

Energy, Growth & Development

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Agenda for today

- How does our society use energy?
- Energy, innovation and growth
- Energy poverty and development
- Energy and the environment

How have I used energy today?

- Phone Alarm
- Turned on lights
- Hot Shower
- Hot Coffee
- Cereal & Milk
- Drove to work

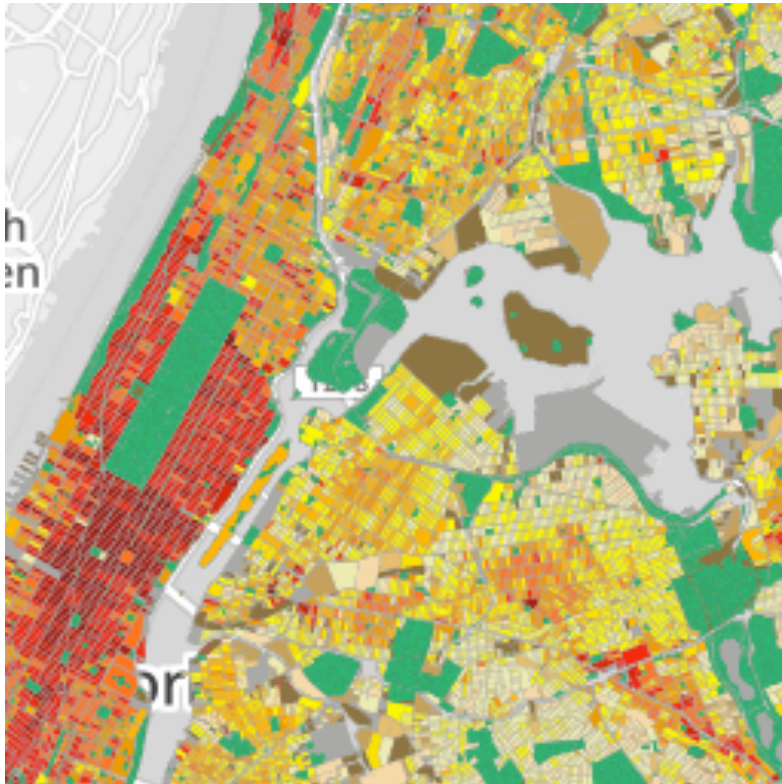


How does our society use energy?

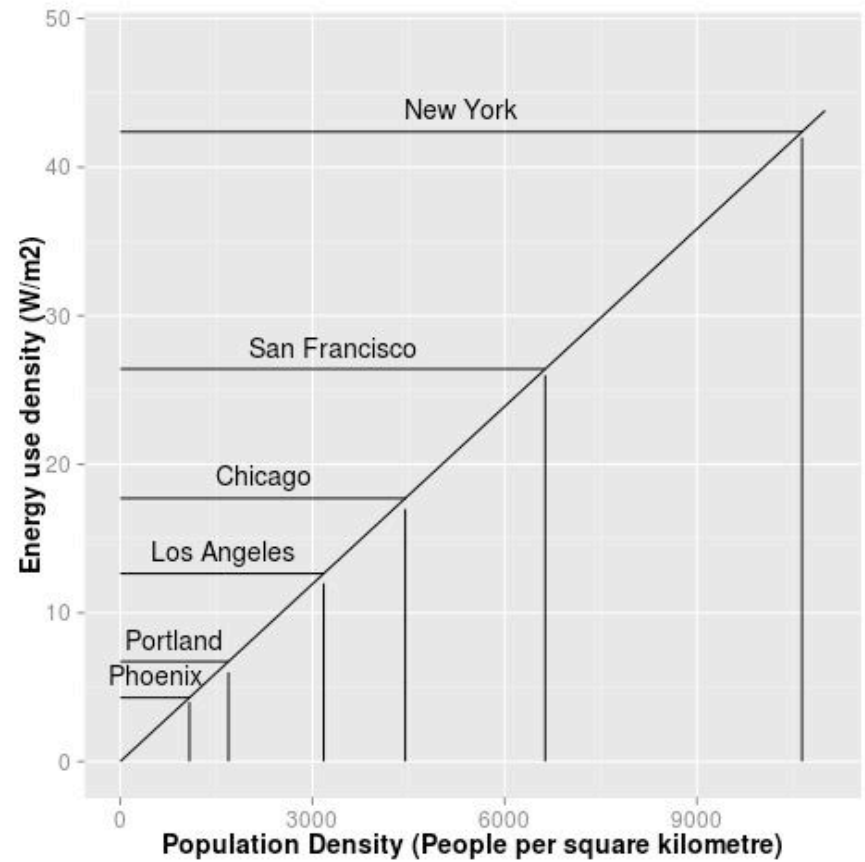
Societal energy uses

- Transportation
- Food production
- Goods and Services
- Water treatment
- Lighting
- Heating & Cooling
- Entertainment

Modern cities use a lot of energy

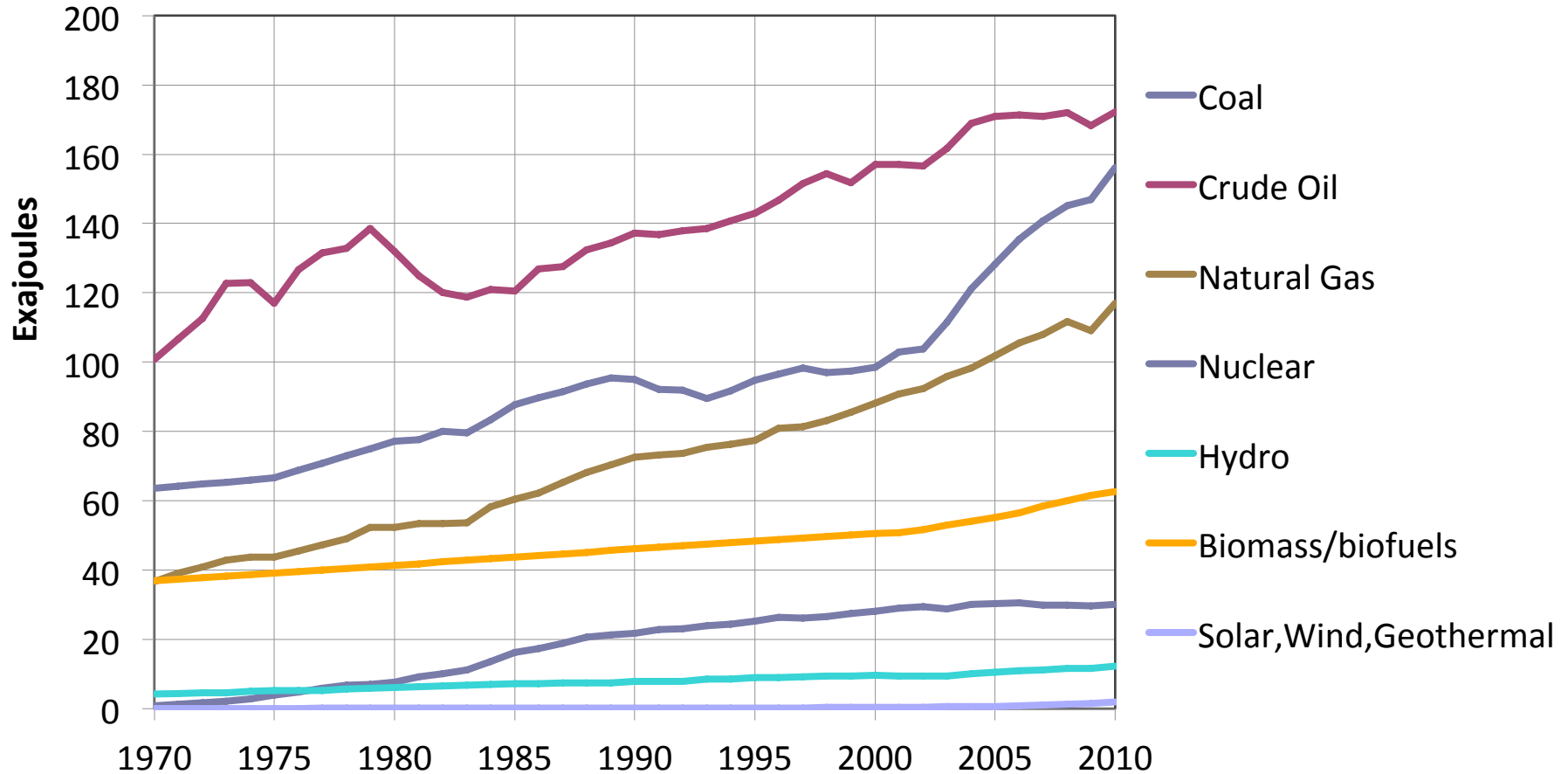


NYC Energy Use (City block)

