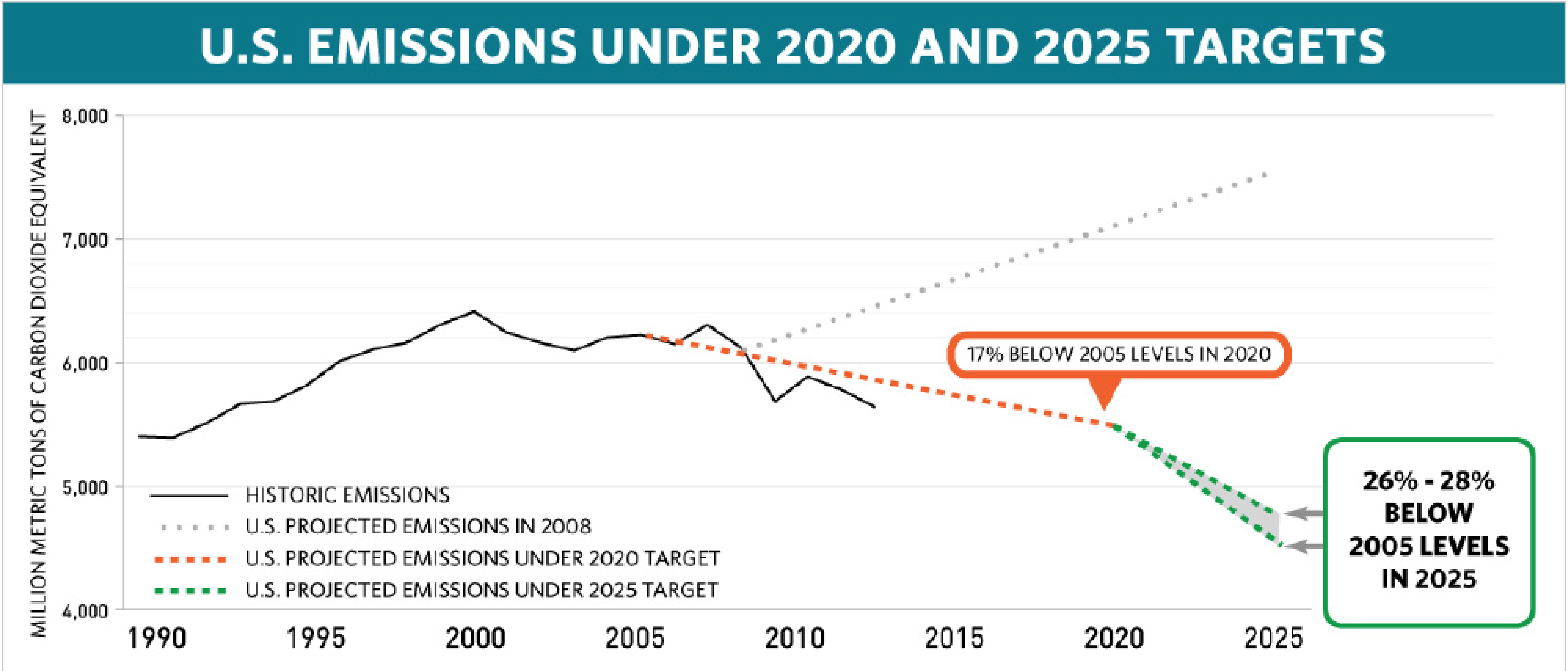
Energy and the Built Environment
CRP 470.004 /570.004

