Infrastructure
August 1, 2006

INFRASTRUCTURE PATHWAY

Question: Identify the basic elements of an infrastructure pathway.

Method: Participants were divided into six groups and discussed the elements of the pathway, writing one element per card. Each group posted and presented their elements. The group discussed what each element in the pathway should look like. The group reached a general consensus on a pathway (see following diagram) but agreed they need more than 10 minutes to develop a pathway.

General Comments

- Need to look at the bigger picture and work down to more specific.
- What type of fuel is being looked at, there are a range of biofuels from ethanol to synthetic diesel.
- The group decided to concentrate on ethanol since it is what is known and is cost competitive.
- Ethanol is the only biofuel in production that can be expanded to meet the President's target.
- Government intervention is needed to develop alternative fuels; noting the market place decided on oil over biofuels.
- Government should not be prescribing the solution instead options should be presented. Policies should allow the market to decide the best way.
- Government should not be deciding which fuel to use but instead have end point solutions such as decrease CO_2 then let the producers decide how best to meet the incentive.
- The infrastructure will work itself out as companies decided what to produce.
- Not worth identifying a pathway because it will change over time.

Farm/Forest

- What feedstocks are being considered, is it energy crops or others?
- Harvesting is another element to consider.
- There is no insurance for energy crops and no USDA back program as there is for food crops.
- Assume a diversity of feedstocks; if produced within 100 miles of a processing plant will have diversity in feedstocks.
- Decisions around feedstocks will be based on economies of scale.
- There needs to be some type of assembly place where feedstock is processed into a uniform product, which is then sent to a processing plant.
- It was agreed trucking is the only transportation option from field to plant.

Transportation – Farm/Forest to Pre-Processing/Depot

- More transportation is needed (biomass source to pre-processing/plant) but not sure what type – probably trucks.
- Mode of transportation will be case specific to feedstock and distance.
- Trucks will be used at the initial point of feedstock collection.
- Transportation is an issue of scale or radius from depot, how far does the feedstock need to be shipped.
- If there are more plants this will shorten the distance fuel is transported, where the greatest cost saving will come from.
- Transportation is secondary, more important is cost effectiveness in acquiring the feedstock.
- Timing is an issue: on the East coast, in 2007, there are only a few ethanol plants using mostly local corn. At some point as more plants are built corn is going to be railed in from the mid-west. A plant

built in Maryland will initially use regional feedstock but when it expands will have to get feedstocks from mid-west.

Pre-Processing/Depot

- Does the feedstock go directly to the plant or a pre-processing stage?
- What should be done at the farm to the feedstock before shipping to a plant?
- Do not know what pre-processing looks like – is it done at the farm or someplace else?
- If pre-processing is done on the farm need to consider the farm's infrastructure such as electricity and sewage.
- Not practical to ship feedstock 150 miles to store then ship again. Should be pre-processed at the farm or at a rural co-op.
- Not every farm will have pre-processing ability.
- The depot is a correct step but it needs to be optimized.
- Could eliminate the depot. Feedstocks need to be dried out before going to plant.
- Combine pre-processing/depot. There is no room at processing facility to the handle pre-processing of large quantities of feedstock.
- What does a depot look like? A big unknown. Financial community does not know what it will look like in the future. Financial decisions will determine particular locations, which drives all other considerations in the infrastructure.
- The method will work itself out depending on the needs or demands of the plant.
- A concern or potential problem is seasonal crops which can only be used for part of the year. It creates a storage problem. How to smooth out the seasonality?
- Seasonal crops may not be the solution.

Processing Plant

- Who are we to make decisions about what the infrastructure looks like when plants have yet to be define.
- What is the cost of enzymes?
- Decisions are made based on return on investment (ROI). ROI issues are specific to feedstocks
- Ethanol plants are being financed; financing of ethanol plants is hot today. From the view point of the financial community ethanol is real.
- Financial decisions greatly affect all other matters.
- The investment community will come forward once cellulosic ethanol is competitive.

Transportation - Processing Plant to Terminal/Distribution/Blending

- Dedicated pipeline – ethanol is produced in the middle of the country with the population centers on the coasts. One barrier to the pathway is pipelines.
- When is volume enough to justify a pipeline?
- Transportation has to be broken down by fuels; different fuels require or use different types of transportation.

