



**ZNC Farms**  
ZERO-NET-CARBON

*Sustainable, cost competitive, climate proof  
**food** production of the future*

"WASTE IS A VERB" - ABBY ROCKEFELLER

NOVEMBER 12, 2020

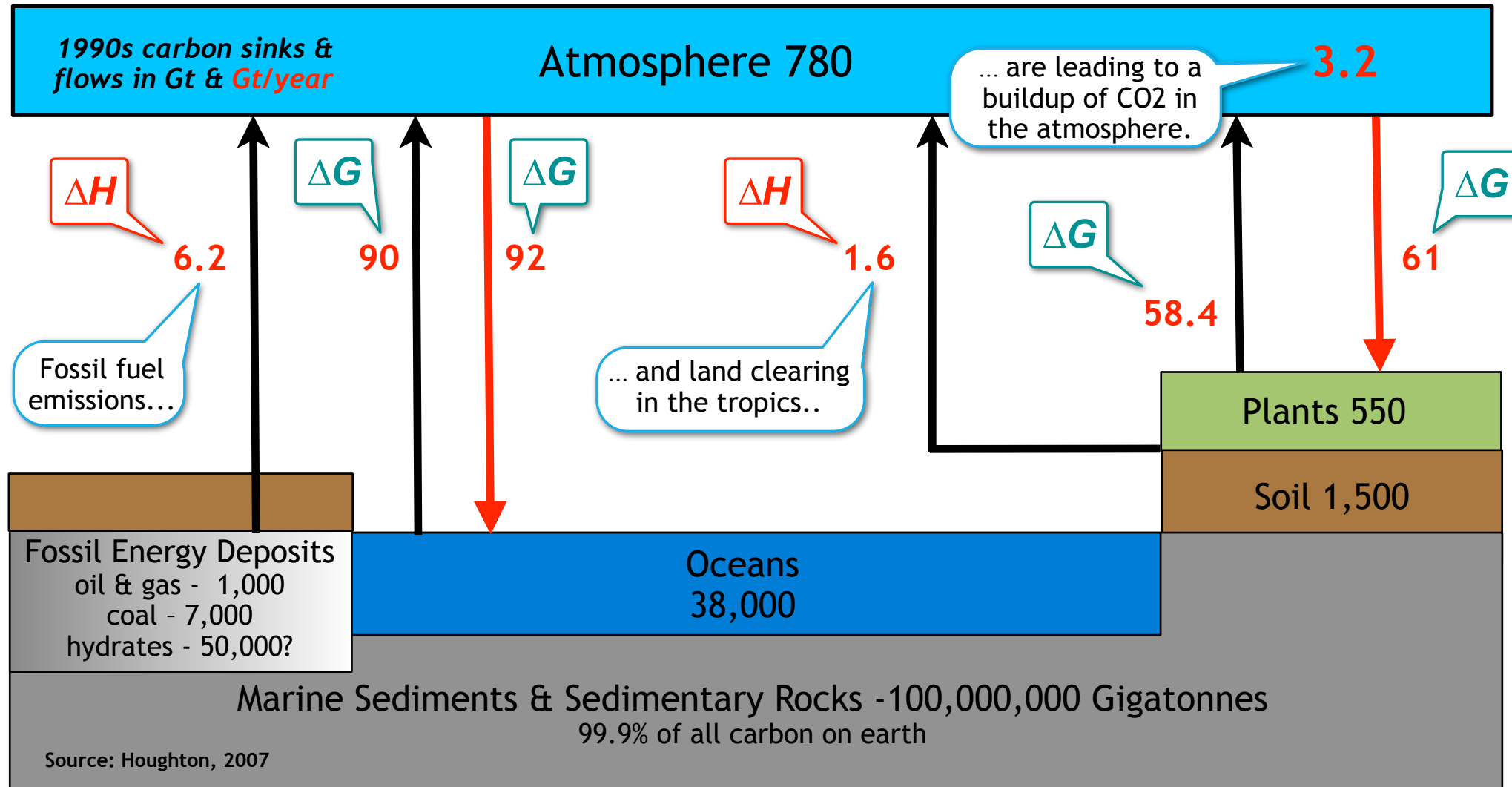
# Vision: Zero-Net-Carbon\* (ZNC) Farms

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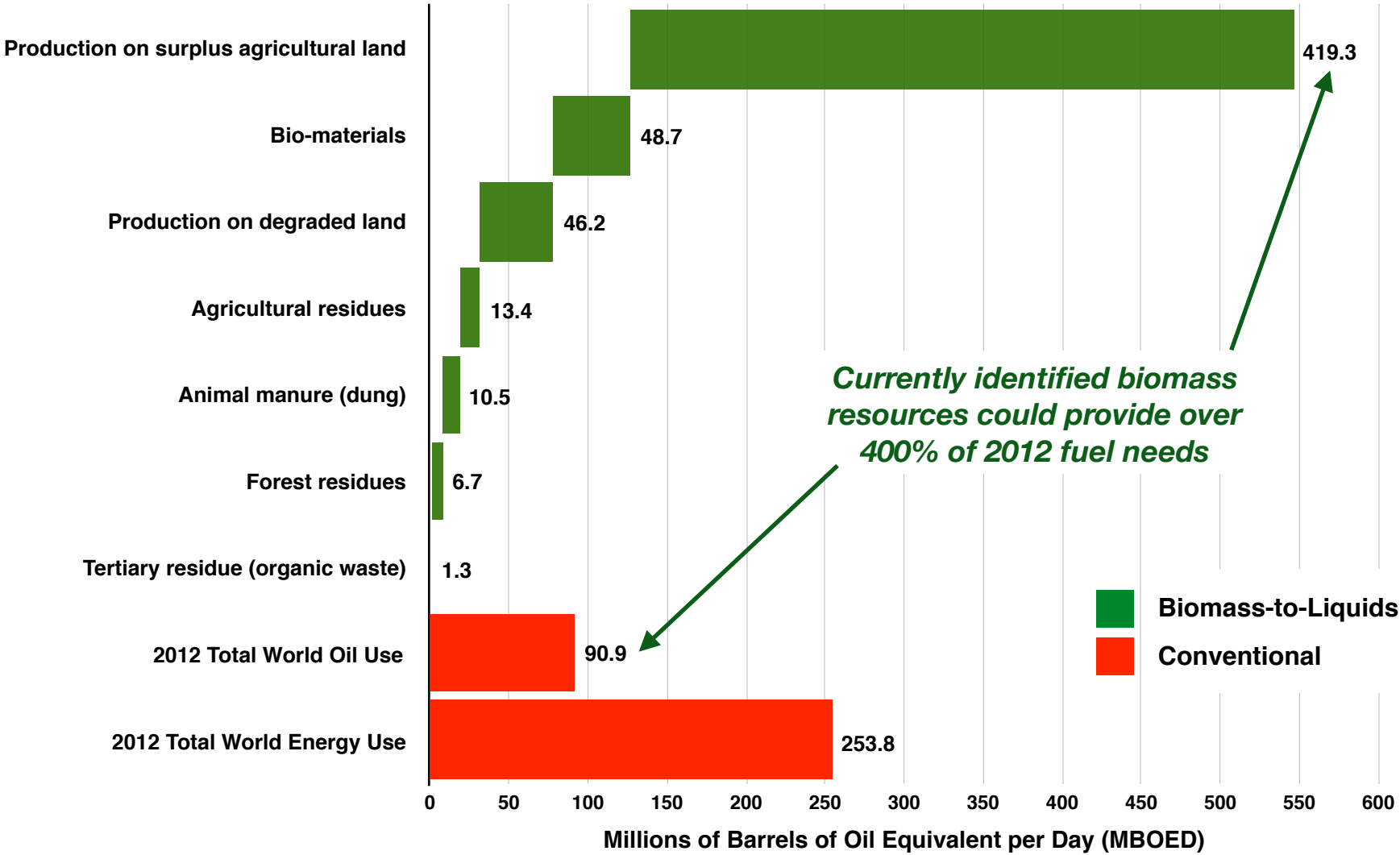
*ZNC Farms was created to restore agriculture as the primary energy source for modern civilization through the integration of energy and food production in distributed, modular, mass-produced biorefineries that convert organic materials into high-value organically grown ZNC-Produce™, ZNC-Fuel™ and ZNC-Fertilizer™.*

**\*Zero-Net-Carbon:** Our systems capture, recycle and sequesters more carbon than the production and use of our products.

