White Paper

Fulfilling the Natural Step Conditions via Environmental Fiscal Reform: an FSSD analysis

Incentivizing the transition to sustainability

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Executive overview

The Natural Step offers a five-level framework for planning complex systems. The framework is accompanied by a set of system conditions for global socio-ecological sustainability.

This paper takes as its starting point the economic system, and using the framework explores how the economic system – with price signals as powerful motivators- can be designed to meet citizens' needs whilst ensuring natural resources and eco-systems are available for future generations.

The framework methodology requires that the system itself is described thoroughly. This analysis offers a model of the monetary system as a flow of money from citizens to enterprises and government and back again. The analysis is taken one step further identifying the main areas where the monetary system and the socio-ecological system interface: production, extraction and property ownership.

Models of the circular economy - where substances are reused rather than being emitted as pollutants or made unrecoverable – include the concept of system nutrients. These nutrients flow between the various spheres of the natural and social system. Here the concepts of product, service, property ownership and legal transactions are investigated to identify where the economic system can provide incentive barriers or stimulus for individuals and companies to change their behavior towards sustainability.

The economic system cannot be accurately described solely in terms of money flow. We identify four types of capital along with the role of the monetary system in building up capital that supports the sustainable society.

Starting from the generally accepted idea that money – within limits – can act as an incentive for good, opportunities within the modern digitalized economy are identified where fees and surcharges can be applied to points in the system in ways that incentivize desired behaviours and influence the functioning of the system as a whole. Applying a system control approach to the economy, such economic mechanisms would be designated as 'actuators'. 'Sensors' measure system performance and data from sensors is fed back to inform decisions on surcharges.

Rather than creating new taxes and fees, more efficient stabilization of the economy can be achieved by applying surcharges and dividends within already existing fee and tax mechanisms. Five types of fiscal mechanisms: import fees, property fees, interest rates, extraction fees and sales taxes can be surcharged in a way that provides stabilizing feedback to ensure the economic system performs to requirements. A citizens' tax account provides the other potential financial stimulus point. Sensors include economic performance measurements that most nations have in place already including emission figures, import figures, the status of various ecosystems and figures on mineral reserves and extraction rates. Recycling performance statistics are also important "sensor" measurements.

The methodology for analyzing the often complex eco-system of economic incentives implicated in pollution and resource depletion is a step methodology called back-stepping. It involves identifying the key substances at molecular level and mapping out their route

through the supply chain. The elements to prioritize – carbon from fossil sources phosphorus and nitrogen - are identified in the work on planetary boundaries by the Stockholm Environmental Institute.

Fiscal mechanisms need to be flexible so the levy can be raised at regular intervals until the market responds. They need to be redistributive in ensuring that goods and services are affordable even to the poorest, and they need to be self – financing rather than putting an overall drain on the economy.

Six fiscal mechanisms, applied together, can create an economic system that incentivizes the socio-ecological system to perform within system conditions. These mechanisms are described for each system condition in terms of strategic guidelines for their implementation, specific actions required and the tools that will aid their introduction. The description includes the sensor measurements that provide the feedback to decision-makers.

This report also offers a way of categorizing investments in the firm as circular or linear, and of analyzing to what extent a product is linear (uses non-recycled material) or circular (uses recycled or natural material). From this it is possible to create the circular company financial statements and report.

Several reports and analyses have been produced on the economic stabilizing mechanisms. Based on the findings in these reports next steps could include small scale trials and simulations.

INTRODUCTION

The purpose and structure of this paper

This white paper offers a route to transforming the present economy to one that performs to the socio-ecological requirements as defined by the Natural Step's four conditions, or principles[1].

The proposed route is to introduce the feedback mechanisms for stabilizing the economy developed by Anders Höglund[2] and the Swedish Sustainable Economy Foundation. The strategy – applying control mechanisms to the economy – is described within the Framework for Strategic Sustainable Development, (FSSD) and the Five Level Framework (5LF) planning approach developed by The Natural Step (Waldron, D. et al 2008). When the 5LF is applied to the socio-ecological system (or society within the biosphere) it is called the Framework for Strategic Sustainable Development (FSSD) and is also known as The Natural Step Framework.

The System Conditions & The Sustainability Principles are based on and emanate from; the basic principle of recirculation of limited resources, thermodynamic laws, principles for energy use, ecological sustainability, system optimization and principles for long term sustainable development.

Much work has been done on the interfacing of the FSSD with other known tools and concepts within the sustainable development arena.

For example:

· Factor X; Factor 4; Factor 10; biological footprinting; IS0 14001; EMAS; EMS

· Global Reporting Initiative

What we have not yet encountered is a description of how economic factors, such as market based instruments, use economic incentives to stimulate societies to adopt sustainable practices that result in society performing in accordance with the Natural Step's four conditions.

The Swedish Sustainable Economy Foundation (TSSEF) proposes an Environmental Fiscal Reform. Reform should harness the potential in the financial (digital) economy and an awareness of the importance of a fair distribution of resources underpinning prosperity to create an economy (financial and real) where the market operates within the boundaries of natural resource handling whilst fulfilling the citizens' needs for basic levels of service.

This widens the scope of the application of FSSED from purely socio-ecological to socio-ecological in the context of the monetary economy.

This paper bases its working methodology on the description of the FFSD in the paper written for the Strategic Leadership towards Sustainability program at Blekinge Institute as an aid for students within that program in their course and thesis work.

In this paper we refer to TSSEF mechanisms as the collective term for instruments of stabilizing feedback control.

What this paper does

Presenting TSSEF mechanisms that exert stabilizing feedback control of the economy

This paper describes, using the FSSD approach, how stabilizing feedback control mechanisms can create a sustainable economy that performs to requirements given

[1] See the http://www.thenaturalstep.org/our-approach/ for a deeper description of the four conditions.

[2] See TSSEF's website for descriptions of the instruments http://tssef.se

by the Natural Step's system conditions. The paper describes each of the TSSEF instruments and their application.

With this approach, TSSEF is not proposing to plan the economy. Rather, the proposal is to introduce mechanisms that ensure the economy performs to requirements. The approach uses the power of market forces and at the same time contains them to work for the common good.

Presenting TSSEF instruments applied to market economies

TSSEF has developed six instruments of economic stabilizing control that together form a stabilized economic system:

- Dividend-bearing pollutant surcharges (System Condition one)
- Dividend-bearing essential substance extraction surcharges (System Condition one)
- Dividend – bearing toxin and man-made substances surcharges (System Condition two)
- Dividend-bearing land immaturity surcharge (System Condition three)
- Dividend-bearing property surcharges (System Condition three)
- Employment stabilization surcharges/discounts (System Condition four)
- Mortgage interest rate surcharge for house price stabilization (System Condition four)

To understand the application of the TSSEF instruments at nation state level, it is also necessary to include an analysis of the fundamental building blocks of a market economy; the four fundamental forms of capital, the concept of property as an economic entity, the legal organization, the nature of transactions and the fiscal framework of taxes and fees surrounding transactions.

How this paper is organized

Section one provides the background to the paper including a description from The Natural Step and academic literature of the 5LF and FSSED and how the authors of that paper intend it to be applied.

Section two follows the 5LF methodology with the economic system at national level under scrutiny. This section gives a basic explanation of how the economy works, giving special emphasis to those factors relevant to the application of TSSEF's mechanisms. This section examines the relationship between key economic and sustainability concepts including capital, property, transactions, work and ownership.

Section three examines the definition of success criteria for the societal system in the context of the money-based economy. These conditions are quantified and qualified in terms of emission boundaries, key substances and measurements of human standards. The concept of the safe house for humanity is developed, where the ceiling represents limits to emissions and the floor represents the fulfillment of basic needs.

Section four implements the 5LF approach in planning for an economy that performs according to the Natural Step's framework, taking each System Condition in order. The TSSEF approach, of applying stabilizing feedback control to the economy, is added in this system context. That is to say; how to apply fiscal instruments to ensure that the economy performs to success requirements identified in section three.

Section five presents experience so far with the instruments and offers proposals for further research.

FSSD Levels	*FSSD Applied to the economy*	*Report Sections*	*TSSEF instruments and Concepts*	*Key Concepts*
	General description of the FSSD approach	1		
1 System description	The economy is identified as the system	2	The bath tub model of the economy.	capital, property, transactions, work, ownership The Geo, Bio and Techno-spheres Characteristics of the circular economy
2 Success principles or conditions with management tools	Success for the economy is defined according to the Natural Step principles	3		Planetary boundaries, key substances and measurements of human standards Substances to prioritize Biosphere and geosphere integrity Ecological maturity
3 strategic guidelines that will help choose actions that will lead to success	The potential of the digital economy to apply stabilizing mechanisms	4	Economic System stabilizing Mechanisms Back-stepping. Analyzing the fiscal framework that surrounds the societal use of the potential pollutant to identify successful handling of the substance in socio-ecological, successful way.	The concept of the econosphere. The potential of the digital economy • Essential characteristics of stabilizing mechanisms Internalization of externalities • Fair distribution of externality costs • Democratic acceptance of changes to economic system
4 What **actions** will follow overall strategic guidelines (level 3) to help move the system towards success (level 2)?	Applying stabilizing feedback mechanisms at suitable points in the economy	4	Matching the mechanisms to the system conditions	THE SIX MECHANISMS • Dividend-bearing pollutant surcharges • Dividend-bearing essential substance extraction surcharges • Dividend – bearing toxin surcharges • Dividend-bearing property surcharges

FSSD Levels	*FSSD Applied to the economy*	*Report Sections*	*TSSEF instruments and Concepts*	*Key Concepts*
				• Employment stabilization surcharges/discounts • Mortgage interest rate surcharge for house price stabilization
5 Tools may also be used to assess the system itself (e.g. the overall result) from following the plan or to assess capacity building efforts of the planning team (e.g. building team competency).	Measurement tools to track the performance of the economy: its effect on the biosphere, essential mineral availability, and meeting human needs	**4**	**The control engineering approach of creating sensors to provide fast feedback on system performance**	Flow of products through the social system monitored with Bar coding and product classification Ecological status of land related to property tax

1) SECTION ONE: Background and context

Section one summary

The Natural Step offers a five level framework for planning complex systems. Applied to socio- ecology the framework is called FSSD. Application of this framework - by answering a set of questions for each system level - increases the chances of success of the planning effort. The framework is accompanied by a set of causes of unsustainability (system conditions) for global socioecological sustainability. Planning of the transformation of the economic system should include measures and systems that ensure the sociecological system is not degraded by these factors.

The Generic Five Level Framework (5LF)

The Natural Step suggests that the generic 5LF[5] supports planning in any complex system where there is an intended success. The aim of the framework is to "bring clarity, rigor and insight to planning and decision-making".

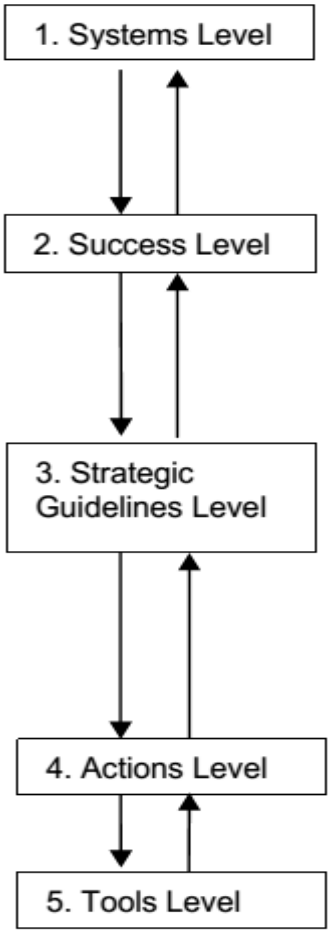
The planning regimen includes a set of basic conditions.

Basic principles ('Sustainability Principles" or "System Conditions") for global socioecological sustainability comprise the following: In a sustainable society, nature is not subject to systematically increasing (1) concentrations of substances extracted from the Earth's crust, (2) concentrations of substances produced by society, (3) degradation by physical means and, in that society, (4) people are not subject to conditions that systematically undermine their capacity to meet their needs (Holmberg and Robèrt 2000; Ny et al. 2006).

The process of planning systems and system changes requires systematically analyzing each level of system according to FSSD.

The table below presents the system levels and the set of questions to be investigated at each level.

[5] http://www.thenaturalstep.org/sustainability/5-levels/



FSSD Question
How does the system work? What are its boundaries?
Especially, what are its most basic functions, flows, laws, mechanisms, feedback loops, etc. that are needed to inform what defines success and strategy, as well as potential actions and tools (see levels below)? What constitutes success of the planning endeavor?
In particular, what are the most basic (and least changing) **success principles** or conditions that define a successful outcome of the planning? What additional techniques, instruments, measurements, management tools, etc. can be used to assess actions to see whether they are, in fact, strategic (level 3) to arrive at success (level 2) in the system (level 1)?
What are the overall **strategic guidelines** that will help choose actions that will lead to success (level 2) in the system (level 1)? Here, the powerful concept of "backcasting from success principles" plays a prominent, guiding role. This guides a systematic step-by-step approach towards the defined goal, while ensuring that resources continue to feed the process towards success
What **actions** will follow overall strategic guidelines (level 3) to help move the system towards success (level 2)?
Tools may also be used to assess the system itself (e.g. the overall result) from following the plan or to assess capacity building efforts of the planning team (e.g. building team competency).

Above: The five layer framework and the Framework Questions for socio-ecological application

It is this above analysis we will apply to the economy and how the conditions for sustainability can be met.

2) SECTION TWO: The economy as the system under scrutiny

Section Two Summary

The money-based economic system and its effect on the social-ecological system is described in terms of the FSSED levels. The analysis is taken one step further using a system description of how the monetary system works, specifically identifying the main areas where the monetary system and the socio-ecological system interface: production, extraction and property ownership.

Models of the circular economy - where substances are reused rather than being emitted as pollutants or made unrecoverable – include the concept of system nutrients. These nutrients flow between the various spheres of the natural and social system. Here the concepts of product, service, property ownership and legal transactions are investigated to understand where the economic system can provide incentive barriers or stimulus for individuals and companies to change their behavior.

No analysis of the economic system would be complete without a discussion of the notion of capital and investment. Four types of capital are identified along with the role of the monetary system in building up capital that supports the sustainable society.

Applying FSSD to the Economy

To apply FSSD stringently requires that each level be described thoroughly by answering a set of system level questions. The table below illustrates the main planning approach for each level: generically, then for global society. The third column summarizes TSSEF's description of the national economy and its economic and socio-environmental performance.

