

Future of Energy

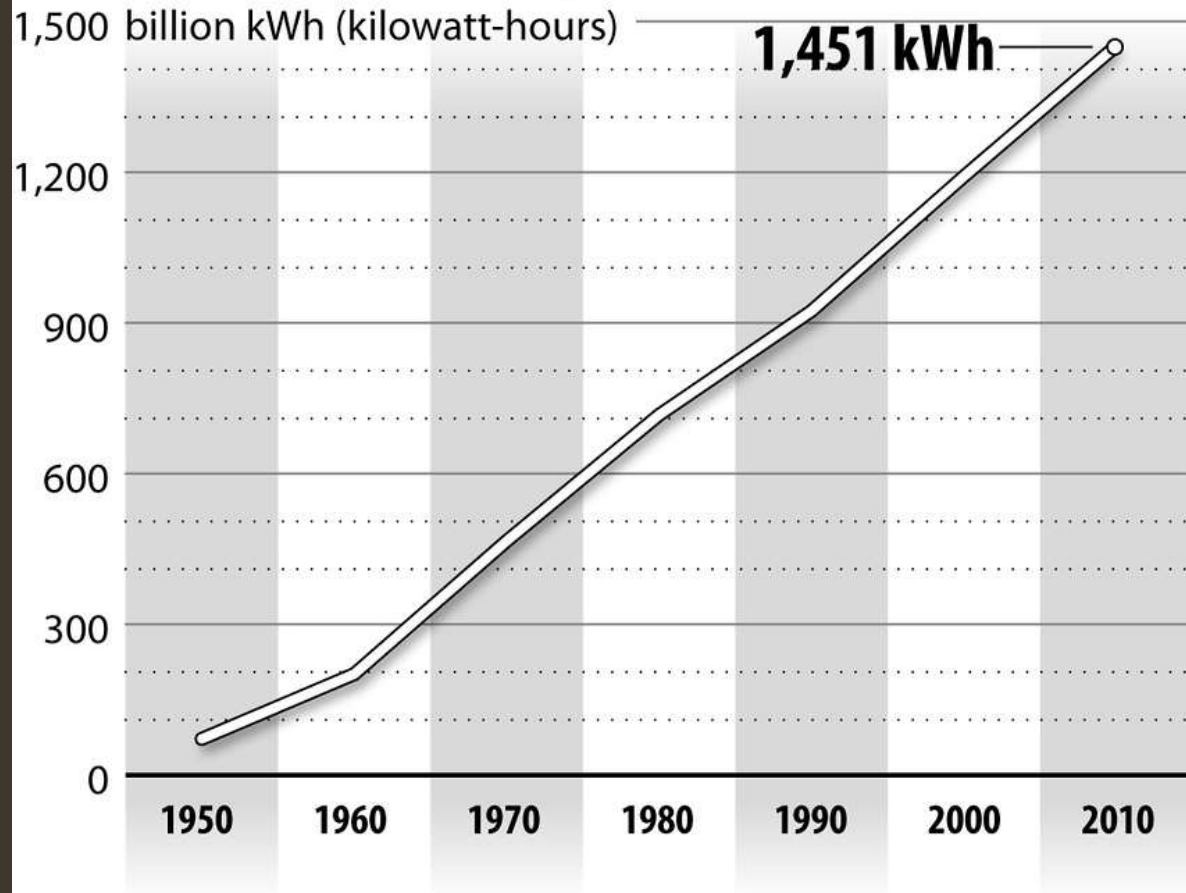
Preparing for Distributed Energy Resources



Presenters

- Jay Stowe, PE
- Wes Kelley
- Guangsheng Zhang, Ph.D

Residential Electricity Use



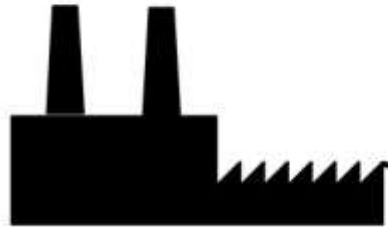
Data: Energy Information Administration

Steadily Rising Until...

- Homemaker Electrification
- Air Conditioning/Heat
- Technology Revolution
- Improved Building Materials
- HVACs and LED Bulbs

Transporting Electricity

Power plant
generates electricity



Transformer
steps up voltage
for transmission



Transmission line
carries electricity
long distances



**Neighborhood
transformer**
steps down voltage



Distribution line
carries electricity
to house

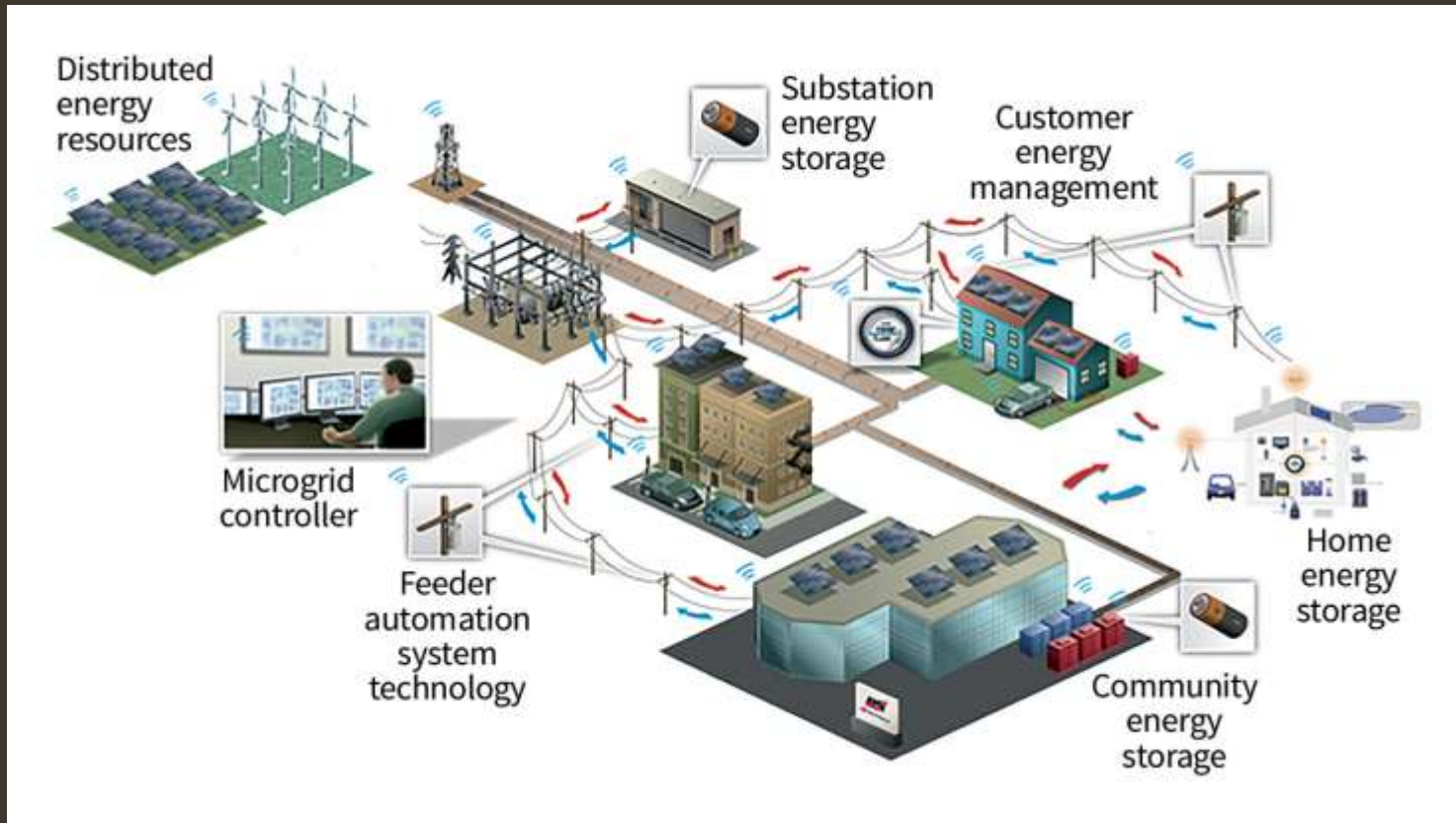


Transformer on pole
steps down voltage
before entering house



Traditional Power Grid

- Limited players
- One way flow of power
- Monthly meter reading
- Simply flow of dollars



DER Grid

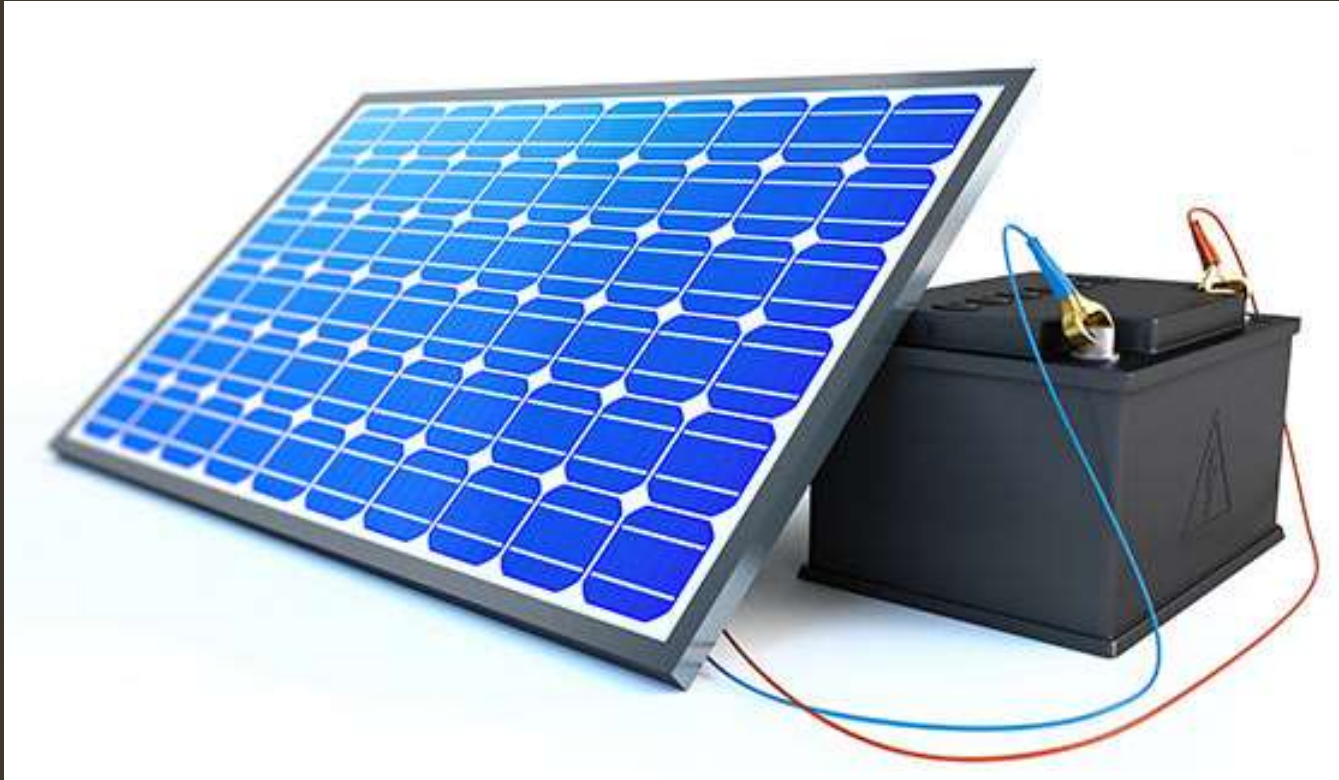
- Many players
- Multiple flows of power
- Real-time meter reading
- Complex flow of dollars

