Electricity and the Human Prospect: A Vision

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Key Points

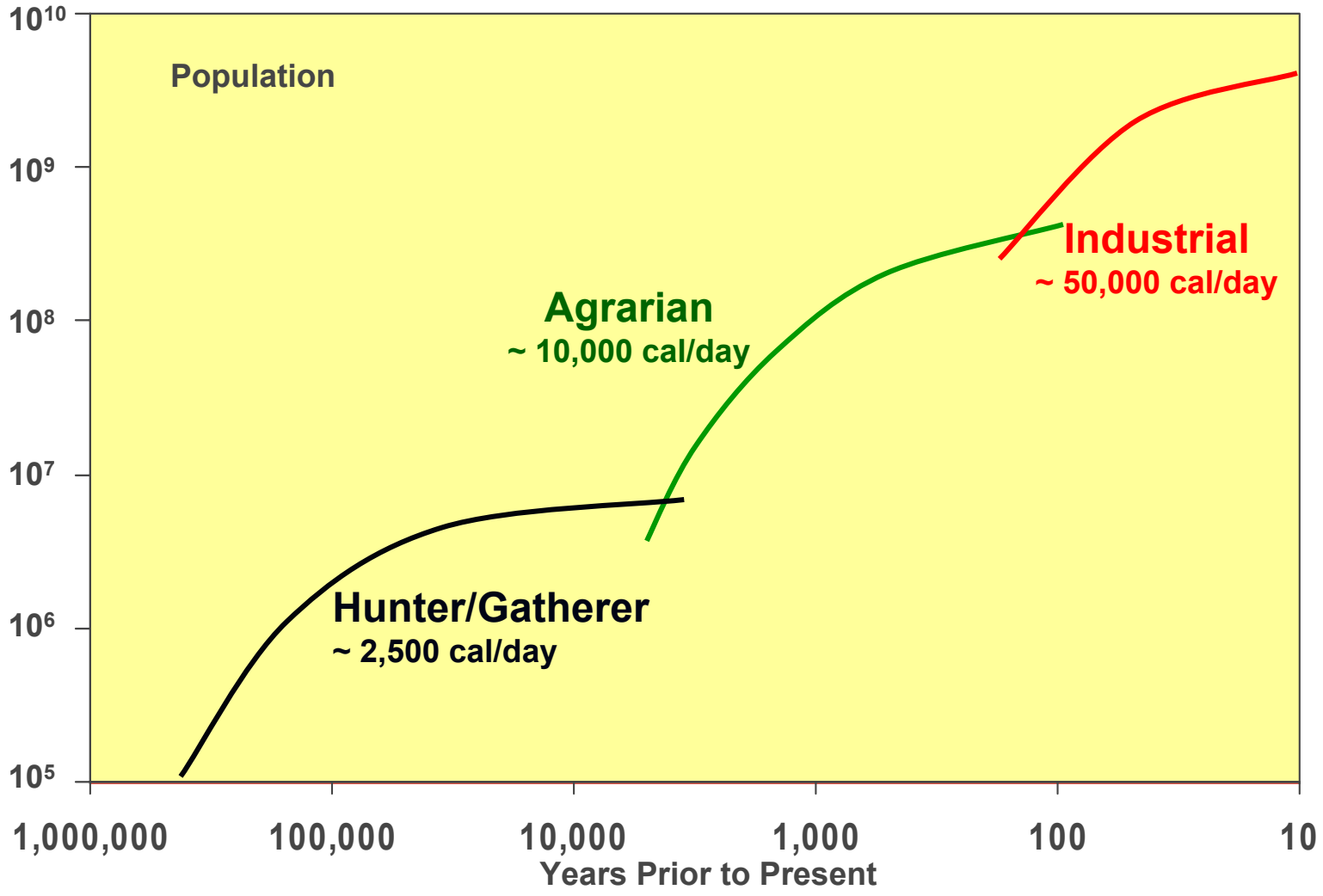
1. Throughout history, mankind's ability to master its environment has depended on energy availability.
2. The Developed World is precariously perched at the top of an increasingly unstable global energy access pyramid.
3. The driving force for technological modernization is resolution of the global energy gap.
4. Transforming the world's "hunter/gatherer" energy economy is essential to sustainability.
5. Electricity is the essential agent for this global energy transformation.

The Challenge of the 21st Century

Navigating Between:

- The global demographic threat posed by those denied energy access, and
- Resistance to the modernization on which energy access depends.

