

Survey on Gap Analysis in Workforce Skills and Policies in the Battery Industry

Conducted by NAATBatt Education Committee

Overview of Results

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Survey: Background Information

Overview

- This survey was drafted and reviewed by members of the NAATBatt Education Committee for Clean Energy Storage
- The survey was released on **October 29** and remained open until **November 29**
- There were a **total of 62 responses** submitted to the survey, with 193 survey responses initiated
- The invitation was distributed via the NAATBatt email list and posted on LinkedIn by various members of the NAATBatt Education committee

Objectives / Mission

- The goal of the survey was **better understand the existing skills gaps** in the battery industry and **identify future needs for skilled workers** in the battery industry across manufacturing, applications and ancillary industries.
- The survey results will be used to guide activities, policies, incentives and tools for **workforce development and training for the battery industry in various regions of the US.**

Hiring: Past and Future Trends

- Roughly 75% of respondents are planning to hire within the next year and 71% have hired in the past year
- Most companies have hired 1-9 professionals (61%) in the past 12 months; 21% had hired 10-49 employees and 7% had hired 50 or more employees
- Hiring across all education levels is expected in the next 12 months, with the greatest hiring challenge at the 4-yr degree & graduate levels
 - The more skilled the worker is, the more difficult they are to find
- Most respondents (90%) found that there were a limited number of applicants with required skills for recent postings
- Roughly half (44%) did not find local applicants with required skills; this highlights the need for regional support of training and education



Opportunities
for up-skilling
local workforce
to fill newly
created jobs in
battery industry!

Missing Skills from Existing Applicant Pool (n=58)

skills gaps in **number of responses** within individual sectors

	Application 1: Stationary Battery Sector (utility & customer side)	Application 2: Transportation Sector (incl. EV, charging, aviation, two wheeled vehicles)	Cell and Component Manufacturing (electrodes, electrolytes, modules, packs)	Raw Materials, Refinement, and Recycling	Total Responses re: skill
Electrochemistry, Battery Chemistry	14	14	30	20	43
Battery materials (chemical engineering, materials science)	11	14	25	22	39
Mining	2	2	1	9	11
Electrical	10	9	14	1	20
Power Electronics	9	9	9	2	15
Software/BMS	19	16	14	6	28
System Design	18	15	17	6	27
Prototyping	9	11	13	4	19
Battery testing	14	14	14	5	26
Safety (electrical, fire, hazmat, etc.)	8	12	10	3	17
Application of batteries (installation, operation, etc.)	14	13	10	2	23
Operation and maintenance	10	8	9	2	18
Battery recycling	6	10	6	12	24
Environmental engineering	3	4	4	4	8
Project management	9	8	9	7	16
Technical lead, manager	9	8	16	7	21
Supply chain management	7	6	10	9	16
Manufacturing (incl. plant design)	9	8	17	8	26
Total Responses from Sector	25	26	34	28	

- 58 respondents selected any skills, in any sector
- Skills highlighted in **red** are most frequently missing and most needed
- Software, BMS, and system design biggest skills gaps in stationary storage sector
- More need for safety, testing and system design in transportation sector
- Greatest skills gaps in cell and component manufacturing
- Most shortage of skills across the board in electrochemistry and battery materials

Missing Skills from Existing Applicant Pool (n= 58)

skills gaps in % of responses within individual sectors

	Application 1: Stationary Battery Sector (utility & customer side)	Application 2: Transportation Sector (incl. EV, charging, aviation, two wheeled vehicles)	Cell and Component Manufacturing (electrodes, electrolytes, modules, packs)	Raw Materials, Refinement, and Recycling	Total Responses re: skill
Electrochemistry, Battery Chemistry	56%	54%	88%	71%	43
Battery materials (chemical engineering, materials science)	44%	54%	74%	79%	39
Mining	8%	8%	3%	32%	11
Electrical	40%	35%	41%	4%	20
Power Electronics	36%	35%	26%	7%	15
Software/BMS	76%	62%	41%	21%	28
System Design	72%	58%	50%	21%	27
Prototyping	36%	42%	38%	14%	19
Battery testing	56%	54%	41%	18%	26
Safety (electrical, fire, hazmat, etc.)	32%	46%	29%	11%	17
Application of batteries (installation, operation, etc.)	56%	50%	29%	7%	23
Operation and maintenance	40%	31%	26%	7%	18
Battery recycling	24%	38%	18%	43%	24
Environmental engineering	12%	15%	12%	14%	8
Project management	36%	31%	26%	25%	16
Technical lead, manager	36%	31%	47%	25%	21
Supply chain management	28%	23%	29%	32%	16
Manufacturing (incl. plant design)	36%	31%	50%	29%	26
Total Responses from Sector	25	26	34	28	

