GREAT LAKES BIOENERGY RESEARCH CENTER

Biogasdoneright™

A Sustainable System for Large Scale Bioenergy Production

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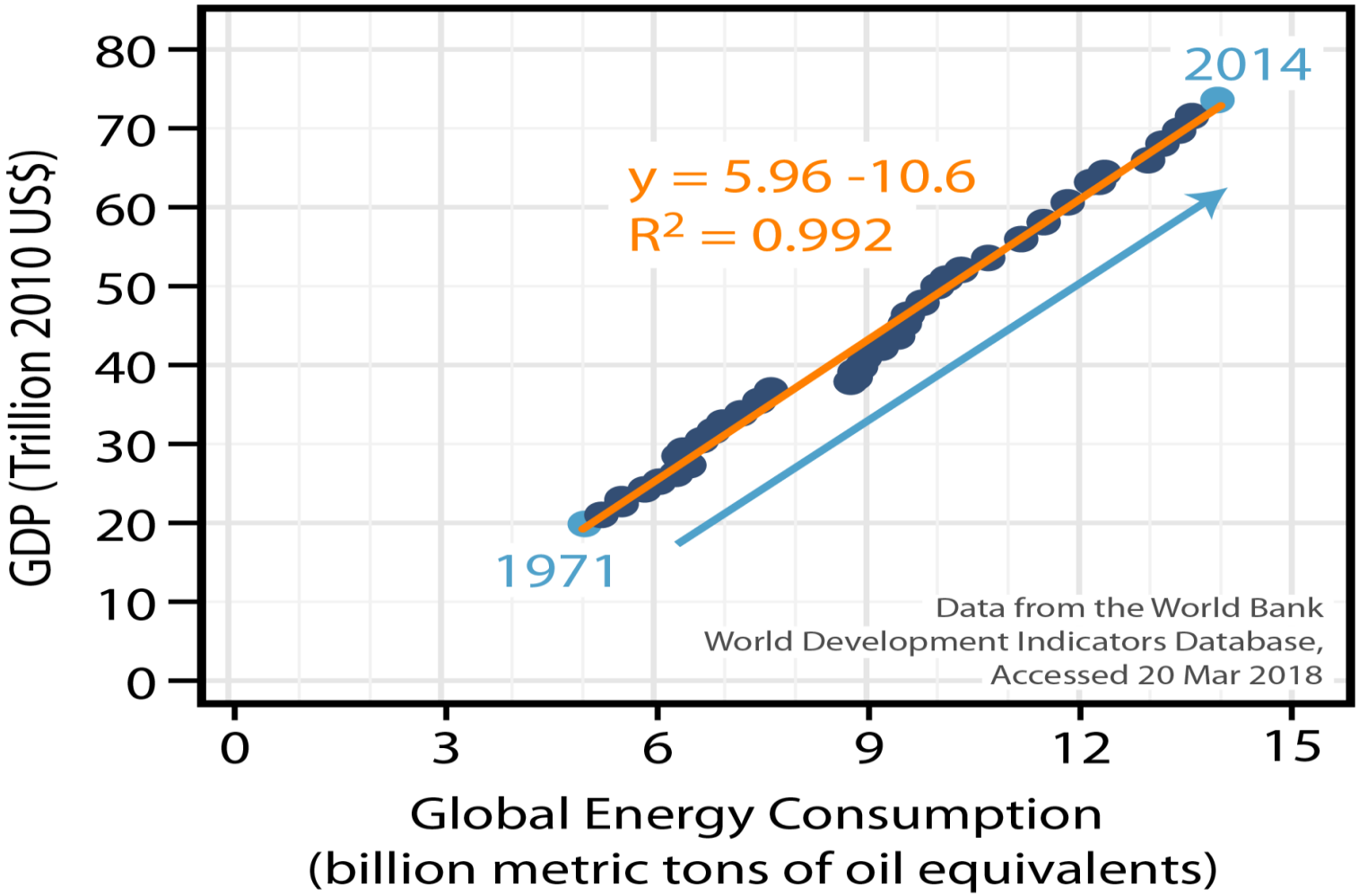
U.S. DEPARTMENT OF ENERGY
DOE Bioenergy Research Centers

(Renewable) Energy is Critical for Long-Term Human Wealth and Well Being

1. Rate of energy use (*rate of doing work*) determines our wealth and opportunities for human development
2. Many people seem ignorant of this basic fact: ***energy use makes us prosperous…lack of energy will make us poor!!***
3. Current prosperity is based largely (~85%) on finite fossil fuels—thus our prosperity has an "expiration date"- it will end!
4. Lack of energy access condemns billions of human beings to poverty—and will also impoverish future generations of those who are currently wealthy unless….
5. We implement sustainable, terawatt scale renewable energy systems—in the next few decades
6. Bioenergy is an essential part of a renewable energy future
7. Thus farmers—those who own and manage land--must benefit from and participate in bioenergy production

Energy Consumption and Wealth: A Linear Relationship



Energy Consumption & Human Well Being are Linked: How Much Energy is "Enough"?

