

ROLE OF INNOVATION IN SUSTAINABILITY

A JOURNEY OF PERSPECTIVE, AWARENESS, ACTION

What exactly is Sustainability
A Historical Perspective, Anthropogenic Age
Energy and Materials
Engaging Society
Sustainability and Extraterrestrial life

Prepared for Sciencetech
May 18, 2015
Kenneth F Miller

SUSTAINABILITY: HOW DID I GET INVOLVED?



First 27
Years with
GE Plastics



Last 8
Years with
SABIC*



*SABIC Sustainability Reports 2011-2013; **Ecomagination is General Electric's green initiative

SUSTAINABILITY: "MAKING THING LAST"



Health



Organizations



Businesses



Objects of Culture

SOME THINGS WORTH SUSTAINING

Planet



Prosperity/Life Style



PROSPERITY COMES WITH SEVERAL PLANETARY RISKS

Human Induced
Climate Change



Non Renewable
Resource Depletion

Increasing
Energy Demand



Food and Water
Shortage

Ecological
Degradation,
Species Loss



Wastes
Bio-Persistence

Interconnected Trends/Risks all moving in wrong direction

SUSTAINABILITY: THE FORMAL DEFINITION

Sustainability: Meeting the developmental needs of the present without compromising the ability of future generations to meet their needs (economic, social, environmental)



UN Conference 1987 Brundtland Commission
“Our Common Future”

-Earth Summit, Rio 1992

-UN Millennium Goals 2000-2015 (8)

-Rio + 20, Rio 2012

-**Sustainability Development Goals 2015-2030 (17)**

UN SUSTAINABILITY DEVELOPMENT GOALS 2015



Ratification of 2015-2030 SDG anticipated by General Assembly in September

SUSTAINABILITY IS ALSO ABOUT MANAGEMENT OF RISKS

WORLD ECONOMIC FORUM 2015 RISK ASSESSMENT

Likelihood

- 1 Interstate conflict
- 2 Extreme weather events
- 3 Failure of national governance
- 4 State collapse or crisis
- 5 Unemployment or underemployment
- 6 Natural catastrophes
- 7 Failure of climate-change adaptation
- 8 Water crises
- 9 Data fraud or theft
- 10 Cyber attacks

Impact

- 1 Water crises
- 2 Spread of infectious diseases
- 3 Weapons of mass destruction
- 4 Interstate conflict
- 6 Energy price shock
- 7 Critical information infrastructure breakdown
- 8 Fiscal crises
- 9 Unemployment or underemployment
- 10 Biodiversity loss and ecosystem collapse

Categories

- Economic
- Environmental
- Geopolitical
- Societal
- Technological

A Primary Reason Why Business Must Embrace Sustainability

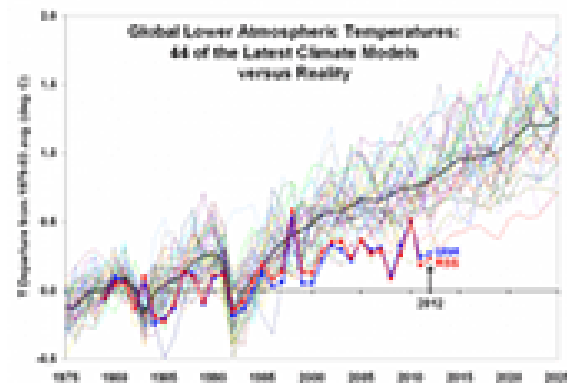
SUSTAINABILITY RISK AND HUMAN NATURE



Gradual



Out of Sight



Scientifically Complex and Debated



Conflicts with Other Priorities

Scientists Must Create Awareness, Perspective and Action

HISTORICAL
PERSPECTIVE

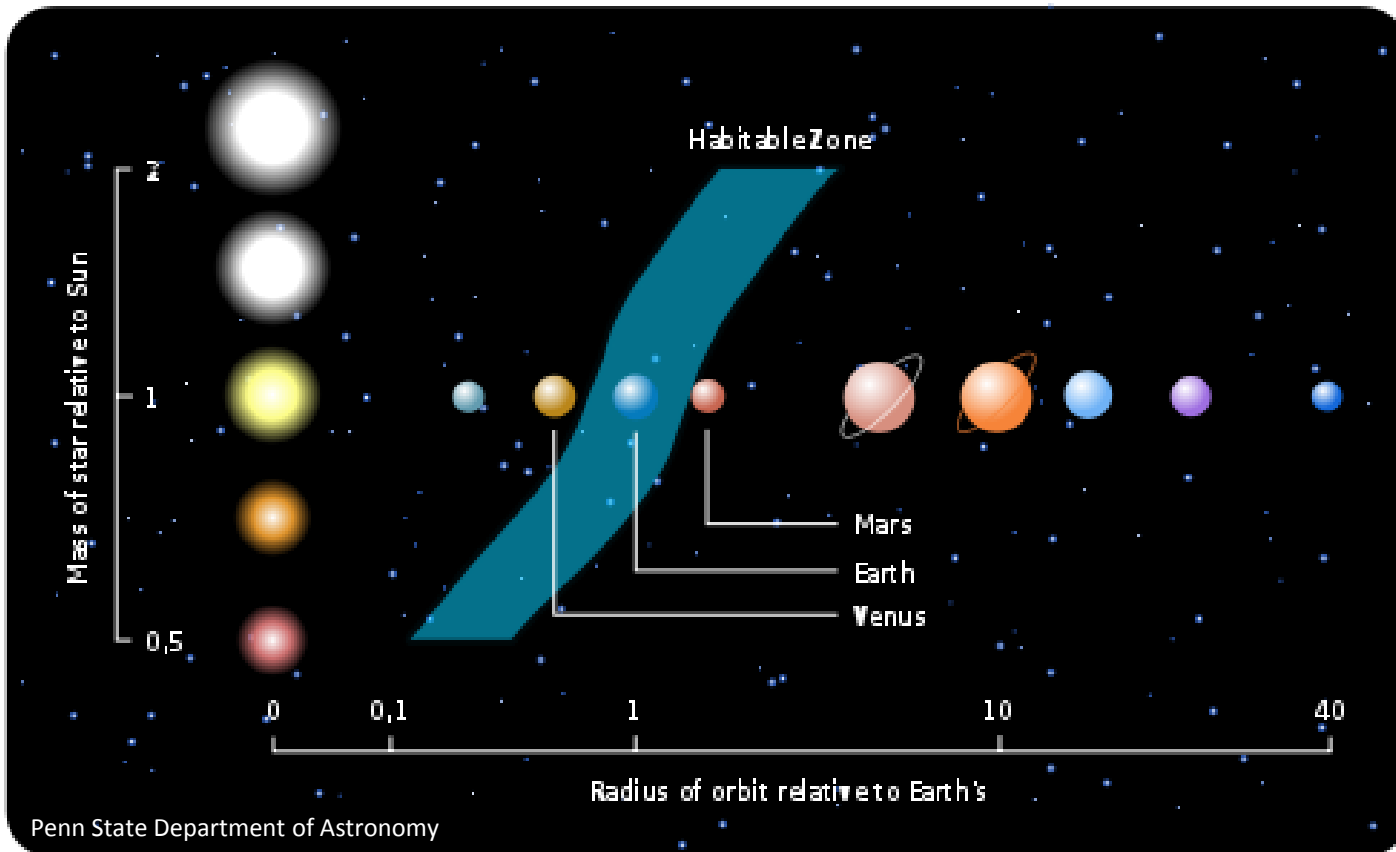
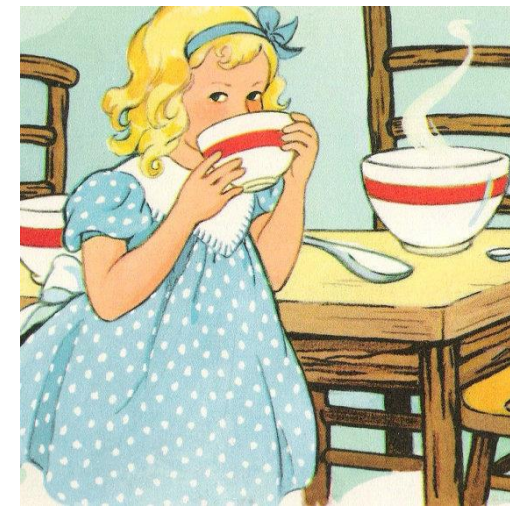
GOLDBLOCKS
CONDITION

ANTHROPOCENE
AGE

EXTINCTION IS THE
RULE. SURVIVAL IS THE
EXCEPTION.

