California Regional Manufacturing Center (CA RMC)

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CLEAN ENERGY SMART MANUFACTURING INNOVATION INSTITUTE™

Accelerating
Your Smart Manufacturing Transformation

Overview

- Smart Manufacturing?
- Why CESMII, the Smart Manufacturing Institute
- CA-RMC Team
- Demonstration Centers

What is Smart Manufacturing?

The ability to take action, in real time, to OPTIMIZE assets in the context of business strategies and imperatives

Affordable, Accessible, Innovative and Secure Intelligent, Seamless & Collaborative Networked-Based, Smart Manufacturing
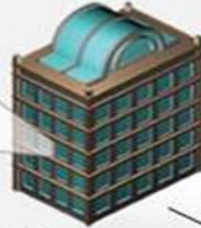
Connected Supply Chain
- Agile
- Demand Driven
- Raw Material to Finished Product

Business Systems, ERP

Safe Production
- Improved safety
- Fewer incidents
- More user friendly

Sustainable Production
- Higher value products
- Data for decision making
- Product Lifecycle Management
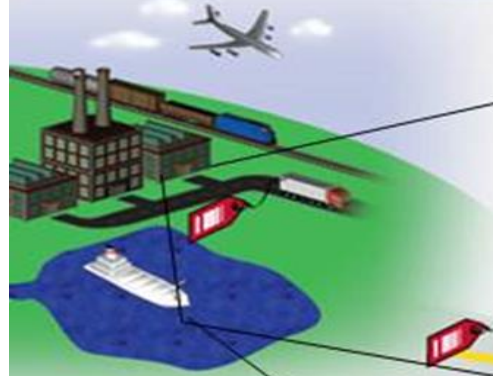
Supply Chain

Smart Factory

Distribution Center

Customer

Smart Grid

Energy Efficient
- Lower emissions
- Less energy used
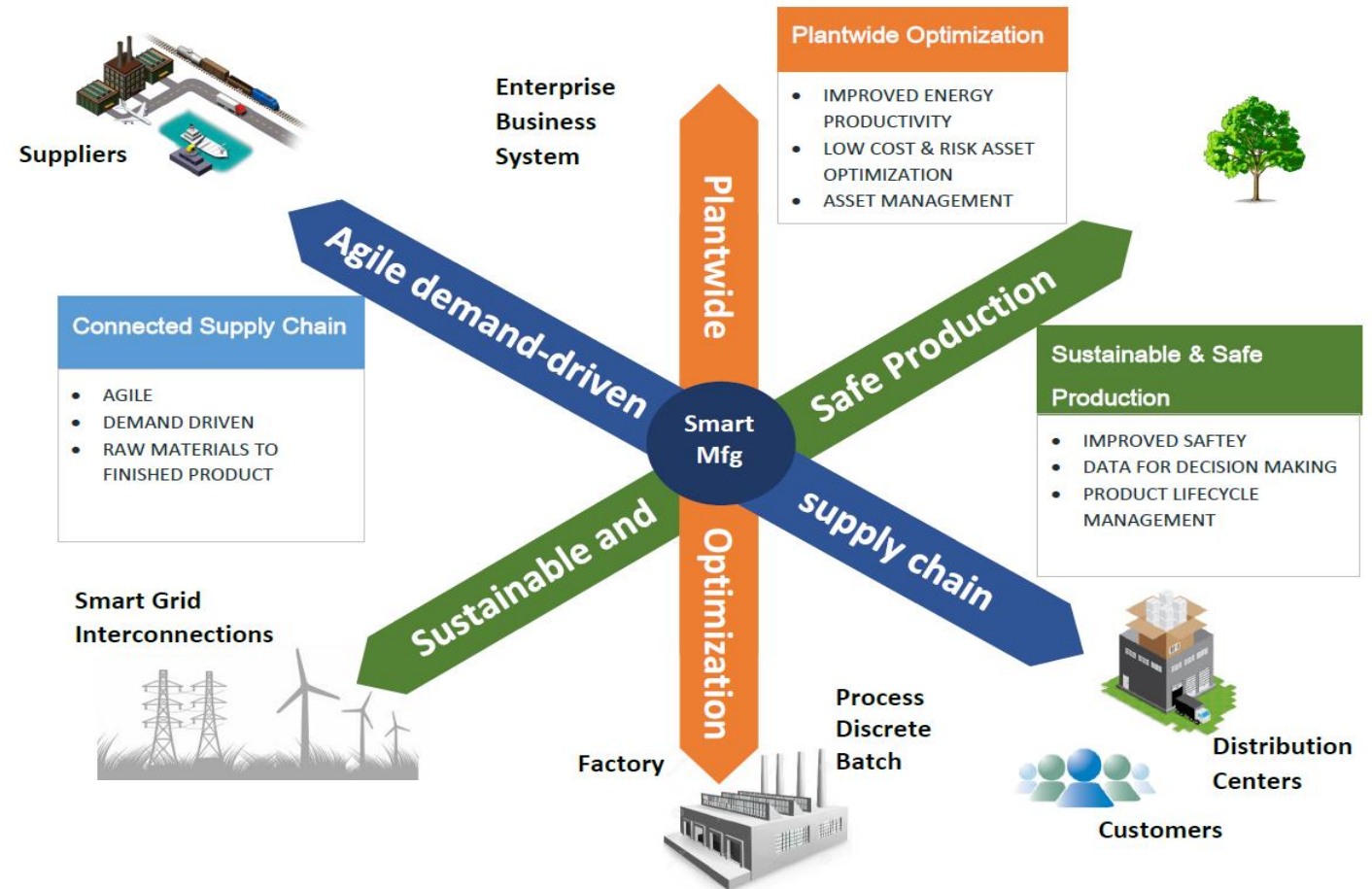- Green manufacturing

Optimization
- Asset Utility/Zero Downtime
- Quality/Zero Defects
- Reliable results

Smart Manufacturing

**A Comprehensive Approach
to Manufacturing**

…to achieve:
- Connected Supply Chain
- Plantwide Optimization
- Sustainability & Safety
- Increased Productivity
- Effective Risk Management
- High Quality Products
- Innovation
- Great Customer Service

