Incorporating (energy) poverty thresholds in IAMs

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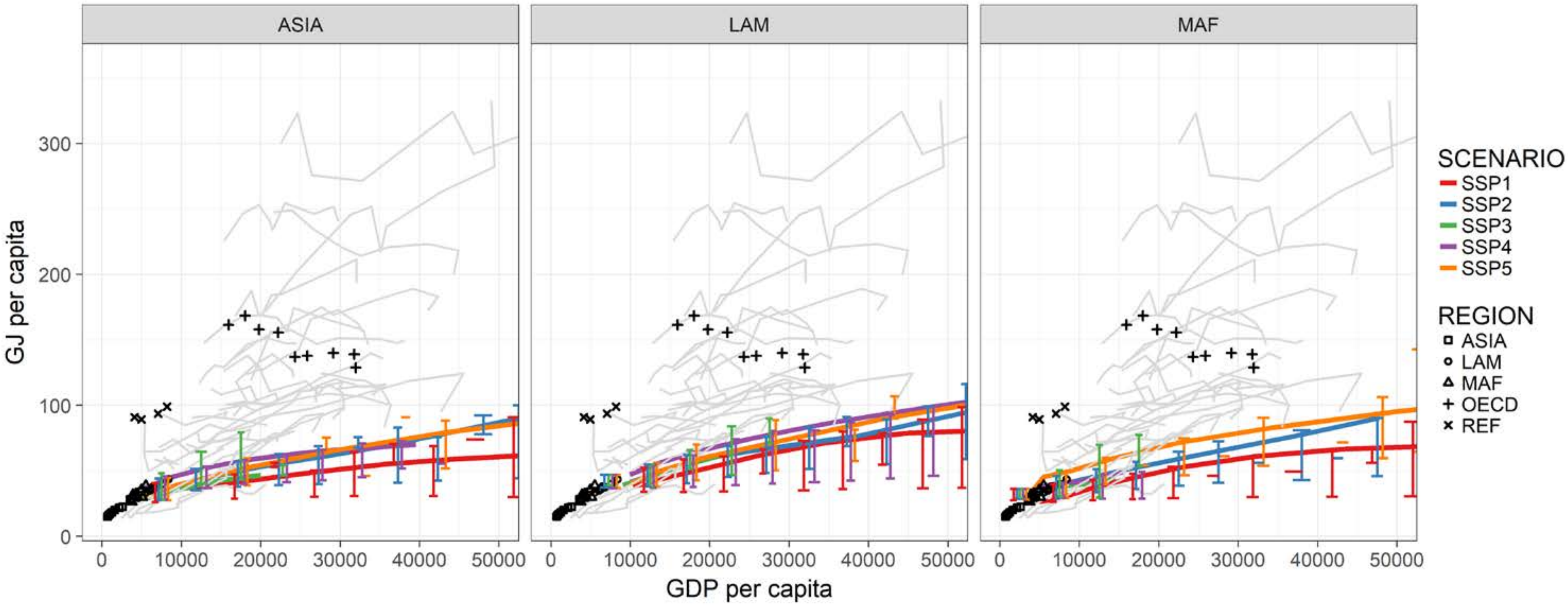
Messages

- Energy demand pathways in IAM 2°C scenarios need ‘ground-truthing’
- Estimating energy for basic needs ‘bottom-up’ provides one such reality check
- Their comparison reveals expected growth inequality

