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National Action Plan for
Energy Efficiency

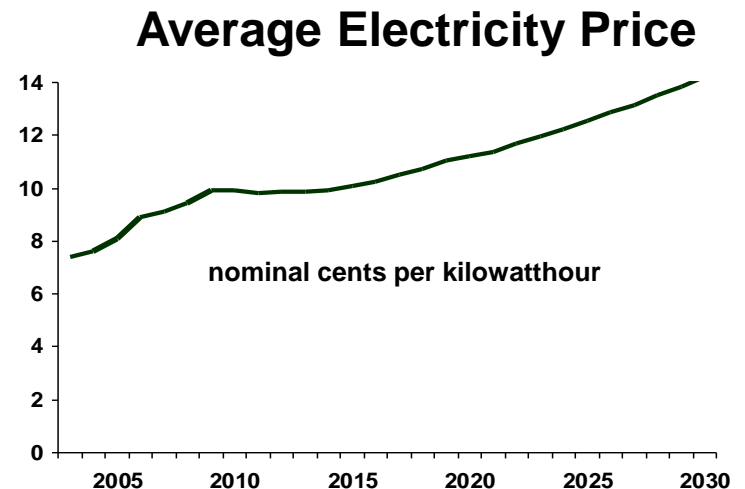
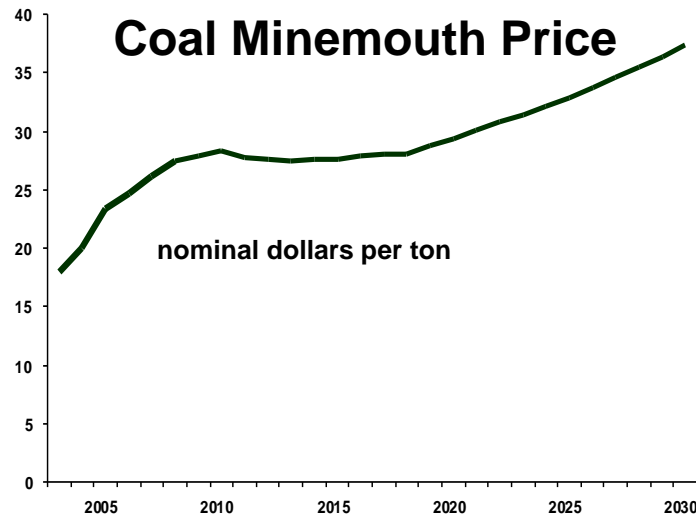
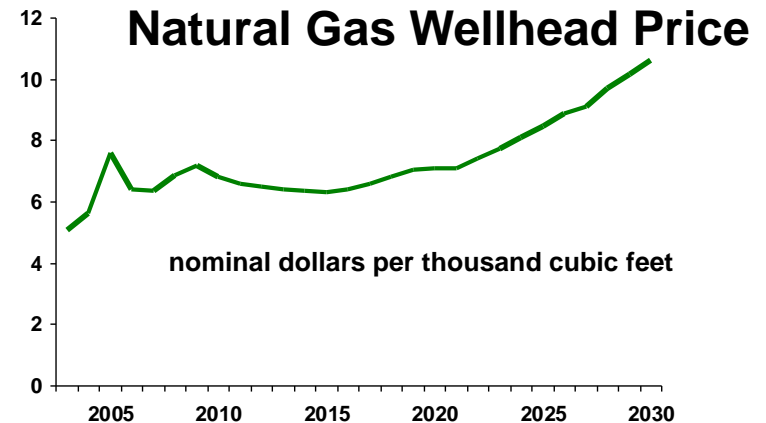
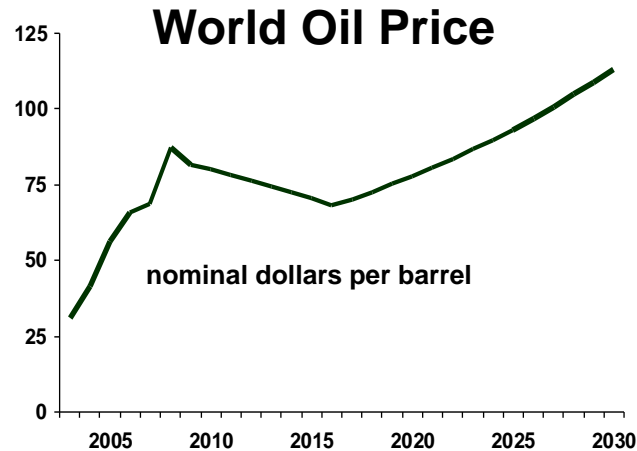


State and Local
Climate and Energy Program



Producing Reliable Energy
& Preserving the Environment

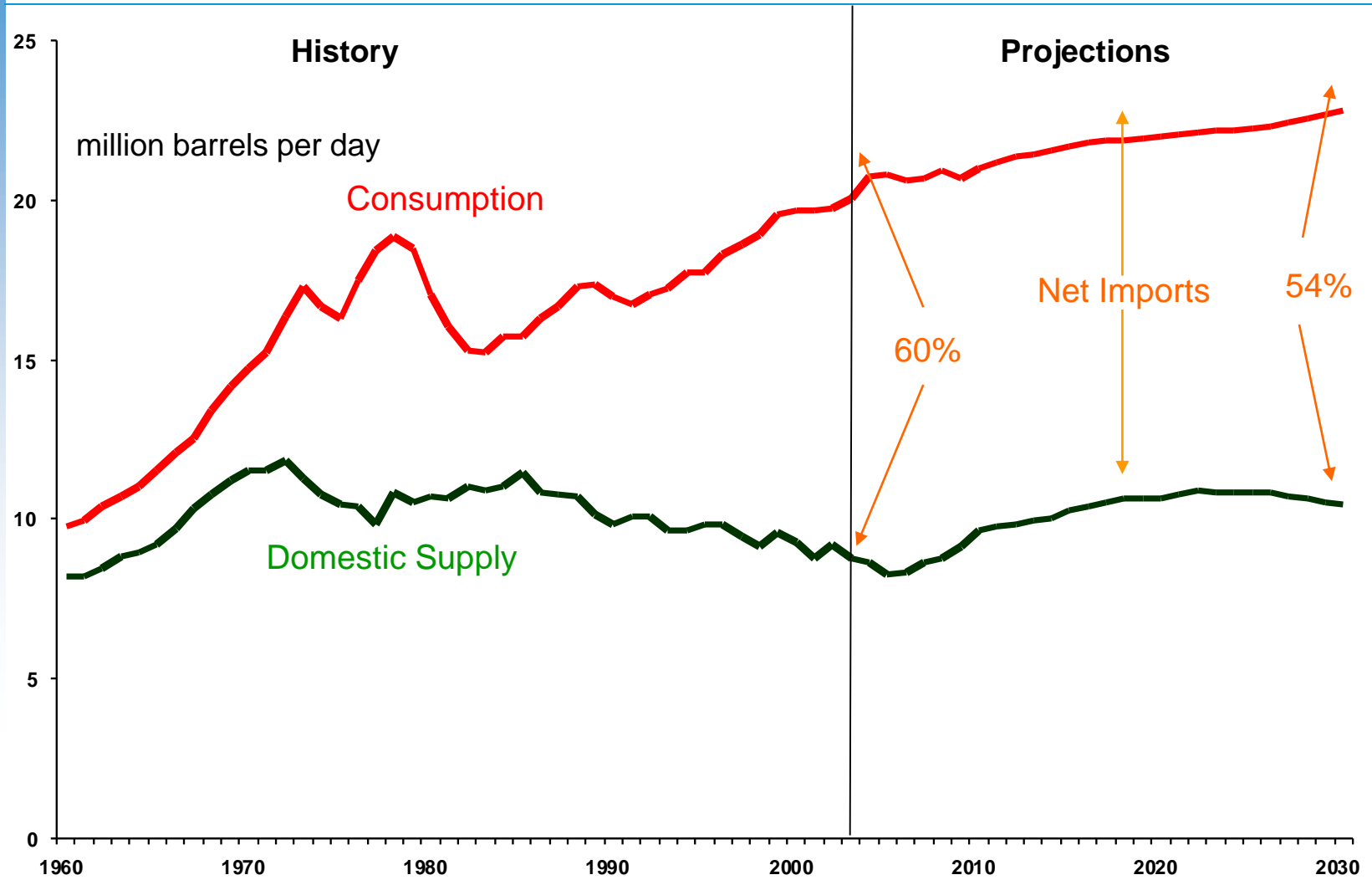
Annual Energy Outlook 2008 Price Forecasts