SMLC and CESMII Road

SMLC's Industry-Driven Strategy
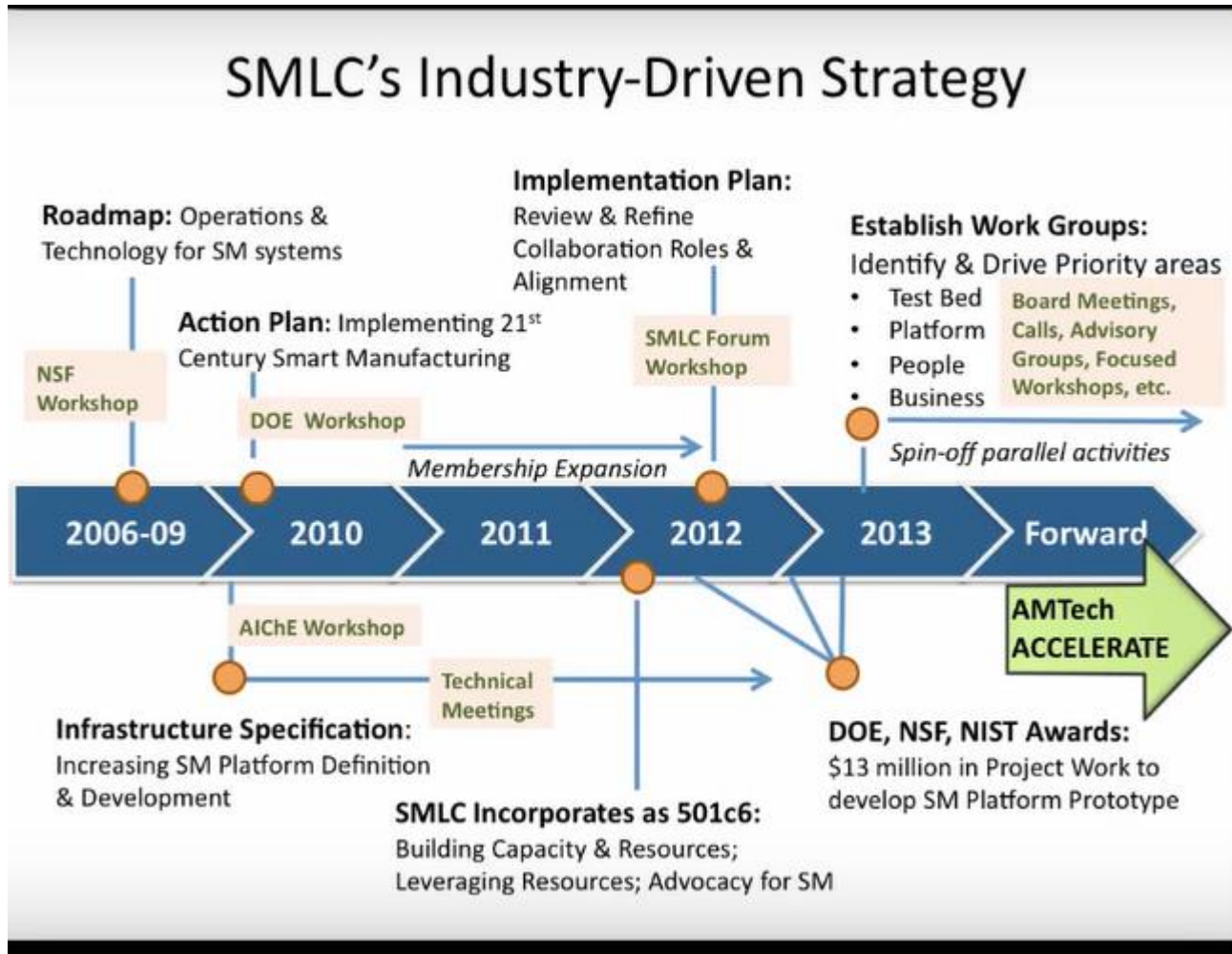
- DOE defined industry's requirements for Smart Manufacturing.

- DOE released RFP for Smart Manufacturing FY15.

- SMLC and others submitted response.

- DOE awarded contract to SMLC FY16.

- SMLC and DOE jointly outlined program objectives, FY16.

- SMLC created CESMII to be the preforming institute FY16.

- CESMII kickoff event held at UCLA Fed 23rd.

- Program infrastructure phase 1 standing up, 6 months.

- We are here today.
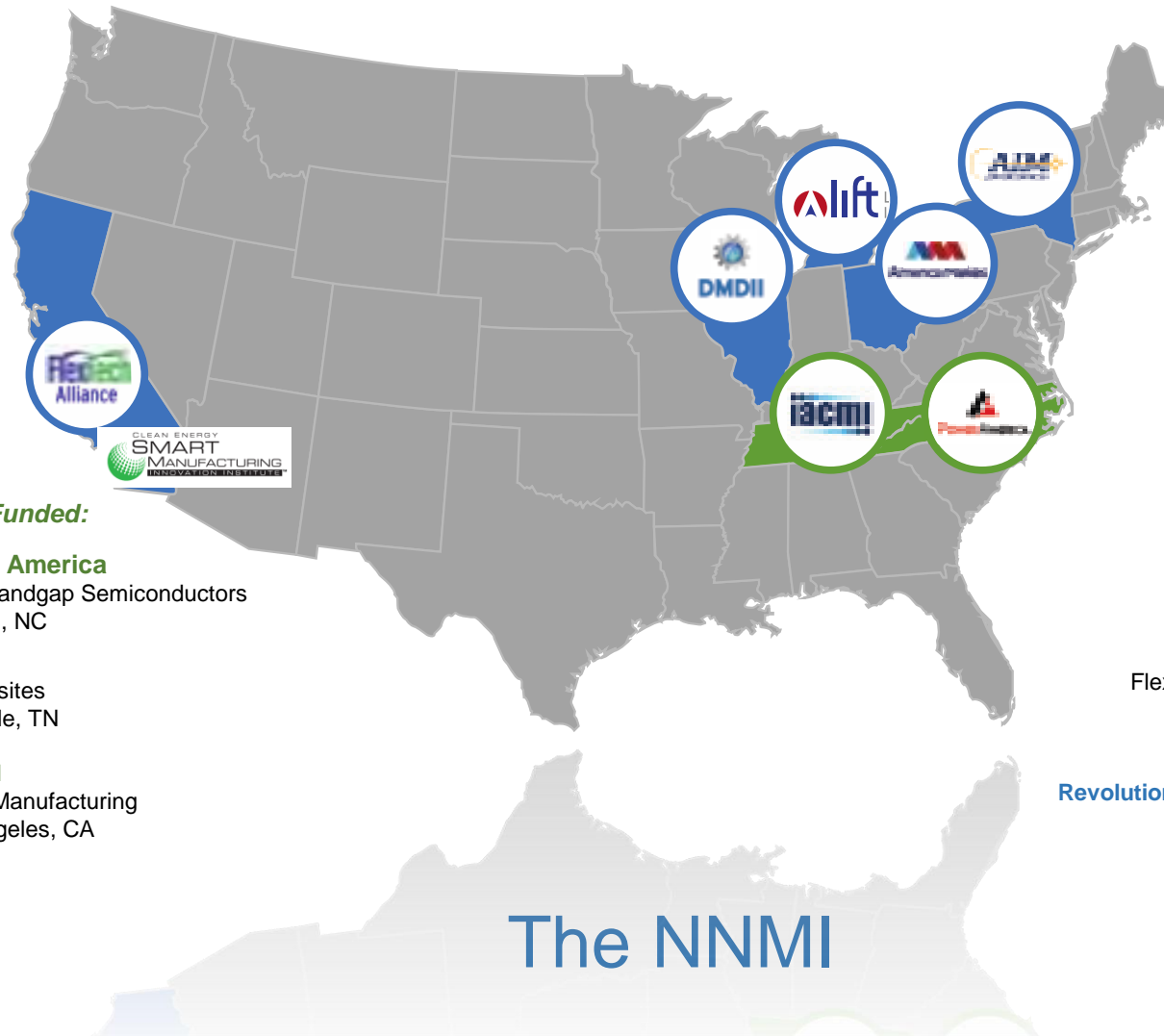
DOE Funded:

