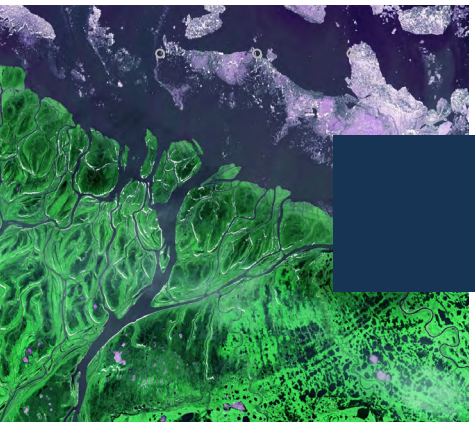
The Transition Institute 1.5

The ambition for an actual transition



SCIENTIFIC PROGRAM

The scientific program of TTI.5 focuses on the conditions surrounding the emergence and management of a low-carbon transition, related to the ambition advocated by the IPCC to restrict average global warming to 1.5 degrees. This means taking seriously all the implications of such a particularly ambitious global decarbonization objective, while the strategies to achieve it are struggling to prove their effectiveness. The research we conduct are driven by the question :

How can the advent of carbon neutrality be achieved and what is the extent of the transformations needed to reach this objective?

In order to find answers to this complex question, the Institute's scientific program is divided in 5 areas. The first research axis in TTI.5, **Design of the transition**, aims to clarify the mechanisms required to guarantee the desired decarbonization. Axis 2, **an electric planet**, explores the implications of an associated vision of decarbonization, including massive electrification. The third axis, **the inclusive planet**, is dedicated to identify solutions and tools to engage all actors in the transition, reconciling at the same time the multi-scale issues of the climate challenge and

the multiple constraints that they are both facing. Axis 4 will be dedicated to the analysis of the transition through the prism of international issues, to take into account **the planet as an issue of influence** of all kinds : geostrategic, commercial, economic, political, etc. The aim of Axis 5 will be **to elucidate the relationship with living beings** in the context of climate crisis and biodiversity loss.

The institute offers a resolutely holistic approach that requires the issues addressed to be discussed by integrating a set of unavoidable constraints in terms of : technological supply, vectors and resources, issues of operation and flexibility of systems, spatiality, pace of implementation, land use planning, lifestyles, costs and financing engineering, governance, regulation and institutional conditions, and externalities.

This scientific program has been designed to bring coherence, enhance, and extend the various research projects already conducted at Mines Paris - PSL. It should also make possible the initiation of new research on topics that have been rarely tackled until now, but which are necessary for the management of the transition. In addition, it will draw on the expertise of Mines Paris - PSL and the TTI.5 Institute's partners.



AXIS 1: DESIGN OF THE TRANSITION

Conception of the transition

The first part of this research theme seeks to unravel the mechanisms and dynamics of transitions. It aims to identify the mechanisms and processes that contribute to the triggering and realization of a strong and rapid decarbonization.

One of the applications of this axis is based on the development for transition models in order to support our analyses and reflections on a clarified framework. Such models will draw on analogies, for example with phase transition physics, or may be derived from retrospective analyses, etc. This should allow us to define clear objectives and evaluate the actual state of the transition of technical, social, economic, political systems and the conditions of their bifurcation towards a decarbonized system.

The second part proposes to study the nature of the movement and the forms of organization required to make this transition to a desired unknown reality. The approach could be inspired by lessons learned from different contexts, such as the semiconductor industry, where Moore's Law has led to the questioning of models and organizations in order to rethink our use of semiconductors and possible alternatives, taking into account the difficulties related to the complexities of globalized supply chains and the problems of resource availability. This work should allow us to reflect on new organizational and governance forms adapted to lead the desired transitions.

Transition engineering

In this section, we discuss low-carbon solutions and their regulatory environment, meaning the financial levers and public policies associated with this transition (investments, taxes, redistribution, subsidies) that should initiate and then drive the decarbonization process. This involves considering both solutions based on the decarbonization of production (green energies, CO2 capture, etc.) and solutions based on the modification of consumption (sobriety, efficiency, etc.). In order to avoid the solutions of the one becoming the problems of the other, these solutions will always be evaluated through different disciplinary, temporal and spatial prisms and their interaction and integration into the economic, energy, political and social system.

As an example, technological solutions concerning buildings will be discussed regarding their integration into the energy system at different scales, issues of associated consumption (self-consumption, digital externality), use of nudges, insulating materials, household equipment, behavior, policy, standards, subsidies, competitiveness, etc. Concerning the integration of CO2 capture, storage and utilisation techniques (CCUS) or hydrogen use in the reconfiguration of the industrial sector, we will address not only the technical issues, but also the issues of acceptability, the geopolitical consequences of the reorganisation of the sectors, the industrial policies of deployment of the technologies themselves, etc.



