Table 5.1 a. Social Dimension

Each SDG cell gives: INTERACTION · NILSSON SCORE · EVIDENCE · LITERATURE AGREEMENT · CONFIDENCE

Mitigation option		1 No Poverty	2 Zero Hunger	3 Good Health and Well-Being	4 Quality Education	5 Gender Equality	10 Reduced Inequalities	16 Peace, Justice and Strong Institutions	17 Partnerships for the Goals
Industry demand reduction	Efficiency	**Reduces poverty** ↑ [+2] 🕮 ☺ ★ % of people living below poverty line declines from 49% to 18% Altieri et al (2016)		**air pollution reduction and better health** ↑ [+2] 🕮🕮 ☺☺ ★★ People living in the deprived communities feel positive and predict considerable financial savings. *Xi et al (2013), Zhang et al (2015),*					
	Behaviour								
Industry fuel decarbonization and cross sector collaboration	Switch to low-carbon	**Reduce inequality (1.4)** ↑/↓ [+2,-1] 🕮 ☺ ★ Energy efficiency and biomass strategies benefitied poor more than wind and solar whose benefits are captured by industry. carbon mitigation can increase or decrease inequalitites *Casillas et al (2012)*							
	CCS/CCU								
Residential demand reduction	behavior	**Poverty reduction via financial savings** ↑ [+2] 🕮 ☺ ★ People living in the deprived communities feel positive and predict considerable financial savings. *Scott, Jones, and Webb (2014)*		**Improved warmth and comforts** ↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★ Home occupants reported warmth as the most important aspect of comfort which were largely temperature-related and low in energy costs. Residents living in the deprived areas expect improved warmth in their properties after energy efficiency measures are employed. *Scott, Jones, and Webb (2014); Huebner, Cooper, and Jones (2013); Yue, Long, and Chen (2013); Zhao et al. 2017*				**Environmental justice** ↑ [+2] 🕮 ☺ ★ Hult et al. found that consumption perspective strengthens the environmental justice discourse (as it claims to be a more just way of calculating global and local environmental effects) while possibly also increasing an individualized environmental discourse. *Hult and Larsson (2016)*	
	efficiecy	**Poverty and Development** ↑ [+2] 🕮🕮 ☺☺ ★★ Energy efficiency interventions lead to cost savings which are realized due to reduced energy bills that further lead to poverty reduction. Participants with low incomes experience greater benefits. *Maidment et al. (2014); Scott, Jones, and Webb (2014); Berrueta et al. (2017)*	**Food Security** ↑ [+2] 🕮 ☺ ★ Using the improved stoves supports local food security and has significantly impacted on food security. By making fuel lasting longer, the improved stoves also help improve food security and provide a better buffer against fuel shortages induced by climate change-related events such as droughts, floods or hurricanes (Berrueta et al. 2017). *Berrueta et al. (2017)*	**Healthy lives and well-being for all at all ages** ↑ [+2] 🕮🕮🕮🕮 ☺☺☺☺ ★★★★ Efficient cookstove improves health especially for indigenous and poor rural communities. Household energy efficiency has positive health impacts on children's respiratory health, weight, and susceptibility to illness, and the mental health of adults. Household energy efficiency improves winter warmth, lowers relative humidity with benefits for cardiovascular and respiratory health. Further improved Indoor Air Quality by thermal regulation and occupant comfort are realised. However in one instance negative health impacts (asthma) of increased household energy efficiency were also noted when housing upgrades take place without changes in occupant behaviours. *Berrueta et al., 2017; Maidment et al., 2014; Willand, Ridley, and Maller, 2015; Wells et al., 2015; Cameron, Taylor, and Emmett, 2015; Liddell and Guiney, 2015; Sharpe et al., 2015; Derbez, 2014;* [illegible]	**Reducing school absences** ↑ [+2] 🕮 ☺ ★ Household energy efficiency measures reduce school absences for children with asthma. *Maidment et al. (2014)*	**Women empowerment** ↑ [+2] 🕮 Efficient cookstoves lead to empowerment of indigenous women. *Berrueta et al. (2017)*		**Energy justice** ↑ [+2] 🕮 ☺ ★ The energy justice framework serves as an important decision-making tool in order to understand how different principles of justice can inform energy systems and policies. Islar et al. (2017) states that off-grid and micro-scale energy development offers an alternative path to fossil-fuel use and top-down resource management as they democratize the grid and increase marginalized communities' access to renewable energy, education and health care. *Islar et al. (2017)*	
Residential fuel decarbonization	Switch to low-carbon	**Poverty reduction** ↑ [+2] 🕮 ☺☺ ★★ Providing sustainable low carbon energy to poor population in the developing countries help in reducing poverty. *Zulu and Richardson, 2013; Pode, 2013*							
Transport demand reduction	behavior			**Road Traffic Accidents (3.4/3.6)** ↑/↓ [+2,-1] 🕮🕮🕮 ☺☺☺ ★★ Active travel modes' (such as walking and cycling) represent strategies not only for boosting energy efficiency but also, potentially, for improving health and well-being (e.g., lowering rates of diabetes, obesity, heart disease, dementia, and some cancers). However, a risk associated with these measures is that they could increase rates of road traffic accidents, if the provided infrastructure is unsatisfactory. Overall health effects will depend on the severity of the injuries sustained from these potential accidents relative to the health benefits accruing from increased exercise. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Creutzig et al. (2012); Haines and Dora (2012); Saunders et al. (2013); Shaw et al. (2014); Woodcock et al. (2009)			**Reduce Inequality (10.2)** ↑ [+2] 🕮🕮 ☺☺ ★★ The equity impacts of climate change mitigation measures for transport, and indeed of transport policy intervention overall, are poorly understood by policymakers. This is in large part because standard assessment of these impacts is not a statutory requirement of current policy making. Managing transport energy demand growth will have to be advanced alongside efforts in passenger travel toward reducing the deep inequalities in access to transport services that currently affect the poor worldwide. (Lucas & Pangbourne, 2014)(Figueroa, Lah, Fulton, McKinnon, & Tiwari, 2014)		
	efficiency			**Reduce illnesses from hazardous air, water and soil pollution (3.9)** ↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★ Locally relevant policies targetting traffic reductions and ambitious diffusion of electric vehicles results in measured changes in non-climatic population exposure included ambient air pollution, physical activity, and noise. The transition to low-carbon equitable and sustainable transport can be fostered by numerous short- and medium-term strategies that would benefit energy security, health, productivity, and sustainability. Evidence-based approach that takes into account greenhouse gas emissions, ambient air pollutants, economic factors (affordability, cost optimisation), social factors (poverty alleviations, public health benefits), and political acceptability is needed tackle these challenges. (Schucht et al., 2015);(Figueroa, Lah, Fulton, McKinnon, & Tiwari, 2014);(Peng, Yang, Wagner, & Mauzerall, 2017); (Klausbruckner et al., 2016)				**Ensure responsive, inclusive, participatory decision making (16.7)** ↑ [+2] 🕮🕮 ☺☺ ★★ In transport mitigation is necessartb to conduct need assessment and stakeholder consultation to determine plausible challenges, prior to introducing a desired planning reforms. Further, the involved personnel should actively engage transport-based stakeholders during policy identification and its effective implementation to achieve desired results. User behaviour and stakeholder integration is key for successful transport policy implementation (Aggarwal, 2017); (AlSabbagh, Siu, Guehnemann, & Barrett, 2017)	
Transport fuel decarbonization	Switch to low-carbon	**End Poverty in all its forms everywhere (1.3)** ↑/↓ [+2,-1] 🕮🕮 ☺☺ ★★ Climate change threatens to worsen poverty, therefor pro-poor mitigation policies are needed to reduce this threat; for example investing more and better in infrastructure by leveraging private resources and using designs that account for future climate change and the related uncertainty. Communities in poor areas cope with and adapt to multiple-stressors including climate change. Coping strategies provide short-term relief but in the long-term may negatively affect development goals. And responses generate a trade-off between adaptation, mitigation and development (Hallegate et al, 2015); (Suckall, Tompkins, & Stringer, 2014)							
Phasing out coal supply-side, upstream-sector impacts				**Disease and Mortality (3.1/3.2/3.3/3.4), Air Pollution (3.9)** ↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★ Reduce adverse impacts of upstream supply-chain activities, in particular local air pollution, and coal mining accidents IPCC AR5 WG3 (2014); Koorneef et al. (2011); Singh et al. (2011); Hertwich et al. (2008); Veltman et al. (2010); Corsten et al.(2013); Ashworth et al. (2012); Einsiedel et al. (2013); IPCC (2005); Miller et al. (2007); de Best-Waldhober et al. (2009); Shackley et al. (2009); Wong-Parodi and Ray (2009); Waööquist et al. (2009, 2010); Reiner and Nuttall (2011); Epstein et al. (2010); Burgherr et al. (2012); Chen et al. (2012); Chan and Griffiths (2010); Asfaw et al. (2013).					
Improving Access to Modern Energy modern biomass, nuclear, other renewables (sol		**Poverty and Development (1.1/1.2/1.3/1.4)** ↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★★ Access to modern energy forms (electricity, clean cook-stoves, high-quality lighting) is fundamental to human development since the energy services made possible by them help alleviate chronic and persistent poverty. Strength of the impact varies in the literature. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Bonan et al. (2014); Burlig and Preonas (2016); Casillas and Kammen (2010); Cook (2011); Kirubi et al. (2009); Pachauri et al. (2012); Pueyo et al. (2013); Rao et al. (2014)	**Food Security and Agricultural Productivity (2.1/2.4)** ~/↓ [0,-1] 🕮🕮 ☺☺☺ ★★ Modern energy access is critical to enhance agricultural yields/productivity, decrease post-harvest losses, and mechanize agri-processing - all of which can aid food security. However, large-scale bioenergy and food production may compete for scarce land and other inputs (e.g., water, fertilizers), depending on how and where biomass supplies are grown and the indirect land use change impacts that result. If not implemented thoughtfully, this could lead to higher food prices glo (Quote from McCollum et al., in review)bally, and thus reduced access to affordable food for the poor. Enhanced agricultural productivities can ameliorate the situation by allowing as much bioenergy to be produced on as little land as possible. *McCollum et al. (in review);* Asaduzzaman et al. (2010); Cabraal et al. (2005); Finco and Doppler (2010); Hasegawa et al. (2015); Lotze-Campen et al. (2014); Msangi et al. (2010); Smith et al. (2013); Smith, P. et al. (2014); Sola et al. (2016); Tilman et al. (2009); van Vuuren et al. (2009)	**Disease and Mortality (3.1/3.2/3.3/3.4)** ↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★★ Access to modern energy services can contribute to fewer injuries and diseases related to traditional solid fuel collection and burning, as well as utilization of kerosene lanterns. Access to modern energy services can facilitate improved health care provision, medicine and vaccine storage, utilization of powered medical equipment, and dissemination of health-related information and education. Such services can also enable thermal comfort in homes and contribute to food preservation and safety. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Aranda et al. (2014); Lam et al. (2012); Lim et al. (2012); Smith et al (2013)	**Equal Access to Educational Institutions (4.1/4.2/4.3/4.5)** ↑ [+1] 🕮 ☺☺☺ ★★ Access to modern energy is necessary for schools to have quality lighting and thermal comfort, as well as modern information and communication technologies. Access to modern lighting and energy allows for studying after sundown and frees constraints on time management that allow for higher school enrollment rates and better literacy outcomes. