From Fields to Wheels

Recent and Future Automotive Biofuels

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Our Future Resources - Our Common Future

Basic Challenges of Today´s Energy System

- **Limited crude oil resources and supply** (security of energy supply)
- **Increasing import dependency** (With "business as usual" the EU's of gas import dependency is expected to increase from 57% to 84% by 2030, of oil from 82% to 93%.
- **Energy prices and volatility**
- **Climate change and other environmental risks** (Energy accounts for 80% of all greenhouse gas (GHG) emission in the EU) climate change and most air pollution.
- **Geo-strategic tensions caused by scare energy resources**

What needs to be done?

- Promotion of renewable energy and energy efficiency
- Development of effective framework conditions and markets for RE and EF
- Implementation of intelligent energy policy and coherent, effective instruments
- Creation of effective communication processes and experience across the Atlantic
- Involvement of the broader public in RE and EF issues

Summit Meeting April 30, 2007

President Bush, Chancellor Merkel and EU-President Barroso

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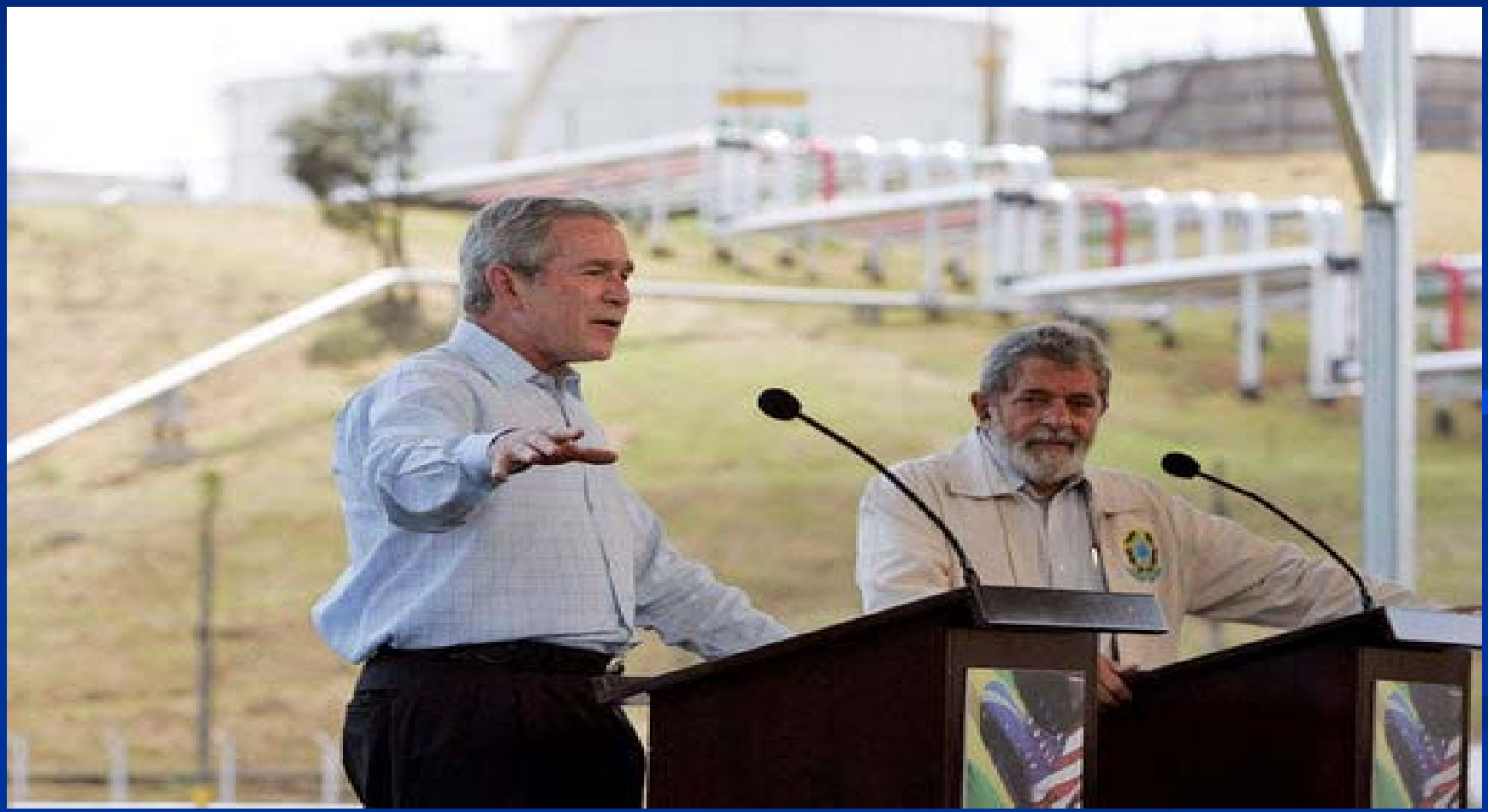
- Strengthening efforts towards development of biofuels and standards
- Commitments to global climate protection strategies

President Bush and President Lula of Brazil Discuss Biofuel Technology (Mar. 03, 2007)



President Bush Meeting with American Automobile Manufacturers

March 28, 2007

- They discussed Bush's support for his administration's proposal to substitute gasoline by ethanol by 20 percent in 10 years
- The three auto executives reiterated their commitment to double their production of flexible fuel vehicles to about 2 million a year by 2010.
- Bush checked out some flex-fuel vehicles GM's flex-fuel Chevrolet Impala running on E85
- Ford's Edge HySeries with a plug-in hydrogen fuel cell
- and DaimlerChrysler's Jeep Grand Cherokee Diesel filled with B5, a biodiesel blend

US Governors' 2007 Policy Recommendations

Adoption of a goal of providing only 20 percent of the nation's gasoline supply from biofuels would deliver extraordinary benefits to the nation, including:

- Approximately 60 billion gallons of annual ethanol production, an amount equal to about 25 percent of projected future gasoline demand in 2030;
- $52 billion a year in avoided oil imports, creating lasting reductions in our trade deficit; and
- • $110 billion of direct economic activity each year with the total impact to the nation's economy of $368 billion a year; and
- • 2.4 million new jobs.

