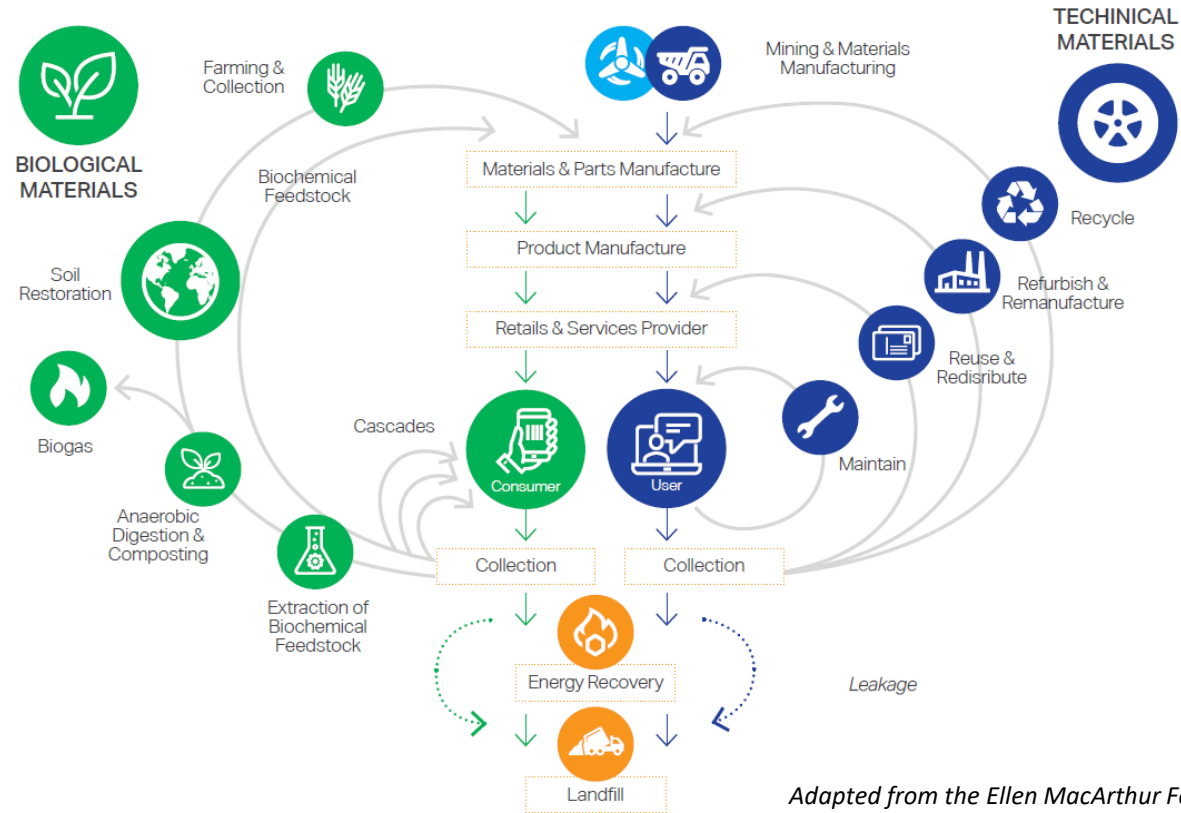




# Circular Economy

## in the 4<sup>th</sup> Industrial Revolution

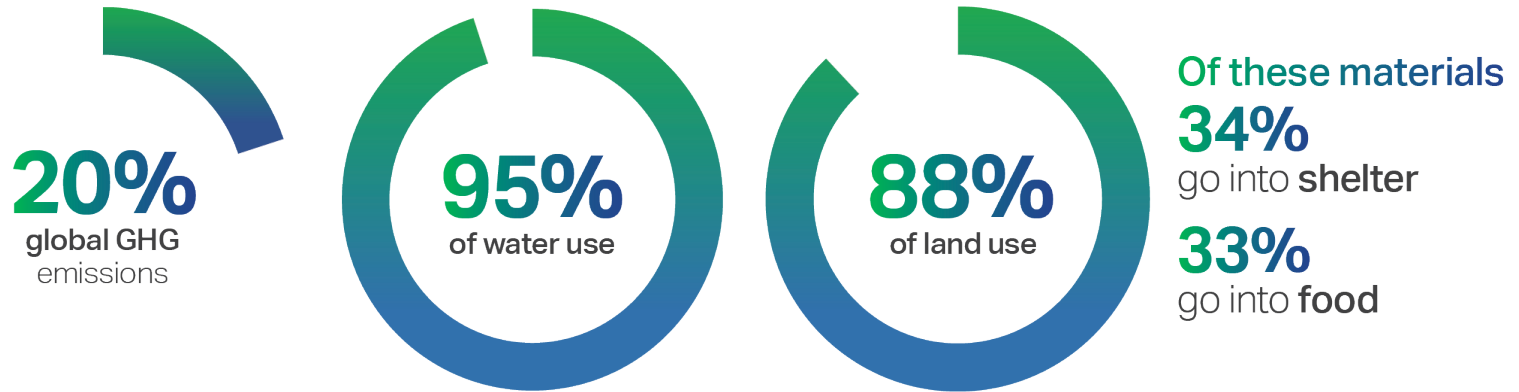
# The circular economy concept



*Adapted from the Ellen MacArthur Foundation's original illustration*

# The circular economy environmental opportunity

Steel, aluminum, plastic, cement, glass, wood, primary crops and cattle



*Taken from WBCSD's Circular Economy: Environmental Priorities for Business*

# The circular economy business models



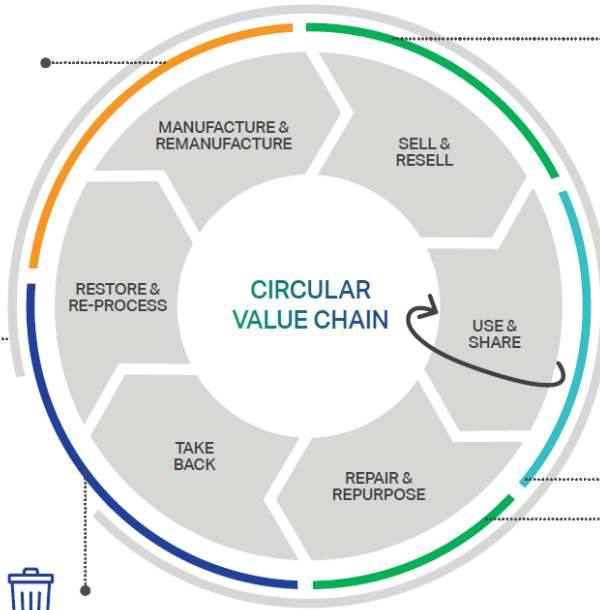
**CIRCULAR SUPPLIES:** Use renewable energy, bio-based or fully recyclable input material to replace toxic and single-lifecycle inputs



**PRODUCT AS A SERVICE:** Offer product access and retain ownership to internalize benefits of circular resource productivity



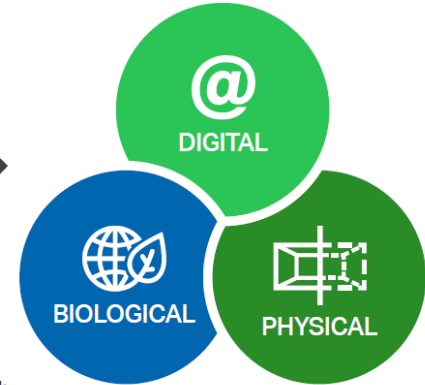
**RESOURCE RECOVERY:** Recover materials, resources and energy from disposed products or by-products



**PRODUCT LIFE-EXTENSION:** Extend working lifecycle of products and components by reselling, repairing, remanufacturing and upgrading



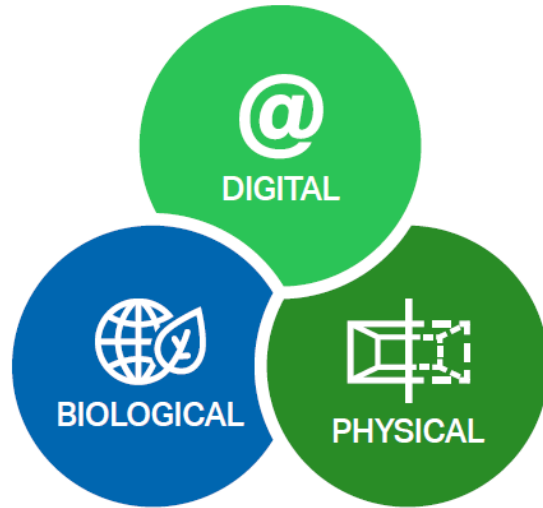
**SHARING PLATFORM:** Enable increased utilization rate of products by making possible shared use/ access/ownership



*Taken from WBCSD's CEO Guide to the Circular Economy*



# The circular economy business models



- **DIGITAL TECHNOLOGIES** such as **Internet of Things (IoT), big data, blockchain, and RFID** help companies track resources and monitor utilization and waste capacity
