Green Technology Choices:

The Environmental and Resource Implications of Low-Carbon Technologies

The report of the International Resource Panel (IRP), *Green Technology Choices: The Environmental and Resource Implications of Low-Carbon Technologies*, is the first international assessment of this type, which investigates the life-cycle environmental and natural resource implications of large-scale deployment of energy efficiency technologies. This report covers 8 demand-side technologies that consist of 36 sub-technologies across three clusters: (1) buildings, (2) industry and (3) transportation. In addition, the combined effects of low-carbon energy supply and deployment of efficient demand-side technologies under the 2 degree and 6 degree Celsius scenarios are assessed. Research confirms that demand-side technologies reduce greenhouse gas emissions as well as many other environmental impacts. However, the magnitude of those improvements varies widely among technologies and regions. In some cases, demand-side technologies may increase resource consumption and even greenhouse gas emissions. Therefore, this report can help to design policies for mitigating the potential unintended consequences of large-scale transitions toward a low-carbon society.

Avoiding the most catastrophic impacts of climate change in the coming decades will require unprecedented deployment of energy efficient demand-side technologies to reduce energy consumption in conjunction with large-scale development of low-carbon energy supply technologies. Although the climate change benefits of these low-carbon technologies on both the supply and demand sides are well established in the literature, their implications on other environmental impacts and natural resources are yet to be fully understood.

Addressing this gap, the International Resource Panel (IRP) commissioned a series of report on the long-term global transition to low-carbon technologies and their environmental and resource implications. The first report, Green Energy Choices, assessed the environmental and natural resource implications of low-carbon electricity supply technologies under the 2-degree Celsius scenario. Building upon the previous report, the present report uses life cycle assessment to identify the potential environmental and natural resource benefits, risks, and trade-offs of demand-side and energy efficiency technologies over the course of the International Energy Agency's 2-degree Celsius and 6-degree Celsius scenarios that cover 2010-2050. Specifically, this report quantifies the environmental, human health and natural resource impacts of more than 30 demand-side energy efficiency technologies across the following technological clusters: (1) lighting, (2) building shell, (3) demand-side energy management, (4) information and communications technology, (5) copper production, (6) co-generation, (7) passenger transportation, and (8) freight transportation.

In addition to assessing the environmental impacts of demand-side technologies, this report integrates the results of the Green Energy Choices report to understand the combined effects of low-carbon energy supply and efficient demand-side technologies when deployed together under the 2-degree Celsius scenario and the 6-degree Celsius baseline scenario. The report also evaluates the risks of the rebound effect by deploying demand-side technologies.

TECHNOLOGY-SPECIFIC FINDINGS

- Many demand-side low-carbon technologies exhibit significant co-benefits on the environmental and resource impacts considered, while significant regional variations are observed.
- At present, the technologies reducing building energy consumption for heating, cooling and lighting are the most environmentally benign.
- Reducing natural gas combustion and electricity demand by using building envelope improvements, ICT-enabled building energy management systems, and space and water heating can create large environmental and natural resource co-benefits.
- Cogeneration can be a beneficial short-term strategy in countries with GHG intensive electricity, and replacing outdated copper smelters with more efficient flash-furnace technologies can achieve energy savings with substantial co-benefits in human health and metal depletion.
- Efficient information and communications technologies such as computers, smartphones, televisions and displays have moderate potential to reduce GHG emissions and other impacts.
- Additional deployment of building insulation technologies shows substantial GHG benefit and other environmental co-benefits, while showing relatively small additional metals and minerals consumption
- Aggressive electrification of passenger transport, while underlying electricity generation still relies on coal and oil, may lead to an increase—rather than a decrease—in environmental impacts and natural resource pressures. Decarbonisation of electricity prior to a widespread electrification of passenger transportation would be more beneficial for the environment.

FINDINGS FROM COMBINED MODELLING

- Combining the electricity supply technologies and the demand-side technologies considered in the report, aggressive deployment of low-carbon energy technologies under the 2-degree Celsius scenario is shown to reduce most of the environmental impacts throughout their life-cycles.
- Aggressive deployment of both low-carbon energy supply and demand technologies considered in the report is shown to reduce most of the environmental impacts throughout their life-cycles under the 2-degree Celsius scenario. More specifically, they have the potential to:
  - ✓ Reduce about 25 billion tonnes per year of GHG emissions (in CO2 -eq) by 2050 relative to the 6-degree Celsius scenario, which is about 34% lower than the GHG emissions under the 6-degree Celsius scenario.
  - ✓ Avoid over 17 million tonnes per year of particulate matter in PM10 equivalency and over 3 billion tonnes of human-toxic emissions measured in 1,4 DCB equivalency as compared to 6-degree Celsius scenario
  - ✓ alleviate the pressure on water by over 200 billion cubic meters per year and nearly 150 thousand square kilometres of land occupation by 2050 as compared to the 6-degree Celsius scenario
- Low-carbon technologies, however, require over 600 million tonnes of metal resources (measured in iron-equivalency) by 2050 for additional infrastructure and wiring needs. The relative magnitude of additional metal demand by low-carbon supply- and demand-side technologies is likely small compared to the background consumption of metals caused by the rest of the economy.
- Some efficiency technologies are known to increase the demand on the service that they provide, which is one of the main mechanisms of so called, "rebound effect". In order to nullify the environmental co-benefits of low-carbon technologies, however, more than 100% increase in demand of the same service is needed for most of the technology-impact category pairs. However, an increase in demand of less than 30% could eliminate their environmental benefits of efficient information and communication technology and passenger vehicles.
- Understanding the regional and temporal variations in the life-cycle impacts of low-carbon technologies can foster effective policy design that maximizes the co-benefits.

The International Resource Panel was established in 2007 to contribute to a better understanding of sustainable development from a natural resources perspective, providing science-based policy options on how to decouple economic growth from environmental degradation while enhancing human well-being. In order to achieve this, the International Resource Panel uses a systems approach to:

Prepare independent, coherent and authoritative scientific studies and assessments of policy relevance on the sustainable use and management of natural resources and in particular their environmental impacts over the full life cycle;

Inform international policy discourse and development on emerging challenges and opportunities for the sustainable use and management of and equitable access to natural resources.

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The full report can be downloaded here:
http://www.resourcepanel.org/reports/green-technology-choices