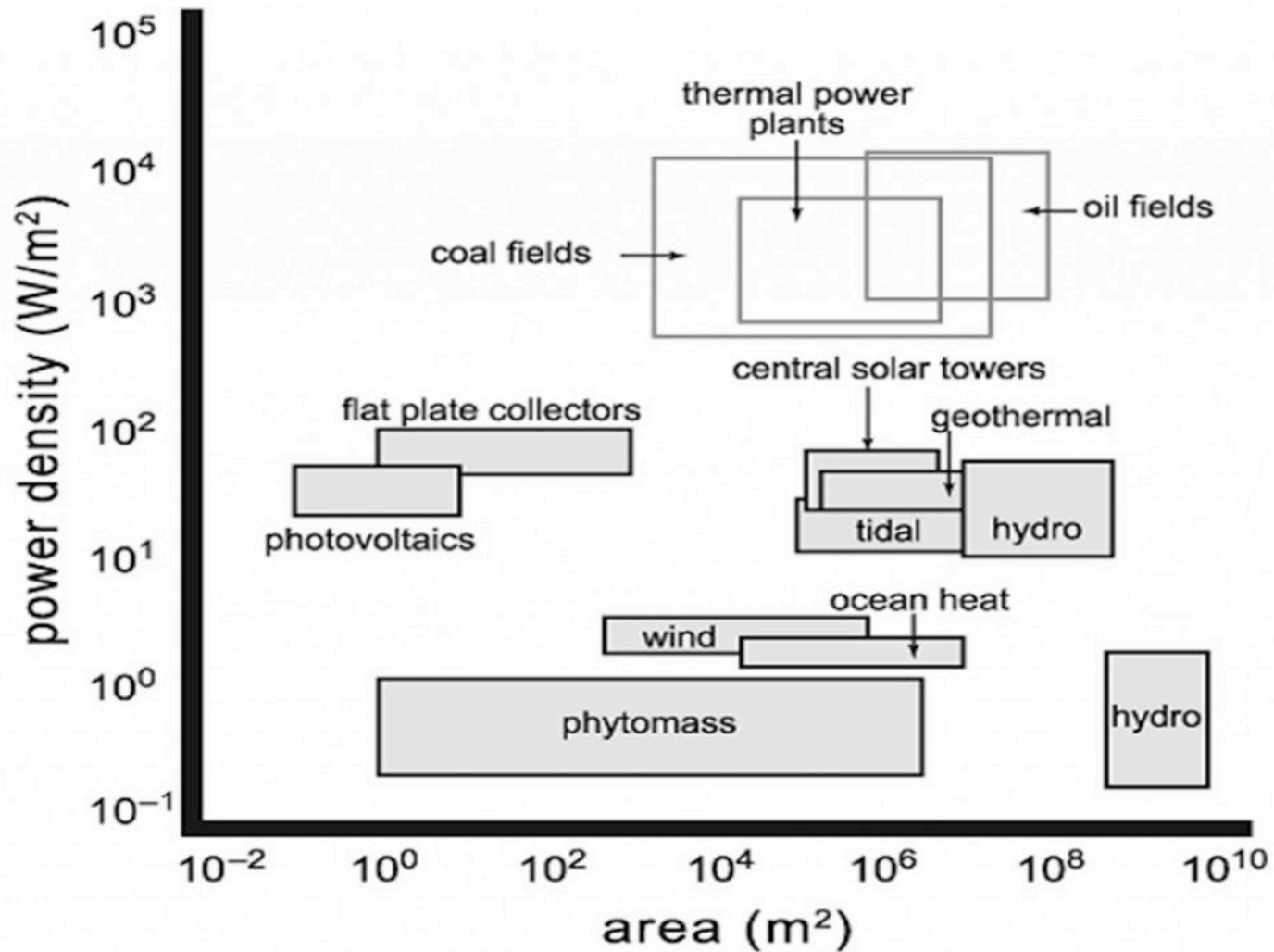


Where does the energy come from?

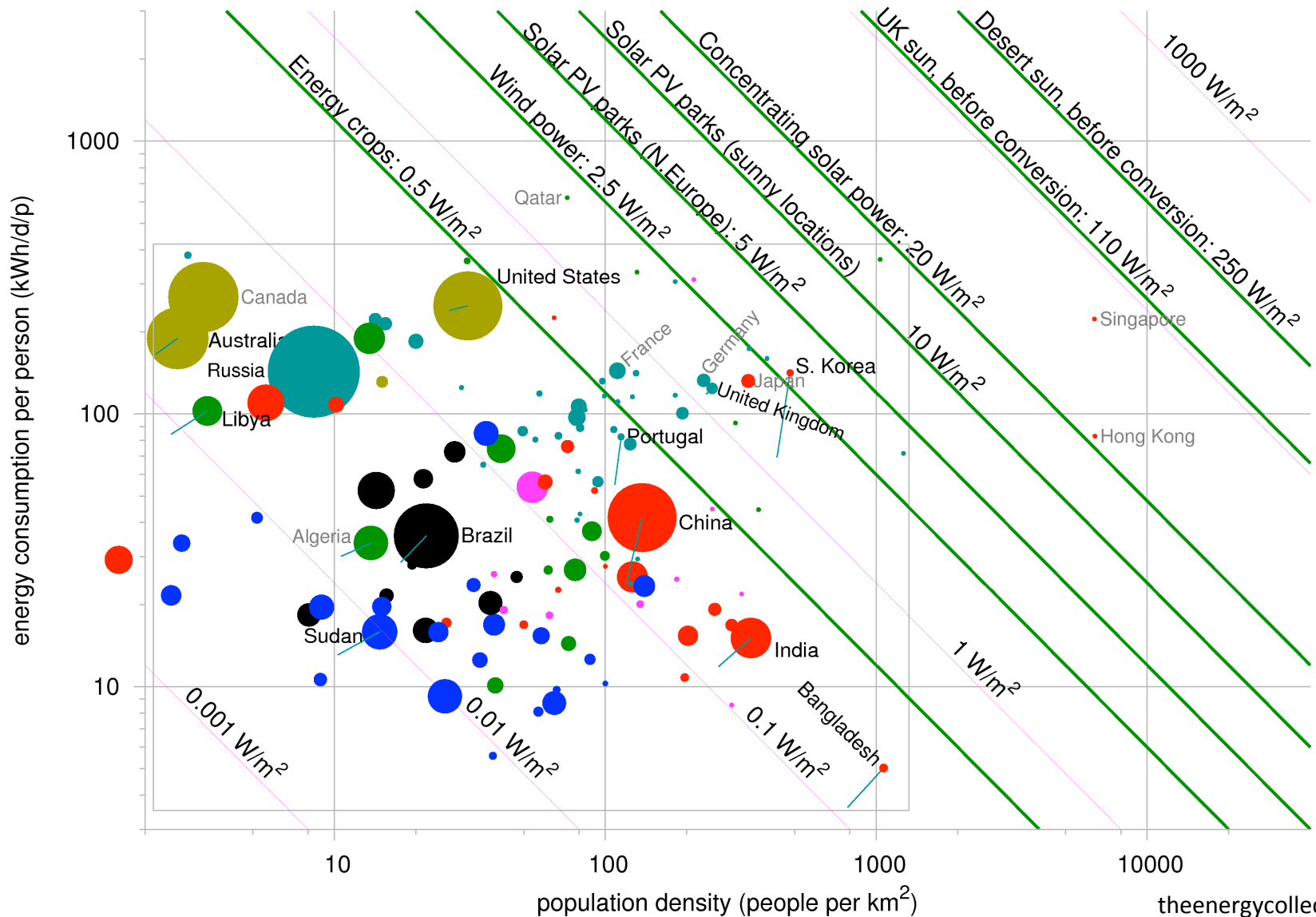
Global Primary Energy Consumption 1970 - 2010



