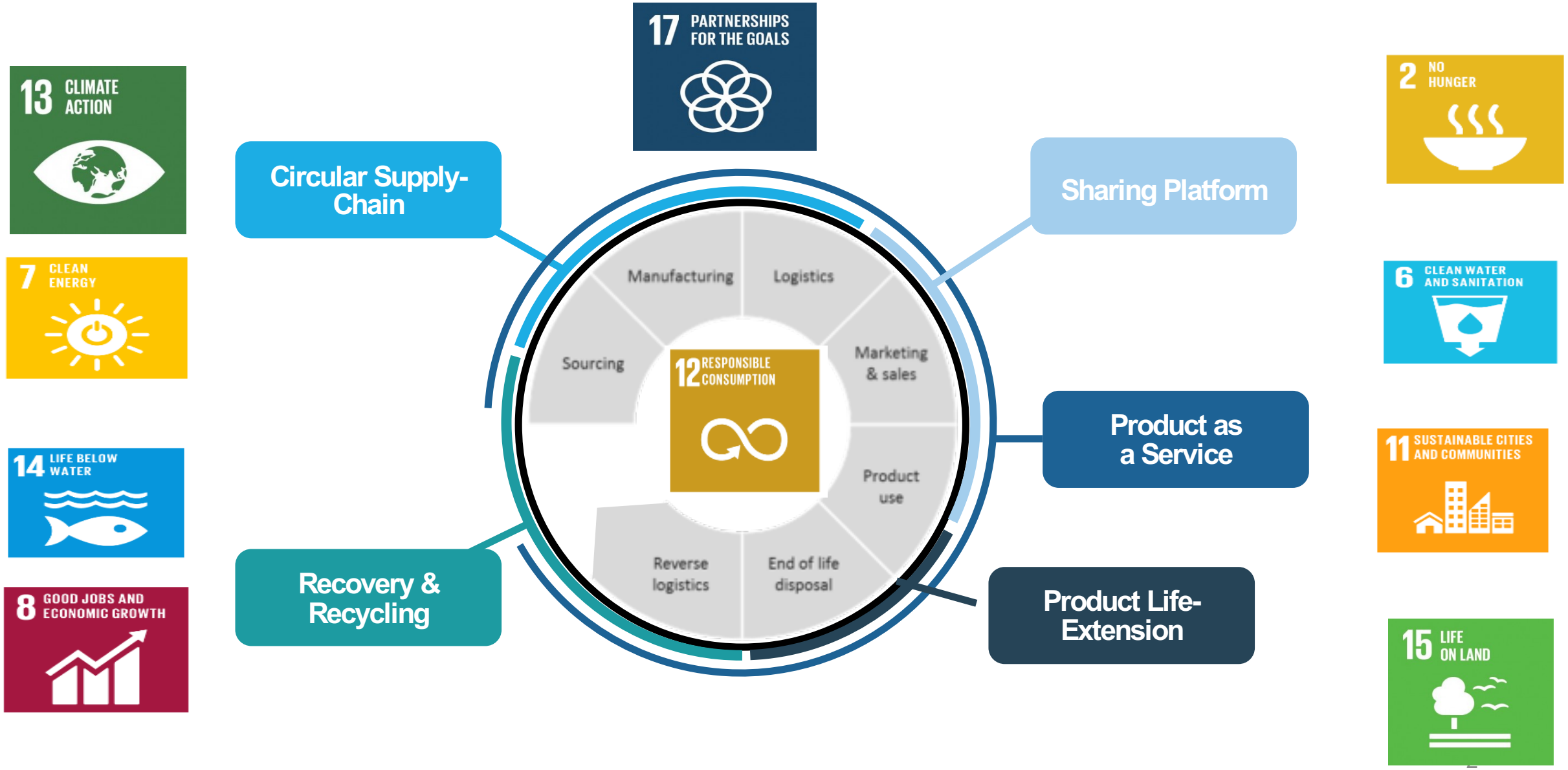
HOLLAND CIRCULAR ECONOMY WEEK (HCEW) 2018

