



G2EI

Who is Investing in Energy Poverty?

USAEE/IAEE Webinar

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Gürcan Gülen, Ph.D.
Principal, G2 Energy Insights
gurcan@gzeis.com

What we will talk about...

- ▮ Overarching themes on poverty & economic growth
 - ▮ **Warning:** there is some moral philosophy involved!
- ▮ Defining energy poverty
 - ▮ **Hint:** energy access does not end energy poverty
- ▮ Investment needs to eliminate energy poverty
- ▮ Energy investment trends: who, what, where
- ▮ The gap is large: what to do?



Central conflict

Poverty

- 736 million: <\$1.90/day
 - 700 million: no water
 - 2.4 billion: no sanitation
 - 1 billion: no road
 - 5-10 million deaths/year
- Economic growth is necessary albeit insufficient to end poverty

<https://ophi.org.uk/policy/multidimensional-poverty-index/>

"Limits to Growth"

- No economic growth
 - "Growth cannot be green"
- Reject GDP & related metrics for measuring quality of life
- Happiness, wellbeing, or other indexes as alternative metrics

<https://www.postcarbon.org/program/limits/>

COVID-19
may erase
years of
progress in
eradicating
poverty

- ▮ **50 to 600 million** may fall back into poverty (World Bank, Brookings, United Nations University)
- ▮ **130 million** additional lives and livelihoods at risk (World Food Program)



Many still accept the need for ending poverty but rich countries must “de-grow”

Does AI help the poor get a job?

Meaning of work?

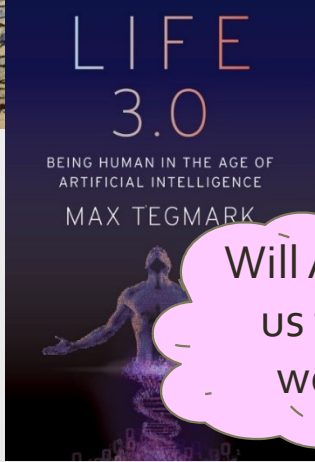
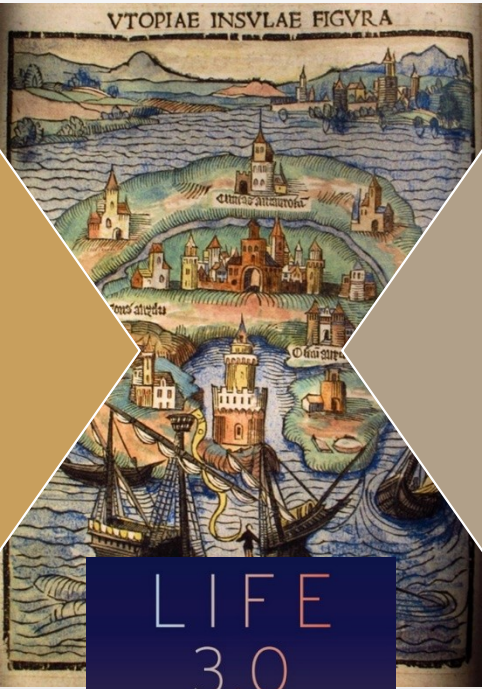
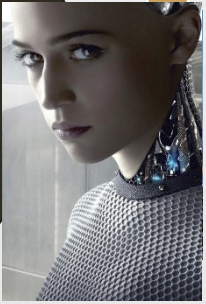
Why do we consume so much?

Who is cutting back? Gen Z?

Poor consume more until?

Rich countries consume less until?

Or, should we stop worrying and love AI?



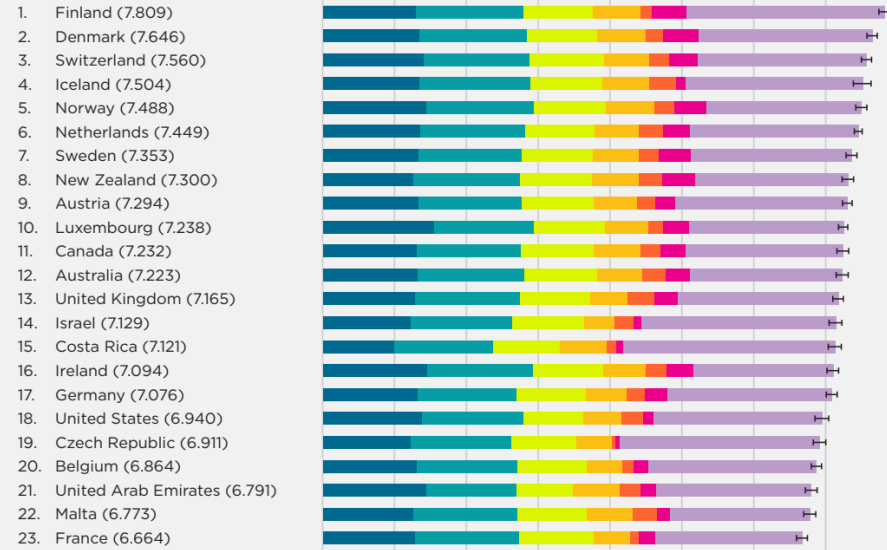
Will AI save us from work?

If we all consume less, will there be enough jobs?



Difficult to find "happiness" in low-income countries

Figure 2.1: Ranking of Happiness 2017-2019 (Part 1)



- Explained by: GDP per capita
- Explained by: social support
- Explained by: healthy life expectancy
- Explained by: freedom to make life choices

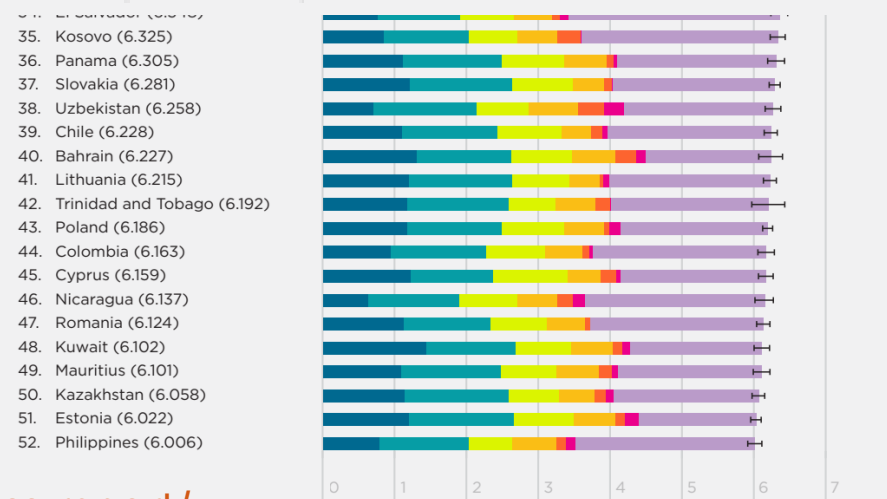
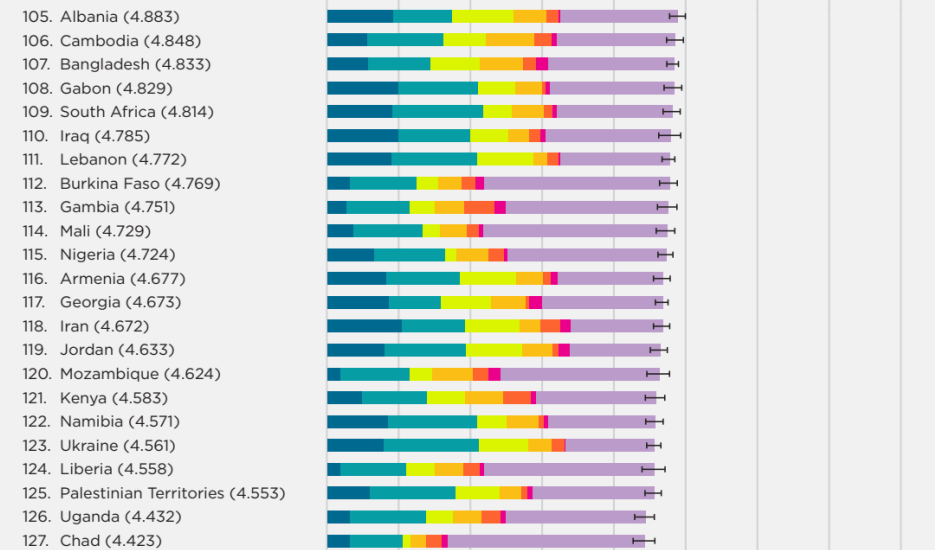
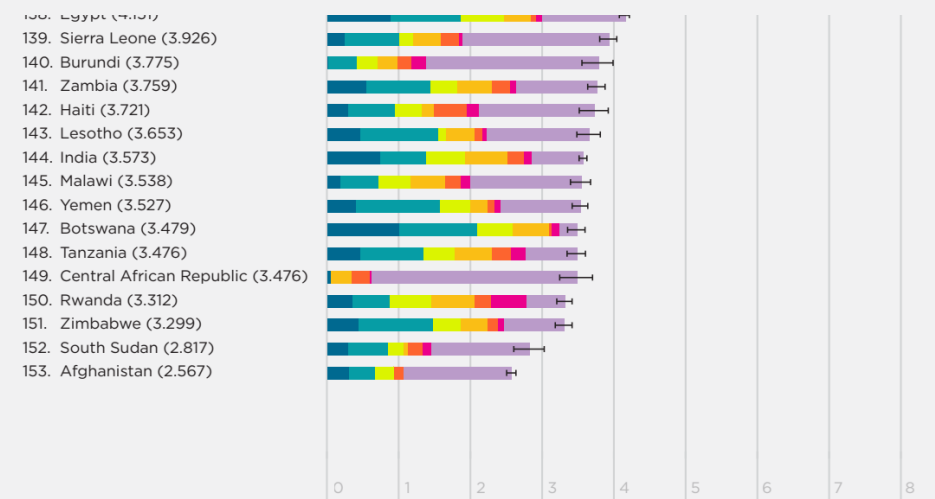


