Biofuel, the Rural Economy, and Farm Structure

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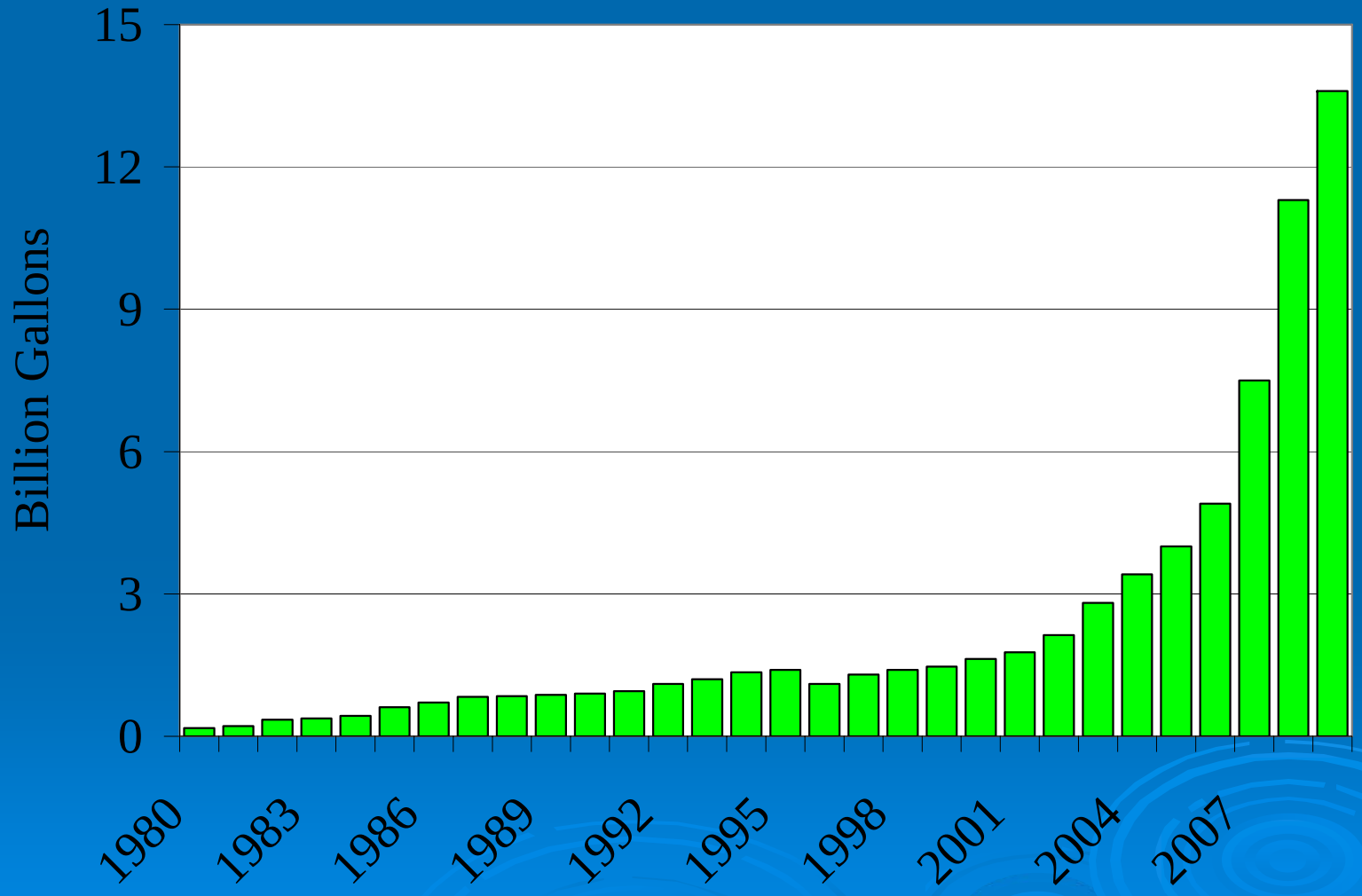
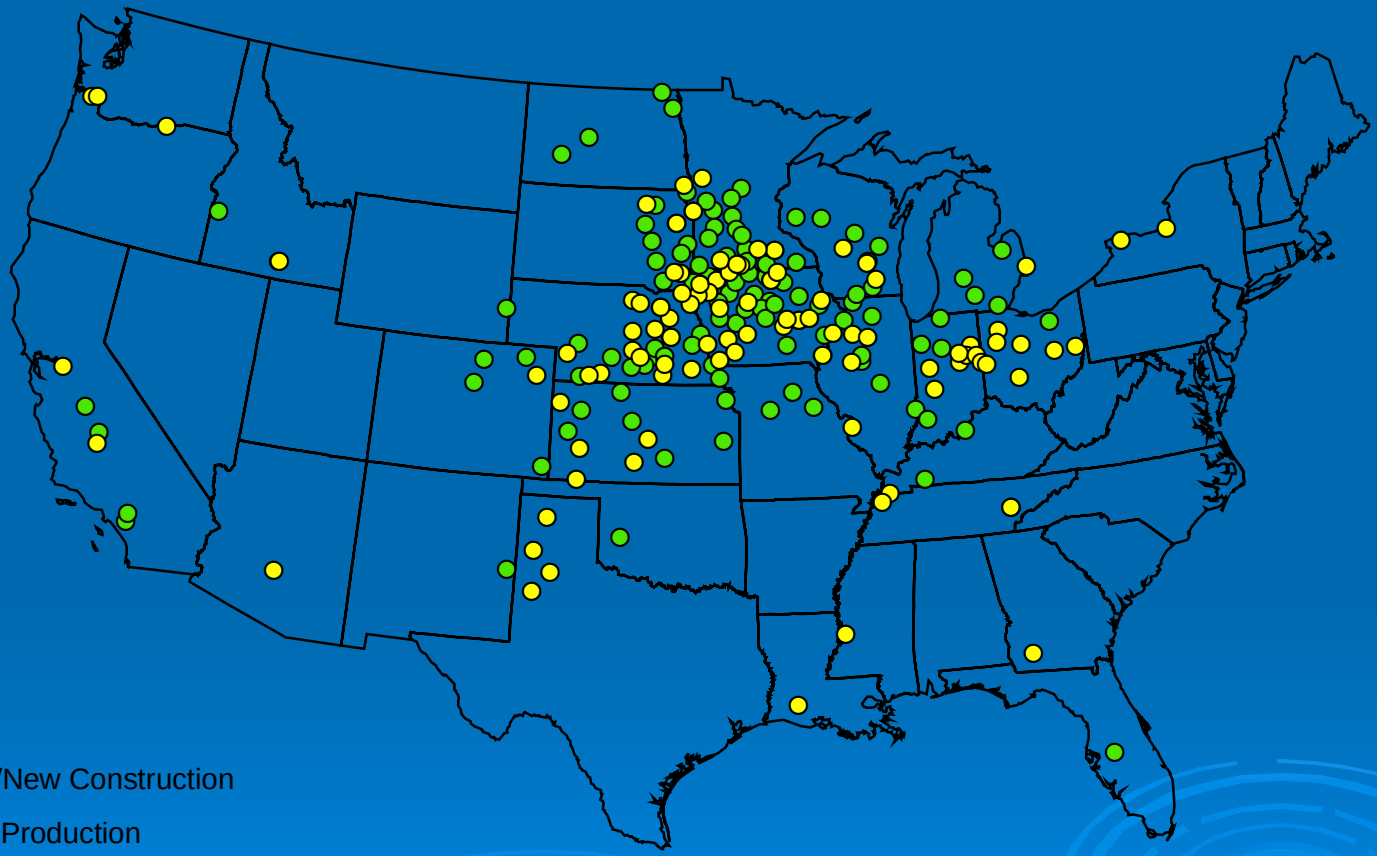
The Ethanol Explosion