Christian E. Casillas

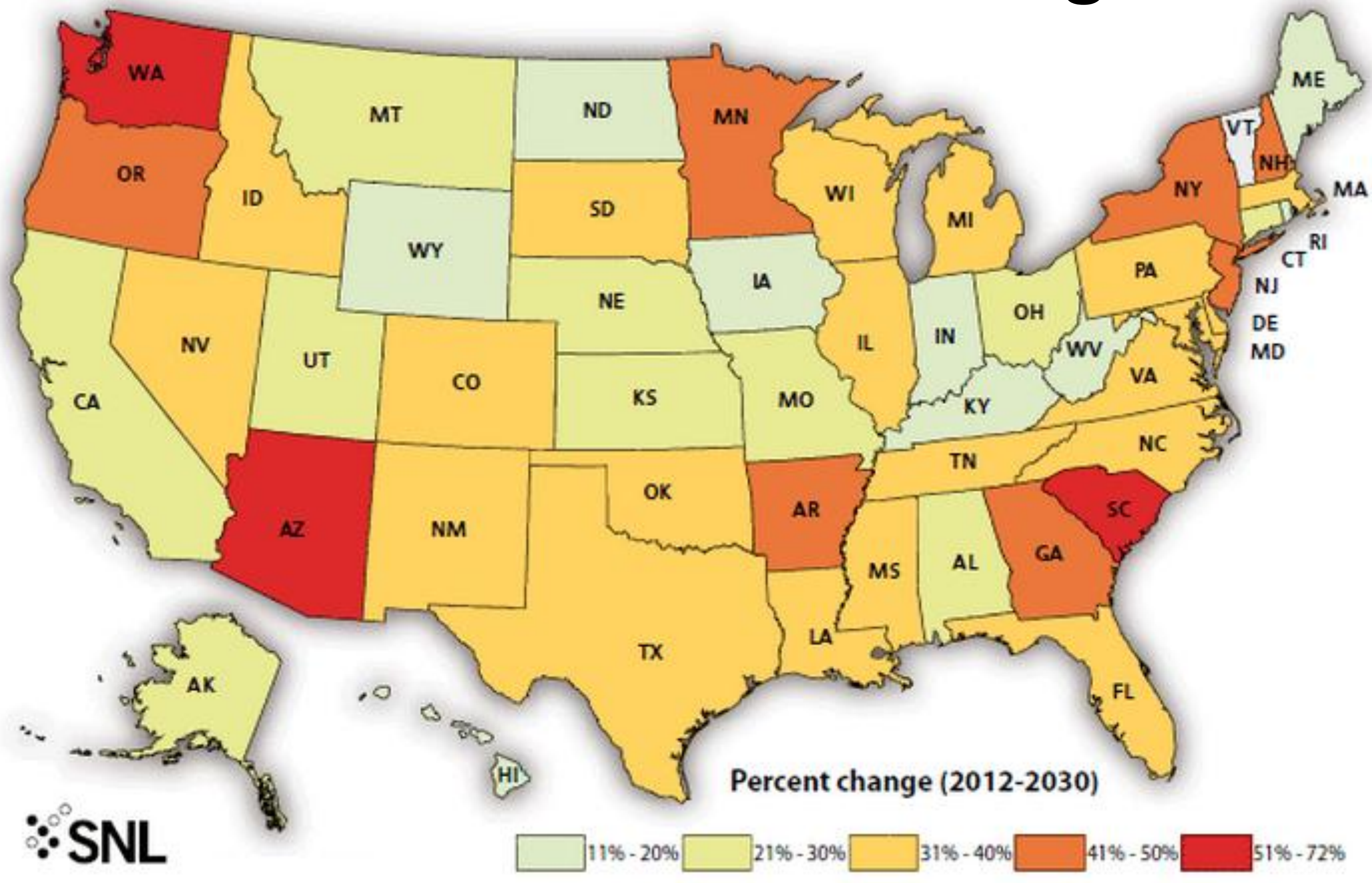
Lecture 13

Global energy trends

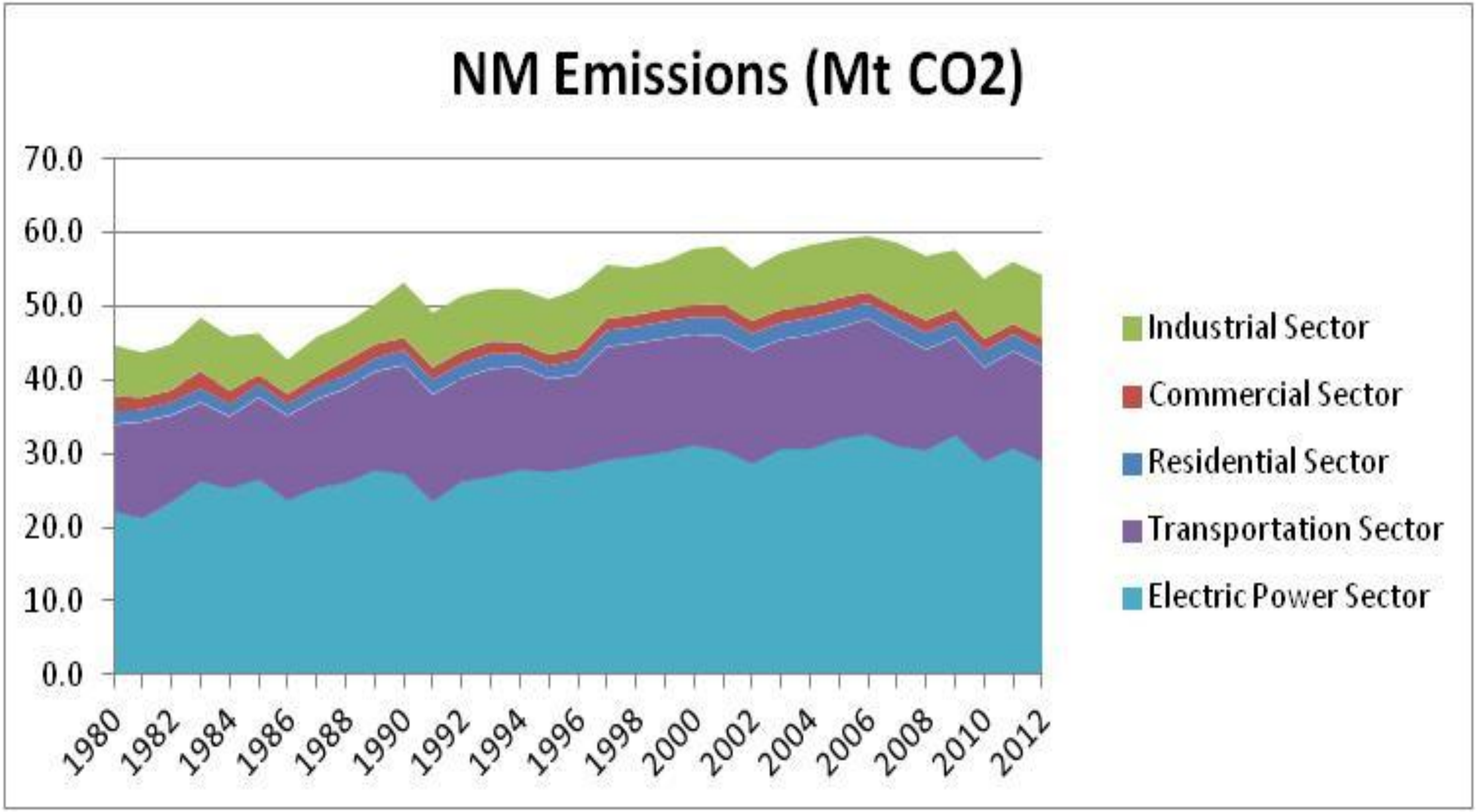
Document submitted to UN



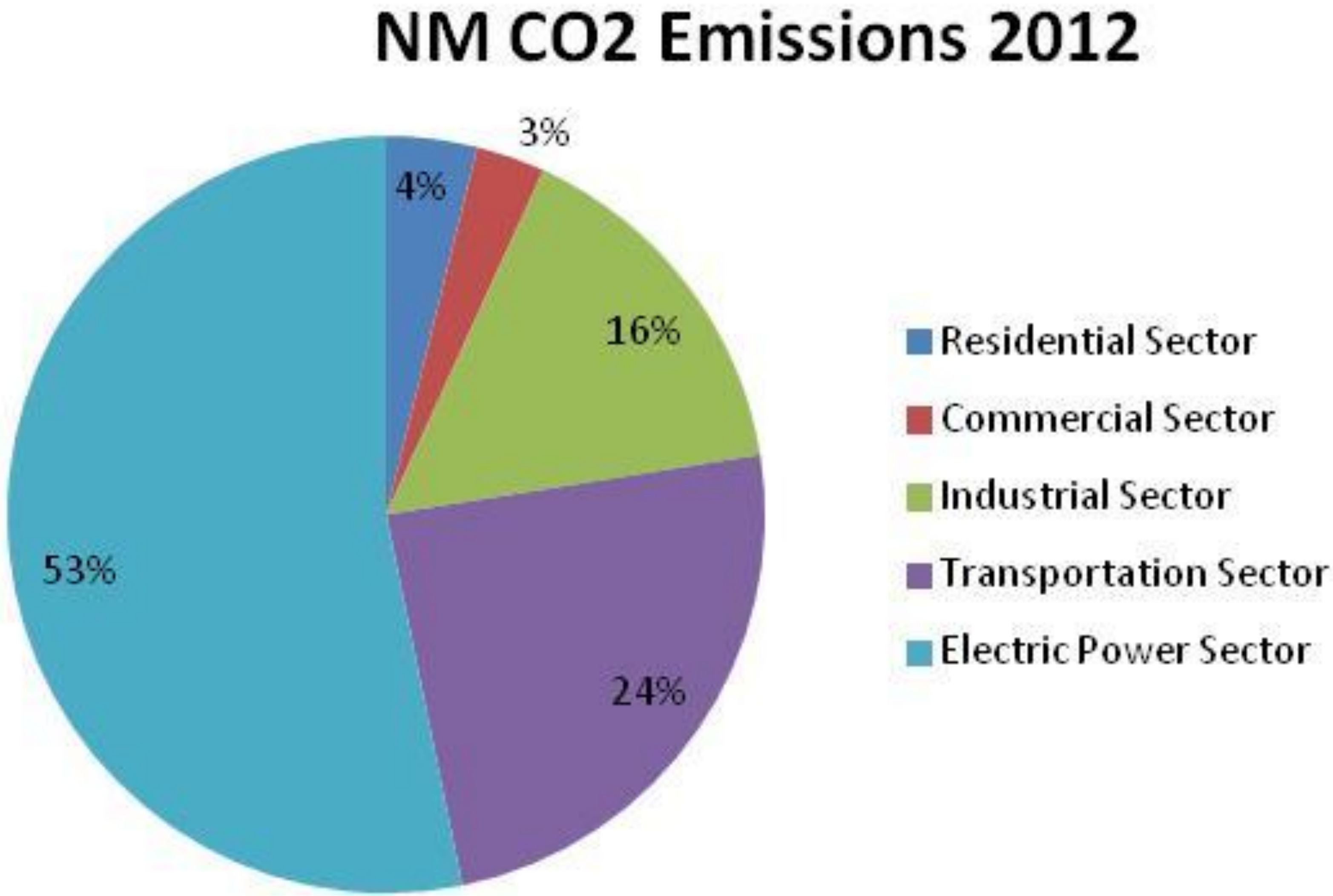
EPA Clean Power Plan Targets



SNL



Source: www.nmenv.state.**nm**.us



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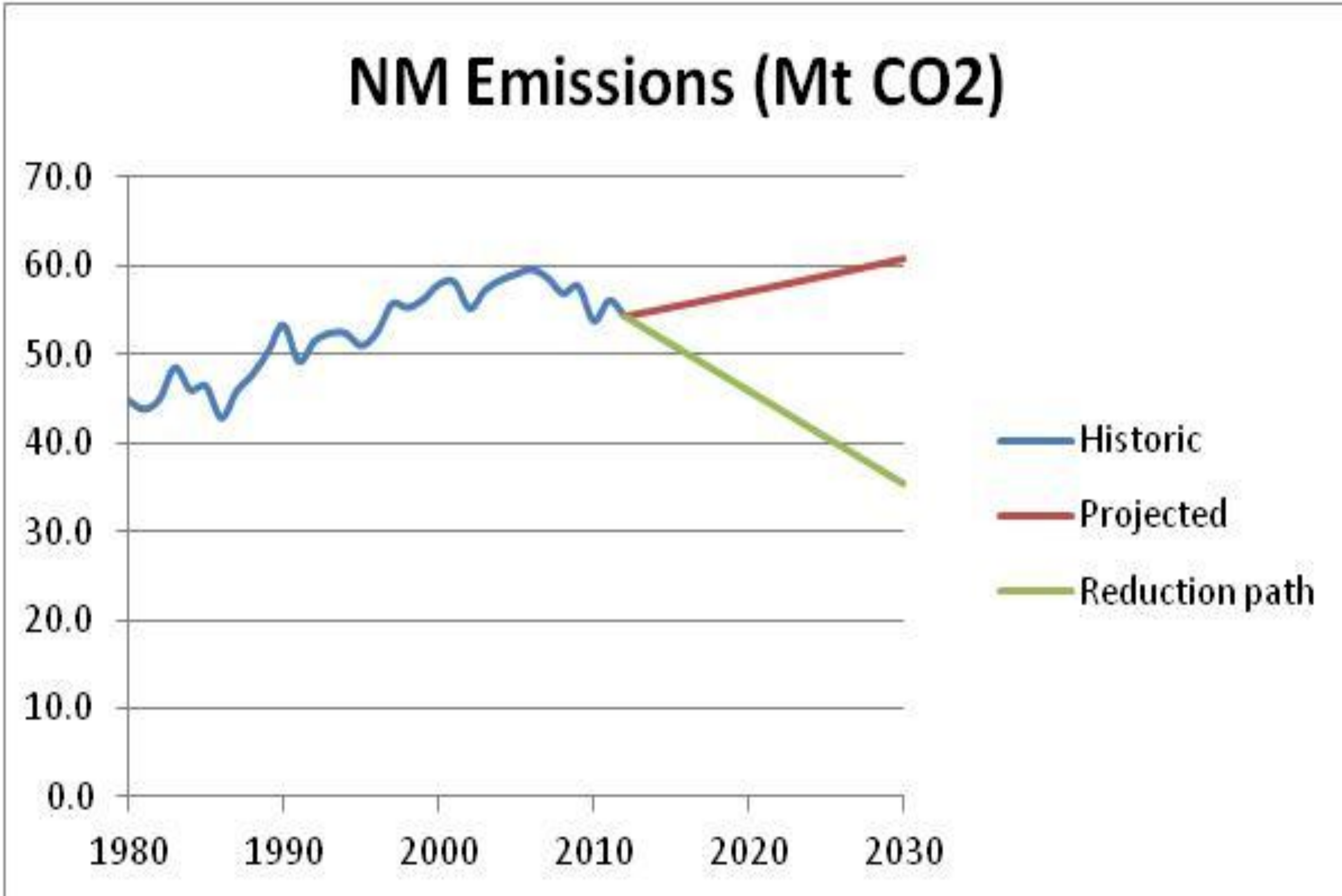
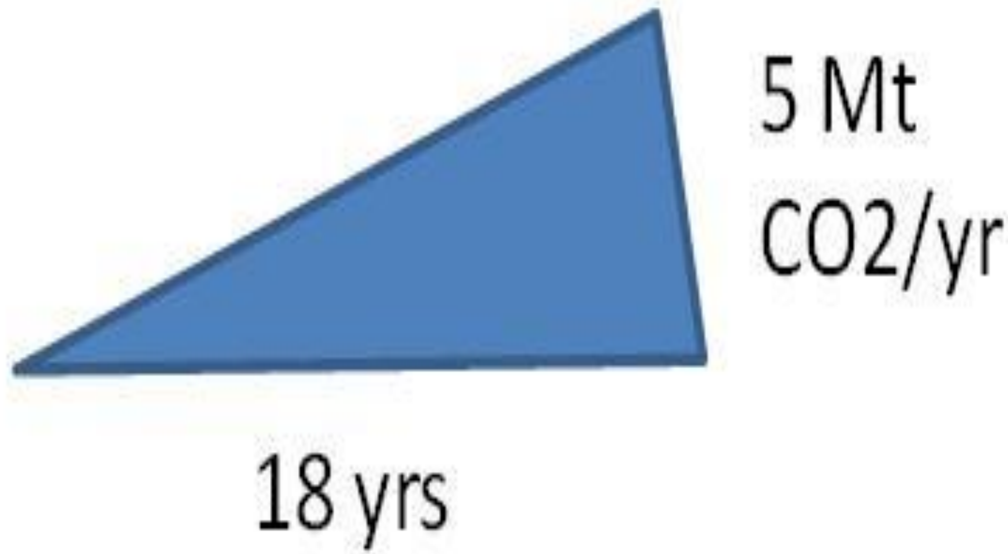


Total emissions reduced to 34% below 2005 emissions.
Project emissions growth equal to population growth, of 0.64% per year

5 near-term wedges (18 yrs) of 45 Mt CO_2



How to calculate a solar wedge

- Current grid emissions: 0.66 kg CO2/kWh
- Want to reach 5Mt CO2/yr by 2030
- Total kWh reduction by 2030:

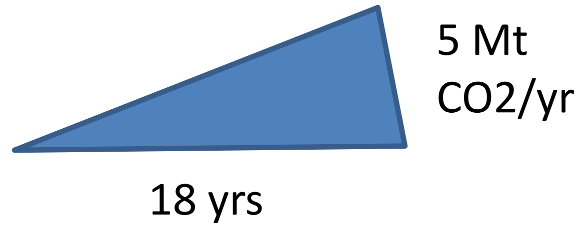
$$\frac{5x10^6 tCO_2 / yr}{0.00066 tCO_2 / kWh} x \frac{GWh}{1x10^6 kWh} = 7576 GWh / yr = 21 GWh / day$$

- Equivalent PV installed capacity in 2030 (ave CF of 0.23)

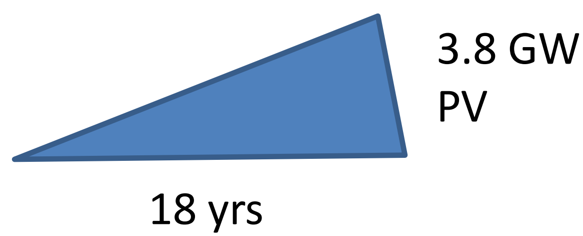
$$\frac{21 GWh}{24 hr * 0.22} = 3.8 GW$$

Example: solar PV

5 near-term wedges (18 yrs) of 45 Mt CO_2 eq (.5 x 18yrs x 5 Mt/yr)



Total PV installations:
3.8 GW installed in 18 yrs (210 MW/yr)



Rate of installation

- 3.8 GW of PV installations in 18 years
- 210 MW/year
- If ave household installation is 2kW, then this would be 210,000 kW / 2kW = 105,000 households/year.
  - There were only 905,000 housing units in NM in 2013!!
- Or twenty-one 10 MW solar PV plants per year…
  - Pretty fast!

