

Solar Turbines

A Caterpillar Company

CHP Solutions to Climate Change

DOCKET

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DATE July 23 2009

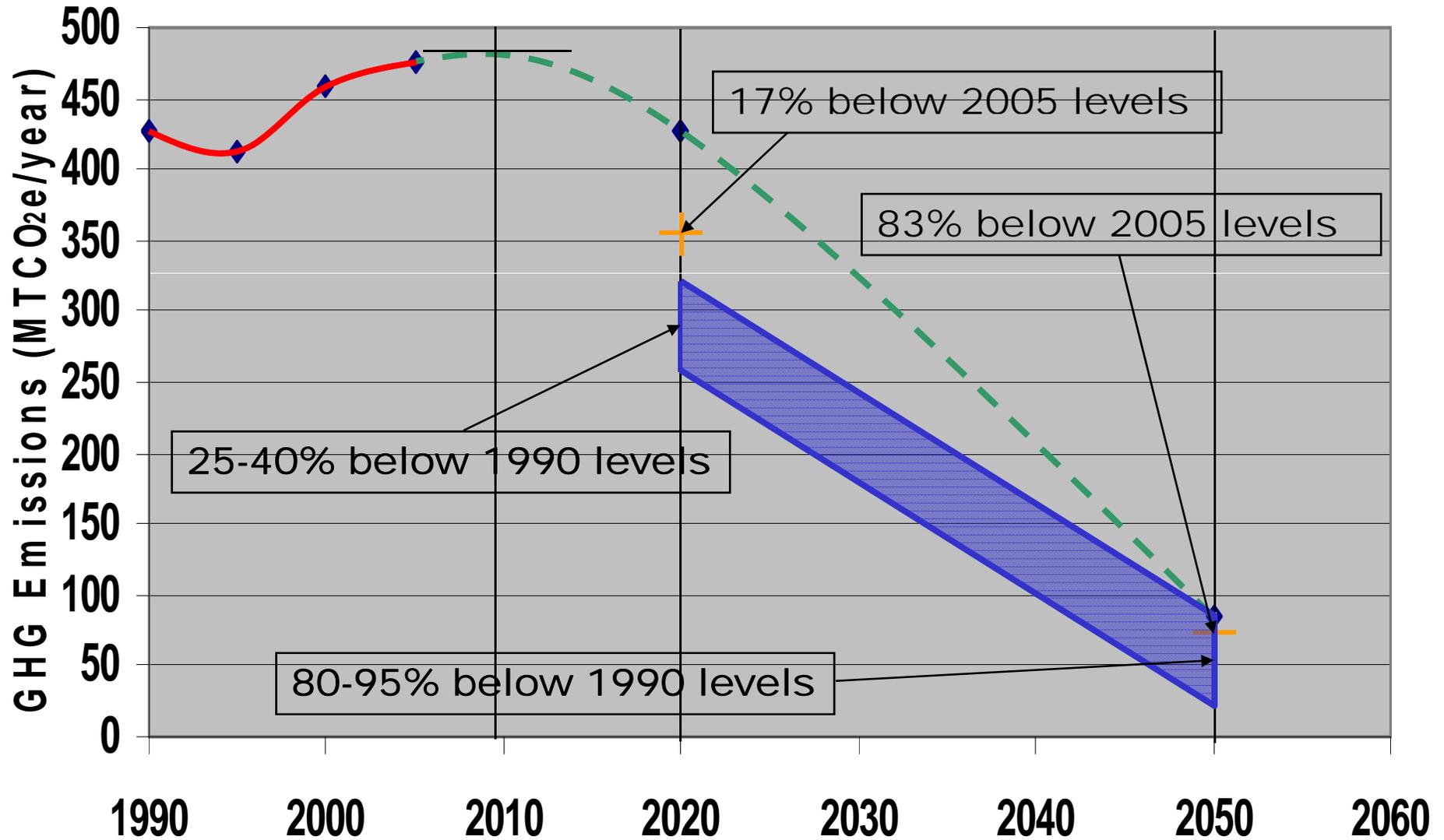
RECD. July 27 2009

David Schnaars
Manager, Environmental Strategies

California Energy Commission
CHP Workshop
July 23, 2009

- **Based in San Diego, CA**
- **In Business since 1927**
- **More than 12,500 Gas Turbines Operating in 120 Countries**
- **More than 1.3 Billion Fleet Operating Hours**
- **World's Largest Manufacturer of Industrial Gas Turbines (1 to 15 MW Range)**
- **Subsidiary of Caterpillar Inc. since 1981**