Ethanol Plants



- Expansions/New Construction
- Currently in Production

Drivers of Feedstock Price

- Processor's break-even price for corn:

$$P_{Corn} = 2.80 \times (P_G * .667 + T_{Credit} + V_O + V_{DDG} - C_K - C_O)$$

- $60 per bbl price of crude oil translates into $2.07/gallon price of gasoline ($100 bbl oil is $3.45 P_G and $2.30 P_E)
- Sensitivity to current tax credit of $0.51/gallon ($1.40/bu)
- Long Run Breakeven Corn Price: $4/bu at $60/bbl

Implications for agricultural commodities prices and food-fuel debate

- Corn and biomass price driven by ethanol price driven by oil price
- Growing global demand for crude oil and livestock products
- Crop and livestock products competing for same domestic and global cropland base – all prices increase (Searchinger, et al)
- Higher commodity prices capitalized into cropland values so growing opportunity cost of land, including land producing biomass

Is biomass ethanol the answer?

- Biomass Processor's WTP:

$$P_{Biomass} = (P_{Gas}*E_V + T_{Credit} + V_O + V_{BP} - C_K - C_V - C_F - C_E)Y_E$$

$$P_{Biomass} = MWTP$$

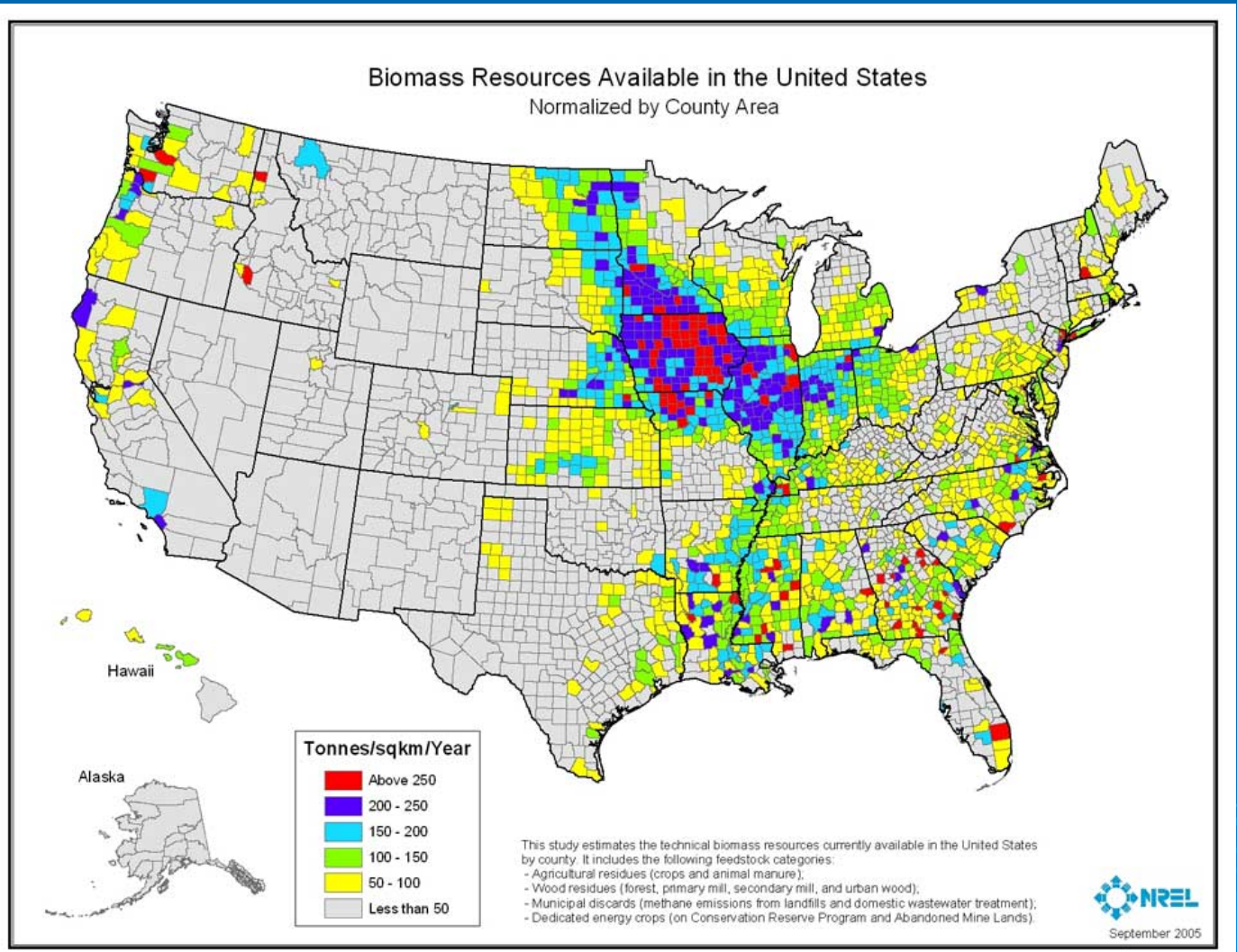
- Biomass Supplier's WTA:

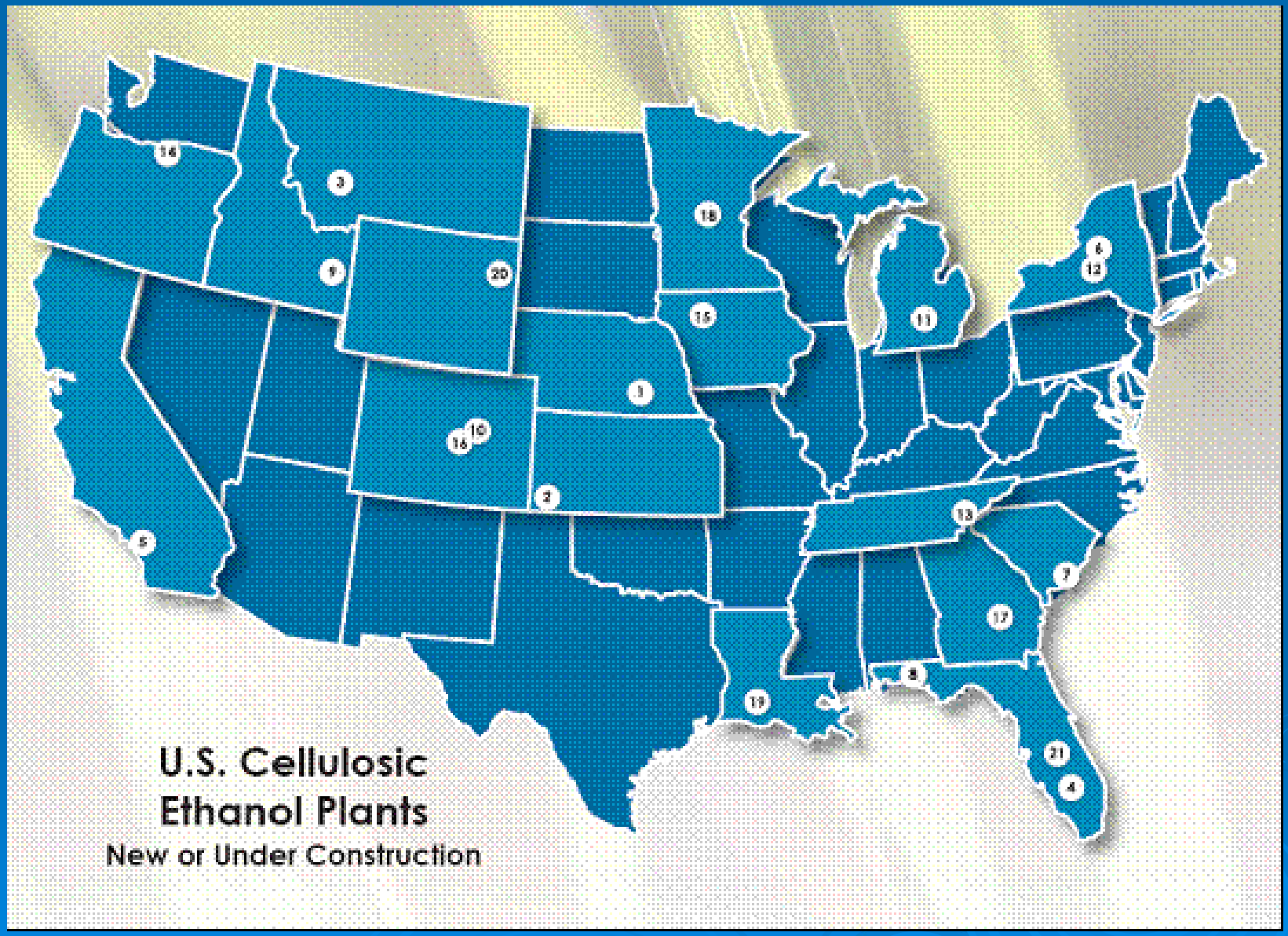
$$P_{SBiomass} = C_{NR} + C_{HM} + C_S + C_T*D + (C_{ES} + C_{Opp})/Y_B$$

