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Executive Summary of the study led by Nicolas Raillard for *The Shift Project*



EXPLORING FUTURES TO PLAN ENERGY TRANSITION

**GUIDELINES
FOR FUTURE STUDIES ON ENERGY AND POWER TRANSITION**

SCENARIO-BASED FUTURE STUDIES ARE VITAL TOOLS FOR THE 21ST CENTURY

The Shift Project is a French think tank that advocates the shift to a post-carbon economy. As a non-profit organization committed to serving the general interest through scientific objectivity, we are dedicated to informing and influencing the debate on energy transition in Europe.

Many other players (NGOs, public actors, professional associations, international organizations) seek to inform and influence the debate on energy transition through future studies. Several future studies reports are published each year in the form of "grey literature". These reports are not peer reviewed per se, but they involve professional or academic experts from various fields in their constructions, and they inevitably trigger reactions and criticism when they are released (a form of post publication peer reviewing).

Energy transition is a long-term process taking place through time, and involving all sectors of the economy, the environment and of society. The scenario approach clearly meets the requirements for exploring energy transitions: it is holistic and time-based. In addition, it leaves room for creativity and for exploring new, unconventional pathways. However, for this approach to positively influence the public debate on energy transition, it must be compatible with physics, and it must be truly holistic (otherwise certain first order consequences of the proposed transitions could be neglected).

Scenario-based future studies are currently facing various difficulties with regards to the high expectations placed on them. In a context of growing concern about climate change, biodiversity integrity, material and energy resource criticality, an increasing number of societal stakeholders question future studies regarding several aspects, and expect more and more from them.

We believe future studies are vital tools for the debate on energy transition, and we call for significantly more resources to be poured into future studies activities. In order to adequately inform the debate on energy transition, future studies should be more diverse, and their collective production processes should be upgraded. In addition, dialogue across future studies must be facilitated.

In January 2018, *The Shift Project* launched a project whose goal is to **foster the development of a science-based debate on energy transition through the scenario approach.**

We reviewed the collective practices of future studies with respect to these key topics. We observed several critical limitations. **We propose a Framework that helps scenario producers to overcome these limits, thus helping future studies activities to 'grow up'.**

Nicolas Raillard,
for *The Shift Project*

FUTURE STUDIES CURRENTLY FACE CRITICAL LIMITATIONS

THE LAWS OF PHYSICS ARE NOT PROPERLY INTEGRATED IN SOME ASPECTS OF ENERGY TRANSITION

Physical limits (planetary boundaries and resource depletion) are not discussed, with the exception of climate change. Very few studies discuss material depletion and changes in land use. Biosphere integrity is never discussed.

Climate change is taken into account through GHG emissions. However, **future effects of climate change are not discussed**, even in business as usual (BAU) scenarios which generally describe futures leading to high levels of emissions.

Energy flows are not properly accounted between economic production and energy demand. In scenarios, energy demand is not physically linked to the energy consumed by the energy system itself. This may be a critical limitation in the case where energy system self-consumption is significant in total consumption (which, typically, for example, increases during transition or may increase as a consequence).

Finally, certain **specific but critical aspects of the power system's operation are not systematically discussed**. In particular, frequency stability may not be ensured in some scenarios, because the level of reserves and inertia are not discussed. Reserves and inertia are required for the power system to remain stable and operate properly. Their lack may lead to power outages. Only a few studies assess the amount of reserves, and a few studies discuss inertia qualitatively.

SOME CRITICAL INTERACTIONS WITH SURROUNDING SYSTEMS ARE NOT DISCUSSED

We call an interaction "critical" when its integration in the scenario could result in significant changes in the story told. **Such critical interactions are not systematically discussed**. For instance, key environmental impacts (material or energy criticality, water use, land use, etc.), upstream conditions for employment to enable the transition (skills, training structures, geographical mobility of workers, etc.), and desirability issues, are rarely discussed, even though integrating them in the narrative could radically change the story. They are typically constraining or limiting interactions which could change the story.

TRANSPARENCY IS POOR IN SOME CRITICAL ASPECTS OF THE TRANSITION

The reasons for the technological improvements involved in the transitions described, from a technical or cost point of view, are rarely discussed in concrete terms. For example, no explanation is provided about what type of new design could be implemented, the amount research needed to develop them, or the concrete reasons for their cost decrease (offshoring in low-cost labor countries, improvements in design or production processes, etc.). This aspect is particularly critical for scenarios relying on technological advances and their smooth adoption through markets.

The reasons for the evolution of industrial activities are not systematically discussed, even in scenarios involving a trend reversal compared to today. In other words, no discussion is provided about why industrial activity would increase, or decrease (offshoring patterns, relocation patterns). This may be critical for scenarios in which industry represents a significant share of energy demand.

