Implementing the green economy in a European context: lessons learned from theories, concepts and case studies

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PEER

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PARTNERSHIP FOR EUROPEAN
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FOREWORD

Humans have changed ecosystems more rapidly and more extensively over the past 100 years than in any comparable period of time in human history. Past and current consumption and production systems have generated various and severe environmental problems in different parts of the world such as increasing water deficiency, depletion of natural resources including arable land and soils, loss of ecosystem services and biodiversity, and – most likely – also climate change. Some of these changes may be irreversible. These developments have been largely driven to meet rapidly growing demands for e.g. food, fresh water, timber, fiber, and fuel as well as minerals and are a result of traditional one-way linear economic models: "resource – product – waste". This way of thinking is nowadays considered unsustainable and society, industry and politics have started to acknowledge an urgent need for its reconsideration and revision. The required consideration of interlinkages and consequences of human activities will not only help avoiding environmental problems but is essential to gaining long-term prosperity in all fields of our economies and societies.

"Green Economy" is considered an approach to developing a more sustainable industry. In 2014, PEER – the Partnership for European Environmental Research decided to explore how environmental research can contribute to a positive and sustainable economic development. The Directors of the eight large environmental research centres that form PEER decided to implement a joint research project about green economy within PEER. All the PEER partners supported the preparation of the project, and finally five institutes, namely the Finnish Environment Institute (SYKE, coordination of the project, Finland), Alterra Wageningen UR (the Netherlands), IRSTEA – the National Research Institute of Science and Technology for Environment and Agriculture (France), the Helmholtz Centre for Environmental Research – UFZ (Germany) and the Danish Centre for Environment and Energy (DCE) at Aarhus University (Denmark) were active research members in the project.

The project aimed at producing increased understanding about the concepts and foundations for future circular and green economy securing the maintenance of a full range of ecosystem services on which society relies. The project synthesised recent work related to this topic and analysed ten European case studies of green economy. These case studies were utilised to reveal opportunities, but also barriers and challenges for the transformation into a zero waste, renewable bio- and ecosystem-services-based production system.

The project resulted in manuscripts of three scientific papers that were submitted to peer review process in November 2015:

A. *Loiseau, E., Saikku, L., Antikainen, R., Leskinen, P., Pitkänen, K., Droste, N., Hansjürgens, B., Kuikman, P., Thomsen, M. Conceptual framework and methodological tools used by green economy. Submitted to Journal of Cleaner Production.*
B. *Pitkänen, K, Antikainen, R., Droste., N., Loiseau, E., Saikku, L, Aissani, L., Hansjürgens, B., Kuikman, P.J., Leskinen, P., Thomsen, M. What can be learned from practical cases of green economy? –studies from five European countries. Submitted to Journal of Cleaner Production.*
C. *Droste, N. Hansjürgens, B., Kuikman, P., Antikainen, R., Leskinen, P., Pitkänen, K., Saikku, L., Loiseau, E., Thomsen, M. Supporting innovations for the transition towards a green economy: An analysis of governance factors and government intervention in five European cases. Submitted to Journal of Cleaner Production.*

This summary report is based on these three manuscripts.

As PEER chair, it is my great pleasure to introduce our green economy project report to our stakeholders in the international scientific community and in politics, industry and society. I acknowledge and thank all the colleagues who contributed to this work. I expect that the lessons learnt in this research project will be of profound value for the future development of a green economy. As PEER, we are committed to integrated research and providing sound and policy-relevant information to Europe's decision makers.

Leipzig, Germany, November 25th
Prof. Dr. Georg Teutsch
PEER chair

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SUMMARY

As a response to the economic crisis and sustainability challenges the world is facing, the discussion related to green growth and green economy was launched by the Organisation for Economic Co-operation (OECD) and United Nations Environment Programme. Green growth and green economy have been seen as opportunities to foster economic growth and development, while ensuring that natural assets continue to provide the resources and ecosystem services on which our well-being relies. The central message is that greening the economies can help to generate new jobs and skills, promote clean technologies, and reduce environmental risks and poverty.

This report summarises the key results of a PEER project analysing the green economy. The project explored green economy concepts and 10 practical cases from Finland, France, Germany, the Netherlands and Denmark. The work is based on three article manuscripts and thus divided into three parts:

1) a conceptual and methodological framework for the implementation and the monitoring of the different dimensions of a green economy (Loiseau et al., 2015),
2) critical factors for achieving a green economy in practice (Pitkänen et al., 2015), and
3) governance factors with respect to institutional frameworks that may facilitate a transition to a green economy (Droste et al., 2015).

The concept of a green economy can encompass several meanings and be related to different economic theories, concepts and practical approaches aiming to achieve environmental, economic and social benefits. In order to measure the effects of these solutions, different assessment tools can be used. The concepts and practical approaches related to the green economy are varyingly implemented in the cases of enhancing green economy in practice. For instance, principles of industrial ecology

lie behind several of our case study approaches. Similarly, circular economy and waste hierarchy concepts were present in several of the studied cases, combined for instance with energy or material efficiency approaches.

The results emphasise that transitioning to green economies is never purely based on win-win solutions, but requires taking into account potential trade-offs among multiple goals, across sectors and international leakage. The case studies indicate the need for far-sighted and multiple-source planning of funding of green economy initiatives. The results emphasise a better and more holistic integration of research in green economy initiatives and projects from the beginning. As illustrated by our study, the complexity and multi-sectoral nature of the green economy calls for a broad co-integration of policies bridging the environment, innovation, transport, housing, energy, agriculture and spatial planning. Our case studies also illustrate the need for comprehensive analysis of the effects of regulation and legislation. Many of our cases also illustrate the importance of stakeholder commitment, good leadership and coordination.

Transforming the economy requires innovation in terms of available technology, organisational support, market and broader societal conditions, and an overarching governance framework, but most of all, political will. The practical implementation of the green economy is related to a multiplicity of factors and causalities depending on the context. Some solutions are more compliant with the mainstream economy and require few changes (e.g. cleaner production), whereas other solutions are more system-oriented and based on profound transformations in the patterns of production and consumption (e.g. industrial ecology).

