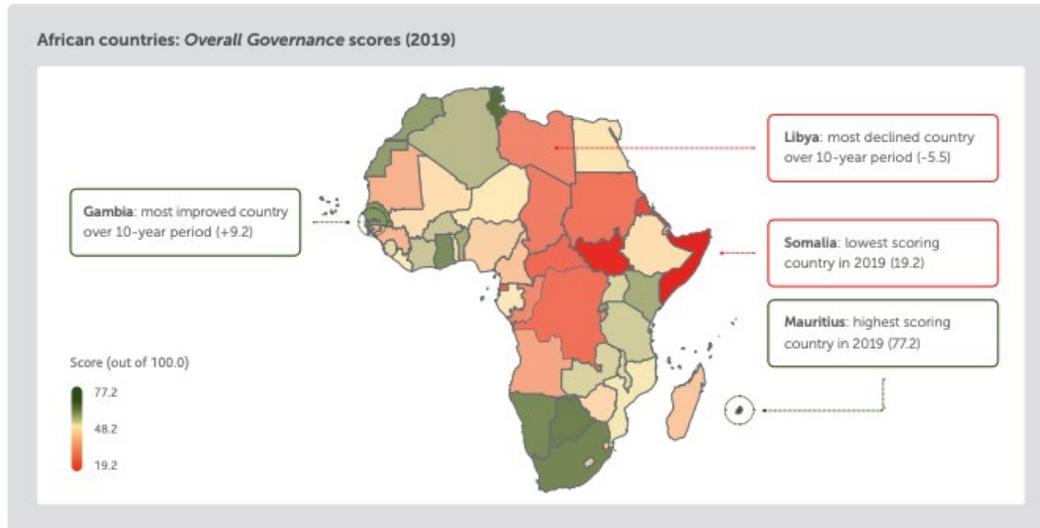
Source: [Alliance for Rural Electrification](#)

b. Households with electricity, latest available data (percent)



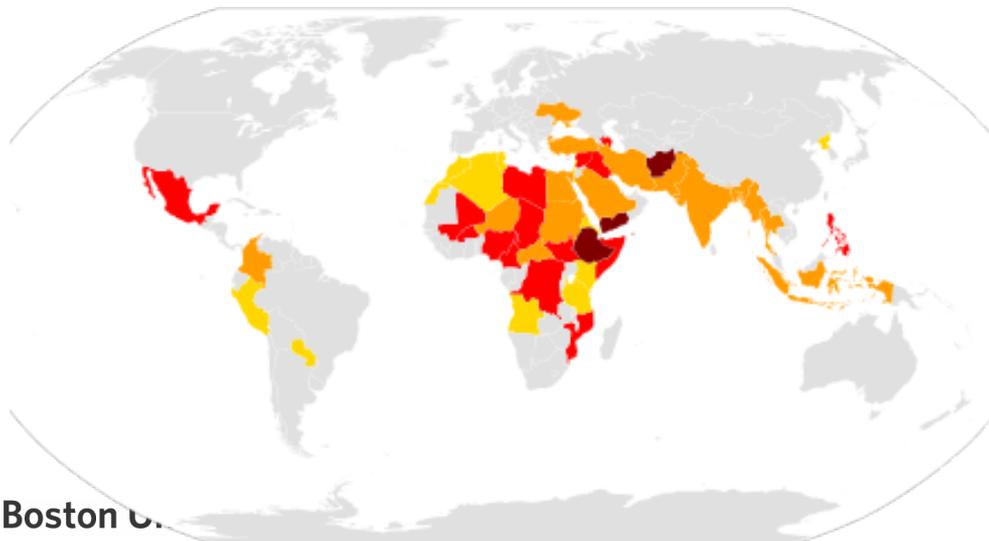
Source: [Brookings Institution](#)

