Co-benefits Annex

Sam Betts-Davies
June 2025

UNIVERSITY OF LEEDS

Priestley Centre for Climate Futures

What do we know from the academic literature on co-benefits?

Mitigating and adapting to climate change carry numerous forms of co-benefits to society over and above the avoidance of the damaging impacts of climate change. However, the extent to which these benefits are realised depends on the solutions chosen, and the design of policies to achieve the transition. Here, we review the academic evidence that explores a range of co-benefits and reflect on literature highlighting how they may be better integrated into climate decision making.

Health & air pollution

It is well evidenced that climate policy measures across sectors can have significant positive impacts on people's health, increasing life expectancy, reducing inequalities in health impacts and reducing costs for healthcare provision. In buildings, there is evidence suggesting that the improved insulation of dwellings when combined with measures to improve ventilation can improve occupants' respiratory health as well as carrying significant mental health benefits (Jensen et al., 2013; Osman et al., 2010; Wilkinson et al., 2001).
In the food sector, diets with lower calorific intake and shifts towards plant-based diets have the potential to reduce food related emissions whilst making diets healthier (Clark et al., 2022; Kumar et al., 2017; Richi et al., 2015). In travel and mobility, shifts towards active travel away from motorised transport could support healthier lifestyles (Chapman et al., 2018; Jarrett et al., 2012; Laverty et al., 2013; Tainio et al., 2016; Woodcock et al., 2013) and reduce transport-related health burdens that disproportionately impact lower income areas (Fecht et al., 2015).
Broadly, the health benefits of transitions have been found to disproportionately benefit lower income and disadvantaged communities (Wang et al., 2020).

A final key source of health benefits, and a key co-benefit of climate transitions, is the improvement in air pollution levels. A key source of air pollution mitigated by transitions to net-zero stem from the phasing out of internal combustion engine vehicles, with shifts to electrified private and public transport and active travel, in addition to air pollutants caused by waste sites, and fuel combustion within in the home (Gouldson et al., 2018). The Government Office for Science, in a Foresight project examining the social change required to achieve net-zero emissions, found in a wide range of scenarios significant reductions in all air pollutants (Government Office for Science, 2023). In all scenarios air pollutants are at least halved by 2030 and reduced by ~90% by 2050. This level of reduction in particulate pollution has significant health implications. Globally, Shindell et al. (2018) found that decarbonisation could lead to 153 million fewer air pollution related premature deaths between 2020 and 2100. Greenstone et al. (2022) found that if the World Health Organisation's targets on particulate matter are met, 2.2 years could be added to the global average life expectancy.

These co-benefits are of the most common to be included within policy assessments and thus policy decision-making on pursuing climate policies. This is largely due to the existence of established methodologies to monetise the health and air pollution implications of policies and integrate them into cost-benefits analysis tools already used by policy makers to evaluate policy.

Nature and wider environmental benefits

Beyond air pollution, there are many co-benefits that can be yielded for the wider environment through climate action strategies and policies. We already know that mitigating climate change to limit temperature rises to minimum levels has significant benefits to other ecological indicators, such as biodiversity, ocean acidification and water availability, amongst other impacts (IPCC Working Group 2, 2022). But, beyond the benefits of limiting temperature increases, mitigation and adaptation strategies can also carry important benefits in and of themselves to nature and the environment.

When it comes to nature and the environment, the ways in which we use land differently, to both mitigate and adapt to the impacts of climate change, carry significant co-benefits for the environment. For example, reductions in the consumption of meat and reductions in food waste can help to reduce the eutrophication and erosion of soils, whilst also reducing a key source of methane (Clark et al., 2022; Garvey et al., 2021; Sakadevan & Nguyen, 2017). Similarly, land use policy, such as allocating a greater share of land to forestry, can increase carbon sinks, whilst also supporting adaptation and resilience to climate impacts by acting as a flood defence (Green et al., 2021).

