Supplementary Note 1: Interactive SDG Co-benefit framework

From our previous systematic literature review, see paper Hultman et al, 2020, we find that a great deal of variation in co-benefits existed not only among project types but also within project type. In this section, we take one step further to assess the co-benefits of these projects in a more quantified way by drawing up studies of scoring exercise at the level of the SDG targets to better understanding the interaction between the CDM project technologies and the SDG dimensions. The two primary studies on this topic are McCollum et al., 2018 and the IPCC special report Global Warming of 1.5° C (IPCC, 2018.)

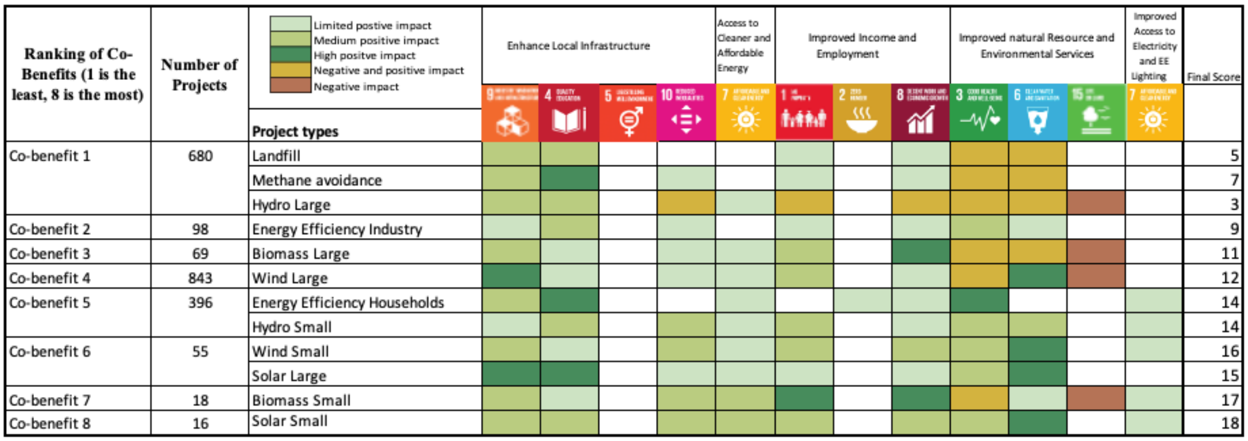
Both studies have conducted thorough research on the potential SDG targets from the deployment of mitigation options. Our paper adopts the structure of integrating the SDG targets into the mitigation options from both studies, while adds another layer of five co-benefit criteria on top of this structure. Thus, the final structure of the assessment is presented in **Supplementary Figure 1**.

Supplementary Figure 1 | Structure of integrating SDGs into five co-benefit criteria. We have layer five categories as the topic level under the co-benefits. Then each category is associated with one or more SDG goals. Thus, we are able to cover as many as SDGs as possible.

Under each SDG target, we assign an SDG-interaction score from this specific SDG targets and the project. The SDG-interaction score is a seven-point scale score. Interaction between outcomes of the CDM projects and the SDG targets can be positive or negative. For the positive interaction, we have "significant impact" "high impact", "medium impact", and "limited impact" four scales, and for negative interaction, we have "minor damage", "medium damage" and "massive damage". Additionally, we present the validity of the results in the literature by examining the quantity, quality, and consistency of the literature into four scales, limited, medium, robust, and extensive. Eventually, we assign the current level of confidence ("low", "medium", "high") to each SDG interaction based on the previous two aspects. This bottom-up direction of assessing the SDG interaction scores eventually can be aggregated at the level of co-benefit criteria. We present the results and the supportive evidence of how we obtain the SDG scores[1] in

[1] Our implication assumption is that the SDG goals are weighted equally, despite that countries may have different focus areas on sustainable development based on their national development priorities.

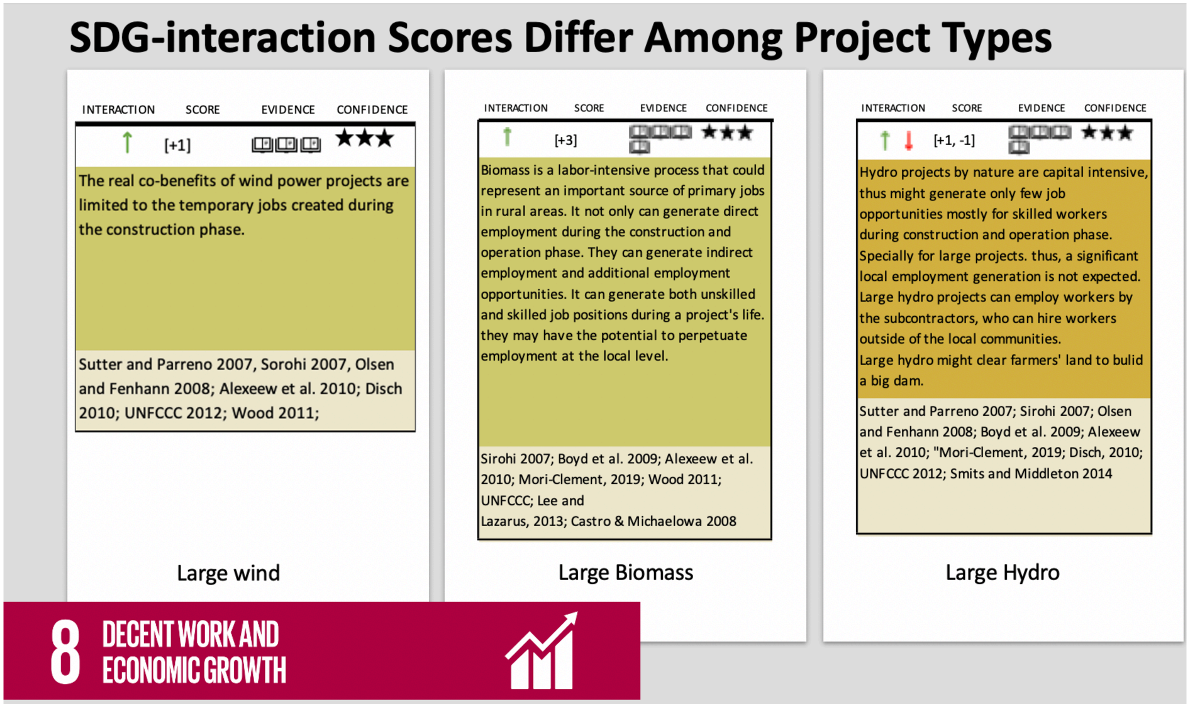
Supplementary Table 1 at the end of the document for your reference**.** But a simplified version of this table is provided in **Supplementary Figure 2** to give the audiences an overview of the main findings of the SDG-interaction score system in a brief way.



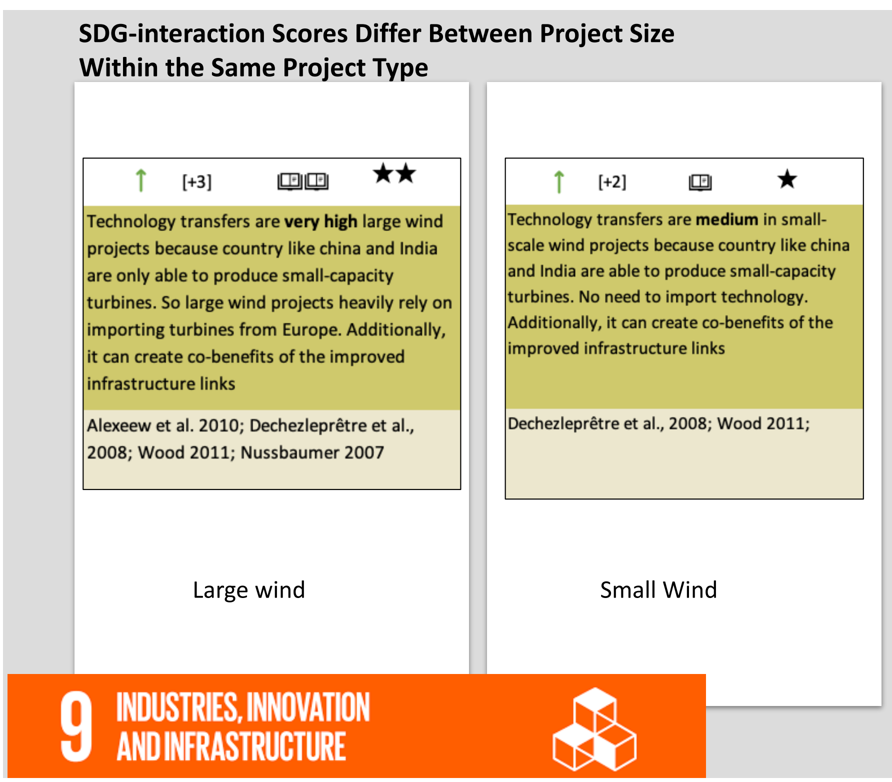
Supplementary Figure 2. Simplified version of the SDG-interaction score platform. This simplified version only contains different levels of impacts from the CDM projects. Green shaded colors indicate limited, medium, and high positive impacts. The yellow color points to the projects which might have both positive and negative impacts on the local communities. The red color indicates potential negative impacts.

Supplementary Figure 3 and **Supplementary Figure 4** are examples of this platform showing that the SDG-interaction scores vary among project technologies and between project sizes. These samples illustrate how we assess the 12 SDGs over 12 project-type-size combinations in a much deeper way. **Supplementary Figure 3** illustrates that in the capacities of creating potential jobs, many studies agree that large wind projects have limited impacts on local communities because of temporary jobs created during the construction phase. Based on that, we have assigned one SDG-interaction score to the large wind projects with high confidence. Large biomass projects can bring more positive impacts on the job creation to the local communities. They can generate direct and indirect job opportunities to perpetuate employment at the local level. Thus, we have assigned an SDG-interaction of three to the large biomass projects. Large hydro projects have both positive and negative impacts on the local job market.