Weak Governance and Many Conflicts Across Africa



Brahim Index of African Governance

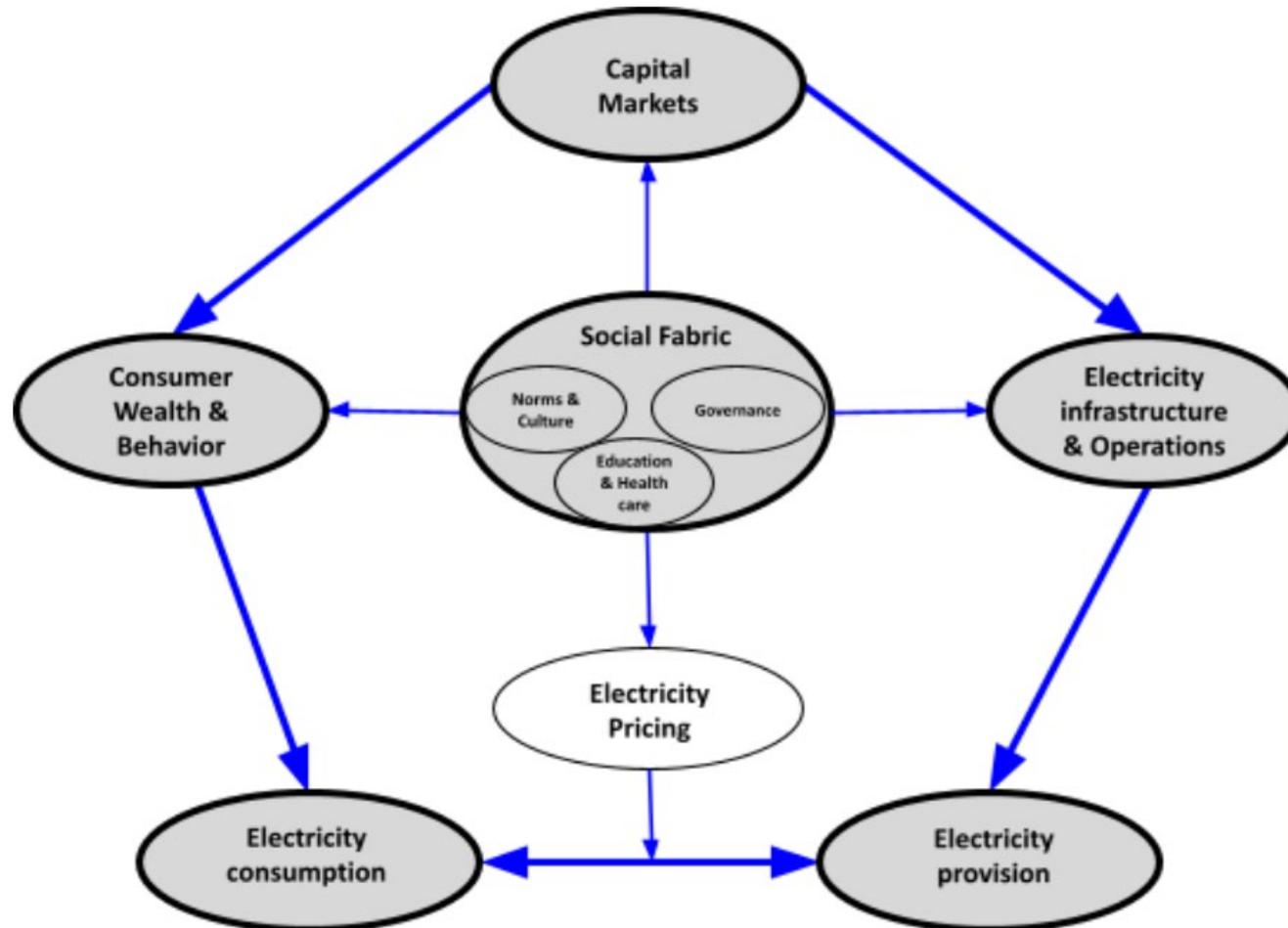
- Safety & Rule of Law
- Participation & Human Rights
- Sustainable Economic Opportunity
- Human Development



