Energy Sustainability in a Larger Context

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Roundtable on Science and Technology for Sustainability

Sustainable Energy and Materials: Assessing the Landscape

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Energy Sustainability Involves Two Related Concerns (I):

- **The sustainability of <u>energy supply and use trajectories</u> themselves – can trajectories be made to work sustainably?**
- **Relationships between <u>energy trajectories and development goals and pathways</u> -- are connections of energy trajectories with broader social, economic, political, and institutional contexts sustainable?**

Regarding the Sustainability of Energy Supply and Use Trajectories (I):

- **Dimensions of sustainability from a *societal* point of view:**
  - The adequacy/abundance of services
  - The reliability of services
  - The affordability of services

Regarding the Sustainability of Energy Supply and Use Trajectories (II):

- **Dimensions of sustainability from a *system design* point of view:**
  - The sustainability of resource supplies
  - Linkages between energy sustainability and other systems
  - Social consensus about acceptability
  - Effective production and delivery infrastructures
  - Effective science and technology infrastructures for innovation and problem-solving

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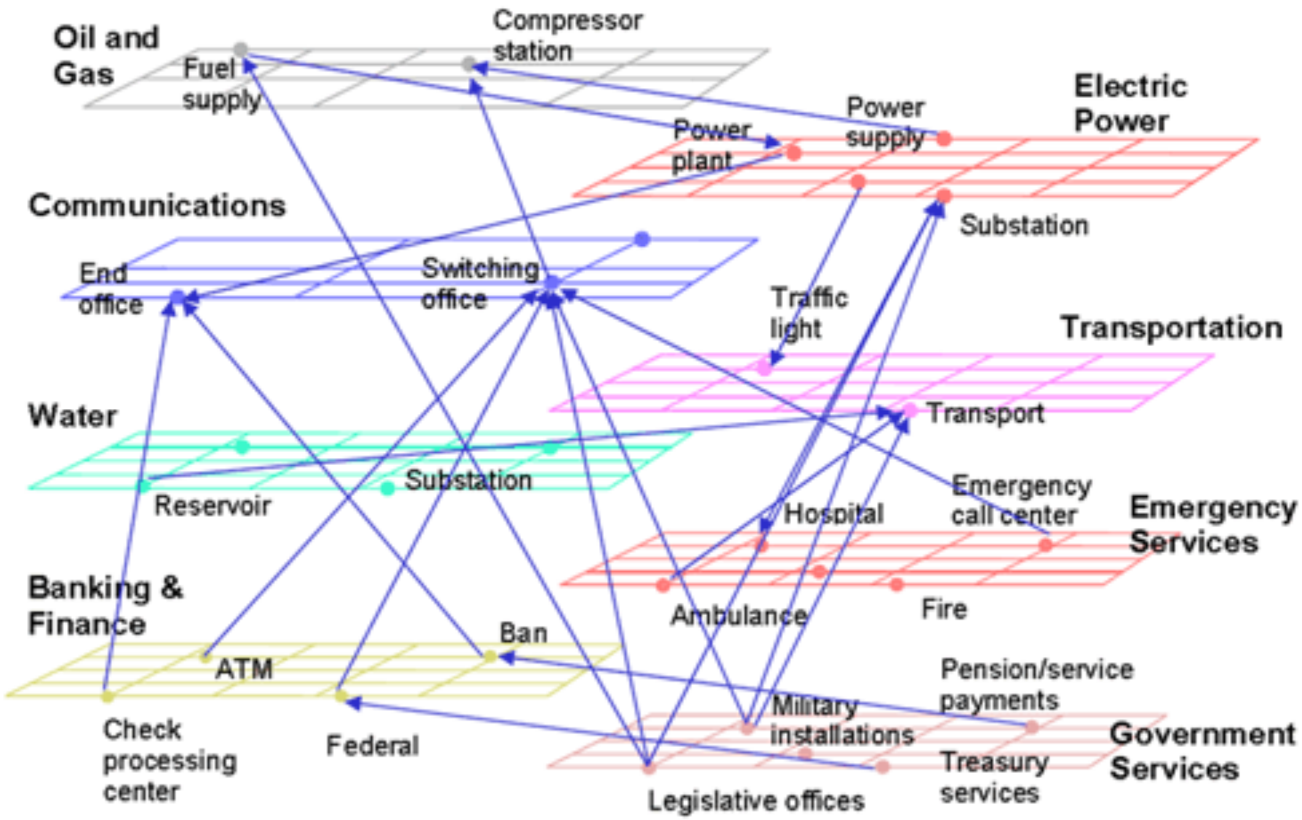
Infrastructure Systems Can Be Modeled as Interconnected Infrastructure Layers



