

Advanced Master in Energy Systems Optimization

NEW ANGLES OF ATTACK

A CONTRIBUTION TO PREPARATIONS FOR
THE PARIS CLIMATE CONFERENCE 2015

Coordinated by
Prof. Nadia MAIZI



Abstract

Over the last 20 years, successive COPs have highlighted the need for urgent action in reducing greenhouse gas emissions to avoid the global mean temperature exceeding a 2°C increase. In the meantime, agreements discussed in the course of negotiations are extremely complex, mainly focused on legal terms. Discussions about the kind of decisions to implement, which rely on scientific contribution, seem to be on the back burner.

Several reasons explain this: the climate change timeframe is much longer than a political mandate and does not put across the urgency of the situation. Implementing long-term strategies relevant to climate issues is often difficult and the measures unpopular. For example, in France transport sector lobbies recently put up barriers to stop a new pollution tax.

Moreover, the decisions taken need to shake up a very inert system. To deal with climate urgency, new planning paths must be accepted.

For all of these reasons, the discussion process at climate negotiations is extremely slow and a range of approaches and measures at different levels should be envisaged.

This was the framework for the research conducted by the promotion 2014 of the Master of Advanced Studies 'Energy System Optimization', whose 8 proposals address climate change issues from a different perspective: they suggest that tackling the challenge at regional, sectorial, and individual levels can bring relevant and quicker results.

Even if they come across as fanciful policies or overly naive, we hope that these ideas will enlighten negotiators and extend policy choices in an interesting way.

Professor Nadia Maïzi,

MINES ParisTech, March 2015

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CLIMATE FUNDS IN SOUTHERN COUNTRIES

AN EFFECTIVE APPLICATION



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MINIMIZING ADVERSE IMPACTS OF CLIMATE CHANGE POLICIES

ECONOMIC DIVERSIFICATION OF OPEC



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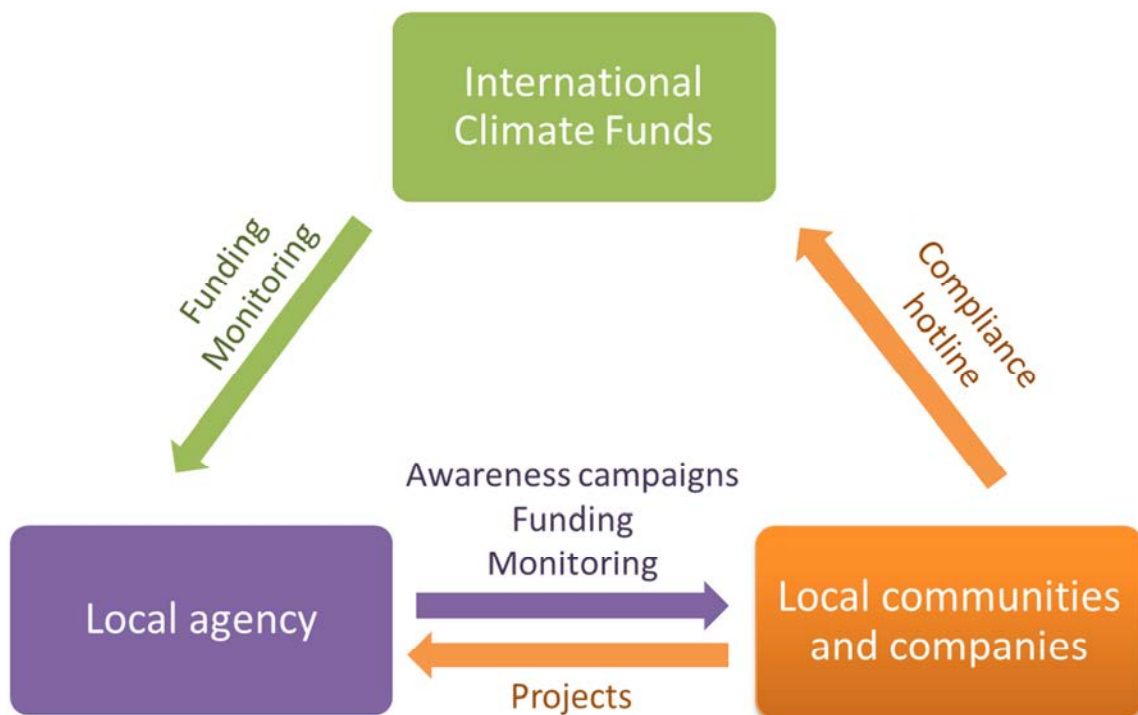
GREEN ECONOMY IN SOUTHERN COUNTRIES



