Electrifying Everything

An Energize PoV

June 2022

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Executive Summary

Electrifying Everything: An Energize PoV

Context

In 2020, climate technology interest and investment activity experienced a massive resurgence. The Energize team observed a familiar refrain in climate innovation: predilection for climate moonshots, breakthrough innovations, unproven technology, and capital-intensive scale-ups – all in a race to attach climate technology to trillion-dollar market opportunities or “venture-scale outcomes.”

We believe the optimal, near-term strategy to decarbonize is clear: electrify everything, and power those electrons with zero-carbon clean energy. Moreover, software businesses accelerating electrification represent a compelling opportunity to generate investment alpha within the climate technology category.

Objective

- Establish why we believe “electrifying everything” is the fastest economic pathway to achieve close to 80% decarbonization in the next 20 years
- Define a framework of key “electrifying everything” technology categories
- Identify pain points where software could accelerate or optimize electrification
- Canvas the early-stage ecosystem for emerging “electrifying everything” leaders

Electrifying Everything: The Key to Decarbonization & A More Sustainable Future

75% of emissions come from energy use in the U.S. Globally, 73% of emissions are created by energy use.

Most of the **technologies required to decarbonize energy are technically viable and economically competitive** TODAY.

GHG avoided in the next 5 to 10 years is exponentially more valuable than GHG avoided in 30 years due to compounding and carbon cycle feedback loops.

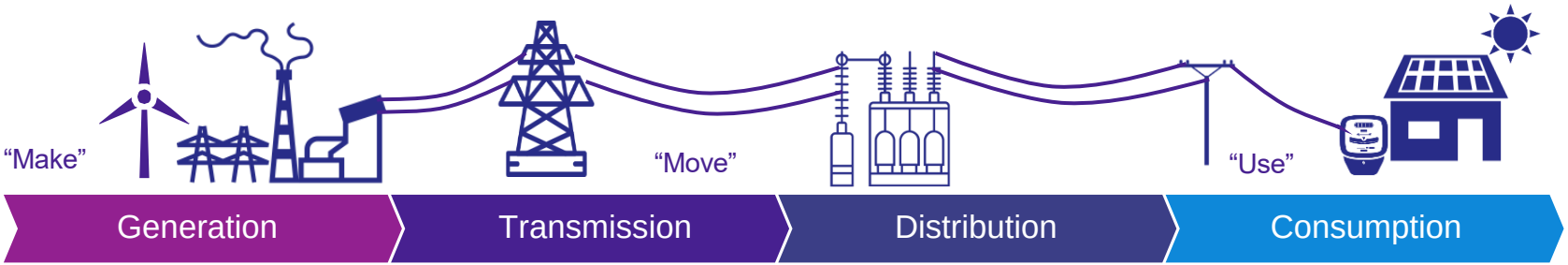
Financial value transfer from **fossil to electric is the largest wealth creation opportunity of our lifetime – $11T+** of economic value at stake and growing.

We believe **digital, asset-lite startups aligned to electrifying everything** sectoral trends represent **compelling market opportunities**, even as these markets are still nascent.

Source(s): Our World in Data

Decarbonizing by Electrifying Everything

Power Value Chain

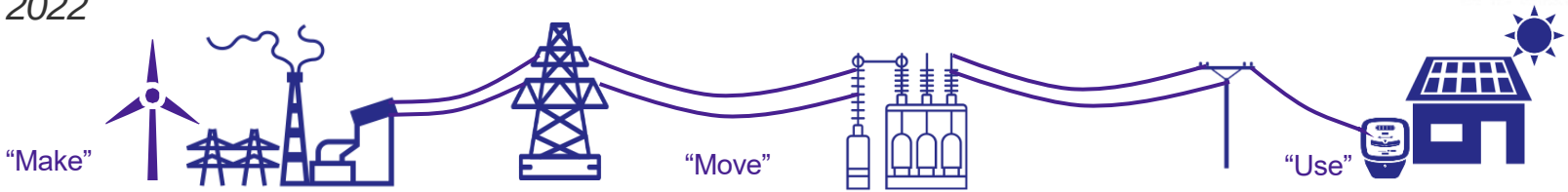


Energize Framework for Electrifying Everything

1	2	3	4
Generate Electricity from Sun and Wind	Firm and Move Electrons from Sun and Wind	Electrify Mobility and Buildings	Make Electricity Demand Digital and Efficient

Top 30 Software Innovators in Electrifying Everything

2022



SOLAR: RatedPower, PVcase, PosiGen, PALMETTO, MOSAIC, goodleap, aurora

BATTERY STORAGE: PowinEnergy, TWAICE, KoBold Metals, SPAN

WIND: Level10 Energy, SKYSPECS

TRANSMISSION: prisma photonics, neara

EV CHARGING: smartcar, ev.energy, MONTA, WeaveGrid

CLEAN FIRM POWER

BUILDING ELECTRIFICATION & EFFICIENCY: runwise, Sealed, measurabl, BLOC POWER, cove.tool

GENERAL: Arcadia, myst ai

DEMAND FLEXIBILITY: CAMUS (Zero Carbon Grid Orchestration), leap, uplight, DAVID ENERGY

*Source(s): Energize Ventures Internal Data

Top 30 Software Innovators in Electrifying Everything: Selection Criteria

Per our evaluation criteria, each company in the list should have the following characteristics:

- Private company that has not announced intent to IPO or SPAC.
- Software or asset-lite business model. This does not include pureplay manufacturers, novel chemical or material processors, project developers, installers, etc. but does include firms that have developed a novel software or digital architecture to scale a non-SaaS business model.
- Should not be recently acquired or a subsidiary of a larger company.
- Should have a clear GHG reduction impact via Electrifying Everything.
- In our belief, these firms should be most likely to achieve higher enterprise value over the course of time by internal Energize Ventures analysis.

Why Should We Electrify Everything to Decarbonize?

Electrifying Everything is Going Mainstream

How do you think I'm still going at 44? – Tom Brady

Electrifying Everything: The Key to Decarbonization & A More Sustainable Future

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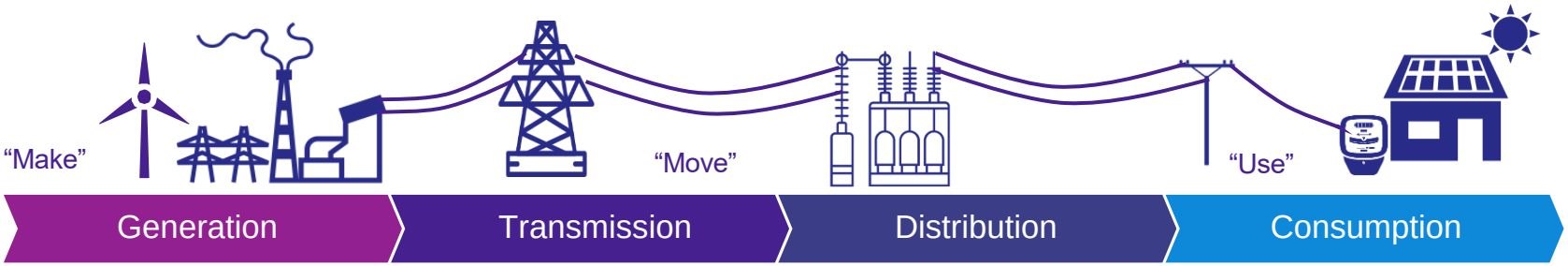

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The Energize Framework for Electrifying Everything

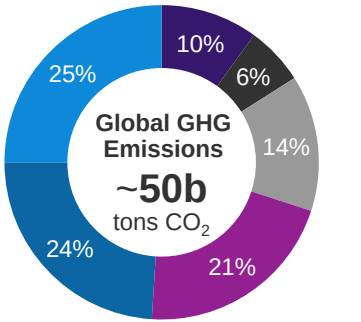
Generation	Generate Electricity from Sun and Wind
Transmission	Firm and Move Electrons from Sun and Wind
Distribution	Electrify Mobility and Buildings
Consumption	Make Electricity Demand Digital and Efficient

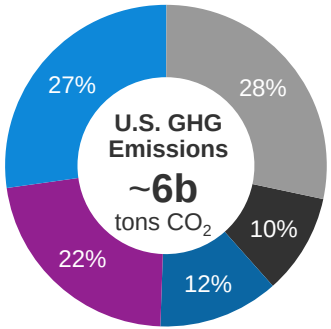
- SOLAR
- WIND
- BATTERY STORAGE
- CLEAN, FIRM POWER GENERATION (HYDRO, GEOTHERMAL)
- TRANSMISSION
- ELECTRIC VEHICLES + CHARGING
- BUILDING ELECTRIFICATION & EFFICIENCY
- DEMAND FLEXIBILITY

“Electrifying Everything” Eliminates the Vast Majority of GHG Emissions

66 – 80%+ of U.S. GHG emissions can be eliminated with commercially available technology

Greenhouse Gas Emission by Source

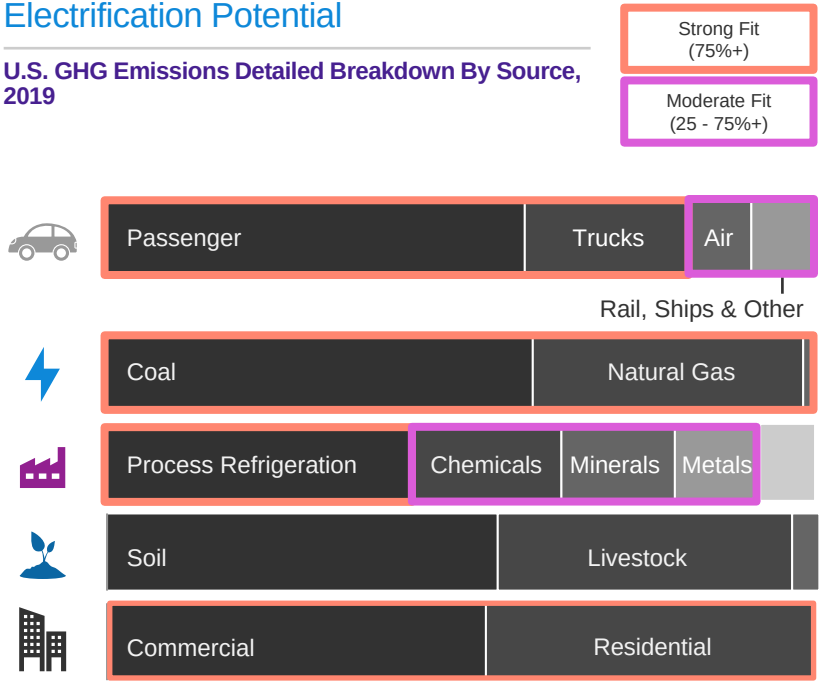




Electricity · Industry · Buildings
Agriculture + land use · Transportation
Other

Electrification Potential

U.S. GHG Emissions Detailed Breakdown By Source, 2019

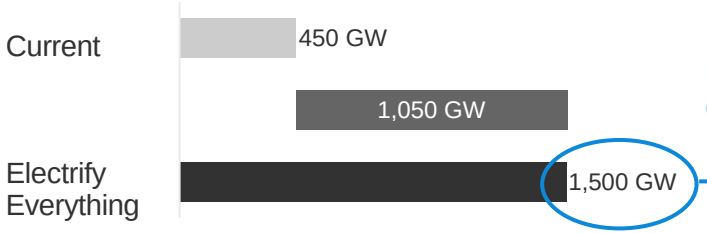


Source(s): IPCC, EPA, EIA, Project Drawdown, Princeton NZA Study

Electrifying Everything Will Increase Electricity Demand by 3 – 5x

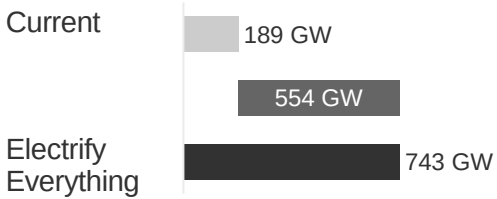
Electricity Demand Increase from Electrification

UNITED STATES



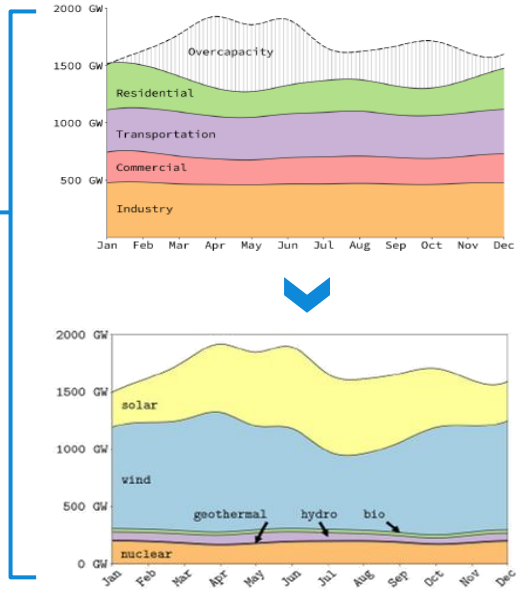
3.3x
U.S electricity demand increase

EUROPE



3.9x
Europe electricity demand increase

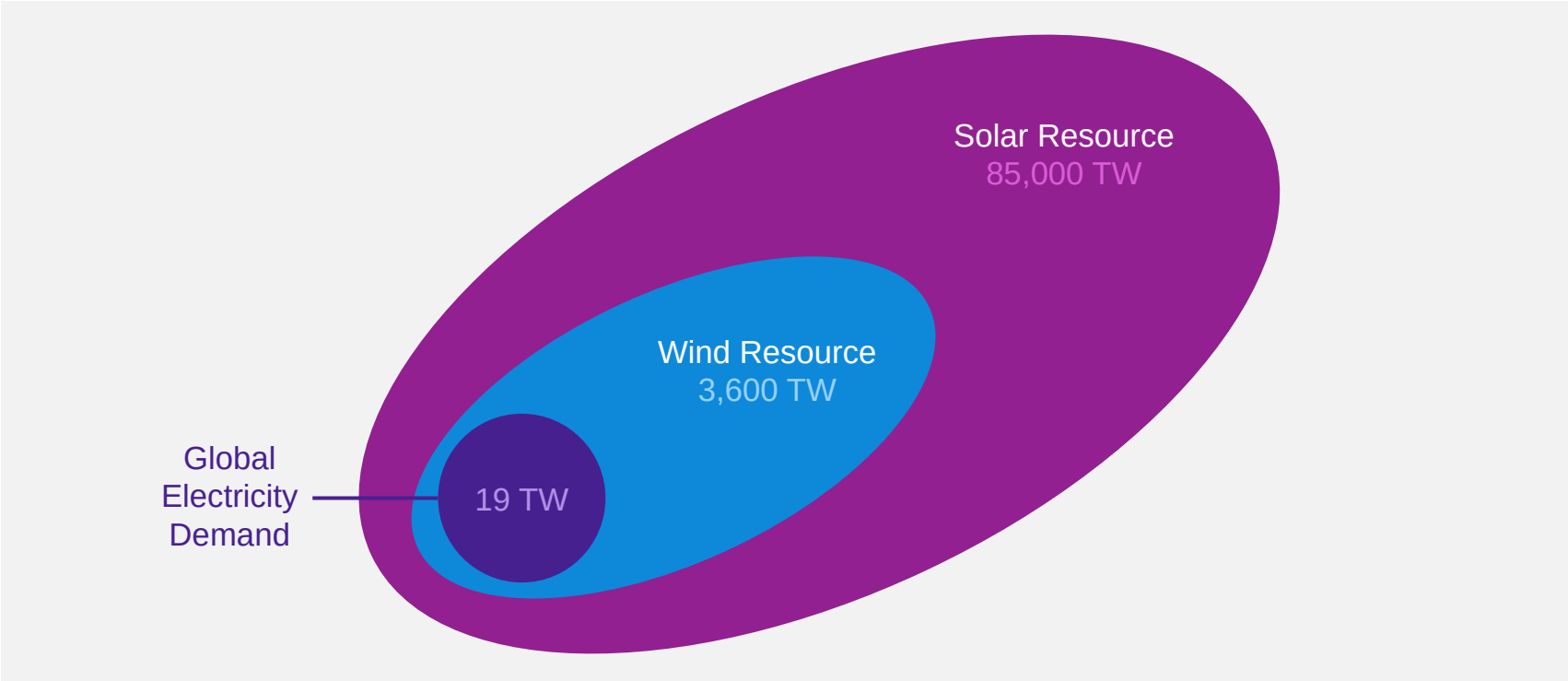
Future U.S. Electricity Annual Supply / Demand Profile



Deep electrification will add significant complexity to electricity demand, requiring software, dynamic load management and market-based price signals to better align consumption to production via renewables.

Source(s): Rewiring America, McKinsey

Solar and Wind Can Power the World's Electricity Demand 100x+ Over

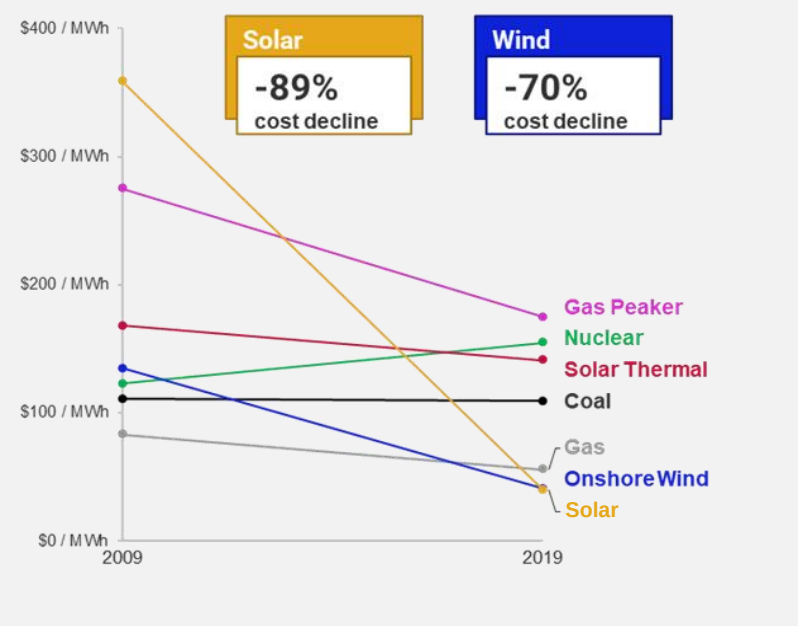


Source(s): Rewiring America

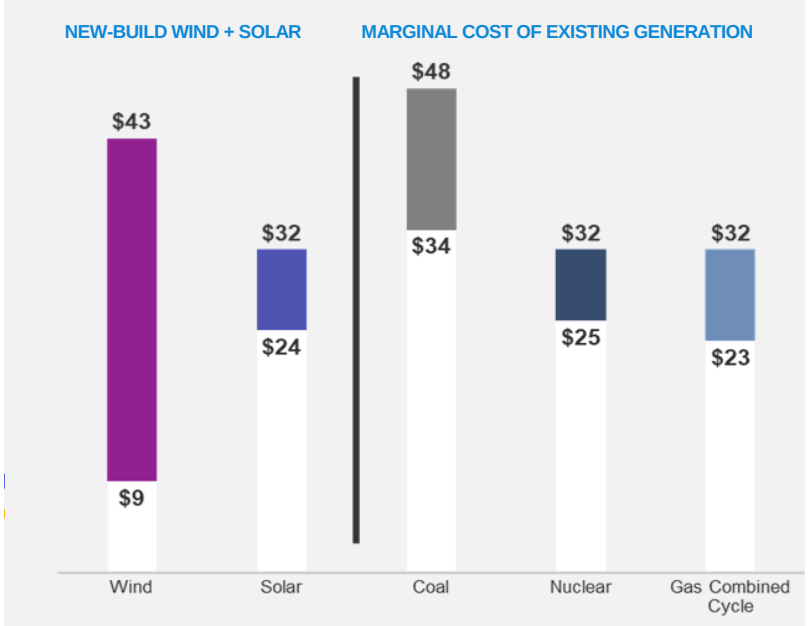
Solar and Wind Costs Have Dramatically Declined

The levelized cost of solar and wind has decreased 70 – 90% in the past 10 years, now outperforming all other forms of power generation

Levelized Cost of Electricity for New Power Plants



Levelized Cost of Electricity in 2020, $.MWh

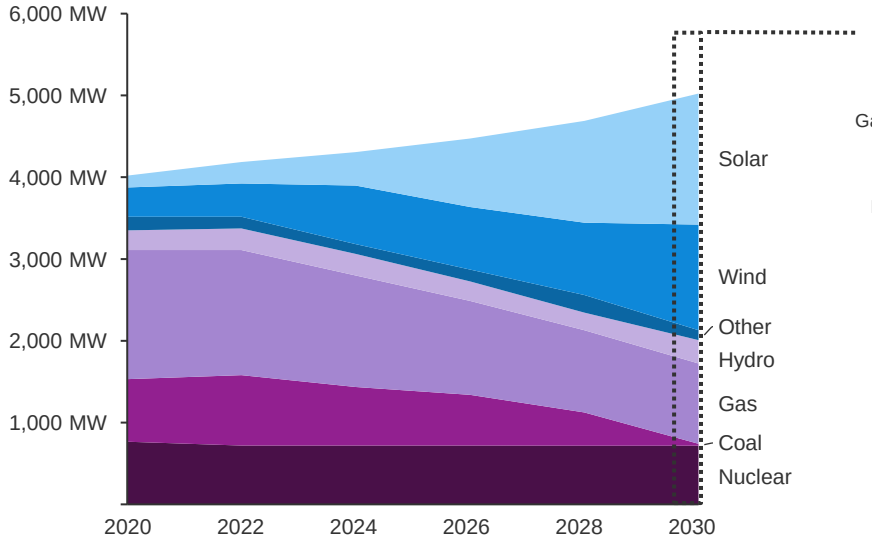


Source(s): Lazard Levelized Cost of Energy, OurWorldInData.org

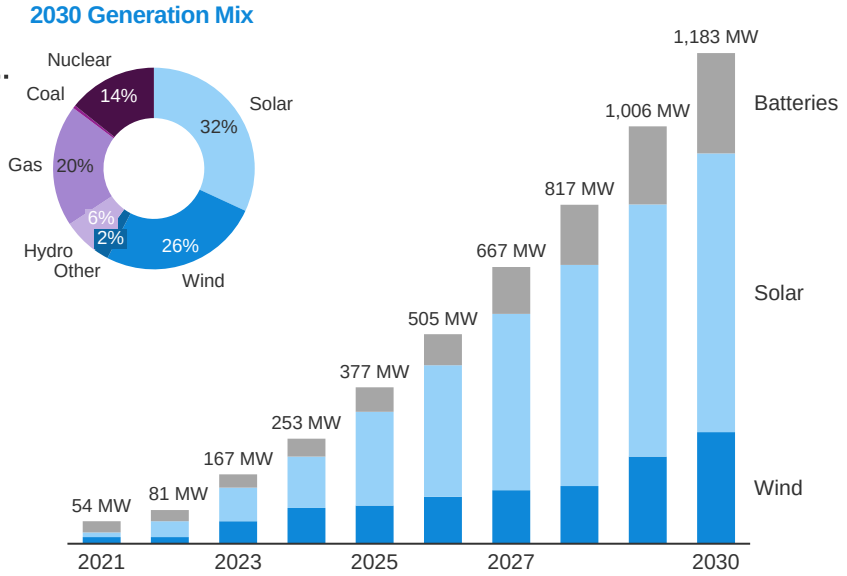
Solar + Wind + Storage are a Killer Combo, But Not a Panacea

Solar, wind and storage can decarbonize at least 80 percent of electricity. The remaining 20 percent will require “clean, firm power”: non-intermittent, dispatchable, low-carbon electricity.

