CAREERS

OUTSOURCING US drug-makers shift clinical trials to contractors **p.106**

EMPLOYMENT LAW Association argues for US graduate assistants' right to unionize **p.106**

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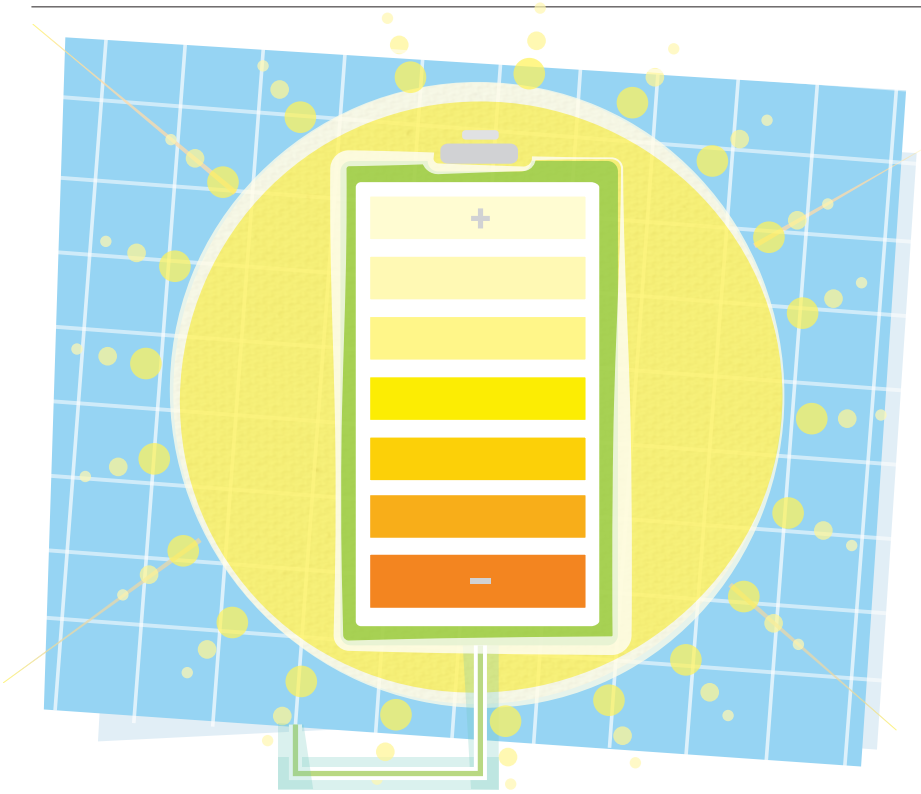


CLAIRE WELSH/*NATURE*

MATERIALS RESEARCH

Batteries warm up

Interest in energy-storage research is growing, opening up opportunities for chemists with interdisciplinary skills.

BY KATHARINE GAMMON

For materials scientist Lynn Trahey, the impetus for a change in career direction was a single sentence she heard in 2005. Then a doctoral student in chemistry at the University of California, Berkeley, she was attending a talk about the potential of powering the world with solar energy. The speaker made an offhand comment — that energy storage is part of the equation for the future of green energy — and Trahey's interest was piqued. "I took that and ran with it — he's right. We will need to store energy from all kinds of sources. Batteries have to be part of the innovation," she says.

Trahey completed her studies in 2007 and went hunting for a postdoctoral position that would satisfy her interest in lithium-ion batteries, the most common rechargeable battery used in electronics and cars. She landed a joint postdoc in 2008 at two institutes in Illinois — Argonne National Laboratory near Chicago and Northwestern University in Evanston — then nabbed a permanent position as an assistant materials scientist at the lab two years later.

Today, she is researching materials and reactions in high-energy-density rechargeable cells with the aim of making longer-lasting batteries. Specifically, she wants to learn why the devices degrade where their liquid and solid components connect. She is also working to develop anodes — where positive current flows into the battery — from materials such as tin and silicon, which are cheaper and last longer than lithium.