AXIS 2: AN ELECTRIC PLANET ?

This axis is dedicated to question the relevance of a vision regularly put forward as a desirable or even indispensable orientation for the transition : the deployment of the electric vector. The purpose is to explore issues inherent to electrification and propose to define the technical, social, organizational and political conditions as well as the modalities for the implementation of trajectories that are conducive to a low-carbon transition at different scales.

This requires exploring both technological and consumption trajectories that are compatible with decarbonized electrification. In this regard, we need to consider operational issues for the electricity system, production technologies, energy carriers and resources, as well as lifestyles. We also propose to explore the economic and political levers for implementing the identified trajectories. To ascertain the coherence and applicability of the analyzed measures, projects and solutions, the questions will always be approached in terms of accessibility, social appropriation and acceptability and we will propose multi-scale analyses allowing to take into account regional singularities, geopolitical conditions as well as various externalities such as the export of impacts (digital sector, consumption of rare metals, relocation, etc.).

For all considered options, research conducted at the Institute will aim to clarify the tensions that arise around energy choices related to electrification, through the analysis of their environmental impacts (in particular through life cycle analyses), issues

related to the management of resources needed to follow these trajectories, socio-political questions linked to these choices, and business models related to this bifurcation towards an electric planet.

For example, in the deployment of renewable energies, such as solar energy, all aspects related to the choice of this resource will be strengthened : life cycle analysis of panels, environmental risks, issues of materials and resources needed, resource forecasts, effects of the deployment of photovoltaic on competition in land use, planning issues related to integration into networks and in a territory, associated business models, investment needs, uses, regional acceptance, etc.



AXIS 3: THE INCLUSIVE PLANET

Since the transition responds to a global problem, it is necessary to integrate all scales and all actors in society while ensuring coherence between them in order to avoid, once again, that the solutions of some become the problems of others. This axis deals respectively with the issues of governance of this transition towards a decarbonization of our societies and the inclusiveness of this governance, which also remains framed by some physical constraints. Conditions of this inclusion are developed taking account of the multi-scale nature of climate challenges and the constraints we are facing to solve this decarbonization:

in particular the physical limits linked to the planet's finiteness and all the associated consequences at the economic, social, geopolitical level, etc.

Actors

The idea is to identify solutions that will allow us to engage the various actors in the transition. Initially, our work will focus on businesses and households. In order to question the various options for engaging businesses and industries in the transition, we will consider tools to clarify the approaches and strategic choices of companies, the incentives and coercive measures to be deployed, while integrating the challenges of viability, sustainability and adaptation. As an example, the developments envisaged on the scale of a territory will be evaluated according to their integration in the metabolism of this same territory (integration in the flows and stocks of materials within the territory, integration in the urban, economic and social fabric). Some of the tools that support this approach include the design and deployment of ecological accounting tools, the construction of indicators specific to decarbonation, the implementation of life cycle analyses, the consideration of environmental risks, business models and prospective approaches.

It also means designing tools to encourage the commitment of households to the transition and the reshaping of their lifestyles, to activate sobriety levers and to encourage the use of low-carbon solutions in the three sectors of mobility, housing and the consumption of goods and services. The questions raised will take into account the issues of acceptability and accessibility of solutions, services, infrastructures, resources and all that contributes (in terms of forms of governance) to the broadest possible social appropriation of these socio-technical choices related to decarbonization.

Coherence tools

We propose to deploy tools and approaches that allow the coherence of various actors in the transition, among which are the circularity models. Faced with the challenges of finite resources, continuous growth of waste production and reduction of greenhouse gas emissions, circularity models aim, through recycling, reuse of products and reduction at source of waste and production, to simultaneously transform supply systems and consumer behavior. This involves reducing the material footprint of the economy by improving material efficiency, extending the life of products and technologies (reparability, reuse) and intensifying their uses (economy of functionality). Their implementation requires coordination of a large number of actors (local authorities, companies, households, associations) and raises questions about different scales of action and decisions. Therefore, they are relevant to reflect on the principles and conditions of implementation of the circular economy and industrial symbiosis.



AXIS 4: THE PLANET AS AN ISSUE OF INFLUENCE

This field is dedicated to the analysis of the ethical and geopolitical tensions that arise around the issue of environmental protection. Insofar as these issues can constitute factors of inertia and thus represent obstacles to the transition, it' s essential to understand the fundamentals and to decipher the mechanisms that drive them.