Generation mix for the 80% Clean Case



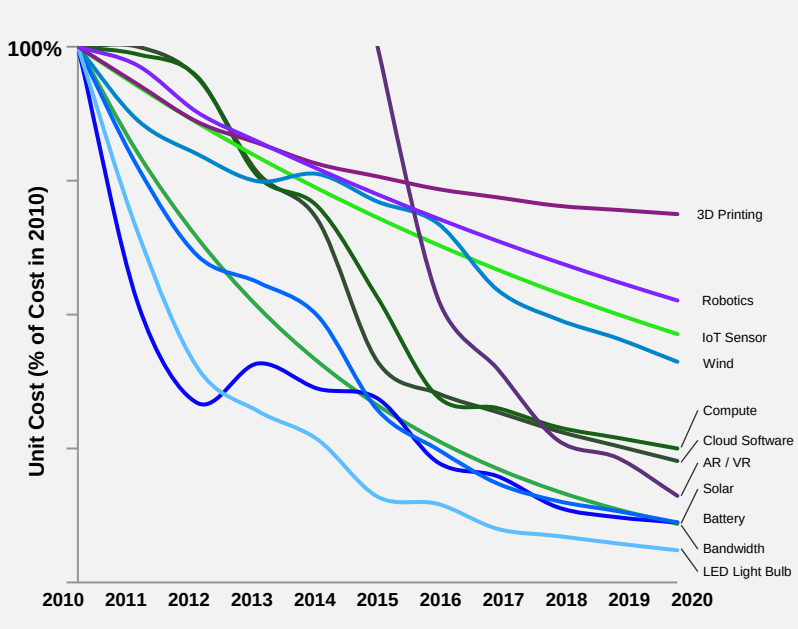
Cumulative new capacity additions in the 80% Clean Case



Source(s): Energy Innovation and Policy

Electrification is Colliding with Digital

Emerging Technology Cost Decline (2010 – 2020)



Cumulative Growth of Emerging Technologies

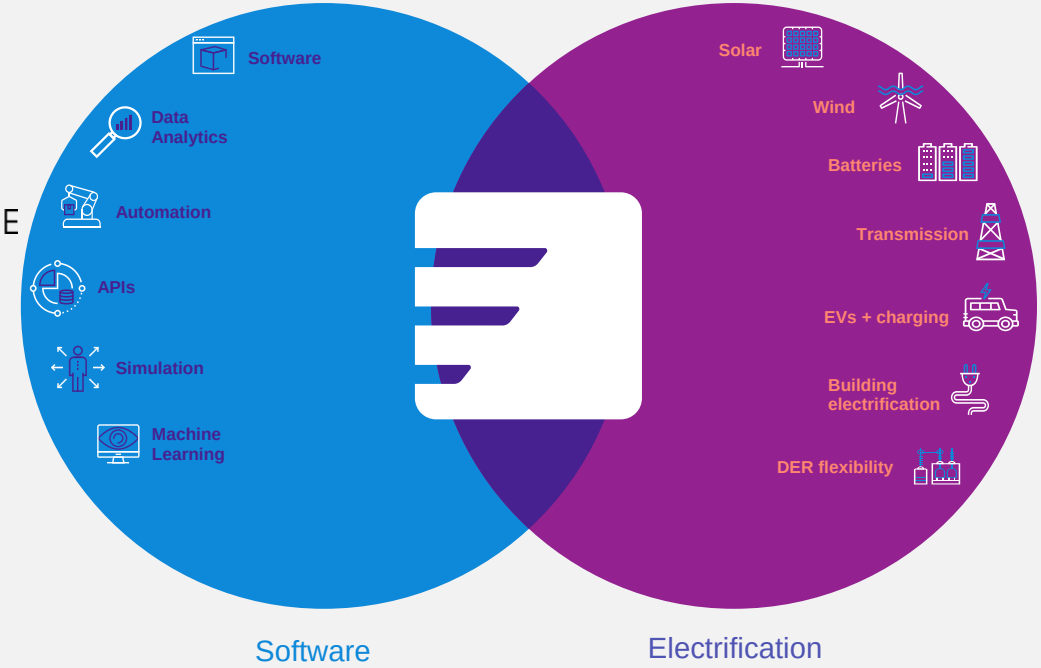
	Technology	Unit	2010	2020	CAGR
Tech Backbone	Cloud Software	ZB/yr	1.2	17	+30%
	Compute - Memory	TFLOP/s	20	1,100	+49%
	Bandwidth	KB/s	4.9K	19K	+18%
	IoT Sensors	sensors	4.1B	30B	+22%
Apps & Tools	Connected Worker	AR headsets	0	34M	+134%*
	3D Printing	3D printers	0	2.5M	+90%*
	Robotics	robotic arms	1M	2.7M	+11%
Equipment	Solar Power	GW	44	770	+33%
	Battery – Lithium	GWh	0.5	650	+106%
	Wind Power	GW	190	670	+13%
	LED Light Bulb	bulbs	1M	39B	+188%

**5 yr CAGR from 2015 – 2020*

Source(s): Cisco, BNEF, Microsoft, Goldman Sachs, Cowen Research, Top500.org, LED Inside, TeloGraph, Fast Radius

Examples of Energize Portfolio Companies at the Intersection of Software & Electrification

+ Vertical software — aurora, TWAICE
+ Workflow automation — SITETRACKER
+ API + data infrastructure — smartcar, ZEDEDA
+ Business model innovation — volta
+ Machine learning — sparkcognition



Energize Mental Model for Energy Technology Innovation Cycles

1. HARDWARE LEARNING CURVE

Rapid cost declines driven by manufacturing scale learning curve dynamics. Unit costs decline by 50 – 90% or more. Hardware becomes commoditized and manufacturing market share often shifts to lowest cost provider.

Panasonic ENPHASE. First Solar. LONGi Solar TESLA Trinasolar

2. BUSINESS MODEL INNOVATION

Innovative business models speed early adoption with an integrated solution. Access to lower cost financing and economies of scale further compress unit costs. No money down solar power purchase agreements are a prime example.

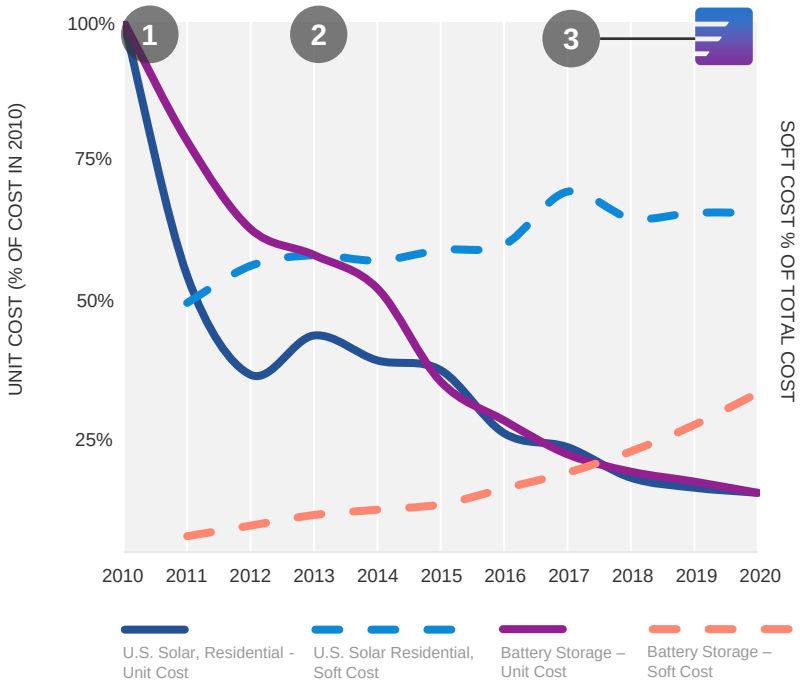
sunrun sunnova stem

3. SOFTWARE-ENABLED SCALE

Soft costs begin to exceed 40 – 50% of overall unit cost, dragging profitability across the value chain. Software becomes imperative to unlock efficient growth, reducing soft costs, streamlining workflows, and unencumbering human capital.

aurora TWAICE

Solar and Battery Unit Cost Decline, Soft Cost Increase from 2010 to 2020



Source(s): Energize Ventures Internal Data

sunrun Climate Software Budgets Support Venture Scale

ENERGIZE VENTURES

SunRun IT Expenditure Estimate

all values in '000s

Year	2019	2020	2021 (Sept.)
Revenue	$858,578	$922,191	$1,495,131
Operating Expenses	**$428,489**	**$643,773**	**$966,047**
General & Administrative	$125,023	$266, 746	$354,923
Sales & Marketing	$275,148	$352,229	$583,782
Research & Development	$23,563	$19,548	$21,950
IT Budget (estimated)	**$30,050**	**$48,415**	**78,494**

2021 (estimated)

$78m
Total IT Spend

$50m
Horizontal IT Spend

$28m
Vertical IT Spend

Solar Installer Hypothetical IT / Software Architecture

Customer Relationship Management (CRM)	salesforce, HubSpot
Project Management	SITETRACKER
Enterprise Resource Planning (ERP)	NETSUITE
Work Management	ServiceTitan
Communications	twilio
Analytics	tableau
General IT, Cloud and Data Management	Microsoft

ILLUSTRATIVE

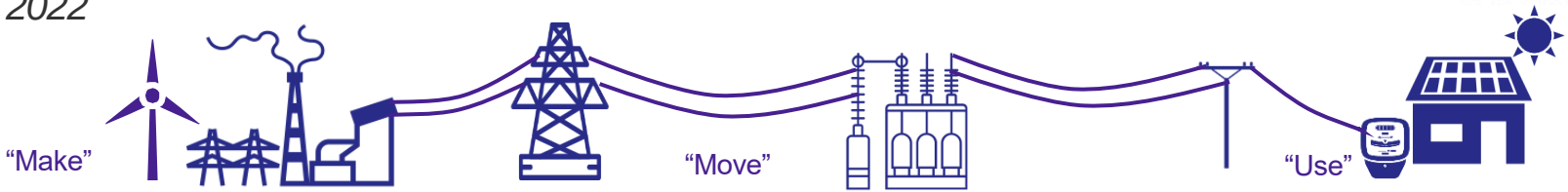
Lead Gen & Origination → Sales → Design & Engineering → Proposal & Permitting → Financing → Installation & Construction → Commissioning → Operations & Maintenance

Homegrown — aurora — goodleap — DroneDeploy

Source(s): Energize Ventures Internal Data, Publicly Available Sunrun Filings
*Solar Installer Hypothetical IT/ Software Architecture is based on hypothetical solar installer

Top 30 Software Innovators in Electrifying Everything*

2022



Generation	Transmission	Distribution	Consumption

SOLAR

RatedPower

PVcase

PosiGen

PALMETTO

MOSAIC

goodleap

aurora

BATTERY STORAGE

PowinEnergy

TWAICE

KoBold Metals

SPAN

WIND

Level10 Energy

SKYSPECS

TRANSMISSION

prisma photonics

neara

EV CHARGING

smartcar

ev.energy

MONTA

WeaveGrid

CLEAN FIRM POWER

BUILDING ELECTRIFICATION & EFFICIENCY

runwise

Sealed

measurabl

BLOC POWER

cove.tool

GENERAL

Arcadia

myst ai

DEMAND FLEXIBILITY

CAMUS
Zero Carbon Grid Orchestration

leap

uplight

DAVID ENERGY

*See selection criteria on following page

Source(s): Energize Ventures Internal Data

Top 30 Software Innovators in Electrifying Everything: Selection Criteria

Per our evaluation criteria, each company in the list should have the following characteristics:

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Energize: Electrifying Everything Killer Insights

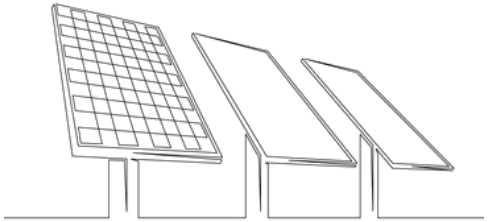
Electrifying Everything Category	Energize Insight
Solar	**Squashing "soft costs" with solar software** is the playbook for newly emerging climate technology to mimic
Battery storage	**Battery behavior is the *debutante of the climate ball*** – adored, flirtatious, fickle, powerful …and must be understood
EV charging	**EV charging payments**, the less sexy cousin to EV smart charging, may quickly become THE lucrative EV charging play
Demand flexibility	"Ideal" software play in theory, insanely difficult in practice; **expecting DER regulatory unlock (e.g. FERC 2222) a fool's errand**
Building electrification	The war for building electrification will be won with **PAYBACK PERIOD** (<3 year) and **DISTRIBUTION** (contractors!)
Wind	Wind is consolidated and thus a challenging software market, however **O&M budgets are large + ripe for outsource**
Transmission	Automating transmission interconnection modeling is an underrated angle for software, selling to ISO / RTOs is an impossible task
Clean, firm power	**Engineering innovation** (versus technological breakthrough) will drive greater impact in **geothermal, hydro, and nuclear**

Source(s): Energize Ventures Internal Data

Solar

Solar

WHAT IS IT?



Solar photovoltaics (PV) are glass encased sheets of semiconducting materials that generate electrons when exposed to sunlight.

Solar PV panels are mounted on racking on buildings or trackers in areas with strong solar resource. Modules are wired in series or parallel then connected to an inverter. Direct current is converted into alternating current to integrate with the power grid.

WHY DOES IT MATTER?

Abundant, Global Resource

85,000 TW global resource is 4,473x current global power demand and diversified geographically

Lowest Cost New Power Plant

<$30 per MWh LCOE represents a 90% decline in past decade, cheaper than coal, gas, nuclear and even wind

Modular, Flexible Architecture

Solar PV can be installed on rooftops at <1 MW scale or in 100 MW+ utility-scale plants in remote areas like deserts

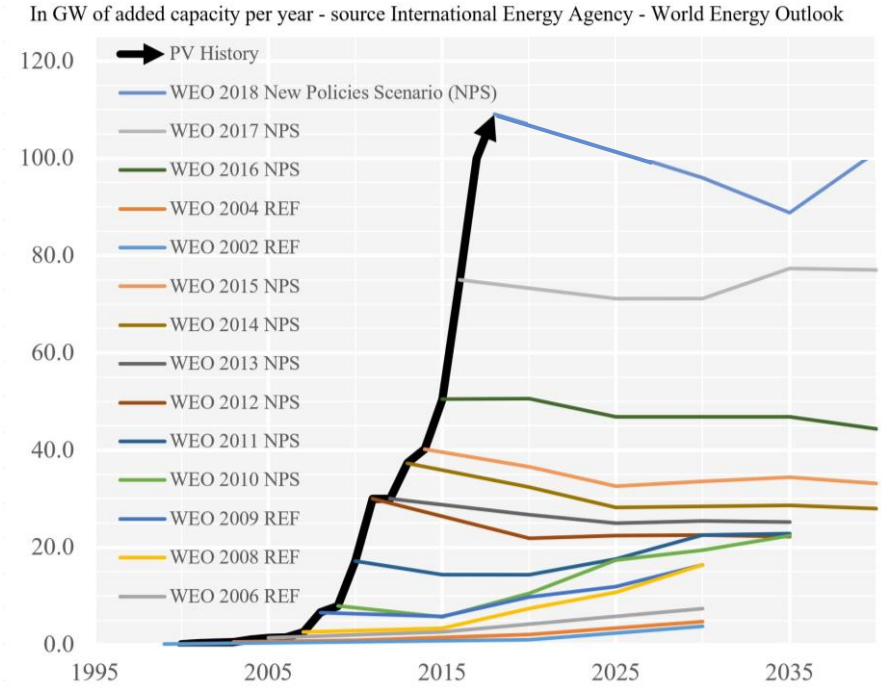
ENERGIZE KEY TRENDS

Software eats “soft costs”

Solar + storage = a killer app

Leading Agencies and Forecasting Firms Underestimate Solar Growth

Annual PV Additions: Historic Data vs. IEA WEO Predictions



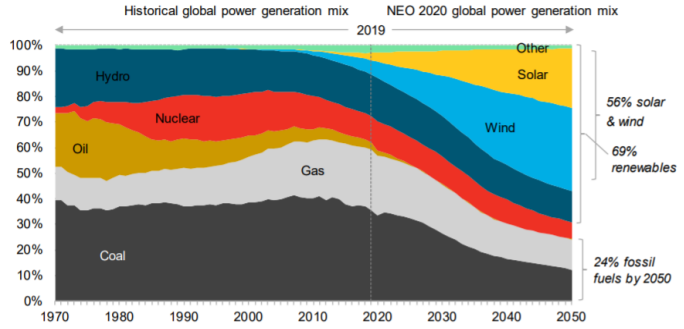
Source(s): BNEF, Auke Hoestra, Nat Bullard (Twitter)

"A lesson I learned (when working directly for Jenny Chase during our last global crisis) is that it seems to be impossible to keep the global solar market from growing year-on-year. Global financial crisis didn't do it; pandemic won't either. Annual installs +15x from 2009 to 2020"

- Nat Bullard, Chief Content Officer, BloombergNEF

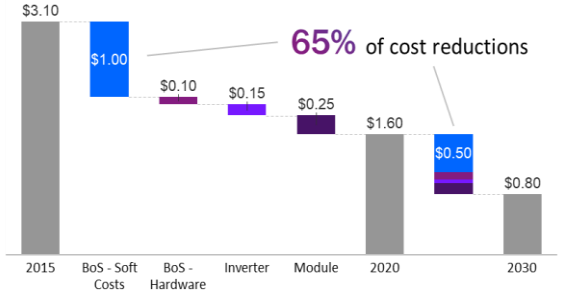
Why Now for Solar Software

12x Increase in Solar Capacity by 2050



50 – 70% of Distributed Solar = "Soft Costs"

RESIDENTIAL SOLAR INSTALLED COST ($/WATT)



Source(s): BNEF, DOE Sunshot, Energize Ventures Internal Data

How will solar scale efficiently?

Software

Automation

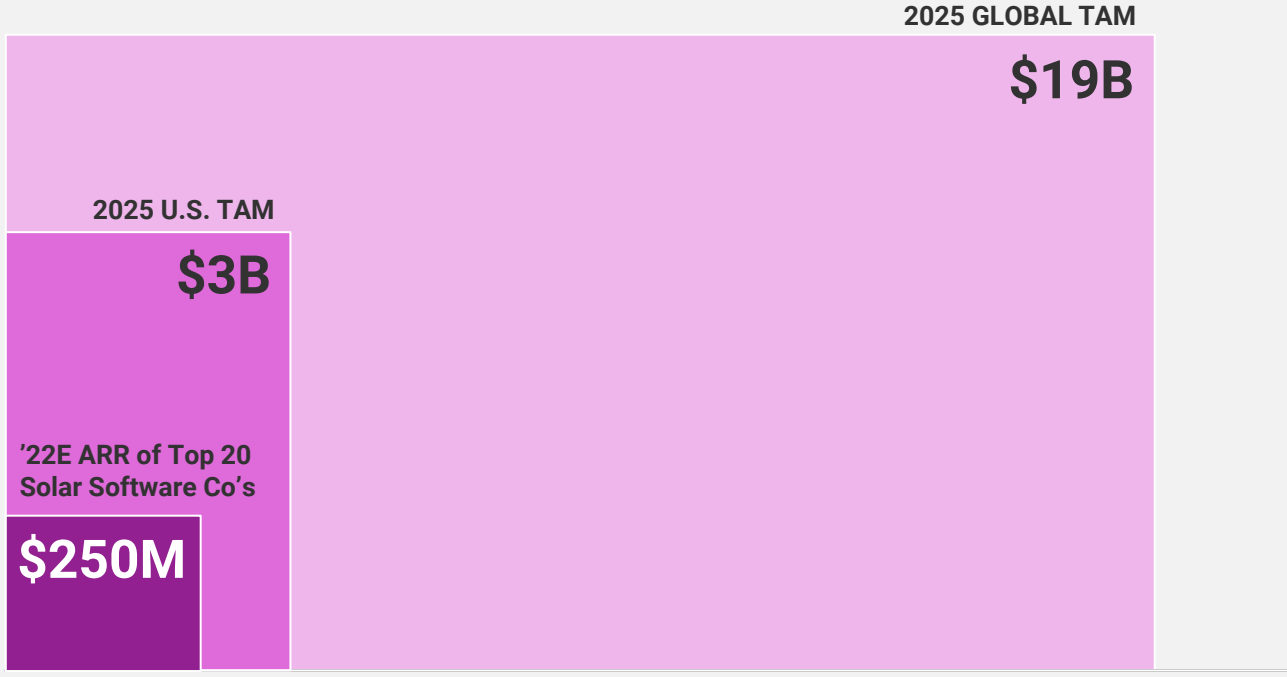
Solar Software Market Tailwinds

Fast Growing Market	Solar is growing at **20 – 30%+ CAGR**
High “Soft Costs”	**Soft costs = 40 – 70%** across customer segments (e.g. residential)
New / Underserved Market	**IT stack not entrenched**, adoption exceeds market growth by 3 – 6x
Fragmented Customer Base	**Thousands of solar installers** (logos) in the U.S. alone
Multi Product Potential	Multiple value chain steps (**sales, design, financing**) drive customer P&L
Moving Upmarket	**5 – 10x account expansion** potential within individual solar companies
M&A Consolidation	**Valuable solar software point solutions** are available for consolidation

Source(s): Energize Ventures Internal Data

Solar Software Total Addressable Market (TAM)

Solar Software TAM vs Aggregate ARR of Solar Software Co's

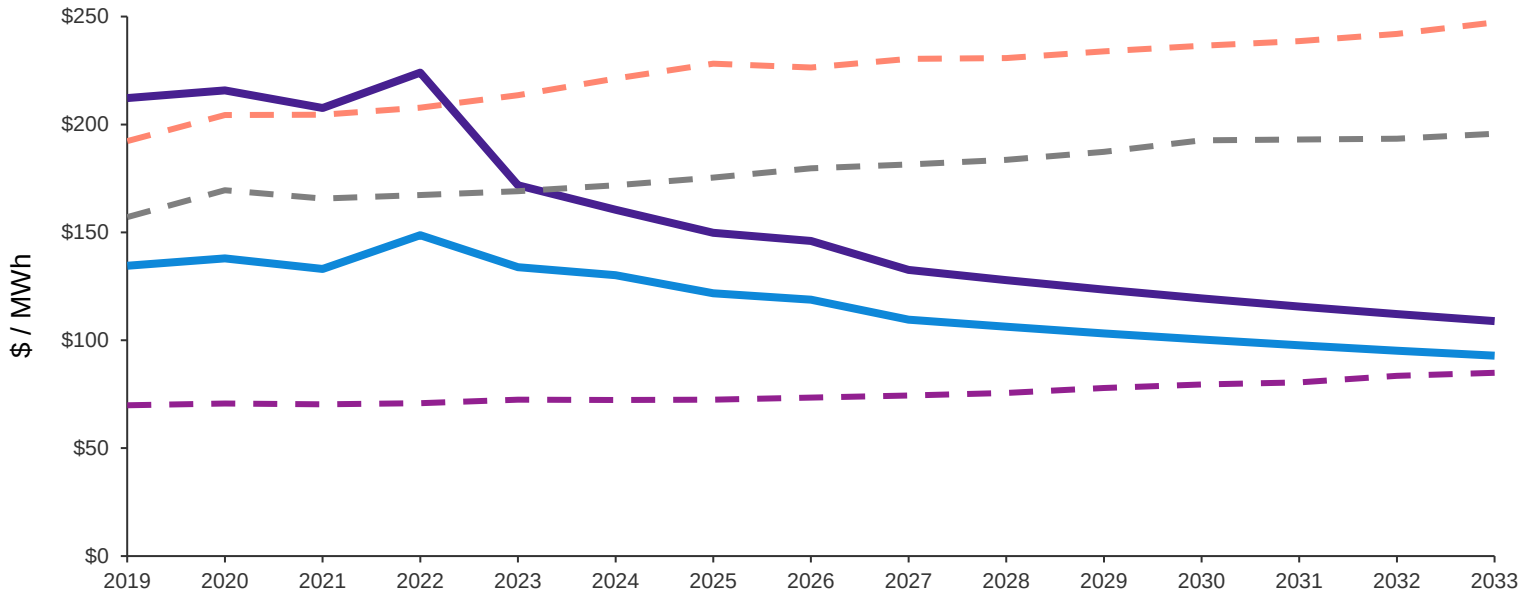


Source(s): Energize Ventures Internal Data, SEIA

Solar + Storage Cost Parity with Grid Electricity

Solar + storage parity with retail electricity rates could accelerate adoption by liberating reliance on Net Energy Metering.