IEA Annual Energy Outlook 2008



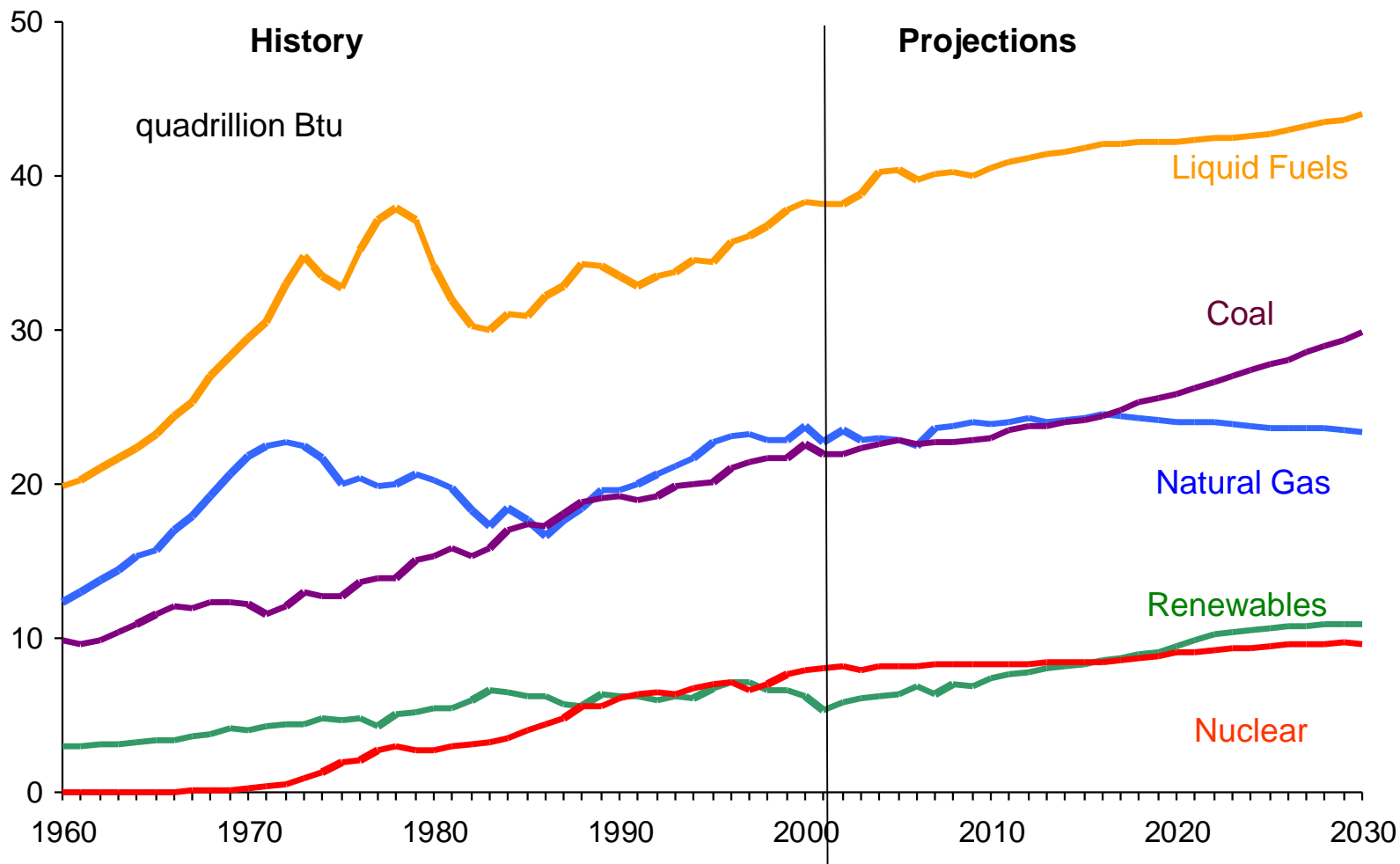
US Dependence on Imported Liquid Fuels



IEA Annual Energy Outlook 2008



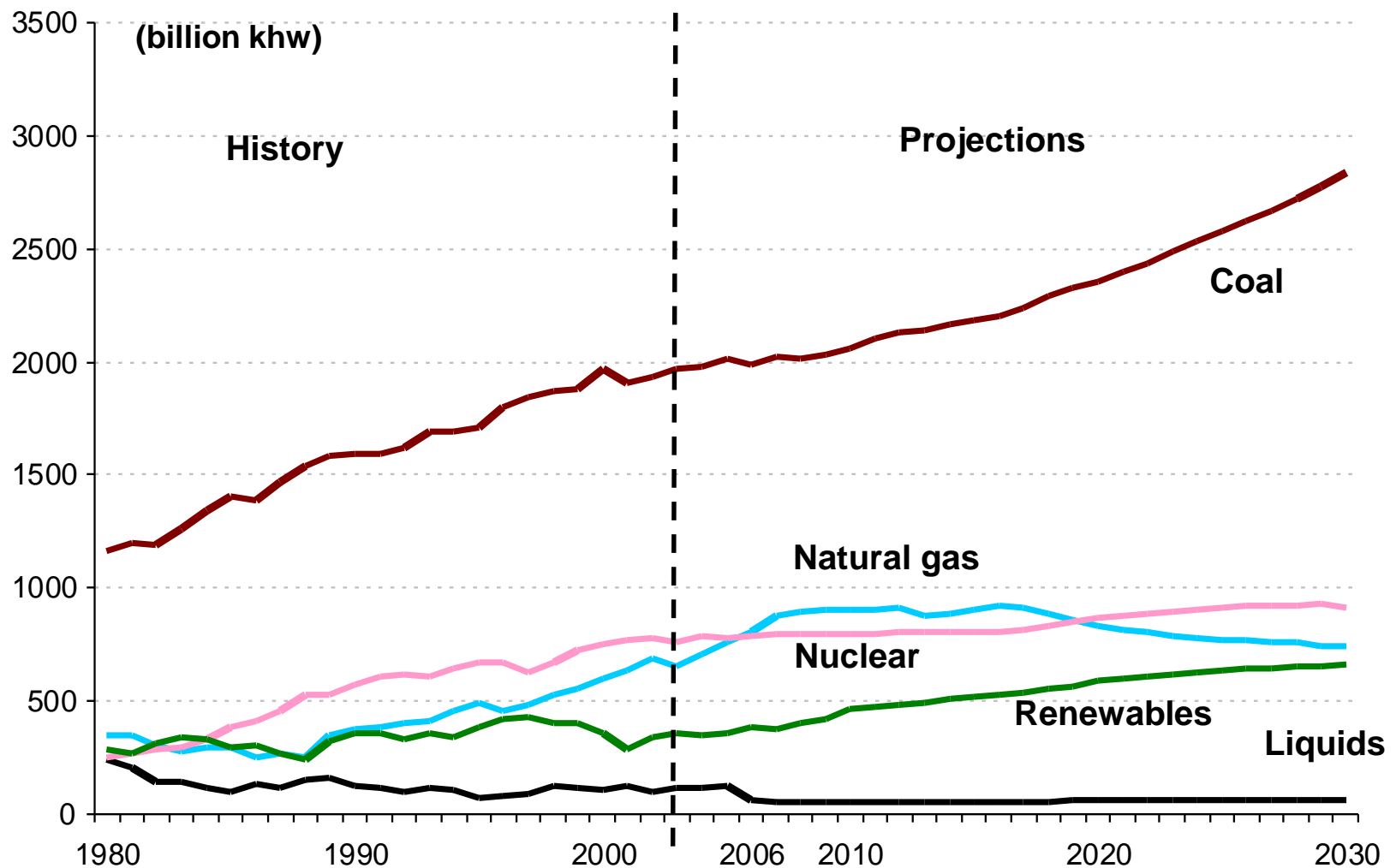
Energy Consumption by Fuel Type



IEA Annual Energy Outlook 2008



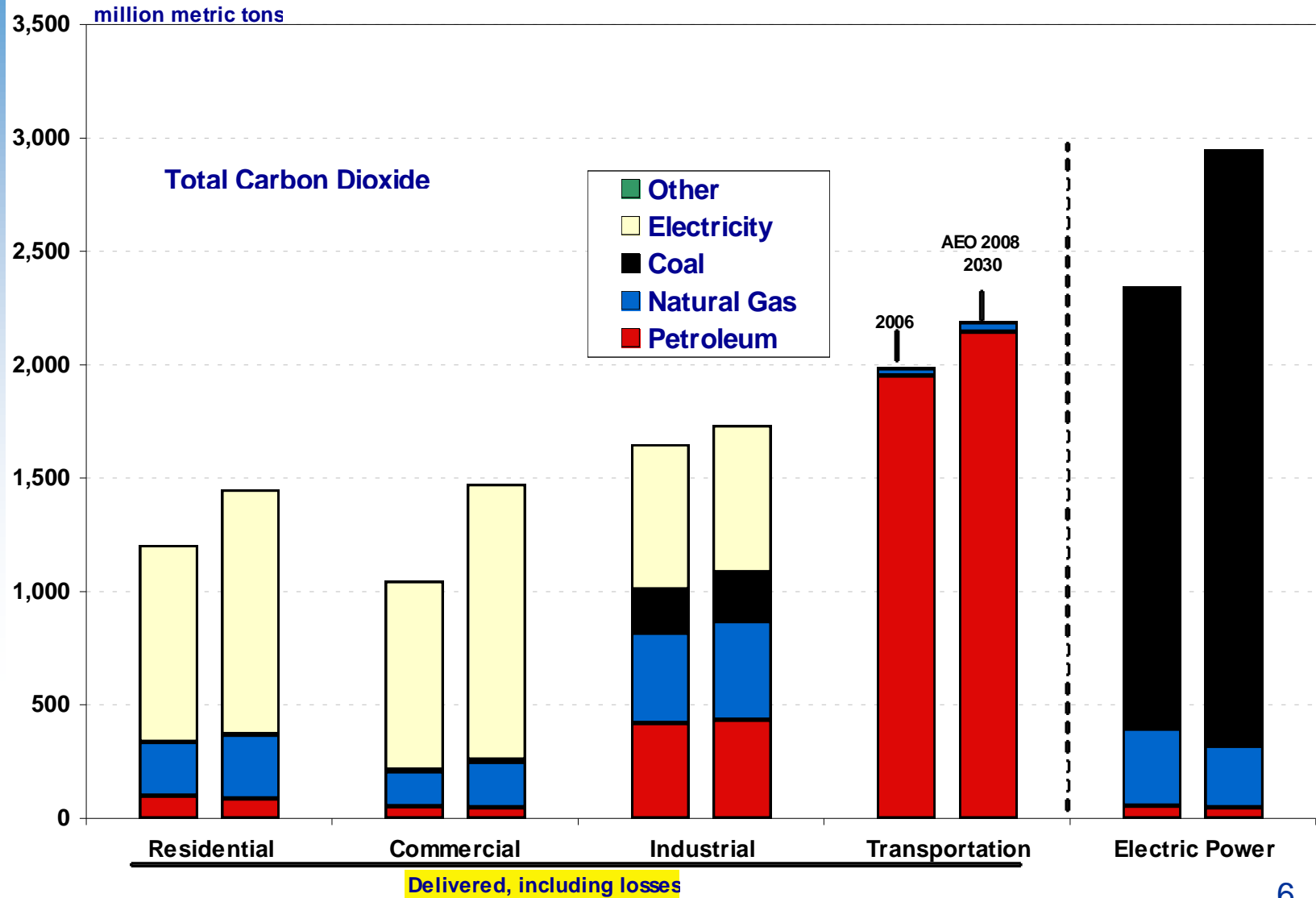
Electricity Generation by Fuel 1980-2030



IEA Annual Energy Outlook 2008



Current & Future CO₂ Emissions



Expected Impacts by Sector from Climate Change

- **Health**
 - Likely to affect the **health status of millions of people**, particularly those with low adaptive capacity
 - Increased deaths, disease & injury from **heat waves, floods, storms, fires & droughts**;
 - Increased frequency of **cardio-respiratory diseases** from higher concentrations of ground level ozone related to climate change
- **Food production**
 - **Crop productivity projected to increase slightly at mid to high latitudes** for local mean temperature increases of up to 1-3°C depending on the crop, & **then decrease** beyond that in some regions.
 - At lower latitudes, crop productivity is projected to decrease for even small local temperature increases (1-2°C), which would **increase risk of hunger**.