One of the expectations of CDM is to stimulate the North-South transfer of clean technology, which can fit under SDG 9, Industries, Innovation, and Infrastructure. Taking wind technology as an example in **Supplementary Figure 4**, the equipment of wind power generation is usually imported from developed countries. Especially for these projects that have higher capacity, they rely on imported turbines. While local companies normally are able to produce small-capacity turbines. Thus, we have assigned a higher SDG-interaction score to the large wind technologies.



Supplementary Figure 3. Example of the interactive SDG co-benefit platform to illustrate variation of co-benefits among project technologies.

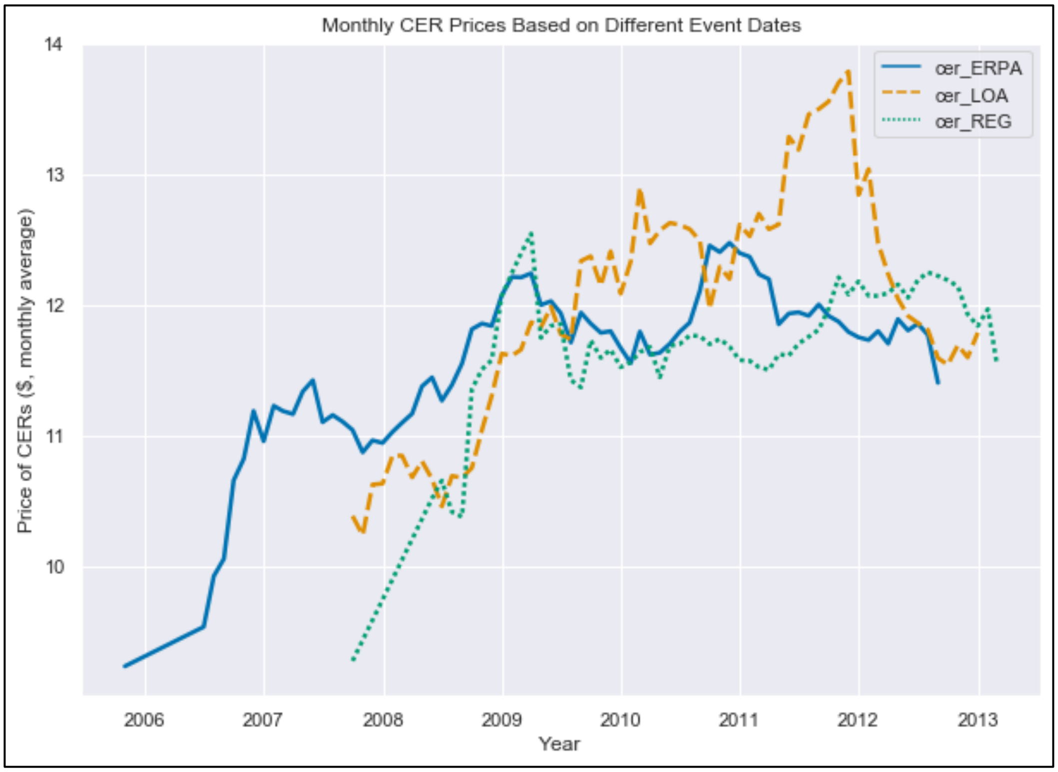


Supplementary Figure 4. Example of the interactive SDG co-benefit platform to illustrate variation of co-benefits between large and small project.

Supplementary Note 2: Accuracy of the ERPA Dates

To check the accuracy of the ERPA dates extracted by the machine, we adopted two methods to validate the data.

First, we plotted the monthly average CER prices over the period of April 2005 to February 2013 against the signed date of ERPA, along with two other event dates (the date of getting the Letter of Approval (LOA) and the date that a project get registered) in Supplementary Figure 5. We can see that the line of CER prices drawn from the ERPA is quite different from the other two lines based on the other two events: LOA date and project registration Date. We expect that the date of LOA will be close to the ERPA line, or might be delayed from the timewise perspective, compared to the ERPA dates, which is confirmed in the figure.



Supplementary Figure 5. Monthly CER prices based on different event dates. The line of CER prices drawn from the ERPA is very different from the other two lines based on the other two events. Normally, the date of LOA will be close to the ERPA dates (but somewhat delayed), which is confirmed in the figure. The low price at the early stage is due to the uncertainty of whether or not the Kyoto Protocol would even come into force. Thus, it leads to limited demand for CERs with an understandably low price of the CERs (Kamel et al., 2007). The second fall of the CER prices is due to the 2008 economic crisis. (Data is from the CDM project pipelines, with ERPA dates collected by the author. Note: The three lines are calculated based on a five-year moving average in order to smooth out dramatic price fluctuation. LOA: Letter of Approval. REG: Project Registration Date. Units: US dollar per ton.)

Second, we compared the overall trend of the monthly average CER prices based on ERPA dates with the spot market price trend. We find that among the three lines, the line of ERPA date fits the spot market trend best in Supplementary Figure 6.

Source: Norwegian Ministry of Finance, 2012

Supplementary Figure 6. EU ETS spot price ("EUA") and price of approved CDM allowances ("CER") from 1 January 2009 to 3 September 2012. Units: EUR per ton.

Supplementary Table 1. CDM technology and SDG table.

Enhance Local Infrastructure	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	4 QUALITY EDUCATION	5 LIGESTILLING MELLEM KØNNENE	10 REDUCED INEQUALITIES
	INTERACTION / SCORE / EVIDENCE / CONFIDENCE	INTERACTION / SCORE / EVIDENCE / CONFIDENCE	INTERACTION / SCORE / EVIDENCE / CONFIDENCE	INTERACTION / SCORE / EVIDENCE / CONFIDENCE
Landfill	↑ [+2] ★ Technical transfers can be a knowledge transfer and an equipment transfer or both. They create local technological capacity. Technology transfers are **high** in large landfill gas project because the high temperature flare, blower, gas analyzer, industrial computer are all imported from Europe. Dechezleprêtre et al., 2008	↑ [+2] ★ Has the **medium high** score in the creation of education opportunities in MATA-CDM research. Disch, 2010; UNFCCC 2012, IPCC 2018	No direct interaction	No direct interaction
Methan avoidance	↑ [+2] ★ Technical transfers can be a knowledge transfer and an equipment transfer or both. They create local technological capacity. Technology transfers are **high** in large landfill gas project because the high temperature flare, blower, gas analyzer, industrial computer are all imported from Europe. Dechezleprêtre et al., 2008	↑ [+3] ★ Has the **high** score in the creation of education opportunities in MATA-CDM research. UNFCCC 2012	No direct interaction	↑ [+1] ★ **Low-medium** impact on halting migration for local community. Subbarao and Lloyd 2011
Energy Efficiency Industry	↑ [+1] ★ Technical transfers can be a knowledge transfer and an equipment transfer or both. They create local technological capacity. Technology transfers are **medium** in large EE industry projects. additionally, EE industry has a low potential in the creation of infrastructure Alexeew et al. 2010; Dechezleprêtre et al., 2008	↑ [+2] ★★ Has the **medium** score in the creation of education opportunities in MATA-CDM research. And also EE deployment creates demand for sustainability training. Alexeew et al. 2010; UNFCCC 2012, Disch, 2010	No direct interaction	↑ [+1] ★ **Lowest** impact on halting migration for local community. Subbarao and Lloyd 2011

Energy Efficiency Households	↑ [+2] ★★ EE household has **medium-high** impact on capacity building with technology transfer. Dechezleprêtre et al., 2008; Nussbaumer 2007	↑ [+3] ★★ Small-scaled EE household through POAs can build local capacity, and increase institutional learning. It has medium impact in terms of quality time spent at school by children and turnaround in number of children attending school Schomer and van Asselt, 2012; Subbarao and Lloyd 2011; UNFCCC 2012	No direct interaction	↑ [+2] ★ It reduces household expenditure on fuel, reduce the amount of time they spend collecting fuelwood, thereby allowing them to engage in other activities, which further has a high impact on equal distribution. Wood 2011; Nussbaumer 2007
Hydro Large	↑ [+2] ★★ Technology transfers are **limited** in hydro area due to the fact that hydro is a local mature technology, but road is a part of the project construction. Sirohi 2007; Alexeew et al. 2010; Dechezleprêtre et al., 2008; Nussbaumer 2007	↑ [+2] ★★ Has the **medium** score in the creation of education opportunities in MATA-CDM research. Sirohi 2007; Alexeew et al. 2010; Disch 2010; UNFCCC 2012	No direct interaction	↑ ↓ [+1, -1] ★ Renewables, including biomass, hydro, wind, solar, have a higher socio-economic profile with relative many projects contributing with employment, welfare, economic growth and energy benefits. Large hydro benefits affluent areas with a high demand on electricity. Rousseau, 2017; Olsen and Fenhann 2008; Alexeew et al. 2010
Hydro Small	↑ [+1] ★★ Technology transfers are **limited** in hydro area due to the fact that hydro is a local mature technology, but road is a part of the project construction, if properly designed, has the potential to generate the co-benefits. Sirohi 2007; Cole and Roberts 2011; Alexeew et al. 2010; Dechezleprêtre et al., 2008	↑ [+2] ★★ **Medium** impact in terms of quality time spent at school by children and turnaround in number of children attending school. Subbarao and Lloyd 2011; Sirohi 2007; Cole and Roberts 2011; Alexeew et al. 2010; Disch, 2010; UNFCCC	No direct interaction	↑ [+2] ★★ **Low-medium** impact on halting migration for local community. Subbarao and Lloyd 2011; Sirohi 2007; Olsen and Fenhann 2008; Cole and Roberts 2011; Alexeew et al. 2010

