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SA 035

EMPLOYMENT IMPACTS OF HYDROGEN AND FUEL CELL TECHNOLOGIES

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June 8, 2016

RCF Economic & Financial Consulting, Inc.

Argonne NATIONAL LABORATORY

OVERVIEW

Timeline

Start date: FY 2016

End date: FY 2018

Barriers

Future Market Behavior (A)

Stove-piped/Siloed Analytical Capability (B)

Inconsistent Data, Assumptions and Guidelines (C)

Insufficient Suite of Models and Tools (D)

Budget

FY16 DOE Funds: $250k

Includes partners and model acquisition

Funded partners/collaborators

Argonne National Laboratory

RCF Economic & Financial Consulting

Valerie Taylor, consultant

Energetics

RELEVANCE

Modeling & Analysis

- **Update** 2008 DOE Report to Congress, *Effects of a Transition to a Hydrogen Economy on Employment in the United States*
- Consider **additional applications** of fuel cells and model effects between industries and regions

Stakeholder Support

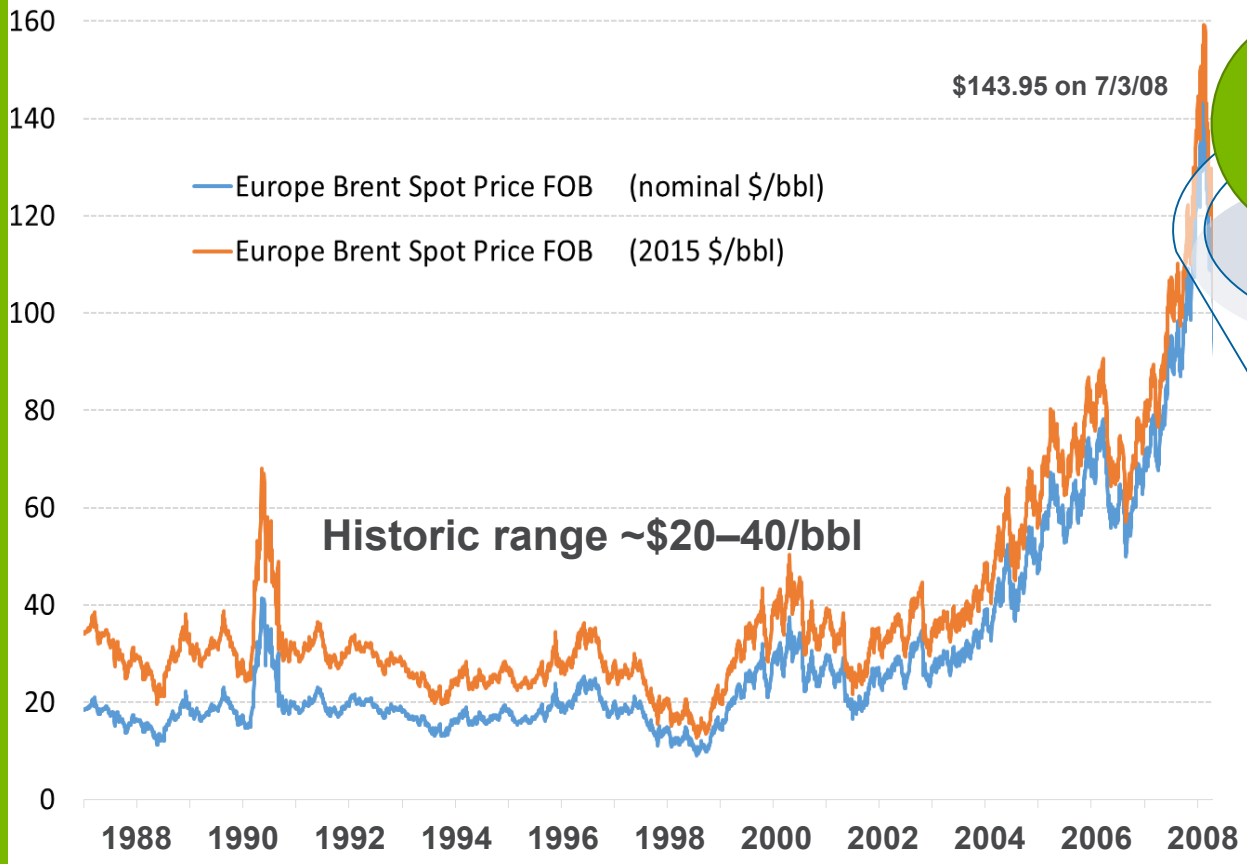
- Work with stakeholders to determine consensus estimates of **current and future prospects** for H_2 and FC deployment
- Report analytical results to **demonstrate benefits** of hydrogen and fuel cells

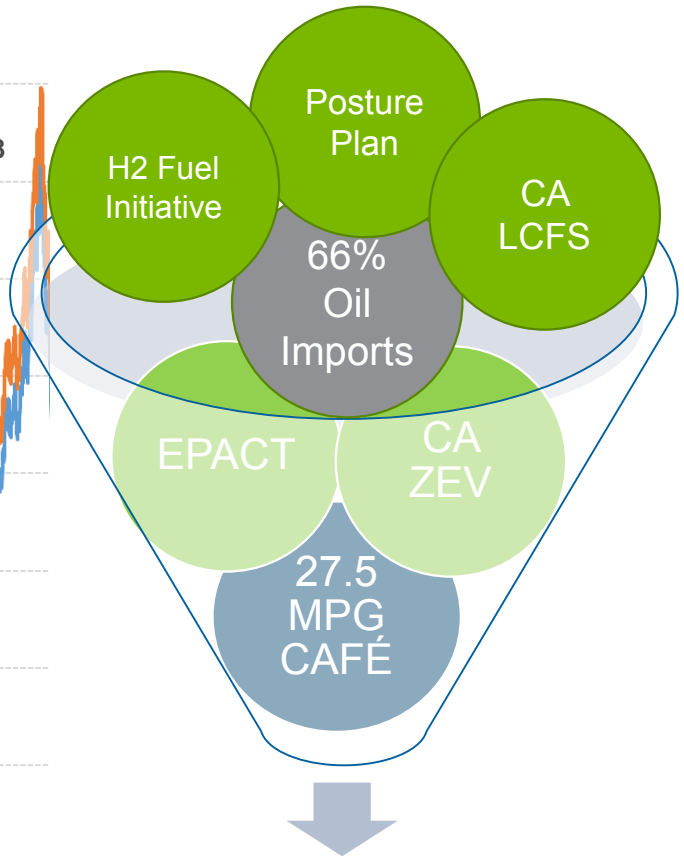
Policy Implications

- Estimate net impacts on **national and regional employment** under alternative H_2 and FC scenarios
- Identify implications of scenario results on **work force development**

WHY UPDATE REPORT TO CONGRESS?