Terminal/Distribution/Blending

- Co-locate processing points; combine blending and storage.
- Co-location will be a financial decision made by companies.
- Currently there are 30 blends of conventional fuels and will be even more with biofuels. Should not require so many blends.
- Blending and storage occurs at petroleum terminals which are near the population centers.

- Blending assumes the only place ethanol is blended with gasoline is at the terminal but that is not the case.
- Biobutanol is blended before shipped through pipeline.
- Will not be able to rail 60 billion gallons of biofuels; will have to transport by pipeline.

Consumer

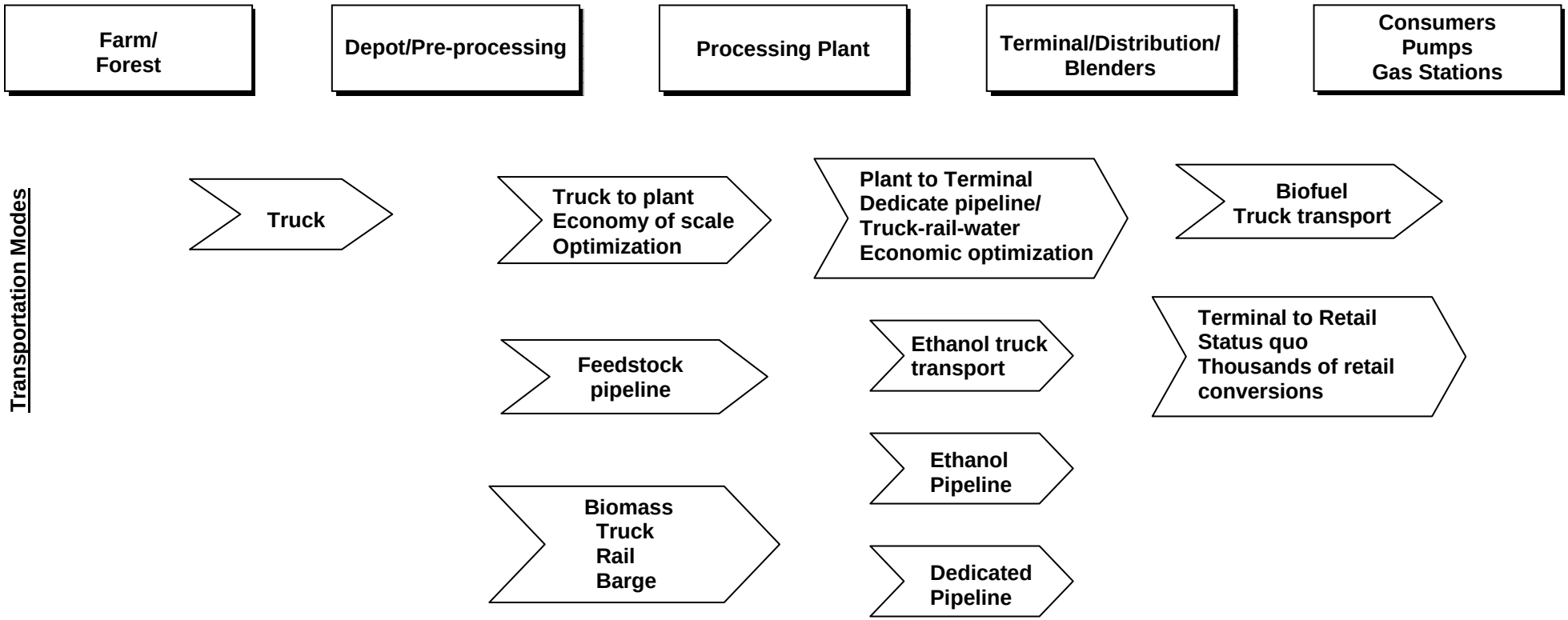
- Users have problems with the infrastructure. Need pumps, if there are not enough pumps consumers cannot get fuel.

