

consumer, energy being expended as an overwhelmingly invisible part of their daily lives^{3,4}. Their engagement with the energy system is limited to occasional — often poorly understood — bills, and their views of energy providers are marked by much distrust⁵. We believe that such an arrangement is poorly suited for the development of a smart grid using DSM, which fundamentally alters the part played by the end user, from a passive to an active role.

Certainly, some demand-response could be achieved in a manner that does not require the householder to be active, but examples, such as smart fridge-freezers that schedule cooling according to grid signals, are rare. Most DSM solutions require the householder to modify their practices to varying degrees. DSM advocates must then attend to the question of how this shift in role can best be achieved.

Demand-side management as set out by van Renssen assumes a reliance on demand-responsive pricing. Trials have demonstrated successful results; however,

the vast majority have required end users to opt-in⁶, skewing results. One of the few large-scale non-voluntary schemes, run in northern Italy, actually resulted in increased energy use⁷. Furthermore, monetizing incentives can undermine 'social good' incentives that studies suggest can be highly effective^{8,9}. A final danger in relying on a consumer frame for DSM is highlighted by van Renssen's claim that "comfort [can] not be compromised." In fact, perceptions of 'comfort' are constantly evolving, and fixing particular demands can unnecessarily exacerbate energy demand^{9,10}.

To harness people power, we must recognize power in terms of social agency, as well as physical forces, and approach users as energy citizens rather than consumers. One way this has already been achieved is when users become generators as well as consumers. Whether through privately- or community-owned renewables, this can be important in fostering a sense of agency; it also helps people perceive the grid as a shared resource¹¹. The next step is to find

further means of supporting such active engagement, giving people a real stake in the energy system. A smart grid that fails to recognize the value of smart users will be a missed opportunity. □

References

1. van Renssen, S. *Nature Clim. Change* **4**, 417–419 (2014).
2. Goulden, M. *et al. Energy Res. Soc. Sci.* **2**, 21–29 (2014).
3. Burgess, J. & Nye, M. *Energy Policy* **36**, 4454–4459 (2008).
4. Shove, E. *Comfort, Cleanliness and Convenience: The Social Organization of Normality* (Berg, 2003).
5. Parkhill, C., Demski, C., Butler, C., Spence, A. & Pidgeon, N. *Transforming the UK Energy System: Public Values, Attitudes and Acceptability: Synthesis Report* (UKERC, 2013); <http://go.nature.com/ATa5Gv>
6. Faruqui, A. & Sergici, S. *J. Regulatory Econ.* **38**, 193–225 (2010).
7. Torriti, J. *Energy* **44**, 576–583 (2012).
8. Spence, A., Leygue, C., Bedwell, B. & O'Malley, C. *J. Environ. Psychol.* **38**, 17–28 (2014).
9. Strengers, Y. *Energy Policy* **38**, 7312–7322 (2010).
10. Strengers, Y. *Policy Studies* **32**, 35–58 (2011).
11. Wolsink, M. *Renew. Sustain. Energy Rev.* **16**, 822–835 (2012).

Murray Goulden

Horizon Research Institute, University of Nottingham, Triumph Road, Nottingham NG7 2TU, UK.

*e-mail: murray.goulden@nottingham.ac.uk

COMMENTARY:

Debt relief and financing climate change action

Adrian Fenton, Helena Wright, Stavros Afionis, Jouni Paavola and Saleemul Huq

Slow progress in scaling-up climate finance has emerged as a major bottleneck in international negotiations. Debt relief for climate finance swaps could provide an alternative source for financing mitigation and adaptation action in developing countries.

The institutional framework for climate finance has evolved considerably during the past two decades. However, the inability to mobilize adequate and predictable funds to support adaptation and mitigation in developing countries has become a principal source of tension between developed and developing countries.

In the Marrakesh Accords of 2001¹, it was agreed to deliver finance through the replenishment of the Global Environment Facility, bilateral and multilateral sources, the Least Developed Country Fund, the Special Climate Change Fund and the Kyoto Protocol Adaptation Fund.

The Green Climate Fund was announced during the 2009 Copenhagen Conference of the Parties (COP) and it will join the architecture of climate finance when it becomes fully operational in 2015². In the Copenhagen Accord of 2009, developed countries also agreed to a goal of raising US\$30 billion of 'fast-start finance' during the period 2010–2012, and to mobilize US\$100 billion annually by 2020 from a variety of sources to support mitigation, adaptation, forest loss prevention (REDD+) and technology development and transfer to address the needs of developing countries.