San Diego, California



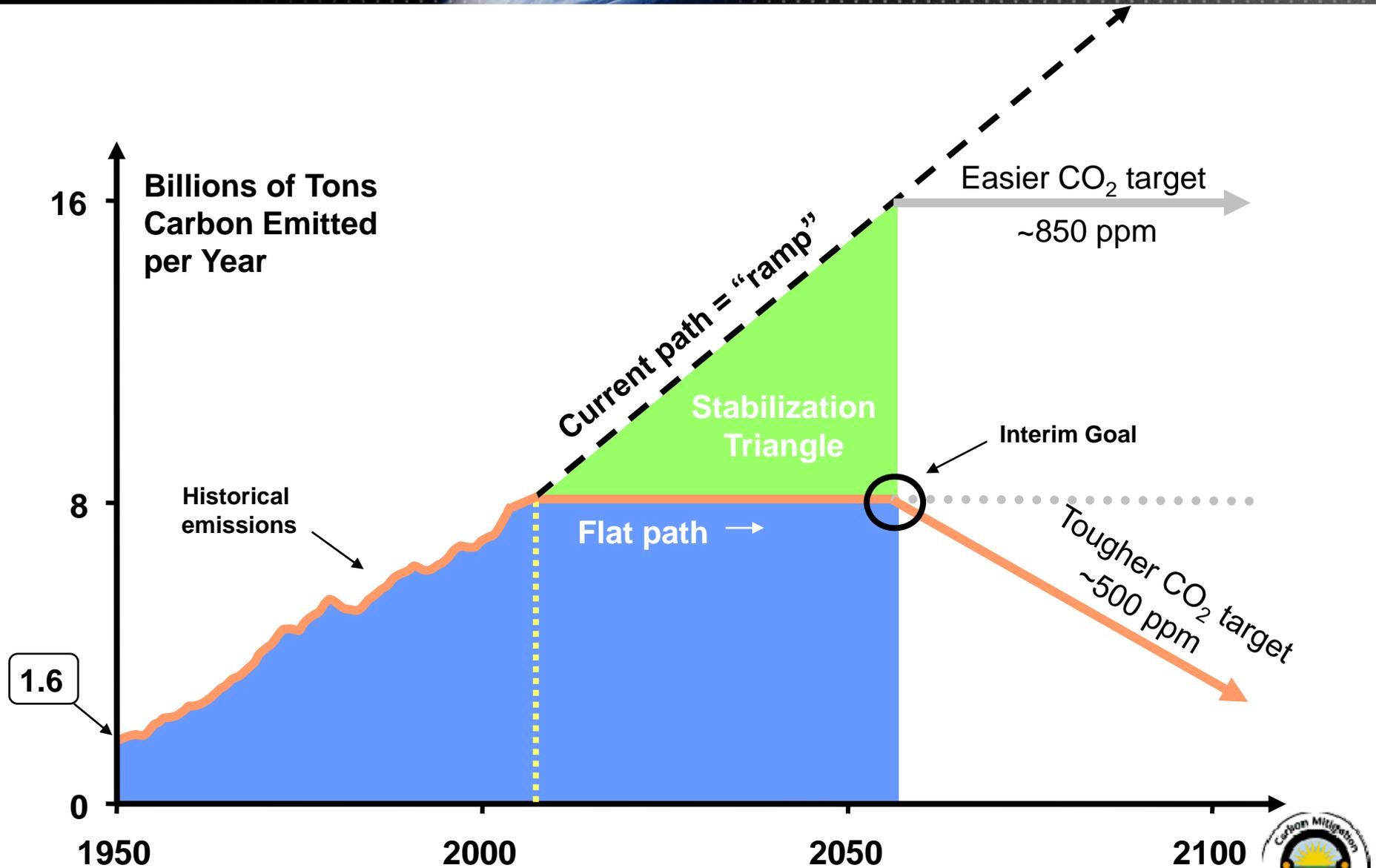
Historical Data from ARB California GHG Emissions Inventory

There Are Only 4 Ways to Reduce Greenhouse Gases:

- Switch to a Less Carbon-Intensive Fuel
- Increase Energy Efficiency
- Sequester Atmospheric CO₂
- Reduce Non-CO₂ Gas Emissions

CHP

The Stabilization Triangle



This slide based on Stabilization Wedges: Solving the Climate Problem for the next 50 Years with Current Technologies," S. Pacala and R. Socolow, Science, August 13, 2004.