The world is gradually moving to greener sources of energy, but trapping that power is troublesome because energy is lost every time it is moved or converted. Governments and industry are investing heavily to improve energy storage, and this is translating into research opportunities for early-career scientists who have skills in chemistry, electrochemistry and materials science, and are familiar enough with physics and engineering to discuss energy storage with physicists and engineers.

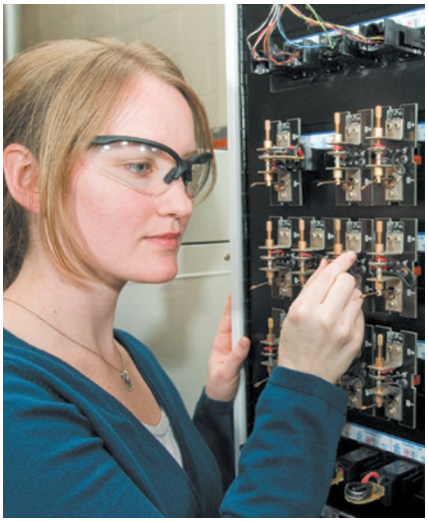
Trahey recommends that doctoral students who are interested in the field get a multidisciplinary education, particularly in the fields of electrochemistry and chemical engineering. In her battery group, she is surrounded by materials engineers and physicists who communicate well with one another. "We speak different languages on the same topic," she says, but she learned on the job how to make sure she understands — and is understood by — those in other specialities. She advises early-career researchers to hone these skills by attending talks on energy storage that lie outside their specific field.

BOUNDARY BREAKERS

A collaborative mindset helps to boost employability because the battery field requires a particularly cooperative spirit owing to its complexity. Devin Hodge oversees hiring for the Joint Center for Energy Storage Research (JCESR) in A, a five-year, US$120-million partnership between government, industry and academia that is funded by the US Department of Energy (DOE) and located at Argonne. He says that scientists who want to work effectively in an energy-storage laboratory should have a spirit of innovation as well as collaboration.

Hodge says that research opportunities will be opening up at the JCESR in the next year or so, but not all is rosy in the field's hiring outlook. Funding, at least in US academia, could well tighten; although federal spending on battery research has risen in the past five years, researchers hoping to grab a slice of that pie have glutted the field to some extent, says Brent Melot, a chemist at the University of Southern California in Los Angeles. "Some people say that it's the worst funding environment because of the number of people who are now competing for the same opportunities," he says. "All the people who used to research magnets now work on energy storage."

But industry, including the car and electronic-device sectors, is not stymied by the same funding crunch as academia. And the field of energy storage is growing around the world — meaning more jobs. Globally, government-funded battery and fuel-cell research and development ▶



WES AGRESTA/COURTESY ARGONNE NATL LAB.

Lynn Trahey is researching anode materials.

accounted for $8.7 billion from 2008 to 2012, and that number is expected to increase. The French government has allotted €140 million (US$189 million) to automotive-battery research. And energy-storage associations also cropped up in Asia: the Korea Battery Industry Association started in 2011; India's version launched in 2012; and China's Energy Storage Alliance started in 2010. Each of these associations supports research efforts and helps to move information to partners who can use it.

The JCESR — launched by the DOE in 2012 — now has 14 national partners, including Johnson Controls in Glendale, Wisconsin, and the Dow Chemical Company in Midland, Michigan. It aims to develop batteries that generate power in different ways, partnering lithium with oxygen or sulphur, for example (see *Nature* **507,** 26–28; 2014). That means opportunities for early-career scientists in chemistry, electrochemistry, materials science, nanotechnology, chemical engineering, computation and mechanical engineering.

In the next wave of hiring, some of the current postdocs will move into staff-scientist positions internally. Hodge says that graduate students, and postdocs in particular, will learn skills such as computational and materials techniques, which will effectively position them for high-paying permanent positions at research centres or in industry.