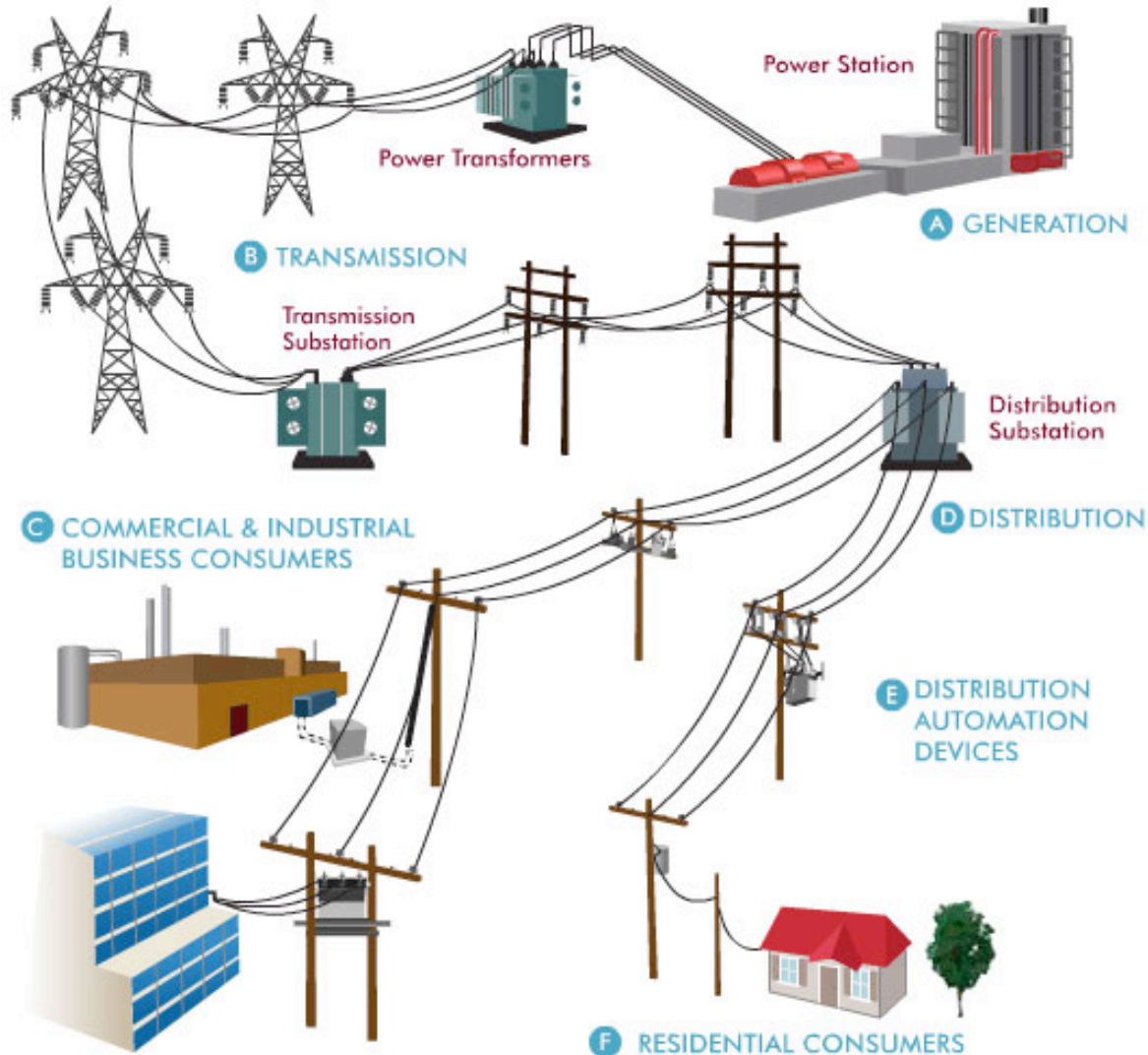
Why are fossil fuels so useful?



Power density, usage and population



Electrification makes it all work!



Energy, innovation and growth

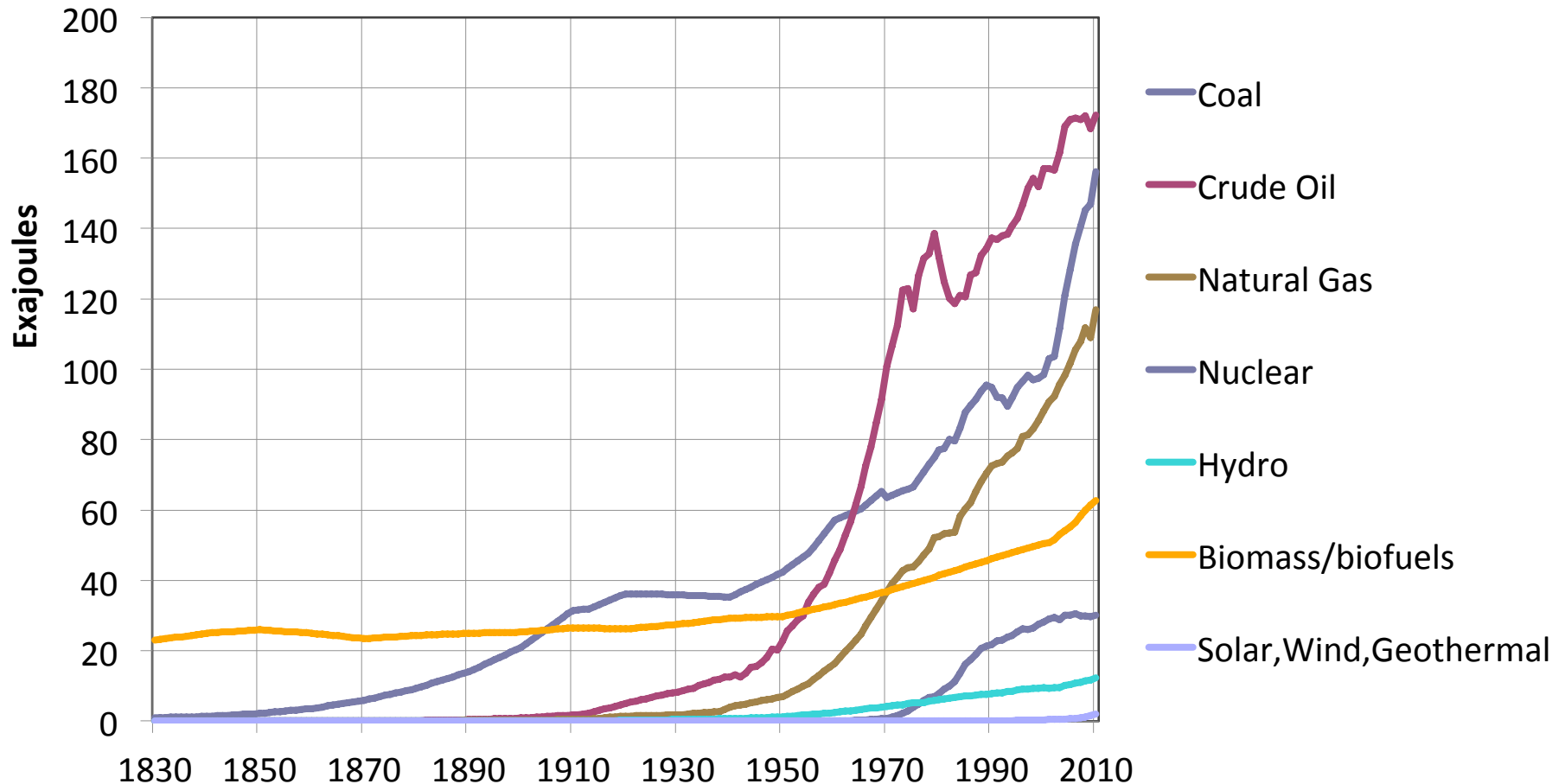
We have know about fossil fuels for a VERY long time

“There is only one kind of primary energy that was not known to the first high civilizations of the Middle East and East Asia and by all of their pre-industrial successors: isotopes of the heavy elements whose nuclear fission has been used since the late 1950’s to generate heat that, in turn, produces steam for modern electricity turbo-generators. Every other energy resource has been known for millennia, and most of them were harnessed by pre-modern societies.”

– Vaclav Smil

It has not always looked this way

Global Primary Energy Consumption 1830 - 2010



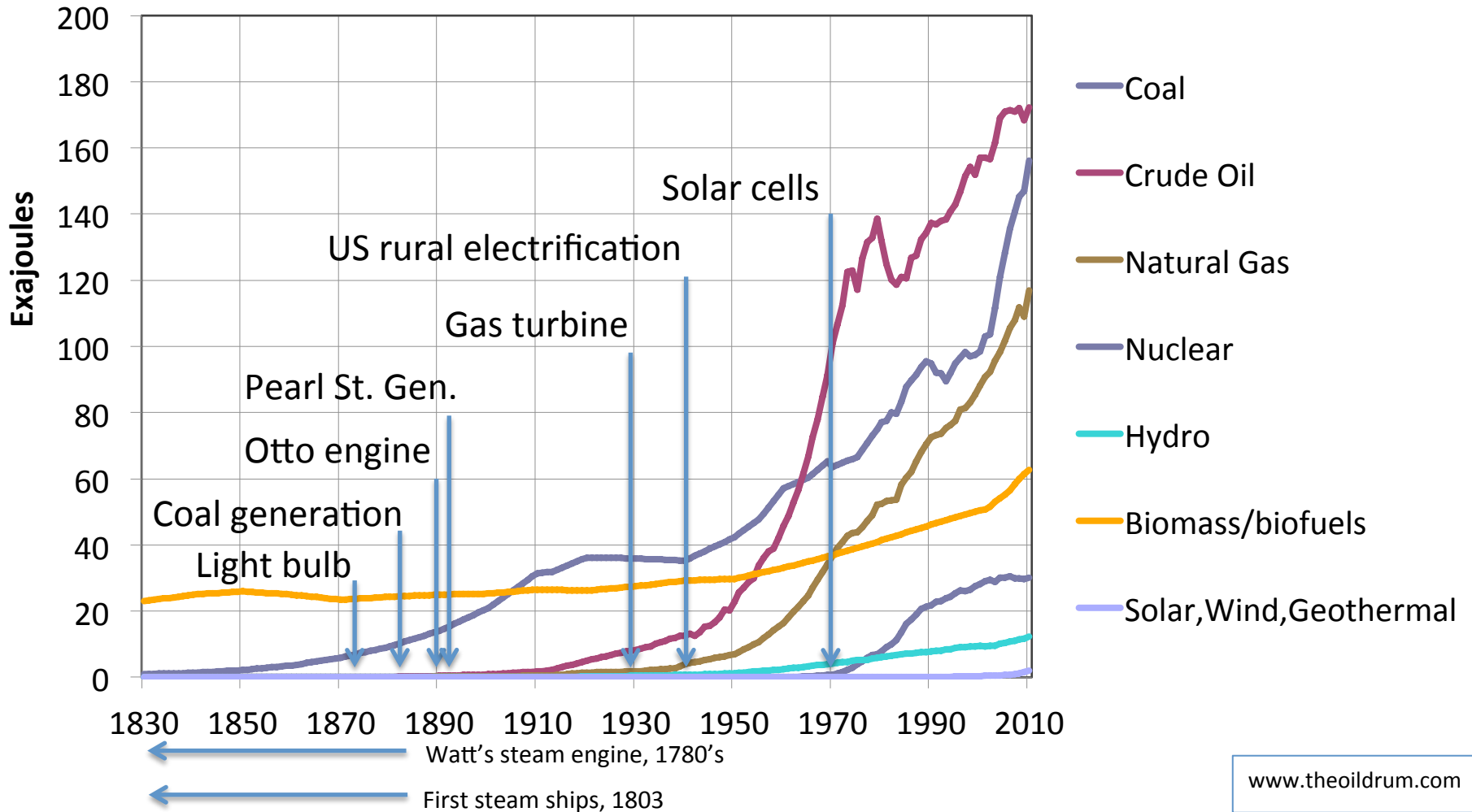
What changed?