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**Wind
Electricity**



Photo courtesy of DOE

**Install 1 million 2 MW
windmills to replace
coal-based electricity,**

OR

**Use 2 million windmills
to produce hydrogen
fuel**

**A wedge worth of wind electricity will require
increasing current capacity by a factor of 30**

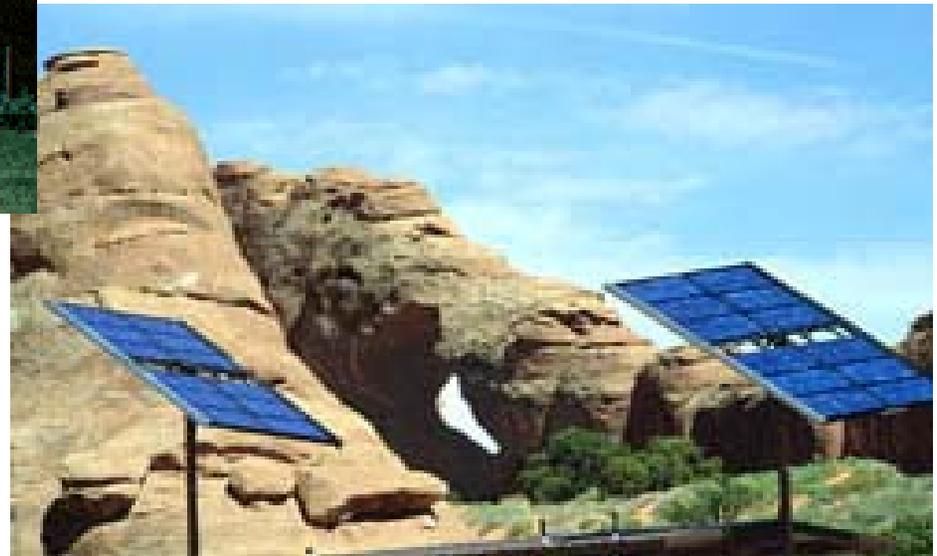
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Solar Electricity



**Install 5,000,000
acres for dedicated
use by 2055**

Photos courtesy of DOE Photovoltaics Program

A wedge of solar electricity would mean increasing current capacity 700 times

This slide based on Stabilization Wedges: Solving the Climate Problem for the next 50 Years with Current Technologies," S. Pacala and R. Socolow, Science, August 13, 2004.