Carl Sagan

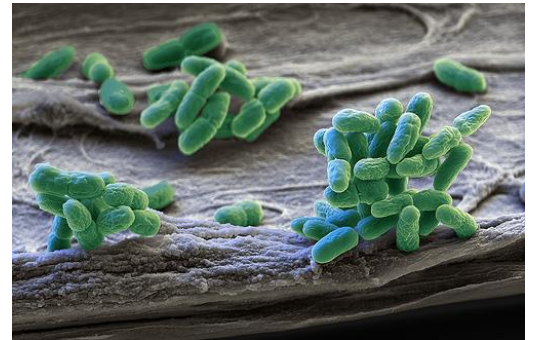
GOLDBLOCKS CONDITION



- Right type of sun
- Stable period in our solar system
- Right distance from sun
- Right size
- Iron core
- Water abundant
- Right atmosphere
- Right temperature

EARTH HISTORY: A PERSPECTIVE

• Universe	13,700,000,000
• Planet	10,000,000,000
• Life	4,000,000,000
• Oxygen Atmosphere	3,000,000,000
• Fossil Fuels	300,000,000
• Dinosaurs	200,000,000
• Mammals	65,000,000
• Humans	250,000
• Industrial Revolution	250

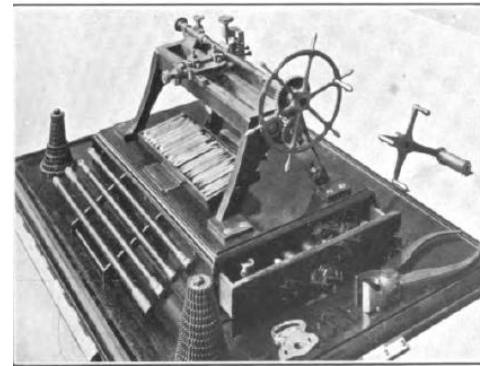


Events in Earth's Evolution/History created the Goldilocks Condition

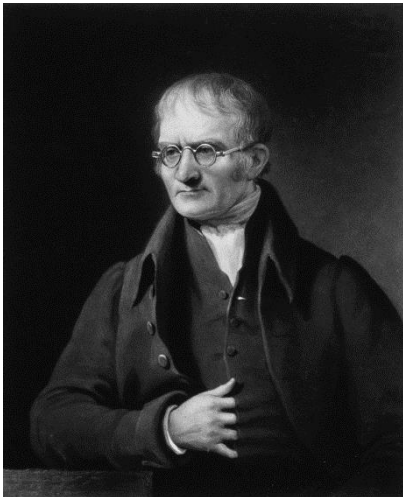
Big History Project, David Christian

INDUSTRIAL REVOLUTION CIRCA 1760-1840

The Age of Machines



The Age of Materials (Chemistry)



Dalton



Davy

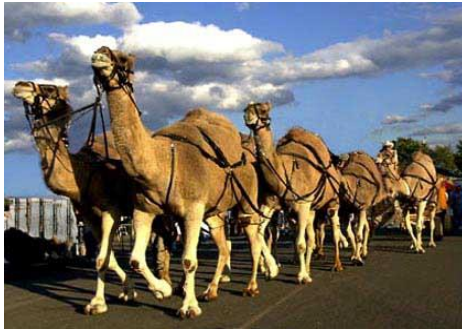


Avogadro.....

ANTHROPOCENE AGE

Anthropocene: an epoch that begins when human activities have had a significant global impact on the Earth's ecosystems.