Equity Issues

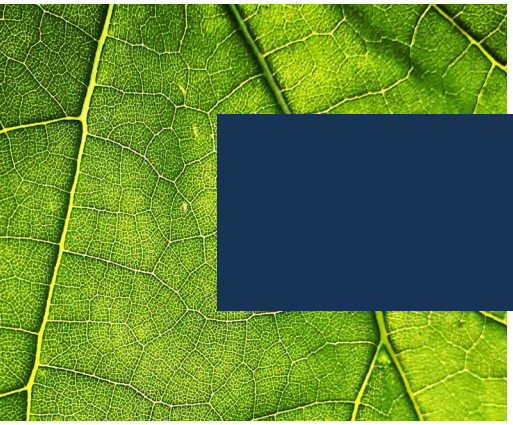
In this axis, we question the organizations, political instruments, financial mechanisms, as well as the rules, procedures and norms that regulate global processes of climate and biodiversity protection. In particular, we propose examining the ways in which global objectives are constructed and implemented. This insight is inseparable from an understanding of the technical, economic, social and political conditions associated with the various objectives adopted, and more particularly those related to temperature stabilization.

Discussion of how global objectives should be applied to different scales is also fundamental : this requires questioning the distribution of reduction efforts, and re-examining questions of differentiated responsibility and fair contribution to decarbonation. Behind these questions lie ethical issues related to resource management as well as engineering practices and, at a more political level, issues of environmental justice, ownership and value sharing, which must be linked to the constraints of climate physics. More specifically, a true low-carbon transition requires taking into account not only the point of view of developed countries, but also those of emerging countries whose visions and models may differ substantially from the developed ones. The issues surrounding the use of indicators as an information system in governance (issues of outreach and accountability; issues surrounding the conventions used; issues concerning the management of data and the intervention of the private sector) are also central.

Competition and geostrategy

While the transition is part of a global vision and context, it takes place at local levels, and is therefore confronted with diverse realities and competitive issues. The transition can also fuel economic competition between different economic actors: via patents, technological advances, the deployment of

sectors, standards, etc. Thus, the strategies of influence around the climate change The position displayed by several regions, from the EU-27 to China and the United States, of wanting to take power over the climate issue, is driving a reshuffling of international power relations, which is leading to a reappraisal of cooperation but also of forms of rivalry, especially over the control of resources. These relative positions are also elements that must be integrated in the reflection for the elaboration of a real low-carbon transition.



AXIS 5 : THE LIVING PLANET

Exploring our relationship with living beings in the context of the climate crisis and the erosion of biodiversity.

The Earth is a 'living planet' because it possesses properties that allow life to emerge and be sustained, as manifested by the presence of organisms capable of reproducing, growing, developing and, ultimately, dying. Living beings structure the biosphere, which is itself the result of multiple interactions with the elements of the geosphere (lithosphere, hydrosphere, atmosphere).

The development of our societies (anthroposphere) is based on these interactions because they provide us with energy and matter. In turn, our activities have a strong influence on these dynamics and, since the middle of the 19th century, the growth of the human population coupled with the development of

our technologies have led to a profound transformation of our natural environment, causing a degradation of biodiversity at an unprecedented rate, leading to the emergence of risk situations for our societies: erosion of fertile soils, forest dieback, degradation of water quality, epidemics and pests that spread more easily, disrupted climate regulation, etc.

In addition to these impacts on living organisms, climate change is amplifying uncertainty about the future of living organisms and ecosystem services, and could become the main factor in the degradation of biodiversity in the 21st century.

The 'Living Planet' research axis aims to explore the interdependence between our societies and the rest of the living world, in a context of transition, in order to understand the dynamics at play by recognising their complexity. This area examines the way in which we consider the living world, its governance, legal status and economic and social contributions, as well as its dynamics and future in the face of global change.

With a view to (Re)placing the living world at the heart of decision-making, we rely on prospective to provide new knowledge to support the transition of our societies and territories in the long term. This requires an analysis of the knowledge, methods and expertise involved in these anticipation practices, as well as the definition of indicators for the governance of the transition. In addition, we need to look at the solutions to be proposed in the light of the results of the research, how they are incorporated by decision-makers and how the democratic issues involved in defining a common future are taken into account.

The complex nature of the systems studied also invites us to approach transition using systemic and integrative approaches, such as the Ecosystem-based Approach (EbA), which explicitly recognise the relevance of interdisciplinary approaches combining natural sciences, environmental and earth sciences,

engineering sciences and human and social sciences to support planning and development decision-making processes by intrinsically considering the links between human societies, living organisms and environmental factors.

The activities of the Institute's members also aim to support the inclusion of living organisms in the tools used by companies to manage and steer their activities, and by local and regional authorities to plan for the transition.

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SCIENTIFIC PROGRAM

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