INVESTIGATING TURKEY’S ANNUAL OFFSET VOLUME FROM RENEWABLE ENERGY SECTOR AND VOLUNTARY CARBON PROJECTS

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ABSTRACT

INVESTIGATING TURKEY'S ANNUAL OFFSET VOLUME FROM RENEWABLE ENERGY SECTOR AND VOLUNTARY CARBON PROJECTS

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Turkey has a unique circumstance listed as an Annex I country of the United Nations Framework Convention and not listed as an Annex B country of the Kyoto Protocol. Due to this unique position, Turkey cannot benefit from flexible mechanisms and participated in the voluntary carbon market. Turkey has started to find alternative ways to reduce its GHG emissions cost-effectively.

In this study, Turkey's annual offset volume is studied with five main cases based on Turkey's renewable energy sector, all Turkish voluntary carbon projects, Turkish voluntary carbon projects eligible to issue carbon credits, and issued and transacted Turkish carbon credits with a bottom-up approach. First, it is found that the annual offset volume from the renewable energy sector for 2018 was more than 52 million tCO_2. Secondly, it is found that there are 436 Turkish voluntary carbon projects with a total annual offset volume equal to 33 million tCO_2. Furthermore, it is realized that only 187 of them are eligible to issue carbon credits equal to an annual offset volume of more than 14 million tCO_2. Lastly, it is calculated that the annual average issuance and transaction volume are respectively 3.6 and 2 million tCO_2 for the period between 2010-2019. The results show that more than half of the annual offset volume is unavailable due to the ineligible projects. The actual market volume is even less considering the issuance and transactions. It indicates a need to increase the demand for the credits by introducing a mandatory offsetting requirement.

Keywords: Voluntary Carbon Market, Voluntary Carbon Projects, Carbon Credits, Emission Reduction, Offset

ÖZ

YENİLENEBİLİR ENERJİ SEKTÖRÜ VE GÖNÜLLÜ KARBON PROJELERİNDEN TÜRKİYE'NİN YILLIK DENKLEŞTİRME HACMİNİN İNCELENMESİ

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Türkiye, Birleşmiş Milletler Çerçeve Sözleşmesi'nin Ek I ülkesi olarak listelenmiş ve Kyoto Protokolü Ek B ülkesi olarak listelenmediği benzersiz bir duruma sahiptir. Türkiye, bu benzersiz konumu nedeniyle esneklik mekanizmalardan yararlanamamakta ve gönüllü karbon piyasasına katılmaktadır. Türkiye, sera gazı emisyonlarını maliyet etkin bir şekilde azaltmak için alternatif yollar bulmaya başlamıştır.

Bu çalışmada Türkiye'nin yıllık denkleştirme hacmi, Türkiye'nin yenilenebilir enerji sektörüne, tüm Türk gönüllü karbon projelerine, karbon kredisi piyasaya sürmeye uygun Türk gönüllü karbon projelerine ve aşağıdan yukarıya bir yaklaşımla piyasaya sürülen ve işlem gören Türk karbon kredilerine dayalı beş ana durum altında incelenmiştir. İlk olarak, 2018 için yenilenebilir enerji sektörünün yıllık denkleştirme hacminin 52 milyon tCO_2'den fazla olduğu bulundu. İkinci olarak, yıllık toplam denkleştirme hacmi 33 milyon tCO_2'ye eşit olan 436 Türk gönüllü karbon projesi olduğu bulunmuştur. Ayrıca, bunlardan sadece 187'sinin yıllık 14 milyon tCO_2'yi aşan denkleştirme hacmine eşit karbon kredisini piyasaya sürmeye

uygun olduğu anlaşılmıştır. Son olarak, 2010-2019 dönemi için yıllık ortalama piyasaya sürülen ve işlem gören hacmin sırasıyla 3,6 ve 2 milyon tCO_2 olduğu hesaplanmıştır. Sonuçlar, uygun olmayan projeler nedeniyle yıllık denkleştirme hacminin yarısından daha fazlasının mevcut olmadığını göstermektedir. Piyasaya sürülen ve işlem gören hacim düşünüldüğünde gerçek piyasa hacmi daha da azdır. Bu da zorunlu bir denkleştirme gerekliliği getirerek kredi talebini artırma ihtiyacını gösterir.

Anahtar Kelimeler: Gönüllü Karbon Piyasası, Gönüllü Karbon Projeleri, Karbon Kredileri, Emisyon Azaltımı, Denkleştirme

To Gökhan and Güneş

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LIST OF ABBREVIATIONS

AAU	Assigned Amount Unit
BM	Build Margin
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CM	Combined Margin
COP	Conference of Parties
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
ERU	Emission Reduction Unit
ET	Emission Trading
EU	European Union
GHG	Greenhouse Gas
GS	Gold Standard
ICAO	International Civil Aviation Organisation
INDC	Intended Nationally Determined Contributions
ITMOs	International Transferred Mitigation Outcomes
JI	Joint Implementation
KP	Kyoto Protocol
LCMR	Low-Cost/Must-Run
MoENR	Ministry of Energy and Natural Resources
MoEU	Ministry of Environment and Urbanisation

NDC	Nationally Determined Contribution
OECD	Organisation for Economic Cooperation and Development
OM	Operating Margin
PA	Paris Agreement
SDG	Sustainable Development Goals
TETC	Turkish Electricity Transmission Cooperation
UNFCCC	United Nations Framework Convention on Climate Change
VCM	Voluntary Carbon Market
VCP	Voluntary Carbon Project
VCS	Verified Carbon Standard
VCUs	Verified Carbon Units
VER	Voluntary Emission Reduction
VVB	Validation & Verification Body

CHAPTER 1

INTRODUCTION

1.1 Background Information

The United Nations Framework Convention on Climate Change (UNFCCC) entered into force in 1994. As of 2020, 197 countries have ratified the UNFCCC to build international cooperation to combat climate change and its adverse effects ("History of the Convention | UNFCCC" n.d.). As stated in the UNFCCC, the ultimate goal of the Convention is the "stabilization of greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." While reaching this goal, the Convention gave the leading role to the Parties, developed countries, as per their "common but differentiated responsibilities and respective capabilities." The Convention has an Annex system, where the Parties are classified as either Annex I, Annex II, or non-Annex Parties. The Convention put the responsibility on Annex I countries to limit their GHG emissions to mitigate climate change. Furthermore, the Organisation for Economic Cooperation and Development (OECD) and the European Union (EU) countries formed the Annex II countries, which are also Annex I countries. They committed to providing financial and technical support to the non-Annex countries ("United Nations Framework Convention on Climate Change" 1992).

In 1997, the Kyoto Protocol (KP) was adopted to put the UNFCCC into operation by defining targets to the Parties. The KP entered into force in 2005 ("What Is the Kyoto Protocol? | UNFCCC" n.d.). The KP puts "quantified emission limitation or reduction commitment" to the countries listed in its Annex B ("Kyoto Protocol to the United Nations Framework Convention on Climate Change" 1997). In total, the emission reduction levels specified in Annex B of the KP reach 5% of emission reduction compared to 1990 levels for the first commitment period, which was between 2008 to 2012 (“What Is the Kyoto Protocol? | UNFCCC” n.d.). The KP allowed Annex B countries to use “flexible market mechanisms” to maximize economic efficiency while meeting their emission reduction targets (Michaelowa, Shishlov, and Brescia 2019). These “flexible market mechanisms” are “International Emission Trading (ET),” “Joint Implementation (JI),” and “Clean Development Mechanism (CDM)” (“What Is the Kyoto Protocol? | UNFCCC” n.d.). In general, these mechanisms are also called “carbon markets” with compliance.

As a member country of the OECD, together with other member countries, Turkey was listed as an Annex I and Annex II country of the UNFCCC. Thus, Turkey was responsible for providing financial support, technology transfer, and reducing GHG emissions. However, Turkey had an exceptional circumstance of being at an early industrialization stage (Turhan et al. 2016). Between 1992 and 2004, the average of Turkey’s CO_2 emissions (metric tons per capita) was 3.11, and the average of OECD member countries’ was 10.83 (“CO2 Emissions (Metric Tons per Capita) - Turkey, OECD Members | Data” n.d.). Due to this reason, the Parties of the UNFCCC realized Turkey’s special circumstance, and Turkey was de-listed from Annex-II at the 7th Conference of Parties (COP) in Marrakech in 2001. Then in 2004, Turkey became a Party of the UNFCCC. However, within that period, the KP was adopted in 1997 and entered into force in 2005. Thus, when the KP was adopted, Turkey was not a Party of the UNFCCC. As a result, Turkey was not included under Annex B of the KP (Alkan-Olsson and Alkan-Olsson 2012). While Turkey was listed as an Annex I country that is a Party of the UNFCCC, Turkey was not listed as an Annex B country in the KP, which did not put any binding emission reduction targets (Ari 2013). After all of this, Turkey gained a unique position, where it is listed as Annex I country of the UNFCCC and not listed as Annex B country of the KP.

While the KP's second commitment period was coming to an end, the Paris Agreement (PA) was negotiated by the representatives of 196 countries at the COP-21 in Paris and adopted by the consensus on the 12th of December 2015. The

Agreement entered into force in 2016 with the ratification of 51 Parties ("The Paris Agreement | UNFCCC" n.d.; Streck, Keenlyside, and Unger 2016). Unlike the UNFCCC, the PA does not classify countries as Annex I or Annex II countries, but it refers to developing and developed countries. However, there is no defined differentiation between developing and developed countries in the Agreement. Like the KP, the PA realizes the principle of "common but differentiated responsibilities and respective capabilities." While the KP was putting binding emission reduction targets only over the Annex I countries, the PA stresses all countries to control their future emissions (Clémençon 2016). In this regard, Article 4 states that "Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions." In terms of market and non-market mechanisms, Article 6 stands out the most. Article 6 enables international collaboration and countries to meet their nationally determined contribution (NDC) targets cost-effectively (Michaelowa, Shishlov, and Brescia 2019).

On the 30th of September 2015, before attending the COP-21 in Paris, Turkey submitted her intended nationally determined contributions (INDC) to the UNFCCC by pledging up to 21% emission reduction from the business as usual scenario by 2030, which is expected to be 1.175 million tCO_2 in 2030 ("Republic of Turkey Intended Nationally Determined Contibution" 2015).

While the UNFCCC puts binding emission reduction targets on the Parties and the PA stresses emission reduction for all countries, global GHG emissions continued rising. In 2018, global GHG emissions due to electricity and heat production were 13,978,000,000 tCO_2, accounting for 42% of the total global GHG emissions ("Data & Statistics - IEA" n.d.).

Meanwhile, in 2018, Turkey's GHG emissions from electricity production increased to 158,490,439 tCO_2. This amount accounts for 30% of the total GHG emissions ("National Inventory Submissions 2020 | UNFCCC" n.d.). Figure 1.1 illustrates the sectoral GHG emission distribution of Turkey for 2018.

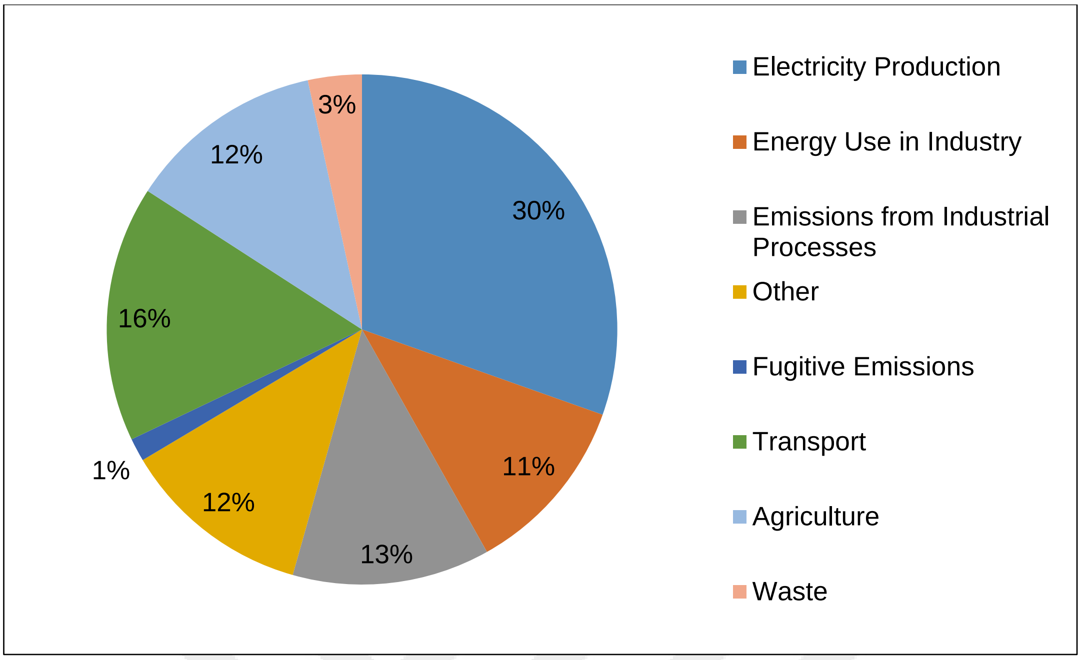


Figure 1.1. Sectoral distribution of Turkey's GHG emissions ("National Inventory Submissions 2020 | UNFCCC" n.d.)

As given in Figure 1.1, energy and industry-related emissions cover 54% of Turkey's total GHG emissions. Compared to 1990 levels, GHG emissions from electricity production have increased by 425%, and total GHG emissions have risen by 261%.

While the energy-related GHG emissions are growing, Turkey's annual electricity generation has been increased by 530% compared to 1990 levels (Turkish Electricity Transmission Cooperation 2018c), as illustrated in Figure 1.2.

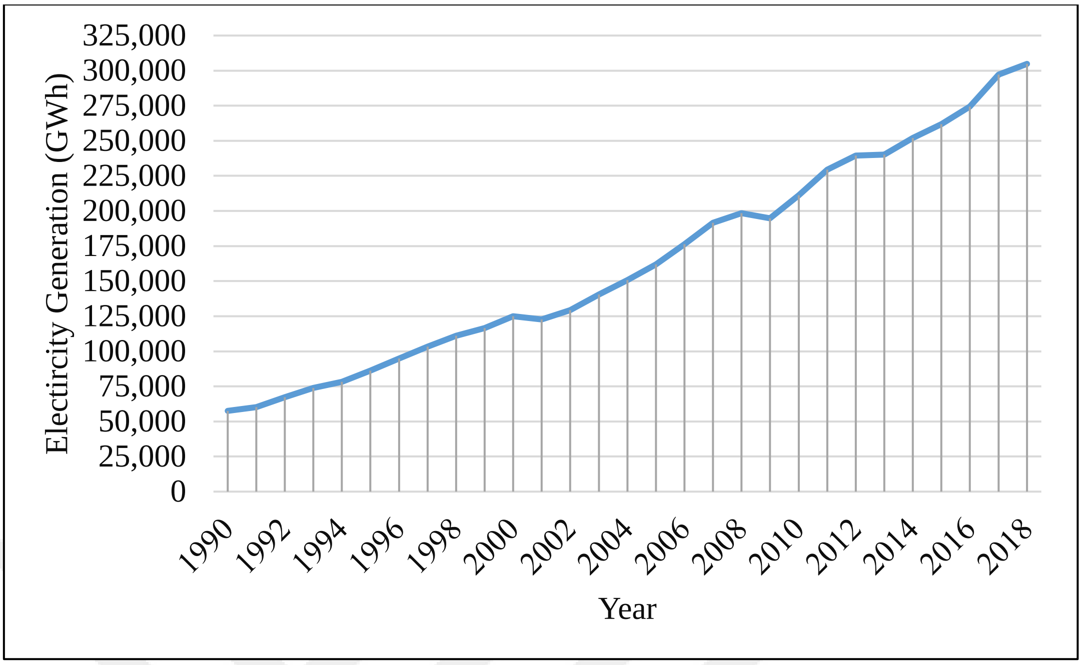


Figure 1.2. Annual development of Turkey's electricity generation (GWh) between 1990-2018 (Turkish Electricity Transmission Cooperation 2018c)

As Turkey's annual electricity generation has been increased by 530% compared to 1990 levels, GHG emissions from electricity production have been increased only by 425% (Turkish Electricity Transmission Cooperation 2018c; "National Inventory Submissions 2020 | UNFCCC" n.d.). The main reason behind it is the emission reduction obtained by renewable energy. Figure 1.3 presents the annual electricity generation by the main sources in years.

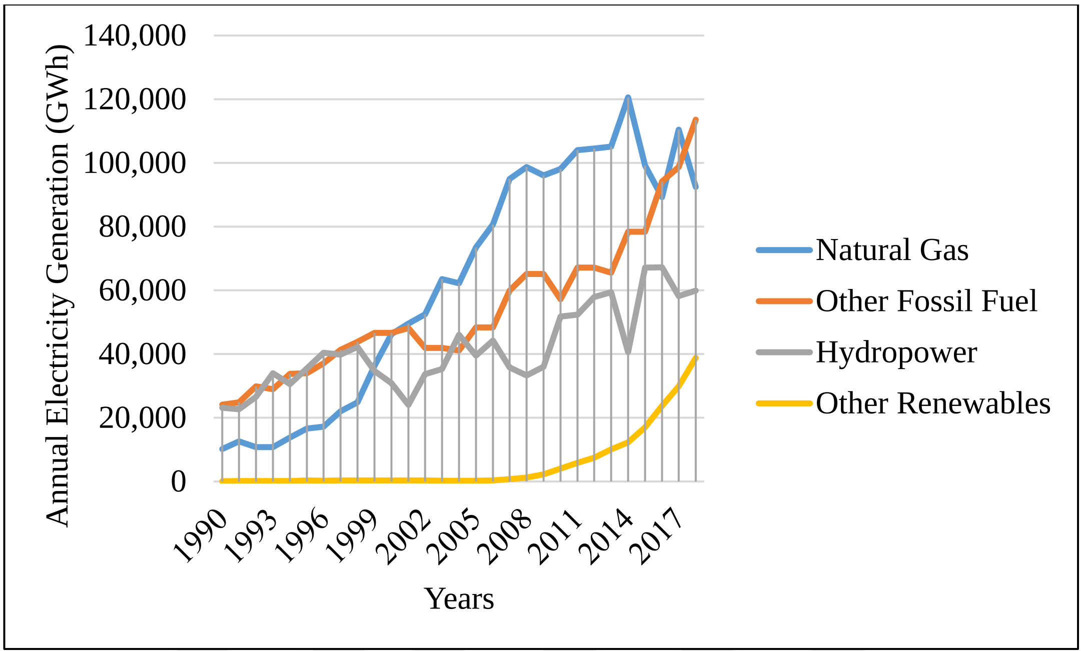


Figure 1.3. Annual development of Turkey's electricity generation (GWh) by main sources between 1990-2018 (Turkish Electricity Transmission Cooperation 2018c)

Figure 1.3 classifies the main sources as natural gas, other fossil fuels that include thermal, fuel oil and diesel oil, hydropower; and other renewables, including wind power, geothermal, solar, waste, and waste heat. Other fossil fuels are dominated by thermal, and wind power dominates the other renewables category. Until 2000, the mix was mainly dominated by hydropower and other fossil fuels. After 2000, the electricity generation from natural gas increased sharply and dominated the mix in 2014 with a 48% share. Until 2007, the share of other renewables was less than 1%. However, it was increased to 13% in 2018, mainly due to the investment in wind power plants.

In 2018, the total share of renewable energy in electricity generation was 32.4% (Turkish Electricity Transmission Cooperation 2018c). Figure 1.4 gives the fuel share in electricity generation in 2018.

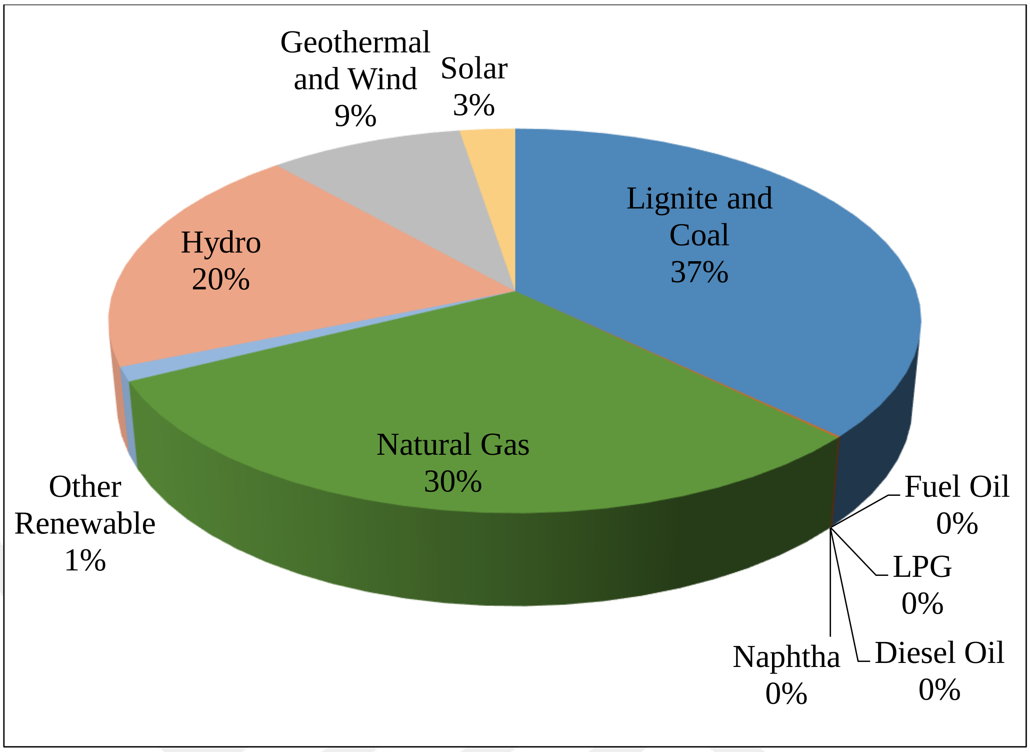


Figure 1.4. Fuel share in electricity generation in 2018 (Turkish Electricity Transmission Cooperation 2018c)

Due to its unique position as being listed as Annex I country of the UNFCCC and not listed as Annex B country of the KP, Turkey has started to find alternative ways to reduce its GHG emissions cost-effectively. Some of the Turkish renewable energy projects have been registered as "voluntary carbon projects" (VCP) and benefited from the "voluntary carbon market" (VCM) by selling their issued carbon credits at the market.

1.2 Problem Definition

As illustrated in Figure 1.1, GHG emissions from electricity generation have the largest share in Turkey's GHG emissions. With renewable energy, electricity generation also holds the highest emission reduction potential among other sectors.

As a result, Turkey has a high emission reduction potential in the VCM, in other words, a high carbon credit supply due to this high renewable energy share.

There are reports and studies calculating the emission reduction potential of the Turkish VCM, in other words, annual carbon credit supply potential. First of all, these studies estimate the potential with a top-down approach by using the data obtained from the registry systems of the VCM Standards. None of these studies investigate every / each VCP from Turkey with a bottom-up approach to understand and examine the current status of the VCM in Turkey. Secondly, not all VCPs registered in Standards such as Gold Standard (GS) and Verified Carbon Standard (VCS) are eligible to issue carbon credits due to strict restricting rules of the Standards. Even though a project applied to a Standard to benefit from the VCM, it does not necessarily mean that it would be eligible to issue carbon credits. There are many steps to be taken to achieve that status, which is also temporary. None of these studies and reports discuss the eligibility of these VCPs to issue carbon credits, which directly affects the annual emission reduction potential and the supply potential. As a result, the annual offset volume is over-calculated, and the resulting value is misleading. Therefore, a bottom-up approach is vital to calculate the exact offset volume. This mentioned bottom-up approach is what makes this thesis topic so unique and one of its kind. This is the first thesis that calculates the offset volume of all VCPs and only eligible ones with a bottom-up approach.

This thesis estimates the annual offset volume from the renewable energy sector by calculating Turkey’s electricity grid's emission factor as a first step. Afterward, it calculates the annual offset volume of all VCPs and the VCPs eligible to issue carbon credits. For that purpose, it reviews the VCPs and differentiates them as eligible or ineligible to issue carbon credits. When the VCPs are not distinguished, the emission reduction potential and the carbon credit supply will not reflect the actual situation, which creates a significant problem.

Moreover, this study calculates Turkey’s annual issued and transacted carbon credits from the VCPs to reflect the actual supply and demand of the VCM.

1.3 The Objective of the Study

This thesis's research question is: “What is Turkey's annual offset volume from the renewable energy sector and the VCPs at the carbon market?”. In addition to that, the study's main objective is determining the annual offset volume with five main cases that depend on renewable energy as a whole, all Turkish VCPs, VCPs that are eligible to issue carbon credits, and issued and transacted carbon credits at the VCM from Turkish VCPs.

While determining the annual offset volume under these five main cases, this thesis estimates Turkey’s electricity grid's emission factor to calculate the annual offset volume from the renewable energy sector. Furthermore, this thesis calculates the annual offset volume from all VCPs and VCPs eligible to issue carbon credits with a bottom-up approach that makes this study one of its kind. Furthermore, this thesis aims to investigate:

- Emission reduction potential of VCPs by renewable types,
- Issued carbon credits by years,
- Transaction volume by years.

1.4 Scope of the Study

This study's primary objective is determining Turkey's annual offset volume from the renewable energy sector and the VCPs with five main cases based on renewable energy as a whole, all Turkish VCPs, VCPs that are eligible to issue carbon credits, and issued and transacted carbon credits at the VCM from Turkish VCPs.

While determining the annual offset volume from the renewable energy sector, the total annual emission reduction of Turkish renewable energy projects is estimated from the emission factor of Turkey’s grid and the annual electricity generation from the renewable sector. The emission factor of Turkey’s grid is calculated as per the

CDM Guideline for grid-connected electricity generation from renewable sources for 2018.

