Panel Discussion on Manufacturing and New Business Development Opportunities

Moderator - Joe Barron, CorpDev Director, Mitsubishi Electric Power Products

Plastics Manufacturing – Joe Eddy, President, Eagle Manufacturing Co

Power Generation – Andrew Dorn, Managing Partner, Moundsville Power LLC

Advanced Manufacturing – Bill Peter, Interim Director, U.S. DOE ORNL MDF
M&A & VC INVESTMENT IN THE POWER GRID

PRESENTED BY JOE BARRON

CORPORATE DEVELOPMENT DIRECTOR
MITSUBISHI ELECTRIC POWER PRODUCTS INC.

ENERGY AND ADVANCED MANUFACTURING
BLUE TREE ALLIED ANGELS
Major Trends in Electrical Power

• Generation will become more distributed as large coal and nuclear facilities come off line

• Distributed Generation will transform the power grid from one directional power flow to bi-directional

• The variability of renewables like solar and wind will place extreme demand on power management

• Ageing infrastructure was not originally designed to handle the coming changes in the power grid

• Power Electronics in the transmission & distribution space will be critical to managing these demands

• Changes in regulation need to catch up with changes in the power business model enabled by emerging technology
There will be more change in the next 10 years than has occurred in the last 100.
Grid Edge Market Segments:

- Advanced metering infrastructure (AMI)
- Communications (for AMI and other applications)
- Demand-side management
- Distribution automation
- Energy storage and fuel cells
- Grid support
- Network operations center (NOC)
- Data analytics (soft grid)
- Distributed solar photovoltaics
- Cybersecurity

Utilities will benefit from new technologies that enable a more efficient, reliable & resilient distributed power grid.
Top VC & PE Deals - Past 5 years

Raised capital in the top third of their market, completed IPOs or been acquired
M&A & VC & the Power Grid: Look Ahead

- M&A deal count nearly doubled from 2010 to 2014.
- However M&A deal value grew only 14%.
- This weak growth & limited IPOs, indicates a shortage of high-value exits in power grid markets.
- More vendors received funding in 2014 than previously creating the largest opportunity yet to demonstrate the value of investment in power grid solutions.

In the 1980’s it was Telecom
In the 1990’s it was Datacom
In the 2000’s it was Software Application
In the next 20 years - Energy?
JOE C. EDDY - PRESIDENT/CEO
EAGLE MANUFACTURING COMPANY
2400 CHARLES STREET
WELLSBURG, WV 26070
Shale Gas Value Chain – The Downstream Segment

One real “Value Proposition” - keep the ethane local and crack it into ethylene
Shale Gas Value Chain - Downstream

- Ethane, Propane, Butane downstream of cracker
- Focus on Ethane to Ethylene to Polyethylene Stream

Product Categories:
- Fertilizers
- Adhesives
- Alkyd Resins
- Solvents
- Corrosion Inhibitors
- Textiles
- Inks, Adhesives
- Shampoos, Detergents, Soaps
- Paints
- Coatings
- Pipes, Hoses, Wire Coating
- Coolant, Antifreeze
- Films, Packaging, Bottles
- Paint Remover
- Tires and Rubber
- Lubricant Additives
- Solvent, Industrial Cleaners
- Plastics

Market Sectors:
- Apparel and Accessories
- Beverages and Tobacco Products
- Chemicals
- Computer and Electronics
- Fabricated Metal Products
- Food and Kindred Products
- Leather and Allied Products
- Machinery, Except Electrical
- Nonmetallic Mineral Products
- Paper
- Petroleum and Coal Products
- Pharmaceuticals
- Printed Matter and Related Products
- Primary Metal Manufacturing
- Rubber Products
- Textile and Fabrics
- Transportation Equipment
- Wood Products

Source: PwC and TopLine Analytics

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Appalachian Basin is the heart of the plastics processing industry.

