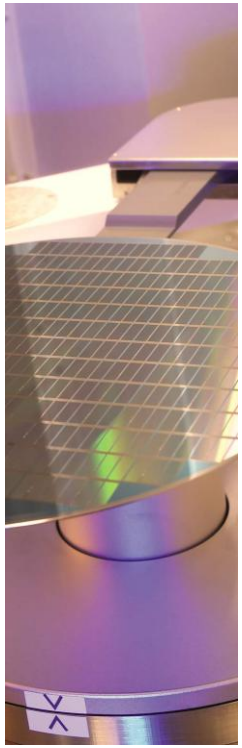
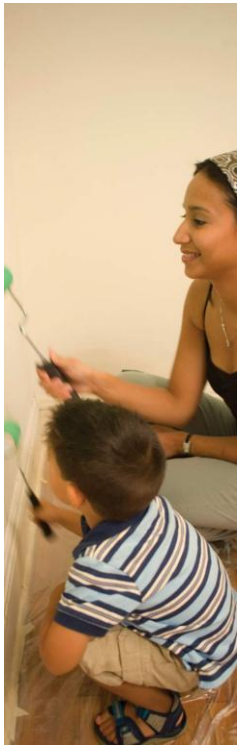
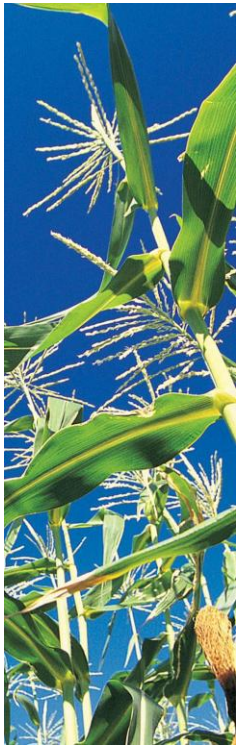
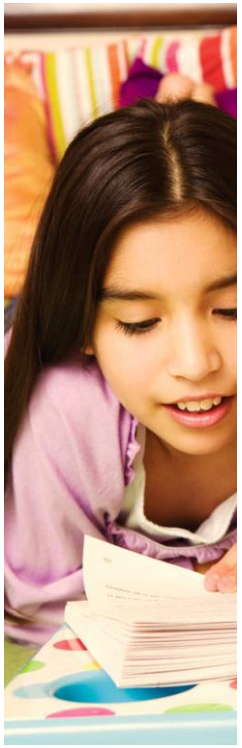
# *Driving a Sustainable Future Through Innovation*



