# Transforming Industries for Advancing the Circular Economy

René VAN BERKEL
UNIDO Representative

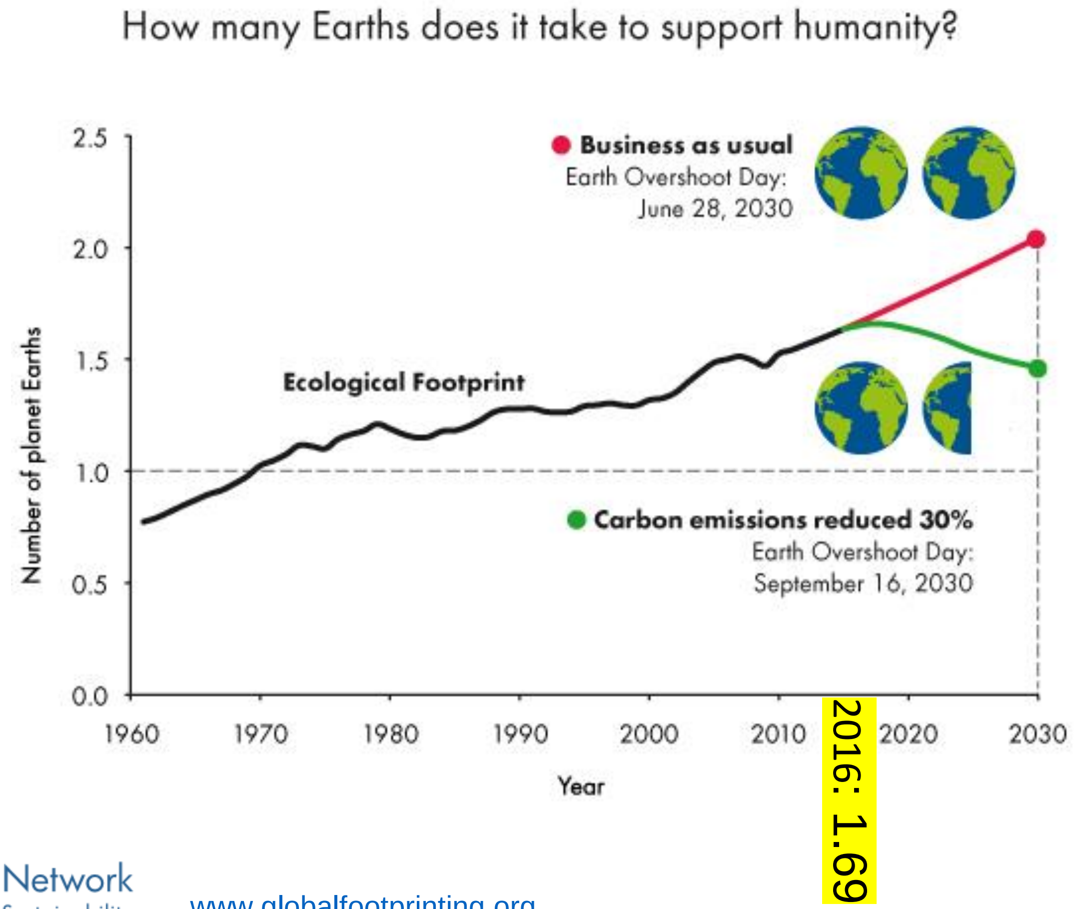
21 January 2020

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

# Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation


*Making industrial development work for markets, people & society, and planet & climate*