Wind Large	[+3] ★★ Technology transfers are **very high** large wind projects because country like china and India are only able to produce small-capacity turbines. So large wind projects heavily rely on importing turbines from Europe. Additionally, it can create co-benefits of the improved infrastructure links Alexeew et al. 2010; Dechezleprêtre et al., 2008; Wood 2011; Nussbaumer 2007	[+1] ★★ Has the **low-medium** score in the creation of education opportunities in MATA-CDM research. Alexeew et al. 2010; Disch 2010, UNFCCC	No direct interaction	[+1] ★ Renewables, including biomass, hydro, wind, solar, have a higher socio-economic profile with relative many projects contributing with employment, welfare, economic growth and energy benefits. Olsen and Fenhann 2008; Alexeew et al. 2010;
Wind Small	[+2] ★ Technology transfers are **medium** in small-scale wind projects because country like china and India are able to produce small-capacity turbines. No need to import technology. Additionally, it can create co-benefits of the improved infrastructure links Dechezleprêtre et al., 2008; Wood 2011;	[+1] ★★ Has the **low** score in the creation of education opportunities in MATA research. Disch 2010, UNFCCC	No direct interaction	[+2] ★ Renewables, including biomass, hydro, wind, solar, have a higher socio-economic profile with relative many projects contributing with employment, welfare, economic growth and energy benefits. Olsen and Fenhann 2008
Solar Large	[+3] ★★ Technology transfers are **very high** in large-scale solar projects because larger projects are better able to exploit economies of scale in technology transfer Dechezleprêtre et al., 2008; Nussbaumer 2007	[+3] ★ Has the **high** score in the creation of education opportunities in MATA-CDM research. UNFCCC 2012	No direct interaction	[+1] ★ Renewables, including biomass, hydro, wind, solar, have a higher socio-economic profile with relative many projects contributing with employment, welfare, economic growth and energy benefits. Olsen and Fenhann 2008
Solar Small	[+2] ★★ Technology transfers are **medium** in small-scale solar projects. Dechezleprêtre et al., 2008; Nussbaumer 2007	[+2] ★★ Small-scaled EE household through POAs can build local capacity, and increase institutional learning. UNFCCC 2012; Schomer and van Asselt, 2012	No direct interaction	[+2] ★ Renewables, including biomass, hydro, wind, solar, have a higher socio-economic profile with relative many projects contributing with employment, welfare, economic growth and energy benefits; Small scale RE deliver a slightly higher number of SD benefits than large-scale. Olsen and Fenhann 2008

Biomass Large	↑ [+2] ★ Technology transfers are **limited** in biomass area due to the fact that biomass is a local mature technology; Indirect infrastructure development in the project area as a result of setting up of rural industries. Alexeew et al. 2010; Dechezleprêtre et al., 2008;	↑ [+1] ★★ Biomass that rely on on-farm residues can offer the **low medium** number of benefits. Sirohi 2007; Lee and Lazarus, 2013; Alexeew et al. 2010; Disch 2010; UNFCCC 2012	No direct interaction	↑ [+1] ★ Renewables, including biomass, hydro, wind, solar, have a higher socio-economic profile with relative many projects contributing with employment, welfare, economic growth and energy benefits. Olsen and Fenhann 2008; Alexeew et al. 2010;
Biomass Small	↑ [+2] ★ Technology transfers are **limited** in biomass area due to the fact that biomass is a local mature technology; Indirect infrastructure development in the project area as a result of setting up of rural industries. Sirohi 2007; Alexeew et al. 2010; Dechezleprêtre et al., 2008;	↑ [+1] ★★ Biomass that rely on on-farm residues can offer the **low medium** number of benefits. Additionally, low impact in terms of quality time spent at school by children and turnaround in number of children attending school Subbarao and Lloyd 2011; Alexeew et al. 2010; Disch, 2010; UNFCCC2012; Lee and Lazarus, 2013	No direct interaction	↑ [+2] ★ Renewables, including biomass, hydro, wind, solar, have a higher socio-economic profile with relative many projects contributing with employment, welfare, economic growth and energy benefits; Small scale RE deliver a slightly higher number of SD benefits than large-scale. Subbarao and Lloyd 2011; Olsen and Fenhann 2008; Alexeew et al. 2010;

	Access to Cleaner and Affordable Energy for Heating or/and Cooking				Improved Income and Employment											
	7 AFFORDABLE AND CLEAN ENERGY				1 NO POVERTY				2 ZERO HUNGER				8 DECENT WORK AND ECONOMIC GROWTH			
	INTERACTION	SCORE	EVIDENCE	CONFIDENCE	INTERACTION	SCORE	EVIDENCE	CONFIDENCE	INTERACTION	SCORE	EVIDENCE	CONFIDENCE	INTERACTION	SCORE	EVIDENCE	CONFIDENCE
Landfill	No direct interaction				↑	[+1]	📖	★	No direct interaction				↑	[+1]	📖📖	★★
					Benefits of using landfill gas projects are from cost savings associated with using landfill gas as a replacement for more expensive fossil fuel, thus improving income at the local level. However, research shows that little or no impact on poverty alleviation.								Landfill gas projects have the potential to generate employment opportunities for semi-skilled and high-skilled workers along the different phases of the projects. Thus, it is very limited impact on generating employment overall.			
					Sutter and Parreno 2007; Mori-Clement, 2019								Sutter and Parreno 2007; Mori-Clement, 2019; Disch, 2010; UNFCCC 2012			
Methan avoidance	No direct interaction				↑	[+1]	📖	★	No direct interaction				↑	[+1]	📖📖	★★
					Research shows that little or no impact on poverty alleviation.								Methane avoidance projects have the potential to generate employment opportunities for semi-skilled and high-skilled workers along the different phases of the projects. Thus, it is very limited impact on generating employment overall.			
					Sutter and Parreno 2007; Mori-Clement, 2019								Sutter and Parreno 2007; Mori-Clement, 2019; Disch, 2010; UNFCCC 2012			
Energy Efficiency Industry	No direct interaction				↑	[+1]	📖	★	No direct interaction				↑	[+1]	📖📖	★★
					Indirectly, the technical transfer from EE industry project might have a role in play in poverty alleviation. But other research also found out that the this type of projects also has the lowest score in physical well-being.								Has a low score in generating employment.			
					Sirohi 2007; Alexeew et al. 2010								Alexeew et al. 2010; Disch, 2010; UNFCCC 2012			

Energy Efficiency Households	↑ [+1] ★ Small-scaled EE households (efficient cook-stoves) through POAs can improve the access to modern energy services in the developing world Ellis el at. 2007; Schomer and van Asselt, 2012	No direct interaction	↑ [+1] ★ It reduces household expenditure on fuel, reduce the amount of time they spend collecting fuelwood, thereby allowing them to engage in other activities. Wood 2011	↑ [+1] ★★ Has limited impact on generating local jobs. Subbarao and Lloyd 2011; UNFCCC 2012; Wood 2011; Nussbaumer 2007
Hydro Large	↑ [+1] ★ Renewables, including biomass, hydro, wind, solar, have a higher socio-economic profile with relative many projects contributing with employment, welfare, economic growth and energy benefits. Olsen and Fenhann 2008	↑ ↓ [+1, -2] ★★★ Renewables, including biomass, hydro, wind, solar, have a higher socio-economic profile with relative many projects contributing with employment, welfare, economic growth and energy benefits; has impact on local poverty reduction through enhanced energy security; Negative impact to local communities due to wide-ranging livelihood changes triggered by dams; Large hydro cause resettlement of villages and flooding of their agricultural lands Sutter and Parreno 2007; Boyd et al. 2009; Alexeew et al. 2010; "Mori-Clement, 2019; Disch, 2010; Smits and Middleton 2014; Rousseau, 2017; Haya 2007; Haya and Parekh 2011	No direct interaction	↑ ↓ [+1, -1] ★★★ Hydro projects by nature are capital intensive, thus might generate only few job opportunities mostly for skilled workers during construction and operation phase. Specially for large projects. thus, a significant local employment generation is not expected. Large hydro projects can employ workers by the subcontractors, who can hire workers outside of the local communities. Sutter and Parreno 2007; Sirohi 2007; Olsen and Fenhann 2008; Boyd et al. 2009; Alexeew et al. 2010; "Mori-Clement, 2019; Disch, 2010; UNFCCC 2012; Smits and Middleton 2014
Hydro Small	↑ [+1] ★★ Renewables, including biomass, hydro, wind, solar, have a higher socio-economic profile with relative many projects contributing with employment, welfare, economic growth and energy benefits; Small scale RE deliver a slightly higher number of SD benefits than large-salce Subbarao and Lloyd 2011; Sirohi 2007; Olsen and Fenhann 2008; Cole and Roberts 2011	↑ [+2] ★★ Renewables, including biomass, hydro, wind, solar, have a higher socio-economic profile with relative many projects contributing with employment, welfare, economic growth and energy benefits; Small scale RE deliver a slightly higher number of SD benefits than large-scale. Subbarao and Lloyd 2011; Sutter and Parreno 2007; Sirohi 2007; Olsen and Fenhann 2008; Cole and Roberts 2011; Alexeew et al. 2010	No direct interaction	↑ [+1] ★★★ Hydro projects by nature are capital intensive, thus might generate only few job opportunities mostly for skilled workers during construction and operation phase. specially for large projects. thus, a significant local employment generation is not expected. Small scale RE deliver a slightly higher number of SD benefits than large-scale. Subbarao and Lloyd 2011; Sutter and Parreno 2007; Sirohi 2007; Olsen and Fenhann 2008; Boyd et al. 2009; Alexeew et al. 2010; Disch, 2010; UNFCCC 2012