PLANNING IN COMPLEX SYSTEMS			
	NATURAL STEP Generic Planning	NATURAL STEP Planning for Sustainability – Global Society in the Biosphere	TSSEF Economic planning - A nation in environmental and economic balance
1.System	Any 'system' or set of variables that are relevant to the goal you want to achieve	Society within the biosphere, including the social and ecological laws/rules/norms which govern this system.	The Nation-State, national currency, national economy.
2. Success	Any goal you want to achieve	Society within the Biosphere compliant with the conditions for socio-ecological sustainability (i.e. the Four System Conditions)	The four system conditions applied to the specific social and geographic conditions of that nation. Elimination of contributions to violating Sustainability principles (SPs).
3. System guidelines	The strategic principles for selecting actions you use to achieve your goal. - Backcasting from success - Step-by-step while ensuring influx of resources	Backcasting from success for socio-ecological sustainability and the associated 3 prioritization questions as a minimum	Back-stepping. Analyzing the fiscal framework that surrounds the societal use of the potential pollutant to identify successful handling of the substance in socio-ecological, successful way.
4. Actions	The actions you need to take to achieve your goal.	The actions that help move the global socio-ecological system towards success	The implementation of economic mechanisms that help move the nation towards compliance with success standards.
5. Tools	The tools that support you in achieving your goal	The tools that support efforts to achieve global sustainability.	The tools that help move the nation and its economy to sustainability

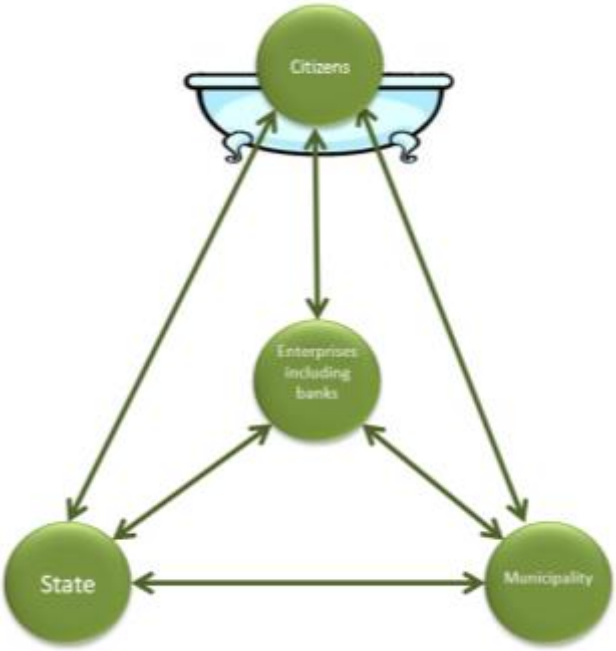


Figure 1: the bath-tub model of monetary flows in the economy

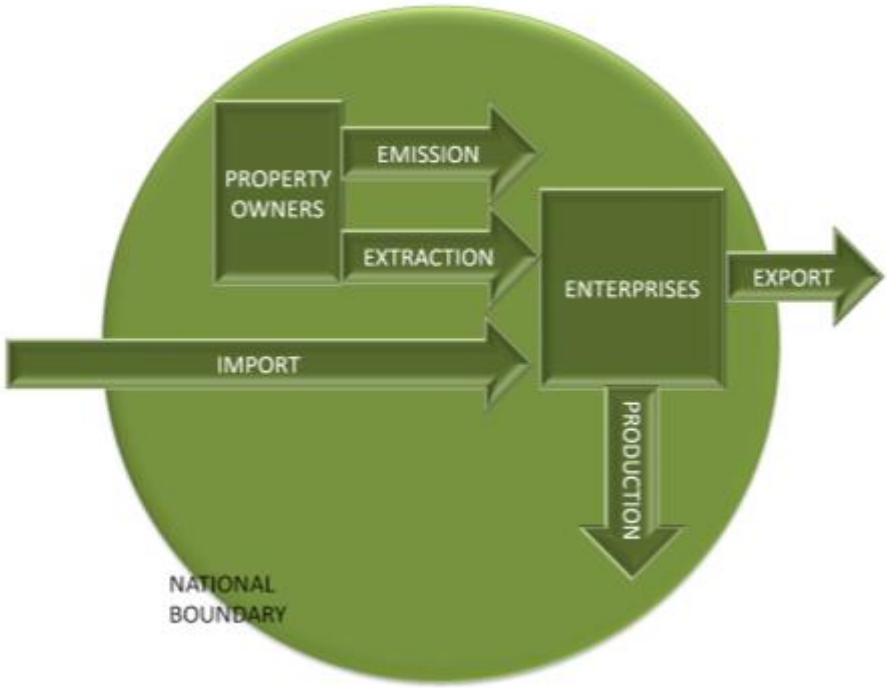
The bath-tub model

- *FSSD: How does the system (any system under study within which the planning is to occur) work? What are its boundaries?*

The system under study focuses on a set of money-based transactions – including their consequences for the biosphere and society - that occur between four basic types of entities; citizens, enterprises, municipalities (local authorities) and State (including Government agencies). The study includes the regulatory and incentive factors surrounding these transactions.

The diagram above shows a simple way to see money flow in the real economy. If we represent citizens at the top, with their money to spend as a stock in a bath-tub, money flows (following the water analogy) to the other three classes of actors in the economy: enterprises including banks, the state and the municipality. Every month, the stock of money is replenished by transfer of money between the actors, and up to the citizens. Much of what goes back to citizens is then redistributed back to the other three classes and so the cycle begins again.

Boundaries of Property and Legal Entity



The diagram above illustrates the three key boundaries operating in the system:

- National boundaries represent the legal, monetary and physical limits that define a nation.
- Property boundaries represent the concept of ownership of property by individuals either directly or through their ownership of legal entities.
- Legal entities as legal, rather than physical, bodies, in turn owned by citizens.

Basic components of the system under study

The system comprises four basic kinds of components which flow between legal entities:

Biological Nutrients

These include those elements essential for life, which circulate freely in nature. Nutrients critical to supporting human life in the current system and of special focus are phosphorus and nitrogen, which have been implicated in the second most serious breach of planetary boundaries (Rockström et al).

Nutrients are contained in biomass which also contains energy captured from sunlight.

Mined Minerals

This class comprises minerals extracted from the geosphere and includes, for example, iron ore mined to extract iron.

Products

Products are combinations of nutrients and mined minerals, defined in transactions and changing hands between legal entities or citizens and legal entities. There are two main types of products; consumables and capital products.

In defining the circular economy, the term technical nutrient is also used. A technical nutrient can be spare parts, components, manufactured materials, even used products for repair or refurbishment. A product, then, is made up of technical nutrients.

Fossil carbon energy sources

We identify energy sources with fossil carbon as a specific category of components of the system. This is due to the pressing issues around CO2 from fossil sources accumulating in the atmosphere.

Flows

Nutrients and minerals can flow between legal (and physical) entities associated with money transactions.

From each property there is an extraction of nutrients (for example mining of phosphate-rich rock) or a transfer of nutrients (for example when a house-owner discharges nutrient-containing waste-water into the waste water system).

Socio-economic-ecological- spheres

The boundaries in the system can be better understood by referring to the various key spheres of the earth system.

- BIOSPHERE (and Stratosphere)
- GEOSPHERE
- TECHNOSPHERE

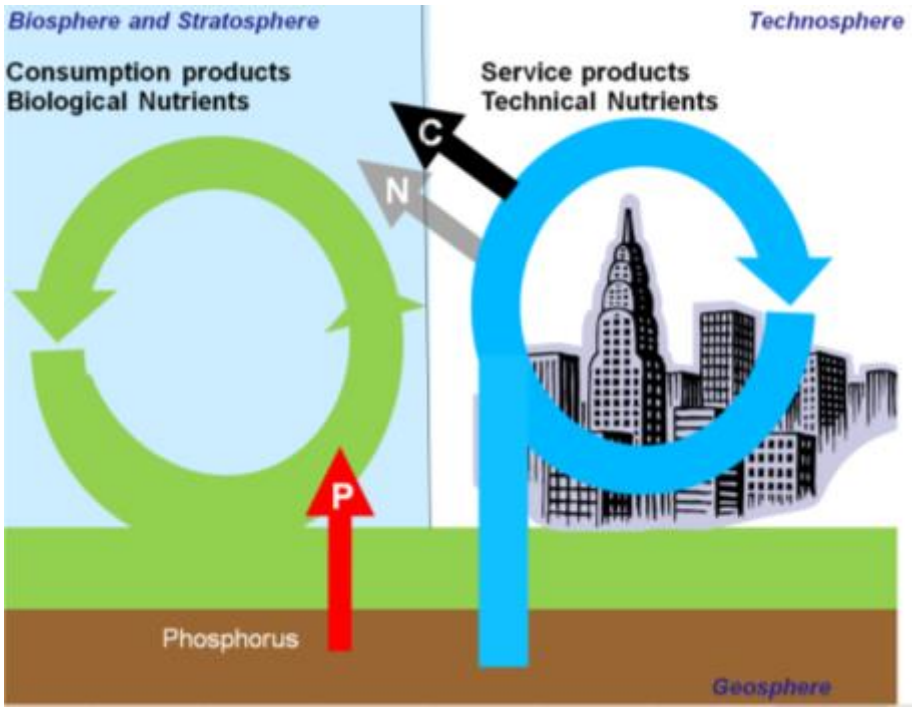
Main boundary passages between the spheres

GEOSPHERE TO BIOSPHERE

TECHNOSPHERE TO BIOSPHERE

GEOSPHERE TO TECHNOSPHERE

The spheres and the circular economy



The diagram above illustrates the essentials of the circular economy and where the current economy is not performing in circular fashion.

Biological material flows from the biosphere into the stratosphere and back again. These flows include the harvesting of food, fuel and fiber.

In the non-circular economy, large amounts of phosphorus are mined and circulated in the biosphere.

Minerals and manufactured substances circulate in the technosphere after extraction from the geosphere. Extracted minerals include fossil fuel. In the circular economy no extracted minerals or elements of fossil origin enter the biosphere.

In the non-circular economy, mined minerals enter the biosphere; manufactured substances (toxic and non-toxic) and carbon of fossil origin enter the biosphere and stratosphere.

Classes of nutrient

A nutrient is something that passes hands as a result of a financial transaction within terms of contract. There are three types of nutrients in the system: one is biological (which include nutrients and bio energy, another is technical. Technical nutrients can be broken down to various degrees into and include broken products that can be mended, repurposed or upgraded, and all kinds of components that can be recombined in new products or indeed raw technical materials that can be remade into components.

The third class is carbon-containing nutrients of fossil origin that can provide energy.

Property

For completeness, we also include property as an entity in itself (i.e. associated with a land title) and of a manufactured or built object (for example a house or factory).

Understanding Capital

Various uses of the term "capital" exist. As the notion of capital is pivotal to a systemic view of the economy this section proposes applications of the term based on generally accepted views.

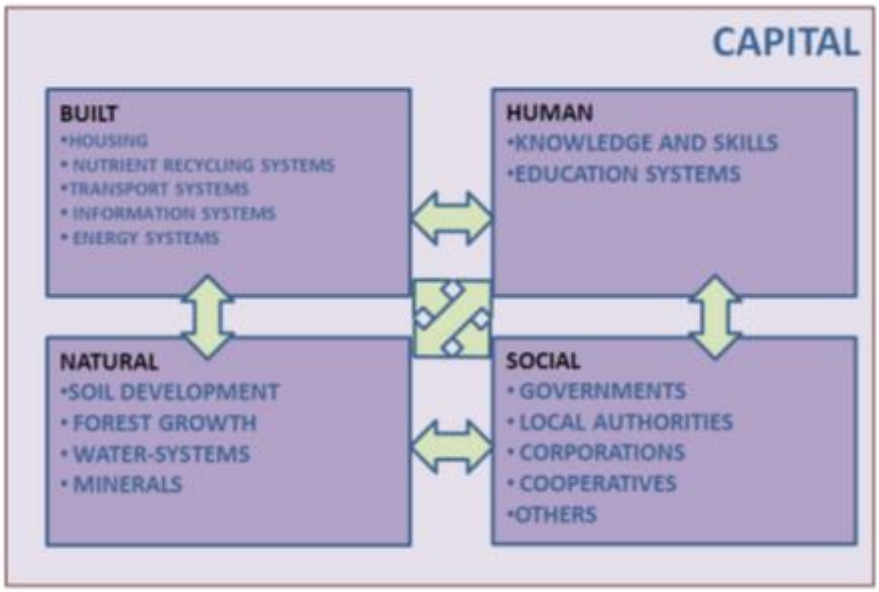
In classical economics, Adam Smith (*Wealth of Nations*, Book II, Chapter 1) distinguished fixed capital from circulating capital. Fixed capital comprises physical assets not consumed in the production of a product (e.g. machines and storage facilities). Circulating capital refers to physical assets consumed in the process of production (e.g. raw materials and intermediate products).

The concept of capital (as in Adam Smiths' Fixed Capital) as being something that is not consumed, rather something that is used in production of a good provides a relatively clear basis to build a systemic approach.

Instead of circulating capital we can use the circular economy terminology of technical and biological nutrients.

This paper proposes the following four categories of capital.

- BUILT (REAL) CAPITAL
- NATURAL CAPITAL
- HUMAN CAPITAL
- SOCIAL CAPITAL



In the diagram above, the arrows between the forms of capital represent the use of that form of capital to form another kind of capital.

For example, natural capital in the form of forest can be used together with human capital (knowledge of construction techniques) with the social capital of a building firm to produce a house (built capital).

Identifying the role of the monetary system

One of the uses of money is to provide a formalized means of exchange to replace barter. The diagram below depicts how the monetary system can be employed to formalize the application of labor and resources to employ capital to produce goods and fulfill human needs.

