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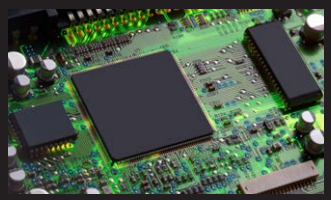

DECOUPLING 2

technologies, opportunities and policy options

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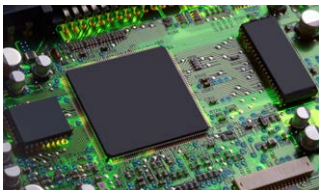
Summary for Policy Makers



DECOUPLING 2

technologies, opportunities and policy options

Produced by the **International Resource Panel**

This document highlights key findings from the report and should be read in conjunction with the full report. References to research and reviews on which this report is based are listed in the full report.

The full report can be downloaded from **www.unep.org/resourcepanel/**.
Additional copies can be ordered via email: resourcepanel@unep.org, or via post:

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75441 Paris CEDEX 09, France

Preface

The urgency for decoupling escalating resource use and environmental degradation from economic growth is now widely acknowledged by policy-makers, industry leaders and civil society. Indeed, it has become a key issue in the on-going deliberations on the Sustainable Development Goals (SDGs).

Decoupling lies at the heart of the mission of the International Resource Panel. Established by UNEP in 2007, the Panel provides independent, coherent, authoritative and policy relevant scientific assessments on the management of natural resources and the environment for the highest net benefit of present and future generations. Its analysis, based on full lifecycle impacts of resource use, has repeatedly highlighted the importance of decoupling for ensuring that the gains in human well-being made by economies are not lost because of the simultaneous costs arising from resource scarcity and environmental destruction.

In its first Decoupling report published in 2011, the Panel showed that breaking the link between human well-being and resource consumption is necessary and possible but in reality is hardly happening. In this follow-up report – *"Decoupling 2"* – the Panel highlights existing technological possibilities and opportunities for both developing and developed countries to accelerate decoupling and reap the environmental and economic benefits of increased resource productivity.

Many decoupling technologies and techniques that deliver significant resource productivity increases are already commercially available and used in both developing and developed economies. They allow economic output to be achieved with fewer resource inputs, reducing waste and saving costs that can further expand the economy or reduce its exposure to resource risks.

But while these technologies are readably available, their uptake and upscaling requires policies to remove barriers to decoupling and intentionally promote a transition towards greater resource productivity. Economies often do not naturally adjust to changes in resource availability by promoting innovation and resource productivity; they can suffer from blocks to transition which "lock-in" existing patterns of resource use. The legacy of past policy decisions and technological, behavioural, organisational and institutional biases against innovation in resource productivity present significant barriers to decoupling.

Facilitating decoupling will thus require removing these barriers and overcoming the "lock-in". Developing countries may have a relative advantage

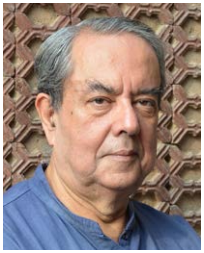
in decoupling, because they are not so strongly locked-in by resource-intensive consumption patterns, production systems, infrastructure and institutions as in the developed world. But in both cases, raising resource productivity is easier and more successful when policymakers are sensitive to the perceived needs of stakeholders and the interests, relative power, the norms and assumptions that shape economic and societal decisions. Obviously, a high level of leadership is needed in the public and private sectors to overcome the resistance that is commonly faced by such deep policy changes and to promote the needed policy action.

This report examines several policy options that have proved to be successful in helping different countries to improve resource productivity in various sectors of their economy. It also highlights examples that demonstrate significant progress towards decoupling economic growth from resource use.

In particular, the report mentions two policy proposals which are illustrative of the type of combined policy that is needed. One proposal uses taxation or subsidy reduction to move resource prices upwards in line with documented increases of energy or resource productivity. Another looks to shift revenue-raising onto resource prices through resource taxation at source or in relation to product imports, with recycling of revenues back to the economy.

There is growing evidence that decoupling will be one of the next big opportunities for innovation, wise use of resources, and thus for continued economic development. Policymakers along with corporate leaders with vision and an understanding of political realities can take significant steps to benefit from future resource trends and decoupling opportunities.

The International Resource Panel is committed to continue providing cutting-edge scientific knowledge on sustainable resource management and promote a better understanding of the opportunities of decoupling technologies and policies. We are grateful to the lead authors of this report for their encouraging findings and incisive recommendations, and we are very much looking forward to the reaction of policy-makers to the tremendous challenges and opportunities highlighted in this report for overcoming the barriers to decoupling and collecting the economic benefits of increased resource productivity.



Dr. Ashok Khosla

Co-Chair,
International Resource Panel (IRP)
New Delhi, India, May 2014

Foreword

One of the greatest challenges facing humanity today is to maintain the healthy growth necessary to lift the world's one billion people out of absolute poverty and manage the natural resources required for the well-being of nine billion people by 2050 – all while keeping environmental impacts within acceptable limits and sustaining life's natural support system.

The first Decoupling Report by UNEP's International Resource Panel (IRP), launched in 2011, sought to apply the concept of "decoupling" economic growth and human well-being from negative environmental impacts and escalating resource use to address this challenge.

Improving the rate of resource productivity (*doing more with less*) faster than the economic growth rate is the notion behind decoupling, to the extent of actually using less resources.

That goal, however, demands an urgent rethink of the links between resource use and economic prosperity, buttressed by a massive investment in technological, financial and social innovation, to at least stabilise and ultimately reduce per capita consumption in wealthy countries and help developing nations follow a more sustainable path.

The IRP's new *Decoupling 2* report demonstrates that the worldwide use of natural resources has accelerated, causing severe environmental damage and depletion of natural resources.

Annual material extraction grew by a factor of eight through the twentieth century. At the same time, the use of resources, such as freshwater, land and soil has transgressed sustainable levels.

This explosion in demand is set to accelerate as population growth and the increase in incomes continue to rise. More than 3 billion people are expected to enjoy "middle class" income levels in the next twenty years, compared to 1.8 billion today.

A global economy, based on the current consumption models, is not sustainable and carries significant economic consequences. Price volatility and supply shocks of resources have already been observed across a range of key materials and commodities. The volatility of food prices, for example, increased to 22.4 per cent in 2000-2012 compared to 7.7 per cent in the previous decade.

Placing the world's environmental resources – such as water, biomass, fish stocks and ecosystems – under too much stress can lead to sudden, non-linear collapse. Over-mining has led to a decline in average ore grades for several key metals, such as copper, gold and tin. As a result, three times as much resources and materials needs to be moved for the same quantity of metal extraction as a century ago.

Global markets cannot respond adequately by simply raising the supply of resources to meet demand, especially when they are not set up to factor in the anticipated scarcity of resources.

The decoupling of economic growth rates from resource use is, therefore, more than just an imperative. It is the next big opportunity for green economic growth, innovation and sustainable development at large.

The *Decoupling 2* report highlights that efficient technologies do exist for both developing and developed countries to significantly reduce resource intensity and, where feasible, achieve the absolute decoupling of resource use. Decoupling allows economic output to be achieved with fewer resource inputs, reducing waste and saving capital. Those funds can further expand the economy or reduce its exposure to resource risks.

This new IRP report also explores the enabling environment required for national economies to promote decoupling and prosper in the future, through identifying and removing barriers, including technical and institutional "lock-in", which can hold back effective policy change.

The report concludes that with leadership, vision and an understanding of political realities, policy makers can take significant steps to reap benefits from future resource trends. These steps include the creation of favorable conditions for investment in technological and institutional innovation and transformation.

In 2014, the United Nations Open Working Group on Sustainable Development Goals will submit a proposal to the General Assembly that will set development priorities for the coming years.

It is my sincere hope that the findings of this important report will inspire Member States to embed sustainable resource management and the concept of decoupling in the post-2015 development agenda, and trigger visionary political and business leadership to foster policy co-ordination in the public and private domain aimed at effectively decoupling economic growth from the escalating use of energy, land, water and materials.

I would like to express my gratitude to the International Resource Panel, under the leadership of Ashok Khosla and Ernst Ulrich von Weizsäcker, for coordinating this important report.

Achim Steiner

UN Under-Secretary General and UNEP Executive Director

Nairobi, Kenya, May 2014

Executive Summary

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1 Introduction

As the work of the International Resource Panel (IRP) shows, the worldwide use of natural resources has accelerated, bringing with it the thinning or depletion of numerous resource stocks and causing negative environmental impacts.[1]

Adjusting our societies to these trends is one of the grand challenges of our times. The trends in resource use suggest that successful economies will be the ones that can increase the value they deliver, while using fewer resources.