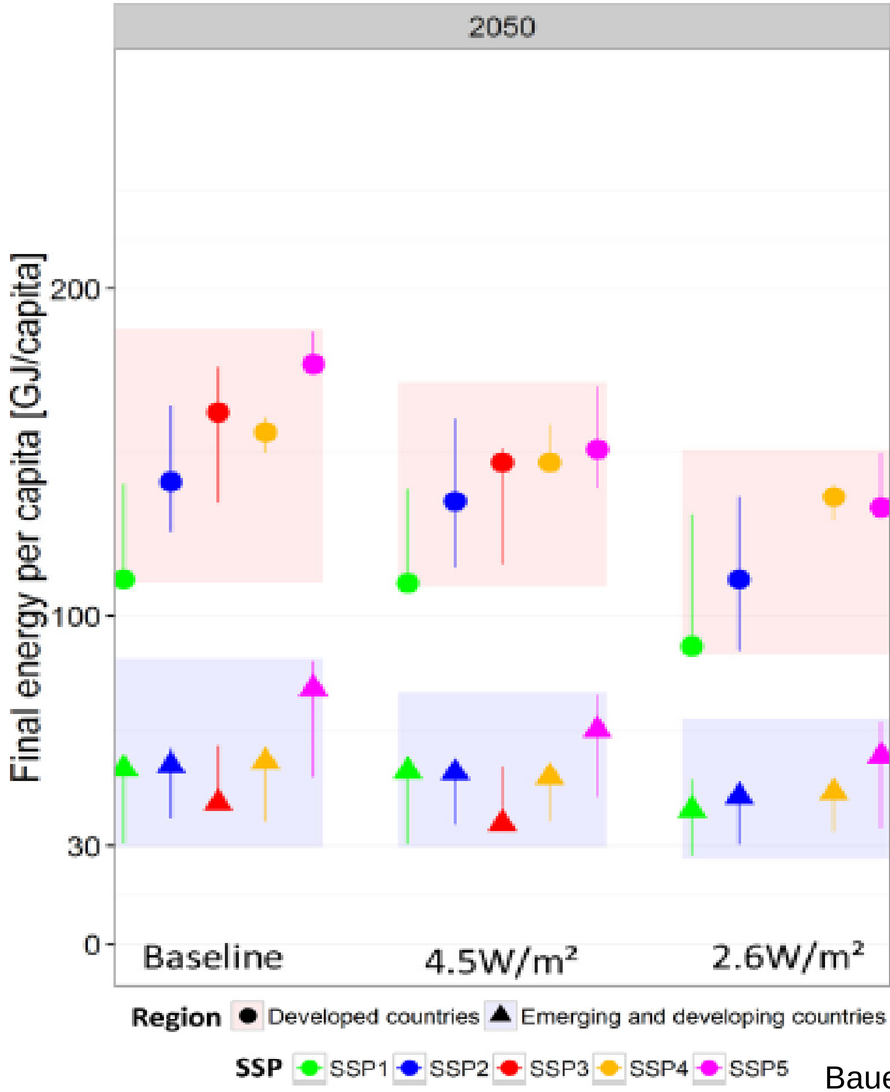
In the SSPs, developing countries' energy demand is below OECD at the same income level



CREDIT: B. van Ruijven

SSP: Shared Socioeconomic Pathways

In a <2C world, non-OECD energy demand stays almost flat…



Bauer et al. 2017

