WORKFORCE CHALLENGES AND OPPORTUNITIES
A PANEL DISCUSSION

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OAK RIDGE NATIONAL LABORATORY

NETL RWFI AND THE HYDROGEN WORKFORC

Disclaimer

NETL REGIONAL WORKFORCE INITIATIVE (NETL RWFI)

NATIONAL ENERGY TECHNOLOGY LABORATORY

U.S. DEPARTMENT OF ENERGY

NETL RWFI MISSION STATEMENT

NETL RWFI is a platform for engagement and collaboration with key stakeholders who are critical for the deployment of U.S. DOE and NETL Energy and Advanced Manufacturing technological research.

Supporting Regional Economic and Workforce Development opportunities.

NETL RWFI- MEASURING OUR IMPACT - PEOP

Key Metrics are Levels of Engagement and Outreach

800+
individual stakeholders

400+
institutions and organizations represented

2000+
registrants to the NETL RWFI Webinar Series

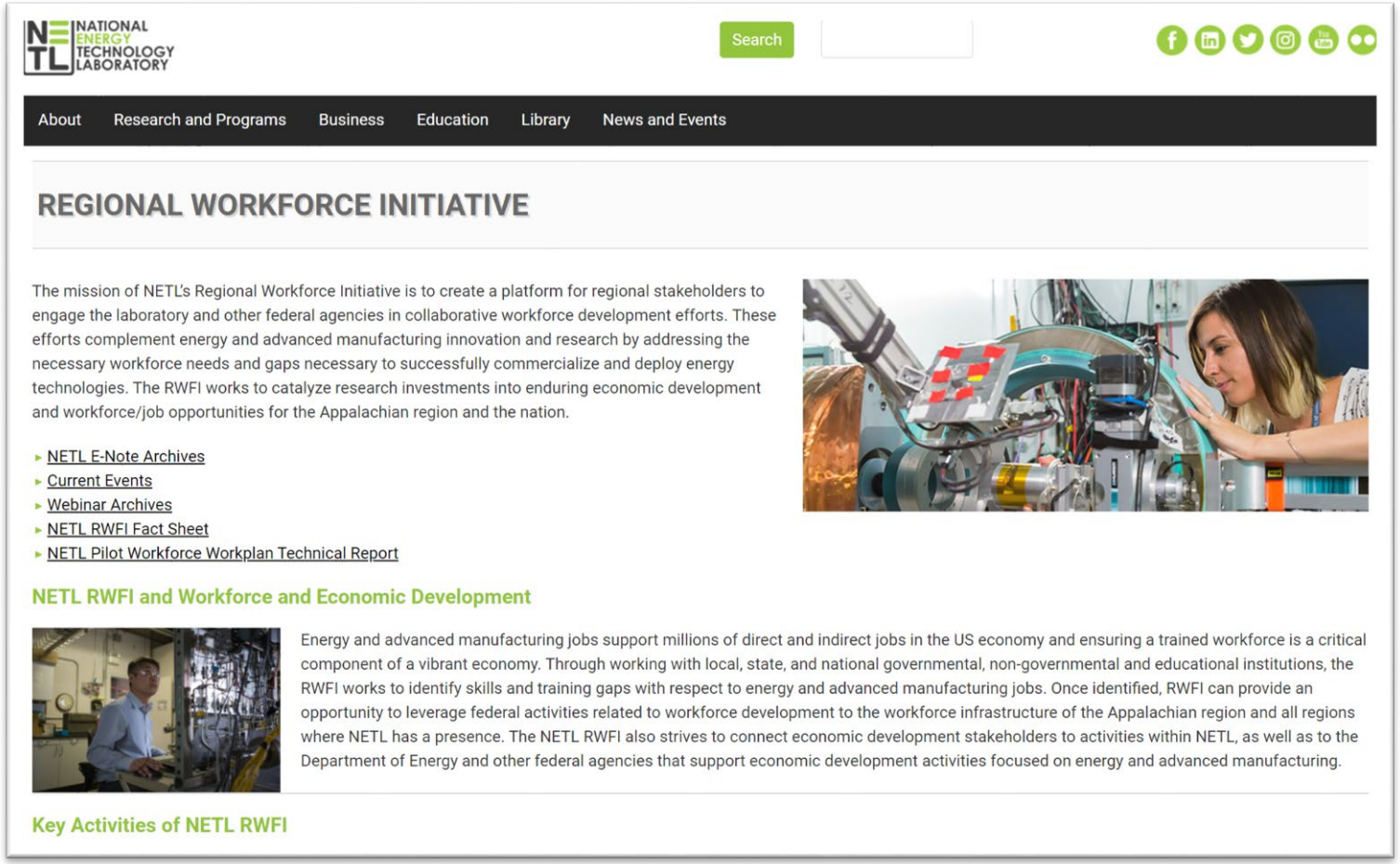
300+
subscribed to the NETL RWFI e-Note Monthly Newsletter

Catalyzed over 2M in energy/advanced manufacturing workforce & economic development funding

CONSISTENT ENGAGEMENT & OUTPUT

Outreach Tools

- **Webinars (Energy 101 Series)**
- **Networking (meetings, lab tours, site visits)**
- **E-note (monthly) Webinars Archive**
- **RWFI website and archives**
- **www.netl.doe/gov/rwfi**



REGIONAL IN FOCUS, NATIONAL IN REACH

400+ Organizations Representing Multiple Stakeholder Groups

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Stakeholder groups include:

- Economic Development Organizations
- Federal, State, & Local Governments
- Community Colleges & Universities
- Philanthropic Organizations
- National Laboratories
- Workforce & Other NGOs
- Industry

Appalachian Regional Commission
America Makes
Belmont College
TEAM Consortium
Benedum Foundation
BRITE Energy Innovators
Catalyst Connection
Carnegie Mellon University
Claude Worthington Benedum Foundation
Energy Futures Initiative
National Association of Workforce Boards
Coalfield Development Corporation
Community College of Allegheny College
Westmoreland Community College
PA Department of Economic Development
University of Pittsburgh
Siemens Corporation
Eastern Community College West Virginia
E2 Network
IACMI
ARM consortium
IN-2-Market, Inc.
Manufacturing Extension Partnership
West Virginia University
WVU Industrial Extension/MEP
Allegheny Conference
Charleston Area Alliance
Electric Power Research Initiative
Pittsburgh Regional Alliance
Robert C. Byrd Institute
Oak Ridge National Laboratories
West Virginia University, And more

LATEST RWFI COLLABORATIVE EFFORTS/ FUNDING AWARDS

NETL RWFI, DOE IEDO Industrial Sustainability, Energy Efficiency and Decarbonization (ISEED) Workforce Consortium (FY24to FY26)- Awarded 200K (Planned 500K) to work with NREL and ORNL to establish an Industrial Efficiency Workforce Consortium for DOE IEDO.

DOE TCF- MSI Connect Program with Brookhaven National Lab (FY 2023-24)- Awarded a TCF to improve MSI engagement with labs (BNL,LLNL, SNL, PPPL, SLAC). NETL will potentially host students from MSI universities to work on Carbon Management IP commercialization- TCF Extension concept paper for FY2024-25 with partner labs is currently in process.

