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The Circular Economy and Benefits for Society

Swedish Case Study Shows Jobs and Climate as Clear Winners



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Executive Summary

The central theme of this report is how to greatly enhance resource efficiency. The proposition is that a circular economy, where products are designed for ease of recycling, reuse, disassembly and remanufacturing should replace the traditional, linear 'take, make & dispose' model that has dominated the economy so far. This, no doubt, is a major prerequisite to stay within the Planetary Boundaries.

It now takes the Earth almost one and a half year to regenerate what we use in a year (Ecological Footprint). Both governments and businesses are beginning to realize that our linear systems of resource use expose both societies and businesses to a number of serious risks. Resource constraints as well as increasing volumes of waste and pollution are likely to impose increasing threats to welfare and wellbeing and, from a business point of view, to competitiveness, profits and business continuity.

Simply put: We are in urgent need of decoupling, or put in other words, a transition to an inclusive and circular economy.

The 'circular economy' is an industrial system that is restorative by intention and design. The idea is that rather than discarding products before their value are fully utilized, we should use and re-use them. Presently only a few percentage points of the original product value is recovered after use.

While relative decoupling of economic growth from resource use has been happening over the past decades, the gains made so far have been rapidly eaten up by a combination of economic growth and the so-called rebound effect, i.e. that the resources freed up by increased efficiency are used up very soon through increased consumption. Here is where the circular economy as a powerful concept comes into play.

Most studies so far on the circular economy have focused primarily on the business case for enhanced resource efficiency. This report rather focuses on the social benefits that a transformation from a linear to a circular economy would entail.

The main purpose of this report is to broadly explore the potential for a significant increase in resource efficiency and to specifically assess what the main benefits for society would be - looking at carbon emissions and employment in particular. We are using the Swedish Economy as a test case.

In the full version of our report, to be released in June/July 2015, the Dutch and Spanish Economies will be examined as well. Our hypothesis is that the circular economy as a concept will offer a number of societal benefits for Europe, not least in terms of carbon emissions reductions and job gains. To draw such conclusions at the general level, however, will require studies pertaining to more than one member-state.

The study is relevant not only from an academic but also from a political perspective, not least in the EU context. The European Commission took several important initiatives in the area of resource efficiency during the years 2011-2014, culminating with the Circular Economy Package.

Regretful as it is, the Juncker Commission decided to withdraw the proposal under the pretext of “deregulation”. After a lot of critique the Commission has made a commitment to re-launch the proposal. We hope that this report can provide input for the Commission’s new proposal, particularly in terms of recognizing the Circular Economy as a key instrument for Mr Juncker’s competitiveness and jobs agenda.

Case Study findings

By making use of a traditional Input/Output model – which accounts for the interdependencies of different branches of a national economy - the report assesses what the likely effects would be on carbon emissions and job opportunities in Sweden by:

- Enhancing energy efficiency.
The Swedish economy would become 25% more energy-efficient.
- Increasing the percentage of renewable energy in the energy mix.
In the case of Sweden, from today's 50% to 75%, cutting fossil fuel use in half.
- Organizing manufacturing along the lines of a materially-efficient circular/performance-based economy, i.e. by extending wealth, minimizing waste and maximizing the reuse and recycling of materials.
A combination of a 25% overall increase in material efficiency + half of virgin materials being replaced by secondary materials + doubling the life-time of long-lived consumer products compared to today.

The results are most intriguing. For each and every-one of the decoupling alternatives there would be a significant reduction in carbon emissions. In addition, the employment effect would be clearly positive.

The results in detail were the following:

- The renewable-scenario led to a 50% reduction in carbon emissions, created some 5000 additional jobs (+0,1%) and improved the trade surplus with roughly 1% of GDP.
- The energy-efficiency-scenario cut carbon emissions by 28%, created some 20.000 additional jobs (+0,5%) and improved the trade balance with 0,2% of GDP.
- The job increase is partly temporary in nature but would last for many years, probably a couple of decades, during which time the necessary investments in retrofitting of old buildings and other efficiency improvements are undertaken.
- The material efficiency-scenario cut carbon emissions by an estimated 10%, created more than 50.000 additional jobs (+1-2%) and increased the trade surplus significantly (more than 2% of GDP). The jobs generated are permanent as a consequence of the changes in the goods-to-services ratio in the economy.

If all three decoupling strategies are being pursued together the results would be substantial:

- Carbon emissions are likely to be cut by almost 70%.

- The number of additional jobs would likely exceed 100.000 – representing between 2 and 3% of the labour-force and in fact cutting unemployment by at least a quarter, may be even half in Sweden.
- The improvement in the trade balance would be above 3% of GDP, i.e. at least 10 billion € a year.

The result of the simulation is like a snapshot. It describes a hypothetical situation, based on certain assumptions. The simulations were based on a combination of manipulating sector supply chains – in favour of renewables and secondary materials - and anticipating at the same time a significantly higher overall level of resource efficiency in the economy.

Policy implications

While further case studies are needed to confirm the results of the case study of the Swedish Economy, it is nonetheless possible to draw some preliminary conclusions in terms of policy implications, of relevance for both the Swedish policy context and the ongoing wider EU debate on a Circular Economy.

With a growing population, and in the developing countries a much-needed increase of per-capita-income (affluence), technology innovation - in combination with policy reforms - are the only options we have to bring down the environmental impacts. Luckily, there are many types of decoupling that could and should be achieved by improved technology, often complemented by behaviour change. Unfortunately, policies to promote such actions are rare. While the promotion of labour productivity has been a priority, resource productivity has been more or less neglected.

To move the economy in the direction of a circular economy, with the potential to deliver considerable social benefits, would require deliberate policy measures - as well as targeted investments - over a period of time; the main objective being to reduce the energy and material throughput in society. In this study the target date for the changes to be obtained in terms of decoupling is set for 2030.

Of central importance will be to view a circular economy not as an environmental issue alone, but as an integral part of jobs and competitiveness strategies. On a related note, a current limitation is that most climate change mitigation strategies are sector-based, with a primary focus on energy use. The general level of resource use in society is seldom taken into account – in spite of the fact that the climate benefits from using products longer and from enhanced rates of recycling and reuse of materials ought to be obvious. The energy saved when recycling metals, for instance, is significant. As a consequence, climate change mitigation strategies need to become more holistic and consider resource efficiency as a key instrument.

In addition to this much needed reframing of the circular economy debate, far-reaching policy reforms are also needed. Some of these measures are already being implemented in Sweden as well as the EU, albeit not to the full extent possible. Such examples are support systems for renewable energy, emissions trading, the eco-design directive, energy efficiency standards, targets for recycling of materials etc. All these policy measures are in need of being strengthened.

In addition a number of new policy measures should be considered, like a more proactive use of public procurement, earmarking investments in favour of resource efficiency within EU's different funding schemes, adoption of resource efficiency targets for materials where scarcity is looming or the overall environmental impact of resource extraction and use is significant and the promotion of new business models geared at functional sales.

Of crucial importance will also be to rethink taxation. This policy area is not an EU competence at present. But the European Commission should be encouraged to take the lead and stimulate a process encouraging member-states to embark on a necessary tax shift.

Taxation in industrialized countries is hitherto dominated by taxes on labour. Taxes on the use of natural resources and the resulting undesired waste and emissions, however, are very low. To move society towards sustainability – both socially and ecologically - would require a tax shift, lowering taxes on work and increasing taxes on the consumption of non-renewable resources in the form of materials and fossil fuels. Such a tax shift would accelerate the transition to a circular economy, which is low-carbon and resource-efficient in nature.

