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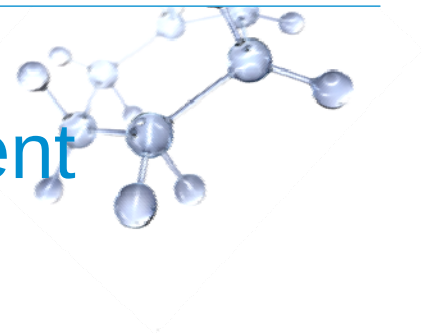
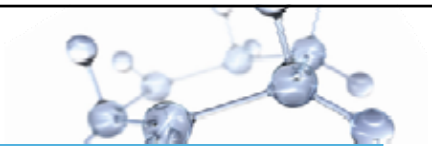


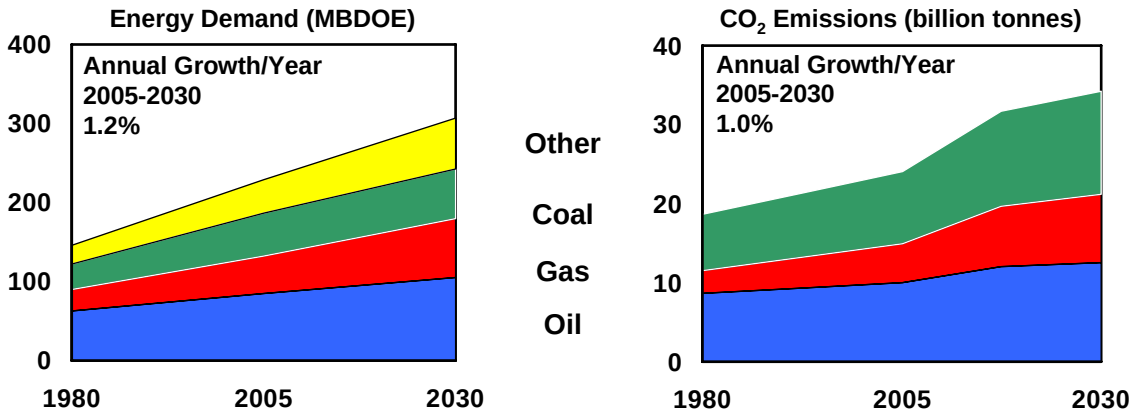
Energy & Environment

Technology considerations

Dr. Tomas R. Melli
April 23, 2009

GLOBAL ENERGY TRENDS





- Global demand for energy projected to grow 1.2% per year 2005-2030
  - Increase of 35% from 230 to 310 MBDOE
  - Population and economic growth the main drivers
- Carbon dioxide emissions projected to increase 1.0% per year 2005-2030 reflecting shift to lower emission sources

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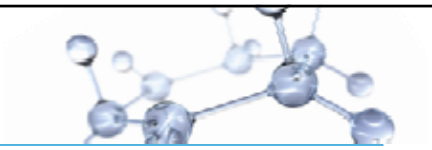
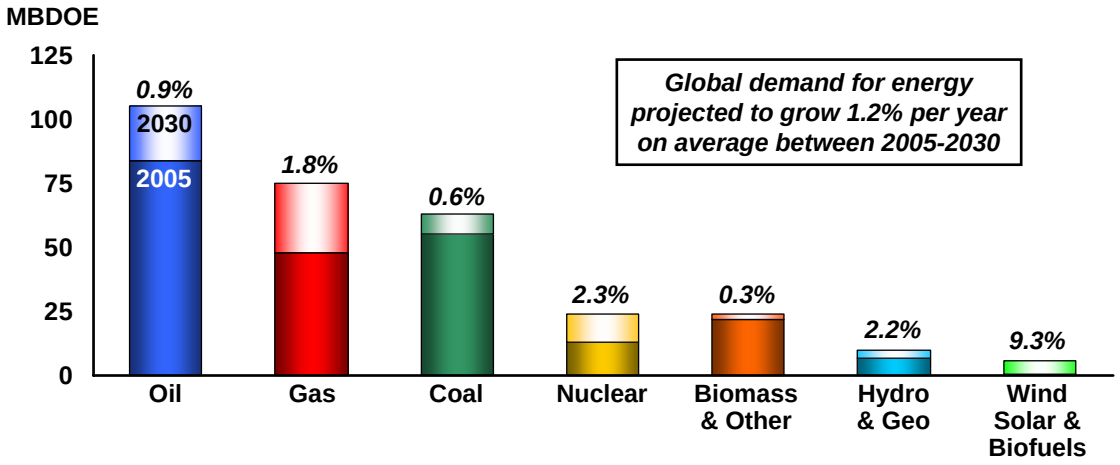
GLOBAL ENERGY MIX





