CTCN
CLIMATE TECHNOLOGY CENTRE & NETWORK

CTCN Technical Assistance
Request Submission Form

Please fill in the form in the grey spaces, by following the instructions in italic.

Requesting country:	*Vietnam*

Request title:	*Feasibility Study for Carbon Mineralization by using CO2 issued from coal power plant for recycle ash slag in Cao Ngan coal power plant.*

Contact information:

{Please fill in the table below with the requested information. The request proponent is the organization that the request originates from, if different from the National Designated Entity (NDE).}

	National Designated Entity	**Request Applicant**
Contact person:	*Pham Van Tan*	*Mr. Nguyen The Giang*
Position:	*Deputy Director - General*	*Deputy Director*
Organization:	*Department of Climate Change (DCC), Ministry of Natural Resources and Environment of Vietnam (MONRE)*	*Department of Natural Resources and Environment of Thai Nguyen Province (DONRE Thai Nguyen)*
Phone:	*+84912287998*	*+84912858856*
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Postal address:	*10 Ton That Thuyet, Hanoi, Vietnam*	*132 Hoang Van Thu street – Thai Nguyen city – Thai Nguyen province.*

Technology Needs Assessment (TNA):

{Select one of the three boxes below:}

☑ *The requesting country has conducted a TNA in 2012 (please insert date of TNA completion)*

☐ *The requesting country is currently conducting a TNA*

☐ *The requesting country has never conducted a TNA*

{If the requesting country has completed a TNA, please indicate what climate technology priority this request directly relates to. Please indicate reference in TNA/TAP/Project Ideas.}

The TNA of Vietnam in 2005 identified and assessed technology needs for GHG emission reduction

and climate change adaptation in Vietnam. Some technologies were suggested for household sectors, mostly for energy saving (lighting, air conditioning, cogeneration, electricity control and biogas), but none was mentioned for coal power industry, especially in terms of reducing waste ash treatment.

The TNA of Vietnam in June 2012 identified priority sectors for TNA for GHG mitigation, which include energy, agriculture, waste and LULUCF sectors. According to the Multi Criteria Decision Analysis (MCDA), high priority GHG mitigation technologies were identified for energy, waste and forestry, based on their costs and benefits. In the coal power industry, technology for treating ash and carbon dioxide can help reduce consumption of coal from coal mines, produce green materials, and remediate environment, as the key low carbon options, which have been identified as mitigation

CTCN Request Incubator Programme:

{Please indicate if this request was developed with support from the Request Incubator Programme:}

☐ *Yes*

☑ *No*

Geographical focus:

{Select below the most relevant geographical level for this request:}

☐ *Community-based*

☑ *Sub-national*

☐ *National*

☐ *Multi-country*

{If the request is related to the sub-national or multi-country level, please indicate here the areas concerned (provinces, states, countries, regions, etc.)}

Cao Ngan Thermoelectric Power Plant was built in Thai Nguyen with a capacity of 100 MW, the annual output of 600 million kWh, and the total investment of USD 123.9 million. The plant was started construction in November 2002, and then from February 2006 it was started operation and, connected with the national power network. The Cao Ngan Thermoelectric Power Plant Company - Vinacomin, formerly known as Cao Ngan Thermoelectric Power Plant Company – TKV, is a subsidiary company of Vinacomin Electricity Corporation (belonging to the Vietnam National Coal Group). This company was established under the Decision No. 171/QD-BCN of Minister of Ministry of Industry on October 24, 2003. It is responsible for helping Vinacomin to manage and supply electricity.

Raw materials supplied for Cao Ngan Thermoelectric Power Plant are mainly from Khanh Hoa and Nui Hong coal mines. Khanh Hoa mine locates in Phuc Ha commune- Thai Nguyen city and An Khanh commune- Dai Tu district whereas Nui Hong coal mine belongs to Yen Lang commune- Dai Tu district. In order to supply coal to Cao Ngan Thermoelectric Power Plant, the Nui Hong Coal Company has built a 2.7 km-long conveyor belt from Khanh Hoa coal mine through Quan Trieu and Tan Long Ward and finally ended at Cao Ngan Thermoelectric Power Plant. Cao Ngan Factory is consuming coal from Khanh Hoa and Nui Hong mines to provide electricity for six northern border provinces.

