Feasibility Study project for GCF/CTCN (FY2016)

CTCN project feasibility study for the introduction of energy saving technology in South American caustic soda • chlorine manufacturing process

Report

Disclosure version

March, 2017
ASAHI GLASS CO., LTD.
Summary

Production of caustic soda and chlorine is a base industry of chemical engineering that links to a variety of interim products and final ones. The amount of production in South America especially of Brazil ranks relatively high in the world. In the Brazil, Uruguay, Peru and Argentina, a mercury cell process is still used in the caustic soda and chlorine production facilities which consume high energy and emit mercury that affects bad impact towards environment. Conversion to the ion-exchange membrane process which achieves large-scale energy conservation and mercury use reduction is advanced taking the climate change measure and the Minamata convention enforcement. Ion-exchange membrane process is the technology which can achieve about 30 percent of energy conservation compared with mercury cell process, and only 2 companies of other ones of Asahi Glass Co., Ltd. are possessed most high technique in the world. There is also a diaphragm cell process which is different from mercury cell process in these countries. Achievement of energy conservation of 10-20% is expected by installment of the latest ion-exchange membrane process in case of diaphragm cell process and achievement of energy conservation of 5-10% is expected by installment of the latest ion-exchange membrane process in case of old type of ion-exchange membrane process.

This feasibility study project (It was called "this project" in the following.) aims that install latest ion-exchange membrane cell process into 4 countries as a final target. A CTCN project feasibility investigation on caustic soda and chlorine production process for energy saving was performed as an initial stage.

As a result of this project, An initiative was founded for the company and the Ministry of the Environment to promote the CTCN project in Brazil. We presented the draft of CTCN request submission form and the MMA agreed it. The finalization of CTCN requirement and necessity information are in charge of MMA. We also introduced the Green Climate Fund (GCF) as a potential fund option and decided to examine it as necessary. We visited the CTCN NDE and the person who is in charge of the mercury issues in Uruguay. For CTCN, the politics area for moderation in Uruguay is the transportation. In 2015, more than 90% of Uruguay’s electricity was generated by wind and hydropower. Thus, the electricity reduction in industry sector does not contribute to the GHG reduction. The CTCN NDE is not positive to the proposal but, the GEF NDE is positive to this in Peru. The Peruvian government has referred to the Secretariat of the Convention for an extension of five years. For CTCN request, there are many requirements such as the priority area for politics, the expansion of the benefit, the
participation of related and the GHG reduction effect in Argentine. Furthermore, Ion-exchange membrane technology and CTCN was presented in CloroSur technical seminar X at Buenos Aires during 16th to 18th November, 2016. Simple energy conservation diagnosis by a data collection with Chlor-Alkali producers and energy conservation effect expectation and expectation of mercury usage reduction etc. were carried out. It was also clarified the issue of utilization of CTCN through this project.
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<th>Full Form</th>
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<tbody>
<tr>
<td>AGC</td>
<td>ASAHI GLASS CO., LTD.</td>
</tr>
<tr>
<td>BNDES</td>
<td>The Brazilian Development Bank</td>
</tr>
<tr>
<td>BRICs</td>
<td>Brazil, Russia, India, China etc.</td>
</tr>
<tr>
<td>CDM</td>
<td>Clean Development Mechanism</td>
</tr>
<tr>
<td>CEO</td>
<td>Chief Executive Officer</td>
</tr>
<tr>
<td>CONAMA</td>
<td>Conselho Nacional do Meio Ambiente</td>
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<tr>
<td>COP</td>
<td>Conference of Parties</td>
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<td>CTC</td>
<td>Climate Technology Centre</td>
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<td>CTCN</td>
<td>Climate Technology Centre and Network</td>
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<td>EBRD</td>
<td>European Bank for Reconstruction and Development</td>
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<td>EFCM</td>
<td>Emission Factor of Combined Margin</td>
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<td>FS</td>
<td>Feasibility Study</td>
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<tr>
<td>GCF</td>
<td>Green Climate Fund</td>
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<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
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<tr>
<td>GEF</td>
<td>Global Environment Facility</td>
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<tr>
<td>GHG</td>
<td>Greenhouse gas</td>
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<tr>
<td>IDB</td>
<td>Inter-American Development Bank</td>
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<tr>
<td>IGES</td>
<td>Institute for Global Environmental Strategies</td>
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<tr>
<td>INDC</td>
<td>Intended Nationally Determined Contributions</td>
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<td>JBIC</td>
<td>Japan Bank for International Cooperation</td>
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<tr>
<td>JCM</td>
<td>Joint Crediting Mechanism</td>
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<tr>
<td>JETRO</td>
<td>Japan External Trade Organization</td>
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<tr>
<td>MCTI</td>
<td>Ministério da Ciência, Tecnologia, Inovações e Comunicações</td>
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<tr>
<td>MINCYT</td>
<td>MINISTRY OF SCIENCE, TECHNOLOGY AND PRODUCTIVE NOVATION</td>
</tr>
<tr>
<td>MMA</td>
<td>Ministério do Meio Ambiente</td>
</tr>
<tr>
<td>MRV</td>
<td>Measurement, Reporting and Verification</td>
</tr>
<tr>
<td>MVOTMA</td>
<td>Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente</td>
</tr>
<tr>
<td>NAMA</td>
<td>Nationally Appropriate Mitigation Actions</td>
</tr>
<tr>
<td>NDE</td>
<td>National Designated Entity</td>
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<tr>
<td>OECC</td>
<td>Overseas Environmental Cooperation Center, Japan</td>
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<tr>
<td>OSPAR</td>
<td>Convention for the Protection of the Marine Environment of the North-East Atlantic</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Name</td>
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<tr>
<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<tr>
<td>UNIDO</td>
<td>United Nations Industrial Development Organization</td>
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<tr>
<td>WCC</td>
<td>World Chlorine Council</td>
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</table>
Chapter 1 General Information of Each Country