According to the Overseas Development Institute, developed countries mobilized over

US\$30 billion of fast-start finance during 2010–2012³. Although a variety of financial instruments have been used to provide climate finance, grants and loans have dominated (Table 1). Climate finance is expected to grow further following negotiations in the 2012 Doha and 2013 Warsaw COPs, where Annex-I countries were encouraged⁴ and urged⁵ to continue to mobilize additional climate finance from "a wide variety of sources, public and private, bilateral and multilateral, including alternative sources"⁵.

Problems

It remains debatable whether sufficient progress has been made in mobilizing

climate finance. Up to 80% of fast-start commitments made by developed countries have not been new and additional³ to official development assistance as expected by Article 4 of the United Nations Framework Convention on Climate Change (UNFCCC)⁶. Moreover, only about US\$5.7 billion (18%) of the funds have been allocated to adaptation efforts³, significantly less than the latest World Bank estimate of US\$70–100 billion required annually by 2050 for adapting to a 2 °C warmer planet⁷. However, funding needs will probably be much higher, as current post-Copenhagen emission-reduction pledges leave the world on track for 3.7 °C of warming⁸. Even if current adaptation and mitigation efforts are successful, residual losses and damages will still occur⁹. Thus, a climate finance gap is emerging at a time when the overall level of climate finance is decreasing: 2013 pledges were 71% below the 2012 pledges¹⁰. In comparison, global fossil fuel consumption subsidies rose from US\$523 billion in 2011¹¹ to US\$544 billion in 2012 — an 8.8% rise¹² — dwarfing the US\$22.6 billion provided for mitigation efforts as part of the fast-start commitments during 2010–2012.

There is as yet no agreement regarding how to attain the US\$100 billion annual finance target agreed in Copenhagen. Negotiations at COP 19 in Warsaw were expected to result in an agreement on scaling-up climate finance, but the final agreement only reaffirmed earlier COP decisions. In the negotiations on long-term finance, developing countries proposed an interim target of US\$70 billion by 2016 but developed countries, led by the US and Australia, rejected quantified pathways¹³. Since then, little progress has been made, prompting calls for a radical transformation of the architecture of climate finance¹⁴.

A 2010 UN report on climate change financing¹⁵ stressed the importance of the private sector and noted that concessional and non-concessional loans would need to play a part in meeting finance commitments under the UNFCCC¹⁵. Yet, concerns remain about whether climate finance should be made available as grants or concessional loans, which have been criticized for leaving developing countries with additional debt rather than development¹⁴.

The role of the private sector in reaching the US\$100 billion target is also subject to debate. Developed countries have argued that much of the pledge must come from the private sector, with the public sector leveraging private investment. But private finance to the developing world

Table 1 | Instruments used to fulfil climate finance commitments.

Financial instrument	Amount (million US\$)	Share
Grants and related instruments	14,379.1	45.2%
Unknown	614.4	1.9%
Multiple	419.3	1.3%
Loans, guarantees and insurance	14,840.2	46.7%
Debt relief	82.5	0.3%
Capital contribution	1,457.4	4.6%
Total	31,792.9	100%

Data taken from ref. 18.

is concentrated in a small number of countries, and least developed countries struggle to attract significant funding flows¹⁶. In addition, limited profit-making opportunities exist for private-sector funding of adaptation, particularly in the least developed countries. Yet the least developed and most vulnerable countries would need funds to adapt to the adverse impacts of climate change. Thus, most of the funds for adaptation in these countries will have to come from public-sector sources from developed countries.

Financing commitments

Debt owed by developing countries could provide an alternative source for achieving the annual US\$100 billion climate finance target. Its potential is substantial — over the period 2010–2012 the combined total external debt servicing of developing countries stood at more than US\$1.7 trillion¹⁷, far surpassing discussed levels of climate finance.

External debt — either long-term or short-term — can be owed to the private sector, bilaterally to countries or to multilateral institutions. Private sector and multilateral debts can be ignored as potential sources of finance, as private sector and multilateral institutions do not have financial commitments under the UNFCCC. Bilateral debt — debt owed to other sovereign states — is the most promising source of climate finance. Short-term debt needs to stay out of the equation as it has a vital role in supporting the balance of payments. This leaves long-term bilateral debt as the only remaining debt component that could be used as an alternative source of climate finance.

According to the World Bank, long-term bilateral debt held by developing countries increased from US\$336.7 billion in 2010 to US\$345.1 billion in 2012¹⁷. Repayments of the principal over this period stood at approximately US\$69.2 billion and interest payments totalled about US\$21.5 billion¹⁷.

