Towards and Beyond Energy Efficiency: HPC System and Datacenters
SC11 EE HPC WG Workshop
November 14, 2011

Satoshi Matsuoka, Tokyo Institute of Technology
Alan Yoder, Net App
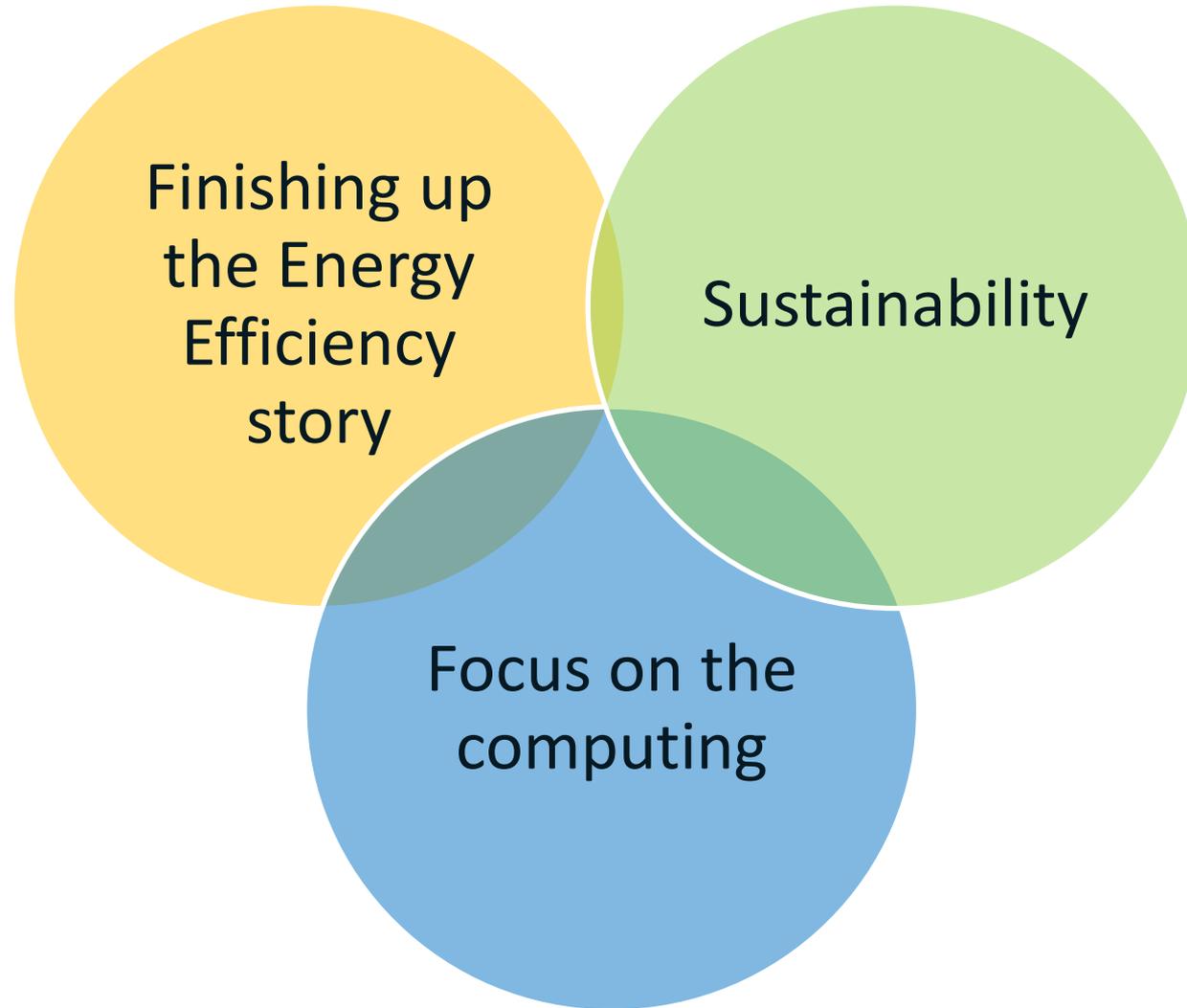Anna Maria Bailey, LLNL