Elmer.rietveld@tno.nl

SHARING INNOVATION

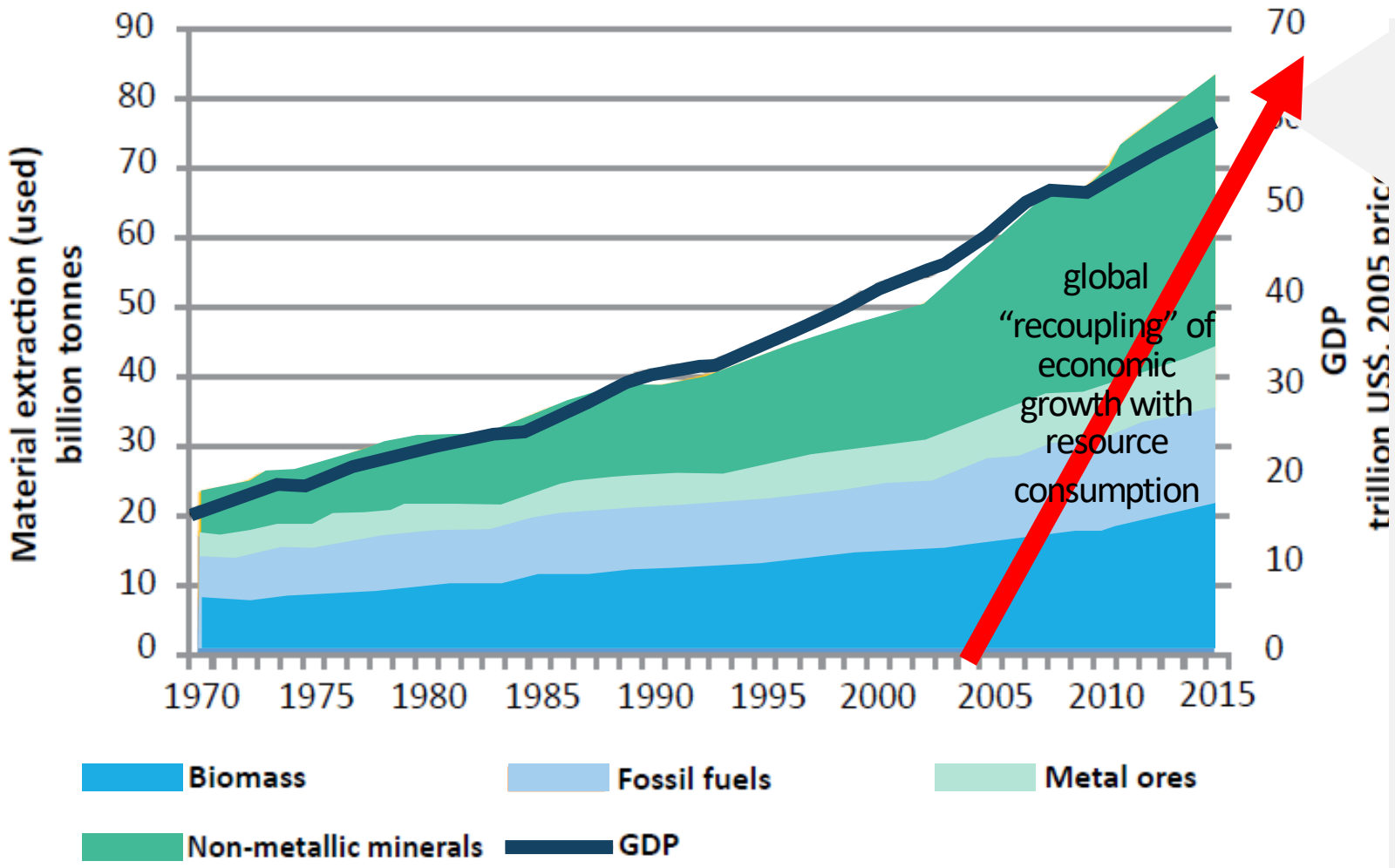
Accelerating Circular Economy



Personal Background

- Serving as Circular Economy Fellow at the World Resources Institute and Senior Advisor on the Platform for Accelerating Circular Economy (PACE) in partnership with the World Economic Forum.
- Senior political official in the Obama Administration, served the USEPA Assistant Administrator
  - Led the effort to advance the transition to a circular economy through a life-cycle based sustainable materials management approach as a key effort to advance climate change mitigation.
  - Established public-private partnerships with the food sector to achieve SDG 12's goal of reduce food waste by 50% by 2030, and with the electronics sector to drive 100% of used electronics recycled to certified recyclers
  - Represented the U.S. (Obama Administration) at G7 deliberations that led to the formation of the G7 Alliance for Resources Efficiency
  - Led G7 engagement with manufacturers to identify best practices to advance resource efficiency and circular economy in the supply chain.
  - Advanced President Obama's Climate Action Plan by integrating climate change strategies into office's programs including adaptation plans to address consequence of more intense, frequent storms and sea-level rise.

The Urgency to Decouple Raw Materials from Economic Growth



Raw material demand is projected to **double** by 2050 just to maintain current levels of economic growth.

- *Accelerating GHG emissions, biodiversity loss and water scarcity*
- *Growing global resource consumption*
- ***Asia -Pacific has increased its global share of material use from around 25% in 1970 to above 50% in 2010, while becoming a net exporter of materials through large exports of manufactured goods which are mostly consumed in Europe and North America***

The Journey from Waste Management to Circular Economy

The historic effort to reduce "waste" effectively focused on optimizing the linear economy.

This is currently embedded in international agreements and national/subnational laws and budgets.

Externalities: What are the Real Costs of Environmental Damage?

- "Costs of pollution, ecosystem depletion and health impacts have grown steadily."
  - Now exceed $ 1 trillion/year for US companies - ~equal to 6.2% of GDP.
  - $3 trillion/year for global companies.

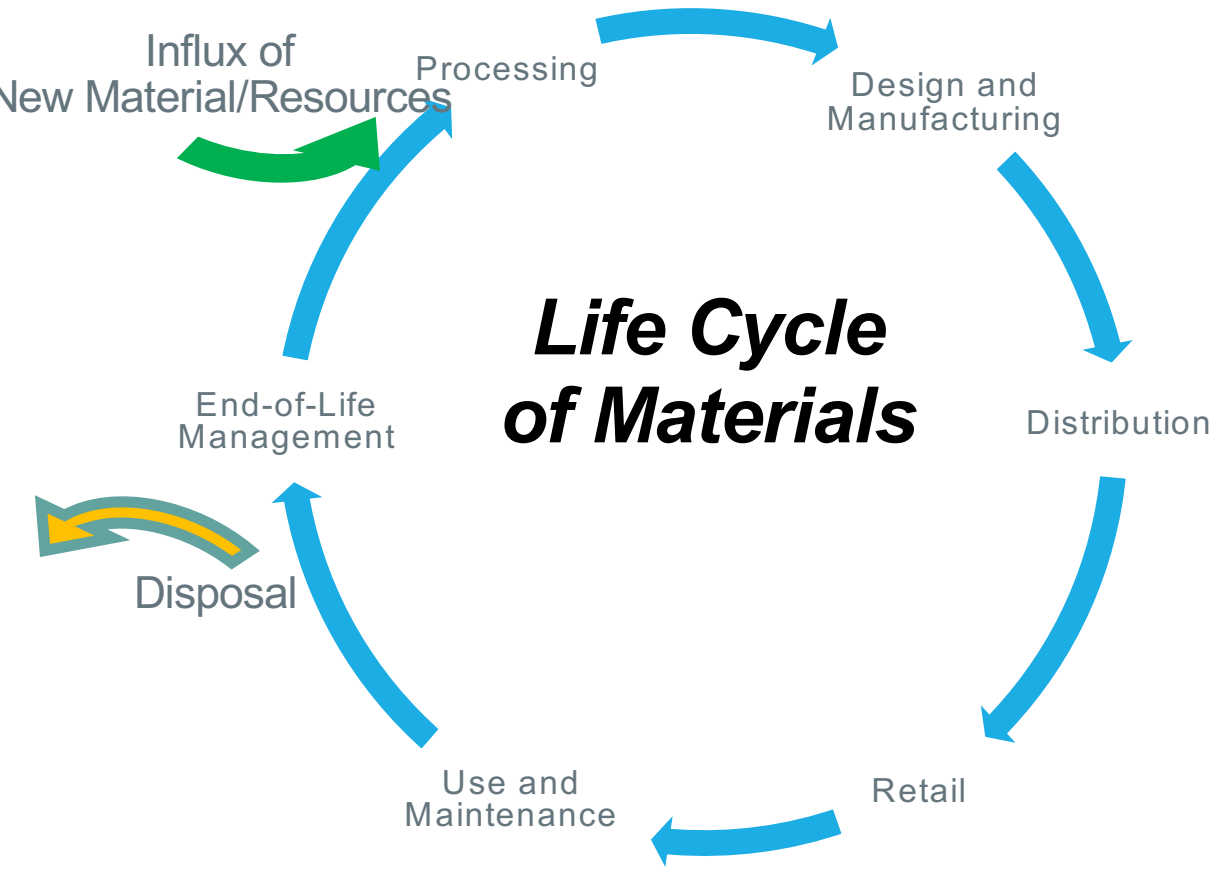
- **Access to life cycle information helps us better understand the real costs associated with the products and services we demand.**