- The percentages are based on the number of responses for each skill divided by the number of responses in that sector for all skill
- These percentages highlight the in-sector importance/shortage of each skill
- Materials and electrochemistry are most highlighted here, especially for manufacturing and materials, but storage applications saw greater desire for:
 - Software and BMS
 - System Design
 - Battery Testing

Where should missing skills be taught? (n=56)

skills gaps in **number of responses** at different levels of training institutions

	Trade School	In-house training or re-training	2-year Community College	4 Year College/ University	Post-Graduate	Total Responses
Battery materials (chem. engineering, mat. science)	6	7	12	32	32	44
Mining	5	4	5	7	6	14
Electrical	4	4	13	15	7	23
Power Electronics	4	3	11	17	10	24
Software/Battery Management	2	3	12	22	12	31
System Design	2	4	8	21	14	30
Prototyping	5	11	11	18	9	25
Battery Testing	13	14	21	23	9	35
Safety (electrical, hazmat, fire, etc.)	11	11	15	14	8	23
Application of batteries (installation, operation, etc.)	6	6	12	13	6	21
Design for Waste management	6	6	9	16	8	20
Battery Recycling	9	8	13	18	15	27
Environmental engineering	2	3	4	14	8	17
Project management	3	7	12	16	6	21
Technical lead/ management	3	9	7	19	11	25
Supply chain management	3	7	11	16	5	24
Manufacturing including plant design	2	5	10	22	11	28
Installation of battery systems	11	9	14	8	5	21
Operation and Maintenance of systems	14	13	11	10	2	22
Electrical skills for battery technicians (high voltage)	16	13	20	13	4	29
First response to battery fires	10	14	13	8	5	20
Total responses from training institution	27	26	35	43	42	

- Educational institutions in **red** indicate where respondents felt key skills should be taught
- Greatest gaps for educational programs at the community and 4 year college level
- Training gaps for first response, safety, electrical skills, O&M, and installation at the trade school and community college level or through internal training programs
- Knowledge of trade school, in-house training programs may be limited in responding population

Where should missing skills be taught?

skills gaps in % of responses at different levels of training institutions

	Trade School	In-house training or re-training	2-year Community College	4 Year College/ University	Post-Graduate	Total Responses
Battery materials (chem engineering, mat science)	22%	27%	34%	74%	76%	44
Mining	19%	15%	14%	16%	14%	14
Electrical	15%	15%	37%	35%	17%	23
Power Electronics	15%	12%	31%	40%	24%	24
Software/Battery Management	7%	12%	34%	51%	29%	31
System Design	7%	15%	23%	49%	33%	30
Prototyping	19%	42%	31%	42%	21%	25
Battery Testing	48%	54%	60%	53%	21%	35
Safety (electrical, hazmat, fire, etc.)	41%	42%	43%	33%	19%	23
Application of batteries (installation, operation, etc.)	22%	23%	34%	30%	14%	21
Design for Waste management	22%	23%	26%	37%	19%	20
Battery Recycling	33%	31%	37%	42%	36%	27
Environmental engineering	7%	12%	11%	33%	19%	17
Project management	11%	27%	34%	37%	14%	21
Technical lead/ management	11%	35%	20%	44%	26%	25
Supply chain management	11%	27%	31%	37%	12%	24
Manufacturing including plant design	7%	19%	29%	51%	26%	28
Installation of battery systems	41%	35%	40%	19%	12%	21
Operation and Maintenance of systems	52%	50%	31%	23%	5%	22
Electrical skills for battery technicians (high voltage)	59%	50%	57%	30%	10%	29
First response to battery fires	37%	54%	37%	19%	12%	20
Total responses from training institution	27	26	35	43	42	