Oil price, production and policies looked very different in 2006–2008



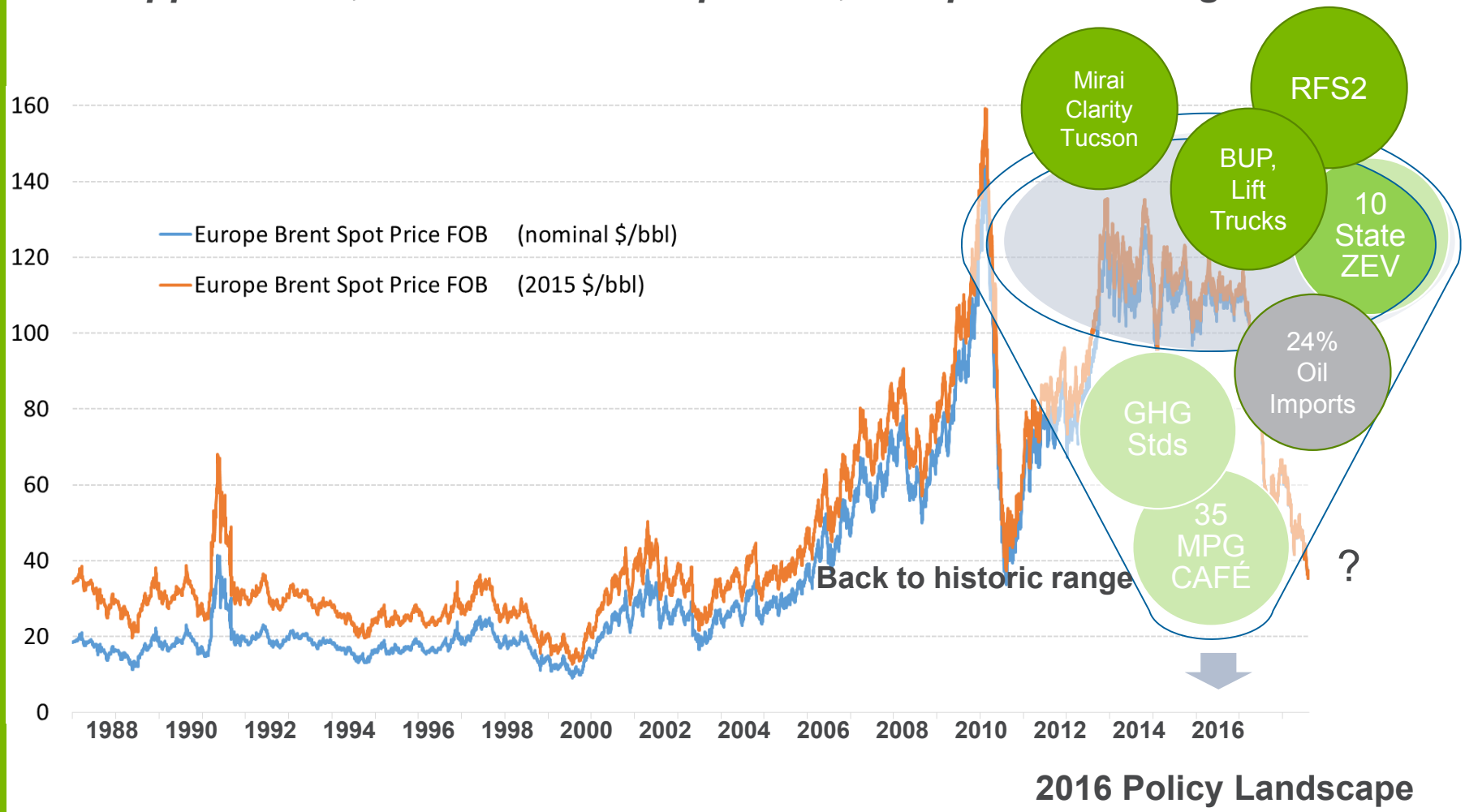


2006–2008 Policy Landscape

Relevance

MARKETS, TECHNOLOGIES & POLICIES HAVE EVOLVED

More applications, more market competition, less price advantage

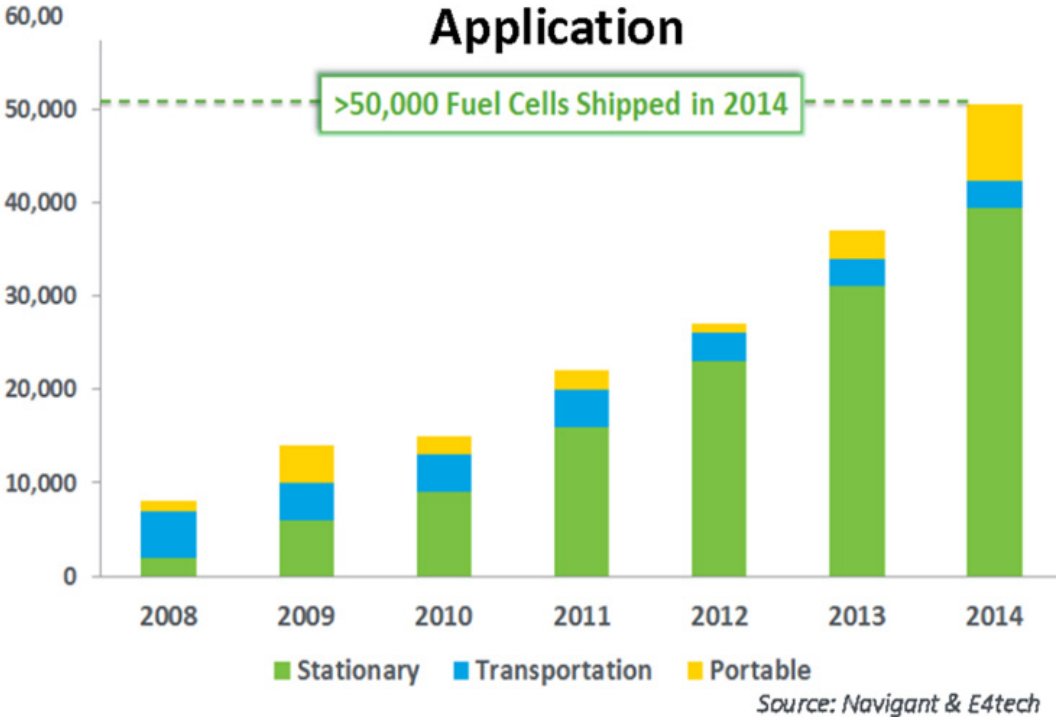


"We can't have an energy strategy for the last century that traps us in the past. We need an energy strategy for the future – an all-of-the-above strategy for the 21st century that develops every source of American-made energy."

