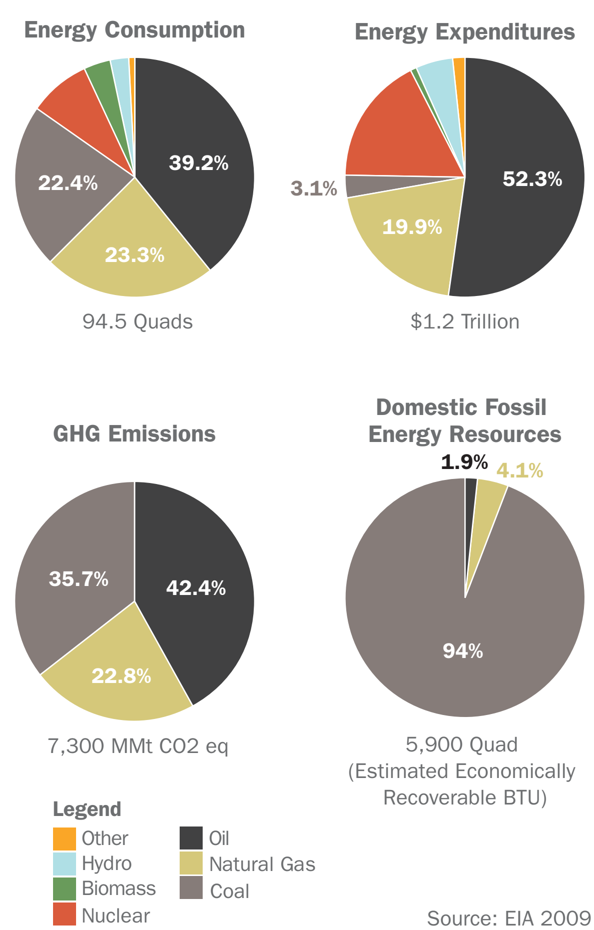
America 2050

Rethinking CO_2

From Waste to Recyclable Resource: A Roadmap to Commercialization of Profitable Emission Mitigation Technologies

What if there were a zero-cost technology that enabled continued and even increased U.S. coal utilization with a 90% reduction of associated greenhouse gas (GHG) emissions? How would the U.S. economy change if implementation of this technology could offset billions of dollars in foreign oil purchases through domestic coal use and create thousands of jobs over the next 5 years? How would U.S. consumers benefit if this technology produced sustainable bio-crude for use in existing petroleum refineries at less than $50/barrel and high quality vegetable protein and micronutrients for human, livestock, and aquaculture consumption for less than $500/ton?

2007 US Energy Profile



Source: EIA 2009

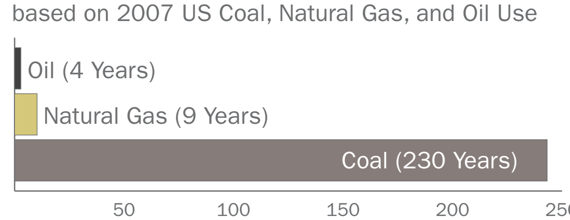
Problem

The United States is the largest national economy and largest emitter of GHGs on earth. In 2007, the United States spent roughly $1.2 trillion, approximately 8.5% of its GDP on energy and generated approximately 20% of global emissions (EIA 2009, CIA 2009).

Despite its ownership of over 28% of global coal reserves and less than 3% of global oil reserves (BP 2009), oil accounted for 40% of U.S. energy use, and nearly 70% of its energy expenditures in 2007 (EIA 2009). Unnecessary reliance on foreign energy inputs makes the U.S. economy vulnerable to energy price volatility, supply disruptions, and reduces its long-term economic competitiveness. In 2007 alone, the United States spent over $360 billion on foreign oil. The economic, environmental, political, and military costs of our current modes of energy production and consumption are unsustainable.