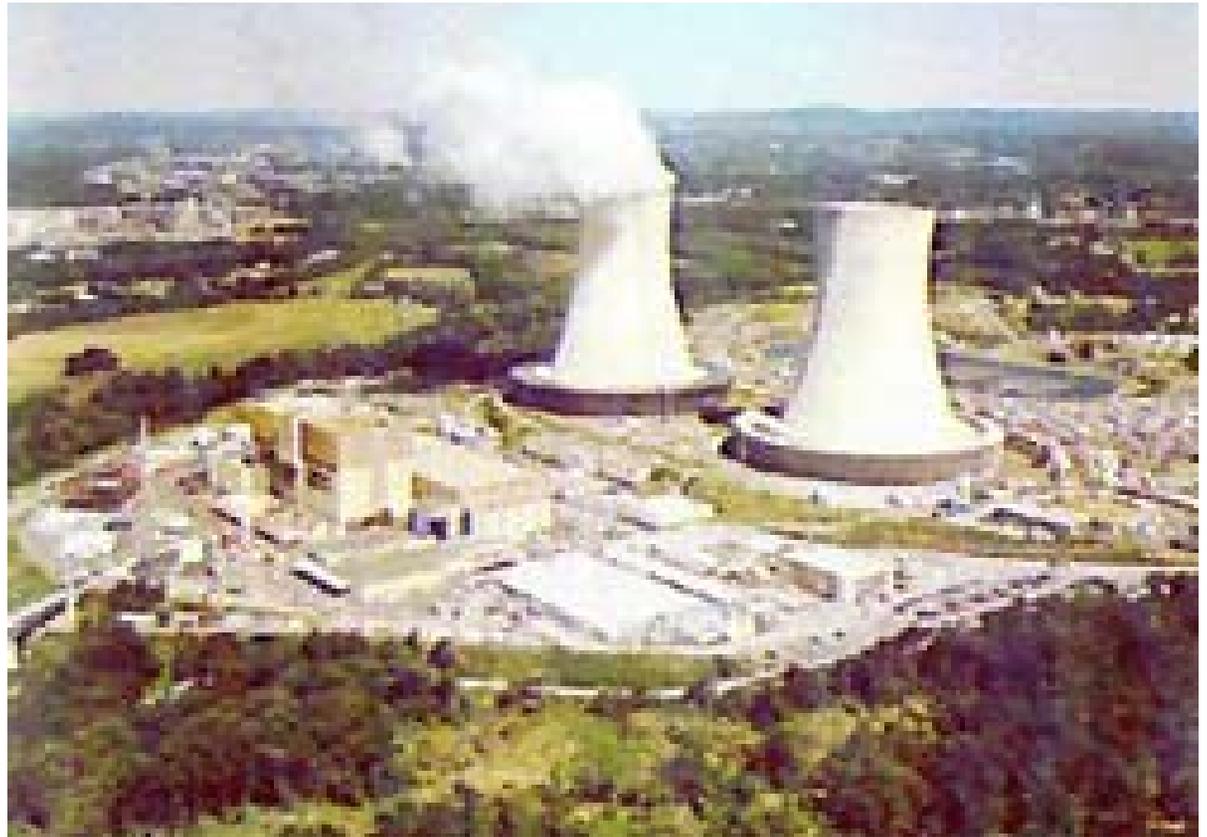


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*Nuclear
Electricity*

**Triple the world's
nuclear electricity
capacity by 2055**



Graphic courtesy of NRC

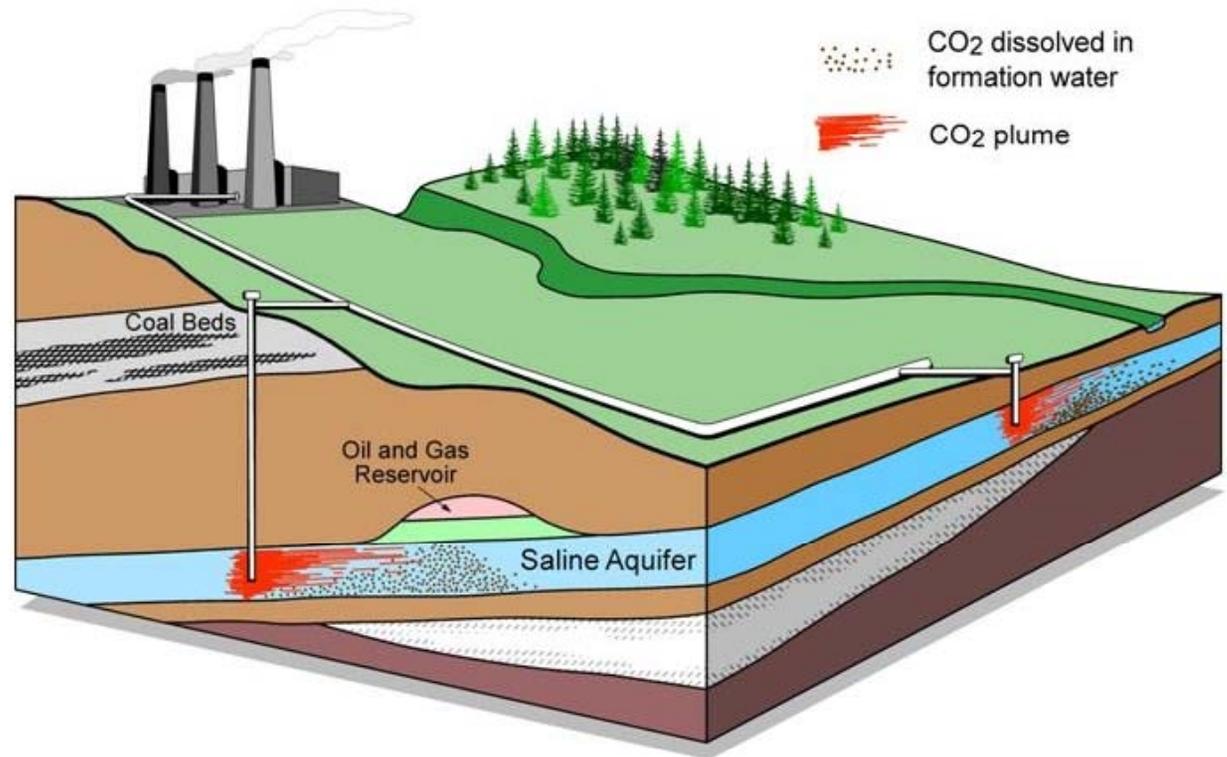
The rate of installation required for a wedge from electricity is equal to the global rate of nuclear expansion from 1975-1990.

