Limiting Global Climatic Disruption by Revolutionary Change in the Global Energy System

Keynote Opening Talk

Xconomy Forum: The Rise of Smart Energy

Calit2@UCSD

June 8, 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

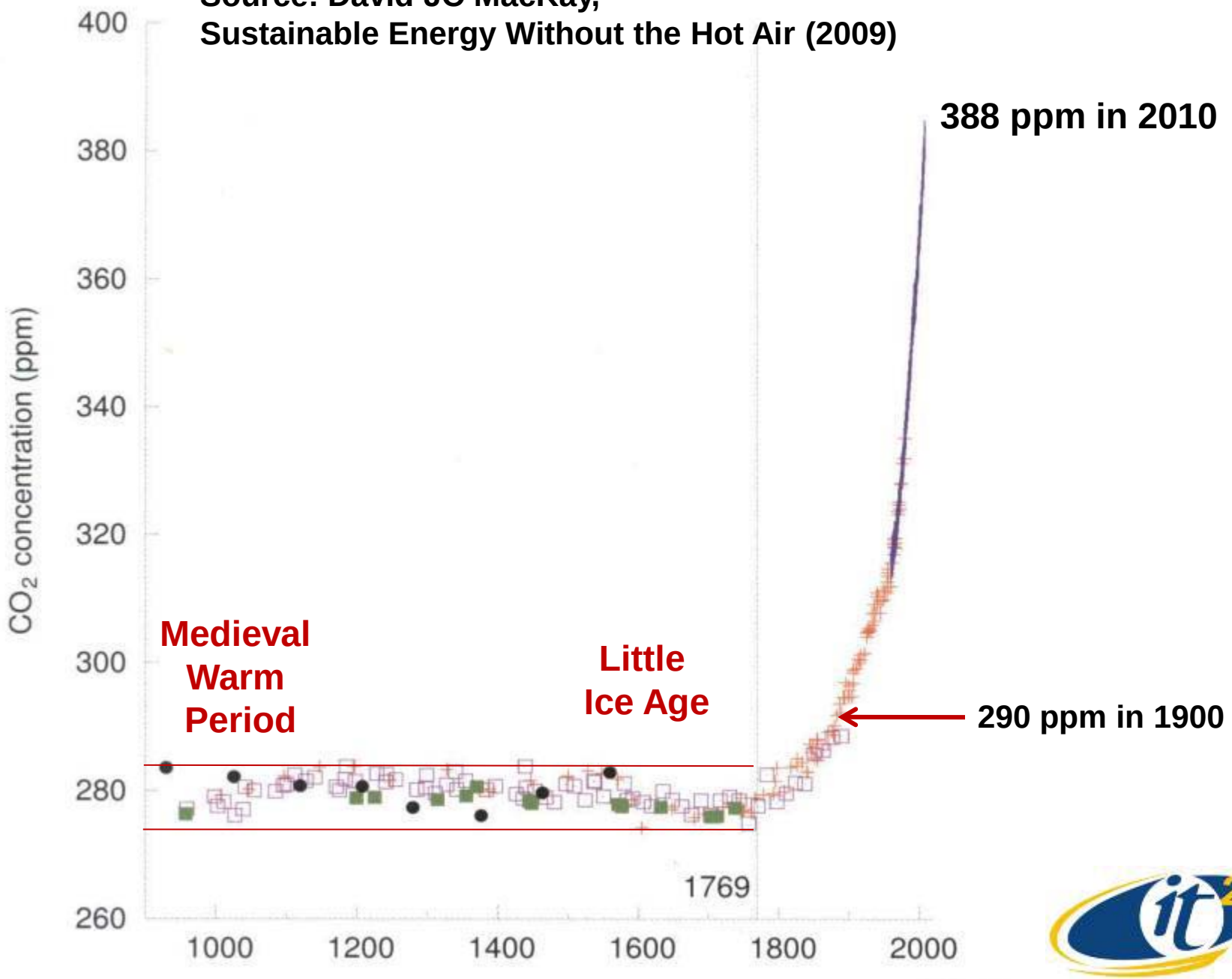
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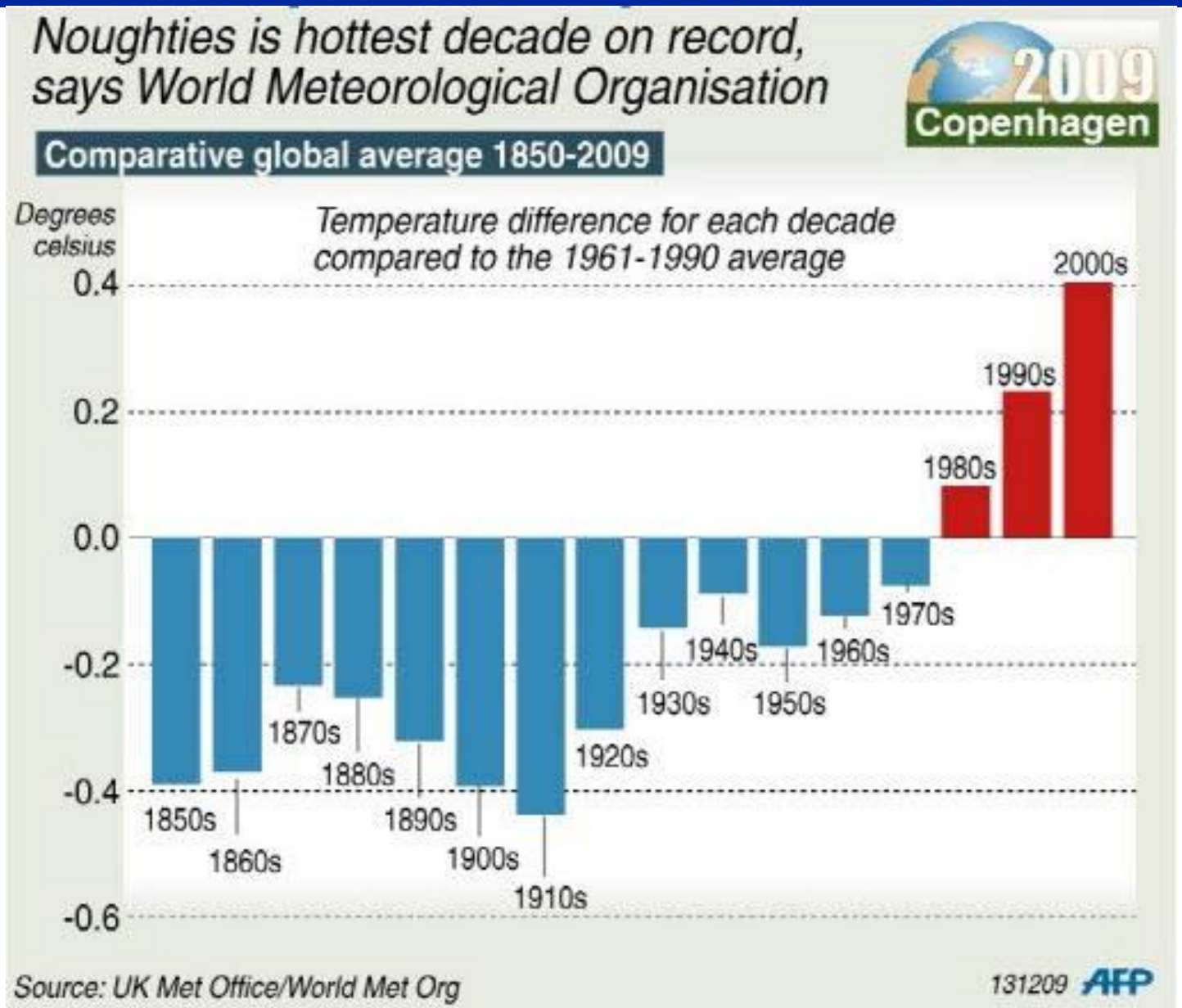
Rapid Increase in the Greenhouse Gas CO_2 Since Industrial Era Began

