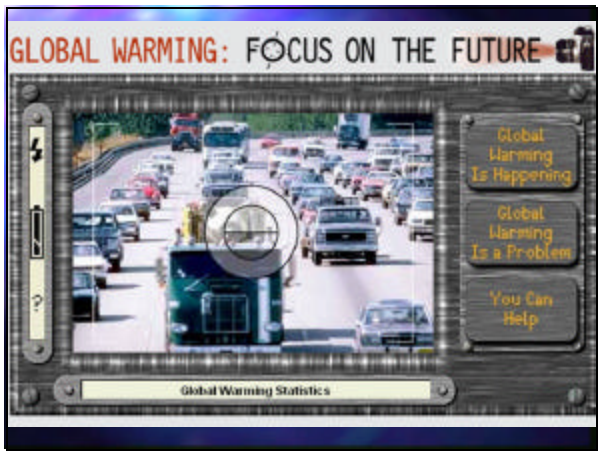
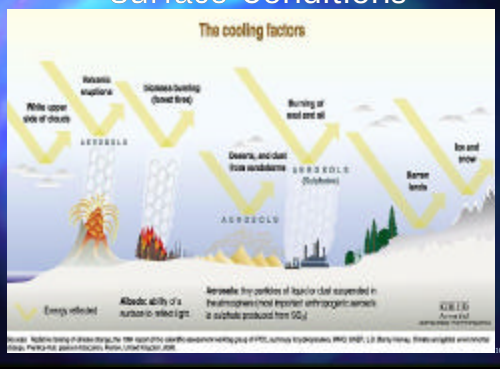
Global Warming and Energy Conservation

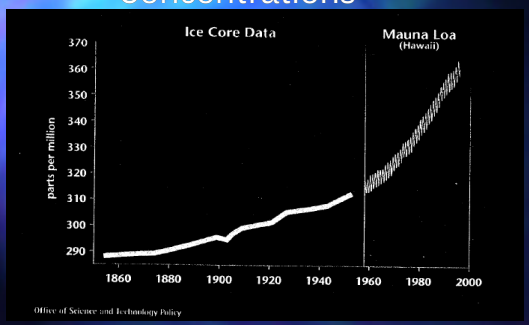
Kyoto Protocol:
Stimulus for New Technologies