CLIMATE FUNDS IN SOUTHERN COUNTRIES

AN EFFECTIVE APPLICATION

The issue of financial aid for developing countries is consistently debated at the multiple climate negotiation conferences (COP). So far, methods have proved ineffective, calling for a new system to be studied. Our proposal is set out in the following figure. It consists of a local agency in each target country, subject to an international organization managing the funds. Communities and companies could submit their climate change projects directly through this local agency. The projects would then receive funding and be monitored. Any complaints regarding the agency's operations could be reported to the international organization through a compliance hotline. This is particularly useful to combat corruption.



OPERATION OF AN EFFECTIVE FINANCING SYSTEM

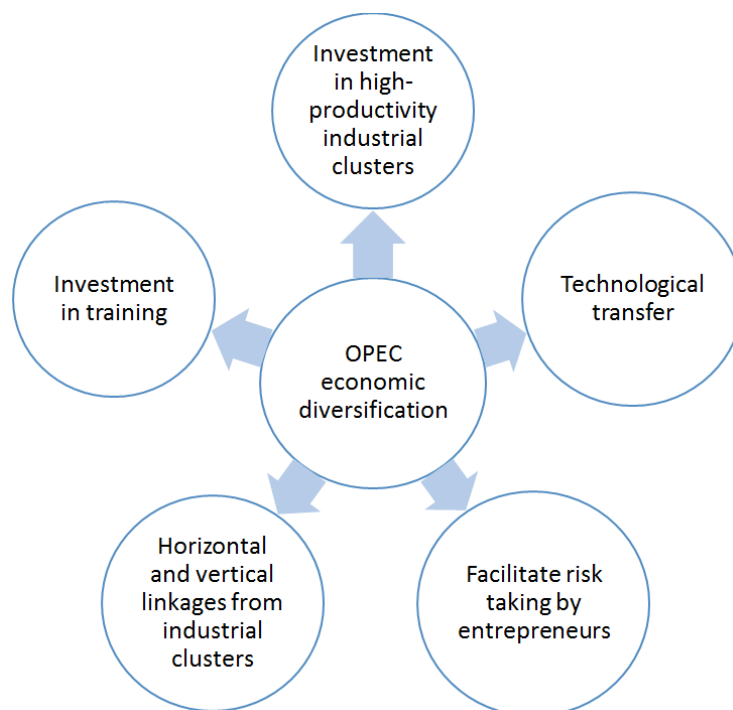
MINIMIZING ADVERSE IMPACTS OF CLIMATE CHANGE POLICIES

ECONOMIC DIVERSIFICATION OF OPEC

The organization of the petroleum exporting countries (OPEC) contributes to satisfying world energy needs, which increase year on year. Global primary energy consumption rose by 2.3% in 2013, a greater increase than in 2012 (+1.8%). Oil is the world's leading fuel, representing 32.9% of 2013 world fuel shares of total final energy consumption. Consequently, OPEC member countries' economies rely heavily on their petroleum export revenues.

However, energy usage represents the largest source of greenhouse gas (GHG) emissions. In the energy sector, CO₂ emissions account for the largest share of global GHG emissions. In 2011, CO₂ emissions from oil increased to 11.1 GtCO₂, a growth of 0.6%. Therefore, OPEC members see efforts to reduce emissions by implementing the Kyoto protocol as a threat to their oil export revenues. At climate negotiations, OPEC members solicit developed countries for compensation for their losses, to minimize the impact on their revenues. However, it is impossible to evaluate with certainty the level of lost revenues to be compensated.

In this study, we investigate different measures that could be employed to minimize the adverse effects of the Kyoto Protocol on OPEC. Economic diversification, as illustrated in the figure below, needs to be implemented to reduce OPEC's dependency on their petroleum export revenues and to meet the targets of Kyoto Protocol.