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Lipscomb et al. (2013); van de Walle et al. (2013)	**Women's Safety & Worth (5.1/5.2/5.4) / Opportunities for Women** ↑ [+1] 🕮🕮 ☺☺ ★★ Improved access to electric lighting can improve women's safety and girls' school enrollment. Cleaner cooking fuel and lighting access can reduce health risks and drudgery, which are disproportionately faced by women. Access to modern energy services has the potential to empower women by improving their income-earning and entrepreneurial opportunities and reducing drudgery. Participating in energy supply chains can increase women's opportunities and agency and improve business outcomes. (Quote from McCollum et al., in review) McCollum et al. (in review); Anenberg et al. (2013); Chowdhury (2010); Haves (2012); Matinga (2012); Pachauri and Rao (2013); Chowdhury (2010); Clancy et al (2011); Dinkelman (2011); Haves (2012); Kaygusuz (2011); Kohlin et al. (2011); Pachauri and Rao (2013)		**Institutional Capacity and Accountability (16.1/16.3/16.5/16.6/16.7/16.8)** ↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★★ Institutions that are effective, accountable, and transparent are needed at all levels of government (local to national to international) for providing energy access, promoting modern renewables, and boosting efficiency. Strengthening the participation of developing countries in international institutions (e.g., international energy agencies, United Nations organizations, World Trade Organization, regional development banks and beyond) will be important for issues related to energy trade, foreign direct investment, labor migration, and knowledge and technology transfer. Reducing corruption, where it exists, will help these bodies and related domestic institutions maximize their societal impacts. (Quote from McCollum et al., in review) Limiting armed conflict and violence will aid most efforts related to sustainable development, including progress in the energy dimension. *McCollum et al. (in review);* Acemoglu (2009); Acemoglu et al. (2014); ICSU, ISSC (2015); Tabellini (2010)	
Deployment of Renewables modern biomass, other renewables (solar, wind, etc.)		**Exposure and Vulnerability (1.5)** ↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★ Deployment of renewable energy and improvements in energy efficiency globally will aid climate change mitigation efforts, and this, in turn, can help to reduce the exposure of the world's poor to climate-related extreme events, negative health impacts, and other environmental shocks. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Hallegatte et al. (2016); IPCC (2014); Riahi et al. (2012)		**Air Pollution (3.9)** ↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★★ Promoting most types of renewables and boosting efficiency greatly aid the achievement of targets to reduce local air pollution and improve air quality; however, the order of magnitude of the effects, both in terms of avoided emissions and monetary valuation, varies significantly between different parts of the world. Benefits would especially accrue to those living in the dense urban centers of rapidly developing countries. Utilization of biomass and biofuels might not lead to any air pollution benefits, however, depending on the control measures applied. In addition, household air quality can be significantly improved through lowered particulate emissions from access to modern energy services. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Anenberg et al. (2013); Chaturvedi and Shukla (2014); Haines et al. (2007); IEA (2016); Kaygusuz (2011); Nemet et al. (2010); Rafaj et al. (2013); Rao et al (2013); Rao et al (2016); Riahi et al. (2012); Rose et al. (2014); Smith and Sagar (2014); van Vliet et al. (2012); West et al. (2013)			**Empowerment and Inclusion (10.1/10.2/10.3/10.4)** ↑ [+1] 🕮🕮 ☺☺ ★★ Decentralized renewable energy systems (e.g., home- or village-scale solar power) can enable a more participatory, democratic process for managing energy-related decisions within communities. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Cass et al. (2010); Cumbers (2012); Kunze and Becker (2015); Walker and Devine-Wright (2008)		**International Cooperation (all goals)** ↑/~ [+2,0] 🕮🕮 ☺☺ ★★ International cooperation (in policy) and collaboration (in science) is required for the protection of shared resources. Fragmented approaches have been shown to be more costly. Specific to SDG7, to achieve the targets for energy access, renewables, and efficiency, it will be critical that all countries: (i) are able to mobilize the necessary financial resources (e.g., via taxes on fossil energy, sustainable financing, foreign direct investment, financial transfers from industrialized to developing countries); (ii) are willing to disseminate knowledge and share innovative technologies between each other; (iii) follow recognized international trade rules while at the same time ensuring that the least developed countries are able to take part in that trade; (iv) respect each other's policy space and decisions; (v) forge new partnerships between their public and private entities and within civil society; and (vi) support the collection of high-quality, timely, and reliable data relevant to the furthering their missions. There is some disagreement in the literature on the effect of some of the above strategies, such as free trade. Regarding international agreements, ""no-regrets options"", where all sides gain through cooperation, are seen as particularly beneficial (e.g., nuclear test ban treaties). (Quote from McCollum et al., in review) *McCollum et al. (in review);* Clarke et al. (2009); Eis et al. (2016); Montreal Protocol (1989); New Climate Economy (2015); O'Neill et al. (2017); Ramaker et al. (2003); Riahi et al. (2015); Riahi et al. (2017)
Subsidies for Renewables Energy Sources this category collects impacts that are specific to funding instruments for renewable energy sources		**Poverty and Development (1.1/1.2/1.3/1.4)** ~/↓ [0,-1] 🕮🕮🕮 ☺☺☺ ★★★ The distributional costs of new energy policies (e.g., supporting renewables and energy efficiency) are dependent on instrument design. If costs fall disproportionately on the poor, then this could impair progress toward universal energy access and, by extension, counteract the fight to eliminate poverty. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Cameron et al. (2016); Casillas and Kammen (2012); Fay et al. (2015); Hallegate et al. (2016); Hirth and Ueckerdt (2013); Jakob and Steckel (2014)					**Empowerment and Inclusion (10.1/10.2/10.3/10.4)** ↑/↓ [1,-1] 🕮🕮🕮 ☺☺☺ ★★★ The distributional costs of new energy policies (e.g., supporting renewables and energy efficiency) are dependent on instrument design. If costs fall disproportionately on the poor, then this could work against the promotion of social, economic and political equality for all. The impacts of energy efficiency measures and policies on inequality can be both positive (if they reduce energy costs) or negative (if mandatory standards increase the need for purchasing more expensive equipment and *McCollum et al. (in review);* Cameron et al. (2016); Casillas and Kammen (2012); Fay et al. (2015); Hallegate et al. (2016); Hirth and Ueckerdt (2013); Jakob and Steckel (2014); Cayla and Osso (2013)		
Increased use of biomass			**Farm Employment and Incomes (2.3)** ↑/↓ [+2,-2] 🕮🕮🕮 ☺☺☺ ★★★ Large-scale bioenergy production could lead to the creation of agricultural jobs, as well higher farm wages and more diversified income streams for farmers. Modern energy access can make marginal lands more cultivable, thus potentially generating on-farm jobs and incomes; on the other hand, greater farm mechanization can also displace labor. On the other hand, large-scale bioenergy production could alter the structure of global agricultural markets in a way that is, potentially, unfavorable to small-scale food producers. The distributional effects of bioenergy production are underexplored in the literature. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Balishter et al. (1991); Creutzig et al. (2013); de Moraes et al. (2010); Gohin (2008); Rud (2012); Satolo and Bacchi (2013); van der Horst and Vermeylen (2011); Corbera and Pascual (2012); Creutzig et al. (2013); Davis et al. (2013); van der Horst and Vermeylen (2011); Muys et al. (2014)						
Large-scale hydro									
Deployment of CCS in the power sector Either with fossil fuels or bioenergy (BECCS)				**Disease and Mortality (3.1/3.2/3.3/3.4)** ↓ [-1] 🕮🕮 ☺☺☺ ★★★ Adverse impacts of upstream supply-chain activities, risk of CO2 leakage IPCC AR5 WG3 (2014); Atchley et al. (2013); Apps et al. (2010); Siirila et al. (2012); Wang and Jaffe (2004); Koorneef et al. (2011); Singh et al. (2011); Hertwich et al. (2008); Veltman et al. (2010); Corsten et al.(2013).					
Nuclear energy				**Disease and Mortality (3.1/3.2/3.3/3.4)** ↓ [-2] 🕮🕮 ☺ ★★ Nuclear accidents and waste treatment, uranium mining and milling, increased occurrence of childhood leukaemia in popoulations living within 5 km of nuclear power plants IPCC AR5 WG3 (2014); Cardis et al. (2006); Balonov et al. (2011); Moomaw et al. (2011a); WHO (2013); Abdelouas (2006); Al-Zoughool and Kewski (2009) cited in Sathaye et al. (2011a); Smith et al. (2013); Schnelzer et al. (2010); Tirmarche (2012); Brugge and Buchner (2011); Møller et al. (2012); Hiyama et al. (2013); Mousseau and Møller (2013); Møller and Mousseau (2011); Møller et al. (2011); von Stechow et al. (2016); Heinävaara et al. (2010), Kaatsch et al. (2008); Sermage-Faure et al. (2012).				**Reduce illicit arms trade (16.4)** ↓ [-1] 🕮🕮 ☺☺ ★★ Proliferation risk IPCC AR5 WG3 (2014); von Hippel et al. (2011, 2012); Sagan (2011); Yim and Li (2013); Adamantiades and Kessides (2009); Rogner (2010).	
Improving energy efficiency general demand-side measures (where they cannot be specifically attributed to one sector)							**Empowerment and Inclusion (10.1/10.2/10.3/10.4)** ↑ [+1] 🕮🕮🕮 ☺☺ ★★ Energy efficiency measures and the provision of energy access can free up resources (e.g., financial, time savings) that can then be put towards other productive uses (e.g., educational and employment opportunities), especially for women and children in poor, rural areas. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Dinkelman (2011); Pachauri et al. (2012); Pueyo et al. (2013)		
AFOLU demand-side measures & dietary change	Reduced meat consumption	**Poverty and Development (1.1/1.2/1.3/1.4)** ~/↓ [0,-1] 🕮🕮 ☺☺☺ ★★ Cutting livestock consumption can increase food security for some if land grows food not feed, but can also undermine livelihoods and culture where livestock has long been the best use of land such as in parts of SSA IPCC WGIII, 2014							
	Reduced food waste								
AFOLU supply-side measures	Increased efficiency of livestock systems								
	climate smart agriculture and Soil carbon sequestration	**Poverty and Development (1.1/1.2/1.3/1.4)** ~/↓ [0,-1] 🕮🕮 ☺☺☺ ★★ Mitigation policies implemented through a uniform global carbon price would have negative effects on agricultural production. Developing regions would be more affected than developed ones. (Quote from Havlik et al., 2015) Havlik et al. 2015							
	Enhanced Weathering, terrestrial								
	Forestry, Forest management , REDD+	**Poverty and Development (1.1/1.2/1.3/1.4)** ~/↓ [0,-1] 🕮🕮 ☺☺ ★★ The distributional and equity impacts of REDD+ and similar measures are dependent on instrument design. If the poorest households have lowest opportunity costs, then in the case of flat rate payments they could be the ones generating most of the emission reductions. (Quote from Ickowitz et al., 2017) Luttrell et al. 2013, Ravikumar et al. 2015, Di Gregorio et al. 2017, Ickowitz et al. 2017, Loft et al. 2017				**Opportunities for Women (5.1/5.5)** ~/↓ [0,-1] 🕮 ☺ ★ Women have been less involved in REDD+ initiative (pilot project) design decisions and processes than men Brown 2011, Larson et al. 2015			
Non-CO2 mitigation measures	Methane removal								
Oceans/Water	Ocean iron fertilization								
	Blue carbon								
	Enhanced Weathering, ocean								