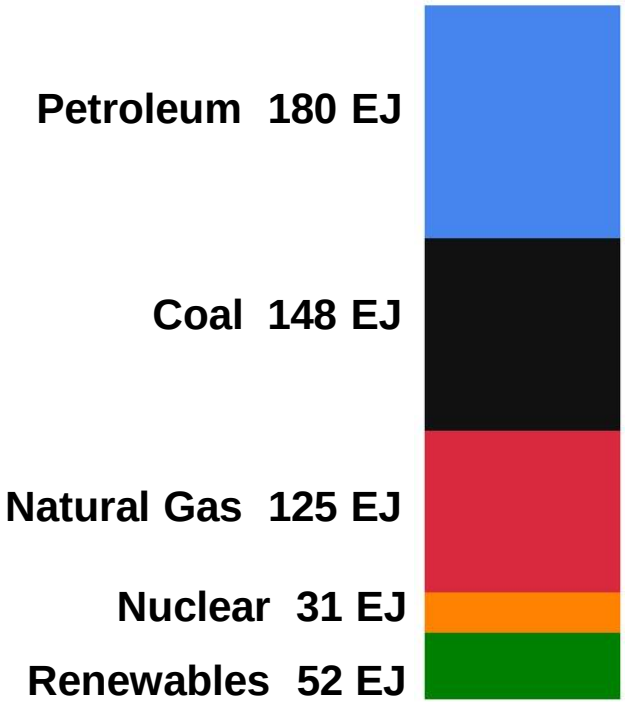
**Dr. Theresa Kotanchek**

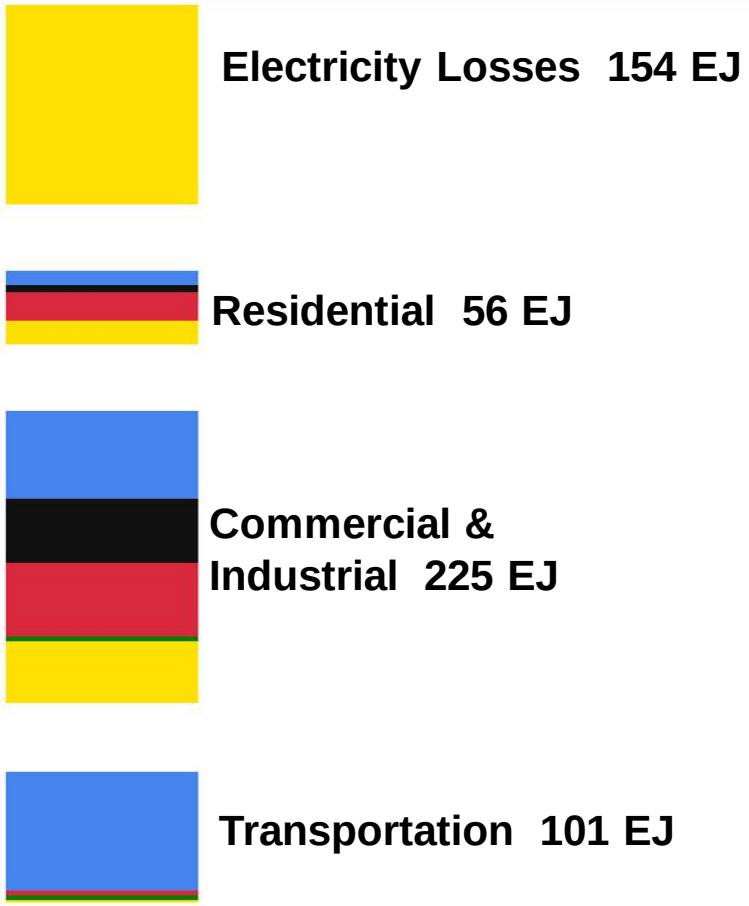
Vice President for Sustainable Technologies and Innovation Sourcing

*May 6, 2011*

# The World Needs Energy

## Primary Energy
## 536 Exajoules (EJ)



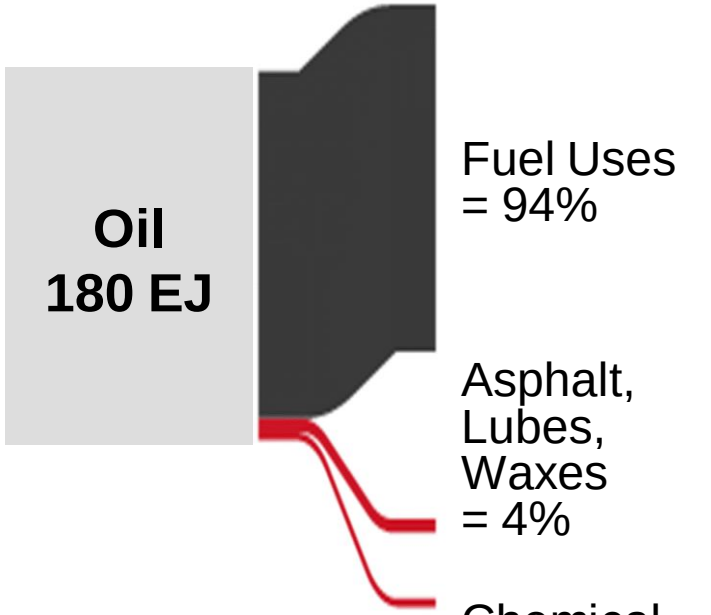

The chemical industry uses **38 EJ** (8% of world consumption)

*Adapted from EIA Energy Outlook May 2009, and IEA: Chemical & Petrochemical Sector 2009*

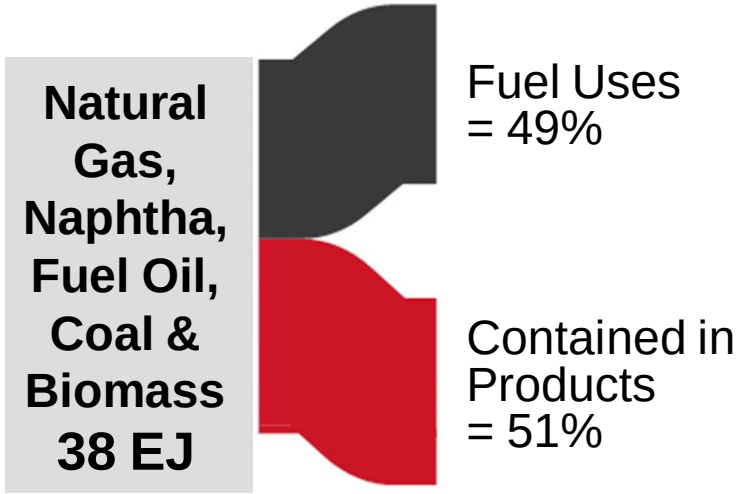
# Carbon Stewards

## *The Fate of Carbon*

### Oil Refining




### Chemical Production




*EIA 2004 Refining Data and IEA Energy Technology Transitions for Industry 2009.*

