WWF PAPER ZA 2018

Futures food for thought

Low-carbon manufacturing

Takeaway

The imperative to substantially reduce global carbon emissions over the coming decades will require reductions beyond the energy sector (including energy efficiencies). Strategies for manufacturing products fit for a low-carbon economy are multi-faceted. Rethinking product and process design, the overall value chain for the creation, use and end-of-product life, and the management and use of waste streams are some of them.

Besides the carbon emissions benefits, new processes, technologies and products present opportunities for localising manufacturing. Low-carbon manufacturing can boost South Africa's competitive advantage and give access to export markets while overcoming barriers to carbon-intensive exports which other countries are increasingly considering establishing.

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CONTENTS

Ensuring sustainable manufacturing and consumption patterns, supports Sustainable Development Goal (SDG) 12 of the 2030 global agenda for sustainable development, which feeds into SDG 11 and 13.

SUMMARY

South Africa is planning to reorient its economy towards a low-carbon trajectory. At the heart of this lies a change in the country's energy system which continues to rely on fossil fuels, and a shift in the country's industrial base which is both energy- and carbon-intensive.

So far, visions for fostering low-carbon goods have been lacking in the debate. While the idea of minimising the carbon footprint associated with goods is understood, there is limited understanding on the ways in which industrial products and consumer goods can be produced to be low-carbon.

Many countries are considering establishing barriers to carbon-intensive exports. Making the shift to low-carbon manufacturing will help South Africa better protect its competitiveness in the global arena. Exploring the multi-faceted strategies that can be used in low-carbon manufacturing provides us with insights into where the shifts need to be made in the manufacturing value chain, and the challenges that must be factored in.

WHY SHOULD YOU THINK ABOUT THIS?

Countries across the world are beginning to institute more stringent legislative requirements to encourage the consumption of low-carbon goods and to improve resource management. Developments in technology and market changes will also continue to shape manufacturing, although under stricter environmental constraints.

US$5 TRILLION

estimated worth of global market for low-carbon products[1]

About 29% of South Africa's carbon emissions are exported to other countries – the highest percentage of any country's emissions that are so transferred.[2] This renders South Africa's exports highly vulnerable in the face of global low-carbon shifts, making it imperative to transition the economy away from this carbon-intensive export model.

Apart from avoiding trade barriers, a shift to low-carbon manufacturing offers South Africa various benefits:

- OECD estimates that across G20 countries, combining climate action with economic reforms will lead to an increase of 1% of GDP by 2021 and 2.8% by 2050.[3]

- There is a substantial market for low-carbon products.

1 Organization for Economic Cooperation and Development (OECD). Undated a. OECD Sustainable Manufacturing Toolkit. https://www.oecd.org/innovation/green/toolkit/aboutsustainablemanufacturingandthetoolkit.htm.

2 CarbonBrief. 2017. Mapped: The world's largest CO_2 importers and exporters. https://www.carbonbrief.org/mapped-worlds-largest-co2-importers-exporters.

3 OECD. 2017. Investing in Climate, Investing in Growth. OECD. Paris.

The matrix below provides an overview of how goods and manufacturing relate in terms of their carbon intensity. The challenge for the South African economy is to gradually move away from a **high-carbon manufacturing–high-carbon goods** quadrant to a **low-carbon manufacturing–low-carbon goods** quadrant. The former provides little opportunities for promoting low-carbon manufacturing, whereas the latter has a range of approaches available to support low-carbon manufacturing.