- Oil and natural gas continue to supply 60% of demand
- Natural gas surpasses coal ... Nuclear draws even with biomass
- Hydroelectric and geothermal limited by availability of natural sites
- Solar, wind, and biofuels grow rapidly from a very small base

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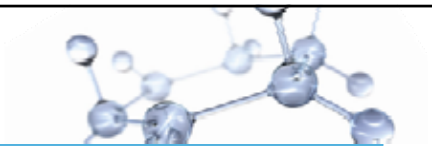
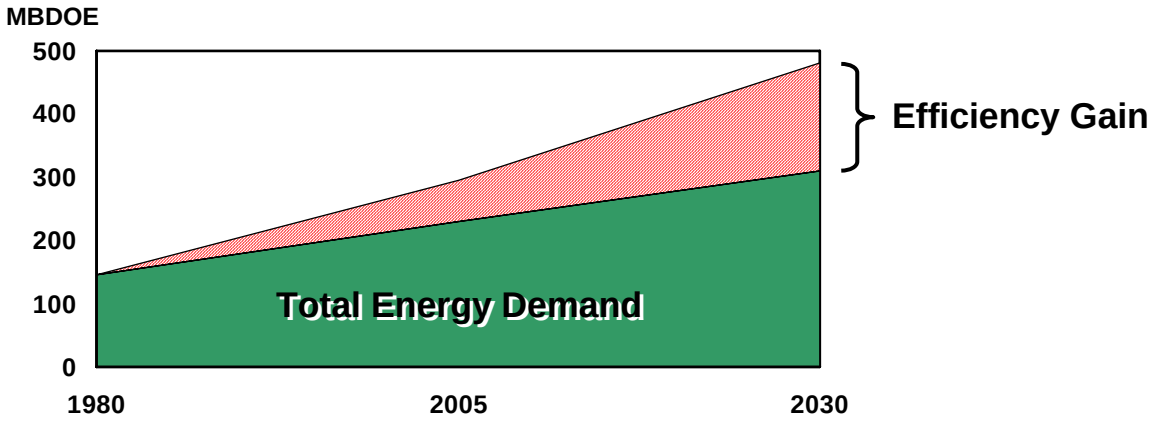
ENERGY EFFICIENCY





- Efficiency improvements accelerate from 1.0% to 1.7% per year
- Reduces total energy demand by 170 MBDOE in 2030
- Efficiencies the single-largest "source" of energy by 2030
- Gain exceeds total energy demand in 1980

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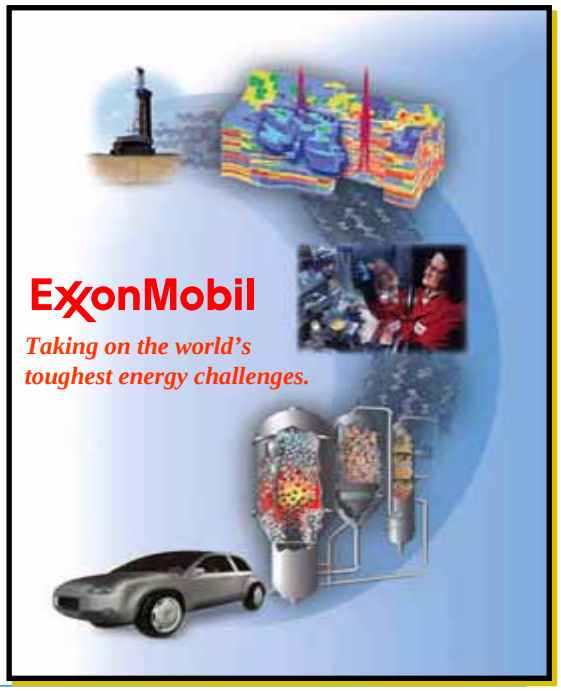
TAKING ON THE CHALLENGES

