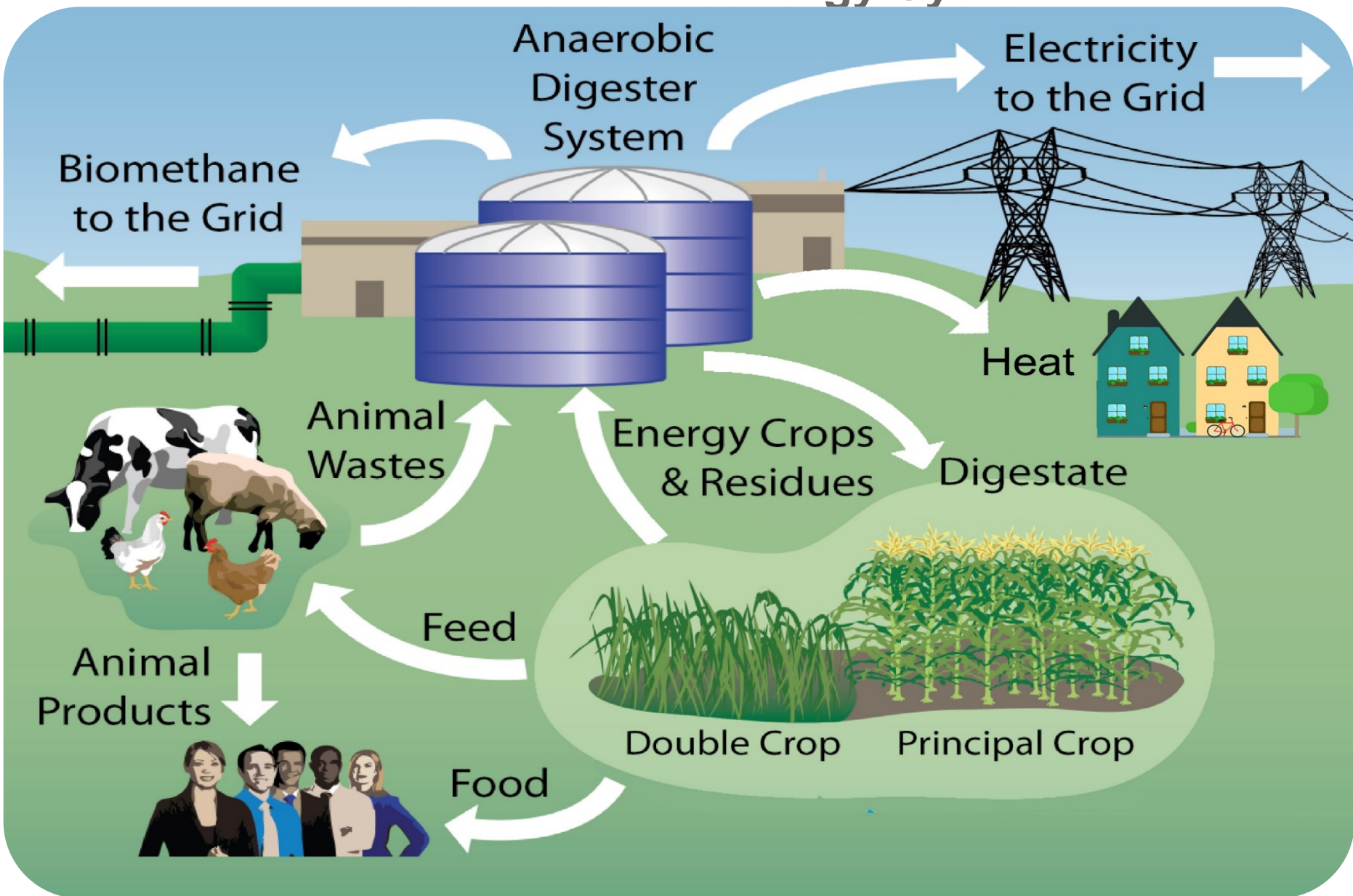


Biogasdoneright™ and Net Zero Carbon: *Starting the Conversation*

**WORLD BIOGAS SUMMIT
VIRTUAL CONFERENCE
6 October 2020**

Bruce E. Dale
University Distinguished Professor
Michigan State University

The Biogasdoneright™ System: A Farm Level Bioenergy System



Guiding Principles of Biogasdoneright™

- Grow regular crop for feed/food market– no “food vs. fuel” conflict
- Grow and then ensile a **double (or “sequential” crop)** to feed the anaerobic digesters (plus manure and other locally-available “wastes”)
- Burn biogas on site to generate dispatchable electricity for power grid or
- Purify biogas, export/store biomethane in the natural gas grid—thus meeting needs for dispatchable electricity, heating/cooking, chemicals
- Convert biomethane to compressed natural gas (RNG) or liquid natural gas (LRNG) to meet transportation fuel needs
- Apply innovative, sustainable farming methods with 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

Sustainable Agriculture by Intensive Double Cropping: Utilize “Wasted” Land Resource

- Grow second crops for energy while **still** growing food crops
- Does **not** require new land- no expansion of agricultural “frontier”
 - Increase sustainable crop residue harvest rate
 - Use second crop for bioenergy, animal feed, and new markets
 - Reframe the “food vs. fuel” debate—now “food AND fuel” (and markets for important environmental services)



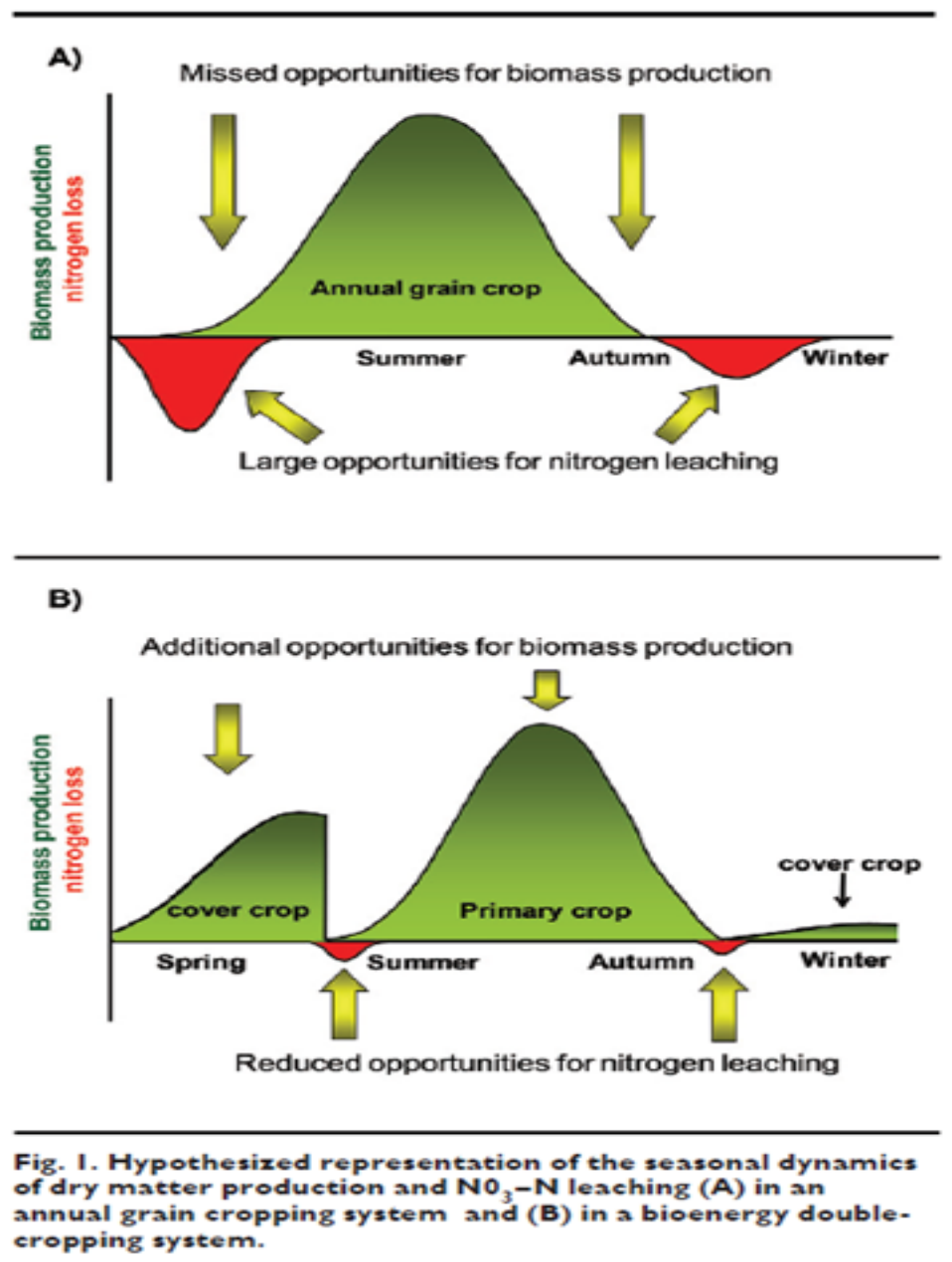
Benefits of Double Cropping: *Keep the Soil Covered & Active Year Round*