Under the VCM, the two most used Standards are GS and VCS (Hermwille and Kreibich 2016b). In Turkey, VCPs are either registered under GS or VCS. As one of the cases is based on the annual offset volume from all VCPs, the thesis calculated the annual emission reduction potential of the VCPs from GS and VCS. For that purpose, all VCPs are taken from these two standards' project databases, registries. Subsequently, Turkish VCPs are examined, and classifications are made according to the projects' annual estimated reduction volumes and renewable energy types. Then, by reviewing each project's project documents one by one, projects eligible to issue carbon credits are identified and used to calculate the market's actual emission reduction potential, which is another objective of this thesis.

Lastly, the remaining two cases were based on determining the annual offset volume from the VCM. For that purpose, the issued and the transacted carbon credits are taken from these two standards' project databases. Then, the Turkish projects are filtered from that list. As a result, the issued and the transacted Turkish carbon credits are obtained, consisting of this study's last objective. Lastly, the data and information are obtained from the Standards' registry systems on 23/06/2020. As a result, the results are all as of 23/06/2020.

1.5 Structure of the Study

Chapter 2 of this thesis consists of an overview of the literature research done on carbon pricing, the VCM, and the PA. It elaborates on the flexible market mechanisms of the KP. It also presents a conceptual framework of global VCM. It elaborates on the foundation and the project cycles of the GS and VCS. Furthermore, it gives the studies on the Turkish VCM. This chapter also gives the recent developments on the market's supply side. Lastly, it focuses on Article 6 of the PA.

Chapter 3 focuses on the case development for Turkey's annual offset volume from domestic renewable energy power plants and the VCPs. It holds five cases and includes the rationale behind the selection.

Chapter 4 is the overview of the data related to electricity generation, fossil fuel consumptions, installation-based installed power, and electricity generation. Furthermore, this chapter gives the data and information sources related to the GS and VCS projects, the annual issuances, and transactions.

Chapter 5 is on the methodologies and methods used to calculate the annual offset volumes under each case. For that purpose, it gives the methodology of estimating the CO_2 emission factor of Turkey's electricity system by using CDM's "Tool to calculate the emission factor for an electricity system." Furthermore, this chapter includes the method calculation of annual emission reduction from VCPs and estimating the annual issuances and transactions of the VCM.

Chapter 6 presented the results of the study. The annual offset volumes resulting from each case are given as a result. In addition to these five results, Turkey's emission factor of the grid is also included in this chapter. Regarding the VCPs, the following results are covered under this chapter as well: corrected annual estimated emission reductions from GS and VCS projects along with the number of projects; corrected annual estimated emission reductions from only registered GS and VCS projects eligible to issue carbon credits, and the number of projects; issuances and transactions of GS and VCS projects between 2008-2020.

Chapter 7 presents the discussion based on the deductions made over the results.

Chapter 8 gives the conclusion of the thesis and recommendations for future works.

CHAPTER 2

CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1 Overview

This chapter consists of three sections. The first section presents carbon pricing by focusing on the flexible mechanisms introduced by the KP. It elaborates the CDM, the project-based mechanism.

Then, the second section thoroughly presents the VCM that emerged, in addition to KP's flexible mechanism. After the general introduction, it gives the detailed project cycle of GS and VCS. Then, it gives Turkey's position in the VCM.

The third and the last section introduces the PA and elaborates on Article 6.

2.2 Carbon Pricing

Parties to the KP that has commitments to reduce their GHG emissions are expected to meet their targets through national measures. Besides these national measures, the KP introduced three market-based mechanisms as the flexible mechanism, what is now called as "carbon market" (Erdogdu 2010a). Carbon markets intend to help countries meet their targets in a cost-effective way, encourage the private sector to reduce their GHG emissions, stimulate sustainable development, technology transfer, and investment in developing countries (Murphy, Drexhage, and Wooders 2009).

JI, a project-based mechanism like the CDM, allows an Annex B country to implement an emission reduction project in another Annex B country to acquire emission reduction units (ERUs), which are equivalent to 1 tonne of CO_2 to meet their KP target (Erdogdu 2010b; Michaelowa et al. 2019). The JI aims to increase the market efficiency by allowing Annex B countries to fulfill their KP obligations through investing projects in other Annex B countries that have a lower abatement cost (Murphy, Drexhage, and Wooders 2009).

The second flexible market mechanism, ET, allows Annex B countries with emissions lower than their target to trade assigned amount units (AAUs), which are equivalent to 1 tonne of CO_2. An Annex B country is allowed to sell the unused and excess AAUs to other Annex B countries that need AAUs ("Emissions Trading | UNFCCC" n.d.; Erdogdu 2010b). As two examples for the AAU transfer, the Czech Republic sold 40 million AAUs to Japan in March 2009, and Latvia sold 2 million AAUs to Austria in early 2009 (Murphy, Drexhage, and Wooders 2009).

Through CDM, Annex B countries, which have emission reduction or limitation targets, are allowed to fulfill their commitments by purchasing certified emission reductions (CERs), which are equivalent to 1 tonne of CO_2, from emission reduction projects in non-Annex B countries. This mechanism gives the Annex B countries flexibility of meeting their emission reduction or limitation, in other words, KP targets. CDM is a project-based mechanism where the emission reductions are achieved from the projects located in developing countries (Erdogdu 2010a).

CDM has two goals. One of them is helping Annex B countries cost-effectively limiting GHG emissions and secondly helping developing countries achieve sustainable development (Murphy, Drexhage, and Wooders 2009). The CDM is governed under the UNFCCC, which includes the CDM Executive Board for carbon offset governance (Lovell 2010). Until 2019, more than 7800 projects were registered as CDM projects, and more than 1.9 billion CERs were issued (Michaelowa et al. 2019).

Most of the crediting mechanisms ensure environmental integrity, which is that global GHG emissions should not increase due to the crediting mechanisms. For instance, the CDM requires all emission reductions to be "real, measurable and additional to any that would occur in the absence of the certified project activity" (Michaelowa et al. 2019). All CDM projects need to be compatible with their sustainable development objectives (Murphy, Drexhage, and Wooders 2009).

In the context of project-based mechanisms, the baseline is the reference scenario that indicates the GHG emissions would most likely have occurred in the absence of the proposed project. Additionality indicates that the project would not happen anyway in the absence of revenue from the sale of the carbon credits (Michaelowa, Shishlov, and Brescia 2019; Michaelowa et al. 2019). There are three primary ways to assess the additionality of the proposed projects. The first one is the investment analysis that demonstrates the proposed project activity is not economically viable without the revenue. The second one is the barrier analysis that demonstrates the project activity is economically attractive however faces prohibited barriers. The last one is the positive lists, negative lists, eligibility criteria, and decision trees that draw the limits of the additionality (Michaelowa et al. 2019).

2.3 Voluntary Carbon Market

In addition to the regulatory and mandatory carbon market consist of the ET, JI, and the CDM, which was established with the KP, the VCM has been developed without international oversight (Başsüllü and Tolunay 2014; Hermwille and Kreibich 2016a). The VCM enables businesses and individuals seeking to offset their GHG emissions. The VCM has grown independently of the international KP, and anyone could generate and consume voluntary offsets (Lovell 2010). Projects from different sectors such as forestry, energy efficiency, renewable energy, and waste acquire Voluntary Emission Reduction (VER) units equivalent to 1 tonne of CO_2 for the reduced amount of GHG emissions. VERs are traded in the VCM and exchanged in the over-the-counter market (Başsüllü and Tolunay 2014).

While the CDM Executive Board governs the CDM market, the VCM has no international oversight and involves privately organized carbon crediting schemes

(Hermwille and Kreibich 2016a; Lovell 2010). Although international voluntary standards are outside of the UNFCCC, they have their centralized governing bodies. For instance, GS has GS Foundation Board, and VCS has VCS Board (Michaelowa et al. 2019). The VCM has evolved outside of the United Nations climate change mechanism and also an example of a private sector mechanism. However, it would be affected by the PA (Lang, Blum, and Leipold 2019).

The international compliance market demand was driven by either countries that have binding quantified emission reduction targets under the KP and/or the PA or private entities that have legal obligations to fulfill. In 2018, 98.4 million carbon offsets were transacted with a market value of 295.7 million USD (Donofrio et al. 2019).

Like the CDM putting sustainable development into its main two objectives, the VCM has also acknowledged sustainable development in its principles. For example, GS claiming to be a standard for "global goals" and mandating the projects demonstrate their contribution to at least three sustainable development goals (SDGs), including SDG13 on climate action.

In 2003, GS had been founded with close collaboration between technical and policy experts from civil society, governments, multilateral organizations, and the private sector. GS aims to meet the need for a system that could identify and encourage well-designed activities as the sources for credible GHG reductions that maximize broader sustainable development outcomes ("FAQs | The Gold Standard" n.d.). Verra, founded in 2005, manages the VCS Programme launched in 2006. VCS Programme allows certified projects to generate tradable carbon credits from their GHG emission reductions and removals ("Who We Are - Verra" n.d.). The issued credits from VCS and GS projects account for 86% of the total issuances of the first quarter of 2018. Similarly, the transacted credits from them account for 93% in the first quarter (Hamrick and Gallant 2018).

The VCM functions just like the CDM. The project cycle of GS and VCS, the two most used standards, almost have almost an identical project cycle that consists of 4 steps: Listing, validation, registration, and verification. Figure 2.1 shows the steps to be taken to become a GS registered project and VCS registered project. The right-hand-side shows the VCS cycle, whereas the left-hand-side shows the GS project cycle.

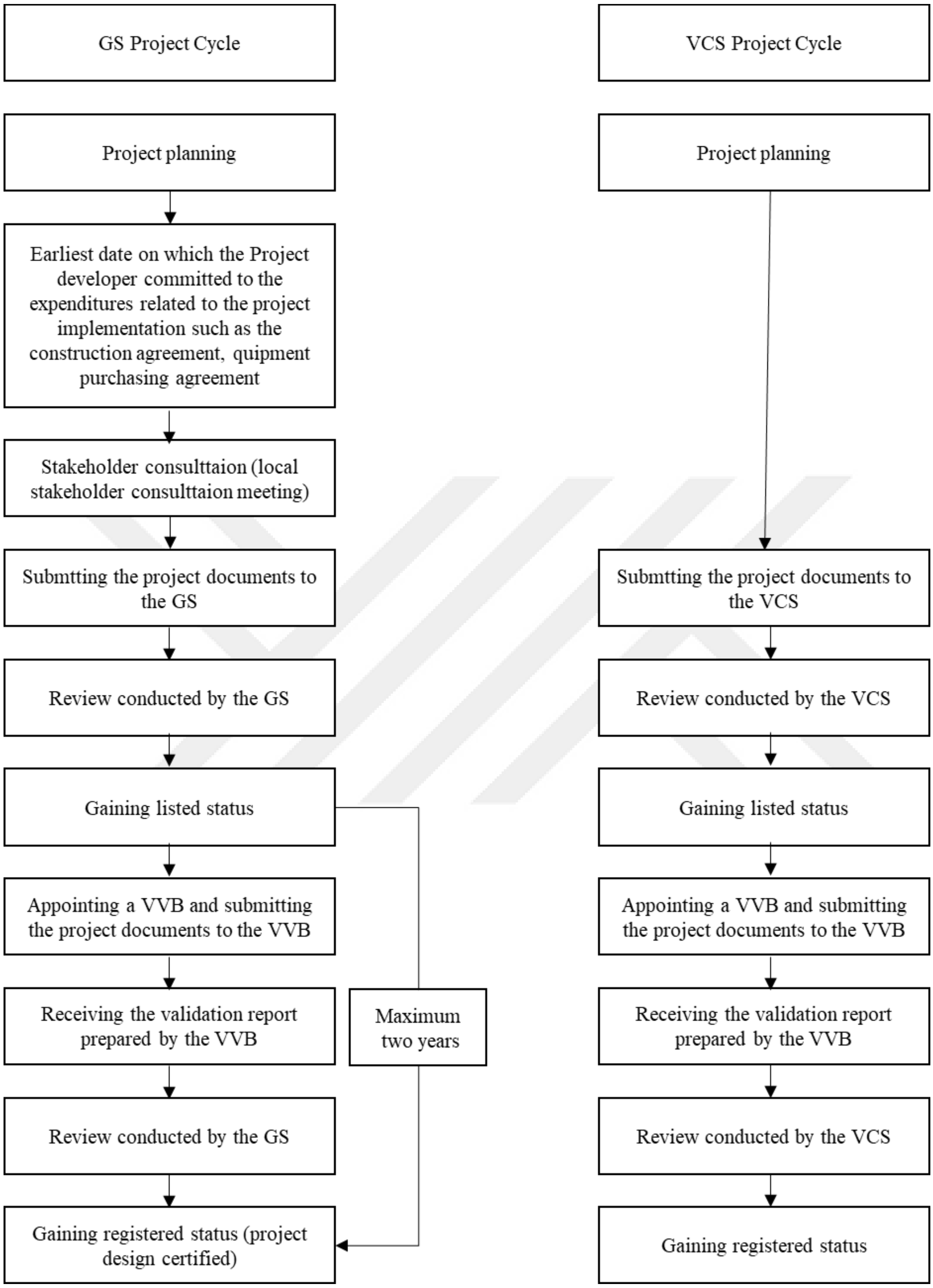


Figure 2.1. GS and VCS project cycles for the listing, validation, and registration

As shown in Figure 2.1, GS has more initials steps to be followed compared to the VCS. Projects seeking to gain the listed status need to conduct a stakeholder consultation first. This step is not included in the VCS project cycle. The stakeholder consultation, in other words, the local stakeholder consultation meeting, shall be conducted, and the time of the first submission should not be later than the earliest date on which the project developer has committed to expenditures related to the implementation of the project. For instance, it could be the signature date of the construction agreement or the equipment purchase agreement. This time restriction indicates that ideally, projects need to conduct the stakeholder consultation prior to the project implementation to reflect the stakeholder comments to the project design.

Once the stakeholder consultation is over, then the project documents are submitted to the GS. Upon GS's review process, the successful projects gain listed status. For the VCS side, project documents are submitted to the VCS and upon a review, the successful projects gain the listed status. Then, only the listed projects can pursue the steps for validation.

The next step is to gain validated status. For that purpose, in both VCS and GS project cycles, the project developer appoints a Validation&Verification Body (VVB). The required project documents must be submitted to the VVB for their review, and a site visit must be conducted. After the review period, based on the site visit and the finalized project documents, the VVB issues a validation report. At the end of this process, the project gains a validated status.

As a final step, both the GS and VCS review the validated project documents, and after a review period, the successful projects are registered. The registration is the most significant step for projects since only registered projects are eligible to issue carbon credits based on their GHG emission reduction or removals just for their crediting period. The crediting period, which varies from 5 to 10 years, means the allowed time period for projects to issue carbon credits. When a project's crediting period comes to an end, the project must apply to renew its crediting period. Otherwise, it would not be eligible to conduct verification to issue credits for the years after the crediting period. Apart from the stakeholder consultation, there is another significant time restrain for the GS projects. GS projects need to gain the registered status within two years of the date of listing. For VCS projects, the only time limitation is that project shall complete validation within two years of the date on which the project began generating GHG emission reductions or removals.

After gaining the registered status, the next step for the projects is verification. Figure 2.2 presents the VCS and GS project cycles for the verification process.

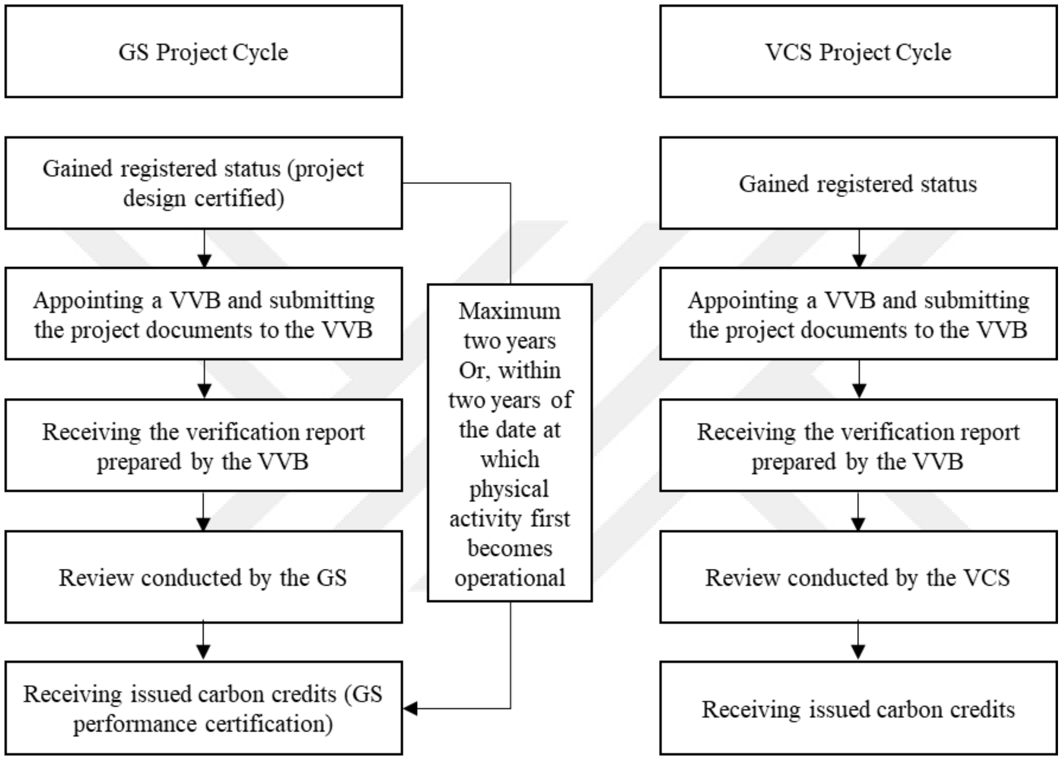


Figure 2.2. GS and VCS project cycles for the verification

As illustrated in Figure 2.2, GS and VCS have the same cycle for verification. There is only one difference between them, which is the time limitation put for the GS projects. As the first step, the project developer shall appoint a VVB for verification. The required project documents must then be submitted to the VVB for their review, and a site visit must be conducted. Upon receiving a verification report for the finalized project documents from the VVB, both GS and VCS conduct a review process for these documents. At the end of this review period conducted by the Standard, the claimed credits are issued by the Standard. In other words, the project must complete verification for their ex-ante GHG emission reductions or removals to issue carbon credits for their registered crediting period. As discussed, the GS verification project cycle has time constrain. Projects must complete their first verification within two years of either the project registration date or the date at which physical activity first becomes operational. An example of physical activity first becomes operation, could be the first date of starting electricity generation.

Due to Turkey's unique position and not being eligible to benefit from CDM and generate CERs, Turkey turned its face to the VCM and has been participating in the VCM. Ministry of Environment and Urbanisation (MoEU) published "The Communique on the Registry of Voluntary Carbon Projects," and it came into force on the 9th of October 2013. This Communique sets the procedures and principles to record the VCPs that are registered to a Standard. However, it does not establish the procedures and principles to track the issued credits or transactions. The most important feature of this Communique is that it is entirely voluntary and not prepared to fulfill a national or international obligation.

GS announced its new renewable energy eligibility criteria in 2018 and published it in 2019. Due to these new eligibility criteria, the upper-middle and higher-income countries, as per World Bank's classification, are no longer eligible to issue GS carbon credits. Furthermore, a country where the penetration level of the implemented renewable electricity technology is greater than 5% of the total grid installed capacity is no longer eligible to issue GS carbon credits ("Renewable Energy Eligibility Criteria | The Gold Standard" n.d.). Similar to the new eligibility rules of GS, VCS announced its new draft eligibility rules in 2018 and published them in 2019. The new eligibility criteria of VCS makes non-least developed countries ineligible to issue carbon credits from the project activities from grid-connected electricity generation ("VCS Version 4 - Verra" n.d.). As a result, no new renewable energy projects, such as hydropower or wind energy projects, from Turkey will be registered as GS or VCS projects, and the existing GS and VCS projects will continue issuing credits.

In the literature, there are four sources of studies evaluating Turkish VCPs. According to the first study, there were 308 VCPs in Turkey under GS and VCS with an annual estimated emission reduction of 20,605,688 tCO_2. Table 2.1 lists the VCPs according to the project type and gives the number of projects and the annual estimated emission reduction potentials as of 18/04/2014 (Urbanisation. n.d.).

Table 2.1. Turkish VCPs covering GS and VCS projects and their annual estimated emission reduction potentials (as of 18/04/2014) (Urbanisation. n.d.)

Project Type	Number	Annual Estimated Emission Reduction (tCO_2)
Hydropower	159	8,747,634
Wind Power	106	7,951,391
Landfill and Biogas	27	3,069,273
Energy Efficiency	10	432,081
Geothermal	6	405,309
Total	308	20,605,688

As per the table, in 2014, the total annual offset volume by the VCPs was over 20 million. However, this study does not give the breakdown of the offset potential by the Standards. Furthermore, it does not detail the project status, such as the registered or listed projects, or it does not consider the projects' eligibility to issue carbon credits.

The second study assesses the 2015 data. According to the study, as of August 2015, there were 108 VCS projects and 243 GS projects. While the majority of the Turkish VCS projects consist of hydropower projects, their annual emission reduction potential is 8,428,897 tCO_2. On the other hand, the most developed GS projects are from wind projects, and their annual emission reduction potential is 9,737,734 tCO_2 (Ekinci and Gönençgil 2015).

According to the third study, there were 323 projects with an annual estimated emission reduction potential of 24,542,000 tCO_2 in 2016 (Neelis et al. 2016). Table 2.2 lists the VCPs according to the project type and gives the number of projects and the annual estimated emission reduction potentials for 2016.

Table 2.2. Turkish VCPs covering GS and VCS projects and their annual estimated emission reduction potentials (for 2016) (Neelis et al. 2016)

Project Type	Number	Annual Estimated Emission Reduction (tCO_2)
Hydropower	142	8,440,707
Wind Power	129	9,972,858
Landfill and Biogas	32	4,043,066
Geothermal	10	1,845,731
Energy Efficiency	10	239,608
Total	323	24,542,000

As per the table, in 2016, the total annual offset volume by the VCPs exceeded 24 million. According to the study, among these 323 projects, 243 of them were GS projects, and 80 were VCS projects.

The last study is the most recent one. It reported that there were 244 registered VCPs consist of 130 GS projects and 114 VCS projects as of May 2018. It should be noted that unlike the other three studies, this one only accounts for the registered projects. Furthermore, the total installed capacity of the VCPs was equal to 8,929 MW. The annual average emission reduction potential of an individual project was estimated to be 75,000 tCO_2, equal to 75,000 carbon credits ("Opportunities For Turkey Under CORSIA" 2019).

2.4 Paris Agreement

Since the KP's second commitment period was coming to an end in 2020, 196 countries negotiated the PA at the COP-21 in Paris. The Agreement was approved by the consensus on the 12th of December 2015 and came into force with the ratification of 51 Parties in 2017 ("The Paris Agreement | UNFCCC" n.d.; Streck, Keenlyside, and Unger 2016). The PA changed the structure of the Annex system came with the UNFCCC and the KP. Annex I countries do not have any obligation to reduce the GHG emissions now facing such obligations with the PA (Hermwille and Kreibich 2016b). Unlike the KP that was putting binding emission reduction targets only over the Annex I countries, the PA stresses all countries to control their future emissions (Clémençon 2016).

One of the significant differences between the KP and the PA is that the PA brings a bottom-up approach based on each country's effort. Concerning this, Article 4 states that "Parties shall pursue domestic mitigation measures, to achieve the objectives of such contributions." These country-specific individual efforts are declared in the INDCs of each country (UNFCCC 2015). On the other hand, the KP was putting binding emission reduction targets just on the developed countries, Annex I countries.

Article 6 enables international collaboration and countries to meet their NDC targets cost-effectively. Among other articles, it stands the most in terms of market and non-market mechanisms (Michaelowa, Shishlov, and Brescia 2019). This article includes four concepts: cooperative approaches, transfers of mitigation outcomes, mechanism to contribute to mitigation and support sustainable development, framework for non-market approaches (Marcu and Carbon n.d.). It introduces two international carbon markets. One of them is the cooperative approach, and the other one is the sustainable development mechanism (Gao et al. 2019).

Article 6.2 involves mitigation of outcomes being transferred internationally based on the cooperation of Parties voluntarily. However, the scope of "international transferred mitigation outcomes (ITMO)" is not set under this Article and left undefined (Arı and Sarı 2020). In addition to that, the type of transferrable outcomes is not defined under this Article. Under Article 6.4-6.7, the concept of "mechanism to contribute to mitigation and support sustainable development" appears to establish a new sustainable development mechanism to mitigate GHG emissions and support sustainable development (Marcu and Carbon n.d.). Lastly, Article 6.8 and 6.9 gives a framework for "non-market approaches." Under Article 6.2-6.3, cooperative approaches enable countries to use ITMOs while reaching their NDC targets and, at the same time, achieve ambitious mitigation targets, promote sustainable development, and ensure environmental integrity (Gao et al. 2019). In addition to cooperative approaches, sustainable development mechanism allows countries to use emission reduction outcomes generated under this mechanism to meet their NDC targets while promoting further reduction and ensuring sustainable development. This mechanism could be seen as the successor of the CDM (Gao et al. 2019).

In the context of Article 6, there is no direct differentiation of the countries and the eligibility criteria of the countries. Among many other details, the countries' eligibility criteria and the type of the transferable outcomes are not defined yet, and most importantly, a consensus has not been reached over these issues.

