FOOD SECURITY
VIA
CLEAN ENERGY

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evrblaze™ ENERGY FOR GOOD

GINET

Alex Lightman

Alex has over 30 years experience in high technology innovation, including defining, design, developing and deploying new and novel hardware, software, communications, and Internet products, platforms, and protocols. He was a pioneer in wearables (wearable computing) in the 1990s, sparking global publicity via over 700 television appearances and 300 additional articles that have paved the way for public interest and demand for Google Glass and the wearable devices of The Quantified Self wave of innovation.

He was the author of the first book on 4G (Brave New Unwired World, John Wiley, 2002). Producer of 108 wearable computer fashions shows held in six US states and 25 nations. Alex co-inventor of multiple patents for wearable computing and related communications, including some with Thad Starner, the technical lead of Google Glass. For his contributions on behalf of innovation in 4G wireless, he received the first Economist magazine Reader's Award, Oct. 21, 2010 (after panel of judges and readers in 200 countries voted on "the innovation most likely to radically change the world over the next decade, 2010-2020").

Alex successfully proposed US government mandate for IPv6 and federal requirement of inclusion of IPv6 in all federal IT procurement, including testimony before US Congress, in May 2005, that was directly responsible for the unprecedented mandate that all federal agencies become "IPv6-capable." He provided the first two IPv6 transition plans for NATO, and one of the first two IPv6 transition plans for the US Dept. of Defense, via DISA, as well as the IPv6 Best Practices World Report, sponsored by Juniper, and used by numerous federal agencies. Alex is an MIT '83 graduate (Civil and Environmental Engineering) and attended Harvard University's J.F. Kennedy School of Government. His next book, to be published in Q4, 2014, is "Food Security via Clean Energy."

Agenda

Introduction

Problem Overview

Where and When

Dangers of Food Insecurity

Threats of Food Insecurity

A Way Ahead: Potential Solutions

Renewable Energy

Green Ammonia

Water

Pilot Project

Conclusions

Prioritize

The Importance of Food Security

3 million children die from starvation every year.

842 million people live in Food Threatened areas.

Food Security growing more critical: potential of a tipping point.

ALL NATIONS - Involves not just developing nations, but the US & Allies.

WHY NOW?

Food prices rising fast.

Planetary depletion- desertification, water shortages.

Malnutrition causes pandemics that spread across the world.

Climate change = increased temperature variability.

Biofuels competing with food.

Increased pollution speeding decline.

The Issue of Food Security

FOOD SECURITY MEANS...

All people at all times have physical and economic access to abundant, safe, nutritious food for an active and healthy life (UN).

Not just hunger - international security and strategic relationships.

Not just lack of food - most countries with famine have lots of food available.

70-80% of people in developing nations are smallhold farmers...

...many at subsistence level

...cannot afford ammonia-based fertilizer, fuel, electric power

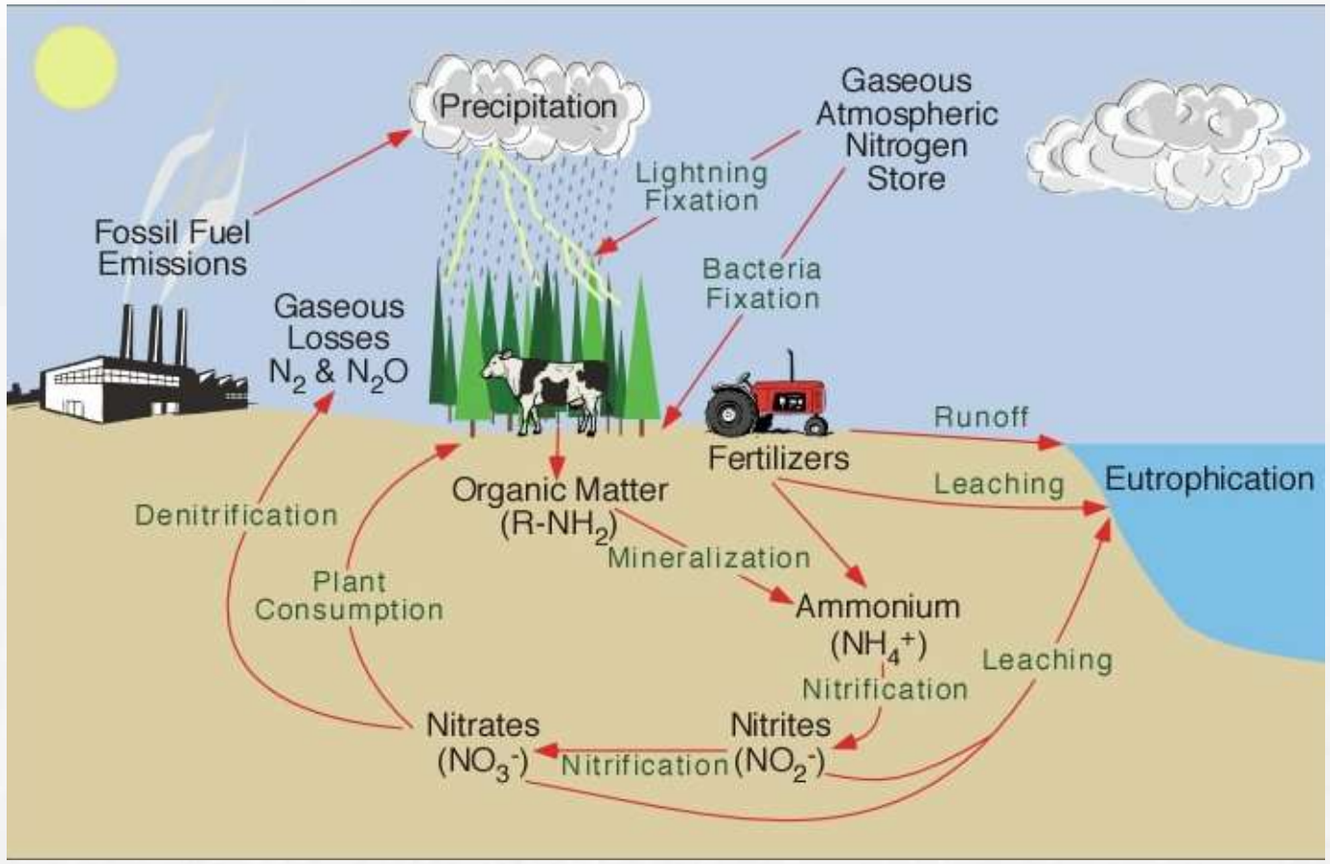
...any increase threatens their livelihood.