Table 5.1b. Economic Dimension

Columns per SDG: INTERACTION | NILSSON SCORE | EVIDENCE | LITERATURE AGREEMENT | CONFIDENCE

Mitigation measure		7 Affordable and clean energy	8 Decent work and economic growth	9 Industry, innovation and infrastructure	11 Sustainable cities and communities	12 Responsible consumption and production
Industry demand reduction	**Efficiency**	**Energy savings** ↑/~ [+2] 🕮🕮🕮 ☺☺☺ ★★★ Energy Efficiency lead to reduced relatively less energy demand and hence energy supply and energy security. Positive rebound effect can raise demand but to a very less extent due to low rebound effect in industry sector and also help in supplying surplus energy to cities. Zhang et al (2015), IPCC WGIII (2014), Chakravarty et al. (2013), karner et al(2015)	**Reduces Unemployment** ↑ [+2] 🕮 ☺ ★ Unemployment rate reduction from 25% to 12% Altieri et al (2016)		**Sustainable cities (15.6,15.8,15.9)** ↑ [+2] 🕮 ☺ ★ Industries are becoming supplier of energy, waste heat , water, roof tops for solar energy generation and supply to neighbourial human settlements and hence reduved primary energy demand also and make twons and cities grow sustainably Karner et al (2015)	
	Behaviour					
Industry fuel decarbonization and cross sector collaboration	**Switch to low-carbon**		**Economic growth with decent employment (8.1,8.2,8.3,8.4)** ↑ [+2] 🕮🕮🕮🕮 ☺☺☺☺ ★★★★ Circular economy instead of liner global economy can achieve climate goal and can help in economic growth through industrialisation which saves on resources, enviornment and supports small, edium and even large industries, can lead to employment generation. so new regulations, incentives, tax regime can help in achieving the goal. Supino et al (2015),Fan et al (2017), Leider et al (2015), Zheng et al (2016), Shi et al (2017), Liu et al (2014), Stahel (2017)	**Innovation and new infrastrcutture (9.2,9.3,9.4,9.5.9.6)** ↑ [+2] 🕮🕮🕮🕮 ☺☺☺☺ ★★★★ Circular economy instead of liner global economy is helping new innovation and infrastrcuture can achieve climate goal and can help in economic growth through industrialisation which saves on resources, enviornment and supports small, edium and even large industries, can lead to employment generation. so new regulations, incentives, tax regime can help in achieving the goal. Supino et al (2015),Fan et al (2017), Leider et al (2015), Zheng et al (2016), Shi et al (2017), Liu et al (2014), Stahel (2017)		**Sustainable production (12.2.,12.3, 12.4,12.5, 12.9,12.11)** ↑ [+2] 🕮🕮🕮🕮 ☺☺☺☺ ★★★★ Circular economy instead of liner global economy can achieve climate goal and can help in economic growth through industrialisation which saves on resources, enviornment and supports small, edium and even large industries, can lead to employment generation. so new regulations, incentives, tax regime can help in achieving the goal especially in newly emerging developing cpuntries although applicable for large indsutrialised countries also. Supino et al (2015),Fan et al (2017), Leider et al (2015), Zheng et al (2016), Shi et al (2017), Liu et al (2014), Stahel (2017)
	CCS/CCU					
Residential demand reduction	**behavior**	**energy savings behaviour and lifestyle change** ↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★ Lifestyle change measures and adoption behavior affect residential energy use and implementation of efficient technologies as residential HVAC systems. Also social influence can drive energy savings in users exposed to energy consumption feedback. Effect of autonomous motivation on energy savings behaviour is greater than that of other more established predictors such as intentions, subjective norms, perceived behavioural control and past behaviour. Use of a hybrid engineering approach using social psychology and economic behaviour models are suggested for Residential peak electricity demand response. *Yue, Yang, and Chen , 2013; Somerfeld, Buys, and Vine, 2017; Zhao et al. (2017); de Koning et al., 2016; Isenhour and Feng, 2016; Sluisveld et al., 2016; Noonan et al. 2015; Allen et al., 2015; Jain et al. 2013a; Hori et al., 2013; Sweeny et al. 2013; Webb et al., 2013; Huebner et al. (2013); Gyamfi, Krumdieck, and Urmee (2013)*				**Responsible and sustainable consumption** ↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★ Technological improvements alone are not sufficient to increase energy savings. Zhao et al. (2017) findings indicate that building technology and occupant behaviors interact with each other and finally affect energy consumption from home. They found that occupant habits could not take advantage of more than 50 percent of energy efficiency potential allowed by an efficient building. In the electronic segment product obsolescence represents a key challenge for sustainability. Echegaray (2015) discusses the dissonance between consumers' product durability experience, orientations to replace devices before terminal technical failure, and perceptions of industry responsibility and performance. *Zhao et al. 2017; Somerfeld, Buys, and Vine, 2017; Isenhour and Feng, 2016; He, Xiong, and Lin, 2016; Hult and Larsson, 2016; Sluisveld et al., 2016; Allen et al., 2015; Sweeney et al., 2013; Webb et al., 2013*
	efficiecy	**Increase in energy savings** ↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★ There is high agreement among researchers based on large number of evidence across various countries that energy efficiency improvement reduce energy consumption and hence lead to energy savings. Efficient cookstove saves bioenergy. Efficient cookstove saves bioenergy. *Berrueta et al., 2017; Cameron, Taylor, and Emmett, 2015; Liddell and Guiney, 2015; McLeod, Hopfe, and Kwan, 2013; Noris et al. 2013; Salvalai et al. 2017; Yang, Yan, and Lam, 2014; Kwong, Adam, and Sahari, 2014; Holopainen et al., 2014*	**Sustainable economic growth and employment** ↑ [+2] 🕮 ☺ ★ Efficient cookstoves lead to local employment generation. *Berrueta et al. (2017)*			
Residential fuel decarbonization	**Switch to low-carbon**	**Meeting energy demand** ↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★ Renewable energies could potentially serve as the main source of meeting energy demand in the rapidly growing developing country cities. Ali e et al. (2015) estimated the potential of solar, wind and biomass renewable energy options to meet part of the electrical demand in Karachi, Pakistan. *Creutzig et al., 2014; Connolly et al., 2014; Islar et al, 2017; Mittlefehldt, 2016; Bilgily et al., 2017; Ozturk et al., 2017; Mahony and Dufour, 2015; Byravan et al., 2017; Abanda et al. 2016; Peng and Lu, 2013; Pietzcker, 2013; Ali et al. (2015); Li, Yang, and Lam, 2013; Yanine and Sauma, 2013; Pode, 2013; Zulu and Richradson (2013)*	**Sustainable economic growth and employment** ↑ [+2] 🕮🕮 ☺ ★ Creutzig et al. 2014 assessed the potential for renewable energies in the European region. They found that a European energy transition with a high-level of renewable energy installations in the periphery could act as an economic stimulus, decrease trade deficits, and possibly have positive employment effects. *Creutzig et al., 2014; Byravan et al., 2017; Ali et al., 2015*			
Transport demand reduction	**behavior**		**Promote Sustained, inclusive economic growth (8.3)** ↓ [-2] 🕮🕮🕮 ☺☺☺ ★★★ Policy contradictions (e.g. standards, efficient technologies leading to increased electricity prices leading the poor to switch away from clean(er) fuels); unintended outcomes (e.g.redistribution of income generated by carbon taxes) results in contradiction to the primary aims of (productive) job creation and poverty alleviation, and in trade-offs between mitigation adaptation and development policies. Detailed assessment of consequences of mitigation policies requires developing methods and reliable evidence to enable policymakers to more systematically identify how different social groups may be affected by the different available policy options. (Klausbruckner, Annegarn, Henneman, & Rafaj, 2016); (Lucas & Pangbourne, 2014);(Suckall, Tompkins, & Stringer, 2014)		**Make cities & Human settelments inclusive, safe, resilient (11.2)** ↑ [+2] 🕮 ☺ ★ Climate change threatens to worsen poverty, therefor pro-poor mitigation policies are needed to reduce this threat; for example investing more and better in infrastructure by leveraging private resources and using designs that account for future climate change and the related uncertainty (Hallegate et al, 2015)	**Ensure Sustainable Consumption& Production patterns (12.3)** ↑ [+2] 🕮🕮 ☺☺ ★★ Urban carbon mitigation must consider the supply chain management of imported goods, the production efficiency within the city, the consumption patterns of urban consumers, and the responsibility of the ultimate consumers outside the city. Important for climate policy of monitoring the CO2 clusters that dominate CO2 emissions in global supply chains because they offer insights on where climate policy can be effectively directed. (Lin, Hu, Cui, Kang, & Ramaswami, 2015); (Kagawa et al., 2015)
	efficiency		**Promote Sustained, inclusive economic growth (8.3)** ↑/↓ [+2,-2] 🕮🕮 ☺☺ ★★ Significant opportunities to slow travel growth and improve efficiency exist and, similarly, alternatives to petroleum exist but have different characteristics in terms of availability, cost, distribution, infrastructure, storage, and public acceptability. Production of new technologies, fuels and infrastructure can favour economic growth, however, efficient financing of increased capital spending and infrastructure is critical. **(Gouldson et al., 2015)**;(Karkatsoulis, Siskos, Paroussos, & Capros, 2016)	**Build Resilient Infrastructure (9.1)** ↑/↓ [+2,-2] 🕮🕮 ☺☺ ★★ Combining promotion of mass transportation, integrating train lines, a tram line, BRTs, gondola lift systems, a bicycle-sharing systems and hybrid buses and telecommuting, reduce traffic and significantly contribute to meet climate targets a comprehensive package of complementary mitigation options is necessary for deep and sustained emission reductions **(Dulac, 2013)**(Aamaas & Peters, 2017); (Martínez-Jaramillo, Arango-Aramburo, Álvarez-Uribe, & Jaramillo-Álvarez, 2017)		**Sustainable Consumption (12.2/12.8)** ↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★ Relational complex transport behavior resulting in significant growth in energy-inefficient car choices, as well as differences in mobility patterns (distances driven, driving styles) and actual fuel consumption between different car segments all affect the non-progress on transport decarbonisation. Consumption choices, and individual lifestyles are situated tied to the form of the surrounding urbanization. Major behavioral changes and emissions reductions requires *(Stanley, Hensher, & Loader, 2011);(Heinonen, Jalas, Juntunen, Ala-Mantila, & Junnila, 2013); (Gallego, Montero, & Salas, 2013); (Aamaas & Peters, 2017);(Gössling & Metzler, 2017);; (Azevedo & Leal, 2017)*
