

SO CLIMATE CHAOS IS A HOAX?

**MARKET PATHWAYS TO A LOW-CARBON
ECONOMY**

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FESC RDD&D OPPORTUNITIES NG & HFCEV VEHICLES & INFRASTRUCTURE

- *HOW FAR CAN WE GO? HOW DO WE GET THERE QUICKLY?*

RESEARCH -- TRAINING -- POLICY

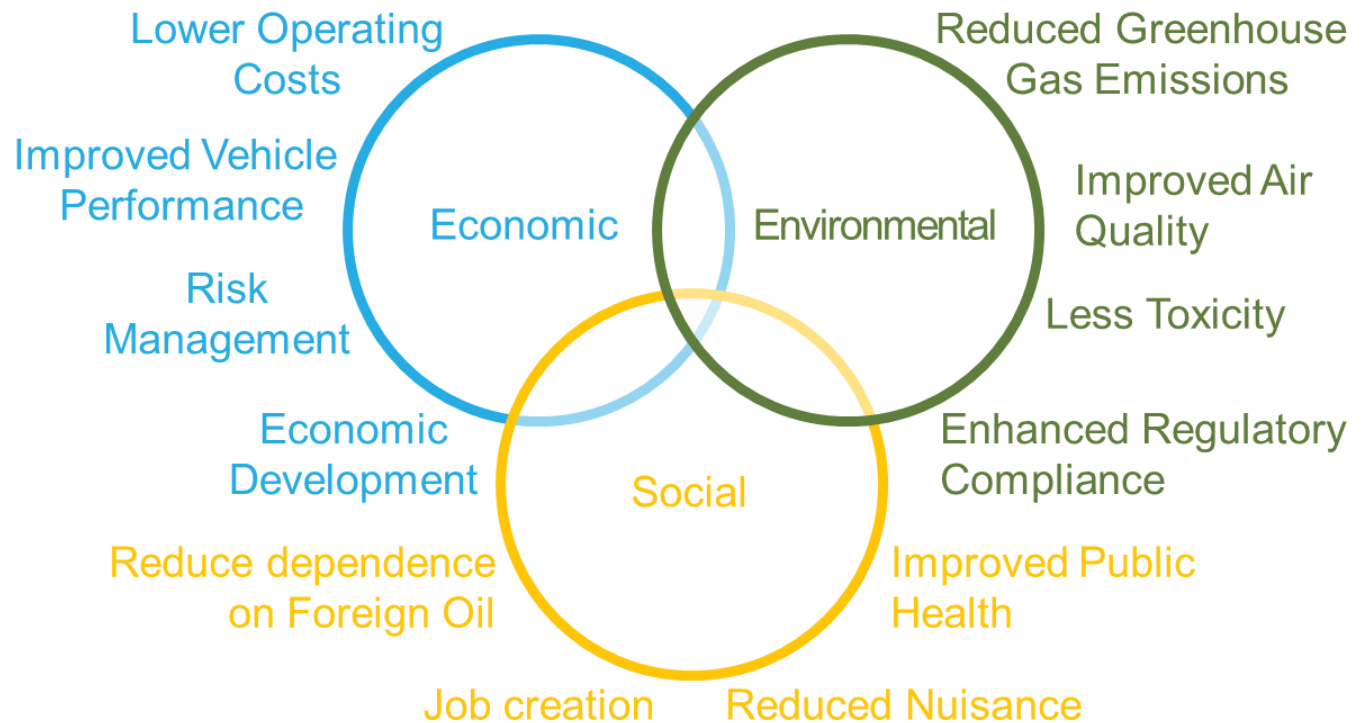
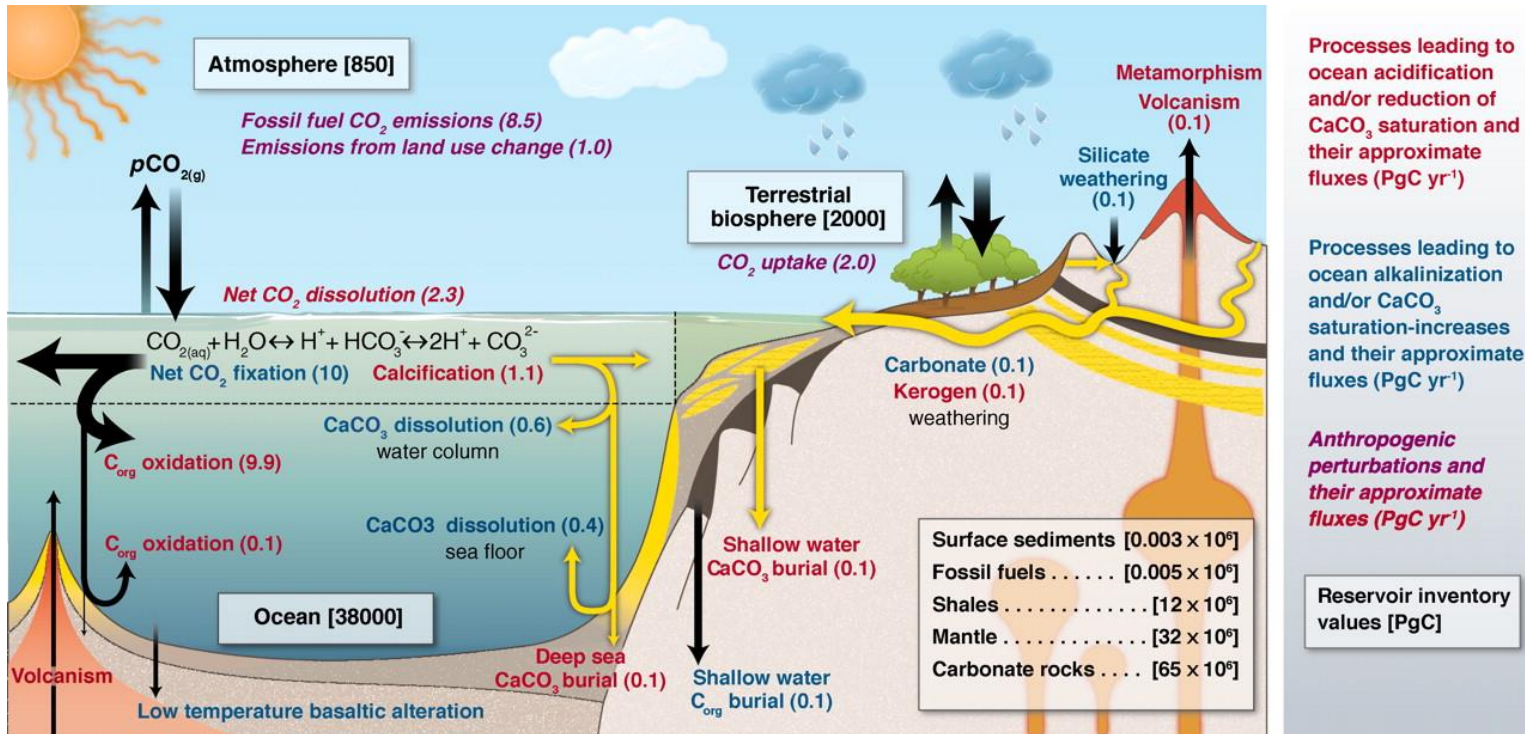