INTRODUCTION

Greening the economy has lately been promoted as a new strategy for enhancing human well-being and reducing environmental risk, being defined as low-carbon, resource-efficient and socially inclusive (Box 1). The term 'green growth' is often used alongside or interchangeably with the 'green economy'. Several countries have developed their own green economy strategies and a range of policy measures on the basis of national needs and priorities (see UN-DESA, 2012). National and international platforms, partnerships, programmes, funds and other initiatives have been developed to provide support for countries and stakeholders to implement the green economy in practice (see UN-DESA 2013). In the European Union, a range of elements of the green economy concept are integrated in strategic documents such as Europe 2020 (COM 2010) and the resource efficiency roadmap (Mazza and ten Brink, 2012). Many countries on other continents also see a green economy as a highly strategic target. In Asia, for example, South Korea and China have implemented a five-year plan to support a green economy (www.greengrowth.go.kr). The United Nations Environment Programme (UNEP) -led Green Economy Initiative, launched in late 2008, provides analyses and policy support for green sector investments and in the greening of environmentally unfavorable sectors (www.unep.org/greeneconomy). UNEP also sees the green economy as essential in poverty eradication (UNEP 2011).

BOX I DEFINITIONS FOR GREEN ECONOMY

"A green economy is one that results in improved well-being and social equity, while significantly reducing environmental risks and ecological scarcities."
UNEP, 2011.

"A green economy is one that generates increasing prosperity while maintaining the natural systems that sustain us."
EEA, 2014.

"Green growth is about fostering economic growth and development while ensuring that the natural assets continue to provide the resources and the environmental services on which our well-being relies. In order to do this it must catalyse investment and innovation which will underpin sustained growth and give rise to new economic opportunities."
OECD, 2011.

"Green growth is growth that is efficient in its use of natural resources, clean in that it minimises pollution and environmental impacts, and resilient in that it accounts for natural hazards."
World Bank, 2012.

Reducing environmental harm while growing the economy requires a transformation of the existing production and consumption patterns (Allen, 2012, UNEP 2011). The green economy concept can help such transformations (Borel-Saladin and Turok, 2013). A green economy focuses on the origin of the problem of environmental degradation: the way the existing economic system works and ways of transition and aims to produce win-win solutions for both the environment and the economy (Droste et al., 2015). Two central focus areas are identified as the main elements of a green economy: (i) enhancing natural capital, i.e. stocks of and flows from agriculture, fisheries, water and forests, and (ii) energy and resource efficiency, i.e. facilitation of environmental technology in renewable energy, manufacturing, waste, buildings, transport, tourism and cities (UNEP, 2011). Thus, a green economy is linked with many other concepts and approaches with similar and partly overlapping targets. These include such things as resource efficiency, renewable resources, cleaner production, the waste hierarchy (reduce, reuse, recycle, repair), life-cycle approaches (life-cycle assessment, LCA), circular economy, industrial ecology,

industrial symbiosis (or eco-industrial parks), eco-design, cost-benefit analysis (CBA) and green infrastructure (Loiseau et al., 2015).

The transition to greener economies has been facilitated by concrete cases and experiments on a variety of different industrial and social sectors. Sometimes these experiments have remained temporary and incremental (Kemp et al., 2007). Sometimes, like in the case of the German energy transition, local initiatives and experiments have been part of more substantive transitions transformed into successful practices or even national policies and system-level changes (Geels et al., 2004). While describing these experiments and transitions in different sectors, previous studies have often aimed at identifying factors that have negatively or positively contributed to their success. So far, literature on sustainable transitions has mostly focused on cases limited to a single approach, sector or nation. What is lacking is research that would synthesise key findings and "lessons learned" across the different fields of green economy transitions. Also, there is need for a framework that would identify the characteristics of a green economy, illustrate how a green economy can be helpful in tying together the multiplicity of concepts and approaches and making them more attractive to governments and local policy makers who have a vital role in interventions and implementing the green economy strategies.

This report summarises the key results of a PEER project analysing the green economy. The project explored green economy concepts and 10 practical cases from Finland (FI), France (FR), Germany (DE), the Netherlands (NL) and Denmark (DK) (see Pitkänen et al., 2015). The work is divided into three parts:

1) a conceptual and methodological framework for the implementation and the monitoring of the different dimensions of a green economy (Loiseau et al., 2015),
2) critical factors for achieving a green economy in practice (Pitkänen et al., 2015), and
3) governance factors with respect to institutional frameworks that may facilitate a transition to a green economy (Droste et al., 2015).

CONCEPTS, APPROACHES AND TOOLS FOR A GREEN ECONOMY

A green economy can be operationalised through different economic theories (Box 2) as well as concepts, practical approaches and tools. UNEP (2011), for instance, has listed resource efficiency, renewable resources, cleaner production, the waste hierarchy (reduce, reuse, recycle, repair), life-cycle approaches (life-cycle assessment, LCA), circular economy, industrial ecology, industrial symbiosis (or eco-industrial parks), eco-design, cost-benefit analysis (CBA) and green infrastructure to be closely related to the green economy. In addition, the European Commission (2012) identified bioeconomy as a key element for a green and smart economy, and the US EPA (2009) proposed that servicising can improve both economic and environmental performances. Several central elements are introduced in Table 1.

BOX 2
THEORETICAL BACKGROUNDS: GREEN ECONOMY AND GREEN ECONOMIC GROWTH

The concept of a green economy is related to ecological modernisation (Bina and La Camera, 2011; Lorek and Spangenberg, 2014). Ecological modernisation refers to an environmental policy, related to the precautionary principle, and involves long-term structural change of the patterns of production and consumption (Andersen and Massa, 2000). One of the main assumptions of this perspective is that economic growth and a sustainable use of resources can be achieved simultaneously. However, growth and resource consumption can be interpreted in different ways, and the theoretical basis of the green economy can be interpreted through the subfields of environmental and ecological economics (Buttel, 2000).