Transport fuel decarbonization	**Switch to low-carbon**	**Increase share of renewable (7.2)** ↓ [-2] ☺ 🕮 ★ Biofuel cincrease share of renewables but can perform poorly if too many countries increase their use of biofuel, whereas electrification performs best when many other countries implement this technology. The strategies are not mutually exclusive and simultaneous implementation of some provides synergies for national energy security. Therefore, important to consider result of material and contextual factors that co-evolve. (Månsson, 2016)	**Promote Sustained, inclusive economic growth (8.3)** ↑/↓ [+2,-2] 🕮🕮 ☺☺ ★★ the decarbonisation of the freight sector tends to occur in the second part of the century and that the sector decarbonises by a lower extent than the rest of the economy. Decarbonising road freight on a global scale remains a challenge even when notable progress in biofuels and electric vehicles has been accounted for. (Carrara & Longden, 2016); (F. Creutzig et al., 2015);IPCC AR5 WG3 (2014)		**Make cities & Human settelments inclusive, safe, resilient (11.2)** ↑ [+2] 🕮🕮 ☺☺ ★★ in rapidly growing cities, the carbon savings from investments at scale, in cost-effective low-carbon measures could be quickly overwhelmed – in as little as 7 years – by the impacts of sustained population and economic growth, highlighting the need to build capacities that enable the exploitation not only of the economically attractive options in the short term but also of those deeper and more structural changes that are likely to be needed in the longer term. (Gouldson et al., 2015); (Figueroa, Fulton, & Tiwari, 2013)	**Ensure Sustainable Consumption& Production patterns (12.3)** ↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★ Due to persistent reliance on fossil fuels, it is posited that transport is more difficult to decarbonize than other sectors. This study partially confirms that transport is less reactive to a given carbon tax than the non-transport sectors: in the first half of the century, transport mitigation is delayed by 10–30 years compared to non-transport mitigation. The extent to which earlier mitigation is possible strongly depends on implemented technologies and model structure. (Pietzcker et al., 2013); (Figueroa, Lah, Fulton, McKinnon, & Tiwari, 2014); IPCC AR5 WG3 (2014); (Creutzig et al., 2015)
Phasing out coal supply-side, upstream-sector impacts						
Improving Access to Modern Energy modern biomass, nuclear, other renewables (solar, wind, etc.)			**Employment Opportunities (8.2/8.3/8.5/8.6)** ↑ [+1] 🕮🕮 ☺☺☺ ★★ Provision of energy access can play a critical enabling role for new productive activities , livelihoods and employment. Reliable access to modern energy services can have an important influence on productivity and earnings. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Bernard and Torero (2015); Chakravorty et al. (2014); Grogan and Sadanand (2013); Pueyo et al. (2013); Rao (2013);		**Housing and Transport (11.1/11.2)** ↑ [+3] 🕮🕮🕮 ☺☺☺ ★★★★ Ensuring access to basic housing services implies that households have access to modern energy forms. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Bhattacharya et al. (2016); UN (2016c)	
Deployment of Renewables modern biomass, other renewables (solar, wind, etc.)			**Innovation and Growth (8.1/8.2/8.4)** ~ [0] 🕮🕮 ☺☺ ★★ Decarbonization of the energy system through an up-scaling of renewables and energy efficiency is consistent with sustained economic growth and resource decoupling. Long-term scenarios point towards slight consumption losses caused by a rapid and pervasive expansion of such energy solutions. Whether sustainable growth, as an overarching concept, is attainable or not is more disputed in the literature. Existing literature is also undecided as to whether or not access to modern energy services causes economic growth. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Bonan et al. (2014); Clarke et al. (2014); Jackson and Senker (2011); New Climate Economy (2014); OECD (2017); York and McGee (2017)	**Inclusive and Sustainable Industrialization (9.2/9.4)** ~/↓ [0,-1] 🕮🕮 ☺☺☺ ★★ A rapid up-scaling of renewable energies could necessitate the early retirement of fossil energy infrastructure (e.g., power plants, refineries, pipelines) on a large-scale. The implications of this could in some cases be negative, unless targeted policies can help alleviate the burden on industry. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Bertram et al. (2015); Fankhauser et al. (2008); Guivarch et al. (2011); Johnson et al. (2015)	**Disaster Preparedness and Prevention (11.5)** ↑ [+2] 🕮🕮🕮 ☺☺ ★★★ Deployment of renewable energy and improvements in energy efficiency globally will aid climate change mitigation efforts, and this, in turn, can help to reduce the exposure of people to certain types of disasters and extreme events. (Quote from McCollum et al., in review) *McCollum et al. (in review); D* aut et al. (2013); Hallegatte et al. (2016); IPCC (2014); Riahi et al. (2012); Tully (2006)	**Natural Resource Protection (12.2/12.3/12.4/12.5)** ↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★★ Renewable energy and energy efficiency slow the depletion of several types of natural resources, namely coal, oil, natural gas, and uranium. In addition, the phasing-out of fossil fuel subsidies encourages less wasteful energy consumption; but if that is done, then the policies implemented must take care to minimize any counteracting adverse side-effects on the poor (e.g., fuel price rises). (Quote from McCollum et al., in review) *McCollum et al. (in review);* Banerjee et al. (2012); Bhattacharyya et al. (2016); Cameron et al. (2016); Riahi et al. (2012); Schwanitz et al. (2014)
Subsidies for Renewables Energy Sources this category collects impacts that are specific to funding instruments for renewable energy sources			**Employment Opportunities (8.2/8.3/8.5/8.6) / Strong Financial Institutions** ↑/↓ [+2,-1] 🕮🕮 ☺ ★★ Deploying renewables and energy-efficient technologies, when combined with other targeted monetary and fiscal policies, can help spur innovation and reinforce local, regional, and national industrial and employment objectives. Gross employment effects seem likely to be positive; however, uncertainty remains regarding the net employment effects due to several uncertainties surrounding macro-economic feedback loops playing out at the global level. Moreover, the distributional effects experienced by individual actors may vary significantly. Strategic measures may need to be taken to ensure that a large-scale switch to renewable energy minimizes any negative impacts on those currently engaged in the business of fossil fuels (e.g., government support could help businesses re-tool and workers re-train). To support clean energy and energy efficiency efforts, strengthened financial institutions in developing country communities are necessary for providing capital, credit, and insurance to local entrepreneurs attempting to enact change. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Aether (2016); Babiker and Eckaus (2007); Bertram et al. (2015); Blyth et al. (2014); Borenstein (2012); Creutzig et al. (2013); Clarke et al. (2014); Dechezleprêtre and Sato (2014); Dinkelman (2011); Fankhauser et al. (2008); Ferroukhi et al. (2016); Frondel et al. (2010); Gohin (2008); Guivarch et al. (2011); Jackson and Senker (2011); Johnson et al. (2015)	**Infrastructure renewal (9.1/9.3/9.5)** ↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★ Financial and technical support can play a critical role in promoting the development of the renewable energy industry and more energy-efficient infrastructure. This includes targeted policy incentives (e.g., subsidies) and spending on scientific research to encourage technological innovation. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Bhattacharyya et al. (2016); Goldthau (2014); Meltzer (2016); Riahi et al. (2012)		
Increased use of biomass						
Large-scale hydro						
Deployment of CCS in the power sector Either with fossil fuels or bioenergy (BECCS)			**Innovation and Growth (8.1/8.2/8.4)** ↓ [-1] 🕮🕮🕮 ☺☺☺ ★★★ Lock-in of human and physical capital in the fossil-resources industry IPCC AR5 WG3 (2014); Vergragt et al. (2011); Markusson et al. (2012); IPCC (2005); Benson et al. (2005); Fankhauser et al. (2008); Shackley and Thompson (2012); Johnson et al. (2015); Bertram et al. (2015).			
Nuclear energy			**Innovation and Growth (8.1/8.2/8.4)** ↓ [-1] 🕮🕮 ☺☺☺ ★★★ Legacy cost of waste and abandoned reactors IPCC AR5 WG3 (2014); Marra and Palmer (2011); Greenberg, (2013a); Schwenk-Ferrero (2013a); Skipperud et al. (2013); Tyler et al. (2013a).			
Improving energy efficiency general demand-side measures (where they cannot be specifically attributed to one sector)				**Infrastructure renewal (9.1/9.3/9.5)** ↑ [+1] 🕮🕮 ☺☺ ★★ Transitioning to a more renewably-based energy system that is highly energy efficient is well alighed with the goal of upgrading energy infrastructure and making the energy industry more sustainable. In the reverse direction, infrastructure upgrades in other parts of the economy, such as modernized telecommunication networks, can create the conditions for a successful expansion of renewable energy and energy efficiency measures (e.g., smart-metering and demand-side management). (Quote from McCollum et al., in review) *McCollum et al. (in review);* Bhattacharyya et al. (2016); Goldthau (2014); Meltzer (2016); Riahi et al. (2012)	**Urban Environmental Sustainability (11.3/11.6)** ↑ [+2] 🕮🕮 ☺☺☺ ★★★★ Renewable energy technologies and energy-efficient urban infrastructure solutions (e.g., public transit) can also promote urban environmental sustainability by improving air quality and reducing noise. Efficient transportation technologies powered by renewably-based energy carriers will be a key building block of any sustainable transport system. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Bongardt et al. (2013); Creutzig et al. (2012); Grubler and Fisk (2012); Kahn Ribeiro et al. (2012); Raji et al. (2015); Riahi et al. (2012)	**Sustainable Practices and Lifestyles (12.6/12.7/12.8)** ↑ [+1] 🕮🕮🕮 ☺☺☺ ★★★ Sustainable practices adopted by public and private bodies in their operations (e.g., for goods procurement, supply chain management, and accounting) create an enabling environment in which renewable energy and energy efficiency measures may gain greater traction. (Quote from McCollum et al., in review) *McCollum et al. (in review);* CDP (2015); European Climate Foundation (2014); Khan et al. (2015); New Climate Economy (2015); Stefan and Paul (2008)
AFOLU demand-side measures & dietary change	**Reduced meat consumption**					
	Reduced food waste					
AFOLU supply-side measures	**Increased efficiency of livestock systems**					
	climate smart agriculture and Soil carbon sequestration					
	Enhanced Weathering, terrestrial					
	Forestry, Forest management , REDD+					
Non-CO2 mitigation measures	**Methane removal**					
Oceans/Water	**Ocean iron fertilization**					
	Blue carbon					
	Enhanced Weathering, ocean					