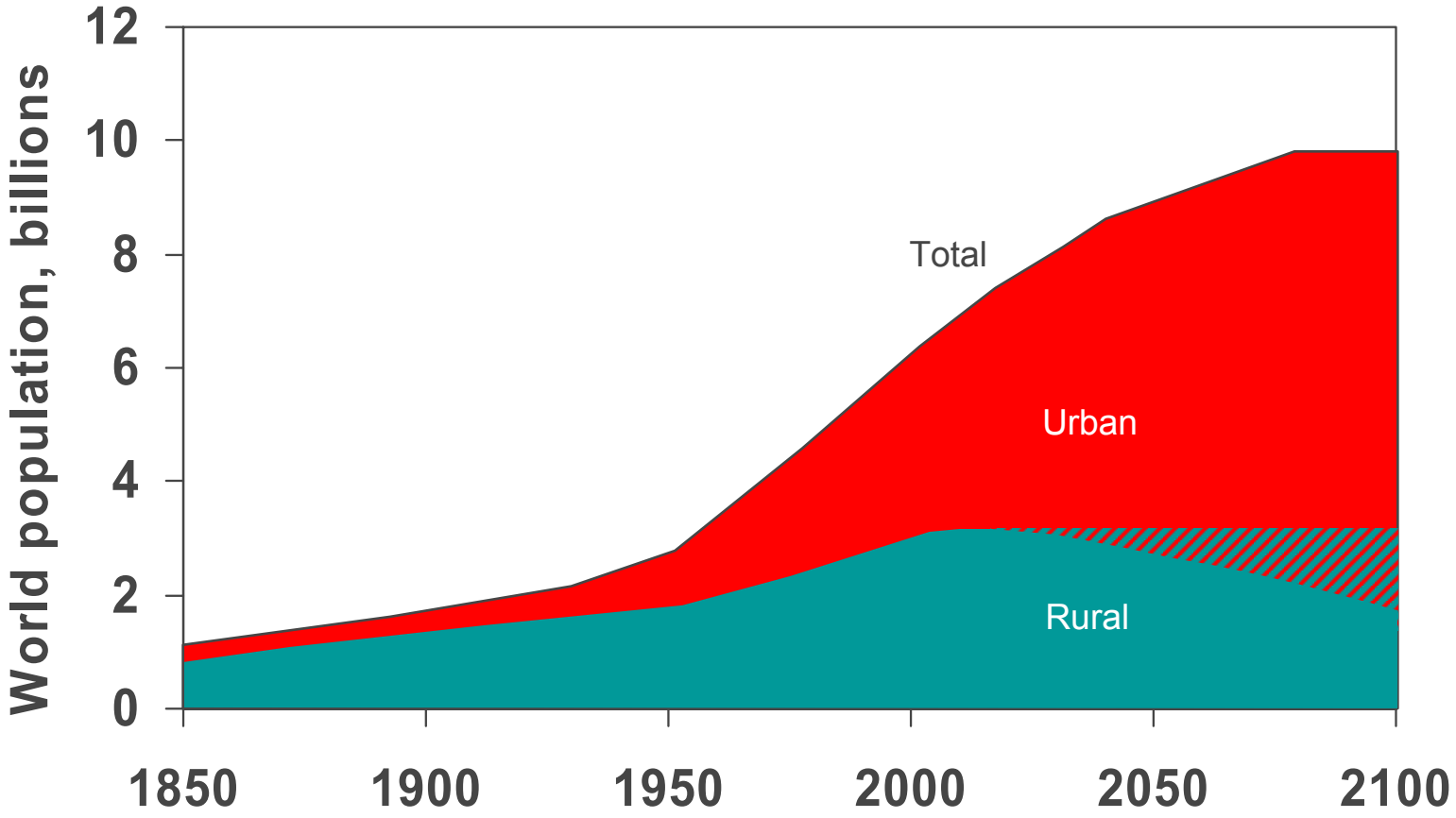
Cycles of Demographic Growth



The Energy Gap

- Half the world's population subsists on agrarian or lower levels of energy access, and
- Their population density generally exceeds the carrying capacity of their environment