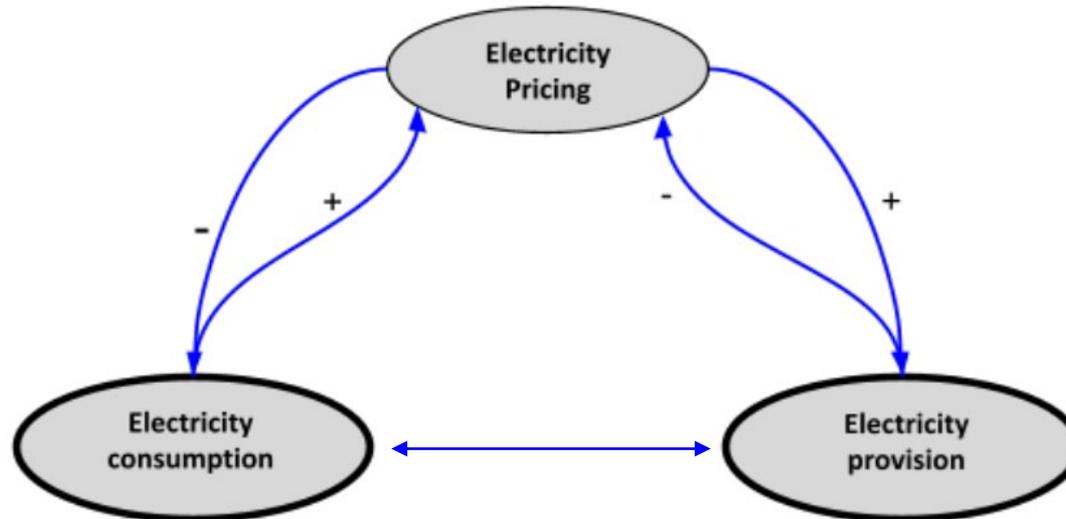
Ongoing conflicts around the world (March 2021)

- Major wars, 10,000+ deaths in current or past calendar year
- Wars, 1,000–9,999 deaths in current or past calendar year
- Minor conflicts, 100-999 deaths in current or past calendar year
- Skirmishes and clashes, 10-99 deaths in current or past calendar year

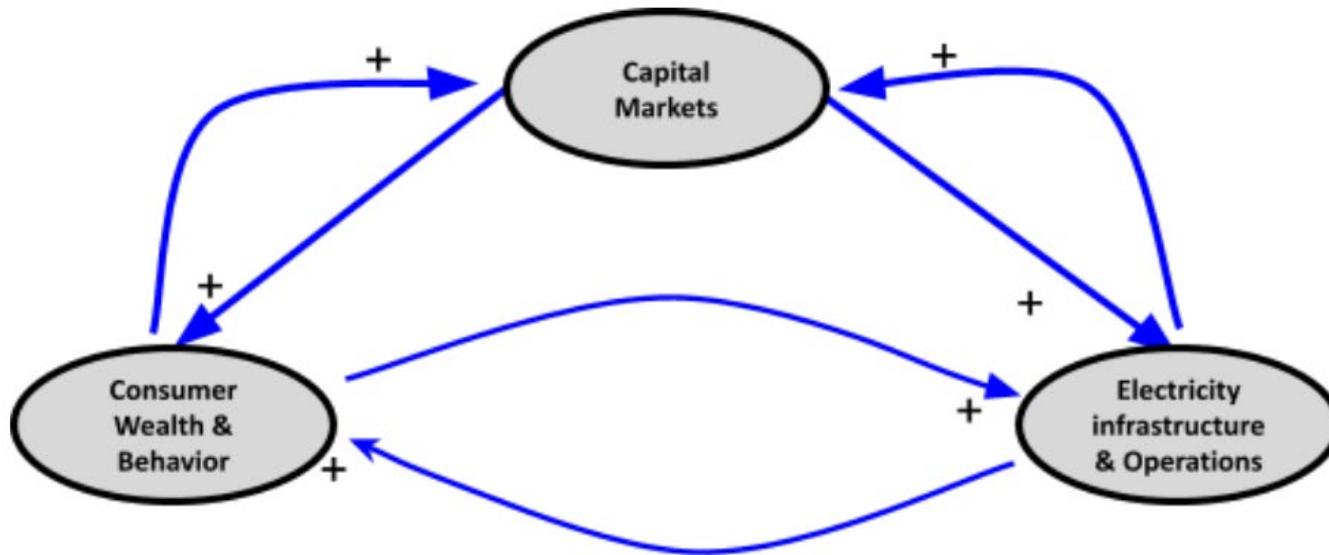
System Dynamics Framework For Electricity Sector Expansion



