FIELD NOTES

Applied Expertise in Sustainability, Climate Change and Air Pollution

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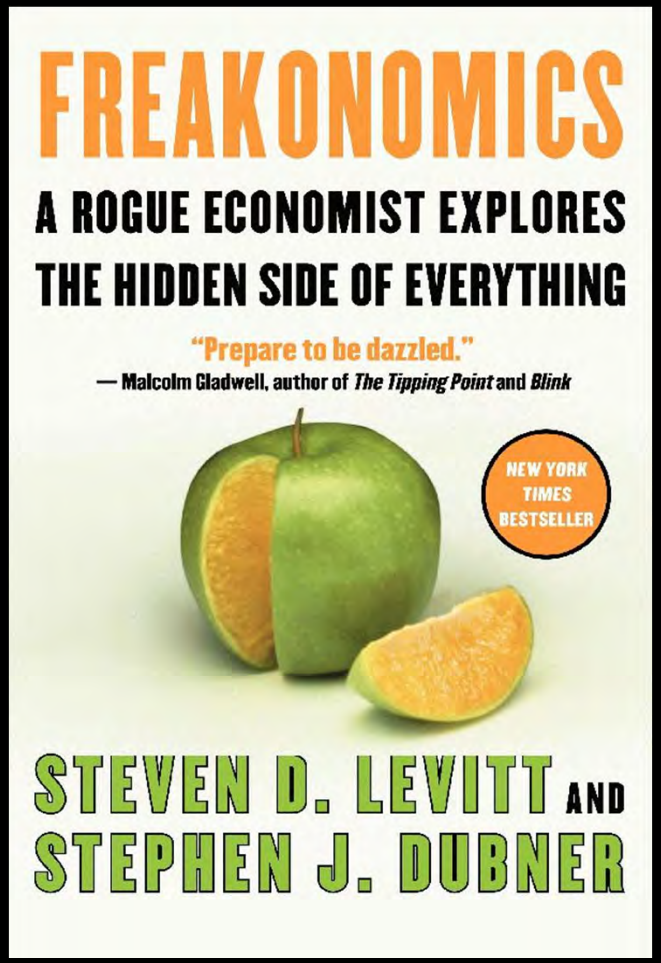
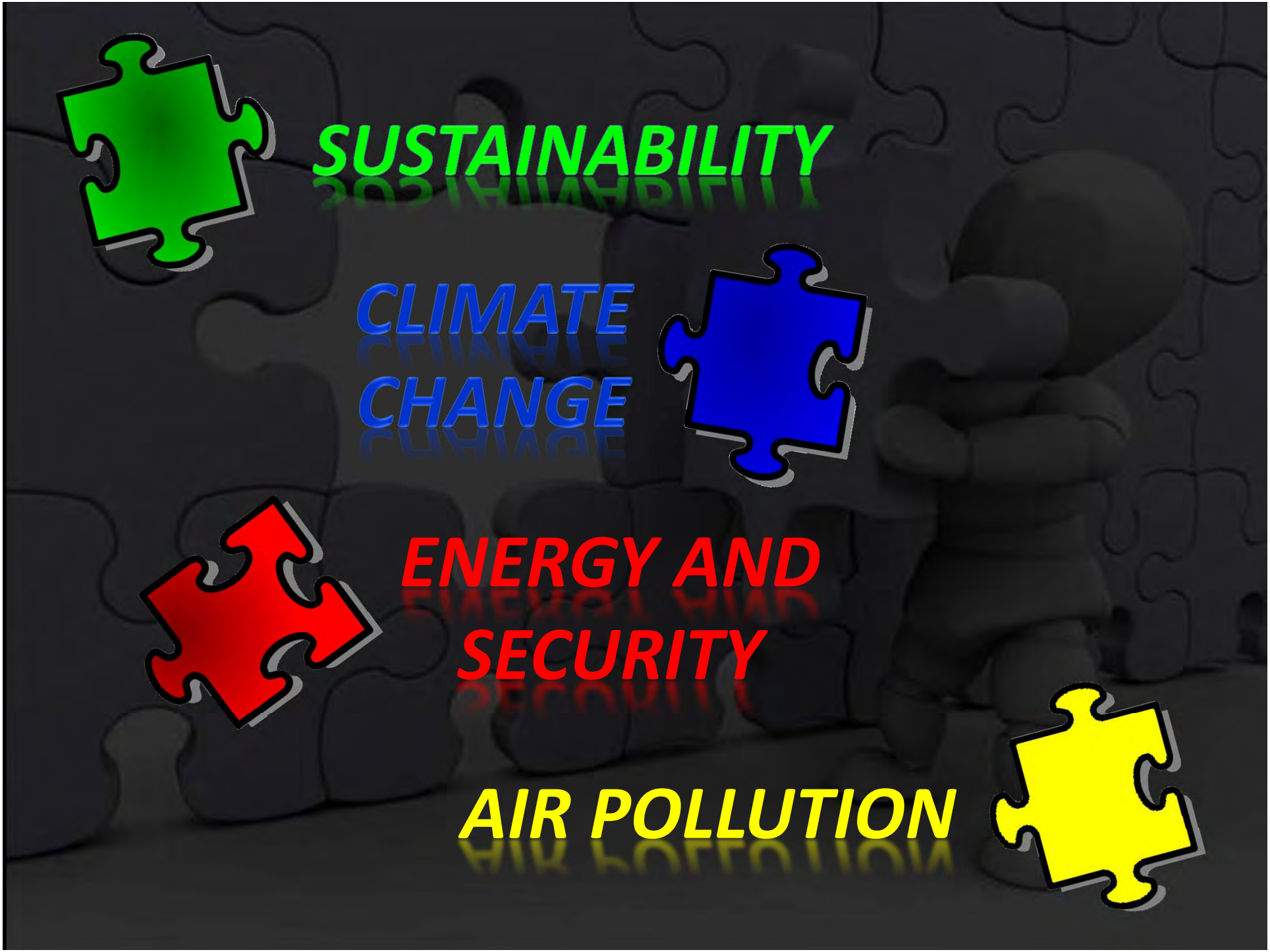
- Which is more dangerous, a gun or a swimming pool?
- Do real-estate agents have their clients' best interests at heart?
- Do schoolteachers cheat to meet high-stakes testing standards?
- Is summo wrestling corrupt?




SUSTAINABILITY
CLIMATE CHANGE
ENERGY AND SECURITY
AIR POLLUTION

SUSTAINABILITY

What is Sustainability?

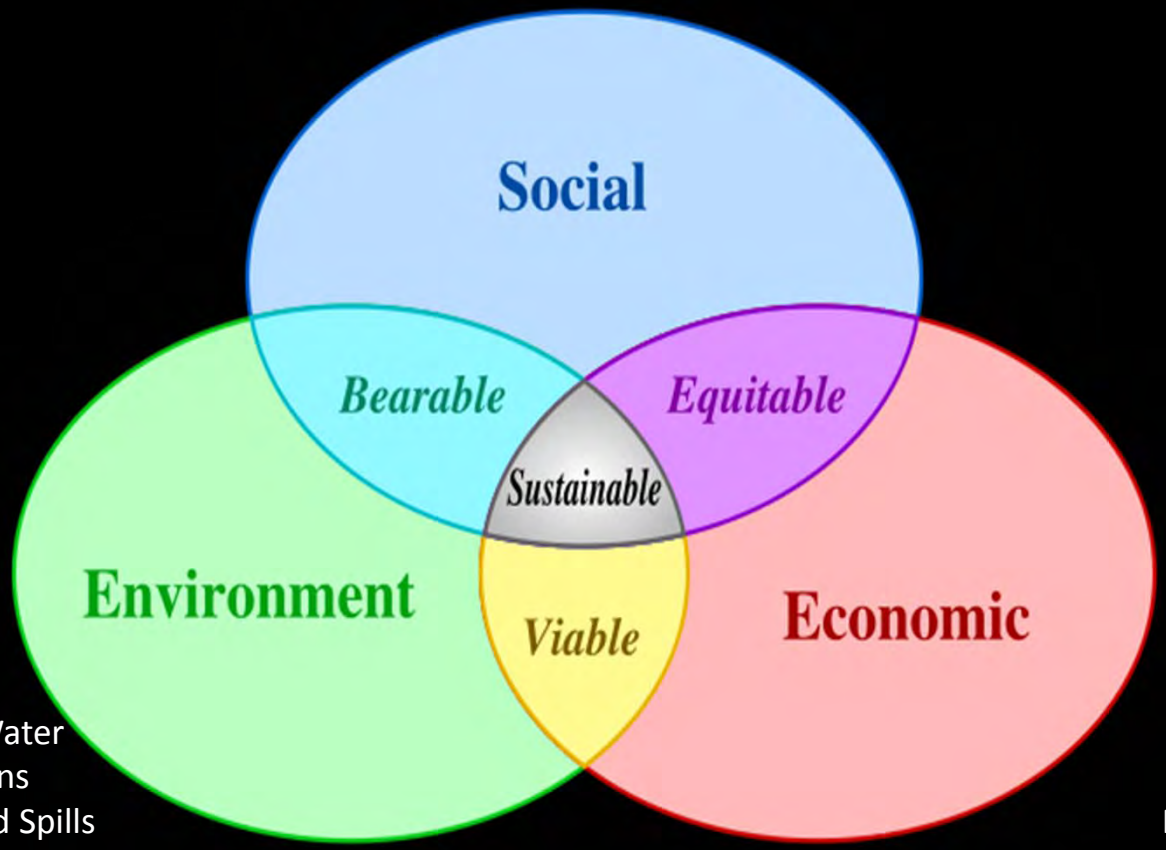
Sustainability is many things to many people. It can simultaneously be an idea, a property of living systems, a manufacturing method, or a way of life.

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

World Commission on Environment and Development report, 'Our Common Future' (Brundtland Report), 1987.

- Issues with defining sustainability
  - Not universally accepted and has undergone various interpretations.
  - It may be seen to encompass all human activity.
  - The strategies needed to address "sustainability" will vary according to the particular circumstances under consideration.

Diversity
Human Rights
Community Outreach
Indigenous Communities
Labor Relations



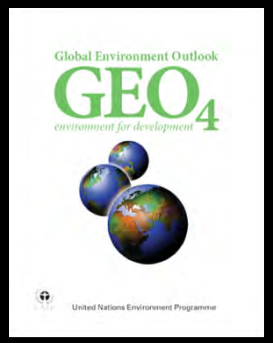
Clean Land, Air and Water
Emissions Reductions
Zero Waste, Release and Spills
Biodiversity

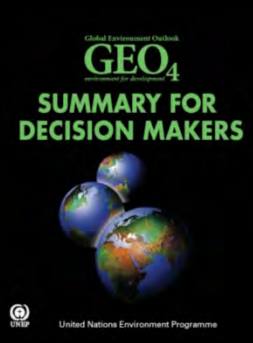
Innovation
Capital Efficiency
Risk Management
Margin Improvement
Growth Enhancement
Total Shareholder Return

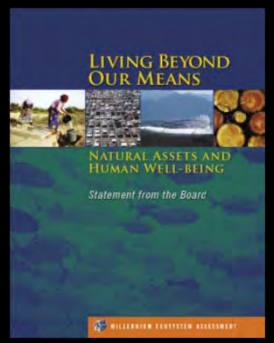
Environmental Sustainability

Focuses on the overall viability and health of living systems – defined in terms of a comprehensive, multi-scale, dynamic, hierarchical measure of resilience, vigor and organization

Consumption of renewable resources	State of environment	Sustainability
More than nature's ability to replenish	Environmental degradation	Not sustainable
Equal to nature's ability to replenish	Environmental equilibrium	Steady-state economy
Less than nature's ability to replenish	Environmental renewal	Sustainable development



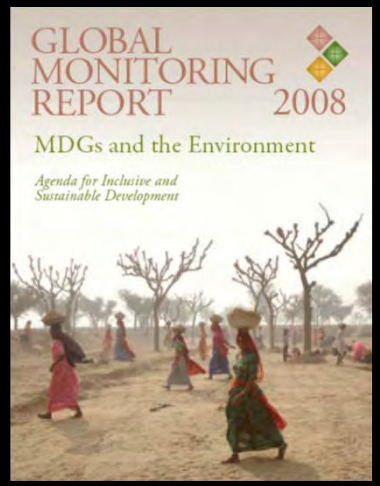




Social Sustainability

Reducing vulnerability and maintaining the health (i.e., resilience, vigor and organization) of social and cultural systems, and their ability to withstand shocks

Poverty and equity are two important issues, which have social, economic and environmental dimensions



goals

Millennium Development Goals

Goal 1

Eradicate extreme poverty and hunger

Target 1.
Halve, between 1990 and 2015, the proportion of people whose income is less than $1 a day

Target 2.
Halve, between 1990 and 2015, the proportion of people who suffer from hunger

Goal 2

Achieve universal primary education

Target 3.
Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling

Goal 3

Promote gender equality and empower women

Target 4.
Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015

Goal 4

Reduce child mortality

Target 5.
Reduce by two-thirds, between 1990 and 2015, the under-five mortality rate

Goal 5

Improve maternal health

Target 6.
Reduce by three-quarters, between 1990 and 2015, the maternal mortality ratio

Goal 6

Combat HIV/AIDS, malaria, and other diseases

Target 7.
Have halted by 2015 and begun to reverse the spread of HIV/AIDS

Target 8.
Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases

Goal 7

Ensure environmental sustainability

Target 9.
Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources

Target 10.
Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation

Target 11.
Have achieved by 2020 a significant improvement in the lives of at least 100 million slum dwellers

Goal 8

Develop a global partnership for development

Target 12.
Develop further an open, rule-based, predictable, nondiscriminatory trading and financial system (includes a commitment to good governance, development, and poverty reduction—both nationally and internationally)

Target 13.
Address the special needs of the Least Developed Countries (includes tariff- and quota-free access for Least Developed Countries' exports, enhanced program of debt relief for heavily indebted poor countries [HIPCs] and cancellation of official bilateral debt, and more generous official development assistance for countries committed to poverty reduction)

Target 14.
Address the special needs of landlocked developing countries and small island developing states (through the Program of Action for the Sustainable Development of Small Island Developing States and 22nd General Assembly provisions)

Target 15.
Deal comprehensively with the debt problems of developing countries through national and international measures in order to make debt sustainable in the long term

Some of the indicators listed below are monitored separately for the least developed countries, Africa, landlocked developing countries, and small island developing states

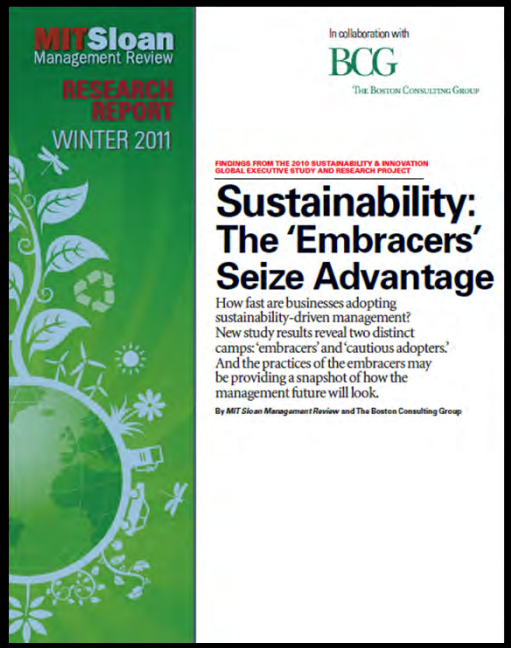
Target 16.
In cooperation with developing countries, develop and implement strategies for decent and productive work for youth

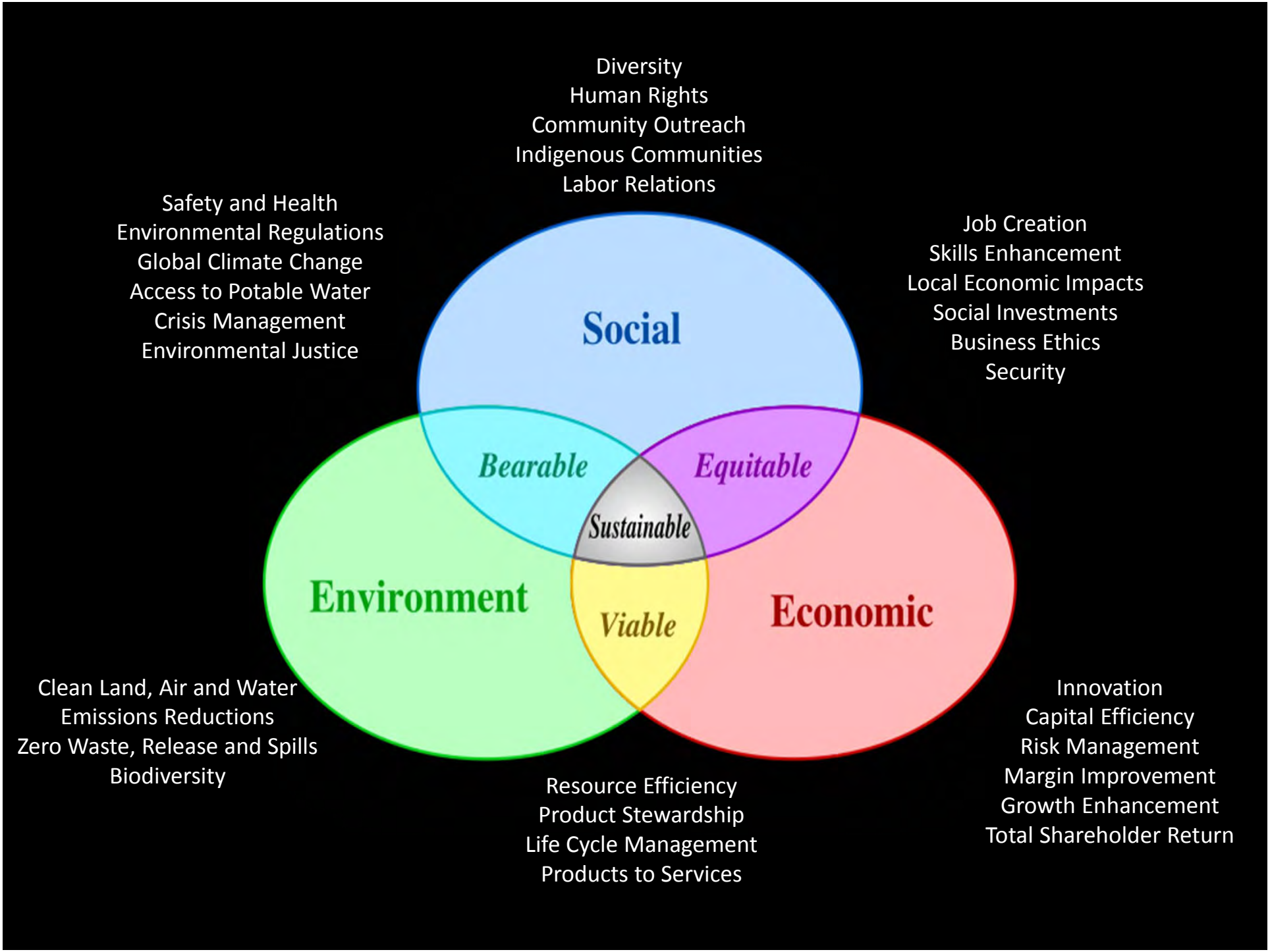
Target 17.
In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries

Target 18.
In cooperation with the private sector, make available the benefits of new technologies, especially information and communications technologies

Economic Sustainability

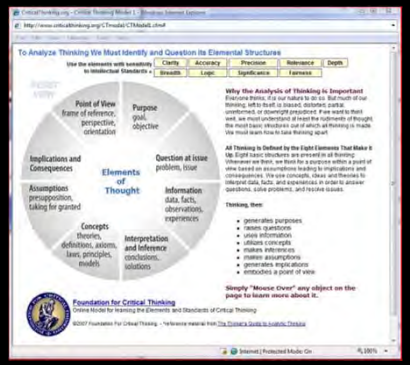
Maximize the flow of income that could be generated while at least maintaining the stock of assets (or capital) which yield this income

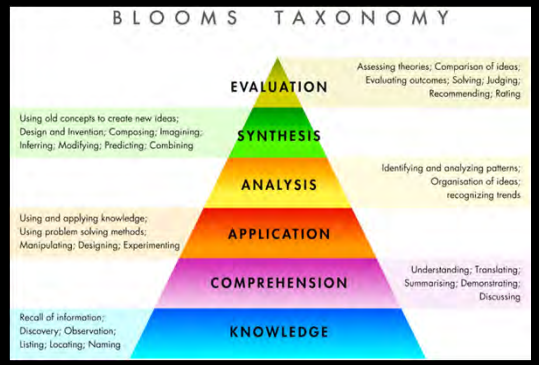



Diversity
Human Rights
Community Outreach
Indigenous Communities
Labor Relations
Safety and Health
Environmental Regulations
Global Climate Change
Access to Potable Water
Crisis Management
Environmental Justice
Job Creation
Skills Enhancement
Local Economic Impacts
Social Investments
Business Ethics
Security
Social
Bearable
Equitable
Sustainable
Environment
Viable
Economic
Clean Land, Air and Water
Emissions Reductions
Zero Waste, Release and Spills
Biodiversity
Resource Efficiency
Product Stewardship
Life Cycle Management
Products to Services
Innovation
Capital Efficiency
Risk Management
Margin Improvement
Growth Enhancement
Total Shareholder Return