World Population 1850-2100, Rural-Urban



Source: United Nations

The Thermodynamics of History

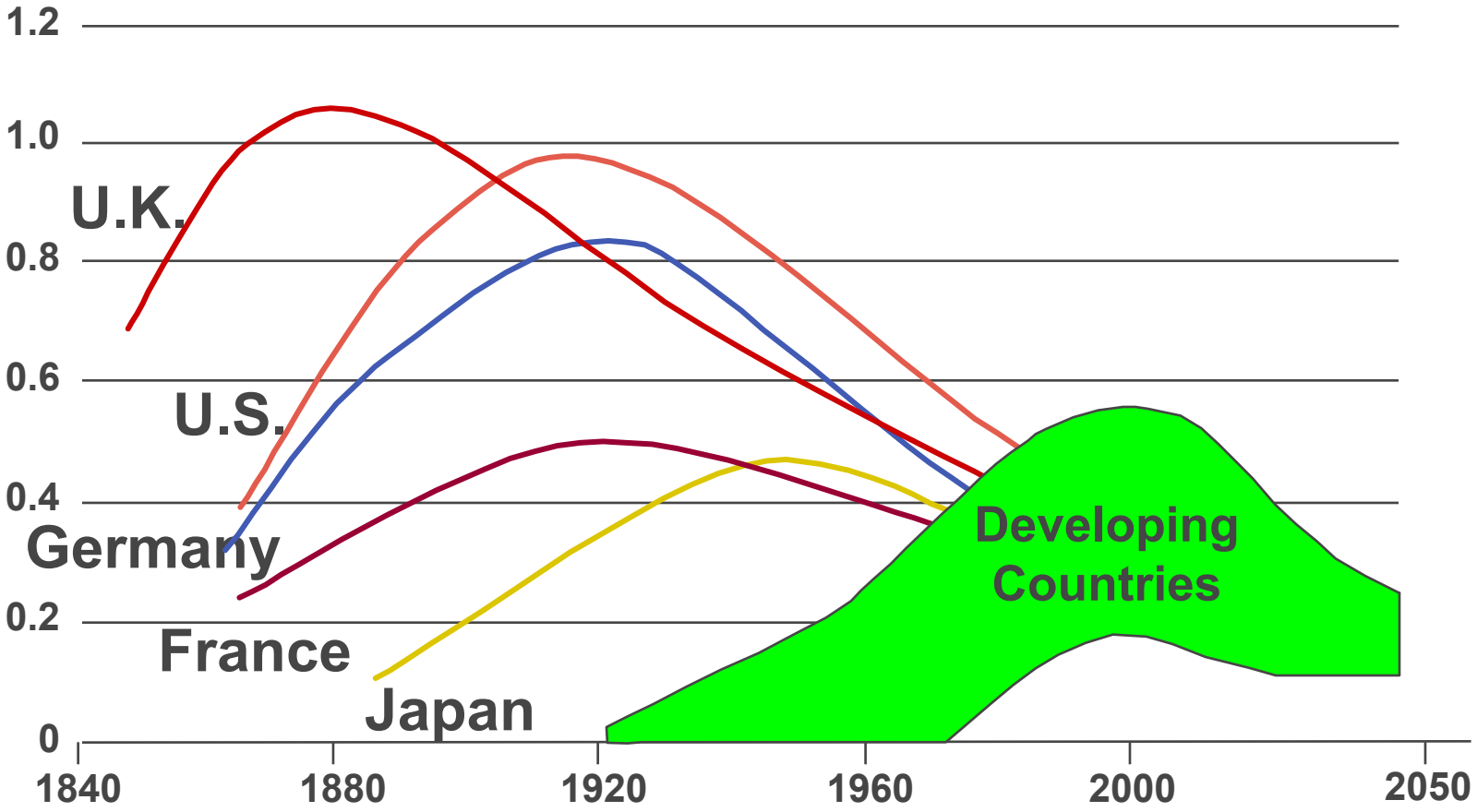
- Human history reflects the creation of increasingly complex technological and social arrangements for capturing free energy
- Collapse sets in when entropy can no longer be offset and the energy returns per capita diminish

Fundamental Advantages of Electricity

- Equal opportunity transformer and transmitter of all energy sources
- Greatest overall source-to-use energy efficiency
- Essential empowerment agent for modern innovation

Energy Intensity Can Be Reduced Through Electrification

Energy Intensity (MTOE/$1,000 GDP)



