RENEWABLE ENERGY

A CRASH COURSE FOR LANDSCAPE ARCHITECTS

LANDSCAPE ARCHITECTURE FOUNDATION

- 501(c)(3) nonprofit based in Washington, DC
- Founded in 1966 to preserve, improve and enhance the environment
- Research, Scholarship, and Leadership programs
- Increase collective capacity of landscape architects to achieve sustainability:
  - Invested over **$3 million** in research since 1986
  - Awarded over **$1.25 million** in scholarships to over **550** students

1.0 LA CES CEU (HSW)

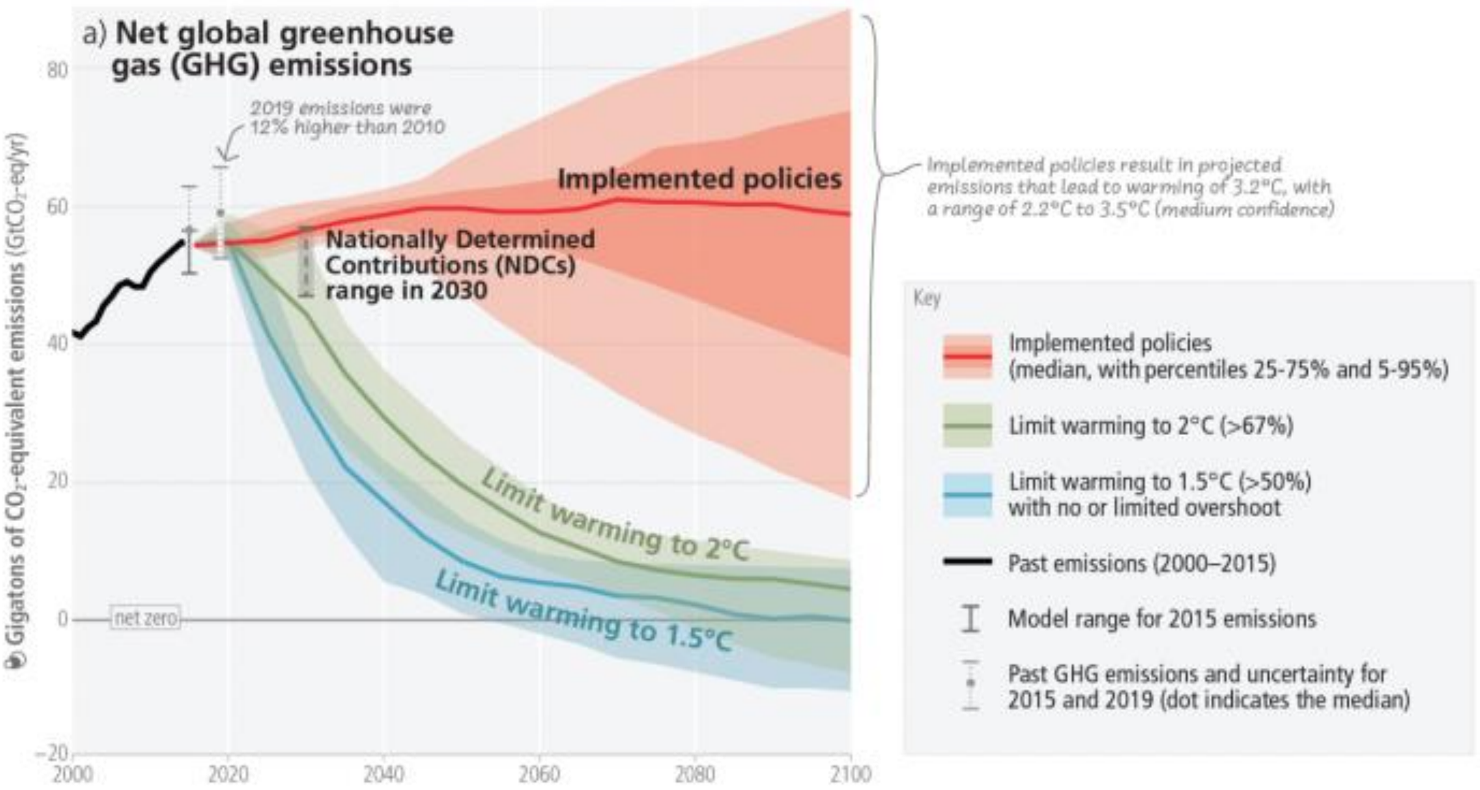
- Link to quiz in the chat + follow-up email
- 1.0 PDH (HSW) issued upon completion of 10-question quiz with a score of at least 75%
- Retakes allowed
- Certificate will be emailed **within 2 weeks**

RENEWABLE ENERGY:
A CRASH COURSE FOR LANDSCAPE ARCHITECTS

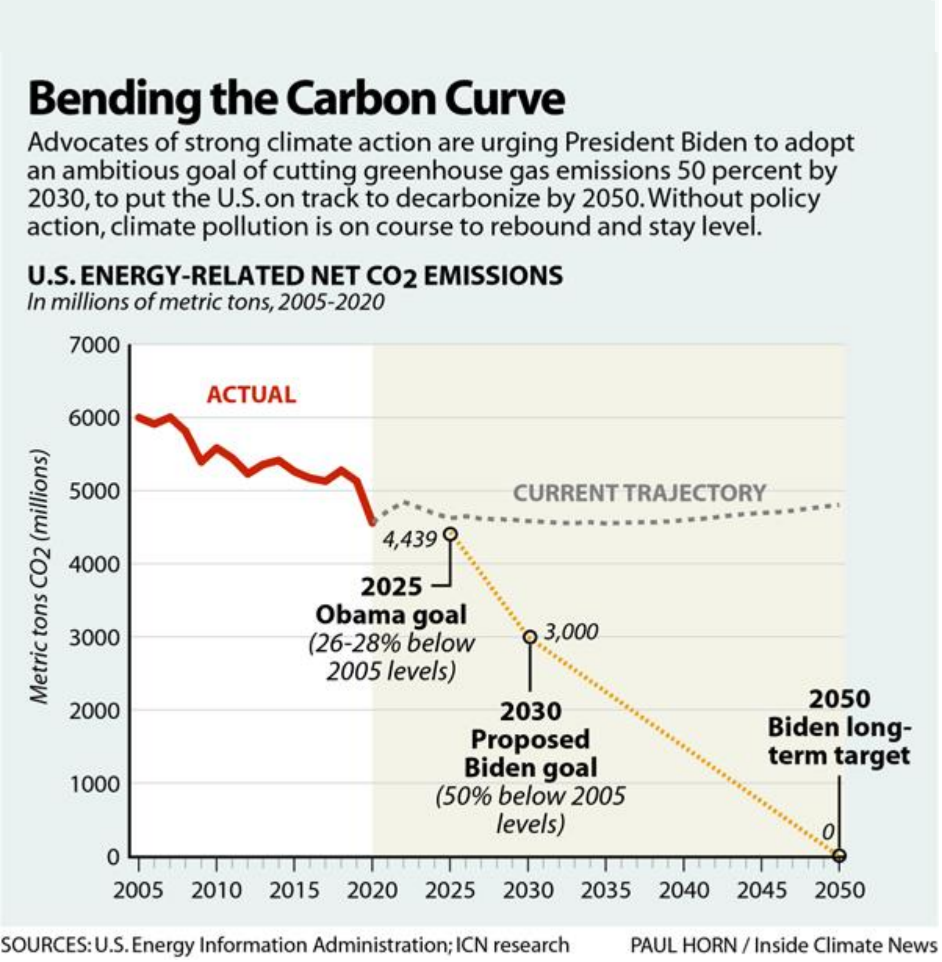
Nicholas Pevzner
University of Pennsylvania
pevzner@design.upenn.edu

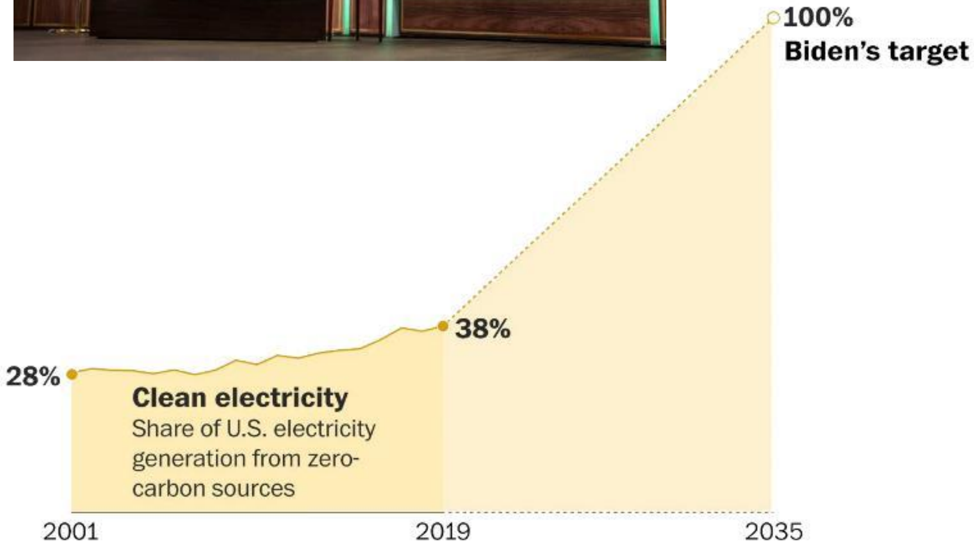
Limiting warming to 1.5°C and 2°C involves rapid, deep and in most cases immediate greenhouse gas emission reductions

Net zero CO_2 and net zero GHG emissions can be achieved through strong reductions across all sectors



IPCC via vox.com





Inside Climate News, April 13, 2021

The Washington Post, July 30, 2020


CHARGING STATION
CHARGING STATION


H2
H2

What is the role of design in this transition?

COURTESY OF THE STANDARD OIL COMPANY OF NEW JERSEY.

