NFPA Technology Roadmap

Update Process Overview

January 23, 2017

NFPA Technology Roadmap

The NFPA Technology Roadmap describes an industry-wide consensus regarding the pre-competitive research and development needs associated with improving the design and function of fluid power components and systems.

The research and development agenda it describes is focused on advancements that will help the fluid power industry meet the future needs of its customers, expand into new markets, and attract the best and brightest students to the field.

It is used by the NFPA and the Center for Compact and Efficient Fluid Power (CCEFP) to guide their research efforts, by NFPA members and other industry partners to inform decisions about research partnerships and product development, and by academic, government, and other organizations that wish to pursue research and development projects of importance to the fluid power industry.

It is updated every two years under the guidance and leadership of the NFPA Roadmap Committee.

NFPA Roadmap Committee as of January 20, 2017

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Vice Chair
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- **Kevin Landhuis, Danfoss Power Solutions**
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- **Charles Tuggle, Hydra-Power Systems**
- **Nic Copley, Parker Hannifin (Automation)**
- **Tony Vaughan, Parker Hannifin (Hydraulics)**
- **Brent Archer, Proportion-Air**

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- **Nathan Knotts, Chevron**
- **Doug Robertson, Clippard Instrument Laboratory**
- **Mike Freisleben, CNH**
- **Bob Hammond, Deltrol Fluid Products**
- **Gary Gift, Donaldson Company**
- **Don Smolenski, Evonik Oil Additives**
- **Rajeev Kumar, Exxon Mobil**
- **Tim Saupe, Gates Corporation**
- **John Welch, HYDAC/Schroeder Industries**
- **Scott Lane, Linde Hydraulics**
- **Shubhamita Basu, Lubrizol**
- **Dave Geiger, Moog**
- **Wiley Abner, Netshape Technologies**
- **Gilles Lemaire, Poclain Hydraulics**

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- **John Tysver, Woodward HRT**