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Theme:

{Select below the most relevant theme(s) for this request:}

☐ *Adaptation to climate change*

☐ *Mitigation to climate change*

☑ *Combination of adaptation and mitigation to climate change*

Sectors:

{Please indicate here the main sectors related to the request. e.g. energy, industry, transport, waste, agriculture/fisheries, forestry, water, ecosystem/biodiversity, coastal zones, health, education, infrastructure/human settlement, tourism, businesses, early warning/disaster reduction, institutional design and mandates, cross-sectorial}

Cross-sectorial:

- Main sector: Ash - slag treatment (Coal power industry)
- Other sectors: Water environmental remediation; Conservation of forest resources; Education and healthcare for community, creating sustainable livelihoods

Problem statement *(up to one page): {Please describe here the difficulties and specific gaps of the country in relation to climate change, for which the country is seeking support from the CTCN. Please only provide information directly relevant to this request, and that justifies the need for CTCN technical assistance.}*

Currently, there exist 20 coal-fired power plants in operation with total capacity of nearly 14,500 MW, which generate about 15.7 million tons of coal slag per year, of which coal ash accounts for 75%. It is predicted that by year 2020, there will be 43 factories, which will generate more than 30 million tons of coal slag per year. However, most of these factories only have the license of 5 years for dump sites and slag is mostly buried. Therefore, at present, there are no suitable solutions for this huge amount of slag. In order to contain such an amount of wastes, 600,000 hectares of land will be needed, or in other word, every four years the land-area of an average commune in Vietnam will be consumed. Meanwhile, the ability of recycling slags from coal-fired power plants is very limited. This leads to many environmental problems, land-use for waste disposal sites, and costs of treatment that need to be solved. Therefore at present, the recycling of slag from coal-fired power plants is an urgent matter in Vietnam.

According to calculations, in order to have a capacity of 36,000 MW by 2020, the thermoelectric power plants (TPPs) will need 67 million tons of coal/year, and to generate a capacity of 75,000 MW by 2030, Thermoelectric Power Plants will need 171 million tons coal/year. The amount of slag accounts for 25% to 60% of coal fuel, depending on coal quality and combustion efficiency (technology).

Principally, the ash slag may be used as an additive for cement production, concrete, unbaked brick and other construction materials. Generally, the ash contains a considerable amount of unburned coal (residual coal), which can be up to 20 to 30%. Therefore, to reuse ash slag, it is necessary to separate residual coal through a separation process. Thus, the company must invest a system which separates coal from ash slag. At present, the technology for separating residual coal from ash slag is not widely available, so its reuse is very limited. Vietnam is facing environmental problems from the

development of coal-fired power plants. By 2030, we have to manage many slag dumps with total area of more than 28 thousand hectares (2 meters depth assumed), distributed along the the country through large electric centers in northern and central parts and Mekong Delta of Vietnam. This is a problem not only of the electricity industry, the coal industry or the construction industry, but a general problem of the whole society. In other words, thermal power plants need drastic involvement of researchers, policy makers and provincial People's Committees in continuing to study the application of emissions of thermal power plants. In many fields of industry, study and adjust the machinery and equipment of thermal power plants to ensure the loss when baked low and need specific mechanisms, incentives for people and businesses in production use products with raw materials from thermal power plant emissions.

In addition, advanced technologies such as the Integrated Gasification Combined Cycle (IGCC) and the Pressurized Fluidized Bed Combustion (PFBC) allow higher thermal efficiency by 50% in the future, meaning that new plants will emit by less than one kWh if compared to the older ones. Ultra-clean coal (UCC) technology with new processing solutions will reduce fly ash to below 0.25% and sulfur at very low level. It means that ground coal can be used as fuel instead of heavy oil for large-sized navigation engines. However, this leads to some problems of waste generated by UCC. Therefore, the gasification process, using steam and oxygen to transform coal into carbon monoxide and hydrogen have also been studied and applied.

Recently, in Vietnam, the ash slag from the thermoelectric power plants using Circulating Fluidized Bed Combustion technology with desulphurization, started to be studied. For example, the bottom ash of the Cao Ngan thermoelectric power plant has been applied for road construction and unbaked brick production. The fly ash of Cao Ngan thermoelectric power plant after separating unburned carbon by flotation technology to meet the F-type standard, has been successfully used in production of light brick (density from 0.7 to 0.85 tons/m^3). The factory signed some contracts with waste treatment facilities, including Quan Trieu Cement Plant (the study started from early 2015) and ATK Thai Nguyen Unbaked Materials Joint Stock Company (the study started in July 2009 and the production begun in 2015).