# The Chemical Industry
# Turning Feedstocks into Essential Products

Energy

Salt

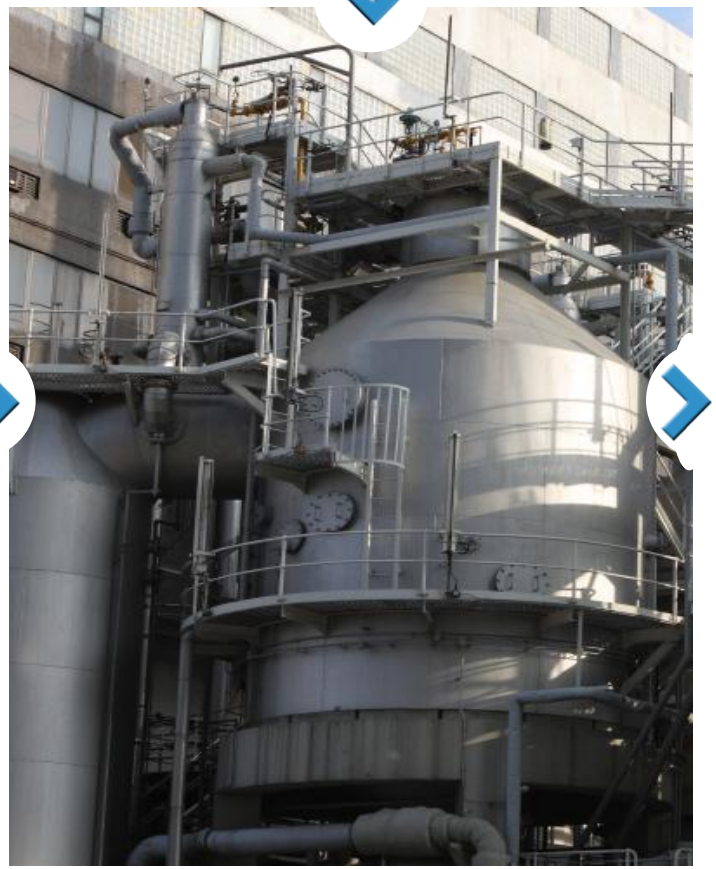
Gas

Oil

Coal

Biomass

Recycle



Building & Construction

Electronics

Agriculture

Wire & Cable

Coatings

Automotive


# Dow's Energy Plan

Four fundamentals enable the transition to a **sustainable energy future**

**1.** Aggressively pursue energy efficiency and conservation

**2.** Increase, diversify and optimize hydrocarbon energy and feedstock supplies

**3.** Accelerate development of alternative & renewable energy and feedstock sources

**4.** Transition to a low carbon economy

# Energy Efficiency – Dow Processes

# R&D Investments in Energy Technologies

## Net Present Value

(non risk adjusted)

~$7.5 B

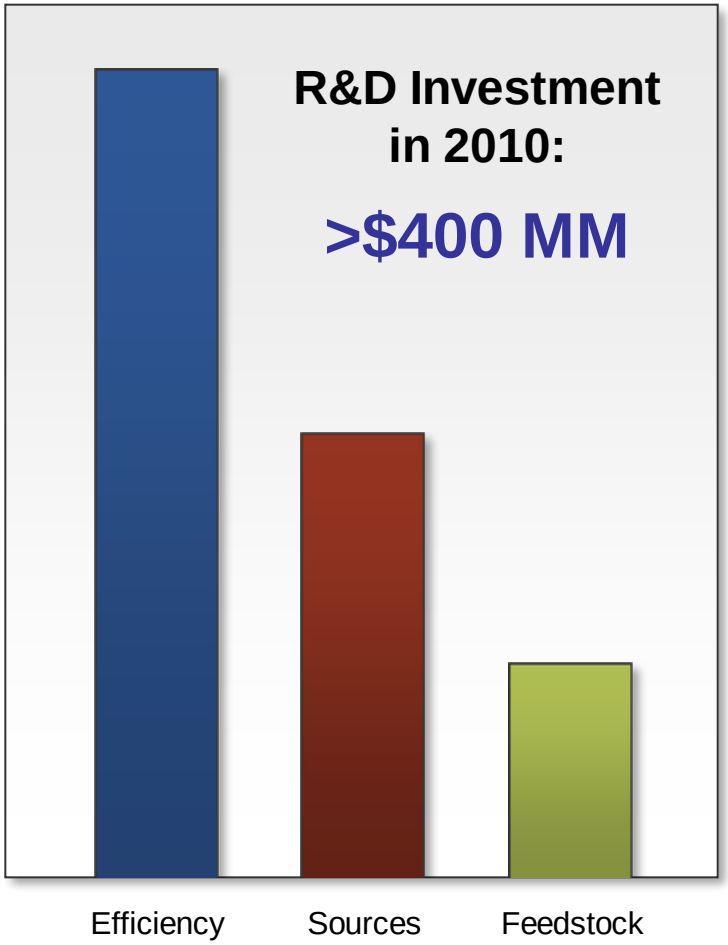
(risk adjusted)

