



# Time to stop investing in carbon capture and storage and reduce government subsidies of fossil-fuels

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Government investment in carbon capture and storage (CCS) is a large and expensive fossil-fuel subsidy with a low probability of eventual societal benefit. Within the tight resource constrained environments that almost all governments are currently operating in, it is irresponsible to sustain this type of subsidy. CCS has been promoted as a 'bridging' technology to provide CO<sub>2</sub> reductions until non-fossil-fuel energy is ramped up. But the past decade of substantial government investment and slow progress suggests that the challenges are many, and it will take longer to build the CCS bridge than to shift away from fossil-fuels. Optimism about the potential of CCS is based primarily on research on technical feasibility, but very little attention has been paid to the societal costs of governments perpetuating fossil-fuels or to the sociopolitical requirements of long-term regulation of CO<sub>2</sub> stored underground. Deep systemic change is needed to alter the disastrous global fossil-fuel trajectory. Government investment in CCS and other fossil-fuel technologies must end so that the distraction and complacency of the false sense of security such investments provide are removed. Instead of continuing to invest billions in CCS, governments should invest more aggressively in technologies, policies, and initiatives that will accelerate a smooth transition to non-fossil-fuel-based energy systems. We need to divest from perpetuating a fossil-fuel infrastructure, and invest instead in social and technical changes that will help us prepare to be more resilient in an increasingly unstable and unpredictable future. © 2013 The Authors. *WIREs Climate Change* published by John Wiley & Sons, Ltd.

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## INTRODUCTION

For over a decade, billions of dollars of government investment in carbon capture and storage (CCS)

technology have provided a glimmer of hope for reconciling carbon dioxide (CO<sub>2</sub>) emissions and global growth in fossil-fuel use.<sup>1,2</sup> CCS has offered a vision of a future in which the impacts of growing fossil-fuel reliance are minimized by capturing and storing the CO<sub>2</sub> instead of allowing it to accumulate in the atmosphere.<sup>3,4</sup> Many have projected that CCS is a technology critical to 'solving' climate change while continuing our reliance on fossil-fuels.<sup>5–10</sup>

But it is becoming increasingly clear that investing in CCS is not money well spent. As the global

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climate-energy situation becomes increasingly dire, bold measures with near-term influence are needed to reduce, rather than sustain, fossil-fuel reliance. Governments around the world need to divest in fossil-fuel technology and stop subsidizing CCS and other fossil-fuel technologies. Instead of continuing to invest billions in CCS, governments should be investing more aggressively in technologies, policies, and initiatives that will accelerate a smooth transition to non-fossil-fuel-based energy systems. Despite the challenges of envisioning a less-fossil-fuel-dependent energy future, we know that an eventual move away from fossil-fuels is inevitable. A decrease in investment in fossil-based energy technology coupled with an increase in innovation investment in non-fossil-based energy systems will help us prepare for this transition promoting gradual change and reducing the likelihood of an abrupt, disruptive shift away from fossil-fuels.

## A FALSE SENSE OF OPTIMISM

Given the magnitude of society's reliance on fossil-fuels, the technological vision of CCS has had a powerful influence on governmental action on climate change.<sup>11,12</sup> The emergence of the possibility of CCS over 10 years ago enabled many fossil-fuel dependent actors, particularly individuals and institutions in coal-dependent regions of the world, to stop denying the existence of climate change; CCS provided the possibility of continuing coal use while also addressing climate change.<sup>13</sup> Now with recent increases in natural gas reliance, CCS similarly offers the possibility of reconciling climate mitigation goals with growth in natural gas power plants. But this vision of CCS has also enabled complacency about the growing dangers of sustained fossil-fuel dependence. And the billions of dollars in government funds devoted to CCS has reduced the level of investment in non-fossil-fuel energy including initiatives and technologies with more concrete, near-term societal benefits. As the need to reduce fossil-fuel reliance is increasingly acknowledged for climate and many other reasons, CCS investments are dangerous as they further incentivize and legitimize continued use of fossil-fuels, and they create a false sense of optimism that our current energy systems can be safely perpetuated.