Until the end of 2015, Cao Ngan factory has delivered nearly 32,000 tons of fly ash for testing cement production at Quan Trieu Cement Plant. The average monthly amount is around 6,500 to 7,000 tons (particularly, the used amount of fly ash in May, June, July, August and October is 1,886 tons, 7,155tons, 5,857 tons, 3,047 tons, 6,882 tons, and 6,262 respectively). Among 200,000 tonnes of ash slag discharged annually, only about 120,000 tonnes are fly ash. Hence, the cement production process could be optimized if ash slag is recycled and the market for product consumption is ensured. In other word, basically, fly ash of Cao Ngan Thermoelectric Power Plant will be completely consumed at maximum capacity of Quan Trieu Cement Factory.

However, the remaining 80 tons of bottom ash Cao Ngan Thermoelectric Power Plant have not yet been reused for any purposes. It is a difficult mission to determine which field the bottom ash could be used for, because the loss on ignition (LOI) of Cao Ngan thermoelectric power plant's ash slag is very high (about 18%). In addition, there is a lot of lime in the bottom ash, soil can not be used for production of cement as well as aggregated brick. At present ATK's brick is made by 80% grit and 20% fly ash of the Cao Ngan thermoelectric power plant.

Cao Ngan Thermoelectric Power Plant has been trying to find out suitable solutions to reuse all the ash slag released annually. The factory has invited some German or American equipment suppliers to adjust the burning mode in order to reduce the ignition loss. In trial period, the ignition loss could be reduced to 16%. However, this significantly affects the operation system. As a result, the factory will further study to find out the most suitable option on the basis of preserving operation system as well as equipment. Because the most essential issue of the Cao Ngan thermoelectric power plant is to ensure the operation mode for power generation. Once the factory started its operation, the executive committee had the plan for saving coal during combustion if it could reduce the ignition loss.

Annually, the plant consumes about 500,000 tons of coal, so if it saves 1%, the equivalent

amount is 5,000 tons of coal. In addition, the coal price is over 1 million VND per ton, so they will save 5 billion VND each year. However, it is difficult to find out a way to save, because the nature of this depends on three following factors: quality of input coal, operation mode, and electricity supply. The operation mode can be adjusted by the factory itself while the other factors are dependent

Thus, after 8 years seeking the optimal solution to use all the ash for production of building materials and road construction, etc. the Cao Ngan Thermoelectric Power Plant has not yet solved the problem of redundant ash slag. While the use of fly ash for production of cement and cemented aggregate brick has succeeded, there are still about 800 tons of bottom ash left. This is not only the challenge for power industry, or coal industry or construction industry, but also a common problem for the whole society. In other word, Thermoelectric Power Plants need further contribution of researchers, policy makers and provincial people's committees in studying the application of wastes from Thermoelectric Power Plants for different fields of industry; researching and adjusting machinery of Thermoelectric Power Plants to ensure low level of ignition loss: and providing specific and incentive mechanisms for people and enterprises who use waste materials from Thermoelectric Power Plants in their production. Therefore, for coal thermoelectric power plants it is very important and urgent for the research and implementation of modern technologies which utilize Circulating Fluidized Bed Combustion technology in order to create useful products from fly ash and bottom ash.

Past and ongoing efforts *(up to half a page):*

{Please describe here past and on-going processes, projects and initiatives implemented in the country to tackle the difficulties and gaps explained above. Explain why CTCN technical assistance is needed to complement these efforts, and how the assistance can link or build on this previous work.}

Assistance requested *(up to one page): {Please describe here the scope and nature of the technical assistance requested from the CTCN and how this could help address the problem stated above and add value vis-à-vis the past and on-going efforts. Please note that the CTCN facilitates technical assistance and is not a project financing mechanism.}*

To deal with environmental pollution from ash in Cao Ngan Thermal Power Plant, the plant has been applying the following solutions:

1. Using fly ash as an important material to make roller compacted concrete and high-value lightweight bricks, specific additives.

2. Making input materials for cement production in Quan Trieu cement plant

3. Using coal slag of Cao Ngan coal power plant for production of aggregated brick

However, a necessary key solution, a suitable green technology to produce cost-effective and sustainable ash treatment in coal-fired power plants, has yet to be paid attention to study, invest, develop and transfer to domestic production units. Therefore, the support from industrial technology is very important, which helps to solidify the preparatory work in ongoing and near-completion projects, for practical application in coal power plants (short solution term), as a viable proof for the green production model, thereby replicating and widely applying in the national coal power industry (long-term solution), contributing strongly to the goal of gas reduction national greenhouse.