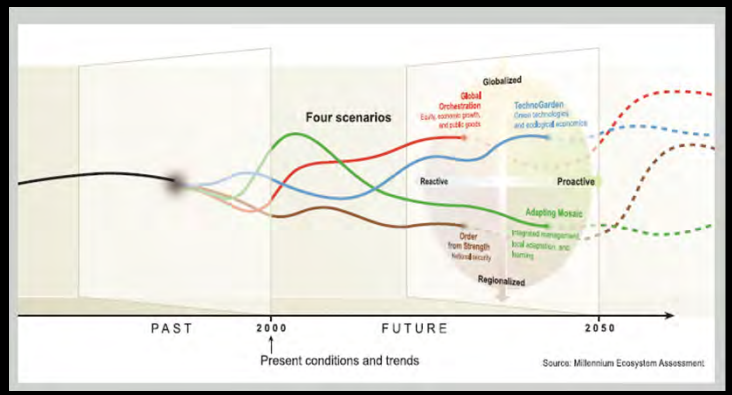
FRAMEWORKS

CRITICAL THINKING

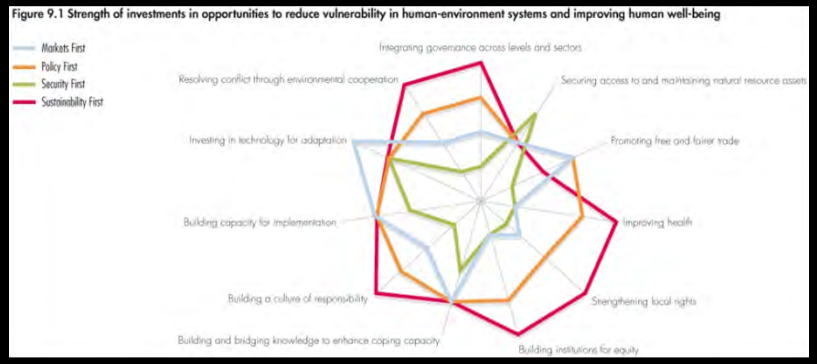




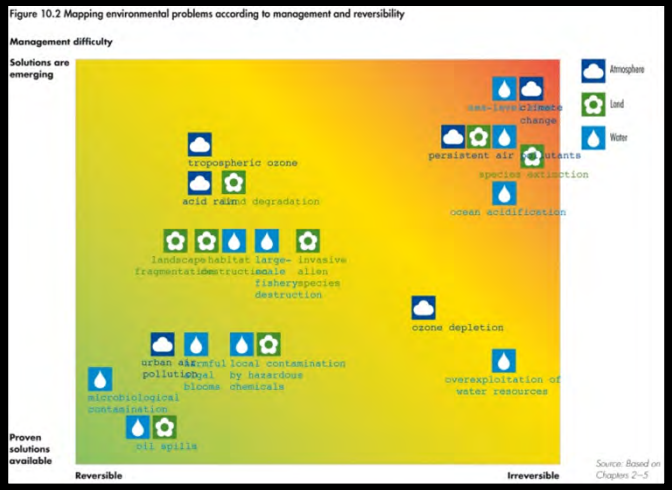
SCENARIOS



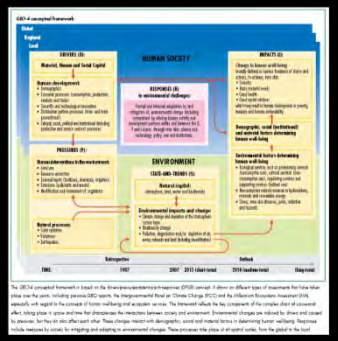
VISUALIZATION



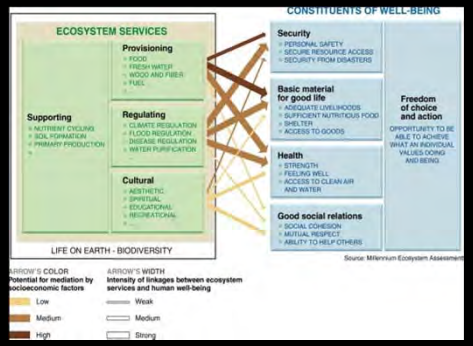
MAPPING



ANALYTICAL

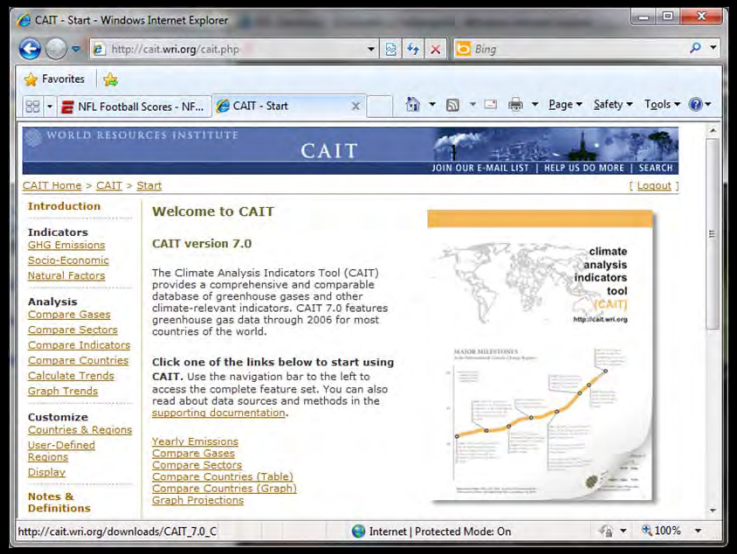


RELATIONSHIPS

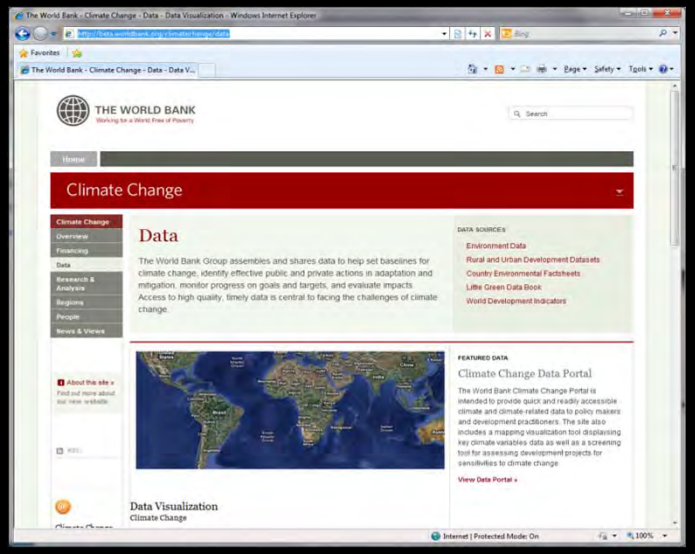


TOOLS / RESOURCES

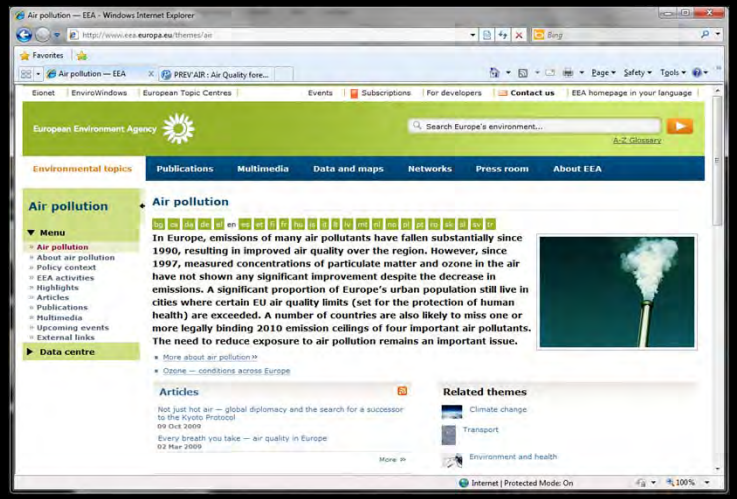
WORLD RESOURCES INSTITUTE



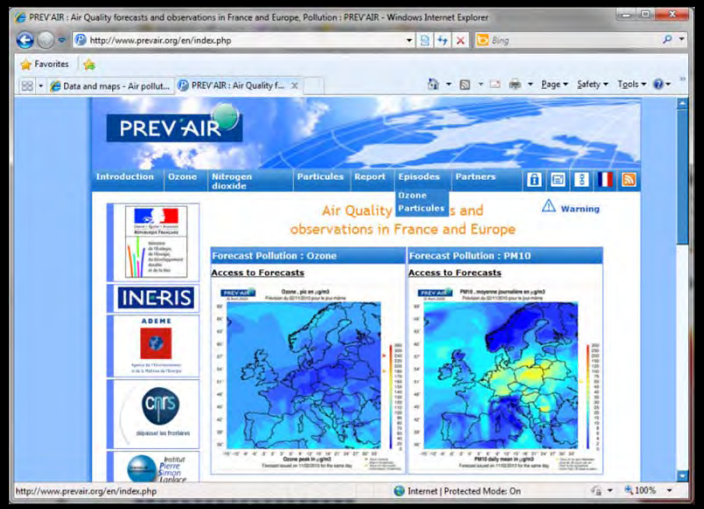
WORLD BANK



EUROPEAN ENVIRONMENTAL AGENCY



PREV AIR



INNOVATION

The following counting task is difficult and requires silence and concentration.

The task measures selective attention.

Most people can complete the task successfully if they try hard enough.

INNOVATION

"The Gorilla in the Room"

"Innovation . . . is generally understood as the successful introduction of a new thing or method . . . Innovation is the embodiment, combination, or synthesis of knowledge in original, relevant, valued new products, processes, or services."

--Luecke and Katz (2003)

INNOVATION
"The Gorilla in the Room"

- Massive amount of research and study of innovation
  - Lead-user innovation
  - Value creation vs. value capture
  - Assessments of needs versus solutions
  - Disruptive innovation

- Three major points to convey today
  - The goal of innovation is to learn, not necessarily to succeed
  - Innovation involves making new and unique connections
  - Innovation is a process rather than a product

INNOVATIVE !!!

INNOVATIVE ???

CASE-BASED SOLUTIONS

unique, timely and relevant

WHITING SCHOOL OF ENGINEERING
JOHNS HOPKINS UNIVERSITY

ENVIRONMENTAL ENGINEERING, SCIENCE AND MANAGEMENT

EPF Ecole d'ingénieurs

ENVIRONMENTAL AND INNOVATIVE ENGINEERING

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

MITSloan MANAGEMENT

SLOAN SCHOOL OF MANAGEMENT (EXECUTIVE MBA)

SUSTAINABILITY
CASE STUDY EXAMPLES

MASDAR CITY

Masdar City is poised to become world's most sustainable, zero-waste, car-free, carbon neutral city

Masdar Initiative Objectives

- To emerge as the **global hub** for Cleantech education, research, development and production
- To **partner** with global leaders and innovative companies in the Cleantech industry
- To **diversify** the Abu Dhabi economy with a focus on renewable energies
- To develop a sustainable city that incorporates the **highest quality of life with the lowest environmental footprint**
- To create a city which is **carbon-neutral**, uses only **renewable energies** and produces **zero waste**

MASDAR مصدر

Masdar Initiative Overview

The Masdar Institute

- Independent, not-for-profit, research-driven, graduate level institute
- Create a new generation of world energy leaders in Abu Dhabi; a generation that will have major influence worldwide
- Developed in partnership with the Massachusetts Institute of Technology (MIT)
- Offers Masters and PhD programs in science and engineering disciplines, with a focus on alternative energy and sustainable technologies
- Located in Masdar City. The first phase will be completed by Fall 2009
- Full financial aid package for students

In partnership with:

MIT Massachusetts Institute of Technology

Mobility Solutions

- Masdar City will be the first land-based city to operate without fossil fueled autos and trucks
- Walking, Cycling, PRT and LRT are the modes of transportation within Masdar City.
- With 50,000 commuters per day, Masdar City will have strategically placed parking areas for fossil-fueled vehicles

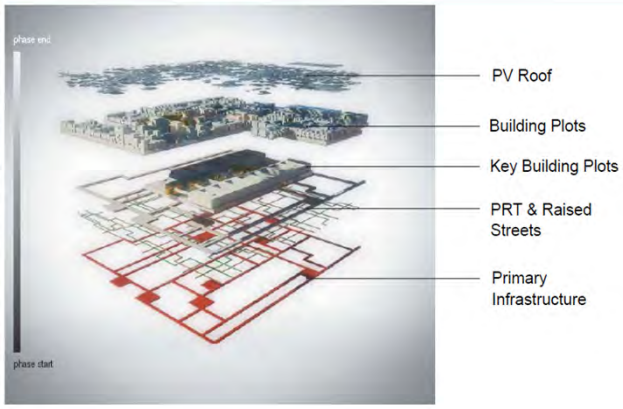
PRT Fast Facts	
PRT Vehicles:	2,160
PRT Stations:	83
MRT Vehicles	810
PRT Trips per day:	100,000
Max. Walking Distance to PRT Station:	150m
LRT Trips per day:	5,000

Personal Rapid Transport (PRT)

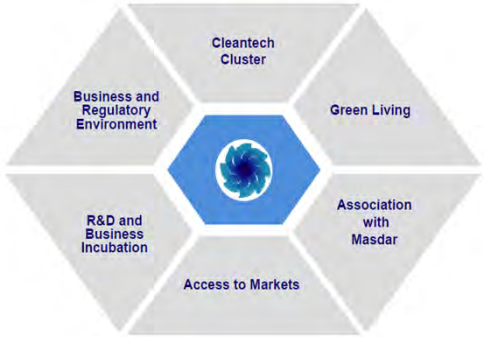
Light Rapid Transport (LRT)

February 09

Masdar City Layering



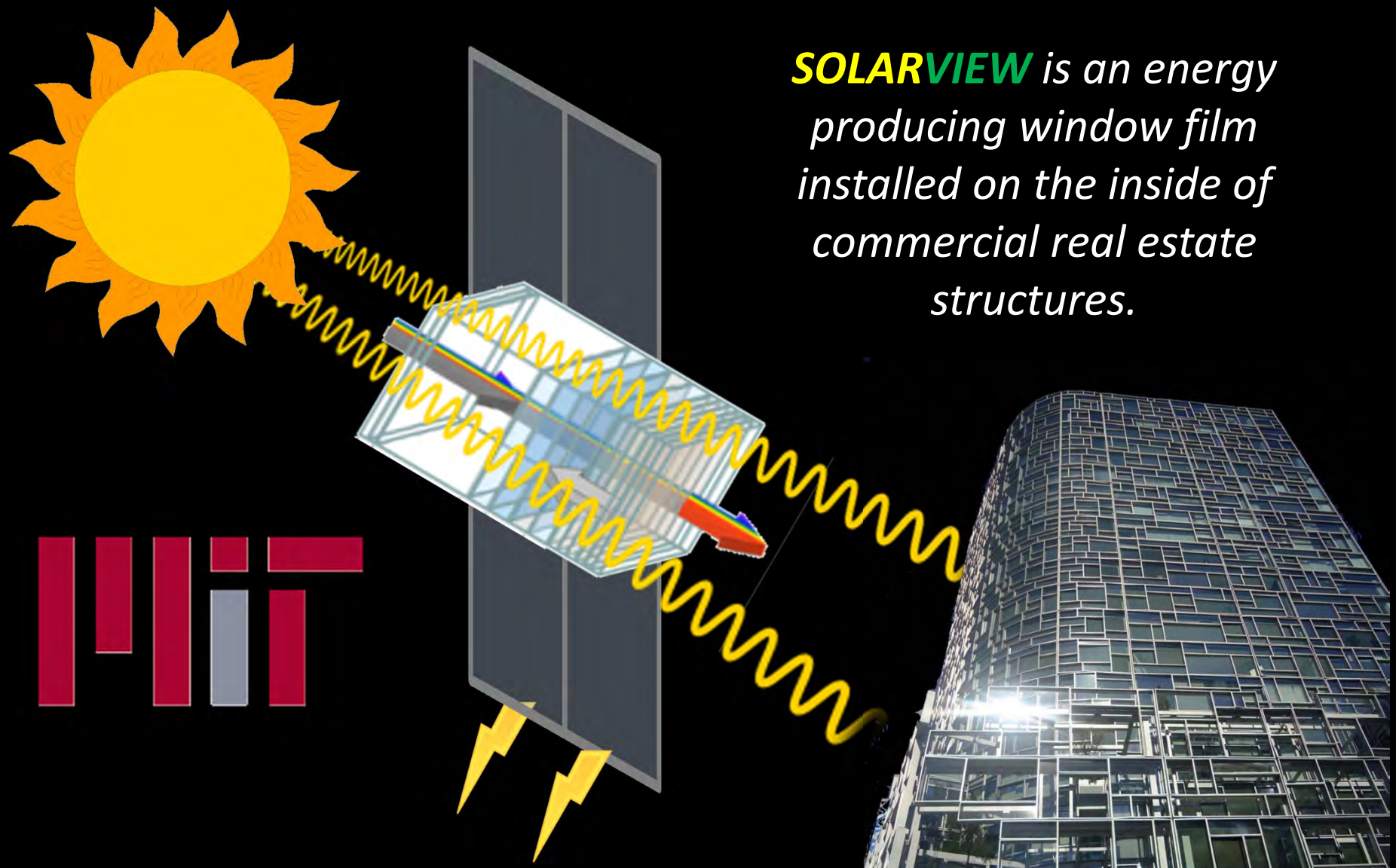
Masdar's Business Model



MasdarPV

SOLARVIEW

CREATING A CLEAR VIEW TO A SUSTAINABLE FUTURE



SOLARVIEW *is an energy producing window film installed on the inside of commercial real estate structures.*

- Solar energy passes through **SolarView** laminate
- OPV technology converts incident energy to electricity
- Film provides direct electric input to the grid

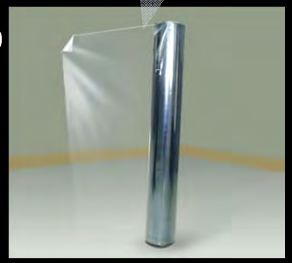
The Value Chain…Built Together.

Materials and Consulting Solutions to Bring OPV Technology to Market

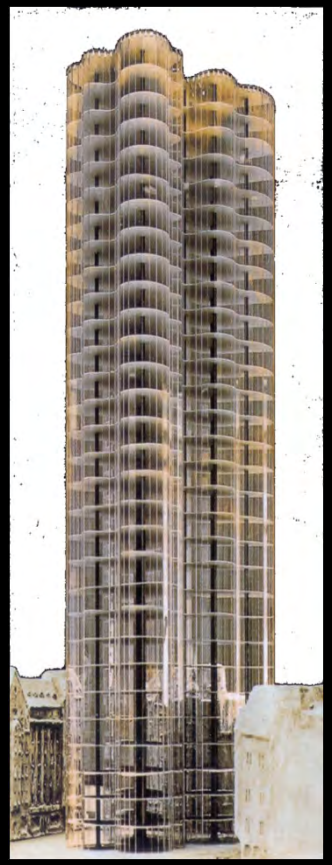
Laminate Materials

Manufacturing Process

Finished Products

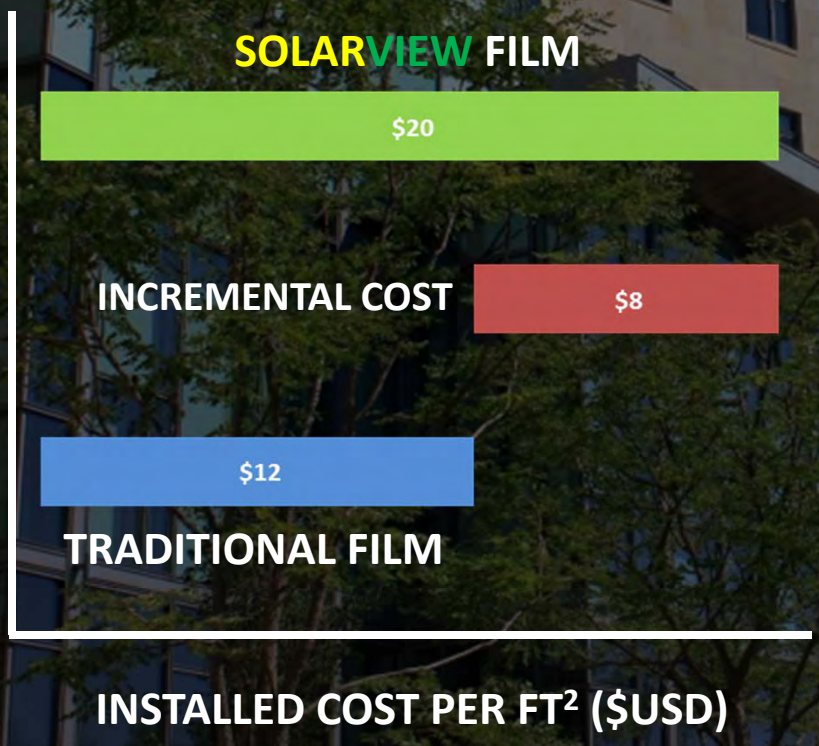


Commercial Real Estate Applications



ECONOMIC JUSTIFICATION

UNIT ECONOMICS

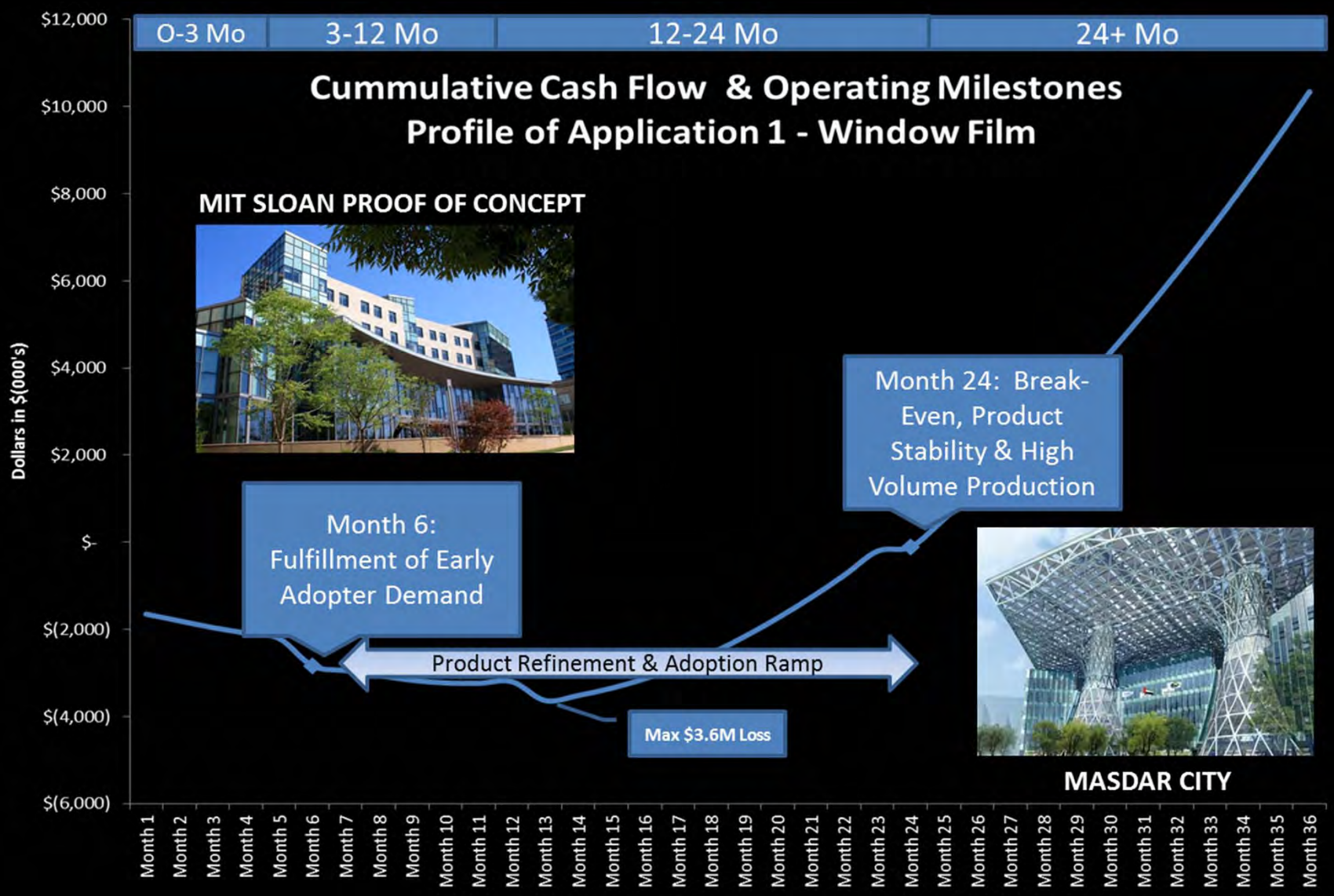


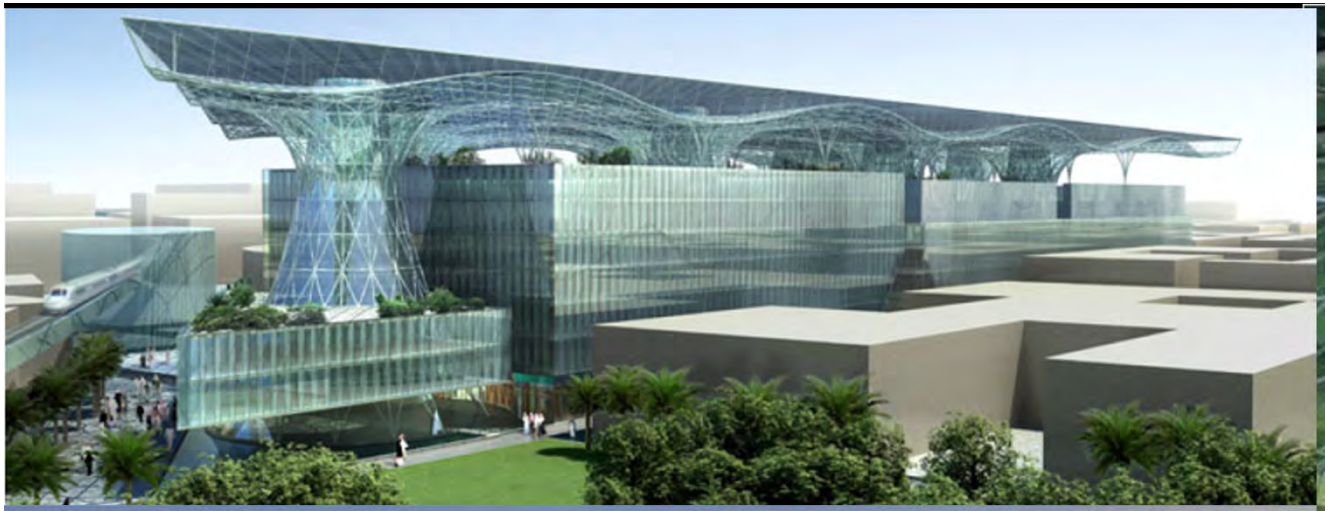
SCALE ECONOMICS (210k GSF)

