U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Advanced Manufacturing and Sustainable Chemistry

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EERE's Advanced Manufacturing Office (AMO)

U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Advanced Manufacturing Office

BUDGET

$395M

FY20

WHAT WE DO

Partner with industry, academia, states, and National Laboratories **to catalyze R&D and the adoption of advanced manufacturing technologies and practices**

STAFF

~70

Feds, contractors, and fellows

GOLDEN, CO AND DOE HEADQUARTERS

R&D Projects

FY20 = $151M

R&D Consortia

FY20 = $199M

Technical Assistance

FY20 = $45M

AMO Guiding Principles

AMO works to **increase energy and material efficiency in manufacturing** to drive energy productivity and economic growth.

MANUFACTURING

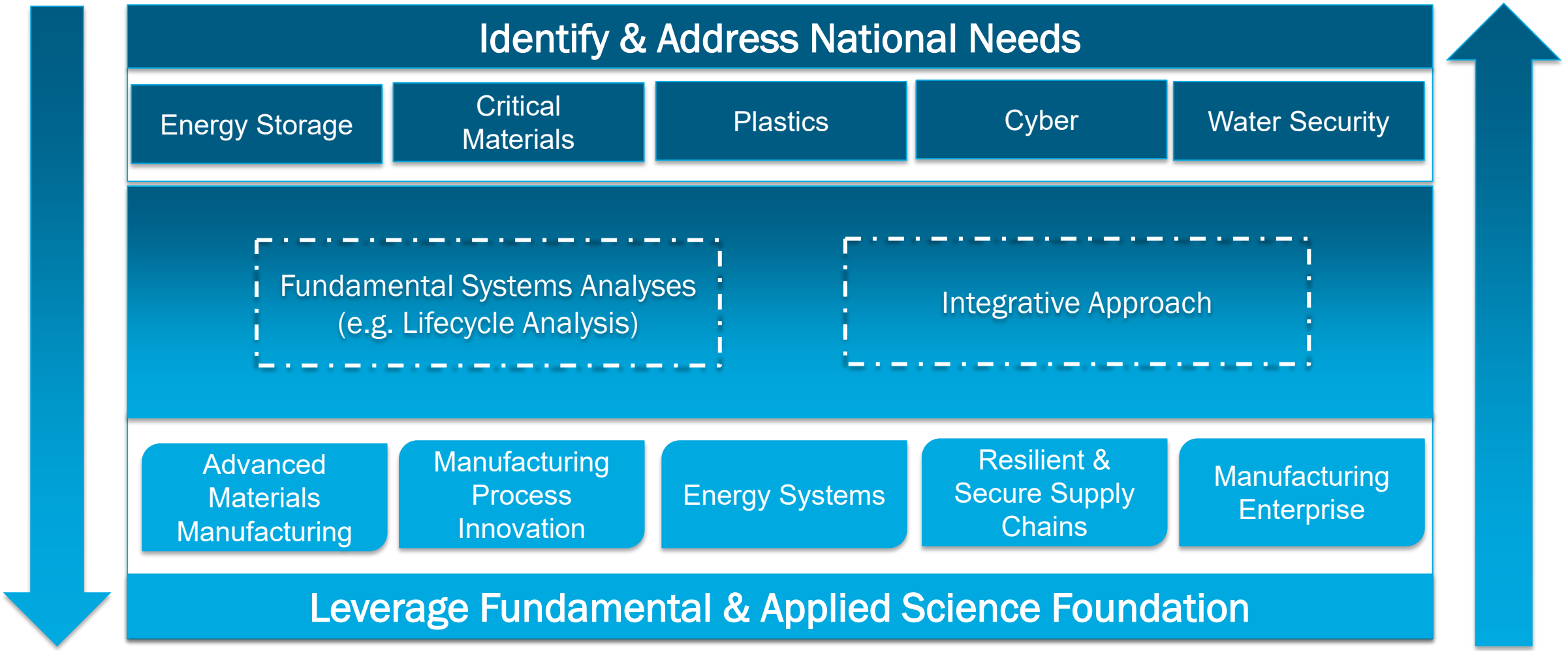
- Uses roughly 25% of the nation's primary energy
- Represents nearly 80% of energy use in energy-intensive sectors
- Generates 11% of the U.S. GDP and 12 million jobs
- Incurs $150 billion in energy costs annually