luxury
IS YOUR HOME

EXPLORE SOLEIL LOFTS

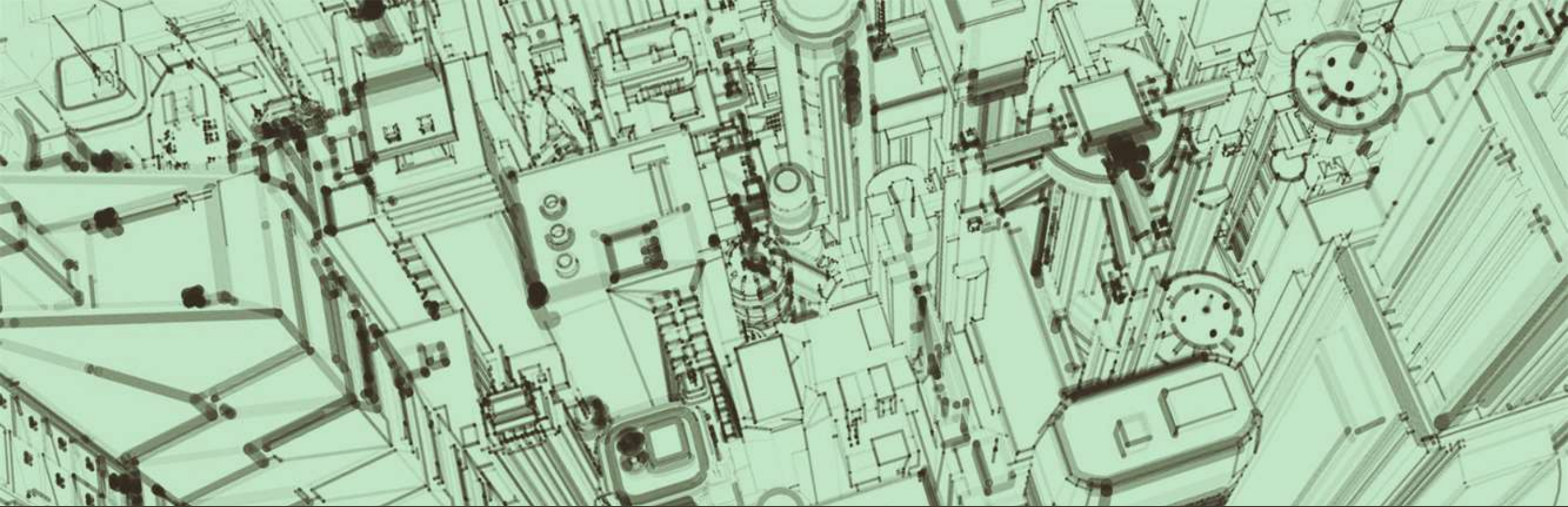
Self-Supply

- Solar
- Storage
- Backup Grid Power



Solar & Storage

- Rooftop
- Ground Mounted/Tracking
- 5-7 acres per MW (650 homes)
- Storage Safety (NFPA 855)
- Grid Backup



Future of Energy

Planners and Energy





SUSTAINABLE DEVELOPMENT GOALS

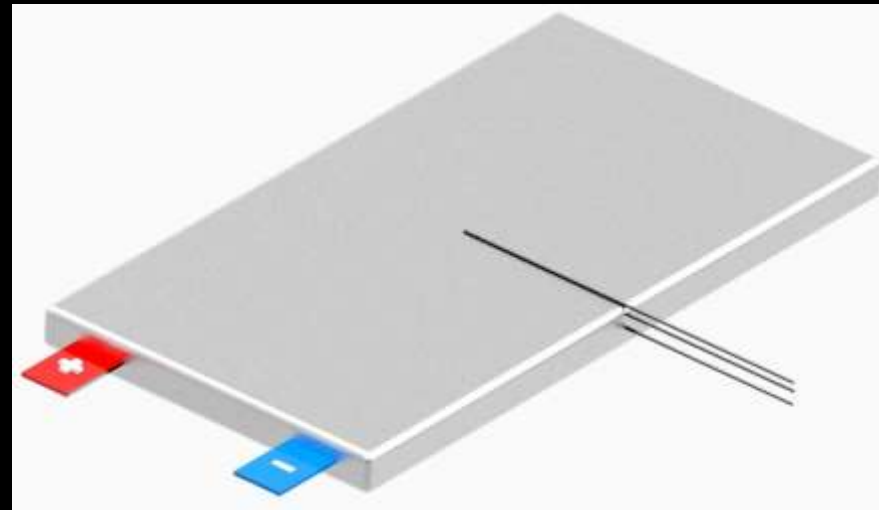
17 GOALS TO TRANSFORM OUR WORLD

1 NO POVERTY 	2 ZERO HUNGER 	3 GOOD HEALTH AND WELL-BEING 	4 QUALITY EDUCATION 	5 GENDER EQUALITY 	6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY 	8 DECENT WORK AND ECONOMIC GROWTH 	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE 	10 REDUCED INEQUALITIES 	11 SUSTAINABLE CITIES AND COMMUNITIES 	12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION 	14 LIFE BELOW WATER 	15 LIFE ON LAND 	16 PEACE, JUSTICE AND STRONG INSTITUTIONS 	17 PARTNERSHIPS FOR THE GOALS 	 SUSTAINABLE DEVELOPMENT GOALS

Another Way to Look at SDGs



The Future of Energy - A Battery Perspective



Guangsheng Zhang
George Nelson

Trends

Transportation is going electric



chevrolet.com



tesla.com



ford.com



bmwgroup.com



nissanusa.com



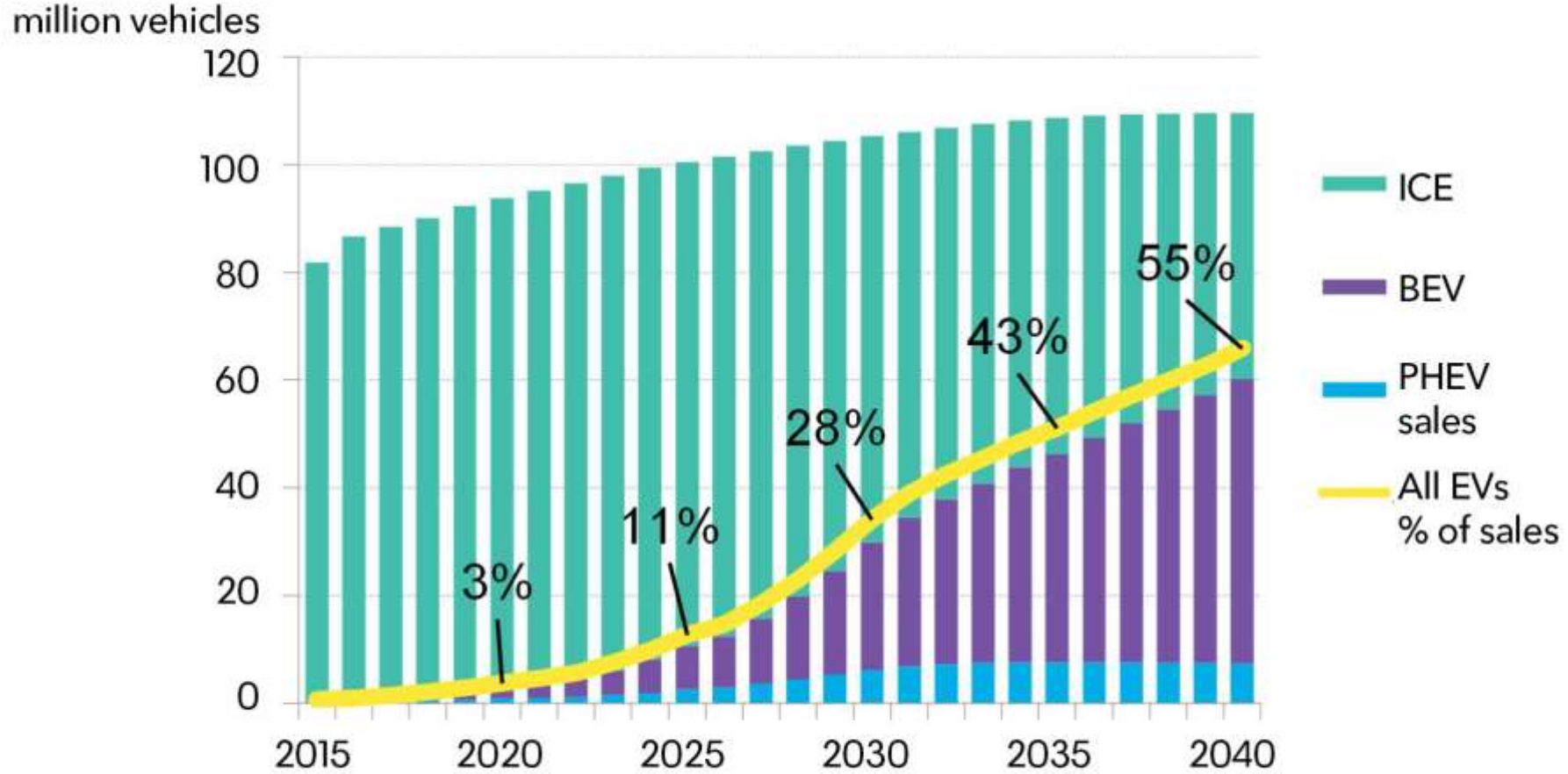
audiusa.com

Transportation is going electric



Transportation is going electric

Annual global light duty vehicle sales



Source: Bloomberg New Energy Finance

Transportation is going electric

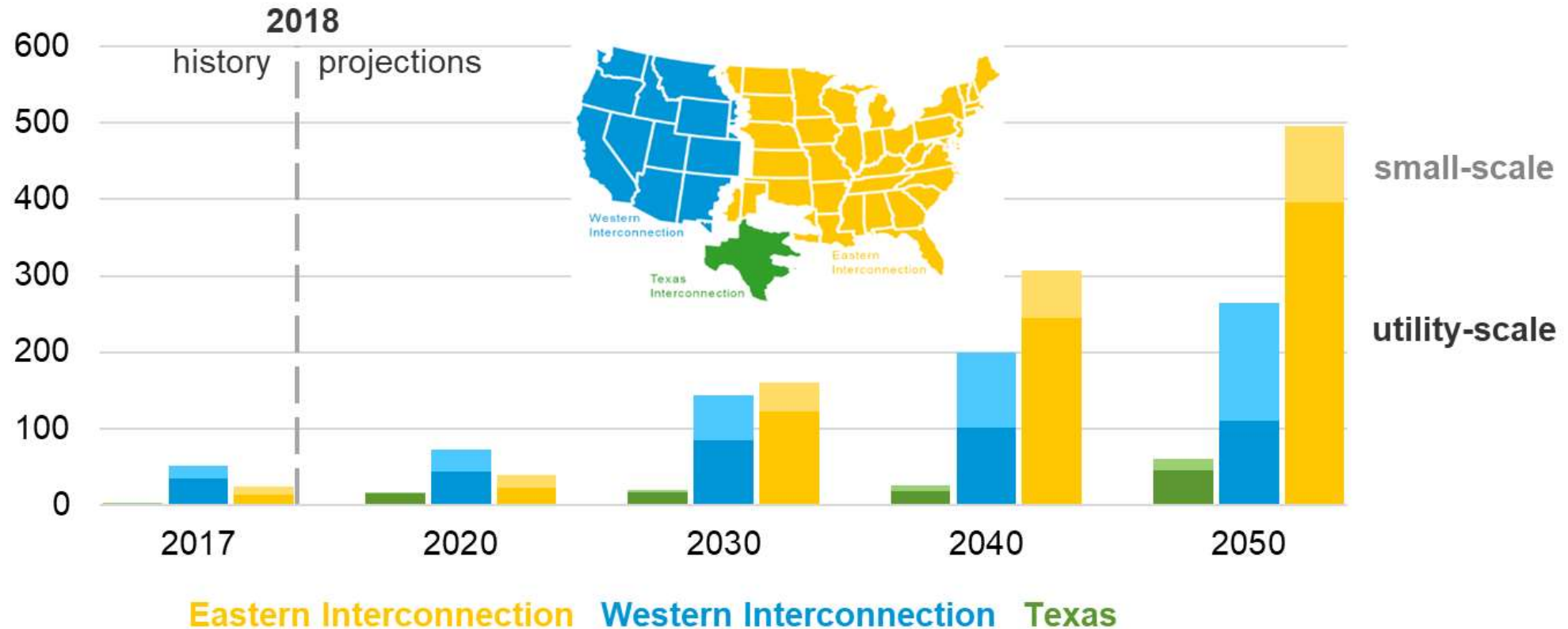


More and more EVs on UAH campus

Solar electricity generation will increase significantly

Solar photovoltaic electricity generation by region (Reference case)

billion kilowatthours



www.eia.gov/aeo

Solar electricity generation will increase significantly

madeinalabama.com/2019/05/125-million-solar-project-heading-to-rural-montgomery-county/

