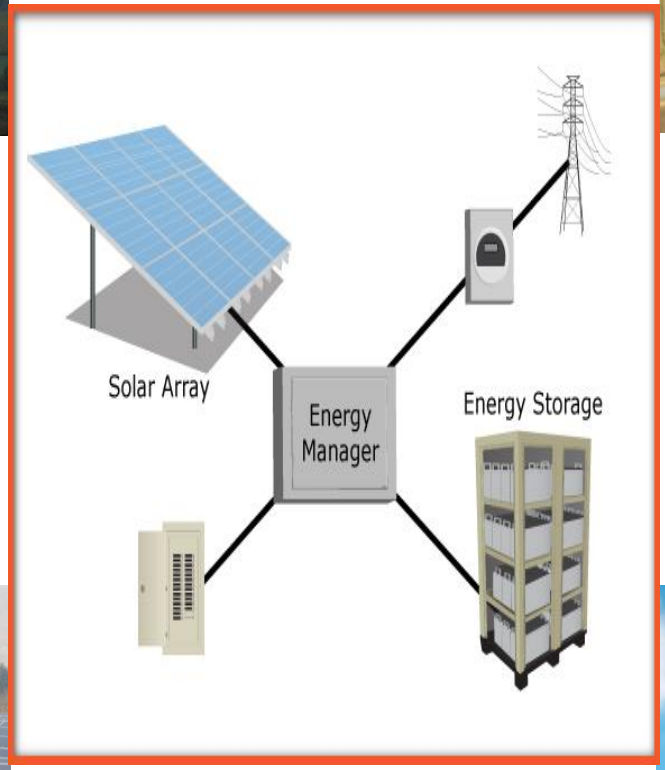
On-Farm Energy Management



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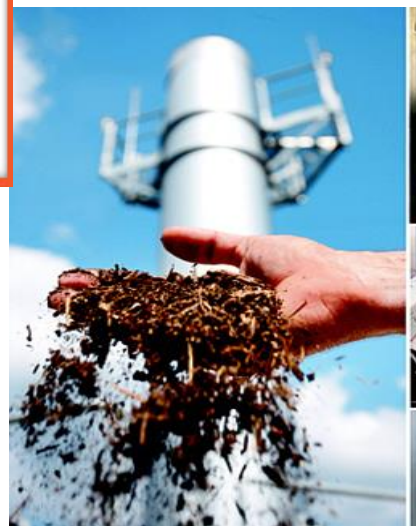
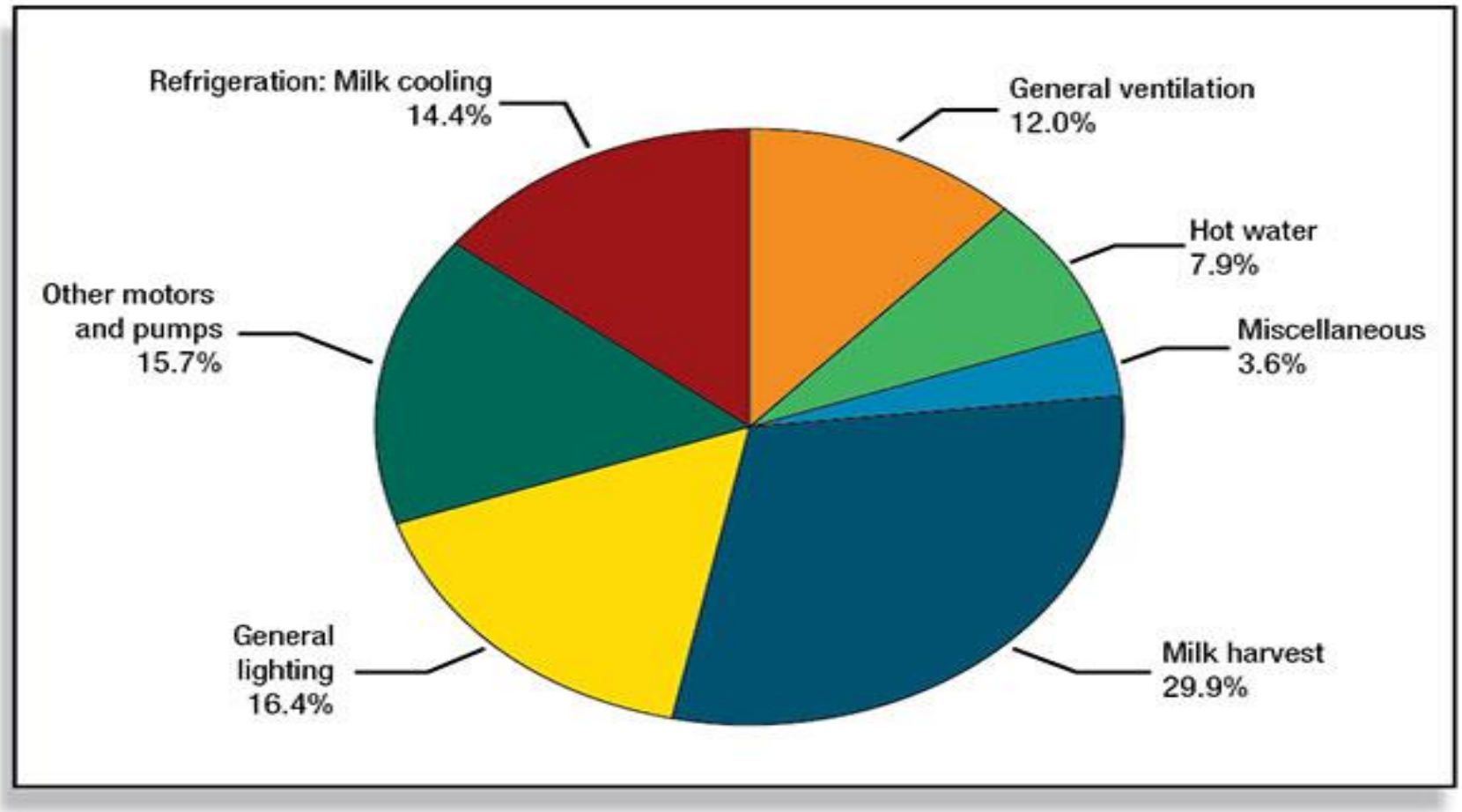


Base-line Analysis Drives Opportunities: Investigating Energy Loads

Figure 1 Breakdown of electricity use on the farm

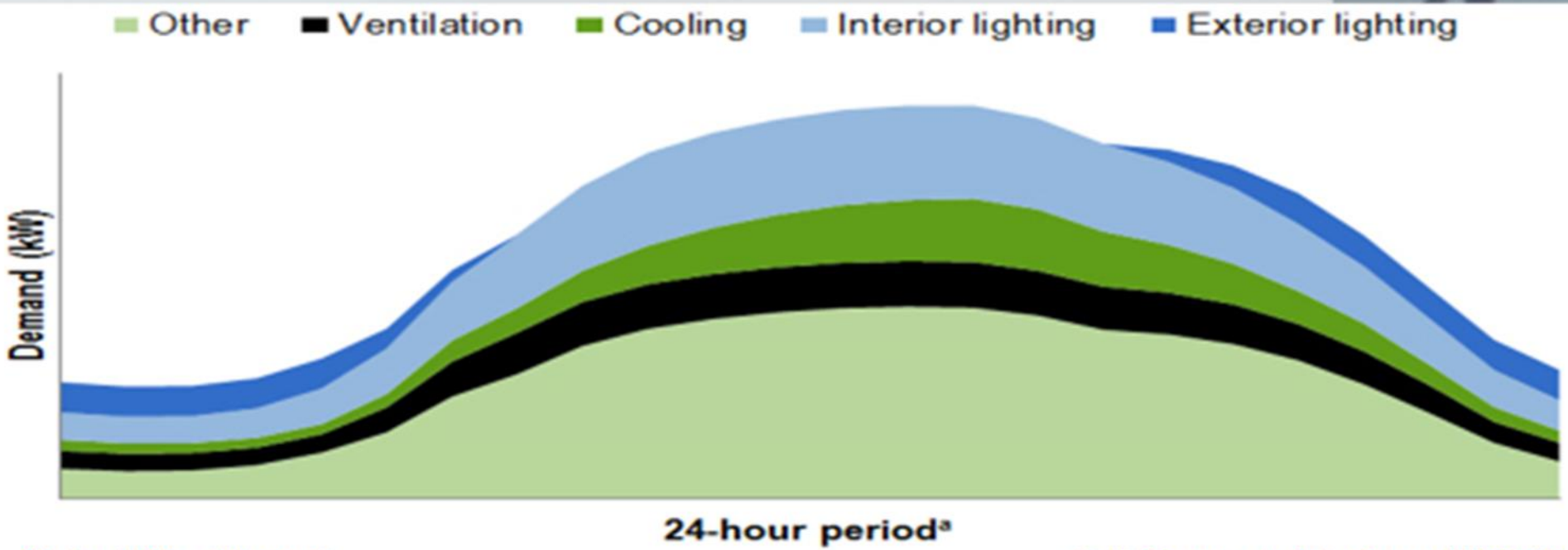


Source: https://www.agproud.com/articles/20179-what-can-an-energy-audit-do-for-you