1.1 Brazil

1.1.1 Economic Overview

The population of Brazil is about 207,840,000, and GDP is 1,774,700,000,000 dollars. GDP per one person is 8,528 dollars (the World Bank and 2015). The main industries are manufacturing, mining, agriculture (sugar, orange, coffee, soybeans, etc.). It also has abundant natural resources, in particular the world's largest iron ore exporter. Main products such as iron ore and soybean boast the world's largest export products, especially iron ore. In Brazil there is the world's largest Carajas mine (eastern part of the Amazon River). The reserves of the Carajas mine are said to be comparable to the demand for iron ore for the next 500 years. Looking at the breakdown of Brazilian exports, the major products such as iron ore counts only about 30%, and industrial products dominates the most. In particular, the aircraft industry, which requires advanced industrial technology, boasts the most competitive technology in the world. The economy is getting out of a serious and long-term recession. By effective fiscal adjustment, monetary policy will be further relaxed and support investment recovery.

1.1.2 Energy saving policies, carbon management by industry

Today, the need for alternative energy is rising, facing soaring crude oil prices and global warming. Brazil is focusing on the ethanol industry, which is drawing attention as an alternative energy source. In order to cope with the oil shock in 1973, Brazil has been implementing a pro-alcohol policy since 1975, and it is promoting substituting ethanol produced from domestic abundant sugar cane into gasoline. Brazil is promoting the diffusion of ethanol fuel under the national policy against the backdrop of competitive superiority with high-tech technology, and is now one of the world's leading energy-advanced countries to produce ethanol. Two-thirds of new cars already sold in Brazil have become flexible fuel vehicles compatible with ethanol fuel. Bioethanol is environmentally friendly and its price is cheap, about half of that of gasoline. Brazil overwhelmingly leads the BRIC's (Brazil, Russia, India and China etc.) for renewable energy. In Brazil, hydroelectric power is supporting about 40% of energy consumption, and more than 80% of Brazilian electricity consumption is already procured by hydroelectric power generation. Ethanol is also an important energy source. Brazil's Intended Nationally Determined Contribution (INDC) has announced that it will reduce greenhouse gas emissions by 37% by 2025 compared to 2005. Also, it is stated that the greenhouse gas emissions will be reduced by 43% by the year 2030.
compared with the 2005 level. Brazil has proposed to make the proportion of renewable energy in their energy mix of up to 45% by 2030. Also, by 2030, Brazil aim to raise the share of renewable energy (other than hydropower = biomass sunlight, wind power) for power generation up to 23%.

1.1.3 Policies related to mercury management
The Minamata Convention on mercury was signed in October 2013 in Kumamoto Prefecture and will enter into force on the 90th day after 50 countries have ratified it. Since 38 countries have ratified as of February 28, 2017, it is expected that parties will soon exceed to 50 countries, the Secretariat of the Convention, the United Nations Environment Program (UNEP), said on September 24, 2017 that the first meeting of the Conference of the Parties (COP 1) in Geneva will be held from September 24th to 29th, 2017.

Brazil is currently deliberating domestic bills at the National Assembly Committee as a domestic procedure for ratification (February 28, 2017). According to the Ministry of the Environment of Brazil, it is planned to participate in the COP 1 as a contracting party, and it is expected that domestic procedures will be completed by then.

In addition to the treaty related law, domestic laws and regulations and ministerial ordinances are being developed. The main laws are listed below.

· Federal law 9.976
This is a federal law regulating the production of caustic soda and chlorine using electrolytic cells. It prohibits installation and expansion of electrolytic cell using domestic mercury method or asbestos diaphragm method. For those who do not comply with this law, warnings, fines, temporary or permanent suspension of industrial activity may be considered.

· Regulation 2.436
It is an ordinance prohibiting the establishment or expansion of electrolytic cells using RI or asbestos diaphragm method in Rio de Janeiro. Regarding technology conversion, the three years from 2005 to 2008 were set as deadlines. As a result of a hearing conducted by the state of Rio de Janeiro in November 2006, the ordinance was revised in order to broaden the scope of application not only to the "chlorine alkali industry" but
also to all industrial processes using sodium chloride electrolysis. The amendment has not been approved yet.

· National Environment Council Resolution 430 (CONAMA Resolution 430)
It is a resolution that revised a part of Resolution No. 357 which CONAMA entered into in 2005. Establish conditions and standards for sewage and industrial wastewater from wastewater treatment facilities. Maximum allowable mercury is 0.01 mg Hg / 1. Piracy is imposed on illegal persons under the law No. 9605 (1998).

· Bill No. 1,031 · Draft Law No. 1.031 (Sao Paulo, 2011)
Prohibit the use of mercury and asbestos diaphragm technology in all industrial processes, including salt electrolysis. It was approved on February 19, 2014.