Whilst land use and agriculture strategies carry significant opportunities to unlock nature and environment co-benefits, other strategies also have the potential to improve environmental outcomes. In cities, pedestrianisation and the reduction of car transportation, and increased green space and tree cover can help to a) reduce cities carbon footprint, b) increase the liveability of urban spaces as temperatures rise, and c) improve the biodiversity of urban areas. In industry, resource efficiency and waste reduction strategies that reduce the material throughput of societies will reduce the ecological strain placed on environments.

Prosperity and economy

The economic impacts of climate policies are often used as key arguments both in favour of mitigation options, and as possible costs to the transition. However, to contextualise the economic co-benefits for climate action fully, one must consider the costs of inaction on climate change to properly compare the benefits, something rarely done in assessments of climate policy. Benayad et al. (2025) found that given expected rates of warming with current policies (3°C by 2100), cumulative economic output by 2100 would be reduced by 15% to 34%, compared with a counterfactual of limiting warming to 2C. Once adding in the economic costs of limiting temperature rises to below 2°C, (1-2% of GDP per year), the net-cost of inaction sits at 11% to 27% of cumulative GDP by 2100.

This work presents a clear economic case for climate action, and a high return on investments in mitigation and adaptation measures. However, in policy impact assessments seeking to understand the costs and benefits of proposed policies, it is rare for the 'do-nothing scenario' to incorporate the costs of inaction on climate change. Thus, the economic benefits of climate policies are understated, emphasising their financial cost rather than their benefit.

In the UK, supplementary guidance to the HM Treasury's 'Green Book' on policy appraisal was published in 2024, aiming to integrate climate impacts into policy appraisal processes (HM Treasury, 2024a). This approach aims to include the potential impacts of climate change on both baseline scenarios and the policy scenarios included within the appraisal processes. This is a positive step to contextualise economic co-benefits of acting against a baseline that includes climate impacts.

However, as noted by Benayad et al. (2025), there exists a temporal mismatch of costs and benefits in acting to mitigate climate change, where the bulk of the costs are required in the next 10-25 years but yield delayed benefits in the second half of the century, given that future benefits are often heavily discounted. This problem is exacerbated by the prioritisation of short-term goals, such as elections or profits, which are less likely to be impacted by differences in climate impacts between scenarios of mitigation.

Beyond changes to the total level of economic output implied by climate (in)action, there are other opportunities to realise economic co-benefits from climate policy, pertaining more closely to their design. For example, to achieve a fair transition that facilitates high levels of wellbeing for all, the need to use climate policy to help to reduce levels of inequality in society is argued to be central to a just transition (Betts-Davies et al., 2024; Millward-Hopkins & Johnson, 2023; Owen & Barrett, 2020). Climate policies that target energy uses that are strongly correlated with income, and are currently very unequal, such as frequent flier levies, are likely to be inherently progressive (Büchs & Mattioli, 2022). Similarly, if access to highly efficient technologies is improved, it could have a disproportionately beneficial impact on poorer households, due to being far more likely to be living in lower efficiency housing, whilst spending a disproportionately high percentage of their income on energy bills (Middlemiss & Gillard, 2015; Millward-Hopkins & Johnson, 2023). Importantly, many factors around the design (Millward-Hopkins & Johnson, 2023) and funding of (Owen & Barrett, 2020)climate policy will determine the ability to unlock these positive co-benefits.

Social and wellbeing

Whilst the evidence of the impact of climate policy on physical co-benefits (air pollution, health, physical exercise etc) is well documented in the academic literature, there is less evidence exploring the implications for social dimensions of wellbeing, such as social cohesion, personal security or political stability (Creutzig et al., 2022). Despite this, there are some key measures that are likely to have significant socio-cultural impacts. Gendered aspects to energy poverty, such as lower average incomes, greater share of single adult households with or without children, and a greater responsibility for domestic energy service use (Clancy et al., 2017; Kooijman et al., 2023; Schubert et al., 2025), are all aspects that can be addressed through climate mitigation policy that seeks to increase the affordability of domestic energy service access or improve the thermal efficiency of domestic dwellings. Social cohesion could be improved through the design of compact cities and urban systems that seeks to integrate important services into communities, requiring them to travel less and thus use less energy (Creutzig et al., 2022; Raman, 2010). Finally, teleworking may have positive social co-benefits by freeing up leisure time, but carries risk of social isolation if face-to-face contact with others is omitted (Creutzig et al., 2022; Golden et al., 2008).