Power America
Wide Bandgap Semiconductors
Raleigh, NC

IACMI
Composites
Knoxville, TN

CESMII
Smart Manufacturing
Los Angeles, CA

DOD Funded:

America Makes
3D Printing / Additive
Manufacturing
Youngstown, OH

DMDII
Digital Manufacturing
& Design
Chicago, IL

LIFT
Lightweight Metals
Detroit, MI

AIM Photonics
Photonics
Rochester, NY

FLEXTECH Alliance
Flexible Hybrid Electronics
San Jose, CA

Unawarded Institutes:
Revolutionary Fibers & Textiles

The NNMI

A National Network of Institutes focused on advanced manufacturing technologies
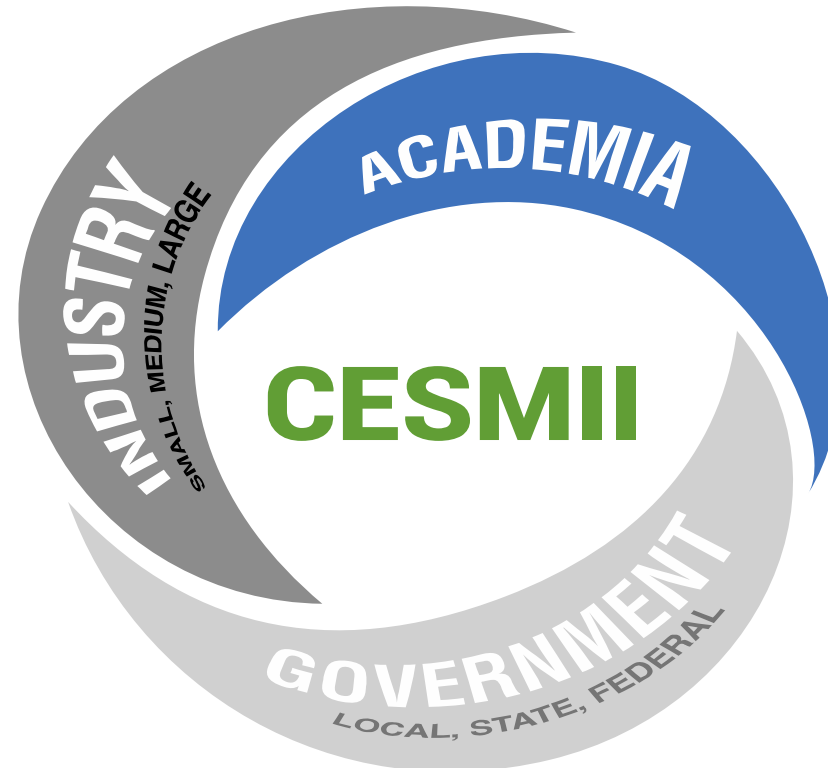
CESMII Objectives

Our Institute will:

- Provide Breakthrough Capability to Drive Energy Reduction by $195 B

- Be Industry Led and Driven

- Service all Manufacturing Segments

- Develop the Workforce and Job Creation

- Be Open to All Size of enterprises

- Achieve Financial Independence in 5 Years or less

CESMII
A National Network of Capability
Headquartered in LA

Northwest

Northeast

California

Southeast

Gulf Coast
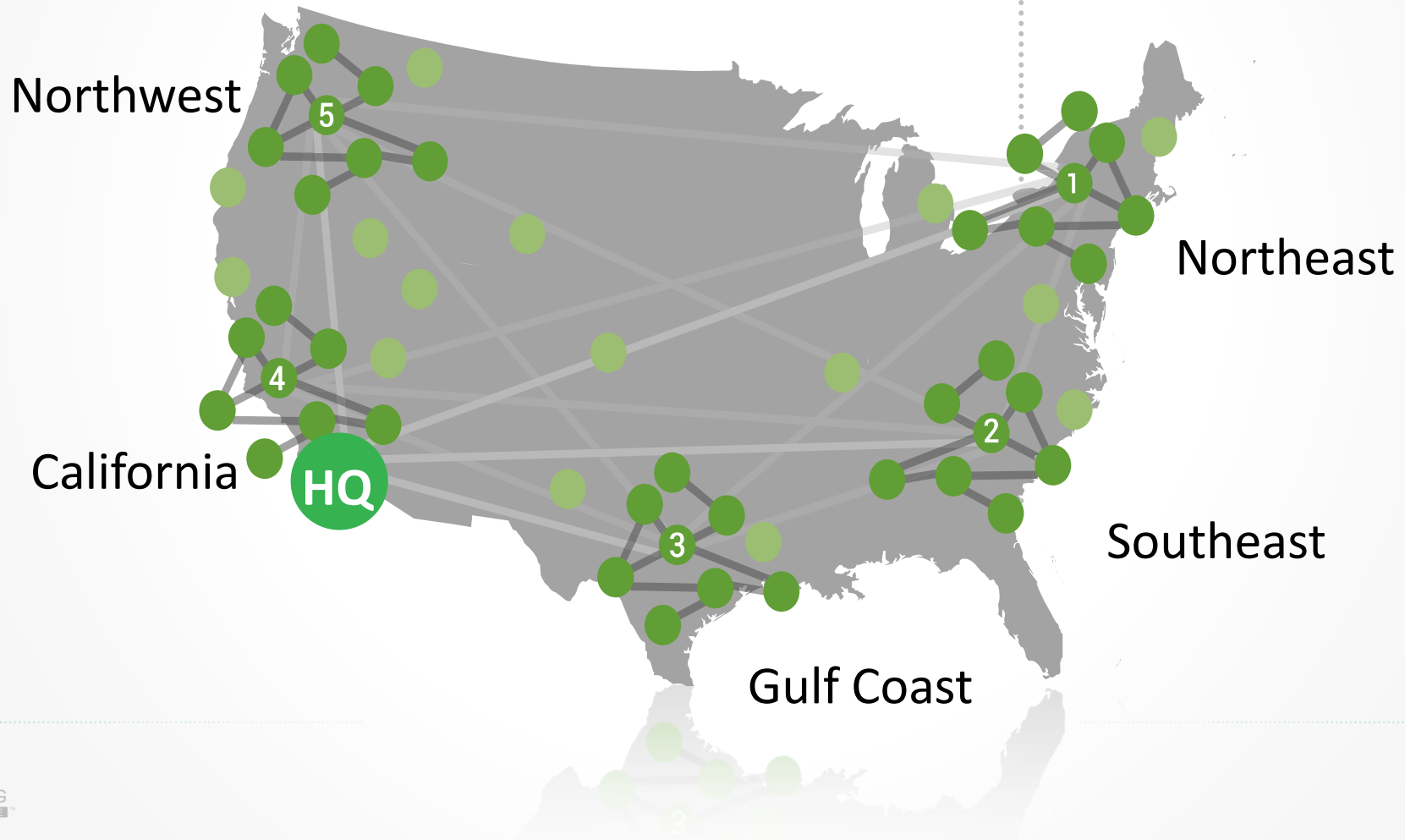
The Regional Manufacturing Centers