Source: Scientific American, Sept.1990

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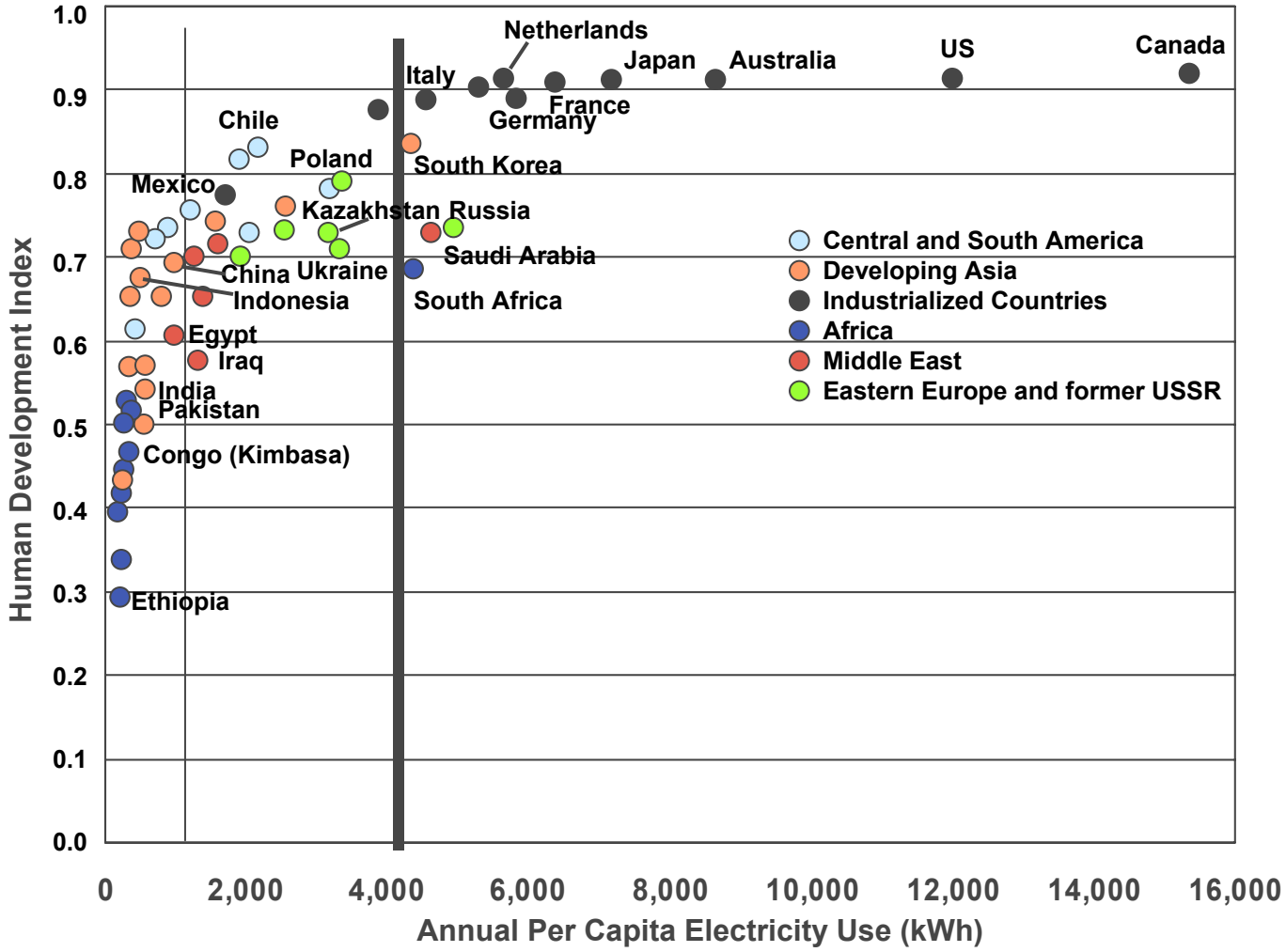
Inextricably Linked Global Needs

- Restore and protect the integrity of the earth's life-support systems
- Manage resources crucial to human welfare
- Eliminate poverty
- Stabilize population

Correlation Between Human Development Index & Per Capita Electricity Consumption



Source: S. Benka, MIT, The Future of Physics Today, April 2002

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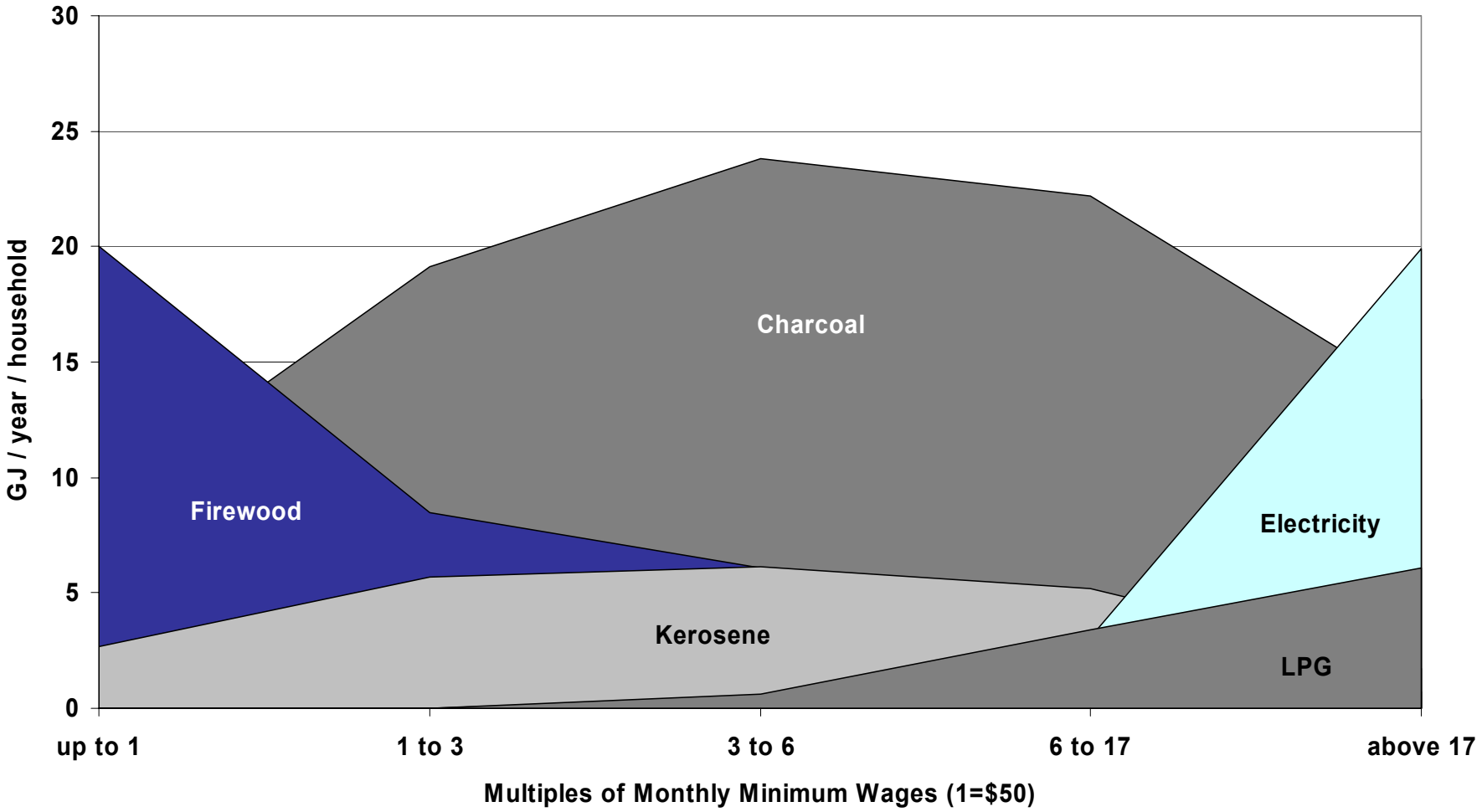
Household Energy Use by Household Income: Nairobi, Kenya