Levelized Cost of Solar / Solar + Storage (2019 – 2033) – Base Case Assumptions with ITC



Source(s): Energize Ventures Internal Data, EIA, LBNL

“Nano-grids” Become Economic

Solar + storage are poised to disrupt status quo as clean, resilient “nano-grids” become economic

Estimated Total Cost of Home Electricity Back-up over 20 years for a California Residential Customer

Home back-up options	Solar + storage	Gasoline backup generator
Total purchased electricity costs	$500	$51,300
Upfront cost	Solar: $10,900 Storage: $19,000	$3,400
Total maintenance cost	$1,000	$1,000
Replacement cost	$19,000	$1,800
Total fuel cost (100 hours per year)	$0	$1,600
Incentives	Storage incentives: $12,450	$0
Cost of electricity + backup	**$37,950**	**$59,100**

-36%

Source(s): EnergySage, Energize Ventures Internal Data

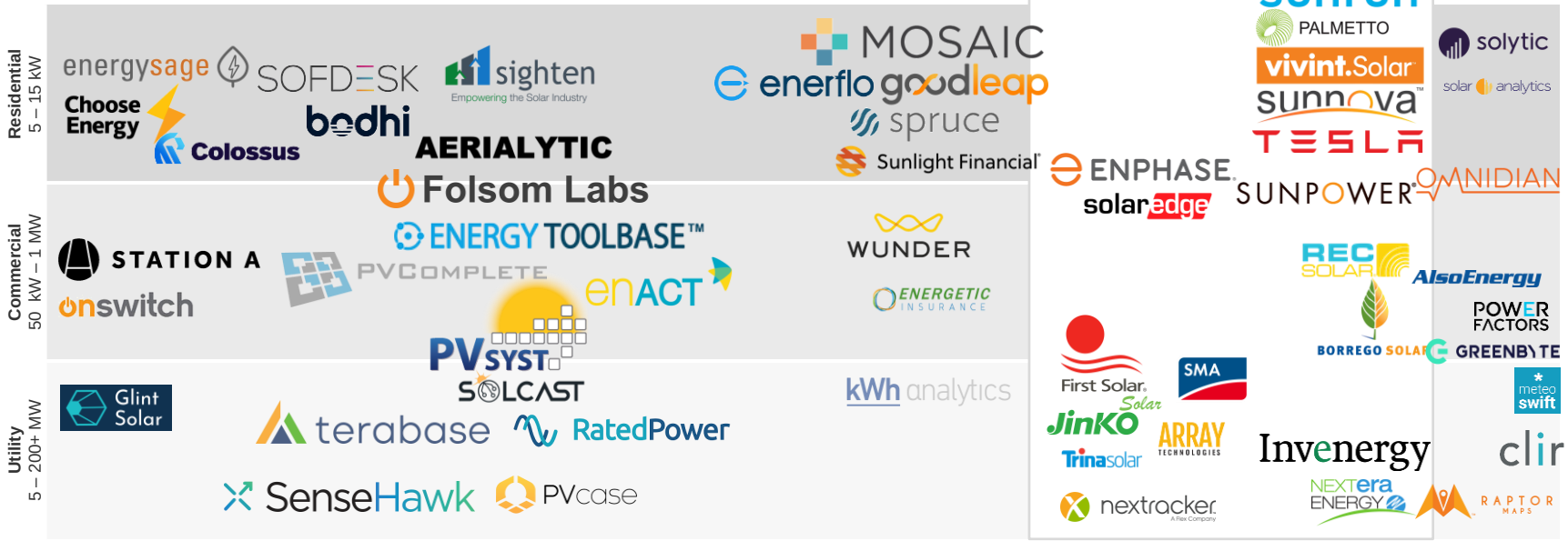
Energize's Solar Software Market Map

SOLAR VALUE CHAIN*

Lead Gen & Origination | Sales | Design & Engineering | Proposal & Permitting | Financing | Installation & Construction | Commissioning | Operations & Maintenance

aurora

Aurora is integrating across the distributed solar value chain



*List of competitors / companies is non-exhaustive

Source: Energize Ventures Internal Data

Solar: Companies to Watch

Solar Software

Distributed

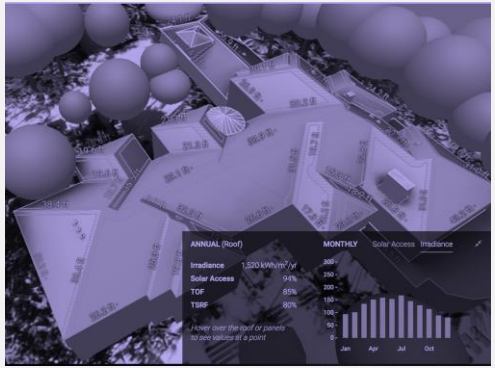
Utility-scale

Company	What is it?
aurora	Software to help automate rooftop solar design and sales
Colossus	Software-enabled solar lead generation service
OMNIDIAN	Software-enabled residential solar performance guarantee plans
RatedPower	Software to optimize design and engineering of large-scales solar plants
Glint Solar	Software to streamline solar site evaluation and selection
PVcase	Software to streamline utility-scale solar engineering
RAPTOR MAPS	Drone-based utility-scale solar inspection and predictive maintenance

Solar + Storage

Company	What is it?
SPAN	Smart electrical panel prefabricated to integrate solar and storage
SCALE MICROGRID SOLUTIONS	Turnkey microgrid provider

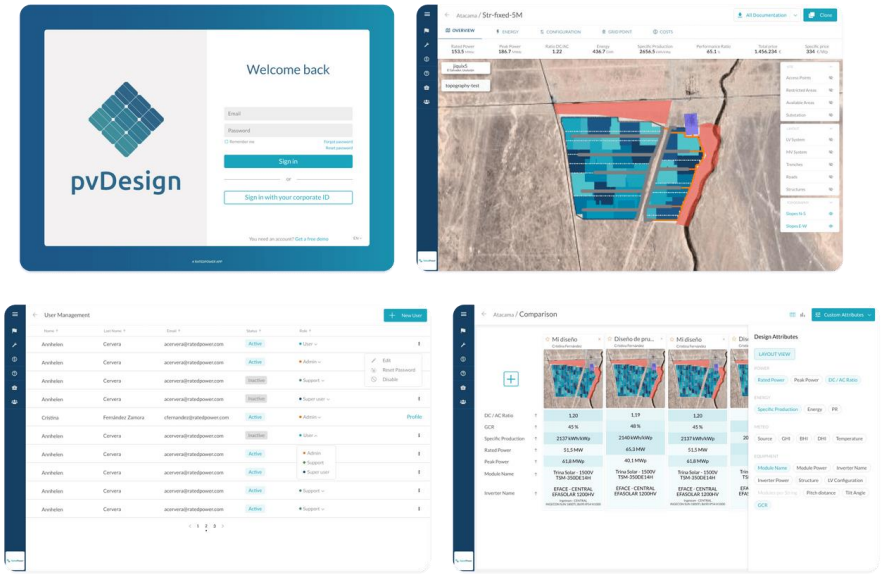
AURORA SPOTLIGHT



Click the image for an overview of Aurora's product

Innovator Spotlight: RatedPower

RatedPower develops pvDesign, utility-scale solar engineering and design optimization software.



RatedPower - Energize Ventures View

Utility-scale solar volume will dominate the capacity deployment of solar globally over the next 10 – 20 years. Large-scale solar developers, owners and operators have been slower to adopt dedicated vertical software than their distributed solar counterparts. Headcount was sufficient to drive capacity growth.

Utility-scale solar soft costs … engineering, interconnection, supply chain, O&M … are now most of cost. Software will be critical to slash soft costs and unlock further scale. We believe utility-scale solar software adoption is accelerating. Firms like RatedPower are extremely well-positioned to capture market share with proven large-scale solar solutions.

Wind

Wind

WHAT IS IT?

Wind energy is powered by tower mounted turbine blades (thinner versions of airplane wings). Wind blows over the blade surface, generating lift, spinning the blade on an axle and cranking a generator to produce electricity.

Wind farms are often located in remote areas like grasslands and offshore along coastlines where wind speeds are high & consistent.

WHY DOES IT MATTER?

Abundant, Diverse Resource

3,600 TW global resource is 189x current global power demand and diversified geographically

Capacity Factor Improvement

Wind farm capacity factor massive improvement, from 27% historically trending to 40 – 50%+

Megascale Plant Potential

Taller, bigger wind turbines mean wind farms sizes can approximate legacy GW-scale fossil fuel plant sizes

ENERGIZE KEY TRENDS

Software & data at scale

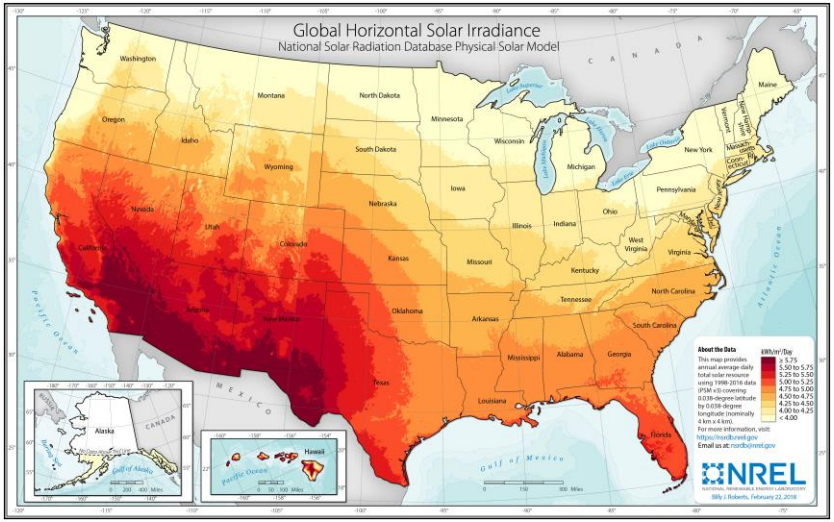
Soak up excess wind

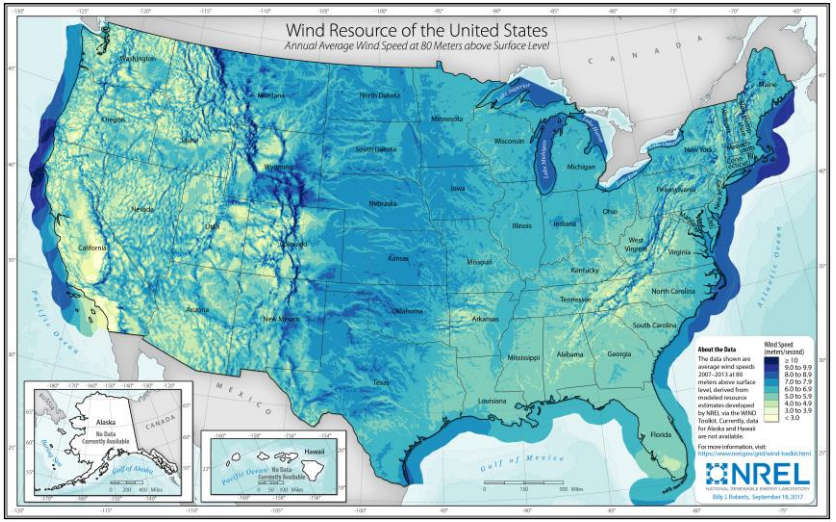
Offshoring comes to wind

Source(s): Energize Ventures Internal Data

U.S. Wind and Solar are Highly Complementary Geographically

Solar, irradiance is strongest along the West Coast and Southeastern U.S., while wind resource is primarily concentrated in the middle of the country.



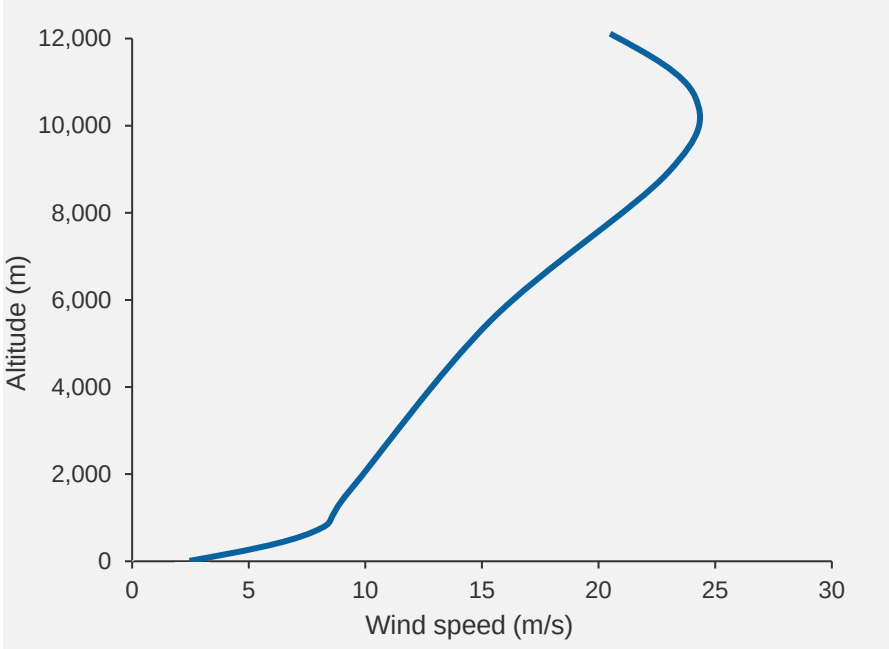


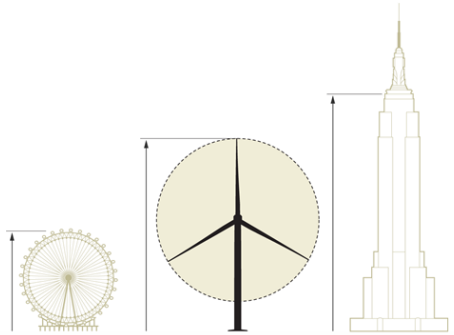
Source(s): NREL, IEA

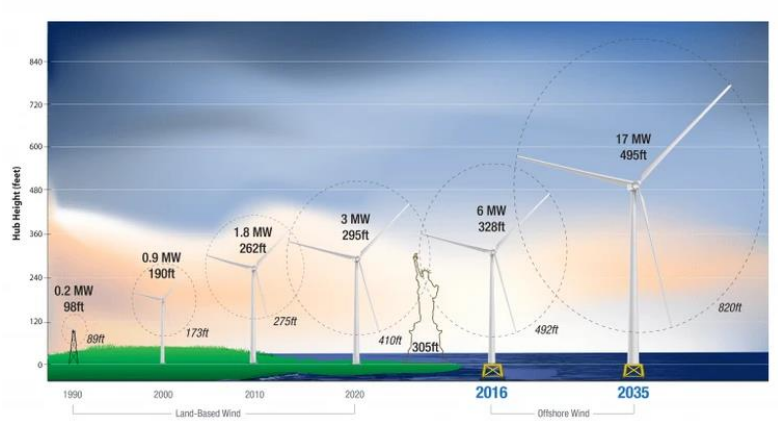
The Physics of Wind

Wind production is primarily a function of height and blade length, which is why wind manufacturers are heavily focused on bigger, longer turbines (and moving turbines offshore).

Dutch Wind Speed Variation with Altitude



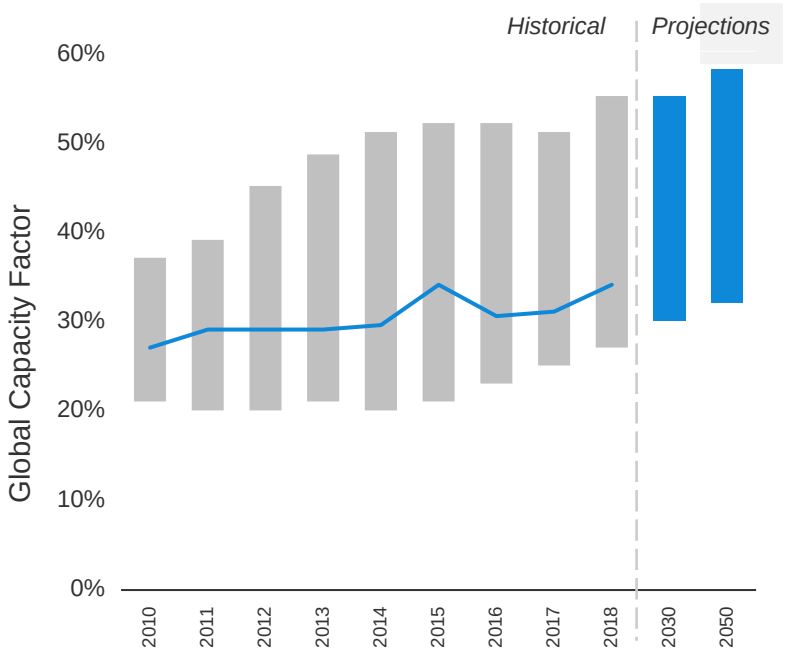




Source(s): New York Times

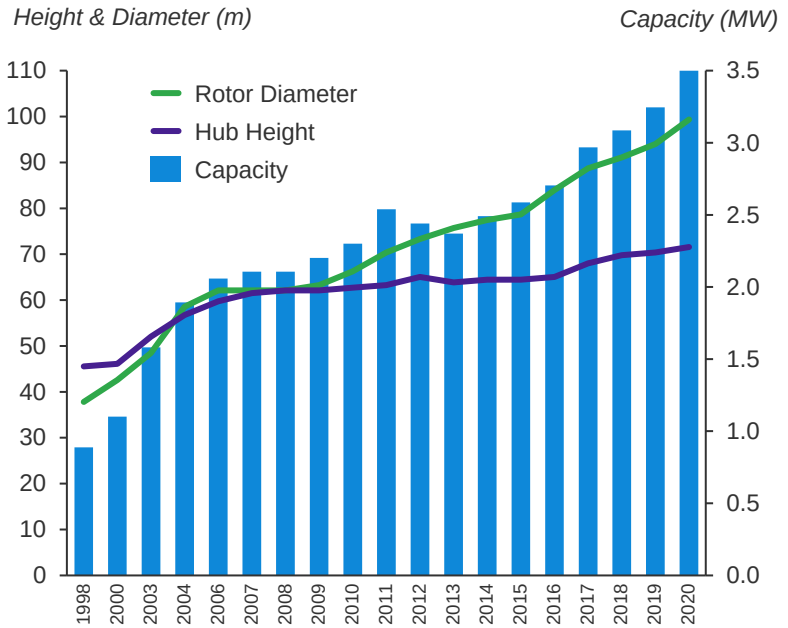
Wind Capacity Factor and Size of Wind Turbines

Onshore Wind Capacity Factors



The capacity factor is based on the project commissioning year

Wind Turbine Size and Capacity Over Time

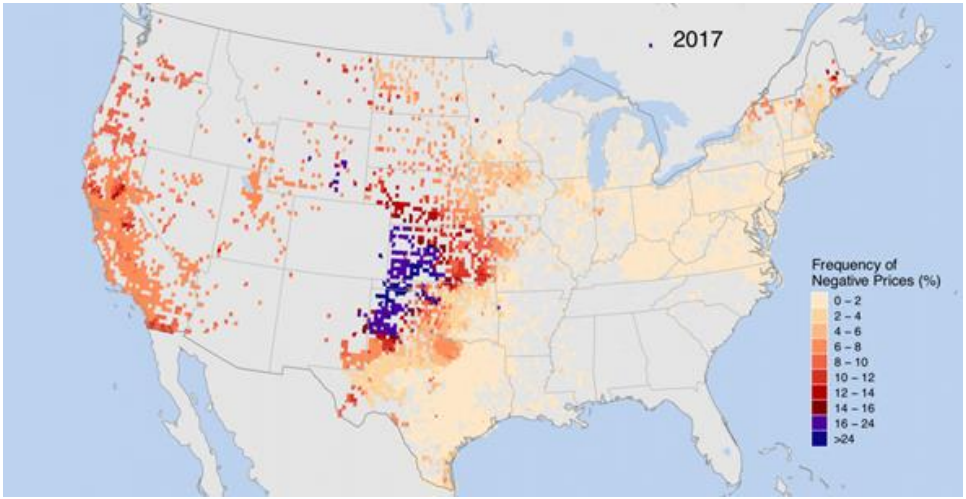


Source(s): IRENA

Wind Turbines go to Wind Rich Regions

Soaking up excess wind production in wind-rich regions will act as an economic accelerant for energy-intensive industries like cloud data centers, crypto mining and hydrogen production.

Transporting a large wind blade … it almost looks like an ant carrying a leaf!

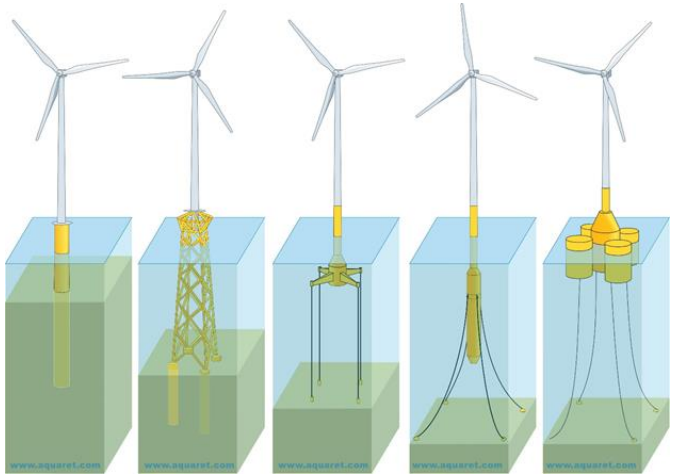


Specific use cases we are tracking:
Data centers for cloud computing, Crypto mining, Hydrogen production

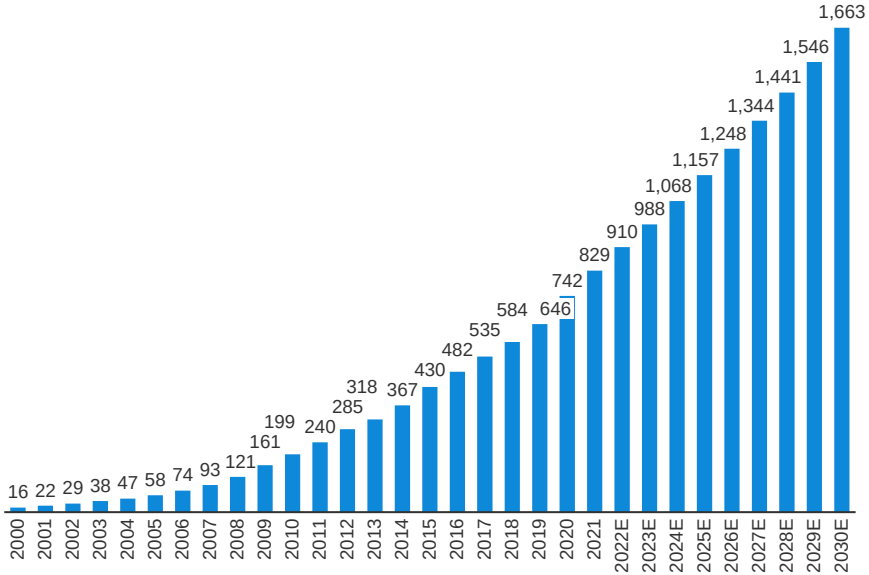
Offshore Wind Will be Key

Offshore wind will be a significant growth avenue for land-constrained coastal regions.

Offshore Wind Turbine Foundation Types



Global Offshore Wind Capacity Outlook (GW)



Source(s): BNEF

Wind Software Market Map

WIND POWER SOFTWARE

Origination & Biz. Development	Engineering & Design	Construction	Financing & Commercial Ops	Operations & Maintenance	Second Life + Recycling

TRAVERSE
AKSELOS
SHORELINE
Level10 Energy
SKYSPECS
clir
WindESCo
REsurety
bazefield
An Envision digital Company
jungle
Mercatus
A State Street Company
ENSEMBLE ENERGY

Analysis & Analytics	myst ai, Seeq, C3.ai, sparkcognition, ELEMENT ANALYTICS, UPTAKE
Data Processing & Communications	ZEDEDA, helium, STARRY
Data Acquisition	Sterblue, HUVR, PRENAV, DroneDeploy, GeckoRobotics

Source(s): Energize Ventures Internal Data

Technologies Optimizing Wind Assets (1/2)

New software technologies have been developed to optimize the development, construction, and operation of wind power assets.

Company	What is it?
ENSEMBLE ENERGY	AI-based asset management software for wind operators to avoid equipment failures
ZEDEDA	Edge computing software to deliver visibility, control and security for the distributed edge, including wind farms
clir	Wind optimization and reporting software
Matroid	Drag and drop computer vision for subject matter experts, including wind manufacturers and developers
AKSELOS	Structural digital twin software for large energy assets, including offshore wind

Technologies Optimizing Wind Assets (2/2)

Company	What is it?
Arcadia	Renewable energy subscription, sourcing power from wind (and solar)
Level10 Energy	Wind and solar power purchase agreement (PPA) corporate procurement marketplace
LANCIUM	Carbon neutral cloud computing power by low-cost wind
SHORELINE	Wind life cycle simulation and optimization software
SKYSPECS	Automating wind operations and maintenance with drones

Innovator Spotlight: Ensemble Energy (now Sparkcognition Wind)

Ensemble Energy (acquired by Sparkcognition) provides predictive analytics to optimize energy production and prevent failures.

