ETH zürich

Institute of Science, Technology and Policy

ISTP Colloquium Autumn Semester 2021

A Collection of Reports

Written by ISTP Students

ISTP

Table of Contents

1 Climate Extreme and Unprecedented Weather Events: Conclusions from the **Newest IPCC Report** 3

2 What is the Problem of Solving the Climate Problem? Insights from Implementing **Carbon Pricing** in Germany and the EU 6

3 Technology Competition for the **Low-Carbon Transport** Transition in Switzerland / Can a Uniform and Dynamic Incentive Scheme Across Europe Lead to the Development of a Temporally Balanced and Spatially Distributed **Renewable Energy** Supply? 9

4 How Humans **Judge Machines** 11

5 Science **Policy Advising** in Times of a Pandemic 13

6 **Optimal Investments** in an Electricity System with Intermittent Renewable Generation - The Impact of Consumer Responsiveness / **Reskilling** for the European Green Transition 15

7 The Economics of Incomplete Plan: on Conditions, Procedures and Design of **Mission-Oriented Innovation Policies** 18

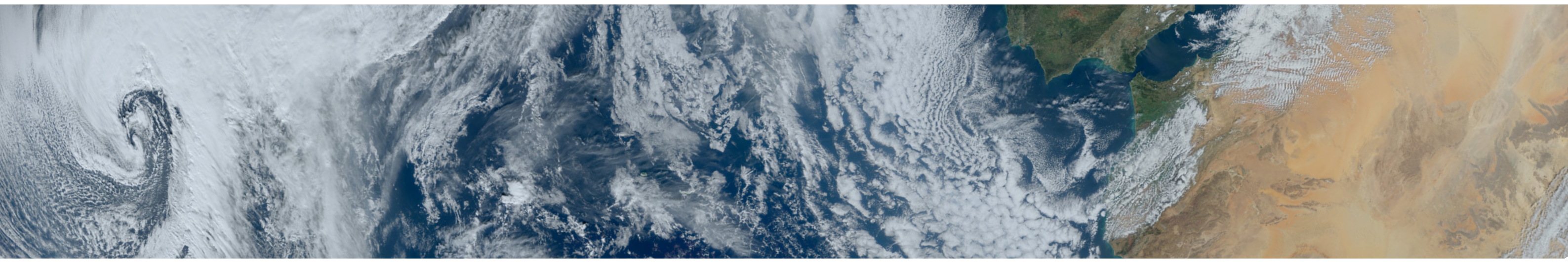
8 Deomcratizing **Tech Giants** 20

This collection contains reports about the ISTP Colloquia talks in the Autumn Semester 2021 written by our Master's students. Find out more about the ISTP Colloquia series: ***www.istp.ethz.ch/events/colloquia***

1

Climate Extreme and Unprecedented Weather Events: Conclusions from the Newest IPCC Report

by Florian Abeillon & Yilin Huang
based on an ISTP Colloquium talk by Prof. Dr. Sonia Seneviratne



With the recent release of the 6th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), there is a lot of buzz on the findings — but what are the key takeaways of this report? We were incredibly fortunate to have Prof. Sonia I. Seneviratne of ETH Zürich's Institute for Atmospheric and Climate Sciences break down the report before us. Having served as a coordinating lead author of this IPCC report, Prof. Seneviratne had many first-hand insights on the findings. We sincerely thank Prof. Seneviratne for her time and motivating talk full of daunting prospects but also hopeful prospects on how we still have a chance at stabilizing our climate.

Introduction

Six years after seemingly promising agreements at the 2015 Paris Agreement (COP21), the effects of climate change are still not waning: global warming rates continue to increase while climate imbalance has led to a record-high number of extreme events. In spite of the urgency, current political agendas do not reflect the necessary actions needed to stabilize — let alone to reverse — the trend. Prof. Dr. Sonia I. Seneviratne served as a coordinating lead author on the Intergovernmental Panel on Climate Change (IPCC) 6th Assessment Report. Released a couple of months before the October 2021 climate summit at Glasgow (COP26), this report will be the basis for providing policymakers with a scientific understanding of the current state of the climate and the possible scenarios for the future, in hopes of motivating policy that will limit human-induced climate change.

The Current Climate Situation

For Earth's climate, the 2011-2020 decade has been a first: the temperature level is at an unprecedented high in over 100,000 years, and warming rates are at the highest they've been in over 2,000 years. Compared to the average temperature in 1850-1900, this decade has been 1.09 °C warmer. As a reference, the Paris Agreement's objective was to "limit global warming to well below 2 °C, preferably to 1.5 °C, compared to pre-industrial levels". Thus a warming of 1.09 °C has already set in motion irreversible and lasting consequences to our climate. This overall increase has been even more pronounced on land, with an average warming of 1.59 °C, and some regions reporting even sharper increases.

Simultaneously, CO2 concentrations have been increasing unabatedly, and even the COVID-19 pandemic — which caused an exceptional reduction of industry activity world-wide — decreased CO2 production by only 7%. What is arguably one the most frustrating aspects however, is that the sources are confirmed and well-known: burning of fossil fuels and land use (mainly deforestation for agriculture). "It is unequivocal that human influence has warmed the atmosphere, ocean and land", reports the IPCC report, as 98% of the current global warming is assessed to be induced by human activity. But what do all these numbers translate to in day-to-day life?