This slide based on "Stabilization Wedges: Solving the Climate Problem for the next 50 Years with Current Technologies," S. Pacala and R. Socolow, *Science*, August 13, 2004.



Implement CCS at

- 800 GW coal electric plants or
- 1600 GW natural gas electric plants or
- 180 coal syngas plants or
- 10 times today's capacity of hydrogen plants



Graphic courtesy of Alberta Geological Survey

There are currently three storage projects that each inject 1 million tons of CO₂ per year – by 2055 need 3500.

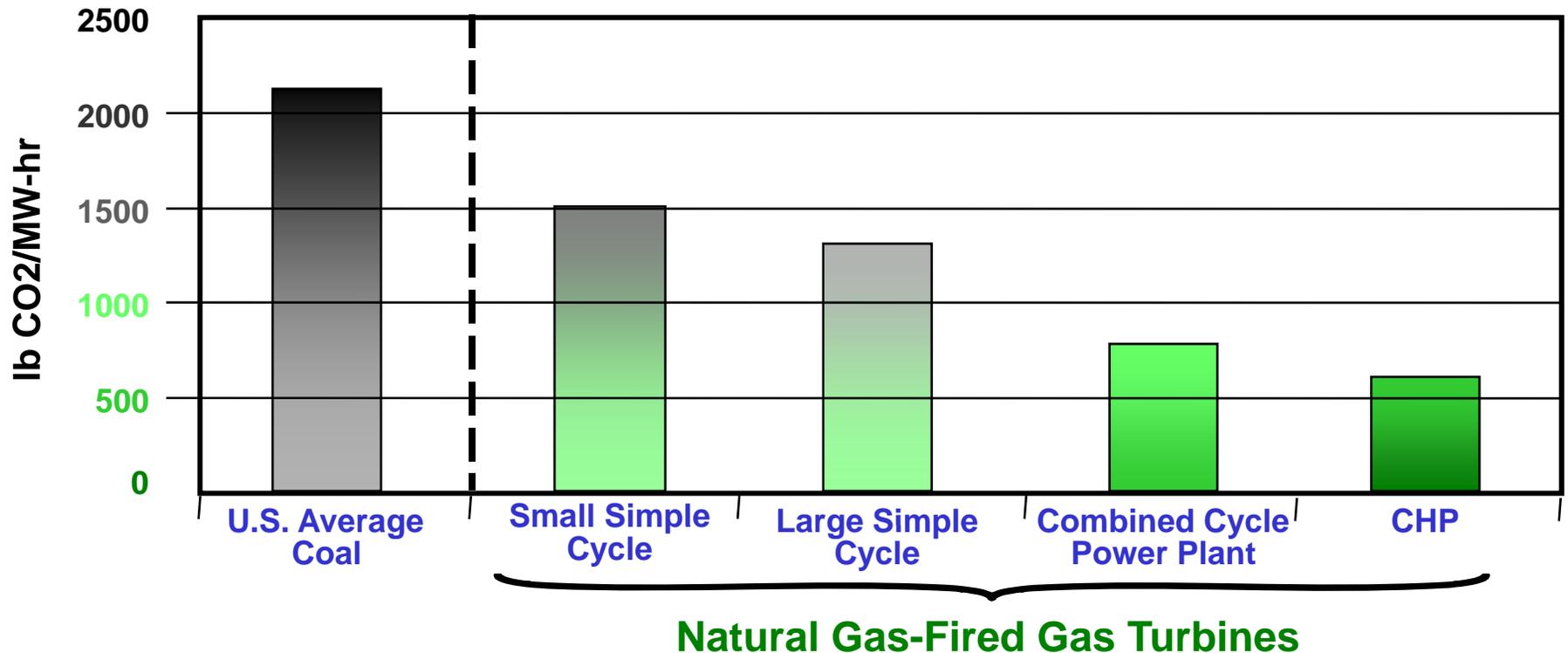
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- **NG Is the Least Carbon-Intensive Fossil Fuel:**

