BLUEWAVE

Maine Agrivoltaic Overview

Developing Sustainable Solar for Farm Country

BLUEWAVE

Founded in 2011.

OUR MISSION

Revolutionize energy with simple, powerful solar solutions.

OUR VISION

Protect the planet by transforming access to renewable energy.

WHY ARE WE HERE?

Introduction

Solar is getting rapidly deployed across the country as states like Maine ramp up clean energy goals. Significant portions are getting built on farmland, where it is typically easier, cheaper, and simpler to build. In result, tensions are growing due to the temporary loss of farmland and displacement of farmers and associated agricultural productivity. If solar is to grow responsibly and at scale in rural areas, innovations are needed to ensure that both uses can co-exist. However, regulatory and financial hurdles remain.

Approach

Rather than put solar and farming at odds with each other, BlueWave is developing projects that promote both uses on the same plot of land. Such multi-use solar projects, commonly referred to as “dual-use solar”, are increasing in popularity due to the benefits accrued to the land, surrounding agricultural community, and environment. Maine now faces questions on how to encourage the approach.

Dual-Use Philosophy

Principally, “dual-use” is an emerging land planning and solar development framework that respects land as a natural asset and seeks to manage it with ecosystem health and agricultural productivity top of mind. By weaving complementary land uses into solar management, dual-use helps to ensure continued farm production while promoting healthier soils, ecology, and hydrological function. This directly benefits farms, rural communities, and the environment via carbon sequestration, pollination, water filtration, and other “ecosystem services”. In turn, dual-use sets stage for more holistic community development.

FRAMING THE CONVERSATION

First question we should ask ourselves (and each other) is – what do we <u>want</u> as a collective?

Assuming that's more clean energy…

Everyone here would also agree that:

- Farmland loss is bad
- Economic disparities are bad
- Health disparities are bad
- Deficient food access is bad

Which would imply that:

- Farmland preservation is good
- Economic opportunity is good
- Healthy communities are good
- Access to healthy food is good

We want these things too, right?

Let's start here.

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Second question we should ask ourselves (and each other) is – how do we get there together?

Financial / regulatory hurdles make dual-use incentive highly unlikely…

- Discussion between regulatory mechanisms vs. voluntary approaches.
- Maine has golden opportunity to show how voluntary dual-use market works.

This is worth considering.

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How can I help?

AGRIVOLTAICS IN MAINE

WHY WHOULD YOU BE INTERESTED?

- Approach Is Here to Stay Because It Is Proven
- Opportunity to Put New Ideas Into Practice and Reach for Goals
- Access to Resources, New Opportunities, and Partnerships
- Promote Holistic Rural Development and Create Shared Value
- Preserve Farmland and Support Next Generation of Farmers
- Be Part of Rural Energy, Agricultural, Environmental Solutions
- Growing Policy / Market Interest, Collaborative Networks