Technology based solutions ensure Food Security AND create huge international markets!

Food Security Life Cycle

Food Security is a Process in a large System

Air quality is just as important as soil quality



Grow Food or Burn Fossil Fuels, But Not Both

Burning fossil fuels over the next **30 years** will cause:

Temperature Collapse

After 30 degrees C, 1 degree increases risk of crop failure by 10%.

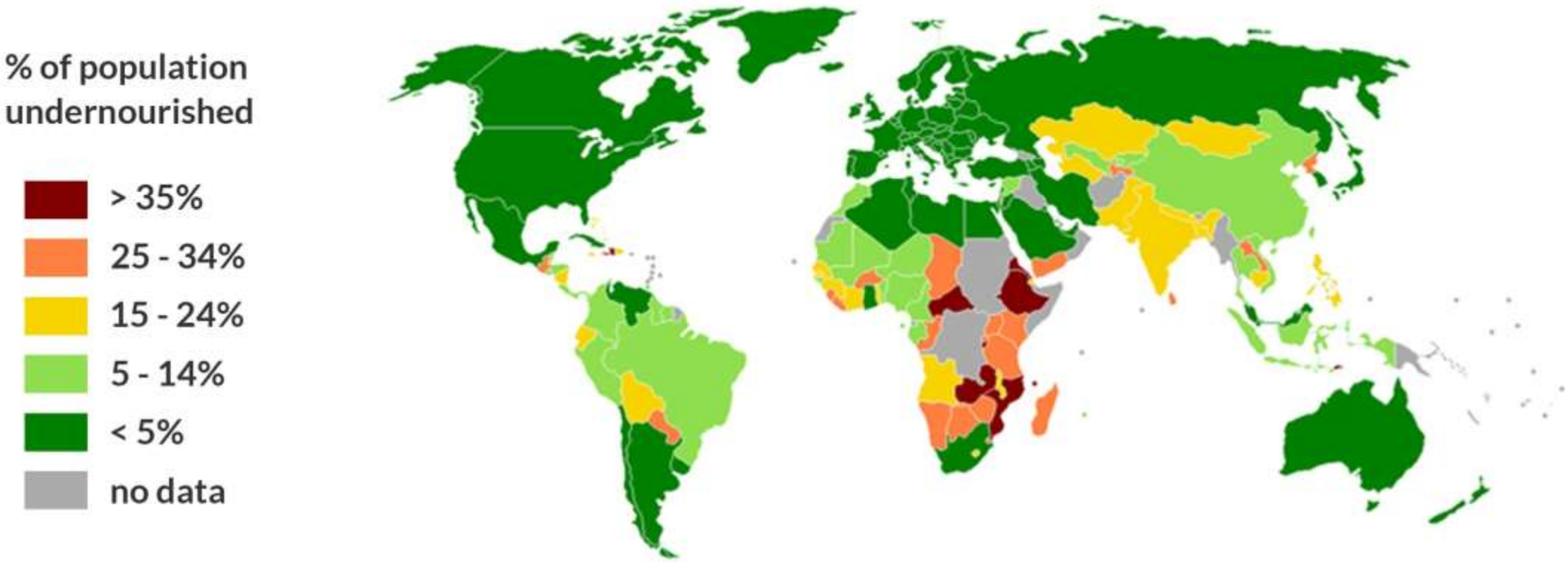
Nutrient Collapse

Extra CO2 causes wheat to grow 11% larger with 10% less protein.