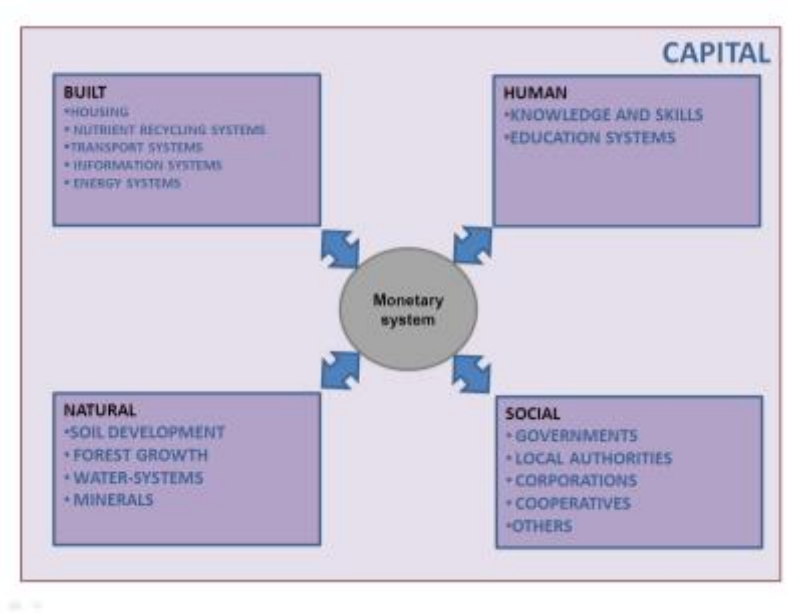


Figure 2 Economic transactions (blue arrows) where one form of capital is transformed to another

The role of financial capital

Economist Henry George (2006) argued that money, as well as financial instruments like stocks, bonds, mortgages or other certificates for transferring wealth is not really capital. Because "Their economic value merely represents the power of one class to appropriate the earnings of another." and "their increase or decrease does not affect the sum of wealth in the community".

For the purpose of simplification in this report, we will restrict the use the term capital to the four main categories above, excluding financial capital.

The connection between the forms of capital and sustainability

As earlier described, capital is something that is used in providing services, but is not consumed in the process.

Each class of capital can be said to have intrinsic properties that make it more or less useful to utilize in providing these services sustainably.

- For built capital, infrastructure that requires fossil-fuel for heating, with a heating system that is not easily adapted to other heating sources, is less sustainable that one which uses renewable.
- For Human capital, knowledge and skills in using renewable energy and preserving nitrogen and phosphorus cycles is more sustainable than knowledge that is based on linear flows and emissions. This is highlighted in the difference between organic and conventional agriculture.
- For social capital, the existence of organizations that provide services in a circular way is far more sustainable that extractive, linear organizations.
- Natural capital is more sustainable the further towards ecological maturity it has developed (Christensen 1995), (Odum, 1969).

The diagram below summarizes the sustainable and resilience aspects of the types of capital.

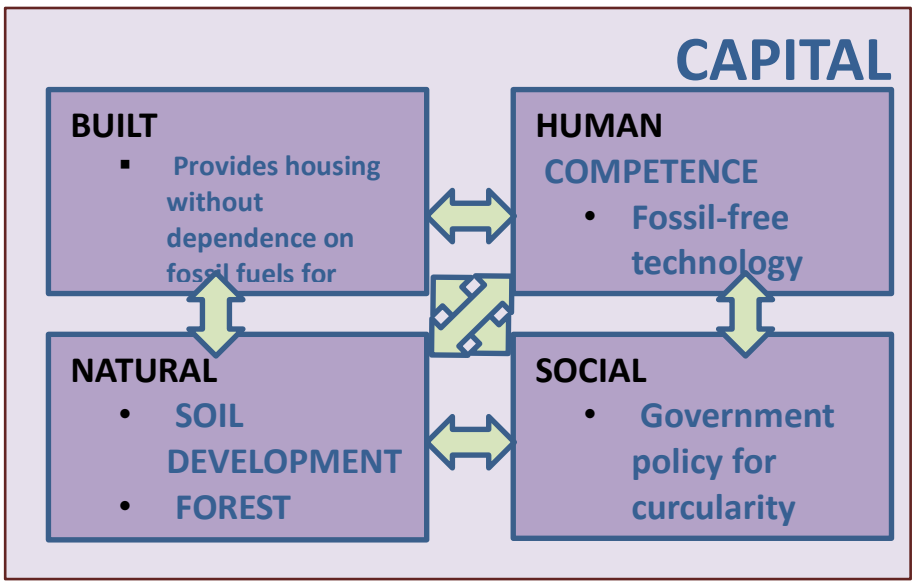


Figure 3: The four types of capital and their transformation to other types

The role of work

For completeness, an explanation of how the notion of work relates to the description of the system under scrutiny is required.

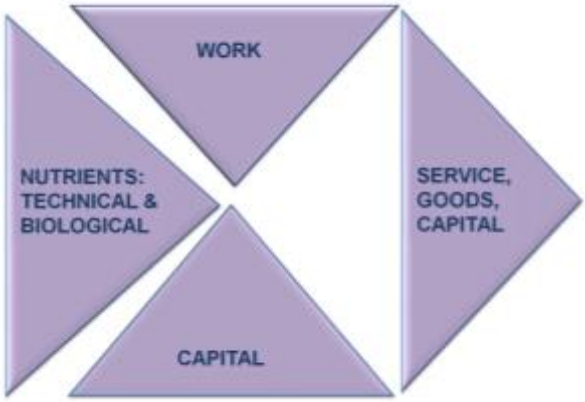


Figure 4: Work, together with nutrients, aided by capital produces services and goods

The diagram above shows how nutrients are input as part of an activity. Work combines with capital to produce the services that fulfil a human need or produce inputs or capital for the next step of the process.

Work then, is the effort that is applied to bring about a change of state of an object or a situation.

The view of the firm

A generalized view of the firm is where: materials come in (including energy). Using infrastructure (capital) and labor, a product and or service is produced that is sold, the money from the sale covering the purchase of labor and materials as well as capital infrastructure.

A certain amount of waste is generated that goes to waste handling services.

A simplified Equation using Cobb-Douglas

Output= Labour · Capital

$Y=L \cdot K$

Adding the elements above:

Output = Labour · Capital · Energy · Materials

Defossilisation as investment in infrastructure

For the firm to defossilise the energy sources need to be switched to renewable, and the capital infrastructure needs to be adapted to use renewable energy and materials too.

$$\text{Output} = \text{Labour} \cdot \text{Capital}(C_{Renewable} + C_{Linear}) \cdot \text{Energy}\ (E_{Renewable} + E_{Fossil}) \cdot \text{Materials}(M_{extracted} + M_{recycled})$$

Linear production consists of:

$$\text{Linear Production} = \text{Labour} \cdot \text{Capital}(C_{Linear}) \cdot \text{Energy}\ (E_{Fossil}) \cdot \text{Materials}(M_{extracted})$$

Circular production can be represented as :

$$\text{Circular Production} = \text{Labour} \cdot \text{Capital}(C_{Renewable}) \cdot \text{Energy}\ (E_{Renewable}) \cdot \text{Materials}(M_{recycled})$$

A measure of circularity can be created from

$$\text{Circularity} = \text{Labour} \cdot \frac{\text{Capital}(C_{Renewable})}{\text{Capital}(C_{Renewable} + C_{Linear})} \cdot \frac{\text{Energy}\ (E_{Renewable})}{\text{Energy}\ (E_{Renewable} + E_{Fossil})} \cdot \frac{\text{Materials}(M_{recycled})}{\text{Materials}(M_{extracted} + M_{recycled})}$$

$$\text{Percentage circularity} = f(C_{Renewable}\% \cdot E_{Renewable}\% \cdot M_{recycled}\%)$$

The circular balance sheet.

From the above we can envisage a balance sheet from which it is possible to glean the current state of the firm's investment in circularity. A worked example is given below.

THE TRANSITIONAL COMPANY
PERIOD ENDED 31/12/2016

CURRENT ASSETS		CURRENT LIABILTIES	
Cash	200 000 €	Accounts payable	0 €
Accounts recieveable	0 €	Accrued Expenses	0 €
Inventory	0 €	Taxes owed	0 €
TOTAL CURRENT ASSETS	200 000 €	Long term debt	0 €
		TOTAL CURRENT ASSETS	0 €
PROPERTY AND EQUIPMENT			
*Circular Infrastructure	100 000 €	LONG TERM DEBT	
*Non-circular Infrastucture	50 000 €	*Loans for Circular investment	100 000 €
		*Loans for other infrastructure	
Less depreciation	-4 000 €	investment	30 000 €
NET FIXED ASSETS	146 000 €	Other loans	
		TOTAL LIABILITES	130 000 €
OTHER ASSETS		STOCKHOLDERS EQUITY	
Licence	0 €	Paid in Capital	0 €
Goodwill	0 €	Retained Earnings	0 €
TOTAL OTHER ASSETS	0 €	TOTAL NET WORTH	0 €
TOTAL ASSETS	346 000 €	TOTAL LIABILITES AND NET WORTH	
*Percentage circular infrastructure value	67%	*Percentage investment loans circular	77%

An extended profit and loss statement can also be created as shown below.

From this you can derive measures like % of sales of circular products, cost of circular technology, circular vs non-circular expenses and trends over time

INCOME STATEMENT	
PERIOD ENDED 31/12/2016	
	CURRENT
OPERATING INCOME	
*Circular product sales	50 000 €
*Non-circular sales	100 000 €
Net sales	150 000 €
*Renewable energy	2 000 €
*Non-renewable energy	2 000 €
*Non-circular materials purchase	2 500 €
*Circular materials purchase	2 500 €
Other costs of good sold	100 €
GROSS INCOME	140 900 €
OPERATING EXPENSES	
*Renewable energy	2 000 €
*Non-renewable energy	4 000 €
*Non-circular materials purchase	3 000 €
*Circular materials purchase	10 000 €
*Repairs and maintenance on linear infrastructure	20 000 €
*Repairs & maintenance on circular infrastructure	30 000 €
* Costs for waste elimination, non-recycled	2 000€
Other expenses	
TOTAL OPERATING EXPENSES	69 000 €
Other income	0 €
Other expenses	0 €
NET INCOME BEFORE TAXES	71 900 €
TAXES	25 000 €
NET INCOME	46 900 €

Circular products 50/150	33%
Renewable energy 2/6	50%
Circular materials 10/13	77%
Circularity lost to waste	14%
Circular infrastructure costs 30/50	60%

A description of the basic flows in the system

As described in the bath tub model, money flows around the system from citizen to enterprises, state and local authority and back again.

Connected to these flows, are the flows of nutrients, minerals and products. For the purposes of identifying possibilities to control the flow of nutrients in society, the role of enterprises and individuals as property and organization owners is of special interest, although other actors also extract and emit.

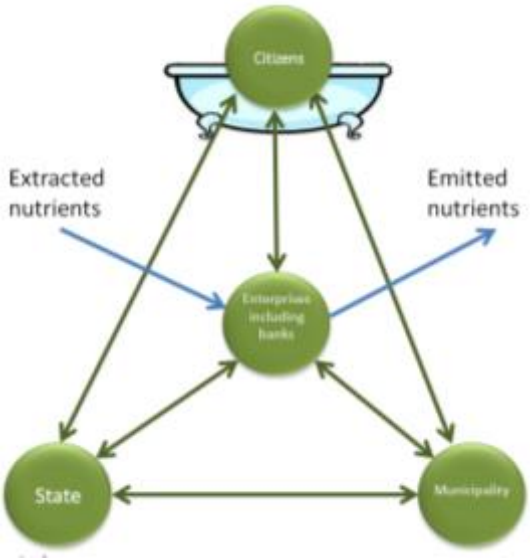


Figure 5: Whilst money flows around the four types of actors in the economic system, nutrients are largely under the control of enterprises and property owners

System opportunities to apply barriers or incentives

Form the above analysis it follows that points in the system to apply incentives or barriers are on pollutant-containing nutrients as they enter the economy through import, extraction or manufacture, and where they leave the economy by leaving the property of a property-owner to a natural recipient rather than another actor in the economic system. The next section outlines the conditions for success in a system that has zero emission.

3) SECTION THREE: THE CONDITIONS OF SUCCESS

Section three summary

Success of the economic system is defined as the system demonstrating that it provides efficacious incentives for society to fulfill the Natural Step's four system conditions. These conditions comprise meeting the needs of citizens whilst ensuring the integrity of the biosphere and geosphere so future generations can meet their needs. Another way of describing this is as creating a "safe house" for humanity, where the economic system provides a stabilizing mechanism that disincentivizes

depletion and not meeting citizen's needs.

The FSSD Question to define successful outcome

- *FSSD: In particular, what are the most basic (and least changing) success principles or conditions that define a successful outcome of the planning?*

	MAIN CHALLENGE	DETERMINED LIMITS	PRIME ELEMENTS	EMISSION BOUNDARY	SUCCESS	Source of measurement
1	Ocean acidification Climate system disruption Eutrophication	Planetary boundaries Swedish Environ-mental goals UNSDP	C (fossil) C (fossil) N P	Combustion Combustion Leakage/ emission Leakage/emission	Emissions within safe limits	Import/ extraction Import/ production Import/ extraction
2	Public health & safety	REACH	Identified toxins	Human body intake Waste stream	Humans and environment exposure within limits	Product ingredients Manufac-ture/import
3	Degradation of the ecological maturity of land	Swedish environ-mental goals	N P	Leakage from the property Waste stream	Land status above minimum	Emission from Property
4	Food insecurity Housing insecurity Job insecurity	National goals	N/A	N/A	Human Rights objectives met. Transparency of Fiscal Reform	Unemployment , CPI, House prices, opinion poll results

Table 1: quantification of the four system conditions in the economic system

Figure 6: the three areas of human needs to be met whilst managing planetary systems responsibly

The common economic system should;

Meet needs of citizens

- Meet the basic needs of citizens (As defined by the UN Declaration of Human Rights[6])
- Prevent insecurity of food, housing, employment and democratic involvement
- Ensure public health safety

Ensure biosphere and geosphere integrity

- Ensure that the biosphere and geosphere are intact so that these spheres can continue to provide the services for coming years and future generations, as developed by the Bruntland committee (Bruntland 1987).
- Maintain ecological maturity
- Ensure supply of essential mined minerals for future generations