DIVERSIFICATION PROCESS

COAL POWER PLANTS

HOW TO ENCOURAGE BANKS TO FINANCE VIRTUOUS PROJECTS



**JEREMY
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URANIUM

TOWARDS BETTER USE OF A SENSITIVE RESOURCE



**JULIEN
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STEEL RECYCLING

AN OPPORTUNITY FOR CO₂ EMISSIONS REDUCTION



**ALICE
DIDELOT**



**MELISSA
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SUSTAINABLE GROWTH IN INDUSTRY AND ENERGY CONSUMPTION



COAL POWER PLANTS

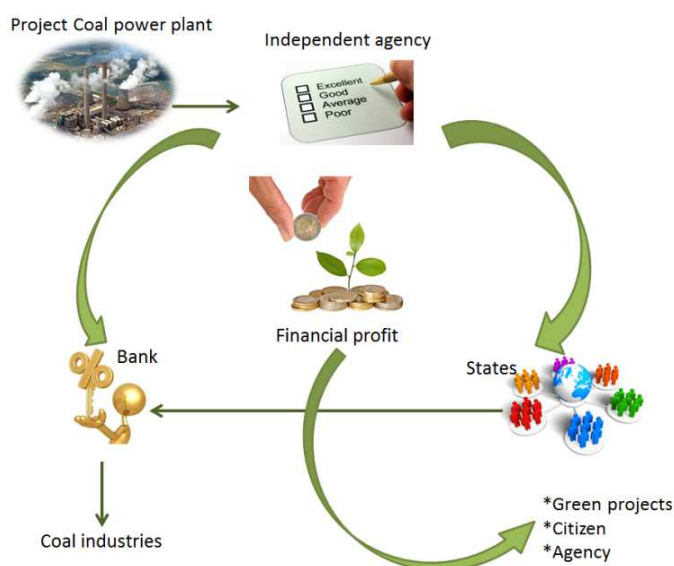
HOW TO ENCOURAGE BANKS TO FINANCE VIRTUOUS PROJECTS

To limit the temperature increase on the planet's surface, it is vital that we reduce our greenhouse gas emissions. Fossil fuels contribute significantly to greenhouse gas emissions, in particular coal, which is the most polluting combustible on the planet. It is also one of the most abundant natural resources.

Projects to build thermal power plants and coal mines are extremely expensive, sometimes costing several billion euro. These projects are difficult to achieve without the support of banks, which play a major financial role, either through granting credits to coal industries, or in other forms such as stock emission and bank bonds.

A study of 92 banks by Banktrack and Amis de la Terre gives the figures: from 2005 to 2013, banks invested 373 billion euro in the coal sector.

The aim is to set up a notating system to tax banks and companies that finance and build coal power plants.



A TAX SYSTEM TO CREATE GREEN FUNDS

The final advantage is that the notating agency could be paid, and India and China could be made more aware of their domestic energy issues. This fund could be also used to finance low-carbon projects and give projects the opportunity to use more powerful technologies. For example, supercritical power plants, which operate at higher temperatures and pressure vapor than traditional coal power plants. Therefore, they reach efficiency of up to 45% compared to a world average of around 30%. In 2012, only 10% of coal power plants were supercritical. Projects that were not of a supercritical type (or ultra-supercritical) would incur a strict penalty that would considerably bring down their rating. Thus, power plants fitted with CO₂ capture and storage systems would benefit from a bonus reflected in the investment effort.

First of all, a notating Independent agency carries out an environmental study of the future power plant buildings involving multiple requirements: GHG emissions, impact on air quality, water and soil pollution, social impact on neighboring populations, etc.

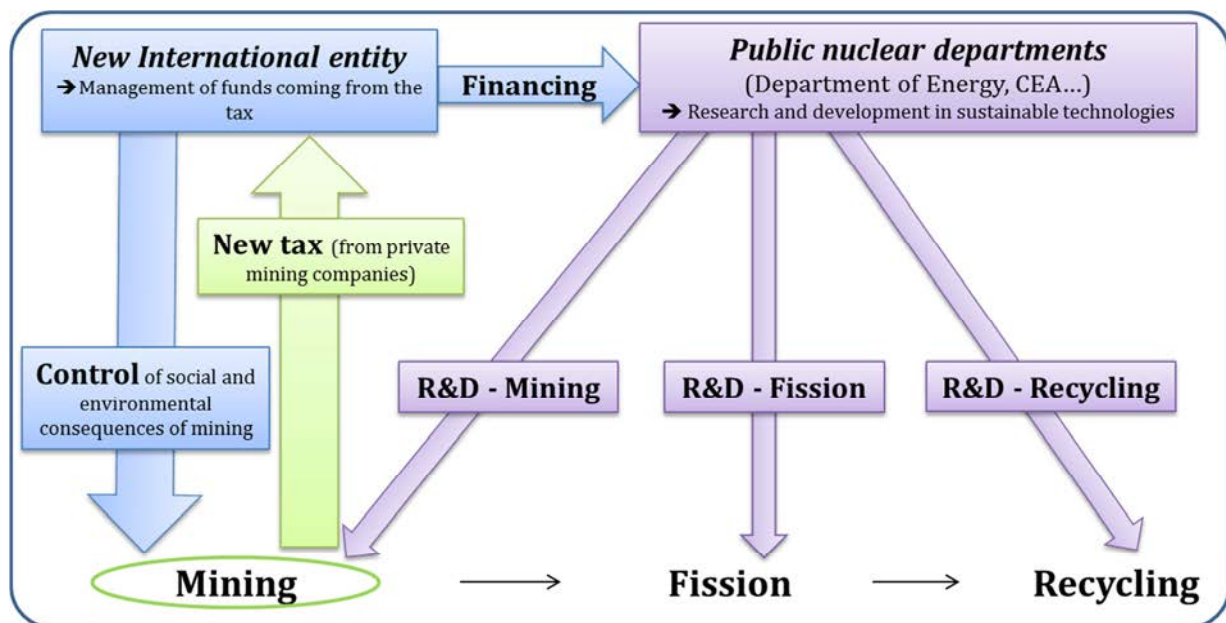
Depending on the type of technology used for the future power plant, the rating will be positive or negative.