1800



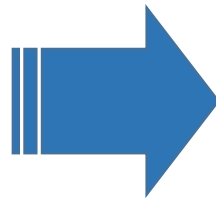
~1.0 B people; 30y avg. longevity

Human and animal muscle

Energy from sun

Materials from natural world

Human impact local/innocent



2014



>7.0 B people; >70y avg. longevity

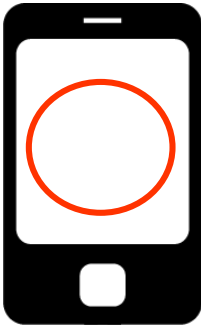
Machine driven economies

Energy from fossilized sunshine

Synthetic materials not found in nature

Human impact undermines Goldilocks Condition

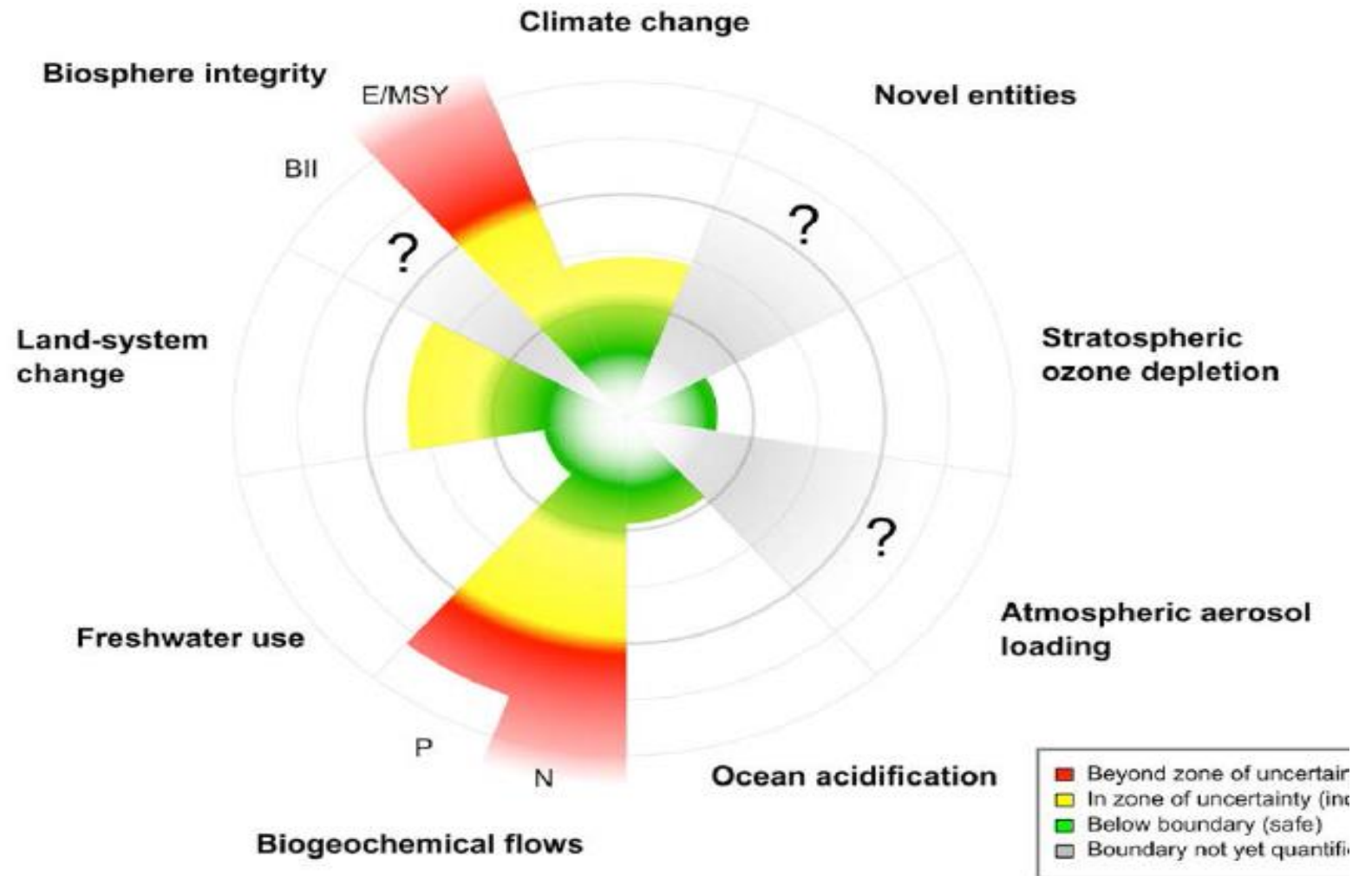
MASTERY OF THE PERIODIC TABLE



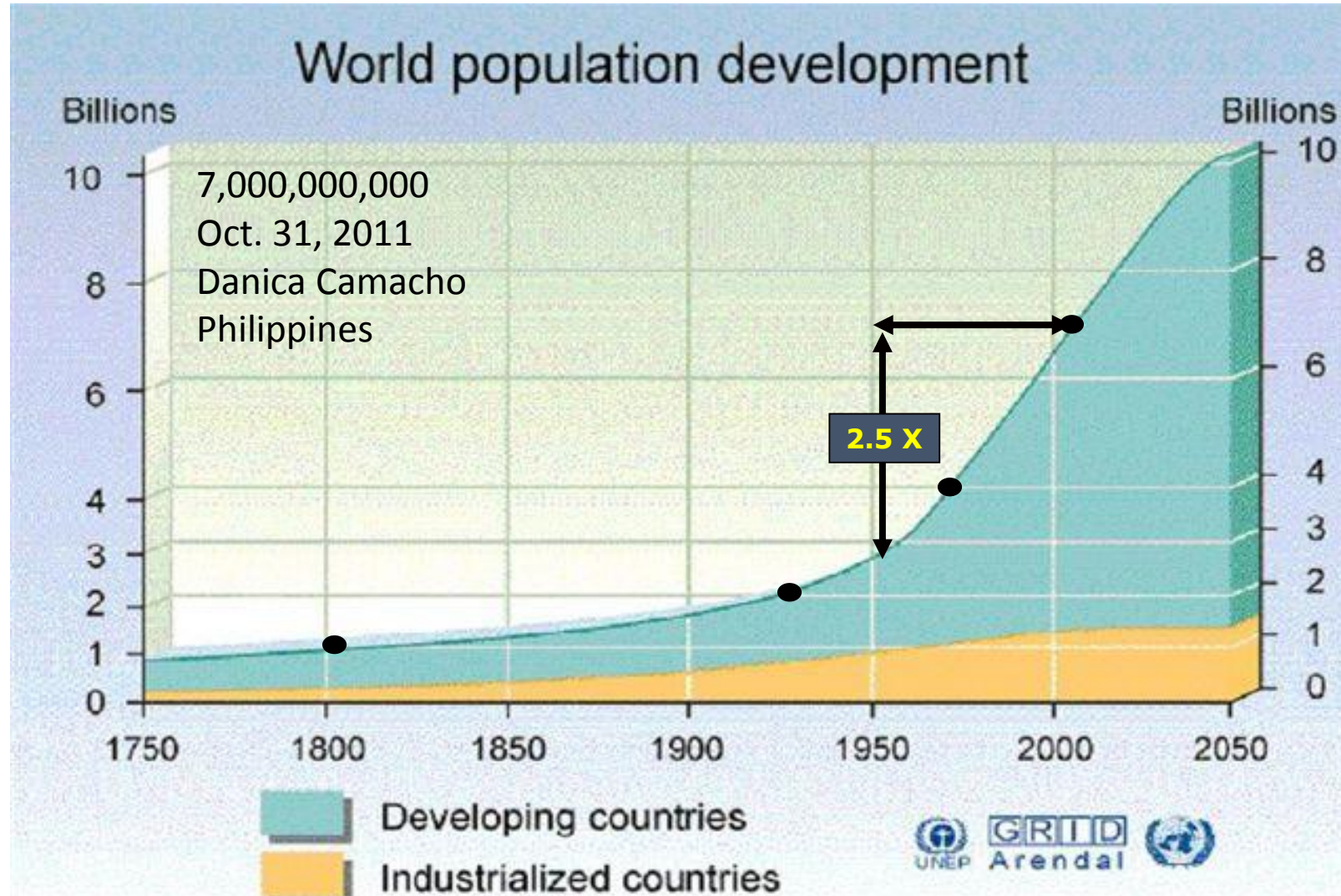
1 IA												13 IIIA		14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA	
1	H																	He	
2	Li	Be											B	C	N	O	F	Ne	
3	Na	Mg	3 IIIV	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VII	10	11 IB	12 IIB	Al	Si	P	S	Cl	Ar	
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
6	Cs	Ba	57-71	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
7	Fr	Ra	89-103	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Uut	Ff	Uup	Lv	Uus	Uuo	
		6	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	6	
		7	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	7	

PLANETARY BOUNDARIES 2015

Establish safe operating boundaries within intrinsic bio-physical processes for **Population** and **Economic** Expansion



ANTHROPOGENIC PERIOD (AGE OF MAN)



CONSUMPTION AND POPULATION TRENDS

Indicator	1992	2012	% Change
• Population	5.5B	7B	+27

Consumption is out pacing population

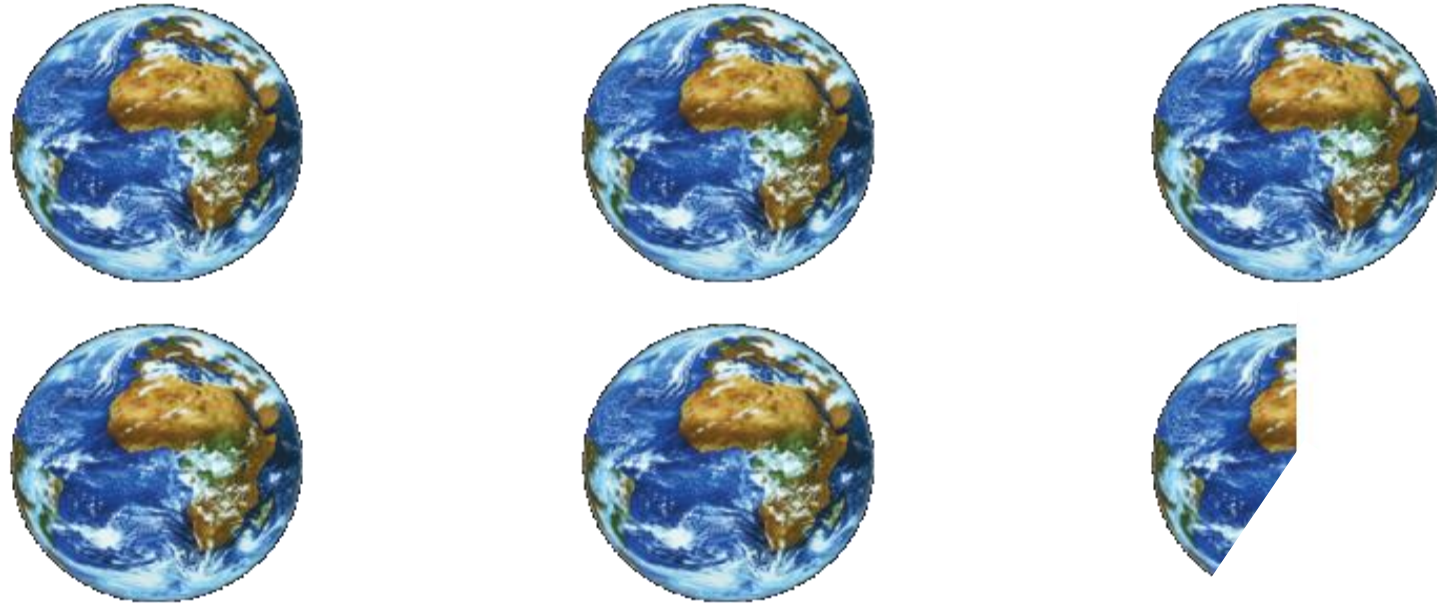
• Plastic	116 MMT	>265MMT	+130
• Natural Res	42 Billion T/y	60 Billion T/y	+43
• Energy	8.8K MToe	13.5K MToe	+50



UN, Rio+20

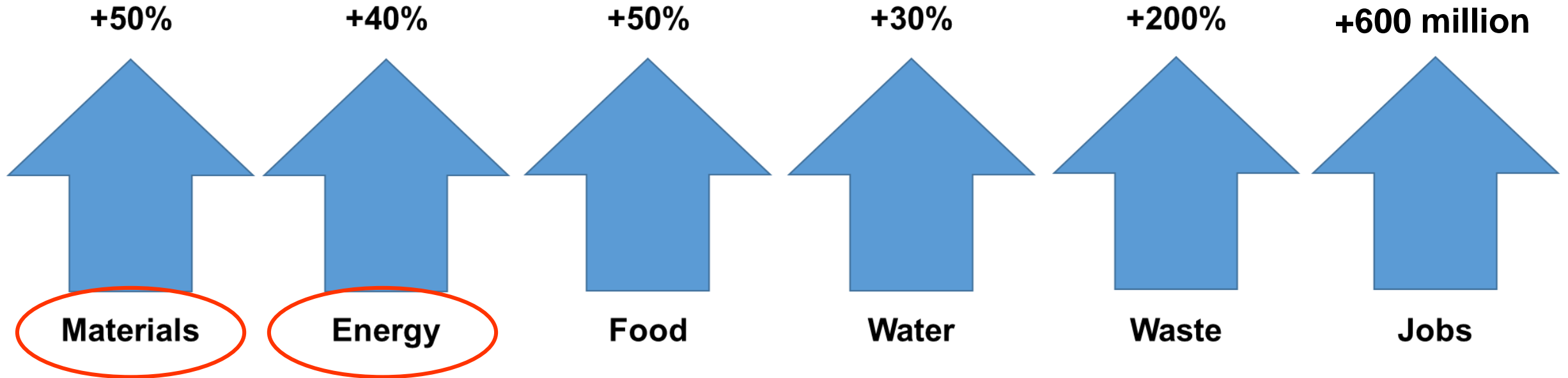
3 Billion people will enter the middle class in next 30 years

AMERICANS ARE LEADING THE CONSUMPTION COMPETITION



If everyone consumed like Americans, we need 5.4 earths to support

HUMANITY'S NEEDS BY 2025-2030 ARE OVERWHELMING



Meeting society's needs outside of planetary boundaries is making the 21st century very risky

ANTHROPOCENE AGE: WILL HUMANS RESEMBLE DINOSAURS OR LOCUST?