Non-OECD average

In 2015: **35 GJ/cap**

In 2050
In a <2°C world: **30-50 GJ/cap**

Messages

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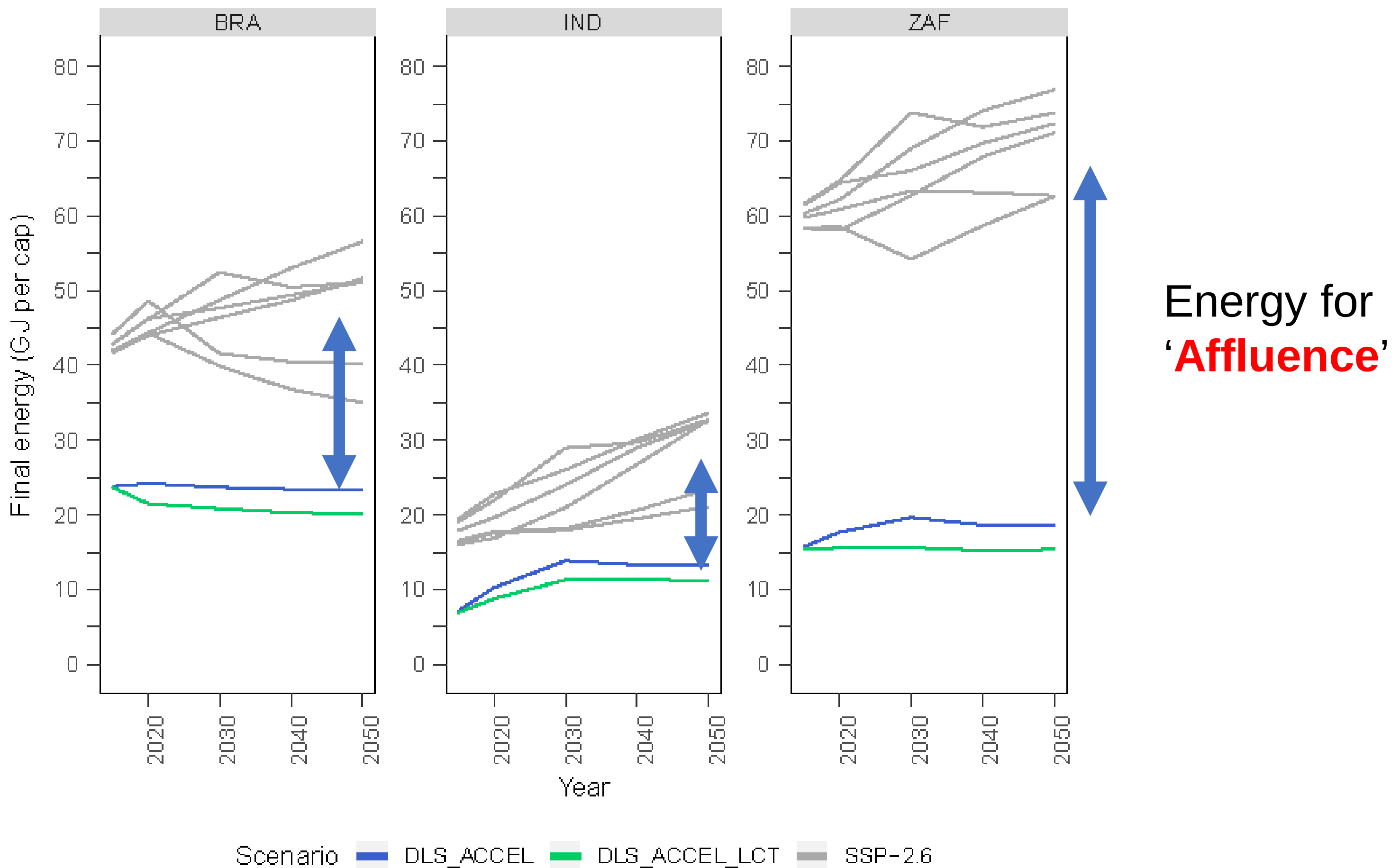
Energy requirements for "decent living standards" in India, Brazil and South Africa