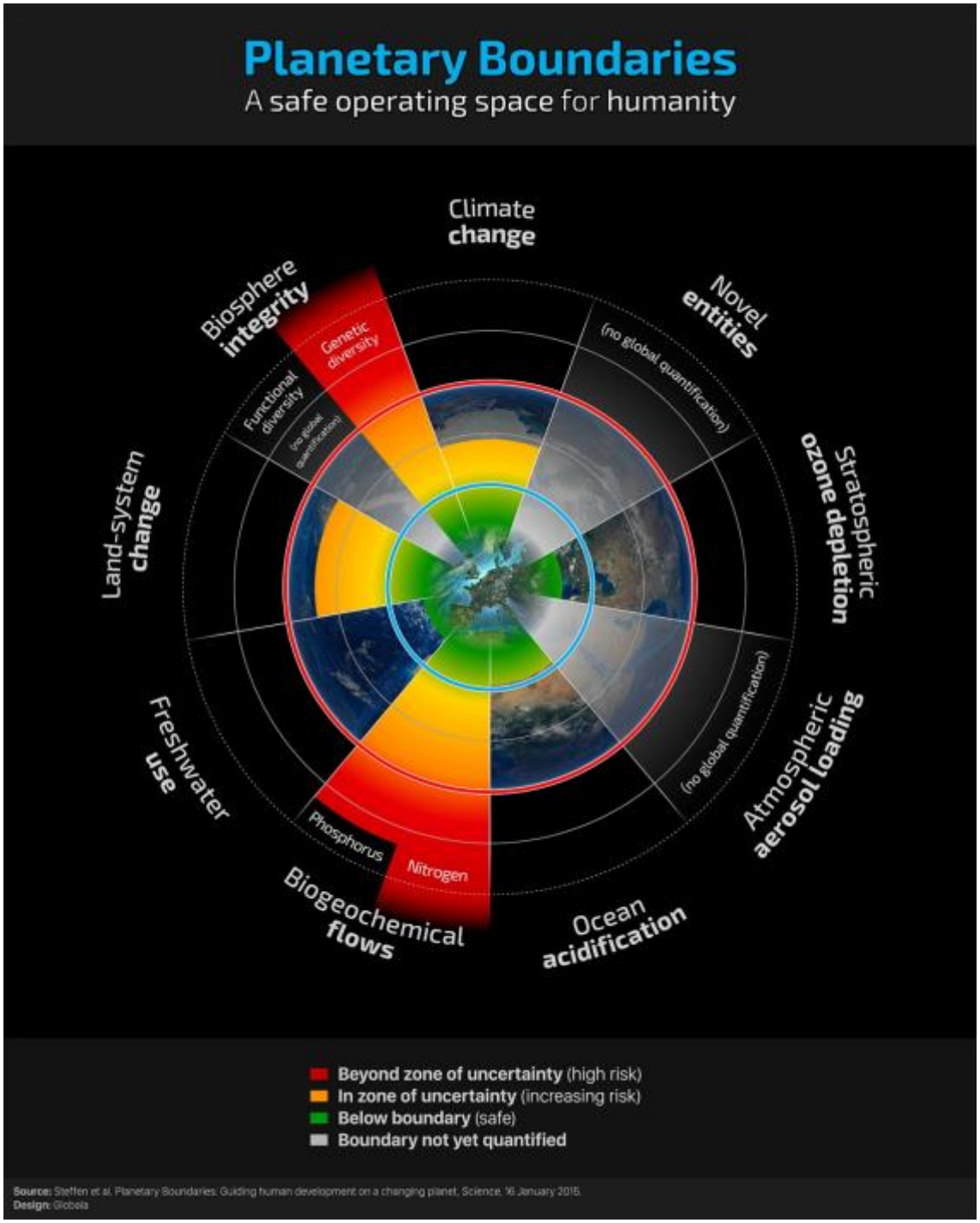
Exert fairness

Those with most money are often those who, through the supply chain their purchases require, pollute directly through e.g. air travel or indirectly through consumption. The effects of pollution are however carried by everyone. It is often the poorest who are hardest-hit by the effects of pollution. The way the economic system transfers this burden is called externalization.

A successful transformation of the economic system would ensure that externalities are removed entirely or at least that the effects are compensated fairly.

[6] http://www.un.org/en/documents/udhr/

Planetary Boundaries



According to the research on planetary boundaries, risks to humanity in order of severity are:

High risk:

- Phosphorus and nitrogen biogeochemical flow interruption
- Genetic diversity reduction

Increasing risk:

- Land system change
- Climate change: climate system destabilization

Safe:

- Ocean acidification (nearing boundary)

Not quantified:

- Novel entities

Societal challenges

- Inclusion
- Homelessness
- Food security

Applying planetary boundaries to the Sustainability Principles and legal and environmental boundaries we get the table below. The final column presents the appropriate TSSEF mechanism to apply to the challenge.

Condition	Priority Challenge	AUTHORITY	Prime elements	Entry to the economy	Exit from the economy	Measurement	Instrument Surcharge on
1	Ocean acidification Climate system disruption Eutrophication	Planetary boundaries Environmental goals UNSDP	C (fossil source) C (fossil source) N P	Fossil fuel extraction Industrial Process Mineral extraction	Combustion Combustion Leakage/emission Leakage/emission	Import/extraction Estimated emission Import/production Import/extraction Emissions	Import/ extraction *Dividend-bearing pollutant surcharges*
2	Control of dangerous substances[7]	REACH		Manufacture	Waste stream	Manufacture/ import	Sales/import *Dividend – bearing toxin surcharges*
3	Degradation of the ecological maturity of land	National environmental goals	N P	Property purchase	Leakage from the property Waste stream	Property emission	Land tax/property tax *Dividend-bearing pollutant surcharges*
4	Food insecurity Housing insecurity Job insecurity		N/A	Registered residency	N/A	Unemployment , CPI, House prices	VAT Mortgage interest VAT, Employer tax VAT Employment stabilization surcharges/discounts Mortgage interest rate surcharge for house price stabilization

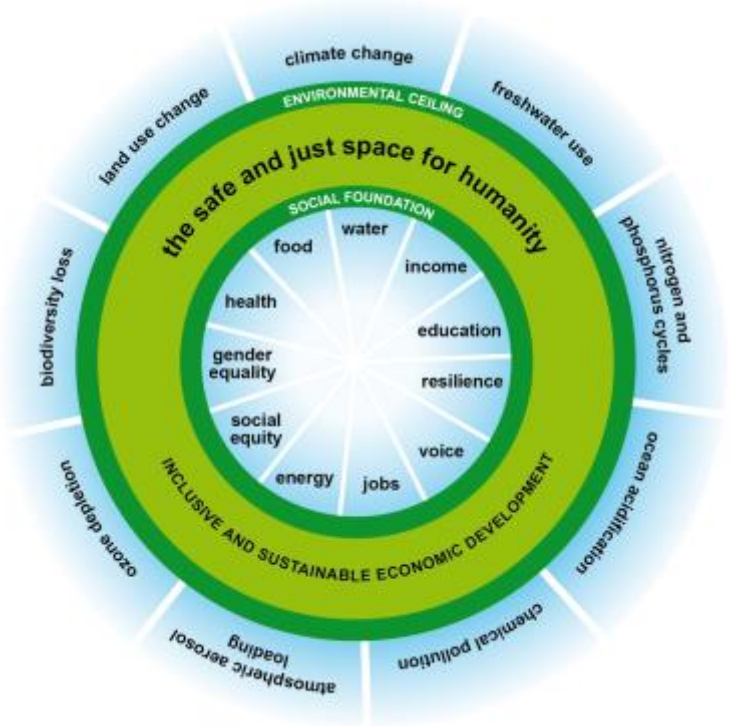
[7] http://ec.europa.eu/environment/archives/dansub/home_en.htm

The success matrix: meeting needs and preserving biosphere

Putting these two success criteria into a matrix we get the following diagram:

Figure 7: Alternative combinations of meeting needs and maintaining biosphere integrity

Another way to describe the conditions for success has been put forward by Kate Raworth (2012) with the notion of the ceiling and the foundation. A successful system performs to provide the basic needs of humanity whilst ensuring the activities do not transgress planetary boundaries.



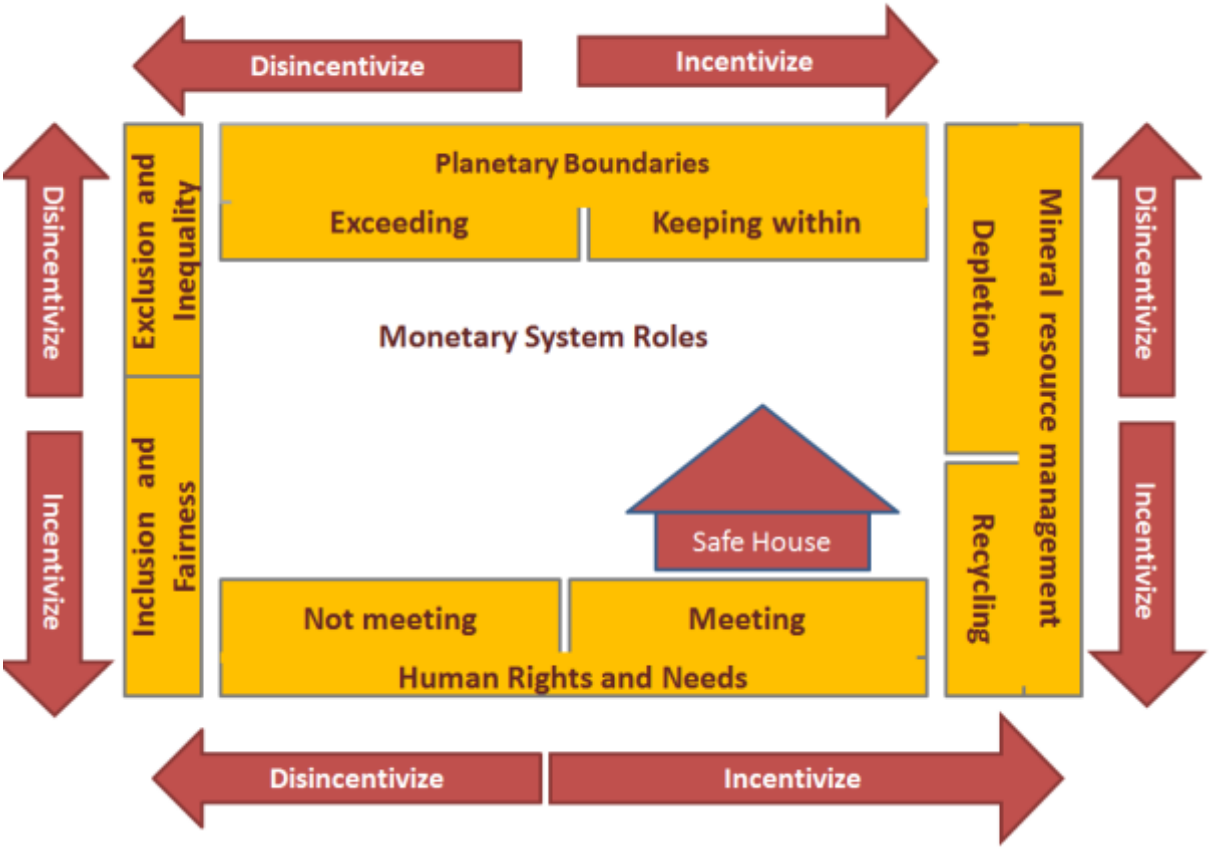


Figure 8: A safe house for humanity, where the economic system incentivizes desired behavior of the system

A safe house for humanity, with a fiscal system that supports it, would contain monetary incentives and disincentives. Human needs should be assured, and the system should provide each individual with protection should they come close to their needs not being met. It should also encourage sharing and generosity[8].

The system should disincentivize the depletion of essential minerals and incentivize circularity. It should prevent vital planetary boundaries being breached, and incentivize inclusion.

[8] As an example, the Living Planet reports by the Global Footprint Network suggests the appropriate measurement framework for a safe house for humanity is the Human Development Index for a nation mapped against its Ecological Footprint.

4) SECTION FOUR: Applying fiscal mechanisms to achieve System Conditions

Summary:

Starting from the generally accepted idea that money – within limits – is an incentive, the modern digitalized economy allows for fees and surcharges to be applied to points in the system in ways that influence the functioning of the system as a whole. Applying a system control approach to the economy such economic mechanisms would be designated as 'actuators'. The term 'sensor' is applied to mechanisms that measure system performance. Rather than creating new taxes and fees, greater control over the economy can be achieved by applying surcharges to already existing fee and tax mechanisms and feeding back to citizen's accounts. Four types of transaction, import fees, property fees, extraction fees and sales taxes can be surcharged in a way that provides a stabilizing feedback. A citizens' tax account provides the other potential financial stimulus point. Sensors include economic performance measurements that most nations have in place already. These include emission figures, import figures, the status of various ecosystems and figures on mineral reserves and extraction rates. Recycling performance statistics are also important "sensor" measurements.

The methodology for analyzing the often complex eco-system of economic incentives implicated in pollution and resource depletion is a step methodology called back-stepping. It involves identifying the key substances at molecular level and mapping out their route through the supply chain. The elements to prioritize are given by the work done on planetary boundaries by the Stockholm Environmental Institute.

Fiscal mechanisms need to be flexible so the levy can be raised at regular intervals until the market responds. They need to be redistributive in ensuring that goods and services are affordable even to the poorest, and they need to be self – financing rather than putting an overall drain on the economy.

Five fiscal mechanisms, applied together, can create an economic system that incentivizes the socio-ecological system to perform within system conditions. These mechanisms are described for each system condition in terms of strategic guidelines for their implementation, specific actions required and the tools that will aid their introduction. The description includes the sensor measurements that provide the feedback.

Applying fiscal mechanisms to ensure the system performs to requirements.

Section three established that the requirements on the economic system that the system is configured to encourage compliance with the system conditions as defined by the Natural Step, and to remain within the boundaries as identified in the work on planetary boundaries.

Introducing the TSSEF economy stabilization approach

TSSEF have identified the potential to control the functioning of the economy using surcharges on common taxes and fees, applying feedback mechanisms of redistribution of funds to citizens and adjusting the size of the surcharge based on monitoring performance against target.

The approach is similar to control engineering.

What is control engineering?

With the advent of digital technology, engineering has developed a way of applying a control layer to a device to ensure that it behaves according to intentions. Examples include the anti-locking devices fitted to brakes, cruise controls and the automatic landing systems in aircrafts. This approach is called control engineering.

Control engineering adds a control layer to a device through which the operator sets the expected performance of the device. The functions of the device are controlled in turn by actuators. These actuators are connected via the control layer to sensors. Control is achieved by the digital control layer receiving feedback from the sensors, input from the operator and through a set of rules and, at a sufficiently high frequency, controls the actuators.

When control engineering is applied to vehicle engines, for example, the digital control layer consists of sensors, actuators and controls. The control comes from the driver of the vehicle as a signal of intended performance, through this intermediary control system. This is where the term “fly by wire” comes from as the driver of the vehicle is not in direct mechanical control of the engine, but sends the commands to the control layer which in turn interprets the signals depending on a range of factors including the information coming from the sensors.

The benefit of control engineering approach is that mechanical controls can be simplified yet the control more precise and the workings of the device can be highly sophisticated. Once dirty technology, like the diesel engine, can be run cleanly as optimum combustion (and therefore clean burning) can be obtained by micro-controlling each piston stroke and the combustion cycle.

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An actuator is a type of mechanism that is responsible for moving or controlling a system

In a financial system, subsidies and surcharges on existing levies could act as actuators.