$$P_{SBiomass} = MWTA$$

- Break-even market equilibrium: MWTP = MWTA

Midwest the Saudi Arabia of Biomass

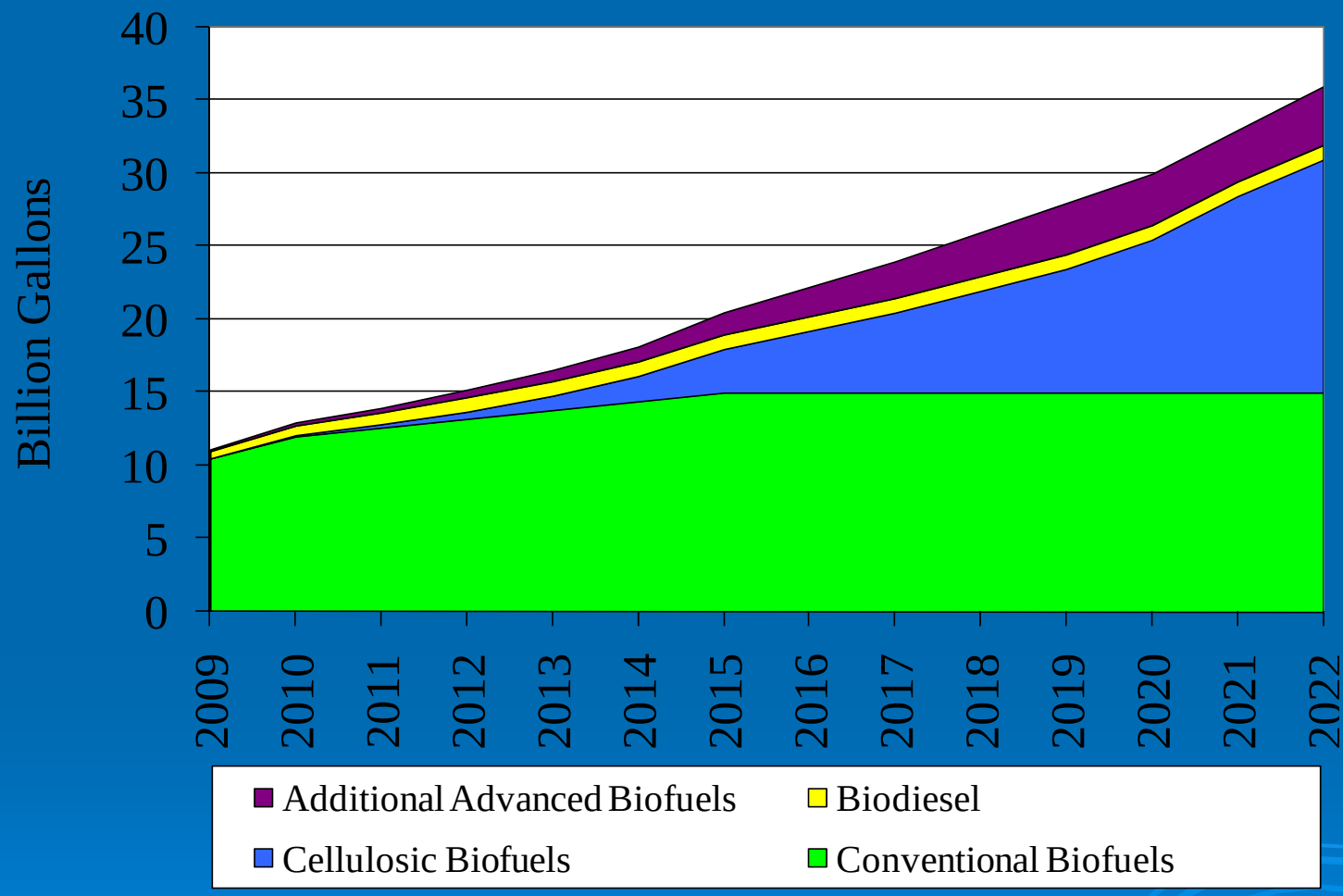



U.S. Cellulosic
Ethanol Plants
New or Under Construction

Current Biomass Ethanol Economics

- Maximum breakeven processor price for biomass is $60/ton with $60/bbl oil; $150/dry ton @ $120/bbl
- Minimum farmer price for delivered biomass is $50-175/ton
- Harvest, transport, and storage costs are $45-100/ton
- Establishment costs are $0-275+/acre
- Opportunity cost of corn land for biomass crop is $200-400/acre
- What is implicit cost/ton of carbon reduced by expanding biofuel?
- Is biofuel an efficient solution to reducing carbon and GHG emissions?