Crucially, these socio-cultural co-benefits are contingent not only of the specific climate policy direction chosen, but also their design to account for and target the unlocking of these benefits. Assessing these benefits, to make a case for them in policy assessments is a challenging task, given they do not neatly fit into the monetised cost-benefit analyses that are able to better capture some of the physical co-benefits discussed above. As such, more qualitative decision-making tools, such as that described in case study 2 (Braunholtz-Speight, 2024; Gilbertson, 2021), have been developed to consider these important social aspects in policy design.

Aligning policy areas with climate benefits: co-benefits can work both ways

There is also evidence in the literature that climate benefits, be those through reducing emissions to mitigate climate change or adapting to the impacts of climate change, can result from policies with the primary intention of achieving other policy objectives. Karlsson et al. (2020) categorise these as one of three taxonomic types of co-benefits: those that occur because of climate policy (type 1); climate co-benefits occurring because of policy in other areas (type 2); and ‘benefit synergies’ resulting from policy with multiple objectives (type 3). While this analysis has primarily focused on type 1 co-benefits, it is equally important to consider how policies aimed at other objectives may generate benefits or trade-offs that impact the climate agenda.

Examples of type 2 co-benefits could be, for example, the reduction in greenhouse gas (GHG) emissions generated by a speed reduction policy primarily designed to increase public safety and reduce traffic (Perez-Prada & Monzon, 2017). Similarly, ensuring these reverse co-benefits are assessed is crucial when developing energy security policy (Chaturvedi, 2016). There are various ways in which energy security could be achieved, both through increasing domestic renewable production and reducing energy demand or through increasing domestic fossil fuel production (Jewell et al., 2016). Thus, integrating and aligning policy areas by understanding and designing policies to maximise the positive interactions between those areas is important in achieving multiple objectives.

Further literature can be accessed through the co-benefits and trade-offs tool developed by the University of Leeds and the Met Office. It can be accessed here: **https://priestleycentre.shinyapps.io/climatecobenefitsportal/**

References

Benayad, A., Hagenauer, A., Holm, L., Jones, E. R., Kämmerer, S., Maher, H., Mohaddes, K., Santamarta, S., & Zawadzki, A. (2025). *Landing the Economic Case for Climate Action with Decision Makers*.

Betts-Davies, S., Barrett, J., Brockway, P., & Norman, J. (2024). Is all inequality reduction equal? Understanding motivations and mechanisms for socio-economic inequality reduction in economic narratives of climate change mitigation. *Energy Research & Social Science*, 107, 103349. **https://doi.org/10.1016/J.ERSS.2023.103349**

Braunholtz-Speight, T. (2024). *Carbon and Co-benefits Decision Support Tool - CAST*. Centre for Climate Change and Social Trasformations. **https://cast.ac.uk/cast-tools/carbon-and-co-benefits-decision-support-tool/**

Büchs, M., & Mattioli, G. (2022). How socially just are taxes on air travel and 'frequent flyer levies'? *Journal of Sustainable Tourism*. **https://doi.org/10.1080/09669582.2022.2115050**

Chapman, R., Keall, M., Howden-Chapman, P., Grams, M., Witten, K., Randal, E., & Woodward, A. (2018). A Cost Benefit Analysis of an Active Travel Intervention with Health and Carbon Emission Reduction Benefits. *International Journal of Environmental Research and Public Health*, 15(5). **https://doi.org/10.3390/IJERPH15050962**

