n.5
Spring
2019

EAERE Magazine

Table of contents

n.5
Spring
2019

EAERE
European Association of Environmental and Resource Economists

EAERE Magazine serves as an outlet for new research, projects, and other professional news, featuring articles that can contribute to recent policy discussions and developments in the field of environmental and natural resource economics. It is published quarterly in the Winter, Spring, Summer, and Fall. Contributions from the wider EAERE community, especially senior level researchers and practitioners, and EAERE Country Representatives, are included in the magazine.

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Welcome to the Spring issue of the EAERE Magazine!

This issue is very policy oriented. It starts with an article by Thomas Stoerk and Tom Van Ierland, both from the DG Climate Action at the European Commission, who give an overview of the Commission's proposal to prepare the EU's submission of a long-term emission reduction strategy to the UNFCCC by 2020. In the second article, Ottmar Edenhofer and Michael Pahle, both from the Potsdam Institute for Climate Impact Research (PIK), provide an assessment of Germany's recently announced plans to phase out coal.

Then we have two articles presenting economists' views on a number of policy issues. Moritz Drupp, University of Hamburg, Mark Freeman, University of York, Ben Groom, London School of Economics, and Frikk Nesje, University of Heidelberg, discuss the importance of the social discount rate for policy making and present results from a survey among discounting experts who have published on this topic in leading economics journals. Thomas Sterner, Jens Ewald, and Samson Mukanjari, all from the University of Gothenburg, present results from the survey that was conducted right after last year's World Congress in Gothenburg and thus show our own views on the Paris Agreement, policy instruments, leadership, and food.

The issue ends with our juniors-ask-senior interview series and I am happy to announce that this time Maureen Cropper, from the University of Maryland, has agreed to answer the juniors' questions.

Enjoy reading!

Astrid Dannenberg

University of Kassel

Towards the climate policy of 1.5°C climate change

Thomas Stoerk and **Tom van Ierland**
DG Climate Action, European Commission

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Tom van Ierland *joined the Commission in 2006. Within DG Climate Action he is head of unit C1, dealing with Strategy and Economic Assessment. This unit is closely involved in the development of the overall climate change policy framework both at the EU and international level and the economic modeling underpinning it. He started his career at the Belgian's Federal Planning Bureau in 1999 where he focused on capacity building concerning the flexible mechanism and economic modeling. He was an advisor to the Belgian State Secretary for Energy during the negotiations that lead to the Marrakech Accords. Intermediate he has worked as a climate change consultant for Price Waterhouse Coopers and for 2 years as an advisor within the cabinet of the Belgian Federal Minister for the Environment. He has a broad experience in the development of most of the recent EU Climate Change policies and their implementation at EU Member State level. He holds academic degrees in Applied Economics, Environmental Economics and Computer Sciences from the University of Leuven and University College London.*

Introduction

Climate change is already impacting our biosphere, our economy and our societies. The global community has recognised this threat. 185 Parties have ratified the Paris Agreement and have endorsed as such clear concrete temperature goals: an increase in global mean temperature of well below 2 °C above pre-industrial levels and to pursue efforts to limit it to 1.5 °C.

Under the Paris Agreement, global ambition to reduce greenhouse gas emissions is slated to rise through periodic revision of pledges by the signatories. Currently, these pledges for the time period 2025-2030 are likely to lead to an emissions pathway in line with warming of around 3°C (UNEP 2018). Pledges - and their periodic updates - are to be informed by a view on what action is required on the long term. For this reason, all Parties to the Paris Agreement are invited to present mid-century, long-term low- greenhouse gas emission (GHG) development strategies by 2020.

To allow the EU to submit an ambitious long-term strategy to the UNFCCC in time, the European Commission came forward with a proposal to prepare for a debate in the EU. Following the IPCC Special Report on Global Warming of 1.5°C (IPCC 2018), it concluded that it is in our interest to pursue efforts to stabilise climate change at 1.5□ C to protect our security and prosperity. Today, global temperatures have already risen by 1°C. Which raises a crucial question:

What does climate policy that takes 1.5°C seriously look like for Europe?

This very question is what the European Commission has been addressing when it adopted a Communication in November 2018 on its long-term vision for European climate policy: a vision for a prosperous, climate-neutral European economy by 2050 (EC 2018a). This vision is not the European Union (EU)'s long-term strategy for the Paris Agreement. Instead, it is the European Commission's contribution in its preparation, which should lead to the adoption of an EU long-term strategy by 2020. We want to use this opportunity to show climate leadership, with the aim of improving

the understanding on how to achieve the overall ambition of the Paris Agreement.

This article will discuss what analysis underlies it, and what climate policy for 1.5°C might look like for the European Union (EU).

What greenhouse gas emissions trajectories to aim for

The starting point is the latest climate science: the IPCC Special Report on Global Warming of 1.5°C tells us what feasible GHG emissions pathways towards 1.5°C of warming look like. In aiming for net-zero GHG emissions by 2050 in the EU, it was decided to be on the ambitious

major economies could follow in the Paris Agreement. In other words, the proposal looked into a vision that is ambitious while bringing positive economic gains to Europe. The detail of this analysis was captured in an in depth analysis supporting the Communication (EC 2018b).

How to go from greenhouse gas constraints to specific actions

How to go from an overall constraint on emissions to a specific climate policy proposal?

The European Commission's 2050 climate vision is based on a detailed analysis, looking ex ante into the econom-

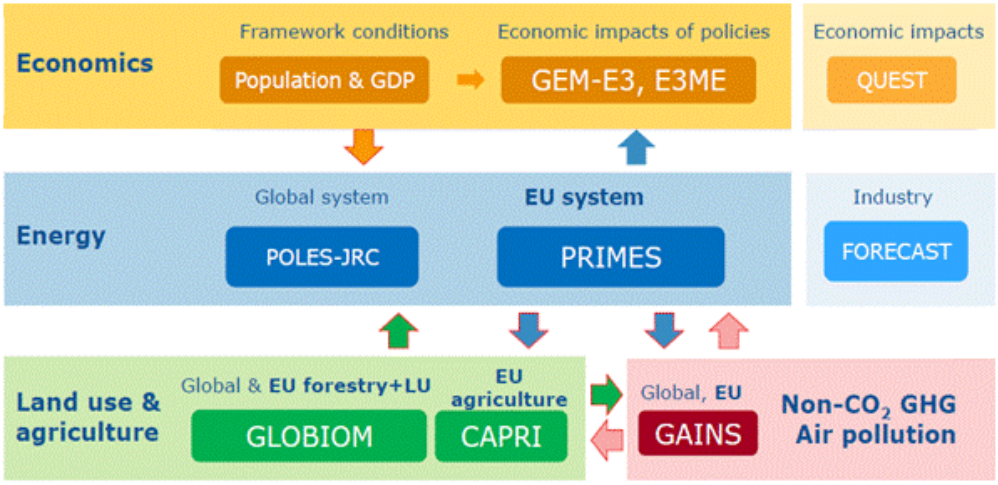

Figure 1. Scenario analysis

end of the IPCC pathways, with the IPCC concluding that globally by 2050 net-zero CO2 should be achieved. Net-zero GHG emissions includes GHGs beyond CO2 such as methane, nitrous oxide, and F-gases[1]. In more technical language, the modelling used puts a flow constraint of net GHG emissions of zero in 2050 in the European Union as the central ambition.

