Global Climatic Disruption and its Impact on Victoria and California

High Definition Remote Presentation to the
Monash Undergraduate Research Projects Abroad (MURPA) Program
Located at Monash University, Australia
From Calit2@UCSD
May 20, 2010

Dr. Larry Smarr

Director, California Institute for Telecommunications and Information Technology

Harry E. Gruber Professor,

Dept. of Computer Science and Engineering

Jacobs School of Engineering, UCSD

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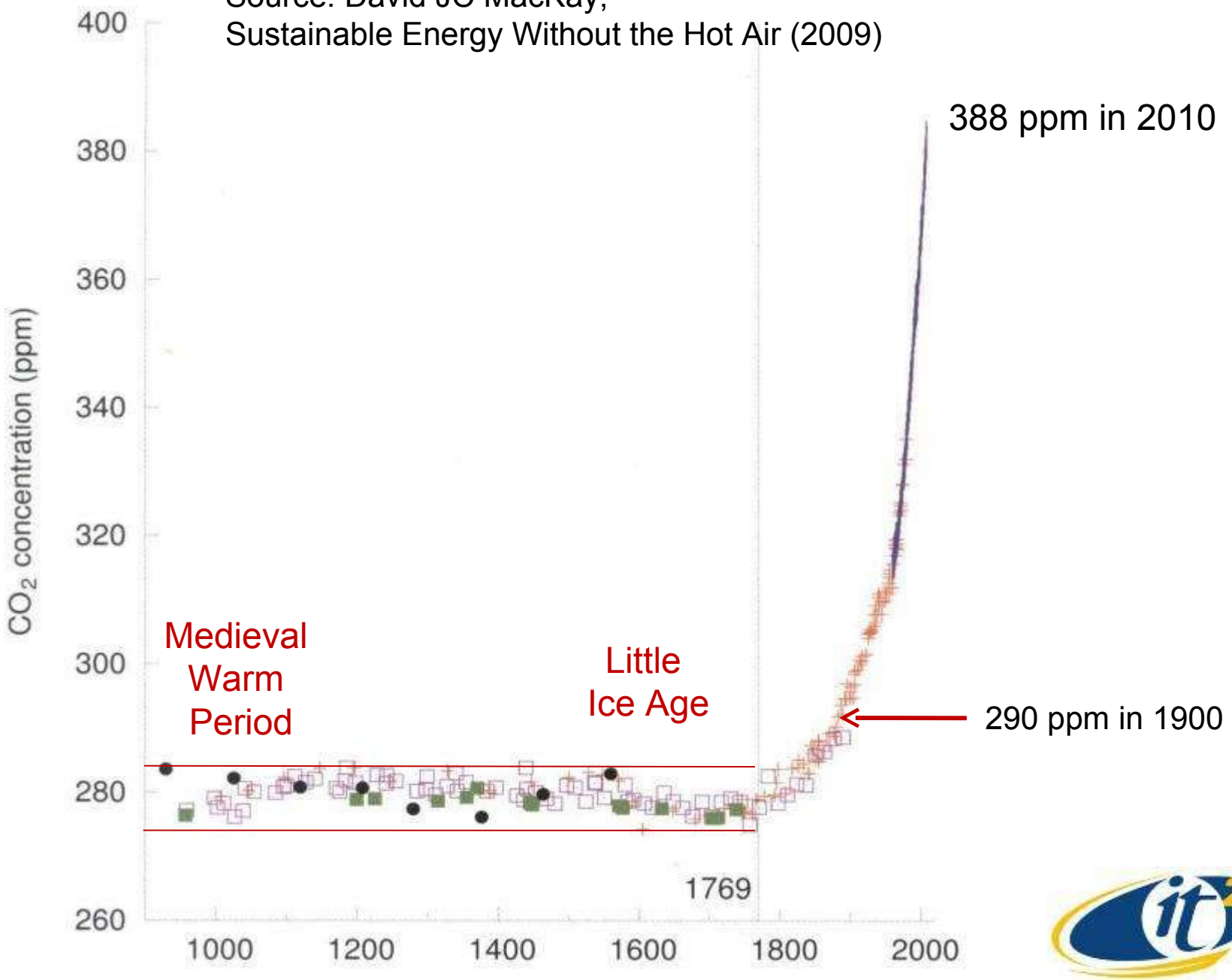
Abstract

Both the United States and Australian governments have recently backed away from putting through climate/energy legislation that would set up carbon markets. Greenhouse gas emissions continue to increase globally. I will review the potential for these increasing emissions to cause global climatic disruption, focusing specifically on the potential impacts for water and wildfires on Victoria and California. I will go over the radical changes on short time scales in the world's energy system which need to occur to prevent global temperatures from rising above 2 degrees centigrade over pre-industrial levels. There is still time to make these changes, but that time is running out...

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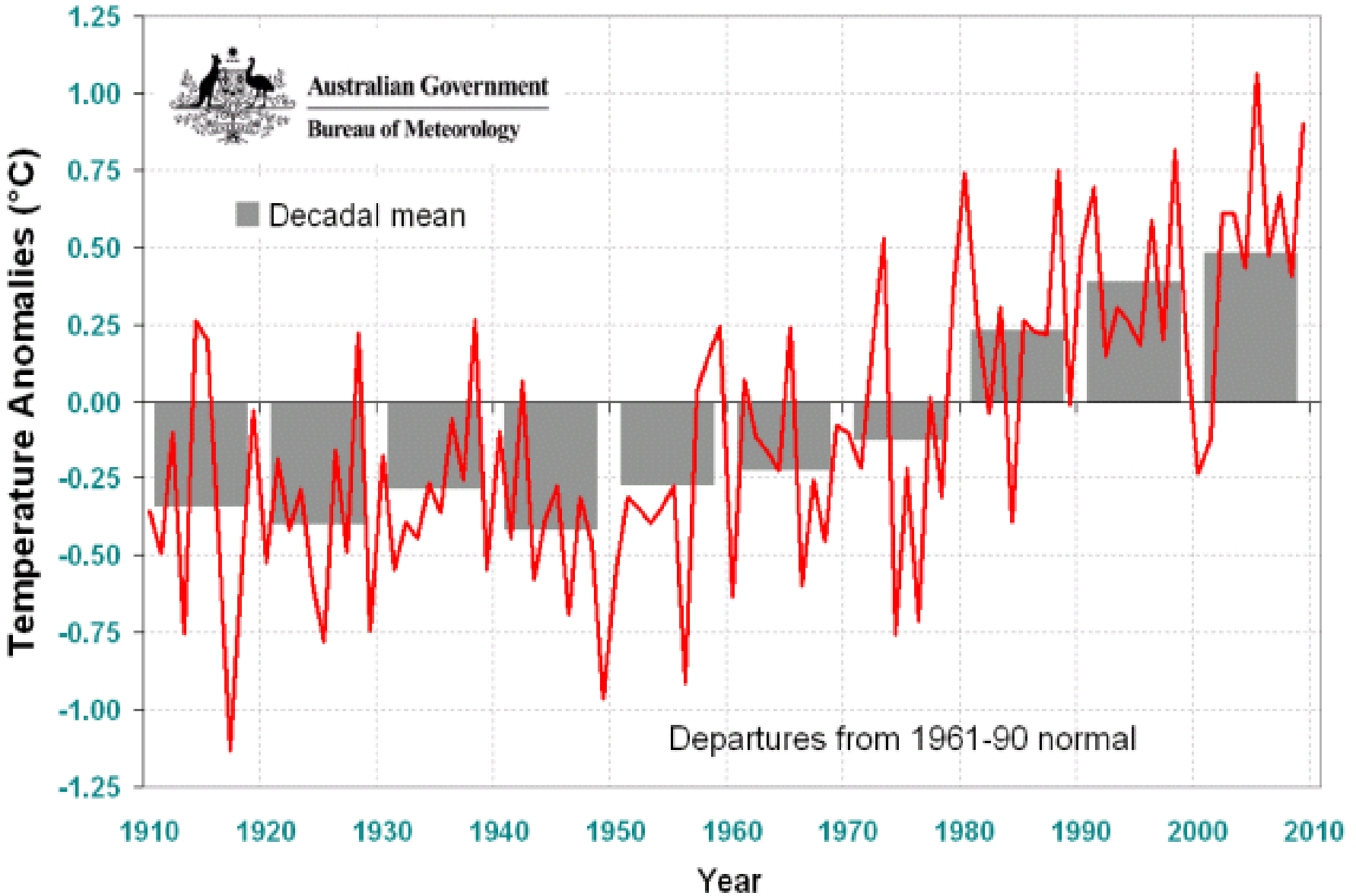
Rapid Increase in the Greenhouse Gas CO_2 Since Industrial Era Began

Source: David JC MacKay,
Sustainable Energy Without the Hot Air (2009)



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Annual and Decadal Mean Temperature Anomalies for Australia

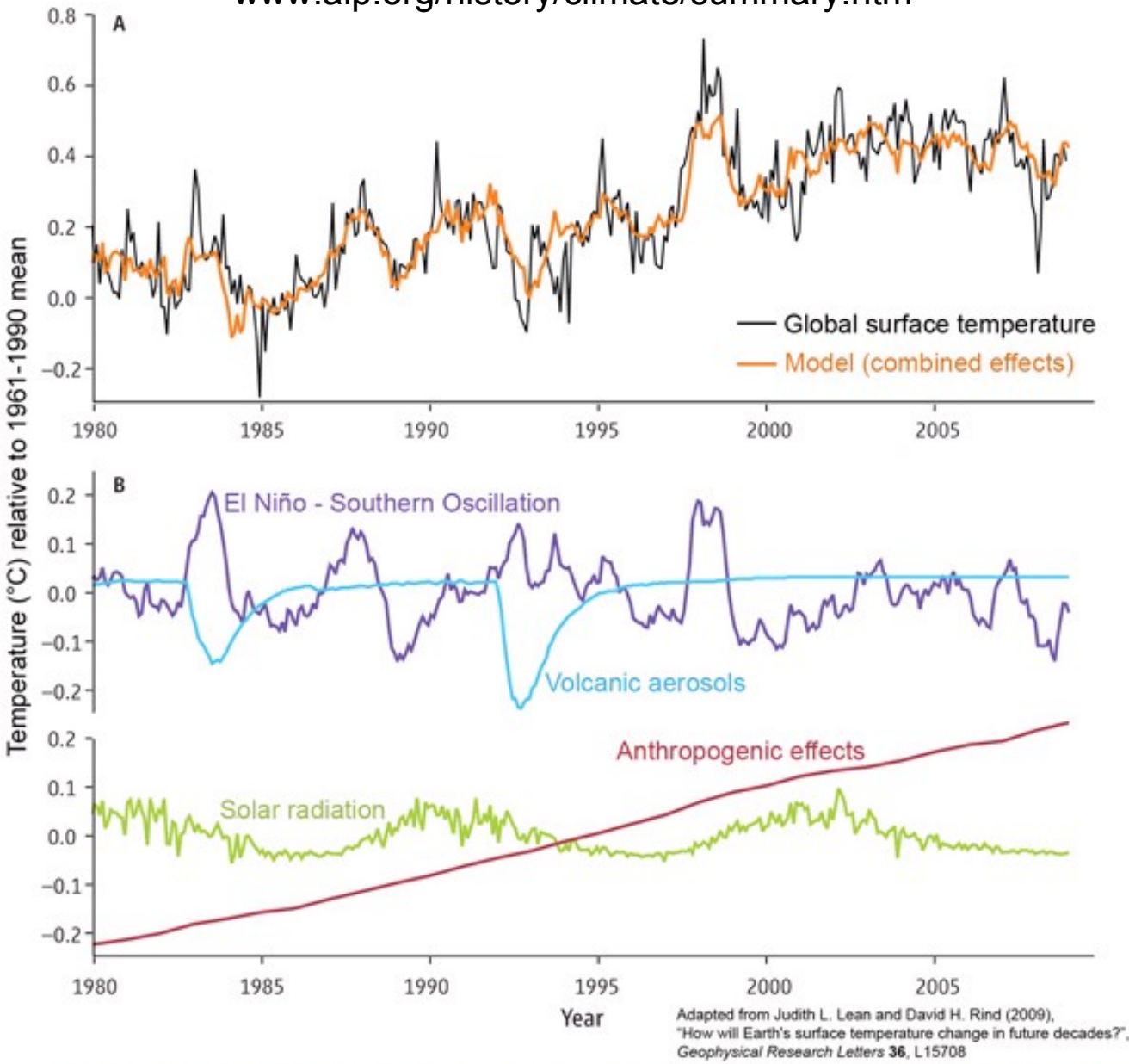


Five Decades of Mean Temperature Rise

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Climate Models Match Past Temperature Variations, Combining Both Natural and Anthropogenic Effects

www.aip.org/history/climate/summary.htm



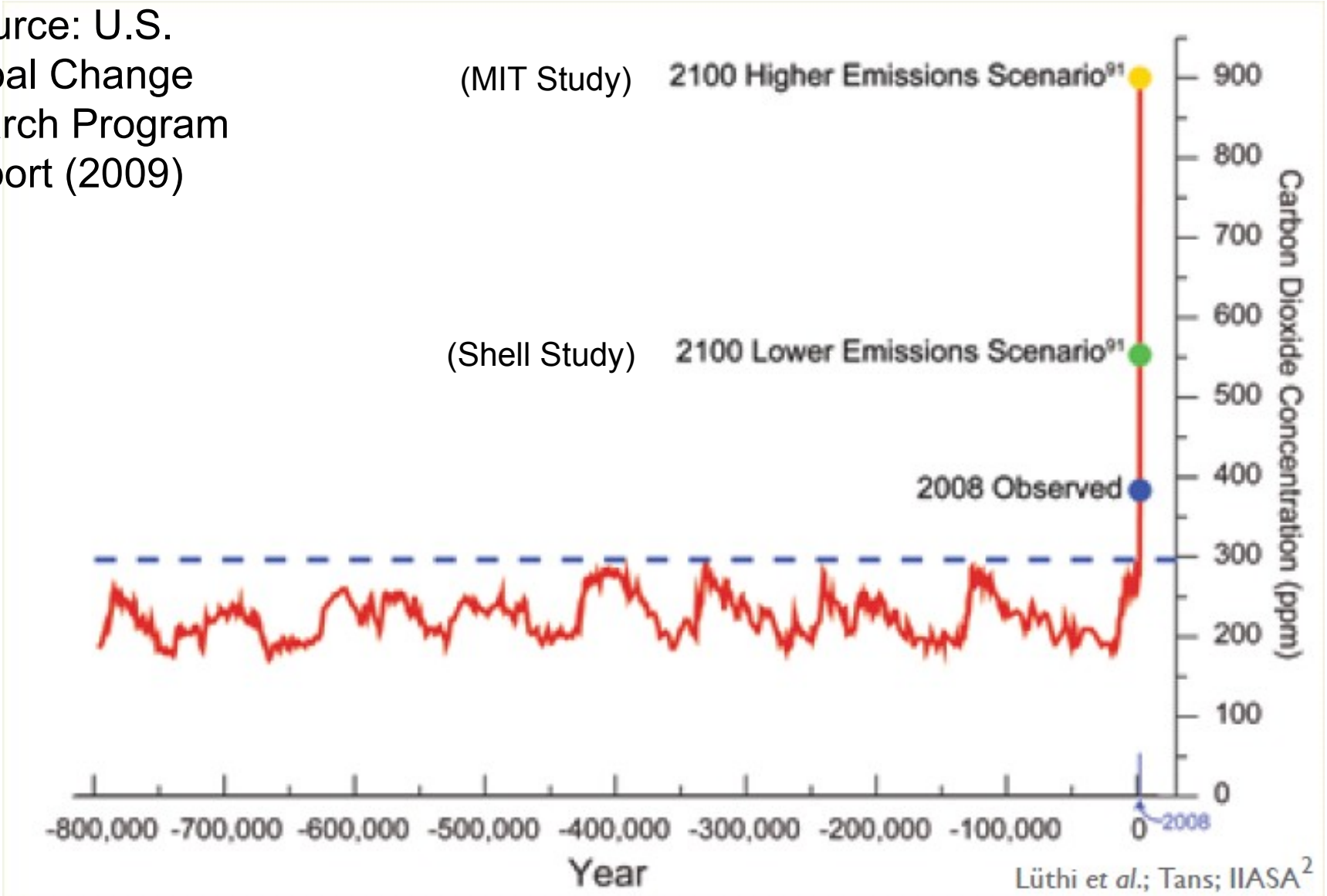
Adapted from Judith L. Lean and David H. Rind (2009), "How will Earth's surface temperature change in future decades?", *Geophysical Research Letters* **36**, L15708