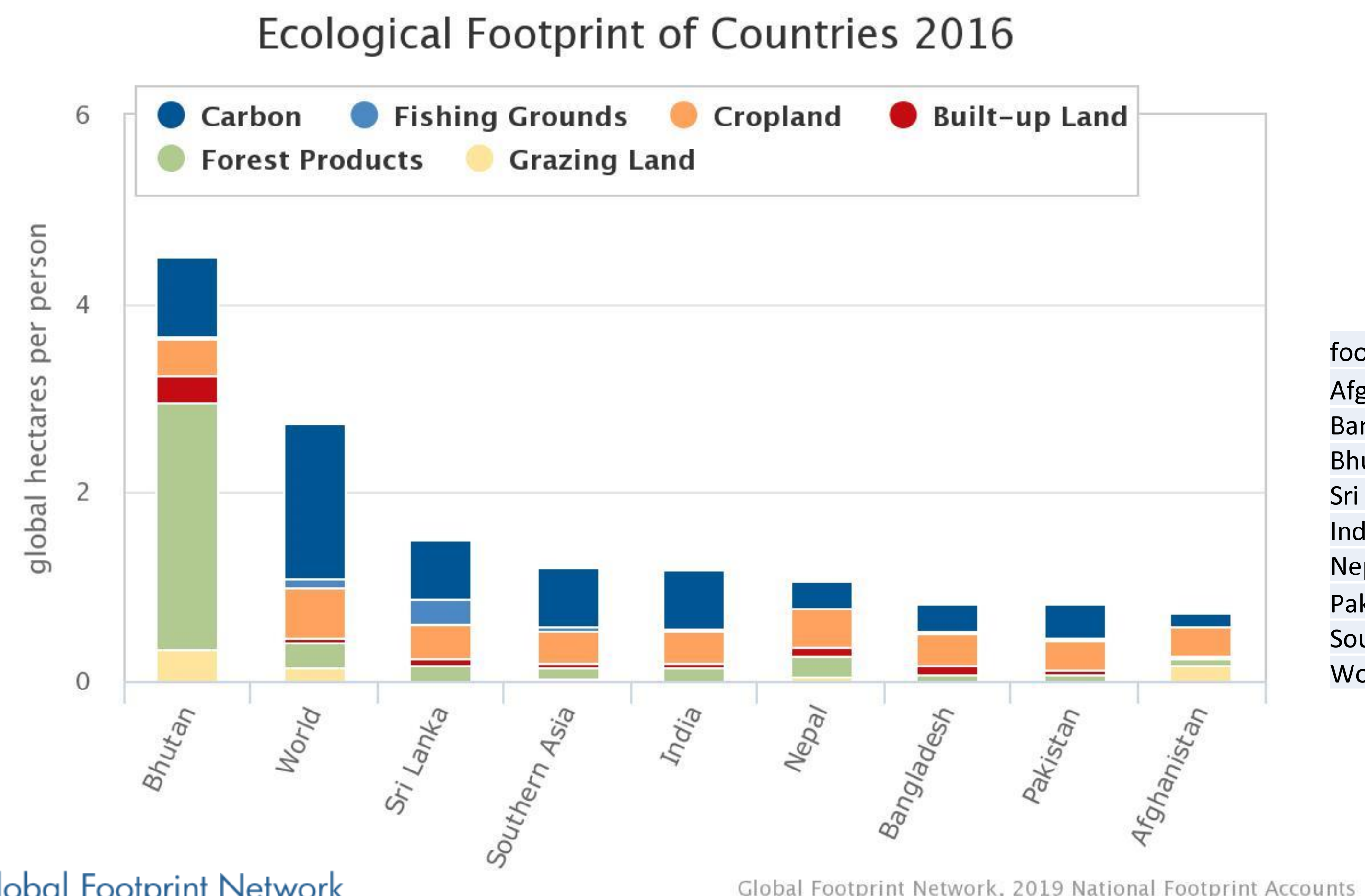
# Living Beyond Planetary Means




Global Footprint Network
Advancing the Science of Sustainability

www.globalfootprinting.org

# Global Footprint




| footprint 2016 | gha/person |
|---|---|
| Afghanistan | 0.73 |
| Bangladesh | 0.84 |
| Bhutan | 4.49 |
| Sri Lanka | 1.49 |
| India | 1.17 |
| Nepal | 1.07 |
| Pakistan | 0.83 |
| Southern Asia | 1.19 |
| World | 2.7 |

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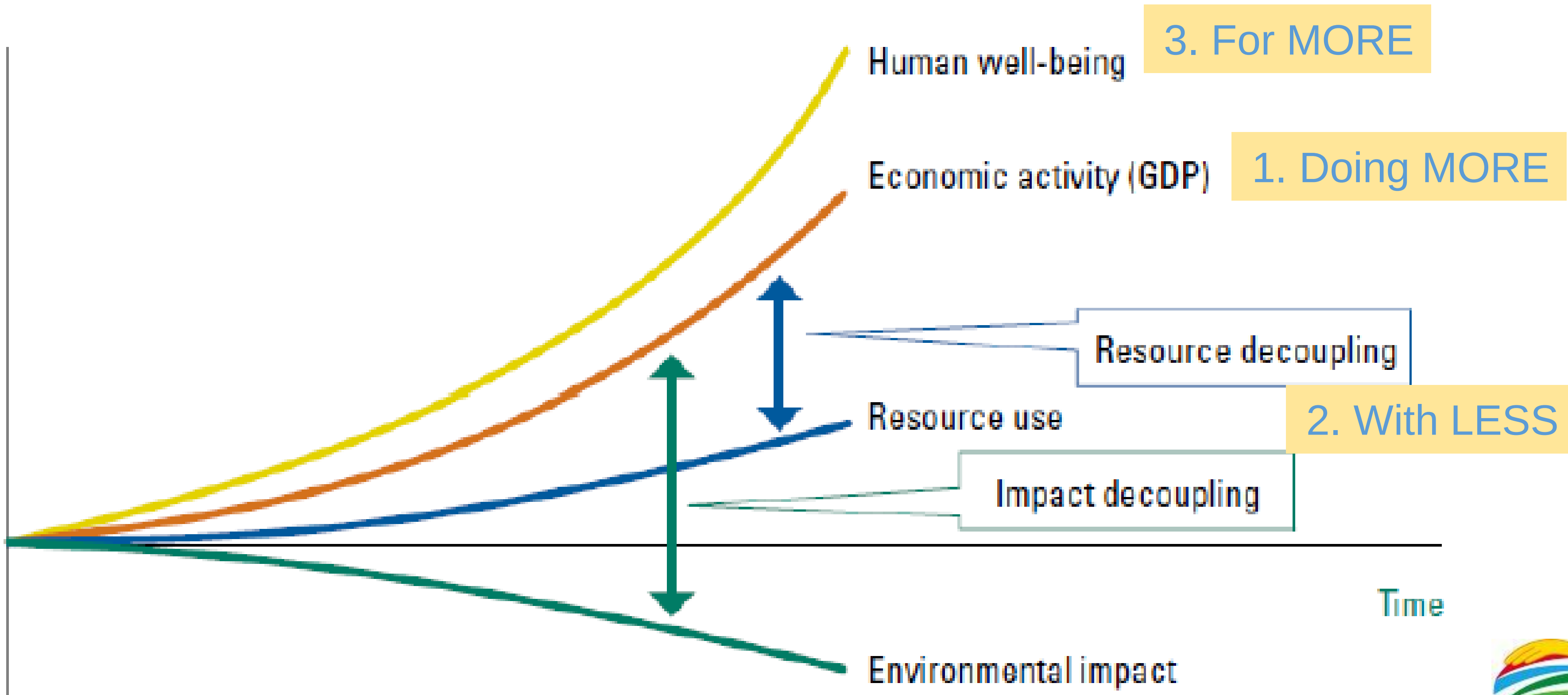



International Resource Panel

Decoupling economic development from increased natural resource consumption and aggravated negative environmental impacts

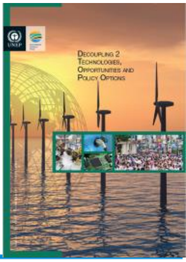
International Resource Panel, 2011

# Decoupling

- Can mean different achievements
  - Decoupling through *maturation*
    - Decoupling is observed as countries shift from an extraction and production-based economy towards a service economy (structural transformation)
  - Decoupling through *burden shifting*
    - Decoupling is achieved when resource-intensive activities and their environmental impacts are shifted offshore (international trade)
  - Decoupling through *intentional innovation*
    - Decoupling is possible through technological innovation, infrastructures conducive to resource efficient and low material intensity manufacturing and living, and appropriate attitudes and consumption pattern

Resource Efficiency

International Resource Panel



International Resource Panel, 2014

# Resource Efficiency

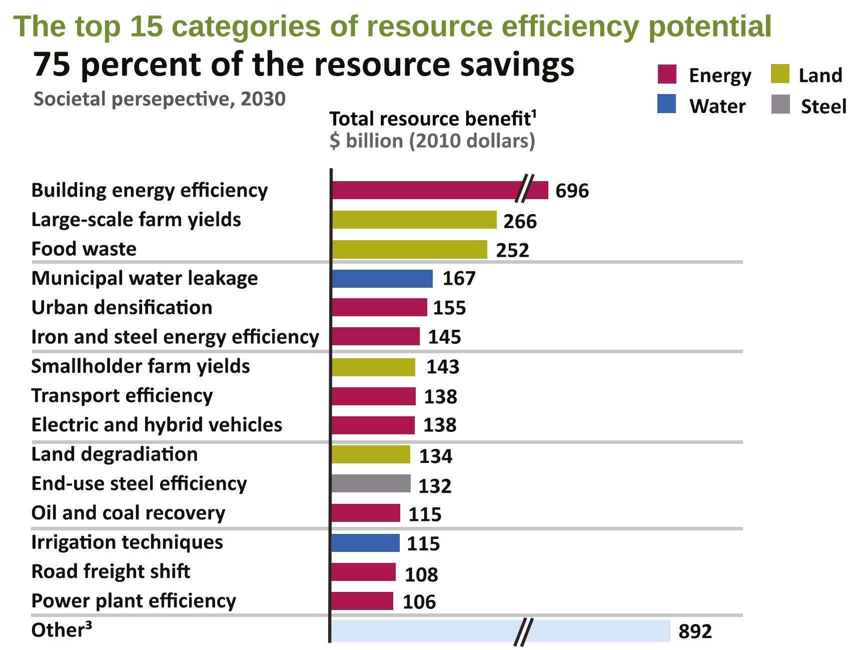
- Encompasses different ideas
  - Technical efficiency of resource use
    - measured by the useful energy or material output per unit of energy or material input
  - Resource productivity, or extent to which economic value is added to a given quantity of resources
    - measured by useful output or value added per unit of resource input
  - Extent to which resource extraction or use has negative impacts on the environment
    - increased resource efficiency implies reducing the environmental pressures that cause such impacts
  - Resource intensity is the inverse of resource productivity, and is therefore measured by resource use per unit of value added
  - Environmental intensity is similarly the environmental pressure per unit of value added