- Test Bed Pipeline
- Drive Membership
- Develop Technology
- Implement SM Projects
- Participate in CESMII LRP
- Regional Workforce Development and Training
- Members of Advisory Committees
- Regional Budget Management
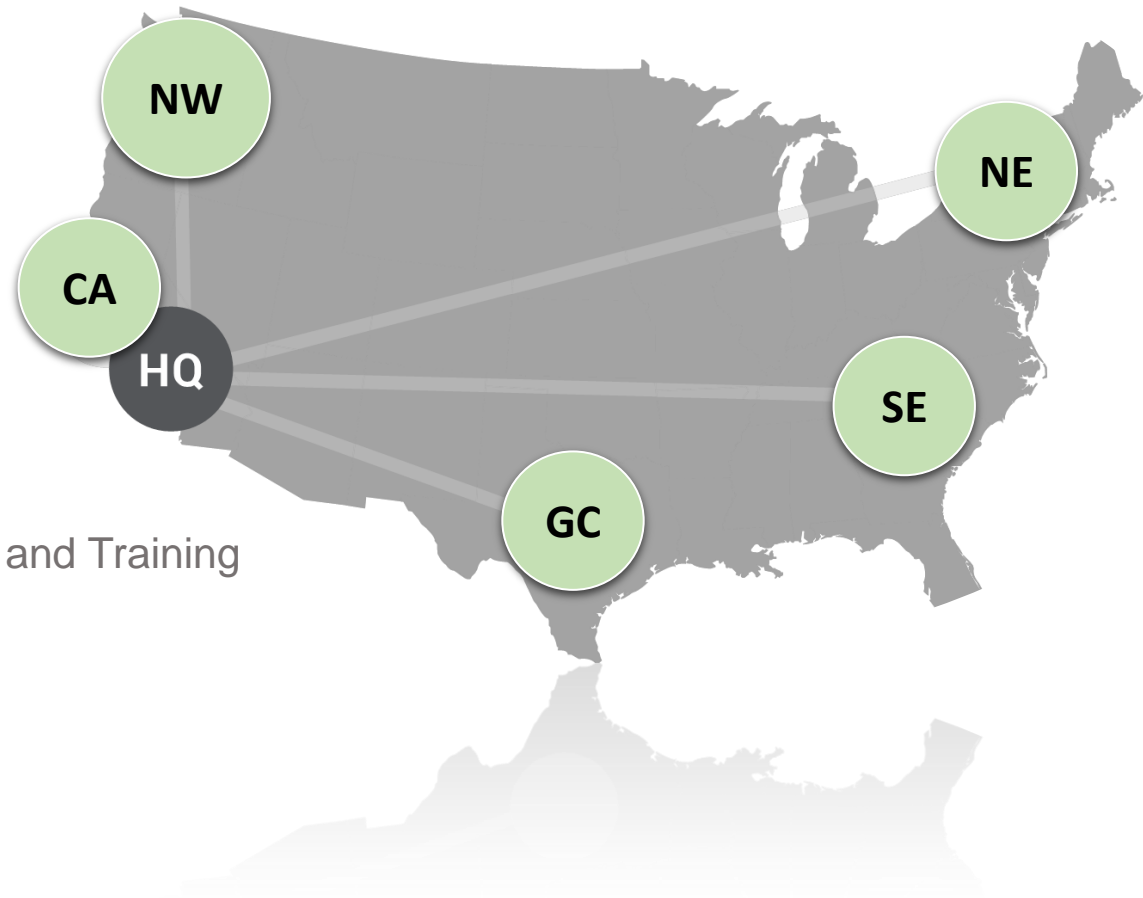
US Manufacturing Has Regional Diversity
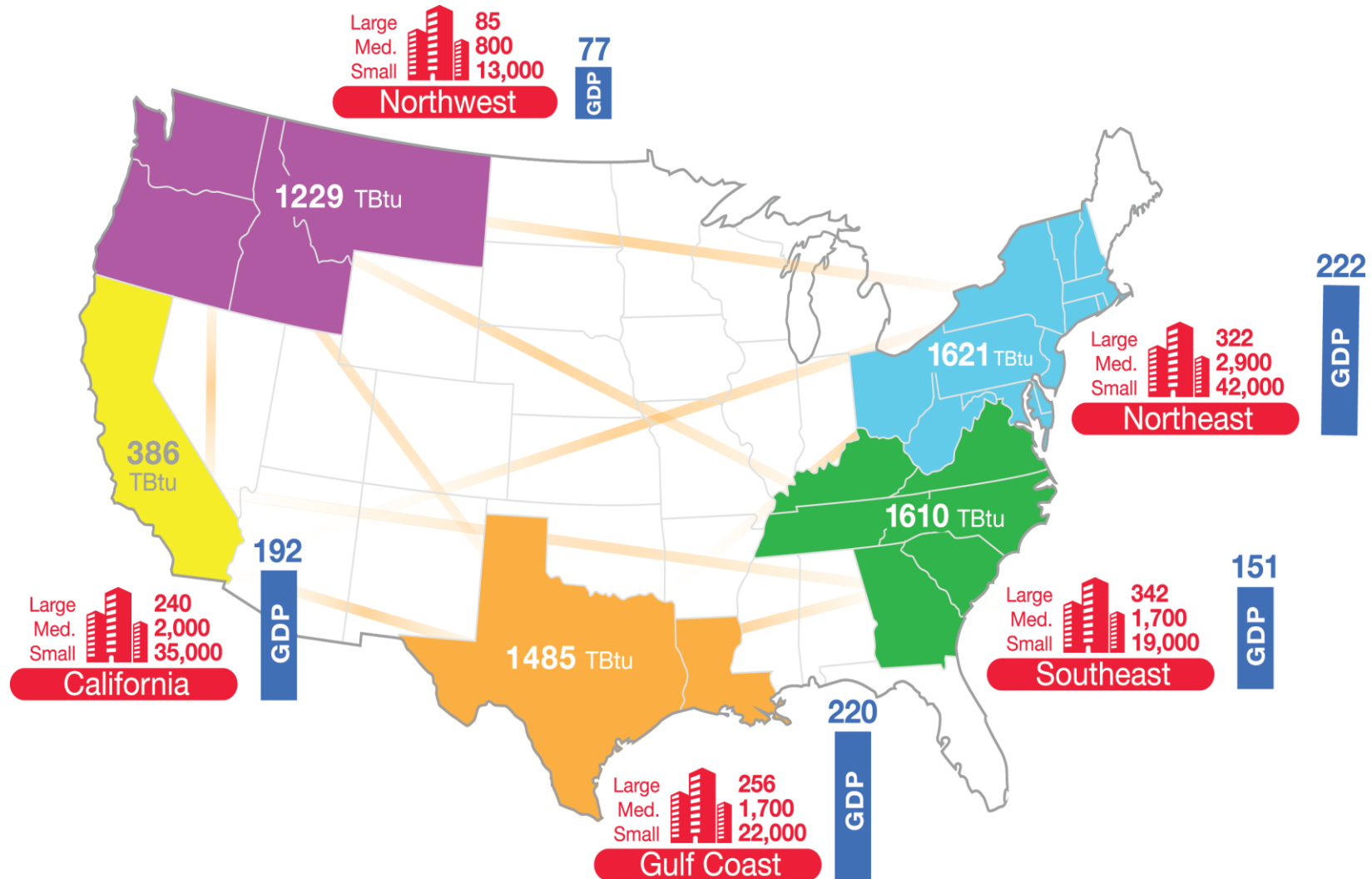
Regional Centers

