

Responses to Cost Target Questions: How do you define cost competitive for cellulosic ethanol? What fuel is this pathway competing with? When do you see fuel from this pathway entering the market?

1. Cost competitive with gasoline in the marketplace.
2. Gasoline
3. 2012 on a small scale (50-100M gallons)

1. Farmer profit - yield
2. Petroleum [?]
3. 2012

1. \$1.50/gallon
2. Ag residues, wood
3. 2010 - 2012; future of farmer incentives; farm bill is a huge opportunity to drive this feedstock; 08 - high fiber

1. \$4/gallon; more if environmental benefits recognized; petroleum
2. 2018

1. Cost competitive is lower cost than gasoline.
2. Gasoline
3. At the latest, 2012 pilot, 2015 commercial

Return is greater than cost + support
2012

1. Bought in marketplace to meet a specified need - tax structure to pay for the environmental cost of fossil
2. Grain ethanol/gasoline
3. 2015

Competitive with long-term oil/petroleum projections (\$40-50/barrel) & CTL CCS farm gate price/policy supports; other revenue; competitive with other crop choices
plant gate with ag residues 3-5 years

Regional competitiveness with conventional fuels
Gasoline
2012 - 2015

Cost vs. sugarcane/Brazil
corn & cane, economics
2010

\$1.07 in 03 dollars
EtOH/gasoline
15 - 20

1. Equivalent or \$/mile driven basis (incl. Policy)
2. All alternatives vehicle systems
3. 2015

Production cost = corn ethanol (2012)/gasoline (2020)
Competition = corn ethanol (2012)/gasoline (2020)
Market penetration - 2020

1. Profit to the farmer; returns beyond production costs; price of oil drives the system
2. Not sure fuel is the correct question; herbaceous competes with other sources (residues) and other uses (livestock, wildlife)
3. Next decade

1. Multi Feed!!! Competitive drivers include crop residues or other immediately available biomass directly
2. Enables standard ag resources for ethanol 1st -> value -> competes for production acres - 2012-2015

Price of gasoline/crude oil
2010

1. Based on land cost - acres, feedgrains [?] (regional)
2. Gasoline
3. 3-5 years

1. Cost competitive to starch based ethanol
2. Starch based ethanol & gasoline - gas first, ethanol 2nd
3. 2015 - herbaceous crop utilization (full scale); 2012 pilot

*Each participant responded to the questions above and posted their cards (with answers) on the sticky wall. They were not asked to prioritize or reach a consensus.

	Genetics	Agronomic Systems	Feedstock Production	Harvesting/Handling/Storage	Transport	Blending	Cross Cutting	Conversion	Mixed Sugars
Barriers	Improved genetics & breeding technology & delivery of value-added traits (15)	Sustainability - residue required? Wildlife, erosion, soil quality (5)	Farm Bill policy (9)	Storage of adequate quantities of dry biomass (7)	Densification (6)			Efficient conversion technology, engineering & construction services (6)	Full integration of ethanol process energy efficiency; robust C5 organisms; lower pretreatment cost; better enzymatic systems; better understanding of feedstock structures (7)
	Genetics/agronomy beyond switch (3)	Incorporation of energy crops into existing farming operations (3)	Managing producer risks, incl lender education, who provides capital funds, etc. (9)	Harvest systems for major crop types (4)	Cost of transport (2)			Funding support for demonstration plants - 10% (3)	Value-Added Products
	Improving feedstock by genetics - prods/processing (2)	Lack of trials showing how switchgrass compares to others (2)	Seed supply; rate of establishment - annuals; engineering/construction (6)		Roads or railroads for transport (0)			Processing technology & cost analysis (0)	Syngas
	Lack of knowledge (mol knowledge of plants - miscanthus - need genome info) (2)	Coordination of agricultural opps with processing opps (1)	Feedstock cost & availability: yield, collection costs, farmer's return/lack of subsidies; timeline to ramp up production (2)		Transportation & storage of light products (non dense); bale density/package (0)				Heat & Power
	Feedstock yield/acre (2)	Inadequate regional/state 25 mi radius feedstock production capabilities; inadequate ag research institute capacity to address need; supporting science - pathology & endomology (1)	Other uses for grasses/CRP (2)						
	Transgene containment (1)	Limited harvest window; need for long term storage; very limited scale-up, planting sites, & information; Need for specific harvest systems for major herbaceous crop types (0)	Currently no farm support (uncompetitive w/ farm program opps); land rent production/yield CRP modification (1)						
	Technologies for rapid insertion of multiple transgenes (1)	How does the industry capture value? Will seed companies rely on frequent sales of seed? Will they own the product? Can we get the volume w/o Federal price support. (0)	Ecological constraints: mono cultures - seed needs structures; ecosystem-habitat loss; Policies for widespread herbaceous development: education, CoOps, partnerships (0)						
	Genetics tie to end use (what do we need? Technical fees?) (1)	Local ownership [?] cellulosic high capital cost barrier to local ownership; Danes & other European countries have good examples large scale (0)	Finding the 55 million acres of the Billion Ton Study (0)						
	Lack of transformation systems for herbaceous perennials (1)		Propagation of miscanthus (& switchgrass) if sterile forms are used (0)						
	Feedstock quality (conversion yield) (1)		Low yields of switchgrass (0)						
	Conversion process modifications - utilize in plants hydrolase (1)		Competition for land resources; knowledge of crop cultures (local); implications for soil erosion; existing commodity policy (0)						
	Higher yields; co-product value (protein extraction); feedstock/processing logistics (1)		Regional/state production capacity info; research capacity for bioenergy production w/in states (0)						
	Deregulation of GMO/new species (0)								
	Advanced Breeding Technologies (0)								
Assuming a demand function, crop development -> trait delivery; adaptation to regional cropping systems (0)									
Synergies/Conflicts	Genetic transformations of corn stover to improve quality for cellulosic ethanol production likely to apply to perennial grasses: miscanthus & switchgrass		Mixed feedstocks (herbaceous and woody or herbaceous and ag res) - seasonally and storage method synergies	Feedstock supply systems will be similar to crop residues	Processing & Infrastructure similar to all pathways			Similar conversion process with ag res and woody	
			Ag res, woody crop, herbaceous - yearly cycle	Feedstock types similar to residues	Investing in combustion/gasification now will provide infrastructure that can be used later			Distillers grain cellulose to ZTO [?]	