Fig. 2 When CO₂ dissolves in seawater, it reacts with water to form carbonic acid, which then dissociates to bicarbonate, carbonate, and hydrogen ions.

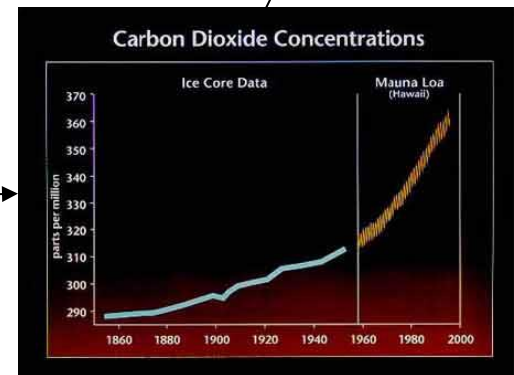
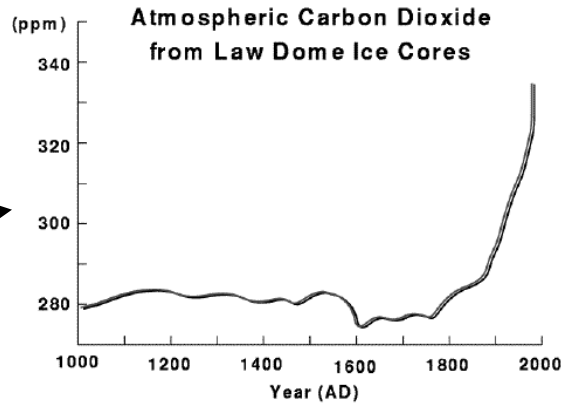
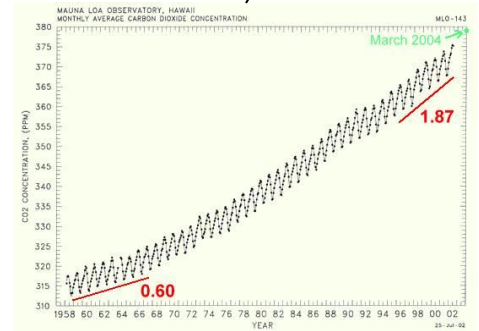
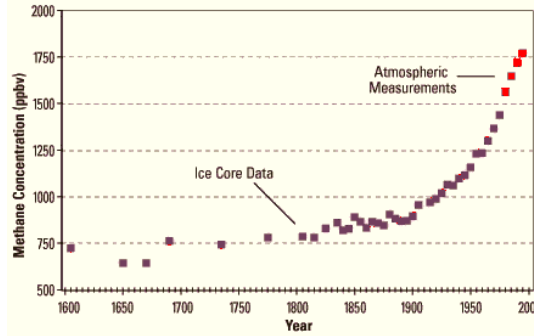
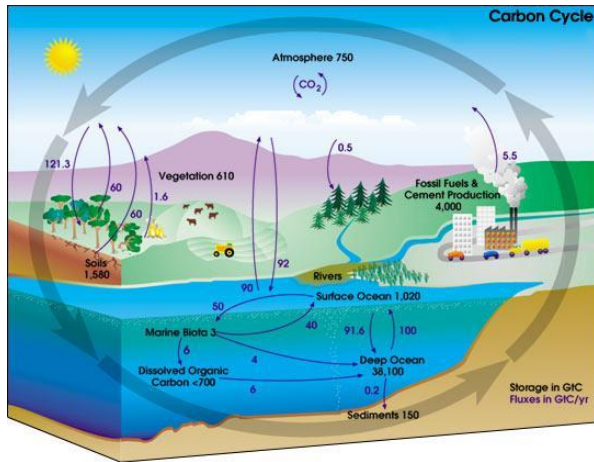
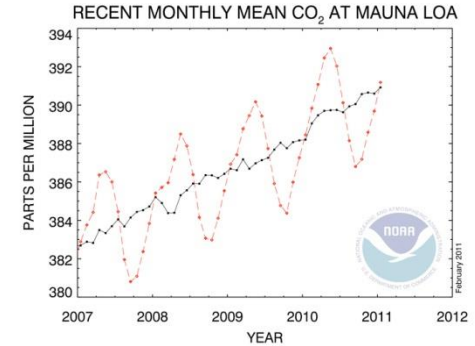


B Hönisch et al. Science 2012;335:1058-1063



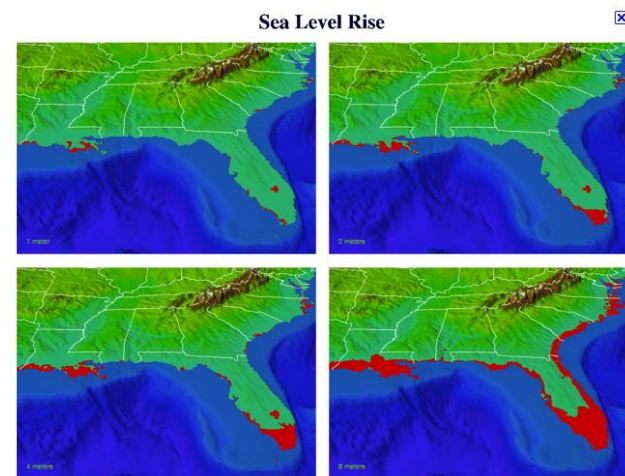
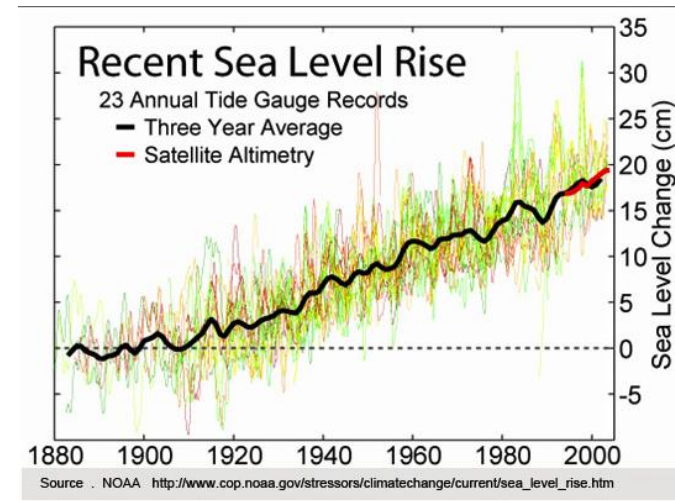
January 2011: 391.19 ppm

Fact – CO₂ → 310 ppmv to **400+ ppmv**
30% increase in my lifetime
 The rate of change is **accelerating!**



400+ ppmv: What is the Tipping Point?