According to ***environmental economists***, environmental issues arise from the inefficient use of natural resources and the undervaluation of natural capital (Borel-Saladin and Turok, 2013). **The underlying assumption is that**

"The main difference between environmental and ecological economics is the mindset in addressing the value of natural capital and the associated ecosystem services needed by society. While the former supports the idea that ecosystem services may be substituted by technical solutions, the framework of ecological economics starts with the unsubstitutability of supporting ecosystem services as an inherently embedded function of natural capital."

man-made and natural capitals are substitutable by technical solutions (Bina and La Camera, 2011). In this perspective, economic development and people's demands do not need to change, and there is optimism about the ability of humankind to solve any problems that may arise concerning resource depletion (Williams and Millington, 2004). The economic strategy pursued by environmental economics is to get prices right by putting an accurate value on natural capital. A broad set of potential instruments can be used for the internalisation of environmental costs, i.e. command and control, taxes, fiscal transfers, subsidies and market-based instruments such as tradable permits or payments for ecosystem services. Their respective efficiency, effectiveness and legitimacy are discussed differently and vary among circumstances and institutional frameworks.

In ***ecological economics***, the economy is defined as a subsystem of a larger local and global ecosystem which sets limits to the physical growth of the economy. **The ecosystems and natural capital cannot be substituted by technology**. Economic systems must acknowledge the biophysical limits imposed by Earth, and they have to adapt to operate within a safe operating space (Bina and La Camera, 2011). Ecological economics discipline attempts to model socio-ecological systems by mapping cause-effect relationships and dynamic processes with the environment. Among solutions, a great emphasis is placed on structural change such as a more small-scale decentralised way of life based upon greater self-reliance in order to create social and economic systems that are less destructive towards nature (Williams and Millington, 2004). In addition, physical or ecological indicators (e.g. material input per service unit, the ecological footprint, critical natural capital) based on the concept of dematerialisation and the conservation of non-substitutable natural capital are developed (Ekins et al., 2003; Farley, 2008; van den Bergh, 2001).

TABLE I CONCEPTS, APPROACHES AND TOOLS FOR A GREEN ECONOMY

Term	Short definition	Refs.
Bioeconomy, bio-based economy	All economic activities that are linked to the development and use of biological products and processes. In Europe, the concept puts a strong emphasis on biomass consumption, innovations, sustainable growth and creation of added-value.	OECD, 2009; Brunori, 2013; EC 2012
Cleaner production	Cleaner technologies that generate less pollution and waste, and make more efficient use of materials and resources.	El Kholy, 2002
Eco-design	Product designed for zero waste production, take-back and reuse, where life-cyclic environmental impacts of a product are considered.	
Waste hierarchy approach	Emphasises the minimisation of waste generation. The stages of waste hierarchy are first prevention, then **reuse, recycle, recovery** and finally disposal.	Directive 2008/98/EC
Nature-based solutions	Designing multifunctional landscapes that provide multiple benefits simultaneously such as flood control, carbon storage, raw materials, human health and biodiversity.	Mazza et al., 2011
Green infrastructure (GI)	Planned networks of natural and semi-natural areas which are seen as a cost-effective alternative or complement to grey, man-made infrastructure to satisfy human needs.	EC, 2013
Industrial ecology	Material and energy flows through industrial systems and interaction with the biosphere. In ideal industrial systems, the use of energy and materials is optimised and the generation of waste is minimised in order to move from linear throughput to closed-loop materials and energy use.	Ehrenfeld and Gertler, 1997
Circular economy	*"An industrial economy that is restorative by design, and which mirrors nature in actively enhancing and optimising the systems through which it operates."*	The Ellen MacArthur Foundation, 2012
Biomimicry	Imitates designs and processes of nature to innovatively solve human problems.	Benyus, 2002
Industrial symbiosis (IS)	Aims at engaging traditionally separate activities in physical exchanges of materials and energy flows. Aims at fostering eco-innovation and encourages networks of organisations to make new investments and change business practices. It also stimulates research and development, new businesses and joint ventures.	Lombardi and Laybourn, 2012
Servicising, functional economy	The economic objective of the functional economy is "to create the highest possible use of value for the longest time while consuming as few material resources and energy as possible." The idea of the functional economy is that function is the key to customer satisfaction.	Stahel, 1997; Tukker, 2013; Mont, 2002
Material flow analysis (MFA)	Analysis of the throughput of process chains comprising extraction or harvest, chemical transformation, manufacturing, consumption, recycling and disposal of materials.	Bringezu and Moriguchi, 2002
Life-cycle assessment (LCA)	A tool for assessing the environmental impacts of a product or service from "cradle to grave."	Finnveden et al., 2009
Environmentally extended input-output model	Extends the classical input-output model. It describes the interdependencies between different sectors of the economy, including also environmental impacts.	Kitzes, 2013
Life cycle costing (LCC)	Measures the total cost of an asset over its life cycle including capital costs, maintenance costs, operating costs and the asset's residual value at the end of its life.	Sesana and Salvalai, 2013
Social life cycle assessment (S-LCA)	Developed for evaluating the social dimension with indicators such as employment, workplace health and equity.	Benoit Norris, 2012; Macombe et al., 2013
Life cycle sustainability assessment (LCSA)	Integrating environmental, economic and social aspects with the concept of life-cycle assessment.	Guinée et al., 2011; Heijungs, 2010;
Cost-benefits analysis (CBA)	A decision support tool to assess the welfare effects of a project or an investment.	Hansjürgens, 2004

Source: Ioiseau et al. (2015)

BOX 3 OCCURRENCE OF CONCEPTS, PRACTICAL APPROACHES AND TOOLS RELATED TO GREEN ECONOMY IN THE LITERATURE

In scientific literature, certain concepts, approaches and tools frequently co-occur with the green economy, such as cleaner production, resource efficiency, renewable resources, industrial ecology, LCA, CBA and the approaches linked to the waste hierarchy (waste prevention) (Fig. 1). Other terms, such as bioeconomy, servicising and green infrastructure, co-occur less often and can be interpreted more as emerging concepts (Loiseau et al., 2015).