The "**What**" of your Energy Buy

A) Investigating Your Energy History and Current Condition

- Updated engineering documents – **single line diagrams**
- Identifying **load centers** and **time-of-operation**
- Investigating internal loads throughout the day – "**interval" data**
- Determining **opportunities** for significant **efficiency** upgrades
- Assessing and understanding **basis of CFE prices** and fees

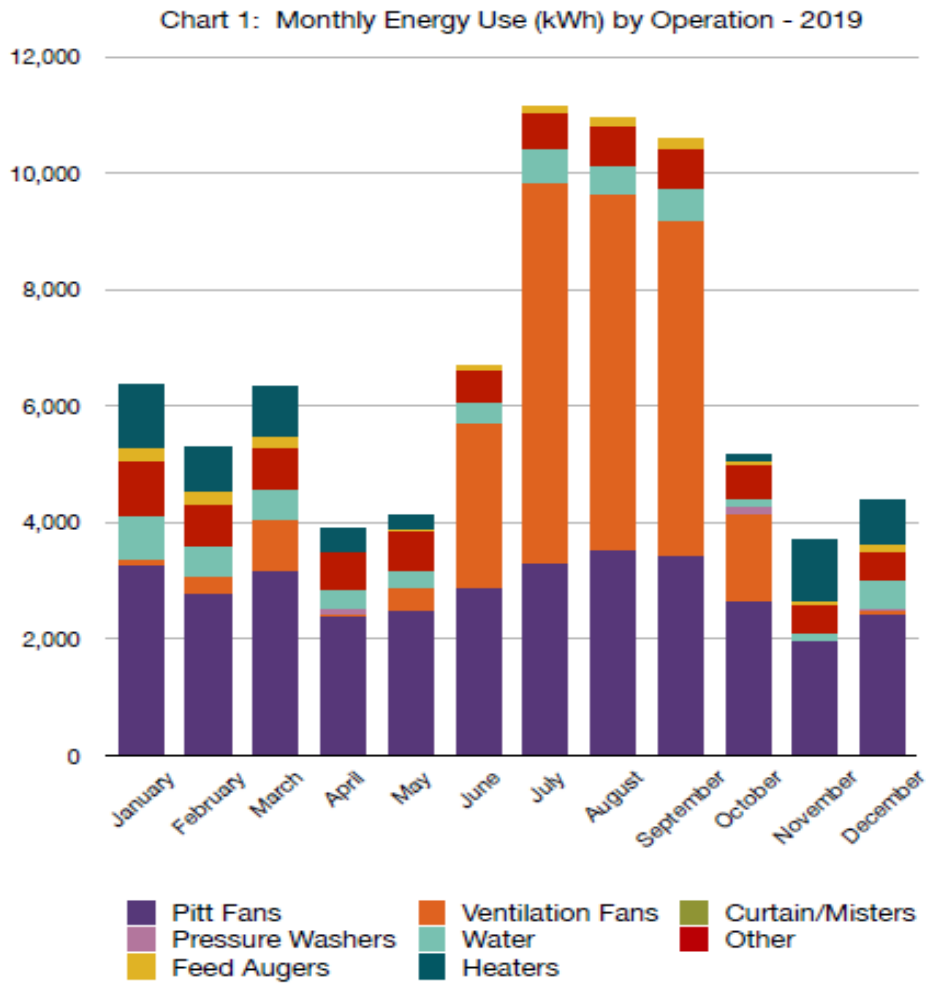


Note: kW = kilowatt.
a. 24-hour period = midnight to midnight.

© E Source; data from ITRON

Example: Over the 12-month period, Ohio hog farm west feeder/finishing barn used 78,730 kWh of energy for the swine operation

On average, the farm used 6,561 kWh per month, including the minimum of 3,715 kWh used in November 2019 and a maximum of 11,149 kWh in July 2019. The pit fans represent the largest and most consistent load source accounting for 34,142 kWh or 43% of the annual energy usage. Tunnel ventilation fans were the second largest consumer of energy using 24,343 kWh or 31% of the total energy use over the 12-month period. Combined, the pit and ventilation fans loads used 58,485 kWh or 74% of the total energy use over the 12-month period.
As illustrated in Chart 1, during the months between June and September the ventilation fans accounted for over 84% of the total energy consumption, including 88% in both July and August



Energy Management Drivers

- **Total Energy Buy** – reduction in Therms or kWh per unit of output (milk, grain, etc.)
- **Energy price** stability/predictability
- **Energy supply** assurance, power or thermal system resiliency
- **Carbon footprint** management (& processor carbon accounting)
- **Revenue** diversification (including environmental attributes)
- Other

A-CEW **Carbon Investment and Practice Decision Tool**

	Option	Savings	Revenue	CapEx	OpEx	EBDITA	ITC	Financial Return on Total Capital Deployed	Carbon Reduction Attributable to Option	Impact on Farm's Product CI if Carbon Reduction Internalized	Farm Financial Impact from Reduced CI	Carbon Reduction Allowable as Offset	Additional Carbon Offset Verification Costs	Carbon Offset Price	Farm Revenue from Carbon Offset Sale	Total Return on Capital From Option Direct + Carbon
Power	On-site Solar															
	Solar + Storage															
	Biogas Genset															
	Biogas + Solar															
	Wind															
	Wind+Storage															
	Wind, Solar, Storage															
	Energy Efficiency															
	Utility Renewable Program															
	Other															
Fuels	Biodiesel Blending															
	CNG Retrofit for Heavy Equipment															
	Biogas for NG or Propane															
	Biomass for NG or Propane															
	Electification of Dryers/Boilers															
	EV for Combustion Engines															
	Other															
Nutrient Mgnt	Solids Seperator															
	Solids Seperator & Compost															
	Tea Water Irrigation															
	Digester, RNG															
	Digester, Power/Genset w/o CHP															
	Digester, Power/Genset w/ CHP															
	Lagoon clarifier & Irrigation															
	Nutrient Recovery, precipitator															
	Nutrient Recovery, distillation															
	Nutrient Recovery, UF/RO															
	Manure practice: knifing															
	Manure practice: pumping															
	Manure practice: other															
	Fertilizer Switch (lower CI)															
	Precision Application System															
	Other															
Logistics	Reduction in Machine Hours: Tillage															
	Reduction in Produce-2-Market Miles															
	Reduction in Input-2-Farm Miles															

Farm Models Financial Cost/Benefit of Option

Farm Determines Carbon Savings Attributable to Option

Carbon Conversion Actuarial Platform & Place-based, Farm Management Model

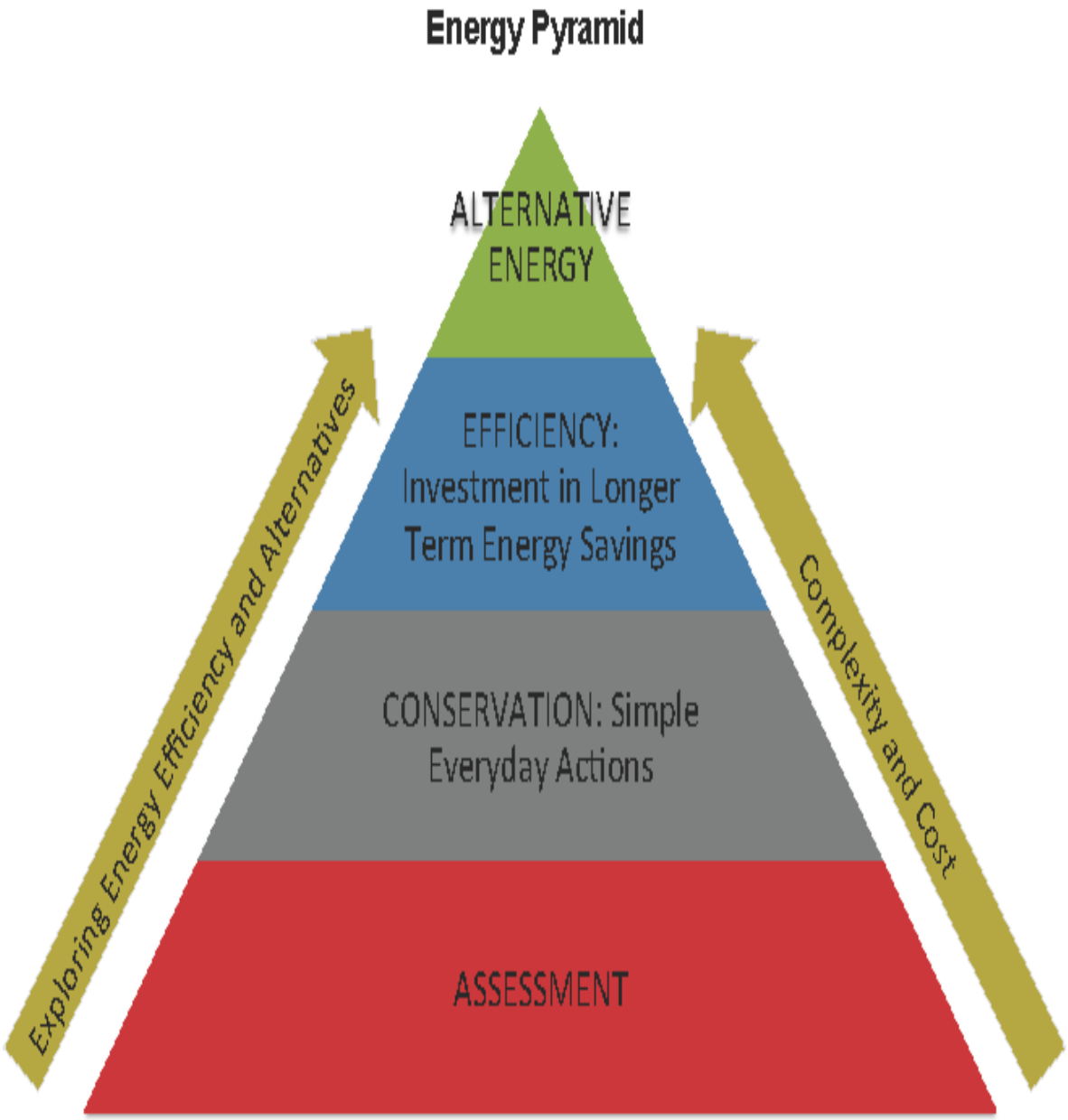
Farm Models Cost/Benefit of Applying Carbon Savings Internally