Crop rotation and plant diversity is improved, greater biodiversity, reduced pesticides & herbicides (double cropping, nitrogen fixing crops, etc)

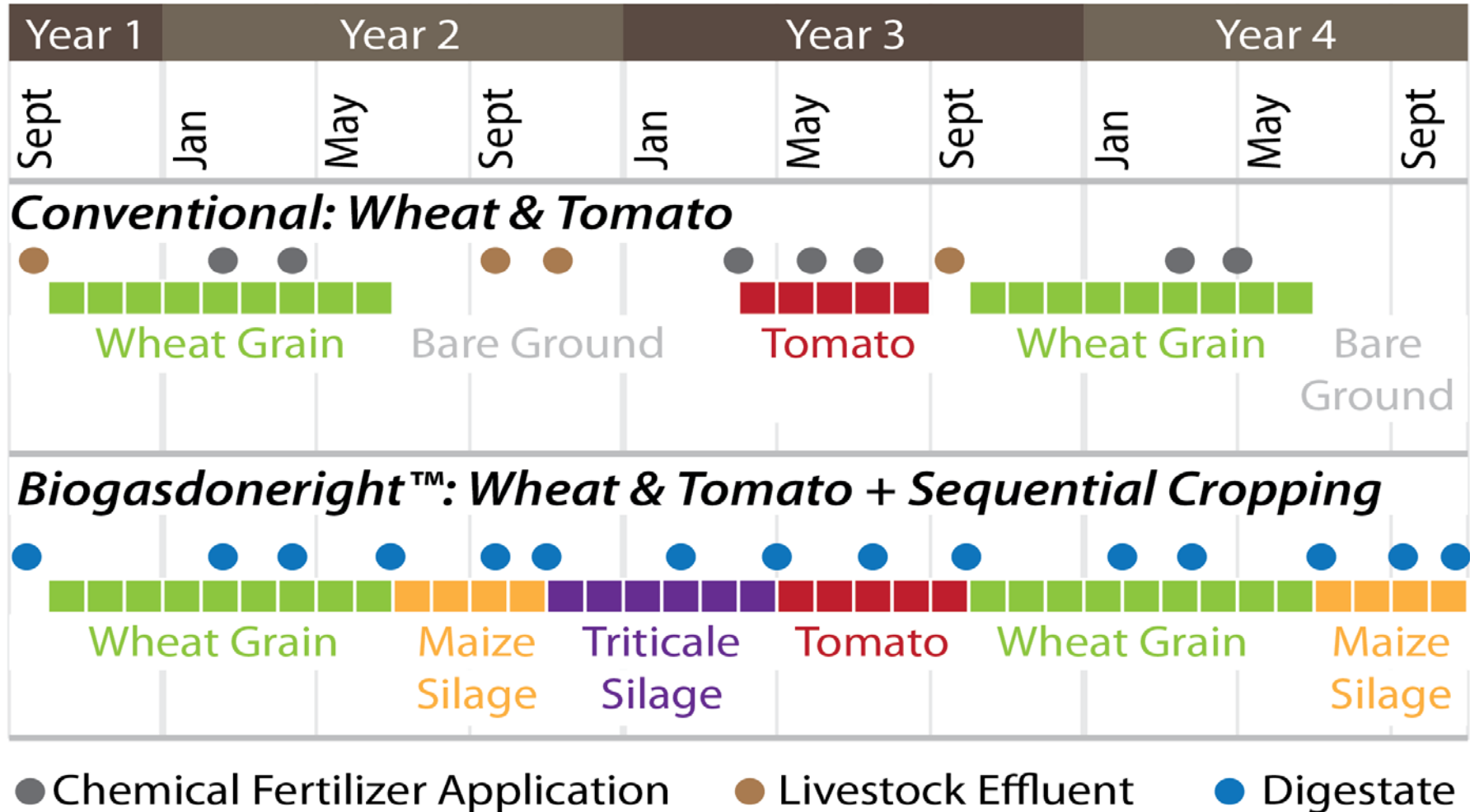
Year round soil coverage, reduced erosion, reduced nutrients loss to ground and surface water, reduced nitrous oxide (GHGs), more agricultural residues available

Fertilizer inputs greatly reduced by nutrient recycling via digestate

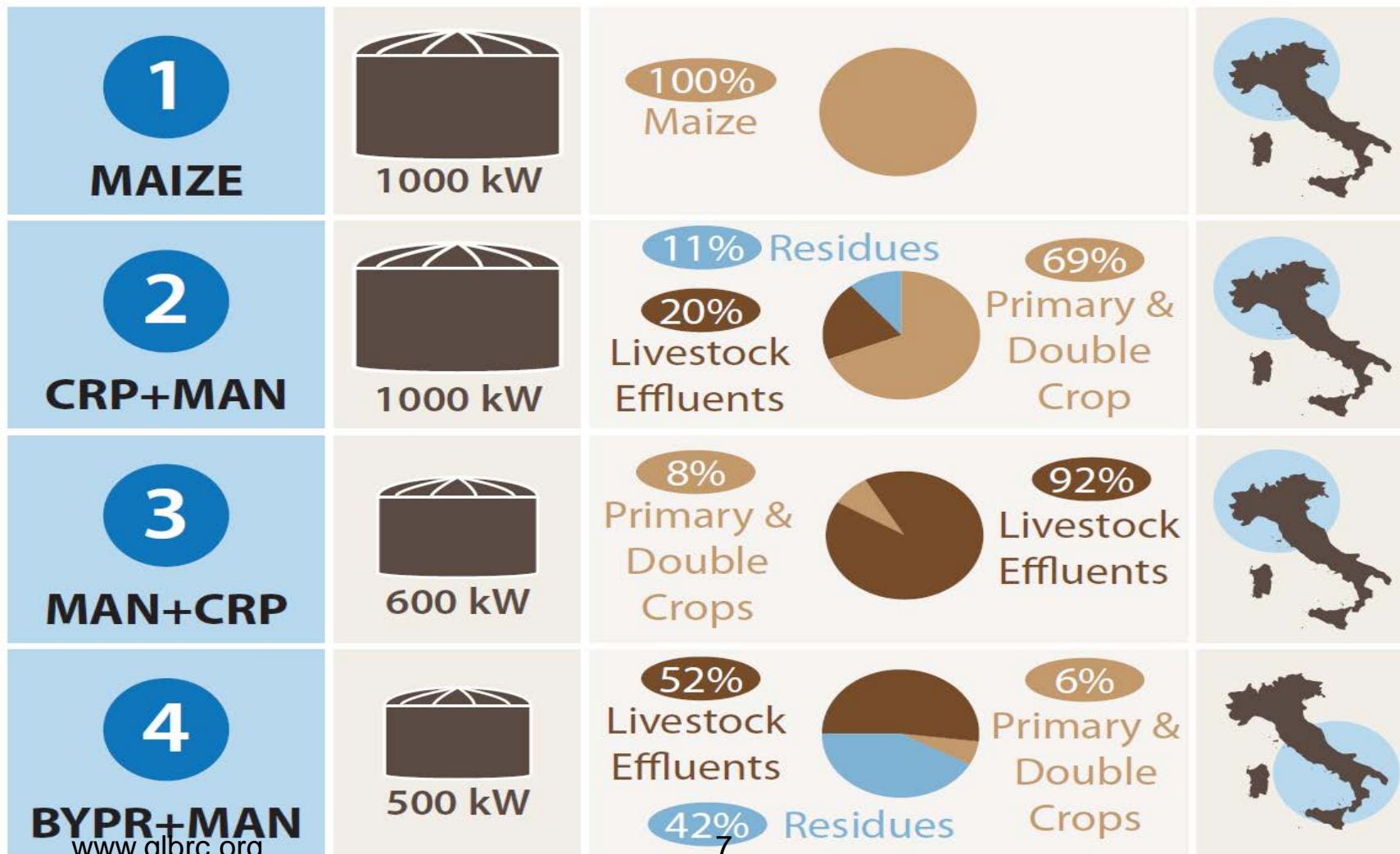
Soil carbon levels increase, increased soil fertility, less nutrient loss, carbon sequestration, soil biodiversity increases, more resistant to drought