Toxicity Alchemy

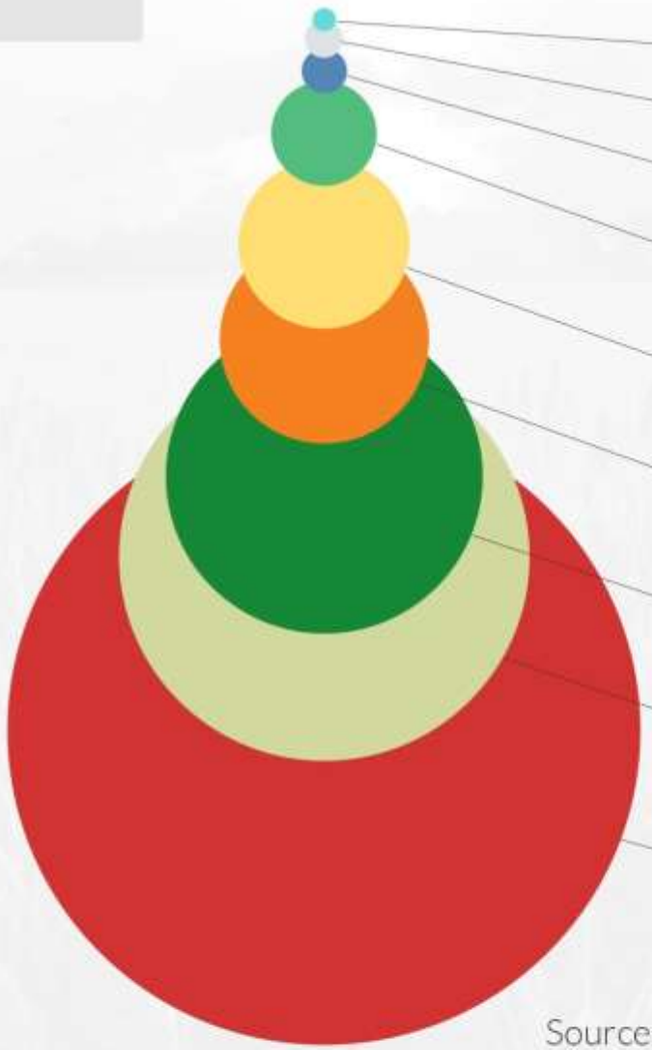
Cassava, a staple for hundreds of millions, develops cyanide when exposed to CO2.

Locations of Food Insecurity



Areas of Food Insecurity

TOTAL - 868 Million



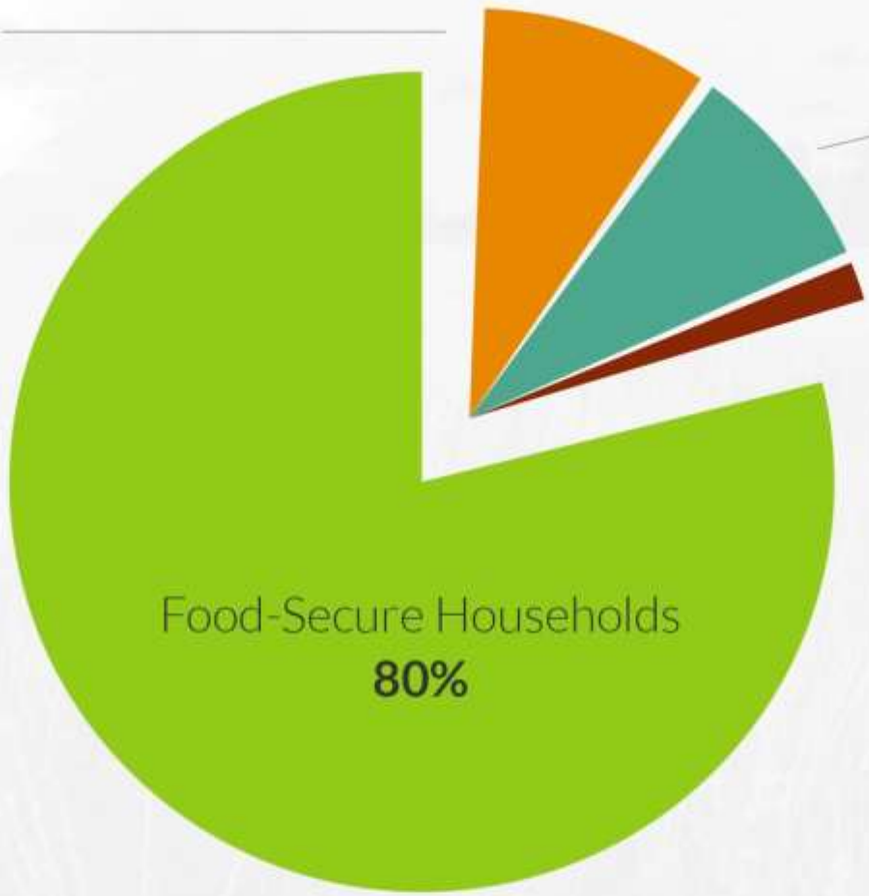
1	Oceana
6	Caucasus and Central Asia
16	Developed Regions
25	Western Asia and Northern Africa
49	Latin America and the Caribbean
65	South-Eastern Asia
167	Eastern Asia
234	Sub-Saharan Africa
304	Southern Asia

Source: FAO

Areas of Food Insecurity

Food-Insecure Households 20%

Food insecurity among adults only in households with children - 10%



10% Food-Insecure Households

Low food security among children - 8.8%

Very low food security among children - 1.2%

Source: Calculated by ERS using data from the December 2012 Current Population Survey Food Security Supplement.