Farm Models Cost/Benefit of Selling Carbon Savings as Offset

Farm: Go/No-Go/Wait Decision

Demand-Side Management: Energy-Use & Optimization

- **Efficiency**
- **Effectiveness**
- **Load shifting**
- **Reduction**



Source: University of Wyoming and Montana State University. (2011, October). *E3A User's Guide Assessment and Fact Sheets.* E3A-UG.1.

Enterprise-Scale Energy Management

In field sensors, ZigBee powered

Gateway

Database

Weather & Crop Information

Actuator

Decision Support System

SmartGrid

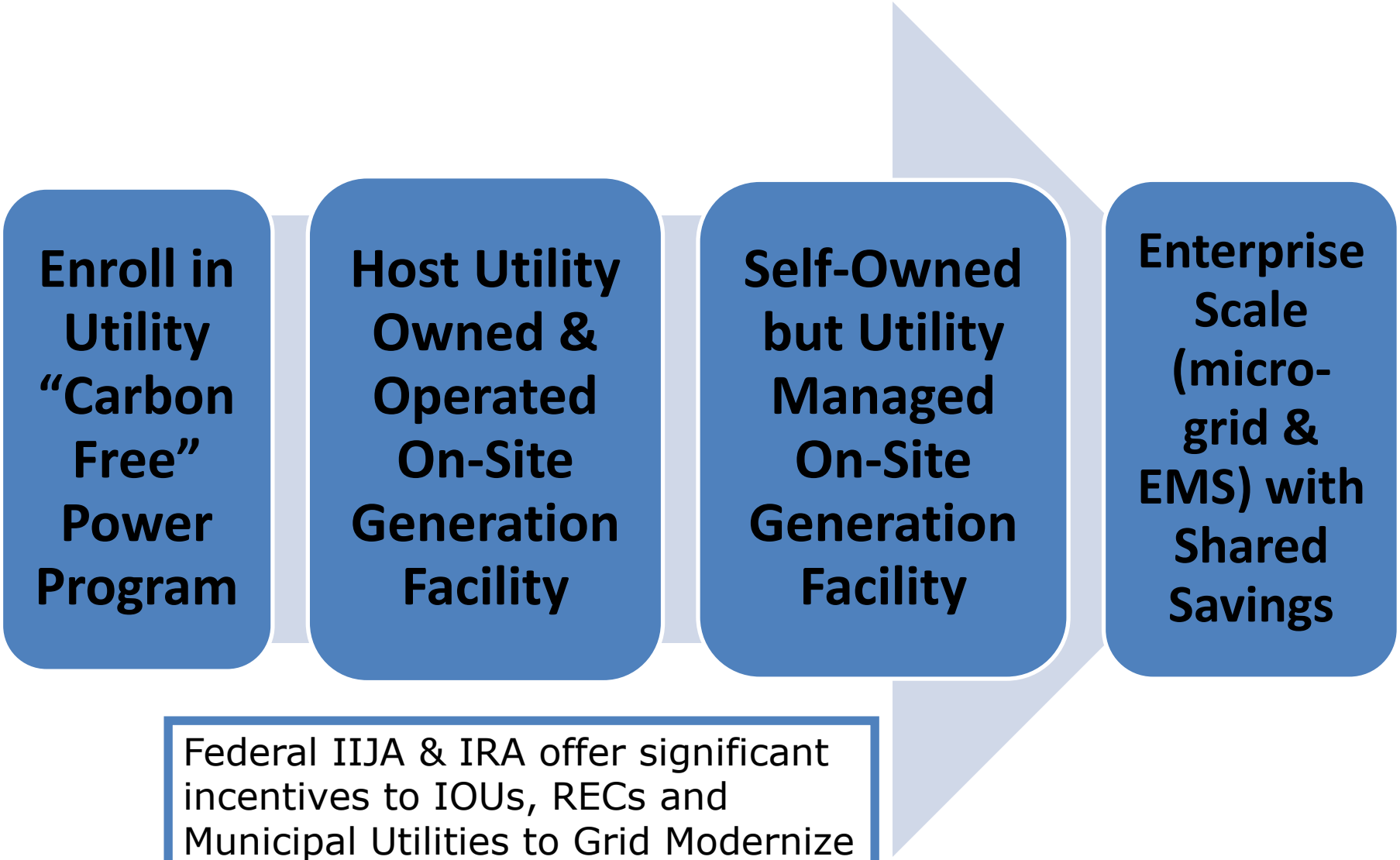
Processing Facility with equipment

Residue Storage

Power generator

Copyright Boston College

Partnering with Farm's Legacy Utility



Federal IIJA & IRA offer significant incentives to IOUs, RECs and Municipal Utilities to Grid Modernize & Recruit DERs

Self Generation of Electric Power Options: Little-to-a-Lot

Self Generation of Electric Power Options: Little-to-a-Lot

Baseline

- Smart meter/EMS (plus efficiency)
- Back-up generation (fossil)

Supplemental

- Roof-top Solar
- Heat-pump/Fuel Cell/NG Generator

All-In

- Max Roof-top + Ground Mount/Wind
- Storage/Baseload, including Digester/CHP

Note: PSC-WI Currently Revising DER rules, directly impacting terms, conditions and economics