- Universal standard, country-specific energy needs
  - Identical minimum nutrition, floor space, mobility
  - Different diets, construction methods, infrastructure
- Minimum energy needs to fill poverty gaps by 2030
  - With 'development-first' low-carbon options
- Comparison to national IAM SSP(1,2,4)-2.6 energy demand pathways

Rao et al., *Nat. Energy,* forthcoming

Compare IAM 2C scenarios to energy requirements for “decent living standards” in IND, BRA and ZAF



Rao et al., *Nat. Energy,* forthcoming

If countries were to provide for this minimum, what combinations of (energy) growth and inequality are implied by the IAM demand pathways?

More formally, we relate inequality, growth and minimum consumption

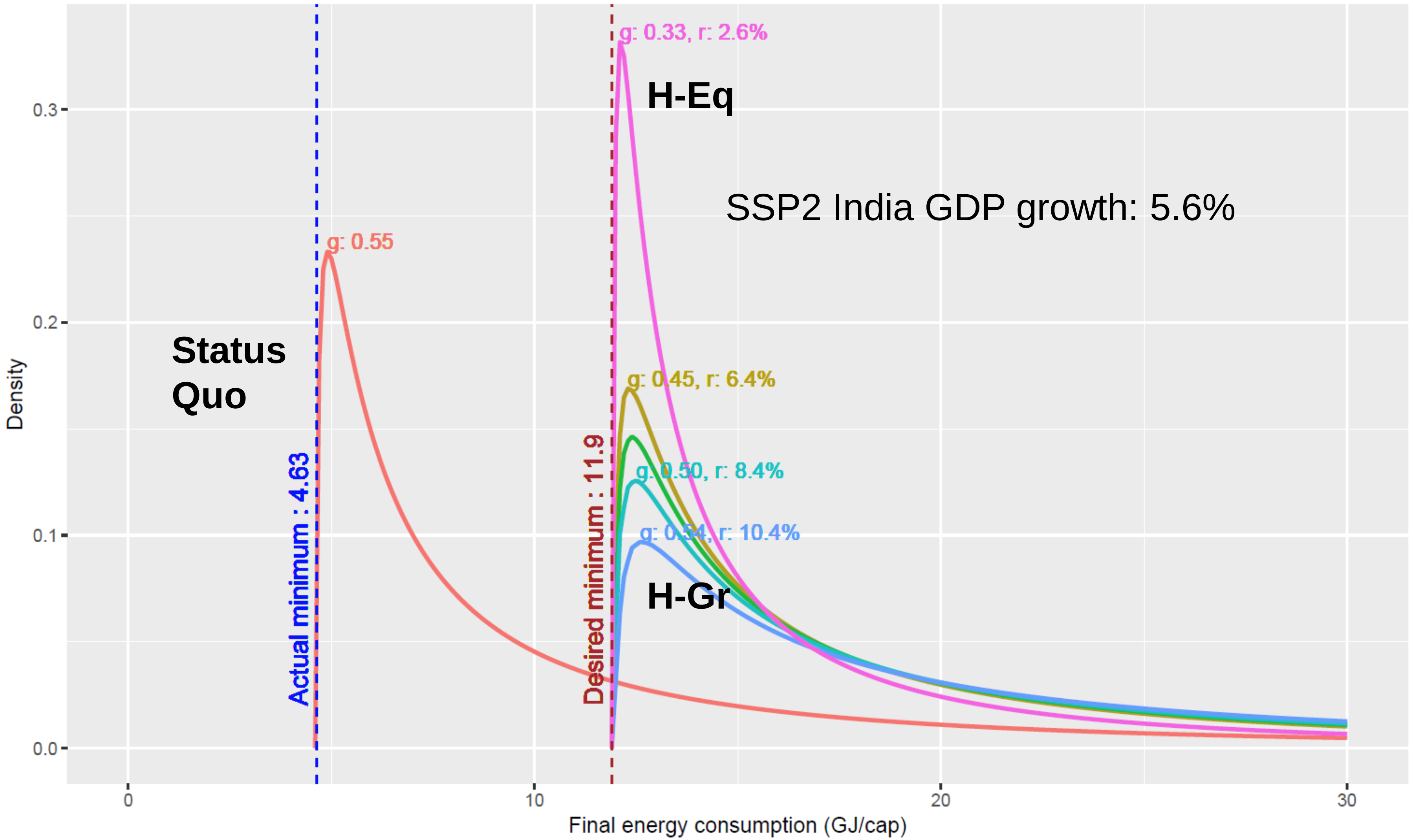
- For generalized income distribution $f_X(x)$
  - with mean μ_X, Gini G_X
- *Given* a minimum threshold *D*
- Define growth as a scale-and-shift in X
  - giving $Z = kX + d$, where $d = D - k \cdot min(X)$
  - with new mean μ_Z and Gini G_Z
- We can show that

$$G_Z = \frac{k\mu_X}{k\mu_X + d} G_X = \frac{\mu_Z - d}{\mu_Z} G_X.$$

We can now examine this relationship empirically

- What rates of GDP growth are required in India to fill the DLS gap *d* under two growth paths:
- Rising tide lifts all boats ($k \geq 1$, high growth, current inequality) H-Gr
- Redistributive growth ($k<1$, modest growth, low inequality) H-Eq