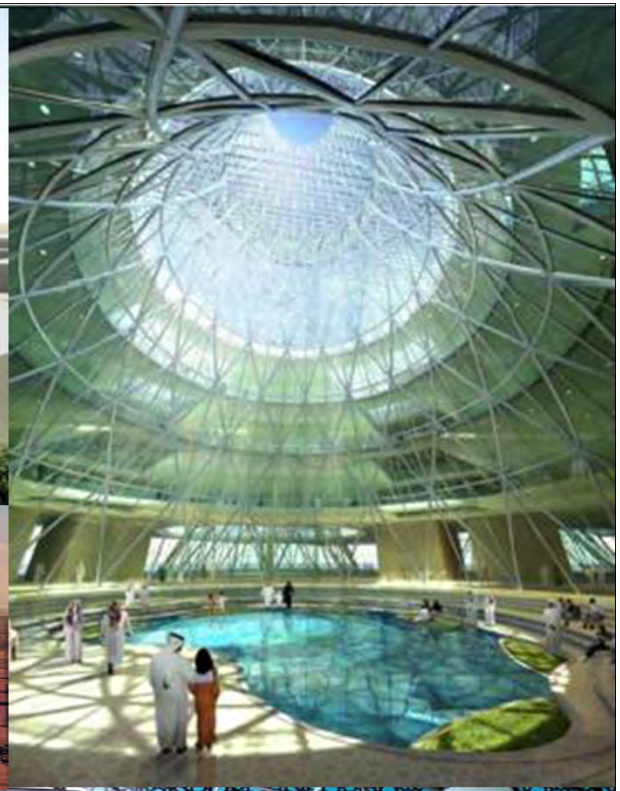
- ***Spectrally sensitive film cost*** ***$202,000***
- ***Incremental cost to install SolarView:*** ***$143,000***
- ***Energy produced annually:*** ***$39,000***
- ***Payback period:*** ***3.7 yrs***
- ***Benefit produced over system life:*** ***$772,000***

5.4X return multiple over an expected 20-year life cycle.

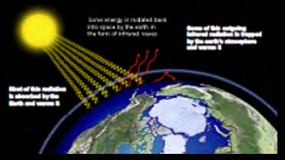
Project Milestones & Economics







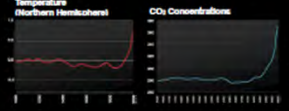
CLIMATE CHANGE

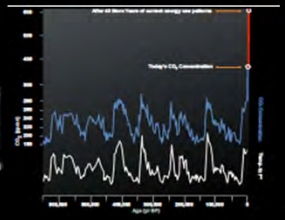


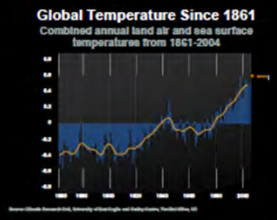
"What gets us into trouble is not what we don't know...

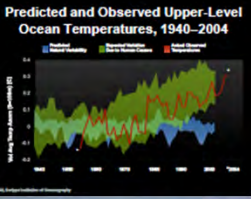
It's what we know for sure that just ain't so."

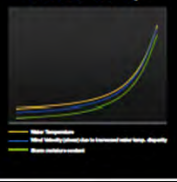
Mark Twain

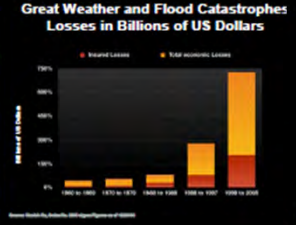


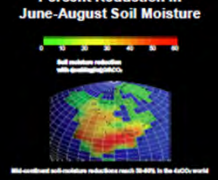


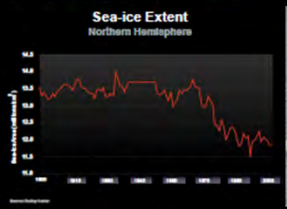


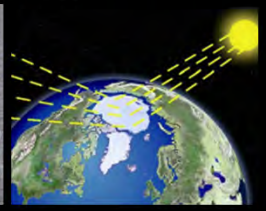


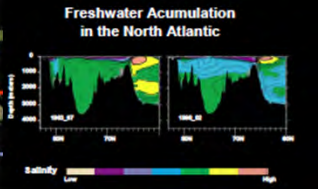


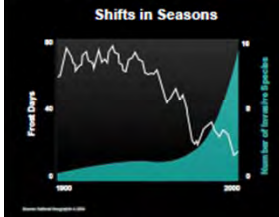


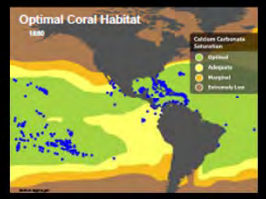






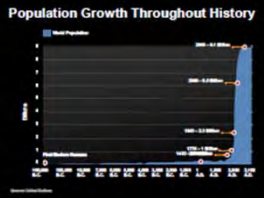


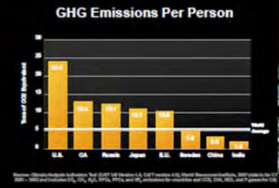




3 Factors

1. The Population Explosion
2. The Scientific and Technological Revolution
3. Our Way of Thinking

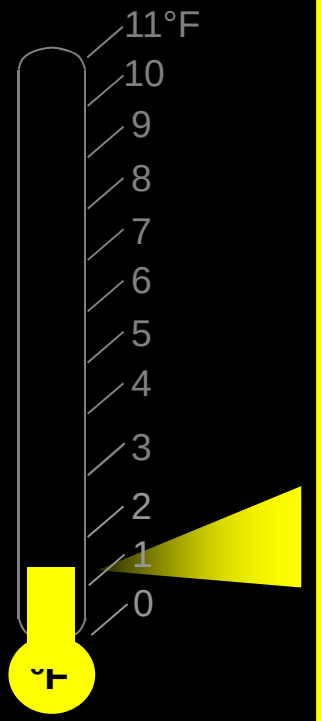




Sea Level Rise
Heat Waves
Intensity of Storm and Drought Events
Strength and Duration of Hurricanes
Species Extinctions
Ocean Acidification
Coral Reef Bleaching
Enhancement of Disease Vectors

Extreme Heat and Dry Years
Water Shortages
Sierra Nevada Snowpack Reduction
Bay Area Sea Level Rise
Agricultural Impacts
Air Quality Impacts
Decreasing Forest Yields
Shifts in Vegetative Cover
Increased Forest Fires
Stress on Local Ecosystems

California Climate Impacts
(over the past 100 years)



1.3 ºF higher temperatures

~7 inch sea level rise

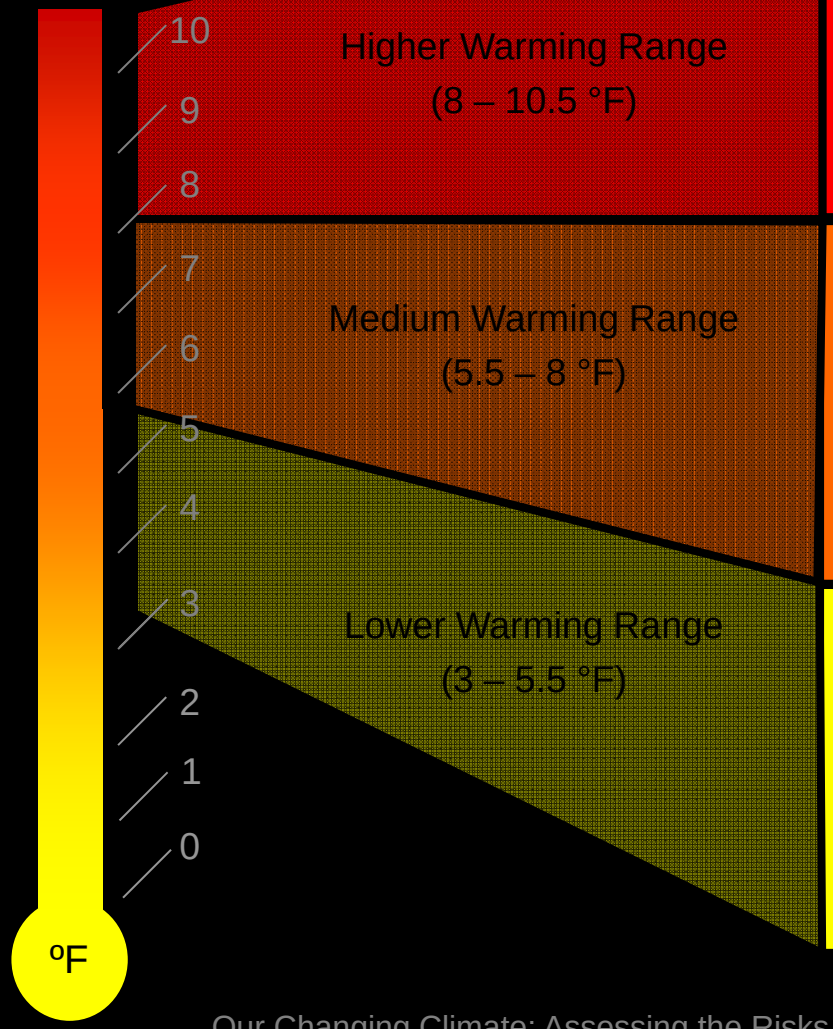
12% decrease in fraction of runoff between April and July

Snowmelt and spring blooms advanced 2 days/decade since 1955

Cal/EPA-OEHHA, "Environmental Protection Indicators for California" (2002), *www.oehha.ca.gov/multimedia/epic/Epicreport.html*

Projected Global Warming Impact on California, 2070-2099

(as compared with 1961-1990)



Higher Warming Range (8 – 10.5 °F)

3 - 4 times as many heat wave days
22 - 30 inches of sea level rise
90% loss in Sierra snowpack
20% increase in energy demand

Medium Warming Range (5.5 – 8 °F)

2.5 - 4 times as many heat wave days
14 - 22 inches of sea level rise
70 - 80% loss in Sierra snowpack
30% decrease in forest yields (pine)
55% increased risk of large forest fires
10% increase in energy demand

Lower Warming Range (3 – 5.5 °F)

2 - 2.5 times as many heat wave days
6 - 14 inches of sea level rise
30 - 60% loss in Sierra snowpack
7 - 14% decrease in forest yields (pine)
10 - 35% increased risk of large forest fires
3 - 6% increase in energy demand

Our Changing Climate: Assessing the Risks to California (2006), *www.climatechange.ca.gov*

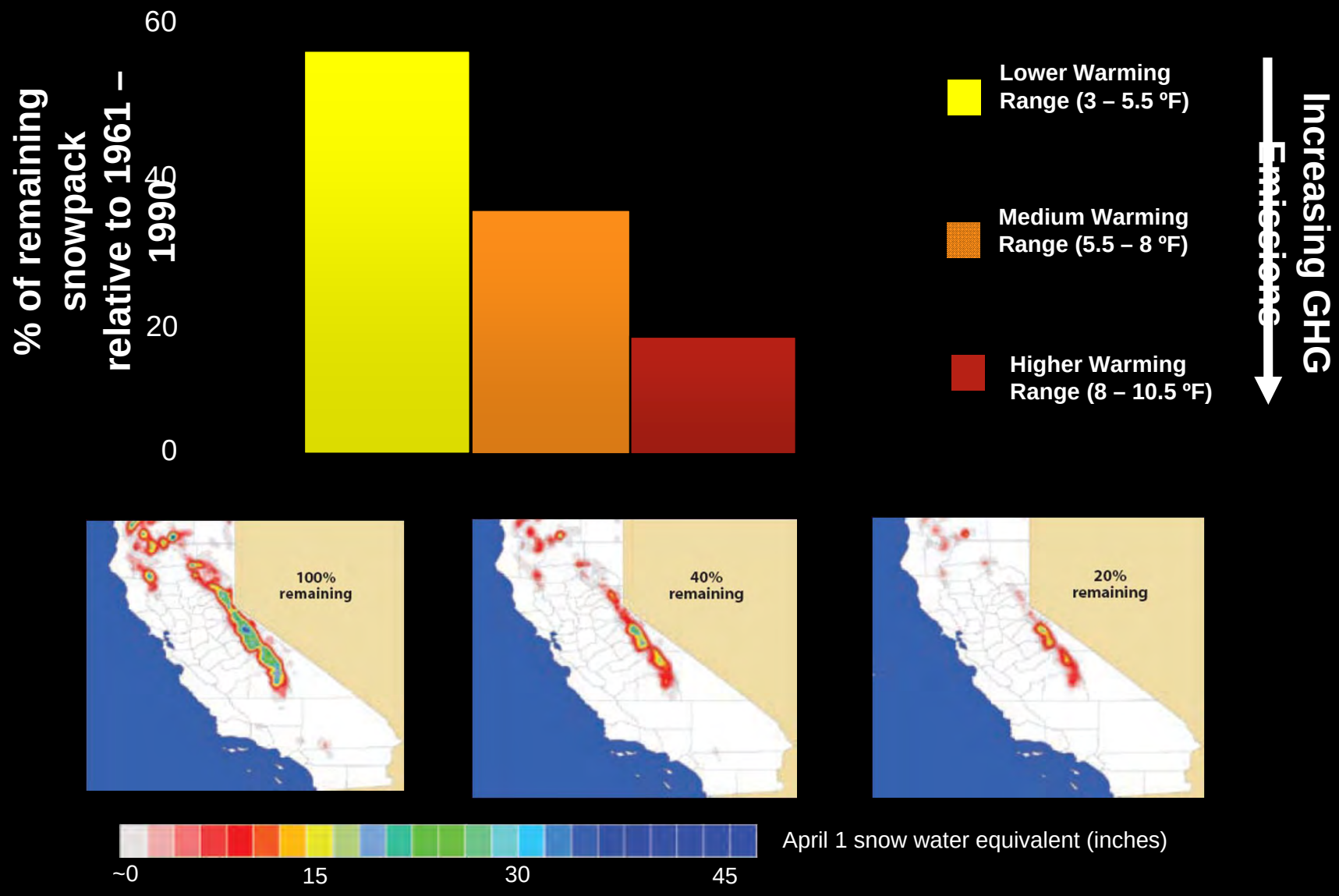
Lyell Glacier

Yosemite National Park

1903

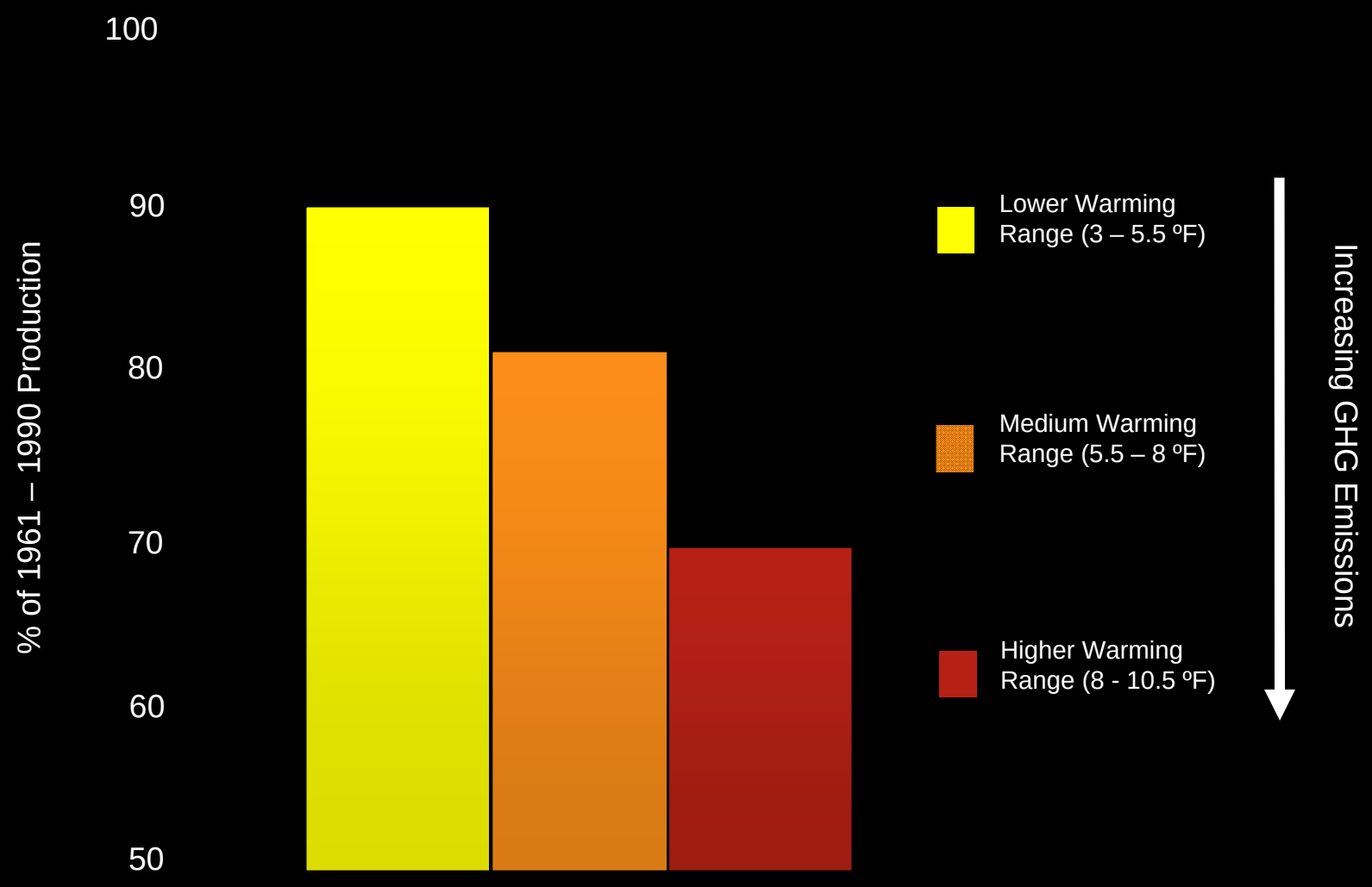
2003

Decrease in Sierra Nevada Snowpack



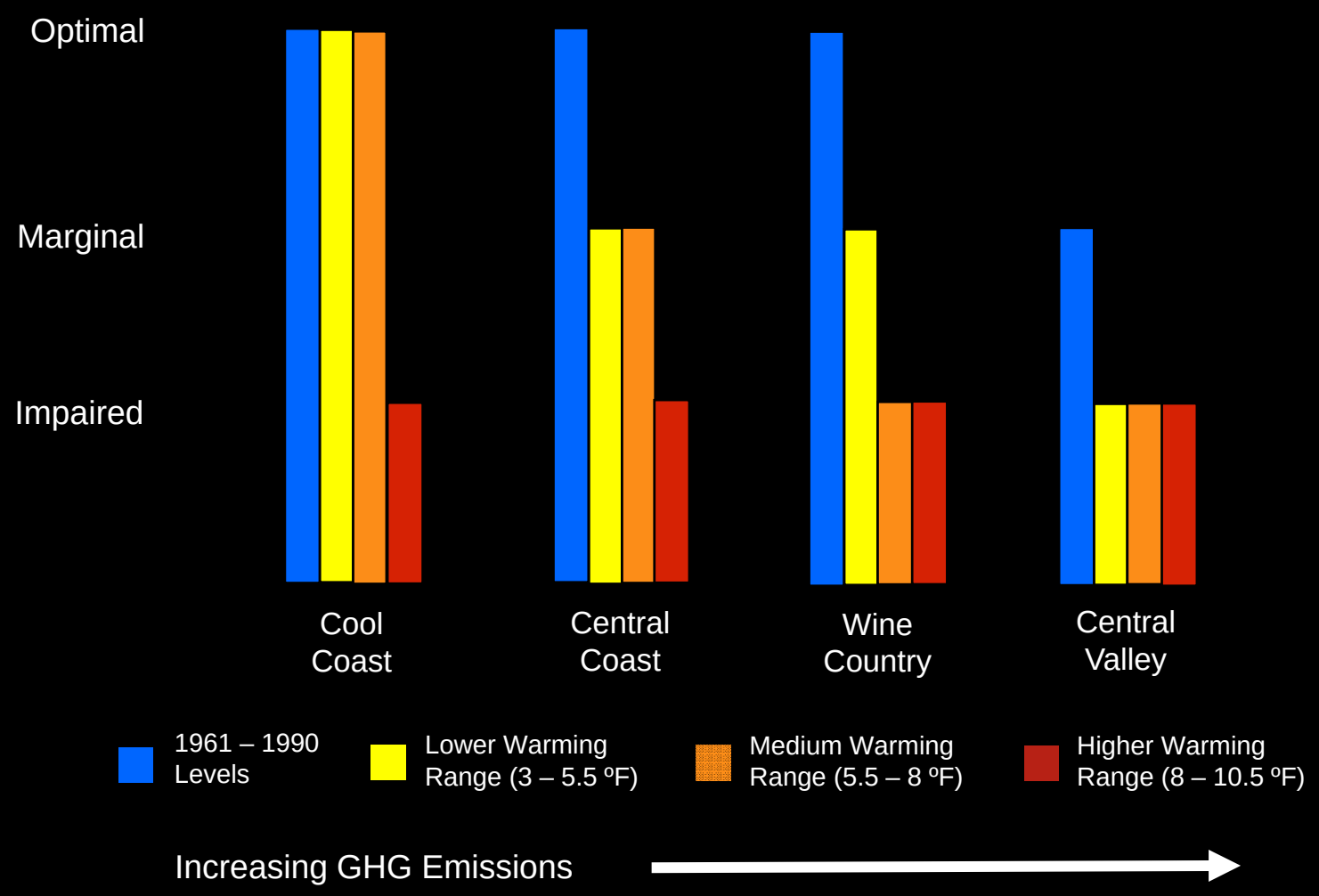
Our Changing Climate: Assessing the Risks to California (2006), *www.climatechange.ca.gov*