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Regarding Sustainable Relationships between Energy and Socioeconomic Development Aims and Pathways

- **Goals of energy policies for development (WDR, 2010):**
  - Sustainable economic growth
  - Increased energy access
  - Enhanced energy security
  - Improved environmental management
- **To which sustainability science might add such sociopolitical dimensions as:**
  - Equity in energy system management and performance: who the services are for
  - Broad-based participation in energy-for-development planning and problem-solving: how issues regarding tradeoffs are resolved

Combining These Two Concerns, Energy Sustainability Issues that Seem to Need Particular Attention Include:

- **Sustainable paths for global energy demand and supply**
- **The elusiveness of social consensus about desirable/ acceptable energy trajectories**
- **The place of technology innovation and development in assuring sustainability**
- **How energy infrastructure transitions work in assuring sustainability as energy systems shift from the current state to a new state**

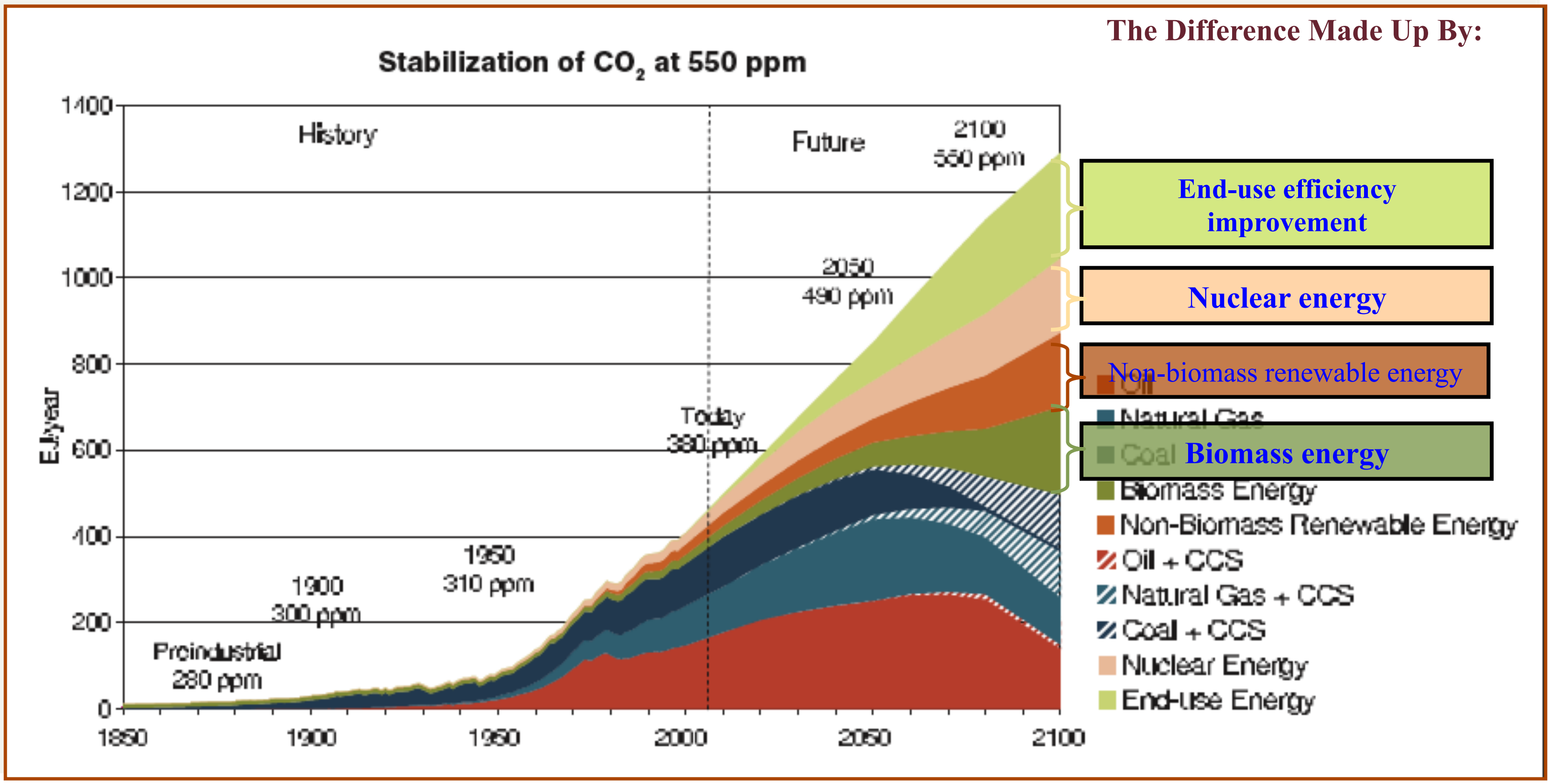
Regarding the Path of Global Energy Demand and Supply (I):