Transportation

- What is lowest cost – is it energy or environmental cost?
- The most valuable product transported is fuel; the least valuable is feedstock.
- Should not just focus on truck and rail, do not forget the Mississippi River.
- Within a specific geographic area trucks are most appropriate but as the distance increases such as plant to terminal use different modes of transportation such as pipelines.
- First segment of infrastructure pathway (source to plant) want the distance as short as possible; second segment (plant to consumer) want more distance.
- As move along the infrastructure pathway transportation options increase.
- Railroads, trucks, pipelines, and barge all play a role in infrastructure.
- There are a minimum number of transportation steps; logistics of going point to point.
- When looking at life cycle costs what costs are included for example, if there are too many trucks coming into a plant stirring up a lot of dust causing environmental concerns, is this part of the analysis?

DRAFT

Infrastructure Pathway
Agreed upon elements in the pathway



COST TARGET

Question: From biomass source to conversion, and conversion to consumer, what delivered cost target or cost range do biofuels have to meet in order to be competitive with gasoline and when will the target be met? Why was this cost target or range chosen?

Method: Participants were organized into six groups by table. Three tables were assigned to answer cost target question looking from biomass source to conversion side of the pathway and the other three tables answered the cost target question from conversion to consumer. Answers were posted and discussed by the group.

Biomass Source to Conversion

2012 Cost Target

$30 - $35 per ton 2012
$40/ton dependent on feedstock

- Assuming a yield of 70 gallon per ton to get to $35/ton
- Both targets were backed into by assuming yield of corn based on $1.07 target

- Is this feasible on the agriculture side?
- Have a hard time motivating growers to grow crops if the price is not profitable to them. Cost targets assume current incentives stay in place.

Conversion to Consumer

2012 Cost Target

30% lower than gasoline E-85
A price to the consumer equal to that of gasoline when energy content is figured in (whatever that is)

2030

- The price needs to be 30 percent lower than the price of gasoline.
- If do not maintain the 30 percent ratio people will switch back to gasoline. This has been seen in Brazil. Consumers will figure out how far they can travel on a tank of gas vs. ethanol therefore the price of ethanol has to be priced based on gasoline and has to be lower than 30 percent. Assuming ethanol is a major component it should be priced based on energy equivalent.

- Currently the price of ethanol is the price of gasoline plus 4 or 5 percent but with the credit the price is lower. Today the price of ethanol equivalent to the price of unleaded plus $.45 because of the credit.
- There is the price to the consumer vs. the distributor. The distributor keeps the credit.
- Low blends (E-10) will only get you to 14 billion gallons not the 60 billion target.

BARRIERS, R&D AND POLICY NEEDS

Question: Identify the major barriers which need to be overcome and the timeframe each needs to be address. Identify the R&D needs which have to occur in order to overcome the barriers. Identify the policy needs to have to occur in order to overcome the barriers

Method: Participants remained in their groups and focused on the same segment of the pathway as assigned during the previous question. The group was asked each of the questions one at a time. Each group posted and presented their results with discussions following each presentation. Results of the questions and ensuing discussion are combined in the following table.

Farm/Forest

Time	Barrier	# Dots	R&D Actions	Policy Actions
	Price to producers 2012/Net back to farmer 2007	8		Feedstock price floor (if needed)
	◆ Net back to the farmer needs to be resolved early on then need to work on developing/improving harvesting equipment.			◆ Price floor for feedstock, if necessary, similar to existing USDA programs.
2007	Monocluture mindset	3		Incentives to catalyze or help farmers transition to new crops with lower water needs and other benefits
				Increase support for university-extension outreach for new crops
	◆ We are good at turning corn and soybeans into ethanol and biodiesel. There is an opportunity to diversify the feedstock with cellulostic ethanol. ◆ While there is long-term gain using other sources there will by systematic water problems. ◆ Risk and safety a concern are we trading one for the other. Draughts can change farming in some areas.			
2007	States/regions vary in support of ethanol	1		
	◆ Competing uses for resources will vary by state or region. ◆ Some states/regions support biofuels; some do not. For instance Minnesota supports ethanol.			