An economy favouring reuse and recycling of materials as well as product-life extension is, by definition, more labour-intensive than one based on a “throw away” concept, i.e. linear resource-flows. The main reason, of course, is that caring for what has already been produced – through repair, maintenance, upgrading and remanufacturing – is more labour-intensive than both mining and manufacturing (often in highly automated and robotized facilities).

Parallel to tax reform, the system of VAT should be carefully analyzed. Goods produced by secondary materials – where VAT has already been paid once – should be exempted from VAT. Such a reform would promote the use of secondary materials – i.e. reuse and recycling – and help correct a situation where it is often less expensive to use virgin materials than recycled ones.

The investments required – in addition to the “normal” level of investments - for moving towards a circular economy have been estimated to be in the range of 12 Billion €, or 3% of GDP, per annum from now on until 2030. This amount equals about half of the present Swedish balance of payment surplus. The investments are needed primarily in the following sectors; agriculture, forestry, timber, pulp and paper, installation services, construction/renovation, maintenance and repair, recycling and development and engineering services.

Some investments must also be directed towards education and employment services to make the labour force ready to take on the new tasks required in the “new” structure of the economy.

1. The Evolution of Resource Efficiency and the Circular Economy Concept

More than forty years have passed since the launch of “Limits to Growth”. Its key message was that a combination of resource depletion and pollution, if un-tackled, would ultimately – i.e. within the next hundred years - bring the global economy down. The background was the rapidly increasing ecological footprint of humanity, as a consequence of the growth in the number of humans and in the resources used and pollution generated per person. The scenarios of the report showed how population growth and natural resource use trends interacted to impose limits to industrial growth - a novel and, indeed, controversial idea at the time.

It should be emphasized that the main focus of Limits to Growth was the growing physical impact of economic growth, not growth itself. The message was that the ecological footprint cannot continue to grow indefinitely because Planet Earth is physically limited and, in fact, rather small relative to rapidly increasing human activities.

In 1972 – when the report was presented - the world’s population and economy were still probably within the planet’s carrying capacity. The report warned, however, that the human footprint was likely to overshoot the physical limitations of the planet – often expressed today as planetary boundaries – in the near future mainly because of delays in decision-making at the political level. It stressed at the same time that forward-looking policy ought to be able to solve the problems. The report warned, however, that technological measures alone would not suffice. A truly sustainable solution for the world would require a combination of technological advance and behavioural change.

Few reports have become so controversial and, not least among economists, so heavily criticized. The main criticism centred on the fact that the report was based primarily on higher consumption trends, while not taking sufficiently into account technological development, substitution and price adjustments.

The debate is slowly sobering up. In recent years a stack of international reports have emerged which essentially confirm the majority of the conclusions in the Limits to Growth. The principals behind these reports are various research institutions, the UN Secretary-General, UNEP, the European Commission, OECD, but also organizations tied to the private/business sector. All of these reports issue strong warnings about the combination of an increasingly unstable climate and the overexploitation of many important ecosystems and natural resources – renewable as well as finite - and pollution taking a heavy toll on vital ecosystems and, as well, on human health.

Growing human footprint

The human ecological footprint has continued to increase. It now takes the Earth almost one and a half year to regenerate what we use in a year. It is important to note, however, that the ecological footprints of developed country citizens are by far much larger than those of developing countries. If all citizens of the world would live by US standards, for instance, we

would need more than 4 planet Earths.

The ecological footprint as a concept was developed in the early 1990's. It has its limitations, but works quite well, especially pedagogically, as an indicator over time about the growing tension between economy and ecology. But even before the launch of the ecological footprint, attempts had been made to describe the impact by human society on the environment. The most important one was the IPAT equation.

IPAT was introduced in the 1970's by a group of pioneers among environmental scientists with regard to the environment – individuals like Paul Ehrlich, John Holdren and Barry Commoner. The equation describes the interaction between population (P), affluence (A) and technology (T) and their multiplicative contribution to environmental impact.

The IPAT equation states that the Impact (I) = Population (P) x Affluence (A) x Technology (T).

The message is simple and, indeed, very useful when considering different ways of reducing the negative impact of human activities – the footprint - on the biosphere as well as the atmosphere. For example, to reduce the risk of an increasingly unstable climate we can either improve technology, change lifestyles and consumption patterns and/or limit the size of the population.

The population factor is often up for discussion. The point is made that the increase in population numbers primarily take place in low-income countries and that the carbon footprint of poor people is low. Right, but the objective ought to be that every human being born on this planet should be able to attain a decent living standard and hence the total size of the population will matter.

Decoupling a must

The central theme of this report is the need to use all kinds of natural resources in a much more efficient way than hitherto. Simply put: We are in urgent need of decoupling, or put in other words, a transition to an inclusive and circular economy (will be defined later).

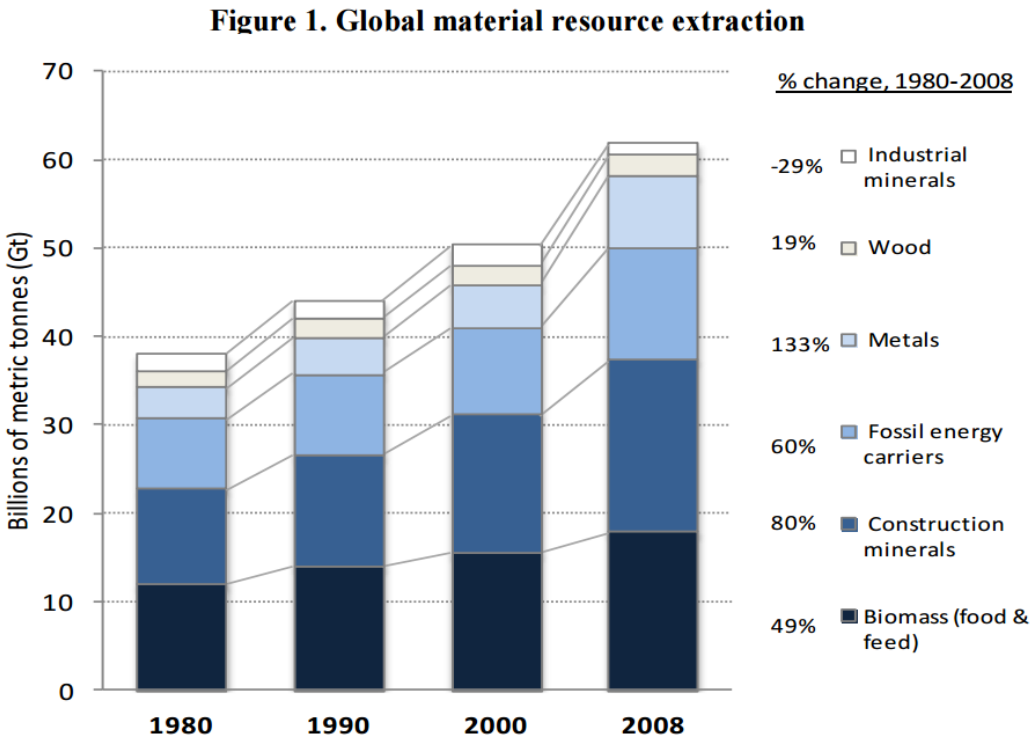
Decoupling refers to the ability of an economy to grow without corresponding increases in energy-and resource use (source limits) and in environmental pressure (sink limits). A decoupled economy should ideally not negatively affect soil fertility and biodiversity, not diminish resource stocks and not lead to increased toxicity of land, water and air. Relative decoupling will buy time, i.e. give the economy some extra time before it runs into resource constraints and/or excess pollution. Once the economy comes close to a limit/boundary, absolute decoupling will be a requirement so as to enable the economy to continue to develop (grow) sustainably.