After the PA, the issue of double-counting has been raised as a significant problem, which also affects the VCM. The transferred carbon credits need formal recognition in the host countries' GHG balance sheet to overcome the double-counting problem (Hermwille and Kreibich 2016b).

2.5 Closing Remarks

In this chapter, each flexible market mechanism, namely ET, JI, and CDM, is introduced. After the general introduction, the CDM is presented in a detailed manner by elaborating its governance, its environmental integrity, and the number of projects until 2019. Furthermore, it introduces the two very significant concepts, additionality, and baseline.

Then, the next section continues with the VCM. It first reviews the emerged VCM and then compares some aspects of it with the CDM. Then, the project cycles of GS and VCS are elaborated thoroughly with supporting illustrations. After the review on the global VCM, studies on the Turkish VCM, the annual offset volume, the share of GS and VCS, and the project types and numbers are given. In total, four studies are evaluated. The first one was a study published by the MoEU reporting that as of 18/04/2014, there were 308 VCPs with a total annual offset volume of more than 20 million tCO_2 (Urbanisation. n.d.). The second study assesses 2015 data, and it resulted in 351 VCPs with a total annual offset volume of more than 18 million tCO_2 (Ekinci and Gönençgil 2015). According to the third study, there were 323 projects with an annual estimated emission reduction potential of more than 24 million tCO_2 in 2016 (Neelis et al. 2016). The last study reported that there were 244 registered VCPs. This last study does not report the total annual offset volume. However, it reports that an individual project's annual average emission reduction potential was estimated to be 75,000 tCO_2 (“Opportunities For Turkey Under CORSIA” 2019). Among these four studies, only the last one considers the registered projects and eliminates the non-registered ones. However, it only gives the number of registered projects and does not give the total annual offset volume by the registered projects. Furthermore, none of these studies consider projects' eligibility to issue carbon credits while estimating the annual offset volume.

Lastly, the PA that negotiated at COP-21 while the KP’s second commitment period was coming to an end in 2020 is given. Article 6 of the PA enables international collaboration and countries to meet their NDC targets cost-effectively. It introduces two international carbon markets. One of them is the cooperative approach, which enables countries to meet their NDC targets through ITMOs. The second one is the sustainable development mechanism allowing countries to use emission reduction outcomes generated under this mechanism to meet their NDC targets.

CHAPTER 3

CASES

3.1 Overview

This chapter consists of six main sections. The first section introduces five cases developed to answer the research question of this thesis. Then, in the upcoming five sections of the chapter, each main case is presented. The outcome of each case reflects the annual offset volume under different circumstances. Furthermore, these five upcoming sections also indicate the required data.

3.2 Case Development

As this thesis's research question is: “What is Turkey's annual offset volume from the renewable energy sector and the VCPs at the carbon market?”, the primary objective is to determine the annual offset volume. Within this framework, five main cases are set to determine the annual offset volume under different situations. The scope of all five cases covers the Turkish renewable energy sector. Although their common scope is the Turkish renewable energy sector, each represents a different classification, reflecting emission reduction potential under different conditions and situations. Thus, each case's outcome reflects Turkey’s annual offset volume from domestic renewable energy power plants in different situations.

While developing these five main cases, renewable energy as a whole, all Turkish VCPs, VCPs eligible to issue carbon credits, and issued and transacted carbon credits at the VCM from Turkish VCPs are considered. Figure 3.1 illustrates the case development and its outputs.

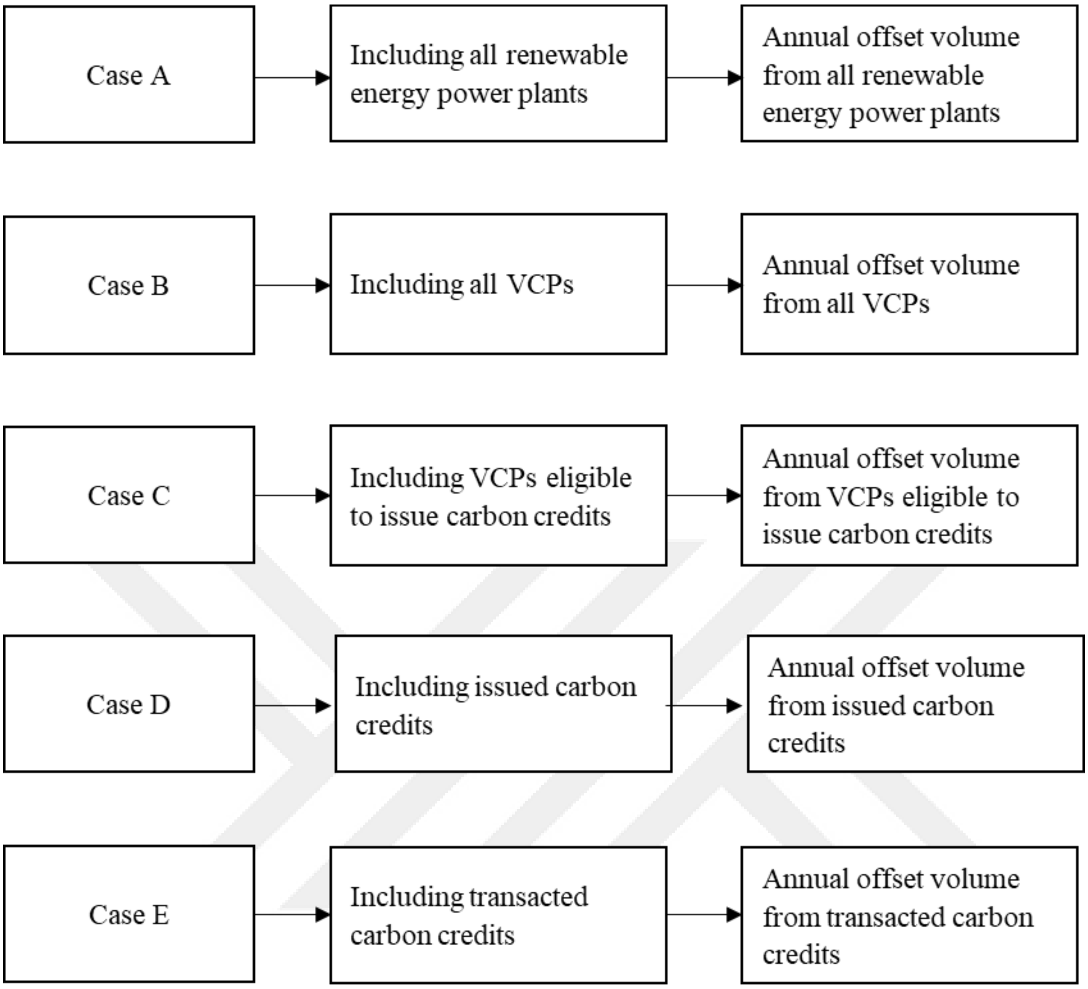


Figure 3.1. Overview of case development and output of the cases

Case A covers all renewable power plants in Turkey, while Case B covers those in the voluntary carbon market. When moving from Case B to C, Case C includes those eligible to issue carbon credits. Case A, B, and C differentiate according to project types and aim to determine the emission reduction potential accordingly. In contrast, Case D and E aim to determine the emission reduction potential according to supply and demand in the market. Therefore, it does not classify renewable power plants. Case D reflects the issued credits to reflect market supply, while Case E reflects the traded portion of issued credits.

3.3 Case A

Regardless of the Turkish VCM, Case A covers renewable energy power plants in Turkey due to their high emission reduction potential. Although the Turkish VCM consists of only GS and VCS projects, it is possible to establish a local certification system under a potential ETS. Thus, this case's target is calculating the annual offset volume from the renewable energy sector in Turkey.

As the annual offset volume means the annual emission reduction, electricity generation from the renewable energy sector, and the CO_2 emission factor of Turkey's grid should be calculated. For that purpose, 2018 data is used, and the resulting annual offset volume represents the annual offset potential from all renewable power plants in 2018.

3.4 Case B

Introducing a potential local certification system creates Case A, while the remaining cases reflect the existing VCPs and VCM. Case B includes all Turkish VCPs regardless of the eligibility of issuing carbon credits or their registration status. Therefore, it represents the total potential annual offset.

While determining the annual offset volume from all Turkish VCPs, the required data and information is obtained and retrieved from GS and VCS registries on 23/06/2020. Thus, the calculated potential annual offset volume is as of 23/06/2020.

3.5 Case C

While Case B includes all Turkish VCPs, Case C only covers the eligible VCPs to issue carbon credits. This eligibility issue is another significant concept that this study brings. Studies and reports so far have not focused on or took into consideration this issue. As a result, the potential annual offset volume from Turkish VCPs often deceptive and reflects an over-calculation.

While determining the annual offset volume, the required data and information is obtained and retrieved from GS and VCS registries on 23/06/2020. As the next step, a differentiation is made to determine the eligibility of the projects to issue carbon credits. Since the data up to 23/06/2020 has been studied, both the projects' eligibility status and the potential annual emission reductions of eligible projects reflect the situation on 23/06/2020.

3.6 Case D

While Case B and C reflect the existing VCPs, Case D aims to reflect the existing VCM considering the supply of the credits. Beyond the eligibility of the projects, Case D interests in the issuances, where the issuance volume represents the supply.

Like the data sources used for Case B and C, the data related to the issued VCS and GS credits are retrieved from GS and VCS registry systems as of 23/06/2020. Thus, the total issued volume is until 23/06/2020. To conclude, Case D is set to calculate the annual offset volume based on the annual issued carbon credits from the VCPs.

3.7 Case E

While Case D reflects the total issued volume from GS and VCS projects, Case E includes the transacted carbon credits from GS and VCS projects. The transacted carbon credits represent the demand side of the VCM.

It uses the transaction data retrieved from GS and VCS registry systems as of 23/06/2020. Therefore, the total transacted volume is until 23/06/2020. As a result, Case E gives the annual offset volume based on the annual transacted carbon credits from the VCPs is until 23/06.2020.

3.8 Closing Remarks

In this chapter, five cases are set to determine Turkey's annual offset volume. For Case A, Turkey's renewable energy sector is taken due to its high emission reduction potential. The rationale behind the choice is the assumption of introducing a possible local certification system. This case results in the total annual offset volume from Turkey's renewable energy sector in 2018.

It is assumed that a local certification system will not be established for the remaining cases. In this context, all GS and VCS projects are taken as a basis in Case B. Case C is based on the VCPs eligible to issue carbon credits based on their registration status or the end date of their crediting period. Therefore, Case B results in the annual offset volume from all VCPs, whereas Case C results in the annual offset volume from VCPs eligible to issue carbon credits.

The remaining two cases, Case D and Case E, are built on the supply and demand side of the VCM. For that purpose, annual issued carbon credits and transacted carbon credits from GS and VCS projects are taken to calculate the annual offset volume. Lastly, Cases B, C, D, and E are based on data retrieved on 23/06/2020. Thus, their results are as of 23/06/2020.

CHAPTER 4

DATA

4.1 Overview

This chapter consists of four main sections. The first section gives the electricity generation related data such as the net and gross electricity generation, electricity generation from renewable energy and fossil fuels, and the imported and exported electricity. The second section gives the fossil fuel related data such as heating values of fossil fuels, fossil fuel consumption amounts, and CO_2 emission factor of fossil fuels. The third section gives the installation-based data and information such as the annual electricity generation, installed capacity, and fuel type information. The fourth and the last section of this chapter provides the VCP related information and data obtained from GS and VCS registries, such as the annual estimated emission reduction amount in tCO_2, fuel type, the project status, the issuance volume, and the transaction volume.

4.2 Electricity Generation Data

4.2.1 The Imported and Exported Electricity

Turkish Electricity Transmission Cooperation (TETC) publishes electricity statistics annually. The publishment has ten main sections, and under each section, there are several different statistics. Under section three, “Electric Energy Generation-Consumption-Losses,” there is “Monthly Distribution of Turkey‘s Gross Electricity Generation By The Imports-Exports And Gross Demand” for 2003-2018. It is Excel-based statistical information, and it gives Turkey’s total generation, import, export, and gross demand monthly for 2003 to 2018. By summing each month, the imported and the exported electricity volume is obtained for 2003 to 2018, each year. Under Chapter 5.2, the imported and exported electricity for 2018 is used.

4.2.2 Gross Electricity Generation by Renewable Sources and Fossil Fuels

Under section three of TETC's annual electricity statistics, "Electric Energy Generation-Consumption-Losses," there is "Annual Development of Turkey's Electricity Generation by Primary Energy Resources" for 2000-2018. It is Excel-based statistical information. It gives electricity generation for hard coal and asphaltite, imported coal, lignite, fuel oil, diesel oil, naphtha, natural gas, hydropower, geothermal and wind, solar, and other types of renewables for each year between 2000 to 2018. Table 4.1 gives Turkey's electricity generation's annual development by primary energy resources for 2016 to 2018.

Table 4.1. Annual development of Turkey's electricity generation by primary energy resources for 2016-2018 (Turkish Electricity Transmission Cooperation 2018c)

Fuel Type	Electricity Generation in 2016 (GWh)	Electricity Generation in 2017 (GWh)	Electricity Generation in 2018 (GWh)
Hard Coal and Asphaltite	5,985	5,664	5,173
Imported Coal	47,718	51,118	62,989
Lignite	38,570	40,694	45,087
Fuel oil	969	521	329
Diesel Oil	957	679	0
LPG	0	0	0
Naphtha	0	0	0
Natural Gas	89,227	110,490	92,483

Table 4.1. (continued)

Fuel Type	Electricity Generation in 2016 (GWh)	Electricity Generation in 2017 (GWh)	Electricity Generation in 2018 (GWh)
Other Renewables, Waste, and Waste Heat	2,372	2,972	3,623
Hydropower	67,231	58,218	59,938
Geothermal and Wind	20,336	24,031	27,380
Solar	1,043	2,889	7,800

Thus, from Table 4.1, the annual electricity generation from renewables and fossil fuels is calculated.

4.2.3 The Net and Gross Electricity Generation

Under section three of TETC's annual electricity statistics, "Electric Energy Generation-Consumption-Losses," there is "Annual Development of Electricity Generation- Consumption and Losses in Turkey." It is Excel-based statistical information. It gives the gross electricity production, net electricity production, gross electricity consumption, net electricity production along with several other data such as the grid losses for each year between 1993 to 2018. Table 4.2 gives the annual development of gross and net electricity generation in 2016-2018.

Table 4.2. Annual development of gross and net electricity generation in 2016-2018 (Turkish Electricity Transmission Cooperation 2018a)

Years	Gross Generation (GWh)	Net Generation (GWh)
2016	274,407.7	261,936.8
2017	297,277.5	284,257.5
2018	304,801.9	290,502.2

4.3 Fossil Fuel Related Data

4.3.1 Fossil Fuel Consumption Amounts

Under section four of TETC's annual electricity statistics, "Amount of Fuel Used, Heating Values, and Cogeneration Statistics of Thermal Power Plants in Turkey," there is "Annual Development of Fuels Consumed in Thermal Power Plants in Turkey by the Electric Utilities" for 2006-2018. It is Excel-based statistical information. It gives heating value (in tonne and in 10^3 m^3 for natural gas) for hard coal and imported coal and asphaltite, lignite, fuel oil, diesel oil, LPG, naphtha, and natural gas for each year between 2006 to 2018. Although the statistical information gives the breakdown of the data such as mobile power plants, production companies, auto producers, etc., Table 4.3 includes the values in total for 2016, 2017, and 2018.

Table 4.3. Annual development of fuels consumed in thermal power plants in Turkey for 2016-2018 (Turkish Electricity Transmission Cooperation 2018b)

Fuel Type	Fuels Consumed in 2016 (tonne, or Nm^3)	Fuels Consumed in 2017 (tonne, or Nm^3)	Fuels Consumed in 2018 (tonne, or Nm^3)
Hard Coal, Imported Coal, and Asphaltite	19,642,410	21,139,104	24,981,829
Lignite	60,213,772	64,412,257	73,533,486
Fuel Oil	526,674	317,724	225,297
Diesel Oil	306,393	197,219	11,776

Table 4.3. (Continued)

Fuel Type	Fuels Consumed in 2016 (tonne, or Nm^3)	Fuels Consumed in 2017 (tonne, or Nm^3)	Fuels Consumed in 2018 (tonne, or Nm^3)
LPG	0	0	0
Naphtha	0	0	0
Natural Gas	18.954.093	22.954.854	19.568.140

4.3.2 Heating Values of Fuels

Under section four of TETC's annual electricity statistics, "Amount of Fuel Used, Heating Values, and Cogeneration Statistics of Thermal Power Plants in Turkey," there is "Heating Values of Fuels Consumed in Thermal Power Plants in Turkey by the Electricity Utilities" for 2006-2018. It is Excel-based statistical information. It gives the consumption amount (in ton and in 10^3 m^3 for natural gas) for hard coal and imported coal and asphaltite, lignite, fuel oil, diesel oil, LPG, naphtha, and natural gas for each year between 2006 to 2018. Although the statistical information gives the breakdown of the data such as mobile power plants, production companies, auto producers, etc., Table 4.4 includes the values in total for 2016, 2017, and 2018.

Table 4.4. Heating values of fuels consumed in thermal power plants in Turkey by the electricity utilities for 2016 to 2018 (Turkish Electricity Transmission Cooperation 2018d)

Fuel Type	Heating Values in 2016 (Tcal)	Heating Values in 2017 (Tcal)	Heating Values in 2018 (Tcal)
Hard Coal, Imported Coal, and Asphaltite	112,945	119,134	140,333
Lignite	103,496	107,247	118,942
Fuel Oil	5,336	3,409	2,498

Table 4.4. (Continued)

Fuel Type	Heating Values in 2016 (Tcal)	Heating Values in 2017 (Tcal)	Heating Values in 2018 (Tcal)
Diesel Oil	3,235	2,102	121
LPG	0	0	0
Naphtha	0	0	0
Natural Gas	17,078	201,863	169,605

4.3.3 The CO_2 Emission Factor of Fossil Fuels

"2006 IPCC Guidelines for National Greenhouse Gas Inventories" has five volumes. Among these five volumes, the second one is the energy volume. The energy volume holds a table for "Default Emission Factors for Stationary Combustion In The Energy Industries." The CO_2 emission factors for hard coal and imported coal, lignite, fuel oil, diesel oil, LPG, naphtha, and natural gas are taken from that particular list. Table 4.5 gives the emission factors of the fuels.

Table 4.5. CO_2 emission factor (tCO_2/GJ) of fossil fuel type (Darío Gómez et al., n.d.)

Energy Sources	CO_2 Emission Factor (tCO_2/GJ)
Hard Coal and Imported Coal	89.5
Lignite	90.9
Fuel Oil	72.6
Diesel Oil	72.6
LPG	61.6
Naphtha	69.3
Natural Gas	54.3

4.4 Installation-Based Information and Data

Ministry of Energy and Natural Resources (MoENR) publishes the “Annual Energy Investments” for each year. It is an Excel-based report including the following information for each year: license date, license number, company name, power plant name, province, fuel type, installed capacity of that license, and the acceptance date of the plant. This investment data is available for each year between 2003 to 2020. Table 4.6 gives a list of some of the licensed power plants put into operation in 2018.

Table 4.6. Some licenced power plants put into operation in 2018 (Turkish Ministry of Energy and Natural Resources 2018)

Number	Licence Date	License Number	Company Name	Plant Name	Province	Fuel Type	Power of Unit (Mwe)	Number of Unit	Additional Capacity (MWe)	Provisional Acceptance Date
1	10/21/2016	EÜ/6538-5/03590	Akköy Enerji A.S.	Akkoy I Cansuyu HES	Gumushane	Hydropower	0.495	1	0.495	1/4/2018
2	6/8/2009	EÜ/2124-2/1493	Mon Elektrik Uretim A.S.	Ege II-III-IV HES	Denizli	Hydropower	0.715	1	0.715	1/10/2018
3	7/27/2017	EÜ/7199-16/03718	Renoe Enerji Yatirim Bilişim Tekn. San. Ve Tic. A.S.	Renoe Acipayam GES	Denizli	Solar power	-	-	5.00	1/12/2018
4	1/9/2014	EÜ/4817-12/02655	Duzhan Enerji Yatirim Uretim ve Ticaret A.S.	Tire RES	Izmir	Wind power	4x3,2+7x1,7	11	23.80	1/12/2018
5	12/27/2011	EÜ/3584-20/2191	Aksar Nazar Enerji Uretim A.S.	Aksar-Nazar HES	Bitlis	Hydropower	2x11,78+1x6,68	3	30.24	1/19/2018
6	8/18/2011	EÜ/3382-7/2047	Iletken Enerji Yatirim Uretim ve Tic. A.S.	Gokdağ RES	Kocaeli	Wind power	1.667	1	1.665	1/19/2018
7	9/12/2007	EÜ/1309-1/943	Silen Elektrik Uretim ve Ticaret A.S.	Oltu HES	Erzurum	Hydropower	4,543+1,567	2	6.110	1/19/2018
8	4/30/2009	EÜ/2070-6/1464	Aksa Akrilik Kimya San. A.S.	Aksa Santrali	Yalova	Imported coal	99.00	1 BT	24.00	1/26/2018
9	12/1/2016	EÜ/6624-6/03606	Dunya Enerji Elektrik Uretim A.S.	Ulkün Reg. ve HES (Ulkün HES-1)	Corum	Hydropower	5.235	1	5.235	1/26/2018

Apart from the “Annual Energy Investments,” TETC publishes five years of production capacity projection reports each year. They are publicly available for each year between 2005 to 2018. The report includes demand development, actual electricity generations for the past years, transmission and distribution losses, and the 5-year production projections. This report has an Annex providing a report on the power plants put in and out of service in the latest year. For some years, the list gives both the installed capacity and the annual generation in MWh, and for some years, it only gives the installed capacity. When all reports are reviewed:

- Installation-based annual electricity generation data is available for 2018, 2017, 2016, and 2015,
- Only installation-based installed capacity data is available for 2014 and 2013.
- Installation-based installed capacity, project generation capacity, and dependable production capacity at the end of each year for 2012 to 2005.

Reports between 2005-2012, data only shows the overall plant-based annual electricity generation data. In other words, the data gives the total electricity generation at the end of the year, rather than the data of the power plants that became operational in that year.

Table 4.7, Table 4.8, and Table 4.9 are prepared to serve as an example for the above explanations regarding the five years of production capacity projection reports. Table 4.7 lists some of the power plants put into operation in 2018. Since the installation-based annual electricity generation data is available for the years between 2018 to 2015, Table 4.7 holds both installed capacity and electricity generation information. Table 4.8 lists some of the power plants put into operation in 2014. As the installation-based annual electricity generation data is not available for 2014 and 2013, Table 4.8 only gives the installed capacity information for 2014. Lastly, Table 4.9 provides some of the power plants put into operation in 2012. The data gives the total electricity generation at the end of 2012.

Table 4.7. Some power plants put into operation in 2018 (Turkish Electricity Transmission Cooperation n.d.)

<table>
<tr><td>Plant Name</td><td>Installed Power (MW)</td><td>Electricity Generation (MWh)</td></tr>
<tr><td>3S Kale JES</td><td>17</td><td>378</td></tr>
<tr><td>Acıbadem Eskişehir</td><td>0.8</td><td>5,335.1</td></tr>
<tr><td>Ada Tepe HES</td><td>1.25</td><td>1,240.9</td></tr>
<tr><td>Ahi Suluova BES</td><td>1.1</td><td>0</td></tr>
<tr><td rowspan="2">Akbuk RES</td><td>4.8</td><td rowspan="2">29,652.7</td></tr>
<tr><td>2.4</td></tr>
<tr><td rowspan="3">Akdag RES</td><td>7.3</td><td rowspan="3">24,855.3</td></tr>
<tr><td>13.1</td></tr>
<tr><td>2.6</td></tr>
<tr><td>Akhisar RES</td><td>11.3</td><td>124,516.9</td></tr>
</table>

Table 4.8. Some production plants put into operation in 2014 (Turkish Electricity Transmission Cooperation n.d.)

Plant Name	Installed Power (MW)
Agaoglu DGKCS	12.9
Acma Reg. Ve HES	2.4
Adana Dogu Atik Su Sant.	0.8
Afyon Biyogaz Enerji Sant. Biyokutle Proj.	4
Ak Gida Termik Kojen. San.	7.5

Table 4.8. (Continued)

Plant Name	Installed Power (MW)
Ak Nisasta San. Ve Tic. Kojen Sant.	2
Akdere HES	7.5

Table 4.9. Some of the hydropower plants as the end of 2012 (Turkish Electricity Transmission Cooperation n.d.)

Plant Name	Installed Power (MW)	Project Generation Capacity (GWh)	Dependable Production Capacity (GWh)
Adıguzel HES	62	150	80
Almus HES	27	100	30
Altınkaya HES	702.6	1632	740
Aslantas HES	138	569	320
Alparslan 1	160	488	418
Akkopru HES	115	343	176
Ataturk HES	2405	8100	5230

4.5 VCP Related Information and Data

In Turkey, as discussed before, projects seeking to become a VCP could either apply to VCS or GS. Both have their own registries for the issuances and transactions, and databases for the projects. The data and the information, such as the project name, project status, estimated annual emission reduction amount (tCO_2), issued credits, transacted credits, etc., could be retrieved or obtained from their registries.

For the study, all data and information required for the cases are obtained and retrieved on 23/06/2020. In the following two sub-sections, first the data and information of VCS projects, then the GS projects are given.

4.5.1 Information and Data of VCS Projects

Data could be retrieved from the VCS registry in five main groups: all projects, registered, pipeline, verified carbon units (VCUs), and buffer. All these five groups could be retrieved in either .csv or .pdf format. For this thesis, the .csv format is preferred. In this section, some of the data obtained from the four groups will be shown respectively.

