Conclusions

15 Low Carbon Mobility: Urgent futures and radical transitions

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Introduction

More people than ever before are moving more frequently and at accelerating speeds, often for shorter periods of time (Creutzig *et al.*, 2015). These mobilities are largely dependent on unsustainable high-carbon technologies (IEA, 2015). Continuing technical innovations have enhanced the energy efficiency of some transportation technologies. However, efficiency gains and other technical breakthroughs tend to reduce the cost and increase the uptake of transportation, rather than reduce absolute transport-related carbon emissions (Vivanco *et al.*, 2015). Demand for high carbon transportation is growing and is forecast to continue to grow rapidly over the course of the next three decades to 2050 (Creutzig *et al.*, 2015; Peeters & Dubois, 2010). High demand for personal mobility in the developed world, which is now greater than ever, is compounded by a rapidly developing appetite for high-carbon forms of transportation in the emerging economies of the world. Transportation now accounts for 23% of anthropogenic CO_2 and is growing in both relative and absolute terms (Creutzig *et al.*, 2015).

State of the Climate

The State of the Climate is a continuing series of annual summary reports on the global climate system produced by the National Ocean and Atmospheric Administration (NOAA) and published in the *Bulletin of the American Meteorological Society.* The 2015 State of the Climate Report (NOAA, 2016) draws together the '*…contributions from more than 450 scientists from 62 countries, drawing on tens of thousands of measurements of Earth's climate*' (Milman, 2016). NOAA (2016) reports that 2015 was the hottest year on record, exceeding the previous hottest year (2014) by 0.1°C and pre-industrial temperatures by 1°C. This is attributed almost entirely to the continued emission of greenhouse gases. Meanwhile the United Nations agency, the World Meteorological Organisation (WMO, 2016), reports that in the first six months of 2016 temperature data confirms a 1.3°C increase upon the late 19th century pre-industrial baseline.

> *'Global temperatures for the first six months of this year shattered yet more records… Two separate reports from the U.S National Oceanic and Atmospheric Administration and NASA's Goddard Institute for Space Studies (NASA GISS) both highlighted the dramatic and sweeping changes in the state of the climate. June 2016 marked the 14th consecutive month of record heat for land and oceans. It marked the 378th consecutive month with temperatures above the 20th century average. The last month with temperatures below the 20th century average was December 1984' (WMO, 2016).*

These temperature increases should be considered alongside the fact that 3.5°C above pre-industrial levels has been described as the 'extinction event' (Denayer, 2016). Rapid changes in climate are a consequence of concentrations of CO_2 that reached 399.4ppm in 2015 (NOAA, 2016). The oceans of the world have absorbed much of the CO_2 that has been released into the atmosphere over the course of the last century. Global sea levels are 70mm higher than when satellite measurement began in 1993, increasing at an average annual rate of 3.3mm due to glacier melt and thermal expansion of the world's oceans (NOAA, 2016).

Paris 2015

The Paris Climate Agreement (December 2015) came about following intense negotiations at the 21st Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC). It embodies the commitment of 196 countries (Parties to the Agreement) to the goal of stabilising global average temperatures below +2°C relative to pre-industrial levels (UNFCCC, 2015), with many Parties to the Agreement indicating a commitment to stay within a 1.5°C target. The *State of the Climate* (NOAA, 2016) reports leaves absolutely no doubt about how difficult this will be. Signatories must now develop policies that align with 2030 emission reduction goals as expressed in Intended National Determined Contributions (INDCs) (UNFCCC, 2015). Given the failure of earlier climate negotiations (Vidal *et al.*, 2009), the Paris Agreement has been described as one of the '*world's greatest diplomatic success*' (Harvey, 2015 online) and as a '*remarkable international consensus*' (Scott, Hall & Gössling, 2016:1). Clearly the success of Paris lies in the execution of 2030 INDCs (Clémençon, 2016). The meeting of 2030 INDCs will determine the extent to which anthropogenic climate change, already in train (NOAA, 2016; WMO, 2016), can be mitigated and the most severe consequences of climate change avoided (Scott *et al*., 2016; Bailey & Jackson Inderberg, 2016).

It is both in the extent of the INDCs and the likelihood of achieving Paris INDCs that doubts arise. Some consider the Paris Agreement likely to only slow the rate at which GHG emissions are *increasing*, rather than achieve the radical emission reductions that are required to achieve a low carbon energy system, and that a zero net increase in atmospheric CO_2 and other GHGs by 2050 will be insufficient to avert the most severe consequences of climate change. The absence of specific targets for international aviation and maritime transport (European Federation for Transport and Environment, 2016) in the Paris Climate Agreement has also been highlighted as a cause of considerable doubt. The absence of international transport emissions from national GHG inventories is a longstanding challenge that continues to confound efforts to mitigate transportation emissions (Smith & Rodger, 2009).

Transportation and climate change

The links between transportation and climate change are well established. Transport accounts for just under a quarter (23%) of total global energy-related CO_2 emissions, and transport emissions are projected to double by 2050 (Creutzig *et al*., 2015). The Intergovernmental Panel on Climate Change [IPCC] 5th Assessment Report (AR5) notes that transport emissions must be addressed as part of the challenge of achieving a low carbon energy system in order to stabilise the global climate. A special issue of *Transportation Research Part D: Transport and Environment* on Climate Change and Transport (Volume 45, June 2016) explores this relationship in detail. In this special issue, transportation is recognised as the second largest source of anthropogenic CO_2 emissions (Jochem *et al*., 2016), but growing fast and likely to soon exceed emissions from electricity generation (IEA, 2015).

The continued and accelerating growth of transportation emissions is attributed to changing mobility patterns among the high emitters of hypermobile developed societies, combined with the rapid development of high carbon intensity transport systems in emerging economies (Jochem *et al*., 2016). The level of decarbonisation required to align regional and global transportation systems with the agreed targets of the Paris Climate Agreement (2015) has proved to be a particularly acute challenge. Mitigation of transport emissions remains largely absent from the political agenda, despite growing recognition of the urgent need to address transportation emissions, because it is fundamentally incompatible with neoliberal ideals (Harvey, 2011; Young *et al*., 2014). The political risk of addressing transportation emissions arises from the relationship between economic growth and cheap transportation (Creutzig *et al*., 2015).