SOLAR ON AGRICULTURAL LANDS—PRESERVING POLLINATOR HABITAT AND SOIL HEALTH

THURSDAY, MAY 21, 2020
3:00 PM ET / 2:00 PM CT / 1 PM MT / NOON PT
Hosted by NCSL’s Natural Resources and Infrastructure Committee

- Who Decides a State’s Energy Mix?
- New WOTUS Rule & States Response to Jurisdictional Changes
- Solar on Agricultural Lands – Preserving Pollinator Habitat and Soil Health
- State Legislative Trends: Traffic Safety
- What’s Exceptional? State Efforts to Meet Clean Air Standards

For more information on the webinars and how to register visit NCSL’s Webpage
SPEAKERS

- Jordan Macknick
  National Renewable Energy Laboratory

- Maggie Clark
  Solar Energy Industries Association

- Gerry Palano
  Massachusetts Dept. of Agricultural Resources
Solar on Agricultural Lands: The DOE InSPIRE Project

Jordan Macknick

NCSL Natural Resources and Infrastructure Committee 2020 Spring Webinar Series
May 21, 2020
Land Use of Achieving SunShot Solar Deployment Goals

2030: 3 million acres
2050: 6 million acres
Challenge: Farm Profitability

Gross farm income, production expenses, and net farm income, inflation adjusted, 2000-19F

$ billion (2019)

- Gross farm income
- Production expenses
- Net farm income

Note: F = forecast. Values are adjusted for inflation using the chain-type GDP deflator, 2019=100.
Data as of March 6, 2019.

Farm profitability remains a challenge

American Bankers Association and the Federal Agricultural Mortgage Corporation release results of joint survey.

The next money crop for farmers: Solar panels

Ground mounted solar: What does it look like?

Photos courtesy of Rob Davis, Fresh Energy
Vision: Low-Impact Solar Development

Photos courtesy of Rob Davis, Fresh Energy; Dennis Schroeder, NREL
InSPIRE Project Overview

Low-impact site preparation
Pollinator and native vegetation solar
Solar-agricultural co-location

Department of Energy Funded (2015-2021)
Extensive Industry Partnerships
Field and Analytical Modeling Work
InSPIRE Project Overview

Field-based research topics:
1. Economic viability of solar-agriculture co-location configurations
2. Increasing agricultural yields in arid environments
3. Energy, water, and food security in remote, off-grid areas
4. Pollinator habitat and ecological services

Analytical research topics:
1. Satellite imagery analysis of current land groundcover practices
2. Cost-benefit analysis of O&M ground cover practices
3. Quantification of ecological services of groundcover options

InSPIRE Project Sites

Select from the options below to display all sites using that technology.
- Beekeeping
- Co-location of Solar and Agriculture
- Native Vegetation
- Solar–Integrated Greenhouse
- Beneficial Predators
- Dryland Agriculture Co–location
- Pollinator Habitat

Acknowledgments from institutions.
InSPIRE Project Sites
Research and Outreach Advisory Group

Feedback on research directions and study designs

Development of new InSPIRE research sites and activities

Coordinated outreach activities

Quarterly meetings

Partial list of ASTRO Members
Specific research activities for field studies

- Study Design
- Crop Planting
- Harvesting
- Data Collection and Analysis

Temperature Probe
Rain Gauge
Soil Heat Flux Plate
Soil Thermocouple
Soil Moisture Reflectometer
PV Panel Thermocouple

Soil Carbon
Relative Humidity Probe
Datalogger
Wind Anemometer
Pyranometer

Armstrong et al., 2016
NREL Standard Protocols for Vegetation Evaluation

http://www.nrel.gov/docs/fy17osti/66218.pdf
Pollinator-Friendly Solar Research: Minnesota

- Vegetation and seed mix comparisons
- Pollinator population monitoring
- Value of ecological services analysis
- Instrumentation for validation and connecting vegetation with PV performance
- Multiple sites with diverse soil/ecotypes

Photos courtesy of Rob Davis, Fresh Energy; Lee Walston, Argonne
Over 800,000 acres of agricultural land would benefit if existing solar facilities had pollinator-friendly vegetation.
Updated Solar & Nearby Agriculture Calculations

• Examined 2016-2018 solar facility data from EIA (operating plants)
  o Installed ground-mounted solar electricity capacity increased from 22 GW in 2016 to 32 GW in 2018 (45% increase).
  o As of 2018 there’s over 1,200 mi² of pollinator-dependent agriculture in the foraging zones around operating solar facilities (70% increase)
Agrivoltaics: Growing Crops Underneath Solar Panels