Cost

- 210 MW/year
- 4 $/W ave installed cost (2013)
- 210 e6 W/yr x 4 $/W = 840 million $/yr
- Ave annualized lifetime cost per “system” per year (assuming 20yr payback, 7% discount)
  - 840e6 $/yr x (.07/(1-1.07^-20)) = 79 million $/yr
  - 79 million $/yr for 210 MW installations per year

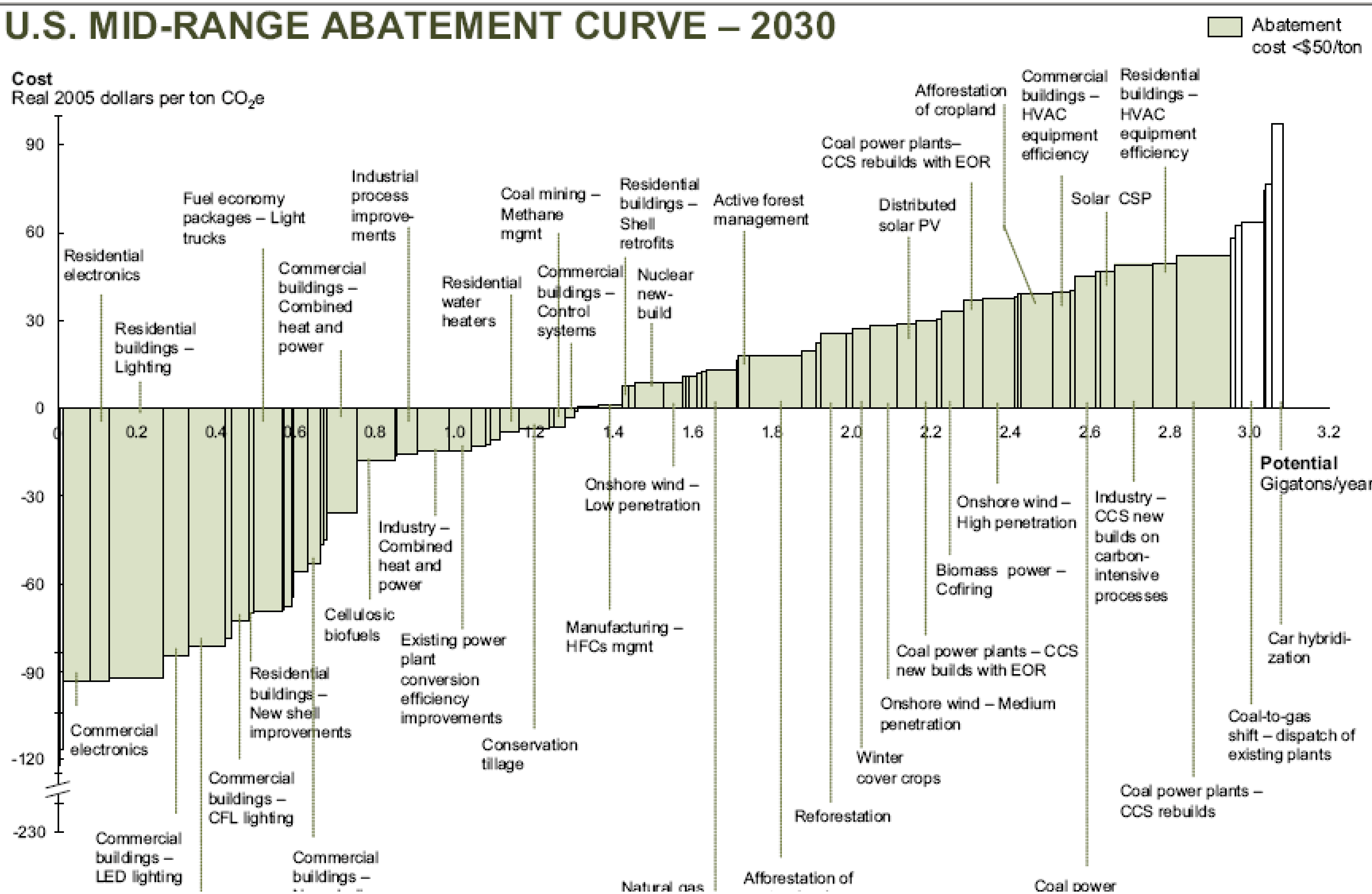
Mitigation cost

- 79 million \$/yr for 210 MW installations per year
- Annual emissions reductions from 210 MW/yr
  - 0.278 MtCO_2/yr
- 79 M\$/yr / 0.278 MtCO_2/yr = 284 \$/CO_2

What is the comparative advantage?

- Who saves money from the investment?
- Who does this cost?
- Is there job creation?
- Are there other life-cycle environmental implications (not just CO_2 – what about water, other pollutants)

Mitigation sources (McKinsey)



What are policies that can encourage this…

- PACE (only in SF county)
- Net metering (less than 10 kW)
  - Additional paper work up to 80 MW
- NM State tax rebate: up to $9,000 or 10% of installation cost
- Federal tax credit: 30%
- RPS

Emissions from reforestation?

- 27% of NM is forestland (5.3 million ha)
- Annual estimated Mt CO_2 absorption
  - 16.7 Mt CO_2/yr
  - 3 tCO_2/ha yr
- How much land would need to become forested to reach an additional 5Mt CO_2/yr by 2030?
  - 16,042 sq km of land reforested
  - An additional 5% of land area in NM

Emissions reference: http://www.nmenv.state.nm.us/cc/documents/CCAGFinalReport-AppendixD-EmissionsInventory.pdf

How do we impact market transformation?

- Does fire suppression lead to long term, increased carbon sequestration?
- Can we encourage reforestation?
- Can we utilize wood overgrowth for power generation/heating?
- What are co-benefits to greater forest management/protection/hands-off?

Emissions from chickens?

- 1.4 Mt of CO_2 emissions associated with 1 Mt of chicken production (Pelletier, 2008)
- For 5 Mt/yr reduction, need to replace 3.6 Mt of chicken consumption in 18yrs.
- Ave US consumption/yr: 45 kg/person
- NM pop: 2.068 million people
- tons of chicken consumption in NM: 0.1 Mt

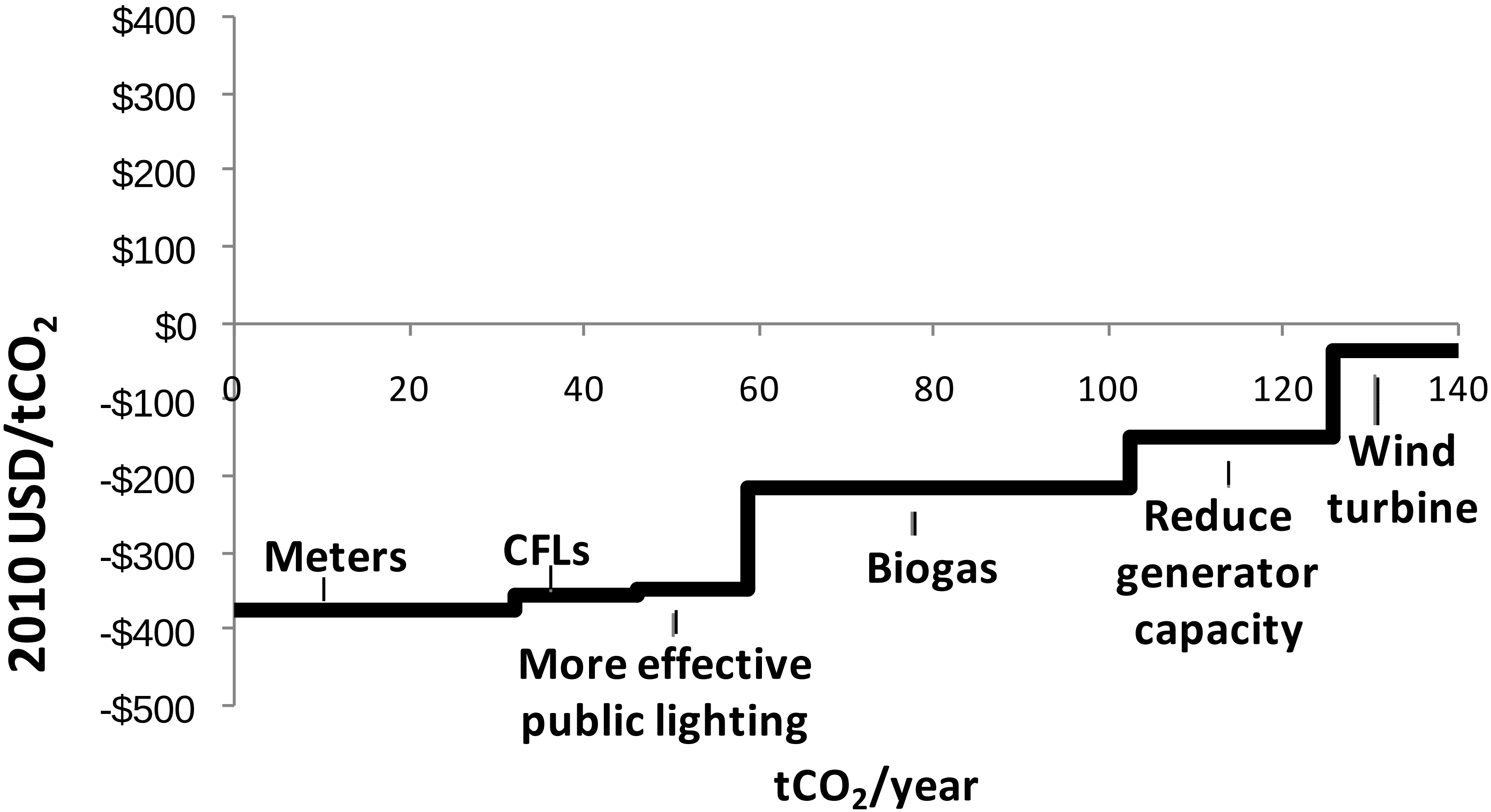
What are the co-benefits?