Ensemble

“Ensemble’s software can increase wind farm annual energy production while reducing the cost of unplanned maintenance by 10 percent or more.”

“Our engineering and physics-based optimization algorithms take in SCADA, meter, meteorological, maintenance and financial data. We then evaluate fleet-level performance and identify specific turbines affected by issues such as bearing and generator health. Operators close the loop by remotely adjusting control parameters or directing maintenance crews to undertake a preventative action.”

- Ensemble CEO, Sandeep Gupta

Innovator Spotlight: Akselos

Akselos is an engineering simulation technology for structural monitoring of infrastructure assets such as offshore wind.

Akselos

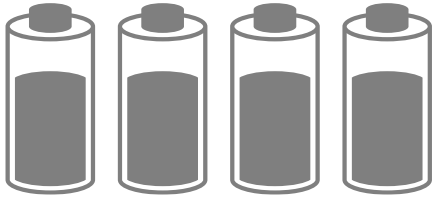
Thomas Leurent, CEO of Akselos, is optimistic about the nexus of wind and hydrogen:

“In the long view, if ammonia with hydrogen becomes cheap enough, developing economies can convert recently built coal plants into zero-emission plants,” said Leurent. “We can decarbonize faster by triangulating different but complementary approaches. For example, floating wind farms or giant ammonia-producing solar farms can repurpose coal power and petrochemical plants, all while outlining a clear pathway for traditional fossil fuel firms to join the energy transition.”

Battery Storage

Battery Storage

WHAT IS IT?



Batteries are electrochemical systems enabling storage of energy for later use.

Renewable energy can be stored in batteries to help fill gaps smooth the intermittent production of solar and wind energy. Electric vehicles rely on batteries in lieu of a fuel tank to provide energy for propulsion. Batteries are the key to a heavily electric grid and transportation sector.

WHY DOES IT MATTER?

Intermittent Resources

Solar and wind need storage capacity to store excess power during off-peak and discharge during peak demand

Storage at the Grid Edge

Consumers and businesses can produce energy on-site and ride through grid interruptions with batteries for resiliency

Electric Vehicle Adoption

Global electric vehicle (EV) sales are expected to grow at a 29% CAGR through 2030

ENERGIZE KEY TRENDS

Software defined materials innovation

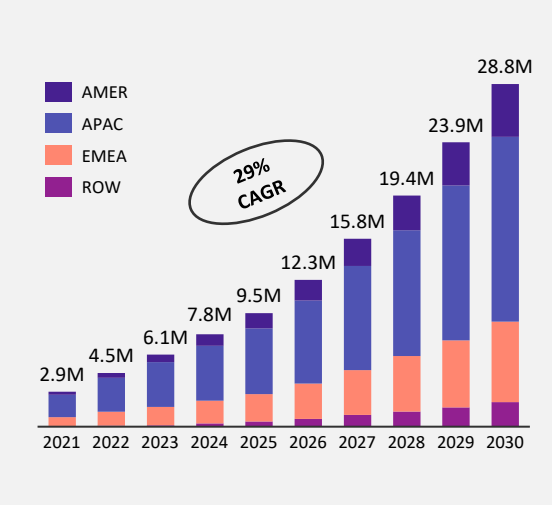
Lifecycle battery soft cost reduction

Source(s): Energize Ventures Internal Data

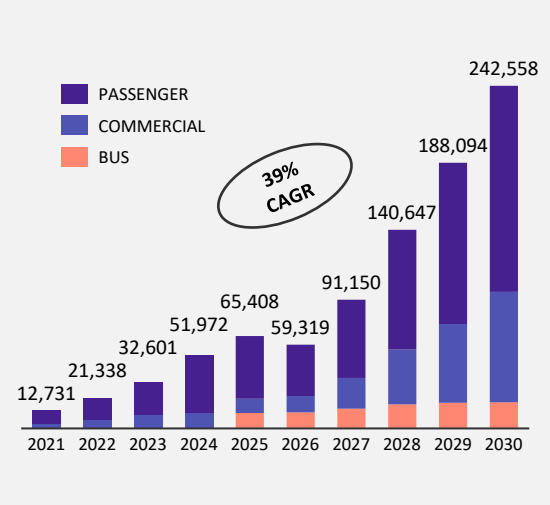
Battery Storage: What is it? & Why Does it Matter?

Princeton's Net Zero America study estimates that the U.S. will need 180 GW of six-hour batteries for a power grid dominated by renewable energy. That means we would need 70x as many batteries that we have today, and that each battery would need twice the duration than current averages.

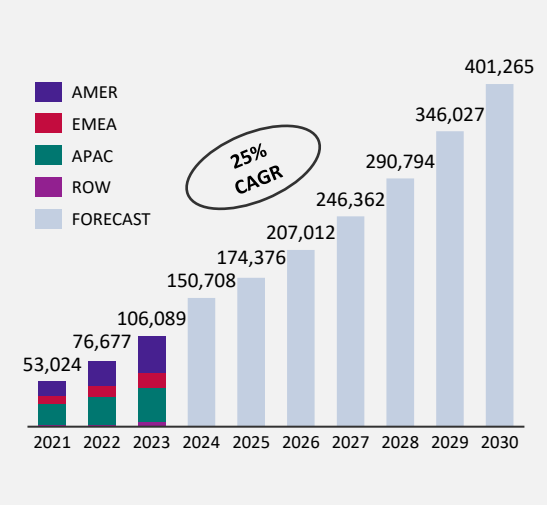
Yearly global electric vehicle sales



Yearly second life auto battery capacity (mwh)



Cumulative global energy storage capacity (mwh)



Due to tailwinds in renewable energy & EVs, the auto battery & energy storage markets are expected to grow at a 25%+ CAGR over the next decade.

Source(s): Princeton Net Zero America, BNEF, Energize Ventures Internal Data

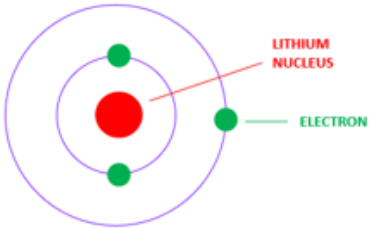
Battery Storage: How it Works

To address this deficit, there are a range of energy storage technologies commercially available today, from pumped hydroelectric to lead-acid batteries. However, none can achieve the combination of cost efficiency, energy density, end-use flexibility and production volume of lithium-ion battery storage, which has captured more than 90 percent market share in the U.S., according to the EIA.

HOW A LITHIUM-ION BATTERY WORKS

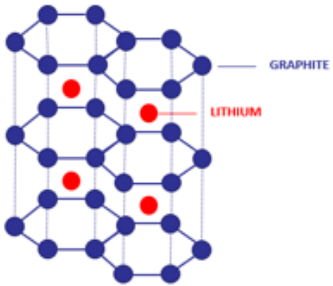
LITHIUM ATOM

Lithium atoms have the ability to donate their outermost electron



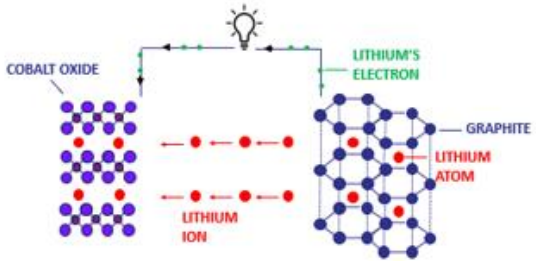
LITHIUM ION BATTERY ANODE

Lithium atoms are placed between layers of graphite in the battery anode



LITHIUM ION BATTERY

Electrons flow to a cobalt oxide cathode and the lithium ions follow

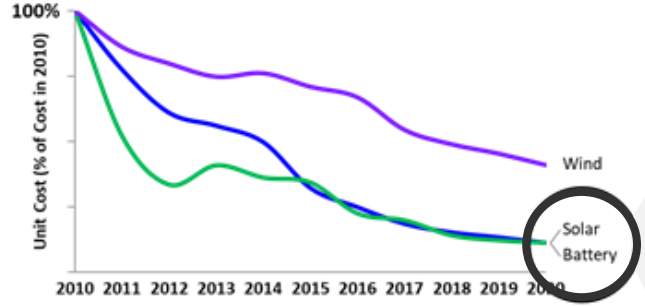


Learning Curve Dynamics

Like solar PV, lithium-ion battery cell cost declined by roughly 90 percent over the past 10 years.[1] Lithium-ion battery technology is also seeing a massive scale-up in production — initially to produce batteries for iPhones, then for Teslas, and now to support our transition from a fossil economy to a battery-electric economy.

LITHIUM-ION LEARNING CURVE MIMICS SOLAR PV

Emerging Energy Technology Cost Decline (2010 – 2020)

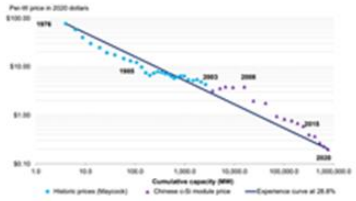


Cumulative Growth of Emerging Energy Technologies

Technology	Unit	2010	2020	CAGR
Battery – Lithium Ion	GWh	0.5	650	+106%
Wind Power	GW	190	670	+13%
Solar Power	GW	44	770	+33%

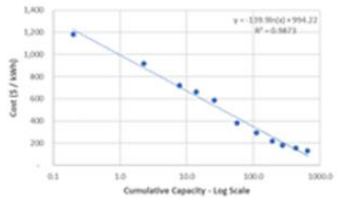
"Swanson's Law" applying to batteries as well …

Solar PV Costs vs Cumulative Capacity



~28% reduction in solar module cost for every **doubling of shipped module volume**

Li-ion Battery Costs vs Cumulative Capacity



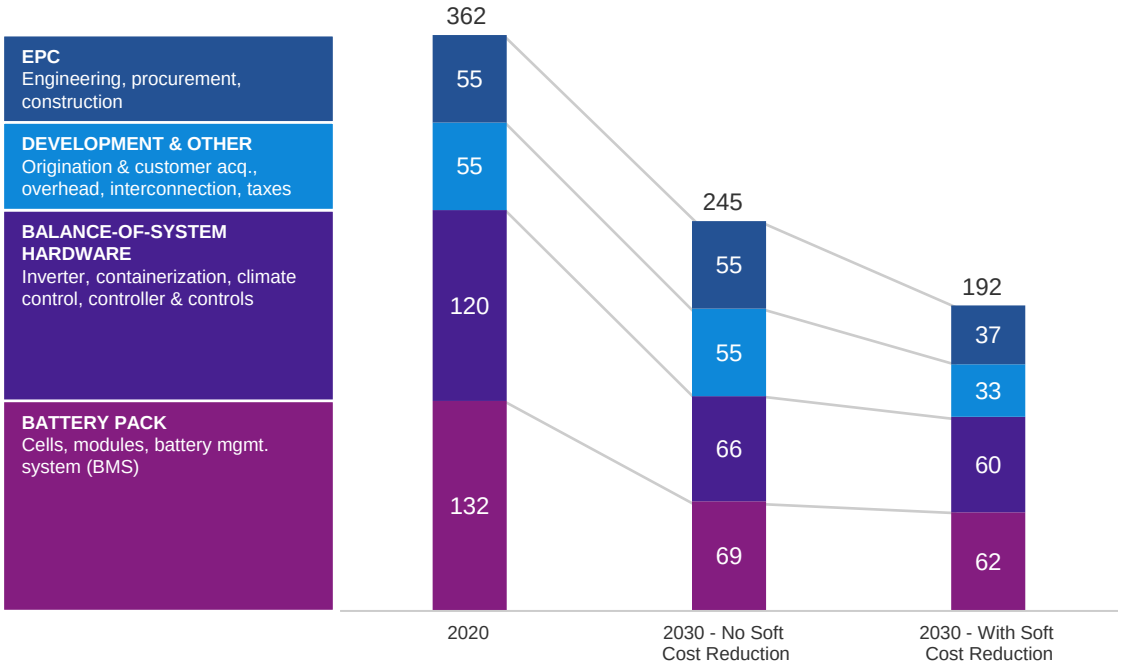
~23% reduction in storage cell cost for every **doubling of shipped cell volume**

Source(s): Energize Ventures Internal Data, BNEF, Goldman Sachs, Cowen Research, Auke Hoestra

Soft Cost Issue is Replicating in Storage

Battery storage hard costs are expected to decline, but soft costs remain.

Battery Storage Installed Cost Trajectory ($ / kWh)



Stubborn Soft Costs

As solar scaled to a multibillion industry, soft costs accounted for 60 – 70% of installed cost.

Soft costs remained stubbornly high due to customer acquisition costs, complex engineering workflows, unexpected maintenance costs, challenges securing permits … sound familiar?

The battery storage industry, across both mobility and energy use cases, faces similar challenges … however, software can play an essential role in aiding efficient growth & scale.

30% → 50%

storage soft cost as a % of cost in 2030 w/o further reductions

$400B+

annual soft cost expenditures by 2030 w/o further reduction

Source(s): Energize Ventures Internal Data, McKinsey, BNEF

Why Now: Storage Software

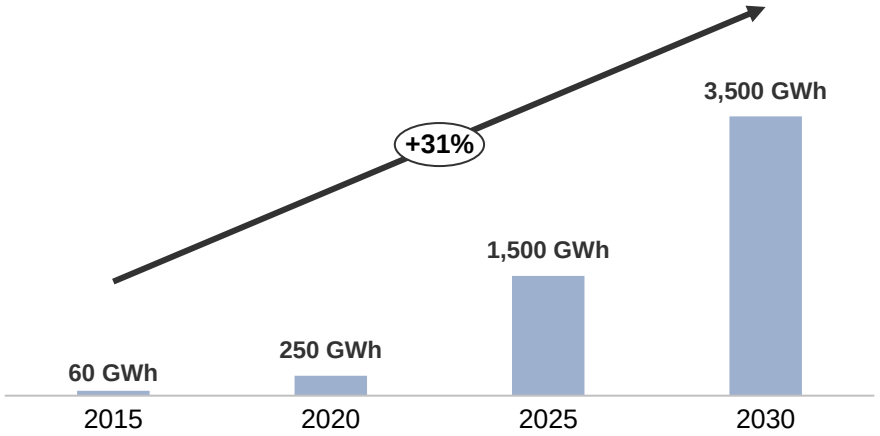
Rapidly accelerating deployment of lithium-ion batteries will necessitate a digital application layer.

-80%
Battery Pack Cost Reduction from 2013 – ‘20

22M
Annual Electric Vehicle Sales by 2025

250 GWh
Global Installed Battery Storage Capacity by 2025

Global Lithium-Ion Battery Demand, 2015 - 2030



Source(s): Energize Ventures Internal Data, BNEF

Storage market forces at work …

Massive battery storage demand growth
Rapidly maturing applications in both electrified mobility and renewable-heavy power generation

Emerging pain point in degradation / risk
First movers in electric vehicles and grid storage realizing battery operations caused shorter battery life than expected

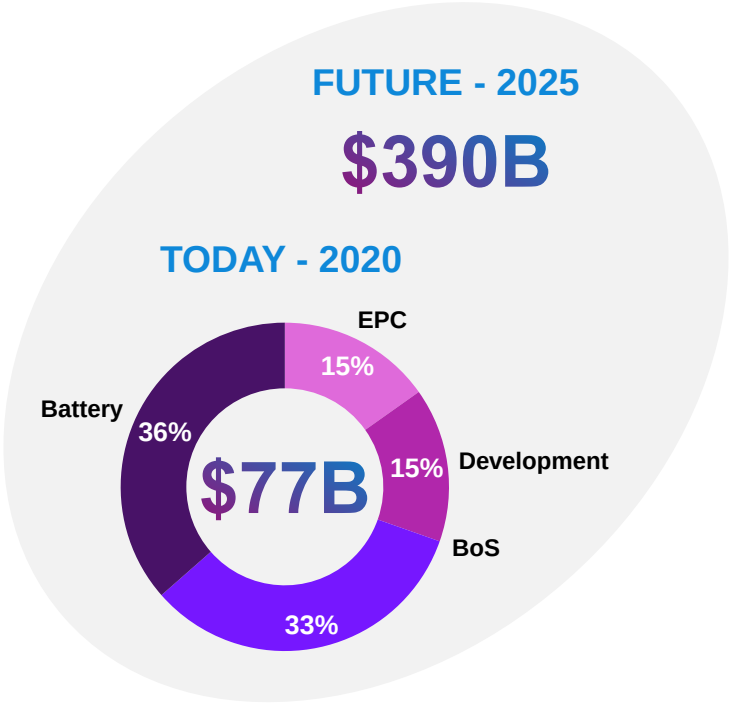
“Soft cost” problem replicating in storage
Becoming more expensive & complicated to design and operate batteries, problem only exacerbated with scale

Existing solutions bespoke & not scalable
Internally-developed or consultant-generated analytics become costly & break as battery volume increases exponentially

Battery engineering talent shortage
Corporate scale-up of battery production and lifecycle mgmt. creating intense pressure to hire battery engineers

Storage Software TAM is Large & Growing

Battery Storage Global Total Addressable Market (TAM)



TAM Breakdown by Business Model Type

FUTURE – 2025

Hardware	Services	Software
$262B	**$113B**	**$15B**
+37% CAGR	*+38% CAGR*	*+48% CAGR*

Battery Storage Software

- TAM growing fastest
- Hardware becoming commoditized
- Service providers look for differentiation via software

Source(s): Energize Ventures Internal Data, McKinsey, BNEF, Lazard

Emerging Battery Storage Value Chain / Market Map

ENERGIZE VENTURES

BATTERY STORAGE VALUE CHAIN

Raw Materials Acquisition	Chemistry & Cell Selection	Manufacturing	Systems Integration	Development & Construction	Battery Mgmt. & Market Ops	Second Life / Recycling

TWAICE

Software

VOLTAIQ
BATEMO UNDERSTANDING BATTERIES
AMS
RECURRENT
novo
CITRINE INFORMATICS
PEAXY / Geli
KoBold Metals
stem
ELEMENT ENERGY
SILA NANOTECHNOLOGIES
TESLA
FLUENCE A Siemens and AES Company
TITAN ADVANCED ENERGY SOLUTIONS
REDWOOD MATERIALS
PowinEnergy
northvolt
Invenergy
Li-Cycle
Lilac solutions
form energy

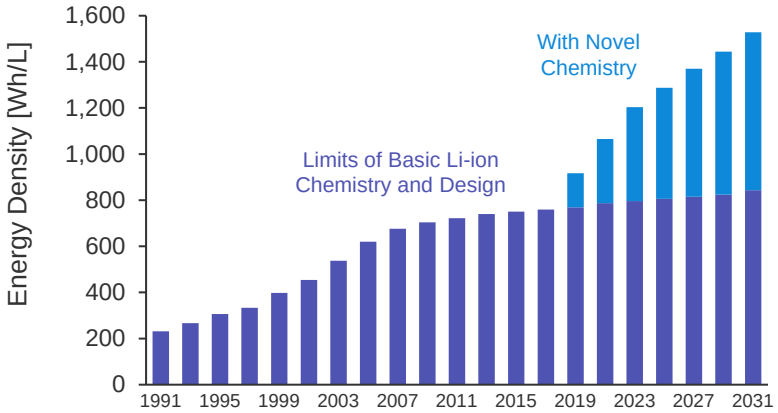
Hardware

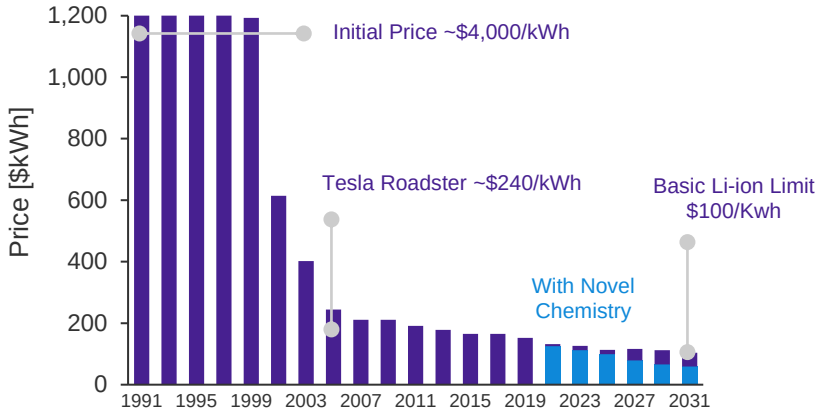
Source(s): Energize Ventures Internal Data

Changes in Lithium-Ion Cells

The energy density of lithium-ion cells has increased over time and will continue to increase with novel chemistry approaches. Meanwhile, the price of lithium-ion cells will decline towards a limit of $100 / kWh unless novel chemistries (anode, cathode, electrolyte technology, etc.).

Next generation of lithium-ion batteries will require software-enabled exploration of novel chemistries and precision manufacturing techniques to sustain improvements in energy density and cost.





Source(s): Sila Nanotechnologies

Materials Software

Software can be used to help discover and design novel chemistries to continue to sustain improvements in battery energy density while minimizing costs.

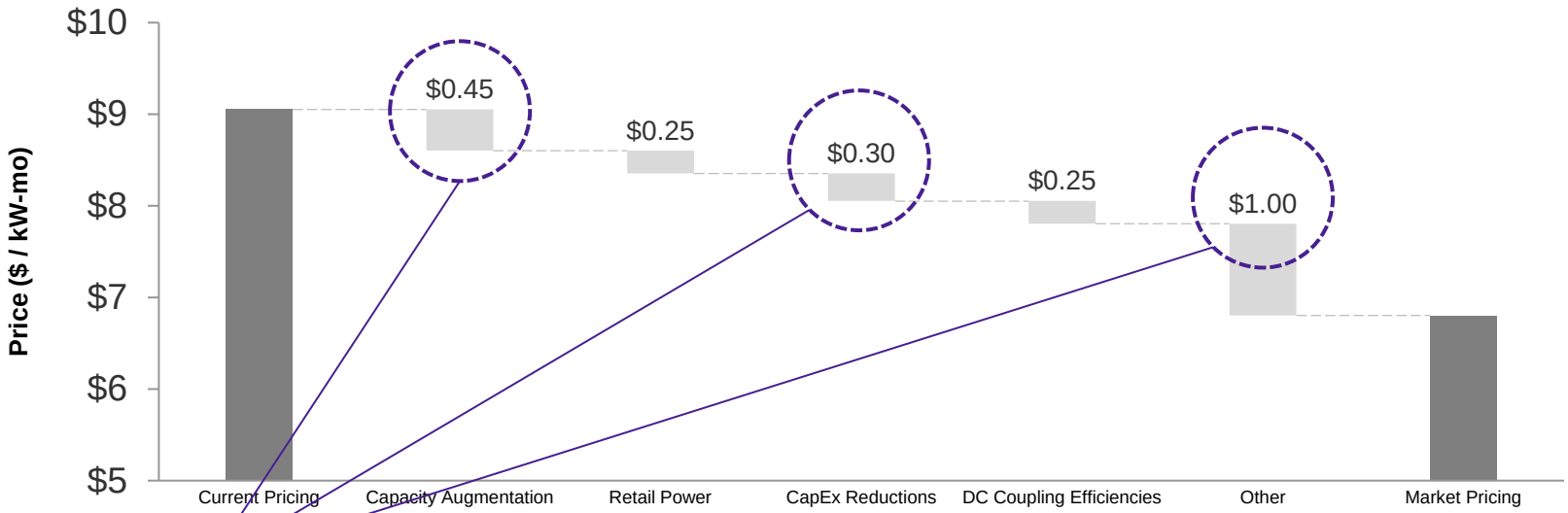
A few innovative startups working on battery material software we are keeping our eye on:

Company	What is it?
EXABYTE.IO MATERIALS DISCOVERY CLOUD	Cloud-native digital materials R&D platform
CITRINE INFORMATICS	Online platform to accelerate materials & chemical development with machine learning
KoBold Metals	Data science driven mineral exploration & rights platform for Nickel, Cobalt, Lithium, Copper & other critical material projects across the globe

Battery Storage Software Customer Business Case Example

The installed price of battery storage can be optimized with software tools.

Battery Storage Installed Price ($ / kW-mo) for a 4-hour, 20 – 50 MW System



Energize Proprietary Insight

1. Better software storage tools can **reduce upfront costs by 11 – 22%**
2. Additional operational benefits of **15 – 25% maintenance cost reduction & extended life / increased revenue**

Source(s): Energize Ventures Internal Data

Storage Soft Cost Reduction

Battery storage lifecycle soft costs are trending toward 30 to 50 percent of installed system cost. Soft cost drivers include system overdesign, high development and interconnection costs, ineffective O&M strategies.

