RAPID
Transforming Process Industries

Rapid Advancement for Process Intensification Deployment (RAPID)

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RAPID
Transforming Process Industries

RAPID Overview

Timeline

- RAPID award issued March 2017
- Projected end date March 2022
- Project 25% complete

Barriers

- The key barriers to increased penetration of MCPI technologies were translated to 14 institute metrics

Budget

	FY 17 Costs	FY 18 Costs	Total Planned Funding (FY 17-Project End Date)
DOE Funded	4.8M	17.7M	$70M
Project Cost Share	4.8M	26.9M	>$70M

Partners

- RAPID is integrate within the American Institute of Chemical Engineers (AIChE) and strongly aligned with its mission of promoting excellence in ChE education and practice
- RAPID has 68 institutional members who provide key support in governance, technology evaluation, and outreach
  - 41% industrial, 45% academic, 14% other
  - Retention year 1 to 2 at 90%
  - Strong pipeline of potential members

RAPID Advancing the DOE Mission Through Innovation, Collaboration, and Education

RAPID is designed to progress AMO's mission of catalyzing energy efficient manufacturing technologies through the application of modular chemical process intensification (MCPI)

- MCPI is one of the 14 areas identified in the DOE MYPP
- RAPID institute metrics aligned with DOE FOA & drawn from the MYPP

RAPID's Mission

BRING together private and public entities to co-invest in R&D projects that advance innovative technologies and address high-impact manufacturing challenges.

BUILD RAPID membership through an inclusive and attractive value proposition.

LEAD a national effort to research and develop high-impact modular chemical process intensification solutions for U.S. Manufacturing.

ESTABLISH a technical education and workforce development program.

PROVIDE members with access to process intensification resources, tools, expertise, and facilities.

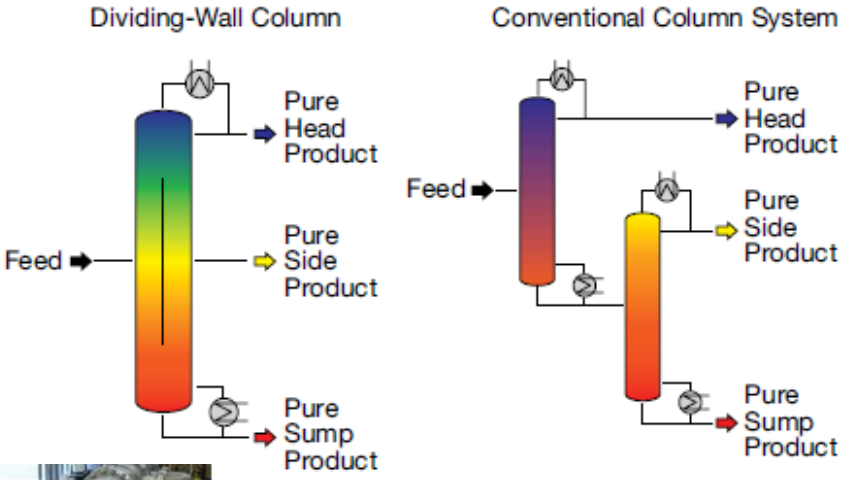
OPERATE the Institute efficiently to benefit a wide range of stakeholders.

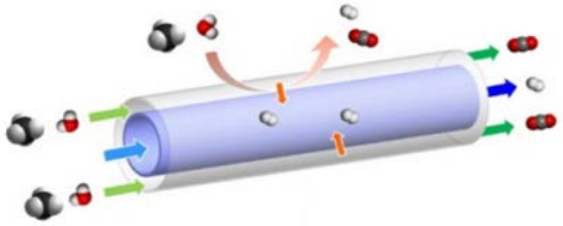
SUSTAIN the institute beyond DOE funding period.