- The percentages are based on the number of responses for each skill divided by the number of responses that included that institution for any skill
- These percentages highlight unique roles each type of training institution provides
- Training in materials and electrochemistry are most likely to be taught at the university and post-graduate level
- Testing, installation, O&M, electrical skills and fire response are much more likely to be taught at trade or community colleges or through in-house training

Policies, Incentives and Tools Needed to Support Workforce Development

More than half of respondents provided valuable input to open-ended prompts about policies, incentives and tools

[See back up slides to read 74 valuable raw inputs on policy, incentives and tools](#)



- Urgently meet “desperate need” for trained workforce for battery industry through a multi-front effort
 - Federal and State investment and recognition system for skilling and reskilling in trade schools, community colleges, universities and mobile centers of excellence. Also grants for on the job in-house training with incremental reaccreditation system to ease job transitions
 - Overcome barriers to entry and red tape in utilizing funds by using latest digital technologies to demonstrate success with hands-on training programs, trade schools, career placement guarantees, in-house training/internships and retention programs by employers
 - Invest in scaling up promising technologies and leverage start-ups and labs in industry/academia partnerships for preparing future workforce (e.g. solid state batteries)
 - Fast track process to attract foreign graduates with top skills

Policies, Incentives and Tools Needed to Support Workforce Development (Contd.)

More than half of respondents provided valuable input to open-ended prompts about policies, incentives and tools

[See back up slides to read 74 valuable raw inputs on policy, incentives and tools](#)

- New approach towards workforce development within regions
 - Student outreach, aptitude matching, tuition assistance, add-on curriculum development and accreditation for key technical fields (electrochemistry, battery materials, power system integration, high voltage electricals, safety, installation, manufacturing etc.) using latest technologies for learning and “school to careers” tracking
 - Centers of Excellence and mobile demonstration/training/exploration labs that can move from college to college for a quarter/semester
 - Transformation of criminal justice system as a source of productive workforce
 - Strong demand for STEM at primary level and specifically towards targeted battery related careers while motivating kids towards a sense of purpose towards addressing 21st century challenges for the communities
 - Policy and R&D to create consistent ESG (Environmental, Social and Governance) standards and educating organizations and workforce on them
 - Public-private partnerships to support training, investments and job placements including community and environmental organizations using databases with open metrics traceability and management software

Respondent Demographics

- Saw responses across the lithium ion battery manufacturing supply chain, its applications (especially EVs), and ancillary industries (e.g. transportation, manufacturing, environmental services, etc.)
- Companies responding tended to be headquartered on the Coasts (55% of respondents) but more likely to have main production facilities in Great Lakes, Central and Southern US
 - This highlights the need for training programs across the country to ensure workforce exists to support the industry
- Wide range of company size, experience in industry highlighted among respondents
- Not enough coverage from Research, Academia, Electrical Contractors

Next Steps

- Reach out to additional stakeholders to ensure representative sample of battery industry was captured
 - Electrical Contractors, Academia, Research bodies, More start-ups?
 - Responses initiated in first round but not completed
- Collaborate with Energy Storage Grand Challenge workforce development efforts and align with Li-Bridge Studies
- Compare results from NAATBatt survey to published work completed by European Battery Alliance
- Develop follow-up survey to further refine workforce development needs by sector

Back up



Raw inputs from the Survey

- More than half of respondents provided valuable input to open-ended prompts about policies, incentives and tools
- 74 valuable raw inputs on policy, incentives and tools

What needs or recommendations do you have for **policies** that would support needed workforce development?

Emphasis in bold by NAATBatt Education Committee Survey Core Team to harness common themes on pages 8-9