AN ENERGY POLICY FOR EUROPE {SEC(2007) 12}

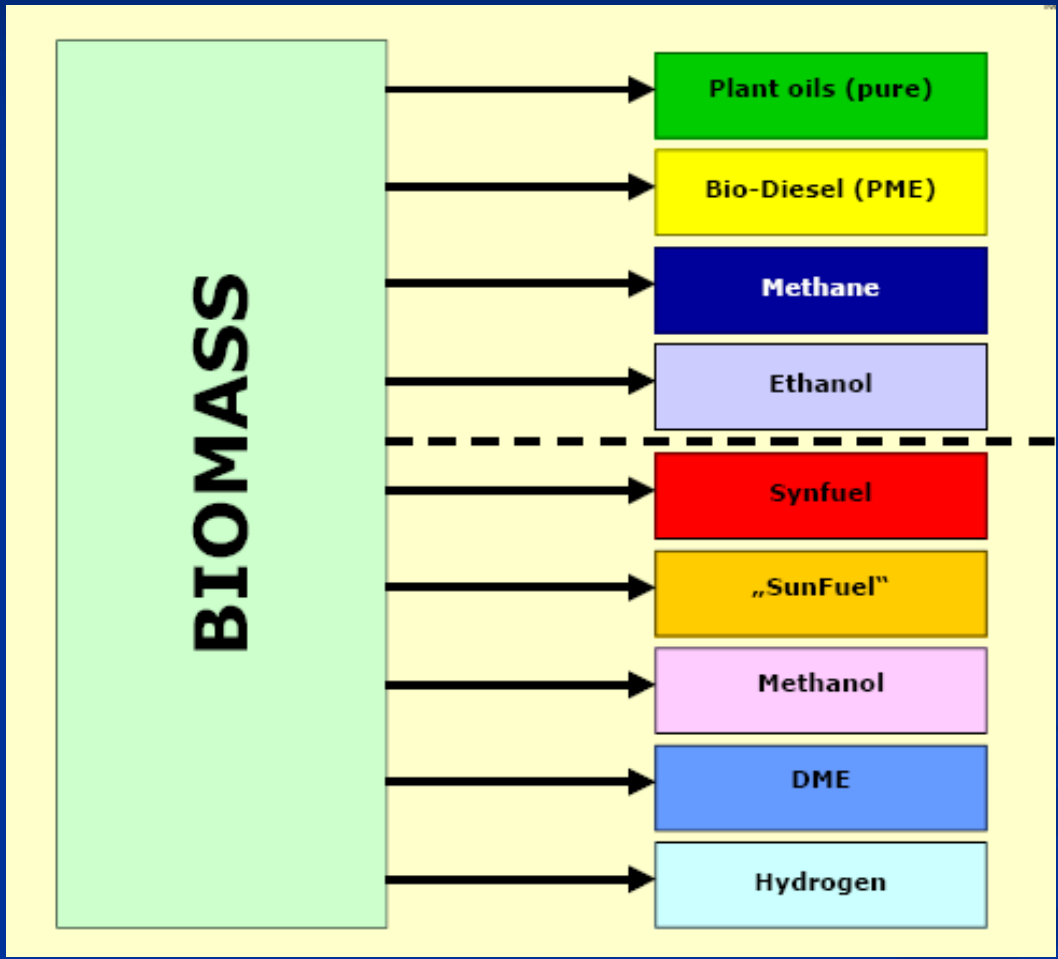
- Endorse the binding targets of 20% for the share of renewable energy in overall EU energy consumption by 2020 and 10% minimum biofuels (Germany 20% ?)
- Developing biofuels, in particular second generation biofuels, to become fully competitive alternatives to hydrocarbons;
- Using fuel cell and hydrogen technologies to exploit their benefits in decentralized power generation and transportation fuels