International Resource Panel


International Resource Panel, 2016

# Resource Efficiency Potential

- **60-80%** improvements in energy and water efficiency
- Economic **cost savings of 2.9-3.7 trillion USD** per year by 2030
- In 70% of cases, the required resource efficient investment would offer a rate of **return greater than 10% per year**
- Investing some USD 900 billion could potentially generate **9-25 million jobs**




International Resource Panel


International Resource Panel, 2016

# Resource Efficiency has Multiple Benefits

reduce natural resource use globally by **28%** by 2050

reduce global greenhouse gas emissions globally by **63%** below 2015 levels by 2050

more than offset the economic costs of ambitious climate action

increase **7%** of GDP in the **G20**. And If combined with climate mitigation, generate US$2.1 trillion increase in GDP by 2050.

International Resource Panel, 2018

International Resource Panel

# Circular Economy

- Looking beyond the current "take, make and dispose" extractive industrial model, the circular economy is *restorative* and *regenerative* by design.
- Relying on system-wide innovation, it aims to redefine products and services to design waste out, while minimising negative impacts.
- Underpinned by a transition to renewable energy sources, the circular model builds economic, natural and social capital

- Circular Economy is a new way of looking at the relationships between markets, customers and natural resources.
- It leverages new business models and disruptive technologies to transform the linear economic model

ELLEN MACARTHUR FOUNDATION

wbcsd

# Circular Economy (CE) Economics

## India

- CE could create:
  - Annual value of USD218 to 624 billion by 2030 and 2050
  - Reduction of GHG intensity by 23% to 43% by 2030 and 2050
  - Equivalent of 22% of the total SDG opportunity by 2030

ELLEN MACARTHUR FOUNDATION

## China

- CE could create:
  - Annual value of USD 1.5 to USD 11.2 trillion by 2030 and 2050
  - Reduction of GHG emissions (11-23%) and of particulate emissions (10-50%) by 2030 and 2040
  - Fall in traffic congestion (36-47% by 2030 and 2040
  - Middle class lifestyle for more urban dwellers


ELLEN MACARTHUR FOUNDATION

**World:**

CE presents a USD4.5 trillion business opportunity by 2030

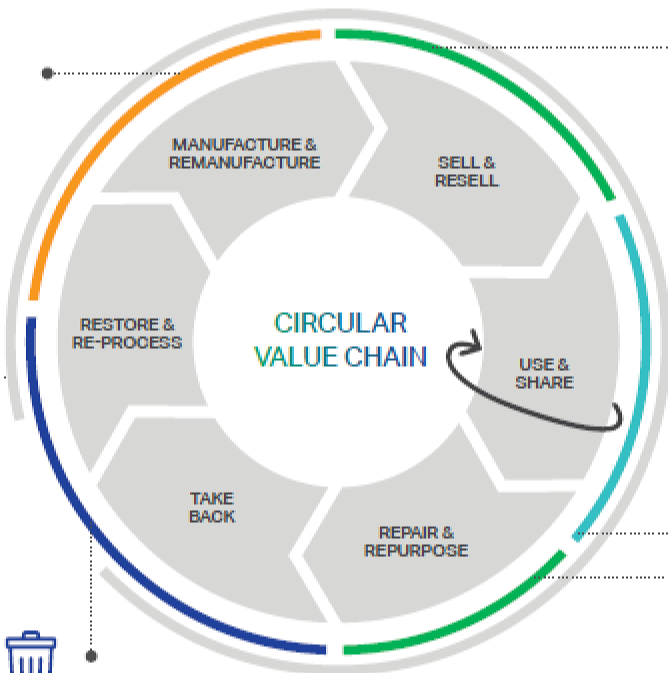



WBCSD, 2017; E Macarthur Foundation 2016; 2018

# Five Business Models + Three Disruptive Technologies

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

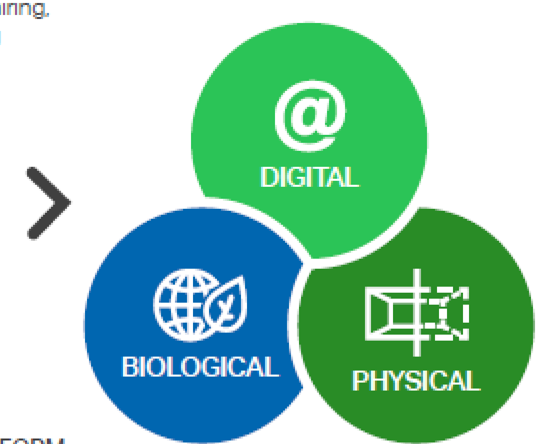
**PRODUCT AS A SERVICE:** Offer product access and retain ownership to internalize benefits of circular resource productivity




**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

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# Two Strategies + Six Business Models