– President Barack Obama, March 15, 2012

MORE EMPHASIS ON NON-HIGHWAY APPLICATIONS AND OCCUPATION ANALYSIS

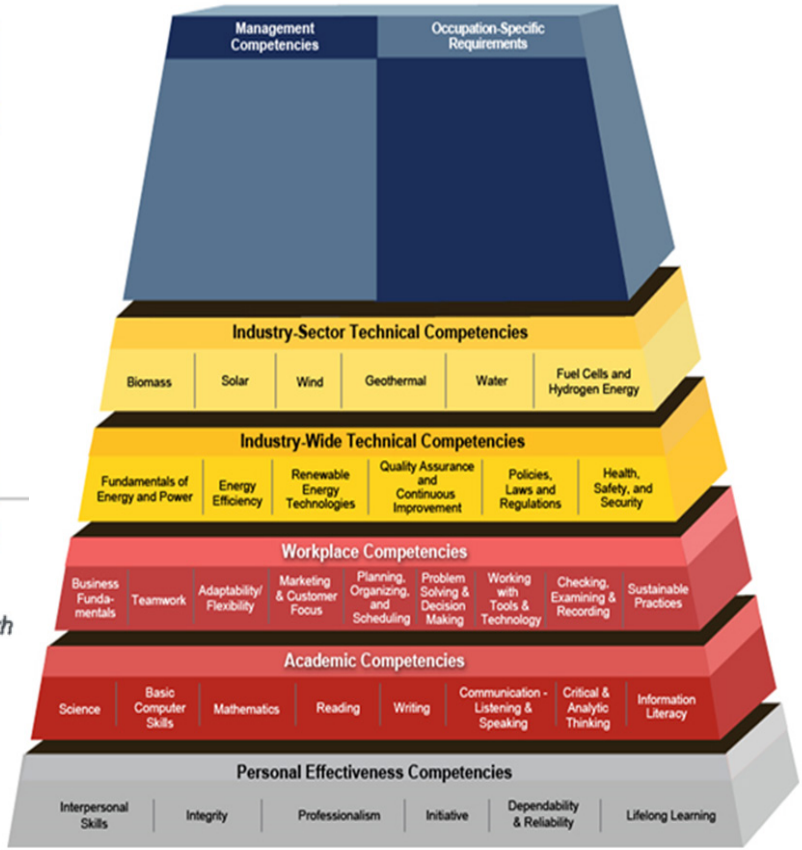
Fuel Cell Systems Shipped Worldwide by Application



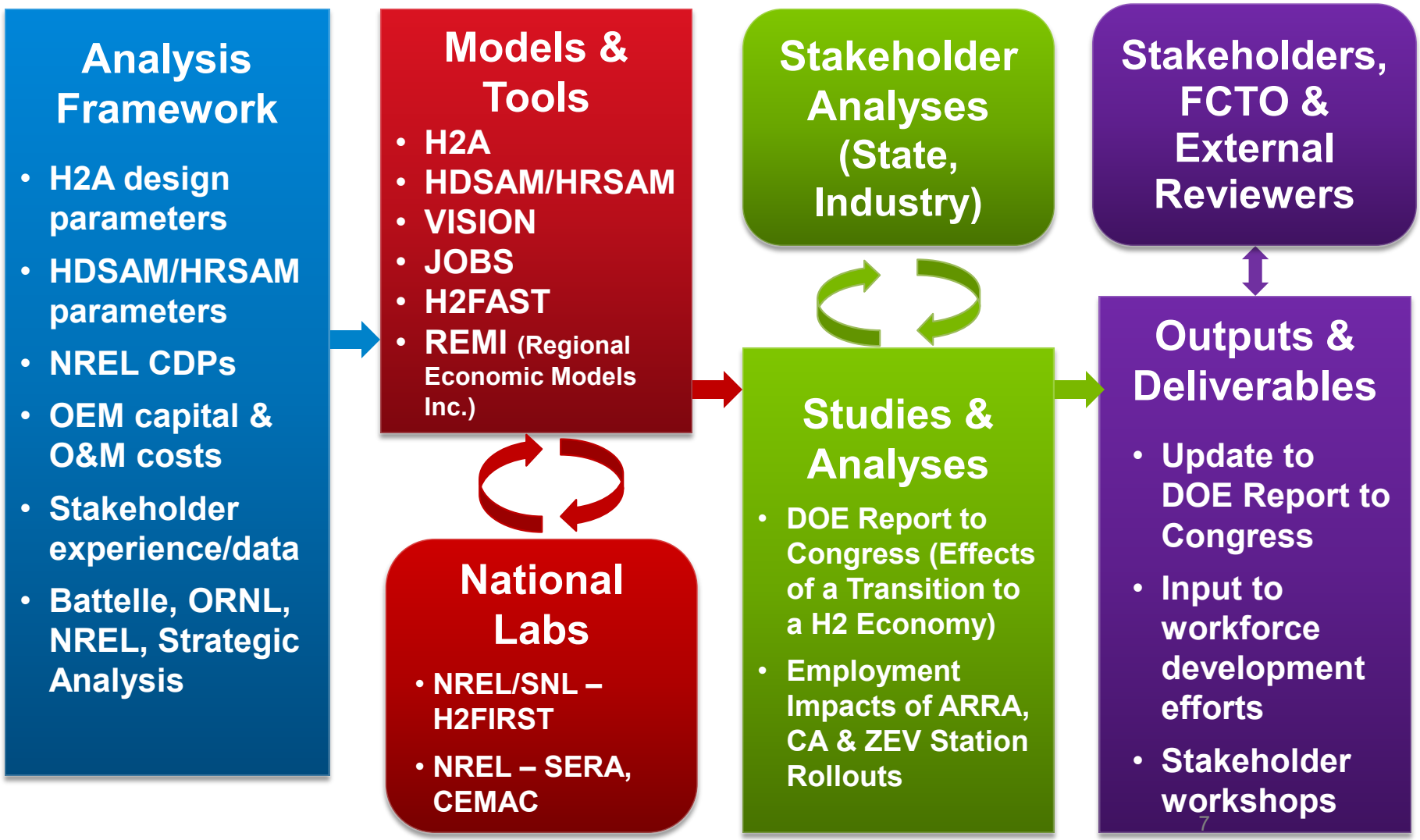
Source: Navigant & E4tech

- Consistent ~30% annual growth since 2010
- Global Market Potential in 10- 20 year
  - $14B – $31B/yr for stationary power
  - $11B /yr for portable power
  - $18B – $97B/yr for transportation