Wind Large	↑ [+1] ★ Renewables, including biomass, hydro, wind, solar, have a higher socio-economic profile with relative many projects contributing with employment, welfare, economic growth and energy benefits. Olsen and Fenhann 2008	↑ [+2] ★★ Has the medium score in physical well-being, and moderate impact of using CERs as income. Sutter and Parreno 2007, Olsen and Fenhann 2008; Alexeew et al. 2010;	No direct interaction	↑ [+1] ★★★ The real co-benefits of wind power projects are limited to the temporary jobs created during the construction phase. Sutter and Parreno 2007, Sorohi 2007, Olsen and Fenhann 2008; Alexeew et al. 2010; Disch 2010; UNFCCC 2012; Wood 2011;
Wind Small	↑ [+1] ★ Renewables, including biomass, hydro, wind, solar, have a higher socio-economic profile with relative many projects contributing with employment, welfare, economic growth and energy benefits; Small scale RE deliver a slightly higher number of SD benefits than large-scale. Subbarao and Lloyd 2011; Olsen and Fenhann 2008	↑ [+2] ★★ Has the medium score in physical well-being, and moderate impact of using CERs as income. Sutter and Parreno 2007, Olsen and Fenhann 2008; Alexeew et al. 2010;	No direct interaction	↑ [+2] ★★★ The real co-benefits of wind power projects are limited to the temporary jobs created during the construction phase Small scale RE deliver a slightly higher number of SD benefits than large-scale. Sutter and Parreno 2007, Sorohi 2007, Olsen and Fenhann 2008; Alexeew et al. 2010; Disch 2010; UNFCCC 2012; Wood 2011;
Solar Large	↑ [+1] ★ Renewables, including biomas, hydro, wind, solar, have a higher socio-economic profile with relative many projects contributing with employment, welfare, economic grwoth and energy benefits Olsen and Fenhann 2008	↑ [+1] ★ Renewables, including biomas, hydro, wind, solar, have a higher socio-economic profile with relative many projects contributing with employment, welfare, economic grwoth and energy benefits Olsen and Fenhann 2008	No direct interaction	↑ [+1] ★ Has a **medium** score in generating employment. Olsen and Fenhann 2008; UNFCCC 2012; Nussbaumer 2007
Solar Small	↑ [+2] ★★ Small-scaled technology, such as solar water heaters through POAs can improve the access to modern energy services in the developing world; Olsen and Fenhann 2008; Schomer and van Asselt, 2012	↑ [+2] ★ Renewables, including biomass, hydro, wind, solar, have a higher socio-economic profile with relative many projects contributing with employment, welfare, economic growth and energy benefits; Small scale RE deliver a slightly higher number of SD benefits than large-scale. Subbarao and Lloyd 2011	No direct interaction	↑ [+2] ★ Has a **medium** score in generating employment; Small scale RE deliver a slightly higher number of SD benefits than large-scale. Olsen and Fenhann 2008; UNFCCC 2012; Nussbaumer 2007

Biomass Large	↑ [+1] ★ Saving the power at grid that is currently used by them to divert it elsewhere; for country with vast agricultural produce that makes available large quantities of agricultural residues, Biomass can meet energy needs. Sirohi 2007; Olsen and Fenhann 2008;	↑ [+2] ★★ Direct: Farmers income from supplying biomass material; Indirect: contribute to farmers' livelihood; It also improved the livelihoods of the poor by creating a value for previously worthless biomass residues. Biomass fuel not being sourced from sustainable sources leads to negative impact to poor people in local community. Sirohi 2007; Olsen and Fenhann 2008; Boyd et al. 2009; Alexeew et al. 2010;Mori-Clement, 2019; Wood 2011	No direct interaction	↑ [+3] ★★★ Biomass is a labor-intensive process that could represent an important source of primary jobs in rural areas. It not only can generate direct employment during the construction and operation phase. They can generate indirect employment and additional employment opportunities. It can generate both unskilled and skilled job positions during a project's life. they may have the potential to perpetuate employment at the local level. Sirohi 2007; Boyd et al. 2009; Alexeew et al. 2010; Mori-Clement, 2019; Wood 2011; UNFCCC; Lee and Lazarus, 2013
Biomass Small	↑ [+2] ★ Saving the power at grid that is currently used by them to divert it elsewhere; Small scale RE deliver a slightly higher number of SD benefits than large-scale. Subbarao and Lloyd 2011; Sirohi 2007; Olsen and Fenhann 2008;	↑ [+3] ★★★ Direct: Farmers income from supplying biomass material ; Indirect: contribute to farmers' livelihood; creation of jobs as supplementary source of income to conventional farming Minor impact on poverty alleviation"; It also improved the livelihoods of the poor by creating a value for previously worthless biomass residues. Sirohi 2007; Olsen and Fenhann 2008; Boyd et al. 2009; Alexeew et al. 2010;Mori-Clement, 2019; Wood 2011	No direct interaction	↑ ↓ [+4] ★★★ Biomass is a labor-intensive process that could represent an important source of primary jobs in rural areas. It not only can generate direct employment during the construction and operation phase. They can generate indirect employment and additional employment opportunities. It can generate both unskilled and skilled job positions during a project's life. they may have the potential to perpetuate employment at the local level. Sirohi 2007; Sutter and Parreno 2007; Boyd et al. 2009; Alexeew et al. 2010; Mori-Clement, 2019; Wood 2011; UNFCCC; Lee and Lazarus, 2013;Castro & Michaelowa 2008

	Improved natural Resource and Environmental Services												Improved Access to Electricity and Energy Efficient Lighting			
	3 GOOD HEALTH AND WELL-BEING				6 CLEAN WATER AND SANITATION				15 LIFE ON LAND				7 AFFORDABLE AND CLEAN ENERGY			
	INTERACTION	SCORE	EVIDENCE	CONFIDENCE	INTERACTION	SCORE	EVIDENCE	CONFIDENCE	INTERACTION	SCORE	EVIDENCE	CONFIDENCE	INTERACTION	SCORE	EVIDENCE	CONFIDENCE
Landfill	↑ ↓	[+2, -2]	📖📖📖	★★★	↓	[-1]	📖	★	No direct interaction				No direct interaction			
	CH4 reduction projects have a medium green profile with many projects contributing to environmental benefits such as improved air and water quality. it is also cheap emission reductions face opposition from local communities opposed to the extension of the life of these sites, or bring negative effects on local health, because CDM postponed the closing down of the waste				Might contaminate ground water is mismanaged.											
	Ellis el at. 2005; Boyd et al. 2009; Sutter and Parreno 2007; Olsen and Fenhann 2008; Sun et al. 2010; Disch, 2010; UNFCCC 2012															
Methan avoidance	↑ ↓	[+2, -2]	📖📖📖	★★★	↓	[-1]	📖	★	No direct interaction				No direct interaction			
	CH4 reduction projects have a medium green profile with many projects contributing to environmental benefits such as improved air and water quality. it is also cheap emission reductions face opposition from local communities because it might bring negative effects on local health, because CDM postponed the closing down of				Might contaminate ground water is mismanaged.											
	Boyd et al. 2009; Sutter and Parreno 2007; Olsen and Fenhann 2008; Sun et al. 2010; Disch, 2010; UNFCCC 2012															
Energy Efficiency Industry	↑	[+2]	📖📖📖📖	★★★	↑	[+1]	📖	★	No direct interaction				No direct interaction			
	Has the **medium-high** impact on reducing air pollution, and promoting of environmental well-being.				A switch to low-carbon fuels can lead to a reduction in water demand, but the impact is the low in improving water quality.											
	Alexeew et al. 2010; Nussbaumer 2007; Sirohi 2007; UNFCCC 2012				Alexeew et al. 2010;											

Energy Efficiency Households	↑ [+3] ★★ it can siginificantly improve the air quality within their houses Subbarao and Lloyd 2011; UNFCCC 2012; Wood 2011	No direct interaction	No direct interaction	↑ [+1] ★ Small-scaled EE households (efficient fluorescent lamps) through POAs can improve the access to modern energy services in the developing world. Ellis el at. 2007; Schomer and van Asselt, 2012
Hydro Large	↑↓ [+2, -2] ★★★ Large hydro projects are the medium contributor to co-benefits in terms of pollutants mitigations and improving health; Large hydro might have environmental impacts including clearing of the forest and pollution(dust) during the construction phase. It further impacts local health. Sutter and Parreno 2007; Sun et al. 2010; Alexeew et al. 2010; Mori-Clement, 2019; Disch, 2010; UNFCCC 2012, Smits and Middleton 2014; Rousseau, 2017; Haya 2007; Haya and Parekh 2011; Castro & Michaelowa 2008; Nussbaumer 2007	↑↓ [+2, -1] ★ Has the medium score in improving water quality. Construction will pollute water. While dam have major impacts on the physical, chemical and geomorphological properties of a river. Alexeew et al. 2010; Haya 2007; Haya and Parekh 2011	↓ [-1] ★★ Large hydro might have environmental impacts including clearing of the forest and pollution(dust) during the construction phase. It further impacts local health. Rousseau, 2017; Haya 2007; Haya and Parekh 2011; Castro & Michaelowa 2008	No direct interaction
Hydro Small	↑ [+2] ★★★ Hydro projects are the medium contributor to co-benefits in terms of pollutants mitigations and improving health. Subbarao and Lloyd 2011; Sutter and Parreno 2007; Sun et al. 2010; Cole and Roberts 2011; Alexeew et al. 2010; Disch, 2010; UNFCCC 2012	↑ [+2] ★ Small hydro reduce water demands to displace other water intensive energy processes, it has the medium score in improving water quality. Cole and Roberts 2011; Alexeew et al. 2010, IPCC) 2018	No direct interaction	↑ [+1] ★ Low impact on access to electricity. Subbarao and Lloyd 2011