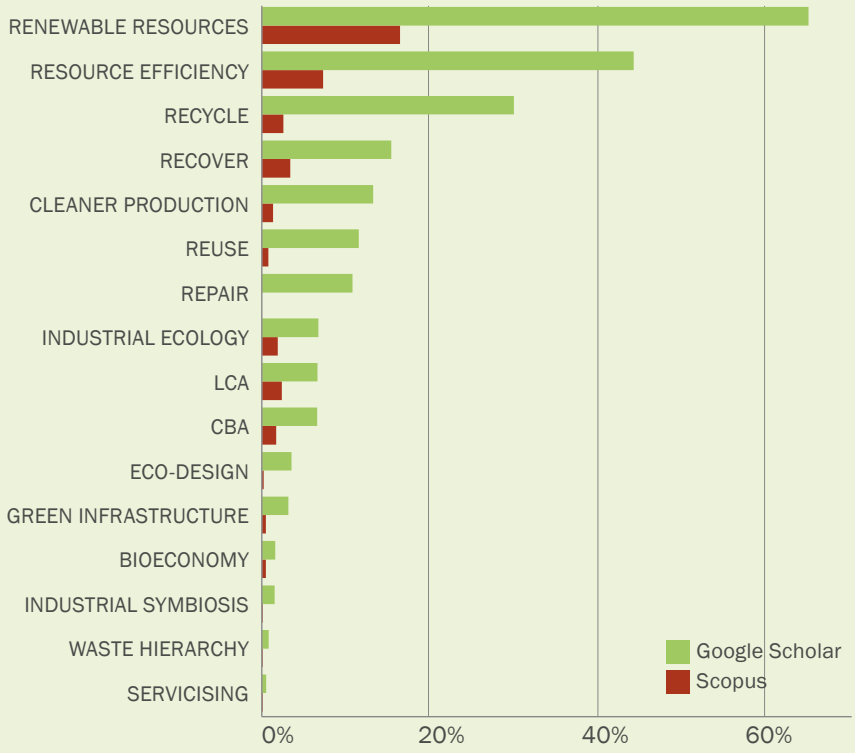

FIGURE 1

Occurrence ratios of terms related to the concept of a green economy. A bibliometric analysis was conducted by using Scopus and Google Scholar. We looked how these different terms co-occur in scientific literature with the term “green economy”. Google Scholar references reports in addition to scientific papers, and the “grey” literature seems to be more abundant on the green economy than the scientific one (Loiseau et al., 2015).

The concept of a green economy can encompass several meanings and be related to different economic theories, concepts, practical approaches and assessment tools (Fig. 2). First, the green economy is linked to both theories of environmental economics and ecological economics (Box 2). The implementation of these two theories has different practical outcomes. Environmental economics is closely related to cleaner production and resource efficiency, whereas ecological economics relies on concepts such as industrial ecology (or circular economy). Waste hierarchy can be related to both, depending on the extent to which it is implemented (downcycling versus upcycling). All these concepts are based on practical approaches or solutions to achieve environmental, economic and social benefits. In addition, in order to measure the effects of these solutions, different assessment tools such as life-cycle assessment can be used.

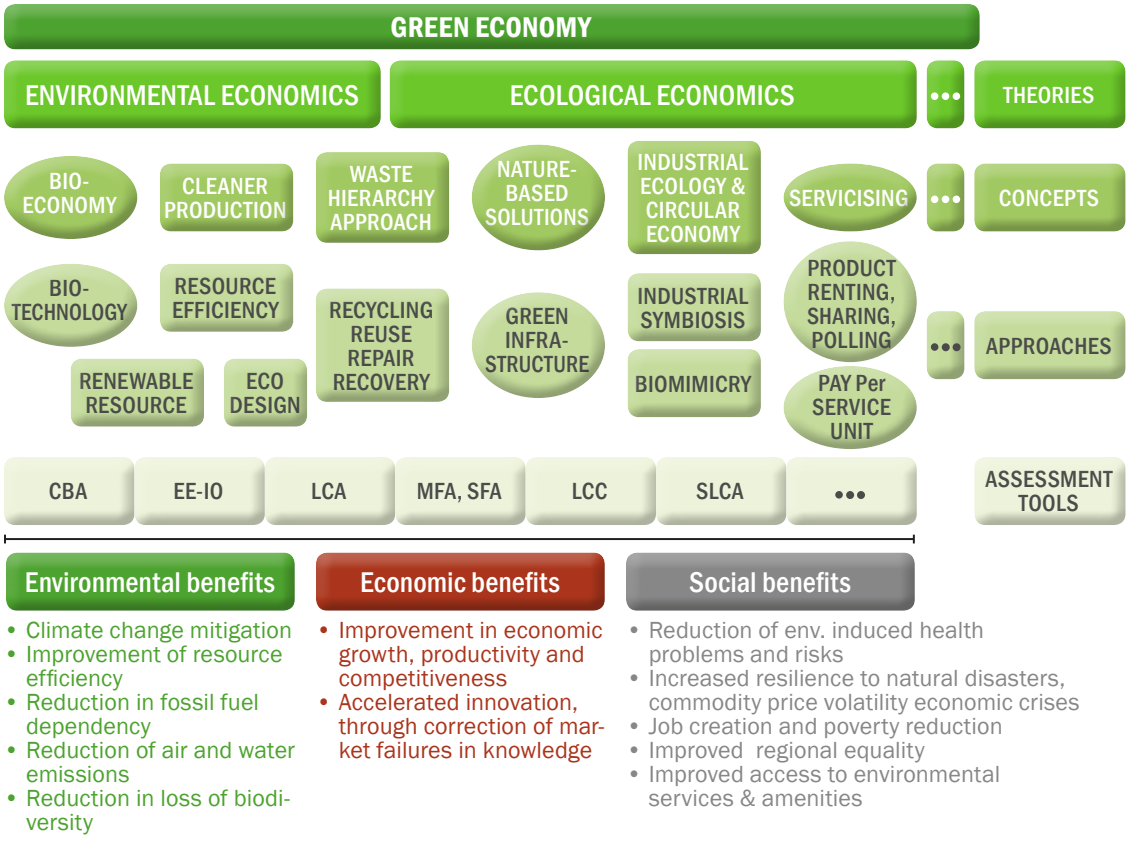

FIGURE 2

Conceptual framework for implementing a green economy in practice (current concepts are marked with boxes, while emerging concepts are in circles) (Loiseau et al., 2015).