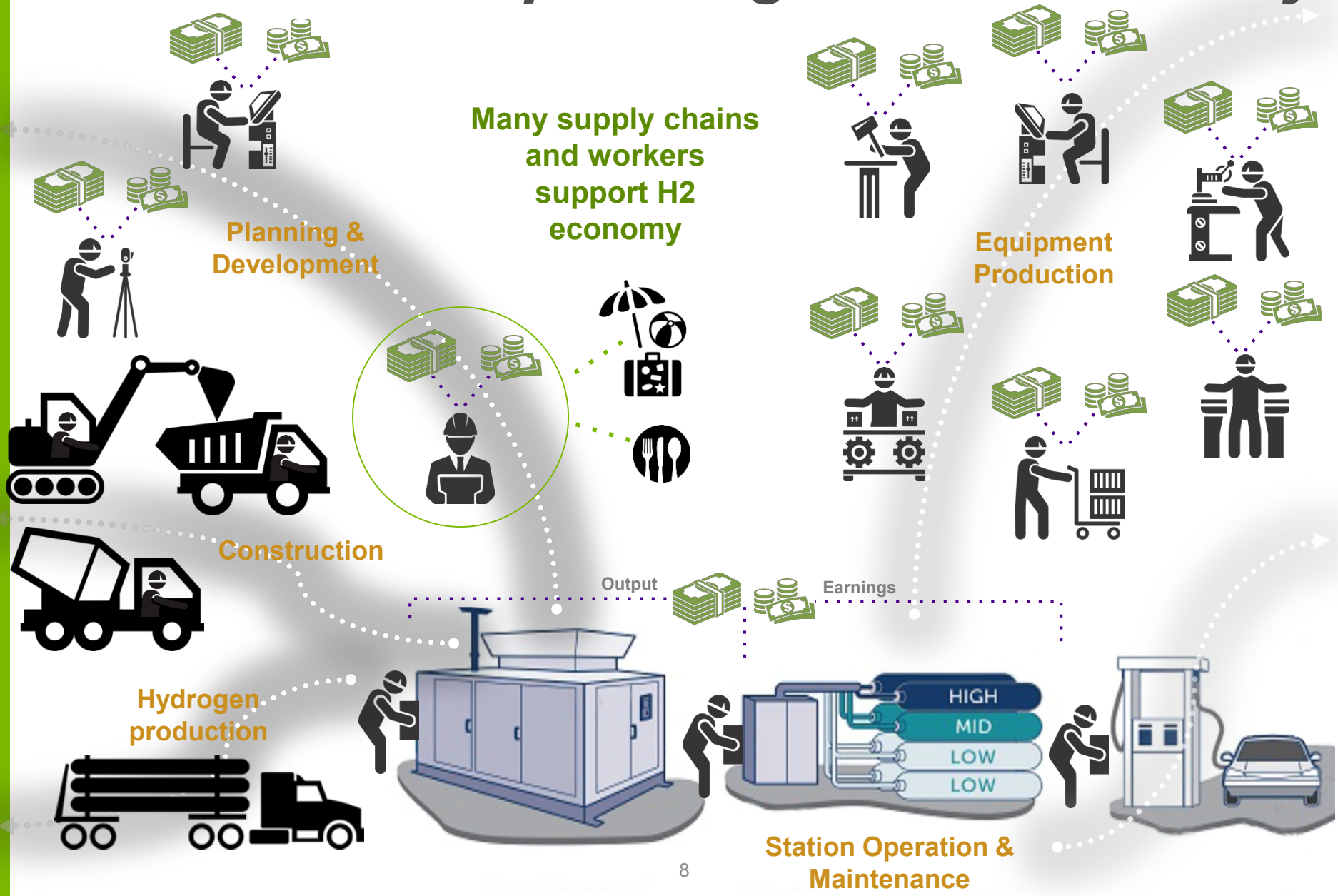
Industry and Occupational Analyses



Employment Impacts of Hydrogen and Fuel Cell Technologies

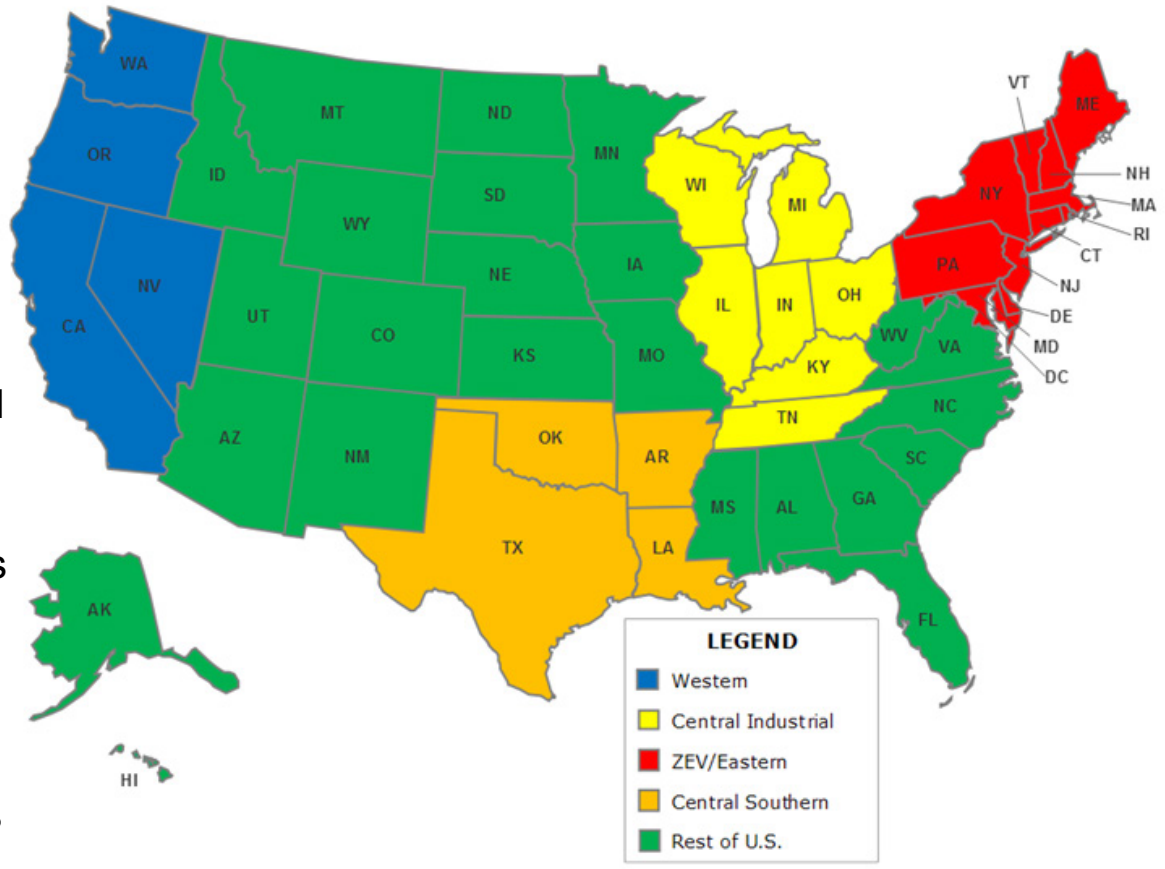


Activities and Spending in the Economy



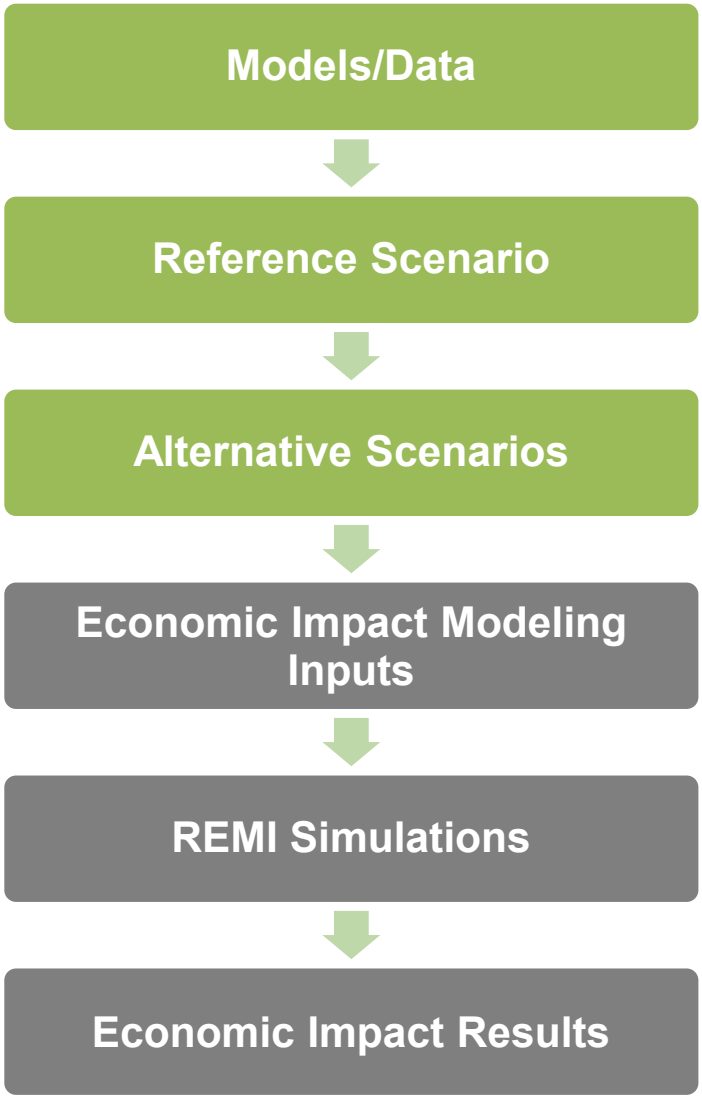
REMI PI+ (POLICY INSIGHT) ECONOMIC IMPACT MODEL

- Integrated approach:
  - Input-Output: transactions between industries
  - General Equilibrium: supply-demand balance (long-run changes in prices, production, consumption, etc.
  - Econometric Analysis: advanced statistical techniques
