Managing environmental and energy transitions for regions and cities

Circular Economy in Cities requires a Systems Approach

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> *"Rather than an economic model based on growth-consumption-obsolescence-disposal that continually exploits the planet's resources, we need circular economies where waste is feedstock, recycling rates are close to 100 per cent, new materials and products are designed to be re-used and re-purposed, cultural norms encourage re-use, maintenance and repair, and fossil carbon stays underground. Rather than large, polluting energy systems for domestic use, industry and transport, we need to switch to clean and often localised energy production and consumption, and clean mobility-as-a-service that will require changes in the way we live and work. Food production must be transformed as well, by changing diets and by replacing intensive tilling with no-till practices to prevent the breakdown of soil structure and by promoting the sequestering of carbon, thereby slowing climate warming. Our obsession with short-term returns in financial markets must be replaced with patient capital designed to value fully the social and environmental benefits of investment, accompanied by a radical shift away from banking on the 'stranded assets' of an expiring fossil carbon economy."*
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> – from Transformation in Time – EIT Climate-KIC strategy

Background information

This paper was prepared as a background document for an OECD/EC high-level expert workshop on "Managing the transition to a circular economy in regions and cities" held on 5 July 2019 at the OECD Headquarters in Paris, France. It sets a basis for reflection and discussion. The background paper should not be reported as representing the official views of the European Commission, the OECD or one of its member countries. The opinions expressed and arguments employed are those of the author(s).

Managing environmental and energy transitions for regions and cities

The workshop is part of a five-part workshop series in the context of an OECD/EC project on "Managing environmental and energy transitions for regions and cities". The five workshops cover "Managing the transition to a climate-neutral economy", "Managing environmental and energy transitions in cities", "Managing the transition to a circular economy", "Managing environmental and energy transitions in rural areas", and "Financing, scale-up and deployment". The outcome of the workshops supports the work of the OECD Regional Development Policy Committee and its mandate to promote the design and implementation of policies that are adapted to the relevant territorial scales or geographies, and that focus on the main factors that sustain the competitive advantages of regions and cities. The seminars also support the Directorate-General for Regional and Urban Policy (DG REGIO) of the European Commission in work of integrating sustainability transitions in the next generation of European Union Cohesion Policy programmes 2021-2027, as well as to support broader discussion with stakeholders on managing long-term environmental and energy goals in regions and cities. The financial contributions and support from DG REGIO are gratefully acknowledged.

The OECD Centre for Entrepreneurship, SMEs, Regions and Cities on Twitter: @OECD_local

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1. Background

Almost fifty years have passed since the launch of the “Limits to Growth” report by the Club of Rome. Its key message was that a combination of resource depletion and pollution, if un- checked, would ultimately bring the global economy down.

The background was the rapidly increasing ecological footprint of humanity, as a consequence of the growth in population, as well as the resources used and pollution generated per person. The report tracked industrialization, population, food, resource use and pollution and developed a number of scenarios, all dependent on various degrees of human action on environmental and resource issues. The model used predicted that “overshoot and collapse” was inevitable before 2070 with continued “business as usual”, that is, without significant changes to economic activity.

The approach by the Limits Report was both novel and controversial at the time. First, it challenged the notion that infinite material growth is possible on a finite planet. Secondly, it applied a systemic approach, i e taking in to account a number of factors such as population, renewable resources, non-renewable resources, food production, pollution, industrial output as well as services output and their interactions.

Global Resources Outlook 2019

A recent report by the International Resource Panel – Global Resources Outlook 2019 (GRO 2019) – shows that the forecasts made by Limits to Growth had a great degree of accuracy. Over the past five decades, the population has doubled and global domestic product has increased by more than four times. The report finds that, in the same period, annual global extraction of materials grew from 27 billion tons to 92 billion tons (by 2017). This is likely to double again by 2060 on current trends. An OECD report published in February 2019 – ”Global Material Resources Outlook to 2060” – came to roughly the same conclusions. It projects a doubling of global primary materials use between today and 2060. The main drivers of the growth in material use are population and converging income growth.

GRO 2019 further states that our throw-away models of consumption have devastating impacts on the planet – “the extraction and processing of materials, fuels and food make up about half of total greenhouse gas emissions and more than 90 per cent of biodiversity loss and water stress.” The report also emphasizes that the benefits of this type of resource use remain limited to but a few. Inequalities in the material footprint of countries are stark. “High-income countries maintain per capita levels of material consumption that are more than 13 times the level of low-income countries.”

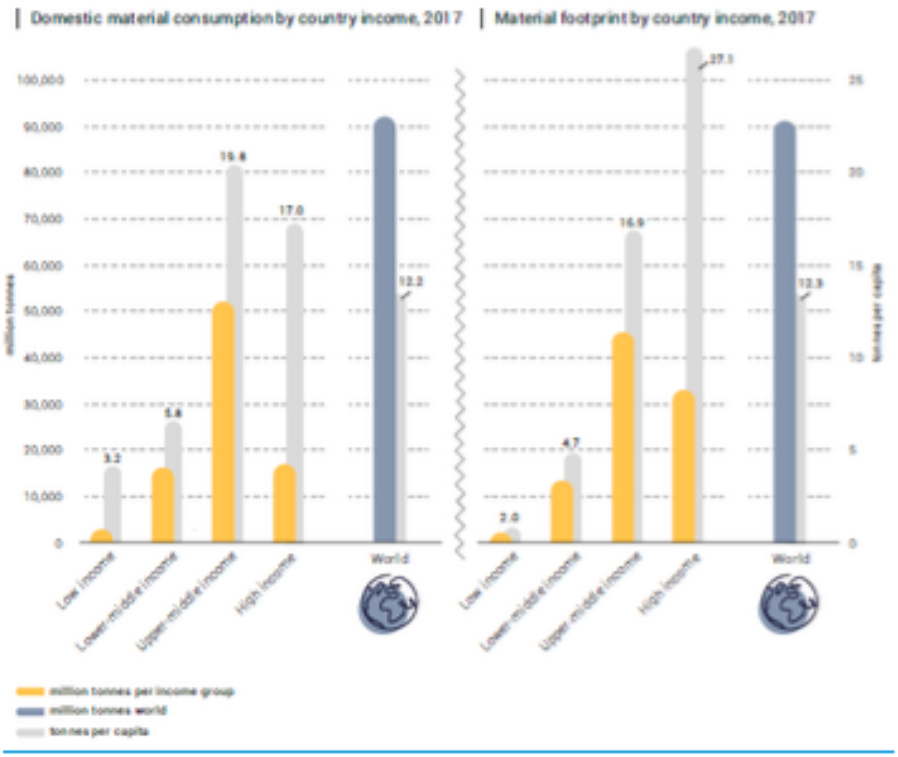
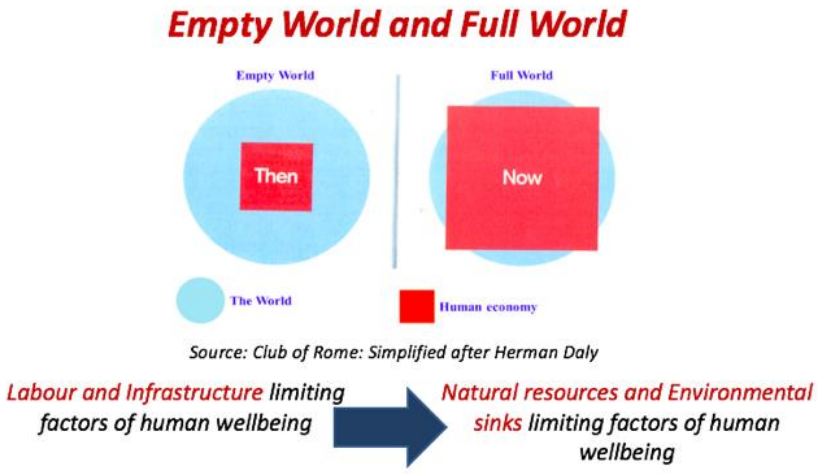


Figure 1 Inequalities of material footprints. (Global Resources Outlook 2019)

In a comment at the launch of the report the Acting Executive Director of UN Environment, Joyce Msuya, said “that the Global Resources Outlook shows that we are ploughing through this planet´s finite resources as if there is no tomorrow, causing climate change and biodiversity loss along the way. Frankly, there will be no tomorrow for many people unless we stop”.

Experts argue about what the main constraints for human development will be – resource depletion, pollution or climate change? Judging by the GRO 2019 - and except for a few resources, like healthy soils, phosphorus and biodiversity (the main reason being there are no substitutes) - the limiting factor in the short and medium term will be the health and environmental consequences by our excessive and irresponsible use of resources.



The discussion on resource use hitherto has mainly focused on factors like resource depletion, security of supply and the health and environmental consequences of excessive use. Yet another factor to consider are the economic consequences of the prevailing linear production model. Several studies have shown that huge material values are being wasted after the first use cycle.

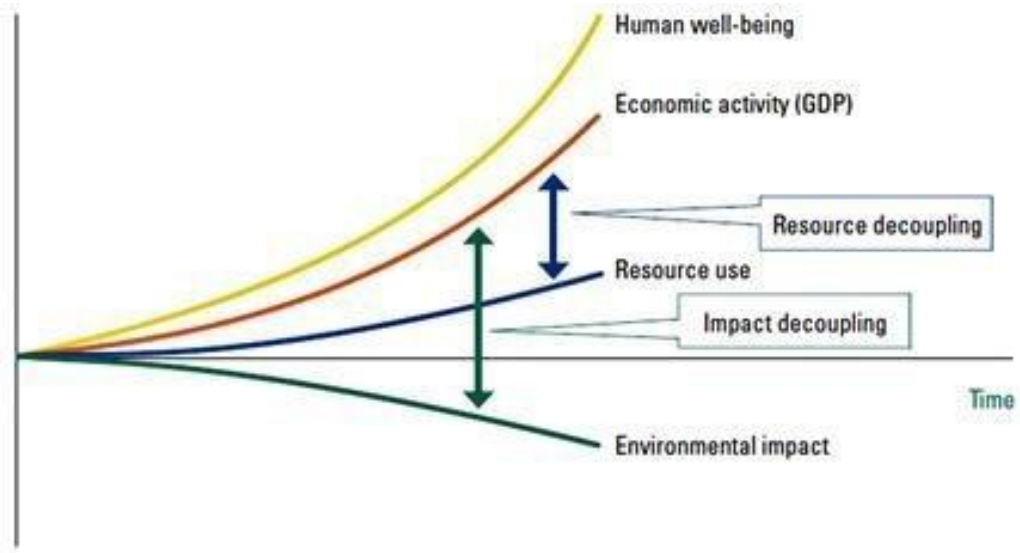
A major study in 2015 by Ellen Mac Arthur Foundation – "Growth within" – estimated that "material recycling and waste-based energy captures only around 5% of the original material value in the European Economy as of today" – a colossal waste.

A report by Material Economics in 2018 – "Retaining value in the Swedish Materials System" - showed that for material categories like steel, cement, aluminum and plastics on average only ¼ of the original material value was captured after first use cycle. Most of the loss of value is the result of the physical loss of materials in combination with downgrading of quality. Plastics are the worst. Only about 13% of the original value is retained and almost half of that in the form of energy production. In the Swedish case this means that for the materials examined Billions of euros are thrown away yearly because of a combination of poor design, flawed economic incentives and ineffective separation and recycling.

Decoupling

The concept of *decoupling* economic activity from resource use has been a central theme in the sustainability debate for decades. 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.(Decoupling Natural Resource Use and Environmental Impacts from Economic Growth), UNEP, International Resource Panel 2011.)

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 boundary condition, *absolute decoupling* will be a requirement so as to enable the economy to continue to develop 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, judging by the way society hitherto is managing resources the relationship seems less clear for people in general, economists included.

While *relative decoupling* has been happening - and is happening - the gains made have most often 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. If we look at the global economy as a whole, the fact is that material use today increases faster than the growth of GDP, primarily a consequence of rapid infrastructure development in the so-called emerging economies

With a growing population, and a much-needed increase of per-capita-income in developing countries, a combination of technology innovation, behavior change and redistribution of wealth appear to be the main vehicles for change, i e to help bring down the environmental impacts of energy and material use. Luckily, there are many types of decoupling that can be achieved by improved technology, often complemented by behavior change. Regretfully, policies to promote such actions have been rare, and if put in place, most policymakers seem reluctant to let them influence material throughput and/or the relative prices of energy and materials to any significant degree. Historically, almost all focus has been on promoting labor productivity, instead of also focusing on material productivity.

Materials, carbon emissions and jobs

Most climate change mitigation strategies hitherto have been sector-based, with a primary focus on energy use. The general level of material use in society is seldom taken in to consideration – in spite of the fact that the climate benefits from using products longer and from enhanced rates of reuse, refurbishment and recycling 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 material efficiency as a key instrument.

Numerous studies have been done exploring how enhanced efficiency in the use of key materials could reduce carbon emissions. The Club of Rome published a report in 2016 analyzing the overall societal effects for five European economies of moving towards a circular economy. By making use of a traditional Input/Output model, which accounts for the interdependencies of different branches of a national economy, the report assessed first and foremost what the likely effects would be on carbon emissions and job opportunities in Finland, France, the Netherlands, Spain and Sweden (a year later the same analysis was done for Poland and the Cech Republic) – of the following key steps:

- Enhancing energy efficiency**:** The economy in each country would become 25% more energy-efficient.
- Increasing the percentage of renewable energy in the energy mix, by cutting fossil fuel use in half and substituting it with renewable energy sources, as for example wind, solar and biofuels.
- 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 + 50% of all virgin materials being replaced by secondary materials + doubling the product life of long-lived consumer products compared to today.