William Tschudi, LBNL
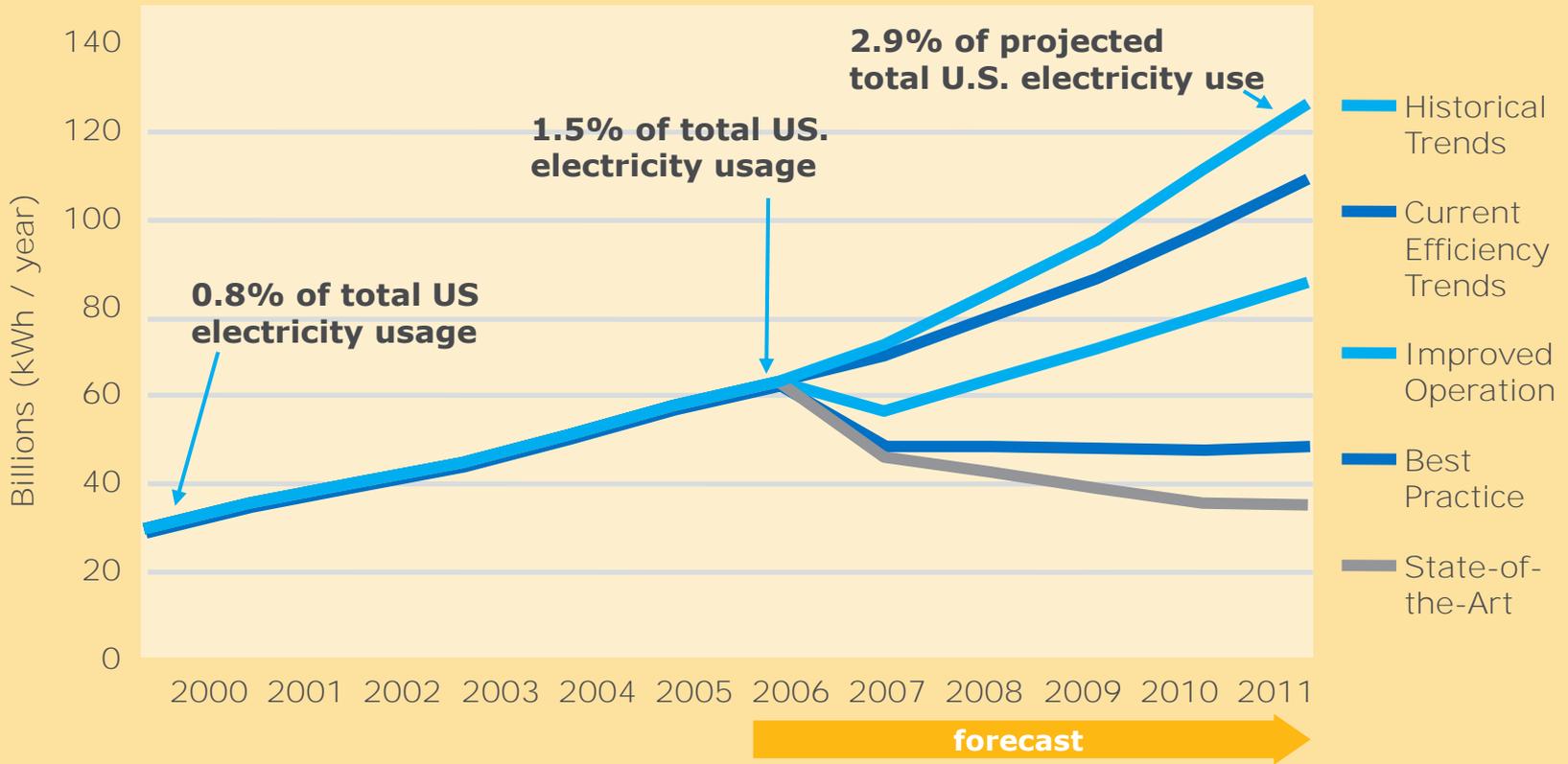Michael Patterson, Intel
Ingmar Meijer, IBM
Nic Dube, Hewlett Packard
Natalie Bates, Energy Efficient HPC Working Group

