COMMENTARY

# Reaping the benefits of renewables in a nonoptimal world

**Ottmar Edenhofer[a,b,c,1], Brigitte Knopf[a], and Gunnar Luderer[a]**

[a]Potsdam Institute for Climate Impact Research (PIK), Research Domain Sustainable Solutions, 14412 Potsdam, Germany; [b]Mercator Research Institute on Global Commons and Climate Change (MCC), 10829 Berlin, Germany; and [c]TU Berlin - Berlin Institute of Technology, Faculty VII, 10623 Berlin, Germany

Positive and negative side effects of economic activities—"externalities" in the language of economists—are universal in the energy sector. Coal-fired power plants not only produce electricity, but also $CO_2$, which contributes to global warming, and local air pollutants such as sulfur dioxide ($SO_2$), which have adverse health effects on the population living downwind of the smoke stacks. The study by Siler-Evans et al. (1) analyzes the combined health, environmental, and climate benefits from solar and wind power and finds that these benefits feature strong regional variations. Crucially, they quantify the synergies between renewable energy policy and health and climate protection and demonstrate that they can be optimized if support schemes incorporate regional differences in benefits. The study is timely and provides insights into a number of ongoing scientific and policy debates not only in the United States but also in the European Union (EU) and other global regions. We explore these insights in the following analysis.

## Cobenefits as a Compelling Narrative for Policy Makers

Siler-Evans et al. (1) come to a different conclusion from that which might be suggested by optimal policy design; economists usually recommend implementing a well-tailored set of dedicated policy instruments to tackle relevant externalities in an economically efficient manner. Their tool box of policy instruments for the energy sector might include cap-and-trade schemes, taxes penalizing negative environmental externalities, or subsidy schemes incentivizing the installation of low-emission technologies. By contrast, Siler-Evans et al. (1) argue in favor of addressing multiple externalities by aligning public support schemes for renewables with the regional patterns of benefits. It is worthwhile noting that the existence of cobenefits depends mainly on three conditions (2): (*i*) the synergies and tradeoffs between objectives of climate and energy policies, (*ii*) the existence of externalities when private agents have insufficient incentives to achieve these goals, and (*iii*) the interaction between different policy instruments that are supposed to be implemented to address these externalities.*

Siler-Evans et al. (1) find multiple synergies between policy objectives in the power sector, and in addition, they suppose that crucial externalities cannot be removed, e.g., by $CO_2$ pricing. In effect they suggest, with good reason, the taking advantage of cobenefits, i.e., the positive effects of policies aimed at one objective on other policy objectives. In the real world, policy makers frequently shy away from putting the full set of economically optimal policy instruments into practice. This may be because some of the measures are likely to be unpopular, there are vested interests, or there are other institutional barriers. The narrative underlying the study by Siler-Evans et al. (1), by contrast, is much more compelling for politicians, who are more interested in achieving a broad buy-in from key interest groups than in implementing efficient policies. Politicians might hope that by supporting renewables they cannot only help to reduce emissions but can also create jobs, increase energy security, and improve air quality. This rationale is understandable; if cobenefits exist, politicians might be able to convince various societal groups to support such a policy. Moreover, by relying on cobenefits from technology policies, policy makers avoid implementing less popular measures such as carbon taxation. Additionally, synergies might reduce the costs of policies (3) and might even have positive effects for disadvantaged groups or for groups whose support is essential for the implementation of these policies.

**Siler-Evans et al. argue in favor of addressing multiple externalities by aligning public support schemes for renewables with the regional patterns of benefits.**

However, the concept of cobenefits is not always used appropriately. It is important to note that, taken alone, the existence of cobenefits is not a sufficient criterion for a policy to be rational. Siler-Evans et al. (1) argue that the promotion of renewables will reduce $CO_2$ emissions. However, a renewable policy is only welfare enhancing under very specific circumstances, and this occurs particularly when carbon pricing is nonexistent or too weak. If all externalities are addressed optimally, then there is no room for further improvements, and from an economic point of view, net social benefits from cobenefits only occur when externalities are not properly addressed by regulation. Economists describe these situations as second-best settings, when some barriers for an appropriate regulation cannot be removed. It must be emphasized that the study calculates cobenefits because of the imperfect regulation in the United States. Addressing the relevant externalities directly would in any case be the better choice. The study could be misused in the public debate by interest groups arguing that promoting renewables is a more favorable way to reduce emissions than the pricing of $CO_2$. In fact, the study proposes that if efficient policy instruments like $CO_2$ taxing cannot be implemented—for whatever reasons—then the support of renewables has cobenefits for climate policy and health effects.