- Coal = 208 lb CO₂/MMBtu (HHV)
- Distillate Oil = 161 “
- Natural Gas = 117 “

- **CHP Is Most Efficient Use of Natural Gas**



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Mercury 50 Integrated Energy System

**Dell Children's Medical Center of Central Texas
Muller Energy Center of Austin Energy, Austin, Texas**



**Energy Center Provides Power, Heating and Cooling to
Hospital**

First Hospital in the World to Obtain LEED Platinum Status

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4.6 MW Centaur 50 California Dairies



- Provides All Heating, Cooling, Hot Water & Steam Needs of NYC's 2nd Tallest Building
- Provides for 35% of the Building's Electrical Load
- Building Uses 50% Less Energy than Conventional Skyscraper
- Expected to Achieve LEED Platinum Rating



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2 x 5.7 MW Taurus 60's
Talisman Energy, Alberta, Canada



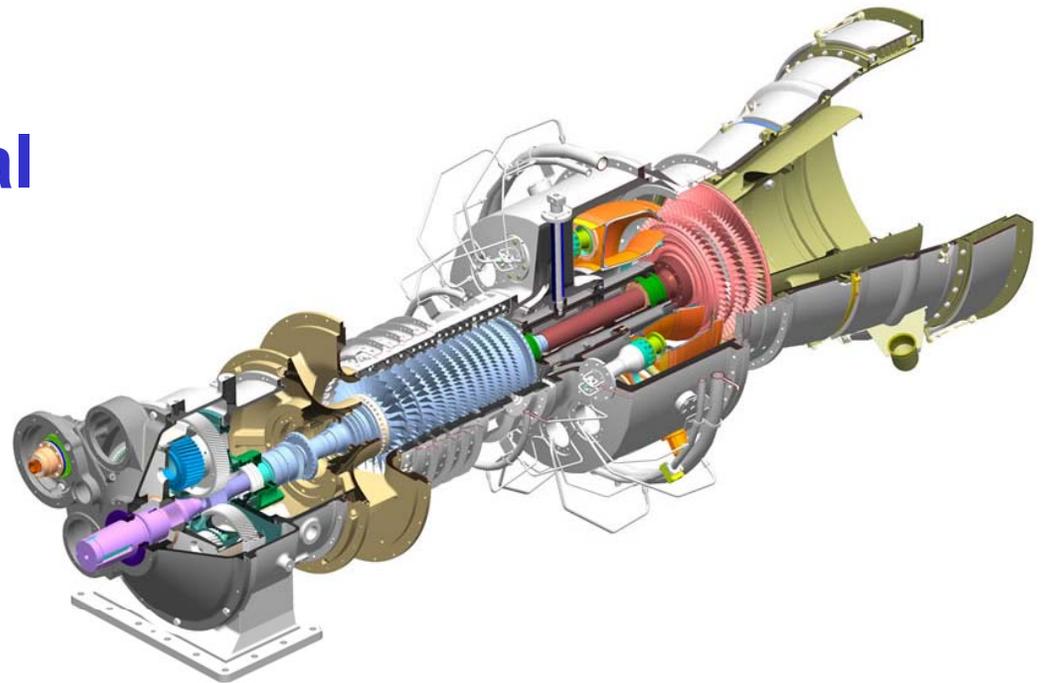
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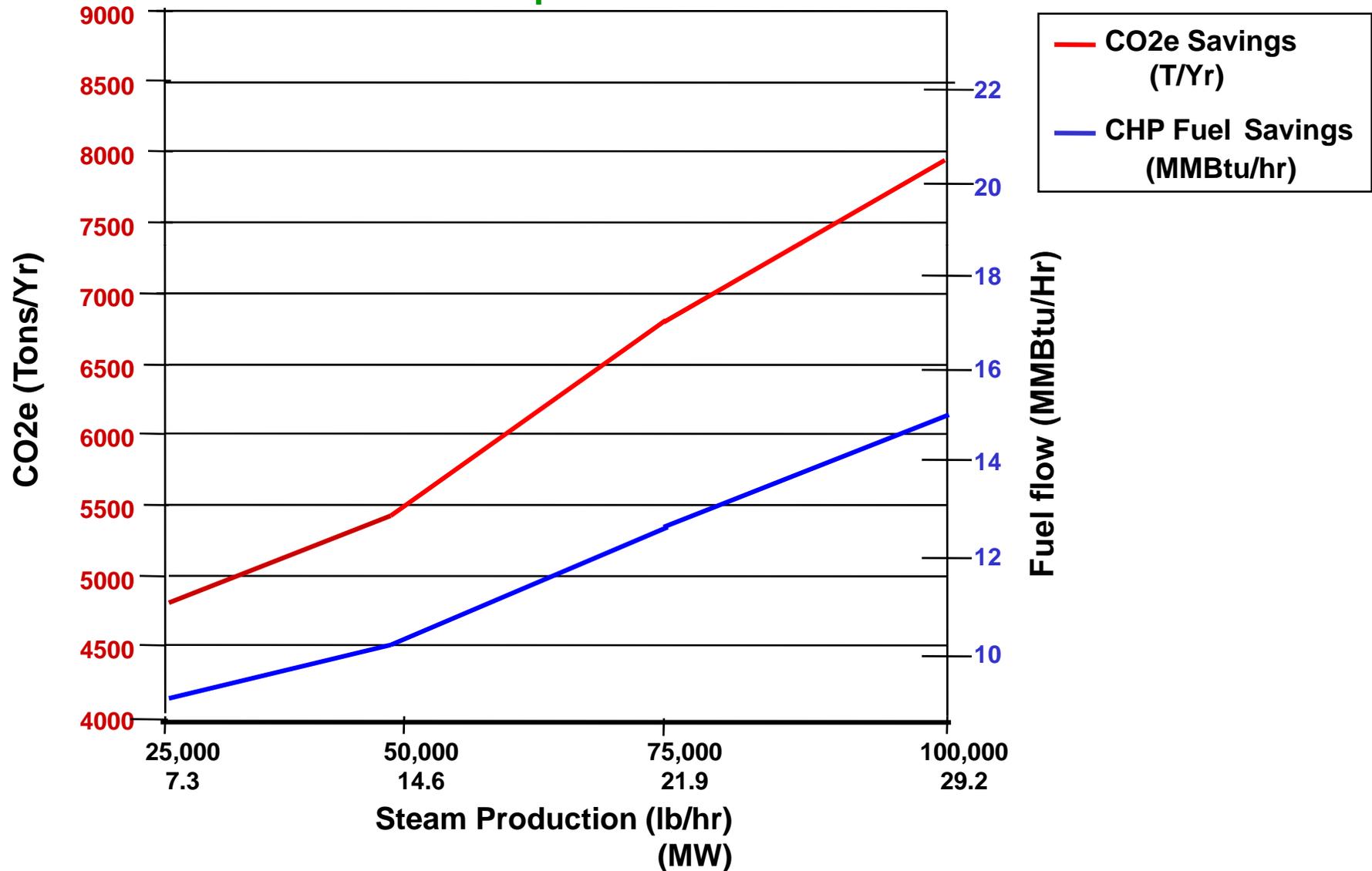
6.3 MW Taurus 65, Michelin Tire Hallstadt, Germany



- **Power: 6.3 MW**
- **Simple Cycle Thermal Efficiency: 32.9%**
- **CHP Thermal Efficiency: 84-92%**
- **NO_x Emissions: <15 ppmv with SoLoNO_x Combustion**