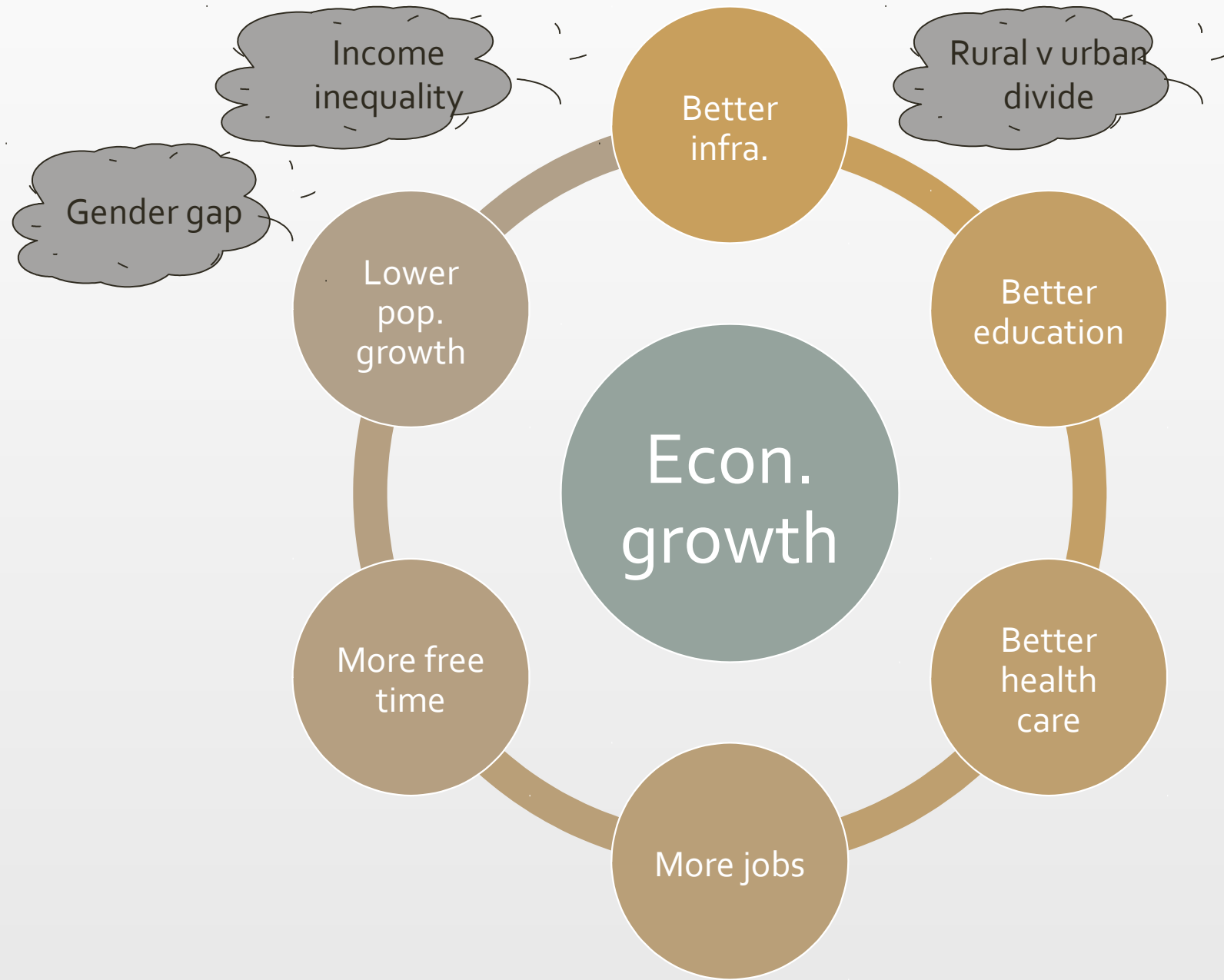
Figure 2.1: Ranking of Happiness 2017-2019 (Part 3)



- Explained by: generosity
- Explained by: perceptions of corruption
- Dystopia (1.97) + residual
- H 95% confidence interval



Economic growth is a pre-condition of "happiness"



Poverty and global health



<https://www.who.int/tdr/en/>

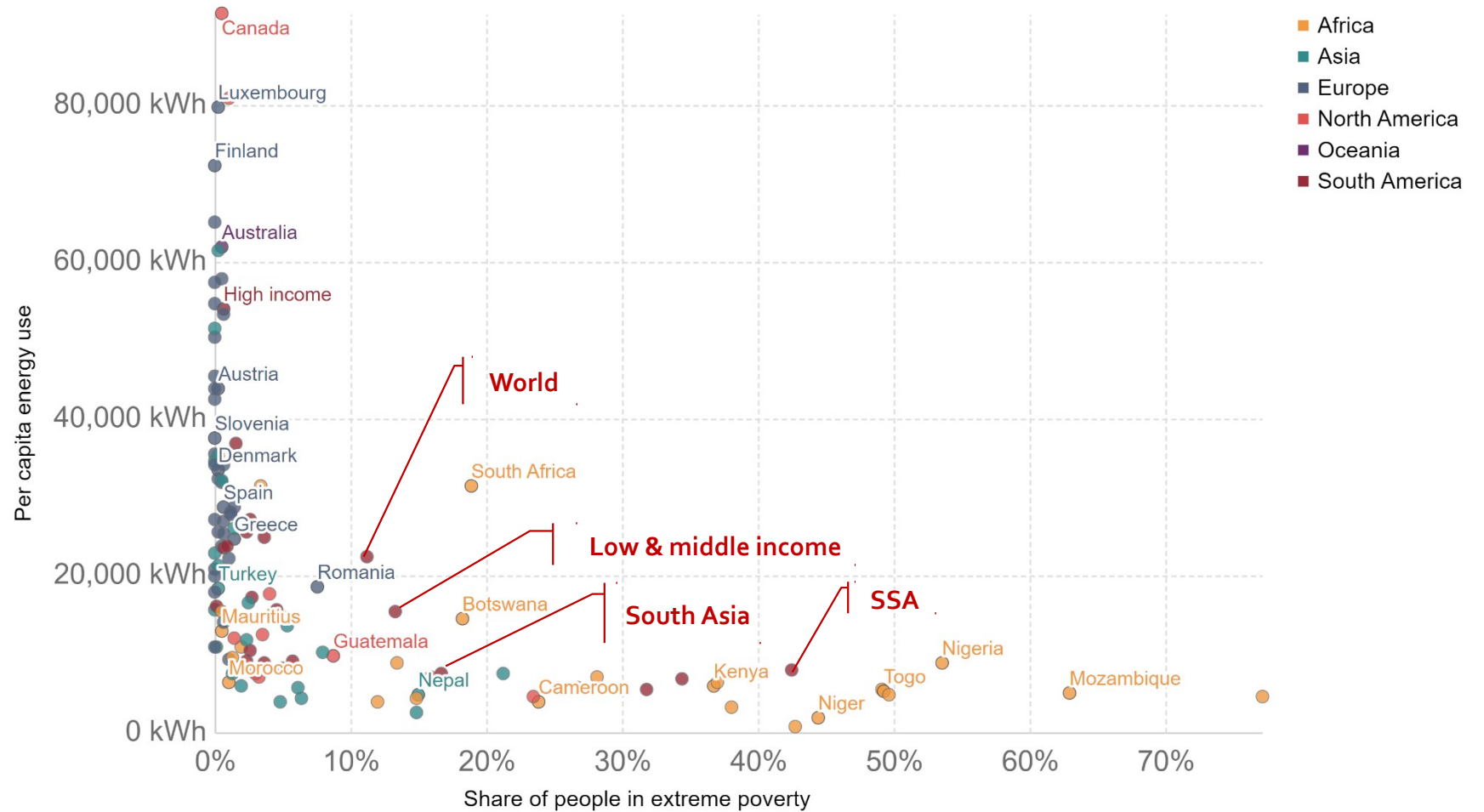
<https://www.ecohealthalliance.org/>

<https://www.cidrap.umn.edu/>

Energy use & poverty

Energy use per capita vs. share of population in extreme poverty, 2014

Per capita energy use is measured in kilowatt-hours (kWh) per year. Extreme poverty is defined as living at a consumption (or income) level below 1.90 "international-\$" per day. International \$ are adjusted for price differences between countries and price changes over time (inflation).