- **IPCC 2013 “Extremely Likely”**
- Low Carbon Motor Fuels Can be Used to Save Money AND Reduce GHG Emissions **NOW**
- **Natural Gas & Electric Vehicles Can Reduce GHG Emissions 20+% TODAY**
- Hydrogen FCEVs Promise **50+% Reduction TOMORROW**



Climate Physics for Dummies

Q = Energy Flow (Tea or Earth)

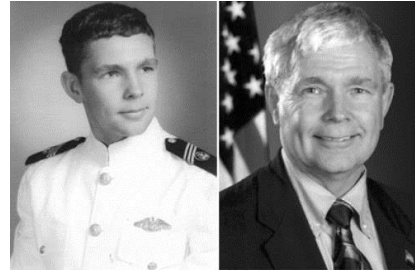
$$Q_{\text{in}} = Q_{\text{out}} + Q_{\text{Storage}}$$

if $Q_{\text{in}} > Q_{\text{out}}$, then

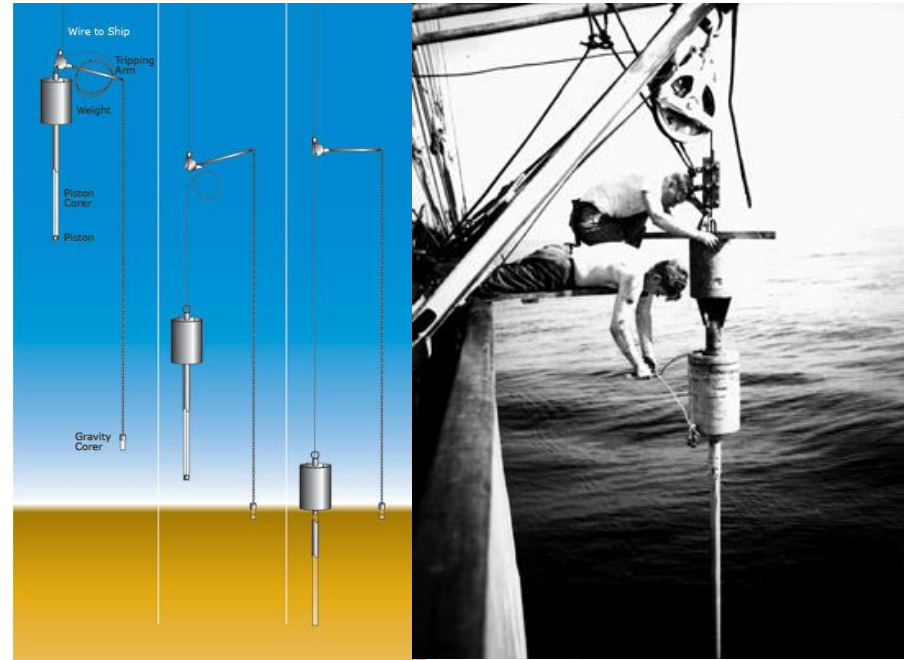
$Q_{\text{Storage}} = \text{Hot Tea or Climate Chaos}$

Why am I Here? – Start in 1965

- BS – USMMA
– Kings Point
- US Navy
- Lamont Earth Science Institute
- MS - Columbia University
- Harbor Branch Oceanographic Institute



A young Dave Bruderly (left) at the U.S. Merchant Marine Academy in Kings Point, N.Y. and Dave now (right), as a member of the Band of Brothers 2006.