Process Intensification & Modular Processing

Process Intensification

Process redesign to enhance performance, lower capital and energy, & remove bottlenecks





Modular Processing

Novel designs to unlock the value of distributed feedstocks

Technical Approach

A common approach has been used across all R&D activities within RAPID

1. Divide technical scope into manageable areas (7 established)
2. Use a structured roadmapping process to define key technology gaps
3. Establish work plans linked to institute metrics & roadmapping
4. Create milestones and go/no-go decisions to track progress
5. Define approach - outside of individual projects - to measure progress towards metrics

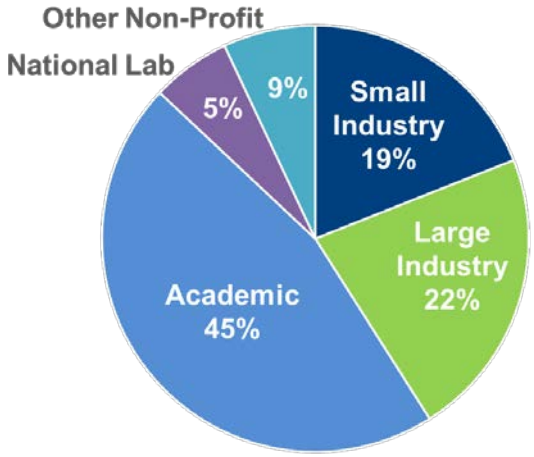
Key Institute Technical Challenges

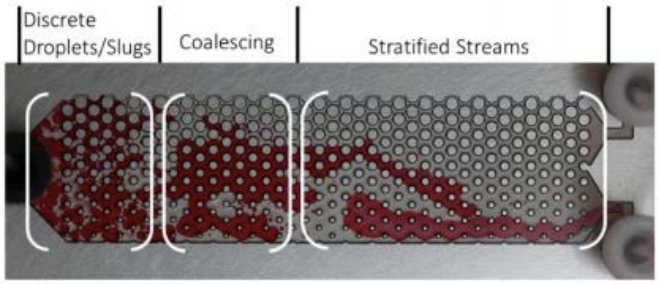
- Broad Scope
  - Addressed via member engagement
- Linkages between projects
  - Addressed via review structure

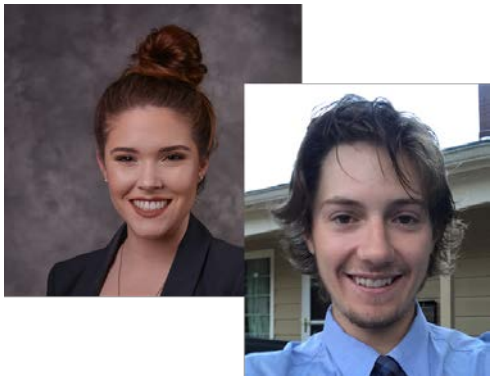
Technology Gap Assessment

Significant Progress in Year 1

- RAPID has established a diverse and **engaged** membership base – 68 and growing
  - Over 100 subject matter experts from industry, academia and non-profits active in roadmapping process
- Two calls for projects carried out
  - Fall 2017: 74 submissions, 21 selected
  - Spring 2018: 41 submissions, reviews underway
- Initial internal RAPID projects reviews have kicked off
  - 6 Focus area reviews covering 25 projects in 2Q18
  - Metrics assessment program kicked off in 1Q2018
  - DOE Peer Review held July 11/12
- Multiple Education & WFD activities started in 2018
  - 10-part webinar series underway (5/10 complete)
  - Summer intern program – 14 interns in 2018
  - Project call for short course development – under review







Institute Transition Plan

- Have identified multiple value streams, including projects, EWD, publishing, conferences, membership….and more.
- Engaging key stakeholders to develop these, including members, RAPID and AIChE staff, DOE and others
- Using AIChE's experience in designing & managing successful industry coalitions including the Center for Chemical Process Safety
- Using a rigorous new business review process which is AIChE standard practice
- Confident in ability to create a dynamic and sustainable entity in the long-term

Process to Develop Transition Plan

***RAPID* will be a multi-dimensional high-value organization**

RAPID-DOE Institute Metrics

1. Energy Efficiency: Demonstrate MCPI with >20% energy efficiency / 1st-of-kind pilot demo within 5 years. Demonstrate an order of magnitude improvement in energy productivity in 1 or more processes within 10 years.

2. Energy Productivity: Demonstrate a doubling of energy productivity by a combination of capital ($/kg per day) and operating cost related to improved feedstock and fuel efficiencies.