Unsustainable growth would unavoidably lead to less development (growth) in the long run since the very preconditions for growth and development – the sources and sinks referred to - are being diminished. The crucial interdependency between the economy and the life-supporting systems provided by planet Earth is well understood by most natural scientists.

However, for most social scientists – economists included – and ordinary people the relationship seems to be less clear.

The concept of decoupling economic activity from resource use has been a central theme in the sustainability debate ever since the Limits to Growth Report. While relative decoupling has been happening – and is happening – the gains made, so far have been rapidly eaten up by a combination of economic growth and the so-called rebound effect, i.e. that the resources freed up by increased efficiency are used up very soon afterwards through increased consumption. The demand for commodities has continued to increase over time.

The global material extraction over time is increasing as we speak. The graph below, from a recently published report by OECD, *Material Resources, Productivity and the Environment – Key findings*, describes the situation well:



Source: SERI (Sustainable Europe Resource Institute) material flows database.

According to OECD, growth has been primarily driven by increased global demand for construction minerals, biomass for food and feed and fossil energy carriers. These three material groups account for 80% of total global material extraction.

By 2050, the world economy is expected to quadruple and the global population to grow from 7 billion today to over 9.2 billion. Another *OECD* report, *Environmental Outlook to 2050*, shows the additional strain that this will place on the earth’s material and energy resources and the environment. A growing population with higher average income will require more food, more industrial products, more energy and more water. This creates formidable challenges for sustainable economic and environmental development and, indeed, for a much more efficient use of resources.

With a growing population, and in the developing countries a much-needed increase of per-capita-income (affluence), technology, albeit in combination with policy reforms, is the only factor left in the IPAT-equation to bring down the environmental impacts. Luckily, there are many types of decoupling that can be achieved by improved technology, often complemented by behaviour change. Unfortunately, policies to promote such actions are rare, and if they are put in place, politicians seem reluctant to really let them influence the industrial metabolism and the relative prices of energy and materials to any significant extent. Historically, almost all focus has been on promoting labour productivity, instead of also focusing on material productivity.

Relative decoupling is happening but...

During the early stages of industrialisation the relationship between GDP growth and resource demand has been more or less linear for most countries. Over time, however, the combination of regulation and technology innovation – and, in some cases, price increases - has led to more efficient resource use, not least for energy – and, indeed, lower emissions per good produced. This means that the link between the growth of GDP and resource use has become less pronounced.

To make use of the IPAT-equation again, technology improvements and/or behavioural choices (e.g. choosing a renewable energy source instead of fossil fuels) has made it possible to break the previous linear relationship between economic growth – the combination of increases in population and affluence – and resource use and pollution.

Sweden is a case in point. Demand for electric power, for instance, has been more or less stable since the early 1990's. GHG emissions were roughly 22% lower in 2013 as compared to 1990 (territorial emissions only; when embedded carbon in imports is accounted for the picture is different) .

Based on recent developments the assumption for Sweden would hence be that there is an almost natural movement towards enhanced resource efficiency, in particular with regard to energy. For resources in general the trend can be described as “relative decoupling”, i.e. resource demand per production output is lowered but has so far been eaten up over time by a growing economy. To attain “absolute decoupling” – something urgently needed in a world where the ecological footprint is increasing rapidly, and where the footprint of industrialised countries are many times higher compared to low-income countries - specific policy measures will be needed though.

Using the IPAT-equation again, the technology factor needs to be pushed significantly, both with regards to all kinds of efficiency improvements and innovations - but also concerning fuel choices, modes of transportation and so on - to reduce the environmental impact so as to meet the targets defined by science (exemplified by the IPCC 5th Assessment Report, the Planetary Boundaries Report etc).

One thing we know: The world population is likely to increase by two to three Billion people in the next coming decades. Parallel to that several Billion people will have to experience an increase in their per-capita income to meet the sustainable development goals proposed by the UN. All this means increased demand for energy and materials – and this in a situation

where several of the planetary boundaries have already been transgressed – or are close to being transgressed. The only possible factors to push the equation back within the planetary boundaries will be technology and behaviour change.

All focus so far is on labour productivity

It is, indeed, interesting to compare labour productivity and resource productivity over time. While labour productivity has increased by a factor of twenty or more since the beginning of the 19th century, the productivity gains with regard to the use of natural resources have been modest in comparison.

As an example, the world economy extracts an estimated 40% more economic value from each tonne of raw material today compared with thirty years ago. But the world economy has grown by more than 150% during the same period of time, so the result has been a rapid increase in material consumption. (UNIDO, Green Growth 2013).

Both governments and businesses are beginning to realize that the basically linear systems of resource use expose both societies and businesses to a number of serious risks. Resource constraints as well as increasing volumes of waste and pollution are likely to impose increasing threats to welfare and wellbeing and, from a business point of view, to competitiveness, profits and business continuity.

The main reasons can be summarized as higher input costs of energy and key raw materials, increased competition for resources in general – leading to possible shortages and disruptions – political instability or resource protectionism among key producing regions and increasing social pressure about resource stewardship and climate change.

One issue at a time

Different natural resources and their use are linked to each other in several ways. Energy and water is a case in point. Securing energy supplies accounts today for more than 30% of total water withdrawals globally. The current quest for shale oil and gas and exploitation of tar sands are the latest examples, not only using massive amounts of water, but also polluting water and the surrounding areas heavily.

A number of research reports have shown that both resource and environmental strategies have to be systemic in nature and not focus on individual resources alone. Still, there is a strong tendency among most governments today to deal with one issue at a time. Climate change is no exception.

Most climate change mitigation strategies are sector-based, with a primary focus on energy use. The general level of resource use in society is seldom taken into account – in spite of the fact that the climate benefits from using products longer and from enhanced rates of recycling and reuse of materials ought to be obvious. The energy saved when recycling metals, for instance, is significant.

According to a study by UNEP (2011), less than one-third of some 60 metals studied have an

end-of-life recycling rate above 50 per cent and 34 elements are below one per cent recycling. In theory, metals can be used over and over again, minimizing the need to mine and process virgin materials and thus saving substantial amounts of energy and water, while minimizing environmental degradation and CO₂ emissions. In spite of all this, recycling and reuse rates remain very far from optimal for most metals.

Even if attitudes are gradually changing, we should not disregard the fact that both environment protection and climate mitigation most often have been portrayed as costs or burdens for society and, indeed, for business. Many businesses perceive environment taxes and/or regulation as a threat to competitiveness as well as employment. This is the main reason why progress in terms of environment policy-making in many areas is slow, often painfully slow.

While competition in an increasingly globalized economy is a challenge, there are overwhelmingly good reasons not to view resource efficiency as a threat – neither to competitiveness, nor to employment. On the contrary, our main objective with this study is to demonstrate that there are multiple benefits by moving society – and companies – in the direction of decoupling, i.e. in the direction of a circular economy model.

Resource efficiency is gaining ground

Decades ago the concept “Cradle to Cradle” was introduced, first by Walter Stahel, Founder-Director of the Product Life Institute and leading advocate of resource efficiency, and later on by Michael Braungart and William McDonough, in their landmark report, *Cradle to Cradle; Remaking the way we make things*.

The main thrust of the concept is to create industrial systems that are not only efficient, but essentially waste-free. The basis for this thinking is that the linear way in which the world economy currently operates fuels a culture of excessive consumption and creates much more waste than is sustainable in the long term. In contrast, the living world operates in a circular cycle where the by-product of one species easily provides the feedstock of another.

In his seminal book “The Performance Economy” (2010) Walter Stahel presents a convincing case for extending wealth, by replacing material throughput with activities like reuse remanufacturing and recycling. Today's business models are based on maximizing the volume of sales of various products. As an alternative, Stahel advocates a transition to offer services. Sales of products in many areas will be replaced by leasing, coupled with high-quality services.