- **Ecosystems**
 - The **resilience of many ecosystems is likely to be exceeded this century** by an unprecedented combination of climate change, associated disturbances
- **Water**
 - By mid-century, annual average river runoff & water availability projected to **increase by 10-40% at high latitudes** & in some wet tropical areas, & **decrease by 10-30% over some dry regions** at mid-latitudes and in the dry tropics, some of which are presently water stressed areas.

Source: IPCC (2007) Summary for Policymakers of Working Group II.



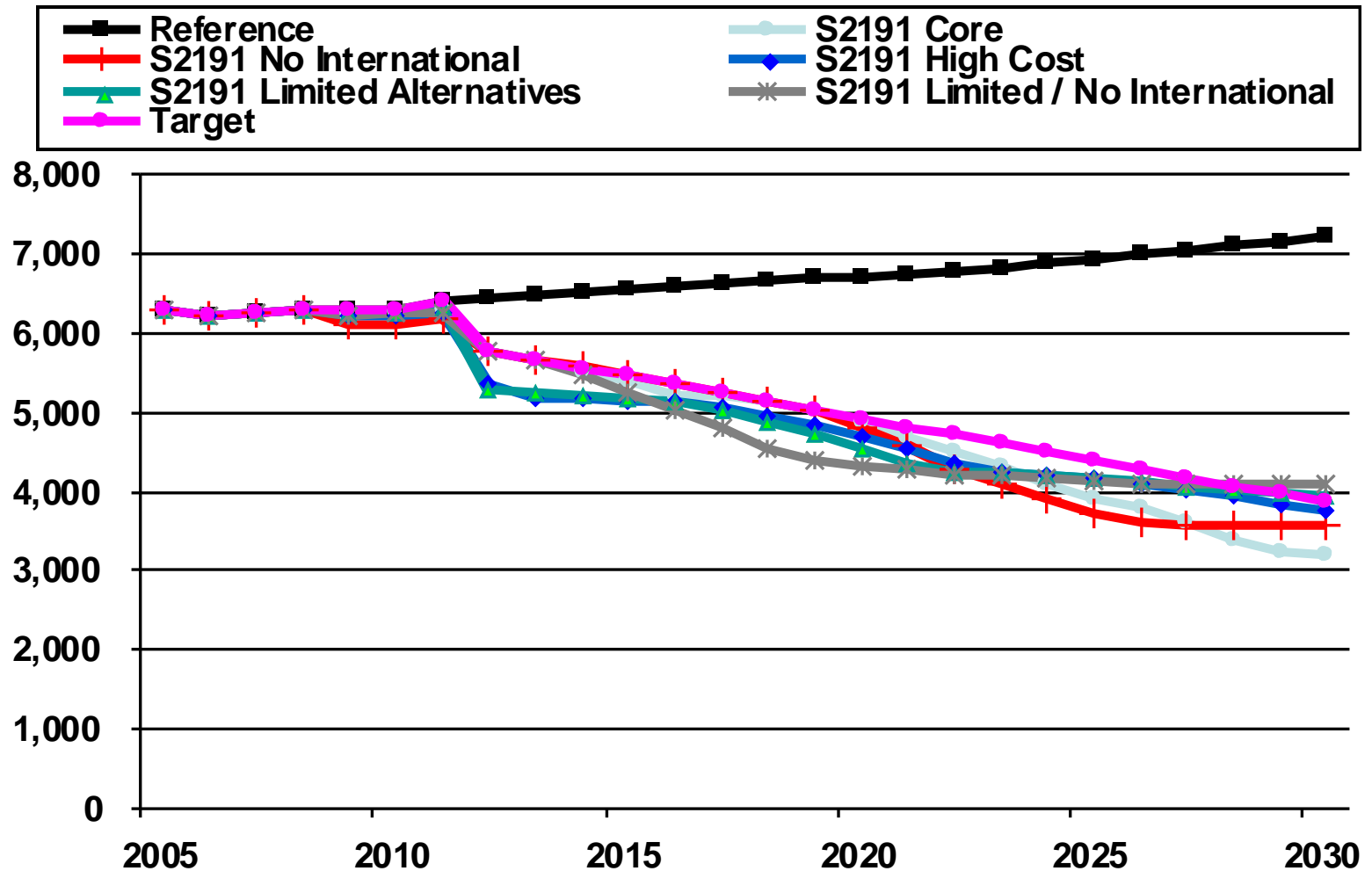
Climate Change Seen as Threat to U.S. Security

- The **Pentagon and the State Department** have studied issues arising from dependence on foreign sources of energy for years **but are only now considering the effects of global warming in their long-term planning documents.** The Pentagon will include a climate section in the Quadrennial Defense Review, due in February; the State Department will address the issue in its new Quadrennial Diplomacy and Development Review.