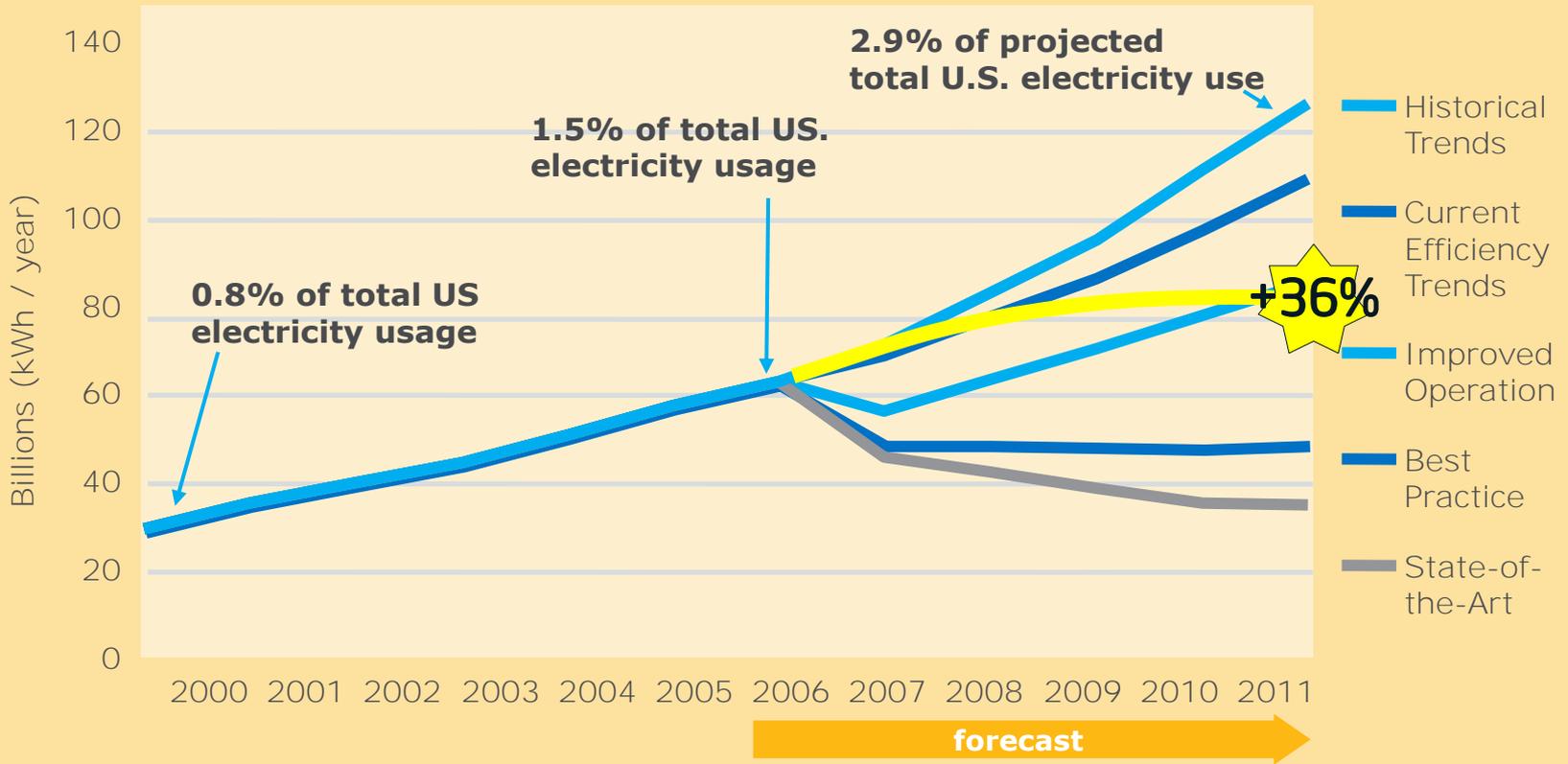# Themes in the HPC Data Center… the day ahead