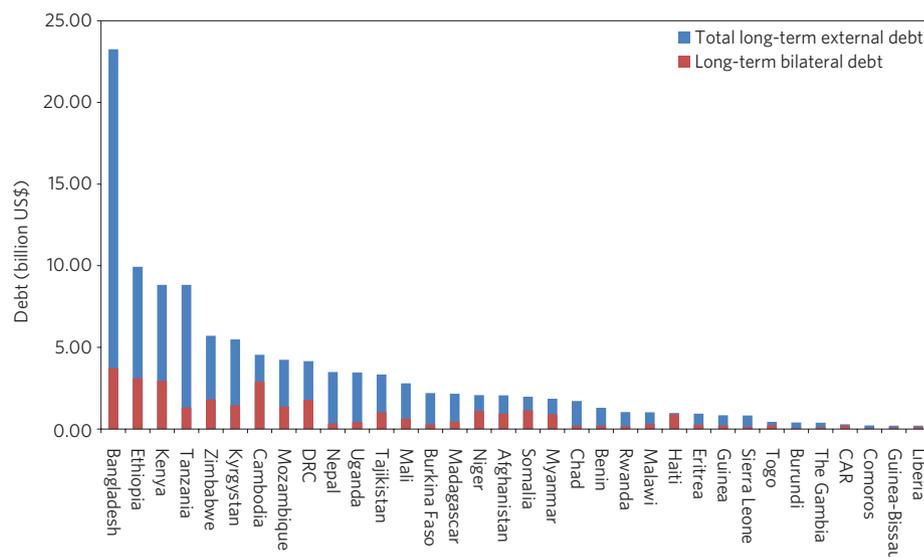


Figure 1 | The long-term bilateral and total long-term external debt of low-income countries in 2012. DRC: Democratic Republic of the Congo. CAR: Central African Republic. Data taken from ref. 17.

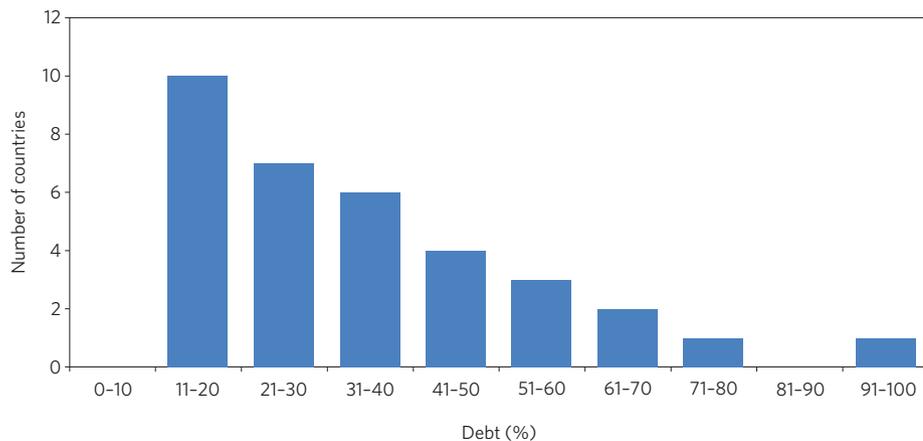


Figure 2 | Histogram showing long-term bilateral debt as a proportion of total long-term external debt for low-income countries. Data taken from ref. 17.

That is, payments to service long-term bilateral debts were greater than US\$90.7 billion during the period 2010–2012, which was triple the fast-start finance goal of the Copenhagen Accord and just under its goal to raise US\$100 billion annually by 2020. Figure 1 shows debt levels for low-income countries.

Debt relief is a viable option for fulfilling climate finance commitments under the UNFCCC, and has already been used³. Debt relief amounting to US\$82.51 million (0.3%) contributed towards the fast-start finance goal of the Copenhagen Accord¹⁸. The US fulfilled 0.5% (US\$32 million) of its fast-start finance commitments via a ‘debt-for-nature’ swap made under its Tropical Forest Conservation Act¹⁸. This act enables eligible developing countries to relieve official debt owed to the US Government by redirecting it to tropical forest conservation activities. Similarly, Italy fulfilled 11% (US\$50.51 million) of its fast-start finance commitments through debt-for-nature swaps in Vietnam, Ecuador and the Philippines¹⁸.