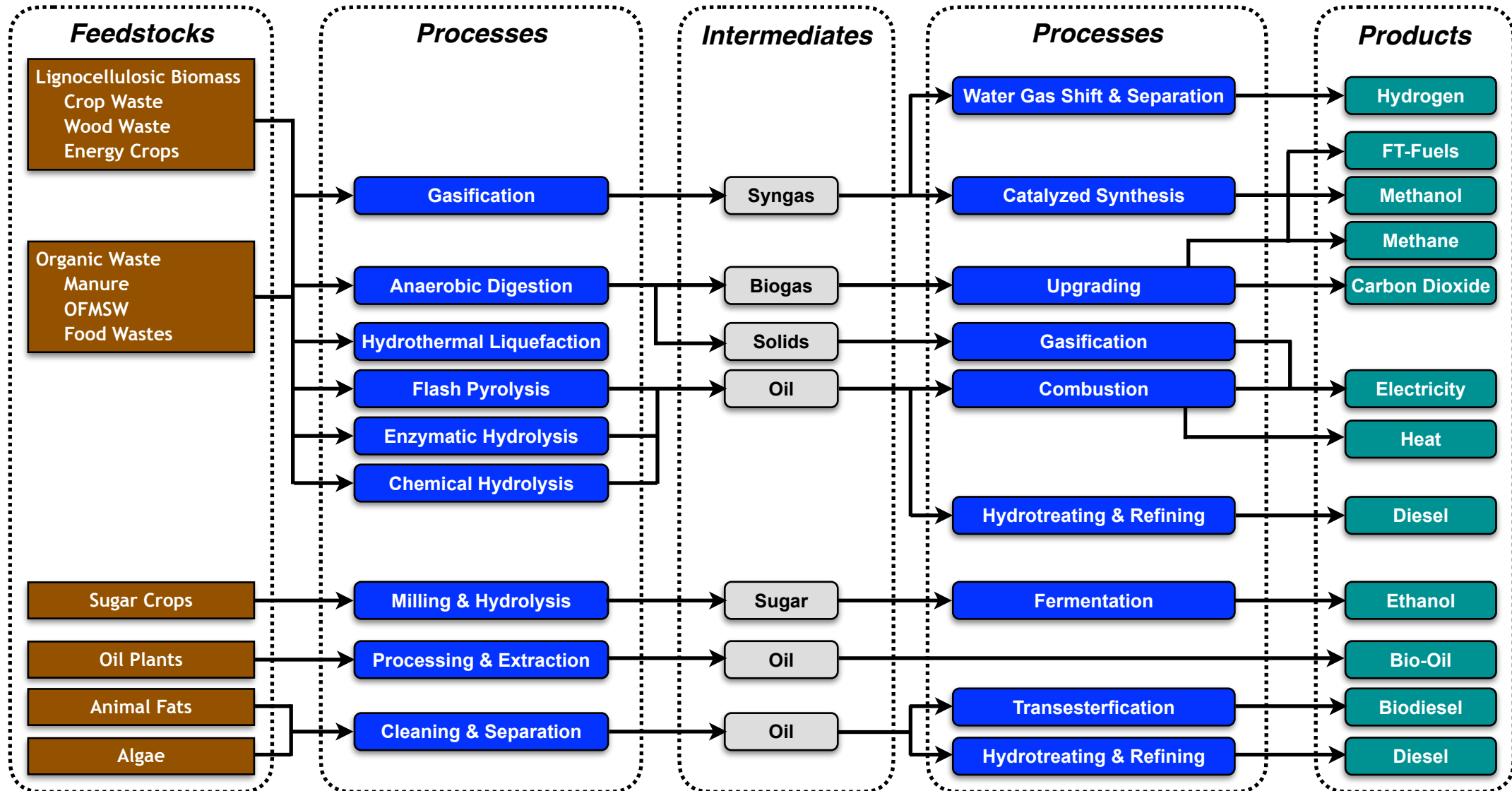
# Carbon Fluxes and Driving Forces



# World BTL Potential v 2012 Oil & Energy Use



# Conventional Biomass Pathways



# Simplified Project Requirements

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# FEEDSTOCK

available, appropriate & affordable

## Offtakes

bankable

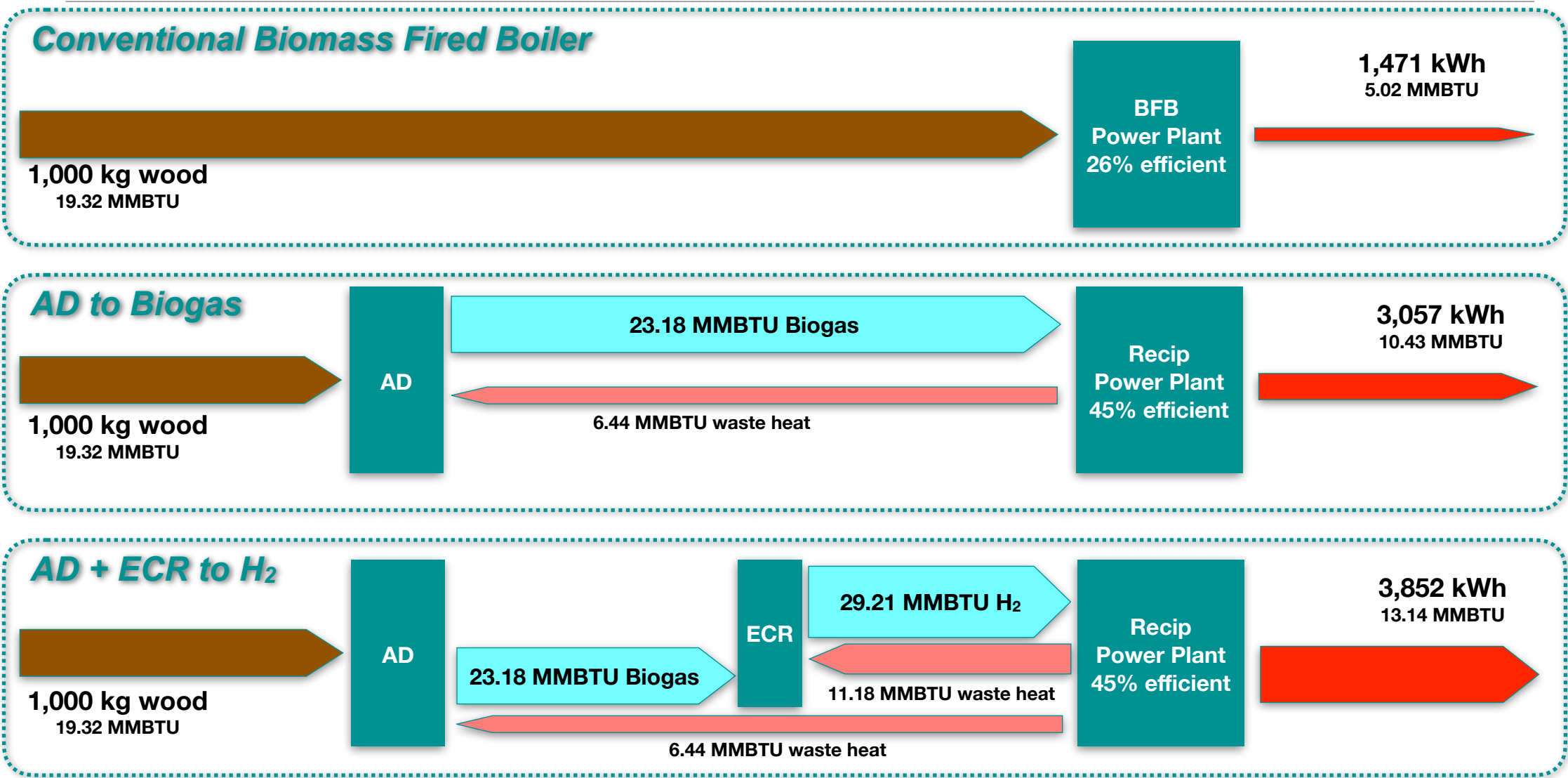
## Site

acceptable

## Permits

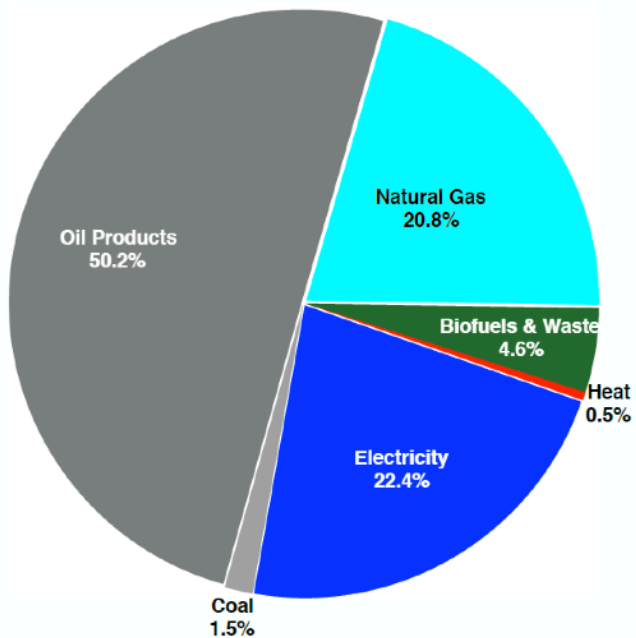
obtainable