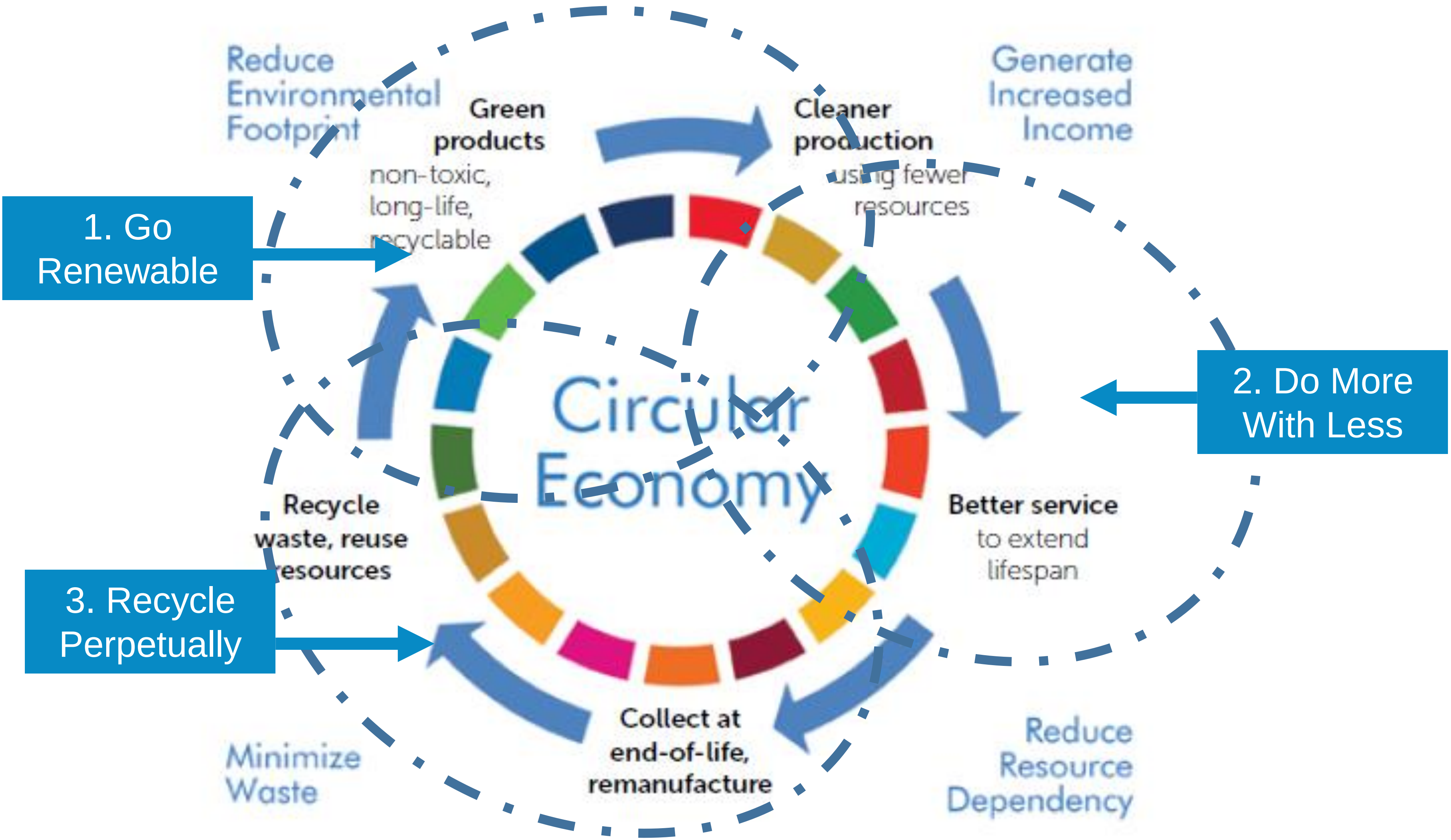
## ***Slowing*** **the Loop**

- Access and performance model
  - Shared use
- Extending product value
  - Direct reuse
- Classic long life model
- Encourage sufficiency

## ***Closing*** **the Loop**

- Extending resource value
  - Waste to value
- Industrial (and urban) symbiosis
  - Eco-industrial parks


Confederation of Indian Industries, 2018




Circular Economy, United Nations Industrial Development Organization, 2017

1. Go Renewable

# Resource Man Made Systems up to Nature's Capability

- Nature as *input*
  - Substitute non-renewable inputs to man-made systems
    - Materials
    - Energy
    - Water
    - Land
    - Biodiversity
    - @rates compatible with long term availabilities and cycles

- Nature as *mentor*
  - Model man-made processes on natural processes
    - Biomimicry
    - Green Chemistry/Engineering

# Today's Opportunities

- Solar Heating of Industrial Process

Advanced dehydration unit based on conduction, convection and radiation


Global Cleantech Innovation Programme

S4S technologies

Concentrating Solar Thermal proven up to ~400ºC, coving ~52% of industrial heat use

gef

- Process & Product Innovation

Water purification without chemicals or energy

Global Cleantech Innovation Programme

WATSAN

Enzymes as biocatalyst for production of antibiotics, at room temperature, without solvents and higher efficiency