Regional University Engagement and Training: Univ. of Pittsburgh Applied Data Driven Methods Grad. Certificate Program **(FY23-26)-** Collaborative effort with Pitt on their ARC, DOL-WORC, Build Back Better 2M funded project to provide cost free training and upskilling. NETL is providing in-class projects and other proposed professional development activities.

Energy Jobs Workforce Skills Data Pilot Project (FY23): Awarded 20K to work with NREL & Julius Education using ML/AI, to discover overlaps in Fossil Energy and EERE skills, building a skills taxonomy. RWFI continues to collaborate with NREL and Julius on the potential continuation of the pilot project.

NETL RWFI Workforce Readiness Skills Database/Skills Commons (FY24): Updates and enhancements to our pilot workforce readiness skills database utilizing NETL and other lab entries as well as potential collaborative efforts with other collaborative partners to utilize data science and data analytics capabilities.

NETL RWFI WORKFORCE READINESS PLAN

Skills Identification - Pilot Program

- ✓ Available and accessible training programs
- ✓ Ongoing or planned collaborations with education and training providers
- ✓ Identify necessary certifications or other educational attainment involved in technology/activity
- ✓ Identify Economically Distressed Communities, state or federal designated Opportunity Zones, or other geographically defined empowerment zones where this activity may occur

Originated from conversations with stakeholders and through ARC workshop participation (2017-18)

Prevalent questions were:

- What are the occupations needed?
- What skills/education is required for those occupations? "Future casting"

NETL technologies 3-5 years from commercialization

Effort to understand occupations and skills necessary for the present and the future

DOE now requires a statement of job creation on FOAs

NETL RWFI- Community Stakeholder Engagement and Regional/National Workforce Activities: Aggregation/Integration/Communication

- Hydrogen 101 Webinar Series
- Hydrogen 101 Resources Website
- Hydrogen Workforce Skills Taxonomy Pilot
- Continuing to build out capacity to support regional hydrogen economy & Broader NETL Hydrogen activities

NETL, University of Pittsburgh and Julius Education Collaborative Efforts and partner engagement strategy

- Collaborative approach to analysis and creation of data science tools to interrogate labor and economic impacts and workforce analytics and metrics

HYDROGEN WORKFORCE: DATA DRIVEN ANALYSIS, ENGAGEMENT, TRACKING COMMUNITY SENTIMENT AND AWARENESS, AND INVESTIGATING WORKFORCE READINESS

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Community Stakeholder Engagement and Regional/National Workforce Activities: Aggregation/Integration/Communication/Deployment (NETL RWFI)

- Regional and national outreach (Leverage RWFI network)
- Hydrogen 101 Series (Hydrogen tech basics/workforce impacts/research impacts and roadmaps)
- Hydrogen focus group (Education and Workforce) (best practice sharing—catalyzing follow-on funding, stakeholder awareness)
- Workforce Readiness and Workforce Awareness Regional and National Index
- Skills Taxonomy and Skills Matching
- Regional Hydrogen workforce playbooks (Australia Hydrogen Workforce Industry Roadmap Strategic Plan, Victoria Hub Hydrogen Workforce DOE roadmap)/dashboard hosting
- Answer the what, when, and where of Hydrogen Workforce

Dashboard Tracker of Workforce Impacts and Assessment Tools

- Impacts and analysis integration and tracking through an online/real time dashboard
- Potential future work with integration with LLM for occupation discovery and worker outreach/education on hydrogen skills/current occupation and skills match
- ChatGPT Virtual guidance counselor feature
- Dynamic real time reporting on national hydrogen strategy goals progress

EXAMPLE OF A POTENTIAL HYDROGEN SKILLS TAXONOMY: OPPORTUNITY TO PROVIDE DEEP SKILLS ANALYSIS AND ENABLE SKILL TRANSFERABILITY

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Hydrogen Plant Machinery Operator Skills Model (Example)

Rich Skill (tied to role)	Generic Skill
Monitor equipment for safety and performance	equipment monitoring
Operate valves and pumps to control the flow of hydrogen	valve/pump operation
Adjust machinery to maintain the desired pressure and temperature	machinery adjustment
Troubleshoot and repair any malfunctions or breakdowns	troubleshoot
Inspect and maintain equipment to ensure compliance with safety regulations	equipment inspection
Perform routine maintenance to keep machinery in optimal condition	maintenance technician
Monitor hydrogen levels and adjust as needed	hydrogen monitoring
Load and unload materials for processing	material handling
Follow established safety protocols	safety protocols
Document all work performed and test results	documentation testing
Observe safety precautions when handling hazardous materials	safety handling
Coordinate with other personnel to ensure efficient operation	coordinating
Analyze data and make adjustments to ensure optimal performance	data analysis
Operate computer systems to monitor and control machinery	computer systems operations
Respond to alarms and take corrective action	alarm response
Prepare reports to document operations and maintenance activities	report preparation
Perform tests on samples to measure hydrogen levels	testing hydrogen
Follow instructions from supervisors to ensure proper operation	following instructions
Train other personnel in the operation of hydrogen plant machinery	training others
Adjust settings on machinery to optimize performance	machine tuning
Identify and report any defects or malfunctions	troubleshoot
Monitor and adjust hydrogen levels as required	hydrogen monitoring
Assemble, install and maintain machinery	machinery maintenance
Calibrate instruments to ensure accuracy	calibration
Troubleshoot and repair any issues with machinery	machinery repair
Maintain records of hydrogen production and consumption	hydrogen tracking
Perform quality checks on products and materials	quality control
Follow safety guidelines when handling hazardous materials	safety handling
Analyze data to identify trends and potential problems	data analysis

- Having a skills taxonomy and ontology provides a critical enabler of a whole host of workforce use cases to support recruiting, employee retention, workforce and academic program development, and upskilling.
- It also helps match potential employees to the right job, clarifies skills “delta” between where a job seeker or employee is today and the job they aspire to, illuminates skill transferability between jobs with similar skills, and helps educators develop more employer aligned programs, among many other benefits.
- They use AI tools to automate the development and maintenance of a Hydrogen Skills Taxonomy.

BLS OCCUPATIONAL SKILLS PROFILE DATA ANALYSIS ACROSS GEOGRAPHIC LOCATION OF ENERGY LABOR ACTIVITY (U. PITT.)