- What are other benefits from reducing reliance on factory-farmed chicken?
- Raising chickens at home?

Key Points

1. Carbon mitigation analysis tools should emphasize strengthening vulnerable communities.
2. Policy makers need continued exposure to tools of analysis that simplify connections between social, economic, and environmental impacts of carbon mitigation projects.

Marginal abatement cost (MAC) curve

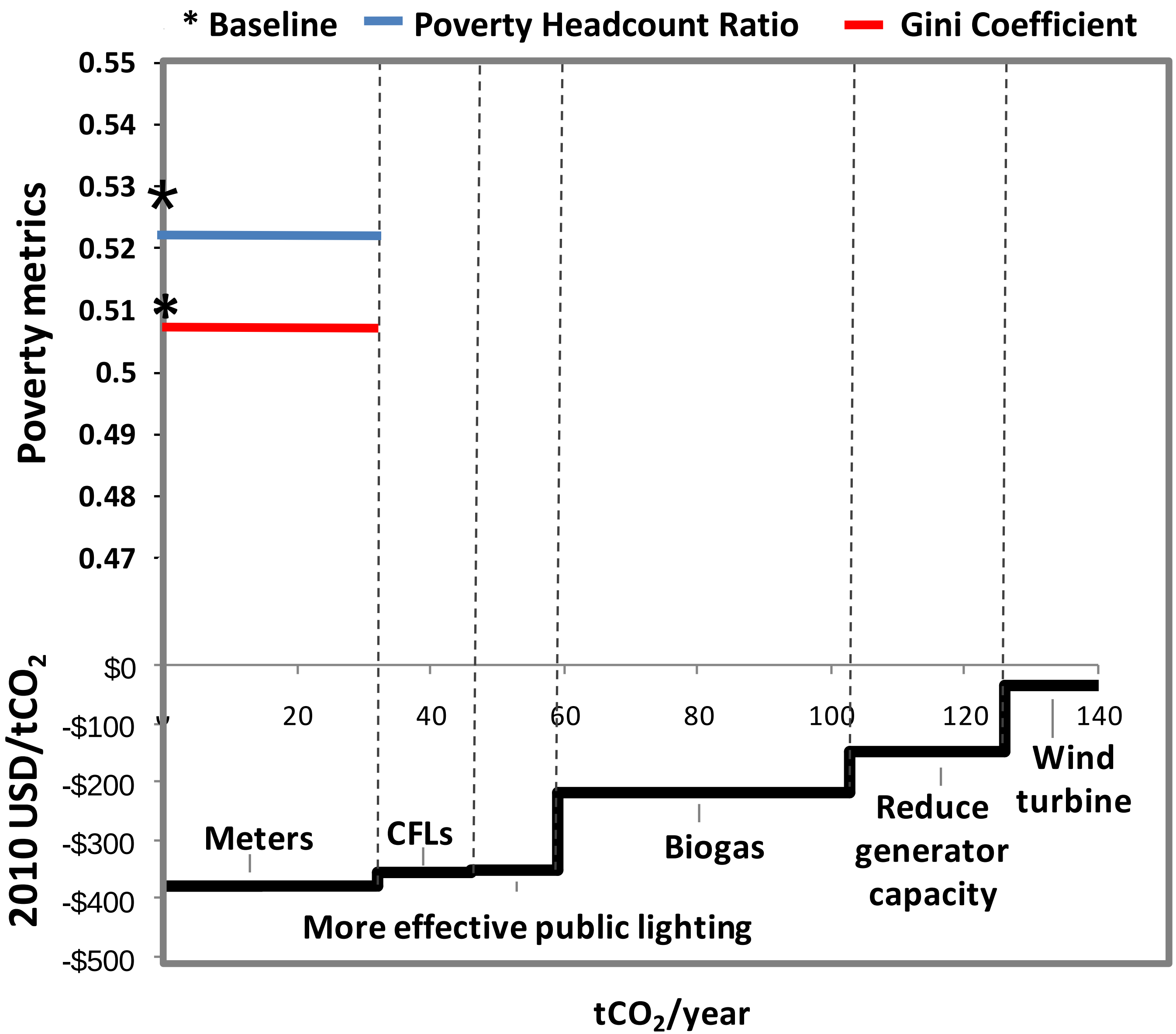


Casillas, C. E., & Kammen, D. M. (2010). The Energy-Poverty-Climate Nexus. ***Science*, *330*** (6008), 1181.

Inclusion of welfare metrics

- Poverty Headcount Ratio
  - *The fraction of the population that is living below $ 1.25 per day*
- *Income Gini coefficient (ranges from 0 to 1)*
  - *0 indicates perfect income equality*
  - *1 indicates total inequality*