1.2 Uruguay
1.2.1 Economic Overview
Uruguay has an area of 176,000 m2 (about half of Japan) and the population is 3.34 million (2015, World Bank). Agriculture and fisheries, manufacturing industry (especially product processing), service industry are the main industries. Per capita GDP is $15,720 (2015, World Bank). Major export items are meat, grain, timber and dairy products and major import items are electrical equipment, mineral resources, machinery, automobiles etc. (International Trade Center, 2015). Uruguay's economy also recorded negative growth until 2002, due to the economic crisis of Brazil and Argentina in the first half of the 2000s. But making use of the lessons learnt, Uruguay is avoiding excessive dependence on Mercosur, diversifying foreign economic relations and actively attracting investment. From 2011 to 2014, the economic growth rate has been changing from 3.2% to 5.2%. (Source of this section: Uruguay basic data such as Ministry of Foreign Affairs)

1.2.2 Energy saving policies, carbon management by industry
As Uruguay developed an attractive policy to provide accessible funding to secure investment in renewable energy, Uruguay's domestic and foreign investment in the energy sector increased nearly 70 times between 2010 and 2014, Uruguay's total clean energy investment amounted to approximately 1.2 billion dollars in 2014 and ranks among the top five countries that make the largest investment in renewable energy and fuel per GDP.

The transport sector is still dependent on oil (which accounts for 45% of the total energy
mix). However, the industry centered on agricultural processing is mainly supported by the biomass cogeneration factory.

By the end of 2015, renewable energy reduced power costs in Uruguay by 44%. The wind power plant in the country can produce about 65 to 70 cents per kWh, which is half of the gas generation cost. In 2015, there were 11,050 people in the renewable energy sector (excluding 6,550 employments in the utility sector). This employment level is 1.5 times that of employment at refineries and employment of natural gas (7,460 employees). In conclusion, the renewable, abundant and diverse energy mix enhances energy security, reduces energy costs, revitalizes the national industry, creates employment from clean energy and relieves dependence on oil.

In the past five years Uruguay's energy investment (including not only renewable energy but also liquid gas) reached $7 billion, reaching 15% of annual GDP. It is five times the average of South America.

1.2.3 Policies related to mercury management

Uruguay ratified the Minamata Convention on mercury on September 24, 2014. It is the first ratifying country in South America, becoming the sixth party in the world.

Uruguay's chlorine alkali operator Efice S.A. is cooperating with the Uruguay Environment Bureau's pilot study on mercury waste management technology.

1.3 Peru

1.3.1 Economic overview

Peru's industry is primarily primary industry (agriculture, fish, mining). Mining produces gold, silver, copper, zinc and others. The manufacturing industry also has a large share of major products.

In 2009 after the Lehman shock, Peru maintained positive growth, with the economic growth rate of 2002-11 averaging 6.4%, the highest level in South America. This had a major impact on foreign direct investment in the mining sector. The mining export amount which accounted for 65% of the total mining export value in December 2013 was $2.251 billion. The manufacturing industry achieved an annual growth rate of 10% between 2008 and 2012.

The energy consumption of industrial sector in 2014 is 159,000 TJ which is equivalent to 26% of total consumption. Together with the steel sub-sector, 29% of them were consumed.
1.3.2 Energy saving policies, carbon management in industry

Peru's electrification rate at the national level is 83.55% (6,394,049 households). Nonetheless, this is one of the lowest rural electrification rates in South America, as 38.32% (979,476 households) of the rural population (about 4 million people) can't access electricity. Electricity is generated by thermal power generation and hydropower (44%) using gas or petroleum (56%), and the share of renewable energy sources other than hydropower is negligible. In spite of the fact that the installed capacity is evenly divided between the hydropower generation and the conventional thermal energy, 62.9% of the total Peru generation amount is generally from the hydroelectric power plant.

Presently, Peru has one energy efficiency program with seven concrete measures for the commercial and industrial sectors. In Peru there is a support program for the development of the capacity of companies in the service and production departments, but there are no measures to promote the energy management system yet.

Examples of concrete measures adopted in the industrial sector and service sector include replacement of boilers, substitution of inefficient engines, promotion of cogeneration system, substitution of incandescent lamps and fluorescent lamps. By implementing these measures, Peru aims to reduce CO2 emissions by 10-15% by 2025.

1.3.3 Policies related to mercury management

On January 21, 2016 the Peruvian government became the 21st party to ratify the Minamata Convention by depositing the instrument of ratification. The Ministry of the Environment (MINAM) issued a Decree (No. 010-2016-MINAM) that approved the multi-sector action plan for the implementation of the Minamata Convention on Mercury. This plan establishes a roadmap to properly manage, reduce or eliminate the use of mercury in the main sectors of Peru.

Several policies concerning the Minamata Convention are as follows.

- Atmospheric environmental standards related to mercury (Ministry of Resource Conservation 041-2014-MINAM)
- Small scale construction and sanitation management strategy on mining right extraction (highest decree 029-2014-PCM)
- Regulations for formulating the small-scale manual extraction process (Law No. 1105)
- Management of illegal transactions of scientific materials and equipment for illegal mines (Legislative No. 1107)
Management of distribution, transportation, and sales of scientific substances that can be used at illegal mines (highest order 073-2014-EF)

Regarding the goal of the chlorine alkali business operator's abolition of mercury 2025, the Peruvian government has referred to the Secretariat of the Convention for an extension of five years. For business operators, it is supposed to be able to continue using the Mercury Law line up to the year 2030.