Green CHEMISTRY

Global Cleantech Innovation Programme

Cellzyme Biotech

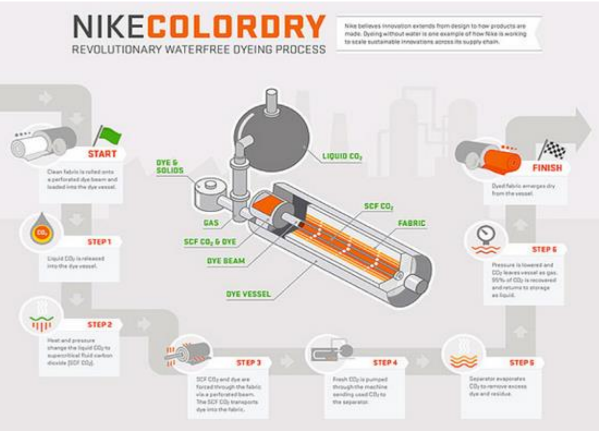
# Waterless Textile Dyeing


## Process Benefits


Zero water
Zero waste water

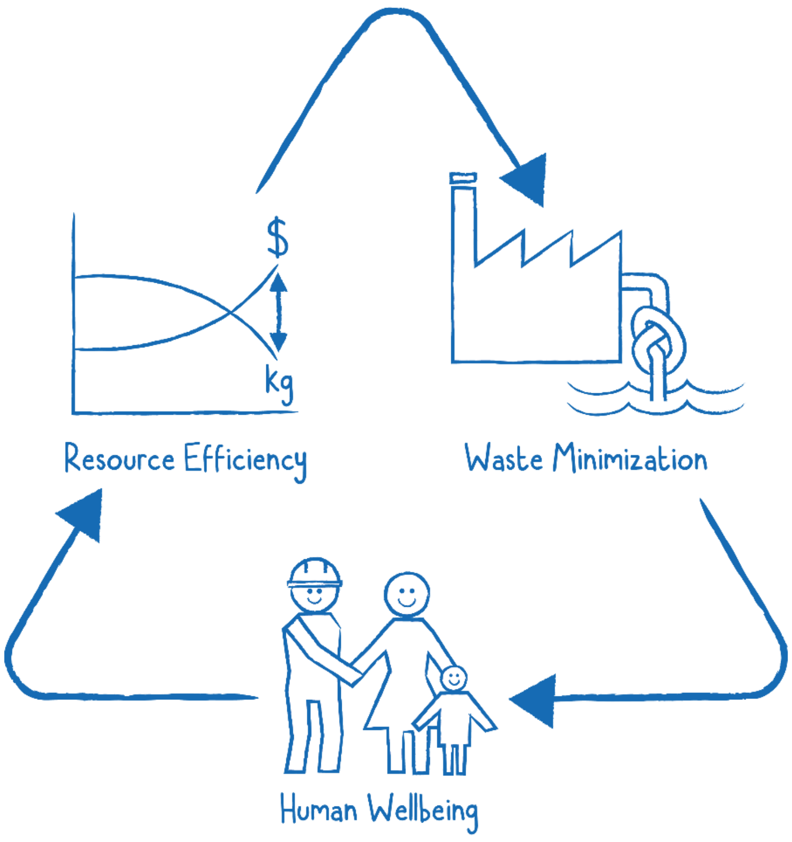
Zero process chemicals
98% dye uptake

Vibrant colours
1/4th floorspace
40% faster
63% lower energy




2. Do More With Less

# Resource Efficient and Cleaner Production




- Improve efficiency of use of materials, water and energy
  - Thereby
- Minimize the generation of wastes, effluents and emissions
  - Thereby
- Improve occupation and community health and wellbeing
  - Thereby
    - Improve productivity etc.

Virtuous Synergy

# RECP Outcomes

Increase

**Material Productivity**

Selection and efficient use of **materials**

**Water Productivity**

Sourcing and efficient use of **water**

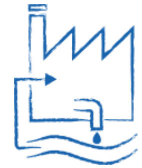
**Energy Productivity**

Selection and efficient use of **energy**

Decrease

**Waste Intensity**

Reduction and safe disposal of **waste**



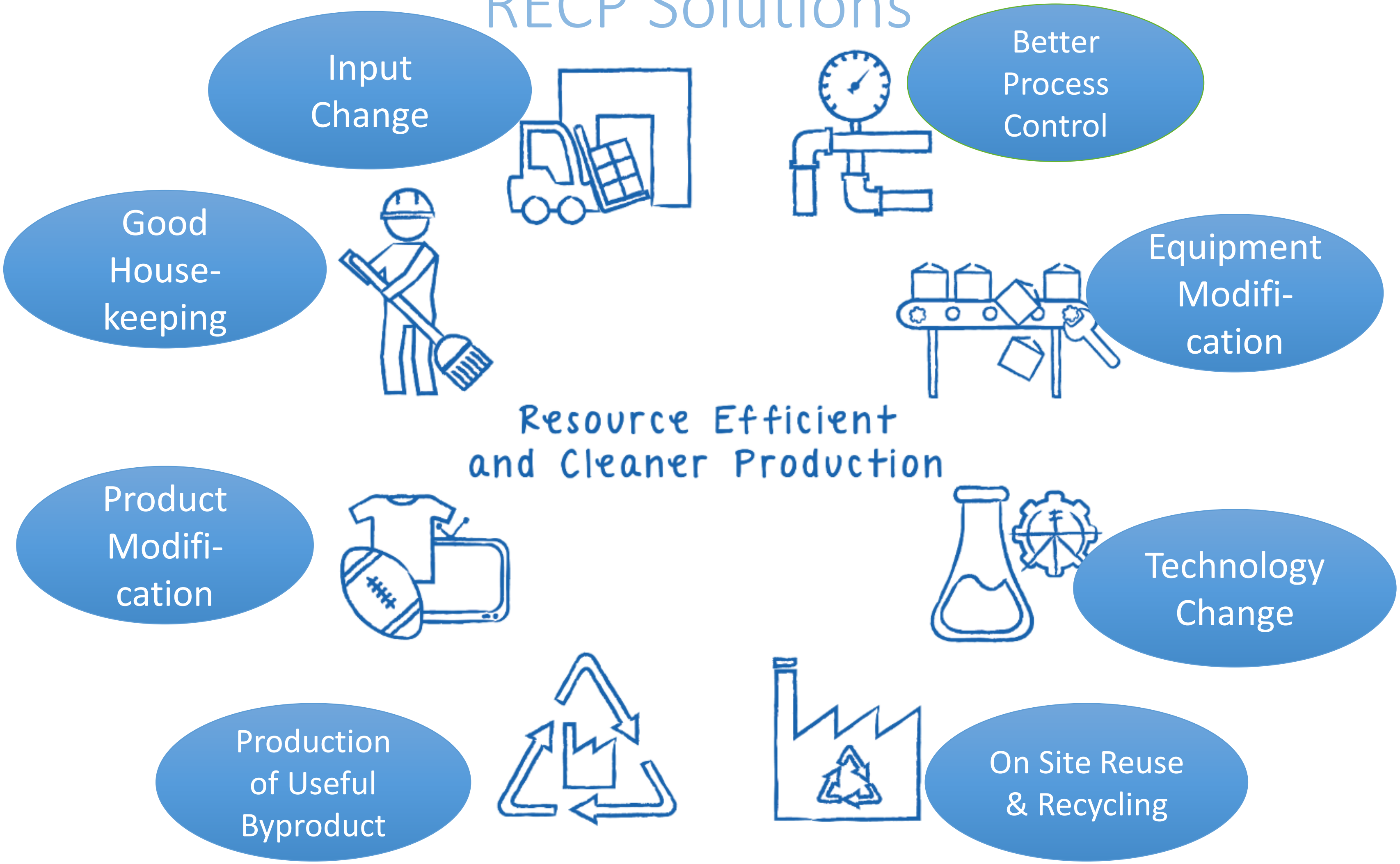
**Waste Water Intensity**

Reduction and treatment of **waste water**

**Emission Intensity**

Reduction and control of **air emissions**

# RECP Solutions



| RECP Practice | Description | Common Water-Related Example |
|---|---|---|
| **Good Housekeeping** | Maintain a clean, organized and productive ('neat') workplace to eliminate avoidable 'wastage' | • Switch off what is not in use (e.g. taps)<br>• Repair what is broken or leaking (e.g. pipes )<br>• Remove dry-debris before factory wash down |
| **Input Change** | Choose inputs that are efficient, effective and/or pose minimum harm to the environment and health | • Use secondary, recovered water<br>• Use less harmful chemical substances (dyes, detergents, etc.)<br>• Enzyme-enhanced bleaching, scouring |
| **Better Process Control** | Monitor and control processes and equipment so that they always run at highest efficiency and with lowest wastage | • Establish and follow Standard Operating Procedures (SOP)<br>• Sub-meter use of water<br>• Install automatic shut-off and overflow prevention valves |
| **Equipment Modification** | Make existing equipment more efficient and less wasteful | • Align and debottleneck production line<br>• Close, hot and cold, process equipment |
| **Technology Change** | Change over to new technology that is more efficient or produces less waste | • Waterless dyeing<br>• Additive, 3D printing |
| **On-Site Reuse & Recycling** | Use previous 'waste' for similar or alternative purpose in company | • Counter-current or cascaded use of water<br>• Condensate recovery |
| **Production of Usefull By-Product** | Convert a previous 'waste' for a useful use elsewhere | • Provide used cooling water for external heating or cooling purposes |
| **Product Modification** | Redesign product to reduce its environmental impact during production, use and/or disposal | • Produce easy care textiles that require minimal water by consumers |

