institute has been at the centre of this transformation. With almost 1,200 employees, it sits at the intersection of applied science and industry, carrying out research with a mixture of public and private funding. Henning argues that federal funding alone isn't enough to create a sustainable renewables-research sector — and that policymakers and academics need to make sure they retain the support of the public and Germany's business sector.

"THERE'S A SENSE THAT WE SHOULD GET OUT OF SOLAR AND DO SOMETHING ELSE."

Photovoltaic (PV) solar panels are a good example: government support put the country at the forefront of PV research, but low-cost manufacturing eventually drove PV-panel makers elsewhere. Henning worries that German investments in battery research and other areas could face a similar fate if politicians aren't careful. "In PV we were leading, and others took over," Henning says. "The research and development budget is still there, but how long can we keep it if we don't have local production and markets?"

MODEL FOR FUTURE POWER

Fluri is one of the researchers at the forefront of this more-integrated approach. At the lab where she works in Freiburg, she uses computer models to determine the best combination of technologies for reaching Germany's goals for renewable power. She says that the fundamental questions have changed as the lab, founded in 2009, has grown to more than a dozen researchers. "At first, the question was 'can we supply Germany with renewable energy?'" says Fluri. "Now there are more and more questions around how can we integrate it and what business models will support it."

That's why the models Fluri builds incorporate public opinion-survey data gathered by sociologists, and why her degree combined engineering know-how with economics. When it comes to the Energiewende, "it's important to understand the socio-economic aspects, too," she says. "Is it economically viable to build a PV battery system on an apartment building, for example? Are people willing to invest even at a lower rate of return?"

As the Energiewende matures, the research driving it will, too. "There's an understanding that we still need individual technologies," says Sontheimer. "At the same time, one of the big challenges of the future is bringing all these technologies which are being investigated together into a system and make it work." ■

Andrew Curry is a journalist in Berlin.

PROFILE
THE SECOND COMING OF SOLAR

Lured back to Germany by funding opportunities, Eva Unger thinks that the country's solar-cell research could be entering a boom period.

Unger was born in Germany, but did most of her scientific training elsewhere, including a PhD at Uppsala University in Sweden and postdoctoral research at Stanford University in California. When the opportunity to pursue solar-cell research back home came up in 2016, she had her doubts — Germany's solar industry was struggling, and she already has a tenure-track position in Sweden.

In 2016, she moved to Berlin with funding from the German Ministry for Education and Research (BMBF) as part of its Helmholtz Innovation Lab initiative, a programme designed to provide lab infrastructure to young researchers to jump-start their work. (She still has a tenure-track position at Uppsala University.)

One year later, Unger's BMBF-funded laboratory at the Helmholtz-Center Berlin for Materials and Energy was up and running. And Unger says that the country's solar-cell research future is bright thanks to the discovery of substances that yield even better returns from the Sun's rays when integrated with traditional photovoltaic (PV) materials.

Some of the most promising materials are perovskites, crystalline substances that combine organic and inorganic materials. Since they were first successfully used to convert light into electricity in 2009, researchers have shown that perovskites are among the most efficient candidates for the PV cells of the future. "Perovskites are the biggest hype in solar energy research right now," Unger says.

So far, however, their high yields have only been seen in experimental applications across small surfaces of 1 centimetre or less. Unger is focused on transforming their theoretical potential into real-world technology for converting solar energy into electricity. "One of the tasks is figuring out how we scale from 23% efficiency at less than 1 centimetre to 1 metre," she says.

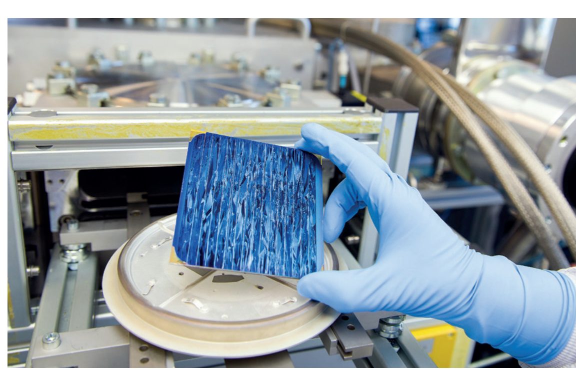
In Berlin, Unger shares the all-purpose lab with two colleagues who are tackling issues that are equally crucial to deploying perovskites in the real world, such as how to keep the substances stable and integrate them with more conventional silicon-based solar-cell technologies.

HELMHOLTZ-ZENTRUM BERLIN

"WITH THE KNOW-HOW WE HAVE, WE CAN ANSWER A LOT OF QUESTIONS WHEN IT COMES TO NEW MATERIALS."

The Innovation Lab is also intended to connect young researchers with corporate partners, a departure for the academic-research-oriented Helmholtz Association. "It's helping me really understand what the important parameters are in terms of whether the material will work as a device in the future," says Unger.

And to her surprise, even the crash of Germany's once-vaunted solar industry seems to have a silver lining. Start-up firms focused on using next-generation materials in solar arrays have begun returning to Berlin-area factories that were emptied out by a wave of bankruptcies. And there are lots of well-trained engineers with solar-cell experience based in Germany. "Sure, the German PV industry declined, but the facilities and expertise are still there," she says. "With the know-how we have, we can answer a lot of questions when it comes to new materials." **A.C.**



MICHAEL SETZPFANDT /HZB

Eva Unger's group work on new photovoltaic materials such as metal-halide perovskites.

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