Most tax and fee systems are rather complex. Adding more would only add to the complexity. The Foundation proposes putting surcharges on already existing instruments in order to simplify administration. These surcharges (which can be negative) can be put on VAT, import fees, interest rates, and property deed transfers. The surcharges act as actuators. For example, putting a surcharge on the import of fossil fuels would make fossil fuels and products dependent on fossil fuels more expensive and encourage the purchase of alternatives. If at the same time revenues from the fees levied were to be paid back to citizens, purchasing power – and thereby overall demand in the economy – would be retained, another form of actuator.

The diagram below illustrates the principles: a fee is levied on substances that pollute as they enter the economy. The fee is adjusted depending on how the market responds in reducing pollution. If targets are not met, the fee is raised. If they are above target, the fee is adjusted downwards

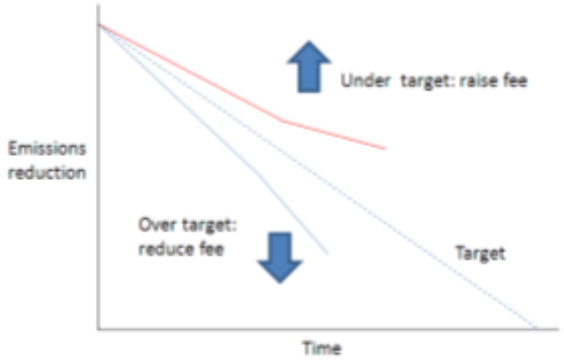


Figure 9: an example of how raising or lowering fees can change buying behavior of polluting products/services by making them relatively more expensive

Essential to stabilizing mechanisms is feedback. A good proportion of the fees levied should be channeled directly back to taxpayers. The increased costs of production inputs through extra fees are merely passed on to consumers. This reduces the money in circulation and is generally negative for an economy. (See the bath-tub model below.)

Benefits of the mechanisms

Transparency of fee-setting

Like fuel prices, or the stock-market that is closely watched by market actors, the level of fees set will likely be closely followed. The fees will be set sufficiently high to affect the demand for goods and the demand for alternatives, including the demand for investment in new equipment. In this way, the ecological performance of the nation's economy will be scrutinized by market actors.

Dividend

The size of the dividend paid to citizens will be a sign that internalization of externalities is working, and that distribution of the costs is fairer. The existence of a dividend will help ease through the decisions to levy fees on substances and practices that will affect most private economies.

Flexibility

The floating nature of the levies allows them to be raised or lowered depending on how the market reacts. The aim is not to penalize businesses, but stimulate them to circularity. If the fees become too high, the businesses will not be able to invest and switch to circularity in a timely way.

A description of the basic flows in the system

As described in the bath tub model, money flows around the system from citizen to enterprises, state and local authority and back again.

Connected to these flows, are the flows of nutrients, minerals and products.

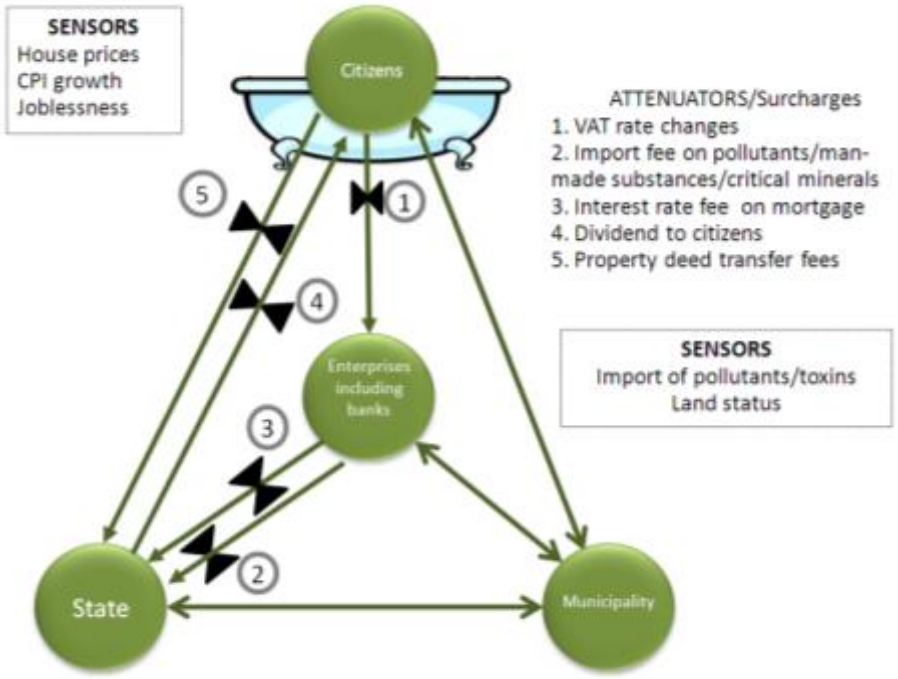


Figure 10: surcharges act as actuators to influence and stabilize the performance of the economic system

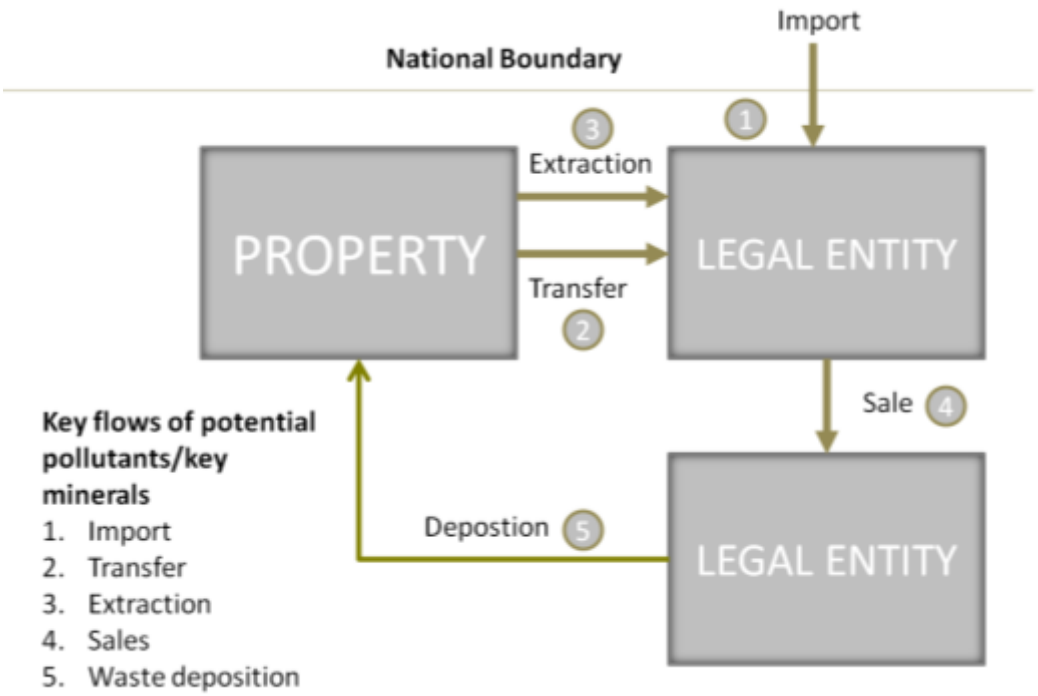
The diagram above shows suitable points to add surcharges.

To control extraction of nutrients and minerals into the economy a surcharge can be levied on import fees of pollutant – containing and pollution-causing products.

To encourage spending, sales tax, or value added tax can be reduced to encourage spending and thereby encourage employment. (The surcharge is negative.)

A holistic approach is important. Encouraging spending requires increasing controls on pollutants, or increased demand will increase externalities.

As a positive feedback mechanism, fees collected should return to the economy to ensure spending power is maintained.



The diagram above shows the five types of transfer of potential pollutants/key substances that can be subjected to a surcharge mechanism.

An additional fee can be levied on import of pollutant – containing products or substances at risk of depletion (1).

For property owners, a surcharge can be levied depending on the nutrient transfer performance of the property. For example, if all nutrients are removed by another company then the charge will be zero. If the property is a farm property that leaks nutrients to surrounding eco-systems then a surcharge could be added to property tax. If the property absorbs nutrients, then a negative fee could be put on the property (2).

Any extraction (for example of gaseous nitrogen, phosphorous or fossil fuel) can be subjected to a surcharge (3).

Sales of any items from one legal entity to another can be subjected to additional sales tax or value-added tax (4).

A fee for depositing key substances on any property will encourage recycling or substitution (5).

Sensors

Most modern economies are highly digitalized and this provides opportunities to measure the performance of the economy. For instance, sales of fossil fuel can be monitored almost in real time, and many environmental authorities regularly monitor water quality. Each product has its own number and barcode, and knowing the ingredients in each product it is possible to collect vast amounts of data on the flow of substances through the economy as they pass through the supply chain.

As the economy exists to provide for citizens, suitable measurements include

unemployment figures, homelessness, reports on food insecurity etc. Consumer price index can form part of the measurements package too, as well as average house prices

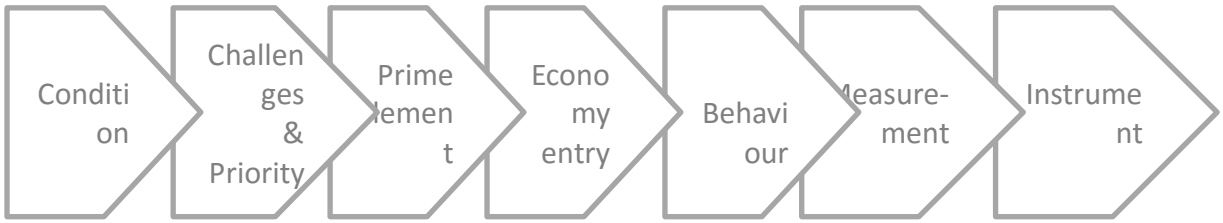
.

A sensor is a device or mechanism that detects and responds to some type of input from the environment. The output is generally a signal that is converted to human-readable display at the sensor location or transmitted electronically over a network for reading or further processing.

Data is captured each time a barcode is scanned throughout the production and retail distribution chain. Each product has a unique code so it is possible to track (and put levies on) pollution-containing products.

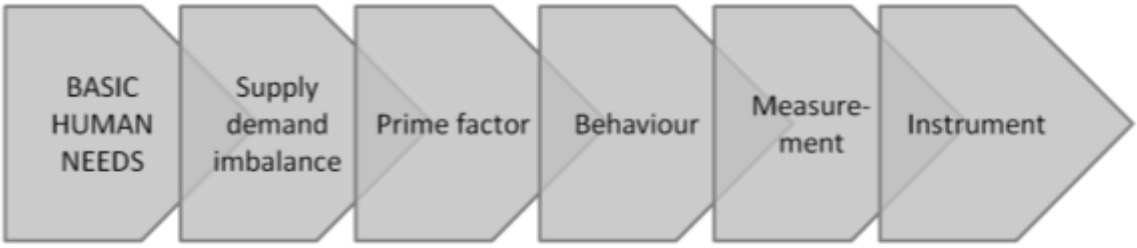
Analysis at the molecular level: Backstepping

The Foundation's methodology for applying control engineering works at the molecular level.



For each system condition – that is to say desired state – challenges are identified and prioritized. For each of the challenges the molecule involved is identified and then where it enters the national economy. From its entry into the economy to the point(s) at which it exits, the behavior of the system is identified and measurement points (sensors). From this data, the appropriate selection and application of instruments (actuators) can be applied.

Where the challenge is not at molecular level (condition four) the relative supply and demand of essentials is the basis for instrument implementation.



Specifically the supply and demand for labor (joblessness) and the supply and demand for homes (availability in terms of price and relative ratio of homes to citizens).

To find the priorities at national level the work done on planetary boundaries provides us with sound scientific basis as the overshoot of the boundaries are quantified and qualified.

For each of the four conditions we identify the greatest challenges (based on scientific body of knowledge including the nine boundaries identified by Rockström et.al) as well as the work done by

public bodies to identify risk substances (including UN's The Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

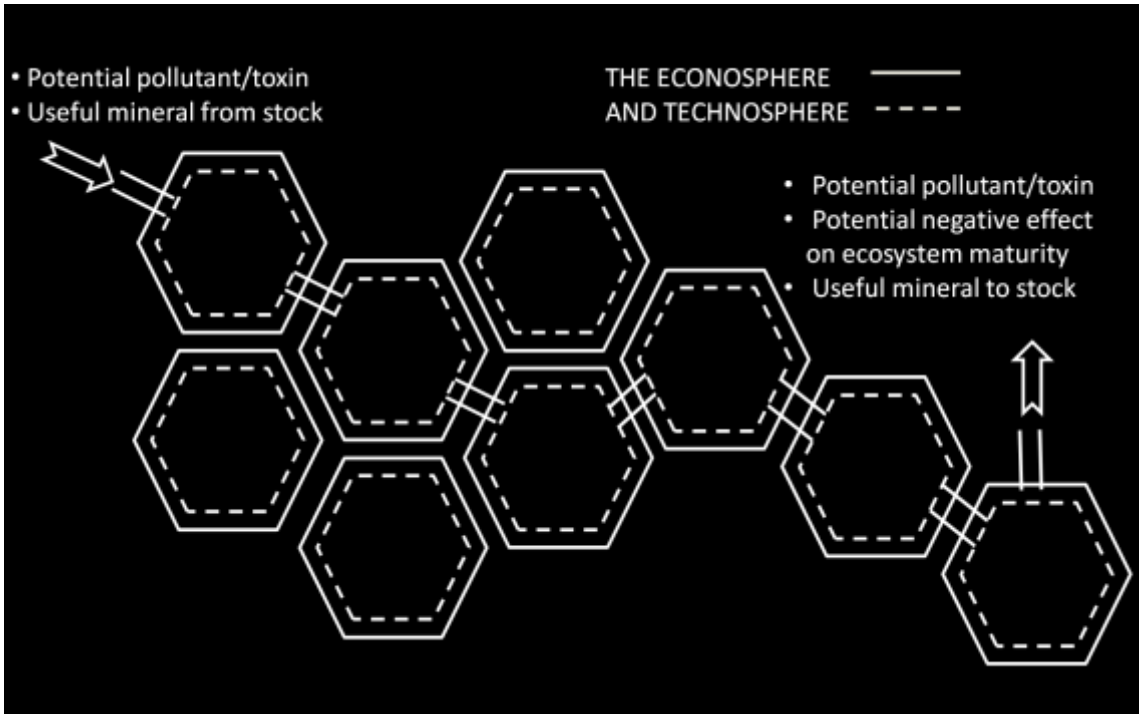
For each challenge we identify the prime element in the challenge. (That is to say, if that element were not present, the challenge would be eliminated or significantly reduced.) If a prime element is not identifiable we seek to understand where the challenge and economic system interact as far up the supply chain as possible.