- Integrated set of solutions required to meet world's energy challenges ...
  - New exploration and enhanced production
  - New technologies and improved products
  - Energy conservation and efficiency
  - Actions now and research for the future



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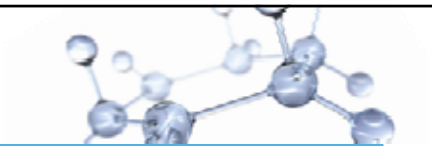
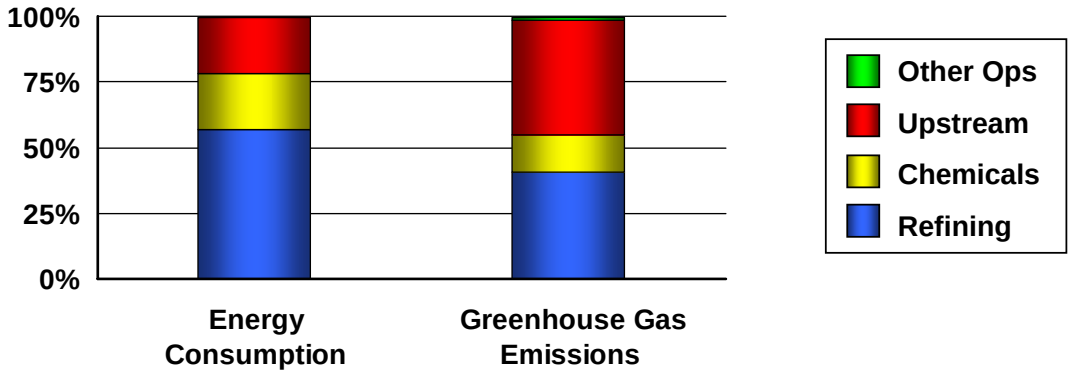
A CORPORATE FOCUS





- Refining and Chemicals account for over 75% of corporate energy consumption and over 50% of corporate greenhouse gas emissions
- Energy the single-largest cash operating expense – about 50% of total
- Improving energy efficiency is a win-win-win …
  - Extends supply and affordability of conventional energy sources
  - Reduces plant operating costs and greenhouse gas emissions
  - Benefits companies, consumers, and the environment … Now!

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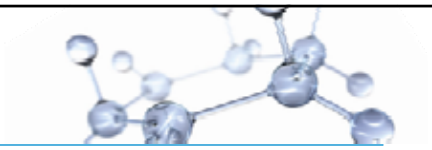
A GLOBAL APPROACH



OBJECTIVES

- Establish a single, comprehensive global energy management system (GEMS)
- Utilize a common methodology to identify performance gaps, implement closure plans, sustain progress, and continuously improve results

BUSINESS MODEL

- Operate existing facilities optimally and efficiently through application of best practices
- Identify economic investment opportunities above an optimized base for step-change improvement
- Implement strong management systems to sustain progress and drive continuous improvement

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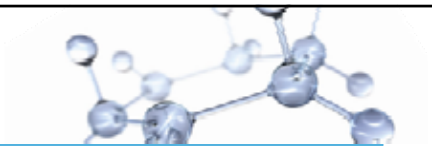
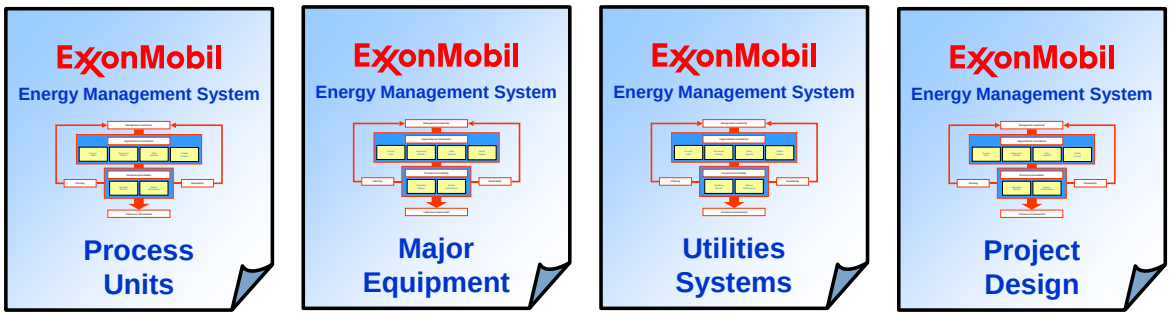
GEMS DEVELOPMENT