Time	Barrier	# Dots	R&D Actions	Policy Actions
2012	Harvesting, drying, pre-processing	12	Processing Standardizing ◆ Drying ◆ Concentrating ◆ Storing	
2012	Development of harvesting equipment	5	Design harvest and processing equipment and storage	Policy to encourage design and production of equipment
2012	Financial risks of changing to non-food crop	4		
	◆ Competition with food crops. What are the risks from changing from food to energy crops?			
2012	Competing uses of biomass feedstocks uncertain	3		
	◆ Availability of raw materials: Can make an estimate of resources but what are the other competing uses for biomass i.e., agricultural residues are used for silage for dairy or nutrients for the next growing season. ◆ Recycling may compete for wood resources.			
2015	Sustainability ◆ Inputs (H2O, fertilizer) ◆ Downstream impacts ◆ Emissions (PM) ◆ Habitat/wildlife ◆ Etc.	24	Increasing yields and conversion – ready plant – sustainably Feedstock plants with low water needs	
	◆ Water resources are a significant issue with irrigation and plants, especially if scaling up production at a farm. ◆ Vast majority of agriculture land is not irrigated; see it more as a regional issue. ◆ Surface water quality and downstream issues.		◆ Increase crop yield and conversion readiness be done sustainably? ◆ Develop plants with low water needs.	
	Unknown availability of raw material	0		

Time	Barrier	# Dots	R&D Actions	Policy Actions
Depot/Pre-Processing				
2012	Bulk density goal of 15 lbs./cubic ft.	6		
	◆ Bulk density of corn needs to be 15 pounds/cubic foot to make the $35 - $40 cost target. ◆ A 70 million gallon plant needs 375,000 cubic feet of feedstock per day equivalent to 75-80 trucks. What plant can handle this?			
	Bulk storage/fire hazard	0		
Processing Plant				
2007	Lack of uniform permitting process delays ⇒ $	4		
	◆ Lack of uniformity in permitting processing plants not only from state to state but from state to federal. Delays in permitting cost money. ◆ Includes local land use issues. ◆ Permitting is a cross-cutting barrier. Needs to be resolved today to help plants being built now.			
2007	Permitting issues for cellulosic ethanol facilities unknown	2		
	◆ Understand corn ethanol plants but do not understand other plants.			

Time	Barrier	# Dots	R&D Actions	Policy Actions
2012	Continuous feedstock stream (purity, quantity)	8	Full life assessment by feedstock type 2007-2012 Life cycle assessments for all pathways, fossil fuels needs and potential for biosubstitutes Investigate alternative uses of biofuel co-products to maxamze ROI	Facilitate development of enzymes with more flexibililty by underwriting some conversion costs and/or providing demonstration projects
			◆ Full life cycle analysis for each feed stock. A cost/ton analysis by feedstock to determine if farmers will provide the feedstock, and if we are we focusing on the right feedstock. ◆ Include CO_2 life cycle analysis and broader sustainability analysis. ◆ Analysis of processing plant's fossil fuel needs and the potential of biomass to power plants. ◆ Some analysis needed of particulate emission and include environmental impact. ◆ All feedstocks and processes need to stand up to life cycle analysis. ◆ Investment in alternative uses of bio-products in order to maximize returns such as injecting waste stream back into the process. ◆ Minimize impact of bi-products i.e., have organisms which chew on end product creating sledges, how to minimize sludge.	◆ Policy supporting or creating incentives to develop enzymes.
2012	Water demand (4:1)	8	Enzymes: Low cost; flexibility of input and output Conversion processs requiring less water	
	◆ Water demand at the processing plant – it takes four gallons of water to produce one gallon of ethanol. This is an issue in Minnesota. ◆ The 4:1 ratio is "peanuts" in the overall life cycle of ethanol but waste water is a different issue. ◆ Plants increase demand on municipal water system. Need conversion process requiring less water; optimize the process.		◆ Standard processing method regardless of feedstock ◆ Research needed to optimize conversion process requiring less water.	