High/low-carbon goods and manufacturing matrix

External environment & Business	Goods reinforce economic dependence on fossil fuel consumption	Goods support transition to a low-carbon economy
Policy	**High-carbon goods**	**Low-carbon goods**
Fossil fuels subsidised **High-carbon manufacturing**	• **Energy supply**: Predominantly coal- and oil-based.	• **Energy supply**: Predominantly coal and oil-based.
	• **Supply chain**: Fossil fuel intensive; transportation of raw material and finished goods primarily by road; limited usage of rail, freight and public transport.	• **Supply chain**: Fossil fuel intensive; transportation of raw material and finished goods primarily by road; limited usage of rail, freight and public transport.
	• **Usage**: Finished goods reinforce dependence on fossil fuels by promoting carbon intensive consumption, e.g. heavy private vehicles, Mineral Energy Complex in South Africa.	• **Usage**: Finished goods support low-carbon transition, e.g. solar panels, windmills, electric cars and increased production of energy-efficient goods.
	• **Approaches for low-carbon manufacturing**: Remanufacturing.	• **Approaches for low-carbon** manufacturing: Remanufacturing, material substitution, recycling and reducing yield losses.
Renewable energy and climate policy in place **Low-carbon manufacturing**	• **Energy supply**: Flexible, not solely dependent on coal and oil.	• **Energy supply**: Flexible, predominantly based on renewable sources of energy.
	• **Supply chain**: Sustainability and reduction of carbon emissions emphasised; usage of rail, public transport and freight promoted to transport goods.	• **Supply chain**: Sustainability and reduction of carbon emissions emphasised; usage of rail, public transport and freight promoted to transport goods.
	• **Usage**: Finished goods sustain dependence on fossil fuels by serving carbon intensive consumption, e.g. heavy private vehicles, Mineral Energy Complex.	• **Usage**: Finished goods support low-carbon transition, e.g. solar panels, windmills, electric cars and increased production of energy-efficient goods.
	• **Approaches for low-carbon manufacturin**g: Eco-design, additive manufacturing, material substitution, remanufacturing, reducing yield loss.	• **Approaches for low-carbon manufacturing**: Eco-design, material substitution, additive manufacturing, reducing yield losses, recycling and remanufacturing.

APPROACHES TO LOW-CARBON MANUFACTURING

There are two main approaches to manufacturing low-carbon goods:

- **Managing the energy supply for and energy consumption by industry:** This centres on developing low-carbon alternatives for energy provision on the supply-side and supporting energy-efficiency measures on the demand-side. Even the adoption of best available technology by industry largely results in energy-efficiency gains, because new technologies tend to improve on older ones, particularly when it comes to energy efficiency.

- **Manufacturing and increased update of low-carbon technologies and optimising supply chains:** A country can insert itself into global low-carbon value chains by developing capacity for manufacturing low-carbon energy-supply technologies. This requires a favourable policy environment. A case in point is the Renewable Energy Independent Power Producer Procurement Programme in South Africa, which has brought into focus the manufacturing of equipment and components for the functioning of the renewable energy industry. This is also substantiated by the focus on green growth as indicated in the South Africa's industrial strategy.

However, opportunities extend beyond technologies that can be directly identified as low-carbon, and the manufacturing process needs to go beyond promoting renewable energy and energy-efficiency interventions.

OPTIONS AND CHALLENGES FOR LOW-CARBON MANUFACTURING

A range of options could be deployed throughout the lifespan of a product to achieve the production of goods that emit less carbon per equivalent output than their conventional counterparts.

These include, amongst others, eco-designing and manufacturing long-lasting products; reducing yield losses; material substitution (e.g. light-weight design); additive manufacturing (also called 3D manufacturing); recycling; and remanufacturing.

All these options have their own challenges, and their deployment is not foolproof. The various options also pose different trade-offs.

Eco-design

Eco-design is the integration of environmental considerations at the design phase, considering the whole product life cycle, from raw materials acquisition to final disposal.[4] Once a product has been designed and the manufacturing technologies fixed, there are only minor possibilities to increase process efficiency and to minimise emissions in the production processes. Eco-design means that the carbon content of goods can be reduced even before actual manufacturing.

80%

of product-related environmental impacts that occur during the design phase[5]

Options for eco-design include:

- Minimising the material throughput per product
- Making smaller products
- Designing and manufacturing longer-lasting products
- Designing products for recyclability or remanufacturing.

Research indicates that one-third of all material used could be saved if products were designed to optimise material-use instead of costs.[6] While smaller products mean less packaging, longer-lasting products spread the embodied energy or carbon in the product across a longer period.[7] Goods can be made long-lasting if they are designed in a way that extends their life, gives them a second use, or allows them to be easily repaired or upgraded.

Home appliances energy efficiency (A = most efficient)

Naturally, the optimal lifespan of a product is not the same for everyone, and depends on the discretion of the user.[8]

Dishwasher detergents that clean effectively and remove stains at temperatures as low as 40 °C compared to 50–55 °C, allow consumers to achieve as much as 20% energy savings on average.[9]

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4 Schischke, K., Müller, J. & Reichl, H. 2006. *EcoDesign in European Small and Medium Sized Enterprises of the Electrical and Electronics Sector Status Quo and the Road towards EuP*: 233–238. 10.1109/ISEE.2006.1650067.

5 Schischke, *et al.*, 2006. *EcoDesign in European Small and Medium Sized Enterprises of the Electrical and Electronics Sector Status Quo and the Road towards EuP*: 233–238.

6 Carruth, M.A., *et al.*, 2011. Quoted in Allwood, *et al.*, 2013. Material efficiency: Providing material services with less material production. *The Royal Society Philosophical Transactions, A: Mathematical Physical and Engineering Sciences*. March 13: 371(1986): 20120406.

