



IMPLEMENTING  
**CIRCULAR ECONOMY**  
GLOBALLY MAKES  
PARIS TARGETS  
ACHIEVABLE



**CIRCLE**  
ECONOMY

**ECOFYS**

# IMPLEMENTING **CIRCULAR ECONOMY** GLOBALLY MAKES PARIS TARGETS ACHIEVABLE

The climate conference in Paris has produced a landmark agreement. The emission reduction commitments made by 195 countries are a leap forward, but not yet sufficient to stay on a 2 °C trajectory, let alone a 1.5 °C pathway. Current commitments address only half the gap between business as usual and the 1.5 °C pathway. There is still a reduction of about 15 billion tonnes CO<sub>2</sub>e needed to reach the 1.5 °C target.

Further solutions are therefore needed; solutions that go beyond decarbonising our energy system. Since over half of the worldwide greenhouse gas emissions are associated with producing basic materials, there is a clear role for circular economy strategies in reducing this gap.

Analysis by Ecofys and Circle Economy estimate that circular economy strategies can reduce the gap between current commitments and business as usual by about half. To do this, the circular economy describes a practical and scalable landscape of opportunities by moving towards business models for an economy that is by design regenerative and as waste free as possible. Strategies at the heart of the circular economy include measures to reduce the input of virgin materials, improve the use of existing assets and reduce the output of waste. Circular economy strategies related to materials are: recovery and reuse, lifetime extension, sharing and service models, circular design and digital platforms.

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# 1

## CURRENT COMMITMENTS AND INITIATIVES PROVIDE ONLY HALF THE SOLUTION

The Paris Agreement marks a new phase in international cooperation on climate change. There was a recognition of the urgent need to take action on climate change, while also uniting 195 countries behind a strong commitment to reduce greenhouse gas emissions in a universal, legally binding global climate deal with the ambition to limit global temperatures well below 2 °C, with the intention to limit it even further at 1.5 °C. In the lead up to Paris, countries submitted their mitigation commitments for 2030 or beyond. These commitments or “Intended Nationally Determined Contributions” (INDCs) focus on emission reduction measures, such as improving energy efficiency, promoting renewable energy, improving land management, reducing deforestation, and reducing non-CO<sub>2</sub> greenhouse gas emissions.

To reach the 1.5 °C ambition it is estimated that annual global greenhouse gas emissions need to be reduced with 26 billion tonnes CO<sub>2</sub>e<sup>a</sup> in 2030.<sup>1</sup> In an assessment for the United Nations Environment Programme (UNEP), researchers show that if all policies and measures proposed by the countries that participated in the negotiations are successfully implemented, we already deliver about half of the reductions needed by 2030.<sup>1</sup> Although further actions are needed. Actions that should go beyond what countries have currently proposed.

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<sup>a</sup> The unit CO<sub>2</sub>e describes, for a given mixture and amount of greenhouse gasses, the equivalent amount of carbon dioxide that would have the same global warming potential, when measured over a specified time period.

# 2



**Circular economy is a business logic to decouple prosperity gains from raw material use.**

## CIRCULAR ECONOMY CAN HELP BRIDGE THE REMAINING HALF

The circular economy is a business logic that describes practical and scalable opportunities, made possible by moving towards business models and policies for an economy that is by design regenerative and as waste free as possible. The circular economy thereby provides a practical solution to the planet's emerging resource problem. At the heart of the circular economy is the idea of moving away from linear value chains that we have had in place for more than 200 years. Away from an economy of take-make-waste, a linear approach, and moving towards a circular approach that allows to cycle products and materials many times and make better use of existing assets. The real benefit of the circular economy is to decouple things that we want from our economic system; prosperity, from what we do not want; the wasteful use of scarce natural resources. A circular economy is thereby a decoupling strategy aimed at growing prosperity while operating within the boundaries of our finite planet.