Massachusetts Test Facility

Preliminary results (broccoli)
Harvested August 10, 2019
InSPIRE Research Site: 
Agrivoltaics at the Biosphere 2 Living Lab

• Elevated (10 ft) solar panels
• Outside of Tucson, AZ
• Professor Greg Barron-Gafford
• Growing peppers, tomatoes, basil, carrots, broccoli, lettuce, melons, flowers, chard (plus more!) in full sun and underneath solar arrays
Key Highlight: Solar-Powered Honey Production

Hives can be located in or outside of project fence
Innovative branding and marketing opportunities
Ongoing work evaluating honeybee and native bee preferences
Key Highlight: Solar-Integrated Grazing

Sustainable grazing practices can improve soils
Cost reductions from standard mowing practices
Ongoing work evaluating pastureland performance
Siting on reservoirs can reduce evaporation and algae growth
Avoid conflicts with land used for agriculture
Recent NREL study identified over 25,000 man-made reservoirs that could supply 10% of U.S. power

Key Highlight: Floating Solar on Agricultural Reservoirs

Key Highlight: Education through field research

Educational benefits through internships, field trips, work experience, tours
Elementary school through PhD students
State agency, academic, and professional training
Enel, NREL partner on three-year solar vegetation study

PRESS RELEASE: ILLINOIS POLLINATOR-FRIENDLY SOLAR ENERGY BILL PASSES, ADDS MOMENTUM TO SOLAR ENERGY DEVELOPMENT

Key Highlight: Broad Stakeholder Impacts

Pollinator-Friendly solar standards and scorecards
State Agency partnerships and technical assistance
Direct partnerships with solar and agricultural industry
University initiatives

In bid to help bees, Xcel to require vegetation disclosure in solar RFPs

Organic Valley Announces Next Phase of Community Solar Partnership To Become 100 percent Renewably Powered in 2019

New York Pollinator-Friendly Solar Bill Unanimously Passes Assembly and Senate

New York League of Conservation Voters
02/28 05:00

For Immediate Release: June 11, 2018
Contact: Shachar Sharon

New York Pollinator-Friendly Solar Bill Unanimously Passes Assembly and Senate, Healthy Pollinators From Solar Sites to Benefit Crops

Now growing and flowering meadows of deep-rooted native plants to benefit honey bees, native pollinators, birds, and enrich agricultural soils.

High-resolution photos courtesy: Prairie Restorations, Inc. Caption: Pollinator-friendly solar arrays provide urgently needed habitat for honey bees and native pollinators.
Thank you

Jordan.Macknick@nrel.gov
https://openei.org/wiki/InSPIRE

Photo courtesy of Rob Davis, Fresh Energy
Solar on Agricultural Lands Preserving Pollinator Habitat and Soil Health

Maggie Clark
Senior Manager, State Affairs
Solar Energy Industries Association
U.S. Solar PV Deployment Forecast

Yearly Installed Solar Capacity (MWdc)

- Residential (PV)
- Non-residential (PV)
- Utility (PV)
COVID Impacts to the Solar Industry

38% fewer U.S. solar workers than pre-COVID forecasts

These job losses would negate 5 years of solar industry growth, pushing the workforce back to a level not seen since 2014.

COVID-19 Solar Job Losses by State

- 60% or more
- 40% - 59%
- 30% - 39%
- 10% - 29%

36 states will suffer solar job losses in excess of 30%

https://www.seia.org/research-resources/covid-19-impacts-us-solar-industry
Is solar going to cause a “land crunch”?

Figure 8. Projected percentage of cropland occupied by utility-scale

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Cropland (Acres)</th>
<th>Projected New Land Occupied by Solar (Acres)</th>
<th>Percentage of Cropland Occupied by Solar</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>4,833,141</td>
<td>11,494</td>
<td>0.24%</td>
</tr>
<tr>
<td>2018</td>
<td>4,803,821</td>
<td>13,566</td>
<td>0.28%</td>
</tr>
<tr>
<td>2019</td>
<td>4,774,502</td>
<td>15,832</td>
<td>0.33%</td>
</tr>
<tr>
<td>2020</td>
<td>4,745,183</td>
<td>17,738</td>
<td>0.37%</td>
</tr>
<tr>
<td>2021</td>
<td>4,715,864</td>
<td>19,653</td>
<td>0.42%</td>
</tr>
<tr>
<td>2022</td>
<td>4,686,545</td>
<td>21,020</td>
<td>0.45%</td>
</tr>
<tr>
<td>2023</td>
<td>4,657,226</td>
<td>21,714</td>
<td>0.47%</td>
</tr>
<tr>
<td>2024</td>
<td>4,627,907</td>
<td>22,294</td>
<td>0.48%</td>
</tr>
<tr>
<td>2025</td>
<td>4,598,588</td>
<td>22,828</td>
<td>0.50%</td>
</tr>
<tr>
<td>2026</td>
<td>4,569,269</td>
<td>23,343</td>
<td>0.51%</td>
</tr>
<tr>
<td>2027</td>
<td>4,539,950</td>
<td>23,853</td>
<td>0.53%</td>
</tr>
<tr>
<td>2028</td>
<td>4,510,630</td>
<td>24,347</td>
<td>0.54%</td>
</tr>
<tr>
<td>2029</td>
<td>4,481,311</td>
<td>24,822</td>
<td>0.55%</td>
</tr>
<tr>
<td>2030</td>
<td>4,451,992</td>
<td>25,192</td>
<td>0.57%</td>
</tr>
</tbody>
</table>