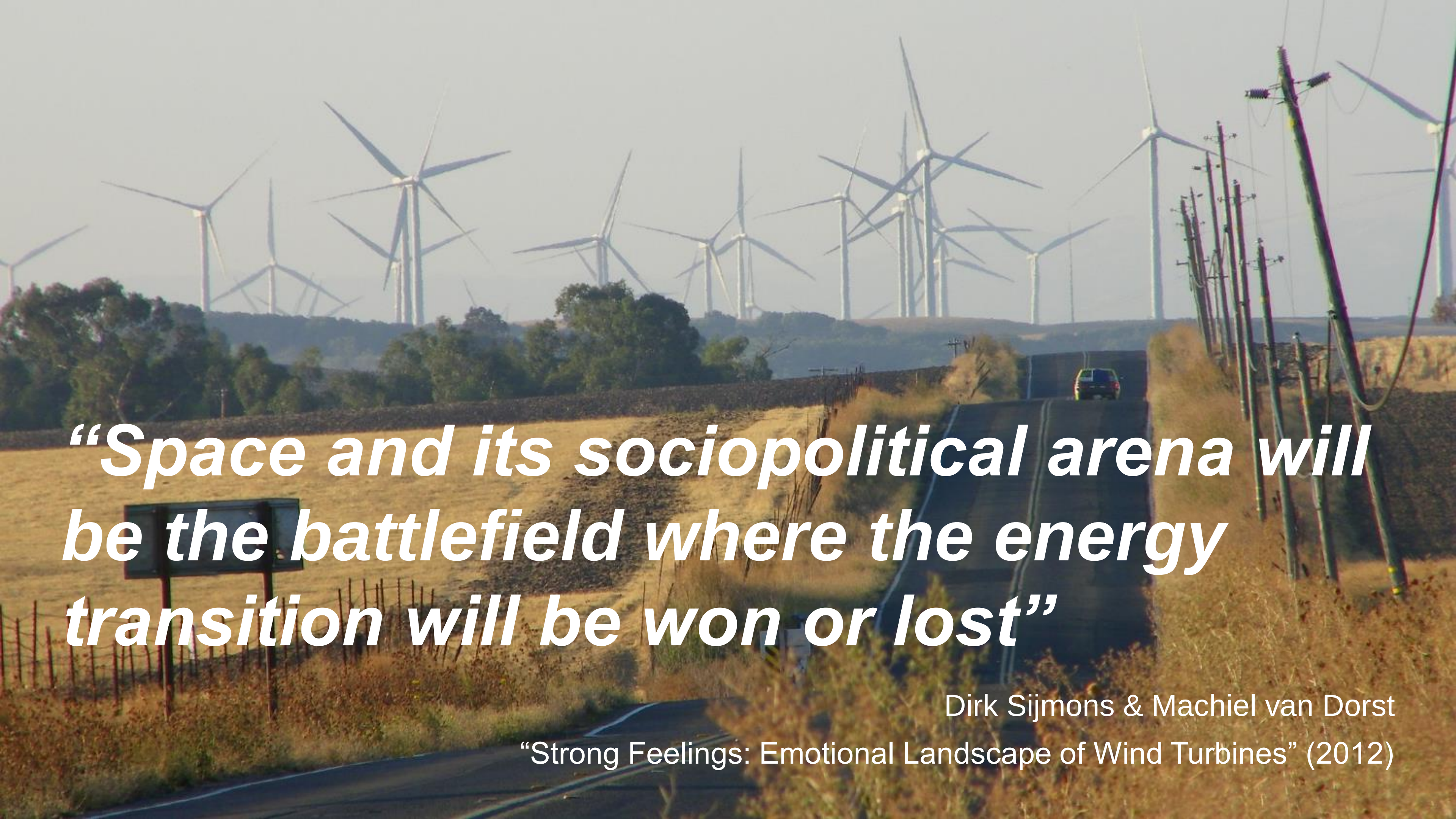
The Machine in the Garden

TECHNOLOGY
AND THE PASTORAL IDEAL
IN AMERICA

Leo Marx

OXFORD
UNIVERSITY PRESS

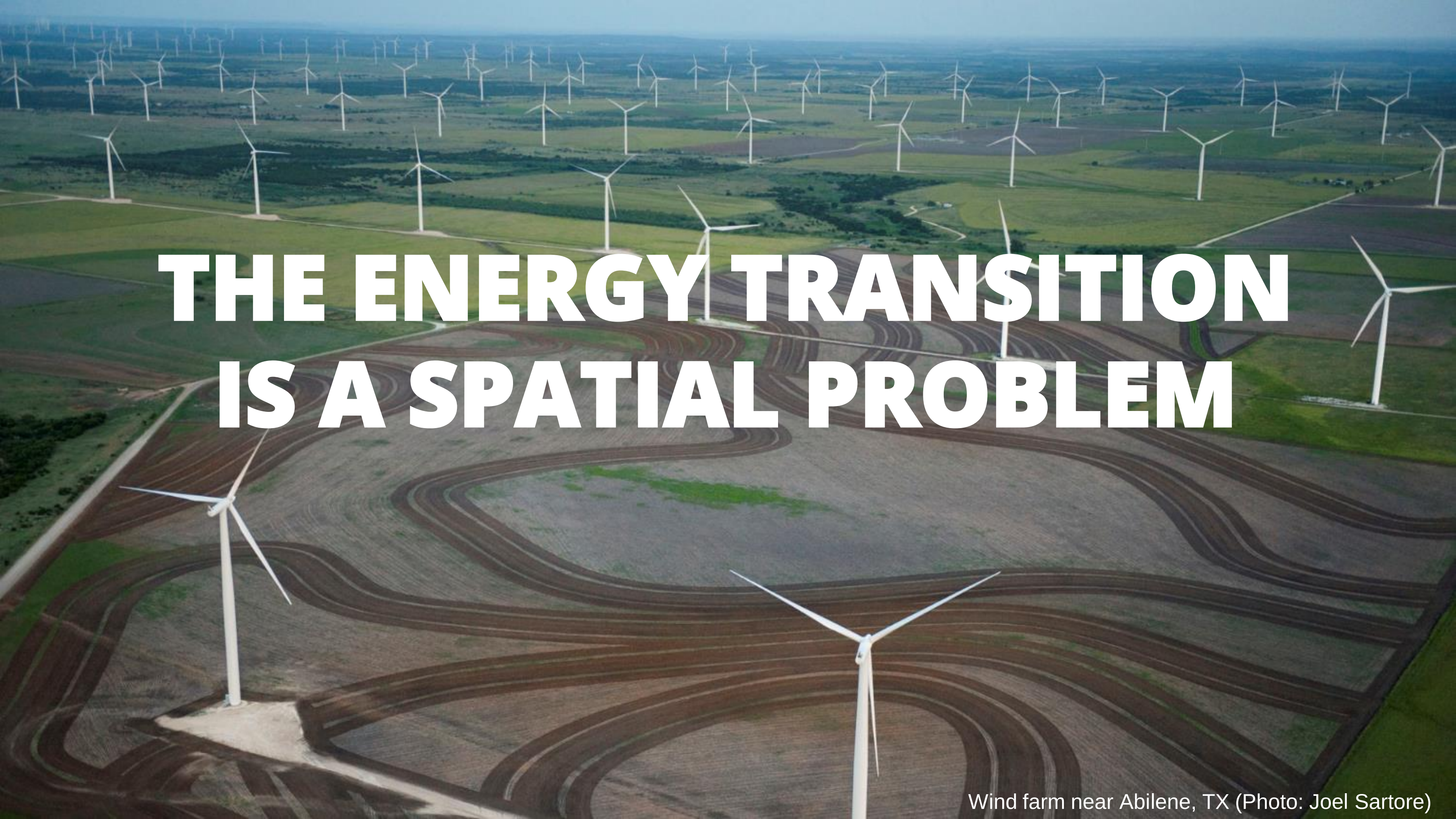
Leo Marx, *The Machine in the Garden*
(Oxford & New York: Oxford University Press, 1964)



"Space and its sociopolitical arena will be the battlefield where the energy transition will be won or lost"

Dirk Sijmons & Machiel van Dorst

"Strong Feelings: Emotional Landscape of Wind Turbines" (2012)



Wind farm near Abilene, TX (Photo: Joel Sartore)

POWER PLAYER

DESIGNING FOR JUST AND MULTIFUNCTIONAL ENERGY LANDSCAPES.

BY NICHOLAS PEVZNER, YEKANG KO, AND KIRK DIMOND, ASLA

RENEWABLE ENERGY IS A CENTRAL ELEMENT IN THE BIDEN ADMINISTRATION'S CLIMATE PLANS, a response to President Joe Biden's campaign goal of a 100 percent clean grid by 2035 and the promise of 10 million well-paying green infrastructure jobs. Renewable energy and the power sector must play a central part in this plan if the United States is to meet Biden's ambitious new national climate target. The goal, released on Earth Day as part of a virtual international climate gathering ahead of the COP26 Climate Change Conference, is to achieve a 50 percent reduction in climate emissions by 2030 measured against 2005 levels. And clean energy transmission, generation, and storage have a major presence in the American Jobs Plan, the Biden administration's $2.3 trillion infrastructure proposal now making its way through Congress. All of this renewable energy would represent a major transformation of the landscape. What would it mean for landscape design, and what would the designer's role be in such a major overhaul of the energy sector?

This clean energy transition is already under way—even if the federal government were to completely back away from any new clean energy initiatives, we can expect that actions by the private sector, such as corporate power purchase agreements (PPAs), which let companies contract with specific energy generators to buy energy directly from them, will lead to the construction of many new renewable energy facilities throughout the country as companies try to meet their internal climate commitments. A number of states and municipalities, including California, New York, and New Mexico, have committed themselves to 100 percent clean electricity targets through binding legislation. Last year, the bipartisan year-end omnibus spending package, which was signed into law in the final days of 2020, provided $35 billion in support of clean energy and climate action.

But the success of the clean energy transition will depend on the speed and scale with which new renewable infrastructure can be deployed and how much opposition and backlash it engenders. Renewable energy is politically popular in general, with increased investment in clean energy enjoying bipartisan support according to polls. Less well understood is how all this will affect vast swaths of the American landscape, but we can be sure that the spatial impacts will be dramatic—more renewable energy facilities closer to where people live, work, and play. Conflicts over land use might be the most challenging piece of the puzzle for building out clean energy at scale, and large infrastructure projects have historically faced backlash and animosity. Multiple studies have identified community opposition to visual and land-use impacts of wind, solar, and transmission projects as one of the most likely bottlenecks on the path toward a net-zero America.

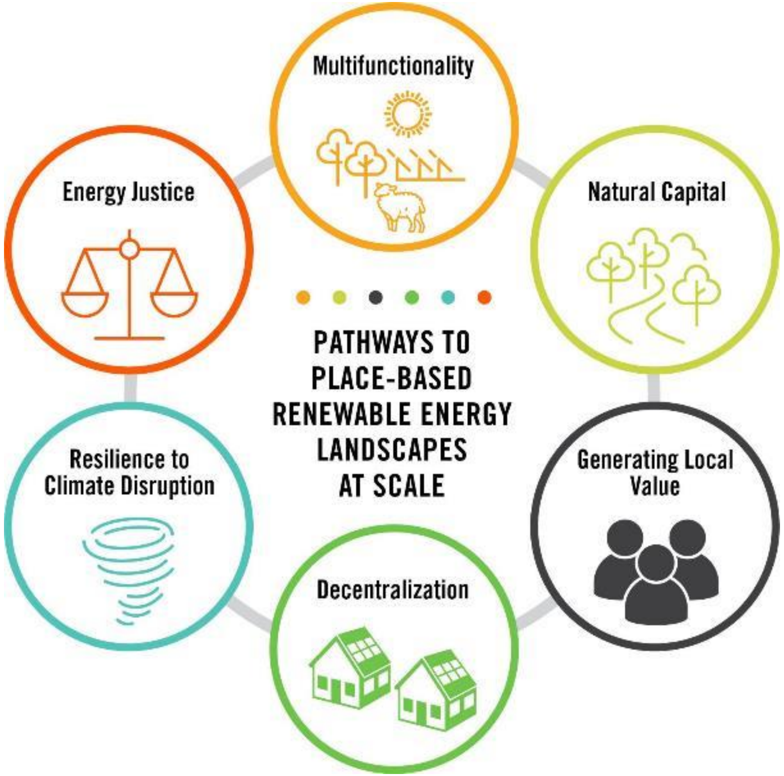
How can designers promote a rapid energy transition that avoids these bottlenecks, while supporting a cleaner and more just economy? Landscape architects must get ready to welcome this renewable energy build-out—to defend it in the face of inevitable opposition, to address communities' legitimate concerns, to improve it, and to help coax it into being.

Energy Infrastructure and the Built Environment In the American Jobs Plan

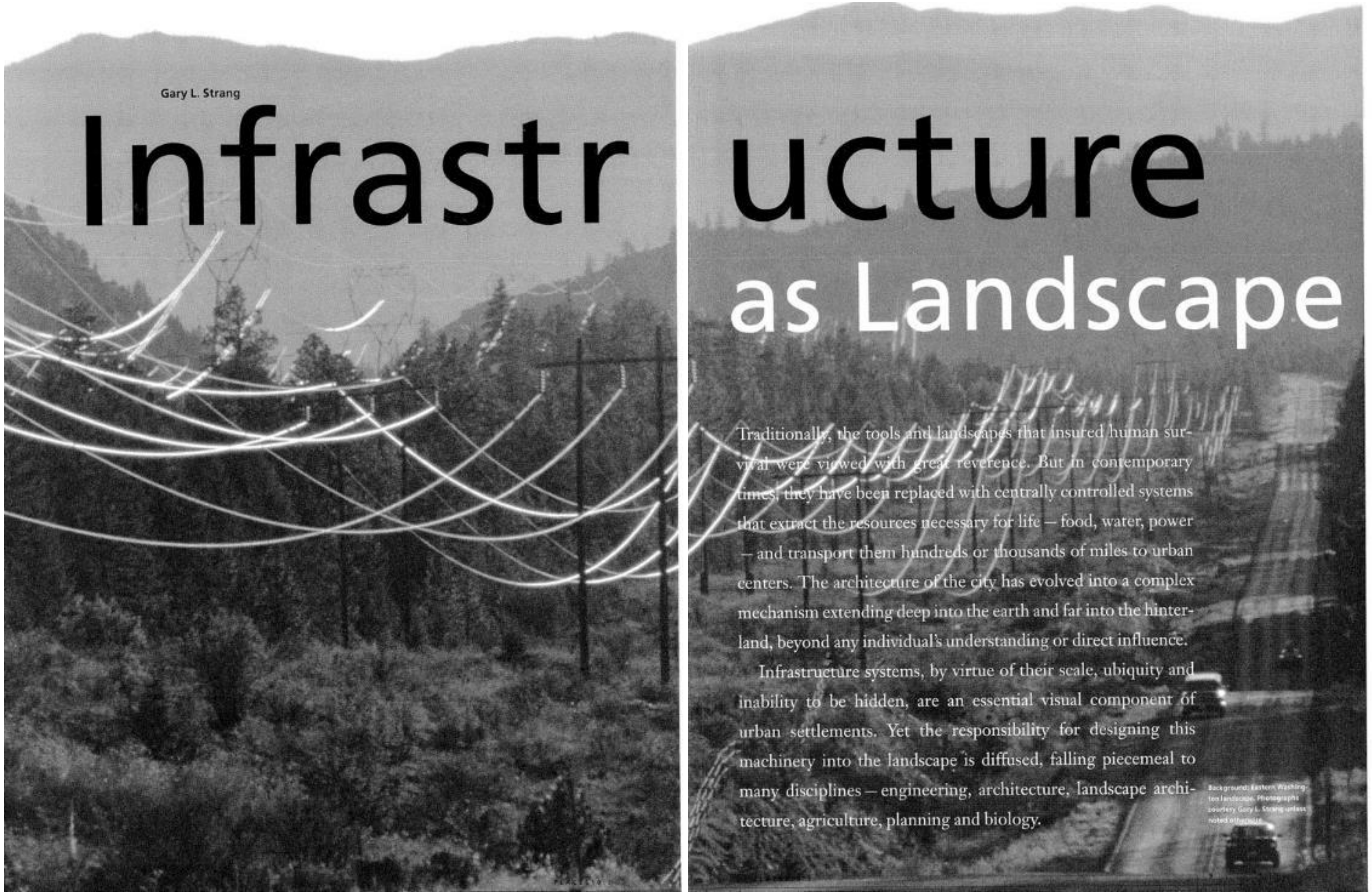
The existing state-level and private sector initiatives on renewable energy could get a major boost at the federal level thanks to the Biden administration's American Jobs Plan. The fate of this plan ultimately rests with Congress, and the final form of this legislation is still being debated at the time of this writing. But as originally proposed by President Biden in March,

Nicholas Pevzner, Yekang Ko, and Kirk Dimond. **"Power Player: Designing for Just and Multifunctional Energy Landscapes."** *Landscape Architecture Magazine*, June 2021

Rebecca O'Neil, Danielle Preziuso, Katie Arkema, Yekang Ko, Nicholas Pevzner, Kirk Dimond, Simon Gore, Katherine Morrice, Chris Henerson, and Devryn Powell. **"Renewable Energy Landscapes: Designing Place-Based Infrastructure for Scale."** Pacific Northwest National Laboratory (White Paper), July 2022.




MULTIFUNCTIONALITY



Gary L. Strang

Infrastructure as Landscape

Traditionally, the tools and landscapes that insured human survival were viewed with great reverence. But in contemporary times, they have been replaced with centrally controlled systems that extract the resources necessary for life — food, water, power — and transport them hundreds or thousands of miles to urban centers. The architecture of the city has evolved into a complex mechanism extending deep into the earth and far into the hinterland, beyond any individual's understanding or direct influence.

Infrastructure systems, by virtue of their scale, ubiquity and inability to be hidden, are an essential visual component of urban settlements. Yet the responsibility for designing this machinery into the landscape is diffused, falling piecemeal to many disciplines — engineering, architecture, landscape architecture, agriculture, planning and biology.

Background: Eastern Washington landscape. Photographs courtesy Gary L. Strang unless noted otherwise.