* Bolded terms represent each stage of the selected priority pathway route.

*Barrier responses are listed in order of priority based on votes. The number after each in () represents the number of votes (dots).

*Synergies/Conflicts were not prioritized.

	Genetics	Agronomic Systems	Feedstock Production	Harvesting/Handling	Storage	Transport	Blending	Cross Cutting	Conversion	Mixed Sugars
R&D	Transformation systems & genomic information needed now for new lines in 2020-2030	Production research in each main agro-ecosystem of USA & their subunits	Business & economic plans for growers		Logistics: storage, handling, processing (10)			Quantify environmental impacts - soil, water, wildlife, energy & carbon balance	Improvement of conversion efficiency (8)	Value-Added Products
	Genetics transformation, nomics, mapping- public & private programs (15)	Nation wide trial information for switchgrasses, miscanthus, etc.	Economics - marketing, business plans, ag capital & famer ownership					LCAs on entire WTWs sustainability (7)	Increase energy efficiency of conversion processes for both biological & gasification routes (0)	Syngas
	ID additional energy crops	Local assessment of production potential within 25 - 50 mi. radius	Risk management - econ, ecology, sustainability - cross cutting (9)							Heat & Power
	R&D for energy crop production - best practice for simple mixtures, yield improvements mixtures	Regional experimental design - GIS based units (11)	Continued 5 Carbon: continued enzyme flexibility toward variable feedstock (0)							
	Get beyond switchgrass - other species, mixtures (9)	Low input/fertilizer practice for perennials - minimize fertilizer & water inputs								
	Perennial Crop Genetics - Transgenic & Breeding (4)	Environmental & wildlife cost/benefit analysis (seek value for land shift)								
	Sequence miscanthus (3)	Sustainability of large energy crop acreage (soil, water)								Fractionation
	Ag/genomic R&D on C sequestration capacity/soil health - mixtures, best practices, root improvements (2)	Sustainability of feedstock - how much can you remove? (6)							Food, feed, fiber, food - F4-sustainability processing interface (2)	
	Continued agronomic & genomic research to improve plant constituents for fuel processing/conversion (0)	Develop regional science teams - genetics, pathology, entomology, physiology (4)								Gasification (2)
	Genetic improvement (0)	Pesticide control issues (0)								
Policy	GMO rules of engagement established (2)	Minor use pesticide policy issues (1)	Risk management policy for producers	Support for development of distributed infrastructure - smaller processing plants; rural development (3)				Farm Bill funding for research (in biofuels/biomass)	Loan guarantees for conversion plants (3)	
			Government backed insurance for feedstock price					Authorize & appropriate R&D - DOE, USDA, DOT, EPA, etc., Sun Grant (12)		
			USDA establish perennial biomass crops as key focus							
			Production subsidies/insurance							
			Policy decision - Do we want energy or subsidized hunting or both? (20)							
			Create new land category: bioenergy reserve, with tax incentive link to decrease in defense spending							
			2007 Farm Policy support for perennial crops (CRP authorization? BRP new program or practice?)							
			Expand Title 9 2007 Farm Bill (local ownership)							
			Working Land Policy - dedicated biomass energy crop) equip-pilot							
			Working Land Policy for dedicated energy crops in 2007 Farm Bill (17)							
			Farm Bill funding - demonstrations projects for biomass production (11)							
			Energy crops become focused agriculture activity - USDA state level with farmers on board (5)							
			Incentives for crops (1)							
		Extensive farmer training					Deployment strategies (eg. Education and extension)			