Time	Barrier	# Dots	R&D Actions	Policy Actions
2012	NIMBY Community outreach	3		
	◆ A bigger issue as more plants are built. ◆ Three plants in Pennsylvania and one in Maryland were delayed because locals organized against the construction of the plants, a grass root effort. ◆ Part of outreach and early involvement or early education			
	Different local preferences for system heat	0		
	Construction matertials	0		
	Return on investment (Barrier was struck)			
	◆ Reasonable return to industry – What return on investment does industry want? It is a capital market issue not a plant profitability issue. The margin of loss at a plant can be there for years but it relates back to the original investment and the individual. Return on investment is not a major barrier but should be kept in mind. It is a cross-cutting issue. ◆ Financial community does not understand how cellulosic ethanol is produced. The cellulosic industry is evolving; the financial sector is looking at the industry with the science community and is being investigated.			
Plant to Terminal				
2012	Purity of product in transportation	7		
	◆ Moisture and corrosion are issues. Also, other materials can accumulate during transport.			
Terminal/Distribution/Storage				
2007	Additional storage facilities	1	Determine capatibility of biofuels with storage tanks via accelerated aging	
2012	Not enough rail	17	Investigate increasing throughput of existing rail systems	
	◆ Rail infrastructure insufficient. ◆ No rail where crops are grown so looking at trucks to transport feedstock to plant.		◆ Analysis on efficient utilization of railroads.	

Time	Barrier	# Dots	R&D Actions	Policy Actions
2012	Inland waterway infrastructure 5 year lead time	5		Waterways reconstruction
	◆ A lot is moved by barge but there is not enough capacity on the rivers to handle an increase in volume. ◆ It takes 15 years build new locks. Need to pass the bill now and start building the new locks. ◆ Work on renovating older locks needed to start last year. ◆ Need a five year led time to renovate locks.			◆ Funding for construction of inland waterways.
2015	Availability of pipeline	15	Research ability to use existing pipelines wih biofuels	Accelerated tax write off for capitalization of pipelines
			Identify and develop materials for biofuel pipelines	Right of way for biofuel pipeline ala natural gas
			Materials standards cost reduction	Regional coordination – biofuel “coridors” or “centers” – bio-pipeline incentives
	◆ Moving biofuels and gasoline in the same pipeline. ◆ Need to build pipelines and lay more track. ◆ Issues with right of way when constructing pipelines. ◆ When the volume of biofuels starts increasing the current transportation system will be burdened.		◆ Material standards for pipelines and storage tanks. Look at materials, eventually drive cost down.	◆ Regional coordination for pipeline incentives; need to make vehicles, pumps, etc available at the same time.
	Biofilms in distribution and storage	0		
Consumer/Pumps/Gas Stations				
2007	Educate consumer 2007	5		
	◆ Consumer education is needed now in the use of biofuels in general.			

Time	Barrier	# Dots	R&D Actions	Policy Actions
2012	Retail biofuel pump and storage	9		Incentives for fuel station conversion to biofuels
				Eliminate Stage II vapor recovery requirement on E-85 pumps (EPA/Carb)
				Road tax should be applied to fuels based on energy and fossil carbon content
				◆ Incentives to increase number of pumps. Loan guarantee to station owners for pump conversion. ◆ Small businesses do not want loans but grants or tax incentives; want to minimize out of pocket expenses. ◆ Different funding mechanisms for different biofuels. ◆ UL standards or certification for E-85 pumps. Government can bring parties together to develop standards. ◆ Need EPA to say E-85 pumps do not have to comply with standards.

Cross-Cutting Policy

Incentives for CO_2 output targets/reduce greenhouse gas emissions on life cycle basis (cross-cutting)
◆ Create incentives to decrease CO_2 output and greenhouse gas emissions on a life cycle analysis basis. ◆ Conduct life cycle analysis of CO_2 of biofuel facilities and encourage or create incentives to use biomass over fossil fuels. ◆ Biomass recycles carbon; it is not releasing more carbon into atmosphere unlike fossil fuels in which carbon is dug out of the ground, releasing more carbon into atmosphere. .
Fund all LCA projects
◆ Funding for life cycle analysis; need to know if there will be funding projects.
Credits/incentives that impact entire value proposition/Energy policy that recognizes multiple fuels/approaches
Increase federal funding for research
◆ Increase federal funds for research not just national laboratories but for industrial projects.
Increase tariffs with imported energy
◆ Increase tariffs on imported energy. What if foreign countries started importing feedstocks?