Since responsibility for the material used in a product remains with the manufacturing company, strong incentives are created to earn revenue on what has already been produced for as long as possible. The contrast with today's system is significant. According to Stahel the net effects on employment by moving towards a circular / performance-based economy are obvious as service-sectors are more labour-intensive than mining and increasingly mechanized assembly lines in factories. To accelerate a shift to a circular economy Stahel suggests a tax reform – not taxing renewable resources, including human labour - but taxing non-renewable resources instead.

The main principles behind “cradle to cradle” and the performance economy – to extend wealth, to minimize waste and to go for maximum reuse and recycling of materials – is gradually gaining ground. The European Commission flagship program “For a Resource-Efficient Europe”, presented in September in 2011, stressed that:

- Improving the design of products can both decrease the demand for energy and raw materials and make those products more durable and easier to recycle.
- Increasing recycling rates will reduce the pressure on demand for primary raw materials, help to reuse valuable materials which would otherwise be wasted, and reduce energy consumption and greenhouse gas emissions from extraction and processing.

The UNEP Green Economy Report (2011) – which makes a compelling case for investing at least 2% of global GDP in greening the central sectors of the economy – is another example. The report convincingly argues in favour of enhanced resource-efficiency, postulating that such a direction of manufacturing and construction would both save energy, reduce CO₂ emissions and offer new job opportunities.

The OECD work on green growth is yet another example. As expressed in the report “Resource Productivity in the G8 and the OECD” (2011): “By reducing, reusing and recycling (the 3Rs) materials, we can decrease the need for virgin materials and improve resource efficiency. The challenge before us is to move towards a society where we create more value with less natural resource input, and where we do not compromise the needs of future generations”.

The Ellen MacArthur Foundation and its work on the circular economy represents another major breakthrough, not least because the primary focus is on the business sector. The first report of the foundation – Towards a Circular Economy, I - was presented in early 2012 and backed up by a group of leading multinationals, including B&Q, British Telecom, Cisco, National Grid and Renault. The report makes a strong pitch for a “circular economy” and defines the objectives as follows:

“A circular economy is an industrial system that is restorative by intention and design. In a circular economy, products are designed for ease of reuse, disassembly and remanufacturing – or recycling – with the understanding that it is the reuse of vast amounts of material reclaimed from end-of-life products, rather than the extraction of new resources, that is the foundation of economic growth.

Moreover, the circular economy shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior and innovative design of materials, products, systems, and, within this, business models.”

The report also estimated that a subset of the EU manufacturing sector could realize net materials cost savings worth up to \$ 630 billion annually towards 2025—stimulating economic activity in the areas of product development, remanufacturing and remanufacturing. That sum only covers “sweet spot” sectors representing a little less than

half of the GDP contribution of EU manufacturing.

The report also assumed the addition of only one product cycle with today's technologies, while the potential naturally would be to add several cycles to a product and/or its main components. That ought to be made much easier in the future, not least through new technology developments – such as the internet of things, which, among other things, would help keep track of materials and components and make upgrading much easier.

If the next generation of technology would be aiming for long product-lives instead of today's "fast turn-over" focus, which sometimes seems to promote early obsolescence, the circular economy as a concept will be even more interesting to pursue. One main business case to be developed would be the potential of value creation by preserving the embedded labour, energy and material costs in finished products as long as possible. Labour, energy and material all represent value, and the more value which has been added to something, the more reason to maintain, upgrade and make the best use of the product and its components. In mobile phones, for example, it is estimated that roughly 50% of material costs could be saved by the effective use of remanufacturing.

The Ellen McArthur Foundation has also analysed the potential to apply the circular economy concept on fast-moving consumer goods, which currently account for about 60% of total consumer spending, 35% of material inputs into the economy, and 75% of municipal waste. Importantly, the consumer goods sector absorbs more than 90% of our agricultural output – possibly our most embattled resource in the future.

The study – (Towards the Circular Economy II, 2013) - shows that an adoption of the principle of the circular economy could be worth as much as USD 700 billion in consumer material savings alone. The study also highlights the added benefits in terms of land productivity and potential job creation.

A recently published report by IVA (The Royal Swedish Academy of Engineering) also presents a strong plea for enhanced resource efficiency. The point is made that commodities make up roughly 50% of the cost base for manufacturing companies in Sweden today. To enhance resource efficiency is therefore seen as a main prerequisite for competitiveness in the future.

Yet another important report worth mentioning is "Factor 5", a report to the Club of Rome in 2009 written by Ernst von Weizsäcker, today co-president of the Club of Rome. Weizsäcker gives a broad overview of technology options in different sectors of the economy and concludes that already 2009 (at the time of the publication) technology was available in most areas making it possible to radically reduce the energy and materials throughput while maintaining the same quality of wellbeing and service.

The book deals specifically with the issue of the "rebound effect" and how to make sure that resources "saved" will not be put to use in even more environmentally detrimental ways. The best approximation currently proposed to achieve absolute decoupling, without a rebound effect, according to von Weizsäcker, is to politically ensure that energy and resource prices are elevated each year by the percentage of documented efficiency increases of the previous year. This would result in a self-accelerating ping-pong between

resource productivity and related prices, while the real cost paid for energy and resource *services* remain unchanged (on average) over time.

Juncker Commission falters

As a follow-up to the flagship program on Resource-Efficiency the EU Commission in 2011 launched the European Resource Efficiency Platform – composed of policymakers, scientists and business leaders within the EU – to help advance the agenda. A legislative proposal “The Circular Economy Package” was launched in July 2014. Regretfully the new EU Commission – under Jean-Claude Juncker – decided on December 16, 2014 to withdraw the proposal. The pretext given was “deregulation”. After heavy criticism – from Member States as well as businesses and civil society – the Commission has made a commitment to re-launch the proposal later on in 2015. Hopefully this report will help persuade the EU Commission to plan for something bold in their re-launch of the circular economy package.

Resource efficiency and societal welfare

Maximizing resource efficiency gains for society as a whole cannot be seen in isolation. It must be linked to and primarily concerned with how well an economy can provide jobs and other forms of societal welfare gains – including the reduction of pollution, not least carbon emissions. On this score relatively little information appears to exist or, at least, it is not easily attainable. The Ellen McArthur Foundation reports have not embarked specifically on studies pertaining to such aspects.

Companies facing choices between becoming more capital-or labour intensive will largely analyze relative financial/market costs between labour and capital. In both cases these costs are more or less distorted from a societal point of view. The economic costs – i.e. the costs for society - of using especially natural capital are often undervalued. Furthermore, natural capital is also embedded in the usage of built capital (minerals, water, energy etc.), and that usage of natural resources and ecosystem services is most often underappreciated, often resulting in both misuse and over-use. Lastly but not the least, natural capital is also often undervalued through subsidies and the fact that no account is made for its depreciation.

Labour is usually heavily taxed and no account is taken of the positive externalities associated with employment. Under-usage of labour, i.e. unemployment, is actually a cost to society – usually a significant cost as unemployment benefits will have to be paid out. Moreover, the person in question would rather work; by not working he or she is losing competence (human capital) making both the person and society worse off. There is also usually a social cost involved as unemployment very often is related to health issues and social problems like exclusion, not only affecting the unemployed person, but his/her family and even the wider community.

Why tax labour, why subsidize resource use?

In spite of the fact that numerous studies have shown the benefits of a tax shift – moving from taxing labour to resource use – modern tax systems in the EU apply high rates to

employment while leaving the use of natural resources tax-free or even subsidized. In such a distorted business environment it is little wonder that most firms find it financially attractive to overuse natural capital and underuse human capital.

