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# White Paper

How flexible emission fees can drive sustainable development

Stiftelsen Hållbart Samhälle  
Stephen Hinton  
April 2009

## **WHITE PAPER**

# How Flexible Emissions Fees Can Drive Sustainable Development

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## TABLE OF CONTENTS

|  |    |
|--|----|
| About the Foundation.....  | 1  |
| The Foundation’s view: harness market forces to create a prosperous and pollution free society .....                                     | 1  |
| Global supply chains bring us all kinds of goods – and tie us into dependency on finite materials.....                                   | 2  |
| Waste represents a market failure and is a sign of inefficiencies .....  | 4  |
| Fostering dependence on finite resources is an unsustainable long-term strategy for societal development ...                             | 5  |
| In a declining economy, loss of faith in market forces will bring demands for sanctions regardless of the promise of market forces. .... | 6  |
| The argument for restriction of emissions and material depletion .....   | 6  |
| Need to control emissions while retaining economic growth.....   | 7  |
| The problem with regulation.....   | 7  |
| The problem with emission rights trading .....   | 7  |
| The promise of cleantech applied to existing technical infrastructure .....  | 8  |
| Description of Höglund’s fee mechanism.....  | 10 |
| Benefits of the Höglund mechanism.....   | 14 |
| Q&A .....  | 15 |
| Call To Action: Pilots And Demonstrations.....   | 15 |
| Appendix.....  | 16 |
| REFERENCES.....  | 19 |

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## ABOUT THE FOUNDATION

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Established in 1995, the Foundation's purpose is to offer systemic approaches and solutions to the challenge of developing society in a sustainable way. The Foundation develops and supports the development of these solutions mainly in the areas of ecology, economy and work. The Foundation takes a non-political, holistic approach to promoting these solutions through research and development, education and spread of information.

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## THE FOUNDATION'S VIEW: HARNESS MARKET FORCES TO CREATE A PROSPEROUS AND POLLUTION FREE SOCIETY

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*Although large inputs of energy are good for the economy, the damage from emissions and use of natural resources, like water, may create costs far outweighing the benefits of this growth*

### MARKET FORCES

The Foundation recognizes that market forces represent a powerful, dynamic potential to change that could be harnessed to promote sustainable development.

### EMISSIONS WILL ULTIMATELY COST

On the other hand, market forces alone do not bring sustainable development and can ultimately present society with huge costs if emissions, for example, are not curbed.

### THE PURPOSE OF THIS WHITE PAPER

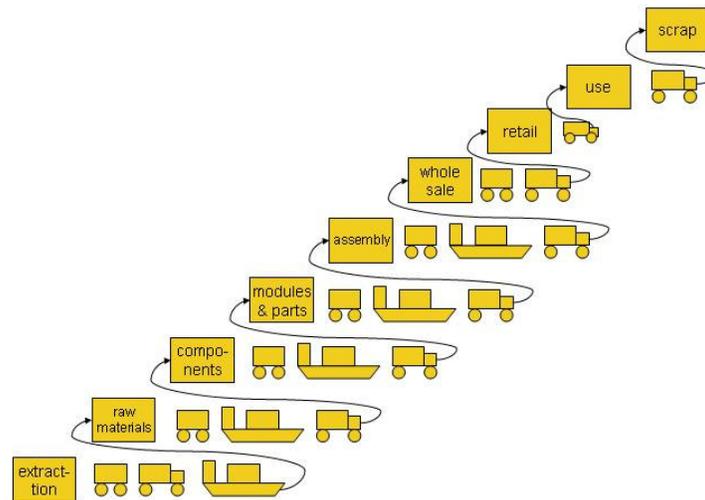
This paper examines the pricing of emissions and depletion of natural resources. It analyses the interplay between development of supply chains, economic growth and the costs to society of emissions, resource depletion and waste handling. It introduces the subject of emission fees, and the use of market forces to stimulate clean technology (cleantech). Later sections present the Höglund flexible emissions fee mechanism as a way of stimulating development of cleantech, using the principles of dynamic control developed for diesel engines, among others.

For readers seeking more advanced knowledge the paper provides footnotes, references and sections offering deeper analysis.

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**GLOBAL SUPPLY CHAINS BRING US ALL KINDS OF GOODS – AND TIE US INTO  
DEPENDENCY ON FINITE MATERIALS**

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**SUPPLY CHAINS BRING GOODS AND SERVICES TO MODERN CONSUMER**

In striving to reach high levels of organizational effectiveness and efficiency, services come to consumers via long supply chains of interlinked, highly specialized firms. The chain starts with raw materials, like sand, which make up components in, for example, electrical devices which eventually end up in the refuse collection system.



*Public and private waste streams represent an additional cost for the product over its lifetime, especially if biological and mineral nutrients are emitted to burden and degrade the environment. However, waste streams also represent potential sources of raw materials for new products.*

**THE ACCUMULATION OF BIOLOGICAL AND MINERAL SUBSTANCES IN SOCIETY**

The range of products available today to the average consumer comes a price to societies and the environment at all segments of the chain. Along the supply chain, emissions flow into natural and societal sinks. In many cases, the substances are in a form that makes them in principle unrecoverable. (For example when metals are in special alloys, or materials are fixed together.)

In other cases, these materials represent a biological burden on ecosystems (e.g the Baltic sea is experiencing algal bloom due to excess nutrient emissions)

As an illustration, the table below shows the massive throughput of materials needed to keep London functioning.