Land Needed to Power the Country with Solar

The yellow square is approximately 21,000 square miles. Map courtesy of Google Maps.

https://www.freeingenergy.com/how-much-solar-would-it-take-to-power-the-u-s/
Regenerative Agriculture and Solar

“Regenerative Agriculture is a system of farming principles and practices that increases biodiversity, enriches soils, improves watersheds, and enhances ecosystem services.

Regenerative Agriculture aims to capture carbon in soil and aboveground biomass, reversing current global trends of atmospheric accumulation.

At the same time, it offers increased yields, resilience to climate instability, and higher health and vitality for farming and ranching communities.”

http://www.regenerativeagriculturedefinition.com/
Solar and Multiuse Farming Practices

- Livestock grazing
- Native plant restoration
- Wetland restoration
- Pollinator habitat creation, at times paired with an apiary
- Permeable fencing to maintain wildlife habitat
- Solar project decommissioning plan
Pollinator-Friendly Solar Scorecards

Items of Consideration for State Policymakers

• Mandatory vs. guidance
• Holistic vs. targeted
• Greenfield and brownfield development
• Prime farmland
• Balancing private property rights
Thank you!

mclark@seia.org
Solar PV on MA Agricultural Land:
Trying to Finding the Balance

National Conference of State Legislators
May 21, 2020

Gerry Palano, P.E.
Renewable Energy Coordinator, MDAR
Gerald.Palano@mass.gov
Thank you & Recognition!

- Governor Baker & Lt. Governor Polito
- Secretary of Energy & Environmental Affairs Theoharides
- MDAR Commissioner Lebeaux
- DOER Commissioner Woodcock
- MA State Legislators
- UMass: Clean Energy Extension, Vegetable Extension and Cranberry Experiment Station

On behalf of all the above, we thank the National Conference of State Legislators for the invitation to present MA efforts of Solar on Agricultural Lands.
Presentation Outline

• Brief Overview of MA Farmland
• *How & Why* Massachusetts is working with solar siting on farmland – the dawning of Dual Use
• From SRECs to SMART
• What is the MA SMART program and how it incentivizes dual use of agricultural land
• Early SMART Dual Use Applications
Some Relevant MA Information

- MA has a total of 5 million acres of land
- 60% of MA is forest land, 3 million acres
- 491,000 acres is farmland, so < 10%, spread over 7,000+ farms
- Of that < 200,000 acres is actual cropland, so < 5%
- MA Buy Local Food interest and efforts are soaring
- The recent MA Food Plan has goals to increase MA food production from existing <10% to 20/30% and higher
- At the same time, MA has climate change mandates and goals to reduce GHGs and convert to clean energy
- As well, MA Farms seek diverse income streams for short and long term viability, sometimes attracted by commercial development options
SNAPSHOT of MA Agricultural Land

Snapshot of Massachusetts Agriculture

Legend

<table>
<thead>
<tr>
<th>Percentage of County in Farmland</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% - 2%</td>
<td>7,241</td>
</tr>
<tr>
<td>3% - 7%</td>
<td>491,933</td>
</tr>
<tr>
<td>8% - 10%</td>
<td>68</td>
</tr>
<tr>
<td>11% - 15%</td>
<td>1,814</td>
</tr>
<tr>
<td>16% - 18%</td>
<td>497,154</td>
</tr>
</tbody>
</table>

State Summary

- Number of farms: 7,241
- Acres of farmland: 491,933
- Average size farm (acres): 68
- Number of farms with direct sales: 1,814
- Market value of agricultural products sold ($1000s): 497,154
- Average value of agricultural products sold per farm: 995,624
- Crops ($1000s): 995,624
- Livestock, poultry, and their products ($1000s): 911,001
- Value of direct sales ($1000s): 132,446
- Number of hired paid farm workers: 13,452
- Value of hired paid farm workers: 418,311

