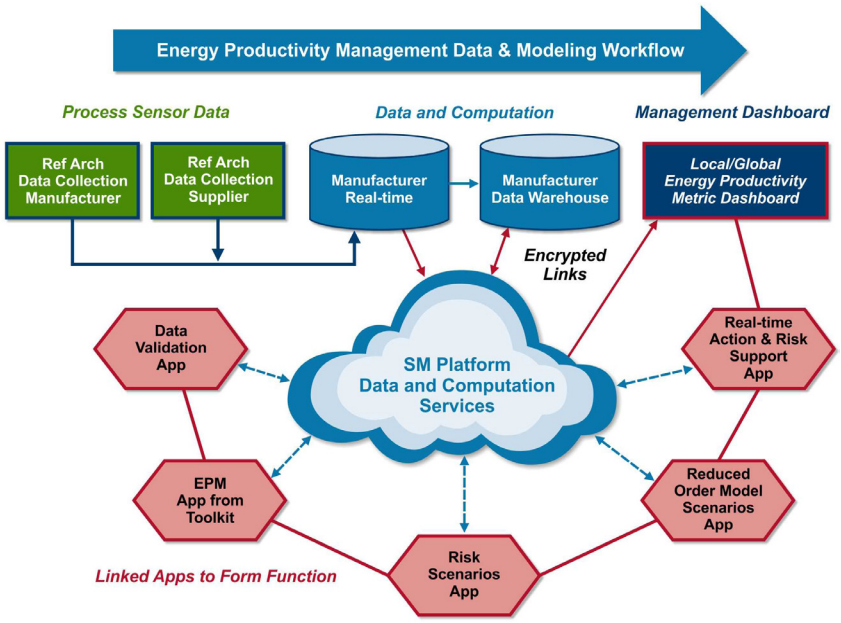
Industrial Scale Demonstration of Smart Manufacturing Achieving Transformational Energy Productivity Gains

Development of an Open Architecture, Widely Applicable Smart Manufacturing Platform

While many U.S. manufacturing operations utilize optimization for individual unit processes, smart manufacturing (SM) systems that integrate manufacturing intelligence in real time across an entire production operation are rare in large companies and virtually nonexistent in smaller organizations. One example of an area where SM systems can be applied is in the management of waste heat. A smart system that not only sought to recover waste heat, but also to generate less heat initially, would be a cost-effective tool optimizing the relationship between energy use and product output together.

The Smart Manufacturing Application and Data Platform (SM Platform) to be developed during this project is an innovative approach that integrates information technology, models, and simulations driven by real-time plant data and performance metrics. This SM Platform will allow manufacturing organizations, regardless of their industry or size, to assemble new management systems at a much lower cost, optimizing process knowledge and improving energy productivity by integrating with existing process control and automation systems. Development of an energy productivity metric—integrated with real-time process information—that provides comparisons for potential, practical, and actual performance, as well as the development of an Energy Dashboard that displays



Applying the capability of the SM Platform: energy productivity management data and modeling workflow. *Graphic image courtesy of the Smart Manufacturing Leadership Coalition*

alternatives to optimize energy use within specific business contexts, will help improve energy productivity and reduce emissions in U.S. manufacturing.

Benefits for Our Industry and Our Nation

The project team anticipates that project success, coupled with broad multi-sector adoption of the developed technology, could reduce waste heat generation by an amount equivalent to 1.3% of total U.S. energy use, as well as reduce annual carbon dioxide emissions by 69 million tons. Other potential benefits include reducing process times, solid and liquid wastes, environmental impacts, and water use.

This investment has an anticipated payback period of less than one year in energy-intensive applications. The SM Platform could also reduce the costs of deploying SM systems by 50% in manufacturing operations.

Applications in Our Nation's Industry

Installation of an SM management system could provide energy savings and cost reductions to a wide range of manufacturing industries. The SM Platform framework would be beneficial for large, energy-consuming manufacturing sectors, such as petroleum refining, chemicals, steel, and biofuels. The energy, food, and paper processing industries would also likely realize attractive payback periods by adopting the SM Platform.

Project Description

The overall project objective is to develop an industry-accepted SM Platform that can be scaled to a diverse set of manufacturing operations. Specifically, the project plans to (1) design and demonstrate the application of a prototype SM Platform for two diverse commercial test beds, (2) demonstrate a 30% reduction in waste heat generation at each of the test beds, and (3) work with a group of leading automation vendors to catalyze low-cost commercialization of the technology developed.

Barriers

- Ensuring timely access to high-quality data from test beds.
- Integrating all desired functionalities into the SM Platform.

Pathways

The SM Platform will be designed based on current manufacturing and IT industry standards; basic hardware and software components that will be used have already been successfully demonstrated. In addition, an energy productivity metric and an application toolkit will be defined so that they can be tailored to a specific business situation. The project will involve the use of two test beds—one in a hydrogen production plant, and the other in a forging and heat treating operation. For each test bed, sensor-driven modeling, measurement, and simulation systems, in conjunction with the SM Platform, will be developed, deployed, and operated, allowing energy consumption to be managed in real time. An Energy Dashboard developed for each test bed will provide situation awareness by integrating the energy productivity metrics with real-time information. Previously unavailable intelligence will be used to identify overall operations improvement opportunities at both test beds. Finally, outreach programs will be created to disseminate the technology.

Milestones

This three-year project began in 2013.

- Develop operational prototypes of the SM Platform framework, initial modeling and workflow tools and energy performance metrics, and test bed installation plans (2014).
- Use test bed data to analyze the dominant factors for energy use and optimal forging furnace performance (2014).
- Begin test bed operations and develop strategies and integrated energy performance metrics (2015).
- Implement model-based design and control using the SM Platform framework (2016).
- Populate the SM Platform with functionalities and tool kits developed from the test bed work (2016).
- Implement expanded SM Platform framework along with new test bed demonstrations (2016).

Commercialization

The commercialization of the SM Platform will require significant cross-industry collaboration. Specific project tasks are dedicated to the commercialization process and include (1) upgrading the industry community website to include interaction, input, and co-development; (2) analyzing the savings from deployment of the SM Platform compared to other systems; and (3) testing industry community websites as portals for accessing and distributing application resources. The project will launch SM Platform workshops, webinars, and conferences targeted to individual industry segments, with a focus on small and medium-sized organizations.

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