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ENTERPRISE

\$125 million solar project heading to rural Montgomery County



Download Image

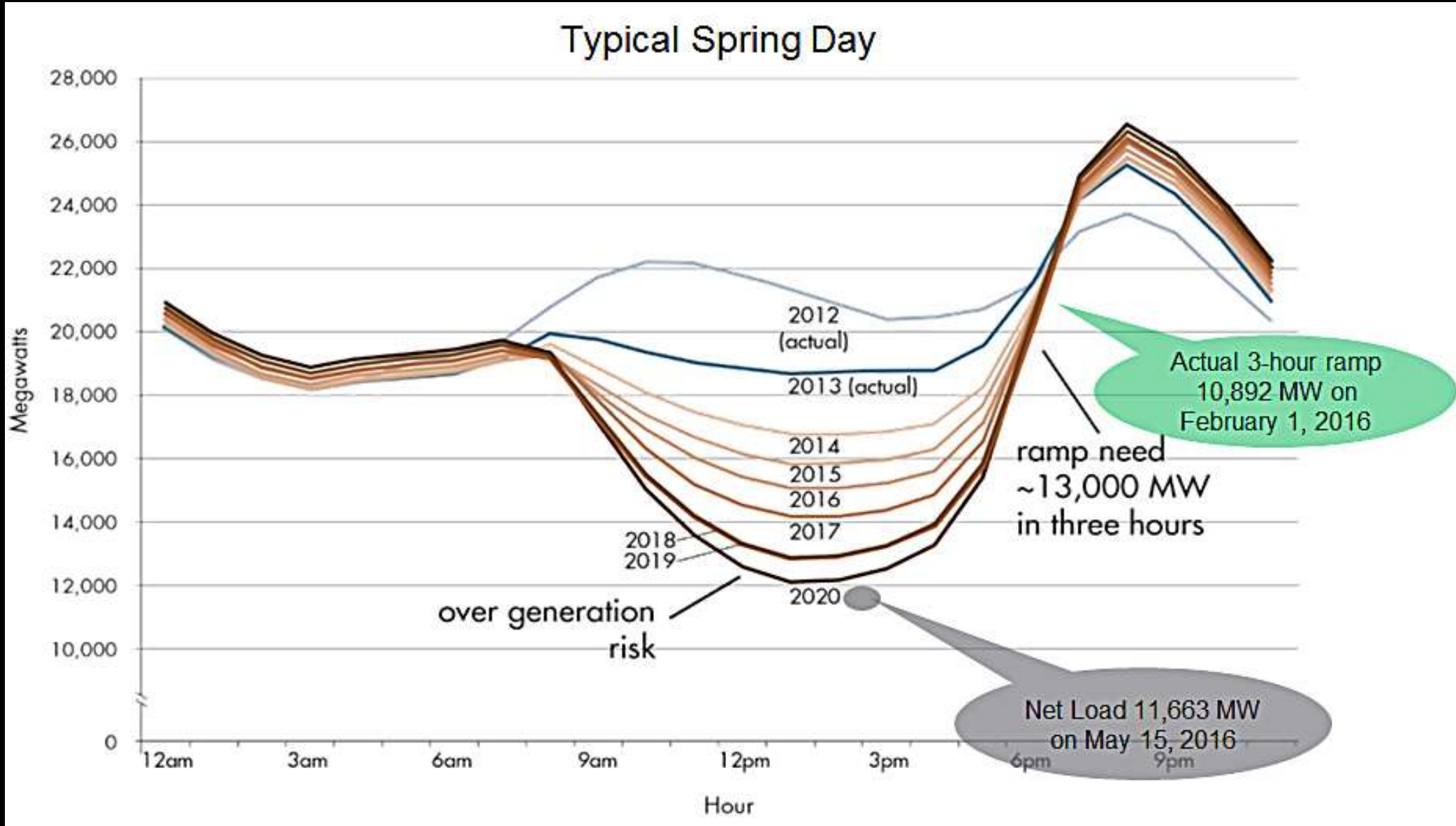
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May 29, 2019 | Words by Jerry Underwood | [More stories in Enterprise](#)

MONTGOMERY, Alabama – A utility-scale solar project, developed with a \$125 million

Solar PV's over generation risk – the “Duck Curve”



Battery energy storage can be used to mitigate the “Duck Curve”