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Atmospheric CO_2 Levels for 800,000 Years and Projections for the 21st Century

Source: U.S. Global Change Research Program Report (2009)

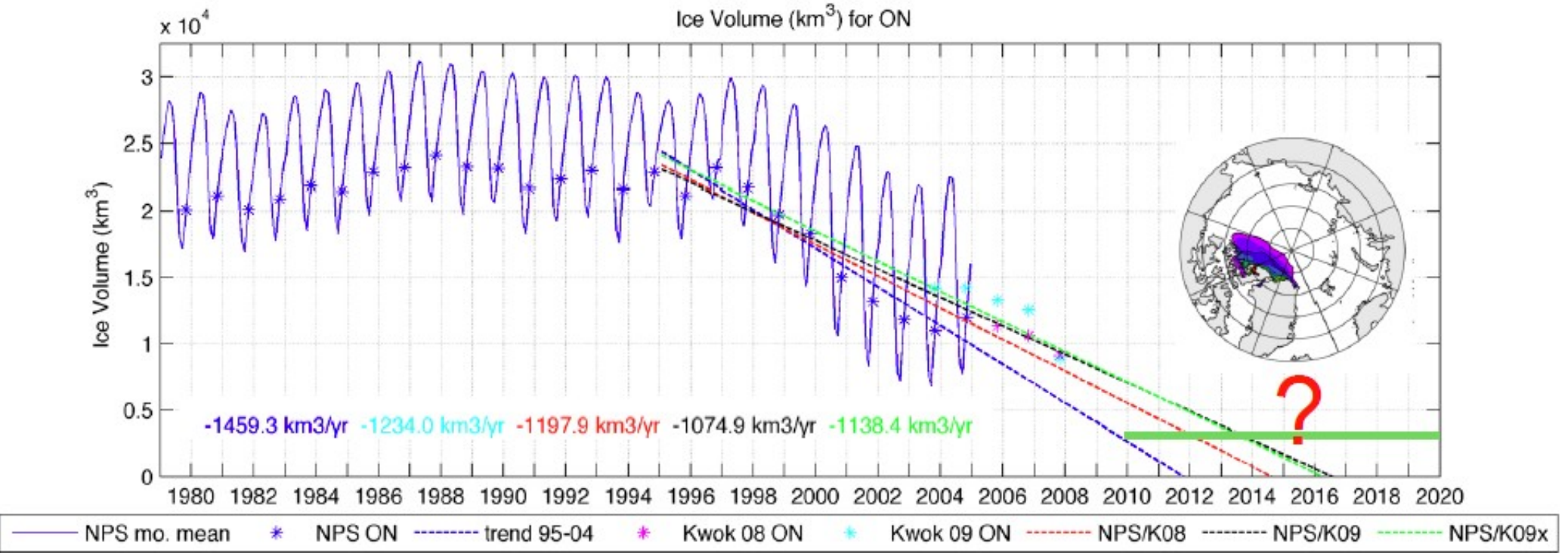


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www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/download-the-report

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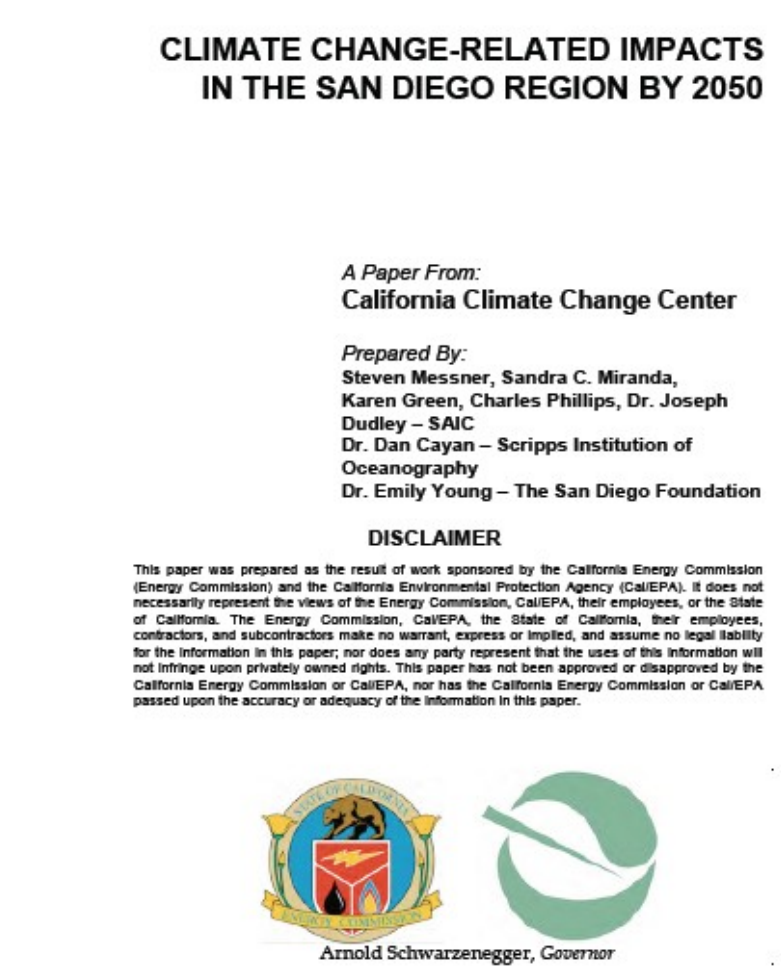
Summer Arctic Sea Ice Volume Shows Even More Extreme Melting—Ice Free by 2015?



Source: Wieslaw Maslowski
Naval Postgraduate School,
AAAS Talk 2010

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Climate Change Will Pose Major Challenges to California in Water and Wildfires



CLIMATE CHANGE-RELATED IMPACTS
IN THE SAN DIEGO REGION BY 2050

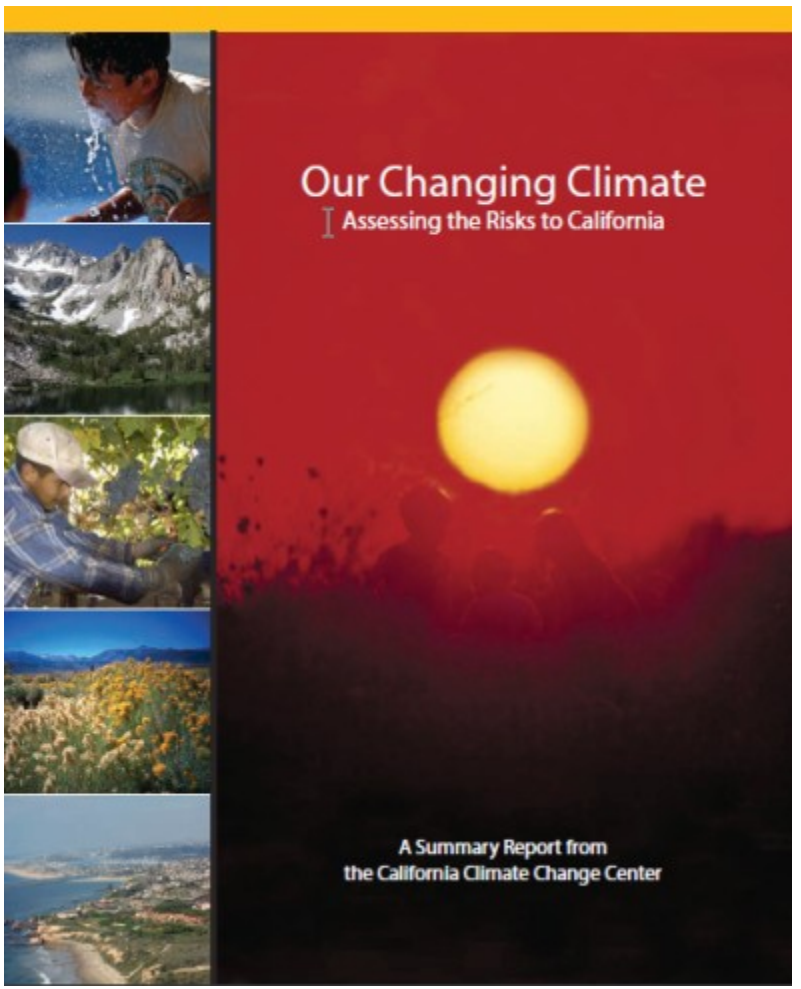
A Paper From:
California Climate Change Center

Prepared By:
Steven Messner, Sandra C. Miranda, Karen Green, Charles Phillips, Dr. Joseph Dudley – SAIC
Dr. Dan Cayan – Scripps Institution of Oceanography
Dr. Emily Young – The San Diego Foundation

DISCLAIMER

This paper was prepared as the result of work sponsored by the California Energy Commission (Energy Commission) and the California Environmental Protection Agency (Cal/EPA). It does not necessarily represent the views of the Energy Commission, Cal/EPA, their employees, or the State of California. The Energy Commission, Cal/EPA, the State of California, their employees, contractors, and subcontractors make no warrant, express or implied, and assume no legal liability for the information in this paper; nor does any party represent that the uses of this information will not infringe upon privately owned rights. This paper has not been approved or disapproved by the California Energy Commission or Cal/EPA, nor has the California Energy Commission or Cal/EPA passed upon the accuracy or adequacy of the information in this paper.

Arnold Schwarzenegger, *Governor*



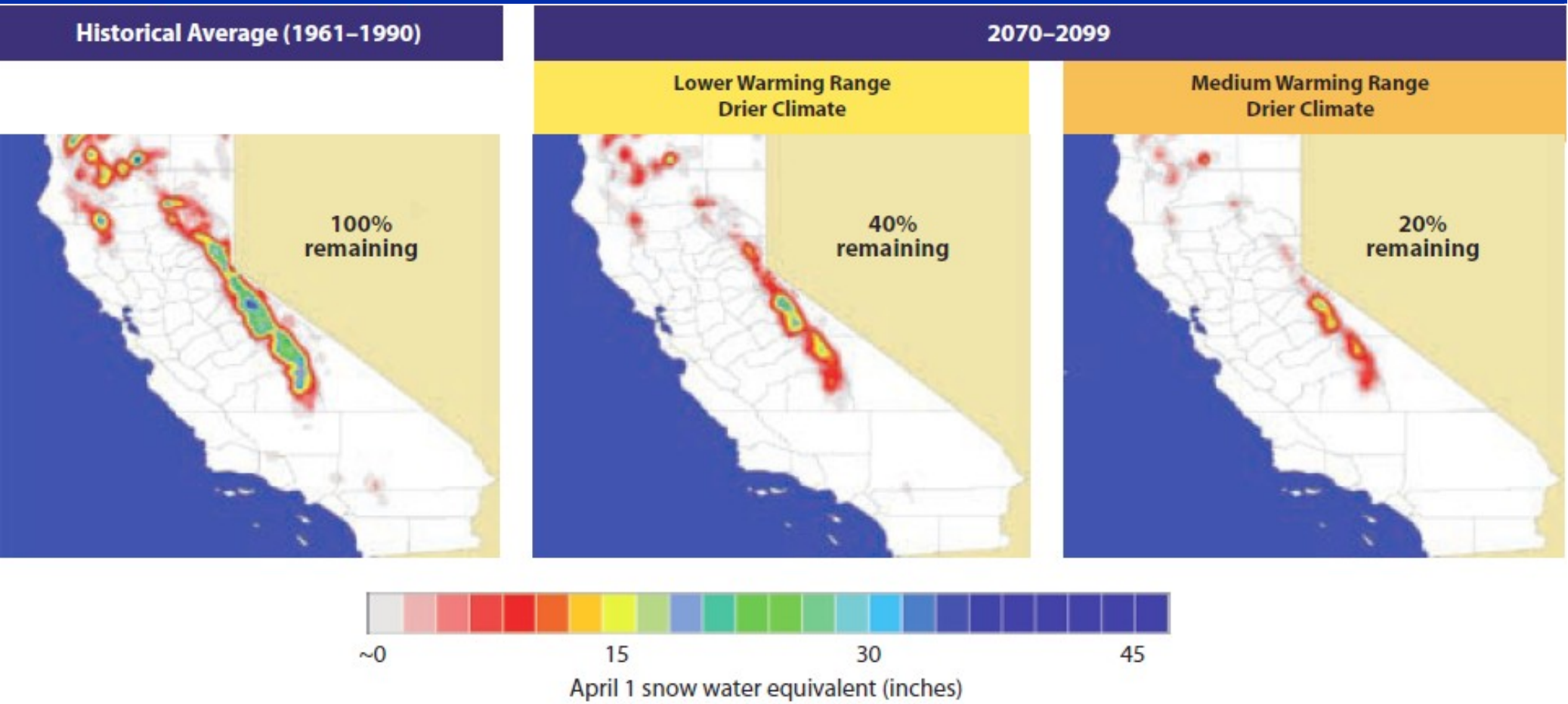
"It is likely that the changes in climate that San Diego is experiencing due to the warming of the region will increase the frequency and intensity of fires even more, making the region more vulnerable to devastating fires like the ones seen in 2003 and 2007."