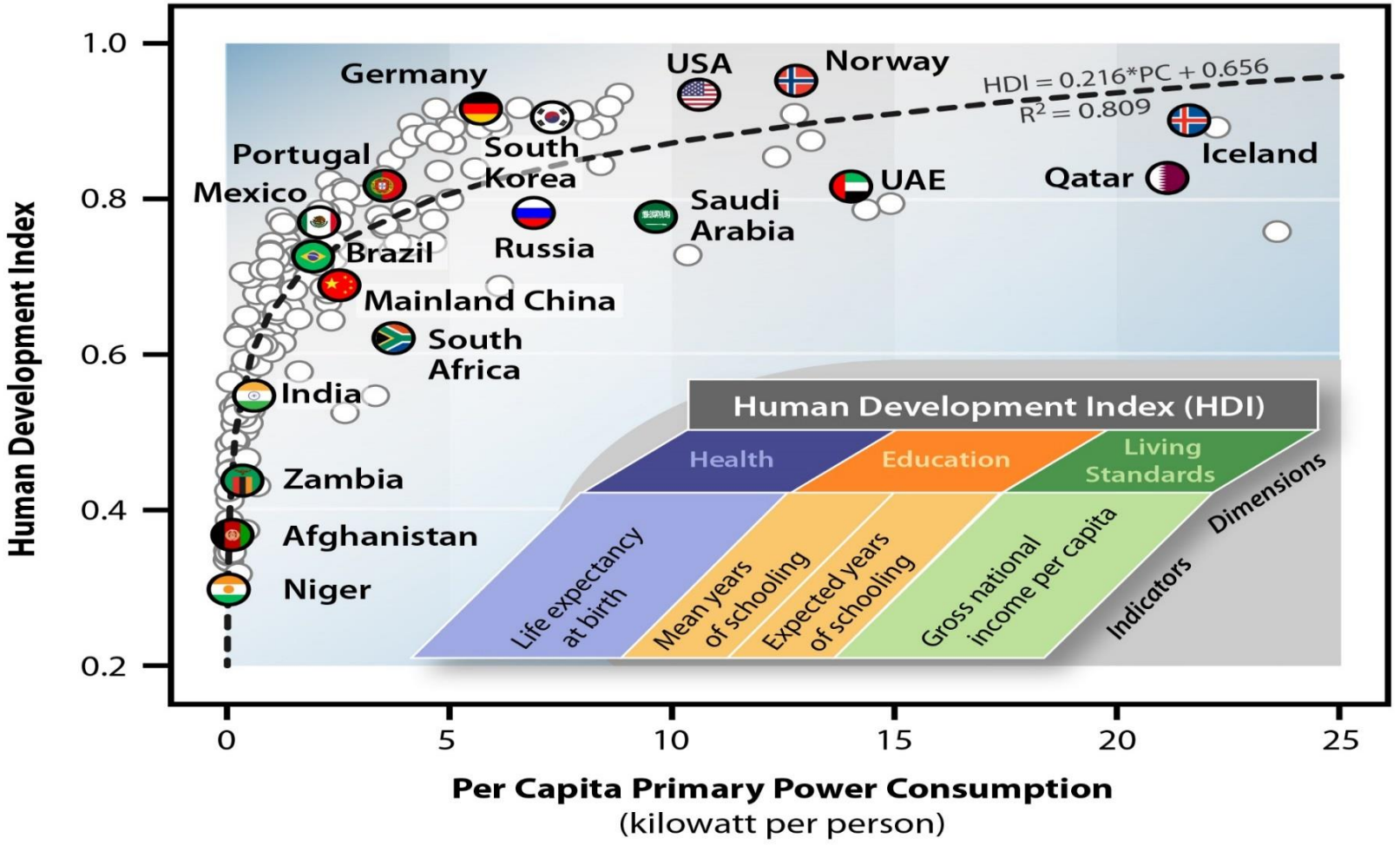
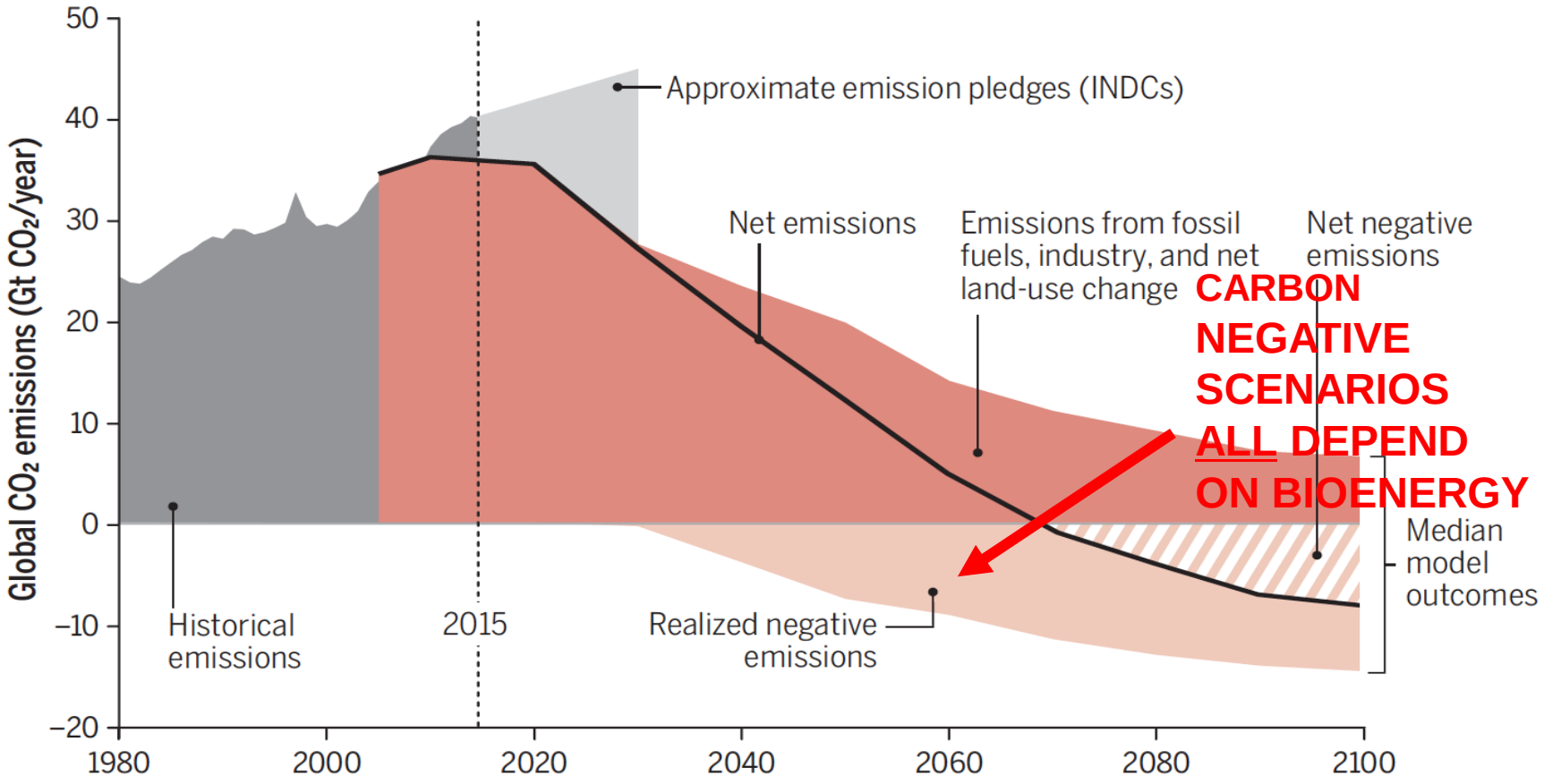


Figure 1. Human Development by Country versus Per Capita Power Consumption in 2010