Renewable Fuels Standard



Source: Renewable Fuels Association

Biofuel Policy Approach to Carbon Problem

Impacts of 2007 Energy Independence and Security Act

- 15B gal corn ethanol by 2016 and 20+B gal biomass ethanol by 2022
- Know where we want to go with biomass, residue, and waste biofuels, but how we get there is uncertain
- Life-cycle analyses for new facilities and feedstock create uncertainties
- Implementation of new RFS (e.g., use of waivers) will be critical
- Role of tax credits and tariffs becomes less important

Biofuel Policy Approach to Carbon Problem

- **Impact of 2008 Food, Conservation and Energy Act**
  - Lowers VEETC to $.45/gal
  - Establishes $1.01 credit for biomass ethanol
  - Provides $45/ton payment to producers for HST of biomass to processing plants

Impacts on Rural America of Ethanol Industry?

- Initial plant size was smaller because of capital subsidies leveled playing field and rents captured by local investors: 5 - 40M gal
- Newer plants in era of high oil prices: 50-100M and 275M gal
- Labor-output ratios: 2.0L/1M gal to 0.4L/1M gallons
- Local ownership share decreasing with plant size
- Marginal rural economy impacts of corn ethanol expansion decreasing

Implications of evolving industry structure for the rural economy

- Use a national IO (IMPLAN) model for projections
- Compare 2007 to 2016 CARD baseline ($60/bbl constrained) and LR ($70/bbl unconstrained) equilibrium solutions; 15B and 29B gal ethanol (Searchinger, et al)
- Recognize limitations of IO approach, but indicative of direction and livestock tradeoffs of expansion
- Too early to speculate on biomass feedstock impacts

Estimated Economic Impacts of U.S. Ethanol Industry

	Solutions	Direct	Indirect	Induced	Total
Output ($Billions)	2007 Crop	22.9	13.6	3.1	39.6
	2016 Crop $60/bbl	27.6	16.9	.43	47.9
	2016 Crop $70/bbl	69.0	34.5	6.0	109.7
Value Added ($ Millions)	2007 Crop	669	958	1,495	3,122
	2016 Crop $60/bbl	970	1,185	1,800	3,955
	2016 Crop $70/bbl	973	2,414	3,164	6,551
Labor Income ($ Millions)	2007 Crop	369	503	712	1,590
	2016 Crop $60/bbl	502	623	1,020	2,151
	2016 Crop $70/bbl	837	1,284	1,791	3,913
Jobs (Thousands)	2007 Crop	6.6	8.5	18.6	33.7
	2016 Crop $60/bbl	9.0	11.6	26.7	47.2
	2016 Crop $70/bbl	15.0	23.6	45.8	84.4

Composite rural economic impacts

- 2007-2016 baseline crop ($60/bbl oil constrained)
  - **E** direct and total VA $0.3B and $0.8B
  - **LP** direct and total VA $1.6B and $15.2B
  - **E** direct and total labor income $0.1B and $0.6B
  - **LP** direct and total labor income $1.3B and $9.2B
  - **E** direct and total jobs 2.4K and 13.5K
  - **LP** direct and total jobs 34.3K and 268.4K
- 2016 baseline crop ($60/bbl) – LRE crop ($70/bbl)
  - **E** direct and total VA $0.0B and $2.6B
  - **LP** direct and total VA -$0.4B and -$4.2B
  - **E** direct and total labor income $0.3B and $1.8B
  - **LP** direct and total labor income -$0.4B and -$2.5B
  - **E** direct and total jobs 6.0K and 37.2K
  - **LP** direct and total jobs -9.5K and -74.5K

Biofuels and future farm structure

- Corn Belt commodity agriculture will continue current structural trends
  - Larger commercial farms and less operators
  - Corn stover production will not alter trends
  - Harvest window and HST costs
  - Smaller farms will not be players
  - Integrated farming operations and demand for rural labor?
  - Role of corn and corn stover in long run equation

Biofuels and future farm structure

- Major areas of biomass production (e.g., South, SP, NE, PNW) will focus on large scale, contract production (Epplin)
  - Logistics drive biomass fuels to large scale HST service providers (eg, coops, private)
  - Operating between producer and processor (wheat cutters, hay harvesters, cane sugar)
  - Further concentrate operation of land
  - Storage costs may be prohibitive for some regions and feedstocks