Four Pillars of Food Security

Availability

- Stability: Sufficient quantity of food available to fulfill the needs of the entire population.
- Barrier: Smallhold farmers lack sufficient access to fertilizer, water, and power, resulting in low yield crops. Insufficient yields limit food availability and insufficient profits prevent farmers from upscaling, creating cyclical scarcity.

Access

- Stability: Population has access to sufficient food, regardless of location.
- Barrier: Road networks in threatened areas (eg Afghanistan...) are dangerous, unreliable, and can be cut off, limiting access.

Utilization

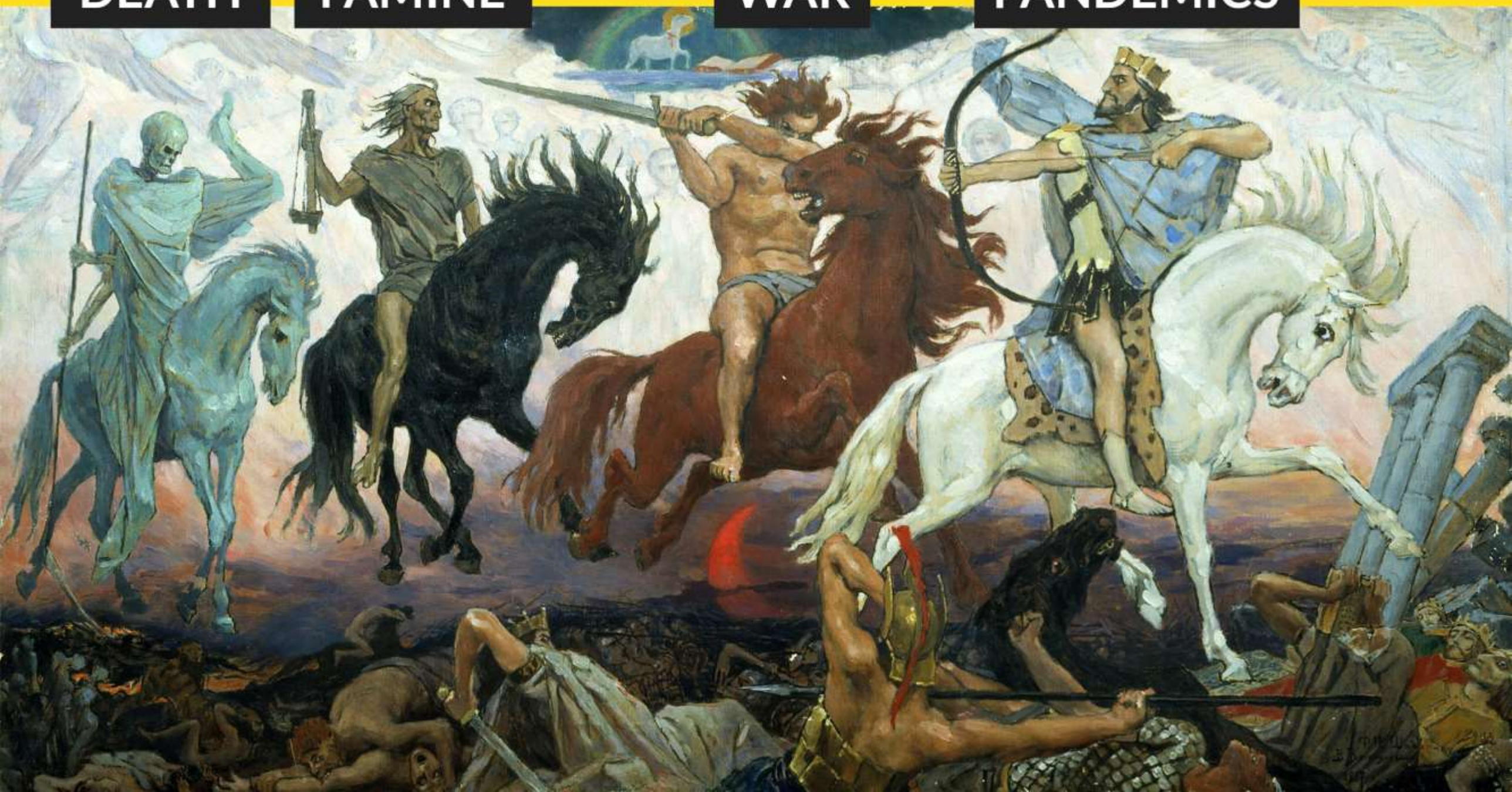
- Stability: Available food and water sources are usable, clean and uncontaminated.
- Barrier: Food and water sources can be unusable due to lack of refrigeration and insufficient sanitation.

