



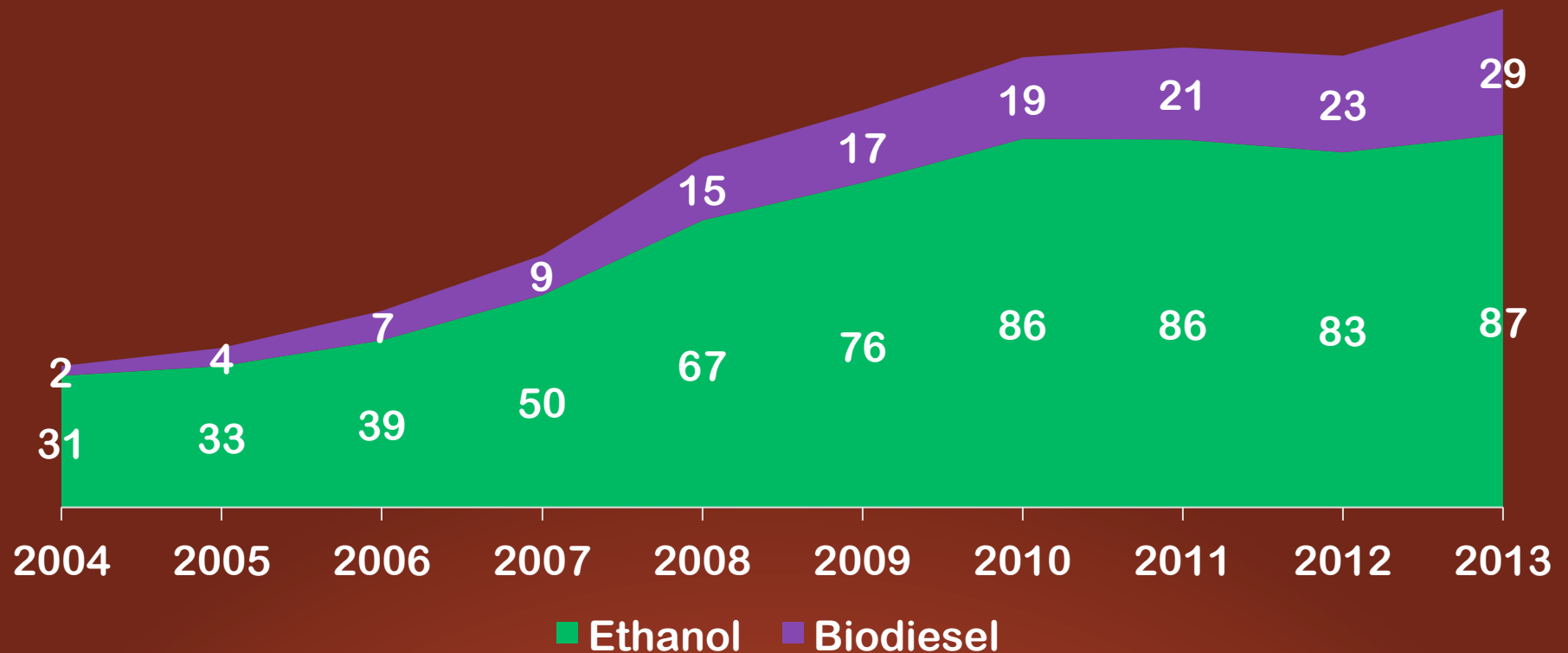
# Global Biofuel Development after 2007/08 Crises

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# Global production of biofuels

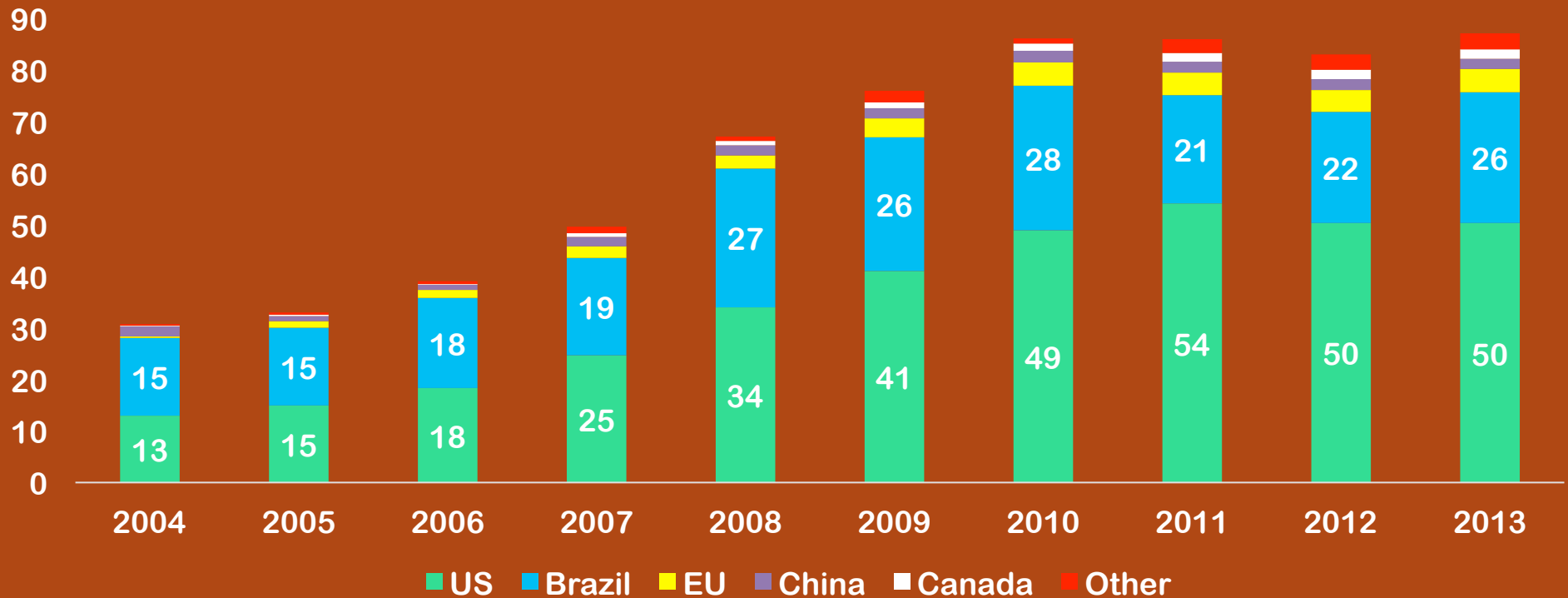
(Billion Liter)