~$2.4 B

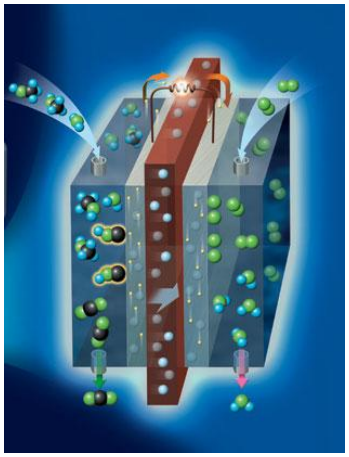
Alternative Sources

Alternative Feedstock

Energy Efficiency



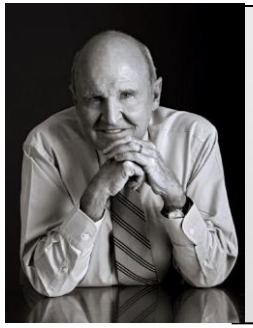

# Alternate Energy Options




# Asking the Right Questions

***How will we make money?***

***What is our Competitive Advantage?***

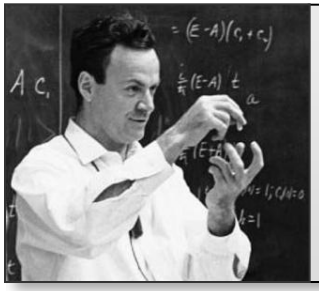


*If you don't have a competitive advantage…. don't compete"*

***- Jack Welch***

# Asking the Right Questions

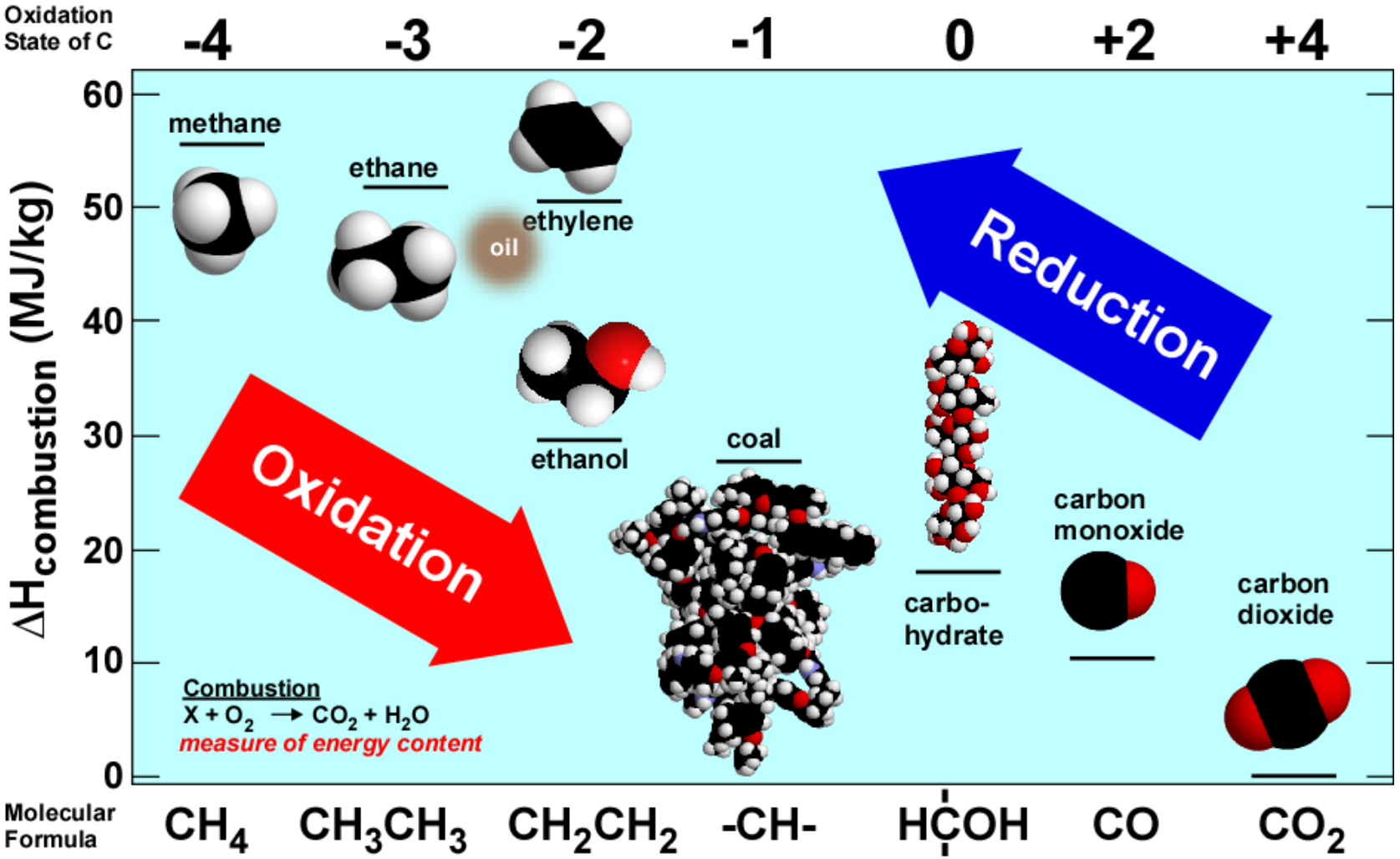
- What is the material balance?
- What is the energy balance?
- What is the cost?
- Is it sustainable?
- Have we defined proper control volumes?