# Key Fact 1: Biochemical & Electrochemical Leverage

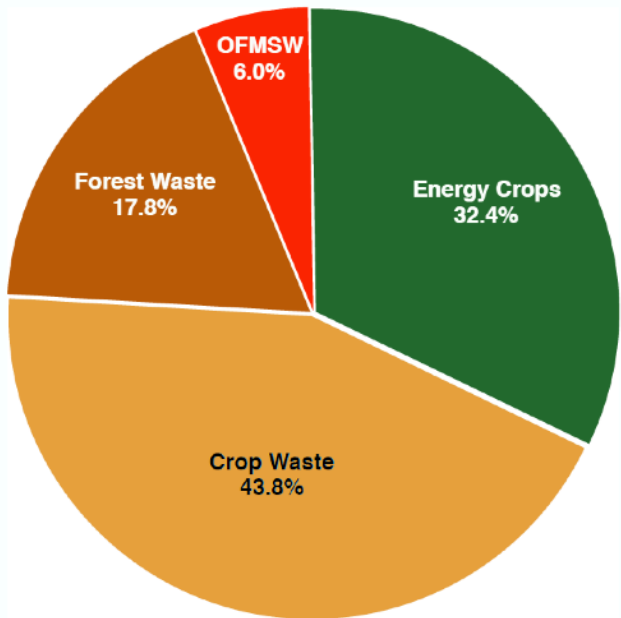


# US Comparison

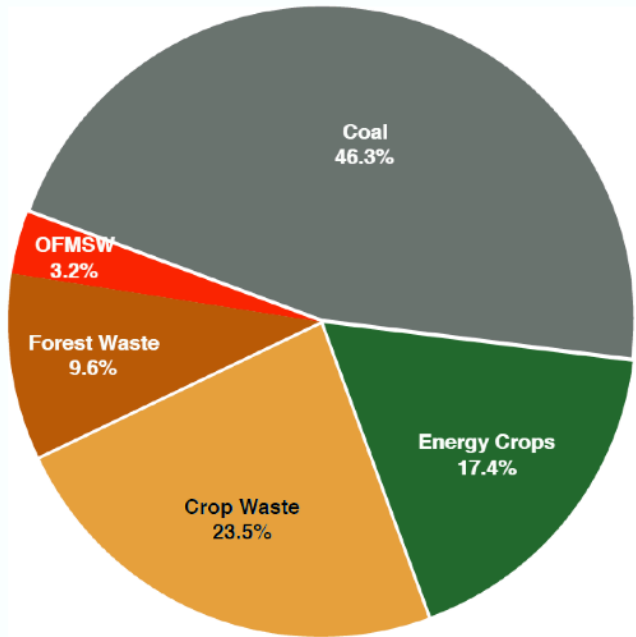
2015 US Consumption  
28.8 MBOED



Current Biogas Potential  
10.8 MBOED



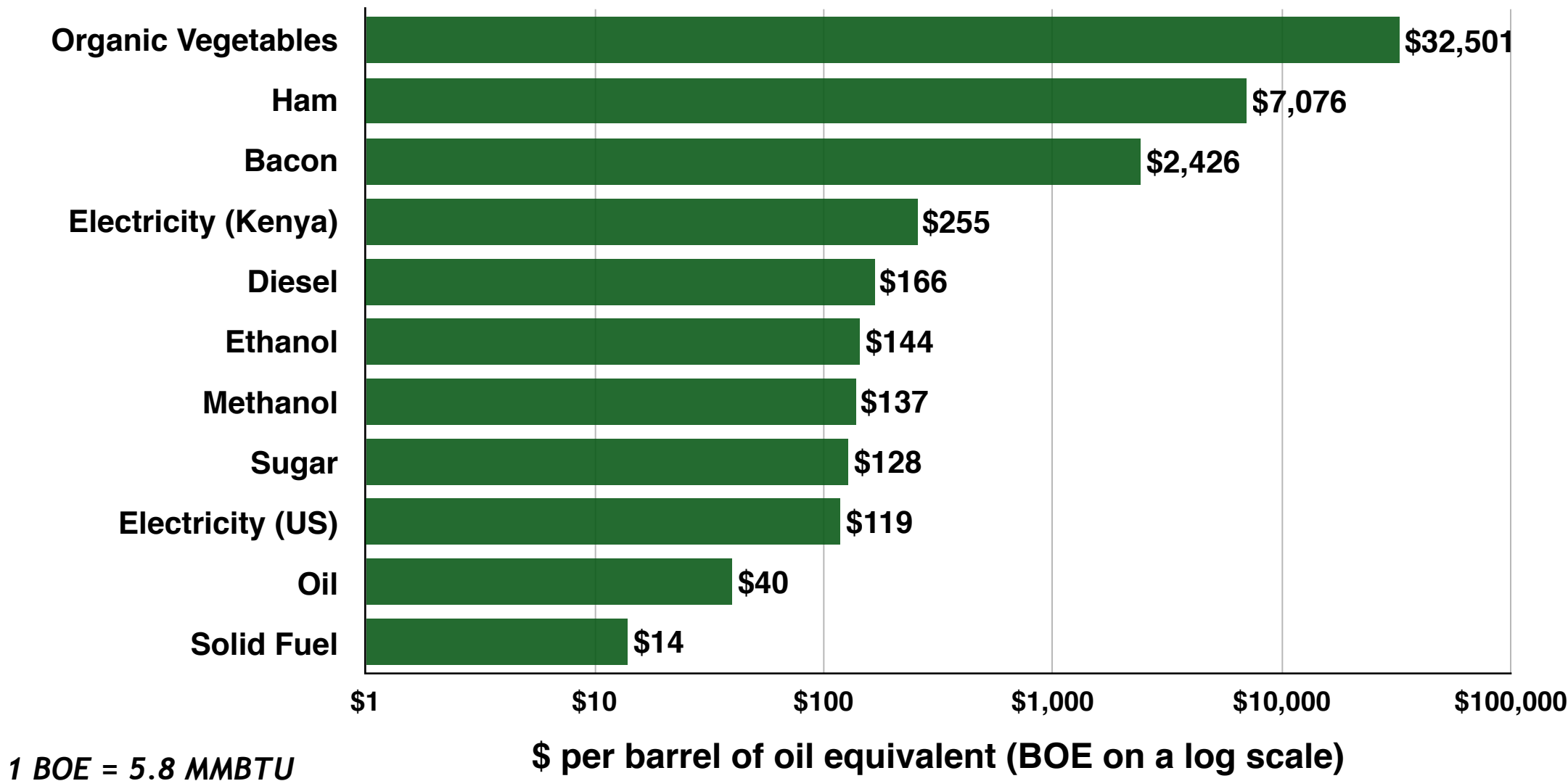
Future ZNC Hydrogen Potential  
35.6 MBOED



Notes: Sources - IEA, CIA, FOA, World Bank  
1 BOED = barrels of oil equivalent per day (1 BOE = 5,800,000 btus = 6.2 GJ)