To fully inform the policy debate, mitigation pathways were studied for GHG emissions reductions in 2050 in the EU compatible with well below 2°C pathways as well as more ambitious pathways in-line with 1.5°C. It informs about how different technologies and actions can reduce emissions. The aim is to be ambitious while demonstrating this can be achieved with rising living standards and economic activity within the EU, and to show an attractive way forward that other

ic, social and environmental impacts of the proposed vision. Because of its forward-looking nature such assessment is not empirical. Instead it relies on a modelling suite to conduct a scenario analysis, as well as basing itself on an overview of existing literature and input of stakeholders on the opportunities and challenges associated with such a transition.

The need for a sectoral picture: A theoretical economist might be inclined to rely on an abstract one-sector model to identify insights on cost-efficient GHG emissions pathways in an aggregate economy. However, this is not what we do. Why?

The reason is that any proposal for a climate vision must take political economy constraints seriously. It must provide additional insights. Citizens, stakeholders and policy-makers want to know what a spe-

cific policy means for their livelihood, sector or region. They need to know the story of how a transformation towards a climate neutral economy will impact them.

Modelling output, therefore, needs to be at the relevant level of disaggregation to allow for societal and political debate. This is often an economic sector, e.g. the power sector, transport, buildings, industry, waste or agriculture and land-use. By providing insights how a specific policy ambition affects sectors, how these impacts change under differing assumptions and how efforts to mitigate in one sector affect other sectors, modelling can supply

hurt the well-being or deny economic opportunities to future generations is doomed to fail. Any analysis into such a transformation needs to give good insights into the costs associated with the transformation. It needs to highlight opportunities and cannot ignore that with the transformation to a cleaner society many benefits come along, including the fact that if achieved at global scale, it reduces the impacts of climate change itself.

Assumptions about technology and innovation: In creating the 2050 climate vision, the point of departure is cautious by design. The modelling behind the

Long Term Strategy Options

	Electrification (ELEC)	Hydrogen (H2)	Power-to-X (P2X)	Energy Efficiency (EE)	Circular Economy (CIRC)	Combination (COMBO)	1.5°C Technical (1.5TECH)	1.5°C Sustainable Lifestyles (1.5LIFE)
Main Drivers	Electrification in all sectors	Hydrogen in industry, transport and buildings	E-fuels in industry, transport and buildings	Pursuing deep energy efficiency in all sectors	Increased resource and material efficiency	Cost-efficient combination of options from 2°C scenarios	Based on COMBO with more BECCS, CCS	Based on COMBO and CIRC with lifestyle changes
GHG target in 2050	-80% GHG (excluding sinks) ["well below 2°C" ambition]					-90% GHG (incl. sinks)	-100% GHG (incl. sinks) ["1.5°C" ambition]	
Major Common Assumptions	• Higher energy efficiency post 2030 • Deployment of sustainable, advanced biofuels • Moderate circular economy measures • Digitilisation					• Market coordination for infrastructure deployment • BECCS present only post-2050 in 2°C scenarios • Significant learning by doing for low carbon technologies • Significant improvements in the efficiency of the transport system.		
Power sector	Power is nearly decarbonised by 2050. Strong penetration of RES facilitated by system optimization (demand-side response, storage, interconnections, role of prosumers). Nuclear still plays a role in the power sector and CCS deployment faces limitations.							
Industry	Electrification of processes	Use of H2 in targeted applications	Use of e-gas in targeted applications	Reducing energy demand via Energy Efficiency	Higher recycling rates, material substitution, circular measures	Combination of most Cost-efficient options from "well below 2°C" scenarios with targeted application (excluding CIRC)	COMBO but stronger	CIRC+COMBO but stronger
Buildings	Increased deployment of heat pumps	Deployment of H2 for heating	Deployment of e-gas for heating	Increased renovation rates and depth	Sustainable buildings			CIRC+COMBO but stronger
Transport sector	Faster electrification for all transport modes	H2 deployment for HDVs and some for LDVs	E-fuels deployment for all modes	Increased modal shift	Mobility as a service			• CIRC+COMBO but stronger • Alternatives to air travel
Other Drivers		H2 in gas distribution grid	E-gas in gas distribution grid				Limited enhancement natural sink	• Dietary changes • Enhancement natural sink

Figure 2. Long term strategy options

the kind of information that the political process demands before being able to endorse an economy wide transformation.

Where is the economics, you might ask?

It is always in the background. The modelling tools simulate decisions on investments and operation of capital goods, cost related to infrastructure and inputs like labour and fuel costs, using market price assumptions including annuity payments for capital expenditure. As such it provides estimates of real costs, as experienced by our private sector and our citizens. One of the guiding principles of European policy is to look into how a policy can improve the life of European citizens. Any policy that would unduly

2050 vision builds on currently available technologies as much as possible. It does include nascent technologies that exist, but are not yet economical at scale. The latter for instance relate to the capture of CO2 from biomass combustion, industrial flue gas or the atmosphere for use in products including synthetic fuels.

The technological assumptions are based on a literature review and discussed ex ante with stakeholders and experts in the ASSET project[2]. Furthermore the in-depth analysis refers per sector to technology potential based on external studies, including references to stakeholder contributions and studies provided during the public consultation that was organised in preparation of the

proposal[3]. These assumptions try to incorporate best available knowledge, and are not meant to express a technological preference. The analysis merely illustrates that a climate neutral, modern, and competitive European economy by 2050 is possible today, with existing technologies.

Our scenario analysis in more detail

Conceptually, a scenario analysis was conducted that uses modelling to study different sets of exogenous constraints in a consistent framework. As shown in Figure 1, this framework consists of a number of different modelling tools. Each tool fulfils a different purpose. They are all soft linked, with outputs of one model being the input of others and overall using where possible the same exogenous assumptions. This ensures a minimum coherence and allows the modelling analysis to look at sectoral interaction, which is important when looking at climate neutrality at economy wide scale

As shown in Figure 2, the analysis builds on 8 different pathways to illustrate the action space to achieve a low carbon transformation. The reason for studying more than one pathway is to give insights on what type of action is needed, while not pretending there is only one single pathway that is preferred from a technological, economic or societal perspective. The analysis wanted to show a vision of what is possible and illustrate also that the ultimate choice of which pathways to choose will be with society.