Greenhouse Gas Emissions

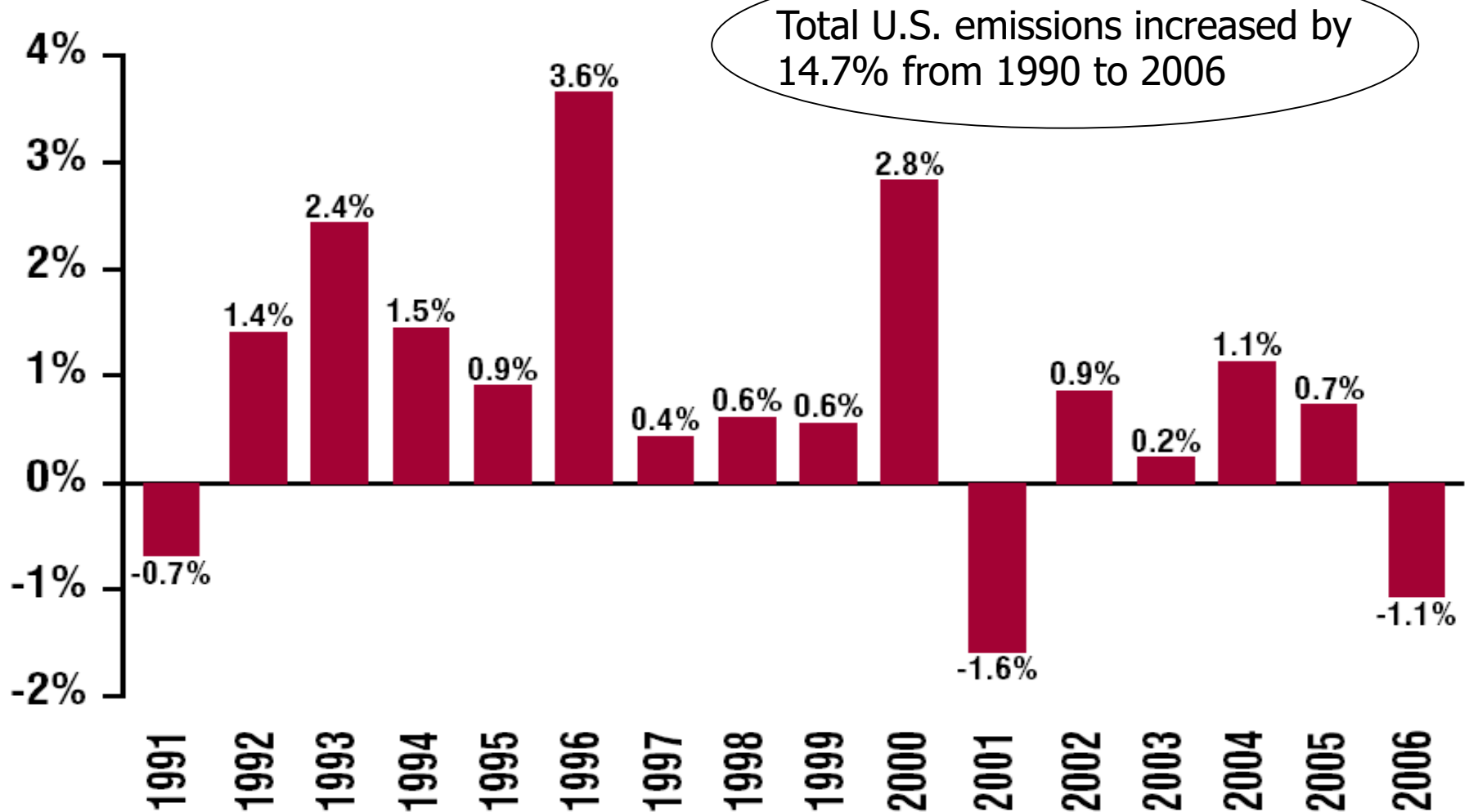
(million metric ton carbon dioxide equivalent)



Covered entities are expected to slightly over comply through 2030 to prepare for compliance beyond 2030.

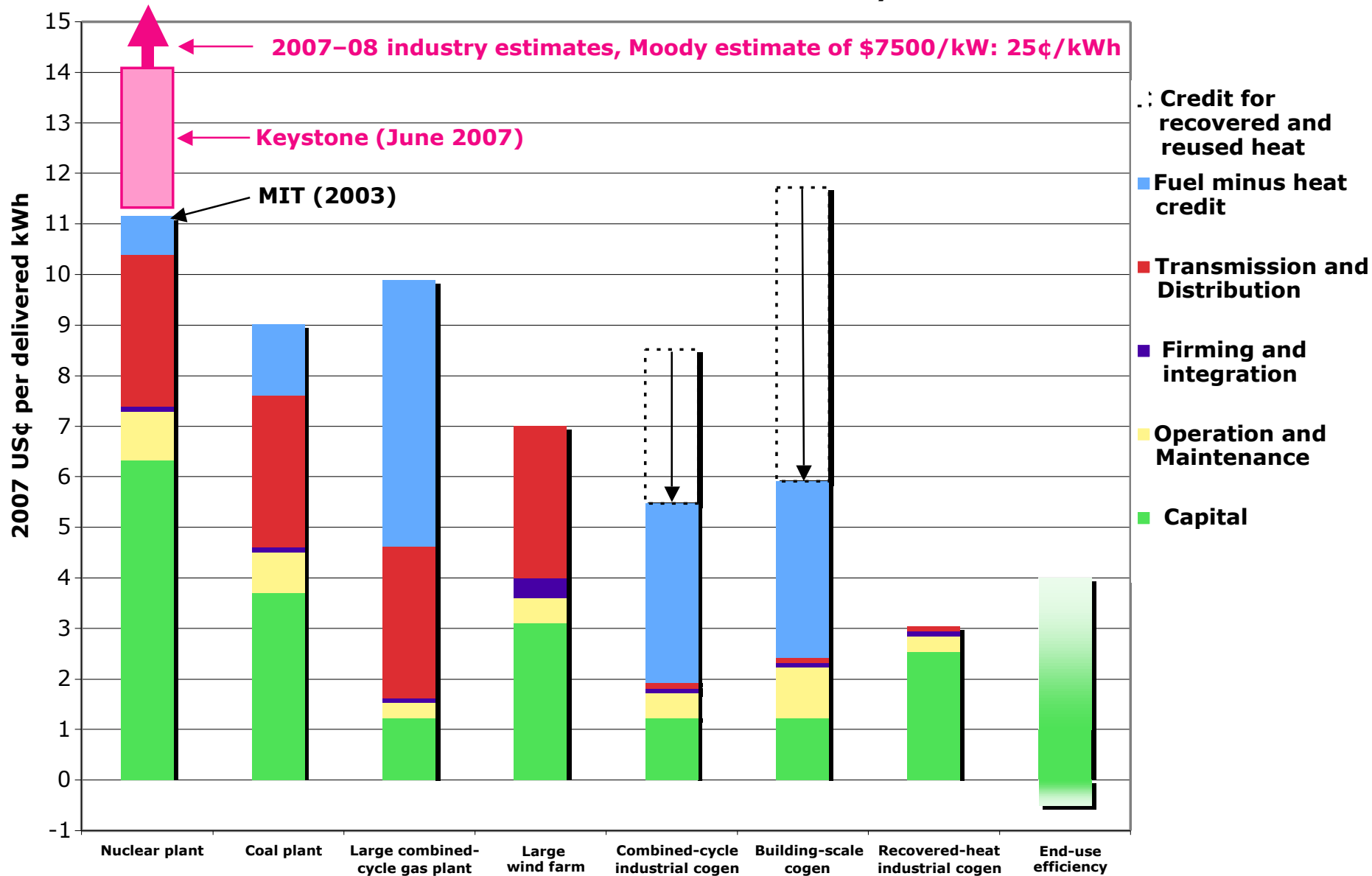


Cumulative change in U.S. GHG Emissions Since 1990



Energy Efficiency: A Cheaper Resource

Cost of new delivered electricity



Federal Climate Change Policy Update

- American Clean Energy & Security Act of 2009
 - “Waxman-Markey” – H.R. 2454 Passed in June
 - Discussion of general building efficiency requirements but no specific requirements around datacenters
 - Goal: to have legislation in time for the UN Climate Change Conference in Copenhagen
- More attention expected to be paid to buildings, the need for disclosure of energy consumption information and the associated GHG emissions.