Circular economy strategies can help countries to find ways to reduce emissions beyond what they currently committed. Strategies that are the cornerstone of circular economy, but which are limited in current emission reduction commitments, use concepts like car-sharing, modular building, refurbishment of equipment and optimised cascading of biological waste materials. These strategies enable us to do more with less resources. When realising that over 50% of our greenhouse gas emissions are related to material management, making more efficient use of our existing materials and assets becomes a sound greenhouse gas mitigation strategy.

## THE SITUATION

Under a business as usual scenario, the global temperature by 2100 will be more than 4°C above pre-industrial levels

## THE END GOAL

To limit temperature rise to 1.5°C, we need to cut greenhouse gas emissions from 65 to 39 billion tonnes CO<sub>2</sub>e per annum by 2030

## THE SOLUTION

Current national commitments achieve about half of the required emissions cuts. Circular economy may fill about half of the remaining gap

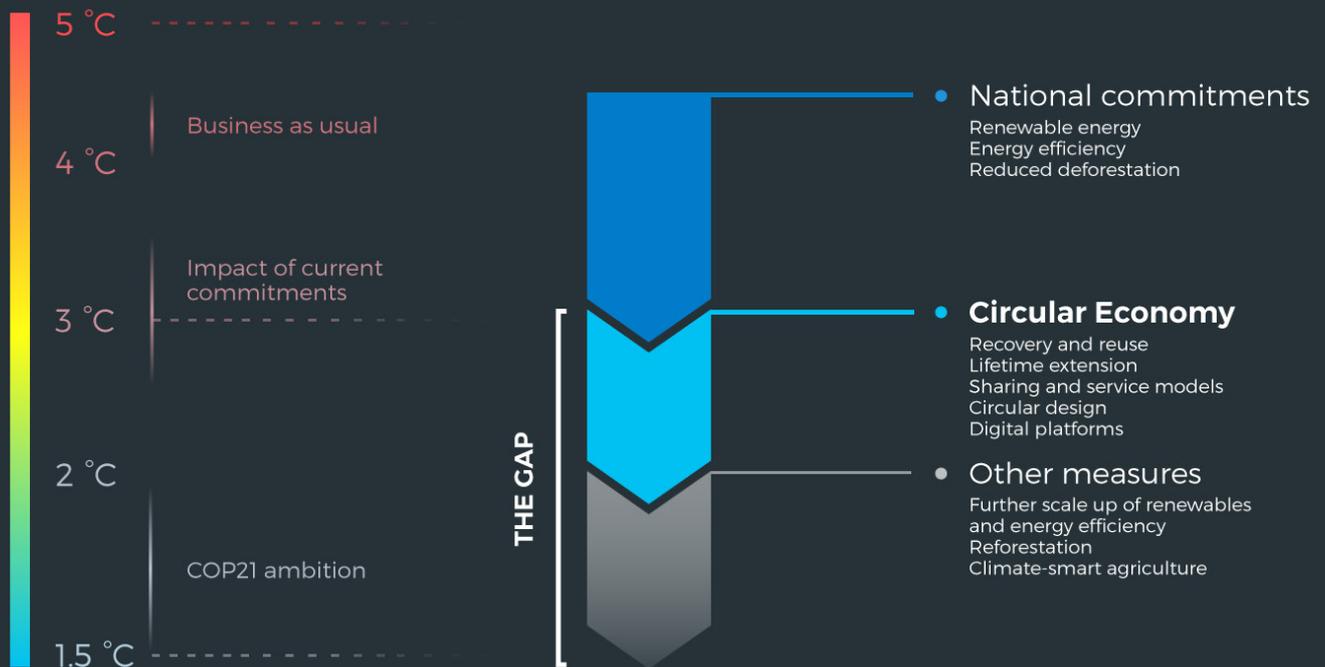


Figure: Global greenhouse gas emissions amounted to 48 billion tonnes CO<sub>2</sub>e in 2010. When continuing on a 'business as usual' pathway, emissions would reach 65 billion tonnes CO<sub>2</sub>e by 2030. In that scenario we are facing dangerous climate change, with an increase of the global temperature over 4 °C by the year 2100. To limit climate change by the end of the century to the 1.5 °C ambition expressed in Paris, annual emissions should stay below 39 billion tonnes CO<sub>2</sub>e per year by 2030. Compared to the 'business as usual' scenario there is a gap of 26 billion tonnes CO<sub>2</sub>e. Climate policies already in place and committed to under the Paris Agreement, can deliver a reduction of 11-13 billion tonnes CO<sub>2</sub>e. Of the remaining emissions, we estimate that circular economy strategies can contribute to further mitigating the emissions gap by about half.<sup>1</sup>

# 3



Only 7% of the materials used by the global economy today are reused.