Table 5.1 c. Environment Dimension

Measure	Sub-measure	6 Clean Water and Sanitation (Interaction / Nilsson score / Evidence / Literature agreement / Confidence)	14 Life Below Water (Interaction / Nilsson score / Evidence / Literature agreement / Confidence)	15 Life on Land (Interaction / Nilsson score / Evidence / Literature agreement / Confidence)
Industry demand reduction	**Efficiency**	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑//~ | [+2] | 📖📖📖 | ☺☺☺ | ★★★ Efficiency changes in the industrial sector that lead to reduced energy demand can lead to reduced requirements on energy supply. As water is used to convert energy into useful forms, the reduction in industrial demand is anticipated to reduce water consumption and wastewater, resulting in more clean water for other sectors and the environment. In extractive industries there is trade off unless Vassolo and Doell (2005); Fricko et al. (2016); Holland et al. (2016);Nguyen et al (2014)		
	Behaviour	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ | [+2] | 📖📖📖 | ☺☺☺ | ★★★ Behavioral changes in the industrial sector that lead to reduced energy demand can lead to reduced requirements on energy supply. As water is used to convert energy into useful forms, the reduction in industrial demand is anticipated to reduce water consumption and wastewater, resulting in more clean water for other sectors and the environment. Vassolo and Doell		
Industry fuel decarbonization and cross sector collaboration	**Switch to low-carbon**	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ / ↓ | [+2,-2] | 📖📖📖 | ☺☺ | ★★★ A switch to low-carbon fuels can lead to a reduction in water demand and wastewater if the existing higher-carbon fuel is associated with a higher water intensity than the lower-carbon fuel. However, in some situations the switch to a low-carbon fuel such as e.g., biofuel could increase water use compared to existing conditions if the biofuel comes from a water-intensive feedstock. Hejazi et al. (2015); Song et al. (2016); Fricko et al. (2016)		**Sustainable production (15.1,15.5,15.9,15.10)** ↑ / ↓ | [+1,-1] | 📖 | ☺ | ★ Circular economy instead of liner global economy can achieve climate goal and can help in economic growth through industrialisation which saves on resources, enviornment and supports small, edium and even large industries, can lead to employment generation. so new regulations, incentives, tax regime can help in achieving the goal especially in newly emerging developing cpuntries although applicable for large indsutrialised countries also. Shi et al (2017)
	CCS/CCU	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ / ↓ | [+1/-2] | 📖📖📖 | ☺☺ | ★★★ CCU/S requires access to water for cooling and processing which could contribute to localized water stress. CCS/U process can potentially be configured for increased water efficiency compared to a system without carbon capture via process integration. Meldrum et al. (2013); Fricko et al. (2016); Byers et al. (2016); Brandl et al. (2017)		
Residential demand reduction	**behavior**	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ | [+2] | 📖📖📖 | ☺☺☺ | ★★★ Behavioral changes in the residential sector that lead to reduced energy demand can lead to reduced requirements on energy supply. As water is used to convert energy into useful forms, the reduction in residential demand is anticipated to reduce water consumption and wastewater, resulting in more clean water for other sectors and the environment. Bartos and Chester (2014); Fricko et al. (2016) Holland et al. (2016)		
	efficiecy	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ | [+2] | 📖📖📖 | ☺☺☺ | ★★★ Efficiency changes in the residential sector that lead to reduced energy demand can lead to reduced requirements on energy supply. As water is used to convert energy into useful forms, the reduction in residential demand is anticipated to reduce water consumption and wastewater, resulting in more clean water for other sectors and the environment. Hendrickson et al. (2014); Bartos and Chester (2014); Fricko et al. (2016) Holland et al. (2016)		
Residential fuel decarbonization	**Switch to low-carbon**	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ / ↓ | [+2,-2] | 📖📖📖 | ☺☺ | ★★★ A switch to low-carbon fuels in the residential sector can lead to a reduction in water demand and wastewater if the existing higher-carbon fuel is associated with a higher water intensity than the lower-carbon fuel. However, in some situations the switch to a low-carbon fuel such as e.g., biofuel could increase water use compared to existing conditions if the biofuel comes from a water-intensive feedstock. Hejazi et al. (2015); Song et al. (2016); Fricko et al. (2016)		
Transport demand reduction	**behavior**	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ | [+2] | 📖📖📖 | ☺☺☺ | ★★★ Behavioral changes in the transport sector that lead to reduced transport demand can lead to reduced transport energy supply. As water is used to produce a number of important transport fuels, the reduction in transport demand is anticipated to reduce water consumption and wastewater, resulting in more clean water for other sectors and the environment. Vidic et al. (2013); Tiedemann et al. (2016); Fricko et al. (2016); Holland et al. (2016)		
	efficiency	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ | [+2] | 📖📖📖 | ☺☺☺ | ★★★ Similar to behavioral changes, efficiency measures in the transport sector that lead to reduced transport demand can lead to reduced transport energy supply. As water is used to produce a number of important transport fuels, the reduction in transport demand is anticipated to reduce water consumption and wastewater, resulting in more clean water for other sectors and the environment. Vidic et al. (2013); Tiedemann et al. (2016); Fricko et al. (2016); Holland et al. (2016)		
Transport fuel decarbonization	**Switch to low-carbon**	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ / ↓ | [+2,-2] | 📖📖📖 | ☺☺ | ★★★ A switch to low-carbon fuels in the transport sector can lead to a reduction in water demand and wastewater if the existing higher-carbon fuel is associated with a higher water intensity than the lower-carbon fuel. However, in some situations the switch to a low-carbon fuel such as e.g., biofuel could increase water use compared to existing conditions if the biofuel comes from a water-intensive feedstock. Hejazi et al. (2015); Song et al. (2016); Fricko et al. (2016)		
Phasing out coal supply-side, upstream-sector impacts		**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ | [+2] | 📖📖📖 | ☺☺☺☺ | ★★★★ Phasing out coal in favour of other energy resources is anticipated to reduce water demands, if the alternative fuels have lower water intensity than coal. Most fuels do have a lower water intensity than coal, and switching to natural gas as a bridge to low-carbon societies is also expected to bring water benefits due to increasing power generation efficiency and reduced cooling water demands. Webster et al. (2013); Zhang et al. (2014); Fricko et al. (2016); Wright et al. (2017)		**Healthy Terrestrial Ecosystems (15.1/15.2/15.4/15.5/15.8)** ↑ | [+1] | 📖📖 | ☺☺☺ | ★★★ Reduced impact from coal mining IPCC AR5 WG3 (2014); Adibee et al. (2013); Cormier et al. (2013); Smith et al. (2013), and reference cited therein: Palmer et al. (2010); Koorneef et al. (2011); Singh et al. (2011); Hertwich et al. (2008); Veltman et al. (2010); Corsten et al.(2013).
Improving Access to Modern Energy modern biomass, nuclear, other renewables (solar, wind, etc.)		**Access to improved water and sanitation (6.1/6.2)** ↑ / ↓ | [+2,-1] | 📖📖 | ☺☺ | ★★★ Access to modern forms of energy will enable water treatment and distribution. This will prevent water related human and environmental hazards. Transitioning away from non-commercial biomass is expected to avoid associated deforestation impacts on surrounding hydrology. However, if the transition to modern forms of energy results in the development of water-intensive energy resources, improved energy access could lead to increased water stresss. Rao and Pachauri (2017); Cibin et al. (2016); Fricko et al. (2016)		**Healthy Terrestrial Ecosystems (15.1/15.2/15.4/15.5/15.8)** ↑ | [+2] | 📖📖 | ☺☺☺ | ★★★ Ensuring that the world's poor have access to modern energy services would reinforce the objective of halting deforestation, since firewood taken from forests is a commonly used energy resource among the poor. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Bailis et al. (2015); Bazilian et al (2011); Karekezi et al. (2012); Winter et al. (2015)
Deployment of Renewables modern biomass, other renewables (solar, wind, etc.)		**Water efficiency and pollution prevention (6.3/6.4/6.6) / Access to improved** ↑ / ↓ | [+2,-1] | 📖📖📖 | ☺☺☺ | ★★★ Wind/solar renewable energy technologies are associated with very low water requirements compared to existing thermal power plant technologies. Widespread deployment is therefore anticipated to lead to improved water efficiency and avoided thermal pollution. However, managing wind and solar variability can increase water use at thermal power plants and can cause poor water quality downstream from hydropower plants. Access to distributed renewables can provide power to improve water access, but could also lead to increased groundwater pumping and stress if mismanaged Bilton et al. (2011); Scott et al. (2011); Kumar et al. (2012); Kern et al. (2014); Meldrum et al. (2014); Fricko et al. (2016)	**Marine Economies (14.7) / Marine Protection (14.1/14.2/14.4/14.5)** ↑ / ↓ | [1,-1] | 📖 | ☺☺☺ | ★★ Ocean-based energy from renewable sources (e.g., offshore wind farms, wave and tidal power) are potentially significant energy resource bases for island countries and countries situated along coastlines. Multi-use platforms combining renewable energy generation, aqua-culture, transport services and leisure activities can lay the groundwork for more diversified marine economies. Depending on the local context and prevailing regulations, ocean-based energy installations could either induce spatial competition with other marine activities, such as tourism, shipping, resources exploitation, and marine and coastal habitats and protected areas, or provide further grounds for protecting those exact habitats, therefore enabling marine protection. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Buck and Krause (2012); Michler-Cieluch et al. (2009); WBGU (2013); Inger et al. (2009)	**Healthy Terrestrial Ecosystems (15.1/15.2/15.4/15.5/15.8)** ↓ | [-1] | 📖📖 | ☺☺ | ★★ landscape and wildlife impact for wind Wiser et al. (2011); Lovich and Ennen (2013); Garvin et al. (2011); Grodsky et al. (2011); Dahl et al. (2012); de Lucas et al. (2012); Dahl et al. (Dahl et al., 2012); Jain et al. (2011).