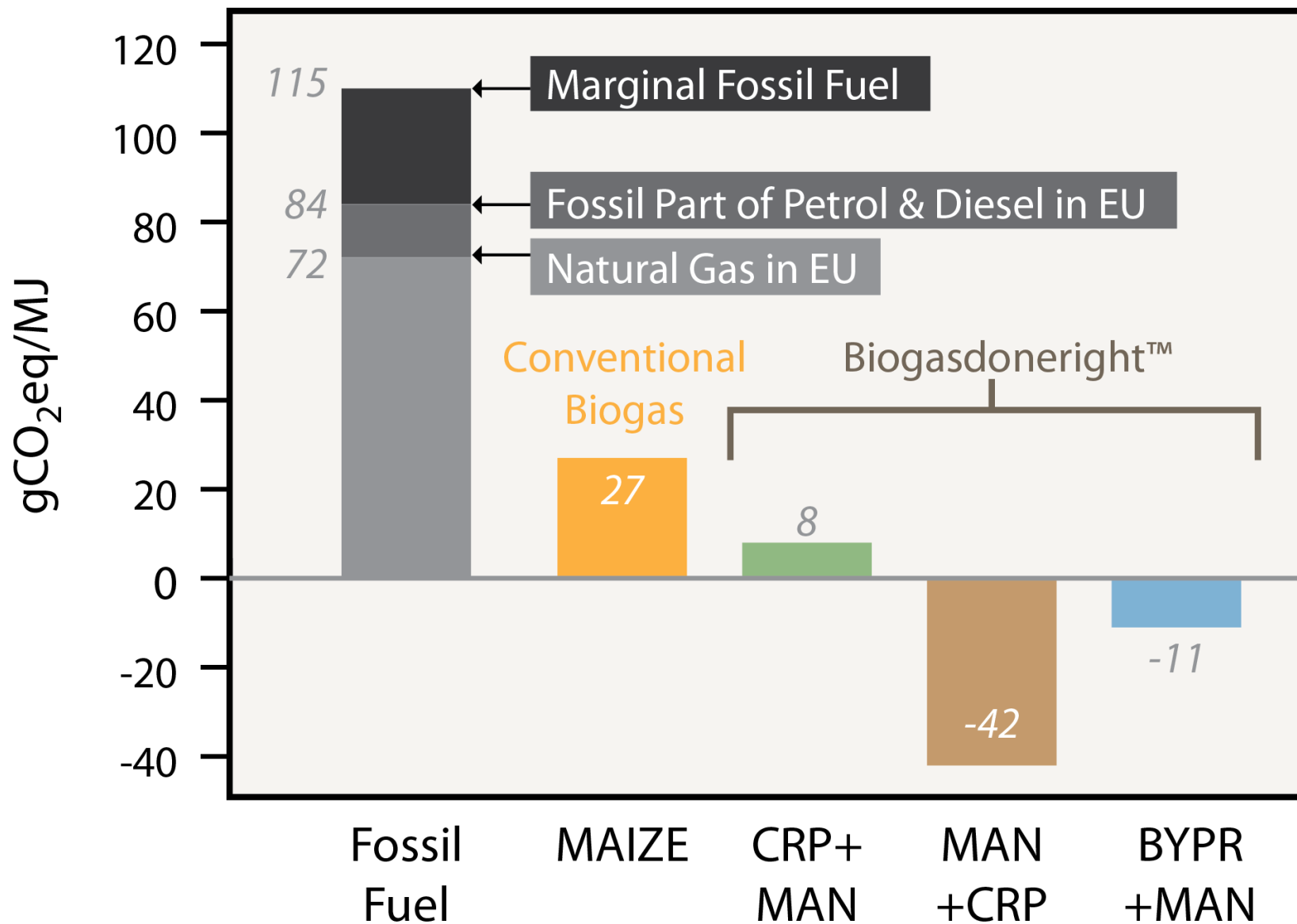


Two Different Cropping Cycles: Conventional vs. Biogasdoneright™



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

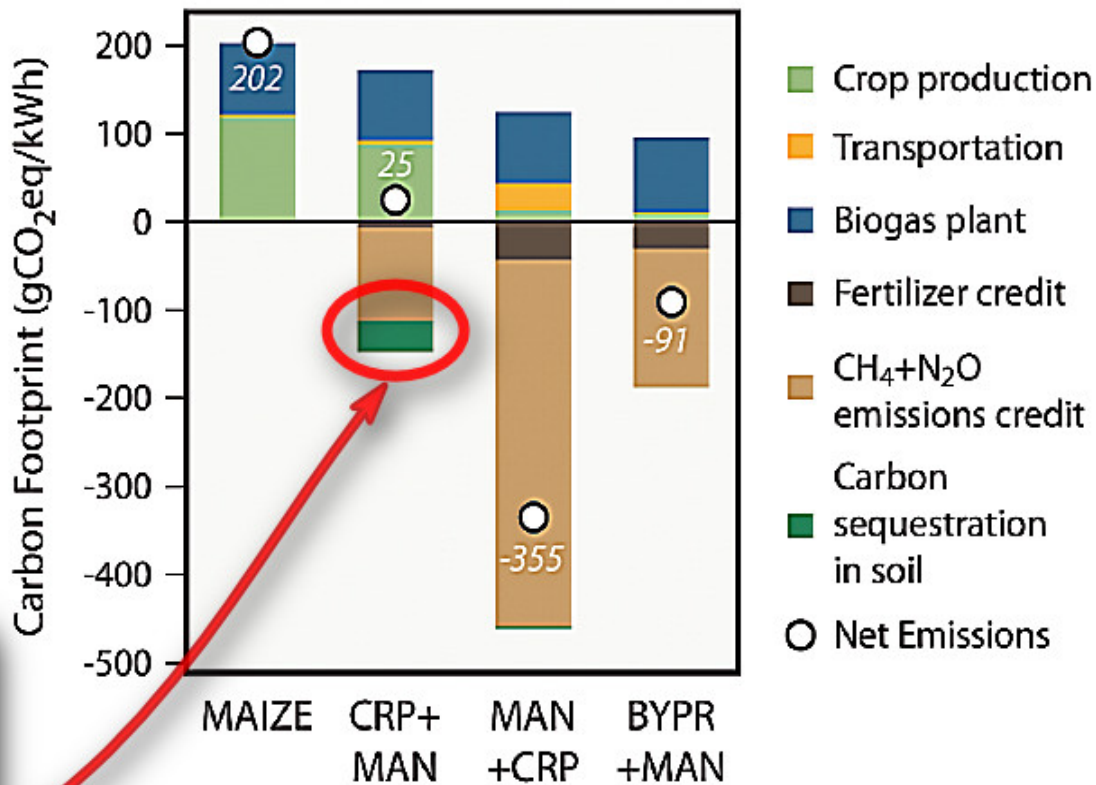




Applying Digestate to Maize Crop- Ernesto Folli Farm near Cremona, Italy



Where Do the GHG Emissions Come From?