7 Royal Academy of Engineering (RAE). 2013. *Made For The Future. Challenges in creating a sustainable domestic supply chain.*

8 RAE, 2013. *Made For The Future. Challenges in creating a sustainable domestic supply chain.*

9 OECD, Undated a. *OECD Sustainable Manufacturing Toolkit.*

Challenges to overcome

- Designing for sustainable solutions requires an ecosystem approach that prioritises Research and Development (R&D) and professional skills development. These are long-term interventions that take time to show results.
- A recent study identifies eco-design challenges in five areas: strategy, tools used, collaboration, management and knowledge.[10] While tools design is an on-going area of focus, management and knowledge-related challenges are most often cited by practitioners. Eco-designers also identified resistance amongst staff to meet eco-design requirements as a new challenge.
- Complying with the international eco-design standards is necessary to reach international markets. Matching the designer with material-maker can also be a constraint.

Reducing yield losses

Yield losses refer to the difference between mass of material purchased and the mass of material eventually used in products. Studies examining yield losses along supply chains suggest that despite efforts by companies, accumulated losses in certain manufacturing industries are significantly high, such as in printing, packaging, textiles and those industries using metals to make final products.[11] However, new technologies could reduce yield losses. For example, yield losses in the clothing industry can be reduced when sheets of fabric are laser-cut into pieces prior to sewing, thus allowing for better tessellation so that patterns and shapes fit perfectly together.

Challenges to overcome

- Reducing yield losses cuts the availability of scrap for recycling.
- It also reduces both the supply and demand for material flowing through secondary production.

These factors make this strategy less effective than pursuing light-weight design or product life extension.[12]

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10 Dekoninck, E.A., Domingo, L., O'Hare, J. A., Pigosso, D. C.A., Reyes, T. & Troussier, N., 2016. Defining the challenges for ecodesign implementation in companies: Development and consolidation of a framework. *Journal of Cleaner Production*, 135: 410–425.

11 Milford, *et al.*, Quoted in Allwood, *et al.*, 2013. Material efficiency: Providing material services with less material production. *The Royal Society Philosophical Transactions, A: Mathematical Physical and Engineering Sciences*. March 13: 371.

12 Allwood, *et al.*, 2013. Material efficiency: Providing material services with less material production. *The Royal Society Philosophical Transactions, A: Mathematical Physical and Engineering Sciences*. March 13: 371.

So Critical So Fashion exhibition in Milan on September, 20 2013. Alternative fashion exhibition of biological, vegan and recycled materials during Milan Fashion Week

Material substitution

The types of materials used and how they are combined determine the environmental impacts in the extraction of the material, the end-of-life options for the product, and the carbon content of goods. Material substitution is using low-carbon products or materials rather than more emissions-intensive products or materials. In some cases, material substitution involves redesign at the component level to optimally utilise the specific properties of the new material.

Hemp-fibre shirts

Examples from the textiles industry

The textiles industry can produce low-carbon goods by substituting organic fibres for conventionally grown fibres. Organic or natural fibres use less energy, no petrochemical-based fertilisers and pesticides for production, and have lower carbon emissions. Alternatives include organic wool, linen, bamboo, hemp, abaca, and soybean fibre.

Natural fibres also have a smaller carbon footprint in the production of the spun fibre, and can be degraded by micro-organisms and composted, as opposed to synthetic fibres that do not decompose.

Examples from the construction industry

20%

embodied carbon emissions reduction achievable with light-weight structural solutions

Light-weight material usage in the construction industry can minimise the consumption of raw material:

- Use of light-weight structural solutions for elements such as roofs can result in savings in embodied carbon not only in the component itself but also in the associated structure. Savings in emissions vary by building type and specification, but typically as much as 20% emissions reduction is achievable.[13]

- Even simple substitutions such as replacing concrete or steel with wood products leads to low-embedded carbon goods. Evidence suggests that the amendment in 2009 to the Canadian British Columbia Building Code to allow wood-use instead of steel and concrete for mid-rise residential construction, has led to avoiding approximately 92 000 tonnes of CO_2e from approximately 145 buildings. These buildings are also said to store 103 000 tonnes of CO_2e given that wood acts as a natural storage for carbon.[14]