Expected benefits *(up to half a page):*

{Please outline here the medium and long-term impacts that will result from the CTCN technical assistance, including how the assistance will contribute to mitigate and/or adapt to climate change.}

The project requires CTCN's technical assistance to study the pre-feasibility of carbon mineralization technology to treat waste ash, as a green production model, low carbon emissions and solutions to overcome environmental pollution. The most important solution of climate technology for carbonization of coal ash from thermal power plants is the use of waste ash to produce H-CSA cement and green concrete.

Concrete is a widely used building material with significant impacts of greenhouse gas mainly due to cement production. Fortunately, the cement industry in the world and Vietnam are already familiar with the use of additional cementitious materials such as ash slag to reduce the cement content in concrete. Minimization of cement content is the most effective way to reduce the impact of greenhouse gas of concrete. In some markets, coal ash is even cheaper than cement. A challenge to the use of coal ash is its potential impact on the progress of construction. When used as a cement substitute (by replacing 30% of total cement amount), both fly and bottom ash may have the characteristics of fast fixation that may affect the progression of many specific structures. In general, the concrete industry is actively developing and testing new additional cement materials to meet the demand for clean and durable concrete products. The strategies outlined in the specific module of the climate-friendly purchasing toolkit will allow government buyers to reduce the specific greenhouse gas impact of the procurement. According to a study conducted by Korea Technology Center and Korea Hanil Cement Company, the H-CSA cement is better in terms of physic-chemical properties and more environment-friendly than conventional cement. In addition, the combination of H-CSA cement, carbon mineralization, and recycling of bottom ash at Thermoelectric Power Plants of HANIL Cement company has created green-concrete, which is an effective solution for treating ash slag as well as CO_2 emission by coal combustion at the thermoelectric power plants.

To implement this CTCN-TA project, the total cost is estimated at US $ 250,000.

Technical support of the industry includes the following activities:

• Implementing feasibility study and synthesize the report, including evaluation at Cao Ngan Thermal Power Plant, on the transfer of ash - slag treatment technology by carbon mineralization method.

• Detailed design of the pilot plant with demonstration of the carbon mineralization technlogy, including drawings, capacity, location and estimated cost, etc.

• Developing plan for monitoring and observing the implementation of the project with demonstration of the technology.

Expected benefits *(up to half a page):*

{Please outline here the medium and long-term impacts that will result from the CTCN technical assistance, including how the assistance will contribute to mitigate and/or adapt to climate change.}

+ Reduction of CO_2 emission in CSA cement production:

The best way in terms of lucrative finance and sustainable development of cement industry is the usage of industrial by-products and wastes for production. It not only reduces costs but also contributes significantly to the reduction in CO2 emission per ton of cement produced.

It is estimated that the production of portland cement accounts for about 8% of global CO_2 emission. Carbon dioxide is released into the atmosphere when $CaCO_3$ is converted to CaO during heating. For every 1,000 kg of portland cement produced, 579kg of CO_2 is emitted. By contrast, the

production of CSA cement emits 216kg CO_2 per 1,000kg of cement produced, i.e. a reduction of 62% compared to the production of portland cement. It is therefore easy to estimate that CO_2 emission is reduced to about 3% of global CO_2 emission if we use CSA cement instead of portland cement in construction works in the world.

Almost all of these processes are more environmentally friendly due to the following reasons: easy recycling of carbon dioxide generated from the coal power industry, reduced consumption of input coal, and less emissions With waste water and coal by-products, the energy consumption is less due to shorter refining and drying times. Besides research, development and application of cabon mineralization technology is also essential. When determined to be feasible in Cao Ngan, technological processes and production models can be commercialized, transferred and replicated to other Thermal and Local Plants or extended to the entire Vietnam electricity industry.

Beside reducing CO_2 emission, application of this technology can bring many environmental and socio-economic benefits, such as: Handling huge amount of ash slag generated from thermal power plants; Reducing emissions and solid waste; Reducing the amount of fuel and energy used; Reusing industrial by-products in CSA cement production and saving natural resources; Creating green materials from recycling for slag at a suitable cost for the Vietnamese market; Enhancing awareness on environmental protection and climate change mitigation by local residents, etc.