“The fundamental difference between traditional and modern uses of energy consists not in access to new or better energy resources, but in the invention and mass deployment of efficient, affordable, reliable, and convenient “prime movers,” devices that convert primary energies into mechanical power, electricity, or heat.”

– Vaclav Smil

Dramatic energy innovation

Global Primary Energy Consumption 1830 - 2010

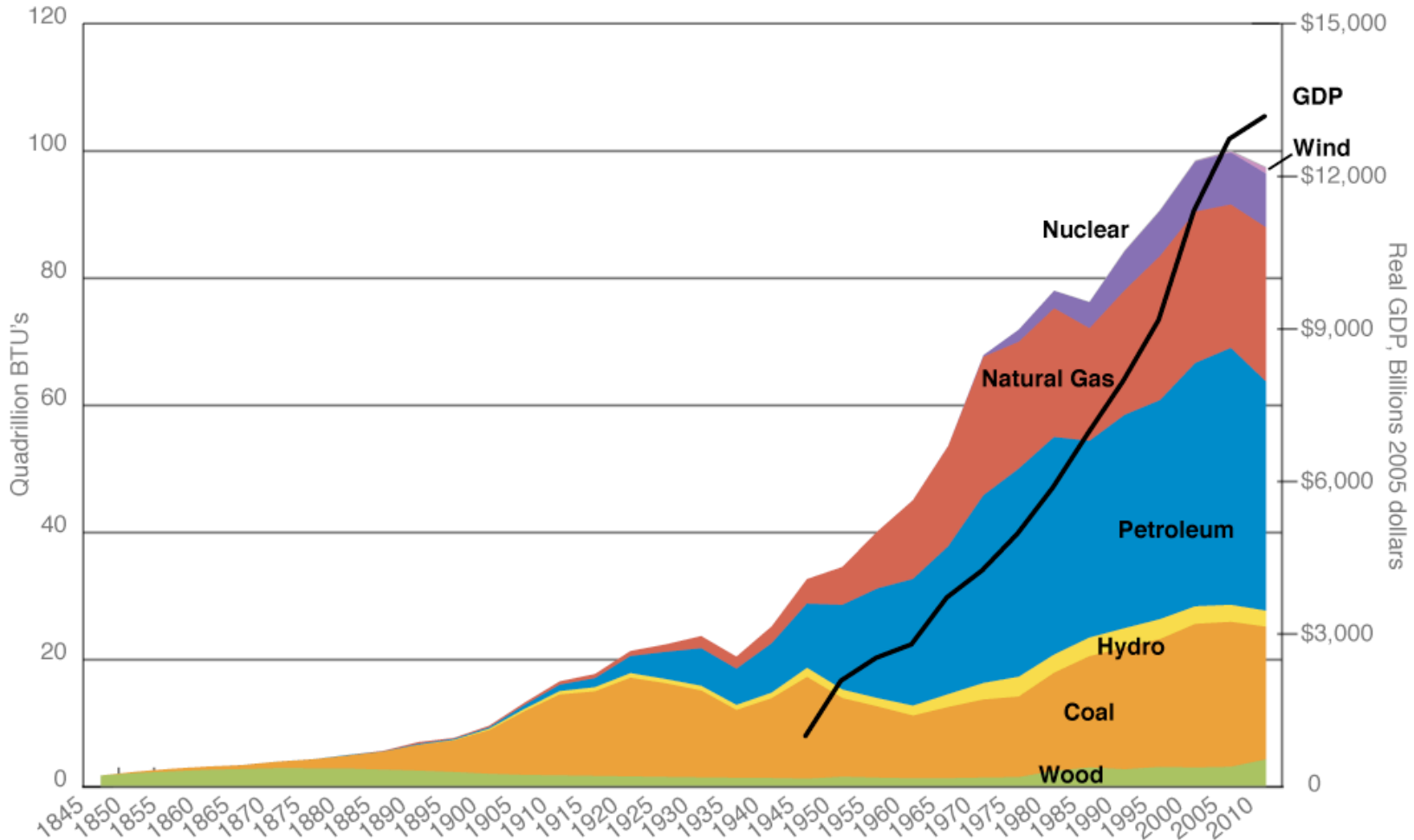


Energy fuels economic growth



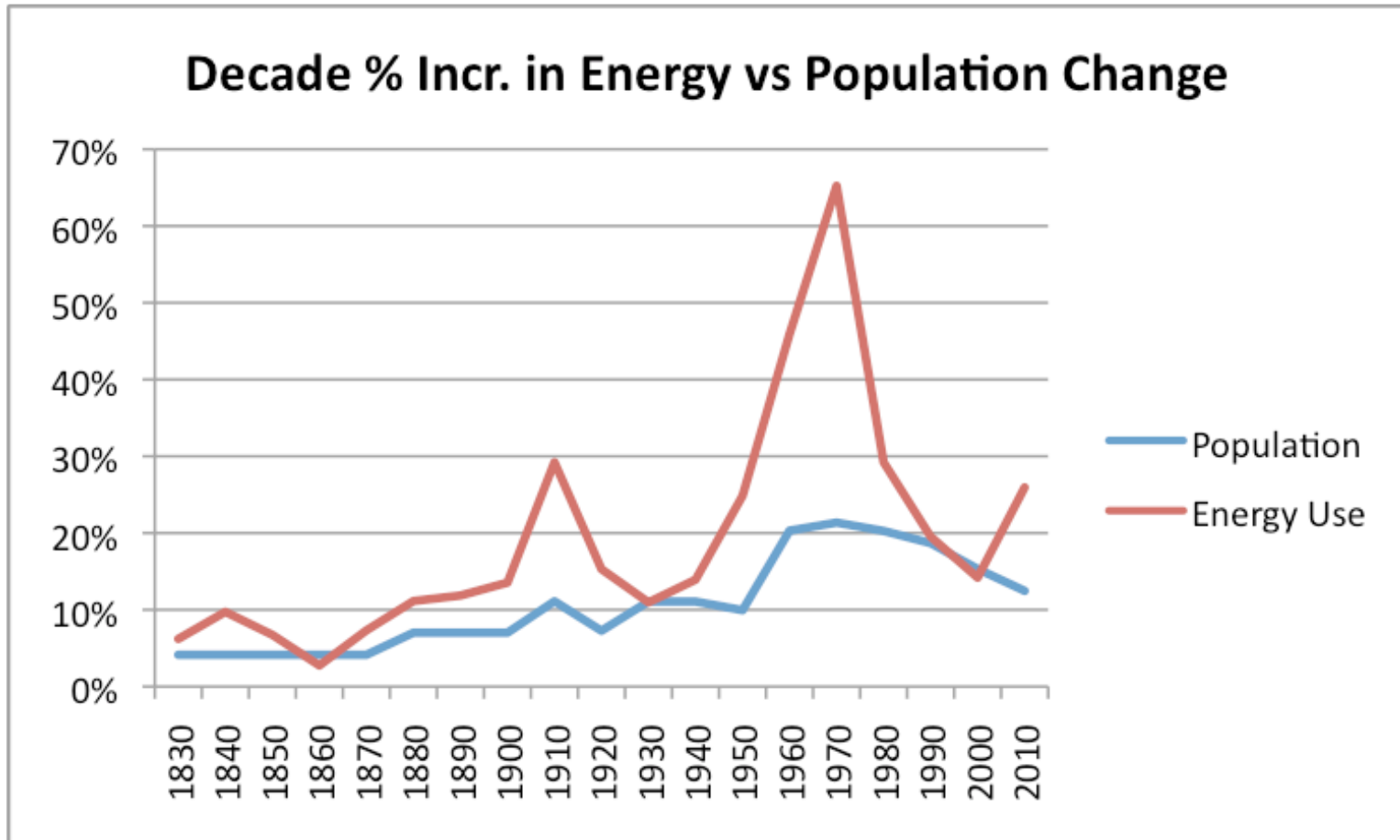
Energy fuels economic growth

U.S. ENERGY CONSUMPTION BY SOURCE VS. REAL GDP



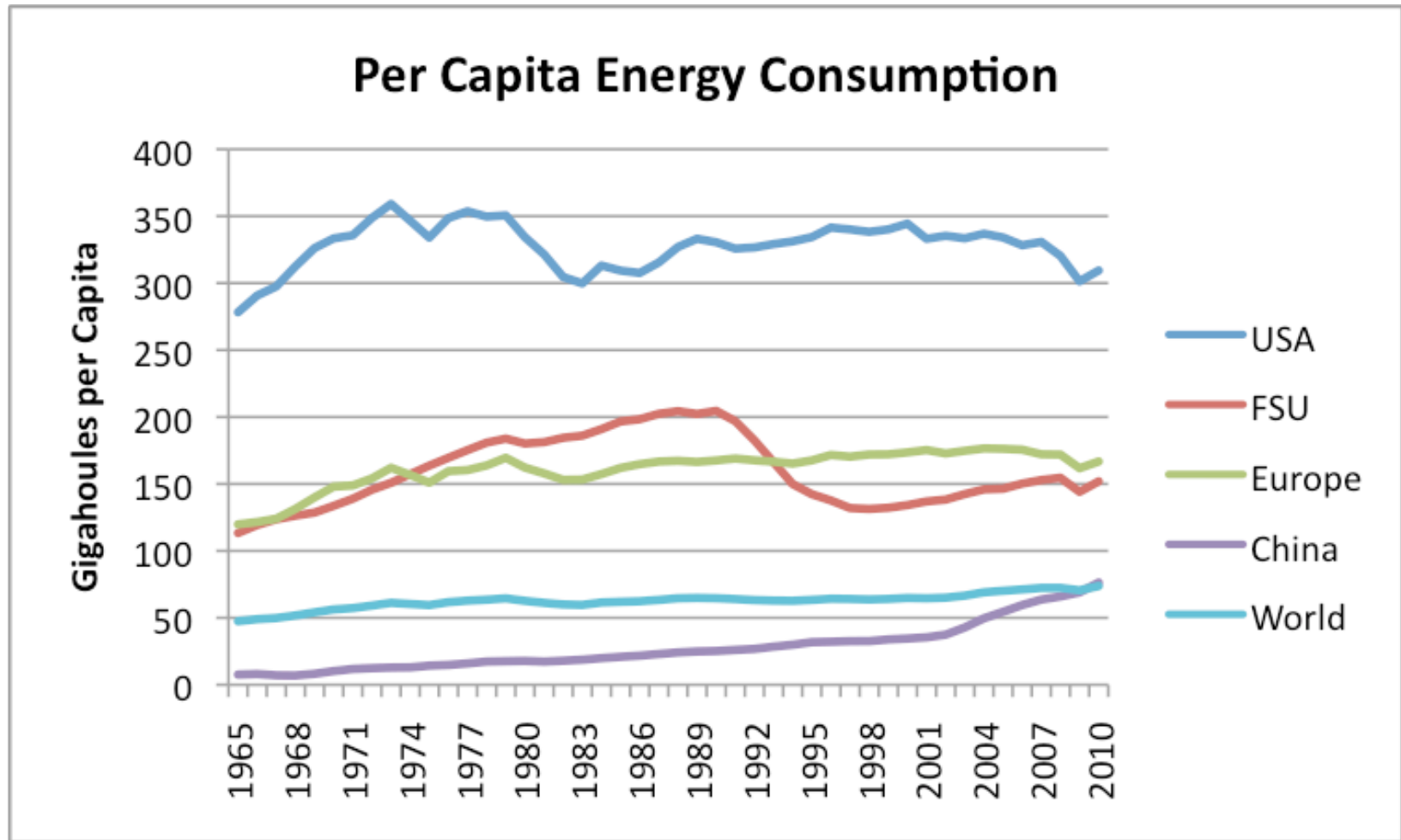
Sources: EIA, MER June 2013;
St. Louis Federal Reserve, FRED;
EIA, AER 2011 Note: Solar and Geothermal consumption are too small to be visible