Wind Large	↑ ↓ [+2, -1] ★★★ Wind power projects can create co-benefits of the absence of any pollution that would have been caused by conventional power generation; Sun et at.2010; Alexeew et al. 2010; Disch 2010; UNFCCC 2012; Wood 2011	↑ [+3] ★ Wind with very low water requirement leads to the **high** impact in improving water quality. Alexeew et al. 2010, IPCC 2018	↓ [-1] ★ Has the negative impact on land issue. Nussbaumer 2007	No direct interaction
Wind Small	↑ [+2] ★★★ Wind power projects can create co-benefits of the absence of any pollution that would have been caused by conventional power generation. Subbarao and Lloyd 2011; Sun et at.2010; Disch 2010; UNFCCC 2012; Wood 2011	↑ [+3] ★ Wind with very low water requirement leads to the **high** impact in improving water quality. Alexeew et al. 2010, IPCC 2018	No direct interaction	↑ [+1] ★ Low impact on access to electricity. Subbarao and Lloyd 2011
Solar Large	↑ [+2] ★ Has the **medium** score improve air quality. UNFCCC 2012	↑ [+3] ★ Solar with very low water requirement leads to the **high** impact in improving water quality. IPCC 2018	No direct interaction	No direct interaction
Solar Small	↑ [+2] ★ Has the **medium** score improve air quality. UNFCCC 2012	↑ [+3] ★ Solar with very low water requirement leads to the **high** impact in improving water quality. IPCC 2018	No direct interaction	↑ [+1] ★ Small-scaled EE households (efficient fluorescent lamps) through POAs can improve the access to modern energy services in the developing world. Schomer and van Asselt, 2012

Biomass Large	↑ [+2, -1] ★ Biomass that rely on on-farm residues can offer the medium number of benefits. Has the medium score improve air quality; it improved air quality by reducing the burning of biomass in the fields, and supplying villagers with organic fertilizer. Alexeew et al. 2010; Disch 2010; Lee and Lazarus, 2013; UNFCCC 2012; Castro & Michaelowa 2008	↑ ↓ [+2, -1] ★ Has the **medium** score in improving water quality, meanwhile large biomass could lead to increased water stress. Alexeew et al. 2010, IPCC 2018	↓ [-1] ★ Biomass fuel not being sourced from sustainable sources leads to deforestation and affecting poor people that use biomass as cooking in local community. Castro & Michaelowa 2008	
Biomass Small	↑ [+2, -1] ★ Biomass that rely on on-farm residues can offer the medium number of benefits. Has the medium score improve air quality; it improved air quality by reducing the burning of biomass in the fields, and supplying villagers with organic fertilizer.Biomass fuel not being sourced from sustainable sources leads to negative impact to poor people in local community. Alexeew et al. 2010; Disch 2010; Lee and Lazarus, 2013; UNFCCC 2012; Wood 11; Castro & Michaelowa 2008	↑ [+2] ★ Has the **medium** score in improving water quality. Alexeew et al. 2010	↓ [-1] ★ Biomass fuel not being sourced from sustainable sources leads to deforestation and affecting poor people that use biomass as cooking in local community. Castro & Michaelowa 2008	↑ [+1] ★ Low **impact** on access to electricity. Subbarao and Lloyd 2011

Supplementary Table 2. Treatment effect of Gold Standard on CDM projects (LOG)

Models	Model 1	Model 2	Model 3	Model 4	Model 5
	Full regression	Propensity score matching with all 9 covariates	Propensity score matching at 5 continuous covariates	Exact matching on the credit buyers	Exact matching on the credit buyers and project location
TREAT	0.1026***	0.2900***	0.1424***	0.1175*	0.0654*
	(0.0288)	(0.0708)	(0.0553)	(0.0680)	(0.0407)
Year fixed effects (FE)	yes	yes	yes	yes	yes
Type FE	yes	yes	yes	yes	yes
Credit buyer FE	yes	yes	yes	yes	yes
Project location FE	yes	no	no	no	yes
F joint test	4.14***	16.55***	2.9**	5.21***	3.81**
No. of Observation	2251	378	378	294	126
TREAT	64	63	63	49	21
UNTREAT	2187	315	315	245	105
R Square	0.3406	0.9521	0.3404	0.2062	0.8327

Note: The dependent variable in all five models is Log (CER price). Coefficient estimates are reported in this table, with standard errors in parentheses. Standard errors are clustered at credit buyers' company level. We control for project location fixed effects, credit buyer fixed effects, project type fixed effects, and year fixed effects in the model.
* p<0.10 ** p<0.05 *** p<0.01

Supplementary Table 3. Company-level regression results A.

Sectoral Analysis		
	Model 1 (linear)	Model 2 (log-linear)
TREAT	0.0262	0.0045
	-0.588	(0.047)
TREAT & Financials	0.549	0.0310
	(0.721)	(0.058)
TREAT & Consumer discretionary	-1.080	-0.0967
	(1.024)	(0.0912)
TREAT & Industrial & material	6.496**	0.319*
	(3.261)	(0.167)
TREAT & Government Foundation	1.578**	0.150**
	(0.798)	(0.061)
TREAT & Carbon related	2.916**	0.141*
	(1.477)	(0.083)
TREAT & Utilities	-0.643	-0.0273
	(2.329)	(0.166)
TREAT & Energy	0.0262	0.0045
	-0.588	(0.047)
No. of Observation	2251	2251

Note: The dependent variable in model 1 is CER price and in model 2 is natural log of CER price. Coefficient estimates are reported in this table, with Standard errors in parentheses. Standard errors are clustered at credit buyers' company level.
* p<0.10 ** p<0.05 *** p<0.01

Supplementary Table 4. Company-level regression results B.

Sectoral Analysis: Buyer Profit Status		
	Model 1 (linear)	Model 2 (log-linear)
TREAT	0.625***	0.0661***
	(0.176)	(0.0141)
TREAT & Private Local	2.687	0.0972
	(1.809)	(0.0957)
TREAT & Private Global	0.909	0.00992
	(0.960)	(0.0552)
TREAT & Government	2.260**	0.191***
	(0.919)	(0.0571)
TREAT & Foundation	0.613	0.0462
	(1.140)	(0.0789)
TREAT & MDB	0.625***	0.0661***
(Omitted)	(0.176)	(0.0141)
No. of Observation	2251	2251

Note: The dependent variable in model 1 is CER price and is model 2 is natural log of CER price. Coefficient estimates are reported in this table, with Standard errors in parentheses. Standard errors are clustered at credit buyers' company level.
* $p<0.10$ ** $p<0.05$ *** $p<0.01$

Supplementary Table 5. Statistical summary.

Variable	Obs	Mean	Std. Dev.	Min	Max
CER price \$/CO_2e	2,205	11.70592	2.76698	1.31	42.02
Years of projects	2,205	7.454422	1.078723	5	10
1st period kt**CO_2e/yr**	2,205	124.9621	186.9285	2	3016.7
Expected accumulated 2020 ktCO_2e	2,205	1143.599	1744.64	18	30167
Expected accumulated 2030 ktCO_2e	2,205	2206.96	3250.614	38	54489
Methodology	2,205	0.2585034	0.4379114	0	1
ERPA	2,205	2009.222	1.716408	2002	2013
Project investment (million USD)	2,173	53.15113	72.70766	0	999.1

Note: The sample includes all 2205 CDM projects up to Jan 10, 2019. We used data from UNEP DTU Partnership. Additional information such as ERPA dates are collected by author, and project size (methodology) dummy is created by using the UNFCCC CDM Methodology Booklet (UNFCCC, 2017).

Supplementary Table 6. Projects distribution based on project types and size by Gold Standard and regular CDM.

	Regular CDM			Gold Standard CDM		
	Project Size			Project Size		
Project Type	**Small**	**Large**	**Total**	**Small**	**Large**	**Total**
Biomass energy	15	67	82	1	2	3
Coal bed/mine methane	0	39	39	0	0	0
EE households	6	0	6	1	0	1
EE industry	3	2	5	2	0	2
EE own generation	19	70	89	0	2	2
EE service	0	0	0	3	0	3
EE supply side	0	8	8	0	0	0
Energy distribution	0	3	3	0	0	0
Fossil fuel switch	1	18	19	0	0	0
Fugitive	0	4	4	0	0	0
Geothermal	0	1	1	0	0	0
Hydro	383	518	901	6	2	8
Landfill gas	19	48	67	0	2	2
Methane avoidance	63	8	71	19	1	20
Mixed renewables	0	1	1	0	0	0
N2O	0	1	1	0	0	0
Reforestation	0	2	2	0	0	0
Solar	13	31	44	5	2	7
Transport	0	2	2	1	2	3
Wind	18	832	850	2	11	13
Total	540	1,655	2,195	40	24	64

Supplementary Table 7. List of key factors affecting CER prices.