Proposal

Using debt-servicing payments to finance adaptation and mitigation efforts in developing countries would have several advantages. First, it would reduce the strain on national budgets and could facilitate domestic financing of adaptation efforts in developing countries. Many of the countries that are vulnerable to climate change are also currently classified as low income and highly indebted. Second, it would reduce the difficulty of scaling-up climate finance to meet the goal of mobilizing US\$100 billion annually by 2020. Third, it

would fulfil the predictability requirement stipulated in Article 4 of the UNFCCC by providing a predictable source of finance over the long term, as developing countries already hold the capital in their national accounts. It would also comply with agreements made during COP 19, which called for ‘alternative sources’ of finance to meet the Copenhagen commitment. Finally, debt relief would also help developed countries to finance their climate commitments at a time when they are implementing austerity cuts and public finance is in short supply.

Using debt-servicing payments ... would reduce the strain on national budgets and could facilitate domestic financing of adaptation efforts in developing countries.

Large-scale debt relief may be politically difficult, in light of the limited successes of earlier major campaigns such as the Jubilee 2000 debt forgiveness campaign. However, even the relief of interest repayments would make a significant contribution to scaling-up climate finance under the UNFCCC.

Debt relief for climate finance swaps could be easier in developing countries that already have an institutional set-up for adaptation and mitigation, such as National Adaptation Programmes of Action and Nationally Appropriate Mitigation Actions. Some countries — such as Indonesia, Brazil and Bangladesh — also have National Climate Funds, which could be used as

vehicles for channelling finance generated from debt relief for climate finance swaps. Climate funds established under the UNFCCC such as the Least Developed Countries Fund, the Adaptation Fund or the Green Climate Fund could also be used for the purpose.

Debt relief for climate finance swaps could be significant for low-income countries (LICs) that are among the most vulnerable to climate change according to the Notre Dame Global Adaptation Index¹⁹. Over the fast-start period of 2010–2012, debt relief on long-term bilateral debt for LICs would have totalled almost US\$3.5 billion with interest payments and repayments on the principal approximately US\$1 billion and US\$2.5 billion respectively¹⁷.

For example, over the period 2010–2012 Bangladesh repaid a total of US\$1.3 billion in long-term bilateral debt with interest payments equalling about US\$187 million¹⁷. In comparison, Bangladesh received US\$357.57 million in climate finance over the same period²⁰. That is, for this period, for every US\$1 that Bangladesh received in climate finance, it paid back over US\$3 to service long-term bilateral debt. Its debt servicing payments are over four times the finance diverted from its national budget to its Climate Change Trust Fund (US\$300 million) and almost seven times the amount that donors placed in its Climate Change Resilience Fund (US\$190 million). However, Bangladesh has the highest long-term bilateral debt among LICs (Fig. 1), meaning that debt relief for climate finance swaps would generate less finance for other LICs.

Furthermore, long-term bilateral debt remains only a component of total long-term external debt with a median average of 28.93% (Fig. 2). In relative terms, LICs would benefit more from debt relief for climate finance swaps when the proportion of long-term bilateral debt to total long-term external debt is high. Therefore, they would generate relatively high levels of climate finance for Haiti, which has the highest proportion of long-term bilateral debt in relation to total long-term external debt (92.05%). Furthermore, they would vastly reduce Haiti’s total long-term debt servicing obligations (Fig. 1). However, these swaps would be relatively less beneficial for Nepal, which has the lowest proportion of long-term bilateral debt in relation to total long-term external debt (10.11%). On average, long-term bilateral debt relief for climate finance swaps would still have generated approximately US\$102 million per country for LICs during the period 2010–2012 with average payments

on the principal and interest repayments equalling about US\$74 million and US\$28 million, respectively¹⁷.

Summary

There is no agreement on how developed countries should meet the agreed target of raising US\$100 billion annually by 2020 for financing mitigation, adaptation, forest-loss prevention (REDD+) and technology development and transfer for developing countries.

Developed countries have been urged to mobilize additional finance from a variety of options, including alternative sources. We have proposed one alternative source: the relief of debt servicing on long-term bilateral debt owed by developing countries to developed countries. If this principle were adopted generally, it could contribute approximately one-third of the US\$100 billion per year target. However, bilateral debt agreements are negotiated on a case-by-case basis. Therefore debt relief for climate finance swaps should also be negotiated on a case-by-case basis by the parties directly involved.