fluenceenergy.com



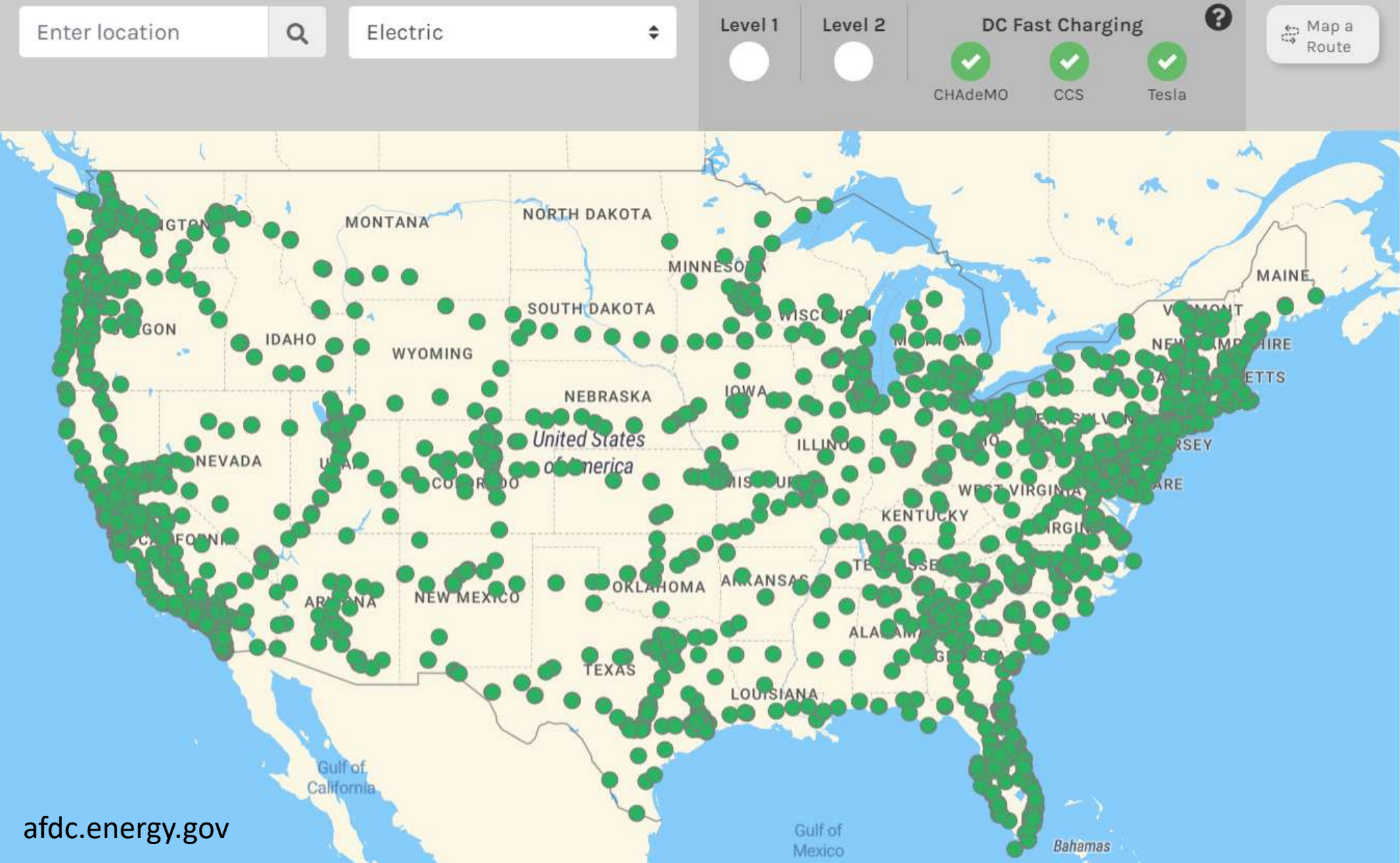
cleantechnica.com



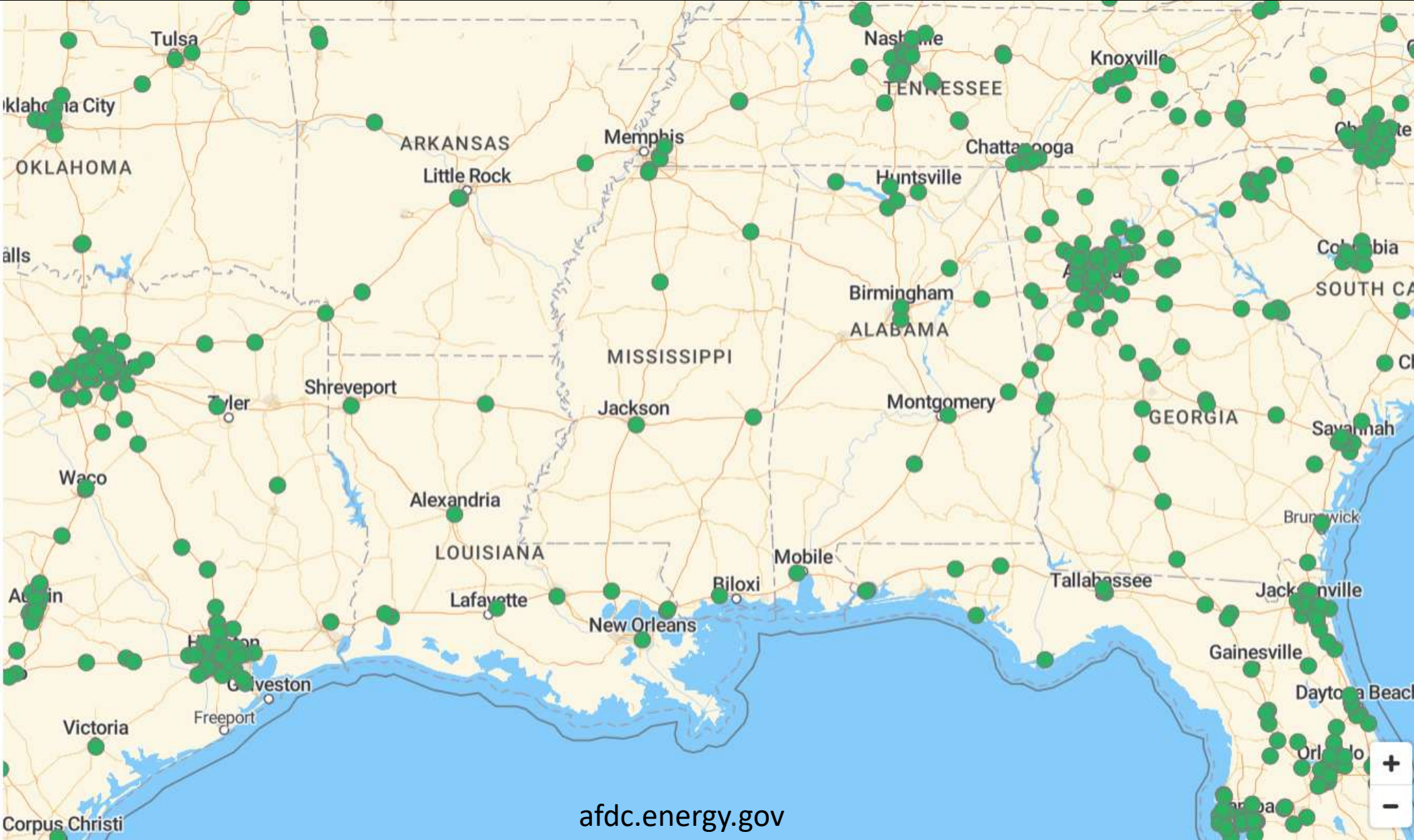
electrek.com

Opportunities

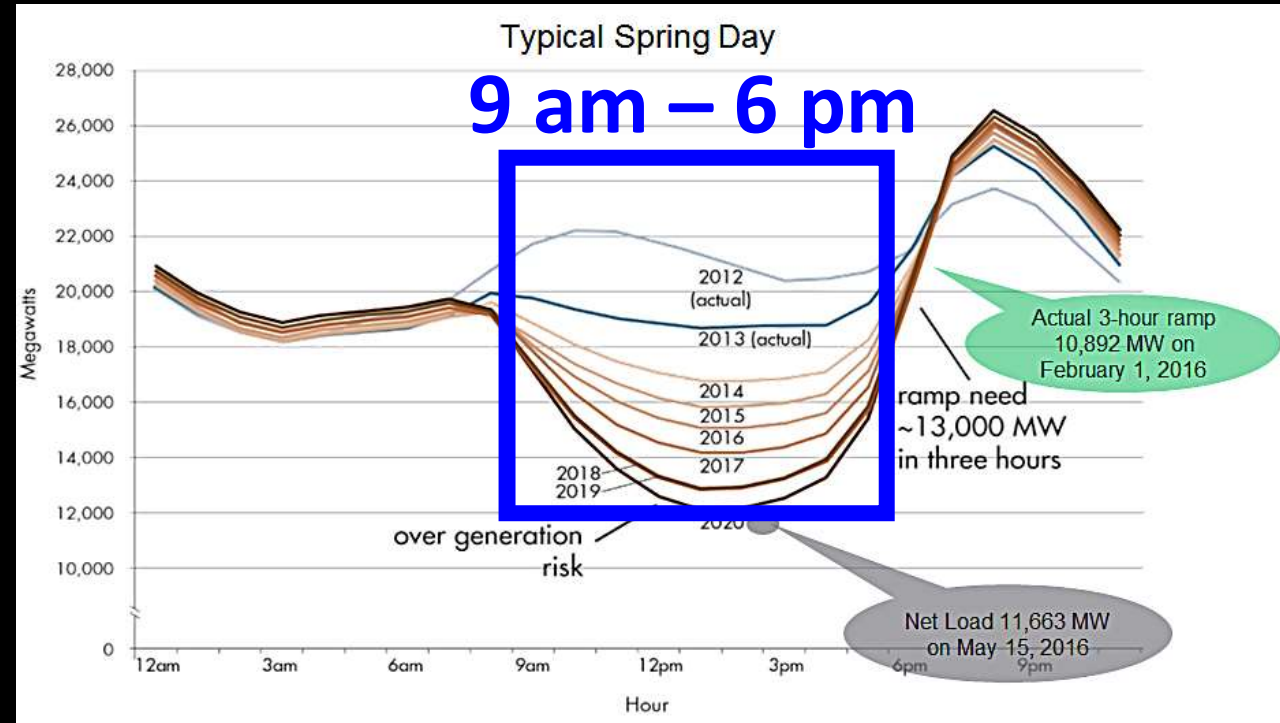
Room to grow for infrastructure, e.g. fast charging stations



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Mitigate solar over generation risk with workplace EV charging



Reuse of EV batteries for energy storage



15 used Nissan Leaf batteries store solar energy at the UC Davis Robert Mondavi Institute

<https://www.tdworld.com/electrification/power-reusing-electric-vehicle-batteries>