The report highlights existing technological possibilities, for developing and developed countries, and their economic advantages. It shows that there is growing evidence that decoupling will be one of the next

1 UNEP (2010) Assessing the Environmental Impacts of Consumption and Production. Priority Products and Materials. A Report of the Working Group on the Environmental Impacts of Products and Materials to the International Resource Panel. Hertwich, E., Van der Voet, E., Suh, S., Tukker, A., Huijbregts, M., Kazmierczyk, P., Lenzen, M. McNeely, J., Moriguchi, Y.

big opportunities for economic growth, innovation and wise use of resources. The report explores the actions that a country would need to take to create the conditions for its economy to prosper in the future.

It finds that policymakers with leadership, vision and an understanding of political realities can take steps to benefit from the future resource trends. The report identifies the barriers that can hold back effective policy change, and examines technological, organisational and policy options that have proved to be successful in different regions of the world. It highlights the forms of policy action that can make faster progress towards the decoupling of economic growth from use of resources.

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2 Changes in Resource Use and Scarcity

Trends in resource use

During the twentieth century, the annual extraction of ores and minerals grew by a factor of 27, construction materials by a factor of 34, fossil fuels by a factor of 12 and biomass by a factor of 3.6. In total, material extraction increased by a factor of about eight.

The extraction of many metals has followed an essentially exponential growth path since the beginning of the twentieth century, as Figure 1 shows.

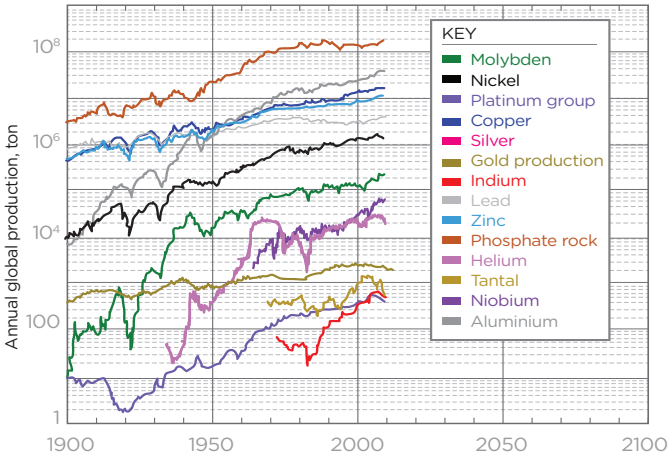

Figure 1: Extraction of many metals grew exponentially since the year 1900 (the ordinate on the picture being logarithmic) From Sverdrup et al, 2013[2]

2 Sverdrup, H. U., D. Koca, K. V. Ragnarsdóttir (2013). *Peak Metals, Minerals, Energy, Wealth, Food and Population: Urgent Policy Considerations for a Sustainable Society. Journal of Environmental Science and Engineering*, 2(B): 189-222.

Other reports have illustrated that the use of some natural resources essential to prosperity – including freshwater, land and soils, and fish – have similarly increased, in many cases beyond sustainable levels.

The underlying drivers for this explosion in demand appear set to continue. The UN projects global population to grow by more than 2.5 billion people by 2050[3] and incomes (on average) are on track to continue rising. According to one estimate, in 20 years there will be 3 billion more people worldwide enjoying "middle class" income levels, compared to 1.8 billion today[4].

In our first Decoupling report, we described three future scenarios for resource use. In the scenario which represents many policymakers' current plans – in which levels of resource use per head for all global citizens reached the levels of current use of the average European – annual resource extraction would need to triple by 2050, compared to extraction in 2000.

This probably exceeds all possible measures of available resources and assessments of the limits of the planet to absorb the impacts of their extraction and use. For example, global demand for water is expected to rise by 40%, so that in 20 years' time available supplies may probably satisfy only 60% of world demand.[5]

Consequences of these changes

It does not seem possible for a global economy based on the current high-consumption model of resources to continue into the future. The economic consequences of increasing resource use are already apparent in three areas: increases in resource prices, increased price volatility and disruption of environmental systems.

Price increases: During most of the nineteenth and twentieth centuries, commodity prices had a tendency of declining. But recent developments of massively increased demand have caused the reverse, as shown in Figure 2.

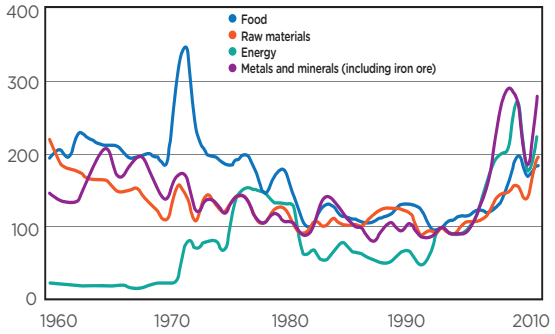

Figure 2 Commodity price indices
(Source: World Bank Commodity Price Data, 2011[6])

3 UN (2013) World Population Prospects, the 2012 Revision. United Nations, Department of Economic and Social Affairs, Population Division.

4 Kharas, H. (2010) *The emerging middle class in developing countries*. OECD Development Centre Working Paper 285.

5 2030 Water Resources Group (2009) *Charting our Water Future: Economic Frameworks to Inform Decision Making*. Munich: 2030 Water Resources Group. McKinsey and Company (2009).

6 World Bank (2011) *Commodity Price Data* (Pink Sheet), historical price data, [Online] Available from http://blogs.worldbank.org/prospects/globalcommodity-watchmarch-2011.

Increased price volatility: Price volatility and supply shocks have already been observed across a range of key materials and commodities used in the economy. For instance, the United Nations Food and Agriculture Organization found that the volatility of food prices increased to 22.4 per cent in 2000-12 compared to 7.7 per cent in 1990-99[7]. Price volatility can be more disruptive than trends of price increase – some believe that rising global food prices led to civil dissatisfaction which fuelled the "Arab Spring"[8].

Disruption of environmental systems: There are strong links between resource use and damage and depletion of environmental systems, including greenhouse gas emissions.[9] The UN Millennium Ecosystem Assessment documented several accelerating, abrupt, and potentially irreversible changes already occurring to the world's ecosystems, and a number anticipated to occur in the coming decades.

These include possible fishery collapses, bleaching of coral reefs, desertification, increased vulnerability to natural disasters, and crop failures.[10] Studies show that such environmental deterioration is affecting economies and economic growth.[11]

There are several reasons why the market is unlikely to respond adequately to these challenges by simply raising supply of resources to meet demand.

- The scale and rate of change has accelerated, and often outpaces the supply side response.
- There are real physical constraints: past mining of the most attractive ores has led to declining average ore grades for several key metals, such as copper, gold or tin, so that, for many metals, about three times as much material needs to be moved for the same quantity of metal extraction as a century ago.
- For environmental resources – like climate, fish stocks or local ecosystems, too much stress may lead to sudden, non-linear collapse[12].

7 Measured by the standard deviation around the average price. However, note that before 1990, food prices were also volatile, having a higher standard deviation than in the years 2000-12.

8 See for example: Center for Climate and Security (2013) *The Arab Spring and Climate Change*. Washington D.C.: Center for American Progress, Stimson.

9 UNEP (2010) Assessing the Environmental Impacts of Consumption and Production. Priority Products and Materials. A Report of the Working Group on the Environmental Impacts of Products and Materials to the International Resource Panel. Hertwich, E., Van der Voet, E., Suh, S., Tukker, A., Huijbregts, M., Kazmierczyk, P., Lenzen, M. McNeely, J., Moriguchi, Y.

10 Millennium Ecosystem Assessment (2005) *Ecosystems and Human Well-being: Synthesis*. Washington D.C.: Island Press.

11 See: Stern, N. (2006) *The Stern Review*. Cambridge: Cambridge University Press: and Brown, L.R. (2008) Plan B 3.0: Mobilizing to Save Civilization. New York: W.W. Norton & Company.

12 for further explanation see: Smith, M., Hargroves, K. and Desha, C. (2010) *Cents and Sustainability: Securing Our Common Future by Decoupling Economic Growth from Environmental Pressures*, The Natural Edge Project. London: Routledge, chapter 5, element 2.

- And, importantly, markets are not adequately set up to factor in much of the expected scarcity of resources – but rather reflect today's extraction cost of still conveniently available ores.