STORAGE STARS

A constellation of battery-related start-up businesses has emerged across the United States, and prospects abound for young, talented researchers who can innovate using chemistry. One of those is Vincent Giordani, a senior scientist at Liox Power, an energy research-and-development company in Pasadena, California.

Giordani acknowledges that his career path was serendipitous. When he presented his doctoral thesis on rechargeable non-aqueous lithium–air batteries at a conference in Canada, two executives from Liox happened to be in the audience. He was hired soon after, and moved to the United States two weeks after finishing his PhD jointly in France and the United Kingdom in 2010.

Industry presents interesting challenges for scientists in battery research, he says. "In academia, you have to bring money and write papers, but in industry there are higher stakes in coming up with a new technology." He is working on batteries that are more recyclable, hold more energy and can push cars farther.

Indeed, the automotive industry is focusing on creating cheaper and longer-lasting batteries, which should produce opportunities for early-career researchers. "The auto industry will change more in the next 10 years than it has in the past 100 years — a battery is no longer a commodity, but an integral part of the vehicle itself, with increasing demands for power and longevity," says David Cue, a vice-president at Johnson Controls Power Solutions in Milwaukee, Wisconsin, which is hiring PhD graduates with a background in engineering and materials.

To succeed in battery research, it helps to have a broad view of the necessary components. The shift from characterizing materials to working in a battery system can be daunting. "It's especially challenging for chemists because energy storage is an engineering-focused world," says Melot. "If you're not able to focus on the whole device, you go down dead-end roads." He recommends that early-career researchers get immersed in the wider field by gaining experience in labs that look at a whole device instead of one tiny part.

Despite academia's uncertain outlook, the interest in — and funding for — a world of better batteries continues to rise. In late June, the DOE announced a $3.2-million investment in the National Incubator Initiative for Clean Energy, which will create a network to assist small businesses focused on clean energy in honing their ideas and bringing green products to market. The incubators should help small businesses to grow, creating more jobs for early-career researchers.

"The auto industry will change more in the next 10 years than it has in the past 100 years."

The International Energy Agency estimates that by 2018 one-quarter of the electricity produced worldwide will come from renewable sources. Wherever clean energy is, there will always be a need to store it in a better way. "There are a lot of opportunities," says Cue, who has worked in Germany, China and France as well as in the United States. "And there aren't enough electrochemists to fill the demand." ■

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RESEARCH AND DEVELOPMENT

Outsourcing trends

US drug-makers are outsourcing more and more of their research and development, mainly to contract research organizations, according to figures released in July by the US National Science Foundation (NSF). The shift could be good news for researchers seeking positions in industry. In 1991, pharmaceutical companies spent about US$800 million on external research and development, but that skyrocketed to $13 billion in 2011, says John Jankowski, head of research and development statistics at the NSF. That growth outstrips that of any other sector. In 1991, industrial extramural research spending totalled $3.3 billion, but by 2011, spending had risen to $25.3 billion for domestic companies alone. Pharmaceutical firms' share of that total was 23% in 1991, but ballooned to 51% by 2011. Jankowski says that much of the increase comes from the outsourcing of clinical trials. The number of US contract research organizations has risen to match the demand, from around 800 in 2000 to more than 3,100 by the end of 2011, according to the Tufts Center for the Study of Drug Development in Boston, Massachusetts.

EMPLOYMENT LAW

Graduate rights

The American Association of University Professors in Washington DC has filed a legal document to the National Labor Relations Board arguing that graduate assistants, including research technicians, at private institutions should be considered employees and should therefore have collective-bargaining rights. The brief argues that the board should revise its definition of employee status, which is based on a 2004 decision that graduate assistants at Brown University in Providence, Rhode Island, were not employees because their work was inextricably linked to their study. Union representation of graduate assistants is a contentious issue. In 2012, Michigan banned graduate-student research assistants in public universities from unionizing, arguing that giving students employee status would alter the student–teacher relationship. In 2008, research assistants at the Research Foundation of the State University of New York voted to elect union representation after a 2007 board ruling that they were fundamentally employees.