AMO GOALS

- Improve the **productivity, competitiveness, energy efficiency, and security** of U.S. manufacturing
- Reduce the **life cycle energy and resource impacts** of manufactured goods
- Leverage diverse **domestic energy resources and materials** in U.S. manufacturing, while strengthening environmental stewardship
- Transition DOE-supported innovative technologies and practices into **U.S. manufacturing capabilities**
- Strengthen and advance the **U.S. manufacturing workforce**

Framework to Shape AMO's Portfolio

A holistic top-down and bottom-up systems approach to shape the AMO portfolio with the highest potential for impact.



Better Plants Program

Public-private partnerships to help manufacturers and industrial organizations set and achieve long-term energy intensity reduction goals through:

- Technical assistance and in-plant training
- Access to National Laboratory resources, software, and instrumentation

3M

BETTER PLANTS CHALLENGE GOAL ACHIEVER

99 facilities

25% reduction in energy intensity

9 years to achieve goal

240+ partners

3,200+ plants

67 energy & water goals achieved

>$8B cumulative energy cost savings

>1.7 quadrillion Btu saved

Better Plants®
U.S. DEPARTMENT OF ENERGY

High Performance Computing (HPC)

AMO encourages energy intensive industries to apply to use HPC tools to reduce manufacturing process energy intensity.

- Up to $300,000 per award with at least 20% cost-share
- Manufacturers are paired with National Laboratory experts
- DOE encourages partnerships with universities and nonprofits in federally designated Opportunity Zones and/or Historically Black Colleges and Universities

COMING SOON: HPC FALL SOLICITATION

Photo : "Separation-Intensive U.S. Manufacturing Industries," ORNL

EXAMPLE

ENERGY-EFFICIENT ALTERNATIVE SEPARATIONS

- Develop a machine-learning algorithm that can be run off of a desktop computer to replace computationally intensive models
- Rationally design new materials and processes capable of highly-selective, low energy separations
- Increase productivity in other separation processes using similar technologies

HPC 4 MANUFACTURING

On the Horizon

ENGAGING WITH AMO

- Participate in upcoming topic-specific and multi-topic **funding opportunities**
- Respond to **Requests for Information** to inform R&D portfolio planning
- Register and attend additional **stakeholder workshops** for in-depth discussions around current and emerging challenges and opportunities in:
  - Thermal Process Intensification
  - Next Generation of U.S. Manufacturing
  - Workforce Development
  - Semiconductor Manufacturing
  - Critical Materials Analysis

To learn more and subscribe for updates from AMO, visit manufacturing.energy.gov.

Sustainable Chemistry and AMO Goals

More than 95% of all manufactured products rely on chemistry.

THE CHEMICAL INDUSTRY

Consumed more than **7** Quadrillion BTU in 2018

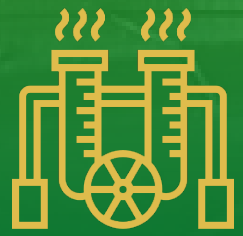
Will grow to consume **>30%** more energy by 2030

Improvements to chemical manufacturing processes could reduce energy intensity **20-40%** by 2050

Sustainable chemistry can improve lifecycle energy for all manufactured goods, and competitiveness for the entire manufacturing industry.