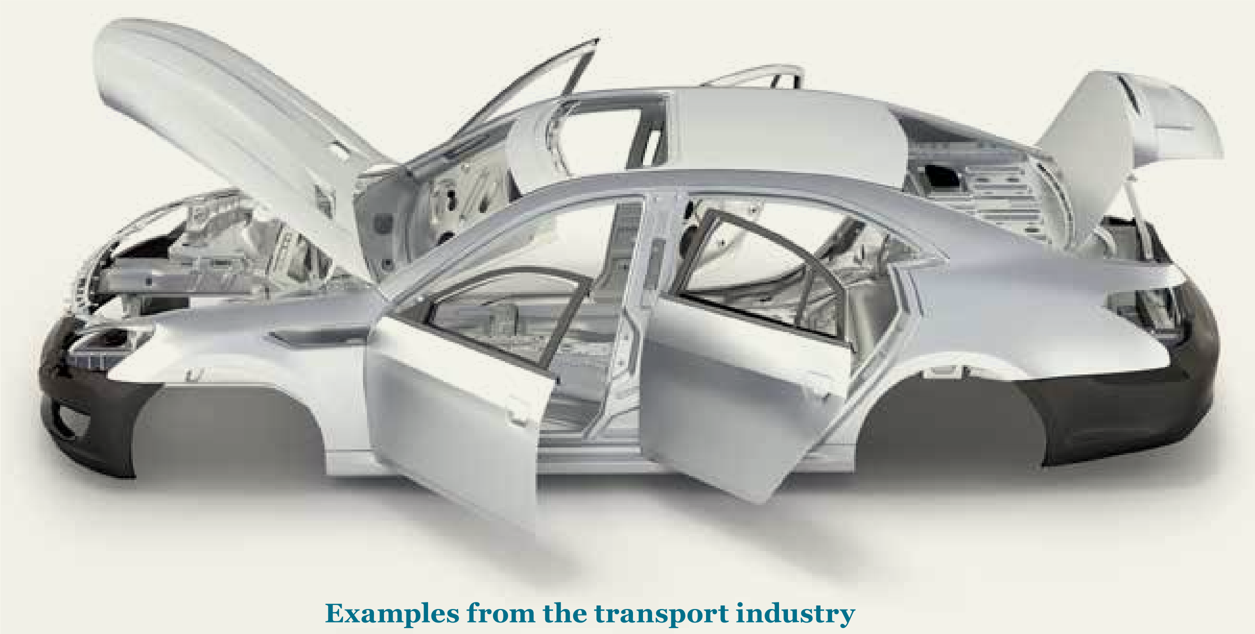
- There are new binders, alternative to Portland cement for certain applications, which may hold the potential for absorbing carbon as they cure, offsetting the process emissions of their manufacture.

About CO_2e

To enable us to compare the warming effect of the 17 different greenhouse gases (GHGs), they are converted to a common basis called carbon dioxide equivalent – CO_2e – expressed as 'carbon emissions' for short.

13 Waste and Resources Action Programme (WRAP), Undated. *Cutting embodied carbon in construction projects*. Available at: http://www.wrap.org.uk/sites/files/wrap/FINAL%20PRO095-009%20Embodied%20Carbon%20Annex.pdf. Accessed on 28 August, 2017.

14 Melanidis, M., 2017. The substitution effect. *Pacific Institute for Climate Solutions*. Available at: https://pics.uvic.ca/sites/default/files/04_substitution_final.pdf. Accessed on 28 August, 2017.



Examples from the transport industry

High performance or excellent fuel-efficiency are primary in the aerospace, automotive, and locomotive industries. Using new light-weight composite materials instead of heavy components, can reduce material utilisation in goods and minimise weight, reducing the direct carbon footprint and energy consumption of the product when it is used.[15]

Light-weight materials offer low density with high stiffness and strength. They are also becoming popular for low-carbon technologies, such as wind turbines. Fibre-reinforced polymer composites and carbon fibres are also providing alternatives to traditional fibres.[16]

6%–8%

the fuel economy improvement in a vehicle with a 10% weight reduction[17]

The idea behind using light-weight materials in industries with moving parts such as in the transport and wind turbine industries is that such materials offer significant potential for increasing efficiency because less energy is used to accelerate a lighter object than a heavier one.

> *"Replacing cast iron and traditional steel components with lightweight materials such as carbon fiber, high-strength steel, magnesium and aluminium alloys, and polymer composites can reduce the weight of a vehicle's body and chassis by up to 50% and therefore reduce a vehicle's fuel consumption."*
>
> (US Department of Energy (DoE), undated)

15 McKinsey & Company, 2012. *Lightweight, heavy impact. How carbon fiber and other lightweight materials will develop across industries and specifically in automotive.* Available at: http://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/Automotive%20and%20Assembly/PDFs/Lightweight_heavy_impact.ashx.