All pathways are based on significant energy efficiency improvements and all see a strong shift towards renewable energy. Five pathways achieve an at least 80% reduction of GHG emissions on 1990 levels by 2050, compatible with 2°C. Of the five 2°C scenarios, three focus on technological supply side drivers (electrification, large-scale deployment of hydrogen, power-to-X technologies), while two scenarios study demand-side changes (energy efficiency, resource and material efficiency in a circular economy). Then a combination of these five scenarios is analysed, which achieves a GHG emissions reduction of 90%. Finally, two different pathways look into a transformation that achieves net GHG emissions to zero in 2050. Both pathways further increase the application of technologies and actions to reduce emissions and both also increase absorption of emissions through the land use sector as well as through the application of negative emissions technologies. One scenario focuses on technological solutions (1.5TECH) while the other pathway (1.LIFE) puts its emphasis on a circular economy and on the role of consumer choice to reduce emissions with carbon dioxide removal mainly through land use policies.

The pathways do not aim at selecting a preferred solution. Instead, the analysis wants to give insights in the range of possible options to become climate neutral.

The resulting sectoral analysis is rich in detail, including how different actions have different impacts across sectors economy wide. It is further enriched with macro-economic modelling that assesses how our economy – including jobs –, would react to the transformation. The transformation centres around a shift towards an energy system with increased investment in capital goods and with reduced expenditure on fossil fuels. The required transformations in the European economy are large. In practice, a single climate policy instrument that could achieve a full transformation does not exist.

Instead, our 2050 climate vision has identified 7 policy building blocks that can deliver a climate neutral Europe together: energy efficiency; deployment of renewables and increased electrification; clean, safe and connected mobility; competitive industry and a circular economy; infrastructure and inter-connections; the bio-economy and natural carbon sinks; and carbon capture and storage technology. An enabling framework that leverages the strengths of the European Union will additionally be needed. Key areas for action identified are sustainable finance; research, innovation and deployment of technologies at scale as well as policies focussed on allowing for a just transition taking into account other transformations happening in our society.

Our analysis finds that this transition is feasible, and that it offers attractive GDP

and employment growth paths for the future. Investment requirements in the energy system beyond baseline quantities would on average amount to up to 0.8% of EU GDP per annum, or in total the equivalent of 2.8% of GDP over the period 2031-2050. These are not small numbers, but they also translate into continued economic growth, close to baseline projection and in some projections even leading to additional economic growth of up to 2% above baseline by 2050.

It is important to keep in mind a large number of co-benefits through decreased payments for energy imports (captured directly in the economic modelling), or improved air quality and public health (which can be estimated separately but are not captured in GDP growth estimates). What is more, the analysis only looks at the private returns, and does not consider avoided damages from climate change through implementation of the Paris Agreement.

Conclusions

The climate policy for 1.5°C presented in this article is a vision to become climate neutral as expressed in the European Commission's Communication (EC 2018a). The Communication is ambitious. It aims at starting a discussion with all relevant stakeholders in the EU to allow the EU to adopt, by 2020, an EU long-term greenhouse gas reduction strategy in-line with the Paris Agreement. It is supported by a 400 page in-depth analysis which we hope can be of interest to the environmental economics community (EC 2018b).

A note of caution for an academic audience: Recent EAERE/WCERE policy sessions called on the environmental economics community to take political economy constraints more serious in their research and policy advocacy. The in depth analysis is a document that illustrates how to do this in practice. This means that it is longer than a typical academic article – or indeed a dissertation. The conclusions drawn from it can be found in the Communication. Its very purpose is to stimulate reflection and provide insights for the ongoing debate. To make your lives easy, we are therefore also hosting an EAERE2019 policy session on our long-term strategy that includes an exciting panel of experts. Hope to see you there.

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EC (2018b): In Depth Analysis In Support of the European Commission Communication COM(2018) 773. A Clean Planet for all A European strategic vision for a prosperous, modern, competitive and climate neutral economy. economy. https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en_0.pdf

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UNEP (2018): Emissions Gap Report 2018. www.unenvironment.org/resources/emissions-gap-report-

Endnotes

1. The aggregate of greenhouse gas emissions as included under the greenhouse gas inventory reported to the UNFCCC covering CO2, CH4, N2O, HFCs PFCs, SF6 and NF3.

2. https://asset-ec.eu/

3. https://ec.europa.eu/clima/consultations/strategy-long-term-eu-greenhouse-gas-emissions-reductions_en

The German Coal Phase Out: Buying out polluters, not (yet) buying into carbon pricing

Ottmar Edenhofer[1,2,3] and Michael Pahle[1]

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Michael Pahle *is Head of the Working Group "Climate and Energy Policy" at the Potsdam Institute for Climate Impact Research (PIK). In his PhD, he analyzed the economics and politics that lead to Germany's dash for coal in the last decade. He is coordinating lead author of the report on transforming the electricity system and phasing out coal in "ENavi", Germany's largest social-science research project on the Energiewende.*

The way towards the coal commission and its recommendations

While Germany has been lauded for its 2011 decision to implement the *Energiewende (*energy transition), its 2020 climate target – one of the transition's central planks – is almost out of reach. In 2010, the German government pledged to (1) increase the share of renewables to 80% by 2050, and (2) achieve a gradual reduction of GHG emission of 80%-95% relative to 1990 levels by 2050. By now it is well on track regarding the first goal; whereas, it fares poorly as regards the reduction of GHG emissions. In the power sector, which accounts for approximately one third of the country's emissions, emissions have, by and large, stagnated – despite an increase of the share of renewables from 20% in 2011 to 35% in 2018. The primary reason has been that the share of coal has remained high. Indeed, 10 GW of new capacity have gone online in the last years as a consequence of a "dash for coal" (Pahle 2010)new investments amounting to around 15% of the total sector capacity were brought on the way, and plans for a multitude of additional projects are pending. This 'dash for coal' in Germany has raised considerable public concern, especially as it risks to undermine recent political attempts to combat global warming. Yet, the question of why the dash for coal has emerged has not yet been addressed in a thorough analysis. This article attempts to close this research gap, while at the same time contributing as a case study to the general understanding of investment patterns in liberalized electricity markets. It finds that the main reasons for the dash have been (1, triggered by the 2002 decision to phase out nuclear.