# Energy Cost Comparison



# ZNC Farms Opportunity

Sustainable indoor food growing cost competitive with field growing/greenhouses

60% higher agricultural yield and higher EBITDA than traditional greenhouses

80% less water, 90% less land use than traditional agriculture

85-95% less shipping fuel for year-round food close to consumers

Design climate proof system suitable for today and worsening climate conditions

Great value through Zero-waste system with optimized water and energy usage

Proven technologies with large potential for improvements

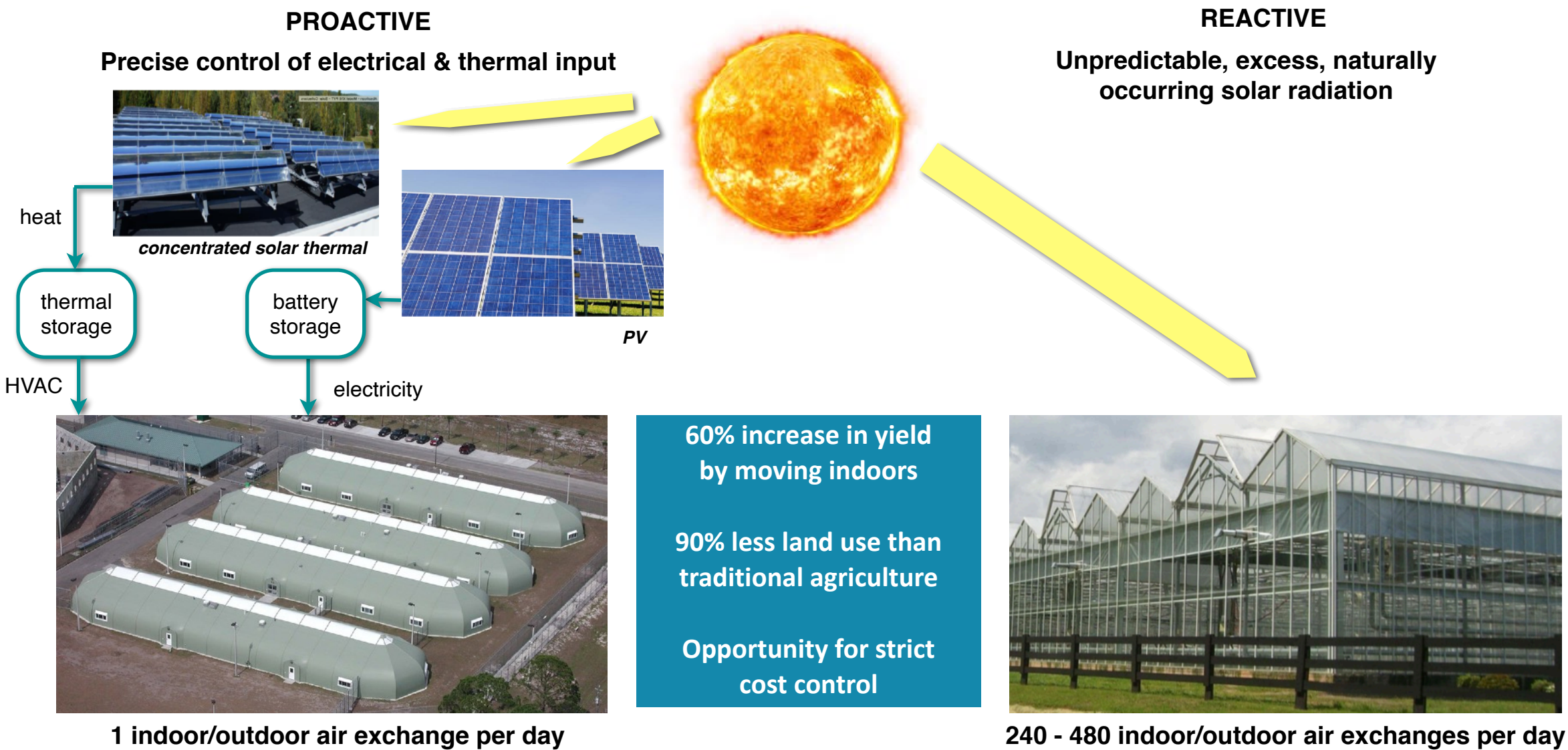
Significant carbon emissions reduction

Increased US Food & Energy security

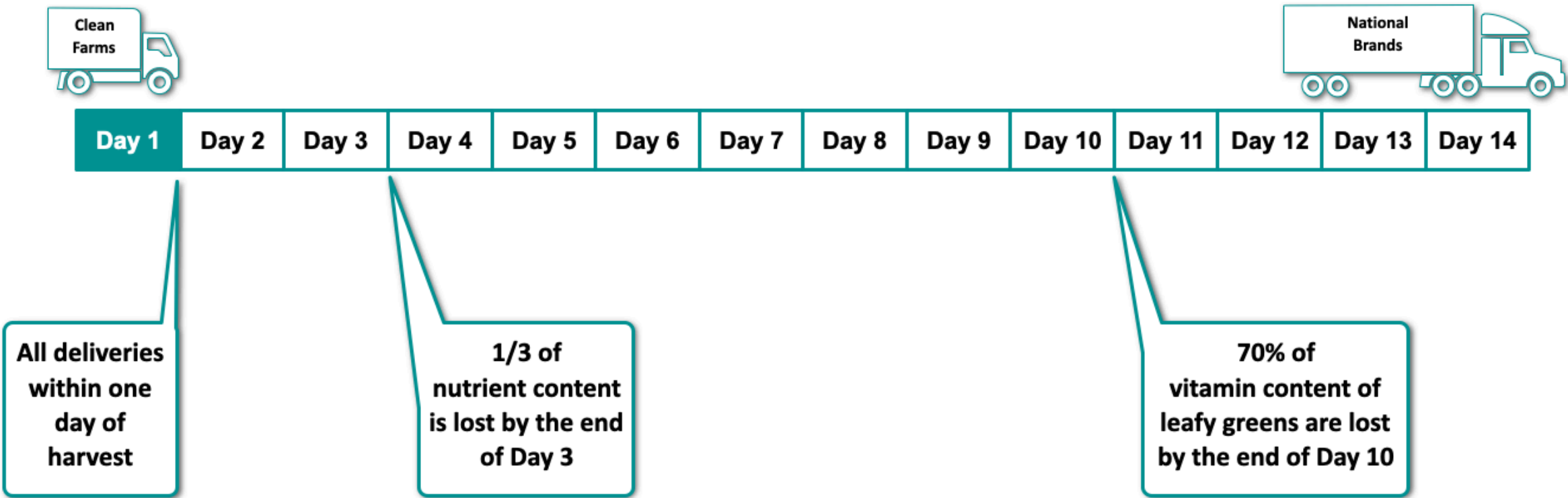
500-750 high-paying jobs/site

<u>Round</u>	<u>Amount</u>	<u>Timing</u>
Round A	\$5M	start
Round B	\$220M	M 12
EBITDA / Sales	2025	59%

# Food Factories Intercept, Store & Meter In the Sun



# Fast Delivery Nutrition Benefit



# Growing the Cleanest Produce



473,540 metric tons  
of pesticides were  
spread on US crops  
in 2018  
(UN FAO)