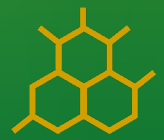
BANDWIDTH STUDIES IDENTIFY HIGH IMPACT AREAS

Iron & Steel



CHEMICAL MANUFACTURING

Pulp & Paper



Composites

Refining

AMO R&D Highlights

G. Jeremy Leong, Technology Manager, AMO

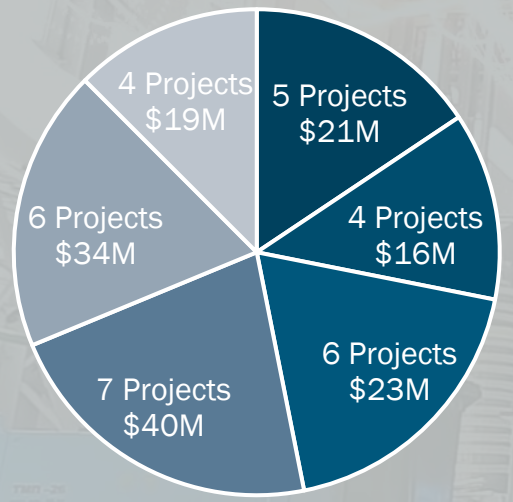
Process Intensification / Chemical Manufacturing: AMO Portfolio

AMO invested more than $105M in FY20 through its R&D projects and consortia pillars

| $207M grand total investments, including non-federal cost share

RAPID INSTITUTE

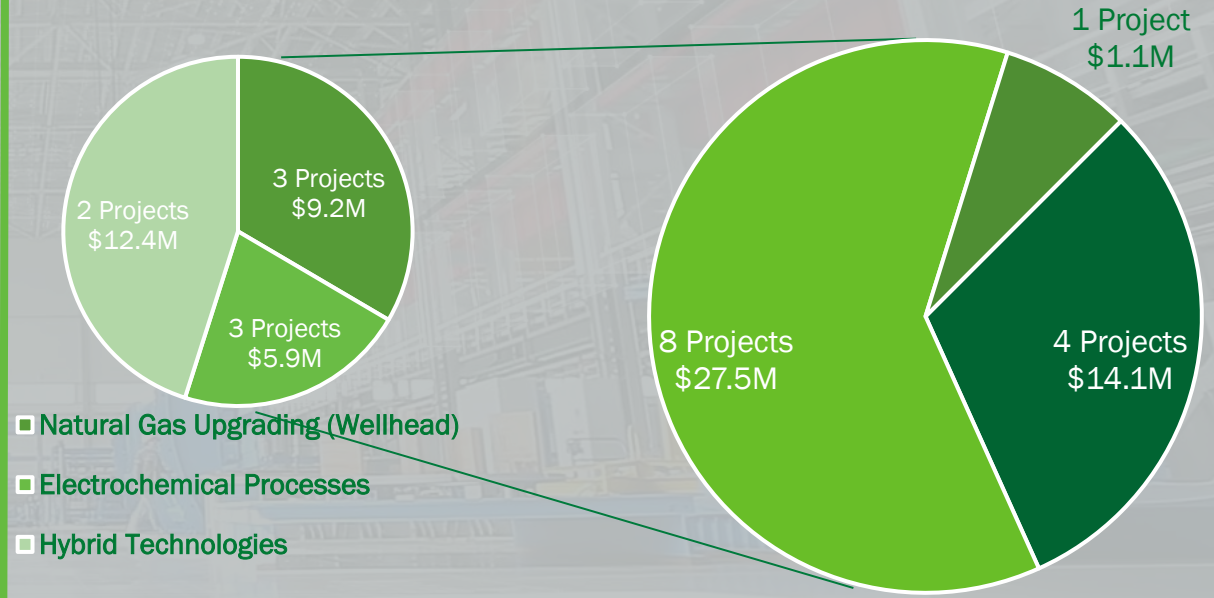
- Expected total of investment >$165M, $70M DOE funding



- Chemical & Commodity Processing
- Natural Gas Upgrading
- Renewable Bioproducts
- Intensified Process Fundamentals
- Module Manufacturing
- Modeling & Simulation