- ❖ Sharp growth between 2007 and 2010 (ethanol production increased with an average rate of 15% per year and biodiesel with 19% per year)
- ❖ Ethanol production remained stagnant since 2010; decreased in 2012 and slightly increased in 2013; similar growth pattern for biodiesel, but sharp increase (30%) in 2013

Source: REN21

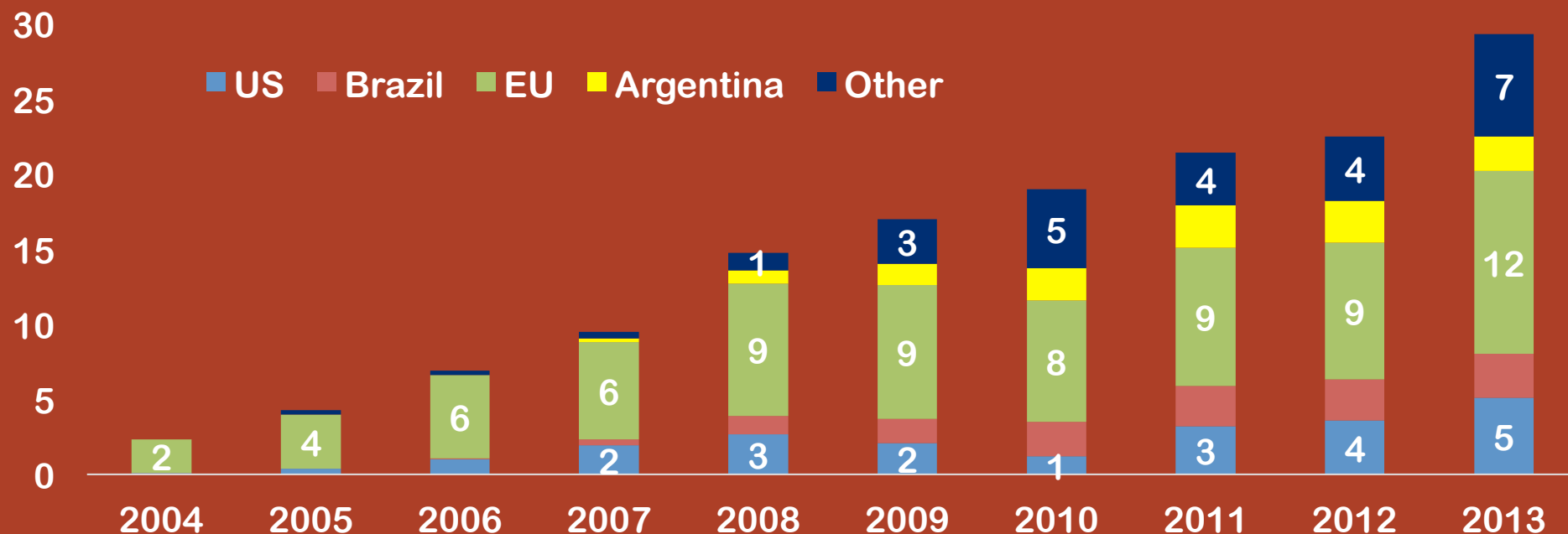
# Historical Production of Ethanol by Country (Billion Liter)



- ❖ There are two major producers (Brazil and US) with more than 85% of the global production
- ❖ United States remained the largest producer since 2005

Source: REN21

# Historical Production of Biodiesel by Country (Billion Liter)



- ❖ Production of biodiesel is more distributed geographically than that of ethanol
- ❖ European Union remained the largest producer