Emissions Reduction is Not Enough: We Need Large Scale Negative Emissions



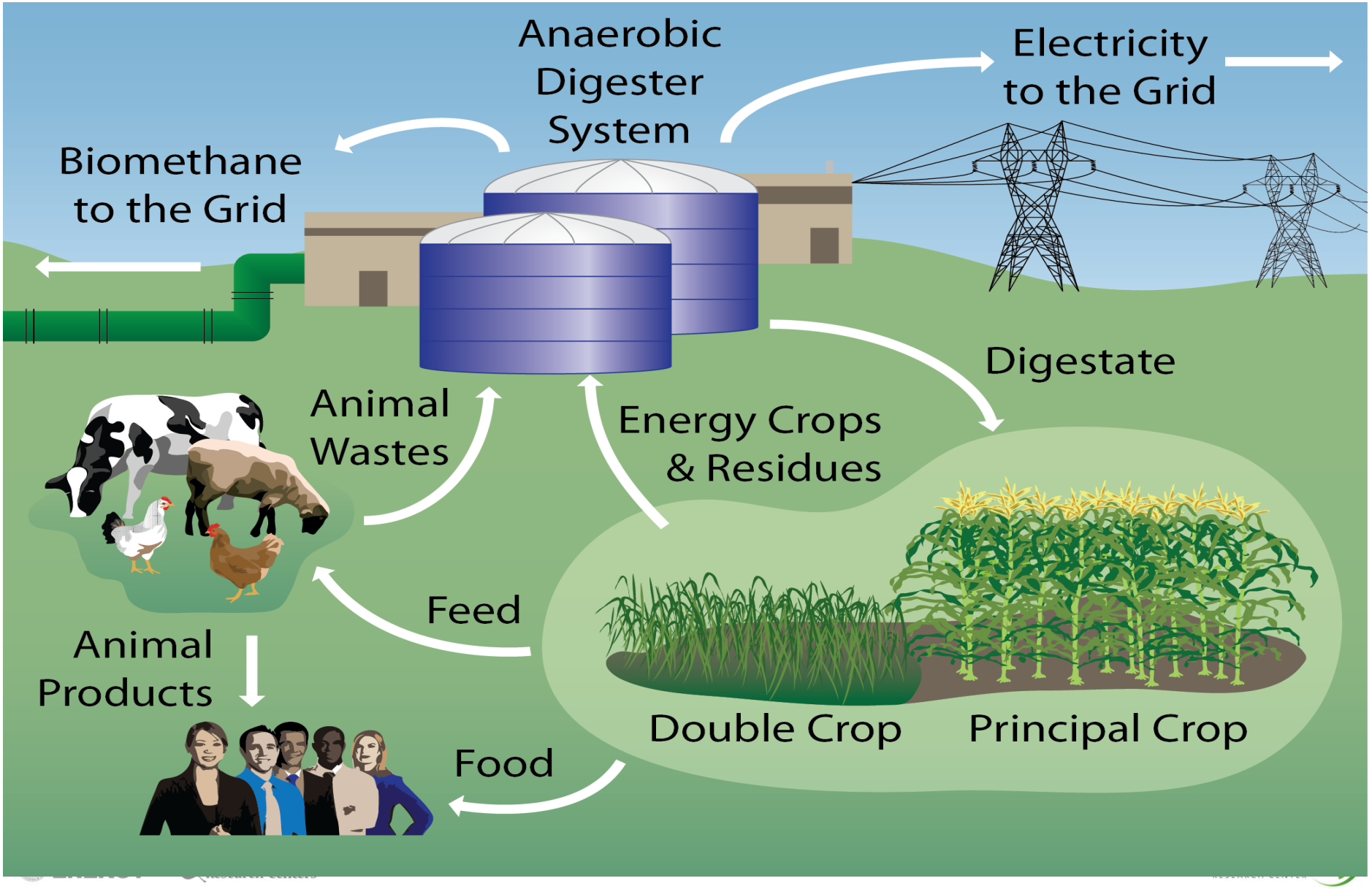
Anderson and Peters. 2016

sciencemag.org SCIENCE

Agriculture and Biofuels: *we must ask the right questions*

- The current approach to bioenergy production is to impose a large new demand for bioenergy on an **existing agricultural system that otherwise does not change**
- ***This approach is short-sighted and often self-defeating***
- We should be asking: Can we redesign agriculture around the world to produce bioenergy, food/feed & large environmental benefits?
- Agriculture has changed before; *it can, should (and must) change again—and farmers are key to that change*
- Biogasdoneright™ is a new paradigm ("business model") for sustainable, large-scale bioenergy production.

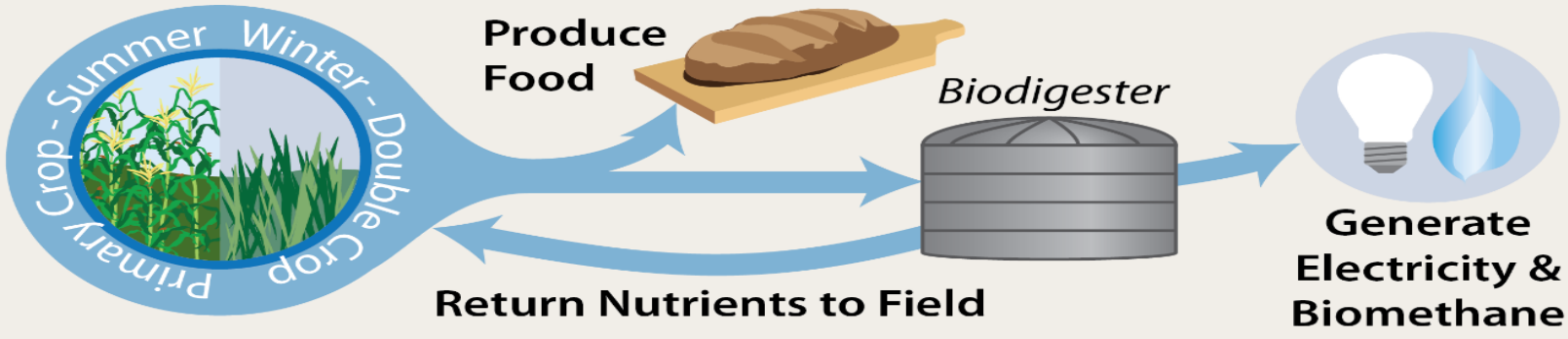
Biogasdoneright™



Guiding Principles: "Biogasdoneright™"

- Grow regular crop for feed/food market– no "food vs. fuel" conflict
- Grow and then ensile a double crop to feed the anaerobic digesters (plus manure and other locally-available "wastes"—whatever is available and fits)
- Burn biogas on site to generate dispatchable electricity for power grid and/or purify and then export and store biomethane in the natural gas grid—thus meeting needs for dispatchable electricity and heating/cooking
- Convert biomethane to compressed natural gas (RNG) or liquid natural gas (LRNG) to meet transportation fuel needs
- Apply innovative, sustainable farming methods using existing technologies:
  - Fertilize fields with digestate liquid using GPS systems→ reduce purchased fertilizers (and associated GHGs)→ reduce irrigation water
  - Apply the digestate solids using GPS → rising soil carbon levels→ increased fertility and farm productivity→ low cost biological carbon capture & storage (BECCS)
  - Result: improved farm profitability—increased farm income and resilience, reduced expenses, better environmental performance

What is Biogasdoneright™?



