



MANUFACTURING

# The HPC4Mfg Program

**Lawrence Livermore National Laboratory, Lead  
Sept 2015 - Present**

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# Overview of the High Performance Computing for Manufacturing (HPC4Mfg) program



## Program Goals

- Bring the power of DOE HPC resources to industry
- Solicitation process used to select projects

## Timeline

- Program initiated September 2015
- Projected End: Ongoing

## Budget

- Approximately \$6-7M in projects/year
- 20% cost share required from industry projects
- Additional funds for summer student program
- Approximately 10-15% in management and outreach costs

## Barriers

- Some larger companies use HPC, but difficult to stay current
- Small to medium size companies don't use HPC as much
- Difficult for industry to understand how to best partner with DOE expertise

## Partners

- Principal Laboratories: LLNL, ORNL, LBNL
- All DOE labs eligible to participate
- Industries that have manufacturing facilities in the United States are eligible to participate

# Program Approach: The HPC4Mfg Program issues solicitations to elicit industry challenges



- Showing what is possible with HPC through demonstration projects
  - AMO funds < \$300K to laboratories
  - Industry funds at least 20%; either in-kind support or optional cash contribution
  - Project duration < one year
- Encouraging the adoption of HPC through follow-on projects
  - AMO funds < \$300K to laboratories
  - Industry funds at least 50%; at least half of which is a cash contribution
  - Project duration: one to two years
- Building the HPC Manufacturing community
  - Industry Engagement Day
  - Student intern programs



# Program Approach: The solicitation topics directly align with AMO goals



## Broad impact on energy efficiency and/or productivity:

- use HPC to overcome a key technical challenge
- existing process optimization
- advanced product design
- predicting performance and failure rates



## Accelerating adoption of clean energy technologies:

- new design and discovery on products or processes that impact energy use
- new materials that lower carbon release into atmosphere during use
- lower energy during manufacturing
- lower energy use during product life-cycle

In both cases, projects need to articulate the national scope of impact of a successful outcome and how HPC uniquely contributes to that outcome

# Program Approach – Solicitation process



**Engage  
industry**

Industry  
submits  
challenges

**Match  
challenge  
to PI**

AMO  
approval;  
Feedback to  
industry

Sign  
agreements

**Inform  
industry**



## Technical Merit Review Committee

- Partner labs and AMO representatives
- Heavy focus on **nation-wide** impact to energy efficiency and clean energy technology industry-wide

Execution streamlined through the required use of the DOE short form

# Program Innovation: HPC4Mfg has a new process for matching lab expertise to industry challenges



- Convened a Laboratory POC council from 8 major eligible laboratories: ANL, LANL, LBNL, LLNL, ORNL, NREL, SNL, PNNL
- “To Be Determined (TBD)” concept papers screened for appropriateness to program by principal labs and AMO program official
- Those that are ‘appropriate’ sent to POC council; they return a 1 page description of lab approach and expertise to solve the problem
- If concept paper strong enough to be asked for a full proposal, technical review team matches lab expertise to industry problem
  - If there is a ‘best response’, it is a selected
  - If multiple are comparable, balance among lab partners
- Else
  - Lab POC information of interested labs sent to industry partner to build possible future connections

# Approach: HPC4Mfg outreach activities are designed to reach new companies

- Conference/Meeting participation
  - Networking event at last AMR
  - Computational Science Graduate Fellowship Program booth
  - FABTECH – Chicago - November
  - HPC Impact Showcase at SC - November
  - HPC User Forum – overview talk and panel in Milwaukee - September
  - American Iron and Steel Institute visit to LLNL
  - ECP Industry advisory board presentation at LLNL
  - TMS conference
- Fact sheets
  - Generating 2 page brochures for completed projects to highlight examples and success
- HPC4Mfg Business cards



# Program Status: The HPC4Mfg Program is in steady state



## March – September 2015

### Launch program with seedling projects

- LLNL established the program
- \$1.5M: 5 seedling projects
- Industry outreach



## September 2015–March 2016

### Inaugural solicitation

- LBNL, ORNL join as partner labs
- \$3M solicitation: 10 demonstration projects to 8 companies



