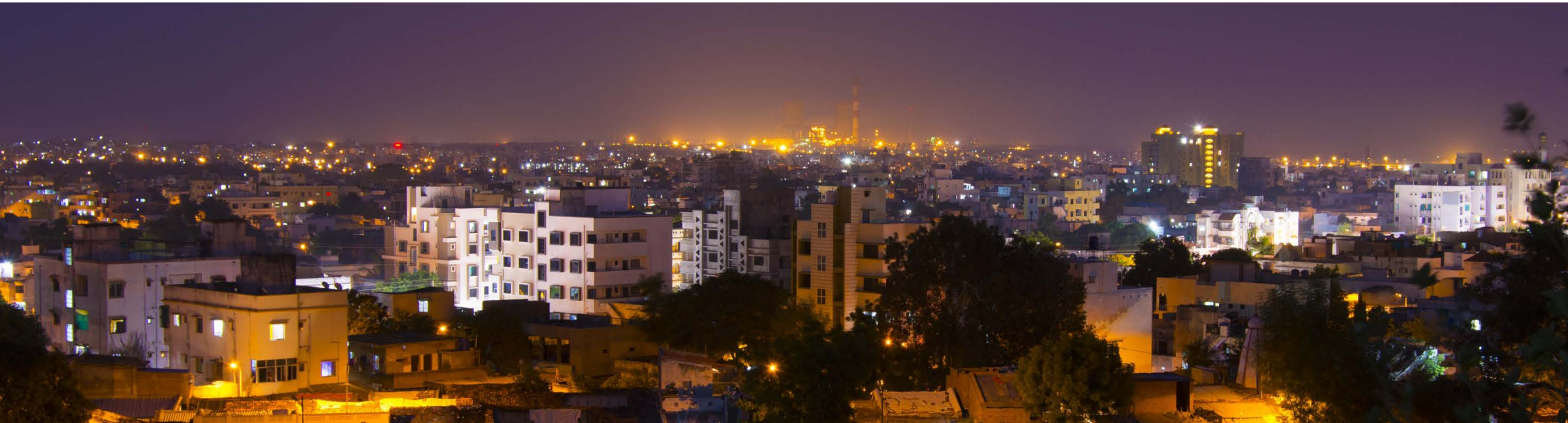




SAREP Agrivoltaics Knowledge Series: Agrivoltaics Groundwork

Jordan Macknick

July 30, 2024



Learn More: Session 2

Agrivoltaics 101 July 23

Basics, history, and potential benefits



Kate Doubleday

Model Engineer and
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Researcher

Agrivoltaics Groundwork July 30

Collaboration and partnerships
for success



Jordan Macknick

Agrivoltaics Principal
Investigator and Lead
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Agrivoltaics Pathway August 6

Steps and processes to develop a
project



Brittany Staie

Agrivoltaics and
Food-Water-Energy
Nexus Researcher



Brian Mirletz

Energy Analyst and
Software Engineer

Agenda

- The importance of collaboration and capacity building for agrivoltaics
- Opportunities for agrivoltaics in the South Asian context
- Agrivoltaics Groundwork



The Importance of Collaboration and Community in Successful Agrivoltaics Projects



Agrivoltaics Definitions



Grazing

Sheep, cows, or other grazing animals foraging underneath and/or in between solar panels.



Crop Production

Agricultural production under or in between rows of solar panels.