Regional Climate Change Efforts

- **Western Climate Initiative** - Relevant to LARGE NW users of electricity
 - Goal: Reduce GHG pollutants to 15% of 2005 levels by 2020
 - January 1, 2012: Phase 1 covers emissions from electricity, including imported electricity, industrial combustion at large sources, and industrial process emissions.
 - 2015: Phase 2 expands the program to include transportation fuels and residential, commercial and industrial fuels not otherwise covered
- Regional efforts may play a role depending on the outcome national climate change legislation,.

www.westernclimateinitiative.org



Regional GHG Programs cont.

- **Regional Greenhouse Gas Initiative (RGGI)'s CO2 Budget Trading Program:**
 - 10 states in NE US (CT, DE, ME, MD, MA, NH, NJ, NY, RI, & VT)
 - Caps CO2 emissions from electric power plants, starting in 2010. Goal: 10% reduction by 2018
 - **Status:** 2009 is first year of compliance; four allowance auctions held so far, raising millions for energy efficiency and renewable energy projects
- **Midwest GHG Reduction Accord**
 - 6 states (IA, IL KS, MI, MN, WI) + one province (Manitoba)
 - April 2009 - Finalized recommendations for Midwest program design elements for back-stop regional GHG trading program if no national trading system; similar design to WCI's.
 - **Status:** Currently focusing on providing recommendations to Congress for national cap and trade program.



State & Municipal Policy Update

- Trend towards energy codes that mandate reporting of building energy use
- Washington State: SB 5854, passed Spring 2009
 - January 1, 2010 - Qualifying utilities must maintain and make available to building owners records of the energy consumption data of all nonresidential buildings they serve
 - Starting in 2011-2012, Non-public, non-residential building performance data must be uploaded to **ENERGY STAR Portfolio Manager**; implementation differs depending on the size of the building
- Data centers are not exempt from these requirements

Wash state: <http://bcap-energy.org/node/371>

DC: http://www.energy codes.gov/news/items/111708_dc_report.stm



Mandatory GHG Mandatory Reporting Rule

- **Objective** – To provide accurate data that will inform and support development of national climate policy
 - Final rule approved by White House Sep. 22
- **Six greenhouse gases covered:** carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulfur hexafluoride (SF₆), and other fluorinated gases including nitrogen trifluoride (NF₃) and hydrofluorinated ethers (HFE).
- **Approximately 85% of US total** GHG emissions covered by this rule (about 10,000 reporters)



GHG Source Category Coverage

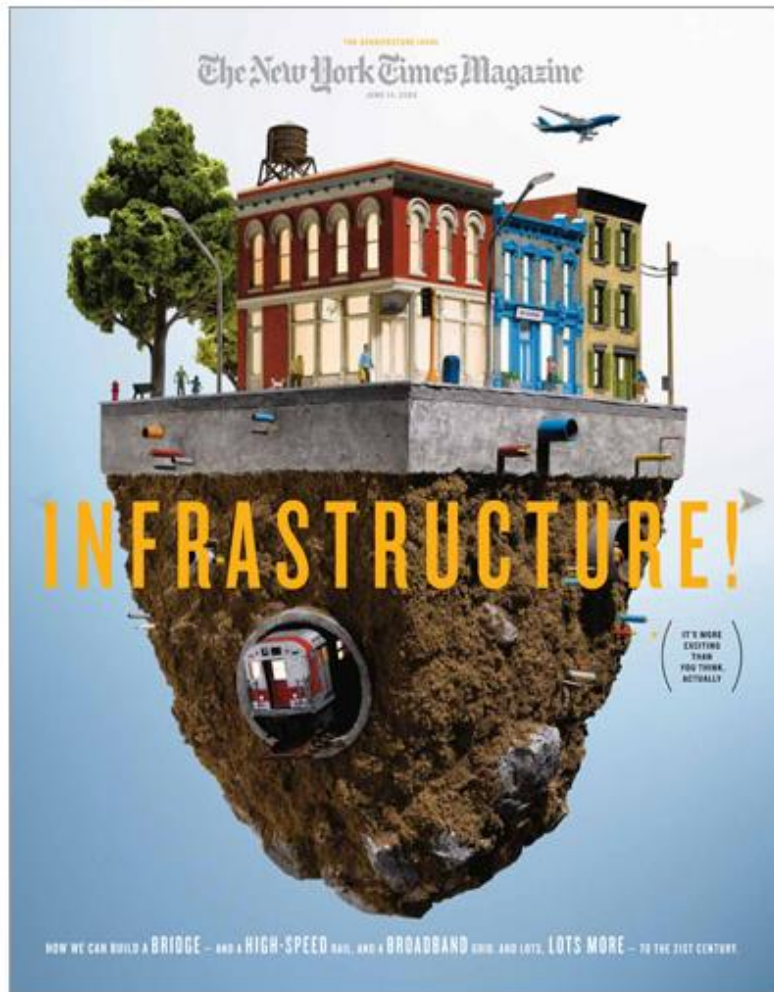
Applies to 29 specific categories of covered sources

- **Both upstream & downstream** suppliers of fossil fuels, producers of aluminum, cement, iron and steel, glass, and various chemicals (both direct emitters and consumers of fuels & chemicals)
 - **Upstream sources** covered includes producers, importers and exporters of petroleum products, natural gas, and industrial GHGs. They will report based on GHG content of fuels or gases they supply to the market.
- **Covers fuel, vehicle, and engine manufacturers and suppliers** but light duty engines exempt because of separate rule making.
 - Starts with CO₂ in model year 2011 and other GHGs in subsequent model years. Individual car and truck owners and fleet owners excluded
 - Added NOx requirement for aircraft engine manufacturers from proposed rule, but postponed CH₄



“Data Center Overload”

The NY Times Magazine - June 14, 2009



DATA TECHTURE

Flickr, MySpace, iTunes, Gmail.
In our hyperconnected, superfast age, how can the internet
data centers we've built keep up?
BY TOM VANDERKIL

Big game with an Xbox game.
On a recent rainy evening in Brooklyn, I was at a friend's house playing a hit sheepskin, given my impatient middle-aged Call of Duty: World at War. Smiling through the game's menu, I noticed a screen for Xbox Live, which allows you to play against remote users via broadband. The number of Call of Duty players online at that moment? More than 66,000.

Walking home, I fantasized on the number. Sixty-six thousand is the population of a small city — Munich, Ind., for one. Who and where was this invisible metropolis? What infrastructure was needed to create this city of ether? We have an almost identical technology when it comes to infrastructure. It needs to be there in our imagination only when it's not working. The Google search results that are returned in 0.1 seconds were once a rising agony as they were because just another assumption in our lives, like the air we breathe. Yet whose day would proceed

PHOTOGRAPHS BY SUZANNE KENT
Known for its lean and spartan fields, Quincy, Mass., is also home to rows of servers in a 500,000-square-foot data center that Microsoft built in 2005.

Though data centers are as ubiquitous as the clouds, Microsoft did struggle that way in Quincy, Mass., could hold 6.75 million photographs.

Company offered. And so when you think about Internet supporting 375 million users, or search supporting three billion queries a month, or Messenger supporting hundreds of millions of users, you can easily see that these properties are very large properties for our company.

Thanks to the efforts of Amazon Internet Communications, there are occasional glimpses behind the silicon curtain. One Amazon manager to copy a memo from a 2005 video of a Microsoft executive's PowerPoint presentation showing that the company had nearly 150,000 servers in a number that presumably would now be much higher, given an estimated monthly server growth of 10,000 and that nearly 80,000 of those were used by its search application, now called Bing. When I discussed the figures with her, Company would only ever, cryptically, that "in an average data center, it's not uncommon for search to take up a big portion of a facility."