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California Applications Program (CAP) & The California Climate Change Center (CCCC)
CAP/CCCC is directed from the Climate Research Division, Scripps Institution of Oceanography

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Climate Change May Reduce the Sierra Nevada Spring Snowpack by as Much as 60 to 80 percent



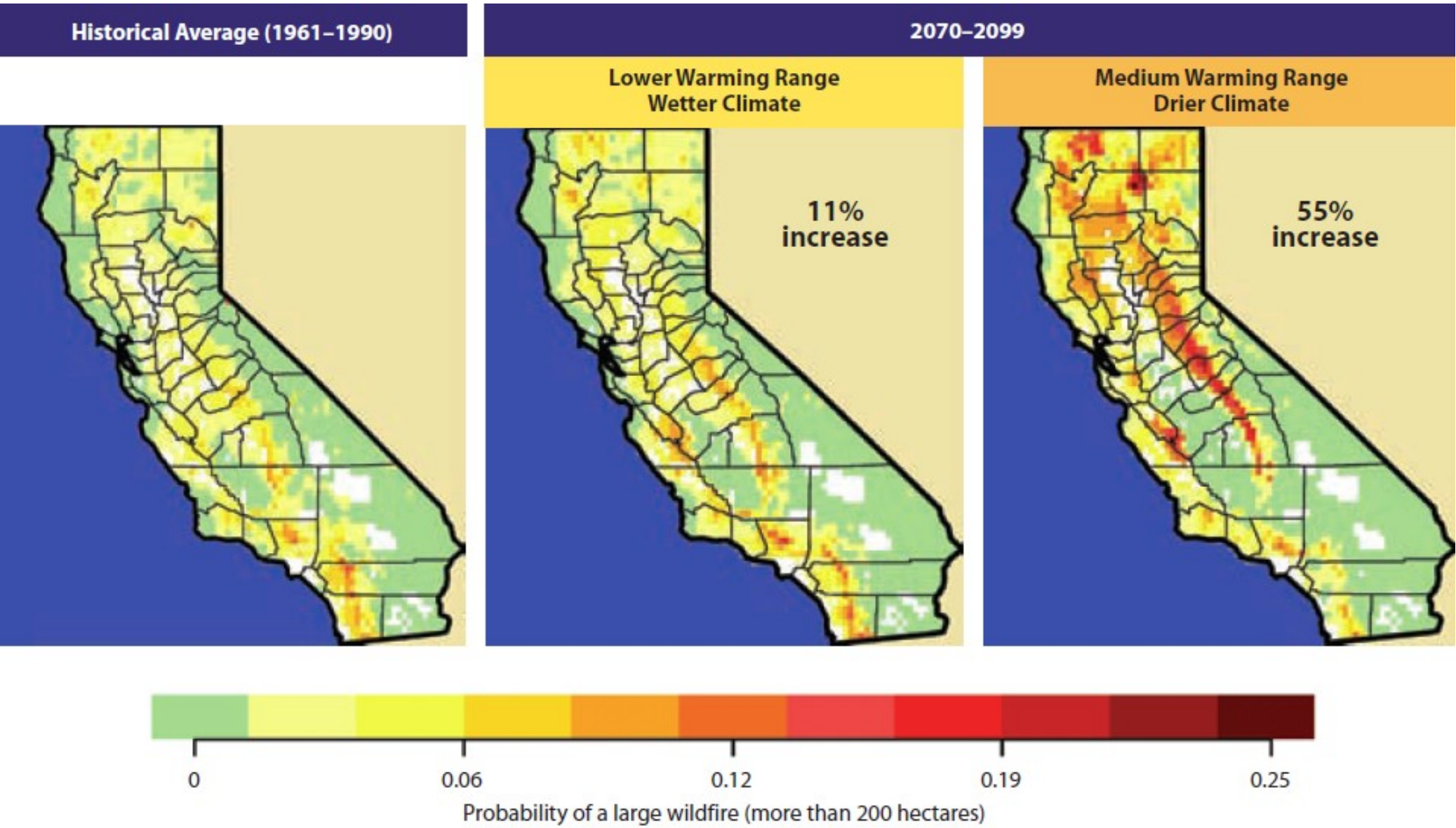
- **Loss of Snowpack Would:**
  - **Pose Challenges to Water Managers,**
  - **Hamper Hydropower Generation,**
  - **Nearly Eliminate Skiing And Other Snow-Related Recreational Activities**

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Source: http://meteora.ucsd.edu/cap/pdffiles/CA_climate_Scenarios.pdf

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Climate Change will Increase Greatly Increase the Probability of Large Wildfires in California



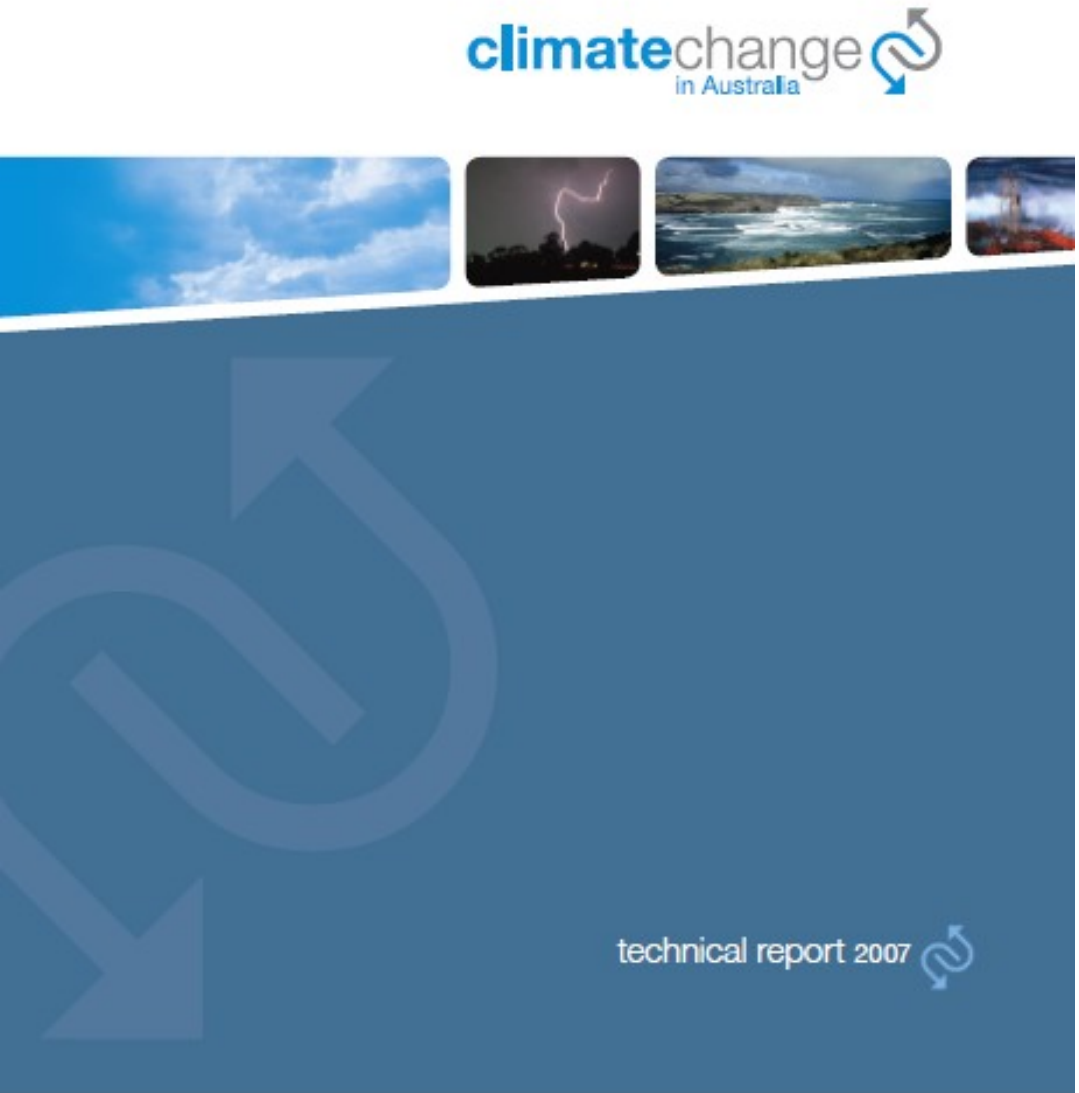
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Source: http://meteora.ucsd.edu/cap/pdffiles/CA_climate_Scenarios.pdf

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CSIRO Comprehensive Study of Past and Future Regional Climate Impacts on Australia

www.climatechangeinaustralia.gov.au/documents/resources/TR_Web_FrontmatterExecSumm.pdf

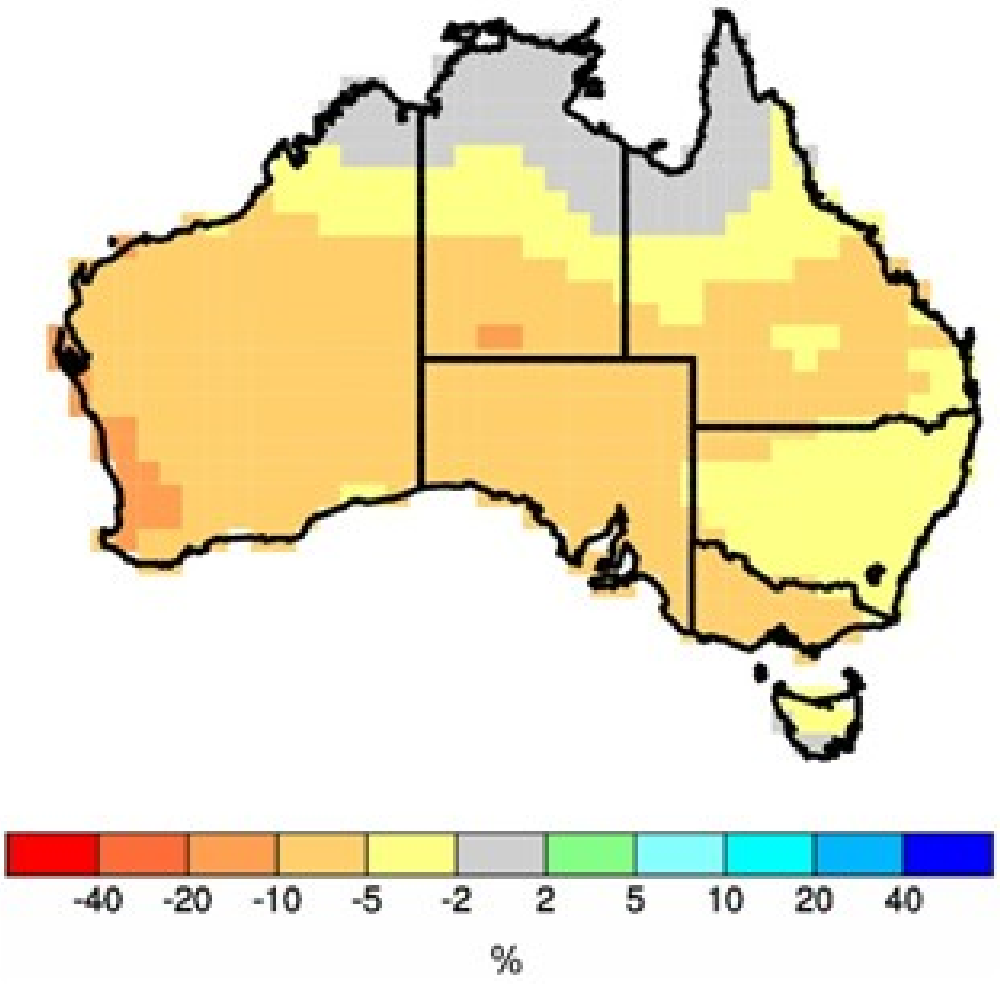


- **A substantial increase in fire weather risk is likely at most sites in southeastern Australia**
- **Drought occurrence is projected to increase over most of Australia, but particularly in south-western Australia**
- **Australian region studies indicate a likely increase in the proportion of the tropical cyclones in the more intense categories, but a possible decrease in the total number of cyclones**

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Australia Will Become Drier as Climate Change Unfolds

Predicted percentage change in annual rainfall by 2050, with respect to 1990 levels

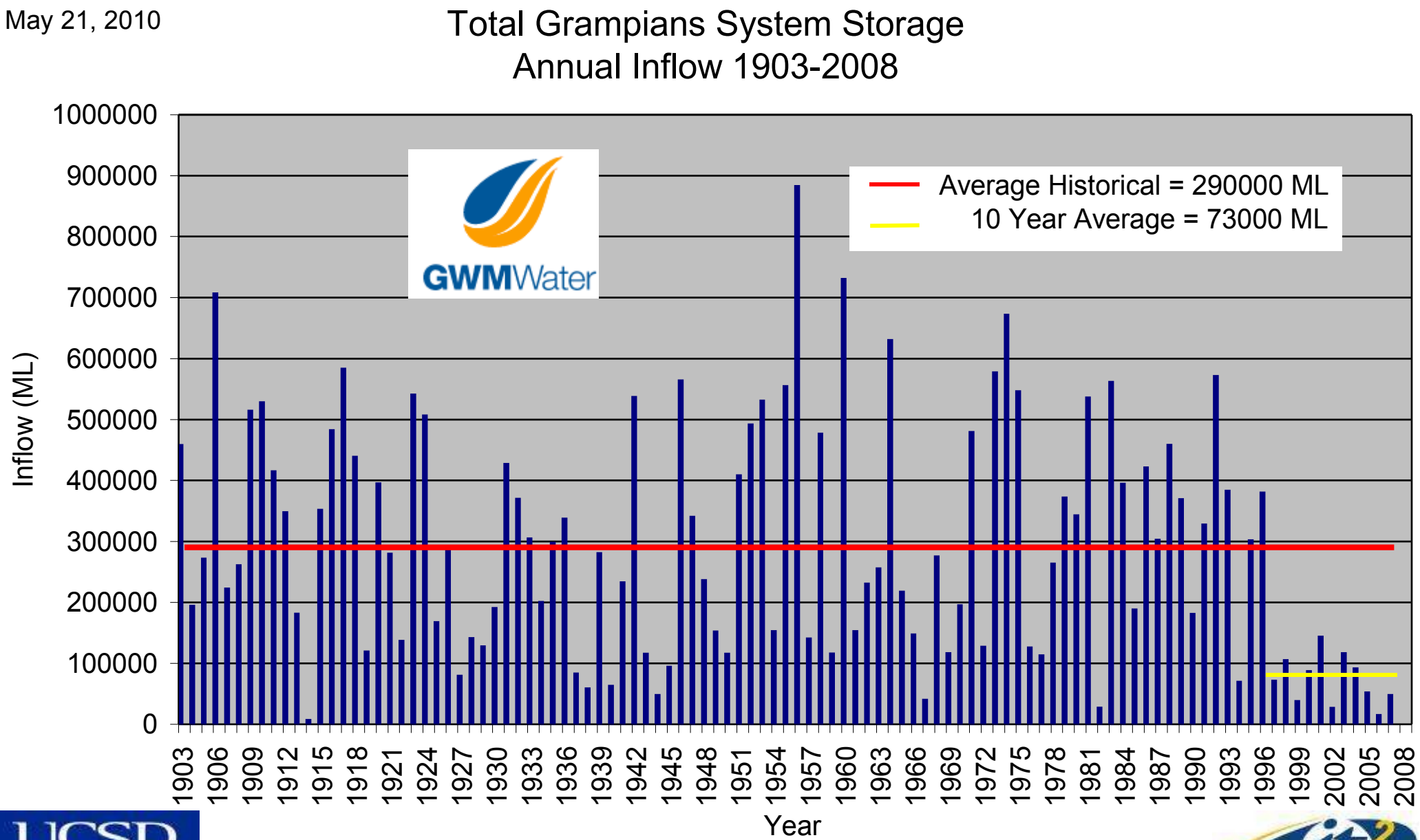


Source: Bureau of Meteorology and CSIRO, *Climate change in Australia* (2007)