Energy



ENERGY

The Good News is that Energy is Essentially Infinite

Energy Intensity

Earth's Annual Sunshine

Joule

10^{25}

Earth's Fossil Fuels

10^{23}

Annual Human Energy Consumption

10^{20}

1 Million Tons of Coal

10^{16}

1 Gallon of Gasoline

10^8

$> 100,000 \times$

- **Fossil Fuels not a short term supply issue**
- **Affordable technology is emerging**
- **The issue is the consequences of Fossil Fuel Use**



HOW MUCH ENERGY HAS BEEN AND WILL BE REQUIRED ?



Myles Allen

Since Industrial Revolution

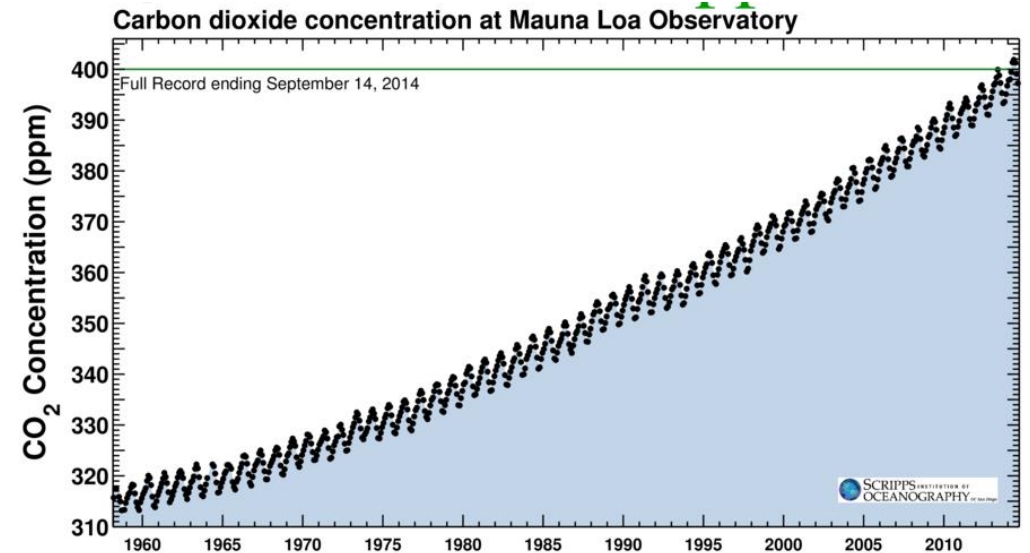
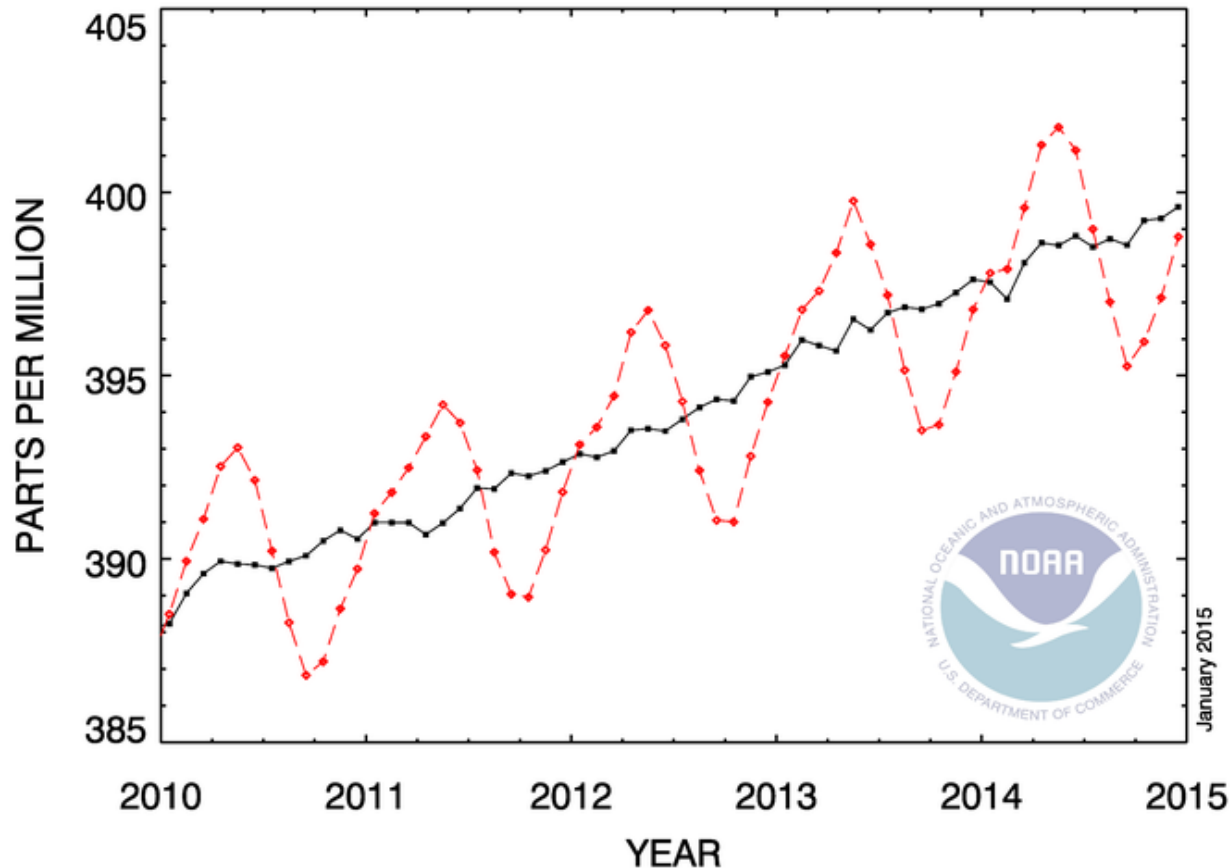
- 0.5 Trillion Tons of Carbon = Coal train wrapping equator 1690 times
- 1.8 Trillion Tons of CO₂ + Heat
- 0.5 Trillion Tons needed by 2050

WHERE DOES THE CO₂ GO?

KEELING CURVES*

Recent Monthly Average Mauna Loa CO₂

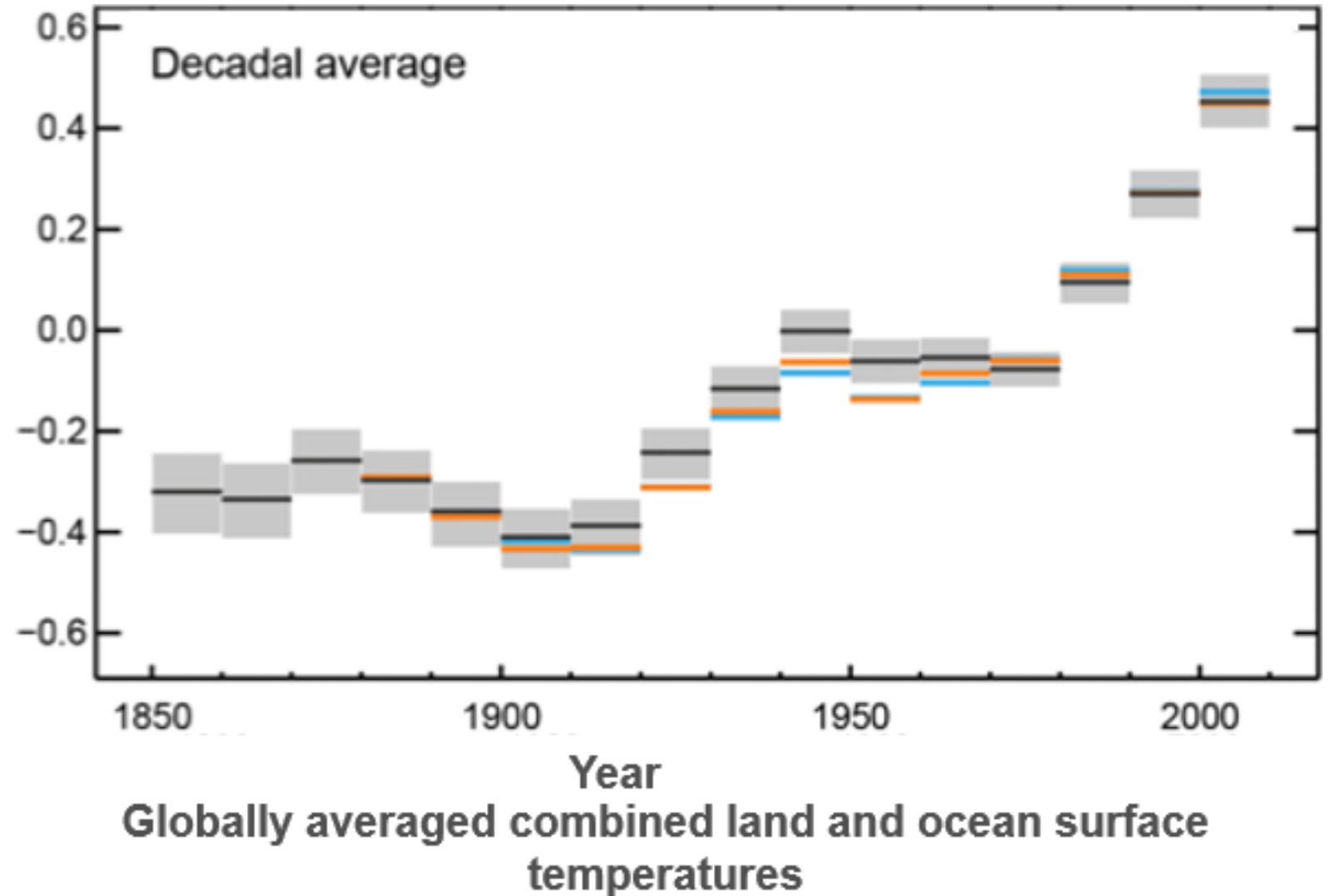
December 2014: 398.78 ppm
December 2013: 396.81 ppm