16 Mishnaevsky, L., Branner, K., Petersen, H.N., Beauson, J., McGugan, M., & Sørensen, B.F., 2017. Materials for Wind Turbine Blades: An Overview. *Materials*, 10(11): 1–24.

17 US Department of Energy (DoE), undated. Lightweight Materials for Cars and Trucks. Available at: https://energy.gov/eere/vehicles/lightweight-materials-cars-and-trucks. Accessed on 28 August, 2017.

Find out more

You can find out more about the options for producing lower-carbon cement in the following documents:

- *Global Cement Technology Roadmap: Low-carbon transition in the cement industry,* 2018. International Energy Agency and Cement Sustainability Initiative. Available at: www.wbcsdcement.org/index.php/key-issues/climate-protection/technology-roadmap
- *Eco-blend cements for low-carbon construction*, 2018. WWF South Africa. Available at: www.wwf.org.za/report/cements_lowcarbon
- *Cement sector: Life Cycle Optimisation Service, 2018.* Available at: wwf.org.za/report/cement_sector_life_cycle_optimisation_service

Challenges to overcome

Swapping traditional manufacturing techniques and materials with alternatives such as bio-composites or light-weight materials has complications:

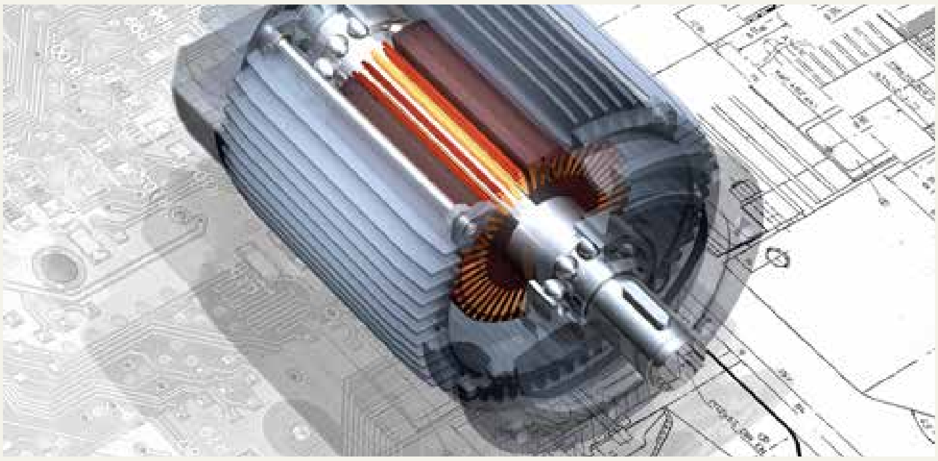
- Less carbon-intensive substitute materials that have performed as well as traditional carbon-intensive options may not be available in comparable quantities to match the ambition to decarbonise manufactured products.
- The technologies that will play an important role in the clean energy shift are, "*more material intensive in their composition than current traditional fossil-fuel-based energy supply systems*" (World Bank, 2017).
- Some low-carbon alternatives may consume considerable amounts of energy and other resources, such as water.
- For light-weight materials:
  - There are many different ways to engineer materials to be light-weight, and the risks associated with them need to be determined on a case-by-case basis.
  - More importantly, light-weight materials that replace metal and glass must be able to resist temperature variations and meet the same standards of reliability and safety.
  - Light-weight materials offer weight-reduction potential, but at a much higher cost. For example, carbon fibre that is 50% lighter than steel and offers the highest weight-reduction potential is also the most expensive, costing 570% more than steel.[18]

BIO-COMPOSITE:

a composite material created by a matrix (resin) and a reinforcement of natural fibres

18 McKinsey & Company, 2012. *Lightweight, heavy impact. How carbon fiber and other lightweight materials will develop across industries and specifically in automotive.*

Additive manufacturing (3D manufacturing)



Motor section detail

ADDITIVE MANUFACTURING OR 3D PRINTING:

a process by which physical objects are created by depositing raw materials layer upon layer based on a digital prototype design[20]

3D manufacturing is an example of new manufacturing processes and technologies that lower emissions. This contrasts with 'subtractive' methods of manufacturing, where raw materials are removed to create the desired form or structure.[19]

- The 3D manufacturing process enables a significant reduction in waste, as no material is removed or cut away, and only the material that forms the finished product is used.
- 3D manufacturing techniques are becoming popular for manufacturing parts for aircrafts and motor vehicles, as well as for use in the plastics, ceramics, textiles and metals industries, where raw materials are converted more directly to end-products and many of the intermediate steps and assembly lines are avoided. In doing so, 3D manufacturing has the potential to reduce imports and localise manufacturing of products and components.
- Besides reducing the energy and carbon footprint of the manufacturing process, 3D techniques decrease transport emissions and packaging waste associated with the shipment of manufactured goods.