## ORGANIC

**DOES NOT MEAN  
PESTICIDE FREE**

Regular

Organic

ZNC Farms

78%

46 %

0%

% FOUND WITH PESTICIDE RESIDUES

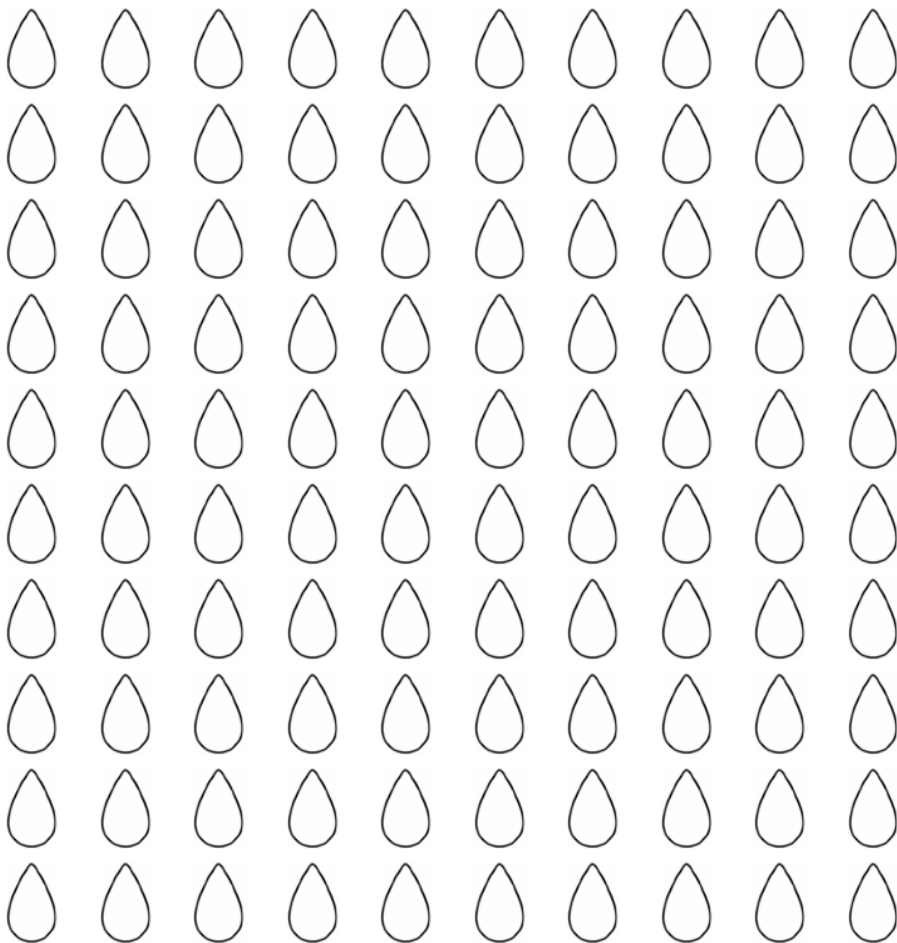
# Using Fewer Resources

80% LESS WATER USE

Clean Farms



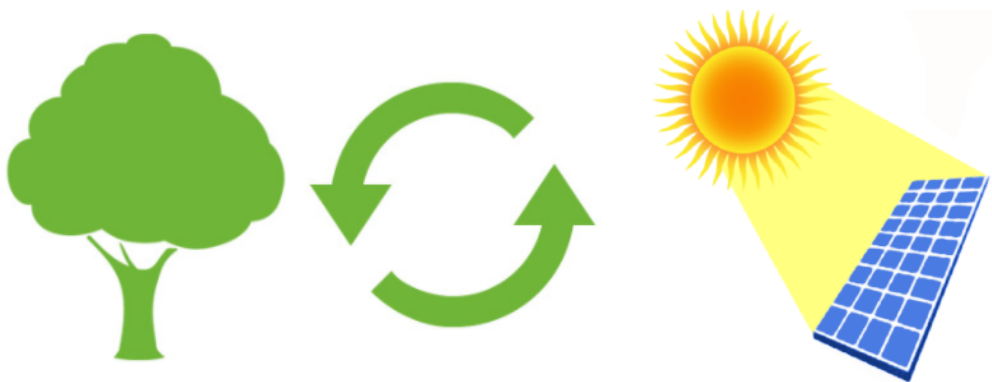
Field Grown Crops



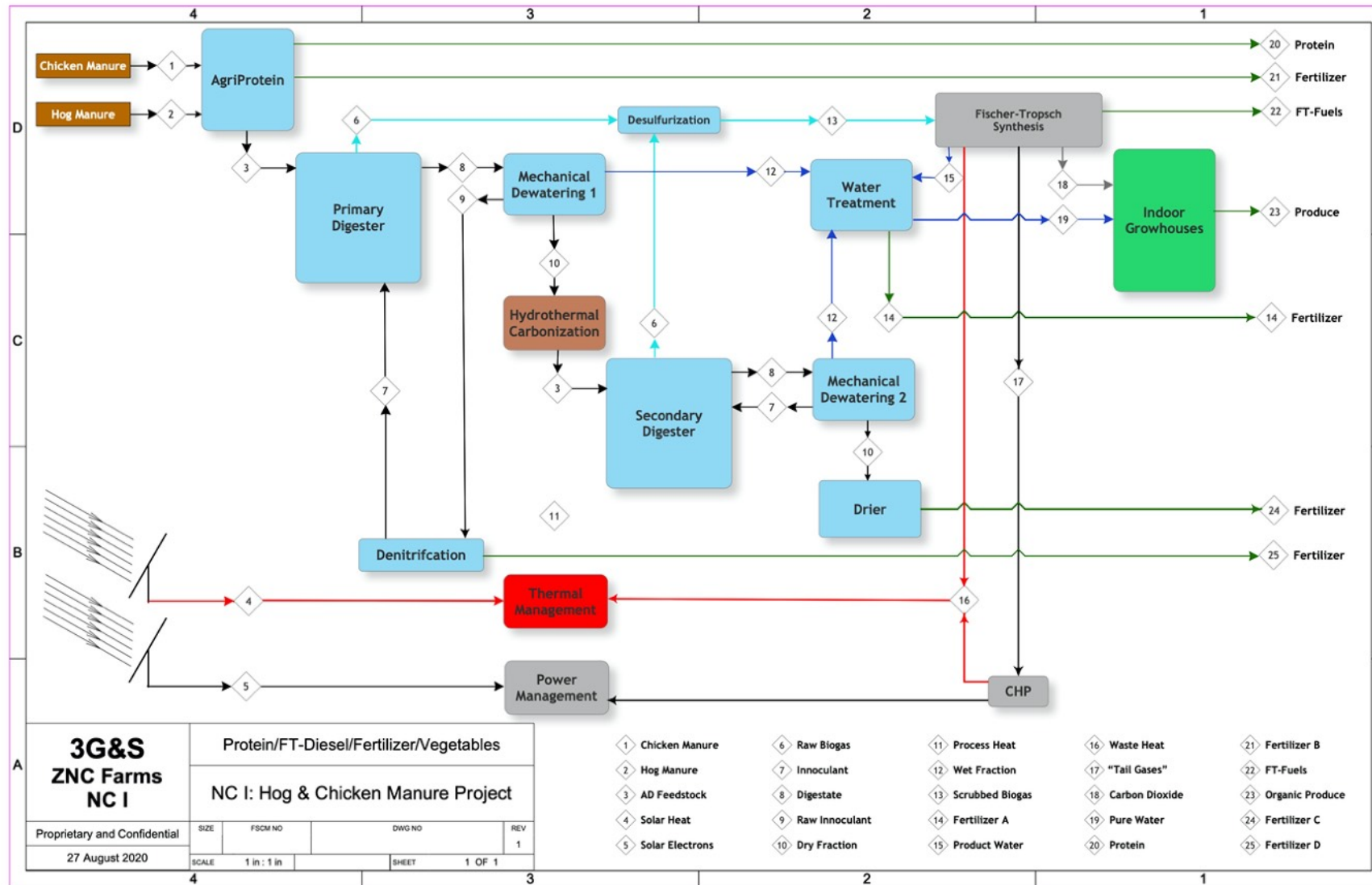
GROWN WITH

100%

RENEWABLE ENERGY



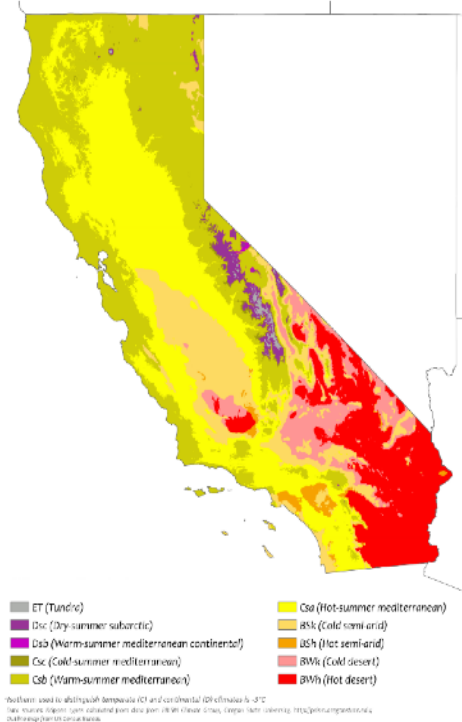
## Example: North Carolina Manure





# California: major climate issues and large Hydrogen market

Köppen climate types of California

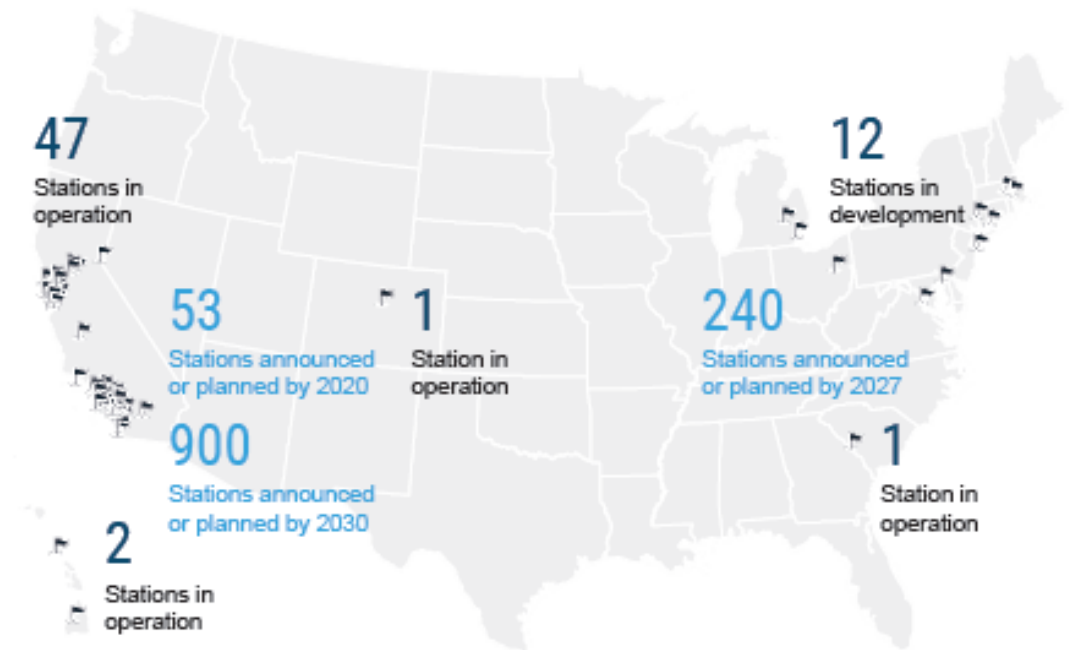


California droughts and wildfires have intensified

Semi-arid and arid land will increase

State agricultural market (54 billion USD) will need a re-invention to deal with changing climate

Agave will grow on (semi-) arid land



Highest proposed Hydrogen fueling stations

State plans to end sale of new IC engine vehicles by 2035



# California: identified biogas resources & H<sub>2</sub> potential

Source	biomethane	Hydrogen	improvement
	Bscf	tons	100%
Animal Manure	19.7	200,885	401,770
Landfill Gas	53.0	540,452	540,452
OFMSW	12.6	128,485	256,970
Waste Water Treatment Plants	7.7	78,519	157,037
Total	93.0	948,341	1,356,229

Source: CEC

# California: identified hydrogen demand

Demand by 2050	tons	substitution cost range		assumptions			
LDV	1,900,000	\$	2.00	\$	4.00	based on a dispensed price target of \$6.00 - \$8.00	
NON-LDV	1,100,000	\$	2.00	\$	4.00	based on a dispensed price target of \$6.00 - \$8.01	
Refining	255,000	\$	2.20	\$	3.40	SMR CI of 125 and carbon price of \$20 - \$100/ton	
Electricity	385,000	\$	2.20	\$	3.40	assumes \$15 - \$25/MMBTU for delivered biomethane	
Commercial/Residential	575,000	\$	2.00	\$	3.00	assumes \$140 - \$200/MWh	
Ammonia	138,000	\$	3.00	\$	6.00	SMR CI of 125 and carbon price of \$20 - \$100/ton	
	4,353,000						

Source: CEC

# California: cropland & biomass potential

CA harvested cropland 2002		acres
orchard and vineyards		2,872,000
hay - all types		1,953,000
vegetables and melons		1,197,000
cotton		695,000
rice		531,000
wheat for grain		410,000
barley for grain		75,000
other crops		733,000
total harvested cropland		8,466,000
5% pasture and rangeland		699,065
	5% desert	1,307,168
		2,006,233

Biomass Feedstock	BDT	tons H2
<b>Forestry</b>	32,000,000	6,852,526
<b>OFMSW</b>	1,200,000	256,970
<b>Manure</b>	3,400,000	401,770
<b>Energy Crops</b>	19,485,878	4,172,734
		11,684,000

