CEE CENTER FOR ENERGY ECONOMICS

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Energy in Economic Development

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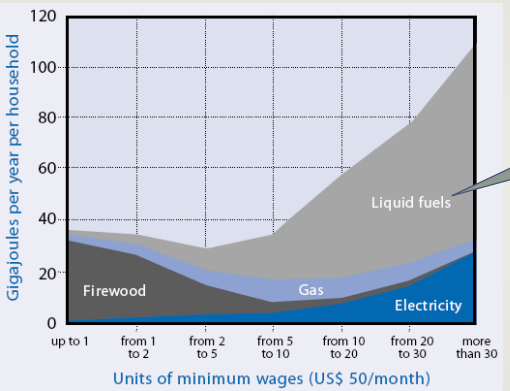
Some stylized facts

- Greater GDP ⇔ more energy consumption.
- Greater GDP per capita ⇔ more energy consumption per capita.
- As countries get richer, energy intensity declines because economy transitions: agricultural ➔ industrial ➔ services

Energy demand by income



Rapid liquid fuel demand growth in emerging economies led by China has been a key driver of the crude oil price since the early 2000s.

Source: E. Almeida and A. De Oliveira. "Brazilian Life Style and Energy Consumption," in Energy Demand, Life Style Changes and Technology Development (London: World Energy Council, 1995) as reported in UNDP, World Energy Assessment Overview: 2004 Update

Energy poverty

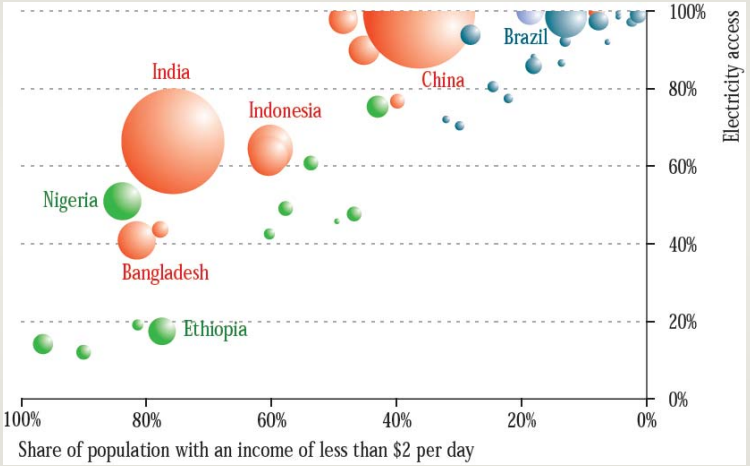
- ~1.4 billion with no access to electricity
  - IEA base case: ~1.2 billion in 2030
- ~2.7 billion relying on traditional biomass
  - IEA base case: ~2.8 billion in 2030
- 28% electrification, 80% biomass in Sub-Saharan Africa (excluding South Africa)
- South Asia is the second biggest challenge

Chapter 8 – Energy poverty, World Energy Outlook 2010, IEA.

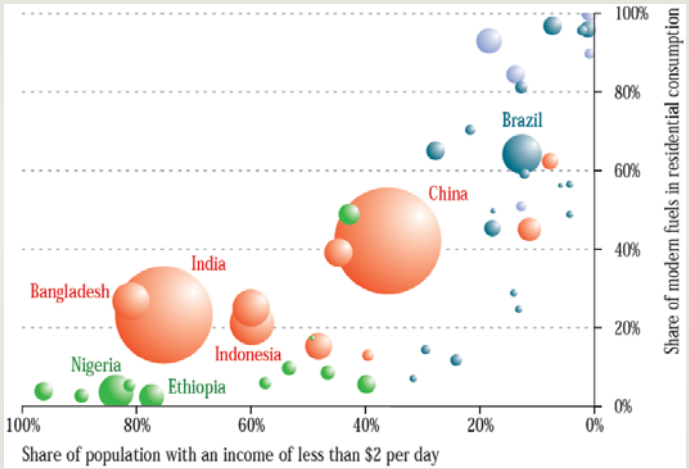
Implications of energy poverty

- Economic poverty
- Increased illiteracy
- Decreased life expectancy
  - Water-borne diseases
  - Indoor air pollution
- Environmental degradation
  - Deforestation
  - Pollution (e.g., diesel generators)