Continuous Land Cover

Improved Water Quality

Reduced Erosion

Increased Economic Stability

More Economically Robust Farms

Less Volatile Food & Energy Markets

Reduced Fertilizer Costs

Increased Soil Organic Matter

Reduced Loss of Nutrients

More Drought Resistant

More Fertile Soils

Reduced Greenhouse Gas Footprint

Food *AND* Fuel

No Indirect Land Use Change

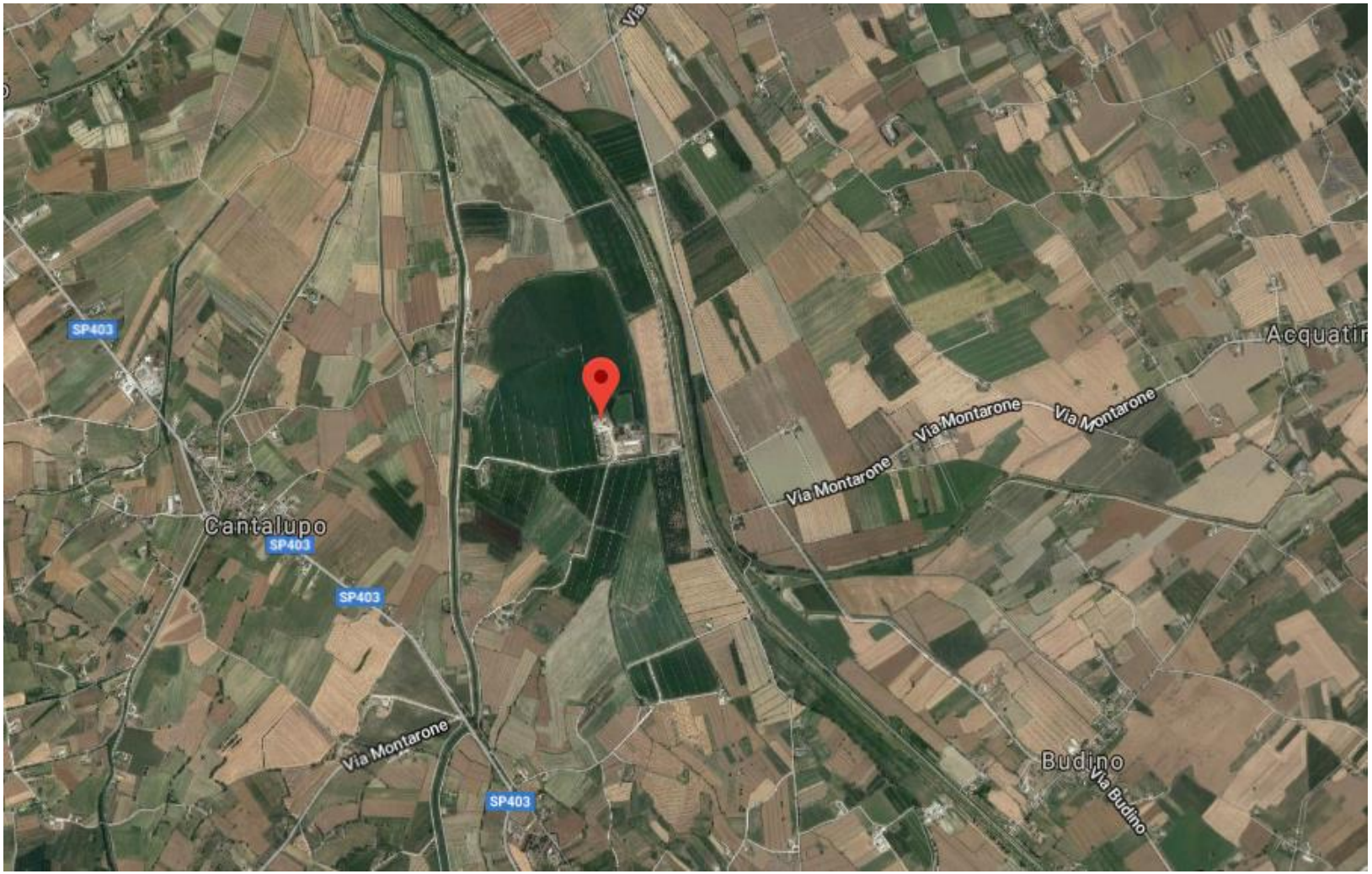