Finishing up the Energy Efficiency story

Sustainability

Focus on the computing

A Data Center Crisis...or Opportunity?

Projected Data Center Energy Use Under Five Scenarios

- Historical Trends
- Current Efficiency Trends
- Improved Operation
- Best Practice
- State-of-the-Art

0.8% of total US electricity usage

1.5% of total US. electricity usage

2.9% of projected total U.S. electricity use

Billions (kWh / year)

forecast

A Data Center Crisis...or Opportunity?

Projected Data Center Energy Use Under Five Scenarios

- 2.9% of projected total U.S. electricity use
- 1.5% of total US. electricity usage
- 0.8% of total US electricity usage
- +36%

Legend:
- Historical Trends
- Current Efficiency Trends
- Improved Operation
- Best Practice
- State-of-the-Art

Y-axis: Billions (kWh / year) — 0, 20, 40, 60, 80, 100, 120, 140

X-axis: 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011

forecast

Koomey, 2011, estimates 36% growth

4

(intel)

How we did it? Where do we go next?

- Economic Downturn

  - Impacted growth to some extent

- IT equipment performance per watt improvements

  - Moore's Law continues

- Data Center Improvements

  - Design and Operational

  - Metrics; PUE awareness and improvements

BBC News Science and Environment, 7NOV11

Late last week, Oak Ridge National Laboratory (ORNL), which hosts the US's official emission-counting agency, released data showing a huge surge in carbon dioxide emissions from 2009 to 2010.

Now, consultants Pricewaterhouse Coopers (PwC) has an analysis showing that greenhouse gas emissions rose by more than economic growth.

Economic activity expanded by 5.1%; CO2 output by 5.8%.

TECHNOLOGY AND THE ENVIRONMENT

Drive Computing to
Be More
Energy Efficient

~2%
Opportunity

Use Computing to Improve
Energy Savings Outside
Information and
Communications Technology

98%
The Big Opportunity

~2%

Does HPC have a Carbon ROI?
Should we explore it?

(intel)

Carbon Accounting

We will talk about a lot of metrics but here is one that we might want to develop...

$$COP_{Carbon} = \frac{Total\ Carbon\ Reduced}{Total\ Carbon\ Used}$$

$$COP_{Carbon} = 0$$

$$COP_{Carbon} > 1.0$$

ORNL ReView "Supercomputers Help Model Cars in Collisions"