Fuels from Biomass

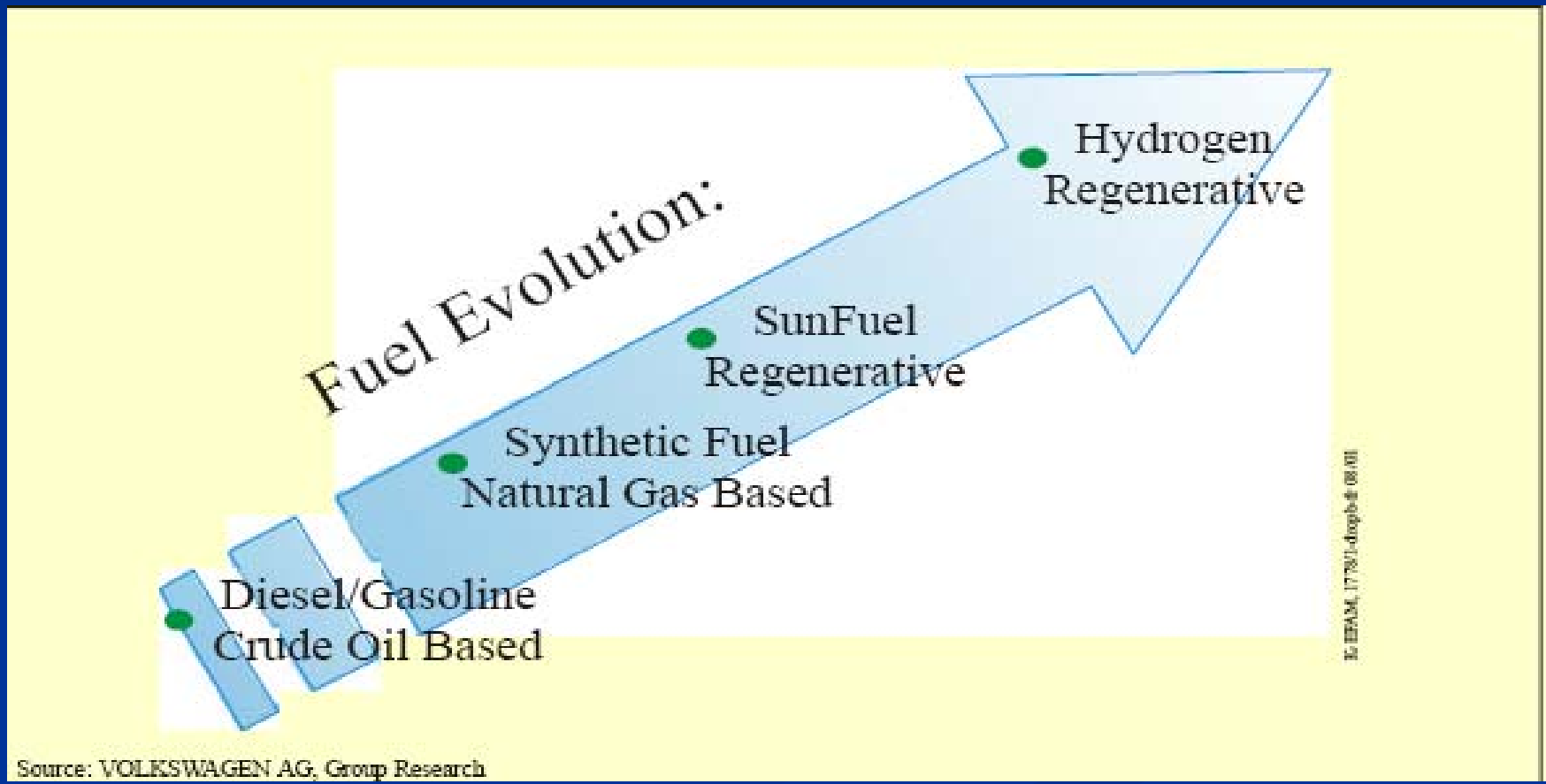
- Fuels derived from biomass are not only potentially renewable, but are also sufficiently similar in origin to be the fossil fuels (which also began as biomass) to provide direct substitution.

- They can be converted into a wide variety of energy carriers using existing and novel conversion technologies, and thus have the potential to be significant new sources of energy into the 21st century.

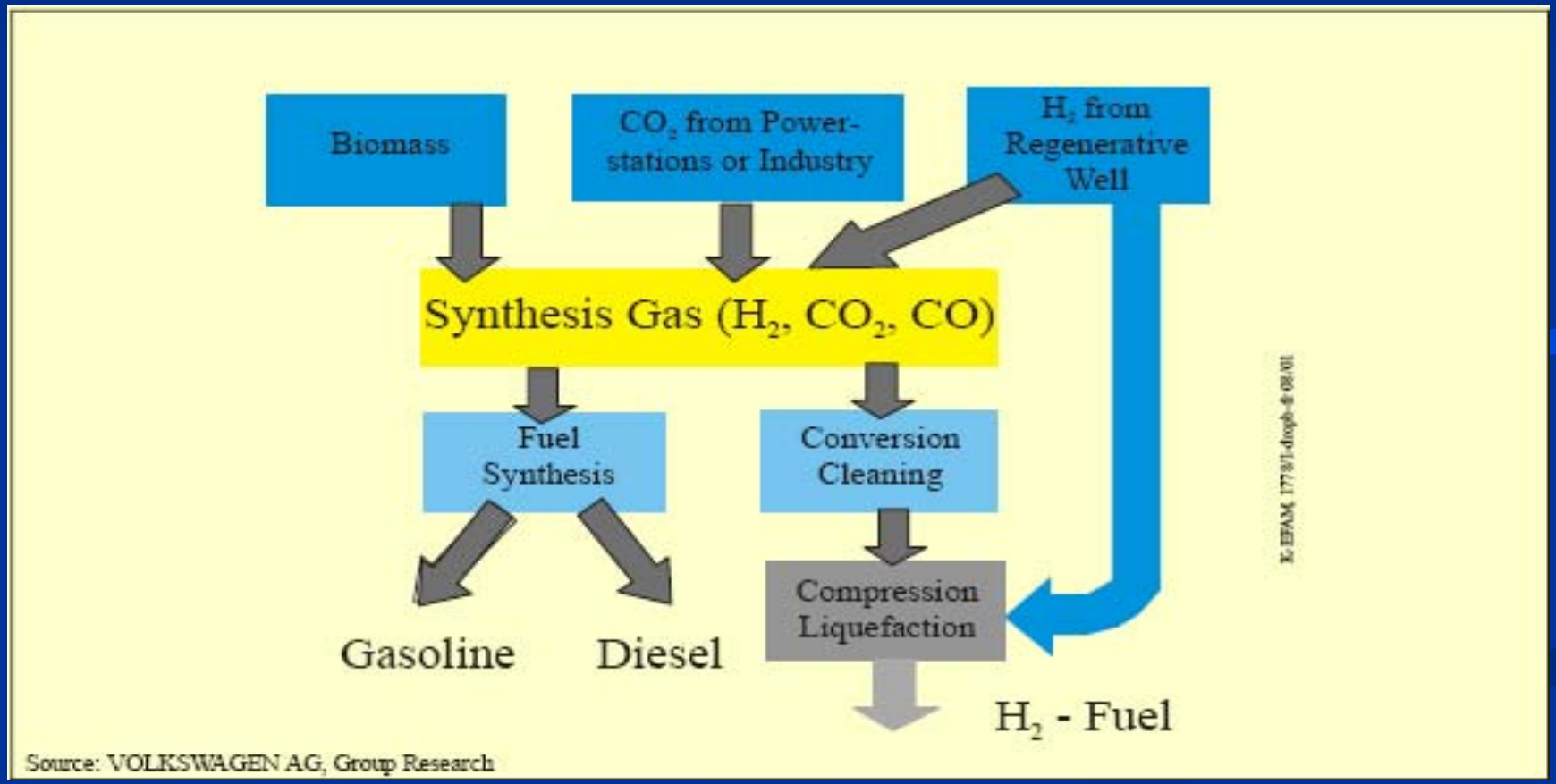
Transportation Fuels from Biomass



Fuel Strategies of Automotive Industries



Ways to CO_2 Neutral Fuels



Bio-Ethanol

Ethanol is a biofuel alternative to gasoline. It can be combined with gasoline in any concentration up to pure ethanol (E5-E100).