The stories told by models are not concretely described, due to the lack of popularization of models. Models are highly complex and take a long-time to understand (or might not even be fully understandable by a single person in some cases). It typically takes a significant effort to popularize results, but this effort must be made to foster democratic debate on energy transition, in which interested stakeholders understand the story as applied to their particular situation.

The transition of the power system distribution grid is never precisely described in future studies. This may be a serious limitation for scenarios involving large shares of renewables connected to the distribution grid, as they might entail significant modification of this grid.

THE EXPLORATION OF BEHAVIOR CHANGES AND OF DESIRABILITY ISSUES IS POOR, COLLECTIVELY SPEAKING

Behaviors change over a lifetime, depending on the social context, the material environment, and societal environment (economy, institutions, etc.). Political levers can foster such changes.

Collectively speaking, future studies hardly investigate aspects pertaining to behavior changes and instead focus on the smooth spread of technological changes (energy efficiency) in society through market mechanisms. This should not be seen as a problem for one particular future study to investigate technological progress. The problem for society emerges when a large majority of future studies focus on this aspect while leaving other aspects unexplored. Hence, geopolitical, political, institutional, cultural aspects are barely explored in future studies.

Similarly, **desirability of the transitions proposed is hardly explored**, except as an impact on total costs (undesired projects would cost more to implement because they would have to be modified, or moved away). We show that this question is much more complex and deserves discussion in future studies.

In a word, human aspects of future studies are typically neglected. This may be due to the fact that questions about the energy system are traditionally tackled by engineers and economists. However, in the context energy system transition, its systemic and all-encompassing aspect requires studying the evolution of human behaviors interacting with it. Hence **skills and knowledge from the behavioral sciences must be included in future studies production**.

ECONOMIC BOUNDARY CONDITIONS LACK DIVERSITY, COLLECTIVELY SPEAKING

Some studies take macroeconomic parameters as boundary conditions for the evolution of the energy system. Typically, GDP drives the overall levels of energy-service demand in scenarios, which in turn to a great extent drives the evolution of the energy system (both its supply and demand sides). In other words, in these scenarios, the GDP hypothesis determines society's capacity to modify and use the energy system. Thus, the GDP hypothesis is crucial.

However, **GDP evolution hypotheses are typically very homogeneous** across these future studies: stable and growing steadily, stabilizing at a low but positive growth rate on the long-term. These hypotheses emerge from a few narratives produced by a few actors, whereas many other consistent narratives could be imagined. Again, this should not be seen as a problem for a single future study, but may become one for society as no future study explores alternative GDP pathways.

The situation is the same for hypotheses about fuel prices. Unlike GDP, fuel prices do not drive the size of the overall energy system in scenarios. Rather, they drive the internal choices within the energy system, across different technological choices.

COMMON DISCUSSION FRAMES ARE MISSING TO LEVEL UP THE ENERGY TRANSITION DEBATE

In future studies, the vocabulary used to describe the evolution of energy demand is usually poor, composed of two concepts (energy sufficiency and energy efficiency). Similarly, the vocabulary used to think the evolution of behaviors fostered by policies is nonexistent. The vocabulary used to think desirability issues is typically composed of one concept (NIMBY). The vocabulary to discuss cost indicators and their meanings is missing.

Standardized ways of discussing hypotheses and results are missing, making it difficult for the scenario community to easily understand what is investigated in each future study and what is not.

In other words, the activity of future study production on energy transition could turn into a 'grown-up' science through the adoption of new collective concepts and frameworks to discuss and describe energy transition efficiently.

TURNING FUTURE STUDIES INTO A 'GROWN-UP' SCIENCE: OUR RECOMMENDATIONS

In order to overcome these critical limitations, **we propose a Framework**, which is primarily composed of **12 Technical Files**. The Framework is based on **a few guiding principles**.

TRANSPARENCY ON EACH KEY ASPECT OF THE TRANSITION

In order to foster transparency on more than a hundred key aspects of the transition, our framework, through most of its recommendations, asks for **different levels of transparency**. For each key aspect, the philosophy is the following:

- The first, basic level is that of discussing the future study's strategy regarding this aspect. The first step is to declare if this aspect is dealt with in the study. If it is not, a reason may be provided with regard to the driving questions of the study, and a qualitative impact analysis of not considering this aspect may be provided, typically to show that this aspect is not critical for the results.
- The second level of transparency is useful for the studies which indeed integrate the aspect. This level is about discussing the details of the aspect (the method used to handle the aspect, the different sub-aspects which need to be thought out and so on).