**Material throughput of London, UK population circa 7,5 million**

| <b>Input, millions of tonnes</b> |              | <b>Output, millions of tonnes</b> |             |
|----------------------------------|--------------|-----------------------------------|-------------|
| <b>Water</b>                     | <b>1,000</b> | <b>CO<sup>2</sup></b>             | <b>60</b>   |
| <b>Food</b>                      | <b>2.4</b>   | <b>Household waste</b>            | <b>4</b>    |
| <b>Fuel</b>                      | <b>20</b>    | <b>Industrial waste</b>           | <b>11.4</b> |
| <b>Timber</b>                    | <b>1.2</b>   | <b>SO<sup>2</sup></b>             | <b>0.4</b>  |
| <b>Plastics</b>                  | <b>2.1</b>   | <b>NOx</b>                        | <b>0.28</b> |
| <b>Metals</b>                    | <b>1.2</b>   | <b>Sewage</b>                     | <b>7.5</b>  |
| <b>Glass</b>                     | <b>0.36</b>  |                                   |             |
| <b>Cement</b>                    | <b>2</b>     |                                   |             |
| <b>Building materials</b>        | <b>36</b>    |                                   |             |
| <b>Oxygen</b>                    | <b>40</b>    |                                   |             |
| <b>Paper</b>                     | <b>2.2</b>   |                                   |             |

Source: New Scientist

An example of waste streams pouring massive amounts of potentially useful material into the biosphere is that of accumulation of plastic in the oceans. Reporting in the journal *Science*<sup>1</sup>, researcher Richard Thompson, a senior marine ecology lecturer at the University of Plymouth, says “the action of waves and the elements work to break plastic objects down into fragments tiny enough to be ingested by countless other marine organisms.”

He argues that the very life of animals in the sea may be threatened. Apart from releasing potentially dangerous chemicals plastic also absorb toxins. These may then be transported to organisms that eat the plastic."

Such toxic chemicals include PCBs (polychlorinated biphenyls) and DDE (dichlorodiphenyldichloroethylene), which are derived from pesticides and other manmade substances. These agents are known endocrine disruptors—chemicals that interfere with the reproductive, developmental, and immune systems of animals.

Some idea of the scale of this accumulation can be gleaned from how researchers from the Algalita Marine Research Foundation in Long Beach, California, found that the mass of plastic fragments in parts of the central Pacific Ocean is six times greater than that of resident plankton.

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<sup>1</sup> Thompson et al.(2005). *New Directions in Plastic Debris Science* 18 November 2005 <http://www.sciencemag.org>

## LEGAL CONTROL AND ENFORCEMENT LAG BEHIND DEVELOPMENT

Commercial development naturally moves faster than the development of legislation and control. This can lead to situations where the economic realities surrounding a business make it cheaper to, for example, use materials mined in a far off country and shipped to its factory, rather than recovering materials from its already sold and discarded products.

Recycling, repairing and reusing all sound like strategies that would use less energy, be simpler to manage and represent a better solution for society as a whole. In practice, however, firms demonstrate de facto that there is more profit in a linear, energy intensive approach to material handling.



*Model T ford 1923. Photo: Biscuit in pursuit, FlickrR*

Take the example of fuel economy: the 1908 Ford Model T went at 25 miles per gallon. As of 2004, the average fuel economy of cars and trucks was 24.6 miles per gallon<sup>2</sup>.

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## WASTE REPRESENTS A MARKET FAILURE AND IS A SIGN OF INEFFICIENCIES

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### MARKET FAILURE AND EXTERNALIZATION

In today's complex societies and supply chains, then, costs incurred for the provision of products and services with the extraction, production, supply and disposal of materials are not all born by the firms along the supply chain.

Costs for everything from educating workers, to health care, for roads, railways, and for cleaning up pollution and for refuse disposal are not fully born by the firms. This is called externalization of costs<sup>3</sup>. When

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<sup>2</sup> See <http://www.dailyfuelconomytip.com/miscellaneous/100-years-of-improvement/>

<sup>3</sup> The question of the environment is viewed, in the traditional economic framework, as being related to the externalization of costs. That is, market economics assumes that a good which is underpriced, is overconsumed. Externalization of cost, in this view, will be corrected by pricing the overconsumed resources which are being used, for example the work of [Lester Thurow](#) and also see [Pigovian taxes](#). Not all economics study accepts this paradigm, and, instead, there is a seven decade old tradition of viewing economic relationships as being based on the scarcity of energy, rather than price, as the central feature of economics.

society incurs harsh costs for externalization, for example when air pollution causes health care burden, the term “market failure” is used<sup>4</sup>.

Waste in itself actually represents unused resources and are signs that society is not functioning as efficiently as it could. Waste represents business potential given the right conditions.

The Foundation sees these failures as situations where the context within which the firm operates is not effective in ensuring that market forces preserve the environment or health.

Identifying ways to create a context for market forces to operate within where costs are not externalized must be the major tasks of governments. At the least, it befalls government to do everything in their power to introduce monitoring and control mechanisms to curb externalization as they have no mandate to allow degradation of the nation’s ecosystem or depletion of resources human, natural, mineral or otherwise.

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**FOSTERING DEPENDENCE ON FINITE RESOURCES IS AN UNSUSTAINABLE LONG-TERM STRATEGY FOR SOCIETAL DEVELOPMENT**

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Many long-term visions of business expansion and development of nations take no account of the availability of essential material. For example: according to a study, titled "Metal Stocks and Sustainability,"<sup>5</sup> all of the copper in ore, plus all of the copper currently in use, would be required to bring the world to the level of the developed nations for power transmission, construction and other services and products that depend on copper. The researchers believe scarce metals, such as platinum, risk depletion in this century because there is no suitable substitute for use in devices such as catalytic converters and hydrogen fuel cells. They also found that, for many metals, the average rate of use per person continues to rise. As a result, the report says, even the more plentiful metals may face similar depletion risks in the future.

There are energy constraints to growth too. To quote sustainable development expert Richard Heinberg:<sup>6</sup> “The most cursory examination of our current energy mix yields the alarming realization that about 85 percent of our current energy is derived from three primary sources—oil, natural gas, and coal—that are non-renewable, whose price is likely to trend higher (and perhaps very steeply higher) in the years ahead, whose EROEI<sup>7</sup> ( net energy yeild for energy used for extraction) is declining, and whose environmental impacts are unacceptable.”