* Scripps Institute of Oceanography. NOAA

“HUMAN INDUCED CLIMATE CHANGE IS INDISPUTABLE”...IPCC

2014: 0.69 C degree > 20th century average ●



2014 Hottest Year on Record

Since 2000: 9 out of 10 hottest Years on Record

Over the last 20 years

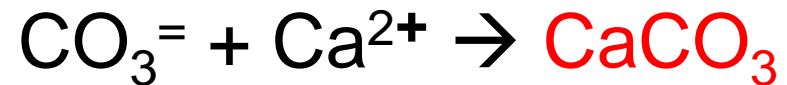
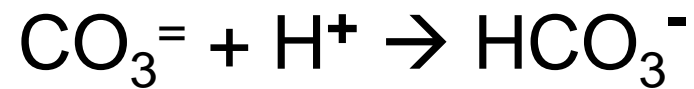
-Ocean levels rise 5 cm

-Ocean Temp. rises 0.3 C°

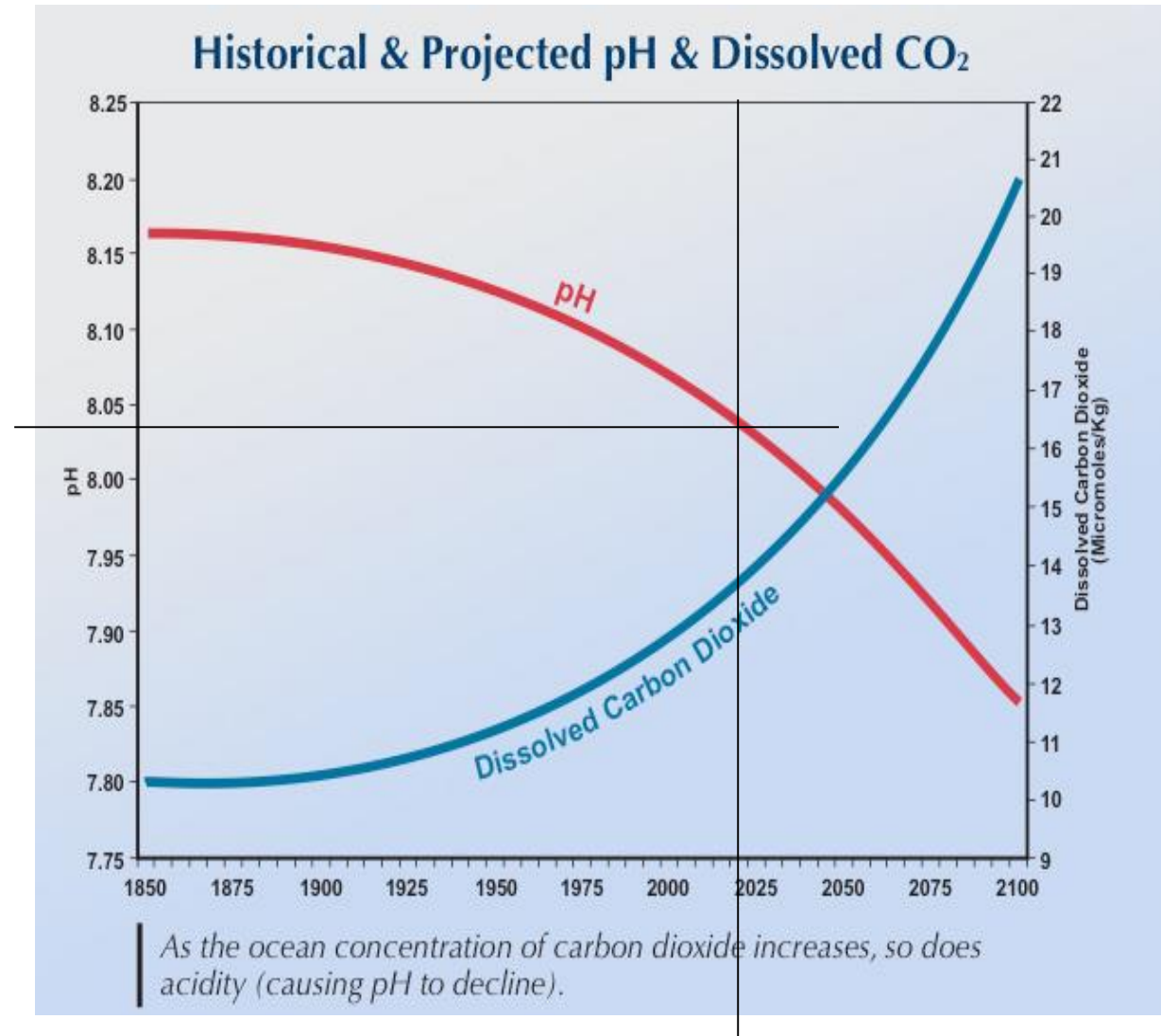
-Sept. Arctic Ice diminishes 35%

THE OCEAN CHEMISTRY IS CHANGING

- 25% of CO₂ ends up in the Ocean



- Ocean food chain depends on organisms to utilize CaCO₃



HUMAN IMPACT ON GOLDBLOCKS CONDITION

Human Influence is at the ppm level with dramatic effect

Composition of Atmosphere

- N_2
- O_2
- H_2O
- Ar

- CO_2
- O_3
- SO_x, NO_x



Mario Molina

Understanding and Successful Action demonstrated !

ALTERNATIVE VIEWS

- Heartland Institute.com
- Climate Depot.com
- Christopher Monkton
-
-
-



Materials

Unlike energy, our planetary resources are fixed...

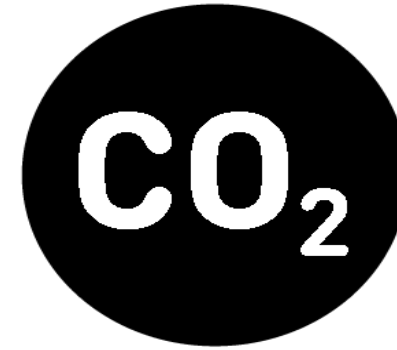
with one big exception.