- The Asian dilemma: global GHG emission growth increasingly driven by China and India, but fossil energy is a key to their development
- Both expected to more than double their energy use between 2004 and 2030 – from 10% of world energy consumption in 1990 to 25% in 2030 (only 40 years)
- Domestic coal projected to supply 80% of electricity in China and 70% in India in 2030
  - Development paths depend on these energy services
  - But such emission trajectories would mean really substantial global climate change

Regarding the Path of Global Energy Demand and Supply (II):

- **Realistic alternatives are difficult to find, but they may include:**
  - **Pushing efficiency improvement and natural gas use in place of coal (but foreign policy implications of possible natural gas dependence on Russia?)**
  - **Accelerating innovative energy technological change – *and demonstrations* -- by industrialized countries: e.g., carbon capture and storage (but time lag)**
  - **Encouraging development <u>incentives</u> for accelerated technology shifts through partnerships with the region, e.g.:**
    - **Partnerships in appropriate technology development, including sharing of intellectual property (IPR obstacles)**
    - **Market incentives for Asian technology leadership (China and solar energy?)**

What Does This Imply For Energy Policy And Technology -- Technology Uses To Stabilize At 550 ppm?



Regarding the Path of Global Energy Demand and Supply (III):

- **Other issues include:**
  - Oil peaking: a crisis for alternative energy sources sooner rather than later?
  - Development pathways for the global economy – more or less resource-intensive
  - Prospects for technology breakthroughs (a topic to come…)

Regarding the Elusiveness of Social Consensus:

- **Depends not only on characteristics of energy resource and conversion systems but also on the level of societal trust in responsible institutions**
- **Particular questions about energy alternatives viewed by society as "risky" (ORNL Report, 2009: *Generic Lessons Learned about Societal Responses to Emerging Technologies Perceived as Involving Risks*, with particular attention to possible concerns about bioenergy technologies associated with genetic engineering)**
- **Consensus may be enhanced by participative consultation at an early stage: e.g., the Asilomar Conference in 1975 to discuss safety issues raised by DNA manipulation: led to NIH guidelines that defused most major societal concerns**
- **Raises questions about prospects for energy sustainability unless new low-risk energy technologies can be developed or social values change: e.g., acceptance of climate change impacts (coal), resource/technology risks (nuclear, biomass), or higher energy prices (renewables at a large scale)**