Several technological changes we have witnessed over the last decades have been rapid: the spread of mobile phones, the Internet, digital music players. All of these examples are, however, light in terms of materials and energy intensity. Technological infrastructure like transport systems, power generation and waste water purification and handling all take decades to transform. A report sponsored by the United States Government<sup>8</sup>, concludes: “The depreciated value of existing U.S. transportation capital stock is nearly \$2 trillion and would normally require 25 – 30 years to replace.”

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<sup>4</sup> One definition of market failure is: “A condition that arises when unrestrained operation of markets yields socially undesirable results”.

<sup>5</sup> Proc. Natl. Acad. Sci. USA. By Robert Gordon and Thomas Graedel of Yale University and Marlen Bertram of the Organisation of European Aluminum Refiners

<sup>6</sup> [http://richardheinberg.com/MuseLetter\\_203\\_March\\_2009.html](http://richardheinberg.com/MuseLetter_203_March_2009.html)

<sup>7</sup> Energy Return on Energy Invested. For a deper discussion of the relation of EROEI see the article at <http://www.chrismartenson.com/forum/implications-eroei-peak-oil/11020>

<sup>8</sup> Peaking Of World Oil Production: Impacts, Mitigation, & Risk Management, Robert L. Hirsch, SAIC, February 2005

Another report, by the Pacific Institute on behalf of Ceres,<sup>9</sup> finds that water stress is rapidly becoming a key strategic risk to commerce. Several business sectors are at risk, including clothing production, food production, metals and mining and electricity production

Material suppliers, like oil companies and metals and mining, have an economic interest in businesses being dependant on their materials. Their mandate is to maximize profits as long as possible until the asset runs out. Conservation, taking depletion into account and minimizing societal dependency risks are not written into the articles of association that govern these organizations. The formation of legal bodies operating under these tenets is accepted practice, the benefits of the creativity and effectiveness these structures unleash is seen as outweighing their downsides.

Given that businesses cannot be expected to act in the interests of the national economy, and that replacement of existing heavy infrastructure would take a long time, and given the scarcity of metals and impending lack of water, governments would be wise to start to:

- steer their country's economy to be less dependent on finite materials
- ensure the ecosystem can provide water, etc in enough quantities to supply essential services.

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**IN A DECLINING ECONOMY, LOSS OF FAITH IN MARKET FORCES WILL BRING DEMANDS FOR SANCTIONS REGARDLESS OF THE PROMISE OF MARKET FORCES.**

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Thanks partly to the development of modern media, consumers are becoming more aware of how global supply chains work, the conditions of the workers along them and the downsides of the emissions created. Increasingly, opinion is going against the negative sides of these practices and, in the light of the current economic downturn, a negative backlash against the highly paid executives who control these chains.

If banks and large corporations are to retain their credibility and license to continue, consumers and voters need to be assured that mechanisms are in place to ensure that externalization is effectively controlled and development is moving in a positive direction.

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**THE ARGUMENT FOR RESTRICTION OF EMISSIONS AND MATERIAL DEPLETION**

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There are four main arguments the Foundation puts forward for governments to start now to develop restriction mechanisms on emissions and material depletion.

**Restricting emissions and depletion:**

- ultimately reduces material supply costs to businesses
- encourages recycling and breaks dependance of the economy on finite resources
- preserves the ability of the environment to provide vital services
- ensures the long term stability of the economy

standards rise, businesses relying on cheap raw materials will be badly hit. As larger industries, like the transport industry, have long replacement cycles, these need to start to adapt in a timely fashion to preserve long-term economic stability.

Firstly, that the extraction, refining, transport and processing of materials is cheaper than recycling represents a temporary dysfunction, or market failure. This has come about in part, as civil rights groups make us painfully aware, through social inequalities along the supply chain. As materials continue to deplete and living

Secondly, emissions and accumulation of materials create costs and represent unused potential. An economy which uses energy and materials effectively is more competitive than one that takes energy invested in mineral extraction and literally dumps it on a waste heap<sup>10</sup>.

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<sup>9</sup> [http://www.pacinst.org/reports/business\\_water\\_climate/full\\_report.pdf](http://www.pacinst.org/reports/business_water_climate/full_report.pdf)

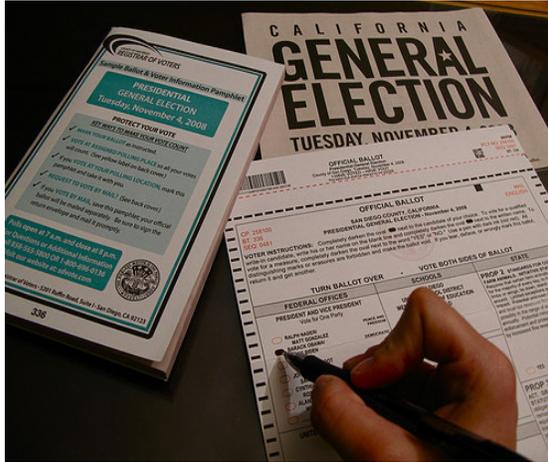
Thirdly, as consumers and voters are becoming aware, material accumulation can damage ecosystem services which affects productivity and ultimately slows economic growth.

Finally, restricting material depletion reduces the risk of businesses being forced into dependency on cheap and available materials.

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## NEED TO CONTROL EMISSIONS WHILE RETAINING ECONOMIC GROWTH

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*Politicians face the question: how can we preserve the environment, reduce waste and be seen to be stimulating economic growth at the same time?*

As illustrated above, Governments have no legal mandate to allow degradation of a nation's resources, yet they have the task of stimulating economic growth short term as well as long term.