In addition to TWAICE, a few other software companies are targeting soft costs:

Company	What is it?
TWAICE	Battery analytics software across the entire lifecycle
VOLTAIQ	Enterprise battery intelligence (EBI) platform
PowinEnergy	Grid-scale storage system integrator

Source(s): Energize Ventures Internal Data

Innovator Spotlight: TWAICE

Battery software is well-suited to streamline the iterative storage design and validation process.

TWAICE

Twaice

"**First** is having the right design system in place that can deliver the promised performance over the project lifetime.

Second is optimizing the actual use and leveraging the full capacity of the storage. We see many developers design battery systems in which 10% of battery capacity is not used during actual operation, which can be corrected by analytics.

Third, and most importantly, is forecasting the lifetime and total number of charge & discharge cycles a particular storage system can achieve."

-TWAICE CEO Stephan Rohr

Enhanced Storage Operations

Many batteries have been deployed within the past 10 years and have not yet operated through a full 20 to 25 year expected useful life. Battery systems cycled aggressively require replacement faster than expected, creating economic challenges due to battery pack replacement costs.

Innovative start-ups that can enhance storage operations:

Company	What is it?
TITAN ADVANCED ENERGY SOLUTIONS	Ultrasonic-based monitoring for batteries
ELEMENT ENERGY	Cell-level Battery Management System (BMS) for Lithium-ion batteries
RECURRENT	Electric car range reports for buyers, drivers and dealers

Ways to improve operations:

1. *Unlocking battery operating data to bring transparency to system health and remaining cycles*

2. *Preempting dangerous operating conditions — such as thermal runaway events — that can cause battery degradation or damage*

3. *Assessing credentials of batteries at the end of first life to quantify remaining capacity*

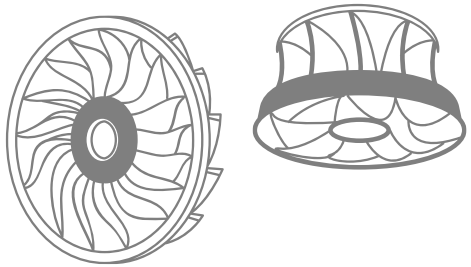
4. *Conducting real-time economic analyses that balance revenue versus costs for batteries actively participating in energy markets*

Source(s): Energize Ventures Internal Data

Clean, Firm Power Generation

Clean, Firm Power Generation

WHAT IS IT?



To complete the energy transition, we'll need a combination of technologies that can provide "clean, firm power" – non-intermittent, dispatchable electricity. Nuclear, hydropower, geothermal, biomass or biofuels, or natural gas plans paired with in-situ carbon capture and sequestration (CCS) are prime candidates.

WHY DOES IT MATTER?

Non-Intermittent Resource

Low carbon, resource based energy supply is abundant in the U.S. and can provide 24/7 power generation

Technological Maturity

Tech is available to produce low carbon energy but can supplemented with digital tech to improve operational efficiency

Compelling Economics

Economics have been proven out for low carbon production

ENERGIZE KEY TRENDS

Consistent supply

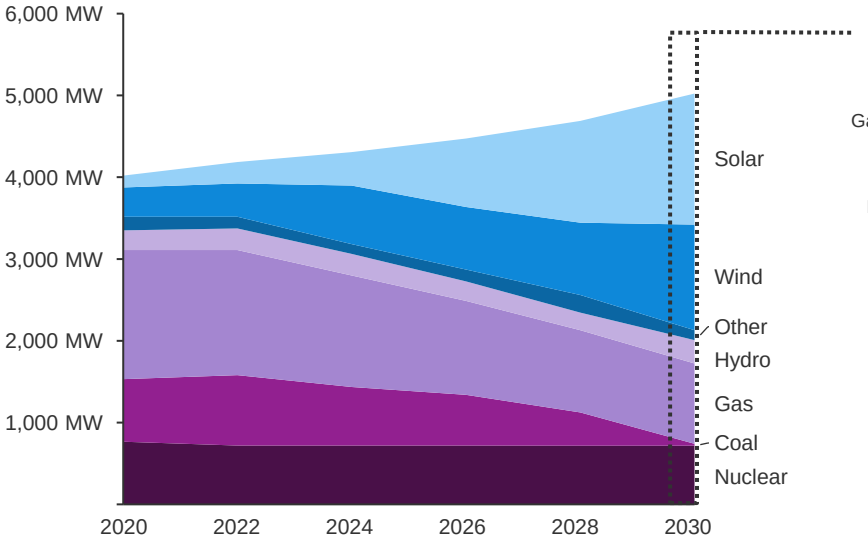
Capable technology

Long operating history

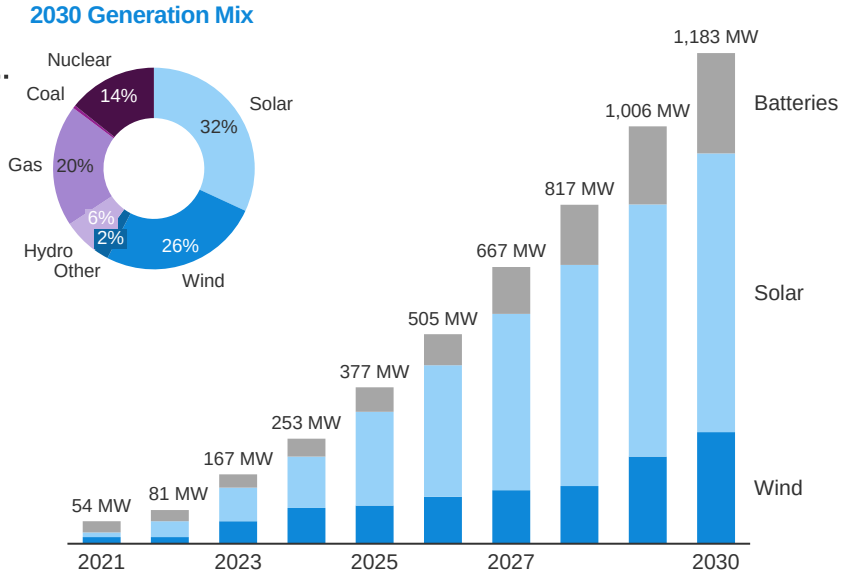
Solar + Wind + Storage are a Killer Combo, but not a Panacea

Solar, wind, and storage can decarbonize at least 80 percent of electricity. The remaining 20 percent will require “clean, firm power”: non-intermittent, dispatchable, low-carbon electricity.

Generation mix for the 80% Clean Case



Cumulative new capacity additions in the 80% Clean Case



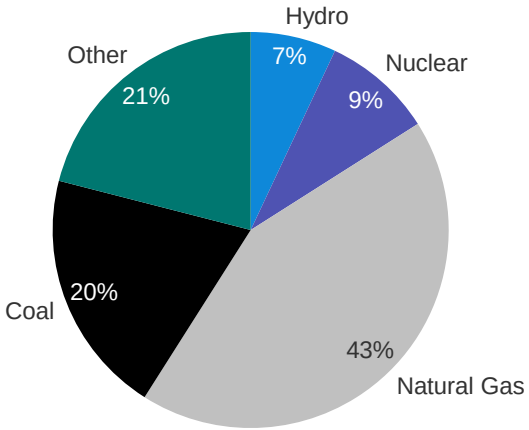
Source(s): Energy Innovation & Policy

Nuclear Energy

When it comes to nuclear power generation, simply keeping existing plants online is the key. Unfortunately, most existing nuclear plants are increasingly uneconomic as levelized costs have ballooned by 23% in the past decade while costs for alternatives like solar, wind and natural gas have plummeted. However, shutting down operating plants is incredible costly from an emissions standpoint.

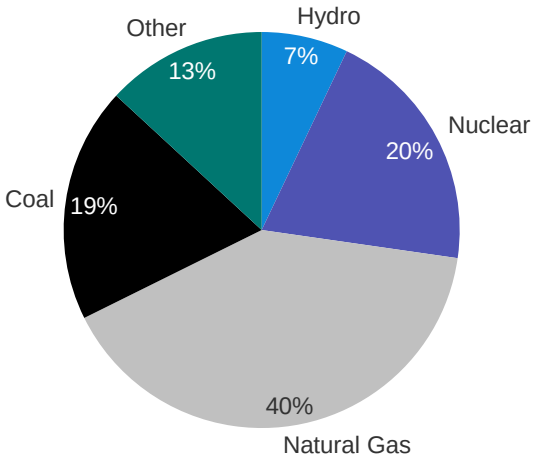
2020 Capacity

Total = 1.1 million megawatts

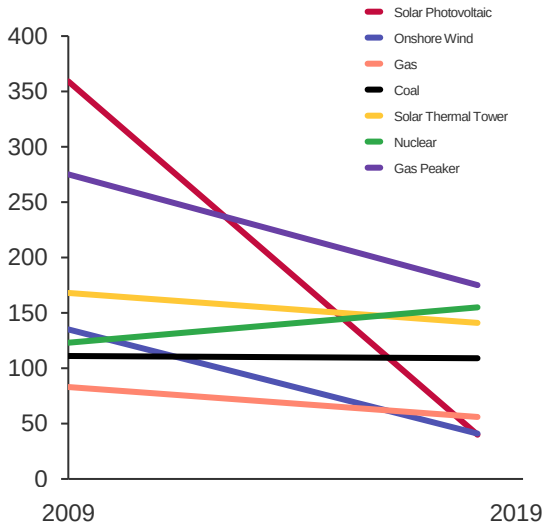


2020 Generation

Total = 4.0 billion megawatt hours



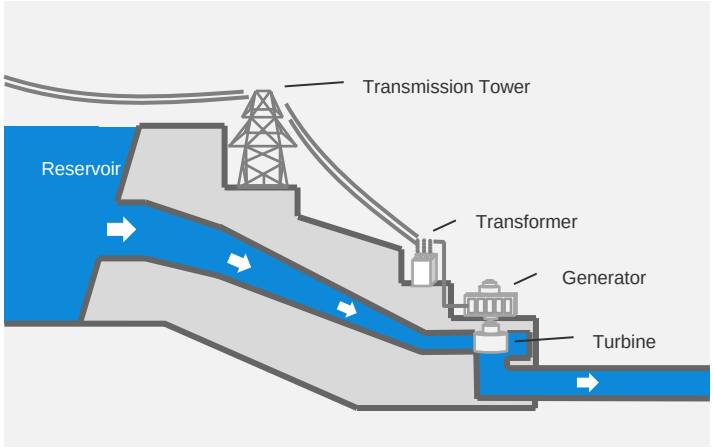
2020 LCOE of New Power Plants



Source(s): EIA, Lazard

Hydropower

Today, hydropower generates about 16% of the world's electricity usage.



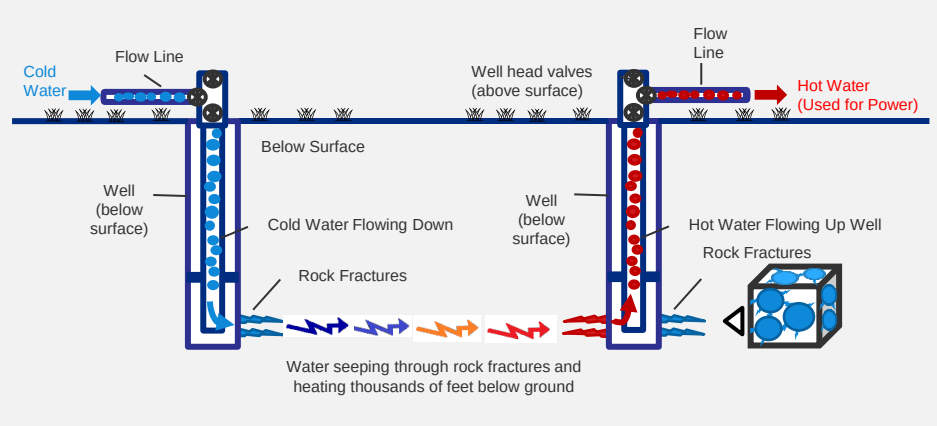
Impoundment plants consist of three parts: a reservoir of water, a dam to channel the water, and a turbine generator.

Water from the reservoir is released through the dam to generate power and meet electricity needs.

In fact, impoundment plants are incredibly efficient: modern hydro-turbines can convert as much as 90 percent of available energy into electricity. This is on-par with capacity factors for nuclear power, and twice that of typical gas and coal plants.

Geothermal

Existing existing technologies, the U.S. has been able to find and develop about 3 GW of near-surface geothermal power. However, now that the obvious resources have been tapped, we need to improve prospecting capabilities to scan the earth for less obvious reservoirs.



Geothermal projects must balance cost with resource quality. Drilling deeper to access better, hotter resources often increases the overall cost of the project.

The goal is to find a hot enough resource close enough to the surface so that the project economics make sense.

Using the earth as a heat exchanger, companies inject cold water into wells thousands of feet deep. The water is warmed by the heat of the earth, and then exits through a production well where it can be used to generate power.

Source(s): Energize Ventures Internal Data

Hydropower Technologies

Maintaining and monitoring asset performance is key to operating hydropower facilities. Companies like Natel Energy develop their own connected, fish-safe turbine generators that operate in shallow rivers and dispatch in coordinated fashion to provide distributed baseload energy.

Company	What is it?
Natel Energy	Fish safe turbine generator units and machine learning analytics for smarter operations and forecasting
ORPC	Low profile turbine generator units for river and tidal applications
Instream Energy Systems	Distributed, networked power generation units to generate and aggregate hydro-electric power

Geothermal

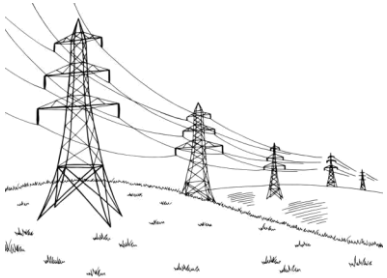
Easy-to-access geothermal resources have been exhausted. New software tools are needed to find and develop deeper and more complex locations. Companies like Zanskar are creating software platforms to improve prospecting for geothermal deposits.

Company	What is it?
ZANSKAR	Software platform to accelerate the discovery of geothermal resources
FERVO ENERGY	Developer of geothermal energy projects that leverage innovative subsurface drilling and completion methods
Eavor™	Closed-loop geothermal power facilities that circulate isolated working fluid

Transmission

Transmission

WHAT IS IT?



High-voltage power transmission lines move electricity via conductive materials across long geographical swaths with minimal loss of energy.

Transmission lines are key to transmitting electricity from oftentimes remotely located power generation sites to areas where the electricity is “stepped down” by transformers to distribution voltage, where it is then consumed.

WHY DOES IT MATTER?

Unlock Renewables

Increase U.S. renewable energy capacity by 3 – 5x with transmission in key regional corridors

Improve System Reliability

Diversify power generation resource type and region to increase system uptime across many conditions

Enable Electrification

Create domestic energy supply for rapid electrification of transportation, buildings and industrial processes

ENERGIZE KEY TRENDS

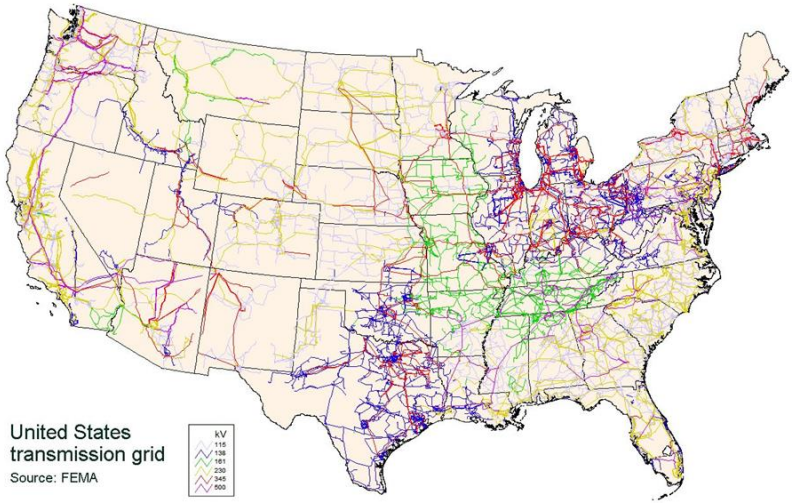
Digital to optimize existing transmission

Machine learning to plan new transmission

U.S. Transmission Grid & Interconnection Request Time

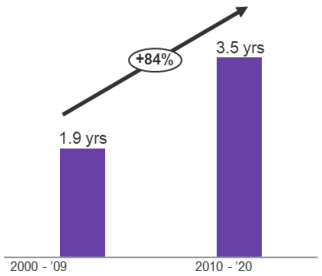
U.S. transmission interconnection time and cost is untenable to achieve decarbonization goals.

U.S. Transmission Grid By Voltage

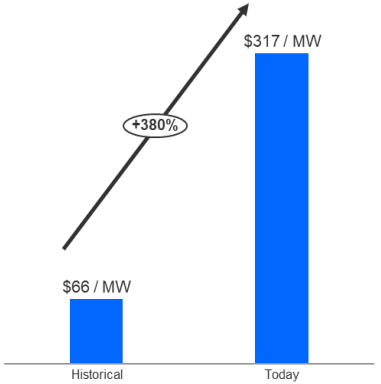


Interconnection Wait Time And Cost

Average Connection Wait Time, U.S. ISOs



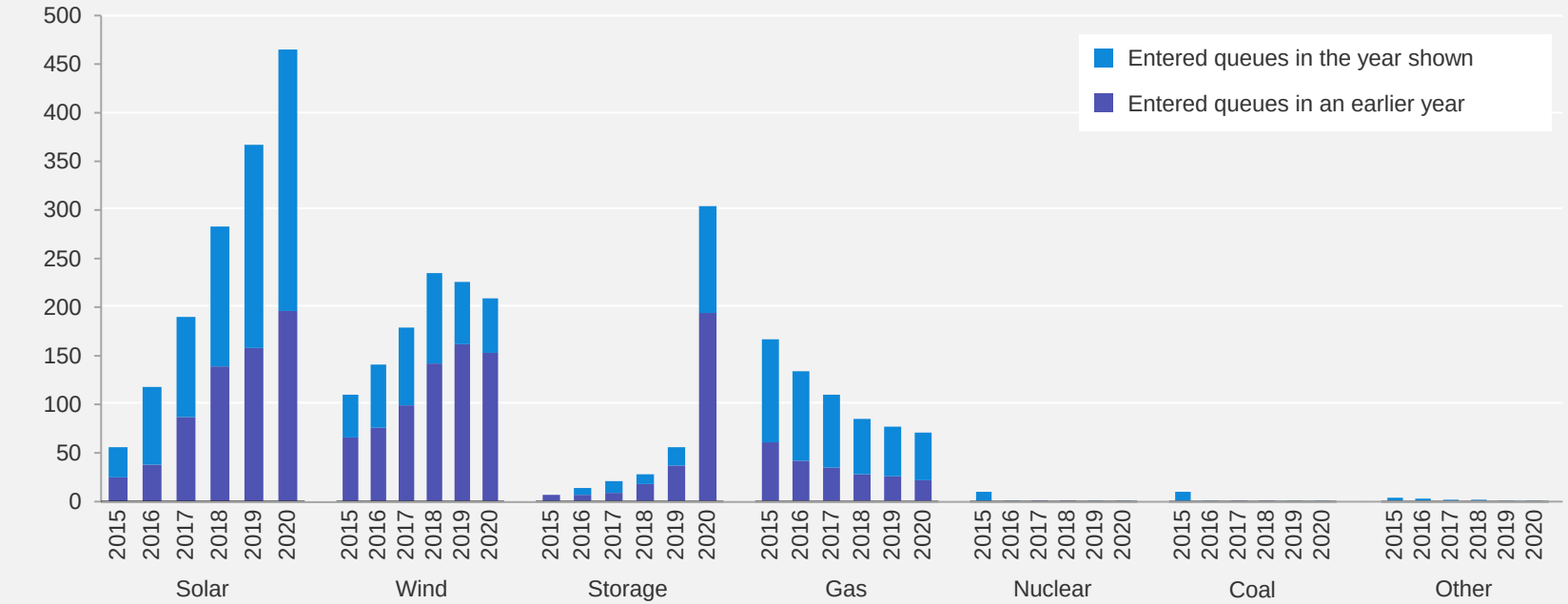
Wind Interconnection Cost, MISO



Source(s): Lawrence Berkely National Laboratory, FEMA, Americans for a Clean Energy Grid, Energize Ventures Internal Data

Capacities in Interconnection Queues are Mostly Wind and Solar

U.S. Transmission Interconnection Capacity in Queues at Year-End (GW)



Source(s): Lawrence Berkely National Laboratory, FEMA, Americans for a Clean Energy Grid, Energize Ventures Internal Data

Record Number of Wind & Solar Projects Seeking Grid Interconnection

As of the end of 2020, there were over 5,600 projects seeking grid interconnection across the U.S., representing over 755 GW of generation and an estimated ~204 GW of storage.

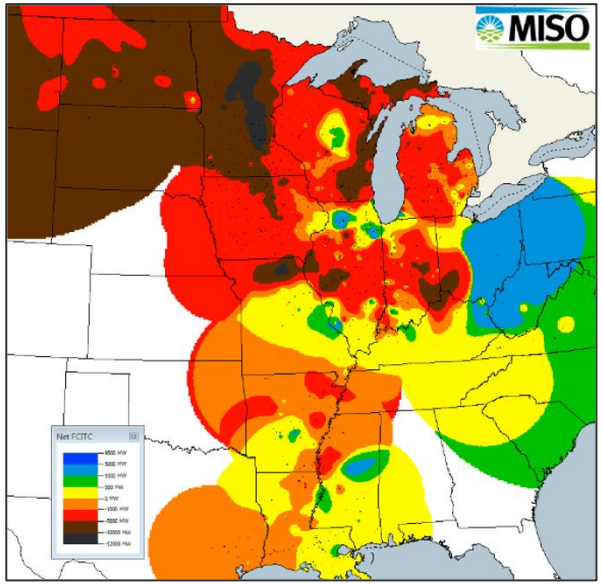
- **Solar (462 GW) accounts for >60% of all active generator capacity in the queues** though substantial wind (209 GW) and gas (74 GW) capacity is also in development. Notably, **29% of the wind capacity in the queues is for offshore projects** (61 GW).
- Considerable standalone (89 GW) and hybrid (~112 GW) battery capacity is also in development, along with 4 GW of other storage.
- Growth in proposed solar and storage capacity is consistent across regions. Proposed wind has contracted in some regions, but continues to grow in those with proposed offshore development. **Gas is declining in all regions except for non-ISO Southeast.**
- **Hybrids now comprise a large – and increasing – share of proposed projects**, particularly in CAISO and non-ISO West. 159 GW of solar hybrids (primarily solar + battery) and 13 GW of wind hybrids are in the queues.
- The vast majority (71% of capacity in the queues has requested to come online by the end of 2023, and some (13%) already has an executed interconnection request.
- **The time projects spend in queues before reaching COD may be increasing**. For the four ISOs studied, the typical duration from IR to COD went from ~1.9 years for projects built in 2000-2009 up to ~3.5 years for those built in 2010-2020.
- **More than half (671 GW) of the estimated 1,100 GW of wind and solar capacity needed to approach a zero-carbon electricity target is already in development.**
- **Ultimately, much of this proposed capacity will not be built. Historically, only ~24% of projects in the queues reached commercial operations, and less for wind (19%) and solar (16%).** There are growing calls for queue reform to reduce cost, lead times, and speculation.

Source(s): Lawrence Berkely National Laboratory, FEMA, Americans for a Clean Energy Grid, Energize Ventures Internal Data

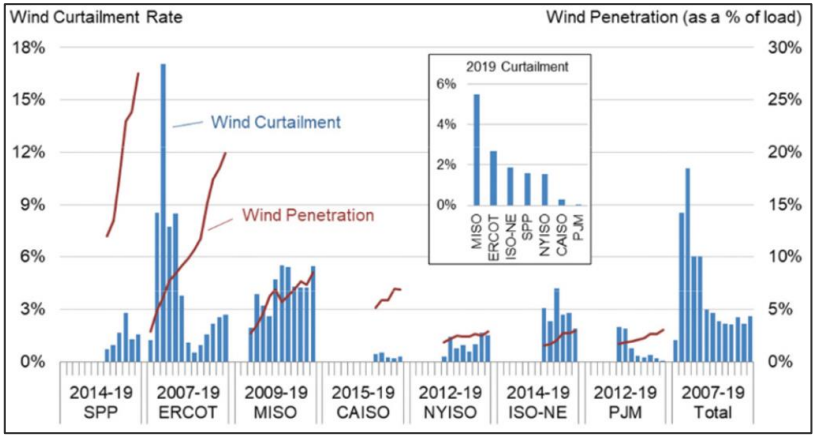
Wind Penetration and Curtailment Across the U.S.