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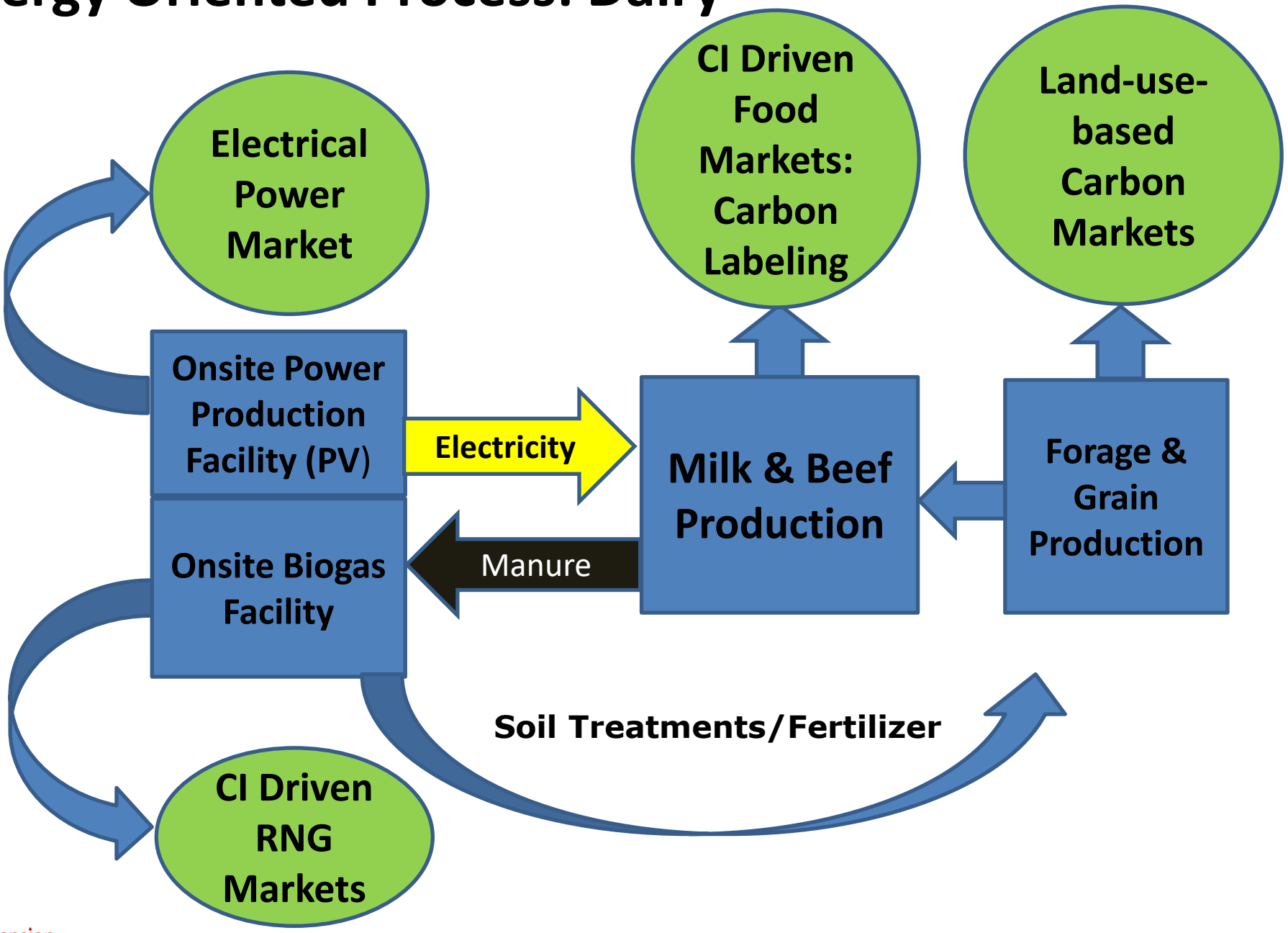
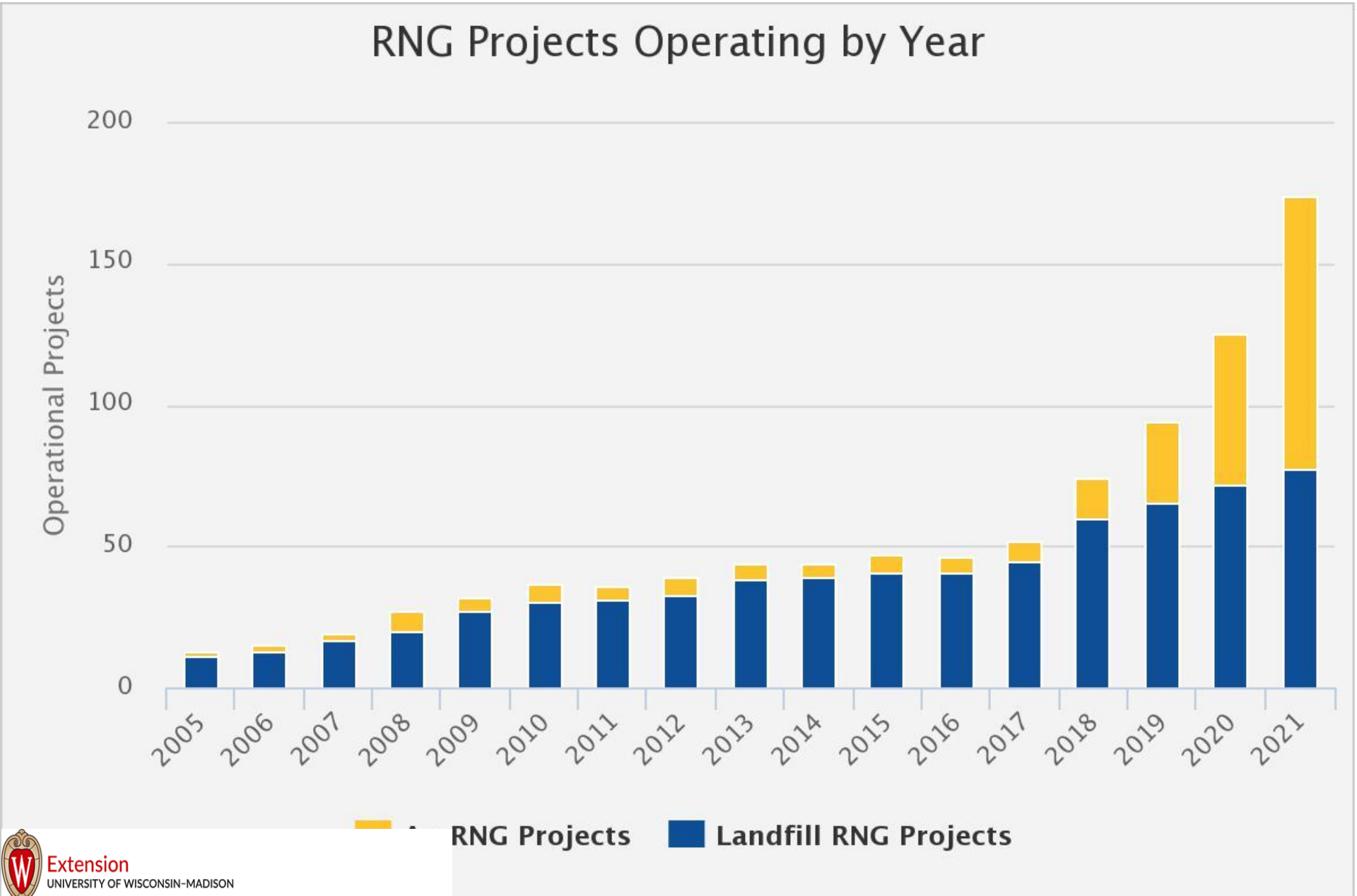
Indicative System: PV + AD + Carbon Intensity

Entire Enterprise Implementing Carbon Accounting

Energy Oriented Process: Dairy



RNG Project Growth: U.S. EPA



Recent RNG Trends

BP acquiring landfill RNG company Archaea for $4.1B (10/22)

Divert to provide RNG for BP from food waste digesters via 10-year contract. (10/22)

Why The AD Industry Is Poised For Expansion: *Institutional Capital Is Flowing*. (12/22)

A recent survey of 450 RNG producers by US clean energy consultancy EcoEngineers found that many companies are beginning to **draw around $20/MMBtu for RNG sold into voluntary markets on a long-term basis.** These stable supply arrangements could look increasingly attractive to producers -- especially if stakeholders are **uninterested in the machinations of renewable fuel credits** offered for transportation RNG, like Renewable Identification Numbers offered under the US Renewable Fuel Standard. **S& P Global, 12/22**

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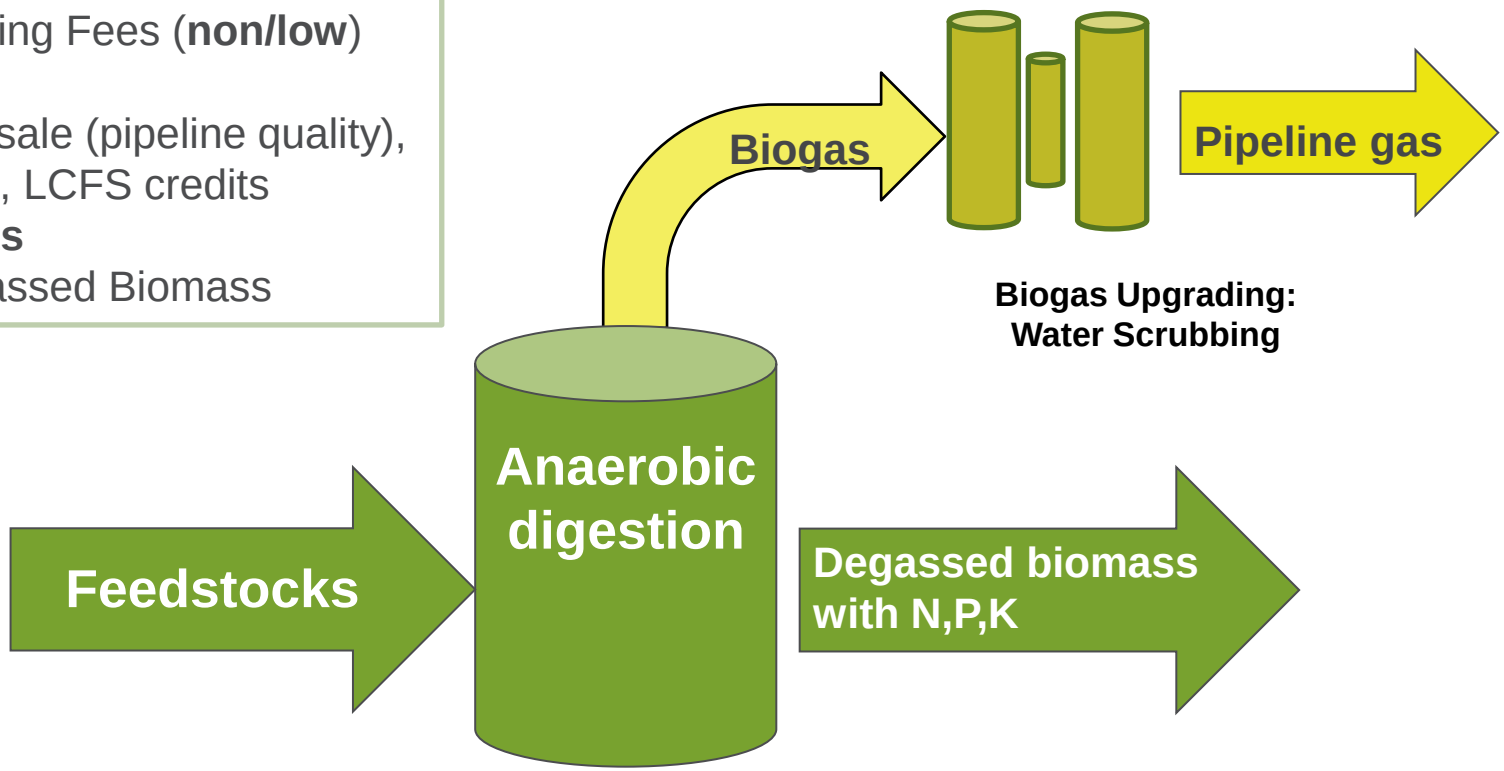
Standard Biogas Concept