Source: State of Green Business 2015 by Joel Makower and the editors of GreenBiz.com

Circular Decisions Require Life Cycle Thinking

- Life cycle information offers greater “return on investment.”
  - Prioritizing and strategic planning.
    - Life cycle information can help target program resources to where they may be most effective (i.e., hotspots with real opportunities) in achieving significant environmental impact reductions.
  - Challenging preconceived ideas about where and how agencies should target their efforts and policy approaches to mitigate environmental issues.
  - Avoiding unintended consequences.
  - Identifying key partners and stakeholders

"An approach to serving human needs by using/reusing resources productively and sustainably throughout their life cycles, generally minimizing the amount of materials involved and all associated environmental impacts." ***Sustainable Materials Management: The Road Ahead, EPA (2009)***



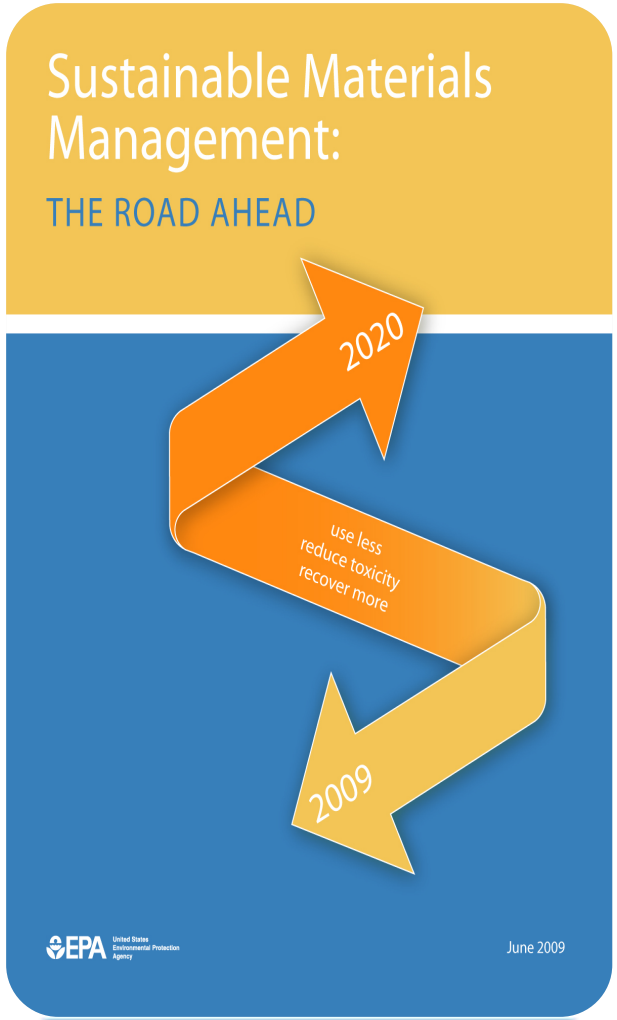
The framework examined 480 materials, products and services that underlie the U.S. economy

The materials, products and services were examined:

Across 17 environmental criteria: abiotic depletion, **land use, global warming**, ozone layer depletion, human toxicity, freshwater aquatic toxicity, marine aquatic toxicity, terrestrial ecotoxicity freshwater sedimental ecotoxicity, marine sedimental ecotoxicity, photochemical oxidation, acidification, eutrophication, **material use, water use, energy** use and material waste.

From three material system perspectives: business perspective, consumer perspective and direct impact or "hot spot" perspective.

U.S. EPA Transition to Life Cycle Based Decision making



- Identified top materials, products and services with the greatest opportunity to impact the environment through sustainable approach to materials in key sectors including:
    - **textiles,**
    - **metals/electronics**
    - **construction and development**
    - **forestry**
- Report also had specific recommendations for Government:
    - Promote efforts to manage materials and products on a life cycle basis
    - Build capacity & integrate materials management approaches in existing government programs.
    - Accelerate the broad, ongoing public dialogue on life cycle materials management

Harmonizing Regulations to Advance Circular Economy: From Waste Management to Valuable Materials

- EPA's amended recycling regulations recognizing the economic incentives manufacturers have for materials reuse and recycling in their production process

- Removed from "waste" definition:
  - in-process recycling, where materials are returned to the production process.
  - Remanufacturing of value solvents from one industry (e.g., pharmaceuticals) being remanufactured into similar high grade solvents in another industry (e.g., chemical manufacturing).
    - **Pharmaceutical manufacturers use at least 100 kg of solvents to make 1 kg of active pharmaceutical ingredient.**

Economic & Environmental Impacts

$59M/yr
future cost savings

344K metric tons
CO2 equivalents/yr (GHG reduction)

G7 U.S. Workshop Observations

- Business cases play critical role in demonstrating value of resource efficiency and to promote best practices
- Think more broadly about where we might draw "best practices"
- Industry needs "safe spaces" to advance innovative ideas
  - Pre-competitive environments with suppliers and flexible policy frameworks from government
- Availability/transparency of data are key to promoting/tracking resource efficiency efforts across supply chains
  - Consistent data is needed across organizations to understand cumulative impacts. Data must be transparent across the supply chain to get the full picture of resource efficiency opportunities and progress.

Workshop Observations

- Metrics/measures are important tools for making progress.
- New models of ownership are shaping sustainable practices and can do much to promote circular approaches/resource efficiency
  - More service/sharing-based models promote a “value of reuse” mindset that helps promote acceptance of other reuse efforts
  - Models shape design, durability and other features of products that influence resource efficiency
- End of use is not the end of life
  - Encourage holistic-thinking about product design – beyond recycling/reuse
  - Address an array of “next life” issues to maximize circularity/resource efficiency
  - Address regulatory/public perception issues of remanufactured/refurbished products

Life Cycle in Practice to Drive Circularity

Whirlpool

Uses Hotspot Analysis

TOYOTA

Created an Auto Recycling Center to develop recycling info and training

3M

Created Life Cycle-Based Design Handbook

Department for Environment Food & Rural Affairs

Shared Resource Efficiency Manager for SME's

DELL

Developed Closed Loop Plastics Recycling Program

GE

Developed Life Cycle Assessment & Management Tools

RENAULT

Recovering strategic materials through Joint Venture on ELVs

SAVOR...

