DSM at a glance

- DSM’s Bio-based Products & Services group has formed a joint venture with POET to produce cellulosic ethanol.
  - Project Liberty is the joint venture’s cellulosic demonstration plant in Emmetsburg, Iowa, which held its Grand Opening on September 3\textsuperscript{rd}. It has already produced cellulosic ethanol.
  - POET-DSM will license cellulosic ethanol production technology in the U.S. and around the world to interested producers.
  - Most likely first adopters will be existing grain ethanol plants.
Construction Facts

• 100,000 man hours to design Project LIBERTY
• 200+ vendors and suppliers
• 680 people at peak
• 2 million man hours
• 13 cranes on site at one time
• 45 fork lifts
• 30,000 yards of concrete
• 1500 tons of structural steel
• 20 tanks that are nearly 1 million gallons each
• 200 pumps
• Many miles of pipe
• 29,000 HP
Project LIBERTY
The Value of Cellulosic Ethanol

Economic
● A single plant brings:
   – $200+ million investment.
   – 45 full-time jobs and hundreds of construction jobs.
   – Over $2 million into the community per year before add-on effects.
   – Over $20 million for biomass acquisition a year.

Energy Security
● A single plant replaces:
   – About 1 million barrels of imported oil per year.
   – $50 million in annual foreign spending with US jobs.

Environmental Sustainability
● Cellulosic ethanol must be 60% better than gasoline’s 2005 green house gas emission levels.
● A single plant will reduce over 210,000 tons of CO₂ per year.
● We gather about 25% of the corn stover from the field which has been demonstrated to be long term sustainable.
We need a thousand of these [biorefineries] by 2040 or so. Relying on oil, our economy is stuck to that global marketplace. Biofuels will break the cycle and break that paradigm and allow us an alternative.
Ethanol Plants in Michigan

268 million gallons in production

- **1** Poet Biorefining, Caro:
  - 53 million gallons
  - Operational November 2002

- **2** The Andersons Albion Ethanol, LLC, Albion:
  - 55 million gallons
  - Re-opened Summer 2009

- **3** Carbon Green BioEnergy, Lake Odessa:
  - 50 million gallons
  - Operational August 2006

- **4** Green Plains Renewable Energy, Blissfield:
  - 60 million gallons
  - Operational March 2007

- **5** Marysville Ethanol, LLC, Marysville:
  - 50 million gallons
  - Operational October 2007

- **6** Mascoma, Chippewa County:
  - 40 million gallons
  - Woody-Biomass Cellulosic

**Plants in Production**

**Plants Under Construction**
What if Michigan’s five corn ethanol plants added cellulosic ethanol?

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Liberty</th>
<th>Michigan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct jobs</td>
<td>45</td>
<td>225</td>
</tr>
<tr>
<td>Indirect Jobs</td>
<td>180</td>
<td>900</td>
</tr>
<tr>
<td>Construction Jobs</td>
<td>200+</td>
<td>1,000+</td>
</tr>
<tr>
<td>Investment</td>
<td>$200 million</td>
<td>$1.0 billion</td>
</tr>
<tr>
<td>Biomass Purchases</td>
<td>$20 million annually</td>
<td>$100 million annually</td>
</tr>
</tbody>
</table>
What if the U.S. added 1,000 cellulosic ethanol biorefineries by 2040?

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Liberty</th>
<th>United States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct jobs</td>
<td>45</td>
<td>45,000</td>
</tr>
<tr>
<td>Indirect Jobs</td>
<td>180</td>
<td>900,000</td>
</tr>
<tr>
<td>Construction Jobs</td>
<td>200+</td>
<td>1,000,000+</td>
</tr>
<tr>
<td>Investment</td>
<td>$200 million</td>
<td>$1.0 trillion</td>
</tr>
<tr>
<td>Biomass Purchases</td>
<td>$20 million annually</td>
<td>$100 billion annually</td>
</tr>
</tbody>
</table>
What if Michigan added 1/50\textsuperscript{th} of the 1,000 new cellulosic ethanol biorefineries?

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Liberty</th>
<th>Michigan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct jobs</td>
<td>45</td>
<td>900</td>
</tr>
<tr>
<td>Indirect Jobs</td>
<td>180</td>
<td>3,600</td>
</tr>
<tr>
<td>Construction Jobs</td>
<td>200+</td>
<td>4,000+</td>
</tr>
<tr>
<td>Investment</td>
<td>$200 million</td>
<td>$4.0 billion</td>
</tr>
<tr>
<td>Biomass Purchases</td>
<td>$20 million annually</td>
<td>$400 million annually</td>
</tr>
</tbody>
</table>
Investment Stability

DSM has invested more than $150 million in Project LIBERTY to produce 25-million gallons of cellulosic ethanol annually.
Investment Stability

DSM made this investment in America because of the administration’s clear and unequivocal support of the RFS and the development of a robust cellulosic fuel industry.
Investment Stability

How can you have a stable investment environment when there is uncertainty about key legislation that stabilizes ethanol?
Other Countries Seeking Energy Environmental/Security Benefits
Which Came First?
Which Came First?