BASIS OF OUR GLOBAL ECONOMY TODAY



+



+



THE LINEAR ECONOMIC (LE) MODEL

Take



Make



Consume



Dispose



**Linear Economy Model is totally embedded in our culture, technology and businesses,
It has relied on:**

**Abundance and
Low Cost**

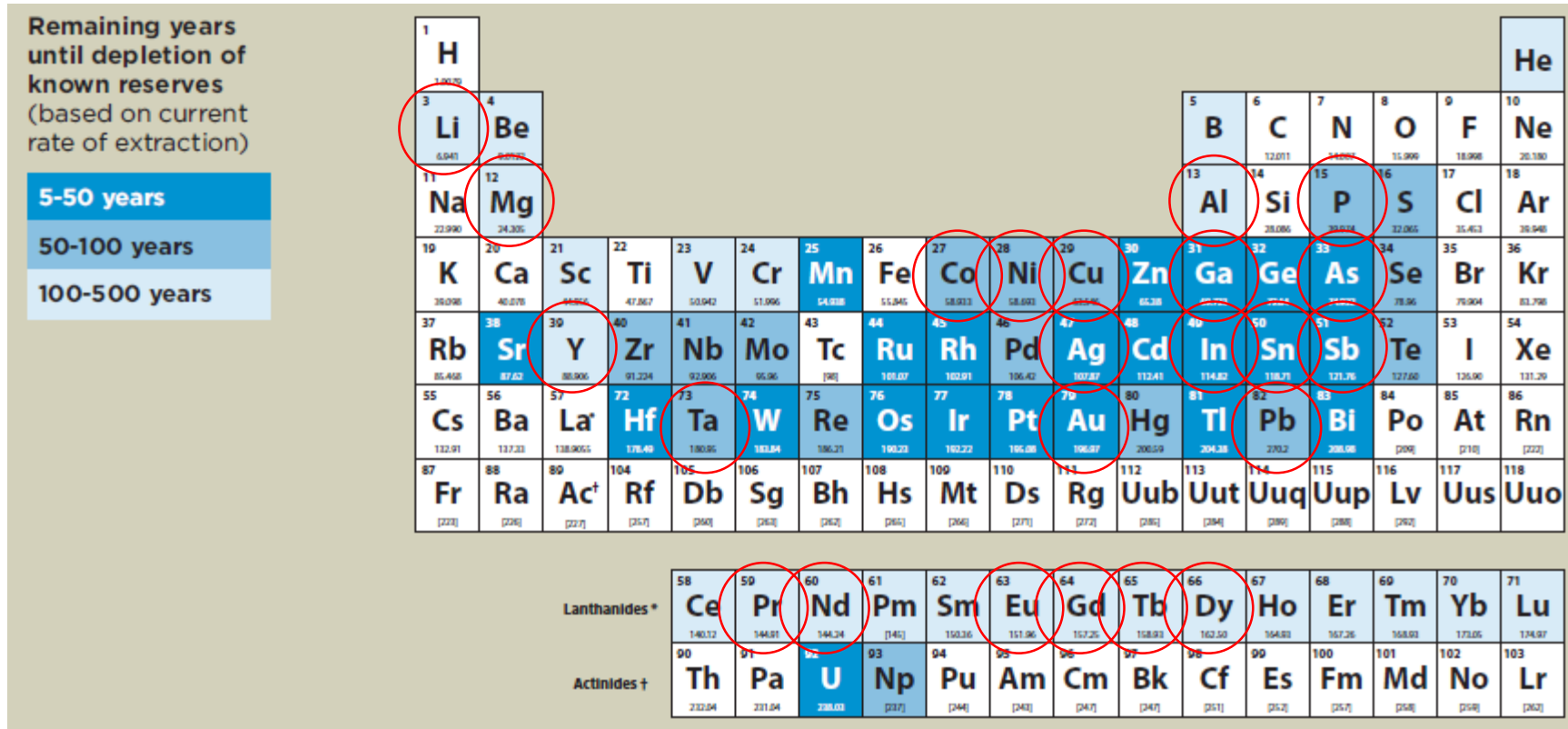
**Increasing
Efficiency**

**Growing Global
Demand**

**Convenience
Low Cost**

LE has delivered: prosperity, amazing innovation, and global supply chains!

MATERIALS, UNLIKE ENERGY, ARE FIXED / FINITE

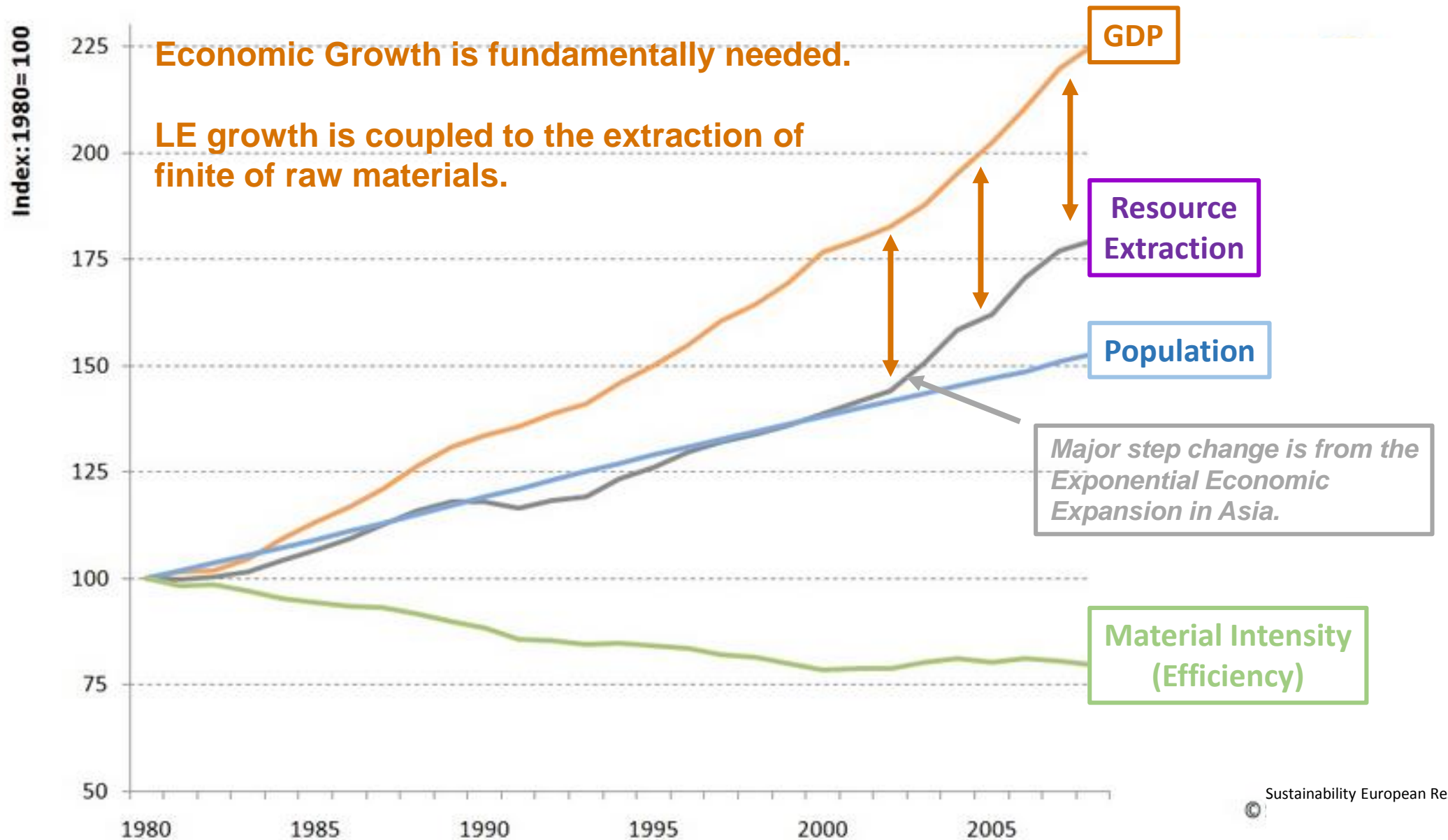


Cell Phone

Scarcity and security are already major issues for many economies

* Toward a Circular Economy, 2014, Ellen MacArthur Foundation

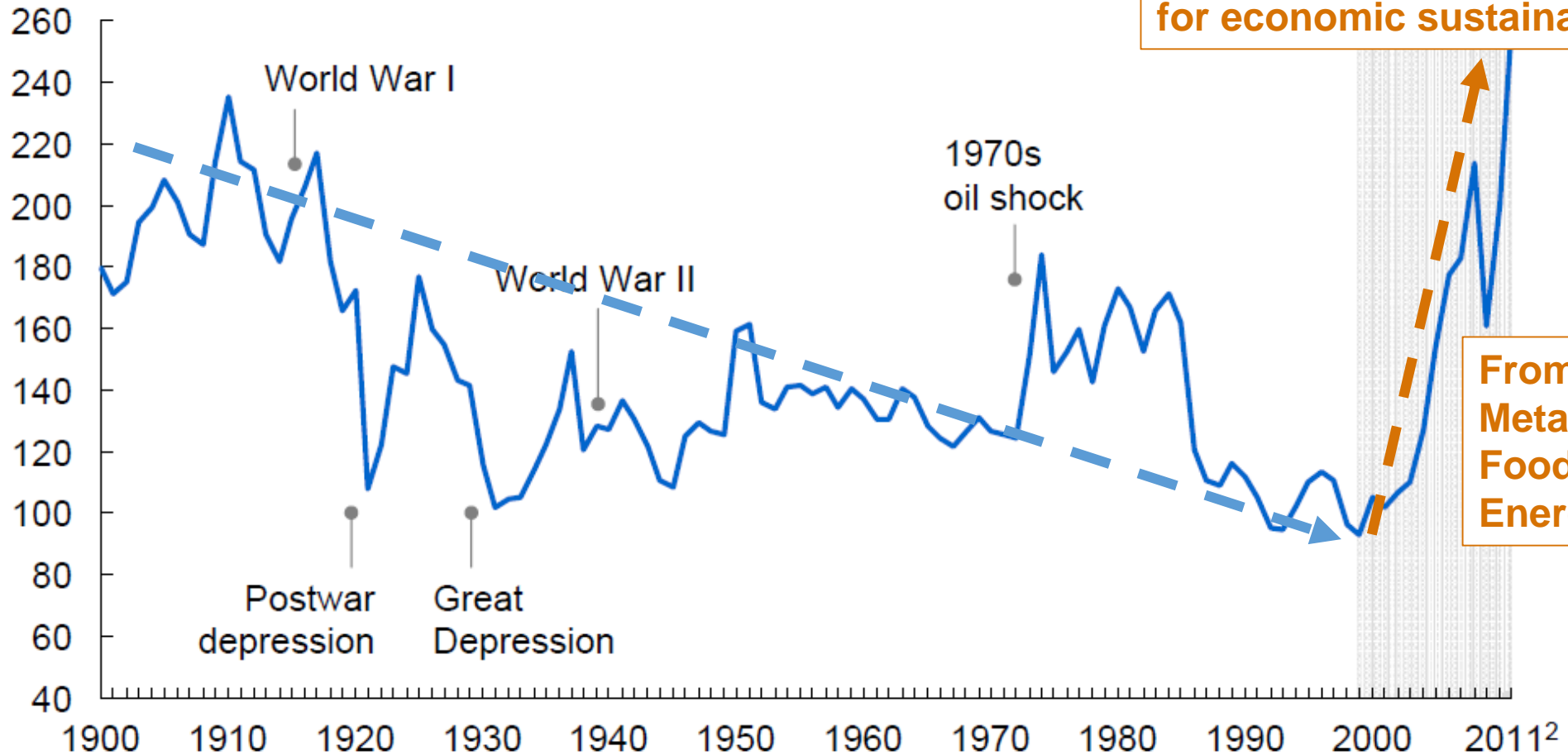
THE LINEAR MODEL AND SUSTAINABLE ECONOMIC GROWTH