Works with Stakeholders to Implement Sustainable Food Programs

Circular economy is a powerful strategy to adress some of the most presssing environmental, economic and social challenges of the 21st century

Context

NEED FOR URGENT ACTION

2x

During the 20th century the use of natural resources rose at about twice the rate of population growth[3]

RECOUPLING

In the last decade we have seen a recoupling of economic growth with material use, with more materials being used per unit of GDP[4]

Only 9% of materials cycled back

We extract over 84 billion of materials per year to meet the functional needs of society. Yet, only 9% of these materials are cycled back into our economies[5]

Estimates suggest that by 2050, if current trends continue, there will be more plastic than fish in the ocean[6]

Disease caused by pollution was responsible for more than 9 million premature deaths in 2015 – 16% of deaths worldwide three times more deaths than from AIDS, tuberculosis, and malaria combined[7]

PROMISING SOLUTION

Circular economy provides a $4.5 trillion opportunity before 2030 through avoiding waste, making businesses more efficient and creating new employment opportunities[8]

USD 4.5 trillion

The Circular Economy is an important strategy to achieve SDG 12 on responsible consumption and production and is also critical to delivering on a further related 6 SDGs.

Reducing or reusing just one fourth of the present amount of food wastage can feed 870 million hungry people in the world[9]

for 870m people

Circular Economy has been shown to almost halve the number. of years of anticipated water shortages in water stressed regions of California[10]

1/2

CE in India could lead to 82% less consumption of virgin materials in transportation & vehicle manufacturing by 2050[11]

- 82% material consumption

Circular Economy can also accelerate the progress towards Paris Agreement and and SDGs

Emission reduction commitments in NDCs address only half the gap between business as usual and the 1.5 °C pathway. Of the remaining emissions, Circular Economy strategies can contribute to further **mitigating the emissions gap by about a half.**

The Circular Economy is about transforming our production and consumption approaches….

12 RESPONSIBLE CONSUMPTION

Sustainable Production and consumption

CE would lead to **less consumption of virgin materials**

….but given the system transformation, it will positively impact a number of other SDGs.

2 NO HUNGER

Zero Hunger

Reducing or reusing the present amount of food wastage can feed **870 million hungry people** in the world

7 CLEAN ENERGY

Clean Energy

In the US, **community based solar power** plants are expected to provide **30GW of power by 2020**

11 SUSTAINABLE CITIES AND COMMUNITIES

Sustainable Cities & Communities

In CE scenario, a city could source **$ 21 billion worth of gold and silver** that goes into the electronics each year **from its own waste**

6 CLEAN WATER AND SANITATION

Clean Water & Sanitation

Circular Economy has been shown to almost **halve the no. of years of anticipated water shortages** in water stressed regions of California

8 GOOD JOBS AND ECONOMIC GROWTH

Good Jobs & Economic Growth

About **500,000 jobs are created by the recycling industry** in the EU, and this number could well rise in a CE scenario

14 LIFE BELOW WATER

Life Below Water

The European Commission is to adopt a **strategy on plastics** in the Circular Economy to **reduce marine litter by 30%** by 2020

Each industry has unique opportunities to leverage the Circular Economy

Industry	Circular Economy Opportunities (Illustrative)
Food & agriculture	**~33.3-50%** of **food produced** (production stage in developing and consumption stage in developed countries) is **wasted** or lost globally every year
Fashion & textiles	In US, only **15% of used clothing is recycled** or donated and ~10.5mn tons a year goes into landfills, giving textiles one of the poorest recycling rates of any reusable material
Construction & building materials	**534mn tons of construction and demolition debris** were generated in US in 2014, more than twice the amount of generated municipal solid waste, **90% of this can be reused**
Energy systems & carbon	**The renewable energy use worldwide is expected to reach to only 26% by 2020 due to source variability and cost concerns**
Chemicals	**60%** of the molecules provided by the European chemical industry to customer industries and end-users **can be re-circulated**
Electronics & hi-tech	Total **e-waste discarded** in 2014 contained 1.9mn tons of Copper, 300 tones of gold, significant amounts of silver and palladium, with **$52bn** in value globally

Circular Economy can drive economic growth, create employment opportunities and decrease the risk of resource conflicts

Circular Economy APPROACHES AND PRACTICES

The CE and economic growth

Resource efficiency will be particularly important in supporting global prosperity in coming years

- In 2012 governments around the world released resource security strategies, in response to concerns that **reduced availability of some raw materials might reduce economic growth**

The CE and employment

Jobs created in remanufacturing, repair and high-tech recycling are likely to be skilled roles

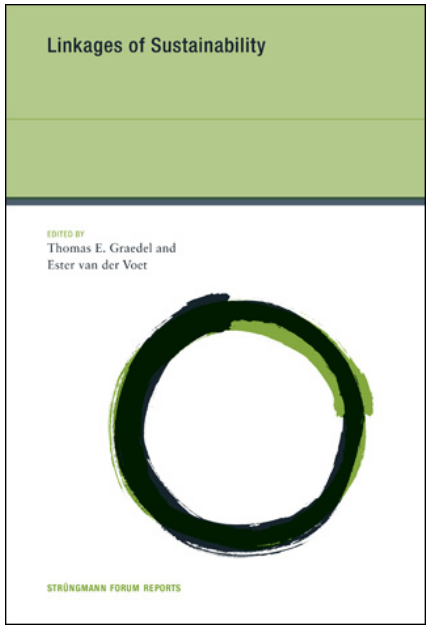
- Recent meta-analysis of 65 academic studies in this area conducted that "while more research is needed, existing studies point to the **positive employment effects occurring in the case that a Circular Economy is implemented[3]**"

The CE and resource conflicts[5]