The target date for the changes was 2030. The results were very clear. For each and every one of the three decoupling alternatives – and in each of the countries studied - there would be a significant reduction in carbon emissions. In addition, the employment effects would be clearly positive. If the three decoupling strategies would be pursued together the results would be substantial. *Carbon emissions* were estimated to be cut by two thirds or more, structurally. *The number of additional jobs* would, according to the study, exceed 75,000 in Finland, 100,000 in Sweden, 200,000 in the Netherlands, 400,000 in Spain and half a

million in France. This meant that unemployment rates – compared to the situation in 2014 - could be cut by a third in Sweden and the Netherlands, and possibly more. Most of the new jobs would be offered in activities like recycling, reuse and refurbishment, renewable energy but, as well, as an effect of turning products into services. It should be added that the move towards a more circular economy wiil lead to losses of some jobs and creation of others. It is will also change the composition of skills required in various sectors and most likely to a larger ratio of higher-value added jobs as compared to traditional jobs.

In another study on the European economy as a whole – ”The Circular Economy – A Powerful Force For Climate Mitigation” - Material Economics (2018) assessed what the likely effects of making better use of already produced materials would be, and, by doing so, reducing the need for new production.

The study examined key material flows, like steel, cement, aluminum and plastics, and the corresponding value chains. It identified relevant circular economy approaches – like reducing waste in production, recírculating a larger share of materials, light-weighting products and structures, extending the life-time of products and deploying new business models based around sharing of cars, buildings and the likes.

The key conclusion was that a more circular economy can make deep cuts to emissions from heavy industry: in an ambitious scenario for the EU, as much as 296 million tons CO2e per year could be cut by 2050, out of 530 million tons CO2e in total. Demand-side measures thus could take us more than halfway to net-zero emissions from EU industry, and hold as much promise as measures on the supply side. Moreover, they are often economically attractive.

The report summarizes its findings in the following way: ”Much like improving energy efficiency is central to the EU´s efforts to achieve a low-carbon energy system, a more circular economy will be key to developing European industry while cutting its carbon emissions.” One may add that to achieve circularity will require a number of changes in policy frameworks – both at the EU level and in EU member-states – not least in the provision of clear incentives to enhance material efficiency, the extension of product life and moving from selling products to offering services.

Yet another study of relevance in this context is ”’The Future of Urban Consumption in a 1.5°C World” 2019, by C40 Cities, Arup & the University of Leeds.

Resource efficiency and social 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. This area has received relatively little attention in academic studies and policy reviews thus far, even though many organizations recognize the key role a circular economy can play in the creation of high skilled jobs and social development. New Zealand is looking to create a “wellbeing economy”, basing their national policy framework on the OECD framework for measuring wellbeing and progress. *Zero Waste Scotland* says that “there is a strong case” for including a balance of “employment, mental health and social cohesion” as elements of a sustainable economy.

Companies facing choices between becoming more capital or labor intensive will analyze carefully the relative financial or market costs between labor and capital (the actual costs and relative prices they face). In both cases these costs are more or less distorted from a societal point of view. The economic costs for society of using natural capital are most often undervalued – on top of it often heavily subsidized - and no account is made for its depreciation. 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.

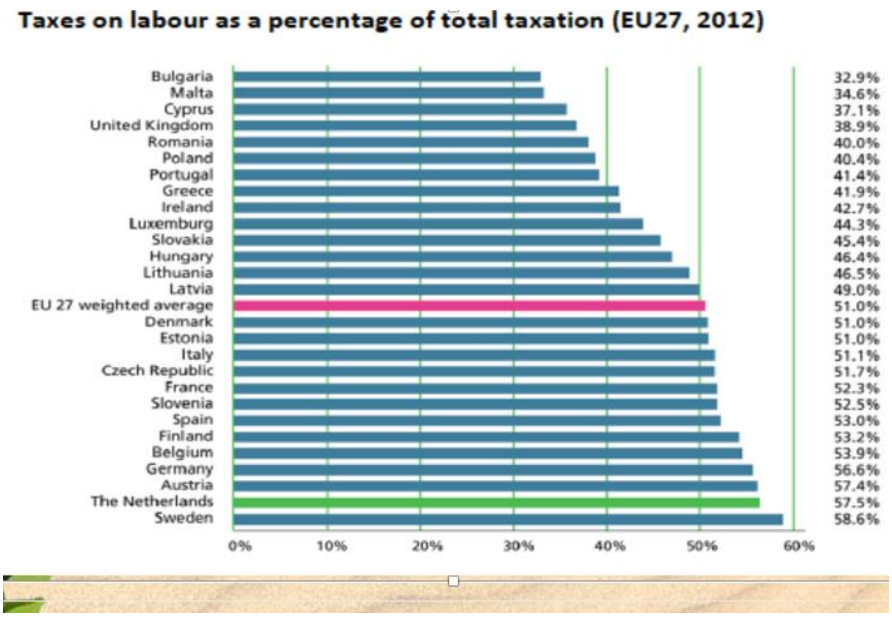
Labor is usually heavily taxed and limited account is taken of the positive externalities associated with employment. Under-usage of labor, i.e. unemployment, is actually a cost to society, as unemployment benefits will have to be paid out. Moreover, the person in question would rather work; by not working he or

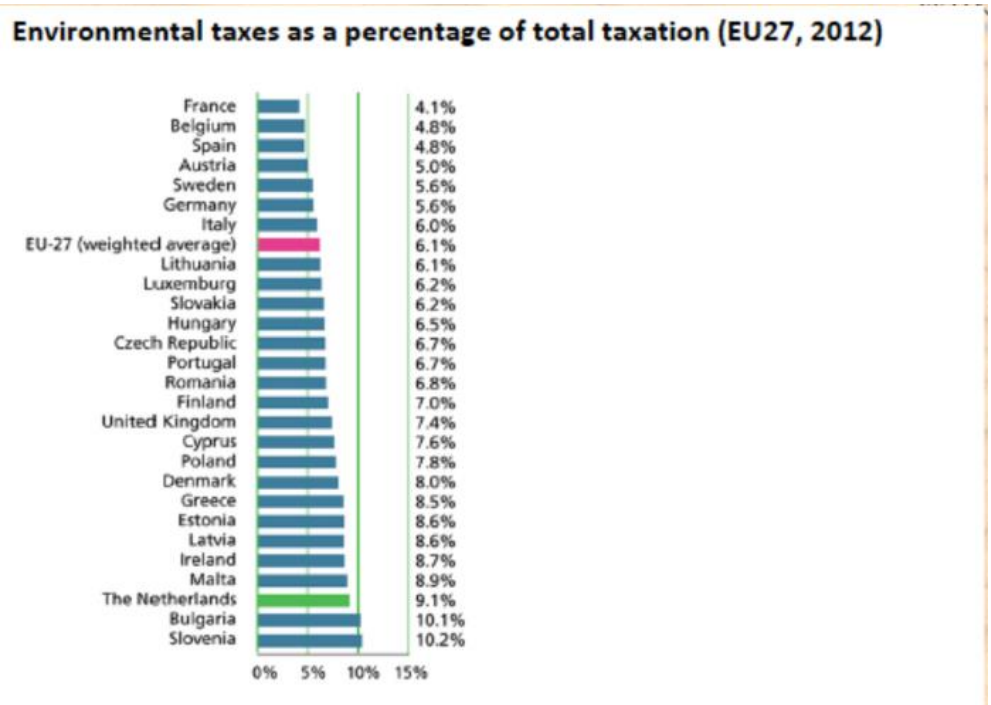
she is losing competence, human capital, making both the person and society worse off. There is also usually a social cost involved as unemployment very often is related to health issues and social problems like exclusion, not only affecting the unemployed person, but his/her family and even the wider community.

Why tax labor and not resources?

In spite of the fact that numerous studies have shown the benefits of a tax shift – moving from taxing labor 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 study a few years ago - *New Era. New Plan. Fiscal Reforms for an Inclusive, Circular Economy* – (The Ex´Tax Project 2014), the point was made that in 2012, out of 5 trillion euros in tax revenue in the EU member states, over 50% was derived from labor taxes and social contributions and almost 30% in consumption taxes and the remaining 20% was based on capital taxes . Only 6% of the tax revenues consisted of environmental taxes, mainly on energy and transport as part of the consumption taxes. This situation has not changed much. In most EU member states environment-related taxes make up 5-6 % of total tax revenue.





Several studies have been made recently examining the role of taxation in the efforts to enhance material as well as energy efficiency. There are also examples of individual governmens taking initiatives to promote resource use. Notable examples are

- a research proposal by RREUSE on how to differentiate VAT in support of reuse and repair (http://www.rreuse.org/wp-content/uploads/RREUSE-position-on-VAT-2017-Final-website_1.pdf),
- a research project by SITRA and Green Budget Europe about the key role played by fiscal incentives in achieving a Circular Economy (https://green-budget.eu/project-confirms-key-role-of-fiscal-incentives-in-achieving-circular-economy/
- a tax break to reduce food waste by the French Government (https://www.independent.co.uk/news/uk/politics/food-suppliers-should-be-given-french-style-tax-break-to-reduce-food-waste-parliamentary-inquiry-a7448206.html),
- a new Architect Journal Campaign championing reuse of materials in built environment (https://www.architectsjournal.co.uk/news/introducing-retrofirst-a-new-aj-campaign-championing-reuse-in-the-built-environment/10044359.article

In 2018, the Green Budget Europe (GBE), the Institute for European Environmental Policy (IEEP), the Ex'Tax Project Foundation (Ex'Tax) and the Finnish Innovation Fund (SITRA) presented Tax Options in the Modelling of Fiscal Reform for a Carbon-Neutral Circular Economy in Finland. The quantified options for natural resource taxation included water abstraction, mineral extraction, non-energy use of fossil fuels, and a carbon price. At the same time, the group presented the need to phase out environmentally harmful energy subsidies, transport, agriculture and waste related tax options, labour tax reduction options, and R&D and investment subsidies.

Cutting VAT rates on refurbishments could prioritise retrofitting existing buildings over demolition and rebuild, which is extremely carbon-intensive. The Architects Journal's RetroFirst campaign calls for this, together with the introduction of new clauses into planning guidance and building regulations to promote

the reuse of the building stock, and to stimulate the circular economy by supporting a whole- life cycle carbon approach in construction.

To redress the many distortions - because of externalities not being accounted for and natural resource use in general being subsidized - will require actions at the level of the firm, the industry and the economy at large. Companies view their costs and production processes through the lens of financial or market prices, taking in to account: 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 and circular technologies.

The difficulties associated with moving from taxing labour to resource use, however, can be no excuse. Higher taxes on pollution and resource use is seen as a precondition for moving towards a more sustainable economy. The recent fall in global oil prices is providing an opportunity to reform fiscal measures targeted at the production and consumption of energy from conventional sources (notably fossil fuels), e.g. by reinforcing carbon-pricing mechanisms and revisiting fossil fuel subsidies (IEEP, 2015). All the studies made recently on the huge benefits for society by using materials more efficiently ought to make it easier introducing taxation on resource use while lowering taxes on labour.

2. The case for a Circular Economy

The rationale for resource efficiency is compelling and multi-dimensional, encompassing ecological, economic and social considerations. Direct ecological impacts uniformly align with economic benefits that enhance social cohesion. The analytical foundations for actions to conserve and wisely use resources have been established for years.

Resource efficiency alone, however, is not enough. The combination of growing economies and rebound effects will eventually balance out the resource savings made. In many areas resource use will continue to increase, albeit with a delay. What is urgently needed is a move away from today´s linear production model – from ”take-make-dispose linear production” - towards a circular production model, i e business models that allows goods to be designed and produced for extended use, disassembly, reuse, refurbishment, remanufacturing and recycling from the outset. The United Nation’s Sustainable Development Goal number 12, “Responsible Consumption and Production,” clearly addresses the need for a Circular Economy(CE), and the concept is high on the European Union’s political agenda, being the subject of the ambitious action plan “Closing the Loop” from 2015.

The potential for a change from a Linear to a Circular Production Model is supported and underpinned by the mushrooming of digital technologies, enabling the development of a variety of new services that have the potential to radically reduce material use. Policy measures for climate mitigation, protection of biodiversity and changes in consumer behaviour would, if designed correctly, assist in the process of moving away from linear material flows.

Circularity would help address the risk for rebound effects. However, in addition, policymakers must be prepared to ensure that energy and material prices are elevated over time to make sure that resources “saved” will not be put to use in environmentally detrimental ways. In his seminal work “Factor Five”, Ernst

von Weizsäcker suggests a sort of "self-accelerating ping-pong" between resource productivity and related prices, while the real cost paid for energy and resource services would remain unchanged over time.

Circular Economy poorly defined

The Circular Economy as a concept has been around for decades, partly under different terminologies. It synthesises a number of schools of thought, such as the functional service economy (performance economy) of Walter Stahel; the Cradle-to-Cradle design philosophy of William McDonough and Michael Braungart; Biomimicry as articulated by Janine Benyus; the industrial ecology of Thomas Graedel; natural capitalism by Amory and Hunter Lovins and Paul Hawken; and the Blue Economy systems approach as proposed by Gunter Pauli.

More recently the Ellen MacArthur Foundation has given strong impetus to the advance of the concept of the circular economy with a series of CE reports and initiatives. Another key actor has been SITRA, the Finnish Innovation Fund, in developing a Road Map to a Circular Economy for Finland in 2016 and as the initiator and organizer of the World Circular Economy Forum. Worth mentioning are also proactive efforts both by the Dutch government – in the form of a national strategy – and several Dutch cities, not least Amsterdam.

