



**Paul Dickerson**  
Chief Operating Officer  
Energy Efficiency and Renewable Energy  
United States Department of Energy

Presentation at the  
BAFF Sustainable Ethanol Conference  
Gothenburg, Sweden  
May 26, 2008

1



## Implementing Agreement with Sweden

- June 2007, USA and Sweden signed agreement to
  - further expand cooperation on renewable energy and vehicle technologies
  - establish a bilateral working group to explore prospective projects.
- Further implements the U.S.-Sweden Science and Technology Agreement (June 2006) to cooperate on
  - biomass production
  - transportation and automotive research
  - reducing the cost of renewable energy
  - improving energy efficiency.
- Also announced plans for cooperation between DOE and Mack Trucks (subsidiary of Volvo AB) to develop environmentally friendly commercial vehicle technologies.

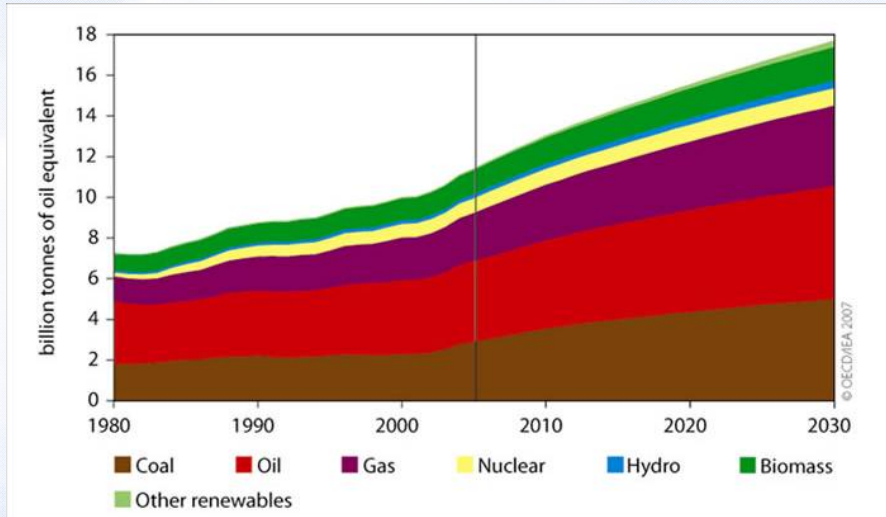


**Maud Olofsson**  
Swedish Deputy  
Prime Minister and  
Minister of Enterprise  
and Energy

2



## Projected Global Energy Demand to 2030



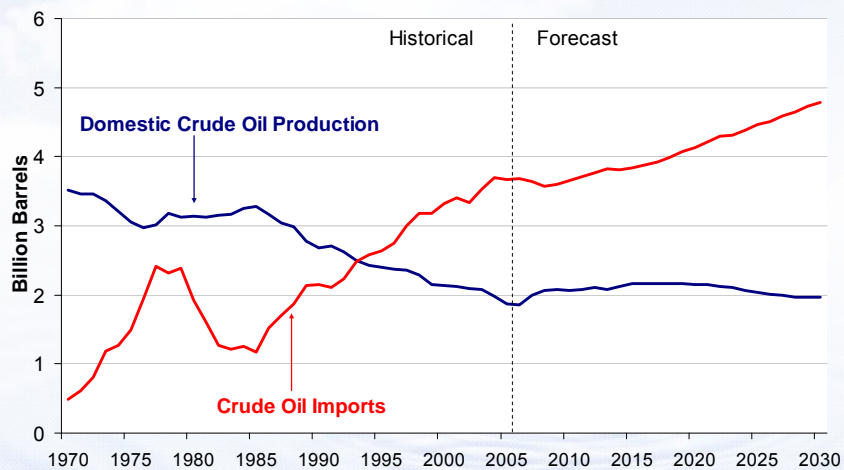
Source: IEA WEO 2007, Reference Scenario