Energy use and population growth

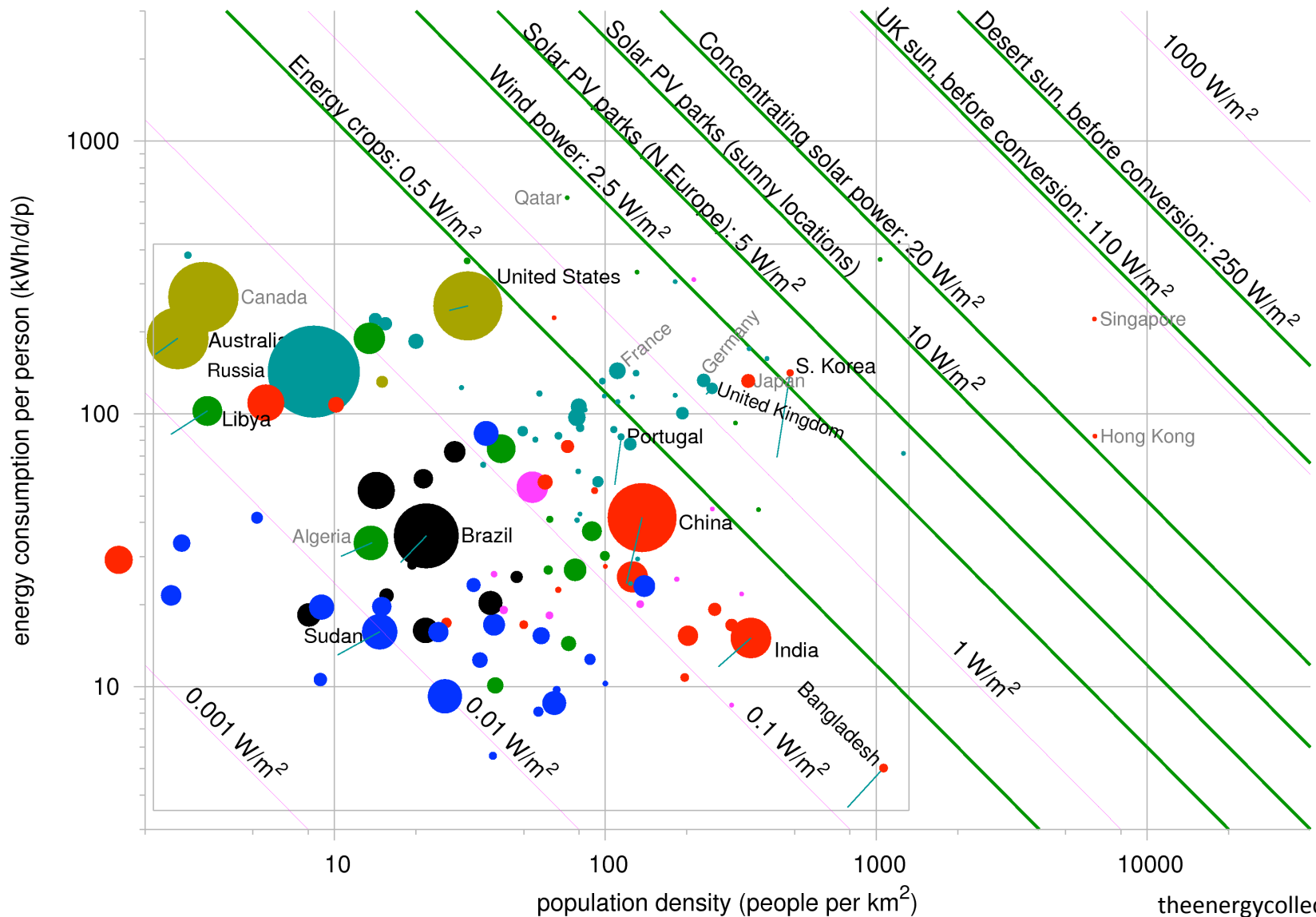


Energy poverty and development

Just like economic prosperity, energy use is uneven around the world

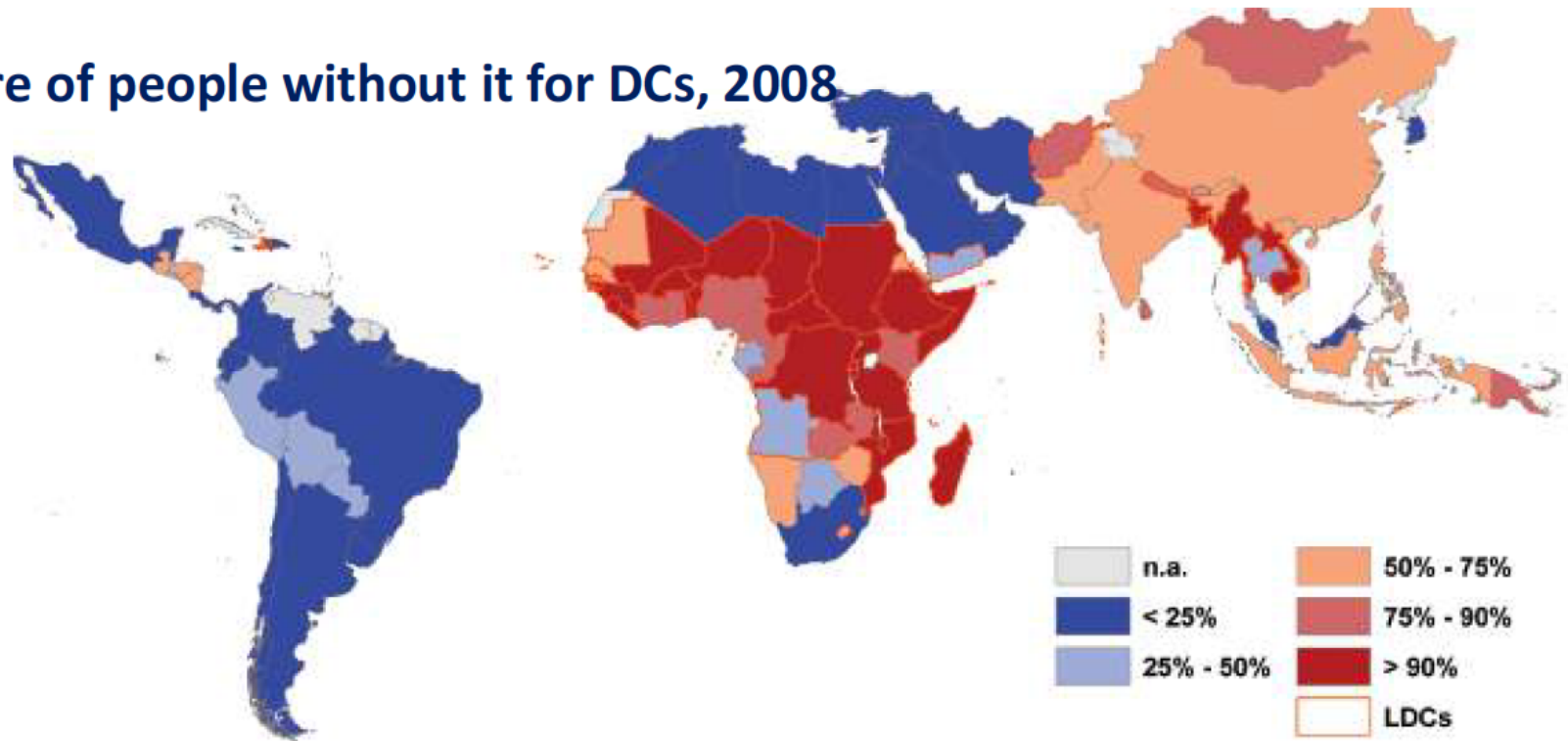