  - Economic Geography: industry clustering & labor market access affect inter-regional trade, productivity, competitiveness
- 160 industries
- 95 occupational categories
- 4 regions plus U.S.



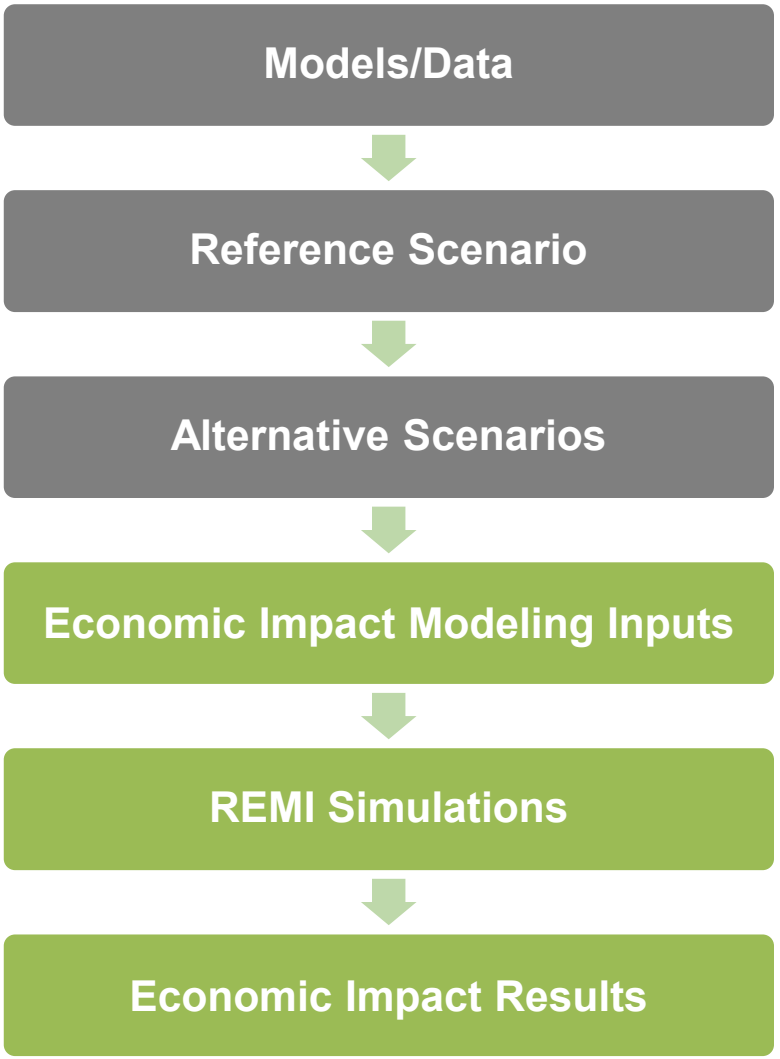
MODELS/DATA & SCENARIOS

- Review/compare models and data sources
- Estimate market penetration for each technology modeled
- Define needed infrastructure
- Create custom industries when appropriate
- Determine changes by region for each scenario
- Outreach to stakeholders (webshop)