THE RISE OF THE MEDIA DATA CENTER

Data centers were not always unattended, unassuming and highly restricted places. In the 1960s, in fact, large IBM mainframe computers commanded pride of place in corporate headquarters. "I was called the gluttonous," says Kenneth Bell, founder of the Uptime Institute, a data-center research and consulting group. "I was located near the executive suite. Here you'd spend \$5 to \$10 million on this thing — the executives wanted to show it off."

Over the past few decades, Bell notes, there has been an oscillation between using centralized IT resources and using more dispersed computing power — a battle between mainframes and desktop computers. The latest iteration of what's called the thin client: the use of constrained servers rather than the software and operating systems of desktops to perform the bulk of computing needs. But this is the effect has come with increased thickness elsewhere: more servers in ever-larger data centers.

In his book "The Big Switch," Nicholas Carr draws an analogy between the rise of mega-data centers and the Industrial Revolution. Just as ancient industries, once powered by water wheels, were by the 20th century able to "run their machines with electric current generated in distant power plants," advances in technology and transmission speeds are permitting computing to function like a utility, a distant but ever-accessible cloud of services.

This has sweeping implications for business and society. Instead of

buying software and hiring IT employees, companies can outsource things like customer relationship management, or CRM, the database software that companies use to track client interactions, to an Internet company like Salesforce.com, which sells subscriptions, or rents, to its services. "Customer who have two seats on salesforce.com, like a mom-and-pop flower shop, have access to the same application as a customer that has 65,000 seats, like Starbucks or Dell," Adam Ossi, vice president of platform marketing with salesforce.com, told me at the company's offices in San Francisco. By contrast, just a few years ago, however, "if you were to attack a really large problem, like delivering a CRM application to 50,000 companies, or serving every single song ever, it really sort of felt outside your domain unless you were one of the largest companies in the world. There are these architectures now available for anybody to really attack these massive-scale kinds of problems."

And while most companies will maintain their own data centers, the promise is that instead of making costly investments in redundant IT hardware, more and more companies will tap into the utility computing grid, piggybacking on the infrastructures of others. Already, Amazon Web Services makes available, for a fee, the company's enormous computing power to outside customers. The division already more than handles Amazon's extensive retailing operations, while its Simple Storage Service holds some 52 billion virtual objects. "We used to think that owning facilities was an important piece of a business's value," says Bryan Doern, the chief technology officer of Savvis, which provides IT infrastructure and what the company calls "virtualized utility services" for companies like Hallmark. "Then we realized that owning what the factory produces is more important."

THE ANNIHILATION OF SPACE BY TIME

For companies like Google, Yahoo and, increasingly, Microsoft, the data center is the factory. What these companies produce are services. It was the increasing "viability of a service-based model," as Ray Ossi, now the chief software architect at Microsoft, put it in 2005 — portended initially by Google and its sprawling scale network of data centers — that Microsoft set in its high data-center rollout. If people no longer needed desktop software, they would no longer need Microsoft. This realization brought new seriousness to the humble infrastructure layer of the data centers, an aspect of the business that at Microsoft, at almost such companies, typically escaped notice — unless it wasn't working. Data centers have now become, as Dena Chappas of Microsoft put it, a "true differentiator."

Indeed, the number of servers in the United States nearly quadrupled from 1997 to 2007 (according to Bell of the Uptime Institute, some 400 mega-data centers of Google and its ilk account for only an estimated 5 percent of the total machine). The expansion of Internet-driven business models, along with the data retention and compliance requirements of a society of tighter accounting standards and other financial regulations, has

New McKinsey Consulting Report

- *Unlocking Energy Efficiency in the U.S. Economy*
 - Notes EPA's projection of data center energy use growth by 9.6%/year through 2020
 - As many as 30% of servers consuming electricity operating at less than 3% daily utilization
- Message – efficiency a significant energy resource – abating as much as 1.1 gigatons of CO₂ by 2020 - but accessible only if a national policy can be crafted to unlock it

McKinsey & Company

McKinsey Global Energy and Materials

Unlocking Energy Efficiency in the U.S. Economy



www.mckinsey.com/USenergyefficiency



Why Data Centers?

Annual source energy use of a 2MW data center is equal to energy consumed by 4,600 typical U.S. cars in one year



=



2MW data center

4,600 typical U.S. cars



Growing Interest by Utilities



“By 2012, Virginia-based Dominion Power estimates that fully 10 percent of all the electricity it sends to northern Virginia will be gobbled up by [the region’s] data centers.”



Energy Efficiency Opportunities



- Server innovation
- Virtualization
- High efficiency power supplies
- Load management

- Better air management
- Move to liquid cooling
- Optimized chilled-water plants
- Use of free cooling
- Heat recovery

Power
Conversion &
Distribution

Server Load/
Computing
Operations

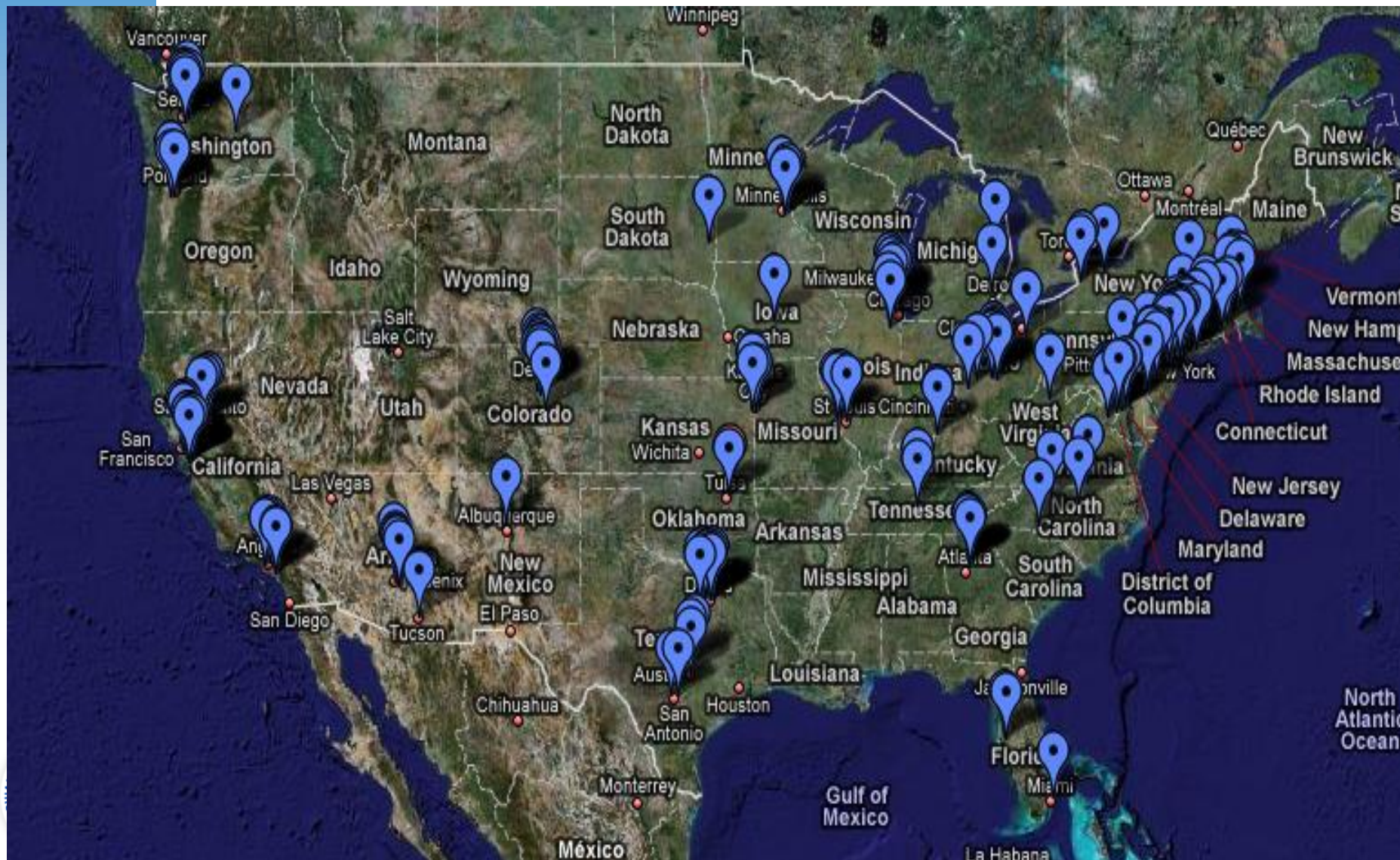
Cooling
Equipment

- High voltage distribution
- High efficiency UPS systems
- Efficient redundancy strategies
- Use of DC power