Subsidies for Renewables Energy Sources this category collects impacts that are specific to funding instruments for renewable energy sources		**Water efficiency and pollution prevention (6.3/6.4/6.6) / Access to improved** ↑ / ↓ | [+1,-1] | 📖📖📖 | ☺☺☺ | ★★★ Subsidies for renewables are anticipated to lead to the benefits and tradeoffs outlined when deploying renewables. Subsidies for renewables could lead to improved water acccess and treatment if subsidies support projects that provide both water and energy services (e.g., solar desalination). Bilton et al. (2011); Scott et al. (2011); Kumar et al. (2012); Kern et al. (2014); Meldrum et al. (2014); Fricko et al. (2016)		
Increased use of biomass		**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ / ↓ | [+1,-2] | 📖📖📖📖 | ☺☺ | ★★★★ Biomass expansion could lead to increased water stress when irrigated feedstocks and water-intensive processing steps are used. Bioenergy crops can alter flow over land and through soils as well as require fertilizer and this can reduce water availability and quality. Planting bioenergy crops on marginal lands or in some situations to replace existing crops can lead to reductions in soil erosion and fertilzer inputs, improving water quality. Hejazi et al. (2015), Bonsch et al. (2016), Cibin et al. (2016); Song et al. (2016); Gao et al. (2017); Taniwaki (2017); Woodbury et al. (2017); Griffiths et al. (2017); Ha et al. (2017)		**Healthy Terrestrial Ecosystems (15.1/15.2/15.4/15.5/15.8)** ~ / ↓ | [0,-2] | 📖 | ☺☺☺ | ★★ Protecting terrestrial ecosystems, sustainably managing forests, halting deforestation, preventing biodiversity loss and controlling invasive alien species could potentially clash with renewable energy expansion, if that would mean constraining large-scale utilization of bioenergy or hydropower. Good governance, cross-jurisdictional coordination, and sound implementation practices are critical for minimizing trade-offs. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Smith et al. (2010); Smith et al. (2014)
Large-scale hydro		**Water efficiency and pollution prevention (6.3/6.4/6.6) / Access to improved** ↑ / ↓ | [+2,-2] | 📖📖📖📖 | ☺☺☺☺ | ★★★★ Developing dams to support reliable hydropower production can fragment rivers and alter natural Ziv et al. (2012); Grill et al. (2015); Grubert et al. (2016); Fricko et al. (2016); De Stefano et al. (2017)		**Healthy Terrestrial Ecosystems (15.1/15.2/15.4/15.5/15.8)** ↓ | [-1] | 📖📖 | ☺☺ | ★★ Habitat impact IPCC AR5 WG3 (2014); Kumar et al. (2011); Alho (2011); Kunz et al. (2011); Smith et al. (2013); Ziv et
Deployment of CCS in the power sector Either with fossil fuels or bioenergy (BECCS)		**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ / ↓ | [+1,-2] | 📖📖📖 | ☺☺ | ★★★ CCU/S requires access to water for cooling and processing which could contribute to localized water Meldrum et al. (2013); Fricko et al. (2016); Byers et al. (2016); Brandl et al. (2017)		
Nuclear energy		**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ / ↓ | [+2,-1] | 📖📖📖 | ☺☺☺ | ★★★ Nuclear power generation requires water for cooling which can lead to localized water stress and Webster et al. (2013); Fricko et al. (2016); Raptis et al. (2016); Holland et al. (2016)		**Healthy Terrestrial Ecosystems (15.1/15.2/15.4/15.5/15.8)** ↓ | [-1] | 📖📖 | ☺☺ | ★★ Safety and waste concerns, uranium mining and milling IPCC AR5 WG3 (2014); Visschers and Siegrist (2012); Greenberg (2013a); Kim et al. (2013); Visschers
Improving energy efficiency general demand-side measures (where they cannot be specifically attributed to one sector)		**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ | [+2] | 📖📖📖 | ☺☺☺ | ★★★ As water is used to convert energy into useful forms, energy efficiency is anticipated to reduce water consumption and wastewater, resulting in more clean water for other sectors and the environment. Bartos and Chester (2014); Fricko et al. (2016) Holland et al. (2016)	**Ocean Acidification (14.3)** ↑ | [+2] | 📖📖📖 | ☺☺☺ | ★★★ Deployment of renewable energy and improvements in energy efficiency globally can reduce carbon dioxide emissions, and this, in turn, will slow rates of ocean acidification. (Quote from McCollum et al., in review) *McCollum et al. (in review);* Caldeira and Wicket (2003); Feely et al. (2009); Gruber (2011); Le Quére et al. (2009); The Royal Society (2005); WBGU (2013)	
AFOLU demand-side measures & dietary change	**Reduced meat consumption**	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ / ↓ | [+2,-1] | 📖📖📖 | ☺☺☺ | ★★★ Reduced meat consumption avoids direct water demand and wastewater for livestock and livestock feed products (e.g., crops), and avoids water used for energy supply by reducing agricultural energy inputs. However, switching diets could cause increased consumption of plant-based products that can also be water-intensive. Khan et al. (2009); Mekonnen et al. (2013); Bajzelj et al. (2014); Ran et al. (2016)		
	Reduced food waste	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ | [+2] | 📖📖📖📖 | ☺☺☺☺ | ★★★★ Reduced food waste avoids direct water demand and wastewater for crops and food processing, and avoids water used for energy supply by reducing agricultural, food processing and waste management energy inputs. Khan et al. (2009); Bajzelj et al. (2014); Ran et al. (2016); Villarroel Walker et al. (2014)		
AFOLU supply-side measures	**Increased efficiency of livestock systems**	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ / ↓ | [+2,-1] | 📖📖📖 | ☺☺☺ | ★★★ Livestock efficiency measures are expected to reduce water required for livestock systems as well as associated livestock wastewater flows. However, efficiency measures that include agricultural intensification could increase water demands locally, leading to increased water stress if the intensification is mismananged. Mekonnen et al. (2013); Kong et al. (2016); Ran et al. (2016)		
	climate smart agriculture and Soil carbon sequestration	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ / ↓ | [+1,-1] | 📖 | ☺ | ★★ Soil carbon sequestration can alter the capacity of soils to store water, which impacts the hydrological cycle and could be positive or negative from a water perspective, dependent on existing conditions. Smith (2016)		**Conservation of Biodiversity (15.5/15.9)** ↑ / ↓ | [+1,-1] | 📖📖📖 | ☺☺☺ | ★★★ Agricultural intensification can promote conservation of biological diversity by reducing deforestation, and by rehabilitation and restoration of biodiverse communities on previously developed farm or pasture land. However, planting monocultures on biodiversity hot spots can have adverse side-effects, reducing biodiversity IPCC WGIII, 2014
	Enhanced Weathering, terrestrial	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↓ | [-1] | 📖 | ☺ | ★ Weathering agents may end up in water bodies impacting their quality. Interactions with the water cycle are also anticipated but highly uncertain and under researched Taylor et al. (2015)		
	Forestry, Forest management , REDD+	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ / ↓ | [+1,-1] | 📖📖 | ☺☺ | ★★ Forest management alters the hydrological cycle which could be positive or negative from a water perspective and is dependent on existing conditions Bonsch et al.		**Conservation of Biodiversity (15.2/15.3/15.4/15.5/15.9)** ↑ | [+1] | 📖📖📖 | ☺☺☺ | ★★★ Policies and programs for reducing deforestation and forest degradation, for rehabilitation and restorationof degraded lands can promote conservation of biological diversity IPCC WGIII, 2014
Non-CO2 mitigation measures	**Methane removal**	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↑ | [+2] | 📖📖📖📖 | ☺☺☺☺ | ★★★★ Methane removal from wastewater can be used to generate low-carbon energy. This energy can be used to offset increasing water treatment energy demands to ensure water quality objectives. Stillwell et al. (2010); McCarty et al. (2011); McDonald et al. (2016); Kavvda et al. (2016)		
Oceans/Water	**Ocean iron fertilization**	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↓ | [-2] | 📖 | ☺ | ★ Ocean iron fertilization involves changing the chemistry of ocean water bodies which will directly impact water quality, but these impacts are under researched. Koehler et al. (2013)		
	Blue carbon	**Integrated water resources management (6.3/6.5)** ↑ | [+2] | 📖 | ☺ | ★ Development of blue carbon resources (coastal and marine vegetated ecosystems) can lead to coordinated management of water in coastal areas. Vierros et al. (2013)		
	Enhanced Weathering, ocean	**Water efficiency and pollution prevention (6.3/6.4/6.6)** ↓ | [-1] | 📖 | ☺ | ★ Weathering agents are expected to impact water quality. Interactions with the water cycle are also anticipated but highly uncertain and under researched Taylor et al. (2015)		