Factors	Level	Explanation	Literature	Indicator
Short-term expectation (Volume)	Micro	Phase one and phase two prices	(Meyrick, 2007)	1st period $ktCO_2e/yr$
Credit period	Macro and Micro	Long-term supply; CDM project can have either a seven-year crediting period, which can be renewed twice to make a total of twenty-one years, or a one-off ten-year period	(Nordseth, et al., 2007)	Years of projects
Middle-term expectation (Volume)	Macro and Micro	the likelihood that the project will generate and deliver CERs	(Wilder and Willis, 2007)	Expected accumulated 2020 $ktCO_2e$
long-term expectation (Volume), and project size	Macro and Micro	The likelihood that the project will generate and deliver CERs	(Bishop, 2007; Wilder and Willis, 2007)	Expected accumulated 2030 $ktCO_2e$
Financing	Micro	Production cost	(Gao and Li Liyan, 2007)	Project investment*
Seller	Macro	Carbon-related country risks; host country approval risk	(Ascui and Moura Costa, 2007; Bishop, 2007)	Project location
Project type	Micro	The nature of the project; Specific project influences; limited use of large-scale hydro and exclusion of CERs from forest from EU-ETS	(Bishop, 2007; Wilder and Willis, 2007)	Project type
Buyer	Macro	Buyers' level of sophistication, and the extent to which they provide an underlying debt or equity investment	(Palmisano, 2007; Wilder and Willis, 2007)	Project buyer
Legal contract	Macro and Micro	Contract for CERs are highly heterogenous [2]	(Bishop, 2007)	Emission Reduction Purchase Agreement (ERPA)
Year	Macro	General economy variation	(Koch et al., 2014)	Year of the ERPA

Note: *Total investment cost

[2] Because of the heterogenous of the contract, therefore CER were traded in a wider price range. It is important to include the ERPA data in the model to control for the variability.

Supplementary Table 8. Covariate balancing check between the control group and the treatment group.

(a) Before matching

	Mean in treated (GS projects)	Mean in Untreated (Regular projects)	Standardized diff.
1st period $ktCO_2e$/yr	80.28	133.87	-0.317
Years of projects	8.24	7.45	0.608
Expected accumulated 2020 $ktCO_2e$	739.63	1228.90	-0.313
Expected accumulated 2030 $ktCO_2e$	1278.00	2345.72	-0.365
Project investment	70.85	56.27	0.070

(b) Matching at both categorical and continuous covariates

	Mean in treated	Mean in Untreated	Standardized diff.
1st period $ktCO_2e$/yr	80.28	64.13	0.194
Years of projects	8.24	8.57	-0.223
Expected accumulated 2020 $ktCO_2e$	739.63	546.63	0.274
Expected accumulated 2030 $ktCO_2e$	1278.00	961.94	0.206
Project investment	70.85	26.88	0.219

(c) Matching at continuous covariates

	Mean in treated	Mean in Untreated	Standardized diff.
1st period $ktCO_2e$/yr	80.28	79.88	0.004 **
Years of projects	8.24	8.33	-0.064 *
Expected accumulated 2020 $ktCO_2e$	739.63	742.55	-0.003 ***
Expected accumulated 2030 $ktCO_2e$	1278.00	1202.95	0.037 **
Project investment	70.85	42.38	0.136

Note: Standardized differences (SD) are the standardized difference of means. *** SD <0.001, **SD<0.05, and *SD<0.1

Supplementary Table 9. Robustness check: effect of different co-benefits on CDM projects

Models	**Model 1**	**Model 2**	**Model 3**	**Model 4**
	Linear	Linear	Linear	Log-linear
Co-benefit 1	0	0	0	0
	(.)	(.)	(.)	(.)
Co-benefit 2	0.705*	2.536***	2.120***	0.126**
	(0.391)	(0.549)	(0.676)	(0.0503)
Co-benefit 3	0.924***	3.002***	2.445***	0.159***
	(0.342)	(0.549)	(0.697)	(0.0521)
Co-benefit 4	2.013***	4.054***	3.492***	0.245***
	(0.169)	(0.473)	(0.641)	(0.0480)
Co-benefit 5	0.262	0.0956	0.634	0.0566
	(0.191)	(0.197)	(0.540)	(0.0403)
Co-benefit 6	1.463***	4.658***	4.640***	0.345***
	(0.383)	(0.745)	(0.727)	(0.0553)
Co-benefit 7	3.463***	4.865***	4.891***	0.276***
	(0.782)	(0.836)	(0.836)	(0.0618)
Co-benefit 8	0.681	4.344***	4.906***	0.371***
	(0.598)	(1.019)	(1.156)	(0.0862)
Year FE	Yes	Yes	Yes	Yes
Project Type FE	No	Yes	Yes	Yes
Project Location FE	Yes	Yes	Yes	Yes
Credit buyer FE	Yes	Yes	Yes	Yes
Project Size Dummy	No	No	Yes	Yes
Gold Standard	1.284***	1.627***	1.631***	0.0782**
	(0.470)	(0.470)	(0.470)	(0.0348)
No. of Observation	1744	1744	1744	1744
Adjusted R2	0.2887	0.2976	0.2983	0.3309

Note: The dependent variable in all the first three models is CER price and is natural log of CER price in Model 4. Coefficient estimates are reported in this table. We control for project location fixed effects, credit buyer fixed effects, project type fixed effects, and year fixed effects in the model.

* $p<0.10$ ** $p<0.05$ *** $p<0.01$

Supplementary Table 10. Robustness check: treatment effect of Gold Standard on CDM projects.

	Model 1	Model 2	Model 3	Model 4	Model 5
Models	Full regression	Propensity score matching with all 9 covariates	Propensity score matching at 5 continuous covariates	Exact matching on the credit buyers	Exact matching on the credit buyers and project location
TREAT	2.006**	3.697***	2.713***	2.338*	1.130*
	(0.847)	(1.078)	(0.964)	(1.180)	(0.616)
Year FE	yes	yes	yes	yes	yes
Type FE	yes	yes	yes	yes	yes
Credit buyer FE	no	no	no	no	no
Project location FE	yes	no	no	no	yes
No. of Observation	2251	378	378	294	126
TREAT	64	63	63	49	21
UNTREAT	2187	315	315	245	105
R Square	0.3307	0.9160	0.2996	0.2062	0.8327

Note: The dependent variable in all five models is CER price. Coefficient estimates are reported in this table, with standard errors in parentheses. Standard errors are clustered at credit buyers' company level. We control for project location fixed effects, credit buyer fixed effects, project type fixed effects, and year fixed effects in the model.
* p<0.10 ** p<0.05 *** p<0.01

Supplementary Table 11. Placebo test: treatment effect of Gold Standard on CDM projects.

Models	Model 1	Model 2	Model 3	Model 4	Model 5
	Full regression	Propensity score matching with all 9 covariates	Propensity score matching at 5 continuous covariates, combined regression	Exact matching on the credit buyers	Exact matching on the credit buyers and project location
TREAT	0.109	0.0259	-0.0526	-0.0274	-0.0375
	(0.0931)	(0.0982)	(0.120)	(-0.143)	(0.144)
Year FE	yes	yes	yes	yes	yes
Type FE	yes	yes	yes	yes	yes
Credit buyer FE	yes	yes	yes	yes	yes
Project location FE	yes	no	no	no	yes
No. of Observation	2195	378	378	294	126
TREAT	1098	63	63	49	21
UNTREAT	1097	315	315	245	105
R-squared	0.3097	0.3075	0.1863	0.4714	0.4182

Note: The dependent variable in all five models is CER price. Coefficient estimates are reported in this table, with standard errors in parentheses. Standard errors are clustered at credit buyers' company level. We control for project location fixed effects, credit buyer fixed effects, project type fixed effects, and year fixed effects in the model
Standard errors in parentheses
* p<0.10 ** p<0.05 *** p<0.01

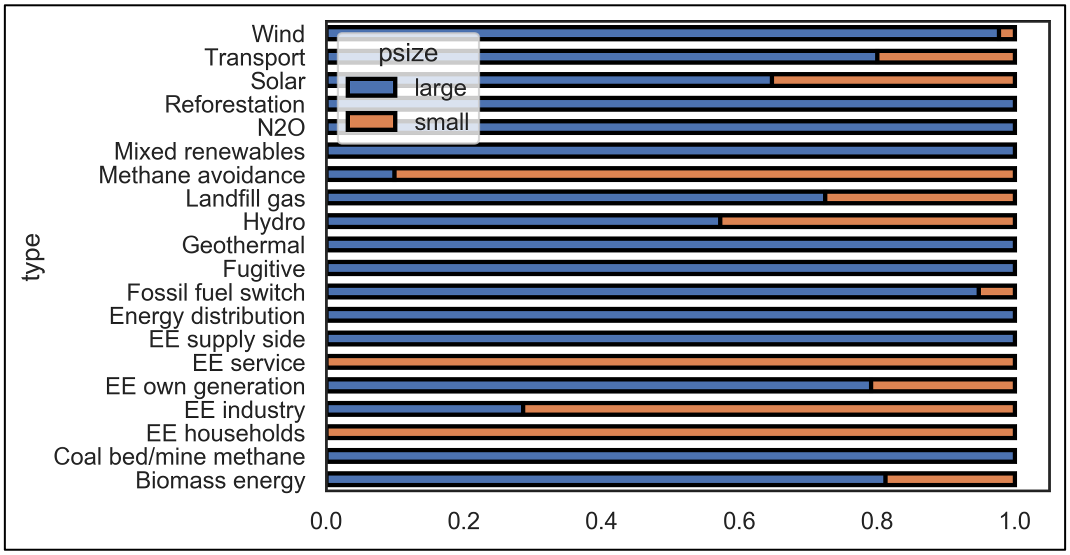
Supplementary Table 12. Effect of project features on CDM projects.