Van Berkel, 2017

# China Textile Wet Processing

| Practice | Typical Percentage Resources Saved | Largest Savings Seen at Any Mill | Cost | Savings | Payback Period |
|---|---|---|---|---|---|
| **Water leak detection, preventive maintenance, improved cleaning** | Water: 1.1-5%<br>Fuel: N/A-1% | Water: 6.1%<br>Fuel: 2.2 % | Insignificant | <$1,000-$20,000 | < 1month |
| **Reuse cooling water** | Water: 2-8.9%<br>Fuel> N/A-0.3% | Water: 18.8%<br>Fuel: 0.5% | $2,000-$3,000 | $2,000-$18,000 | 2-7 months |
| **Reuse of condensate** | Water: 0.5-5.4%<br>Fuel: 0.6-3.1% | Water: 20.3%<br>Fuel: 7% | $12,000-$33,000 | $8,000-$78,000 | 4-18 months |
| **Reuse process water** | Water: 1.1-6%<br>Fuel: N/A-0.9% | Water: 21.1%<br>Fuel: 2.9% | <$1,000-$24,000 | $6,000-$48,000 | 1-10 months |
| **Recover heat from hot water** | Fuel 6.6-10.4% | Fuel: 29.7% | $35,000-$79,000 | $119,000-$265,000 | 4-7 months |
| **Improve boiler efficiency; prescreen coal; insulate boiler and economimizer** | Fuel: 2.6% - 4.3%<br>Electricity: N/A-1%<br>Fuel: 1.6-2.4%<br>Fuel: 0.6 – 1.8% | Fuel: 19.7%<br>Electricity: 2.3%<br>Fuel: 3.9%<br>Fuel: 15.1% | $12,000-$22,000<br>$5,000-$6,000 | $23,000-$49,000<br>$10,000-$18,000 | 6-9 months<br>4-8 months |


NRDC, 2013

# China Textile Wet Processing

| Practice | Typical Percentage Resources Saved | Largest Savings Seen at Any Mill | Cost | Savings | Payback Period |
|---|---|---|---|---|---|
| Maintain steam traps and system<br>Maintain steam traps<br>Repair steam leaks | Water: N/A-0.1%<br>Fuel: 1-4.3%<br>Fuel: 0.4-1.2%<br>Fuel: 0.3-198% | Water: 0.8%<br>Fuel 10.2%<br>Fuel: 3.9%<br>Fuel: 5.1% | $2,000-$5,000<br>$0-$1,000 | $7,000-$28,000<br>$4,000-$16,000 | 2-6 months<br><1-2 month |
| Insulate equipment and tanks | Fuel 1.4-3.2% | Fuel: 19.2% | $15,000-$47,000 | $24,000-$72,000 | 6-10 monhs |
| Recover heat from hot air | Fuel: 0.7-2.8% | Fuel: 5.7% | $16,000-$36,000 | $11,000-$38,000 | 7-18 months |
| Optimize compressed air system | Electricity: 1-3.9% | Electricity: 15.4% | $0-$19,000 | $9,000-$38,000 | <1-12 months |
| Total | Eelectricity: 1-5%<br>Fuel: 12.9-30%<br>Water: 4.3-25.4% | | $110,000-$300,000 | $230,000-730,000 | 3-10 months |


NRDC, 2013

# Kanpur Leather Development Project

## Clean Leather Technologies

Reducing salinity and effluent load by over 30% through hair save un-hairing

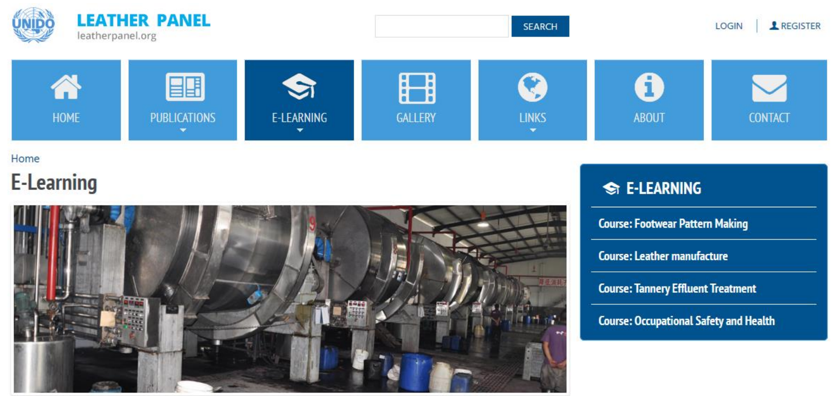
Up to 20% water conservation through measurement and reuse

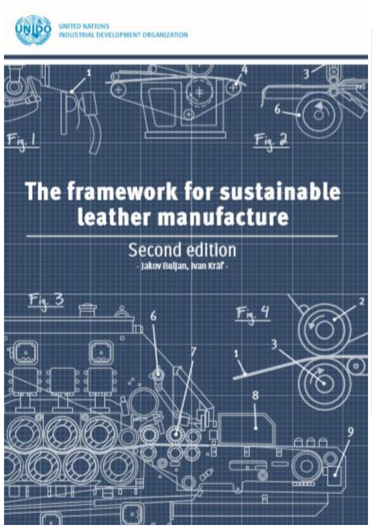
10% energy savings with solar air drying of leather

# Kanpur Leather Development Project

## Safer Working Practices

- Created learning modules on safe working practices
- Over 1,400 industry staff trained in class room
- E-learning portal already utilized by over 17,000 industry stakeholders in India




