# Environmentally Benign Energy for the Twenty-first Century

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**Sponsor:** Carnegie Institution

**Description:** We are engaged in a range of studies designed to better understand the century-scale drivers of the demand for energy services and how that demand might be met, given the wide range of constraints that are in operation (i.e., material, environmental, political, health and safety, cost, etc.). We start from the assumption that nobody can predict the future on the century time scale, nevertheless, it is useful to look at simple energy-services-demand scenarios and then look at fundamental physical constraints on satisfying those demands.

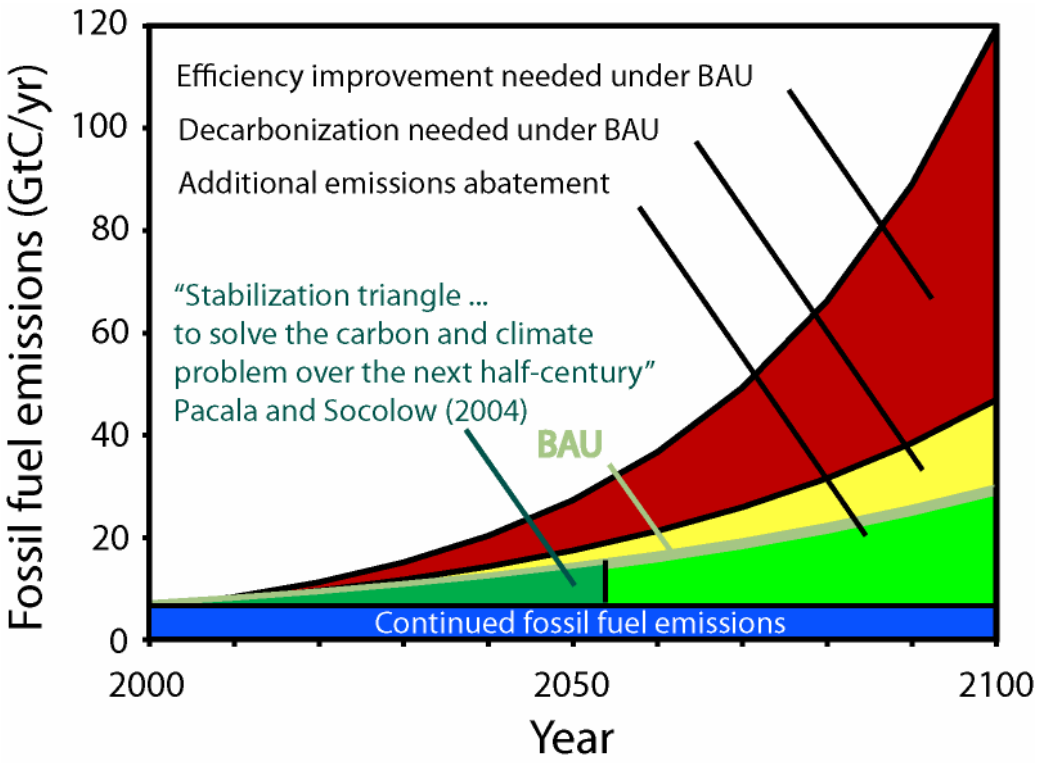


**Figure 1:** It has been suggested by Pacala and Socolow (2004) that solving the climate problem for the next 50 years means supplying seven "wedges" of environmentally benign energy or energy savings ramping up to 1 GtC/yr-equivalent after 50 years. In their Business-as-Usual (BAU) scenario, GDP grows at 3 % per year, efficiency improvements increases at 1 % per year, and decarbonation of the energy system proceeds at 0.5 % per year (despite the transition towards a coal based economy). Thus they define the problem as finding energy sources to fill the dark green wedge in the first half of the century. In fact, providing a 3 % per year increase in the provision of energy services at constant $CO_2$ emissions involves filling in the red, yellow, and green areas of the figure, which, especially for the second half of the century, is a

monumental task. To solve the climate problem, in the first half of this century, we need to design and start deploying the energy system for the second half of this century.

**Status:** Current work involves writing a paper that expands upon the ideas mentioned in the caption to Figure 1. We are also thinking about how one might develop a process that could more rationally allocate of scarce R&D resources to help achieve the goal of an environmentally benign energy system. To help this thought process along, we are imagining how one might have allocated scarce R&D resources in the year 1900 to aid in the development of the transportation system of the twentieth century, given the inability to predict the success of aviation, automobiles, and other technological innovations.

**Publications:**

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