Decreasing Dairy Production



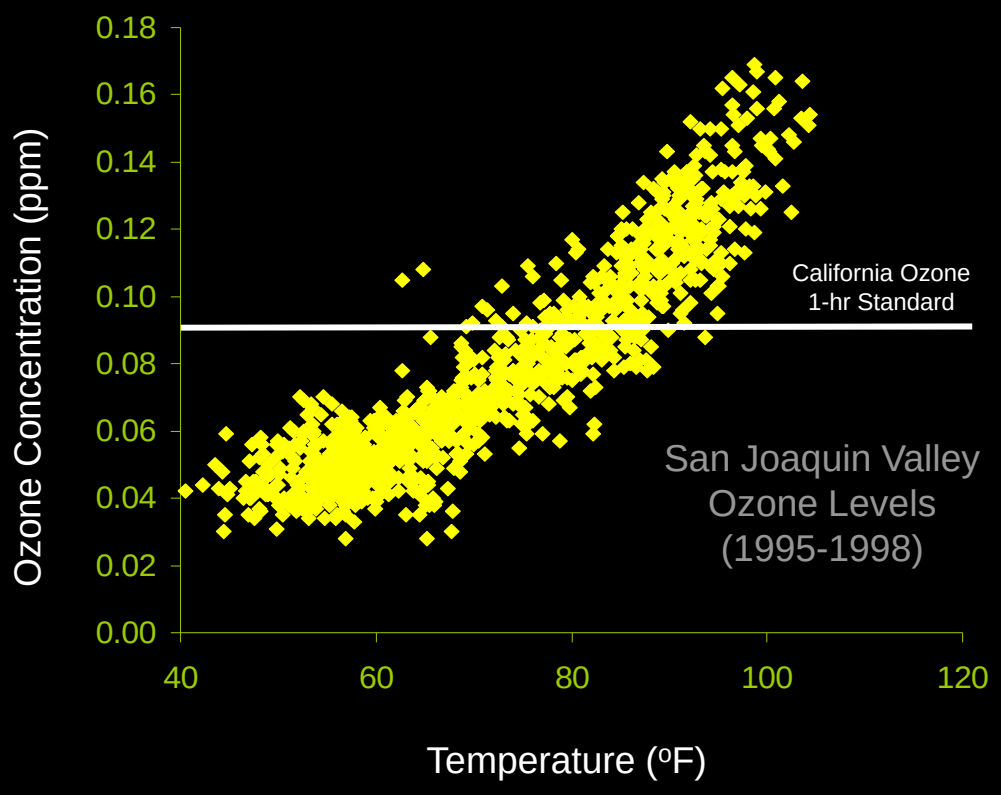
Source of data : Hayhoe et al. “Emissions pathways, climate change, and impacts on California”, *PNAS* (2004)

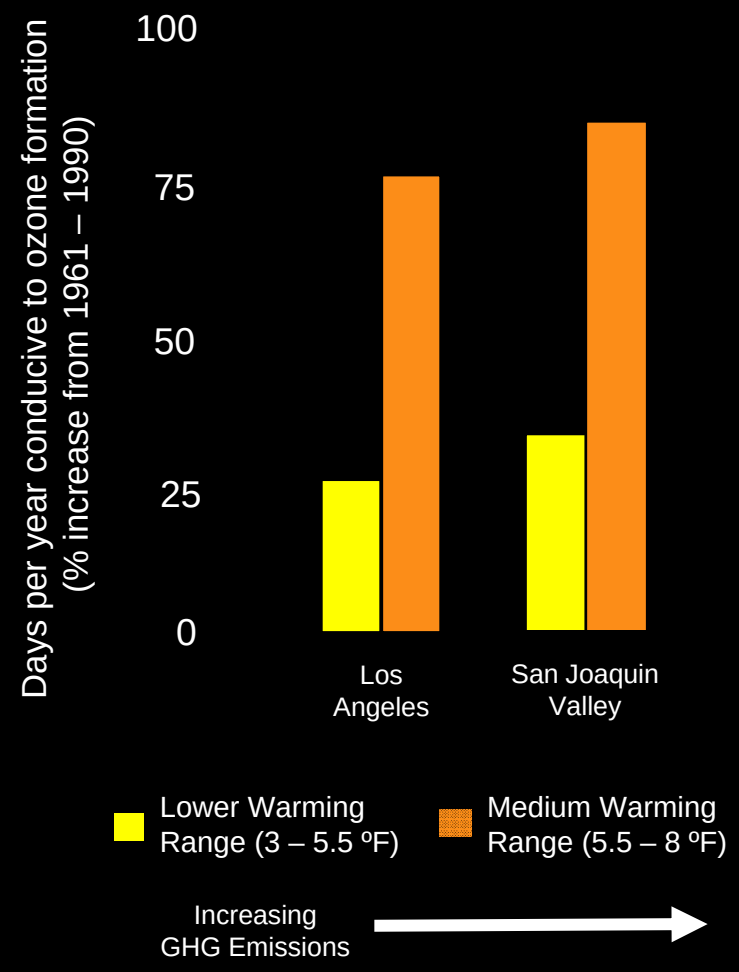
Decreasing Wine Grape Quality



Source of data : Hayhoe et al. “Emissions pathways, climate change, and impacts on California”, *PNAS* (2004)

Increased Risk of Poor Air Quality



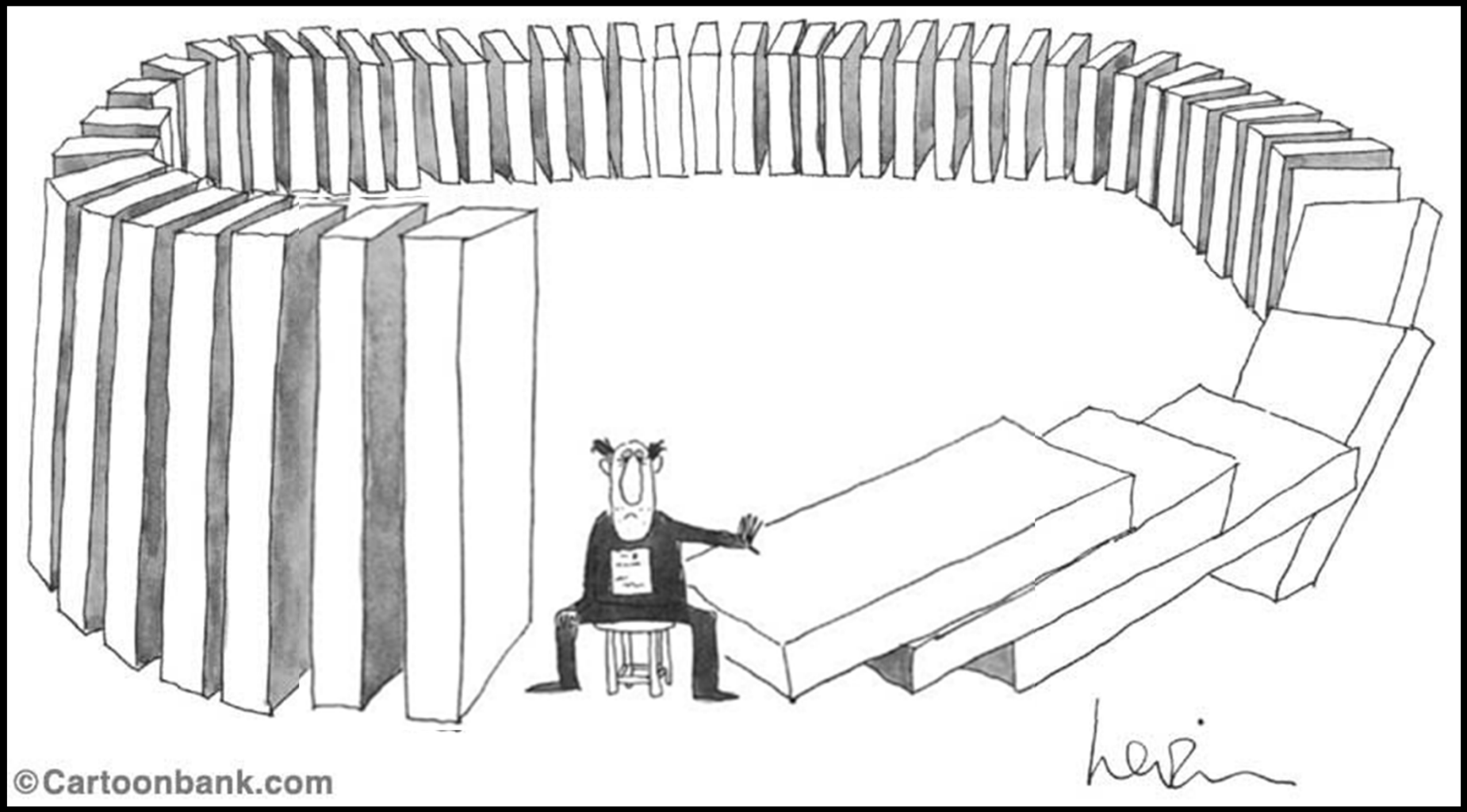


Our Changing Climate: Assessing the Risks to California (2006), *www.climatechange.ca.gov*

de Paris

SIMULATION
A Systems Dynamics Perspective

SIMULATION
A Systems Dynamics Perspective



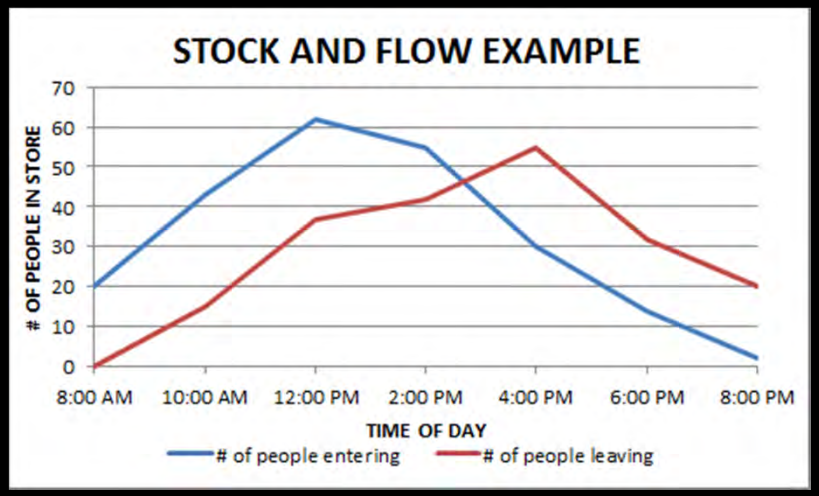
Systems Dynamics Fundamentals

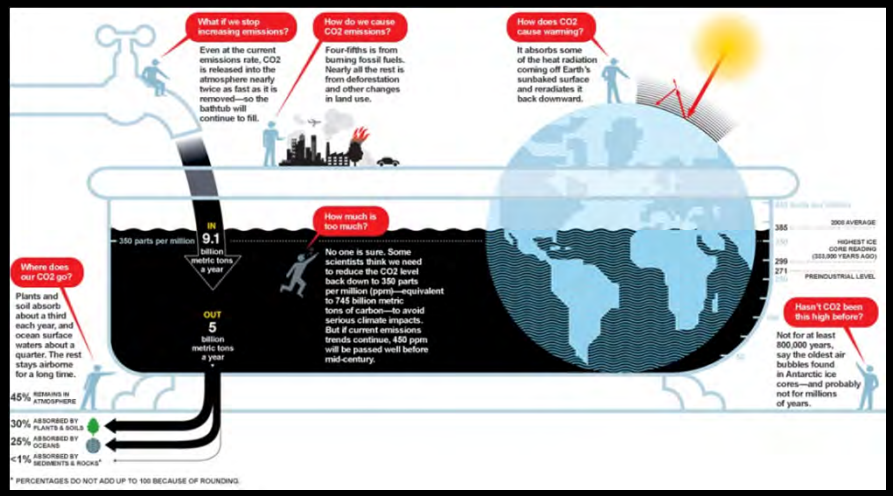
RE-ENFORCING AND BALANCING LOOPS

RE-ENFORCING
Awareness
Appeal

BALANCING
Technology
Competition

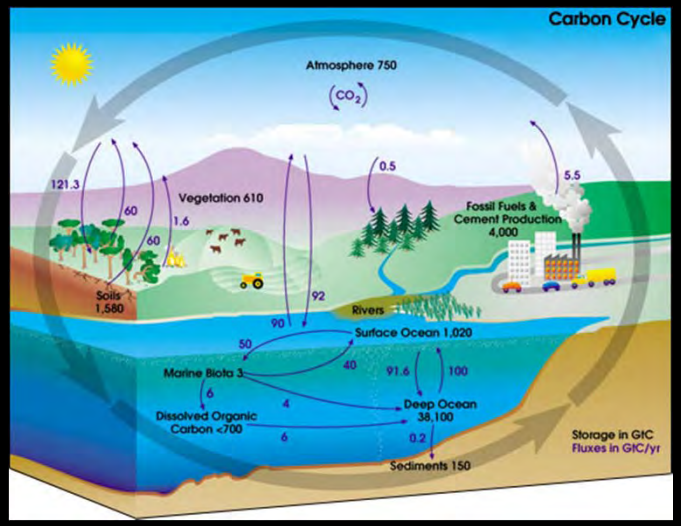
STOCKS AND FLOWS



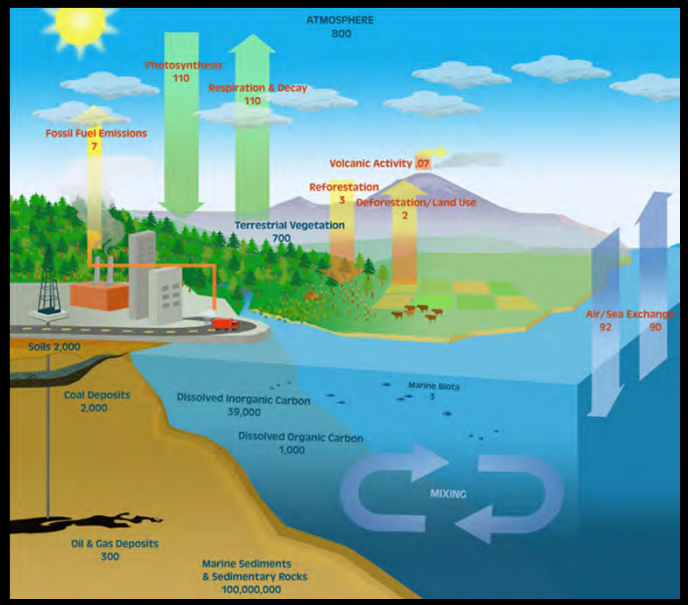


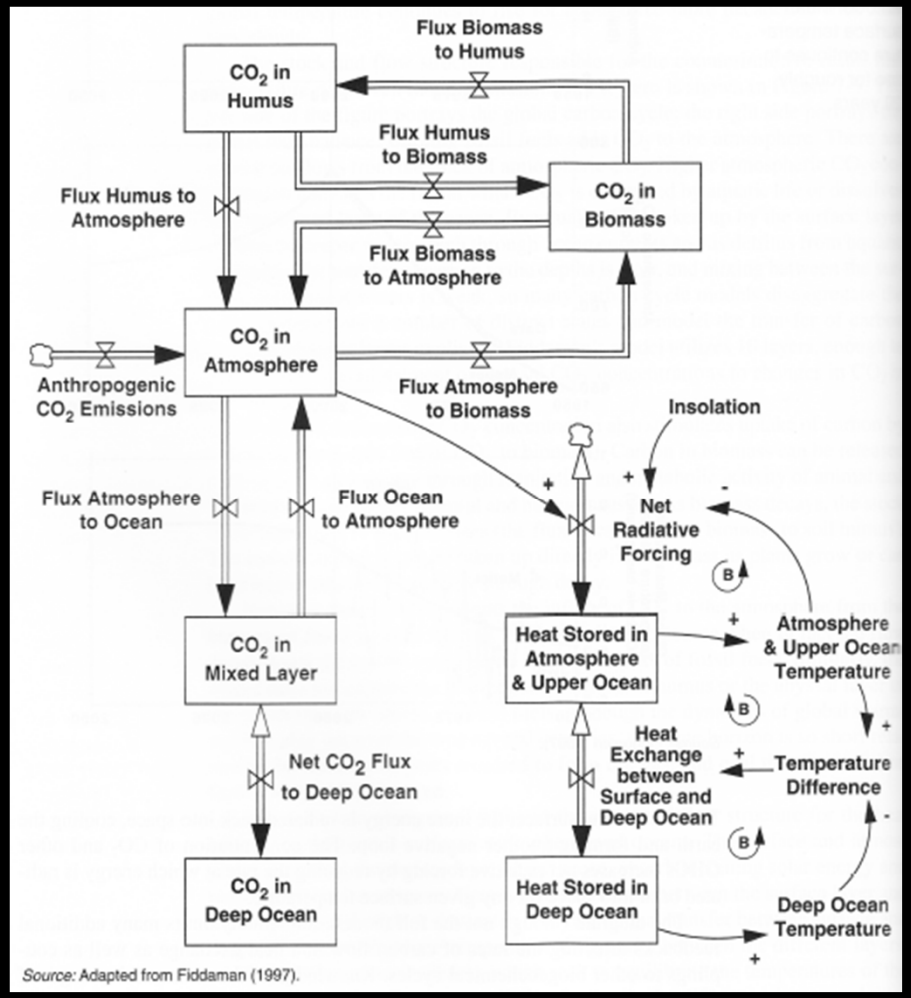
Basic Systems Dynamics Climate Model

CARBON CYCLE



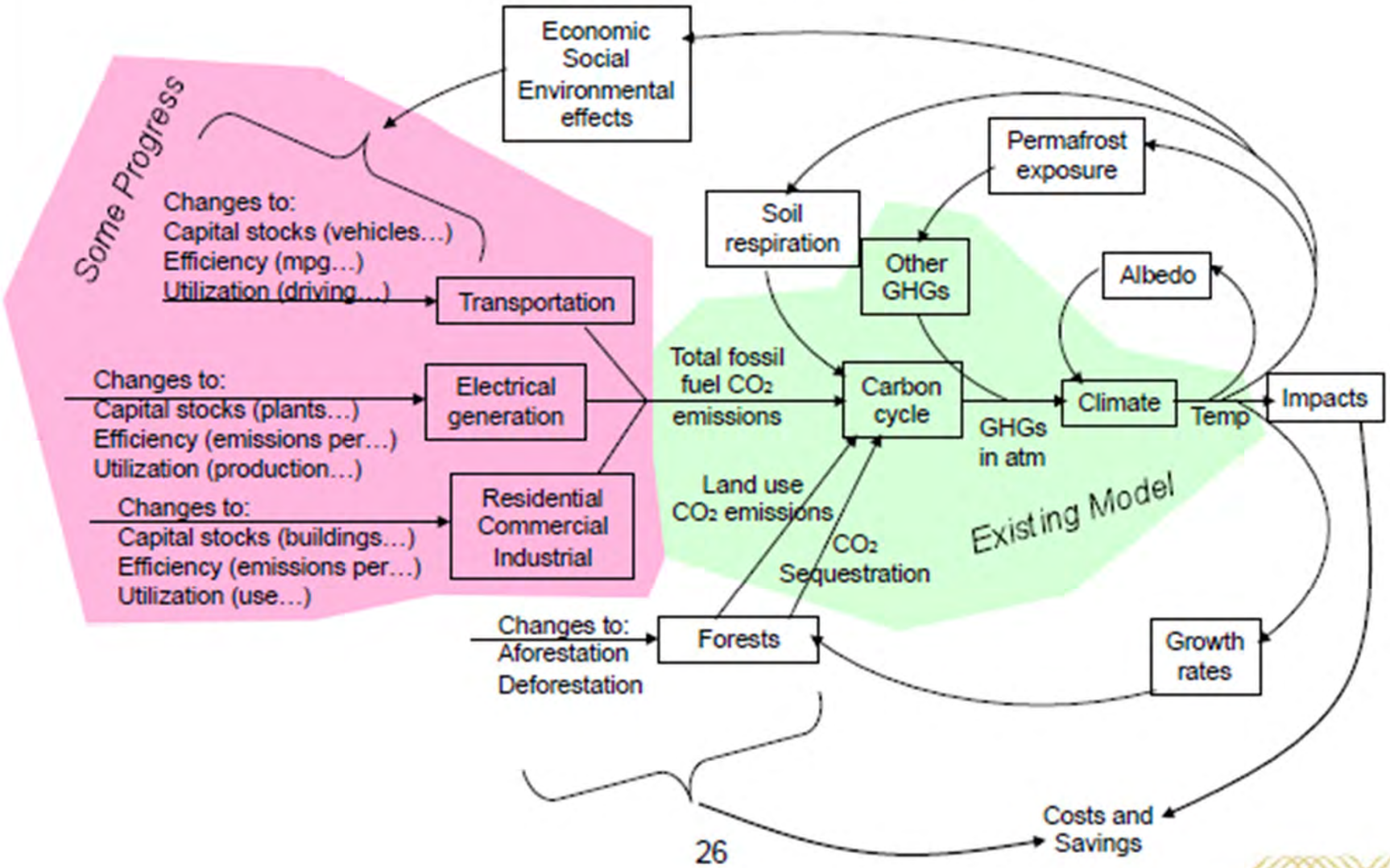
ENERGY BALANCE





Source: Adapted from Fiddaman (1997).

Current Scope and Potential Expansion



Sustainability Institute

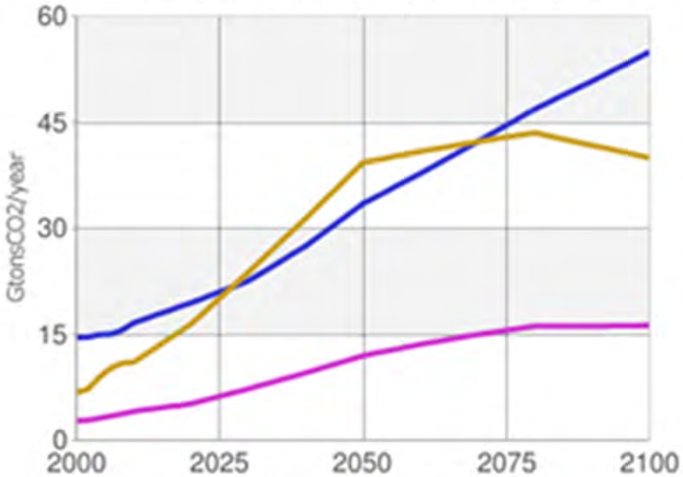
C-LEARN Climate Simulation

HOME | BRIEFING | FOSSIL FUEL EMISSIONS | OTHER EMISSIONS | CO2 & CO2eq | TEMPERATURE | SEA LEVEL RISE | DAT

Main Control Panel

Change the values and click "Run Simulation". See the graphical representations of your decisions below, and explore climate impacts in the graphs to the right and using the menu options above.