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



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Global Average Temperature Per Decade Over the Last 160 Years



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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

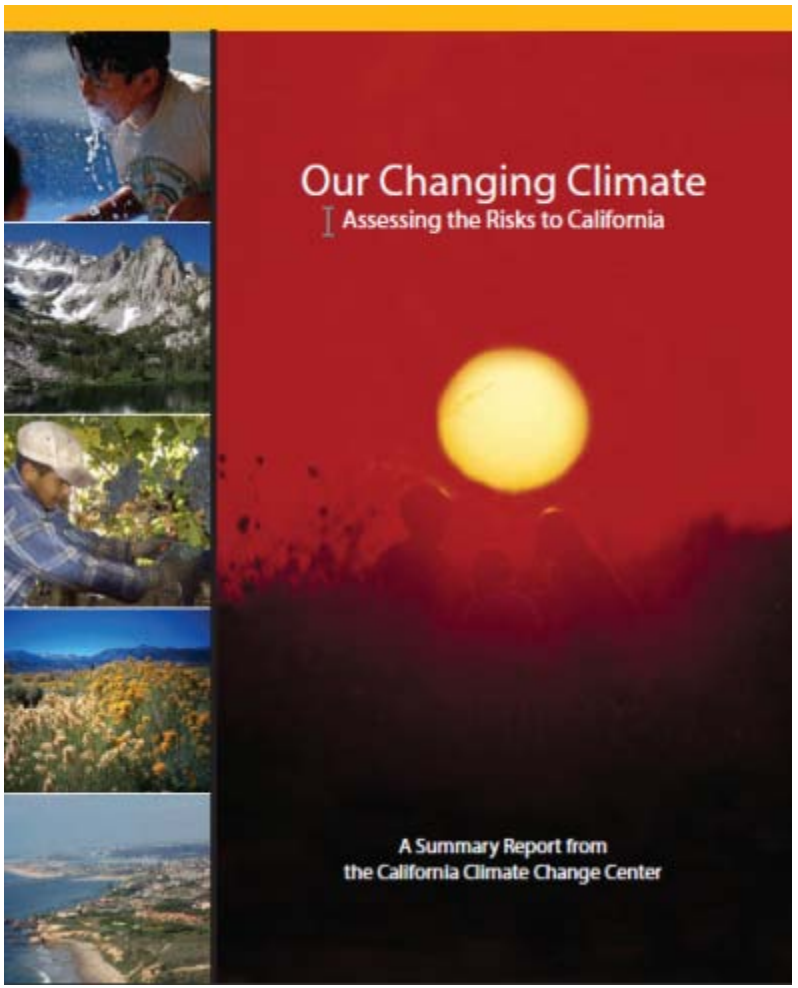
A Paper From:
California Climate Change Center

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."

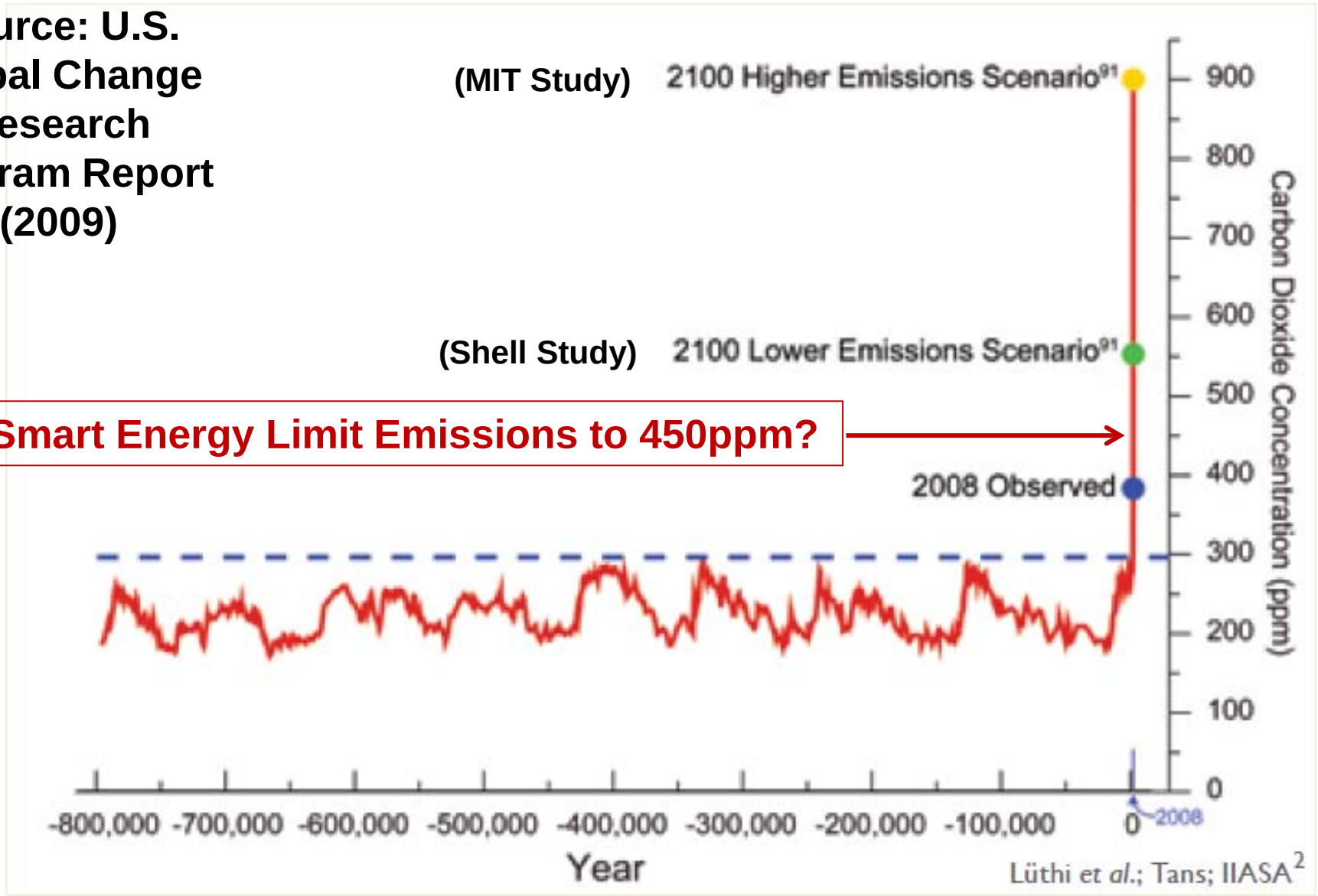
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California Applications Program (CAP) & The California Climate Change Center (CCCC)
CAP/CCCC is directed from the Climate Research Division, Scripps Institution of Oceanography