Chaturvedi, V. (2016). Energy security and climate change: Friends with asymmetric benefits. *Nature Energy 2016 1:6, 1*(6), 1–2. **https://doi.org/10.1038/nenergy.2016.75**

Clancy, J., Daskalova, V., Feenstra, M., & Franceschelli, N. (2017). *Gender Perspective on Access to Energy in the EU*. Publications Office of the European Union. **https://doi.org/10.2861/190160**

Clark, M., Springmann, M., Rayner, M., Scarborough, P., Hill, J., Tilman, D., Macdiarmid, J. I., Fanzo, J., Bandy, L., & Harrington, R. A. (2022). Estimating the environmental impacts of 57,000 food products. *Proceedings of the National Academy of Sciences of the United States of America, 119*(33). **https://doi.org/10.1073/pnas.2120584119**

Creutzig, F., Niamir, L., Bai, X., Callaghan, M., Cullen, J., Díaz-José, J., Figueroa, M., Grubler, A., Lamb, W. F., Leip, A., Masanet, E., Mata, É., Mattauch, L., Minx, J. C., Mirasgedis, S., Mulugetta, Y., Nugroho, S. B., Pathak, M., Perkins, P., … Ürge-Vorsatz, D. (2022). Demand-side solutions to climate change mitigation consistent with high levels of well-being. *Nature Climate Change, 12*(1), 36–46. **https://doi.org/10.1038/s41558-021-01219-y**

Creutzig, F., Roy, J., Devine-Wright, P., Diaz-Jose, J., Geels, F., Grubler, A., Maizi, N., Masanet, E., Mulugetta, Y., Onyige-Ebeniro, C. D., Perkins, P. E., Pereira, A. S., & Weber, E. U. (2022). Demand, services and social aspects of mitigation. In IPCC (Ed.), *Working Group III contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1–192). IPCC. **https://www.ipcc.ch/site/assets/uploads/2018/05/uncertainty-guidance-note.pdf**

Fecht, D., Fischer, P., Fortunato, L., Hoek, G., De Hoogh, K., Marra, M., Kruize, H., Vienneau, D., Beelen, R., & Hansell, A. (2015). Associations between air pollution and socioeconomic characteristics, ethnicity and age profile of neighbourhoods in England and the Netherlands. *Environmental Pollution (Barking, Essex : 1987)*, 198, 201–210. **https://doi.org/10.1016/J.ENVPOL.2014.12.014**

Garvey, A., Norman, J. B., Owen, A., & Barrett, J. (2021). Towards net zero nutrition: The contribution of demand-side change to mitigating UK food emissions. *Journal of Cleaner Production, 290*, 125672. **https://doi.org/10.1016/j.jclepro.2020.125672**

Gilbertson, Z. (2021). *Creating a Personal Doughnut* | DEAL. Doughnut Economics Lab. **https://doughnuteconomics.org/stories/creating-a-personal-doughnut#decision-wheels**

Golden, T. D., Veiga, J. F., & Dino, R. N. (2008). The Impact of Professional Isolation on Teleworker Job Performance and Turnover Intentions: Does Time Spent Teleworking, Interacting Face-to-Face, or Having Access to Communication-Enhancing Technology Matter? *Journal of Applied Psychology,* 93(6), 1412–1421. **https://doi.org/10.1037/A0012722**

Gouldson, A., Sudmant, A., Khreis, H., & Papargyropoulou, E. (2018). *The Economic and Social Benefits of Low-Carbon Cities: A Systematic Review of the Evidence.* **http://newclimateeconomy.net/content/cities-working-papers**

Government Office for Science. (2023). *Net zero society: scenarios and pathways.*

Green, D., O'Donnell, E., Johnson, M., Slater, L., Thorne, C., Zheng, S., Stirling, R., Chan, F. K. S., Li, L., & Boothroyd, R. J. (2021). Green infrastructure: The future of urban flood risk management? *Wiley Interdisciplinary Reviews: Water, 8*(6), e1560. **https://doi.org/10.1002/WAT2.1560**

Greenstone, M., Hasenkopf, C., & Lee, K. (2022). *Air quality life index (AQLI) Annual Update*.