International scientific consensus attributes the roughly 1 degree Fahrenheit warming experienced over the past 60 years primarily to anthropogenic fossil fuel combustion (IPCC 2007). Since preindustrial times, atmospheric concentrations of CO_2-equivalent GHGs have increased roughly 30% to 385 parts per million in the earth's atmosphere. Severe, negative economic, human health and social impacts are expected to result from future climatic change associated with an increase in the concentration of GHGs (Alley et al 2003, IPCC 2007, Mills 2005, Vorosmarty et al 2000).

Longevity of Domestic Resources
based on 2007 US Coal, Natural Gas, and Oil Use



Source: EIA 2009, BP 2009

Toward a Solution

Reduction of GHG emissions may come through either a reduction in total energy use or a reduction in the GHG intensity of our energy supply. Reducing the GHG intensity of our energy supply is expected to eventually include replacement of fossil fuels with renewable energy sources, and direct capture and storage of GHG emissions from fossil sources. However, all of these strategies face challenges to rapid deployment.

1. Reducing energy use will require both behavioral changes by individual consumers and technology change in buildings, transportation, industry, agriculture, and waste management. While there are profitable opportunities to implement conservation programs through both behavioral and technological change, they have proven difficult to quickly scale up.

2. Replacing fossil fuels with renewable energy sources will require cost competitive, abundant, and dispatchable (responsive to short term changes in demand) renewable energy technologies. While the cost of solar and wind-based electricity has steadily decreased, low-cost, grid-scale electron storage must first be developed before these intermittent renewable energy sources can play a major role in our energy supply.

3. While both energy conservation and renewable energy integration should occur over time, the urgency of reducing GHG emissions to avoid significant future climate change requires rapid, large-scale mitigation of emissions from fossil fuels which currently supply 85% of our energy (EIA, 2009). With approximately 50% of U.S. GHG emissions coming from large point sources, practical implementation of industrial scale emissions control is possible. Rapid implementation will require a mitigation technology that is low cost, quantifiable, easily verified, and sustainable. Traditional options considered for 'disposal' of emissions including geological (underground injection) and biological (conserving and planting forests) sequestration, are projected to be able to mitigate about 25-50% of 2030 baseline emissions at a cost of about $100 per ton (IPCC, 2007). However, the costs of these traditional sequestration options would significantly increase the cost of energy production.

Within the past year, however, important technology advances have demonstrated a new paradigm for GHG emissions management: recycling. Profitable, photosynthetic-based technology now exists at pilot scale that enables recycling of CO_2 to commodity-price competitive protein and 'biocrude' for use in existing petroleum refineries. In simple terms, the technology uses the sun's energy to recycle GHGs into valuable commodities that can be transported, processed, and sold with no changes to our existing energy and agricultural infrastructure.

A Promising New Technology: Algae Emissions Recycling

Industrial cultivation of algae has been studied for over 50 years (Burlew, 1953) with significant government research being conducted in the United States and Japan in the 1980s and 90s. Algae has been commercially produced for sale into the niche nutraceuticals, wastewater treatment, and aquaculture feed markets for over 30 years (Spolaore et al. 2005). However, the nutraceutical markets into which algae has traditionally been sold are limited in scale and can bear prices in excess of $5,000/t. In order to produce and sell algae into commodity energy and protein markets at prices below $300/t, productivity of algae must be at least 60 grams per square meter per day and total cultivation, drying, and processing capital costs must be no more than $150,000/hectare (Benemann 2008). Within the past year, this productivity has been demonstrated in a modular facility with commercial scale production costs projected to be well within an economic threshold. The economic, social, human health, political and environmental benefits from profitable reduction of the GHG intensity of our energy use could transform the United States and are achievable today using the fossil, infrastructural, technological, and solar resources we currently possess.

With questions or comments, please contact:
Daniel J. Fuller,
Research Fellow, Regional Plan Association
(917) 546-4309
dfuller@rpa.org