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- **Ken Baker, Bailey International**
- **Jeffrey Lemonds, Casappa**
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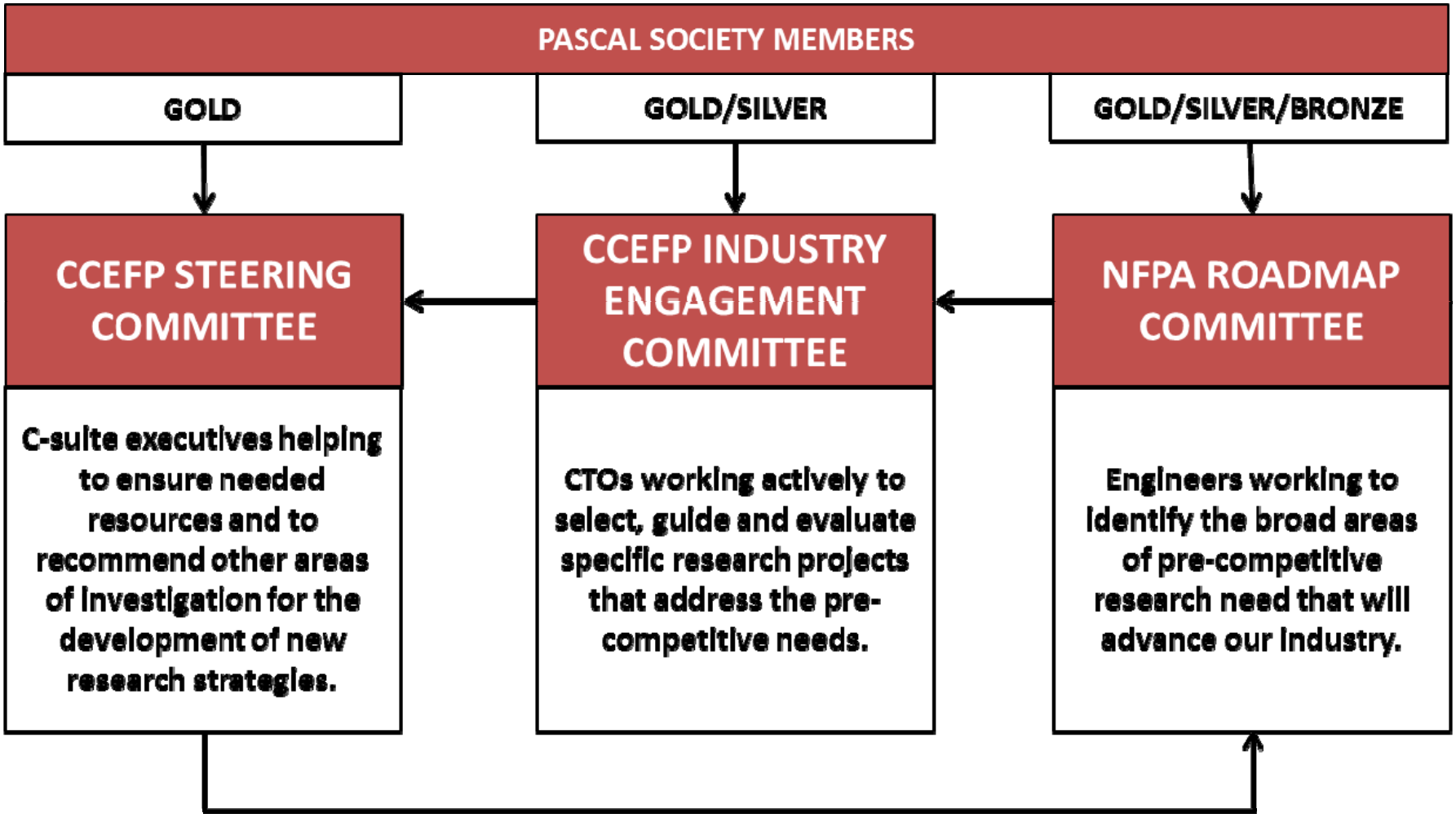
- **Lyle Shuey, Czero**
- **Jacob Paso, Delta Computer Systems**
- **Jerry Jadwisiak, DunAn Microstaq**
- **Qinghui Yuan, Eaton Corporation**
- **Charbel Nasr, Famic Technologies**
- **Thomas Braun, FasTest**
- **Celine Cabana, FD Groups America**
- **Frank Latino, Festo Corporation**
- Fluid Power World Magazine
- **Bill Haley, FORCE America/Valve Division**
- **Mark Torbett, GS Global Solutions**
- **Phil Priolo, G.W. Lisk Company**
- **Bob Pettit, HAWE Hydraulik NA**
- **Allen Rasmussen, HECO Gear**
- **Yashodeep Lonari, Hitachi**
- **Eric Hamkins, HUSCO International**
- **Ron Kilmko, Hydraulics & Pneumatics Magazine**
- **Ryo Yamada, Idemitsu Kosan**
- **Jeff Anders, IMI Precision Engineering**
- **Steve Schaus, Industrial Hard Chrome**
- **Greg Kuhlman, Iowa Fluid Power**
- **Kevin Kraft, JARP Industries**
- **Martyn Molsom, JCB**
- **Scott Maher, Kaman Industrial Technologies**
- **Mike Casper, KYB America**

Pascal Society Bronze Members, continued
- **Kazumi Ito, KYB Japan**
- **Scott Paxton, Lehigh Fluid Power**
- **Karen Mackey, Main Manufacturing Products**
- **John Kempf, Master Pneumatic**
- **Rick Bush, Micromatic**
- **Bob Mosey, Moseys Production Machinists**
- **Larry Wesley, Muncie Power Products**
- National Tube Supply
- **Tim Thomas, PARTsolutions**
- **Rob Wuertz, OEM Controls**
- **Bruce Downard, R. T. Dygert**
- **Jay Dalal, ROSS Controls**
- **Volker Schmitz, Schamlz**
- **Sujan Dhar, Simerics**
- **Cameron MacNeil, Stauff Corporation**
- **Mike Stewart, Steelhead Composites**
- **Koichiro Tsukane, Sumitomo Heavy Industries**
- **Mark Bokorney, Sun Hydraulics**
- **John Kess, The Toro Company**
- **Travis Peterson, Walvoil Fluid Power**
- **Tony Zingman, Wandfluh of America**
- White Drive Products
- **Sean McCarthy, World Wide Fittings**
- **Steve Cavera, Yates Industries**

Industry Oversight Committees

Pascal Society members are invited to serve on our industry oversight committees. Each committee plays an important role in shaping and directing the CCEFP in a way that serves the long-term interests of our industry.