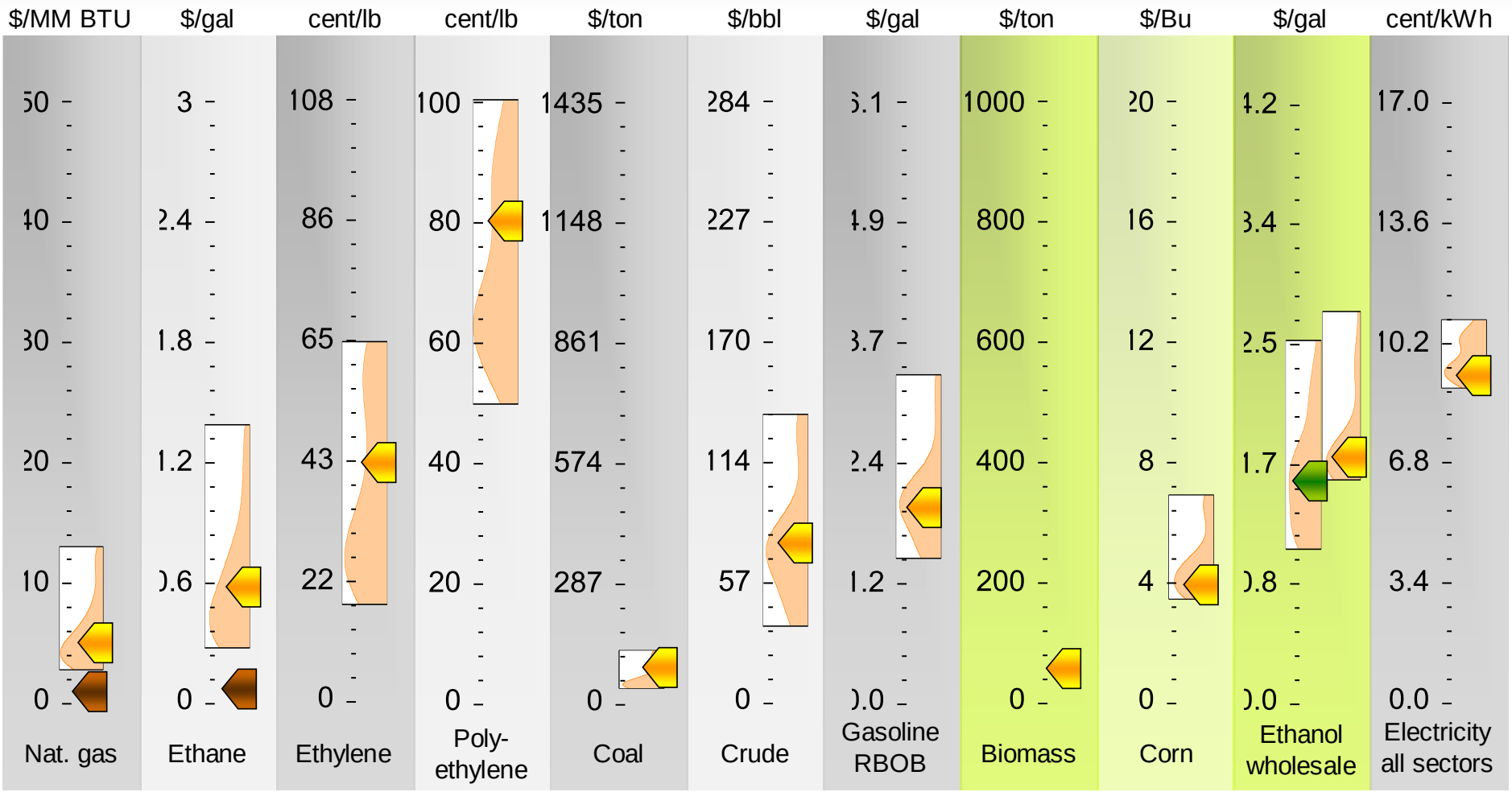
For a successful technology, reality must take precedence over public relations, for Nature cannot be fooled.