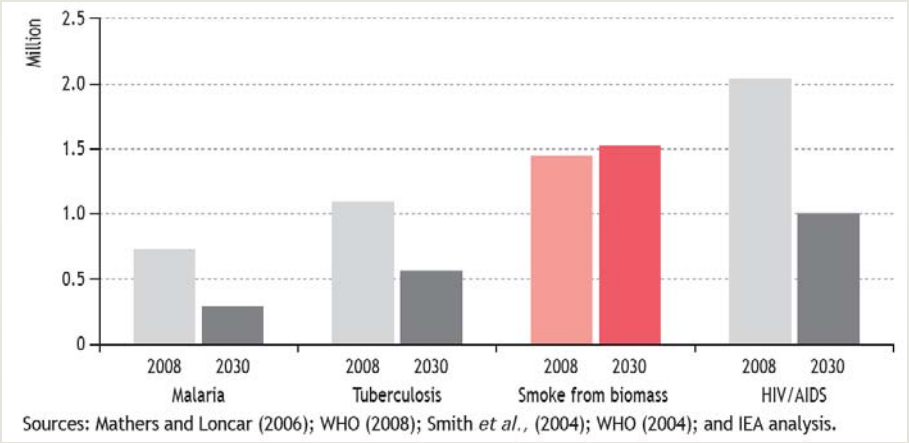
Income and electricity access



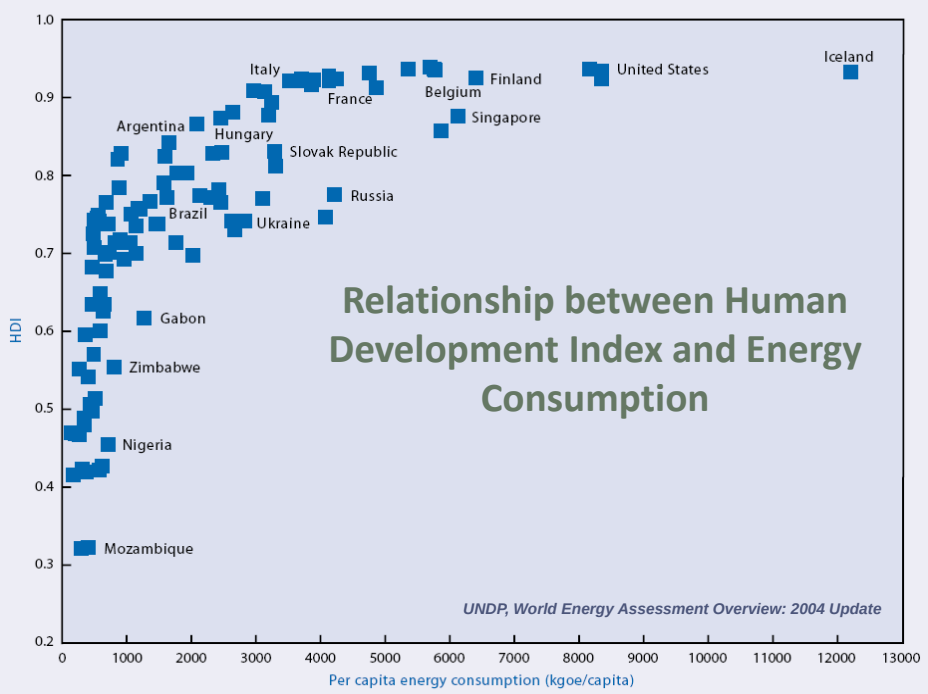
Income and access to modern fuels



Premature deaths



Sources: Mathers and Loncar (2006); WHO (2008); Smith *et al.*, (2004); WHO (2004); and IEA analysis.



What can be done?

- Electrification
  - Central generation for urban areas (more efficient and reliable)
  - Distributed generation for rural areas (more fitting for wind, solar, mini hydro)
- Modern fuels indoors
  - Cleaner burning stoves for biomass or coal
  - Switching to gaseous fuels (e.g., LPG)

What can be done?

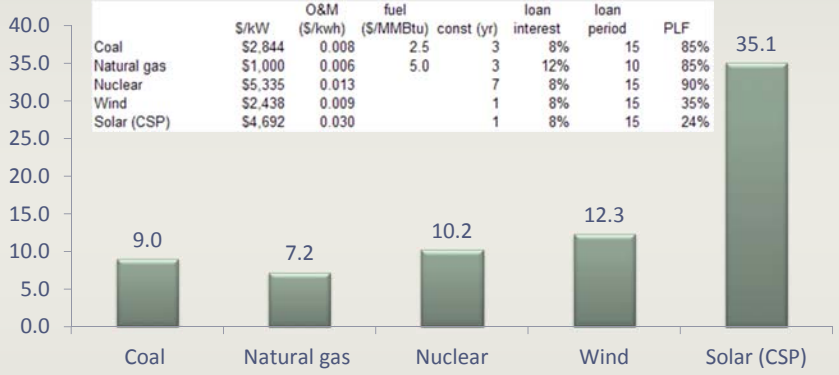
- Remove subsidies on fuels and electricity
  - IEA: $312 billion of fuel subsidies in 2009 v $77 billion per year until 2015 and $36 billion per year during 2015-2030 to end energy poverty
- Focus on private sector delivery of energy services
- Smart urbanization
- Move away from subsistence farming