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The Recent Drought is Unprecedented in the Last One Hundred Years

May 21, 2010



Source: Dr. Andrew Barton, Senior Water Resources Engineer. GWMWater

Climate Change Will Increase the Number of Extreme Forest Fire Days Per Year

Forest Fire Danger Index (FFDI)

Based on temperature, relative humidity, wind speed, drought, and fuel state

	2020		2050	
	Low global warming (0.4ºC)	High global warming (1ºC)	Low global warming (0.7ºC)	High global warming (2.9ºC)
Very high	+2-13%	+10-30%	+5-23%	+20-100%
Extreme	+5-25%	+15-65%	+10-50%	+100-300%

bushfire CRC

CSIRO

Very High FDDI > 25
Extreme FDDI > 50
Catastrophic FDDI > 100

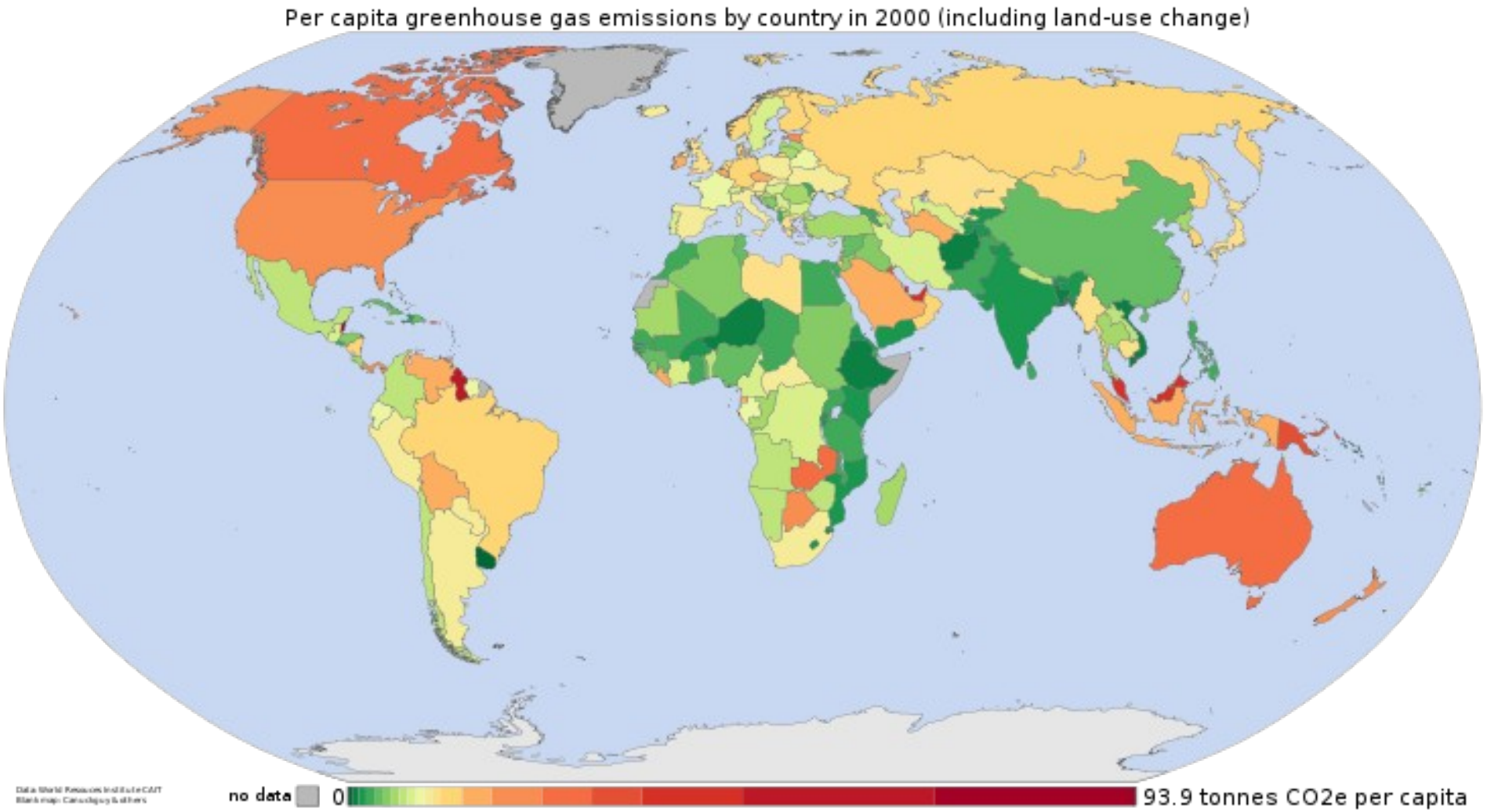
February 7, 2009 Victoria was 150-200!

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www.climateinstitute.org.au/images/stories/bushfire/fullreport.pdf

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Australia, the U.S., and Canada Share a Problem: Top 3 Developed Countries For Per Capita GHG Emission



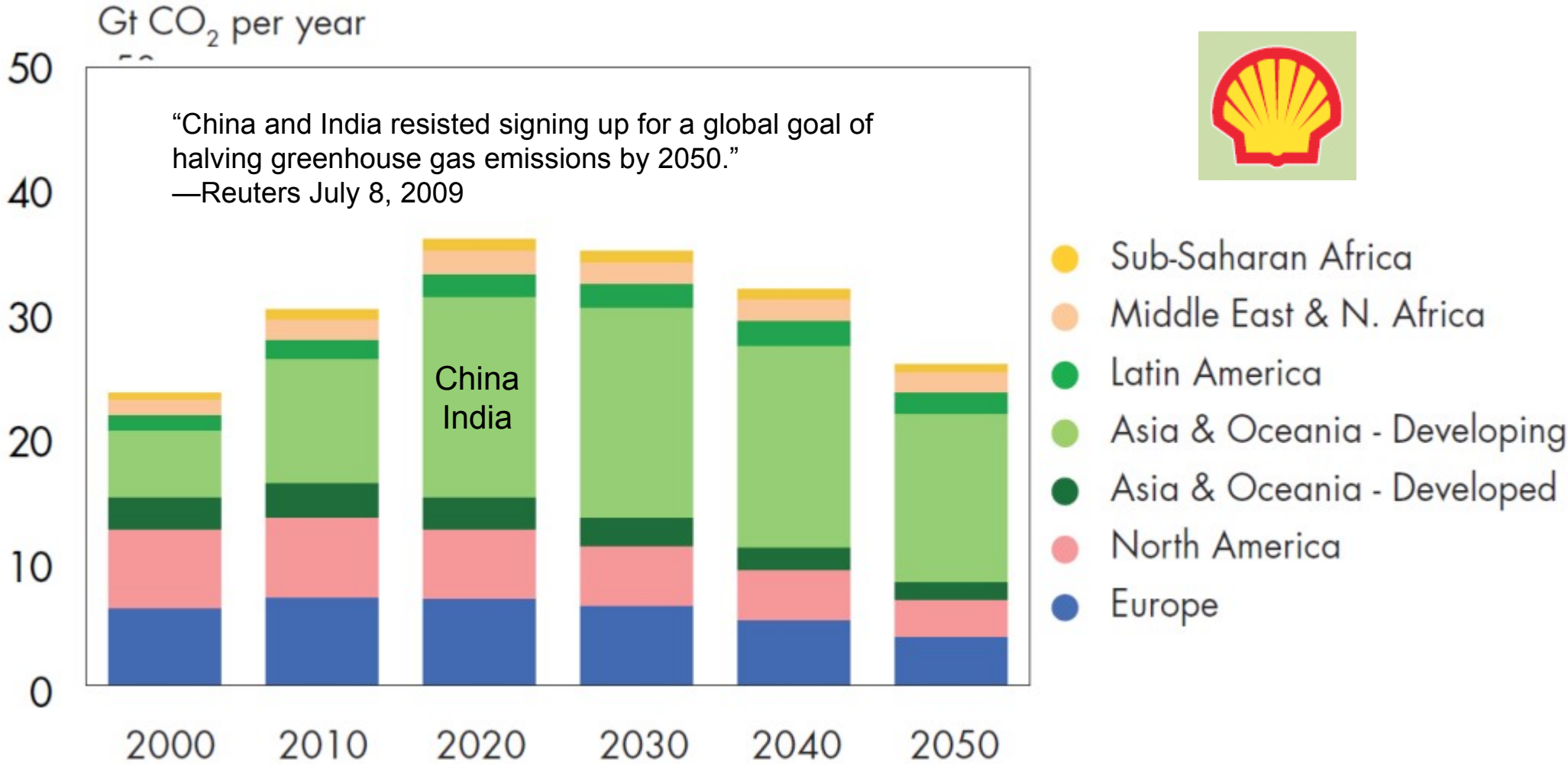
"Australia's Total Emissions Exceed Those of France and Italy"
--Australia Institute

http://en.wikipedia.org/wiki/File:GHG_per_capita_2000.svg

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Future Estimates of CO_2 Emissions From Energy: An Aggressive CO_2 Emission Reduction Scenario

www-static.shell.com/static/public/downloads/brochures/corporate_pkg/scenarios/shell_energy_scenarios_2050.pdf

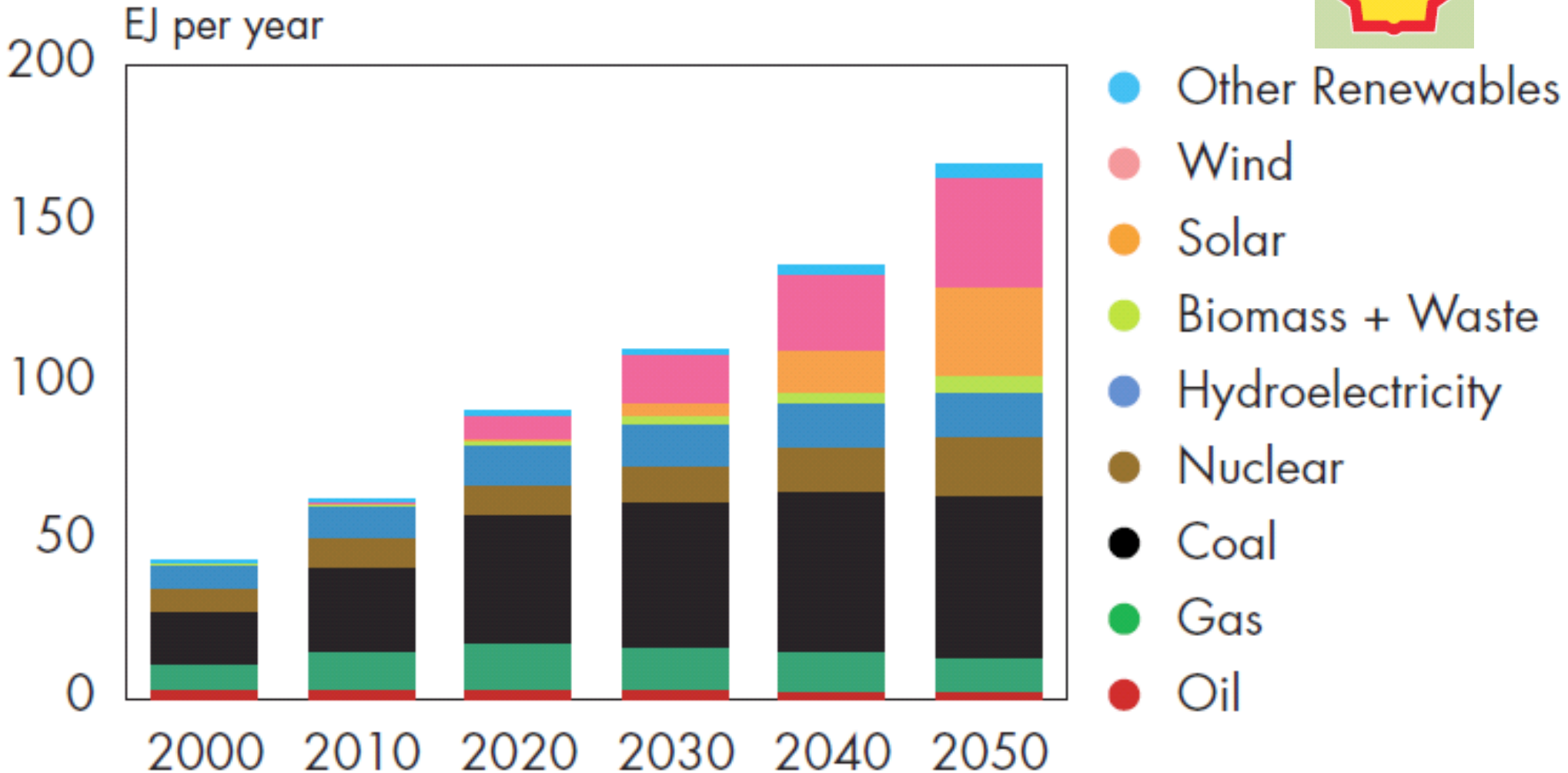


Estimated CO_2 Level in 2100 is 550ppm

Current CO_2 Level is 388 ppm

In Shell's "Blueprints" Scenario, 60% of Electricity is Generated by Renewables by 2050

90% of All OECD Coal and Gas Power Plants
Use Carbon Capture and Sequestration



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What Must the World Do To Limit CO_2-Equivalent Emissions Below 450ppm?