3. Individual Process Modules: Demonstrate 1,000 pilot hours in 1 or more processes with 10x reduced capacity cost ($/kg per day), 20% improvement in energy efficiency and 20% lower emissions/waste relative to commercial state-of-the-art.

4. Cost-Effective Module Manufacturing: Demonstrate technologies to scale-out module manufacturing that reduce by over 20% cost/unit, with each doubling in module manufacturing production.

5. Potential for Cost Effective Deployment: Develop tools to reduce the cost of deploying MCPI in existing processes by 50% in 5 years. Be on pathway for installed & operating cost parity for MCPI at full scale in one or more applications.

6. R&D Portfolio: Establish a portfolio of enabling technologies for next generation PI with quantitative goals

7. Build Industrial Partnership and Eco-System: Demonstrate potential for industry adoption of MCPI.

8. Self-Sustainment: Establish a portfolio of external support that directly replaces the initial Federal funding of $14 million/yr, starting in Year 6.

9. Train the Trainers: Train at least 50 professionals per year in MCPI by year 3.

10. Educate Students: Train at least 500 students per year in MCPI by year 3.

11. Annual Planning Process: Develop an annual planning process & funding - how new ideas & partners will be included, and how changes to plan will align with roadmaps and enable partnerships with other Fed agencies.

12. Industrial Roadmap: Develop a roadmap for MCPI that is updated annually, using a process that engages key stakeholders, including Institute members and subject matter experts

13. Emerging Supply Chain: Document the existence of the domestic supply chain for MCPI. Assess its health annually and document Institute capabilities supporting the supply chain.

14. Diversity: Demonstrate participation of SME's, MOBs, WOBs in technology development, workforce development and Institute governance.

RAPID Transforming Process Industries

Institute Scorecard

Summary

Institute Deliverable	Progress	Outlook
1. Technologoy - Energy Efficiency	16 projects beginning in 2018 that have potential to meet this metric	Strong
2. Technology - Energy Productivity	11 projects beginning in 2018 that have potential to meet this metric	Strong
3. Technology - Individual Process Modules	7 projects beginning in 2018 that have potential to meet this metric	Addressing
4. Technology - Cost-Effective Module Manufacturing	4 projects beginning in 2018 that have potential to meet this metric	Addressing
5. Technology - Potential for Cost Effective Deployment	7 projects beginning in 2018 that have potential to meet this metric	Addressing
6. Technology - R&D Portfolio	11 projects beginning in 2018 that have potential to meet this metric	Strong
7. Build Industrial Partnership and Eco-System	68 member companies, 23 of 26 projects with joint industry/academic participation	Strong
8. Self-Sustainment	Annual membership dues in excess of $500k. Structured sustainability planning process underway.	Addressing
9. Train the Trainers	Faculty training workshop fall 2018, 2018 project call solicited advanced-content short courses	Strong
10. Educate Students	5 webinars hosted in 2018 with 434 attendees to-date, E-learning course development underway, student intern program launched with 14 interns	Strong
11. Annual Planning Process	Internal steward (Technical and Governance) along with broad external engagement on future actives - other institutes, national labs	Strong
12. Industrial Roadmap	Roadmap developed via structured gap analysis process in 2017 with 100+ participants. Reviews planned in 2018	Strong
13. Emerging Supply Chain	Membership activities actively linking supply chain nodes - driving new project relationships	Strong
14. Diversity	Established Economic Development Council with MEP support.	Addressing

Summary

- RAPID is focused on the DOE goal of catalyzing technology transformation in the manufacturing sector through the promotion of Modular Chemical Process Intensification (MCPI)
  - A broad slate of institute deliverables ensures aligned with DOE MYPP
- The RAPID community has come together to generate a diverse and technically strong portfolio of research projects
  - Broad collaboration between industry and academia
  - Engagement by SMEs across RAPID to evaluate and steward programs
- Significant progress toward institute deliverables already in year 1
  - Tracking toward successful completion of most/all deliverables
- Industrial partnership in place to facilitate technology deployment – leading to impact in the manufacturing sector
  - >85% of projects have at least one industrial collaborator
  - Over $10M in direct industry support for projects in 2018 alone
- Institute already making plans to ensure long term sustainability