Power density, usage and population



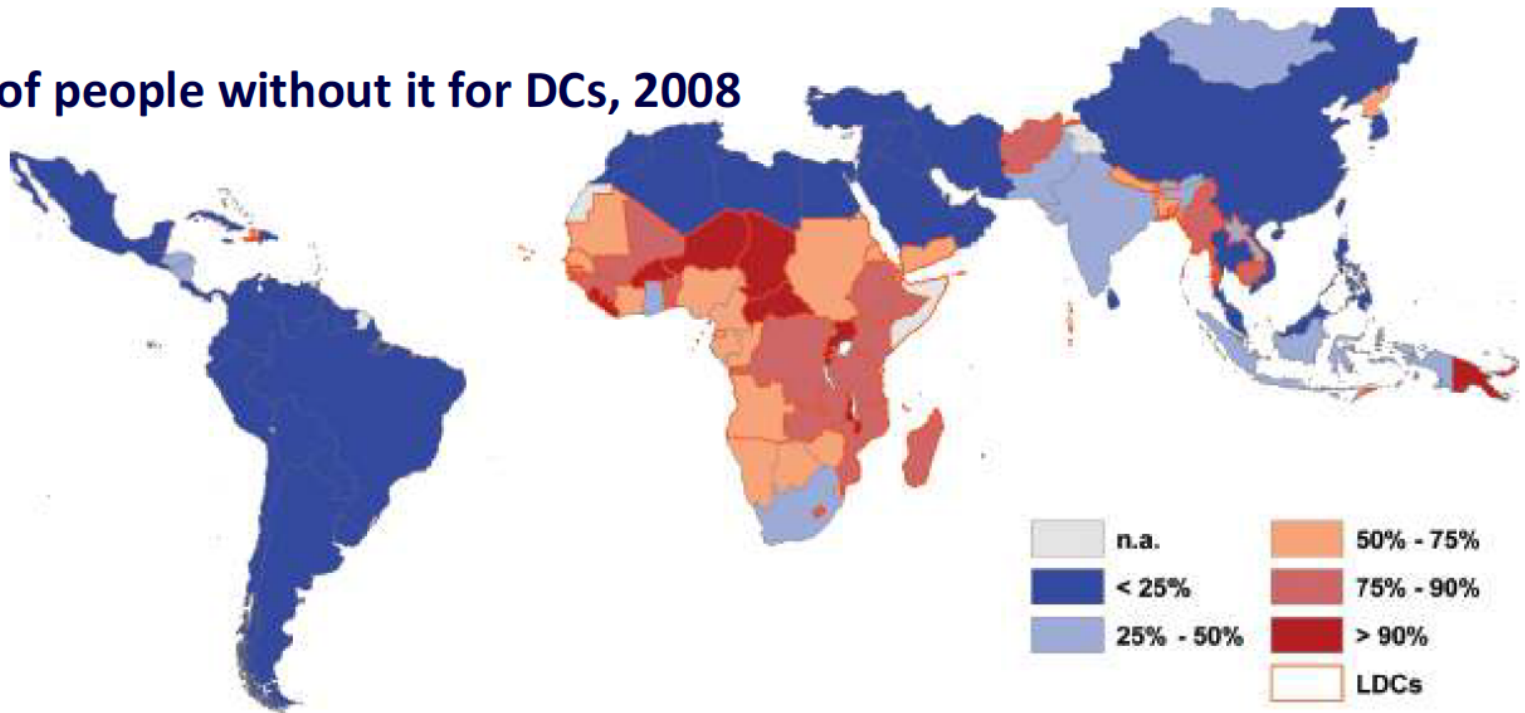
Access to modern fuel

Share of people without it for DCs, 2008

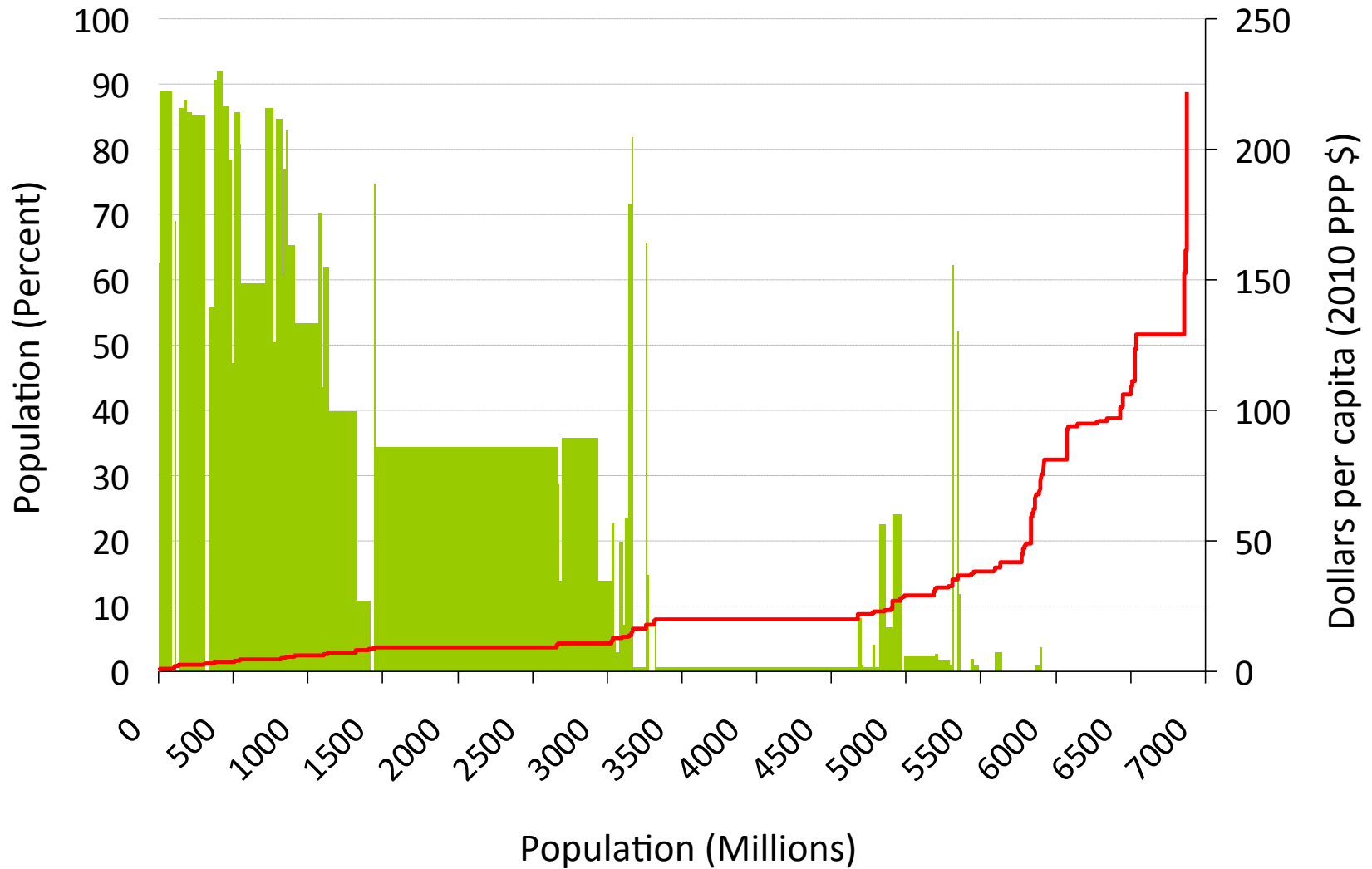


Access to electric energy