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



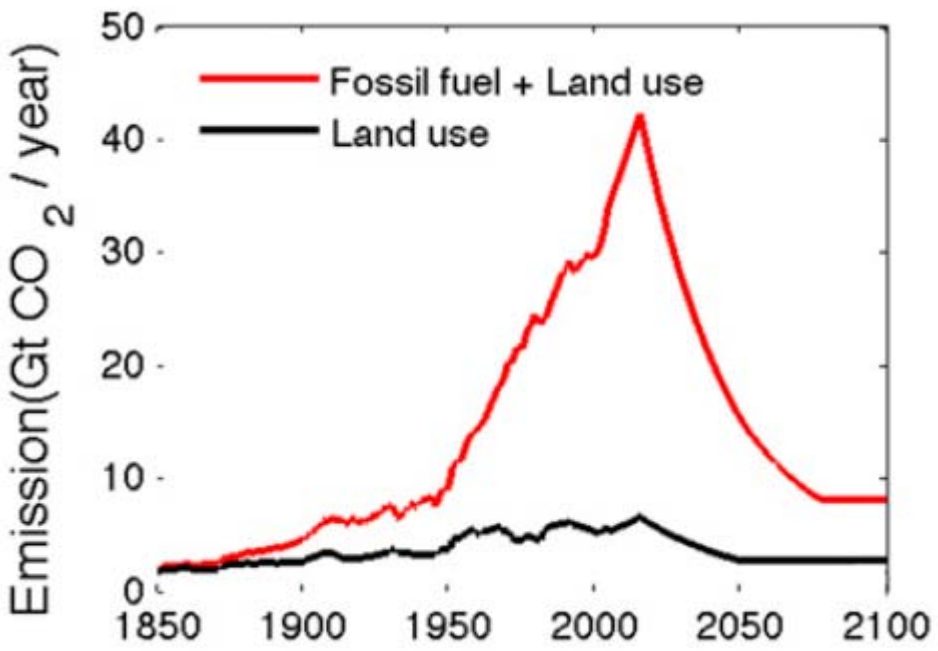
Limiting GHG concentrations to 450 ppm CO_2-equivalent is expected to limit temperature rises to no more than 2°C above pre-industrial levels. This would be extremely challenging to achieve, **requiring an explosive pace of industrial transformation going beyond even the aggressive developments outlined 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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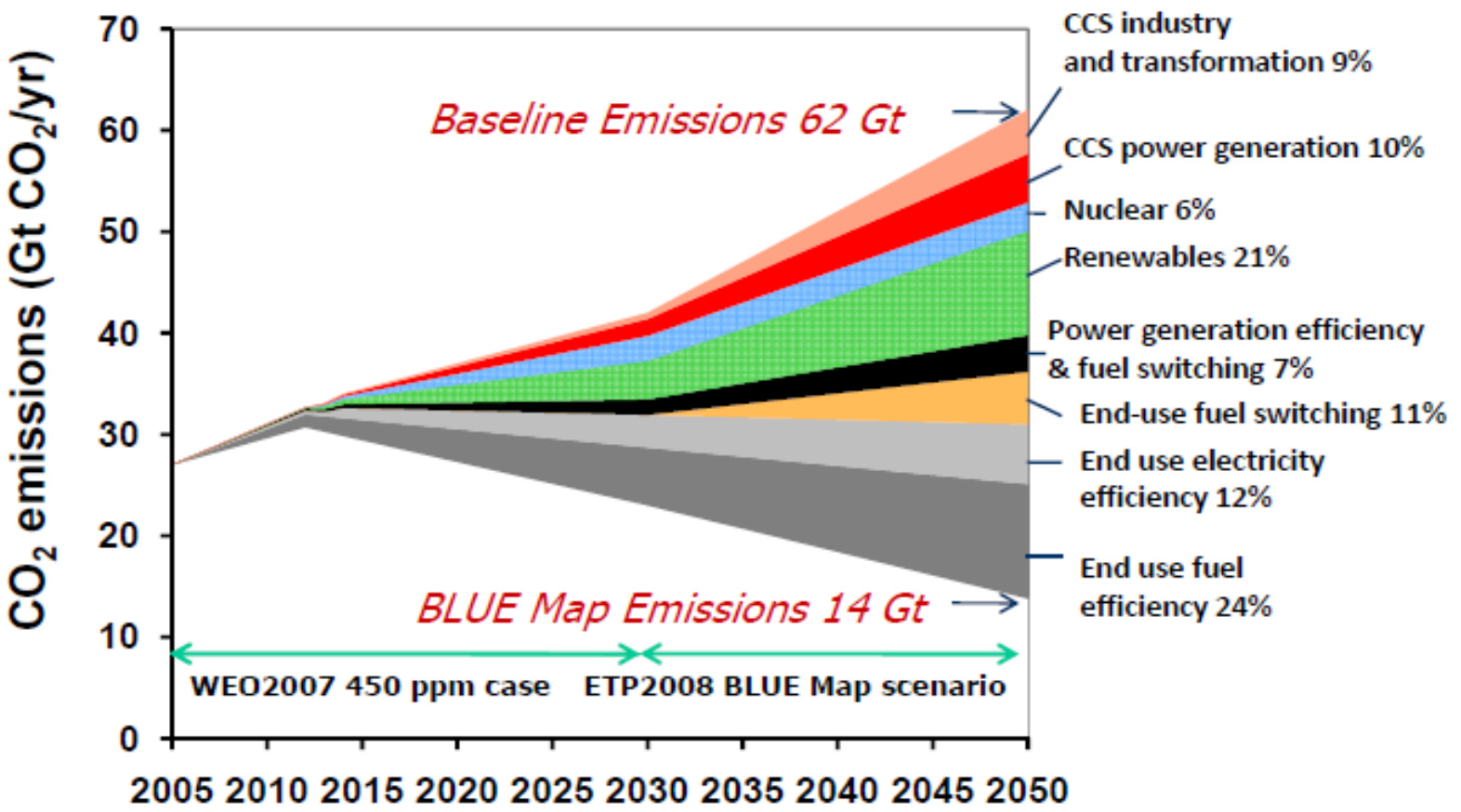
Urgent Actions Required to Limit Global Warming to Less Than 2 Degrees Centigrade

- **Three Simultaneous Actions**
  - **Reduce Annual CO_2 Emissions 50% by 2050—Peak in 2015**
  - **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**



"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

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



IEA "Blue" Scenario

ENERGY TECHNOLOGY PERSPECTIVES 2008

Scenarios & Strategies to 2050

INTERNATIONAL ENERGY AGENCY

In support of the G8 Plan of Action

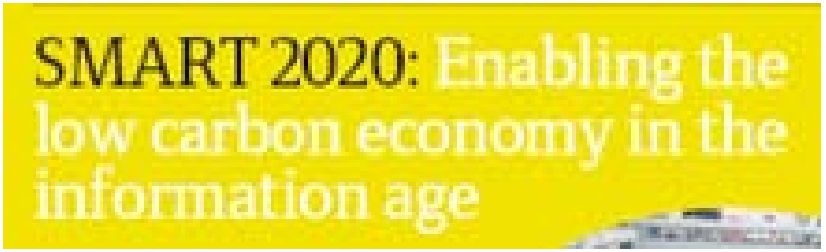
© OECD/IEA - 2008

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The Transformation to a Smart Energy Infrastructure: Enabling the Transition to a Low Carbon Economy

Applications of ICT
could enable emissions reductions
of 15% of business-as-usual emissions.
But it must keep its own growing footprint in check
and overcome a number of hurdles
if it expects to deliver on this potential.





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www.smart2020.org

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Application of ICT Can Lead to a 5-Fold Greater Decrease in GHGs Than its Own Carbon Footprint

While the sector plans to significantly step up the energy efficiency of its products and services, ICT's largest influence will be by enabling energy efficiencies in other sectors, an opportunity that could deliver carbon savings five times larger than the total emissions from the entire ICT sector in 2020.