Strategic implications

The resource trends have strategic implications for economies. They appear likely to alter the relative importance of resources compared to other inputs into production – and in doing so change the basis of relative competitive advantage between countries.

This implies that the economies that move first, or fastest, to adapt to the changed economic conditions stand to gain and bring greater security and wealth to their populations.

As the current model of development is not sustainable in the long term, a real change of course will be needed, significantly changing technologies, policies and consumption habits.

Some commentators believe that the economic growth of many developing countries means that they, compared to those developed countries that are in some situations locked in wasteful infrastructures and habits, have more opportunities to adapt, and so can gain more from change.

At the same time, trends in resource use increase the risks of disruption to economic growth from potential resource scarcity and shocks, including environmental degradation and possible collapse. These often cause more severe effects in developing countries, than in richer economies.

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3 Choices of Response for Policymakers

For economic prosperity and growth, one of the most appealing strategies for adapting is decoupling[13] – the seizing of opportunities for resource productivity, so that a nation can produce greater economic value out of fewer resource inputs (both material and energy) per unit of value[14]. When considering changes, decision-makers need to look as closely as they can at the productivity changes in the resources that matter most to them.

Aggregate figures for resource use – which are frequently the most available – may not reflect the possibilities for decoupling economic growth from some particularly important resources.

13 See: UNEP (2011) *Decoupling natural resource use and environmental impacts from economic growth.* A Report of the Working Group on Decoupling to the International Resource Panel. Fischer-Kowalski, M., Swilling, M., von Weizsäcker, E.U., Ren, Y., Moriguchi, Y., Crane, W., Krausmann, F., Eisenmenger, N., Giljum, S., Hennicke, P., Romero Lankao, P., Siriban Manalang, A.: and Smith, M., Hargroves, K., and Desha, C. (2010) *Cents and Sustainability: Securing Our Common Future by Decoupling Economic Growth from Environmental Pressures*, The Natural Edge Project. London: Routledge.

14 Growth is more strongly decoupled where a greater share of an economy's growth comes from resource productivity relative to labour productivity

Decoupling, can mean different achievements. We propose to distinguish between three types of decoupling:

1. **Decoupling through maturation**. This type of decoupling is a "natural" process of overcoming clumsy and inefficient techniques, of building-up of infrastructures, and of actively reducing environmental pollution. This is related to the maturation process as countries shift from an extraction and production-based economy towards a service economy.

2. **Decoupling through shifting to other countries the more material intensive stages in product life cycles** (burden-shifting). If domestic extraction and production is replaced by imported materials and products, resource use may decline domestically, but still occur elsewhere in the world where the more material intensive, often more polluting, stages in products life cycles may be taking place. This type of decoupling is often labelled as burden-shifting, where resource-intensive activities and their environmental impacts are shifted offshore.

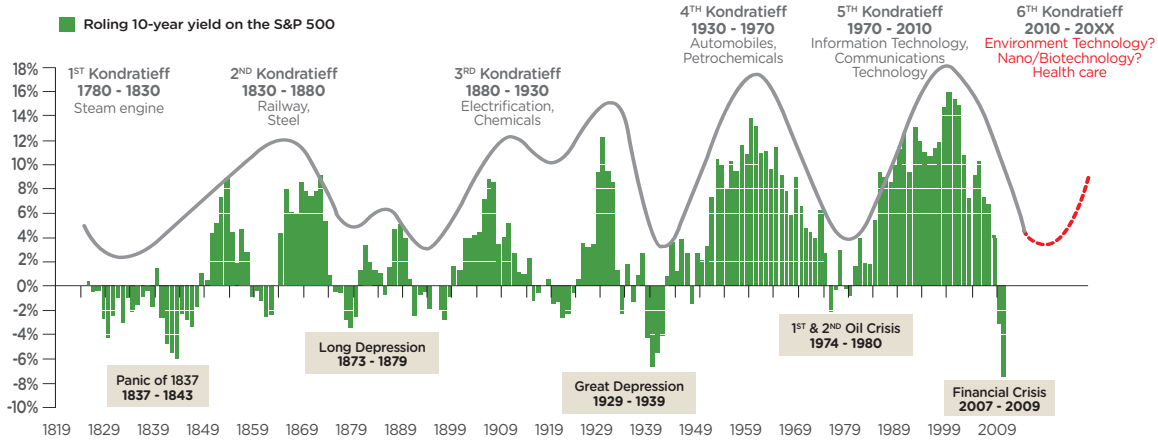
3. **Decoupling through intentional resource productivity increase**. This is what is really needed to reduce pressures on limited resources, on climate, and on the environment in general. It requires technological innovation, infrastructures conducive to resource efficient and low material intensity manufacturing and living, and appropriate attitudes and consumption patterns. Intentional decoupling is the main focus of this report.

Investments in resource productivity can bring multiple gains, ranging from reduced operational costs for companies and the public sector to better environmental quality and the creation of jobs.[15] For example, energy efficiency policies in California are estimated to have created nearly 1.5 million jobs from 1977 to 2007. Similar figures emerged from Germany's resource productivity policies in the years before 2004, creating or saving more than 1 million jobs.[16]

Economic growth comes, partly, through investments in innovations, and policymakers can influence the nature of the innovations that receive investment through their enabling policies.

15 Smith, M. Hargroves, K. Desha, C. (2010) *Cents and Sustainability. Securing our Common Future by Decoupling Economic Growth from Environmental Pressures*, notably chapter 9: Decoupling Economic Growth from Freshwater Extraction, London: Routledge.

16 Fischer, H./Lichtblau, K./Meyer, B./Scheelhaase, J. (2004) *Wachstums- und Beschäftigungsimpulse rentabler Materialeinsparungen* [Growth and employment impulses of profitable material savings]. In: Wirtschaftsdienst, vol 84, issue 4, pp 247-254. Also the Ecological Tax Reform 1999 – 2003 created jobs, chiefly by reducing indirect labour cost.



A vivid visualisation of the relationship between innovation and economic growth is given by "Kondratiev cycles"[17]. Economic growth has been observed to come in waves of prosperity, each driven by the spread of new technologies and structural economic change. Figure 3 illustrates the way that growth usually involves changes in technologies.

Considering the trends in global resource use and environmental degradation, we might expect a well-functioning economy to naturally respond to information on resource scarcity by increasing innovations in resource productivity. That implies that decoupling would be one of the drivers of the next period of growth in successful economies.

Figure 3 Kondratiev cycles. Source: Allianz Global Investors "The Sixth Kondratieff" – Long waves of prosperity, 2010. The description of the sixth Kondratieff suggests that resource productivity could become the overarching characteristic of the new cycle.

In practice, there are several barriers and biases that hold back the desired improvements, meaning that the steep rise in resource productivity requires courageous policy changes[18]. In the past era of declining resource prices, business has tended to focus on increasing labour productivity – with the result that labour productivity has grown at faster rates than other factors of productivity (Figure 4).

17 Freeman, C./Louçã, F. (2001) As Time Goes By. From the Industrial Revolution to the Information Revolution. Oxford: Oxford University Press.

18 See UNEP (2011) *Decoupling natural resource use and environmental impacts from economic growth.* A Report of the Working Group on Decoupling to the International Resource Panel. Fischer-Kowalski, M., Swilling, M., von Weizsäcker, E.U., Ren, Y., Moriguchi, Y., Crane, W., Krausmann, F., Eisenmenger, N., Giljum, S., Hennicke, P., Romero Lankao, P., Siriban Manalang, A. Pages 48, 74.

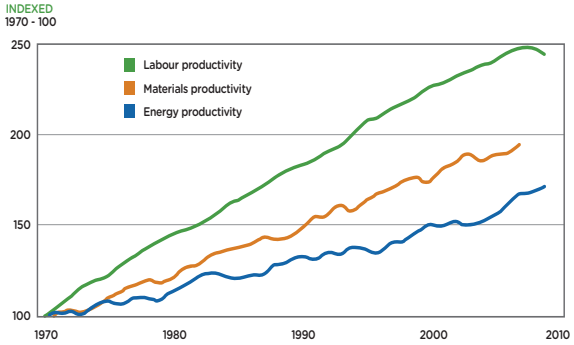


Figure 4: Resource Productivity, Labour Productivity and Energy Productivity Source: EEA, 2011

While the existing policy set may have been suitable for promoting growth in the past, it seems unlikely to meet the challenges of the future. The trends in resources imply that to maintain stable future economies and natural life support systems, resource productivity increases would need to be greater than the rate of economic growth for the world as a whole.