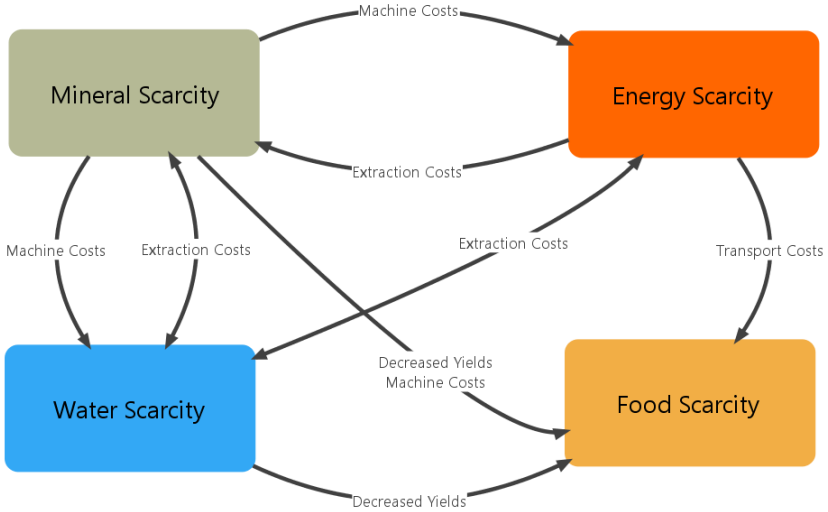
The systemic shift to a Circular Economy has the potential to make a significant contribution to mitigating the risk of resource-related conflict

- **Implementing a more Circular Economy will reduce stress on key resources such as freshwater and land, and also reducing the impact of climate change**
- According to the UN, 'The challenges associated with preventing, managing and **resolving natural resource-induced conflicts may well come to define global peace and security in the 21st century'**

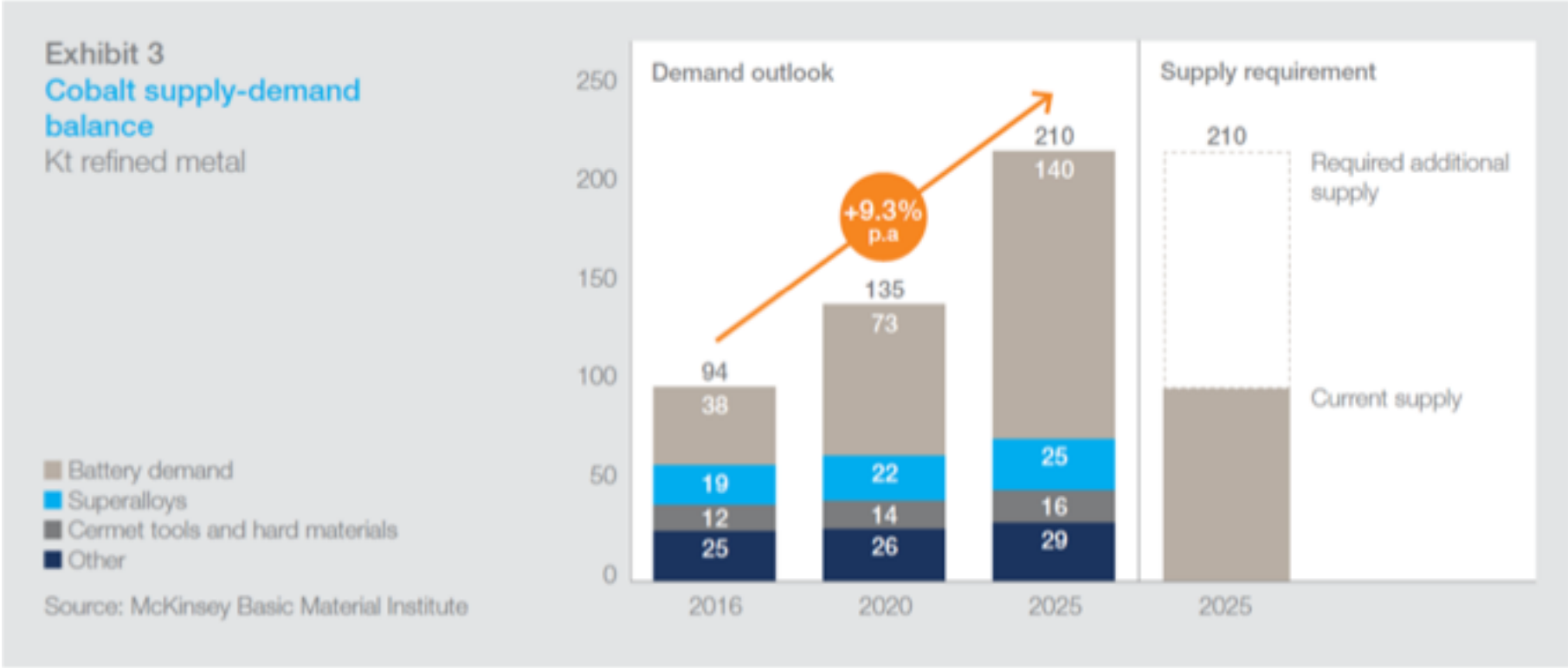
"LINKAGES OF SUSTAINABILITY" (2010)



- Intense linkages:
  - in 2050 up to 40% energy required for metals extraction
  - Metals required for energy transition
  - Material production leads to CO2 emissions
  - Renewable energy leads to less CO2 emission for material production
- Focus of this session:
  - Energy Materials Nexus



SCENARIOS FOR FUTURE ENERGY TECHNOLOGIES AND MATERIAL CONSEQUENCES



Platform for Accelerating the Circular Economy (PACE)

PACE vision, mission and scope

VISION	**Stimulate market transformation for a circular economy at scale and speed, regionally and globally**
MISSION	**Drive collaborative projects to implementation, and scale learnings through global leadership**

The specific scope and value proposition that PACE brings to the table is threefold:

- Bring the **public and private sector into collaborations** to scale impact around circular economy initiatives, in mature, emerging and developing economies
- Help to create and adjust **enabling frameworks** (e.g. policy, technology, business models) to address specific barriers to advancing the circular economy
- Apply **blended financing models** on projects that incorporate a balanced contribution from public and private partners

The PACE Leadership Group exists of leaders from over 40 public and private organizations

Co-Chairs

gef · PHILIPS · UNEP

Knowledge Partners

accenturestrategy · ELLEN MACARTHUR FOUNDATION · WORLD RESOURCES INSTITUTE · International Resource Panel · CIRCLE ECONOMY · WORLD ECONOMIC FORUM