Price Stability

- Stability: Stable prices enable reliable access to food and water.
- Barrier: Food prices fluctuate with the price of oil, gas, and ammonia.

DANGERS of FOOD INSECURITY
THE **FOUR** HORSEMEN

DEATH **FAMINE** **WAR** **PANDEMICS**



War and Insurrection

Examples of Wars and Insurrection caused by Food Insecurity:

Russian Revolution (1917)

- Bread unavailable in Petrograd (Russian Capital).
- Women marched in protest. The czar sent Cossacks instead of food.
- Soldiers refused to fire on women, revolution spread, czar overthrown.

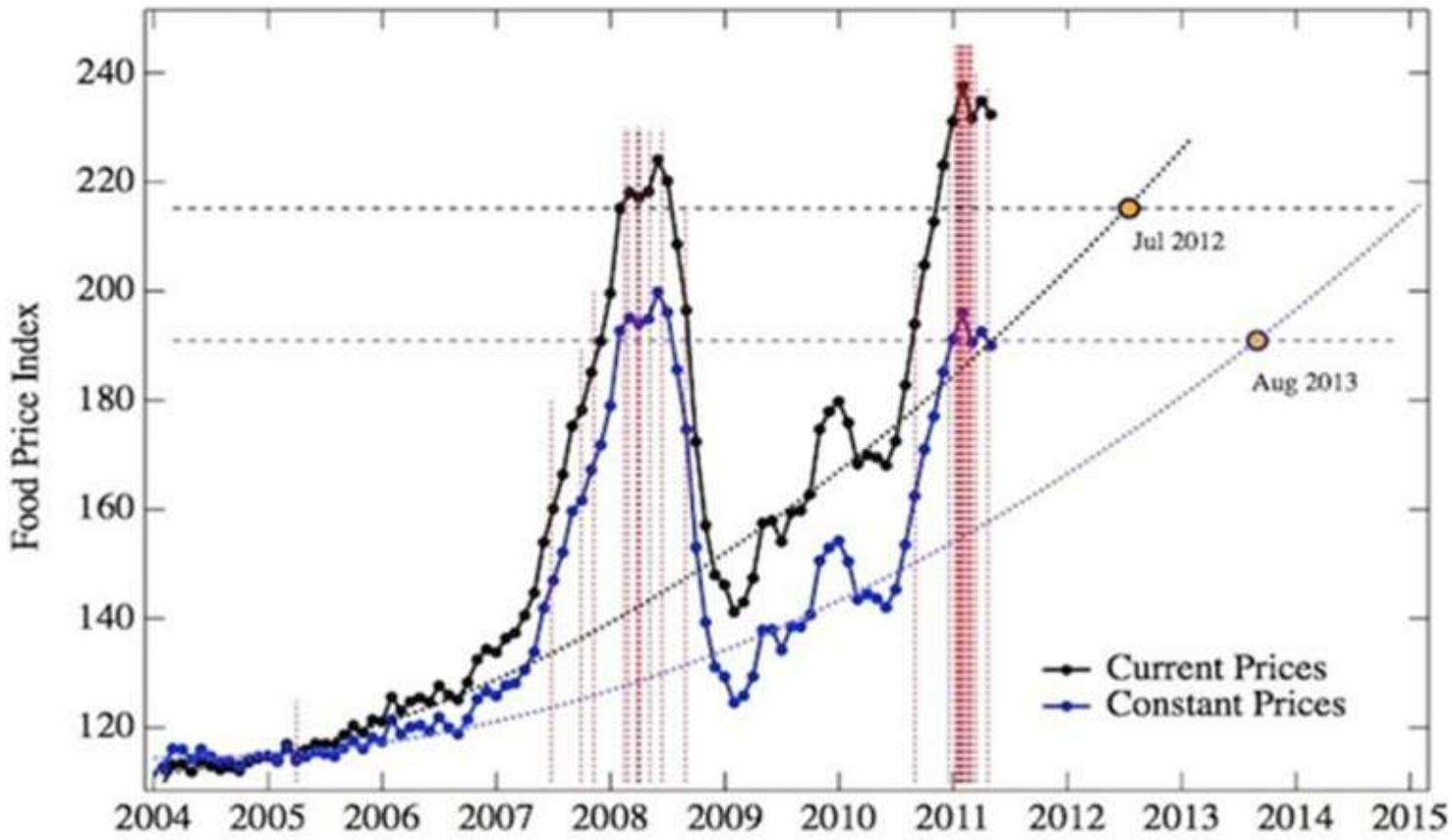
French Revolution (1789)

- Bread prices rise suddenly. Women march.
- Troops refuse to fire on women.
- King is overthrown, executed.

Arab Spring (2011)

- Food prices spike suddenly across region.
- Women protest. Soldiers refuse to shoot.
- National leaders overthrown.