This is called "decoupling". Decoupling can either reduce the use of resources absolutely as an economy grows, or only relatively – so that the rate of increase in resource use is lower than the growth rate of the economy. With absolute decoupling, in contrast, resource use declines, irrespective of the growth rate of the economies.

Indeed, for resources – although pressures differ greatly by resource and country – approximately a factor five improvement[19] in total resource productivity by 2050 would be required for OECD countries (resulting in just 20 per cent of today's material usage/unit of production), including also the resources embedded in the goods and services they import from other countries.

This implies that each unit of production is produced using between 25 per cent and 10 per cent of its current resource inputs by 2050[20], a much greater rate than resource productivity gains previously seen.

For instance, the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report, published in 2007, warns that to maintain an agreeable kind of climate, global emissions need to peak by 2015, and then reduce by 25-40 per cent by 2020 and 80 per cent by 2050.

OECD countries would need to absolutely decouple their growth from their greenhouse gas emissions, at a rate that would give more room to developing countries to raise living standards until they too can achieve absolute decoupling.

Apart from greenhouse gas emissions, such decoupling is also needed for a number of other resources such as

19 Weizsäcker, E./Hargroves, K./Smith, M./Desha, C./Stasinopoulos, P. (2009) Factor 5: *Transforming the Global Economy through 80% Improvements in Resource Productivity*, London: Earthscan.

20 World Business Council for Sustainable Development WBCSD (2010) Vision 2050. Conches-Geneva: WBCSD.

forestry, fishery, food, waste, air pollution, minerals. The IPCC's Fifth Assessment Report, published in October 2013, also confirms these findings.

The required intentional policy change should influence all aspects of economic and environmental policies, with a view of facilitating their economy's transition to absolute decoupling.

Knowing that relative decoupling will not suffice on a global scale, the focus of this report is on the opportunities for countries to pursue strategies of better lives for their people while significantly reducing resource intensity and consumption patterns and, where feasible, even achieving absolute decoupling of resource use.

As an encouragement for decoupling policies, our report shows that:

- The potential exists for much greater levels of absolute decoupling to be achieved through strategic changes in technologies and design. Much of the technologies and technique "know how" to achieve significant levels of resource productivity (as much as five to tenfold improvements) already exist.

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A number of publications over the last 15 years[21] have shown that decoupling is technically possible for material resource consumption, greenhouse gases, and water extraction. (Chapter 3)

- Success stories exist of countries that achieved some modest absolute decoupling of economic growth from selected aspects of resource use and greenhouse gas emissions, from which we can learn. (Chapters 6 and 7)
- Much of the policy "know how" required to achieve economy wide "decoupling" exists in the form of legislation, incentive systems, administrative measures, and institutional reform. But additional policy options could be opened for a yet more strategic and long-term avenue towards ecologically sound growth. (Chapters 7 and 8)

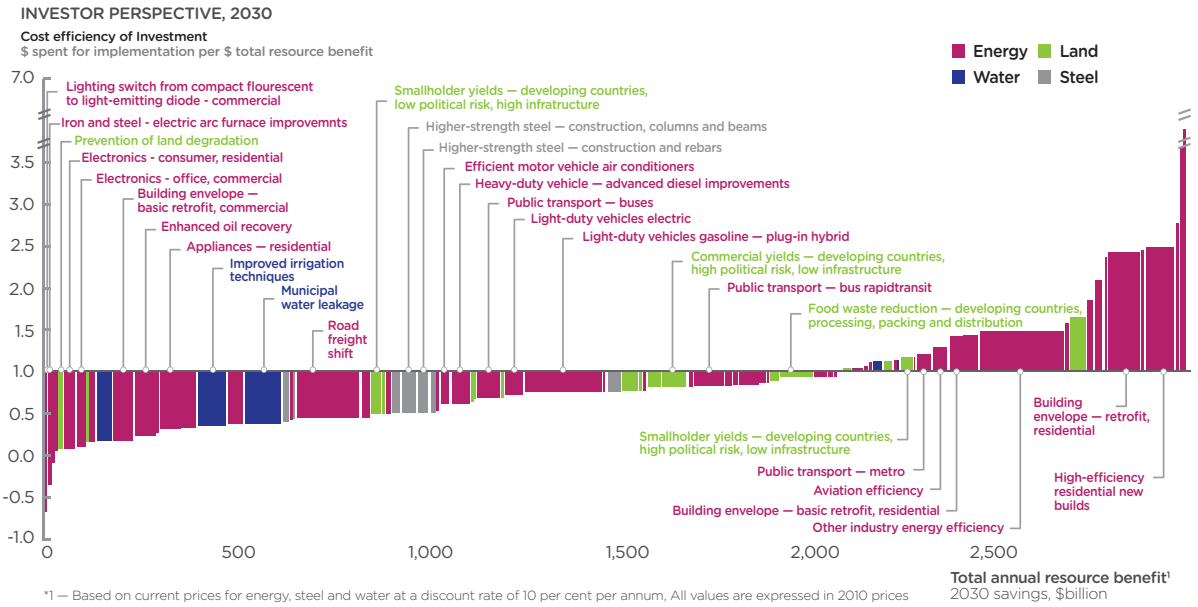
21 Hawken, P./Lovins, A./Lovins, L. H. (1999) *Natural Capitalism: Creating the Next Industrial Revolution*. London: Earthscan; McDonough, W./Braungart, M. (2002) Cradle to Cradle: *Remaking the Way We Make Things*. San Francisco: North Point Press; Hargroves, K./Smith, M. (2005) *The Natural Advantage of Nations: Business Opportunities, Innovation and Governance in the 21st Century*. London: Earthscan/James&James; Pacala, S./Socolow, R. (2004) *Stabilization Wedges: Solving the Climate Problem for the Next 50 years With Current Technology*. In: Science, 13 August 2004, vol 305, p968; Pauli, G. (2010) *The Blue Economy*. 10 Years, 100 Innovations 100 Million Jobs. Taos: Paradigm Publishers; Smith, M./Hargroves, K./Desha, C. (2010) *Cents and Sustainability: Securing Our Common Future by Decoupling Economic Growth from Environmental Pressures*, The Natural Edge Project. Earthscan: London; Lovins, A. (2011) *Reinventing Fire*. Snowmass: Rocky Mountain Institute.

4 Technological Responses Allowing Significant Decoupling

Increasing resource productivity is technologically possible: technologies and techniques that bring very significant resource productivity gains are already available, right across the range of resource consuming activities, with different technologies applicable at different levels of economic development.

The Rathkerewwa Desiccated Coconut Industry (RDCI) in Maspotha, Sri Lanka, provides a good example. RDCI could reduce 12 per cent of energy use, 8 per cent of material use and 68 per cent of water use, while increasing the production by 8 per cent during the same period by adopting a series of recommendations on its peeling process, water treatment, and fuel switching.

The total investment required for implementing these recommendations was less than US$5,000, while an annual financial return of about US$300,000 was



*1 — Based on current prices for energy, steel and water at a discount rate of 10 per cent per annum, All values are expressed in 2010 prices

reported.[22] Sweden introduced an energy efficiency programme in 2005 for its energy intensive industries. A recent analysis showed average payback periods of less than 1.5 years.[23]

The wide range of existing opportunities is illustrated by Figure 5. Our report describes some of the more remarkable technologies and techniques.

Figure 5: Mapping the range of opportunities for resource productivity gains.
Source: McKinsey Global Institute. Resource Revolution (2011)

The scale of the opportunity is very large. One estimate places the savings potential between US$2.9 trillion and US$3.7 trillion each year (by 2030). Ninety per cent of the opportunities had an internal rate of return of greater than 10 per cent, if adjusted for subsidies, carbon prices and a social discount rate[24].

22 For details, see http://www.unido.org/fileadmin/user_media/Services/Environmental_Management/Cleaner_Production/RECP_SriLanka.pdf

23 Stenqvist, C and L.J.Nilsson, 2013. Energy efficiency in energy-intensive industries – an evaluation of the Swedish voluntary agreement PFE, *Energy Efficiency,* 5(2): 225-241.

24 McKinsey Global Institute (2011) *Resource Revolution: Meeting the world's energy, material food and water needs* .The study suggests also that 70% of the opportunities have a greater than 10% IRR at current prices. The higher figure (3.7 trillion) applies if carbon is appropriately priced and perverse subsidies phased out.