Energy realities we can't wish away

- Alternatives are far away from the scale needed to replace conventional fuels.
- They are more expensive than conventional technologies.
- Integration problems (e.g., intermittency, scalability limits, inability to communicate with existing infrastructure, impact on other fuels).

CEE Model (cents/kWh)

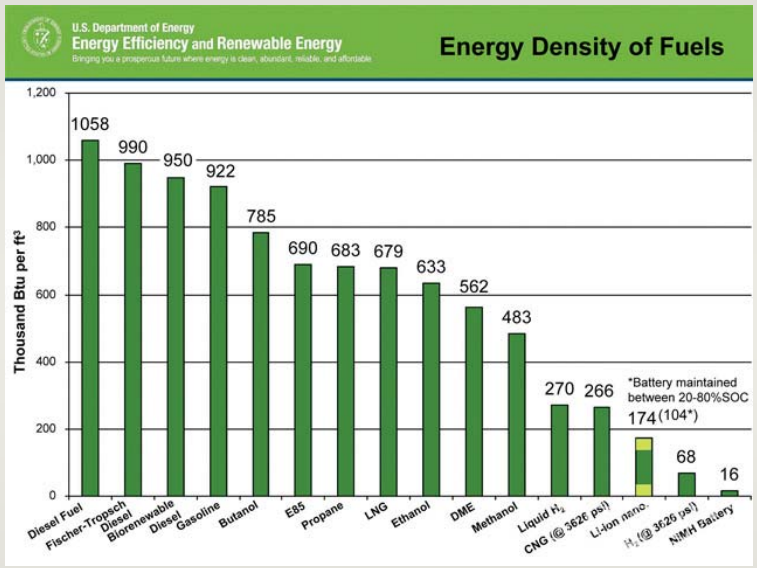
	$/kW	O&M ($/kwh)	fuel ($/MMBtu)	const (yr)	loan interest	loan period	PLF
Coal	$2,844	0.008	2.5	3	8%	15	85%
Natural gas	$1,000	0.006	5.0	3	12%	10	85%
Nuclear	$5,335	0.013		7	8%	15	90%
Wind	$2,438	0.009		1	8%	15	35%
Solar (CSP)	$4,692	0.030		1	8%	15	24%



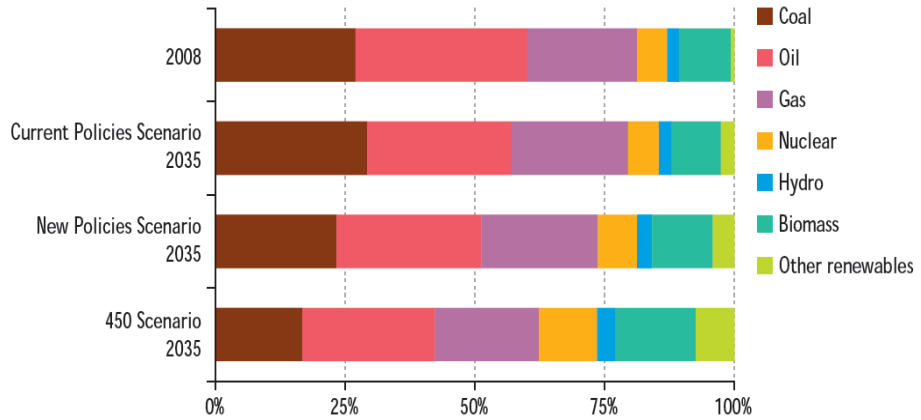
Capital and O&M costs are based on EIA's Nov 2010 report: http://www.eia.gov/oiaf/beck_plantcosts/index.html

Energy content & efficiency

- Coal: 24-30 MJ/kg and 35-45% conversion efficiency
- Natural gas (methane): ~55 MJ/kg and 55-60% conversion efficiency (CC)
- Natural uranium: ~560 MJ/kg
- Reactor-grade uranium: ~3,700 MJ/kg and 30-35% conversion efficiency



Change is Slow & Difficult



Chapter 2 – Energy projections to 2035, World Energy Outlook 2010, IEA.