Policy makers took a long time to respond to this "renaissance of coal". With only two years to meet the 2020 climate target, a commission to phase out coal was established. This rather slow response can partly be explained by the expectation – in the early 2010s – that prices in the EU ETS would rise, concomitantly disincentivizing coal generation in the future. In 2013, however, there was no more denying that for the foreseeable future ETS prices would remain at very low levels. Simultaneously, emissions in all other sectors declined rather slowly – and even increased in the transportation sector. Prodded into action by both the 2015 Paris Accord and its aspiration to be a climate frontrunner, the German government adopted the "Climate Action Plan 2050" in 2016, setting out measures for achieving its long-term climate targets[1]. The (political) linchpin for the power sector was a "Commission on Growth, Structural Development and Employment", thus framing the coal problem in terms of economic - rather than climate - policy[2]. This reframing, it trans-

pired, would prove most consequential for the commission's recommendations.

In the commission's recommendations, published in January 2019, financial compensations of different sorts figure prominently, albeit market-based instruments much less so. The commission, installed in June 2018, consisted of 28 members, representing politicians, civil society, the business and the scientific community. It was tasked with developing an action plan for (a) the structural development of the country's lignite mining regions, (b) attaining the 2030 climate target for the energy industries (electricity, heating) sector and (c) proposing a timeline, including an exit date, for phasing out coal. In its recommendations[3] the commission believes shutting down the equivalent of 12 GW of coal capacity by 2022, and an additional 13 GW from 2023 to 2030 to be sufficient for meeting the 2030 climate target. It also recommends decommissioning a number of plants commensurate with the required capacity reduction by using direct controls based on bilateral agreements (lignite plants) and voluntary phase-out premiums (hard coal plants) respectively. All remaining capacity is to be closed down by 2038 (see Figure 1). Furthermore, measures for structural aid, supporting coal workers close to the retirement age, and dampening future power price increases are recommended. The commission only puts a price on some of the measures (see Table 1), making it difficult to evaluate their actual costs. Despite this and the government's ability to influence the costs by modifying the commission's recommendations, the costs will likely be of a double-digit billion order of magnitude.

Measure	Recommended funding
Structural aid for coal regions (infrastructure investments, fostering innovation and research, (re)settlement of government agencies, early retirement / adaptation allowance mechanisms for coal workers, civil society and community support programs)	• € 1.5b early action in current legislation period • € 1.3b annually for 20 years for specific measures (controlled by federal legislation) • € 0.7b annually for 20 years at the disposal of the States • If possible re-earmark existing funding
Compensation of consumers for potential power price increases from 2023 onwards	• Commission estimates costs of at least 2 billion EUR per year • Exact amount to be determined in 2023 review
Compensation of plant owners for early decommissioning	• No estimates provided; approximately € 0.6b per GW paid for decommissioning lignite plants in the past years through other measures

Figure 1. Recommended decommission roadmap for coal capacities (*historical capacities)

Evaluation and outlook

At the time this comment is written, thus far only a legislative package to enact the structural aid measures is on the way. This package has been met with much political will for its implementation – not least to keep the populist, anti-climate party AfD in check in this year's upcoming elections in three of the four coal-mining states. In combining climate policy with efforts to curb the populists' political heft, this package might muster sufficient support to be enacted. More broadly, the commission has identified a balance between compensation and concrete action that is agreeable for unions, business associations and NGOs. Striking this balance would have been hardly possible in the current parliament – not least in virtue of the Grand Coalition's internal division on the issue. This in turn puts into perspec-

tive the substantial costs associated with structural aid and compensatory measures – both apparently instrumental for having reached a compromise. Indeed, these measures would likely have been implemented anyhow had the generation of coal come to an end. Hence, viewed in a generous light, the commission's outcome seems to just have reversed the order by putting compensation before termination.

Yet, the commission's proposal is fraught with risks: the recommended shut downs might be (a) insufficient to achieve the 2030 climate target and (b) only marginally important in the European context. In contrast to regulating via carbon pricing, polluters benefit from direct control as inducing exit from partial markets creates rents for remaining producers - at least temporarily (Buchanan and Tullock 1975). In the German debate this is referred to as the "rebound effect": when old coal plants go out of the market the ensuing higher electricity price incentivizes newer coal plants, still in the market, to increase their production and, by extension, increase emissions. The longer it takes to phase out coal and the lower carbon and coal prices will be, compared to the price of natural gas, the larger the rebound effect. Additionally, the lack of a reliable carbon price creates the risk of overinvestment in gas-fired plants which would require yet another commission to phase out gas. Finally, as a new analysis (Osorio et al. 2018) suggests, most of the additional emission reductions will be offset by the waterbed effect in the EU ETS - despite the new cancellation provision from 2023 onwards. The reason being that most coal plants will be shut down only after 2023 when the fraction of a marginal ton of reduction that will be cancelled is relatively small (Burtraw, Keyes, and Zetterberg 2018; Perino 2018). Accordingly, Germany's national effort may well be in vain.

Regarding instrumentation and plant owner compensation, the commission's recommendations can thus be characterized as a lop-sided deal: Its members agreed to buy out vested interest groups while the majority was reluctant to buy into a reliable carbon pricing scheme. The lack of support from energy companies and trade unions is unsurprising since they risk missing out on rents and pending investments in gas infrastructure otherwise. Environmental groups have not supported a carbon price as they distrust market-based instruments and, from the outset, regarded the concrete exit date, though largely symbolic, as their most important contribution to the commission's recommendations. In short, both the owners' thirst for compensations and environmental groups' infatuation with pyrrhic victories, such as the concrete exit date, bode ill for carbon pricing's implementation, leaving a rather small coalition in its favor.

This coalition, however, may grow now that conflicting interests no longer stand in the way of more effective policy instruments (Pahle et al. 2018). The drawbacks of direct control are already becoming apparent and, in search for better solutions, the economic toolbox has much to offer: A minimum price in the EU ETS can alleviate both the rebound and the waterbed effects while safeguarding against the still prevailing regulatory uncertainty. One step would be a nationally or regionally coordinated minimum price that gradually morphs into an EU-wide one over time. In the mid- to long-term a reform of the broader policy architecture is essential. For one, the country's current 2030 sectoral targets might be useful to initiate a transition, especially in the still laggard non-power sectors (Vogt-Schilb, Meunier, and Hallegatte 2018). But, with more ambitious targets, increasing price spreads between sectors will be very costly. Likewise, at the European level considerably more stringent regulation in the Non-ETS sectors up to 2030 will likely establish another carbon price in the coming decade, which adds yet another piece to the emerging carbon pricing puzzle. Making these pieces fit into a unified whole is the vision Germany should strive to articulate. This requires a reform of energy taxes and fees, including transportation and heating/cooling, with a proposal now on the table (Edenhofer et al. 2018). One can only hope that policy makers

sooner - rather than later - realize that carbon pricing is the instrument needed to get the Energiewende back on track.