Food Prices Are Predictors of Uprisings



Pandemics

Food Insecurity highly correlated with disease outbreaks. Hunger weakens body, reduces resistance.

Most of the millions that die each year do not die of starvation, but of disease, which can spread.

Pandemics associated with extreme hunger:

Spanish Flue (1918) killed over **50 MILLION**

Bubonic Plague (1348) **20-30 MILLION**

Bhola Cyclone, East Pakistan (1970) **100,000**

Poor government response time.

Region broke off as Bengladesh

Resulted in regional realignment

Famine

Two main types of starvation:

Marasmus (Lack of calories and body weight)

Kwashiorkor (Extreme lack of protein and nutrients)

Famous example: Irish Potato Famine (1845)

Monoculture (relied on a single crop, potatoes)

Blight devastated harvest.

Over **1 MILLION** died of famine-related causes.

Country exported food during the famine (enough to feed population). Smallhold farmers lived harvest-to-harvest, could not afford to buy food.

Causes of Food Insecurity

Rising Food Prices

High dependence on vacillating prices of oil, gas and ammonia.

Population Increases

Overpopulation (above sustainability) in stressed areas.

Moving Up the Food Chain

From grain to meat means much more food must be produced.

Desertification

Lack of fertilizer leads to soil depletion, loss of topsoil.

Food for Fuel

Biofuel competes for food (30% of US corn production).

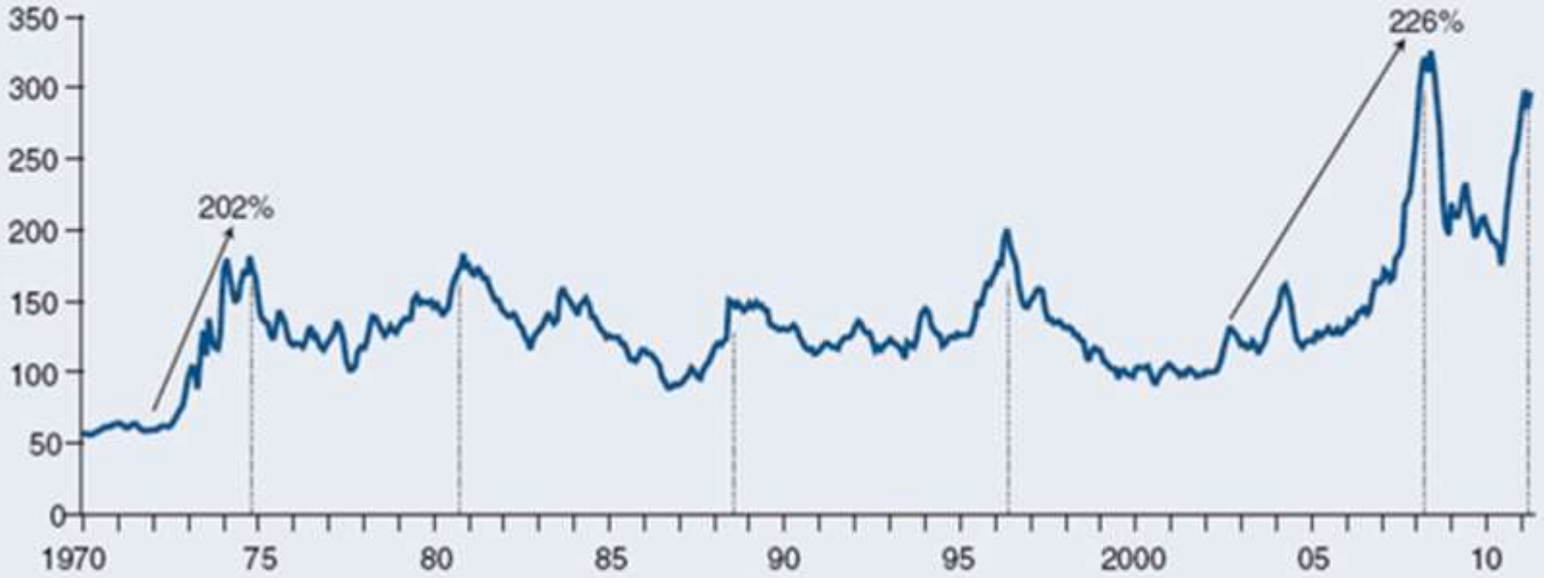
Pollution

Polluted water, air and soil lead to reduced crops and farmer health.