E15 Gasoline

or

E15 Warranted Vehicles
Which Came First?

E15 Warranted Vehicles 
(more than you think!)

- 11 million Flex-Fuel Vehicles in service at beginning of 2013
- MY 2013: 5.3 million E15-warranted Ford and GM vehicles added
- MY 2014: 11.34 million E15 vehicles sold by Ford, GM, VW, Toyota
- MY 2015: Sales pace of E15-warranted vehicles expected to continue
Which Came First?

Model Year 2014 E-15 Warranted Vehicles
(represent more than 70% of U.S. car & light truck sales)

General Motors
Buick – All five models/variations
Cadillac – All five models/variations
Chevrolet – All 15 models/variations
GMC – All five models/variations

Ford Motor Company
Ford – All 13 models/variations
Lincoln – All five models/variations

Honda Motor Company
Honda – Six of seven models/variations
Acura – Four of six models/variations

Jaguar – All eight models/variations
Land Rover – Both models/variations
Mercedes-Benz – Ten of 13 models/variations
Toyota Motor Corporation
Toyota – Six out of 14 models/variations
Lexus – Eight out of 13 models/variations
Volkswagen of America – All nine models/variations
Which Came First?

243.5 million vehicles registered in the U.S.

<table>
<thead>
<tr>
<th></th>
<th>E15 Warranted</th>
<th>Total E15 Warranted</th>
<th>% of Total U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flex-fuel vehicles in service end of 2012:</td>
<td>11 million</td>
<td>11 million</td>
<td>4.50%</td>
</tr>
<tr>
<td>GM and Ford 2013 MY vehicles (all E15 warranted)</td>
<td>5.3 million</td>
<td>16.3 million</td>
<td>6.70%</td>
</tr>
<tr>
<td>Add all current 2014 MY E15 warranted vehicles</td>
<td>11.34 million</td>
<td>27.64 million</td>
<td>11.35%</td>
</tr>
<tr>
<td>Add projected 2015 MY E15 warranted vehicles</td>
<td>11.34</td>
<td>38.98 million</td>
<td>16.00%</td>
</tr>
<tr>
<td>Add projected 2016 MY E15 warranted vehicles</td>
<td>11.34</td>
<td>50.32 million</td>
<td>20.06%</td>
</tr>
</tbody>
</table>

Note: Less than 10% of American vehicles require premium gasoline
In 2014: 80% of vehicles approved (by EPA) to use E15; 13% of vehicles are explicitly warrantied by OEMs for E15.
By 2017: 89% approved by EPA for E15; 26% warrantied by OEMs
By 2020: 94% approved by EPA for E15; 43% warrantied by OEMs

Percent of LDV/T Fleet MY2001<, OEM Approved for E15, and FFV

RFA RENEWABLE FUELS ASSOCIATION

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In 2014: Fleet can consume 28 BG of ethanol (assumes E15 in all MY01+); 22 BG in OEM-warrantied vehicles
By 2017: Fleet can consume 32 BG of ethanol; 26 BG in OEM-warrantied
By 2020: Roughly the same as 2017 due to declining FFV production, but greater % of OEM-warrantied E15
Ethanol Economics

E-85’s discount to regular gasoline can be about $1.00

Hartford, Michigan
Ethanol Economics

E-85’s discount to regular gasoline can be about $1.00
Ethanol Economics

E-85 is available at this discount at 33 Michigan locations

Source: YellowHose.com
Ethanol Economics

E-15’s discount to regular gasoline is about 20 cents

Minnesota
Ethanol Economics

*Ethanol saves 90 cents/gallon*
Mazda SkyActiv-G Generation 2

- Homogeneous Charge Compression Ignition (HCCI)
- High compression ratio - 18:1
- Result:
  - 30-percent thermal efficiency improvement
  - 30-percent fuel economy improvement
  - total well-to-wheel CO₂ emissions for ‘average’ model could be brought down to around 80g/km
- Fuel considerations? *Mid-level ethanol blend (E25)*
Cummins Ethos 2.8L E85 Engine

- Up to 80 percent well-to-wheels carbon dioxide (CO2) reduction using E85
- Operates at diesel-like cylinder pressures
- Incorporate advanced spark-ignition technology
- Delivers the power (259 HP) and peak torque (450 lb.-ft.) of gas/diesel engines twice its size
- Incorporates an integrated start-stop system, further reducing fuel consumption & emissions
Cummins Ethos 2.8L E85 Engine
DSM at a glance

• DSM believes in a bio-based economy that provides healthier, brighter living for all.

• Moving our economic system to bio-based from fossil-fuel-based offers prospects of:
  – job creation
  – energy security
  – sustainable economic growth
  – lower carbon emissions
  – rural regeneration
DSM at a glance

- DSM is driving this move to a more sustainable, brighter future by creating breakthrough technology in the areas of:
  - Advanced biofuels
  - Biochemistry
  - Biomaterials