My Early Career was Linked to Oil Pollution Either Making It or Cleaning It Up

- New York Harbor
SS Alva Cape &
Texaco Massachusetts
- Lands End
SS Torrey Canyon
- Mississippi River
SS African Star and Oil Barges
- Offshore Yucatan Oil Rig Blowout
- Superfund Sites
- LUST Fiascos
- Exxon Valdez
- Deepwater Horizon



45+ Year Consulting Career

Environmental Science

- Physical Oceanography
- Meteorology
- Water Quality
- Hydrology
- Groundwater
- Ecology
- Air Quality
- Toxicology
- Wastewater & Sludge Treatment
- Solid Waste Management
- Air Pollution Control
- Facility Remediation (Clean-Up)
- Pollution Prevention

Energy Engineering

- Bunker C - Marine Steam Boilers
- Marine C.I. Diesels
- Offshore Oil
- Oil Refining & Terminals
- LNG Carriers & Terminals
- Landfill Methane
- Nuclear Electricity
- Coal Electricity
- Natural Gas Comb. Turbines
- Animal Waste to Methane
- Battery Electric Vehicles
- Plug-In Hybrid EVs
- PEM & SOX Fuel Cells
- Micro-Turbines
- Gasoline S. I. Engines
- CNG & LNG Vehicles
- Hydrogen Vehicles

Science-Based Policy

- 1968 NEPA
- 1970 Clean Air Act
- 1972 Clean Water Act
- 1976 Resource Conservation Act (RCRA)
- 1980 CERCLA – aka Superfund Act
- 1986 Toxic Substances Act
- 1986 Safe Drinking Water Act
- 1988 Alternative Fuel Act

These **Laws & Policies Empowered
Industry** and **Consumers** to **Solve**
Serious Air, Water and Waste
Pollution Challenges
and
Create JOBS! JOBS! JOBS!

Pollution Prevention Act of 1990

(Hydrocarbons were Exempted by Congress)



The average car produces its own weight in CO₂ emissions each year.

Introducing...

The 2002 Chrysler New Yorker



Low-profile impact-resistant design - GPS navigation system (standard) - Infrared vision system (standard)
Computer-controlled ride stabilization (standard) - Air-conditioning and NBC overpressure system (standard)
120mm main gun armament (standard) - Optional colors: Desert Tan or Traditional Olive Drab

City/Hwy MPG ...don't even go there.