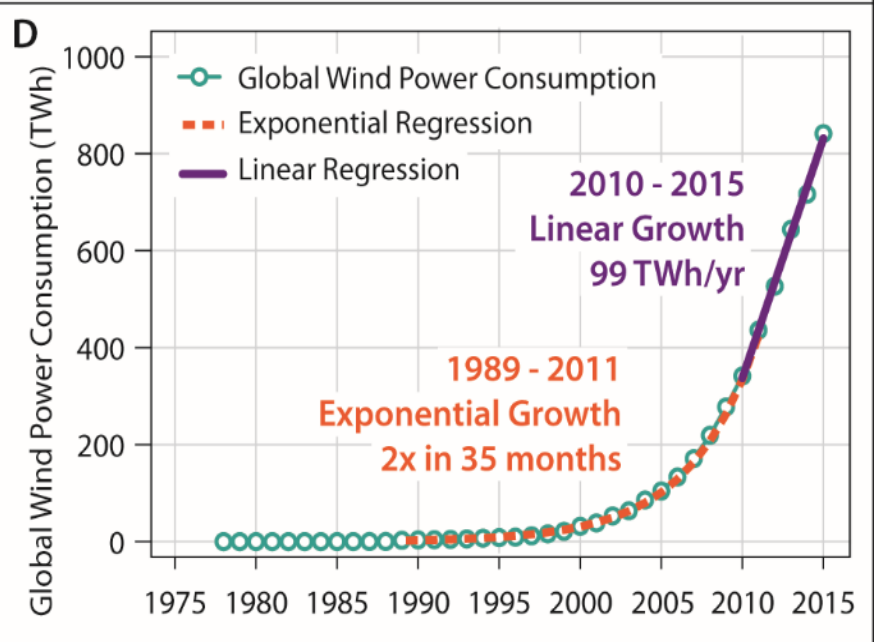
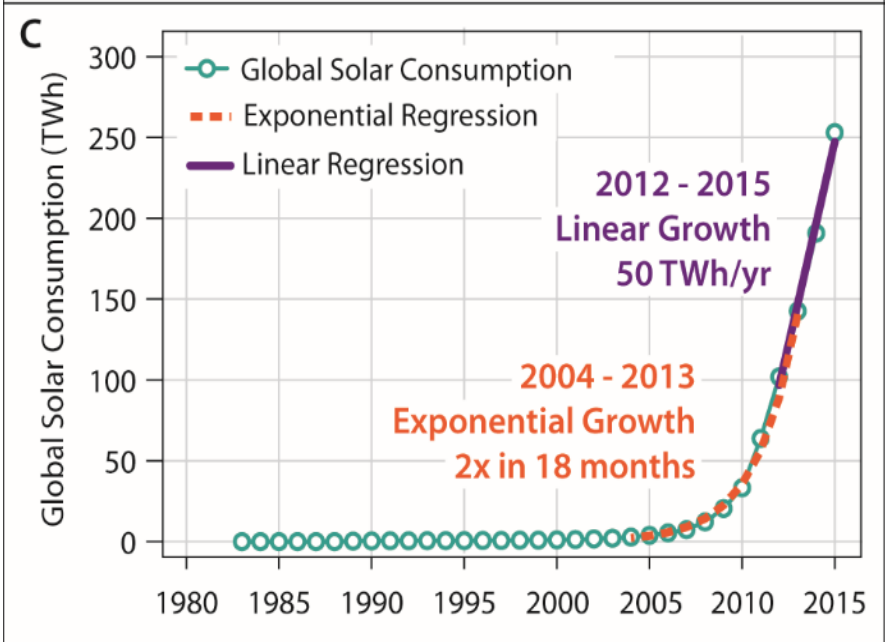
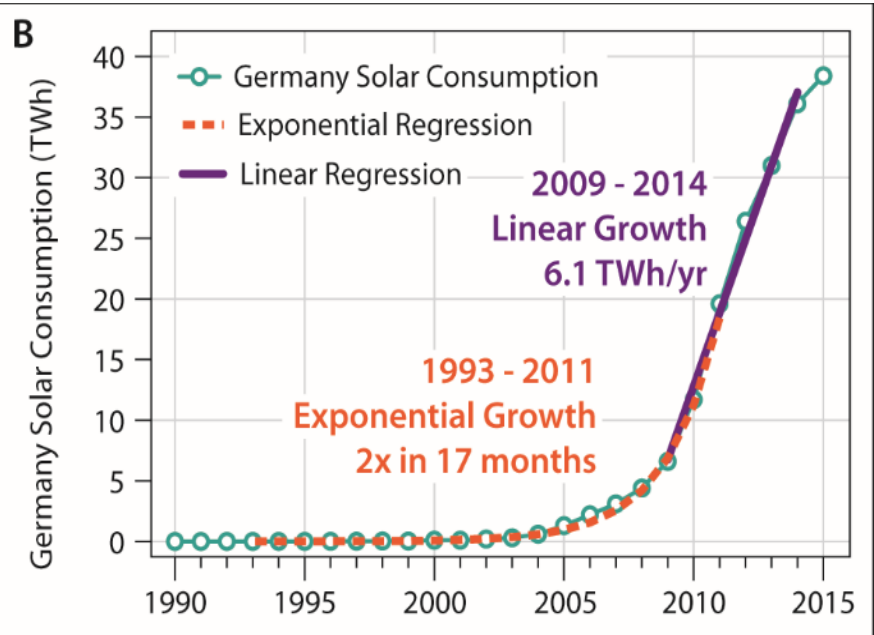
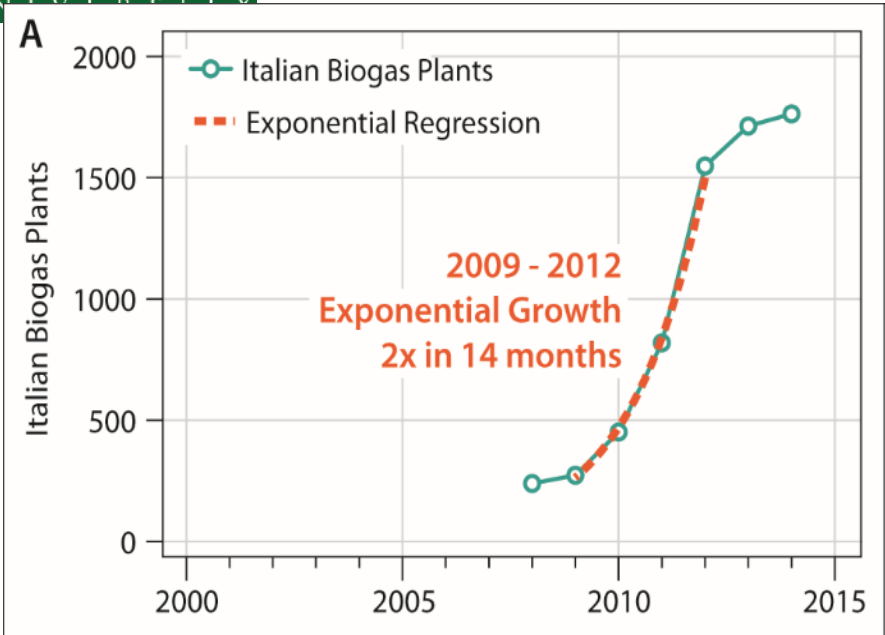
Sequestered, stable soil carbon --mostly from double crop

Two Enormous, Intersecting Challenges

1. In the next few decades we must feed several billion more people, while greatly reducing the negative environmental impacts of modern agriculture.
2. Simultaneously, we must provide many more billions of people with essential energy services, while sharply reducing fossil fuel use

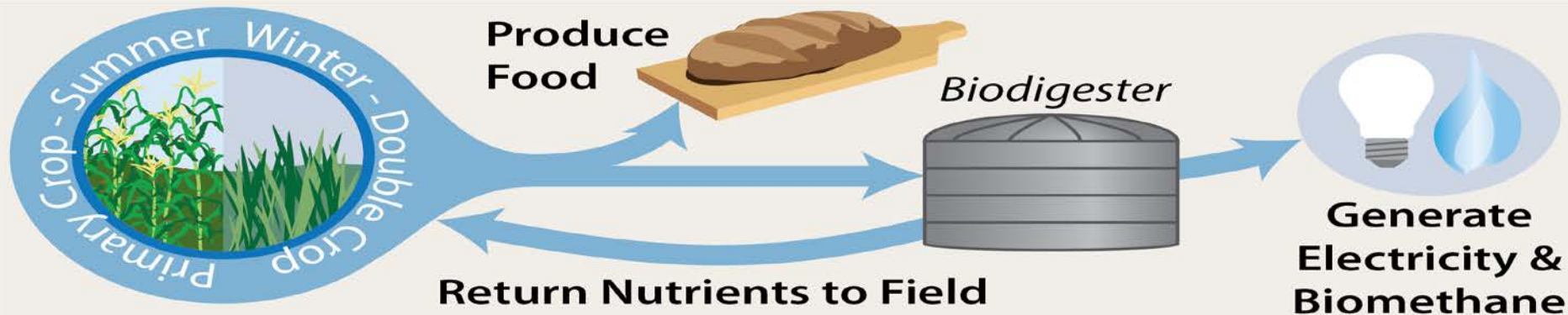
We need practical, investment-ready, rapidly-scalable systems, that *benefit farmers*—

I believe Biogasdoneright™ is an agro-energy system that can grow at the required rate to meet food and energy needs--sustainably



Support Provided by Michigan State University
AgBioResearch Office and by the USDA/NIFA Program

What is Biogasdoneright™?