Beyond acknowledging CCS investment as an additional fossil-fuel subsidy,<sup>14</sup> many other factors indicate that the time has come for governments to stop investing in CCS. First, despite the billions of dollars already invested, widespread CCS deployment remains a distant, far-fetched, extremely expensive possibility.<sup>15–17</sup> The slow progress and long-time horizon for realizing any potential societal benefits

from CCS investments is problematic because the CCS strategy has a limited lifetime.<sup>18</sup> CCS has been promoted as a 'bridging' technology to provide some CO<sub>2</sub> reductions until non-fossil-fuel energy is ramped up. But the past decade of steady investment but slow progress suggests that it will take longer to build this bridge than to shift away from fossil-fuels.<sup>16</sup> Australia's recent cuts and deferred investment in its CCS programs reflects recognition of this time-scale problem; Australia cut its investment in its long-term CCS strategy to provide near-term budgetary relief and also to offset costs of the country's emission trading scheme, which represents a more direct, near-term approach to reducing atmospheric CO<sub>2</sub> (the future of Australia's cap-and-trade system is now uncertain following the September 2013 election).

In the current global economic situation, government expenditure of the magnitude required to advance CCS is no longer justifiable. A single CCS demonstration plant is estimated to cost on the order of 1 billion dollars, and those advocating for more investment in CCS are asking governments to spend \$3–4 billion each year for the next decade.<sup>9,19</sup> Reallocation of this level of funding to promoting non-fossil-fuel energy would be a much less-risky more responsible and justifiable way for government to invest public money.

The amount of energy required to capture and store CO<sub>2</sub> is often not adequately recognized in optimistic perceptions of the potential of CCS. This so-called energy penalty has been estimated to be about 30% with a range from 11 to 40%.<sup>20</sup> This means roughly that for every three coal-fired power plants utilizing CCS an additional power plant would be required simply to supply the energy needed to capture and store the CO<sub>2</sub>. The magnitude of this energy penalty (including even the lower estimates) is so high that it is difficult to imagine a future scenario in which consuming this much additional energy to enable CCS would actually make sense.

In addition, CCS is unlikely to ever become an effective global CO<sub>2</sub> reduction strategy because of the political difficulties of managing and preventing leakage of the underground storage of CO<sub>2</sub> for thousands of years after it is injected.<sup>21</sup> Optimism about the potential of CCS is based primarily on research on technical feasibility, but very little attention has been paid to the sociopolitical requirements of regulating and enforcing long-term monitoring and maintenance of CO<sub>2</sub> stored underground.<sup>22</sup> Global institutional structures with capacity to enforce liability for thousands or even hundreds of years do not exist. And political instability, corruption, and inevitable tensions among countries create severe and

constant risks of any proposed global CO<sub>2</sub> storage management scheme.<sup>23</sup>

The health and safety costs of perpetuating fossil-fuels represent another reason to end government investment in CCS.<sup>24</sup> The large, industrial-scale, fossil-fuel power plants that CCS is being designed to enable cause major health and safety risks to both the communities surrounding the plant (including water and air pollution) and to the communities impacted by fossil-fuel extraction (including coal mining, hydraulic fracturing for natural gas extraction, and fossil-fuel transport).<sup>25</sup> In addition, strong public concern about the health and safety risks of storing CO<sub>2</sub> underground has derailed several large-scale CCS demonstration projects in the past 4 years including the Vattenfall project in Germany and the Barendrecht project in the Netherlands.<sup>26</sup> Concern about earthquakes triggered by injection of large volumes of CO<sub>2</sub> underground is contributing to technical understanding of the risks of leakage.<sup>27,28</sup> The private sector has recognized the many risks of CCS and has only been willing to invest in CCS in conjunction with strong government investment.

## ENCOURAGING COMPLACENCY WITH CLAIMS OF ‘SOLVING’ CLIMATE CHANGE

A final critical reason to end government investment in CCS relates to the impossibility of claims that CCS is critical to ‘solving’ climate change. Climate science now tells us very clearly that no matter what is done to curb greenhouse gas emissions the climate is changing irreversibly to a new and different reality.<sup>29</sup> So any claims that a specific technology like CCS is critical to ‘solving’ climate change is misleading and perpetuates a false sense of complacency about the realities and risks of climate change. This complacency coupled with optimism that CCS provides a ‘solution’ to climate change is dangerous, and it detracts from the increasingly urgent need for systemic changes that are now desperately needed to prepare us for the changing climate regime.