Unprecedented Weather Extremes

Regardless of where you were physically, it was impossible not to hear of the extreme weather events happening around the world this year. The summer of 2021 brought to the world's attention just how drastic the effects of extreme weather can be, irrespective of the country's OECD development index. Severe flooding in Western Europe that was considered a 1-in-100 year event 60 years ago is now an event that is expected every few decades. Forest fires in Canada, California and Southern Europe have been touted "record-breaking" annually for the past few years. Not to mention still more devastating droughts and tropical storms wreaking havoc in developing countries.

One effect of the increased warming that Prof. Seneviratne highlighted for us was the increased occurrence of compound events. Compound events were especially emphasized in this edition of the IPCC report since they have been projected with high confidence to increase, in particular the combination of heatwaves and droughts. An incident that already supports this prediction was the combination of extreme heat and drought in Western Canada which propelled the intensity of wildfires this year, eventually leading many to be deemed uncontrollable.

Prospective Scenarios

Of the handful of scenarios portrayed in the report, only the most optimistic one is compatible with the aims of the Paris Agreement — that is to say to stabilize global warming at 1.5 °C. What is rather alarming is that, however optimistic the scenario, the frequency and intensity of extreme events will continue to increase with the effects of climate change.

In light of the exponential increase of extreme events due to global warming, it is clear that stabilizing at 1.5 °C warming should not be a second-class objective but rather a goal to aim for, given the much higher risks forecast in the +2 °C scenario. Prof. Seneviratne emphasized that this "minute" 0.5 °C difference could still have tremendous, yet less trivial impacts — it would for instance push many life-sustaining systems such as coral reefs from being dangered to extincted. An overall intergenerational inequity is at stake, and should be mitigated as much as possible: for example, in the +2 °C scenario, a child born in 2020 has a 4 times higher risk of experiencing hunger from crop failure compared to a child from 1960, and this factor goes up to 30 regarding heatwaves.

Stabilizing at 1.5 °C — What Needs to Be Done?

Now that the drastic effects of global warming are clear, the next step logically asks: what needs to be done to prevent this from worsening? Since global temperatures have already increased by 1.09 °C compared to pre-industrial levels, the next climate goal to maintain comparatively liveable conditions is to stabilize at 1.5 °C. This stabilization would require a reduction of global CO_2 emissions to be half of 2010 levels by 2030, and a net-zero CO_2 emission by 2040. Even so, reaching these objectives is not a full guarantee of stabilizing at 1.5 °C, as the IPCC anticipates only a 66% chance of succeeding even if the 2040 goal is reached.

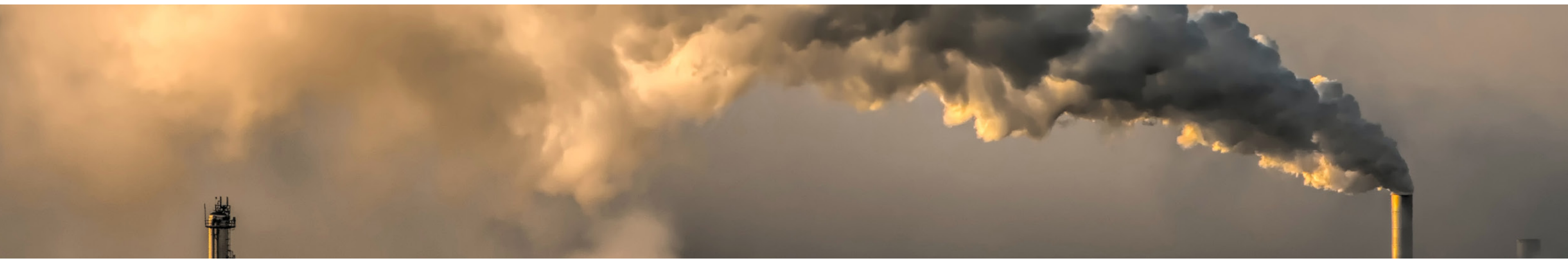
Yet numbers in a report will remain so, unless concrete actions are taken based on them. Ideally, we will no longer need to rely on fossil fuels — which are accountable for 90% of CO_2 emissions — replacing them with renewable, clean, electrified energy sources, while concurrently implementing CO_2 removal techniques, such as afforestation or various carbon capture and storage techniques. But how can we actually make sure this happens? Prof. Seneviratne noted that in her opinion, it would be more effective to have accountability on a year-to-year basis rather than a distant goal for say, 2050, as it is easy to promise to eventually take action when given a 30-year time-span. For a reduction of 50% by 2030, a 6% reduction of global CO_2 emissions is required annually — a much more tractable goal.

Ultimately, stabilizing at 1.5 °C requires an alignment between society and policy. It is not enough to create a political agenda, a change is simultaneously required in the habits and mentality of the people. Better air quality alone would bring health benefits that easily offset the global cost of emissions reduction. Doing nothing is costly, and brings us to an increasingly risk-prone world. Prof. Seneviratne wrapped up her talk by asking us: "What is the barrier to change in society?". Perhaps it is our expected standard of living, or it is a result of our economic systems — but knowing what is down the road, it is hard to justify a barrier being the reason we failed to change in time.