Biogas Upgrading

Possible Revenues

- **Feedstock**
  - Tipping Fees (**non/low**)
- **Biogas**
  - Gas sale (pipeline quality), RINs, LCFS credits
- **Nutrients**
  - Degassed Biomass



Nitrogen is not stabilized in the degassed biomass and thus volatile. Storage needs to be covered to keep ammonia in biomass

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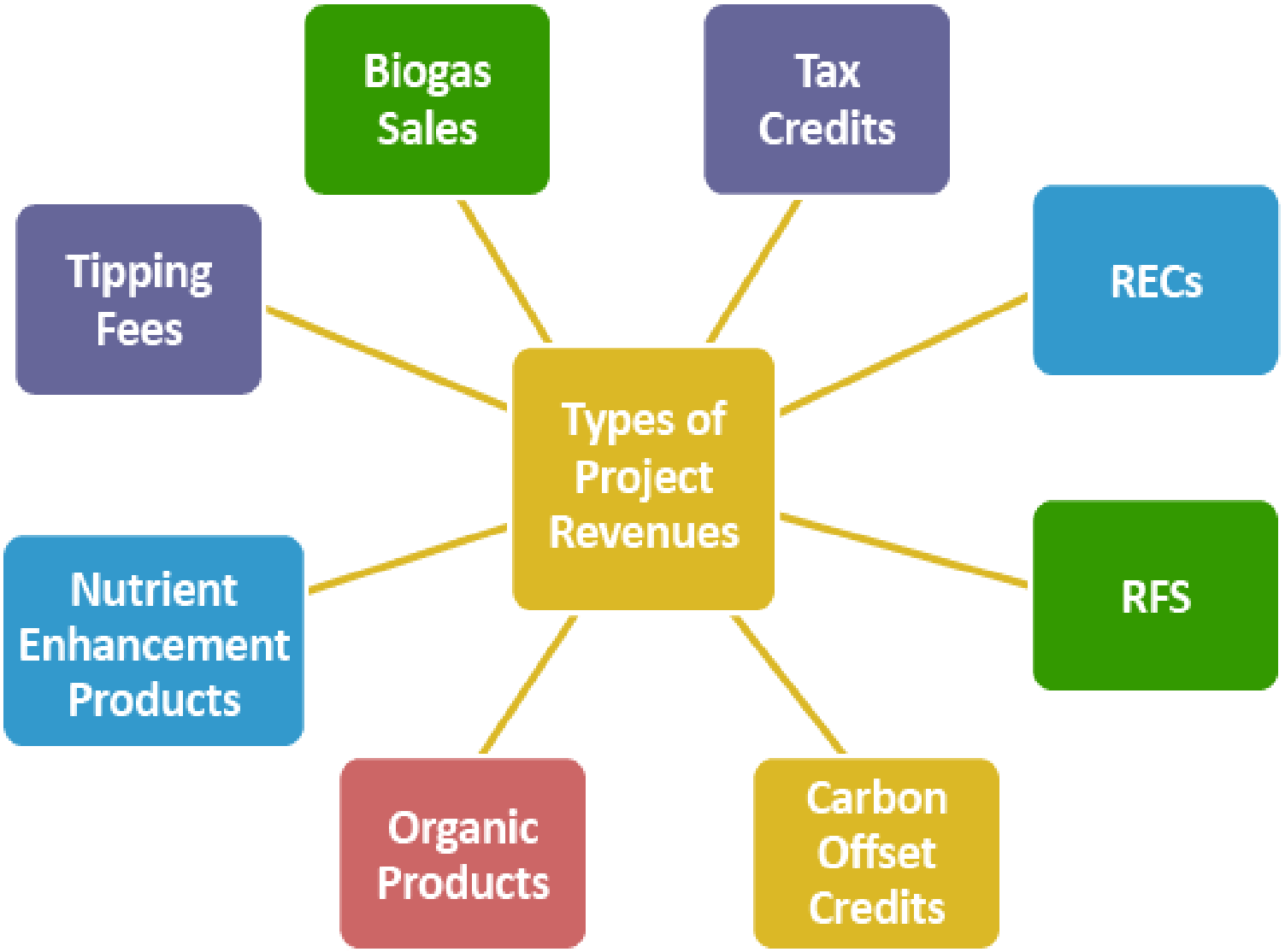
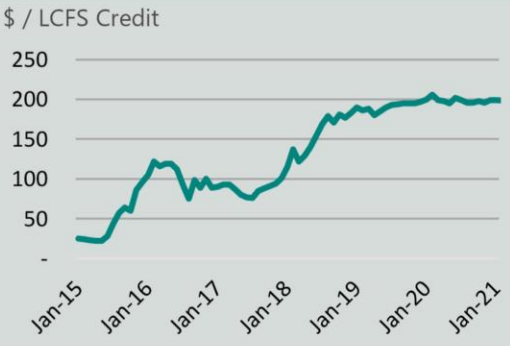
renew energy

Types of Project Revenues



RNG Value Components

THERE ARE THREE VALUE DRIVERS BEHIND RNG WHEN SELLING GAS INTO CALIFORNIA'S CNG MARKET: THE LCFS CREDIT, THE RIN, AND THE COMMODITY (NATURAL GAS) VALUE

Value Component	Description	Historical Price Performance
California Low Carbon Fuels Standard (LCFS) Credit	• California program to reduce the carbon intensity of its transportation fuels – RNG must be dispensed into a vehicle in California • CI score varies depending on project and will be one of the most important factors in RNG project viability • LCFS changes expected in 2024 may make dairy CI scores less favorable	
Renewable Fuel Standard: D3 (Cellulosic) RIN	• 2005 federal program to reduce greenhouse gas emissions and reduce reliance on imported oil • RIN credits are generated with each gallon of qualifying renewable fuels that are produced and is not reliant on carbon intensity • Dairy RNG produces D3 (cellulosic) RINs	
Natural Gas	• Dairy RNG is identical to fossil methane (CH_4) and can be injected into the same infrastructure as fossil methane	