This rating then obliges banks to adapt their interest rates for companies to which they lend money. Interest rates will go up in cases where rated projects fail. The banks' initial profits would go towards financing green funds. Secondly, states could increase the tax rate for banks financing projects that generate considerable GHG emissions. In this case also, profits would help finance green projects.

URANIUM

TOWARDS BETTER USE OF A SENSITIVE RESOURCE

Uranium is an energy resource that calls for careful consideration. The environmental and social problems caused by uranium mining are still not fully understood, and international environmental recommendations are not inspected on the field. In addition, technology has not yet found a way to recycle uranium waste. Rising energy consumption will inevitably lead to increased consumption of the ore along with its depletion if no technological solution is found for rational and sustainable mining. This points to the future technologies announced by nuclear plant designers. Fourth-generation reactors, which are currently a subject of research in many countries, will potentially multiply uranium reserves by 100, and guarantee waste recycling. If this technology comes to fruition, many current problems will be limited. Thus, efforts should be made to develop this kind of technology as fast as possible. As shown in the figure below, our study leads us to suggest a tax on uranium mining, aimed at private companies currently mining in developing countries, for example Areva, Cameco and Rio Tinto. The rationale is that distributing more financial funds would undoubtedly accelerate research in new technologies. The tax could be progressive to avoid strongly impacting the competitiveness of nuclear power plants. In our estimation, with a tax of US\$2.5/lbU during the first years, increased to US\$10/lbU after 10 years would raise US\$27 billion. This would increase by a quarter the funds already allocated to research and development in nuclear technologies. Part of this revenue would be allocated to mining technologies, and crucially used to improve their environmental impact rather than boost productivity. The consequence of such a process would be a decrease and therefore better use of the ore extracted.