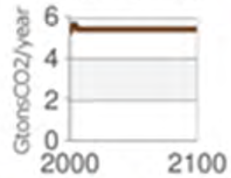
Fossil Fuel Emissions by Country Group



	0=BAU 1=User Input	% Change by 2050	Reference Year	Start Year
Developed	0	0	2005	2010
Developing A	0	0	2005	2010
Developing B	0	0	2005	2010

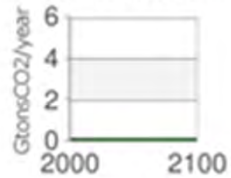
Click for Info on Baseline Scenarios

Emissions from Deforestation



(0-1 index for low to high values) 1.0

Sequestration from Afforestation

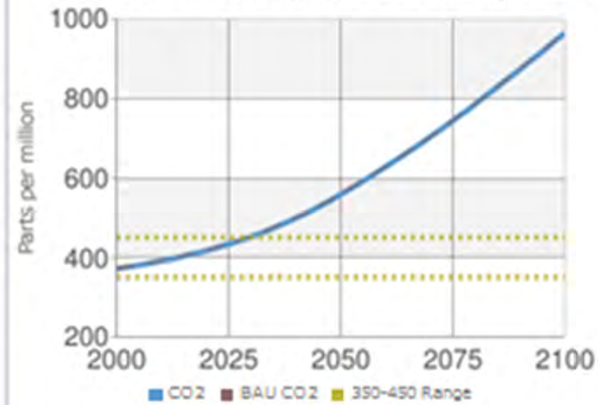


(0-1 index for low to high values) 0.0

Change scenario name(s) | Run Simulation | Reset Inputs | Clear Runs

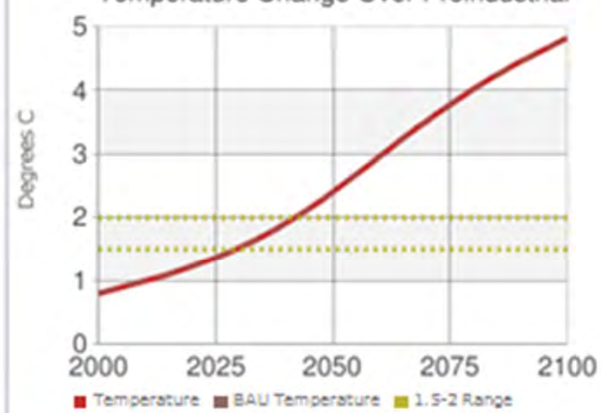
Impacts

CO2 Concentration in the Atmosphere



CO2 in 2100: 964 ppm

Temperature Change Over Preindustrial

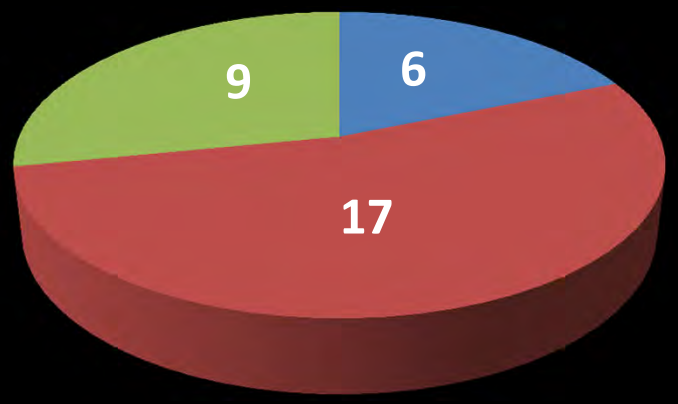


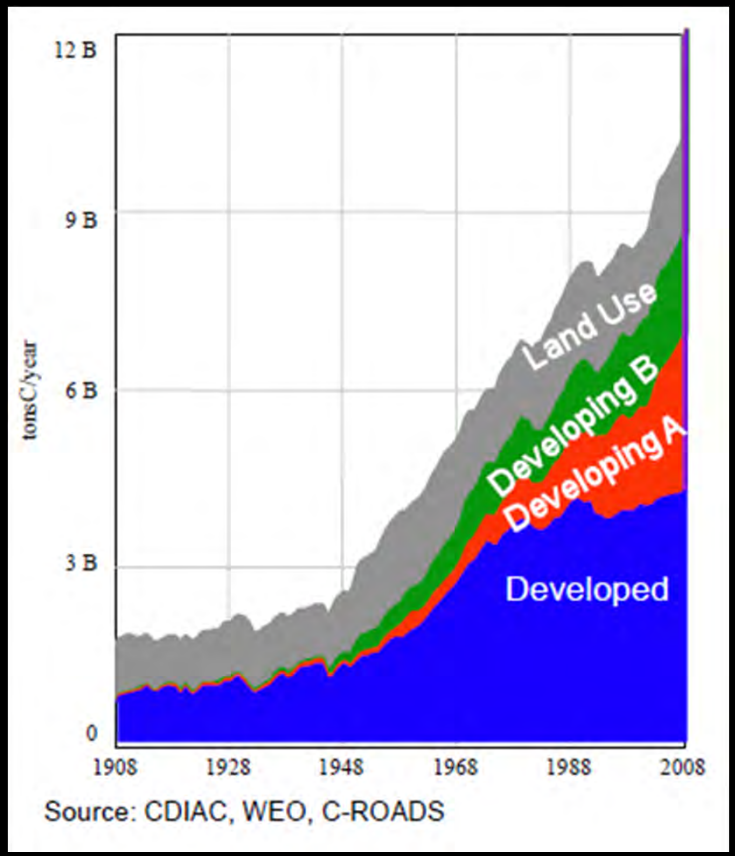
Temperature change by 2100: 4.8 degrees C

Comments/Suggestions?

Optimized for Firefox and IE8

CLIMATE INTERACTIVE | MIT Sloan Management | VENTANA systems, inc. | Simulation hosted by Forio Broadcast





FOSSIL FUEL AND
GLOBAL DEFORESTATION

GOAL

Achieve emissions reduction commitments to stabilize GHG levels by 2100 at a level that limits global warming to no more than 2 °C above preindustrial Levels.

Three Rounds of Negotiation

Round A – 30 min
Round B – 20 min
Round C – 10 min

Agreement

Developed: 50% reduction
Developing A: 27% reduction, deforestation to .1
Developing B: 0% reduction, deforestation to 0

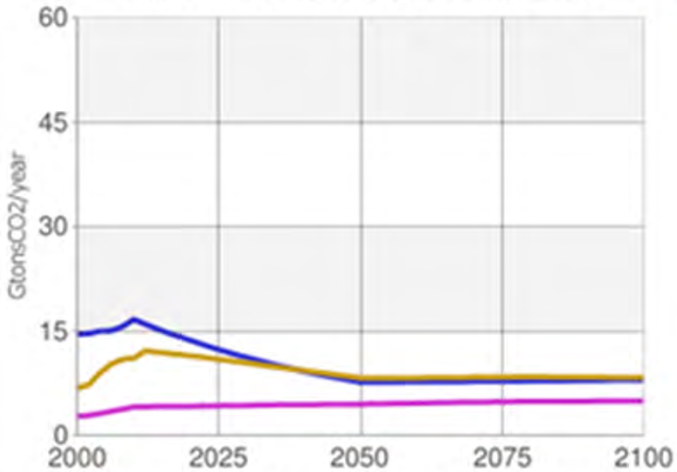
C-LEARN Climate Simulation

HOME | BRIEFING | FOSSIL FUEL EMISSIONS | OTHER EMISSIONS | CO2 & CO2eq | TEMPERATURE | SEA LEVEL RISE | DATA

Main Control Panel

Change the values and click "Run Simulation". See the graphical representations of your decisions below, and explore climate impacts in the graphs to the right and using the menu options above.

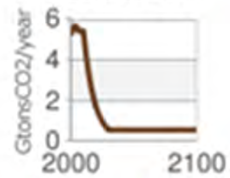
Fossil Fuel Emissions by Country Group



	0=BAU 1=User Input	% Change by 2050	Reference Year	Start Year
Developed	1	-50	2005	2010
Developing A	1	-27	2005	2012
Developing B	1	0	2005	2010

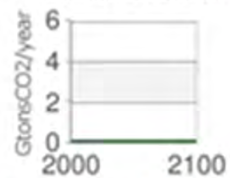
Click for Info on Baseline Scenarios

Emissions from Deforestation



(0-1 index for low to high values) 0.1

Sequestration from Afforestation

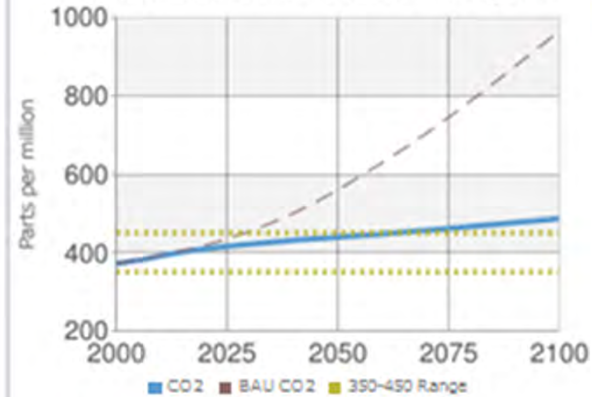


(0-1 index for low to high values) 0.0

Change scenario name(s) | Run Simulation | Reset Inputs | Clear Runs

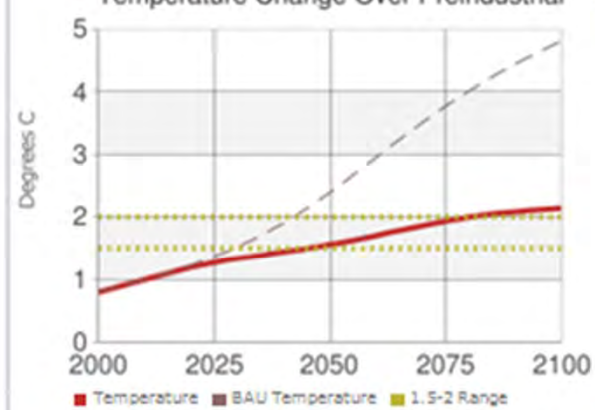
Impacts

CO2 Concentration in the Atmosphere



CO2 in 2100: 487 ppm

Temperature Change Over Preindustrial

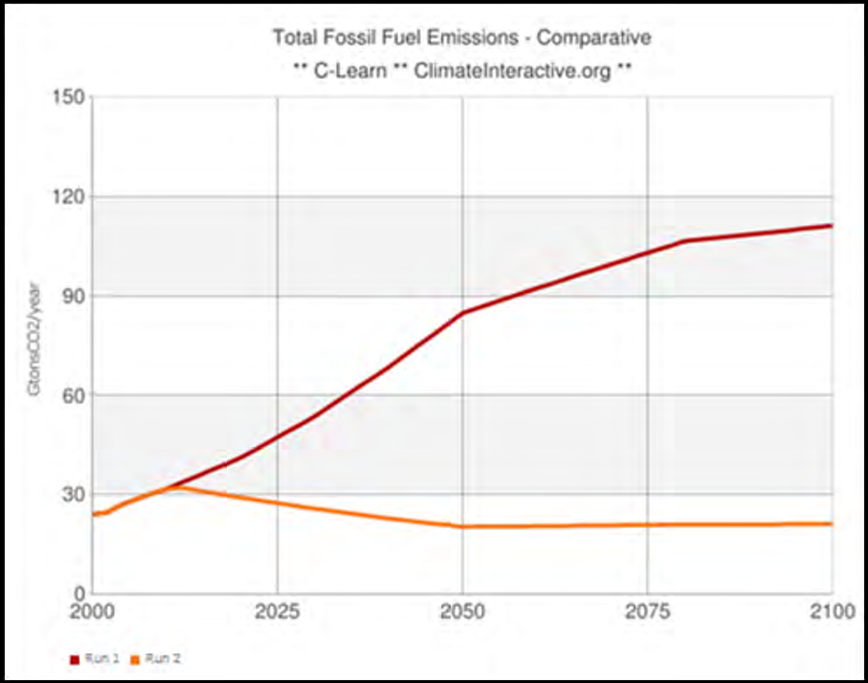


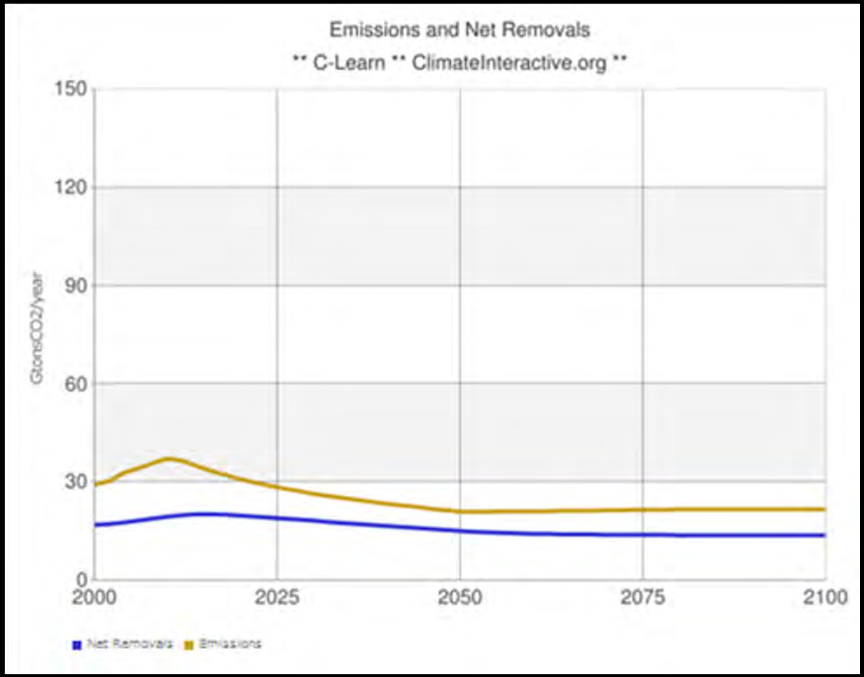
Temperature change by 2100: 2.1 degrees C

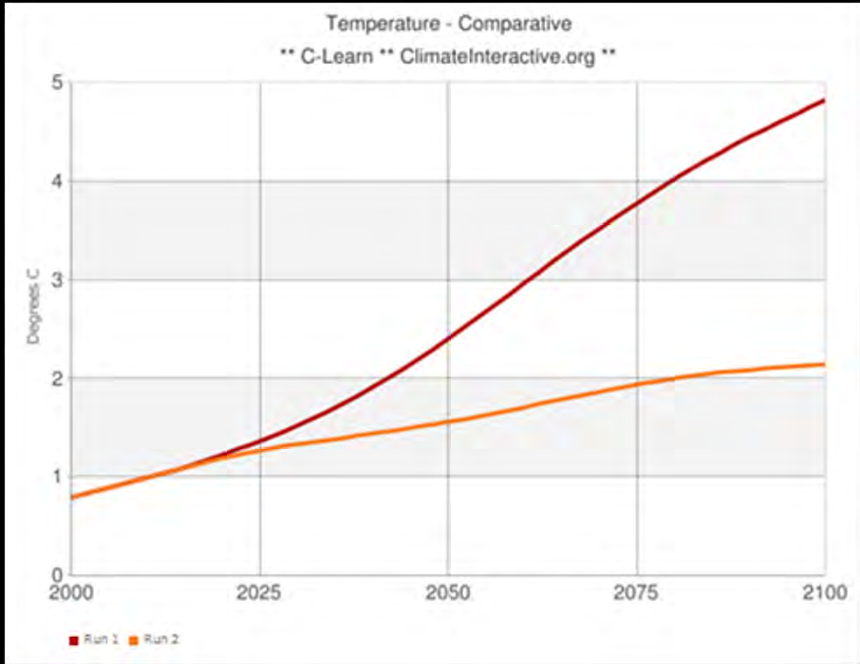
Comments/Suggestions?

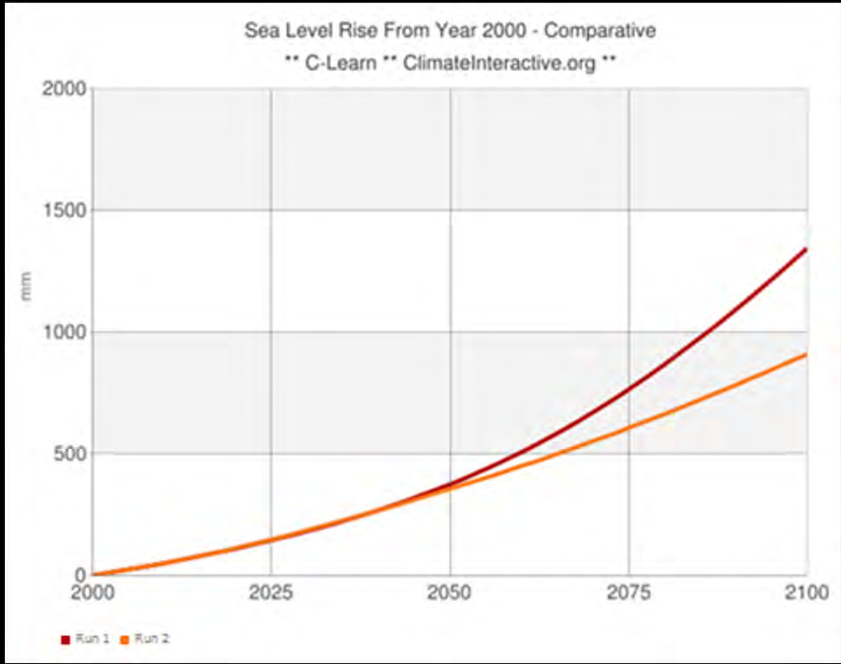
Optimized for Firefox and IE8

Climate Interactive | MIT Sloan Management | Ventana Systems, Inc. | Simulation hosted by Forio Broadcast


Total Fossil Fuel Emissions - Comparative
** C-Learn ** ClimateInteractive.org **
GtonsCO2/year
150
120
90
60
30
0
2000
2025
2050
2075
2100
Run 1
Run 2

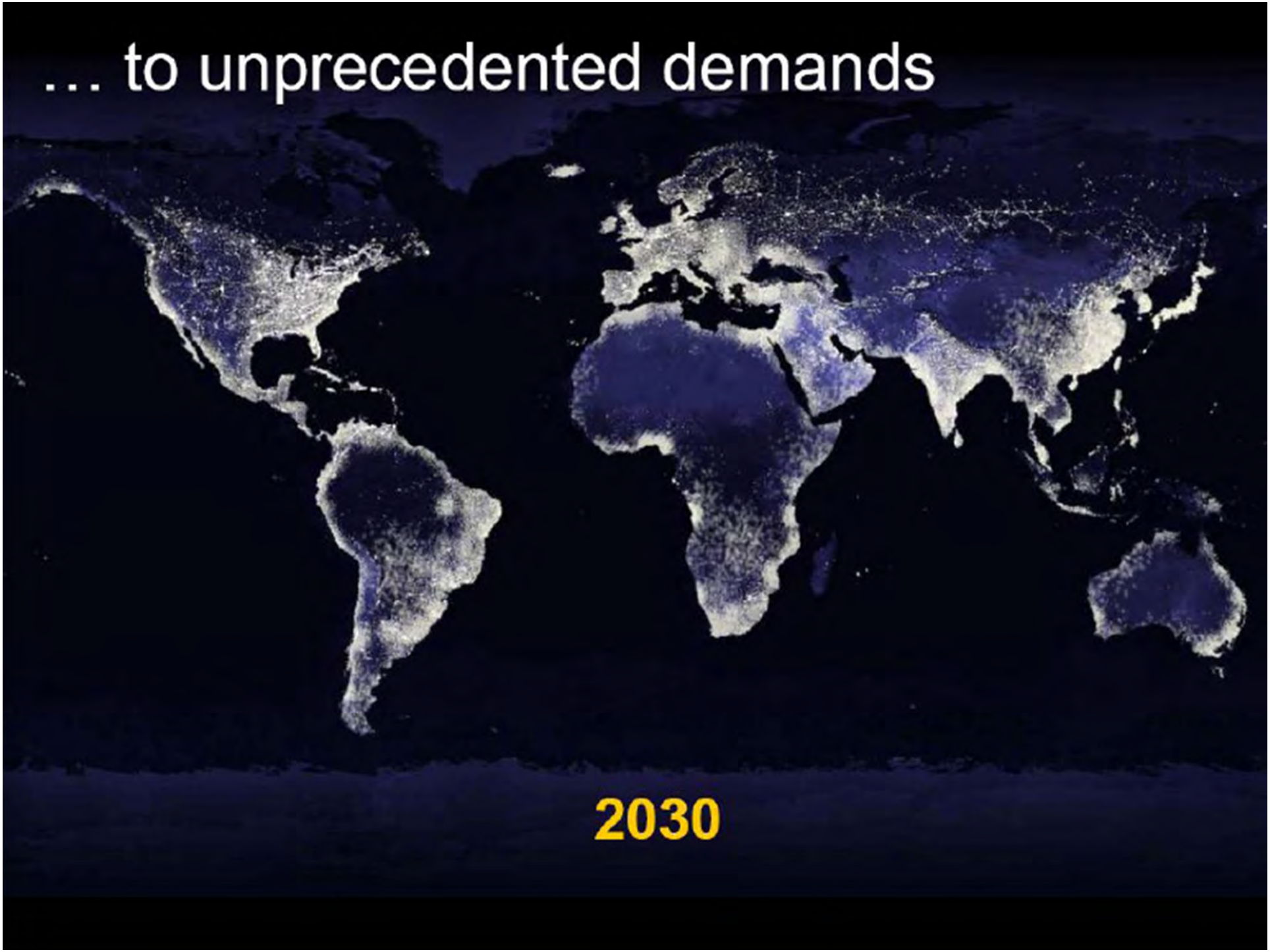

Emissions and Net Removals
** C-Learn ** ClimateInteractive.org **
GtonsCO2/year
150
120
90
60
30
0
2000
2025
2050
2075
2100
Net Removals
Emissions


Temperature - Comparative
** C-Learn ** ClimateInteractive.org **
Degrees C
5
4
3
2
1
0
2000
2025
2050
2075
2100
Run 1
Run 2


Sea Level Rise From Year 2000 - Comparative
** C-Learn ** ClimateInteractive.org **
mm
2000
1500
1000
500
0
2000
2025
2050
2075
2100
Run 1
Run 2

ENERGY AND SECURITY

Energy consumption growing


… to unprecedented demands
2030

We all deal with pain & uncertainty at the pump

Hybrid Car

Fuel tank: 12 gallons

Today

$2.05/gallon

Cost to fill up: **$24.60**

Last Summer (& the Future?)