ecoengineers
people-driven solutions

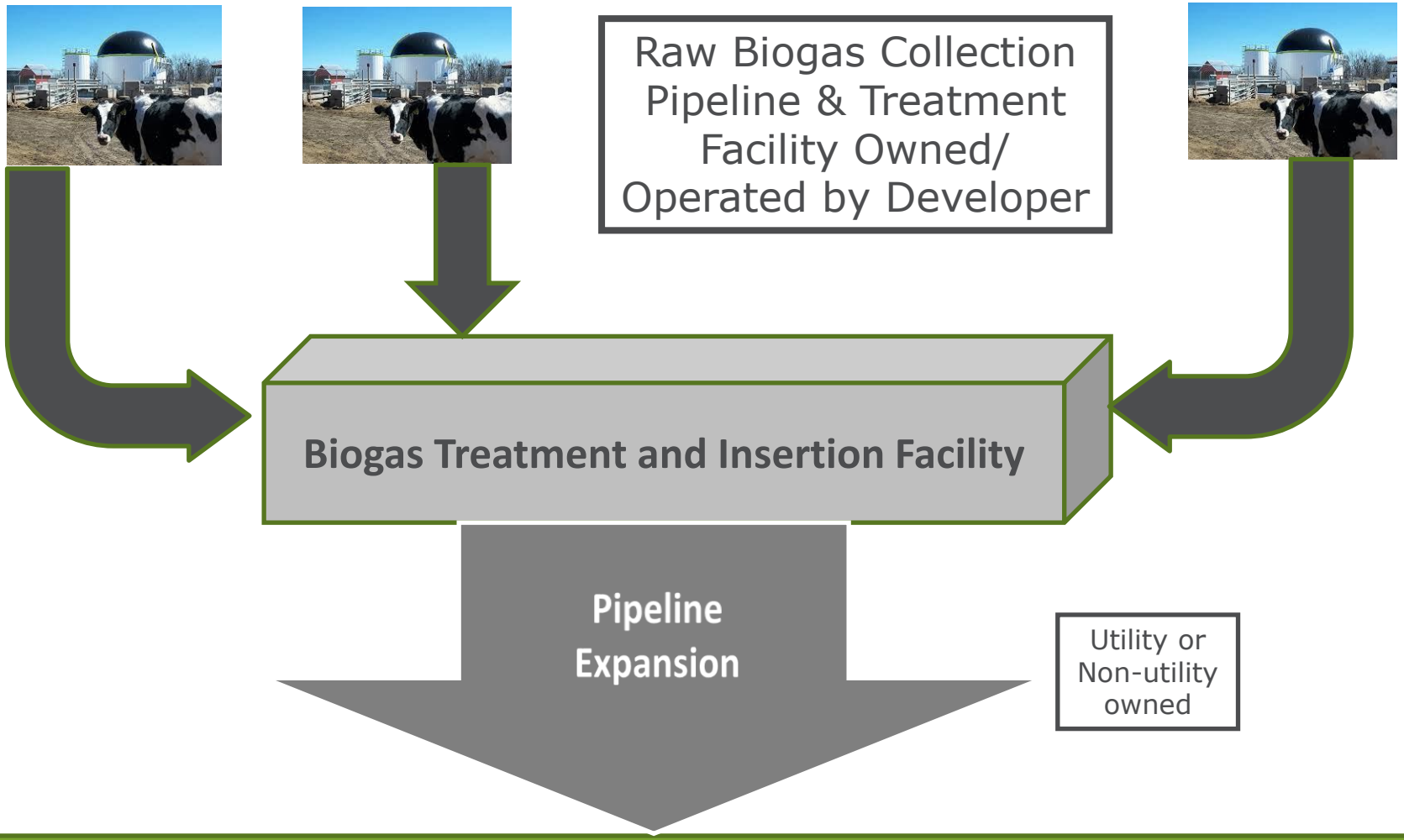
Daily RIN, LCFS & CFP Update

11/10/2022

D-Code	Average Price				Closing Value			
	2020	2021	2022	2023	2020	2021	2022	2023
D3	$2.980	$2.970	$2.525	$2.210	$2.980	$2.970	$2.520	$2.210
D4	$2.040	$2.050	$1.930	$1.815	$2.040	$2.050	$1.930	$1.820
D5	$2.030	$2.040	$1.920	$1.810	$2.030	$2.040	$1.920	$1.810
D6	$1.790	$1.790	$1.785	$1.750	$1.790	$1.790	$1.790	$1.750

	Average Price	Closing Value
California LCFS Credit	$70.00	$70.25
Oregon CFP Credit	$119.50	$119.50

Biogas Cluster Development: Illustration



Farm Biogas Project

Economic Summary (indicative, May 2022)

Key Assumptions:

Milking Cow Equivalents		5,000
Annual mmbtu produced		100,000
Price per delivered mmbtu	$	61.62
OpEx per mmbut	$	21.20
Farm Royalty		10.00%

RNG Investment (000s):

Digester(s)	$	7,000
RNG Plant		7,000
Injection Point/Pipeline		5,000
Working Cap. (80%*12 mos. Exp)		1,696
Separation		excluded
Total Investment	**$**	**20,696**

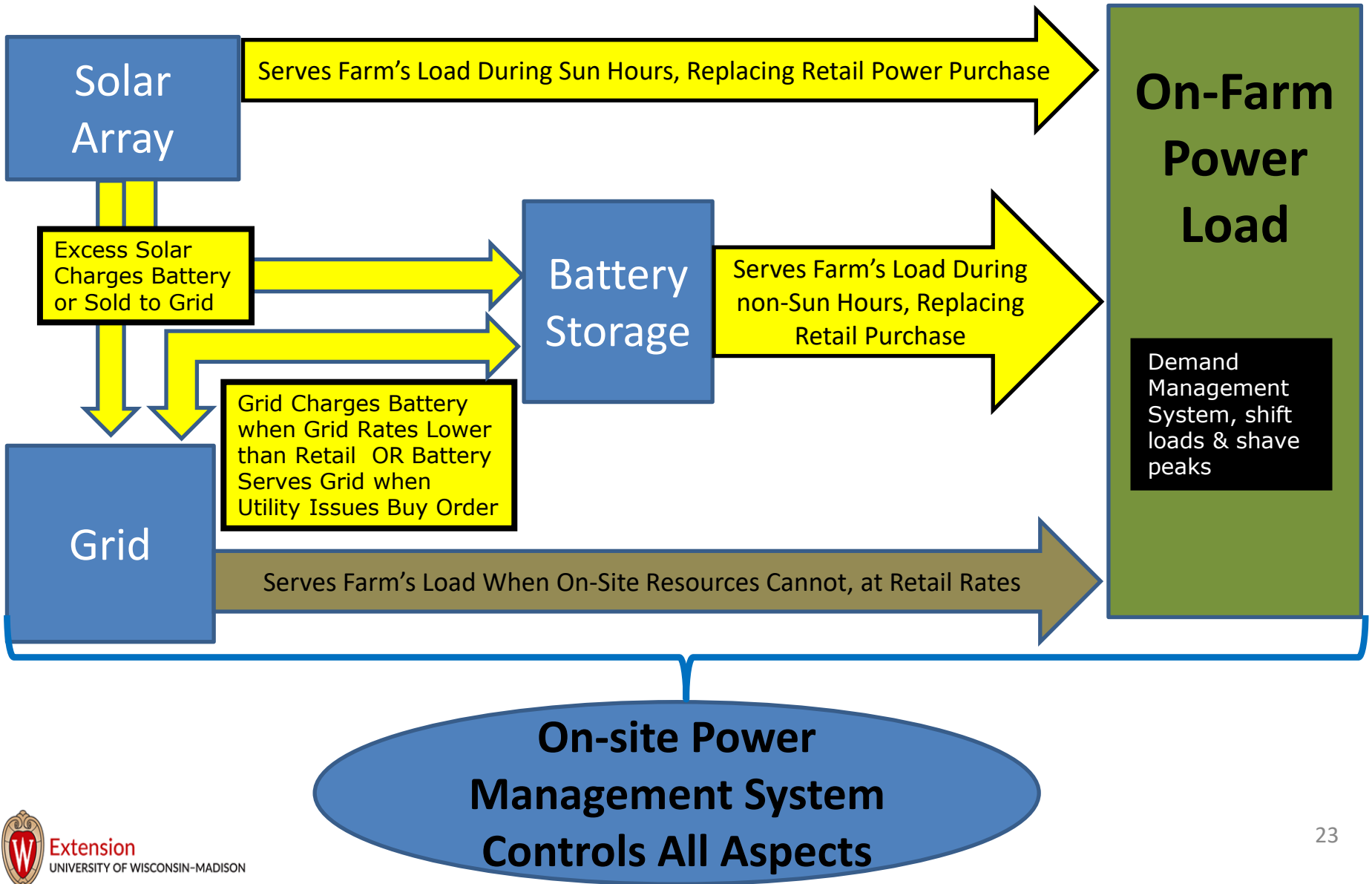
Note: Pricing Indicative of LCFS & RFS Market Conditions as of May 2022

Inflation Reduction Act of 2022

- Significant set of incentives: **ITC up to 50%** (6% base ITC); PTC extension
- Expands PPP options, with **direct payment of ITC for non-taxpayer entities**
- Expands eligible **("qualified")** investments to include **AD system + Gas Treatment**
- $2 billion for Rural Energy for America Program
- Series of eligibility windows, from **today through 2027**
- Some systems may qualify for CCS **(Sec 45Q)** $60/mt for industrial reuse, $85/mt for geological storage

References:
Biocycle, Aug 23 2022. https://www.biocycle.net/the-ira-revolutionizes-ad-tax-credits/
National Law Review, Nov 14 2022. https://www.natlawreview.com/article/inflation-reduction-act-gives-boost-to-biogas-sector

On-site Energy Production & Efficiency Improves Farm Profitability: Simplified Example



Power Purchase Agreements

PPA Agreement between you and PPA provider

Renewable energy system installed by PPA provider

The system generates energy for your building for which you pay a pre-determined energy price

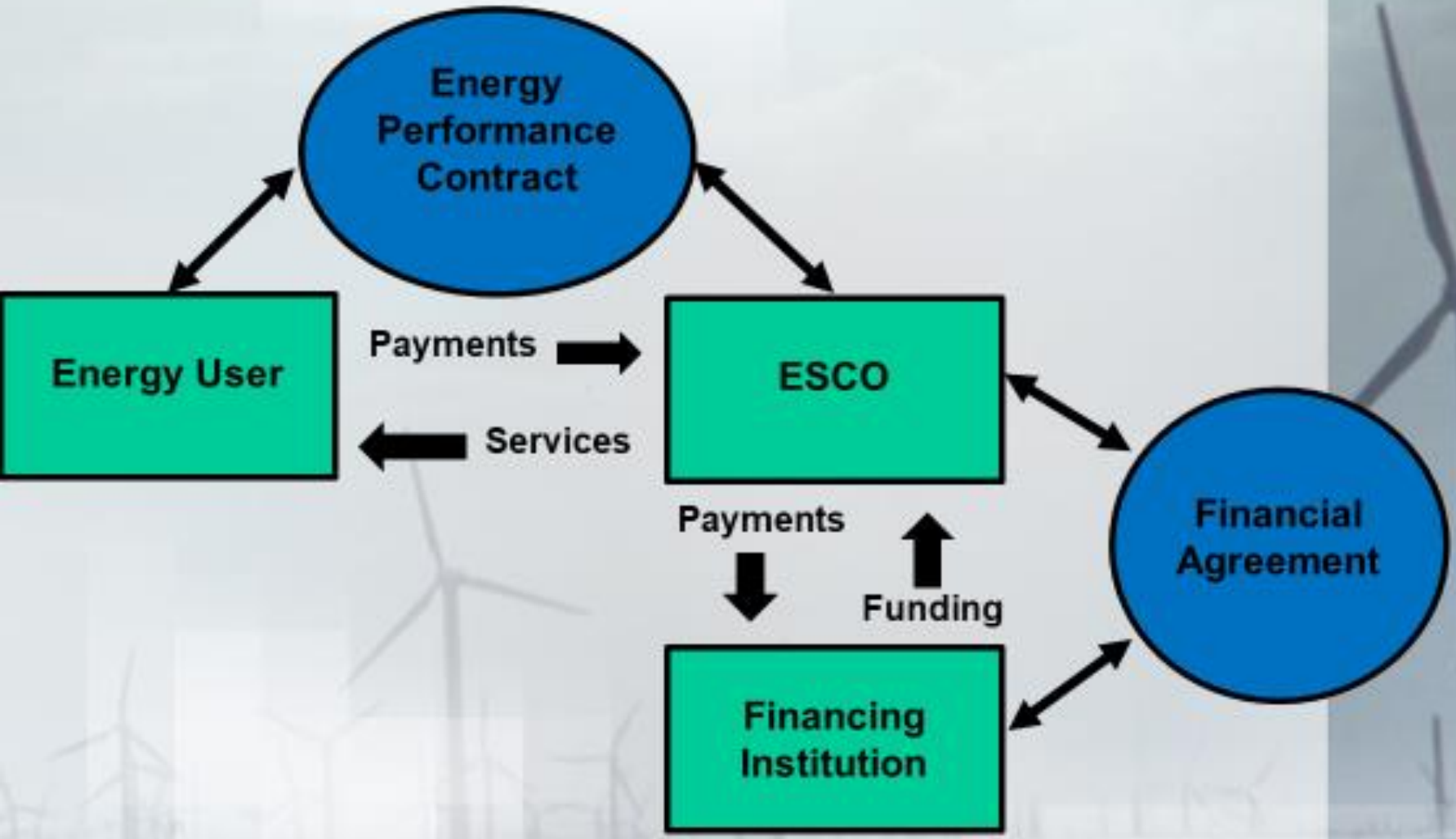
PPA provider owns, manages and maintains system