HM Treasury. (2024). *Accounting for the effects of climate change: Supplementary Green Book guidance*.

IPCC Working Group 2. (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability*. **https://www.ipcc.ch/report/ar6/wg2/**

Jarrett, J., Woodcock, J., Griffiths, U. K., Chalabi, Z., Edwards, P., Roberts, I., & Haines, A. (2012). Effect of increasing active travel in urban England and Wales on costs to the National Health Service. *Lancet* (London, England), 379(9832), 2198–2205. **https://doi.org/10.1016/S0140-6736(12)60766-1**

Jensen, H. T., Keogh-Brown, M. R., Smith, R. D., Chalabi, Z., Dangour, A. D., Davies, M., Edwards, P., Garnett, T., Givoni, M., Griffiths, U., Hamilton, I., Jarrett, J., Roberts, I., Wilkinson, P., Woodcock, J., & Haines, A. (2013). The importance of health co-benefits in macroeconomic assessments of UK Greenhouse Gas emission reduction strategies. *Climatic Change, 121*(2), 223–237. **https://doi.org/10.1007/S10584-013-0881-6**

Jewell, J., Vinichenko, V., McCollum, D., Bauer, N., Riahi, K., Aboumahboub, T., Fricko, O., Harmsen, M., Kober, T., Krey, V., Marangoni, G., Tavoni, M., Van Vuuren, D. P., Van Der Zwaan, B., & Cherp, A. (2016). Comparison and interactions between the long-term pursuit of energy independence and climate policies. *Nature Energy 2016 1:6, 1*(6), 1–9. **https://doi.org/10.1038/nenergy.2016.73**

Karlsson, M., Alfredsson, E., & Westling, N. (2020). Climate policy co-benefits: a review. *Climate Policy, 20*(3), 292–316. **https://doi.org/10.1080/14693062.2020.1724070**

Kooijman, A., Clancy, J., & Cloke, J. (2023). Extending energy access assessment: The added value of taking a gender perspective. *Energy Research & Social Science, 96*, 102923. **https://doi.org/10.1016/J.ERSS.2022.102923**

Kumar, P., Chatli, M. K., Mehta, N., Singh, P., Malav, O. P., & Verma, A. K. (2017). Meat analogues: Health promising sustainable meat substitutes. *Critical Reviews in Food Science and Nutrition, 57*(5), 923–932. **https://doi.org/10.1080/10408398.2014.939739**

Laverty, A. A., Mindell, J. S., Webb, E. A., & Millett, C. (2013). Active travel to work and cardiovascular risk factors in the United Kingdom. *American Journal of Preventive Medicine, 45*(3), 282–288. **https://doi.org/10.1016/J.AMEPRE.2013.04.012**

Middlemiss, L., & Gillard, R. (2015). Fuel poverty from the bottom-up: Characterising household energy vulnerability through the lived experience of the fuel poor. *Energy Research & Social Science, 6*, 146–154. **https://doi.org/10.1016/J.ERSS.2015.02.001**

Millward-Hopkins, J., & Johnson, E. (2023). Distributing less, redistributing more: Safe and just low-energy futures in the United Kingdom. *Energy Research & Social Science, 95*, 102915. **https://doi.org/10.1016/J.ERSS.2022.102915**

Osman, L. M., Ayres, J. G., Garden, C., Reglitz, K., Lyon, J., & Douglas, J. G. (2010). A randomised trial of home energy efficiency improvement in the homes of elderly COPD patients. *The European Respiratory Journal, 35*(2), 303–309. **https://doi.org/10.1183/09031936.00187708**

Owen, A., & Barrett, J. (2020). Reducing inequality resulting from UK low-carbon policy. *Climate Policy, 20*(10), 1193–1208. **https://doi.org/10.1080/14693062.2020.1773754**