SURGING GLOBAL DEMAND IS FUNDAMENTALLY SHIFTING *

Commodity prices have increased sharply since 2000, erasing all the declines of the 20th century

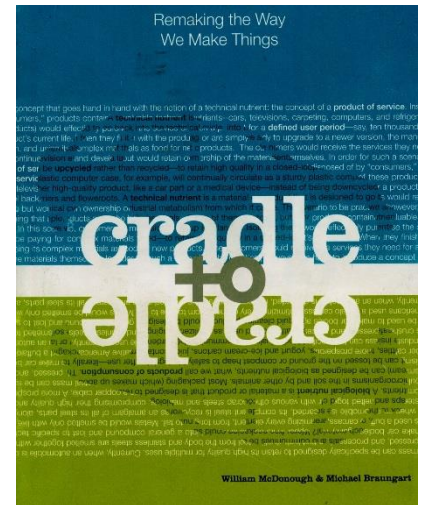
MGI Commodity Price Index (years 1999–2001 = 100)¹



*McKinsey Global Institute, Resource Revolution, Nov 2011

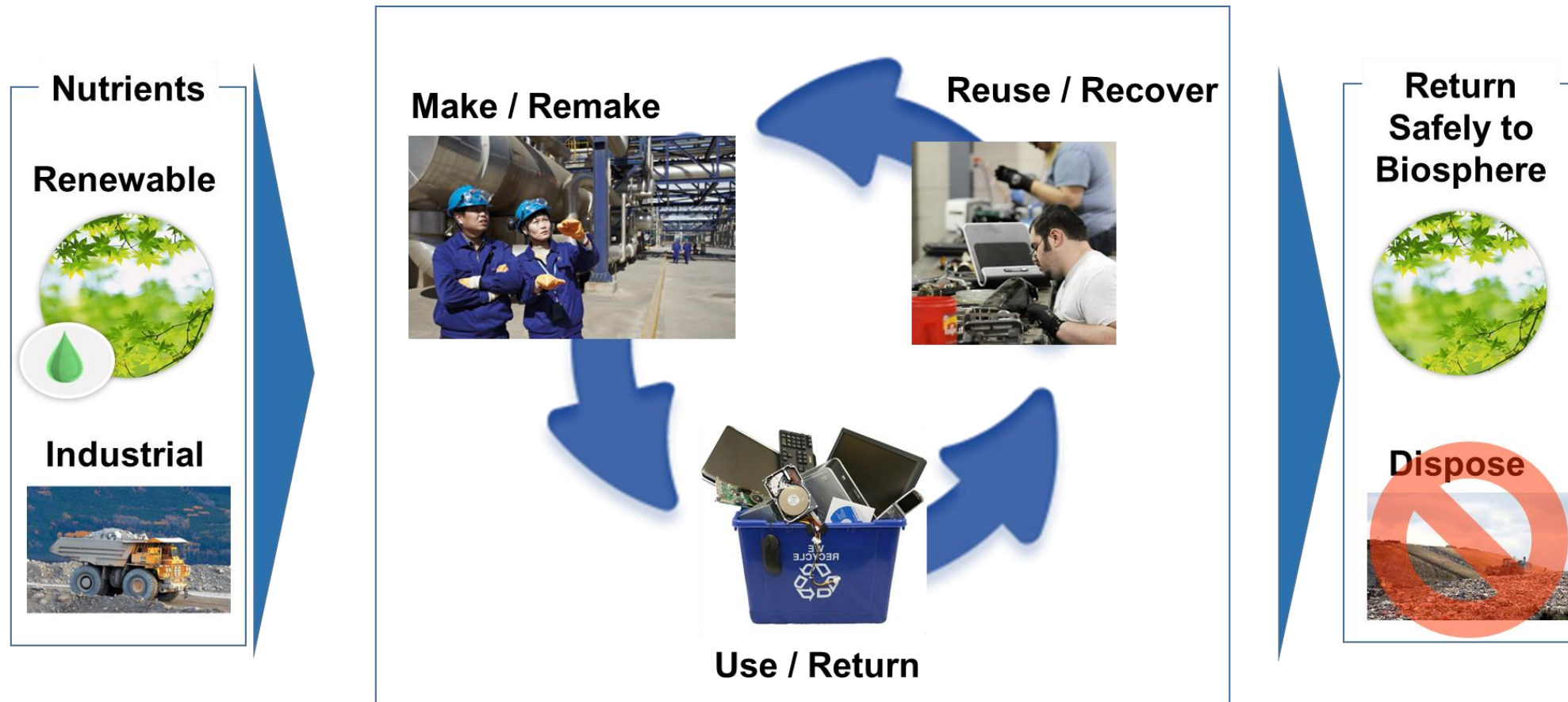
THE CIRCULAR ECONOMY(CE) MODEL IS THE ALTERNATIVE

- Inspired by Nature's sustainable design
- Restorative/regenerative by design
- Decouples prosperity from consumption
- Focused on **commerce** as the engine for change
- Provides for jobs, saves energy, eliminates wastes