Source: International Energy Agency (IEA) via The World Bank OurWorldInData.org/energy-production-and-changing-energy-sources/ • CC BY

Energy poverty

- Eliminating energy poverty is a necessary but insufficient condition to end poverty
- Without access to reliable, affordable and sufficient energy, many problems remain:
 - Lack of clean water and sewage systems, health care, clean fuels for cooking and heating...
 - 3-4 million deaths/year due to indoor air pollution (WHO)



How does one define energy poverty?





Energy access does not end energy poverty



https://www.ted.com/talks/rose_m_mutiso_how_to_bring_affordable_sustainable_electricity_to_africa/transcript

Electricity Access – Multi-tier, multi-dimensional Framework

Tier \ Dimension	Tier 0	Tier 1	Tier 2	Tier 3
Capacity	No electricity	Lighting + Basic entertainment / communication (Radio/ Mobile) (~1-50W)	Lighting + Air circulation + entertainment / communication (TV/ Computer) (~50-500W)	Tier 2 services + Medium to Heavy loads (>500W)
Duration	<4hrs	>4hrs and <8hrs	>8hrs and <20hrs	>=20hrs
Reliability (Black-out Days)	5 or more days	2-4 days	1 day	0
Quality*	$N_H > 3; N_L > 6$	$N_H = 0-3; N_L = 0-6$	$N_H = 0-1; N_L = 0-3$	$N_H + N_L = 0$
Affordability	Unaffordable		Affordable	
Legality	Illegal		Legal	

* N_H is number of high voltage days in a month causing appliance damage; N_L is number of low voltage days in a month limiting appliance usage.

NOTE: For dimensions where the categories span multiple tiers, only the higher tier values apply. For example, affordability can only be categorised as Tier 1 or Tier 3. The same is the case for legality.

Cooking Energy Access – Multi-tier, multi-dimensional Framework

Tier \ Dimension	Tier 0	Tier 1	Tier 2	Tier 3
Health & Safety	Only traditional fuel used (firewood, dung-cakes, agricultural residue)	A mix of traditional fuel and BLEN (Biogas, LPG, Electricity, Natural Gas) is used		Only source of cooking fuel includes BLEN
Availability	Cooking less because of availability	Unsatisfied with availability	Neutral to availability	Satisfied with availability
Quality	Quality of cooking is not adequate		Quality of cooking is adequate	
Affordability	Not affordable		Affordable	
Convenience	Both Difficult to use and Time consuming		Either Difficult to use or Time consuming	Neither difficult, nor Time Consuming

NOTE: For dimensions where the categories span multiple tiers, only the higher tier values apply. For example quality and affordability dimensions can only take on Tier 1 or Tier 3. Health and safety can take on Tier 0, Tier 2 and Tier 3.

Source for tables: Realities and Challenges of Energy Access in India by Abhishek Jain, Council on Energy, Environment and Water, 23 February 2017. <https://niti.gov.in/writereaddata/files/Abhishek%20Jain.pdf>

When does energy poverty end?



Energy poverty in numbers

- **2.5-3 billion**, mostly in South Asia & SSA, without access to clean cooking fuels and stoves
- **0.8-1.3 billion** without electricity “access”
- But much more has unreliable and unaffordable “access” to electricity
 - For example, India: **<70%** of households electrified; **only 37%** above Tier 0 (see Jain)



Investment needs to uplift each global denizen to 2018 levels – rough estimates

Generation capacity investment to ensure 3,700 kWh per person per year

	Existing Gen Mix	CCGT	Utility Solar	Rooftop Solar	Onshore Wind	Offshore Wind	Nuclear
CAPEX (\$million/MW)	\$1.5	\$1.2	\$1.2	\$2	\$1.2	\$2.5	\$6
Utilization	Cur. Avg	65%	30%	25%	45%	55%	90%
Total Gen Inv (\$trillion)	\$5.1	\$2.6	\$5.7	\$11.4	\$3.8	\$6.5	\$9.5
Trans. (miles per MW)	50	50	100	25	100	150	50
Total T cost (\$trillion)	\$0.4	\$0.3	\$1.2	\$0.4	\$0.8	\$1.0	\$0.2
NG infr. cost (\$trillion)		\$1.0					
TOTAL (\$trillion)	\$5.5	\$3.9	\$6.9	\$11.8	\$4.6	\$7.5	\$9.7

Liquids infrastructure investment to ensure 0.01 BD per person

\$0.6-1 trillion

Simplifying assumptions:

- Transmission captures system integration costs. Total cost is based on \$2,500/MW-mile.
- NG infra. assumes land-based LNG import terminals & 5 miles of pipeline per 1000-MW.
- Liquids infra. assumes domestic refining capacity at \$25,000 per BD capacity.