While the general principles are relatively easy to understand there is as of today no generally accepted definition of a Circular Economy. For many people it stands out as a metaphor for different aspects of resource efficiency. Among the mostly quoted definitions are:

> *"Looking beyond the current take-make-waste extractive industrial model, a circular economy aims to redefine growth, focusing on positive society-wide benefits. It entails gradually decoupling economic activity from the consumption of finite resources, and designing waste out of the system. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural, and social capital. It is based on three principles:*
>
> - *Design out waste and pollution*
> - *Keep products and materials in use*
> - *Regenerate natural systems"*

-Ellen Mac Arthur Foundation, 2019

> *''A circular economy provides opportunities to create well-being, growth and jobs, while reducing environmental pressures. The concept can, in principle, be applied to all kinds of natural resources, including biotic and abiotic materials, water and land".*

- European Environment Agency, 2016

The circular economy is a model of consumption and production, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended. In practice, it implies reducing waste to a minimum. When a product reaches the end of its life, its materials are kept within the economy wherever possible. These can be productively used again and again, thereby creating further value.

This is a departure from the traditional, *linear* economic model, which is based on a take-make-consume-throw away pattern. This model relies on large quantities of cheap, easily accessible materials and energy. Also part of this model is *planned obsolence,* when a product has been designed to have a limited lifespan to encourage consumers to buy it again. The European Parliament has called for measures to tackle this practice". - *From the European Parliament Website (Headlines)*

The fact that the circular economy is seen more as a metaphor for all kinds of activities that promote resource efficiency may not appear as a problem to most people. But, in fact, it is. The circular economy has rapidly become one of the most embraced, but regretfully also vague, concepts in the field of sustainable development. The interpretations range from very narrow ones with a focus on the need to enhance recycling rates or increase take-back of certain products to very broad interpretations that focus on significant reform of the global economy to become ecologically sustainable and socially equitable.

In a recent report to the Swedish EPA, sustainability consultant Dennis Pamlin brings attention to the risks posed by the absence of a clear-cut definition of the circular economy. The lacking of a definition, according to Pamlin, makes it possible for different actors to continue their unsustainable practices under the disguise of circularity. Examples that come to mind are companies, based on thoroughly unsustainable practices – like fast fashion, food waste, consumer electronics and planned obsolence or unsustainable tourism – that are using initiatives within the circular economy realm as a way of diverting attention from their wasteful business models. Examples are recycling and take-back schemes that represent only marginal improvements in unsustainable business models.

A case in point is the ongoing debate on plastics pollution. Several of the largest petrochemical companies have taken the lead in the discussion on plastics pollution of the oceans or micro-plastics permeating the most remote corners of the Earth, like the Arctic, implying that the solution would be enhanced recycling. This is a ridiculous claim since even with a 60-70% recycling rate most of the plastics would end up as pollution anyway, albeit with a delay. What the petrochemical companies fail to see – and accept – is that much of the plastics produced for packaging is the wrong material in the wrong place.

The fact that some companies try to hide obviously unsustainable business models under the umbrella of the circular economy, while others try to use it to deliver the transformative system shift that is needed, is a significant problem for the circular economy as a concept and for sustainability. Adding to the challenge is that the companies that are the most unsustainable tend to have the largest budgets for sustainability communications. This results in conferences, reports, and a consulting market, dominated by companies in sectors such as fossil fuels and fast fashion, or based on linear, resource-intensive and polluting practices.

The Circular Economy and Sustainability

The circular economy will be truly sustainable only if it will help contribute to a societal transformation where the Sustainable Development Goals (SDGs) can be met in a systemic way. The seventeen goals are interconnected and progress towards one target will influence the others. If for instance first-hand priority was given to goal 8, i e decent work and economic growth, goals 13 (climate action), 14 (life below water) and 15 (life on land) would suffer badly. Hence, in the words of the Stockholm Environment Institute (SEI), ”*to deliver on the 2030 Agenda, governments, international organisations, businesses and other actors have to plan efficiently, exploiting the synergies, mitigating the trade-offs and treating the Agenda as an invisible whole”.*

Another key prerequisite for a transformation to a sustainable society will be a fundamental shift in the overall objectives of the business community. The main purpose of companies can no longer be to maximise short-term profits and shareholder value, but rather to broaden their objectives – which in some countries may require changes in the company law – and help contribute in a positive way to societal objectives in relevant areas.

One indication of change happening was a statement in August 2019 by the Business Roundtable, a group representing 192 large U.S. companies, which for the first time committed the purpose of a corporation from maximizing profits for shareholders above all else to ”the benefit of all stakeholders – customers, employees, suppliers, communities and shareholders.” The statement from the organization, which is chaired by JPMorgan Chase CEO Jamie Dimon, stresses the importance of ”maintaining long-term value”.

The statement represented only a small first step but it indicates that even in the US sentiments within the business community are changing.

From a policy point of view, major changes will be needed in global, regional and national policy frameworks. Further, policies at different levels of government need to be aligned and work in harmony to advance meaningful progress toward a circular economy. The orthodoxy of market capitalism is built on fundamentals of transparency, effective pricing that accommodates all costs, and informed actors seeking long-term 'value'. The reality, however, of our current global economy offers a muddle of inadequate, mixed signals obscured by complex supply chains and huge corporate structures. Concerted and profound efforts are needed to untangle the muddle and begin to align motivations in support of the necessary shift to an economy that operates effectively and fairly by ensuring that market prices reflect the true costs of production, are visible and well integrated into transaction decisions. The use of blockchain technologies, distributed ledgers and SMART contracts could play an essential role in the implementation of a circular economy by enabling the required financial transparency.

Such shifts will take time, and to begin making progress policy-makers will need to create and strengthen economic incentives to enhance efficiency and effectiveness, i.e., to do *the right thing*. Negative externalities must be heavily penalised. Product design requirements, connected to desired outcomes, have to be introduced. Products put on the market ought to be easy to reuse, refurbish, remanufacture or recycle. Public procurement must be allowed to proactively support the transition to a sustainable circular economy. Lastly, but not the least, measures must be introduced to deal with rebound effects.

A particular challenge will be to address the fact that major parts of the prevailing consumption patterns are unsustainable. To this category belongs of course all types of consumption that rely heavily on fossil fuels. But the same goes for activities that can be generally categorized as overconsumption and/or wasteful consumption - like fast fashion, consumer electronics, unsustainable tourism and the like. They evolved over time in a situation where the assumption seems to have been that there are no ecological limits and that upcoming problems would easily be solved through technology and innovation. Today we know better.

A transformation of the energy system, enhanced material efficiency as well as a phase-out of toxic chemicals are necessary elements in a transition to a sustainable society. But as important will be to rethink many of today´s lifestyles and consumption patterns.

Ever since the concept of sustainability was launched in the 1980´s the issue of production and consumption patterns have been on the agenda. However, behavioural change was most often not touched upon. Most of the focus was on measures to reduce different kinds of industrial pollution. While crucially important, it is increasingly clear that behavioural change must be an important part of the solution. Everyone has a role to play from the individual to civil society, businesses and governments. The levels of overconsumption and wasteful consumption, primarily in industrialised countries but also emerging in many low-income countries, is a major barrier to overcome.

A recent report by C40, the University of Leeds and Arup – "The Future of Urban Consumption in a 1,5° C World" demonstrated that across six key sectors of the consumption economy, there are actions that individuals, wider civil society organisations, businesses and governments can take to shift behaviours and choices. In the majority of cases success will depend on action from all major stakeholders. For example, citizens can only choose to buy more sustainable products if they are available and affordable – and businesses may rely on government policies to enable a level playing field. This report also outlined the benefits of action to reduce consumption-based emissions. Reducing the volume of resource intensive materials we consume by reducing consumption, designing for reuse and finding alternative materials can have economic, health and environmental benefits.

Recycling has its limits

A move away from linear to circular material flows is at the core of the circular economy. Referenece is made to the seven R:s: *Reduce, Reuse, Regenerate, Refurbish, Remanufacture, Recycle and Recover.* Materials should be kept in use as long as possible and against this backdrop design becomes a key issue. But concern should as well be paid to systemic issues such as to whether a product, a service and/or a packaging is at all needed, thereby making it possible to reduce material throughput.

Recycling has an important role to play. By material recycling a lot of energy will be saved and pressure on fragile ecosystems will be lessened. But recycling in itself is no panacea. Among the 7 R:s recycling is the next to least effective from a resource efficiency point of view.

As of today a significant part of the recycled materials are only suitable for downcycling into a lower-grade product. Moreover, while metals and glass can be recycled on and on again, materials such as textiles, plastics and paper can only be recycled a few times. Lastly but not the least, even with high recycling rates – such as 60-70% - the loss of materials in the process is substantial.

Consequently, a major issue when moving towards a circular economy will be to decide which materials to use in different situations – not least for short-lived products – to avoid a lot of waste in a system that is formally labeled as ”circular”. Plastics, paper and textiles are all a case in point.

Barriers to change

While there are clear limitations in the concept of a circular economy as presently perceived, the arguments in favor of moving from a linear to a circular production model are strong. However, there are a number of barriers to be overcome in order for the circular economy to become a reality. Linear material flows dominate the economy for multiple reasons:

- Raw materials have been historically abundant and cheap and the capacity of nature to absorb waste and residues was perceived as infinitely large.
- Producers rarely paid for the external costs involved in material extraction and production
- Virgin materials are most often less expensive than secondary materials – a huge market failure since externalities are most not reflected in the prices of virgin materials
- Quality criteria for secondary materials are mostly lacking
- Many products include banned substances and hence difficult to reuse or recycle
- Global markets and supply chains make it difficult to close the loops Productivity focus has been on labor cost, not on materials
- Business models have favored high throughput and short product life
- Consumption patterns in general have been developed without consideration of whether they are sustainable or not
- There are very few examples of governments introducing incentives for material efficiency (unlike for energy efficiency)

To effectively overcome the barriers, a number of things have to happen, mostly at the policy level of either the global level, the regional level – in Europe´s case the European Union – or at national level.

Policy frameworks must radically change

Interest for the circular economy as a concept is rapidly increasing in many parts of the world. The EU Commission has played a seminal role through the launch of the Circular Economy Package (CEP) in 2015. So far however the implementation of the CEP has mostly had its focus on waste management and the waste directives. Those are important issues but will have limited impact on the move towards a circular economy. Recycling rates have been enhanced but recycling is but one – and in most cases - the least important component in moving from linear to circular production. For the circular economy to happen focus must be up-stream at the costs of production and materials, at design issues, finance and business models.

Some of the most important policy measures to consider therefore will be:

- A tax shift – lowering taxes on labor and increasing taxes on resource use (to account for unaccounted externalities in a linear production system - e.g. carbon emissions).
- Remove VAT on all reused materials.
- Introduce design criteria across the board, i e products should be designed for reuse, refurbishment, remanufacturing and recycling
- Use Public Procurement proactively in the advancement of CE
- Recognize the importance of Cross-Cutting policy strategies: make material use a priority in climate mitigation and resilience strategies
- Stimulate skill development- launch innovation programs to promote circularity
- Explore the feasibility of introducing the Extended Producer Liability across the economy
- Explore policy measures to address the rebound effect
- Recognise the need for Multi-Level policy interventions: EU-level policy interventions need to be complemented by national policies with adaptations to local circumstances (the policy and economic starting point will be different for each country)
- Complement today's flow-based metrics such as GDP as a measure of economic progress with measures of a country's stock of assets to account for the restoration and regeneration of natural capital

3. The role of Cities in the Circular Economy

Although the circular economy as a concept has been mostly used in the industrial sector and in the context of waste management, the role of cities and regions in the transition to a circular economy will no doubt be crucially important. Urban areas lend themselves particularly well to a circular economy system due to their close proximity of citizens, producers, retailers and service providers. Moreover, cities make up for more than 80 % of global GDP, 75 % of resource use and an estimated 65-70 % of greenhouse gases. Dense urban environments are also highly vulnerable to systemic risks in many forms – access to energy and water; air and water pollution; food access as well as catastrophic events like flooding, heavy storms, sea level rise, etc. – risks that can be significantly reduced by applying circular economy principles.

Today, more than 50% of the global population lives in cities, a number that is expected to grow to 70% in 2050, making cities also hot spots of personal consumption. If left unchecked, growing prosperity in emerging economies will lead to the urban population emulating western lifestyles and wasteful consumption patterns. The application of circular economic principles – and technology leap-frogging - would help reduce ecological and carbon footprints.

This being said, cities should not be seen as a necessarily less sustainable alternative for people to live. Cities normally generate a higher degree of economic value than rural areas and the negative external effects are, in relative terms, lower than in rural areas. If cities are governed properly the opportunities to deal with the externalities should be manageable.

According to a research project run by the Ellen MacArthur Foundation and ARUP – ”Circular Economy in Cities” – the benefits for cities to move towards circularity are many and significant. 90 % of European residents live in harmful levels of air pollution. The annual cost of congestion – most of it in cities – is estimated to be in the range of 2-5 % of Global GDP. Up to 20 % of municipal budgets are spent on waste management. More than 90 % of cars are parked most of the time and when on the road only 1,5 in 5 seats are used. 60 % of European office space is not in use during working hours. 80 % of household items are used less than once a month and, when discarded, 80% is burned, landfilled or dumped.