Challenges to overcome

- Products produced through these techniques tend to exhibit limited properties and generally have poor surface finish, necessitating further process steps.
- Some applications of these techniques require energy intensive processes.[21]

19 McKinsey & Company, 2012. *Lightweight, heavy impact. How carbon fiber and other lightweight materials will develop across industries and specifically in automotive*.

20 Campbell, T., Williams, C., Ivanova, O. & Garrett, B., 2011. Could 3D Printing Change the World? *Strategic Foresight Initiative*. Atlantic Council of the United States. Washington, DC.

21 Allwood, *et al*., 2013. Material efficiency: Providing material services with less material production. *The Royal Society Philosophical Transactions, A: Mathematical Physical and Engineering Sciences*. March 13: 371.

Recycling

Reusing materials or existing parts after the end of their operating life to produce the equivalent of new products, reduces the waste of materials, saves energy, and therefore carbon emissions.

Recycling usually applies to simple items such as drinks containers, steel products, paper goods, and even textiles and apparel. In manufacturing however, recycling applies to complex products, and usually results in a loss of up to 95% of the value added in the initial manufacture.[22]

One possibility in the context of recycling is the circular economy, industrial ecology or industrial symbiosis, where one manufacturer's waste serves as another's raw material to supply or fuel a machine or industrial process.[23] Examples include using leftover wood chips and sawdust obtained from furniture makers as kiln fuel in brick manufacturing.

> *"A circular economy is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life."*
>
> (WRAP homepage)

Challenges to overcome

While recycling promotes material efficiency, it may lead to increased energy demand because making parts re-usable may be energy-intensive.[24] Some options may even have the rebound effect.

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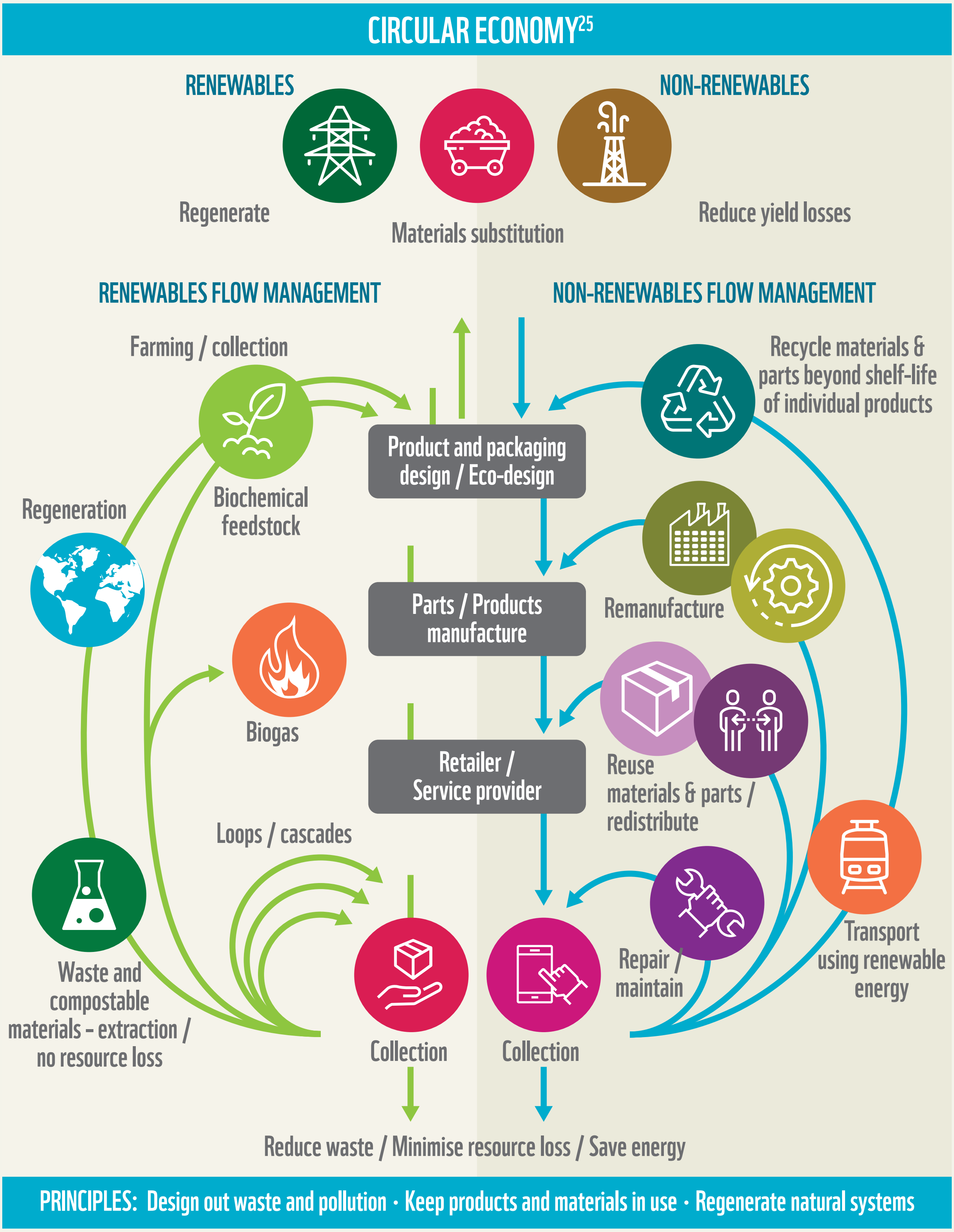
22 Allwood, *et al.*, 2013. Material efficiency: Providing material services with less material production. *The Royal Society Philosophical Transactions, A: Mathematical Physical and Engineering Sciences*. March 13: 371.