The next step is to understand the path of the prime element through the economy, and the behavior of the societal system in breaching the condition.

All primary pollutant elements enter into the economy via extraction or import, all carried out by legal bodies. The sale of the primary pollutant element into the economy is often regulated by a range of fiscal instruments. We identify suitable instruments to place a surcharge on to control the element and effect a phase out of the behavior. We propose a trajectory of the phase out that would be reasonable based on scientific evidence, risk assessment and economic analysis.

Measurements are identified to monitor behavior change, and finally a suitable government body is set up to oversee the changes and manage the transition.

The Econosphere: transactions and the movement of pollutants through the economy



Econosphere and Technosphere diagram

By Econosphere we mean the area of activity that is controlled by the economic and fiscal system. Each of the hexagons above represents a legal entity which is either parcels of land or organizations. For a substance to enter the Econosphere, one of the legal entities must either purchase it or the right to extract it. The right to extract will come from an owner of land, which is itself registered as a legal entity.

Legal entities create and distribute products. These products are traceable (including the materials they are made of) via the Global Product system which classifies it under type of product and then the legal entity that produced it, then a unique code to identify it.

The Global Product Classification

Each corporate entity in the Econosphere has a company code, and each product has an item reference number. Transactions have invoice and receipt numbers. This means that practically every transaction is trackable and can be data-mined.

Radio-frequency identification (RFID) is a way to know where things are in the world. Tags are placed on for examples shipping containers containing information about the shipment. Readers can automatically identify and track these tags.

The Technosphere

The technosphere can be envisaged as sitting within the econosphere. The technosphere is the physical space where the technical management of goods and materials takes place. The econosphere is the framework laid down by governments regulating economic transactions and requiring verifications for each transaction, so the technosphere is regulated by the econosphere. You can say that a substance enters the technosphere after being registered on the books of a legal entity. An example of technosphere thinking is the coffee roaster that imports coffee beans. The beans enter the econosphere and technosphere of the exporting country when an exporter bags them into sacks as green beans. From there, the beans are exported into the econosphere of the importing nation, go into the roaster and grinder and then into to sealed plastic bags for sale to consumers. They do not leave the technosphere until the coffee grounds meet their final destination – as landfill or compost waste. When consumers have opened and drunk the coffee and disposed of the waste the product leaves both the econosphere and the technosphere.

This is important for the understanding of the circular economy. Substances that pass into consumers' hands leave the economy. They re-enter the economy as waste stream inputs from the property that the consumer is located in to the legal organization that is designated to receive the waste stream. The responsibility for circularity is clearly with these two organizations and the consumer.

The detailed control of the monetary system gives potential for substance control

Money is a highly regulated tool, the connection to legal entities and products (which is stipulated in the law covering how all

transactions must be documented) can be used to control the flow of substances in and out of the economy, the econosphere and technosphere.

Potential pollutants and scarce minerals can be fully controlled.

Readers can see from the econosphere and technosphere diagram above that as long as a substance remains in the technosphere and econosphere, it is under the control of the fiscal system. Through big data it is possible to know where it is in the world (e.g by barcoding and RFID tags), what is in it (from the product classification and identification) and which legal entity has it in its possession (from invoice information).

For there to be a management of the substance from a planetary point of view, most interesting is where the substance is input to the economy, and where there is a potential output. As long as the substance remains in the technosphere it is doing no harm and is potentially recoverable. In both cases, the legal entities carrying out input and emission activities are the main focus of attention. This narrows the size of the task down somewhat.

The approach in principle: levies on and digital monitoring of all substances that pollute and deplete

As described earlier in this paper, control can be achieved by levying additional surcharges on already existing mechanisms, depending on the substance. An additional levy, for example could be placed on import fees for phosphorus in fertilizers. The import fee would be passed on to consumers. Raising the market price in this way would ensure that a market for recycling of this potential pollutant could arise.

The Swedish Sustainable Economy Foundation advises that fees should, preferably, return to taxpayers as tax refunds and not be used by governments for other purposes. These fees are control mechanisms to ensure the market controls (and is controlled by) them.

End of life is also controlled by law. In many countries all waste is the jurisdiction of the municipal waste authority which, by law, takes care of end of life. Here, additional fees can be levied on waste, fees to ensure that poisons, unsorted material, unreclaimable material, etc cost more. Again, this cost goes back to the consumer, i. e., in the form of reimbursements on tax accounts.

So, with big data monitoring status, with big data controlling material flows and with the fiscal system adding controls on inputs and outputs to the economy there is a good chance that the planetary system can be put on a healthy path.

System level approach for Conditions 1 to 3

Figure 11: The economic system (blue ring) manages the key system factors (in yellow)

FSSD: How does the system (any system under study within which the planning is to occur) work? What are its boundaries?

- The system is the national economy.
- It consists of four types of actors.
- Of the four actors, there is a subset which is property owners.
- Its boundaries are transactional. When substances are imported over national boundaries or brought into the economy by either extraction or manufacture.
- Note that the national economy is depicted as hollow. Substances can enter the economy from the outside, but leave by entering the human body. They return to the economy from the human body when part of a financially regulated transaction (eg enter a paid for waste stream handling):
- Physical properties (real estate) also constitute a boundary element in the system that is in the hollow middle of the loop. The molecules in question can leave a property and enter the adjacent eco-system or another part of the economy.
- The transactional boundaries are defined in the diagram above. Import, extraction/production, nutrient release from a property, sales.

Especially, what are its most basic functions, flows, laws, mechanisms, feedback loops, etc. that are needed to inform what defines success and strategy, as well as potential actions and tools (see levels below)? What constitutes success of the planning endeavor?

Success is defined differently for each of the elements. This is because their physical nature is different in terms of handling risks, scarceness and recyclability.

- Phosphorus is recyclable but in short supply: therefore what constitutes a success is that the societal system performs to ensure extraction limits are not reached and that recycling is so efficient that only low levels of phosphorus escape into natural watercourses.

- Nitrogen is ubiquitous, recyclable but reliant on fossil fuels to enter the national economy. What constitutes success is a high level of recycling, low emissions to air and water, and a decline in reliance on fossil fuel based extraction methods.
- The energy from carbon from fossil sources is both non-recyclable and in short supply. Success is reduction of need for fossil fuels, replacement with renewable energy and cessation of emission of carbon as carbon dioxide.
- Toxins. Success is defined by the toxicity limits identified by scientists for this class of chemical. A phase out of the exposure of living systems to these toxins and safe containment as outlined in various bodies like REACH.
- For citizens success is defined as security of food, housing and inclusion (freedom from social exclusion).
- Land or property maturity is defined by ecologists as the retention of water and nutrients within property boundaries as well as absorption rather than reflection of radiant energy.

In particular, what are the most basic (and least changing) success principles or conditions that define a successful outcome of the planning? What additional techniques, instruments, measurements, management tools, etc. can be used to assess actions to see whether they are, in fact, strategic (level 3) to arrive at success (level 2) in the system (level 1)?

- National environmental goals and United Nations directives as well as international standards bodies have all defined success principles.

What are the overall strategic guidelines that will help choose actions that will lead to success (level 2) in the system (level 1)? Here, the powerful concept of "backcasting from success principles" plays a prominent, guiding role. This guides a systematic step-by-step approach towards the defined goal, while ensuring that resources continue to feed the process towards success.

Phase-out trajectories for each of the elements can be identified. As shown below, the phase-out trajectory is defined by scientific principles together with what is thought to be possible from an economic point of view in terms of speed of technology shift. Existing infrastructure should at least be utilized to the break-even point in order that businesses do not rapidly go under en mass, leaving little room for investment in the circular society.

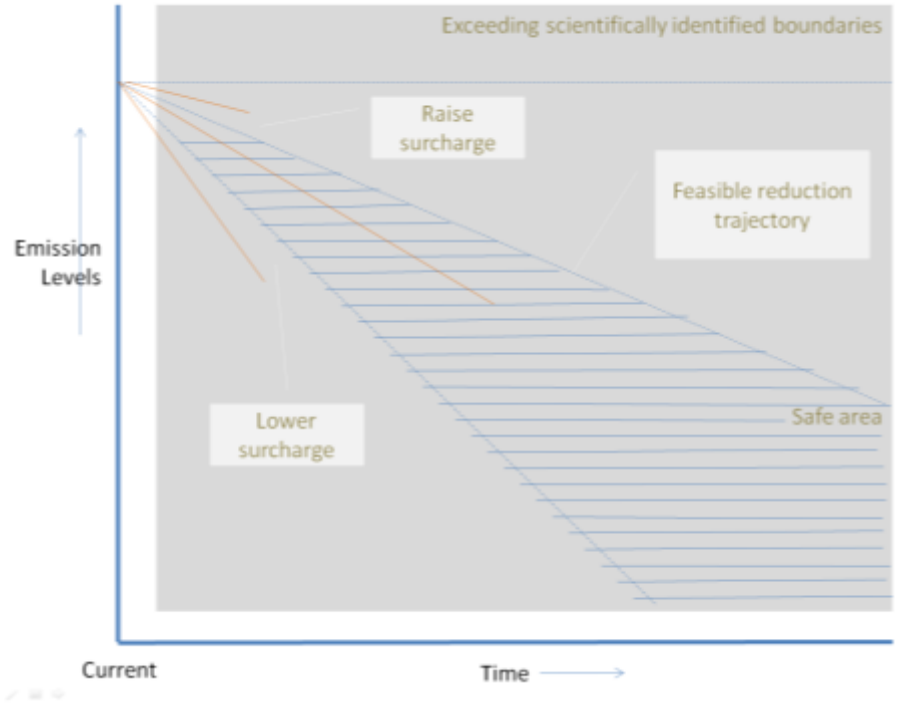


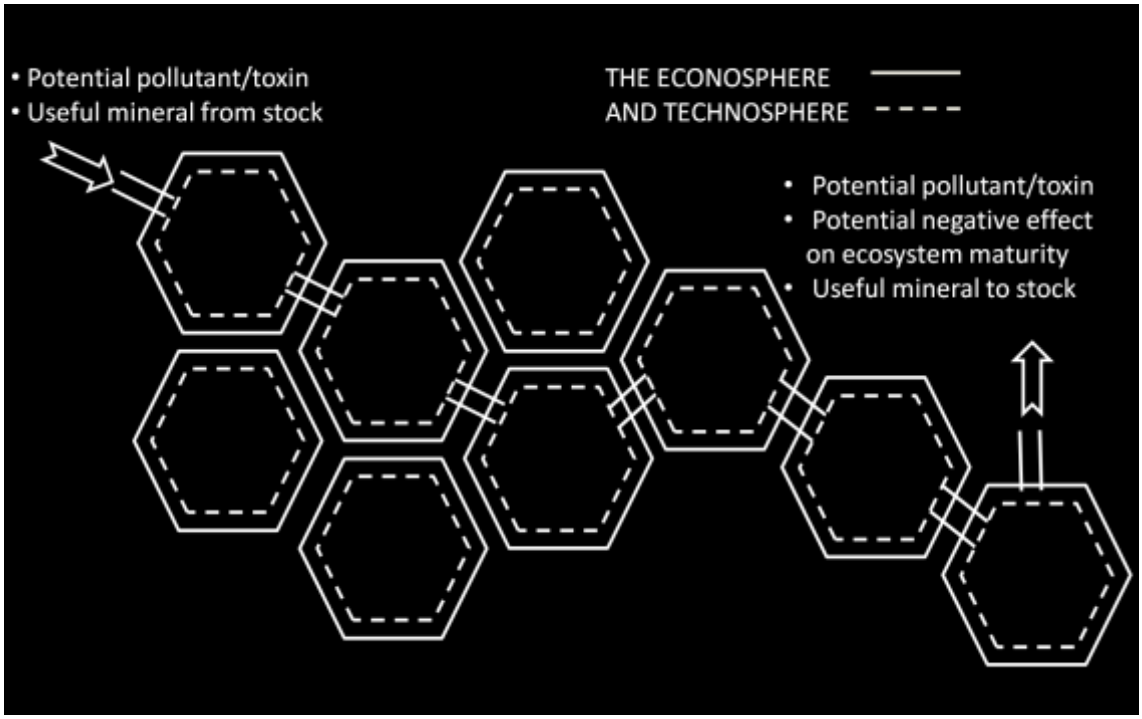
Figure 12: How fees can incentivize the economy to keep within phase-out trajectories

Backcasting with financial instruments and control of pollutants

The backcasting procedure takes as its starting-point the pollution symptom, following the pollution back to source. For the analysis phase we use the term back-stepping as the actual events are known. We use backcasting when we have proposed a financial instrument intervention point to plan its implementation.

In back-stepping we ask the following:

- What legal entity last had the pollutant in its financial records?
- What technical system was the pollutant present in?
- What decision process was used by person/s in the legal entity to make the decision to release the pollutant? What criteria were used? What assumptions were present?
- What taxes, fees and other costs were present in the framework surrounding the pollutant purchase decision?
- Where did the pollutant enter the operations of the entity? What commercial decision criteria were present when the decision was made? What technical system was involved?
- At the entry point, what was the knowledge level of the decision-makers in the effects of the pollutant purchase and the alternatives available?
- At the legal entity before, what was the decision criteria to provide the service with the pollutant in this way?
- These questions above are used until the entity that imported, created or extracted the potential pollutant is identified.



The diagram above shows the potential of the modern, digitalized economy to control the flow of substances through supply chains and to control the effect of the output of that legal entity into the biosphere. Substances enter the economy into a legal entity, solid line, are managed in the technical handling of the entity (dotted line) and are passed to other entities via legal transaction (double solid line) until they leave.

Stabilization instrument #1: Dividend-bearing Flexible Pollutant surcharges

As described in the earlier section, once the substance is identified, along with the eco-system of financial restrictions and incentives that surround it, mechanisms are constructed to control the use of the substance.

The main approach is to levy a surcharge on an already existing fee or tax, raise it at regular intervals, monitoring market response. At the same time, money collected from fees is returned to citizens to ensure spending power is maintained.

The market will respond to the surcharge, passing on costs to consumers. Products and service delivered using polluting and/or depleting practices will be relatively more expensive. Sustainable purchasing behavior will thus be cheaper. The economic system will thereby incentivize purchasing behavior that fulfills System Condition One.

For the circular economy to function then, there should be a price differential favoring circular products. Without that, the linear economy will continue.

From the equation earlier it follows that the price of the product will be affected by the price of recycled over newly-extracted materials and the price of renewable rather than fossil energy.