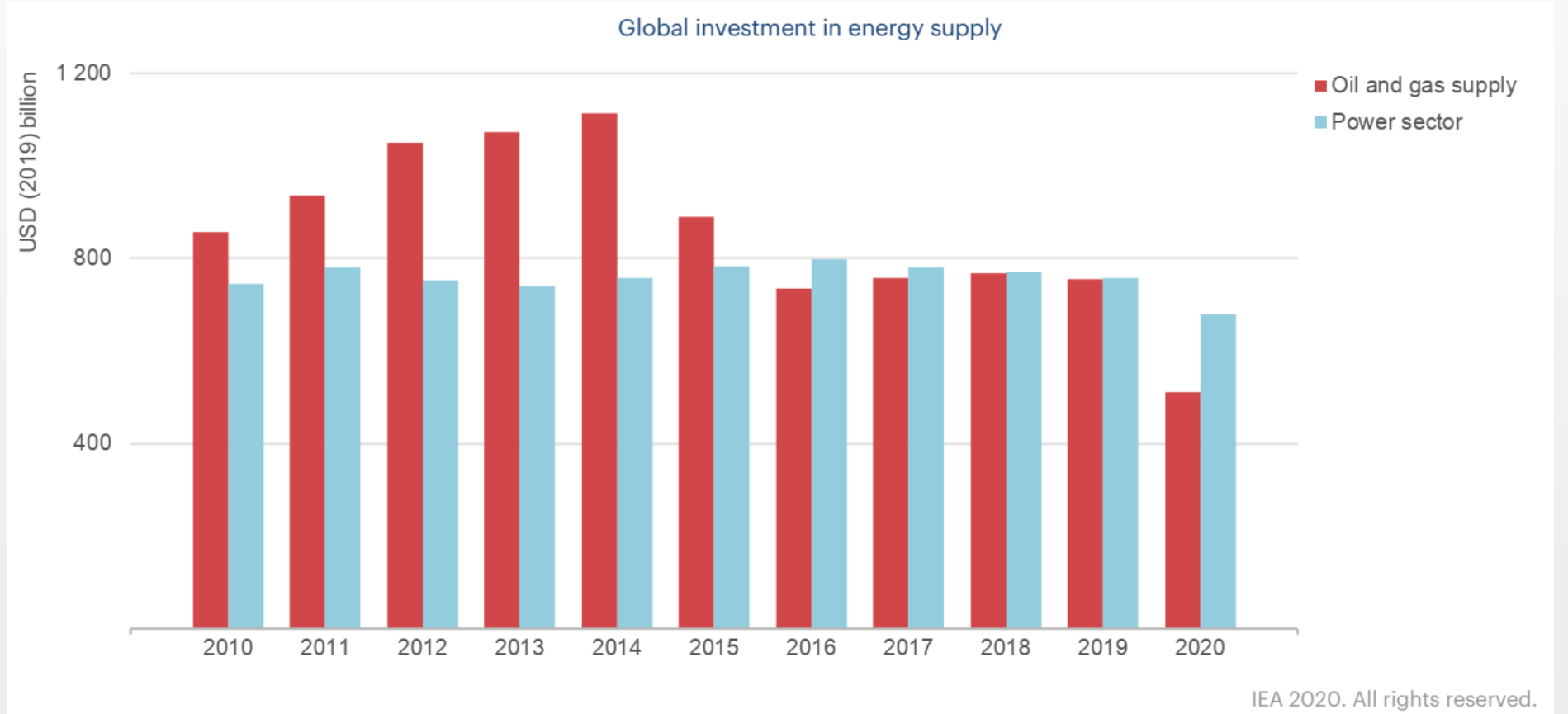
\$ Trillions for billions

- ▮ **\$4-10 trillion** to bring everyone to 2018 global averages
- ▮ **Several \$100 billion/year** to keep up with demand growth
- ▮ Much more to replace existing “brown” with “green”
 - ▮ Up to **\$130 trillion** 2016-50 (IRENA Global Renewables Outlook 2020)
 - ▮ **\$0.3-1 trillion per year** in low- and middle-income countries’ electricity sectors (World Bank Beyond the Gap)

For perspective

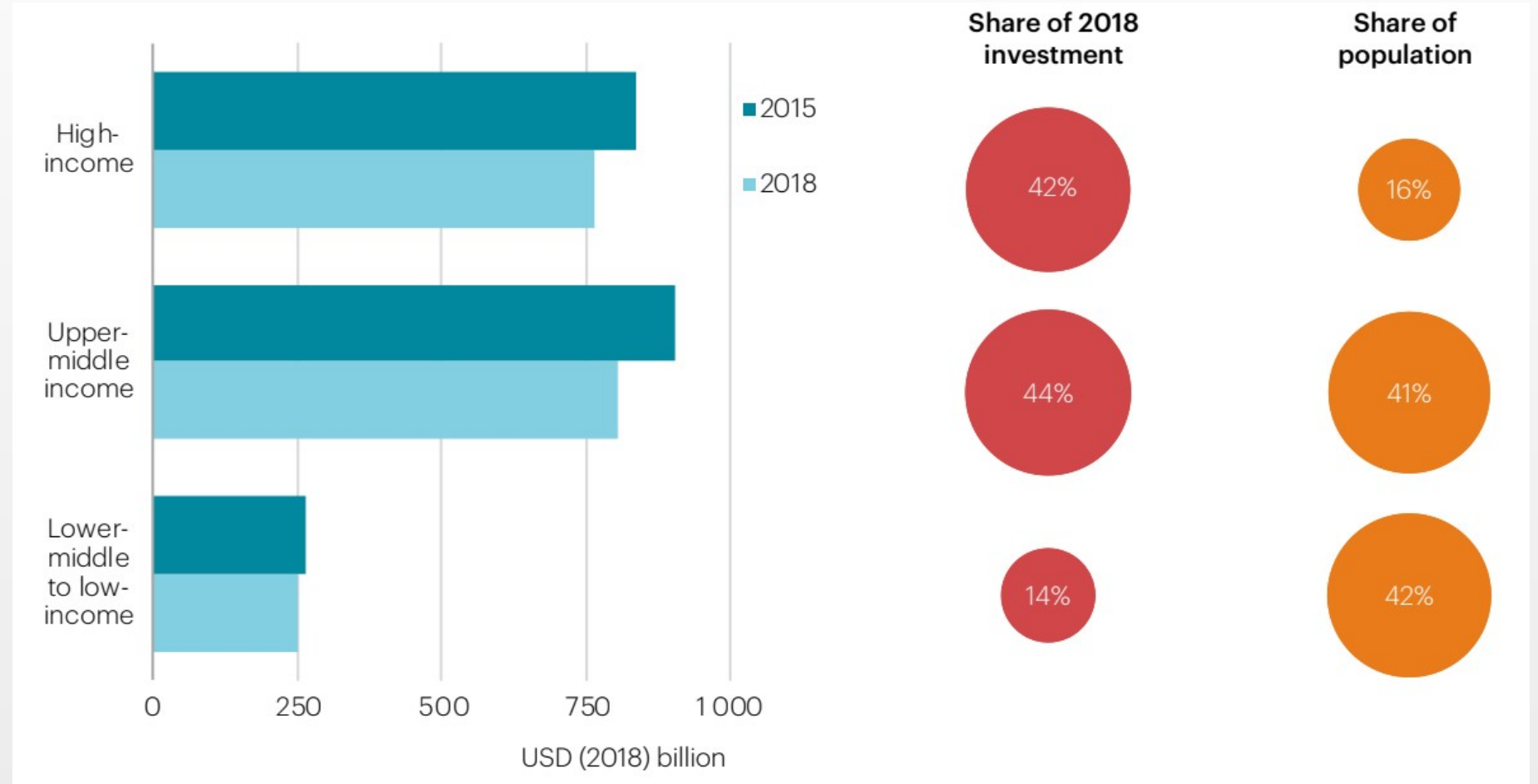
- **~\$90 trillion** of global GDP
- **<\$2 trillion** of annual energy investment
- **\$15-20 billion** corporate wind & solar PPAs
- **~\$250 billion** of green bonds
- **~\$30 billion** by institutional investors (all energy)
- Almost all “green” in developed economies

Actual
investment
too low



IEA World Energy Investment Outlook 2020

Only about \$50 billion in power gen in low-income countries



IEA World Energy Investment Outlook 2019

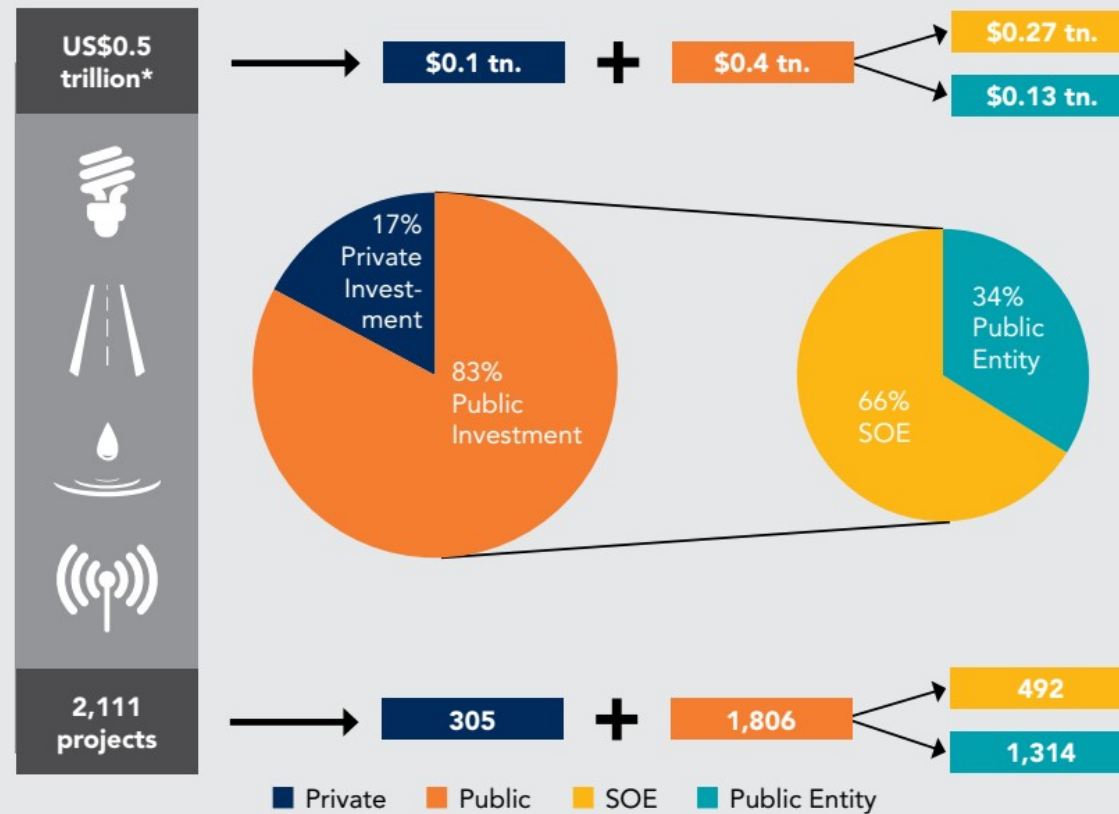
Note: IEA WEI 2020 only provides a percentage for “developing” countries, which include upper middle income countries that are not part of the OECD!

