

Institution: University of Cambridge		
Unit of Assessment: UoA 13		
Title of case study: Quantifying macroeconomic impact of stranded fossil-fuel assets for use by regulators, policy circles and class actions		
Period when the underpinning research was undertaken: 2014-2018		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Professor Jorge E. Viñuales	Harold Samuel Professor of Law and Environmental Policy, Founder and former Director of C-EENRG	October 2013-present
Dr Jean-François Mercure	EPSRC Research Fellow, Fellow of C-EENRG	January 2011-December 2015
Dr Pablo Salas Bravo	Senior Research Associate Deputy-Director of C-EENRG	March 2017-present
Period when the claimed impact occurred: 2018-2020		
Is this case study continued from a case study submitted in 2014? No		
1. Summary of the impact (indicative maximum 100 words)		
<p>Research conducted at the Centre for Environment, Energy and Natural Resources Governance, University of Cambridge (C-EENRG) has directly contributed to the ability of policy authorities, regulators, major investment companies and international corporations to understand both the macroeconomic implications and the financial risks arising from the transition to a low-carbon economy. The research provides a quantitative estimation of the cost of 'stranded assets'. Its impact has been felt in 5 main ways: (1) it has been expressly relied upon by the Bank of England (BoE) in taking the lead to demand disclosure by financial intermediaries of climate-related risks; (2) the estimation and analysis has featured prominently in influential policy reports, such as the Intergovernmental Panel on Climate Change (IPCC)'s 2018 Special Report on 1.5°C, the 2018 Report from the Global Commission on the Economy and Climate and the Banque de France (BdF)'s The Green Swan report; (3) the research has also attracted substantial attention and specific requests for information from senior political and governmental actors (Canadian Prime Minister Trudeau, Canadian Energy Ministry, US Senate), financial regulators (BoE, BdF), investment funds, and energy companies; (4) it has been specifically relied upon in a major class action brought by 17,200 claimants and 7 non-governmental organisations (NGOs) against Royal Dutch Shell, and (5) it has influenced UK Government's engagement strategy with Brazil, China and India.</p>		
2. Underpinning research (indicative maximum 500 words)		
<p>The underpinning research was conducted from 2014 to 2018 by a network of researchers spanning several institutions. The core team was led by researchers from the University of Cambridge (C-EENRG): Viñuales, C-EENRG Founder and Director; Mercure, EPSRC Post-Doctoral Fellow, C-EENRG Fellow; Edwards, Open University, C-EENRG Fellow; Pollitt, Cambridge Econometrics, C-EENRG Fellow. C-EENRG was established in 2014 within the Department of Land Economy in order to conduct integrative research on the governance of environmental transitions, such as the climate-driven transition from a carbon-intensive inefficient energy matrix to a decarbonised and efficient one.</p>		

[R1] proposes a novel theoretical approach to the modelling of policy interventions for sustainability transitions, which accounts for complexity (e.g. self-reinforcing mechanisms, such as technology lock-ins, arising from multi-agent interactions) and agent heterogeneity (e.g. differences in consumer and investment behaviour arising from income stratification). The approach is illustrated by reference to four key areas of sustainability policy: (i) technology adoption and diffusion, (ii) macroeconomic impacts of low-carbon policies, (iii) interactions between the socio-economic system and the natural environment, and (iv) the anticipation of policy outcomes.

[R2] details the key features of the model that implements the theoretical approach. This model, E3ME-FTT-GENIE1, is a non-optimisation integrated assessment model with very high sectoral granularity. The research shows how it can be used to assess the impact of realistic policy portfolios on both the economy and the environment.

[R3] is a specific application of this novel approach/model to assess the macroeconomic consequences on GDP and employment of the decline in demand for fossil fuels arising not only from possible climate policies, but also, for the first time, in the absence of any new policies to reach the 2°C target set by the 2015 Paris Agreement. Research showed that as a result of the decline in demand, some fossil fuel assets would become 'stranded'. This is driven by an already ongoing technological trajectory, irrespective of any new climate policies. If such policies are indeed adopted and/or if low-cost producers (some OPEC countries) increase production despite declining demand, the loss is amplified. The magnitude of the loss from stranded assets may amount to a discounted global wealth loss of **USD1-4 trillion** (up to **USD12 trillion**, if not discounted). There are clear winners (net importers such as China or the EU) and losers (Canada, the United States or Russia, which could see their fossil fuel industries nearly shut down), although the two effects largely offset each other at the level of aggregate global GDP. This 'carbon bubble' could trigger a global financial crisis.