1.4 Argentina

1.4.1 Economic Overview
Argentina, which GDP exceeds 550 million dollars, is one of South America's largest economic zones, with the economy growing dramatically over the past decade. Argentina is investing heavily in health, 7% of its GDP and to education which accounts for 6% of its GDP.

1.4.2 Energy saving policies, carbon management in industry
The country still relies on about two-thirds of electricity for fossil fuels. Although the country has a large reserve of shale gas and petroleum, it has failed to attract investment due to the deteriorating economy, such as a slump in oil prices and soaring drilling costs.
Ente Nacional Regulador de la Electricidad (ENRE) has developed a new fee structure that utilities apply to companies and homes.
Energy price increases (in some cases 500%) are putting pressure on optimizing the use of energy.
Argentina has enormous natural resources in energy and agriculture. Argentina has fertile land within 2.8 million square kilometers and the potential of renewable energy is high.
The government is trying to promote energy conservation by raising energy prices, abolishing subsidies for energy consumption, promoting renewable energy sources, optimizing grids through the framework of electricity transmission fees, and so on.
The Ministry of Energy and Mining (MINEM) was established in December 2015. In August 2016, MINEM issued a resolution of 164-E / 2016 on the establishment of the energy policy advisory committee. Through this committee, the new administration elected in December 2015 will reform the energy policy as part of helping to cover one-fifth of Argentina's electricity from renewable energy sources by 2025, hoping to attract $ 20 billion. Argentina also plans to issue policies and action plans on energy
efficiency and energy conservation.

1.4.3 Policies related to mercury management

Articles 14 and 240 of Argentina's new commercial and civil law enacted in August 2015 will promote the rights of individuals and organizations for the protection of clean environment and resources.

Institutionally, the Ministry of Environment and Sustainable Development is in charge of environmental policy. There is no special law on mercury at present, but the Environment Law (No. 25.675) considers certain aspects of the Minamata Convention. For example, Law No. 25.612 reflects the environmental impact and management of industrial waste. Law No. 26.184 shows acceptable mercury levels of batteries. There is also Act No. 26.473 which prohibits the importation of incandescent bulbs. In parallel, since Argentina is part of the Mercosur (the common market in the south), Law No. 24.449 fully complies with the regulations concerning the transportation of harmful goods. Finally, there are regulations concerning occupational injuries and health problems of workers who use mercury for certain parts.

At the international level, Argentina is a party to the Basel Convention on the movement of cross-border movement of hazardous waste and its disposal, and is also a party to the Rotterdam Convention on International Trade in Hazardous Chemicals and Pesticides.

Regarding the Minamata Convention, Argentina signed in 2013. Argentina may ratify closely as lawmakers accepted the bill in connection with the ratification of the parliament in September 2016.
Chapter 2 Consensus building with stakes holders

2.1 Field survey

Table 2.1.1 shows the first field survey schedule.

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Counter country</th>
<th>Other party</th>
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</thead>
<tbody>
<tr>
<td>11/16</td>
<td>PM</td>
<td>Argentina</td>
<td>CTCN NDE (telephone conference)</td>
</tr>
<tr>
<td>11/18</td>
<td>AM</td>
<td>Uruguay</td>
<td>Ministério de Vivienda Ordenamiento Territorial y Medio Ambiente (MVOTMA)</td>
</tr>
<tr>
<td>11/21</td>
<td>AM</td>
<td>Peru</td>
<td>Ministerio del Ambiente</td>
</tr>
<tr>
<td>11/22</td>
<td>AM</td>
<td>Brazil</td>
<td>Ministério do Meio Ambiente (MMA), Abiclor</td>
</tr>
<tr>
<td></td>
<td>PM</td>
<td>Brazil</td>
<td>Ministry of Science, Technology, Innovation &amp; Communication</td>
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</tbody>
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Table 2.1.2 shows the second field survey schedule.

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<th>Time</th>
<th>Counter country</th>
<th>Other party</th>
</tr>
</thead>
<tbody>
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<td>PM</td>
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<td>Ministerio del Ambiente</td>
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<tr>
<td>2/15</td>
<td>AM</td>
<td>Brazil</td>
<td>Ministério do Meio Ambiente (MMA), Abiclor</td>
</tr>
<tr>
<td></td>
<td>PM</td>
<td>Brazil</td>
<td>Ministry of Science, Technology, Innovation &amp; Communication, Ministry of Environment, Abiclor</td>
</tr>
<tr>
<td></td>
<td>PM</td>
<td>Uruguay</td>
<td>Ministerio de Vivienda Ordenamiento Territorial y Medio Ambiente (MVOTMA)</td>
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</table>

2.2 Government organization chart and explanation of other parties

Brazil

The ministries of Brazil treat with environmental issues (includes mercury) are summarized in Figure 2.2.1. The associations are also included in the figure.
This time, we have visited the Ministério do Meio Ambiente (MMA) that is in charge of the mercury waste issue and the Ministério da Ciencia, Tecnologia e Inovacao (MCTI) that is in charge of CTCN NDE. Both ministries showed interest and MMA asked for the draft of CTCN request submission form. Then it is enough opportunity of co-operation with Brazilian government.