NFPA Anti-Trust Guidelines

Because of federal anti-trust laws, certain topics are not proper subjects for discussion at any NFPA function. In many cases, our members are competitors and any action or agreement which may eliminate, restrict or govern competition among members or their colleagues could be a violation of anti-trust laws. Those violating the anti-trust laws are subject to severe criminal and civil penalties.

This means that we must not discuss any items falling within the realm of competitive practices, such as current or future prices, terms of service, discounts, production or productivity rates, allocation of markets, profit levels, credit terms, or refusal to deal with a particular supplier or customer.

Please adhere strictly to these guidelines during all NFPA functions to protect yourself, your company and the NFPA from liability.

Definition of Pre-Competitive Research

Pre-competitive research is performed at the time in the technology development cycle when interested, but potentially competitive parties agree that there is value to be gained from a collaborative rather than a competitive approach. It generally resides in the middle ground between fundamental basic research conducted mainly in universities and proprietary research performed or directed mainly by companies. It can be performed to develop new technologies or to determine the market readiness of new technologies.

Many organizations use the hierarchy of Technology Readiness Levels (TRLs) first developed by the U.S. Department of Defense to describe a series of discreet steps along a technology development timeline. For the purposes of updating the NFPA Technology Roadmap, Roadmap Committee members should stay focused on TRL 1-4.

TRL 1	**Scientific research begins translation to applied R&D**
TRL 2	**Invention begins**
TRL 3	**Active R&D is initiated**
TRL 4	**Basic technological components are integrated**
TRL 5	Fidelity of breadboard technology improves significantly
TRL 6	Model/prototype is tested in relevant environment
TRL 7	Prototype near or at planned operational system
TRL 8	Technology is proven to work
TRL 9	Actual application of technology is in its final form

Roadmap Elements

The NFPA Technology Roadmap is comprised of three primary elements, each connected to the next in an interdependent chain.