The public sector dominates utility investments

Even 55% of what's classified as private investment was financed by public banks, bilaterals and multilaterals.

FIGURE A

Infrastructure Project Investment Commitments in 2017



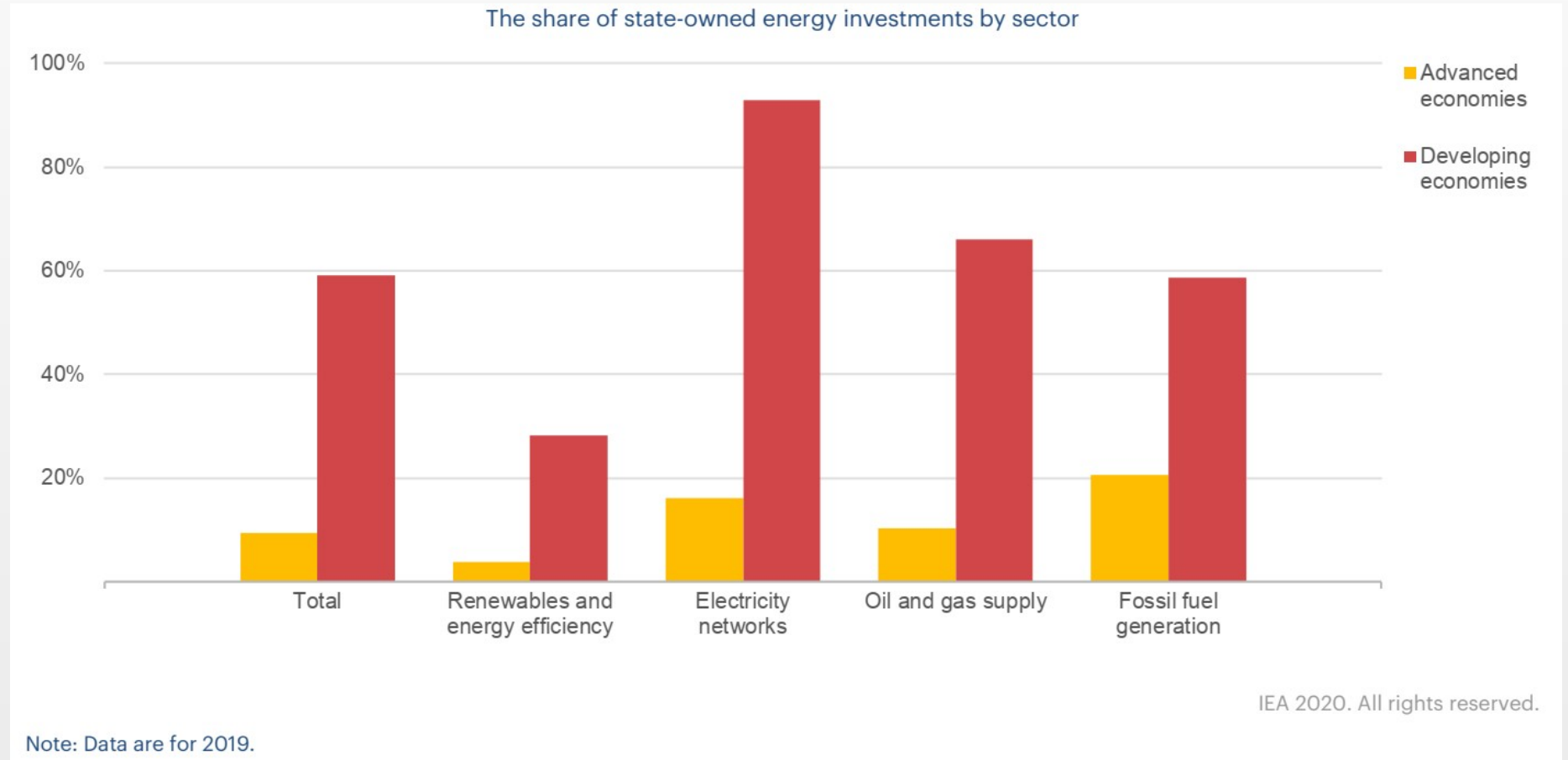
50% of total investment was in electricity generation and grid, and natural gas distribution systems

*Rounded to nearest decimal

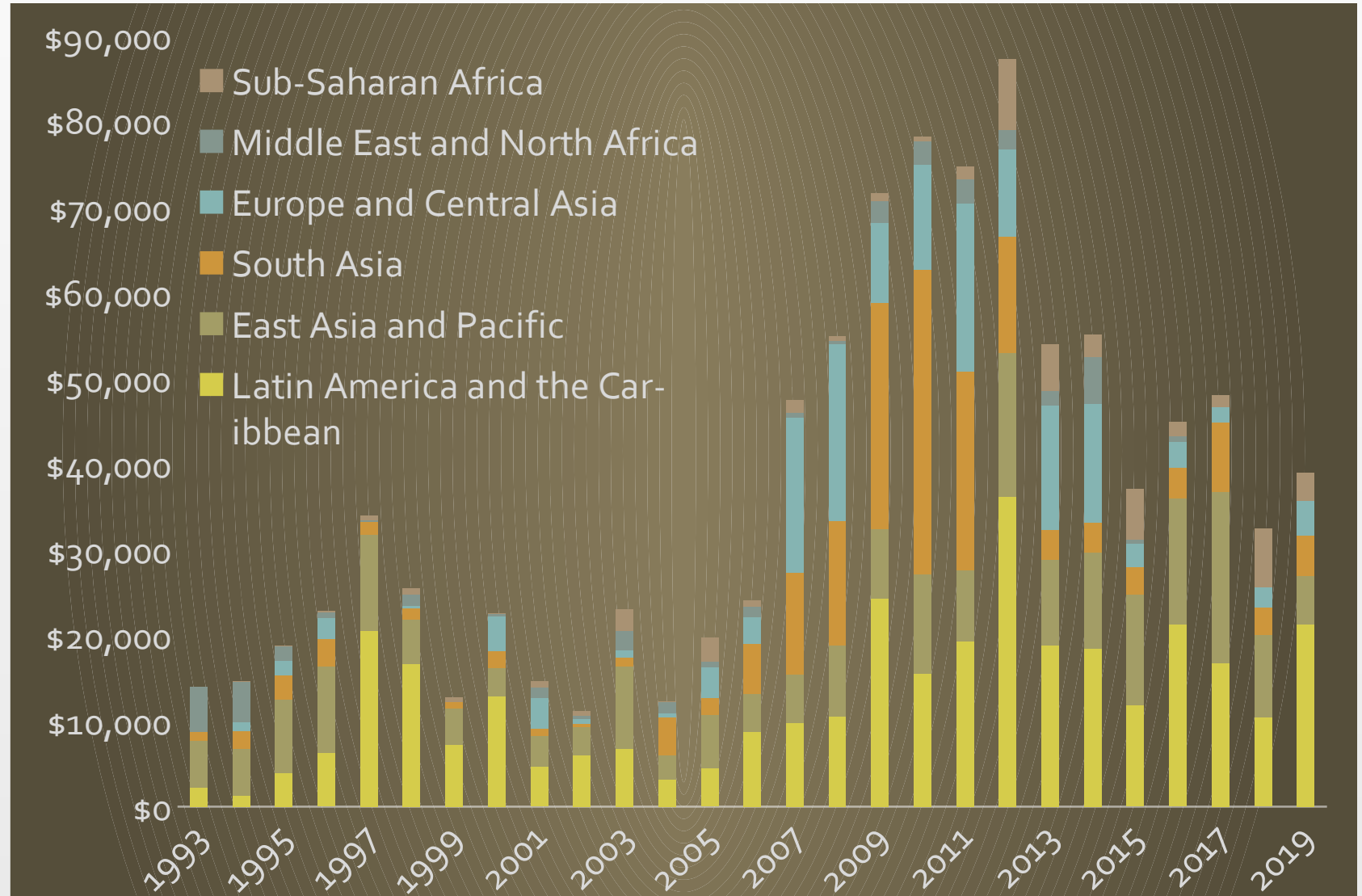
Sources: SPI and PPI databases, World Bank, as of November 2018

https://ppi.worldbank.org/content/dam/PPI/documents/SPIReport_2017_small_interactive.pdf