3



## U.S. Oil Dependency

### Crude Oil: Annual U.S. Production and Imports

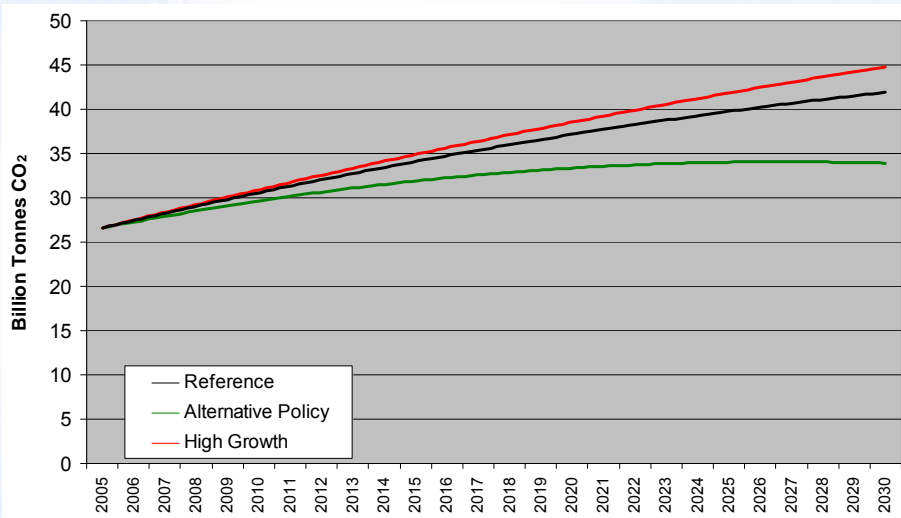


Source: EIA. Annual Energy Review 2005 and Annual Energy Outlook 2007.

4



## World Energy Related CO<sub>2</sub> Emissions Projected to 2030

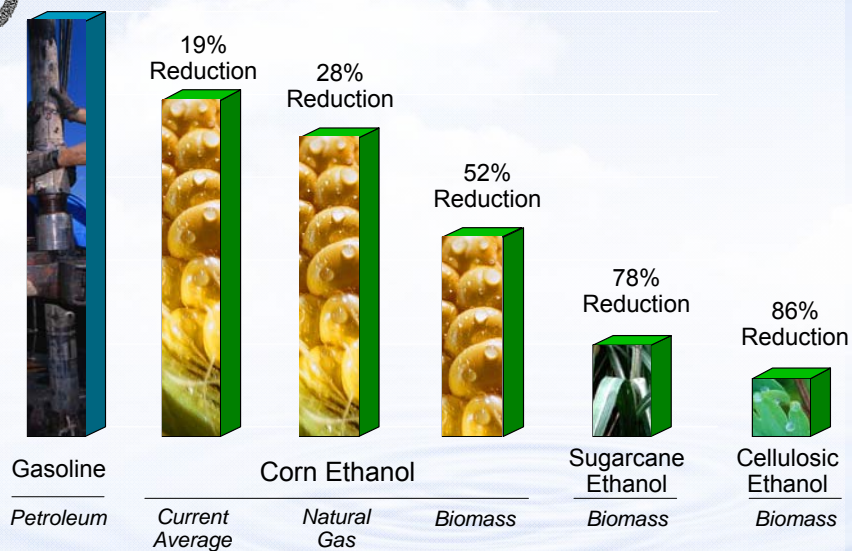


Source: IEA WEO 2007

5



## Lifecycle Greenhouse Gas Emissions Associated with Different Fuels



Sources: Wang et al, *Environ. Research Letters*, May 2007; Wang et al, *Life-Cycle Energy Use and GHG Implications of Brazilian Sugarcane Ethanol Simulated with GREET Model*, Dec. 2007.

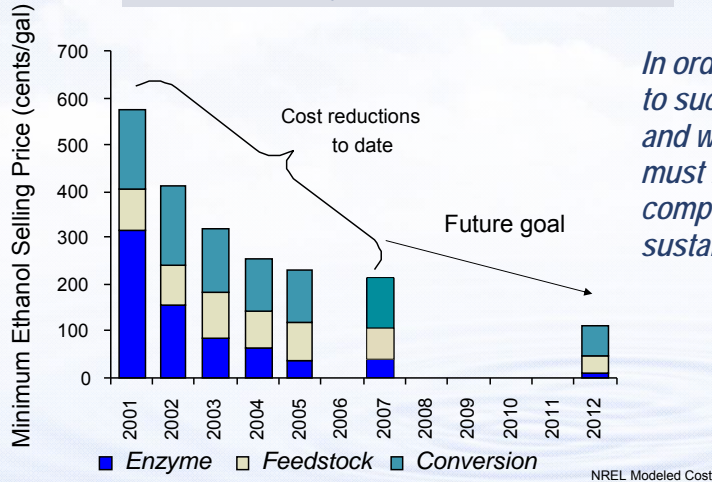
6



## Reducing Cost of Cellulosic Ethanol

Modeled Ethanol Cost for "nth Plant"

### Historical and Projected Cellulosic Ethanol Costs



*In order for biofuels to succeed in the US and world-wide, they must be both cost-competitive and sustainable.*

**Cost-competitive in the blend market by 2012**

7



## National Biofuels Targets

### New Renewable Fuel Standard

- Expand use of renewable fuels to 36 billion gallons annually by 2022
- Cellulosic biofuels component
  - 0.5 billion gallons by **2012**
  - 3 billion gallons by **2015**
  - 16 billion gallons by **2022**
- Includes Significant Safeguards
  - Targets are within 2006 Billion-Ton study volumes
  - Ethanol production from corn is capped at 15 bgy
  - EPA authorized to waive targets annually
  - Requires GHG reductions, which include land use impact
  - Requires studies on environmental impacts