Source: CEC & UC Davis

# Next generation feedstock to be used - AGAVE

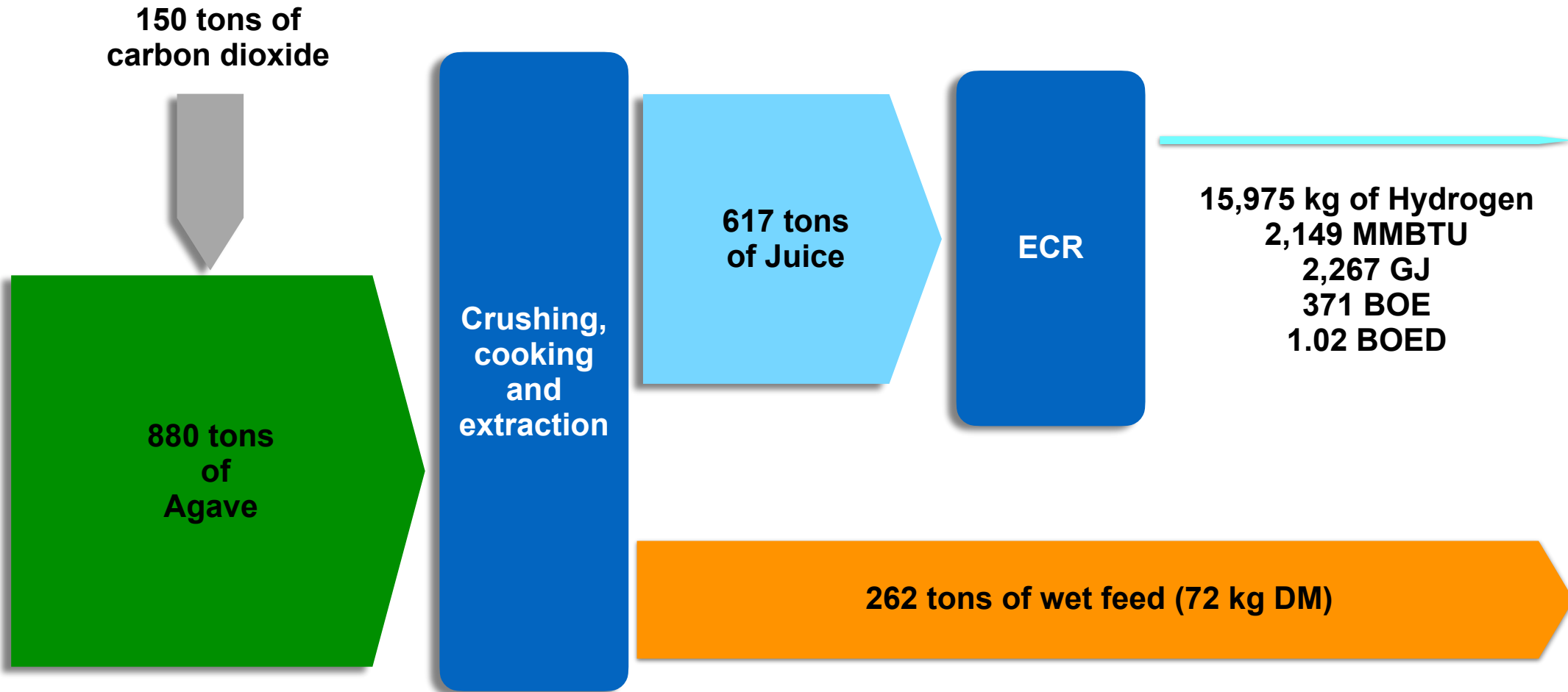
## Agave

- Growing agave will provide ZNC Farms an opportunity for **vertical integration with stronger feedstock control**
- Desert plant that requires **minimal water**
- Agave grows on non-food land
- Agave survives under harsh conditions (drought) and retains water better than most crops
- Agave is a natural tool for carbon capturing
- Large scale plantations operational outside USA
- Fire resistant; can be used as fire barrier
- Withstands climate change effects
- Agave has 5-year growth cycle; yield/ha higher than other crops



Conditions	Sugarcane	Agave
Yield (ton/ha/yr) food land	80-120	160-180
Water requirements	Very high	Low
Sugars/starch	10-14%	15-25%
CO2 absorption above ground	15 tons/ha/yr	30 tons/ha/yr

# Products from 1 ha of Agave



# Annual Average Almond Farm (6,800 total in CA)

## Almonds

755 thousand metric tons of water

200 million gallons

235 acre  
almond  
orchard  
(95.1 hectares)

507,600 lbs of almonds  
230 metric tons

Total Revenue @ 2.34/lb

\$1,187,784  
or  
\$5,054/acre

*Current Almond Acreage would produce over 2 million tons of ZNC H<sub>2</sub>/year  
with a 60% reduction in water consumption*

## Agave

287.6 thousand metric tons of water

76 million gallons

235 acre  
agave farm  
(95.1 hectares)