- Best practices documented in 12 volume set of manuals
- Contain 1200 pages and identify over 200 key energy variables
- Cover process units, major equipment, and utilities systems
- Focus on key energy-related aspects of operations and maintenance
- Also incorporate energy efficiency into project design of new facilities

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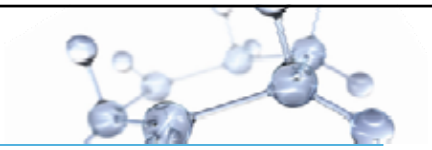
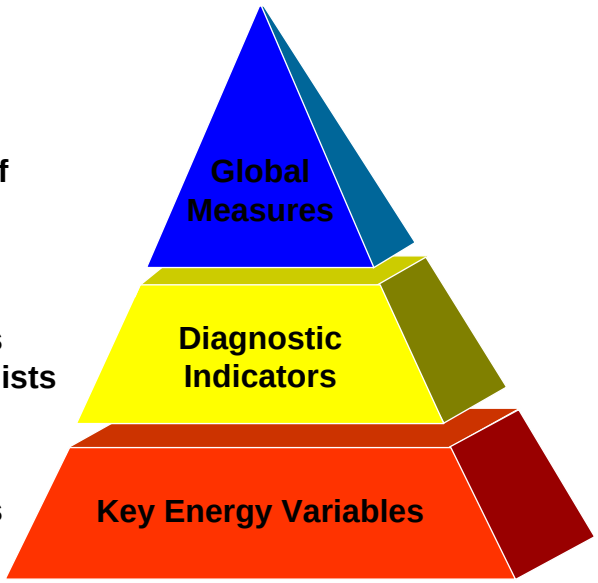
GEMS MEASUREMENT



Corporate & Plant
Management / Staff

Business Teams
Process Engineers
Equipment Specialists

Shift Supervision
Console Operators
Field Operators



Plant / Site
Energy Index
Energy Expense
Profitability

Area / Complex
Implementation
Lost Opportunity

Unit / Equipment
Targets & Handles
Directly Actionable

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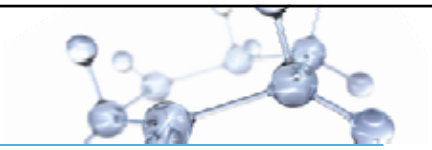
GEMS ASSESSMENT