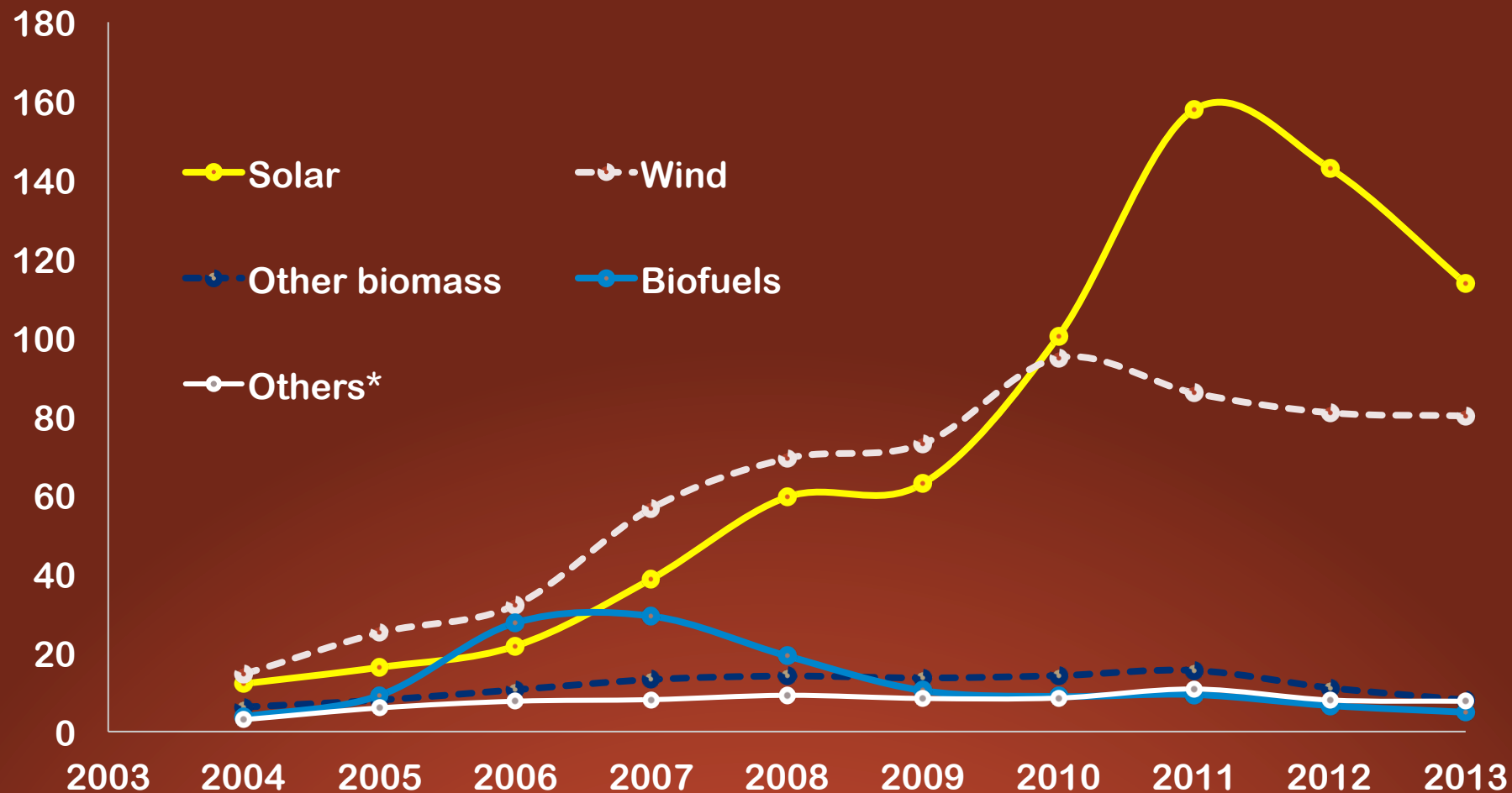
# Global Biofuel Investment (Billion US\$)



- ❖ Biofuel investment peaked in 2007 when global financial crisis started
- ❖ It has sharply dropped since 2007; it is still declining

Source: REN21

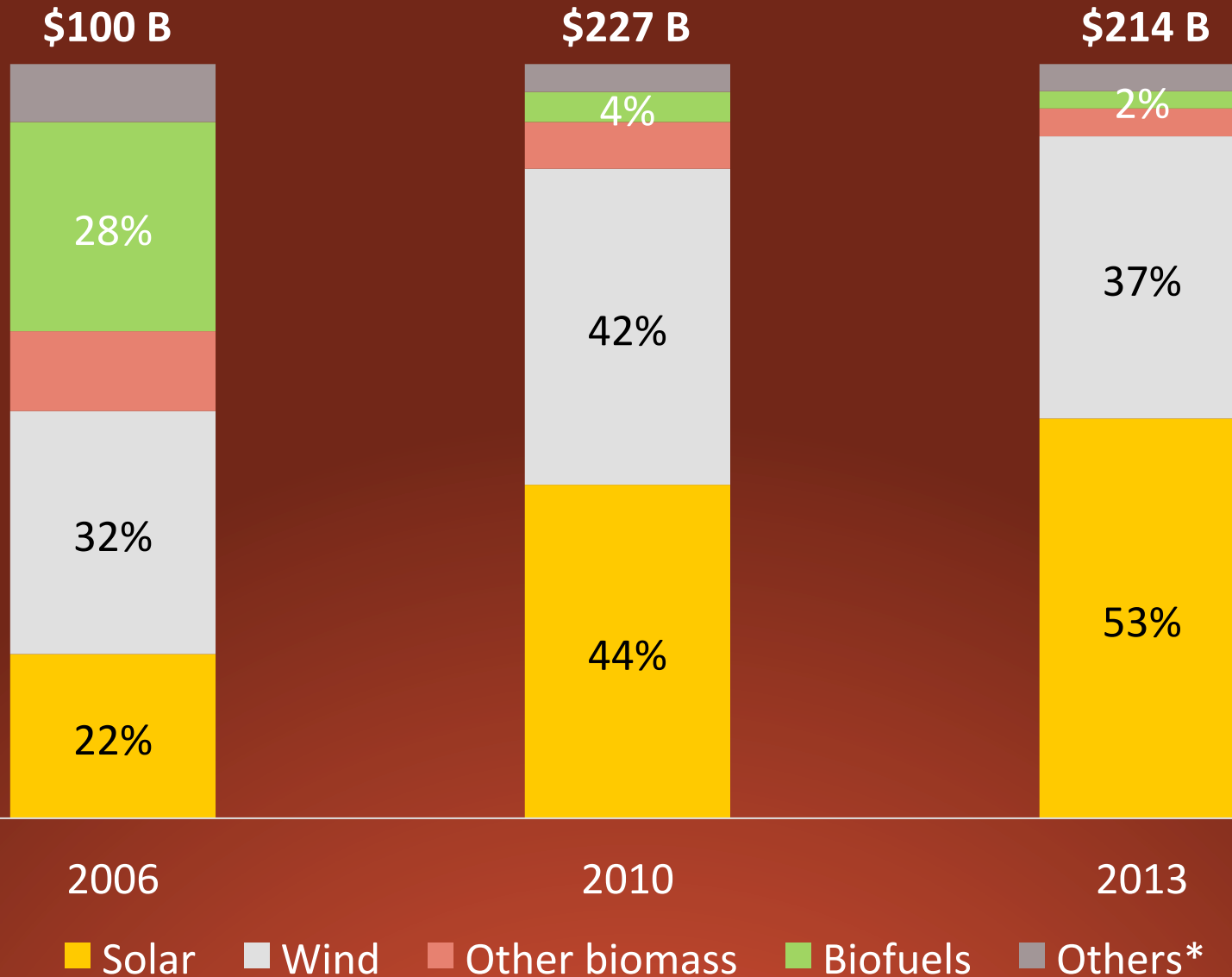
# Biofuels vis-à-vis other renewable Investment (Billion US\$)