It is manufactured from plants containing sugar, starch or lignocelluloses, their selection depends on regional availability: Europe: cereals, sugar beet and potatoes , Brazil: Sugarcane, USA: Corn (maize).

Croplitres Ethanol/ha

- Miscanthus 14.031
- Switchgrass 10.757
- Sweet Potatoes 10.000
- Poplar Wood 9354
- Sweet Sorghum 8419
- Sugar Beet 6679
- Sugar Cane 6192
- Cassava 3835
- Corn (maize) 3461
- Wheat 2591

Biomass Potentials

- More than 250,000 species of higher plants exsit worldwide
- Only 1000 species comprise the world‘s crops which are cultivated to provide food and fodder, industrial uses and construction materials
- 80% of edible plant material comes from 11 species, of which two-thirds are cereals !

Tall Grases

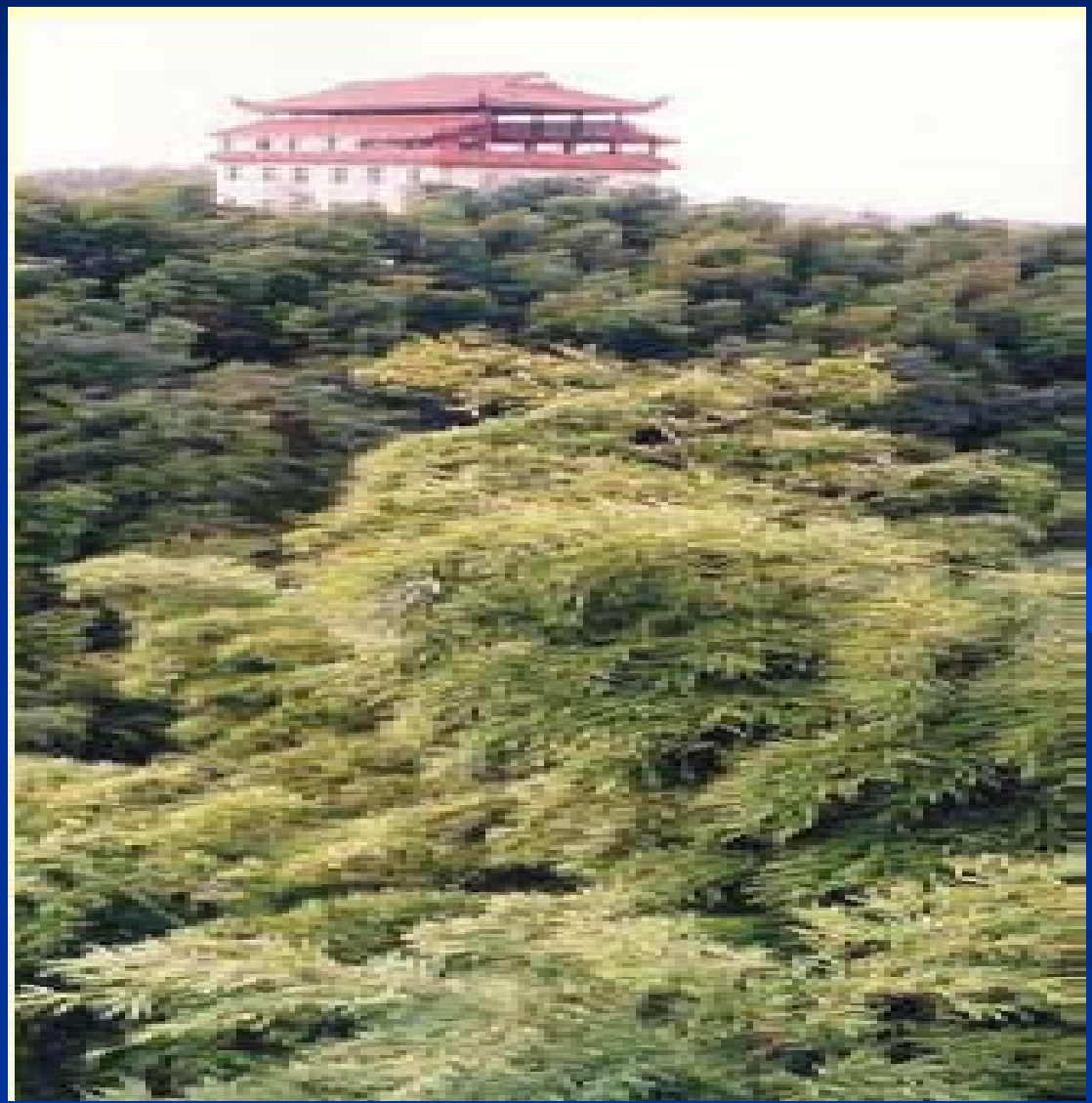
Sweet and Fiber Sorghum

Miscanthus In Germany

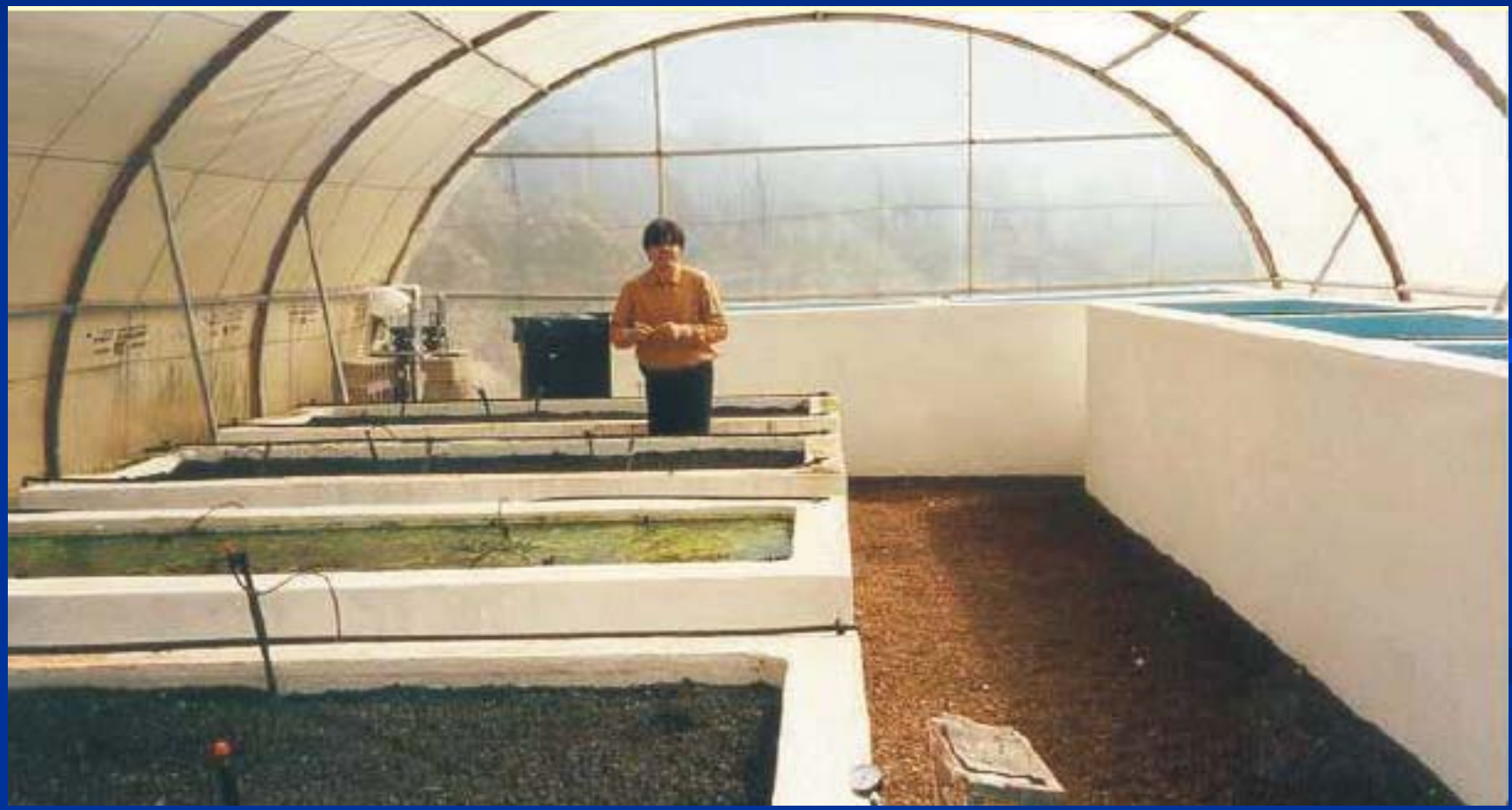
Miscanthus Growth over a Single Growing Season in Illinois, USA