--Smart 2020 Report

Major Opportunities for the United States*

- Smart Electrical Grids
- Smart Transportation Systems
- Smart Buildings
- Virtual Meetings

*** Smart 2020 United States Report Addendum**

www.smart2020.org

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Applying ICT – The Smart 2020 Opportunity for 15% Reduction in GHG Emissions

Smart Transportation

Smart Buildings

Smart Electrical Grid

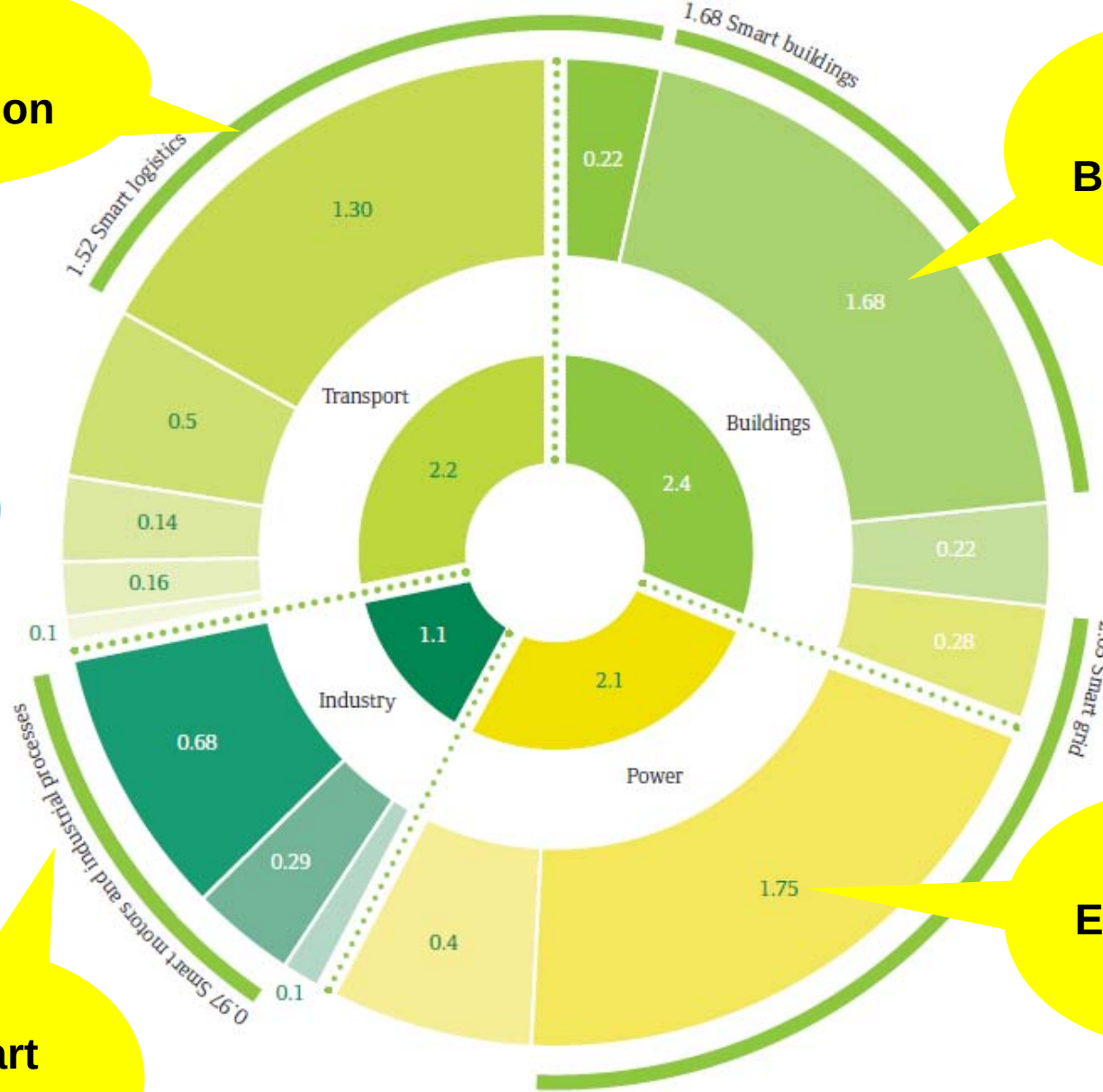
Smart Motors

Industry
- Smart motors
- Industrial process automation
- Dematerialisation* (reduce production of DVDs, paper)

Transport
- Smart logistics
- Private transport optimisation
- Dematerialisation (e-commerce, videoconferencing, teleworking)
- Efficient vehicles (plug-ins and smart cars)
- Traffic flow monitoring, planning and simulation

Buildings
- Smart logistics†
- Smart buildings
- Dematerialisation (teleworking)
- Smart grid‡

Power
- Smart grid
- Efficient generation of power, combined heat and power (CHP)



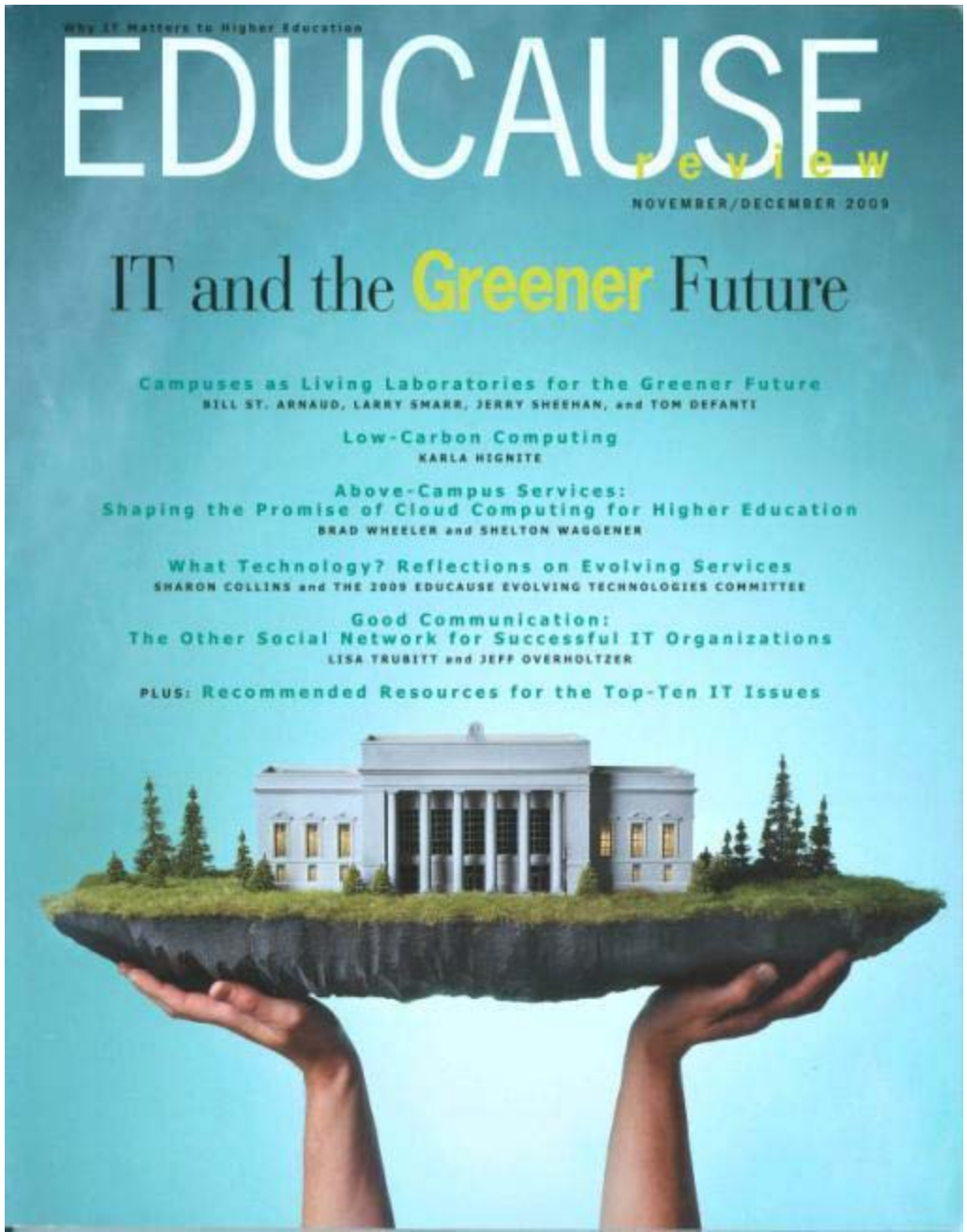
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Making University Campuses Living Laboratories for the Greener Future

www.educause.edu/EDUCAUSE+Review/EDUCAUSEReviewMagazineVolume44/CampusesasLivingLaboratoriesfo/185217