Continuous Land Cover

Improved Water Quality, Reduced Erosion

Increased Economic Stability

More Economically Robust Farms, Less Volatile Food & Energy Markets

Increased Soil Organic Matter

Reduced Loss of Nutrients, More Drought Resistant

More Fertile Soils

Reduced Greenhouse Gas Footprint

Reduced Fertilizer Costs

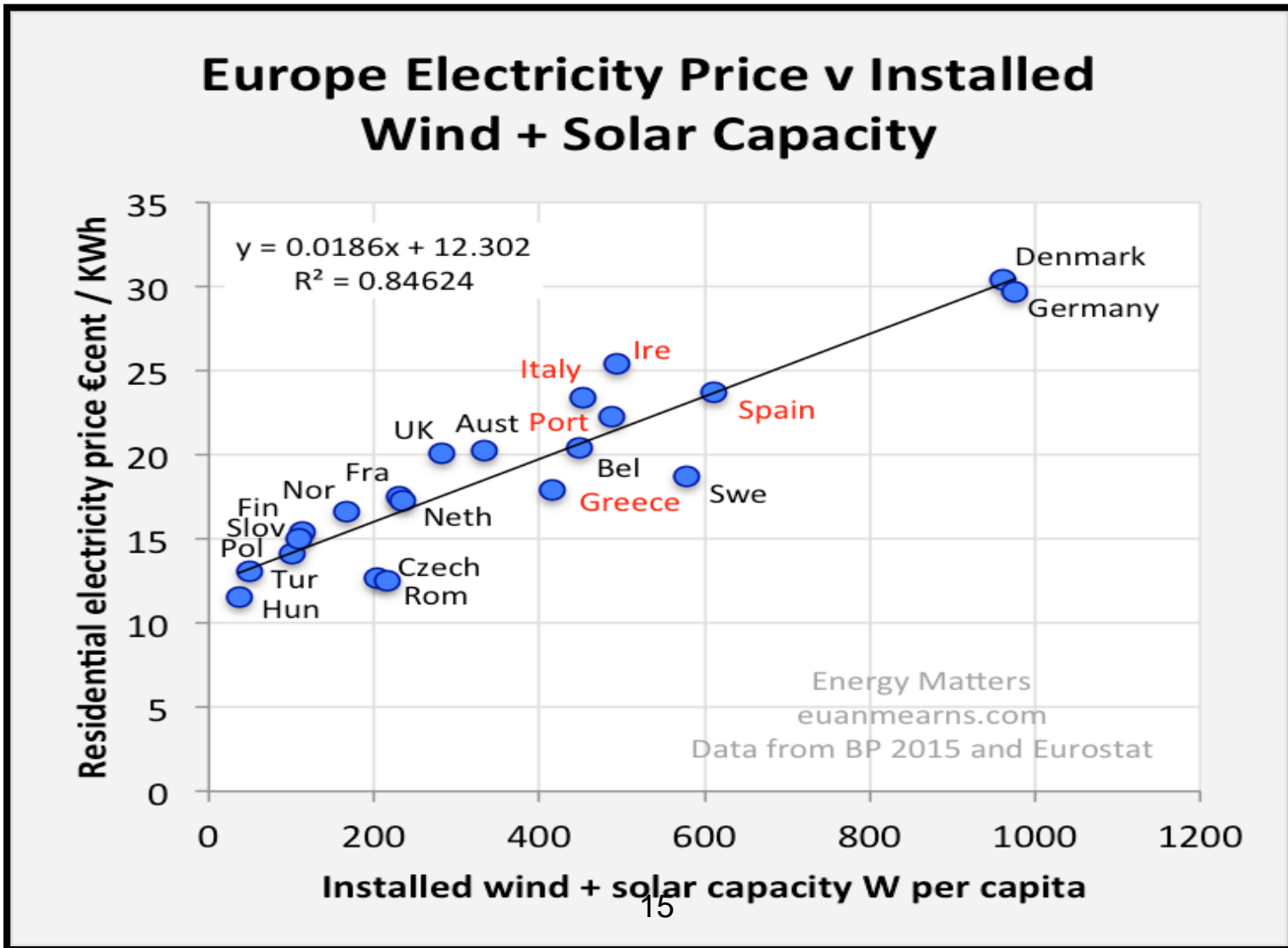
Food AND Fuel

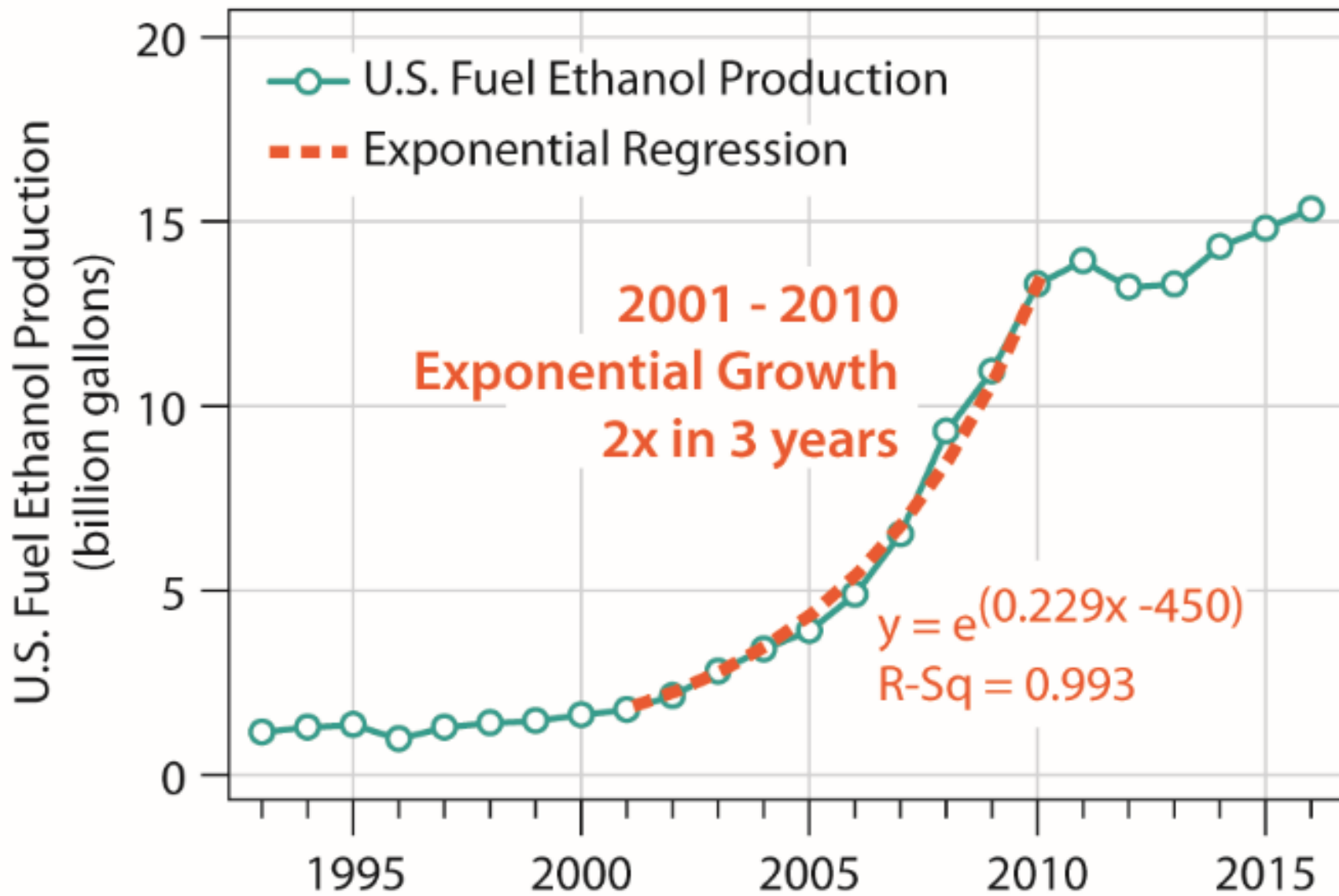
No Indirect Land Use Change

Residue Valorization

Energy from Residues, Avoided Emissions

European Electricity Prices Increase as Installed Solar and Wind Capacity Grow

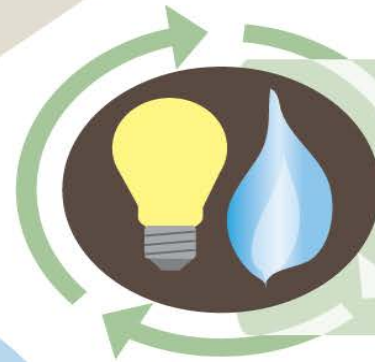




Farm Level Benefits of Biogasdone right™



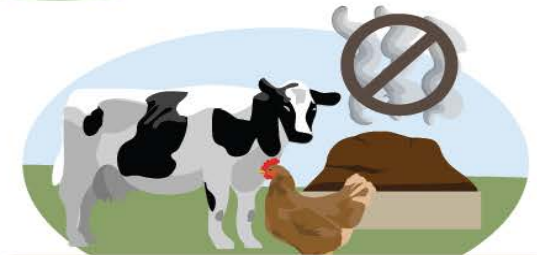
More Attractive Investments
Market Diversification
Better Cash Flow
More Jobs



Increased Proportion of Renewable Energy in Agriculture



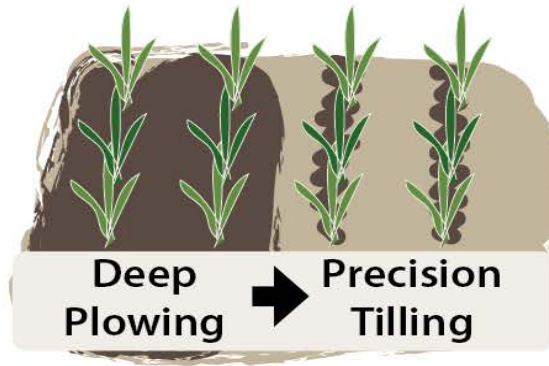
Year-Round Soil Coverage & Double Cropping Systems



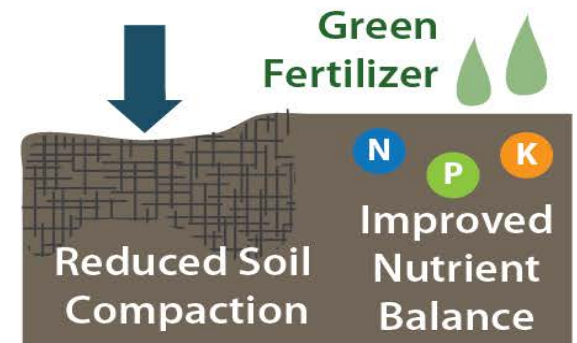
Mitigation of Emissions from Livestock Effluent