Greenhouse

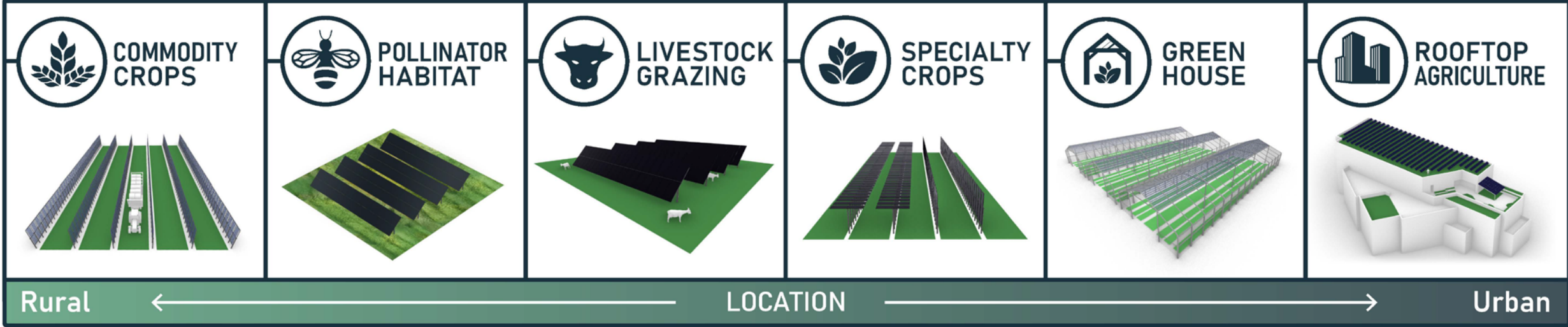
Solar technologies placed on top of or integrated with greenhouses.



Habitat

Pollinator habitat, native grasses and vegetation, and naturalized beneficial vegetation.

The Scale of Agrivoltaics

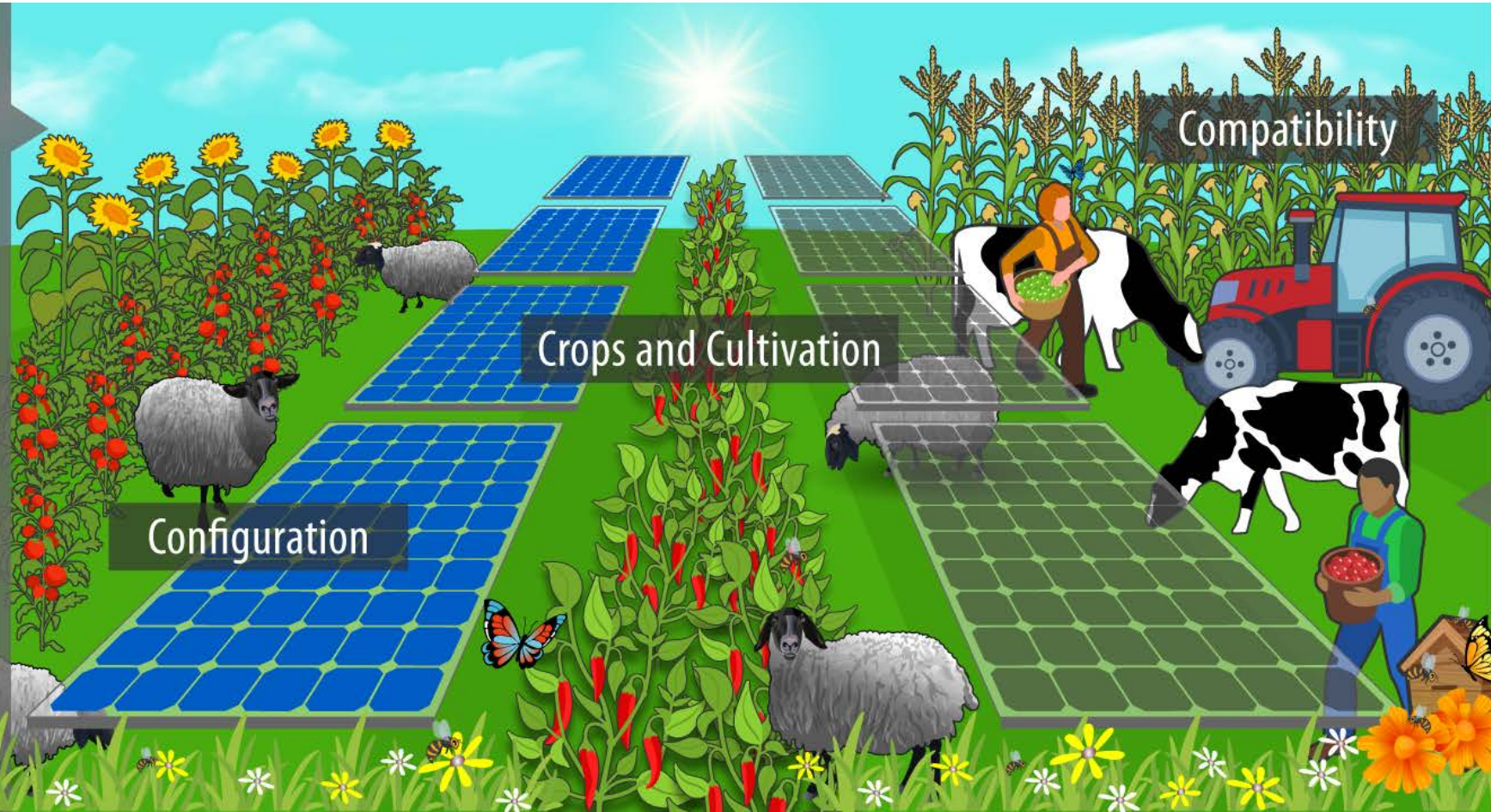
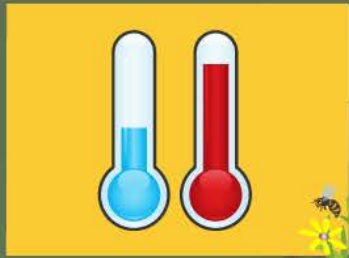