CHEMICAL MANUFACTURING R&D PROJECTS

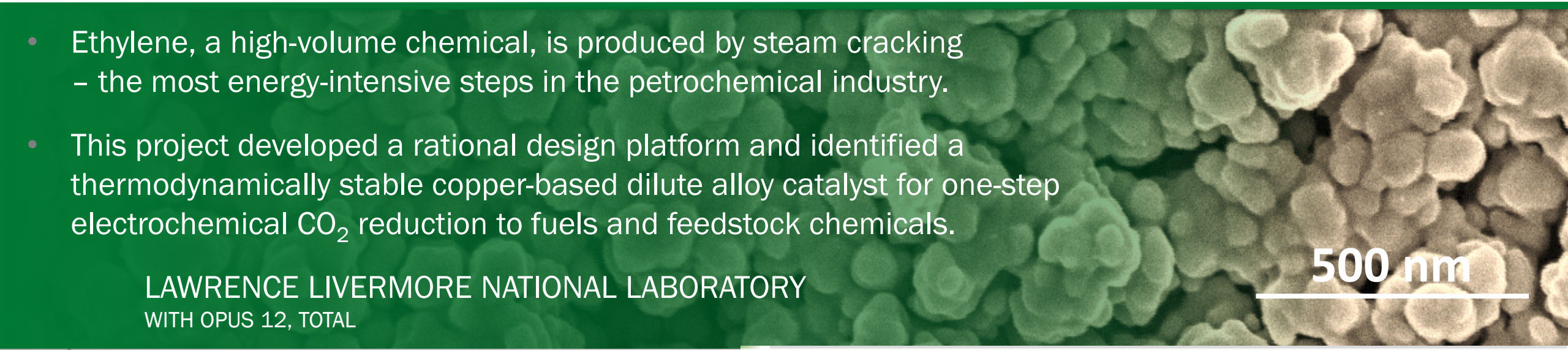
- Current investment >$42.68M, $35.17M DOE funding



- Natural Gas Upgrading (Wellhead)
- Electrochemical Processes
- Hybrid Technologies
- Catalysis Science and Design
- Intensified Processes
- Supporting Technologies