Others include small hydro (< 50 MW), geothermal and ocean energy

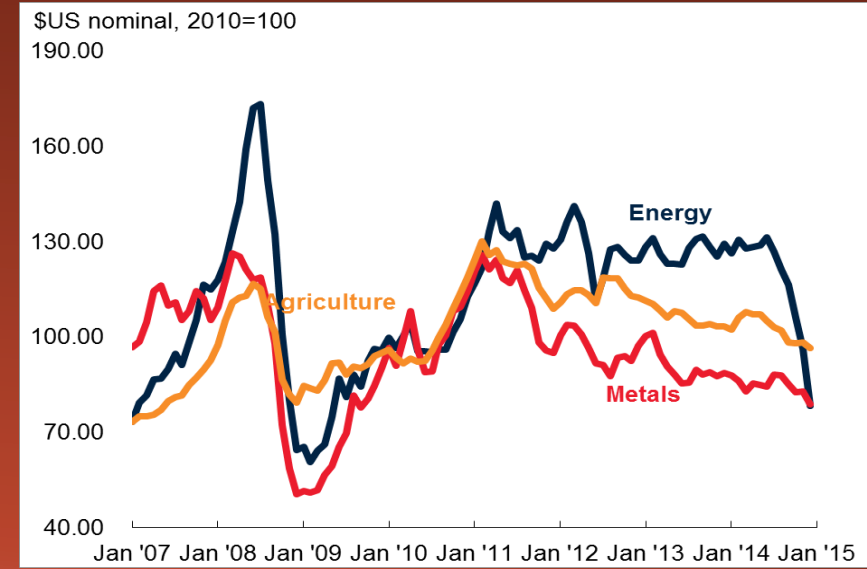
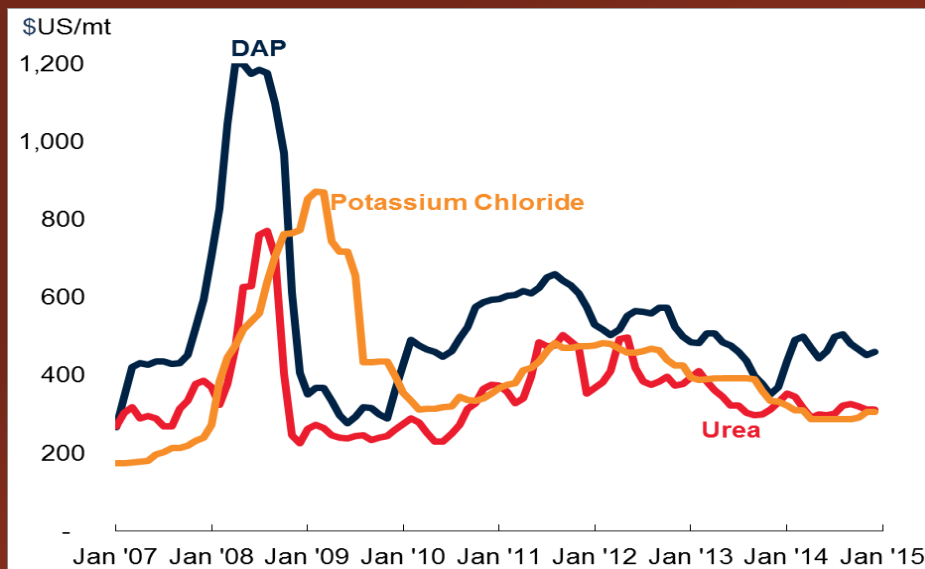
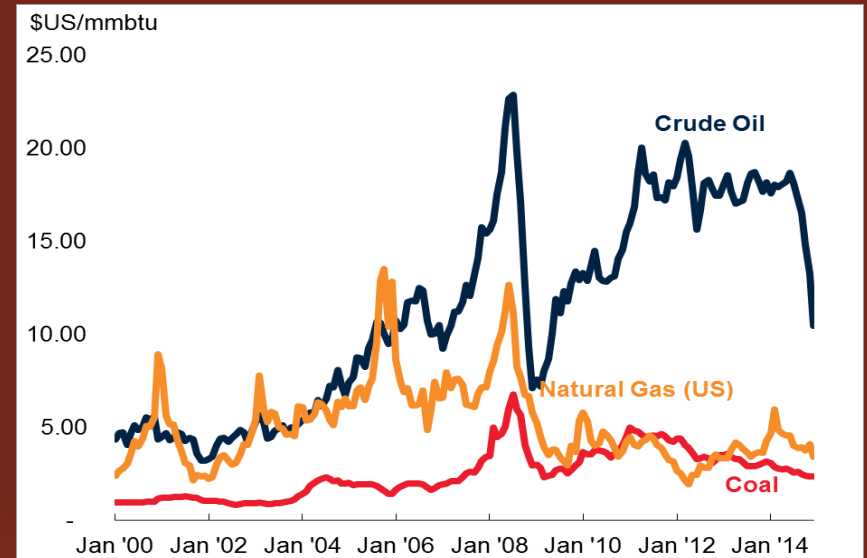
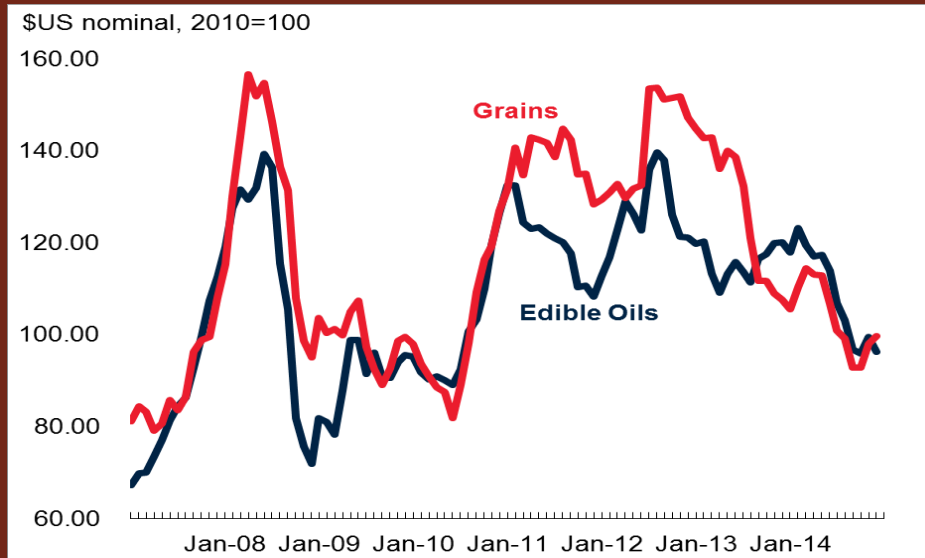
Source: REN21