Each regional center is operated according to three key tenets:

R&D

Workforce Development

Testbed Infrastructure

CA RMC Team

Smart Manufacturing Capabilities

CA RMC contains a wealth of Smart Manufacturing capabilities…

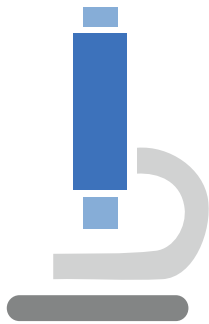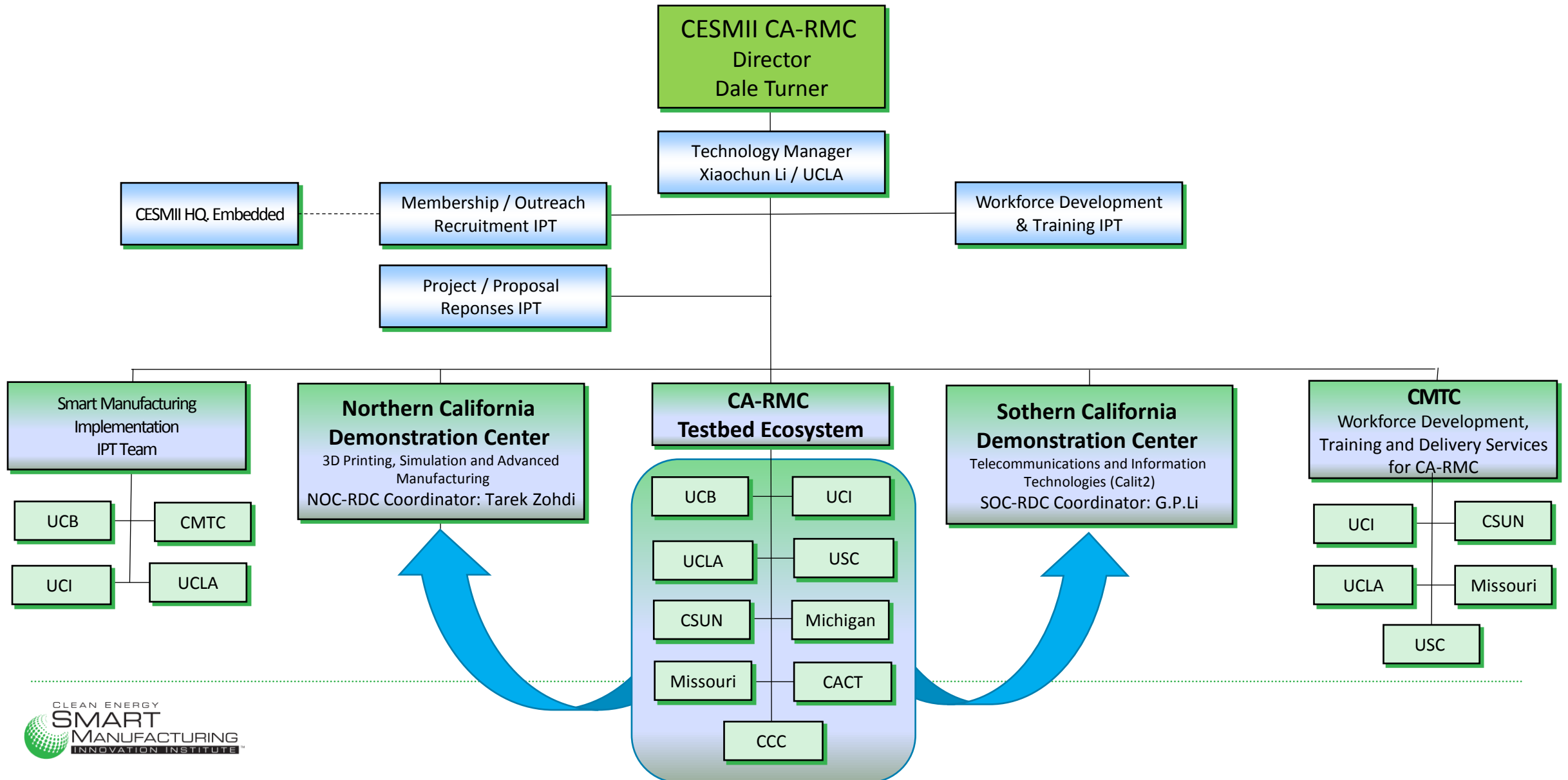|	University of California Berkeley (UCB)	University of California Irvine (UCI)	University of California Los Angeles (UCLA)	University of Southern California (USC)	California State University Northridge (CSUN)	California Community Colleges (CCC)	Centers for Applied Competitive Technologies (CACTs)	Michigan Technological University (MTU)	Missouri University of Science & Technology (MS&T)
Unique Technical Capabilities	• Internet of Things (IoT) • Modeling & Control • High Performance Computing • Hybrid robotically-enabled manufacturing systems	• Smart worker IIoT workflow • Ultra precision sensing • Semiconductor process design & control • Augmented Reality / Virtual Reality (AR/VR) workflow modeling	• Sensors, wireless systems & control • Cyber security • Micro/Nano design & fabrication • Science-based & data-based modeling • Smart manufacturing platform	• Robotics & Automation • Internet of Things (IoT) • Sensors • High Performance Computing • Data Analytics • Modeling and Simulation • Systems Architecting and Engineering	• Software development & software systems • Advanced Sensors • Real Time Analysis & Control Systems • Advanced High Fidelity Modeling • Advanced Manufacturing, Composites	• Automation & Robotics Technologies • Electric & Hybrid Automotive Technology • Electrical Systems & Power Transmission • Electro-Mechanical Technology • Machining & Machine Tools	• Automation • Carbon Fiber Composites Manufacturing • Electronics Technology • Industrial Automation • Mechatronics • Machining & CNC Programming • Nano-technology • Photonics • Robotics	• Process Simulation • System Analysis • Bioenergy production • Clean Energy manufacturing	• Peaslee Steel Manufacturing Research Center • MidAmerica Regional Microgrid Education & Training • Advanced sensors • Multi-scale, multi-physics modeling & simulation