Wind penetration (and curtailment) has been increasing across power markets over the last decade.

Net MW First Contingency Incremental Transfer



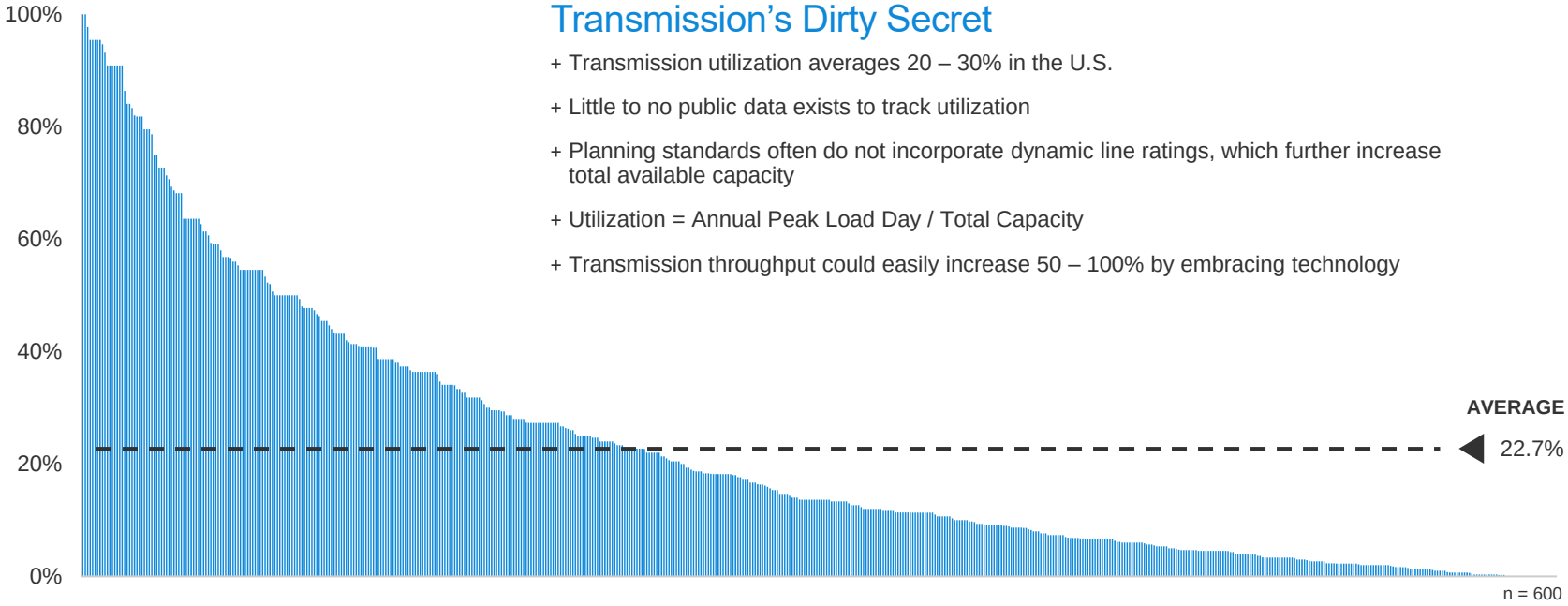
Wind Curtailment and Penetration



Source(s): ERCOT, MISO, CAISO, NYISO, PJM, ISO-NE, SPP

Transmission Capacity is Structurally Underutilized

Transmission Capacity Utilization by Line for an Unnamed RTO



Transmission's Dirty Secret

+ Transmission utilization averages 20 – 30% in the U.S.
+ Little to no public data exists to track utilization
+ Planning standards often do not incorporate dynamic line ratings, which further increase total available capacity
+ Utilization = Annual Peak Load Day / Total Capacity
+ Transmission throughput could easily increase 50 – 100% by embracing technology

Source(s): Energize Ventures Internal Data

Top Automation-based Solutions to Optimize Existing Transmission

There are over 600,000 miles of existing transmission lines in the U.S. that can be optimized for increased capacity in lieu of building new, expensive transmission infrastructure.

Company	What is it?
LINEVISION	Advanced sensors and analytics to optimize power and pipeline transmission
newgrid	Transmission congestion monitoring and mitigation software
SMART WIRES	Grid automation equipment to increase transmission line transfer capacity
IRIS AUTOMATION	Beyond Visual Line of Sight (BVLOS) drones for transmission line inspection

Source(s): Energize Ventures Internal Data

Innovator Spotlight: Linevision

Linevision develops non-contact transmission monitoring systems designed to improve the utilization, efficiency, flexibility, and safety of high-voltage power lines.

Linevision

"We will need to build new inter-regional transmission lines, but to have any shot of reaching our energy transition goals, we also need to get the most out of the power grid we've already built by leveraging grid enhancing digital technologies like DLR."

- Hudson Gilmer,
CEO, Linevision

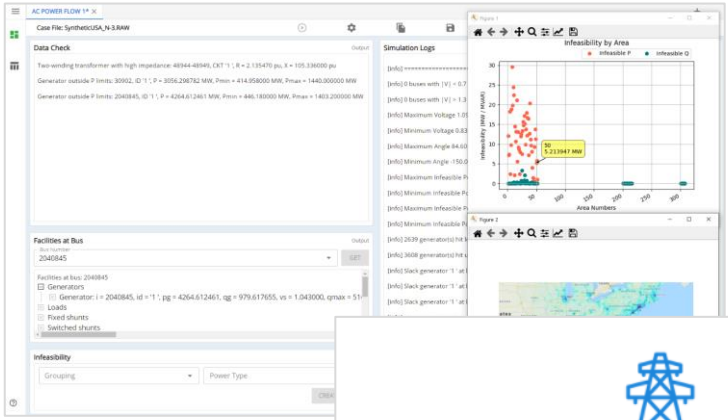
Top Software Companies to Streamline New Transmission

New software companies are helping expedite the buildout of power infrastructure.

Company	What is it?
Pearl Street TECHNOLOGIES	Simulation, optimization, and design platform for power grid planning
envelio	Software to automate grid integration analysis of renewables and DER
neara	Physics-enabled platform to build 3D interactive models of critical infrastructure networks and assets
sensat®	Visualization platform designed to capture, visualize and track infrastructure projects from anywhere
prisma photonics	Helps utility operators to keep critical infrastructure running using existing optical fiber.

Innovator Spotlight: Pearl Street Technologies

Pearl street helps ISOs, utilities, and developers model extreme events, interconnections, and plan expansions and renewable asset siting.



Pearl Street TECHNOLOGIES

Make the most of existing facilities to address reliability needs.

SUGAR™ finds power flow solutions that best utilize available capacity without triggering reliability violations.

Pearl Street Technologies

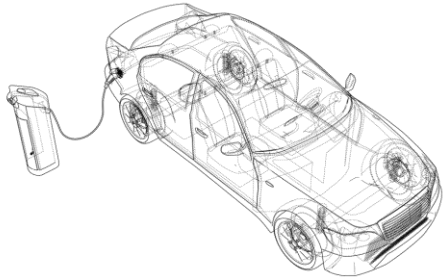
"Clearing queue backlogs across the nation is a complicated equation, but one we need to solve to ensure there is enough renewable energy to power our electrified future. Pearl Street is excited to contribute to the solution by advancing the reliability modeling component of the equation -- both how it's done today and how it will be done tomorrow."

-David Bromberg, CEO, Pearl Street

EV Charging

Electric Vehicle (EV) Charging

WHAT IS IT?



Electric vehicle (EV) charging is the next generation fueling infrastructure, providing electricity as energy for transportation.

23% of U.S. energy production is used for transportation. Shifting to EVs will represent the largest energy transformation in 100 years, as demand for transportation fossil fuels is replaced by renewable electricity.

WHY DOES IT MATTER?

Dominant Emissions Driver

Transportation recently surpassed power as the U.S.'s largest source of GHGs; faces a difficult path to net zero due to slow replacement cycles

Massive Transfer of Energy Demand

Trillions of market cap + billions in annual revenue are concentrated transportation fossil fuels, creating a generational value shift opportunity

Local, Resilient Fueling Infra

Widespread, local electric "fueling" is a natural security imperative that will materially reduce our reliance on foreign energy supply chains

Source(s): Energize Ventures Internal Data

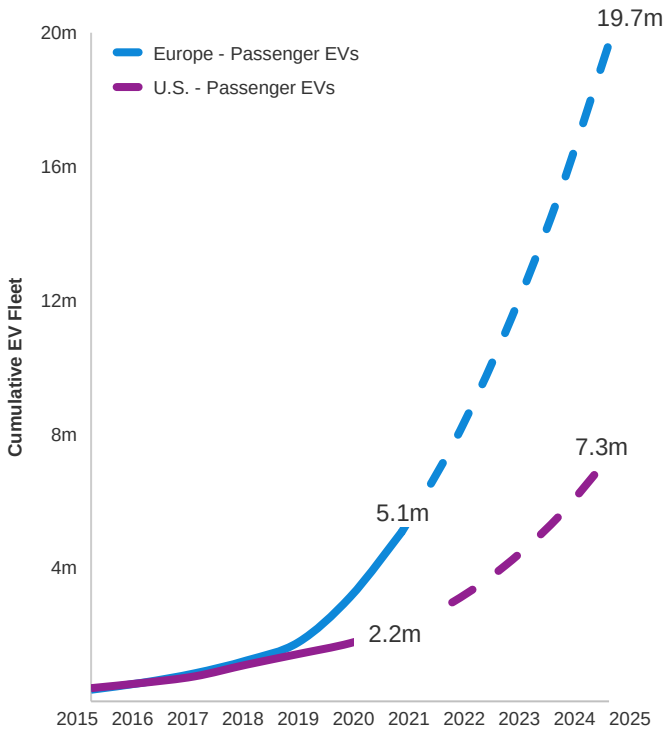
ENERGIZE KEY TRENDS

Optimal charger siting

Smart charging

Transaction volume explosion

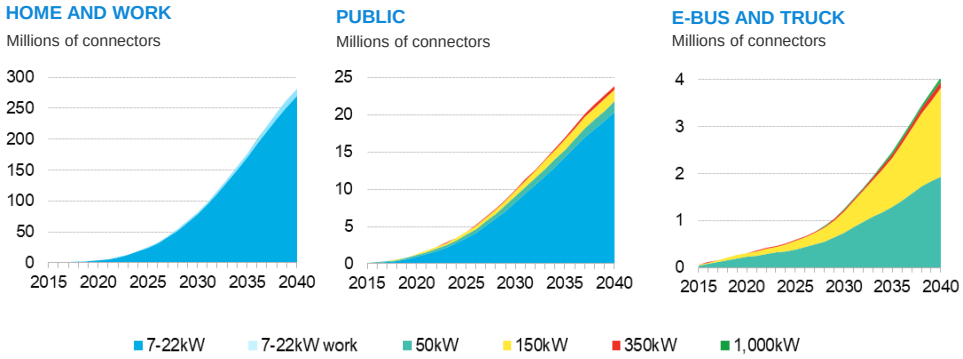
Why Now: Massive Growth of EVs and EV Charging Ahead



Annual Global EV Charging Investment Required by 2030

HOME	PUBLIC	WORK
$17.5b	$16.3b	$1.8b

Global EV Charging Connections by Location

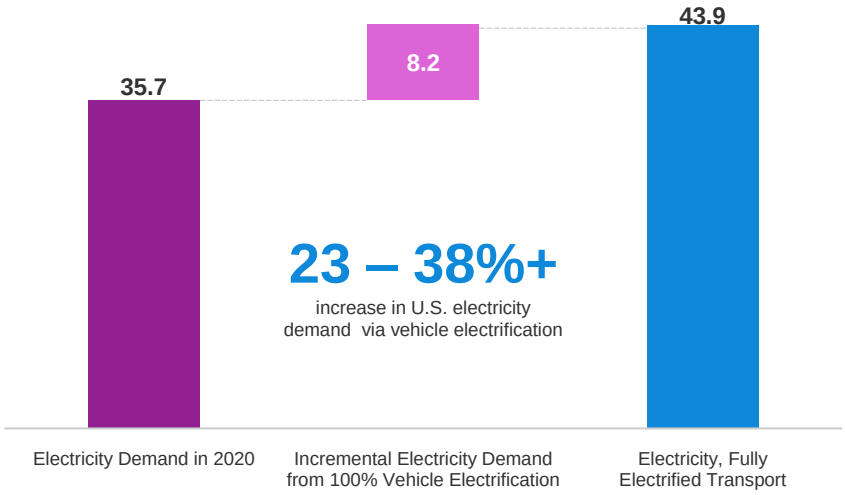


Source(s): BNEF Long Term Electric Vehicle Outlook 2021, Economic Transition Scenario

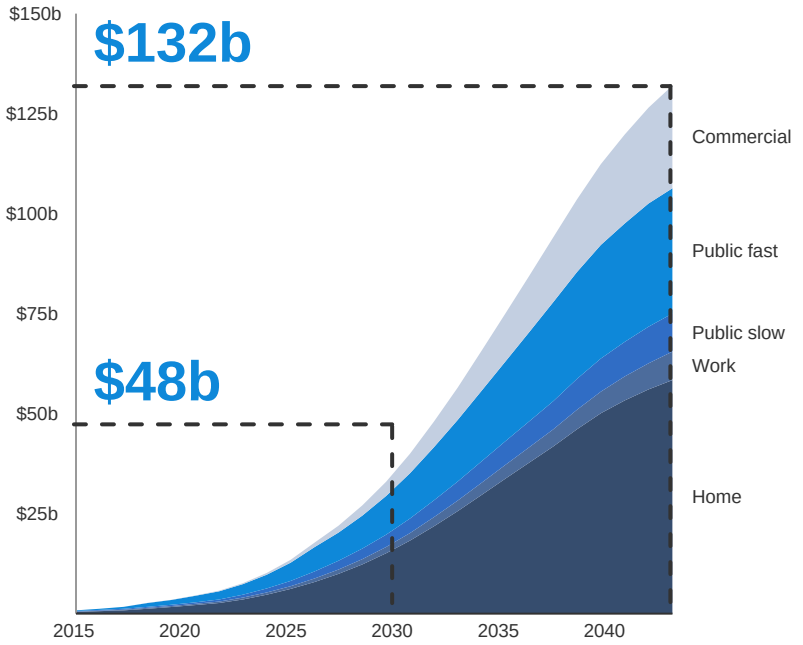
U.S. Electricity Demand & EV Charging Investment from Vehicle Electrification

U.S. electricity demand increases by 23 – 40%+ from EVs, creating a $125b EV charging infrastructure investment boon

U.S. Electricity Consumption, 2020 (quadrillion Btu)



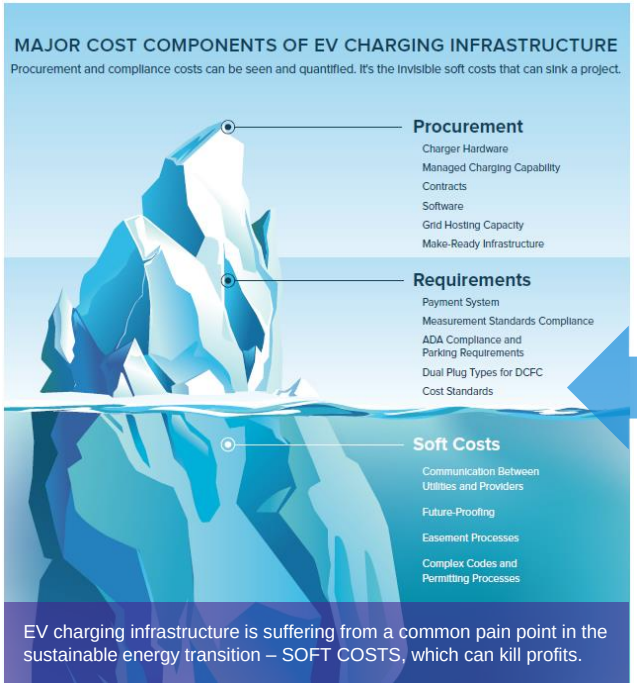
U.S. Cumulative EV Charging Infrastructure Investment



Source(s): Energize Ventures Internal Data, DOE, Bloomberg New Energy Finance (BNEF)

Optimal Siting for EV Charging Infrastructure

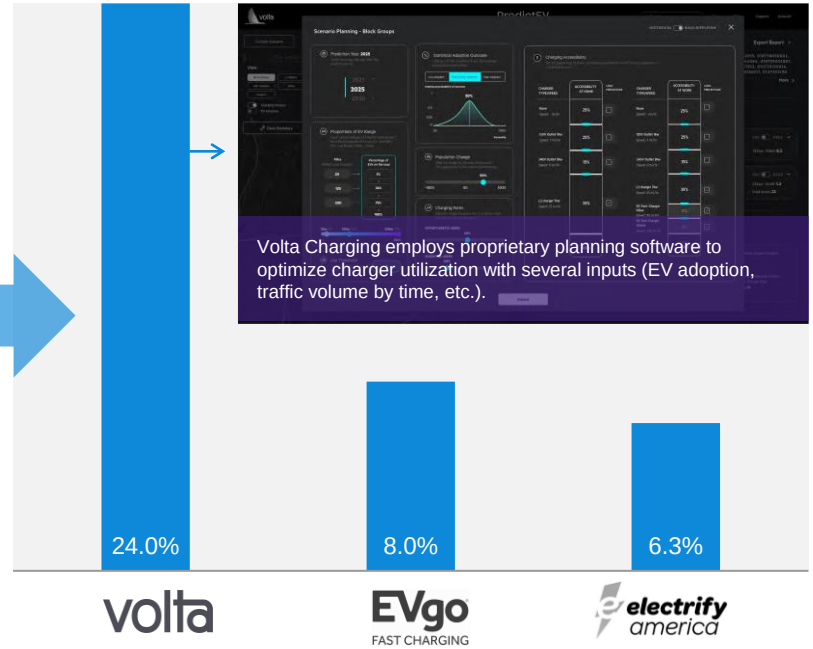
Data-driven EV charging siting reduces soft costs and maximizes utilization, the keys to capital efficient deployment.



HIGH **upfront cost** + LOW **utilization** = **profit** KILLER

?

EV Charging Network Utilization Rate by Provider



Source(s): Rocky Mountain Institute, Citibank

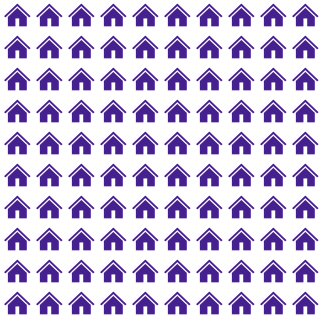
Unmanaged EV Charging Power Grid Impact

EV charging could increase peak electricity demand on local grids by 15 – 50%+, necessitating expensive grid upgrades.

EV charging software matters because our grid can't support EVs at scale

350 kW

Peak DC fast charging speed for consumer cars



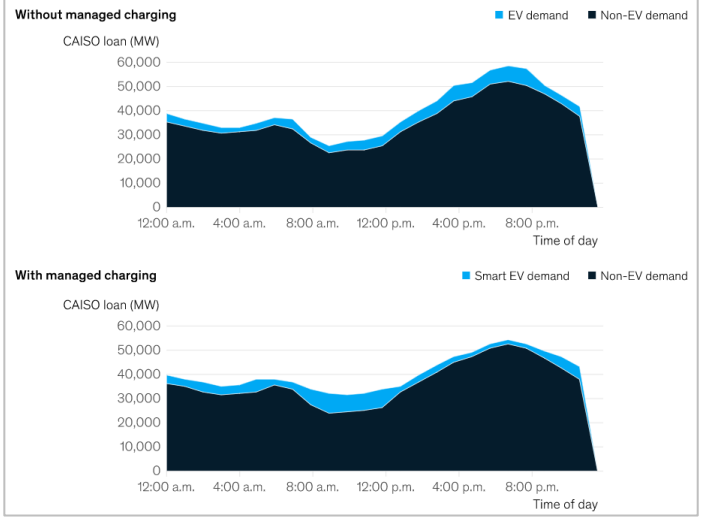
300 kW

Peak load of 100 single family homes (avg. load = 1.2 kW per house)

Source(s): McKinsey, ChargeLab

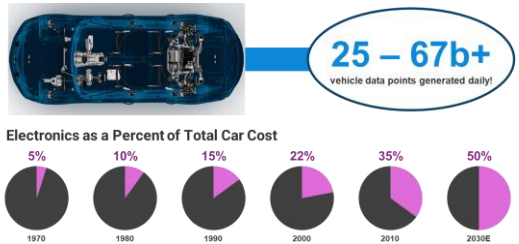
By controlling charging time, duration, and intensity, managed charging can optimize power consumption.

Energy management solutions provide monetizable site and grid services
CAISO[1] illustrative 2031 grid profile with and without managed charging



Variability & Volume of Transactions Increases 10 – 20x for EV Charging

Electric transport will cause exploding transaction volume



+

~40

annual "fueling" transactions

1,000+

annual "fueling" transactions

Emerging Electric Vehicle IT Stack

- **Software + Applications**
  - Smart Charging
  - Demand Response
  - Battery Warranty
  - Vehicle Mile Tax
- **API & Data Acquisition**
- **Communications**
- **Compute**

Source(s): Energize Ventures Internal Data, IEEE (How Software is Eating the Car)

EV Charging Value Chain / Market Map

Source(s): Energize Ventures Internal Data

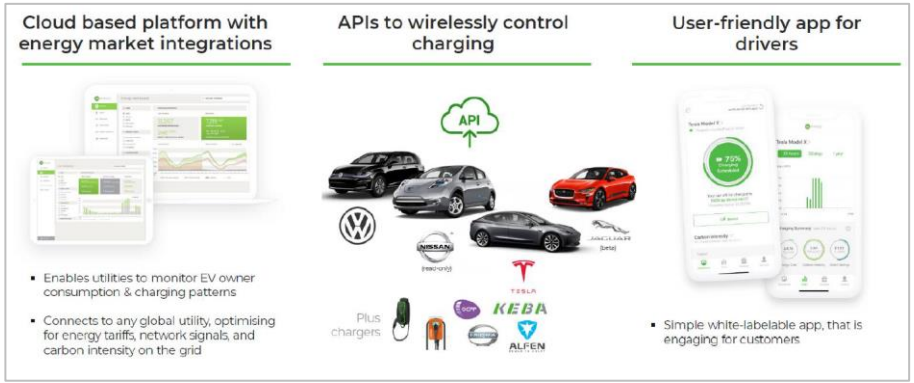
Smart and Managed EV Charging Software

EV charging's impact on the power grid and energy markets could run amok without software solutions that match demand, price signals and supply, while minimizing power grid upgrade needs.

Company	What is it?
ev.energy	Smart electric vehicle charging software
WeaveGrid	Electric vehicle grid integration software
CHARGELAB	Operating system for electric vehicle chargers
optiwatt	Consumer facing smart electric vehicle charging application

Innovator Spotlight: ev.energy

Smart EV charging software as a service helps consumers save money and utilities mitigate grid impact.



Ev.energy - Energize Ventures View

ev.energy's software platform enables utilities to seamlessly deploy managed EV charging programs. Their solution reduces wholesale electricity costs by 35% for utilities and saves EV drivers hundreds of dollars per year in electric bill increases.

Over 30K drivers have registered for ev.energy enabled applications across more than 17 energy companies. A software company like ev.energy that can accumulate a wide user base and sufficient channel via energy partners is well-positioned for success.

Source: ev.energy

EV Charging Transaction and Data Infrastructure

Electric vehicles will produce 25x transaction volume and significantly more data than combustion vehicles, creating a platform opportunity to facilitate and streamline the added complexity.

Company	What is it?
smartcar	Connected and electric vehicle API platform
MONTA	Electric vehicle charger network, billing, and payment management software
enode	Electrical equipment API (including electric vehicles)
evconnect	Diversified set of EV charging network software and services

Source(s): Energize Ventures Internal Data

Innovator Spotlight: Smartcar

Electric vehicle APIs enable software applications to minimize grid impact, manage EV fleets, etc.

Smartcar

Software & Connectivity Will Personalize the EV Experience

“EV owners are generally early adopters and ahead of the curve compared to other traditional vehicle owners. If you drive an EV, there’s a higher likelihood that you see the OEM app on your phone as an extension of the driving experience and you look for third-party apps to enhance it.Nearly all EVs shipped today offer connected services and, with 5G emerging, we’ll see faster connections and less latency. This makes it easier to enable more complex APIs to become available, opening the doors for developers to build even richer and more creative apps for cars and their drivers.”