*- Richard Feynman*

# Feedstock Oxidation States



# Energy Cost

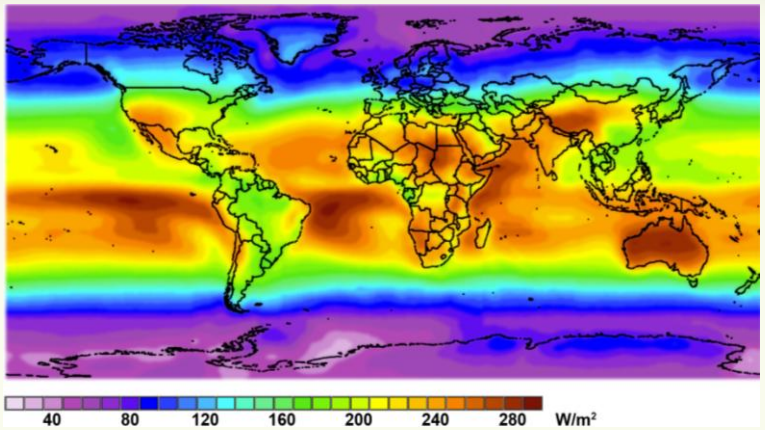



May 2010 prices and last 2 years price density; Source: Dow.

USA Middle East Brazil

# Potential for Solar Energy

| Solar Capture Process | W/m² | Efficiency |
|---|---|---|
| Sugar Cane to Ethanol | 0.60 | 0.30% |
| Energy Crop - Fermentation | 0.70 | 0.32% |
| US Corn to Ethanol (gross) | 0.32 | 0.16% |
| Algenol | 4.0 | 2.0% |
| Wind Farm | 4.0 | 2.0% |
| Concentrated Solar | 3.2 | 1.6% |
| ***PV cell (10%)*** | ***20*** | ***10%*** |

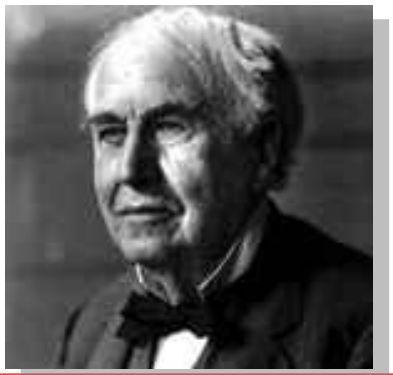



Total solar energy on land
= 697,000 EJ/year

1300 x world needs!

***"I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait until oil and coal run out before we tackle that."***

*Thomas Edison 1931*



**Issues:**

- **Intermittency**
- **Cost**

*Adapted from Mines ParisTech / Armines ©2006*

# Dow Solar Solutions
## Delivering More Affordable Solar Energy

ENERGY

Market Opportunity:
**$5 B** (by 2015)

Dow's Share:
**>$1 B of potential revenue**

Launch:
**2011**

## POWERHOUSE™ Solar Shingle

- Building integrated photovoltaic (BIPV) design combines roofing protection and power generation in one product
- Reduces installation costs by more than 50% compared to conventional solar modules
- Proprietary electrical connections eliminate tedious and costly on-roof wiring

### High Efficiency & Sustainability

- 1 micron of CIGS (copper indium gallium diselenide) PV semiconductor material -- 1/100 of the material of Si solar cells
- Consumes 1/3 of the energy to produce
- Delivers up to 20% conversion efficiency