Location is a major barrier for transferring U.S. fossil fuel employment to green jobs

(Nature Communications; 26, Sept. 2023)

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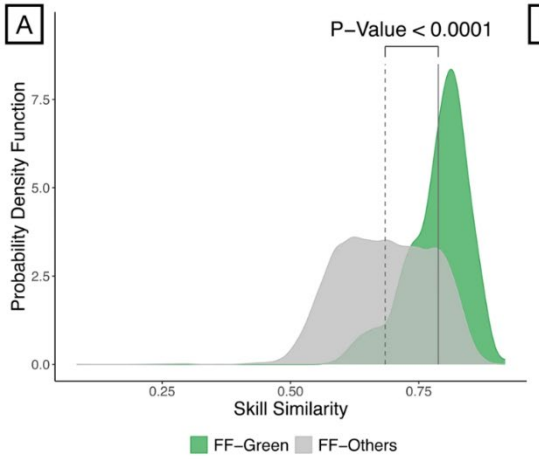

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Dependent Variable: $Transition_{f,m,i',m'}$					
	Model 1	Model 2	Model 3	Model 4	Model 5
Skill Similarity$_{i,i'}$		0.59 (0.0001) $P \leq 10^{-3}$		0.84 (0.0001) $P \leq 10^{-3}$	0.41 (0.0003) $P \leq 10^{-3}$
Distance$_{m,m'}$			-1.13 (0.0001) $P \leq 10^{-3}$	-1.18 (0.0001) $P \leq 10^{-3}$	-2.07 (0.0003) $P \leq 10^{-3}$
Employment$_{f,m}$	0.94 (0.0002) $P \leq 10^{-3}$	0.97 (0.0002) $P \leq 10^{-3}$	1.01 (0.0002) $P \leq 10^{-3}$	1.00 (0.0002) $P \leq 10^{-3}$	1.04 (0.0002) $P \leq 10^{-3}$
Employment$_{i',m'}$	0.85 (0.0002) $P \leq 10^{-3}$	0.90 (0.0002) $P \leq 10^{-3}$	0.98 (0.0002) $P \leq 10^{-3}$	0.97 (0.0002) $P \leq 10^{-3}$	1.04 (0.0002) $P \leq 10^{-3}$
Stay (Industry)					1.11 (0.0006) $P \leq 10^{-3}$
Stay (Location)					-3.43 (0.0012) $P \leq 10^{-3}$
Constant	1.16 (0.0002) $P \leq 10^{-3}$	0.95 (0.0003) $P \leq 10^{-3}$	0.23 (0.0003) $P \leq 10^{-3}$	-0.04 (0.0003) $P \leq 10^{-3}$	-0.34 (0.0003) $P \leq 10^{-3}$
Pseudo R^2	0.16	0.21	0.72	0.81	0.84
Observations	10,352,319	10,352,319	10,352,319	10,352,319	10,352,319

High skills similarity between FE and other EE/RE industry skills

*(North American Industry Classification System two digit/ O*Net)*

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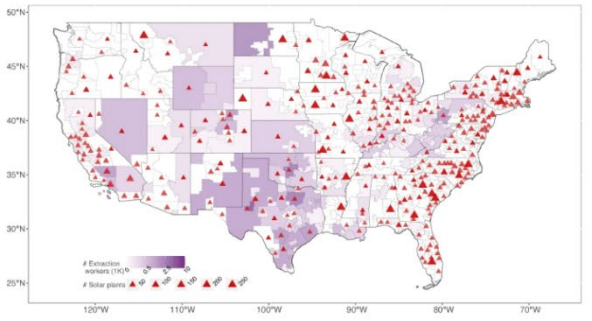

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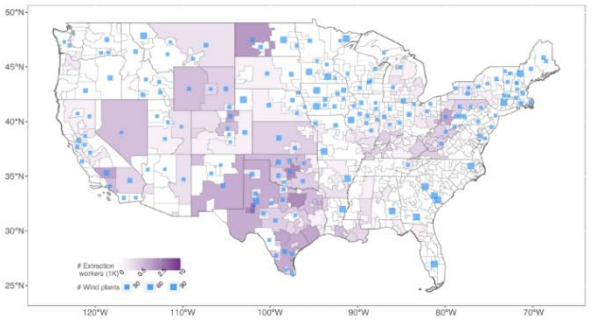

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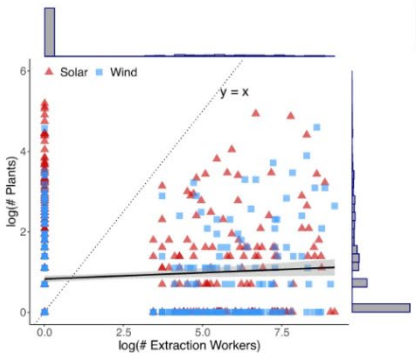
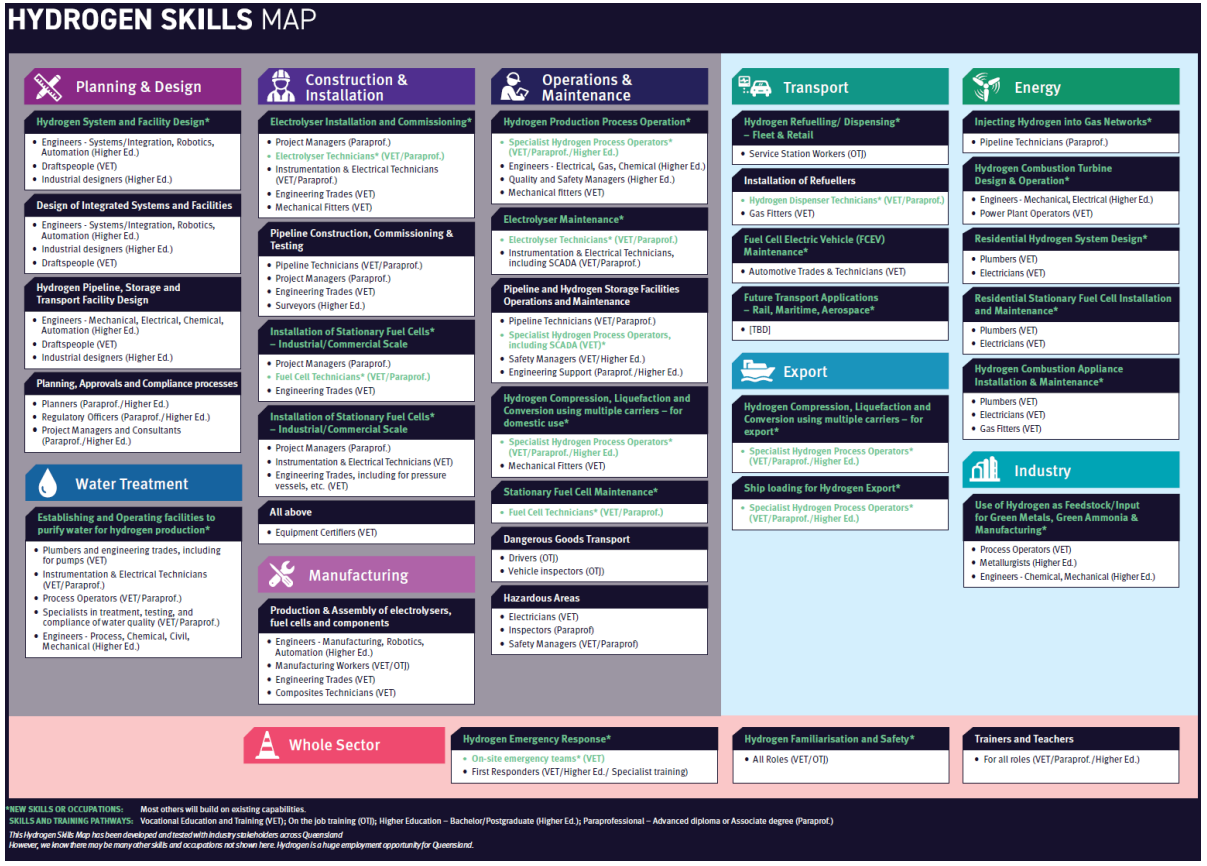