## KEY STRATEGIES TO MOVE TO CIRCULARITY AND MITIGATE EMISSIONS

To move towards a circular economy, we need to understand what is not circular about our current economy. Strategies at the heart of the circular economy can reduce our material and carbon footprint in addition to strategies proposed under the Paris Agreement. Right now, most of these strategies focus on energy efficiency and conservation, renewable energy, land management, reduced deforestation, etc.

### How circular is the world today?

To fuel our economy, we rely heavily on material extraction. We extract roughly 60 billion tonnes of raw materials each year<sup>2</sup> or 22 kilograms per person per day. Firstly, about half of the materials extracted today cannot be recovered because they are the fossil fuels that we combust or the food products that we eat. Secondly, a large share of the materials extracted are construction minerals like sand, gravel and limestone for cement production that we use for the construction of houses, offices, roads and other infrastructure. Materials used in construction are locked in physical structures for relatively long periods (long term stock). These materials can only be recovered when structures are demolished at the end of their lifetime. However, with present processing, materials are typically down cycled. Construction minerals represent the largest material use category, where 'virgin' materials are needed, not only because current reuse options are limited, but mostly to keep up with the demand for infrastructure development in the developing world. Thirdly, the biggest share of the remaining materials is used for products like cars, refrigerators, clothing, cleaning agents, personal care products, etc.

All in all, this is a diverse and complex group of products that generally have short to medium lifetimes in our economy. The opportunities for reuse vary considerably. Some products, such as used paints and cleaning agents, are virtually unrecoverable. Many other products currently are not recovered to their full potential due to a lack of collection infrastructure and the lack of reuse and recycle processes, such as for repurposing of textiles and construction and demolition wastes. Highly recoverable materials presently include metals and glass. Altogether, only 7% of the materials used by the global economy are recycled and reused.<sup>2</sup>

Circular economy strategies include measures that find broad application in climate policies and strategies, like increasing the share of renewables in a country's energy mix and improving energy efficiency. Further, circular economy proposes strategies which reduce the input of virgin materials, improve the use of existing assets and reduce the output of waste. Circular economy strategies related to materials are:

### **Recovery and Reuse**

Recovering and treating wastes and by-products for reuse as inputs or cascading for other uses.

### **Lifetime Extension**

Extending the lifetime of products and assets through a greater focus on maintenance, upgrade, and repair, as well as reverse logistics, product take-back, and remanufacturing.

### **Sharing and Service Models**

Offering products as a service through pay-per-use models and employing sharing and leasing platforms to maximise utilisation of products and assets.

### **Circular Design**

Designing products and assets with low-carbon material selection and minimised resource use throughout the lifecycle in mind.

### **Digital platforms**

Dematerialise by replacing physical services with online equivalents like Spotify and use the internet of things to optimise resource use and maximise value.



# 4

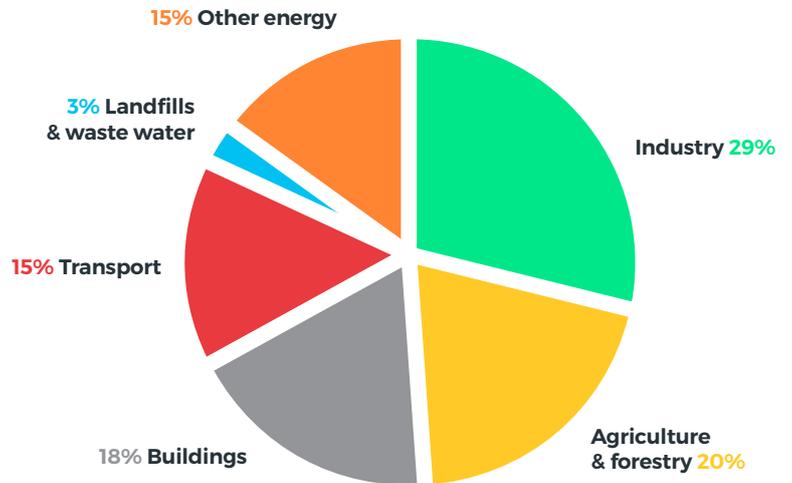


Materials management related emissions account for more than half of total GHG emissions.