16,737 metric tons  
of agave

ECR  
+  
Digester

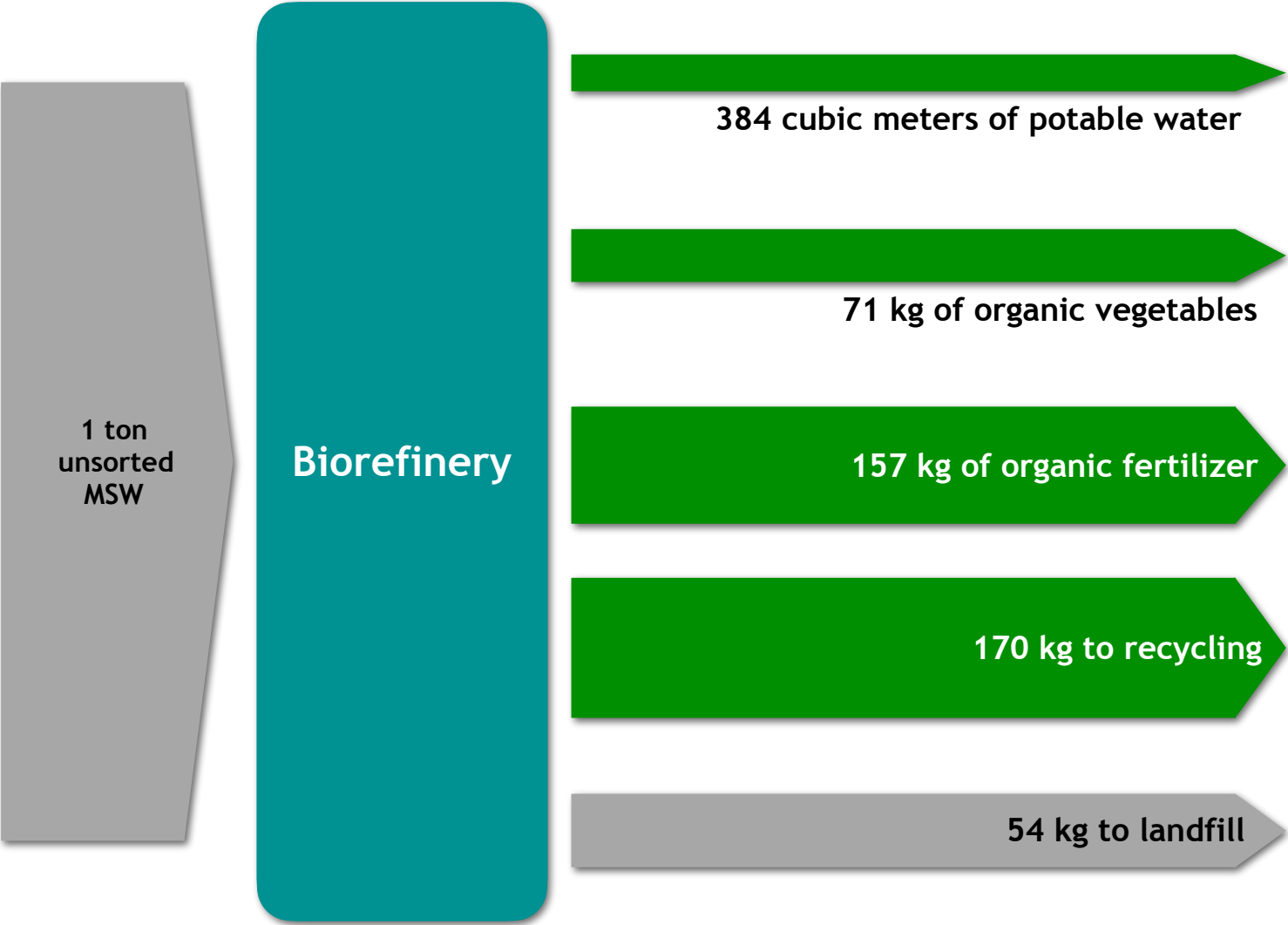
303,845 kg H<sub>2</sub>  
@ \$6.00/kg

38,612 MMBTU biomethane  
@ \$6.00/MMBTU

Total Revenue

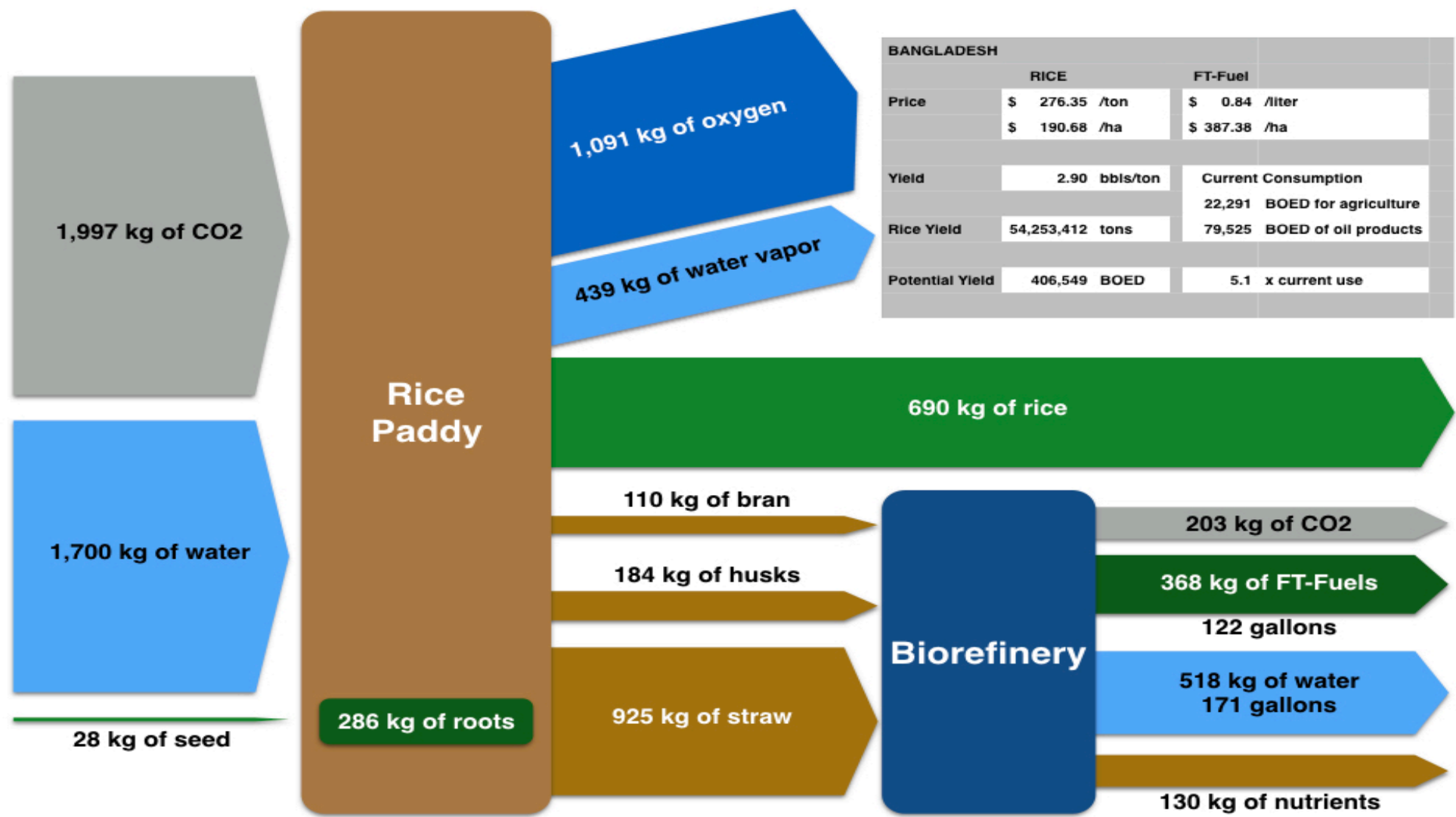
\$1,850,070  
\$231,672  
\$2,081,742  
or  
\$8,858/acre

# Flows & Value from 1 Ton of unsorted MSW



Output	Price	Unit	Revenue
Water	\$0.60	per m3	\$ 70.98
Organic Vegetables	\$4.00	per kg	\$ 284.00
Organic Fertilizer	\$0.25	per kg	\$ 39.37
Recycling	\$0.05	per kg	\$ 8.50
Landfill	-\$10.00	per ton	\$ (0.54)
Total Revenue per Ton In			\$ 402.31

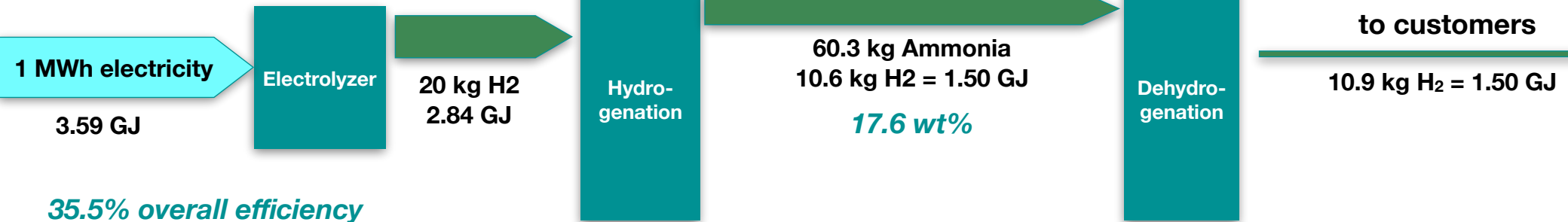
# Flows & Value from 1 Ton of Rice Paddy





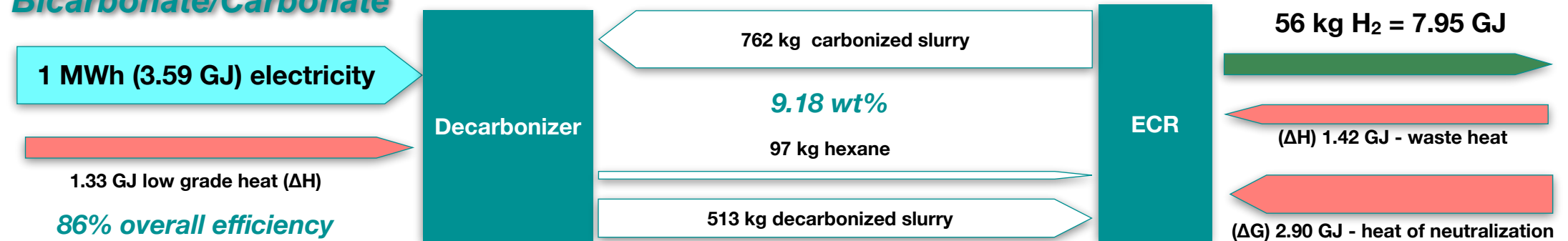
# Storing Sunlight & Wind

## Ammonia



*5 x increase in net H<sub>2</sub> per kWh*

## Bicarbonate/Carbonate



## Conclusion:

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***California can become zero-net-carbon and energy independent using biomass as a baseload renewable and storing the excess wind and solar as liquids.***

# Contact

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# Background

# Succulents as firebreaks



# US Fruits & Vegetable Markets – local production

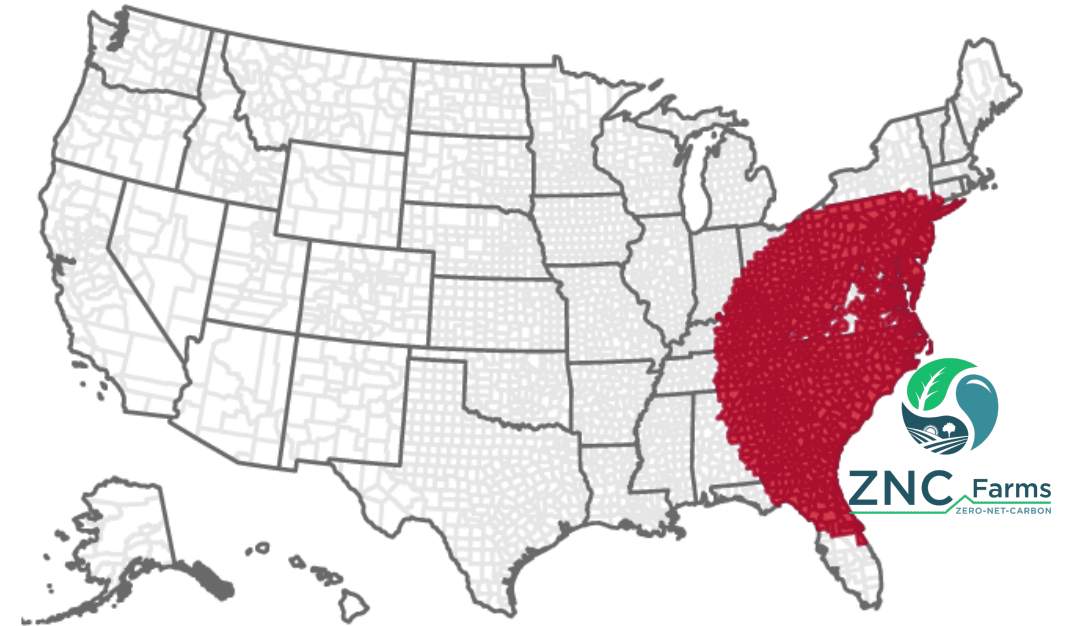


US Organic Food market: \$50B (2019)\*

US Organic Fruit & vegetable market: \$18B (2019)