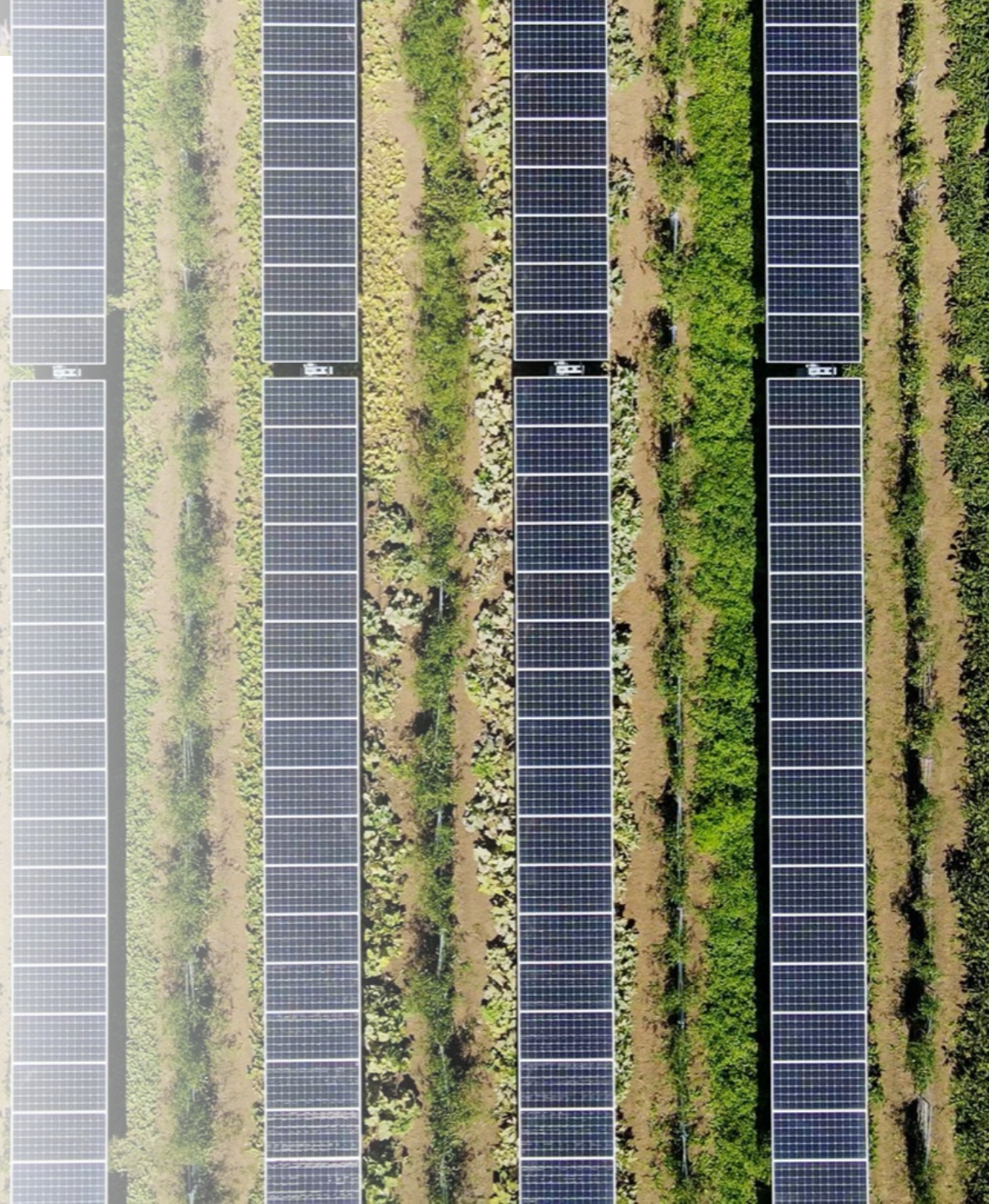
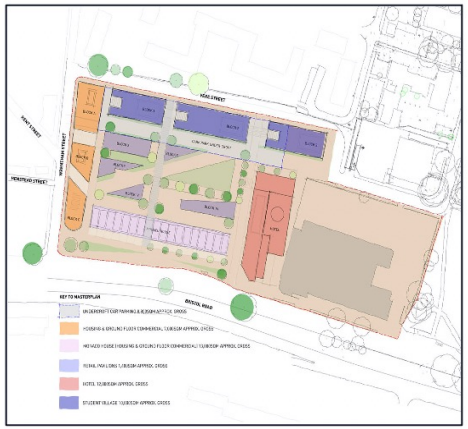


Image Source: Jack's Solar Garden

SUSTAINABLE SOLAR

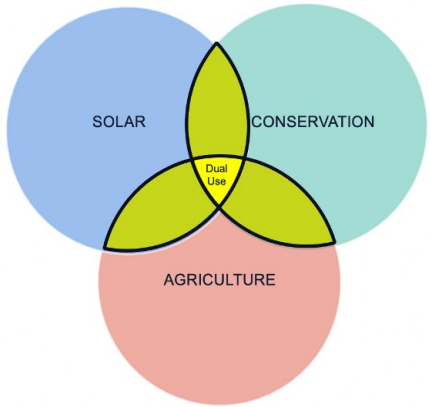
PLANNING LAND EFFICIENTLY FOR MULTIPLE USES

Urban Development Context



Sprawl vs. Mixed Use

Rural Development Context



Standard Solar vs. Multiple Uses

SUSTAINABLE SOLAR ("DUAL-USE")

Definition
Combines solar with land management philosophies rooted in conservation and agriculture to create a multifunctional system with a variety of ecological, agricultural, and energy benefits.

Pollinator-Friendly
Solar sites that maintain or seed wildflowers, pollinator-friendly plants, and native species to create habitat for native pollinators to thrive in.

Grazing
Solar sites that incorporate livestock grazing (e.g. sheep) and forage as part of the overall landscape maintenance plan to replace mowing.