Biofuels and future farm structure

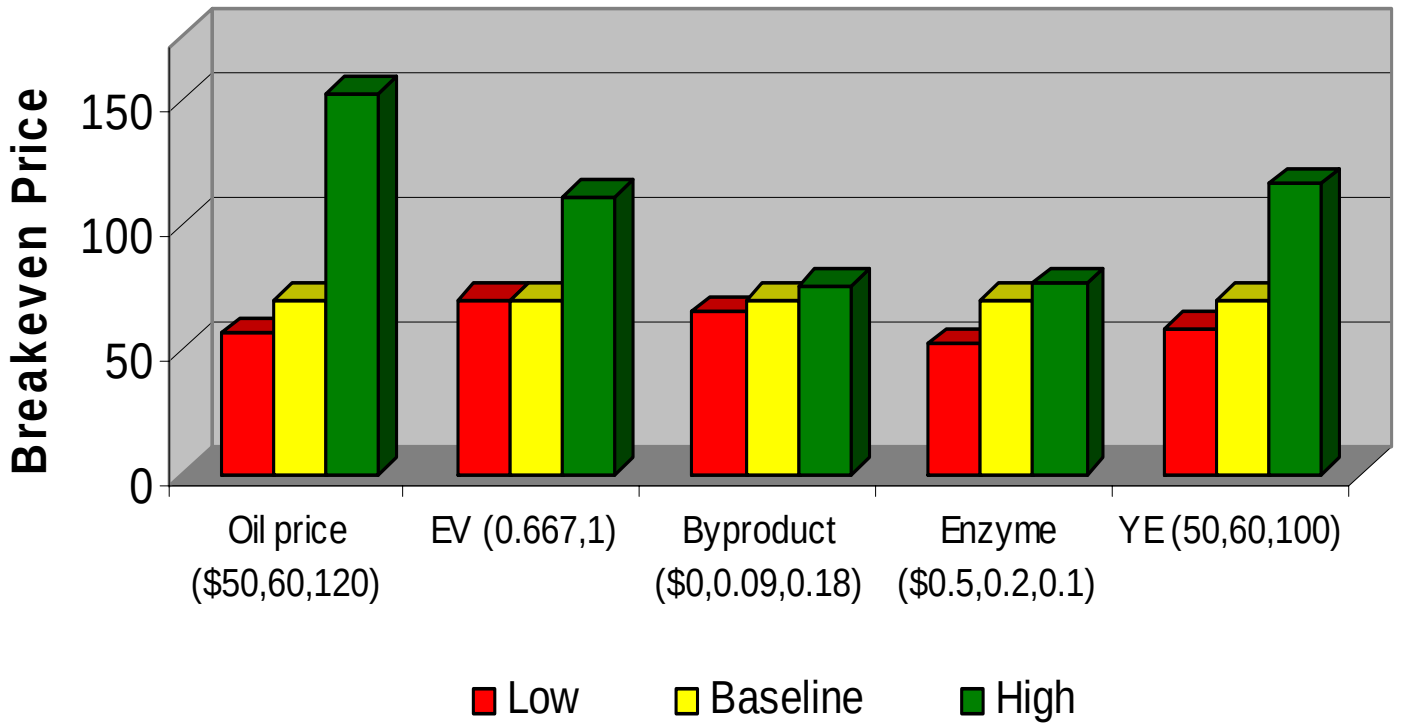
- Processing has scale economies and need 1000-4000 dry tons/day for 25-100M gal/year
  - Possibly use multiple biomass feedstocks
  - Technology will reduce enzyme and processing costs, increase yield, expand byproducts, and change fuel platform
  - Just in time deliveries (2 weeks storage?)
  - Contracting and biofuel plant financing issue

Summary and Conclusions

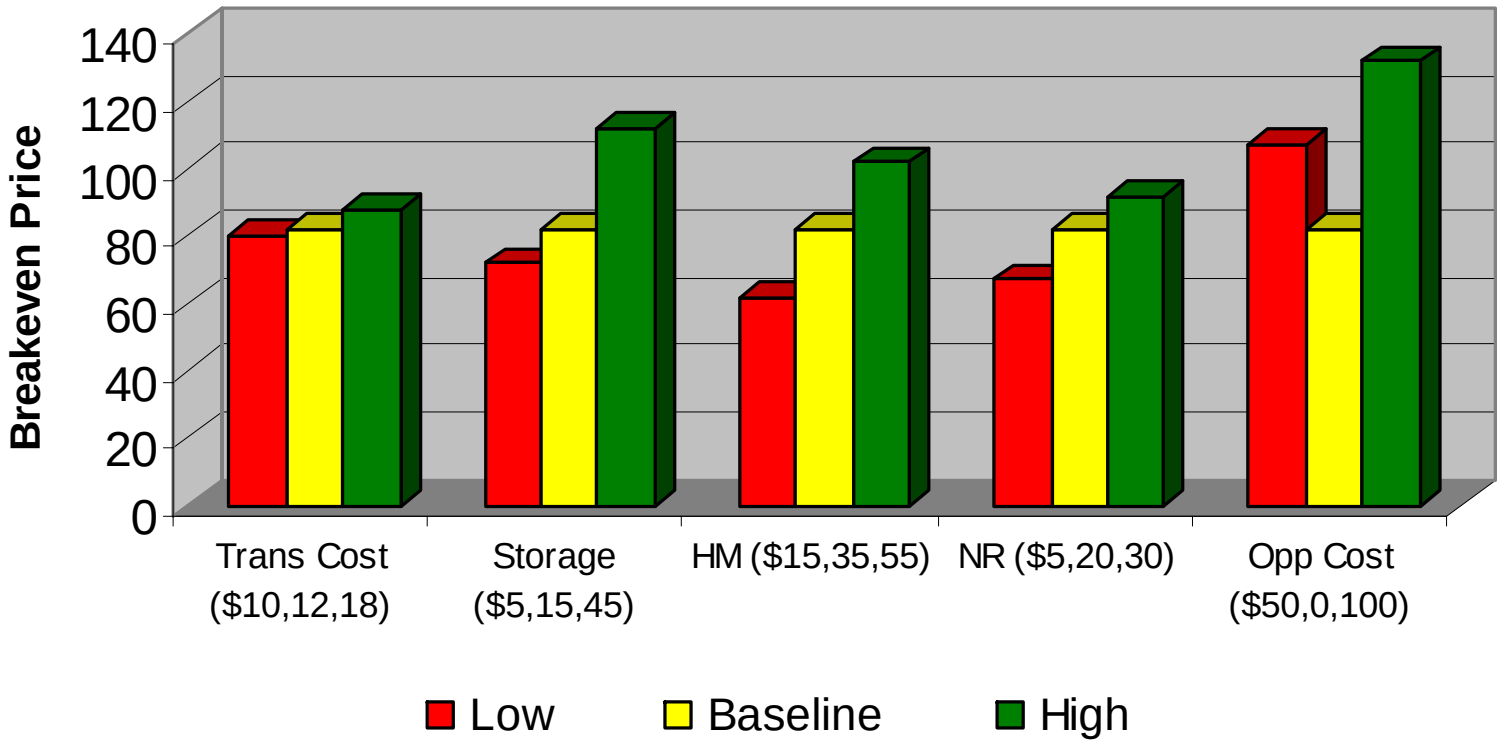
- Ethanol industry structure will continue to evolve as will farm structure
- Ethanol expansion having a impact on the rural economy, but with decreasing marginal impacts over time
- Expansion of corn ethanol above 20B gallons may have negative rural economy impacts
- Is biomass ethanol the answer?
  - MWTP less than MWTA for biomass at 2007 prices
  - Carbon price necessary to sustain a biomass fuel industry
  - Will biomass compete with commodities for cropland?
  - Biomass RFS mandates response regardless of cost
  - Biomass fuels, rural communities, and environment