Clearly, they need to demonstrate that control mechanisms are in place to curb externalization whilst creating the conditions for economic growth.

Increasing taxes is often called for to require polluters to cease. (This approach is called Pigovian taxation.<sup>11</sup>) However, taxes are traditionally difficult to apply effectively and are seen as an unpopular way to exercise government.

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## THE PROBLEM WITH REGULATION

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Regulation as a strategy can backfire. If it is more profitable to break regulations than to keep them, there will always be a temptation to break the rules. In such a case, regulation will bring with it costs of enforcement and prosecution. If it is profitable to abide by regulations, then the incentive will be to follow the regulations.

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## THE PROBLEM WITH EMISSION RIGHTS TRADING

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Emission rights trading is the notion that by allowing trade of emission rights, they will become more expensive and thereby encourage less emissions. This system has not demonstrated that it produces a rise in the price of emission permits. In its simplest form, it does not aim at reducing emissions, just the distribution of the rights to emits.<sup>12</sup>

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<sup>10</sup> The book "Cradle to Cradle" (see references) argues that extraction and emission need never occur in the future, and economic growth is dependent on reuse and recycling of resources

<sup>11</sup> Because the market mechanism fails to factor in the total cost to society, output decisions are flawed, resources are allocated inefficiently, and [social welfare](#) is reduced. One method of reducing the effect of this market failure is to impose a tax equal to the amount of the negative externality (or impose a subsidy in the case of a positive externality).

<sup>12</sup> The problem with trading right can be illustrated with an extreme example. Consider child abuse as the externality to be reduced. Say you allow everybody to strike kids, e.g. 10 times. Since some people do not like hitting kids, or have found other ways to communicate with them, they can sell their 'hitting rights' to other people, more prone to hit kids. This way, the total amount of child abuse would not diminish, but you have created a new market.

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## THE PROMISE OF CLEANTECH APPLIED TO EXISTING TECHNICAL INFRASTRUCTURE

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As argued above, existing technical infrastructure represents a huge investment and takes a long time to replace. For example, diesel engine technology is not only widespread in trucks, boats, electrical generators etc, but is supported by a network of suppliers, manufacturers, service networks and surrounding technology it is integrated into, for example, vehicle electrics and control systems.

A rapid dismantling of such technology, so integrated into the fabric of society would be costly, time consuming and wasteful of the capital, materials and intellectual, invested.

In this context, the existing technological landscape presents a barrier to new advances. Its introduction to be successfully will require massive investments in changes to the existing technological landscape.

On the other hand, existing technology carries a legacy of inefficiency and high emissions.



### CLEANTECH TAKES EXISTING TECHNOLOGY AND ADDS LAYERS OF CONTROL AND CLEANING

This Cleantech approach takes outdated, inefficient, polluting technology and with the application of advanced computer control and some addition of cleaning technologies produces services with less emissions more efficiently.

#### EXAMPLE: DIESEL ENGINE

Advanced computer control of the combustion of the diesel engine, combined with advances in particle filtration have transformed this once dirty and environmentally detrimental technology to an efficient, clean transportation solution. This new development is called Control

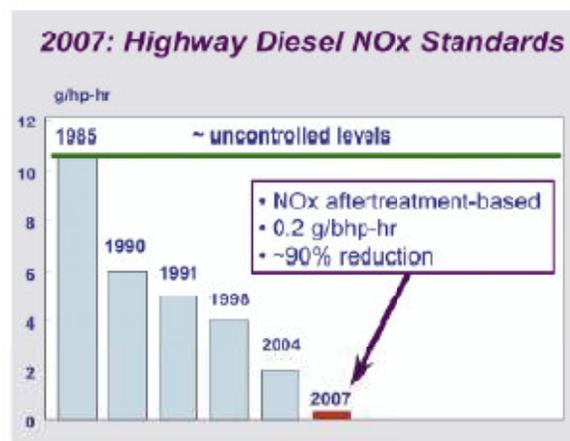
Engineering. Control engineering is the engineering discipline that focuses on the modeling of a diverse range of dynamic systems (e.g. mechanical systems) and the design of controllers that will cause these systems to behave in the desired manner.

#### ADVANTAGES: REDUCED NEED FOR NEW INFRASTRUCTURE

This is, then one of the promises of cleantech: to take existing technology and build a control and cleaning layer to make it perform to modern standards.

#### MAINTAIN ECONOMIC STABILITY

This approach has the benefit of being relatively fast compared to scrapping and replacing existing technology. It also creates more economic stability, reducing the need for firms to raise capital for new infrastructure throughout supply chains. Diesel technology has been successful in reducing NOx. Diagram courtesy of the United States Environmental Protection Agency.



For model year 2007, NOx emission standards for heavy-duty engines are reduced over 90% of current standards.

### COMPARISON BETWEEN ECONOMY AND DIESEL ENGINE

Most economic instruments and regulatory mechanisms used today, with the exception of electronic trading, originate back to the period before ubiquitous computing, global supply chains and awareness of risks of externalized emissions costs.

The table below illustrates the opportunities afforded by modern technology for applying fees and changing them to adapt to conditions.

| Then   | Now  |
|--|--|
| <ul style="list-style-type: none"><li>• Paper document based trading, with long lead times for accounting</li><li>• Minimum of statistics</li><li>• Long and slow methods of communication ( e.g. surface post)</li><li>• Labourious calculations required</li></ul> | <ul style="list-style-type: none"><li>• Computerised trading and tax system</li><li>• Multiple statistics collection points</li><li>• Fast communication</li><li>• Calculations can be handled by modern computer technology</li></ul> |

Application to political economics means applying control approaches to supply and value chains containing pollutants. More specifically, as combustion is controlled by the millisecond depending on conditions in the piston chamber, emissions can be controlled in real time by a variable fee depending on the behavior of these supply and value chains and the markets, including financial markets, that influence them.