In a recent study “New Era. New Plan. Fiscal Reforms for an Inclusive, Circular Economy”(The Ex-Tax Project 2014) the point is made that in 2012, out of € 5 trillion in tax revenue in the EU member states, over 50% was derived from labour taxes and social contributions, almost 30% in consumption taxes and the remaining 20% was based on capital. Only 6% of tax revenues consisted of environmental taxes (mainly on energy and transport as part of the consumption taxes).

To redress these obvious distortions will require actions at the level of the firm, the industry and the economy. Companies view their costs and production processes through the lens of financial or market prices (the actual costs and relative prices they face); the taxes they pay; the accounting rules they follow (especially accounting for depreciation); the sources and terms of finance they secure; the goals and targets that are set by their shareholders; and, for an increasing number of companies, their concerns of corporate responsibility, goodwill and image. However, the financial “bottom line” remains the company’s most important metric. Any attempts to alter the basic structural and pricing regimes may be thwarted on grounds of competitive disadvantage: hence designing policy interventions requires a high level of sophistication and an understanding of the impacts.

Furthermore, attention must be paid to the investment cycles in different parts of the economy and capital destruction avoided. Policy-making should align with the natural turnover of the capital stock and be primarily focused on making sure that fresh capital is no longer invested in “dinosaur technologies” but rather in the new generation of efficient technologies – many of which already are meeting the demands of a circular economy. Finally, it should be emphasized that policy interventions at the EU level are to be preferred to ensure that competitiveness is not compromised. Hence the vital importance of the EU Commission re-launch later on in 2015 of the Circular Economy Package.

2. The Purpose of this report

The calls for a new model of production and consumption are indeed becoming more frequent. The circular/performance-based economy has recently been attracting attention of key business leaders and policy makers. The material savings potential for societies as well as companies of such a transition have, as was mentioned before, been well documented by the Ellen MacArthur Foundation's reports (Towards the circular economy Vol. 1 & 2 & 3).

However, only scant attention has been paid to the wider societal effects of moving towards a circular/performance-based economy. The time has no doubt come to explore these issues, not least with regard to the potential benefits in terms of employment and, as well, the possible reduction of carbon emissions..

The main purpose of this report is to broadly explore the potential for resource efficiency, first and foremost in developed economies, and to specifically assess what the main benefits for society would be - looking at carbon emissions and employment in particular. We are using the Swedish Economy as a test case. In the full version of our report, to be released in June/July 2015, the Dutch and Spanish Economies will be examined as well. The main reason for studying these three economies, which differ significantly from each other, is to be able to draw as wide conclusions as possible. Our hypothesis is that the circular economy as a concept will offer a number of societal benefits for Europe, not least in terms of carbon emissions reductions and job gains. To draw such conclusions at the general level, however, will require studies pertaining to more than one member-state.

3. Systematic Decoupling: the Case of Sweden

Methodology

As stated above the aim of this report is to primarily study the societal benefits of systematic decoupling, with a focus on possible carbon emissions reductions and additional job opportunities. The main analytical tool used is an Input/Output Model for the Swedish economy, managed by the Swedish Statistical Office.

Sweden has been explored in both a 60-sector Input/Output-model and a more aggregated 40-sector model. In the final version of the report – when the Netherlands and Spain will be examined as well – the international database WIOD, which only consists of a 40-sector model, will be used. The methodology used is exactly the same, but the fewer numbers of sectors in the 40-sector-model provide fewer details, as for instance agriculture and forestry are merged instead of treated separately.

By making use of the Input/Output model – which accounts for the interdependencies of different branches of a national economy - the report assesses what the likely effects would be on carbon emissions and job opportunities in Sweden by:

- enhancing energy efficiency.
- increasing the percentage of renewable energy in the energy mix and.
- organizing manufacturing along the lines of a materially-efficient circular/performance-based economy, i e by extending wealth, minimizing waste and maximizing the reuse and recycling of materials.

At the end of the report a discussion will follow with regard to what changes in policy that would be required to move the economy in the direction of systematic decoupling.

This report will explore three possible ways to push the technology factor, by making use of the traditional input-output model in a slightly new way. By doing that we will be able to study employment, energy use and carbon-emissions from different sector-activities in the economy – and, in particular, to study how these variables would be affected by policies promoting a more circular/performance-based/resource efficient economy, but also a more energy-efficient one and furthermore an economy much more based on renewable energy. Such an economy will from now on be referred to as a circular economy.

The Input/Output-tables show how different sectors buy and sell natural resources and intermediate goods from/to each other in often complex supply chains during the production process. The end result is the delivery of a product and /or service to the final user - which might be a household, a public sector entity, another company – often in the form of investment goods - or export.

A move towards a circular economy would affect supply chains in many different ways. The effects of various decoupling attempts on employment and different kinds of emissions can be calculated, based of course on the specific assumptions about the level of resource

efficiency gains aimed at.

The Input/Output model used for Sweden consists of 60 separate sectors. For each sector there is a description of the various inputs in terms of supplies needed for their production. Parallel to that, accounts show the deliverables in terms of intermediate demand – produce sold to other businesses – as well as final sales for public and private consumption, public investments and goods that are exported.

Through simulations of the various supply-chains – anticipating, a higher degree of material-efficiency, reuse and recycling of materials, combined with product-life extension, a higher degree of energy efficiency, and a more rapid phase-out of fossil fuels – it is possible via the Input/Output model to assess what the likely macro-economic effects would be, in this study with priority given to carbon emissions and employment.

To simplify the simulation-runs, the 60 sectors have been divided into different groups:

- Primary sectors which use natural resources as the main (re)source (agriculture, forestry, fisheries, mining, water).
- Secondary sectors, whose main activity is manufacturing, divided into three subgroups:
 - M1) sectors which mostly upgrade natural resources and sell them to other sectors in Sweden and abroad (such as wood and basic metals).
 - M2) sectors, which basically produce consumer goods.
 - M3) sectors, which offer goods that by definition are not long-lived and cannot be upgraded and recycled¹ (such as food or energy-carriers).
- Tertiary sectors, which represent all other sectors – considered as service-sectors – mainly offering services in a variety of fields, like finance, insurance, logistics, design, marketing, retail etc.

The scenario-runs mostly focus on the private sector-activities – so any changes in the model-runs do not change the public sector employment in any direct ways. It should be noted, however, that the public sector's emissions and resource use and so on are part of the model.

The model used is static – using data from 2010 as the entry-point – and can hence not take into account technology changes. Hence technological development will have to be modelled explicitly. No doubt, many things will happen in the years to come in the economy pertaining to both changes in technology and employment. The recycling industry, for instance, which is likely to grow significantly as a consequence of the move towards a circular / performance-based economy, will explore new niches and business models and possibly look vastly different from what it is today.

One general observation is that moving in the direction of enhanced resource efficiency, especially the attempts to enhance the reuse and recycling of materials and product-life

¹ If one does not look at it from a nutrient perspective or the possibility to use the excess energy-potential (heat) of the last remains of the energy-carrier (processes).

extension, will result in a change in the goods-to-services ratio of any given economy. This, no doubt, is a major reason behind the gains in employment. An economy favouring reuse and recycling of materials as well as product-life extension, by definition, is more labour-intensive than one based on a “throw away” concept, i.e. linear resource-flows. The main reason, of course, is that caring for what has already been produced – through repair, maintenance, upgrading and remanufacturing – is more labour-intensive than both mining and manufacturing (often in highly automated and robotized facilities).

Targeted investments needed

This study is asking the question “what would be the overall effects on the Swedish economy be if decoupling as described above had been pursued systematically?” The result of the simulation is like a snapshot. It describes a hypothetical situation, based on certain assumptions. To then move the economy in the same direction would require deliberate policy measures - as well as targeted investments - over a period of time. In this study the target date for the changes obtained in terms of decoupling is set for 2030.