The following examples provide an illustration of some of the potential:

High-efficiency motors: These could potentially save 28-50% of motor energy use, with a typical payback period of one to three years[25]. Electric motors used in industry in China account for around 60 per cent of the country's total electricity consumption. The operational efficiency of these motors is 10-30 per cent below international best practice, depending on the industry. A pilot study at China's second-largest oil field suggested there was the potential to save more than 400 million kilowatt hours (kWh) of electricity per year in the oil field, with a payback period for recovery of the initial investment of 1.6 years[26].

Higher strength steel: Using steel with higher strength for re-enforcement of concrete, beams and columns saves steel: ArcelorMittal, the world's largest steel company estimates use of higher strength steel achieves a 32 per cent reduction in the weight of steel columns and 19 per cent in beams[27]. China and developing countries tend to use lower-strength steel,

© Global Fuel Economy Initiative (GFEI)

with China using steel for reinforcement that is two-thirds the strength of steel averagely used in Europe. This offers a very good opportunity – as these countries' use of steel is very significant. (For example, China currently consumes 60 per cent of global steel reinforcement bar production.) Even partial global switching to higher strength steel could save 105 million tonnes of steel a year, and save 20 per cent of the costs of the use of steel[28].

Blanking sheet metal: The pressing out (or "blanking") of metal components of different size and shape from sheet metal

25 CADDET (1995) *Saving Energy with Electric Motor and Drive*. Sittard: CADDET Energy Efficiency.

26 UNEP (2010) Training programme on Energy Efficient technologies for climate change mitigation in Southeast Asia, Case Studies on Electric Motors, United Nations Environment Program, Thailand.

27 McKinsey Global Institute (2011) *Resource Revolution. Meeting the world's energy, materials, food and water needs*. Dobbs, R., Oppenheim, J., Thompson, F., Brinkman, M., Zornes, M. New York: Mc Kinsey Global Institute. New York: McKinsey Global Institute. p.105

28 Allwood, J. and Cullen, J. (2012) *Sustainable Materials - With Both Eyes Open*. Cambridge: UIT Cambridge Ltd. p. 178

necessarily leaves behind pieces of sheet metal that are not wanted and too small to use for other components. Intelligent organisation of the different shapes to be pressed out can realise significant metal savings. Deutsche Mechatronics GmbH operates in Germany using computer-driven shuffling and a good production planning system that could reduce metal use by 12 per cent.

Methane from waste landfill: In the United States of America (USA), approximately 480 landfill sites, representing around 27 per cent of the nation's landfills, capture released methane gas from decomposing organic waste (2009 figures)[29].

29 Bracmort, K. et al (2009) *Methane Capture: Options for Greenhouse Gas Emission Reduction*. Washington D.C: Congressional Research Service.

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It is estimated that between 60 and 90 per cent of the methane in the landfill gas can be captured and burnt.

Nevertheless, methane from landfills contributes 1.8 per cent to the US total greenhouse gas emissions.

Drip irrigation: Agriculture is responsible for 70% of freshwater withdrawals.[30] In many countries, 90 per cent of irrigated land receives irrigation water through open channels or by intentional flooding. The waste of freshwater through these methods, through evaporation, leakage and seepage is high. Farmers in India, Israel, Jordan, Spain and the USA have shown that sub-surface drip irrigation systems that deliver water directly to crop roots can reduce water use by 30-70 per cent and raise crop yields by 20-90 per cent, depending on the crop[31]. Efficiency savings can be as high as 50-80 per cent, and can be made affordable for use in the developing world[32] with payback periods of less than a year.

30 Weizsäcker, E./Hargroves, K./Smith, M./Desha, C./Stasinopoulos, P. (2009) *Factor 5: Transforming the Global Economy through 80% Improvement in Resource Productivity*. London: Earthscan.

31 Postel.S, Polak.P, Gonzales F, Keller.J (2001) *Drip Irrigation for small farmers:A new initiative to alleviate hunger and poverty* Water International vol 26, no1, p8.

32 Shah.T and Keller.J (2002) 'Micro-irrigation and the poor: Livelihood potential of low-cost drip and sprinkler irrigation in India and Nepal' in 'Private Irrigation in Sub-Saharan Africa', FAO/International Water Management Institute, pp 165

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5 Creating the Conditions for Investments in Resource Productivity

Success comes from creating the right conditions for investment

Policymakers can facilitate the widespread uptake of technologies and techniques for decoupling. A wealth of experience from policies on innovation, decoupling and environment can guide future policy action. Lessons can be learned from some great successes: for example in water efficiency. In Australia, GDP rose by 30 per cent and water consumption was reduced in absolute terms by 40 per cent from 2001 to 2009[33].

Many countries have put in places policy mixes promoting decoupling. For example, at European Union (EU) level, recent initiatives, such as the 7th Environmental Action Programme and the Roadmap to a Resource Efficient Europe, and the Energy

33 Smith, M. , Hargroves, K. and Desha, C. (2010) *Cents and Sustainability: Securing Our Common Future by Decoupling Economic Growth from Environmental Pressures*, The Natural Edge Project. London: Routledge. Chapter 9.

Efficiency Directive of 2012 are long-term strategies moving energy, climate change, research and innovation, industry, transport, agriculture, fisheries and environment policy all towards decoupling. The roadmap also deals with tax policy, making the case for a shift from labour taxes to resource taxes, and discusses the phasing out of environmentally harmful subsidies. Similarly, China has strategically improved energy efficiency writing 20 per cent and 16 per cent efficiency gains into its eleventh and twelfth Five-Year Plans respectively, and adopting regulation and incentives to make it happen.

Whether, where and how decoupling occurs may depend on national decision makers' abilities to overcome biases which currently disadvantage investments in resource productivity. Countries that can overcome those barriers can lead the next wave of development, and gain advantage over their competitors.

Changing current biases

There are currently several factors that lead to bias against investments in resource productivity and two areas of barriers for policymakers to tackle. The first group arises from the effect of the historic policy framework. There a number of areas where current policy structures coming out of past government decisions

steer economies away from resource productivity, examples of which are:

- Subsidies of up to US$1.1 trillion each year for resource consumption[34]. These subsidies encourage the wasteful use of resources while reducing the savings from investments to use the resources more efficiently.
- Taxation of people's work through labour taxes is typically higher than the tax burden on resources (and energy). As labour and resources are often alternative inputs into economic growth, this favours resource consumption rather than increased employment.

34 McKinsey Global Institute (2011) *Resource Revolution. Meeting the world's energy, materials, food and water needs.* Dobbs, R., Oppenheim, J., Thompson, F., Brinkman, M., Zornes, M. New York: Mc Kinsey Global Institute. New York: McKinsey Global Institute.

Together with distortions from subsidisation of resources, taxation reduces the return on investment in resource efficient technologies and techniques. Taking the economy as a whole, it encourages development of an economy that is more resource intensive than it needs to be.

- Regulatory frameworks for markets have often been created in ways that discourage long-term management of resources, but rather promote their wasteful early use. Market regulations that have worked well for old technologies may disadvantage the entry of new technologies. For instance, in some developed country energy markets, bidding systems for electricity supply have taken place one day in advance of electricity delivery. This has put operators of wind turbines at a disadvantage, because they can only reliably predict their electricity output three hours in advance.[35]

The second group of factors holding back decoupling are biases against change. These can be seen as physical and technological biases, behavioural biases, organisational and institutional biases.

35 OECD (2010) *Smart Grids and Renewable Energy, Competition Committee Roundtable 2010*. Paris: OECD.

- Technological bias can arise because many technologies are used in conjunction with existing physical infrastructure, giving existing technologies a significant advantage over alternative technologies that would require different infrastructure (for example, the lack of electric vehicles' recharging points compared to the large number of refuelling stations for oil-powered vehicles).
- Organisational and institutional biases arise from the way in which standard practices, cultural norms, accepted wisdom and rules influence peoples' behaviours and the decisions they make. To illustrate this with one example from the finance sector: due to the internal incentives and controls found in many banks and financing organisations, positive financing decisions tend to be made in areas familiar to the professional expertise of staff. The lack of track record for the investment performance of new technologies makes them appear more risky, and places them at a severe disadvantage when investment decisions are made[36]. This represents a problem as meeting the world's future consumption demands through resource efficient technologies (or supply side technologies) has been estimated to require around US$3 trillion of investment a year globally[37] for which the financing will need to be found.

Both these groups of barriers need to be tackled to make full progress to a successful, resource-productive society. Policy changes can overcome these barriers. In doing so, it would create conditions where investments in resource productivity became more attractive than alternative investments, and open up the universe of opportunities offered by decoupling for both developed and developing countries.