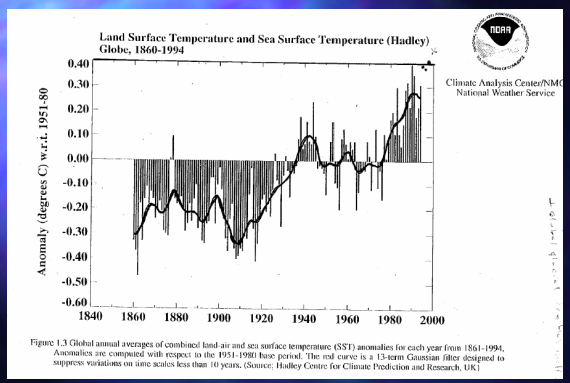


Surface Conditions

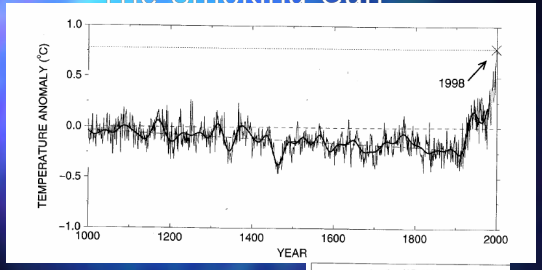


Carbon Dioxide Concentrations



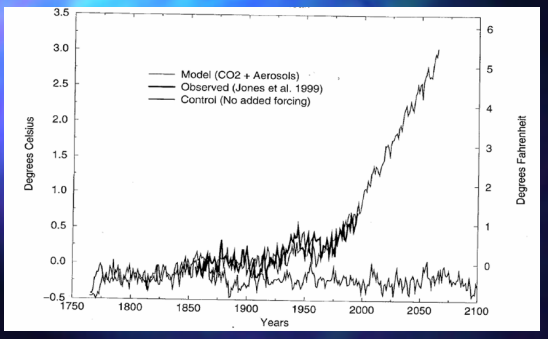


The Smoking Gun



Surface Air Temperature Anomaly

Global Mean



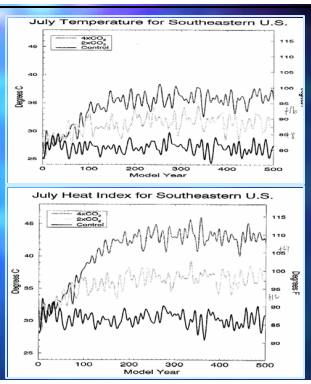
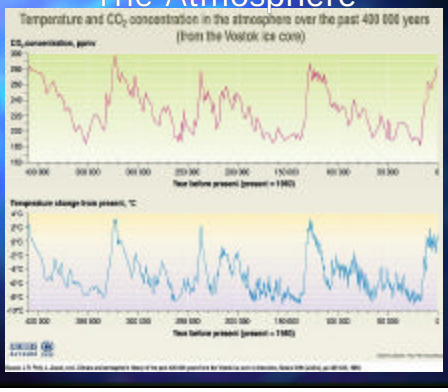


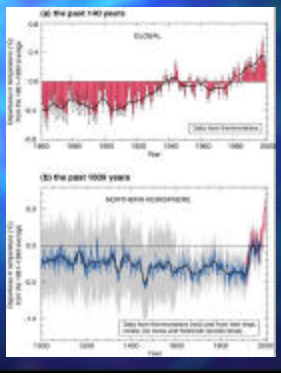
Fig. 4 (a) Time series of surface temperature averaged over the southeastern United States for the three experiments. Only values from July are plotted. Prior to plotting a 10 year low pass filter was applied to the time series. (b) Same as (a) for Heat Index. In the $4xCO_2$ experiment the combination of temperature and humidity is occasionally so large that Heat Index values are not defined (see text for discussion). In such cases, the spatial mean is computed using only those spatial locations with defined Heat Index values

The Atmosphere



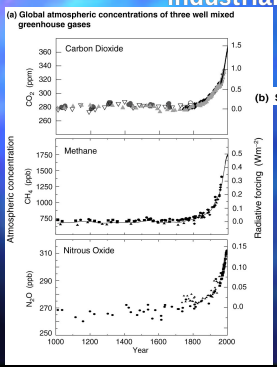
CCS2

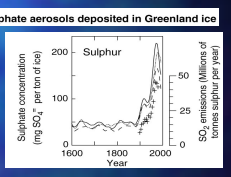
The 1990s were warmer than at anytime during the last 1000 years



CCS3

Human activities have changed the composition of the atmosphere since the industrial era

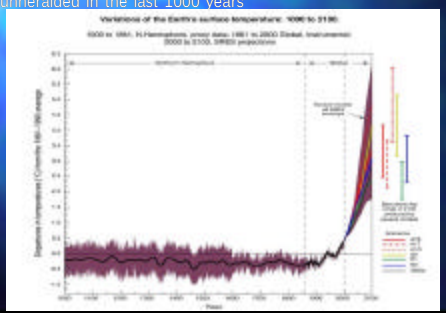




CCS4

Surface Conditions

- Projected surface temperatures for the 21st century would be unheralded in the last 1000 years