Areas of Food Insecurity

Crop price spikes since 1970[1]

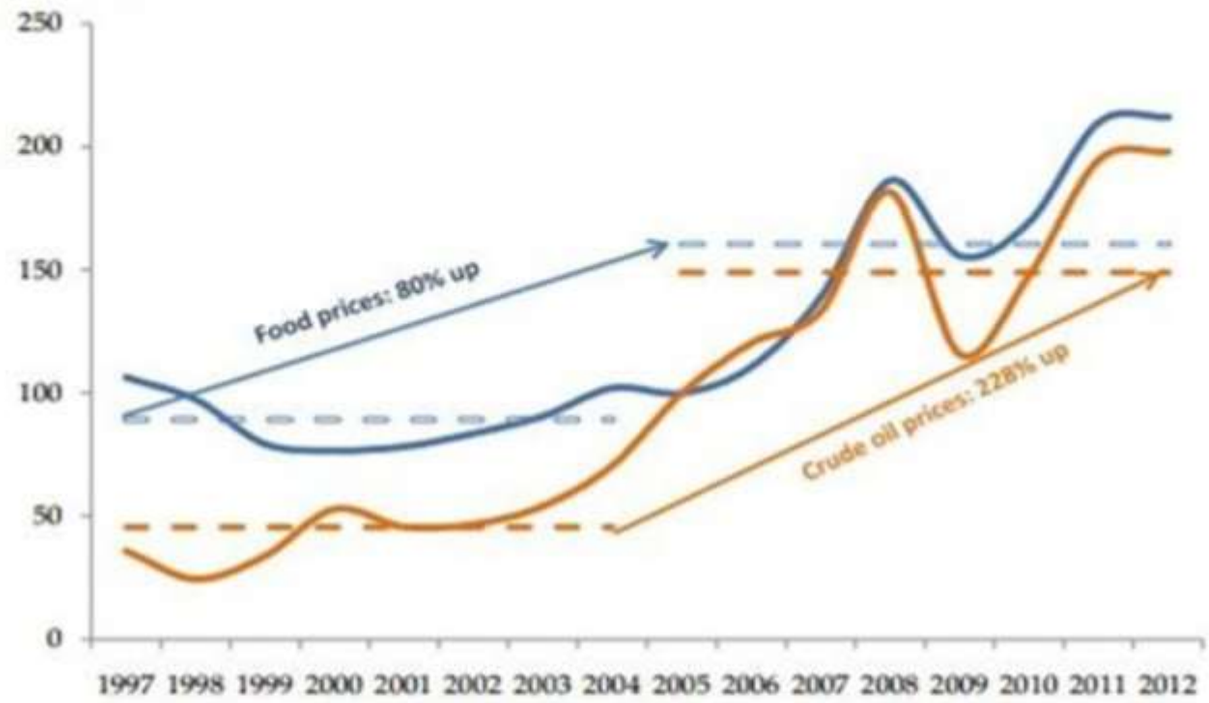
Index: January 2002 = 100



Monthly

[1] Weighted average of four crops (wheat, soybeans, corn, and rice); International Monetary Fund monthly prices weighted by world exports.
Source: USDA, Economic Research Service calculations based on International Monetary Fund nominal prices and weights.

Causes: Food Prices Depend On Oil Prices



Source: World Bank

Causes of Food Insecurity

(continued)

Cost of Ammonia-Based Fertilizer

Millions of farmers cannot afford it, esp. in remote areas.

Water Shortages

Lack of clean water, many deaths from drinking polluted water.

Natural Disasters

Hurricanes etc. destroy infrastructure, leave areas stranded.

Centralization of Resources (Electricity, Ammonia/Fertilizer, etc.)

Higher costs for remote areas, dangerous roads, power outages.

Climate Change

Droughts, storms, rising seawater affecting farmlands.

Productivity Plateau

No more farmland available, no productivity gains for agribusiness.

Government Policy

Subsidies for large agribusiness, oil & gas, coal.

Common Themes for Food Security Threats

Lack of affordable & reliable **Electric Power** for smallhold farms.

- 1.2 billion people have no power (even 40% on some US Native American Reservations).

- Cannot pump water from wells, or distribute water with drip irrigation.

- Lack of farm machinery.

- Lack of access to education, to improve farm methods and reduce family size.

- Even if have lines from distant power stations, can easily be disrupted.

Lack of affordable, local **ammonia-based fertilizer**.

- Hundreds of millions of smallhold farmers cannot afford ammonia ($600+ per ton, $150 per acre).

- Liquid ammonia/urea not available for remote areas (for efficient water/fertilizer injection such as fertigation)

- Lack of Fuel (for farm machinery, vehicles, etc.)

Solution: Green Power / Ammonia Synthesis

Electric Power from Renewable Energy, esp. Solar

- New types of cells (including hybrid PV/CSP) with higher efficiency.
- Store power via generated ammonia for electricity 24/7.
- Electric power can purify/desalinate water for greater supply.