Table 4.10 lists some of the VCPs under all projects group retrieved from the VCS registry. It provides the project ID, project name, project proponent name, project type, project status, country, estimated annual emission reductions in tCO_2, region, and the CDM methodology used.

Table 4.10. Some of the VCPs under “all projects” group retrieved from the VCS registry (“Verra Search Page” n.d.)

ID	Name	Proponent	Project Type	Status	Country	Estimated Annual Emission Reductions	Region	Methodology
1044	Ziqiang 18MW Hydropower Project in Guizhou Province China	Guizhou Zhijn Ouhua Developent Co.Ltd.	Energy industries (renewable/non-renewable sources)	Registered	China	80181		ACM0002
530	Zhumadian Zhongyuan Gas-Steam Combined Cycle Power Project in Henan China	Henan Zhongyuan Gas Power Company Ltd.	Energy industries (renewable/non-renewable sources)	Registered	China	858165		AM0029
35	Zhuhai Hengqin Island Wind Farm Project	Zhuhai Guohua Wonderful Wind Power Exploitation Co	Energy industries (renewable/non-renewable sources)	Registered	China	33217		ACM0002
1260	Zé Tunin Small Hydropower Plant Project	Pequena Central Hidrelétrica Zé Tunin S.A.	Energy industries (renewable/non-renewable sources)	Registered	Brazil	18479		AMS-I.D.
900	Za Hung Hydropower Project	Za Hung Joint Stock Company	Energy industries (renewable/non-renewable sources)	Registered	Viet Nam	69309		ACM0002
1741	Yumrutepe Regulator and 15.013 MW Hydroelectric Power Plant Project	Yumrutepe Enerji Uretim Anonim Sirketi	Energy industries (renewable/non-renewable sources)	Registered	Turkey	26224		ACM0002
806	Yesil Hydroelectric Power Plant (HEPP)	Yesilbas Elektrik Uretim AS	Energy industries (renewable/non-renewable sources)	Registered	Turkey	27069		ACM0002
600	Yeong Yang 61.5 MW Wind Farm Project	Yeong Yang Wind Power Corporation	Energy industries (renewable/non-renewable sources)	Registered	South Korea	112812		ACM0002
1254	Yelisirur wind power project, India	Bhoruka Power Corporation Limited	Energy industries (renewable/non-renewable sources)	Registered	India	49451		ACM0002
1865	Xiguan Afforestation Project in Guizhou Province	Guizhou Baiheng Fertiliser Co., Ltd	Agriculture Forestry and Other Land Use	Registered	China	388420	Asia	AR-ACM0003
1498	Preserving Peat Swamp Forest Ecosystem Through Redd+ Activity in Kampar Peninsula Riau-Indonesia	KPHP Tasik Besar Serkap (KPHP TBS), Riau Province-Indonesia	Agriculture Forestry and Other Land Use	Under validation	Indonesia	1624961		VM0007

By selecting Turkey from the country column and filtering, all the Turkish VCPs will be listed regardless of any distinction. This way, all the Turkish VCPs in the VCS system are obtained. After that, by summing the estimated annual emission reductions (tCO_2), all Turkish VCS projects' emission reduction potential is obtained. Unfortunately, the Excel sheet does not provide information on the renewable energy source, for instance, the breakdown of the hydropower, wind power, etc.

Moreover, Table 4.11 lists some of the VCPs under the registered group retrieved from the VCS registry. It provides the project ID, project name, project proponent name, project type, project status, country, estimated annual emission reductions in tCO_2, region, and the CDM methodology used.

Table 4.11. Some of the VCPs under the “registered” group retrieved from the VCS registry (“Verra Search Page” n.d.)

ID	Name	Proponent	Project Type	Status	Country	Estimated Annual Emission Reductions	Region	Methodology
1	7.25 MW wind energy project of Aruppukottai Sri Jayavilas Ltd	Aruppukottai Sri Jayavilas Limited	Energy industries (renewable/non-renewable sources)	Registered	India	13331		AMS-I.D.
2	LITL's Wind Power Project at Tamilnadu	Lanco Infratech Limited	Energy industries (renewable/non-renewable sources)	Registered	India	22917		AMS-I.D.
3	Liaoning Xingcheng Haibin Wind Farm Project	Hefeng Taoyuan Hydropower Co., Ltd.	Energy industries (renewable/non-renewable sources)	Registered	China	122340		ACM0002
961	‘El Arriero’ Afforestation on degraded grasslands under extensive grazing project	El Arriero’ S.A.	Agriculture Forestry and Other Land Use	Registered	Uruguay	18271		AR-ACM0001
959	‘Guanaré’ Forest Plantations on degraded grasslands under extensive grazing	Guanaré SA	Agriculture Forestry and Other Land Use	Registered	Uruguay	127416	Latin America	AR-ACM0001
738	Carbon Project in the Emas-Taquari Biodiversity Corridor, Goiás and Mato Grosso do Sul, Brazil	Oreades Nucelo de Geoprocessamento	Agriculture Forestry and Other Land Use	Registered	Brazil	6870	Latin America	AR-AMS0001
1390	Carmen del Darién (CDD) REDD+ Project	Multiple Proponents	Agriculture Forestry and Other Land Use	Registered	Colombia	462190	Latin America	VM0006
1408	Chyulu Hills REDD+ Project	Chyulu Hills Conservation Trust	Agriculture Forestry and Other Land Use	Registered	Kenya	1100943	Africa	VM0009
1006	Bursa Light Rail System II Phase	T.C. Bursa Metropolitan Municipality (BMM)	Transport	Registered	Turkey	14794		ACM0016
1322	Buyukduz Hydroelectric Power Plant, Turkey	Ayen Enerji A.S.	Energy industries (renewable/non-renewable sources)	Registered	Turkey	102731		ACM0002
685	Cakit Hydropower Plant, Turkey	Cakit Enerji A.S.	Energy industries (renewable/non-renewable sources)	Registered	Turkey	50903		ACM0002

By selecting Turkey from the country column and filtering, all the registered Turkish VCPs will be listed. This way, all the registered Turkish VCPs in the VCS system are obtained. After that, by summing the estimated annual emission reductions (tCO_2), all registered Turkish VCS projects' emission reduction potential is obtained. Unfortunately, the Excel sheet does not provide information on the renewable energy source, for instance, the breakdown of the hydropower, wind power, etc.

Furthermore, Table 4.12 lists some of the VCPs under the pipeline group retrieved from the VCS registry. It provides the project ID, project name, project proponent name, project type, project status, country, estimated annual emission reductions in tCO_2, region, and the CDM methodology used.

Table 4.12. Some of the VCPs under the "pipeline" group retrieved from the VCS registry ("Verra Search Page" n.d.)

ID	Name	Proponent	Project Type	Status	Country	Estimated Annual Emission Reductions	Region	Methodology
999	Protection of the Amazon Rain Forest II	Redd Services	Agriculture Forestry and Other Land Use	Under validation	Bolivia	54370		VM0007
1000	Conversion to Proteccion of the Amazon Rain Forest	Multiple Proponents	Agriculture Forestry and Other Land Use	Under validation	Bolivia	9900		VM0010
1025	KVSSSKL Co-generation Power Plant at Satara District, Maharashtra	M/s. Kisan Veer Satara Sahakari Sakhar Karkhana	Energy industries (renewable/non-renewable sources)	Under validation	India	13472		ACM0006
1101	Balkodu 1 Hydro Power Plant	BTA Enerji Elektrik Uretim Insaat	Energy industries (renewable/non-renewable sources)	Under validation	Turkey	20642		AMS-I.D.
1106	Sogukpinar Regulator and Hydroelectric Power Plant Project	Arsan Sogukpynar Elektrik Uretim A.S.	Energy industries (renewable/non-renewable sources)	Under development	Turkey	14668		ACM0002
1107	Koprubasi 14.66 MW HEPP	Koprubapy Enerji Elektrik Uretim A.S.	Energy industries (renewable/non-renewable sources)	Under development	Turkey	24081		ACM0002
1799	Forest management to mitigate climate change in Bélgica native community, Madre de Dios region – Peru	Multiple Proponents	Agriculture Forestry and Other Land Use	Under validation	Peru	126168	Latin America	VM0015
1806	Riscales REDD+ Project	Consejo Comunitario General Los Riscales	Agriculture Forestry and Other Land Use	Under validation	Colombia	187240	Latin America	VM0007
1848	Korea - Myanmar Joint - Bago District REDD+ Program, with North Zamari Wildlife Sanctuary	Multiple Proponents	Agriculture Forestry and Other Land Use	Under validation	Myanmar	238397	Asia	VM0006
1979	10 MW biomass based power generation project at Wani, Yavatmal by Shalivahana Projects Limited	Shalivahana Green Energy Limited	Energy industries (renewable/non-renewable sources)	Under development	India	48132		AMS-I.D.
1822	10 MW wind power project by Powerica at BDS - Gujarat	Powerica Limited	Energy industries (renewable/non-renewable sources)	Registration requested	India	24816		AMS-I.D.

By selecting Turkey from the country column and filtering, all the Turkish VCPs in the pipeline will be listed. This way, all the Turkish VCPs in the pipeline of the VCS system are obtained. After that, by summing the estimated annual emission reductions (tCO_2), the emission reduction potential of the Turkish projects in the pipeline is obtained. This indicates the currently unavailable potential since only registered projects are eligible to issue carbon credits.

Lastly, Table 4.13 lists some of the projects and their VCUs under all VCUs group retrieved from the VCS registry. It provides the following information: the issuance date, the vintage period, project ID, project name, country, project type, CDM methodology used, total vintage quantity, the quantity issued, and the retirement/cancellation date.

Table 4.13. Some of the projects and their VCUs under the “all VCUs” group retrieved from the VCS registry (“Verra Search Page” n.d.)

Issuance Date	Vintage Start	Vintage End	ID	Name	Country	Project Type	Methodology	Total Vintage Quantity	Credits Quantity Issued	Retirement/Cancellation Date
10/07/2015	01/01/2012	30/06/2012	902	KARIBA REDD+ PROJECT	Zimbabwe	Agriculture Forestry and Other Land Use	VM0009	2751549	1	03/08/2017
10/07/2015	01/01/2012	30/06/2012	902	KARIBA REDD+ PROJECT	Zimbabwe	Agriculture Forestry and Other Land Use	VM0009	2751549	2	04/08/2017
10/07/2015	01/01/2012	30/06/2012	902	KARIBA REDD+ PROJECT	Zimbabwe	Agriculture Forestry and Other Land Use	VM0009	2751549	1	05/08/2017
10/07/2015	01/01/2012	30/06/2012	902	KARIBA REDD+ PROJECT	Zimbabwe	Agriculture Forestry and Other Land Use	VM0009	2751549	1	06/08/2017
20/03/2012	01/01/2009	31/12/2009	264	Kargilik 24 MW Hydropower Plant, Turkey	Turkey	Energy industries (renewable/non-renewable sources)	ACM0002	56011	6000	17/12/2015
04/11/2011	10/10/2009	31/12/2009	506	DARICA-1 99 MW Hydro Power Plant Project, Turkey	Turkey	Energy industries (renewable/non-renewable sources)	ACM0002	46445	1	15/07/2015
04/11/2011	10/10/2009	31/12/2009	506	DARICA-1 99 MW Hydro Power Plant Project, Turkey	Turkey	Energy industries (renewable/non-renewable sources)	ACM0002	46445	9421	15/07/2015
04/11/2011	10/10/2009	31/12/2009	506	DARICA-1 99 MW Hydro Power Plant Project, Turkey	Turkey	Energy industries (renewable/non-renewable sources)	ACM0002	46445	21445	15/07/2015
27/05/2015	28/02/2008	28/02/2012	904	Reduced Emissions from Deforestation and Degradation in Community Forests – Oddar Meanchey, Cambodia	Cambodia	Agriculture Forestry and Other Land Use	VM0006	597210	2	14/09/2015
27/05/2015	28/02/2008	28/02/2012	904	Reduced Emissions from Deforestation and Degradation in Community Forests – Oddar Meanchey, Cambodia	Cambodia	Agriculture Forestry and Other Land Use	VM0006	597210	1	15/09/2015

This table should be evaluated as the list of transacted, canceled or retired, credits. For instance, the "total vintage quantity" column indicates the total volume of issued credits, which the transacted credit belongs. For example, when the first row of Table 4.13 is reviewed, one credit is transacted on 03/08/2017. This transacted credit belongs to the issued volume of 2,751,549. The issuance was made on 10/07/2015. In this regard, the second row indicates two transacted credits from the same volume of issued credits on 04/08/2020. As a result, the first and the second row belongs to the same issuance. Unfortunately, without further estimations and classifications, the VCUs issued from VCS projects could not be obtained. First of all, the same "total vintage quantities" should be grouped together. By summing all the grouped "total vintage quantities," the VCUs issued from VCS projects would be obtained.

Apart from the data retrieved from the VCS registry in five main groups, the registry has a "project search" option. By entering the project ID, project name, project proponent name, or other advanced search options, further details of the projects are reached. Every project has a page at the registry, which provides the project summary, VCS registration documents, VCS issuance documents, and other VCS documents.

Figure 4.1 presents one of the project pages at the VCS registry. By downloading the documents attached as registration, issuance, and other documents, further information on the project is obtained.

It should be noted that for the projects, the first step is to apply the Standard with required project documents that include the brief project description along with the annual estimated emission reduction amount (CO_2). Then, each project will have a page at the registry. The registry is then based on the initial information supplied. Afterward, the project will undergo validation and then gain registered status. In the meantime, the project documents would most probably be revised more than a couple of times. Differences between the data and information available at the project documents and the data retrieved from the VCS registry might occur. In such a case, the most up-to-date information and the data would be at the project documents available on each project's page.

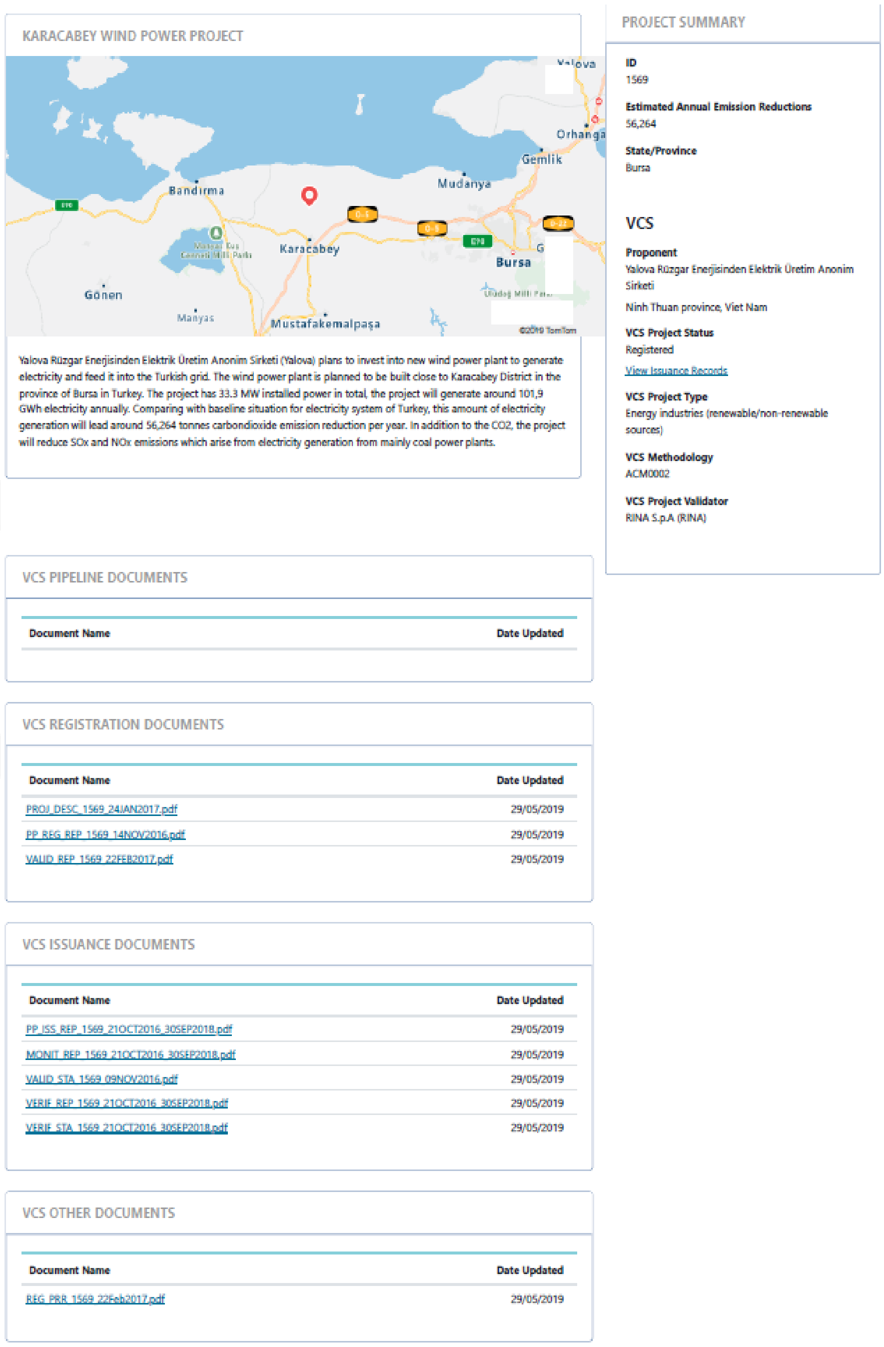


Figure 4.1. One of the project pages from the VCS registry ("Verra Search Page" n.d.)

4.5.2 Information and Data of GS Projects

The GS registry offers two types of classification: projects and credits. When the classification of the credit is chosen, the data could be exported in Excel format. However, when the project classification is selected, data could not be exported in any kind is only available on the website.

When the classification of projects is chosen, all GS projects are listed on the website regardless of their registration status. Figure 4.2 presents some of the VCPs listed on the GS registry/website.

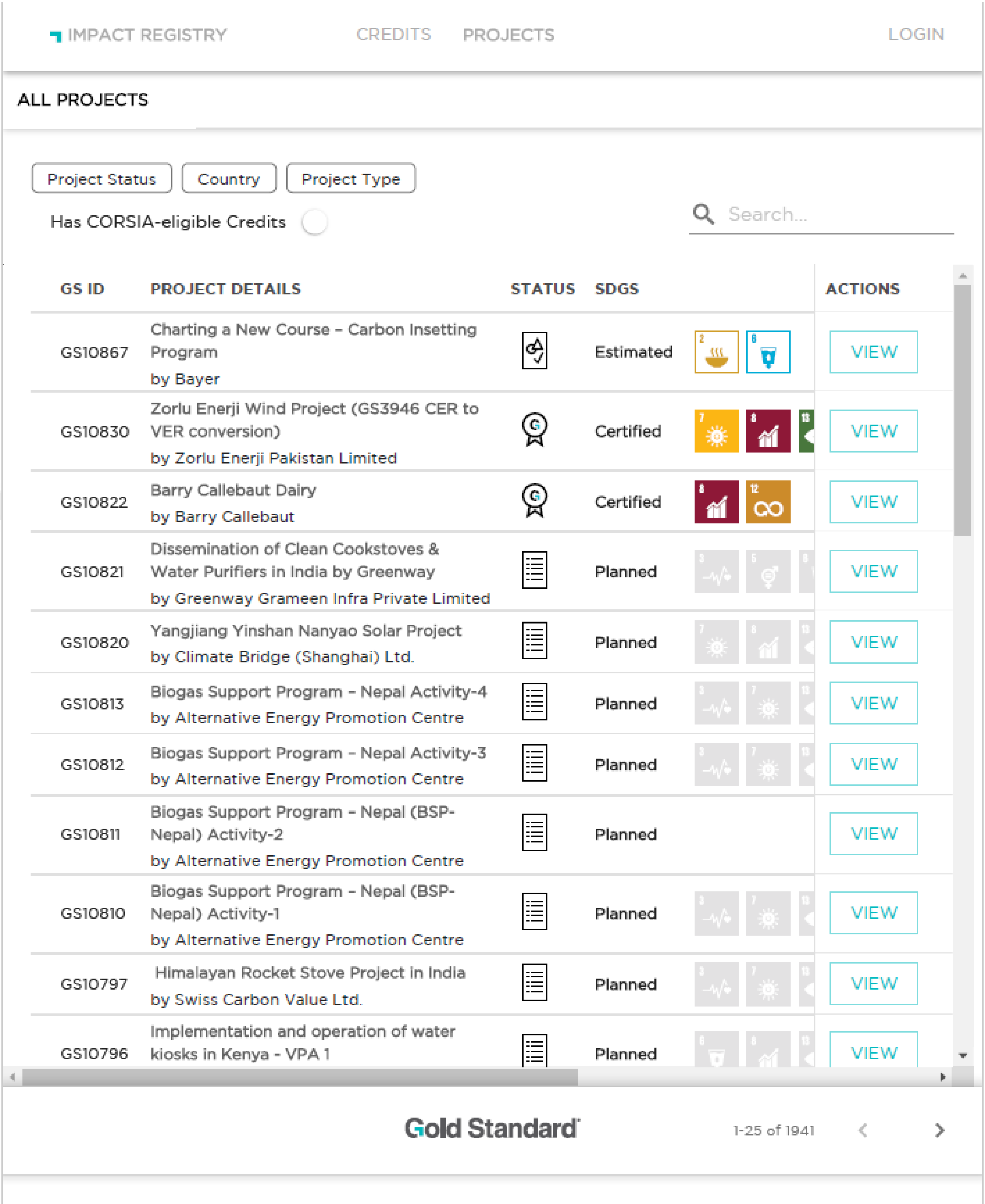


Figure 4.2. Some of the VCPs under "projects" classification from the GS registry ("GSF Registry" n.d.)

The following information is supplied with the list of projects: Project ID, project name, project proponent name, project status, SDGs, project type, and country.

Unfortunately, the annual estimated emission reduction volume of the projects is not provided with this list.

When the classification of credits is chosen, there are two-sub categories: issuances and retirements that could be exported in Excel. Table 4.14 lists some of the projects and their issued credits under the “issuances” classification. It provides the following information: the vintage year, credit status, quantity issued, project ID, project name, project developer name, project type, issuance date, monitoring period start and end dates, and the serial number of the credits.

Table 4.14. Some of the projects and their issued credits under the “issuances” classification retrieved from the GS registry (“GSF Registry” n.d.)

Vintage	Credit Status	Quantity	GSID	Project Name	Project Developer	Project Type	Issuance Date	Monitoring Period Start	Monitoring Period End	Serial Number
2020	Issued	23	3381	Reforestation Sierra Piura	COOP NORANDINO	Other	2014-07-11T00:00	1/1/2020	12/31/2035	GS1-1-PE-GS3381-22-2020-3386-1-23
2012	Issued	26645	1013	Kocaeli Landfill Gas to Electricity Project	Korfez Enerji San. ve Tic. A.S.	Other	2014-07-14T00:00	3/1/2012	6/30/2013	GS1-1-TR-GS1013-21-2012-3384-1-26645
2013	Issued	47563	1013	Kocaeli Landfill Gas to Electricity Project	Korfez Enerji San. ve Tic. A.S.	Other	2014-07-14T00:00	3/1/2012	6/30/2013	GS1-1-TR-GS1013-21-2013-3383-1-47563
2010	Issued	2008	991	Highveld Air Quality - Sakhile project	Nova Institute	Energy Efficiency - Domestic	2012-09-06T00:00	5/1/2010	12/31/2010	GS1-1-ZA-991-16-2010-269-1-2008
2011	Issued	2527	991	Highveld Air Quality - Sakhile project	Nova Institute	Energy Efficiency - Domestic	2012-09-06T00:00	1/1/2011	12/31/2011	GS1-1-ZA-991-16-2011-268-1-2527
2015	Issued	574	1029	The Breathing Space Improved Cooking Stoves Programme India	Envirofit International Ltd.	Energy Efficiency - Domestic	2016-02-10T00:00	9/1/2013	7/31/2015	GS1-1-IN-GS1029-16-2015-4856-1-574
2014	Issued	21816	3367	The Breathing Space Improved Cooking Stoves Programme India - VPA No. 09 Envirofit	Envirofit International Ltd.	Energy Efficiency - Domestic	2016-02-10T00:00	9/30/2013	7/31/2015	GS1-1-IN-GS3367-16-2014-4855-1-21816
2014	Issued	181	3305	Solar for Forest	Ege Orman Vakfi Agaclandirma ve Agac Urunleri Iktisadi Isletmesi	Solar Thermal - Electricity	2016-02-10T00:00	8/1/2014	11/30/2015	GS1-1-TR-GS3305-1-2014-4838-1-181
2015	Issued	449	3305	Solar for Forest	Ege Orman Vakfi Agaclandirma ve Agac Urunleri Iktisadi Isletmesi	Solar Thermal - Electricity	2016-02-10T00:00	8/1/2014	11/30/2015	GS1-1-TR-GS3305-1-2015-4837-1-449
2010	Issued	9603	707	Landfill Gas Extraction and Electricity Generation Project	Ortadogu Enerji A.S.	Other	2016-02-08T00:00	8/21/2010	7/31/2014	GS1-1-TR-GS707-21-2010-4833-1-9603
2011	Issued	25144	707	Landfill Gas Extraction and Electricity Generation Project	Ortadogu Enerji A.S.	Other	2016-02-08T00:00	8/21/2010	7/31/2014	GS1-1-TR-GS707-21-2011-4832-1-25144

Unfortunately, there is no column as “country” from which the Turkish projects issued credits would be listed. However, there is the serial number column. The serial number holds the country abbreviation along with the project ID. The acronym for Turkey is “TR.” By filtering the serial numbers by selecting “TR,” only Turkish credits are listed. After that, by summing the quantity, the volume of the issued credits could be obtained.