Carbon abatement with welfare metrics



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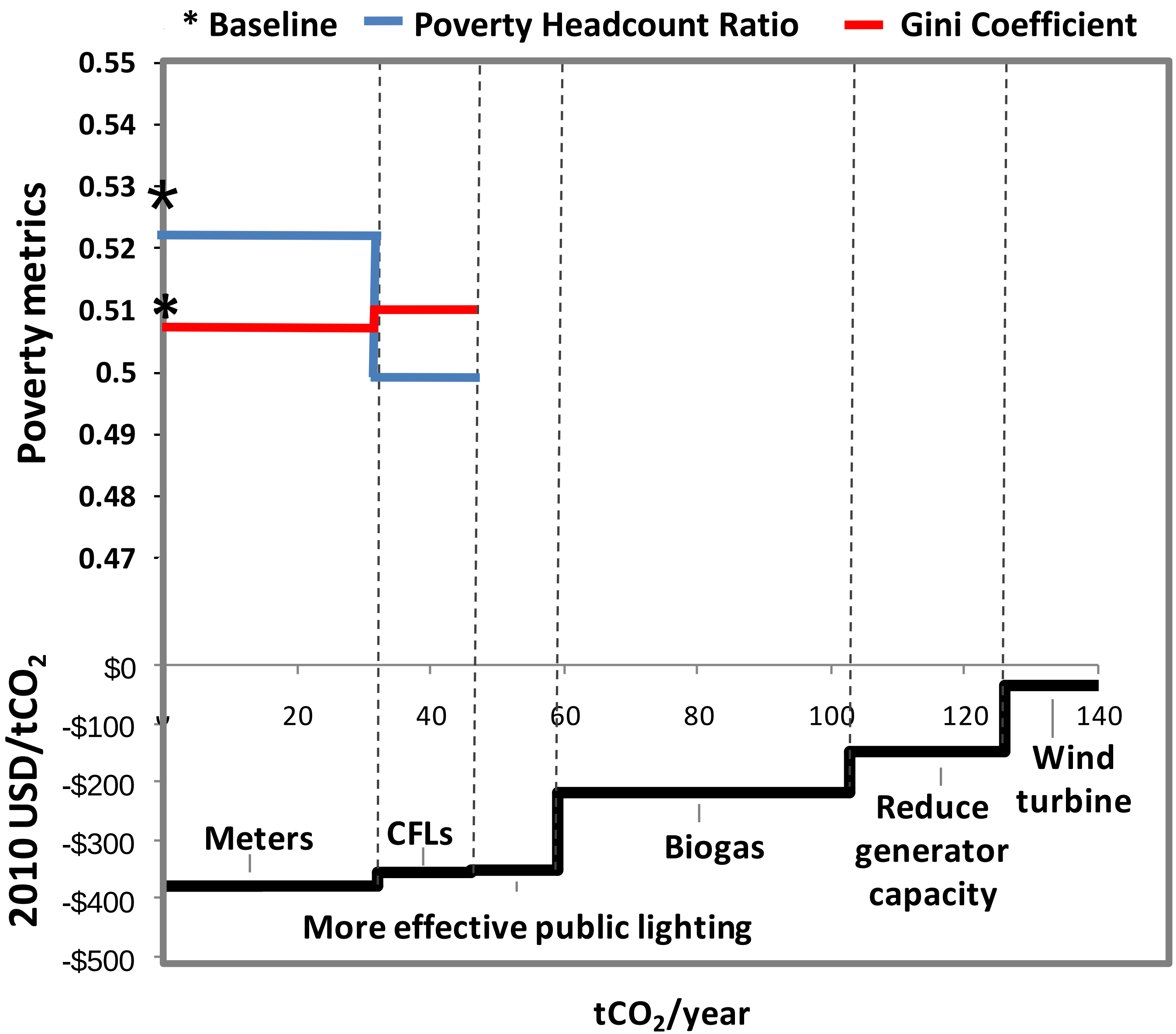
Carbon abatement with welfare metrics



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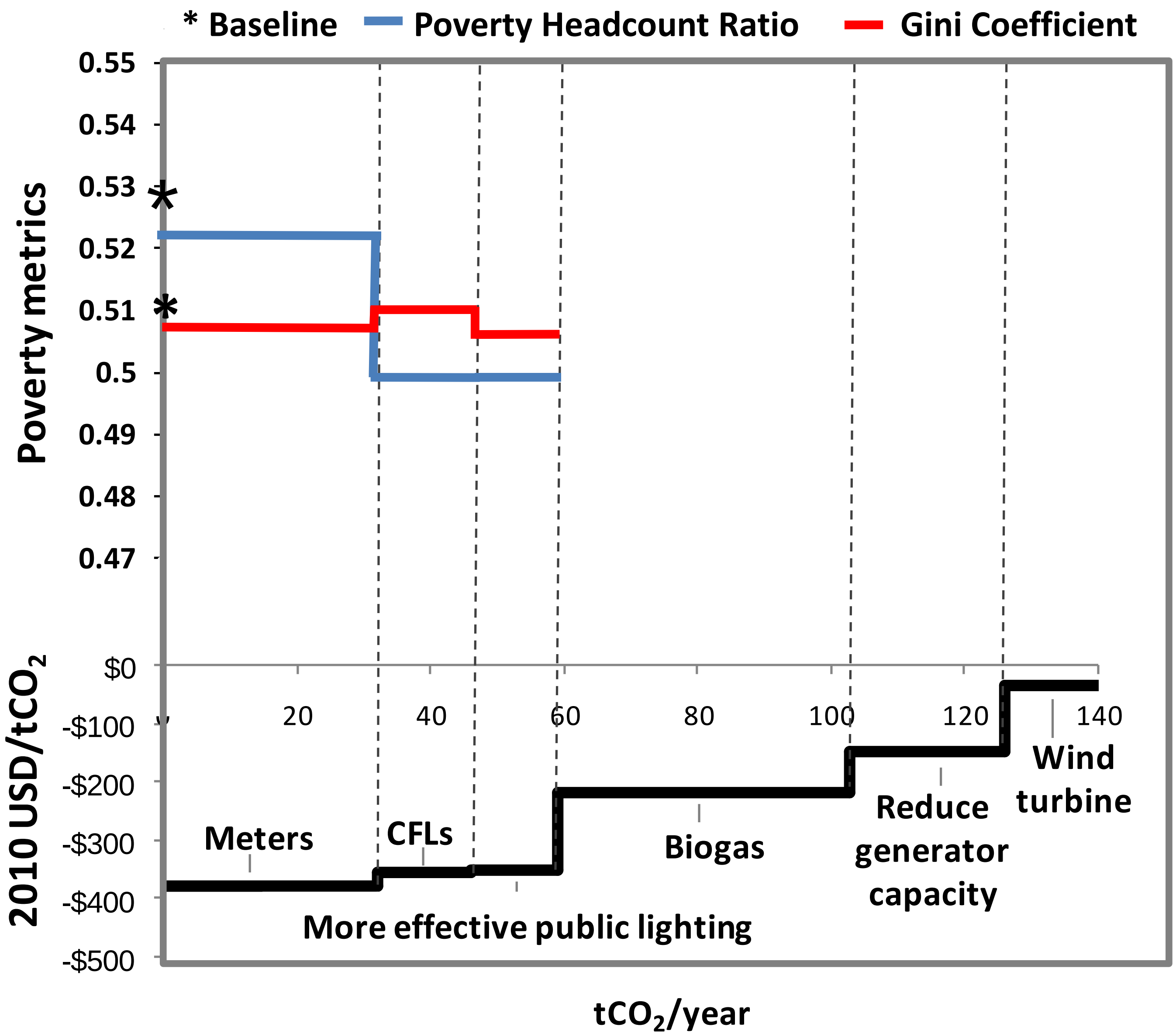