Challenges

Planning and development of EV charging infrastructure

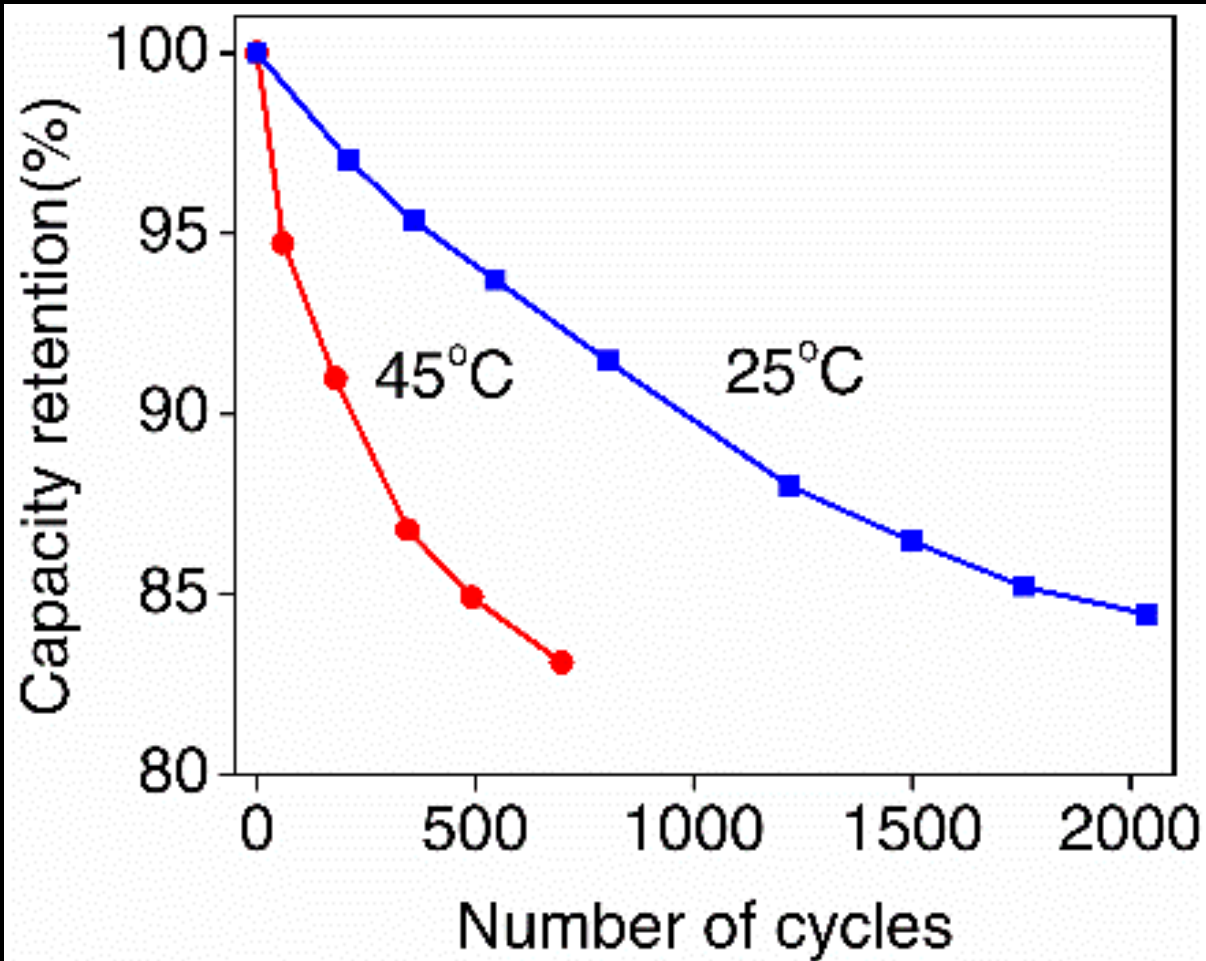


DC fast charging up to 350 kW

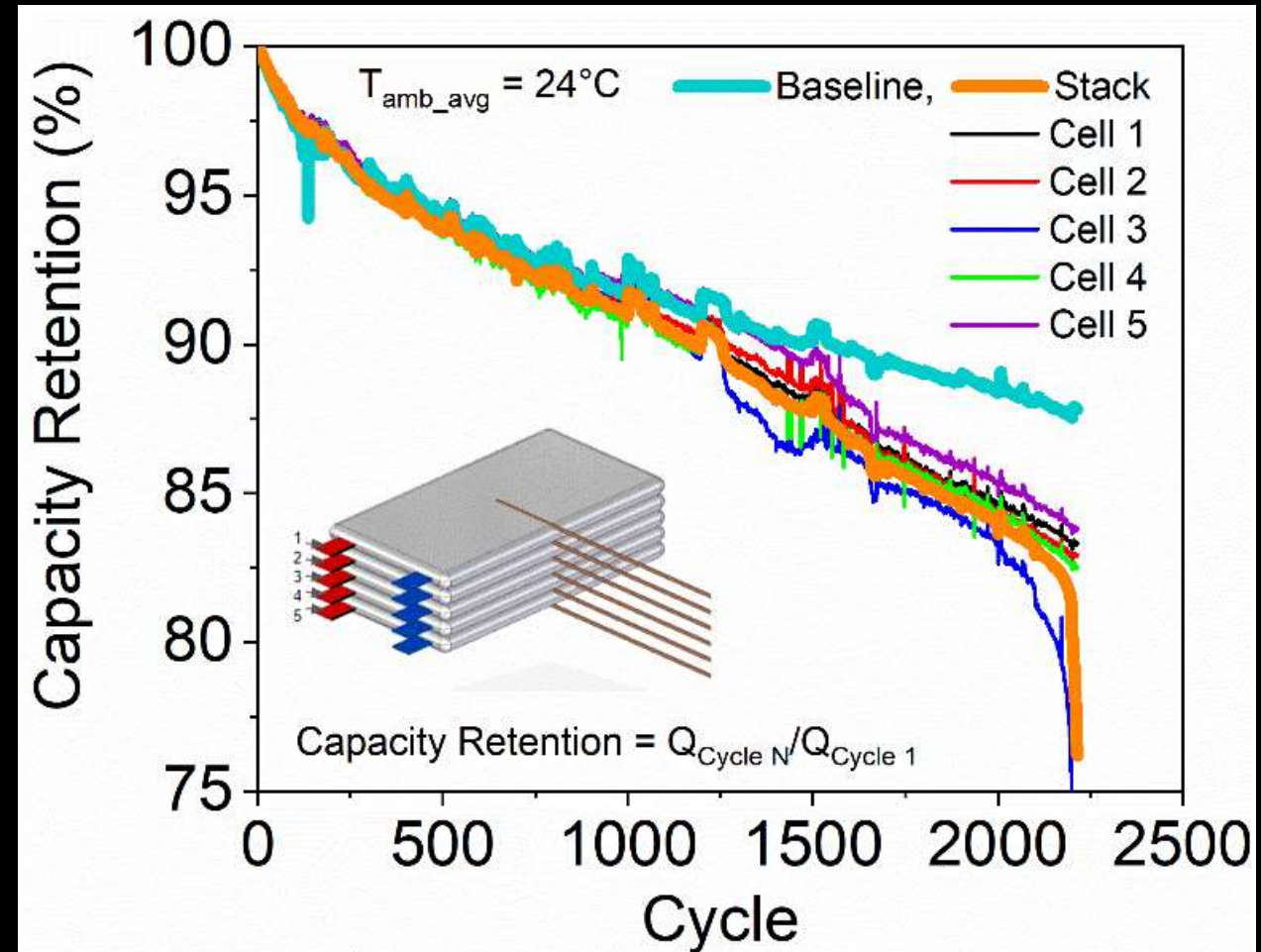
Challenges in batteries: **Safety**



Challenges in batteries: Life

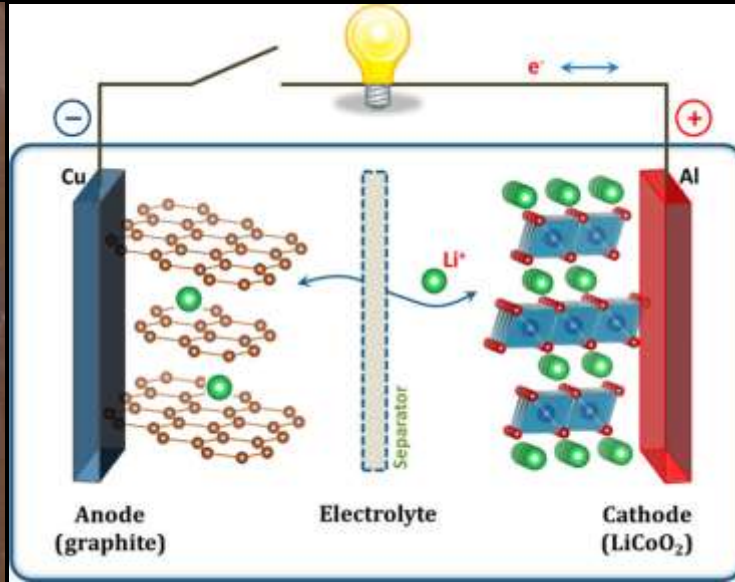
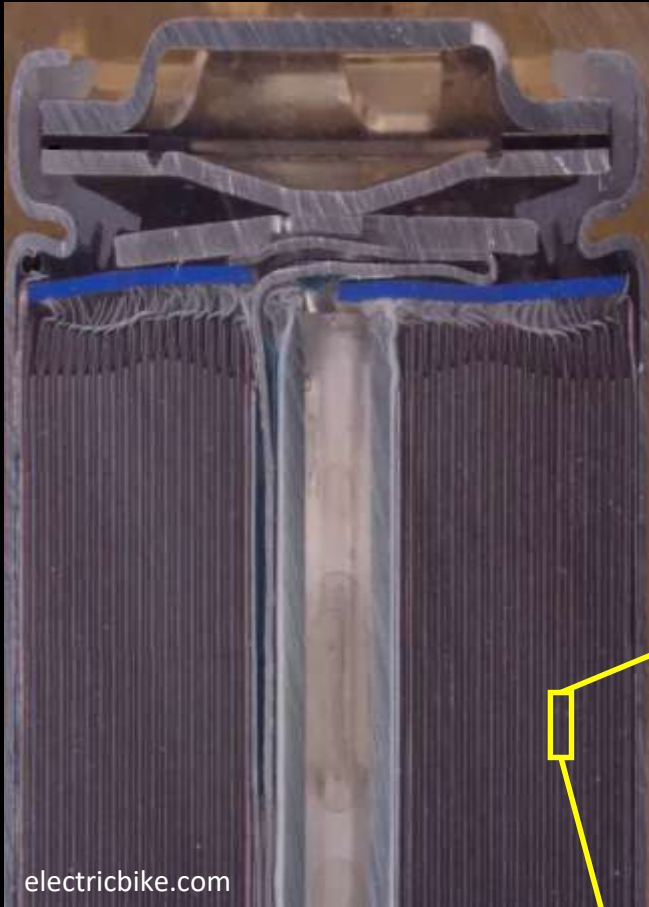


Wang, Zhang, Ge, Xu, Ji, Yang, Leng. *Nature*, 2016

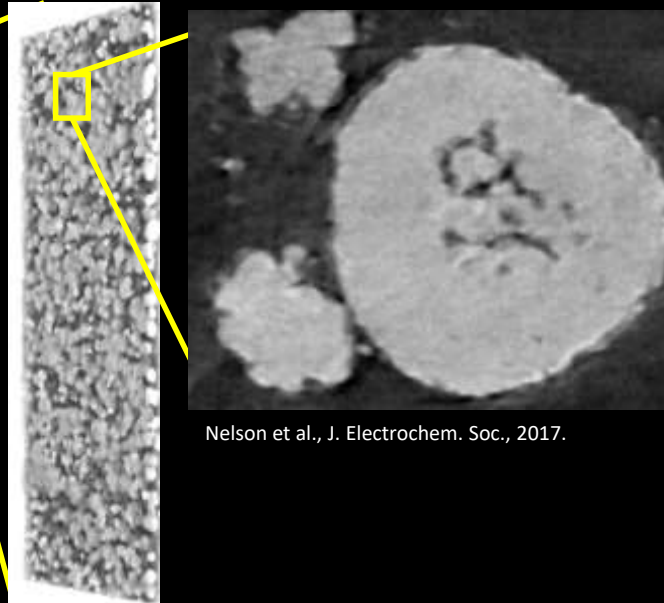


Cavalheiro, Iriyama, Nelson, Huang, Zhang. *ASME JEECS*, 2019

Challenges in batteries: **Materials**



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Rajendra, Nelson et al., *ACS Applied Materials & Interfaces*, 2019.

Batteries are complex collections of materials.

We want:

- Performance (Fast Charge)
- Reliability (Long Life)

Choices made at atomic scales impact supply chains and lives.

We need:

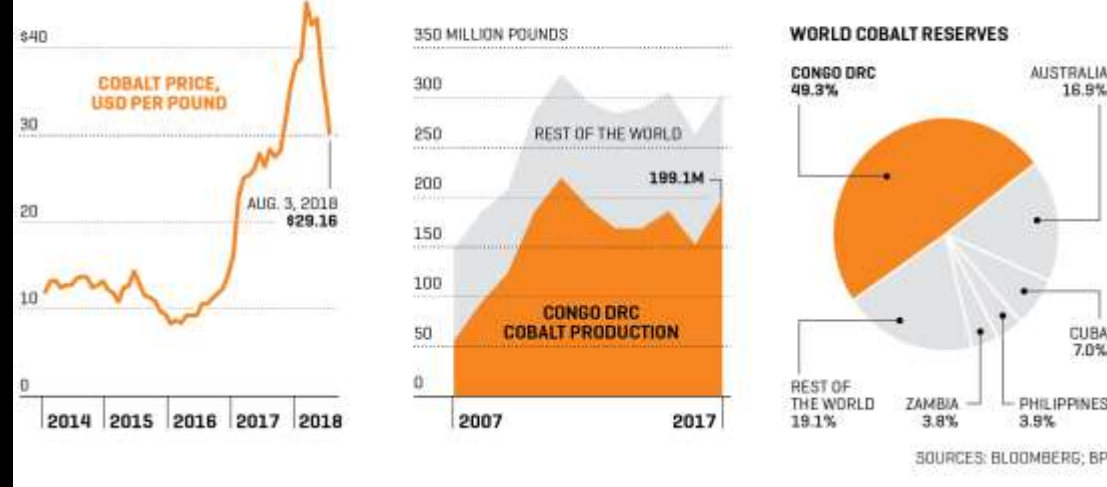
- Humane
- Equitable
- Sustainable



A cobalt (Co) mine in DRC

FEEDING A GLOBAL HUNGER FOR BATTERIES

Cobalt is a key component in lithium-ion batteries, helping to provide high energy density and stability. Soaring demand for smartphones, tablets, and now electric vehicles has caused the price of cobalt to spike. The DRC remains the biggest source of the mineral. But concerns about the country's labor conditions are pushing companies to explore elsewhere for the commodity.