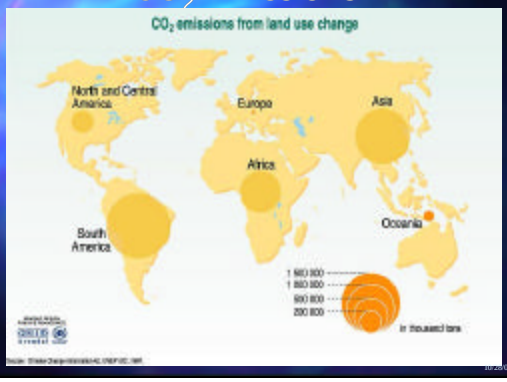


CCS5

CO_2 Emissions

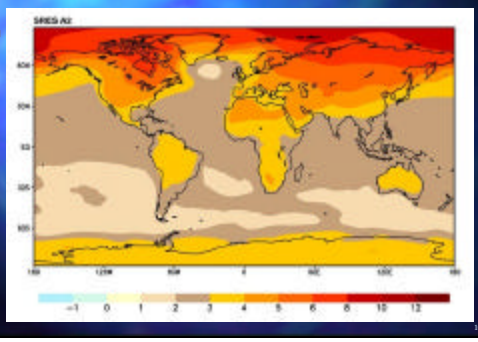
10/28/02-cc5

CO_2 Emissions



10/28/02-cc6

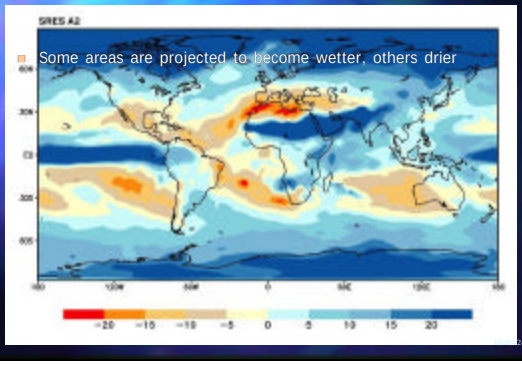
Surface Conditions



10/28/02-cc9

Surface Conditions

- Some areas are projected to become wetter, others drier

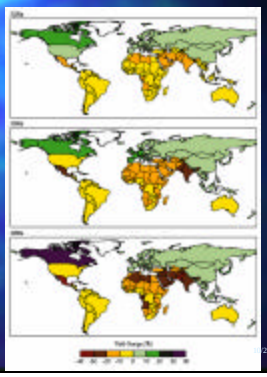


10/28/02-cc10

Surface Conditions

- Crop yields are projected to decrease throughout the tropics and sub- tropics, but increase at high latitudes

Percentage change in average crop yields for the climate change scenario. Effects of CO_2 are taken into account. Crops modeled are: wheat, maize and rice.

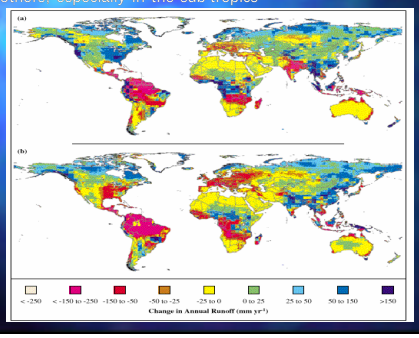


Jackson Institute, University College London / Goddard Institute for Space Studies / International Institute for Applied Systems Analysis

10/28/02-cc11

Surface Conditions

- Run-off is projected to increase in some areas but decrease in others, especially in the sub-tropics



10/28/02-cc12

CCS-13

WHAT DO MODELS SAY ABOUT HUMAN-CAUSED GLOBAL WARMING

- A Doubling of CO_2 Will Produce a Warming Between 1.5 - 4.5 Degrees C (2.7 - 8.1 degrees F)
- The Observed Global Warming is Generally Consistent With Model Calculations

The CO2/Climate Dilemma Over the Next Century:

- Exceeding 2 x CO_2 is Almost Guaranteed
- Significant Climate Change is Inevitable
- Energy Demand Growth is Very Large
- Current "Non CO_2" Energy is Insufficient

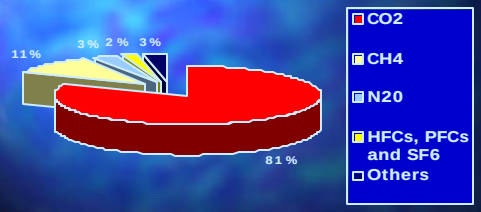
Potential Impacts of Climate Change

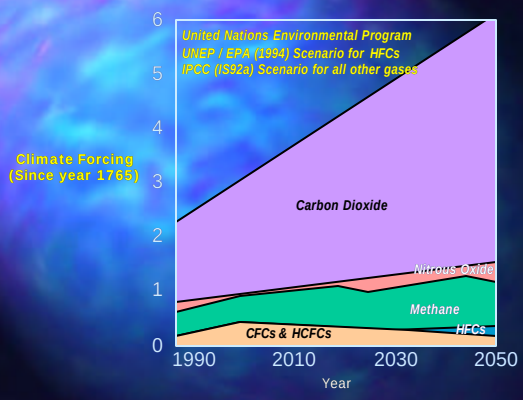
- Agricultural Productivity
- Forest Resources
- Increased Wet-Area Flooding
- Increased Dry-Area Droughts
- Water Resources
- Unmanaged Ecosystems

:
:
:

ALL POTENTIAL IMPACTS REMAIN POORLY QUANTIFIED

Relative Contribution of Greenhouse Gases in U.S.