Moreover, Table 4.15 lists some of the projects and their transacted credits under the “retirements” classification. It provides the following information: the vintage year, credit status, quantity transacted, project ID, project name, project developer name, country, product type, project type, programme of activities, programme of activities ID, issuance date, retirement date, monitoring period, the serial number of the credits, and notes.

Table 4.15. Some of the projects and their transacted credits under the “retirements” classification retrieved from the GS registry (“GSF Registry” n.d.)

Vintage	Credit Status	Quantity	GSID	Project Name	Project Developer	Country	Product Type	Project Type	Programme of Activities	POA GSID	Issuance Date	Retirement Date	Monitoring Period Start	Monitoring Period End	Serial Number	Note
2018	Retired	10000	6748	25.5 MW Wind Energy Farm at Nandurbar Maharashtra by HZL	Hindustan Zinc Limited	India	VER	Wind	Standalone		11/20/2020	11/23/2020	3/19/2017	1/31/2019	GS1-1-IN-GS6748-12-2018-20268-44082-54081	Retired for Planetly GmbH.
2020	Retired	1761	3422	Improved Cook Stoves In Pastoral And Agro-Pastoral Communities In Southern Ethiopia	Carbonsink (Carbonsink Group S.r.l.)	Ethiopia	VER	Energy Efficiency - Domestic	Standalone		11/6/2020	11/10/2020	4/1/2019	3/31/2020	GS1-1-ET-GS3422-16-2020-20254-1-1761	
2019	Retired	5425	879	Energy Efficient Cook Stoves for Siaya Communities Kenya	myclimate Foundation	Kenya	VER	Energy Efficiency - Domestic	Standalone		8/4/2020	8/6/2020	1/1/2019	12/31/2019	GS1-1-KE-GS879-16-2019-19908-11916-17340	
2019	Retired	9005	879	Energy Efficient Cook Stoves for Siaya Communities Kenya	myclimate Foundation	Kenya	VER	Energy Efficiency - Domestic	Standalone		8/4/2020	8/6/2020	1/1/2019	12/31/2019	GS1-1-KE-GS879-16-2019-19908-2911-11915	
2018	Retired	243	7311	GS5658 VPA 9: Water is Life - Phase II Madagascar	Carbonsink (Carbonsink Group S.r.l.)	Madagascar	VER	Energy Efficiency - Domestic	VPA	5658	7/9/2020	7/13/2020	11/26/2018	11/17/2019	GS1-1-MG-GS7311-16-2018-19847-660-902	
2018	Retired	159	7311	GS5658 VPA 9: Water is Life - Phase II Madagascar	Carbonsink (Carbonsink Group S.r.l.)	Madagascar	VER	Energy Efficiency - Domestic	VPA	5658	7/9/2020	7/13/2020	11/26/2018	11/17/2019	GS1-1-MG-GS7311-16-2018-19847-501-659	
2018	Retired	500	7311	GS5658 VPA 9: Water is Life - Phase II Madagascar	Carbonsink (Carbonsink Group S.r.l.)	Madagascar	VER	Energy Efficiency - Domestic	VPA	5658	7/9/2020	7/9/2020	11/26/2018	11/17/2019	GS1-1-MG-GS7311-16-2018-19847-1-500	
2018	Retired	28	854	Balikesir Susurluk 45 MW Wind Farm Project	Iltek Enerji Yatirim Sanayi ve Ticaret A.S.	Turkey	VER	Wind	Standalone		7/3/2020	9/25/2020	9/26/2016	2/12/2018	GS1-1-TR-GS854-12-2018-19798-6970-6997	

By selecting Turkey from the country column and filtering, all the transacted Turkish credits will be listed. After that, by summing the quantity, the volume of the transacted credits will be obtained. Further classifications are possible by filtering according to the project type, the issuance year, or the retirement year.

Apart from the data available and retrieved data from the GS registry, the registry has a “project search” option. By entering the project ID, project name, project proponent name, or other advanced search options, further details of the projects are reached. Every project has a page at the registry, which provides the project description, annual estimated credits, the crediting period, project scale, and many other information. Furthermore, the project page has a link where the certification documents are available. Figure 4.3 presents one of the project pages at the GS registry. By downloading the certification documents, further information on the project is obtained.

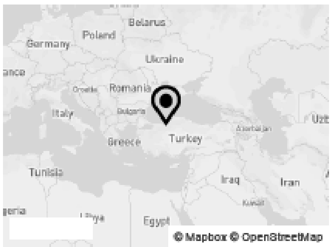
It should be noted that for the projects, the first step is to apply the Standard with required project documents that include the brief project description along with the annual estimated emission reduction amount (CO_2). Then, each project will have a page at the registry. The registry is then based on the initial information supplied. Afterward, the project will undergo validation and then gain registered status. In the meantime, the project documents would most probably be revised more than a couple of times. Differences between the data and information available at the project documents and the data retrieved from the GS registry might occur. In such a case, the most up-to-date information and the data would be at the project documents available on each project’s page.

IMPACT REGISTRY CREDITS PROJECTS LOGIN

BOLU LANDFILL GAS TO ENERGY PROJECT, TURKEY

GS ID

764



REGION

Turkey

PRODUCT

VER

28149 ISSUED

561 RETIRED

CERTIFIED SDG IMPACTS

PROJECT TYPE

Biogas - Electricity

STATUS

Gold Standard Certified Project

PROJECT DEVE...	CEV Enerji retim Sanayi ve Ticaret Limited _irket		
METHODOLOGY	AMS-III.G. Landfill methane recovery	CREDITING PERI...	Aug 12, 2011 — Aug 12, 2018
STANDARDS VE...	2.1	ANNUAL ESTIM...	24,673
PROJECT SCALE	Small Scale	PROJECT TYPE	Biogas - Electricity

DESCRIPTION

The Project is an integrated solid waste management project planned on the managed and unmanaged landfill sites of the Bolu city in Turkey. It involves the collection and combustion of landfill gas in a facility on the landfill site for generating electricity and feeding it to the national grid. The Project owner, CEV Marmara Enerji Üretim Sanayi ve Tic. Ltd. Þti., has been awarded with the right of operating the landfill site for 29 years following a Bolu Municipality tender.

Figure 4.3 (Continued)

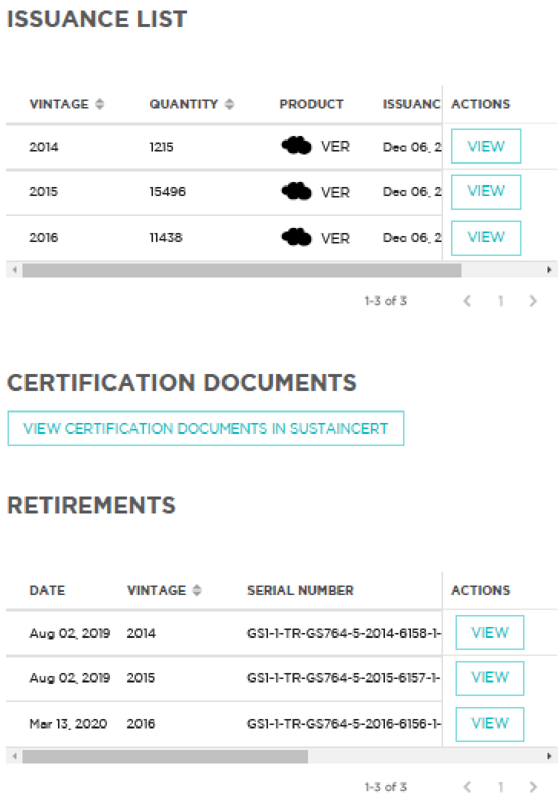


Figure 4.3. One of the project pages from the GS registry (“GSF Registry” n.d.)

4.6 Closing Remarks

This chapter includes the data sources required to reach the cases, which determine the offset volume, developed under Chapter 3. First of all, it gives the electricity generation data obtained from TETC’s annual electricity statistics. The electricity generation data is available for each year. The related data presents the imported and exported electricity in 2018, gross electricity generation by renewable sources and fossil fuels for 2016-2018, net and gross electricity production for 2016-2018.

The next data source is fossil fuel-related data. The data sources used is again TETC’s annual electric statistics. The related data presents the fuel consumption in thermal power plants in 2016-2018, heating values of fuels consumed in thermal power plants in 2016-2018. Lastly, related to the fossil fuel data, “2006 IPCC

Guidelines for National Greenhouse Gas Inventories” is used for the CO_2 emission factor of fossil fuels.

Thirdly, the installation-based information and data are obtained from annual energy investments published by the MoENR and five years of production capacity projection reports published by TETC. The annual investments provide the annual installed capacity for each year. Installation-based annual electricity generation data is available for 2018, 2017, 2016, and 2015 from five years of production capacity projection reports.

Lastly, for the VCP data and information, VCS and GS registries are used. Each registry offers various data such as the annual emission reduction potential, the registered projects, the project type, the credits issued and transacted, etc. Furthermore, each registry has project pages, where further information and the project documents are available. For the study, all data and information required for the cases are obtained and retrieved on 23/06/2020.

CHAPTER 5

METHOD

5.1 Overview

This chapter consists of three main sections. The first section gives the methodology for calculating the CO_2 emission factor of Turkey to calculate the emission reduction potential from the Turkish renewable energy sector, which will result in Case A. The second section then presents the methodology for calculating the emission reduction potential of all VCPs and eligible VCPs to issue carbon credits in Turkey. This will result in Case B and C. The last section gives a methodology to calculate issuances and transactions from VCPs in Turkey, which will provide the result of Case D and E.

5.2 Method for CO_2 Emission Factor Calculation

CDM provides several tools for different methodologies. For "Grid-connected electricity generation from renewable sources," it offers various tools. One of these tools is the "Tool to calculate the emission factor for an electricity system."

GS and VCS projects use CDM methodologies and tools for their additionality presentation and the CO_2 emission factors. Thus, this tool is used to calculate the emission factor of Turkey's electricity system. The tool determines the CO_2 emission factor by calculating the combined margin (CM) emission factor of the electricity system, which is the weighted average of the operating margin (OM) and the build margin (BM). According to the tool: "The OM is the emission factor that refers to the group of existing power plants whose current electricity generation would be affected by the proposed CDM project activity; the BM is the emission factor that refers to the group of prospective power plants whose construction and future operation would be affected by the proposed CDM project activity (CDM 2019)."

The tool gives a six-step procedure to determine the emission factor, CM of the electricity system.

Step 1. Identify the relevant electric systems

According to the tool, the exported electricity should not be subtracted from the total electricity generation data. For electricity import, the tool proposes several different options to determine the CO_2 emission factor(s) for net electricity imports from a connected electricity system. One of these options is to take the emission factor for imports from neighboring countries as considered zero (0) tCO_2/MWh for determining the OM.

Turkey has one national transmission system, and the TETC is in charge of all transmission activities. This is secured by the Electricity Market Law to maintain supply security. Although the share of the imported and exported electricity in Turkey is low, they should be considered as per the tool. In 2018, imported electricity was 0.8% of Turkey's total electricity generation, whereas the exported volume was 1% (Turkish Electricity Transmission Cooperation 2018e).

Step 2. Choose whether to include off-grid power plants in the project electricity system (optional)

As per the tool, either only grid power plants should be included, or both grid power plants and off-grid power plants should be included in the calculation. For the calculation, it is chosen to include only grid power plants.

Step 3. Select a method to determine the OM

The tool offers four different methods for calculating the OM emission factor: Simple OM, simple adjusted OM, dispatch data analysis OM, or average OM. The simple OM method is chosen as the most suitable for Turkey by following the explanation given and the flow chart given under the tool. As defined in the tool: The simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units." The share of low-cost/must-run (LCMR) resources should be less than 50% of the total grid generation in the last five years to choose the simple OM method. Since there is no nuclear power plant under operation in Turkey, the following are considered as LCMR: Hydropower, wind, waste, waste heat, geothermal, and solar.

Table 5.1 gives the LCMR production for the last five years, between 2014-2018. By using the resulting total LCMR production, Table 5.2 presents the share of LCMR production in the total generation.

Table 5.1. LCMR production (GWh) between 2014-2018 (Turkish Electricity Transmission Cooperation 2018c)

	Electricity Generation (GWh)				
Type	2014	2015	2016	2017	2018
Hydropower	40,644.7	67,145.8	67,230.9	58,218.5	59,938.4
Waste and Waste Heat	1,432.6	1,758.2	2,371.6	2,972.3	3,622.9
Geothermal and Wind	10,884.1	15,077.0	20,335.6	24,031.3	27,380.2
Solar	17.4	194.1	1,043.1	2,889.3	7,799.8
Total LCMR Production	52,978.8	84,175.1	90,981.3	88,111.4	98,741.3

Table 5.2. Share of LCMR production (%) between 2014-2018 (Turkish Electricity Transmission Cooperation 2018c)

	2014	2015	2016	2017	2018
Gross Production (GWh)	251,962.8	261,783.3	274,407.7	297,277.5	304,801.9
LCMR Production (GWh)	52,978.8	84,175.1	90,981.3	88,111.4	98,741.3
Share of LCMR (%)	21%	32%	33%	30%	32%

As shown from the share of LCMR in gross production, the LCMR share is less than 50% for the last five years. Thus, the simple OM method applies to Turkey.

Furthermore, the tool offers two options for the vintage data: Ex-ante or ex-post option. The ex-ante option is chosen for the calculation. Thus, a 3-year generation weighted average is used. When this thesis is written, the most recent data set was for 2018. As a result, data sets for 2016, 2017, and 2018 are used.

Step 4. Calculate the OM emission factor according to the selected method

Now that the simple OM method is chosen, the tool offers two options to calculate it. The offered two options are:

- Option A: Based on the net electricity generation and a CO_2 emission factor of each power unit;
- Option B: Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system.

There are three critical conditions to be met if Option B is chosen. First, the necessary data for Option A should not be available. In Turkey’s case, plant-based data is not publicly available every year. Second, only nuclear and renewable power generation should be considered as LCMR sources, and the quantity of electricity supplied to the grid by these sources should be known. As can be seen from Table 5.1, only renewable energy power plants are considered as LCMR. Third, off-grid power plants should not be included. In this third case, there is no publicly available data covering the off-grid plants.

To conclude, these three criteria could be met. Thus, Option B is chosen. Equation (1) gives the calculation of the simple OM that is based on the net electricity supplied to the grid by all power plants serving the system, not including LCMR power plants/units, and based on the fuel type(s) and total fuel consumption of the project electricity system.

$$EF_{grid,OMsimple,y} = \frac{\sum_i FC_{i,y} \times NCV_{i,y} \times EF_{CO2i,y}}{EG_y} \quad (1)$$

Where:

$EF_{grid,OMsimple,y}$: Simple OM CO_2 emission factor in year y (tCO_2/MWh)

$FC_{i,y}$: Amount of fossil fuel type i consumed in the project electricity system in year y (mass or volume unit)

$NCV_{i,y}$: Net calorific value of fossil fuel type i in year y (GJ/mass or volume unit)

$EF_{CO2i,y}$: CO_2 emission factor of fossil fuel type i in year y (tCO_2/GJ)

EG_y: Net electricity generated and delivered to the grid by all power sources serving the system, not including LCMR power plants/units, in year y (MWh)

i: All fossil fuel types combusted in power sources in the project electricity system in year y

y: The relevant year as per the data vintage chosen in Step 3

By following Equation (1) , net calorific values should be calculated. For that purpose, Equation 2 is used.

$$\mathrm{NCV_{i,y}} = \left(\mathrm{FC_{i,y}} \mathrm{x}\ \mathrm{HVF_{i,y}}\right) \div 4.1868 \text{ x } 1000 \tag{1}$$

Where:

$\mathrm{NCV}_{\mathbf{i,y}}$: Net calorific value of fossil fuel type i in year y (GJ/mass or volume unit)

$\mathrm{FC_{i,y}}$: Amount of fossil fuel type i consumed in the project electricity system in year y (mass or volume unit)

$\mathrm{HVF_{i,y}}$: Heating values for fossil fuel type I in year y (Tcal)

4.1868: 1 Tcal/TJ

i: All fossil fuel types combusted in power sources in the project electricity system in year y

y: The relevant year as per the data vintage chosen in Step 3

According to Equation 2, to calculate the net calorific value, the fuels' heating values and fossil fuel amount must be known. Table 4.4 gives the heating values of the fuels, and Table 4.3 presents the fossil fuel used for the last three years, between 2016-2018.

By using Equation 2, Table 4.3, and Table 4.4, the net calorific values of fuels are determined and given with Table 5.3.

Table 5.3. Net calorific values of fuels (TJ/Gg) between 2016-2018

Energy Sources	2016	2017	2018
Hard Coal and Imported Coal	24.07	23.60	23.52

Table 5.3. (Continued)

Energy Sources	2016	2017	2018
Lignite	7.20	6.97	6.77
Fuel Oil	42.42	44.92	46.42
Diesel Oil	44.21	44.62	43.12
LPG	0.00	0.00	0.00
Naphtha	0.00	0.00	0.00
Natural Gas	38.01	36.82	36.29

Once obtaining Table 5.3, now the other parameters of Equation 1 should be determined. The first parameter, the amount of fossil fuel type consumed, is given in Table 4.3. The second parameter is shown in Table 5.3. Lastly, the third parameter is the CO_2 emission factor of the fossil fuel type, which is given in Table 4.5.

The last parameter to be determined under Equation 1 is the net electricity generated and delivered to the grid by all power sources serving the system, excluding the LCMR sources. For that purpose, the net and gross electricity generation values are given in Table 5.4. This table also provides a comparison of these two values in terms of percentage.

Table 5.4. The net and gross electricity production (GWh) between 2016-2018 (Turkish Electricity Transmission Cooperation 2018a)

	2016	2017	2018
Gross Production (GWh)	274,407.7	297,277.5	304,801.9
Net Production (GWh)	261,936.8	284,257.5	290,502.2
Comparison (%)	95.5%	95.6%	95.3%

Now that the relation between the gross and the net electricity production in terms of percentage unit is known, Table 5.5 gives the total gross electricity production by the fossil fuel, total electricity production except for LCMR sources.

Table 5.5. Gross **e**lectricity **p**roduction (GWh) by fossil fuels between 2016-2018

Energy Sources	2016	2017	2018
Natural Gas	89,227.10	110,490.00	92,482.82
Lignite	38,569.90	40,694.40	45,087.0
Coal	53,703.20	56,781.90	68,161.6
Fuel Oil	969.10	520.60	328.9
Motor Oil	957.20	679.30	0.2
Naphtha	0.00	0.00	0.00
LPG	0.00	0.00	0.00
Total Gross Electricity Production (GWh)	183,426.5	209,166.2	206,060.6

The comparison of gross and net electricity production given in Table 5.4 is used to achieve the net electricity production value from the gross value. The result is shown in Table 5.6. Furthermore, according to the tool, to achieve the net electricity generated and delivered to the grid by all power sources serving the system, the imported electricity value should also be added. Thus, Table 5.6 reflects this rule as well and gives the resulting value.

Table 5.6. Net electricity generated and delivered to the grid by all power sources (GWh) between 2016-2018 (Turkish Electricity Transmission Cooperation 2018a)

Energy Sources	2016	2017	2018
Net Electricity Produced by Fossil Fuels (GWh)	175,090.4	200,005.3	196,393.3
Electricity Import (GWh)	6,330.3	2,728.3	2,476.9
Net Electricity Generated and Delivered to the Grid by All Power Sources (GWh)	181,420.7	202,733.6	198,870.2

Finally, all the parameters required to calculate the simple OM CO_2 emission factor with Equation 1 is determined and calculated. Table 5.7 gives the simple OM CO_2 emission factor for 2016, 2017, and 2018. The simple OM is calculated by taking the weighted average of these three years.

Table 5.7. Simple OM CO_2 emission factor (tCO_2/MWh) between 2016-2018

	2016	2017	2018
Simple OM CO_2 Emission Factor (tCO_2/MWh)	0.6804	0.6562	0.6899
3-year Generation Weighted Average Simple OM CO_2 Emission Factor (tCO_2/MWh)	0.6752		

Step 5. Calculate the BM emission factor

The tool offers two options for calculating the BM emission factor, either ex-ante-based or ex-post-based data. There are no defined criteria for the selection. For the calculation, the first option, which is calculating by ex-ante data, is chosen.

As per the tool, a sample group of power units used to calculate the BM should be determined. For that purpose, the set of five power units that started to supply electricity to the grid most recently should be identified. While identifying the set, power units registered as CDM project activities should be excluded. Then the annual electricity generation from this set should be determined. Table 5.8 presents the set of five power units, excluding the CDM project activities. Since the Standards such as the GS and the VCS use CDM methodologies, for the VCPs, excluding the CDM project activity means VCP activity. In other words, it means excluding Turkish VCPs from the list. While detecting these VCPs, Table 4.10 and Figure 4.2 are considered as the data source.

Table 5.8. The set of five power units (excluding the CDM project activities) (Turkish Ministry of Energy and Natural Resources 2018; Turkish Electricity Transmission Cooperation 2020)

Name of the Power Plant	Year	Installed Capacity (MW)	Fuel Type	Annual Electricity Generation (MWh)
Öner HES	31/10/2018	4.2	Hydropower	2,156.6
Durum Gıda Termik	16/11/2018	8.0	Natural Gas and Imported Coal	15,212.8
Tire Biyogaz Elektrik Santrali	17/11/2018	3.6	Biomass	3,631.0

Table 5.8. (Continued)

Name of the Power Plant	Year	Installed Capacity (MW)	Fuel Type	Annual Electricity Generation (MWh)
Pakmaya Kocaeli Termik Kojenerasyon	07/12/2018	1.9	Natural Gas	57,169.4
Swissotel Termik Kojenerasyon Santrali	28/12/2018	0.9	Natural Gas	6,879.8

While Table 5.8 presents the set of five power units, information of the power units that started to supply electricity to the grid most recently are taken from "Annual Energy Investments" published by the MoENR. Since the data set covers 2016, 2017, and 2018, the most recent data is taken for 2018. Furthermore, since the annual energy investment statistics do not have the annual electricity generation data, five years of production capacity projection report 2018 published by TETC is used.

According to Table 5.8, the annual electricity generation of the set of five power units is 85.05 GWh. After identifying the set of five power units, the next step is to determine 20% of the annual electricity generation of the electricity system. Then, these two values should be compared. If the annual electricity generation value of the set of five power units is less than 20% of the annual electricity generation of the project electricity system, 20% of the annual electricity generation of the project electricity system is taken as the data set. The annual gross electricity generation is given in Table 5.4. It was 304,801.9 GWh in 2018, and 20% of it is 60,960.4 GWh. Thus, instead of the set of five power units, 20% of the annual electricity generation will be taken as the data set to be worked. For that purpose, plants put into operation for the last three years are listed. For the OM calculation, the last three years' official data are used: 2018, 2017, and 2016. Likewise, the power plants put into operation in these years are listed. Then, as advised in the tool, the power units registered as CDM project activities are identified and not taken into account. As discussed before, CDM project activities mean Turkish VCPs. Thus, from that list, these VCPs are excluded. While detecting these VCPs, Table 4.10 and Figure 4.2 are considered as the data source.

However, this set's total annual electricity generation is less than 20% of the annual electricity generation in 2018. Power plants set into operation in 2015 are also included in the data set to reach 20% of the annual electricity generation in 2018. Unfortunately, it was not adequate enough to reach that 20% value. The total annual electricity generation of power plants put into the generation in 2018, 2017, 2016, and 2015 makes 48,993 GWh; the CDM project activities are excluded. Yet, plant-based annual electricity data is not publicly available for 2014 and 2013, as discussed under Chapter 4. Furthermore, starting with 2012, the publicly available data only shows the overall plant-based annual electricity generation data. In other words, the publicly available data gives the total electricity generation at the end of 2012, rather than the data of the power plants that became operational in 2012. Thus, considering the data constraint, another approach is followed.

As a result, a different method is used to calculate the BM emission factor: Using weights estimated for the installed capacity in place of annual electricity generation. It is assumed that every power plant operates with full capacity all around the year to tackle this data restraint. Thus, the set of five power units' installed capacity and 20% of the installed capacity in 2018 should be compared. Table 5.9 presents Turkey’s installed capacity by primary energy sources in 2018, and as per the table in 2018, the total installed capacity is 88,550.8 MW.

Table 5.9. Turkey's installed capacity by primary energy resources in 2018 (Turkish Electricity Transmission Cooperation 2018c)

Fuel Type	Installed Capacity (MW)	Share (%)
Natural Gas	21,479.9	24.3
Lignite	9,456.1	10.7
Hard Coal	9,576.4	10.8
Liquid Fuels	370.6	0.4
Hydropower	28,291.4	31.9
Wind Power	7,005.4	7.9
Geothermal	1,282.5	1.4
Waste and Waste Heat	818.9	0.9
Solar	5,062.8	5.7
Solid + Liquid Fuels	616.7	0.7
Liquid Fuels + Natural Gas	4,590.1	5.2
Total	88,550.8	100.0

From Table 5.9, it is calculated that 20% of the installed capacity of the set is 17,710.2 MW. Table 5.8 shows that the set of five power units' installed capacity is less than 17,7100.2 MW. Thus, the data set is taken as 20% of the installed capacity in 2018. MoENR publishes plant-based installed capacity data for each year.

As per the tool, the BM emissions factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units included in the BM for the most recent year and calculated as shown with Equation 3.

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} x\ EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad (2)$$

Where:

$EF_{grid,BM,y}$: BM CO_2 emission factor in year y (t CO_2/MWh)

$EG_{m,y}$: Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)

$EF_{EL,m,y}$: CO_2 emission factor of power unit m in year y (t CO_2/MWh)

m: Power units included in the BM

y: Most recent historical year for which electricity generation data is available

Since fuel consumption and electricity generation data are not available for plant-based, the following equation is used instead.