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Endnotes

1. Initially the government responded by adopting the Climate Action Plan 2020 that included a so called "climate fee", essentially a carbon tax. This proposal, however, failed and as a more feasible default option the government created a "security reserve", which transferred several old coal plants into a reserve for compensation.

2. Because it was clear that this commission had been established in response to the coal problem it has been widely referred to as the "coal commission".

3. https://www.bmwi.de/Redaktion/DE/Downloads/A/abschlussbericht-kommission-wachstum-strukturwandel-und-beschaeftigung.pdf?__blob=publicationFile&v=4

How much should we care about the future? What the experts say

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Our recent survey of 200 world-leading experts in the area of social discounting provides new guidance on how to balance the well-being of future generations with our own (Drupp et al. 2018). This is one of the key difficulties that policy-makers face when deciding how much to mitigate climate change. The survey supplies vital ingredients to governmental guidance and finds that experts largely disagree with government guidelines and practices.

Mitigating climate change is a prime example of a policy problem that has implications spanning many generations. The costs of climate change mitigation must likely be paid by our generation, while future generations are the ones who benefit from a more stable climate. Therefore, policy-makers cannot avoid addressing the appropriate balance between the well-being of present and future generations.

Economists typically summarise the balance between society's present and future consumption by what is known as the social discount rate (SDR). The SDR measures how quickly the weight placed on future benefits diminish. The higher the SDR, the lower the weight future generations receive from today's perspective. The appropriate course of action on climate change, or indeed any intergenerational project, is extremely sensitive to the choice of the SDR.

Looking into the distant future is tricky for policy-makers for many reasons, including inherent scientific uncertainties. Yet even if scientific uncertainties were resolved, another important reason why the distant future looks 'fuzzy' from today's perspective is because it is unclear how governments should strike an appropriate balance between the interests of present and future generations. As Weitzman (2001) showed in a seminal survey, there is a great deal of disagreement about how the future should be discounted. The aftermath of the Stern Review, and the ensuing disagreement between Stern and Nordhaus is testament to this (Nordhaus 2008; Stern 2007). Stern effectively used a SDR of 1.4% for mainly ethical reasons and argued for drastic and immediate action on climate change, while Nordhaus used a market related discount rate of 4.5% and recommended a gradual

increase in mitigation stringency. As a consequence, Stern's estimated social cost of an additional ton of greenhouse gases was around 10 times higher than that of Nordhaus. There has been little convergence in these views in the meantime.

Differences over recommended SDRs might not be so problematic if, like certain elements of scientific uncertainty, further research could narrow the uncertainty or the range of divergence. Yet, such disagreement may stem from differences of opinion, which can remain stubbornly irreducible in relation to the ethical decisions of intergenerational problems. Unfortunately, the survey by Weitzman (2001) does not elucidate the sources behind this huge variation.

To better understand the extent and the sources of this disagreement we elicit recommendations and forecasts from the world's leading experts. Experts were selected based on their pertinent publications in the 100 leading economic journals on the topic. The sample includes responses by 12 of the 13 experts of the Arrow et al. panel who advised the US EPA on this matter. To 'disentangle' the SDR into some of its component parts we structure the survey around a well-known theoretical framework that is applied by many governments around the world.

What are the key components of the SDR that need to be disentangled? First, ask yourself the question: does a euro given to a rich person increase their well-being by as much as the same euro given to a poor person? If your answer is "no", then you can be described as being averse to income inequality. You may then want to place less weight (apply a higher SDR) on changes to future generations' consumption if you also think that they will be richer. This introduces two elements of the SDR over which people may disagree: expected growth in real average global consumption, and the extent of inequality aversion. These two elements are fundamentally different; future economic growth requires forecasting, which can be verified ex post. Aversion to inequality, by contrast, is an ethical choice to which there is no single correct answer. Now consider two equally rich people and ask yourself: would you value the well-being of one of those individuals less just because they are born in the future? If so then this implies that you would discount future generations' utility even if there were no expected change in consumption over time. This, on its own, would lead you to have a positive utility discount rate or 'pure rate of time preference' and, again, this is an ethical choice. These three components – pure rate of time preference, expected economic growth and inequality aversion – combine to form one candidate for the SDR, known as the simple Ramsey Rule (SRR). This rule is the basis for government guidelines on discounting in many countries, particularly in Europe.

An alternative argument for discounting the future stems from opportunity costs: the funds we use to invest in climate policy could be used productively elsewhere. Proponents of this view prefer to use some market-based interest rate as the SDR. Governments that primarily base their discounting guidance on this approach, including the US, are asking economists to forecast the currently unknown future opportunity cost of capital rather than reaching explicitly ethically-based judgements.

Yet, possibly the greatest source of disagreement stems from whether market interest rates or consumption discount rates, such as those embodied in the SRR, should be used. The former is described as a 'positive' approach in that it is based on observed behaviour in the market place. The latter is described as a 'normative' approach as it requires ethical decisions for the values of inequality aversion and the pure rate of time preference. Disagreement on which of the two approaches should be taken was central to the Stern-Nordhaus debate.

Expert opinion is an important source of information that policy-makers routinely draw on also in the realm of social discounting (Groom and Hepburn 2017). It is therefore crucial to obtain a more representative picture of the range of opinions they hold. Specifically, we elicited the opinions of around 200 experts on each of the above-mentioned components, the recommended SDR itself and the range

of SDRs that experts are comfortable with recommending. Finally, we asked for the weight a governmental body should place on normative versus positive issues when determining the SDR and provided an option for qualitative responses.

The survey responses provide new guidance on how to balance the well-being of future generations with our own. The median (mean) recommended SDR of our experts is 2% (2.3%), which is substantially lower than the median (mean) values of 3% (4%) reported by Weitzman (2001) and only slightly lower than the average forecasted risk-free interest rate of 2.4%. We also find that there is disagreement, with point recommendations ranging from 0 to 10% (see Figure 1).

Crucially though, we find more space for agreement than we had anticipated. The pattern of responses shows that 30% of experts recommend a rate less than or

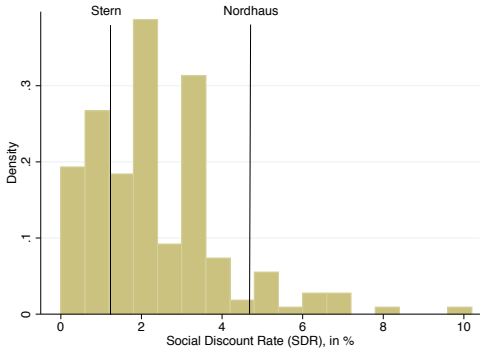

Figure 1. Recommended social discount rates (SDR), based on Drupp et al. (2018), and long-term SDRs from Stern (2007) and Nordhaus (2008)

equal to the Stern rate of 1.4%, while only 9% of experts recommend a rate greater than or equal to the Nordhaus rate of 4.5%. In addition to providing point recommendations on the SDR, experts suggested minimum and maximum values of the SDR they were comfortable with. Even given these ranges, only 58% of experts suggest an acceptable range that includes the Stern rate of 1.4%, while only 31% suggest a range that includes Nordhaus' rate of 4.5%. Taken together these results suggest that public policy has been influenced by positions on the SDR that are not as broadly held by the expert community. The greatest 'consensus' is around the median and modal SDR of 2%, which 77% of experts find acceptable.