The success of this project will contribute to Vietnam's commitment in the 2015 Paris Agreement on climate change. In addition, the success of the project will draw the best solution in waste treatment at power plants of Vietnam today.

Post-technical assistance plans *(up to half a page):*

{Please describe here how the results of the CTCN technical assistance will be concretely used by the applicant and national stakeholders, to pursue their efforts of resolving the problems stated above after the completion of the CTCN intervention (list specific follow-up actions that will be undertaken).}

Once this technical assistance of CTCN demonstrates the suitability and feasibility for coal power industry, this technology for recycling ash by this carbonization method can be replicated and upscaled for similar activities at Vietnam.

Key stakeholders:

{Please list in the table below the main stakeholders who will be involved in the implementation of the requested CTCN technical assistance, and what their role will be in supporting the assistance (for example, government agencies and ministries, academic institutions and universities, private sector, community organizations, civil society, etc.). Please indicate what organization(s) will be the main/lead counterpart(s) of CTCN experts at national level, in addition to the NDE.}

Stakeholder	Role to support the implementation of the assistance
Add as many lines as needed	
Ministry of Natural Resources and Environment of Vietnam (MONRE)	*Main counterpart;* *Overall management and coordination, technical inputs for project activities*
Department of Climate Change (DCC), MONRE	*Support with technical assistance for technology transfer, demonstration*

Ministry of Sciences and Technology (MOST)	*Support with technical assistance for technology transfer, demonstration*
Department of Natural Resources and Environment (DONRE) of Thai Nguyen Province	*Support with technical assistance for research and development, technology transfer* *Review and selection of pilot site for applying the technology* *Monitoring and evaluating implementation of the project*
Cao Ngan Coal Power Plant in Thai Nguyen	*Support with technical assistance for research and development, applying the technology*
Quan Trieu secondary school	*Support on propaganda and awareness enhancement for secondary pupils*
Quan Trieu high school	*Support on propaganda and awareness enhancement for high school pupils*

Alignment with national priorities *(up to half a page):*

{Please demonstrate here that the technical assistance requested is consistent with documented national priorities (examples of relevant national priorities include: national development plans, poverty reduction plans, technology needs assessments (TNAs), LEDS, NAMAs, TAPs, NAPs, sectorial strategies and plans, etc.). For each document mentioned, please indicate where the priorities specifically relevant to this request can be found (chapter, page number, etc.).}

On October 28, 2016, the Action Plan to implement the Paris Agreement was issued by the Prime Minister, in which contents on mitigation of GHG emission is prioritized. Processing ash and slag from coal power plants for the Cao Ngan Thermal Power Plant is in line with this country's orientation and priority.

Researching and developing appropriate technology, using CO_2 to recycle coal ash is the connection and good implementation of the issues of the studied impact of climate change in Vietnam and practical solutions, for application in the electric industry and sustainable development of the coal power industry.

Development of the request *(up to half a page):*

{Please explain here how the request was developed at the national level and the process used by the NDE to approve the request before submitting it (who initiated the process, who were the stakeholders involved and what were their roles, and describe any consultations or other meetings that took place to develop and select this request, etc.)}

The request has been proposed by the Department of Natural Resources and Environment of Thai Nguyen Province (DONRE Thai Nguyen), in track with the national activities to adapt to climate change and mitigate GHG emissions under the UNFCCC, to address and solve specific environmental issues and climate change that are happening in the locality. The proposed technology, once evaluated for its' appropriateness and feasibility in the selected coal power plant, will be an effective green solution and strategic orientation for the electric industry in adopting technology for green manufacturing and reducing greenhouse gas emissions. For these reasons, this proposal is built at the

national level.

This proposal of technical assistance has been developed by a researcher group of community-based environmental remediation and climate change technology in the institute, with consultancy by the local government of the studied site and related stakeholders (as mentioned in the above table).