Leadership Group

COMPANIES

- Frans van Houten, CEO & Chairman, Philips
- Kees van Dijkhuizen, CEO, ABN AMRO
- Eric Schmidt, Executive Chairman, Alphabet
- Lisa Jackson, VP Environment, Policy, Social Initiatives, Apple
- Greg Hodkinson, Chairman, Arup
- Malek Sukkar, CEO, Averda
- Feike Sijbesma, CEO &Chairman, DSM
- Leontino Balbo Junior, CEO, Grupo Balbo
- Dion Weisler, President & CEO, HP Inc.
- Ralph Hamers, CEO, ING
- Carlo Messina, CEO, Intesa Sanpaolo
- Stefan Doboczky, CEO, Lenzing AG
- Arthur Huang, Founder & CEO, MiniWiz
- Jean-Louis Chaussade, CEO, Suez
- Tom Szaky, Founder & CEO, Terracycle
- James Quicey, President & CEO, The Coca Cola Company
- Gonzalo Munos, Co-Founder & CEO, Triciclos
- Paul Polman, CEO, Unilever
- Antoine Frerot, Chairman & CEO, Veolia
- Svein Tore Holsether, President & CEO, Yara International

GOVERNMENTS

- Fang Li, China Council for International Cooperation on Environment & Development
- Jyrki Kateinen, VP, Jobs, Growth, Investment and Competitiveness, European Commission
- Luhut Pandjaitan, Coordinating Minister of Maritime Affairs, Indonesia
- Ibrahim Jibril, Minister of Environment, Nigeria
- Vincent Biruta, Minister of Natural Resources, Rwanda
- Edna Molewa, Minister of Environment and Water, South Africa
- Miro Cerar, Prime Minister of Slovenia

REGIONAL / DEVELOPMENT INVESTMENT BANKS

- Werner Hoyer, President, European Investment Bank
- Luis Moreno, President, Inter-American Development Bank
- Kristalina Georgieva, CEO, World Bank

ORGANIZATIONS

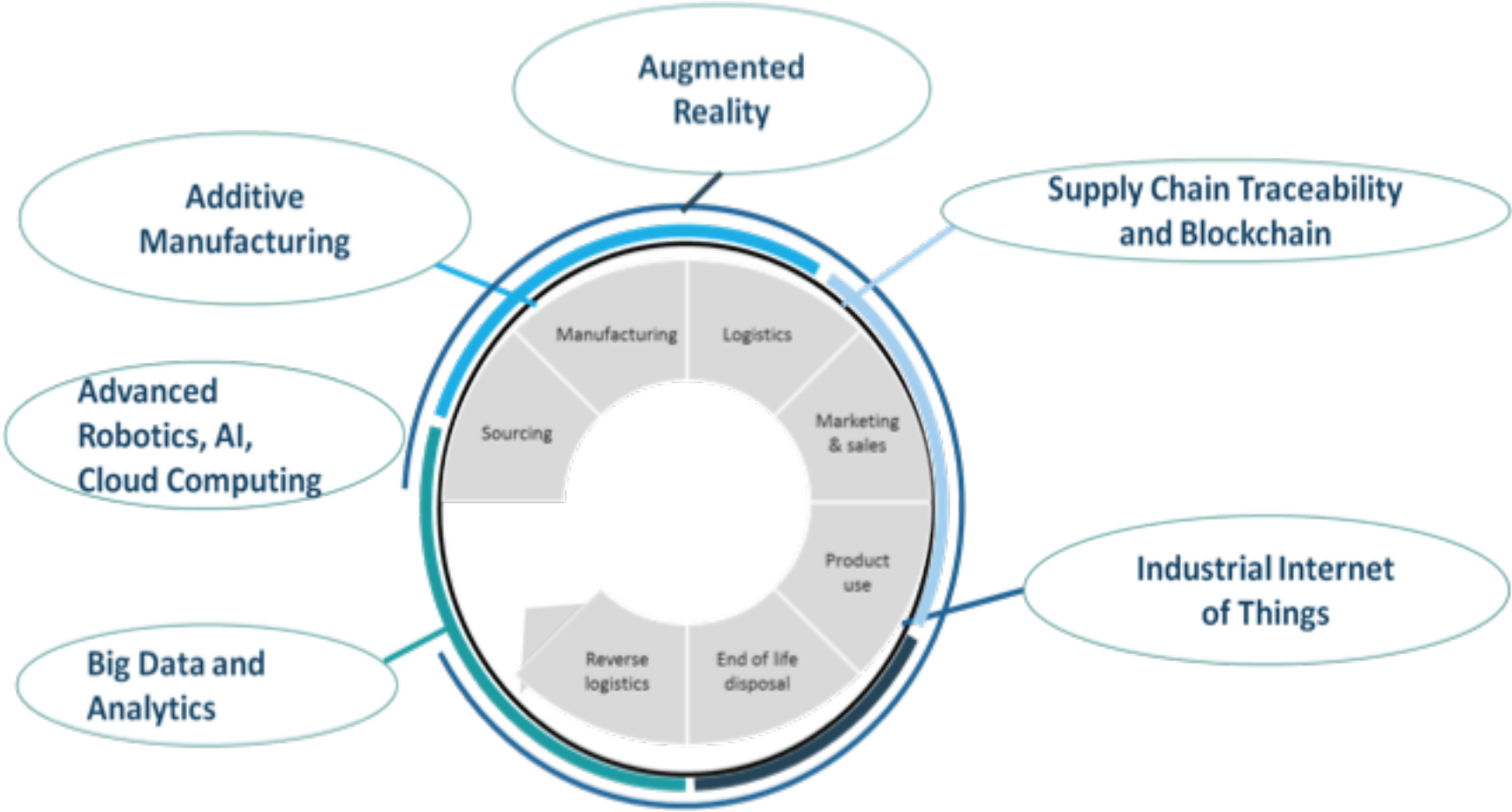
- Naoko Ishii, CEO, Global Environment Facility
- Erik Solheim, Executive Director, UN Environment
- Peter Lacy, Global Managing Director, Growth, Strategy and Sustainability, Accenture
- Harald Friedl, CEO, Circle Economy
- Ellen McArthur, Founder, Ellen MacArthur Foundation
- Scott Vaughn, President, International Institute for Sustainable Development
- Janez Potočnik, Co-Chair, International Resource Panel
- Izabella Teixeira, Co-Chair, International Resource Panel
- Peter Bakker, President, World Business Council for Sustainable Development
- Andrew Steer, President, World Resources Institute
- Marco Lambertini, CEO, World Wildlife Fund