2

What is the Problem of Solving the Climate Problem? Insights from Implementing Carbon Pricing in Germany and the EU

by Thomas Mendoza and Chao Zhang
based on an ISTP Colloquium talk by Dr. Michael Pahle



To achieve its 2030 climate targets, Germany adopted the Climate Action Programme 2030 — two months after Dr. Michael Pahle and his colleagues wrote the report Carbon Pricing Reform Options, which was officially commissioned to the involved decision-makers as input during the creation of this policy. In this talk he reflected on the economic rationale behind the making of the recommended options and their subsequent receptions by policy makers, and in the end he also gave his personal thoughts on possible implications for policymaking research.

The Problem of Solving the Climate Problem

Climate change poses enormous challenges for society and decision makers, which calls for rapid action. However, given the severity of the issue and availability of technological solutions to hit the 1.5 degrees target, it seems somehow surprising that insufficient action has been taken until now — which Dr. Michael Pahle called the "non-action paradox".

The underlying problems are multifaceted and to mitigate climate change he suggested that it is better to take an incremental approach where, rather than starting from preset goals, actions are built upon existing situation and are adjusted stepwise. The reasons are that: firstly, there exists basic disagreement on objectives or values within larger society and decision makers; secondly, regulators often do not know how properly rank different and conflicting solutions; and thirdly, the prioritization of essential social objectives vary a lot in changing circumstances.

Options for Carbon Pricing Reform

In the second part of his talk Dr. Michael Pahle gave an overview of options suggested by him and his colleagues and explained the rationale behind them. When it comes to the assessment of carbon pricing instruments, Dr. Michael

Pahle underlined that there exist four instruments (regulation, carbon tax, DE-ETS, EU-ETS), each with advantages and disadvantages. He further stressed that it is not the instrument itself that matters — for example when comparing carbon tax with the emission trading scheme — but rather how the instruments are implemented and how policy makers design them institutionally. Since setting up sector specific targets would hinder the goal of a single economy-wide carbon pricing system, Dr. Michael Pahle argued that it is more desirable to have not only a national, but also EU-wide target independent of sectors. To achieve this conception, Dr. Michael Pahle suggested that Germany should start with a national scheme first and take a coordinating role within EU member countries to reach a convergence point in the future. This transnational coordination would however require stakeholders from different sides to overcome larger barriers.

Distributional Effects of Carbon Pricing Instruments as Key Lever to Reduce Societal Burden

For a successful implementation of carbon pricing, the distributional effect of such carbon pricing instruments should also be taken into account. In order to reduce the accompanying financial burden on the low-income households, Dr. Michael Pahle suggested that 100% of the revenues from carbon pricing should be paid back to the society through redistribution, for example via a "per-capita lump sum transfer".

Assessing the Climate Action Program 2030

After the "Options for carbon pricing reform" was presented and discussed in the German Climate Cabinet and Germany adopted a new carbon pricing scheme, Dr. Michael Pahle and his colleagues published another paper called "Assessment of the German climate package and next steps" in response. In the third part of the presentation Dr. Michael Pahle compared their initial recommendations from the first paper with the actual policies that came into force and provided explanations for the appearing discrepancies.

The first main recommendation was that governments should define a long-term price path with a carbon price starting at 50€ p. tCO2 and increase it to 130€ p. tCO2 in 2030. However, the final policy starts at a much lower price of 10€ p. tCO2 and increases it to 35-70€ p. tCO2, where only the path till 2025 is definite and the variability afterwards can be very high. The discrepancy can be mainly explained by existing legal barriers for implementing a carbon tax, the political challenges that energy taxes pose as well as CDU's preference to implement ETS not until 2025.

The second main recommendation suggested that the German government should fully use all revenues from carbon pricing to compensate the burden imposed on the low income. However, in the actual policy, due to legal and cost barriers related to direct transfers and other reasons, only 20% of revenues is used for redistribution in the form of reducing EEG levy and tax credits for long-distance commuters, which is, according to the assessment paper, too low to offset the burden for the low income once the price reaches as high as 60 Euros per ton, besides, another issue might have been that the carbon price level itself was discussed independently from the redistribution, therefore the assessment paper suggests that government should create favorable conditions for putting higher percentage of revenues into redistribution in the future and could consider the redistribution scheme first.

The third recommendation stated that a floor price should be introduced to the EU-ETS, and that the German government should aim to gear the carbon pricing policies towards a direction where it is possible to integrate them into a European-wide emissions trading system across all sectors. Both of these were accepted and written into the act, the latter of which was considered as a paradigm shift moment in German climate policy since it strategically oriented climate policy on the European level.

Implications for Policymaking Process

Finally, Dr. Michael Pahle shared his personal thoughts and reflections along the way. He suggested that policy making often involves many stakeholders and solutions are subject to legal and administrative constraints. In this regard research is only decision-relevant when it appeals to at least one of the decision makers and it should respect the conditions at which decisions are made.

We would like to thank Dr. Michael Pahle for his insightful presentation.