## March 2016 -

### Steady state

- Solicitation twice a year
- Demonstration/Capability projects
- Summer internships
- Workshops, Industry Engagement Day
- Added participating laboratories: ANL, NREL, NETL, SNL, NETL

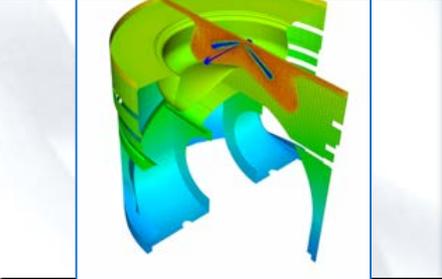
- *Compute resources from across the DOE complex*
- *Launched annual Industry Day*
- *Student internship programs*

# Program Results: Two solicitations have been released since the last review

- Round 4
  - Formally introduced follow on projects
  - 58 concept papers; 24 full proposals
  - 28 of the 44 companies that submitted proposals were new participants; eight asked for full proposals.
  - 7 projects selected – 5 demo, 2 follow on
  - One project co-funded with FE and two projects co-funded with VTO
- Round 5
  - Formally introduced the new process for TBD proposals
  - 55 concept papers, 26 full proposals
  - Under review now



# Program Results: The Round 4 projects selected are aligned with AMO goals



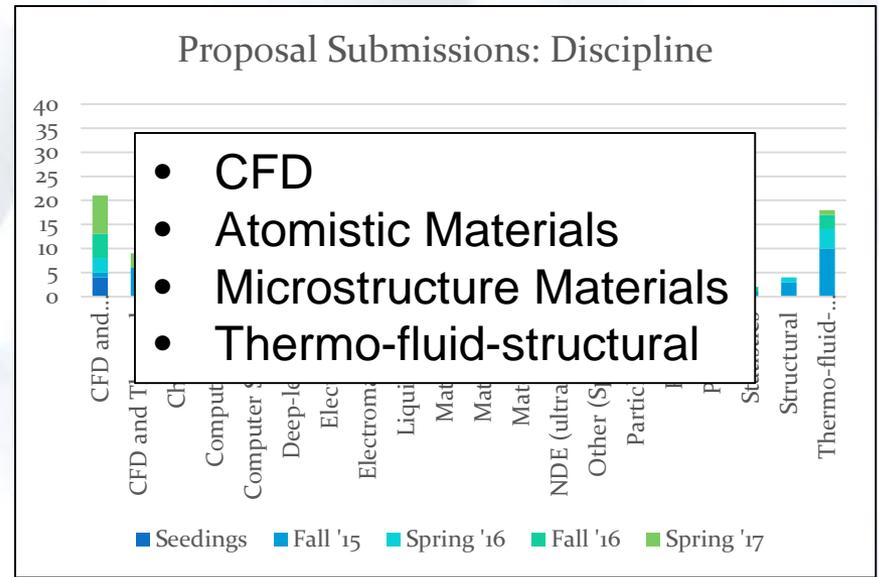