The project has identified a number of urban policy levers, such as *urban planning, asset management, public procurement, financial support, fiscal measures and legislation and regulation.* The project is giving priority to three urban systems when it comes to implementing circular economy principles: *buildings, mobility and products.*

While the main purpose of the circular economy is to bring about a change in the Industrial Production model – aiming at enhanced material efficiency – there are important social aspects to consider as well. Initial research suggests that the circular economy could lead to more jobs and entrepreneurial activity within the areas of remanufacturing, repair, logistics and services. It would also help tackle social-economic challenges like providing access to affordable housing, diversifying the economic base and strengthening social cohesion. By resorting to nature-based solutions the positive health effects would be enhanced as well.

Power must shift

Cities have long been ‘shapers’ of markets, whether for housing, business location, transportation or energy. But the globalisation of the economy and rapid development of global supply chains in most product areas hinder the ability to cities to provide their traditional and crucial role in the governance system. Many negative externalities related to consumption are difficult to address in our current, complex global economy.

Cities often best see and understand the impacts, but their ability to shape policies to reduce such impacts and thus enhance the healthy function of markets has been significantly reduced due to numerous supranational trade regimes and other policies. This reality applies to material throughput and waste management – both with regard to biochemical feedstocks and nutrients and the techno-sphere. Products sold and consumed are often the result of complex supply chains, may contain toxic materials and be difficult to reuse or recycle effectively. It should be pointed out that many global supply chains – built on small wage differences and the absence of pollution taxes – result in considerable environmental degradation and GHG emissions. Because of this, a local supply chain response to the projected impacts of the climate emergency alone might not be viable. Both local and global supply chains are therefore expected to require a correspondingly coordinated response at the global level of governance.

A ”circular city” approach would build on the historic role of cities, noting that cities have the ability to incorporate ecological and social externalities into business and consumer activities. Cities have the authority to decide on a lot of things related to city planning, energy and material use, infrastructure, building and construction, mobility and transport and waste management:

- Zoning and land-use plans can be adapted for example to assign (fewer) parking lots to new and existing developments, reroute public transport, develop nature-based solutions in public spaces such as evaporative pavements and ”cooling islands”, or by earmarking spaces for renewable energy capacity.

- Introducing building efficiency codes and standards; for example appliances, equipment, and lighting energy standards and labelling. Setting minimum aa well as maximum household sizes, requiring building owners to install rainwater collection systems, improve the thermal envelope, or abandon fossil fuels for thermal energy generation are further examples.
- Lead by example: Acting on directly controlled services or assets through public procurement, for example by setting recycling shares for waste management, calling for new wastewater management systems (for example integrating heat recovery), making public transport and public lighting more energy efficient, adopting ambitious carbon neutrality targets for public buildings, public transport, and public lighting.
- Engaging technical and financial service providers: develop financial and non-financial incentives for industry and SMEs to develop circular supply chains by offering dedicated credit lines or other green financial vehicles.
- Working with utilities: decentralised energy generation and the phasing out of fossil fuels consumption will require new business models. Furthermore, energy grids will have to be retrofitted and made ”smart” in order to cope with fluctuating renewable energy.
- Finally but crucially: Engaging and connecting with citizens to explain the ”circular city” approach through online and printed material, public discussions and events, and collaborative workshops where citizens are encouraged to provide ideas and engage in open design competitions.

Increasingly, issues related to consumption patterns come into play and policy measures have to be considered to make both production and consumption systems more sustainable and, indeed, more circular. In light of the imperatives highlighted through the SDG:s, a case can be made for cities to be given more capabilities to shape markets to address externalities, foster innovations in market activities and behaviours and create policies that can inform intelligent and responsive policy-making at senior levels of government.

Such an approach may lead to tensions between those who view free trade as an end in itself and those who see it as a means to an end. However, negative externalities have reached catastrophic levels in many cities around the world, putting human welfare and well-being at serious risk. Further, the policy options to address this situation at national or multi-national levels can be better informed through trial and experimentation at local and regional levels. Such an approach would not only enable more rapid trial and experimentation, due to the relative speed at which local policy changes could be adopted, but would offer, as well, a strategic innovation value in the sense that numerous policy changes could be tested simultaneously at a scale appropriate to such experimentation.

Triangulum is an EU project of 14 European Smart Cities and Communities Lighthouse project set to demonstrate and replicate solutions and frameworks for Europe’s smart cities. The project consortium combines interdisciplinary experience and expertise from twenty-two research, industry and municipality partners who share the same objective and commitment to implement and replicate smart solutions at city level. (https://www.triangulum-project.eu/?page_id=82)

Another example is a Policy Labs initiative, initiated by the Swedish Innovation Agency Vinnova (https://govinsider.asia/innovation/sweden-vinnova-darja-isaksson-climate-change-policy-lab/).

Yet another example is a Cross-border testbed for autonomous vehicle technology, focusing on regulatory approaches. (http://www.vedecom.fr/inauguration-du-site-de-test-transfrontalier-france-allemagne-luxembourg-vedecom-presente-le-projet-triica/?lang=en)

Other examples of policies currently being rolled out in this spirit include pilot projects in five cities in Germany - including former capital Bonn and industrial cities Essen and Mannheim, where free public transport is expected to consistently cut carbon emissions from private cars. Collateral societal benefits

from reduced traffic congestions could be increased life quality, while access to a wider geographical area for potential employment could reduce income inequality in the most exposed parts of the population.

From a global perspective, the stakes of each policy experiment ought to be seen as investments in learning about what policies would work best at the respective levels of government. [It is notable this kind of bottom-up logic is the basis of several constitutional democracies, including the United States.]

Cities have to address negative externalities as a means to prevent harm (primarily ecological and social). The logic would speak in favour of cities being considered the focal points for carbon pricing schemes. Cities badly need the revenue to reinvest into activities like retrofitting, new infrastructure and measures aiming at the greening the cities. While an uncoordinated set of prices on carbon would be seen as untenable, the reality is that cities are more likely to be first movers and better able to reinvest revenues into value-creating projects that reduce emissions. Moves in this direction could also lead higher levels of government to respond by enhancing the systemic performance of any carbon pricing strategy, looking at ways to level price differences while also harmonizing directions across more local governments to ensure broad and equitable application of policy innovations that work.

An illustrative example can further explain this logic. California's cap-and-trade law produces significant revenue for the state government, but effective investment of those revenues has become tangled in competing interests and misaligned incentives. At best those revenues are directed to a category of activity that is at least in some way consistent with climate action. But had those resources been directed to local and regional governments with clear direction to be invested in carbon-reducing actions, much more progress could have been made with the same resources. The same is true in British Columbia, Canada, which adopted a carbon tax in 2008 as a revenue neutral tax shift, offering rebates to individuals and businesses equal to the total revenues that the tax produced (at least initially). Had those resources been directed back to local governments with direction to implement climate actions to reduce emissions, capital would have been immediately available to invest in infrastructure or building projects to reduce emissions. Instead, a decade has passed and cities continue to lack capital for effectively mobilizing project investments.

The examples of California and British Columbia are not unique. Governments rarely give away the authority to decide on taxes. Moreover, the earmarking of tax revenues is something most finance ministries do not favour. Hence, to move forward on this issue, convincing arguments have to be put forward as to why cities should be given the authority to address and price externalities more effectively.

Free trade - with hitherto few restrictions with regard to social and ecological conditions – has resulted in seriously weakening the stability and resilience of local economies. Negative externalities most often are not accounted for in the value chains of modern industrial systems. It is no longer in fashion to heed warnings about the risks for a 'race to the bottom', but that race continues as evidenced in the Amazon and Congo and by the race for operating licenses in the Arctic. The mechanisms for identifying ecological and social disturbances of the economy at a systemic level have been poorly developed.

Progress in this direction came from the private sector in June 2017 with the Recommendations of the Task Force on Climate-related Financial Disclosures (TCFD), chaired by Michael Bloomberg, which called on companies to include climate-related risks in their annual financial disclosures. In the United Kingdom, it is now a legal requirement for all quoted companies to report their annual greenhouse gas emissions. Streamlined Energy and Carbon Reporting (SECR) is the UK government requirement for mandatory annual reporting and disclosure of energy and carbon information within company accounts. SECR came into effect on 1 April 2019. Cities could play

Cities would no doubt have a chance through the principles of the circular economy – and by the promotion of bottom-up innovations – to make a difference and address many of the negative externalities experienced and thus tilt the balance in favour of citizens preferences at the local level.

Plenty of Circular City Initiatives

The motives are very strong, indeed, for cities to embrace a circular economy. A circular approach to the way resources are managed will help address urban problems like waste disposal, air and water pollution, traffic congestion, carbon emissions and the like. That a move towards circularity has not happened long before is primarily due to market failures, i e - and already commented upon - that the linear production model has been totally dominating due to the absence of policies to address negative externalities.

Cities have demonstrated high levels of ambition when it comes to climate action. In many parts of the world, action taken by cities have been by far more ambitious than by their national governments, demonstrating their potential to advance climate change mitigation and adaptation. Leading 'by example" cities have aspired to raise the ambition of national and international climate governance and put action into practice via a growing number of 'climate change experiments' delivered on the ground. Networks of climate-active cities have emerged – like C40 Cities, the Global Covenant of Mayors, UCLG and ICLEI – and most of these networks have made a point of making the circular economy part of their agenda as well.

Similarly, hundreds of cities around the world have adopted circular economy strategies and road maps. City networks have been established to work together, to share best practices, to experiment and to explore different pathways to circularity. Initiatives by C40 Cities, Ellen MacArthur Foundation, SITRA, GEHL, Climate-KIC and many others have inspired cities to get actively engaged in circularity.

Of particular importance have been the initiatives taken by C40 Cities – both within its network but as well in partnership with ARUP and Climate-KIC. For example, the city of Milan, Italy has won the "C40 Reinventing Cities" competition with its Zero Carbon "Housing Social" project centred around the implementation of circular economic principles such as shared, smart mobility, nature based solutions like urban farming and integrated biodiversity, Near-Zero Energy buildings, drastic waste reduction and the creation of a "Zero Carbon Fund".

The already mentioned Ellen MacArthur Foundation research project "Circular Economy in Cities" - in partnership with ARUP – is likely to provide crucial guidance to cities all over the world. ICLEI – a network of 1.500+ cities around the world – has embarked on a multi-year program in cooperation with Circle Economy – an impact organisation committed to practical solutions to transition to a círcular economy – to leverage expertise and experience to support local governments in decoupling urban economic development from resource consumption and environmental degradation.

Two countries – Finland and the Netherlands - stand out as leaders with regard to the circular economy – both in terms of national strategies but, as well, when it comes to inspiring cities within and beyond their national context. Both countries adopted national road maps/strategies for the circular economy in 2016. The crucial role played by cities was stressed in both strategies and has resulted in cities like Amsterdam, Rotterdam, Utrecht, Helsinki and Turkku to take on proactive roles in the transition.

Many other cities in Europe come to mind. Cities like Berlin, Copenhagen, Malmö, Maribor, Milan, Madrid and the like have also made serious efforts to adopt policies promoting circularity.

It should be added that many cities may be pursuing circular strategies that were initiated under the label of "green cities" or "sustainable cities" but have over time been relabelled "circular". As already explained the definitions of "circular", "green" as well as "sustainable" are vague. Hence there does not exist clear boundaries between the different concepts.

Promising practices

A move towards becoming a Circular city will require a holistic approach - in most cases based on new models of governance. Only by applying a system´s approach will the synergies of different actions be harnessed and, indeed, many of the shortcomings of the linear production model be effectively addressed.

Systemic change with scale requires breaking down the conventional barriers of departments, sectors and even regions. It demands a mindset of open innovation. It creates an opportunity of collective design and creativity that aim at delivering win-win-win outcomes.

However, the complexity should not be underrated. Multiple systems in most of the cities have to be fundamentally changed and/or developed, such as:

- Building and Construction
- Clean and Distributed Energy
- Clean water
- Zero-emission mobility
- Food production and nutrient recycling
- Consumer lifestyles
- From Waste to Material Management
- Nature-based solutions
- Growing fair, prosperous and sustainable local economies

The account below is an attempt to describe some of the circular economy activities already ongoing, and opportunities identified, in selected cities – often in partnership with organizations like C40 Cities, Ellen Mac Arthur Foundation and Climate-KIC. The account is organized sector-wise but does in no way imply a weakening of the requirement to organise the transition from a linear to a circular production model through an integrated approach:

Building and Construction

Materials for construction of buildings and roads, basically the hardware that cities are made of, account for a significant share of all materials consumption globally. Buildings and roads are built in a linear or "cradle to grave" way. The most common building material of our times – concrete – does not lend itself well to recycling and is mainly reused in road construction at a fraction of its original value. Construction and demolition waste (CDW) is one of the heaviest and most voluminous waste streams generated in the EU, accounting for approximately 25 % - 30 % of all waste generated.

When it comes to new buildings, the greatest environmental impacts caused by construction are related to energy and material choices and the placement of buildings relative to the rest of the city structure. The carbon footprint of construction, which can be subdivided into embodied and operational carbon, is considerable. The UK government estimates that almost 50% of all greenhouse gas emissions are linked to construction: including the extraction of raw materials, production, transport, construction, operation and demolition of buildings. Studies in Sweden estimate that more than half of a building´s carbon footprint during its life cycle is related the construction phase, while the rest is related to energy consumption during the buildings´ operational life. As new buildings are increasingly more energy-efficient, hence consume less energy during operation, embodied carbon from construction weighs in more heavily, overall. A circular building can be defined as:

> *"The design, construction, and demolition of a building is made in such a way that it incorporates not only the high-value use and reuse of materials and an adaptive, future-proof design but also ambitions for sustainability in relation to energy, water, biodiversity at the building and area level."*

(Amsterdam Roadmap Circular Land Tendering, 2018) Amsterdam, one of the leading cities to develop and establish circular building practices is looking beyond building materials and land to also include energy, water, and biodiversity. (Amsterdam Roadmap Circular Land Tendering, 2018)

In Europe, most of the buildings that are needed have already been built and their construction contributed to past carbon emissions (embodied or upfront carbon). A shift is needed from new construction causing new emissions to maintaining the value of the existing building stock and adapting it to today's and future users' needs and standards for e.g. building energy efficiency. The reuse of the whole building and its load bearing structure in situ is generally to be preferred over demolition and new construction and reuse of building components.