Within 500 miles:
- 45% of NA demand
- 49% of NA converter sites

Announced Projects Since June 2012

<table>
<thead>
<tr>
<th>Projects</th>
<th>20+</th>
<th>11-19</th>
<th>6-10</th>
<th>3-5</th>
<th>1-2</th>
</tr>
</thead>
</table>

Source: Plastics News, ACC analysis; Townsend Solutions
Shale Gas Value Chain-Plastics Model Economics
Ethane to Ethylene to Polyethylene-vs-Pipeline Out of Region

- Estimated 20:1 value added ratio of downstream economy (jobs, tax base, future economic development)

**Pipeline**

- **Ethane Pipeline**
  - 70,000 BPD = 25.5 Million Bbl/yr
  - 100 Direct/425 Indir Jobs = $27.8 Million/yr
  - Total Value Added: $296 Million/yr

**Fractionation**

- 100+425 Jobs

**Cracker**

- 350+1575 Jobs
- Ethane
  - 25.5 M bbl/yr
  - $268 M/yr
  - $296M/yr
- Ethylene
  - 1.4 B lb/yr
  - ($700 M/yr)
  - Same Plant

**Reactors**

- 100+425 Jobs
- Polyethylene
  - 1.2 B lb/yr
  - $900 M/yr
  - $1.21B/yr

**Plastics Processor**

- Poly
  - 1.2 B lb/yr
  - $900 M/yr
  - $1.21B/yr
- Poly Product
  - $2.7 B/yr
  - $5.10B/yr

**Markets**

- 4000+18000 Jobs
- TVA = $6.31B/yr
- Value Added Ratio: 21.3/1.0

**Value Added**

- $296M/yr
- $5.10B/yr
- TVA = $6.31B/yr

**Value Added Ratio**

- 1.0/1.0
- 4.1/1.0
- 17.2/1.0
- 21.3/1.0

**Input – Output**

**Based upon**: 70,000 BPD ethane at $.25/gal, cracker/reactor net output of 1.2 billion lbs/yr polyethylene, plus 20% value for additional products (propylene, butylene, butadiene, others), ethylene at $.50/lb, direct job at $65,000/yr, indirect jobs at 4.5x direct at $50,000/yr, polyethylene at $.75/lb, poly product wholesale value of $2.25/lb, Value Added=Material Output Value + Labor Costs, # of processors based on 50 at 24 million lb/yr, TVA=Total Value Added
Key Takeaways:
- Abundant, affordable energy is key to manufacturing growth
- Marcellus & Utica are most prolific, productive, profitable shales
- Midstream and pipeline buildout supports future growth
- At forefront of shale gas development (10% or less)
- Chemical expansion historically follows raw materials
- Value Proposition is in cracking ethane into ethylene regionally
- Ethylene and Polyethylene create major downstream mfg expansion
- Realize an estimated 20:1 Value Added Ratio

4,550 Direct Jobs - $295 Million Annual Payroll
20,450 Indirect Jobs - $1 Billion Annual Payroll

$6.3 Billion/Yr Total Value Added
Power Generation
Presented by Andrew Dorn
ESC’s West Virginia Projects

WV Combined Cycle Natural Gas Power Plants with Sustainable Fuel Advantages
Market Need for New Generation
Driven by Coal Plant Retirements

Source: SNL
Affect of Coal Retirements
Changing PJM Power Flows

July 18, 2013

March 4, 2014

NG Price

$39.7
5

$47.5
0

$21.0
3

$22.8
1

$21.7
5

$6.8
8
Long Term Fuel Advantage – Marcellus & Utica

Key for Sustained Competitive Advantage
Huge Marcellus & Utica Opportunity
Key is to Develop the Full Value Chain in the Region

- Manufacturing electricity with natural gas is a key component to support downstream industry
PETER, PHD
DEPUTY DIRECTOR
MANUFACTURING DEMONSTRATION FACILITY
MDF supports AMO’s mission

**DOE-AMO Mission**

- Develop and demonstrate new, energy-efficient processing and materials
  - broadly applicable
  - improved products and reduced lifecycle energy consumption
- **Technical assistance to**
  - promote use of advanced technologies
  - capture U.S. competitive advantage in clean energy manufacturing