Deflation of Farming Costs



Deep Plowing → Precision Tilling



Reduced Soil Compaction

Green Fertilizer

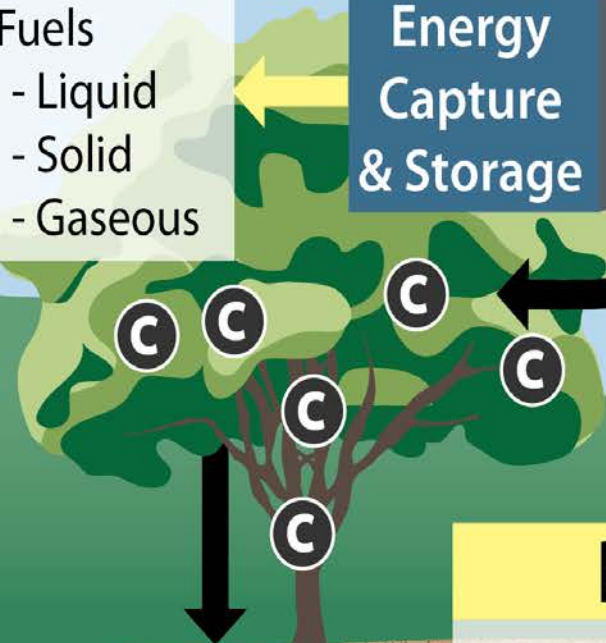
N P K

Improved Nutrient Balance

THE AMAZING GREEN PLANT

- Electricity
- Fuels
 - Liquid
 - Solid
 - Gaseous

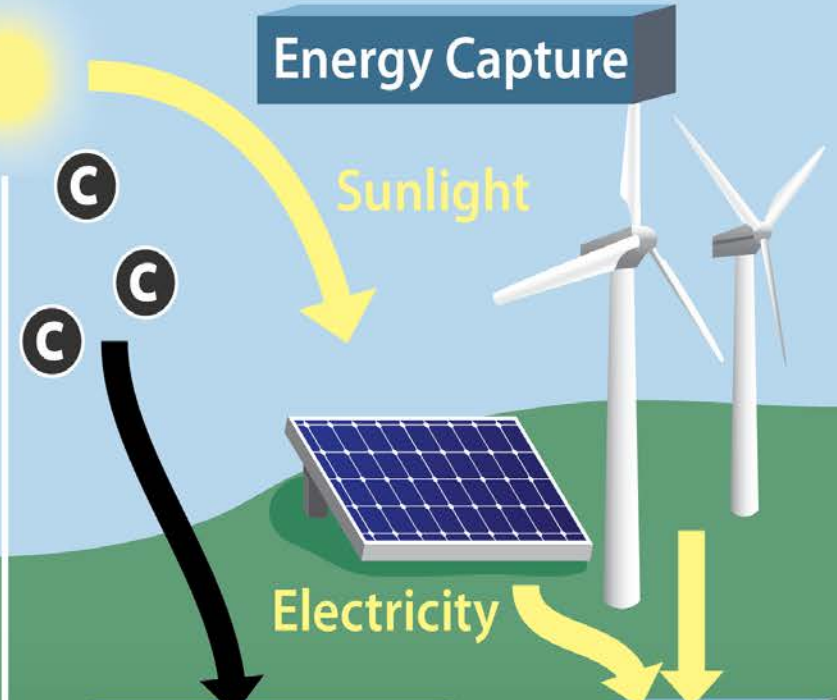
Energy Capture & Storage



CO₂ Capture & Sequestration

- PLUS**
- Water Purification
 - Oxygen Generation
 - Food and Feed
 - Biodiversity Support

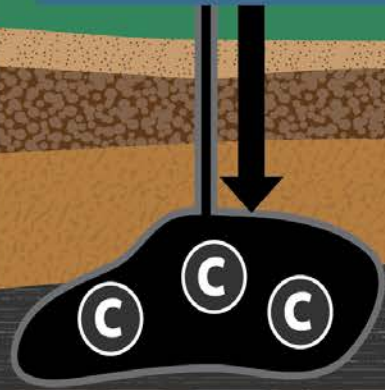
Energy Capture



CO₂ Capture & Sequestration

Energy Storage

- Battery
- Pumped Hydro
- Compressed Air
- Molten Salt



What (Bio)Energy Carriers Should We Produce?

Answer: whatever fits best in the available markets
RNG and LRNG seem to be the most versatile of all

Services Provided by Renewables	ELECTRICITY			BIOFUELS			
	Wind	Solar	Biogas	Biomethane (RNG)	Liquified Biomethane (LRNG)	Bioethanol, Biobutanol, Biodiesel	Biokerosene
Power	●	●	●	●	●		
Heating and Cooling	●	●	●	●	●		
Mobility: Ground	◐	◐	◐	◐	●	●	◐
Mobility: Sea				◐	●		
Mobility: Aviation							●

Documenting Biogasdoneright™

- Three papers planned for initial coverage:
- Introduction to Biogasdoneright™ principles-published
- LCA study comparing Biogasdoneright™ approaches
- Economics of Biogasdoneright™ farms

Feature



Biogasdoneright™: An innovative new system is commercialized in Italy

Bruce E. Dale, University Distinguished Professor Michigan State University, United States
Fabrizio Sibilla, Italian Biogas Council Techno Scientific Advisory board, Italy
Claudio Fabbri, Research Center for Animal Production (CRPA), Italy
Marco Pezzaglia, Efficiencyknow srl, Engineer and Advisor on renewable energies, Italy
Biagio Pecorino, Farmer and Professor for Rural Economy, Department of Agricultural, Food and Environment, University of Catania, Italy
Ezio Veggia, Farmer and Vicepresident of Confagricoltura, Italy's main farmers union, Italy
Angelo Baronchelli, President of AB Cogeneration World, Vicepresident of Italian Biogas Council, Italy
Piero Gattoni, Farmer, Biogas and Cheese producer, Italian Biogas Council President and Parmiggiano Reggiano Council vice-President, Italy
Stefano Bozzetto, Farmer and Executive member of Italian Biogas Council and European Biogas Council, San Giorgio di Nogaro, Italy.

A group of over 600 Italian farmers organized as the Italian Biogas Consortium are redesigning their own farming systems to produce food and bioenergy in a nationwide farm-level movement called *Biogasdoneright™*. This Feature demonstrates how it is possible to simultaneously increase the economic viability and stability of agriculture by reducing farm input costs and enabling farmers to produce food and fuel more sustainably. © 2016 Society of Chemical Industry and John Wiley & Sons, Ltd

View online at Wiley Online Library (wileyonlinelibrary.com); DOI: 10.1002/bbb.1671
Biofuels, Bioprod. Bioref. 10:341-345 (2016)

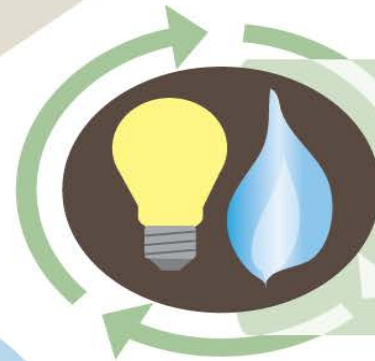
ONE DOUBLE CROP EXAMPLE: *TRITICALE AND TOMATO*



Farm Level Benefits of Biogasdoneeright™



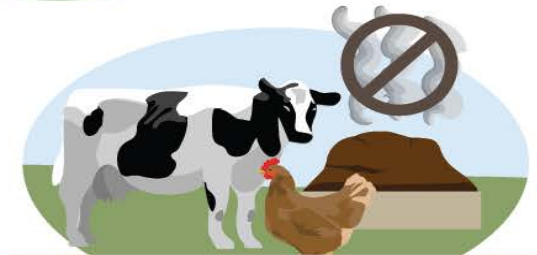
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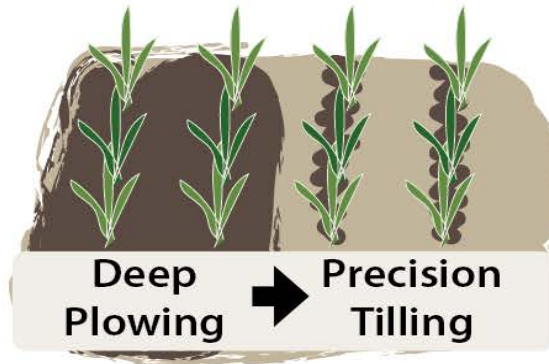
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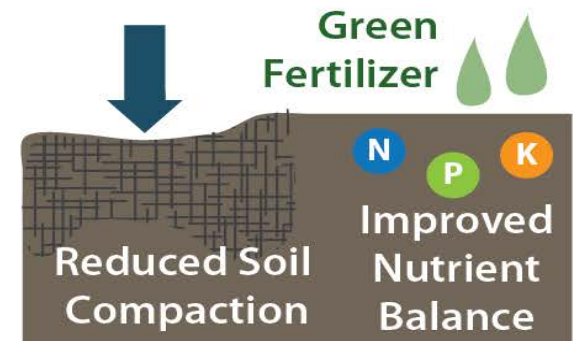
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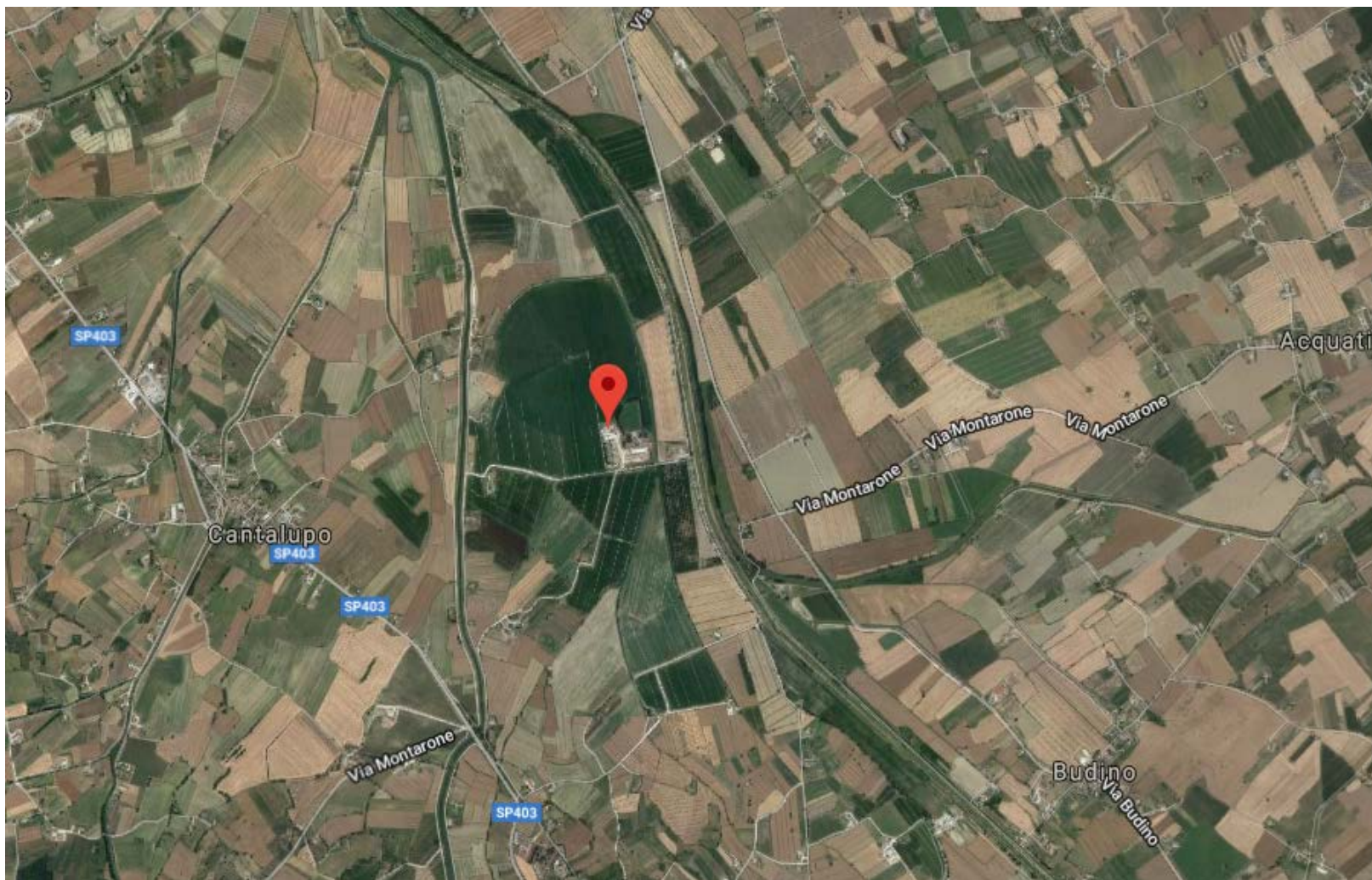
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Green Fertilizer