**Best short-term option to alleviate gasoline prices and heating oil costs**

8



## U.S. Investments in Cellulosic Ethanol

- **Commercial-Scale Biorefineries (up to \$305 million)**
  - Five cost-shared, integrated biorefinery demonstration projects to produce 130 million gallons of cellulosic ethanol in 5 years using variety of conversion technologies and cellulosic feedstocks
- **10%-Scale Biorefinery Validation (up to \$200 million)**
  - Cost-shared, integrated biorefinery demonstrations using cellulosic feedstocks to produce renewable fuels; one-tenth of commercial scale
  - Seven selectees announced for a total investment of \$200 million
- **Ethanolgen Solicitation (up to \$23 million)**
  - Five selected research teams working on microorganisms
- **Enzyme Solicitation (up to \$33.8 million)**
  - Four selected research teams working on inexpensive enzyme systems for commercial biomass hydrolysis
- **Thermochemical Solicitation (up to \$16.7 million)**
  - Integration of gasification and catalyst development
  - Pyrolysis oil stabilization
- **Joint DOE-USDA Solicitation (\$18 million)**
  - Biomass R&D Initiative: 20 awards announced March 2008



9



## Biofuels Beyond Ethanol

Today



Future

- Ethanol** – as a blending agent from either grain or cellulosic material from Ag and/or Forestry industry
- Biodiesel** – Transesterified vegetable oils blended with diesel
- Green Diesel** – fats, algal oils, waste oils, or virgin oils converted to low-sulfur diesel in petroleum refinery
- Higher alcohols** – examples include: butanol, mixed alcohols, higher carbon alcohols (C5- and greater)
- Fischer-Tropsch Liquids** – and other products from syn gas including methanol, dimethyl ether, etc
- Pyrolysis Liquids** – alternative feedstock to petroleum refinery or gasification facility
- Methanol derived fuels** – Methanol to gasoline technology, dimethyl ether and other products
- Other fuels** – Liquid transportation fuels from sugars/oils refinery not discussed or yet envisioned

10



## Our Commitment to Sustainability

EERE is committed to developing the resources, technologies, and systems needed for biofuels to grow in a way that enhances the health of our environment and protects our planet. To that end, we are working to...

- Develop diverse, non-food feedstocks (e.g., switchgrass, sorghum) that require little water or fertilizer
- Foster sustainable forestry practices (e.g., advanced harvesting techniques) to enhance forest health
- Selectively harvest biomass components while leaving adequate soil nutrients
- Assess life-cycle impacts of major scale-up in biofuels production, from feedstocks to vehicles, addressing:
  - land use and soil health
  - water use
  - air quality issues
  - impacts on greenhouse gas (GHG) emission



*Efforts are anchored into senior-level Biomass R&D Board Sustainability Working Group*

11



## DOE Current Work on Sustainability

- **Biodiversity**  
Working with Conservation International to conduct pilot studies to identify best land to locate biofuel crops worldwide while preserving biodiversity
- **Climate Change**  
NREL is conducting a life cycle assessment of replacing 30 percent of gasoline use in the U.S. with biofuels by 2030
- **Indirect Land Use**  
Argonne National Laboratory and Purdue University are refining models that can analytically address international land use change issues due to increasing growth of biofuels
- **Feedstock Production**  
Conducting in-field studies to determine best location for energy crops in collaboration with USDA, the Sun Grant Initiative universities, and other regional partners
- **Water**  
Argonne and NREL are conducting LCA of water demand for biofuels production over the lifecycle in comparison to corn ethanol, sugar cane ethanol, and competing petroleum fuels
- **National Bioenergy GIS**  
ORNL, ANL, INL, UC-Davis and others are developing a national scale GIS-based framework to assist in the analyzing the economic and environmental impacts of feedstock, biorefinery, and infrastructure development options.

12



## U.S. DOE Country Collaborations

### U.S. Energy Department International Collaborations

China	India	Japan	Brazil	EU
General EE Industrial EE Buildings Vehicles Biomass Geothermal Wind Solar Hydrogen Nuclear Fusion Energy FutureGEN CO2 Seques.	General EE Industrial EE Buildings Vehicles Biomass Solar Hydrogen Nuclear Fusion Energy FutureGen CO2 Sequestration	General EE Industrial EE Buildings EnergyStar Vehicles Geothermal Wind Solar Hydrogen Nuclear Fusion Energy FutureGEN CO2 Sequestration	General EE EnergyStar Biomass Hydrogen Nuclear CO2 Sequestration	Industrial EE Buildings EnergyStar Solar Hydrogen Nuclear Fusion Energy CO2 Seques.

13



Thank you

Paul Dickerson  
United States Department of Energy

<http://www.eere.energy.gov>

14