Continued CCS investment appears to fuel optimism in the face of the dire global energy realities including rapid recent growth in coal-fired power plants in developing countries.<sup>30</sup> During the past decade global coal consumption has grown by more than 50% with much of that growth concentrated in China and India. Maintaining optimism about this situation is extremely difficult, but the assumption and hope that one day these new coal-fired power plants might be retrofitted with CCS has been an important mechanism for remaining positive.<sup>31–33</sup>

## CHALLENGING ASSUMPTIONS OF INEVITABILITY OF SUSTAINED COAL USE

For many climate and energy experts around the world, CCS has become the holy-grail of climate mitigation. Advocating for government support for CCS technology has become a passion for many deeply committed, technologically optimistic energy professionals. This optimism seems to make sense for those who believe the dominant narrative that continuing growth of coal is inevitable due to its low cost, abundance, and reliability.<sup>30</sup> In this narrative coal offers unique potential to continue to expand electricity access in the developing world providing unparalleled economic development opportunity. The problem with this narrative is that the extreme negative social, economic, environmental, and human health impacts of coal<sup>24</sup> are dismissed and not adequately considered. The time has come for energy analysts and governments to recognize that sustained growth of coal use is NOT inevitable. If governments invest in and focus on alternative visions, mainstream energy projections based on dominant current assumptions become increasingly unlikely.

The case for substantial government investment in CCS seems to have sustained such broad appeal because many assume that the economic, political, and social hurdles of advancing CCS are lower than the hurdles of moving away from fossil-fuels. CCS advocates frequently point out that CCS is preferable to moving away from fossil-fuels because CCS does not demand a radical alteration of national economies, global trade, or personal lifestyles. But radical systemic change in our energy systems is needed now more than ever before, and investments that slow down this transition are a dangerous distraction.

## POLITICAL LOCK-IN

From a technological perspective, it has been suggested that the infrastructural requirements and inflexibility of CCS would exacerbate ‘technological lock-in’ to fossil-fuel use.<sup>11</sup> From a political perspective, it now seems that the sunk-costs associated with the amount of money already invested in CCS is creating a difficult ‘political lock-in’. For governments that have already invested millions or billions of dollars and considerable political capital to advance CCS, ending this support is politically challenging. And the billions of dollars already spent has created a large and powerful CCS advocacy coalition that includes multiple institutions and individuals

around the world whose professional responsibilities include advocating for more government funding for CCS.<sup>34,35</sup> The technically optimistic focus of these CCS advocates has limited consideration of the societal risks of CCS investments and the societal value of investing instead in alternative non-fossil-fuel-based strategies.

## FOSSIL-FUEL DIVESTMENT

For the well-being of societies around the world, divestment from fossil-fuels needs to become a governmental priority. Despite the obvious political challenges of resisting the powerful fossil-fuel establishment, a subtle but definite signal of movement toward such a rebellious idea was given by President Obama last summer when he mentioned 'divestment' in his speech on climate.<sup>36</sup> Although the US officially continues to espouse an 'all of the above' energy strategy which includes investing in CCS, the time has come for the United States and other governments who have invested in CCS to exercise their influence to selectively divest in fossil-fuels and invest more heavily in non-fossil-fuel energy technologies. The perceived need for CCS has already been reduced in the EU where regulations now in place incentivize moving away from fossil-fuels by putting a price on CO<sub>2</sub> emissions. And proposed new CO<sub>2</sub> regulations

in the United States have already changed firmly held assumptions of sustained long-term coal use in the United States and reduced expectations of widespread deployment of CCS.<sup>37</sup>

Government investment in CCS is a large, expensive, and unnecessary fossil-fuel subsidy with an extremely low probability of eventual societal benefit. In the tight, resource constrained environment that almost all governments are operating within, it is irresponsible for governments to sustain this type of subsidy. Deep systemic change is required to alter the disastrous global fossil-fuel trajectory. Government investment in CCS and other fossil-fuel technologies must end, so that the distraction and complacency of the false sense of security such investments provide are removed.

Albert Einstein famously pointed out that problems cannot be solved with the same mindset in which they were created. We need to move beyond the powerful fossil-fuel mindset, and let go of the false sense of optimism that CCS investments provide. We also need to end the perception that CCS or any specific mix of technologies has the potential to 'solve' climate change. We need to divest from perpetuating a fossil-fuel infrastructure, and instead invest in social and technical changes that will help us prepare to be more resilient in an increasingly unstable and unpredictable future.

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