IMPLEMENTING A GREEN ECONOMY IN PRACTICE

To assess the critical factors behind the success or failure of cases/experiments of a green economy, 10 innovative cases from different sectors from five European countries including Finland (FI), France (FR), Germany (DE), the Netherlands (NL) and Denmark (DK) were studied (Table 2). The cases were selected purposefully from different temporal and spatial scales and from different economic sectors to respond to the need for wide cross-sectorial and international comparisons. Some of the cases aim for substantive transitions, while others can be considered to be more incremental. Each of the cases were studied separately, using multiple sources of materials such as previous literature, policy documents and research reports, websites as well as expert interviews and consultation (Pitkänen et al., 2015).

The concepts and practical approaches related to the green economy introduced above are varyingly implemented in the cases (Table 2). For instance, principles of industrial ecology lie behind several of our case study approaches. Similarly, circular economy and waste hierarchy concepts were present in several of the studied cases, combined for instance with energy or material efficiency approaches. The idea of a bioeconomy was also present in a variety of the examined cases. Most of the cases implement multiple concepts and approaches.

The principles of industrial ecology, circular economy, waste hierarchy, energy or material efficiency approaches and the idea of a bioeconomy lie behind several green economy cases.

TABLE 2

Examples of projects or policies implementing the green economy in practice on a national, regional and local level, as well as the main characteristics and links to the green economy concepts and approaches of the analysed cases .

	Concepts						Approaches						
	Bioeconomy	**Cleantech**	**Waste hierarchy**	**Industrial ecology**	**Circular economy**	**Nature-based solutions**	**Biotechnology**	**Renewable resources**	**Energy efficiency**	**Material efficiency**	**Recycling, reuse, repair, recovery**	**Servicising**	**Industrial symbiosis**	**Green infrastructure**
NATIONAL LEVEL CASES														
Energiewende (DE): Germany's energy transition, since the 1980s	x	x					x	x	x					
Wood construction (FI): Increasing the construction of large-scale buildings from wood in Finland, since the 1990s	x			x				x	x					
REGIONAL CASES														
BIODECOL2 (FR): Project to support the implementation of biogas plants in the area of Brittany (2007-11)	x			x			x	x	x				x	
Miniwaste (FR): Project to minimise organic waste in the Rennes Metropole region (2010-2012)			x	x	x					x	x			
Jyväskylä (FI): Project to develop the city of Jyväskylä into a resource-wise region (2013-2015)		x	x	x					x	x	x	x	x	
HINKU (FI): Project to form a network of municipalities that creates and carries out solutions to reduce greenhouse gas emissions, since 2008	x	x					x	x	x				x	
MoorFutures (DE): Initiative to sell certificates on emission reductions to support peat land restoration, since 2010						x								x
LOCAL CASES														
Dunkirk (FR): Industrial symbiosis initiative in the harbour area of Dunkirk, since the 1960s				x	x				x	x	x		x	
Healthy Sand (NL): Cooperation between farmers and the water company to improve soil in the Duurzaam region, since 2013			x		x	x					x			x
MAB3 (DK): Project on off-shore macro-algae cultivation to promote circular resource management and bio-based production, since 2012	x			x	x	x	x						x	x

Source: Pitkänen et al. (2015)

CRITICAL FACTORS IN THE CASE STUDIES

The factors identified as critical for the success or failure of the cases were summarised under five broad categories: 1) economic and market conditions, 2) technology and R&D, 3) policy and regulation, 4) networks and social capital and 5) public perception (Table 3). Firstly, many of our case studies illustrated the **importance of economic viability** for the implementation of the green economy in practice. Win-win solutions between economic and environmental goals were important especially on the local-level cases, such as Dunkirk, Healthy Sand and MAB3, where synergies and the common cause were perceived to have a clear economic benefit by the local stakeholders. In these cases mutual benefits were reflected in an interest to cooperate and easiness of the cooperation. However, reaching a win-win proposition became more laborious the more stakeholders and competing interests there were. Sometimes win-win solutions were not enough if the alternatives remained more profitable, market structures did not encourage change or stakeholders were not committed.

Many of our cases, such as Jyväskylä or Miniwaste, were or had been initiated as projects that would not have been realised without external funding. Such funding was often channelled through public green economy initiatives and innovation funds. A lesson learned from our cases, however, is that public funding can make the case too reliable on external resources decreasing the interest of local stakeholders to invest and thereby risking the continuity of the case.

Secondly, **technological development** as well as R&D were emphasised in small and large cases with a variety of approaches to the green economy. In many of our cases reaching a certain level of technological development or the emergence or entrenchment of new technology was a critical initiator of the case, especially in cases such as Energiewende or Dunkirk. Technological development was important not only in solving technological barriers, but also in making the case cost-effective, like in the case of wood construction. The role of R&D in providing reliable impact assessments was emphasised equally often. Assessments of environmental and economic benefits were important for stakeholder decision-making, thereby committing stakeholders and publicity. The importance of impact assessments were emphasised in the cases of BIODECOL2, HINKU and Jyväskylä in particular.