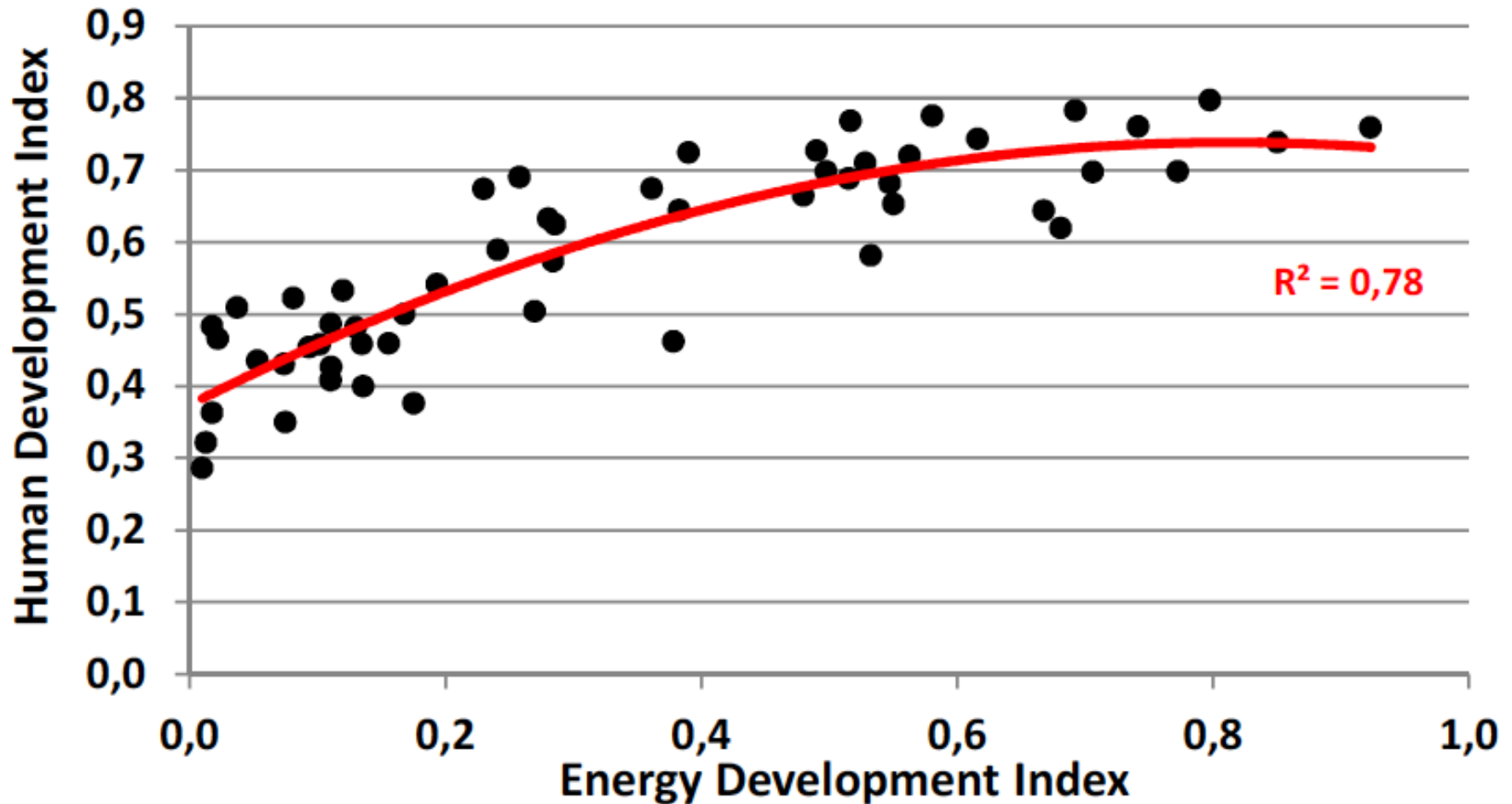
Share of people without it for DCs, 2008



Energy inequality and electrification



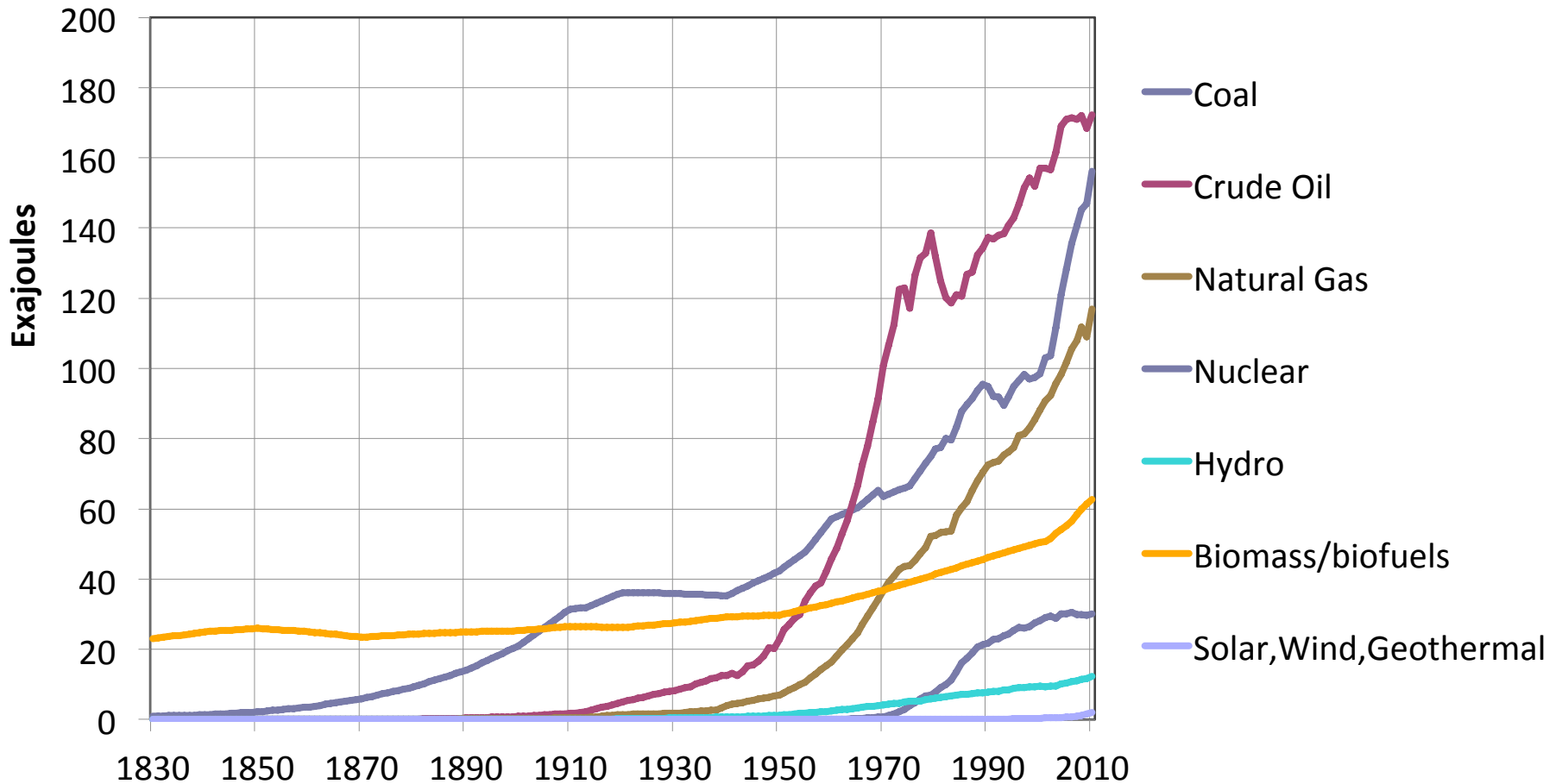
Energy development is needed for human development