ECONOMIC IMPACT MODELING

- Plus (+) examples
  - Transportation FCs and related components
  - Stationary FCs and related components
  - H_2 production and facility construction
- Minus (-) examples
  - Conventional powertrain and components
  - Displaced gasoline, other fuels and electricity
- Results
  - Differences in economic metrics relative to reference scenario
  - Employment, output, earnings, etc.
  - By industry, occupation, region



FY 2016 MILESTONES

Milestone	Quarter	Status
Contract and workscope development	1	✓
Reference scenario development, stakeholder outreach & workshop	2	✓
Model acquisition, sector and occupational analysis (SMART)	**3**	✓
Review and modification of industry cost vectors	4	9/30/16

WEBSHOP FACILITATED STAKEHOLDER INPUT TO REFINE ASSUMPTIONS AND SCENARIOS

- 30 web-enabled attendees:
  - Study benefit: inform federal R&D investment, state & local workforce development, industry planning
  - Webshop process very useful tool
- Overview presentations:
  - 2008 Report to Congress
  - Rationale for revisiting study
  - Economic modeling
  - Scenario options
- Interactive discussions:
  - Benefits and key issues
  - Data and assumptions
- Condensed from 1-day onsite to 3-hr facilitated discussion
- Followup survey + future webshops

Economic Impact of Hydrogen and Fuel Cell Deployment Workshop

Join us for a workshop to help guide economic analyses of hydrogen and fuel cell deployment.

Invited participants will convene to review the U.S. Department of Energy's *Report to Congress on Effects of a Transition to a Hydrogen Economy on Employment in the United States* and current plans for updating and expanding this work. Breakout groups will provide feedback on enhancing the proposed analytic framework, incorporating consensus data and assumptions, and identifying issues and opportunities that should be addressed in the analysis.

Event Details

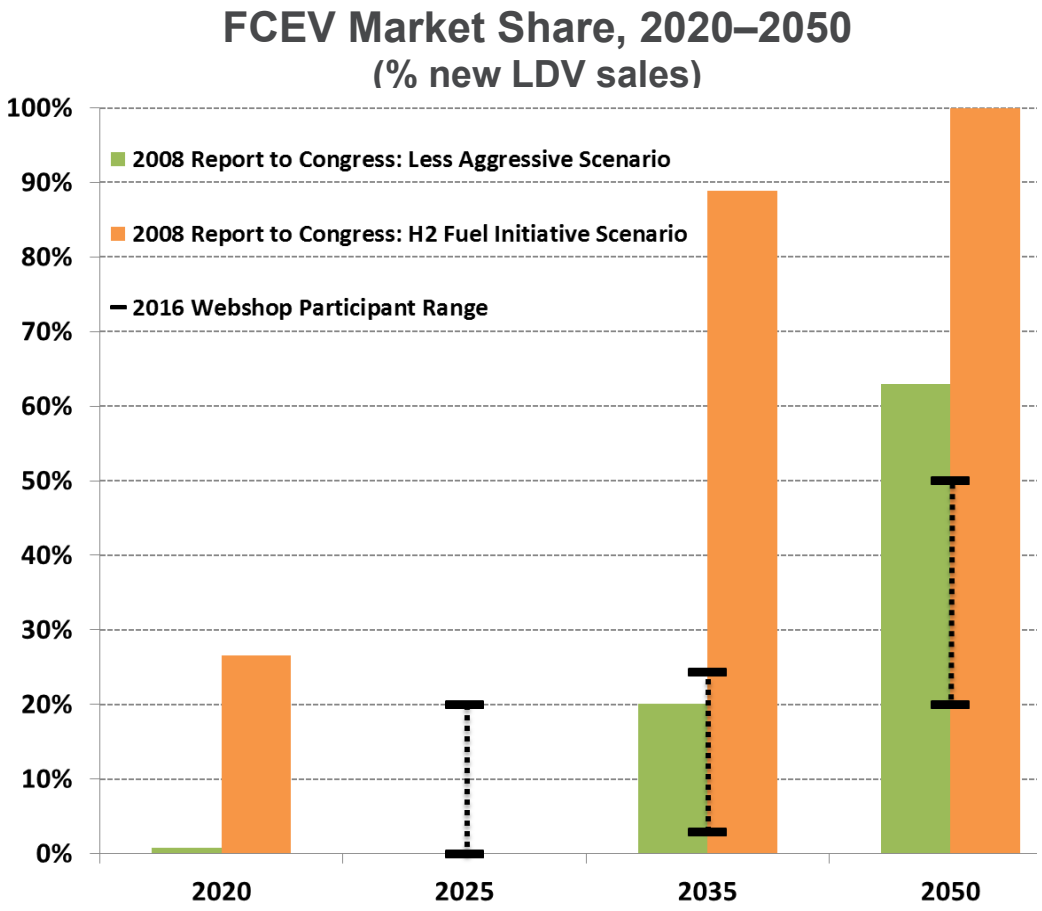
April 28, 2016
8:30 a.m. – 5:00 p.m. CDT
Argonne National Laboratory
Bldg. 240, TCS Conference Center
9700 S. Cass Ave.
Lemont, IL 60439

If you have any questions or require additional details, please contact Marianne Mintz at 630-252-5627.