**MMA**
- Ms. Leticia Reis de Carvalho (Director)
- Ms. Mirian de Oliveira (Coordinator of Environmental Emergencies)
- Mr. Diego Henrique Costa Pereira (Environmental Analyst)

**MCTI**
- Mr. Bruno Nunes, MSc. (General Coordinator)
- Dr. Fábio Larotonda (General Coordinator)
- Dr. Márcia Gonçalves (Senior Analyst of Science and Technology)
- Ms. Nanahira de Rabelo e Sant’Anna, MSc. (Science and Technology Analyst)

Figure 2-1 The ministries of Brazil treat with environmental issues (includes mercury).

The associations are also included in the figure.

**Composição da CONASQ e do GT-Mercúrio**

Ref.: CloroSur IX Technical Seminar (Sao Paulo, Nov 13th in 2014, Dr. Otavio Luiz Gusso Maioli)
(1) Ministry of the Environment, (2) Ministry of Science, Technology and Innovation, (3) Abiclor (Brazil chlor-Alkali and Derivatives Industry Association)

2.3 Consensus building with stakeholders in each country

2.3.1 Consensus building with stakeholders in Brazil
(First field survey)

**MMA**

We had showed the medium- to long-term suggestion about mercury method conversion before the first field survey. At the first field survey, we got the information about it. It was found that MMA was collaborative about our suggestion.

Abiclor (Brazil chlor-Alkali and Derivatives Industry Association) also attended the meeting and confirmed that the suggestion matched the needs of the companies that were under press to the process conversion. We also got the information that the CTCN technical support such as the detailed design and the improvement of the accuracy for cost estimate and timing matched the needs.

**MCTI**

It is confirmed that CTCN technical assistant request by public sector is welcomed during meeting with CTCN NDE.

We visited the CTCN NDE and confirmed that the CTCN technical support was welcomed by private companies. We also got the following information.

- There are no competitive items in Brazil when Brazil government will submit the CTCN request submission form.
- Before submitting the request, the CTCN NDE make a reference to the ministries related to this item. There is a possibility that they ask for the modification or/and addition of the description. The amount of GHC emission reduction is important for the CTCN NDE
- The deadline for the CTCN request submission and the schedule of review are not decided. They accept the submission as-needed.
- MCTI, MMA and Abiclor agreed the GEF suggestion that is considered the fund source of process conversion from mercury method.
- Abiclor has been carrying out the preliminary calculation about the process conversion from mercury method and mercury wastes. They will share the result with MMA, AGC and OECC as a base of GEF suggestion.
(Second field survey)

**MMA**
We presented the draft of CTCN request submission form and the MMA agreed it. We introduced the Green Climate Fund (GCF) as a potential fund option and decided to examine it as necessary.

**MCTI**
We presented the draft of CTCN request submission form to CTCN NDE. MMA agreed that they would be the proposer of the CTCN request. Some General Coordination are set for CTCN NDE, in this case, the General Coordination of Global Climate Change will be in charge of this item. Japan side may need the follow about this item because the Global Climate Change did not attend the meeting.

2.3.2 **Consensus building with stakeholders in Uruguay**
(First field survey)

**MVOTMA**
We visited the CTCN NDE and the person who is in charge of the mercury issues.
- There are few factories in Uruguay that are the massive GHG emission sources.
- In Uruguay, the areas that are treated the CTCN technical support as priority are the renewable energy (adaptation), coastal defense (moderation) and so on.
- The CTCN technical support for industry areas is possible but many companies are need. There are only one company for caustic soda/chlorine industry in Uruguay.
- It is necessary to match the conversion plan of Efice.

(Second field survey)

**MVOTMA**
We visited the CTCN NDE and the person who is in charge of the mercury issues.
- In 2015, more than 90% of Uruguay’s electricity was generated by wind and hydropower. Thus, the electricity reduction in industry sector does not contribute to the GHG reduction. For CTCN, the politics area for moderation in Uruguay is the transportation. As is the same case in GCF. The issue in the Efice’s conversion plan from mercury method is the storage and treatment of the mercury wastes. It is required the support about it.
National Designated Entity (NDE) of the Uruguay Eastern Republic is located in the Department of Climate Change, Ministry of Housing, Space Planning, and Environment (MVOTMA) Environment Bureau. Currently, Deputy Minister Jorge Rucks plays the role of NDE, but its role is being transferred to Secretary Ignacio Lorenzo of National Climate Change Response System. Projects on mercury and hazardous chemicals are generally required to discuss with Judith Torres, Director of Production Chain, Waste and Materials Management Department. The CTCN technical support proposal needs to be consulted with all stakeholders including representatives of the private sector and submitted directly to the NDE.

Figure 2-2 Organization chart of Ministry of Housing, Spatial Planning and Environment (MVOTMA)

2.3.3 Consensus building with stakeholders in Peru
(First field survey)

Ministerio del Ambiente
We visited the CTCN NDE and the person who is in charge of the mercury issues.
• Before the visit, we had proposed the middle- to long-term program (from CTCN
technical support to GEF support). They are favorably disposed toward our proposal.

- Three groups* meeting is desirable for confirming the target and schedule of the conversion plan.
  