India would require high sustained GDP growth rates to fill DLS gaps by 2030

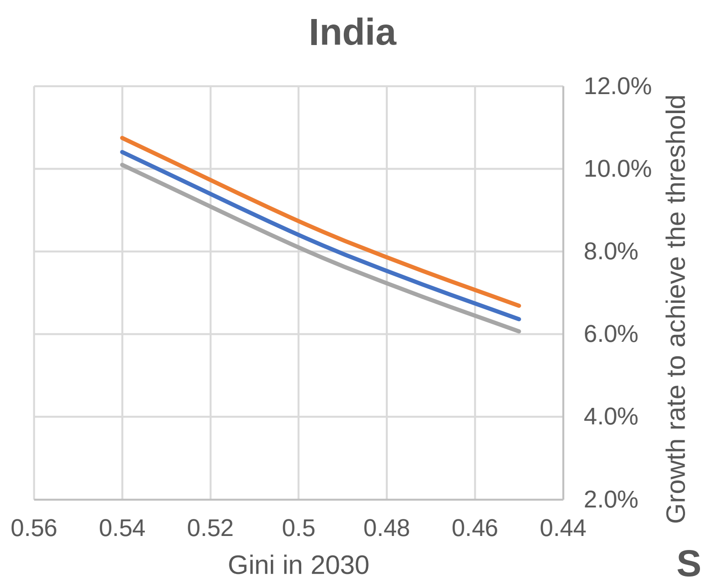


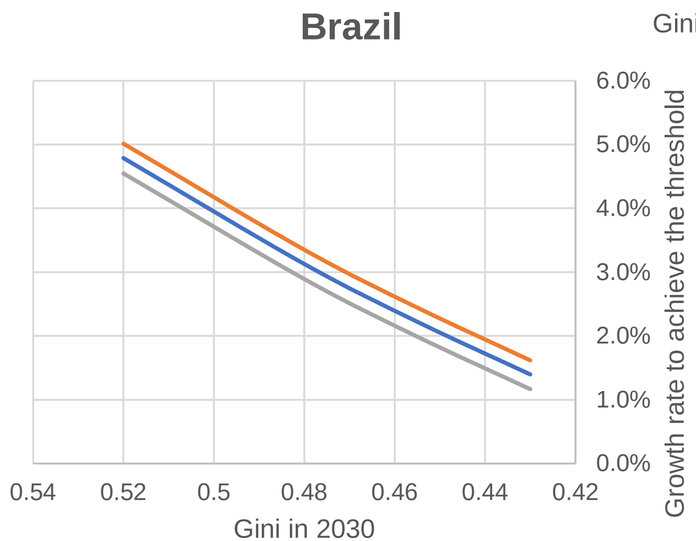
Is unprecedented 'equitable' growth realistic?

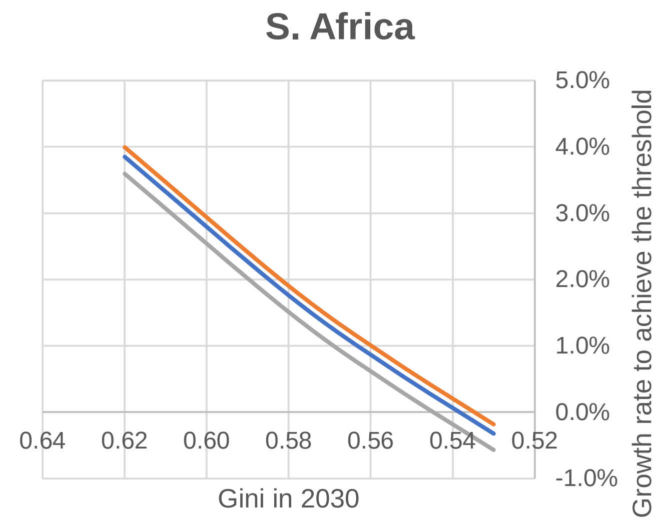
- Gini is a slow-moving variable

Country	Gini @ Year 0	Period	Avg ∆Gini/ decade (p.p)	# of obs
Serbia	39.3	2004-2013	-12.4	5
Venezuela	50.0	2002-2011	-11.6	10
Niger	44.4	2005-2014	-11.5	4
Bolivia	61.9	2000-2009	-11.5	8
Zambia	51.2	1993-2002	-9.8	4
Ghana	36.0	1988-1997	-9.7	6
El Salvador	51.8	1999-2008	-9.0	9
Slovakia	26.7	2002-2011	-8.8	7
Kyrgyzstan	48.9	1996-2005	-8.2	10
Cote d'Ivoire	45.2	1985-1994	-8.2	5
Kazakhstan	35.4	2001-2010	-7.6	10
Ukraine	35.2	1996-2005	-7.5	5
Iceland	28.6	2006-2015	-7.2	9
Chile	57.3	1999-2008	-7.1	4
Ecuador	55.9	2000-2009	-6.9	8

Brazil and S. Africa don't face the same challenge







Lines represent different population growth rates

Scenarios for achieving both DLS for all and meeting climate goals

- CDR technology saves all, even if energy demand exceeds expectations
- Demand-side technology (e.g. LED scenario) saves all, high activity levels beyond DLS
- Modest tech transfer, social transformation, less inequality

Further research for IAMs

- Interpret minimum thresholds for the SSPs
- Examine energy decoupling assumptions in developing countries

THANK YOU!

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Appendix

- Assume a generalized income distribution, x, with mean: μ, cdf: $\mathrm{F}(x)$ and its inverse: Q(p))
- $Lorenz\ curve\ L(r) = \frac{\int_0^r Q(p)}{\int_0^1 Q(p)=\mu}$
- For $\breve{x} = kx + d$

$$Q\widetilde{(p)} = kQ(p) + d$$
$$\breve{\mu} = k\mu + d$$

Gives

$$L(\breve{r}) = \frac{1}{k\mu + d}(k\mu L(r) + d \cdot r)$$

With *Gini* $$G = 1 - 2\int_0^1 L(r)$$

- We can show that $\breve{G} = \frac{k\mu}{k\mu+d} G = \frac{\breve{\mu}-d}{\breve{\mu}} G$