Source: Adjusted from: P.O'Keefe et al, (1984) Energy and Development in Kenya, Scandanavian Institute of African Studies, Uppsala, Sweden, as adjusted in Gordon Leach. (1992) "The Energy Transition." *Energy Policy* (February): 116-

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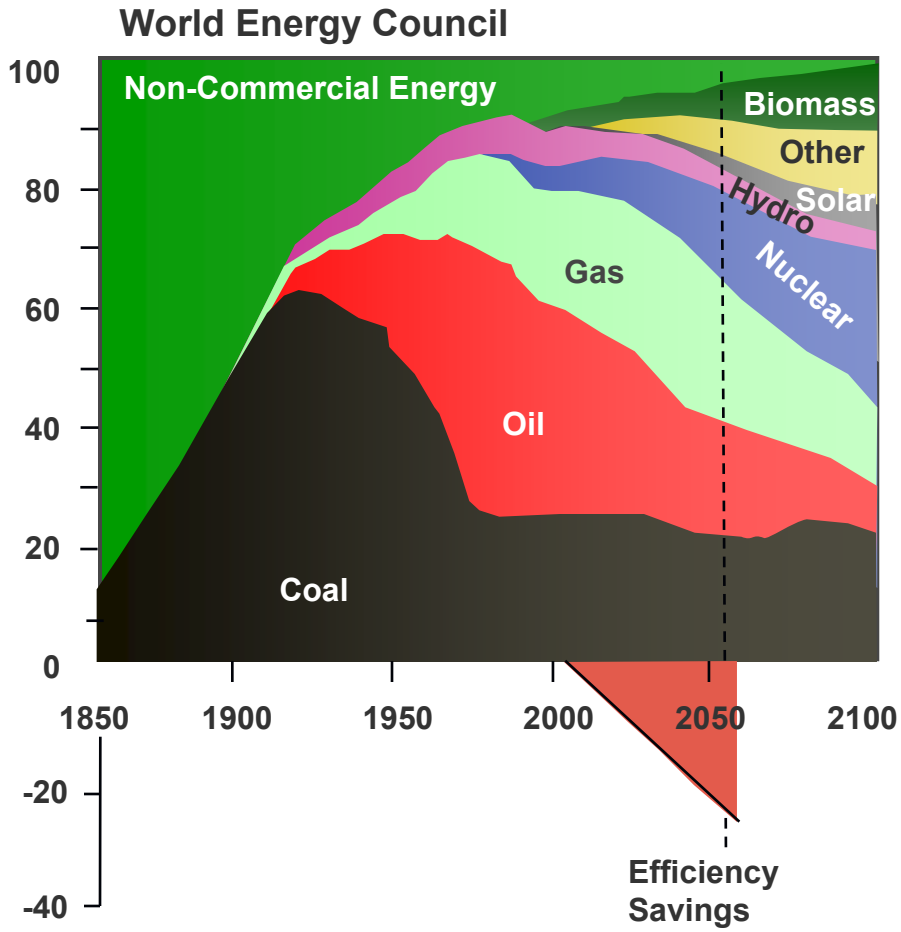
At least 2%/yr growth in global productivity is needed to achieve a sustainable world in the 21st century