'Lock-in' to political and economic structures

Relatively few opportunities for beneficial policy change are currently taken up. Part of the reason for this seems to be that political systems have their own inertia, which often act as a brake on policy reform, or block it entirely. The close interaction in nearly all countries between political decision-making and economic interests can lead to what is called "systems lock-in" because the policy framework is difficult to change without

36 Hudson C, Shopp A, Neuhoff K, (2013), *Financing of Energy Efficiency: Influences on European Public Banks' Actions and Ways Forward*, Deutsche Institut fur Wirstschaftforschung (Berlin).

37 McKinsey Global Institute (2011) *Resource Revolution. Meeting the world's energy, materials, food and water needs.* Dobbs, R., Oppenheim, J., Thompson, F., Brinkman, M., Zornes, M. New York: Mc Kinsey Global Institute. New York: McKinsey Global Institute. .

change to economic interests and vice versa. Political processes can therefore act as barriers to decoupling, because:

- Frequently, policy is formed in response to the interests of leading economic groupings. Where these groupings are biased towards the current arrangements that have given them market power, they tend to engage strongly to preserve existing policy. This can be the case even as underlying conditions change (like resource availability).
- Segmented policy-making governmental structures – with different ministers or departments favouring different specific interest groups – lead to policy inconsistency, with the effect of some policies being cancelled out by the indirect effect of others. This inconsistency, lack of clear direction and

past records of changes in policy creates unpredictability and uncertainty about future investment return dependent on lasting policy change.

- The institutions through which policies are made often reflect existing norms, and change is often resisted, within the institutions (for example government departments) or industrial organisations shaping policy[38].
- Where economic interests are at stake, groups are likely to contest evidence showing the need for change. Where there is some degree of scientific uncertainty about the future (as is inevitable) this can be used to discredit unfavourable information. Even evidence gathered by governments seeking to promote innovation may be sceptically received and scrutinised for bias. This rejection of, or unwillingness to hear, information demonstrating the benefits of change is a key barrier to achieving policy change – as success in policy reform often involves political and economic actors perception of their own self-interest to alter. [39]
- Policy-making procedures are often lengthy, and can have additional lead-in times before policy is expected to take effect – leading to lags in the policy framework in reaction to new information.

The inertia created by these political and procedural factors is frequently the primary barrier to successful decoupling. Understanding these aspects of the problem can assist policy makers in making further progress.

38 Ekins P. and Salmons R. (2010) In. *Making Reform Happen: Lessons from OECD Countries*. Ch 5 p.132

39 Ekins. P and Salmons R (2010) In. *Making Reform Happen: Lessons from OECD Countries*. Ch 5 p133-4.

6 Making progress with Resource Productivity

Action on policies

Policy change, in the face of this significant inertia, requires leadership. A central part of this leadership will be a clear vision of a successful future economy, well adjusted to trends in resource use and scarcity. Many different policy changes can create these favourable conditions - chapter 7 of the report gives some illustrations of past and current policies in both developed and developing countries. So, there are opportunities for leadership for many people. This includes individuals working within organisations and institutions across most parts of government, the economy and civil society (including consumers). Inside government, there are opportunities for decision-makers with influence on policies regarding industry, development, innovation, environment, employment, and taxation.

This wealth of options for areas for positive change arises because decoupling is often best stimulated by creating favourable conditions for investment in resource productive innovation, and letting market

forces provide the best solutions. For these kind of changes, there is clearly no "one size fits all" prescription or instrument, but some common features can be identified for policies aiming at ambitious goals of decoupling including:

- For decoupling, policy needs long-term objectives and the creation of incentives for others that align with those long-term objectives.
- Using a mix of policies simultaneously can maximise the potential for innovation and avoid unwanted knock-on effects in other parts of the economy.
- The potential of resource productivity is increased when policymakers consider the full set of interactions that their policy affects. Reaching the right decisions on policy will probably involve consideration of the indirect effects of a change on resources at each of the life-cycle stages of production and consumption.
- Although this report uses technological potential as the entry point into a transition to resource productivity, policies are also needed that encourage changes in consumption patterns – and support the community to consider arranging their daily habits, their homes and their nutrition so as to consume fewer resources while achieving improvements in quality of life.

Unlocking change in policies

Replacement, reform or complementary addition to parts of the old policy framework, and the reduction of the biases against decoupling is possible, and has often been achieved. Success in creating the conditions for decoupling would need to unlock the observed resistance to policy reform. In this task, the chances of success appear higher where the policymaker looks at the institutional framework in which the political decision is made. In practice for changes to policy, this means being aware of the set of actors who are able to influence the decision, their interests, relative power and the norms and assumptions which are shaping the decision. Those seeking change:

> "... need to become adept at institutional analysis, identifying those elements supportive, or hostile to, the reform in question, and work to strengthen the more supportive elements and weaken the more hostile ones."[40]

For example, there are frequently synergies between policies for decoupling and other policy goals. These can be used to win support for policy change. This was the case in Germany which introduced a relevant tax reform from 1999-2003 in five consecutive steps, eventually shifting some

40 Ekins P. and Salmons R. (2010) In. *Making Reform Happen: Lessons from OECD Countries.* Ch 5 p.132

€18 billion annually from indirect labour charges to taxes on energy. One motive for the tax reform was to reduce incentives for environmental harm, but it also allowed the corresponding reduction of other taxes on labour that lead to an estimated gain of 250,000 jobs[41]. The World Bank's summary of benefits from an environmental fiscal reform[42] gives one illustration of the potential achievement of multiple goals. (Figure 6).

Based on past experience with policy changes[43], success in decoupling appears to be more likely where policymakers seeking change:

- Take account of the potential losers from policy change, and consider what will bring enough of them to favour change.
- Help those affected by change to focus their innovation towards a consensus future goal, by changing their expectations of the future. By creating shared visions and credible strategies, future investment patterns can be

41 Knigge, M./Görlach, B. (2005) *Effects of Germany's Ecological Tax Reforms on the Environment, Employment and Technological Innovation*, Summary of the Final Report of the Project: *Quantifizierung der Effekte der Ökologischen Steuerreform auf Umwelt, Beschäftigung und Innovation*, Research Project commissioned by the German Federal Environmental Agency (UBA).

42 World Bank (2005) *Environmental Fiscal Reform: What should be done and how to achieve it.* Washington D.C.: World Bank.

43 This section draws on Ekins P. and Salmons R. (2010) In. *Making Reform Happen*: Lessons from OECD Countries. Ch 5.

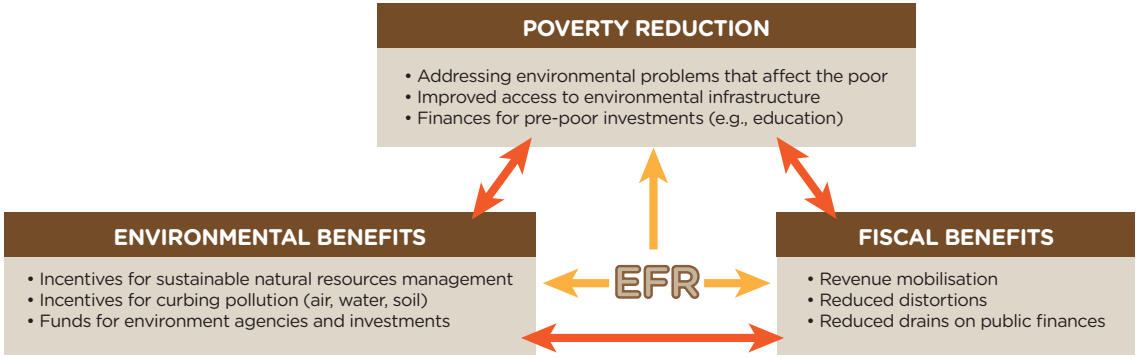


Figure 6. Assumed benefits from an Environmental Fiscal Reform (EFR).
Source: World Bank, 2005, l.c., p. 18.

changed, often without great expense, as firms shift in advance to profit from new conditions.