Smart Manufacturing domain expertise

CA RMC Smart Manufacturing knowledge by industry's…

	Petroleum & Coal Products	Primary Metals	Food & Beverage Processing	Chemicals	Non-Metallic Mineral Products	Paper Products	Fabricated Metal Products
Technical Domain Expertise	• Life Cycle Analysis • Bioenergy production • Petroleum Production & Engineering • Energy Data Management & Analysis • Energy Instrumentation	• Additive manufacturing (metal-based 3D Printing) • Solidification processing • Light metals • Metallic nano-composites	• Chemicals and biologicals analysis	• Systems Analysis • Sensors • Composite Fabrication	• Carbon MEMS • Semiconductor micro-electronics • Sensors • Actuators • Embedded control system	• Process design • Systems Analysis • Process Measurements & Controls • Process Simulation	• Additive Manufacturing (metal-based 3D Printing) • Thin sheet metal stamping, machining, assembly

California Economy
Diverse economy across both geography and industries

California's Manufacturing Sector by Region

Northern California
Manufacturers 2.5 %
Manufacturing Jobs 1.5 %
Small Manufacturers 2.6 %
Wood Products | Food Processing
Beverage
Rural

Central Coast
Manufacturers 3.9 %
Manufacturing Jobs 2.7 %
Small Manufacturers 4.0 %
Computer & Electronics
Food Processing | Beverage
Urban

Los Angeles Area
Manufacturers 33.8 %
Manufacturing Jobs 30.6 %
Small Manufacturers 35.1 %
Fabricated Metal
Transportation Equipment | Apparel
Urban

Sacramento Area
Manufacturers 3.5 %
Manufacturing Jobs 2.9 %
Small Manufacturers 3.8 %
Computer & Electronics
Food Processing | Fabricated Metal
Urban

Central Valley
Manufacturers 7.0 %
Manufacturing Jobs 8.7 %
Small Manufacturers 6.1 %
Food Processing | Fabricated
Metal | Beverage
Rural with some Urban

Orange County
Manufacturers 12.3 %
Manufacturing Jobs 12.6 %
Small Manufacturers 11.9 %
Computer & Electronics | Fabricated Metal
Medical Equipment
Urban

San Francisco Bay Area
Manufacturers 20.9 %
Manufacturing Jobs 26.0 %
Small Manufacturers 20.6 %
Computer & Electronics
Food Processing | Chemicals
Urban

Inland Empire
Manufacturers 8.3 %
Manufacturing Jobs 7.3 %
Small Manufacturers 8.1 %
Fabricated Metal
Plastics & Rubber
Food Processing
Urban

San Diego
Manufacturers 7.8 %
Manufacturing Jobs 7.8 %
Small Manufacturers 7.8 %
Computer & Electronics | Transportation Equipment,
Biotechnology & Pharmaceutical
Urban

California Manufacturing Regions Legend
Regions % of California's Manufacturers
Regions % of California's Manufacturing Jobs
Regions % of California's Small Manufacturers
Top 3 Manufacturing Sectors
Primary Regional Make-up Urban or Rural

- **8th largest economy in the world**
- **Rich manufacturing cross-section**
  - **Manufacturers encompass virtually all industries**
  - **Over 96% of manufacturers are small and medium-sized**
- **Strong technology industry presence**
  - **Silicon Valley**
  - **Silicon Beach**
- **Progressive energy state**
  - **State policies**
  - **Public support**

