They Said It Couldn’t Be Done:  
Alcoa’s Experience in Demand Response

Texas Industrial Energy Management Forum

DeWayne Todd
Alcoa At A Glance…

- Founded in 1888
- 200+ Locations in 31 Countries
- $25.0 Billion 2011 Revenue
- Lost workday injury rate is 1/10 that of U.S. Manufacturing Average
- 120 years of Aluminum Technical Leadership.

Number of Employees (2011)

<table>
<thead>
<tr>
<th>Region</th>
<th>Employees</th>
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<tbody>
<tr>
<td>U.S.</td>
<td>26,000</td>
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<tr>
<td>Europe</td>
<td>17,000</td>
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<tr>
<td>Other Americas</td>
<td>11,000</td>
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<tr>
<td>Pacific</td>
<td>7,000</td>
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Total: 61,000
Alcoa Energy Business and Consumption

- **Alcoa - A Major Consumer of Energy**
  - Over 3000 MW’s of Load in US
  - Over 1400 MW’s of Generation in US (800 of Renewable)

- **Alcoa has many types of loads.**
  - High Load Factor - Smelting
  - Batch Load - Rolling
  - Traditional Industrial

- **Alcoa has a long history of Demand Response**
  - Emergency Response
  - Load Shifting
  - Load Factor Optimization
Drivers for Expanded Demand Response

- **Rising Energy Costs**
  - Energy can be 40% of the cost of Aluminum Production
  - Global Competition

- **Support for Grid Reliability (Less Reserves)**
  - System Emergencies
  - Ancillary Services

- **Integration of Intermittent Technologies**
  - Wind
  - Solar

- **Focus on Clean Energy Alternatives**
  - Demand Response is a Clean Alternative

- **Evolution of Capacity and Ancillary Services Markets**
Warrick Operations Selected as a Pilot Site

- 570 MW’s of Load
- Evolving Market in MISO
Alcoa’s DR Pilot - Warrick Operations

Power Plant (570 MW)

Aluminum Smelter (470 MW)

Rigid Packaging (60-90 MW)

• (5) Pot Lines
• Response Distributed across Energized Lines
• Duel Line Intermittent for Spinning Reserves
Ancillary Services are responses necessary to keep the bulk electric system stable and reliable.

- **Base Load Consumption**
  - Smelting provides steady 24/7 grid load
  - Limited collaboration with energy system

- **Traditional Demand Response**
  - Alcoa provides emergency shutdown capability
  - Smelter a last resort ancillary service

- **Dynamic Demand Response**
  - MISO remotely controls 70 MW of smelter load in real time
  - Enables dynamic grid regulation
Direct Load Control

- Energy - Load Following, Price Responsive Demand
- Ancillary Services
  - Emergency Response (10 min)
  - Contingency Reserves (10 min)
  - Regulation (5 min with 4 sec. response)
- Planning Capacity

Only Supplier of Controllable Demand Response in MISO

- 70 MW’s of Direct Load Control.
- 150 MW’s of Interruptible Spinning Reserves.
- Enabled by Smart Meters and Advanced Controls
Alcoa’s biggest successes have been in Ancillary Services and Load Shifting.
Key Enablers to Demand Response

- **Advanced Metering**
  - Understanding Consumption

- **Data Availability**
  - Accessibility
  - Visualization

- **Integrated Control Systems**
  - Systems that Use the Data to Respond

- **Dynamic Business Models**
  - Co-Optimization of Markets and Business Objectives
Establishing DR Participation at Warrick

- Assessment of Load Profiles and Opportunities
  - Understanding Consumption

- Metering Installation
  - Accessibility

- ICCP Communications with MISO
  - Systems that Use the Data to Respond

- Process Control System Update
  - Redesign of Fundamental Control Logic (MW’s vs lbs)

- Bids/Offers Software
  - Daily Decisions on Amount of Hourly Participation
  - Integration of Metal Price, Production Metrics, and Maintenance

- Settlements Software
Day in the Life….

**Controllable Load**
- 70 MW’s
- 99.1 % Available
- 98.5 % Accurate

**Interruptible Load**
- 75 MW’s
- Avg. 55 Deployments (Annually)
- Avg. Length – 42 Min
- (2) Missed Deployments (3 yr)
Keys to Fitting Demand Response into the Grid

- **Market Design/Flexibility**
  - Loads Often Constrained by Local Utility
  - Utility Model Can Create Competing Objectives
  - State and Federal Involvement

- **Modeling of Demand Response**
  - Model Must Capture Unique Characteristics
  - Generation has a Century of Modeling
  - Integration of Production Priorities

- **Smart Metering**
  - Investment Costs Can Be Significant ($250 k)

- **Compensation**
  - Comparable Payment for Comparable Performance
  - Cost Recovery is a Essential
Keys to Fitting Demand Response into Your Plant

- **Perform a Plant Assessment**
  - Total Load, Top Individual Load
  - BTMG or Process Boilers

- **Understand Consumption Patterns**
  - Types of Loads (Continuous, Batch, Curtailable, Interruptible)
  - Schedules (Maintenance and Operation)

- **Quantify Opportunity**
  - What is the Region/Local Utility Looking for?

- **Identify Easy Wins**
  - Manual Shut Down

- **Evaluate Best Practices**

- **Establish Contact with ISO**
Key Lessons Learned

- Participation is an Evolution
  - Started with Limited Participation (From 12 MW’s to 225 MW’s)
  - Manual Response moved to Automated Response

- Engage the Process Owners and Regional Entities

- Establish “Stop Criteria”

- Economic Models can be Very Different Across Demand Response Providers
  - Capacity Costs
  - Production and Revenue Impact
  - Fixed Costs
Advanced Demand Response— a “win-win-win”

**Grid**
- Up to 210 MW of the fastest, most reliable, and accurate ancillary services
- Renewable Portfolio Standards less costly with improved grid flexibility
- Peak demand impact reduces capital costs

**Society**
- $4 million annual economic savings
- Eliminate the need for 18 natural gas generators in US (35 MW each)
- Increasing levels of Wind & Solar become viable

**Alcoa**
- $15 - $120 k in Additional Net Revenue Daily
- Potential for 10% Reduction in Energy Costs
- Improves US manufacturing competitiveness
Questions?

Thank you!
Alcoa can’t wait for tomorrow

DeWayne Todd – dewayne.todd@alcoa.com