SOE dominance of energy investments

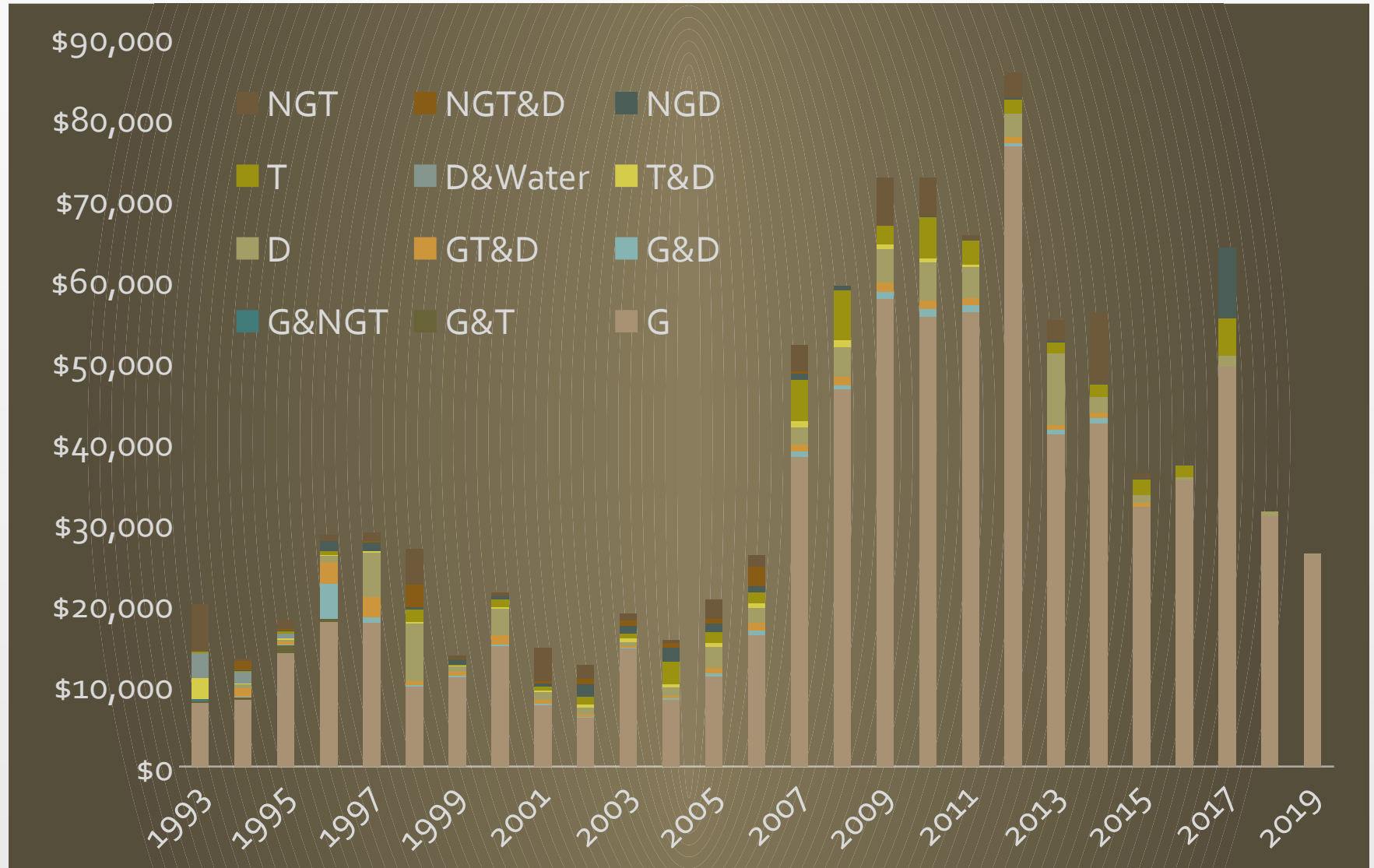


Private dollars don't go to low-income countries



Source: Author analysis of World Bank's Private Participation in Infrastructure Database (<http://ppi.worldbank.org/data>).

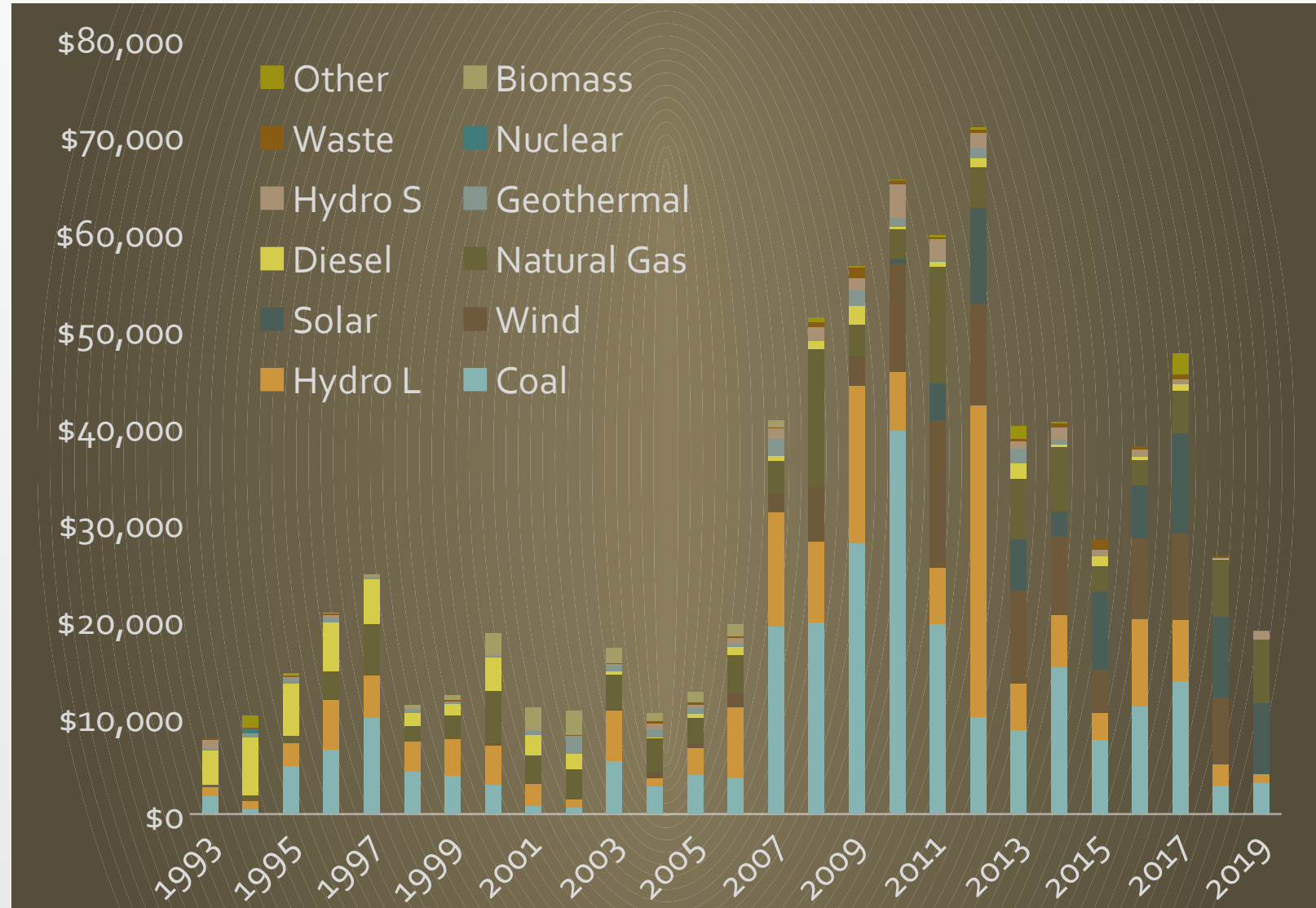
Private dollars like generation with PPAs



Source: Author analysis of World Bank's Private Participation in Infrastructure Database (<http://ppi.worldbank.org/data>).