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Developing Smart Energy Campus Testbeds: Calit2 (UCSD & UCI) Prototypes

- **Coupling the Internet and the Electrical Grid**
  - **Measuring Demand at Sub-Building Levels**
  - **Reducing Local Energy Usage via User Access Thru Web**
  - **Choosing non-GHG Emitting Electricity Sources**
- **Intelligent Transportation System**
  - **Campus Wireless GPS Low Carbon Fleet**
  - **Green Software Automobile Innovations**
  - **Driver Level Cell Phone Traffic Awareness**
- **Travel Substitution**
  - **Commercial Teleconferencing**
  - **Next Generation Global Telepresence**

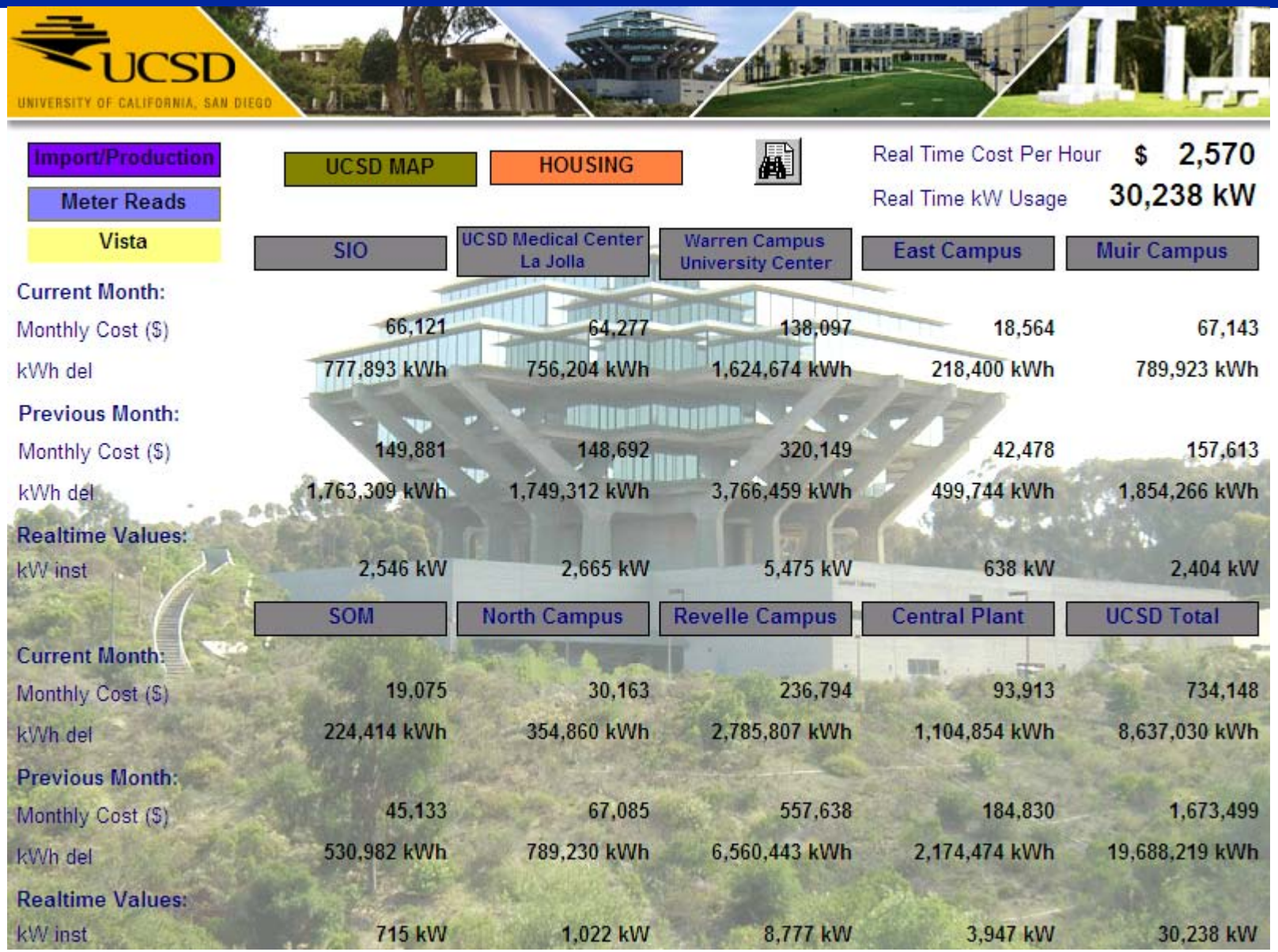
Student Video -- UCSD Living Laboratory for Real-World Solutions
www.gogreentube.com/watch.php?v=NDc4OTQ1 on UCSD

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UCI Named 'Best Overall' in Flex Your Power Awards
www.today.uci.edu/news/release_detail.asp?key=1859

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Real-Time Monitoring of Building Energy Usage: Toward a Smart Energy Campus



http://mscada01.ucsd.edu/ion/

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Reducing Energy Requirements of PCs: 68% Energy Saving Using UCSD's Sleep Server