Limiting GHG concentrations to 450 ppm CO_2-equivalent is expected to limit temperature rises to no more than 2°C above pre-industrial levels. This would be extremely challenging to achieve, requiring an explosive pace of industrial transformation going beyond even the aggressive developments outlined in the Blueprints scenario.

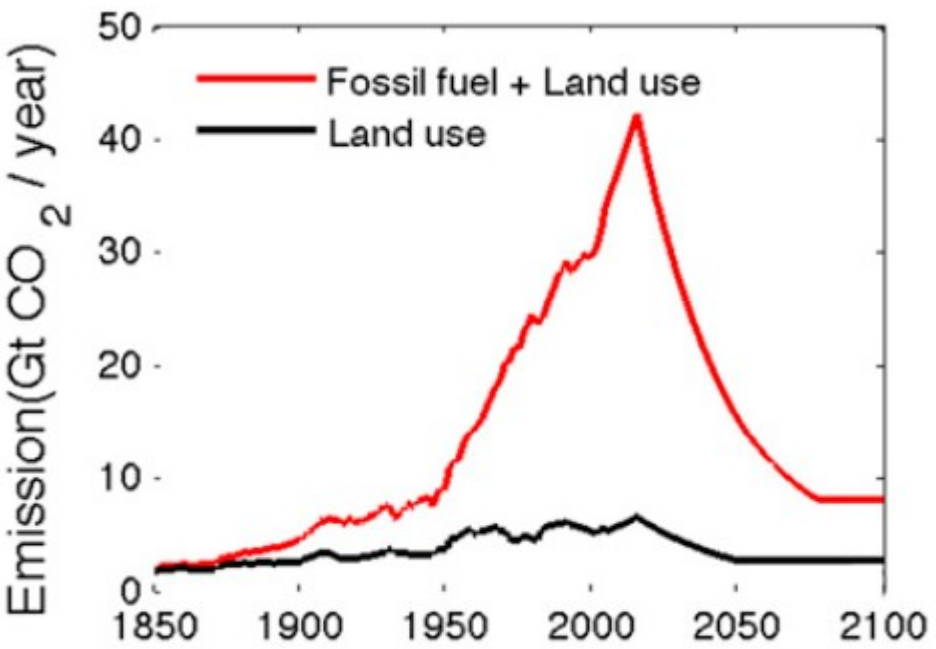
It would require global GHG emissions to peak before 2015, a zero-emission power sector by 2050 and a near zero-emission transport sector in the same time period…

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Urgent Actions Required to Limit Global Warming to Less Than 2 Degrees Centigrade

- **Three Simultaneous Actions**
  - **Reduce Annual CO_2 Emissions 50% by 2050—Keep CO_2 Concentration Below 441 ppm**
  - **Balance Removing Cooling Aersols by Removing Warming Black Carbon and Ozone**
  - **Greatly Reduce Emissions of Short-Lived GHGs-Methane and Hydrofluorocarbons**
- **Alternative Energy Must Scale Up Very Quickly**
- **Carbon Sequestration Must be Widely Used for Coal**



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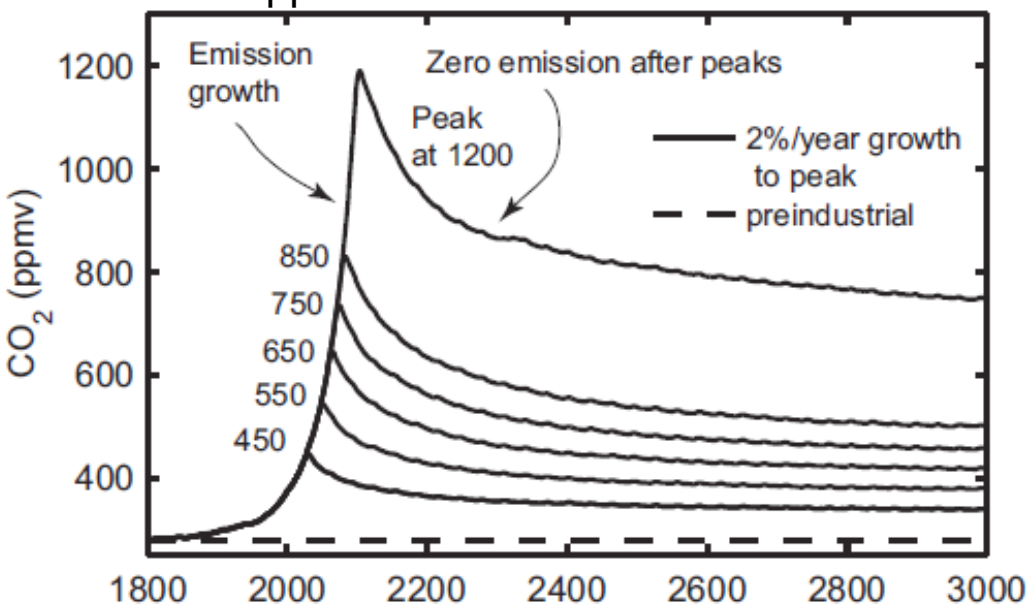
"The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues," PNAS, v. 107, 8055-62 (May 4, 2010)
V. Ramanathan and Y. Xu, Scripps Institution of Oceanography, UCSD

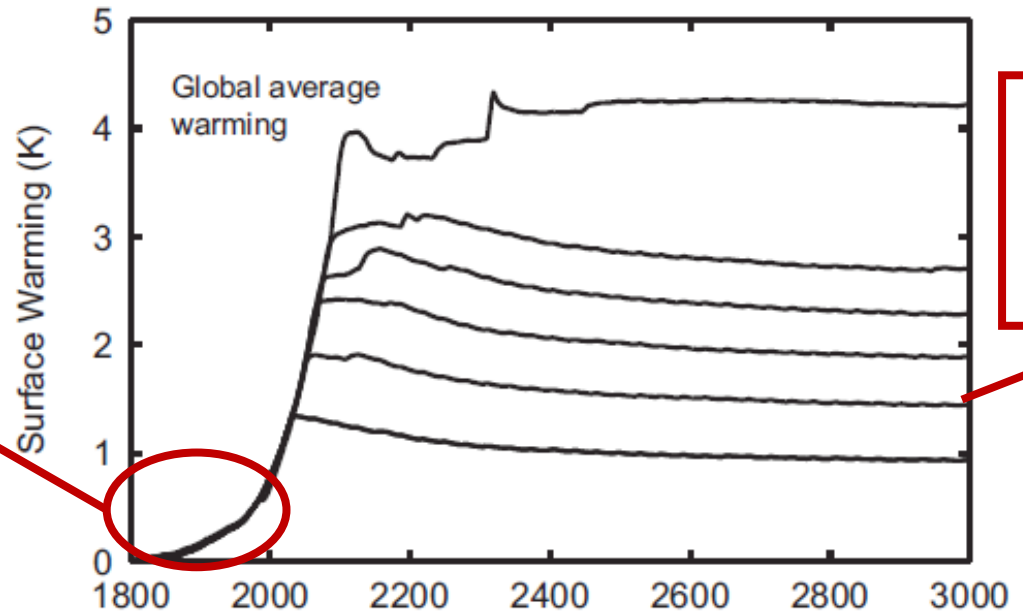
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We Are Transitioning to a New Climate State -- Unlike the Rapid Recovery with Acid Rain or Ozone Hole

Susan Solomon, et al., PNAS 2/10/2009 v. 106 pp1704-9

Assumes
CO_2 Increases
to a Maximum
and Then Emissions
Abruptly Stop



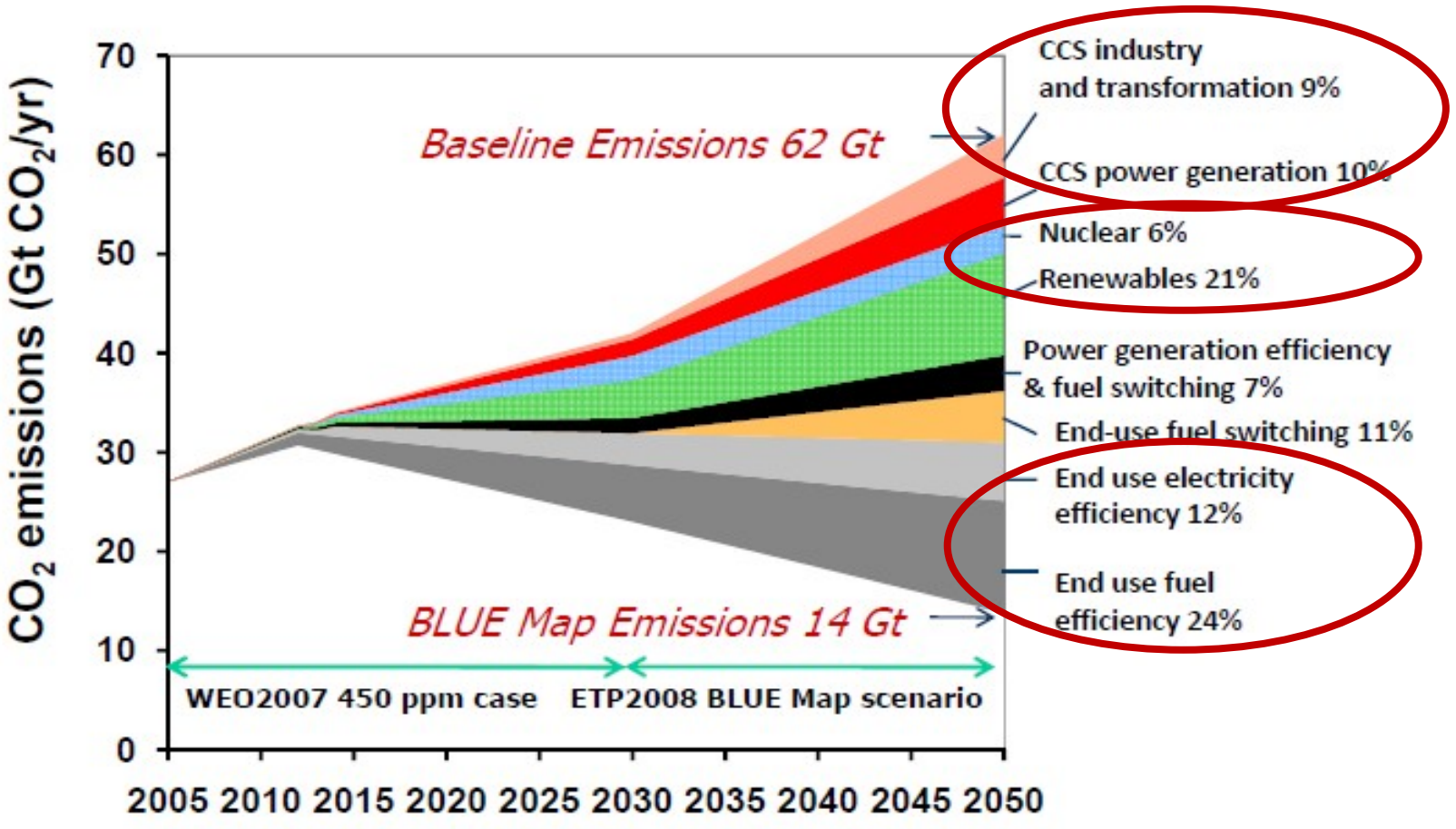


Warming During the Industrial Age -- Last 200 Years

Warming Persists for Over 1000 Years

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To Cut Energy Related CO_2 Emissions 50% by 2050 Requires a Radically Different Energy System



IEA "Blue" Scenario

ENERGY TECHNOLOGY PERSPECTIVES 2008

Scenarios & Strategies to 2050

INTERNATIONAL ENERGY AGENCY

In support of the G8 Plan of Action

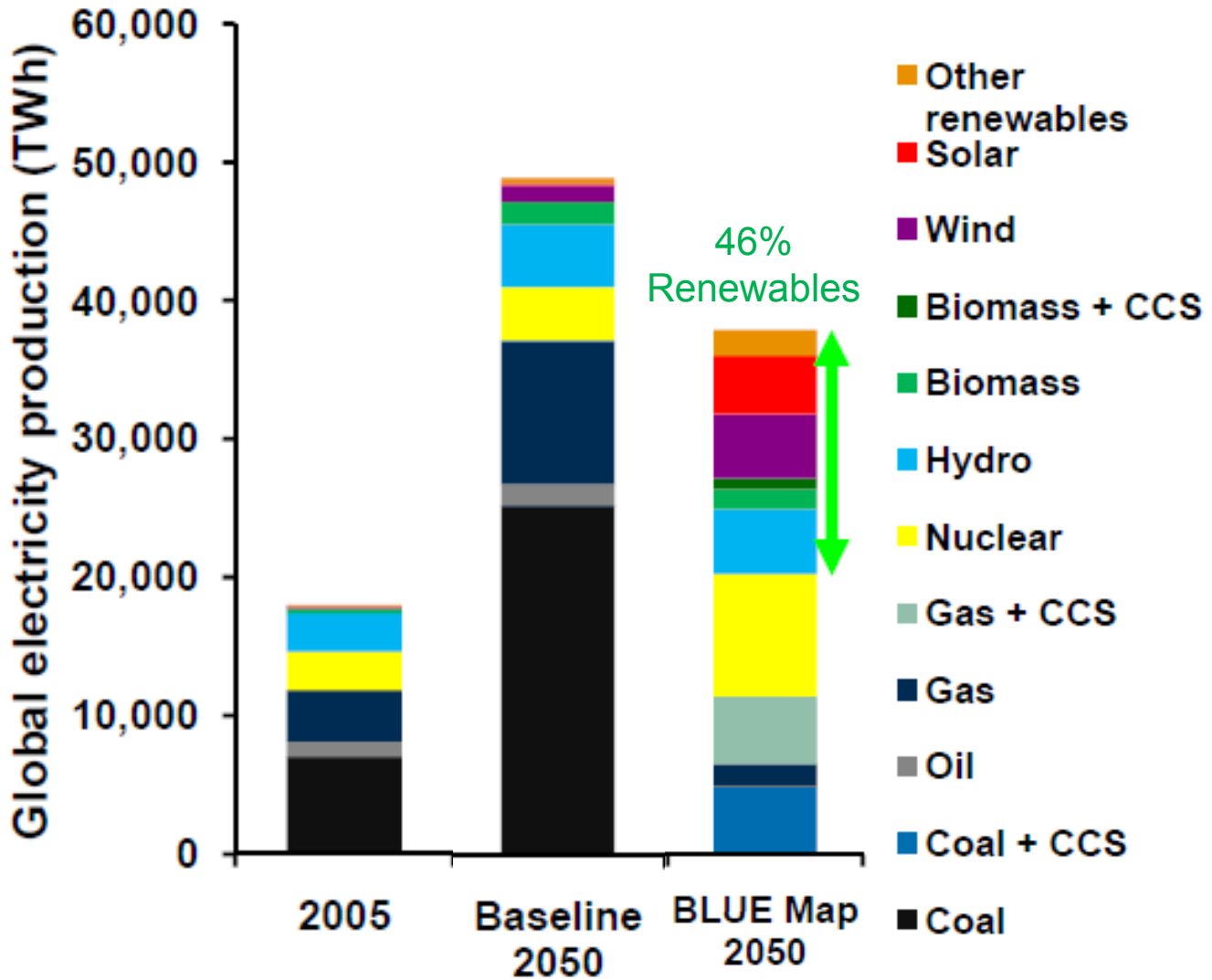
© OECD/IEA - 2008

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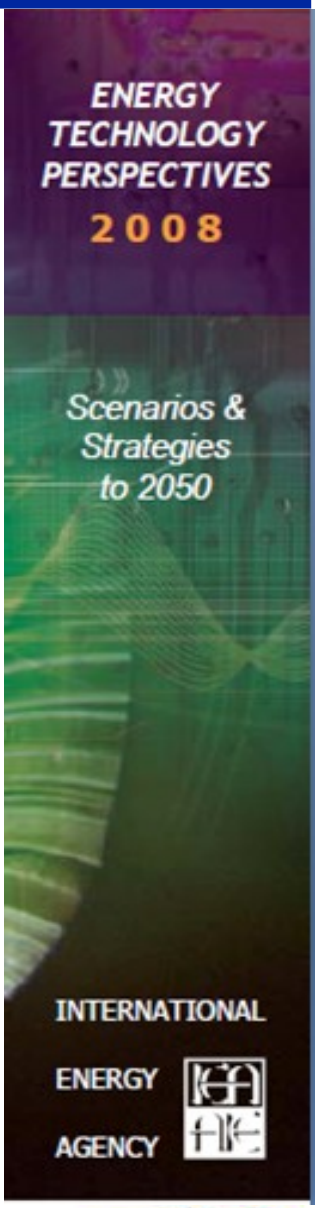
Focus on Negawatts, Renewables, CCS