State: MA, US Department of Agriculture

Data Source: USDA, Economic Research Service
Figure 3.1: Total Land in Massachusetts Farms
Ag Census Years 1974 to 2017

- Non-Adjusted
- Adjusted
Figure 3.6: Total Cropland on Farms
Ag Census Years - 1974 to 2017
MA Ag Land Over the Years

Credit - Center for Agriculture, Food and the Environment
UMass, Amherst, MA

Figure 3.8: Harvested Cropland on Farms
Ag Census Years 1974-2017

Acres (1,000)
The Big Picture

WHAT HAS MA BEEN DOING RE SOLAR ON AG LAND?

Recognizing the need: Why is it Important for Agriculture to implement solar PV

• BIG PICTURE = SUSTAINABLE
• BIG PICTURE = Contribute to MA Environmental Mandates and RE Goals
  – Clean Energy
  – GHG Reductions
• BIG PICTURE = DIVERSIFIED INCOME
  – Aside from behind-the –meter solar projects that help farms become energy sustainable, large-scale projects offer farms a steady revenue stream for 20-25 years plus that can help the farm through the rough years

Trying To Address:

Status quo land cover, siting issues with farms, residents, municipalities
How We Try to Work with Farms & Developers

• Agricultural System Location Options:
  – Smaller Scale – predominantly behind-the-meter on-farm use
    – Roofs first choice
    – Non-productive land
    – Field edges
  
• Larger Scale Ground-Mounted – versus status quo of covering up farm land
  – Non-or least productive land
  – Field edges – generally not cost-effective on a large –scale
  – Dual Use of Land – cropping & regenerating the soil
David Marley Original Concept - Demonstration Dual Use of Land
• Precedent - Mass Clean Energy Center: 2008 grants — to — rebates transition — dawn of large-scale projects
• 2011-2018: SRECS — Solar Renewable Energy Credits — a carveout of the MA RPS Program
• SREC-I: based on supply & demand of the market, size and location (building/ground) agnostic
• SREC-II: still based on supply & demand of the market but factors for size, use and location
• Over 1600 MW installed under SREC Programs
• Agriculture participated, small and large-scale, in SRECs I & II but no specific incentives
Then came SMART

2018 - Solar MA Renewable Target:
225 CMR: DEPARTMENT OF ENERGY RESOURCES 225 CMR 20.00: SOLAR MASSACHUSETTS RENEWABLE TARGET (SMART) PROGRAM

- The next generation of MA solar incentive programs promulgated by Governor Baker’s Administration
- Another 1600 MW Goal in eight 200 MW blocks
- Recently Expanded to 3200 MW with eight additional 200 MW blocks – Effective May 18, 2020
- The SMART program was designed to create a diversity of project types and to steer development away from large scale ground mounted projects in undeveloped spaces i.e. those not industrial/commercially zoned or in any “green” spaces
- Land & location based incentives program
- Combines environmental and energy credits into one incentive
- First time to offer incentives specifically related to dual use of Ag Land – comprised of Regulations & Guidelines
Agricultural Solar Tariff Generation Unit (ASTGU) aka Dual Use:
Primary sections: Regulations & Guidelines

• Regulations
  – Definitions
  – Land Use Categories
  – Performance Standards
  – Special Provisions
  – Incentives

• Guidelines

• Pre-Determination Application Approval

• Incentive - $0.06/kWh above Base incentive
SMART 225 CMR 20.00 – Regulations

• 20.02: Definitions – As recently revised
  • Agricultural Solar Tariff Generation Unit. A Solar Tariff Generation Unit located on Land in Agricultural Use or Important Farmland that allows the continued use of the land for agriculture.
  • Land in Agricultural Use. All land as defined under M.G.L. c. 61A, §§ 1 and 2 and land that had been enrolled in a program established pursuant to M.G.L. c. 61A within the past five years.
  • Important Agricultural Farmland. Means those soils identified by the USDA pursuant to 7 CFR § 657.5 to be Important Farm Land, includes Prime, Statewide Importance, and Unique.
Category 1 Land Use. Solar Tariff Generation Units that meet one or more of the following criteria will be designated as either Category 1 Agricultural or Category 1 Non-Agricultural:

a. Category 1 Agricultural: Solar Tariff Generation Units located on Land in Agricultural Use or Important Agricultural Farmland that meet one or more of the following criteria will be designated as Category 1:

i. Agricultural Solar Tariff Generation Units;

ii. Building Mounted Solar Tariff Generation Units;

iii. Floating Solar Tariff Generation Units;

iv. Canopy Solar Tariff Generation Units;

v. Solar Tariff Generation Units sized to meet no greater than 200% of annual operation load of an agricultural facility.
• (d) Special Provisions for Agricultural Solar Tariff Generation Units. In order to qualify as an Agricultural Solar Tariff Generation Unit, a Solar Tariff Generation Unit must submit documentation itemized in 225 CMR 20.06(1)(d). All final determinations regarding the eligibility of such facilities will be made by the Department, in consultation with MDAR. An Agricultural Solar Tariff Generation Unit must also submit satisfactory documentation to the Department as detailed in the Department’s Guideline Regarding the Definition of Agricultural Solar Tariff Generation Units.