3

Technology Competition for the Low-Carbon Transport Transition in Switzerland / Can a Uniform and Dynamic Incentive Scheme Across Europe Lead to the Development of a Temporally Balanced and Spatially Distributed Renewable Energy Supply?

by Victoria Herbig and Jan Linder
based on ISTP Colloquium talks by Andreas Eckmann and Niklas Stolz

Andreas Eckmann and Niklas Stolz have just graduated from the MSc STP program and present their master's theses. Both works focus on the technological transition to a low-carbon system. While Andreas Eckmann looks at the competition between different technologies in transport, Niklas Stolz investigates an incentive scheme for better distributed power generation by renewable energy.

Andreas Eckmann: Technology Competition for the Low-Carbon Transport Transition in Switzerland

To reach the goals of the Paris Agreement, the road-freight sector needs to switch to low-carbon drive technologies. However, it is unclear to which degree this transition is economically feasible and how policymakers can stimulate it at a minimal cost.

Andreas Eckmann investigated road-freight transport in Switzerland for his master thesis at the Energy and Technology Policy Group (EPG). He presents a modelling framework that contains detailed and adjusted Swiss-specific data on the transportation sector, as well as insight from expert interviews and different technology and policy scenarios. It simulates competition between six drive-technology options: Diesel Trucks, Bio-Diesel Trucks, Natural Gas Trucks, Hybrid Electric Trucks, Battery Electric Trucks and Fuel Cell Electric Trucks (with hydrogen as fuel). Furthermore, the model distinguishes between the range and weight of the vehicles. As inputs for technological scenarios, prices and availability of newer technologies are estimated, as well as prices for fuels. As possible policy scenarios, the LSVA toll existing in Switzerland today for vehicles heavier than 3.5 tons, is adjusted in different ways for low-carbon vehicles.

The results of the simulation predict that battery electric trucks will outcompete other technologies in the future road-freight sector of Switzerland. Their biggest competitor, fuel cell electric trucks, will only be able to gain a cost advantage when the hydrogen price falls significantly. However, in the light-duty 3.5-ton vehicles, the transition to low-carbon drive-technologies is unlikely to happen without policy intervention.

Niklas Stolz: Can a Uniform and Dynamic Incentive Scheme across Europe Lead to the Development of a Temporally Talanced and Spatially Distributed Renewable Energy Supply?

Joining the topic of climate change mitigation, the focus of Niklas Stolz in his master's thesis at the Climate Policy Group extends to Europe and its power generation sector. As the share of power generated by renewable energy sources (primarily wind and solar) is expected to increase a lot over the next years, so does the dependency on resource availability from wind and solar irradiation. This vulnerability to local weather conditions can lead to a problem of energy supply at certain times in the future.

Niklas Stolz presents an incentive scheme which aims to improve the system-friendliness of newly constructed renewable energy electricity generators while keeping the addition cost-efficient and transparent. The goal is to make system-friendly locations, i.e., those that have other resource availability for typical European weather regimes than the already exploited locations, more attractive, even if the absolute resource availability is lower. This incentive scheme results in rewards for system-friendly allocation and penalizes the addition of system-unfriendly generators.

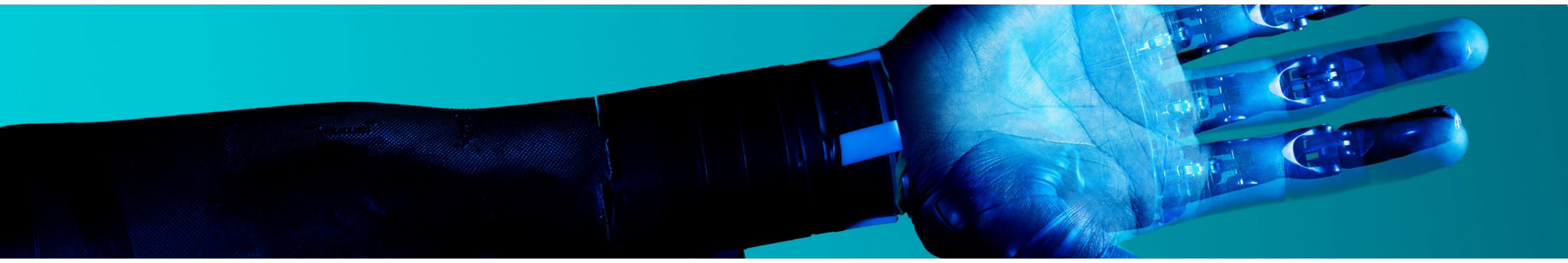
To evaluate the performance of the incentive scheme, different scenarios are modelled using the modelling framework Calliope. Compared to the baseline, the incentive scheme can substantially increase the energy system's resilience while the system costs increase by only 3.8%. This result suggests that a coordinated European strategy for the deployment of renewable power generators would be beneficial for the stability of the future European electricity grid.

We thank the two speakers, Andreas Eckmann and Niklas Stolz, for the interesting insight into master's theses at the ISTP.

4

How Humans Judge Machines

by Sam Mattern und Josep Perna
based on an ISTP Colloquium talk by Prof. Dr. César A. Hidalgo



How Humans Judge Machines compares people's reactions when actions are performed by humans and machines on the basis of several case studies. Data, generated from questionnaires after each case study, is used to compare the responses. The book illustrates how people judge Artificial Intelligence (AI) and provides some of the biases that are prevalent in human-machine interactions based on statistical models.