A lot of investments will be needed to make the decoupling-possibilities and, hence, a more sustainable economic structure come true. The different decoupling-alternatives require different kinds of investments: *rail, mass-transit vehicles, new infrastructure for electric vehicles, wind-turbines, solar panels, bio-fuel-refineries, smart-grids, retrofitting of buildings, recycling-facilities and so on.* In the coming decades the vehicle-industries will still produce vehicles, but with different engines, performance, materials, weight and so on.

The vehicle-industry has always changed these things over time, but the focus from now on will be more on sustainable-technologic performance than in the recent past. That trend is actually already here concerning mileage and how to power engines, but to decouple transport-services even more from material-use, energy-use, emissions, and this development has to continue at even higher speed.

A special dimension will be the likely emergence of driverless cars. Such cars will require much less space on the roads (driverless cars can travel in convoys, inches apart). In such a future transportation scenario, citizens will increasingly refrain from owning a car and prefer benefitting from car pools and transport services. The fleet-managers providing the services will want to have their vehicles both designed and powered differently; the potential for increased material-efficiency, mileage and pollution reduction is immense.

The investments needed to make it possible for the various sectors and subsectors to become increasingly decoupled will temporarily, during the transition phase, increase economic activity, employment and emissions, at least if the investments do not fully crowd out other investments or consumption. There are currently many reasons² to doubt that a full crowding out would occur, though (at least in Sweden as the unemployment rate is rather high and the interest rates historically low).

² For instance: high unemployment, low interest rates for those who can borrow, a need for an economic injection to get the economy out of the risk of falling (back) into recession and/or deflation, and a need from the financial sector (especially insurance-companies and pension funds) for new (society-building) long-term bonds to invest in.

In the following section the different assumptions with regard to enhanced material and energy efficiency and more rapid phase-out of fossil fuels will be described. One conclusion to be drawn is that the suggested time period - fifteen years - for the necessary changes to materialize, is no doubt realistic.

Three main decoupling pathways

As has been discussed already, decoupling can be pursued on several fronts. The ones chosen for this study are the ones most discussed in reports from the UN, the OECD, the World Bank, the EU and thus probably the ones most natural to pursue. A detailed description will follow below.

The manipulation of the Input / Output-model - to mimic the different kinds of decoupling - was done by "rewiring" the supply chains and then "rebalancing" the sectorial trade in the so called A-matrix in the I/O-model, keeping the overall production value in the economy constant. Even if the Ellen MacArthur Foundation studies point in the direction of large gains for the businesses studied, in this study we have not allowed that to happen.

There is an assumption, as well, that in some areas subsidies and/or targeted technological procurement might have to be used in the beginning to get things started:

- **Increasing the ratio of renewable energy in the energy mix** (from roughly 50% to 75%; i.e. substituting for half of the fossil energy used in 2010; excess heat from nuclear power disregarded); this case is explored by modifying how the refineries and the electricity utilities source their feed-stocks – halving their purchases of oil, coal and gas – and substituting those purchases with biomass from mostly forestry residues and black liquor from the paper-pulp industry (or possibly wind and solar power).

The measures to be considered to reach the target no later than 2030 ought to focus primarily on:

- 1) substituting gasoline with bio-fuels and electric vehicles and on
- 2) continuing the expansion of wind energy. Hybrid cars are already on the market, combining bio-fuels and electric power. The bio-fuels should primarily be produced from residue materials (mainly black liquor) from the forest industry. Solar and wave power technology are likely to play an increasing role over time.

Changes in this direction are already happening. Electric vehicles are increasing their market share rapidly; in Norway roughly 25% of all new vehicles sold are electric.

Positive developments in the area of energy storage, notably battery technology, will also help accelerate the transition to a transport system less and less dependent on fossil fuels. The same goes for the development of 2nd generation biofuels.

The incentives to be used will be a combination of emissions trading (ETS) and carbon taxes, complemented by special support for the required learning investments to materialise, like green certificates and feed-in tariffs (for solar and wave power).

- **Obtaining a more energy-efficient economy** (becoming overall 25% more efficient as compared with the actual energy demand for 2010); this case is explored by reducing the use in society in general of products and services offered from refineries and energy utilities by 25%. The money saved from a lower energy bill will be used to purchase energy efficiency equipment and advice.

Positive change is happening in many areas, like lighting, more fuel-efficient engines, electric vehicles, zero – or even plus energy buildings, vastly more efficient household appliances etc

The digital revolution is underpinning much of the positive change. The Internet of things will greatly enhance the potential of using both energy and materials more efficiently. Consumption patterns are changing – such as the evolution of the sharing economy, which is only possible because of the digital revolution.

The policy measures considered to reach the target in real life in 2030 ought to be a combination of taxation and regulation, such as fuel-mileage limits for new vehicles, stricter standards for insulation – both new and retrofitted buildings – as well as stricter energy efficiency standards for energy-use in all energy-related products. A special effort could be considered by introducing so-called white certificates, obliging energy companies to help their customers investing in energy efficiency. Research programs to help harness the opportunities for enhanced resource efficiency through the digital revolution should be launched.

- **Obtaining a more material efficient, circular and performance-based economy** (becoming 25% more material efficient, but also substituting half of the virgin materials used with recycled materials, and furthermore doubling the product-life-time of long-lived consumer products compared to today). The money saved by producers buying less materials is spent on material efficiency equipment and advice and preparing for using more recycled materials, and the money saved by consumers not having to buy new products as often as before is spent on upgrading and maintenance services.

This decoupling pathway would of course take time to achieve; we believe, though, that a target date of 2030 is realistic. The goals would be made possible by incentivising material efficiency through a variety of measures – taxes, stricter recycling targets, limits to waste incineration and/or a tax on waste incineration, new business models which could be nudged ahead by for example enhanced producer responsibility obligations etc. The main objective is to:

- 1) Use materials more efficiently – in this case a doubling of the increase in material efficiency compared to BAU; from 1% to 2% per annum seen in the time perspective of 2030.
- 2) Enhance the use of secondary materials – in effect substituting half of the virgin materials used with recycled materials (which, by the way, many of the companies studied by the Ellen Mac Arthur Foundation have already succeed to do).
- 3) Double the product-life of consumer goods, including the offering of high-quality services in the form of maintenance and repair (a business model/strategy which

Walter Stahel in his studies has shown that many well-functioning companies already are adhering to - *Rolls-Royce* selling power by the hour, not engines; *Xerox* selling copies made, not copying machines and *Volkswagen* and *Renault* taking back used engines and engine components, remanufacturing them and selling them as exchange engines).

What this alternative means is that companies purchase 25% less materials and, in addition replace half of their virgin material demand by secondary materials and design their products to be more easily maintained, repaired, upgradable, dismantled, reused and/or remanufactured. The financial resources saved in the process will – in this simulation – be spent on enhancing material efficiency through consultancy work, efficiency-enhancing equipment, design, research and development etc.

The recycling industries will experience an upswing. Their services will be much more in demand and the focus of their activities will broaden – from mainly being concerned about material recycling to the reuse and remanufacturing of goods and components. Close partnerships with manufacturing industries will be developed to enhance recycling, reuse and remanufacturing and to help develop new business models, like renting and leasing of products instead of selling.

Over time the concept of a “performance economy” is likely to emerge. In such an economy the main interest of customers will be in high-quality services rather than in owning products. Selling performance will differ depending on the characteristics of products but is already present in today’s economy; such as selling services by operating public and private networks (like railways, telecoms, motorways, airports), chemical management services and rent-a- molecule, car pools, leasing of tyres (for trucks), rental and operational leasing of real estate and textile leasing.