Perez-Prada, F., & Monzon, A. (2017). Ex-post environmental and traffic assessment of a speed reduction strategy in Madrid's inner ring-road. *Journal of Transport Geography, 58, 256–268*. **https://doi.org/10.1016/J.JTRANGEO.2016.12.018**

Raman, S. (2010). Designing a liveable compact city physical forms of city and social life in urban neighbourhoods. *Built Environment, 36*(1), 63–80. **https://doi.org/10.2148/BENV.36.1.63**

Richi, E. B., Baumer, B., Conrad, B., Darioli, R., Schmid, A., & Keller, U. (2015). Health Risks Associated with Meat Consumption: A Review of Epidemiological Studies. *International Journal for Vitamin and Nutrition Research. Internationale Zeitschrift Fur Vitamin- Und Ernahrungsforschung. Journal International de Vitaminologie et de Nutrition, 85*(1–2), 70–78. **https://doi.org/10.1024/0300-9831/A000224**

Sakadevan, K., & Nguyen, M. L. (2017). Livestock Production and Its Impact on Nutrient Pollution and Greenhouse Gas Emissions. *Advances in Agronomy, 141*, 147–184. **https://doi.org/10.1016/BS.AGRON.2016.10.002**

Schubert, I., Hinel, A., & Burger, P. (2025). Gendered energy consumption goes beyond sex: Applying a multi-dimensional gender framework to Swiss survey data. *Energy Research & Social Science, 121*, 103944. **https://doi.org/10.1016/J.ERSS.2025.103944**

Shindell, D., Faluvegi, G., Seltzer, K., & Shindell, C. (2018). Quantified, localized health benefits of accelerated carbon dioxide emissions reductions. *Nature Climate Change 2018 8:4, 8*(4), 291–295. **https://doi.org/10.1038/s41558-018-0108-y**

Tainio, M., de Nazelle, A. J., Götschi, T., Kahlmeier, S., Rojas-Rueda, D., Nieuwenhuijsen, M. J., de Sá, T. H., Kelly, P., & Woodcock, J. (2016). Can air pollution negate the health benefits of cycling and walking? *Preventive Medicine, 87*, 233–236. **https://doi.org/10.1016/J.YPMED.2016.02.002**

Wang, T., Jiang, Z., Zhao, B., Gu, Y., Liou, K. N., Kalandiyur, N., Zhang, D., & Zhu, Y. (2020). Health co-benefits of achieving sustainable net-zero greenhouse gas emissions in California. *Nature Sustainability 2020 3:8, 3*(8), 597–605. **https://doi.org/10.1038/s41893-020-0520-y**

Wilkinson, P., Landon, M., Armstrong, B., Stevenson, S., & Mckee, M. (2001). *Cold comfort: the social and environmental determinants of excess winter death in England, 1986-1996*.

Woodcock, J., Givoni, M., & Morgan, A. S. (2013). Health impact modelling of active travel visions for England and Wales using an Integrated Transport and Health Impact Modelling Tool (ITHIM). *PloS One, 8*(1). **https://doi.org/10.1371/JOURNAL.PONE.0051462**

The Priestley Centre's Climate Evidence Unit provides independent insight to inform the delivery of a climate resilient, decarbonised future. It brings together world-leading experts from the University of Leeds to deliver timely and robust evidence that can inform climate action.

The Priestley Centre for Climate Futures is a leading climate change centre based at the University of Leeds.

For more information, including how to work with us, visit **climate.leeds.ac.uk**.

Disclaimer
The information and recommendations presented in this work are based on the current evidence on the date of publication. Any substantial progression in the underpinning evidence could therefore lead to the findings and recommendations of this work being outdated or irrelevant.

The findings and recommendations do not indicate a view or position taken by the University of Leeds.

Funding statement
The Climate Evidence Unit is supported by Research England funding.

DOI: **https://doi.org/10.48785/100/346**

UNIVERSITY OF LEEDS

Priestley Centre for Climate Futures