Strang, G. L. (1996). Infrastructure as Landscape [Infrastructure as Landscape, Landscape as Infrastructure]. Places 10 (3)

Fontana Dam Powerhouse
(Photo: Charles Krutch, TVA)

Norris Dam (Photo: Library of Congress)

Hood Design Studio: “Solar Strand,” University at Buffalo

Landscape Architecture Foundation

Gabe Landes
Director of Engineering, Renewable Properties

Elisabet Metcalfe
Physical Scientist, U.S. Department of Energy

Danielle Preziuso
Socio-Technical Systems Engineer, Pacific Northwest National Laboratory

LAF Webinar: Energy

Solar Energy

RENEWABLE PROPERTIES

August 22, 2024

Gabe Landes
LinkedIn

Agenda

- Solar energy basics
- How projects get financed and built
- How C&I PV engages LAs
- Dual-Use, Agrivoltaics
- Challenges
  - Interconnection
  - Land use constraints
  - Opposition
  - Problems with success
- Opportunities
  - Brownfields
  - Dual-use applications
  - Cost reductions
  - Automation
  - Continued electrification
- Land use and scale
- Looking forward

Solar Energy System

Scale: Resi, Commercial and Industrial, Utility

12 kW for a house

100 MW for the grid

Other

Renewable Properties

2.5 to 10 MW solar arrays. Grid connected.

Community Solar in 15 states.

Emerging opportunities in BESS and EV charger sites

A solar project is a revenue generating asset

Development costs

Land, legal, geotech

CapEx

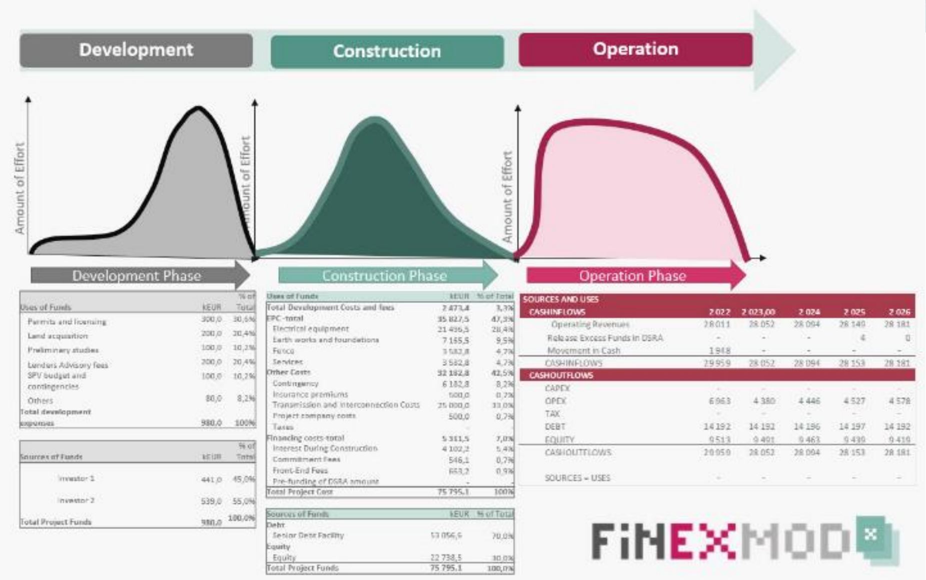
EPC, contingency, financing

OpEx

Taxes

Insurance

Profit and Overhead



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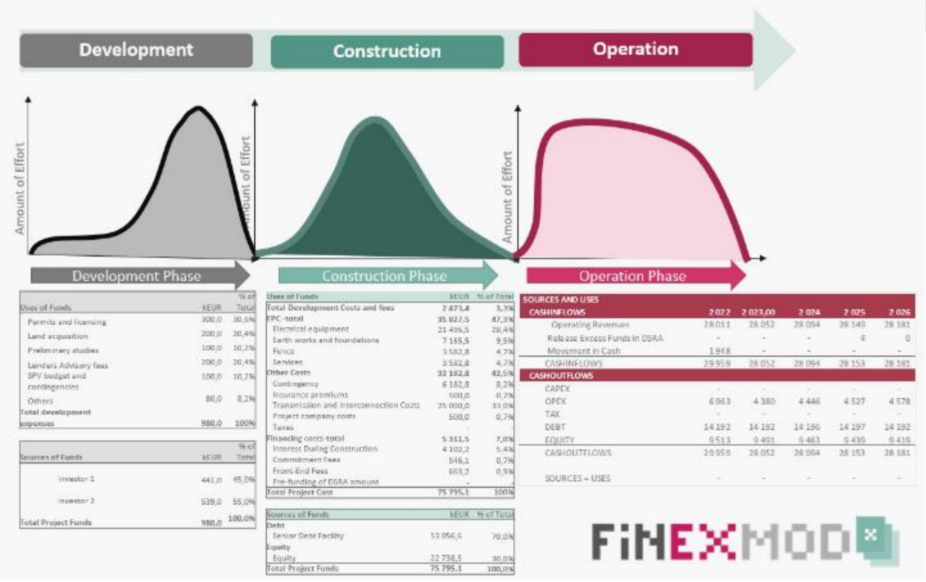
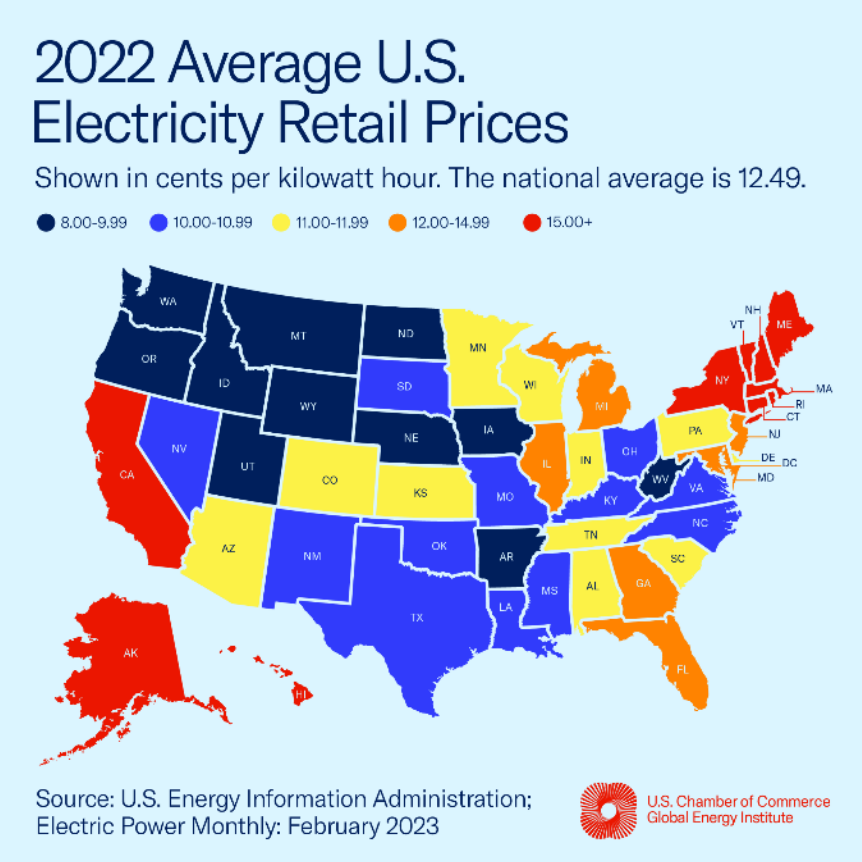
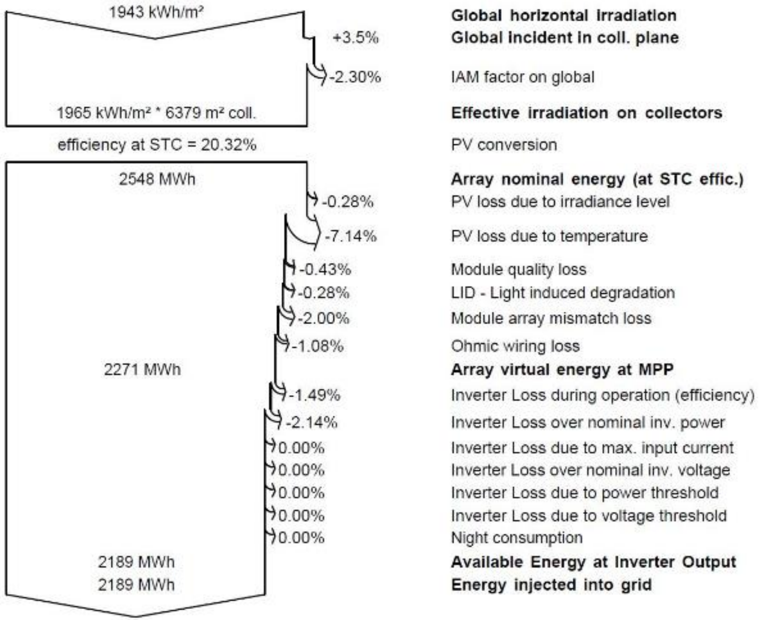


Metering kWh is metering $$$



source

Modeling energy production



PVWatts — AC Energy & Cost Savings — Cautions for Interpreting the Results

(Type comments here to appear on printout; maximum 1 row of 80 characters.)

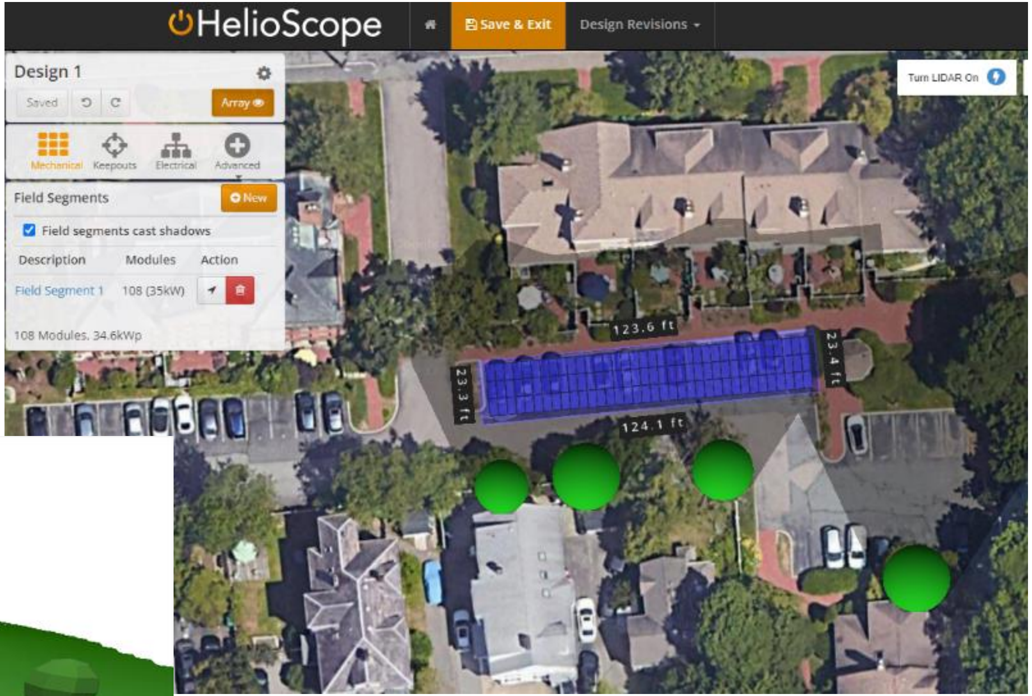
Station Identification	
City:	Sacramento
State:	California
Latitude:	38.52° N
Longitude:	121.50° W
Elevation:	8 m
PV System Specifications	
DC Rating:	4.0 kW
DC to AC Derate Factor:	0.770
AC Rating:	3.1 kW
Array Type:	Fixed Tilt
Array Tilt:	38.5°
Array Azimuth:	180.0°
Energy Specifications	
Cost of Electricity:	12.5 ¢/kWh

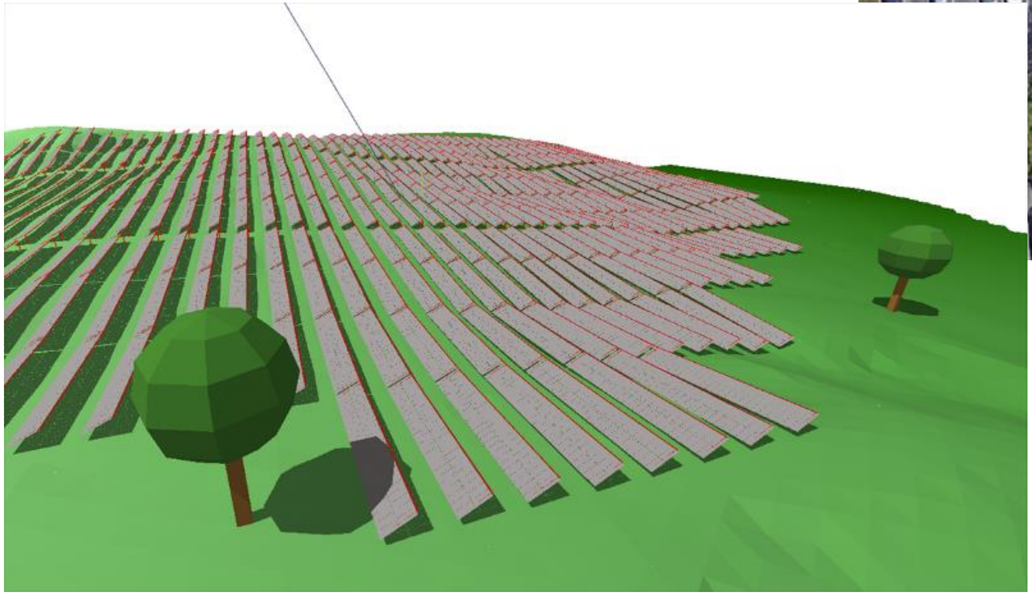
Results			
Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value ($)
1	2.75	252	31.50
2	4.23	348	43.50
3	5.27	477	59.62
4	6.33	543	67.88
5	6.83	584	73.00
6	6.93	563	70.38
7	7.23	599	74.88
8	7.30	607	75.88
9	6.96	568	71.00
10	5.67	494	61.75
11	3.68	317	39.62
12	2.71	243	30.38
Year	5.50	5597	699.62

System design

Layout, Equipment selection,

and Shading





Evaluate impacts to

LCOE, IRR, NPV, ROI

System construction

1.5 yrs of Development

Construction: 3 to 6 months

20 to 35 yr life

LA involvement

Often brought in as a

sub to the Civil Engineer.