3. References to the research (indicative maximum of six references)

R1: Mercure, J.-F., Pollitt, H., Bassi, A., Viñuales, J. E., Edwards, N. R. (2016). Modelling complex systems of heterogeneous agents to better design sustainability transitions policy. *Global Environmental Change*, 37, 102-115. [\[DOI\]](#).

R2: Mercure, J.-F., Pollitt, H., Edwards, N. R., Holden, P. B., Chewpreecha, U., Salas, P., Lam, A., Knobloch, F., Viñuales, J. E. (2018). Environmental impact assessment for climate change policy with the simulation-based integrated assessment model E3ME-FTT-GENIE1. *Energy Strategy Reviews*. 20, 195-208. [\[DOI\]](#).

R3: Mercure, J.-F., Pollitt, H., Viñuales, J. E., Edwards, N. R., Holden, P. B., Chewpreecha, U., Salas, P., Sognaess, I., Lam, A. (2018). Macroeconomic impact of stranded fossil-fuel assets. *Nature Climate Change*, 8, 588-593. [\[DOI\]](#).

As of 7 December 2020, **[R3]** had an Altmetric score of 776, which ranked it in the top 99th percentile of all the 16,339,421 research outputs tracked. [\[Link\]](#)

The research was conducted with support from several grants and published in well-established, peer-reviewed journals. The following research grants underpin the research:

- 1) Dr J. Mercure - Multi-sectoral interactions in global energy end-use (EP/K007254/1) - EPSRC - 01.01.2013-31.12.2015 - GBP231,481.
- 2) Dr J. Mercure - Newton Fund: Links 2015 - Linkages between energy, food and water consumption for Brazil in the context of climate change mitigation strategies (EP/N002504/1) - EPSRC - 01.01.2013-27.04.2015 - GBP46,373.

3) Professor J. E. Viñuales - BRIDGE - Building Resilience In a Dynamic Global Economy: Complexity across scales in the Food-Water-Energy Nexus (ES/N013174/1) - ESRC - 10.2016-03.2020 - GBP578,903.

4) Professor J. E. Viñuales - The Law of Energy Transitions - Philomathia Foundation, donation administered by the School of the Humanities and Social Sciences, University of Cambridge - competitively awarded to support PDRAs, database development and event-hosting between 2015-2019 - c.GBP115,000.

4. Details of the impact (indicative maximum 750 words)

The research conducted at the University of Cambridge (C-EENRG) has directly contributed to the quantification of the macroeconomic risk arising from stranded assets by the Bank of England, and it has shaped several major actions at the regulatory, policy and litigation levels.

Impact on the Bank of England

[R3] is unique in providing an overall estimation of the loss arising from stranded fossil fuel assets at between **USD1 to 4 trillion** (the upper figure is the discounted present value – with a 10% discount factor – in 2016 USD of a calculated loss of up to **USD12 trillion** by 2035).

These estimates have been specifically used by the BoE, as demonstrated by a speech delivered by Sarah Breeden (BoE Executive Director, International Banks Supervision) at the Official Monetary & Financial Institutions Forum, London, on 15 April 2019. In her speech, entitled *Avoiding the storm: Climate change and the financial system*, Ms Breeden uses our estimates: *'The estimated losses are large – \$1tn-\$4tn when considering fossil fuels alone'*. She then speaks of a *'climate Minsky moment, where asset prices adjust quickly with negative feedback loops to growth'* **[E1]**. An official from the BoE, whose contribution in drafting Breeden's speech is expressly acknowledged in it, has confirmed that the figures are derived from **[R3]** **[E2]**. Mark Carney, the Governor of the BoE, has also referred to this Minsky moment in his public interventions, e.g. a 2019 article in *The Guardian* **[E3]**.