R&D & Policy			By 2010, fund land grant experiment stations to initiate regional R&D & extension for perennial herbaceous energy crops					Workforce development - education/training (6)		
			Field stations in key growing areas by 2007 - all growing areas by 2012							
			Assess state of HEC research within 1 year through regional partnerships; implement priority crop development programs based on assessment (10)							

* Colored blocks represent individual responses that were grouped together as one R&D or policy need due to similarities. When group members voted, the votes for each individual need within a group were totaled to count towards the combined needs as a whole.

* R&D and policy need responses are listed in order of priority based on votes. The number after each in () represents the number of votes (dots).

* Bolded terms represent each stage of the selected priority pathway route.

Genomics, Genetics, & Transgenics	Identify Additional Energy Crops	Land Assessment Production Potential	Farm Bill
Major national funding for breeding centers	Screen species, breeding, agronomic management	Regional within state: infrastructure support, operating, personnel	Risk management funding
Development of breeder training	Big bluestem, miscanthus, phalaris, cordgrass - refer to SE regional report for more options	Integration of Federal databases [on land characterization and production potential]	Working land approach
Development of improved populations for species for specific regions	Annuals, forage sorghum, & forage maize for biomass		Points for energy crops under CSP
Coordination between conversion & breeding & agronomic	Genomics of miscanthus (I.e. genome sequencing)		Use equipment to drive sustainability (water quality, conservation)
Rebuild compositional analysis of biomass workforce	Seed distribution system of miscanthus		Research & education funding
Genetic transformation systems for energy crops	Trials of miscanthus including fertile (seeded) forms		Energy Title
Develop genetic confinement technology for forage grasses			Separate biomass reserve under title 9
			Dedicated cellulose biomass crop
			Land rent payment
			Demonstration project funding
			CRP Approach
			Share establishment costs
			Develop message & distribute to community to convey to Congress
			Research & education under title 9 - USD REC, land grants; 9011-SGI

* Bold headings represent simplified versions of some priority needs identified by the group.

* The group decided to add more "meat" to the needs for each priority need. Not every priority need was addressed in this exercise due to lack of time.

*Text in [] represents text I added for clarification, not text that was on the original card.

Federal Role
USDA/ARS: Germplasm maintenance and collection
USDA/CSREES: Land Grant, Extension, and education
USDA/ARS: Long-term high risk research; national need for a plant disease database
NAS: Surveys of energy crops
USDA/RD: Infrastructure funding
USDA/OCE: Procurement, education
USDA/ARS: Genome databases
DOE: Genome sequence
Genetics, Pathology, Entymology
Importation/collection of germplasm
Agronomic systems
Feedstock production
Partnership to moving the farm community ahead to be a stable supplier of energy crops (I.e. through extension service, state agencies, land grant universities)
New funding under Hatch directed to renewable energy
NSF
CSREES, National Research Initiative
Deregulation of new plant species (state role)
Sequencing of herbaceous perennial crops (DOE)
Land Availability (DOD)
Sequencing of microbes in soil (DOE)
Matching funds to industry for technology development (DOE)
Training (USDA, Land Grant)
Storage, distribution - Region specific R&D should be through land grants due to regionality of crops/issues
Long-term directed funds needs to be placed on feedstock R&D (10 year blocks); grants/annual competitive solicitations won't work
What agency is the coordinator of the Federal effort in this area? Numerous parallel plans/efforts.
Link with international R&D @ EU, etc. Learn from international R&D efforts.
OSTP coordinates

*This was a brainstorm list posted on a flip chart.