TAX MECHANISM AND FUNDS REDISTRIBUTION

STEEL RECYCLING

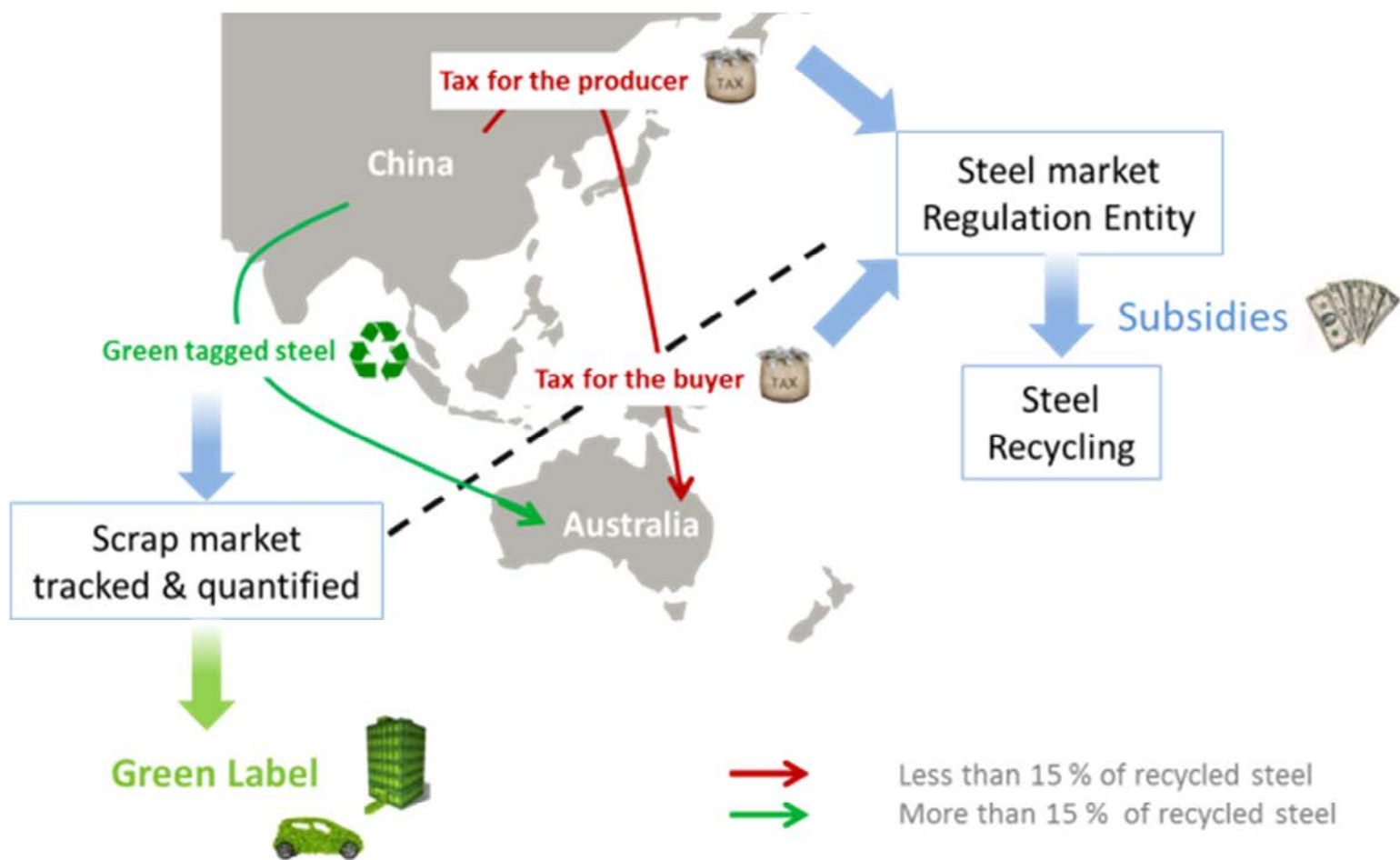
AN OPPORTUNITY FOR CO₂ EMISSIONS REDUCTION

Today's steel industry generates more than 6% of the world's CO₂ emissions. Since steel is 100% recyclable, with no loss of performance, it is the most recycled material in the world. Therefore, focusing on recycling seems to offer an interesting opportunity to reduce steel manufacturing emissions. However, this solution is strongly dependent on the development of electric arc furnaces and the availability of scrap. Establishing an import and export tax system could boost the steel recycling sector because exchanged steel raw material and finite products have to include a minimum proportion of scrap metal. An international independent entity would regulate steel flows and certify their composition.

In this energy-intensive industry, many solutions already exist to encourage CO₂ emissions reduction, like carbon capture and storage, and alternative reducer agents. However, these technologies are still insufficiently developed; they bring added value if they are accompanied by concrete support including recycling. Steel recycling is linked to the increasing development of electric arc furnaces. Nevertheless, its potential is limited by the amount of used steel available and the origin of the electricity required. Therefore, the level of national development and the energy mix are key factors to determine the type of steel production.

In order to encourage high-growth countries like China to shift towards more virtuous steel manufacturing methods, an international tax would apply to imports and exports of steel comprising less than 15% recycled steel. An international entity would manage the amounts charged to the polluting producers and buyers, which would then be reallocated as subsidies to stimulate the development of steel recycling. Recycled steel would be labeled with a green tag to ensure its traceability on the global market. This kind of international tax scheme could be applied to other industrial sectors, such as aluminum. The aim is to prevent undesirable delocalization and mobilize industrial actors as part of climate negotiations.