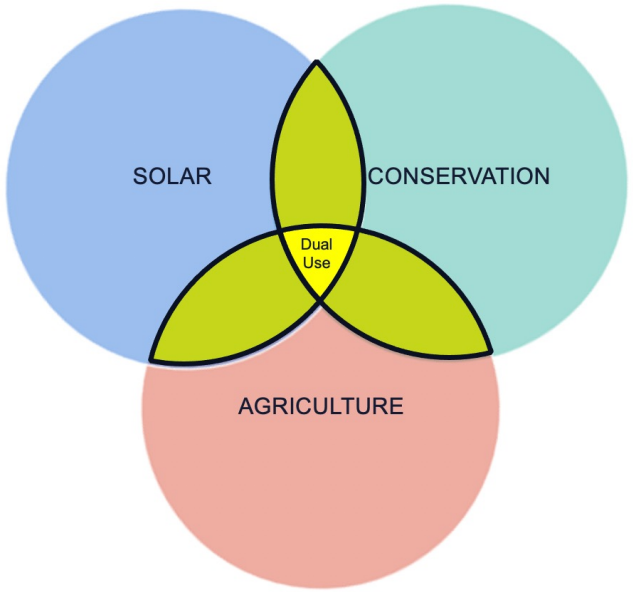
Agrivoltaics
Solar sites that facilitate crop cultivation and other labor-intensive farm plans underneath and around the panels (e.g. via people and equipment)

Conservation
Solar sites designed in consultation with conservation groups focused on restoring ecosystem integrity / vitality via on-site and off-site measures.

SUSTAINABLE SOLAR APPROACH

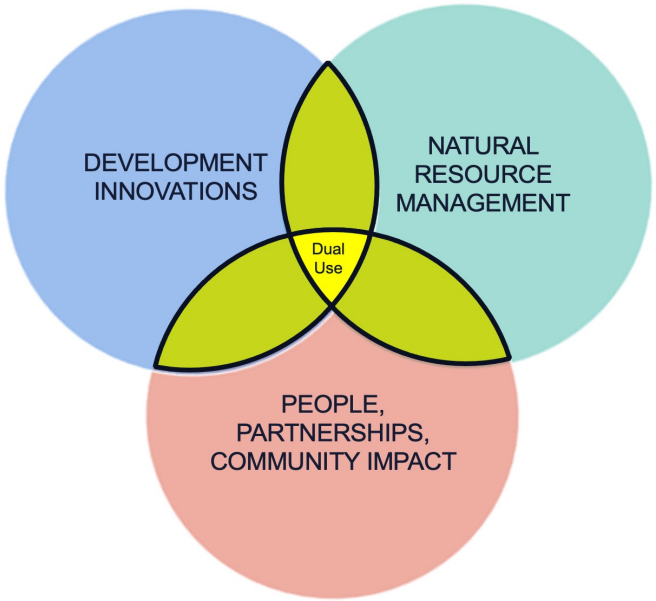
CREATE COLLECTIVE IMPACT THROUGH SHARED VALUE

CONVENE SECTORS



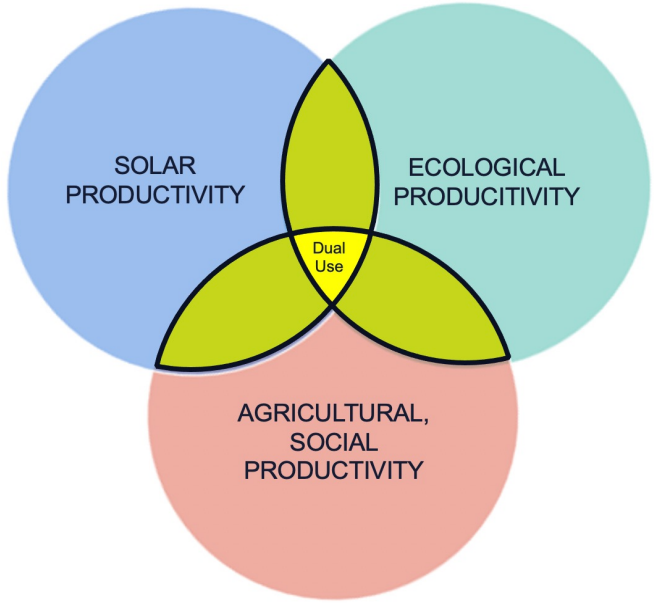
- Recognize **all groups can go further together**
- Commit to **problem-solve collectively**
- Engage **between groups, across value-chains**
- Identify **backbone organizations for support**

DEFINE SHARED GOALS



- Improve **siting, design, development, operations**
- Drive **on-site, off-site ecological improvements**
- Keep **farmers on property, involved, and productive**
- Impact communities via **well-crafted partnerships**

CREATE SHARED VALUE



- Focus **project-, portfolio-, community-, policy-level**
- Measure via **hybrid-metrics across sectors**
- Clustered **community benefits along value chains**
- Promote **continuous open dialogue and refinement**

SUSTAINABLE SOLAR ("DUAL-USE")