California Economy
## California Energy Data Analysis Reflects a Diverse Manufacturing Ecosystem
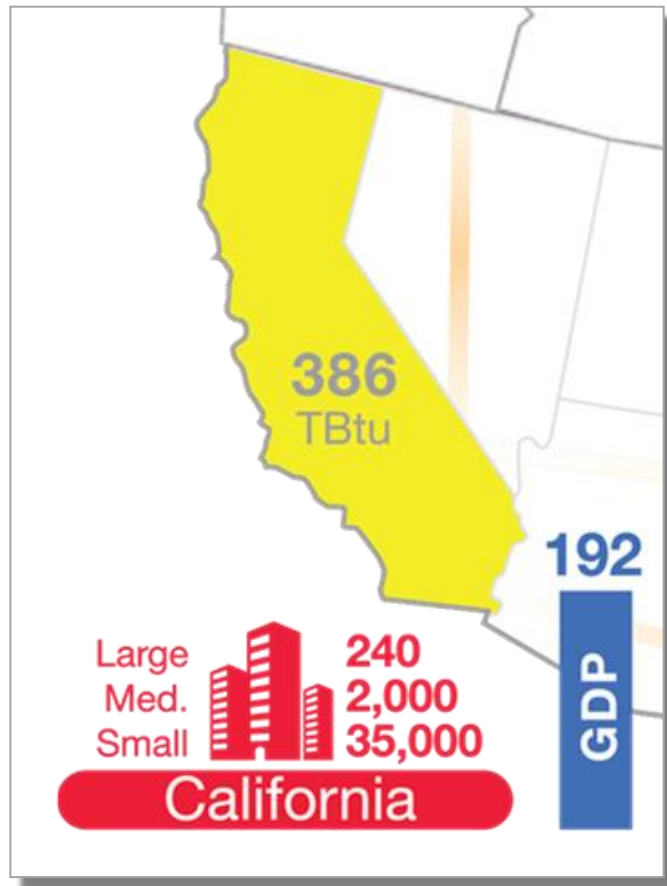
Rank	California				
	Energy (All enterprises)	TBTU	Output (All enterprises)	$Million	
1	Petroleum and Coal Products	100-120	Computer and Electronic Products	57,405	
2	Primary Metals	75-85	Petroleum and Coal Products	33,359	
3	Food & Beverage Processing	40-50	Chemicals	25,500	
4	Chemicals	40-50	Food & Beverage Processing	19,900	
5	Nonmetallic Mineral Products	25-30	Aerospace & Other Transp. Eq.	12,585	
6	Paper Products	25-30	Miscellaneous	12,395	
7	Miscellaneous	15-20	Fabricated Metal Products	11,331	
8	Fabricated Metal Products	8-15	Machinery	10,058	
9	Plastics and Rubber Products	7-12	Motor Vehicles	5,142	
10	Machinery	5-10	Plastics and Rubber Products	4,682	
	Sum of Top Ten	386	Sum of Top Ten	192,357	
	Sum of Top Five	314	Sum of Top Five	148,749	

Rank	California					
	Small Enterprises (<100 employees)	TBTU	Medium Enterises (100-499 employees)	TBTU	Large Enterprises (500+ employees)	TBTU
1	Primary Metals	13-19	Petroleum and Coal Products	90-95	Primary Metals	18-22
2	Food & Beverage Processing	5-10	Primary Metals	45-50	Petroleum and Coal Products	15-20
3	Chemicals	5-10	Food & Beverage Processing	22-28	Chemicals	10-15
4	Nonmetallic Mineral Products	2-6	Chemicals	21-27	Food & Beverage Processing	10-15
5	Miscellaneous	2-6	Paper Products	15-20	Nonmetallic Mineral Products	4-8
6	Petroleum and Coal Products	2-4	Nonmetallic Mineral Products	13-19	Paper Products	4-8
7	Paper Products	2-4	Miscellaneous	7-11	Miscellaneous	4-8
8	Fabricated Metal Products	1-3	Fabricated Metal Products	3-7	Fabricated Metal Products	2-5
9	Plastics and Rubber Products	<2	Plastics and Rubber Products	2-6	Plastics and Rubber Products	2-5
10	Machinery	1	Machinery	2-6	Machinery	-
	Sum of Top Ten	52	Sum of Top Ten	244	Sum of Top Ten	91
	Sum of Top Five	40	Sum of Top Five	206	Sum of Top Five	69

National Network Capabilities

CESMII is closely aligned with the Manufacturing Extension Partnership (MEP) Program
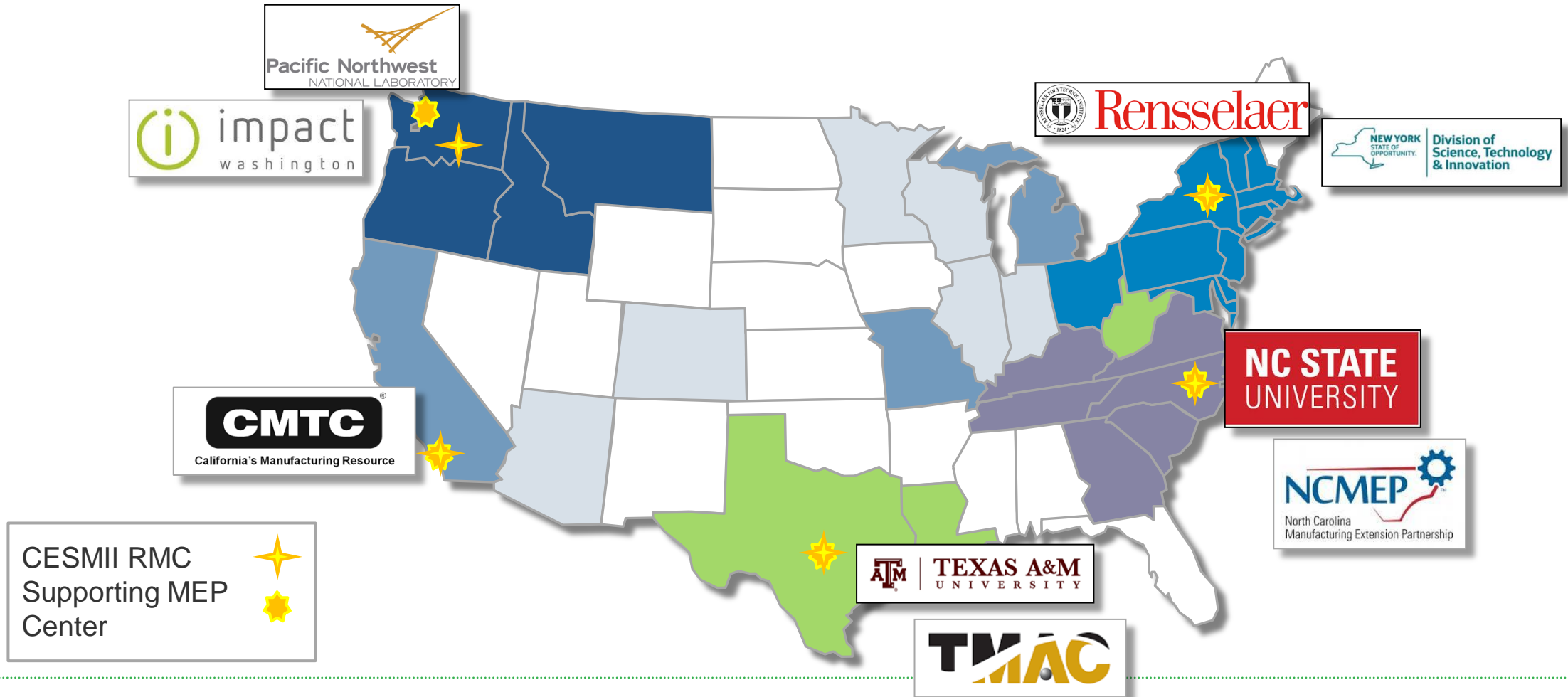
Nationally, MEP Centers are supporting technology transfer at nine Manufacturing USA Institutes