Residue Valorization

Energy from Residues

Avoided Emissions

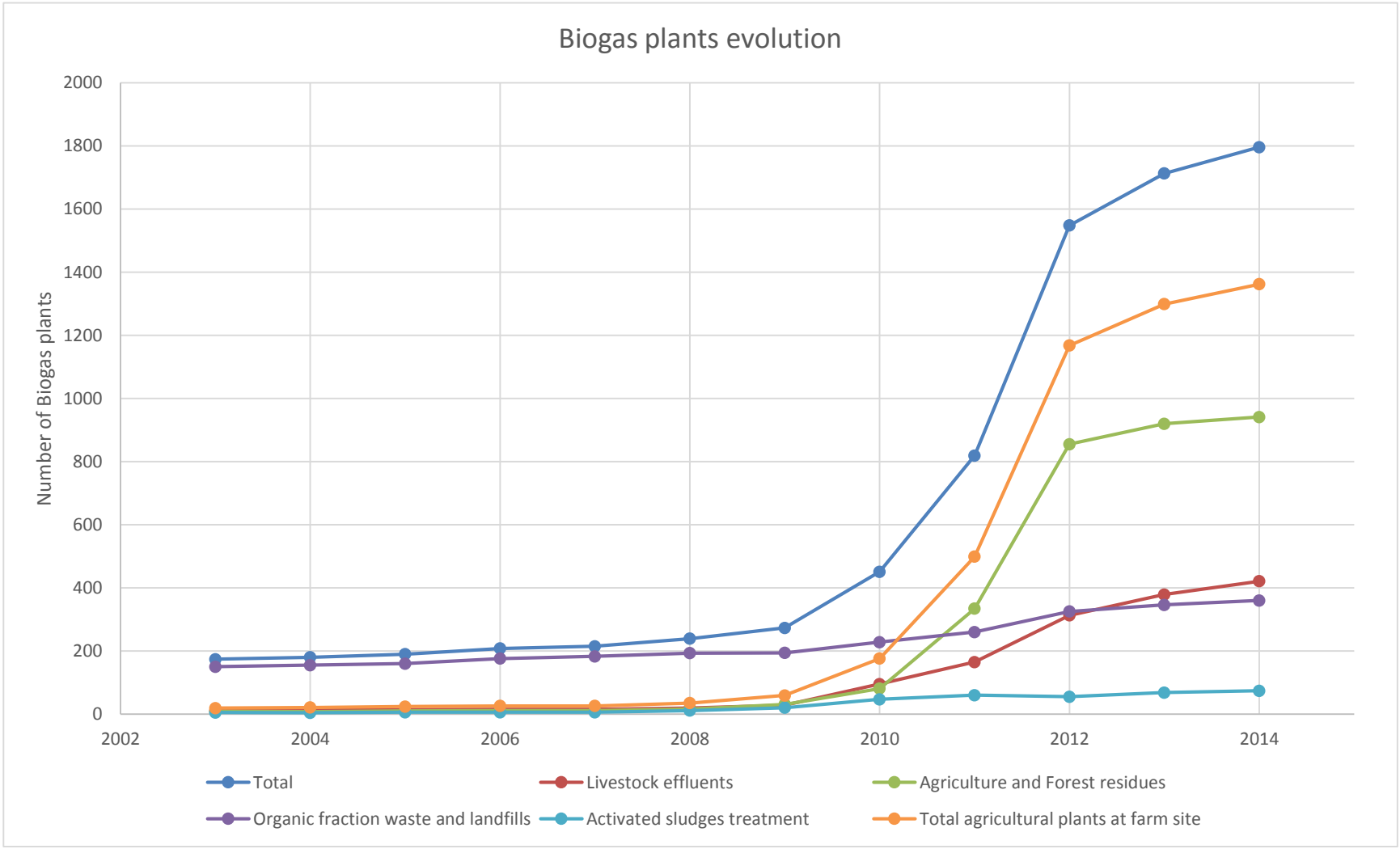
MICHIGAN STATE UNIVERSITY

Example: Iraci Farm on the banks of the Tiber River near Assisi, Italy

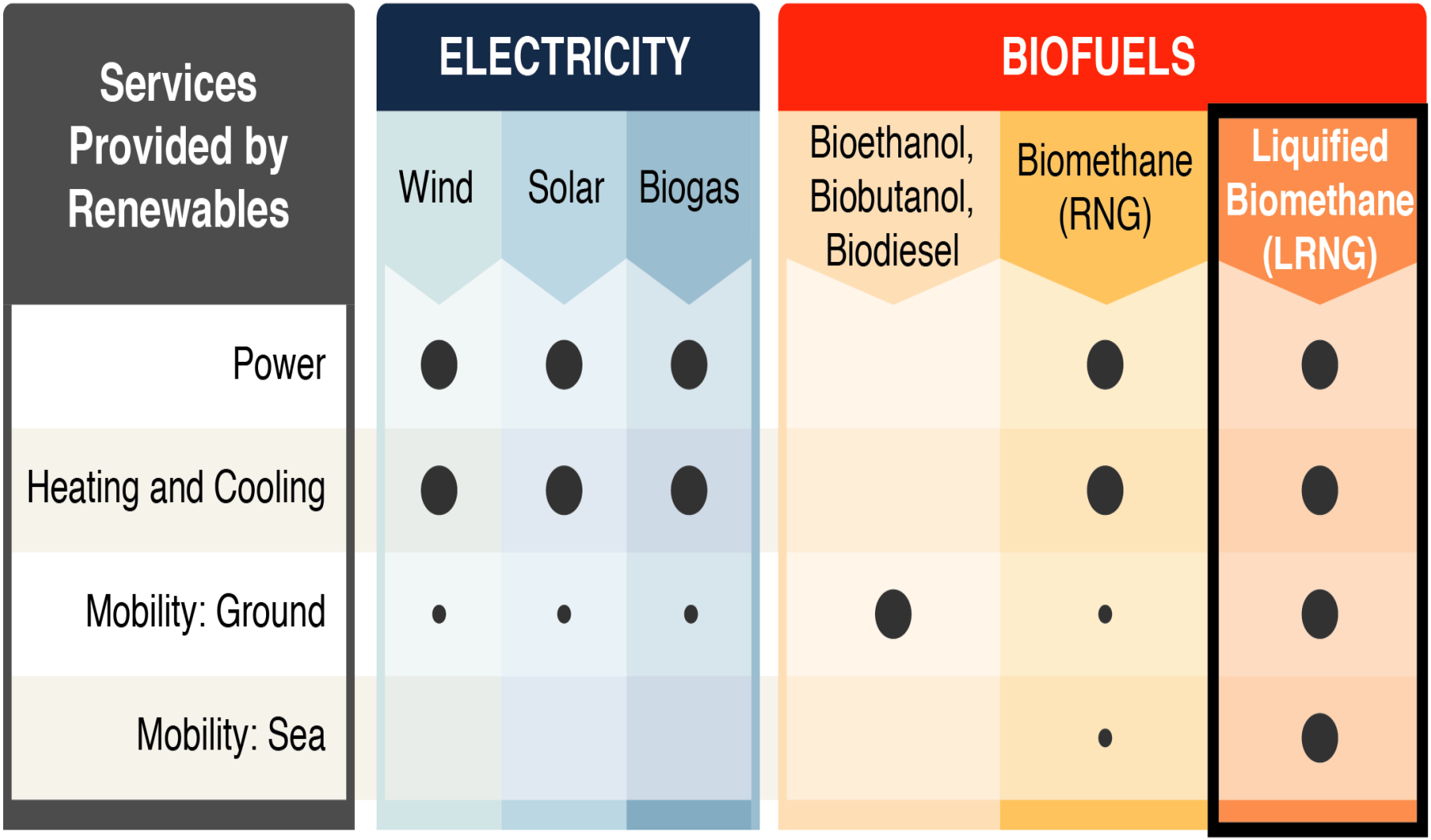



JOHN DEERE

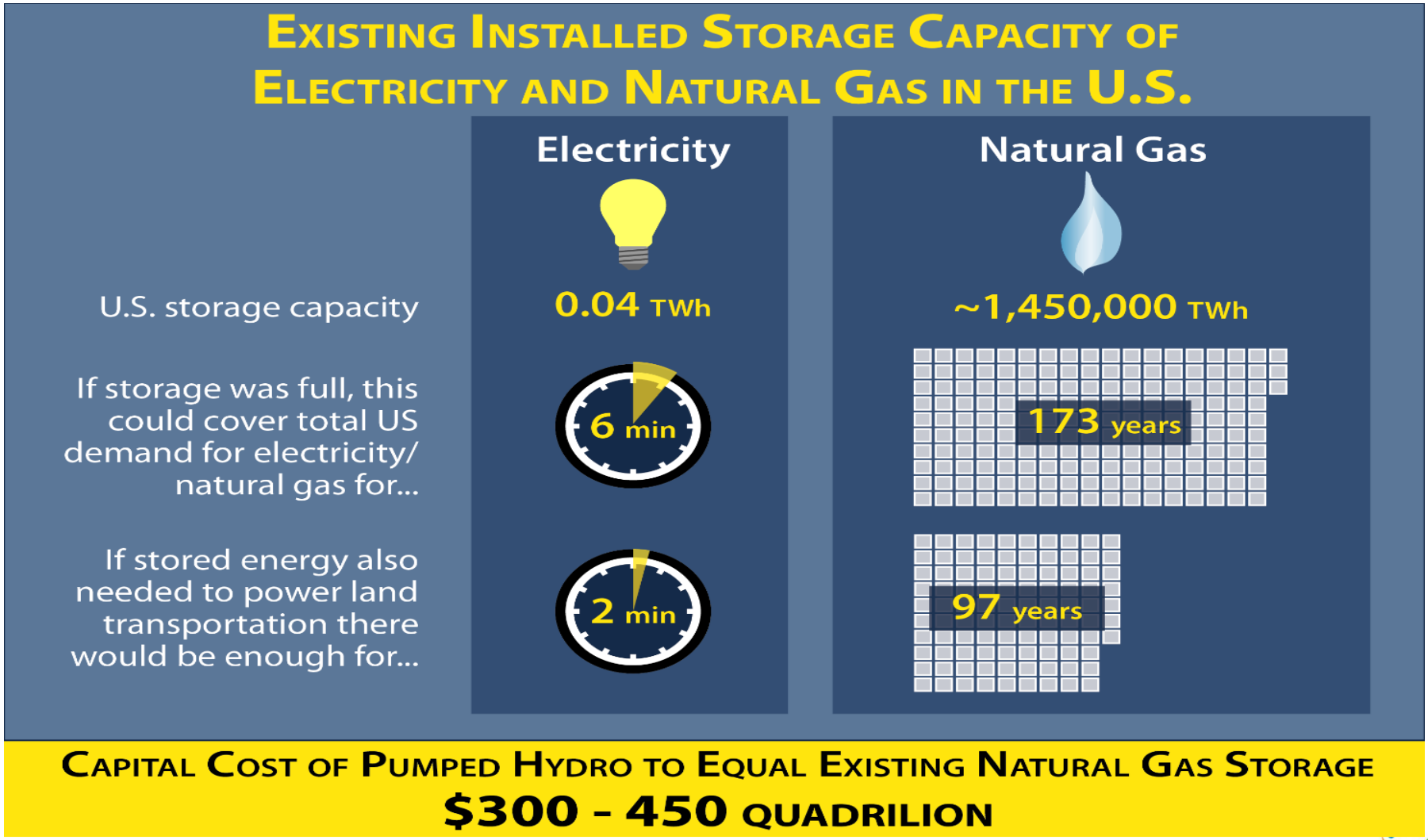
Installed biogas plants in Italy



Biogas & Biogas Derivatives:
the most flexible renewable fuels