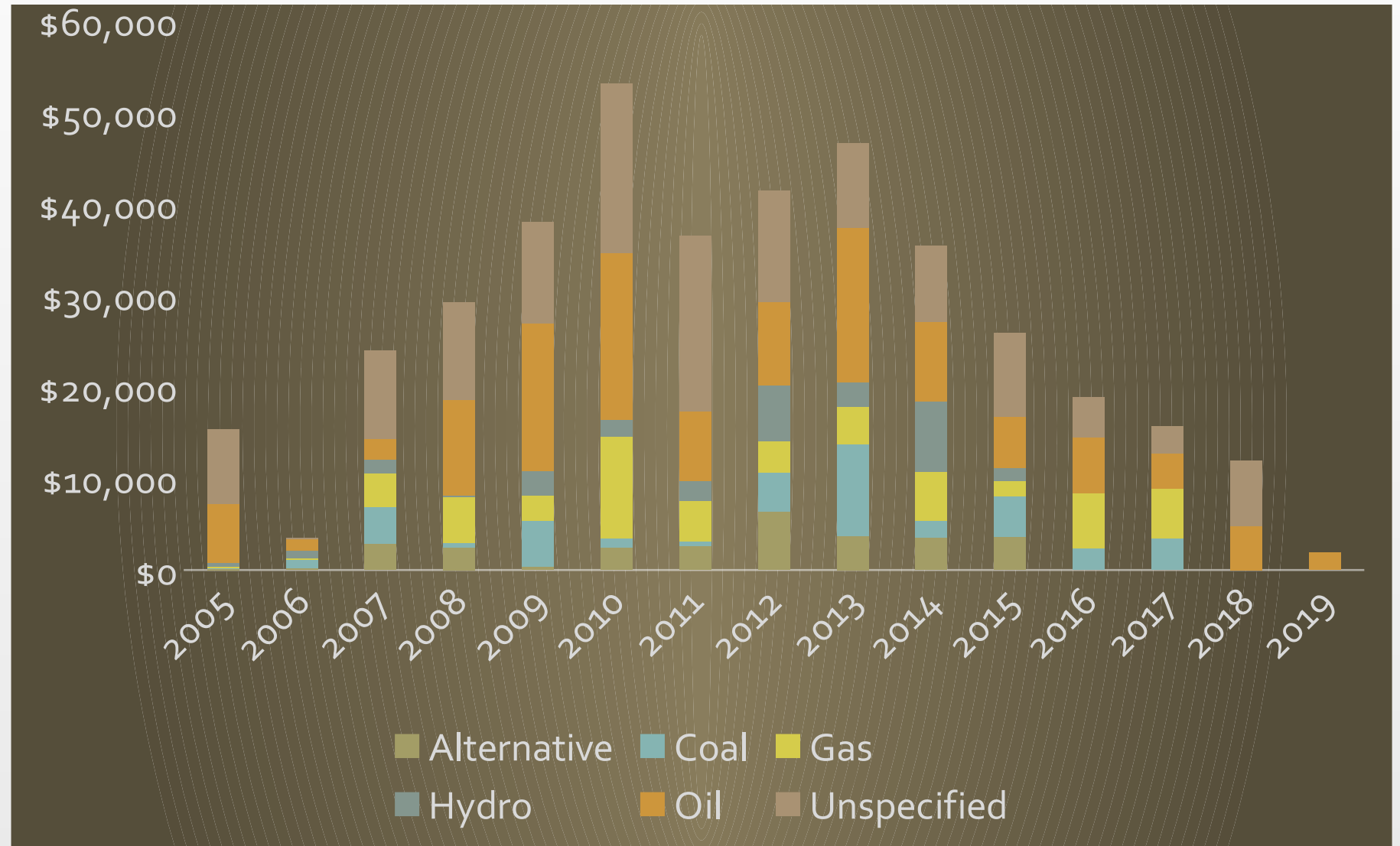


Private dollars chase projects supported by policy



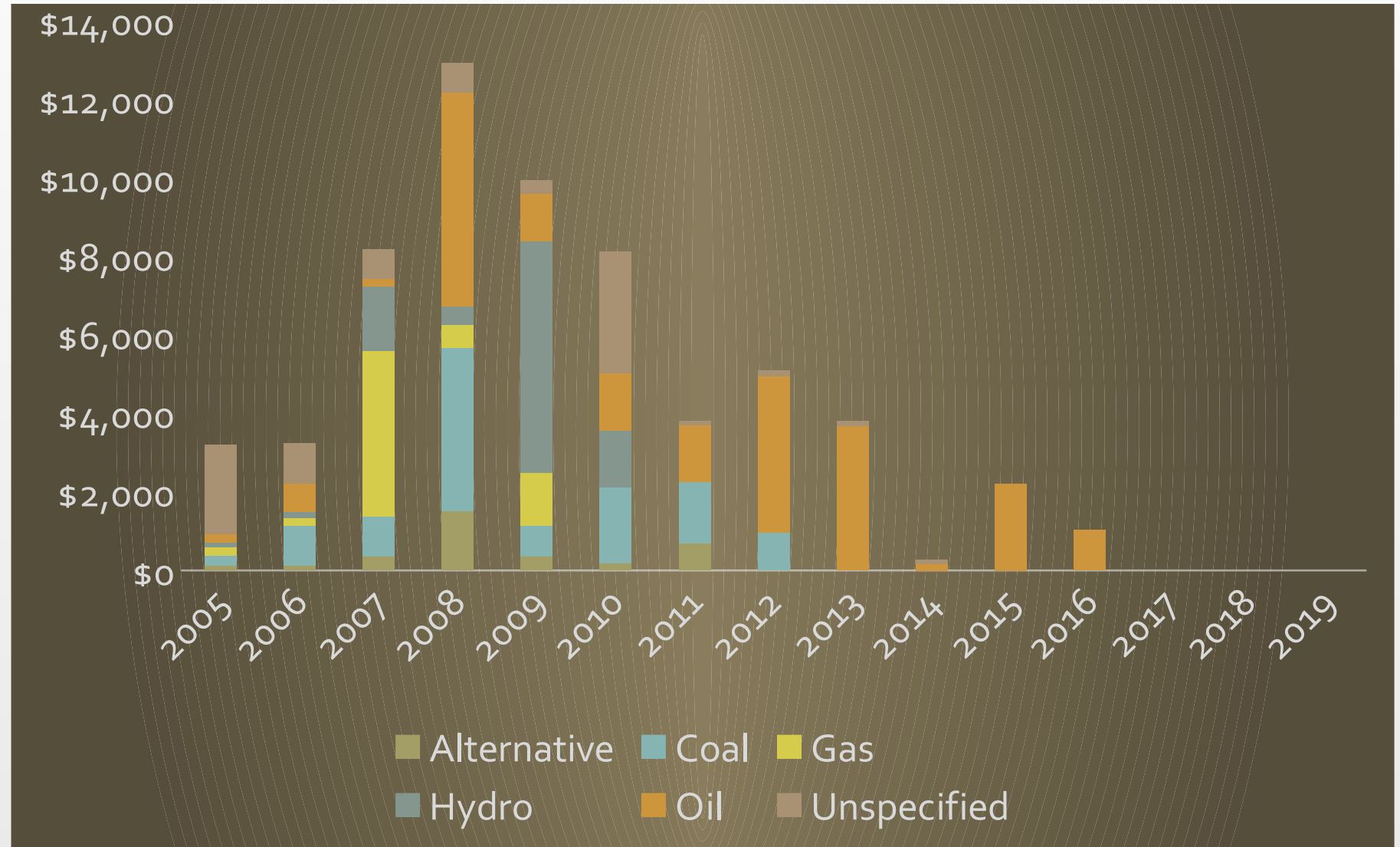
Source: Author analysis of World Bank's Private Participation in Infrastructure Database (<http://ppi.worldbank.org/data>).

Chinese energy investments in non-OECD countries



Based on American Enterprise Institute China Global Investment Tracker
<https://www.aei.org/china-global-investment-tracker/>

