Carbon negative energy systems

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Background

- Rapidly increasing emissions
- Appreciation of the long life of atmospheric CO$_2$
- Climate change & disaster risk
- Ocean acidification
- SRM risks and uncertainties
- Energy and C inefficiency of liquids from biomass
Fossil Fuel Emissions: Actual vs. IPCC Scenarios

Updated from Raupach et al. 2007, PNAS; Data: Gregg Marland, Thomas Boden-CIAC 2010; International Monetary Fund 2010
Impacts of Economic Crises on C Emissions

Peters et al. 2011, Nature CC
Timing

- Committed emissions

Davis et al. Science, 2010
Permanent climate change

Matthews and Caldeira 2007 GRL
Disaster risk management and climate change adaptation can influence the degree to which extreme events translate into impacts and disasters.
Carbon dioxide level, Coral reef distribution, and chemical conditions helping drive reef formation.

Cao and Caldeira, 2008
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Cao and Caldeira, 2008
Bio-electricity vs Liquid biofuels

RCPs in perspective – CO$_2$ emissions