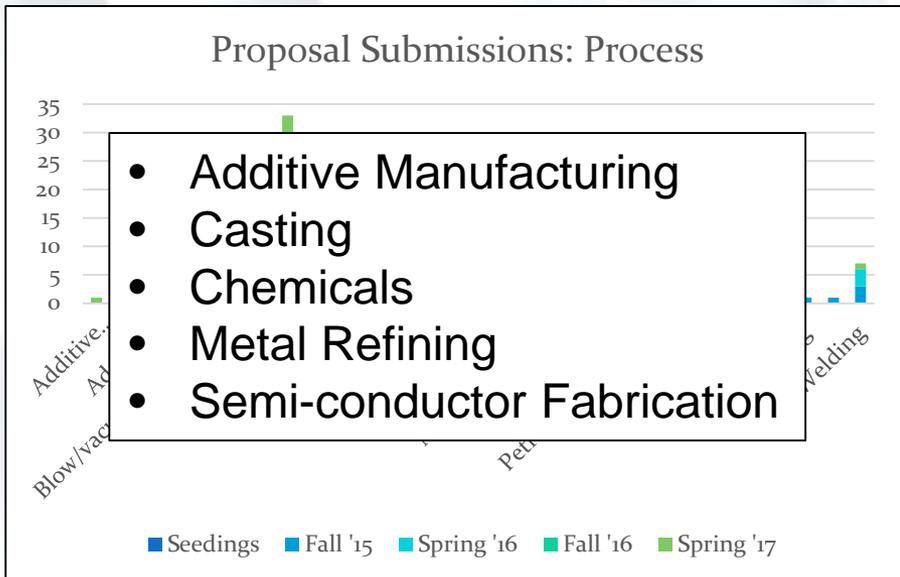
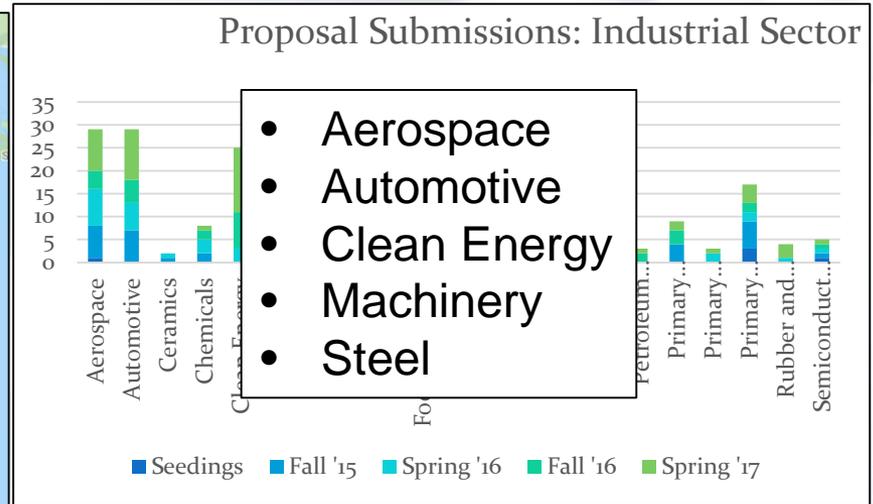
Company	Lead Lab	Topic	Notes
PPG Industries	LBL	Optimizing Rotary Bell Atomization	Follow on
Vitro Flat Glass, LLC.	LLNL	Training of a Neural Network Reduced-order Model for Glass Furnace Operations	Follow on
Eaton Corporation	ORNL	HPC to Enable Next Generation Low Temperature Waste Heat Recovery	
Caterpillar Inc.	ANL	Heavy-duty Diesel Engine Combustion Optimization for Reduced Emissions, Reduced Heat Transfer, and Improved Fuel Economy	VTO/New Company
Vader Systems, LLC	SNL	Computational Modelling of MHD Liquid Metal 3D Printing	New company/new lab/ small business
General Motors LLC	LLNL	Computational Modeling of High Pressure Resin Transfer Molding (HP-RTM) of Automotive Structural Carbon Fiber (CF) Composites	VTO
Arconic Inc.	LLNL	Multiscale modeling of microstructure evolution during rapid solidification for additive manufacturing	FE