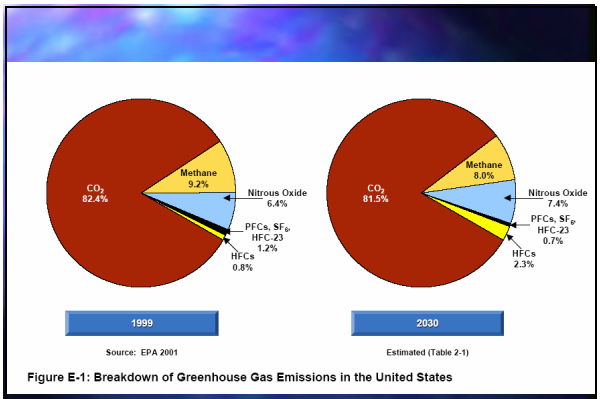
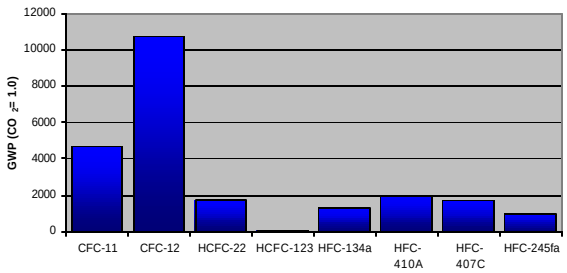
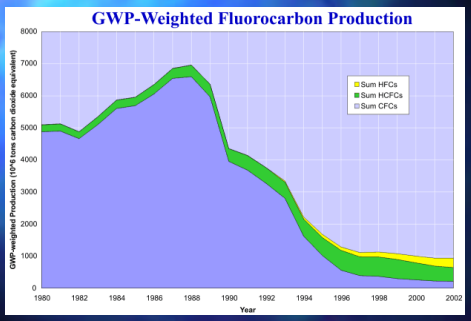


Figure E-1: Breakdown of Greenhouse Gas Emissions in the United States

Global Warming Potential (GWP)



Climate Change Science



CCS9

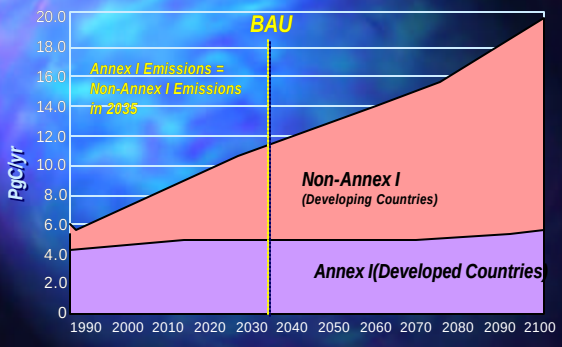
Kyoto Protocol

Sets Greenhouse Gas Emissions Limits

Signed December 1997

Agreement reached by 181 Countries

Annex I and Non-Annex I Fossil Fuel Carbon Emissions:



Kyoto Protocol

- Controls EMISSIONS (no phase out) of greenhouse gases
- CO_2, N_2O, CH_4, HFCs-PFCs-SF_6
- No Developing Country controls required
- Basket of gases – each country/region determine own response

Global Climate Change - Berlin Mandate

- Science Assessment
  - "discernible human influence on global climate"
  - Increase of 2°C from 1990 - 2100
  - Sea Level rise by 50 cm 1990 - 2100
  - Stabilization at 2x pre-industrial levels requires 50% reduction
- Technical and Economic Assessment
  - Reductions are technically possible
  - Reductions are economically feasible
  - "No-Regrets" opportunities are available

Kyoto Protocol Greenhouse Gas Coverage

- Six (6) Gases
  - Carbon Dioxide -- CO_2
  - Methane -- CH_4
  - Nitrous Oxide -- N_2O
  - Hydrofluorocarbons -- HFCs
  - Perfluorocarbons -- PFCs
  - Sulfur hexafluoride -- SF_6
- Base Period
  - 1990 for CO_2 , CH_4 , and N_2O
  - 1990 or 1995 for HFCs, PFCs, and SF_6