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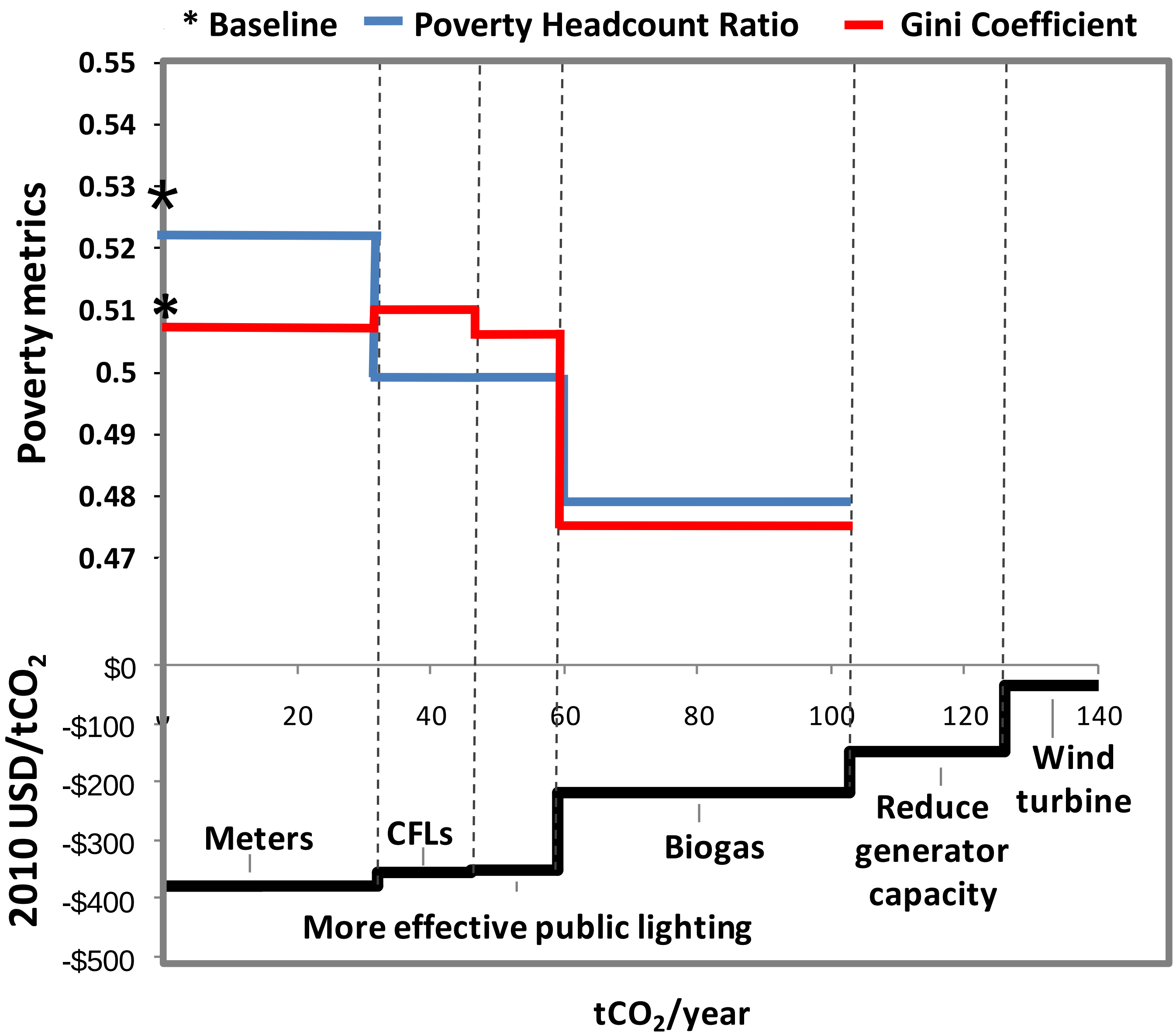

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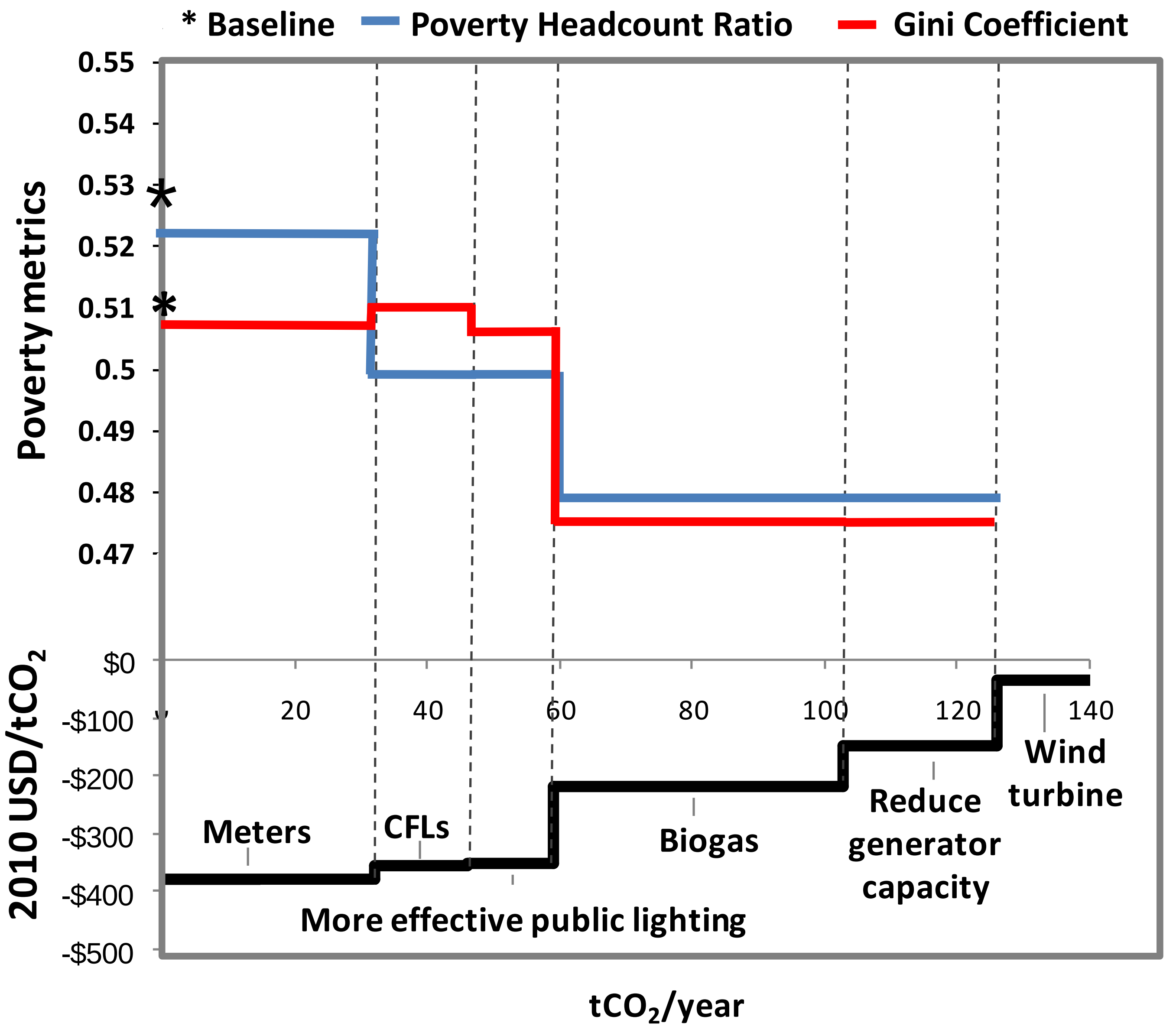