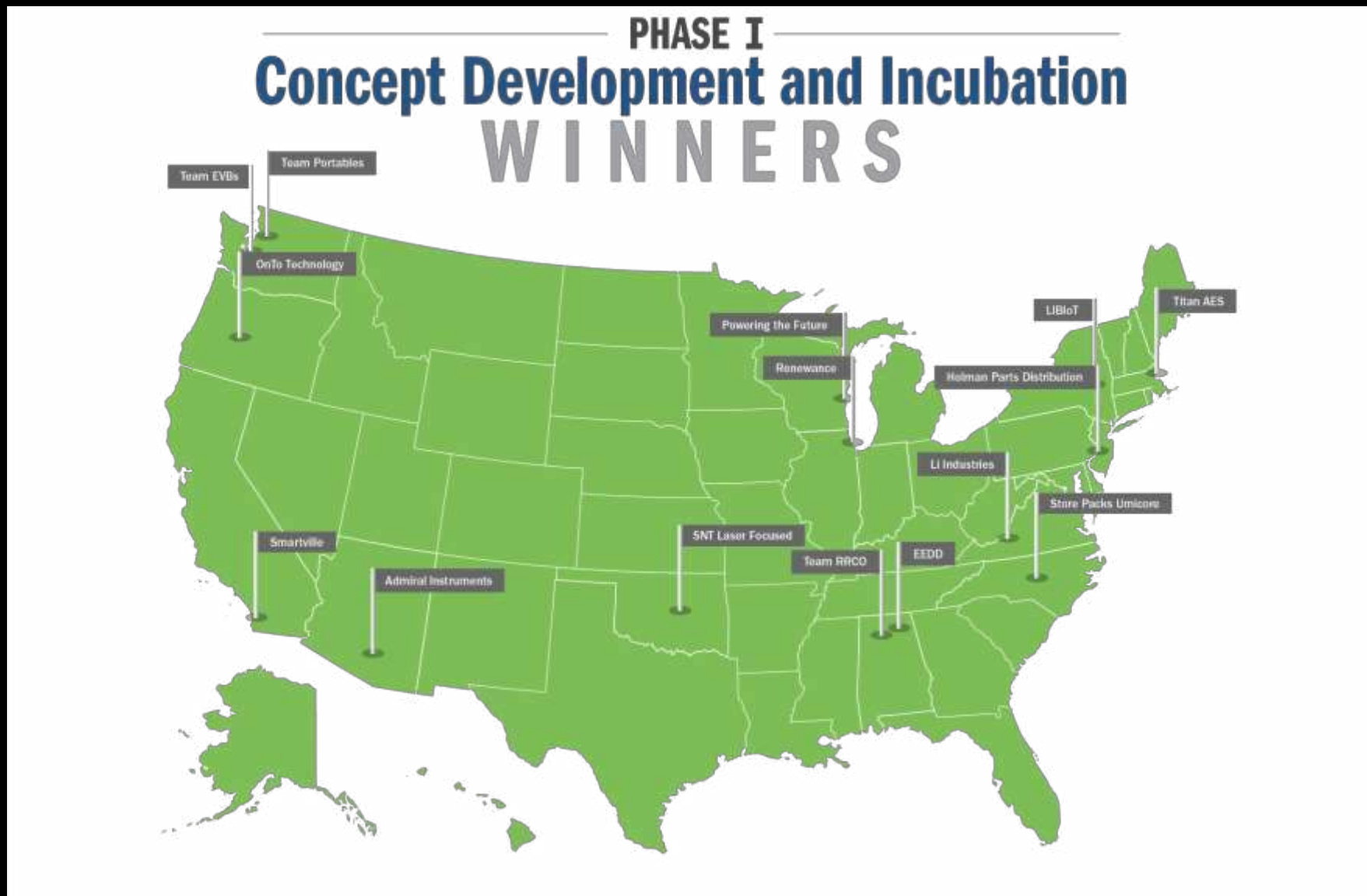


<https://fortune.com/longform/blood-sweat-and-batteries/>

Challenges in batteries: **Recycling**



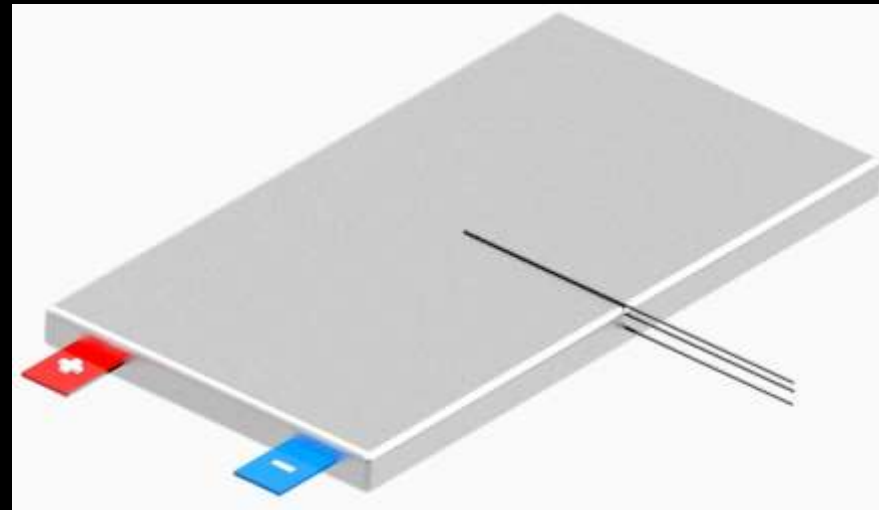
U.S. DEPARTMENT OF ENERGY



<https://americanmadechallenges.org/batteryrecycling/>

DISCUSSION

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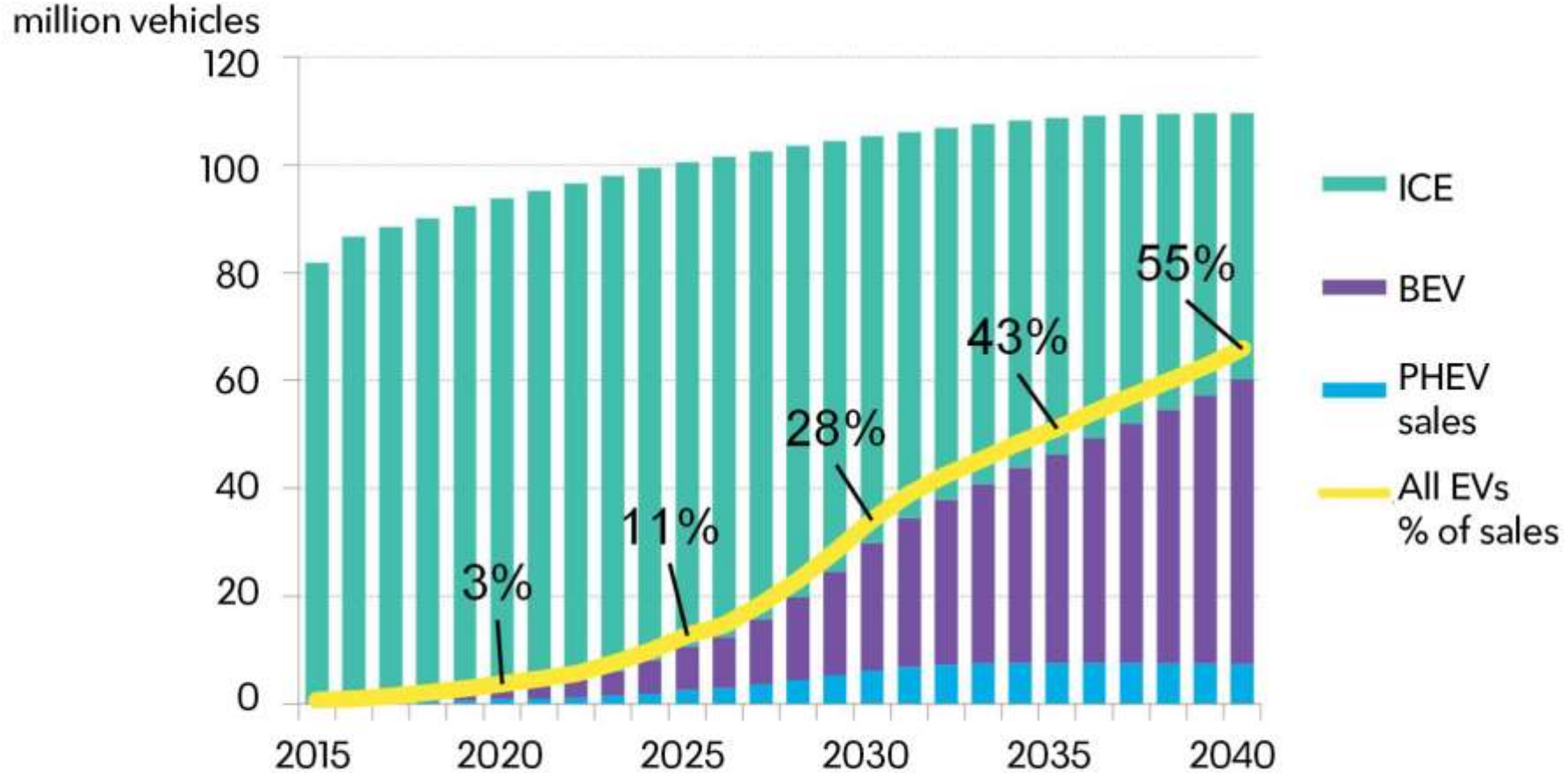
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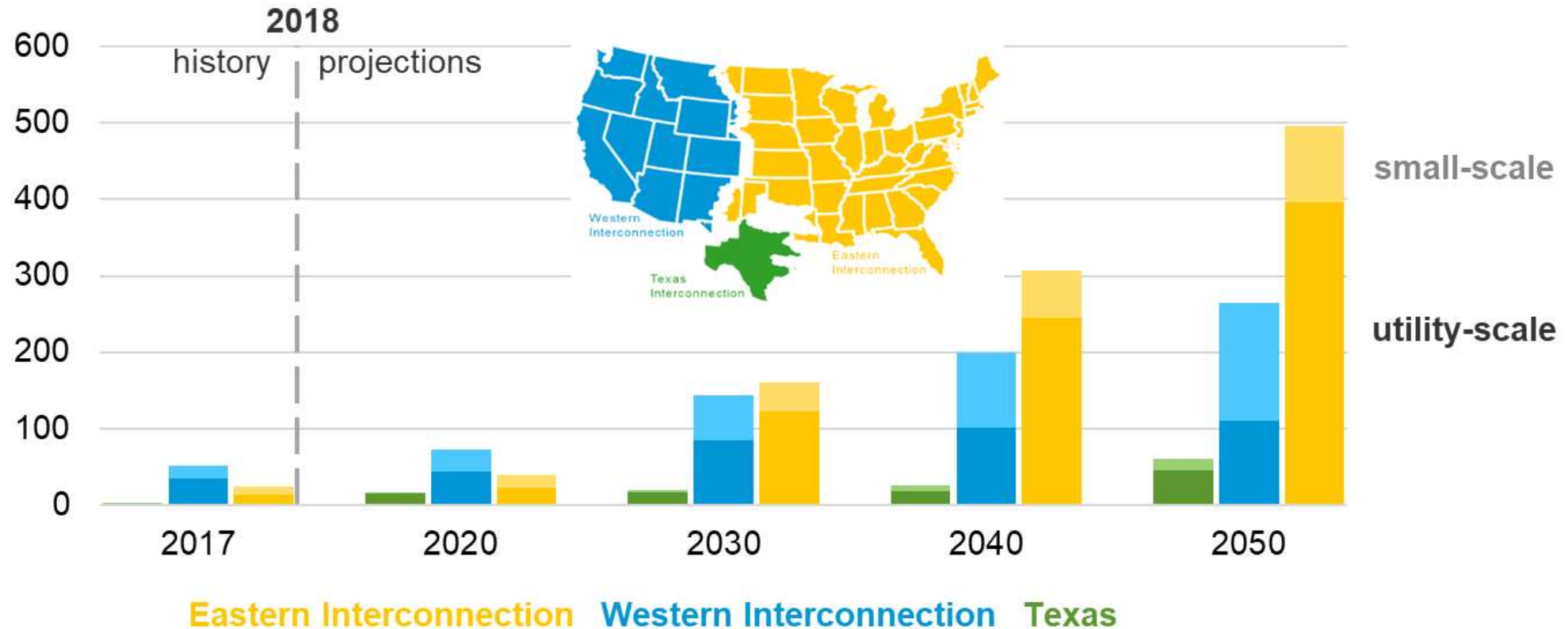


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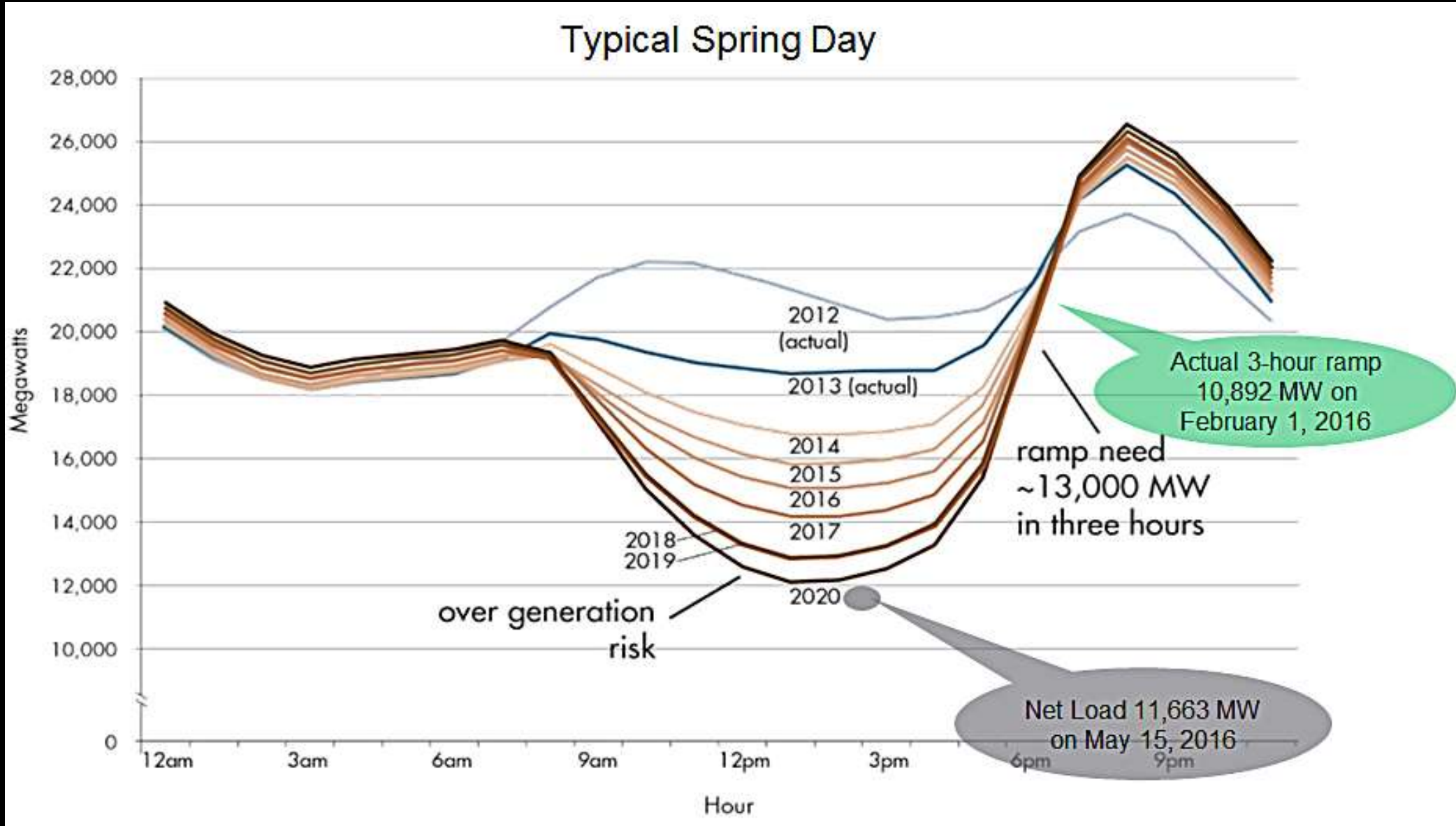
The image is a screenshot of a website with a red header. At the top center, a white-bordered box contains the text "MADE IN ALABAMA". Below this, a navigation bar lists "Quick Links" with options for Home, News, Industries, Why Alabama?, Business Development Division, and Contact Us. The main content area features a large white headline: "million solar project head" on the first line and "ral Montgomery County" on the second line. The background of the page is a photograph of solar panels under a bright sun, with a blurred image of a person in the background. In the bottom-left corner, there is a small white icon of an envelope.