- **MEP Embedded Staff Program**
  - In residence at the Institutes
- **EMUSA Leadership Group**
  - Facilitating collaboration opportunities across institutes

The CA RMC Ecosystem is ready to serve our members

Northern California Demonstration Center

University of California Berkeley

Unique Capabilities:
- Extensive 3D Printing Facilities
- Extensive simulation technologies
- Paul Wright: primarily advanced manufacturing and energy
- Tarek Zohdi (UCB Coordinator/PI): primarily adv. manufacturing and simulation
- The ME Manufacturing Group

Technologies Demonstrated:
- CAD to Print Technologies
- Printing of Multi-physical Materials

Other Participating UCB Centers:
- The UC Berkeley COE
- The Jacobs Institute for Design Innovation
- Center for Information Technology Research in the Interest of Society
- Computational and Data Science and Engineering Program

3,500 Ft² Demonstration Facility planned for Etcheverry Hall, Department of Mechanical Engineering

The CA RMC Ecosystem is ready to serve our members

Southern California Demonstration Center

Unique Capabilities:

- Microsemi IoT Innovation Lab
- Class 100/1,000 sensors/ actuators fabrication facility
- AR/VR Visualization
- Ansys IoT Innovation/ Simulation Center
- IBM Watson Think Tank for Advanced Manufacturing
- Evoke Lab for User Experience Design

Technologies Demonstrated:

- Workflow centric worker/machine interactive collaboration system
- Cognitive Digital Twins for Reduced Order Modeling
- Augmented/Virtual Worlds for game based simulations
- Cognitive learning systems
- User centric actionable information display

3,000 Ft² Demonstration Facility

California Institute for Telecommunications and Technology (Calit2)
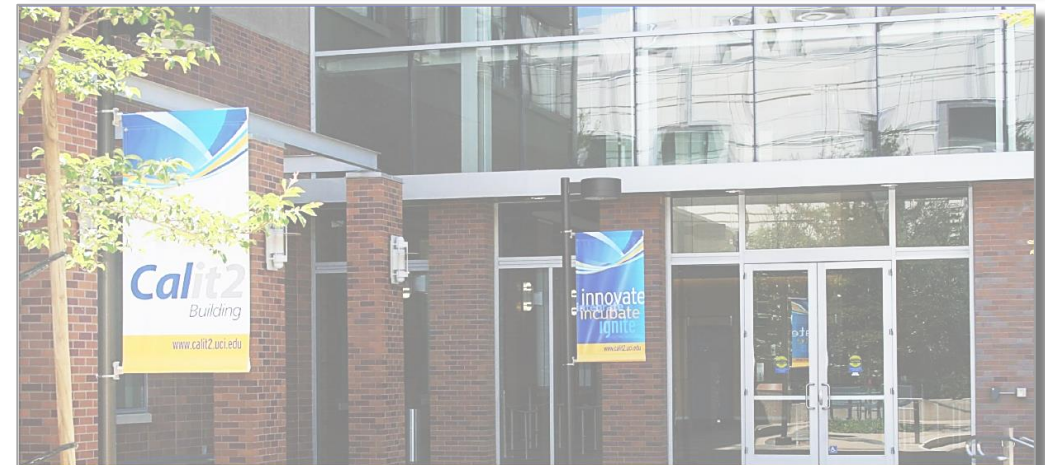
Other Participating UCI Centers:

- Cyber-Physical Systems
- Advanced Power and Energy Program
- Institute for Virtual Environments and Computer Games
- Institute for Design and Manufacturing Innovation

The CA RMC Ecosystem is ready to serve our members

Smart Manufacturing Test Bed Capabilities

- Real time integrated process and materials modeling, via reduced order/dimensionality modeling, improved numerical algorithms and co-processors
- Data assimilation and "real time" data analysis of process
- 9600 sq. ft. class 100/1000/10,000 clean room facility
- Power Electronics for smart grid integrated electric vehicle manufacturing
- Machine learning

- Design, fabrication, and embedding of sensors and wireless systems for harsh manufacturing environments
- Smart grid and energy use optimization
- High fidelity models and simulation schemes for chemical plants, energy systems, materials manufacturing processes and water treatment
- Discrete Element, Finite Element and Finite Difference methods
- Smart sensors and distributed controls
- Sustainable Production

- Advanced Manufacturing, Composites, Modeling, Characterization
- Data processing & management, cloud manufacturing software, cyber security & trustworthiness software,
- Adaptive real-time control, adaptive-dynamic programming based control, iterative process control, optimal control techniques, resilient networked control systems

The CA RMC Ecosystem is ready to serve our members

Workforce Development Capabilities

California Community Colleges

- Device/Software Scalable Augmented/Virtual Reality Technology Enabled by Smart Worker IoT data derived from CESMII Testbed operations
- Enhanced with Cognitive Digital Twins of process and workflow simulations augmented with CESMII platform data

CACT — Centers for Applied Competitive Technologies — MAKING IT IN CALIFORNIA

- Training students to map and analyze energy use in the built environment
- Automation Lab with rapid prototype, 3-D Printers and the latest CNC machines
- Micro-grid demonstration by employing renewable energy and alternative fuel source
- Curriculum development

Missouri S&T

- Apprenticeship and internship development
- Certificate and degree program development
- Comprehensive career pathways development (K-12, Community Colleges and University partnerships)
- Customized training in all areas of manufacturing

UCIRVINE   UCLA   USC University of Southern California   CSUN   Michigan Tech   SFI

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California RMC Capabilities Summary

Sensors, Controls & Algorithms, Platforms , HPC

Energy Sustainability, Economic Development, Workforce Development, etc.

Hold Questions