(intel)
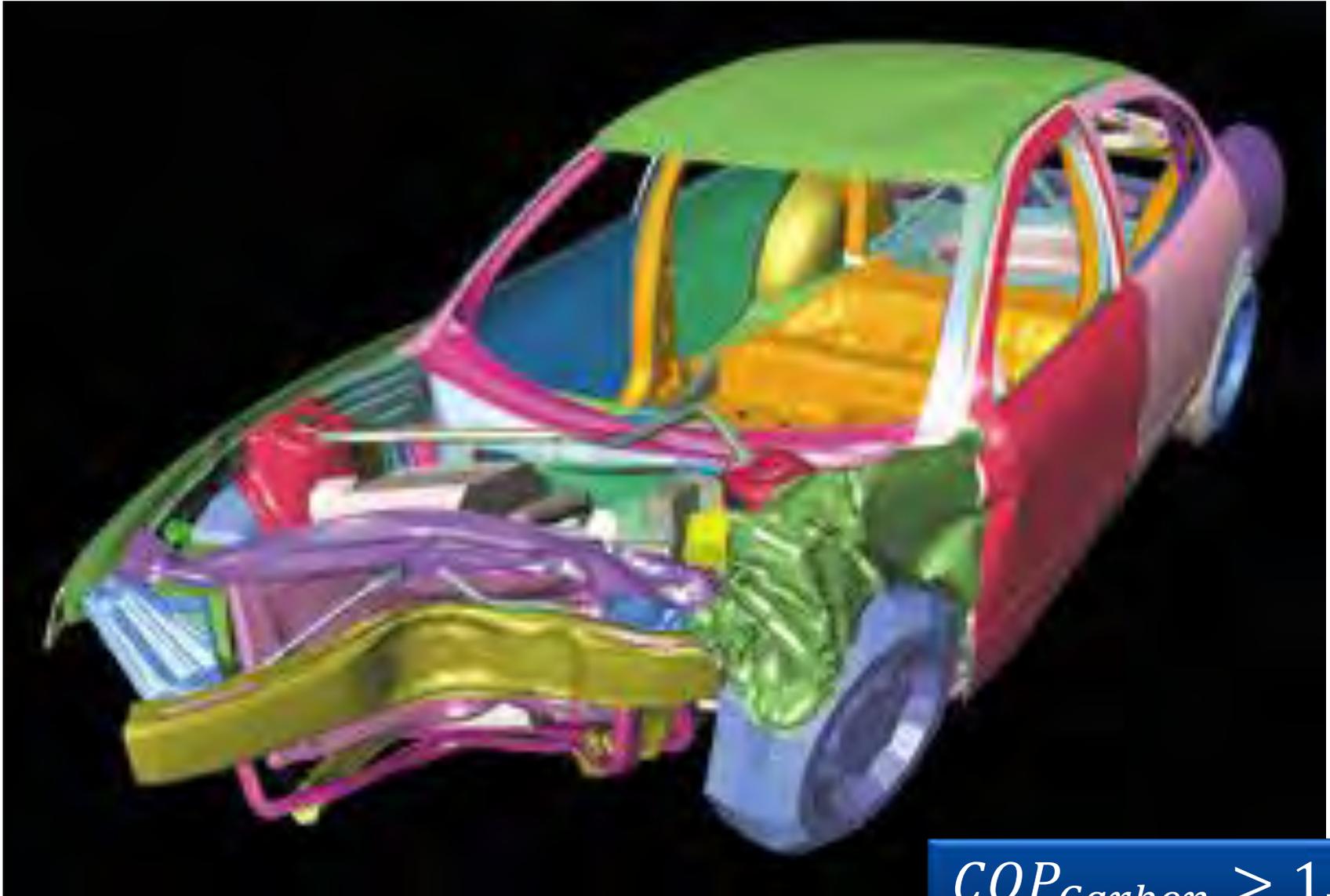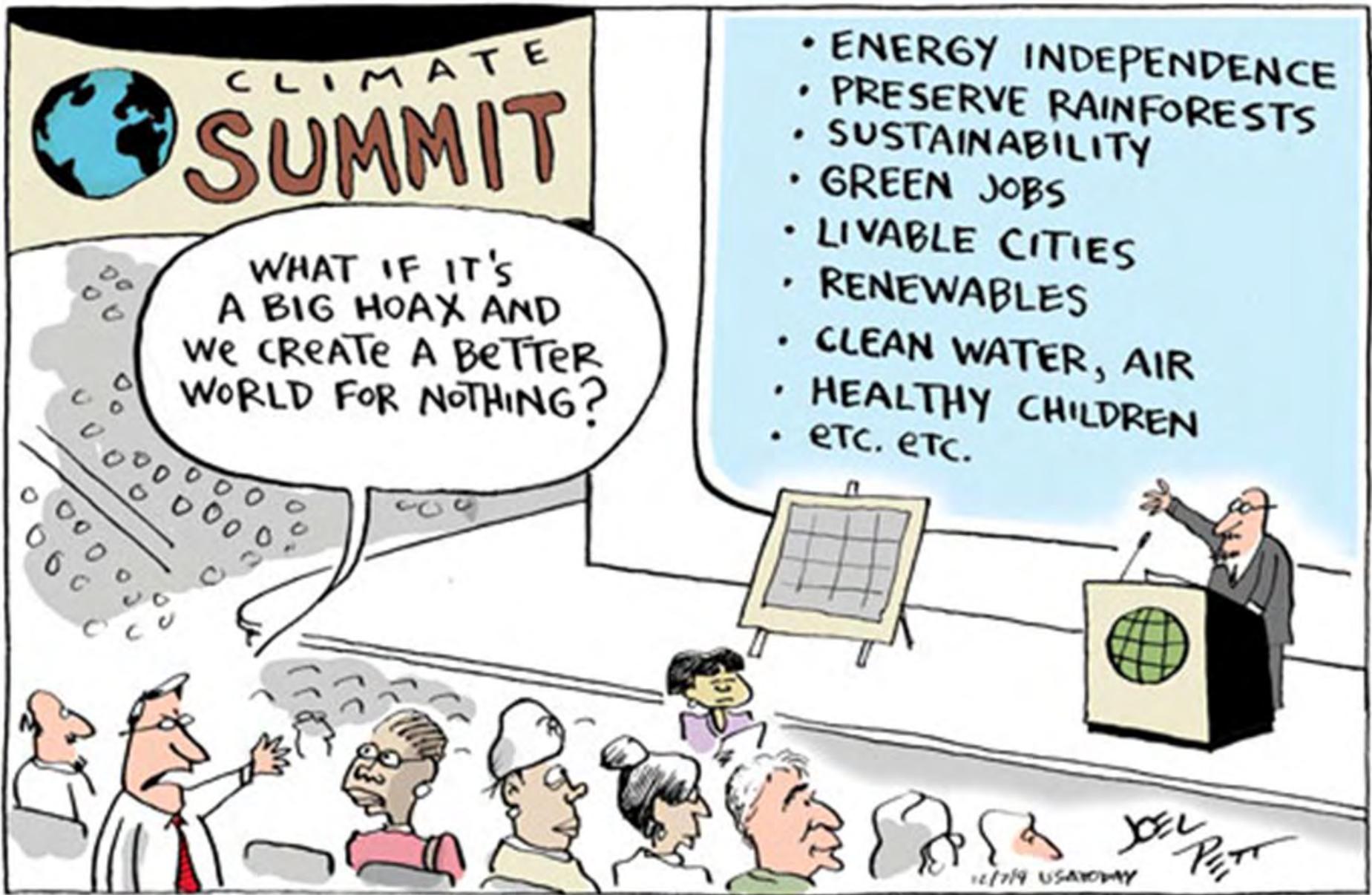
Source: Joel Pett, USA Today, Dec 7, 2009