Short Rotation Willow

Bamboo



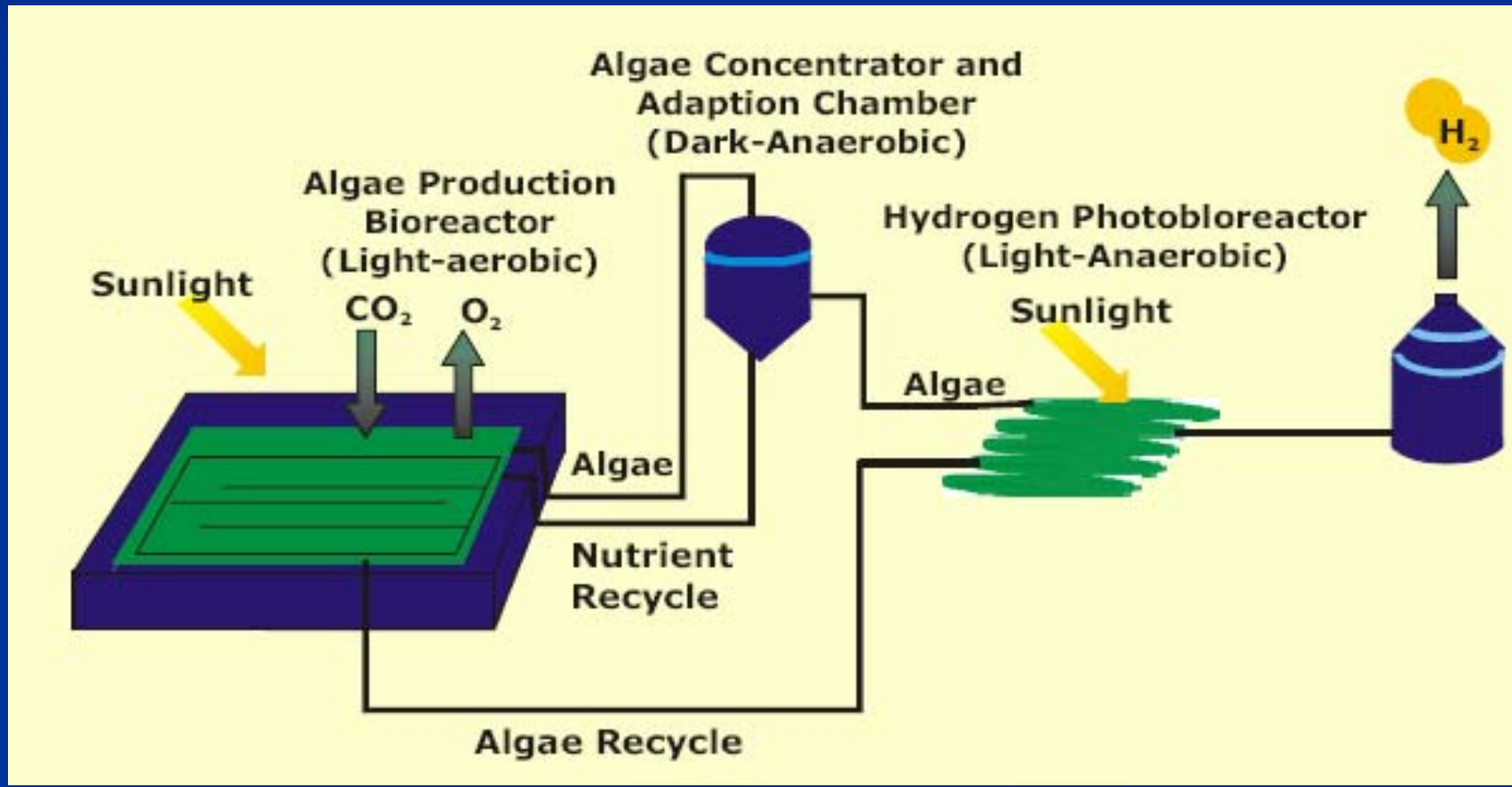
Algae Production



NREL Researchers Developed Strains of Microalgae Producing High Levels of Lipids for Biofuel Production

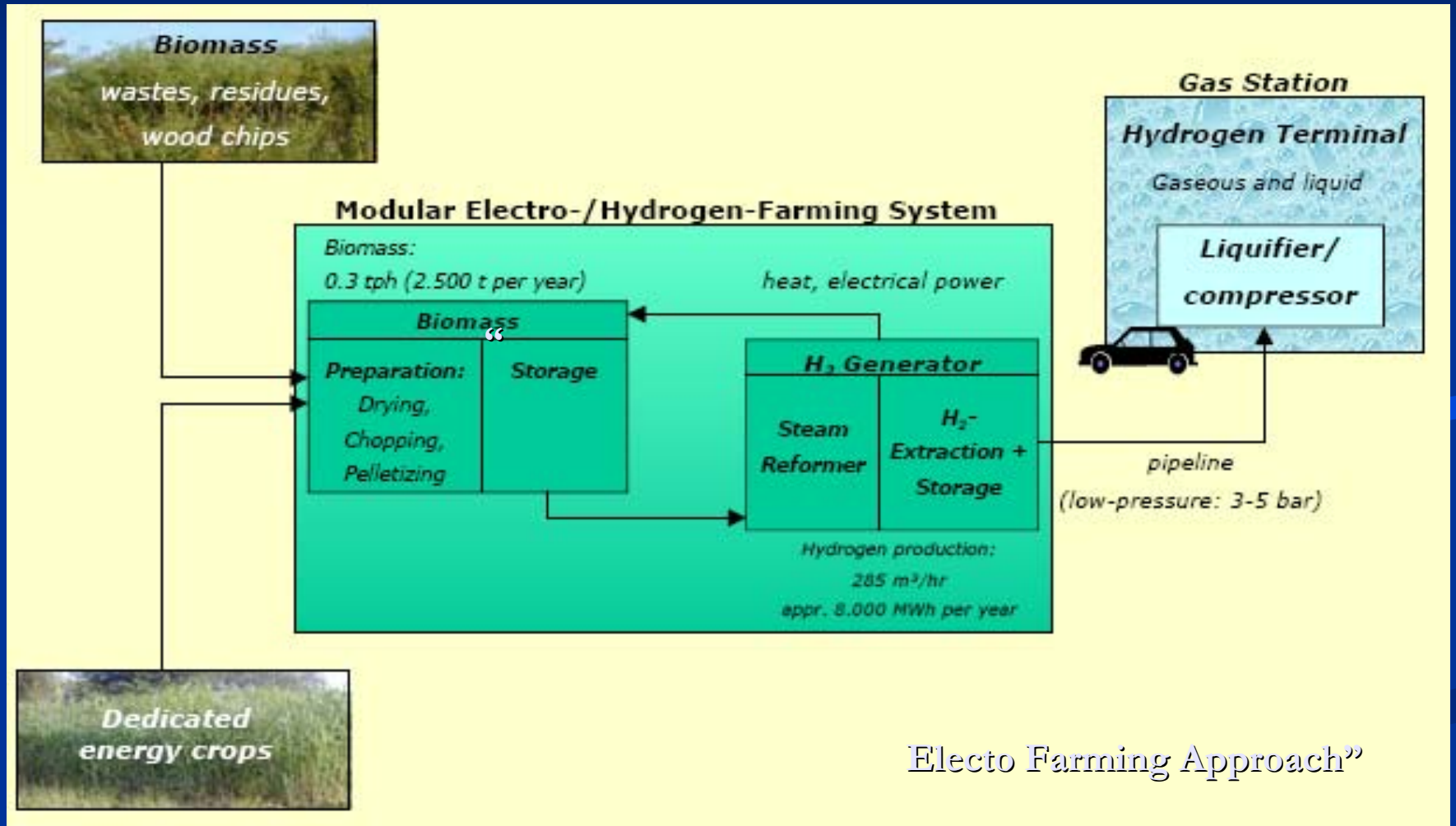
A raceway pond system in Israel growing microalgae for nutraceutical production. PIX 08332