MADE IN ALABAMA

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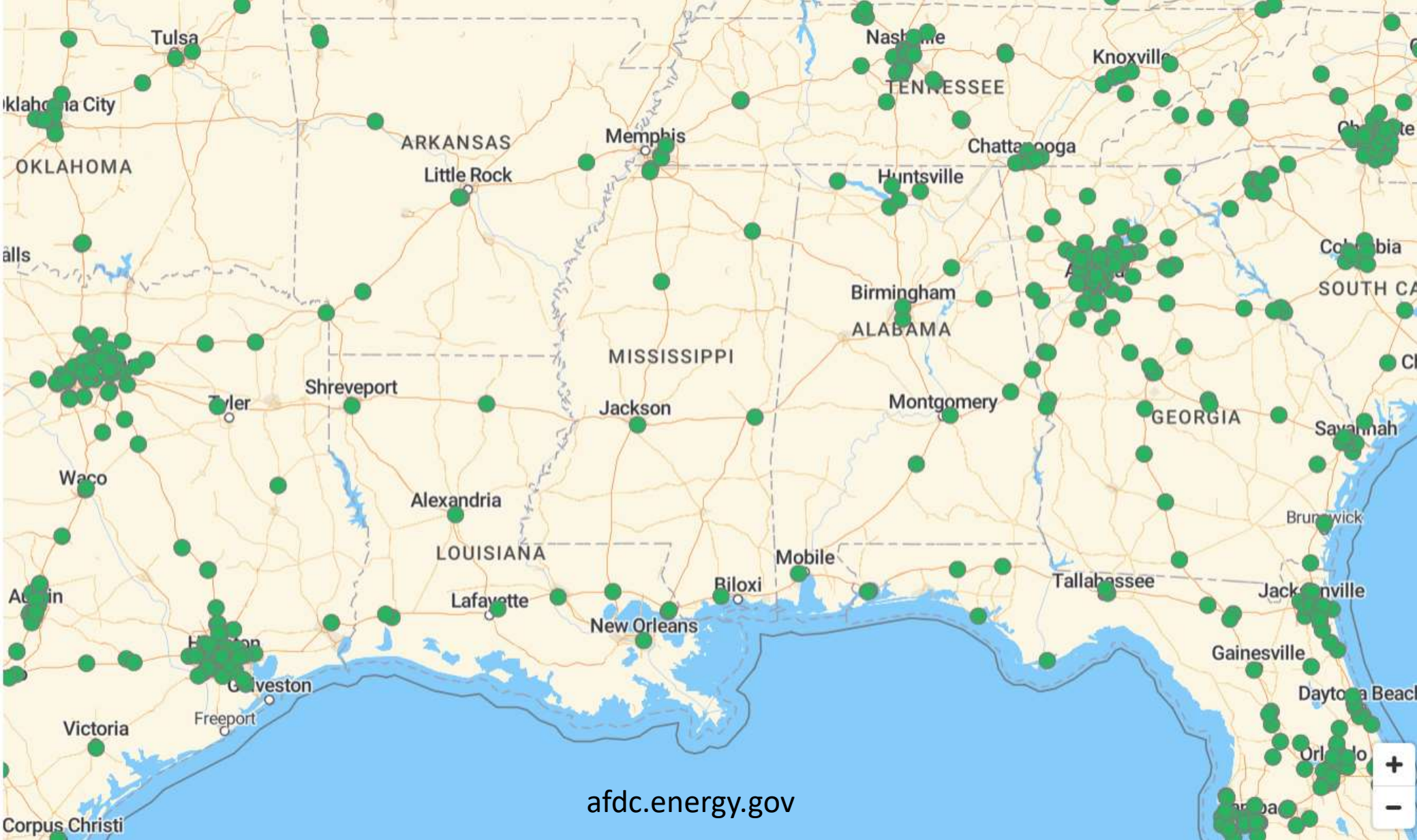
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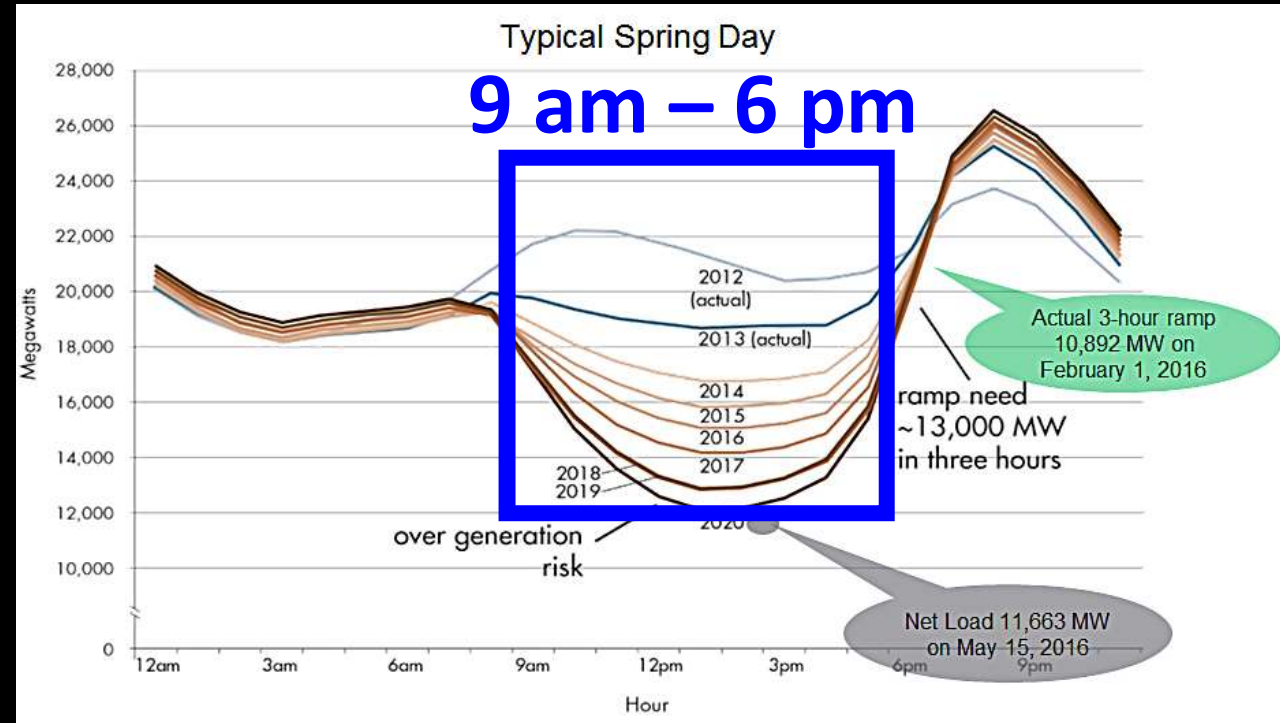
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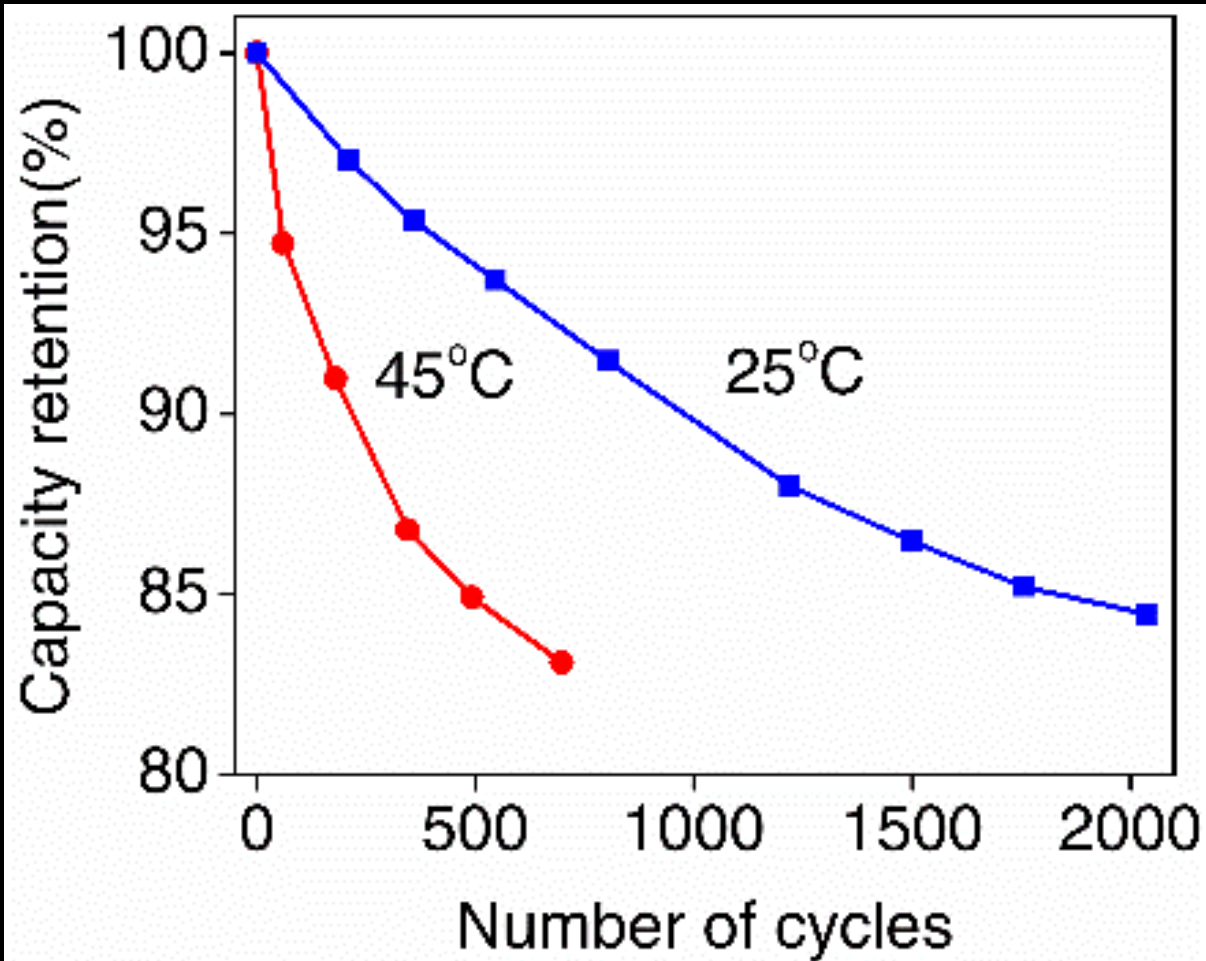