10-25 years fixed rate

Johnson Controls

The "Who" of your Energy Buy

Energy as a Service



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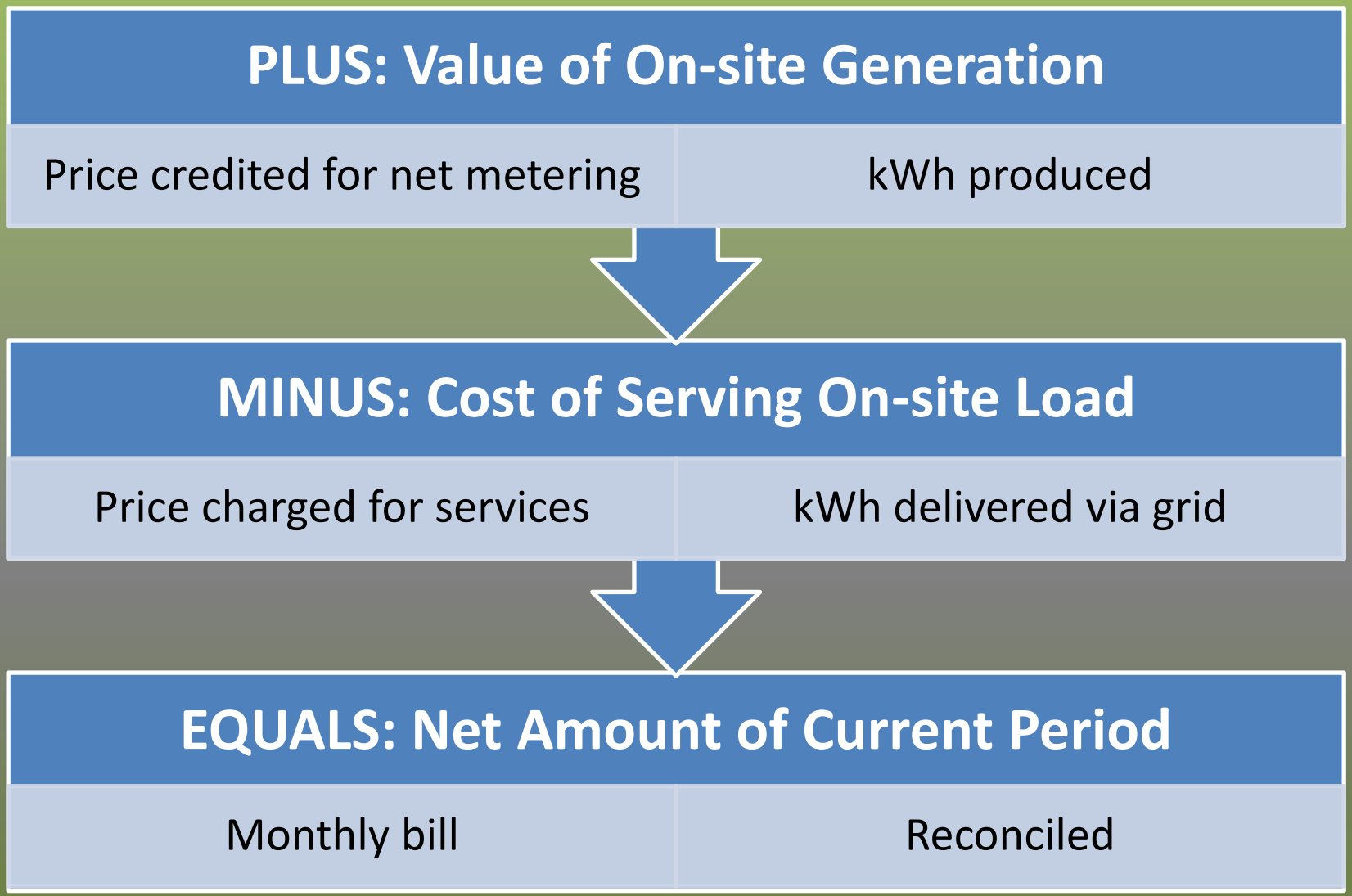
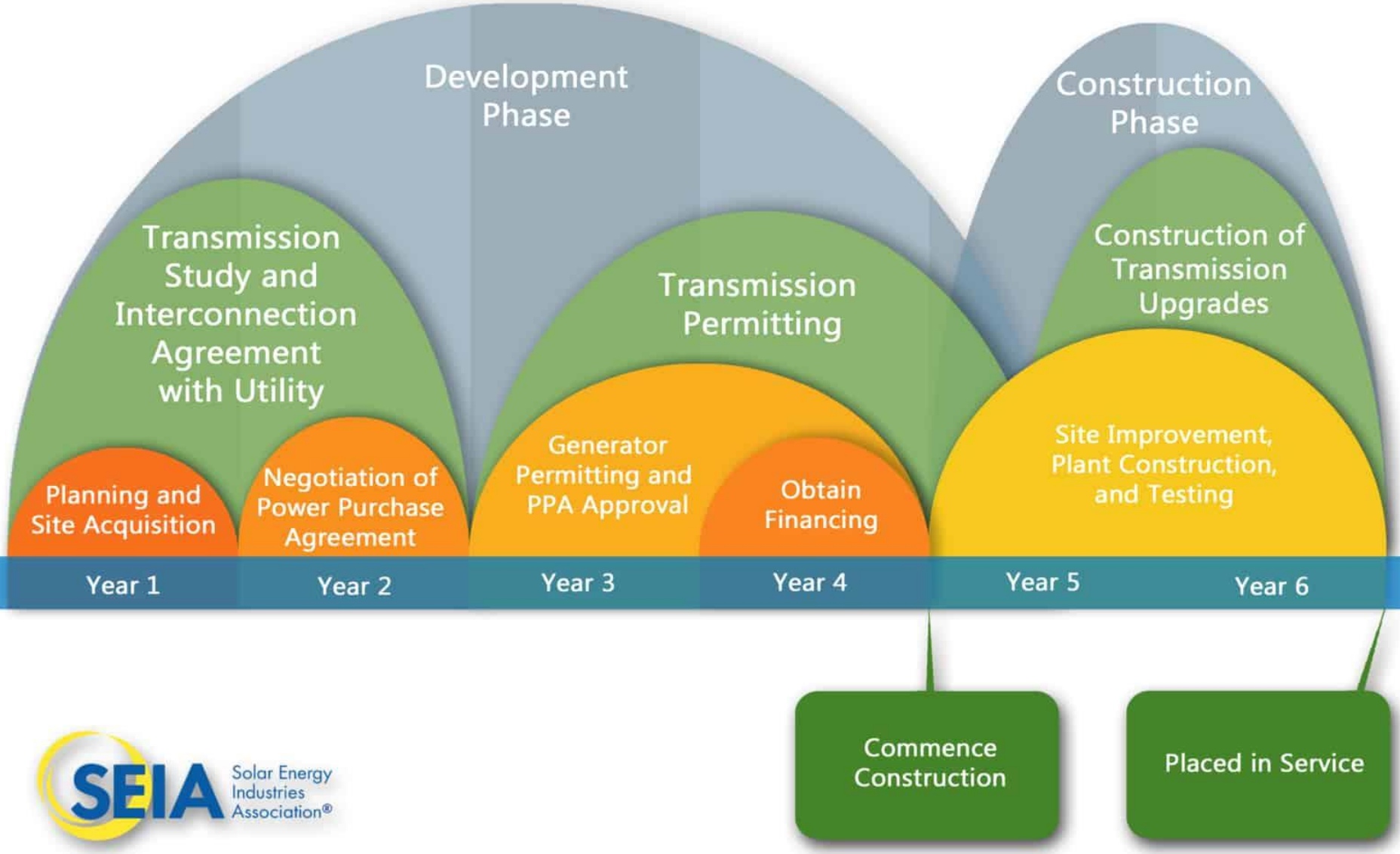
Conventional Net Metering: Behind the Meter System