Register by April 8

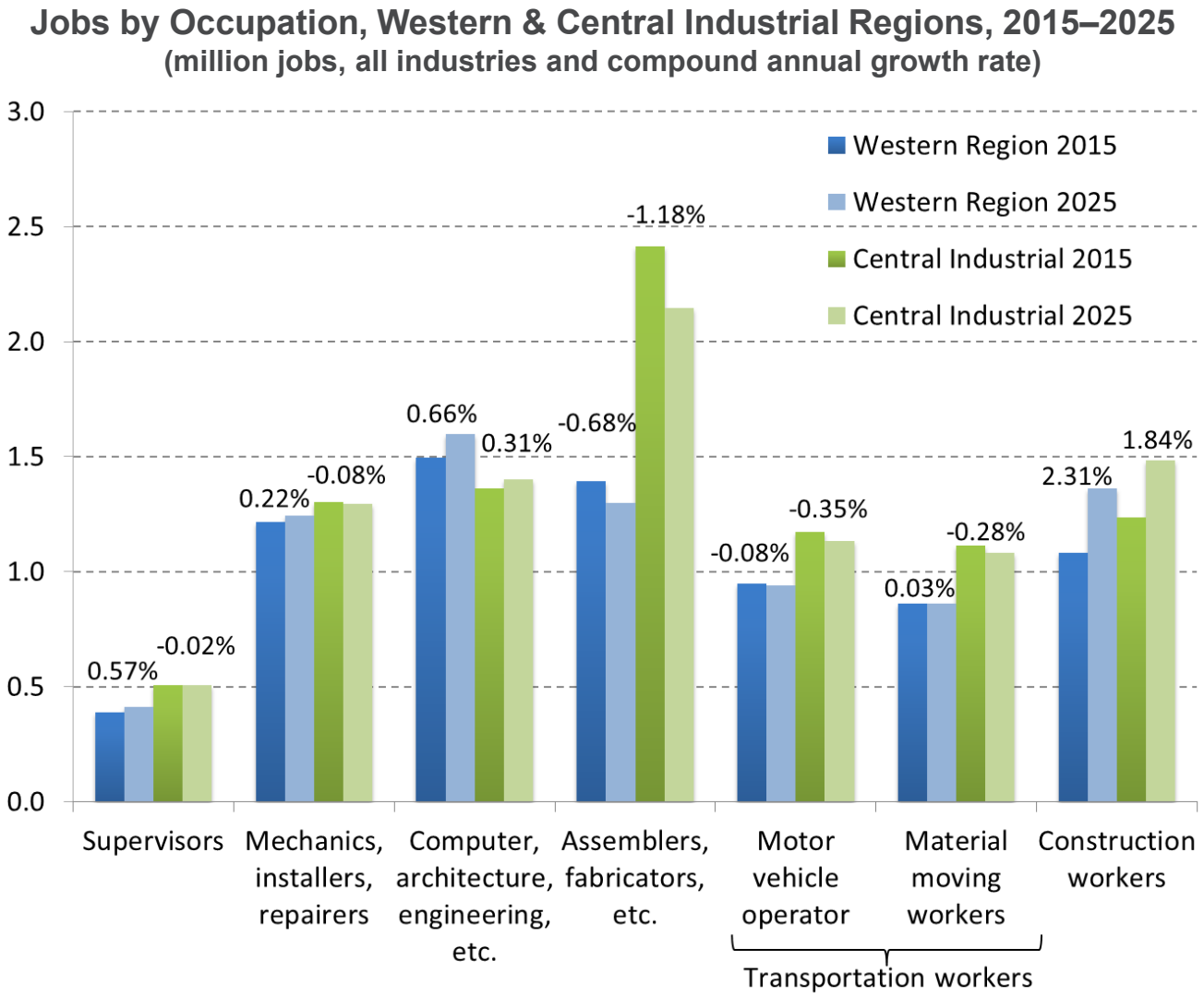
WEBSHOP: SCENARIO ASSUMPTIONS & TAKEAWAYS

- **Energy price** most important macro issue, followed by climate change/GHG emissions & pollutant regulations. EIA/AEO best source.
- **Playing field relatively level** in current emerging market. With deployment, market entry/growth become more difficult & foreign competition increases.
- Hydrogen will be produced from **lowest cost option** (not technology preferred), NG unless policies drive nuclear or coal. State policies/ cultures may favor different options.
- Viability of FCEVs greatest where **state/ regional incentives** exist, but **fueling infrastructure** critical for OEMs to supply vehicles. Cost, utility support & public education/familiarity also key.



- FCEV penetration depends on **oil & electricity price** + **government infrastructure investment**. In near- to mid-term, regulations are driving force (with regional/cultural influence) followed by OEM & foreign strategies.