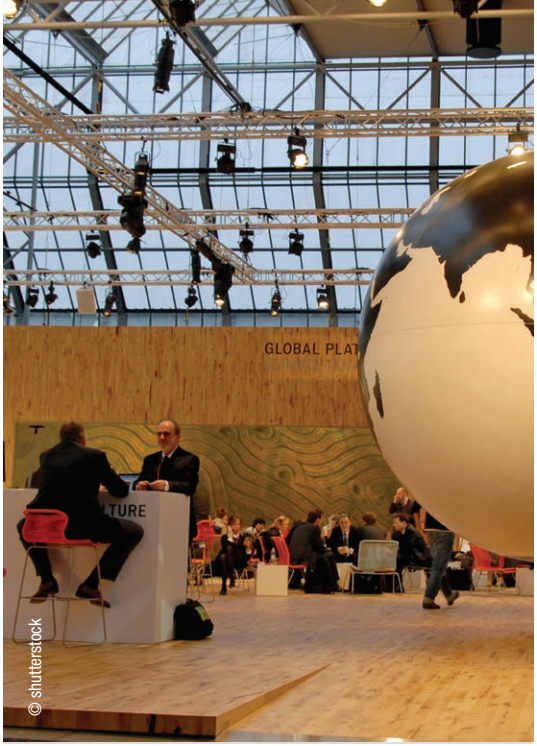
- Create, or rely on, a source of sufficiently trusted independent advice – on the science or on the impacts of change. Objective, transparent scientific evidence is very useful: information sources seen to be self-interested will be much less effective
- Present concrete examples of policies or practices used in different countries, or in different realms of policy. Many of the reforms to increase decoupling will require new structures, behaviours or business models that may seem initially unfamiliar, and odd. Demonstrating that different arrangements work elsewhere can be convincing.
- Create an institutional structure for the specific policy decision that is participatory, sufficiently broad to contain enough people who can form a pro-reform coalition and set up in a way that allows potential supporters of change to voice their support. This facilitates information flows, and can help form a common vision for the future that reconciles previously opposing views.
- Use a simultaneous mix of policy instruments. This can help the actors in

a value-chain of economic activity (for example, from raw material extraction to final product consumption and recycling) to change profitably together. This may be necessary to overcome a "lock-in" between demand and supply, which can commonly happen when a seller offers what is being demanded, the purchaser buys what is being offered and there is little scope for either to innovate.

- Work to increase the cumulative effect of several smaller steps, as it is rarely the case that political or economic conditions exists that allow a policymaker to bring about a very large, radical change in resource productivity in one step.
- Be aware of options for reform and use political opportunities when they arise. Good economic times are often more favourable for introducing change, with less fear of negative consequences and greater availability of finance for innovative investments. Yet, crises can also facilitate reform, in different ways:
    - An unsustainable economic situation in New Zealand in the early 1980s, which included the state running excessive budget deficits (of 9 per cent of GDP), provided the rationale and impetus for a thorough reform of state support for the agricultural sector. The Effective Rate of Assistance to agriculture fell from 123% in 1983 to around zero in the 1990s.[44]
    - Crises may also provide opportunities for productivity reforming economic activity, when they lead to economic slack that can be stimulated to enter into new investments with low opportunity costs. By 2011, as a result of uncertainty on future returns on investments in difficult economic times, publically traded companies in Europe were holding excess cash of €750 billion[45] which could be directed by adept policy change into new areas. Unemployed labour can be re-employed with appropriate training, in growth sectors of the future.

44 The Effective Rate of Assistance is estimated by comparing the value added of an assisted sector with the same value added of an unassisted sector (at a world or reference price.) It includes direct and indirect assistance.

45 McKinsey Global Institute (2012) Investing in Growth: Europe's Next Challenge



Changing the institutional framework to facilitate future policy reform

One aspect of successful reform is to take steps that create the conditions for further, future policy reform. Making changes to decision-making processes, either internal to an organisation or external, can indirectly facilitate future change.

In government, this could mean making a change to the decision-making structures (like the mandate of ministers or committees) that allows decisions promoting the long-term management of resources to be taken more easily. It could also mean implementing a policy that increases the future economic and political weight of innovators, or favourably changes

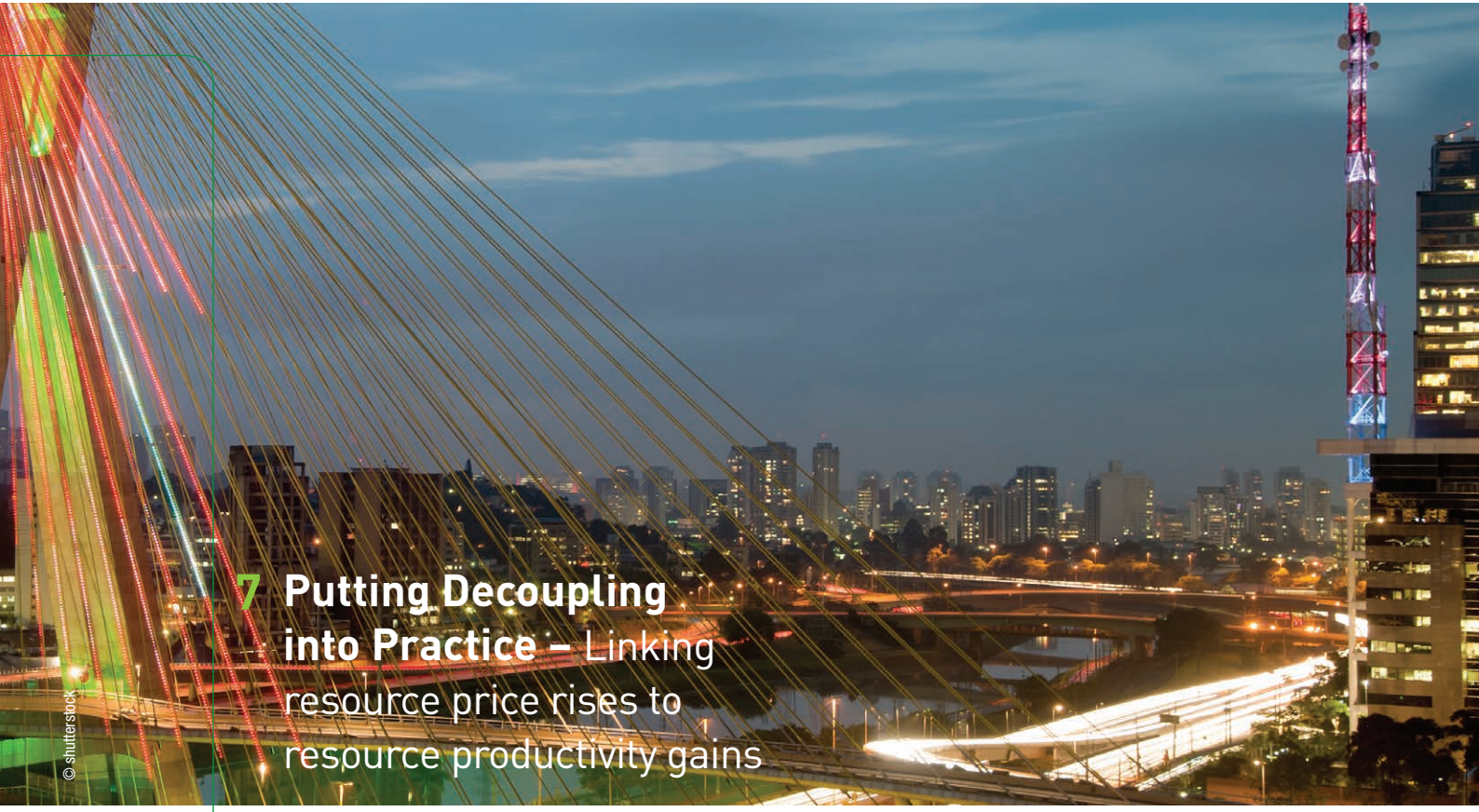
the perception of potential opponents to change (for example by changing company reporting to include information on resources that helps companies take resource factors into account in their business decisions).

Changes to institutional decision-making structures have long been appreciated to have important beneficial outcomes, and

this is particularly the case for overcoming the bias of decision-making towards the short term.

- For example, the UK is seen as a strong, liberal economy. In part this is because, in 1998, authority over monetary policy was passed from the government to the central Bank of England. This transferred the power to set interest rates – a power of huge importance to the economy. The aim was to provide greater economic stability by distancing those decisions from short-term political influence.

There have also been many examples where international agreements have acted as stimulation for domestic action. In part this is because concerted action between countries, which reduces fears of unfavourable distortions in international markets. But it is also because an international commitment can act as a persuasive tool against opponents of change, not least by indicating that change is viewed as internationally important.



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7 Putting Decoupling into Practice – Linking resource price rises to resource productivity gains

Economic instruments to push technologies and markets towards higher resource productivity typically run into one characteristic difficulty: if price signals are strong, industries may just give up or emigrate, and consumers tend to contest the government imposing painful price signals. But if price signals are weak, there is a high likelihood of effects remaining insignificant.