23 RAE, 2013. *Made For The Future. Challenges in creating a sustainable domestic supply chain.*

24 Pera Knowledge, 2006. *Remanufacturing Towards a More Sustainable Future.* Available at: http://www.lboro.ac.uk/microsites/mechman/research/ipm-ktn/pdf/Technology_review/remanufacturing-towards-a-more-sustainable-future.pdf. Accessed on 29 August.



25 Adapted from: Ellen MacArthur Foundation, SUN, and McKinsey Center for Business and Environment; Drawing from Braungart & McDonough, Cradle to Cradle (C2C).

Remanufacturing

Remanufacturing is the process by which used products and assemblies are returned to a new state with minimum waste and expenditure on materials and energy. In this process, parts that do not wear out are disassembled. They are then reused in a rebuilt product that incorporates the technological advances necessary to ensure that the product is returned to functionality in an efficient manner.[26]

Retreading tyres – a particular example of remanufacturing

Products that are suitable for remanufacturing include vehicles, electric motors, tyres, electronic goods such as computers, telephones and televisions, industrial equipment, vending machines, photocopiers, toner cartridges and aircraft parts.

Remanufacturing also contributes towards fostering incentives for value chain modernisation by creating new business models that focus on services instead of products.[27]

Some estimates suggest that remanufacturing requires only 15% of the energy needed to produce a completely new item. Besides saving raw materials, remanufacturing leads to a significant reduction in carbon emissions, while maintaining much of the value added during the product's manufacture.

Challenges to overcome

- Lifespans of products to be remanufactured can be overtaken by the availability of other technologies to perform a function better.
- Prolonged product life may also lead to foregoing opportunities to exploit technological advances offered by newer products that reduce emissions during use. It may result in a technological lock-in, in which the market is stuck with a particular product even though it may be better off with an alternative.[28]

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26 Pera Knowledge, 2006. *Remanufacturing Towards a More Sustainable Future.*

27 World Business Council for Sustainable Development (WBCSD), (2012). *Collaboration, innovation, transformation – Ideas and inspiration to accelerate sustainable growth: A value chain approach.* Geneva: WBCSD. Available at: http://wbcsdservers.org/wbcsdpublications/cd_files/datas/business-solutions/consumption/pdf/CollaborationInnovationTransformation.pdf. Accessed on 29 August, 2017.

28 RAE, 2013. *Made For The Future. Challenges in creating a sustainable domestic supply chain.*

FOOD FOR THOUGHT

- Successful options for low-carbon manufacturing bring additional benefits to companies in the form of lower operating costs, increased flexibility, and distinctive competitive advantages.[29] Industry may delay incorporating these options into their manufacturing strategies, but the global goals of tackling climate change and the 2030 global agenda for sustainable development means that industry cannot ignore the coming changes for long.
- With rapidly growing markets, obtaining even a small market share of the low-carbon manufacturing market would constitute a substantial export opportunity for South African industry.
- The challenge for any industry is to develop a novel product, or to deploy innovative designs and technologies and to rapidly and profitably scale production should the market embrace it. There is no proven solution that can be adopted by industry. Each industry, perhaps even each company, needs to do a comprehensive analysis of the available options.
- Industry and government must work together to explore and develop a suite of options for the production of low-carbon goods and for decarbonising manufacturing. Together they must consider shared opportunities and challenges.