Microalgae Conceptual Two-Stages of Hydrogen Biosynthesis Process



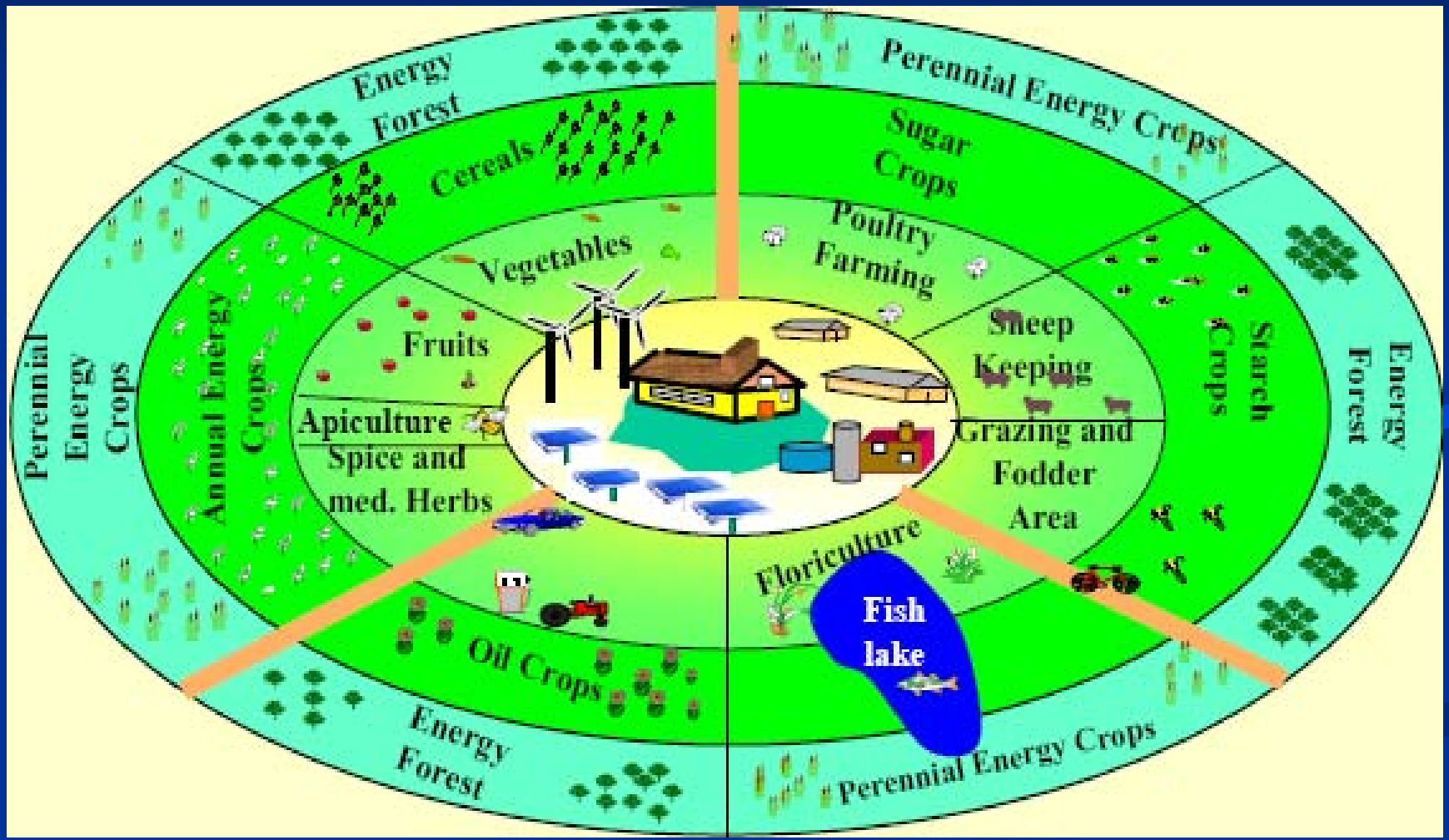
US Researchers are working to identify efficient cellulolytic microbes that can directly ferment cellulose to hydrogen

Decentralized Hydrogen Generation from Biomass and Gas Terminals



Electo Farming Approach"

Integrated Energy Farms and Settelments „FAO-UN-Concept“



Future “Oil Fields” !

Biofuels versus Food ?

- World-wide ca. 35% of the existing areas of arable land are not agriculturally used. Millions of farmers could not cultivate their fields due to the high production costs and low income. The migration from the land and the development of Slum' s in large cities of developing countries were the indirect result of this development.
- Overproduction and set a side EU policy

Ethanol critics also question the wisdom of growing fuel instead of food

- Corn is used mostly for livestock feed and for products such as beverage sweeteners, rather than direct human consumption. As the largest U.S. agricultural crop, it is generally in surplus, requiring price supports
- Cellulosic bioethanol production from stover or dedicated energy crops would have even less impact on food supplies and could be grown on land not economically suitable for food crops.

Energy Balances

- Energy balance value alone is not meaningful in evaluating the benefit of ethanol or any other energy product, energy balance must be compared with that of the product it replaces.
- Compared to gasoline, any type of fuel ethanol substantially helps reduce fossil energy and petroleum use.
- Ethanol produced from corn can achieve moderate reductions in greenhouse gas emissions.
- Ethanol produced from "cellulosic" plants, such as grass and weeds, can achieve much greater energy and greenhouse gas benefits.