# Results: Concept paper participation has been diverse in both geographic location and topic

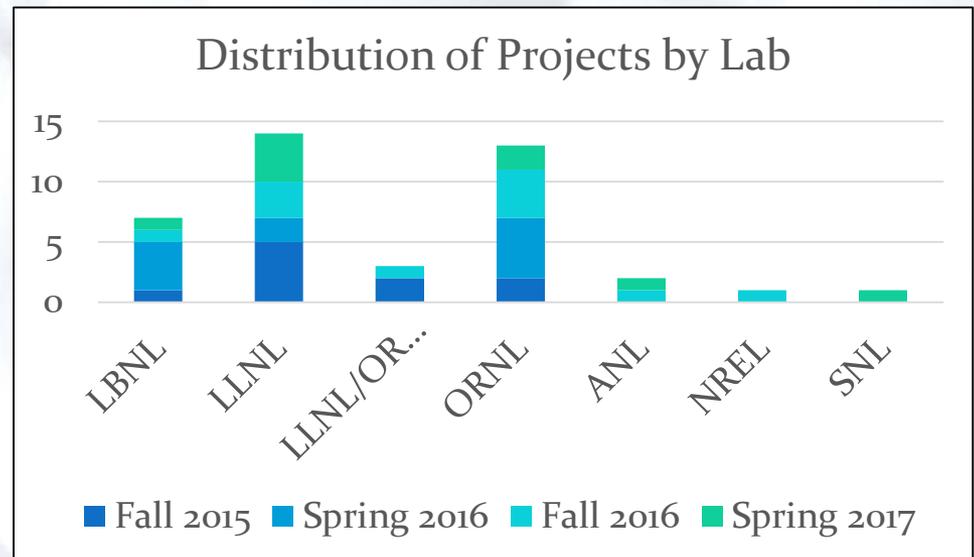
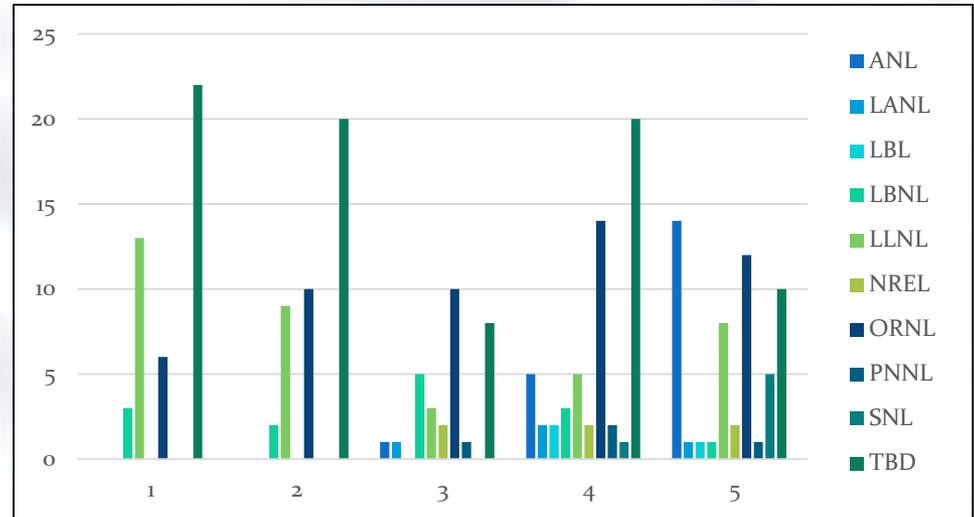


34 States: CA, CT, IL, IN, MI, NY, OH, PA have more than 10 each



# Results: HPC expertise at most of the national labs is being leveraged by industry

- Projects from the first two solicitations went to principal labs
- LLNL, ORNL, LBNL have the bulk of the projects
  - Artifact of how the program started
- Bringing in new laboratories with each solicitation
- Now funding projects with 8 different national laboratories