Delegate community

>80 delegates from the member companies, governments, investment / development banks and organizations

Application of 4th IR tools to Drive Circular Economy

- Reduce Manufacturing Costs by 10 – 20 %, increase speed and flexibility, improved quality and environmental outcomes
- 30% increase in agricultural yield realizable through precision agriculture
- 80% of companies expect data analytics will significantly influence decision making
- Data explosion: 90% of all data produced in the last 2 years, average cost of a data sensor $0.60 - IOT market size $227 Billion



Impact of the identified 4IR production developments: The identified 4IR developments have the potential to drive transformative business impact and contribute to a wide range of SDGs

~30% *Increase in agricultural yield realizable through precision agriculture.*

1 NO POVERTY
2 ZERO HUNGER

80% *Potential reduction in wastage through Biofabricated Leather production scaling*

15 LIFE ON LAND
12 RESPONSIBLE CONSUMPTION AND PRODUCTION

~80% *Lower greenhouse gas emissions for cultured meat production (vis-à-vis traditional farming).*

12 RESPONSIBLE CONSUMPTION AND PRODUCTION
11 SUSTAINABLE CITIES AND COMMUNITIES

$0.5m *Of savings per year at Intel's Chandler, AZ plant by using real time info from chillers to maximize efficiency*

12 RESPONSIBLE CONSUMPTION AND PRODUCTION
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

~80% *Improvement in lead time to manufacture auto-components through Additive Manufacturing*

8 DECENT WORK AND ECONOMIC GROWTH
12 RESPONSIBLE CONSUMPTION AND PRODUCTION

~15% *Cost saving and 7% weight reduction (providing equal bending stiffness) for a 50/50 carbon and flax hybrid bio composite*

12 RESPONSIBLE CONSUMPTION AND PRODUCTION
15 LIFE ON LAND

Sources: Accenture Research, Various

GEARING UP FOR A CONVERSATION

HOW CIRCULAR STRATEGIES CAN EASE MATERIAL CONSTRAINTS FOR OUR FUTURE ENERGY SUPPLY

AND CAN ENERGY DEMAND BE REDUCED BY CE?

Elmer Rietveld

TNO innovation for life


Single truck: 12 m3, 30 metric tons of rubble, 150g of Platinum, 5 metric tons of embedded GHG

SCENARIOS FOR FUTURE ENERGY TECHNOLOGIES AND MATERIAL CONSEQUENCES


ENERGY

A PATH TO
SUSTAINABLE ENERGY
BY 2030

Wind, water and solar technologies can provide 100 percent of the world's energy, eliminating all fossil fuels.
HERE'S HOW

By Mark Z. Jacobson and Mark A. Delucchi

58 SCIENTIFIC AMERICAN November 2009

KEY CONCEPTS

Bron: Scientific American, November 2009

replace ALL fossil fuels by 2030 using:

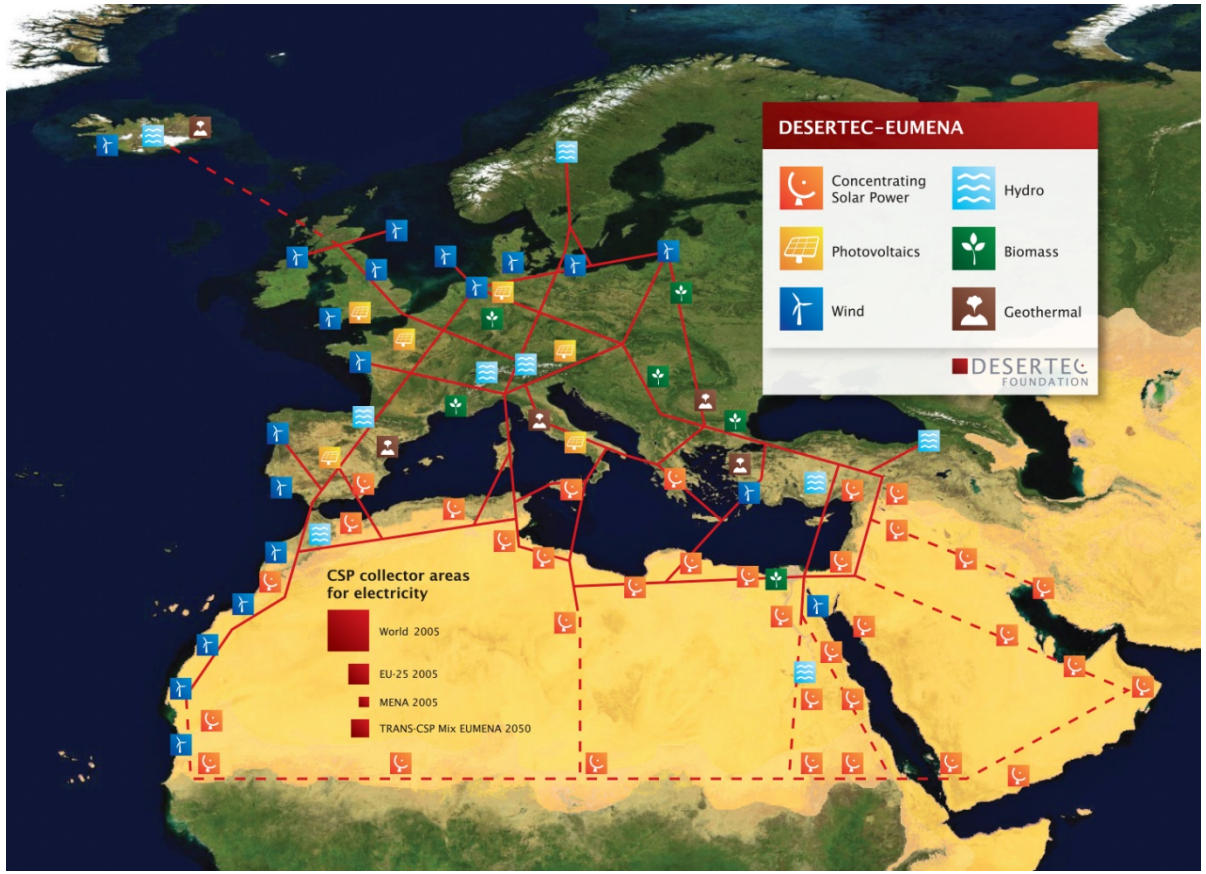
- 490,000 1MW tidal turbines
- 5,350 100MW geothermal plants
- 900 1,300MW hydroelectric plants
- 3,800,000 5MW wind turbines
- 720,000 0.75MW wave converters
- 1,700,000,000 0.003MW rooftop photovoltaic systems
- 49,000 300MW concentrated solar power plants
- 40,000 300MW photovoltaic power plants

- ‘scenario’:
  - 3 Mton Nd required
    - If wind turbine with permanent magnets
  - Current production 20 kton Nd
  - 150 years !