-Smartcar CEO, Sahas Katta, InsideEVs

Building Electrification

Building Electrification

WHAT IS IT?

Building electrification is the transition of key building energy systems such as lighting, HVAC & plumbing to consume electricity rather than fossil fuels (gas or diesel) as an input.

Buildings account for 10% of U.S. GHG emissions. Renewable electrification can remove a significant portion of building emissions while also reducing ongoing operating costs.

WHY DOES IT MATTER?

Major Driver of Energy Demand

Building energy consumption from lighting, cooling, and plug loads (computers) will rise rapidly; pairing with renewables is key

Reduce Building Operating Costs

Improve building operations by optimizing systems that consume electricity

Reduce Local Pollution

Electrifying buildings and optimizing building energy systems can reduce particulate pollution and improve city air quality

ENERGIZE KEY TRENDS

Go-to-market leverage via existing decision channels

Building optimization systems with < 3-year payback

Source(s): Energize Ventures Internal Data

Why Now? The Factors Influencing Building Electrification

Digital Technology

- New innovations in IoT connectivity, AI, and ML have created opportunities to electrify buildings and operate electrical equipment at orders of magnitude lower cost

Market Demand

- Consumer and business building residents are demanding climate friendly goods and services
- The cost of on-site electrical production (solar + storage) has fallen in comparison to natural gas for building use and will continue to become more competitive as US gas infrastructure ages
- Renewable natural gas (RNG) is expensive and limited in being an alternative

Policy and Regulation

- Across the U.S. over 50 cities / counties have proposed or enacted restrictions on natural gas in residential homes (primarily in California, New York, Massachusetts, and Washington)
- Additional states have set GHG reduction goals and targets ever since the U.S. first established a national GHG reduction goal in 2009
- Convenings like the COP26 and the U.S. return to the Paris Accord may influence a renewed focus on climate in national and local policies, such as the provisions and funding proposals in the latest Senate infrastructure bill.

Why Now? Buildings Have Become a Key Focus Across Stakeholders

Local / Regional Mandates

- Regulations on building emissions, design, and efficiency standards
- **California**: LA's Green New Deal and Buy Clean California
- **New York**: Local Law 97
- **Chicago**: Retrofit and Commercial Buildings Initiative
- **UN**: Sustainable Buildings Initiative

Real Estate Investor Focus

- **Prior Strategy:** grow AUM to increase returns
- **Current Strategy:** higher quality deals to drive ROIC
- **Invest in projects designed to generate return on investments**

Evolution of Product Offerings

- Design needs have evolved **beyond aesthetics**; tools must evolve too
- Purpose has shifted toward design for longevity, **sustainability, and minimizing consumption**
- Collaboration across **architects, engineers, and contractors** will be required to meet these needs

Market Consolidation

- The TAM is **large**, but players are **fragmented**
- Forced consolidation to gain customer access
  - **Trimble**: SketchUp, Sefaira
  - **Procore:** Honest Buildings
  - **Autodesk:** Spacemaker, PlanGrid

The Benefits of Building Electrification

Definition and Background

Building decarbonization focuses on the electrification of building processes that heavily rely on fossil fuels. Processes such as heating, cooling, cooking, and ventilation account for most of the building sector's GHG emissions.

70 Million

American homes and businesses burn fossil fuels. Over 500,000 new buildings built every year.

Benefits of Building Electrification

Cleaner air

More affordable housing

All-electric homes cost less to build/operate than homes with natural gas

Lower utility bills

Improved public health

Safer buildings

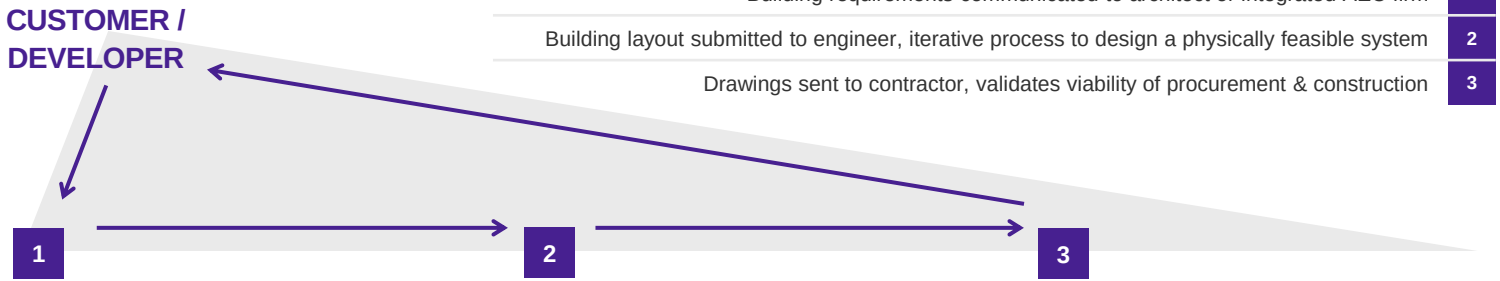
During natural disasters, all-electric buildings are not exposed to gas leaks and related fires

Minimize climate impact

Source(s): EIA

Building Design Has Silos, Especially in Sustainability

Historical Approach to Building Design



1. Building requirements communicated to architect or integrated AEC firm
2. Building layout submitted to engineer, iterative process to design a physically feasible system
3. Drawings sent to contractor, validates viability of procurement & construction

	ARCHITECT	ENGINEER(S)	CONTRACTOR
Primary Objective	Building design, form, function and comfort optimized for occupant intended use.	Building structural, energy (mechanical / electrical), water & waste systems physical work.	Building materials and equipment can be procured and constructed / installed in an efficient manner.
Software	SketchUp, REVIT, GRAPHISOFT Archicad	AUTOCAD, MATLAB, SOLIDWORKS	Excel, PlanGrid, PROCORE

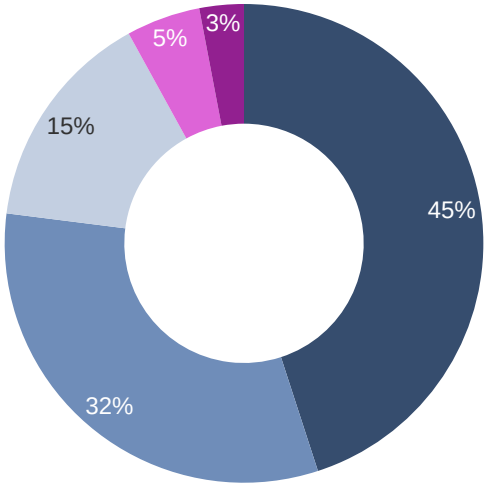
CHALLENGES

- SILOED
- NOT OPTIMIZED FOR ENERGY
- MANUALLY INTENSIVE, COSTLY

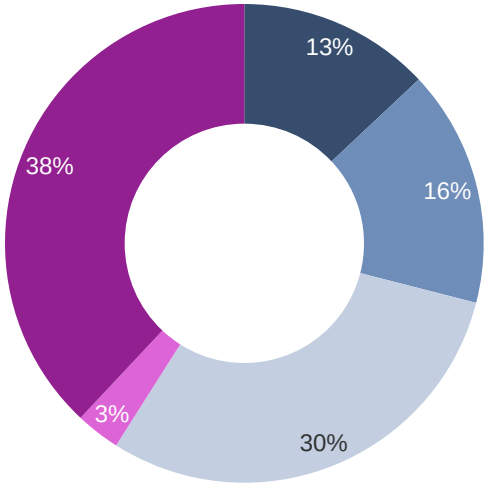
Drivers of Building Emissions via Energy End-Use

Electric heat pumps, water heaters, induction cooking, efficient lighting can rapidly decarbonize buildings.

Building Energy Consumption by End-use, Cold Climate



Building Energy Consumption by End-use, Warm Climate



Space heating | Appliances | Water heating | Air conditioning | Cooking

Source(s): World Resources Institute

Sustainable Building Market Map

ENERGIZE VENTURES

	Building Design & Construction	Building Operation & Management
Software	cove.tool, HYPAR, Prescient, Higharc, MODUMATE, PLANHIMPACT, NODES & LINKS, sefaira, ALICE TECHNOLOGIES	aquicore, enertiv, cohesion, measurabl, LOGICAL BUILDINGS
Hybrid	DOXEL, OPENSPACE, CARBON LIGHTHOUSE, IRISVR, DUSTY ROBOTICS, PassiveLogic	runwise, COI ENERGY, REDAPTIVE, sparkfund, enerbrain, BLOC POWER, parity, vutiliti
Hardware	Advanced Construction ROBOTICS, TOGGLE, BUILT ROBOTICS, KEWAZO, CANVAS, Construction Robotics	75F, TURNTIDE by Software Motor Company, TREAU, SAPIENT

Source(s): Energize Ventures Internal Data

Building Electrification Technologies

New software and service companies offer solutions to improve building efficiency from design to construction to operation.

Company	What is it?
75F	Developer and manufacturer of smart building automation systems created to optimize and save energy consumption.
runwise	Unique wireless control, sensor network and software platform to operate building heating and other operational systems better
PassiveLogic	Hardware + software building control system for new buildings to optimize energy efficiency
cove.tool	Automated performance analysis platform designed for AEC professionals to design energy efficient buildings.
BLOC POWER	No money down all electric heating, cooling, and hot water systems to building owners

Innovator Spotlight: Passive Logic

Easy-to-configure building control system enabling building energy efficiency improvement at the source.

PassiveLogic

Passive Logic

The Passive Logic Hive controller leverages edge computing to enable real-time automation and control of the building's energy equipment.

Passive Logic's control system minimizes sensor commissioning time by 90% and optimizes the building system in real-time without weeks of tuning and tweaking.

Source(s): PassiveLogic

Innovator Spotlight: Runwise

Wireless control, sensor network and software platform to operate building heating systems better.

Runwise

Runwise makes dumb buildings operate smart, saving money and reducing emissions along the way. They provide a custom-developed wireless computer + sensor that is stupid simple to install in order to monitor and control building systems. Runwise optimization software that reduces heating costs by at least 20% with an average all-in payback of 7 – 8 months.

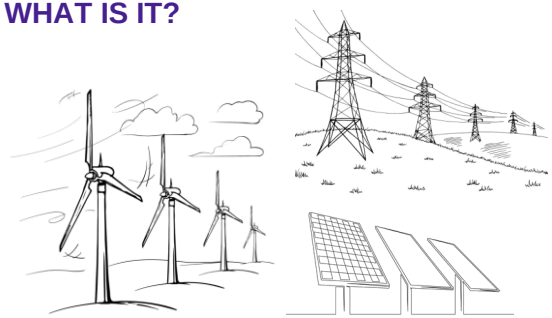
While starting with heating, Runwise will add water, cooling and other building operations capabilities in the coming few years. Runwise is in 4,100 buildings to date with an aggressive goal targeting the remaining 12M.

Source(s): Runwise

Demand Flexibility

Demand Flexibility

WHAT IS IT?



Demand flexibility is the use of technology and market mechanisms to shift electricity use across different times of day while maintaining quality and reliability of the grid.

Demand flexibility enables full utilization of power equipment and infrastructure while better aligning electricity demand to match renewable energy production.

WHY DOES IT MATTER?

Massive, Sleeping Grid Resources

Grid resources are under-utilized and under-monetized for T&D utilities, wholesale markets and electricity consumers

Self Consume Distributed Generation

Self consuming distributed generation is becoming an increasing priority to combat grid constraints

Reshape Load Curves

Demand flexibility will reshape load curves to manage costs and match consumption to renewable energy production

ENERGIZE KEY TRENDS

Technology-enabled DER market access

Machine learning to reshape load

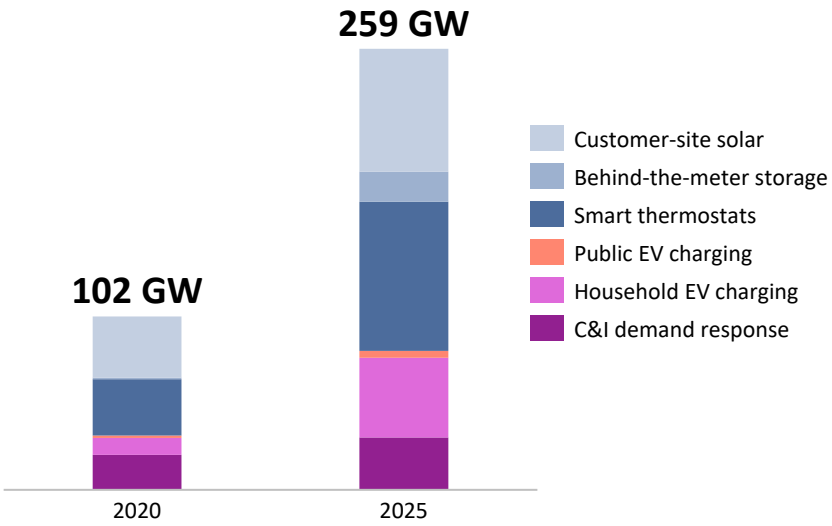
Why Now? DER Management Software

1 TW+
Global DER Capacity by 2025

$900B+
Global Annual Revenue Generated by DER in 2025

+16%
DER Market CAGR through 2025

U.S. Cumulative DER Capacity by Type, Estimates



Source(s): Energize Ventures Internal Data, BNEF, SEIA

DER software market forces at work …

DER for resiliency goes mainstream
DER adoption is expected to dramatically grow globally through 2025 as costs continue to decline and new purchasing reasons, such as resiliency and emissions reduction, increase willingness to pay

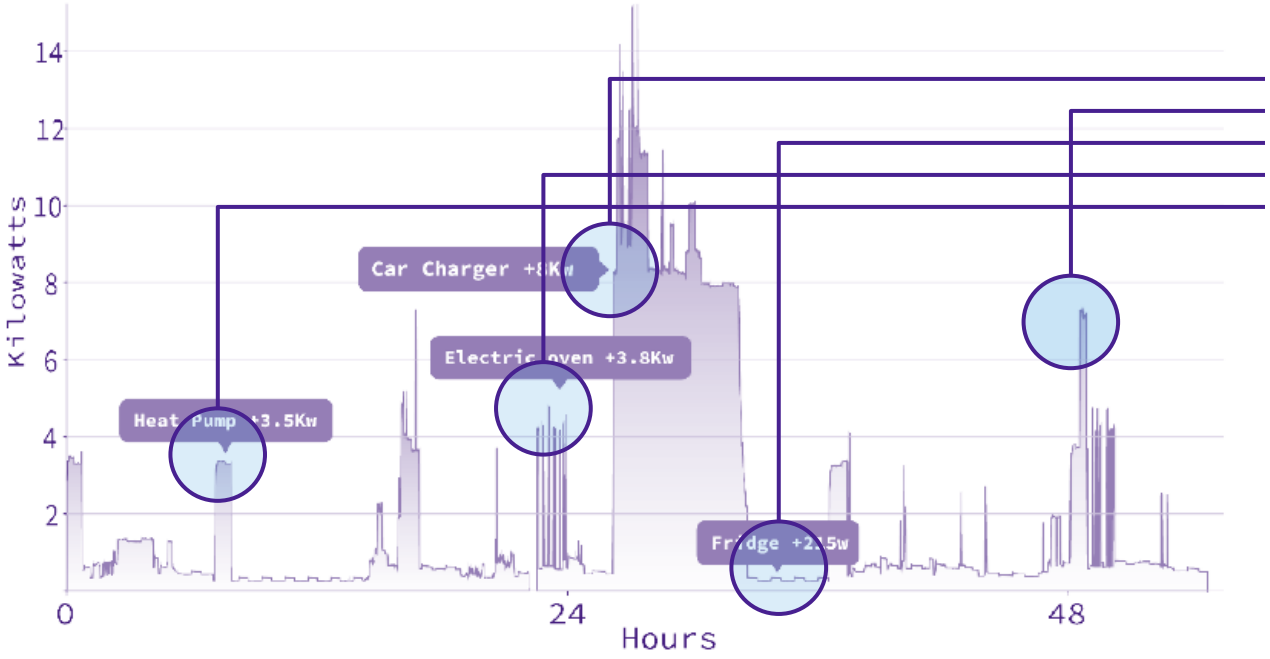
Interconnection a mounting problem
DER connection volume continues to increase, causing mounting delays and costs ultimately born by both DER and utility customers

DER x grid interface increasingly complex
Grid modeling & operational complexity is dramatically increasing as the volume of DER connections increases and utilities deploy grid automation devices to help integrate DER w/ real-time control

1st generation competition consolidating
Early DER software co's (started from 2010 – 2016) are being acquired by corporate owners, facing slow growth, or shutting down – leaving behind a significant revenue capture opportunity to new entrants

Next gen software start-ups, aligned to revenue
New wave (Envelio) have refined product-market fit, built scalable software (not consultancies) to better align to clear business value today, for example – accelerating revenue for DER providers

Example Electrified Home Energy Demand Profile

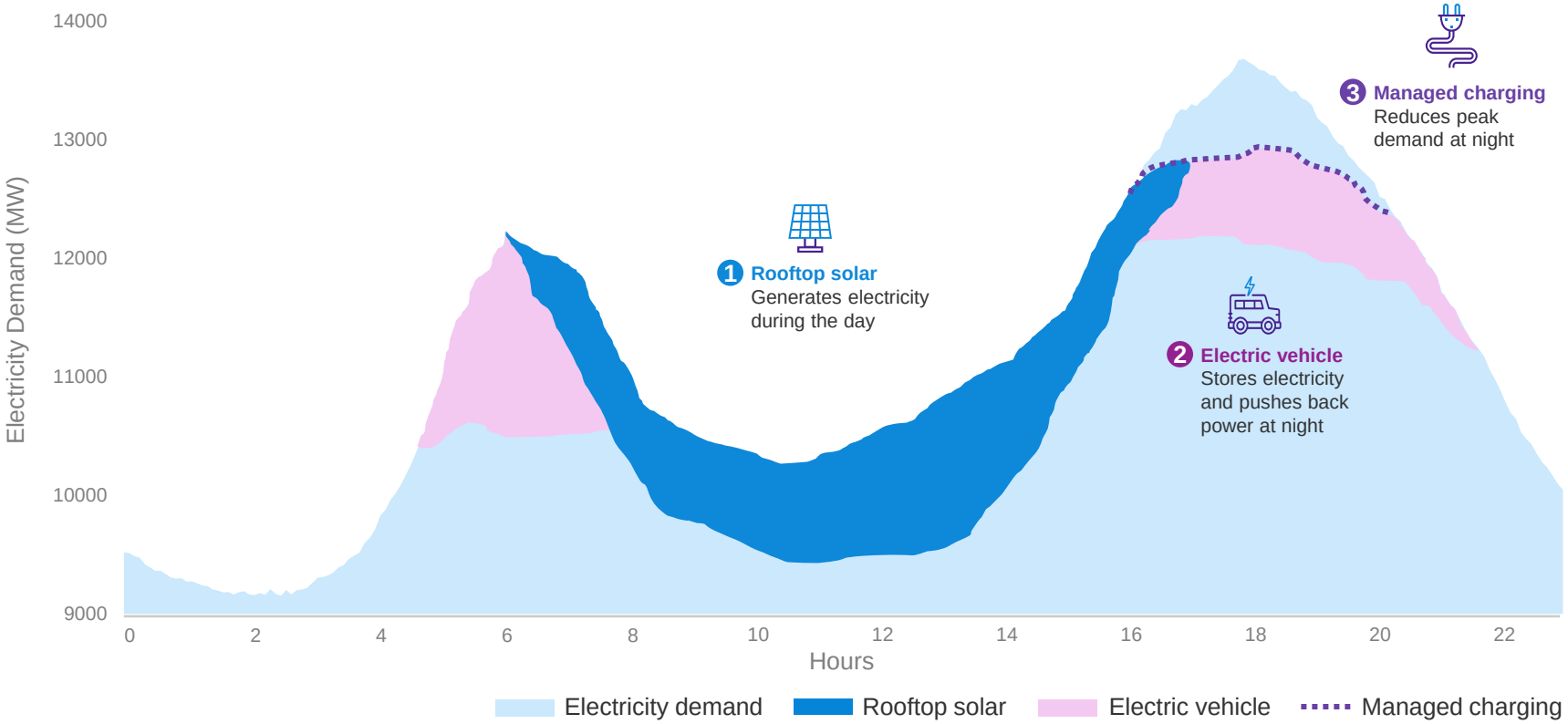


A fully electrified home will not only increase overall electricity consumption, but create a **"spikier" electricity demand profile.**

If left **unmanaged, electricity costs could balloon for consumers**. However, with the appropriate **DER software and market innovation** … "**flexing" distributed energy equipment could enhance rather than inhibit** DER economic payback.

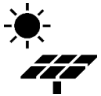
Source(s): Rewiring America

How DERs can Support a Flexible Grid



Note: 1. ISO-NE data for 10/1/2022 used as baseline electricity demand

Interconnection is a Soft Cost Driver

DER Type	Soft Costs as % of Total	Interconnection Time	Interconnection Cost
 **Distributed Solar**	55 – 64%	1 – 3 months	Residential: $1 – 2K Commercial: $50K – $1M+
 **EV Charging**	75 – 83%	5 – 12 months	L2: $5 – 20K DCFC: $60 – 100K+
 **Battery Storage**	30 – 50%	1 – 2 years	$600K – 1M *20 MW / 60 MWh battery*
 **Utility-scale Renewables**	30 – 40%	3 – 4 years	$6M *200 MW plant*

Source(s): Energize Ventures Internal Data, NREL, LBNL, RMI, Electrify America

FERC Order No. 2222

Timeline for ISOs / RTOs

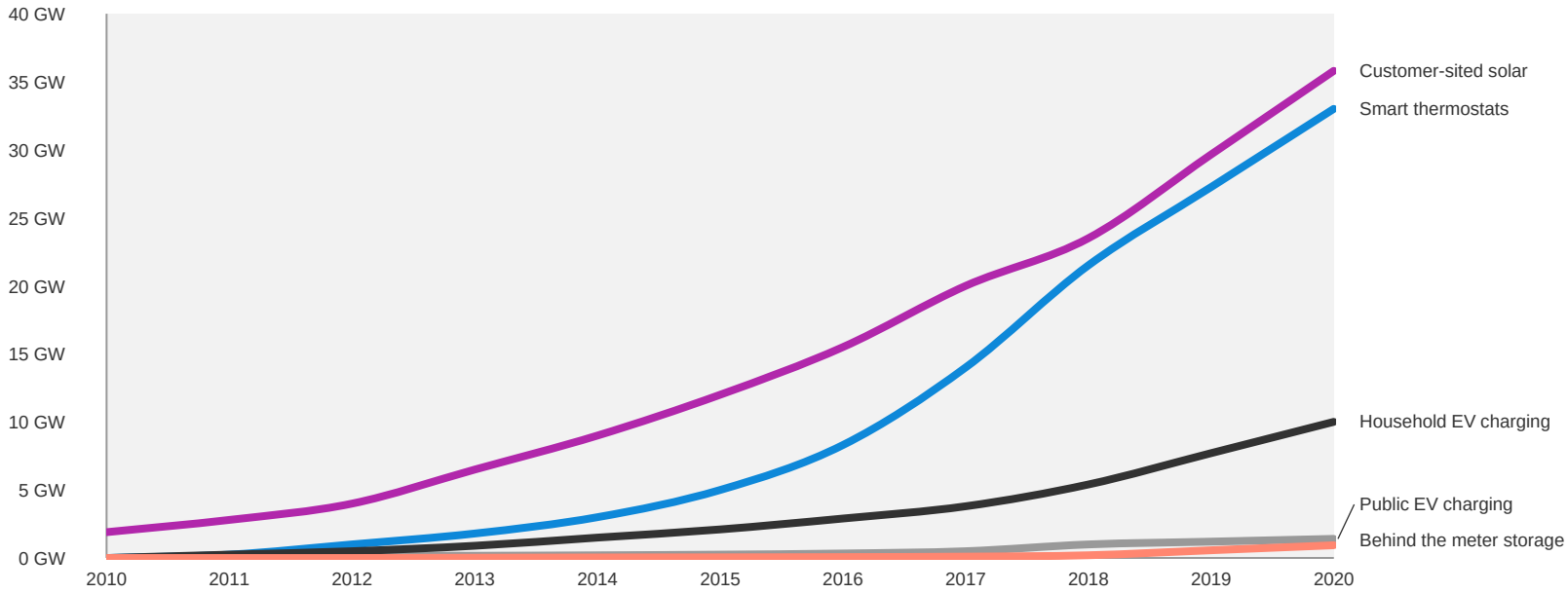
FERC Order No. 2222 was filed in September 2020, requiring ISOs / RTOs to submit compliance plans. Timing will vary across entities – pushing back the implementation of a fully operational DER market in the U.S.