## PRACTICAL IMPLEMENTATION AND ACCELERATION OF CIRCULAR EXAMPLES IN THE WORLD TODAY

Practical examples of the circular economy are found all around us, though not yet on the scale needed and possible. This implementation happens across industries including the four broad categories that represent 82% of the world emissions: industry, agriculture & forestry, buildings, and transport. For all sectors compelling business examples underwrite what the role of the circular economy strategies can be in these sectors.

EMISSION BREAKDOWN<sup>3</sup>



## Industry

Within industry, lifetime extension strategies such as remanufacturing offers one of the biggest opportunities for emissions reduction. Remanufacturing is an industrial process by which a previously used product or component is returned to a “like-new” condition. It involves dismantling a product, restoring and replacing components, and testing individual parts to ensure that it meets

original performance specifications.<sup>4</sup> As remanufacturing preserves much of the material in the original product, less energy and material resources are needed for manufacturing a new product. Looking at the global metabolism, remanufacturing would keep products in circulation, reducing the share of short-lived products and placing them in long-term stocks.

## CASE STUDY CHEMICAL LEASING

### FROM BUYING CHEMICALS TO PAYING PER ITEM CLEANED

Chemical leasing is based on a simple but powerful idea. Instead of selling a volume of chemicals, suppliers get paid for the services rendered by the chemicals - the volume of water treated, the number of parts painted, the lengths of pipes cleaned, etc. Doing so decouples profits from the sale of chemicals and encourages suppliers to focus on the function of chemical over its entire lifecycle instead of the amount sold.

Serbian manufacturer FKL produces metal parts for the global car industry. Cleaning these parts required large amounts of chemicals and solvents like Tetrachloroethylene (PERC), which was discarded as hazardous waste and posed health risks to workers. To optimise the use of PERC, FKL signed a five-year contract with their suppliers to implement a Chemical Leasing model. Instead of paying their suppliers per liter of solvent, FKL paid their suppliers based on the number of working hours. As a result of moving towards the chemical leasing model, FKL achieved significant economic, environmental and safety benefits. The company reduced its use of solvent by over 80% and its production of hazardous waste by over 95%. Operational improvements also resulted from the new model - shorter cleaning cycles, significantly lower maintenance costs, and less frequent changes of the solvent.<sup>5</sup>

Companies such as FKL involved in the global industrial cleaning of metal parts have the biggest gains from chemical leasing. According to UNIDO, these companies consume more than 2.6 million tonnes of chemicals per year globally and could reduce consumption by 50% by moving towards a leasing model. For just the global industrial cleaning industry, chemical leasing would result in estimated waste reductions of more than 100,000 tonnes per year and emission reductions of nearly 300,000 tonnes CO<sub>2</sub>e due to energy savings.<sup>6</sup>

## Agriculture & Forestry

In the agriculture & forestry sector, circular economy strategies can help avoiding food losses, improve waste management and help reuse the waste, for example by the replacement of primary products. The potential is significant since FAO<sup>7</sup> estimates that each year, approximately one-third of all food produced for human consumption in the world is lost or wasted. Without accounting for greenhouse gas emissions from land use change, the carbon footprint of food produced and not eaten is estimated to 3.3 billion tonnes CO<sub>2</sub>e. Besides increasing greenhouse gas emissions this 'not used agricultural production' also occupies valuable

agricultural land, consumes water and contributes to loss of biodiversity. Interesting strategies can be for example 'nutrient recovery technologies'. These technologies can break down manure to produce several nutrient-rich products which can be used to replace synthetic fertilisers, whose costs have increased significantly over the past decade and which contribute heavily to CO<sub>2</sub> and N<sub>2</sub>O emissions.<sup>8,9</sup> Complementing these processes through anaerobic digestion has additional benefits of providing by-products such as biogas that can replace fossil fuels for the generation of heat and electricity.<sup>10</sup>