• 1. the Solar Tariff Generation Unit will not interfere with the continued use of the land beneath the canopy for agricultural purposes;

• 2. the Solar Tariff Generation Unit is designed to optimize a balance between the generation of electricity and the agricultural productive capacity of the soils beneath;

• 3. the Solar Tariff Generation Unit is a raised structure allowing for continuous growth of crops underneath the solar photovoltaic modules, with height enough for labor and/or machinery as it relates to tilling, cultivating, soil amendments, harvesting, etc. and grazing animals;
4. crop(s) to be grown to be provided by the farmer or farm agronomist in conjunction with UMass Amherst agricultural extension services, including compatibility with the design of the agricultural solar system for such factors as crop selection, sunlight percentage, etc.;

5. annual reporting to the Department and MDAR of the productivity of the crop(s) and herd, including pounds harvested and/or grazed, herd size growth, success of the crop, potential changes, etc., shall be provided after project implementation and throughout the SMART incentive period; and

6. other system design information, which shall include, but not be limited to:
   a. dual-use type, e.g., ground mount racking, pole towers, tracking, etc.;
   b. total gross acres of open farmland to be integrated with the project;
   c. type of crop(s) to be grown, including grazing crops;
   d. pounds of crop(s) projected to be grown and harvested, or grazed;
   e. animals to be grazed with herd size(s); and
   f. design drawing including mounting system type (fixed, tracking), panel tilt, panel row spacing, individual panel spacing, for pole tower spacing and mounting height, etc.
Guidelines (Current)

- *(Note: Currently in Stakeholder Review Sessions)*
- Guidelines:
- Base:
  - Panel Height
  - Maximum Sunlight Reduction
  - Growing Season
  - Maximum Size
- Waiver Request:
  - For any of the above Base requirements
  - For any new innovation not accounted for in the Base Guidelines
- SMART Tool
SMART Tool - Fixed
SMART Tool – Single-Axis Tracking
New Pollinator Adder

- $0.0025/kWh (approximately $3,500/MW per year)
- Would apply to projects that are awarded pollinator certification by UMass Amherst Clean Energy Extension
- Existing and new projects may apply for this adder
SMART Program Status for ASTGUs

- Program Status:
- Nine Projects Approved, consisting of 16 separate sub-projects with 15 different farm owners, totaling 15.25 MW AC and > 35 MW DC
- Five of the approved projects combine multiple farms or farm parcels into one common inter-connection point, one of the higher costs
- Agricultural products will be cranberries, variety of vegetables, livestock and hay
- Another 7 MW AC projects in the pipeline for approval
- Many more projects anticipated after Revised Regulations in place (May 18, 2020)
Approved SMART ASTGU Projects
Early Project Observations/Thoughts

- Most all systems using single-axis tracking
- Fixed axis system facing southeast, not due south
- Some systems will be mounted higher than Guidelines due to farmers’ request for existing machinery clearances
- Most all projects plan to incorporate battery storage
- We would like to work with proposed projects on a variety of R&D efforts to obtain more comprehensive, empirical, physiological data for a variety of crops
Applicable for Your State?

- If agricultural land is competed by clean energy and food plan goals, or basic regenerating farm land is desired, protecting and utilizing open and productive farm land with dual use technology is an option to be considered.
- Finding the balance of sustainable and marketable agricultural production in combination with solar economic feasibility is the key to success.
- Our efforts are a work in progress – we look forward to successful solutions with ultimately balanced agricultural/solar projects.
UMass Agronomy Lab – Crop Trials Continuing Today – Thank you NREL for your continuous support & funding
Thank you!!!

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Boston, MA 02114
Gerald.Palano@mass.gov
617-626-1706
NCSL Resources

- Pollinator Webpage
- Environment and Natural Resources database
- Energy Legislation Database
For questions regarding the Solar on Agricultural Lands Webinar
Contact
Glen.Andersen@NCSL.ORG

Questions about the NRI Webinar Series
Contact
Kristen.Hildreth@NCSL.ORG