In an upcoming report by Arup and the Ellen MacArthur Foundation, five sources of lost value in real estate are identified. These are:

- Underutilised space
- Buildings demolished prematurely
- Vacant land
- Depreciated building materials
- Underperforming components

In today's financial systems, buildings have a life span of 25 to 30 years, i.e. ingrained into tax codes by way of depreciation of building assets or return of investments calculations. Another factor that can contribute to short life spans of buildings is that the value of land in cities raises so quickly that it makes economically sense to frequently replace structures by taller or more compact ones, if zoning laws permit. Yet, life cycle analysis is not yet a standard and the cost of demolition as well as external costs of environmental degradation related to extraction and carbon emissions are not accounted for. The extension of existing buildings' life spans by changing financial models and promoting more durable construction will be an important step towards carbon reductions as well as a circular economy.

Virtually, every building or utilitarian structure can be reused and adapted to changed needs. Great designers such as French architects Lacaton & Vassal have demonstrated that even difficult structures such as social housing from the 1960s and 1970s, parking buildings, and industrial structures have inert spatial and material qualities and are worth preserving. Some outstanding examples for adaptive reuse are:

- Transformation of 530 Dwellings, Cite du Grand Parc, Bordeaux, France
- Volkshotel Amsterdam, a former newspaper headquarter turned hotel
- Permeke library in Antwerp, new central library in an old parking building
- Blue City Rotterdam: A former swimming pool turned into circular hub

Through adaptive reuse and refurbishement, outdated or abandoned buildings can be widely improved and given a second life. However, it can be very complex and therefore very costly if flexibility and adaptability are not designed in from the beginning. Design competitions offer an established regulatory framework to source innovative solutions.

Through adaptive reuse and refurbishement outdated or abandoned buildings can be widely improved and given a second life. Design competitions offer an established regulatory framework to source innovative solutions.

Increasingly, cities adopt *densification* as a strategy to make better use of existing neighborhoods and already developed land, allowing construction on vacant or underutilized land, additions to or topping up of existing buildings. The trend towards more densily built up cities needs to be counter-balanced by incorporating more urban green and nature-based solutons to mitigate negative impacts such as urban heat island effects. Integrating leafy vegetation on facades and roofs can contribute to smarter rainwater management by capturing rainwater for cooling and diverting from the public sewer system. It can also provide extra insulation and shading and thus help extend the servive life of buildings.

Urban planning and design have an important role in avoiding the wastage of resources such as land, materials and energy and preventing long-term negative impacts from locking in emissions generated from building energy use or mobility behaviour for the next decades. Larger cities need to work with surrounding municipalities in their metropolitan areas to prevent urban sprawl. Within cities, urban renewal needs to be decoupled from demolition and rebuilding. Through regulation and ambitious target setting cities can shape urban (re)development, promote compact and connected cities, and.

Cooperation and communication between many stakeholders is required through anticipatory and interdisciplinary planning that identifies new operational and business models. One example is waste heat recovery and use in low temperature heating and cooling networks as is planned in the EIT Climate-KIC supported Merezzate+ project in Milan. Another example is Helsinki's model for land mass management. Excavated land mass from construction is kept locally in temporary storage sites to minimize transport emissions and for reuse locally.

If new construction cannot be avoided, sustainable production and procurement need to be imperative. Cities have regulatory authority through the permitting process for new construction and can legislate to influence both the selection and reuse of building materials. They can lead the transition to a more circular economy by including circular building criteria in tendering documents and design specifications for public buildings and public housing projects. The introduction of such criteria will help to set higher standards and create a market for secondary building materials.

Materials that are reusable at high value and that have the capacity to store carbon should be preferred to directly offset the negative impact of their production. Wood and other bio-based materials sequester carbon and can largely replace concrete and steel which have a large environmental footprint.

Upstream design principles for reusability and circularity is very much needed such as durability of structure and materials, design for disassembly, mechanical instead of chemical joints, avoidance of toxic materials, making use of leased materials etc

Simplicity of construction methods should be looked for. Prefabrication and modular construction provide opportunities to improve productivity and material efficiency in the construction sector and exploit the innovation potential of digitization. Smart management of the existing building stock can be done through maintainiung a public 3D-cataster to retain detailed information of buildings. This will enable online market places for trading materials when buildings come up for refurbishment or demolition.

Nature-based Solutions

Nature can be perceived as a equilibrated system where oxygen, carbon dioxide, nutrients and water circulate in closed loops. Plants grow by using energy from the sun via photosynthesis, are eaten by animals, that in turn become food for other animals. When living matter dies it is being decomposed by funghi and microorganisms into biomolecules and minerals to become nutrients for the next generation. Cues can be taken from natural processes for designing closed regenerative loops for water, biomass, and air that are both energy and resource efficient (biomimicry). Examples are wastewater and organic waste recycling in systems that recover such critical resources as phosphorus, nitrogen, organic fertiliser and water as well as energy.

Storm water management is another area where nature provides numerous solutions to the challenges that cities are facing. Increasing the capacity to absorb rainwater in urban areas will be key to mitigate flooding, replenish groundwater, reduce pressure on the municipal sewer systems and adapt to more extreme weather events caused by climate change. Sustainable urban drainage systems (SUDS) include bioswales, tree pits doubling as water reservoirs, permeable pavement, constructed wetlands, green roofs and public spaces as flexible water retention facilities. With political will and the right policies and incentives in place, such solutions can be integrated in new developments from the outset (Sponge City initiatives in China). Retrospectively including them in existing, densily built up city districts on public and private land

and connecting them on the level of the whole city, however, requires working at scale towards transformation and sustaining an implementation strategy in the long term (City of Copenhagen Cloudburst Plan, launched in 2012 and Philadelphia's Green City, Clean Waters programme, launched in 2011).

Figure: Urban meadow

In addition to storm water management, green infrastructure as a planned network of natural and landscaped areas in cities support the transition to more circular approaches in many other respects. Shading from tree canopies, evaporation from greened surfaces and water bodies and air circulation along green corridors help to cool urban areas and mitigate urban heat island effects. These measures also reduce the need for cooling in buildings and thereby reducing demand for energy and, in most cases, a reduction in GHG emissions. Furthermore, urban greenery and soils sequester carbon dioxide and improve air quality by taking up pollutants such as particulate matter and nitrous oxide. The cleaner the air in the city, the likelier urban agriculture will be integrated as part of green infrastructure. Overall, multi-functional green infrastructure addresses not only biodiversity, climate, and mirco-climate challenges but also to societal wellbeing.

Clean and Distributed Energy

Over a century ago, as electricity was brought into buildings, cities created the first electricity markets by effectively establishing the service area, customer base, and capital structures for operating utilities. While only a few cities today continue with those roles, via municipal utilities, all cities have the ability to shape markets for zero-carbon energy services in urban areas. The potential for them to do so can be found in their ability to aggregate demand among multiple customers, engage in the creation and delivery of the desired services, and offering a capital financing approach that can be cost-effective, equitable, and long-term. Established models that exploit these potentials are Energy Community Co-Opertives (ECCOs), and Local Energy Communities (LECs). However, most cities have large, investor-owned utilities whose incentives still are aligning with selling more units of energy and lack the ability to aggregate customers in order to rationalise systemic investments in decarbonization.

Imagine a city that initiated a 10-year strategy to incrementally aggregate customers, within its own micro-grid, to develop a mix of distributed renewable energy sources combined with smart customer-based storage for short-term peak management, and integrated efficiency upgrades into the service offering for all customers. Such an approach could be done with zero, or very new zero, net cost to customers by better understanding how to shape the market for energy services in a world committed to climate stability and the SDGs. It would however, require a relatively large initial investment in hard- and software development, as well as in staff training. This is because current grids and systems are not equipped to deal with networks consisting of large numbers of digitally automated ”prosumers” (units that act as both consumers and producers of energy, such as buildings with integrated photovoltaics).

Zero-emission Mobility

Most big cities transport systems can be characterized in three words: inefficient, unreliable and unsustainable. As being expressed by the Ellen MacArthur Foundation research project ”Circular Economy in Cities”: ”Current linear practices in urban mobility, such as a high dependence on individual car ownership and fossil fuels, have created high levels of congestion leading to wasted time and lost productivity, as well as pollution, noise, heat-island effects, and the depletion of finite resources. Dependence on individual cars in cities can also be a strain on household budgets and can lead to high amounts of urban land devoted to roads and space for parking. With urbanisation and the demand for urban freight rapidly increasing, the need for more effective urban mobility solutions are pressing. Given this, circular economy principles to design out waste and pollution, keep materials in use and at value, and regenerate natural systems provide the much-needed solutions”. Among the oddities with regard to mobility – and the resources tied up - the fact is that on average, European cars are parked 92% of the time and when in use only 1,5 out of 5 seats are occupied. Moreover, a study by the KTH Centre for Sustainable Communications concluded that gridlock on major roadways is usually caused by a simultaneous influx of just 10 per cent of vehicles above capacity. If such an influx was distributed more evenly, traffic would run smoothly instead of being stuck in traffic jams

Cities across the world struggle to expand their built infrastructure to deal with increasing traffic congestion and to reduce its environmental damage. Yet despite enormous investments, the problems tend to remain or get worse. Overwhelming experience tells us that the problems cannot be ”built away”. The solution to urban gridlock is not gigantic investments but simply a combination of better use of existing resources as well as fundamentally rethinking mobility. Thanks to advances in information technology this is now entirely feasible, and can, from a technical point of view, be achieved within a reasonable time period. However, to do so requires great institutional change.

The ”Circular Economy in Cities” project is proposing a set of planning, designing and accessing tools. Among the most salient are:

- Make cities more compact for effective mobility, expand public transport
- Make cities more liveable by freeing up space presently used by traffic
- Make us of big data solutions to optimise mobility systems
- Offer multi-modal transport as an integrated service
- Develop new business models for mobility assets
- Minimising trip length, duration and operational energy use via digital solutions
- Design regenerative and energy positive, mobility infrastructure
- Develop urban freight strategies for effective reverse logistics and resource flows
- Develop infrastructure for zero-emission vehicles and energy storage

- Building infrastructure with new and low-carbon techniques
- Refurbishing and repairing vehicles to extend material cycles

With regard to the role played by digital solutions it is crucial to distinguish between private and public sector initiatives. Internet-based companies have harnessed technology in a way that has created a huge potential for new services and improved efficiency. Digital platforms connect producers and consumers in new and previously unseen ways. The vast potential is evident in the fantastic growth of such companies.

The methods used, however, have generated a limited number of monopolies whose global ambition seem to be to dominate everything from news services to personal transport and retailing. Challenging old-fashioned institutions and regulations is no bad thing, but not at the price of the creation of oligopolies effectively dominating an increasing number of business areas, including infrastructure. When companies like Uber conquer a market – underpinned by digital means – the risk is that the business interests of the company in question trumps the wider societal interest. Hence, the arguments in favour of the public sector counterbalancing the potential dominance of private actors are strong. *It has been suggested that open integrated digital platforms for information and payment (including dynamic pricing and congestion charging) are launched by cities. Such platforms would, as expressed by Professor Anders Gullberg at KTH in Stockholm, "offer new opportunities to counteract increasingly inefficient, underfinanced, climate-damaging and unfair urban transport systems".*

Food and Nutrients

The transformation of existing food systems plays a crucial role for cities reaching their sustainability and carbon reduction goals as food production causes up to a third of global GHG emissions. GHG emissions from the food system can be cut while consumption is kept within environmental limits through improving technology, reducing food waste and changing our diets.

Applying circular economic principles to the food system mean using ingredients to the fullest, sourcing seasonal, regional, and organic produce, and avoid packaging where possible, thereby maximising positive and minimising negative impact. Another crucial issue will be to help encourage regenerative farming practices, thereby restoring soil quality and, in the process, building carbon in the soils.

Figure: Rooftop farming in Paris

In order to bring food production closer to cities again, to close the nutrient loops and reduce the food-related environmental footprint, however, citizens need to radically cut back on their meat and dairy consumption. Industrial meat production requires far more energy, land and water resources than its plant-based counterpart and is wasteful in and of itself. (Livestock on grazing lands, however, does not incur the same environmentally damaging outcomes).

The EAT-Lancet Commission developed the concept of a planetary health diet that works within environmental limits and identifies opportunities produce urban food differently by:

- Establishing zoning regulations that promote urban agriculture and community gardens as a means to produce food locally, supporting biodiversity and ecosystem services, and providing opportunities for citizens to engage with each other through food.
- Supporting local farmers and producers through the provision of incentives for sustainable production of healthy foods in peri-urban spaces, facilitating market access, and by shortening supply chains.

Diet transition

City governments and public sector have a role to play to promote sustainable food systems and a diet that is healthy for both people and planet. The EAT Lancet commission recommends the public sector to promote sustainable diets at schools and education programs. Furthermore, they advice procurement policies that supply healthy diets from sustainable food systems in institutions where public meals are served.

Higher education institutions are often at the forefront of the transition as their students demand change. Goldsmith University of London recently took beef off the menu and also stopped selling bottled water in cafeterias. In response to a student survey, Technical University of Berlin has recently opened a 100% vegan canteen, while also increasing vegetarian and vegan options in all cafeterias.