### CASE STUDY NUTRIENT RECOVERY

#### LARGE-SCALE COW MANURE DIGESTION PLANT

FrieslandCampina, a global dairy company, plans to build a central facility to process cow manure from 100 dairy farmers. This first of its kind large-scale installation will process approximately 100,000 tonnes of manure per year at which scale operation is economically feasible. Presently, in the Netherlands alone, nearly 74 million tonnes of manure is produced yearly and disposed with heavy disposal costs. The facility reverses this logic treating cow manure as a valuable resource for the production of biogas, fertilizer replacement, refined minerals and clean water. The large-scale pilot installation will not only reduce overall emissions by producing biogas but will also recover nutrients like phosphates and soil enhancers for reuse in agriculture. The latter will lead to avoiding additional CO<sub>2</sub> emissions as the production of artificial fertilizer can be avoided. The broader strategy aims to eventually process 8.5 million tonnes of manure by 2020. The biogas extracted from this volume alone will result in nearly 1.2 million tonnes of CO<sub>2</sub>e reduction.<sup>11</sup>

## The built environment

Circular design strategies in the building sector have the potential to realise emissions reductions in the supply chain in addition to making our buildings more energy efficient. Though much of the CO<sub>2</sub> emissions in buildings are attributed to energy use by appliances and for heating and cooling, the embodied emissions in the materials and construction of buildings is often overlooked.

Construction materials make up the vast majority of materials which become long-term stocks. The long lifetime of buildings and infrastructure is positive but still too often the embedded materials end up as waste when a construction reaches the end of its life-time. Substituting construction materials with low-carbon alternatives,

flexible design to aid repurposing and extend the lifetime can reduce the carbon and material footprint of the construction sector.

The CO<sub>2</sub> emissions carbon embodied in building materials make up around 40-50% of the carbon footprint of an office building, primarily due to the production of cement and steel required.<sup>12</sup> Nearly 80% of the energy used during construction comes from the preparation of construction materials, primarily the cement and concrete for the foundations and structures of our infrastructure and buildings. The remaining 20% is used to transport materials, remove waste, and use energy on-site.<sup>13</sup>



Cross-Laminated Timber (CLT) utilises several layers of timber board glued at 90 degree angles to form highly stable material that also provides fire-resistance. The sheets need to be manufactured and cut to exact sizes which favour prefabrication and modular construction. This speeds up the construction process and reduce waste materials on-site. Moreover, the modular construction process also makes dismantling and deconstruction easier, freeing up the CLT sheets to be reused in other buildings. There is a growing movement using CLT as construction material for tall buildings. Led by Vancouver architect Michael Green and his proposed 35-storey Baobab tower in Paris, the concept has spread with multi-storey wooden skyscrapers planned in Stockholm, Vancouver, Vienna, and most recently London.

The emissions savings of greater timber use can be significant. While 1,200 tonnes of CO<sub>2</sub> are produced from constructing a skyscraper out of concrete and steel, 3,100 tonnes are sequestered if the same skyscraper were made out of wood.<sup>14</sup> This is because compared to concrete and steel, the use of wood can take advantage of the carbon cycle. As more trees are planted for use in construction, CO<sub>2</sub> can be absorbed and captured within buildings. This results in global emissions reductions of 14-31% due to a combination of CO<sub>2</sub> stored in the wood as well as CO<sub>2</sub> and fossil fuels use avoided.<sup>15</sup> Additionally, wood is lighter than concrete, reducing energy needs for transportation.<sup>16</sup>

## Transport

Automobiles dominate the transportation and mobility industry. However, a typical automobile is parked and idle for nearly 95% of its lifetime.<sup>17</sup> With over 1.2 billion motor vehicles on the road, this represents a significant amount of resources that

are underutilised and wasted. Circular economy strategies such as sharing models for automobiles and driving as a service models can improve the utilisation of existing automobiles and significantly reduce the demand for new vehicles and associated materials.