Hosting an Energy “Farm” Project

Ideal Development Timeline for a Utility-Scale Solar Power Plant (250 MW)



SEIA Solar Energy Industries Association®

Landowner Initial Considerations Checklist

- Length of Commitment
- Who has Legal Interests in the Land
- Family Matters, including Alternative Uses for Land
- Opportunity Costs
- Property Taxes
- Existing Land-use Constraints
- Liability & Insurance
- Neighbor & Community Relations
- Letter of Intent/Option
- Solar Lease Terms and Conditions
- Viability of Developer

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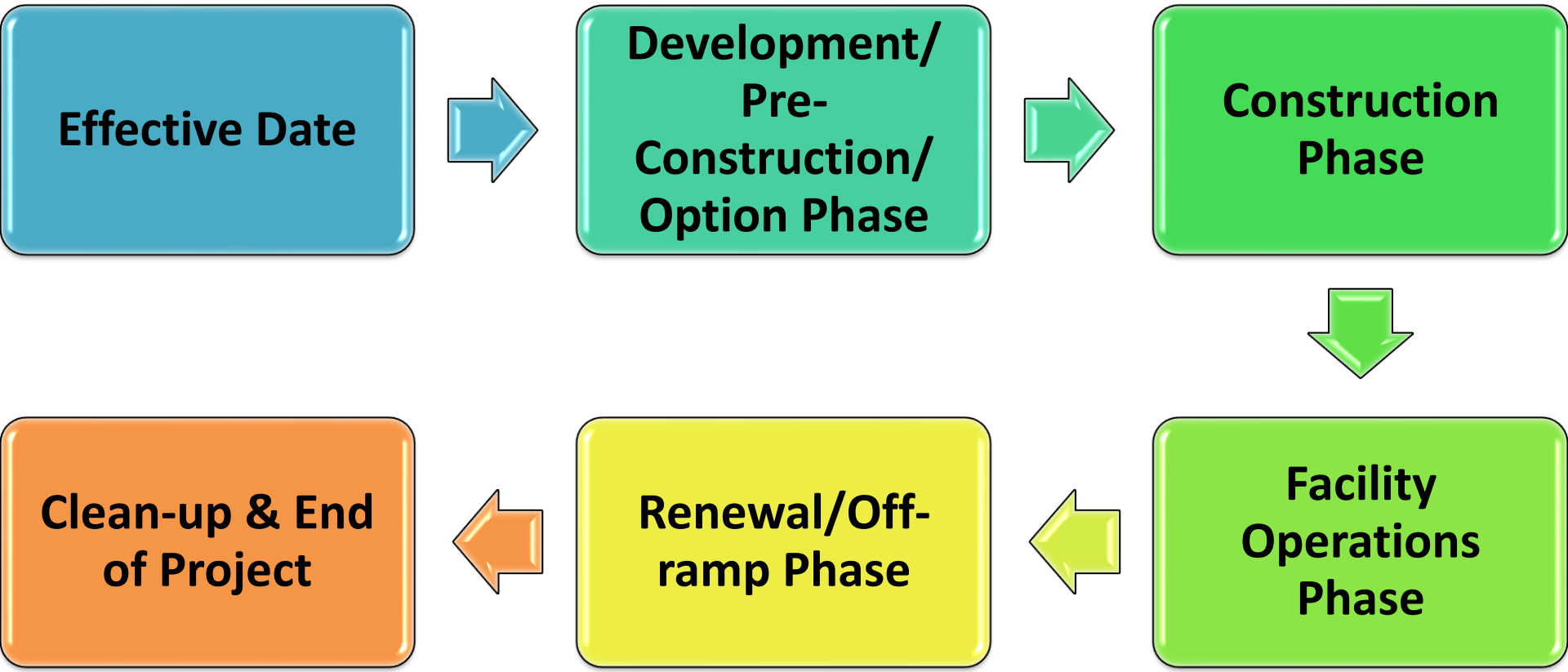
Phases of a Solar Lease



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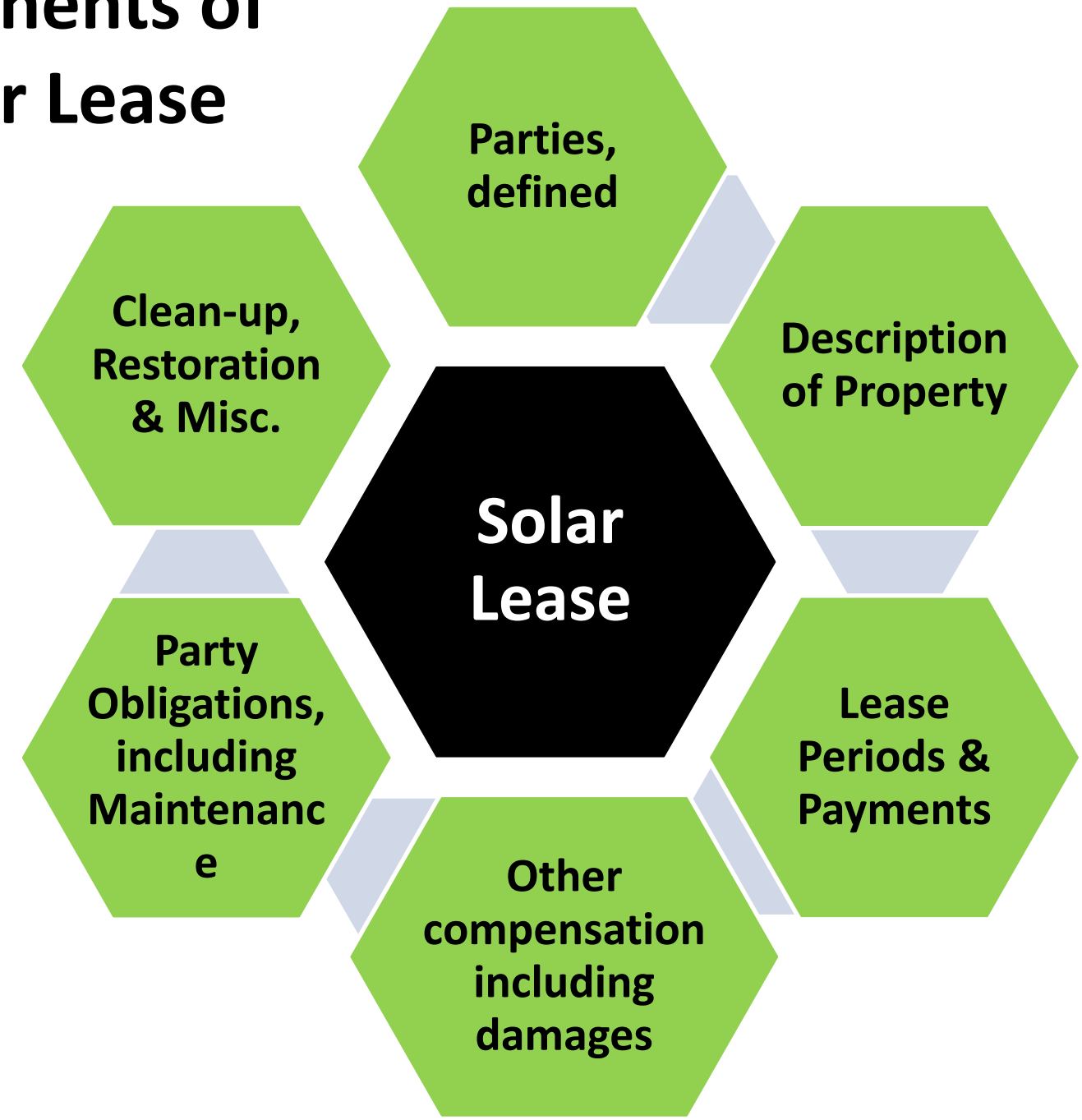
Components of a Solar Lease



Upon the Horizon: Scanning Next Level Developments & Issues (deja vue, sorta)

- **State rules** and regulations regarding distributed energy resources, including ownership, buy-back rates, net metering and standardized contracting
- **EPA E-RIN policy** – significant expansion of feasible AD population
- Transparent and trusted **"energy practice = carbon impact"** by farm location, including CI per kWh references
- **Utility demand** and comfort with DERs
- **FERC** regulations on DER aggregation & wholesale markets
- Outcomes of **USDA** demonstration projects
- Eligibility and impact of **IRA** funding and tax credits
- **Cost** of installation and availability of components

Q&A

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Hosting an Energy "Farm" Project: References and Readings

- https://unboundsolar.com/blog/pros-and-cons-of-leasing-land-to-solar-companies
- https://www.agriculture.com/news/business/solar-leases-more-popular-than-carbon-contracts-among-farmers
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