Work output can impact

Site biodiversity.

Local knowledge is valuable

ERNST SEEDS

Ernst Conservation Seeds
8884 Mercer Pike
Meadville, PA 16335
(800) 873-3321 Fax (814) 336-5191
www.ernstseed.com

Date: August 21, 2024

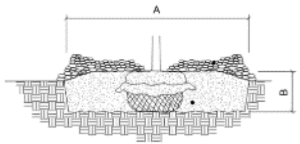
Ernst Native/Naturalized Solar Farm Seed Mix - ERNMX-186-1

	Botanical Name	Common Name	Price/Lb
34.00 %	*Festuca rubra*	Creeping Red Fescue	3.30
33.00 %	*Festuca ovina, Variety Not Stated*	Sheep Fescue, Variety Not Stated	5.52
10.00 %	*Festuca ovina var. duriuscula, 'Jetty'*	Hard Fescue, 'Jetty'	5.10
5.00 %	*Festuca brevipila, 'Beacon'*	Hard Fescue, 'Beacon'	5.10
5.00 %	*Festuca ovina var. glauca, 'Blue Ray'*	Blue Fescue, 'Blue Ray'	5.40
5.00 %	*Poa pratensis, 'Maverick'*	Kentucky Bluegrass, 'Maverick'	3.78
5.00 %	*Poa pratensis, 'Wildhorse'*	Kentucky Bluegrass, 'Wildhorse'	3.78
3.00 %	*Agrostis perennans, Albany Pine Bush-NY Ecotype*	Autumn Bentgrass, Albany Pine Bush-NY Ecotype	16.80
100.00 %		**Mix Price/Lb Bulk:**	**$4.86**

Seeding Rate: 4 lb per 1,000 sq ft

Grasses & Grass-like Species - Herbaceous Perennial; Lawn & Turfgrass Sites; Solar Sites

Provide a 2' clearance between the ground and the solar panels. Mix formulations are subject to change without notice depending on the availability of existing and new products. While the formula may change, the guiding philosophy and function of the mix will not.

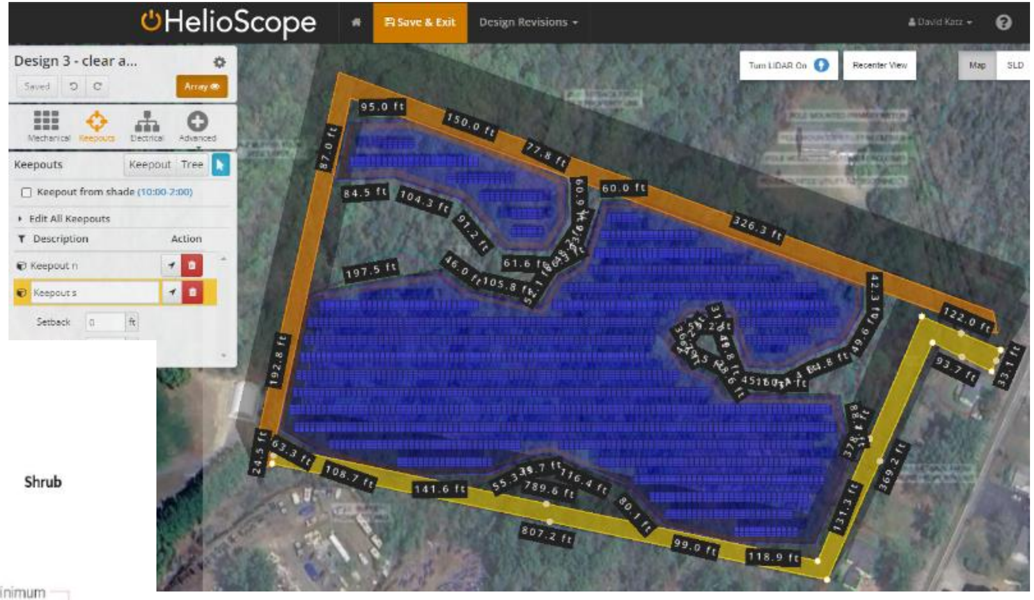


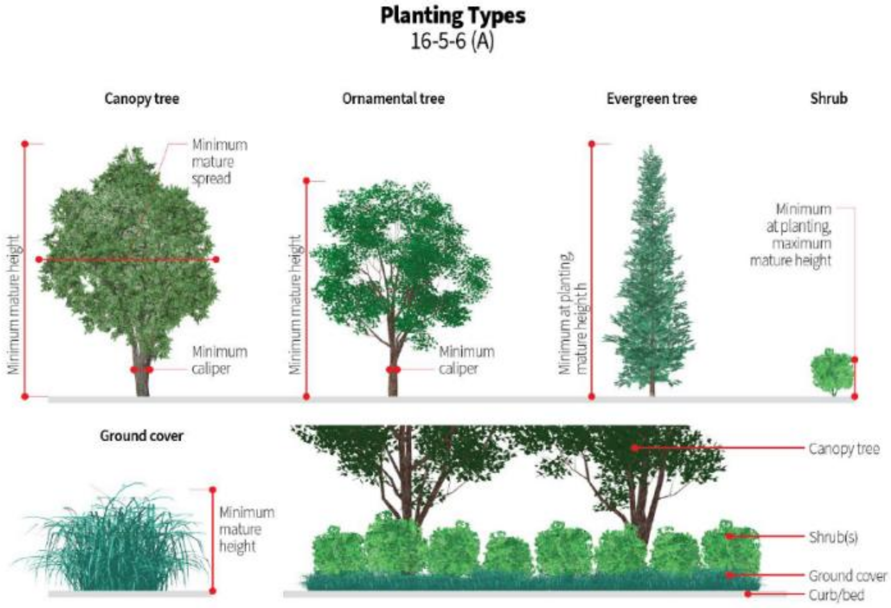
1. SCARIFY SIDES AND BOTTOM OF HOLE.
2. PROCEED WITH CORRECTIVE PRUNING.
3. SET PLANT ON UNDISTURBED NATIVE SOIL OR THOROUGHLY COMPACTED PLANTING SOIL. PLACE PLANT SO THE ROOT FLARE IS AT OR UP TO 2" ABOVE THE FINISHED GRADE WITH BURLAP AND WIRE BASKET, (IF USED), INTACT.
4. SLIT REMAINING TREATED BURLAP AT 6" INTERVALS.
5. BACKFILL TO WITHIN APPROXIMATELY 12" OF THE TOP OF THE ROOTBALL, THEN WATER PLANT.
6. REMOVE THE TOP 1/3 OF THE BASKET OR THE TOP TWO HORIZONTAL RINGS WHICHEVER IS GREATER. REMOVE ALL BURLAP AND NAILS FROM THE TOP 1/3 OF THE BALL. REMOVE ALL TWINE. REMOVE OR CORRECT STEM GIRDLING ROOTS.
7. PLUMB AND BACKFILL WITH PLANTING SOIL.
8. WATER THOROUGHLY WITHIN 2 HOURS TO SETTLE PLANTS AND FILL VOIDS.
9. BACK FILL VOIDS AND WATER A SECOND TIME.
10. PLACE MULCH WITHIN 48 HOURS OF THE SECOND WATERING UNLESS SOIL MOISTURE IS EXCESSIVE.

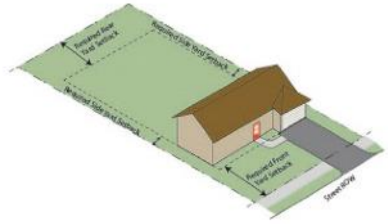
D-1 BALLED & BURLAPPED STOCK

NOT TO SCALE

Impact from local regulations







Setbacks and Buildable Area Diagram

“Dual Use”

Agrivoltaics

Agrivoltaics

Benefits from AgPV:

80% times two

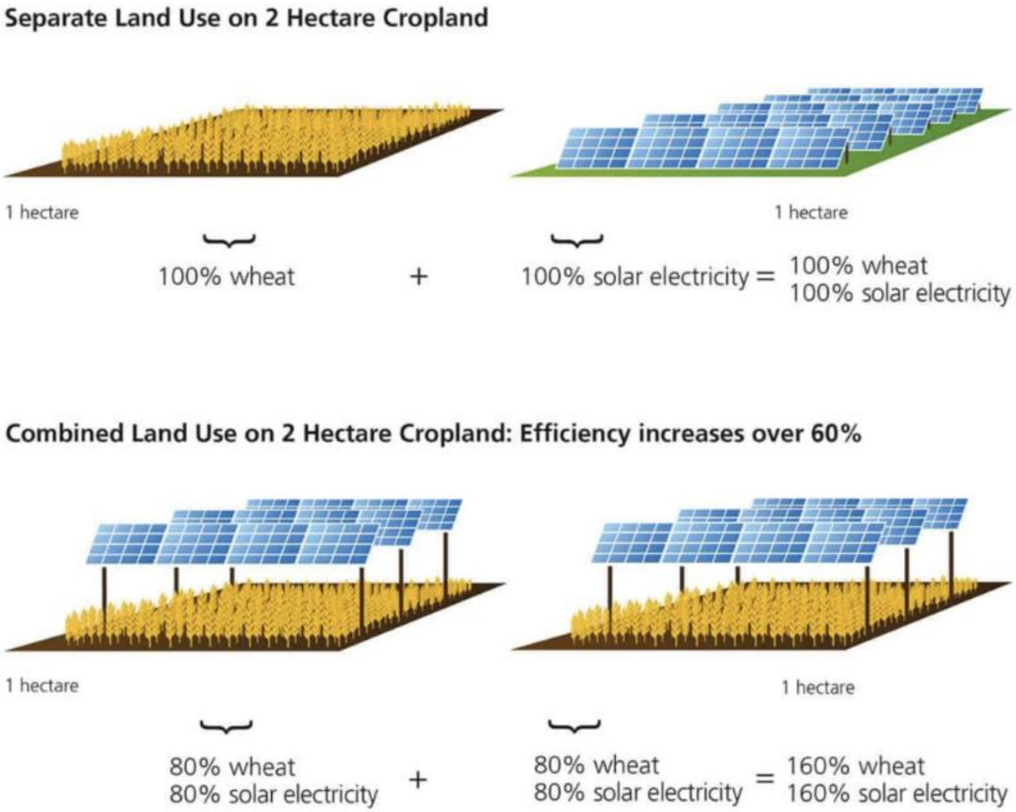


Photo Credit: Renewablepedia

AgPV - diverse array of crops

Jack's Solar Garden in Boulder, Colorado.

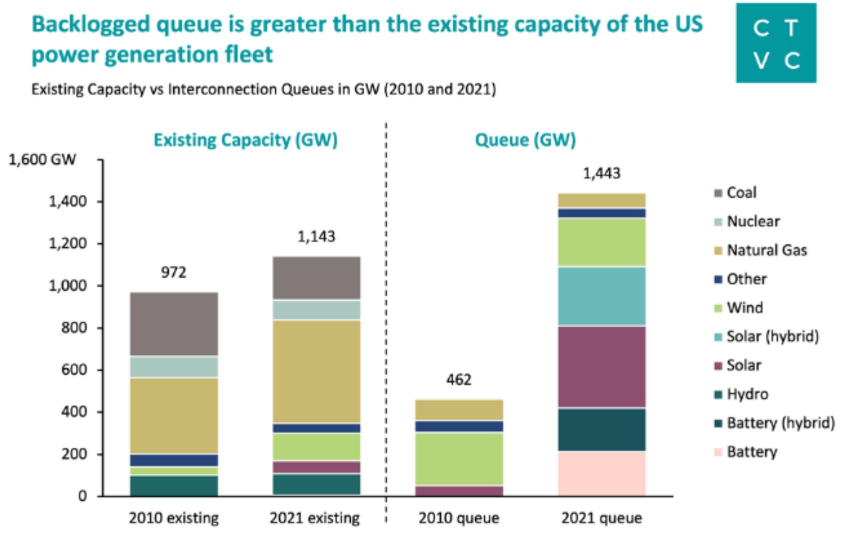
1.2 MW

Link , Link

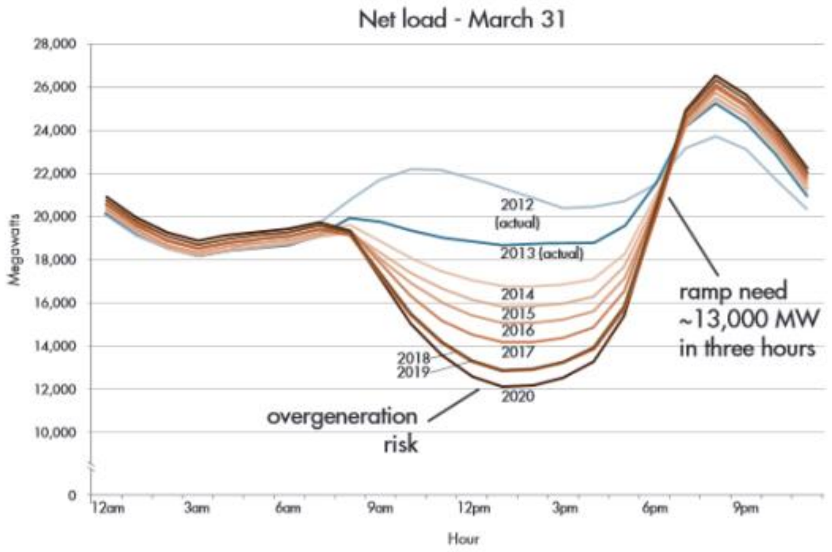
Jack’s Solar Garden - community use

Challenges

Interconnection



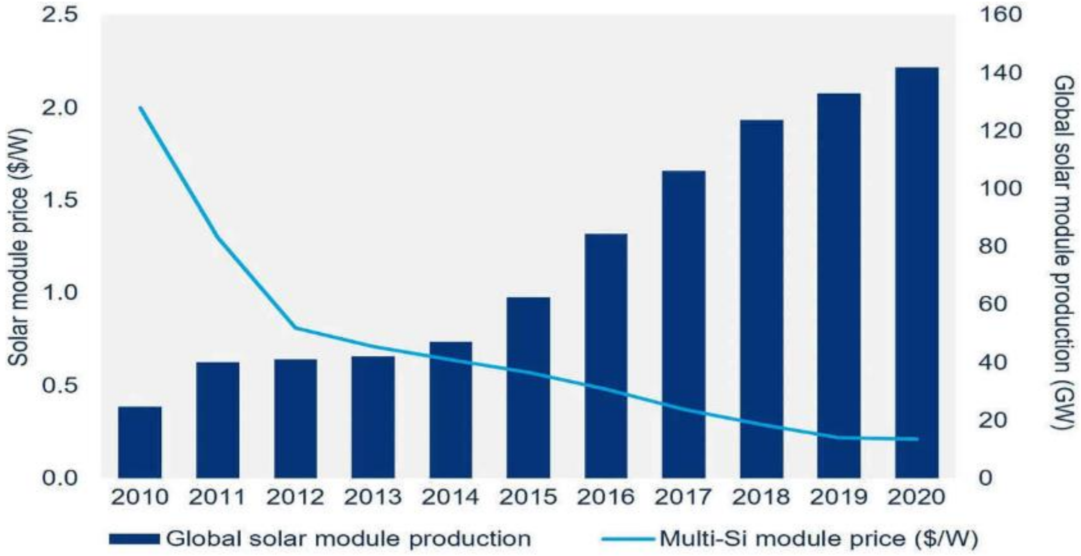
US power generation, storage, and capacity in interconnection queues (Source: LBNL)



Too much solar

Opportunities

Cost reductions



Big steel goes big solar in the US

A deal between Xcel Energy and steelmaker EVRAZ includes the building of a 240 MW solar project near the company's Rocky Mountain Steel mill in Pueblo, Colorado. This is by far the largest behind-the-meter solar project **pv magazine** staff has heard of to date.