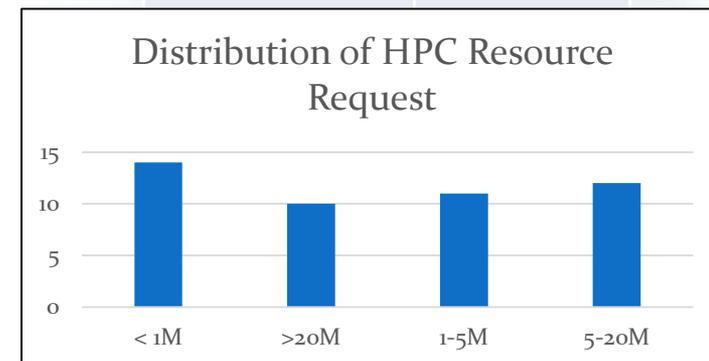


# Results: HPC resources requested are diverse in size, location, and machine type

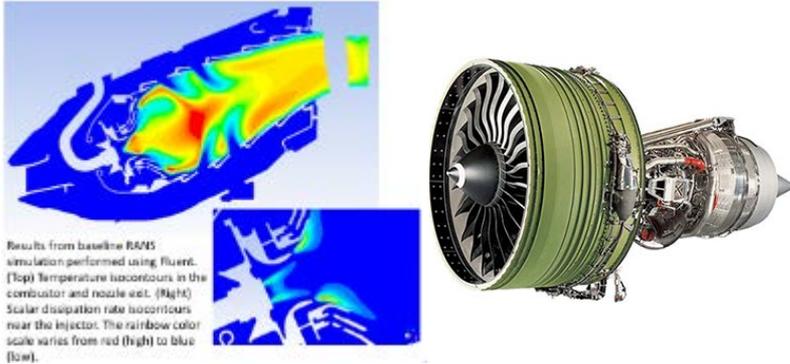
Solicitation	Total Hrs Requested (M)	Number of Projects	Avg Hrs/Project (M)
Seedlings	10.52	5	2.10
Fall 15	75.56	9	7.56
Spring 16	285.0	12	23.75
Fall 16	181.6	13	13.97
Spring 17	97.1	7	13.87
Total	649.7	46	13.82

Lab (# requests)	Average
LBL (8)	30.71
ORNL (18)	10.71
LLNL (33)	3.47
ANL (4)	12.85
NREL (1)	30.00
NETL (1)	1.10
SNL (1)	5.00
Total	9.71

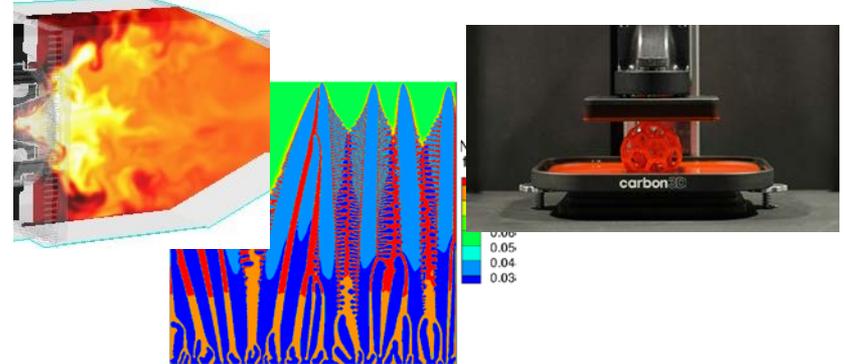
- Average # of core-hours requested: ~13M
- Total needs for the program estimated to be 200-300M core hours/year (100-150M/solicitation)
- Cycles currently come from ALCC requests, NREL, Director's discretionary awards



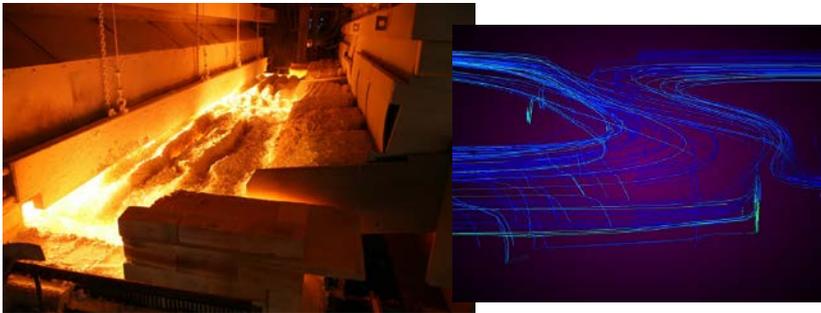
# Results: HPC4Mfg has reached a large number of industrial sectors



**Aerospace and automotive: light-weighting (LIFT), turbine design (GE), spray paint (PPG), Engine efficiency (Ford, Caterpillar), etc**



**Advanced Manufacturing Processes: additive manufacturing (GE, UTRC, Carbon, Arconic), casting (Shiloh), welding/joining (Edison, GM), etc**



**Metal and Glass: furnace operation and optimization (US Steel, Vitro Glass), alloy development and use (Arconic), fiber glass draw (PPG), etc**



**Consumer Products: paper towels (P&G), food particle driers (Zoomessence), LED lightbulbs (SORRA), microelectronics (Samsung), Paper (Agenda 2020), etc**