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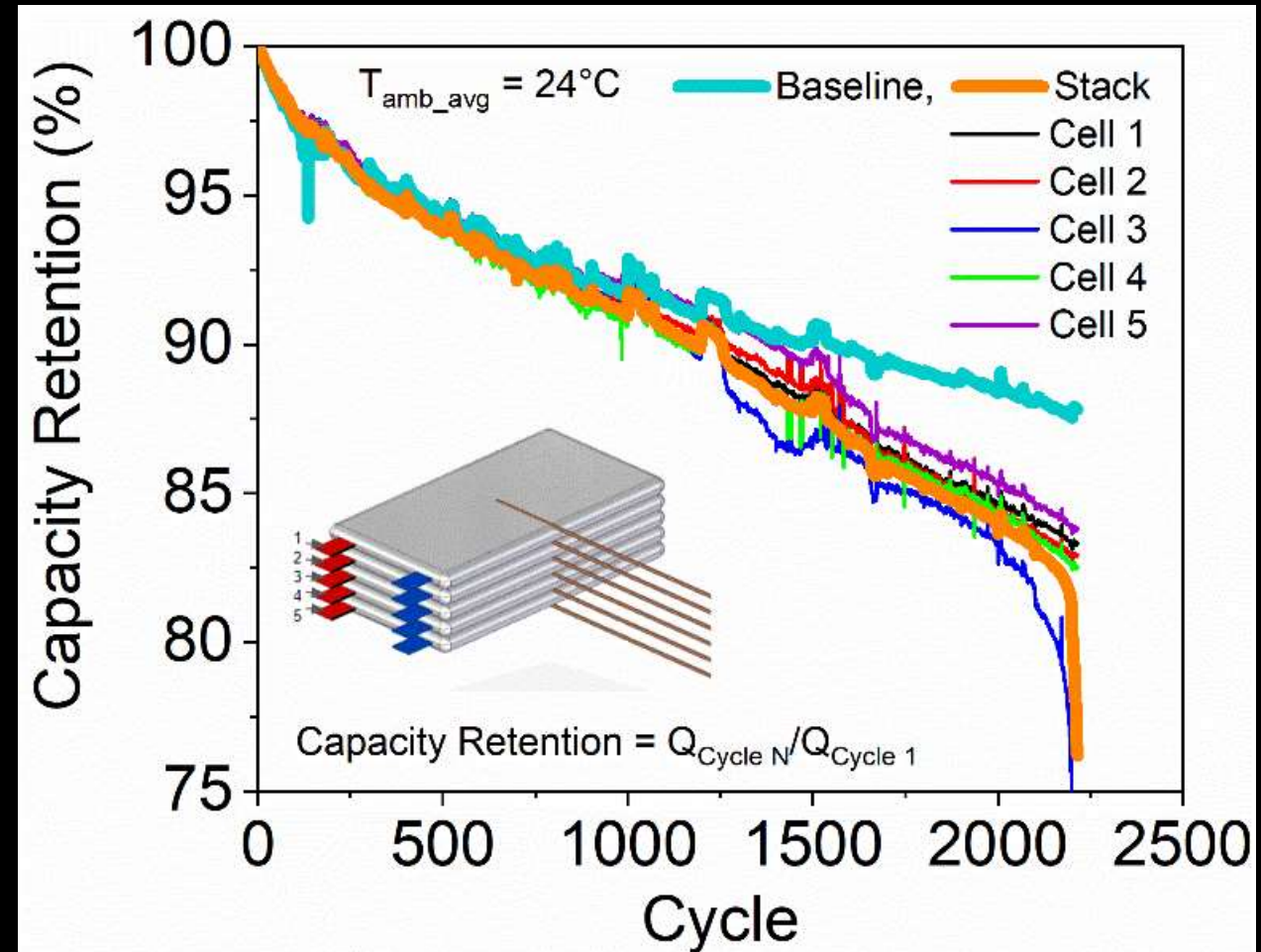
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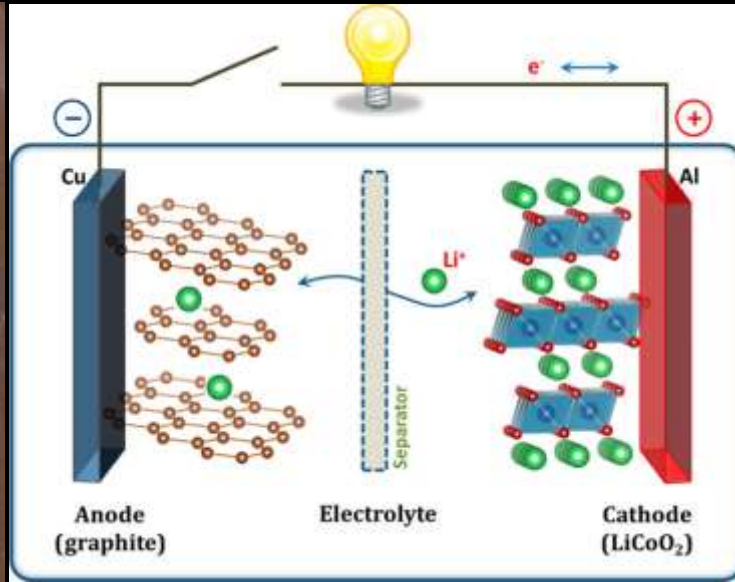
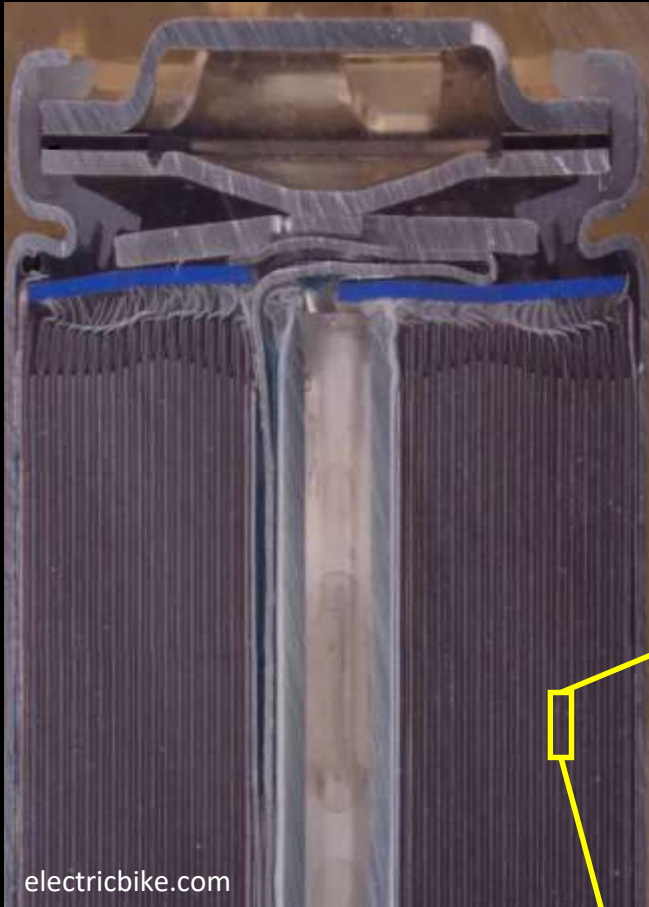


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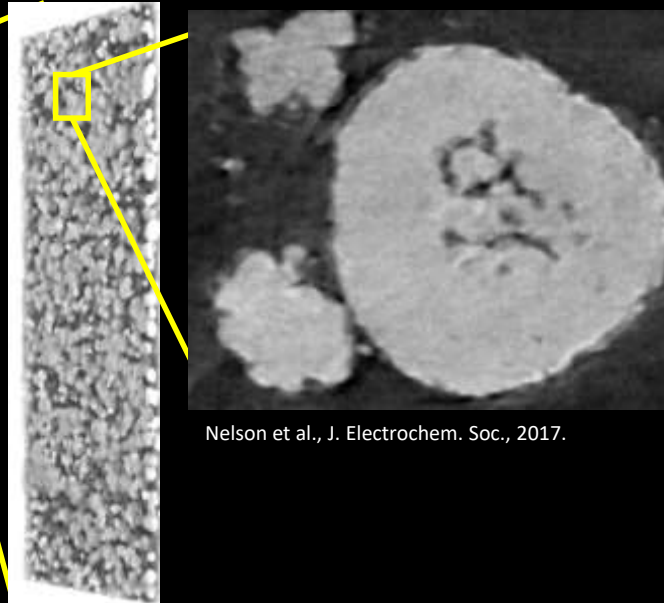


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electricbike.com

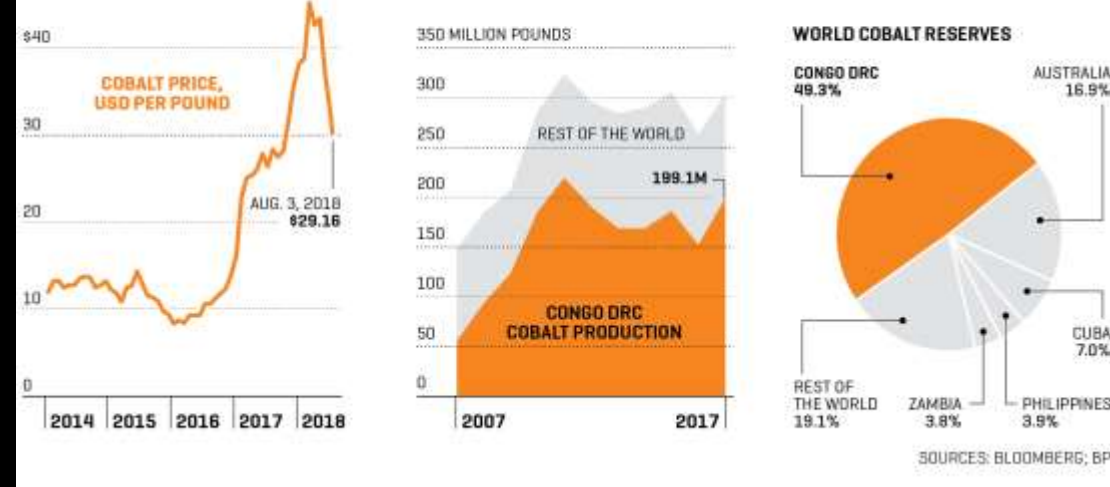
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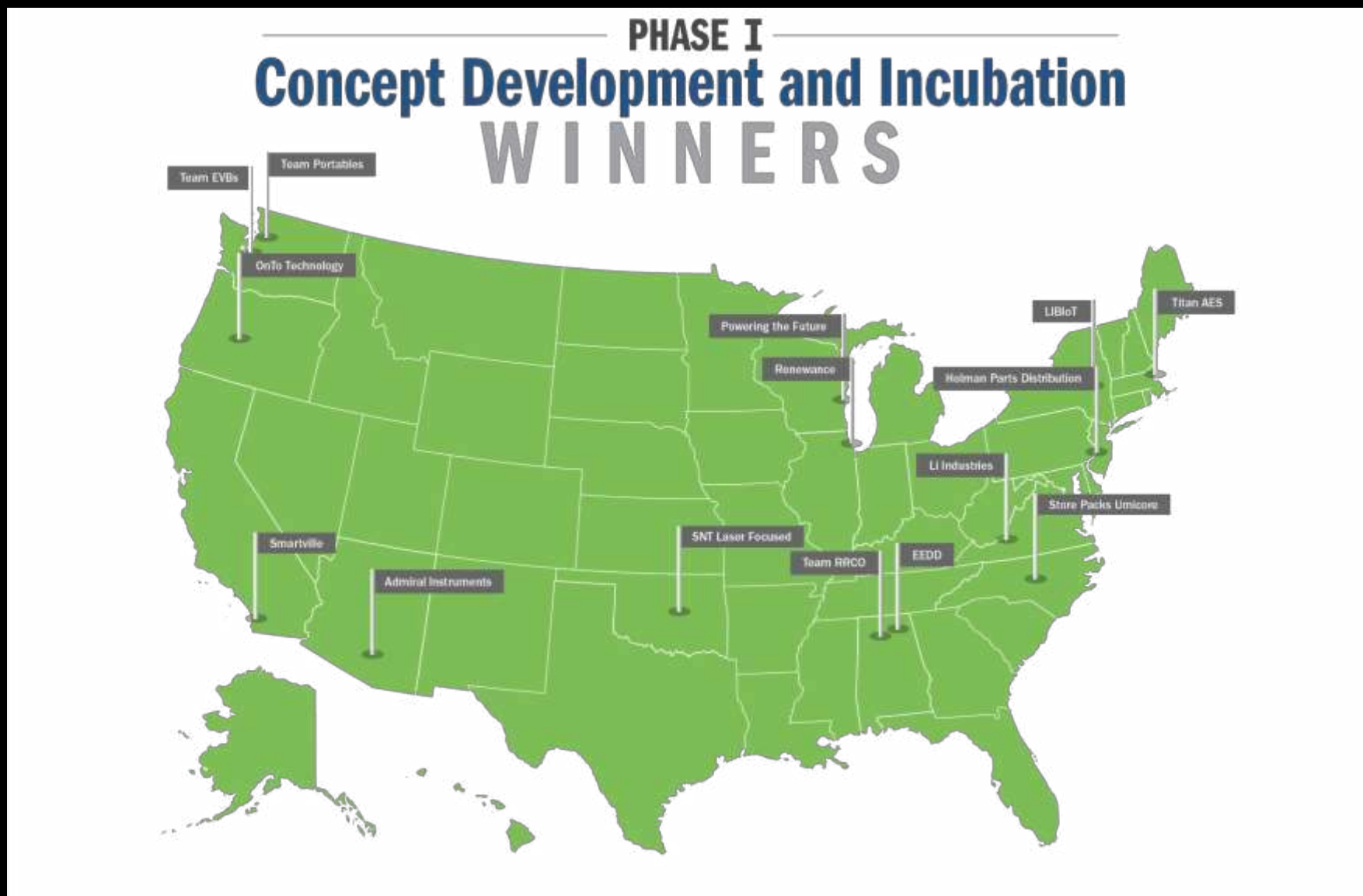


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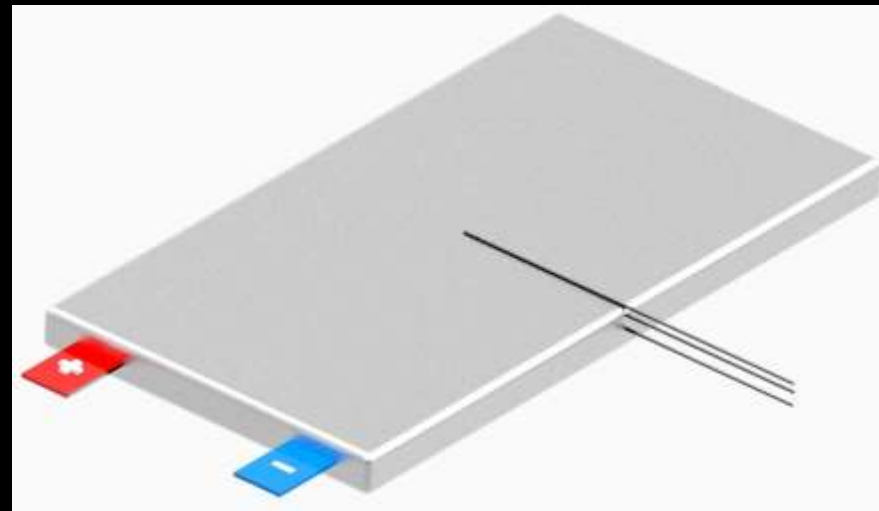


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