AUGUST 20, 2018 CHRISTIAN ROSELUND

COMMERCIAL & INDUSTRIAL PV | HIGHLIGHTS | INSTALLATIONS | UNITED ARAB EMIRATES

Xcel Energy and steel maker EVRAZ signed a deal which includes a solar project that could redefine the scope of behind-the-meter solar.

Image: Center for Land Use Interpretation, licensed under CC-by-SA 3.0

Too much solar

Opportunities

Automation

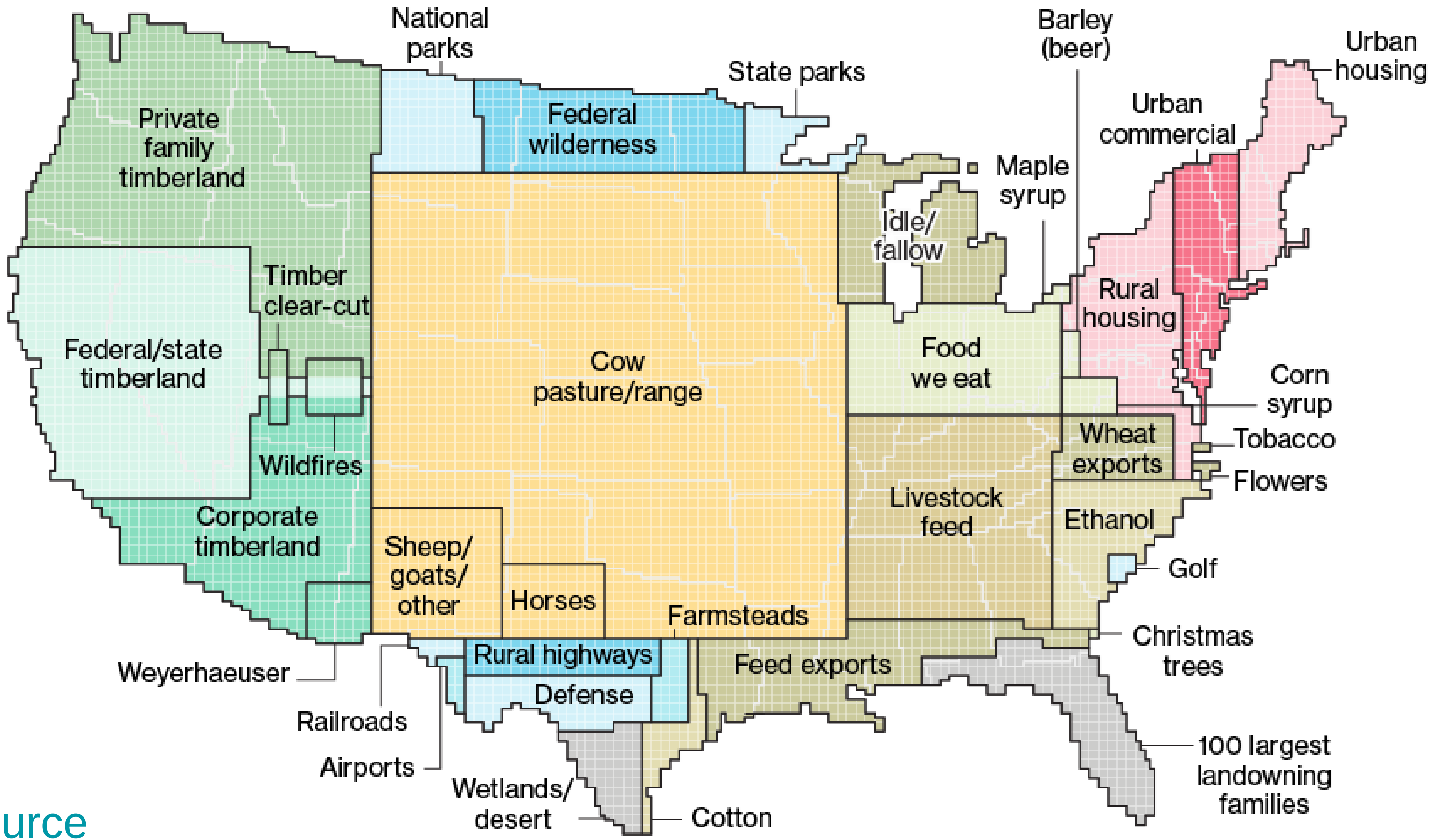
Dual-use installations

Land use and scale

All the panels for all the electricity needs in USA

source

Land use map: note Ethanol



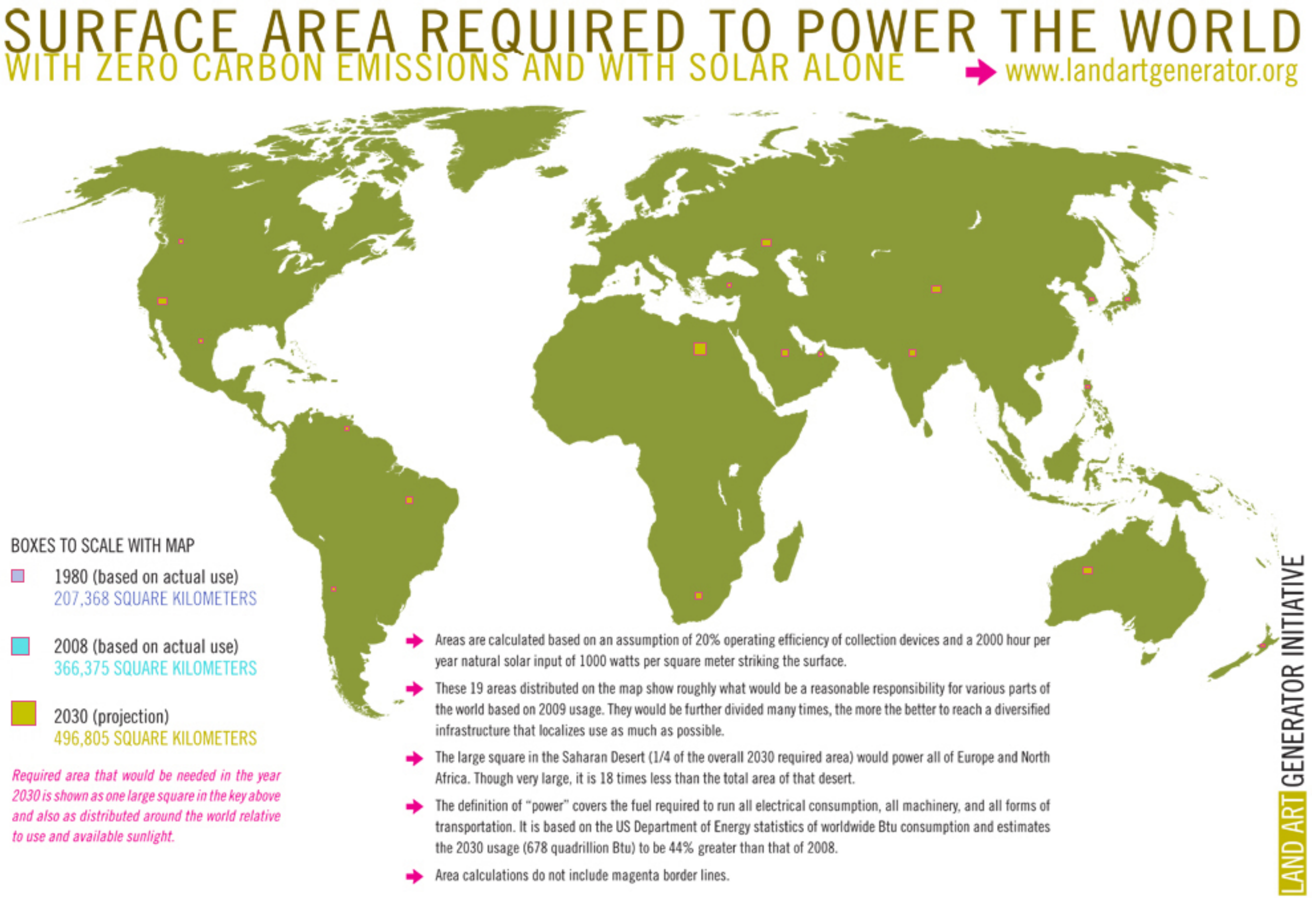
2018

source

For the World’s energy needs

source

Alt img



2009 data

We can do better

Avoid ‘monoculture’

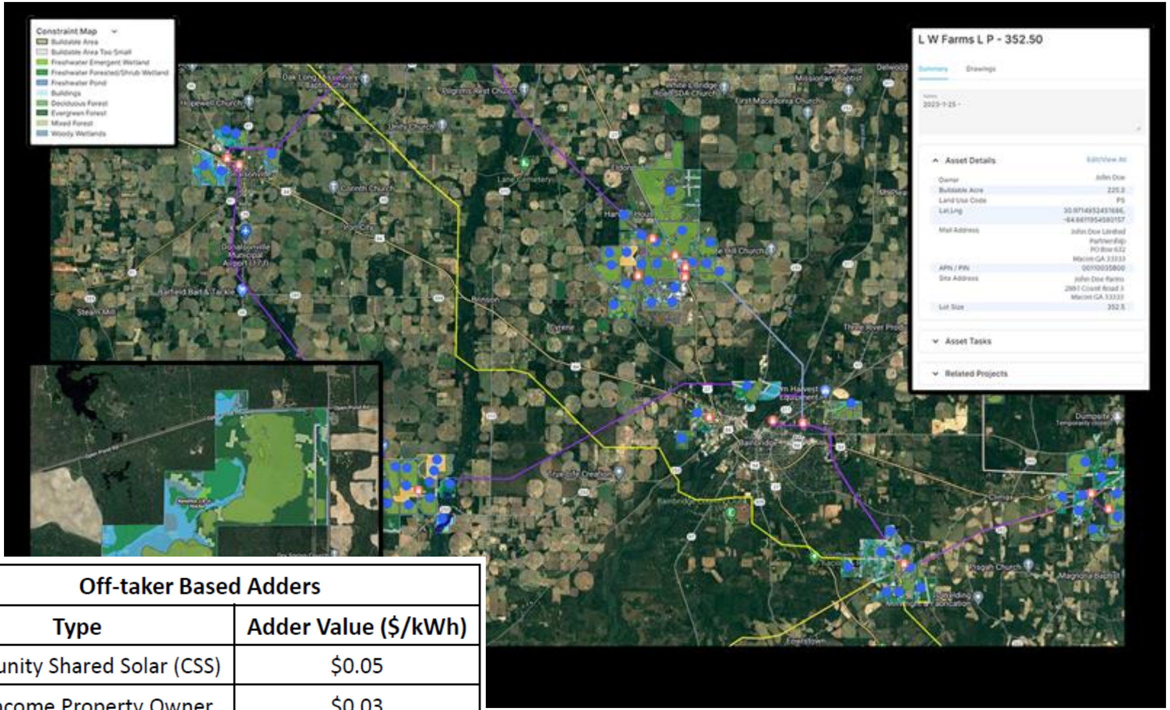
Better site management

Improving site acquisition

And incentivizing

‘Prefered project types’

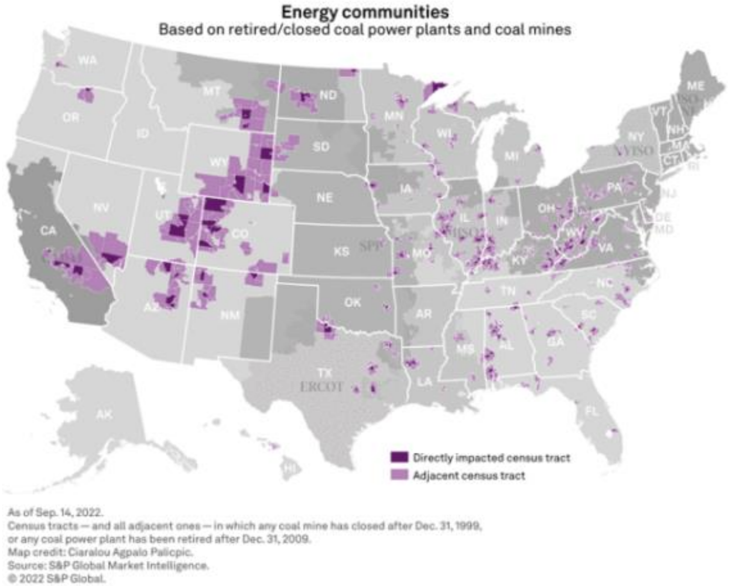
SMART in MA



Location Based Adders	
Type	**Adder Value ($/kWh)**
Agricultural	$0.06
Building Mounted	$0.02
Brownfield	$0.03
Floating Solar	$0.03
Landfill	$0.04
Solar Canopy	$0.06