The ultimate objective of this guiding principle is that scenario producers do not neglect key aspects in their studies.

CONSTANT DIALOGUE WITH STAKEHOLDERS

Interacting with interested stakeholders has many benefits:

- It drives the discussions towards concrete concepts, that is, concepts which are intelligible to the interested stakeholders. Stakeholders are usually closer to the real world in their domains than scenario producers are. Discussion with them fosters concrete descriptions and transparency.
- It greatly reduces the risks of embedding unsaid interests or ideologies in the future study by including inputs from various interests and ideologies.

Interactions with stakeholders can be implemented **during scenario production** to help the future study integrate these positive aspects. It can also be implemented **during the writing** of the final report. For each key topic, **descriptions must be concrete enough to be intelligible** to interested stakeholders, even if they have not participated in the study production. For example, the description of daily passenger mobility must be intelligible to any individual taking a car, a bus, a bike, etc. in their daily life.

COLLECTIVELY ACHIEVING MORE DIVERSITY IN KEY HYPOTHESES AND EXPLORED SCENARIOS...

As presented, some key hypotheses are very homogenous across future studies. We call for a **collectively more diverse exploration of the future**.

In order to foster the emergence of "out-of-the-box" scenarios describing unconventional pathways (which is one of the powers of future studies activities) to collectively inform the map of possible transitions, we recommend for these hypotheses to **discuss the "mainstreamness"** of the hypothesis selected.

Exploring failed transitions is never done either, whereas it could provide key information on the possible failures and dead ends for our societies, and how to avoid them. No explicit recommendation is provided regarding this, whereas **presenting failed transitions** should be seen as a real advance for society.

...WHILE USING A COMMON VOCABULARY AND TRANSPARENCY FRAMES

More diversity is required in the scenarios explored, but **more homogeneity is required in the vocabulary and the frameworks used** to discuss energy transitions.

Our Framework proposes such frameworks and an associated vocabulary to collectively think and discuss several aspects of the transition: a new vocabulary to describe future studies efficiently; a framework and vocabulary to describe the evolution of energy demand and the associated levers; a framework for building and precisely presenting system cost analysis; and transparency framework to describe the technological evolutions of power system supply-side technologies and the associated key indicators is provided.

We recommend scenario producers to employ them, use them and make them evolve.

THE NEXT STEPS

This Framework is open to further co-construction with those who will use it and with scenario readers, as it is only a first proposal by *The Shift Project*, inspired by various experts and various published future studies.

This Framework is incomplete by nature, as it does not cover the supply-sides of all energy carriers. A next step could be to add the supply-sides of other energy carriers. For example, technical files on gas, biogas and so on could be produced, and the existing technical files updated to take into account the specificities of the gas carrier.

This Framework seeks to provide recommendations based on the practices observed in future studies. However, we did not systematically observe the practices of all the future studies on all the key aspects of the transition. Instead, for each key aspect, we reviewed

a few studies to obtain a sense of the current practices and their rationales. We did not perform a review for certain key aspects (e.g. driving questions, data openness, the description of models used, etc.). Furthermore, we interpreted these practices based on the study reports and available annexes, but we did not validate our interpretations with scenario producers.

This is why we aim at producing **complete benchmarks of a few existing studies and validating these benchmarks with the producers of these studies: this will be the next step of this project**. More concretely, we want to describe the current practices of these studies in relation to the key aspects of our Framework.

To this end, we are building a **future study checklist** which gathers the recommenda-

tions proposed in the Framework. For a given future study, this checklist can be filled so as to describe how the future study answers to the various recommendations. The ultimate goals of such a checklist are that scenario producers use it as a to-do-list during scenario production, and that they fill it before publication to efficiently inform the scenario community on where their future study stands among other future studies.

From this checklist, a **"future study ID"** could be extracted, in order to synthetically inform about the practices of a given future study.

METHODOLOGY

The Shift Project has been involved with scenarios since 2011, and has mounted a biannual scientific seminar at Les Houches Physics School, on "Science for Energy Scenarios".

After several editions, *The Shift Project* asked Nicolas Raillard, an experienced project manager and engineer specialised in complex systems, to lead a collective work whose goal is to foster the emergence of a science-based debate on energy transition through the scenario approach.

This project has been primarily funded directly by *The Shift Project*, and has benefited from partial sponsorship from ENEDIS (around 15%) and EDF (around 7.5%).

The work has benefited from the contributions of around a hundred experts and stakeholders.

The main results of this work are the guidelines contained in the complete Framework (12 Technical Files). These guidelines are primarily addressed to scenario producers.

The present Executive Summary and the Synthesis Report are addressed to all actors of society interested in gaining knowledge from, and about, future studies on energy transition.

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