## Sustainable Leather Manufacture

Reference guide for tanning and leather wet processing


leatherpanel.org

# Greening Thai Automotive Supply Chain

- 74 SMEs achieved
  - Annual monetary savings of 7.9M EUR
  - Waste reduced by 2,161 ton/yr, average of 49%
  - Waste water reduced by 118,230 m3/yr, average of 51%
  - Energy reduced by 27%, contributing to 16,431 ton reduction of GHG emissions
  - Improved rankings in GreenMark Certification
  - Improved access to financing

switchasia
NETWORK FACILITY

IMPACT SHEET • SWITCH-ASIA PROJECT
**GREENING OF THE THAI AUTO AND AUTOMOTIVE PARTS INDUSTRY**

# Greening Sri Lankan Hotels

- Introduction of sustainable consumption and production practices in 365 small and medium hotels
  - Rs 250 million annual monetary savings (~1.5 MEUR)
  - Reduction of energy use by 8.3%
  - Reduction of solid waste generation by 20%
  - Reduction of waste water discharges by 14.3%
  - GHG reduction by 9850 MT
  - Increased availability of green products and services

switchasia
NETWORK FACILITY
IMPACT SHEET • SWITCH-ASIA PROJECT
**GREENING SRI LANKAN HOTELS**

# Embed Man-Made in Natural Ecosystem

- Multi-pronged agenda to recover value from previously discarded wastes
  - For recovery of materials, water and/or energy
  - In all life cycle stages
  - With ultimate purpose to
    - Perpetually retain man-made materials in man made systems
    - Release natural materials back to environment within nature's capacity and at its pace
  - Taking care of environmental risks, particularly those arising from increasing material complexity of all wastes
  - Facilitated by conducive policy framework to
    - Discourage or prevent disposal of wastes
    - Encourage or mandate use of recovered/recycled resources
    - Facilitate and support innovation and investment

# Today’s Opportunities

## • Closing the Loop

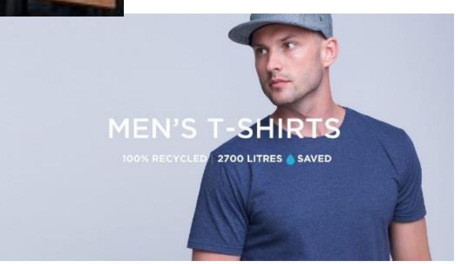
Circularity in denim processing

- 70% water use
- 50% fuels
- 20%  recycled fibre
- Salt recovery

ARVIND
FASHIONING POSSIBILITIES


Circular Product

- 100% post consumer recycled knitwear




## • Wealth from Waste

GCIP
Global Cleantech Innovation Programme

Saathi


Biodegradable sanitary pads from waste banana fibre

ASPARTIKA™

Omega-3 fatty acids from silk worm pupae

BRiSIL
Products for better future

Silica additive from rice husk ash to reduce tyre rolling resistance

# Industrial Symbiosis

- Engages traditionally separate industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water and/or by-products.
  - The keys to industrial symbiosis are:
    - Collaboration and
    - Synergistic possibilities offered by geographic proximity

Chertow, M 2000, 'Industrial Symbiosis: Literature and Taxonomy', *Annual Review of Energy and Environment*, vol. 25, pp. 313-337

# Industrial and Urban Symbiosis

- Kawasaki Eco-Town (Japan)
  - Traditional heavy industry base
  - Industry modernization driven by integration of environmental service delivery to adjacent city, including
    - 69,000 tpa office archives recycled to sanitary paper
    - 130,000 tpa plastics reused for form boards, blast furnace reductant, synthesis gas production and alternative fuel
    - 32,000 tpa organic soil and sludges used as alternative fuel for cement making
    - 315,000 tpa blast furnace slag reused as alternative raw material for cement
  - Total benefits
    - > 0.5 million ton waste diverted from landfill
    - > 130 MUSD annual economic benefit

川崎市
KAWASAKI CITY

van Berkel, et all (2009) *Quantitative Assessment of Urban and Industrial Symbiosis in Kawasaki*, Env Sci & Tech, pg 1271-1281

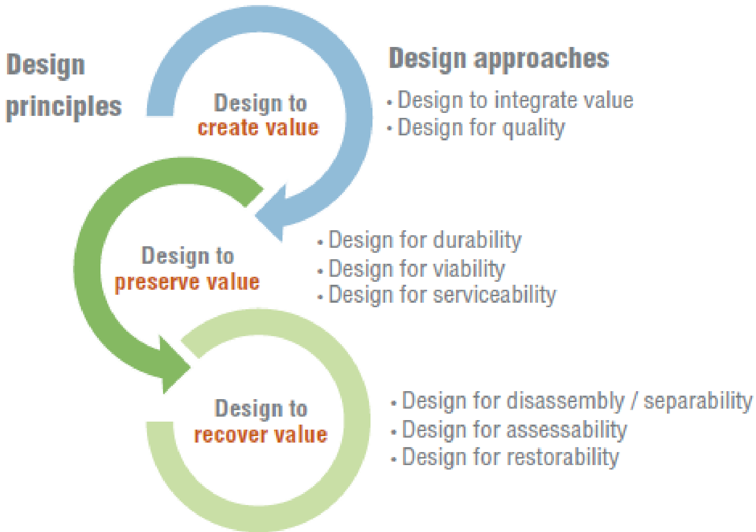
# Value Retention in Circular Economy

| | Value-Retention Process | Definition |
|---|---|---|
| Full Service Life VRPs (Occur within Factory Operations) | OEM NEW[2] (MANUFACTURING) | The value-added to production of merchandise for use or sale, from using labor and machines, tools, chemical and biological processing, or formulation. Manufacturing processes are the steps through which raw materials are transformed into a final product. The manufacturing process begins with the product design, and materials specification from which the product is made. These materials are then modified through manufacturing processes to become the required part. |
| | REMANUFACTURING | A standardized industrial process[3] that takes place within industrial or factory settings, in which cores[1] are restored to original as-new condition and performance or better. The remanufacturing process is in line with specific technical specifications, including engineering, quality, and testing standards, and typically yields fully warranted products. Firms that provide remanufacturing services to restore used goods to original working condition are considered producers of remanufactured goods. |
| | COMPREHENSIVE REFURBISHMENT* | Refurbishment that takes place within industrial or factory settings, with a high standard and level of refurbishment. |
| Partial Service Life VRPs (Occur within Non-Factory Operations) | ARRANGING DIRECT REUSE | The collection, inspection and testing, cleaning, and redistribution of a product back into the market under controlled conditions (e.g. a formal business undertaking). (From Document UNEP/CHW.13/4/Add.2) |
| | REPAIR | Fixing a specified fault in an object that is a waste or a product and/or replacing defective components, in order to make the waste or product a fully functional product to be used for its originally intended purpose.[5] (From Document UNEP/CHW.13/4/Add.2) |
| | REFURBISHMENT | Modification of an object that is waste[4] or a product to increase or restore its performance and/or functionality or to meet applicable technical standards or regulatory requirements, with the result of making a fully functional product to be used for a purpose that is at least the one that was originally intended.[5] (From Document UNEP/CHW.13/4/Add.2) |

International Resource Panel

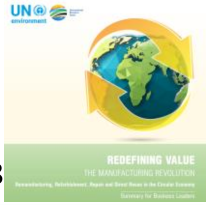

International Resource Panel, 2018

# Value Retention in Circular Economy


- Benefits
  - GHG reductions 79-99%
  - Material savings 80-98%
  - Costs 15-80%
- Contingent on
  - Improved design
  - Parts monitoring and recovery
  - Customer acceptance