GOALS FOR ADVANCING THE BUSINESS MODEL

Steer solar and farming toward climate-, ecology-, people-centered ethos

Help farmers expand production, stack benefits, improve land and livelihoods

Prove "best-in-class" principles to develop solar on farmland

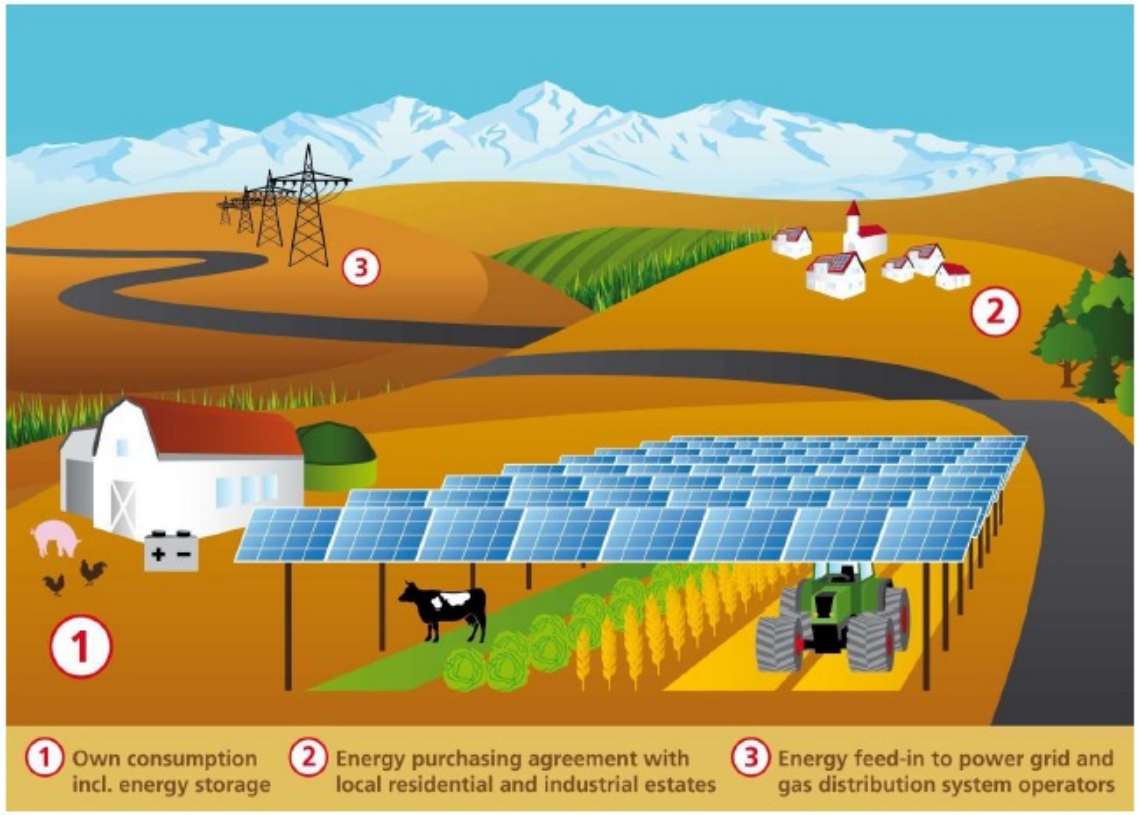
Leverage scale of design, transactions, and portfolios to drive innovation

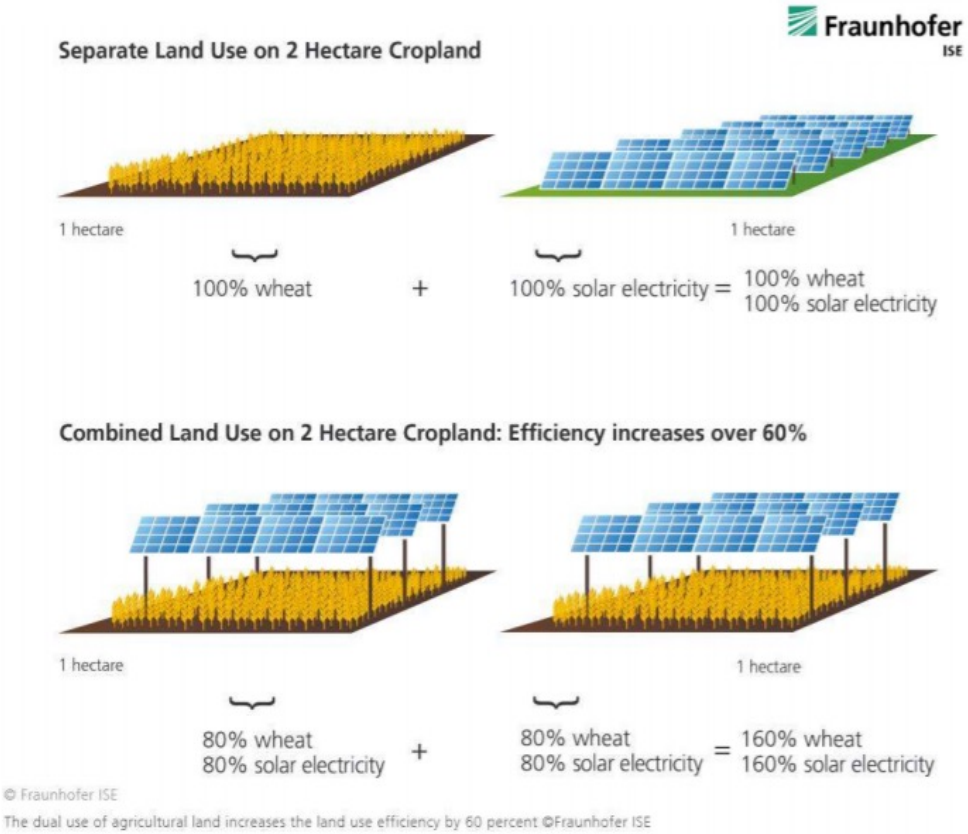
Convene designers, equipment vendors, epc's, and financiers