We live in a world where machines are becoming an increasingly important part of our lives. Not only do we have machines to do the most arduous tasks, such as working on an assembly line, but we also have AI algorithms that decide about aspects that impact people's livelihoods. Therefore, it is of great urgence that we take a decision on how we judge machines. Should we use the same moral philosophy that we use on humans? In the book "How Humans Judge Machines" presented during the colloquium, Prof. Hidalgo and his team look at the different biases that affect how we judge machines in comparison to how we judge humans.

Methodology

To conduct the research, Prof. Hidalgo recruited a sample of 6000 participants to take part in randomised control experiments. Participants were divided into two groups. Then, they were presented with a scenario where either a machine or a human would perform an action (e.g. an algorithm or human decides whether to save 50% of the population from a tsunami with 100% success rate or to save 100% of the population with 50% rate). Then, participants were asked a set of questions with respect to their opinion on the action by either the algorithm or human. Finally, the responses obtained from the two groups were compared to obtain results.

Algorithmic Bias

From previous research, we know that fairness is mathematically impossible. This is because fairness can be defined in a variety of ways. Thus, the outcome of an algorithm will always be unfair with respect to a specific definition of fairness. From this starting point, Prof. Hidalgo uses the data obtained to compare people's reaction to a biased algorithm compared to a biased human. He finds that respondents see the biased action of the human as more intentional and thus, believe that it is less moral and causes more harm. Nevertheless, the differences found are small, signaling that intent is not a strong predictor of judgement in fairness scenarios, or more plainly, that discriminatory decisions are seen as harmful independently of intent.

Automation

Studies show that there is no evidence that tech reduces the need for labour in the long run. Therefore, Prof. Hidalgo states that the main reason to fear technology should not be because it will destroy jobs but because it may make them more precarious, the gig economy is a clear example of that. However, in todays society, the feeling that technology will decrease the number of jobs is still predominant. This causes for a natural dislike towards these types of 'job replacing' technologies and is a great example of a common misconception of what AI can do and how it should be reviewed.

Conclusions

From the results of the experiment, Prof. Hidalgo draws several more general conclusions. He finds that we judge humans and machines using two different moral philosophies. In particular, humans judge machines by their outcomes, while they judge other humans by their intentions and the harm they provoke. Additionally, he studies if demographics can have an impact on the judgement of machines by humans but he finds very small effects. Therefore, from all the results, he reaches the conclusion that we don't have a preference for humans over machines, just two different ways of judging them.

We would like to thank Prof. César A. Hidalgo for the very interesting and thought-provoking presentation.

5

Science Policy Advising in Times of a Pandemic

by Anna Ingwersen & Samira Amos
based on an ISTP Colloquium talk by Prof. Dr. Martin Ackermann

«Leading the Swiss National COVID-19 Science Task Force was by far the most stressful, but also most meaningful period of my career!», this is how Prof. Dr. Martin Ackermann reflected upon his one-year experience as the lead of the COVID-19 Science Task Force. He gave an inspiring insight into the challenges and opportunities arising from the collaboration between scientists and policy makers, focusing on his subjective experience.

The Beginning of a Crisis

100’000’000’000’000 — that's the number of viruses on and inside each person. This number shows that viruses are everywhere, with some promoting health and others causing disease. So you might think that the SARS-CoV-19 virus is nothing out of the ordinary, just one out of a great number of many other viruses. Yet, for over a year, it has brought the world to a standstill. What makes the virus so special?

This question can be answered by looking at the mortality rate of the infection (how deadly is it?) and the basic reproductive number of the virus (how fast is it transmitted?). The virus has a higher age-related mortality than, for example, the seasonal influenza, and is also more transmissible. The evolution of the virus during the pandemic has made it both more transmissible and more deadly. Thus, the virus is special because of (1) its rapid transmission, which can also be asymptomatic, (2) its higher severity than seasonal influenza, and (3) the fact that the global community had no initial immunity to the virus. These characteristics risked overwhelming the healthcare system.

Mid-March 2020, the situation in Switzerland was doing exactly that. Ad hoc, it was the goal at ETH to pool the resources and expertise to support the Swiss government in its response to the pandemic. Therefore, an ETH Covid 19 Task Force was founded on March 18th 2020, which was carried by the ETH Board. Soon, it became clear that the pandemic touches upon every aspect of society and economy. Thus, the Task Force was expanded to be Swiss wide and interdisciplinary. The Swiss National COVID-19 Science Task Force was founded, including 10 expert groups and more than 70 scientists from over 12 scientific fields. All of these scientists offered their expertise voluntarily and without remuneration. In its 1st phase, the Task force developed 30 policy briefs and was then, in its 2nd phase, given a mandate by the government under the lead of our speaker, Prof. Dr. Martin Ackermann. This 2nd phase was characterized by close exchange with the BAG and the GS-EDI, access to more data and participation in the point de press, making the Task Force much more exposed. Ackermann dropped the lead on the 12th of August 2021, succeeded by Prof. Dr. Tanja Stadler. This marks the 3rd phase of the Task Force, which will end when the Task Force becomes obsolete.