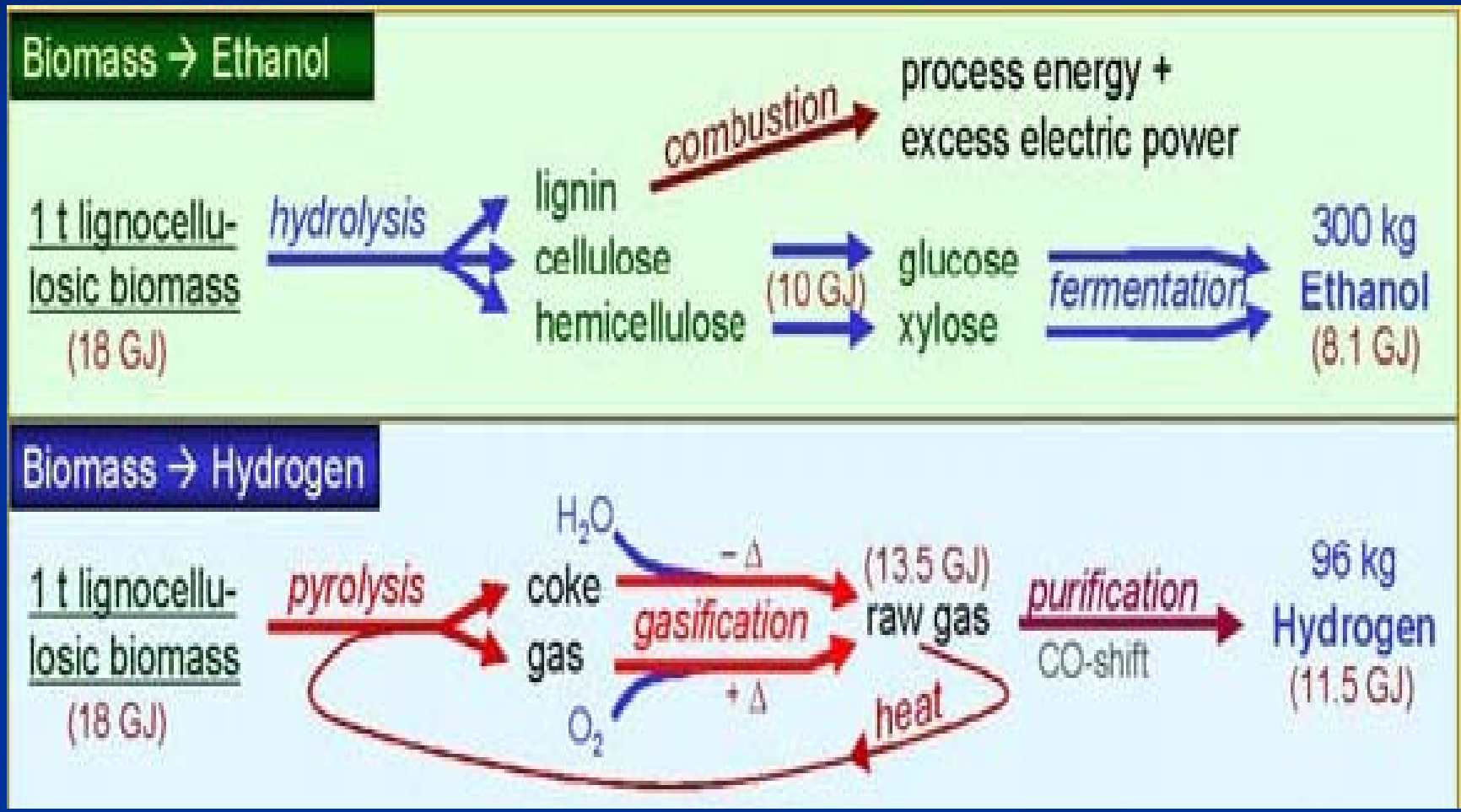
Energy Balances

- The most official and other reviews studies, concludes that the "net energy balance" of making fuel ethanol from corn grain is 1.34;
- On the basis of liquid fuels alone, the net balance is 6.34 (USDA)
- With lower fertilizer requirements for soybeans than corn and simpler processing, biodiesel production and use has a net energy balance of 3.2.
- Ethanol production today requires about 50 percent less energy than in the early 1980s.

Biotechnology

- Biotechnology, its reputation sullied by public protests over GM foods, may make important contributions. According to the science journal Nature, recombinant technology is already available that could enhance ethanol yield, reduce environmental damage from feedstock, and improve bioprocessing efficiency at the refinery.
- The Swiss biotech firm Syngenta is developing a genetically engineered maize that can help convert itself into ethanol by growing

Ethanol and Hydrogen from Biomass



German – American Partnership for Bioenergy Encouragement **(22.02.07)**

- German medium-seized business Freesen & Partner GmbH and the American Steel City Biofuels signed an agreement to accomplish the EWB Expo and Conference 2007. It will focused on energy recovery from biomass and wastage

BASF (Germany) and Monsanto (USA) Collaboration March 21, 2007)

BASF and Monsanto Announce R&D Collaboration Agreement in Plant Biotechnology

- Agreement aimed at developing higher-yielding crops that are more tolerant to adverse environmental conditions such as drought
- Potential $1.5 billion/€1.2 billion devoted to joint pipeline over life of the collaboration
- First products to be commercialized in the first half of the next decade (corn, soybeans, cotton and canola).

Mar 6, 2007

Bank of America announces $20 billion Environmental Initiative

Perspectives of Biomass

- Annual primary biomass production: 220 billions DM, 4,500 EJ = 10 times of world primary energy consumption. Biomass used for food: 800 millions DM = 0.4% of primary biomass production.
- Annual food production corresponds to 140% of the needs of world population.
- The potential biomass productivity is the result of interactions between their genetic make up, the environments and the external inputs. The optimization of these 3 factors is the key issue for a successful introduction of power crops.

- The photosynthsis efficiency is around 1%. An increase in this efficiency (by breeding and biotecnology) would have spectacular effects on biomass productivity
- Microalgae biomass
- Developments in car technologies are leading to significant reduction fuel consumption, i.e less biomass per 100 km drivng distance

One Liter per 100 km Car

Train Powered by Pure Plant Oil

Conclusions

- Of all options, biomass represents the most sustainable substitute fossil fuels

Integration of Concentrated Solar Thermal Power , Wind and Solar Energy for a Absolute Renewable Biofuel Production

Biomass Will Keep the World Moving !

With Biomass the Automotive Fuels Will Never Run Out !

Thank you for your attention !

Vielen Dank für Ihre Aufmerksamkeit !

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