6.1 MW from Combined Cycle Power Plant with Steam from Conventional Boiler Compared to Taurus 65 CHP Plant



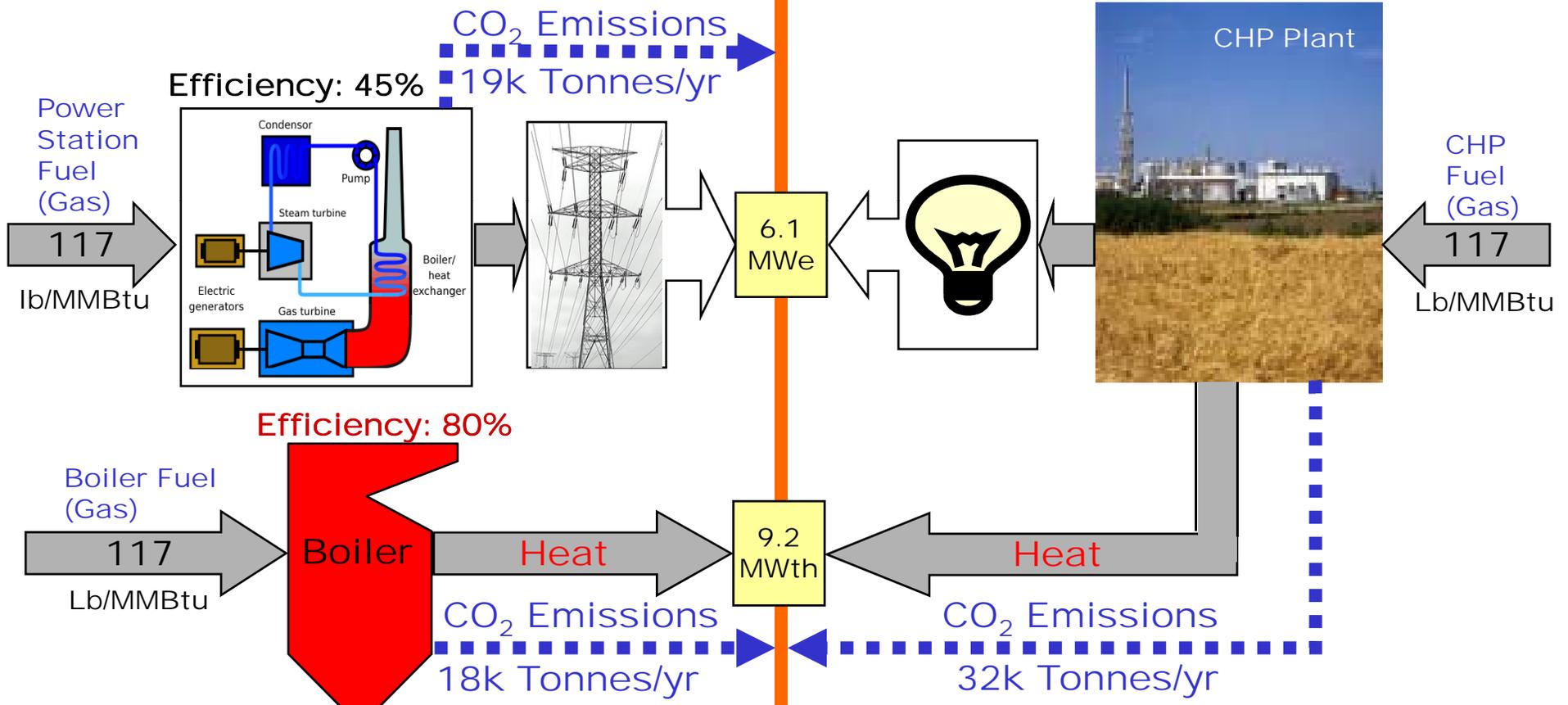
CO₂ Emissions Reductions from CHP

Combined Heat & Power:

Taurus 65 Gas Turbine

Efficiency: 84%

Combined Cycle Generation



40k Tonnes

...TOTAL ANNUAL CO₂ EMISSIONS...

32k Tonnes

8,000 Tonnes Saved/Year

- **Today's Technology**
- **Flexibility to Fit a Variety of Applications**
- **High Efficiency Equates to Low GHG Emissions**
- **Also Has a Low Criteria Pollutant (NO_x, CO) Signature**