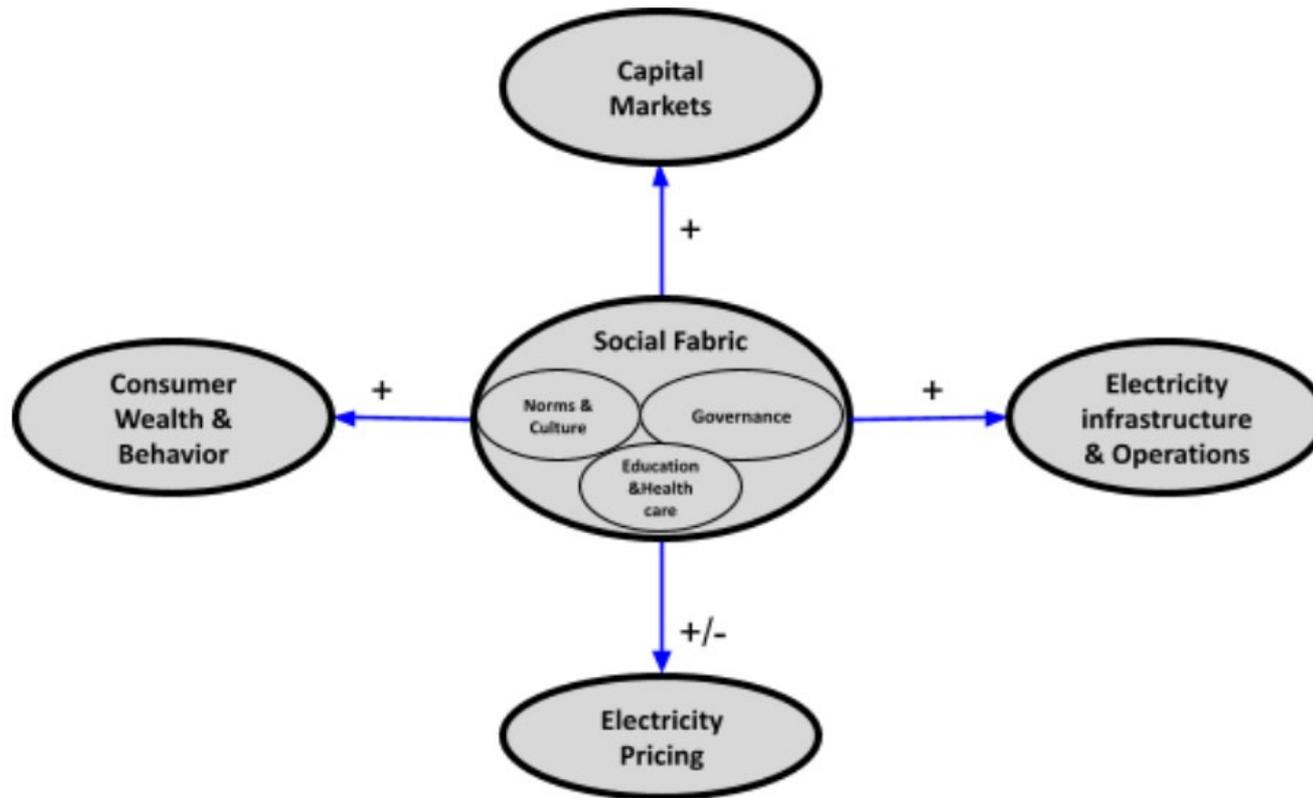
“The Engine”: Electricity Supply and Demand, via Prices