- Demonstration projects are expected to show the potential of HPC to improve manufacturing processes
- Follow on projects can be requested
  - Must move the technology closer to operation/ deployment
  - Higher cost share requirement showcases company commitment
- Possible transition paths for HPC4Mfg projects
  - HPC technology incorporated and run in-house
  - Follow on CRADA with national lab to continue work
  - Use of external commercial software/cloud computing

# If HPC<sub>4</sub>Mfg is successful...

- The development and deployment of energy-efficient manufacturing is accelerated through funded projects
- The production or adoption of clean tech is enabled through funded projects
- HPC becomes a useful tool to a broad array of small, medium, and large companies in designing new products, reducing cost and energy consumption, accelerating time to market
- More collaborations between DOE labs and U.S. manufacturers are enabled increasing competitiveness
- Simulation capabilities at the DOE laboratories are improved

# Questions?

Additional information at [HPC4Mfg.org](http://HPC4Mfg.org)

Questions can be sent to  
[HPC4Mfg@llnl.gov](mailto:HPC4Mfg@llnl.gov)

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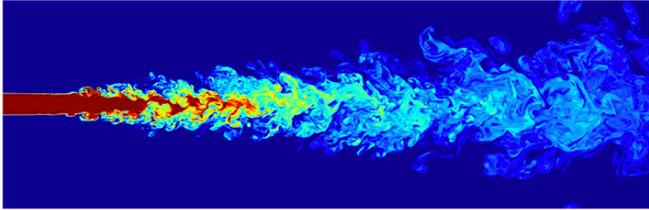
**Four HPC4Mfg posters on display at the reception give a sampling of technical projects**



**HPC4** MANUFACTURING

Home Projects Partner Laboratories Solicitation FAQ Events Mailing List

## High Performance Computing for Manufacturing HPC4Mfg Accelerating Innovation



### DOE HPC4Mfg Program Funds 13 New Projects

The DOE HPC4Mfg Program funds 13 new projects to improve U.S. energy technologies through high performance computing for a total of \$3.9M. The 13 new projects include: LLNL and ORNL partnering with various manufacturers (Applied Materials, GE Global Research, and United Technologies Research) to improve additive manufacturing processes that use powder beds to reduce material use, reduce defects and surface roughness, and improve overall quality of the resulting parts; LBNL partnering with Samsung Semiconductor Inc. to improve the performance of semi-conductor devices by enabling better cooling through the interconnects; Ford Motor Company partnering with ANL to understand how manufacturing tolerances can impact the fuel efficiency and performance of spark-ignition engines; and NREL partnering with 7AC technologies to model liquid/membrane interfaces to improve the efficiency of air conditioning systems. In addition, one of the projects, a collaboration among LLNL, NETL, and 8 Rivers Capital to study coal-based Allam cycle combustors will be co-funded by DOE's Fossil Energy Program.

[View full list of projects.](#)

The HPC for Manufacturing Program (HPC4Mfg) Program unites the world-class computing resources and expertise of Department of Energy national laboratories with the U.S. manufacturers to deliver solutions that could revolutionize manufacturing.

Led by Lawrence Livermore National Laboratory (LLNL), and joined by its partners, Lawrence Berkeley and Oak Ridge national laboratories, HPC4Mfg offers a low-risk path for U.S. manufacturing companies interested in adopting high-performance computing (HPC) technology to advance clean energy technologies and increase energy efficiency while reducing risk of HPC adoption.

The HPC4Mfg Program aims to:

- Infuse advanced computing expertise and technology into the manufacturing industry.
- Advance innovative clean energy technologies.
- Reduce energy and resource consumption.

**News**

- Fall 2016 Awardees
- Industry Engagement Day a success!
- Innovating in Foundational Industries: Steel
- Fall 2016 Solicitation now closed
- DOE Social Media posts:
  - Facebook
    - Round 2 Selection
    - Round 3 Solicitation

**Contact**

For additional information on the HPC4Mfg Program, email [hpc4mfg@llnl.gov](mailto:hpc4mfg@llnl.gov).

**Partner Laboratories**

-  BERKELEY LAB
-  OAK RIDGE  
National Laboratory
-  Lawrence Livermore  
National Laboratory