The challenge will be to step by step widen the concept and include an increasing number of consumer products. By doing so, incentives will be provided for manufacturers to design their products to last longer and to be designed so as to simplify dismantling; by so doing revenue can be obtained much longer by preserving the quality, performance and value of the existing stock. Revenue is earned by maximizing the value of the stock (the wealth) rather than maximizing the flow, by “selling more stuff”.

It is no doubt a simplistic assumption to anticipate that a 25% efficiency improvement in terms of material use – as well as a substitution of secondary materials for virgin materials and a doubling of the service-life of products - can be obtained across the board in all sectors of the economy. There are on the other hand numerous examples of areas and/or products where the efficiency gains and the circularity can be, and have been, pursued even further.

The same goes for the possibilities to extend the lifetime of different products. They do differ and are dependent, as well, on how intense the use of a certain product is. But as an approximation the assumptions made for the modelling seems to be reasonable.

Significant results, both with regard to GHG emissions and jobs

The modelling exercise gave the following overall results:

- The carbon emissions were significantly reduced – albeit to a different degree, depending on the decoupling pathway chosen.
- The effects on employment were also significant, i.e. the number of jobs in the economy increased, but also here to a different degree, depending on the decoupling pathway chosen.
- The trade balance was positively affected, more in some scenarios than others, though.
- The activity level of the economy would be impacted; partly depending on how the trade surplus is being used a variety of different outcomes in terms of GDP growth are possible. Letting the multiplier effects work out freely and not keeping the production value at the same level, actually led to an increase in the economic activity level (GDP) in all scenarios.

The results in detail were the following:

- The renewable-scenario led to a 50% reduction in carbon emissions, created some 5000 additional jobs (+0,1%) and improved the trade surplus with roughly 1% of GDP.
- The energy-efficiency-scenario cut carbon emissions by almost 30%, created some 20.000 additional jobs (+0,5%) and improved the trade balance with 0,3% of GDP. The job increase is partly temporary in nature but would last for many years, probably a couple of decades, during which time the necessary investments in improved insulation and other efficiency improvements are undertaken.
- The material efficiency-scenario (containing efficiency measures, enhanced reuse and recycling as well as product life extensions) cut carbon emissions by a tenth, created some 50.000 additional jobs (+1-2%) and increased the trade surplus significantly (more than 2% of GDP). The jobs generated are permanent as a consequence of the changes in the goods-to-services ratio in the economy.

If all three decoupling strategies are being pursued together the results would be substantial:

- carbon emissions are likely to be cut by almost 70%,
- the number of additional jobs would likely exceed 100.000 – in fact cutting unemployment by at least a quarter, may be even half in Sweden, and
- the improvement in the trade balance would be more than 3 percent of GDP, e.g. at least 10 billion € a year.

	Renewable Case	Energy-efficiency	Material-efficiency	All Three Combined
Emission Reduction	-50 %	Almost -30 %	-10 %	Almost -70 %
Additional Jobs	Over + 5 000	+ 20 000	Over + 50 000	Over + 100 000
Trade Balance Effects	+ 1 % of GDP	+ 0,3 % of GDP	Over + 2 % of GDP	Over + 3 % of GDP

The simulations were based on a combination of manipulating sector supply chains – in favour of renewables and secondary materials - and anticipating at the same time a significantly higher overall level of energy and resource efficiency in the Economy. To obtain a similarly decoupled structure of the Swedish economy in real life would require policy measures – a combination of regulation and economic instruments as well as significant investments in both infrastructure, construction and manufacturing aiming at changing, and primarily reducing, the energy and material throughput in society.

British study confirm the results

While finalizing this report a study was published in the UK by two British research groups/think-tanks (WRAP and Green Alliance) using a similar Input/Output methodology to explore the employment effects in the UK of a more ‘circular economy’, i.e. keeping products and resources in use for as long as possible through recovery, reuse, repair, remanufacturing and recycling.

Modelling a modest increase of the already existing tendencies of recovery, reuse, repair, remanufacturing and recycling in the UK created over 200,000 gross jobs and reduced unemployment by about 50,000 by the year 2030 in the UK.

A more rapid development towards a circular economy could, according to another modelling-scenario-run, create around half a million jobs (gross) and reduce unemployment by around 100,000. When analysing the employment opportunities the study identified an extra bonus effect: i.e. regional unemployment disparities may be reduced by the fact that a circular economy would offer a broader geographical spread of employment opportunities as compared with an economy based on more linear material flows.

Furthermore, the present occupational mismatch may be reduced by a circular economy creating new opportunities across all skill levels. A more extensive development of the circular economy, involving more remanufacturing, services and repair, could also create additional employment near existing manufacturing sites where unemployment tends to be higher, making it easier for the large pool of unemployed people, former employees of manufacturing industries.

Greening of the economy

The movement towards decoupling and a circular economy will require a significant boost in terms of investments. The investments required will temporarily, essentially during the transition period, increase economic activity and employment. Emissions would also increase due to the extra investments, but less and less so as the new, much more resource-efficient structure of the economy come into play.

In the end-state, after all the investments are in place, the “decoupled” economy would be (much) more:

- renewable energy-based
- energy-efficient
- material-efficient (or thrifty if one prefers that expression)
- circular in its resource-use
- performance-oriented (companies increasingly offering HQ products (durable) as services)

The investments required – in addition to the “normal” level of investments - for moving towards a circular economy have been estimated to be in the range of 12 Billion €, or 3% of GDP, per annum from now on until 2030. This amount equals about half of the present Swedish balance of payment surplus.

The investments will primarily happen in the very sectors that matter most for reaching the decoupling objectives described above: agriculture, forestry, wood, pulp and paper, installation services, construction/renovation, maintenance and repair, recycling and development and engineering services. Some investments must also be directed towards education and employment services to make the labour force ready to take on the new tasks required in the “new” structure of the economy.

Running an investment like that through the Input/Output-model gives the following results:

- In today’s more linear economy, i.e. during the first years of an investment-boost, the domestic multiplier would be a little lower than 1,3. This means that, an investment injection by 12 billion € increases production domestically with another 3-4 billion €, so the total effect of the injection becomes around 15-16 billion €. Employment would increase by 140.000 people domestically. Emissions would go up with 350.000 tons CO₂ domestically. Imports increase as well, which result in production, employment and emissions abroad.
- In a future, increasingly decoupled economy, i.e. during the latter years of the investment-boost, the domestic multiplier would have risen to above 1,4. That is, an investment injection by 12 billion €, would increase production domestically by 17 billion € totally. Employment would increase by 155.000 people domestically. Domestic emissions would go up with less than 100.000 tons CO₂. The imports do not increase with as much as in the linear economy case, but the difference is not that large.