Thirdly, the development of local, national and international environmental **policies and regulation**, via making sustainable options more viable, creating

new funding opportunities, securing public sector commitment or setting targets and roadmaps for future development, was identified as critical in many cases. For instance, the EU Waste Framework directive had a positive influence in the case of the Miniwaste project by promoting waste reduction at source and domestic composting. However, regulatory barriers were also distinguished. One of the cases affected by regulatory barriers that our study examined was wood construction in Finland. In particular, our case studies promote a need for multi-sector and multi-level scrutiny of the effects of regulation and legislation.

Fourthly, the importance of the **human dimension** was emphasised especially in terms of leadership and networks. Qualities of social capital (trust, common understandings, interest and commitment of actors to a common goal) were emphasised across cases of different approaches and scales. The role of public bodies and authorities in coordinating and increasing the credibility of the case was emphasised, especially in large national scale transitions such as the German Energiewende. In those cases that have started as projects, external funding for coordination has been essential in the planning and launching of the projects.

Economic viability and stakeholder commitment are highly important for the implementation of a green economy in practice.

In these cases the role of intermediary organisations was especially emphasised. In many successful local level cases having an existing and functioning network of actors to build on or formalising commitments by contracts was found to be critical. Finally, public perception was identified as critical, especially in cases where market demand was important. Growing environmental awareness among the public and potential customers was seen to have raised a need for green image building.

There are similarities across small and large-scale cases and different approaches. The critical factors are also somewhat similar between cases applying concepts and approaches linked to different economic theories. However, in a few of the cases, which rely on concepts and approaches of environmental economics, cost efficiency and market decentralisation play a role. This is reasonable, as environmental economics stresses market instruments. Regarding cases implementing concepts and approaches of ecological economics, the evaluation of the environmental impacts (in particular as a barrier) and image as a success factor are important. This may be related to the aim for a system-level change towards sustainability.

TABLE 3 CRITICAL FACTORS FOR THE SUCCESS OF THE STUDIED GREEN ECONOMY CASES

Critical factor	Success	Barrier
Economic and market	+ Win-win solutions + External financial support + Cost-effectiveness + Decentralised market structures + New financing mechanisms	– Win-win solutions not always profitable enough – No funding after pilot phase – Poor cost-effectiveness – Unfavourable domestic market conditions
Technical and R&D	+ Technological developments + Impact assessment	– Remaining technical problems – Methodological difficulties in impact assessment
Policy and regulation	+ Regulatory push and incentives + Public sector involvement and commitment + Development of standards + Strategic development	– Regulatory barriers
Networks and social capital	+ Social capital between stakeholders + Commitment of stakeholders + Effective coordination/ leadership + Positive role of intermediaries + Relations between actors formalised by contracts	– Lack of leadership – Disciplinary differences
Public perception	+ Green image + Labels, trademarks and clever product design	– Local resistance and NIMBY conflicts – Negative image of green alternatives

Source: Pitkänen et al. (2015)

GOVERNANCE FACTORS FOR A TRANSITION TOWARDS A GREEN ECONOMY

The case studies underlined the decisive role of governance for the success of the cases. Governance is among the essential factors that explain the emergence of (sustainable) innovations that are required for the transition to a greener economy. Five interlinked factors are assumed in a system innovation model (Fig. 3). Innovations take place with an **actor** at the core. The actor is embedded within an **organisation** that helps with the coping for the innovation. The organisation itself is placed into wider **market structures** that are defined by the rules of an overarching **governance system** within the boundaries of the utmost **system earth**. The governance system is considered decisive as it strongly influences the other four categories (Droste et al., 2015).

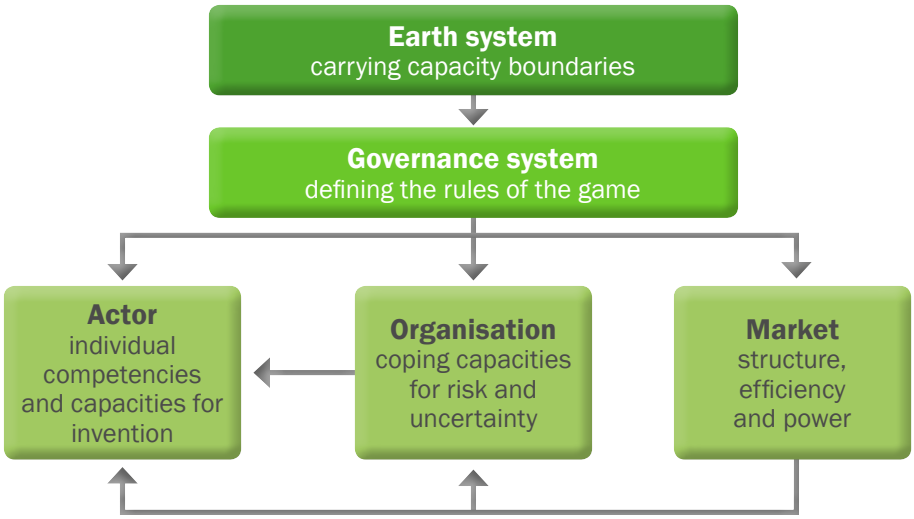

FIGURE 3

A framework for green economy innovations. Source: Droste et al. (2015) based on Röpke (1977).

"A transition to a green economy is both about moving the possibility frontier outwards to a greener economy and limiting the 'action space' at the brown economy end." *(Droste et al. 2015)*

A transition to a green economy is both about moving the possibility frontier outwards to a greener economy and limiting the "action space" at the brown economy end. Weakening cannot occur in the natural or socio-economic dimensions. Furthermore, economic improvements should not cause deterioration in social and environmental dimensions but enhance them. Moreover, those actions where one dimension cannot be enhanced without deterioration in the other should be subject to regulation that helps implement such improvements.

The case studies provide several important findings with respect to the different measures and instruments governments can employ for a transition towards a green economy. **Regulation** is especially important for defining the "rules of the game" and may allow a shift of the "action space" and secure a safe operating space within planetary boundaries. In addition, regulation is also the instrument where most trade-offs have to be dealt with. Nevertheless, through prudent design and sufficient adaptation within the process of regulation, such trade-offs can be dealt with. However, it must be noted that trade-offs may not always be necessary.