Months to Prepare — *Weeks to Execute* — *Years to Implement*

Preparation

Site Orientation
Select & Train Team
Gather & Review Data
Arrange Logistics

Operations Improvements

Process Units
Major Equipment
Utility Systems

Facilities Enhancements

Optimizations
Modifications
Additions

Deliverables

Gap Assessment
Gap-Closing Options
Cost / Benefit Analysis
Milestone Plan

Transfer of Ownership

Site

GEMS

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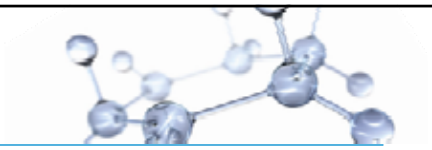
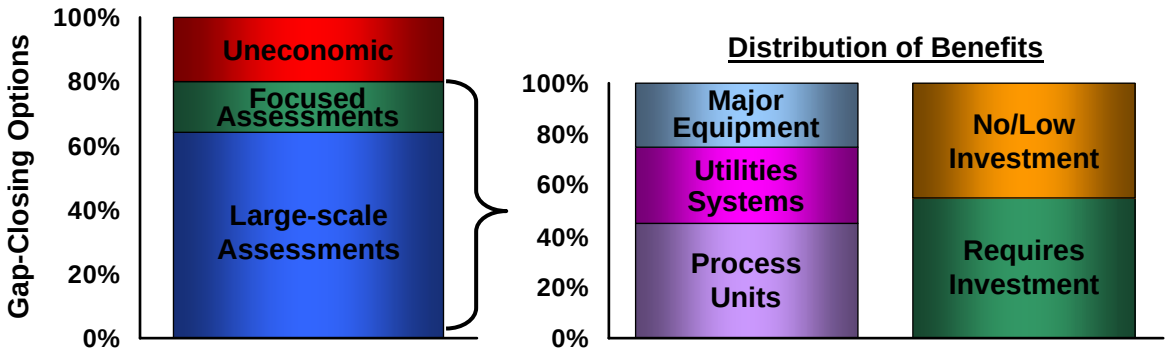
GEMS IMPLEMENTATION





- About 80% of gaps economic to address with current technology
- Identified savings equal to 15-20% of energy costs on average
  - About half of the benefits require little or no investment to capture
- Potential to avoid 14 million tonnes per year of GHG emissions
  - Equivalent to removing about 2.5 million cars from U.S. roads
- Total prize assessed at $1.5 billion per year
  - Already capturing one-half the benefits

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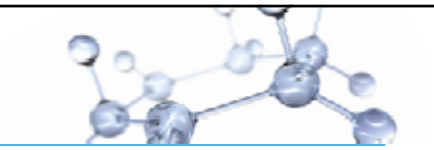
Why Cogeneration?



- ENERGY EFFICIENCY
- COST SAVINGS
- REDUCED EMISSIONS
- SECURE SUPPLY

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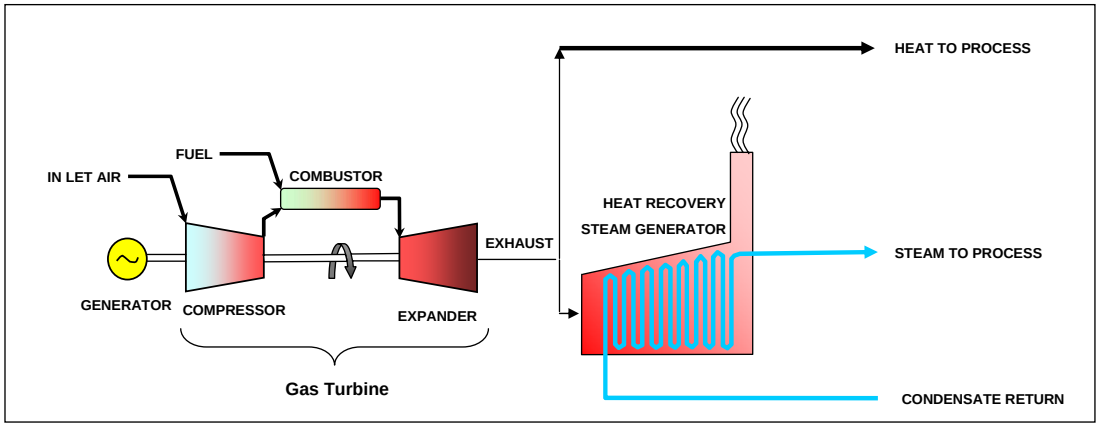
Cogeneration



- Cogen Advantages:
  - Cogen (or Combined Heat & Power) can result in high thermal efficiencies (70-80%); Using direct process heat integration can boost efficiencies even further
  - Lower cost and emissions per MWh than traditional approaches for generating power and steam
  - Eliminates need for expensive condenser required for combined cycle applications