### CASE STUDY CAR SHARING

#### THE SWITCH FROM CAR OWNERSHIP TO USAGE

Zipcar is one of the most successful car sharing operators in the United States. Started in 2000, it has expanded into more than 450 cities globally with over 950,000 members. Each Zipcar serves the need of nearly 40 of its members.<sup>18</sup> Compared to the 4% utilisation of private vehicles, Zipcars are in use nearly 34% of the time – a factor of 8 in improved asset use.<sup>17</sup>

Car sharing has shown to cause changes in travel behaviour that reduces driving by nearly 30% and causes a 46% increase in public transportation trips<sup>19</sup>, which results in nearly 40% emissions reductions.<sup>20</sup> In addition, for every rented Zipcar, nearly 15 private vehicles are replaced<sup>20</sup>, representing significant reductions in vehicle needs and savings in resources required for vehicle production. In the United States, rapid adoption of car sharing is estimated to reduce annual new car sales by nearly 50%. This would lead to even more emissions savings due to the reduced demand for resources for new vehicle production.

Greater global adoption of car sharing can lead to even higher global emissions reductions. In Germany alone, coordinated expansion of car sharing and public transport services could bring down CO<sub>2</sub> emissions by nearly 6 million tonnes per year.<sup>21</sup>



# 5

## IMPLEMENTING CIRCULAR ECONOMY STRATEGIES CAN MASSIVELY REDUCE CLIMATE IMPACT

Circle Economy and Ecofys have estimated that, in order of magnitude, the potential of a more circular world economy can play a key role in bridging the emissions gap to a 1.5 °C pathway. Making our economies more resource efficient will reduce greenhouse gas emission all the way up the value chain, from logistics to manufacturing to the mines from which raw materials are sourced. This potential stretches across the borders which demarcate national climate commitments and favours intensifying cooperation along supply chains and closing local material cycles.

The potential of circular economy is estimated to close half of the emission gap between commitments and the 1.5 °C pathway in 2030. This is based on an analysis of origin of emissions and the reduction potential if circular energy and circular materials were used. This is combined with current studies on the potential of circular economy for different sectors and countries.

First, an important part of the emissions is caused by: industry (29%), agriculture & forestry (20%), buildings (18%) and transport (15%). Within emissions in the industry and agriculture & forestry sector can be related to materials, such as non-metallic minerals (6% of world emissions); iron and steel (5%); chemical & petrochemical (4%); livestock and manure (7%).<sup>27</sup>

This means that half of the worldwide emissions are related to materials. This is also confirmed in a publication by OECD

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Research shows that 54-64% of the emissions are related to materials. Circle Economy and Ecofys see possibilities for the reuse of materials, since this can reduce the greenhouse gas emissions associated with the production of basic materials.

We assume that across the globe about 50% of the greenhouse gas emissions are related to materials. If we are able to reduce the emissions related to materials with about 20-30% with circular economy strategies, we are already closing half of the emission gap between current commitments and the 1.5 °C pathway in 2030.

Such emission reduction potential for circular economy strategies is confirmed by several studies. Circular economy strategies will reduce the use of virgin materials. Using recycled materials results in a strong reduction in energy demand requirements. For example, secondary or recycled aluminium demands only 5% of the energy that is needed to produce primary aluminium.<sup>23</sup> Aluminium is an extreme example, for most materials savings in energy use and greenhouse gas emissions by recycling will be between 40-80%. The circular economy way of thinking can also reduce emissions of materials by challenging businesses to change their strategy by using different materials or think about how to increase the amount of secondary materials availability to reduce the greenhouse gas emissions.