Food waste

One third of food produced for human consumption is lost or wasted, amounting to 1.3 billion metric tons each year according to the United Nations' Food and Agriculture Organization. Waste occurs along the whole value chain, from production, wholesale, retail, in the food service industry as well as in private households. To significantly reduce food waste will require radical changes in the food system as well as changing consumer behaviour.

EAT Lancet calls on cities to address food loss and food waste by:

- Striving to reduce food waste and loss among public vendors by at least 50% overall and by facilitating public behavioural change through education and awareness campaigns, including incentives to reduce household food waste.
- Supporting urban food redistribution schemes that share surplus foods with others.
- Supporting composting and making efforts to avoid losses to landfill and incineration.
- Upgrading municipal sewage treatment to minimize nutrient pollution of aquatic systems and to eventually safely recycle nitrogen and phosphorous in cropping systems.

In recent years, a number of solutions to the food waste problem have emerged. In addition to already established food banks and food donation schemes, apps for sharing surplus food from households and restaurants have emerged. There are now online shops and grocery stores available to resell rescued food at discounted rates (e g EIT Climate-KIC supported start-up Sirplus). Generally, awareness of the issue has risen through documentary films, books and other media. As the first country in the world, France has made it illegal for supermarkets to discard unsold fold making it a norm to reduce waste.

Entrepreneurs are increasingly applying circular economy principles in their businesses. There are many concepts and strategies being tried out: *Winnow Solutions* is leading in the growing business of data management for food businesses, aiming at cutting food waste in the service sector through AI-enabled strategies. Other examples are circular coffee shops and restaurants where everything is used to the full potential: leftover food is turned into new meals, leftover milk into ricotta cheese and yogurt, and stale bread into bread pudding (Isla Coffee in Berlin). Also more businesses are built on collecting and reusing food scraps to turn them into a resource. One example is spent coffee ground that is collected as feedstock for mushroom cultivation or turned into reusable coffee cups (e g Kaffeeform, an EIT Climate-KIC supported start-up).

As a norm, all cities ought to implement centralized or decentralized organic waste collection and treatment schemes to allow for energy and nutrients recovery. Where collection schemes do exist, the participation rate needs to increase and separation at source needs to be improved to raise the overall quality of residual waste from households and businesses. Separating out the organic waste is the most effective way to reduce the amount of residual waste.

Urban Consumption

Fast-growing urban consumption is a key driver of climate change. A recent report by C40, the University of Leeds and ARUP – "The Future of Urban Consumption in a 1,5° C World" - documents the difference between a production-based and a consumption-based approach to GHG emissions and consumption-based emissions. For the overwhelming majority of cities consumption-based emissions by far outweigh production-based or territorial emissions. Consumption patterns and consumption-based emissions within the C40 Cities network vary from 1.2 to 39,7 tons CO2e per capita per year, a difference that is equivalent to 20 return flights between London and New York City. If we were to look specifically at different income groups the difference in average carbon footprints would be even more pronounced. For example, a study

by Piketty in 2015 made an estimate about the average carbon footprint for the 1 % most wealthy US citizens. The figure arrived at was 318 tons CO2e per capita. Purchasing power matters!

The C40 report outlines six consumption categories that cities ought to focus on in their efforts to curb emissions:

- Food – by encouraging citizens to eat less red meat and more vegetables and fruit
- Buildings and infrastructure – by making better use of existing buildings and thereby avoiding or reducing new construction
- Private transport – by reducing vehicle ownership and improving public transport
- Aviation – by reducing flights and supporting the development of sustainable aviation fuels
- Clothing and textiles – by buying fewer new clothes and textiles
- Electronics and household appliances – by optimizing lifetimes of IT equipment 5

From Waste to Resource Management

Waste management is one of the primary services that city governments provide and is a sector over which cities exercise significant authority. The amounts of waste generated globally are growing fast and cities are part of the problem.

Most initiatives at the urban level focus on managing municipal solid waste more efficiently, that is waste collection, separation at source, and recycling. However, as already indicated in the Material Economics Study about “Retaining value in the Swedish Material System”, for materials such as steel, aluminium, concrete, plastics and paper a shockingly small amount of collected waste and residue materials was actually recycled while retaining its original value. As a matter of fact, much of the collected household plastic recyclables in industrialised countries are of such low quality that they are being shipped to low-income countries in Asia for further sorting and recycling. This problem surfaced when China decided to stop waste imports from western countries in 2018.

Only a combination of avoiding waste and making the most of the resources that are already in circulation will make a difference in reducing the amount of municipal solid waste. The mindset needs to shift from efficient waste management to resource management. Governments must legislate to enforce the use of alternatives to plastic, limit excessive packaging, minimise incineration and landfill, and restrict waste exports. City and regional governments can pledge more ambitious goals than are mandated by national and supranational governments. C40 Cities proposes to advance cities towards zero waste in their Zero Waste Cities declaration by:

- Reducing the municipal solid waste generation per capita by at least 15% by 2030 compared to 2015; and
- Reducing the amount of municipal solid waste disposed to landfill and incineration by at least 50% by 2030 compared to 2015, and increase the diversion rate away from landfill and incineration to at least 70% by 2030.

In circular urban economies waste must primarily be seen as feedstock and practices like reuse, refurbishment and recycling are close to 100 per cent. Cities can be at the forefront of supporting sustainable lifestyles and promoting practices of sharing, reuse, recycle and repair through policies, campaigning and communication, and support to civil society actors and entrepeneurs who mobilize around these issues. Cities can support acceleration and business creation in this area to harness innovation and knowledge from businesses.

Zero waste initiatives and pay-as-you-throw schemes provide powerful incentives to avoid waste and nudge better sorting at source, both in industry and private households. In addition, being paid for feeding

back high-quality secondary materials instead of having to pay general waste fees can help to reframe waste as a resource and create financial incentives.

The regulation of waste management very often gives priority to the incineration of waste at the expense of reuse and recycling. It is in many cases more expensive to collect and sort out waste for material recycling than to simply collect it as residual waste and send it to energy recovery,

The regulation of the waste management sector have resulted in excess incineration capacity, and local authorities often have an incentive to assign waste to their own incineration facilities in order to fill up the plants, despite the fact that some of this waste might have been reused, refurbished or recycled. *To encourage reuse and recycling of residue materials provisions should be introduced into the waste legislation that will prohibit incineration of waste unless it is well sorted before.*

Cities can help making sharing and circular economy part of the public infrastructure. A sharing economy, if done well, can help reduce consumption by making the most of products and objects. As circular economy needs space for storage, workshops, markets and other activities, cities can provide city-owned spaces and services to community groups and social entrepreneurs for local innovation hubs and initiatives such as libraries of things for tools, toys and various equipment, reuse warehouses or repair cafes, and include shared spaces in the design briefs for new neighbourhoods. Examples include Repair Café, a network that has grown to 1916 cafés distributed in every continent.

The aforementioned EIT Climate-KIC supported district project Merezzate+ in Milan will promote circularity principles among its residents and provide shared spaces of the social housing to realise different services to share, repair, reuse, and recycle products and objects. Sharing and circular economy features are integrated in the existing community app of the social housing provider to incentivise sustainable behaviour of the residents moving into the new district. Residents will also receive support to organise sustainable purchasing groups for furniture and big household items. These measures are backed by a planned pay-as-you-throw (PAYT) scheme that will be implemented in the district.

A new innovation is the evolution of the Libraries of things movement. Libraries of Things are collections of extremely, but only occasionally, useful items such as tools and specialised equipment. They are run by community groups, social entrepreneurs, universities, public libraries or companies and are enabled through internet and software tools for managing inventories, memberships, online booking, payments and reservations. Renting these items instead of owning them helps people to live cheaper, cleaner, more enjoyable and more sustainable lives.

Networking and Experimentation

In ”Networking Cities after Paris” (2018) Emilia Smeds and Michele Acuto bring to the fore ”how urban climate governance has permeated most policy areas and manifested in interventions such as energy-efficient buildings, bike-sharing systems and behaviour change campaigns”. They refer to a proliferation of such interventions as‘urban climate change experiments’. The importance of such experiments – and the sharing of them through networking – cannot be emphasized enough..

The fact that cities are in the midst of energy and material flows make them ideal for experimentation and testing of different ideas and concepts not only with regard to climate mitigation but, as well, in the move towards a circular economy. Governments need test beds and cities can fullfill such a role.

Smeds and Acuto bring to the fore a lot of experience with regard to the critical role of urban climate change experimentation. Most, if not all, of their findings seem highly relevant to the ongoing work by cities around the world to embrace the circular economy as a concept. Governance with regard to climate action – and with no doubt to circularity, as well – does not consist of policy commitments and frameworks alone but, as well, of a multiplicity of experiments. Such experiments can take on many forms. The main purpose is to ”try out new ideas and methods...in new contexts where they are thought of as innovative and explicitly

seek to capture new forms of learning'(Castan Broto and Bulkeley, 2013, p. 93). The experiments most often take the form of pilots that – if successful – can be made permanent.

A key question is what happens after an experiment? The experience is that the networking among cities greatly facilitates the ”scaling” of experimentation. A distinction is being made between ”scaling out” and ”scaling up”. While ”scaling out” is horizontal, i e repeating the experiment either in the same city or in other cities, ”scaling up” is vertical, i e integrating and applying the experiment at a higher system level – integration of particular elements of an experiment (e g a technology or a policy intervention) into policy at urban, regional, national or global level.

Smeds and Acuto refers to studies within C 40, confirming that ”scaling out” is much more frequent than ”scaling up”. ”Simply, it is far more common that climate change experiments in London are replicated in Melbourne, Paris and Santiago, than that these are taken up and mainstreamed via the UK government, the European Union, or state governments in Australia”.

Experience from Hammarby Sjöstad in Sweden – a pioneer already in the 1990´s in terms of an inegrated eco-district concept – tells the same story. The Hammarby approach has been ”scaled out” in other eco-districts in Sweden as well as globally. But it has not resulted in an overhaul of national urban planning, neither in Sweden, nor elsewhere. At large, climate-proof urban devel-opment remains limited to innovative, but isolated, eco-districts, rather than infrastructural systems in Swedish cities having been reconfigured as a result of significant urban ornational policy change. It should be added that C40 has been busy lobbying national governments to change urban planning practices as a result of all the experience gained through networked urban climate change experimentation. But so far with limited results.

Another observation in terms of urban climate change experimentation has been the relative lack of diversity. Most of the experimentation has been of a socio-technical nature, rather than different approaches to governance. A survey of climate change experimentation in 100 cities globally done by Castan Broto and Bulkeley (2013) found that ‘technical innovation” was the most prevalent type of innovation. Another finding was that only 26% of the experiments featured considerations of environmental justice. If the nature of the experiments are not in line with democratic and just models of action there is considerable risk that the experiments will not meet approval of the majority of the citizens. Just imagine that such experimentation would result in ”green enclaves” in areas for the affluent, similarly aggravating climate risks faced by the vulnerable populations. (Hodson and Marvin 2010b).

The concluding remark would be that networking and experimentation among cities are crucial. Networks facilitate experimentation and help raise the level of ambition among cities learning from and competing with each other. Networking has been strengthened and broadened over time – from twinning in the early days to transnational alliances. It has also been developed in partnership with actors beyond local governments, such as the EU, the World Bank and the UN. Networking has intertwined as well with the private sector, not least with large private philantrophic institutions.

Networking and experimentation ought to be strongly encouraged among cities engaged in moving towards a Circular Economy. However, to maximize impact experimentation should be geared much more towards governance issues. Moreover, efforts to ”scaling up”, i e vertical integration of the results of experiments, must be given increasing priority.

Lastly but not the least, many cities will be in great need of additional financial resources to enable circular economy experimentation. For instance, the experience from the UK during the austerity policy years from 2010 to 2015 was that local governments councils had their central government funding cut significantly, leading to serious constraints when it came to any kind of action.

Cities differ – development is site-specific

While ”scaling out” is crucially important, it has to be remembered that cities differ widely in terms of their characteristics. *All development has to be site-specific.* Local conditions are crucial, like geography, size, industry, culture, people etc Furthermore, cities are made up of parishes, industrial zones, harbours and the like. Such areas often have more in common than the cities themselves. When implementing the circular economy the local perspective must be at the core. One precondition will be that efforts at decentralised decision-making are given priority. The diversity of approaches and context should be seen as a priority feature of any strategy to advance circular economy work among cities. Efforts to prematurely standardize should be resisted, as cities are better able to adapt best practices more quickly and effectively than any top-down directives. This calls on the importance of proper evaluation to understand what drove change and what success factors would be required to replicate an outcome elsewhere.

Circular Procurement

Public procurement concerns a variety of goods and services (e.g. health or food services) and building projects. In Europe, the volume of public procurements is large, accounting for approximately 14 per cent of gross domestic product. This translates to annual purchases of EUR 1,800 billion – made by over 250,000 European public sector actors. The Nordic Countries alone spend EUR 171 billion in public procurements every year.

Public procurements can help promote the development and scaling of sustainable products and services. By driving demand for circular products and services, public procurement will help accelerate circular business activities overall. Through responsible procurement, municipalities can serve as examples to others and spur each other towards more sustainable solutions.

Circular procurement can be defined as a process by which public authorities call for works, goods or services that seek to contribute to closed energy and material loops within supply chains, favoring high-quality services rather than the purchasing of products and giving priority to products designed in such a way that their life time can be extended. Another important aspect will be the choice of products and services whose negative environmental impacts across the lifecycle are negligible.