**Manufacturing Matters**

- 12.5% of U.S. GDP
- 12 million U.S. jobs
- 70% of U.S. engineering and science jobs
- 75% of U.S. Exports
- 17% of the world’s manufacturing output
- 25% of US energy use
ORNL has a rich history in advanced manufacturing R&D

MDF is focused in two key areas—additive manufacturing and carbon fiber & composites
Manufacturing Demonstration Facility
A public-private partnership to engage industry with national labs

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<thead>
<tr>
<th>Core Research and Development</th>
<th>Industry Collaborations</th>
<th>Education and Training</th>
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<tbody>
<tr>
<td>• R&amp;D in materials, systems, and computational applications to develop broad dissemination of additive manufacturing</td>
<td>• Cooperative research to develop and demonstrate advanced manufacturing to industry in energy related fields</td>
<td>• Internships, academic collaborations, workshops, training programs, and course curriculum for universities and community colleges.</td>
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Supporting Industry and R&D with a Wide Range of AM Capabilities

- Electron Beam Melting
- Laser Sintering
- Laser Blown Powder Deposition
- Binder Jetting
- Fused Deposition Modeling
- Multi-head Photopolymer
- Large-Scale Polymer Deposition
- Post Processing
Working with Industry and AM Community to Develop Research Priorities in AM

MDF Roadmaps & Workshops
- Army Additive Manufacturing
- NASA AM Meeting
- EWI AM Consortium 2015
- Advanced Simulation for AM
- Neutron Characterization for AM
- Fuel Cell and Building Technologies for AM
- AM for Small Modular Hydropower

Cumulative Total
>10,000 visitors, to date

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
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<tbody>
<tr>
<td>FY 12</td>
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<td>FY 13</td>
<td>1899</td>
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<td>FY 14</td>
<td>2812</td>
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<tr>
<td>FY 15</td>
<td>~5,000</td>
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6 months of workshops
Technical Collaborations Program
The MDF Model

Explore
- Opportunity for industry to discover and apply new manufacturing technologies

Engage
- Work with MDF staff to develop scope of work

Execute
- Simplified on-line application
- Phase 1 $40K, Phase 2 $200K
- 1:1 Cost Match
- Non-Negotiable CRADA
- ~90-day cycle time from review to a signed agreement

www.ornl.gov/manufacturing

Company Size
- 42 small, medium
- 24 large

Map showing locations of companies in the U.S. with markers for small, medium, and large companies.
Small Business Vouchers Pilot
Partnership in Innovation

Open for Business!
Small businesses working to bring advanced energy technologies and services to market now have the national labs in their corner.

www.sbv.org

SBV Schedule/Award Cycles

Closed 10/23/15

Round 2: Feb – May 2016

Round 3: June – Sept 2016
High Performance Computing for Manufacturing (HPC4Mfg)

https://hpc4mfg.llnl.gov/

DOE’s EERE Industry Day

Dave Danielson, Assistant Secretary for EERE, in front of 3D Printed House, ORNL Industry Day, Sept. 2015

Cyclotron Road

http://www.cyclotronroad.org/

Technologist In Residence

http://energy.gov/eere/cemi/technologist-residence-pilot
ORNL, Cincinnati sign CRADA to develop commercial large-scale additive manufacturing (BAAM) system

Feb 2014

• Strati car printed live at IMTS Show on BAAM system

Mar 2015

• CINCINNATI sells first BAAM beta system

Cincinnati delivers next-generation BAAM system to MDF
The Strati
World's First 3D Printed Car

Dec 2013
ORNL, Local Motors sign CRADA to produce the world’s first production 3D printed vehicle

June 2014
Local Motors opens location in Knoxville, TN

Sept 2014
Strati car printed live at IMTS Show on BAAM system

Jan 2015
Local Motors announces two micro-factories at Detroit Auto Show to be located in Knoxville, TN and National Harbor, DC

May 2015
Local Motors breaks ground on Knoxville micro-factory, co-locates with MDF

Media Mentions for Aug 29-Sept 12, 2014
- 227 articles
- 77 online
- 100 social media
- 50 broadcast

National and International coverage!