Kyoto Protocol -- Developed Countries

- Targets & Timetables
  - 34 Countries
  - Differentiated Targets
  - 5.2 Percent Avg. reduction (versus 1990)
  - 6 Greenhouse gases
  - Commitment period 2008 - 2012

Kyoto Protocol -- Country Targets

Country	% of base
Australia	108x
Austria	92
Belgium	92
Bulgaria	92
Canada	94
Croatia	92x
Czech Republic	92
Denmark	92
Estonia	92
European Community	92
Finland	92
France	92
Germany	92
Greece	92
Hungary	94
Iceland	110

Country	% of base
Italy	92
Japan	94
Lithuania	92
Netherlands	92
New Zealand	100
Norway	101
Poland	94
Portugal	92
Romania	92
Russian Federation	100
Spain	92
Sweden	92
Switzerland	92
Ukraine	100
United Kingdom	92
United States	93)x

Kyoto Protocol

Policies and Measures

- Enhancement of energy efficiency
- Increase use of new and renewable forms of energy
- Phase out market imperfections
- Limit or reduce emissions of greenhouse gases

Kyoto Protocol

Clean Development Mechanisms

- Emission reduction credits for projects between all parties
- Sharing Technologies
- Exporting Technologies

Kyoto Protocol

Emissions Trading

- Developed Countries
- Details at COP - 10

Kyoto Protocol

- Ratification
  - February 16, 2005
  - 55 countries ratify (112 ratified)
  - 55% of Developed Country Emissions
- Second Commitment Period

DENMARK
HFC PHASEOUT LAW

- GENERAL HFC BAN - 2006
- COOLING PLANTS, HEAT PUMPS & AIR CONDITIONING PLANTS HFC BAN FOR SYSTEMS WITH 10kg OR HIGHER - 2007
- EXEMPT FROM BAN
  - COOLING PLANTS, HEAT PUMPS & AIR CONDITIONING PLANTS WITH 0.15 - 10kg.
  - COOLING SYSTEMS FOR PROCESS HEAT RECOVERY WITH CHARGE LESS THAN 50kg.

AUSTRIA
HFC PHASEOUT LAW

- APPLIANCE HFC BAN - 2008
- AIR CONDITIONING AND MOBILE REFRIGERATION HFC BAN - 2008

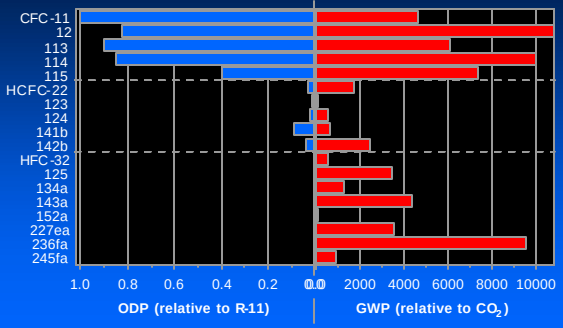
SWITZERLAND
HFC PHASEOUT LAW

- DOMESTIC REFRIGERATION HFC BAN - 2003
- AIR CONDITIONERS HFC BAN - 2005
- MOBILE AIR CONDITIONING HFC BAN - 2008

EUROPEAN UNION
DRAFT HFC REGULATION

- CONTAINMENT OF HFCs
  - PREVENT AND MINIMIZE LEAKAGE
  - MANDATORY INSPECTIONS
  - LEAKAGE DETECTION SYSTEMS
  - MAINTENANCE OF RECORDS
- RECOVERY OF HFCs
- TRAINING AND CERTIFICATION
- AUTOMOBILE HFC-134a BAN
  - No new vehicles with HFCs - GWP greater than 150 in 2012
  - Prohibit sale of vehicles with HFCs greater than 150 in 2018

ODP versus GWP



J. M. Calm and G. C. Hourahan, "Refrigerant Data Summary," *Engineered Systems*, 18(11):74-88, November 2001 (based on 1998 WMO and 2001 IPCC assessments)

Arthur D. Little

Global Comparative Analysis of HFC Technologies for Refrigeration, Air Conditioning, Foam, Solvent, Aerosol Propellant, and Fire Protection Applications

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Final Report to the Alliance for Responsible Atmospheric Policy

March 21, 2002

Prepared by:
John Dieckmann
Arthur D. Little, Inc.