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} x\ 3.6}{\eta_{m,y}} \tag{3}$$

Where:

$EF_{EL,m,y}$: CO_2 emission factor of power unit m in year y (t CO_2/MWh)

$EF_{CO2,m,i,y}$: Average CO_2 emission factor of fuel type i used in power unit m in year y (t CO_2/GJ)

$\eta_{m,y}$: Average net energy conversion efficiency of power unit m in year y (ratio)

m: All power units serving the grid in year y except LCMR power units

y: The relevant year as per the data vintage chosen in Step 3

3.6: Conversion factor (GJ/MWh)

CO_2 emission factors of each fuel type are calculated using the above equation and presented in Table 5.10.

Table 5.10. CO_2 emission factor of fuels used in the sample set (Darío Gómez et al., n.d.; CDM 2019)

Fuels Used in Set Sample	The Average CO_2 Emission Factor of Each Fuel Type (tCO_2/GJ)	The Average Net Energy Conversion Efficiency (ηm,y)	The CO_2 Emission Factor Of Each Fuel Type (tCO_2/MWh)
Natural Gas	0.0543	62.00%	0.3153
Lignite	0.0909	50.00%	0.6545
Import Coal	0.0895	50.00%	0.6444

The main fossil fuels in the sample set (%20 of the installed capacity in 2018) are natural gas, lignite, and imported coal. The total installed capacity additions of power plants based on these three fuel types are identified from the sample set. The total capacity additions are presented in Table 5.11. Then, by multiplying with the capacity addition with the CO_2 emission factor of that fossil fuel type, emission additions in terms ($MW*tCO_2/MWh$) are determined. The resulting values are also presented in Table 5.11.

Table 5.11. Calculation of emission additions of each fossil fuel type

	Total Natural Gas Capacity Addition (MW)	Emission Addition of NG ($MW*tCO_2/MWh$)	Total Lignite Capacity Addition (MW)	Emission Addition of Lignite ($MW*tCO_2/MWh$)	Total Import Coal Capacity Addition (MW)	Emission Addition of Import Coal ($MW*tCO_2/MWh$)
Sample Group Total	5,743.5	1,810.9	2,877.3	1,883.1	3,226.3	2,079.0

After calculating each fossil fuel type's emission addition, the next and the last step is to calculate the BM CO_2 emission factor. The set group's installed capacity and the total emission addition from these three fossil fuels are used while calculating it. In addition to that, the gross/net electricity generation difference is taken into account. BM CO_2 emission factor is calculated as 0.3420 tCO_2.

Step 6. Calculate the CM emission factor

After calculating the simple OM and BM CO_2 emission factors, the last step is to calculate the CM CO_2 emission factor. The tool offers two options: Weighted average CM or simplified CM. Since data to determine the simple OM and BM CO_2 emission factor calculations are present, the weighted average CM method is chosen. For that purpose, Equation 5 is used.

$$\mathrm{EF}_{\mathrm{grid,CM,y}} = \mathrm{EF}_{\mathrm{grid,OM,y}} \mathrm{x}\ \mathrm{w}_{\mathrm{OM}} + \mathrm{EF}_{\mathrm{grid,BM,y}} \mathrm{x}\ \mathrm{w}_{\mathrm{BM}} \tag{4}$$

Where:

$\mathrm{EF}_{\mathrm{grid,BM,y}}$: BM CO_2 emission factor in year y (t CO_2/MWh)

$\mathrm{EF}_{\mathrm{grid,OM,y}}$: OM CO_2 emission factor in year y (t CO_2/MWh)

w_{OM}: Weighting of OM emissions factor (percent)

w_{BM}: Weighting of BM emissions factor (percent)

According to the tool, for wind and solar power generation project activities: wOM = 0.75 and wBM = 0.25. However, for the other type of projects, wOM and wBM should be taken as 0.5. Thus, for that purpose, two types of CM CO_2 emission factors have been calculated. For the wind and solar power generation projects, the CM is 0.5919 tCO_2/MWh and 0.5209 tCO_2/MWh for other types of projects.

5.3 Method for the Calculation of the Annual Estimated Emission Reduction from VCPs

While determining the emission reduction from the VCPs, different methods are used for GS and VCS projects since the data and information supply different breakdowns. Furthermore, as defined with Case B and C, the annual estimated emission reduction from the VCPs should be determined for all projects and only the eligible projects. Thus, three different methods should be built to calculate the emission reduction for all GS projects, all VCS projects, and eligible GS and VCS projects. The summation of all projects and eligible projects will give the result of Case B and C. The remainder of this sub-chapter will list the steps and explain the method used to determine the emission reduction from all GS projects, all VCS projects, and eligible GS and VCS projects in order.

5.3.1 Annual Estimated Emission Reduction from All GS projects

The GS registry supplies data with two types of classification: projects and credits. When the projects classification is chosen, all GS projects are listed on the website regardless of their registration status. Unfortunately, the data could not be retrieved as .csv directly.

The first classification, projects, provides many data and information. However, it does not provide the emission reduction, as shown in Figure 4.2. Furthermore, the other data and information source is the project search option, where the project documents are available. The project documents hold the most up-to-date information. Step 1 is to obtain data and information from the GS registry and obtain the annual emission reductions from project pages. Figure 5.1 illustrates the steps needed to be taken to complete Step 1.

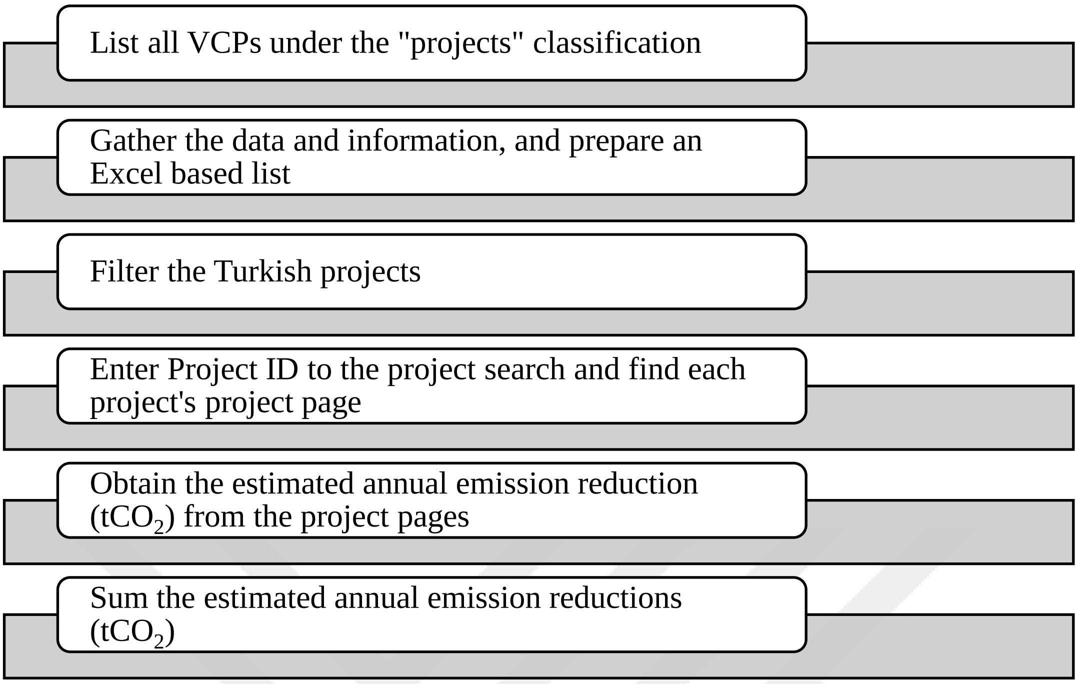


Figure 5.1. Step 1 to obtain data and information from the GS registry and gather the annual emission reductions from project pages

As illustrated in Figure 5.1, the first thing to do is select the “projects” classification and listing all the projects. The next thing is to gather this data and information and create an Excel-based list since the registry does not provide it in .csv format. Then, the Turkish projects are filtered. This way, regardless of their project status, all Turkish projects are obtained. Furthermore, the same list could be used to determine Turkish GS projects’ share in the globe. After listing all the Turkish projects, the estimated annual emission reduction (tCO_2) could not be summed like the VCS projects. Each projects’ ID is entered into the project search to obtain that data. The annual estimated emission reduction (tCO_2) values are obtained and included in the Excel-based list from each projects' page.

As of 23/06/2020, there were 285 Turkish GS projects. The estimated emission reduction values were not available for two projects. Thus, 283 Turkish GS projects are taken into consideration with a total estimated annual emission reduction of

22,488,536 tCO_2. Since this data is not obtained from each / every GS projects' documents, this is the top-down approach.

Then, Step 2 gathers data and information from the project documents available on the project pages and obtains the annual emission reductions. Figure 5.2 illustrates the steps needed to be taken to complete Step 2.

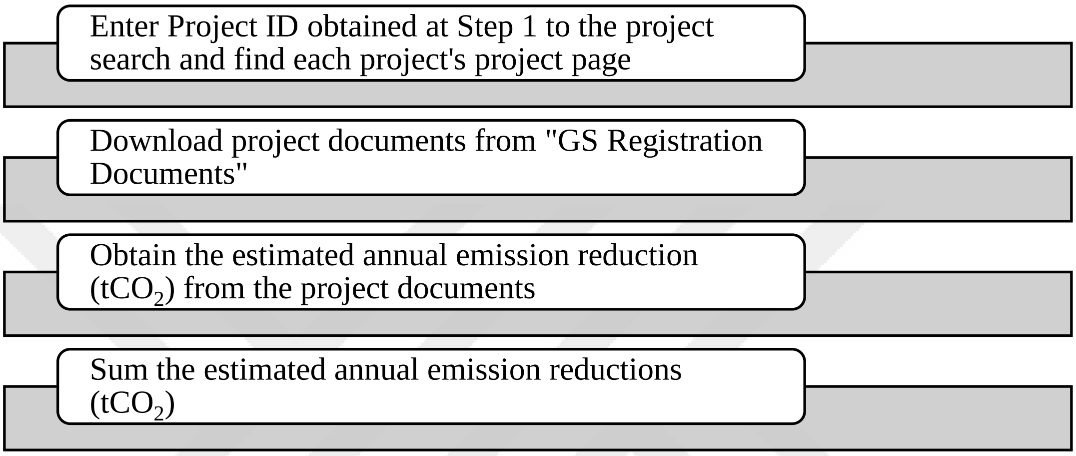


Figure 5.2. Step 2 to gather estimated annual emission reduction values obtained from the project documents

After completing Step 1, a list including all GS projects is obtained. As described in Step 2, the project documents are downloaded from each project's page. Then, the estimated annual emission reduction (tCO_2) for each project is found in the documents. Since the project document provides the most up-to-date information, if these documents are available, they are chosen as the data source. Whenever these documents are not available, the data available on the project page is selected as the data source. In other words, if the project document is available on the project page, then the data source would be the estimated annual emission reduction value obtained from the project document. For some projects, the data available on the project page and data obtained from the project documents might be the same, and for some projects, it might be different. Whenever it is not the same, and the project documents are taken as the data source, then the data source is called corrected estimated annual emission reduction (tCO_2). Lastly, even though there is an available project document for some projects, the project document might not hold the required data. For instance, only the project report discussing the project's social and environmental assessment might be available. For such cases, the data available on the project page is used. Figure 5.3 illustrates the decision tree for the data source choice.

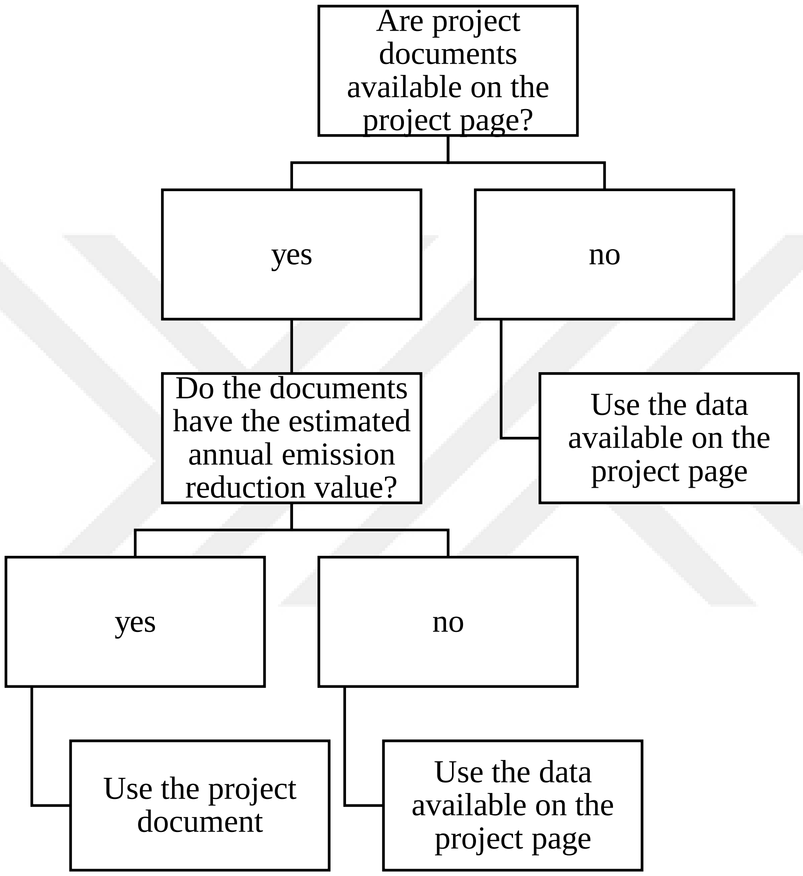


Figure 5.3. Decision tree for the data source choice

By following the decision tree, it has been found that the project documents were not available for 31 projects among 283 projects. Thus, for these 31 projects, the data source is selected as the project page. For 252 projects, the project documents were available. However, it has been detected that 10 of them do not hold the data. As a result, for 10 of them, the data available on the project page is taken, and the project documents are selected as the data source for 242 of them. In the end, the corrected estimated annual emission reductions are collected for 283 GS projects. The corrected estimated annual emission reduction from 283 GS projects is 21,496,643 tCO_2, as of 23/06/2020. Since all the project documents available on the GS registry are investigated one by one, this is the bottom-up approach, which makes this study unique.

5.3.2 Annual Estimated Emission Reduction from All VCS Projects

VCS registry supplies data in five main groups: all projects, registered, pipeline, VCUs, and buffer. The first group, all projects, provides the many data and information as given in Table 4.10. Furthermore, the other data and information source is the project search option, where the project documents are available. The project documents hold the most up-to-date information. Figure 5.4 illustrates the steps needed to be taken to retrieve data from the VCS registry.

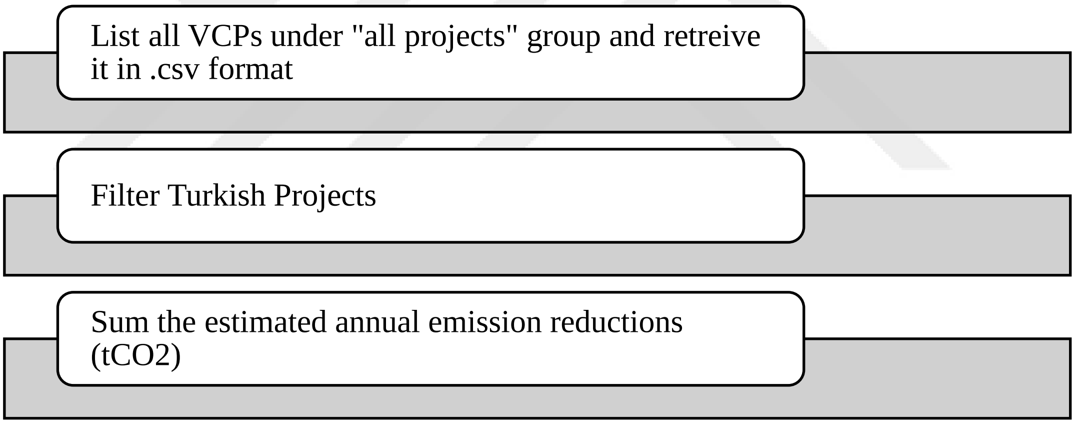


Figure 5.4. Step 1 to retrieve data from the VCS registry and obtain the annual emission reductions

As illustrated in Figure 5.4, the first thing to do is select the “all projects” group and retrieve the data in .csv format from the VCS registry. Then, the Turkish projects are filtered. This way, regardless of their project status, all Turkish projects are obtained. Furthermore, the same .csv could be used to determine Turkish VCS projects’ share in the globe. After listing all the Turkish projects, the estimated annual emission reduction (tCO_2) is summed. As of 23/06/2020, there were 153 Turkish VCS projects with a total estimated annual emission reduction of 11,619,951 tCO_2. In the list, there were two projects withdrawn from the VCS. Thus, these two are not included in the list; in other words, not included in these 153 projects. Since this data is not obtained from each / every VCS projects' documents, this is the top-down approach.

Then, Step 2 gathers data and information from the project documents, which are available on the project pages, and obtain the annual emission reductions. Figure 5.5 illustrates the steps needed to be taken to complete Step 2.

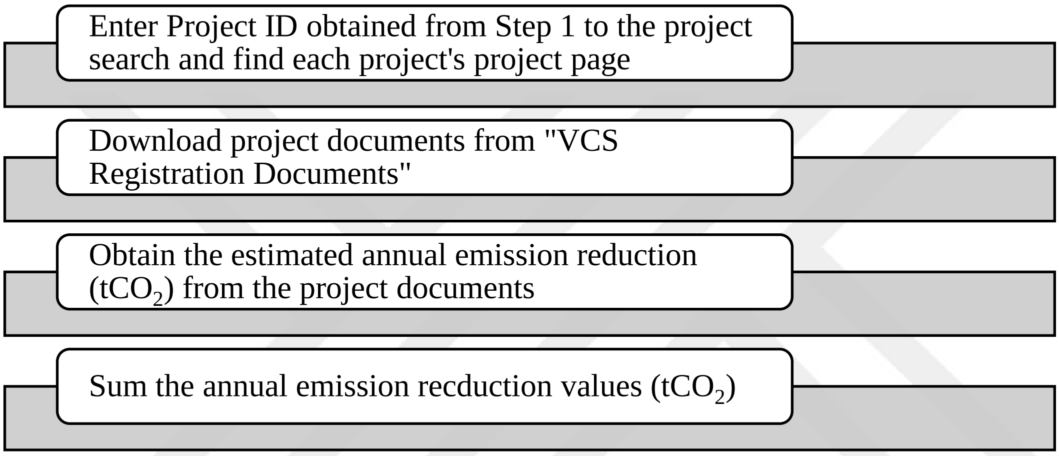


Figure 5.5. Step 2 to gather estimated annual emission reduction values obtained from the project documents

After completing Step 1, a list of all VCS projects is obtained that includes not only the estimated annual emission reductions but also the project ID, the project name, project status, etc. Then by entering each projects' ID into the project search, each projects' page is investigated. On each page, the project documents should be available. There might be some cases where the documents are not available. The same method given for the GS projects is followed for the VCS projects. Whenever the project documents are available, then they are selected as the data source. For some projects, the data retrieved from the registry and data obtained from the project documents might be the same, and for some projects, it might be different. Whenever it is not the same and the project documents are taken as the data source, then the data source is called "corrected estimated annual emission reduction (tCO_2)."

Among 153 VCS projects, the project documents were not available for ten projects. For these ten projects, the data retrieved from the VCS registry is used. Moreover, for four projects, the project documents were available but did not hold the data. As a result, for these 14 projects, the VCS registry was taken as the data source, and for the remaining 139 projects, the project documents were taken as the data source. Furthermore, in 32 projects, the estimated annual emission reduction values obtained from the project documents were different from those obtained from the VCS registries. Thus, for these 32 projects, the "corrected estimated annual emission reductions" are taken. With the corrected reduction values, the annual estimated emission reduction from 153 VCS projects is 11,765,650 tCO_2. Since all the project documents available on the VCS registry are investigated one by one, this is the bottom-up approach, which makes this study unique.

5.3.3 Annual Estimated Emission Reduction from Eligible VCS and GS Projects

As elaborated in a detailed manner under Chapter 2.3, GS and VCS projects need to follow each standard's stringent rules. According to these rules, only registered projects, in other words, the projects that completed the listing and validation steps and became registered, are only eligible to issue carbon credits for the registered crediting period. This means that whenever a project's crediting period is over and not renewed on time, this project becomes ineligible to issue carbon credits. In this regard, a categorization of the projects needs to be done to determine their eligibility status. The following projects are categorized as "ineligible":

- If the crediting period has ended and not renewed on time,
- If the project is only listed,
- If the project is not successfully registered.

While making this categorization and assessment, it should be considered that all the data regarding the projects are obtained and retrieved on 23/06/2020. Therefore, while evaluating the crediting period end date, it should be compared with 23/06/2020. If the project's crediting period end date is later than this date, it should be categorized as an eligible project to issue carbon credits.

The first step should be to assess the registration status of the project. Then, for the registered projects, the project documents should be taken as the primary data source since they have the most up-to-date information. Figure 5.6 gives the decision tree for the differentiation of the projects as eligible and ineligible based on their registration status and crediting period.

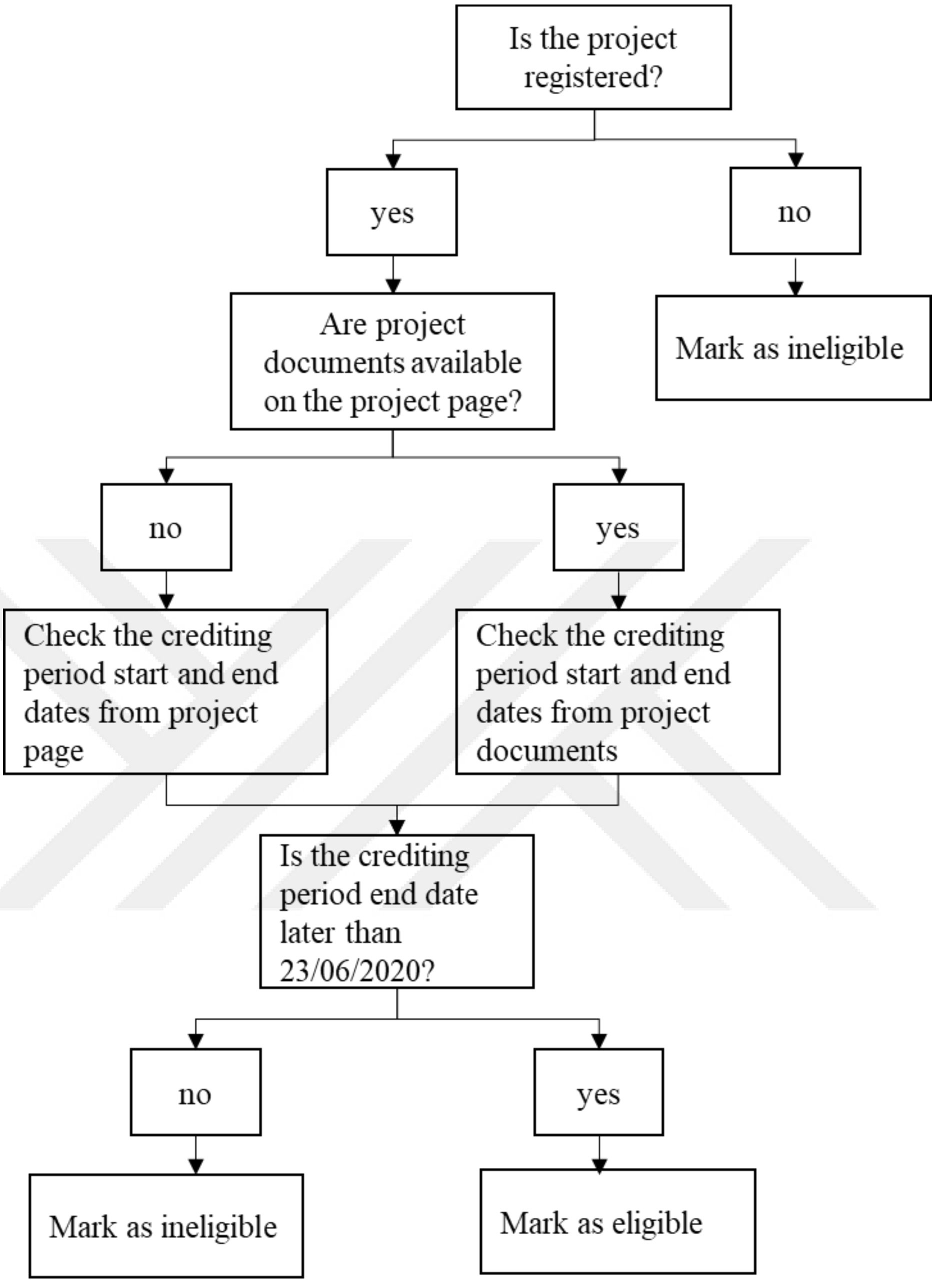


Figure 5.6. Decision tree for differentiation of the projects as eligible and ineligible

Figure 5.6 lays out each step to be followed while deciding each projects' eligibility for both GS and VCS projects. Among 283 GS projects, 116 of them were not registered and marked as ineligible. Then among 167 registered projects, the project documents were not available on the project page or were available but do not hold the crediting period information for four GS projects. Thus, according to the decision tree, the crediting period information on the project page is selected as the data source. Among these four registered projects, one was marked as ineligible since their crediting period was ended. For the remaining 163 registered projects, the project documents were available, and they hold the crediting period data. Among these 163 projects, 91 of them were eligible to issue credits. This means, among 283 GS projects, only 94 of them are eligible to issue credits as of 23/06/2020. Then, for these eligible and ineligible projects, the corrected annual estimated emission reduction values were estimated and gathered under Chapter 5.3.2. are used. The annual estimated emission reduction from the 94 eligible GS projects is 7,108,108 tCO_2.