- We need policies that generate more qualified applicants in our desired skill sets
- **Invest in community colleges, trade schools, and research**
- provide **tuition assistance for students** going into chemistry, electronics, robotics, computing, material science
- Policy and R&D is needed to create **consistency of ESG** (Environmental, Social and Governance) **standards and educating organizations** to support us working towards the collective goal of achieving net-zero.
- Team of State & college Empl. Dev't agencies for **outreach and skills & aptitudes sorting** of region candidates during site selection for battery & thin film PV factories and for **conversion shops** (diesel to BEV). Outreach to both traditional channels and **community development & environmental justice organizations**. Teams of training experts and our engineers to design abstract & **hands-on training programs** for each job and for our business culture. Work with **community colleges, relevant incubators and Maker Spaces**. May work with a leading university to provide graduates and train people here in applying principles of ceramics engineering and manufacturing. These apply directly to both solar thin film and battery fabrication. Also need assembly design (professional) and technician qualifications.
- **Extreme need across the board in technical fields and hands on training** of the workforce. We do not have the **workforce in place today and desperately need to establish curriculum** to meet the high volumes of electrification in both mobility and stationary sectors.
- State and Federal financial support to community colleges and state colleges/universities for technical training.
- Specific programs by schools associated with battery design and manufacturing, with tuition incentives from the government.
- **1) Scholarships 2) low-cost student loans 3) job boards** to encourage placements 4) support for internships/coops 5) yes, tax incentives 6) something for **High Schools** -- more technical training / support , more reinforcement of Trades --- 7) help the trades -- technical schools or ??? I'm not so smart to know, but we need to encourage "**kids**" about **technical schools/trades** is a legit career choice and reduce barriers to entry
- We need **federally mandated funding** for programs to develop skillsets to be pushed down to the local level to address foundational gaps in technical knowledge. A fair amount of battery technology is not new, but rather borrowed from other industries (chemical, sensors, electrical engineering etc). There should be a return to trade schools or community colleges/high schools that require this. For our hourly roles the labor market has been consumed by jobs in distribution which are fundamentally set up with error-proofing and less "**manufacturing & assembly**) this has decreased the candidate pool or truly skilled hourly associates and on the technical engineer side we see in MI that although there are various OEM's growing in the battery space many of them and their employee's are siloed in their knowledge and are **not comfortable working in a hands on, fast paced organization developing various li-on products**.
- Policies should support more hands on and worker/technician level basic technology awareness and introductions.
- **Retraining Budgets**
- Training to support **manufacturing, installation, and commissioning of energy storage systems** at the community college level is needed.
- Support USA **free enterprise without restrictions** (ie unions) as red tape raises costs and slows productivity
- Training for **battery technicians** (cell design/build and testing) at the **trade school and community college level**.
- Offer training in house, more **grant to be able to train in-house employee**
- Development of skills related to **power systems integration** is crucial for development of the energy storage systems, as well as understanding the evolution of the needs of the energy storage systems up stream from a quality and applications perspective. Fundamental work in finding sustainably accessible reserves of materials and retraining to allow mining through finished storage systems are needed.
- Additional programs to **incentivize employers to train and retain employees**. More focus on job training programs for critical engineering skills.
- Training modules and training subsidies to support **STEM and electrical/electrochemical safety needs to occur at the regional level**. In small communities, such as our engineering technical center in XXX, there is a dearth of available training/education in the region to support battery/safety knowledge base, so our company needs to assume all levels of new employees require basic battery/electrical safety training.
- **Encourage Trade schools, Universities to implement LIB programs** to develop expertise needed in industry, partner with manufacturers, give financial support, incentives
- Better **math and science education at the primary school level**
- Policies that encourage the trades. Also **policies to support and incentivize investment in new battery startups**.
- **Support scale-up** of battery manufacturing in US so that there are more experienced battery people around.
- Try **moving high school graduates towards trade schools and community colleges** rather than university; and develop electrical and battery training programs in the community college
- Work at trades (apprenticeship level) and at community college/university for **credentialed add-on courses**. Encourage **employers to consider the value of skilled trades with modern education, in place of 4-year graduates**
- Financial benefit to support training and also **setup training centers** for training
- fast track **Green Cards for foreign graduates with top skills**
- **Curriculum and associates degrees** at community colleges and more classes at the university level
- In order to gain strong local supply chain and manufacturing, in a short/midterm, we have to **welcome global partnership and investment** with and into the US companies. This will build up a much stronger and sustainable ecosystem
- Creating a **national database of battery related data** job, promoting it to the future graduates of high schools vocational, 2-year colleges, 4 year colleges.
- Added **incentives for individuals** getting training for the upcoming e-powered industry.
- Increase the number of job opportunities in this area by **supporting new battery manufacturing companies**
- Classes and training in **2 years colleges**

What needs or recommendations do you have for **incentives** that would support needed workforce development?

