An Introduction To Praxair
Praxair at a Glance

- A Fortune 300 company with 2016 sales of $11 billion
- One of the largest industrial gases companies worldwide
- Doing business in more than 50 countries
- ~26,000 employees
- One million customers worldwide

Safety Performance

- Recordable Injury Rate
- Lost Workday Case Rate


2014 OSHA Industrial Average: 3.3
Leader in advancing supply systems and equipment, and in developing applications technologies; about 4,000 active patents
Major Gas Products

Atmospheric Gases
(derived from air)
oxygen, nitrogen,
rare gases (argon, xenon, krypton, neon)

Process Gases
(derived from industrial processes or natural gas)
hydrogen, carbon dioxide, helium, acetylene

Specialty Gases
Electronics gases
arsine, phosphine, silane, mixtures
Instrument gases and mixtures
Technology Needs List

Production & Distribution of Industrial Gases

Uses of Industrial Gases

Performance Coatings
What Praxair is Seeking

Profitability: Technology to reduce the cost of making, storing and delivering our products
- Improvements to production and supply chain components
- Better methods of control, optimization and risk analysis
- New methods for producing industrial gases
- IP to exclude practice by competitors – no issues with others practicing outside of our field

Growth: New applications for our products
- New uses for gases in existing markets
- New markets for gases
- Equipment that enables use of gases
- Service opportunities that involve gases
- IP to allow for access to the market
Production and Distribution

Turbo machinery
- Gas compression and expansion
- Advanced electric drivers greater than 100 hp including variable speed technology
- Advanced gas turbine and steam turbine drivers

Processes
- Gas separation and purification
- Hydrogen production from fossil and non-fossil feedstocks
- Advanced PSA processes
- Membrane processes
- Electrochemical processes relevant to bulk separation, purification and utilization of gases (oxygen, ozone, hydrogen, CO, argon and other noble gases, nitrogen, CO2, natural gas)
Materials
- Gas separation and purification materials including adsorbents and membranes
- High temperature alloys and coatings
- Low temperature materials and insulations
- Gas storage materials
- Composites suitable for pressure containment

Modeling and control
- Steady state and dynamic process modeling
- Process optimization
- Real time process control
- Online process optimization
- Supply chain optimization and modeling
- Reliability and risk analysis
Gas-liquid contacting
- Components that enable efficient mass and heat transfer for distillation and direct contact heat exchange

Heat exchange
- Compact heat exchangers
- Enhancements for convective and boiling heat transfer
- High temperature heat exchangers

Heat rejection and reuse
- Technology for recovery and reuse of waste heat
- Technologies to minimize water use in process cooling
- Technologies to prevent fouling in water cooled heat exchangers
- Cooling water and boiler feed water treatment
Uses of Industrial Gases

**Combustion**
- Use of oxygen to enhance performance, reduce energy consumption and lower emissions from combustion processes

**Chemicals**
- Industrial gases as feedstocks for chemical production
- Precise control of gas compositions for safety, reliability and productivity

**Energy**
- Extraction of resources enhanced by gases including EOR, and energized fracturing
- Gases used in upgrading and process energy resources
Uses of Industrial Gases

**Food and Beverage**
- Applications for gases and cryogenic fluids in freezing, processing and packaging

**Electronics**
- Gases and materials used in manufacturing of semiconductors, solar panels, displays and lighting

**Healthcare, Biotechnology and Pharmaceuticals**
- Gases and related equipment used in hospitals, clinics, nursing homes and other healthcare facilities
Uses of Industrial Gases

Metals, Glass and Materials
- Gases and equipment used for the production of metals, glass and other materials

Environment
- Water, waste water and waste treatment methods using gases

Metal Fabrication
- Methods for welding or joining metals that use gases to achieve superior characteristics
- Gases and powders for improving properties of 3-D printed metals
Materials and methods to apply high performance metallic and ceramic coatings that are resistant to wear, corrosion and other difficult conditions to various substrates and components.
Multiple approaches adopted

- Technology needs lists
- Focused technology scouting program
- Network with companies, universities, national labs and other organizations with relevant programs
- Participate in new technology forums (NSF, SBIR Summit, NCET2 etc.)
- Mine new patent applications that cite use of gases
- Solicit proposals through corporate website
- Selective engagement with start-ups
- 3rd party organizations
- Competitions