D

	All Plants		Solar Plants		Wind Plants	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
log(Extraction Workers)	-0.01 (0.004) P=0.151		-0.06 (0.01) $P \leq 10^{-3}$		0.18 (0.01) $P \leq 10^{-3}$	
log(FF Workers)		-0.02 (0.01) $P \leq 10^{-3}$		-0.12 (0.01) $P \leq 10^{-3}$		0.19 (0.01) $P \leq 10^{-3}$
log(Labor Force)	0.51 (0.01) $P \leq 10^{-3}$	0.52 (0.01) $P \leq 10^{-3}$	0.70 (0.01) $P \leq 10^{-3}$	0.80 (0.01) $P \leq 10^{-3}$	-0.01 (0.03) P=0.853	-0.06 (0.03) P=0.034
Psuedo R^2	0.26	0.26	0.33	0.35	0.09	0.06
Observations	510	510	510	510	510	510

EE/RE energy production with very little co-localization with FE worker

PROJECTION FOR U.S. HYDROGEN INDUSTRIES (WORKFORCE ROADMAPS)



Australia Hydrogen Workforce Industry Roadmap
Victorian Hydrogen Workforce Report/Roadmap

Future jobs and skills trajectory

Combining the analysis and modelling of the future green hydrogen economy, the emergence of jobs being impacted by green hydrogen-related changes over the coming decades is predicted in the figure below.

As the industry rapidly evolves, these predictions are subjected to change. The introduction of new technologies, implementation of new regulations and adoption of hydrogen to scale is expected to result in jobs needing to be filled earlier than anticipated.

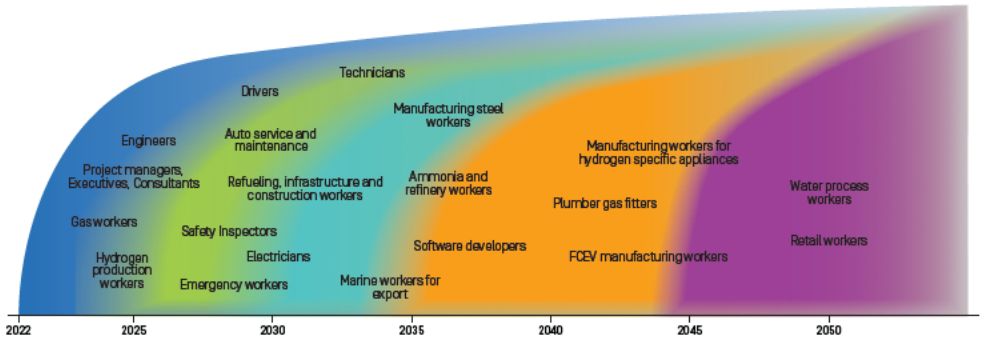
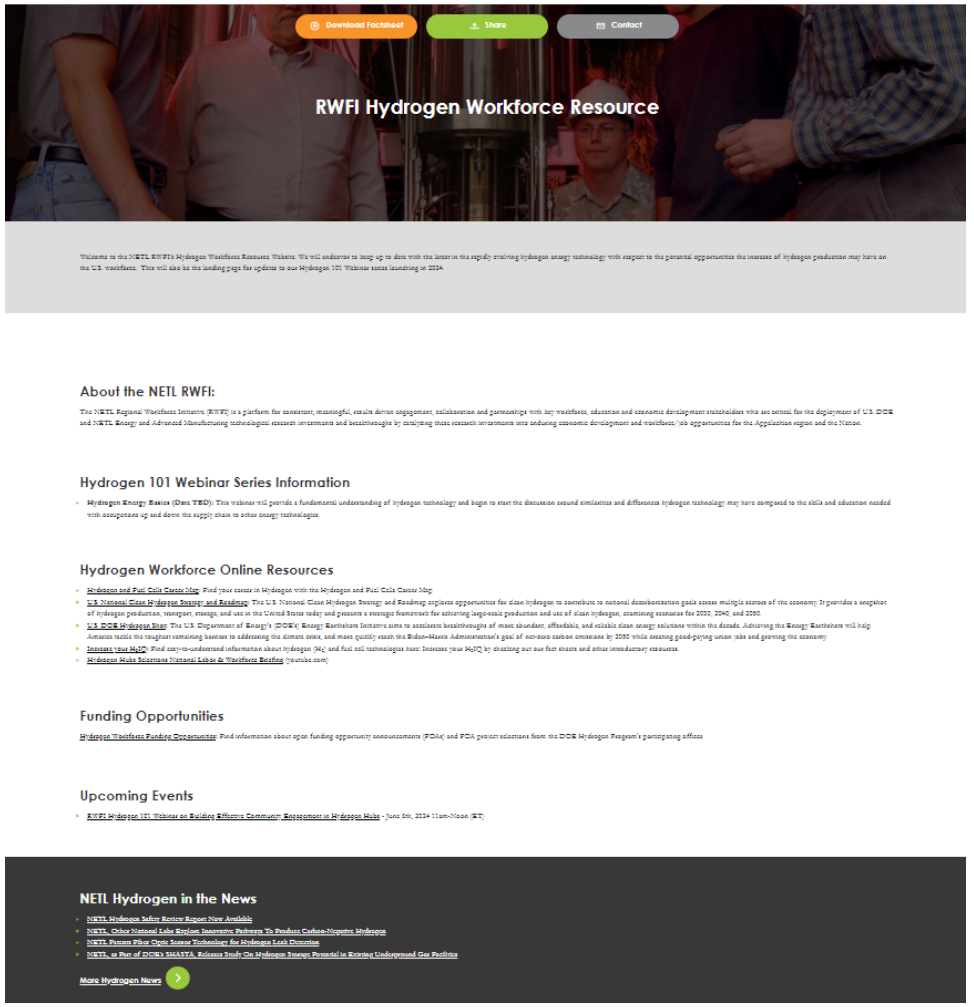


Figure 12. Predicted emerging jobs in various industries driven by green hydro

NETL REGIONAL WORKFORCE INITIATIVE UPDATES

Supporting Regional Economic and Workforce Development opportunities.

- NETL RWFI launched a H2 Workforce website for regional stakeholders as well as a Methane Mitigation Workforce website. NETL RWFI will launch similar workforce resources for carbon mitigation technologies and serve as a web portal for regional stakeholders to learn more about skills, reports, analysis and funding available for workforce activities.



NETL RWFI- Next Steps

Let's Connect, Communicate and Collaborate!

Catalyze external funding with stakeholders and partners to amplify our impact

Expand our support of NETL efforts in supporting a regional and national hydrogen economy and other carbon management technologies

Developing new focus groups regionally around emerging technical areas such as DAC, hydrogen, manufacturing, rare earth metals, etc.