The circular economy reduction potential is also confirmed by the Ellen MacArthur Foundation.<sup>24</sup> This foundation estimates that the European CO<sub>2</sub> emissions from the mobility, food, and built environment can decrease with 48% by 2030 and with 83% by 2050 compared to 2012 emissions if these

sectors become more circular. This is including measures like material efficiency, renewable energy and energy efficiency. With this 48% reduction in 2030 we are already on a 1.5 °C pathway. This study did not yet take into account the impact of a more circular Europe on emissions beyond the borders of the European Union.

The Club of Rome concluded that decoupling strategies, which include renewable energy, energy efficiency and material efficiency, have the potential to cut carbon emissions by two thirds<sup>25</sup>, which will already be sufficient to close the emission gap. Material efficiency measures in this study include overall material efficiency, replacement of virgin materials by secondary materials and increasing the lifetime of products. The Club of Rome estimated that material efficiency is likely to cut carbon emissions up to 10% in comparison with the business as usual scenario.

The potential of circular materials is also confirmed by research by Zero Waste Scotland. This organization has demonstrated that material consumption is responsible for over two thirds of Scotland's carbon emissions.<sup>26</sup> Scotland used about 60 Mt of resources in 2012, of which about a fifth was wasted. Improving circularity in Scotland will help reduce emissions along the relevant value chain, also beyond the Scottish borders.

UNEP emphasised that delaying mitigation efforts would make the transition to longer-term emission

levels in line with a 1.5 °C pathway significantly more difficult.<sup>1</sup> We need to act fast. Also here circular economy strategies can play a major role, since a major part of the additional circular economy strategies do not require large capital investments. They can be deployed relatively fast.

This all confirms our conviction that circular economy purely with material efficiency can and should bridge half of the remaining emission gap in 2030.



# 6

## CONCLUSION AND WAY FORWARD

Climate change is probably now the most visible environmental symptom of human actions and is beginning to define the true cost of linear growth. Across many parts of the world the logic for change is ever more compelling. Life is going to be all about retaining value in every way possible and sharing value whenever possible.

Current and planned climate policies, when all are successfully realised, would reduce greenhouse gas emissions with 11-13 billion tonnes CO<sub>2</sub>e by 2030, resulting in a gap toward the 1.5 °C pathway of 15 billion tonnes CO<sub>2</sub>e. Circle economy strategies are hardly, if at all, considered in the climate policies, although they can add additional mitigation momentum estimated at covering half the gap.

Circularity has a key part to play not only in dramatically reducing our footprint but also in shaping a visionary future in harmony with our planet. For this we need innovation, aspiration and practicality.

To make that possible we need to embed the circular economy in our climate strategies and policies. Four approaches to make that happen:

1. Improve our understanding of the mitigation opportunities of the various circular economy strategies per sector and quantify the potential.
2. Build new carbon metrics next to the sector-based approach to quantifying emissions developed by the UNFCCC and IPCC. These are tailored to making an inventory of global greenhouse gas emissions. To be able to identify circular economy business cases, we need a systems-based approach to categorising emissions, a call which is also supported by the OECD.<sup>22</sup>
3. Make companies aware of circular business opportunities and help governments facilitate them. This requires engagement on the level of product design and the interaction between consumer and producer, rather than being a matter of incremental improvements.
4. Reform tax systems. Reducing the tax and social security burden on labour and moving taxes to the extraction of raw materials and emission of greenhouse gases is a strong incentive for a transition to an economy that is resource efficient, while safeguarding job opportunities.<sup>27</sup>

## Circle Economy

A social enterprise, organised as a cooperative, Circle Economy advocates a new economic approach. The organisation builds programs and tools to help accelerate the scalable adoption of the circular economy across businesses, governments and communities.  
([www.circle-economy.com](http://www.circle-economy.com))

## Ecofys

Established in 1984 with the mission of achieving “sustainable energy for everyone”, Ecofys has become the leading expert in energy policies, climate strategies and policies, energy systems and markets, urban energy as well as sustainable industries and services. The unique synergy between those areas of expertise is the key to its success. Ecofys creates smart, effective, practical and sustainable solutions for and with public and corporate clients all over the world. With offices in Belgium, the Netherlands, Germany, and the United Kingdom, Ecofys employs over 200 experts dedicated to solving energy and climate challenges.  
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