Among 153 VCS projects, 30 of them were not registered and marked as ineligible. For the remaining 123 registered projects, the project documents were not available on the project page for four of them. Thus, for these four projects, the data source is selected as the registry. However, the registry itself does not hold the data regarding the crediting period. As a result, these four projects are marked as ineligible to be on the more conservative side. Among these 119 projects, 26 of them are marked as ineligible since their crediting period was ended. Thus, among 148 VCS projects, 93 of them are eligible to issue credits. Then, for these eligible and ineligible projects, the corrected annual estimated emission reduction values were estimated and gathered under Chapter 5.3.1. are used. The annual estimated emission reduction from 93 eligible VCS projects is 7,489,675 tCO_2.

This is the first study categorizing the VCPs as eligible and ineligible to issue carbon credits. With this approach, the annual offset volume of the Turkish VCM is estimated in a more realistic manner.

5.4 Method for Annual Issuance and Transactions from VCPs

While determining the annual issuance and transactions from the VCPs, different methods are used for GS and VCS projects since the data and information supply different breakdowns. Four different methods should be built to calculate the issuance and transaction volumes for all VCPs: issuances from GS projects, issuances from VCS projects, transactions from GS projects, and transactions from VCS projects. The summation of all issuances would give the result of Case D and all transactions would give the result of Case E. The remainder of this sub-chapter will list the steps and explain the method used to determine issuances from GS projects, issuances from VCS projects, transactions from GS projects, and transactions from VCS projects.

5.4.1 Issuances from GS Projects

Data could be retrieved from the GS registry in two main classifications: projects and credits. When the classification of the credit is chosen, the data could be exported in Excel format. When that choice is made, there are two-sub categories: issuances and retirements. Table 4.14 lists some of the projects and their issued credits under the “issuances” classification. Once the Excel-based data is retrieved from the GS registry, Step 1 is to filter the to obtain the issued credits from GS projects. Figure 5.7 illustrates the steps needed to be taken to complete Step 1.

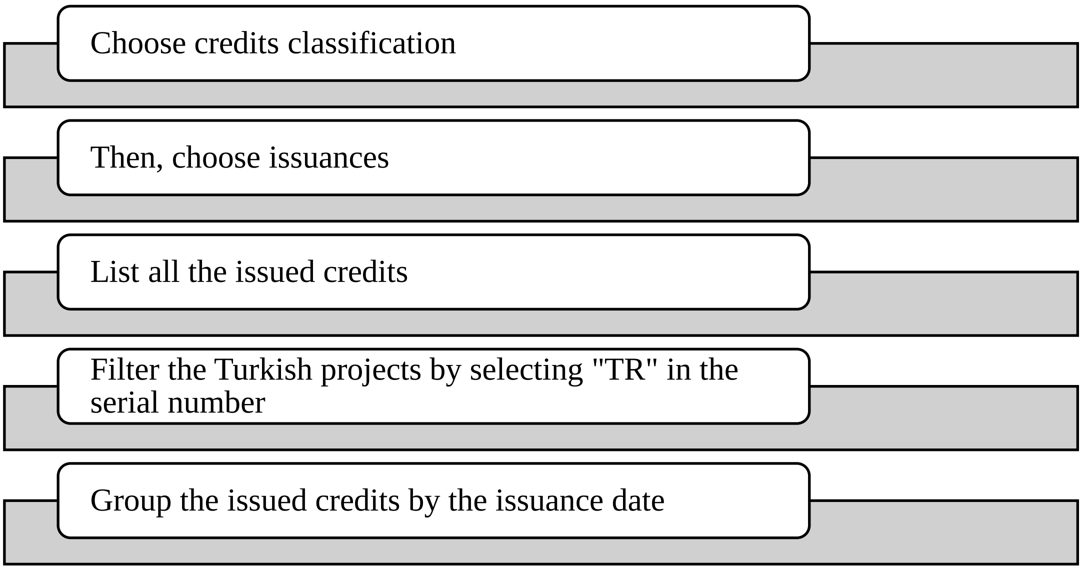


Figure 5.7. Steps to be followed to calculate the issuances from GS projects

After completing Step 1, issued credits from GS projects for each year are obtained. According to the data, carbon credits equal to 33,897,699 tCO_2 are issued from GS projects as of 23/06/2020. This value covers the date between the first issuance is made until 23/06/2020, since the data is retrieved on that date. The last step would be to determine the annual issuance volume from the GS projects.

5.4.2 Issuances from VCS Projects

Data could be retrieved from the VCS registry in five main groups: all projects, registered, pipeline, VCUs, and buffer. When the group of VCUs is chosen, the data could be exported in Excel format. Table 4.13 lists some of the projects and their VCUs under all VCUs group retrieved from the VCS registry. The "total vintage quantity" column indicates the total volume of issued credits, which the transacted credit belongs. Step 1 is to group the "total vintage quantities" to obtain the issuance volume from the VCS projects. Figure 5.8 illustrates the steps needed to be taken to complete Step 1.

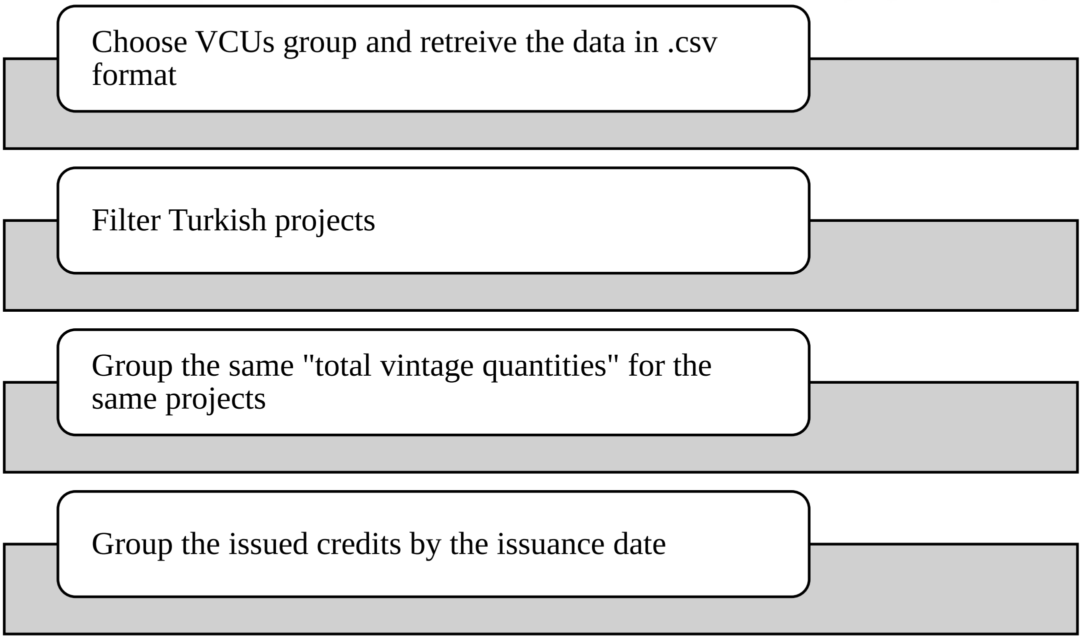


Figure 5.8. Steps to be followed to calculate the issuances from VCS projects

After completing Step 1, it is calculated that carbon credits equal to 9,279,409 tCO_2 are issued from VCS projects as of 23/06/2020. This value covers the date between the first issuance is made until 23/06/2020, since the data is retrieved on that date. The last step would be to determine the annual issuance volume from the VCS projects.

5.4.3 Transactions from GS Projects

Data could be retrieved from the GS registry in two main classifications: projects and credits. When the classification of the credit is chosen, the data could be exported in Excel format. When the classification of credits is chosen, there are two-sub categories: issuances and retirements. Table 4.15 lists some of the projects and their transacted credits under the "retirements" classification. Once the Excel-based data is retrieved from the GS registry, the next steps to be followed to calculate the retired, in other words, transacted credits, are given in Figure 5.9.

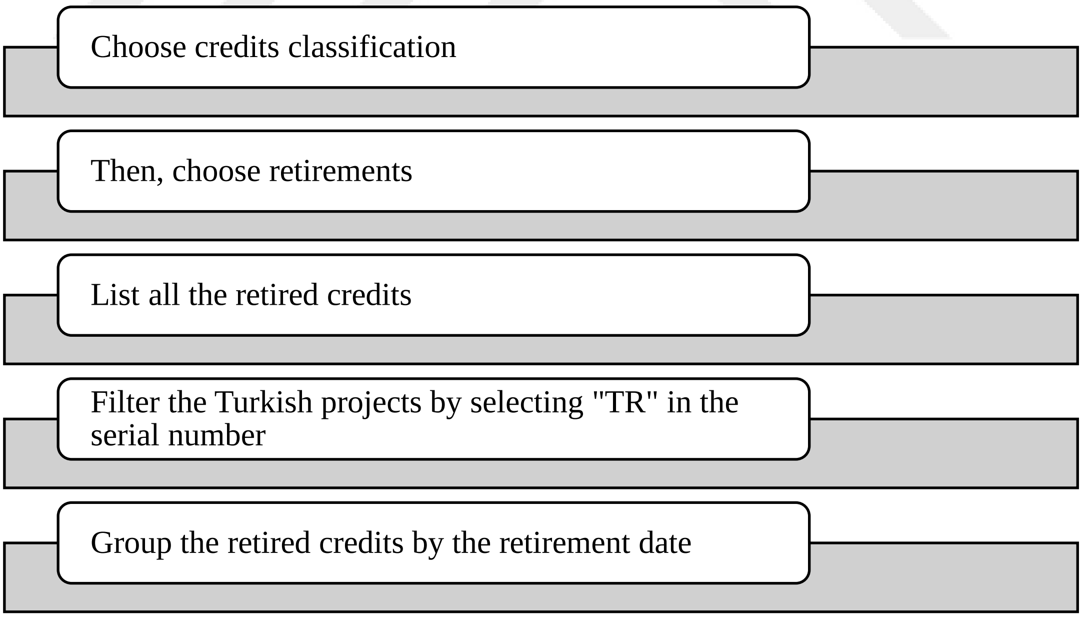


Figure 5.9. Steps to be followed to calculate the retired credits from GS projects

After completing Step 1, the transacted credits from GS projects for each year are obtained. According to the data, carbon credits equal to 18,456,480 tCO_2 are transacted from GS projects as of 23/06/2020. This value covers the date between the first transaction is made until 23/06/2020, since the data is retrieved on that date. The last step would be to determine the annual transaction volume from the GS projects.

5.4.4 Transactions from VCS Projects

Data could be retrieved from the VCS registry in five main groups: all projects, registered, pipeline, VCUs, and buffer. When the group of VCUs is chosen, the data could be exported in Excel format. Table 4.13 lists some of the projects and their VCUs under all VCUs group retrieved from the VCS registry. The "credits quantity issued" column indicates the total volume of retired credits, and the retirement/cancellation date shows the transaction year. Figure 5.10 illustrates the steps needed to be taken to group the retirements for each year to obtain the retired volume from the VCS projects.

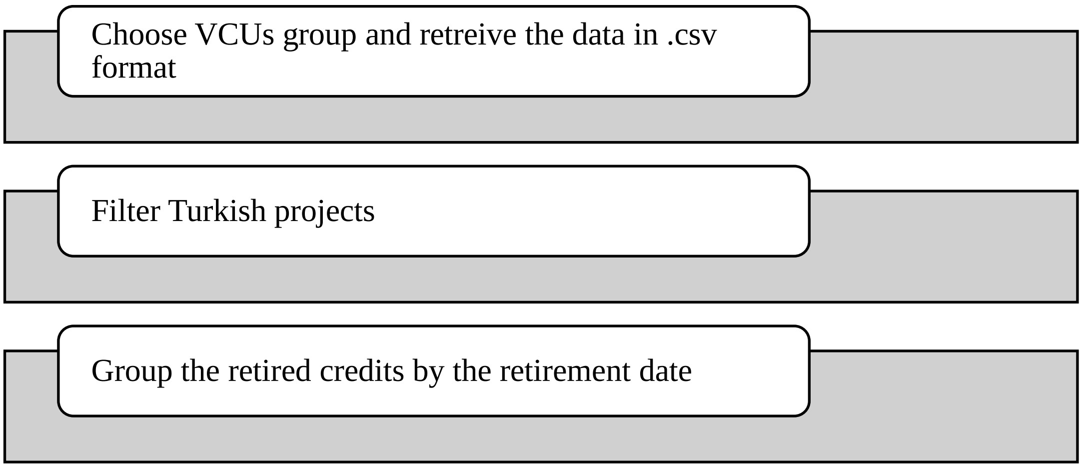


Figure 5.10. Steps to be followed to calculate the transactions from VCS projects

After completing Step 1, transacted credits from VCS projects for each year are obtained. As of 23/06/2020, carbon credits equal to 4,339,376 tCO_2 are transacted.

This value covers the date between the first transaction is made until 23/06/2020, since the data is retrieved on that date. The last step would be to determine the annual transaction volume from the VCS projects.

5.5 Closing Remarks

This chapter presents the methodology of estimating the CO2 emission factor of Turkey's electricity system by using CDM's "Tool to calculate the emission factor for an electricity system." In the end, the calculated CO2 emission factor is used to calculate the emission reduction potential of Turkish renewable energy by multiplying with the electricity generation from the renewable energy sector.

Secondly, this chapter provides a method for the calculation of annual emission reduction potential from VCPs. For that purpose, four different methods are built to calculate the annual emission reduction for all GS projects, all VCS projects, eligible GS projects, and eligible VCS projects.

Thirdly, and lastly, this chapter gives a method for determining annual issuance and transaction volumes from the VCPs. Like the method for the calculation of emission reduction from VCPs, it proposed four different methods: issuances from GS projects, issuances from VCS projects, transactions from GS projects, and transactions from VCS projects.

CHAPTER 6

RESULTS

6.1 Overview

This chapter presents each case's results and consists of three main sections using the data given in Chapter 4 and the methods presented in Chapter 5. The first section gives the annual emission reduction potential of the Turkish renewable energy sector for 2018. It presents the result of Case A, annual offset volume from the Turkish renewable energy sector.

Furthermore, the second and the third sections present the annual emission reduction potential of all Turkish VCPs and Turkish VCPs eligible to issue carbon credits as of 23/06/2020. These two results indicate Case B and C's result, the annual offset volume from all VCPs and only eligible VCPs.

Lastly, the last two sections present the total issued and transacted carbon credits from VCPs, which constitute Case D and Case E, the annual issued and transacted carbon credits.

6.2 Results of Case A

Regardless of the VCM, Case A covers renewable energy power plants in Turkey to reflect the annual offset volume if a local certification system is introduced. For that purpose, emission reduction for the renewable energy sector should be calculated from the renewable energy sector and the CM CO2 emission factor.

While calculating the CO_2 emission factor, electricity generation data for 2016-2018 presented in Chapter 4.2 is used. The electricity generation data obtained from TETC's annual electricity statistics cover the following: imported and exported electricity in 2018, gross electricity generation by renewable sources and fossil fuels for 2016-2018, net and gross electricity production for 2016-2018. Furthermore, fossil fuel-related data is used that is given in Chapter 4.3. The related data covers the fuel consumption in thermal power plants in 2016-2018, heating values of fuels consumed in thermal power plants in 2016-2018 obtained from again TETC's annual electric statistics. Moreover, related to the fossil fuel data, "2006 IPCC Guidelines for National Greenhouse Gas Inventories" is used for the CO2 emission factor of fossil fuels. In addition to the fossil fuel data, the installation-based information given under Chapter 4.4. is used. The annual energy investments published by the MoENR and five years of production capacity projection reports published by TETC are the used data source.

CDM's "Grid-connected electricity generation from renewable sources" methodology is used to calculate the CO_2 emission factor. Under this methodology, "Tool to calculate the emission factor for an electricity system" is chosen. The tool gives a six-step procedure to determine the emission factor, CM of the electricity system. The details of the tool, as well as these six steps followed, are given under Chapter 5.2.

As a result, the CO_2 emission factor for 2018 is calculated as 0.5919 tCO_2/MWh for the wind and solar power generation projects and 0.5209 tCO_2/MWh for other types of projects.

The electricity generated from the renewable energy sector in 2018 is used since the CM CO_2 emission factor is calculated for 2018. Table 6.1 gives the emission reduction potential of Turkey's renewable energy potential for 2018.

Table 6.1. Emission reduction potential of the renewable energy sector for 2018

Renewable Type	Electricity Generation in 2018 (GWh)	Emission Reduction (tCO_2)
Hydropower	59,939	30,485,227
Wind	19,949	11,808,208

Table 6.1. (Continued)

Renewable Type	Electricity Generation in 2018 (GWh)	Emission Reduction (tCO_2)
Geothermal	7,431	3,779,469
Solar	7,800	4,616,810
Renewable Waste and Waste Heat	3,623	1,842,638
Total	98,741	52,532,351

The total emission reduction given in Table 6.1 is directly the outcome of Case A. The annual offset volume from the renewable energy sector is equal to 52,532,351 tCO_2 for 2018.

6.3 Results of Case B

Regardless of the VCM volume, Case B and C are built on the VCPs. Case B includes all Turkish VCPs regardless of the eligibility of issuing carbon credits or their registration status. Therefore, it represents the total potential of annual offset volume.

While estimating the emission reduction potential of the VCS and GS projects, different data sources are used. The data sources are elaborated under Chapter 4.5. Both GS and VCS hold data and information at their registries with different breakdowns. Furthermore, each project has a project page at the registry, which provides further information, and most importantly, project documents are available there. Apart from the data sources, the method for calculating the emission reduction from the VCPs is detailed in Chapter 5.3. As defined under Chapter 5.3, if the project document is available on the project page and holds the required data, the data source would be the estimated annual emission reduction value obtained from the project document. In this way, the most important feature and difference of the thesis is the bottom-up approach.

The annual estimated emission reduction from 283 GS projects is 21,496,643 tCO_2; from 153 VCS projects is 11,765,650 tCO_2 as of 16/06/2020.

While Table 6.2 presents the project type, the number of projects, and the annual estimated emission reduction from the GS projects, Table 6.3 presents the same data for the VCS projects obtained through the bottom-up approach as of 23/06/2020.

Table 6.2. GS projects with the breakdown of their project type, number of projects, and the annual estimated emission reduction (tCO_2)

Project Type	Number of Project	Annual Estimated Emission Reduction (tCO2)
Geothermal	10	1,798,803
Hydropower	68	1,813,312
Landfill	22	4,340,016
Other	24	1,965,950
Solar	7	56,605
Wind	152	11,521,957

Table 6.3. VCS projects with the breakdown of their project type, number of projects, and the annual estimated emission reduction (tCO_2)

Project Type	Number of Project	Annual Estimated Emission Reduction (tCO_2)
Geothermal	2	125,731
Hydropower	116	10,056,874
Other	8	306,102
Solar	10	123,294
Wind	17	1,153,649

When Table 6.2 and Table 6.3 are compared, the first thing that attracts attention is the distribution of the project types. 54% of the GS projects consist of wind projects, whereas 76% of the VCS projects consist of hydropower projects.

The summary of annual estimated emission reductions (tCO_2) from VCPs covering both GS and VCS is presented in Table 6.4.

Table 6.4. The summary of annual estimated emission reduction (tCO_2) from VCPs covering both GS and VCS

The Standard Used	Number of Projects	Data Source	Annual Estimated Emission Reduction (tCO_2)
GS	242	Project Documents	19,528,762
GS	41	GS Registry	1,967,881

Table 6.4. (Continued)

The Standard Used	Number of Projects	Data Source	Annual Estimated Emission Reduction (tCO_2)
VCS	139	Project Documents	10,621,600
VCS	10	VCS Registry	1,144,050
Total	436	-	33,262,293

As shown in Table 6.4, there were 436 projects with an annual estimated emission reduction potential of 33,262,293 tCO_2 as per the data obtained from the project document or the Standard registries. If the top-down approach was followed by taking the data directly from the standard registries, then the estimated emission reduction for these 436 projects would be 34,108,487 tCO_2, which indicates a %2.54 deviation. Lastly, the annual estimated emission reduction potential equal to 33,262,293 tCO_2 gives the result of Case B.

6.4 Results of Case C

Although Case B includes every VCP regardless of their registration status and eligibility, Case C covers only the eligible VCPs. For the method used, a categorization is made. If the project is not registered, then it is marked as ineligible. Furthermore, the crediting period is evaluated for the registered projects. If the crediting period is ended and not renewed, then they are also marked as ineligible. As the details of the evaluation with decision trees are given under Chapter 5.3, projects with a crediting period end date later than 23/06/2020 and not renewed are marked as ineligible since all the data regarding the projects are obtained and retrieved on 23/06/2020.

Regarding the data sources, to detect the registered projects, data and information retrieved from the Standard registries are used. For the registered projects, to check the crediting period information, the data source used is the same as the data source used for Case B, Project documents. If the project document is available on the project page and holds the required information, it would become the source for the crediting period information. Otherwise, the information available on the project page is selected as the information source. Table 6.5 gives the ineligible GS and VCS projects results with the reason for their ineligibility, the information source, and the annual estimated emission reduction. Furthermore, Table 6.6 gives the results of the eligible GS and VCS projects with the information source and the annual estimated emission reduction.

Table 6.5. Annual estimated emission reduction (tCO_2) from ineligible projects covering both GS and VCS

The Standard Used	Number of Projects	Reason for the Ineligibility	Information Source for the Ineligibility	Annual Estimated Emission Reduction (tCO_2)
GS	116	Not registered	GS Registry	8,928,028
GS	72	Finished Crediting Period	Project Documents	5,452,507
GS	1	Finished Crediting Period	GS Registry	8,000

Table 6.5. (Continued)

The Standard Used	Number of Projects	Reason for the Ineligibility	Information Source for the Ineligibility	Annual Estimated Emission Reduction (tCO_2)
VCS	30	Not registered	VCS Registry	1,874,488
VCS	26	Finished Crediting Period	Project Documents	1,643,022
VCS	4	No data or information was available	n/a	758,465
Total	249	-	-	18,664,510

Table 6.6. Annual estimated emission reduction (tCO_2) from eligible projects covering both GS and VCS

The Standard Used	Number of Projects	Information Source	Annual Estimated Emission Reduction (tCO_2)
GS	3	GS Registry	199,589
GS	91	Project Documents	6,908,519
VCS	93	VCS Registry	7,489,675
Total	187	-	14,597,783

The total annual estimated emission reduction volume given in Table 6.6 gives the result of Case C, the annual offset volume from VCPs eligible to issue carbon credit.

Table 6.7 and Table 6.8 present the project type, number of projects, and the annual estimated emission reduction from the eligible GS and VCS projects as of 23/06/2020.

Table 6.7. GS projects eligible to issue carbon credits with the breakdown of their project type, number of projects, and the annual estimated emission reduction (tCO_2)

Project Type	Number of Project	Annual Estimated Emission Reduction (tCO_2)
Geothermal	1	22,525
Hydropower	12	365,005
Landfill	5	1,039,821
Other	4	312,368
Solar	5	39,833
Wind	67	5,328,556

Table 6.8. VCS projects eligible to issue carbon credits with the breakdown of their project type, number of projects, and the annual estimated emission reduction (tCO_2)

Project Type	Number of Project	Annual Estimated Emission Reduction (tCO_2)
Geothermal	1	95,422
Hydropower	73	6,761,282
Landfill	-	-
Other	8	306,102
Solar	3	18,360
Wind	8	308,509

When Table 6.7 and Table 6.8 are compared, the wind projects still dominate the GS side, and hydropower projects still dominate the VCS side. Furthermore, when Table 6.5 and Table 6.7 are compared, it has resulted that 67% of the GS projects are ineligible to issue carbon credits, whereas Table 6.6 and Table 6.8 are compared 39% of the VCS projects became ineligible.

6.5 Results of Case D

Cases D and E are built on the VCM to reflect the supply and demand of the market. In other words, unlike Case B and Case C focusing on the annual emission reduction potential of the projects to reach the potential annual offset volume from the renewable energy projects, Case D focuses on the supply side of the market. In that respect, Case D covers the issuance volume of the VCPs to indicate Turkey's actual supply of carbon credits.

While estimating the issuances from the VCS and GS projects, different data sources are used. The data sources are elaborated under Chapter 4.5. Both GS and VCS hold data and information at their registries with different breakdowns. Chapter 5.4 gives further details of the methodology used to estimate the issuances and transactions from the VCPs. By choosing the "issuances" classification under the credits for the GS projects and choosing the VCUs group for the VCS projects, the volume of total issued credits for each year is obtained on 23/06/2020. Table 6.9, Table 6.10, and Table 6.12 present the yearly issuances and the number of projects for each year.

Table 6.9. Annual issuances from GS projects by the years and number of projects

Years	Number of Projects	Issuance Volume (tCO_2)
2008	2	112,366
2009	4	887,707
2010	12	1,377,848
2011	16	1,635,904
2012	20	2,674,584
2013	20	3,402,574
2014	21	3,355,056
2015	12	4,296,540
2016	11	2,148,804
2017	16	2,964,190
2018	17	4,319,495
2019	12	2,481,373
01/01/2020 - 23/06/2020	11	4,241,258

Table 6.10. Annual issuances from VCS projects by the years and number of projects

Years	Number of Projects	Issuance Volume (tCO_2)
2009	3	92,957
2010	4	174,704

Table 6.10. (Continued)

Years	Number of Projects	Issuance Volume (tCO_2)
2011	8	675,763
2012	10	1,733,128
2013	12	1,679,465
2014	12	1,523,930
2015	7	545,868
2016	5	434,096
2017	3	231,528
2018	-	-
2019	7	615,185
01/01/2020 - 23/06/2020	5	1,572,785

In addition to the annual volumes, Table 6.11 lists the total issuances from GS and VCS projects as of 23/06/2020.