- The '2+% solution' recognizes that only growing economies are able to provide the resources needed for a world of 10 billion
- Unfunded pension and health liabilities for an aging population threaten the world economy and social stability
- Sustainability will increasingly impinge on the electricity business
- Electrification needs to reach an additional 80 million people per year

Evolution of Primary Energy Shares



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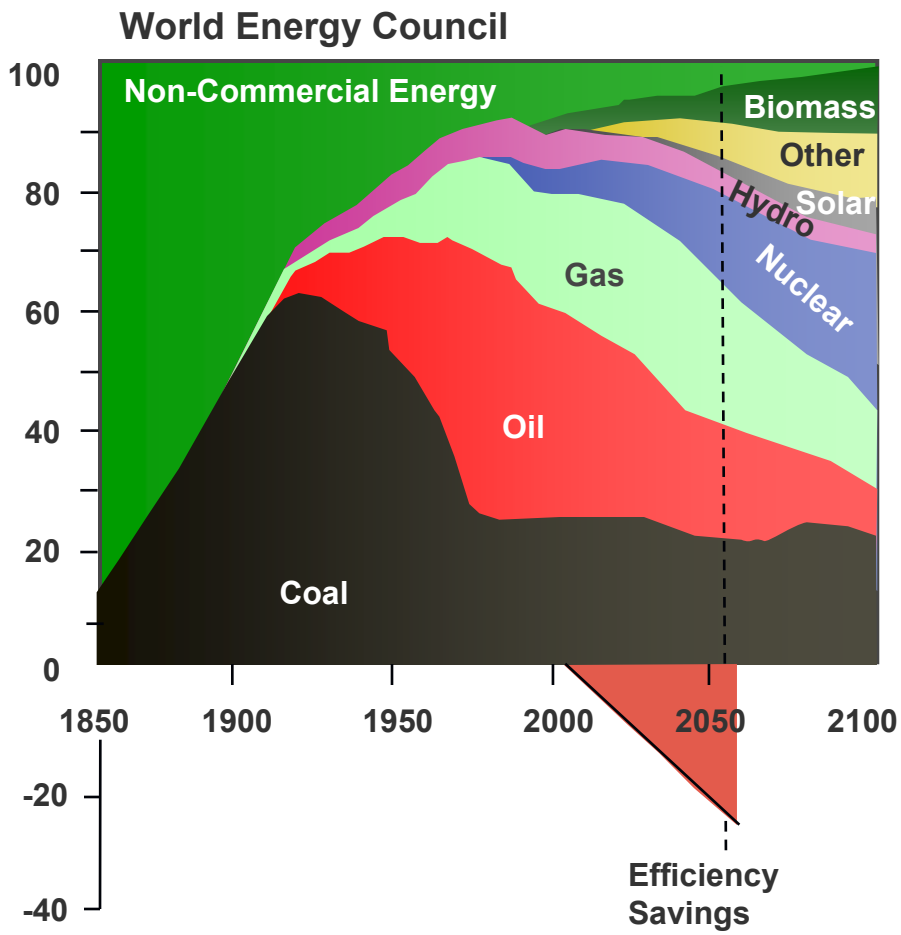