REGIONS DIFFER IN MIX & GROWTH OF JOBS IN SELECT OCCUPATIONS

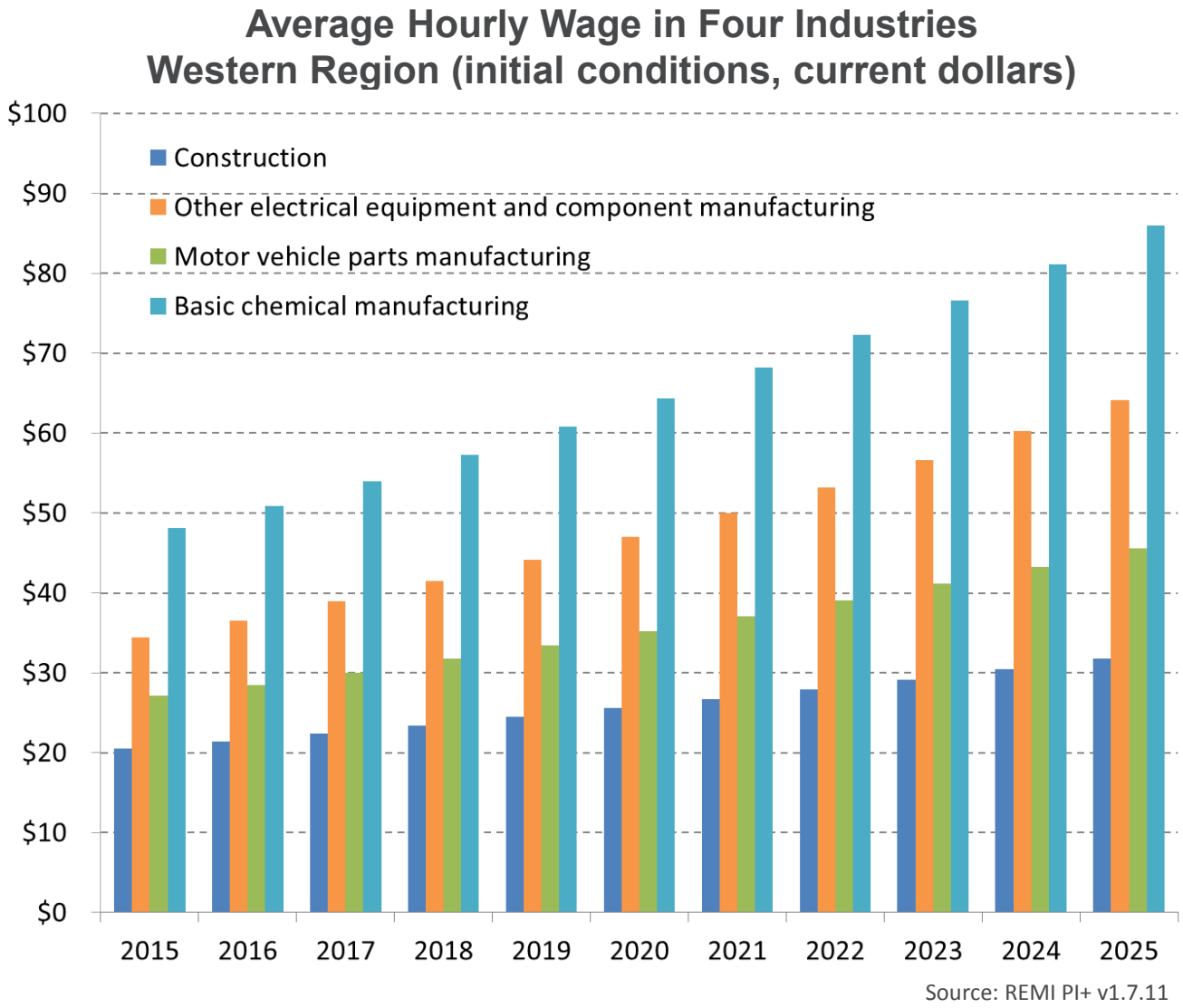


- Initial conditions based on Bureau of Labor Statistics, University of Michigan forecasts
- Western region has more uniform occupational mix
- Most impacts likely in 7 occupational categories (shown) comprising ~ 25% of jobs in each region
- Transportation workers: near even split between motor vehicle operation & material handling
- Largest growth in construction, especially Western Region

Source: REMI PI+ v1.7.11

INDUSTRIES DIFFER IN WAGES & WAGE GROWTH

- Chemical manufacturing most highly paid of industries shown
- Wages expected to grow nominally in next decade for all industries shown
- Wages for electrical equipment & component manufacturing grow most (86%)
- Wages for construction grow least (55%)



COLLABORATORS PROVIDE KEY ADVICE/EXPERTISE

Advisory Group

- Public agencies (CARB, CaFCP, CCAT, OFCC)
- Fuel cell and hydrogen suppliers
- Researchers

Assistance/role

- Defaults (data/analyses)
- Scenarios
- Future directions/needs
- Review

Collaborator	FY 2016 Role
Argonne	Management and coordination; engineering data collection and analysis; quality assurance; outreach; documentation
RCF	Economic data collection and analysis; quality assurance; code development and application; documentation
NREL	Scenario development
Valerie Taylor	Career pathways and workforce development
Energetics	Webshop planning, facilitation and documentation

WORK FLOW FY 2016 – FY 2017

Dec-2015 June-2016 Dec-2016 June-2017

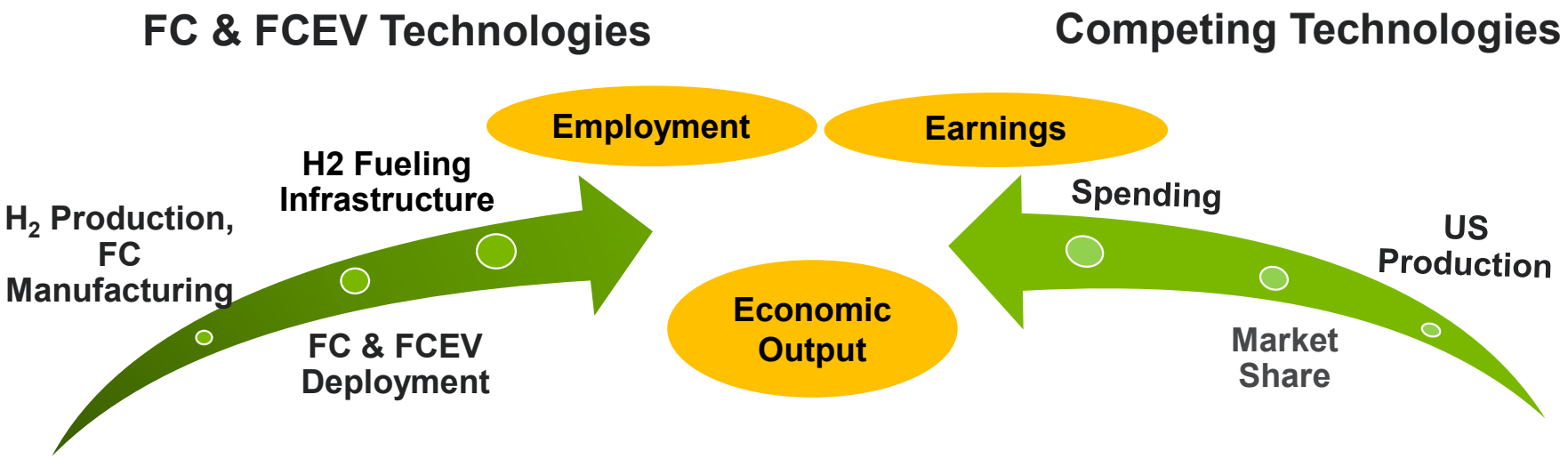
Contracting, Model and Data Acquisition

Advisory Group, Reference & Alternative Scenarios

Initial Industry Modifications and Final Scenarios

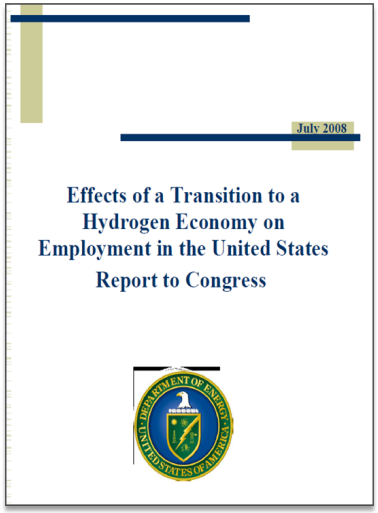
Iterate Industry Modifications, Initial Impact Runs

Advisory Group Interaction, Data Development and Validation



SUMMARY

- **Relevance:** Update DOE 2008 Report to Congress. Fills gap/barrier in analysis portfolio.
- **Approach:** Input-output and general equilibrium modeling to capture long-run changes in employment, earnings, and other economic metrics from H2 and FC deployment.
- **Accomplishments and progress:**
  - April webshop with stakeholders addressed key issues/assumptions. Will guide scenario development.
  - Initial investigations of REMI reference forecasts.
- **Collaborations**: Active partnership between ANL & RCF with assistance from Energetics and Valerie Taylor. Extensive stakeholder interaction.
- **Future work**:
  - Develop scenarios and translate assumptions into economic impact modeling inputs
  - Select and modify industries in REMI
  - Continue validating and refining input data and assumptions.
  - Continue interaction with advisory group.



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