Customer Drivers

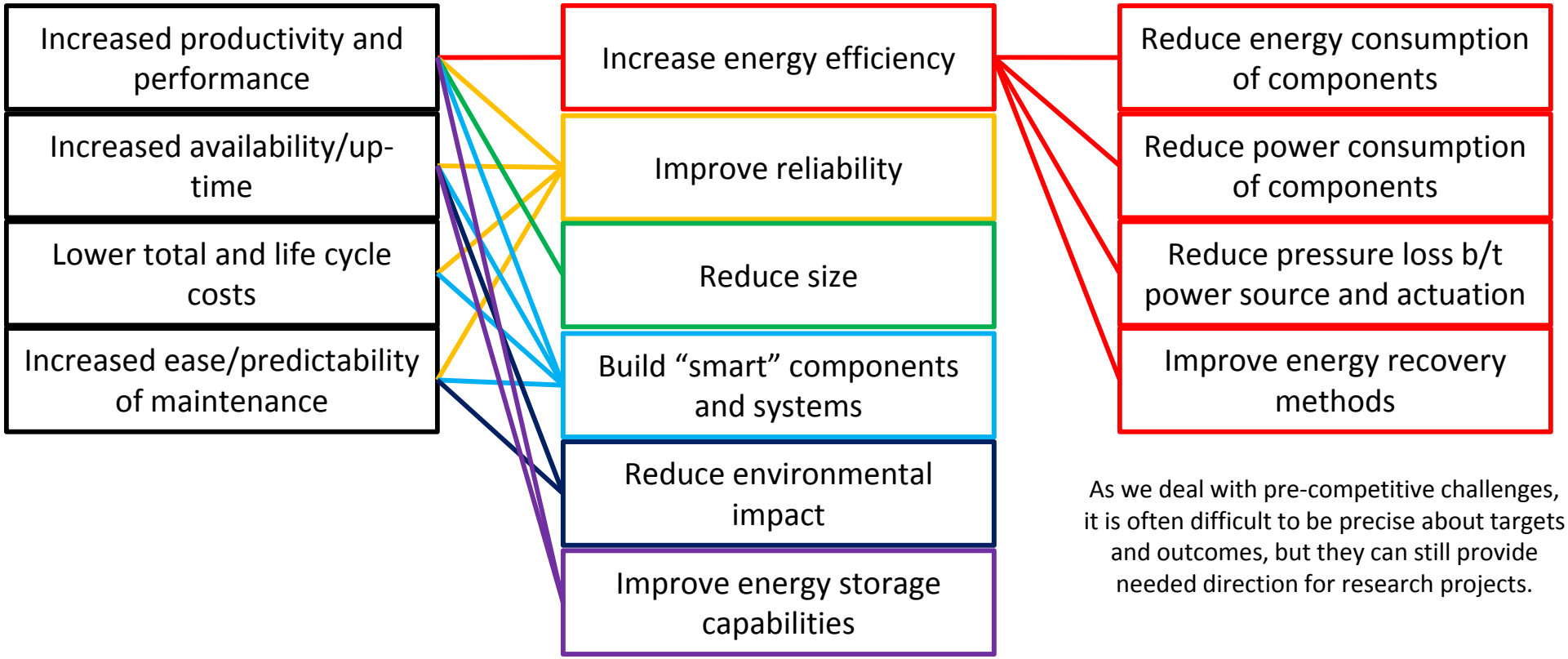
Customer drivers are the business or technology objectives of fluid power customers. They help them serve the needs of their own customers, and are not necessarily connected to their use of fluid power.

Research Challenges

Research challenges are the broad areas of attention that must be addressed if fluid power is to meet or better meet the customer needs described by the drivers.