N P K

Improved Nutrient Balance

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



No Quick Switch to Low Carbon Energy

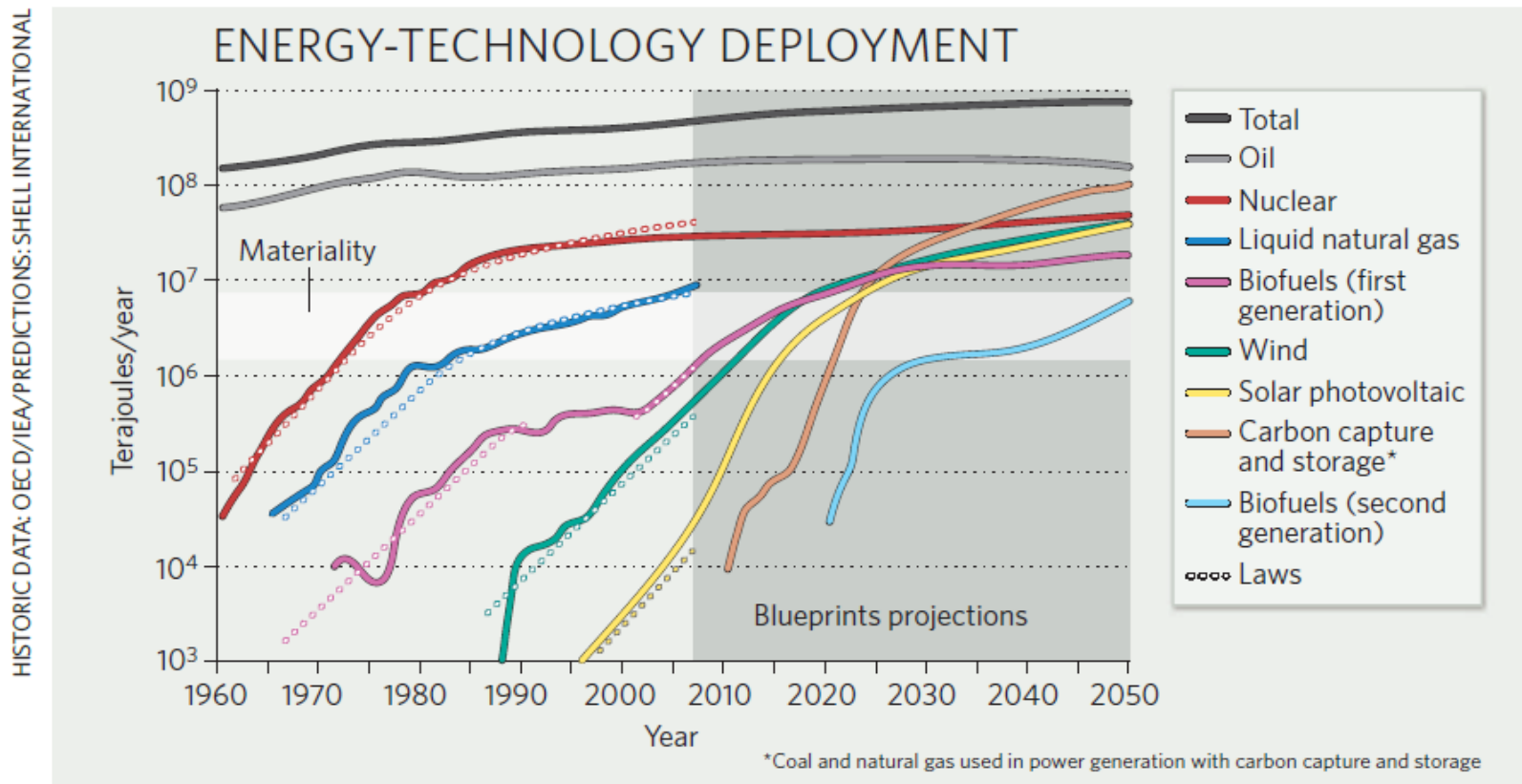
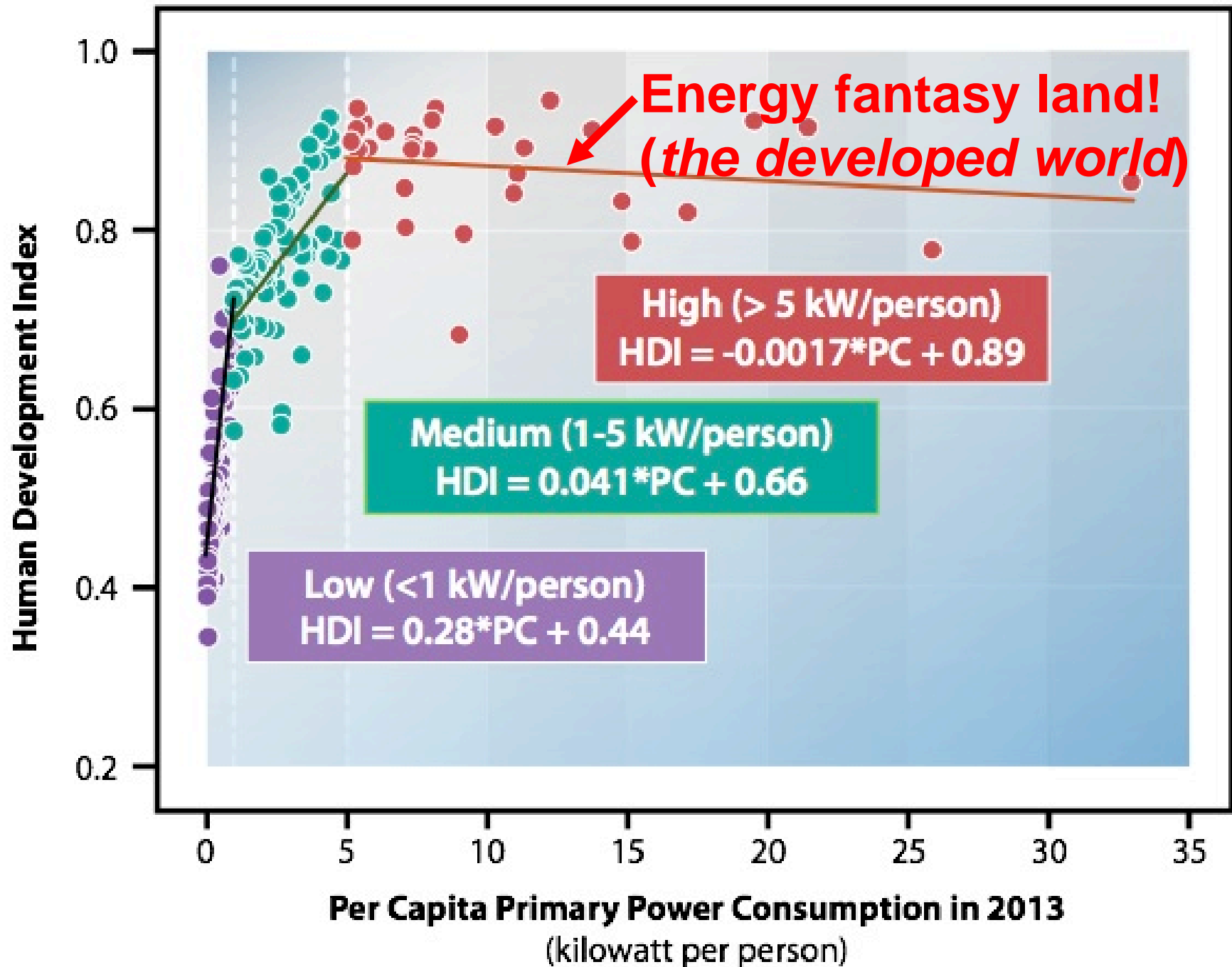
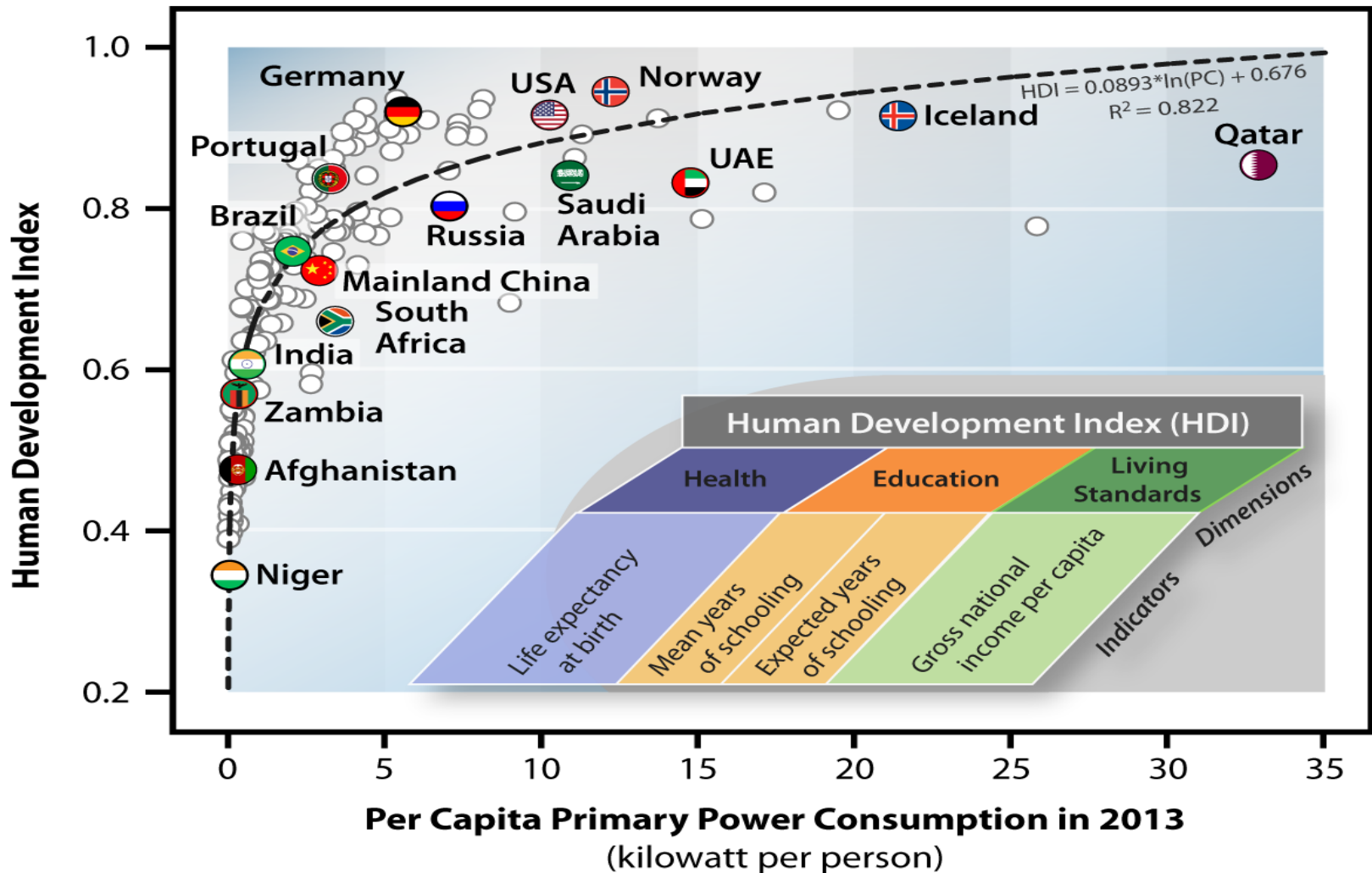