Credit: Tom Hickey

Agrivoltaics has applications across rural and urban settings

The 5 C's of Agrivoltaic Success

Climate



Configuration

Crops and Cultivation

Compatibility

Collaboration



5 C's of Agrivoltaic Success



Adapted from Macknick, Jordan, *et al.* 2022

Credit: Tom Hickey



Collaboration and Partnerships are Critical for Success



Photo by Werner Slocum, NREL

- Long-term agreements
- Balancing multiple, competing objectives
- Clearly defined roles and responsibilities
- Ongoing and regular communication
- Data sharing
- Incorporating stakeholder perspectives

Long-Term Agreements Across Partners

Security: Are all partners receiving benefits they desire while minimizing risks?

Consider:

- Solar industry equipment damage
- Solar industry O&M activities
- Agricultural equipment damage
- Agricultural timing
- Agricultural flexibility
- Roles and responsibilities
- Long-term certainty
- Cross-training
- Risk mitigation



Key Considerations for Planning and Deployment

Compatibility: Are the solar, agricultural, and partnership plans all compatible?



Photo by Jordan Macknick, NREL

Consider:

- Farm equipment
- Solar infrastructure
- Farmer, grazer, and/or herder practices
- Sitewide Operations & Maintenance plans
- Yield, cost, and revenue impacts
- Farmer engagement in site design
- Flexibility of system to adapt to changing agricultural needs

Potential Benefits Across Stakeholders



Pascaris et al., 2020; 2021; 2022; 2023

Photos by Werner Slocum, Dennis Schroeder, Jordan Macknick, NREL

Farmer Benefits

Community Benefits

Industry Benefits

Enhanced farm viability (economic and climate resilience)

Economic and workforce development

Improved community acceptance and company reputation

Revenue diversification

Reduced pressure on farmland

Savings on O&M (site-specific)

Maximized land use, innovative dual-uses

Protect cultural heritage and local interest

Increased land access

Water and energy savings (region-specific)