Off-taker Based Adders	
Type	**Adder Value ($/kWh)**
Community Shared Solar (CSS)	$0.05
Low Income Property Owner	$0.03
Low Income CSS	$0.06
Public Entity	$0.02

Integrating other stakeholders and values



Biodiversity and Ecosystem Services

Tax benefits for locating

a project in an ‘Energy Community’

Thank you

U.S. DEPARTMENT OF
ENERGY

Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

Geothermal in Landscapes

Elisabet Metcalfe
Stakeholder Engagement and Communications Lead
Geothermal Technologies Office
August 22, 2024

Agenda

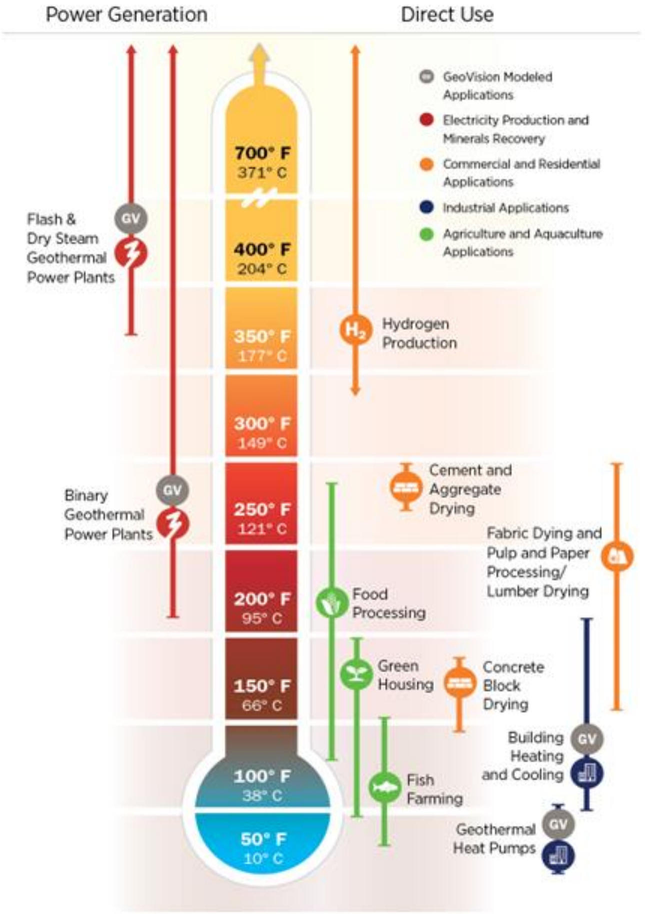
- Geothermal Energy Overview
- Benefits
- Geothermal District Heating and Cooling Overview and Examples
- Opportunities for landscape architects and designers
- How to Engage with GTO

What is Geothermal Energy?

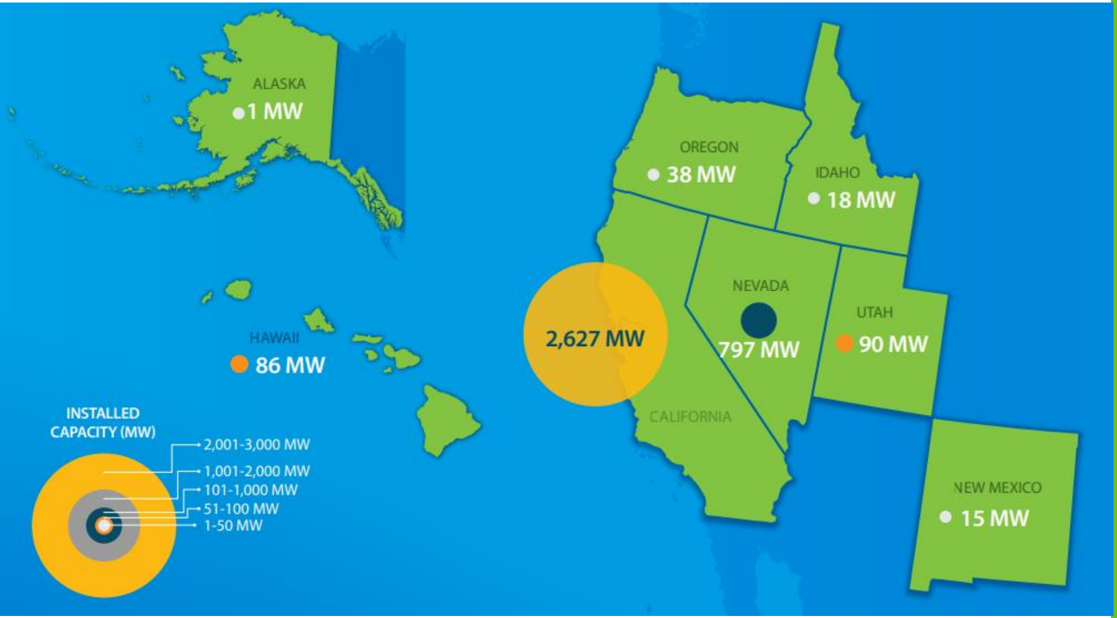
energy.gov/eere/geothermal/geothermal-basics

Geothermal Energy: So Many Hats!

Electric Power	• **High temperatures (>300°F)** • Wells up to many thousands of feet deep • Reliable, flexible, baseload grid power
Direct Use	• **Moderate temperatures (80-300°F)** • Wells hundreds to thousands of feet deep • Large buildings, agriculture
Heating & Cooling	• **Near-ambient temperatures (40-80°F)** • Shallow trenches to wells hundreds of feet deep • Residential, light commercial



Electricity Production



Renewable

Heat in Earth's interior is continually replenished and will be for billions of years.

Reliable and consistent

Geothermal is always available, regardless of the weather.

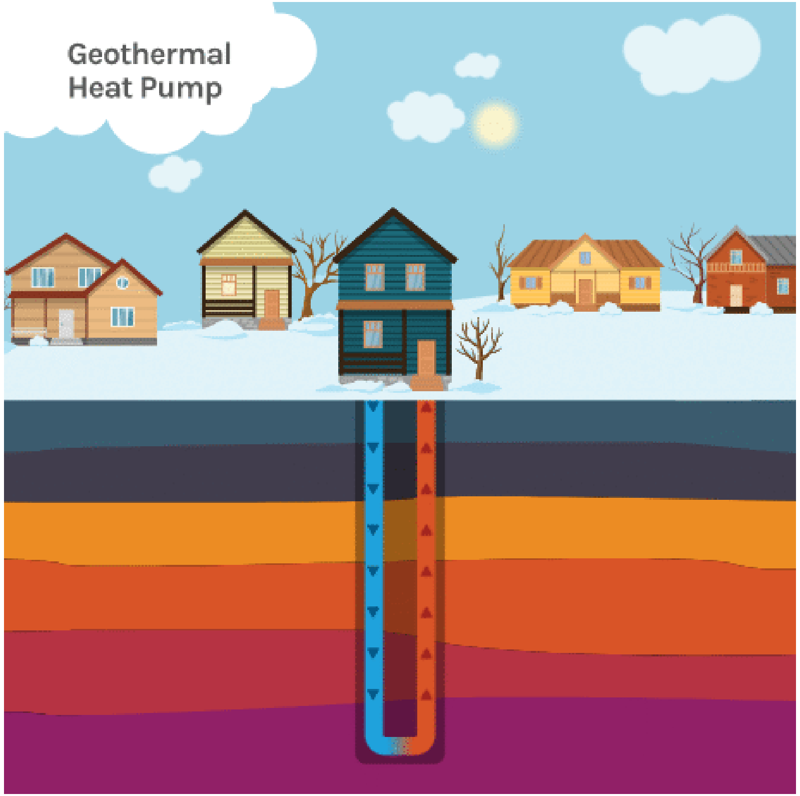
Clean

Using geothermal for power or heating and cooling emits little to no carbon.

Nationwide

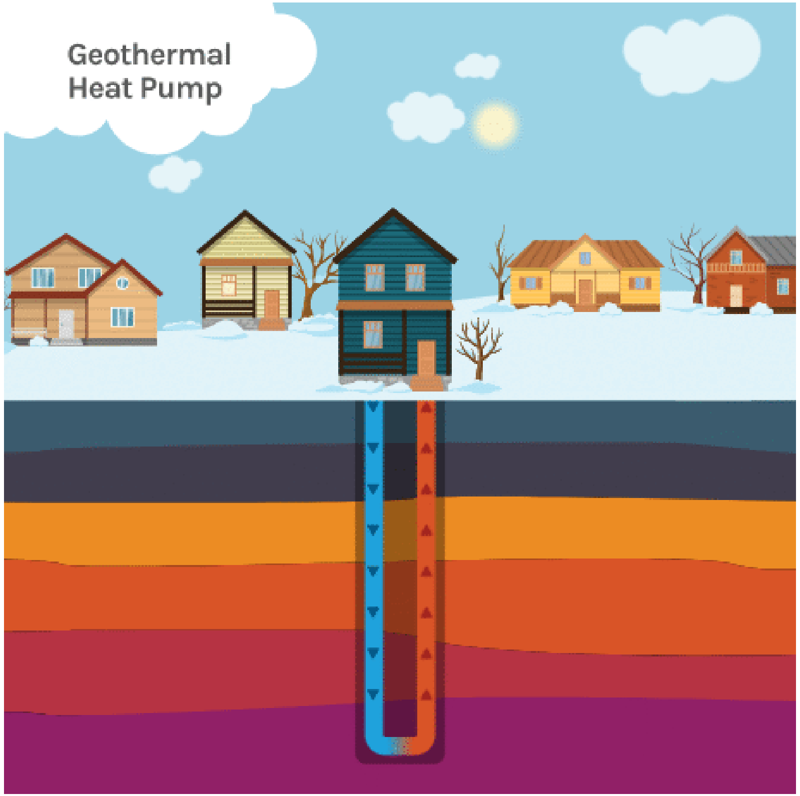
Geothermal heat exists everywhere in the United States!

Geothermal Heat Pumps



energy.gov/eere/geothermal/geothermal-heat-pumps

Geothermal Heat Pumps



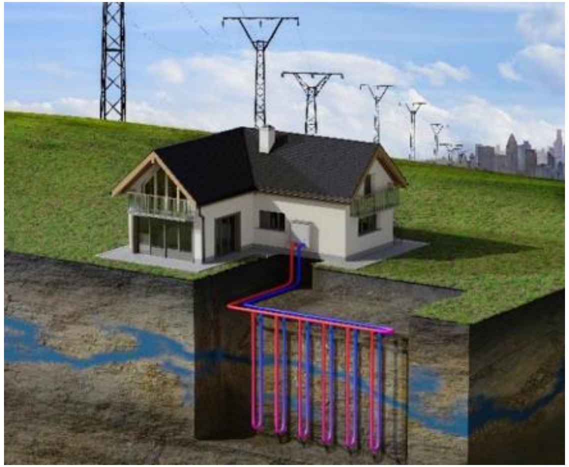
energy.gov/eere/geothermal/geothermal-heat-pumps

Take advantage of constant underground temperatures to efficiently exchange temperatures

- "Heat sink" in summer
- "Heat source" in winter

Three key elements in a GHP system:

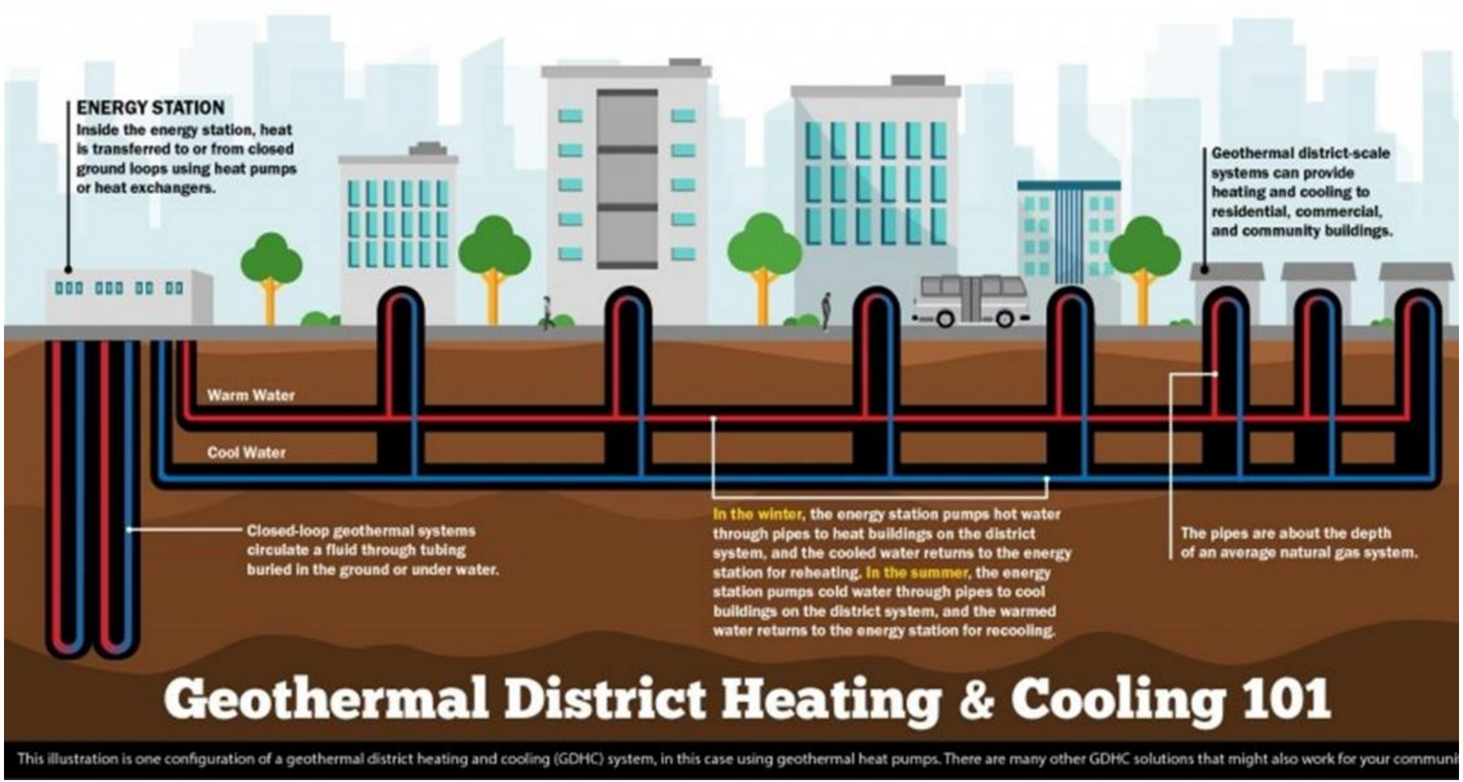
1. An underground heat collector
2. An indoor heat pump
3. A heat distribution subsystem (e.g., ductwork)



Not Seen and Not Heard

- Very little visual space is consumed by GHPs
- Outdoor component is buried (loops of pipes)
- Indoor component is a compact heat pump
- Vents and grates that you see in interior rooms are clean and unobtrusive
- No outdoor condenser
- Quiet operation with no need for sound barriers and acoustic treatments
- Preserves building aesthetics inside and out

These Can Scale UP!