Challenges at the Interface of Science and Policy

Such a close collaboration between science and authorities in the face of a pandemic was never seen before. For this reason, the work of the COVID-19 task force faced several challenges. One of the challenges was that the dialogue between the scientific task force and the authorities was initially difficult. As Ackermann emphasized, it was very important to be able to express ideas that were at an early stage and should be treated confidentially. Central to this constructive atmosphere was — as is so often the case — trust.

Particularly insightful was the comment that politicians are used to exchanging ideas with lobbying groups that pursue specific interests. Mutual understanding and the definition of clear roles was therefore very important: science does not pursue its own interests, but provides important information that should feed into the political decision-making process and inform the public so that it can play its role in democracy. Other challenges included the independent communication of the task force to the outside world and the communication of its experts as individuals. In both cases, this independent communication was important to create transparency and make the scientific assessment publicly available. However, contradictions or unclear statements could be confusing, so coordinated internal and external communication was needed.

The main aspects that challenged the collaboration between Task Force and the governments were masks, economic perspective, the second wave, the development of variants of the virus and the question of when the pandemic will finally come to an end. All of these aspects depended strongly on close communication between the scientists and the government. It took time, patience and trial and error to develop a level of trust between the different actors and with that, a more efficient and effective way of communication.

What Do We Take from It?

The colloquium concluded with a very interesting discussion and the audience almost forgot about their hungry stomachs and lunch break. The key takeaways from the presentation were that trust, mutual understanding, and clear roles are central to successful communication between science and government. Further strengthening institutional trust, defining structures, roles and processes for scientific advisory groups and training a new generation of scientists, politicians and administration will be important for future dialogues. Looking ahead, it is unclear what collaboration between the two sides will look like, once this health crisis is over. However, it came up in the discussion that building on what has been learned may well be important in light of other crises that already exist — such as climate change.

We would like to thank Prof. Dr. Martin Ackermann for his insightful presentation.

6

Optimal Investments in an Electricity System with Intermittent Renewable Generation - The Impact of Consumer Responsiveness / Reskilling for the European Green Transition

by Milena Bojovic & Anshuman Mishra
based on ISTP Colloquium talks by Sebastian Wagner and Felix Zaussinger

Sebastian Wagner-Vierhaus and Felix Zaussinger presented their master's theses during one joint session. The first thesis examines the effect of responsive consumer demand on the optimal level of investment for electrical storage and fossil and renewable generation. The second thesis addresses the consequences the European Green Deal will have on the labour market, assessing reskilling options within the shift to a carbon-neutral economy.

Sebastian Wagner Vierhaus: Optimal Investments in an Electricity System with Intermittent Renewable Generation — The Impact of Consumer Responsiveness

Research question: How does responsive demand impact optimal investment in fossil and renewable generation capacities and in storage?

The transition from fossil-generated electricity to renewables relies on the appropriate distribution of investment in concert with the maintenance of a sufficient supply to satisfy consumer demand. The thesis assesses the impact of responsive consumer demand on the optimal level and distribution of investment using a partial equilibrium model balancing the benefits of consumer electricity usage against the environmental costs of either fossil or renewable electrical generation. The optimal level of investments is assessed for three technologies: fossil generators, renewable generators, and electricity storage. Due to the intermittent availability of major renewable technologies like wind and solar, renewable storage capacity and consumer responsiveness can have useful mitigating impacts and maintain or expand electricity usage. The model presumes a centralized economy acting with the consideration of prioritizing societal welfare.

Model Construction

The initial simple model evaluates the impact of consumer demand balancing pollution and technology costs against electricity consumption and assumes two states: one where only fossil-generated electricity is available and one where both fossil and renewable energy are available if the marginal costs of installing renewables subject to an increasing cost function are lower than the marginal costs of fossil deployment subject to fuel and environmental costs. It is assumed that the cost of storage is substantially higher than the cost of fossil generation. Once investing in storage becomes economically feasible considering the increasing environmental cost of fossil generation, renewable energy can be stored and transferred from the state with both renewable and fossil energy to the state with only fossil energy. As a result, the total amount of necessary fossil electricity installment is reduced, with stored renewable electricity covering the requisite demand. The introduction of responsive demand completes the model, which allows for asymmetric direct consumption in states with and without renewable generation. In one corner solution, responsive demand could lead to the end of fossil electricity consumption as responsive consumers would solely consume renewable energy when available.

Results and Conclusions

Evaluating the model indicates that renewable energy storage and responsive demand complement each other in substituting fossil electricity upon higher environmental costs of the latter. Responsive demand decreases the necessity of storage. As a general case, increases in the price of carbon will lead the economy to transition from an economy with only fossil generation to one with no fossil generation. The model maps this transition. Ultimately, a higher share of responsive consumers generally entails decreased fossil generation and increased renewable generation capacity with optimal investing. However, there are circumstances where responsive demand can have the opposite effect, particularly at transitionary phases in states with equal marginal investment cost of renewables and marginal cost of deploying fossil fuels when renewables are available. At different levels of renewable diffusion there may be different levels of responsive demand. The policy implications are murky — responsive demand is beneficial to renewable profitability, but it may also increase fossil generation. It is optimal to install less storage with responsive demand than without. However, there are caveats to these conclusions — the model is centralized and decentralizing through introducing pricing is worth considering. Intermittency and storage are modelled in a static form despite being inherently dynamic, an assumption that deviates from reality if energy is stored and removed repeatedly. This thesis represents a useful foray into the investigation of additional factors that affect the optimal level of investment for electricity generation technologies.

