Climate Change:

Bad News/Good News

Chuck Kutscher National Renewable Energy Laboratory April 5, 2013 FOX NEWS AL GORE'S GLOBAL WARMING MOVIE: COULD IT DESTROY OUR ECONOMY? DESIGN SPECIAL PLAEVERAGES THAT COMPLIANE ONUSUAL FLA

SERIES AT 2 MIN





THE OTTAWA SERATORS BEAT THE NJ DEVILS 3-2 W

LIVE IS GLOBAL WARMING FOR REAL?





NEWS

Report: Global Warming Issue From 2 Or 3 Years Ago May Still Be Problem

WASHINGTON — According to a report released this week by the Center for Global Development, climate change, the popular mid-2000s issue that raised awareness of the fact that the earth's continuous rise in temperature will have catastrophic ecological effects, has apparently not been resolved, and may still be a problem.

The Science

Air

Global Land-Ocean Temperature Index



lce



Gravity Satellite Ice Sheet Mass Measurements



Greenland Ice Sheet

Antarctic Ice Sheet

Source: Velicogna, I. Geophys. Res. Lett., 36, L19503, doi:10.1029/2009GL040222, 2009.

Ocean



Church, et al. Geophysical Research Letters, September 16, 2011

The Culprit



Sea Level vs. CO₂ For Last 550,000 Years



Foster and Rohling, *Proceedings of the National Academy of Sciences*, January 22, 2013







Extreme Weather

U.S. June Temperature Records Broken



Waldo Canyon Fire





French Drought

East Africa Drought



Texas Drought



Thailand Floods







"We can't afford to fix it."



Projected Cost to US of Climate Change Damage by Year 2025:

\$271 Billion/yr

- Ackerman and Stanton, 2008

The Good News: Solutions!

(and Challenges)

Geothermal



ΡV



Biofuels



Efficiency



CSP





Biomass Power

Wind

Tackling Climate Change in the U.S.

Potential Carbon Emissions Reductions from Energy Efficiency and Renewable Energy by 2030

American Solar Energy Society Charles F. Kutscher, Editor January 2007

Potential U.S. Carbon Reductions



The Challenge: Grid Integration

Operations during mid-April



From Western Wind and Solar Integration Study, courtesy of Debra Lew, NREL

Operations during mid-April



From Western Wind and Solar Integration Study, courtesy of Debra Lew, NREL

Spatial Diversity Smooths Wind Farm Output



Solar and Wind Complementary: Diurnal



Hour

Grid Integration Costs (Arizona Public Service)





Renewable Electricity Futures Study



Exploration of High-Penetration Renewable Electricity Futures

Volume 1 Volume 2 Volume 3 Volume 4 PDF PDF NREL is a national laboratory of the U.S. Department of Energy,

Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

80% RE Scenario



Increased variability requires:

- increased supply- and demand-side flexibility
- new transmission



New Transmission Needs





New NREL Energy Systems Integration Facility



Hardware-in-the-Loop: Connecting Experiments to Simulations





ESIF - Energy System Simulated Operations

A Flight Simulator for Energy System Operators



The Really Good News:

Rapid Change is Happening!

New EPA Fuel Efficiency Standard



Shift From Coal to Gas



PV Module Prices



Germany sets solar record, meets half of electricity demand

By Ian Steadman 28 May 12



PV Resource: Germany vs. U.S.







Gemasolar power tower





US trough plant

Spanish trough plant

World Wind Power (MW)



Current Installed Wind Power Capacity (MW)



January 2013 New U.S. Generating Capacity Added: 1,231 MW

Percent from Renewables: 100%

California's New Cap-and-Trade Law: A Model for the Country?

Although cap-and-trade programs to curb global warming are a nonstarter in Washington, an ambitious plan in California could renew interest.

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Smog gets in your eyes: A Cali highway. (AP PHOTO/MIKE MEADOWS)



Australian Carbon Tax

China







"We will respond to the threat of climate change, knowing that the failure to do so would betray our children and future generations."

 President Barack Obama, January 21, 2013



February 17, 2013





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NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.