Policy perspectives

- Uncertainties about policy trajectories and customer acceptance have a significant effect on the types of low-carbon goods produced by industry and the low-carbon innovation opportunities pursued by companies. What regulations, standards, incentives, certification systems and policies can help low-carbon goods succeed in the marketplace?
- What policies can help industry manage the inherent risks and difficulties in pursuing low-carbon manufacturing?
- Government is establishing flexibilities and safeguards to give carbon-intensive industries breathing space to prepare for the realities of a low-carbon future. Examples include exemptions under the proposed carbon tax. However, too many mechanisms that are too lax weaken the mitigation system, rather than reorient the economy in a low-carbon direction. By receiving such protection, is industry failing to push the transition to low-carbon manufacturing? Would this failure adversely impact the capability of South African companies to compete with international players?
- How can government promote procurement of locally remanufactured products such as office furnishing and equipment, carpet flooring, electrical equipment and medical appliances, where possible?
- How can government encourage original equipment manufacturers to extend the useful life of manufactured products?
- Governing pertains to a long-term vision for the manufacturing of low-carbon goods, in tune with the evolving technology, inherent market uncertainties, and challenges.[30] How can the broader process of manufacturing decarbonisation be governed (bearing in mind that governing is different to regulating and to providing incentives?

29 Hargadon, A., 2011. The Business of Innovating: Bringing Low Carbon Solutions to Market. *Center for Climate and Energy Solutions*. Arlington, VA.

30 Åhman, M., Nikoleris, A., & Nilsson, L.J., 2012. *Decarbonising industry in Sweden. An assessment of possibilities and policy needs*. Department of Environmental and Energy Systems Studies, Lund University. Lund, Sweden.

TALKING POINTS

- How can the production of low-carbon goods boost competitive advantage and give access to export markets?
- How can industry adopt eco-design – specifically design products to have a second life after serving their initial use – and design products in a way that promotes recycling and remanufacturing at the end-of-life?
- How can products be made to last longer? Are any options available beyond the policy and manufacturing arenas?
- How can industry take lifetime responsibility for their products – from manufacture to servicing to disposal – so as to encourage the longer usage and subsequent return of products to manufacturers or remanufacturers at the end-of-life stage?
- How can industry promote shared responsibility throughout the supply chain as opposed to the current practice where responsibility for products is transferred from producer to retailers and finally to consumers upon sale? The shared approach is fast becoming the norm in the electronics industry given the e-waste recycling laws that seek to prevent electronics from ending up in landfills. Manufacturers of various other products will begin to craft their wares to be more readily disassembled and recyclable, especially if the company has to take them back at some point.
- What business models will allow the move to the circular economy?

Futures food for thought

The climate change mitigation debate in South Africa needs to move from improving efficiency within a projection of the existing economy, to innovation and options beyond the constraints of the current dispensation and structure of the economy. It may take step changes in the development path to achieve mitigation adequate to South Africa domestic and international commitments, and maximise economic development and social wellbeing. Business models presently unconsidered may be waiting in the wings.

The 'Low-carbon development frameworks in South Africa' project seeks to deepen understanding of, and reveal opportunities for, transitions to a low-carbon economy. It facilitates and develops contributions at the intersection of climate change mitigation, economic development and socio-economic dimensions, across immediate, medium and long-term horizons.

Working variously with government, business and labour, the project reaches from providing input to emerging government mitigation policies and measures; through investigating the business and socio-economic case for selected mitigation initiatives which hold growth potential in energy, transport, industry, waste, and land use; to analysing potential future economic trajectories and the systemic opportunities offered by these.

This paper is one in a set of 'Futures food for thought' papers. It examines the multi-faceted strategies that could be used to manufacture low-carbon industrial products and consumer goods fit for a low-carbon economy.

The project is funded by the International Climate Initiative (IKI) of the Federal Ministry for the Environment (BMUB) of Germany, and implemented by WWF South Africa.

WWF South Africa's Policy and Futures Unit undertakes enquiry into the possibility of a new economy that advances a sustainable future. The unit convenes, investigates, demonstrates and articulates for policy-makers, industry and other players the importance of lateral and long term systemic thinking. The work of the unit is oriented towards solutions for the future of food, water, power and transport, against the backdrop of climate change, urbanisation and regional dynamics. The overarching aim is to promote and support a managed transition to a resilient future for South Africa's people and environment. The organisation also focuses on natural resources in the areas of marine, freshwater, land, species and agriculture.

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TOPICS IN SERIES

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