Action taken by the BoE to tackle the risk arising from climate change was described, in Breeden's speech as, *'today, and following several months of consultation, we became the first regulator in the world to publish supervisory expectations that set out how the banks and insurance companies we regulate need to develop an enhanced approach to managing the financial risks from climate change'*. This is a reference to Supervisory Statement SS3/19 on 'Enhancing banks' and insurers' approaches to managing the financial risks from climate change' **[E4]**. This Supervisory Statement avoids offering any quantitative estimate of the risk (see para. 2.6) but it explicitly refers to *'transition risks ... from the process of adjustment towards a low-carbon economy'* and, as an example, it refers to the specific issues and sectors analysed in **[R3]**, namely *'rapid technological change, such as the development of electric vehicles or renewable energy technology, affecting the value of financial assets'* (para. 2.4). The Statement introduces, among other things, disclosure requirements (paras. 3.19 and 3.20). In media interventions following the publication of **[R3]**, Viñuales, Mercure and others involved specifically emphasised the need for better disclosure requirements as a tool to manage the financial risk arising from stranded fossil fuel assets **[E5]**, bringing this to the attention of a wider public.

Impact on influential reports from global institutions and the media

Our work on modelling and stranded fossil fuel assets has featured in key international policy reports. There are references to **[R3]** in the IPCC's Special Report on 1.5°C, published in late 2018. In Chapter 4 **[E6]**, **[R3]** is relied upon for the quantification of stranded fossil fuel assets (p. 375) as well as to emphasise the need to carefully set the pace of decarbonisation (Box 4.8). This impact is confirmed by the invitation received by Mercure to contribute the section on stranded fossil fuel assets in the 6th IPCC Assessment Report, planned for 2022-2023 **[E7]**.

In the August 2018 Report from the Global Commission on the Economy and Climate [E8], chaired by the Former President of Mexico, with co-chairs from government (N. Okonjo-Iweala, former Finance Minister of Nigeria), business (P. Polman, CEO of Unilever) and academia (N. Stern), our estimate of the impact of stranded fossil fuel assets is highlighted as a key message in the Report Summary (at p. 14, highlighted in red: *'Estimates suggest US\$12 trillion stranded fossil fuel assets possible by 2035'*). This is elaborated upon, by reference to [R3], in Section 1, at p. 39).

In the January 2019 Report from the Global Commission on the Geopolitics of the Energy Transformation [E9], chaired by the former President of Iceland, O. Ragnar Grímsson, [R3] is the only reference, together with a reference to a press article from BoE's Governor Mark Carney on the 'climate Minsky moment', on which the geopolitical consequences of stranded fossil fuel assets are discussed (at p. 65, the Report warns against the 'systemic consequences' of stranded fossil fuel assets, which may *'even trigger a climate 'Minsky moment', given the large sums involved. One study found that no less than 12 trillion US dollars of financial value could be lost in the form of stranded assets.'*).

More generally, [R3] drew international attention from print media when it was published, being featured on the cover of *Nature Climate Change*. It was widely reported in all major media outlets in the UK (*BBC, the Guardian, The Times, The Daily Mail*) and overseas (Argentina, Brazil, Canada, France, Norway, Spain, etc.). It featured extensively on social media, including on Twitter by former US vice-president Al Gore.

Specific requests for information

[R3] has elicited specific requests for further information, data-sharing, meetings, interviews and explanations from political/governmental actors, financial regulators, investment funds, and energy companies [E10].

On 6 June 2018, the team also received a similar request from the office of a US Senator, Sheldon Whitehouse [E10], who is actively involved in campaigns for climate change-related disclosure by fossil fuel companies.