  *Quimpac (the only company in Peru manufacturing the caustic soda/chlorine), Ministerio del Ambiente, Japan team (AGC and OECC)

(Second field survey)

Ministerio del Ambiente

We visited the person who is in charge of the mercury issues.

- The CTCN NDE is not positive to the proposal but, the GEF NDE is positive to this.
- There is no progress concerning the shutdown of Quimpac’s mercury method plant,

The NDE of the Republic of the Republic of Peru is located in the Department of Climate Change, Desertification and Water Resources under the jurisdiction of the Ministry of the Environment (MINAM). Ms. Claudia Figallo de Ghersi General Coordinator in the Climate Change, Desertification and Water Resources Department is currently serving Peruvian NDE.

Projects on mercury and hazardous chemicals generally need to be discussed with Ms. Vilma Morales Quillama Chemicals and Environmental Risk Coordinator of the Environment and Quality Department.
2.3.4 Consensus building with stakeholders in Argentina
(First field survey)

We had telephone meeting with CTCN NDE
- For CTCN request, there are many requirements such as the priority area for politics, the expansion of the benefit, the participation of related and the GHG reduction effect.
  The governments consider such requirements to choose the request from the various requests. The priority of CTCN request for the conversion of mercury method in caustic soda/chlorine manufacturing is not high.

(Second field survey)
- Based on the first field survey result, we excluded from the second field survey.
2.4 Summary

In this survey, we have visited four countries and understood the situation of the each country. There were difference in the matching with the company's needs and the interest of CTCN NDE. The situation of the each country is as follows:

Brazil
- The feasibility of the submission of CTCN technology request is very high.
- We also introduced the public fund related to the climate change such as GCF (Green Climate Fund) as a optional fund.

Uruguay
- The electricity reduction in industry sector does not contribute to the GHG reduction because more than 90% of Uruguay's electricity was generated by wind and hydropower. For CTCN, The politics area for moderation in Uruguay is the transportation. As is the same case in GCF.

Peru
- The CTCN NDE is not positive to the proposal.

Argentina
- The priority of CTCN request for the conversion of mercury method in caustic soda/chlorine manufacturing is not high.
Chapter 3 Information exchange with caustic soda/chlorine factories

3.1 Situation of global mercury cell plants

According to the data compiled by the United Nations Environment Programme (UNEP) in 2010, some 100 facilities in 43 nations that manufacture caustic soda chlorine apply mercury method and its percentage is reported to be about 29%.

Figure 3.1 shows the chlorine manufacturing capacity by the mercury method, while Table 3.1 shows the number and production capacity of plants using the mercury method by country. According to Table 3.1, the numbers of the mercury method plants in Brazil, Uruguay, Peru and Argentina are 4, 1, 2 and 2* respectively. (* It is reported in Global inventory of UNEP Global Inventories of Chlor Alkali Facilities that the number in Argentina is 5)

source:

Figure 3-1 Mercury cell chlorine capacity
Table 3.1 The number and production capacity of plants using the mercury method by country

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of mercury-cell facilities</th>
<th>2010 mercury-cell capacity</th>
<th>Planned capacity reduction 2010-2015</th>
<th>Known capacity reduction since 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algeria</td>
<td>2</td>
<td>14</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Angola</td>
<td>1</td>
<td>10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Argentina*</td>
<td>2</td>
<td>122</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Azerbaijan</td>
<td>1</td>
<td>145</td>
<td>145</td>
<td>-</td>
</tr>
<tr>
<td>Belgium*</td>
<td>2</td>
<td>420</td>
<td>420</td>
<td>-</td>
</tr>
<tr>
<td>Bosnia &amp; Herz.</td>
<td>3</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Brazil*</td>
<td>4</td>
<td>217</td>
<td>- 115</td>
<td>-</td>
</tr>
<tr>
<td>Canada</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>33</td>
</tr>
<tr>
<td>China</td>
<td>7</td>
<td>81</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Columbia</td>
<td>1</td>
<td>22</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cuba</td>
<td>1</td>
<td>7</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Czech Republic*</td>
<td>2</td>
<td>197</td>
<td>197</td>
<td>-</td>
</tr>
<tr>
<td>Egypt</td>
<td>-</td>
<td>0</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>Finland*</td>
<td>1</td>
<td>42</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>France*</td>
<td>6</td>
<td>690</td>
<td>170</td>
<td>-</td>
</tr>
<tr>
<td>Germany*</td>
<td>6</td>
<td>870</td>
<td>200</td>
<td>478</td>
</tr>
<tr>
<td>Greece*</td>
<td>1</td>
<td>40</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hungary*</td>
<td>1</td>
<td>137</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>India*</td>
<td>7</td>
<td>188</td>
<td>188</td>
<td>453</td>
</tr>
<tr>
<td>Indonesia*</td>
<td>5</td>
<td>25</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Iran</td>
<td>4</td>
<td>332</td>
<td>- 20</td>
<td>-</td>
</tr>
<tr>
<td>Iraq</td>
<td>3</td>
<td>68</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Israel</td>
<td>1</td>
<td>33</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>


3.2 Field survey

Table 3.2 shows the first field survey schedule.

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Place/Other party</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/16 (Wed)</td>
<td>PM</td>
<td>CloroSur technical seminar (reception)</td>
</tr>
</tbody>
</table>
Table 3-3 shows the second field survey schedule.