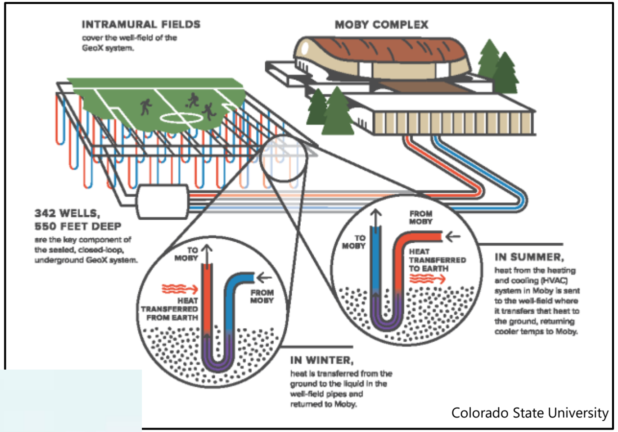


Whisper Valley, Texas

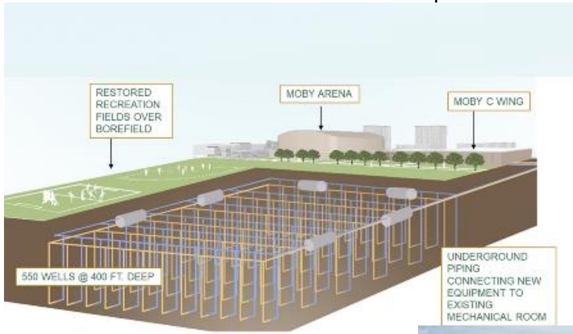
- Residential development near Austin, TX
- Geothermal hybrid system
- Distributed vertical boreholes connected to centralized pump house and cooling tower
- Coupled with solar power to electrify homes
- Reduces energy consumption of up to 80%
- Supports 700 acres of green space, wildlife habitat, organic gardens, pool/gym

Colorado State University

- Carbon neutral by 2040 and 100% renewable electricity by 2030
- 44 LEED certified buildings and 43 solar arrays
- GHP network installed in 2020
- Provides heating and cooling for 380,000 square feet of building space
  - 342 boreholes, 550' deep
  - 80 miles of pipe
- Lowest life cycle option for CSU when looking at replacing aging infrastructure



Colorado State University



https://source.colostate.edu/moby-geothermal-exchange/


https://www.coloradoan.com

Atlanta Braves Truist Park, Atlanta, GA

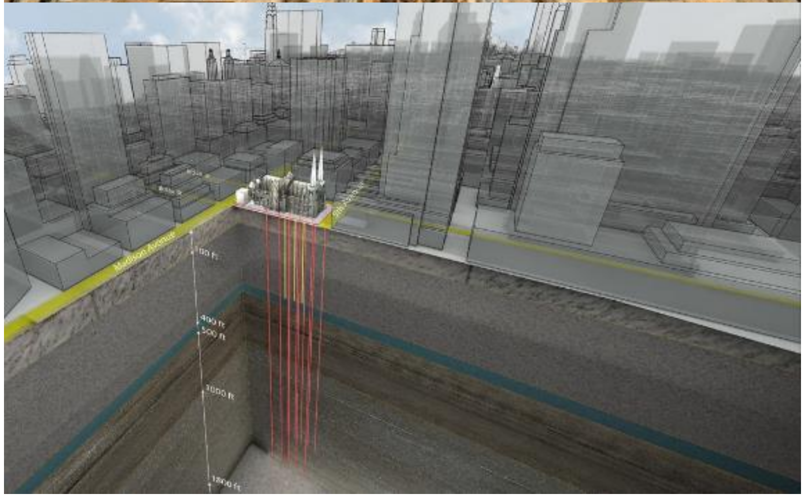
- Drainage, aeration, and geothermal-fed temperature moderation of the root zone for the nearly 130,000 square feet of sod.
- 20,600 linear feet of drainage pipe and 4,100 linear feet of irrigation pipe were installed along with more than a thousand feet of pipe for the geothermal system

https://csengineermag.com/having-a-field-day/

The Motz Group

Saint Patrick's Cathedral

- Construction started 1858; completed 1879
- 5 million+ annual visitors today; 76,000 square feet of space
- Oil-powered steam radiators installed ~1957
- GHP heating and cooling system replaced aging system in 2017
- 10-well standing column well system; depth of 2,200 feet
- Four wells run along 51st Street; remaining six run along 50th Street
- Eliminates cost of burning ~218 barrels of oil per year and reduces CO_2 emissions by 30%

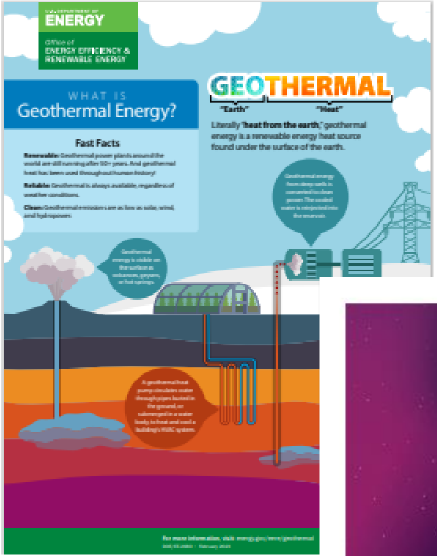


Sources: Dandelion Energy dandelionenergy.com/st-patricks-cathedral-geothermal-heating-cooling; PW Grosser pwgrosser.com/projects/geothermal-system-st-patricks-cathedral/; Renewable Energy Magazine renewableenergymagazine.com/geothermal/new-york-s-iconic-st-patrick-s-20170222

How to Engage with GTO

GTO is using multiple tools and resources to help spread the word about geothermal energy and engage with stakeholders.

- Funding Opportunities
- Updated Website
- Funding Opportunity Quick Guides
- The Drill Down
- Lithium Storymap
- Stakeholder Toolkits
- Infographics
- Project Postcards



Thank You!

Get the hottest geothermal news from ***The Drill Down***, GTO's monthly newsletter!

Sign up today: geothermal.energy.gov

U.S. DEPARTMENT OF
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Office of
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RENEWABLE ENERGY

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Distributed Wind Energy

August 22, 2024

Danielle Preziuso
Distributed Wind Lead
Socio-Technical Systems Engineer

U.S. DEPARTMENT OF ENERGY BATTELLE
PNNL is operated by Battelle for the U.S. Department of Energy

PNNL-SA-202715

Distributed Wind??

Distributed energy resources are technologies used to generate, store, and manage energy consumption for nearby energy customers.

Rooftop Solar Panels

Battery Storage

Smart Thermostats

And wind turbines!

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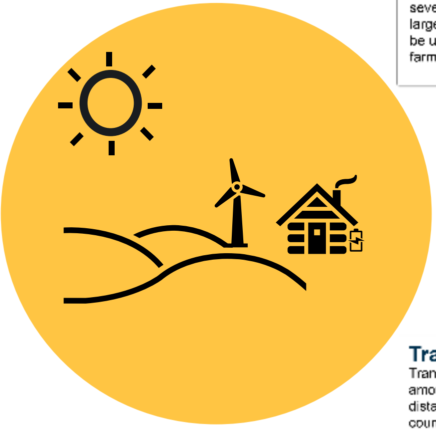
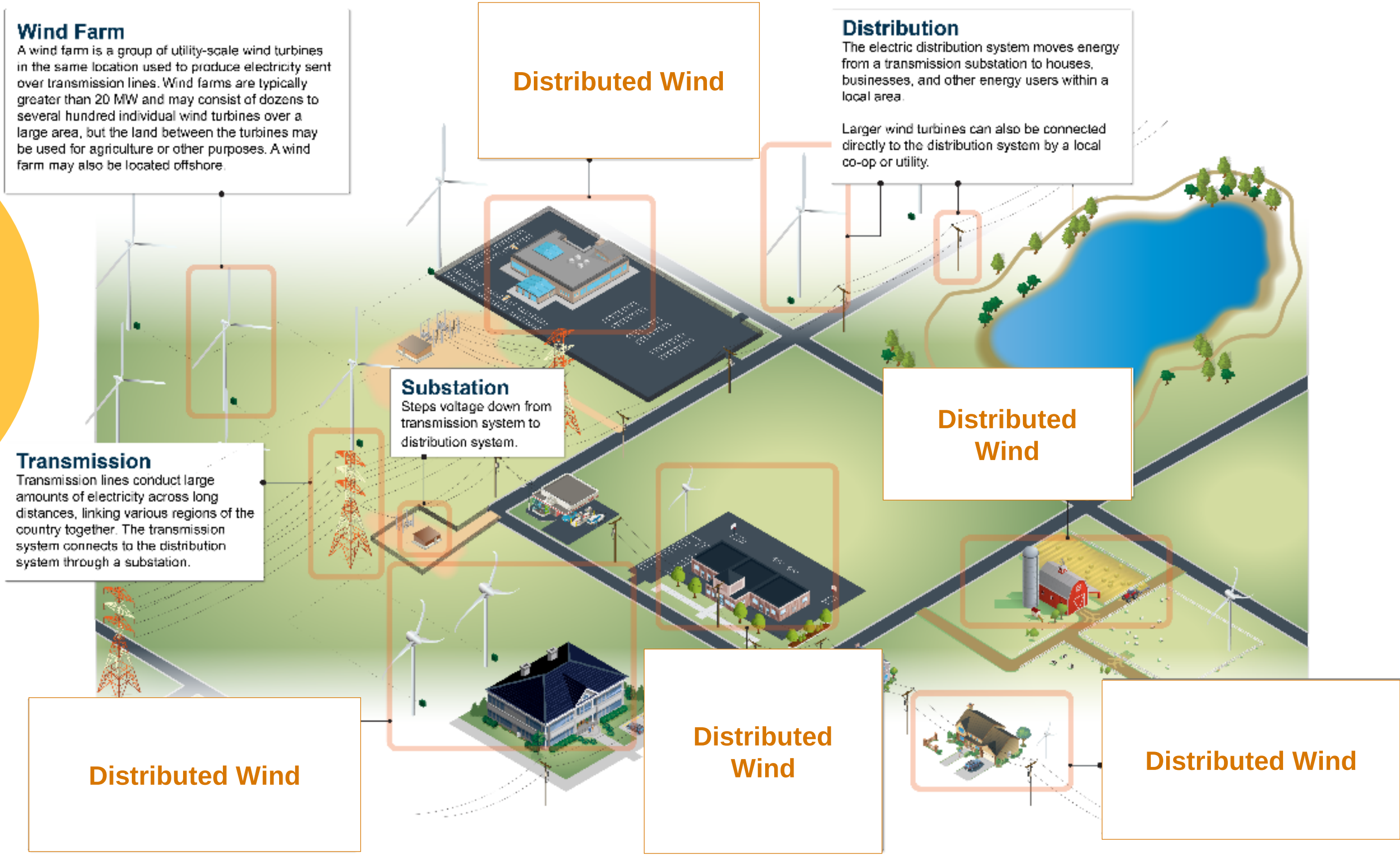
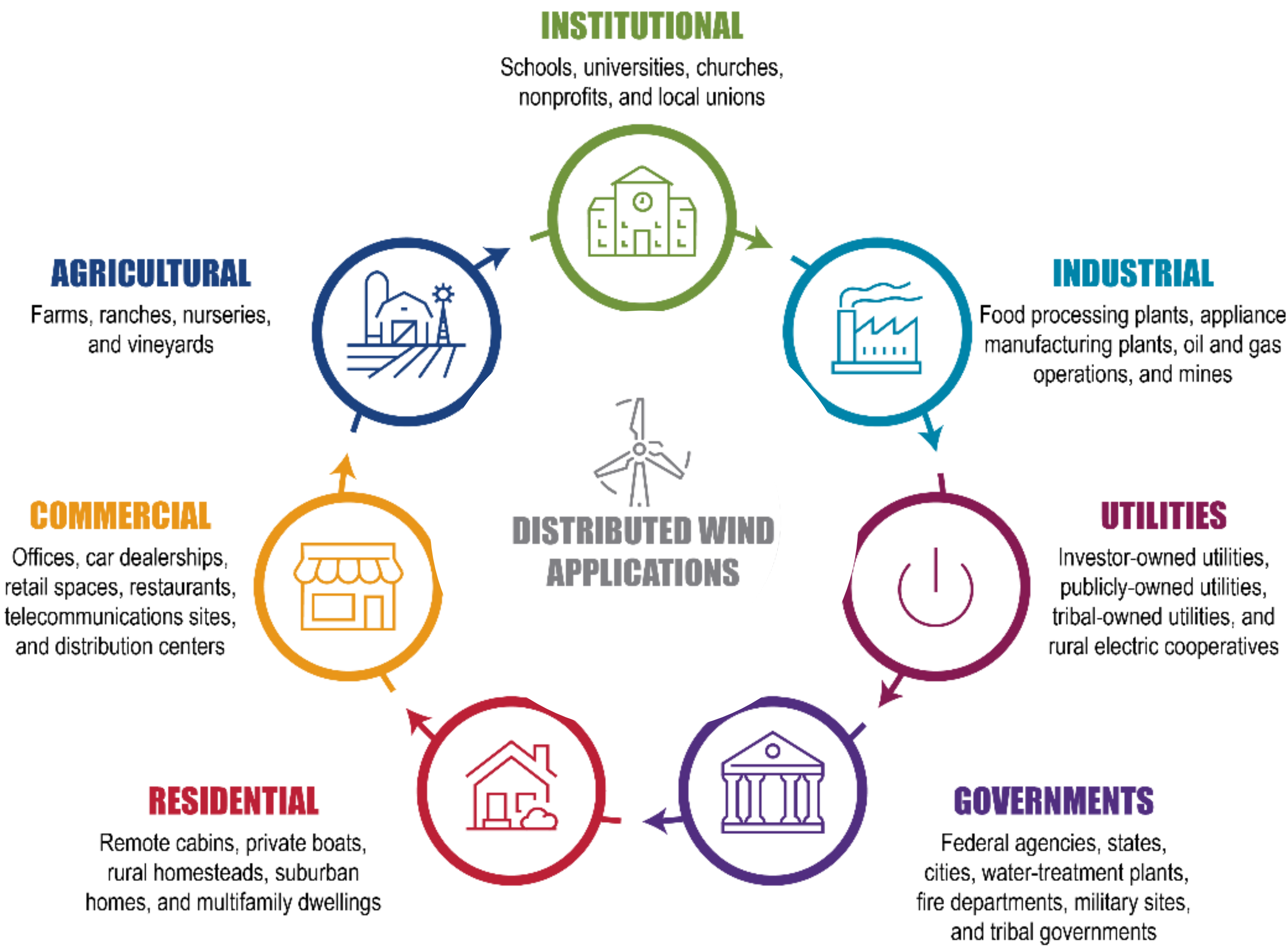
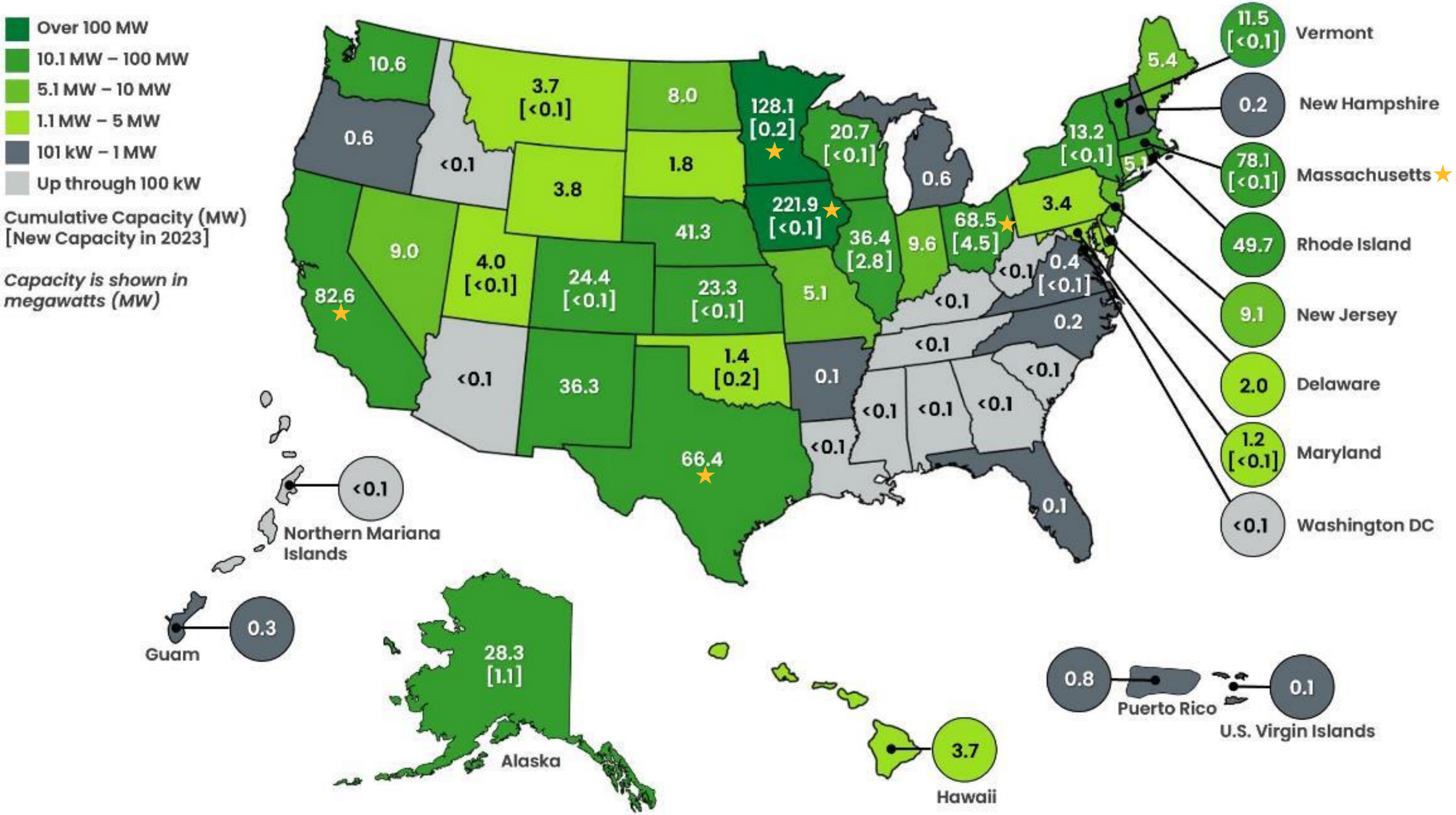