Continuing to work closer with the other national labs, creating a National Lab community of practice and to be collaborative on commercialization, economic development and workforce projects

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Argonne NATIONAL LABORATORY

YUE KE

11 September 2024

US Census/American Communities Survey

- Sociodemographic information on “current” job holders by industry/occupation
- Geographic location of workforce by home address only
- Commuting patterns

Job Postings Data

- Postings tell us how industry is changing over time and how employers are responding
- Postings typically list desired skills and required certifications
- Can compare occupations between and within industries to determine gaps in workforce skills

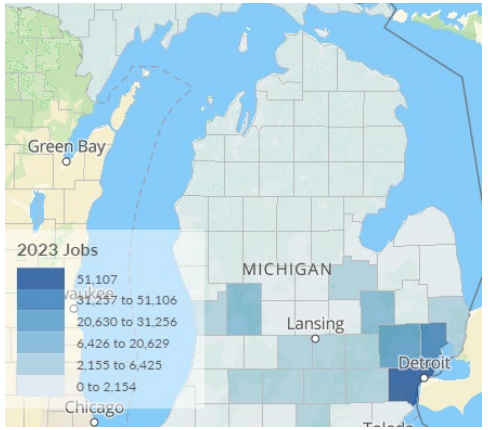
Autoworker demographics in MI

Occupation	% of Industry in Occupation (2023)
Production Occupations	67.8%
Architecture and Engineering Occupations	8.8%
Installation, Maintenance, and Repair Occupations	4.5%
Management Occupations	4.4%
Transportation and Material Moving Occupations	4.4%
Office and Administrative Support Occupations	3.1%
Other	6.9%

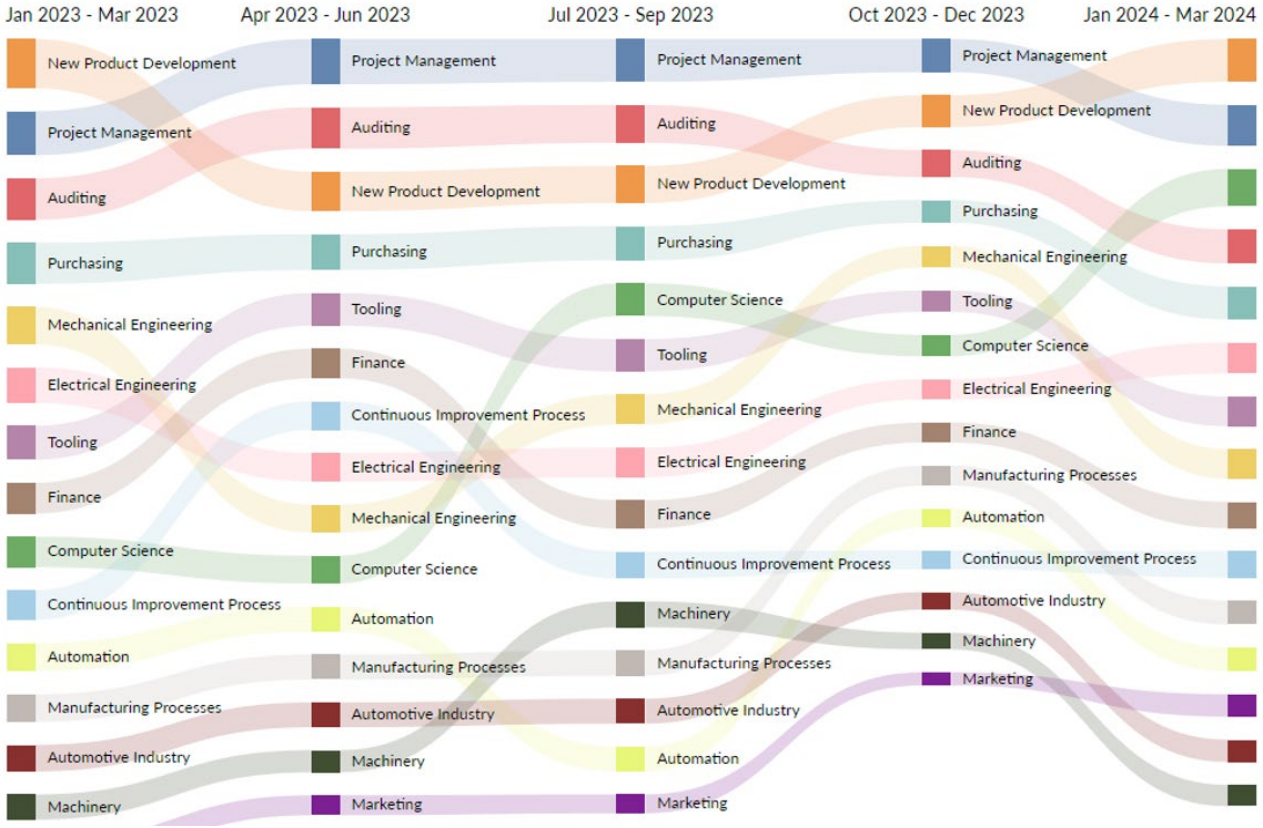
	% of Jobs	Jobs
Males	71.4%	125,305
Females	28.6%	50,070

	% of Jobs	Jobs
White	64.6%	113,289
Black or African American	22.1%	38,810
Asian	6.1%	10,775
Hispanic or Latino	5.4%	9,395
Two or More Races	1.4%	2,490
American Indian or Alaska Native	0.3%	517
Native Hawaiian or Other Pacific Islander	0.1%	99

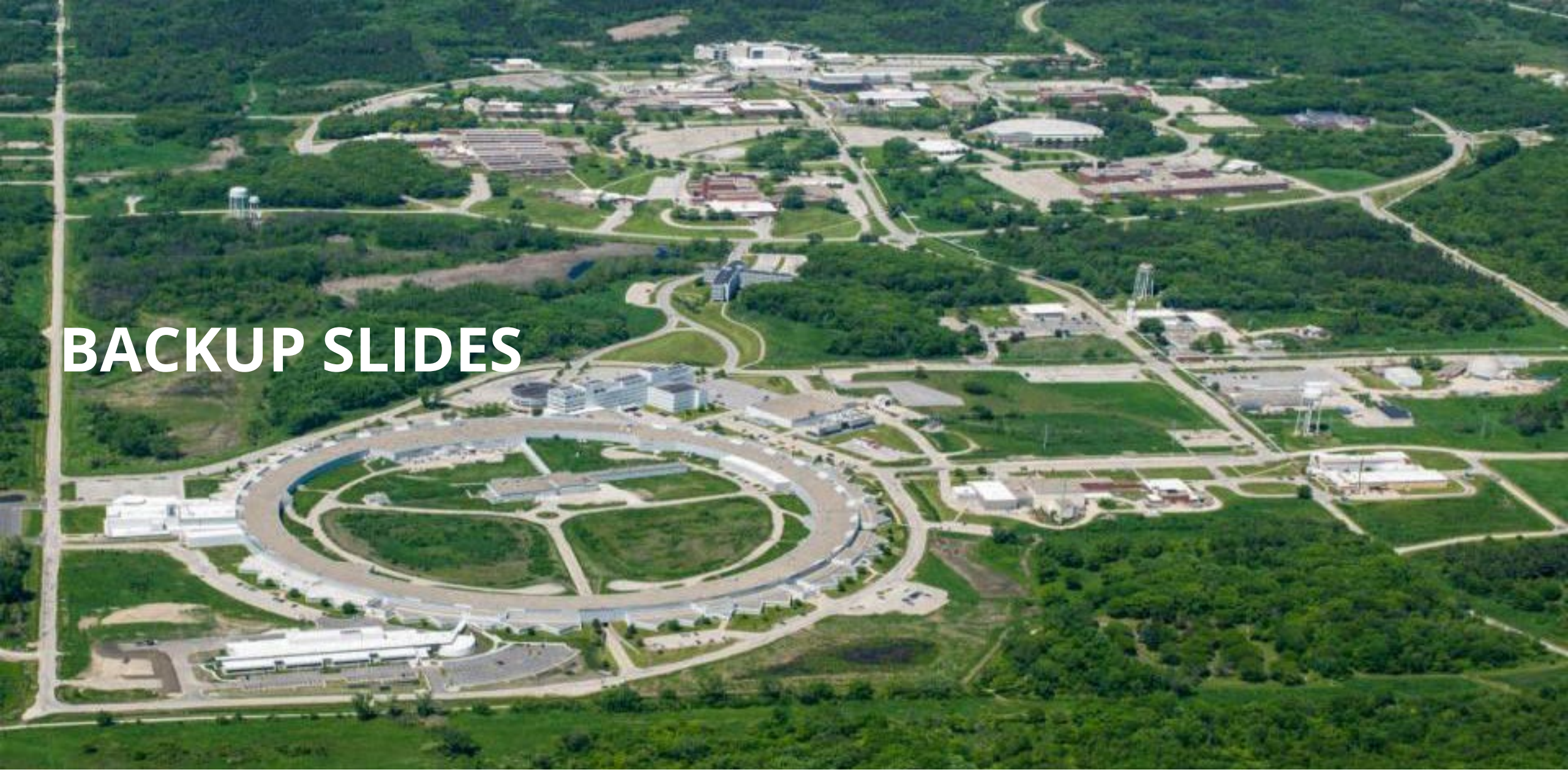
	% of Jobs	Jobs
14-18	0.2%	393
19-24	5.4%	9,513
25-34	21.0%	36,778
35-44	20.7%	36,265
45-54	27.2%	47,664
55-64	22.0%	38,533
65+	3.6%	6,230