Storing Electricity vs. Natural Gas: *Some Comparisons*



Anaerobic Digestion

Animal Wastes

- Waste Treatment
- Limited Scale

Biogasdoneright™

- Produces Food and Low Carbon Energy
- Large Scale
- Increased Soil Organic Carbon
- Improved Farm Economics
- Widely Applicable Nutrient Recycle

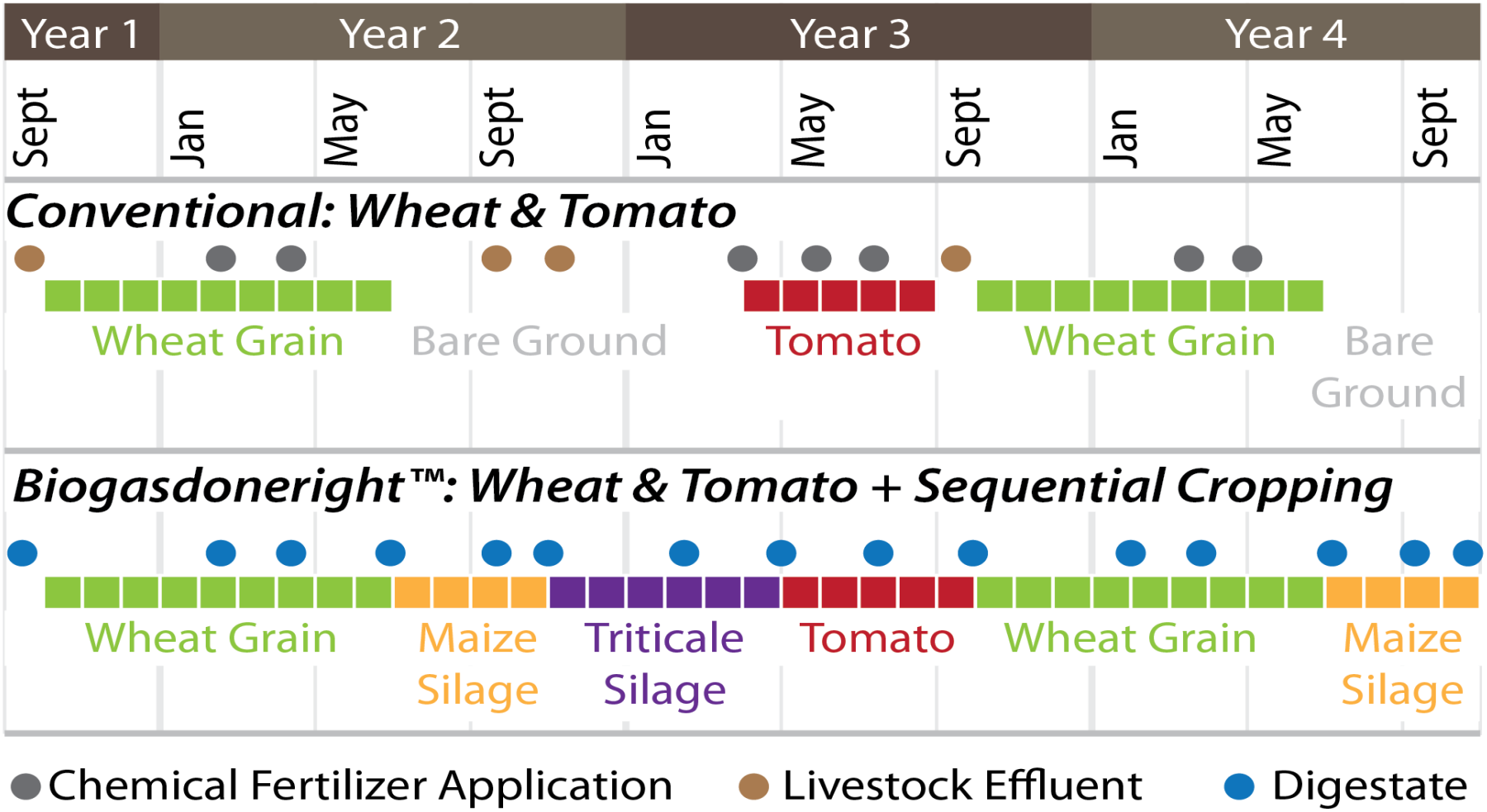
Energy Crops

- Large Scale
- "Food vs. Fuel" Conflict

ONE DOUBLE CROP EXAMPLE:

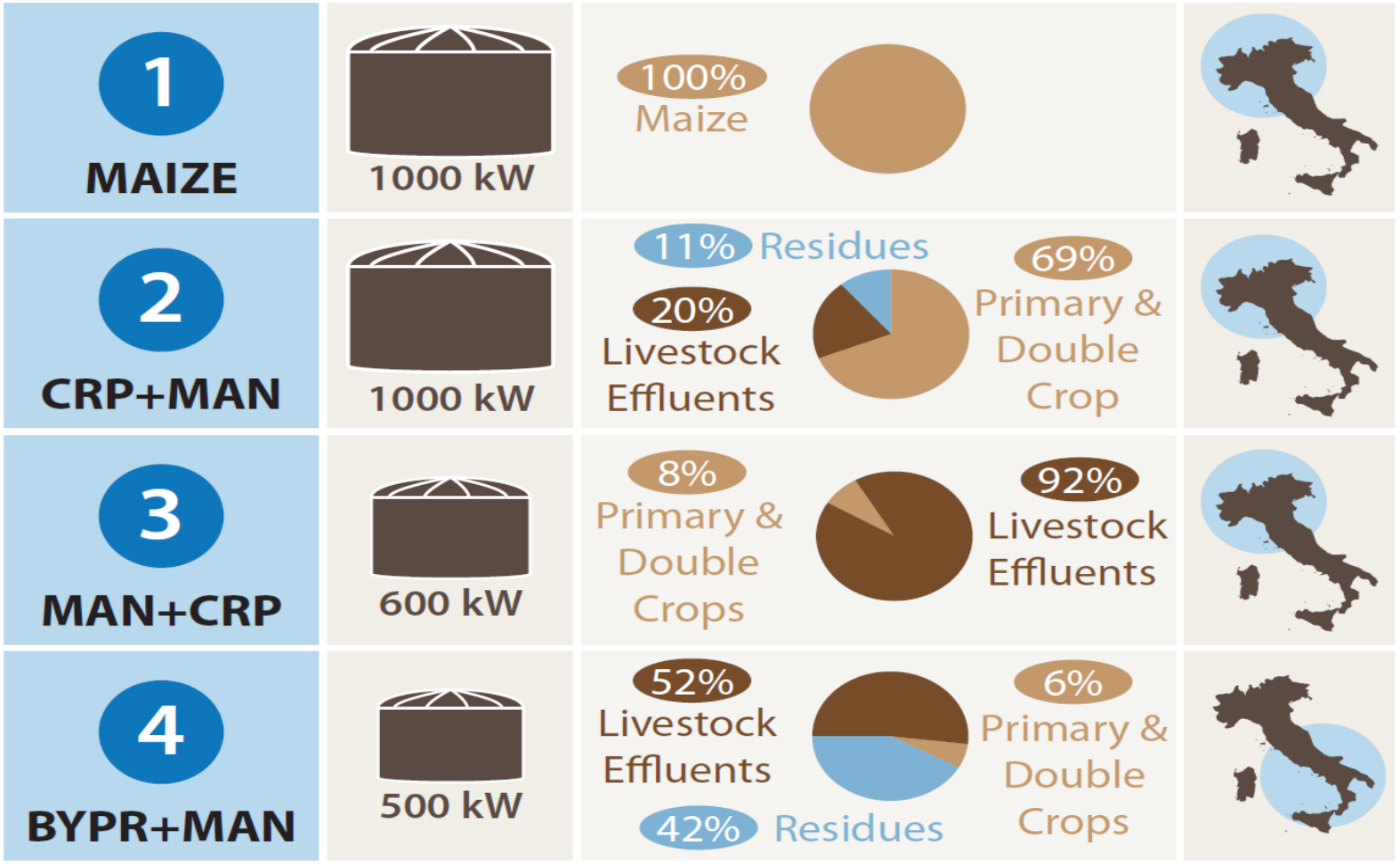
TRITICALE AND TOMATO

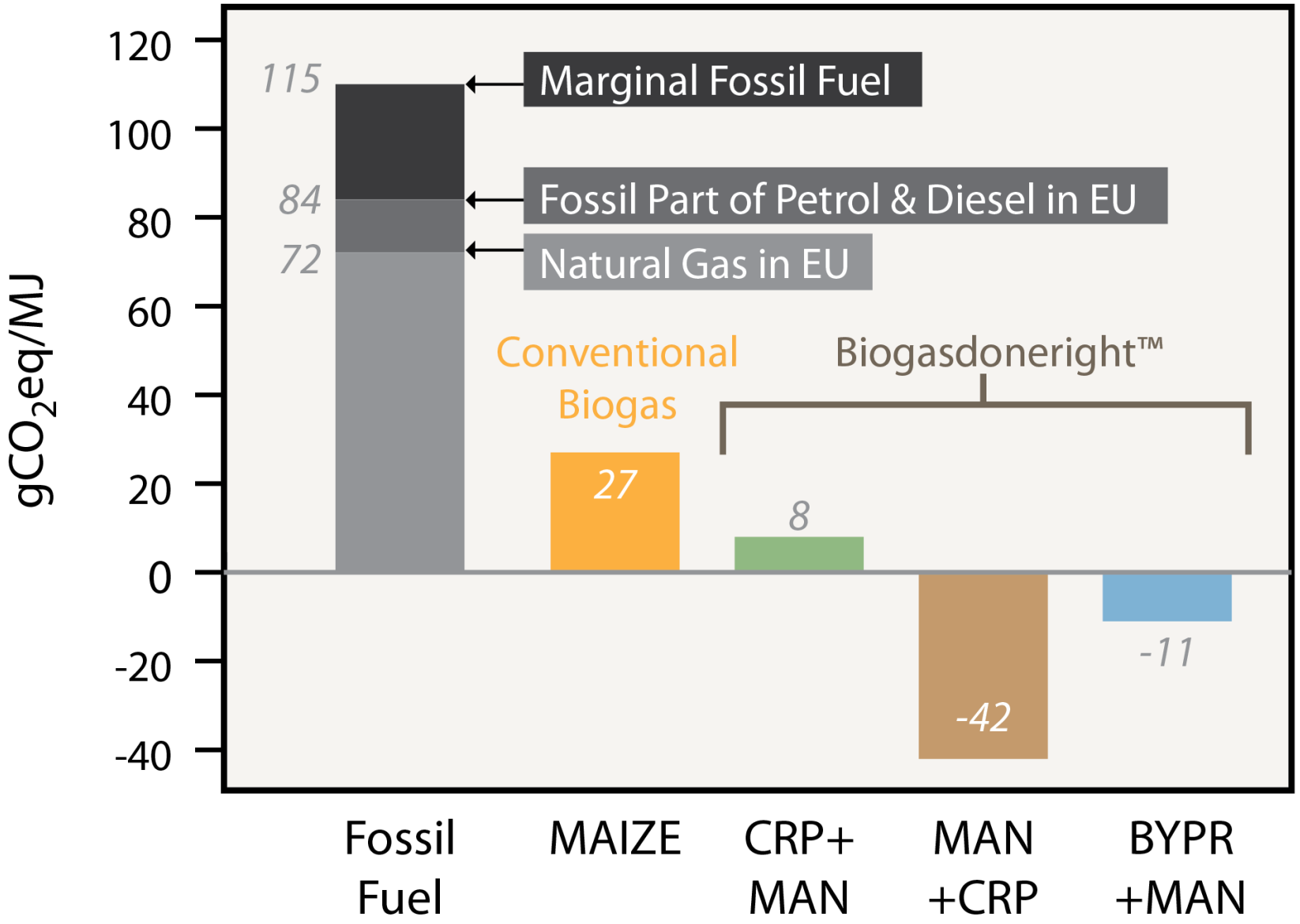
Two Cropping Cycles:
Conventional vs. Biogasdoneright™



Applying Digestate to Maize Crop

Three Biogasdoneright™ Case Studies from Real Farms: GHG Emissions Comparison with Conventional Biogas