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## DESCRIPTION OF HÖGLUND'S FEE MECHANISM

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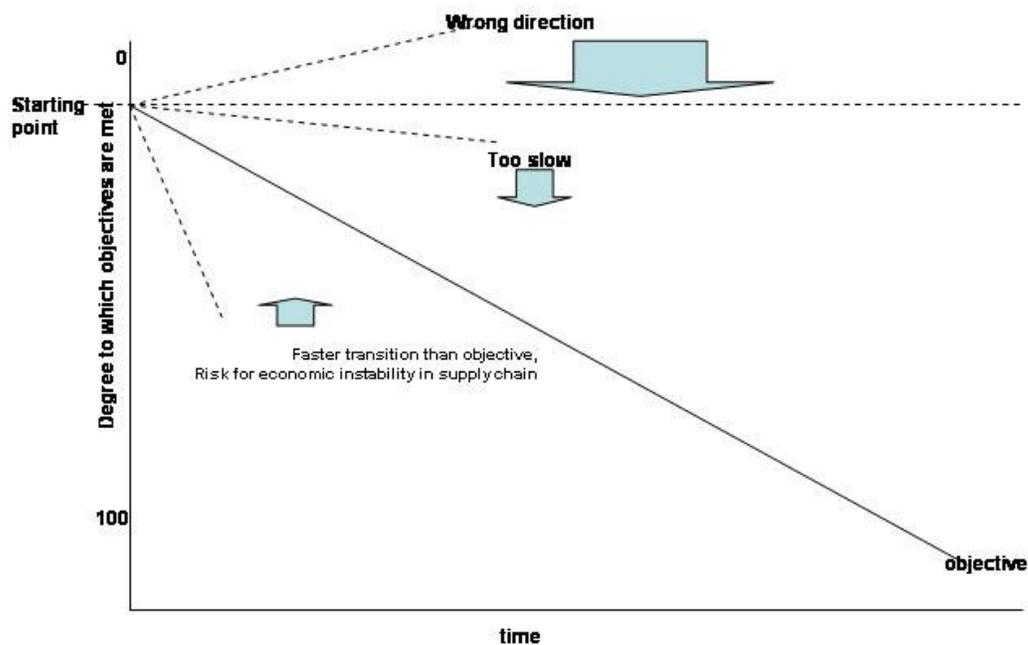
### BASIC CONCEPT

An emissions fee scheme is set up for substances that government goals call for reduction or elimination of their release into the public waste stream or environment. The size of the fee will be increased if sales and emissions increase, and decreased if the rate of reduction is faster than the objective. If the fee is *sufficiently* high, and if there is market uncertainty as to how large the next fee will be, market forces will work to change the behavior of supply chains<sup>13</sup>.

The market will react based on a wide range of factors, including availability of futures markets to hedge the cost of fees, as well as availability of technology and methodology to eliminate emissions.

The fee mechanism allows for the revenue collected to be redirected to firms, for example to introduce cleantech.

### Fees can change the speed and direction of development



*The size of the fee depends on the behavior of the market. The larger the gap between objective and actual, the larger the fee (blue arrow)*

### MAIN ACTORS

- The government agency that is responsible for monitoring emission levels and setting and collecting fees.
- An importer or producer of an emission causing substance.
- The end users of the substance.
- Suppliers of clean tech.
- Market makers in financial markets (options market and options brokers).

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<sup>13</sup> A thorough theoretical analysis of Höglunds mechanism has been carried out by IVL, The Swedish Environmental Research Institute. The report may be downloaded from <http://tiny.cc/F6Dxl>

## MAIN COMPONENTS

The Höglund approach consists of six main components:

- Identification of a traded substance that gives rise to emissions from its use in supply chains.
- A pollution fee levy mechanism as far back in the supply chain as practicable
- A price setting authority that can monitor fees closely in time and change the fee level regularly.
- A mechanism for returning fees back to stimulate commerce, for example, subsidies or grants.
- A reasonable objective for rate of emissions reduction, set by government.
- Opportunity for a futures market to arise spontaneously.

## HOW IT WORKS

### Announcement of fee

The government announces it will introduce a flexible fee system and give actors time to prepare.

This announcement will create an uncertainty in the market. They will be presented with some major choices:

- Continue using the substance and introduce a margin in their business plans to pay the fee (i.e. increase prices to pass on costs to end users).
- Plan to invest in cleantech to reduce or remove emissions.
- Plan to invest in non fee-incurring alternatives.

Choices will depend on the willingness of their customers to absorb the costs involved, the price and availability of clearer alternatives and the time frame within which the alternatives can be introduced. The size of the fee will affect the decision. If it is cheaper to pay the fee, the firm may decide to continue as usual.

### Introduction of fee and monitoring

At regular intervals the government monitors the amount of fee collected as well as levels of emissions.

### Set fee according to market behavior

If levels of emissions do not fall despite fee introduction, the fee is not affecting the market. After the monitoring point that indicates no change, the fee is adjusted upwards. This continues until emissions fall.

If the fee is so high it creates economic instability and disruption in supply chains, an adjustment downwards is made. If emissions are falling according to objectives, fees remain at previous levels.

A market for futures<sup>14</sup> may arise in order to create some kind of insurance for the supply chain actors. In this case, the futures market will also present the government with a measure of the rate of change the market can handle. Another benefit of a futures market arising is that it focuses the attention of the market onto salient aspects of emissions handling like introduction of new technology, its efficacy, investment needs and the performance of the industry compared to government goals. For a more detailed explanation of the mechanism, see the appendix..

As the fees create a revenue stream, governments can or stimulate and reward reduction of emissions and adoption of new technology with grants and subsidies. New technology will come into the market faster in this way.