Top 15 Skills for Auto Industry Jobs

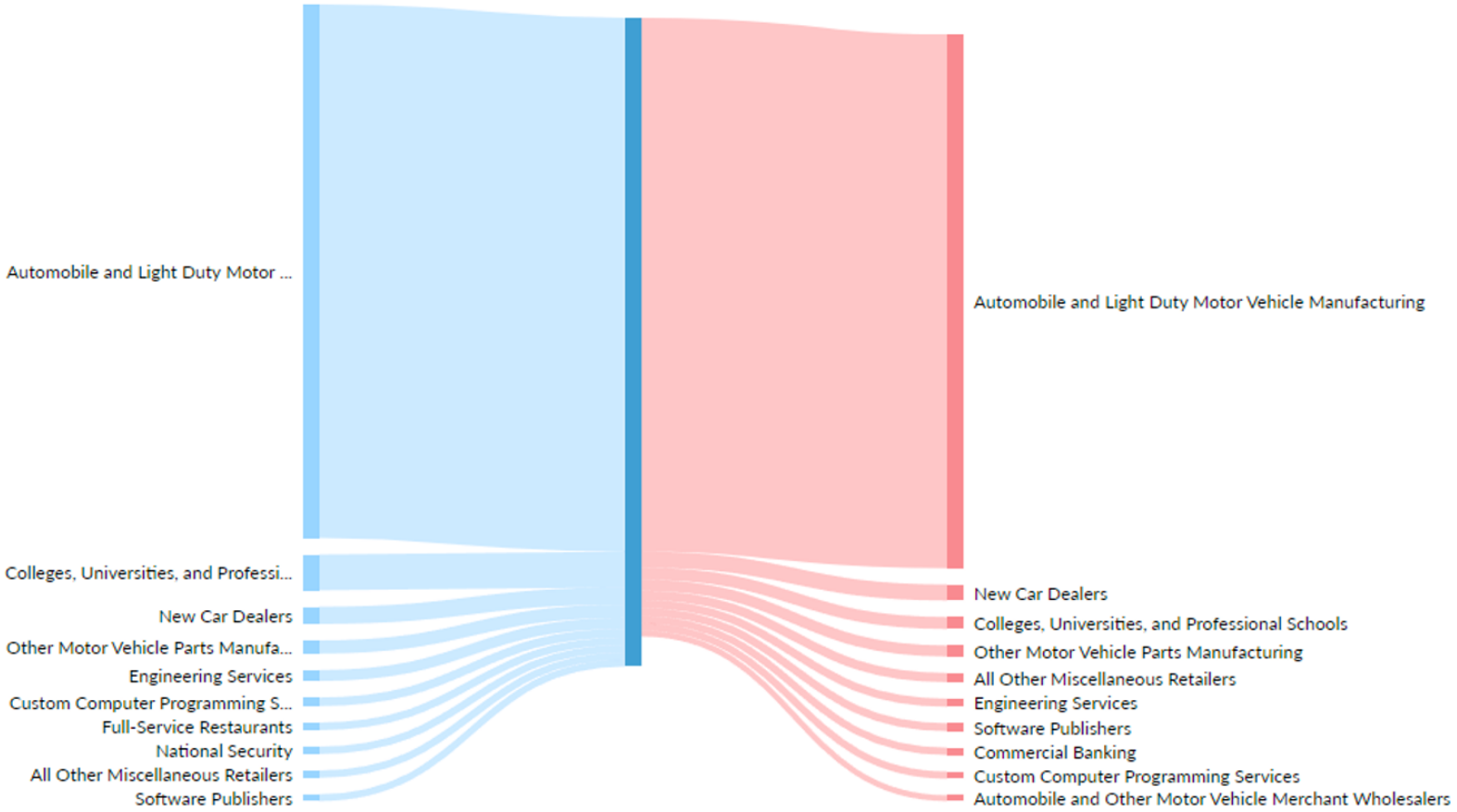


ICEV Job Skills	Green Job Skills
Project management	HVAC
Computer Science	Plumbing
New Product Development	Tooling
Electrical Engineering	Automation
Tooling	New Product Development
Manufacturing processes	Process Improvement
Mechanical Engineering	Electrical Engineering
Automation	Data Analysis
Machinery	Power Tool Operation
Continuous Improvement Process	Electrical Wiring