A progressive extraction surcharge (or import surcharge) on, for example, fossil fuels levied when the material enters the economy together with an exit fee on technical and biological materials leaving the economy, if allowed to be raised sufficiently, could make circular solutions relatively cheaper. Assuming

the input surcharge is carried over to the final consumer price:

(Input surcharge + Linear Product Price + exit surcharge)>=(Circular product price)

However, introducing the fee would make the overall range of product offering more expensive to the end-user.

To redress the imbalance, all or most of the fees levied should be returned to tax payers as a dividend. Guaranteeing the repayment of a sufficient fraction of the dividend in equal amounts to every tax payer by law will be an important step in an Environmental Fiscal Reform and an essential component for majority support in a functioning Circular Economy. The repayment is needed to secure that the majority of the tax payers will always receive more dividend (repayment) each month than their increased cost of living due to the fees levied to correct the price signals and to create a sustainable economic incentive structure.

Original price + fee >= Circular offering + dividend

To reach circular price parity a process of discovery is needed. The surcharge (fee) is raised at regular intervals until circular alternatives become available at parity.

Stabilization instrument #2: Dividend-bearing essential substances surcharges

In the same way pollutant surcharges incentivize reduction or substitution, essential substances (for example, mined minerals) receive an extra levy on extraction, import, or waste stream introduction. The cost of bringing the substance into the economy is passed on to consumers and raised until the market responds with recycling or substitution.

The economic system will thereby incentivize purchasing behavior that fulfills System Condition One.

Stabilization instrument #3: Dividend – bearing toxin and man-made substances surcharges

System Condition two limits the amount of man-made substance and toxins in the economy. By putting surcharge on the introduction of these substances into the economy, raising it a regular interval and redirecting the collected fees to taxpayers, the economy is incentivized to reduce the amounts to desired level, fulfilling System Condition two.

Stabilization instrument #4: Land maturity tax surcharge

Mature ecosystems retain water, radiated solar energy and nutrients. Immature systems "leak" these to nearby eco-systems. The ecological maturity of a property can be the basis of applying a surcharge for immaturity. If property performs as a mature system, (by, for example, retaining phosphorus from the waste stream and from neighbouring eco-systems) then tax surcharge is lower.

In this way, it is more expensive to own and operate non-mature properties. Their value on the market will be reduced. Here, the instrument incentivizes ecological stewardship of the property.

As in the case of the other instruments, a good proportion of the fee can be redirected into citizens' accounts. This provides the economic incentive to fulfill System Condition three.

The economy: designed and run to give housing, food, and inclusion

How does the system (any system under study within which the planning is to occur) work? What are its boundaries?

- The system is the national economy.
- The system consists of
    - Organizations that pay wages to employees.
    - Employees that buy essential goods from employing organizations
    - Employees that either buy houses or rent
    - A VAT tax in place on all purchases
    - A national base lending rate in place for interest on house and living accommodation purchases

Especially, what are its most basic functions, flows, laws, mechanisms, feedback loops, etc that are needed to inform what defines success and strategy, as well as potential actions and tools (see levels below)? What constitutes success of the planning endeavor?

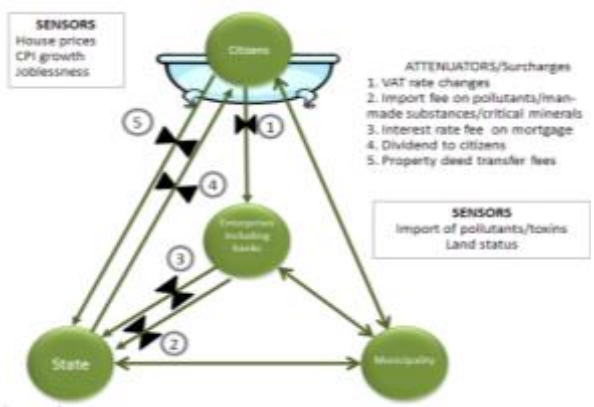
The diagram below shows suitable points to add surcharges on transactions 1-5

To control extraction of nutrients and minerals into the economy a surcharge can be levied on import fees of pollutant – containing and pollution-causing products.

To encourage spending a sales tax or value added tax can be reduced to encourage spending and thereby encourage employment. (The surcharge is negative.)

A holistic approach is important. Encouraging spending requires increasing controls on pollutants.

As a positive feedback mechanism, fees collected should return to the economy to ensure spending power is maintained.



- The flow of money from the citizen to the other entities in the system
- Success is defined as
    - Enough money each month from the citizens to fulfill expenses of the other types of entities
    - Enough money flowing back to citizens for them to purchase essentials including food
    - No systematic accumulation of harmful economic imbalances in the economy
    - Affordability of housing - ability of citizens to purchase or rent homes
    - Inclusion via employment or similar
    - Food security
    - Employment security

In particular, what are the most basic (and least changing) success principles or conditions that define a successful outcome of the planning? What additional techniques, instruments, measurements, management tools, etc, can be used to assess actions to see whether they are, in fact, strategic (level 3) to arrive at success (level 2) in the system (level 1)?

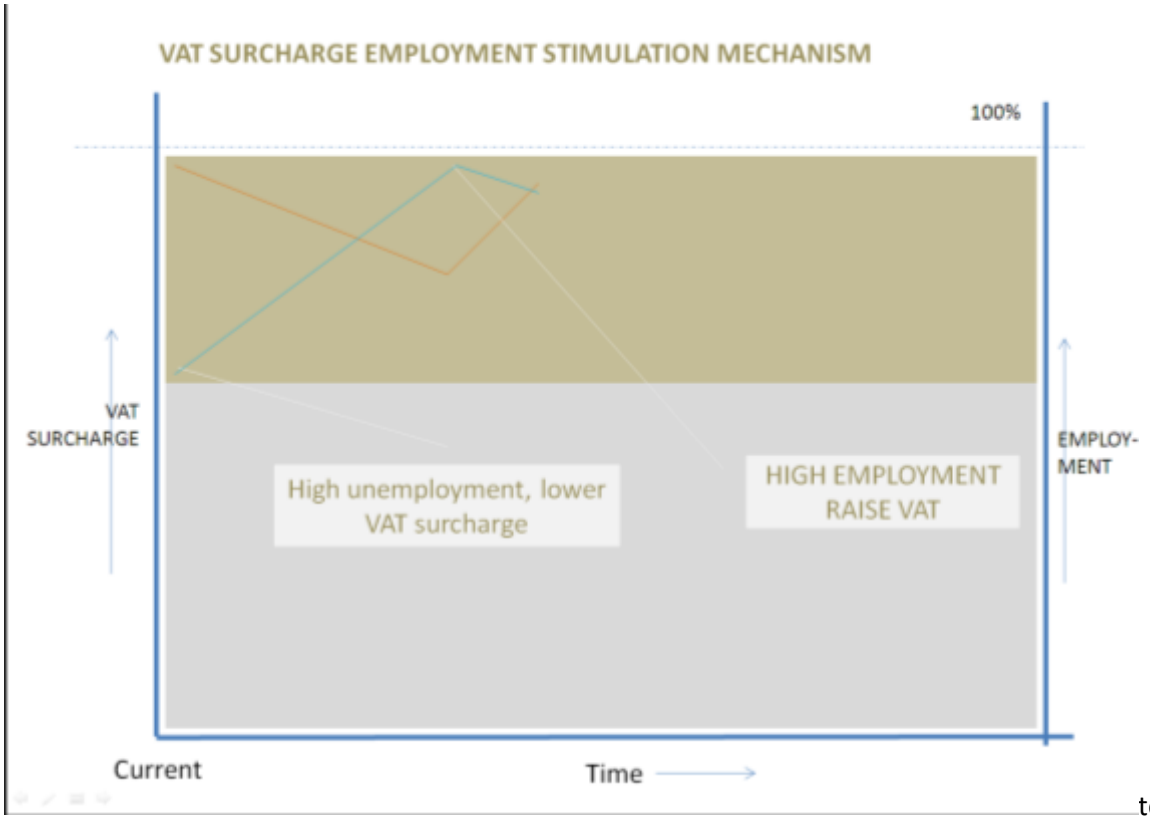
- Measurements:
    - The price of food compared to citizen income
    - The price of accommodation compared to what it takes to build new
    - The amount of money circulating
    - Number unemployed
- Additionally, national environmental goals and United Nations directives as well as international standards bodies have all defined success principles.

What are the overall strategic guidelines that will help choose actions that will lead to success (level 2) in the system (level 1)? Here, the powerful concept of "backcasting from success principles" plays a prominent, guiding role. This guides a systematic step-by-step approach towards the defined goal, while ensuring that resources continue to feed the process towards success.

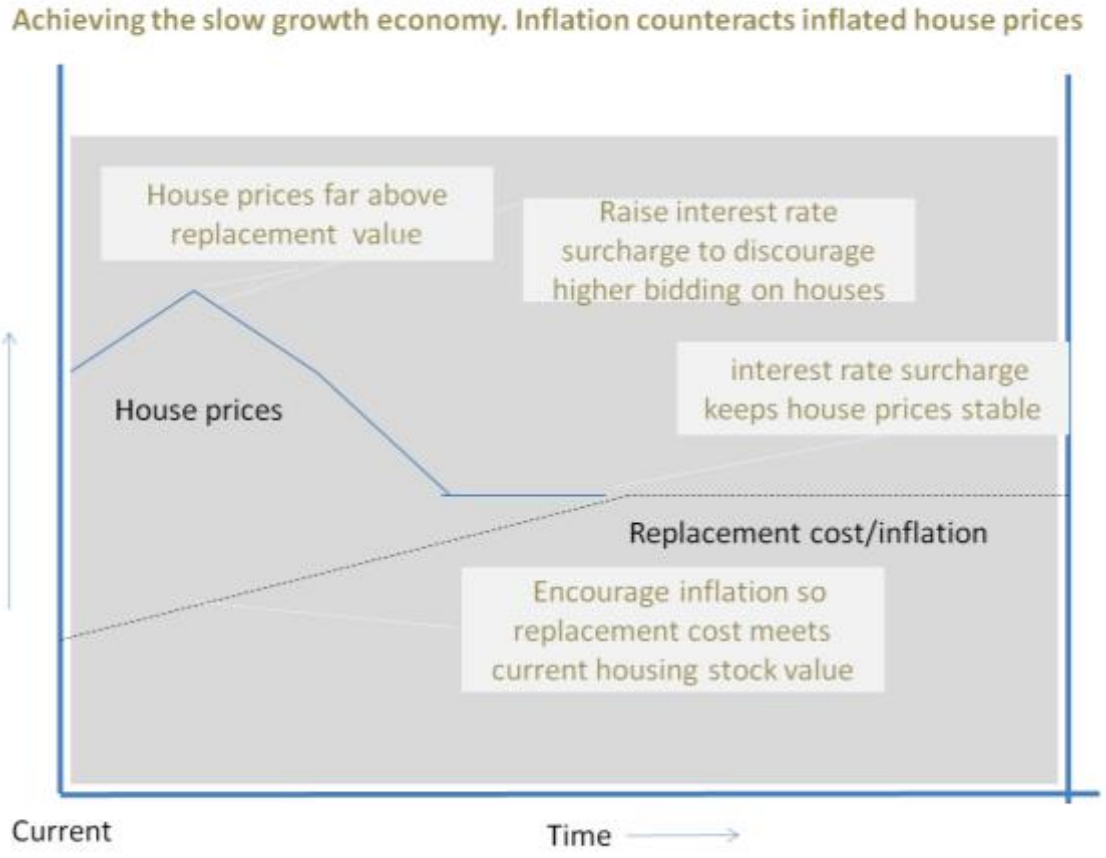
Stabilization instrument #5: Employment stabilization VAT surcharges/discounts

The diagram below shows how the VAT mechanism works. When unemployment goes above levels deemed acceptable, the surcharge on VAT is lowered. This stimulates consumption which stimulates firms to employ more people. As more people are employed, they can increase consumption and the VAT Surcharge can be raised.

In this way, the numbers of unemployed in the economy can be kept at a low (natural) level. The measures can be combined with reduction in employer taxes and special reduction in employer taxes for a high number of employees per output. The measures must be accompanied by emissions fees ensure the increased economic activity stays within ecological limits


VAT SURCHARGE EMPLOYMENT STIMULATION MECHANISM
100%
VAT SURCHARGE
EMPLOY-MENT
High unemployment, lower VAT surcharge
HIGH EMPLOYMENT RAISE VAT
Current
Time

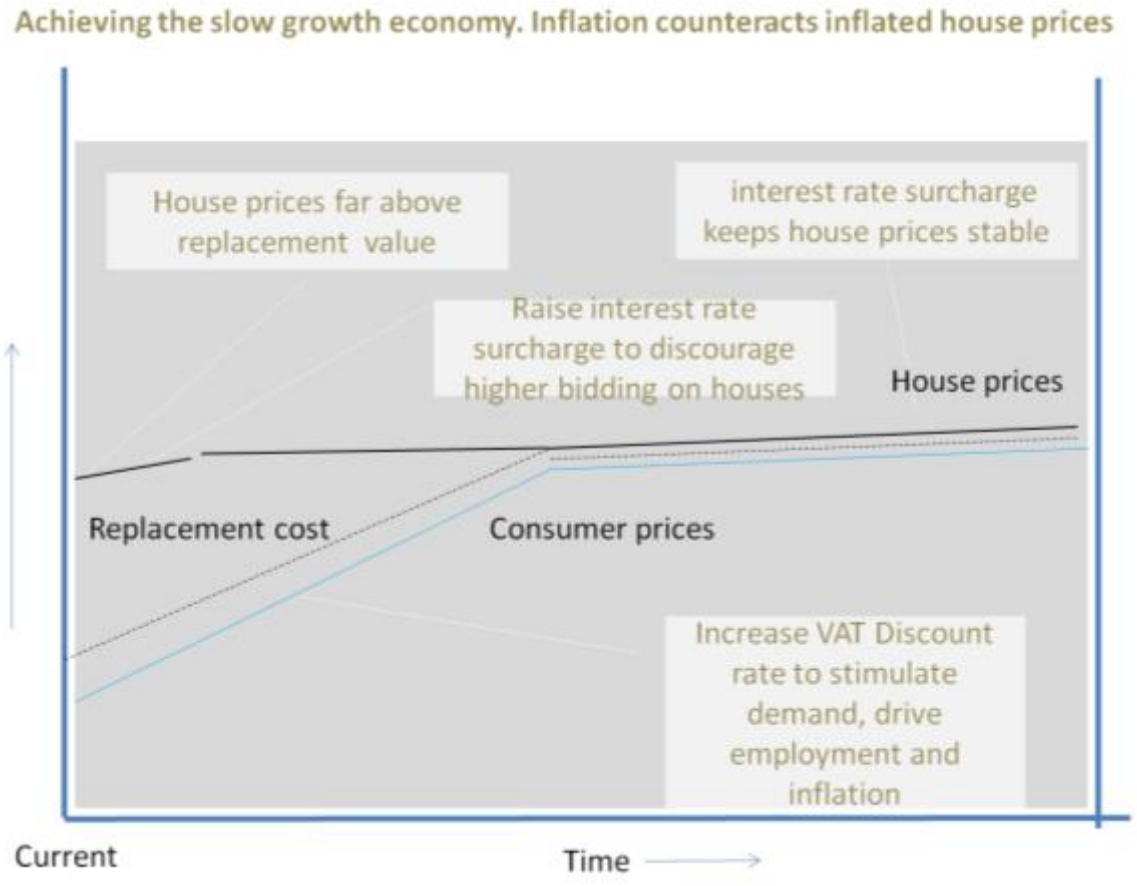
to.