Author contributions: O.E., B.K., and G.L. wrote the paper.

The authors declare no conflict of interest.

See companion article on page 11768.

[1]To whom correspondence should be addressed. E-mail: ottmar.edenhofer@pik-potsdam.de.

*The term cobenefit is not consistently defined in the literature. In this paper, we define cobenefit as positive physical side effect for other policy objectives. A welfare-enhancing effect of the cobenefits is called net social benefit, which can only occur in the second-best setting when the multiple externalities are not properly addressed with the appropriate policy instruments. The term synergies between policy objectives is used synonymously with cobenefits, as it also excludes welfare valuations.



www.pnas.org/cgi/doi/10.1073/pnas.1310754110

## Cobenefits Are Not a Surrogate for Efficient Policy Instruments

The relevance of this paper by Siler-Evans et al. (1) goes well beyond the US policy debate. Cobenefits play an increasingly dominant role in the current debate on environmental, climate, and energy policy, especially against the background of the present economic down-turn. Therefore, it can be expected that this study will also be well perceived by policy makers in other parts of the world. The fact that social objectives, incentives, and available policy instruments differ across regions can also help to explain how the public discourse on energy and climate policy in the United States is very different from that in other parts of the world. In Europe, for instance, the discussion on cobenefits of renewable energy deployment is less related to health benefits and more driven by the idea that "increased shares in renewables [...] contribute to more indigenous energy sources, reduced energy import dependence, and jobs and growth" (4). There is now a window of opportunity to design more coherent climate and energy policy packages at the European level prompted by the discussion of a framework for 2030 (4). In this context, the insights of Siler-Evans et al. are also of great interest for Europe.

The European Union has a binding target for greenhouse gas (GHG) reduction of 20% by 2020 compared with 1990 and intends to increase its share of renewables to 20% by 2020 (5). Additionally, Europe has formulated an indicative target on energy efficiency. For the GHG reduction target, the EU can take advantage of its cap-and-trade emissions trading scheme (ETS). The renewables target is covered by different supporting schemes at the national level, and the energy efficiency target is addressed by a variety of standards and regulations. Moreover, there is a direct regulation on "dirty" fossil fuel power plants that addresses emissions of $SO_2$, $NO_x$, and dust (6), so direct regulation for the problem raised by Siler-Evans et al. (1) is already available. Currently, the EU is in the middle of a debate about how to progress with the three overlapping headline targets and related instruments toward potential targets for 2030 (4). However, an integrated analysis of the consistency between these policy goals and the required policy instruments has not yet been carried out. Such assessments would be very useful for policy makers to help them determine the consistency of their goals and their potential synergies and tradeoffs.

## Incentivizing Grid Investments to Fully Exploit Location Advantages

The main merit of Siler-Evans et al.'s work (1) is the exploration of regional differences in benefits of renewables. However, the study is based on an important assumption: fossil plants are replaced locally by wind and solar, i.e., that the expansion of renewables is not accompanied by a commensurate expansion of the electricity grid. This indicates that there is a tradeoff between the best locations for harvesting renewables output and avoiding local air pollution. However, if transmission networks are expanded, then power plants can be taken off the grid at one place and replaced by wind power plants at another place. Grid expansion is thus an option that can overcome these tradeoffs. According to the US Department of Energy, there is the need for modernization of the system. They argue that "eliminating transmission constraints or bottlenecks is essential to ensuring reliable and affordable electricity now and in the future" (7). Similarly, in Europe, wind and solar potentials vary considerably (8). Europe already has an interconnected grid, with large cross-border interconnectors, and has plans for increasing the infrastructure (9). It is clear that, in both the United States and Europe, it is important to incentivize investments into the grid infrastructure to fully exploit location advantages.