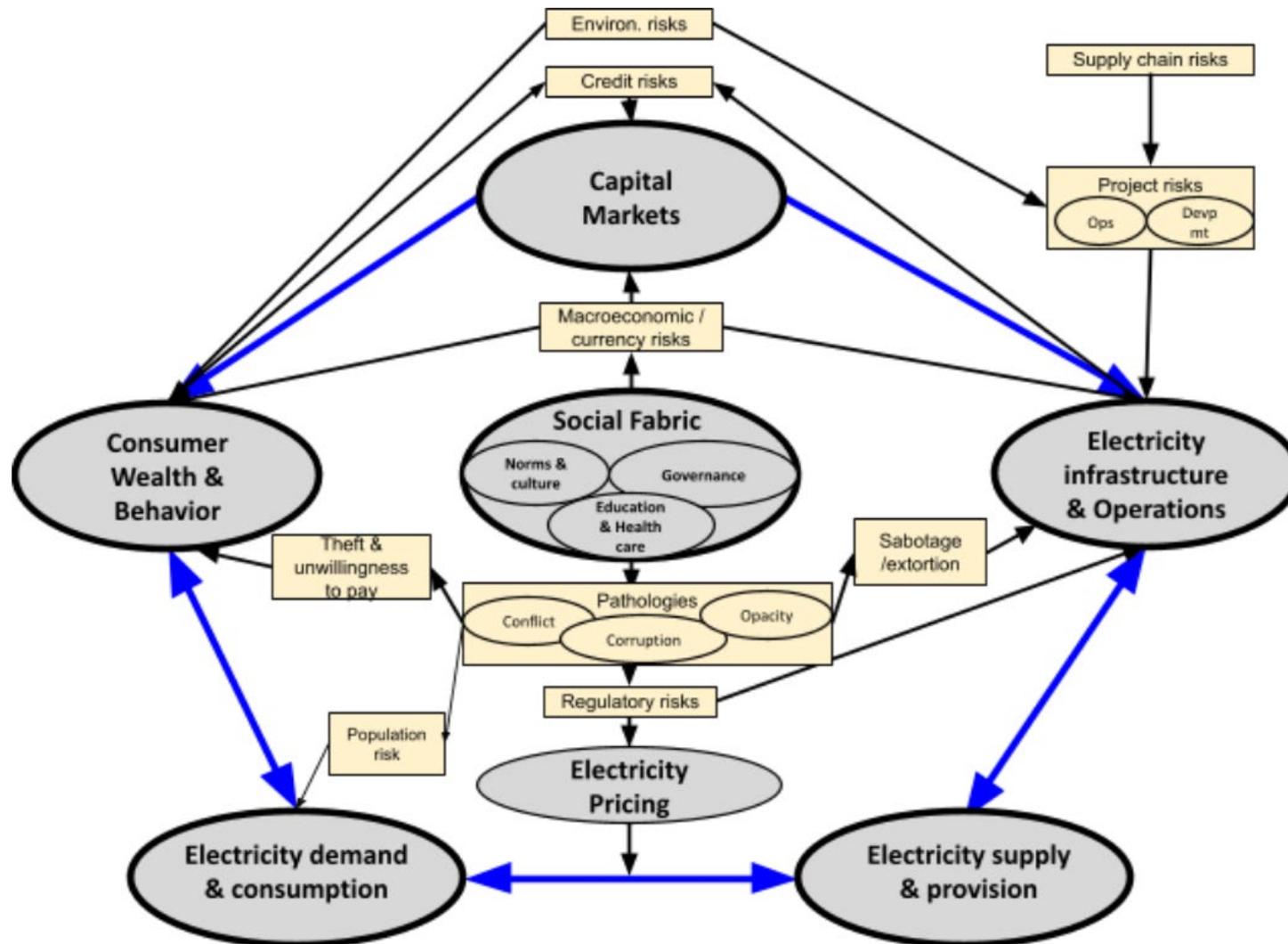
“The Fuel”: Capital Market Access to Enable Supply/Demand