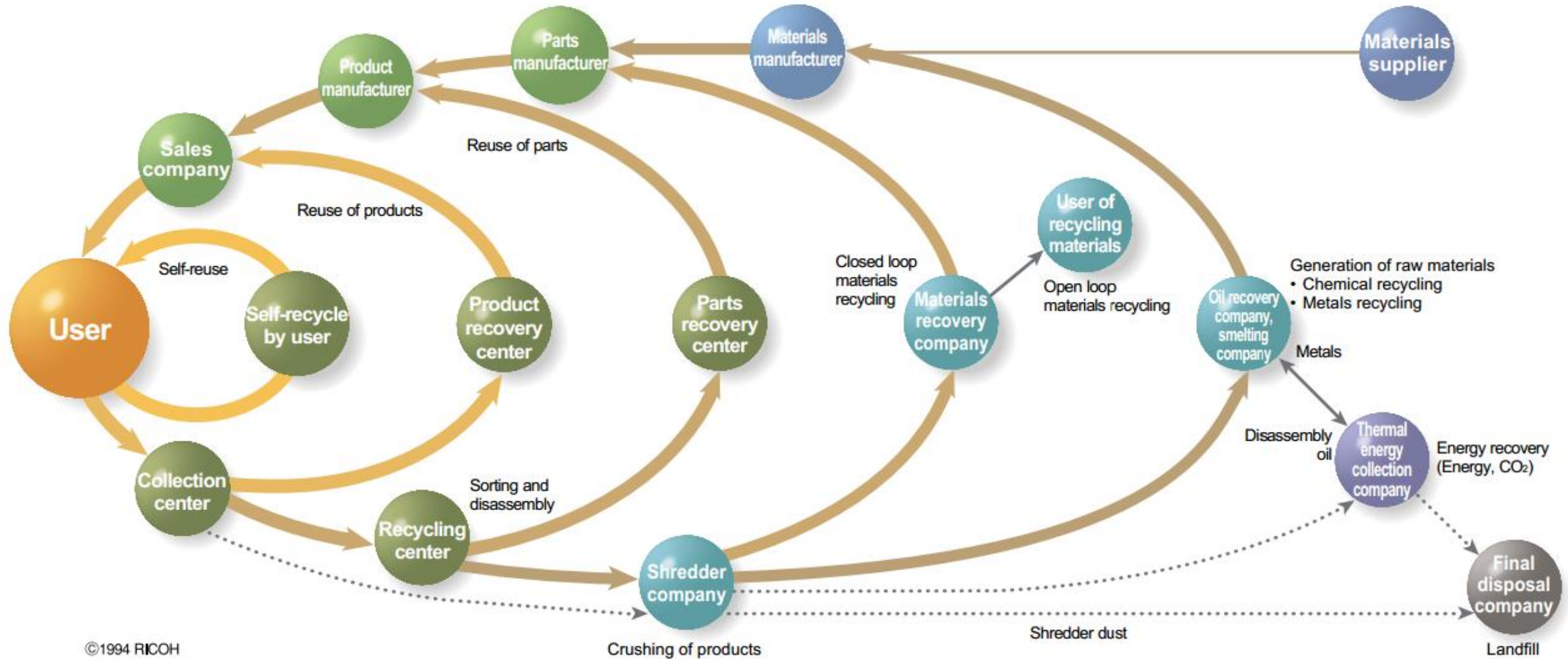
THE RISKS OF FINITE RAW MATERIALS CAN BE REPLACED BY RENEWABLE ABUNDANCE

THE BASICS OF THE CIRCULAR ECONOMIC MODEL



FLOW BACK/RESTORATIVE PROCESS ARE KEY

The Re's: Re-Use, Re-pair, Re-Manufacture, Re-Cycle, Re-Cover RICOH Comet Circle



DURABLES PRODUCT SEGMENT EMBRACING CE PRACTICES



Caterpillar

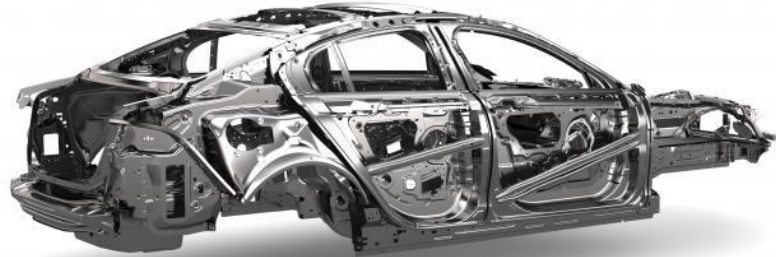
- Since 1973, nine locations. Increased profit margin over new
- 65% of cost is materials, saved with remanufacturing.
- 50-60% of the cost and increased profit margin

Renault Choisy-le-Poi plant

- In 2012, 200,000 components remanufactured/100 M Euros revenue

Jaguar / Land Rover

- Aluminum(Al) now the material of choice, use 50→75% recycle
- Sole Supplier relationship with Novalis to achieve fully recycled Al exterior
- Cars designed for disassembly, all parts labelled by composition



RICOH

- Disassemble 200,000 copiers per year
- GreenLine™ product line of remanufactured copiers is 2x the margin of other new products and reaches non-traditional market segments

FAST MOVING CONSUMER GOODS SEGMENTS ARE MUCH TOUGHER

PLASTICS AND NON DURABLE VALUE RECOVERY

• Re-Use, Repair	Some consumer products	Containers, DVDs....
• Re-Manufacture	A few durable parts	Automotive. Info Mgmt
• Re-Cycle (closed / open loop)	Many applications/low volume	US(7%)* EU(26%)**
• Re-Cover (chemicals)	Condensation Polymers	PET, N6
	Gasification/pyrolysis	Developmental
• Re-cover (energy)	Incineration, steel, cement	US(10%)* EU(36%)**
• Landfill	When Tipping Fees are low	US(83%) EU(38%)**
• Litter	Plastic Soup	~3 % but big effect

* 2011 data, Nickolas J. Themelis and Charles Mussche, Columbia Univ. EEC

** Plastics Europe

PRODUCT OWNERSHIP: A CHANGE OF PERSPECTIVE

- Should **consumers/users actually own the materials** in the Life Cycle?
- **Extended Producer Responsibility** ensures good reverse flow products back to retailers and manufacturers



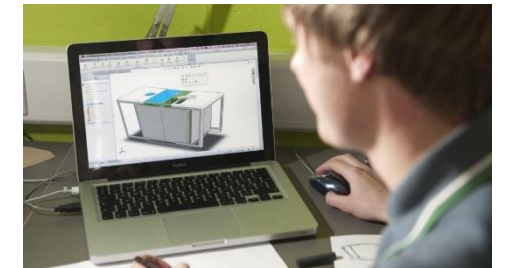
- **Service and Leasing** relations focused on performance vs ownership

CIRCULAR ECONOMY REQUIRES RETHINKING ABOUT DESIGN

Design features which enable restorative technology

- More durable
- Repairable/reusable
- Easy to disassemble, labelled as to composition
- Standardized and transparency of composition
- Simpler/pure material use
- Integrated value chain
- Restorative technology and loops that cross over value chains

A strategy for recovery needs to be designed into products



Engaging Society

"With public sentiment,
nothing can fail:
without it, nothing can
succeed."

Abraham Lincoln; 1859



Global Citizens
2015
Earth Day



April 28, 2015, Vatican City²²

Protect the Earth, Dignify Humanity. The Moral Dimensions of Climate Change and Sustainable Development



Papal Encyclical Summer 2015 reflecting on the moral dimensions of climate change and sustainable development

- **Care for creation**
- **Integral human development**
- **Concern for the poor**

LIVE EARTH

2015

ROAD TO PARIS

June 18th
7 Continents
1 B People

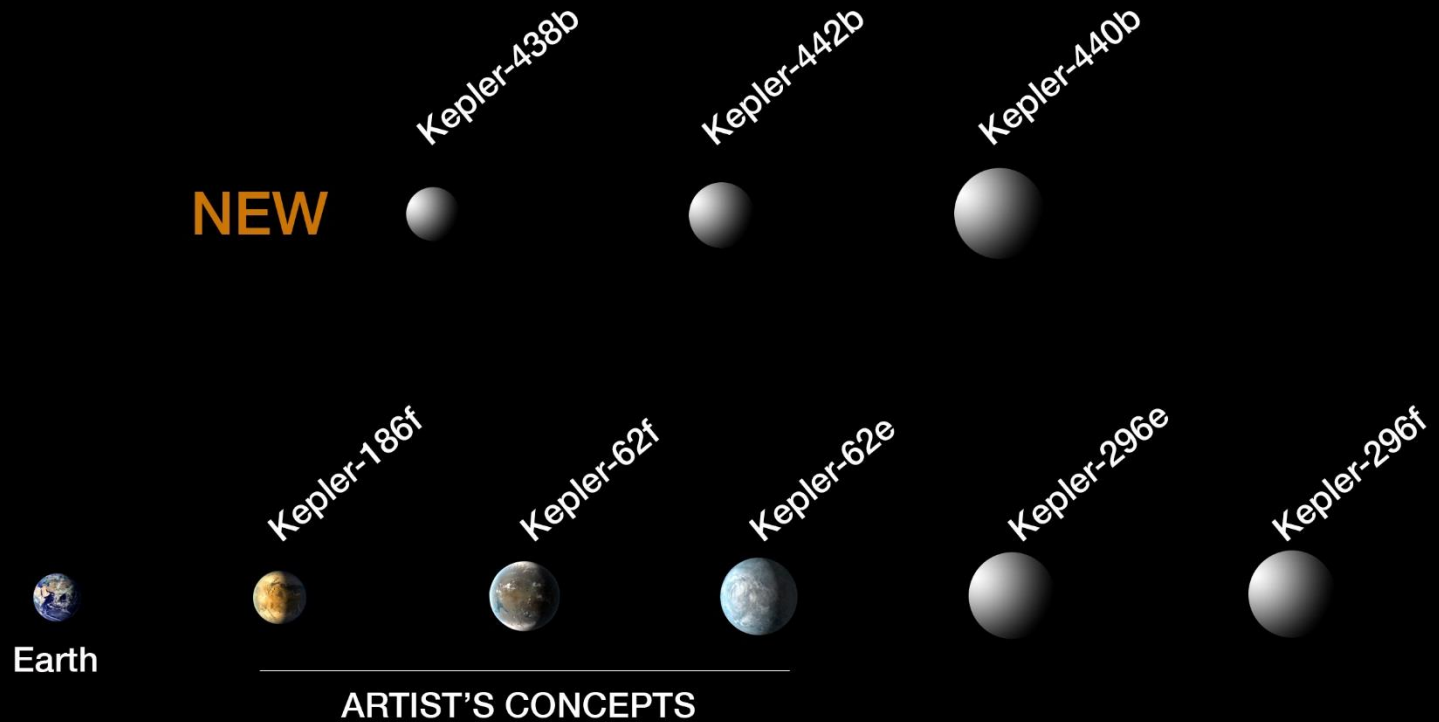
2015 WEF Davos

Extra Terrestrials and Sustainability

‘We will find evidence of extraterrestrial life within a generation. We know: what to look for, where to look and we have the tools’ NASA

- 4000 suspected planets
- 1000 confirmed stars
- Suns without planets are the exception
- >10²² stars in Universe

NASA Kepler's Hall of Fame: Small Habitable Zone Planets *As of January 2015*



NASA TRAVEL POSTERS FOR REAL EARTH LIKE EXO PLANETS



The Humans are Coming

ARE WE ALONE? IS THERE INTELLIGENT LIFE OUT THERE?

A yes or no answer has profound social, theological, scientific, sustainability implications



If the answer continues to come back **No**, then we know just how special we are!



If the answer is **Yes**, then will we be proud of our planetary stewardship?



LOOKING FOR A NEW HOME?



MAY BE TIME TO GET SERIOUS ABOUT
TAKING CARE OF THE ONE WE HAVE.

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