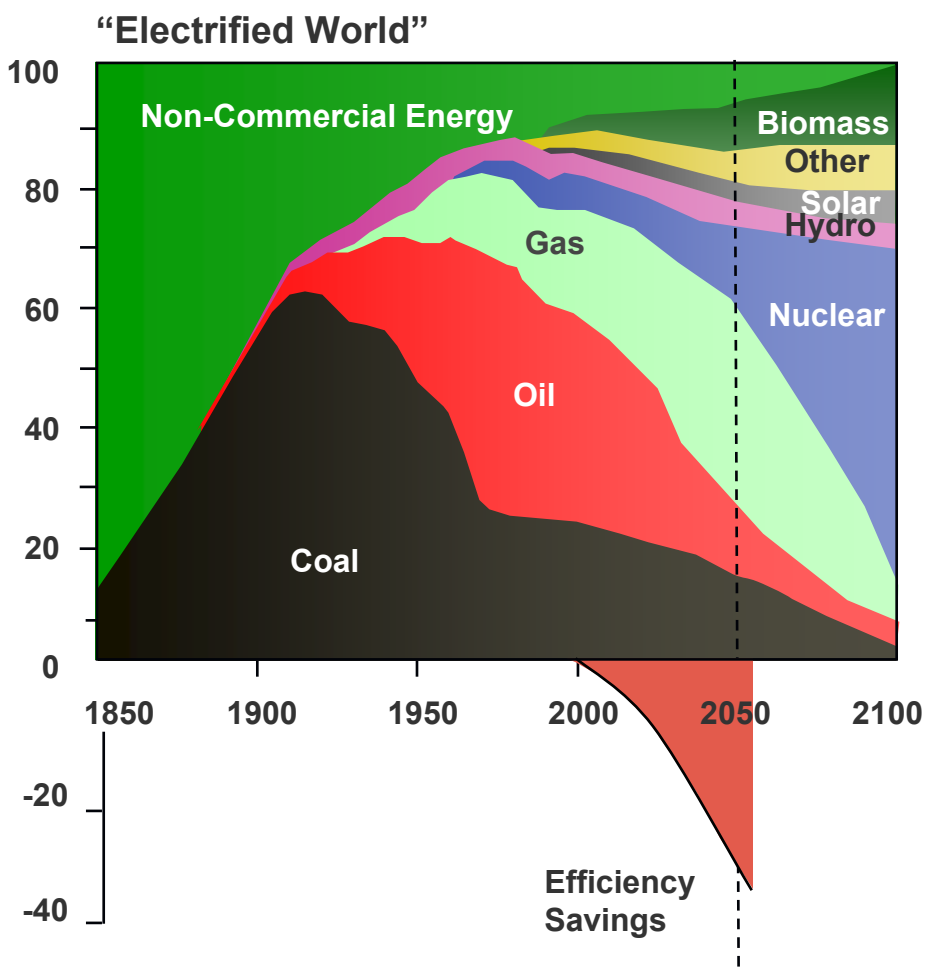

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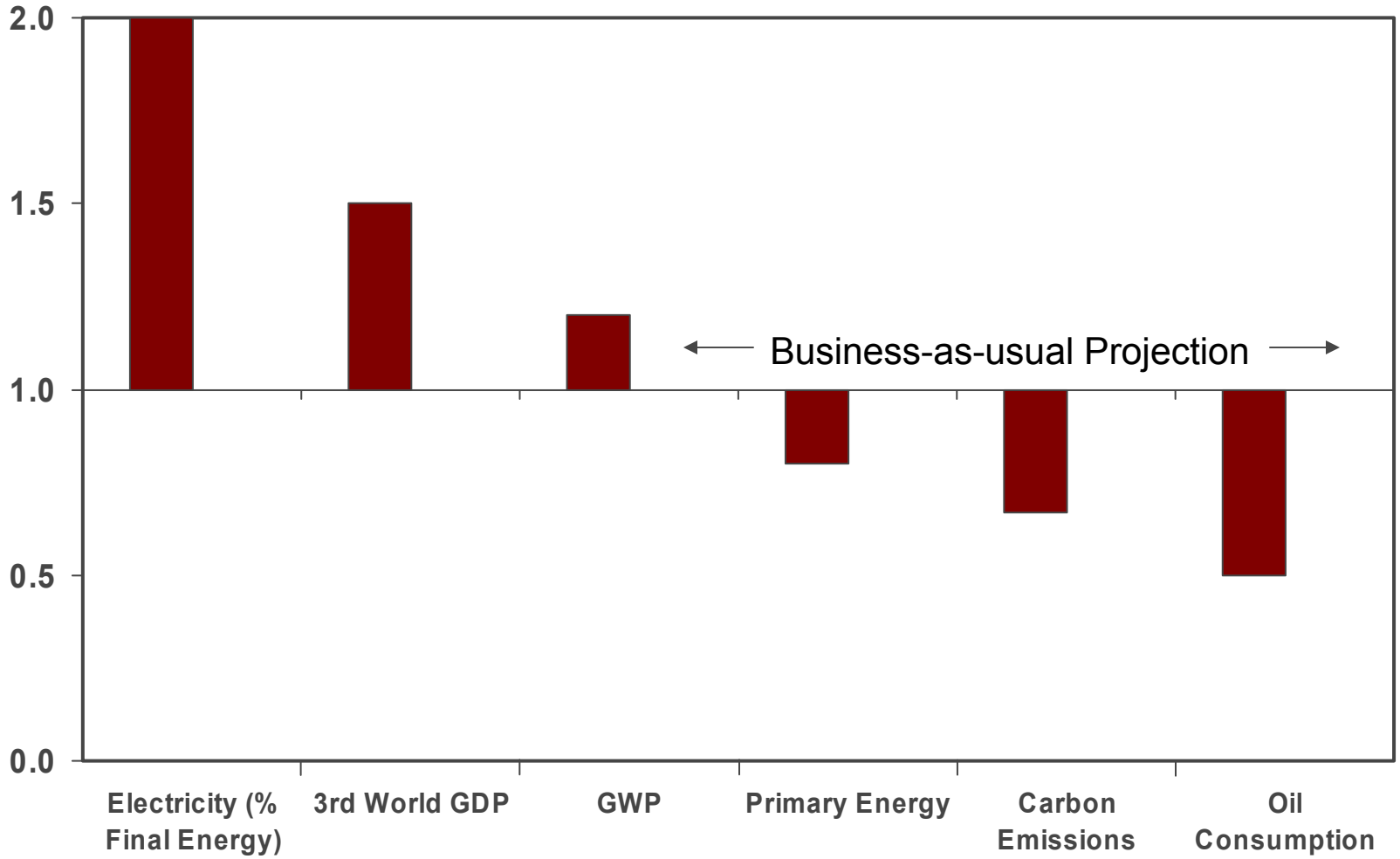
What Adding 10,000 GW of Global Electrification Capacity Means