Contribute to bodies of research in both agriculture and solar development

AGRIVOLTAIC SOLAR

ACHIEVING MORE WITH THE SAME LAND





Combining uses will allow for greater total output over same acreage versus each use standing alone.

AGRIVOLTAIC SOLAR

DUAL-USE

Co-locating agricultural production with solar projects specifically designed to encourage increased productivity

Siting

- To be agriculturally compatible, site and soils must be capable of sustaining long-term production of commodity crops, vegetables, specialty crops, or forage for grazing of livestock.
- Respecting historical agricultural context of site and surrounding community is important.

Design

- Project meets agrivoltaic standard if designed in consultation with farmer to ensure farming flexibility throughout project life while minimizing land-use impacts / promoting good practices.
- Growing conditions, panel clearance, row width, equipment logistics, and fence placement are key.

Construction

- Construction is minimally impactful and incorporates agriculturally-friendly decompaction, site stabilization, and stormwater maintenance strategies.
- Follow-up land preparation and farm infrastructure continues to prepare soil and operation for season.

Maintenance & Support

- Maintenance plan is developed in cooperation with farmer to ensure compatibility with planned agricultural activities on site and to minimize disturbance to animals or crops.
- Good reporting, insurance, and communications protocols are important for smooth relationship.

Community Impact

- Farmland preservation, improved and diversified farm production, community economic benefits.
- Education, training, and employment opportunities for new and existing farmers.
- Bringing three-phase power to rural areas and associated spillover benefits.

AGRIVOLTAIC SOLAR

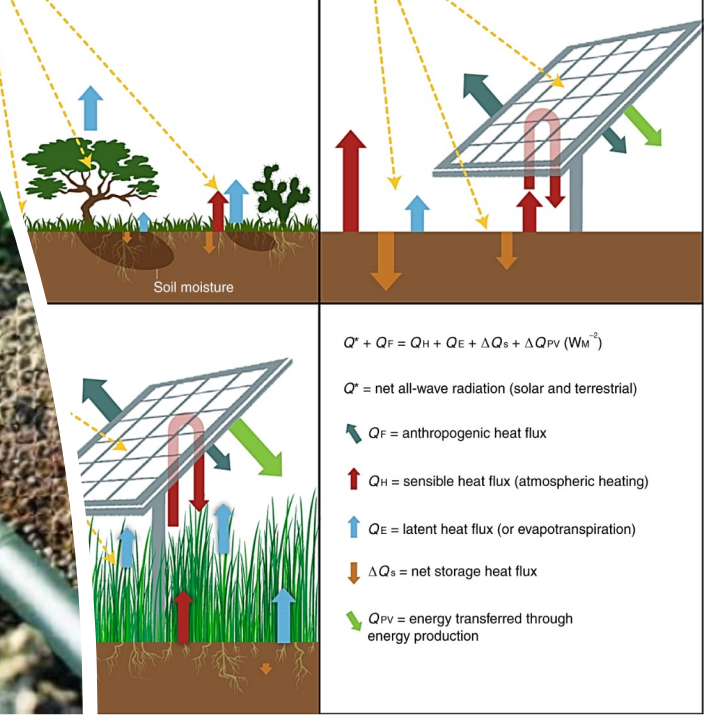
CONSIDERATIONS FOR GROWERS

ADVANTAGES

- **Microclimate benefits by moderating environment** (e.g. sunlight, temperature, moisture retention)
- **Help crops through extreme weather events** (e.g. wind, heavy rain, hail, heat waves)
- **Reduces need for watering** (i.e. greater moisture retention and water use efficiency)
- **Improve farm economics** via winter income, resilient crops, diversification, optionality (e.g. partial-shade in open fields)
- **Provides farm infrastructure** for variety of crop plans and growers (e.g. fencing, water access, on-site power, etc.)