We also elicited experts' stance on the thorny normative-positive issue. Looking at the Stern-Nordhaus debate, one could easily conclude that disagreement stems primarily from differences in geographical location: it is a US versus Europe issue. This is only partly true. In fact, the elicited SDR is most strongly dependent on whether one takes a normative or a positive approach to discounting. An expert with a purely normative approach will on average have a SDR that is 2 percentage points lower than a purely positive expert.

Finally, the survey reveals that the prominence of the SRR in policy appraisal needs to be revisited. When we impute the SRR for all experts individually, we find wide discrepancies between these values and their recommended SDRs (see Figure 2). On average, the recommended SDR is 2.3%, substantially lower than the experts' implied SRR of 3.5%. The rich body of qualitative responses provided by our experts explains the need for long-term public decision-making to depart from the confines of the SRR framework. This includes considering alternative ethical and decision-making frameworks beyond the workhorse model yielding the simple Ramsey Rule. Perhaps most important of all is that many experts raise the point that government guidelines on discounting need to account more explicitly for risk and uncertainty, issues of inequality within generations or changing relative prices of non-marketed environmental goods.

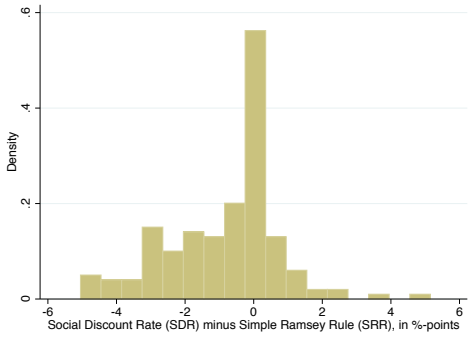

Figure 2. Difference between the recommended SDRs and the imputed simple Ramsey Rule (SRR) rates, based on Drupp et al. (2018)

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WCERE 2018: Reflections from the World Congress

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Thomas Sterner, *a Professor of Environmental Economics at the University of Gothenburg, focuses on the design of policy instruments to deal with resource and environmental problems. Sterner has published more than a dozen books and a hundred articles in refereed journals, mainly on environmental policy instruments with applications to energy, climate, industry, transport economics and resource management in developing countries. With Gunnar Köhlin, he has founded the Environment for Development Initiative. Sterner is the recipient of the Myrdal Prize and past president for the European Association of Environmental and Resource Economists. During 2015-16 he was guest professor at the Collège de France.*

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In 1990 the first international – but actually European conference was held in Venice. It was a wonderfully intimate little event. In 2018 we had the so far largest World Conference with 1,543 participants from 62 countries. It lasted from 25th to 29th of June in Gothenburg. We had fantastic plenaries and policy debates, 680 paper presentations, so-called "egg-timer presentations" and posters. We were very lucky with the weather and according to the evaluation, most people were happy with the arrangement – in particular with the weather! As it turned out it was yet another record hot summer – and yes, that is quite pleasant up here in Scandinavia but still worrying in particular since we got extensive forest fires. We felt we should use the opportunity to survey such a large selection of environmental economists from around the World, so we did a small survey covering a few important issues. Some of the questions will be used in other publications but we present the material briefly here. 537 of the participants answered the online survey. Their age ranged from 24 to 81 years old (with a mean of 42 years), 62% were male and 38% female and the most common country of origin was Germany and USA that together represents 25% of the respondents.

The first batch of questions concerned the Paris Agreement (PA; see Table 1). It seemed somewhat more of us were surprised than unsurprised that the Paris COP was successful and actually led to an agreement and even that it contained the relatively ambitious goal of limiting warming to 1.5°C. On the other hand, only 53% judge the PA feasible and even

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
The agreement is credible	9%	45%	19%	26%	2%
The 1.5°C goal was a surprise	4%	26%	21%	40%	9%
The unanimous signing was surprising	4%	22%	18%	45%	11%
The PA came as a surprise to the public		45%		55%	
The goals of the PA are feasible		47%		53%	

Table 1. Do you agree with the following statements regarding the Paris Agreement?

fewer judge it credible. The lack of credibility is perhaps explained by disappointment concerning the lack of specific tools or goals in the agreement. A total of 85% were at least slightly disappointed by this and when asked what aspect they were most disappointed by, there was an array of answers. As shown in Figure 1, most respondents reacted to the lack of targets

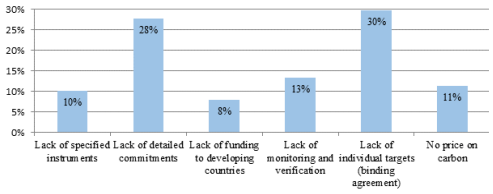

Figure 1. Answers to the question: "From the list below, which one did you find to be the MOST disappointing?"

and more detailed commitments. This is of course a feature of the path taken after Copenhagen. At the Copenhagen COP, there was an attempt or at least an ambition at actually agreeing on a detailed set of abatement targets and thus a comprehensive sharing of burdens to get to a certain collective goal. After that, many argue that it was apparent that sufficiently many prominent powers were against this strategy for it to be almost impossible and we have seen a switch to a so called decentralized architecture with voluntary contributions. Many prominent economists have been particularly critical to the lack of explicit agreement concerning carbon prices (Akerlof et al., 2019; Tirole et al., 2015; Weitzman, 2014). In our survey, we find that some 20% similarly reacted to the lack of specific instruments such as a price on carbon emissions.

This is perhaps somewhat lower than expected at least compared to the somewhat caricatured image of economists who only talk about the carbon price. However, as we can see in Figure 2, the environmental economists do in fact think of prices (and R&D) as the most important instrument to reduce emissions.