It is important to assess governments' own **public procurement processes and investment projects** with regard to its effects to society and the environment. Governments' spending behaviour has a multiplying effect for other societal actors and market participants and showcases solutions that can be picked up in other contexts. Moreover, governments also have a more direct responsibility for social and environmental improvements compared to many other actors.

Setting the incentives right is another crucial feature for moving the action space towards a green economy. By creating economic incentives for a particular behaviour the action is not directly ruled in or ruled out, but new markets and market segments may become economically viable, while other production patterns may become unprofitable.

Often, there is not yet sufficient capacity available to allow for a green economy transition. Governments may take the lead and invest in **capacity building** programmes that allow new (and often cooperative) behaviour to arise.

Finally, any strategy needs **monitoring and informational tools** to assess its success. Such tools may range from life-cycle assessment and environmentally extended input-output models to cost-benefit analyses (Fig. 2), among other things. Government intervention ranging from direct regulation to softer tools such as information may facilitate a green economy transition as we have illustrated with anecdotal case study evidence.

GREEN ECONOMY PUT INTO PRACTICE – LESSONS LEARNT AND FUTURE OUTLOOK

THE GREEN ECONOMY AS A CONCEPT FOR POLICY-MAKING

The concept of a green economy is very attractive to governments and businesses as it aims to provide a simultaneous solution to unemployment, economic growth and environmental issues by introducing new green industries and tools for mitigating environmental damage (Borel-Saladin and Turok, 2013). The potential for green economy solutions worldwide is considered significant, both in developing and developed countries and in all sectors of society. For example, the World Bank (2014) has estimated that the expected investment in clean technology sectors in the world's developing and emerging economies may exceed $6.4 trillion over the next decade. Similarly, a circular economy has been estimated to provide a huge business potential. The improvement in resource productivity would generate a primary resource benefit of as much as €0.6 trillion per year by 2030 to European economies. In addition, a circular economy would generate €1.2 trillion in non-resource and externality benefits annually (The Ellen Mac Arthur, 2015). For the entire Dutch economy, opportunities related to the circular economy have been calculated at €7 billion and more than 50,000 additional jobs (TNO, 2013), and similar estimates have also been presented in many other countries, including Finland (Sitra, 2014).

The conceptual framework developed in this project shows that a large range of concepts, approaches and tools can be used to implement and monitor green economy strategies (Loiseau et al., 2015). However, these practical solutions require substantial investments. The UNEP Green Economy report (UNEP, 2011) estimates that 1-2.5 percent of global GDP are required to facilitate the transformation. While the main investment will have to come from the private sector (i.e. from financial services and the investment sector, banking, and insurance), governments have a vital role to play in steering those investments towards greening the economy.

Environmentally responsible and equitable performance of the private sector can be encouraged and incentivised through well-designed and coherent legal frameworks (Lee et al., 2014). Regulation, charges, levies, taxes and market-based instruments can help scale-up green economy investments and internalise the costs of environmental and social externalities (Pizzol et al., 2014). International governance and multilateral agreements can assist national governments to promote a green economy by institutionalising coordinated behavior. Sustainability reporting in financial sector investments can spur trust, transparency and democratic control. Investments in capacity building can accelerate the transition through workforce training as well as organisational and governmental capacity development. Furthermore, governments will have to incorporate environmental values into their own decision-making, expenditure planning and accounting in a way that does not deplete environmental assets (Barbier, 2011; Ten Brink et al., 2012) and triggers further private investment (UNEP, 2011).

The progress of a green economy transition can be measured and supported with a range of indicators. The OECD designed the Green Growth Indicators to help countries assess and compare their progress (www.oecd.org/greengrowth/greengrowthindicators.htm). The EU-funded Netgreen project has overviewed the existing efforts to measure sustainable development and the transformation to a green economy, created a databank of indicators and also made them accessible via an interactive online tool (http://measuring-progress.eu/). In many countries, such as Finland and the Netherlands, nationally adapted indicators to monitor and follow green economy transition are being developed. In Denmark, green production statistics have been developed to monitor the future development of green business and its significance for the Danish economy.

GREEN ECONOMY TRANSITION AND SUSTAINABILITY

The integrated framework of a green economy shows that different concepts and approaches can be used to achieve environmental, economic and social benefits. However, reservations have been expressed about the ability of the green economy to support the transition towards sustainability (Bina and La Camera, 2011; Lorek and Spangenberg, 2014). This can be partly explained by the two different visions of sustainability that can be found in the two economics subfields related to the green economy (Dietz and Neumayer, 2007; Pearce and Atkinson, 1993). On the one hand, **weak sustainability** in environmental economics states that 'human capital' and 'natural capital' are substitutable. Therefore, concepts and approaches related to environmental economics, i.e. cleaner production, bioeconomy or some elements of waste hierarchy, rely on the hypothesis that new technologies will always

be developed to meet increasing human needs in a world where natural resources are limited. On the other hand, **strong sustainability** in ecological economics assumes that human-made capital and natural capital are complementary but not interchangeable (Solow 1993; Hartwick 1978). According to this view, concepts and approaches such as industrial ecology, nature-based solutions or servicising attempt to find solutions to maintain humanity within a safe operating space in which natural capital is conserved.

"Transforming the economy requires innovation in terms of available technology, organisational support, market and broader societal conditions, and an overarching governance framework *(Barbier, 2011; Hoogma et al., 2002; UNEP, 2011)****, but most of all, political will*** *(Fay, 2015)****."***
(Droste et al., 2015)

Recent works have tried to determine these biophysical limits or planetary boundaries which define the boundaries within which humanity is expected to operate safely (Rockström et al., 2009; Steffen et al., 2015). Crossing certain biophysical thresholds could have disastrous and irreversible consequences for humanity. No trade-offs between environmental dimensions are allowed as risks cannot be overcome by substituting deterioration in one biophysical boundary with improvements in others. Tools, such as system-level based LCA, help in identifying the key factors of transition.