Regarding the Place of Technology Innovation and Development (I):

- **Accelerating technological change appears to be an essential part of the answer: <u>a need for *transformational* innovation</u>**
  - **A recent analysis at ORNL concluded that meeting U.S. goals of both climate protection and energy security requires a high probability of success for <u>all</u> 11 energy technologies considered – a long shot at best: Greene et al., *Energy Policy*, 2010**
  - **In fact, there is a growing sense of urgency about "transformational" energy technological change – not eventually, but soon: some calls for national commitments comparable to the Apollo mission to the moon or the Manhattan project**
  - **The issue is how to induce <u>discoveries</u> of new options, not just incremental changes based on exploiting known options: e.g, the role of DARPA in the IT revolution – ARPA-E???: Wilbanks, *Energy Economics*, 2011**

Regarding the Place of Technology Innovation and Development (II):

- **Accelerating technological change as an essential part of the answer: <u>broadening global engagement in the search</u>**
  - **Chances of a technology breakthrough are greater if we can reach and mobilize the best talent globally in the discovery process**
  - **This requires transferring to them what current science and technology knows and does, to be integrated with local knowledge to stimulate distributed discovery and innovation**
  - **The information technology revolution can be a powerful enabler of access to S&T knowledge, if intellectual property rights obstacles can be overcome: Wilbanks and Wilbanks, *Sustainability*, 2010**

Regarding the Place of Technology Innovation and Development (III):

- **Accelerating technological change as an essential part of the answer: focusing on critical path constraints, e.g.**
  - **The focus of DOE's *bioenergy* centers on liquid fuels from non-food bioenergy sources**
  - **The disposal of *nuclear wastes* (and now increased plant safety concerns related to Japan's earthquake damages)**
  - **Permitting processes for *carbon sequestration* sites as a possible constraint on carbon capture and storage**

Issues Regarding How Energy Infrastructure Transitions Work:

- **Understanding not only where we want to get with our energy technology options but also understanding how to get there, which shapes the rate and level of market penetration by new options – overcoming the standard assumption that new technology takes 25+ years to penetrate markets**
- **Transitions are nearly always impeded by the inertia of systems already in place, along with vested interests – including risk-averse private sector financing**
- **Often understudied:**
  - **Undermined early efforts to deploy solar energy technologies in developing countries such as Mexico**
  - **Lessons being learned from such recent experiments as the accelerated introduction of CNG vehicles into the public vehicle fleet in New Delhi, India**
  - **Often enhanced by commitments of government to assure (sometimes to be) markets for emerging transformational technology/resource alternatives**
- **Usually benefit from wide-ranging stakeholder consultations in order to shape public-private sector partnerships and explore possible social concerns**

In Summary:

- Energy sustainability is enmeshed in a host of socioeconomic and environmental contexts
- It is threatened by forces that seem to call for relatively rapid change, while its current technologies and institutions are not well-suited to rapid change
- We need to be considering risk management strategies to protect against an energy sustainability "perfect storm:" a situation (maybe around 2030?) where global oil supplies peak as global carbon emissions are driving us toward significant development impacts – and we do not have affordable and socially acceptable energy strategies ready to meet global and national needs

Finally, a Few Comments about How to Accelerate Progress toward Energy Sustainability:

- **Catalyze structures for institutional boundary-crossing, collaboration, and partnership:**
  - Sorting out who does which parts of the job best: valuing complementarities
  - Identifying ways in which all partners benefit from collaboration to achieve sustainability: "value chains"
  - Building personal relationships that overcome stereotypes
  - Looking for opportunities for focal issues and events (e.g., bioenergy?)
- **Think creatively about how to "bundle" sustainability with other energy agendas that have funding behind them, e.g.:**
  - U.S. energy security
  - Enlarging niches in the global energy technology markets of the future
  - Risk management in a context of climate change

THANK YOU !

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