“The Oxygen”: A Region’s Social Fabric

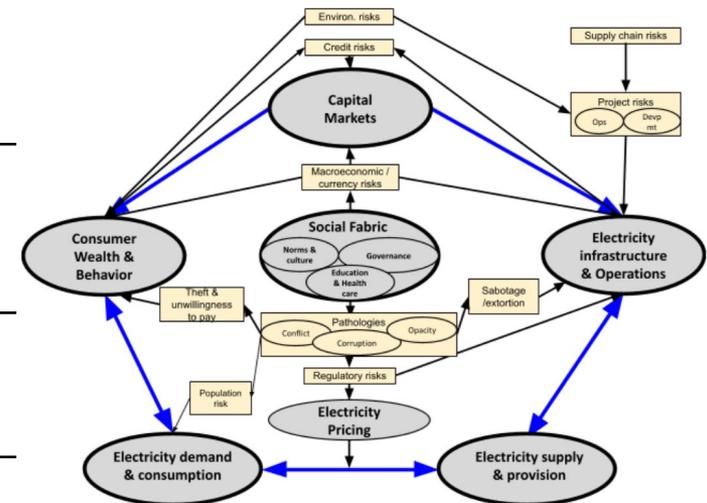


Adding Risk Factors to the Framework

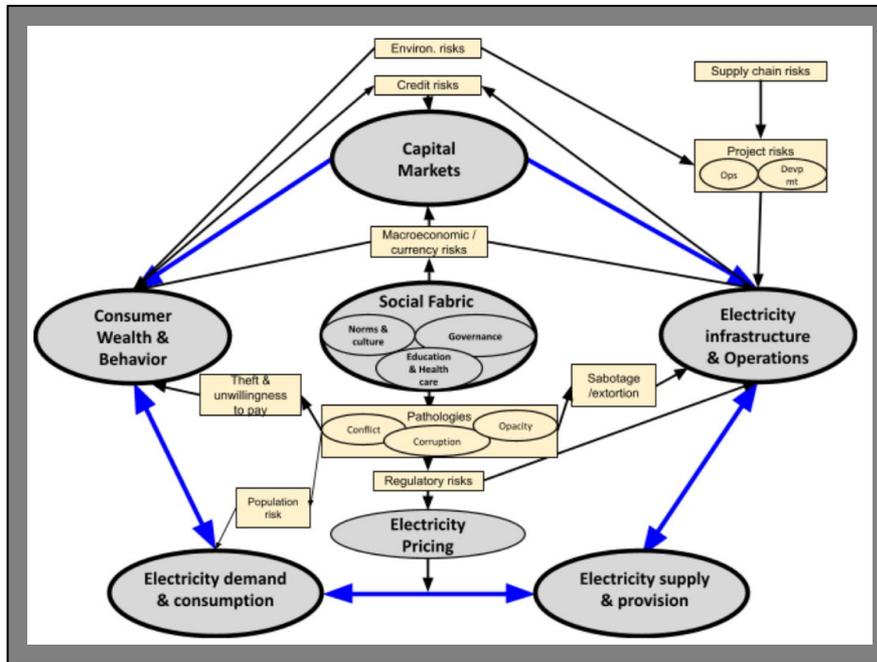


Most Critical Risks for Each Driving Force in Framework

Driving Forces (i)	Risk Factors (j) 1	Risk Factors (j) 2	Risk Factors (j) 3	Risk Factors (j) 4	Risk Factors (j) 5
Electricity Infrastructure and Operations	Supply Chain Risks	Environmental Risks	Legal and Regulatory Risks	Macroeconomic and Currency Risks	Sabotage and Extortion
Capital Markets	Credit Risks	Macroeconomic and Currency Risks			
Consumer Wealth and Behavior	Environmental Risks	Macroeconomic and Currency Risks	Theft and Willingness to Pay	Population Risks	
Electricity Pricing	Legal and Regulatory Risks				