# Share of Biofuels in Global Renewable Investment



Source: REN21

# Price Trends of inputs to biofuel production



Source: World Bank Commodity Prices Reports



# Factors contributing to slow down the growth of biofuel expansion

- ❖ Fuel vs. food controversy

- ❖ Sustainability criteria

- ❖ Policy factors

  - Expiration or reduction of incentives to 1<sup>st</sup> generation biofuels

- ❖ Failure of second generation biofuels to take off

- ❖ Demand factors

- ❖ Price factors

- ❖ Other factors

# Food vs. Fuel Controversy

- ❖ The food vs. fuel controversy ignited by the 2007-08 food crisis did affect the expansion of biofuel industry
  - It created enough confusion to policy makers, incentives to grain based biofuels are reduced or withdrawn
    - Several countries banned use of grains to produce biofuels
    - Some countries restricted use of agricultural lands to produce biofuel feedstocks

# Sustainability criteria

- ❖ Questions have been raised on the main objective of biofuel expansion – climate change mitigation
- ❖ The sustainability criteria (including the indirect land-use effect) discouraged expansion of crop based biofuel production capacity
  - **EU revised its 2009 renewable energy directive limiting the contribution of crop based biofuels to only half of its target (5%)**

# Policy Factors

- ❖ Policy incentives for the first generation biofuels have been expired or lowered
  - ❖ Global production of ethanol is very sensitive to support policies in the two largest ethanol producers (United States and Brazil)
    - In US, federal tax credits expired and RFS was reduced for the first time since it was enacted in 2005 (blending mandate was dropped from 54 to 49 billion liters)
    - Brazil reduced ethanol mandate from 24% to 18/20% in 2011, in response to poor sugarcane yields and higher sugar prices