Models	Model 1	Model 2
type x size (0)	0 (.)	-2.253*** (0.743)
type x size (1)	2.253*** (0.743)	0 (.)
type x size (3)	-1.431 (2.339)	-3.684 (2.412)
type x size (4)	-0.470 (0.622)	-2.723*** (0.960)
type x size (5)	0.0130 (0.168)	-2.240*** (0.760)
type x size (6)	-0.759 (0.655)	-3.011*** (0.980)
type x size (7)	0.631 (0.893)	-1.621 (1.154)
type x size (8)	-0.648 (0.706)	-2.901*** (1.025)
type x size (9)	0.777 (0.554)	-1.476 (0.914)
Biomass energy	0 (.)	0 (.)
Coal bed/mine methane	-0.158 (0.510)	-0.158 (0.510)
EE households	0 (.)	0 (.)
EE own generation	-0.226 (0.437)	-0.226 (0.437)
Hydro	-0.705** (0.305)	-0.705** (0.305)
Landfill gas	-1.088** (0.458)	-1.088** (0.458)
Methane avoidance	-2.719*** (0.948)	-2.719*** (0.948)
Solar	0.0106 (0.523)	0.0106 (0.523)
Year FE	Yes	Yes
Project Location FE	Yes	Yes
Credit buyer FE	Yes	Yes
Wind	1.221*** (0.303)	1.221*** (0.303)
Gold Standard	2.096*** (0.409)	2.096*** (0.409)
Years of projects	0.0721 (0.0712)	0.0721 (0.0712)
Expected accumulated 2020 ktCO_2e	-0.000130 (0.000222)	-0.000130 (0.000222)
Expected accumulated 2030 ktCO_2e	-0.0000247 (0.0000775)	-0.0000247 (0.0000775)
Project investment (million USD)	0.00552*** (0.00144)	0.00552*** (0.00144)
Constant	10.99*** (2.885)	13.24*** (2.890)
Observations	2173	2173
Adjusted R2	0.3137	0.3137

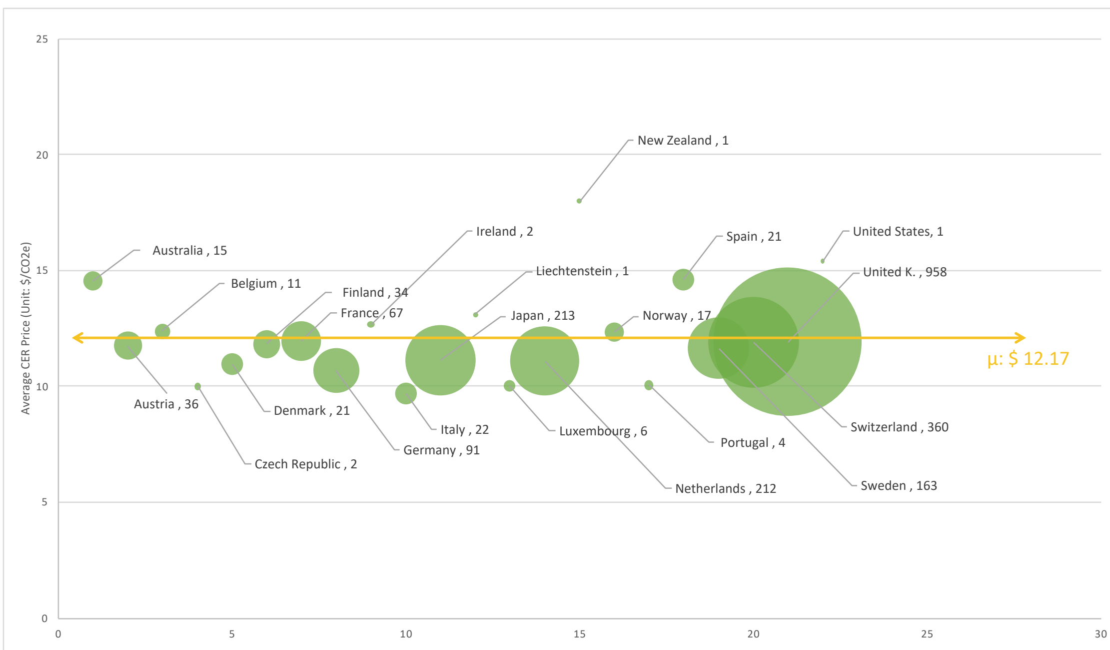
Note: The dependent variable in both models is CER price. Coefficient estimates are reported in this table. The base case in model 1 is type x size (0), and in model 2 is type x size (1). Size is a dummy variable, with large projects coded as 0, and small projects coded as 1. We control for project location fixed effects, credit buyer fixed effects, and year fixed effects in the model.
* p<0.10 ** p<0.05 *** p<0.01

Supplementary Table 13. Categorization of co-benefits of CDM projects

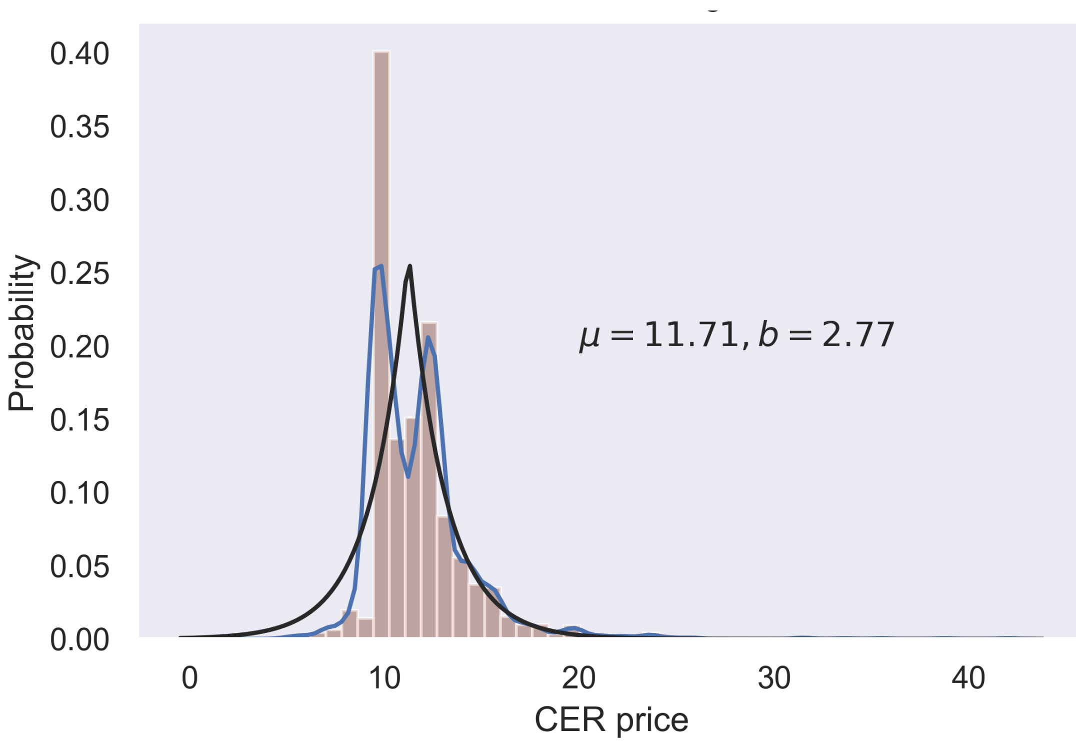
Ranking of Co-Benefits (1 is the least, 8 is the most)	Number of Projects	Project Type	Project Size
Co-benefit 1	680	Landfill gas	All
		Methane avoidance	All
		Hydro	Large
Co-benefit 2	98	EE Industry	Large
Co-benefit 3	69	Biomass energy	Large
Co-benefit 4	843	Wind	Large
Co-benefit 5	396	EE household	Small
		Hydro	Small
Co-benefit 6	55	Wind	Small
		Solar	Large
Co-benefit 7	16	Biomass energy	Small
Co-benefit 8	18	Solar	Small



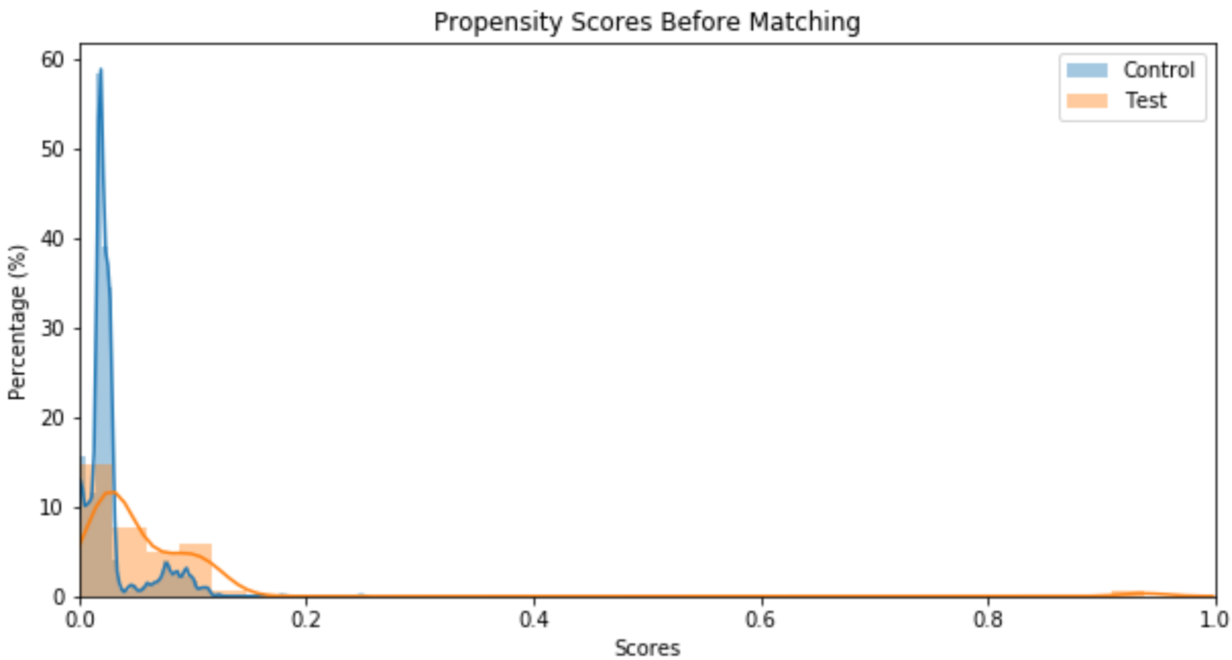
Supplementary Figure 7. CDM projects distribution based on project types and size.