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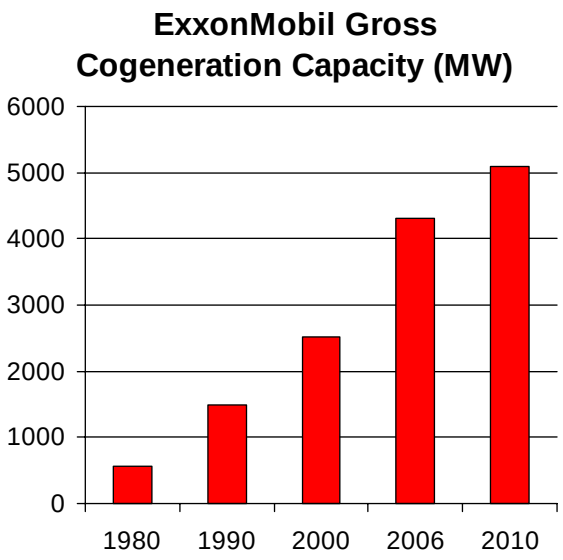
ExxonMobil: A Leader in Cogeneration

- First installation in 1950's
- Over 4,500 MW installed with projects under development all around the world
- ExxonMobil self-generates well over 50% of its total electricity demand
- 100+ installations in 30+ locations around the world
  - Nearly 900 MW of capacity added in 2004-05 (~$1G)
- Cogeneration provides high overall efficiencies, low costs per MWh & low CO_2 emissions. But .....
  - Higher total capital costs
  - Facilities must be base-loaded
  - Back-up power typically required



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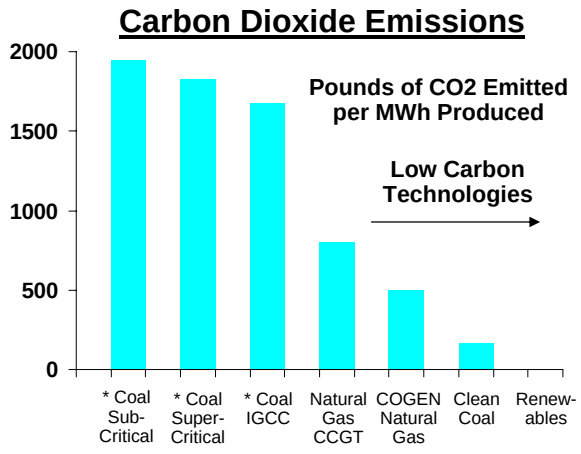
Low Carbon Technology – Bigger Scale & Impact

RENEWABLES

LOW CARBON TECHNOLOGIES

RENEWABLES

COGENERATION
DISTRICT HEATING
DISTRIBUTED ENERGY



* Source: EPA Clean Coal = IGCC w/ Carbon Capture
Note: For comparison purposes, cogeneration basis reflects reduced emissions from avoided fuel firing for process heat

- GHG emissions policies should be supportive of "low carbon technologies"
  - Provide same / similar incentives for technologies producing same / similar results

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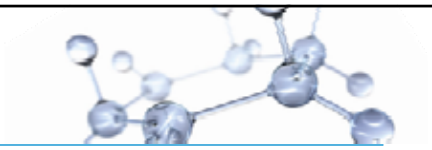
PATH FORWARD



Nearer Term – Actions Now

- Cogeneration Additions ... Flaring Reductions ... GEMS Implementation
- Avoid greenhouse gas emissions of over 20 million tonnes per year
- Equivalent to removing over 3 million cars from the world's roads

Medium Term – Technology Extensions

- Expand Sources and Uses of Natural Gas
  - Fuel Switching – substitution of natural gas for other fuels reduces CO2 emissions
  - Liquefied Natural Gas (LNG) – tech advances in liquefaction / transportation / regasification
- Commercialize Advanced Fuels and Vehicle Technologies
  - Fuels – molecule management for higher efficiency-lower emissions blends
  - Lubricants – lower emissions, improved fuel economy, longer drain intervals, less waste
  - Materials – new plastic components are lighter, stronger, safer, and recyclable
  - Engines – tech advances in non-hybrid and hybridized internal combustion engines

Longer Term – Breakthrough Research

- Support and participate in innovative and far-reaching research projects
  - Investing 100 M$ to fund Global Climate & Energy Project (GCEP) at Stanford University
  - Goal to accelerate development of commercially viable energy technologies on a global scale

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