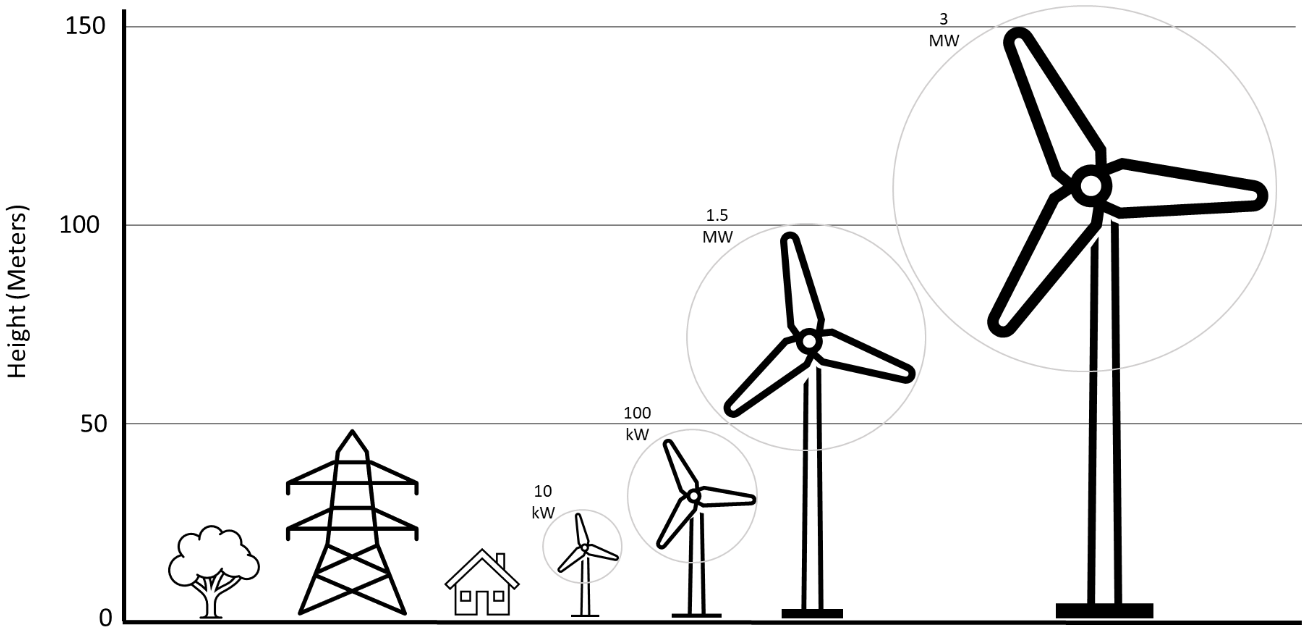
Applications and Customers



Current Deployment



Turbine Sizes



Adapted from Calautit et al. 2018. "A Review of Numerical Modelling of Multi-Scale Wind Turbines and Their Environment" Computation 6, no. 1: 24. https://doi.org/10.3390/computation6010024.

Small (≤100 kW)

Midsize (101 – 1,000 kW)

Large-scale, land-based (1,001 – 5,000 kW)

Small wind turbines are often deployed in rural settings and remote locations.

Anneliese Fensch / PNNL

Alice Orrell / PNNL

Joe DelNero / NREL

Pieter Huebner / Bergey Windpower Co.

Pacific Northwest NATIONAL LABORATORY

Small wind turbines can also be located near infrastructure when properly sited.

Padma Kasthurirangan

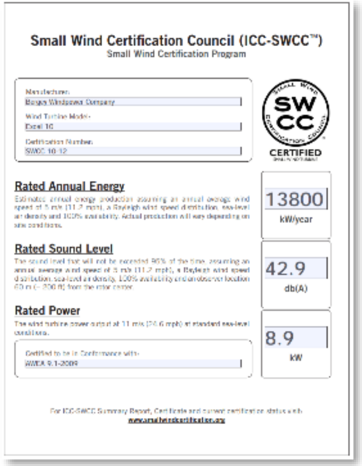
American Windpower

Important Notes on Small Wind Turbines

Building-Integrated and Rooftop Installations

Photo from LinkedIn

Certification



Small Wind Certification Council (ICC-SWCC™)
Small Wind Certification Program

SW CC CERTIFIED

Rated Annual Energy

13800 kW/year

Rated Sound Level

42.9 db(A)

Rated Power

8.9 kW

Building-Integrated and Rooftop Installations

Most turbines deployed on buildings and rooftops perform below expectations

Photo from Flickr 2874788682

- **Estimated Generation for 192 days:** 6,269 kWh
- **Actual Generation for 192 days:** 127 kWh
- **Cost:** $39,000
- **Payback:** None

Photo from Dave Jager / NREL

- **Estimated Monthly Generation:** 100 kWh
- **Actual Monthly Generation (March 2015):** < 1 kWh
- **Cost:** ~$100,000
- **Payback:** None

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Small Wind Certification

Small Wind Standards

IEC
AWEA AMERICAN WIND ENERGY ASSOCIATION
AMERICAN CLEAN POWER STANDARDS

Test Facilities

RE INNOVATIONS
WINDWARD ENGINEERING
UL Solutions
RENEWTEST LLC
NREL Transforming ENERGY

Certification Bodies

ICC-SWCC SMALL WIND CERTIFICATION COUNCIL
SGS
DEWI OCC
DNV

Applicant	Turbine Model	Certified Power Rating @ 11 m/s (kW)	Certification Standard
Bergey Windpower Company	Excel 10	8.9	AWEA 9.1
Bergey Windpower Company	Excel 15	15.6	AWEA 9.1
Eveready Diversified Products (Pty) Ltd.	Kestrel e400nb	2.5	AWEA 9.1
Eocycle Technologies, Inc.	EOX S-16	22.5/28.9	AWEA 9.1
HI-VAWT Technology Corporation/Colite Technologies	DS3000	1.4	AWEA 9.1
SD Wind Energy, Ltd.	SD6	5.2	AWEA 9.1
Wind Resource, LLC	Skystream 3.7	2.1	AWEA 9.1

https://www.pnnl.gov/distributed-wind/market-report/small-wind-turbine-certifications

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Midsize distributed wind turbines are often deployed to support commercial and industrial applications.

Mike Craft

Terry Spradley

Jacob Garbe // PNNL

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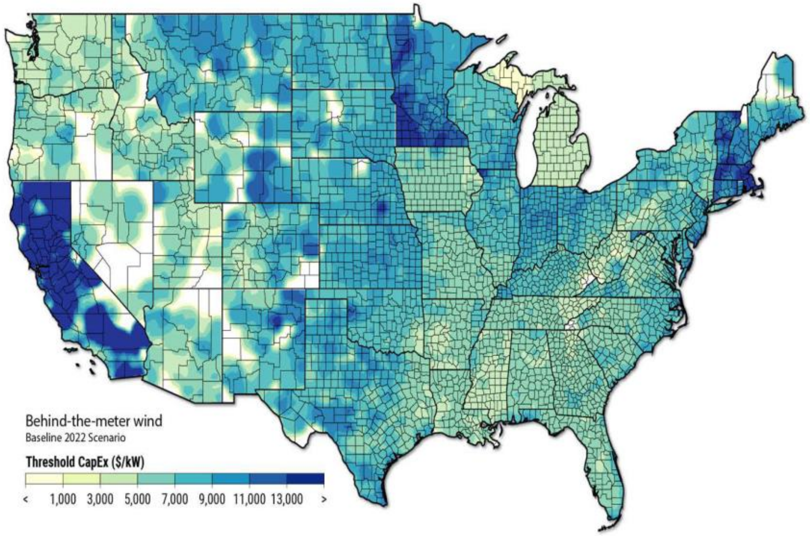
Large-scale wind turbines can be used in distributed applications; they have categorically fewer turbines relative to wind farms.

Opportunities and Challenges



Source: https://www.nrel.gov/analysis/distributed-wind-futures.html

- Lack of consideration of distributed wind
- Continued need for cost reductions and reliability improvements
- Local zoning and permitting ordinances
- Projects require breaking ground

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Thank you!

danielle.preziuso@pnnl.gov

Join us for the 2024 Distributed Wind Energy Summit!

Virtual – September 17th

RENEWABLE ENERGY

A CRASH COURSE FOR LANDSCAPE ARCHITECTS