The issue of substitutability is downplayed by the UNEP Green Economy synthesis for policy makers as it claims that "the so-called 'trade-off' between economic progress and environmental sustainability is a myth" (UNEP, 2011). This point deserves special attention since it assumes that there can be win-win solutions for both the economy and the environment (Porter and Van der Linde, 1995). An increase in environmental and/or economic dimensions is only possible with changes in available technology, management practices and availability of factors of production. Yet, it remains an empirical question as to what extent economic activity can be decoupled from the consumption and depletion of natural resources (Wernick et al., 1996). Most of the green economy debate is about the extent of changes and how to achieve these modifications (Pearce, 1992).

LEARNINGS FROM THE CASE STUDIES

The practical implementation of the green economy is related to a multiplicity of factors and causalities depending on the context. Depending on the solution chosen, the required measures to implement green economy strategies can be more or less incremental or radical / system-oriented. Some solutions are more compliant with the mainstream economy and require few changes (e.g. cleaner

production), whereas other solutions are based on profound transformations in the patterns of production and consumption (e.g. industrial ecology).

Our study is based on a case-study approach, thus it does not provide generalisations but rather recommendations that may be helpful in interpreting and designing future green economy cases. Our results emphasise the need for careful scrutiny of not only case-level benefits and trade-offs, but also the range of stakeholder interests and priorities. Transitioning to green economies is never purely based on win-win solutions, but requires **taking into account potential trade-offs** among multiple goals, across sectors and international leakage (e.g. Lee et al., 2014). Although public funding and investments are critical, they do not guarantee the successfulness of the case. Rather, what our case studies indicate is the need for **far-sighted and multiple-source planning of funding** of green economy initiatives. And finally, market-based economic viability is crucial for success. Simultaneously, impact assessments and R&D are needed for the stakeholders to estimate their benefits. The results emphasise a better and more holistic **integration of research in green economy initiatives** and projects from the beginning.

As illustrated by our study, the complexity and multi-sectoral nature of the green economy calls for a **multi-level and multi-governance approach** and a rethinking of traditional economic development policies. In particular, a broad co-integration of policies bridging the environment, innovation, transport, housing, energy, agriculture and spatial planning is needed in order to support environmental innovations (e.g. Gibbs & O'Neill, 2014). Besides support policies, our case studies illustrate the need for multi-sectoral and multi-level scrutiny of the effects of regulation and legislation.

Many of our cases also illustrate the importance of **good leadership and coordination**, also after the pilot phase. In some of our cases the continuity of the case after the end of the pilot project has not been self-evident. Functioning networks, commitments and shared understandings were emphasised especially in the local and regional level cases, whereas in the national level transitions the leadership and examples of public bodies and authorities came up more often.

Previous and ongoing practical cases provide valuable lessons on the successful implementation of the green economy. In many cases, the results and experiences are communicated only to a limited degree or only in the national language. More systematic international comparisons across contexts and more in-depth case studies are needed to study the complex causalities, relations and hierarchies of critical factors contributing to the success of the green economy practices. Real win-win solutions that are applicable and reproducible in other conditions have to be communicated and advertised across Europe and globally. Whether institutional conditions in other regions or countries are similar enough to reproduce the win-win cases is a question for further research.

CONCLUDING REMARKS

A number of international, national and regional initiatives and practical cases have been launched to promote the green economy transition. Hopes have been set for the concept to show the way to a more inclusive economy that bridges economic growth, poverty alleviation and ecological sustainability. The goal of simultaneous environmental, social and ecological improvement can thus be addressed through a multiplicity of approaches and concepts.

Based on the cases, a few recommendations to achieve a green economy can be given:

- Cases should aim for win-win solutions between environmental and economic goals
- Diversity of approaches to a green economy require co-integration of policies
- The continuity of funding and eventually economic feasibility is crucial even in successful experiments
- Integration of R&D into the practical implementation has many positive effects
- Social capital among stakeholders is a prerequisite for practical implementation

The case studies underlined the decisive role of governance factors that directly or indirectly impact the other dimension of the system innovation model. These include (i) regulation, (ii) public procurement and investment, (iii) setting incentives and raising revenues, (iv) capacity building and (v) monitoring processes.

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Anaerobic digestion process at lab scale for the project Biodecol. © Irstea Rennes.

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Healthy Sand case study: farmers from a Dairy Farming community in Eibergen (the Netherlands). Photo Simone Verzandvoort (Alterra).

MAB3 case study: Harvest, Limfjorden 2014. Photo Mette Nielsen.

Healthy Sand case study. Photo Simone Verzandvoort (Alterra).

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Left: MAB3 case study: Harvest, Limfjorden 2014. Photo Mette Nielsen.

Right: Healthy Sand case study: farmers from a Dairy Farming community in Eibergen (the Netherlands). Photo Simone Verzandvoort (Alterra).

Greening the economy has lately been promoted as a new strategy for enhancing human well-being and reducing environmental risks. A number of initiatives and practical cases have been launched to promote the green economy transition. This report summarises the key results of a PEER project analysing the green economy. The project explored green economy concepts and ten practical cases from Finland, France, Germany, the Netherlands and Denmark. The work synthesises key findings and “lessons learned” across several different fields of green economy transitions, instead of a single approach, sector or nation. A framework identifying the characteristics of a green economy is developed.

The results of the project showed that the goal of simultaneous environmental, social and ecological improvement can be addressed through a multiplicity of approaches and concepts. To promote transition to green economy, cases should aim for win-win solutions between environmental and economic goals. The continuity of funding and eventually economic feasibility is crucial even in successful experiments. Moreover, social capital among stakeholders and integration of R&D into the practical implementation are crucial. The studied cases also underlined the decisive role of governance factors including regulation, public procurement and investment, setting incentives and raising revenues, capacity building and monitoring processes.

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