Thank you!

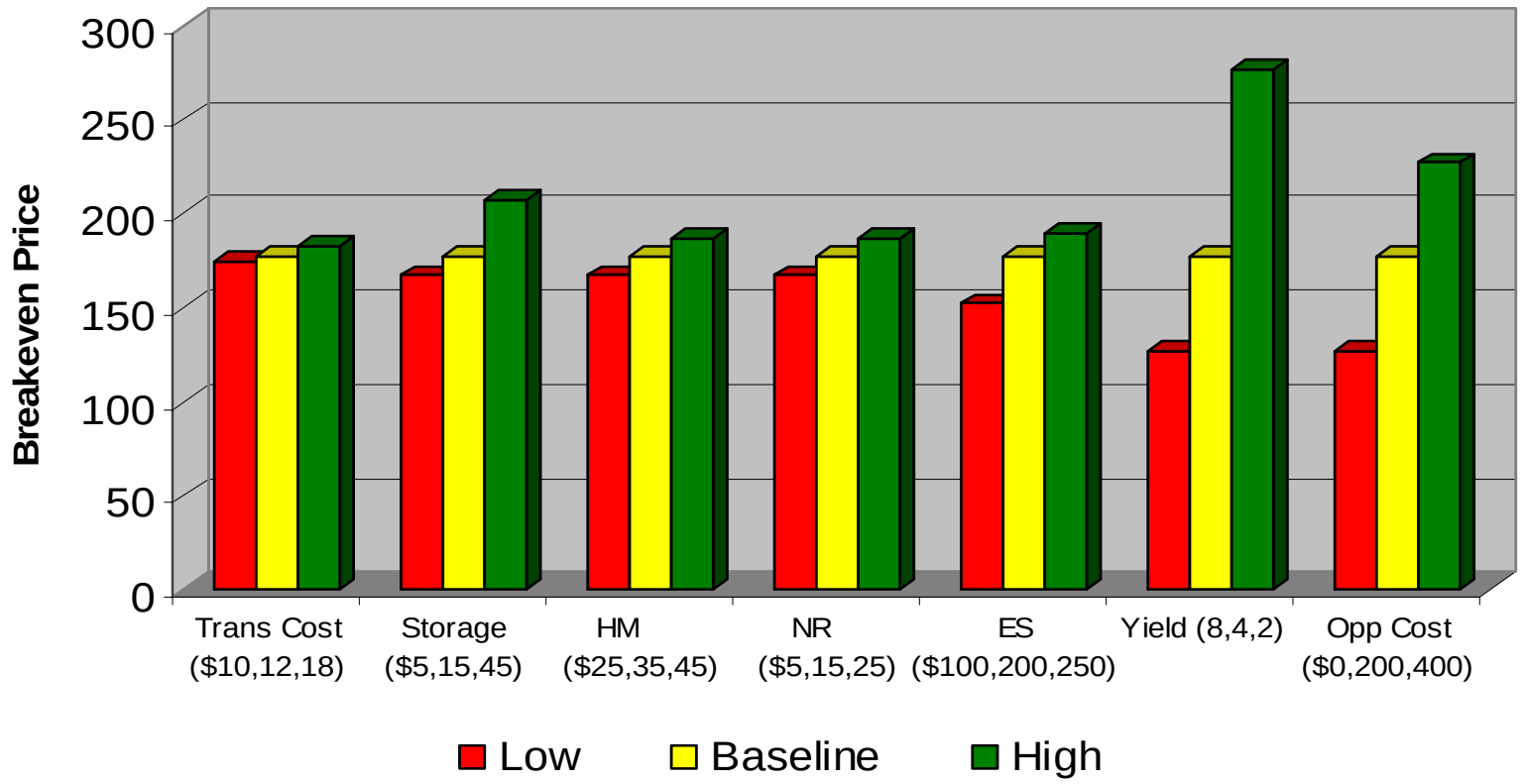
Sensitivity of Biorefinery's MWTP



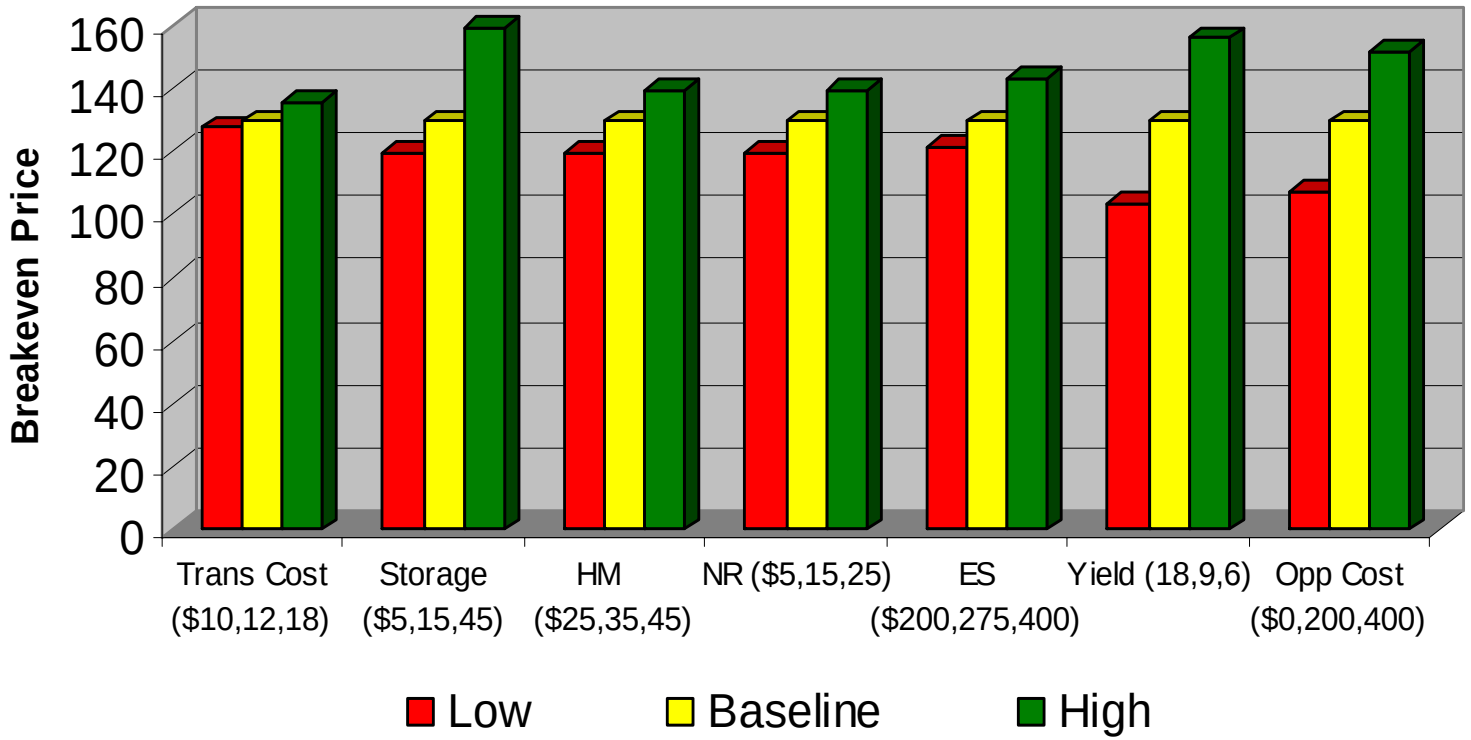
Sensitivity of Corn Stover Supplier's MWTA



Sensitivity of Switchgrass Supplier's MWTA



Sensitivity of Miscanthus Supplier's MWTA



Range of Breakeven Values for Select Parameters

	Corn Stover	Switchgrass	Miscanthus	Woody Biomass
Baseline	$82	$177	$130	$83
C_{opp} = $0	$82	$127	$108	-
C_{opp} = $50	$107	$139.5	$113	-
C_{opp} = $100	$132	$152	$119	-
C_{opp} = $200	$182	$177	$130	-
C_{opp} = $300	$232	$202	$141	-
C_{opp} = $400	$282	$227	$152	-
C_{HM} = $15	$62	$157	$110	$63
C_{HM} = $25	$72	$167	$120	$73
C_{HM} = $35	$82	$177	$130	$83
C_{HM} = $45	$92	$187	$140	$93
C_{HM} = $55	$102	$197	$150	$103
C_{HM} = $65	$112	$207	$160	$113
D = 10	$73	$168	$122	$69.50
D = 20	$76	$171	$124	$74
D = 30	$79	$174	$127	$78.50
D = 40	$82	$177	$130	$83
D = 50	$85	$180	$133	$87.50
D = 60	$88	$183	$136	$92
D = 70	$91	$186	$139	$96.50