A potential way out is a price signal that steadily increases at the pace of decoupling successes. For example, if the average efficiency of the car fleet rises by one per cent in one year, a one per cent price increase of petrol at the pump would seem fair and tolerable. However, the firm announcement of the continuation of this scheme will induce car manufacturers and traders as well as consumers to speed up

efforts to reduce petrol consumption per kilometre or to avoid unnecessary trips. Hence a small signal can have a strong impact if continued over a long period of time. A policy of this kind can combine several of the considerations to unlock inertia described above, and may come close to the type of combined policy which is needed.

One proposal for a policy could use taxation or subsidy reduction to move the price of a chosen resource upwards in line with documented increases of energy or resource productivity. In the sections below we look at different qualities of this proposal. In practical terms, one would not prescribe an exact price trajectory but a "corridor" within which prices can fluctuate a little. Interventions would only be made when such fluctuations are leaving the corridor. Interventions can also reduce prices or taxes if fluctuations leave the corridor upwards. The main purpose is predictability so that investors, manufacturers, and consumers know what is going to happen.

Broadening the economic discourse

By establishing a "ping-pong" between price rise and efficiency gains, costs (which are what influences competitiveness and livelihoods) would, on average, not increase. Under the "ping-pong" policy, on average, one would pay the same amount of money for the same quality of energy services as during the year before – paying a higher price for each unit of energy, but consuming fewer units of energy, as each unit of energy delivers more output thanks to the productivity gain. Of course, some industries and some families cannot increase their resource productivity as fast as the average gains take place. Politics will have to address this problem by a balanced mix of support measures or exemptions without destroying the incentive to innovate or adapt.

Creating a vision of the future and reducing uncertainty

The proposal would not entirely remove uncertainty about returns on investments in resource productivity, as variations in resource prices and uncertainty about future energy or resource productivity increases would remain. However, uncertainty would be reduced, in particular long-term uncertainty about the direction of prices.

This would serve as a strong and predictable incentive to investors, states, individual companies or research laboratories to systematically invest in ever more resource productivity. It seems plausible that the mutual reinforcement

between prices and efficiency increases will lead to a long term and ultimately dramatic increase of resource productivity.

An interesting partial analogy exists to the proposed "ping-pong" dynamics between resource productivity gains and resource prices. It is the increase over at least 150 years in labour productivity and gross wages per hour of work. As productivity increased, workers could successfully demand higher wages. And as wages went up, employers were driven to speed up further increases of labour productivity. Figure 7 shows the parallel dynamics between labour productivity and wages in the USA over 60 years.

Figure 7 The parallel increase of labour productivity and of gross hourly wages in the United States of America from 1947 – 2007.
Source: US Bureau of Labor.

Obviously, the analogy is far from perfect. Wage negotiations typically occur without any state intervention, while the increase or moderation of energy prices does require such interventions. And it is not clear to what extent higher resource prices might lead to moving operations to other countries; in the case of rising wages this is less likely to occur because other countries tend to show the same dynamics of wages rising with productivity.

Creating sufficient winners in favour of change

The proposal has aspects that give it the potential to create sufficient winners to form a coalition that supports its introduction. It would provide a source of government revenue, creating choices for the government to reduce taxation on other people or firms in the economy, increase spending or to reduce fiscal deficits. Linking the size of the tax to productivity increases means that the total potential revenue does not decline, even as the number of units of resource consumed decreases.

Secondly, by increasing resource tax at the rate of average efficiency gain, the proposal increases the relative

competitive advantage of firms which have above average resource productivity gains: these firms reduce costs relative to their competitors. This not only provides greater incentives for competition based on increased resource productivity, but also provides reasons for the more innovative and productive firms to take political positions in favour of change.

Taking account of potential losers in a policy mix

Introducing a slow, incremental, long-term increase of prices in the way suggested might allow industry and families to gradually adapt to higher price levels and yet would serve as a strong signal for all long-term investments and decisions. Often the signalling effect alone induces more resource-efficient behaviours, as firms and people adjust in anticipation.

The generation of revenues allows some recycling of those revenues to the losers from the policy change. Following a model from Sweden's tax on nitrous oxides, the revenues from the policy could be returned to clusters of firms (such as the non-ferrous metals industries) – not per energy unit consumed but per job added or affected by price rises in ways which do not reduce the incentive effect of the resource price increase.

Countries have also found ways to protect vulnerable low-income people (who have limited capacity to improve their resource use) from policy-induced price rises. In many countries of the world, a move from generally low and subsidized energy and water prices to realistic market prices (encouraging private capital to invest in more supplies) has been accompanied by policies that allow for a preferential low price level for poor families. South Africa has set a good example within its integrated water plan.

Creating new institutional arrangements

The design of a policy mechanism that raised prices of energy or resources in line with efficiency increases would require new, presumably legally binding, institutional arrangements. Those would be context specific to autonomous countries, but would be likely to involve binding pre-commitment of government to the mechanism, with independent and credible mechanisms for monitoring and calculating documented efficiency gains.

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8 Conclusions

Trends in global consumption and exhaustion of natural resources and environmental systems imply that the **decoupling of economic growth from resource use will become ever more important for stable, successful economies**. These trends are already sufficiently significant to influence the factors that make economies competitive.

Many technologies and techniques that deliver significant resource productivity increases **are already commercially available and used in developing and developed economies**.

They allow economic output to be achieved with fewer resource inputs, reducing waste and savings costs that can further expand the economy or reduce its exposure to resource risks.

A well-functioning economy might be expected to naturally adjust to changes in resource availability by directing investments into areas of economic activity that bring patterns of resource use in line with society's goals (for example, into innovation in resource productivity). In practice, we see that many economies do not

naturally adjust in this way, but suffer from blocks to transition which "lock-in" existing patterns of resource use. These obstacles to decoupling can be categorised as arising from:

- the legacy of past policy decisions (including those made before information on resource trends was available); and
- technological, behavioural, organisational and institutional biases against innovation in resource productivity.

Facilitating decoupling **will involve removing these obstacles**, to create the conditions in which investments in resource productivity become widespread. **Developing countries may have a relative advantage in decoupling**, because they are not so strongly locked-in by resource-intensive consumption and productions patterns, infrastructure and institutions.

There has been a wealth of experience across the world in policy to intentionally facilitate the decoupling of resource use, or impacts of resource use, from economic growth, with some notable successes. **They indicate that absolute decoupling of economic growth from resource use is possible**.

The chances of success appear higher where policymakers look at the institutional framework in which the political decision is made. **This means being aware of the set of actors** who are able to influence the decision, their interests, relative power and the norms and assumptions which are shaping the decision. **Leadership will be needed to break out of resistance to policy changes**. Leaders within the public and private sectors can draw on past experiences with policy for guidance on how to take forward decoupling.

There are forms of policy available to promote decoupling that combine several of these considerations. The report mentions two, which are illustrative of the type of combined policy which is needed. One proposal uses **taxation or subsidy reduction to move resource prices upwards in line with documented increases of energy or resource productivity**. Another looks to **shift revenue-raising onto resource prices through resource taxation at source or in relation to product imports, with recycling of revenues back to the economy**.

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THIS BOOKLET summarizes the report *"Decoupling 2: technologies, opportunities and policy options"*. The report was produced by the Decoupling Working Group of the International Resource Panel. It explores technological possibilities and opportunities for both developing and developed countries to accelerate decoupling and reap the environmental and economic benefits of increased resource productivity. It also examines several policy options that have proved to be successful in helping different countries to improve resource productivity in various sectors of their economy, avoiding negative impacts on the environment.

It does not seem possible for a global economy based on the current unsustainable patterns of resource use to continue into the future. The economic consequences of these patterns are already apparent in three areas: increases in resource prices, increased price volatility and disruption of environmental systems. The environment impacts of resource use are also leading to potentially irreversible changes to the world's ecosystems, often with direct effects on people and the economy – for example through damage to health, water shortages, loss of fish stocks or increased storm damage.

But there are alternatives to these scary patterns. Many decoupling technologies and techniques that deliver resource productivity increases as high as 5 to 10-fold are already available, allowing countries to pursue their development strategies while significantly reducing their resource footprint and negative impacts on the environment.

This report shows that much of the policy design "know-how" needed to achieve decoupling is present in terms of legislation, incentive systems, and institutional reform. Many countries have tried these out with tangible results, encouraging others to study and where appropriate replicate and scale up such practices and successes.

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