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<sup>14</sup> In finance, a futures contract is a standardized contract, traded on a futures exchange, to buy or sell a specified commodity of standardized quality (which, in many cases, may be such non-traditional "commodities" as foreign currencies, commercial or government paper [e.g., bonds], or "baskets" of corporate equity ["stock indices"] or other financial instruments) at a certain date in the future, at a price (the futures price) determined by the instantaneous equilibrium between the forces of supply and demand among competing buy and sell orders on the exchange at the time of the purchase or sale of the contract. Source: Wikipedia.org

### **Constructing the fee mechanism**

The fee mechanism should fit existing business, regulatory and fiscal practices as far as possible to reduce implementation costs. System barriers should represent already established regulatory points. Examples of these include:

- Import duties
- Export duties
- Value added tax
- Property taxes

Agencies should also work to place fees as early in the supply chain as possible, again to reduce costs for implementation. This is because *extraction or production* of substances that give rise to pollution often have fewer producers than end users. Another advantage of early fee application is that it brings the substance under control before it enters the myriad of streams in the supply chain.

For situations where *natural* substances accumulate in the environment, another point will need to be identified. For example, where individual households release untreated sewage into the sea.

## DEFINING SYSTEM BOUNDARIES

The following illustration comes from the paper published in Nature called “a Safe Operating Space for Humanity.”<sup>15</sup>

| <b>PLANETARY BOUNDARIES</b>                                   |   |                   |                  |                      |
|---|---|-------------------|------------------|----------------------|
| Earth-system process  | Parameters  | Proposed boundary | Current status   | Pre-industrial value |
| Climate change  | (i) Atmospheric carbon dioxide concentration (parts per million by volume)  | 350               | 387              | 280                  |
|   | (ii) Change in radiative forcing (watts per metre squared)  | 1                 | 1.5              | 0                    |
| Rate of biodiversity loss                                     | Extinction rate (number of species per million species per year)  | 10                | >100             | 0.1-1                |
| Nitrogen cycle (part of a boundary with the phosphorus cycle) | Amount of N <sub>2</sub> removed from the atmosphere for human use (millions of tonnes per year)  | 35                | 121              | 0                    |
| Phosphorus cycle (part of a boundary with the nitrogen cycle) | Quantity of P flowing into the oceans (millions of tonnes per year)   | 11                | 8.5-9.5          | -1                   |
| Stratospheric ozone depletion                                 | Concentration of ozone (Dobson unit)  | 276               | 283              | 290                  |
| Ocean acidification   | Global mean saturation state of aragonite in surface sea water  | 2.75              | 2.90             | 3.44                 |
| Global freshwater use   | Consumption of freshwater by humans (km <sup>3</sup> per year)  | 4,000             | 2,600            | 415                  |
| Change in land use  | Percentage of global land cover converted to cropland   | 15                | 11.7             | Low                  |
| Atmospheric aerosol loading                                   | Overall particulate concentration in the atmosphere, on a regional basis  |                   | To be determined |                      |
| Chemical pollution  | For example, amount emitted to, or concentration of persistent organic pollutants, plastics, endocrine disrupters, heavy metals and nuclear waste in, the global environment, or the effects on ecosystem and functioning of Earth system thereof |                   | To be determined |                      |

Boundaries for processes in red have been crossed. Data sources: ref. 10 and supplementary information

The challenge then, is to identify national or international supply chain entry or exit points that affect the Earth-system process, and apply flexible fees to control them.

As an example, the Earth-system boundary is crossed by carbon dioxide when burning fossil fuels. Entry points into the supply chain are at extraction or import. Here import duties or extraction duties could be applied.

<sup>15</sup> *Nature* 461, 472-475 (24 September 2009) | doi:10.1038/461472a; Published online 23 September 2009

For plastics, fees could be levied on sales of raw plastic pellets, and discounted when pellets are produced from recycled plastic.

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## BENEFITS OF THE HÖGLUND MECHANISM

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### COMPETITIVELY NEUTRAL

The fee-setting mechanism is based on what the market can handle. The advantage of this is that the fee does not offer competitive advantages to one actor or another, but rather encourages the free market to dominate within accepted rates of reduction of externalization.

### USES TRIED AND TESTED COMPONENTS

The Höglund approach uses components that are already in place. For example, variable fees and taxes are used for differential VAT. Congestion charges are levied depending on time of day. Sweden and a few other countries already levy carbon dioxide fees on fuel.

Using already existing mechanisms means the costs for the introduction of flexible emission fees can be kept low.

### UNCERTAINTY STIMULATES MARKET ACTOR'S ATTENTION

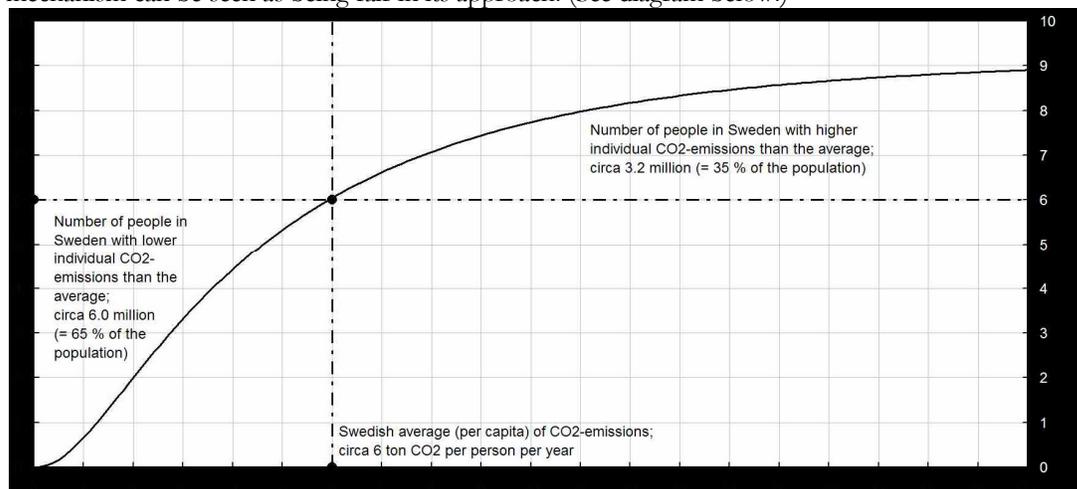
Because the uncertainty generated by the fee system will cause futures market to arise, there will be greater attention on the economic consequences of emission. This is good because the greater information spread will create more awareness of the issues involved and greater willingness to invest in these areas.