International Resource Panel




International Resource Panel, 2018

# Productivity and Innovation: enabling transition to Circular Economy!

| GO RENEWABLES | RELENTLESSLY PRACTICE EFFICIENCY | RECYCLE PERPETUALLY |
| --- | --- | --- |
| Maximize substitution of non-renewable resources | Improve efficiency of use of all resources | Value recovery from all wastes |
| ***Reinventing the Loop*** | ***Dematerializing the Loop*** | ***Closing the Loop*** |

Business and societal value creation through productivity and innovation

# Getting Ahead of the Curve

## Discourage Disposal

- Landfill, effluent and air regulations and enforcement
- (Economic) liability

## Reward Circular

- Standardization
- Product requirements
- (Public) Procurement

## Foster Innovation

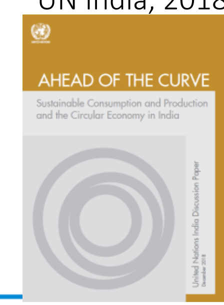
- Lifestyle and consumption patterns
- Business models
- Products and technologies

Environmental Policy

Economic Policy

Innovation & Education Policy

UN India, 2018



# Shifting Gears for Efficiency and Circularity

**Assess**

Improve understanding of key resource flows and environment, climate and socio economic impacts

**Direct**

Improve capacity of government, business sector and civil society to implement CE/RE techniques, practices and policies

**Achieve**

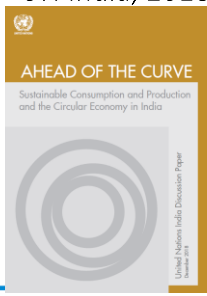
Accelerate development and implementation through focus on catalysts

UN India, 2018

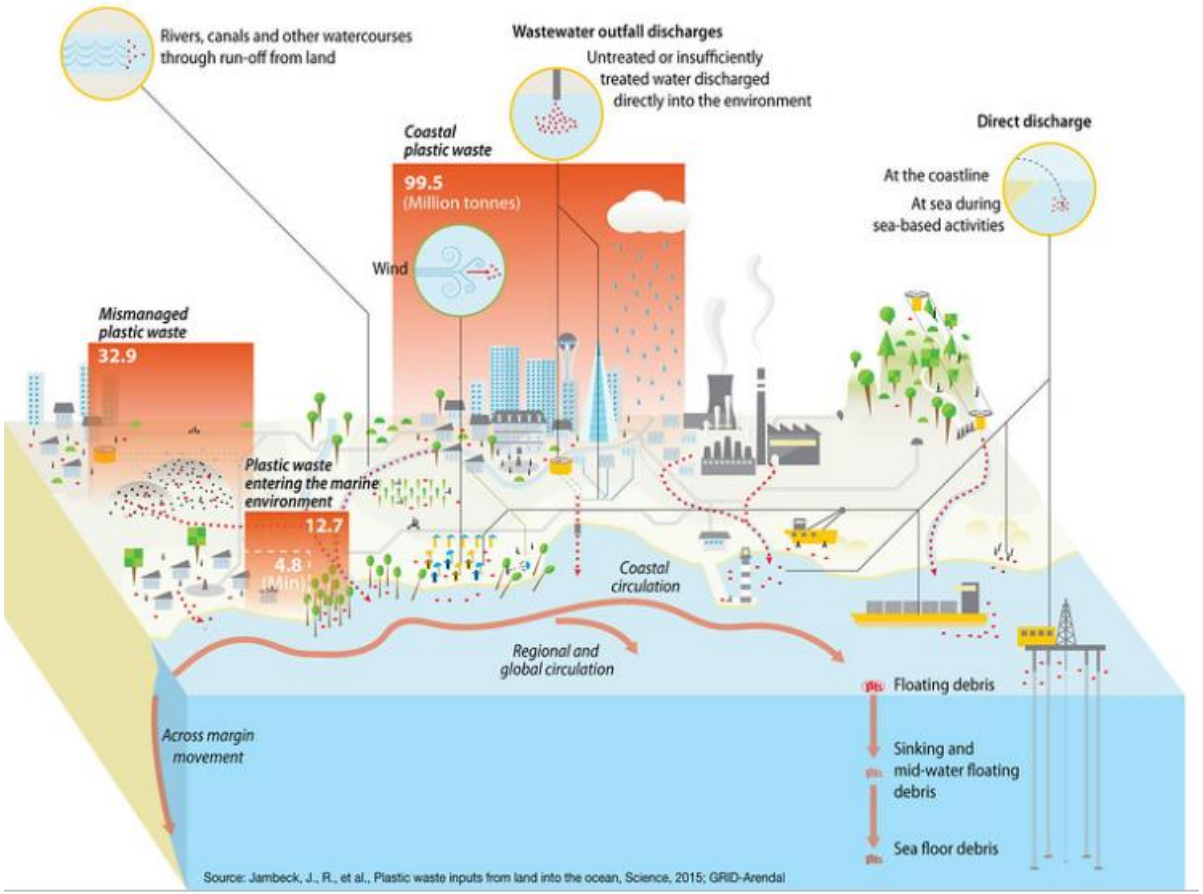
# Accelerators

- Granular assessment of resource flows and their impacts
- Targeted in depth assessment of practical solutions towards dematerialization
- Promotion of roadmap for implementation through partnerships, markets and regulation


UN India, 2018



# Pathways to Marine Litter




GRID Arendal, 2018

# Circular Economy Approaches to Litter Prevention

**Product Design**
- Design for Environment

**Manufacturing & Service Delivery**
- Resource Efficient and Cleaner Production

**Product & Service Use**
- Sustainable consumption and lifestyles

**End of (First) Life**
- Reuse, Recycle and Recover

**Final Disposal**
- Environmentally sound management


UNIDO, 2019

# UNIDO Integrated Approach

**1. Policy Development & Dialogue**

Strengthened waste management regulations, policy incentives and partnerships for plastics waste minimization and litter prevention

**2. Consumer Awareness & Action (litter prevention)**

Improved consumer awareness on and uptake of low-plastic or plastic-free product and packaging alternatives and source segregation and environmentally sound waste management

**3. Industry Awareness & Action (product alternatives)**

Improved industry awareness on and uptake of eco-design, resource efficiency and waste minimization to reduce plastic waste in manufacturing, use and disposal of products and packaging

**4. Recycling Industry (resource recovery)**

Reduced leakages and increased reuse, recycling and/or recovery of plastics in waste collection, management and disposal

UNIDO, 2019

# Want to know more?

René VAN BERKEL
United Nations Industrial Development Organization
r.vanberkel(at)unido.org