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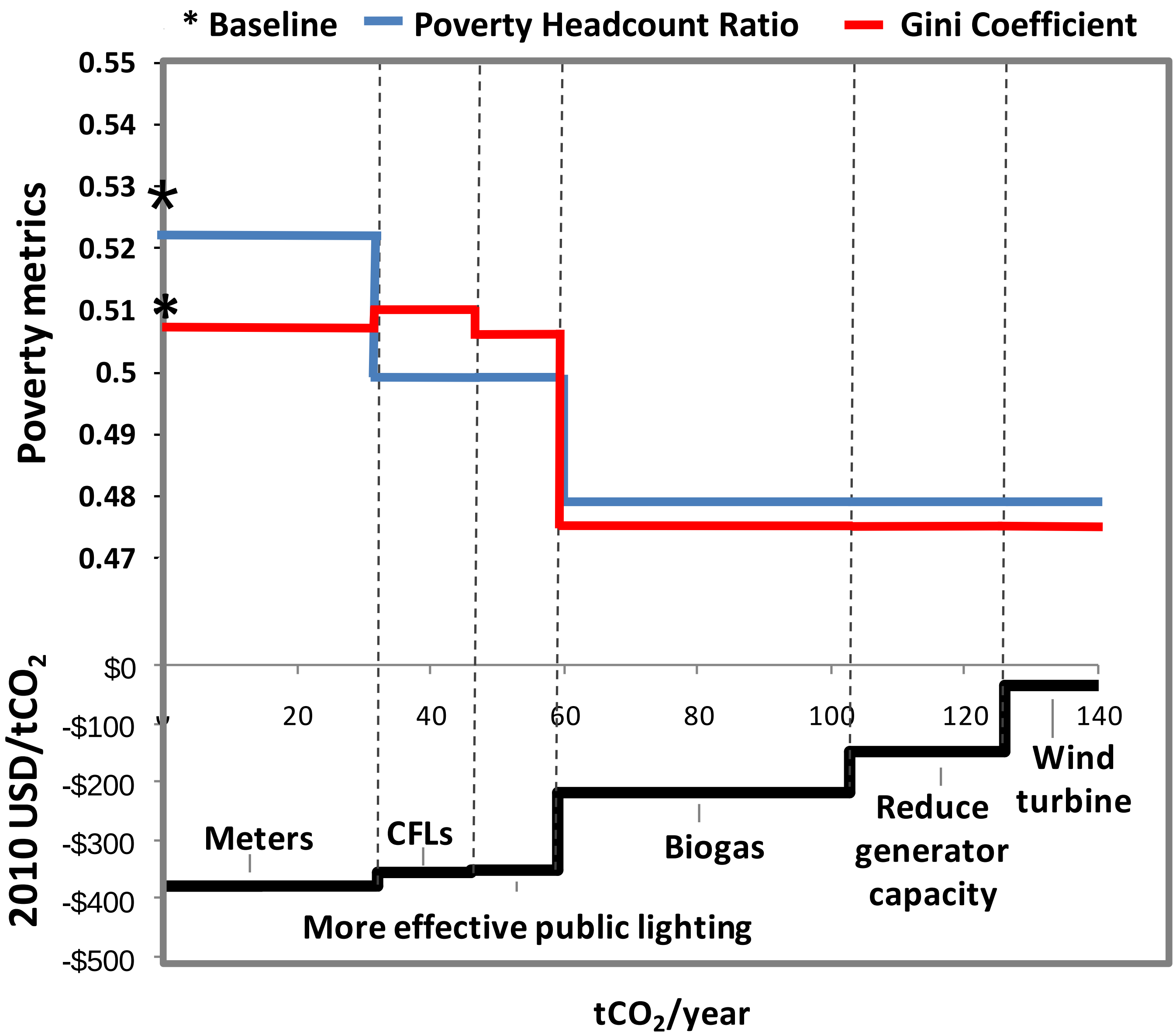

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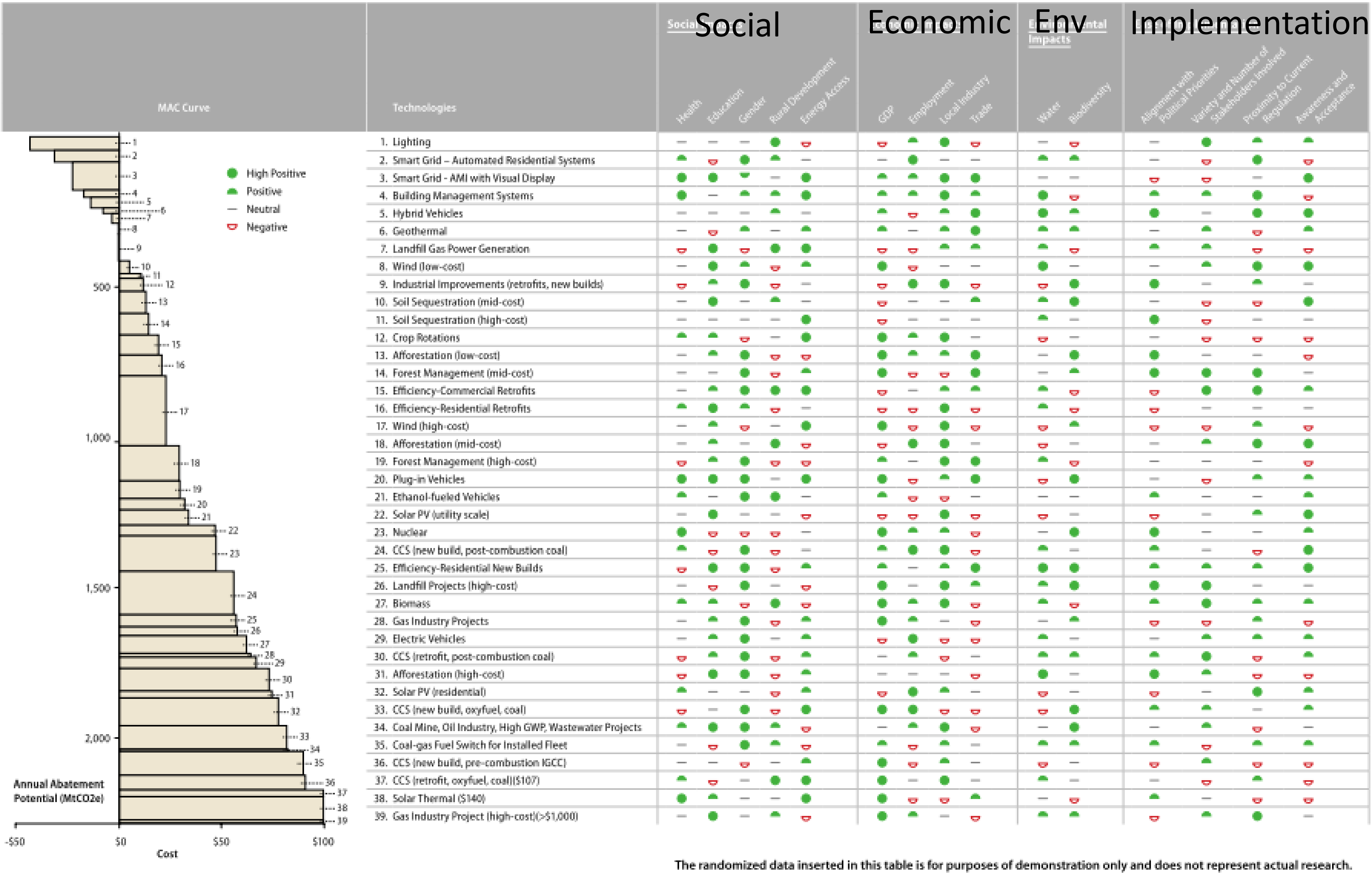
Fig. 1. Proposed visual to simultaneously communicate GHG mitigation potential and development benefits of technology options



Source: Cowlin et al, 2012

A visual Development Impact Assessment (DIA) tool was applied to support an analysis of mitigation options for Kenya's National Climate Change Action Plan (NCCAP)

Legend:
- High Positive
- Positive
- Neutral / Minor impact
- Negative
- Uncertain

	Climate			Sustainable Development				
	Abatement potential in 2030 ($MtCO_2e$)	Abatement cost 2030 (US$/$tCO_2$)	Adaptation impact	Energy security	GDP growth	Employment / Rural livelihoods	Improved land management	Environmental benefits
Agroforestry	4.16	13.25	High Positive	Positive	Positive	Positive	High Positive	High Positive
Conservation Tillage	1.10	14.36	High Positive	Neutral / Minor impact	Positive	Positive	High Positive	High Positive
Limiting Use of Fire in Range and Cropland Management	1.00	21.00	Positive	Neutral / Minor impact	Neutral / Minor impact	Neutral / Minor impact	High Positive	Positive

Figure 3. Overview of mitigation potential, costs, and adaptation and sustainable development impacts of low-carbon development options in the agriculture sector in Kenya

Source: Cox et al, 2014