Project Highlight: One-step Electrochemical CO_2 to Fuel Conversion

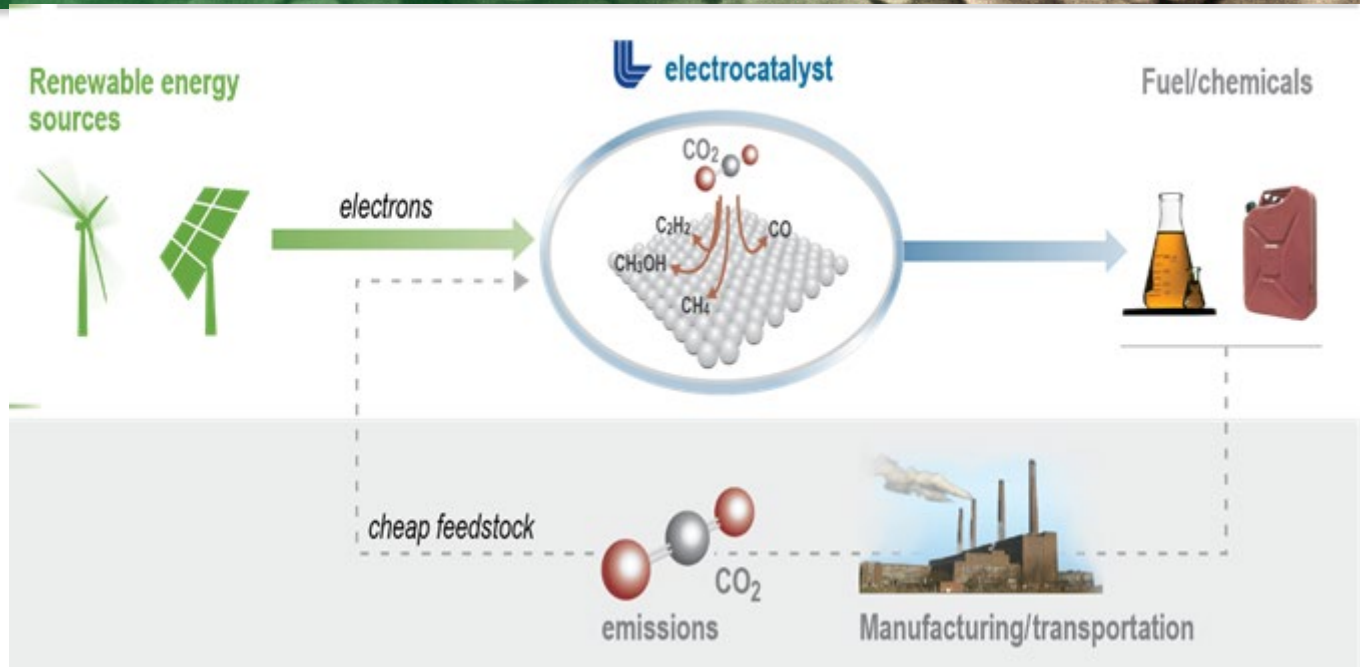
- Ethylene, a high-volume chemical, is produced by steam cracking – the most energy-intensive steps in the petrochemical industry.
- This project developed a rational design platform and identified a thermodynamically stable copper-based dilute alloy catalyst for one-step electrochemical CO_2 reduction to fuels and feedstock chemicals.



LAWRENCE LIVERMORE NATIONAL LABORATORY
WITH OPUS 12, TOTAL

IMPACT

- **Improves the energy efficiency** of one-step electrochemical ethylene production by more than 15%
- **Increases material productivity** through a highly selective catalyst design that limits byproducts
- **Boosts competitiveness** by offering a scalable, decentralized method to turn CO_2 into high-volume chemicals



Project Highlight: A New Pilot Process for Ethylene Production

- This project worked to develop oxygen transfer agents (OTAs) to convert ethane to ethylene *via* the selective combustion of hydrogen in the presence of hydrocarbon feed and products.
- Results from pilot-scale testing indicate that a single Integrated Fluidized Bed Hydrogen Combustion (IFBHC) unit may be able to replace several traditional boilers at the commercial scale.

ECOCATALYTIC

WITH DOW AND SOUTHWEST RESEARCH INSTITUTE

IMPACT

- Demonstrated the viability of a pilot-scale plant to produce ethylene and:
  - **Improves energy efficiency** by 46% - 58% compared to conventional methods
  - **Bolsters competitiveness** for chemical manufacturers through 80% fewer CO_2 emissions and nearly 100% NOx reductions