Emphasis in bold by NAATBatt Education Committee Survey Core Team to harness common themes on pages 8 and 9



- **Gov't funded** training programs for workforce development would be helpful
- **High paying jobs** that are available locally
- direct hire after graduation, scholarships or **tuition allowance not loan**
- Investment to incentivize **ESG education**, authority planning, and renewable energy upskilling. Direct investment into **technological advances that use data to** enable sustainable manufacturing and recycling.
- Pay them a living wage during training. Provide a continuing team-building, **community-related experience that gives people a sense of meaning and purpose** -- making a difference and being valued for it -- that excites them.
- Establish a unified government plan that addresses funding of all entry points from incentives for end product application, **battery product commercialization, component development, recycling, with a keen focus on funding initiatives for educational institutions for training senior leadership, management, technical fields, construction, plant equipment, workforce labor, logistics, recycling, etc. etc.**
- **Company tax incentives for hiring community college/trade school program graduates** especially POC.
- it's easy to say tax incentives -- but we need more talent -- **I think it's about increasing the supply of talent more so than tax incentives** per se.
- train **low level offenders in these skills while still in prison**. The current job market has forced employers to look at candidates they would have previously overlooked. The biggest gap for this population is **direct training in this field**.
- Would like to see **more university programs** offering battery focused courses and degree programs. **More tech schools** offering battery introduction courses.
- **Job placement guaranteed**
- Focused education on **battery technology manufacturing**
- **help to develop and train the employee**
- Support universities and **private partnerships to develop skills and needs**. Support for industry organizations to share future developments in the pipeline and develop skillsets before they are critical. Support **fundamental research in chemical engineering, geology (earth science) and industrial scale up of technologies**.
- Make **funds easily accessible with little red tape**
- Federal /regional electrical/battery training/education subsidies, **recognition of qualified training programs**, and support of certifications for battery safety, including potential for financial bonuses for first responder's training for battery fire response.
- A 40% ITC (*investment tax credit*) would give us reason to **locate manufacturing jobs in the U.S.**
- Funding of the specific industries in the battery product cycle, and **dedicate a fixed percentage to the development of the appropriate skilled workforce**
- USA must setup **dedicated cell manufacturing training centers**
- **federal and state funding** to the academic institutions
- Creating an **industry, university, National lab cooperatives to train job seekers with new skills**.
- Ensure **comparable funding for trade schools** with e-mobility programs as community colleges are receiving.

What needs or recommendations do you have for **tools** that would support needed workforce development?

Emphasis in bold by NAATBatt Education Committee Survey Core Team to harness common themes on pages 8 and 9



- **Demonstrate** that community colleges and trade schools can prepare students for a successful career
- **develop battery making engineering laboratories, analytical equipment, robotics lab and software access and training**
- Supply chain **traceability and management software** to create visibility in global and complex supply chains. The data and insights can then be used to **understand inefficiencies and high carbon processes.**
- **Database development to include digital twins, fleet records, augmented reality visualization for installation and repair, as well as for learning challenging** procedures for manufacturing and / or assembly.
- **Online training modules at various levels of education** in all the aforementioned disciplines followed by hands on or face to face certification to establish qualified personnel for given job positions.
- Setting up energy storage **Centers of Excellence and mobile demonstration/training labs** that can move from college to college for a quarter/semester.
- See above -- more training, more education. we have to catch up with the rest of the world. For profit education is not the way -- we really need to **make it easy to get educated, trained.**
- Recommend using the book "**Handbook of Lithium-ion Battery Pack Design**"
- **easy access to practical exploration**
- Tools are an expensive investment so should be chosen wisely as they can inadvertently raise costs or cause a dangerous environment (fire, explosions, etc.)
- **Standard curriculum** for internal training/retraining of technicians from other fields for battery cell development/design and testing.
- work with professional associations to develop **sub groups that focus** on this space. For example, **AICHE has an electrochemical and energy storage division.**
- **Courses on offer that are more specific for energy storage engineering skills**
- Substantially greater access to basic **training in HV safety, safe battery handling, power electronics control systems, and manufacturing equipment design** that supports battery cell manufacturing as well as supporting components for construction of battery control systems and physical electrical infrastructure
- More **leadership.** Better **critical thinking.**
- Offering programs at the community college level as well as new curriculums focused on battery storage.
- **Collaborate with industry to develop the appropriate tools suitable for academic environments.** Use a **total product life-cycle approach**
- Dry room, high voltage work experience, chemical handling, mechanical assembly tool.
- Training materials, 3 months courses, **outreach materials**