Legend for Table 5.1

Table 5.1 shows Synergies (↑) and Tradeoffs (↓) and undecided (~) relation between sectoral mitigation options and sustainable development dimensions as well as SDGs. Synergies and tradeoffs or even undecided outcome of various mitigation options on SDGs arise due to multiple factors and nature of relation also vary. Brief description of those are given in following three tables based on assessment of the literature. Set of literature used so far based on current search are mentioned as well. Table 5.1a shows Social dimensions of SD along with relevant SDGs. Table 5.1b shows Economic dimensions of SD along with relevant SDGs. Table 5.1c shows Economic dimensions of SD along with relevant SDGs. We use various symbols for evidence (🕮), agreement (☺), confidence (★) and we use various strengths for each of these using following legends. Since variety of interactions among SDGs are possible following explanations from Nilsson et al. 2016 are used to indicate a score [] for showing interactions among SDGs.

Interaction score (Nilsson et al. 2016)

Interaction	Name	Explanation
+3	Indivisible	Inextricably linked to the achievement of another goal.
+2	Reinforcing	Aids the achievement of another goal.
+1	Enabling	Creates conditions that further another goal.
0	Consistent	No significant positive or negative interactions.
–1	Constraining	Limits options on another goal.
–2	Counteracting	Clashes with another goal.
–3	Cancelling	Makes it impossible to reach another goal.