Local food-energy resilience through distributed resources

Maximized system co-benefits

...and Concerns



Photos by Werner Slocum, Dennis Schroeder, Jordan Macknick, NREL

Pascaris et al., 2020; 2021; 2022; 2023

Farmer Concerns

Impacts on soil, crop/forage productivity, land access, farmland preservation

Operational challenges with infrastructure

Long-term planning, decommissioning

Community Concerns

Impacts on cultural heritage and landscapes

Land type, aesthetic

Distributional justice

Industry Concerns

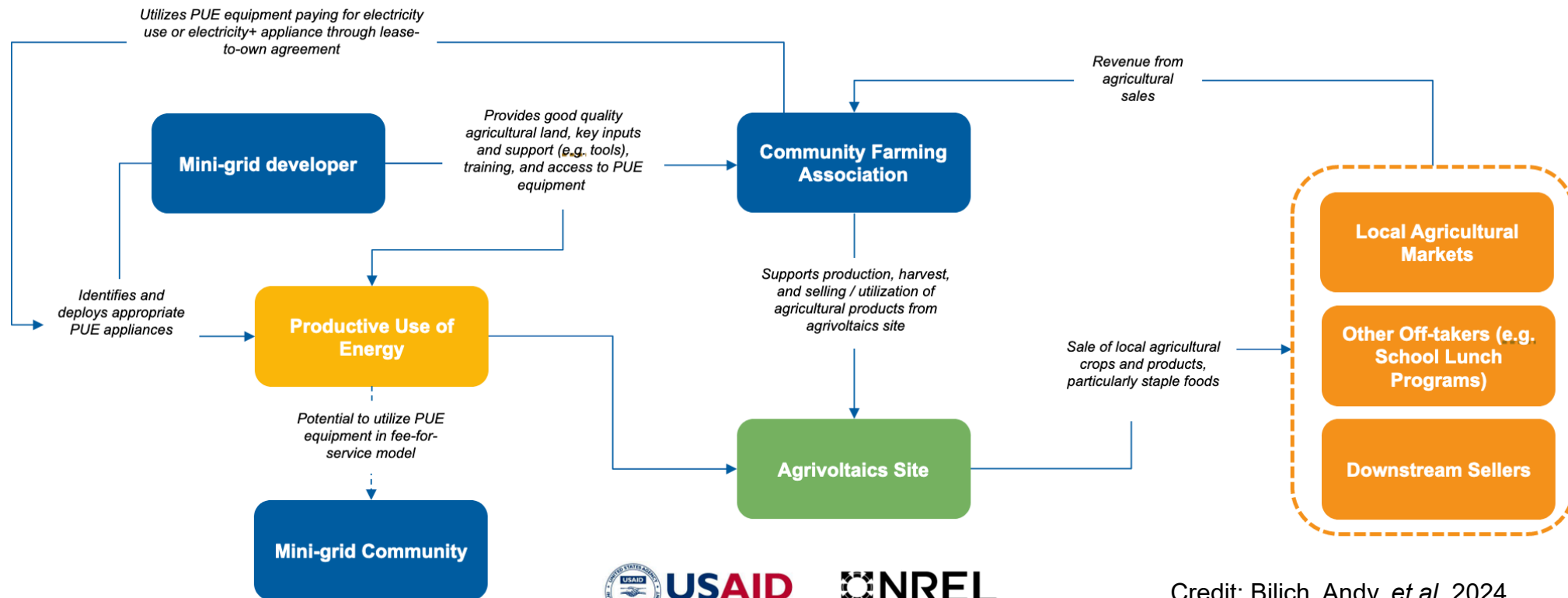
The “liability of newness” (technical, economic, and political unknowns)

Cost-benefit analysis uncertainties

Political feasibility

Multiple Potential Business and Partnership Models

- Farmer-owned projects
- Long-term (25-30 year) land leases
 - Solar owner/operator ↔ landowner
 - Landowner/solar owner ↔ tenant farmer
- Grazing operations and maintenance (O&M) contracts
 - Landowner/solar owner ↔ grazer
- Community association partnerships
 - Landowner/solar owner ↔ community farming association



Planning, Permitting, and Zoning

Aligning with Local Processes: Are all relevant rules being followed?