- Tripling current world capacity
- Adding 200,000 MW/yr of Infrastructure
- Investing $300 billion/yr

It is equivalent to:

- < 5 years of current world automotive power production
- Less than 1.0% of GWP

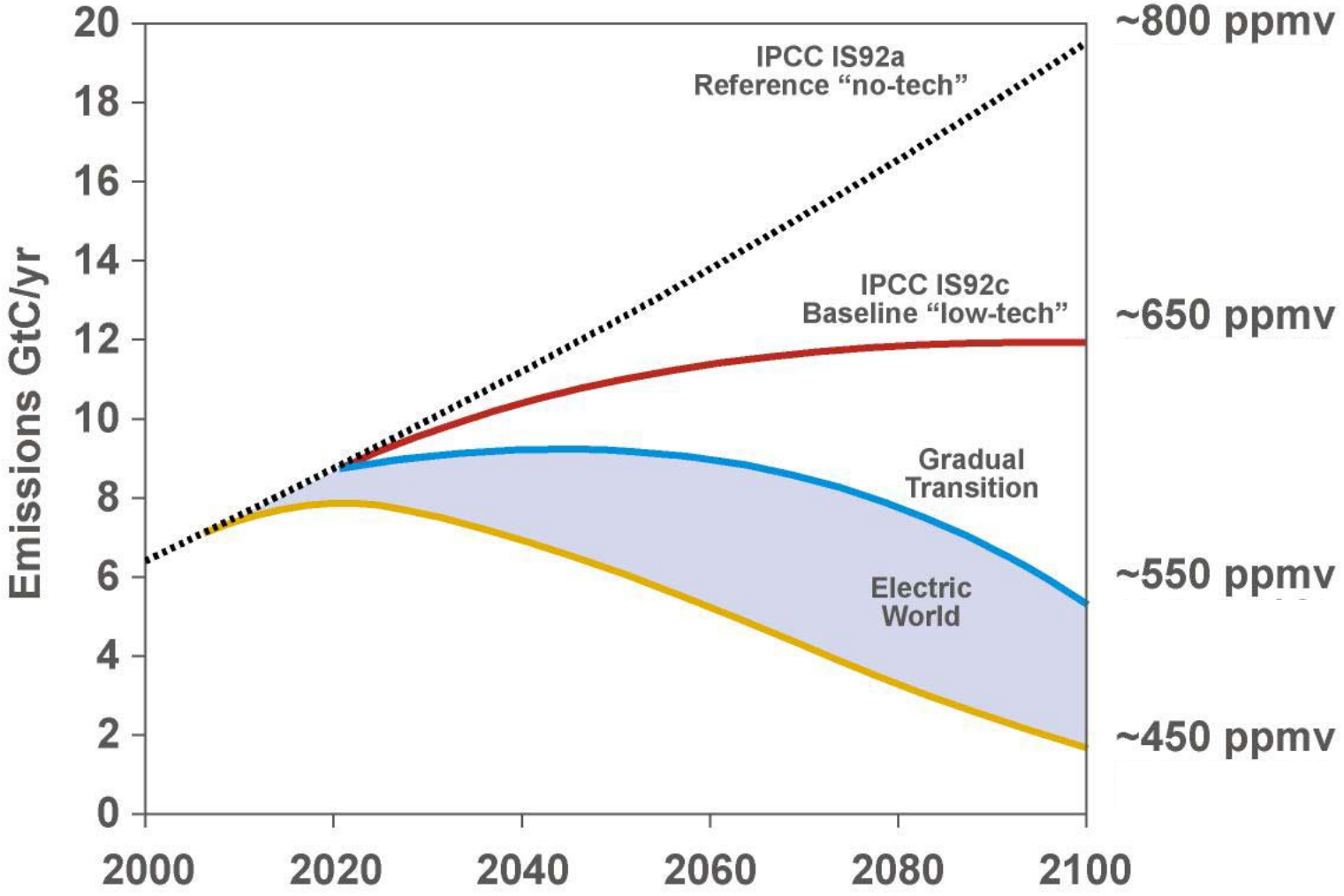
Electrified World vs. Business-as-Usual in 2050



Other Advantages of Electricity

- Reduces pollution / disease
- Encourages gender equity
- Enables education
- Lowers fertility rates

Comparison of CO_2 Emission Scenarios



Conclusions

1. The world is in the midst of unprecedented population growth made possible by mankind's increased ability to harness energy.
2. Only through broader access to energy can the world's demographic "climate change" be resolved.
3. This will require the transformation of what still remains a "hunter-gatherer" global energy economy.
4. The technology portfolio to enable this transformation is feasible but lacks the needed priority and resources.

“Where there is no vision, the people perish”

Proverbs 29:18