Using the Framework: Measuring A Region's Ability to Enable Electricity Sector Expansion



Electricity Access Index (EAI): a measure of how well this system operates within a defined geographic region

Electricity Access Index (EAI)

Electricity Access Index (EAI) for location k:

$$EAI_k = \sum_j \sum_i r_{ij} R_{kj} w_i$$

The term $r_{ij} R_{kj} w_i$ represents the multiplicative product of the following three factors.

- The relative weighting of Risk Factor j on Driving Force i (r_{ij})
- The degree of riskiness associated with Risk Factor j in location k (R_{kj})
- The relative weighting of Driving Force i on overall system dynamics (w_i)

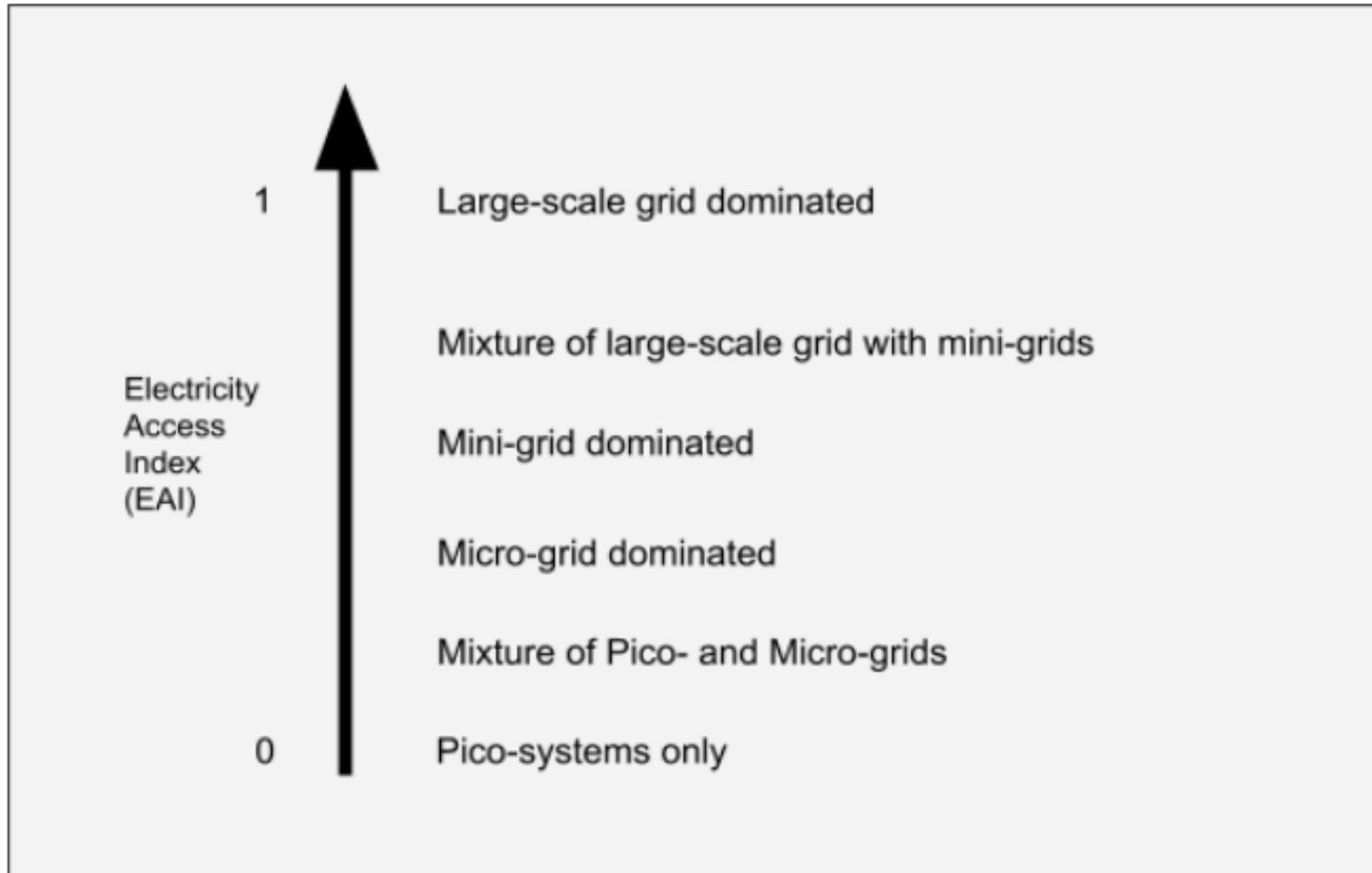
Example: EAI In Risky Location

Driving Forces (i)	Driving Forces Weights (w_i)	Risk Factors (j)	Riskiness (R_{kj}) 1- No Risk 0- High Risk	Risk Factors Weights (r_{ij})	Contribution to EAI ($w_i * r_{ij} * R_{kj}$)
Electricity Infrastructure and Operations	20%	Supply Chain - Project	0.3	10%	.006
		Environmental - Project	0.7	10%	.014
		Supply Chain - Operations	0.3	10%	.006
		Environmental - Operations	0.7	10%	.014
		Sabotage and Extortion	0.5	15%	.015
		Legal and Regulatory Risks	0.2	25%	.010
		Macroeconomic and Currency Risks	0.5	20%	.020
Capital Markets	30%	Credit Risks	0.4	50%	.060
		Macroeconomic and Currency Risks	0.5	50%	.075
Consumer Wealth and Behavior	20%	Environmental Risks	0.7	10%	.014
		Macroeconomic and Currency Risks	0.5	30%	.030
		Theft and Willingness to Pay	0.3	40%	.024
		Population Risks	0.8	20%	.032
Electricity Pricing	30%	Legal and Regulatory Risks	0.2	100%	.060