Expected timeframe:

{Please propose here a duration period for the assistance requested.}

12 months from time of commencement

Background documents:

{Please list here relevant documents that will help the CTCN understand the context of the request and national priorities. For each document, provide web links if available, to attach to the submission form while submitting the request. Please note that all documents listed/provided should be mentioned in this request in the relevant question(s), and that their linkages with the request should be clearly indicated.}

1. ADB (2013). Vietnam: Environment and Climate Change Assessment. Url: https://www.adb.org/sites/default/files/institutional-document/33916/files/viet-nam-environment-climate-change.pdf
2. Ahn, J., Kim, H., Cho, J., Joo, S., Han, G., Han, K., Kim, J. and Cho, H. (2003). Synthesis of Ordinary Portland Cement Clinker Using Waste POSCO Sludge. Materials Science Forum, 439, pp.163-169.
3. Ahn, J., Park, H., Kim, J., Cheong, S. and Kim, J. (2006). Preparation of Single-Phase Aragonite Precipitated Calcium Carbonate Used as an Inorganic Eco-Material. Materials Science Forum, 510-511, pp.986-989.
4. Anne Zimmera, Michael Jakob & Jan Steckela (2013). What motivates Vietnam to strive for a low-carbon economy? – An explorative case study on the drivers of climate policy in a developing country. Url: https://www.pik-potsdam.de/members/steckel/publications/what-motivates-vietnam-to-strive-for-a-low-carbon.pdf
5. Button, J. (2008). Carbon: commodity or currency? The case for an international carbon market based of the currency model. Harvard Environmental Law Review, 32: 571–596.
6. Center for monitoring natural and resources environment (2016). "Report on environmental monitoring results of Cao Ngan thermal power company - TKV".
7. Climate Strategies & Universitat Zurich (2011). Country case study Vietnam – Removing barriers for climate change mitigation. Url : http://climatestrategies.org/wp-content/uploads/2011/05/cs-public-finance-market-mechanisms-country-study-vietnam-final.pdf
8. Joint Circular No. 58/2008 / TTLT-BTC-BTN & MT dated 04 July 2008 of the Ministry of Finance and the Ministry of Natural Resources and Environment on guiding the implementation of some articles of Decision No. 130/2007 / QD -TTg dated 02/8/2007.
9. Decision No. 130/2007 / QD-TTg of the Prime Minister dated 02 August 2007 on some mechanisms and financial policies for investment projects under the Clean Development

Mechanism.

10. Decision No. 2053/QD-TTg dated 28/10/2016 of the Prime Minister on the Promulgation of Action Plan to Implement the Paris Agreement. Url:http://thuvienphapluat.vn/van-ban/Tai-nguyen-Moi-truong/Quyet-dinh-2053-QD-TTg-ke-hoach-thuc-hien-thoa-thuan-Paris-bien-doi-khi-hau-2016-328065.aspx
11. Decision No. 403/QD-TTg approving the National Action Plan on green growth for the period of 2014-2020. Url: https://www.giz.de/en/downloads/Decision_403-2014-TTg_EN.pdf
12. Department of Geology and Minerals of Vietnam (2005) "Report on mineral resources in Thai Nguyen province".
13. Eun-Sung Kim. (2014) Imagining Future Korean Carbon Markets: Coproduction of Carbon Markets, Product Markets, and the Government. Journal of Environmental Policy & Planning 16:4, pages 459-477.
14. GFDRR (2011). Vulnerability, Risk Reduction, and Adaptation to Climate Change in Vietnam.Url:http://sdwebx.worldbank.org/climateportalb/doc/GFDRRCountryProfiles/wb_gfdrr_climate_change_country_profile_for_VNM.pdf
15. Hanil cement, Technical Center Korea (2017). "Report of green cement technology using industrial by - product", Seong Young Nam.