**Named one of TIME Magazine's "50 Best Inventions of 2009"**



# Energy Efficiency – The Net Zero Home

POWERHOUSE™ Solar Shingles

WEATHERMATE™ SILL SEAL

Silicon Solar Array

STYROFOAM™ Spray Polyurethane

THERMAX™ Wall Insulation
STYROFOAM™ Tongue & Groove

GREAT STUFF™ Fireblock


STYROFOAM™ PERIMATE™


FROTH-PAK™ Foam
Insulation & Sealant

STYROFOAM™ SIS

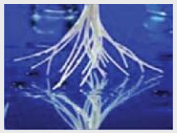
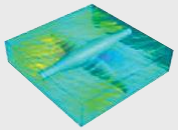

# Dow Water & Process Solutions
## Ensure Clean, Safe Water

TRANSPORTATION & INFRASTRUCTURE

Market Opportunity:
**>$5 B** (today)
**>$10 B** (by 2020)
Dow's Share:
**~$1 B** (today)
**~$3.5 B** (by 2020)
Launch:
**Ongoing**

### Water Leadership

- #1 position in reverse osmosis membranes and ion exchange resins
- Broadest portfolio of high-performance enabling water purification components
- Innovative technologies to reduce the cost of desalination and reuse by 35% by 2015
- FILMTEC™ reverse osmosis membranes are valued by the industry for their reduced energy requirement and low cost of ownership

| Validation & Development | Implementation & Commercialization |
|---|---|
|  New UF Membrane Development |  High-Rejection Low-Energy RO Membrane |
|  New RO Membrane Development |  Largest Active Area UF Membrane |
|  New EDI Development |  Perchlorate Removal IER Media |

**By 2015, 5 Billion People Will Live in Areas of Significant Water Stress**



# Dow's Competitive Advantage

***Dow chooses to operate where***
***materials science & systems expertise drive success***

## Energy Generation

**Superior Materials:**
Balance Of Systems
Aesthetics
Performance
Durability

## Energy Storage


**Superior Materials:**
Cathode
Anode
Electrolytes
Separator

## Water Purification

**Superior Materials:**
Energy efficiency improvements for reverse osmosis and ultra-filtration separations.

# The principles of Sustainable Chemistry and Engineering – Simplified

12 Principles of Green Chemistry – Anastas & Warner

1. Prevention
2. Atom Economy
3. Less Hazardous Chemical Syntheses
4. Designing Safer Chemicals
5. Safer Solvents and Auxiliaries
6. Design for Energy Efficiency
7. Use of Renewable Feedstocks
8. Reduce Derivatives
9. Catalysis
10. Design for Degradation
11. Real-time analysis for Pollution Prevention
12. Inherently Safer Chemistry for Accident Prevention

12 Principles of Green Engineering – Anastas & Zimmerman

1. Inherent Rather Than Circumstantial
2. Prevention Instead of Treatment
3. Design for Separation
4. Maximize Efficiency
5. Output-Pulled Versus Input-Pushed
6. Conserve Complexity
7. Durability Rather Than Immortality
8. Meet Need, Minimize Excess
9. Minimize Material Diversity
10. Integrate Material and Energy Flows
11. Design for Commercial "Afterlife"
12. Renewable Rather Than Depleting