The second batch of questions concerned which instruments run the biggest risk of being distorted by corruption. There were only three alternatives but the survey found quite clearly that physical regulation was believed to lead to more

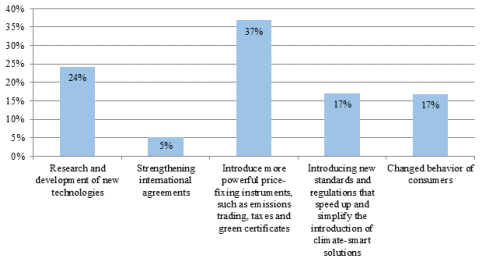

Figure 2. Answers to the question: "What do you think is the most important thing for your country of origin to achieve net zero emissions by 2045?"

corruption than market-based instruments such as cap-and-trade (see Figure 3). Taxation was believed to be the least prone. Again, there is a perceived advantage for market-based instruments.

The third batch of questions addressed the issue of one country going ahead on its own. We believe that this is one of the big stumbling blocks of climate policy. On

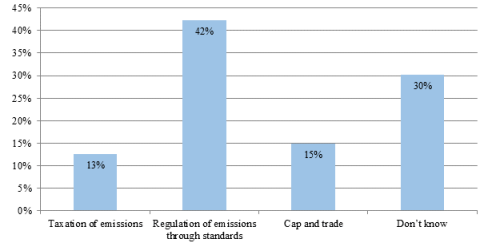

Figure 3. Answers to the question: "Thinking about your own country of origin, which instrument in your judgment runs the biggest risk of being distorted by corruption?"

the one hand, every effective policy must definitely be international and cover all countries in the World. On the other hand, national sovereignty typically implies that climate policy instruments are decided at the national level. This immediately poses the delicate question of which countries are going to take the lead and it is therefore

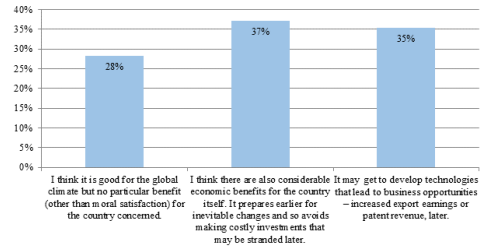

Figure 4. Answers to the question: "What is the most important value of one country going ahead and doing more for the climate than other countries?"

important to understand how the benefits and costs of unilateral action are perceived.

As shown in Figure 4, it seems that less than a third believe that one country going ahead on its own is only good for the globe but confers no benefit to that country itself. This suggests that unilateral action has to be driven by altruism, warm glow or other idealistic preferences. On the other hand, there is a clear majority in excess of two-thirds of the respondents who believe that there are some economic benefits for the country itself. This can be either some avoidance of stranded assets and "some time to prepare" or in fact the existence of business opportunities presumably in renewable and energy efficiency industries.

Speaking of country leadership, we also asked which countries the respondents see as climate leaders (see Figure 5).

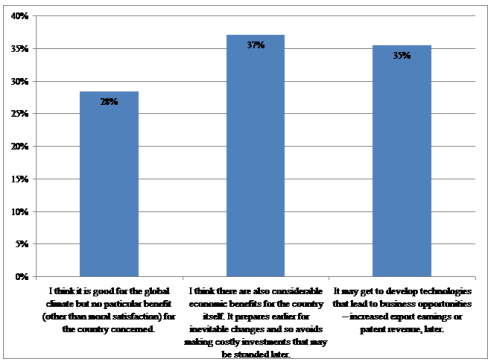

Figure 5. Answers to the question: "Can you think of any country that is a climate leader today – and if so which country?"

The large number for Sweden might be biased upwards due to two factors: politeness to the host country and of course the over-representation of Swedes at the conference. It might of course also be explained by the country having the highest long-standing carbon tax. The second country is Germany, presumably due to its strong Energiewende policies that although partly controversial, are often credited with a major role in lowering the costs of distributed renewables in particular rooftop solar. A more detailed look at the data show that the ranking is only slightly affected by nationalistic preferences although there is some evidence that the Chinese in particular and the Swedes to some extent nominated their own countries.

One of the more striking responses here is of course that 10% mention China as a frontrunner while only 2% mention the US. Even though 19 out of the 44

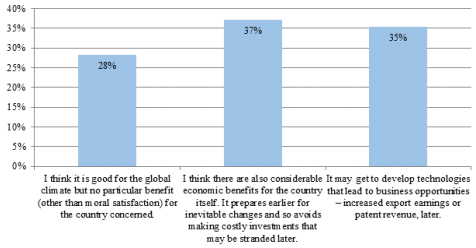

Figure 6. Answers to the question: "Which of the following solutions to climate change would you rank the highest with respect to their effectiveness to mitigate climate change?"

Chinese respondents opted for China, the high number for China is also driven by answers from participants from the US, Germany, France, Italy and others also mentioned China. Presumably one of the main reasons for China being put forward is the very dramatic development of renewables in the country.

The importance of renewable energies is also reflected in the answers to our last set of questions concerning which measures are most important to deal with climate change. In Figure 6, there is no area or renewable energy source that is clearly indicated as being the most important. Suggesting, perhaps, that they are all equally important. However, technological development in airplane design is clearly not viewed as the most effective measure to mitigate climate change.

Although food is ranked somewhat after renewable power it is still considered important. Maybe this is a correct reflection of the fact that emissions from our eating are in fact bigger than emissions from our flying! It seems also that the participants on average were more positive than negative to having been served our climate-friendly (mostly vegetarian) food at the conference (60% was positive and 20% neutral). Of course, it must have been a little difficult to answer "negative" here after all this priming concerning the importance for the climate.

Still 20% actually did that and either we should apologize for poor cooking or we should ask our colleagues if they do not want to put their mouths in the same place as their words and thoughts? This should remind us that eating is a deeply personal experience and if there is an area where inconsequential and illogical behavior and opinions are to be expected it will be in this area. It is worrying that we have not yet convinced the World we need to get serious about gasoline and diesel for our cars – it is not going to be easier when we turn policy attention to the steaks and the giant prawns.

Let me end on a personal note and thank all those who came to the conference and made it such a pleasure. There were over a hundred sessions and these can never be properly summarized – nor can all the personal meetings and exchanges but we have collected a considerable amount of bibliographical, image and video records. For me personally, one of the highlights was a special session we had on the design of policy instruments for the Anthropocene. This was a great session that greatly helped us reshape our thoughts which ultimately helped us in revisions and to get the article published (Sterner et al., 2019; see also this blog).

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Juniors ask Senior

Interview with Maureen Cropper

Maureen Cropper *is a Distinguished University Professor and Chair of the Department of Economics at the University of Maryland. She is also a Senior Fellow at Resources for the Future, a Research Associate of the National Bureau of Economic Research and a member of the National Academy of Sciences. Professor Cropper served as a Lead Economist in the World Bank's Research Department from 1993-2006 and was a member of the USEPA's Science Advisory Board from 1994-2006, where she chaired the Advisory Council on Clean Air Compliance Analysis and the Environmental Economics Advisory Committee. She recently co-chaired the National Academy of Sciences Committee on Assessing Approaches to Updating the Social Cost of Carbon. Professor Cropper's research has focused on valuing the health impacts and health benefits of environmental programs, especially program to reduce air pollution. She is an author of the recent Lancet Commission report on Pollution and Health. Her current research centers on evaluating energy and environmental policies in India.*

What is the most important advice you would give to young researchers starting a career in environmental and resource economics?