Alternative
Power
Generation

- On-site generation
Including fuel cells and
renewable sources
- CHP applications
(Waste heat for cooling)

Participating Datacenters



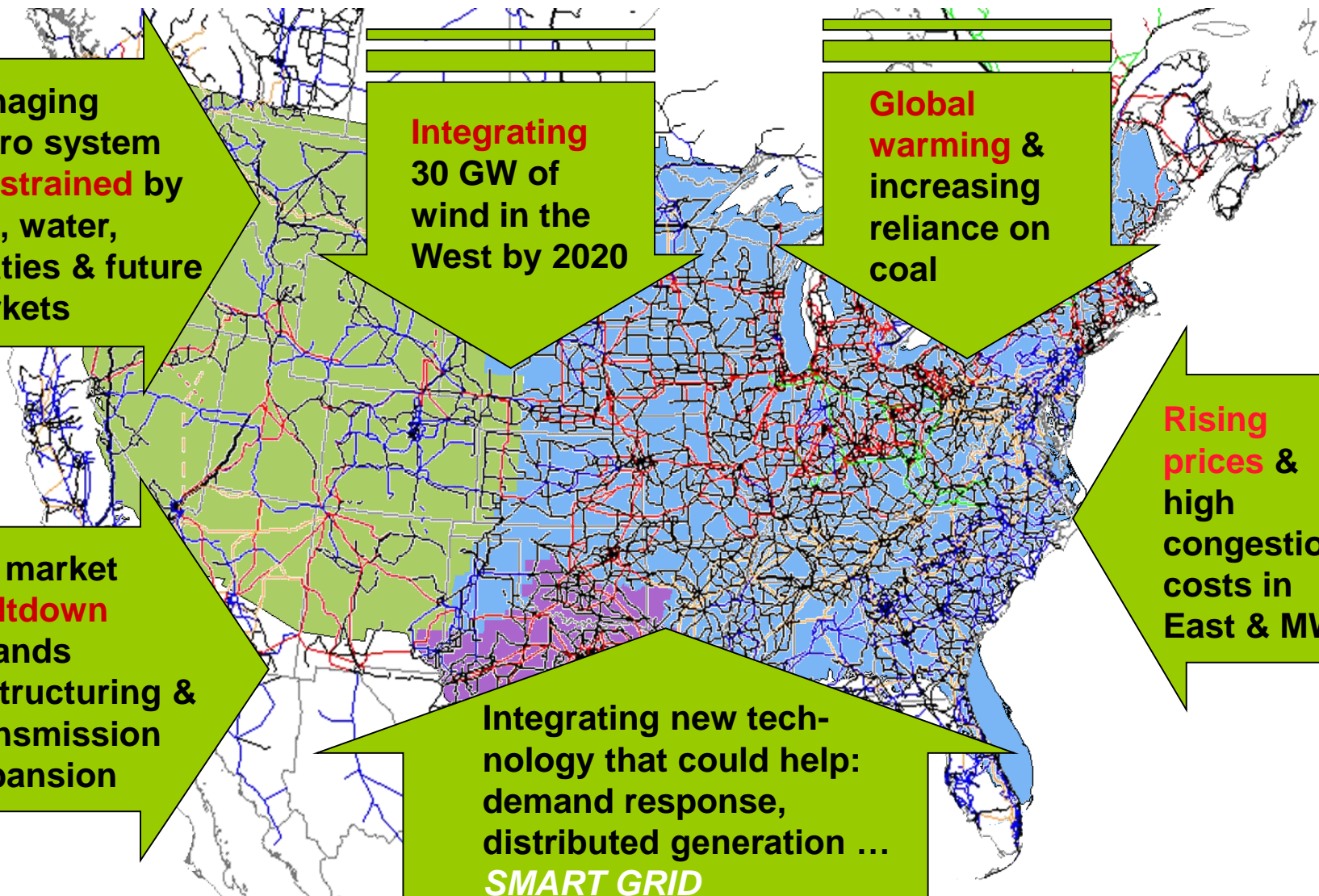
ENERGY STAR Rating for Data Center Facility



- Built on existing ENERGY STAR platform (1-100 scale)
- Score of 75 or higher qualifies for ENERGY STAR designation
- Applies to both stand-alone data centers & those in an office or other building
- Assess performance at the building level to explain how a building performs -- not why it performs a certain way
- Point users to additional unbiased resources to help pursue a tailored strategic energy management plan based on business goals and available resources
- Expect early 2010 announcement



We are facing large transmission and generation investments in an uncertain economic environment



Managing hydro system **constrained** by fish, water, treaties & future markets

Integrating 30 GW of wind in the West by 2020

Global warming & increasing reliance on coal

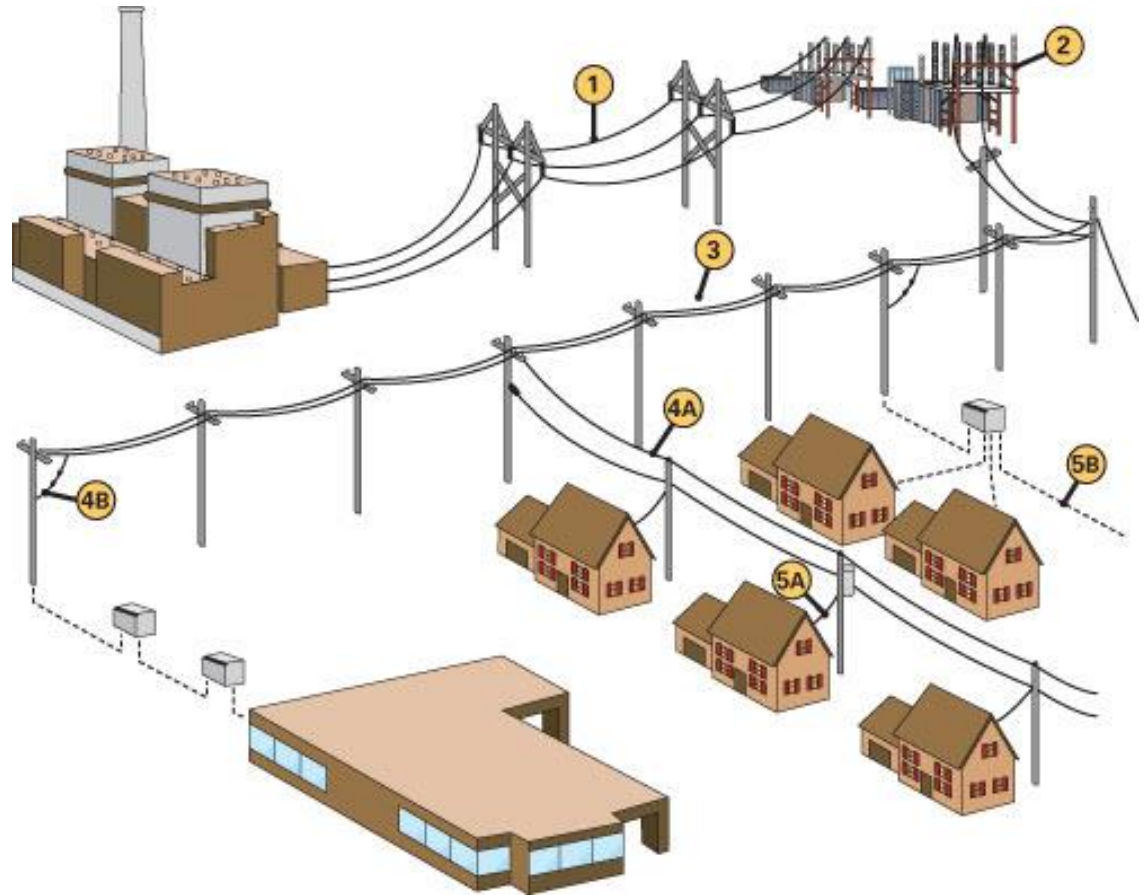
CA market **meltdown** strands restructuring & transmission expansion