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Global Electricity Production Power Generation Mix – Comparing Business as Usual with IEA Blue Scenario



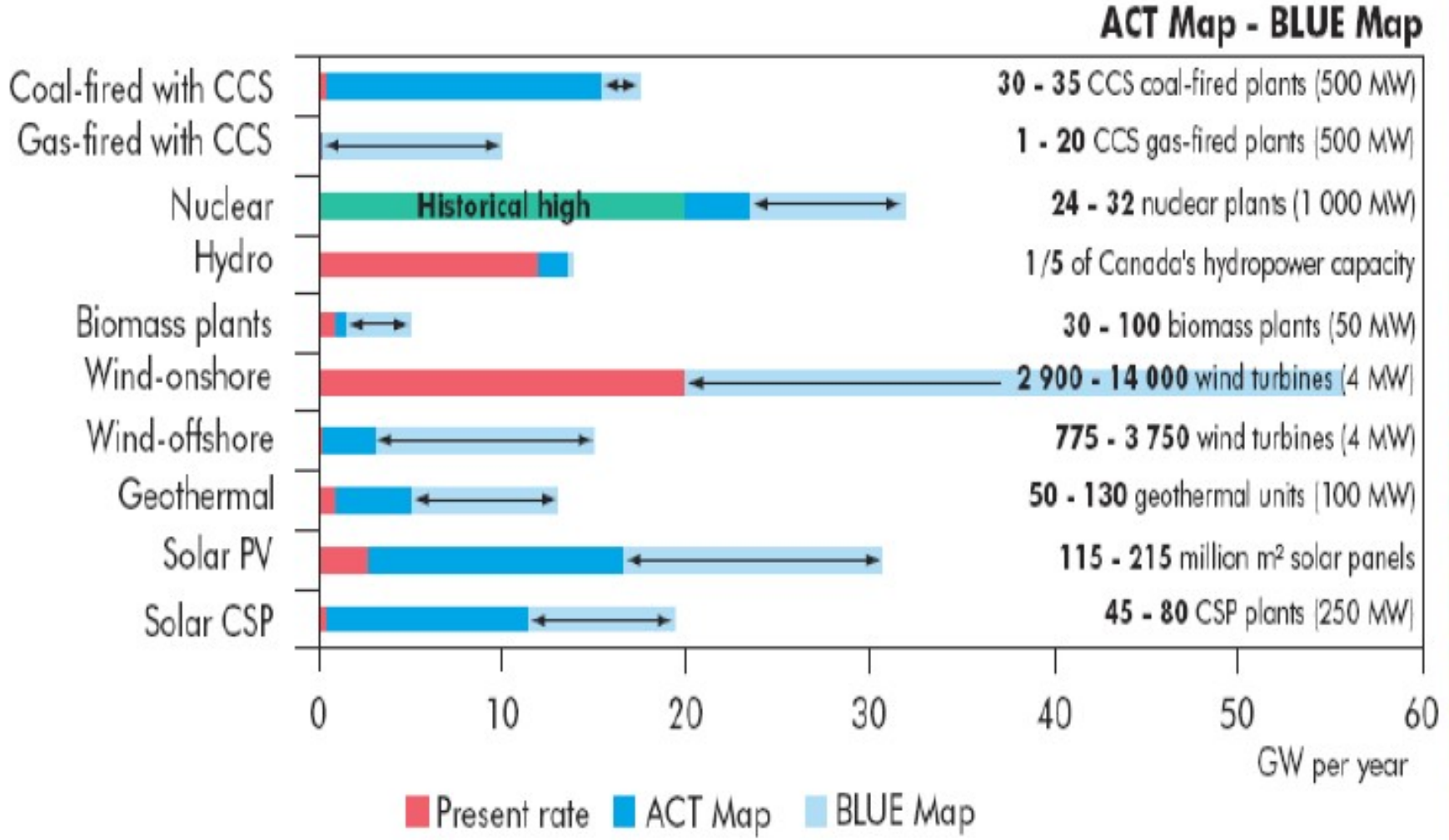
Eliminate Coal Use Without CCS, Scale Up Renewables



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Average Annual Power Generation 2010 – 2050
Energy Capacity Additions--An Energy Revolution!



ENERGY TECHNOLOGY PERSPECTIVES 2008

Scenarios & Strategies to 2050

INTERNATIONAL ENERGY AGENCY

In support of the G8 Plan of Action

© OECD/IEA - 2008

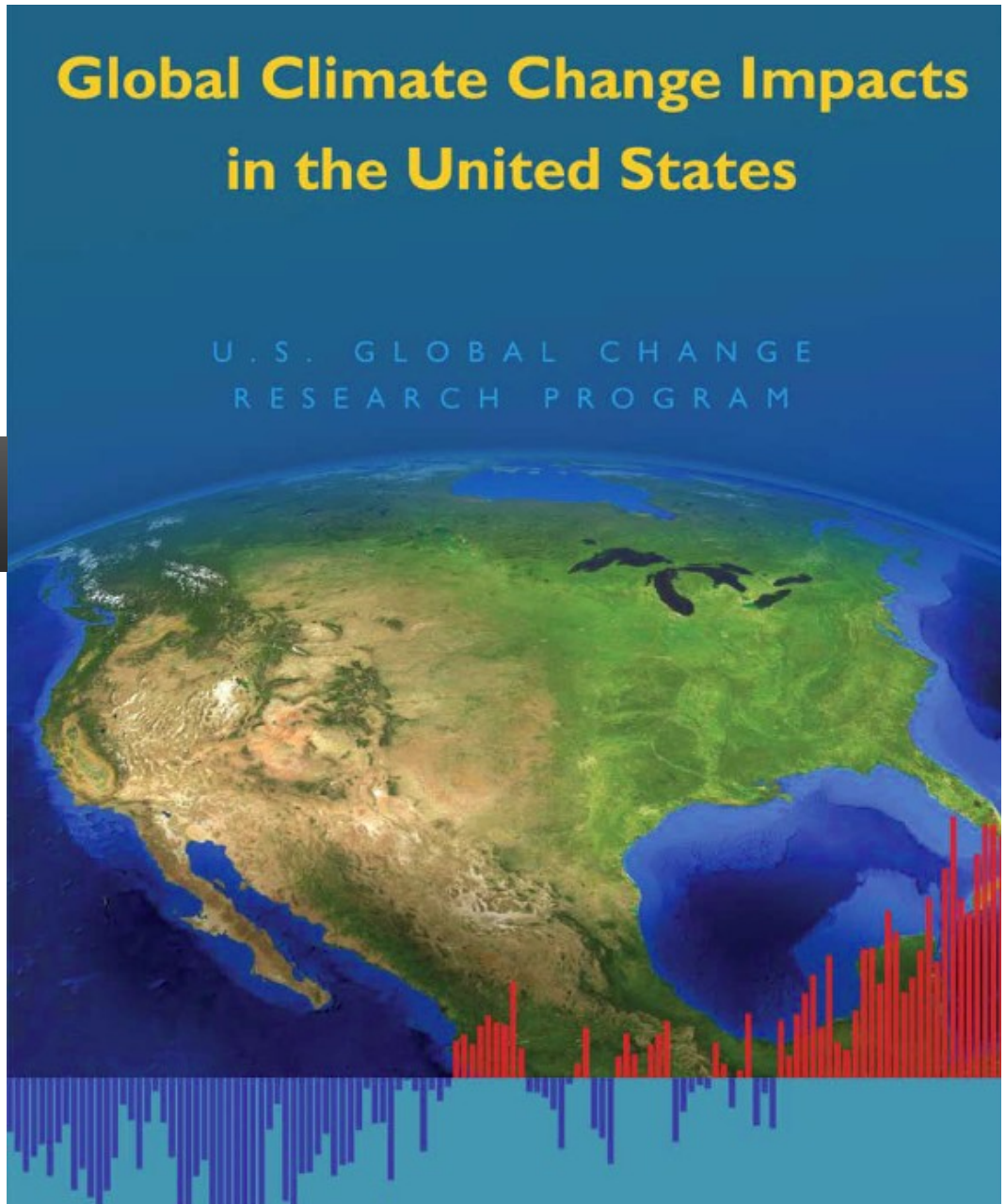
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Accelerate CCS, Solar, and Wind

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“So, choices about how we manage greenhouse gas emissions will have far-reaching consequences for climate change impacts.”

www.globalchange.gov/publications/reports/scientific-assessments/us-impacts



United States Global Change Research Program

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United States and Australia Are Retreating From Passing Carbon Legislation

OPINION ASIA | APRIL 29, 2010, 8:51 P.M. ET

Cap and Trade Loses in Australia

The Rudd government bows to political reality.

Oil spill may kill cap and trade legislation

May 3, 10:18 PM ▪ Global Warming Examiner ▪ John Ryden

Did a climate bill just get less likely?



Editorial: Climate bill would strangle economic recovery

The Detroit News

National Academy of Sciences urges pricier coal, oil

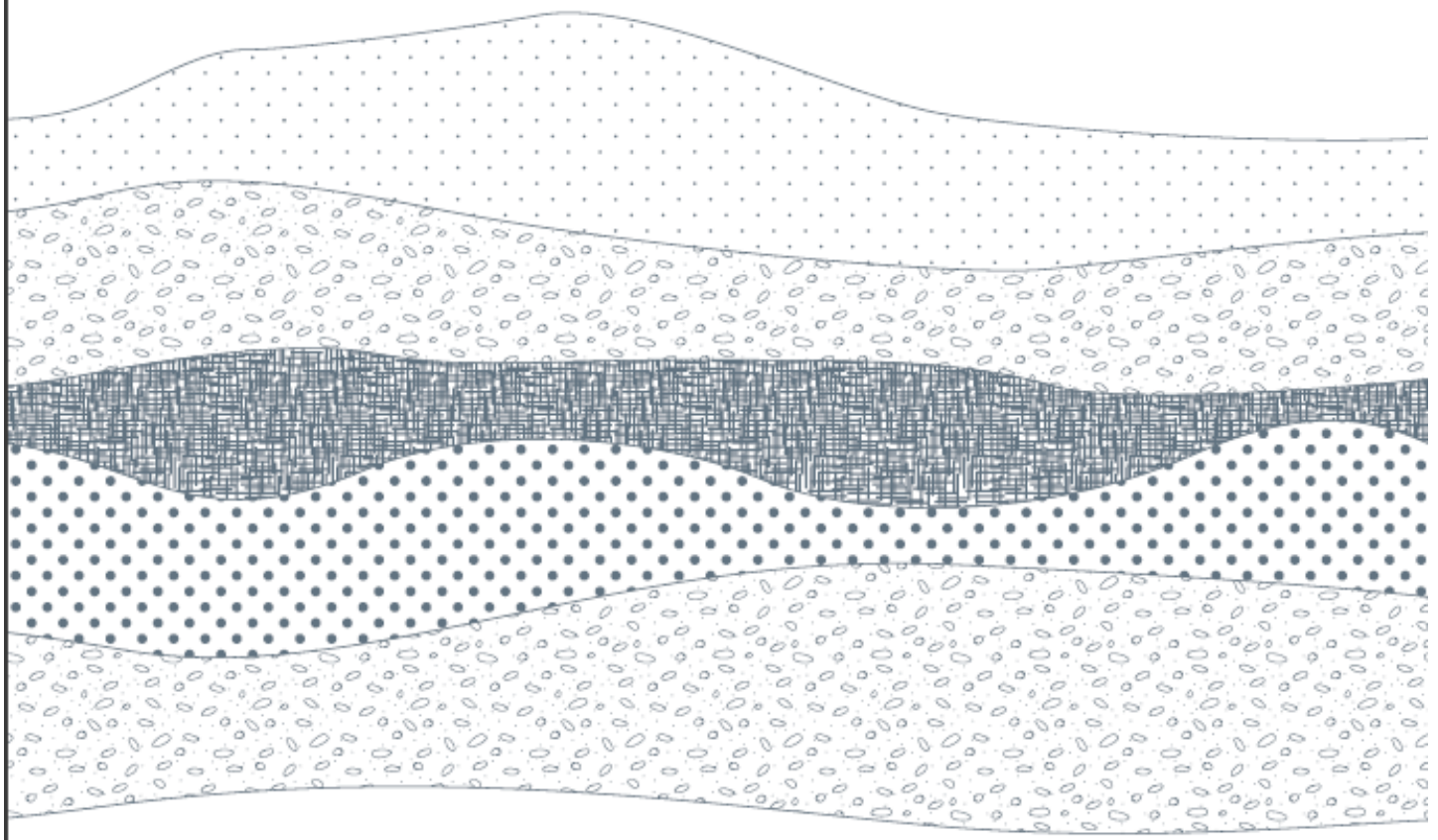
12:00 AM CDT on Thursday, May 20, 2010

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Australia is a Leader in Accelerating Commercial Deployment of Carbon Capture and Sequestration