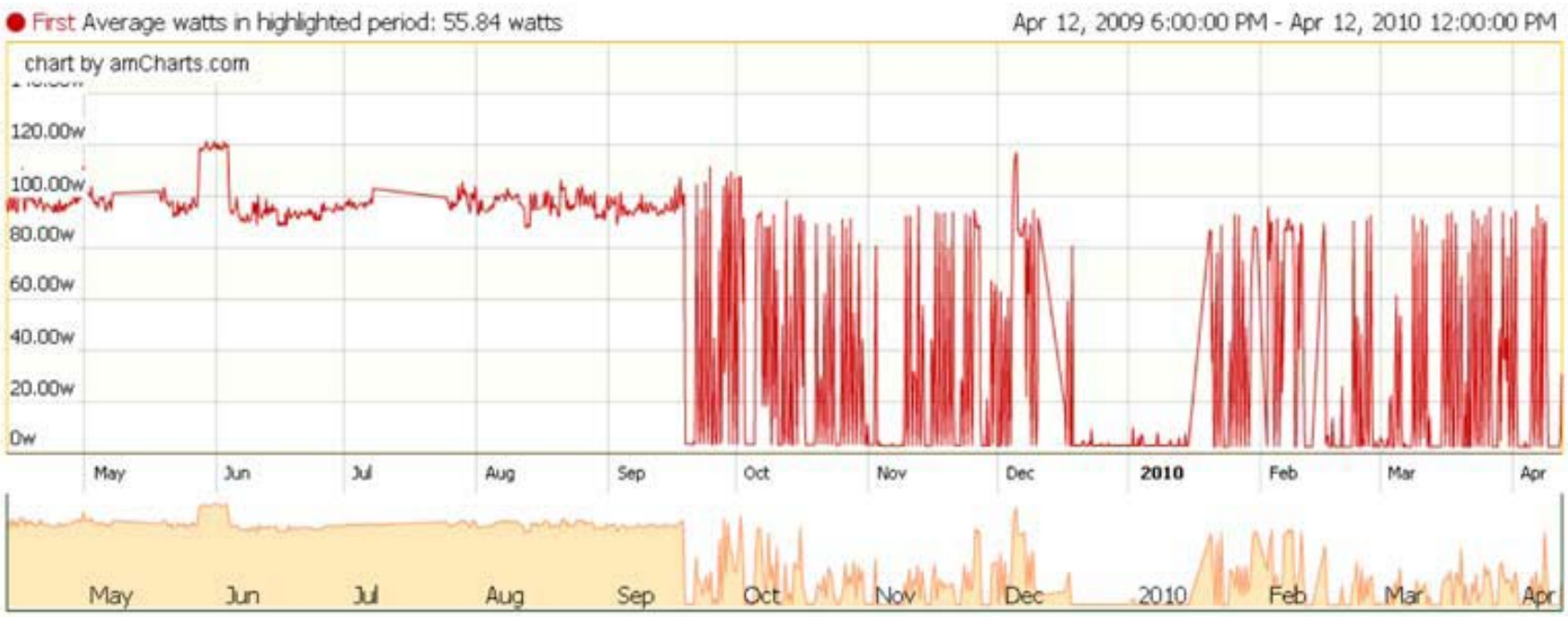


energy.ucsd.edu

kW-Hours:488.77 kW-H Averge Watts:55.80 W
Energy costs:$63.54
Estimated Energy Savings with Sleep Server: 32.62%
Estimated Cost Savings with Sleep Server: $28.4

Past year Power consumption for device #3091420330

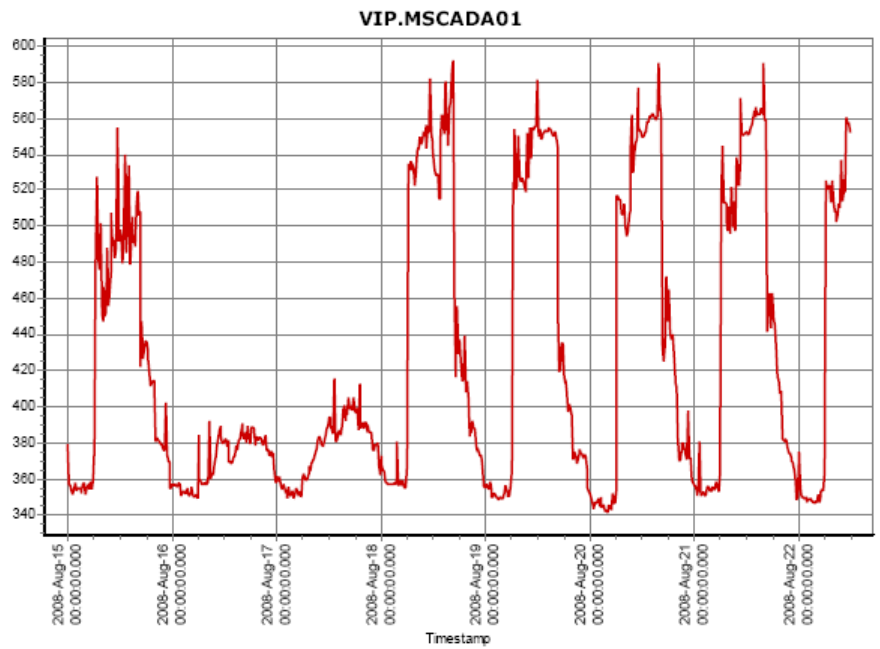
From: Apr, 12, 2009 12:28:50 PM **Resolution:** Every six hours (averaged)
To: Apr, 12, 2010 12:28:50 PM **Timespan:** 1 year



Smart Energy Buildings: Active Power Management of Computers

- **500 Occupants, 750 Computers**
- **Detailed Instrumentation to Measure Macro and Micro-Scale Power Use**
  - **39 Sensor Pods, 156 Radios, 70 Circuits**
  - **Subsystems: Air Conditioning & Lighting**
- **Conclusions:**
  - **Peak Load is Twice Base Load**
  - **70% of Base Load is PCs and Servers**
  - **90% of That Could Be Avoided!**



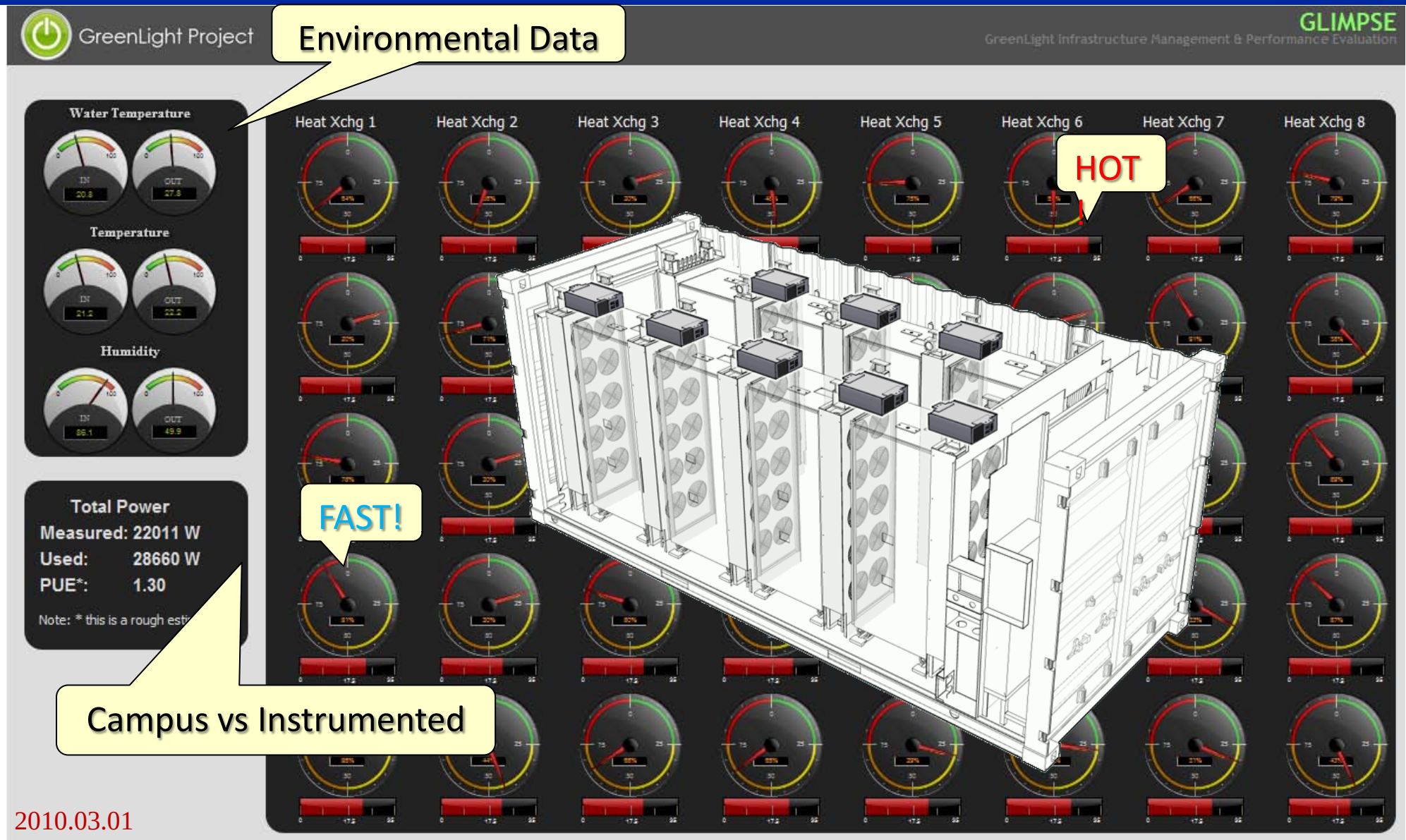


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Source: Rajesh Gupta, CSE, Calit2