# Advanced Biofuels not Taking off Yet

❖ Advanced or second generation biofuels are not taking off yet

▪ **Total global capacity is below 200 million gallons**

Mossi & Ghisolfi Group (Crescentino, Northwestern Italy ) - 13 mgal/y

GranBio (Brazil) – 21.6 mgal/y

DuPont (Nevada, Iowa) - 30 mgal/y

Abengoa (Hugoton, Kansas) - 25 mgal/y

POET-DSM (Emmetsburg, Iowa) – 25 mgal/y

BlueFire Ethanol (Fulton, MS) – 19 mgal/y

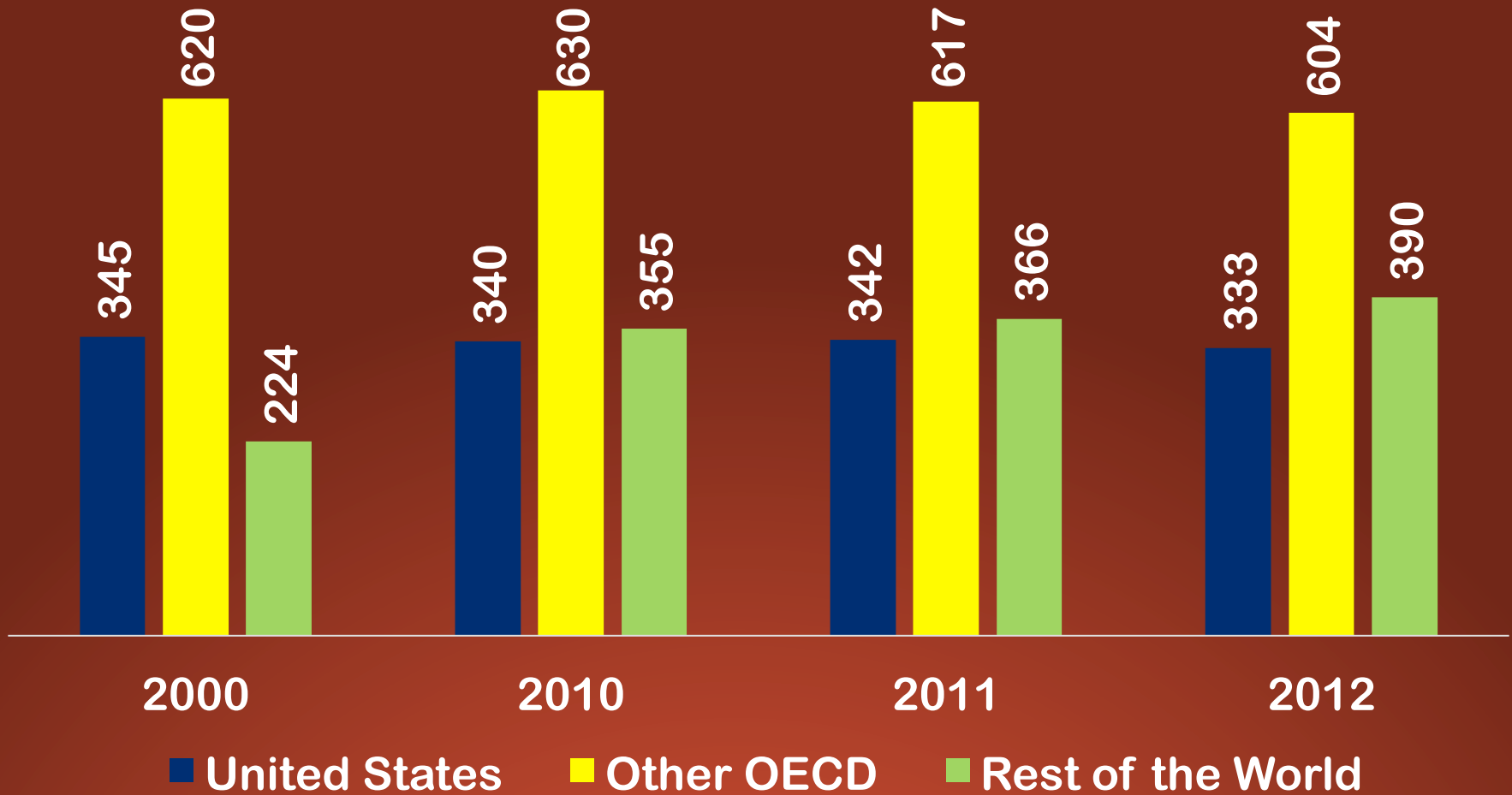
Fulcrum (Reno, NV), 10 mgal/y

Mascoma (Kinross, MI), 20 mgal/y

▪ **In the US, cellulosic targets have been continuously reduced (from 500 million gallons to 10.5 million gallons in 2012; 1 billion gallons to 6 million gallons in August 2013, then to 0.81 million gallons in 2014)**

# Demand Factor (1/2)

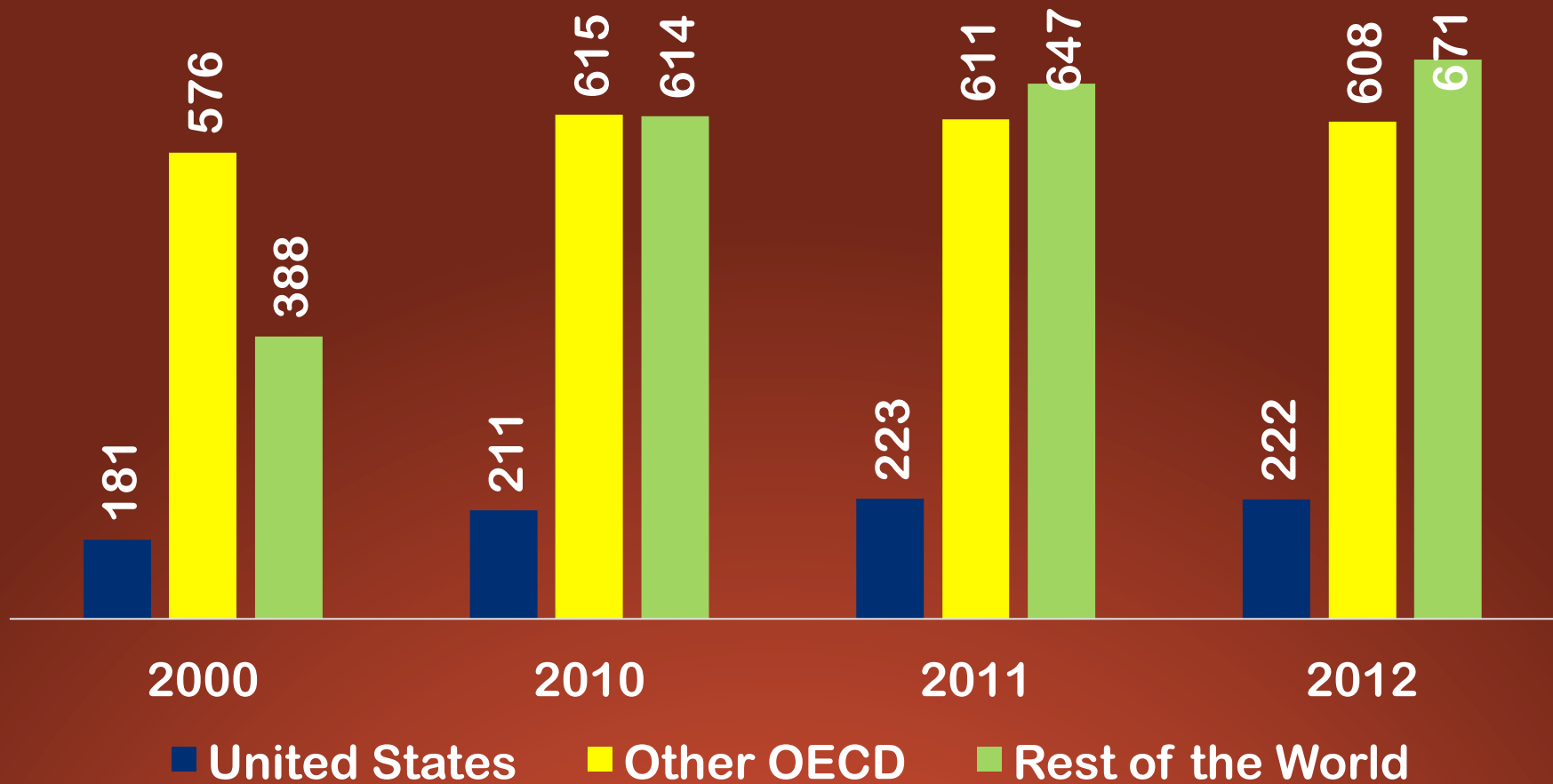
Gasoline Demand (Million Tonnes)