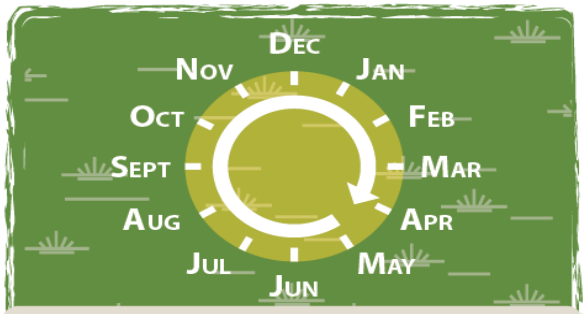



120
100
80
60
40
20
0
-20
-40
gCO2eq/MJ
115
84
72
Marginal Fossil Fuel
Fossil Part of Petrol & Diesel in EU
Natural Gas in EU
Conventional Biogas
Biogasdoneright™
27
8
-42
-11
Fossil Fuel
MAIZE
CRP+ MAN
MAN +CRP
BYPR +MAN

Farm Level Benefits of Biogasdoneright™

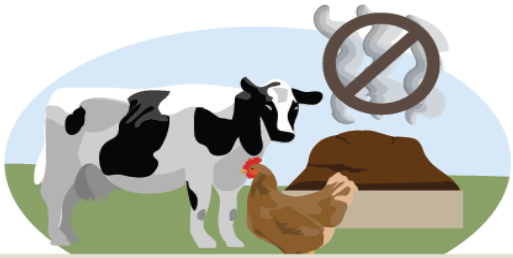
More Attractive Investments
Market Diversification
Better Cash Flow
More Jobs

Increased Proportion of Renewable Energy in Agriculture



Year-Round Soil Coverage & Double Cropping Systems

BIOGAS-DONE-RIGHT
IMPACT ON FARMERS



Mitigation of Emissions from Livestock Effluent

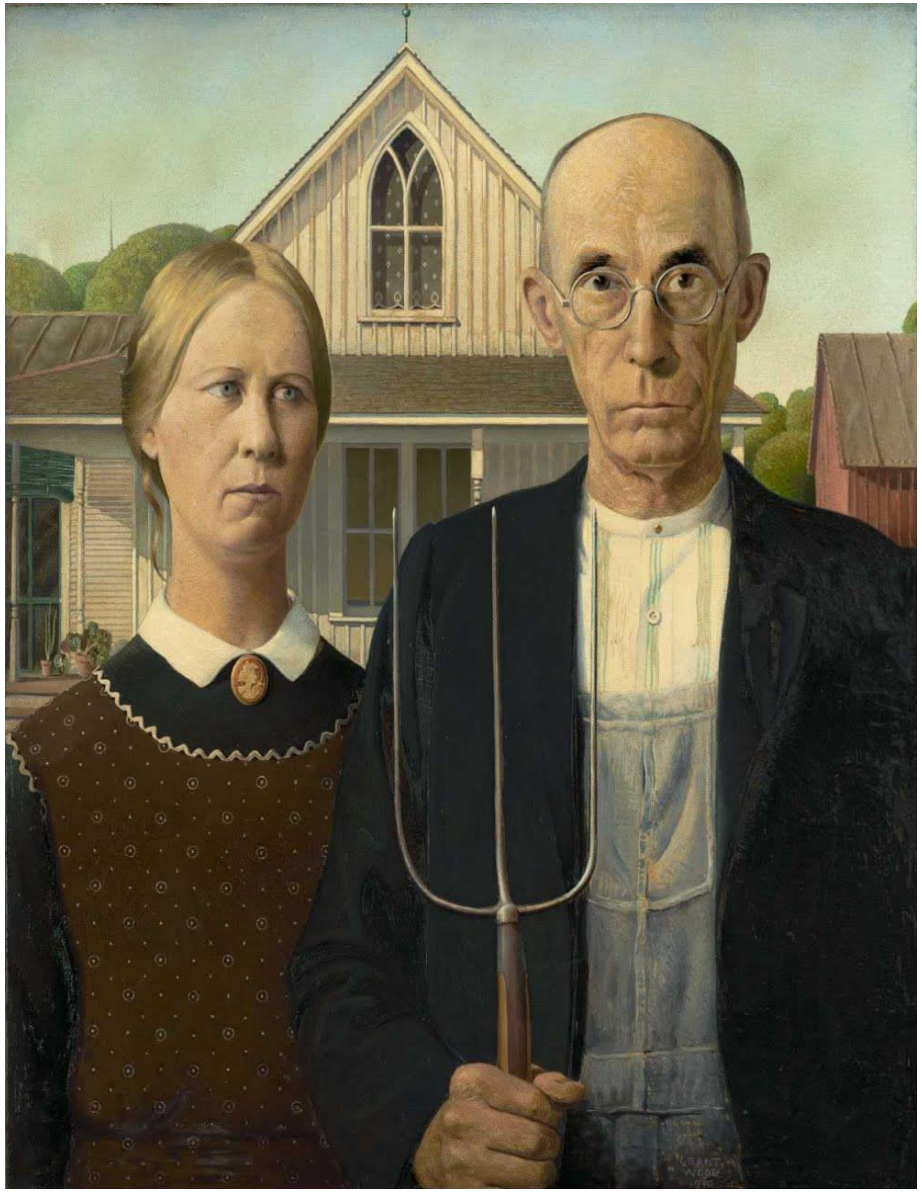
80%
Deflation of Farming Costs
CIRCULAR ECONOMY

Deep Plowing → Precision Tilling

Green Fertilizer

Bioenergy forgot about the farmers… (oops!!)

- The emerging circular bio-economy will not grow strongly unless farmers benefit
- We need to get serious about incentivizing/involving farmers
- Farmers will manage land for feed & food, energy & environmental services
- Using BDR, farmers can hedge energy production & food production to give themselves better economic outcomes & greater benefits to society



Some Concluding Thoughts

- Energy use (power consumption) is critical to human prosperity and well-being
- Without sustainable, large scale energy sources, we will not have sustainable, large scale prosperity— ***we must act soon using available, scalable, sustainable technology***
- We cannot limit GHGs without involving farms and the farmers who manage land to reduce emissions and sequester carbon
- Agriculture can provide food, feed, and large sustainability services, *if redesigned to do so*.
- Coproducing food & energy will stabilize food/energy prices, give farmers (and society) more options and make farming more resilient
- Biogasdoneright™ is making progress in Europe… ***we need a commercialization leader-CEO- for North America***

The Ideal CEO to Advance Biogasdoneright™ in North America

- MSc in Agriculture, PhD in bioenergy or engineering
- Five years working experience in agricultural research and/or in sustainable agriculture and/or agricultural co-ops
- Fluent in English and at least one other language, pref. Spanish
- Good presenter, eloquent and convincing
- Good organizational skills, good at creating teams
- Previous experience leading a start-up would be great asset!
- Dedicated, hard worker and fast learner
- ***Share our vision of large scale, sustainable bioenergy based on Biogasdoneright™ principles***