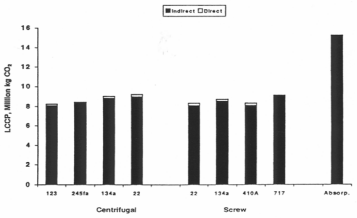
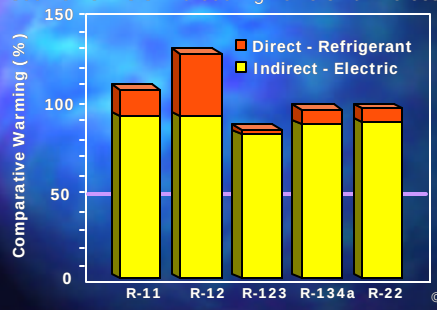


Figure E-7: LCCP for Chillers – Best Current Technology, Atlanta Office Building

The LCCP of a typical direct-fired, double-effect Lithium Bromide -Water absorption chiller is about 65% higher than the average LCCP for the vapor compression cycle chillers.

Total Equivalent Warming Impacts (TEWI)

300 Ton Chillers And Cooling Towers At Two Cost Levels



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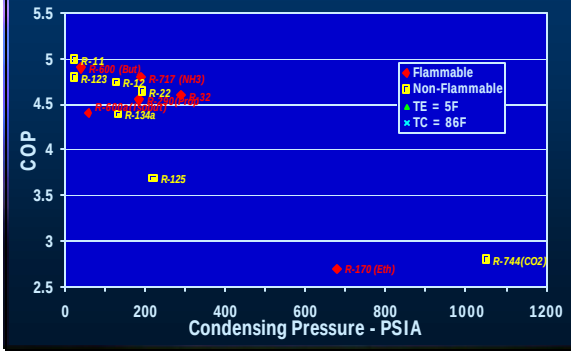
Chiller Efficiency Progress

Year	Efficiency - kW/ton Average	Good
1979	.80	.72
1980	.72	.68
1990	.65	.62
1993	.63	.55
1995	.61	.52
1997	.60	.49
1999	.59	.48
2003	.56	.45

**** 1979 - 2003 . . . Over 35% improvement.***

Ozone Depletion Potential and Global Warming Potential of CFC Alternatives

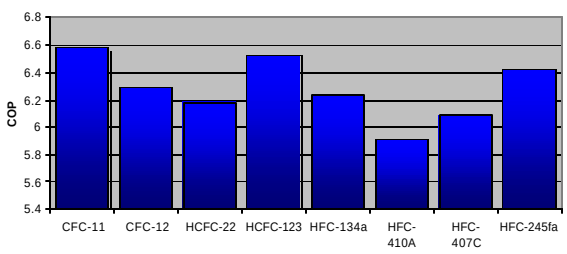
Refrigerant Options



Refrigerants Tested in AREP R-22 Alternatives

R-134a
R-290 (propane)
R-717 (ammonia)
R-410a (R-32/125 [50/50])
R-32/134a [20/80]
R-32/134a [25/75]
R-32/134a [30/70]
R-32/134a [40/60]
R-32/134a [45/55]
R-32/125/134a [10/70/20]
R-407c (R-32/125/134a [23/25/52])
R-32/125/134a [24/26/60]
R-32/125/134a [25/20/55]
R-32/125/134a [30/10/60]
R-32/125/290/134a {20/55/5/20]

Efficiency for Chillers (COP)



Substitute Refrigerants

The Refrigerants for air conditioning are:

HCFC-22	High Pressure
HFC-134A	Medium Pressure Replacement for CFC-12
HCFC-123	Low Pressure Replacement for CFC-11
HFC-407c	High Pressure Replacement for HCFC-22
HFC-410a	High Pressure Replacement for HCFC-22 Equipment

The Future

Focusing on Emissions and Efficiency is fundamental to doing what's right.

Future Means Thinking Green

- Designing "best value versus lowest cost" building
- The green of energy efficiency
- The green of resource sustainability

"Green" Opportunities are Tremendous for:

- Manufacturers
- Consulting Engineers
- Contractors
- Facility Engineers

Summary and Expectations

- Energy Efficiency will be Strongly Encouraged
  - Replacement of Inefficient HVAC, Lighting, and other appliances
  - Life Cycle Cost purchasing will be the preferable process for obtaining energy efficient systems, appliances, buildings, and automobiles