SUSTAINABLE GROWTH IN INDUSTRY AND ENERGY CONSUMPTION



IMPORT AND EXPORT TAX MECHANISM, GREEN LABEL CONCEPT

THE LEAN CITIZEN CONCEPT

A HUMAN-SCALE APPROACH TO REDUCING ENVIRONMENTAL IMPACTS



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WATER SCARCITY

FROM WATER FOOTPRINT TO A VIRTUAL WATER MARKET MECHANISM



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TRAFFIC CONGESTION

A SIMPLE, COMPREHENSIVE AND MULTIDISCIPLINARY TOOL FOR CITIES

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THE LEAN CITIZEN



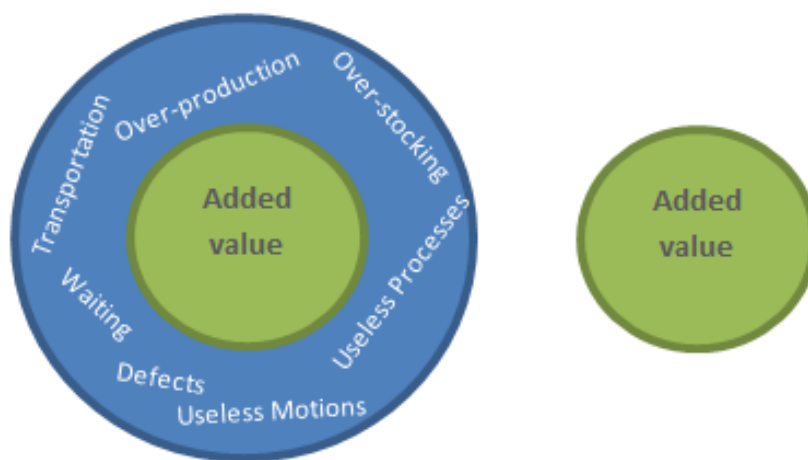
THE LEAN CITIZEN

THE LEAN CITIZEN

A HUMAN-SCALE APPROACH TO REDUCING ENVIRONMENTAL IMPACTS

Global consumption trends are responsible for a great deal of waste with much scope for improvement. We suggest limiting citizens' environmental impacts by focusing on a human scale. This bottom-up approach could also be a solution to compensate for global greenhouse gas emissions.

Our approach is based on an analogy with the manufacturing domain. The method involves focusing on added value by stamping out wastefulness.



LEAN METHOD

The following table sums up our proposal:

	Food supply	Drinking water consumption	Household waste	Domestic energy consumption
LEAN objectives	50% imported (max) (number of products)	75 L / day / person (max)	200 kg / year / person (max)	Heating: 20°C max Energy-efficient electrical equipment

The definition of a LEAN CITIZEN would be a world standard to aim for, regardless of a country's development level. However, solutions would need to be adapted to correspond to each country.

Scaled up to national level, these LEAN actions can have significant consequences: this could be likened to the "butterfly effect". The result would be to offset the North/South imbalance in terms of climate change responsibility.

WATER SCARCITY

FROM WATER FOOTPRINT TO A VIRTUAL WATER MARKET MECHANISM

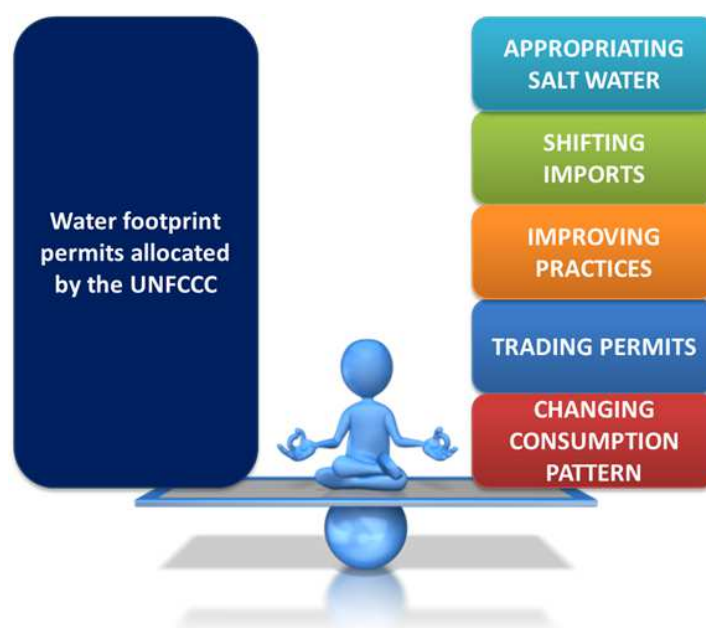
Freshwater is related to food, security and energy, making it one of the most essential resources on earth. As a result, water scarcity is a potential trouble spot in the near future, calling for urgent discussions of proposals to mitigate the risks.

In terms of considering CO₂ emissions embedded in products, the concept of “virtual water” can be used to map out all freshwater consumption in the production process of goods. By adding together all of the virtual water in domestic and imported products, we can work out a country’s “water footprint”.