Another important implication of the study is that the scope and the interaction between multiple policy instruments affect the reaping of cobenefits; in Europe, this might be the interaction between the ETS at the EU level and specific supporting schemes for renewables in the Member States. In the United States, the emerging subnational emission trading schemes such as the Regional Greenhouse Gas Initiative (RGGI) interact with renewable subsidy programs at the federal level. If a cap-and-trade regime for carbon emissions is in place, the introduction of renewable energy policies will reduce the carbon price level. Whether the declining carbon price, due to an additional renewable target, has negative welfare effects is open to debate. In the presence of technological learning, a case can be made for technology policies incentivizing early investments into innovative technologies, which help in the collection of experiences required to bring prices down. On the other hand, one could argue that falling carbon prices reduce the incentive for emissions abatement elsewhere, thus damaging the cost effectiveness of the policies. Therefore, more empirical evidence is needed on the relevance of technological externalities to facilitate a consistent design of policy instruments; otherwise, there is a risk that policy instruments will cancel out each other.

To conclude, the study by Siler-Evans et al. (1) has the potential to stimulate additional research on cobenefits and on the interaction of different policy instruments. Cobenefits can provide a powerful narrative for policy makers to take the first steps of the necessary transformation toward more sustainable energy supply systems. As long as the promise of cobenefits is based on sound evidence, there is nothing wrong with a pragmatic approach that accounts for the fact that some barriers for an efficient policy design will remain in the short term. However, the promise of cobenefits is empty if it is not substantiated by a careful empirical analysis and conceptual clarity. It is misleading if it prevents scientists from thinking about more efficient policies that directly address crucial environmental externalities.


**1** Siler-Evans K, Azevedo IL, Morgan MG, Apt J (2013) Regional variations in the health, environmental, and climate benefits of wind and solar generation. *Proc Natl Acad Sci USA* 110:11768–11773.

**2** Edenhofer O, Seyboth K, Creutzig F, Schloemer S (2013) On the sustainability of renewable energy sources. *Annu Rev Environ Resour*, 10.1146/annurev-environ-051012-145344.

**3** McCollum DL, Krey V, Riahi K (2011) An integrated approach to energy sustainability. *Nature Climate Change* 1:428–429.

**4** European Commission (2013) *Green paper: A 2030 framework for climate and energy policies* COM(2013) 169 final (European Union, Brussels). Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2013:0169:FIN:EN:PDF. Accessed June 19, 2013.

**5** European Parliament and the European Council (2009) *DIRECTIVE 2009/28/EC on the Promotion of the Use of Energy from Renewable Sources* (European Union, Brussels). Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=Oj:L:2009:140:0016:0062:en:PDF. Accessed June 19, 2013.

**6** European Parliament and the European Council (2001) *LCP Directive, 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants* (European Union, Brussels). Available at http://eur-lex.europa.eu/LexUriServ/site/en/consleg/2001/L/02001L0080-20011127-en.pdf. Accessed June 19, 2013.

**7** US Department of Energy (2002) *National Transmission Grid Study* (Washington, DC). Available at http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/TransmissionGrid.pdf. Accessed June 19, 2013.

**8** Institute of Energy Economics at the University of Cologne (EWI) and energynautics (2011) *Roadmap 2050 - a closer look. Cost-efficient RES-E penetration and the role of grid extensions* (Cologne, Germany). Available at http://www.ewi.uni-koeln.de/fileadmin/user_upload/Publikationen/Studien/Politik_und_Gesellschaft/2011/Roadmap_2050_komplett_Endbericht_Web.pdf. Accessed June 19, 2013.

**9** European Network of Transmission System Operators for Electricity (ENTSO-E) (2012) *10-Year Network Development Plan 2012* (Brussels). Available at https://www.entsoe.eu/fileadmin/user_upload/_library/SDC/TYNDP/2012/TYNDP_2012_report.pdf. Accessed June 19, 2013.