Payment plans available for up to 3000 months / 9.5% APR



Direct Macro-Economic Cost of Oil Addiction

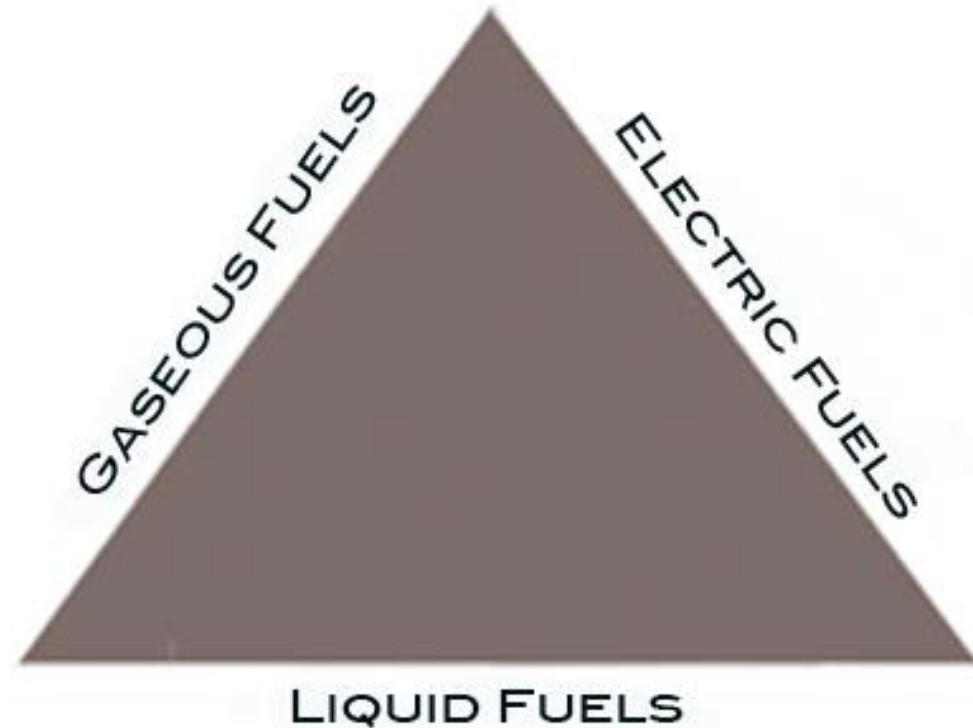
\$ >1 Billion per Day

\$365 Billion per Year

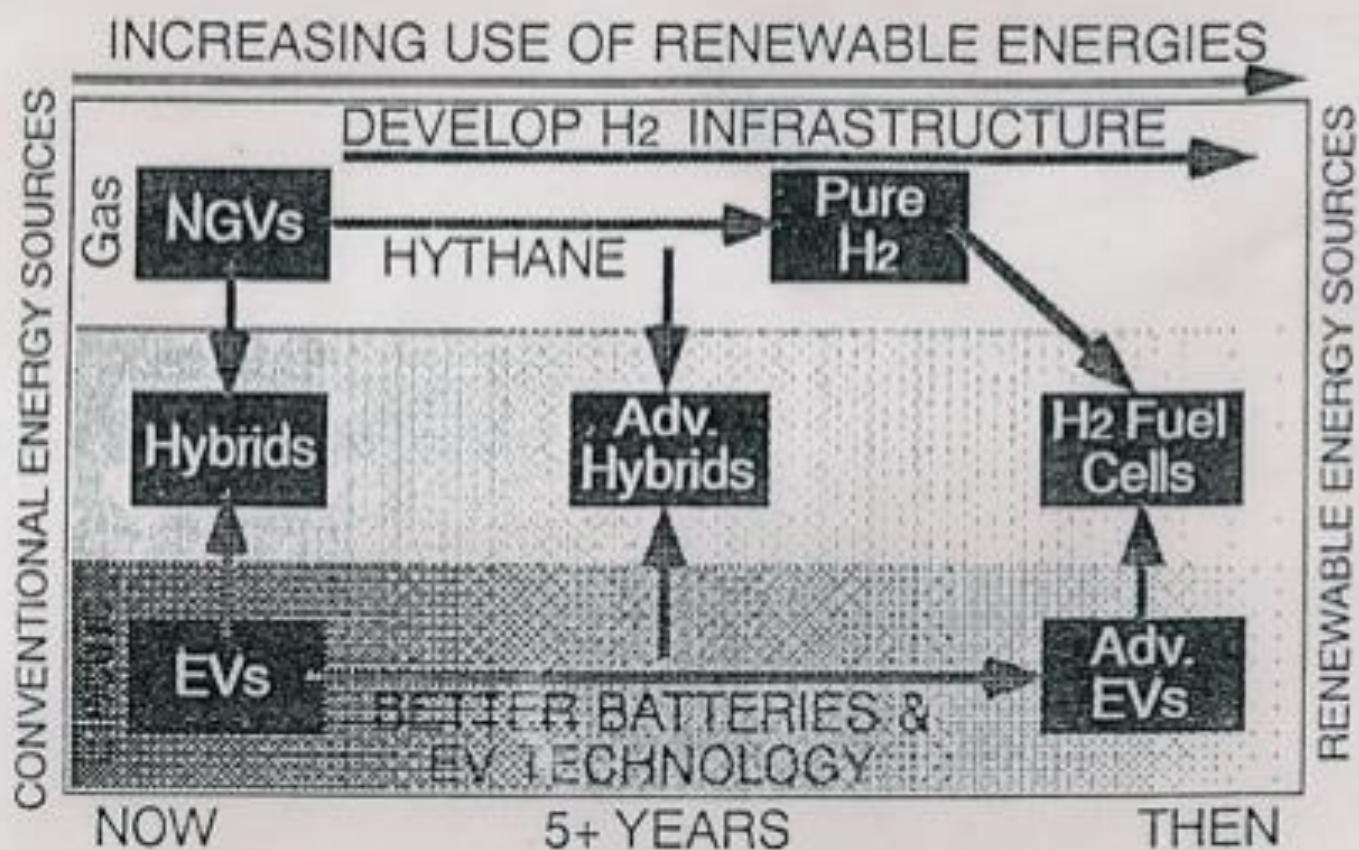
(10-Year Cost is \$3.65 Trillion, Stiglitz)

Econ 101 -- Fuel Diversity Empowers Consumer Choice

- **Liquid Petroleum-Based Fuels**
 - Ethanol Blends
 - Biodiesel Blends
- **Efficient Electric Drives**
 - Advanced Batteries
 - Super Capacitors
 - Fuel Cells
- **Gaseous Fuels**
 - LPG
 - Natural Gas – LNG & CNG
 - Hydrogen



Parallel Paths to Renewable Energy



Natural Gas & Electric Motor Fuels are:

- **Much Cheaper** Than Oil
- Abundant Domestic Supply – More Secure
- Readily Available – Local Utility
- Equivalent Vehicle Performance
- Lower Operating Costs – **Save More \$\$\$**
- Reliable, Safe and Affordable
- In Other Words