BACKUP SLIDES

Based on LinkedIn profile scraping



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Workforce Committee Update

LDES NATIONAL CONSORTIUM

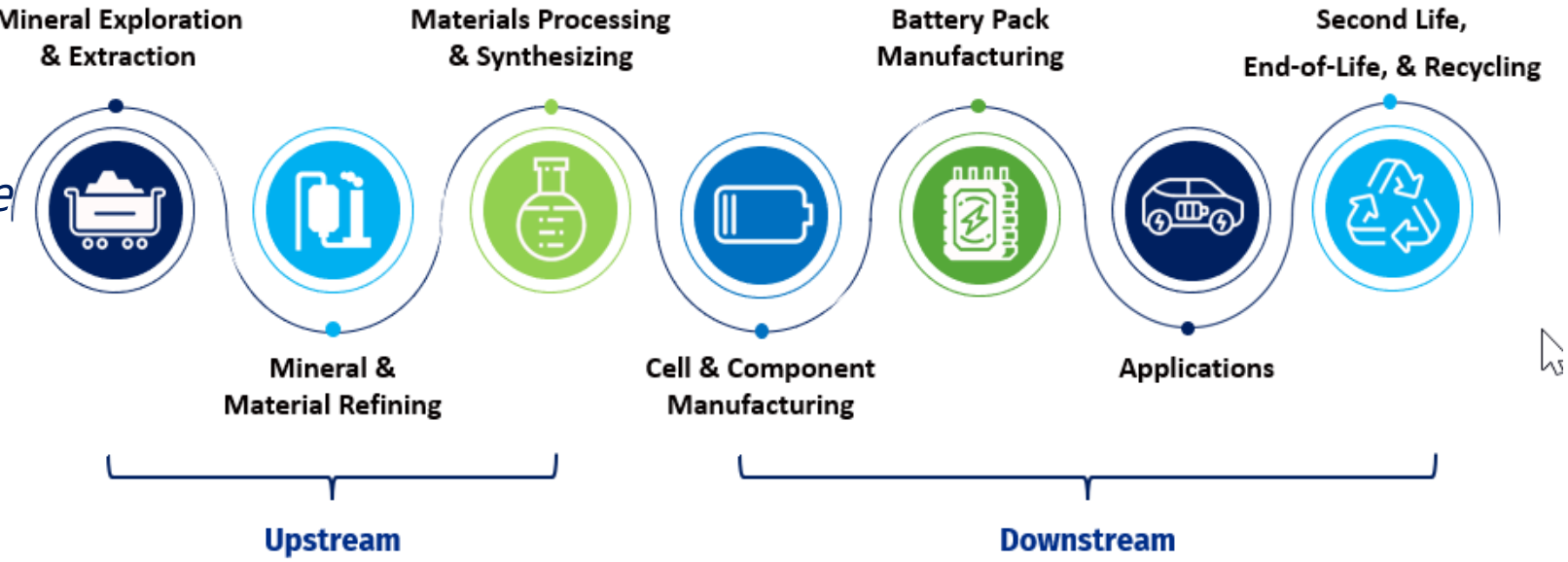
Mission and Assessment Objectives

MISSION

- Parallel to goals of DOE and FCAB[1], Li Bridge[2] objective to strengthen and sustain the domestic lithium battery supply chain
- Meeting this objective requires building a U.S. skilled workforce scaled to industry demand
- Phase 1: Examine Workforce Skills Gaps[3] within current battery industry, determine needs for training and education

ASSESSMENT OBJECTIVES

- Develop, execute comprehensive *assessment of skills gaps and workforce needs*
- Identify needs across the whole battery supply chain
- Capture representative sample from each sector



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[1] FCAB report; [2] Li-Bridge Report; [3] McQuilling (2021)

Scope and Key Metrics of Workforce Needs

SCOPE OF INDUSTRY ASSESSMENT

- Gather perspectives of industry employers within lithium battery industry **across the entire supply chain**
- 2023 assessment executed via online survey platform, contact with industry and public sector
- This phase 1 identifies needs of industry. (Does not catalog training and education resources – that's phase 2)

KEY METRICS OF WORKFORCE NEEDS

Results: Skills Gaps and Outdated Skills

A. Skills Gaps

INDUSTRY-WIDE GAPS

Electrochemistry / Battery Chemistry

Manufacturing

Battery management systems (BMS)

Product & system design

Safety

Battery Recycling

UPSTREAM GAPS

Chemistry/ Chem. Engineering,

Extraction / Mining,

Metallurgical/ Mineral Processing

DOWNSTREAM GAPS

Electrochemistry/ Battery Chemistry

Battery Materials

(Chem. Eng. & Materials science)

Battery Management (BMS)