- **PHYSICAL TECHNOLOGIES** such as **3D printing, robotics, energy storage and harvesting, modular design technology and nanotechnology** help companies reduce production and material costs and reduce environmental impact
- **BIOLOGICAL TECHNOLOGIES** such as **bio-energy, bio-based materials, biocatalysts, hydroponics and aeroponics** help companies move away from fossil-based energy sources

*Taken from WBCSD's CEO Guide to the Circular Economy*



# 4IR & CE in practice: digital technologies

IoT



**EFFIFUEL**

Ecosystem of vehicle sensors to provide recommendations and training in eco-driving techniques

RFID

**EON-ID™**

The industry's first RFID tag in the form of a thread that can integrate with textiles to power recycling

# 4IR & CE in practice: physical technologies

## 3D printing



### Ollie

3D printed care, of which 80% of materials are made from a single material

## Robotics



### Daisy

Disassemble 9 iPhone versions, at rates up to 200 iPhones per hour

# 4IR & CE in practice: biological technologies

## Bio-based energy



### Memthane Technology

Turns 98% of wastewater organics into biogas, providing 10% of the Mars NL plant energy annually

## Biomaterials



### Biomass Balance Approach

Replacement of fossil fuel inputs with biomass by-products



# 4IR & CE in practice: policy implications

- Policies should incentivize and adapt to new business models that
- Collaborate with business to establish effective policies that incentivize right actions
- Collaborate across departments to establish multi-dimensional policies
- Assess how local communities will be impacted economically, environmentally & socially
- Assume policies will need to evolve over time due to unforeseen outcomes (+ and -)