The City of Amsterdam has calculated the material savings and emission reductions that the city could achieve if it were to transition to circular building standards. In the value chain of buildings alone, material savings could be as high as 500,000 tons per year, which is a significant amount considering that the City’s annual material inflow is in the range of 1.5 million tons. The enhanced material efficiency would mean a reduction of carbon emissions corresponding to 2.5 % of the City's annual emissions.

The promotion of a circular economy in the city context was prominently highlighted in the Helsinki City Strategy in 2017. The city strategy was followed by the Carbon Neutral Helsinki 2035 action plan, approved by the City Council in December 2018, the purpose of which is to make Helsinki carbon neutral by 2035. The program includes a total of 147 highly concrete measures, many of which also aim to increase circular procurements in the City’s operations.

If cities increase their demands specifically for circular solutions, it naturally becomes more attractive for designers and producers to offer circular products and services. However, procurers often lack the knowledge of how to incorporate relevant circular requirements for suppliers and how to design tender documents to promote circularity. In addition, procurers often lack knowledge of both the economic and the environmental benefits associated with circular solutions. The same is often true among market players like designers, manufacturers and retailers.

Hence to make circular procurement possible, a dialogue between the main actors – the procurement officials and potential contractors - will be crucially important. Such a dialogue goes against the

conventional practices within public procurement. However, without a dialogue - involving the main actors within a particular supply chain - it will be difficult to obtain circular solutions.

To increase the awareness among public procurers about the potentials of circular solutions – both with regard to cost savings, security of supply, job opportunities and environmental as well as climate benefits – a crash course on Circular Procurement for public procurement professionals within EU Member-States ought to be organized.

Make use of the digital revolution

More digital data is being generated than ever before. Numerous digitally-enabled solutions (e.g. digital sensors, mobile phones, connected devices, satellites) are used to generate and collect new data, including for specific purposes such as a circular economy. For this data to be turned into information and gain value, it must be managed – that is, mined, systematised, processed and shared.

A discussion paper by the European Policy Centre (EPC) – Creating a Digital Roadmap for a Circular Economy – highlight the opportunities offered by disruptive technologies, notably digitalisation. Data and digitally-enabled solutions like digital platforms, smart devices, artificial intelligence, the Internet of Things and blockchain are already contributing to the circular economy. They are used *inter alia* to improve resource efficiency, design, production, consumption, reuse, repair, remanufacturing, recycling and the overall waste management. They are also instrumental for the development of new business models, such as the sharing economy, products as services, smart mobility etc One example among many of the implementation of digital data in the circular economy is the Excess Materials Exchange platform. Digital technologies are enabling circular business models like the sharing economy, and ”products as a service”.

Geospatial information is another sector where digital solutions can lead to increased support for the circular economy. When combined with asset tagging, eventually enabled and accelerated by smart devices, the above can provide visibility on the flow of materials, components, products and people, helping to identify optimal mobility routes, energy demand peaks and troughs, congestion and waste generation.

The EPC paper makes clear, however, that digitalisation will not automatically lead to greater sustainability. ”In fact, there is a risk that if it is not guided well, it will result in unwanted rebound effects, such as an overdrive of a linear ‘take-make-dispose’ economy, and increase in greenhouse gas emissions. However, if adequately steered, data and digitally-enabled solutions could certainly boost the transition to a circular economy. They could help enhance connectivity and the sharing of information; make products, processes and services more circular; and empower citizens and consumers to contribute to the transition by increasing their awareness and enabling them to make sustainable choices and co-create knowledge”.

In a recent study by the Digitalisation Consultancy Industry in Sweden: ”An Innovation Driven Roadmap for Fossil-Free Competitiveness and Global Sustainability” the opportunities to use digital technologies for GHG emissions reductions are discussed. There are, according to the report, three different ways in which digital solutions can help reduce material throughput as well as GHG emissions.

First, existing systems can be optimised. *Second,* the uptake of sustainable solutions can be accelerated. *Third*, transformative changes can be achieved. A transformative change occurs when the impacts of digitalisation at various levels work together, i.e., when novel technical solutions, business models, economic incentives, new legislation, social planning, new financing models and methods for assessment and creating transparency, etc., are brought together.

Studies that mainly look into the optimisation of current systems show that digital solutions can contribute to an estimated 20 % reduction of global GHG emissions. But the potential for enhancing resource efficiency as well as cutting emissions is considerably larger if the focus would be on the transformative impact of digitalisation, having the potential to help meet society’s needs in entirely new ways.

It is relatively easy to understand, to measure and gain political support for optimising existing systems but the transformative and systemic changes required will demand a lot of interactions and require cooperation among many actors, both public and private. *Yet the real potentials rest with the transformative changes.* Therefore cities should be encouraged to adopt policies that will strive to make maximal use of the opportunities offered by digitalisation.

It seems obvious that many solutions powered by digitalisation have great potential to both enhance material and energy efficiency and enable the reduction of GHG emissions. The EPC paper referred to above makes the point that Europe is currently engaged in two major transitions: ”the creation of a more circular economy and the digital revolution”. Major efforts are currently being taken by the EU and its Member-States to promote both transitions. ”However, these efforts are not aligned”.

The paper continues:” EU has the foundation to be ambitious: Europe is already an innovation hub using data and digitally-enabled solutions for greater sustainability. However, as many of these solutions are still small-scale or emerging, it is important to continue to build on this potential. With this in mind, *why not set an EU-wide goal to become a global leader in using data and digitally-enabled solutions, for a more sustainable, circular economy?”*

The recommendation by the EPC is worth repeating. Since cities will be the main actors on circularity *the EU should consider putting in place a policy framework, including economic incentives, aiming at releasing the power of digital technologies as enablers of the circular economy.* As emphasized in the EPC paper, the policy framework has to ”go beyond the traditional digital and environmental agendas; measures will need to be aligned with climate action and the wider sustainability agenda, and be supported by single market tools, industrial agenda, research and development, and social and consumer policy.”

The need for Indicators

Municipalities’ way of measuring success is well established within conventional areas, such as health-care, education and transport. Here, the applications of specific goals and indicators are often deeply embedded and give them prominence in operational matters. When it comes to circularity and sustainability, however, things are not as clear cut. There is a strong need for generally agreed indicators for circularity and as of today that is conspicuously lacking.

It is generally accepted that progress towards a circular economy will require a set of universally accepted and reliable indicators. There is no lack of indicators. On the contrary, the rapidly growing interest in the circular economy in recent years has resulted in the emergence of a variety of different indicators. They deal with everything from material intensity, domestic material consumption, generation of waste per capita, recycling rates of different materials, circular material use rates to the number of patents in secondary raw materials. The cacophony of circular metrics popping up across sectors and geographies has created an environment of competing and often conflicting indications of actual circularity progress achieved. The fact is that there is no agreed system in Europe as to how to review performance with regard to circularity at the city level. A recently launched initiative – The Circularity Gap Report – represents an attempt to improve the situation. While the intentions are good the approach taken seems far too narrow and, to put it frankly, misleading as it mainly assesses the level of materials recycling in an economy. However, recycling is but one of many features of a circular economy and, in fact, not the most important one. Product life extension, reuse, refurbishment, regeneration and remanufacturing are all examples of activities of greater significance for circularity.

A recent initiative within ISO may be a possible way forward. A new ISO technical committee – ISO/TC 323 – is meant to address all aspects of a circular economy, including public procurement, production and distribution, end of life as well as wider areas such as behavioural change in society, and develop tools for assessment, such as some kind of circularity footprint or index.

A suggestion would be for the OECD as well as the EU to closely follow the work within ISO and help make sure that the need for circularity indicators at the city level is being met.

Systemic vs Fragmented Approaches

As already noted, cities offer a major opportunity to drive systemic change in the economy. From scaling demand, they can evolve becoming the largest market driven by policy incentives - such as procurement, regulations and standards. By being the problem-owners, i e facing high levels of waste and pollution and GHG emissions, cities have the opportunity to drive change through innovation along the value chain and (re)design processes in all areas from policy and infrastructure to products and services.

Continued and rapid urbanization, in particular in emerging economies and other developing countries, offers the opportunity to tap into technology leap-frogging and thereby transition, as well as acceleration of scaling. The driver for such a development will increasingly come from public demand, not least from the youth. The public desire for a clean revolution is manifesting itself in cities all over the world. From energy, water and air, to materials and wastes flows, cities are the best placeholder for systemic transition with scale that can be accelerated among the biggest populations on Earth.

However, a major risk so far concerning many of the efforts undertaken to promote the circular economy in cities is the fragmentation in terms of approach. There are exceptions but, in general, the impression when looking at city landscapes is one of a plentiful of vertical interventions, most often aiming at single-point solutions. While many of these efforts are worthy and do bring about improvements in material efficiency as well as reductions in pollution levels, such solutions rarely achieve systemic change, i e the transformation needed, and will not address climate change at the necessary speed and scale.

Based in particular on the work and experience of Climate-KIC, achieving quick and substantial reductions in GHG emissions will best happen by bringing different actors and systems thinking approaches together and by bridging multiple contexts rather than hoping for solutions generated in silos – i e through a systemic approach. This definitely applies to innovation per se but, as well, to the exploration and development of solutions in general.

4. Strategic Innovation

The recent IPCC reports quantify the challenges that will be faced by cities in tackling both mitigation and adaptation.

With regard to the built environment, the challenges are staggering. The global building stock in 2050 will need to have 80-90% lower emissions against the 2010 baseline. Developed countries will need to adopt a 5% per year retrofit rate, with new buildings being net zero energy by 2020. Furthermore, electricity supply will need to be 75-80% renewable by 2050. In the transport sector the expansion of public transport, the promotion of active mobility (walking and cycling), and a rapid increase in infrastructure for and uptake of low-carbon fuels (such as electricity, hydrogen and biofuel) will be needed.

Change of this breadth will require new ways to engage citizens, encouraging different types of behaviour and, as well, innovation with urban policy levers. One particular aspect has to do with a combination of educating people about the urgent need for change, nudging their behaviours and, in addition, the need for regulation of behaviour in certain areas. At the same time we know that the growth of cities is rapid. By 2030 the world is projected to have 43 megacities, most of them in the developing countries. On average urban land is expanding twice the rate of population growth. Future infrastructure must respond both to the pressures of urban growth and the need to transform how cities work in order to create climate-resilient communities and keep global temperature rise well below 2° C. Innovation with regard to regulation as well as policy will be as important as innovation in the built environment.

Today, cities have ambitious carbon targets and a willingness to take a lead in driving change. Whilst nation-states were grappling with how to address climate change in Paris, city mayors and subnational leaders pledged to “deliver up to 3.7 gigatons of urban greenhouse gas emissions reductions annually by 2030”.

As OECD and other global organisations contemplate the ways to catalyse more circular city work, consideration of a new methodology underway through EIT Climate-KIC may offer some insights. Given the imperatives around climate change and the SDG:s, system change demands increased investment in strategic innovation. Building on the logic of systems change through strategic innovation embedded in the ongoing ’mission innovation’ discussions at EU level(and the five Mission Boards being appointed), Climate-KIC has adapted a specific initiative focused on cities.

Cities frequently have ambitious carbon targets, but these are often described in a long-term trajectory with incremental implementation plans that tend to work primarily with known technologies. There are organisations that work with cities to help with the development of carbon plans. However, most of the work so far is incremental in nature, when what is needed is transformation.

The EIT Climate KIC Strategic Plan (2019-2022) identifies visionary city authorities, who view climate action as central to well-being. EIT Climate-KIC provides such city authorities with frameworks for transformation and support with implementation, through leadership and the provision of solutions that can sit alongside the strategic intent.

Much of the work being done by cities will leave a gap between articulated ambition and what is delivered on the ground, unless space, resources, ideas and thought leadership is created around more urgent, transformative systems change across multiple city systems. In other words, strategic innovations are necessary across the full spectrum of urban systems work.

Climate-resilient, sustainable cities can only be attained if people learn how to work together towards critical, shared outcomes. This need goes well beyond traditional political dynamics and relationships towards a more holistic approach with new models of governance; a willingness to experiment with different solutions (moving off the ‘procurement conveyer belt’); an inclusive mindset towards working with local communities and novel solution providers; and building different working relationships.

There is some support out there for cities that want to meet this need for systemic change, but nothing that has taken city system(s) as a whole and attempted to put innovative approaches in place to accelerate a thorough transition. Instead, city governments, along with stakeholders, are expected to undertake horizon-scanning and combine multiple programmes in the hope that they take the city on a trajectory that would resemble a holistic strategy. The aim of the recently launched EIT Climate-KIC Healthy, Clean Cities Deep Demonstration process is to remove the guess work around where and how cities need to invest and intervene, by providing an evidence-based approach that indicates the systems interventions that are needed at the whole city scale, to go further, faster. Another Deep Demonstrations process worth mentioning is the Circular Regenerative Economies. The aim of this process is for innovation to tackle material production and waste flows across key economic systems and in so doing help a country, region or city to curb emissions and advance health and prosperity. The government of Slovenia is considering a contract of cooperation for three years. Other examples of deep Demonstration Processes are ”Just Transition of Heavy Industry Regions” – where the Regional Government of Upper Silesia, the Mondragon Cooperative and the Regional Government of Emilia Romagna are the early potential partners, and ”Net-Zero, Resilient Maritime Hubs”- one of the initiators being the port of Valencia - and ”1 Million Near Zero Energy Homes”, which aims at creating momentum for very large scale refurbishment of existing residential buildings to near-zero energy and near-zero carbon buildings.