On 7 June 2018, Vinuales and Mercure received a request from Chief of the Economic Analysis Division of Natural Resources Canada [E10] to share data relating to a figure that predicted a substantial adverse impact on Canada. The following week, at a time when the debate over the acquisition by the Federal Canadian Government of the Kinder-Morgan pipeline was raging, an MP from the New Democratic Party relied on [R3] in a motion at the Canadian Parliament. The transcript from the session of 13th June 2018 mentions that MP A. Boulerice, addressing Canadian Prime Minister J. Trudeau, stated that *'according to a study by Cambridge University, a foreseeable and inevitable drop in global demand for oil will burst the carbon bubble. This will happen between 2030 and 2050'* [E11]. Prime Minister Trudeau mentioned that the government's move was an effort to diversify Canada's foreign markets. The motion was subsequently defeated.

Use in a major class action

Estimates and projections in [R3] have been used in litigation. In a major class action brought by 17,200 claimants and 7 NGOs (Milieudefensie, ActionAid NL, Both ENDS, Fossielvrij NL, Greenpeace NL, Young Friends of the Earth NL, Waddenvereniging) against Royal Dutch Shell plc before the District Court of The Hague, the claimants' brief argues that *'[a]ccording to a study published in the renowned scientific journal Nature Climate Change, the value of investments in fossil fuels will decrease considerably between 2020 and 2030 due to the declining demand for these products. The losses can amount to 1-4 trillion dollars, an amount that is comparable to the losses made in the 2008 economic crisis'* (para. 783) [E13]. The case was at the oral hearings stage at the time of writing.

Impact on the UK Government

The risks quantified by [R3] and the wider possibilities unveiled by the theoretical framework introduced in [R1] have elicited interest from the UK Department for Business, Energy & Industrial Strategy (BEIS), who together with the Children's Investment Fund Foundation (CIFF) are supporting an extension of the research on the modelling of energy transitions in Brazil, China, India, the EU and the UK, with GBP3 million (BEIS), plus USD 1 million (CIFF) funding (Project EEIST, Mercure PI, Vinuales Co-I) [E12]. Moreover, other financial regulators (e.g. BdF) and private investment funds have relied on [R3] and/or decided to license parts of the model on which the research is based (E3ME-FTT) to apply it to their own projections.

5. Sources to corroborate the impact (indicative maximum of 10 references)

E1: S. Breeden. *Avoiding the storm: Climate change and the financial system*. Speech given at the Official Monetary & Financial Institutions Forum, London, 15 April 2019 [\[Link\]](#)

E2: Testimonial: Official from the Bank of England.

E3: Newspaper article: Carney. The financial sector must be at the heart of tackling climate change. *The Guardian*, 17 April 2019. [\[Link\]](#)

E4: Bank of England. (2019). *Enhancing banks' and insurers' approaches to managing the financial risks from climate change*. Supervisory Statement SS3/19. [\[Link\]](#)

E5: Newspaper articles and media relating to [R3] calling for better disclosure of financial risks arising from the effects of climate change and policy responses to it.

E6: Report: IPCC. (2018). *Global warming of 1.5°C*. See: Chapter 4, pp. 319, 373-375. [\[Link\]](#)

E7: Invitation to J.F. Mercure to contribute to IPCC. (2018). *Global warming of 1.5°C*, AR6

E8: Report: New Climate Economy. (2018). *Unlocking the inclusive growth story of the 21st century: Accelerating climate action in urgent times*. See: pp. 12, 39. [\[Link\]](#)

E9: Report: IRENA. (2019). *A new world: Geopolitics of energy transition*. See: pp. 64-65, 82. [\[Link\]](#)

E10: Requests for expertise, information and invitations to speak received by the authors of [R3].

E11: House of Commons, Canada. Official report (Hansard) for Wednesday 13 June 2018: exchange between MP Alexandre Boulerice (NDP) and Prime Minister Trudeau (Liberals).

E12: Testimonial: Deputy Director, Policy Themes, COP26 Unit, Cabinet Office.

E13: Documents relating to the class action brought against Royal Dutch Shell plc. by 17,200 claimants and Milieudefensie, ActionAid NL, Both ENDS, Fossilvrij NL, Greenpeace NL, Young Friends of the Earth NL, Waddenvereniging: Background, excerpts from the legal brief presented by the Claimants, and testimonial from lead lawyer.