Low Carbon Electric & Natural Gas

Motor Fuels

are

Less Expensive

(to the Consumer & the Macro-Economy than)

Any Other Motor Fuel

AND WILL BE FOR **MANY, MANY YEARS**

(AEO2011 Early Release Overview)

Low Carbon Fuel Infrastructure



Energy Policy Act of 1992

- Defined Alternative Fuels (including Hydrogen)
- Established AFV Fleet Purchase Mandates with Implementation Plan
- Set Goal of 1,000,000 AFVs by 2000
- Established Clean Cities Coalitions – an AFV Advocacy Program

Leverage Industry Resources

DOE Clean Cities Organizations

Clean Cities Coalitions



U.S. Department of Energy

* Connecticut Clean Cities Include:
- Norwich
- New Haven
- Connecticut Southwestern Area
- Capitol Clean Cities of Connecticut

Map Date - 06/12/12

EPACT AFV Provisions Were NOT Supported by 1994 Congress

- AFVs → Unfunded Gov't. Mandate
- Too Expensive
- No \$\$\$\$ for Implementation
- Policy was to **“Starve the Beast”**
- Provisions to Motivate the Use Alt Fuels were not Implemented

ExxonMobil Position on Climate Policy

“anthropogenic causes, pose a risk; and, in order to address this risk society should consider *economically efficient policies* that include both mitigation and adaptation, and that balance **reduction in climate risk** with other global development needs ...”

Energy and Carbon – Managing the Risks, Report to shareholders, March 31, 2014

Energy Macro-Economics 101

Duty of Government

**Create Market Forces That Create
Affordable Choices**

Adam Smith – Father of Capitalism

An Inquiry Into the Nature and Causes of the Wealth of Nations,
(1776, London)

- Book One Labor and Market Pricing
“Invisible Hand” “Mass Production”
 - Book Two Nature of Stock
 - Book Three Different Progress in the Opulence in Nations
“Free Trade”
-
- Book Four Political Economy
 - Book Five Revenue of the Sovereign
“Taxes” & “Duty of Government”

Role of Government in Capitalism

- **Protect** “the Commons, Weak & Poor” from Exploitation by the “Mercantilists & Powerful”
- **Define** the Bounds of the Market by Creating Policy, Laws & Taxes to Protect ... and
- **Regulate** Markets with Just & Fair Enforcement of Policy, Laws & Taxes that ...
- **Empower Customers** to Discipline the Behavior of the Markets

Adam Smith on Efficient Regulation of Markets

“The pretense that corporations are necessary for the better government of the trade is without any foundation. The real and effectual discipline ... is not that of his corporation, but **that of his customers.**” (p.56, Book One)

The Problem with Globalized Oil Markets

- Markets Are NOT Perfect or Transparent
- Taxpayers are Subsidizing Pollution from Use of Coal, Oil & Nat Gas -- External Costs are NOT Monetized
- Oligopoly of Suppliers – **Market Power**
 - Sovereign Nations – aka OPEC
 - International Oil Companies
 - Auto Manufacturers
- American Consumers Have **Limited Ability to Choose** Low-Carbon Motor Fuels and Sources of Electricity

Failed Policy => Market Failure

- Policy Accepts that **Liquid Petroleum-Based Motor Fuels are Controlled** by the OPEC **Oligopoly** of Nations and Multinational Corporations
- Policy Creates and Maintains **Barriers to Competition** from **Non-Petroleum Fuels**
- President Bush labeled this Failed Policy
“America’s Oil Addiction”
- Electricity Markets are Controlled by **Monopolies**
- **Oligopolies & Monopolies Dictate Policy**
- **Greenhouse Gas Pollution is “Free”**

Macro-Economic Costs of “Market Failure”

- Price Volatility → Recession
- Supply Disruptions → Recession
- Job Losses → Recession
- Trade Deficit → Recession
- War → Recession
- Standing Military Cost → Recession
- Catastrophic Spills
- Air & Water Pollution
- Climate Chaos → **National Security**

Energy Solutions by Decade

- 70's – Created USEPA & USDOE

(Brief Policy support for Syn-Fuels RD&D & Solar Deployment)

- 80's – Keep Oil Cheap Oil Policy

(Built Saudi Air Bases for US Use, 12 Carrier Navy & 2 Theatre War Capability)

- 90's – R&D for Hybrids & Tight Gas

(1st Gulf War followed by Iraq Containment)

- 00's – R&D for HFCEVs & Biofuels & Tax Credits

(2nd Gulf War and Iraqi Occupation)