Agenda

Start	Stop	Presenter	Topic
09:00	09:15	M. Patterson	Opening remarks
09:15	09:30	N. Bates	Energy Efficient HPC Working Group Overview
09:30	10:15	S. Matsuoka	System Architecture and Energy Efficiency
10:15	11:00	A. Yoder	Energy Efficiency Strategies for Storage in HPC Environments
11:00	11:15		Break
11:15	12:00	A. Bailey	LLNL's Power Management System
12:00	12:45	W. Tschudi	Energy Efficiency Tools and Resources
12:45	01:45		Lunch
01:45	02:30	M. Patterson	Liquid Cooling Guidelines
02:30	03:15	G. I. Meijer	Hot-water Cooling of Energy-Hungry Data Centers
03:15	03:30		Break
03:30	04:15	M. Patterson	Metrics Overview and Update
04:15	05:00	N. Dube	Sustainability: the Path to a Net-Zero Datacenter (Energy, Carbon, Water)
05:00	05:15	N. Bates	Closure

Energy Efficient HPC Working Group
EE HPC WG

- Driving energy conservation measures and energy efficient design in high performance computing.

- Demonstrate leadership in energy efficiency as in computing performance.

- Forum for sharing of information (peer-to-peer exchange) and collective action.

http://eehpcwg.lbl.gov

Energy Efficient HPC Working Group

Membership: The Energy Efficient High Performance Computing Working Group is open to all interested parties. Please contact us if you would like to join.

EE HPC WG Website
http://eehpcwg.lbl.gov

Email
energyefficientHPCWG@gmail.com

Energy Efficient HPC Linked-in Group
http://www.linkedin.com/groups?gid=2494186&trk=myg_ugrp_ovr

Hope to hear from you soon!
Dale Sartor & Natalie Bates, Co-leads, EE HPC WG

EE HPC WG History and Organization

- Conceived at the Super Computer 2008 conference Austin and formed in '09. Currently ~200 members

- Three sub-groups
  - Infrastructure Team
    - co-led by Bill Tschudi, LBNL and Dave Martinez, SNL
    - Energy Re-use Metric, Liquid Cooling Guidelines, Dashboards
  - System Team
    - co-led by Erich Strohmaier and John Shalf, LBNL
    - System Metrics, System Power Management
  - Conferences Team
    - co-led by Anna Maria Bailey and Marriann Silveira, LLNL
    - SC, ISC, GovEnergy, IGCC

- Monthly Best Practices Webinars

- Bi-monthly General Membership Meetings

EE HPC WG Recent Highlights

- Publish Guidelines for Liquid Cooling Temperature
  - SC11 Paper and ASHRAE Whitepaper
- Collaborate with Top500, Green500, The Green Grid on standardizing energy compute metric(s)
  - Paper on power measurement methodology for HPL workload
- Promote and provide training for DCPro Suite
- Monthly best practices webinar
  - Every 2nd Tuesday at 10AM PT
- Plans: Dashboards, Shifting IT Load, Power Management

Other EE HPC WG Technical Sessions

- Birds of Feather: "Setting Trends for Energy Efficiency"

  - Tuesday, 12:15-1:15PM TC 101

- Birds of Feather: "'Hot' for Warm Water Cooling"

  - Tuesday, 5:30-7:00PM WSCC 613/614

- State of the Practice: "'Hot' for Warm Water Cooling"

  - Wednesday, 4:00-4:30PM   TC 202