ISO / RTO	Implementation Date
PJM	Implementation effective 2026 Q1; Subset effective in 2023 Q3
ISO-NE	Implementation effective 2026 Q4; Subset effective in 2022 Q4
MISO	Implementation effective 2030
SPP	No implementation date set
CAISO	No implementation date set; Plans effective 2022 Q4 but will require software updates for successful integration
NYISO	No implementation date set; Significant software updates needed

Note: 1. Data taken from ISO / RTO compliance filings: CAISO, NYISO, PJM, ISO-NE, MISO, SPP

U.S. DER Capacity Dominated by Solar and Thermostats

Cumulative U.S. DER Capacity (2010 – 2020)

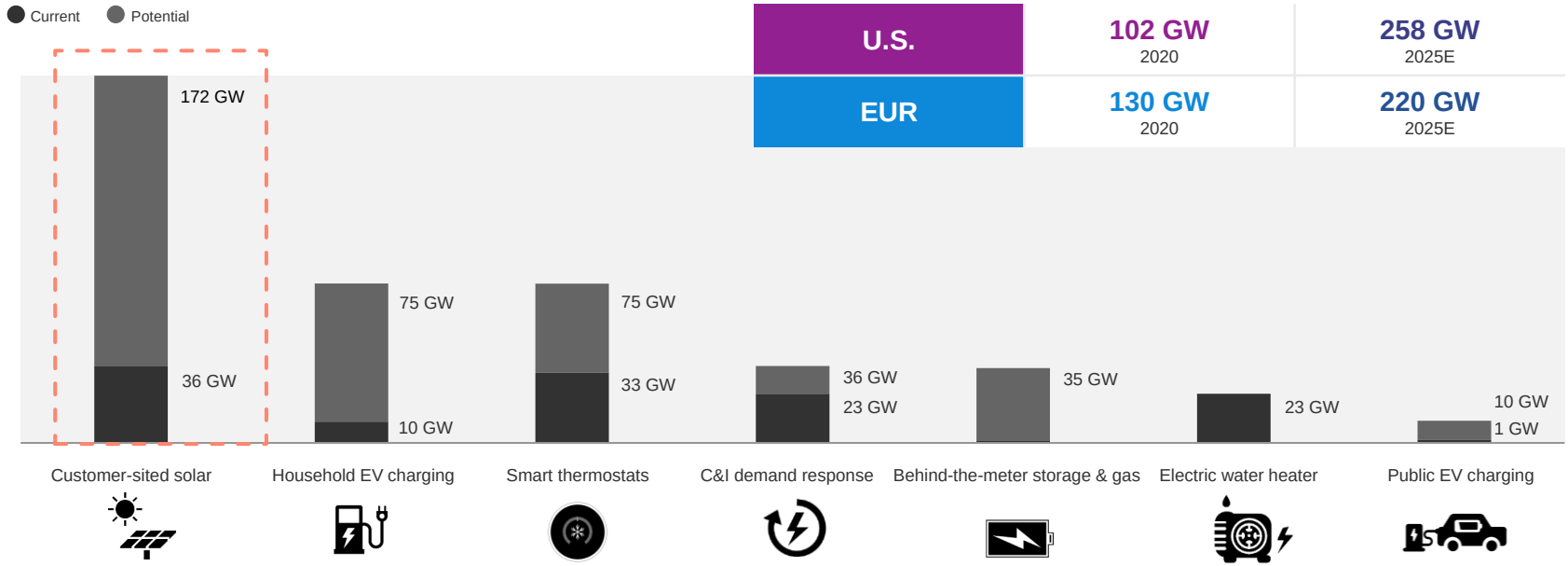


Source: Energize Ventures Internal Data, SEIA, BNEF, EIA

Significant Potential Capacity Across DER Technologies

Estimated Potential U.S. DER Peak Capacity, Non-Coincident, by 2030

NON-DISPATCHABLE W/O STORAGE



DER CAPACITY FOR KEY MARKETS

U.S.	102 GW 2020	258 GW 2025E
EUR	130 GW 2020	220 GW 2025E

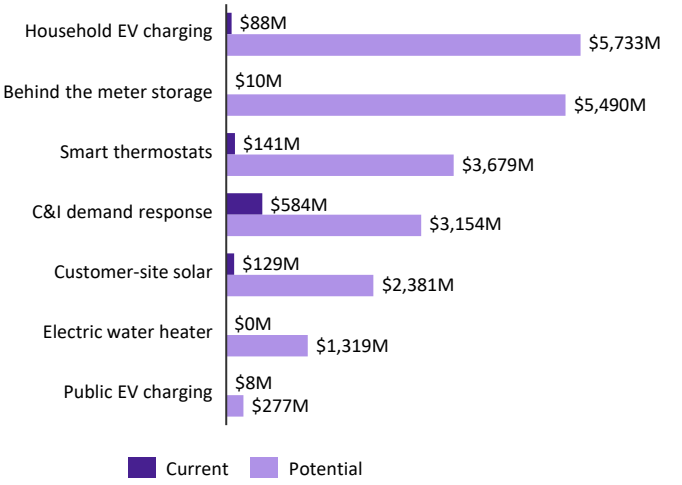
Source: Energize Ventures Internal Data, BNEF, EIA, Navigant

Sizing the "Optimizing Distributed Energy" Market

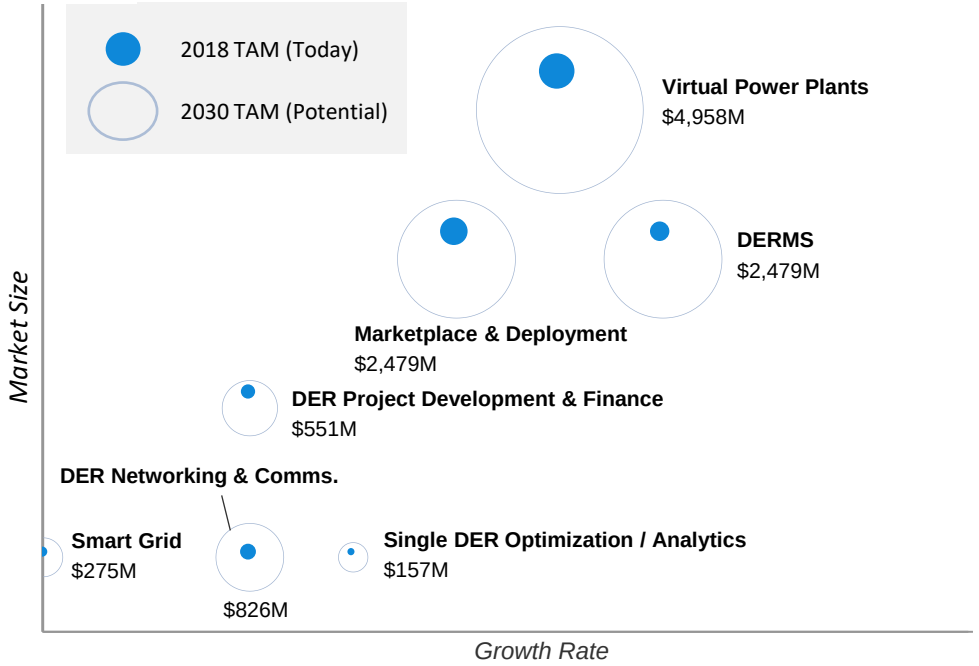
US Market Size by DER

$960M Current

$22B Potential



U.S. TAM by "Optimizing Distributed Energy" Business Model



DER asset & hardware sale revenue must be in place for enabling DER business models to work.

Source(s): Energize Ventures Internal Data

Summarizing Insights of the U.S. DER Market

~102 GW installed U.S. DER capacity today, but resource availability (%) unclear: software can help bring resources online

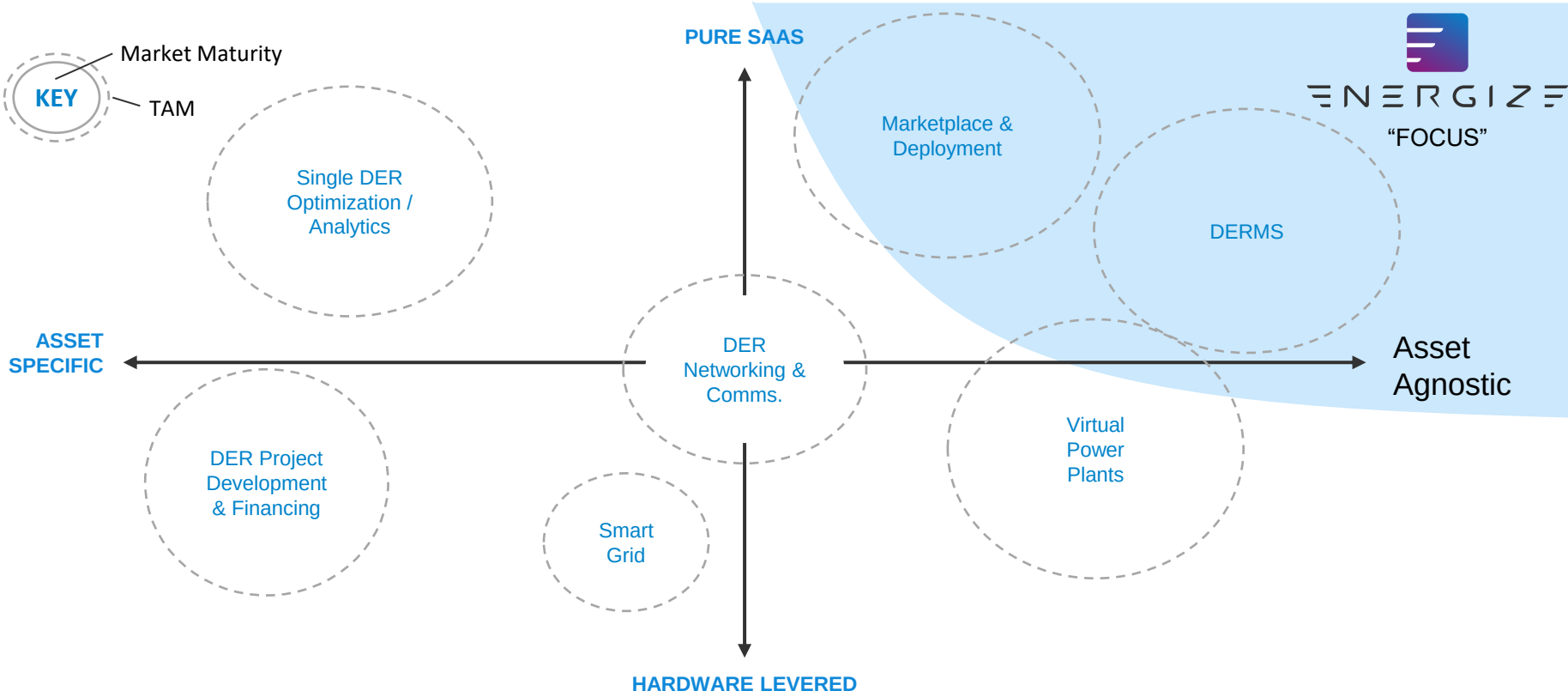
Cost parity suggests exponential growth in next 2 – 5 years, resiliency value prop may accelerate adoption across segments (California fires, Texas freeze, worsening hurricanes)

Software TAM is small & fragmented today (<$2B /yr), compelling tomorrow ($22B+ / yr) … winners can be big companies with patience and efficient growth

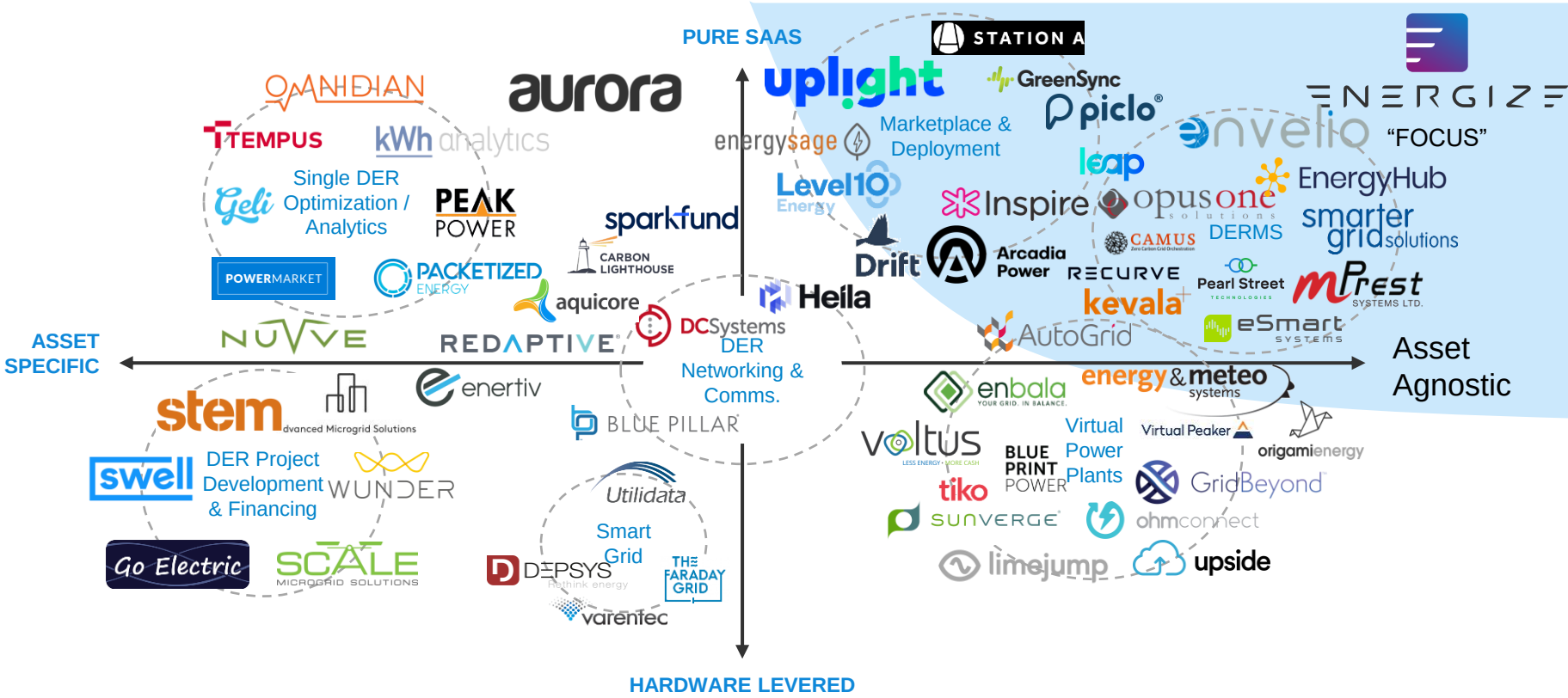
Monetization slow due to complex markets – difficulty scaling across geographies & asset types, solutions with simple workflows and data integration will be required to win

Source(s): Energize Ventures Internal Data

What DER Business Models Have Emerged?



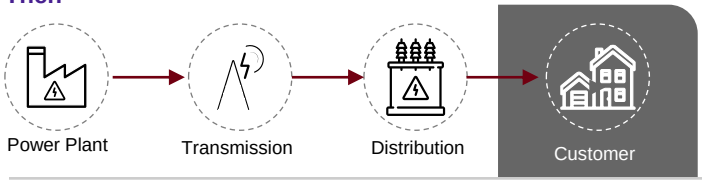
Mapping the “Optimizing Distributed Energy” Market



Source(s): Energize Ventures Internal Data

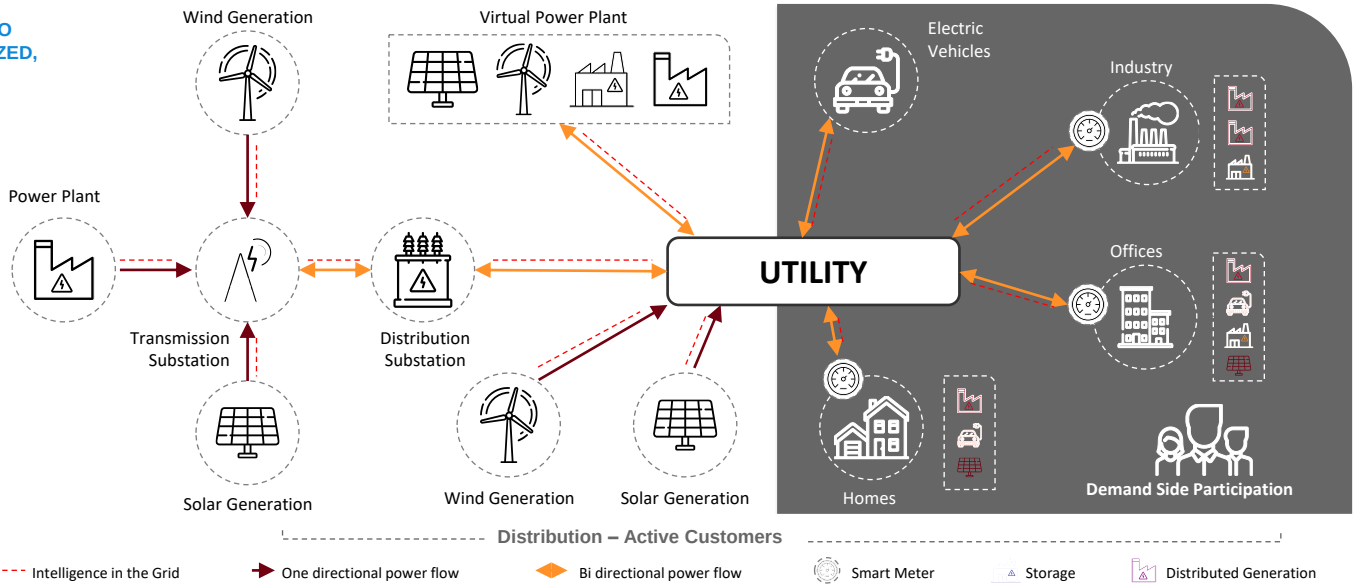
What is DER Management Software & Why Does it Matter?

Then



Now

SOFTWARE IS NEEDED TO MANAGE A DECENTRALIZED, COMPLEX POWER GRID.



Source(s): Energize Ventures Internal Data

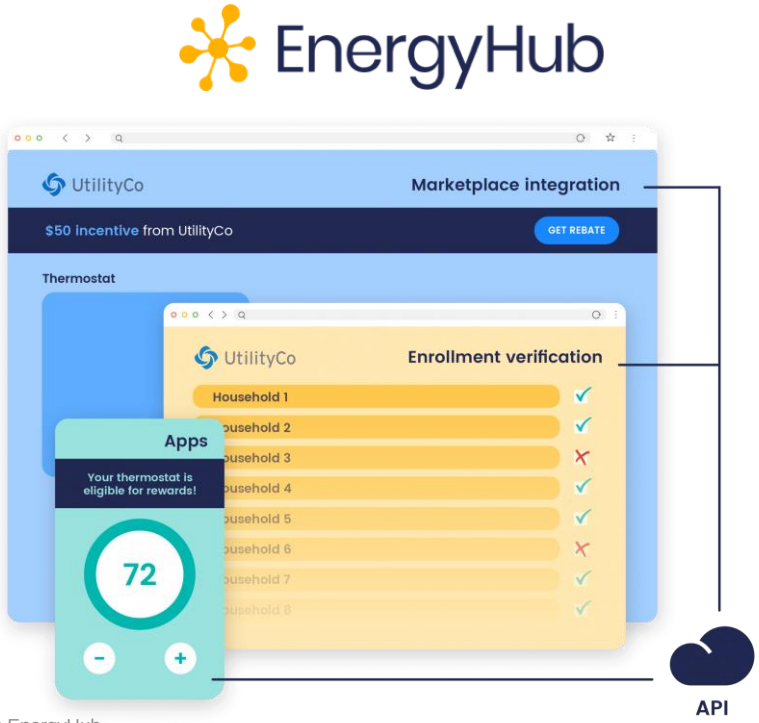
DER Aggregation and Management Platforms

Aggregating DER to provide holistic value to utilities and in energy markets will further enhance DER economics, accelerating the flywheel of adoption for electric, distributed energy technologies.

Company	What is it?
leap	**Customer-facing aggregator** Enables customers to make revenue from connected devices, bidding energy and capacity into the wholesale energy markets through a single API
voltus LESS ENERGY • MORE CASH	**Customer-facing aggregator** Connects distributed energy resources to every wholesale electricity market, generating revenue for customers
CAMUS Zero Carbon Grid Orchestration	**Utility-facing aggregator** Manages DERs on the grid, providing system-wide visibility and advanced control for the distributed energy future
EnergyHub	**Utility-facing aggregator** Provides a Distributed Energy Resource Management System (DERMS) to manage any resources at the grid edge, integrating directly with DER manufacturers
DAVID ENERGY	**Vertically integrated energy provider** Allows devices to react to real-time changes in energy markets, bundling energy to generate savings and reduce stress on the grid

Innovator Spotlight: EnergyHub

Leading Distributed Energy Resource Management System (DERMS) provider for utilities.



Source(s): EnergyHub

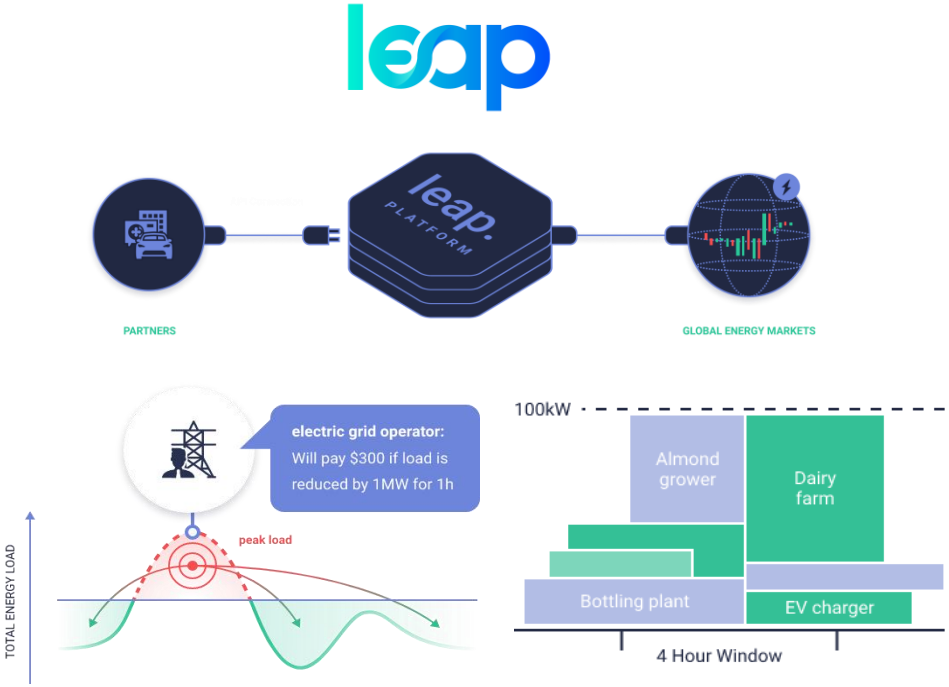
EnergyHub - Energize Ventures View

EnergyHub was an early DER software pioneer that launched in 2007 to help utilities optimize DER's interaction with their grids. The company was then acquired in 2013 by Alarm.com after funding dried up during the Cleantech 1.0 bust. They remain an independent subsidiary to this day.

EnergyHub has quietly developed into a DER software market leader. They've accumulated more than 50 utility customers, 2,900+ MW under capacity, more than 80 employees and a range of sophisticated DER management products. Many competitors have folded or consolidated in downside acquisition cases. EnergyHub continues pursuing its original mission 15 years into its journey!

Innovator Spotlight: Leap

Enables DER wholesale energy market participation with a common API integration.



Leap

DER aggregation & participation in energy markets is a multibillion opportunity. However, many early innovators were stifled by the combined effect of slow regulatory adoption and long sales cycles.

Start-ups that can help create liquid markets for DER grid services without relying on regulatory mechanisms are well-positioned for success. We've seen Voltus reach $40m+ revenue scale by helping C&I customers monetize DER capacity. Leap could find similar success in the residential DER aggregation market.

Source(s): Publicly available Voltus filings.

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