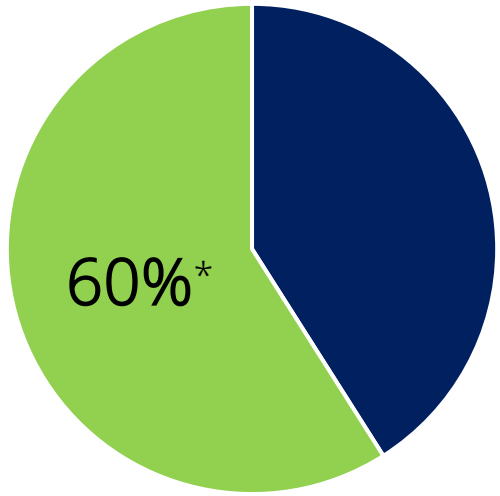
ADVANCED MANUFACTURING

Materials science,

Chemistry/ Electrochemistry,

Managing / operating automated tools

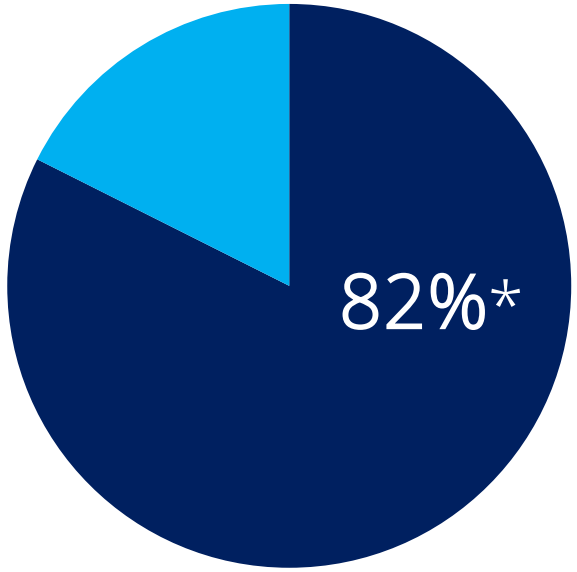
B. Outdated Skills



**Percent reporting 25-100% of employees with outdated skills*

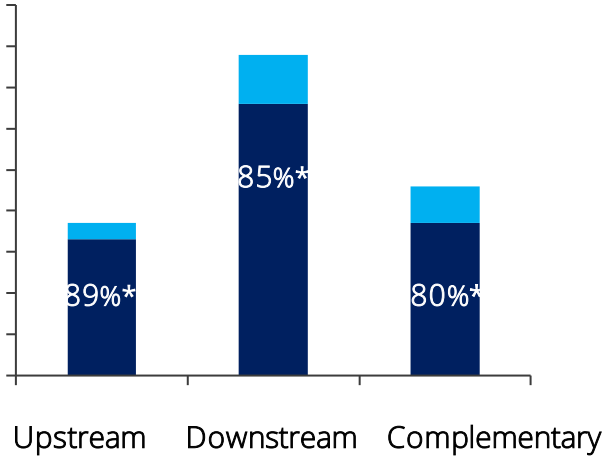
Findings: Workforce Shortages

A. SKILLED LABOR SHORTAGE



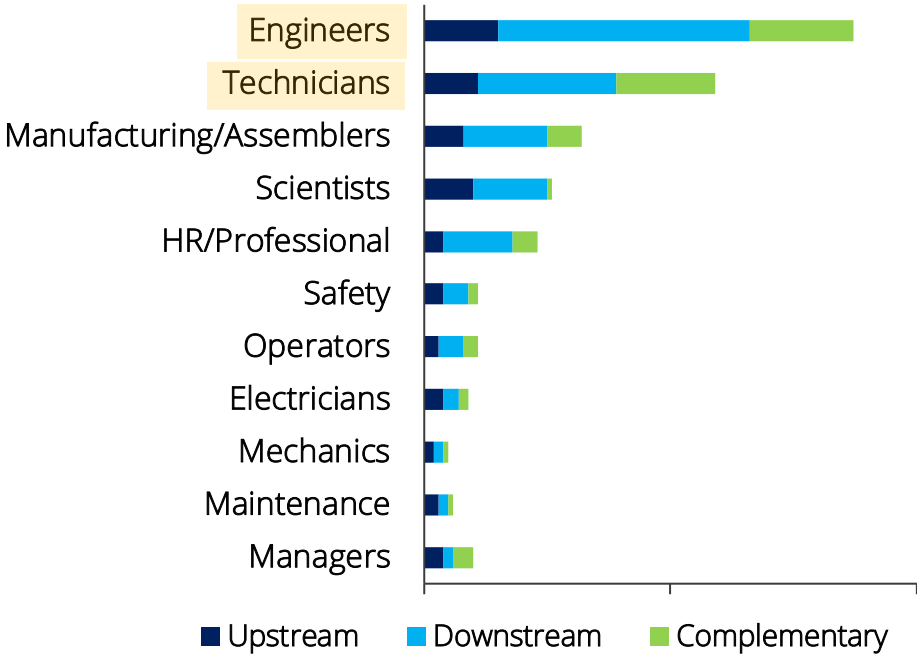
** Percent of employers reporting lack of skilled local labor*

B. LABOR SHORTAGE BY SECTOR



**Percent of employers reporting lack of skilled local labor*

C. ROLES IN SHORT SUPPLY



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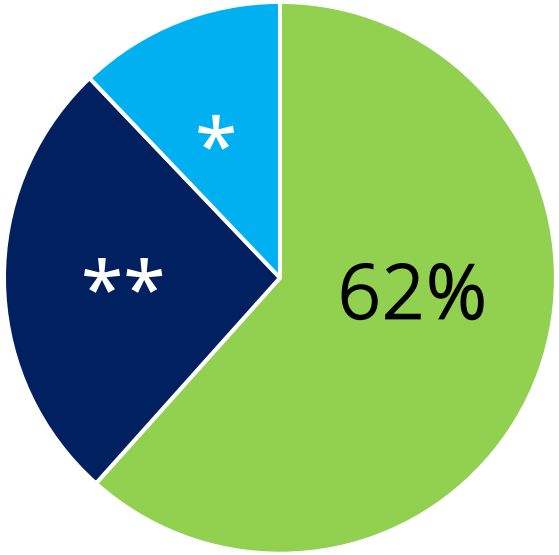
Findings: Recruitment & Retention Challenges

A. Recruitment Challenges for Technical/ R&D Roles



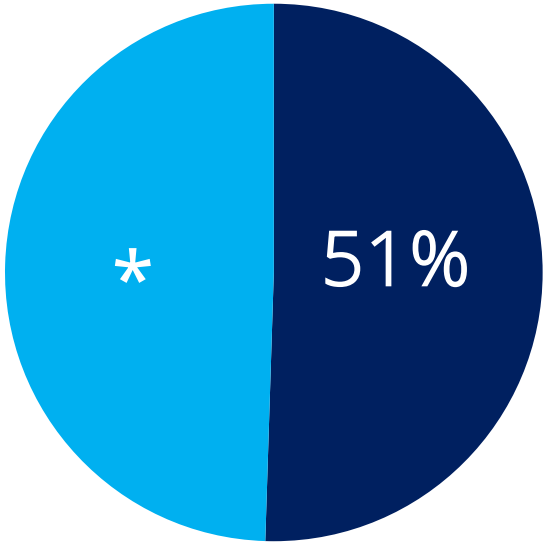
**26% report no challenges,*
***12% challenges developing*

B. Reasons for Retention Challenges

40% report challenges retaining skilled employees

- Competition with other industries
- Lack of veteran leaders and SMEs
- Geographic location/ cost of living
- Shift work
- Turnover due to high demand for battery engineers

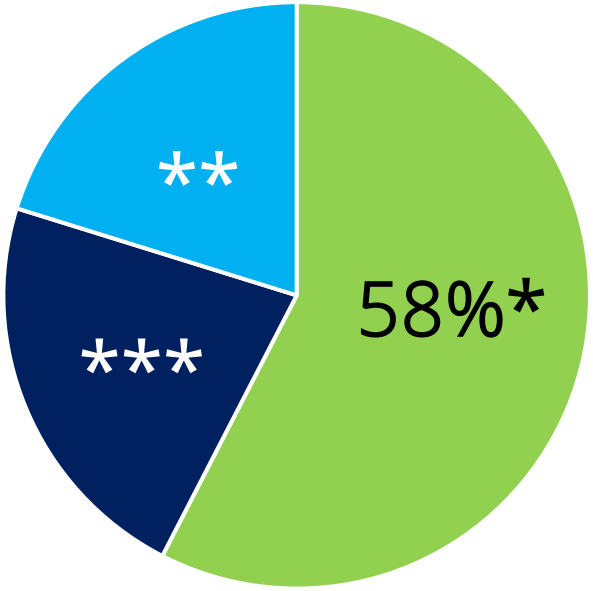
C. Recruitment Challenges: Relocation



**49% report no relocation challenges*

Findings: Growth and Hiring Demand

A. Demand driving Industry Changes



** Industry organizational changes expected (e.g., new departments, structure, or initiatives),*
*** Emerging changes, *** No Change*

B. Hiring Demand Increases (2023-2026) by Area and Training level

UPSTREAM SECTORS

Areas: Mineral exploration, Mining

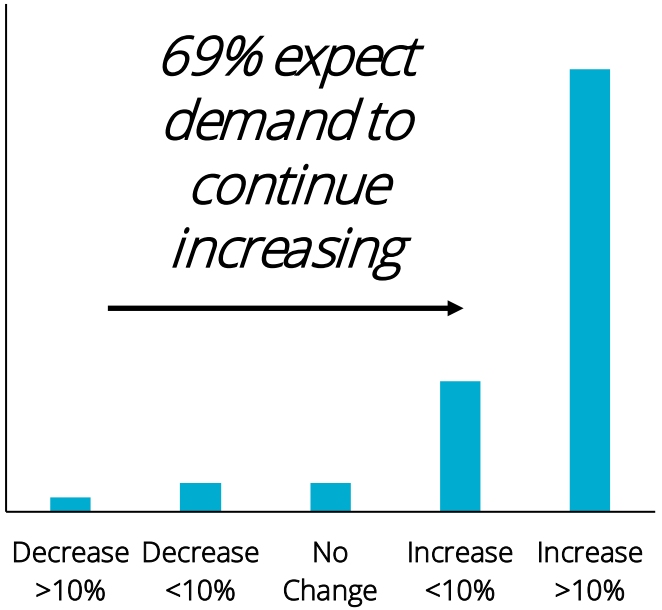
Training Source: On-the-job, Apprenticeship, 2-year degree

DOWNSTREAM SECTORS

Areas: Components, Cell Mfg., Recycling

Training Source: On-the-job, 4-year degree

C. Hiring Demand Following Scale-up (2026 - 2030)



Access the full report: CARgroup.org BIETNA

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