Consider:

- Energy infrastructure requirements
- Agricultural qualifications
- Regulations at multiple jurisdictional levels (national to local)
- Policies and incentives across sectors
- Changes in land-use status



Recommendations

- Initiate conversations and partnership conversations as soon as possible
- Long-term agreements with specific roles outlined, with room for flexibility
- Standardized base contract terms and examples
- Clear policy, permitting, and regulatory frameworks across sectors and jurisdictions



Agrivoltaics Groundwork



Agrivoltaics Groundwork



What are key elements to consider before building and designing an agrivoltaics project?

What activities can continue after an agrivoltaics project is built?

Clean Energy to Communities (C2C) Program



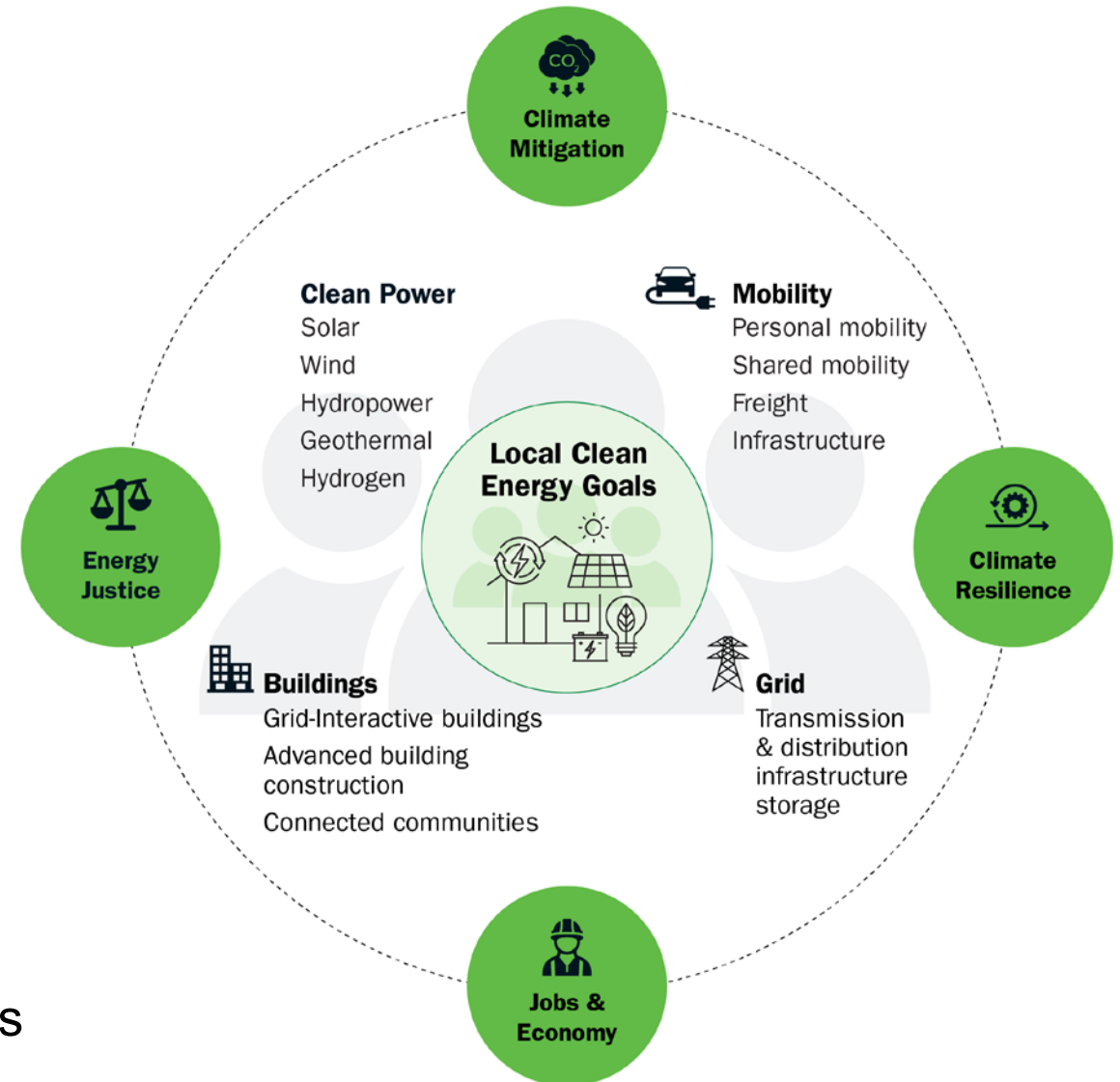
C2C: Clean Energy to Communities

U.S. DEPARTMENT OF ENERGY