Table 6.11. Total issuances from the VCPs

Standard	Total Issuance Volume (tCO_2)
VCS	9,279,409
GS	33,897,699
Total	43,177,108

As the last step, the annual issuance and transaction volumes need to be estimated to reach the result of Case D. To obtain annual issued carbon credits, data from 2010 to 2019 is used. Since 2020 data does not reflect a whole year, it is excluded. Furthermore, in the beginning, the number of projects was very low. Thus, the issued carbon credits were low. For that reason, the data from 2008 and 2009 is not included also. To conclude, by taking the average of the years between 2010-2019, the annual issuance of carbon credits is equal to 3,627,004 tCO_2, as given in Table 6.12.

Table 6.12. Annual issuances from the VCPs

Standard	Annual Issuances Volume (tCO_2)
VCS	761,367
GS	2,865,637
Total	3,627,004

6.6 Results of Case E

Like Case D, Case E is built to reflect the demand side of the market. It does not give a potential of annual offset volume like Cases A, B, and C. In that respect, Case E covers the transacted volume of the VCPs to indicate Turkey’s actual demand for carbon credits.

While estimating the transactions from VCPs, different data sources are used. The data sources are elaborated under Chapter 4.5. Both GS and VCS hold data and information at their registries with different breakdowns. Chapter 5.4 gives further details of the methodology used to estimate the issuances and transactions from the VCPs. By choosing the “retirements” classification under the credits for the GS projects and by choosing the VCUs group for the VCS projects, the volume of total transacted credits for each year is obtained on 23/06/2020. As a result, the volumes for each year and each Standard type is obtained.

Table 6.13 and Table 6.14 presents the yearly transactions and the number of projects for each year.

Table 6.13. Annual transactions from GS projects by the years and number of projects

Years	Number of Projects	Transaction Volume (tCO_2)
2009	4	106,118
2010	8	1,116,008
2011	15	988,640
2012	22	975,848
2013	34	1,533,789

Table 6.13. (Continued)

Years	Number of Projects	Transaction Volume (tCO_2)
2014	42	1,988,821
2015	47	2,077,557
2016	50	1,964,306
2017	54	1,549,204
2018	64	1,602,539
2019	74	2,131,520
01/01/2020 - 23/06/2020	68	2,422,130

Table 6.14. Annual transactions from VCS projects by the years and number of projects

Years	Number of Projects	Transaction Volume (tCO_2)
2009	1	20
2010	3	12,947
2011	5	96,303
2012	7	255,890
2013	14	335,661
2014	20	673,160
2015	11	657,106
2016	19	288,161
2017	18	973,306
2018	12	296,704
2019	15	565,944
01/01/2020 - 23/06/2020	16	184,174

In addition to the annual volumes, Table 6.15 lists the total transaction volumes from GS and VCS projects as of 23/06/2020.

Table 6.15. Total transactions from the VCPs

Standard	Total Transaction Volume (tCO_2)
VCS	4,339,376
GS	18,456,480
Total	22,795,856

As the last step, the annual transaction volumes need to be estimated to reach the result of Case D. To obtain annual transacted carbon credits, data from 2010 to 2019 is used. Since 2020 data does not reflect a whole year, it is excluded. Furthermore, in the beginning, the number of projects was very low. Thus, the issued carbon credits were low. For that reason, the data from 2008 and 2009 is not included also. To conclude, by taking the average of the years between 2010-2019, the annual issuance of carbon credits is equal to 2,008,341 tCO_2, as given in Table 6.16.

Table 6.16. Annual transactions from the VCPs

Standard	Annual Transactions (tCO_2)
VCS	415,518
GS	1,592,823
Total	2,008,341

6.7 Closing Remarks

In this chapter, the results of each five cases are presented. Case A takes Turkey's renewable energy sector due to its high emission reduction potential. Based on 2018 electricity generation data, the annual offset volume is calculated as 52,532,351 tCO_2.

The second case was Case B, which takes all VCPs regardless of their registration status or eligibility to issue carbon credits. The result of this case reflects the total offset potential of the Turkish VCPs. As of 23/06/2020, the annual offset volume from VCPs is calculated as 33,262,293 tCO_2. Furthermore, Case C was based on the VCPs that are eligible to issue carbon credits. In this case, differentiation of the projects is made to detect the eligible ones. As of 23/06/2020, the annual offset volume from VCPs eligible to issue carbon credits is calculated as 14,597,783 tCO_2.

The fourth case was Case D, which was set to determine the annual offset volume based on the issued carbon credits from the VCPs. Case D reflects the supply side of the market. Like Case D, Case E was set to reflect the market's demand-side by taking the annual offset volume based on the transacted carbon credits from the VCPs. As of 23/06/2020, the annual offset volume calculated under Case D was 3,627,004 tCO_2 and 2,901,603 tCO_2 under Case E.

CHAPTER 7

DISCUSSION

Turkey is an Annex I country of the UNFCCC and not an Annex B country of the KP. This situation gave Turkey a unique position and made Turkey one of the most active participants of the VCM. Today, VCM has a significant role in Turkey's participation in the carbon market.

GHG emissions from electricity generation have the largest share in Turkey's GHG emissions, with a 30% share. In 2018, the total share of renewable energy in electricity generation was 32.4%. Thus, due to the high emission reduction potential of renewable energy, Turkey has a high emission reduction potential in the VCM, in other words, a high carbon credit supply.

In 2018, both GS and VCS announced their new eligibility criteria, and both published them in 2019. According to the new eligibility criteria, Turkish renewable energy projects would no longer be registered as GS and VCS projects. However, this rule would not apply to the projects that are already registered. They would continue issuing credits. In other words, the number of GS and VCS projects could be considered at the maximum level and the annual emission reduction potential of the Turkish VCM.

In 2016, the 39th General Assembly of the International Civil Aviation Organisation's (ICAO) approved the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) that puts mandatory rules over the aeroplane operators. Starting from the 1st of January 2019, aeroplane operators have to monitor and report their emissions originating from all international flights. In addition to compliance with the monitoring, reporting, and verification requirements, from the 1st of January 2021 to the 31st of December 2035, aeroplane operators have to offset their emissions originating from international flights between the participating states

(ICAO 2018). Under the CORSIA, the post-2020 growth will be subjected to offsetting through purchasing eligible carbon credits (Maertens et al. 2019).

Turkish Directorate General of Civil Aviation under the Ministry of Transport and Infrastructure declared its intention to participate and implement the CORSIA provisions in the Bratislava Declaration on the 3rd of September, 2016. Thus, Turkish aeroplane operators have to offset their emissions originating from international flights between the participating states starting from the 1st of January 2021.

In August 2020, ICAO published the rules on the CORSIA eligible emission units. As per this document, American Carbon Registry, China GHG Voluntary Emission Reduction Program, CDM, Climate Action Reserve, GS, and VCS are chosen as the approved emission unit programmes with further specifications and limitations on the eligibility timeframe, eligible unit dates, scope of the eligibility, etc. Right now, all six of these programmes are accepted for the 2021-2023 compliance cycle. Finally, the carbon credits from the VCPs under GS and VCS would only be eligible for CORSIA if their first crediting period is started after the 1st of January 2016 and in respect of emissions reductions that occurred through 31st of December 2020 (International Civil Aviation 2020). To conclude, since GS and VCS are accepted as the CORSIA eligible emission units with some restrictions, it would increase the supply for the VCM. In other words, the supply of the Turkish carbon credits from GS and VCS projects would increase.

When the PA was negotiated and adopted in 2015, Article 6 of it was a prominent article for the carbon markets. Article 6 of the Agreement opens the way for the potential use of ITMOs voluntarily. Article 6 had created an expectation of an increase in the demand side of the VCM. Another significant fact that Turkey has not ratified the PA yet. Thus, although the details of the ITMOs and the possibility of uplifting the VCM, Turkey might be left outside like the KP. Thus, the possible effects over the VCM remain very unclear.

Although VCS and GS announced their new rules stabilizing the Turkish market's supply side, the recent developments on the CORSIA increased the demand. Furthermore, Article 6 of the PA gave the green light to the market.

This thesis's research question is: “What is Turkey's annual offset volume from the renewable energy sector and the VCPs at the carbon market?” It is the first comprehensive study investigating this topic. While researching this question, the thesis determines the annual offset volume under five main cases that depend on renewable energy as a whole, all Turkish VCPs, VCPs that are eligible to issue carbon credits, and issued and transacted carbon credits at the VCM from Turkish VCPs. Apart from that, the thesis studies:

- The CO_2 emission factor of Turkey’s electricity grid,
- Emission reduction potential from the Turkish renewable energy sector,
- The annual offset potential, number of projects, the renewable energy type, and the Standard type of all VCPs,
- The annual offset potential, number of projects, the renewable energy type, and the Standard type of only eligible VCPs with the breakdown of registration status of the VCPs,
- Annually issued carbon credits with further information on the Standard type and the number of projects
- Annually transacted carbon credits with further information on the Standard type and the number of projects.

The studies given with the literature research have a top-down approach where they only give the information for all VCPs, and the most recent one belongs to 2018. However, this thesis has a bottom-up approach where the information such as the annual estimated emission reduction (annual offset volume), the renewable type, and most importantly, the eligibility to issue carbon credits are taken from each project’s documents as of 23/06/2020. This bottom-up approach makes this thesis the first of its kind. Furthermore, this thesis introduces the concept of eligibility. Under Case C, it differentiates and categorizes projects as eligible or ineligible to issue carbon credits. With this approach, the annual offset volume from the VCPs without overestimating is reached.

Under the first case, which is defined as Case A, the Turkish renewable energy sector's offset volume is calculated. While calculating the emission reduction amount from either a single renewable energy power plant or the renewable energy sector itself, fundamentally, two data are required. One of them is the annual electricity generation, and the other is the emission factor. For the purpose of calculating the CO_2 emission factor, CDM's "Tool to calculate the emission factor for an electricity system" is used. For the wind and solar power generation projects, the CM CO_2 emission factor for 2018 is calculated as 0.5919 tCO_2/MWh. Other than the wind and solar power, the CM CO_2 emission factor for 2018 is calculated as 0.5209 tCO_2/MWh for the other types of renewable energy power plants. It is estimated that the annual offset volume from wind and solar power plants was 16,425,017 tCO_2 and from other types of renewable energy power plants was 36,107,334 tCO_2 for 2018. In total, the emission reduction potential, in other words, the annual offset volume, from the renewable sector for 2018 was 52,532,351 tCO_2.

After analyzing the Turkish renewable energy sector and calculating the CM CO_2 emission factor for different types of renewable energy power plants, the thesis explores the VCM deeply. In Turkey, VCPs are either registered under GS or VCS.

As of 23/06/2020, there were 285 Turkish GS projects, and two of them were lacking information. Thus, the thesis took 283 GS projects into consideration, which had a total estimated annual emission reduction of 22,488,536 tCO_2. Furthermore, there were 155 VCS projects, and two of them were withdrawn from the VCS. So, only 153 VCS projects are used in the study, with a total estimated annual emission reduction of 11,619,951 tCO_2. That makes a total of 436 Turkish VCPs with a total offset volume of 34,108,487 tCO_2. Like the other studies found and presented under literature research, this data set was created with a top-down approach.

There were 1855 GS projects globally as of 23/06/2020. This means that Turkish projects account for 15.4% of the projects globally. Table 7.1 lists countries and the number of GS projects from these countries. Furthermore, this table gives the share of these projects globally. To shorten the list, not every country is included. If the country's share is less than 1%, then it is excluded from the list.

Table 7.1. Number of GS projects by countries and their share (%) globally

Countries	Number of GS projects	Share of the Projects Globally
Bangladesh	45	2.4%
China	229	12.3%
Eritrea	43	2.3%
Ethiopia	42	2.3%
Honduras	24	1.3%
Indonesia	22	1.2%
India	277	14.9%
Kenya	105	5.7%
Myanmar	20	1.1%
Malawi	43	2.3%
Mozambique	38	2.0%
Nepal	26	1.4%
Rwanda	112	6.0%
Sierra Leone	21	1.1%
Thailand	35	1.9%
Turkey	285	15.4%
Uganda	92	5.0%
Viet Nam	35	1.9%
South Africa	26	1.4%

As per Table 7.1, Turkey has the highest share with 15.4%. Then, India has second place, and China has third place. Similar to Table 7.1, Table 7.2 lists countries and the number of VCS projects from these countries. In addition to the number of projects, this table gives the share of these projects globally. Again, to shorten the list, countries with a share of less than 1% are excluded from the list.

Table 7.2. Number of VCS projects by countries and their share (%) globally

Countries	Number of VCS Projects	Share of the Projects Globally
Brazil	102	5.1%
Chile	25	1.3%
China	400	20.1%
Colombia	55	2.8%
Germany	40	2.0%
India	666	33.5%
Kenya	20	1.0%
Peru	27	1.4%
South Africa	24	1.2%
Thailand	45	2.3%
Turkey	155	7.8%
United States	110	5.5%
Vietnam	26	1.3%

Among 1991 VCS projects, Turkey has the third highest share according to the number of projects with a 7.8% share globally. India has the highest number of projects, and then comes China.

While assessing Turkey's ranking in the VCM, it should be considered that Tukey could only benefit from the VCM and could not benefit from the CDM. For CDM countries, projects are either participating in the CDM or the VCM, which lowers their number of VCS and GS projects in these countries. Thus, the ranking could be at a lower level.

After analyzing the Turkish VCPs with a top-down approach, the next step was to re-analyze the market with a bottom-up approach by investigating each project through project documents. When a bottom-up approach is followed to re-cerate the data set, it has been found that 436 VCS and GS projects have a corrected annual estimated emission reduction value of 33,262,293 tCO_2, with a 2.5% deviation from the volume calculated with a top-down approach. The annual offset volume from 283 GS projects is 21,496,643 tCO_2, and from 153 VCS projects is 11,765,650 tCO_2 as of 16/06/2020.

Among these 283 GS projects, 152 of them are wind power projects, while there are only 17 VCS wind power projects. On the other hand, there are 68 GS hydropower projects and there 116 VCS hydropower projects. As stated in Chapter 6, 54% of the GS projects consist of wind projects, whereas 76% of the VCS projects consist of hydropower projects. The conclusion to be drawn here is that hydropower projects mainly choose VCS over GS, and wind projects predominantly choose GS.

The second case, Case B, was based on estimating the annual offset volume by taking all the VCPs. Thus, the data of 33,262,293 tCO_2 offset volume by 436 projects is the result of Case B.

In the literature, there are four sources of studies evaluating Turkish VCPs. Table 7.3 summarizes three of these four studies. According to these studies, the number of projects varies between 308 to 351, and the annual estimated emission reduction varies between 18,166,631 to 24,542,000 tCO_2. As of 16/06/2020, this thesis calculated that the annual estimated emission reduction from 436 VCPs is 33,262,293 tCO_2. One of the reasons for this difference is that the studies found in the literature reflect the projects between 2014 and 2016, and it has been more than four years.

Table 7.3. Turkish VCPs and their annual estimated emission reduction potentials according to the literature research (Urbanisation. n.d.; Ekinci and Gönençgil 2015; Neelis et al. 2016)

Number of Projects	Annual Estimated Emission Reduction (tCO_2)	Year of the Study
308	20,605,688	2014
351	18,166,631	2015
323	24,542,000	2016

According to the last study found in the literature, there were 244 registered VCPs with an average emission reduction potential of 75,000 tCO_2 ("Opportunities For Turkey Under CORSIA" 2019). Although the number of registered projects was not investigated in this study, the total number of VCPs and their total emission reduction potential were determined. In this context, the average emission reduction volume was calculated as 76,290 tCO_2, regardless of the registration status. This figure is very close to one found in the literature study.

The next step was to differentiate the projects as eligible or non-eligible to issue credits under Case C. It has been found that only 94 GS projects with an annual offset volume of 7,108,108 tCO_2 and 93 VCS projects with an annual offset volume of 7,489,675 tCO_2 were eligible to issue carbon credits. In total, only 43% of the VCPs were eligible to issue credits with an annual offset volume of 14,597,783 tCO_2. That means more than half of the offset potential detected under Case B is not available.

The last two cases, Case D and Case E, aim to reflect the supply and demand of the VCM by estimating the annual issuance and transactions from GS and VCS projects. As of 23/06/2020, the total issuances were 43,177,108 tCO_2, and transactions were 22,795,856 tCO_2. This indicates an oversupply in the market since only 53% of the credits are transacted. When the issuance and transaction values are compared in terms of the Standard type; 33,897,699 tCO_2 carbon credits are issued from GS projects, 9,279,409 tCO_2 carbon credits are issued from VCS projects, 18,456,480 tCO_2 carbon credits are transacted from GS projects, and 4,339,376 tCO_2 carbon credits are transacted from VCS projects. As presented in Chapter 6.4., the number of GS projects participating in the VCM is higher than the VCS projects as well as the annual issuance and transaction volumes. Lastly, it is calculated that the annual issuance volume from GS projects is 2,865,637 tCO_2, the issuance volume from VCS projects is 761,367 tCO_2, the transaction volume from GS projects is 1,592,823 tCO_2, the transaction volume from VCS projects are 415,518 tCO_2 by taking the data from 2010-2019.

Overall, when all five cases are compared, it is concluded that there is a significant divergence between the results. Table 7.4 gives each case's results, which gives Turkey's potential annual offset volume from domestic renewable energy projects.

Table 7.4. Results of each case

Cases	Explanation	Annual Offset Volume (tCO_2)
Case A	Including all renewable energy power plants	52,532,351
Case B	Including all VCPs	33,262,293
Case C	Including VCPs eligible to issue carbon credits	14,597,783
Case D	Including issued carbon credits	3,627,004
Case E	Including transacted carbon credits	2,901,603

While Case A takes the renewable energy sector, it does not differentiate the sector as a participant of the VCM or not. It is built on the assumption of establishing a local certification system under a potential ETS. In the case of a Turkish ETS covering the energy and industry sectors, the covered emission would be 282,273,137 tCO_2 based on 2018 data. When the offset volume of Turkey's entire renewable energy sector is considered, the annual offset volume accounts for 19% of the possible ETS coverage.

While Case A considers the sector, Case B and Case C considers the VCPs. Case B is based on all VCPs and Case C is based on the eligible VCPs to issue carbon credits. Case B reflects the potential annual offset volume. Case C could be considered as a more realistic case reflecting the current situation compared to Case B. The result of Case C could be considered as the real annual offset potential from the Turkish VCPs. Considering the fact that both GS and VCS announced their new eligibility rules making the new Turkish projects ineligible to apply to become VCPs, the annual offset volume would not increase and probably stay as it is now.

Lastly, Case D and E reflect the market's current situation by indicating the annual offset volume in terms of the supply and the demand sides. While the CORSIA would require offsetting through the VCPs, the demand for the credits is expected to increase. However, the limitations on the eligible units, such as the project's first crediting period, should be later than the 1st of January 2016 and emissions reductions should occur through 31st of December 2020, restrain the credits severely. As a result, even though an increase in the demand side is expected, it would not be significant for the Turkish side since there is restrained on the eligibility of the credits. Furthermore, due to GS and VCS's new eligibility rules for the new projects, the supply side is not expected to increase, and the number of the project could be seen as at the highest level for now. Lastly, considering that Turkey has not ratified the PA yet, Article 6 would not probably increase the demand for Turkish carbon credits. As a result, Cases D and E reflect the market's current situation rather than the offset potential, not the annual offsets' potential under a potential ETS.

CHAPTER 8

CONCLUSION AND RECCOMENDATIONS

In this study, the research question of “What is Turkey's annual offset volume from the renewable energy sector and the VCPs at the carbon market?” is studied with five main cases based on renewable energy as a whole, all Turkish VCPs, VCPs that are eligible to issue carbon credits, and issued and transacted carbon credits at the VCM from Turkish VCPs with a bottom-up approach. This is the first comprehensive study investigating this research question. The studies given with the literature research have a top-down approach, whereas this thesis has a bottom-up approach.

One of the first main cases was the annual offset volume from the renewable energy sector regardless of the VCM to reflect the annual offset volume if a local certification system is introduced. It is estimated that the total annual offset volume from the renewable sector was 52,532,351 tCO_2 for 2018. The annual offset volume from wind and solar power plants was 16,425,017 tCO_2 and from other types of renewable energy power plants was 36,107,334 tCO_2 for 2018.

The second main case was the annual offset volume from all VCPs. It has resulted that the total annual offset volume from all 436 Turkish VCPs is 33,262,293 tCO_2, regardless of their eligibility. The annual offset volume from 153 VCS projects was 11,765,650 tCO_2 and 21,496,643 tCO_2 from 283 GS projects. Furthermore, when all GS projects globally are investigated, it is found that Turkish projects as the highest share with 15.4%. Then, India has second place, and China has third place. A similar comparison is also made for the VCS projects globally, and it has resulted that Turkey has the third highest share according to the number of projects with a 7.8% share globally. India has the highest number of projects, and then comes China.

Then, as part of the third case, a differentiation is made on the projects as eligible or ineligible. This thesis presents the concept of “eligibility” to issue carbon credits. It differentiates VCPs as either eligible or non-eligible to issue carbon credits. It has been found that only 94 GS projects with an annual offset volume of 7,108,108 tCO_2 and 93 VCS projects with an annual offset volume of 7,489,675 tCO_2 were eligible to issue carbon credits. In total, only 43% of the VCPs were eligible to issue credits with an annual offset volume of 14,597,783 tCO_2. That means more than half of the annual offset potential detected is not available.

The last two cases, Case D and Case E, were based on the supply and the demand of the VCM. They are built on the annual issuances and the transactions made at the market. It is found that the total issuances were 43,177,108 tCO_2, and transactions were 22,795,856 tCO_2 until 23/06/2020. The total issuances from the GS projects were 33,897,699 tCO_2 and from the VCS projects was 9,279,409 tCO_2. Furthermore, the total transactions from the GS projects were 18,456,480 tCO_2 and from the VCS projects was 4,339,376 tCO_2. The annual issuance volume from GS and VCS projects is calculated as 2,865,637 tCO_2 and 761,367 tCO_2 by taking the data from 2010-2019. Lastly, the transaction volume from GS and VCS projects is calculated as 1,592,823 tCO_2 and 415,518 tCO_2 by taking the data from 2010-2019.

First of all, it is found that the emission reduction potential, in other words, the annual offset volume, from the renewable sector for 2018 was 52,532,351 tCO_2. Secondly, it is found that there are 436 Turkish VCPs with a total annual offset volume of 33,262,293 tCO_2. Furthermore, it is realized that only 187 of these projects are eligible to issue carbon credits for the market with an annual 14,597,783 tCO_2 offset volume. Lastly, it is calculated that the annual average issuance and transaction volume from the Turkish projects are respectively 3,627,004 tCO_2 and 2,008,341 tCO_2 for the period between 2010-2019. Lastly, it is calculated that the annual issuance volume from GS projects is 2,865,637 tCO_2, the issuance volume from VCS projects is 761,367 tCO_2, the transaction volume from GS projects is 1,592,823 tCO_2, the transaction volume from VCS projects is 415,518 tCO_2 by taking the data from 2010-2019.

8.1 Recommendations

Policy recommendations could be proposed for policymakers based on the results obtained in this thesis:

- The first recommendation is based on the “double-claiming” of the carbon credits issued by the VCPs and then retired by selling to anyone who wants to offset their emissions. These retired Turkish carbon credits should be deducted from the emissions reported under the current INDC and the future INDCs to be submitted to the UNFCCC.
- The second recommendation is based on tracking the issued and transacted Turkish carbon credits. Although there is “The Communique on the Registry of Voluntary Carbon Projects,” it only regulates the procedures and principles to record the VCPs. This Communique could be extended to track the Turkish carbon credits effectively with a data management system at its center.
- The third recommendation is to close the significant gap between annual emission reduction potentials achieved with Case D (annual issuances from the VCPs) and Case C (the annual offset volume from the eligible Turkish projects). The Turkish government could create new demand by introducing a mandatory offsetting requirement for the emitters or could encourage the polluters to offset some portion of their emissions by giving incentives. This would increase the demand for credits, allowing more credits to be issued to the market. In this way, the emission reduction potential calculated with Case C will be used more.
- The fourth recommendation is for Turkey to use the emission reduction potential obtained more effectively with the renewable energy sector. There is a significant difference between Case A and Case B and C. In order to close this gap, Turkey could introduce its local certification system. More projects could be included with the local certification system than in Cases B and C,

thereby further exploiting the emission reduction potential identified in Case A.

- Another policy recommendation could be on the ratification of the PA. While Article 6 of the PA opens the way for using the ITMOs voluntarily for each country, the ratification of the Agreement could create an opportunity of increasing the demand for the Turkish carbon credits. Thus, this recommendation would increase the transactions in the market by increasing the demand for the credits. In other words, it would close the gap between Case D and E. Furthermore, if the demand for the credits passes beyond the supply, then the emission reduction potential calculated with Case C will be used more.
- The last policy recommendation could be introducing an ETS to mitigate GHG emissions from the industry, especially the power sector. It would not only contribute to the harmonization of the environmental legislation with the EU but also would make the Turkish VCPs part of the offsetting under the ETS.

In order to evolve current knowledge on the offset volume from the renewable energy sector, VCP, and the VCM in Turkey, this study can be used as a starting point for further studies that focus on:

- Forecast of the global and Turkish aviation sector's demand for the carbon credits under CORSIA,
- Forecast of the annual offset demand from a potential ETS covering power and industry sectors,
- The market value of the existing Turkish VCM,
- The cost of developing VCPs and issuance of the carbon credits for Turkey.

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