Targets & Objectives

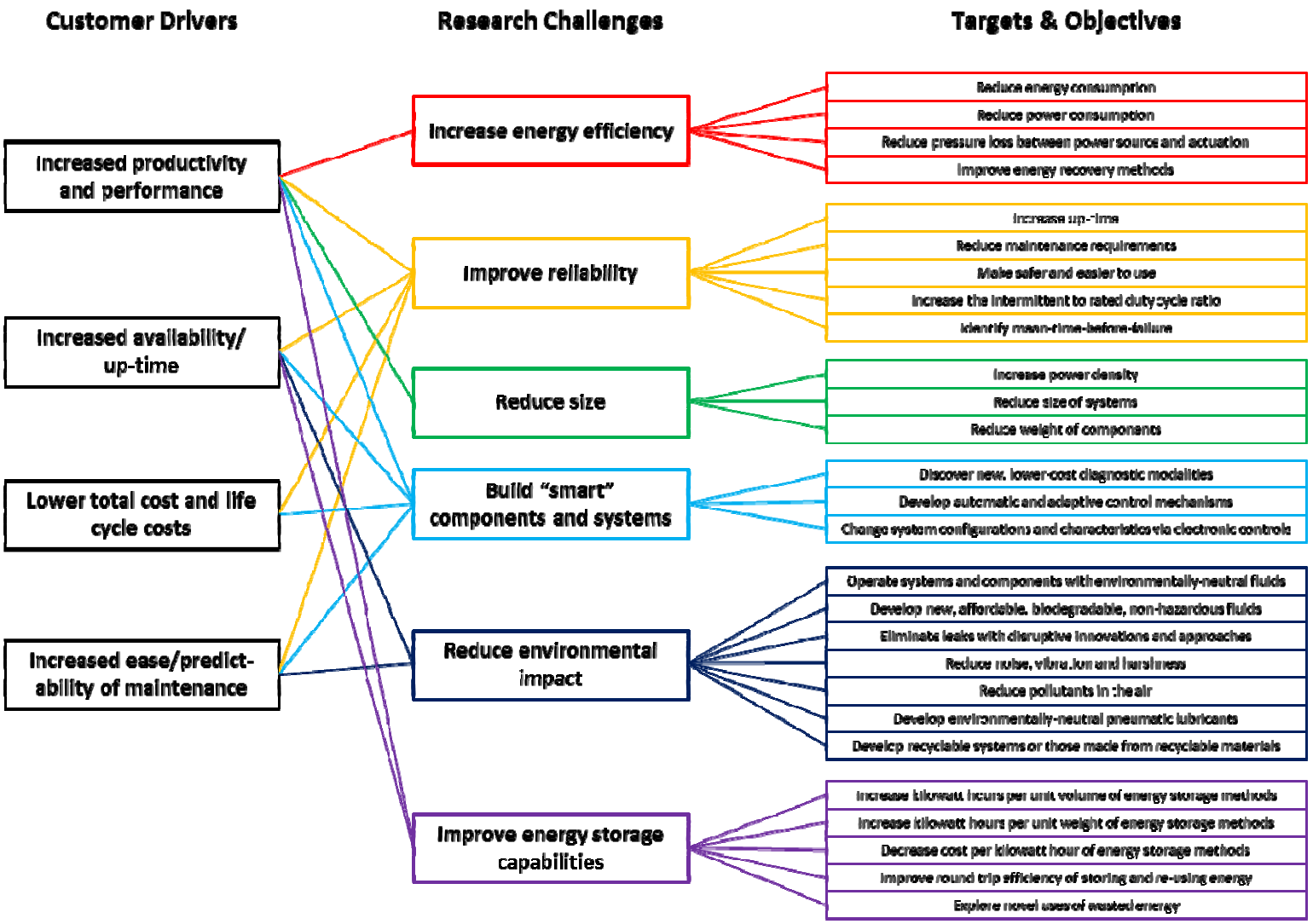
Research targets and objectives seek to quantify or describe successful strategies for pursuing the research challenges.



As we deal with pre-competitive challenges, it is often difficult to be precise about targets and outcomes, but they can still provide needed direction for research projects.

Roadmap Example

This diagram of the 2015 Technology Roadmap is offered to show the overall scope and complexity of the document.



Update Process and Timeline

Jan 23, 2017 — **Introductory conference call to present update process and timeline**

Feb-Apr 2017 — **Phase 1 – Customer Drivers/Research Challenges**

- Briefing materials sent to Roadmap Committee prior to IFPE
  - NFPA Customer Market Survey
  - Executive summaries of NFPA Customer Technology Trends reports
  - Customer Drivers identified in 2015 NFPA Technology Roadmap
- Presentation of draft Fluid Power Manufacturing Roadmap at **March 9** CCEFP Steering Committee meeting at IFPE
- Briefing materials sent to Roadmap Committee following IFPE
  - Summary of CCEFP Research Strategy
  - Summary of Fluid Power Manufacturing Roadmap
  - Research Challenges identified in 2015 NFPA Technology Roadmap
- In-person meeting the **week of April 3** at CCEFP University Summit at Texas A&M to:
  - Identify and rank Customer Drivers
  - Identify, rank, and connect Research Challenges to Customer Drivers
  - Discuss possible Targets & Objectives

Update Process and Timeline, continued

Apr-Jul 2017 — **Phase 2 – Targets and Objectives**

- Working Groups for each Research Challenge identified
- Briefing materials sent to Working Groups
  - Summary of Roadmapping Session at CCEFP University Summit
  - Summary of CCEFP Research Project Accomplishments
  - Research Targets and Objectives identified in 2015 NFPA Technology Roadmap
- Working Group conference calls to identify and rank Targets and Objectives

Jul-Aug 2017 — **Phase 3 – Final Roadmap Document**

- Draft Roadmap sent to Roadmap Committee
- In-person meeting the **week of August 14** at NFPA Industry and Economic Outlook Conference to review and approve final Roadmap

Questions?