RISKS

- **Long-term change to farming philosophies, conditions** (e.g. departing from established norms and certainties)
- **Investments in equipment, business models needed** (e.g. new dimensional, logistical, input considerations)



AGRIVOLTAIC SOLAR

CHALLENGES AND OPPORTUNITIES

Challenges

- **Moving From Research to Commercialization** – Risks inherent with new concepts but widespread precedent exists (e.g. 2.9 GW built worldwide, research via national labs, universities, private companies, elated agronomic research)
- **Winning Over Skeptics** - Perceptions of standard solar on farmland must be overcome with demonstrated innovation, replicable precedents, and persuasive evidence
- **Multiple Moving Parts / Added Costs** – Less density and added steel, labor, and infrastructure costs along with managing a farm operation adds complexity

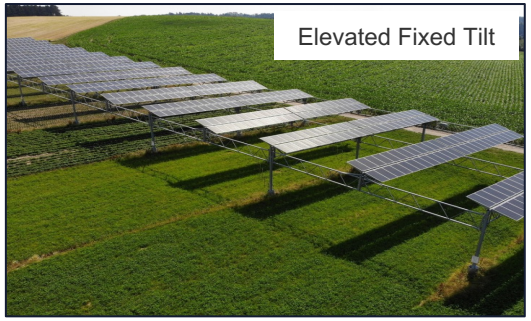
Opportunities

- **Solar + Agricultural Synergies** – productivity improvements on both sides will allow model to scale
- **Regenerative Agriculture** – low-impact practices naturally align with solar asset management / carbon negative farming
- **Research, Education, and Technology** – synergies between these areas will open new areas of pedagogy
- **Consumer engagement** – linking farmers and farm products with community solar will open new markets
- **Community Development** – identifying and linking intersectional priorities will drive value in related areas

AGRIVOLTAIC SOLAR

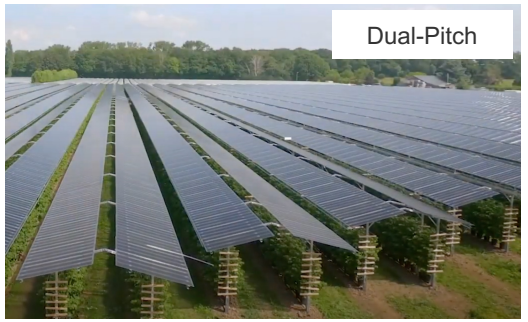
DIFFERENT DESIGN APPROACHES

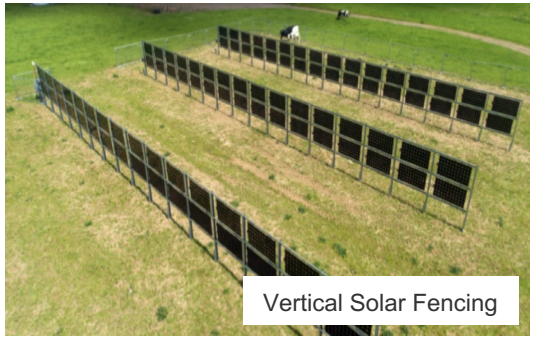
Fixed-Tilt



Trackers

Novel





AGRIVOLTAIC SOLAR

DOMESTIC EXAMPLES

FEDERAL

- National Renewable Energy Laboratory >> public/private research network (InSPiRE) with wide variety of pilot sites
- Department of Energy >> agrivoltaic research grants for collaborations across disciplines (e.g. BlueWave, UMass, American Farmland Trust)

COLORADO

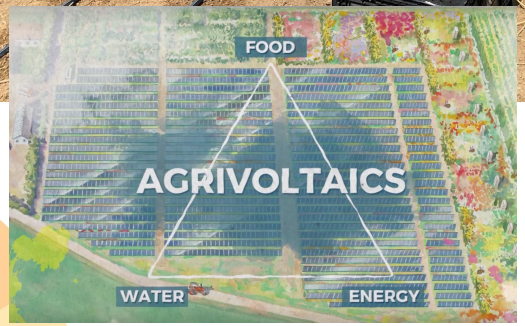
- First commercial-scale agrivoltaic community solar project in the country, Jack's Solar Garden (JSG) >> national significance
- JSG is a collaboration between University of Arizona, Colorado State, NREL, private landowner / solar developer, and partner growers
- Demonstrates farm plan efficacy, new farmer training, and educational curriculum at food/energy/water nexus; typical SAT design