C2C provides communities with expertise and tools to achieve their **clean energy goals** through in-depth partnerships, peer-learning cohorts, and expert match.

C2C Expert Match Participants:

- Local governments
- Tribes
- Community-based/nonprofit organizations
- Universities, colleges, and community colleges



C2C Agrivoltaics Technical Assistance at NREL

Knowledge Transfer



Provides resources for capacity building and project development:

- Agrivoltaics 101 Resources
- Data Access
- Online Tools

Educational and Stakeholder Outreach



Transfers knowledge to audience for action:

- Training
- Webinars
- Expert Support
- Guest Lectures

Modeling and Analysis



Applies knowledge, interprets data to support community action:

- Analysis & Modeling
- System Design
- Site Visits

Demonstration Facilities and Research



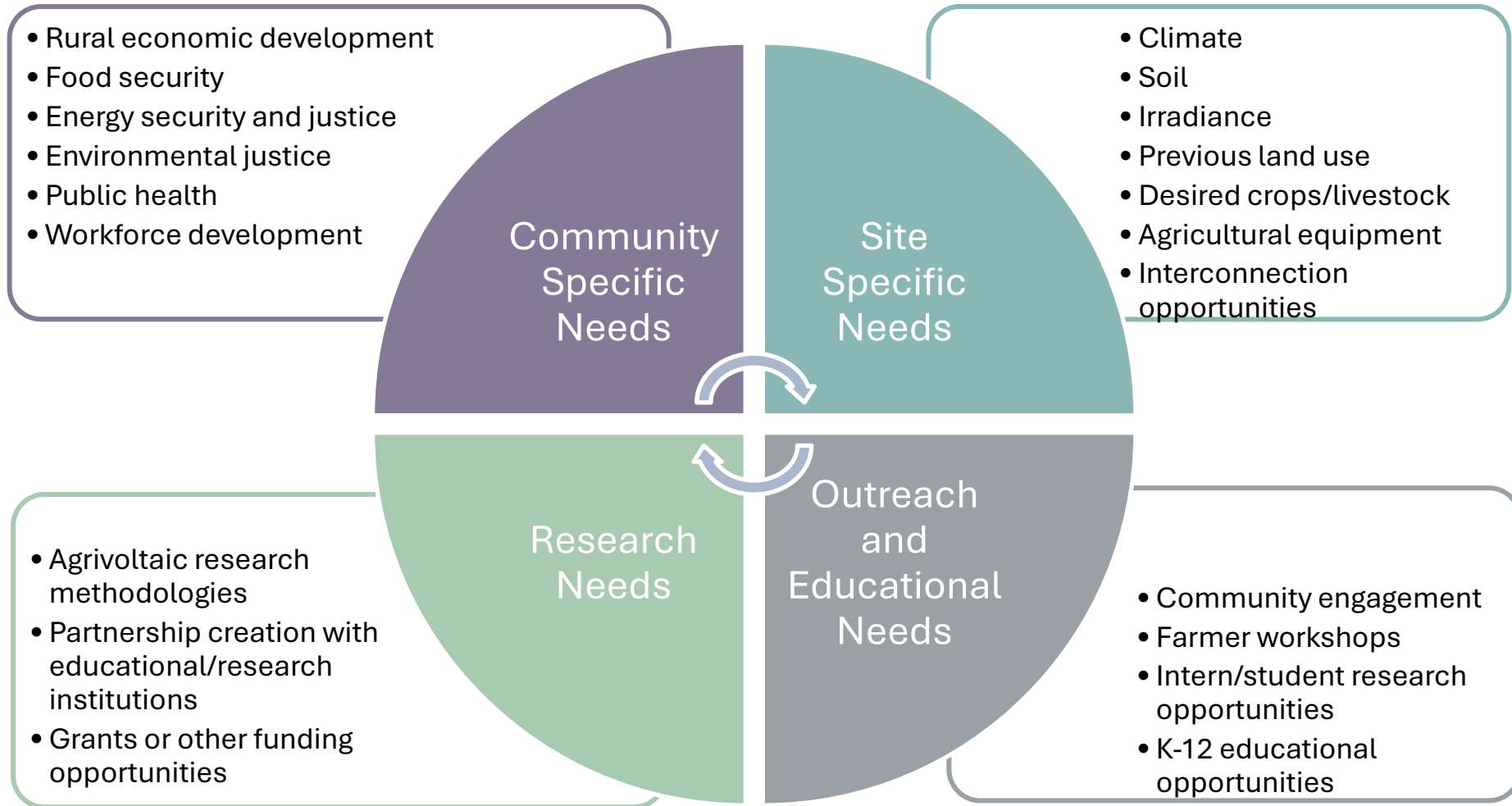
Assist with on-site research development and partnerships:

- Research Methodologies and Questions
- Partnership Development
- Curriculum Development Support

C2C Agrivoltaics Technical Assistance Communities



NREL Agrivoltaics Technical Assistance Framework



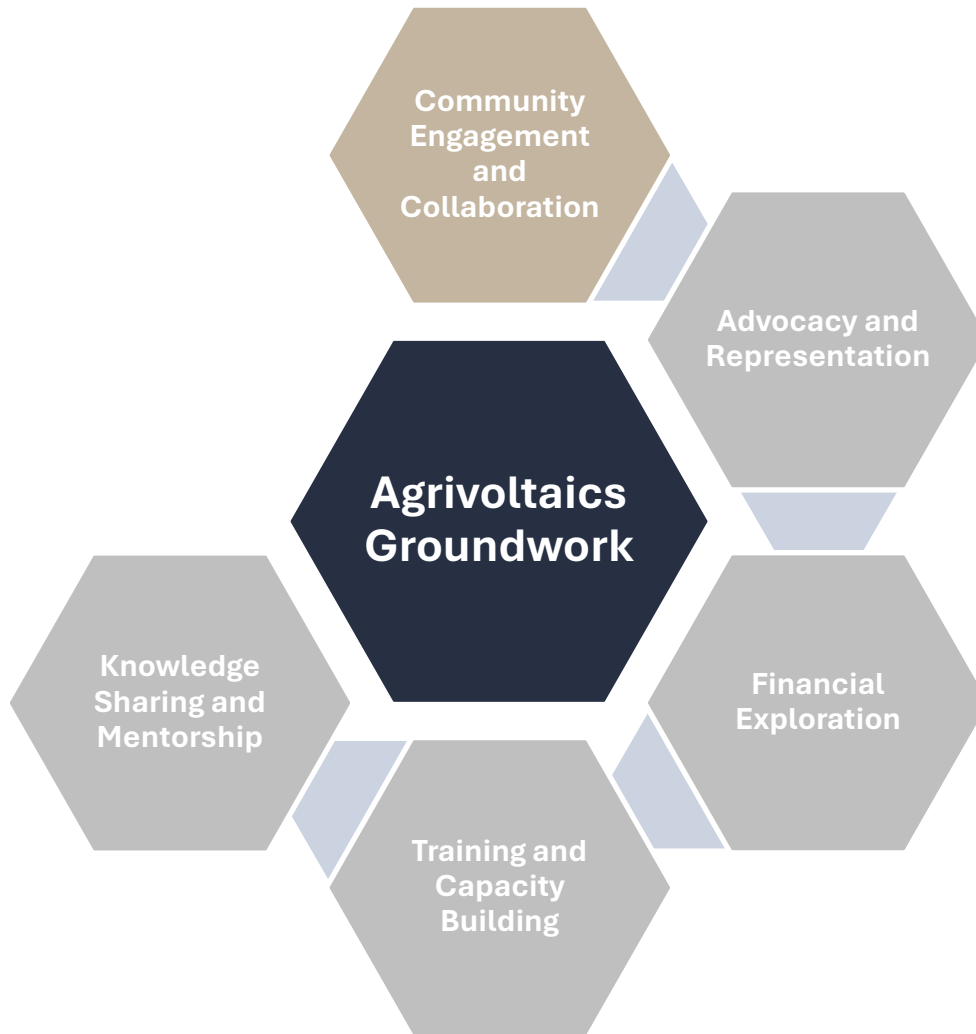
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Agrivoltaics Groundwork: Community Engagement