CAGR 2010-2019: 8.1%

\* Source: USA Organic Trade Association

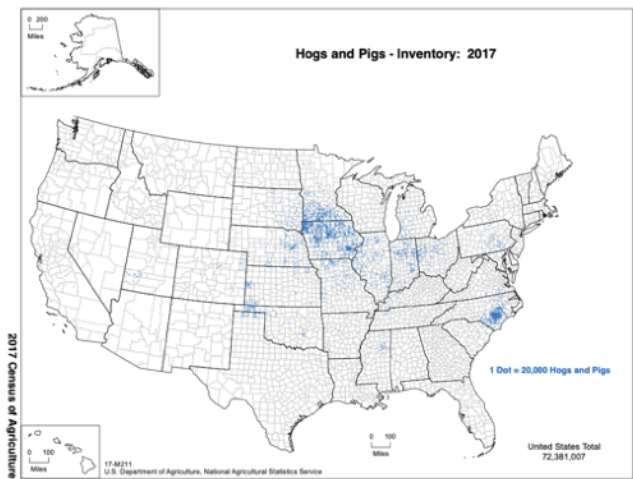


First two sites to be built in North Carolina: 500 miles (800km), reaches 100M+ people

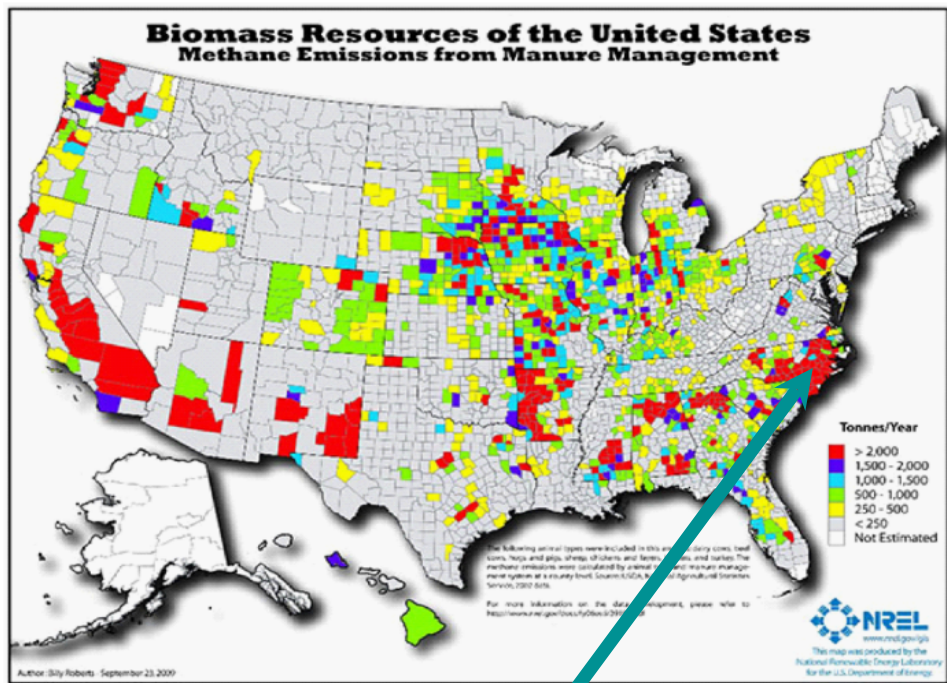
Eliminating supply chains from West Coast results in increased freshness and less food waste



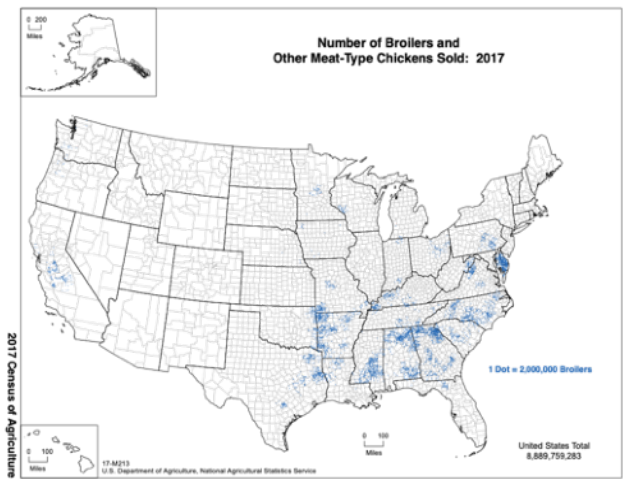
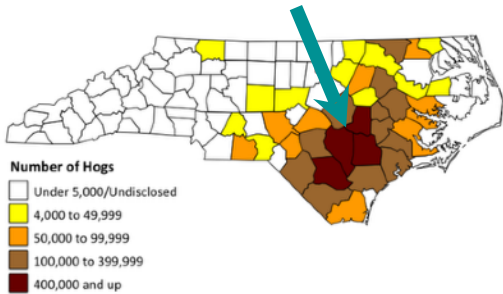
# US has abundance of feedstock available



Top States in Sales (\$ billions) hogs	
Iowa	6.8
North Carolina	2.9
Minnesota	2.8
Illinois	1.5
Indiana	1.3
Nebraska	1.1
Missouri	0.9
Ohio	0.8
Kansas	0.7
Oklahoma	0.7



Site 1 & 2



Top States in Sales (\$ billions) poultry	
Georgia	5.4
North Carolina	5.4
Arkansas	5.1
Alabama	4.1
Mississippi	3.1
Texas	2.9
California	1.8
Pennsylvania	1.6
South Carolina	1.6
Missouri	1.6

# Site 1 feedstock as % of US manure market

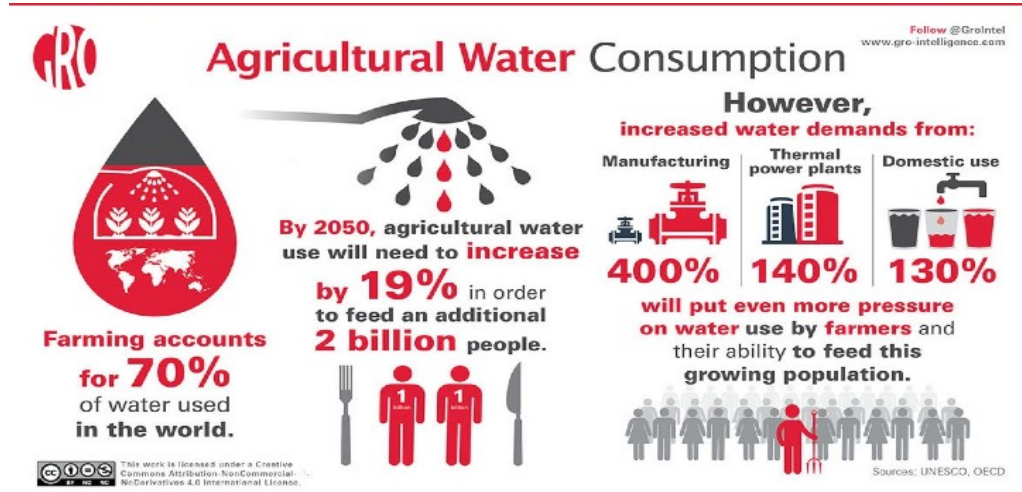
US Manure Market	# of animals	tons TS (total solids)	% of total US resource	tons raw manure	# potential sites	% of Market	Sources: USDA & ASAE
Site 1 Biorefinery	3,680,493	64,801	0.05%	225,400	1	Site 1	Market Share
Duplin County Hogs	2,000,000	356,734	0.27%	5,662,440	6	18.17%	of Duplin County Hogs
Duplin County Broilers	12,464,286	204,878	0.15%	791,033	3	31.63%	of Duplin County Broilers
North Carolina Hogs	9,000,000	1,783,669	1.34%	25,480,980	28	3.63%	of North Carolina Hogs
Total US Hogs	66,000,000	13,080,236	9.85%	186,860,520	202	0.50%	of Total US Hogs
Total US Dairy	9,300,000	23,761,500	17.90%	169,725,000	367	0.27%	of Total US Dairy
Total US Beef	66,200,000	95,902,947	72.25%	652,401,000	1,480	0.07%	of Total US Beef
Total US Layers	355,160,000	4,233,523	3.19%	16,934,093	65	1.53%	of Total US Layers
Total US Broilers	1,500,000,000	24,655,750	18.57%	95,195,946	380	0.26%	of Total US Broilers
Total US Turkeys	119,000,000	4,718,344	3.55%	18,503,310	73	1.37%	of Total US Turkeys
total	2,126,660,000	132,744,683	100.00%	1,008,986,520	2,049	0.05%	of Total US Manure

Site 1 uses manure (tons Total Solids) that accounts for:

- 3.6% North Carolina hogs
- 0.50% USA hogs
- 0.05% total US manure



# Sustainable use of water & energy for food production



ZNC FARMS focuses on producing food in a system that:

- Uses organic materials as feedstock that contain a great deal of water that would go to waste; or
- Uses organic plant materials as feedstock that require significantly less water than other crops

**ZNC Farms Bio-refining system re-uses all system water**

ZNC FARMS focuses on producing food in a system that:

- Uses solar fed indoor food growing facilities
- Uses PV fed LED lighting and solar thermal HVAC
- Creates a controlled ideal growing environment

**ZNC Farms Bio-refining system requires minimal outside energy**



# Long-Term Access to Affordable Feedstock is Key

## Agricultural Waste

- Hog manure contains **93% water**; Poultry waste contains **60% water**
- Current practices leave hog manure in lagoons, which lead to social disturbance (smell) and can lead to ground water contamination
- Manure is a major source of carbon emissions
- Manure lagoons have regularly flooded
- Water in manure is often evaporated before being used
- Other feedstocks include dairy waste, food waste, crop waste
- Natural partnership with farmers converts waste to value