- 10's – \$\$B → Unconventional Gas & Oil, Solar, Wind, Advanced Biofuels & Batteries

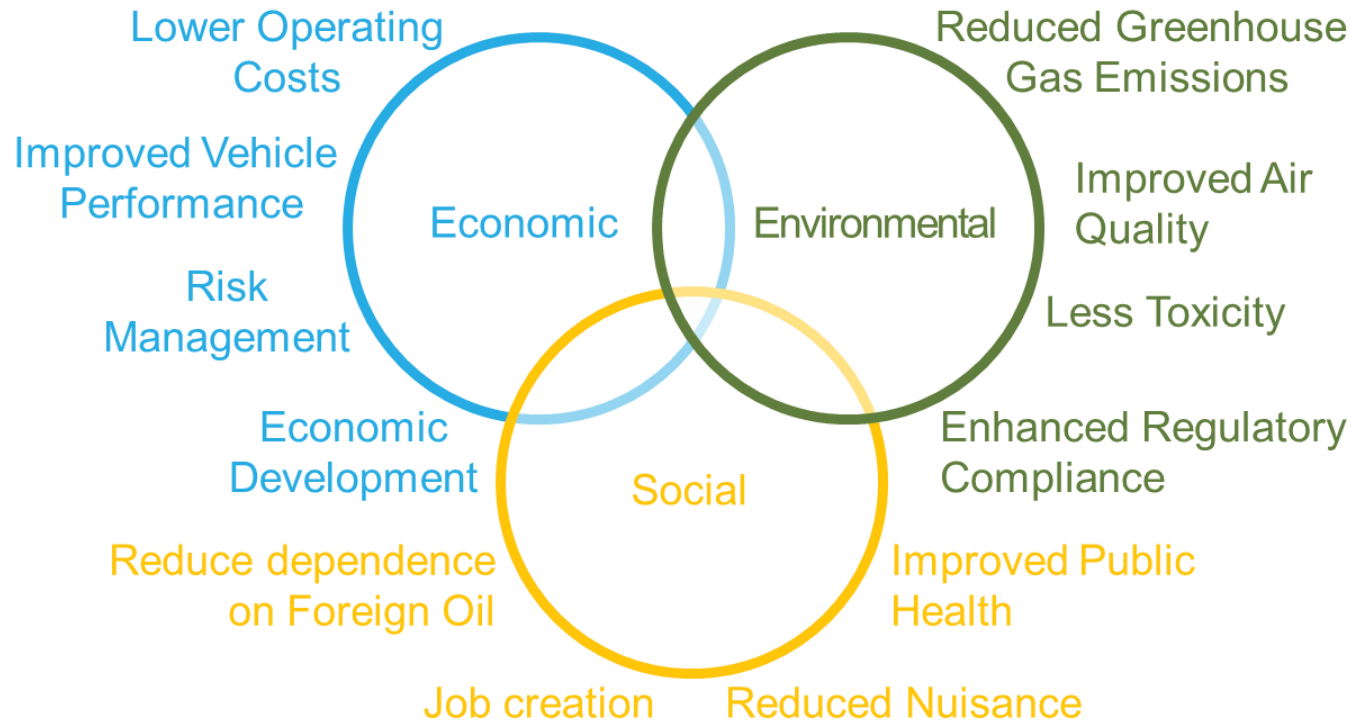
- 20's – **Fact-Based POLICY → Behaviors**

FESC RDD&D OPPORTUNITIES

CLEAN TECH & INFRASTRUCTURE & \$\$\$\$

- *HOW FAR CAN WE GO? HOW DO WE GET THERE QUICKLY?*

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Selected References

Smith, Adam; *An Inquiry Into the Nature and the Causes of the Wealth of Nations*, 1776.

Sachs, Jeffrey; *The Price of Civilization*, 2011

Hawkin, Paul; *The Ecology of Commerce*, 1993.

Hawkin, Paul, et. al.; *Natural Capitalism*, 1999.

Diamond, Jared; *Collapse – How Societies Choose to Fail or Succeed*, 2005.

Samuelson, Paul; *Economics – An Introductory Analysis*, 1967.

Friedman, Thomas; *Hot, Flat and Crowded*, 2008.

Gore, Al; *An Inconvenient Truth*, 2006.

Stiglitz, Joseph, *The Price of Inequality*, 2012.

Graham, Bob, Hand, Chris; *American: The Owners Manual*, 2017.

Gore, Al; *An Inconvenient Sequel: Truth to Power (Movie)*, 2017.