Achieving the slow growth economy. Inflation counteracts inflated house prices
House prices far above replacement value
Raise interest rate surcharge to discourage higher bidding on houses
interest rate surcharge keeps house prices stable
House prices
Replacement cost/inflation
Encourage inflation so replacement cost meets current housing stock value
Current
Time

Stabilization instrument #6: Mortgage interest rate surcharge for house price stabilization

For housing to be affordable it should reflect the replacement cost: the cost of building a new house of the same standard. If house prices rise as a result of buyers outbidding each other, they rise beyond affordability. Borrowing to pay these higher prices does not benefit the real economy, instead is causes asset price inflation with well-known harmful side effects. The above diagram shows how the house price stabilization mechanism works. If house prices are above replacement value, the interest rate surcharge is raised, discouraging bidding by increasing the relative cost of the house to the bidder. As house prices fall to meet replacement value parity the interest rate surcharge can be lowered.

The interest rate surcharge can be complimented with a surcharge on deed transfer. When house prices are above replacement costs, the fee can be levied on the seller to encourage selling rather than waiting. When prices are below replacement rates, the levy can be put on the seller to encourage buying.



Stabilization instrument #5: Employment stabilization VAT surcharges/discounts to control CPI

Another mechanism to deal with house prices that have risen far above replacement value is to increase the CPI. Again, the VAT surcharge reduction will encourage demand for consumption, stimulating employment and driving inflation. This will reduce the relative and the real (inflation

corrected) size of the debt without the negative side effects accompanying the commonly used previous strategies including debt reduction and austerity measures.

The strategic guidelines are given above

- The natural unemployment level can be kept below 3 % in a well-functioning economy
- The price level of real assets (mainly housing) should be stabilized at the replacement cost with a transparent stabilizing economic feedback mechanism

What actions will follow overall strategic guidelines (level 3) to help move the system towards success (level 2)?

The following actions are required for system success

- Ensuring that the prioritization mechanisms are in place to correctly base decisions on best available scientific knowledge
- Putting place an effective monitoring system that gives information back to decision makers as to the status of employment, house prices and the rate of inflation
- Putting in place fee levying mechanisms, VAT control mechanisms and interest rate surcharges
- A communication system to citizens
- Having mechanisms in place to redistribute collected fees to citizens
- Establishing procedures and structures for markets to develop insurance mechanisms to run parallel with the increase in fee mechanisms
- Adjusting the VAT rate to encourage spending
- Stabilizing surcharges on interest rates to ensure house prices do not exceed (the average) replacement cost

Tools may also be used to assess the system itself (e.g. the overall result) from following the plan or to assess capacity building efforts of the planning team.

The following tools could be helpful in assessing the system performance

- IT-based decision support tools
- Best practice technology demonstrations
- Financial support for going from prototype to orderable product for key technologies

How the conditions of success are met by application of the instruments.

Meet needs of citizens

- The employment stimulation mechanism acts to ensure the demand increases when unemployment rises. The increased demand, where citizens have money to spend, means they can meet their basic needs and create demand for employment at the same time.
- Ensure public health safety

The flexible mechanism for toxic materials increases the levy on these substances until the market is stimulated to provide safe alternatives. In this way, companies

are paid to provide services and goods in a safe way.

Ensure biosphere and geosphere integrity

- The flexible fee as a a supplement on land tax depending on land maturity means that landowners are encouraged to ensure the ecological functioning of their land. The less well it performs the higher the fee and the lower its value on the market.
- The flexible fee mechanism on vital minerals ensures that the price of extraction rises to a point where recycling makes better business sense.

Exert fairness

Because of the dividend which is intrinsic to the TSSEF mechanisms, those who consume more pollution-producing services pay more. In practice then, richer citizens, who consume more than the poorer citizens, pay more. The environmental fees for their consumption are returned to all citizens alike, creating a true "polluter pays" situation.

The employment stimulation mechanism ensures a safety net for citizens, acting as an insurance mechanism against unemployment.

The house mortgage mechanism, in a similar way, ensures citizens have access to affordable housing.

Incentivize sustainable behavior, reduce political hurdles

The surcharge on toxins and man-made substances, pollutants and depleting resources makes environmental solutions cheaper. As citizens see money coming into their accounts, the political hurdles to introduce the fees will be reduced.

5) SECTION FIVE: Experience so far and proposals for further research

Research papers

A Flexible Pollution Tax (2006) by Mark Sanctuary & Anders Höglund

The report outlined preliminary research and analysis into the flexible pollution tax proposed by Anders Höglund that could be used to help put a price on some forms of pollution (NUTEK, 2006).

The research involved contributions from agencies and institutes including; Nutek (project's financier), Miljödepartementet, Naturvårdsverket, Näringslivsdepartementet, Gothenburg University, El forsk, and Energimyndigheten. IVL hosted two reference group meetings where the concept and research results were presented and discussed.

According to the report: "The concept combines those efficiency advantages of a pollution tax with an innovative way of setting the level of the tax using the decisions of individual firms acting on an open market. Höglund's tax does not consider damages to the environment when setting the level of the tax. Rather, the level of the tax is dependent on the development and adoption of cleaner technology. Höglund's tax also subjects polluting firms to short-term volatility. This is in fact driving firms to buy and sell pollution contracts on market in order to hedge their abatement decisions. "

Flexible Emission Fees: An Incentive for Driving Sustainable Production and Consumption

With Höglund 's suggested mechanism for "Flexible Emission Fees " as a starting point, the Nordic Council of Ministers assigned the project to look further into the possibilities of developing the concept (*Enell 2012)*. The main goal of the project was to increase the understanding of flexible emission fee setting, answering the following question: "Can flexible emission fees be implemented to abate CO^2 emissions whilst, simultaneously, stimulating technical and economic development?

A sufficiently flexible and budget neutral CO^2 fee with a full rebate could be a major step towards a solution to the potential juridical and political obstacles. The project group felt that the majority of participants viewed the mechanism as having the potential to reverse the trend of emissions, particularly in the areas presented in the workshop: CO^2 and phosphorus. It was also generally accepted that new mechanisms, to complement those currently available, need to be tried as the situation is urgent.

Two approaches to pricing pollution

This report compares the Cap and Trade method with an alternative method, the Flexible Fee Mechanism for emissions of nutrients from agricultural production *(Breugel, 2014).* The report recommended that further development and communication of the mechanism focuses on the economic core and not the broader motivations for environmental regulation nor the spending of revenue. Only this way can the mechanism win broader acceptance among regulators. In addition, the economic reasoning has to be substantiated and tested and an obvious next step is contact to academia and publication in peer- reviewed economic journal.

Simulations

Seeing the economy as a system that is required to perform to standards is a new concept for many. One way to help people appreciate the complexity of the task and how the five instruments might be applied is to offer a business game-like simulation.

The first public workshop with simulation run in October, 2015 in Stockholm concentrated

on dividend-bearing pollutant fees. The teams managed to fulfill the criteria for success by reducing emissions and maintaining profits at a reasonable level.

Simulations are useful tools for introducing the concepts of applying TSSEF's instruments to achieving the four conditions of the Natural Step. One way forward is to develop the simulations to illustrate the four conditions, the five instruments separately and together for different types of audiences.

Modeling the W3 model

World3 is a model originally developed in the 1970s, integrating several aspects of ecological planetary boundaries and many detailed aspects of human society and its interaction with a resource- and pollution limited planet. The model has later been updated and translated to the Modelica equation-based language.
The potential capabilities of the model have significantly improved when used with the recently developed advanced Modelica modeling, simulation, and control technology adapted for such applications. Uncertainty handling, sensitivity analysis, and plug-and-play of submodels are some capabilities. It is now possible to include the economy and the financial system in such an enhanced financial world model which can be used to test and evaluate many kinds of ideas and assumptions about the green economy.

The instruments presented in this paper could be modeled into a version of W3 and tested. Indeed, a recent research proposal MOSES, from Linköping University, proposed this.

Small scale trials on test municipality – an Island possibly

The Danish island of Bornholm in the Baltic Sea, is designated as a test Island by the Danish Government. As such, they have the authority to test surcharges on municipal fees and taxes. It would be possible to set up a small scale test to see if the surcharge on property, depending on its nutrient emission status, could stimulate property owners (agricultural, residential and commercial) to adopt circular technology.

APPENDIX

Summary of FSSD – TSSEF instrument application

FSSD Question	Summary answer	Notes
How does the system work? What are its boundaries?	The system comprises the monetary system, with transactions that affect citizens' health and the ecological performance of property. The boundaries are national borders and the econosphere (the eco-system of transactions ,mechanisms and rules and practices that surround these transactions) and the technosphere (where substances are held by a legal entity)	TSSEF focuses on the overlap between the social system and overshoot of planetary boundaries
Especially, what are its most basic functions, flows, laws, mechanisms, feedback loops, etc. that are needed to inform what defines success and strategy, as well as potential actions and tools (see levels below)? What constitutes success of the planning endeavor?	The flow of money and goods between legal entities and the extraction and emission of nutrients and products to the biosphere. Success is defined in terms of meeting human needs whilst ensuring natural capital is preserved.	TSSEF's mechanisms act as actuators to control unwanted behavior in terms of efficiency of handling potential pollutants and in terms of unemployment, housing security and food security. Biological products • Biological nutrients • Biomass energy Technical products • Technical nutrients Energy-providing substances of fossil origin
In particular, what are the most basic (and least changing) success principles or conditions that define a	The most basics conditions are: • Housing security • Food and water security	Critical substance list is a useful tool here.

successful outcome of the planning? What additional techniques, instruments, measurements, management tools, etc. can be used to assess actions to see whether they are, in fact, strategic (level 3) to arrive at success (level 2) in the system (level 1)?	• Ecological performance of properties (agricultural, residential and commercial) • Natural resource depletion rates with future generation perspective Measuring tools: Homelessness, statistics on food insecure, emission data for P, N. Depletion rates, and proportion recycled of key substances.	
What are the overall strategic guidelines that will help choose actions that will lead to success (level 2) in the system (level 1)? Here, the powerful concept of "backcasting from success principles" plays a prominent, guiding role. This guides a systematic step-by-step approach towards the defined goal, while ensuring that resources continue to feed the process towards success	The actions that lead to success are predicated on the application of the five instruments: • Surcharges on import/manufacture of potential pollutants • Surcharges on import/manufacture of risk substances • Surcharges on land use/mineral depletion • VAT surcharge/discounts to stimulate demand and control CPI • Housing prices controlled by interest rate surcharges and property deed tax	Backcasting involves the technology shift from fossil energy- intensive solutions to renewable energy capturing and harnessing solutions.
What actions will follow overall strategic guidelines (level 3) to help move the system towards success (level 2)?		

Tools may also be used to assess the system itself (e.g. the overall result) from following the plan or to assess capacity building efforts of the planning team (e.g. building team competency).		

Glossary

Actuators	Actuators change parameters as part of a control system. In this paper, surcharges on fees act as actuators.
Backcasting	Technique promoted by the Natural Step to plan system changes
Backstepping	Technique developed by TSSEF to identify the ecology of financial incentivizers surround decisions in supply chains especially of pollutants and key minerals
Biosphere	The part of the earth and its atmosphere in which living organisms exist
Capital	In this report, something that is to be used in an activity to provide a service to a human need but not used up.
Capital types	Natural Capital, Financial Capital, Real Capital, Human Capital, Social Capital
Control engineering	The science of applying control layers to systems to ensure they perform to requirements
CPI	consumer price index
Ecological maturity	Defined by scientist Odum, the status natural systems develop towards, where solar energy uptake is maximized, nutrient leakage minimized, detritus flow is maximized along with the biomass supported by the system. Properties that are Ecologically mature provide more eco-system services and are thus more valuable to the economy.
Economy	The societal system that fulfills citizen's needs through the provision of services and goods exchanges for money via fees, taxes or benefits.
Econosphere	The area encompassing transactions between legally registered bodies including government and local authority. In this report, the digitization of econosphere forms part of the control layer that ensures the economy performs to requirements
Efr	Environmental Fiscal Reform: using fiscal means to bring about environmental performance
Employment	In this paper we see employment as individuals contracted to an organization in a way that the individual is part of being useful to others by taking part in servicing human needs and being able to fulfill their own needs at the same time.
Fiscal mechanisms	Six fiscal mechanisms are proposed by the TSSEF Foundation • Dividend-bearing pollutant surcharges • Dividend-bearing essential substance extraction surcharges • Dividend – bearing toxin surcharges • Dividend-bearing property surcharges • Employment stabilization surcharges/discounts • Mortgage interest rate surcharge for house price stabilization
Flexible fees	Levying surcharges on undesirable pollutants/behavior and raising them until the market performs to requirements.
Human needs	Defined in this paper as the needs addressed by the UN bill of human rights and developed further by MAX NEEF.
Incentive	This paper assumes, within limits, that the prospect of gaining/losing money can incentivize people and be used to promote good, sustainable behavior of people and systems
M0	M0: Bank notes and coins
M1	M1: M0 + money in bank accounts readily available without notice

MBI	Market Based Instruments
Nutrient	Initially a purely biological term for substances that feed living things. Now adapted to include technical nutrients – substances and components that make up the man-made infrastructure of our economy. As food nutrients are recycled, so should technical nutrients be.
Planetary boundaries	Work published by the Stockholm Resilience Center defining the limits to human activity in nine boundaries.
Property	In this paper property refers to real estate, land and infrastructure, like motor vehicles. All property is connected to the econosphere and these connections provide opportunities for fiscal control of the economy.
Real economy	The day to day transactions involved with fulfilling human needs. These transactions create work. This is opposed to the speculation economy where assets change hands and no work is created.
Resilience	The ability of the economy to provide citizens needs and withstand and recover from adversity.
Sustainable development	The increase in capability of a society to meet the needs of coming generations.
Technosphere	Describes the flow of minerals and technical nutrients contained in the societal system

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