Source: IEA

# Demand Factor (2/2)

## Diesel Demand (Million Tonnes)

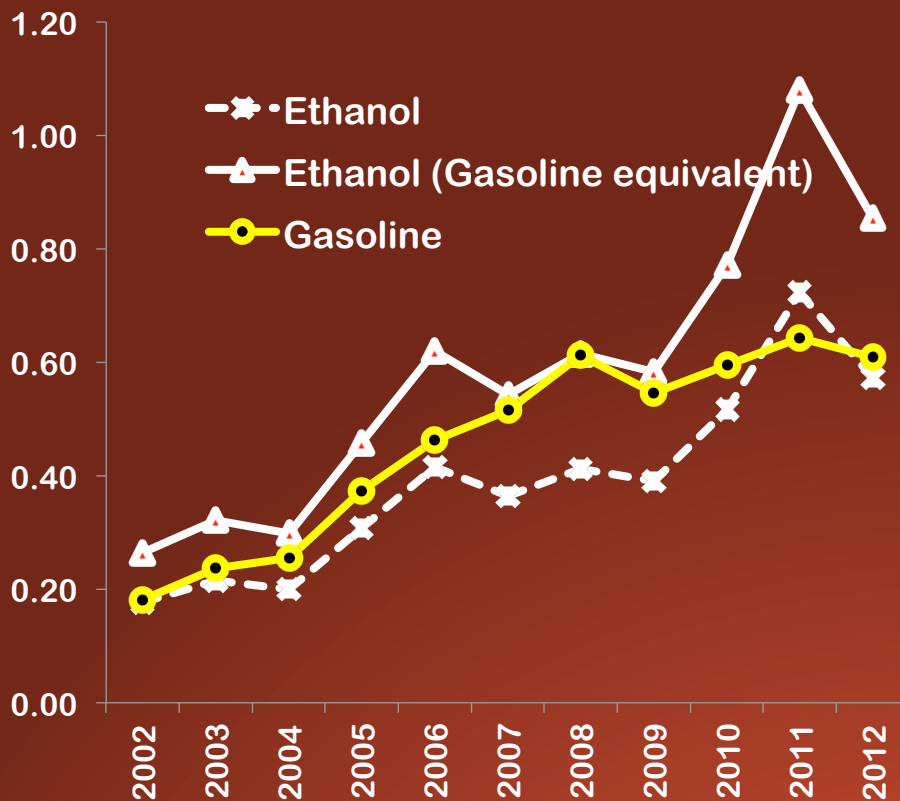


Source: IEA

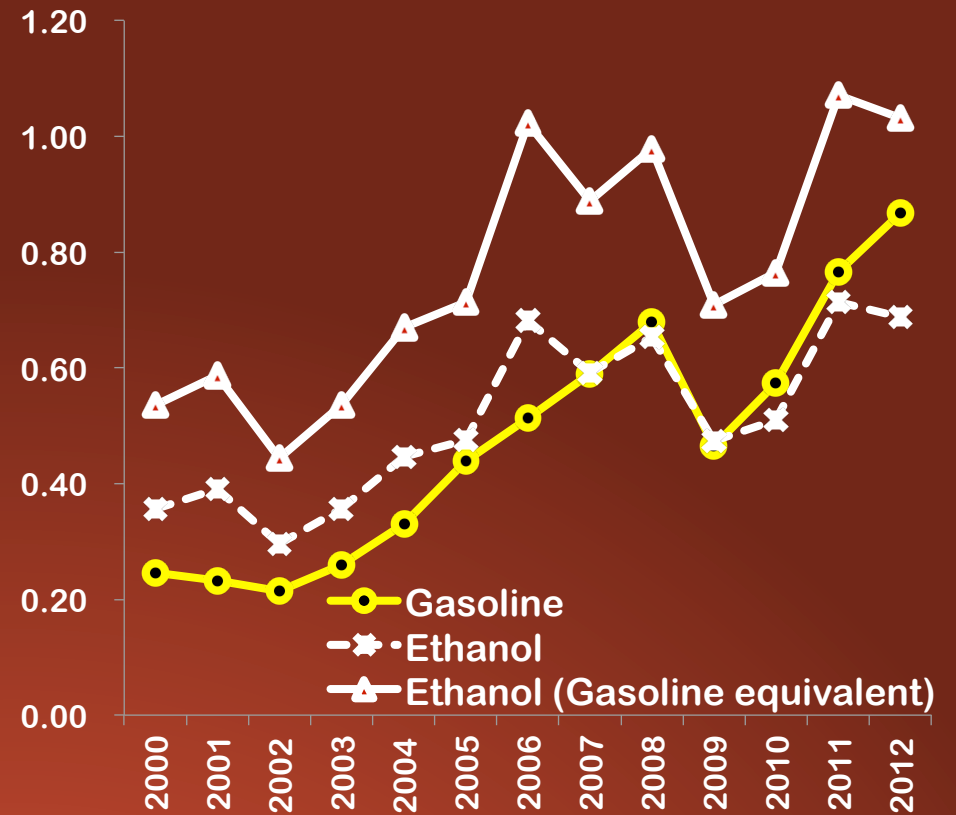
# Price Factor (1/2)