$4.11/gallon

Cost to fill up: **$49.32**

Distance on a tank: 612 miles

Assume 51 MPG Highway

SUV

Fuel tank: 26 gallons

Cost to fill up: **$53.30**

Cost to fill up: **$106.86**

Distance on a tank: 494 miles

Assume 19 MPG Highway

Navy DDG-51

Fuel tank: 450,000 gallons

$1.65/gallon
(F-76 DESC Price)

Cost to fill up:

$742,500

$4.06/gallon
(F-76 DESC Price)

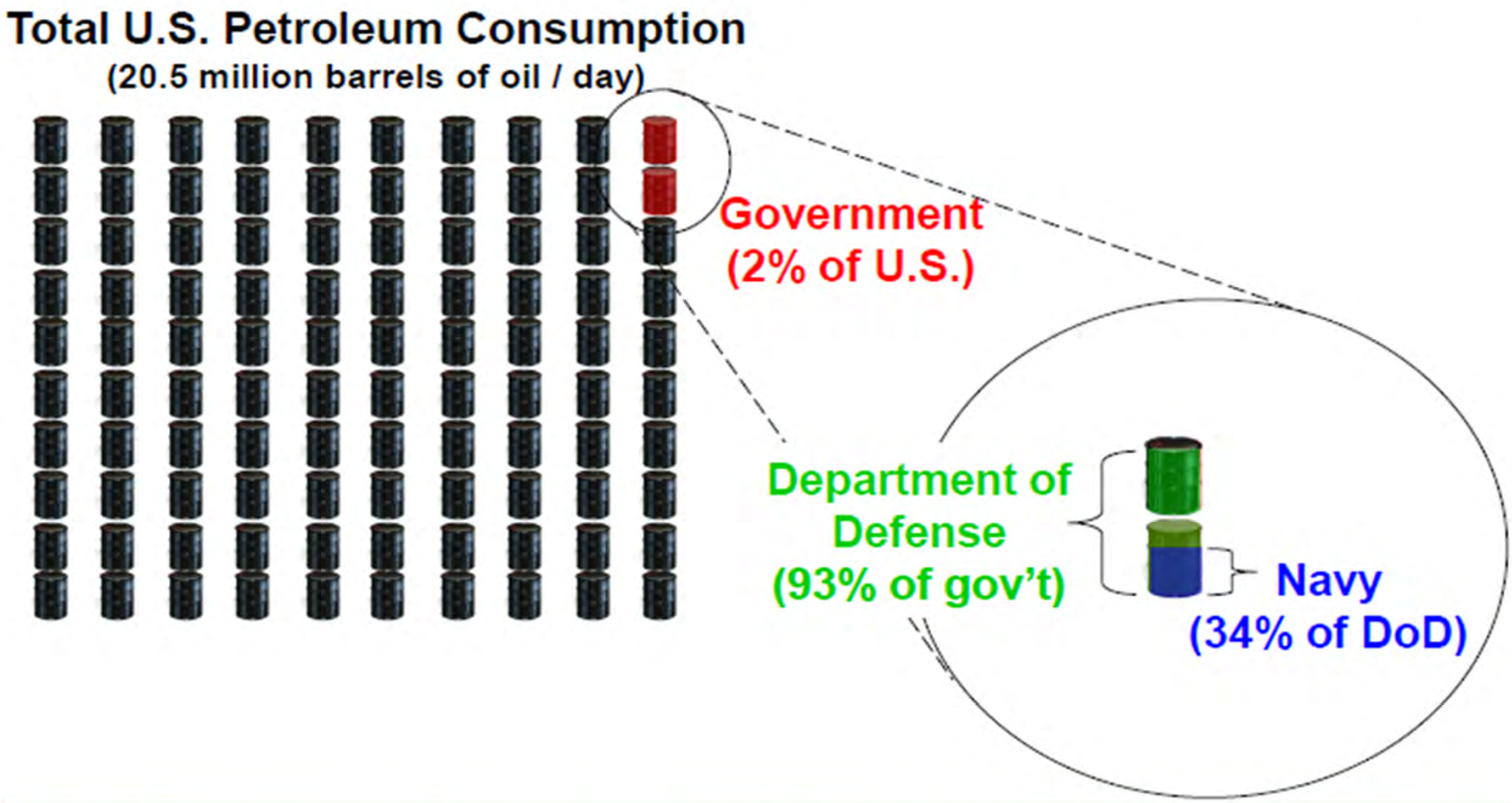
Cost to fill up:

$1,827,000

Distance on a tank: 5060 (statute) miles

Navy's fuel costs can range from $1 billion to over $5 billion due to volatile oil prices

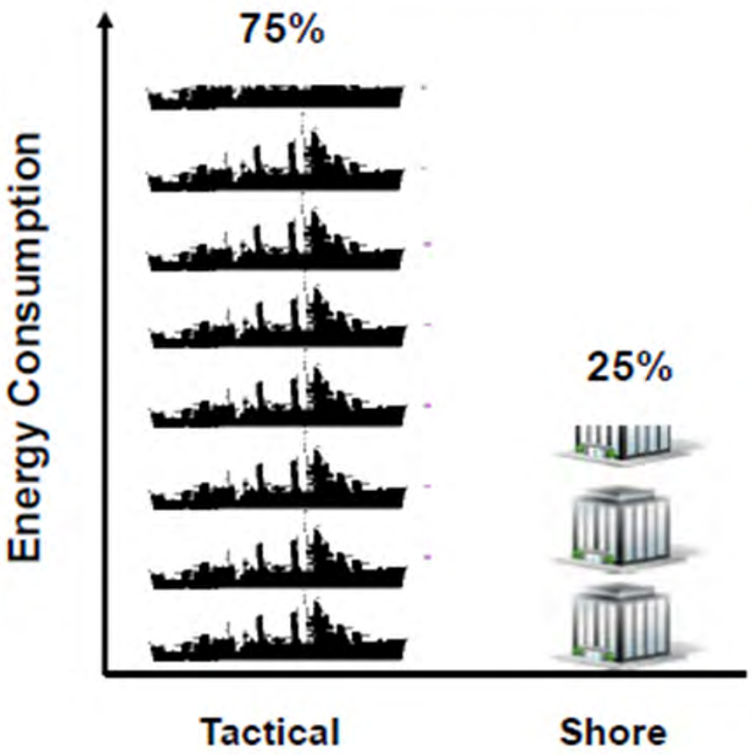
U.S. Petroleum Consumption



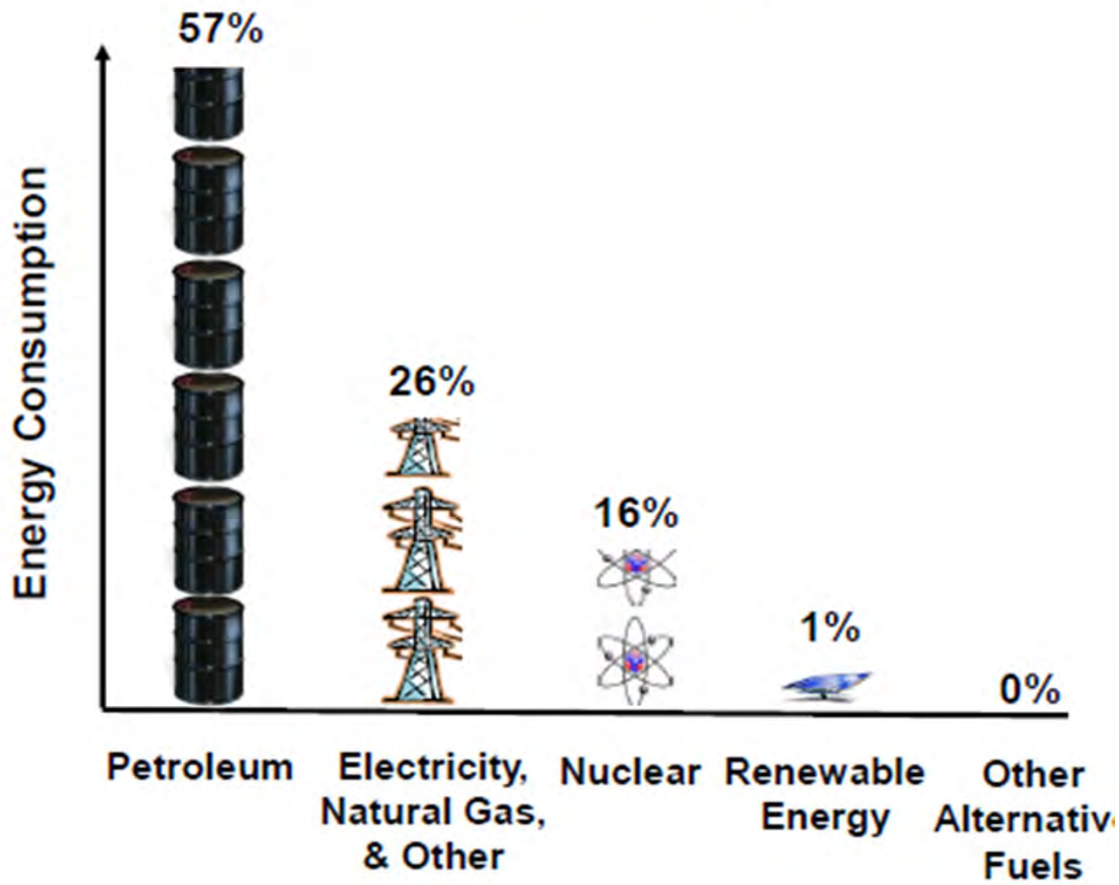
DoD is not a market maker, but it is the largest government and individual consumer and can serve as a technology leader

2008 Navy Energy Consumption & Sources

Consumption



Sources



Navy energy use is dominated by petroleum from its tactical operations

Navy Energy Strategy - Goals for 2020

Shore	Tactical	Environmental Stewardship
Shore Energy Independence	Tactical Energy Independence	CO_2 Emissions
up to 60%	up to 20%	up to 20%
"Shore energy reduction is an opportunity not only for the Navy, but it can also demonstrate to the Nation what is truly possible." (Flag Officer)	*"Energy will be seen as a Tactical Advantage…"* (Flag Officer)	*"Carbon footprint reduction and environmental stewardship will be the way of the future Navy"* (Flag Officer)

Mission First, Energy Always

Tactical Initiatives – Efficiency & Conservation

Maritime

Efficient Ship Systems
Example: Solid State Lighting

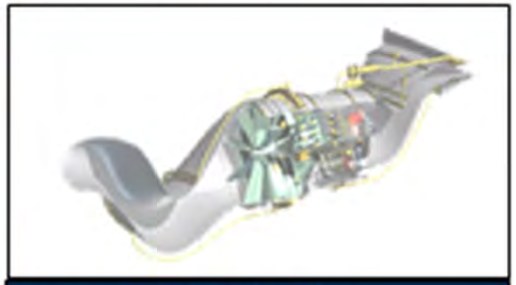
Improved Hydrodynamics
Example: Stern Flaps and Hull Coatings

DDG-51 Hybrid Electric Drive
Test Platform: USS TRUXTUN

Aviation

Operations & Policy
Example: Air ENCON Program

Research & Development
Example: Engine Modifications



Science & Technology
Example: Variable Cycle Engine

Biofuels

F/A-18 Super Hornet
April 22, 2010

RCB-X
October 22 , 2010

MH-60S Seahawk
November 22, 2010

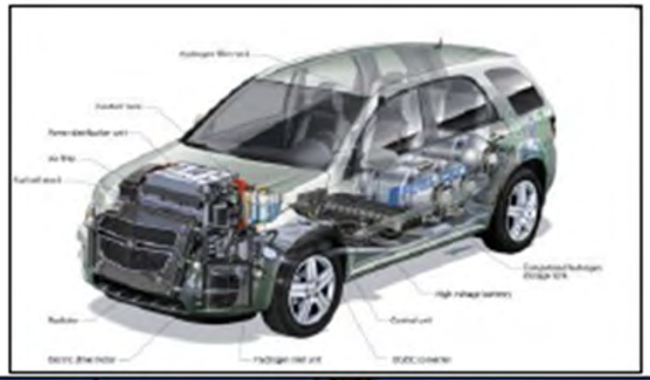
Shore Successes

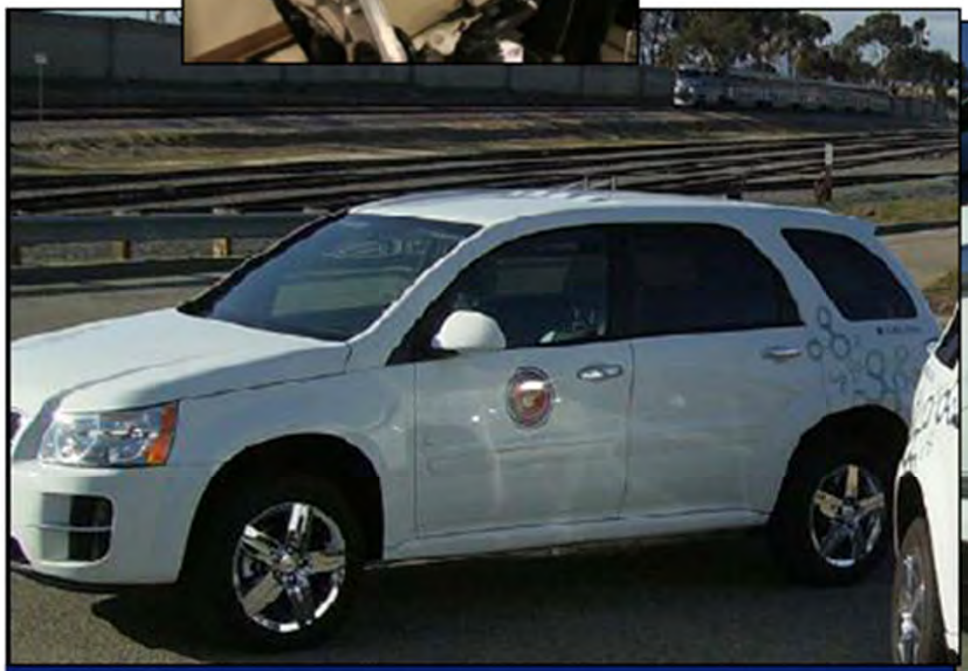
China Lake Geothermal Power Plant, 270 MW, since 1987

North Island Solar Power array on parking garage, 1 MW

Guantanamo Bay Wind Farm, 3.8 MW

Shore Successes



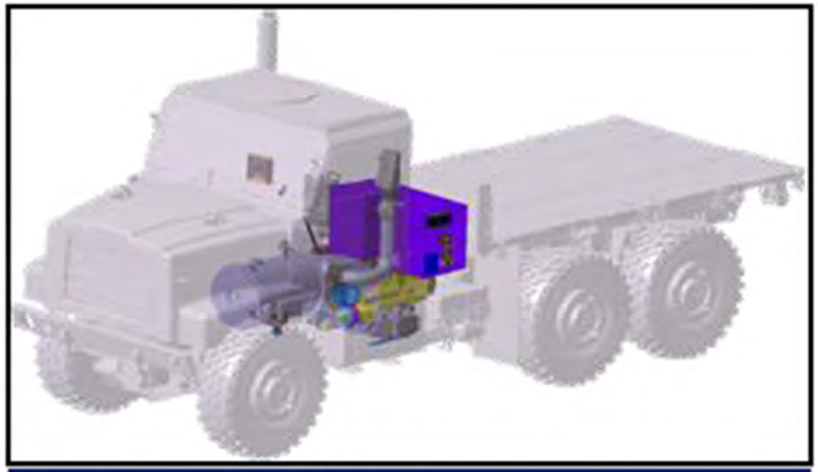


Camp Pendleton, CA GM Equinox Fuel Cell Test Vehicles

American Recovery and Reinvestment Act of 2009

Shore & Expeditionary Investment Areas

Ocean Thermal Energy Conversion and Wave Energy Utilization



On-Board Vehicle Power Generation

Energy Efficient HVAC Systems

Maritime Successes

Incentivized Energy Conservation Program (i-ENCON)

Advanced Hull Coatings

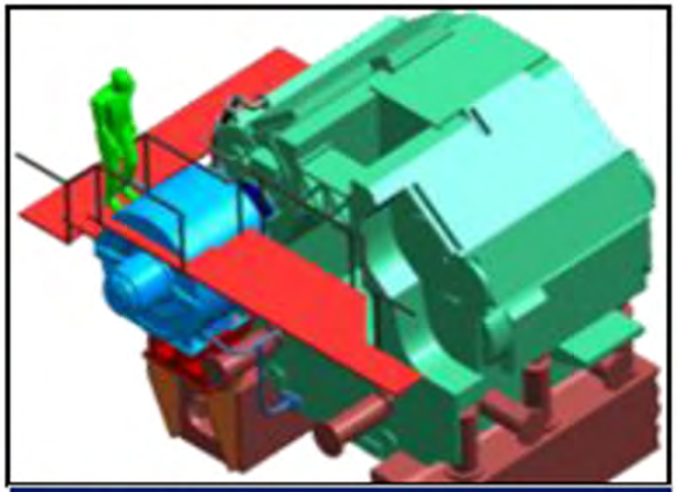
Stern Flaps

Propeller Pitch Control

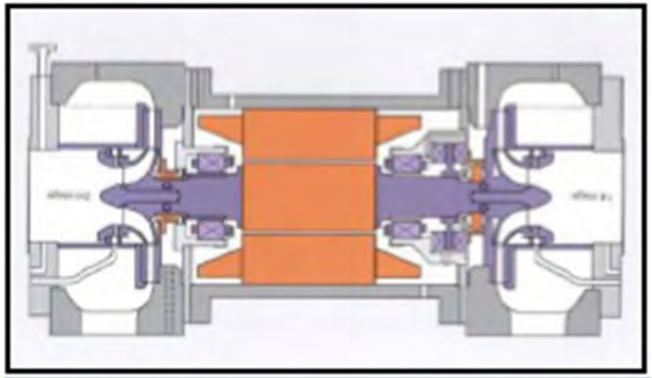
American Recovery and Reinvestment Act of 2009

Maritime Investment Areas

Shipboard Stability Control



Hybrid Electric Drive System



Efficient Shipboard HVAC

Aviation Successes

Efficient GE-38 Engine for CH-53K Helicopter

Training Simulators

Truck Refueling vice Hot Pit Refueling

American Recovery and Reinvestment Act of 2009

Aviation Investment Areas

Biofuels Test & Certification

Aircraft Engine Efficiency

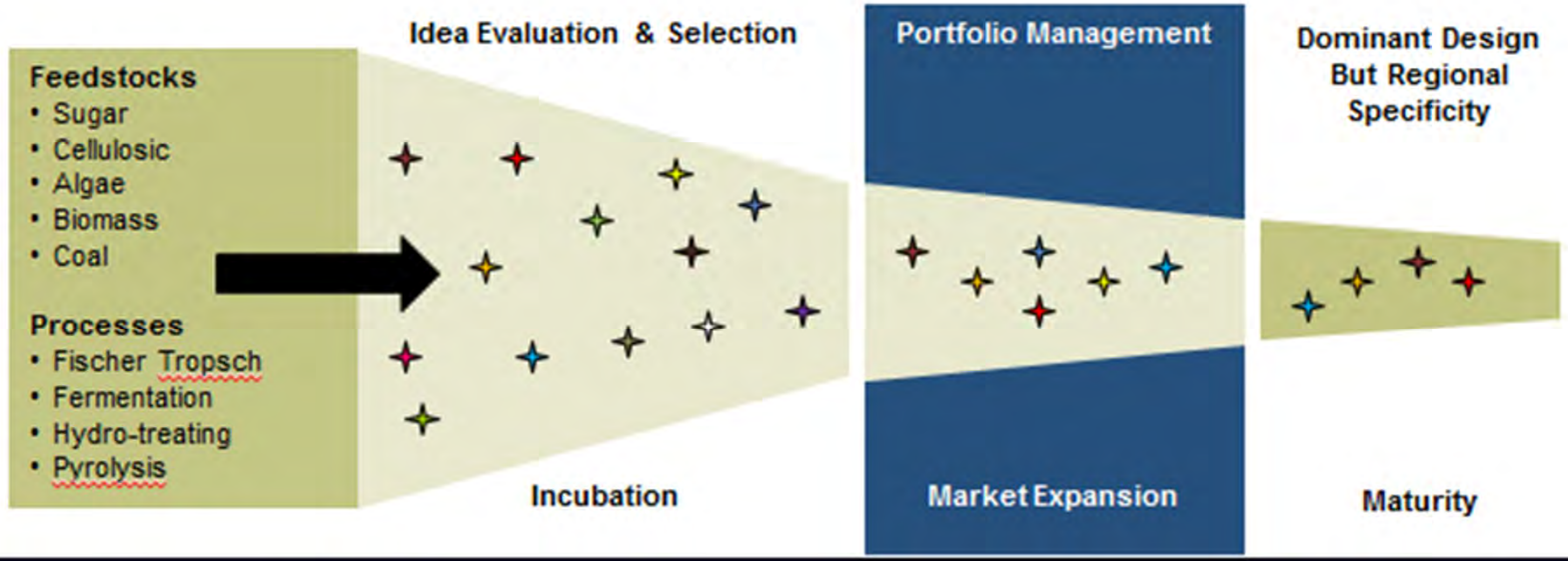
Portfolio Approach to Biofuel Industry

Northwest
- Tallow
- Camelina
- Canola
- Soy
- Agricultural biomass

Southwest
- Biomass
- Algae
- Palm
- Jatropha
- Sugar

Midwest/Central
- Biomass
- Tallow
- Pennycress
- Wood-waste

Southeast
- Tallow
- Camelina
- Sugar
- Woody biomass
- Coal



The winners will be determined by a region's agronomy and logistics to market.

Value Chain Considerations

AGRICULTURAL → INDUSTRIAL

	Biotech	Farmers	Producers	Refineries	Distribution	End consumer
FUNCTION	Genetically modify feedstocks to increase yield & energy content Engineer first technologies for commercial scale	Plant, grow, protect & harvest fuel feedstock crops (i.e., oil seeds & eventually algae)	Separate or extract biocrude from feedstock Potential to sell by-products as meal or other products	Refine biocrude into different forms of usable fuel & chemicals (HRD, HRJ, gasoline etc..) Co-location with petroleum refineries (50/50 blends)	Transportation and logistics of getting refined fuel to end consumer (e.g., DOD, airport, etc)	Replace portion of petroleum-based fuels with biofuel Agnostic to far end of supply chain if standards are met
ISSUES	Need to prove lab results/yields at commercial scale Vertical integration of value chain for near-term; scope	Willingness to adopt processes to grow novel crops Lack of incentive to grow crops without subsidy; high price	Unknown financials Potential for by-products to be more profitable	Capital costs are huge and financing is expensive Ability to install enough capacity to meet demand	Ability to use existing pipelines & infrastructure Trucking is expensive with high GHG emissions	Fuel needs to be price competitive with petroleum Fluctuations in oil prices make long-term commitments unattractive

Risk to entire value chain was studied by MIT.