Solid State Ammonia Synthesis (SSAS)

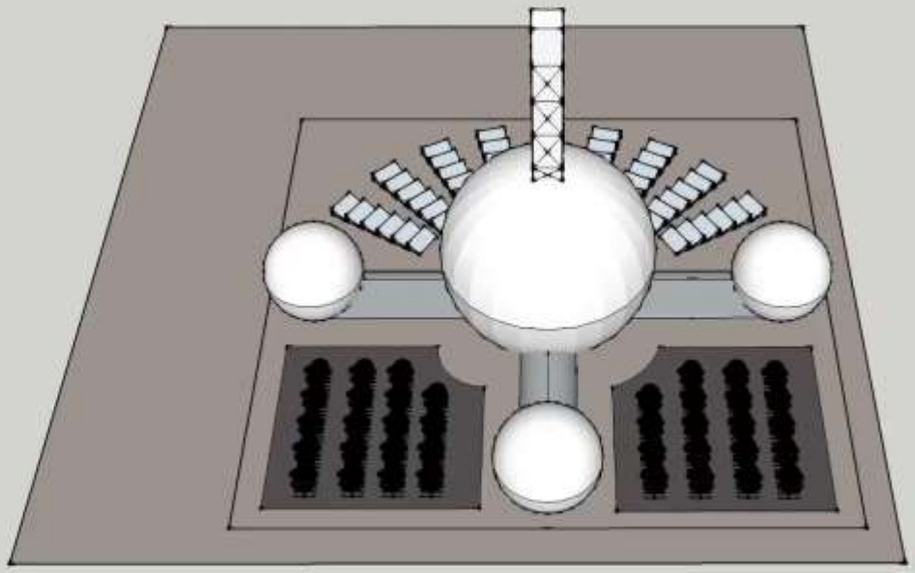
-Lower Cost

- Ammonia combined with CO_2 creates High Grade Urea Fertilizer
- Storage of Solar/Wind energy .
- Use as fuel.

Las Vegas City Hall

evrTree Energy for Good

Solid State Ammonia Synthesis



Transition Technologies

Energy → Green Ammonia → Fertilizer → Larger Crop Yields → Quality Preparation

3D Food Printing Teaching Food Secure nations to create healthy meals from natural products

Foodini
by Natural Machines

High-Efficiency Solid-State Ammonia Synthesis

- Small-scale Solid State Ammonia Synthesis
- Overall efficiency improvement of 50% over electrolysis because H2 is never made – direct water (steam) to NH3.
- Capital costs much less (~50%).
- NH3 produced at costs equal or lower than NH3 from natural gas.
- Power from Solar Generator
- Solid-State Ammonia Synthesis (SSAS) can provide advantages over existing (brown ammonia) technologies, with solar power and minimal transportation costs.
- Empowering local farm communities with solar/ammonia synthesis can raise productivity, resiliency of farmers.
- Renewable Energy can enable many other benefits, including water desalination and purification, sales and export of excess energy (as ammonia).

Haber-Bosch Ammonia Requires Natural Gas Feedstock

Natural gas leaks are **72 times worse** than CO2 as a greenhouse gas over 20 years.

The EPA estimates that **3 TRILLION** cubic feed of methane leaks annually (3.6% of global production). This is the global warming equivalent of **ONE HALF** the US coal plants.

SSAS Requires **NONE**

High-Efficiency Solid-State Ammonia Synthesis

(continued)

Fuel for Farm machinery, Vehicles, etc.

- Spark-Ignited Internal Combustion Engines
- Gasoline or ethanol blend ICEs
- Hydrogen-spiked
- Diesel Engines
- Combustion Turbines

Rapidly Improving Technologies

- Converted Biogas Generators
- Direct Ammonia Fuel Cells
- Reform to liberate H2 [2NH3 > 3H2 > N2]

Collapse

Nearly every major civilization over the last 10,000 years has collapsed from food disruption and, with few exceptions, like China, slid into oblivion. We have over a dozen major risks to food security facing each nation, and are now regularly experiencing failed states. To paraphrase a question by Lester Brown,

"How many failed states - or global food disruptions - can we have before our civilization fails?"

Conclusions

- Green small-scale and community-scale power/ammonia generation could greatly enhance food security.
- Availability of sustainable power attractive both for international marketplace and the US .
- Significant reduction in pollution.
- Availability of ammonia-based fertilizer can help avoid desertification of hundreds of square miles of land each month.
- Availability of ammonia as fuel enables added benefits, including water purification and desalination.
- This helps create improved crop yield for smallhold farmers, greater resiliency of communities against shocks .
- De-linkage of local agriculture from international oil, gas and ammonia prices reduces food price fluctuations.
- An attractive international business model that also benefits mankind!

It’s Our Time for Action

1. Cooperate- Build Alliances combining our funding skill with your technical ability

2. Recognize- Yesterday’s Climate Marches world-wide prove aggressive political will to pursue low and no carbon options for fertilizer, renewables storage, and fuels.

3. Demonstrate the reality of a 1MW SSAS in a public forum

4. Publish the data from a functioning 1MW SSAS Reactor

It’s Our Time for Action

5. Build a 20MW SSAS Reactor, preferably in Iowa, where it will attract the attention of leading contenders for both the Democratic (HRC) and the Republican Nomination (not all candidates known…except to me!)

6. Produce commercial quantities of NH3 via SSAS for fertilizer, molecular batteries, farm equipment, cars, and public transport.

7. Change policies in the US and other nations to list NH3 as a fuel

8. Convert all ammonia production from Haber-Bosch to SSAS saving 15 tons of CO2 with each ton of NH3 generated, thereby preventing 3 billion tons of carbon dioxide

THANK YOU
FOR YOUR ATTENTION!

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