GLOBAL CCS INSTITUTE



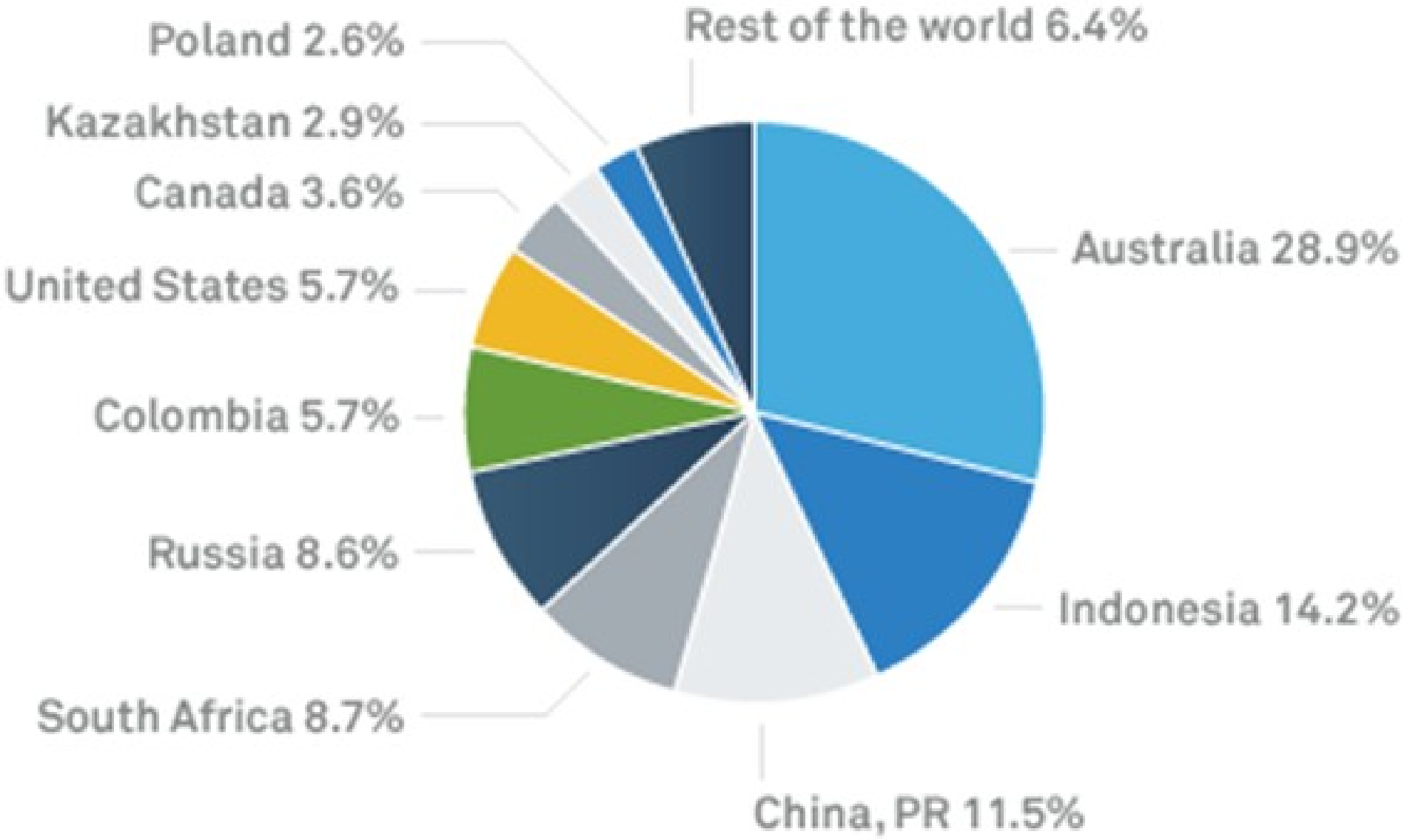
ACCELERATING CCS

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www.globalccsinstitute.com

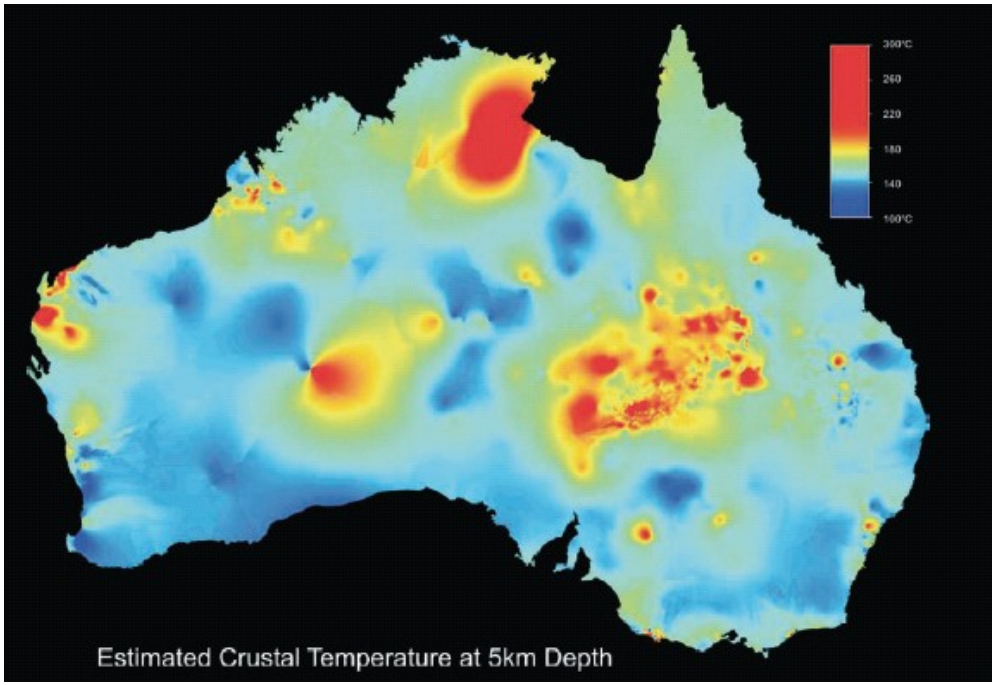
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Australia is the World's Leading Coal Exporter – Couple Coal CCS Technology to This Export Market?



Source: IEA Key World Energy Statistics - 2004 and 2005 editions.
www.australiancoal.com.au/the-australian-coal-industry_coal-exports.aspx

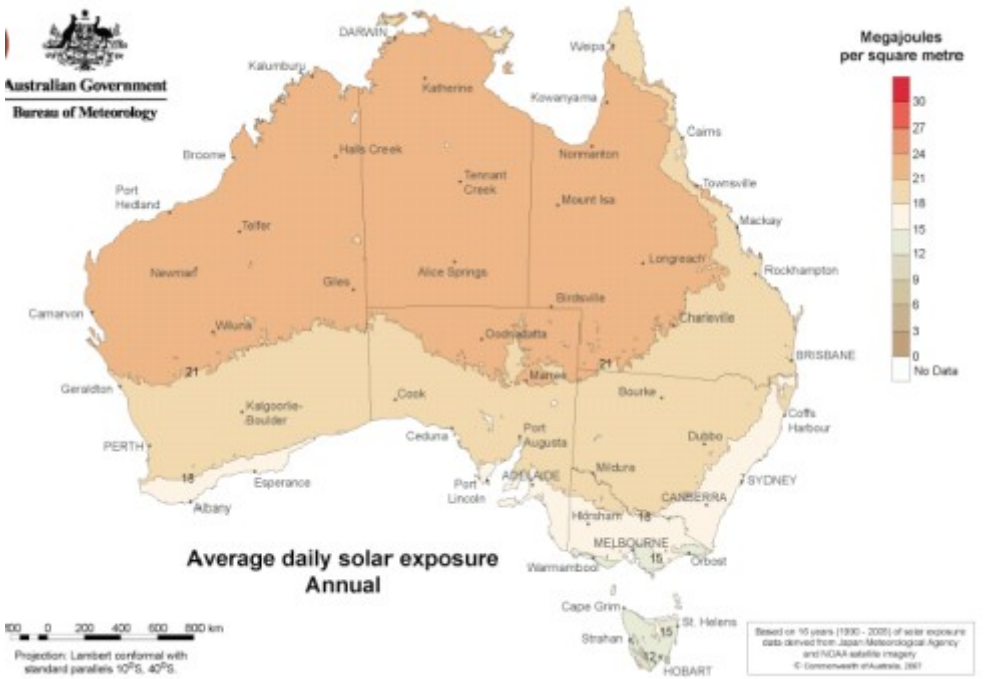
Australia—the Zero Carbon Energy Future



Temperatures at 5 km.
After Budd et al. Australian Geothermal Energy Conference 2008

Placing a data centre at the zero carbon energy source -- the cost of fibre optic cable is ~5-10% the cost of electricity transmission.

A Fiber/HVDC Smart Grid Flows Both Bits and Electrons!



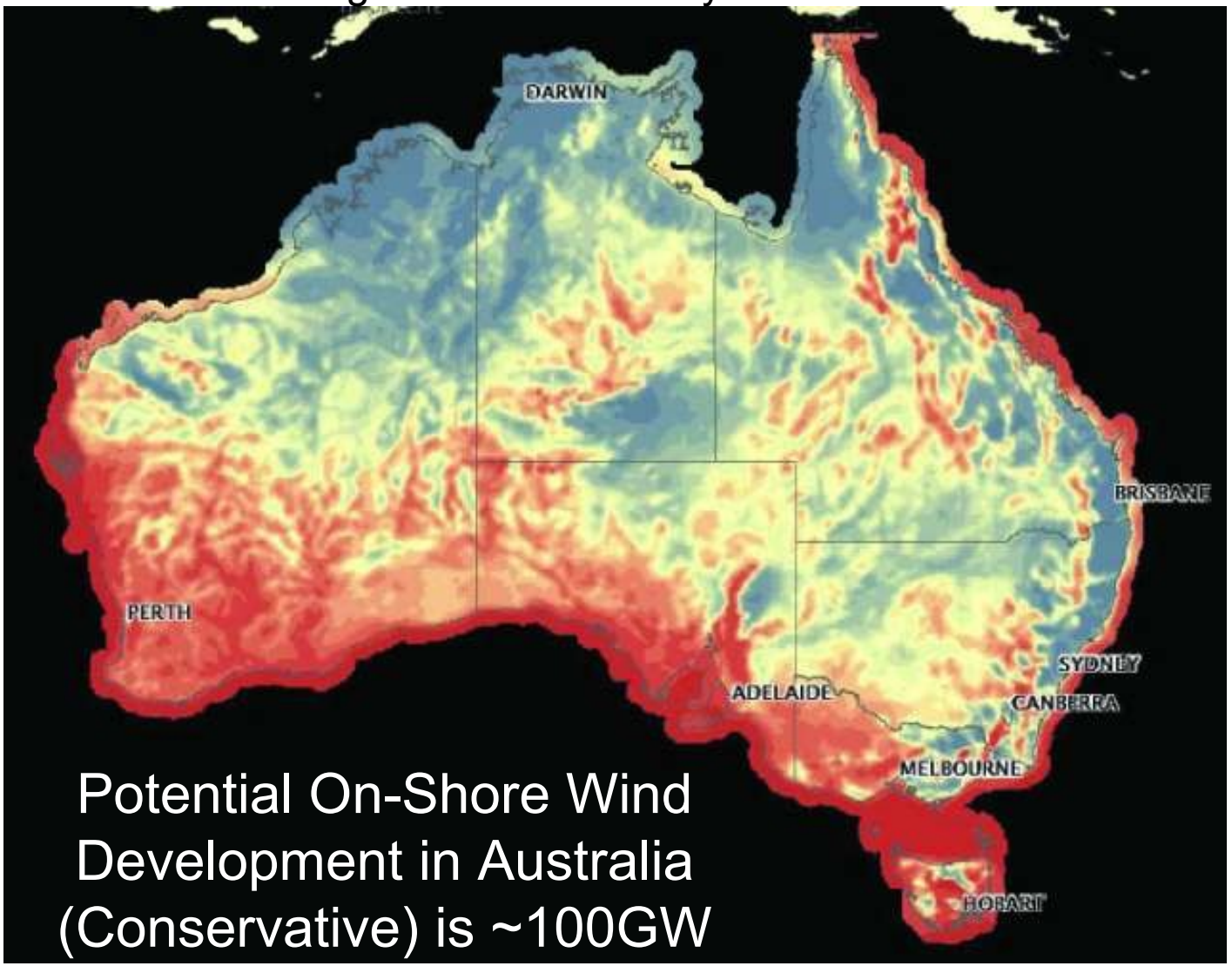
GEODYNAMICS LIMITED

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Source: Geodynamics, Limited