Identify stakeholders (solar, agricultural, educational, government, neighbors)

Discuss plans, alternatives, options

Start early, engage often

Agrivoltaics Groundwork: Advocacy and Representation



Assess local policies, regulations, and permitting requirements

Ensure diverse voices are heard in development and implementation of agrivoltaics projects

Represent other farmer, land-users in process

Share information widely



Agrivoltaics Groundwork: Financial Exploration



How much will it cost to build my specific agrivoltaics system?

How much energy will it produce?

What is the preferred business model?

Will it be grid-tied or off-grid?

What are financing and funding options?

Agrivoltaics Groundwork: Training and Capacity Building



Online webinars
Educational and training programs
On-site agrivoltaics tours
Technical Assistance programs
Peer-to-Peer learning networks
Development of new resources
Capacity building for governments in addition to farmers and solar industry
Policy development

Agrivoltaics Groundwork: Knowledge and Mentorship



Work with others wanting to build an agrivoltaics facility

Create an online platform for sharing ideas and experiences

Mentorship programs

Share information and data widely

Agrivoltaics Groundwork Takeaways



Conducting Groundwork before designing and building an agrivoltaics system can lead to improvements

Knowing your options and available alternatives will help you custom-design your agrivoltaics system to your needs

Agrivoltaics projects can provide multiple community benefits



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Q&A



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Additional Resources

- India Agrivoltaics Alliance (<https://indiaagripv.org/>)
 - Regional knowledge sharing and advocacy alliance
- Agrivoltaics in India website (<https://www.agrivoltaics.in/>) by NSEFI and IGEF
 - India agrivoltaics map, best practices, legal and policy, and case study reports
- American Solar Grazing Association (<https://solargrazing.org/>)
 - Industry association with sample contracts, example budgets, recommendations, and monthly webinars
- Agrisolar Clearinghouse (<https://www.agrisolarclearinghouse.org/>)
 - U.S information hub with Information Library of fact sheets
- NREL InSPIRE project (<https://openei.org/wiki/InSPIRE>)
 - Research data portal of agrivoltaics research worldwide (published in English), US agrivoltaics map
- AgriSolar website (<https://agrisolareurope.org/>) by SolarPower Europe
 - Industry group with best practice guidelines, Europe agrivoltaics map

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