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Smart Energy Data Centers with SensorNets: Enables Lower Energy Usage



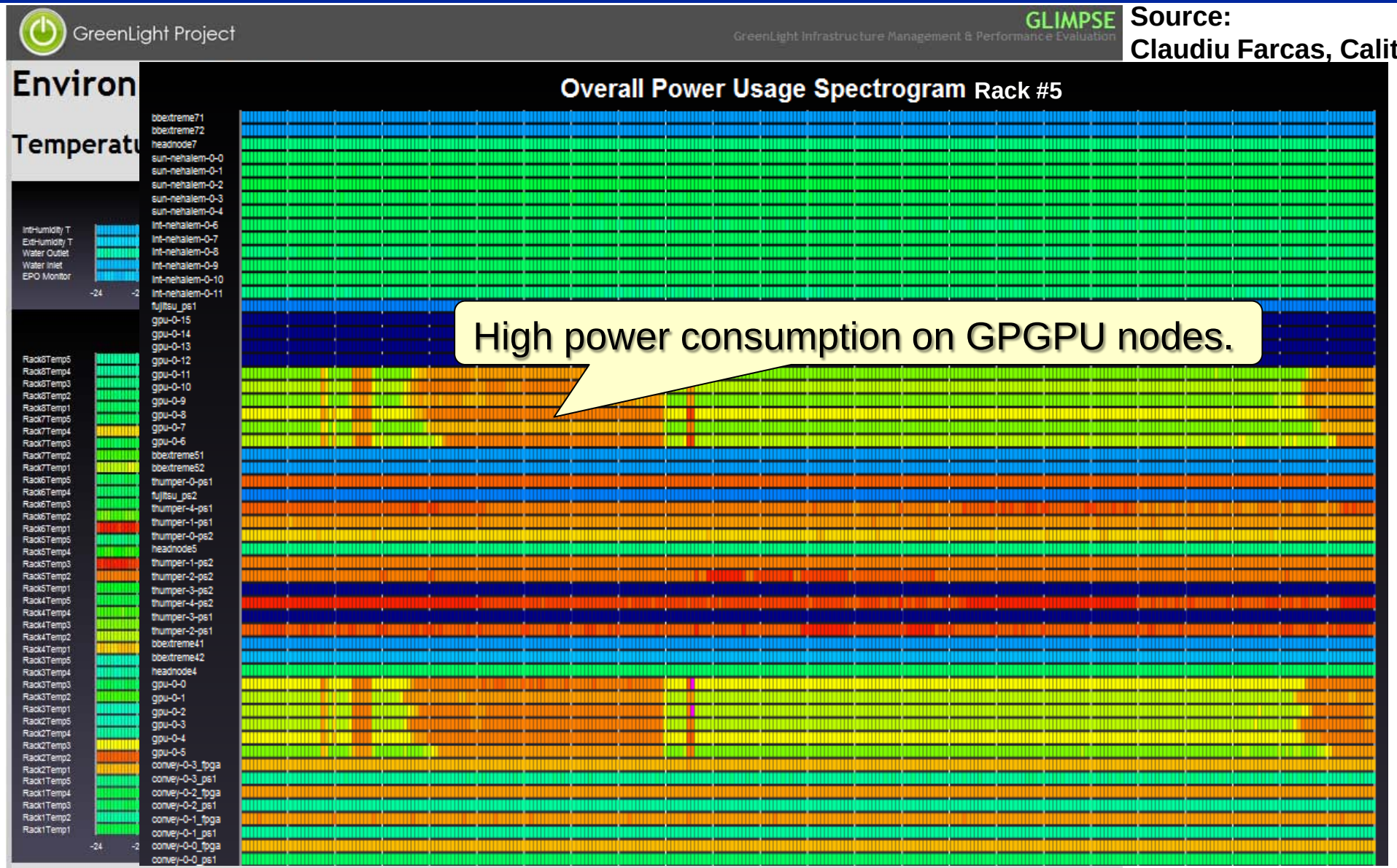
2010.03.01

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Source: Claudiu Farcas, Calit2
http://greenlight.calit2.net

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Visualization of SensorNet Time Evolution: Spectrograms Spot Hotspots of Utilization



Source: Claudiu Farcas, Calit2

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See Calit2 iPad App http://glimpse.calit2.net

http://greenlight.calit2.net

UCSD and UCI Smart Energy Transportation System and Renewable Energy Campus Fleets

- **Calit2@UCSD Developed the California Wireless Traffic Report**
  - **http://traffic.calit2.net/**
  - **Deployed in San Diego, Silicon Valley, and San Francisco**
  - **Thousands/Day Reduce Congestion**
- **UCSD Campus Fleet 45% Renewables**
  - **300 Small Electric Cars**
  - **50 Hybrids**
  - **20 Full-Size Electrics by 2011**
- **UCI First U.S. campus to Retrofit its Shuttle system for B100 (Pure Biodiesel),**
  - **Reducing Campus Carbon Emissions ~480 Tons Annually**

Toyota Delivers Plug-in Prius to UC Irvine and UC Berkeley as Part of Clean Mobility Partnership



Nov. 2007

- **EPA Environmental Achievement Award for its Sustainable Transportation Program,**
  - **Eliminates >18,000 $mTCO_2e$ Annually by Promoting Alternative Transportation**
  - **2008 Governor's Environmental and Economic Leadership Award**

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Reducing CO_2 From Travel: Linking the Calit2 Auditoriums at UCSD and UCI



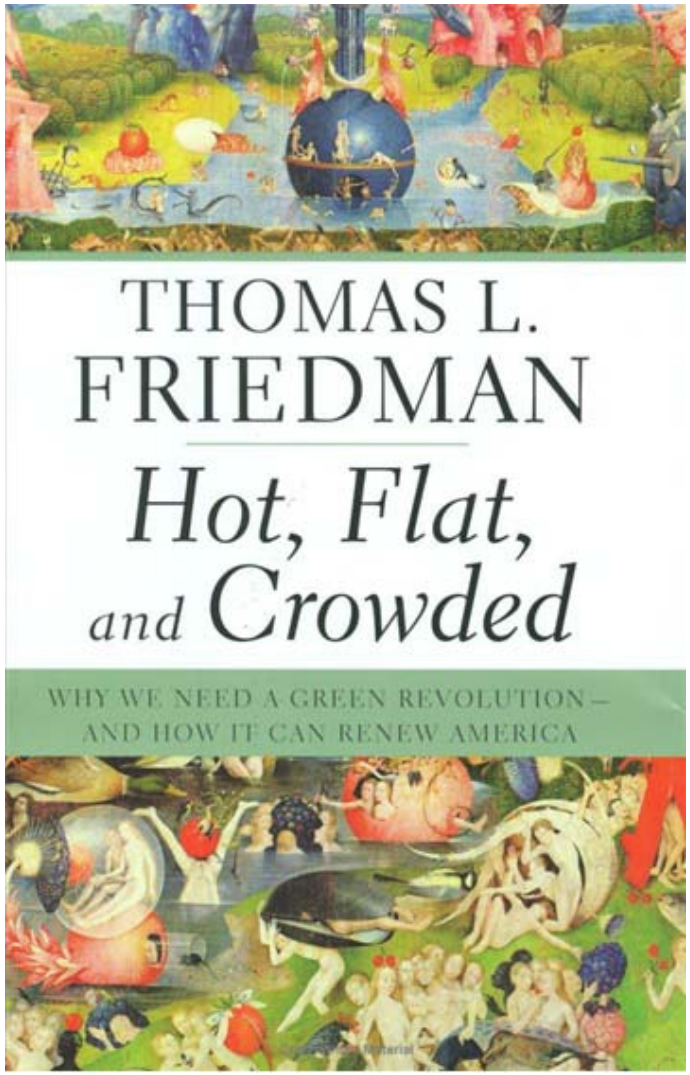
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Photo by Erik Jepsen, UC San Diego