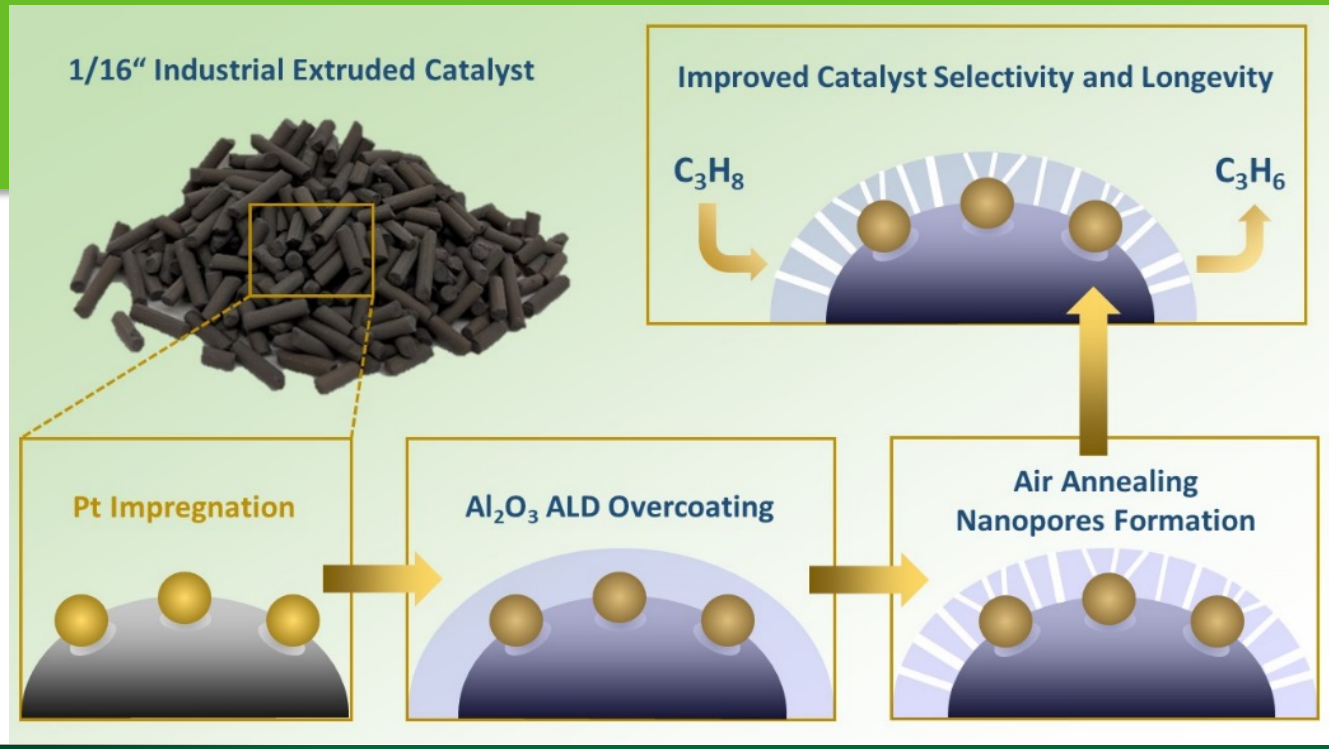
Project Highlight: Catalyst Enhancements for Efficient Chemical Manufacturing

- Intelligent design of catalysts enables diverse and robust chemical manufacturing to:
  - enhance resilience to operational variability, and
  - reduce the energy footprint of a wide array of commodity and specialty chemical manufacturing processes.

- This project uses atomic layer deposition to increase catalyst durability and reaction selectivity to reduce the energy requirements of high-temperature chemical reactions.