NEW JERSEY

- Bill authorizes 200 MW agrivoltaic pilot program encouraging research collaborations across disciplines; rules under development

NEW YORK

- NYSERDA "Smart Solar Siting" scorecard encourages dual-use for utility-scale projects; ranked system will encourage hierarchy of outcomes



Byron Kominek
JSG Founder

Brittany Staie
Sprout City
Farm Manager

Boulder County
NREL NATIONAL RENEWABLE ENERGY LABORATORY
Colorado State University
ARIZONA
Colorado Agrivoltaic LEARNING CENTER
CITY OF BOULDER
Sprout City Farms
Audubon ROCKIES

AGRIVOLTAICS DOMESTICALLY

BLUEWAVE EXAMPLES

ROCKPORT BLUEBERRY PROJECT (VOLUNTARY)

- Standard fixed-tilt solar located on top of existing wild blueberry patch (bi-facials)
- Hosting crop trials over half site in partnership w/ local grower and UMaine
- Research impacts of construction on existing berries, growing conditions, yield
- Grower will manage crop trial for 5 years for prod. subsidy / equip. investment
- Interdisciplinary partnership will inform best practices on all sides

GRAFTON AGRIVOLTAIC PROJECT (REGULATORY)

- Two elevated fixed-tilt agrivoltaic canopies located on 5th generation farm
- Modified design allows for greater sunlight access and maneuverability
- Ground crops / crop trials + rotational grazing / soil carbon study + holistic study of farm
- Intermediary farm manager will oversee agricultural operation / compliance
- Farm infrastructure, operational subsidies provided for subtenant farmers
- Interdisciplinary partnership involves federal, state, university, NGO, private sectors

AGRIVOLTAIC SOLAR

INTERNATIONAL EXAMPLES

JAPAN

- Agrivoltaics emerged around 2004 and have now grown to encompass 2000+ projects nationwide covering 120+ crops; national siting policy

GERMANY

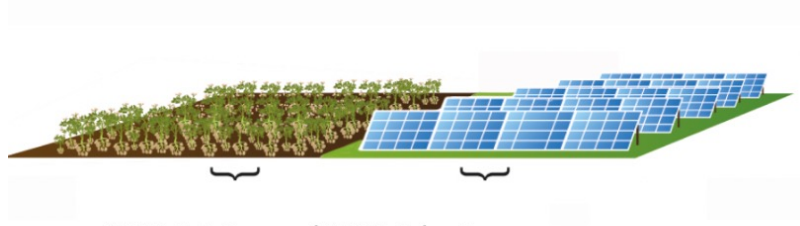
- Fraunhofer Institute agrivoltaic crop trials since 2014 (winter wheat, celery, potatoes, grass clover); crops maintained > 80%

FRANCE

- Cluster of agrivoltaic companies have emerged with the support of national government (e.g. Sun Agri, Ombrea)
- Large-scale energy procurements are seeing agrivoltaic projects with sophisticated crop plans (e.g. vineyards, orchards)

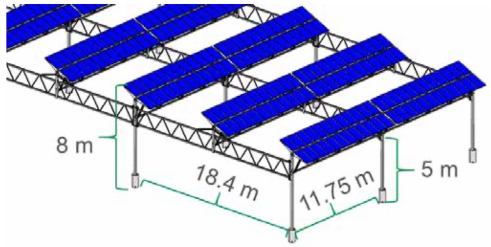
OTHER COUNTRIES

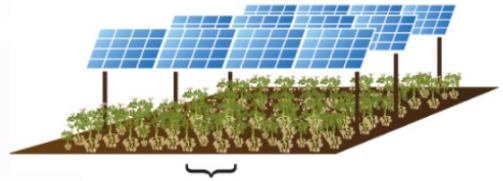
- Portugal launched $10 million agrivoltaic program to spur innovation
- Spain utilities are developing projects with standardized crop plans (e.g. red peppers, broccoli, artichokes, thyme, pitayas, sage, oregano, rosemary, lavender, coriander, broccoli, cauliflower etc.)
- Italian utilities are implementing crop trials in partnership with growers; national gov't announced 2.5 GW agrivoltaic initiative



100% Potatoes and 100% Solar Power

Sketch of agrivoltaic research plant in Germany





103% Potatoes
83% Solar Power
> 186% Land Use Efficiency

Proposed agrivoltaic tracker in Italy with olive trees and aisles designed to accommodate automated equipment

Agrivoltaic project in France with hay cultivation

Agrivoltaic project in Belgium over pear orchard

BENTON PROJECT OVERVIEW

OVERARCHING GOALS, CONCEPTUAL ELEMENTS

1. **Provide Farmers a Permanent Place in Solar O&M** – create pathway for farmers to lead the way toward more harmonious relationship between solar and agriculture by supporting the development of viable farm plans that can co-exist with solar operations.