Australian Wind Potential - Renewable Energy Atlas of Australia

www.environment.gov.au/sustainability/renewable/atlas/index.html

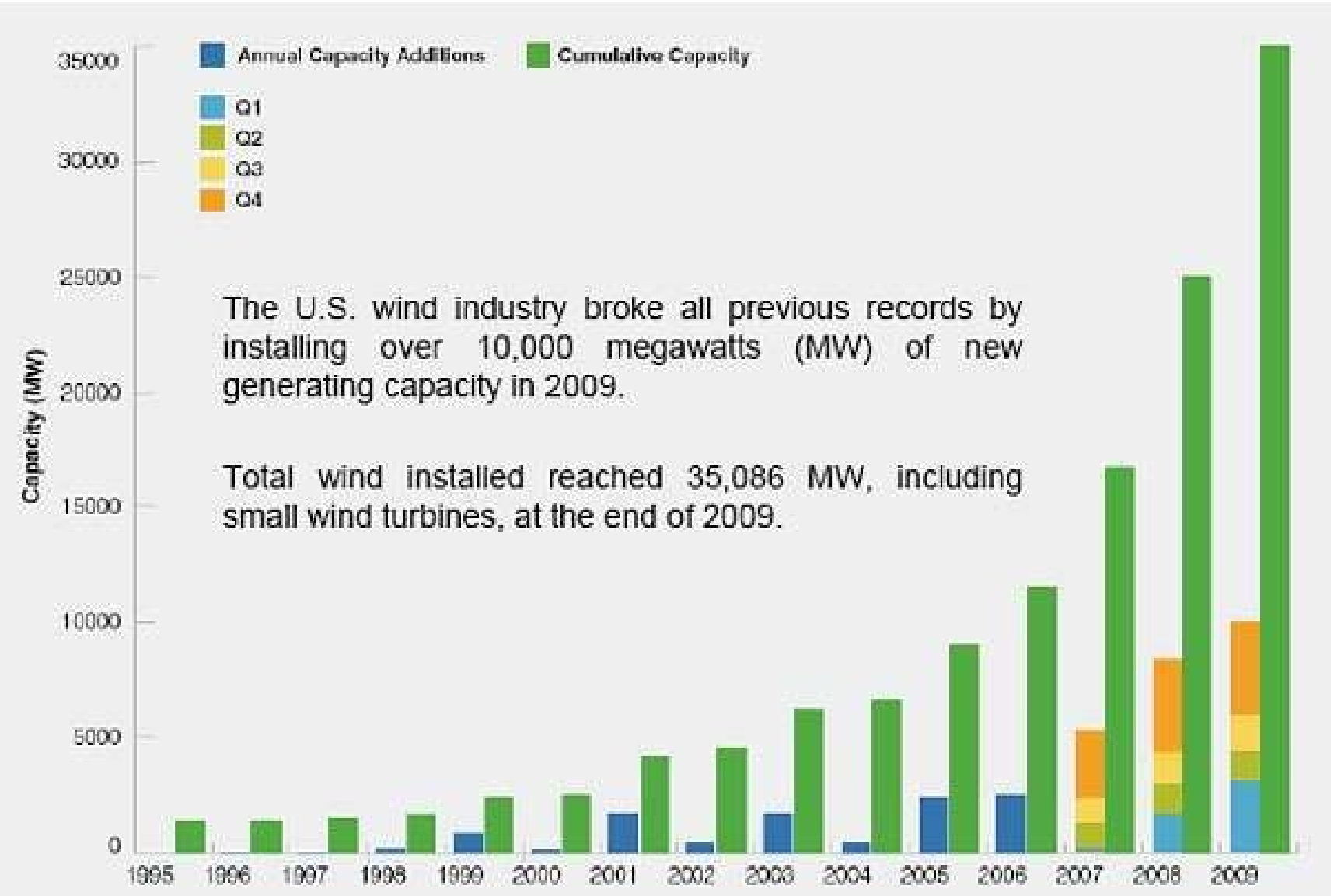


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http://ramblingsdc.net/Australia/WindPPotential.html

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Wind is the World's Fastest Growing Energy Source: Installed Capacity Doubles Every Three Years

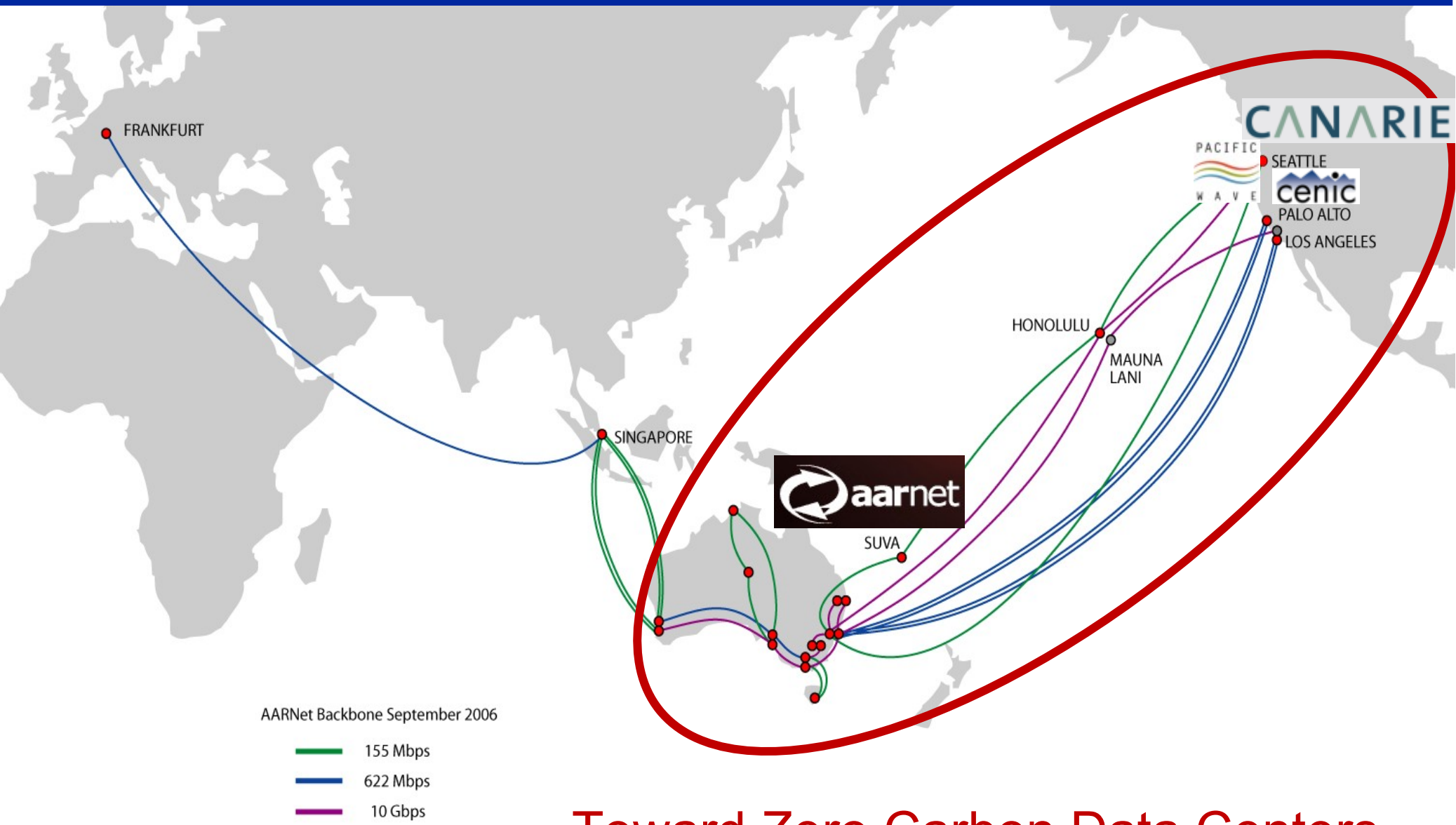


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http://e360.yale.edu/content/images/0410-wind-energy-report.html

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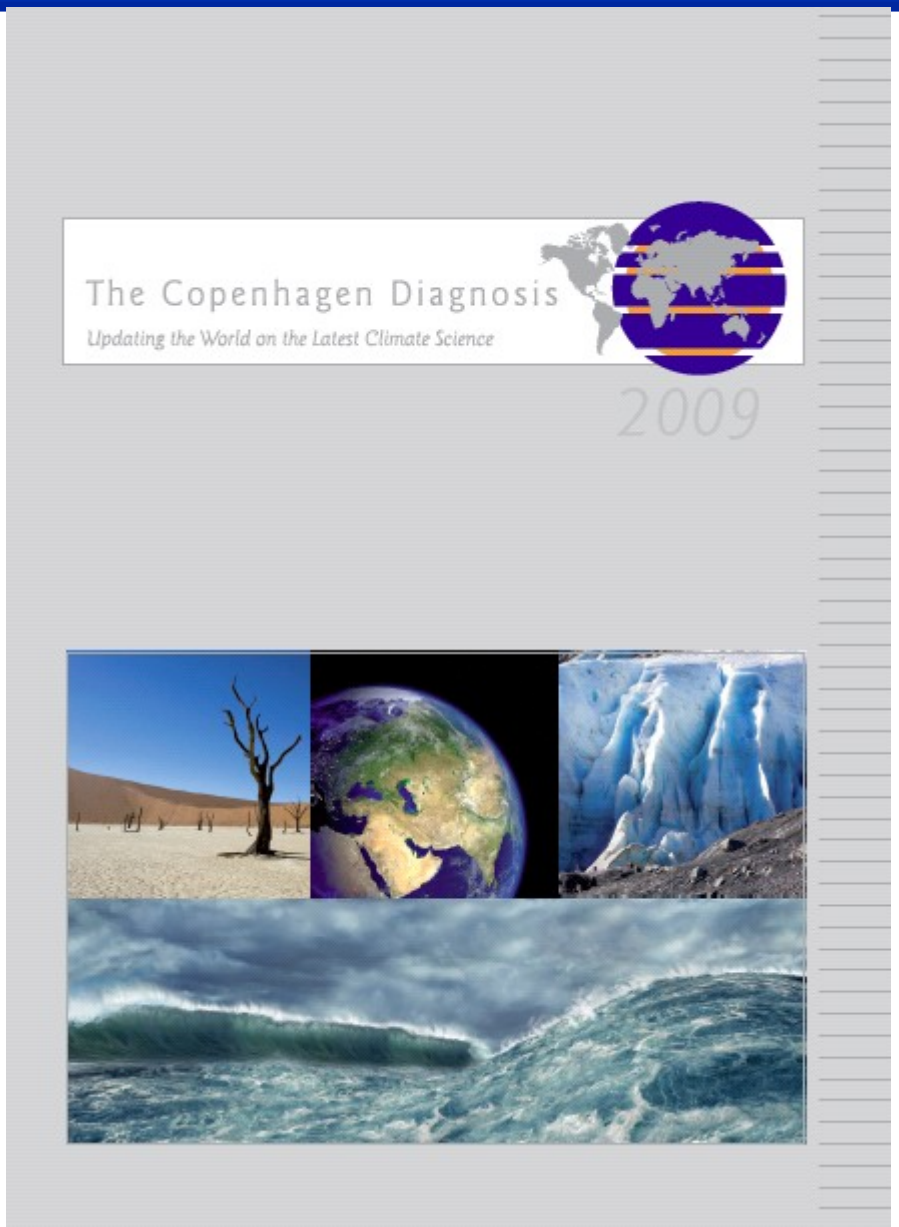
Coupling AARNet - CENIC/PW - CANARIE Optical Nets: An Australian-U.S.-Canada Green Cloud Testbed



Toward Zero Carbon Data Centers

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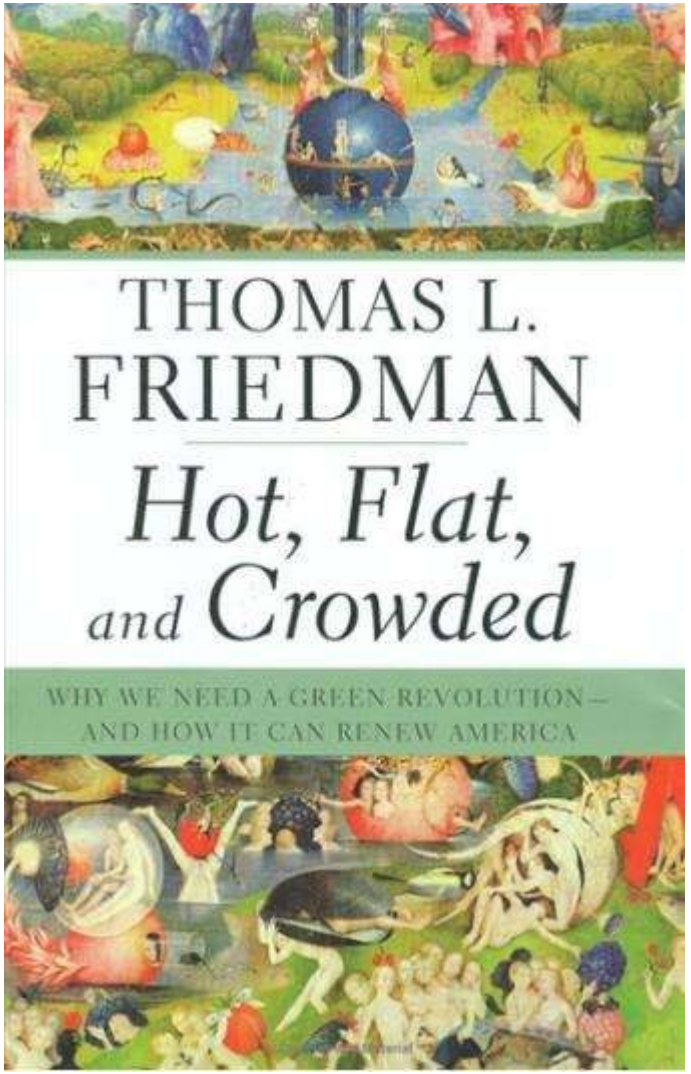
The Latest Science on Global Climatic Disruption
An Update to the 2007 IPCC Report

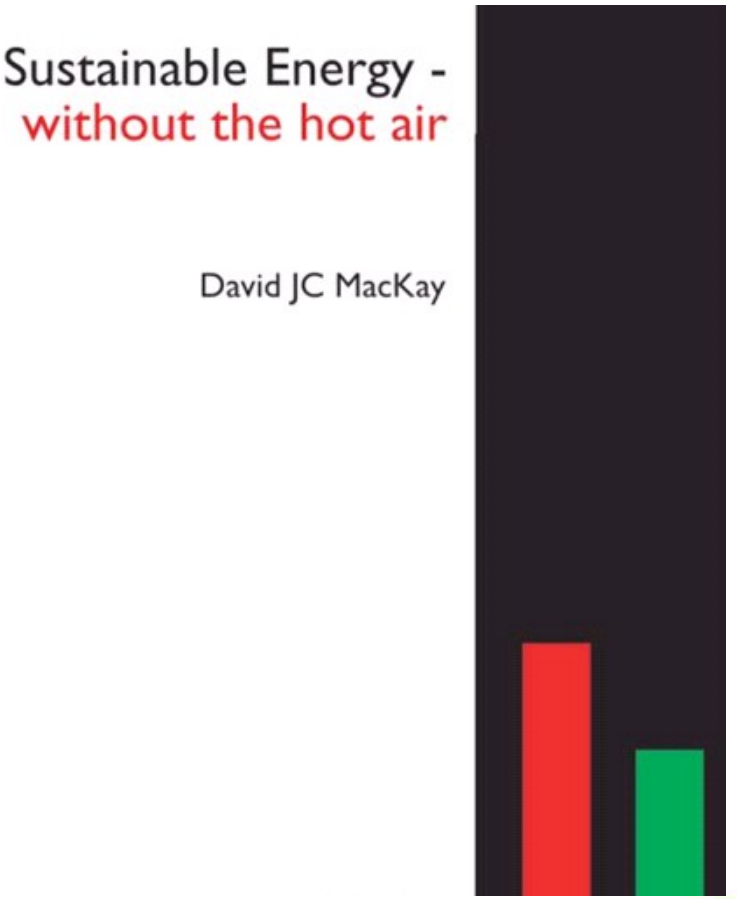


www.copenhagendiagnosis.org

What is Creating the Problem and What Can the World Do to Change?

"It Will Be the Biggest Single Peacetime Project Humankind Will Have Ever Undertaken"





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