I would emphasize three points: (1) Let the topics that you work on be motivated by policy. Environmental and Resource Economics is a policy-oriented discipline. I think this is good advice whether your work is theoretical or empirical. You should always try to address an important policy question. (2) Make sure you learn (and keep up with) state-of-the art analytical methods. This is usually easy when you leave graduate school. As your career progresses, teaching new methods will force you to learn them. (3) Don't try to work on too many projects at once—there's a chance you won't be able to complete them all—or see them through to publication. I have completed more than one research project that remains at the working paper stage because I had too many balls in the air to take it further.

How do you get the ideas for your research questions?

Most of my research has been motivated by policy questions. I've been fortunate to have been affiliated for most of my career with Resources for the Future (RFF) and the World Bank, so it's been easy to identify policy issues. Paul Portney at RFF suggested back in the late 1980s that it would be interesting to look at the tradeoffs implicit in regulations issued by the US Environmental Protection Agency: What is the value of life implied by the decision to ban a pesticide? This led to a series of papers looking at the tradeoffs implied by pesticide regulations, regulations issued under the Toxic Substances Control Act, and by the cleanup of hazardous waste sites under Superfund. When I was at the World Bank road traffic safety became an important issue. Elizabeth Kopits and I used cross-country panel data to examine the impact of per capita GDP on vehicle ownership, fatalities per vehicle and the death rate due to road traffic accidents.

Which research areas or questions in environmental and resource economics do you personally think deserve more attention?

I think that much more research needs to be conducted on the economic impacts of climate change and the costs of adapting to climate change. I don't know how much funding is available in Europe to evaluate the economic damages associated with climate, but there certainly could be more funding the United States. Im-

portant work is being conducted under the auspices of the Climate Impact Lab and at several universities, but there could be more—especially related to non-OECD countries.

How do you deal with very critical reviews of your papers?

First, I try not to take them personally. If I think that a negative review is not warranted, I will send the paper to another journal. But usually reviewers make good points. In my most recent rejection, the reviewer pointed out the need to use a different estimator for one of the models in the paper. My co-authors and I were forced to re-think what we were doing, and it changed the results of the paper. This is perhaps an extreme example. But, it is often the case that referee reports suggest how the presentation of results could be improved. (Why did the referee not understand what I was doing?)

What was the funniest experience you had when you gave a lecture or a talk at a conference?

I once gave a talk at a university in the Western United States on risk perception and on the capitalization of risks into property values. This, of course, requires that consumers have information about such risks. For example, it is essential that water in private wells be tested and that the results of these tests be made available when a house is put on the market. I made quite a point of this, using the professor who had invited me to give the talk as an example, since he had just put his house on the market. When he admitted he had not had his well water tested recently, the audience laughed. Not exactly a funny moment (for my host) but one that I remember to this day.

Young freshman students often loathe the idea of comparing costs and benefits when it comes to environmental protection and regulation. How do you convince them that these things are important? There is an opportunity cost to every policy. Treating health or environmental quality as goods that should be achieved regardless of their cost ignores this. A related issue that often arises is how the lives of people in different countries should be valued for policy purposes—for example, in calculating the social cost of carbon. It might seem appropriate to say that all lives are equally valuable; however, when we are asking what people in different countries would pay to reduce their risk of dying, this is not the correct answer. Studies have demonstrated that the amount poor people will give up to reduce mortality risks—which reflects what they can afford to give up— is lower than the willingness to pay of people in richer countries. Ascribing a higher value to mortality risks than people would themselves choose is a mistake. It implicitly forces them to consume more of a good than they would choose to consume. People everywhere make tradeoffs, and we, as researchers, should respect them.

Discrimination against women was probably a bigger problem when you started your career than it is today. Can you describe an example for the discrimination that you experienced and how you handled it?

To be honest, I can't think of an example of discrimination. I've encountered unpleasant people in my career—but they were unpleasant to everyone! I would prefer to focus on the people who supportive of my career, beginning with Henry Wan, my dissertation advisor at Cornell. Henry took over from S.C. Tsiang, who was on sabbatical the year I wrote my dissertation. The topic of my dissertation ("Bank Portfolio Selection with Stochastic Deposit Flows") was not a topic in Henry's field. But that did not matter. Henry helped me shape the dissertation. He gave me feedback which improved the final product immensely. And he did it quickly. When I gave him a chapter, I found comments from him in my mailbox the next day. I could not have had a better advisor. Colleagues on the USEPA Science Advisory Board were also very encouraging to me. The first time I had to serve as chair of an EPA Science Advisory Board com-

mittee I was uncertain what I should do. I remember that the people on the committee, including Mort Lippmann, a toxicologist, were wonderful and applauded after I chaired the first meeting. Paul Portney was also very supportive of me when I joined RFF as a visiting fellow in the late 1980s.

Which career / job did you have in mind when you finished high school?

I wanted to be an Economist, beginning at about age 16, when I read Robert Heilbroner's *The Worldly Philosophers*. What economists did seemed fascinating to me. When I went to Bryn Mawr College I became an Economics major, and I applied to graduate schools in Economics immediately after graduation. My original interest in Economics was in Macroeconomics, and my first job offer was from the NYU Business School. It wasn't until (for personal reasons) I went to the University of California, Riverside that I became interested in Environmental Economics. Ralph d'Arge was the head of the department then. Tom Crocker also taught there, and Bill Schulze and Jim Wilen were students in the department. It was also the birthplace of the *Journal of Environmental Economics and Management*.

Which book are you reading at the moment?

For the past seven years I've been head of the Economics Department at the University of Maryland. Teaching, doing research and being department chair has been all-consuming, so I'm afraid that I'm not reading anything that is not related to Economics. I'm hoping that this will change when I step down as department head in July.

If you could select a person (alive or deceased) to have dinner with, who would that be?

It would be Martha Caulkins, a former graduate student and co-author, who passed away at the age of 33 in February of this year. I did not have a chance to say goodbye to her.

EAERE
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Resource Economists

The European Association of Environmental and Resource Economists (EAERE) is an international scientific association which aims are:
_to contribute to the development and application of environmental and resource economics as a science in Europe;
_to encourage and improve communication between teachers, researchers and students in environmental and resource economics in different European countries;
_to develop and encourage the cooperation between university level teaching institutions and research institutions in Europe.
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