Figure 1 | Global production of primary energy sources. When a technology produces 1,000 terajoules a year (equivalent to 500 barrels of oil a day), the technology is 'available'. It can take 30 years to reach materiality (1% of world energy mix). Projections after 2007 taken from Shell's Blueprints scenario³.

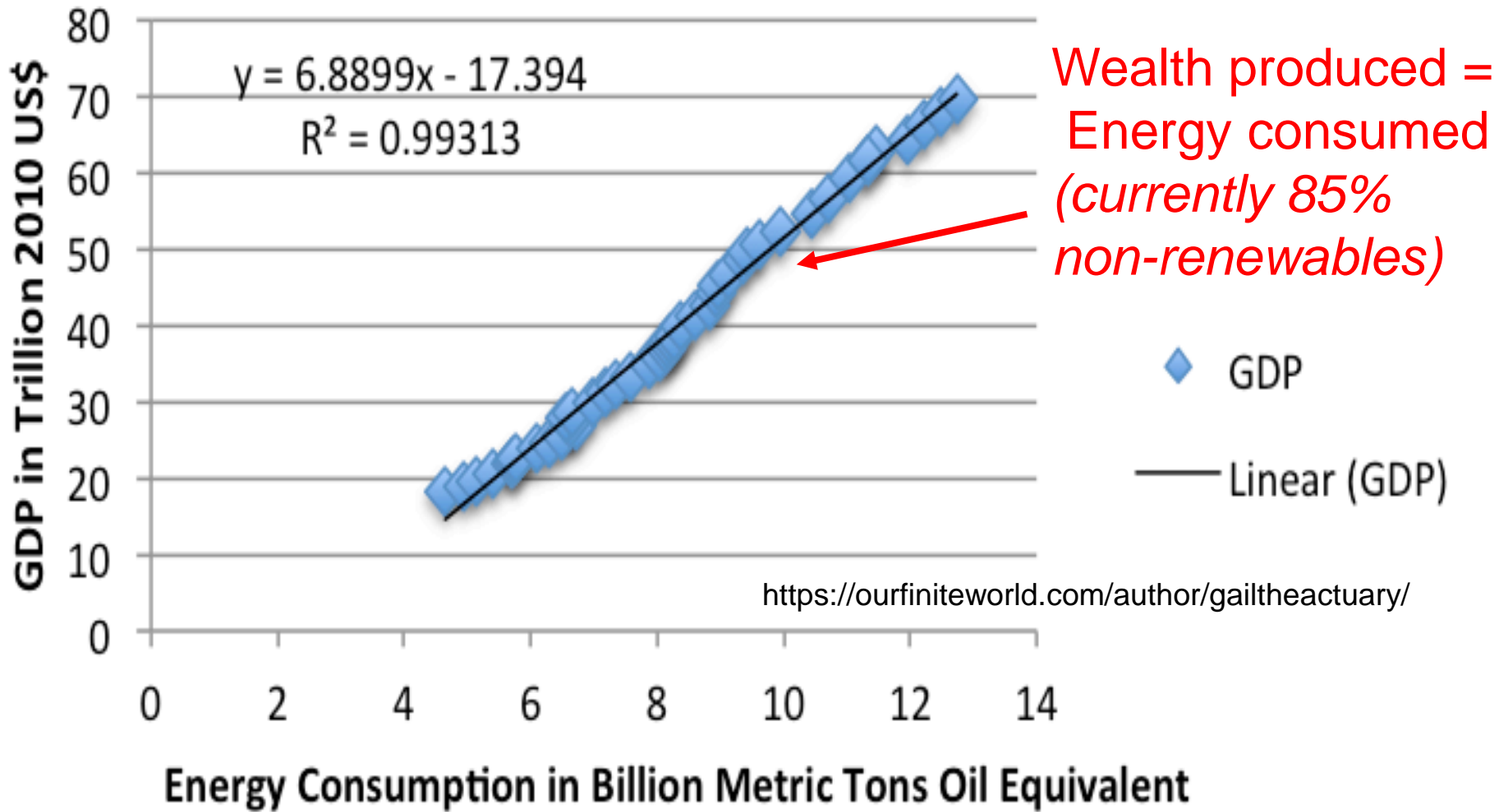
Kramer, G.J.a.M.H., *No quick switch to low-carbon energy*. Nature, 2009. **462**: p. 568-569.



Energy Consumption & Human Well Being are Linked: How Much Energy is “Enough”? (*about 5 kW/person*)



World GDP Compared to Energy Consumption 1969 to 2013



Installed biogas plants in Italy