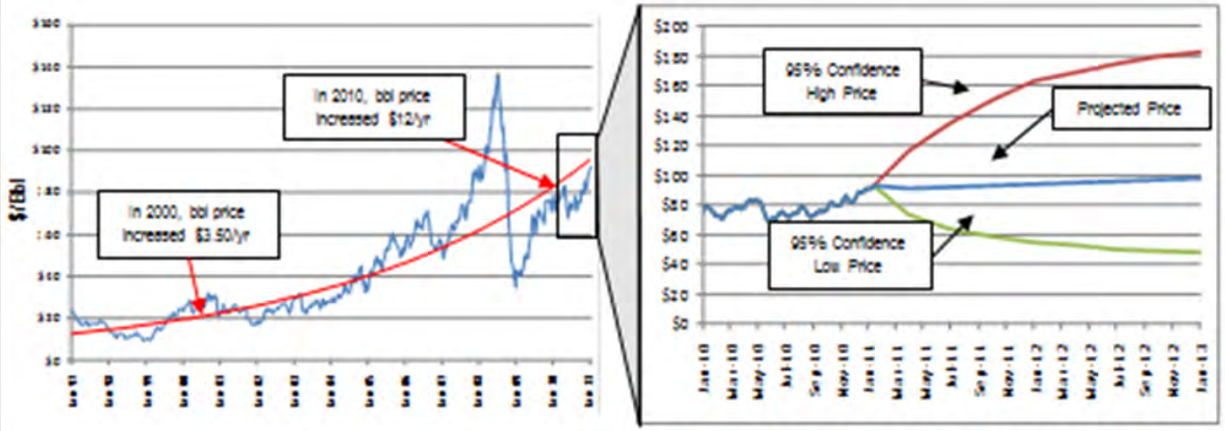
MIT Team stakeholders

AltAir Fuels
AMYRIS
AmericanAirlines
BOEING
ups
Commercial Aviation Alternative Fuels Initiative
FAA
AIA CAAFI ATA
ACI-NA
MIT
Massachusetts Institute of Technology
uop
A Honeywell Company
UNITED STATES POSTAL SERVICE
FedEx
AIR TRANSPORT ASSOCIATION
WESTERN WASHINGTON UNIVERSITY
Sapphire Energy
UNITED
ATA
AMERICAN TRUCKING ASSOCIATIONS
THE HOME DEPOT
CARBON WAR ROOM
The United States Business Council for Sustainable Development
Sustainable Oils
MASCOMA
solazyme
NIKE
LOWE'S
et's Build Something Together
cific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965
CERA
HOOVER INSTITUTION
STANFORD UNIVERSITY
eia
U.S. Energy Information Administration
Independent Statistics and Analysis
MÆRSK
LS9, INC.
Walmart
Save money. Live better.
uop
A Honeywell Company
CMA CGM
DEFENSE LOGISTICS AGENCY
America's Logistics Combat Support Agency
SYNTHETIC GENOMICS
COSTCO.COM
United States Coast Guard
U.S. Department of Homeland Security

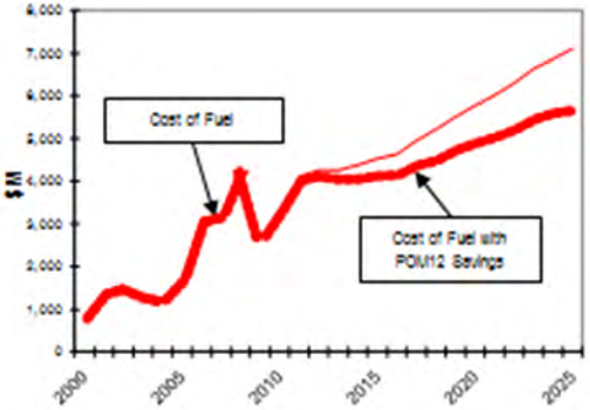
Study covered the waterfront; consumers, producers, & financiers, both commercial and government.

Dashboard #1: Energy Landscape

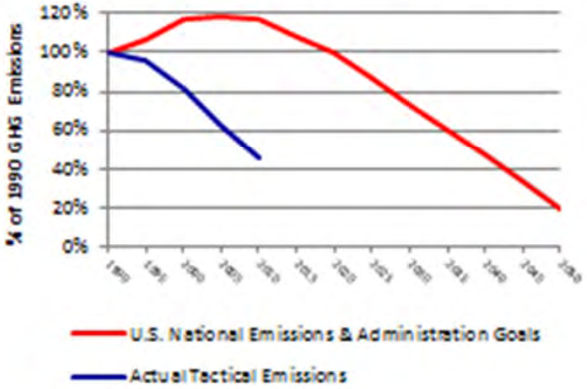
World Oil Prices (1997-2011) and Projection to 2013



Navy Fuel Costs

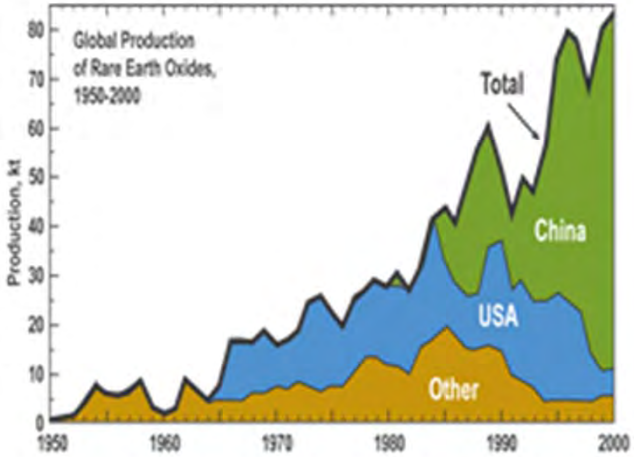


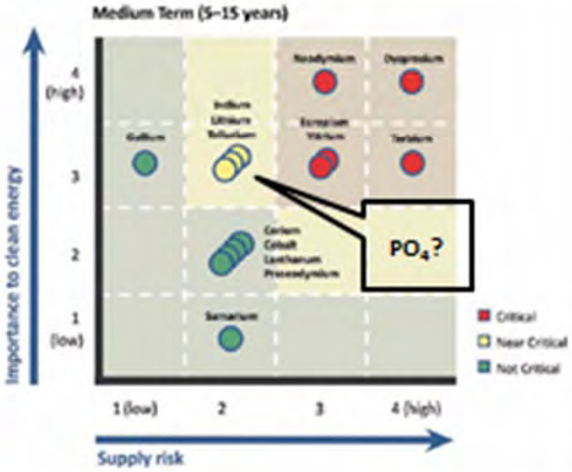
Tactical GHG Emissions



Note: Tactical GHG Emissions are reported but not subject to Administration Goals

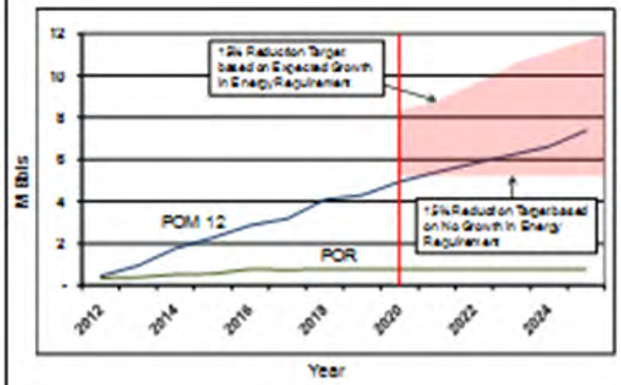
Rare Earths: Potential Supply-Demand Mismatches



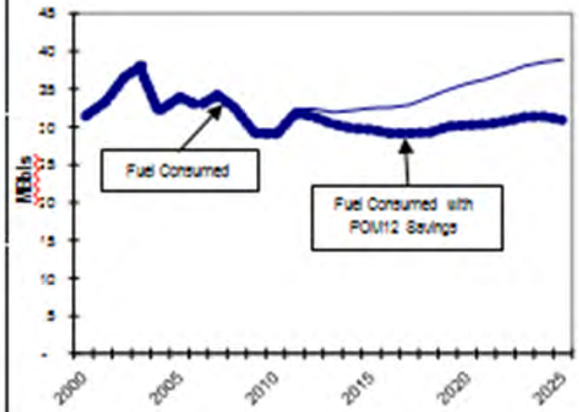


Dashboard #2: Tactical Energy Program

Navy Projected Fuel Savings

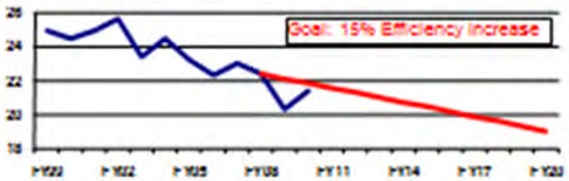


Progress to Goal: Consumption

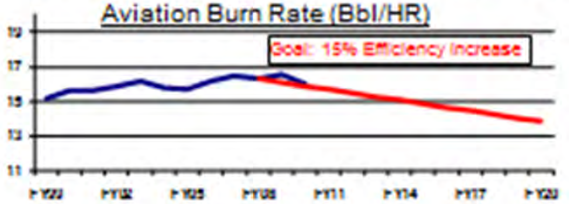


Progress to Goal: Efficiency

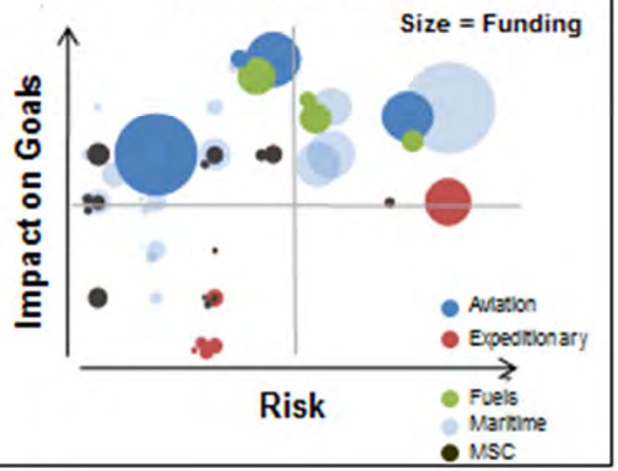
Maritime Burn Rate (Bbl/HR)



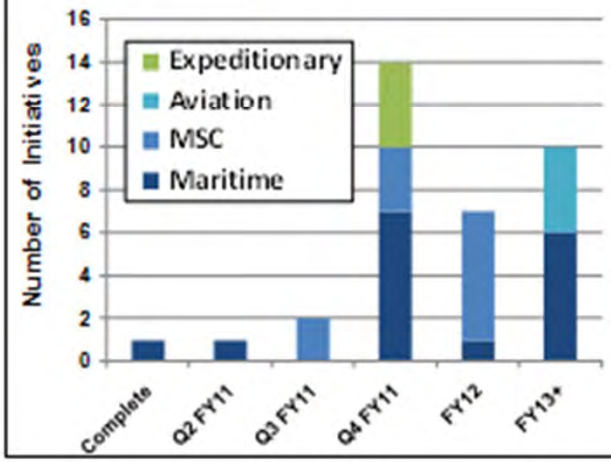
Aviation Burn Rate (Bbl/HR)



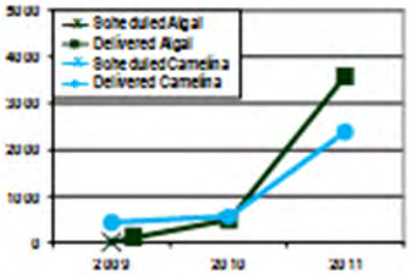
Navy Energy Program: Funding, Impact, Risk



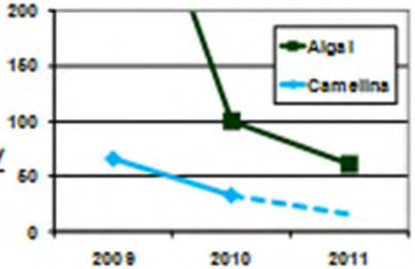
Progress of Efficiency Technologies Through T&E Phase



Navy Alternative Fuel Scheduled / Actual Delivery



Alternative Fuel Prices Paid by Navy



NATIONAL SECURITY
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CLIMATE CHANGE
SecurityAndClimate.cna.org

Sulfur Hexafluoride: The Good, the Bad & the Future
Managing a Mission-critical Greenhouse Gas
SF6 in the Atmosphere

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U.S. Navy Task Force Climate Change
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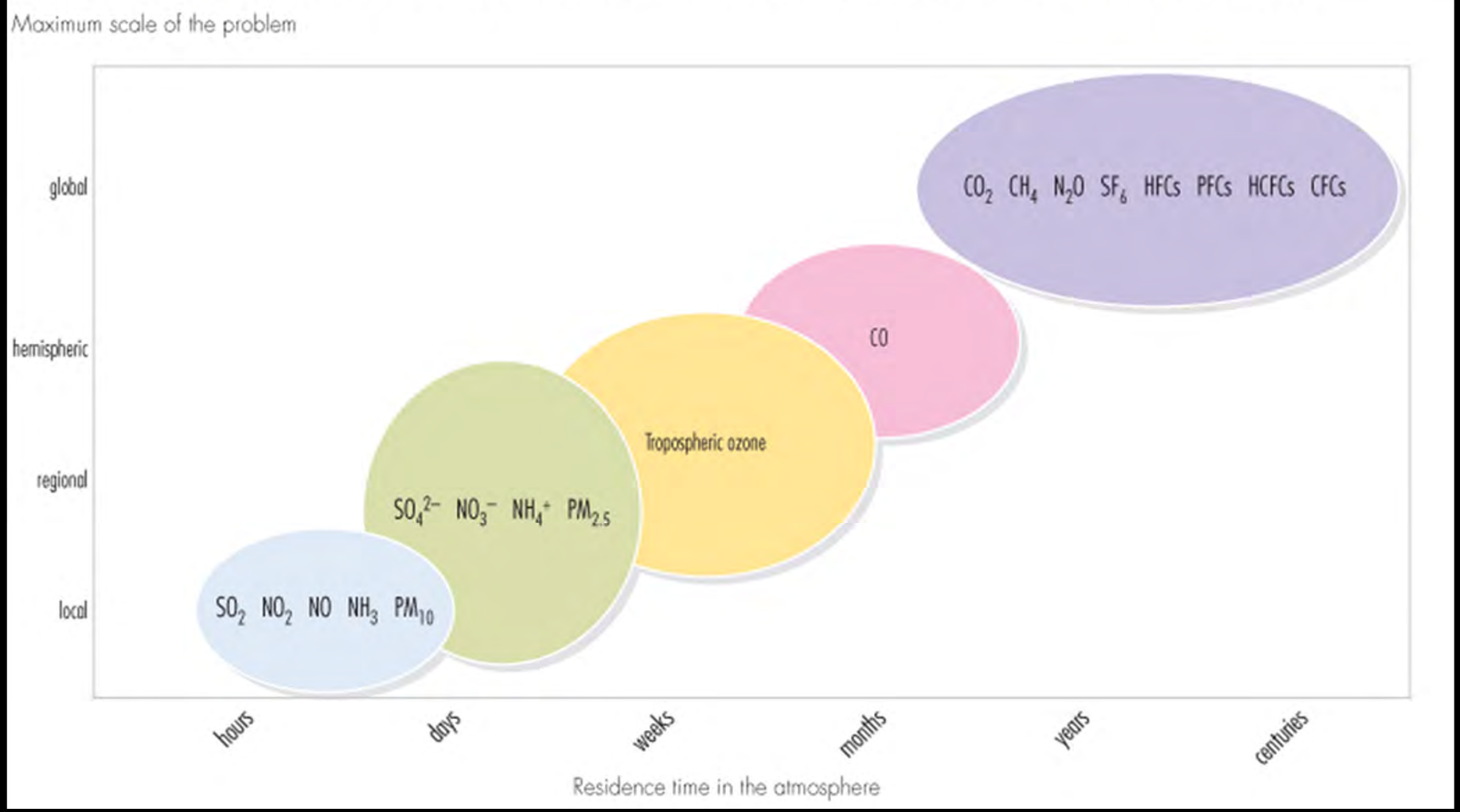
Info
Photos
Notes
Links
About
The official Facebook page for the U.S. Navy's Task Force
598
people like this
Likes
See All
U.S. Global Change Research Program
Department of the Navy Task Force Enemy
U.S. Navy Task Force Climate Change
Standing on the North Pole (l-r) Mr. Mead Treadwell, Lt. Gov. of Alaska, Rear Adm. Dave Titley (USN - Oceanographer of the Navy), Rear Adm. Christopher Colvin (USCG - 17th District), Rear Adm. Nevin Carr (USN - Chief of Naval Research) - Additional photos are in the ICEX 2011 Folder in the Photos section.
March 18 at 1:39pm · Like · Comment
Patricia Toledo, Michael Chelotti, Katarzyna Zysk and 10 others like this.
Jenn Salazar Amazing!!!
Friday at 5:08pm
Arctic Submarine Laboratory
Raytheon systems engineer, Steve Mohnahan, shares his experience supporting ICEX. (tj) U.S. Navy U.S. Navy Task Force Climate Change

NAVY ENERGY

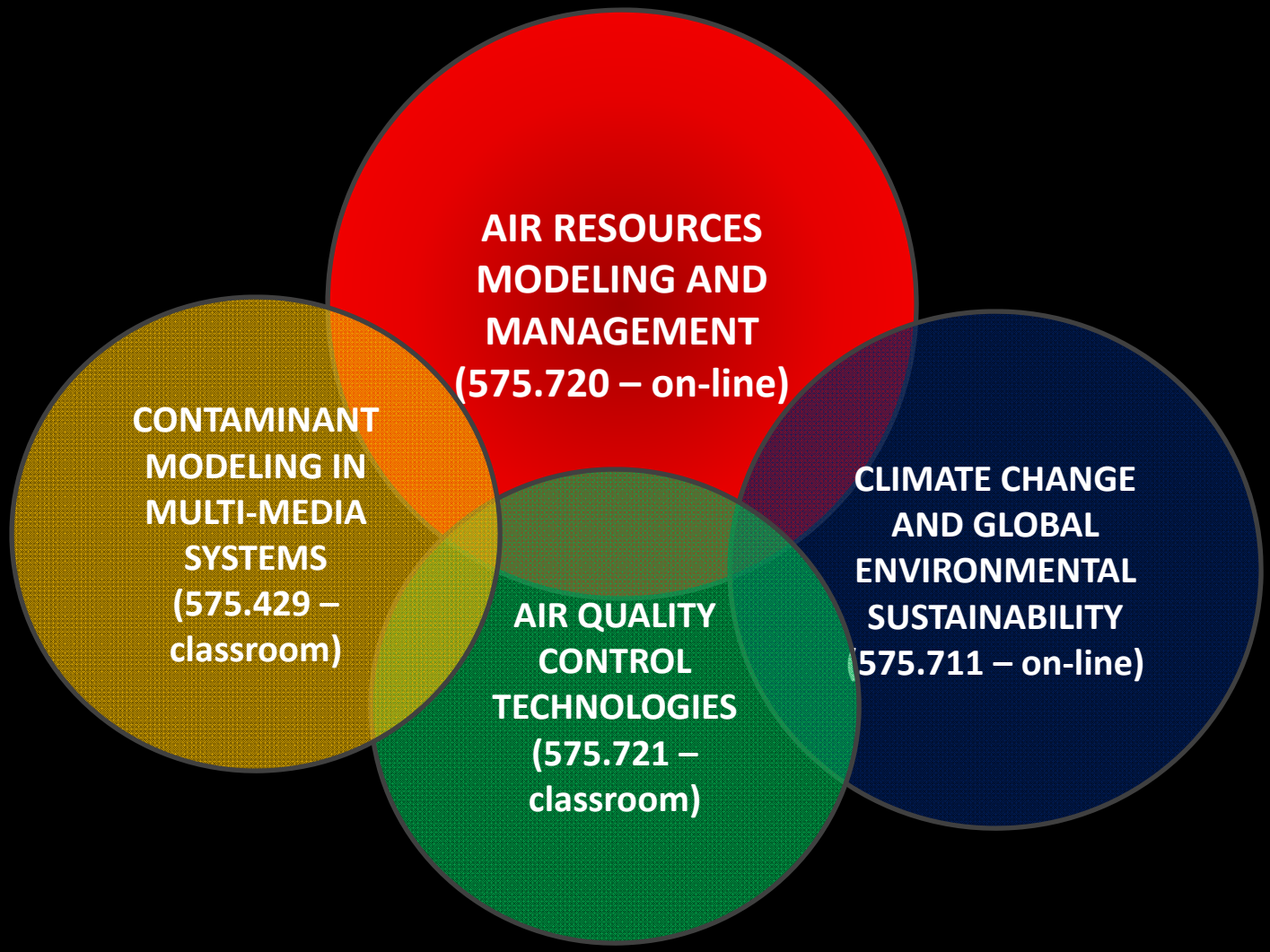
AIR POLLUTION

Air Pollutant Residence Times and Extent of Impacts

Figure 2.1 Selected pollutants, their average residence times in the atmosphere and maximum extent of their impact



JOHNS HOPKINS UNIVERSITY
ENGINEERING FOR PROFESSIONALS
AIR QUALITY CIRRICULUM



gas-phase pollutants

epidemiology / toxicology

climate change

regional modeling

mobile sources

meteorology

indoor air quality

atmospheric chemistry and physics

NAAQS

control technologies

particulate matter

atmospheric structure and stability

Carbon Footprints and Action Plans

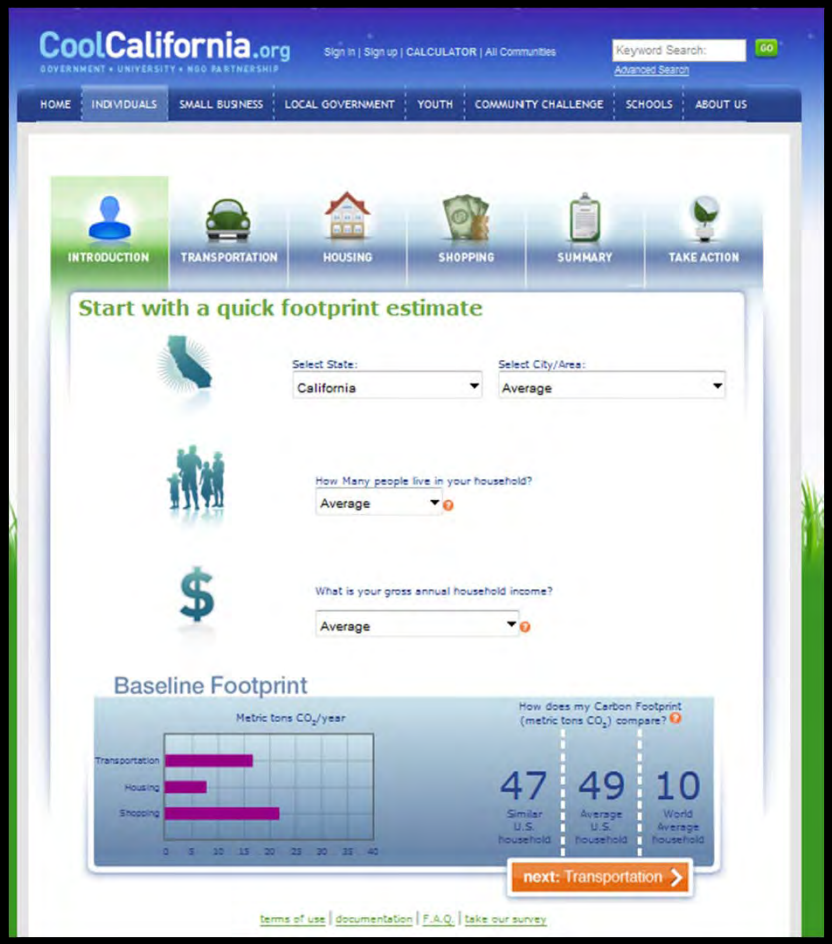


Table 1. Brannon Family Carbon Footprint in Action

Goal	How	Amount	Implemented?
Reduce electricity and water consumption	Wash only full loads of clothes	Reduce from 5 to 3 loads/week	Yes
	Use cold water to wash clothes	Use cold for all 3 loads/week	No
	Set thermostat higher in summer	Increase thermostat set temperature by 4 degrees F	No
Reduce miles driven	Miranda take bus to work 2x/week	Reduce from 18 miles to 6 miles	No
Reduce consumption paper and plastic products	Use only re-usable coffee cups and shopping bags	Eliminate 8 paper coffee cups/week; 10 plastic shopping bags	Yes
Increase recycling efforts	Begin recycling batteries	Varies	No