    http://siteresources.worldbank.org/INTVIETNAM/Resources/CCStrategyVNFinal-Eng.pdf
16. IPCC Special Report on Carbon dioxide Capture and Storage – Chapter 7: Mineral carbonation and industrial uses of carbon dioxide. Url: https://www.ipcc.ch/pdf/special-reports/srccs/srccs_chapter7.pdf
17. Joint Circular No. 58/2008 / TTLT-BTC-BTN & MT dated 04 July 2008 of the Ministry of Finance and the Ministry of Natural Resources and Environment on guiding the implementation of some articles of Decision No. 130/2007 / QD -TTg dated 02/8/2007.
18. Kim, J., Han, G., Lim, M., You, K., Ryu, M., Ahn, J., Fujita, T. and Kim, H. (2009). Effect of Hydraulic Activity on Crystallization of Precipitated Calcium Carbonate (PCC) for Eco-Friendly Paper. International Journal of Molecular Sciences, 10(11), pp.4954-4962.
19. Laurijssen, J., (2007), Restwarmte benchmark: Wat komt er vrij en wat kunnen we hieruit halen?, Workshop Restwarmte, Hotel de Cantharel Apeldoorn, 15 November 2007.
20. Lim, M., Han, G., Ahn, J. and You, K. (2010). Environmental Remediation and Conversion of Carbon Dioxide (CO_2) into Useful Green Products by Accelerated Carbonation Technology. International Journal of Environmental Research and Public Health, 7(1), pp.203-228.
21. MONRE - UNEP (2009) Viet Nam Assessment Report on Climate Change. Url: http://www.unep.org/pdf/dtie/VTN_ASS_REP_CC.pdf
22. MONRE-GEF-UNEP (2005). Technical report on the identification and assessment of technology needs for GHG emission reduction and climate change adaptation in Viet Nam.Url:http://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TNR_CRE/e9067c6e3b97459989b2196f12155ad5/c1f883a4d9654e2f9c95ced0c4eb727f.pdf
23. National strategy on climate change was issued by Prime Minister Nguyen Tan Dung in Decision 2139/QĐ-TTg on December 05, 2011. Url:http://www.chinhphu.vn/portal/page/portal/English/strategies/strategiesdetails?categoryId=30&articleId=10051283
24. Steering Committee for implementation of UN Framework Convention on Climate Change and Kyoto Protocol in Vietnam (2012). Brief information on clean development mechanism and international carbon market.

25. U.S. Department of Energy, 2010. Carbon Sequestration Atlas of the United States and Canada. https://www.netl.doe.gov/KMD/CDs/atlasIII/2010atlasIII.pdf accessed June 2017.

26. Um, N., Nam, S. and Ahn, J. (2013). Effect of Accelerated Carbonation on the Leaching Behavior of Cr in Municipal Solid Waste Incinerator Bottom Ash and the Carbonation Kinetics. MATERIALS TRANSACTIONS, 54(8), pp.1510-1516.

27. UNEP (2014). Migration, Resettlement and Climate Change in Viet Nam. Url: http://www.un.org.vn/en/publications/doc_download/409-migration-resettlement-and-climate-change-in-viet-nam.html

28. UNESCAP (2016). COP21: Statement at the Joint Seminar between Vietnam and the Republic of Korea for Climate Change Response & Green Growth Strategy. Url http://www.unescap.org/speeches/cop21-statement-joint-seminar-between-vietnam-and-republic-korea-climate-change-response

    Url:https://www.usaid.gov/sites/default/files/documents/1861/vietnam_climate_change_final2011.pdf

29. USAid (2011). Climate change in vietnam: assessment of issues and options for USAID funding.

30. Victor, D. F. and House, J. C.(2004). A new currency. Climate change and carbon credits. Harvard International Review, 26(2): 56–59.

31. Vietnam (June 2012): Technology Needs Assessment And Technology Action Plans For Climate Change Mitigation,

    Url:http://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TNR_CRE/e9067c6e3b97459989b2196f12155ad5/95d71d0e507c4e4c9b4fe7851e5c7f2a.pdf;

32. VIETNAM'S INDC. Intended Nationally Determined Contribution of Viet Nam. Url: http://www4.unfccc.int/ndcregistry/PublishedDocuments/Viet%20Nam%20First/VIETNAM'S%20INDC.pdf

33. Worldbank (2011). Climate-Resilient Development in Vietnam: Strategic Directions for the World Bank

    Zelizer, V. (1994). The social meaning of money: pin money, paychecks, poor relief, and other currencies, New York: Basic Books

Monitoring and impact of the assistance:

{Read carefully and tick the boxes below.}

☑ By signing this request, I affirm that processes are in place in the country to monitor and evaluate the assistance provided by the CTCN. I understand that these processes will be explicitly identified in the Response Plan in collaboration with the CTC, and that they will be used in the country to monitor the implementation of the CTCN assistance.

☑ I understand that, after the completion of the requested assistance, I shall support CTCN efforts to measure the success and effects of the support provided, including its short, medium and long-term impacts in the country.

Signature:

NDE name: Pham Van Tan

Date: 3 July 2019

Signature:

THE COMPLETED FORM SHALL BE SENT TO THE CTCN@UNEP.ORG

Need help? The CTCN team is available to answer questions and guide you through the process of submitting a request. The CTCN team welcomes suggestions to improve this form.

>>> Contact the CTCN team at ctcn@unep.org