LITERATURE AGREEMENT	EVIDENCE	CONFIDENCE
very high	very robust	***very high***
☺☺☺☺	🕮🕮🕮🕮	★★★★
high h	robust r	high
☺☺☺	🕮🕮🕮	★★★
medium m	medium m	***medium***
☺☺	🕮🕮	★★
limited l	low l	***low***
☺	🕮	★

References used in this assessment: Impacts of mitigation options on specific targets of the 17 SDGs, for social dimensions (Table 5.1a):

Altieri et al. 2016b; Casillas and Kammen 2012; Scott et al. 2014; Maidment et al. 2014; Berrueta et al. 2017b; Hallegatte et al. 2015; Suckall et al. 2014b; McCollum et al.; Bonan et al. 2014; Burlig and Preonas 2016; Casillas and Kammen 2010; Cook 2011; Kirubi et al. 2009; Pachauri et al. 2012; Pueyo et al. 2013; Hallegatte et al. 2016b; Riahi et al. 2012; Cameron et al. 2016; Fay et al. 2015; Hirth and Ueckerdt 2013; Jakob et al. 2014; IPCC 2014c; Havlík et al. 2015; Luttrell et al. 2013; Ravikumar et al. 2015; Di Gregorio et al. 2017b; Ickowitz et al. 2017; Loft et al. 2017; Asaduzzaman et al. 2010; Cabraal et al. 2005; Finco and Doppler 2010; Hasegawa et al. 2015; Lotze-Campen et al. 2014; Msangi et al. 2010; Smith et al. 2013; Sola et al. 2016; Tilman et al. 2009; van Vuuren et al. 2009; Balishter and Singh 1991; Creutzig et al. 2013; de Moraes et al. 2010; Gohin 2008; Rud 2012; Satolo and Bacchi 2013; van der Horst and Vermeylen 2011; Corbera and Pascual 2012; Davis et al. 2013; Muys et al. 2014; Xi et al. 2013; Zhang et al. 2015; Huebner et al. 2013; Yue et al. 2013a; Zhao et al. 2017; Willand et al. 2015; Wells et al. 2015; Cameron et al. 2015; Liddell and Guiney 2015; Sharpe et al. 2015; Derbez et al. 2014; Creutzig et al. 2012; Haines and Dora 2012; Saunders et al. 2013; Shaw et al. 2014b; Woodcock et al. 2009; Schucht et al. 2015; Figueroa et al. 2014; Peng et al. 2017; Klausbruckner et al. 2016; Koornneef et al. 2011; Singh et al. 2011; Hertwich et al. 2008; Veltman et al. 2010; Corsten et al. 2013; Ashworth et al. 2012; Einsiedel et al. 2013; Miller et al. 2007; de Best-Waldhober et al. 2009; Wong-Parodi and Ray 2009; Reiner and Nuttall 2011; Burgherr et al. 2012; Chen et al. 2012; Chan and Griffiths 2010; Asfaw et al. 2013; Aranda et al. 2014; Lam et al. 2012; Lim et al. 2012; Anenberg et al. 2013; Chaturvedi and Shukla 2014; Haines et al. 2007; IEA 2016; Kaygusuz 2011; Nemet et al. 2010; Rafaj et al. 2013; Rao et al. 2013a; Smith and Sagar 2014; van Vliet et al. 2012; West et al. 2013; Atchley et al. 2013; Apps et al. 2010; Siirila et al. 2012; Wang and Jaffe 2004; Cardis et al. 2006; Abdelouas 2006; Al-Zoughool and Krewski 2009; Schnelzer et al. 2010; Tirmarche et al. 2012; Brugge D. & Buchner 2011; Hiyama et al. 2013; Mousseau and Møller 2013; Møller and Mousseau 2011; Møller et al. 2012, 2011; von Stechow et al. 2016; Heinävaara et al. 2010; Kaatsch et al. 2008; Sermage-Faure et al. 2012; Lipscomb et al. 2013; van de Walle et al. 2013; Chowdhury 2010; Haves 2012; Matinga 2012; Pachauri and Rao 2013; Clancy et al. 2011; Dinkelman 2011; Köhlin et al. 2011; Brown 2011; Lucas and Pangbourne 2014; Cass et al. 2010; Cumbers 2012; Kunze and Becker 2015; Walker and Devine-Wright 2008; Jakob and Steckel 2014; Cayla and Osso 2013; Hult and Larsson 2016; Aggarwal 2013; AlSabbagh et al. 2017; Acemoglu 2009; ICSU and ISSC 2015; Tabellini 2010; Clarke et al. 2009; Eis et al. 2016; Montreal Protocol 1989; New Climate Economy 2015; O'Neill et al. 2017b; Ramaker et al. 2003; Riahi et al. 2015, 2017

References used in this assessment: Impacts of mitigation options on specific targets of the 17 SDGs, for economic dimensions (Table 5.1b):

Zhang et al. 2015; IPCC 2014c; Chakravarty and Tavoni 2013; Karner et al. 2015; Yue et al. 2013b; Zhao et al. 2017; de Koning et al. 2016; Isenhour and Feng 2016; van Sluisveld et al. 2016; Noonan et al. 2015; Allen et al. 2015; Jain et al. 2013; Hori et al. 2013; Sweeney et al. 2013; Webb et al. 2013; Huebner et al. 2013; Gyamfi et al. 2013; Berrueta et al. 2017b; Cameron et al. 2015; Liddell and Guiney 2015; McLeod et al. 2013; Noris et al. 2013; Salvalai et al. 2017; Yang et al. 2014; Kwong et al. 2014; Holopainen et al. 2014; Creutzig et al. 2014; Ali et al. 2015; Månsson 2016; Altieri et al. 2016b; Fan et al. 2017; Shi et al. 2017; Klausbruckner et al. 2016; Lucas and Pangbourne 2014; Suckall et al. 2014b; Gouldson et al. 2015; Carrara and Longden 2016; Bernard and Torero 2015; Chakravorty et al. 2014; Grogan and Sadanand 2013; Pueyo et al. 2013; Rao et al. 2013b; Bonan et al. 2014; Clarke et al. 2014; Jackson and Senker 2011; New Climate Economy 2014; OECD 2017; York and McGee 2017; McCollum et al.; Babiker and Eckaus 2007; Bertram et al. 2015; Blyth et al. 2014; Borenstein 2012; Creutzig et al. 2013; Dechezleprêtre and Sato 2014; Dinkelman 2011; Ferroukhi et al. 2016; Frondel et al. 2010; Gohin 2008; Guivarch et al. 2011; Johnson et al. 2015; He et al. 2016; Lin et al. 2015; Kagawa et al. 2015; Heinonen et al. 2013; Gallego et al. 2013; Aamaas and Peters 2017; Gössling and Metzler 2017; Figueroa et al. 2014; Banerjee et al. 2012; Bhattacharyya et al. 2016; Cameron et al. 2016; Riahi et al. 2012; Schwanitz et al. 2014; European Climate Foundation 2014; Khan et al. 2015; New Climate Economy 2015; Stefan and Paul 2008; Hallegatte et al. 2015; Figueroa et al. 2013; Daut et al. 2013; Tully 2006; Bongardt et al. 2013; Creutzig et al. 2012; Grubler and Fisk 2012; Kahn Ribeiro et al. 2012; Raji et al. 2015; Dulac 2013; Martínez-Jaramillo et al. 2017; Goldthau 2014; Meltzer 2016

References used in this assessment: Impacts of mitigation options on specific targets of the 17 SDGs, for environmental dimensions (Table 5.1c):

Vassolo and Döll 2005; Fricko et al. 2016; Holland et al. 2015; Nguyen et al. 2014; Hejazi et al. 2015; Song et al. 2016; Meldrum et al. 2013; Byers et al. 2016; Brandl et al. 2017; Bartos and Chester 2014; Hendrickson and Horvath 2014; Vidic et al. 2013; Tiedeman et al. 2016; Webster et al. 2013; Zhang et al. 2014; Wright et al. 2017; Rao and Pachauri 2017; Cibin et al. 2016; Bilton et al. 2011; Scott 2011; Kern et al. 2014; Bonsch et al. 2016; Gao and Bryan 2017b; Taniwaki et al. 2017; Woodbury et al. 2017; Griffiths et al. 2017; Ha and Wu 2017; Ziv et al. 2012; Grill et al. 2015; Grubert et al. 2014; De Stefano et al. 2017; Raptis et al. 2016; Khan and Hanjra 2009; Mekonnen and Hoekstra 2012; Bajželj et al. 2014; Ran et al. 2016; Walker et al. 2014; Kong et al. 2016; Smith 2016; Kavvada et al. 2016; Köhler et al. 2013; Vierros 2017; McCollum et al.; Buck and Krause 2012; Michler-Cieluch et al. 2009; WBGU 2013; Inger et al. 2009; Caldeira and Wickett 2003; Gruber 2011; The Royal Society 2005; Shi et al. 2017; IPCC 2014c; Smith et al. 2013; Koornneef et al. 2011; Singh et al. 2011; Hertwich et al. 2008; Veltman et al. 2010; Corsten et al. 2013; Bailis et al. 2015; Bazilian et al. 2011; Karekezi et al. 2012; Winter et al. 2015; Smith et al. 2010; Kim and Brownstone 2013