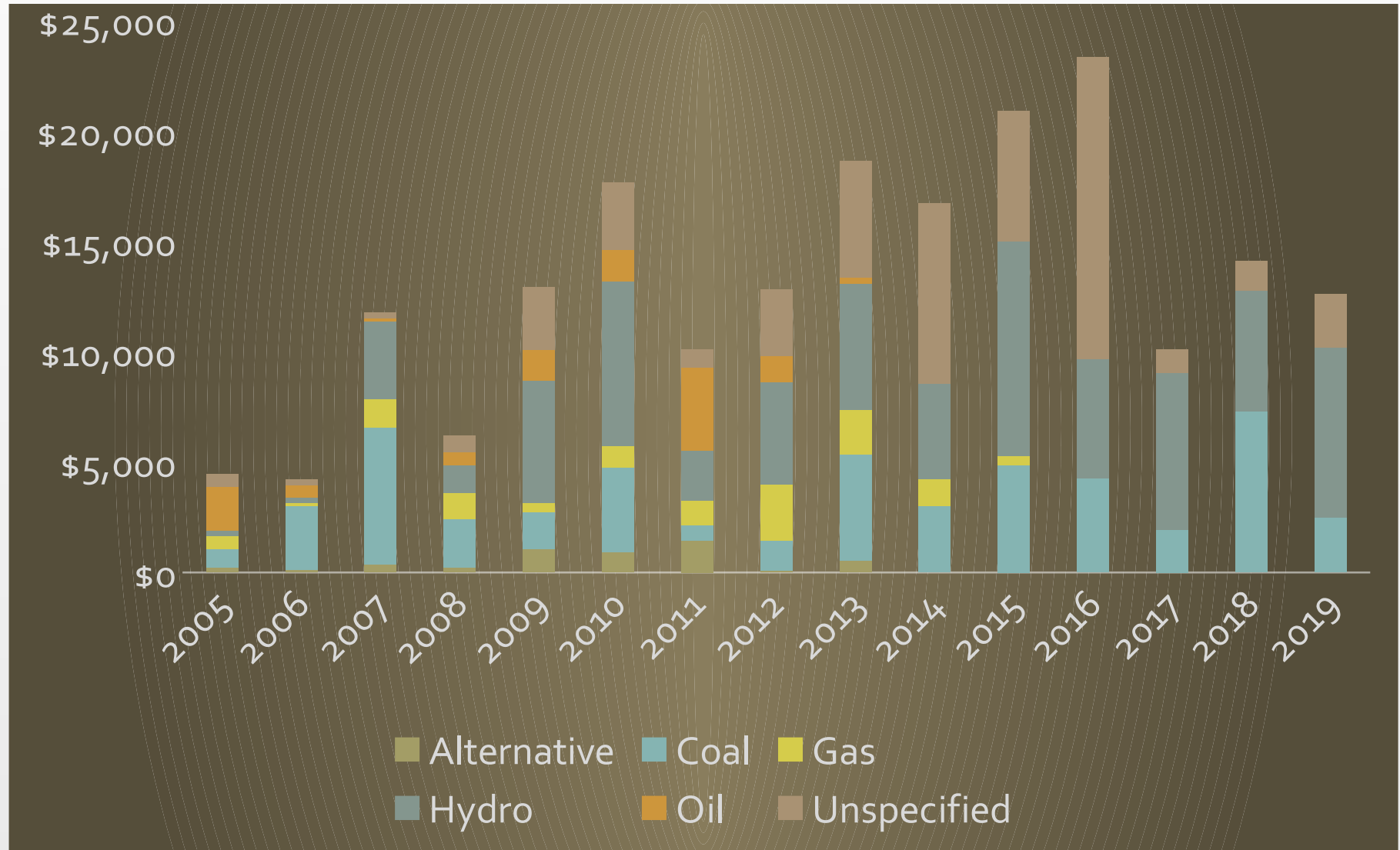
Very little Chinese investment in low- income countries



Based on American Enterprise Institute China Global Investment Tracker
<https://www.aei.org/china-global-investment-tracker/>



Much more Chinese construction in low-income countries



Based on American Enterprise Institute China Global Investment Tracker
<https://www.aei.org/china-global-investment-tracker/>

Summing up

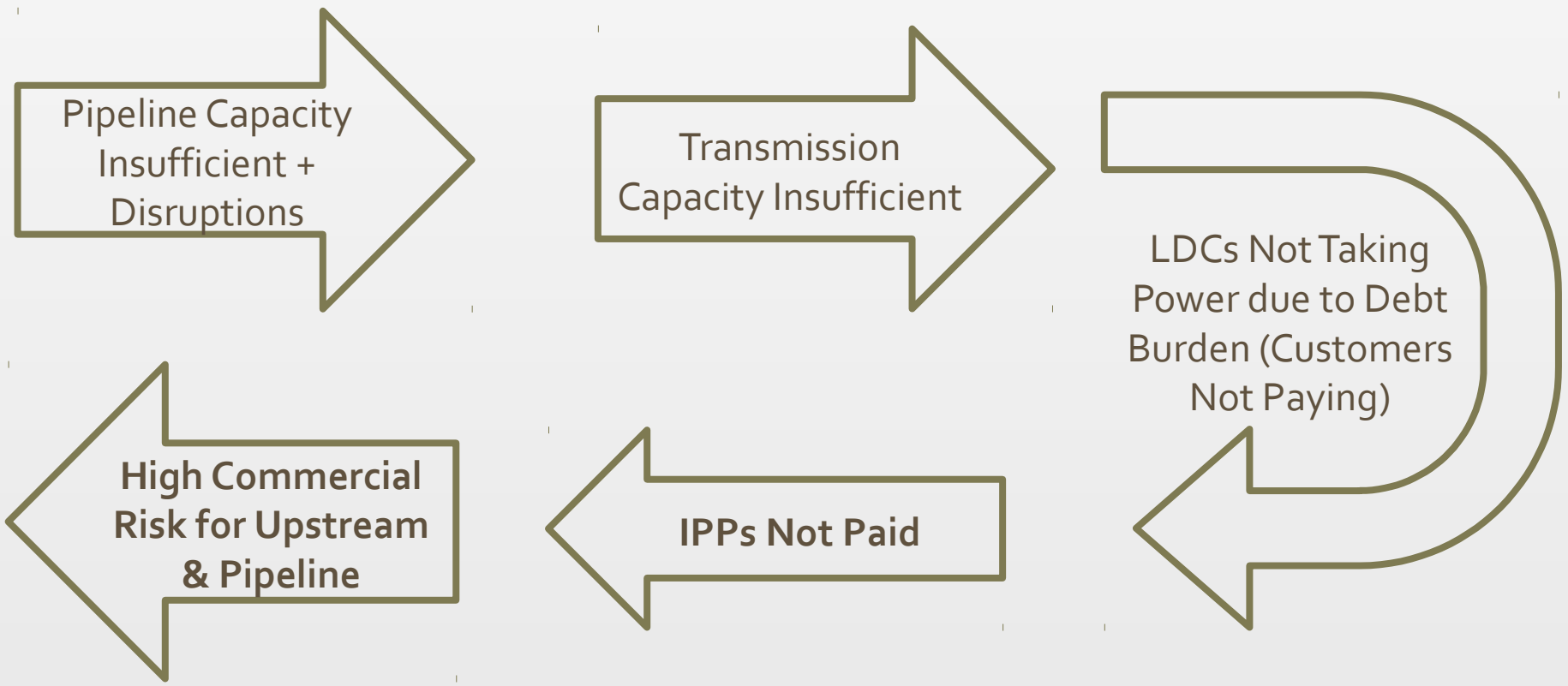
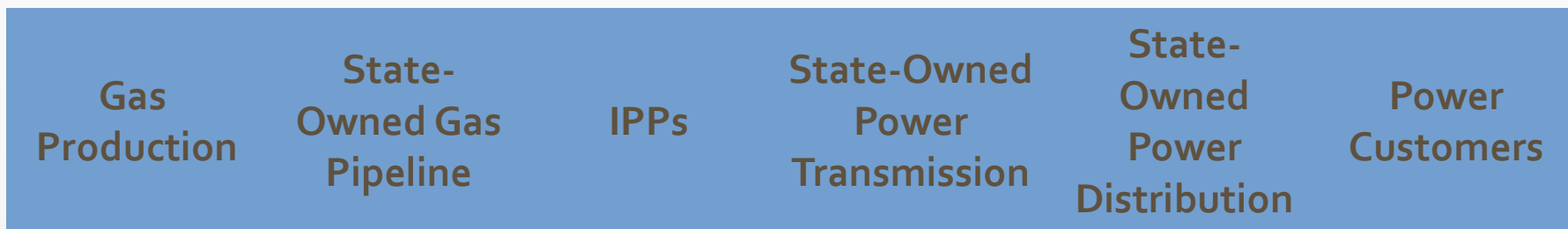
- Investments too low to end energy poverty
- Most in need gets none or very little
- Energy transitions dominate discussions in the West and influence development agencies & investors
- China, OPEC, others invest more in traditional infrastructure but still not enough and focus on a handful of countries
- For the energy poor, the de facto solution becomes distributed resources:
 - Great: low cost, quick to install, improves quality of life
 - But does not solve energy poverty and does not allow a country to develop

Governance and institutional deficiencies hamper domestic initiatives...

- Energy value chains broken
 - Too many state players across the supply chain
 - Non-market pricing of various fuels & technologies
 - Subsidies
 - No cash flow security for private investors
- SOEs still dominant but
 - Badly managed
 - Debt-ridden
 - Politically influenced
- Ministries and regulatory agencies
 - Insufficiently staffed → inefficient
 - Independence of regulator is a mirage
- Insufficient and failing infrastructure



Example of a broken value chain



Alas, none
of these are
new
obstacles

- ▮ Governance and institutional deficiencies must be resolved; **they can only be resolved from within**
- ▮ But, poverty (hence energy poverty) is a global problem
- ▮ Global problems require global cooperation
- ▮ Current trends of political and economic nationalism are not encouraging...