An attempt has been made to estimate broadly what kind of investments that will be required from now on and to 2030 to move the economy towards the desired decoupling objectives:

- Increased investments in railways: 50 Billion € (the Swedish government has already allocated 15 Billion € for this purpose). Please note that the 50 Billion € does not include high-speed trains.
- Greatly extended public transport and commuter services will require an estimated 15 Billion € (out of which roughly half of the amount is likely to come from the normal budget process).
- The development of bio-refineries – in the range of 20-40 Billion € - to offer badly needed 2nd generation biofuels, to a large extent based on residue materials from forest products.
- Extensions of the electric power grid, including smart grids, charging stations for EV:s etc The cost estimate is 20 Billion €, out of which the private sector is assumed to provide half.
- The electrification of parts of the road network for freight traffic, so-called eHighways. Several technical options – like overhead contact lines, magnet technology etc - are being discussed. The investment required in the next fifteen years is being estimated to be in the range of 30-40 Billion €, giving priority to the main highways between the largest cities.
- The vehicle fleet has to be renewed, whether we speak of hybrids, EV's or biofuels. The cost is difficult to estimate, not least because of the significant cost reductions in renewable energy, in particular solar, and battery technology. The vehicle fleet in Sweden comprises some 5 million vehicles. Most of these vehicles will have to be replaced during the next 15-20 years. The extra cost as a consequence of the need to reduce significantly the dependence on fossil fuels may amount to 1-2000 € per vehicle, i.e. 10 Billion €. Including as well, heavy vehicles another 10 Billion € has to be added.
- Energy efficiency improvements within industry is another important target. To estimate the costs, however, is difficult. The payback time for most energy efficiency investments tend to be short. The pace is most often slow, however, the main cause being a lack of information. Hence the need for well-targeted information programs (a variant of which was tried recently within the manufacturing industry in Sweden and was successful, not least because of a parallel introduction of tax-breaks for companies implementing energy efficiency measures) is obvious. The overall costs of such activities tend to be modest. Given the ambition to accelerate the pace of efficiency measures the additional investment for the period 2015 to 2030 can be estimated between 10 and 20 Billion €. The cost tend to increase towards the end of the period when most "low-hanging fruits" have been harnessed.

- Retrofitting of old buildings. Energy efficiency standards and norms for new buildings have been gradually strengthened in the EU in recent years through the Energy Performance of Buildings Directive and the Energy Efficiency Directive. Some provisions in relation to major renovations of old buildings have also been agreed upon. However, much has to happen with regard to the energy performance of old buildings – not least in member states where fossil fuels still dominate the heating sector. But also in member states – like Sweden – where carbon taxation has led to major substitution in terms of energy supply, there is a need to promote energy efficiency vigorously. The biomass saved can and should be used for other purposes.

In Sweden it is estimated that the necessary retrofitting of old buildings – for a number of reasons, social as well as environmental – would amount to 150 Billion € over the next decades. Around 50% of those costs would have been incurred at any rate. So the additional cost as part of the decoupling objectives would amount to 75 Billion €. It should be noted, of course, that part of the investment cost would be off-set by considerably lower costs for heating and cooling in the years to come.

The necessary retrofittings in commercial buildings are easier to implement – the buildings are younger and easier to retrofit, the commercial motive stronger and rents being easier to adjust.

Decoupling has to continue

Doing all of the above, would bring Sweden way beyond the targets of the Input/Output-exercise. On the other hand, Sweden has to go beyond these targets in the decades beyond 2030. Even if the Swedish economy would follow through the combined scenario - doing all the proposals for decoupling - and emissions would come down almost 70% compared with the economic activity level of year 2010, both its population and the per-capita income are expected to keep increasing.

The expected population increase would increase the remaining carbon emissions (the 30% which were left) by an estimated 10%. The increase in affluence, helped by the investment-boost, would increase carbon emissions by almost half, which would bring them to a level only 50% below the 2010-level. It is the IPAT-equation at work again. So from the year 2030 onwards decoupling has to continue on all fronts, to counter the expected increases in both population and affluence from year 2030 onwards.

However, the reduction of carbon emissions would have to be even faster in the years to come as science tells us that we have to reach a level of around max 1 tonne per capita around the year of 2050. The implication would be that the technology factor has to achieve emissions reductions at least at the double pace - possibly the triple - as compared with the years leading up to 2030. We need to get carbon emissions down by around 5% per year.

The strange thing is that policymakers in different parts of the world do not seem to give sufficient reflection to the challenge of moving the economies towards becoming low-carbon and resource-efficient. Many countries – including the EU - are pursuing unusually

expansionistic monetary policies, with the hope that such policies will stimulate demand, grow the economies and reduce unemployment. The success so far has been limited.

Most of the increase in the monetary base seems not to have gone into sustainable investments, but rather to have pushed up the value of property and other assets. An alternative would of course be to utilize the fact that interest-rates are low and initiate both policy measures and investment programs that would promote a transition to circular economies.

4. Conclusions and Policy Measures

When discussing the various decoupling strategies above, a significant number of policy measures were suggested in order to promote the move towards a circular economy. Some of these policy measures are already being implemented, such as subsidies to promote investments in renewables, emissions trading (ETS) to curb CO₂ emissions from power production and energy-intensive industries, energy efficiency standards etc.

The Barroso Commission in its proposal in June 2014, the Circular Economy Package – which was withdrawn by the Juncker Commission - did include a series of policy measures aiming at enhancing resource efficiency. The main focus was on improving waste management, such as stricter standards for recycling and reuse, ban on landfilling, reducing food waste etc.

All these proposals merit support. But they fall far short of what would be required to pursue decoupling at its full potential and achieve the EU's 2050 vision of "living well within the limits of the planet". As recognized in the EEA report from March 2015 "The European Environment – State and Outlook 2015", stricter rates for recycling and reuse are important, but unless complemented by more thorough measures they will not be able to fundamentally change direction – from linear to circular material flows.

There are indeed a number of issues that come to the fore when exploring the policy interventions needed to move towards a circular economy – everything from business models, product design and changes in the ecodesign directive to the greening of public procurement and economic incentives. Clearer direction on these issues will be required from the forthcoming new Commission proposal, for it to be successful.

In addition to the policy measures, already touched upon, the Commission would be wise to propose specific resource efficiency targets for materials where scarcity looms or where the overall environmental impact of resource extraction and use is significant.

Furthermore, considerable efforts should be made at the European level to help stimulate the development of new business models – moving from selling stuff to offering high-quality services. Such business models – labelled as a functional service economy or as selling performance, rather than a product – are by far much more resource-efficient, less polluting and labourintensive than today's linear economy.

At member-state level taxation systems should be reconsidered. The main rationale for such efforts is on the one hand the fact that labour in most member-states is very heavily taxed – something increasingly problematic in a digitized economy – and on the other hand the fact that we are using natural resources wastefully, without paying the full costs of their extraction and use and without extracting all their value. The end result is unemployment, economic loss and depletion of natural capital.

Taxation in industrialized countries is hitherto dominated by taxes on labour, directly and indirectly. This is strange, not least in a situation with high unemployment and technology developments – in particular the digitization of the economy – where an increasing number of jobs will be substituted for by robots and automation in the near future.

Taxes on the use of natural resources and the resulting undesired waste and emissions, however, are very low. To move society towards sustainability – both socially and ecologically - would require a tax shift, lowering taxes on work and increasing taxes on the consumption of non-renewable resources in the form of materials and fossil fuels. Such a tax shift would accelerate the transition to a circular economy, which is low-carbon and resource-efficient in nature.

As expressed by Walter Stahel:

"A circular economy increases employment because less than a quarter of the labour input to produce a physical good is engaged in the fabrication of basic raw materials such as cement, steel, glass and resins, while more than three quarter are in the manufacturing and service phase. The reverse is true for energy inputs: three times as much energy is used to extract virgin or primary materials as is used to manufacture products from these materials. Substituting reused components and goods for primary materials therefore uses less energy but provide more jobs's."

While manufacturing in recent years requires less and less manpower, all the services built up around a product in a circular economy - everything from sustainable design, to maintenance, upgrading, repair and reuse - requires more, rather than less labour than today.

Lowering taxes on work and increasing taxes on the use of natural resources is one important policy measure to be considered. Parallel to that the system of VAT should be carefully analyzed. Goods produced by secondary materials – where VAT has already been paid once – should be exempted from VAT. Such a reform would promote the use of secondary materials – i.e. reuse and recycling – and help correct a situation where it is often less expensive to use virgin materials than recycled ones.

Yet another policy measure to consider would be so-called white certificates for the promotion of investments in energy efficiency. Such certificates could be traded on a market like emission rights or renewable energy certificates.

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