The internationalization of commercial exchanges has a much greater impact on arid countries, like those in the Middle East and North Africa (MENA); these countries withdraw more than 40% of their available freshwater resources, generating considerable water stress.

Could a water market help reduce pressure on these regions by reflecting scarcity through price?

The proposal is to conceive a system of tradable permits between nations in order to improve social equity and ecological sustainability regarding freshwater. To ease the implementation of such market, it should be developed gradually based on national or even regional experiences, and should consider the specific characteristics of these regions. The political and legal aspects would be crucial, as the system would require creating independent authorities to conduct policies. Some of the funds earmarked to help developing countries adapt to climate change could be allocated to developing trade and adapting their social policies.



MEANS FOR HELPING COUNTRIES ADJUST TO THEIR WATER FOOTPRINT PERMITS

TRAFFIC CONGESTION

A SIMPLE, COMPREHENSIVE AND MULTIDISCIPLINARY TOOL FOR CITIES

From the perspective of the COP 21 and in order to push governments to stand by and scale up their commitments, Transport Day 2014 in Lima underlined the necessity for collaboration between local and national stakeholders and the need to decentralize objectives to local level.

An examination of congestion-reducing tactics in several major cities points to three main themes: Intermobility, Infrastructures and Intelligent Transport Systems (ITS). Therefore, we investigated the I^3 tool a simple and multidisciplinary concept that targets deficiencies and generates ideas. To encourage innovation, an “ I^3 label” could be granted to cities that improve their transport networks in each field.

The tool analyzes the whole transportation grid of a city. Following an examination of the entire city, the concepts are organized by field: public and private transport, infrastructure, Intermobility and ITS (cf. figure below). The most obvious concerns infrastructures, which form the basis of a city. For many people, infrastructure tends to imply expensive investments, but in fact Rapid Bus Transit, pedestrian zones and car-sharing are easy to set up and help to reduce jams in high-traffic areas. Intelligent Transport Systems give a boost to transit networks: Automatic Vehicle Location Systems (AVLS), priority transit signals, supervision, traffic apps, congestion charging, etc. ITS provides real-time services and makes the network flexible. Last but not least, intermobility links public and private transport means, because reinforcing these connections is key to easing congestion. According to our concept, a city is “smart” if innovations have been developed in the three main topics. The tool helps them to target their deficiencies and identify where they need to make improvements. In order to introduce concrete examples of traffic management solutions, several state-of-the-art innovations are presented through six success stories.

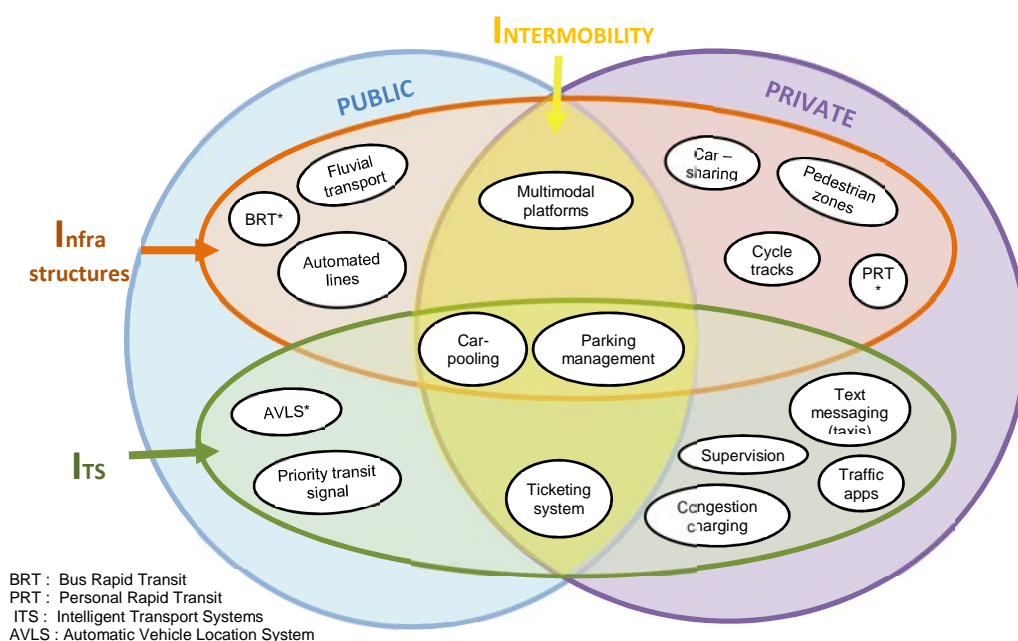


DIAGRAM OF THE I^3 TOOL

ABOUT US



ABOUT US

MINES PARISTECH

MINES ParisTech is one of the most prominent French engineering schools and a member of ParisTech (Paris Institute of Technology) and PSL (Paris Sciences et Lettres).