Rising prices & high congestion costs in East & MW

Integrating new technology that could help: demand response, distributed generation ...
SMART GRID

Today's "old" electric grid

- Central station power plants
- Low load factor
- Consumers don't see real TOU price of energy
- Low RE & DG integration



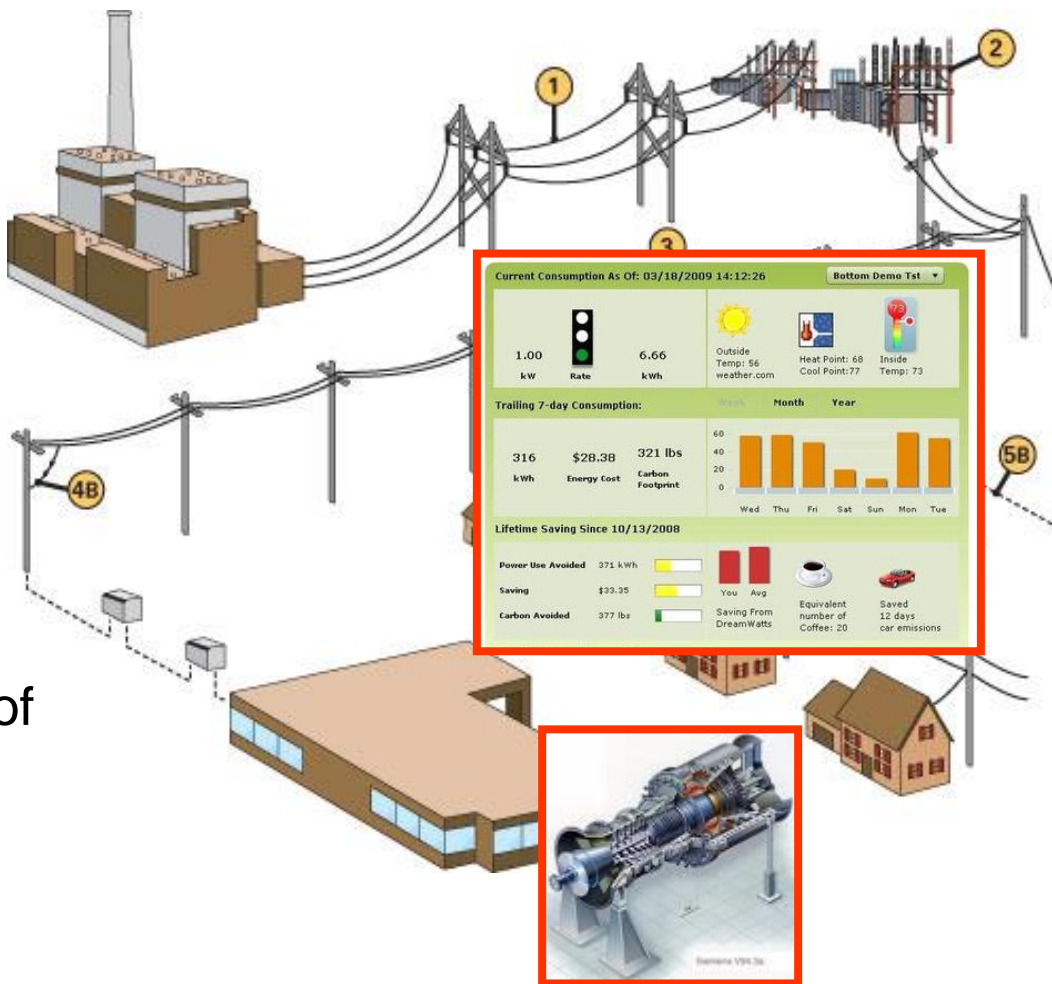
Source: DTE Energy (<http://my.dteenergy.com/products/electricity/images/electricFlow.jpg>)



Tomorrow's next generation electric grid



- More DG, RE, storage
- Information to customers
- Electrification of transportation sector



Source: DTE Energy (<http://my.dteenergy.com/products/electricity/images/electricFlow.jpg>)



What Defines the Smart Grid?

- Many definitions exist but all involve information technology (IT)
 - (1) Power system that has an **intelligent communications** infrastructure enabling the timely, secure and adaptable information flow needed to provide the **right information to the right entity** (e.g. end-use devices, T&D system controls, customers, etc.) at the right time to take the right action
 - *Electric Power Research Institute*
 - (2) Increased use of digital information & controls to improve **reliability, security**, efficiency of the grid; increased use of **distributed generation & renewable energy, demand response, energy efficiency**, use of smart technologies & appliances (like meters, distribution automation), **storage**, information to consumers, development of interoperability standards for device to grid communication, lowering of barriers to adopting smart grid
 - *2007 Energy Independence and Security Act*
- Plethora of technologies that “qualify” - Chinese vs. fixed menu
- Smart Grid technologies and practices already exist BUT not at scale



Smart Grid Federal, State & Utility Activities

Federal

- Energy Independence and Security Act 2007 Title XIII
- American Recovery and Reinvestment Act: ~\$4.5 Billion
- National Institutes of Standards (NIST): interoperability

State/ Utility

- Many utilities invested \$ billions
 - Advanced Metering Infrastructure
 - Less attention in transmission & distribution
 - Buildings focus has been in residential sector
- Some pilots and deployments moving beyond AMI
 - **E.g., Xcel Energy Smart Grid City project, Boulder**



Smart Grid and Clean Energy: Technologies

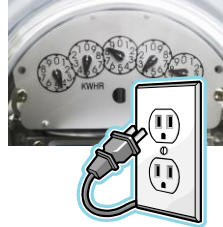
ELECTRICITY GRID — CONNECTIONS — CUSTOMERS



- Transmission monitoring (e.g., dynamic line ratings, phasor measurement units)
- Conservation voltage control
- Energy storage
- Grid-integrated wind forecasting
- Distribution automation
- Flexible alternating current transmission systems



- Plant optimization software
- Monitoring of feed water performance



- Advanced meter infrastructure, including advanced net meters
- Energy data management



Communications Backbone

- Broadband
- Wireless
- Spectrum



- Home area networks & home energy monitors
- Communicating programmable thermostats
- Grid-connected appliances
- Grid-connected solar PV



- Grid-connected controls and equipment



- Advanced building diagnostics (using whole building energy use)
- Grid-connected building controls and equipment



- Grid-connected electric vehicles, including “smart” charging systems

Smart Grid and Clean Energy: Potential GHG reduction pathways

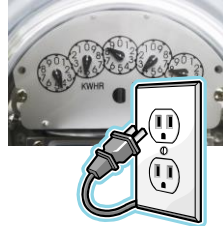
ELECTRICITY GRID — CONNECTIONS — CUSTOMERS



- Energy savings from reduced losses
- Increased renewables
- Reduced footprint from better land use, materials use from optimizing existing grid infrastructure



- Reduce fuel use in generators
- **Improve water management**



- Greater certainty on energy efficiency, clean demand response, and clean distributed generation resource impacts
- Increase use of zero emission options to support grid services



- Integrated electricity, water, and natural gas networks for improved environmental performance



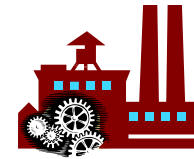
- **Energy savings from behavior change, enabled by energy information**

All customer classes:

- Greater certainty of energy/bill savings from energy efficiency (practices, technologies etc) and behavior changes
- Bill savings from demand response may be used to fund efficiency and on-site clean energy



- **Energy savings from post-diagnostics action**



- Revenue from grid to clean energy/CHP



- Potential lower emissions than traditional or alternative transportation fuels



Why Efficiency is the 'First Fuel'

- **No clean energy strategy will work without substantially moderating demand growth**
- Rising demand is straining all conventional energy markets -- whether fossil fuel or renewable energy resources
- Bringing new supply capacity on line is increasingly tough -- clean or dirty. . . .
- Efficiency is essential to making carbon solutions both achievable and affordable
- Efficiency buys us cost-effectiveness, and buys us time to deploy clean supply options



Will Our Future be Limited by the Choices We've made?

- Energy and water sources are not inexhaustible
- Energy use continues to rise at home and abroad
- The grid needs continual expansion, increased capacity and new energy sources
- Could this lead to a future where quality of life is diminished?
- Growing trend at all levels of government to require “disclosure” of energy use & associated emissions from buildings and industry
- Benchmark your facility to document your baseline