### POLITICALLY EXPEDIENT

Because the fee is set in effect by market forces, the level of political involvement is restricted to creating agreed emission targets and introducing the mechanism. This relieves politicians from having to get involved in the dichotomy between preserving ecological services, health, and natural resources versus the demand for citizens for economic growth. It makes it possible therefore for politicians to work towards sustainable development.

### AFFECTS THOSE WHO CAN AFFORD TO PAY

Analysis reveals that a major percentage of emissions are actually caused by a majority of the population; those with the best incomes. Because the fee is passed on to the end consumer, it will be the best paid members of society - those who can best afford it - who will be affected by higher costs. This means the mechanism can be seen as being fair in its approach. (See diagram below.)



*The top 35% of the wealthy in Sweden are also the largest polluters Source; Höglund*

### **CREATES A REVENUE STREAM THAT CAN BE TRANSFERRED BACK**

The fee can be used to further stimulate transition to cleaner technology. It can be transferred back to those who originally incurred expenses, for example as grants, to introduce clean technology. This mechanism is both fairer and stimulates sales of cleantech and development of “green” jobs.

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### **Q&A**

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#### **Surely emissions fees have been tried before- what is different about the Höglund mechanism?**

Emission fees have been applied it is true. Sweden has a Carbon Dioxide tax on petrol. What is different (and not been tried) is that Höglunds fee is flexible and carries with it uncertainty. If emissions do not go down, despite fees, fees are raised for example. If they go down too quickly, there is possibly detrimental effects on the economy, so they can be adjusted downwards. Although flexible fees have been introduced in airline seats for example, they have not been tried for emissions.

#### **Surely, tough restrictions at home will destroy companies’ competitiveness with foreign firms at home and abroad**

It is true that applying an emissions tax in one country could favor importers. For example, manufacturing of a car can take as much oil (and create carbon dioxide emissions) as the car uses as fuel in its lifetime. A car manufactured in another country and imported will be comparatively cheaper then, as its manufacturing costs are lower.

This illustrates some important points:

- i) A sustainable approach to economy works best on a regional or global level
- ii) A country introducing flexible emissions fees would do best to concentrate on areas where imports from countries with fewer restrictions created a problem for national producers
- iii) The fees collected should be used wisely. For example, subsidies on green vehicles could favor home manufacturers even against importers.
- iv) Emissions fees are applied to substances entering the country, and are thereby neutral to competition. Exporters will not be affected if they do not emit pollutants in their home country.

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### **CALL TO ACTION: PILOTS AND DEMONSTRATIONS**

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The Foundation strongly advises nations to consider the introduction of flexible pollution fees. Experience shows that more information about the fees, the mechanism, about how markets affect the supply chain and the futures markets is needed by decision makers before they are able to commit to the introduction of such mechanisms.

Therefore, the Foundation advises setting up demonstration, or pilot schemes to allow decision makers to study the implications and mechanisms of this approach. The Foundation is willing to provide their expert assistance for this.

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## APPENDIX

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### MORE ON MECHANISMS OF PRICING EMISSIONS FEES

The figure below shows the intersection of a Marginal Abatement Cost (MAC) curve and a Marginal External Cost (MEC). It illustrates the effect of a static pollution fee on levels of pollution, assuming perfect competition. By imposing an optimal fee of  $t^*$ , the level of pollution is reduced from some level  $Q$  (which would be where the MAC curve crosses the horizontal axis) to an optimal level  $Q^*$ . Similarly, a quantity constraint would fix the cost of pollution such that  $Q^*$  is reached. Approaching the pollution issue from this perspective, the challenge for policy makers becomes formulating policy which arrives at a fee level that approaches  $t^*$ , or a quantity constraint that approaches  $Q^*$ .

It is, in many cases, difficult to identify a reliable MEC curve, particularly with longer-term environmental issues such as climate change. In the case of the climate debate for example, substantial resources have been devoted towards developing a better understanding of the MEC. The International Panel on Climate Change and their assessment reports are an example of the steps that are being taken.

MAC curves on the other hand have been derived either using a “top down” or a “bottom up” methodology. Top-down curves are derived from economic models. These are generally produced from Computable General Equilibrium (CGE or GEM) models. Such curves cannot distinguish accurately which sectors or technologies produce abatement and are dependent on the extrapolation of past trends when deriving their curves. On the other hand, bottom up curves are derived from engineering studies and technology assessments. Such curves exhibit good detail but often have gaps in one or more sectors due to a lack of data and do not include feedback effects on other economic variables of investing in certain options.<sup>16</sup> Deriving the MAC curve is difficult for a variety of reasons, commercial confidentiality being another important example. Indeed, many economist consider that the government is in a poor