2. **Implement Crop Trial** – dedicate 5 acres of larger 32-acre site to crop trials TBD with partnering farmers and researchers interested in sustainable agricultural practices.

3. **Design Project With Agriculture in Mind** – build dimensions that can accommodate wide variety of farm plans via panel aisles and heights of sufficient clearance, farm infrastructure, and ample space for vehicular circulation.

4. **Defray Production Costs to Encourage Innovation** – provide farm infrastructure (fencing, water) and agricultural production payments (5 years) to lower barriers to entry and support entrepreneurship.

5. **Support On-Farm Research** – provide means to measure, test, and understand efficacy of growing environment, crop productivity, cultivation techniques, and other elements for successful farming.

6. **Support Long-Term Partnerships** – create sustained support via institutional partnerships spanning agricultural, energy, private, public, research, and non-profit spheres.

7. **Marketing Outcomes to General Public** – generate support for agrivoltaics and farming via strategies that highlight benefits to stakeholders including agricultural / electricity customers, advocacy groups, education sector, new farmer training organizations, policy and government, and others.

The site is currently a hay field similar to above.

Row cropping is encouraged

BENTON PROJECT OVERVIEW

CONCEPTUAL SITE PLAN

Vehicular maneuverability

Space for row cropping

Interior fencing

Water access provided

Optimizing techniques for trackers

BENTON PROJECT OVERVIEW

NEXT STEPS

PROCESS

- Vet permitting and regulatory expectations with local boards and state agencies having jurisdiction
- Set nominal budget aside via underwriting in agreement with transaction parameters and investor requirements; minimal design impacts
- Create “welcome mat” for interested farmers via design, resources, partnerships, real estate access, and consideration in O&M agreements
- Network with interested farmers and other partners to prioritize efforts around crop trials, research, farmer training, enterprise planning, etc.

FARM PLANNING AND REQUIREMENTS

- Selected farmers will be invited to refine farm plans with BlueWave, its agricultural partners, and long-term project owner
- Agreements will be negotiated to finalize details re: site access, financial support, and parameters for farm logistics, safety, and reporting
- Farmer recruitment will occur until all 5 acres are accounted for

AGRIVOLTAIC SOLAR

CHALLENGES AND OPPORTUNITIES

Standard Solar Cost Drivers

- Site Control
- Interconnect Study
- Survey/Design/Eng.
- Geotechnic Study
- Permitting
- Business Agreements
- Financing Costs
- Solar Construction
- Grid Construction
- Land / Equip Taxes
- Land Rent
- Standard O&M

Agrivoltaic Costs (Solar)

- Design Adjustments
- Added Civil Work
- Land Preparations
- Added Solar O&M
- Added Solar Insurance
- Solar Operation Adjust.
- Business Agreements
- Reporting/Compliance

Agrivoltaic Costs (Ag)

- Farm Infrastructure
- Farm Equipment
- Land Preparations
- Added Farmer Risk
- Added Farm Insurance
- Business Agreements
- Farm Manager
- Labor Pipeline/Training
- Ag Research
- Food Safety
- Inputs
- Water Permits/Records
- Pesticide Records
- Integrated Pest Mgmt
- Reporting/Compliance
- Crop Loss
- Crop Marketing

Agrivoltaic Ideas for Maine

- Siting / Permitting
  - Local Bylaws
  - Permitting Certainty
- Tax Policy
  - Ag Use Relief
- Pilot Initiatives
  - Crop trials (Benton)
  - Strategic Farm Plans
  - “Welcome Mat”
  - Scorecard
  - PPA + Certification
- Strategic Farm Plans:
  - Profitable
  - Scalable
  - Local/Region Value
- Econ Dev’t Planning
  - Asset Mapping
  - Program Alignment
  - Network Formation

Stakeholders to Involve

- Solar Developers
- Solar Industry Reps
- Farmers
- Agricultural Companies
- Agri-Trade Groups
- Farm Access Orgs
- Farmer Training Orgs
- Agricultural Extensions
- Universities/Vocational
- Local/Regional Planning
- Anchor Institutions
- Corporate Community
- Community Banks
- Farm Credit East
- ME Department of ACF
- USDA
- NRCS
- NREL Agrivoltaic Group

BLUEWAVE

Stay in Touch

Drew Pierson
Independent Consultant
(e) pierson.drew@gmail.com
(p) 330.715.1579