Unit: US\$/Liter

## Brazil sugarcane ethanol



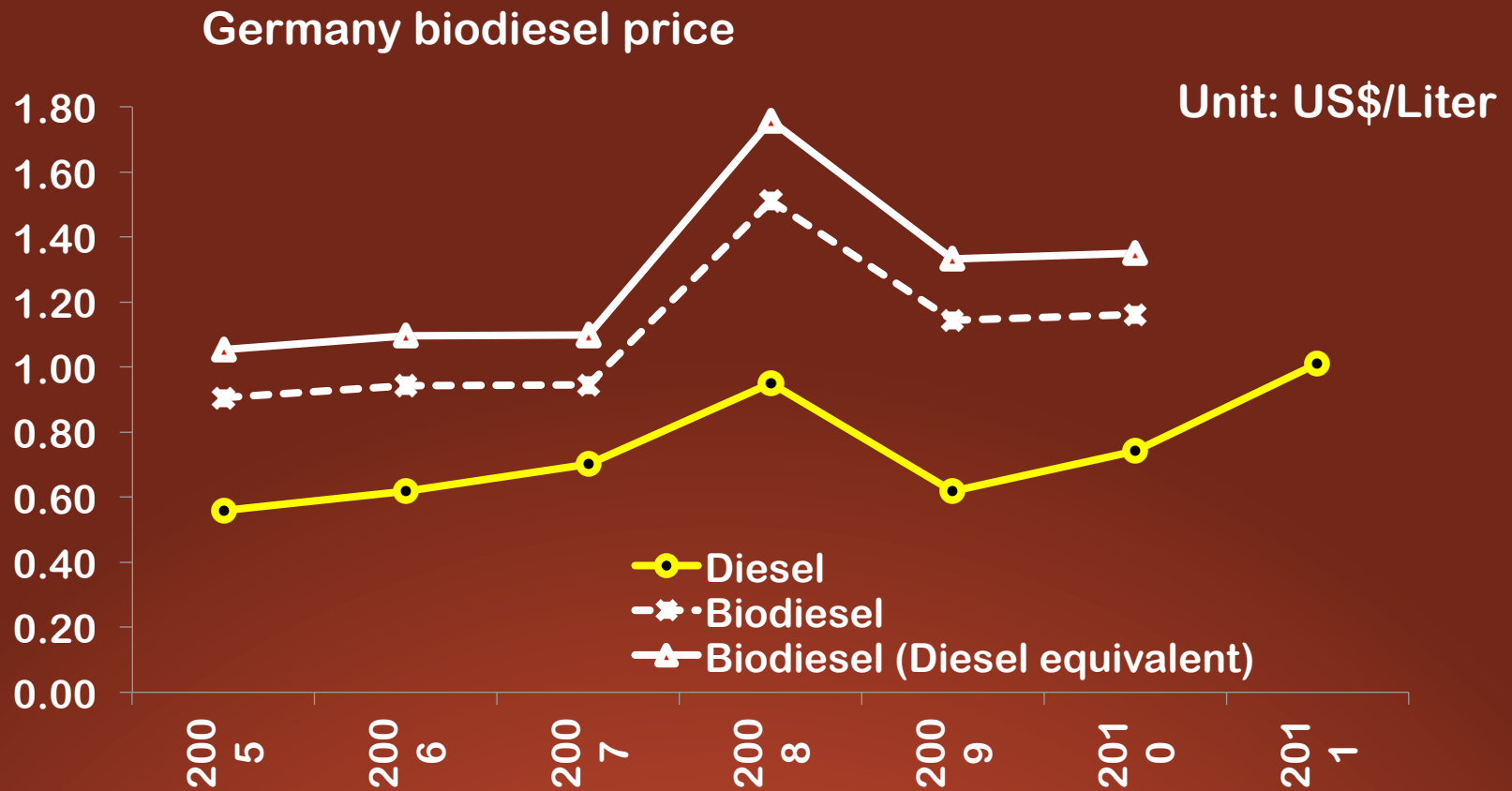
## US corn ethanol



Source: Timilsina, GR (2013). Biofuels in the Long-run Global Energy Supply Mix for Transportation, Philosophical Transactions of the Royal Society A. December 2013, pp. 372-392.



# Price Factor (2/2)



Source: Timilsina, GR (2013). Biofuels in the Long-run Global Energy Supply Mix for Transportation, Philosophical Transactions of the Royal Society A. December 2013, pp. 372-392.

# Other Factors

- ❖ Some biofuels, particularly jatropha based biodiesel, which looked promising earlier, turned out to be disappointing
- ❖ Electric vehicles and CNG are getting more and more competitive than biofuels for transportation
- ❖ The current surprising drop of oil price could add uncertainty to further development of biofuels

# Conclusions

- ❖ Unlike the other renewable energy sources (e.g., wind, solar), which are expanding rapidly, expansion of biofuels has been slowed down
- ❖ Fuel vs. food controversy and the sustainability criteria have discouraged the potential investors to crop based biofuels
- ❖ Cost disadvantage would remain as the key barrier, particularly to second generation biofuels to many years to come
- ❖ Decreasing total demand for gasoline and diesel in the developed world might have also contributed to slow growth of biofuels
- ❖ Recent drop in oil prices could add uncertainty to the future expansion of biofuels