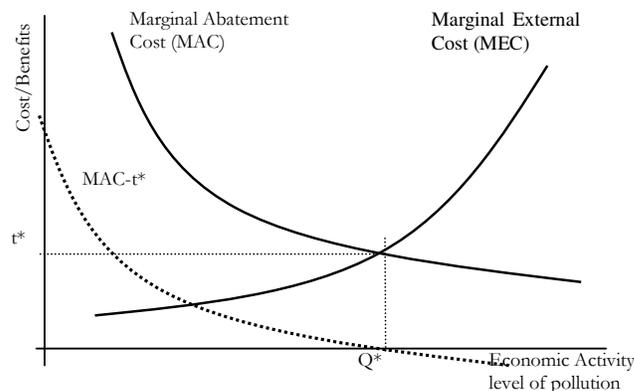


Figure 0-1 – Optimal pollution level  $Q^*$

position to extract this information and some even go so far as to argue that the existence of this information asymmetry is enough to preclude government intervention.<sup>17</sup>

In this regard, environmental policy faces a considerable challenge. On the one hand, the MEC curve must be known to some degree. The less that is known about the result of pollution damages, obviously, the more difficult it is to formulate an effective policy. On the other hand, the MAC curve must also be known to some degree. The less that is known about the MAC curve, the harder it is to formulate an effective

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<sup>16</sup> Ellermann et al. (1998)

<sup>17</sup> Pearce and Turner (1990)

policy. Without the certainty of reliable MAC and MEC curves, there is the risk that the policy will overshoot or undershoot what is economically or environmentally optimal.

The flexible pollution fee would allow firms to act on an open market based on the information they have about their own abatement costs. By hedging their abatement investments (or even hedging their decision not to invest), a level of the pollution fee is established. The fee level would, in the long run, be a function of an aggregate MAC of those firms that participate on the market and the life of their abatement investments.

**From the NUTEK report “[A flexible pollution tax](#)”**

#### **ABOUT ANDERS HÖGLUND**

Anders Höglund is an engine researcher and part owner of Swedish-based Cargine. Anders worked for VOLVO for many years as a combustion engine developer. He started to develop his ideas on flexible emission fees in 1998 when he realized that modern control technology approaches, among other things used to make diesel engines clean, can be applied to modern economies. He has been a member of the Board since its foundation in 1995.

#### **ABOUT THE AUTHOR**

Stephen Hinton, BSc, Cert Ed started teaching science after completing his studies at the University of London, Institute of Education.. Moving into management consulting and then a career in Telecoms during the '90s, he continued to explore sustainable development and the power of innovation. In researching for his book, "Inventing for the Sustainable Planet" he realized that new, sustainable, paradigms were urgently needed. He headed the sustainable drinking water company, Purity, 2006-2008. Currently, he is working to establish new forms of sustainable settlements, called Eco-units and is project managing the Humanitarian Water and Food Award, based in Copenhagen. Recognizing his wide range of experience in industry, and his knowledge of sustainable development, Stephen was invited to join the Board of the Foundation in 2007.

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REFERENCES

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- Ayres, R.U. (1996). Limits to the growth paradigm. *Ecological Economics*, 19, 117-134.
- Cleveland, C. J. (2005). Net energy from the extraction of oil and gas in the United States. *Energy: The International Journal*, 30(5), 769-782.
- Cleveland C. J., Costanza, R., Hall, C.A.S. & Kaufmann, R.K. (1984). Energy and the US economy: A biophysical perspective. *Science*, 225, 890-897.
- Cottrell, F. (1955). *Energy and society*. (Dutton, NY: reprinted by Greenwood Press)
- Dung, T.H. (1992). Consumption, production and technological progress: A unified entropic approach. *Ecological Economics*, XX, 195-210.
- Gagnon, Nate and C.A.S. Hall. A preliminary study of energy return on energy invested for global oil and gas production. (In Review).
- Georgescu Roegen, N. (1971). *The Entropy Law and the economic process*. (Cambridge, MA: Harvard University Press)
- Hall, C.A.S. & Ko, J.Y. (2006). The myth of efficiency through market economics: A biophysical analysis of tropical economies, especially with respect to energy, forests and water. (In G. LeClerc & C. A. S. Hall (Eds.) *Making world development work: Scientific alternatives to neoclassical economic theory* (pp. \_\_\_\_\_) Albuquerque: University of New Mexico Press)
- Hall, C.A.S., Cleveland, C. J. & Kaufmann R. K. (1986). *Energy and resource quality: The ecology of the economic process*. (New York: Wiley Interscience. Reprinted 1992. Boulder: University Press of Colorado.)
- Jorgenson D.W. (1984). The role of energy in productivity growth. *The American Economic Review* 74(2), 26-30.
- \_\_\_\_\_. (1988). Productivity and economic growth in Japan and the United States. *The American Economic Review* 78: 217-222.
- Kaufmann, R. (2004). The mechanisms for autonomous energy efficiency increases: A cointegration analysis of the US Energy/GDP Ratio. *The Energy Journal* 25, 63-86.
- Kümmel R. (1982). The impact of energy on industrial growth. *Energy The International Journal* 7, 189-203.
- \_\_\_\_\_. (1989). Energy as a factor of production and entropy as a pollution indicator in macroeconomic modeling. *Ecological Economics* 1, 161-180.
- LeClerc, G. & Hall, C. A. S. (2007). *Making world development work: Scientific alternatives to neoclassical economic theory*. (Albuquerque: University of New Mexico Press)
- McDonough, W. & Braungart, M (2002). *Cradle to Cradle*. North Point Press

Odum, H.T. (1972). Environment, power and society. (New York: Wiley-Interscience)

Quinn, M. (2006). The power of community: How Cuba survived peak oil. Text and film. Published on 25 Feb 2006 by Permaculture Activist. Archived on 25 Feb 2006. Can be reached at [megan@communitysolution.org](mailto:megan@communitysolution.org)

Ricardo, David. (1891). The principles of political economy and taxation. London: G. Bell and Sons). (Reprint of 3rd edition, originally pub 1821).

Sanctuary, M., & Höglund, A. (2005). A Flexible Pollution Tax (IVL, The Swedish Environmental Research Institute).

Soddy, F. (1926). Wealth, virtual wealth and debt. (New York: E.P. Dutton and Co.)