ARGONNE NATIONAL LABORATORY

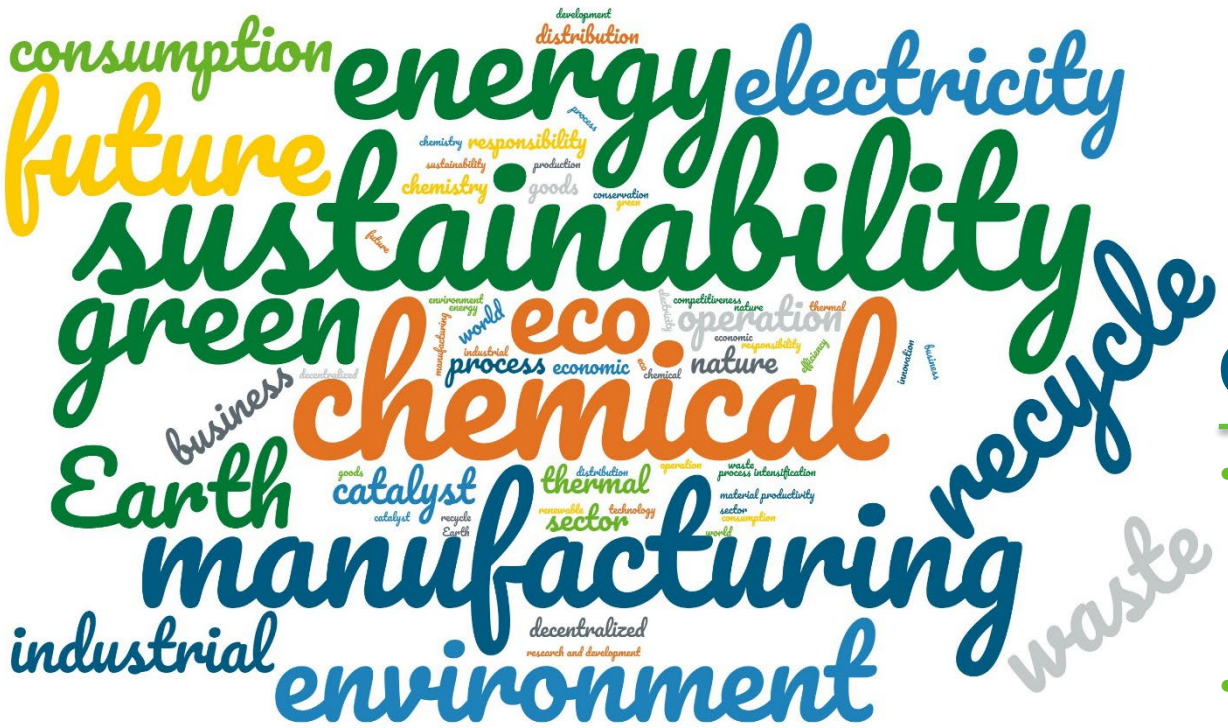
WITH FORGE NANO INC. AND HONEYWELL UOP



IMPACT

- **Demonstrates energy savings** of 35 – 50% of the maximum achievable improvements for propylene production
- **Increases productivity** by improving catalyst selectivity and longevity, reducing byproducts
- Aims to eliminate a separation unit to **improve the competitiveness of chemical manufacturers**

Sustainable Chemistry



WORKSHOP OBJECTIVE

> *Identify opportunities, needs, and barriers to incorporate sustainable chemistry processes and practices into the manufacturing of consumer and commercial products.*

OUTCOMES

- Gain insight into how sustainable chemistry is being incorporated into consumer and commercial manufacturing processes
- Identify manufacturing-related hurdles into incorporating sustainable chemistry technologies
- Prioritize R&D needs to advance sustainable chemistry in manufacturing within the AMO mission space

Thank you

DOE Management, Planning, and Facilitation Teams:


Valri Lightner

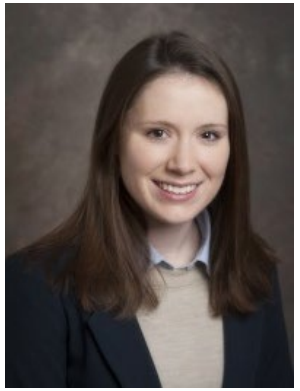

Isaac Chan


Jeremy Leong


Felicia Lucci


Theresa Miller


Sabine Brueske


Diane Sellers


Emmanuel Taylor


Scott Morgan


Joan Pellegrino

GC3 Co-hosts: Planning and Execution


Michele Jalbert


Joel Tickner


Jennifer Landry

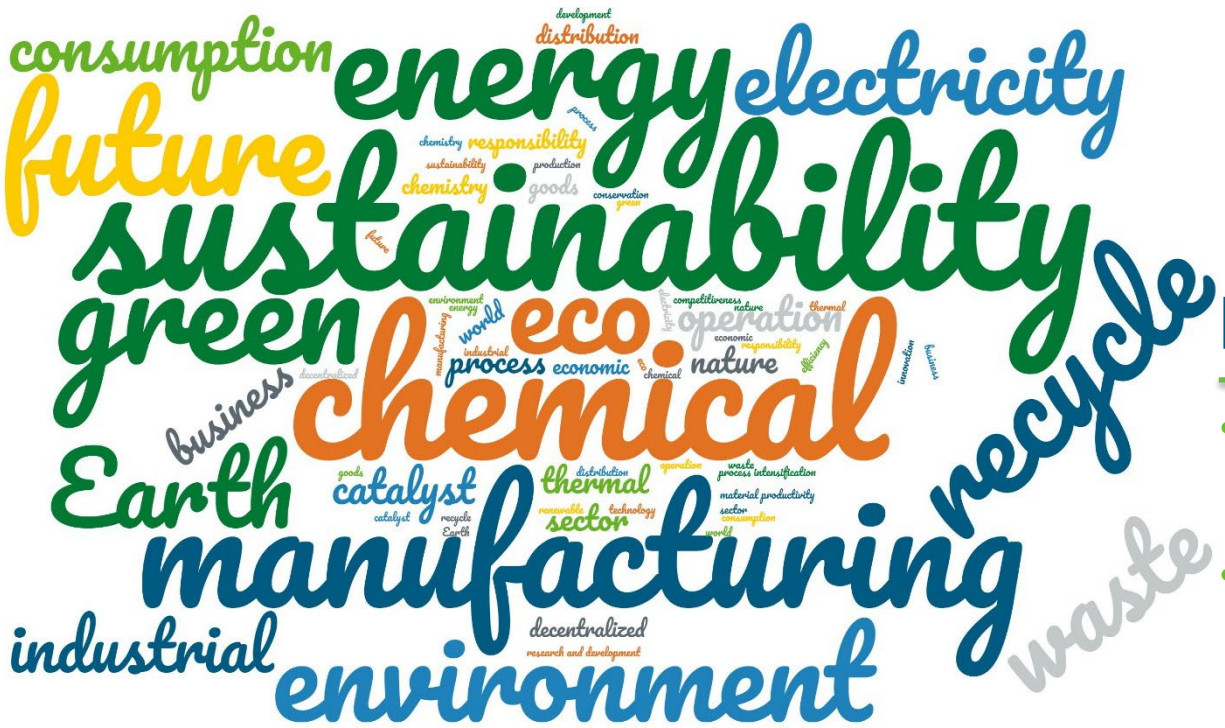

Julie Manley

For additional information and to subscribe for updates: manufacturing.energy.gov greenchemistryandcommerce.org

Closing Remarks

G. Jeremy Leong, Technology Manager, AMO

Meeting Wrap-up/Next Steps



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NEXT STEPS

- Pre-workshop questionnaire will be open until 20th November
- Workshop slides and materials will be posted on website within the next couple of weeks
  - Email will be sent out to all attendees
- Attendees will be sent a draft meeting report mid-late December for input/edits
  - Opportunity to provide input/edits for 2 weeks
  - Final publication mid-late January

Thank you

American Chemistry Council (ACC)

American Chemical Society (ACS):
Green Chemistry Institute (GCI)

American Institute of Chemical Engineers (AIChE):
Rapid Advancement in Process Intensification (RAPID)
and Institute for Sustainability (IfS)

ANGUS Chemical Company

B. Braun Medical Inc.

BASF

Beautycounter

Cargill

Checkerspot

Chemours

Cleanbay Renewables

Covestro

Croda

Dow Chemical Company

DuPont

Estee Lauder

Ford Motor Company

General Motors

Hasbro

Hexion Inc.

Johnson & Johnson

Kalion, Inc

Levi Strauss & Co.

Lowes

MilliporeSigma

National Association of Manufacturers (NAM)

New Balance

Nike

Novozymes

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P2 Science, Inc.

Reckitt Benckiser (RB)

Sironix Renewables

Steelcase

Target Corporation

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