TOTAL	100%				0.380

Example: EAI In Safer Location

Driving Forces (i)	Driving Forces Weights (w_i)	Risk Factors (j)	Riskiness (R_{kj}) 1- No Risk 0- High Risk	Risk Factors Weights (r_{ij})	Contribution to EAI ($w_i * r_{ij} * R_{kj}$)
Electricity Infrastructure and Operations	20%	Supply Chain - Project	0.8	10%	.016
		Environmental - Project	0.7	10%	.014
		Supply Chain - Operations	0.8	10%	.016
		Environmental - Operations	0.7	10%	.014
		Sabotage and Extortion	1.0	15%	.030
		Legal and Regulatory Risks	0.8	25%	.040
		Macroeconomic and Currency Risks	0.9	20%	.036
Capital Markets	30%	Credit Risks	0.9	50%	.135
		Macroeconomic and Currency Risks	0.9	50%	.135
Consumer Wealth and Behavior	20%	Environmental Risks	0.7	10%	.014
		Macroeconomic and Currency Risks	0.9	30%	.054
		Theft and Willingness to Pay	1.0	40%	.008
		Population Risks	1.0	20%	.004
Electricity Pricing	30%	Legal and Regulatory Risks	0.9	100%	.270
TOTAL	100%				0.894

Implications of EAI Value on Infrastructure Choices



Conclusions and Future Directions

- There is no one-size-fits-all solution in Africa
- Successful modes of electrification will be location- and condition-specific
- DER is particularly promising in remote locations where the social fabric is weak
- A region's electrification strategy should also evolve as social and economic conditions evolve
- More work to do: scale development and measurement for risk factors, followed by empirical assessment of EAls for different regions

Discussion

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