Table 3.3 Second field survey schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Country</th>
<th>Other party</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/14</td>
<td>PM</td>
<td>Brazil</td>
<td>Braskem S.A.</td>
</tr>
<tr>
<td>2/16</td>
<td>AM</td>
<td>Uruguay</td>
<td>Efice</td>
</tr>
</tbody>
</table>

In the first field survey, we exchanged the information with companies about the plan (process conversion or shutdown) and the interest in the use of funds. In the second survey, we visited the person who has decision-making power with the conversion to confirm the interest about the CTCN scheme.

3.3 Information exchange with caustic soda/chlorine factories in each country
3.3.1 Information exchange with caustic soda/chlorine factories in Brazil

Table 3-4 shows the caustic soda production capacity in Brazil by the mercury method and Figure 3-4 shows the sites of mercury method plants in Brazil.

Table 3-4 Caustic soda production capacity in Brazil by the mercury method

<table>
<thead>
<tr>
<th>Company</th>
<th>production capacity (ton·100%NaOH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Braskem</td>
<td>70,000</td>
</tr>
<tr>
<td>Pan-Americana</td>
<td>14,000</td>
</tr>
<tr>
<td>Produquimica</td>
<td>29,890</td>
</tr>
<tr>
<td>Unipar Carbocloro</td>
<td>107,000</td>
</tr>
</tbody>
</table>

(source: Abiclor Annual Report 2014)
The companies and persons that we exchanged the information and/or visited are as follows:

Braskem S.A.
- Mr. Alexandre de Castro (Commercial Director, President of Abiclor)
- Mr. Sergio Marcondes (Gerente de Contas)
- Mr. Julio Holanda Tavares (Process Manager)

Unipar Carbocloro
- Mr. Airton Antonio de Andrade (Director Industrial)
- Mr. Antonio Pousa Neto (Gerente de Producao)

Abiclor/CloroSur
Mr. Martim Afonso Penna (Executive Director)

(First field survey)
Braskem S.A.
At the CloroSur technical seminar, we confirmed that they would conduct the detailed technical design and cost estimate for the process conversion from 2017 to 2018. They showed much interest in the CTCN technical support.

(Second field survey)
Braskem S.A.
We explained the middle- to long- term plan for introducing the technology and the contents of CTCN technical support to Mr. Alexandre de Castro (Commercial Director, President of Abiclor)
We obtained the agreement under the following conditions:
・ Conclude the NDA (non-disclosure agreement) with 4 targeted companies respectively.
・ The cooperation for CTCN technical survey does not commit the conversion.

3.3.2 Information exchange with caustic soda/chlorine factories in Uruguay
Table 3-5 shows the caustic soda production capacity in Uruguay by the mercury method and Figure 3-5 shows the sites of mercury method plants in Uruguay.

Table 3-5 Caustic soda production capacity in Uruguay by the mercury method

<table>
<thead>
<tr>
<th>Company</th>
<th>production capacity (ton·100%NaOH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efice</td>
<td>17,000</td>
</tr>
</tbody>
</table>

Figure 3-3 Sites of mercury method plants in Uruguay
Source: Google Map

The companies and persons that we exchanged the information and/or visited are as follows:

Efice
- Mr. Alfredo Infanzon (Gerente de Operaciones)
- Mr. Gabriel Steiner (Gerente de planta)

(First field survey)

Efice
After CloroSur technical seminar, we sent presentation materials of technical data and CTCN technical support.

(Second field survey)

Efice
(New plant plan)
They will shut down the mercury method plant and construct a new ion exchange method plant at the different place in the same site. The production capacity of the new plant is about three times of the present one.
The reason of the plant expansion is due to the construction of the new paper plant in
2015 in Uruguay and the construction plan of the new paper plant in 2017. It means that there will be three relatively large paper plants in Uruguay.

Now, Uruguay depends on the caustic soda for import from the United States. But, this is expected to shift the caustic soda from import to source in the country.

The forest industry is one of the principal industries in Uruguay. It is predicted that the paper will be the first export production in the country by the construction of third paper plant,

They plan to construct from 2020 to 2021 and to operate 2 cycles (100% production capacity during the night time and 25% production capacity during the day time). This is because the electricity price is cheap during the night time.

They want to know the method how to operation in 2 cycles.

They have delegated the funds plan to KPMG and CPA. Now they are raising the finance for the construction of new plant and the treatment of mercury waste

(Treatment of mercury waste)

It is a costly problem. They are looking for the technology to do the pretreatment of mercury waste to clear the discharge standard (5 ppm) in Uruguay.

They also undertake the pretreatment of the medical wastes (such as mercury thermometer and mercury blood-pressure gauge) before carrying them to the disposal field.

The disposal field in Uruguay that accept the mercury wastes was set up in 2016.

**3.3.3 Information exchange with caustic soda/chlorine factories in Peru**

Table 3-6 shows the caustic soda production capacity in Peru by the mercury method and Figure 3-6 shows the sites of mercury method plants in Peru.