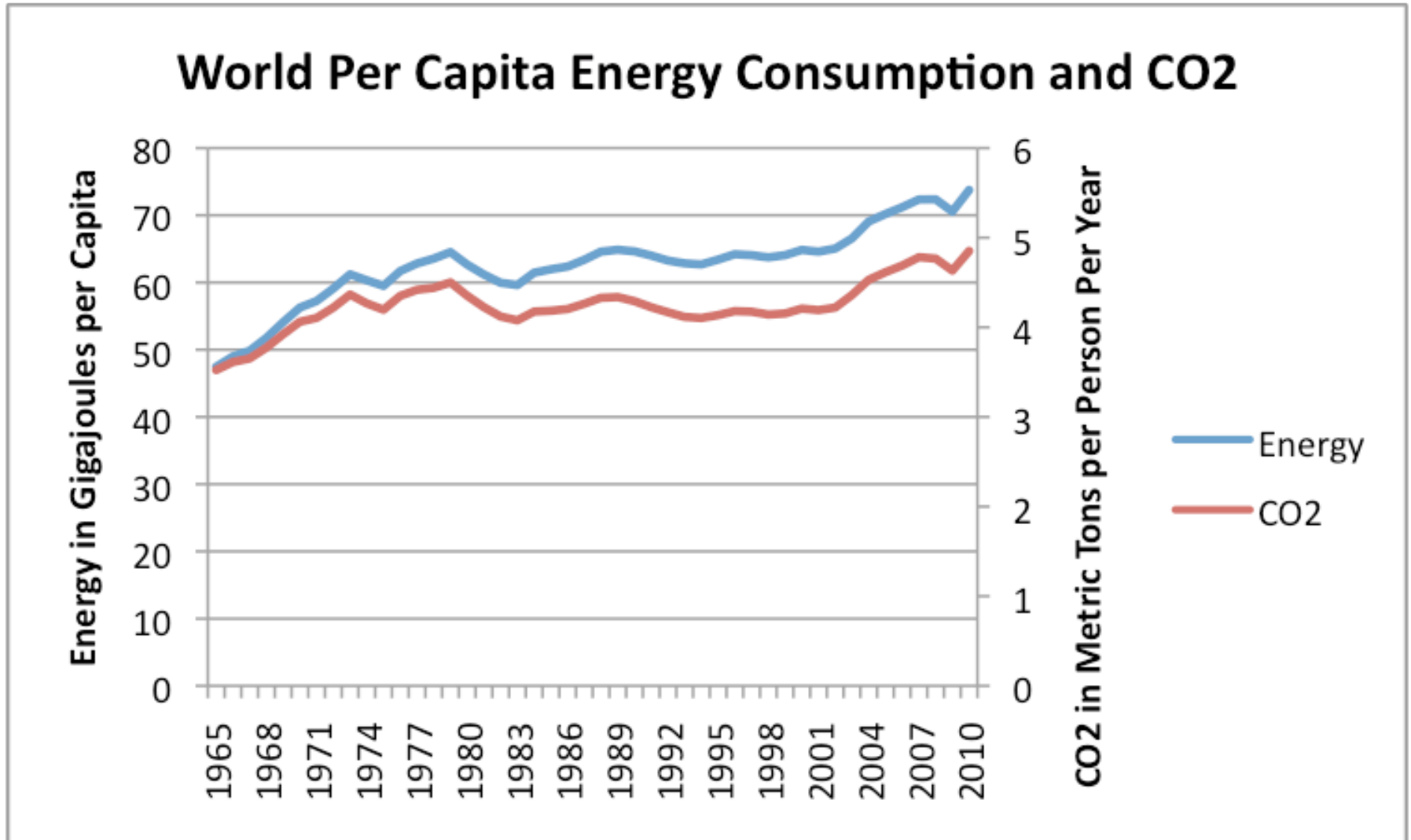
Energy and the environment

Fossil fuels drive GHG growth

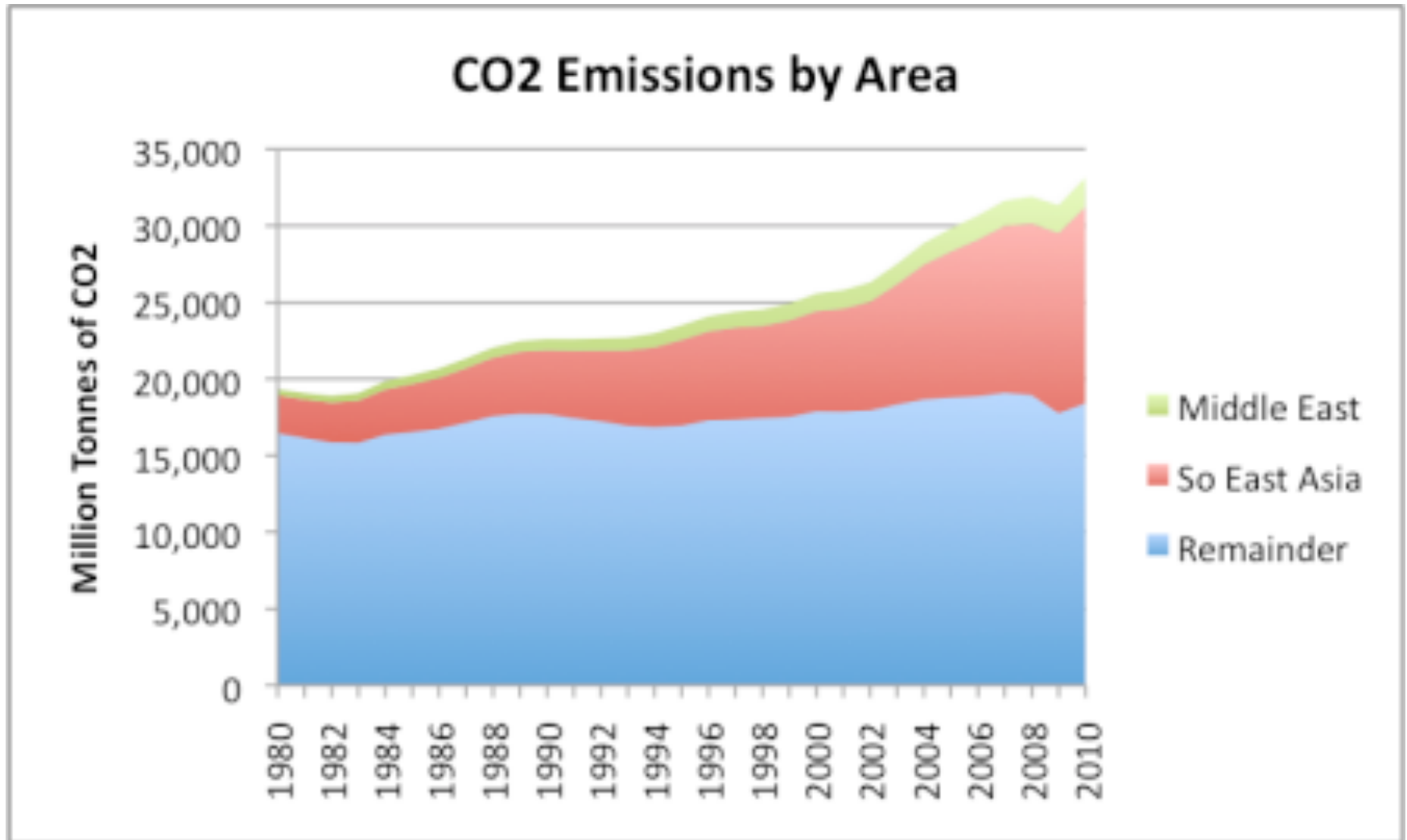
Global Primary Energy Consumption 1830 - 2010



The world is still meeting most of it's energy needs with fossil fuels



Developing countries are the largest sources of economic and GHG growth



Conclusions

- Our society relies on sustainable energy
- Fossil fuels are dense sources of energy that have allowed our global society to rapidly advance over the last two centuries
- Technology innovation has allowed us to harness fossil energy ever more efficiently, fueling our global economic boom
- Not all members of society have been able to access energy and technology
- Future development goals must emphasize the need to greater energy access
- The environmental challenge of the growing demand for energy must also be considered