Felix Zaussinger: Reskilling for the European Green Transition.

Global green transition efforts face substantial opposition from different fields. One concern is the potential for unjust shifts in the labor market as a result of this policy-driven transition to a carbon-neutral economy. Despite the green transition creating a net increase of jobs, regions relying on highly carbonized industries face the fates of losing their jobs as their industries decline. These substantial threats to the economy and livelihoods consequently prompt political repercussions. The implication for policymakers is to shift from an environment against jobs perspective, to a just transition effort, acknowledging and acting upon both intentions together.

The thesis addressed these issues by looking at the reskilling possibilities for the European Green transition. Policy procedures within the European Green Deal have already been put in place, with the Just Transition Mechanism enabling a fund of 40 billion Euro. Nevertheless, how these reskilling efforts and transfers from a declining sector to a growing sector will be enabled is yet to be determined. The thesis presents an initial exploration in this direction.

Distributional Effects of Occupation and Skill

Assessing transferability of skills in high-emission sectors, such as coal miners, to those in low-emission sectors, requires a closer definition of what skills and occupations are. The author assumes skills as applicable knowledge and know-how to complete tasks, whereas an occupation is a vector of skills. Placing said occupation on a vectorial space, differences between occupation can be assessed by distance. Applying the method to labor market data and projections for occupation demand changes enables a valuable insight into reskilling efforts.

A large variation in occupation similarity can be found, nevertheless with distinct clusters of occupations showing similar skill profiles. Looking at reskilling and the distribution of occupations in the different sectors brown (carbon-intensive industries), green (environmentally friendly industries) and neutral — further differences become apparent. In general, brown occupations experience harder than average transitions out of their sector based on skill, whereas transitions from brown to neutral occupations are at least more attainable on average.

Limits of Pathways and Assessing Thresholds

Transitioning into green occupations can be hampered by certain barriers within the occupational field itself. The thresholds for education and work experience are lower on average in the brown occupational sector than in the green sector. This leads not only to skill-related barriers, but also to system-related obstacles. In the neutral sector, thresholds for both education level and corresponding work experience range from zero to high, ultimately providing more entry points at different levels. However, feasibility of such transitions depends not only on the overlap of skill profiles. The transition must also be desirable, offering a reasonable wage continuity and be within acceptable proximity.

An exemplary case study in Germany shows how difficult this actual transition and reskilling is in regional labor markets: a simulation of reskilling is conducted using a sample of 35,000 coal-related workers. The simulation estimates that regional differences in transition trajectories as well as in income changes are readily apparent and show drastic changes within the country. Importantly, it is found that reskilling expands the number of favorable occupation transitions for at-risk coal workers, which allows them to switch into green or neutral occupations that — on average — pay a similar, or even better wage.

Conclusion

The green energy transition will undoubtedly change labor markets. Policymakers should have a substantial interest in avoiding involuntary displacement and helping workers to find jobs with skill profiles in alignment with their experiences. Successful allocation within regions of former highly carbonized industries, needs to be built on the existing local context and skillset. Finding and adapting the right pathways suited to every occupation at the regional level is crucial in sustaining and justifying a carbon-neutral economy.

We would like to thank Sebastian Wagner-Vierhaus and Felix Zaussinger for their research and insightful presentations.

7

The Economics of Incomplete Plan: on Conditions, Procedures and Design of Mission-Oriented Innovation Policies

by Fabian Bättig & Cyril Heim
based on an ISTP Colloquium talk by Prof. Dr. Dominique Foray

Prof. Dr. Foray is a professor at the chair of Economics and Management of innovation at the EPFL. As a guest in the ISTP Colloquium on November 24th, he talked about mission-oriented innovation policies (MOIP) and what it takes to meet the increasingly difficult social innovation needs.

What Is a Mission?

A mission is an intentionality that is not directly linked with economic incentives, for example the Apollo mission in the 80s was such a mission with a rather simple institutional setting: The state was contractor, funder and buyer, while the public was not really concerned with the mission (apart from being tax payers and TV-watchers).

So, at first glance, the mission-oriented policy making totally fills in with innovation policy making. However, Prof. Foray argues, that mission-oriented Innovation Policy is actually an oxymoron.

What Is Innovation?

From an economical perspective, innovation is a change in the business product, service, process or model. This is mainly driven by private actors. Nontheless, Policies can manipulate incentives both on supply (R&D) and demand (adoption of innovation) sides. Therefore, the question is, where is the optimum between profit for suppliants and willingness-to-pay of the consumers? This is where innovation will push through. If we think about this backwards, for something to be an innovation it has to generate enough value to consumers and be low in cost, so the business model is profitable. If that is not the case, it is simply not an innovation.