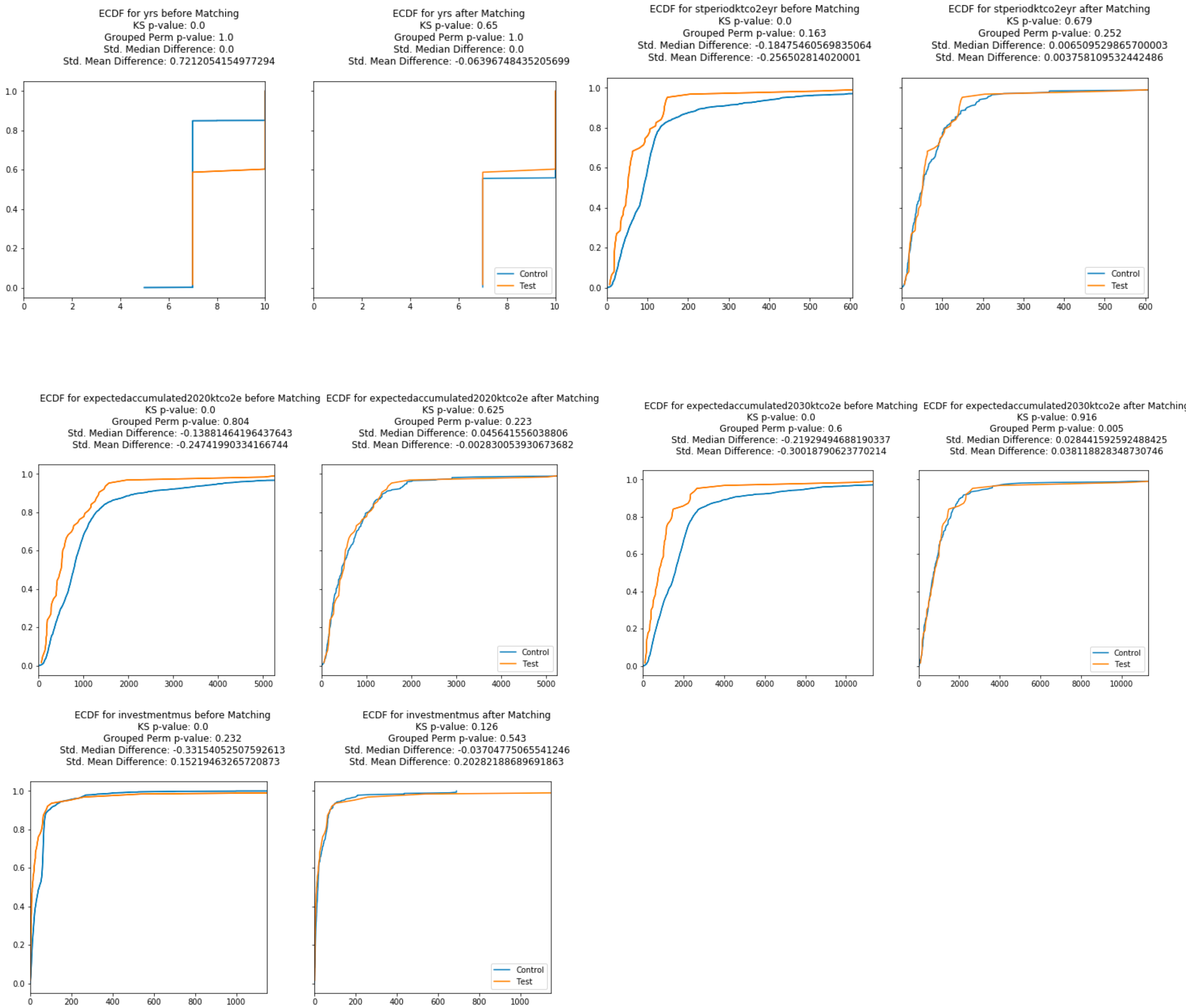
Supplementary Figure 8. Average price of CER and total number of projects by buyer's location. The average CER price of all countries is US$12.17 t/$CO_2$e. The size of the green circle indicates the number of projects hosted by each country. Note: the numbers in the labels are the number of projects purchased by each country



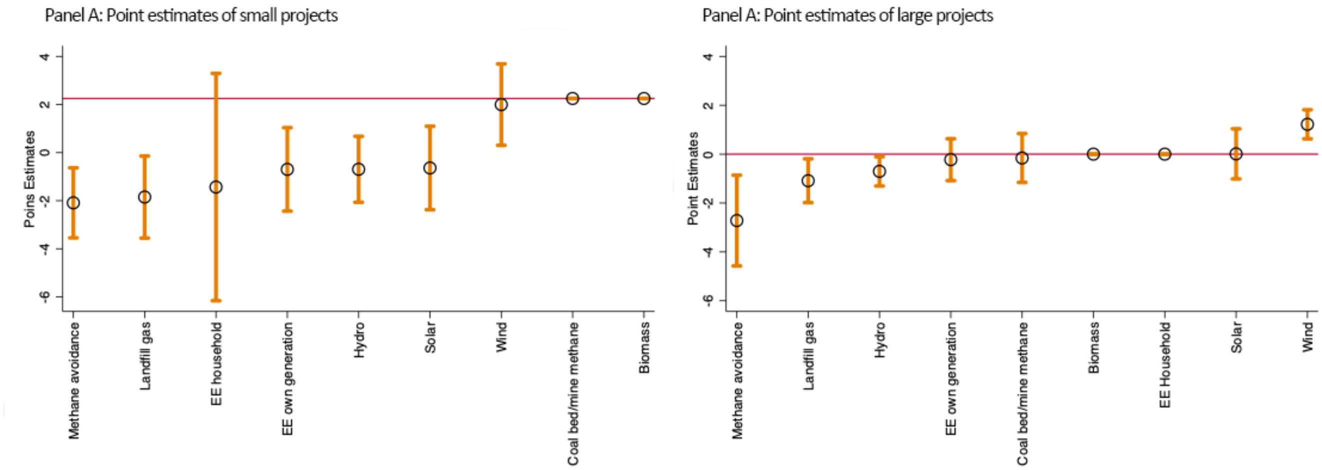
Supplementary Figure 9. Distribution of CER prices. The blue line indicates the kernel density estimation.



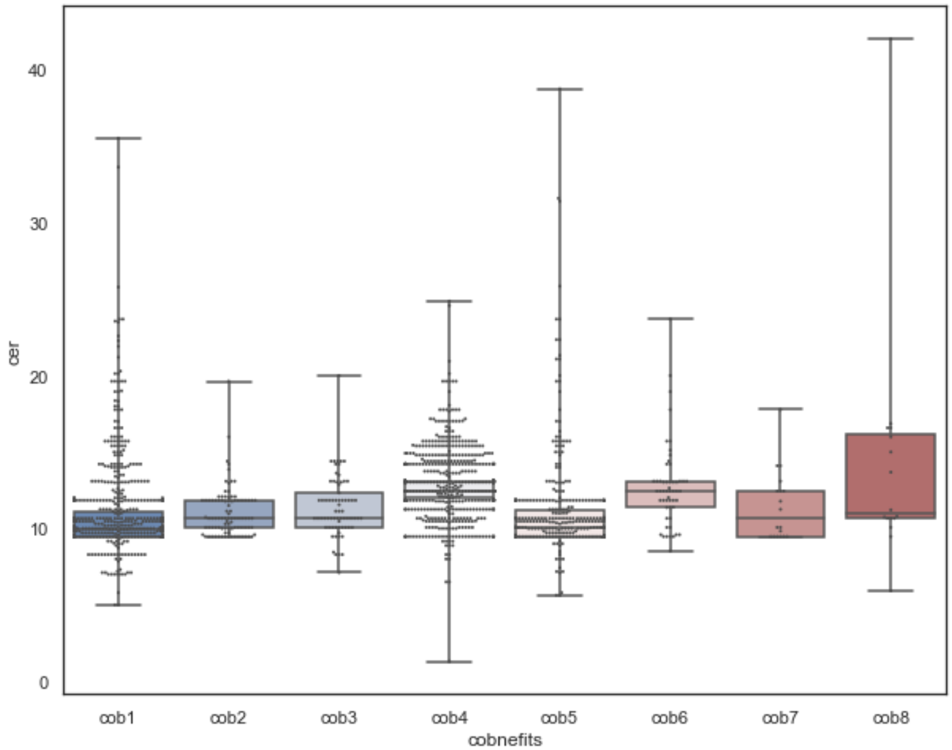
Supplementary Figure 10. Distribution of propensity score across treatment and comparison groups. This figure shows the “common support” area between the treatment and comparison groups.



Supplementary Figure 11. Diagnostic tests for balancing of covariates. Empirical cumulative distribution function (ECDF) for test vs ECDF for control **before** matching (left), ECDF for test vs ECDF for control **after** matching.



Supplementary Figure 12. Point estimates of project types on CERs based on project size. Base case in (a) and (b) is small biomass and large biomass project. We have added the price difference of \$2.25 between small-scale and large-scale biomass projects in (a), so the red horizontal line in (a) indicates the CER prices at \$2.25.



Supplementary Figure 13. Box plot of CERs by co-benefits. Small black dots are observation. The eight level of co-benefits are created based on the SDG-interaction score from **Supplementary Table 13.**