SCENARIOS FOR FUTURE ENERGY TECHNOLOGIES AND MATERIAL CONSEQUENCES

- ‘scenario’:
  - 65% primary energy from solar in Sahara
    - Transport through HVDC
    - 1500 km
  - Copper demand: 60 x current mine production

(Rene Kleijn et al, Renewable and sustainable energy reviews, 2010)

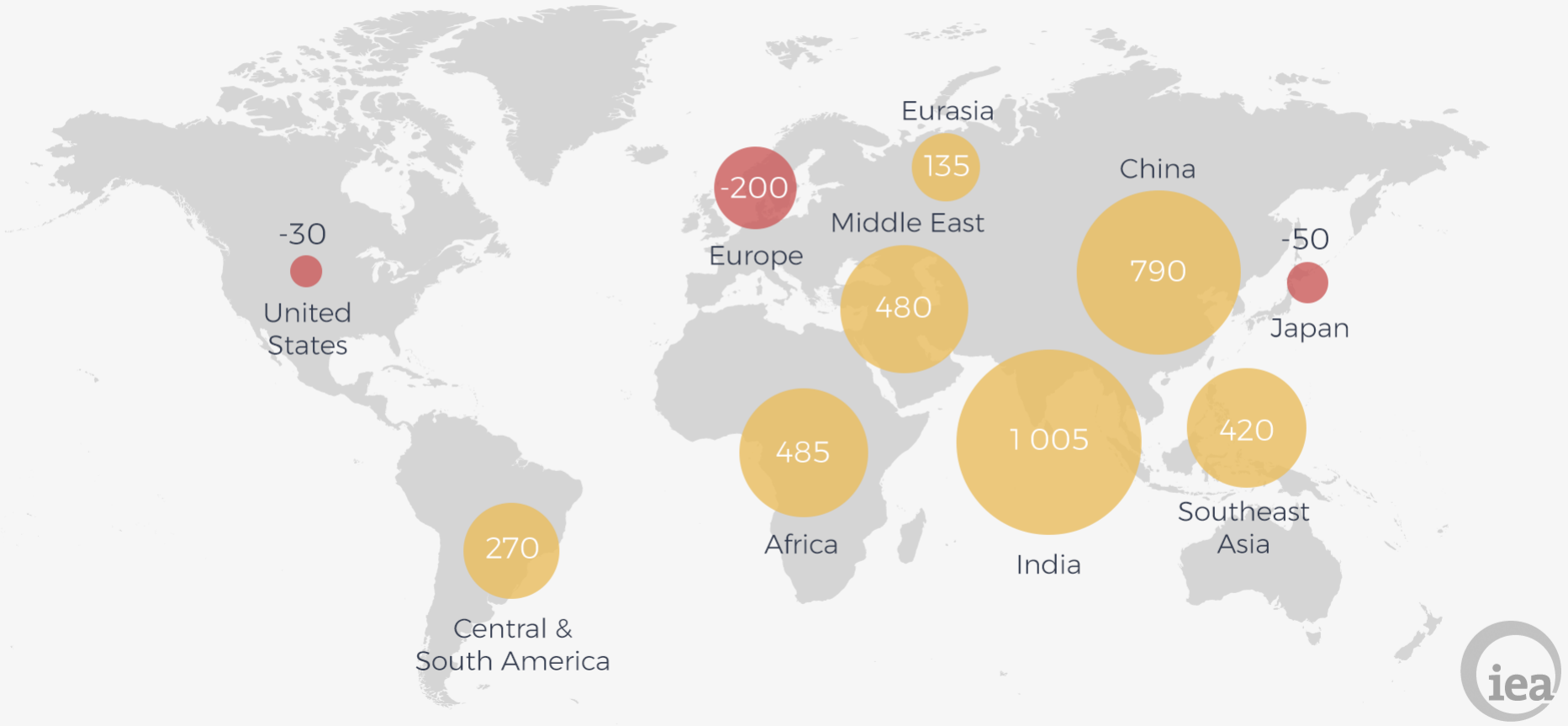


Source: Destertec foundation

SCENARIOS FOR FUTURE ENERGY TECHNOLOGIES AND MATERIAL CONSEQUENCES

Change in primary energy demand, 2016-40 (Mtoe)

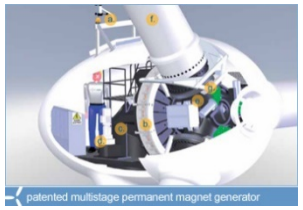
World Energy Outlook 2017



STRONG DEMAND GROWTH FOR HIGH-TECH-MATERIALS

(SOURCE: FRAUNHOFER ISI - DERA, 2016)

RENEWABLE ENERGY



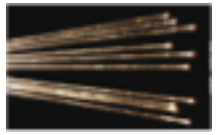
- Rare earths

- Lithium
- Cobalt

- Gallium
- Indium
- Tin

ICT

- Tantalum
- Gallium



- Germanium

- Silver
- Copper

HOW CIRCULAR STRATEGIES CONTRIBUTE:
DESIGN DECISIONS INFLUENCE PERFORMANCE OF SUSTAINABLE ENERGY PRODUCTION

HOW CIRCULAR STRATEGIES CONTRIBUTE: BLOCKCHAIN, SENSORS, RECYCLING PROCESSES CAN SIGNIFICANTLY INCREASE SUPPLY

Energy supply

Path-dependencies in both a decentralised energy transition or a centralised energy transition

Dependency on inferior systems as as result of limited supply of certain raw materials

Urban mining of critical raw materials

Modular design of sustainable energy production facilities

More durable design in case of decentralised energy production

Substituton in terms of material-for-material or proces-for-proces

Problems

Solutions

100% recovery of all metals in a product is next to impossible given laws of nature

Servitization might simply result in equal demand

Secondary materials production requires less energy than primary extraction

Servitization might reduce demand

Energy demand