Deep Demonstration of Healthy, Clean Cities

The Healthy, Clean Cities Deep Demonstration process will support municipalities and their stakeholders (including communities, businesses, etc) to realise a different trajectory for addressing climate change. The programme will work across the following key areas:

- Putting the right building blocks in place: In order to understand how to accelerate climate change strategies, cities need to know where to invest, the economic case for making particular interventions and to be able to build communities of participation across all stakeholders. The first part to the Deep Demonstration process will therefore be to give cities the evidence, data and tools they need to start being able to co-create and enact change in a different way to what has been seen before.
- Tools and resources: There is already an abundance of tools, resources and frameworks developed expressly to help cities work towards their climate goals. Following work to understand where some of the key city challenges and opportunities are, this Deep Demonstration will be able to assemble the right mix of these to lever the necessary changes. They will draw on work from the IPCC, education and capacity-building programmes (including EIT Climate-KIC's Climathon programme) and other well-known and tested frameworks and standards (e.g. the Eco-Districts Protocol).
- Solutions and experts: Ongoing work with the cities participating in these Deep Demonstrations will undoubtedly uncover a need for a range of expertise to support capital planning and to provide new solutions (where there are none currently available). This will involve bringing in, and coordinating: programme experts (from across the globe based on each city's priority activities); solution providers (businesses from the EIT Climate-KIC community and others); and capital and finance experts.
- Strategic innovations and radical acceleration, replication and scaling: To reach carbon neutrality, there will need to be experimentation, for example with regulation and novel technologies. This element may put cities on a very different path towards meeting their climate goals. There will be a strong need for policy innovation to enable implementation and demand creation. This part of the Deep Demonstration programme will work with innovation providers; transformational experiments; accelerator hubs and start-up communities as well as social enterprise platforms.

The Deep Demonstration Processes will enable the participating cities (and regions) that are more ambitious to get beyond solving the 'easy' things at an incremental pace. It will enable cities to accelerate activity and experiment with transformative solutions. The objective is to be able to bring '100 cities to carbon neutrality by 2030'.

There has been significant interest from cities coming forward to work in this more systemic way and the effort is moving forward with an initial cohort of ten cities. The cities involved represent good geographical coverage and include both smaller cities as well as some of Europe's major urban centres. Cooperation has been initiated with the Global Covenant of Mayors to cultivate the work around policy innovation and to build a pipeline of both cities and support organisations going forward.

Parallel to the Deep Demonstration Processes, Climate-KIC has developed a portfolio of innovation programs aiming at circularity in cities. Among the many examples are LOOP – a global innovation platform that aims to close the loop on high-emitting material systems, and dematerialise demand in urban areas; eCircular – accelerating the circularity of plastic-based material systems and dematerialising plastic demand; ZRR for municipal waste – together with Ferrovial, NTU, Cespa and the Wuppertahl Institute deploying and testing a robot to improve municipal waste sorting methods and Façade leasing – a pilot project at Delft University Campus with industrial partners to introduce the circular economy into the construction industry

Possible implementation frameworks

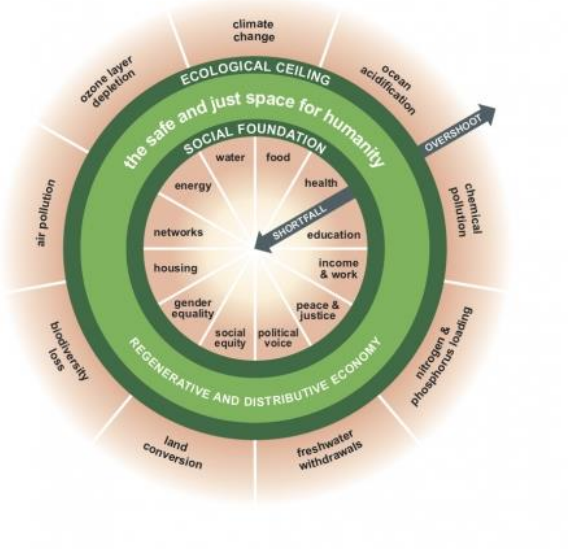
In order to be transformational in the Deep Demonstration Process – and in addition to what has been explained about the background and orientation of the process - a series of implementation frameworks could be envisaged and drawn upon. Outlined here are three frameworks to be considered:

- Doughnut Economics
- Resource Flow Analysis
- User-Driven Circularity

Doughnut Economics

An approach to fully integrate ecological and social objectives

Doughnut Economics, developed by economist Kate Raworth, sets out a framework for delivering essential human needs without exceeding the ecological limits of the planet. It is building on the planetary boundaries concept as defined by Rockström Steffen, Richardsson et al (Nature 2009). The space between the fulfillment of minimum human needs and the planetary boundaries, defined as the "*safe and just space for humanity",* is where a prosperous economy ought to operate. Human needs are defined in altogether twelve categories: food, health, education, income & work, peace & justice, political voice, social equity, gender equality, housing, networks, energy and water.



Doughnut Economics (Kate Raworth, 2017)

The framework has been implemented in Amsterdam as part of a circular economy strategy - *Buildings Blocks for the New Strategy: Amsterdam Circular 2020-2025* - providing the city with an actionable plan for transformation towards a circular economy.

The 4 steps taken were:

- Connect current city targets to both the social needs and ecological limits of the Doughnut model
- Develop a set of policy-focused circular economy "directions" for the city, such as:
- Encouraging healthy, sustainable and plant-based food consumption for all citizens

- Prevent overconsumption and minimise the use of fast-moving consumer goods
- Circular area development through flexible zoning and regenerative urban design
- Evolve existing city targets to incorporate the circular economy directions and limits informed by the Doughnut model
- Enrich and validate these directions through engagement with a wide range of stakeholders, including municipal representatives, businesses, experts and knowledge institutions

With clear and validated circular directions for the city, a baseline could be set and actors could be mapped — both the City of Amsterdam itself and other city stakeholders (including businesses, non-profit organizations, service providers, educational institutions and civil society).

Resource Flow Analysis

An approach for identifying opportunities for circular interventions in different sectors

Resource flow analysis identifies the resources flowing in and out of a system, from its origin to the final destination. With more comprehensive data sources available the ability to map such flows has grown, providing the information requisite for accurately measuring impacts and testing proposed initiatives for resource efficiency. Typically a flow model will consider three main types of resources: *materials* - raw material feedstock (input) and solid waste generation (output)); *energy* -energy demand (input) and surplus energy (output)); and, *water* - water demand (input) and wastewater generation (output).

Such an analysis can be done at multiple scales, wherever one draws the boundary. For a city as a whole a study has been done by the *Chartered Institution of Wastes Management Environmental Body* (IWM (EB)) for Greater London in their report *City Limits* (2002), or at a more limited scale, like the *Circular and Sharing Economy Scoping Study for Old Oak and Park Royal*, produced by Arup, for London Waste and Recycling Board and the Old Oak and Park Royal Development Corporation (2017) — a study considering the inputs and outputs of the regeneration of Old Oak and Park Royal, a development expected to create 25,500 homes and 65,000 jobs. City Limits

The resource flow analysis enables a city to identify opportunities for circularity across many layers. For the Old Oak development the process undertaken to identify these circular opportunities included six components:

1. Design: evaluating how buildings and infrastructure can be designed to increase their useful life, from material selection, adaptability or flexibility in the structure, design for disassembly and reuse of components.
2. Services: reimagining services from energy, water and waste, making better use of low carbon resources, demand-side management and designing circularity into the system (e.g. waste to energy systems, easy waste separation, reuse of waste materials and take-back schemes).
3. Mobility: reimagining the movement of people and things, taking in account connectivity. Incentivising use of sustainable modes of transport; walking, cycling, public transport, low emission vehicles, car sharing through good design as well as the provision of virtual meetings.
4. Reuse: designing for reuse of resources, materials and components.
5. Biological processes: encouraging nutrient harvesting from the biological cycles (e.g. food and garden waste) for local food production. Extracting and reusing biological nutrients via anaerobic digestion and composting.
6. Engage communities: designing and operating the various schemes introduced to encourage locals to adopt sharing and circular behaviours.

Derived from this process were a long-list of initiatives divided into ten categories: food, water, energy, environment, materials, construction, mobility, logistics, space and community. Within the theme of food, some example interventions were: rooftop farming, commercial food distribution and community dining.

A resource flow analysis allowed the team to systematically identify a diverse range of opportunities for circularity, which could be collected and illustrated into scenarios in order to reshape the design of systems, buildings and infrastructure.

User-Driven Circularity

An approach for engaging with users for circular behaviours

The approach, called *Strategic Design*, develops an understanding of users to transform the interactions, services and systems of a city to further a strategic goal. Proven in circular products and other urban domains, like the new Helsinki Library, there are a few examples with respect to strategic circular economy transformation, presenting a ripe opportunity. The importance of such an approach is laid out in Vicky Lofthouse's 2018 paper*, Human-Centred Design of Products And Services for the Circular Economy – A Review.*

The frameworks presented above, i e Doughnut Economics (Framework 1) and Resource Flow Analysis (Framework 2), mainly focus on the design of the interventions through opportunities presented by the system. By contrast User-Driven Circularity starts with the user, being consumers of resources, occupiers of buildings and customers of products and services, as a lever for influencing the overall design and infrastructure of the circular city. To fully engage the users represents an important complement to the visioning approach of Doughnut Economics, and the supply chain focus of Resource Flow Analysis. It provides a mechanism for making sure the transformation from linear to circular meets the expectations of the citizens, taking in account their experiences as well as their needs but, as well, invites the citizens to be co-creators of the transformation.

The approach asks the fundamental question: *how can we develop products, services, buildings and systems for users to cultivate the circular city?*

To answer this, an approach is as follows:

1. Research: identifying user needs and values. Undertaking user research, employing a mix of methods including observation of existing behaviour, intercept interviews, deep interviews and other data (e.g. web analytics, sensor data), whatever is relevant to the area of inquiry.
2. Concept Design: devising concepts for the circular city, which respond to user needs. A concept could include a mobility as a service platform giving users access to a variety of fit for purpose and sustainable transport options. These should be varied and address needs across all parts of life.
3. Prototype: testing, validating and refining circular concepts by reflecting them back to the user group.

5. Concluding remarks

The move towards a circular economy seems unstoppable. While nothing is hundred per cent circular, the benefits of moving from a Linear to a Circular Production Model are obvious both from purely economic as well as environmental and social points of view. The reductions in terms of carbon emissions are striking. Against this backdrop is it somewhat of a mystery that society has done so little hitherto to promote resource efficiency in general and material efficiency in particular. It is important, though, to remind the reader of the rebound effects. Neither resource efficiency nor circularity will be sufficienct to bring about

effective ”decoupling”. There will be a need for complementary measures, primarily through price inceases to balance future demand.

While the main motive behind the move towards a Circular Economy is related to the effects on the environment – reducing the risk of resource depletion, lowering pollution and curbing GHG emissions - there are several strong co-benefits. The most obvious is the values to be captured and money saved. The waste in today´s linear model is huge. In addition there are a multitude of social objectives to be harnessed. Net employment will, according to a number of studies, be positive. Entrepenurial activity is likely to fluorish in areas like repair, maintenance, refurbishment and remanufacturing, in the sharing economy and in turning products into services. Social cohesion is likely to benefit. An economy built increasingly on the offering of services rather than products and on the concept of a sharing economy will result in a large number of interactions between citizens that are likely to enhance quality of life and, more specifically, the level of trust.

Cities have a crucial role to play. As already emphasized, urban areas lend themselves particularly well to a circular economy system due to their close proximity of citizens, producers, retailers and service providers. Moreover, cities make up for 4/5ths of global GDP, 75 % of resource use and an estimated 65-70 % of greenhouse gases. A ”circular city approach” would build on the traditional role of cities. Cities have the authority on things related to city-planning, energy and material use, infrastructure, mobility and transport and waste management – all areas of crucial importance in the move from a linear to circular production model.

Throughout this paper numerous examples of initiatives already taken by cities all over the world – and about to be initiated – in the spirit of circularity have been displayed. The overall benefits are obvious with regard to air and water pollution, congestion, waste management, carbon emissions, health etc However, a major risk so far in most of the efforts undertaken to promote the circular economy has been the fragmentation in terms of approach. Hence the strong preference made to the new strategy pursued by Climate-KIC and the priority given to systemic approaches and to systems innovation.

Of crucial importance in the years ahead will also be the policies enacted at both global, EU and national government levels. The linear production model is dominating today because of massive market failures, i e negative externalities in relation to both the extraction, production and use of all kinds of natural resources are not reflected in market prices. Business models are build upon high throughput of energy and materials. The sourcing of virgin materials most often is less expensive than secondary materials. Furthermore, most products are not designed for reuse, refurbishment or recycling. Cities can, no doubt, do a lot as regards the promotion of circularity. But up-stream issues like (i) production costs being correctly reflected in market prices and (ii) product design requirements to facilitate reuse and recycling must be urgently addressed at the appropriate levels.

There is a need for more explicit and focused intergovernmental discussions about governance. Key issues will be how to align global supply chains with the objectives of a circular economy. The OECD could play an important role facilitating such discussions. Within the EU there is urgent need for rethinking policy frameworks so as to make secondary materials markets competitive and product design in harmony with circularity.

Networking and experimentation among cities will be crucial. The examples already existing from networking demonstrate the importance of both ”scaling out”, i e the replication of successful experimentation, and ”scaling up”, i e the vertical integration of the results of such experiments.

Finally, the importance of definitions must be stressed. The fact that the circular economy is mostly looked upon as a metaphor for a number of parallel features and concepts may not be seen as a problem. But it is. The interpretations range from narrow ones, focusing primarily on recycling, to very broad ones focusing on a thorough reform of the economy in support of ecological and social objectives. There is a strong need

to narrow down the main features of a circular economy, not least to make it possible for nations as well as cities to benchmark against each other and, in particular, to measure progress.

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