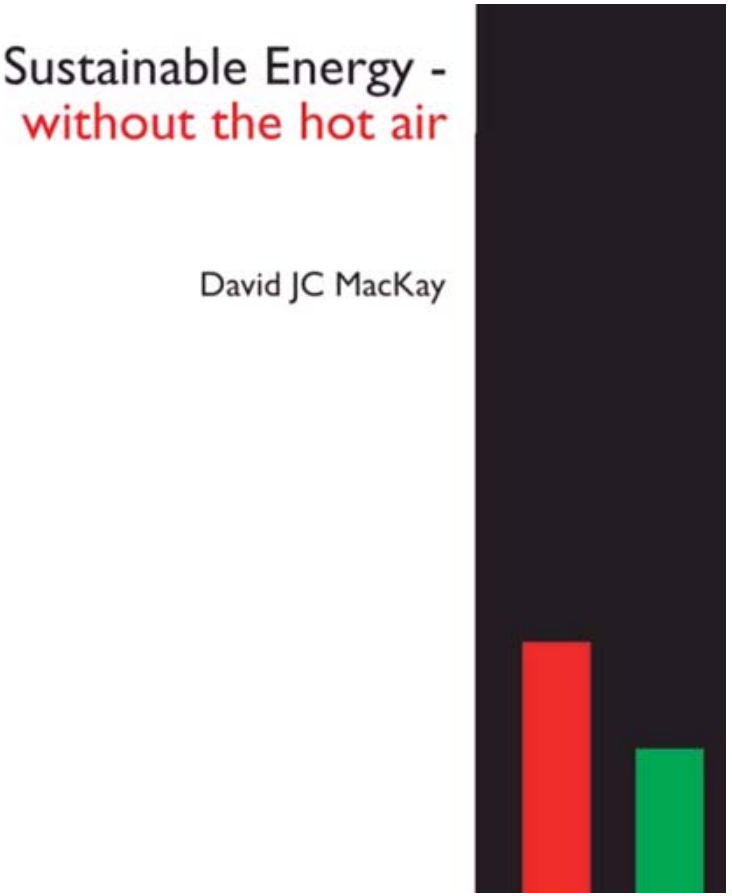
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What is Creating the Problem and What Can the World Do to Change?

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



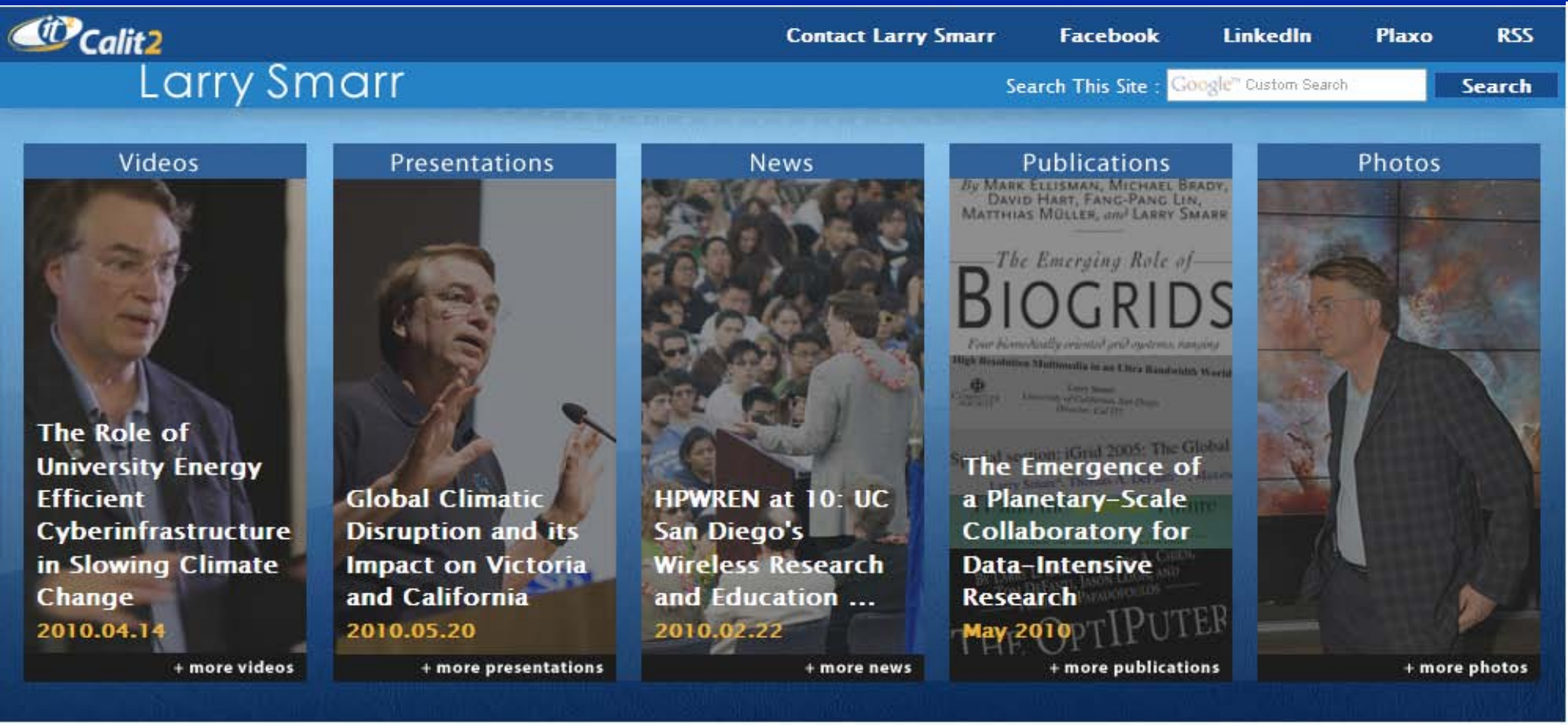
A Huge New Market for Smart Energy Lasting for Decades!



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You Can Download This Presentation at lsmarr.calit2.net



ABOUT LARRY SMARR

Larry Smarr is the founding Director of the California Institute for Telecommunications and Information Technology (Calit2), a UC San Diego/UC Irvine partnership, and holds the Harry E. Gruber professorship in Computer Science and Engineering

WHAT I'M READING

Complete List of Larry's Recommendations

American College and University Presidents' Climate Commitment

RECENT TWITTER POSTS

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lsmarr: Well said John Perry! Let's get on with it! RT @JPBarlow: The time