Social innovation has to be profitable for society (consumers and firms) — the total surplus, generated through the innovation goes to society in the case of social innovation. There is for example the innovation of library of things: People can borrow things, use it, and bring it back. They don't have to buy these things anymore, so using these things becomes cheaper in terms of opportunity costs, and the therethrough generated surplus goes to the consumers.

Mission vs. Innovation

A mission imposes discipline, planning and focus, requires a heavier hand and needs a lot of explicit coordination. Further, the mission is conducted by few experts that reach the goal as soon as the technological accomplishment is a fact. An innovation on the contrary is about indiscipline, requires freedom to experiment and has a decentralized organizational structure. The adoption considers consumer preferences, cost and business models where the adoption of the innovation is not taken for granted. Nevertheless, the I for innovations has been adopted into the MOP, due to the fact that the new Grand Challenges make it as an imperative as it not just requires new technologies but a societal transformation.

New Grand Challenges

The new grand challenges are a field unknown to mankind. T. Schelling stated that the way to decrease emissions has to be very decentralized, participatory and regulatory. It requires people to change their habits and this requires social innovation.

The problems we are facing today are no longer simply difficult engineering problems. We have more and more actors that need to be considered and are not always reachable. For the MOPs, only technological progress was necessary. For the newer MOIPs, we need to manage tensions between mission and innovation. There is a risk of designing policies without innovation or the other way around — neither of them is desirable.

Basic Principles of S3

The Smart Specialization Strategies follow the principles of identifying priority areas, designing a transformational roadmap that is then implemented with an action plan. The strategies are neither a top-down nor a bottom-up approach because they are designed together with stakeholders and do not follow a pre-defined path. The sectors where the S3 are applied are discovered with a matrix of opportunity through change and capacity of change. The transformational activities are in the sectors where both axes are considered to be high.

Our personal take-home message is the following: People are calling for a new Apollo project to solve the climate crisis, but that is misleading. Current global problems are not solvable by extended innovation of technology, but need to include holistic perspectives on society, economy and the environment.

Finally, we would like to thank Prof. Dr. Foray for his insightful presentation.

8

Democratizing Tech Giants

by Drifa Atladottir and Sverrir Arnorsson
based on an ISTP Colloquium talk by Prof. Dr. Hans Gersbach

In the final ISTP Colloquium of this semester, Prof. Dr Hans Gersbach spoke about tech giants from two perspectives. First, from a macroeconomics perspective and secondly, with the aim to democratize them.

Motivation

Over the past decades, different technologies have risen and dominated new industries. Now we are witnessing the rise of Artificial Intelligence (AI) in the technology industry. Although this is somewhat similar to what we saw with machine automation, there is one crucial difference. Unlike automation, which improves with more human resources, AI improves through its usage and data collection. This difference has significant implications on how the technology affects the dynamics of aggregate economic variables and how we can democratize tech giants that gain from AI.

The Macroeconomic Perspective

To understand this from the macroeconomic perspective, we need to study the economic interactions between sectors; this can be done with models that simulate the labour movements between industries. These models predict mass movement between sectors at specific tipping points, such as between AI and applied research (AR). These trends are happening because of the unusual nature of AI; although it requires labour to start with, the more efficient it becomes, the less labour it will need. This new dynamic could create market inequalities because of significant spillovers from AI to the industry. To combat this imbalance, one could implement policy instruments. The most important tool is a tax on AI to rebalance AI and AR.

Democratizing Tech Giants

With more data, AI becomes better, and the product becomes more efficient. Although this leads to a better product for the consumer, this can also generate natural monopolies. Companies that attract more users cultivate significantly better algorithms that improve user experiences. This market position allows them to have better products simply by having more data. Furthermore, this allows them to become so much larger than their competitors that they can buy out anyone still standing. This natural creation of monopolies can be a danger to democracy as these tech giants control the platforms for communication for media, voters, political campaigns, etc. These platforms can significantly affect people's opinions and allow a handful of corporations to control what is permitted, which gives them great amounts of power. On top of that, they have accumulated such detailed data on every user that they can further target who receives what information. To diffuse the power that these companies have, Prof. Gersbach proposed five pathways:

1. Impose vigilant merger control
2. Strengthen competition laws
3. Set data protection laws
4. Set liability rules
5. Democratization

Although the first four pathways can lead to some successful outcomes, they could be problematic in practice when dealing with tech giants. Prof. Gersbach mainly emphasized the idea of democratization. Democratization would allow users of the platforms to be a part of a type of decision-making involving users. To do this, Prof. Gersbach proposed two options. Firstly, one could implement co-boarding. This would be done by randomly selecting a subgroup of users to be a part of an assessment group along with the board of directors. These users could then have voting power along with the board. Secondly, one could implement a user council with groups of expert, avid and regular users who would be elected and have the right to veto critical issues. These actions would provide better transparency into decision making. It would also strengthen the move towards non-biased algorithms and allow users to directly impact the platforms, transferring some power from tech companies to users.

We want to thank Prof. Dr Hans Gersbach for his insights on the issue of natural monopolies in the tech world and his ideas on how to combat them.

Published in January 2022 by

Institute of Science, Technology and Policy

UNO Building
Universitätstrasse 41
8092 Zürich
Switzerland

+41 44 632 03 71
info@istp.ethz.ch
www.istp.ethz.ch

Layout: André Semadeni