CENTRE FOR APPLIED MATHEMATICS

The Centre for Applied Mathematics is a research centre of MINES ParisTech. It was founded in 1976 during the creation of the Sophia Antipolis science and technology park where it is located. It comes under the Mathematics and Systems department and has been run by Nadia MAÏZI since 2000.

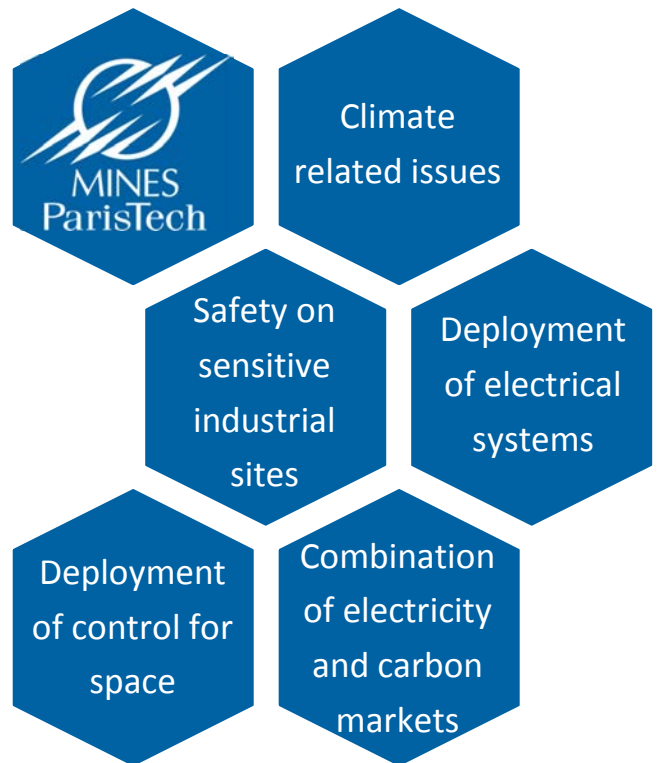
MODELING FOR SUSTAINABLE DEVELOPMENT CHAIR (MPDD)

The MPDD Chair centers around the MINES ParisTech Centre for Applied Mathematics (CMA) and the International Center for Research on the Environment and Sustainable Development (CIRED).

The Chair aims to firmly establish an internationally recognized prospective modeling center in France devising innovative tools to improve understanding of sustainable development issues within companies and different areas of public deliberation.



TOPICS OF RESEARCH



ParisTech's Chair Modeling for sustainable development

- *ETSAP : Energy Technology Systems Analysis Program
- *DGEMP: Directorate-General for Energy and the Climate
- *ADEME: The French Agency for Environment and Energy Management

ABOUT US

MASTER OF ADVANCED STUDIES IN ENERGY SYSTEMS OPTIMIZATION

The MINES ParisTech Advanced Master's Degree "Energy Systems Optimization" (OSE) is a high-level up-to-date Post-Master educational program in the energy field.

The OSE Advanced Master trains young engineers to be able to manage the energy projects of the future, in a specific context where markets are unregulated and environmental problems are on the increase.

Energetic chain analysis, optimization (decision-making support, long term prospective, mathematical programming), energy economy, project management and finance are studied to give students a global perspective of energy and climate challenges. Keys to research sustainable solutions responding to increasingly stronger constraints such as exhaustion of resources, political and financial constraints, etc., are also investigated. Lectures, conferences and projects concerning optimization and decision-support methods are at the core of the training.

A 6-month academic courses followed by a 6-month internship with an industrial partner enables student to specialize in the energy sector through an optimization-based approach.



Throughout the year, students are expected to carry out a series of challenging projects that require both academic and operational performance. This year, the central academic topic is related to the 21st Session of the Conference of the Parties (COP21/CMP11) to the United Nations Framework Convention on Climate Change (UNFCCC) that will take place in Paris in December 2015.

This topic will be the topic of two major conferences, one given abroad before an audience of international academics, the other organized every year locally for the French academic and industrial communities.



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