The proposed solution would also help ameliorate several other climate finance challenges. Importantly, reducing debt-servicing payments would help resolve

the issue of developed countries providing climate finance for mitigation and adaptation in developing countries while at the same time curtailing their abilities to mitigate and adapt. □

Adrian Fenton^{1,2,3}, Helena Wright^{3,4}, Stavros Afionis^{1,2}, Jouni Paavola^{1,2} and Saleemul Huq^{3,5} are at ¹University of Leeds, School of Earth and Environment, Leeds LS2 9JT, UK, ²Centre for Climate Change Economics and Policy (CCCEP), School of Earth and Environment, University of Leeds, Woodhouse Lane, Leeds LS2 9JT, UK, ³International Centre for Climate Change and Development (ICCCAD), Independent University Bangladesh, Aftabuddin Ahmed Road, Dhaka-1229, Bangladesh, ⁴Centre for Environmental Policy, Faculty of Natural Sciences, Imperial College London, South Kensington Campus, London SW7 2AZ, UK, ⁵International Institute for Environment and Development, Climate Change Group, 3 Endsleigh Street, London WC1H 0DD, UK. *e-mail: eeaff@leeds.ac.uk*

References

1. *Report of the Conference of the Parties on its Seventh Session* (UNFCCC, 2002); <http://go.nature.com/mmdUno>
2. *Report of the Conference of the Parties on its Sixteenth Session* (UNFCCC, 2011); <http://go.nature.com/vrKU9wU>
3. Nakhoda, S. et al. *Mobilising International Climate Finance: Lessons from the Fast-Start Finance Period* (ODI, 2013); <http://go.nature.com/KpaJl>

4. *Report of the Conference of the Parties on its Eighteenth Session* (UNFCCC, 2013); <http://go.nature.com/K3SqWr>
5. *Report of the Conference of the Parties on its Nineteenth Session*, (UNFCCC, 2014); <http://go.nature.com/ioMck1>
6. *United Nations Framework Convention on Climate Change* (UN, 1992).
7. *Economics of Adaptation to Climate Change: Synthesis Report* (World Bank, 2010); <http://go.nature.com/PAMHhs>
8. Hare, B. et al. *Warsaw Unpacked: A race to the bottom* (Climate Action Tracker, 2013); <http://go.nature.com/XHFNce>
9. Huq, S., Roberts, E. & Fenton, A. *Nature Clim. Change* 3, 947–949 (2013).
10. *Ten things to know about climate finance in 2013* (ODI, 2013); <http://go.nature.com/UeOlgX>
11. *World Energy Outlook Factsheet* (IEA, 2012); <http://go.nature.com/aLzQ9b>
12. *World Energy Outlook Energy Subsidies* (IEA, 2013); <http://go.nature.com/NWOSA4>
13. Li, L. et al. *Warsaw Outcomes, and Implications for LDCs* (ecbi, 2014); <http://go.nature.com/XTPTw>
14. Khan, F. & Schinn, D. *Nature Clim. Change* 3, 692–694 (2013).
15. *Report of the Secretary-General's High-level Advisory Group on Climate Change Financing* (UN, 2010); <http://go.nature.com/Kf7n3O>
16. Atteridge, A. *Will Private Finance Support Climate Change Adaptation in Developing Countries?* (Stockholm Environment Institute, 2011); <http://go.nature.com/zeo8O6>
17. *International Debt Statistics* (The World Bank, 2014); <http://go.nature.com/afp3lv>
18. Nakhoda, S. et al. *Mobilising International Climate Finance: Lessons from the Fast-Start Finance Period*. (ODI, 2013); <http://go.nature.com/rMhVxK>
19. <http://index.gain.org/ranking/vulnerability>
20. <http://www.climatefundsupdate.org/data>

Acknowledgements

We thank James Porter (University of Leeds) for his helpful comments.

COMMENTARY:

The social heart of global environmental change

Heide Hackmann, Susanne C. Moser and Asuncion Lera St. Clair

The environmental challenges that confront society are unprecedented and staggering in their scope, pace and complexity. Unless we reframe and examine them through a social lens, societal responses will be too little, too late, and potentially blind to negative consequences.

The debate on global environmental change is shifting from a predominant focus on biophysical processes to a focus on societal processes and concerns interacting with the climate and environment¹. As the growing importance of the IPCC's Working Group II and III in the Fifth Assessment Report (AR5) clearly shows, critical issues like food production, the reduction

of emissions, transformation of energy systems and land-use change are human concerns that put people at the heart of climate challenges.

More prominently than ever before, the IPCC report offers an end-to-end picture of what climate change means for societies and natural systems, and why we should be concerned about possible imminent humanitarian emergencies. The report

pays close attention to what an increase in average global surface temperature of up to 4 °C might look like; it assesses our current understanding of how to reduce the risks of the dramatic and catastrophic impacts this rise in temperature may cause². The report's message is clear: there is still time to prevent the most dramatic changes and we have many options to reduce the risks — through adaptation, mitigation