**Atom Economy**

**Energy**

**Reduce Hazard**

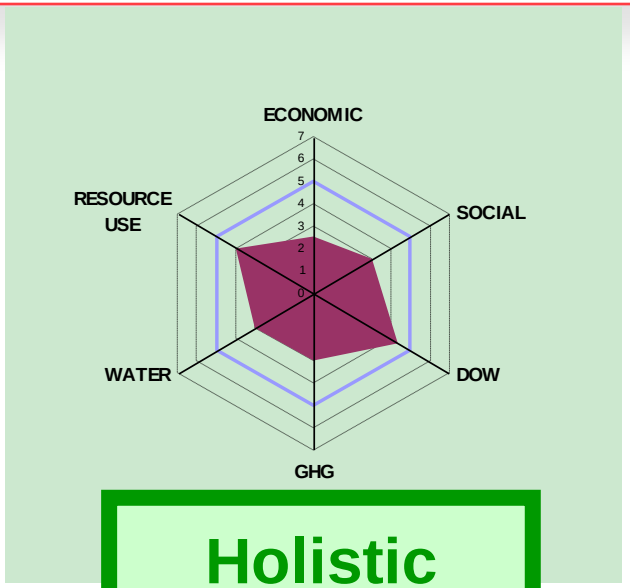
**Holistic Design**

Sandestin Conference: Principles of Green Engineering

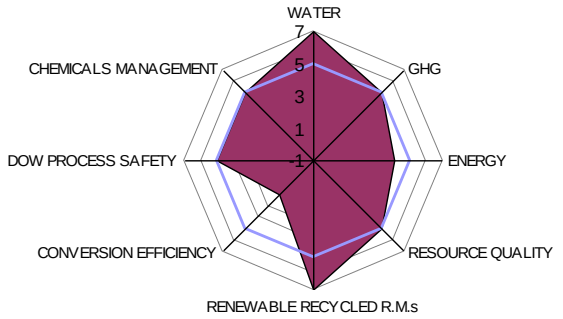
1. Engineer processes and products holistically, use systems analysis, and integrate environmental impact assessment tools.
2. Conserve and improve natural ecosystems while protecting human health and well-being.
3. Use life-cycle thinking in all engineering activities.
4. Ensure that all material and energy inputs and outputs are as inherently safe and benign as possible.
5. Minimize depletion of natural resourc
6. Strive to prevent waste.
7. Develop and apply engineering solut l geography, aspirations, and cultures.
8. Create engineering solutions beyond ; improve, innovate, and invent (technologies) to achieve sustainabil
9. Actively engage communities and stakeholders in development of engineering solutions.

# Maximizing the Value of Dow's Innovation Pipeline

1. Apply Principles of Sustainable Chemistry & Engineering
2. Utilize Sustainability Footprint Assessment tool to evaluate early stage innovation projects
3. Incorporate sustainability assessment into the stage gate review process from ideation through to commercialization
4. Utilize science based, LCA-based tools for quantitative data-based decision making
5. Partner with strategic universities to incorporate & teach principles

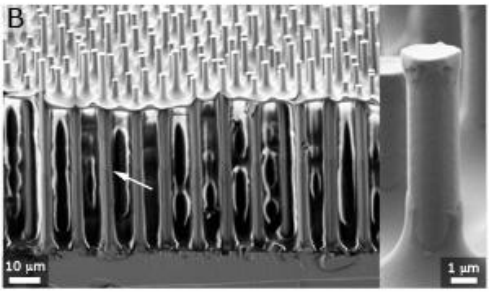



**Holistic Design**

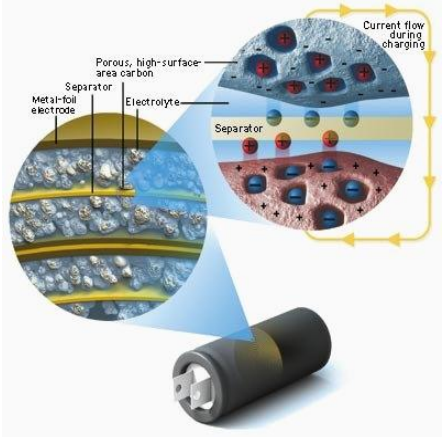



# Innovation & Growth: Where Next?

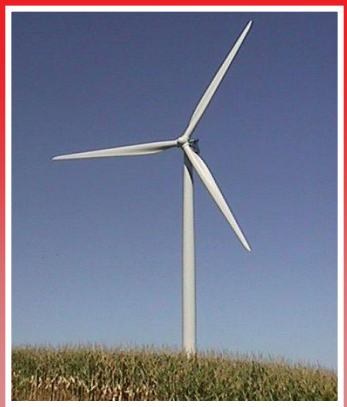
## Solar

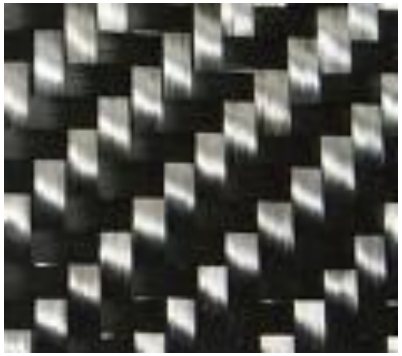



## Energy Storage, Distribution & GRID




## Light Weighting





## Alternate Feedstocks



# Our Innovations Are Aligned With Global Megatrends

## ENERGY

- Photovoltaics
- Wind Power Systems
- Energy Storage

## TRANSPORTATION & INFRASTRUCTURE

- Building Systems
- Architectural Coatings
- Clean Water

## CONSUMERISM

- Electronics
- Packaging
- Home & Personal Care

## HEALTH & NUTRITION

- Healthier Diets
- Rice
- Incipients



# Clean & Sustainable Technology Is Financially Rewarding

**Dow's Clean Technology and Sustainable Innovations Address**
**> $20 billion**
**Market Opportunities**

- Global megatrends define future customer needs
- Clean technology and sustainability are big business
- New opportunities will be won with leadership, innovation and collaboration with our customers, suppliers & development partners
- Dow is meeting consumer demands head-on:
  - Business and technology leadership
  - Geographic reach
  - Technology integration
  - Customer intimacy
  - Materials and formulation expertise