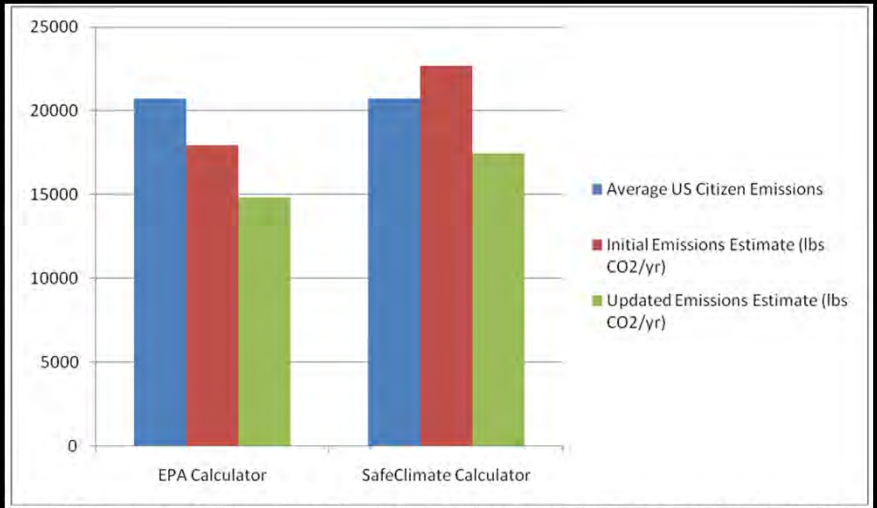
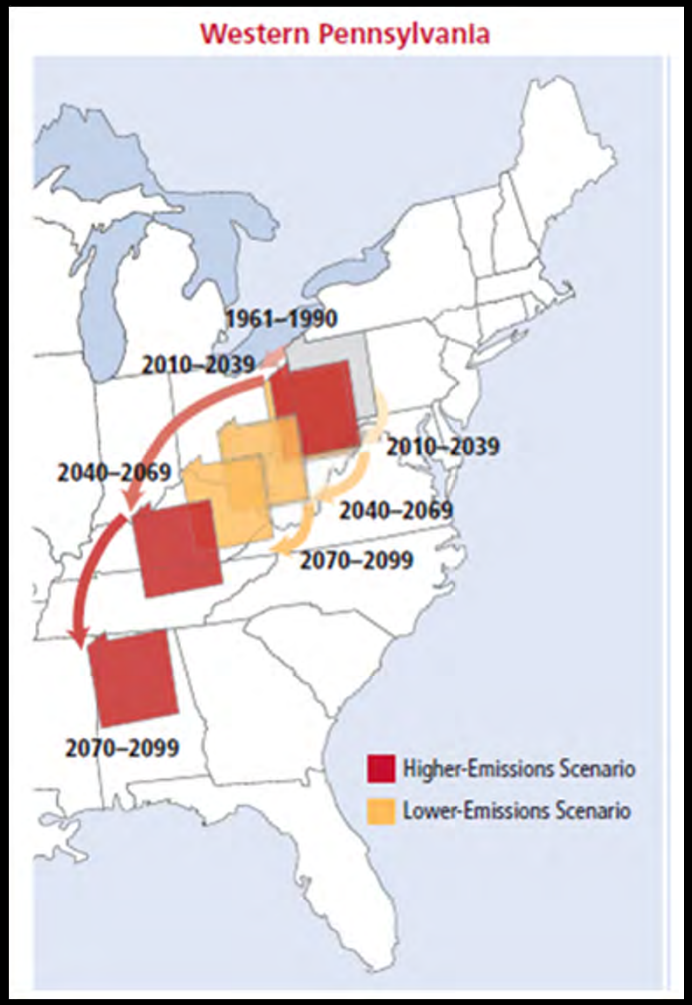
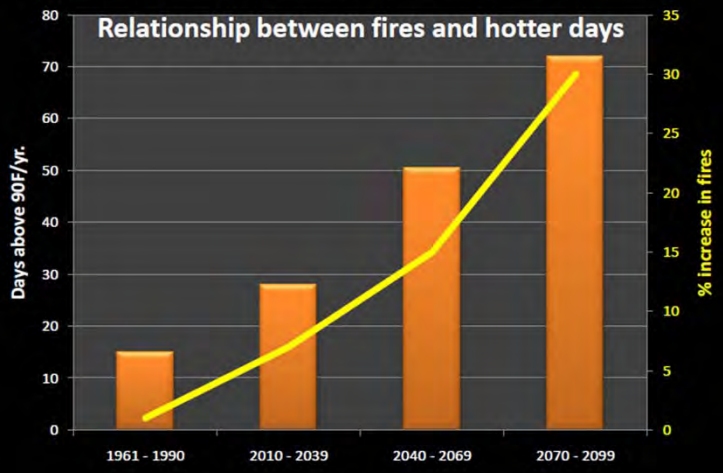
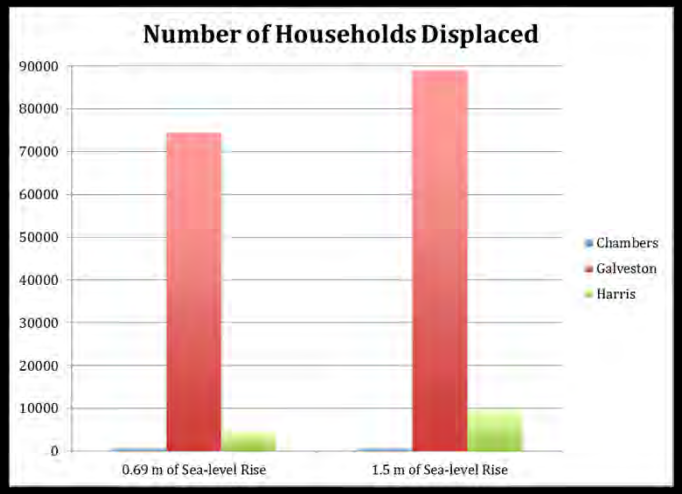


Figure 3: Comparison of US average carbon footprint to Liv Isham's initial and updated carbon footprint

Local Impacts Assessments







Adaptation vs. Mitigation

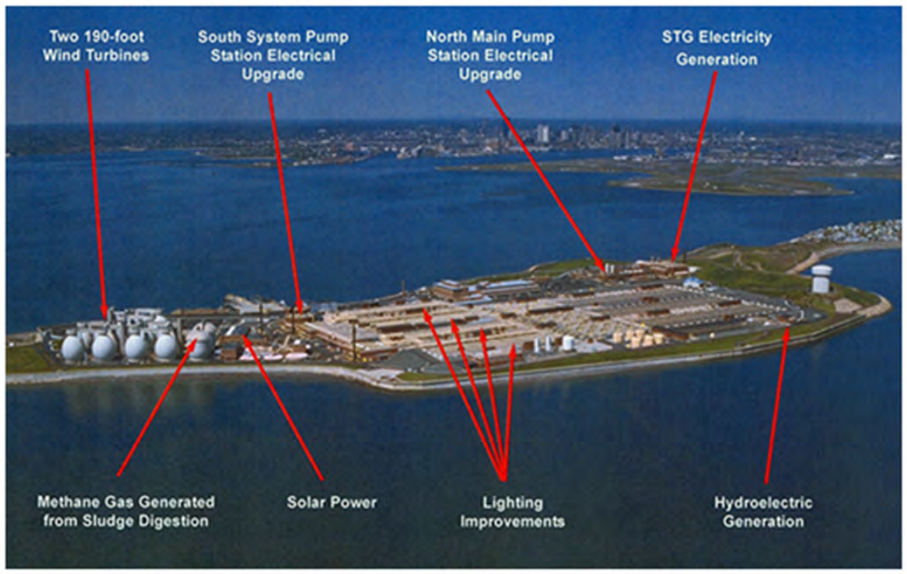
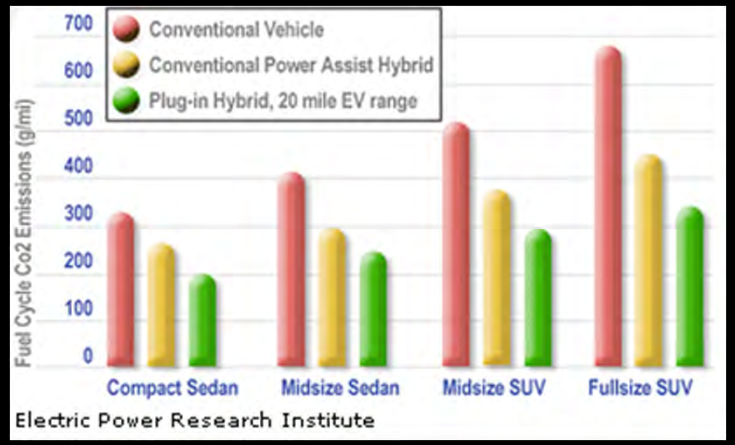
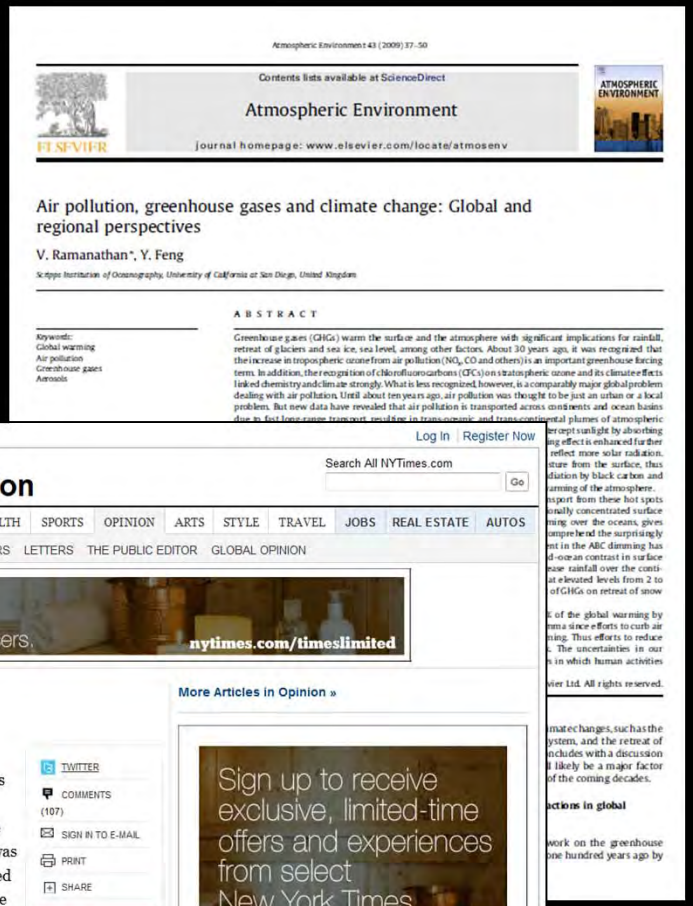
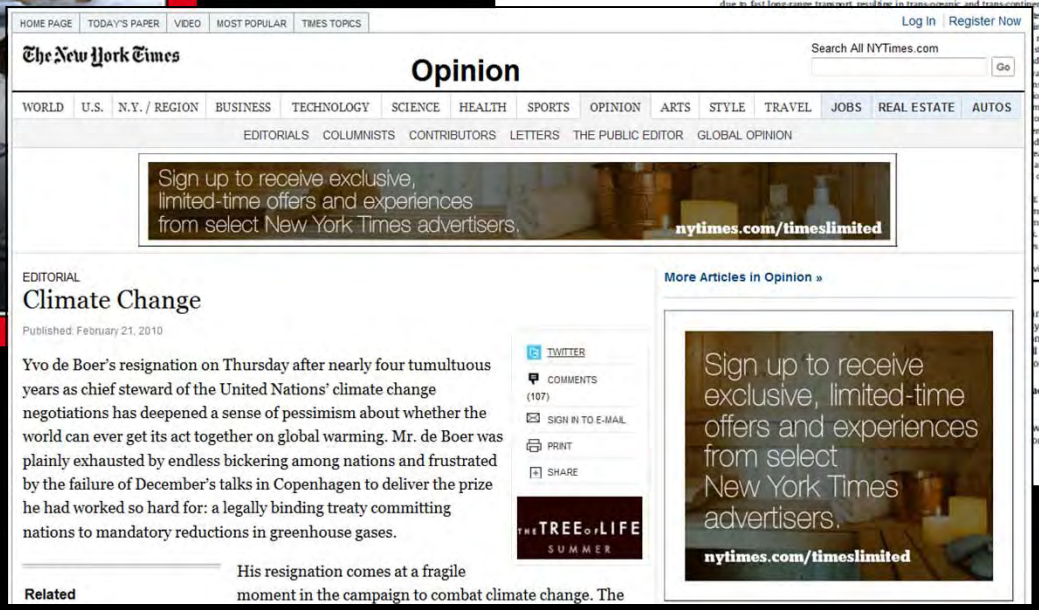


Figure 1. Deer Island WWTP, Boston Harbor, displays numerous sustainable technologies.[5]

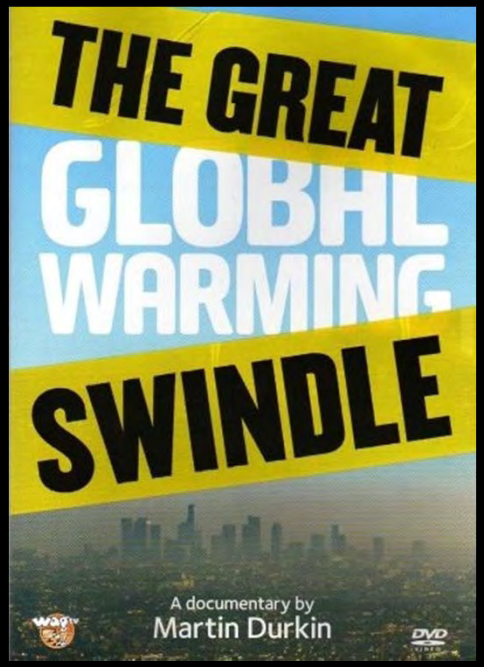


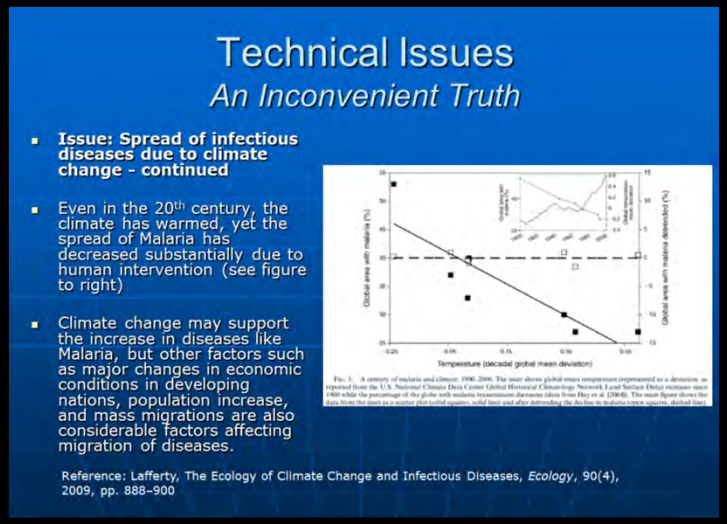
Differentiation



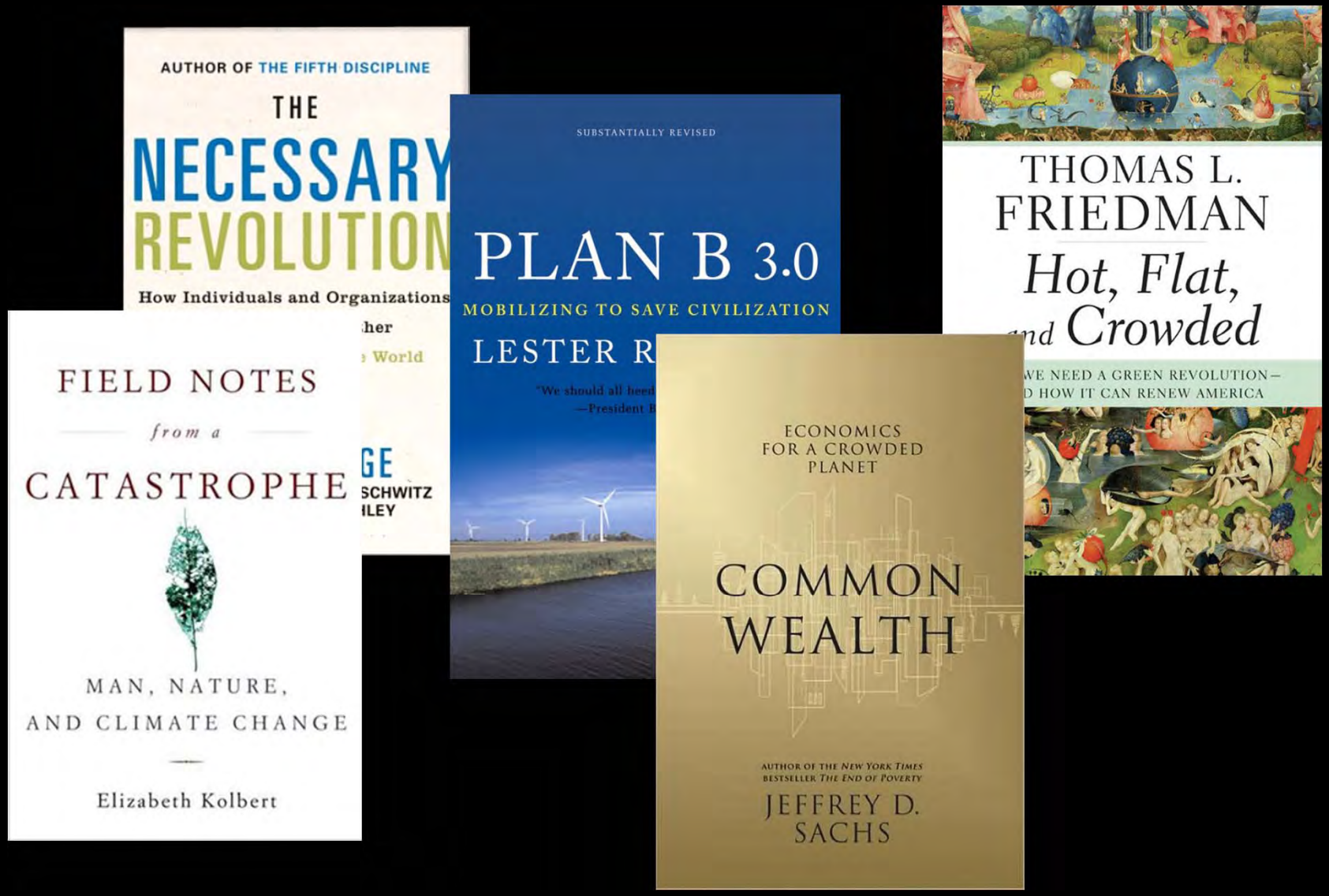


Documentary Critical Reviews

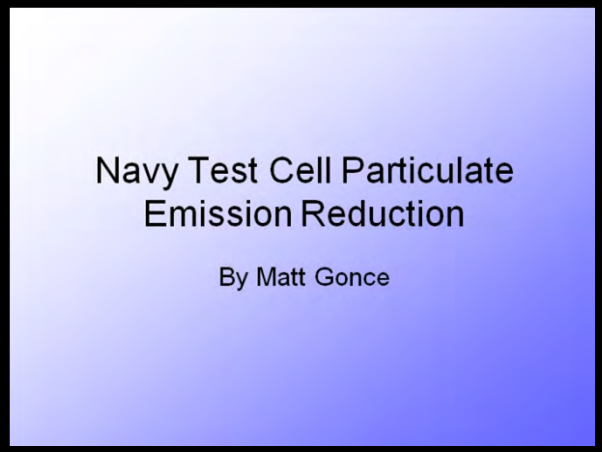


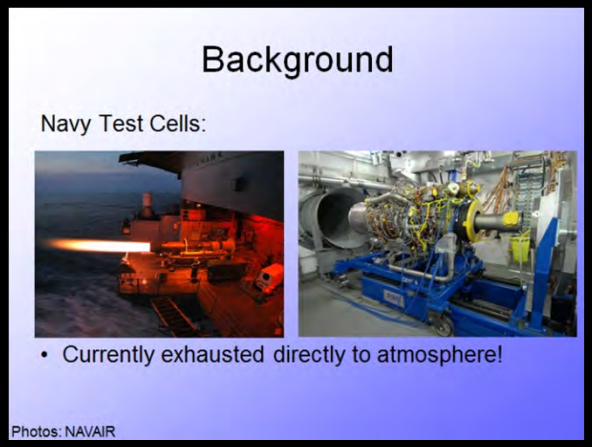


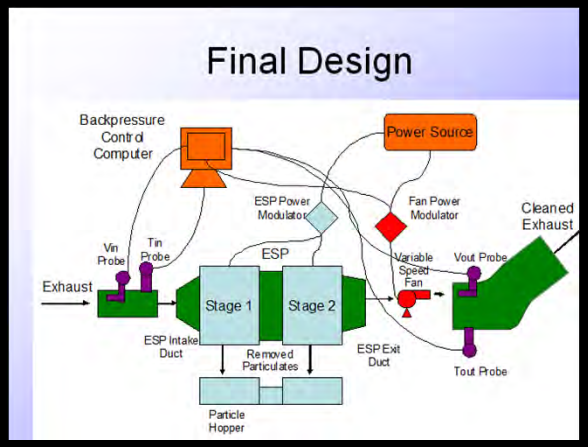
Review of Relevant Work of Non-Fiction



AIR POLLUTION CASE STUDY EXAMPLES







THANK YOU