<table>
<thead>
<tr>
<th>Company (site)</th>
<th>production capacity (ton·100%Cl\textsubscript{2})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quimpac (Callao)</td>
<td>76,000</td>
</tr>
<tr>
<td>Quimpac (Paramonga)</td>
<td></td>
</tr>
</tbody>
</table>

source : UNEP Global Inventories of Chlor Alkali Facilities, Global inventory

Figure 3-4 Sites of mercury method plants in Peru
Source: Google Map

The company and person that we exchanged the information (just by e-mail) are as follows:

Quimpac
  • Mr. Mario Fishman (board member, sun of present CEO)

(First field survey)
  Quimpac
  We tried to adjust the schedule, but we couldn’t.

(Second field survey)
  Quimpac
  We had plan to visit, but, it was canceled by Quimpac in the last time.

(Ref)
According to MINAM, the only company in Peru using the mercury process in the production of caustic soda in Peru is Quimpac, which uses the process in two of its plants. The Ministry has already sent the company a questionnaire about its use of the mercury process. It is in close contact with Quimpac and has a good understanding of the conditions at the company. Furthermore, representatives from three ministries (the
Ministry of the Environment, the Ministry of Health, and the Ministry of Production) visited Quimpac in 2010 and have confirmed the company's intention to replace the mercury process.

(source: FY2014 report, Feasibility studies with the aim of developing a joint crediting mechanism, Energy-saving project for the manufacturing process of caustic soda & chlorine through brine electrolysis in Mexico and other Latin American countries, study for project exploration and planning)

### 3.3.4 Information exchange with caustic soda/chlorine factories in Argentina

Table 3-7 shows the caustic soda production capacity in Argentina by the mercury method and Figure 3-7 shows the sites of mercury method plants in Argentina.

<table>
<thead>
<tr>
<th>Company</th>
<th>Site</th>
<th>Production capacity (ton·100%Cl₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solvay Indupa SAIC</td>
<td>Bahia Blanca</td>
<td>122,000</td>
</tr>
<tr>
<td>Atanor SA</td>
<td>Rio Tercero</td>
<td></td>
</tr>
<tr>
<td>Keghart</td>
<td>Chacras de Coria</td>
<td></td>
</tr>
<tr>
<td>Ledesma</td>
<td>Pueblo Ledesma</td>
<td></td>
</tr>
<tr>
<td>Quimica del Norte/Transclor SA</td>
<td>Pilar</td>
<td></td>
</tr>
</tbody>
</table>

(source: UNEP Global Inventories of Chlor Alkali Facilities, Global inventory

Figure 3-5 Sites of mercury method plants in Argentina
Source: Google Map

(First field survey)
We could not contact the companies at the CloroSur technical seminar.

(Second field survey)
None

3.4 Summary
Brazil
- We formed the basis between the companies and the MMA to voluntarily promote the project.

Uruguay
- It has been revealed that the procurement of public funds for the climate exchange is limited. It is necessary to consider the technology conversion and finance for equipment investment by private company base.
Peru

・The conversion plan of the company is not revealed. It is necessary to follow up the plan.

Argentina

・It is necessary to continuously survey the conversion plan of the company and to promote to encourage the broad use of the advanced Japanese technology.
Chapter 4 Simple energy conservation diagnosis by a data collection and energy conservation effect expectation

4.1 Electric power unit consumption of caustic soda and chlorine production

Simple energy conservation diagnosis and energy conservation effects of caustic soda and chloric production by a data collection in Brazil, Peru, Uruguay and Argentine are performed by Chapter 4.

Caustic soda and chloric production process needs a lot of electric energy for electrolyzing by electrolyzing salt solution. Electricity will be a principal raw material, not a utility for caustic soda and chloric production industry. It is said that about 60% to 70% of the production cost is electricity in general. Therefore energy conservation in an electrolyzing process will be very important for caustic soda and chlorine production.

The following 3 processes are used for caustic soda and chlorine production at present in the world.

- The mercury cell process
- The diaphragm cell process
- The membrane cell process

The outline of production processes are follows:

The mercury cell process

![Diagram of the mercury cell process for caustic soda and chlorine production](image)

Figure 4-1 The mercury cell process for caustic soda and chlorine production
In the mercury cell process, sodium forms an amalgam (a 'mixture' of two metals) with the mercury at the cathode. The amalgam reacts with the water in a separate reactor called a decomposer where hydrogen gas and caustic soda solution at 50% are produced. As the brine is usually re-circulated, solid salt is required to maintain the saturation of the salt water. The brine is first de-chlorinated and then purified by a precipitation-filtration process. The products are extremely pure. The chlorine, along with a little oxygen, generally can be used without further purification.

Of the three processes, the mercury process uses the most electricity, but no steam is required to concentrate the caustic solution. The use of mercury demands measures to prevent environmental contamination. Also, mercury must be removed from the hydrogen gas and caustic soda solution.

Mercury losses have been considerably reduced over the years. Increasingly, chlorine producers are moving towards membrane technology, which has much less impact on the environment.

The diaphragm cell process

Figure 4-2 The diaphragm cell process for caustic soda and chlorine production
In the diaphragm cell process the anode area is separated from the cathode area by a permeable diaphragm. The brine is introduced into the anode compartment and flows through the diaphragm into the cathode compartment.

Diluted caustic brine leaves the cell. On various sites, evaporation of caustic is not needed because of a site-specific process integration, technology and management of the energy balance. The caustic soda can also be concentrated to 50% and the salt removed. This is often by using an evaporative process with about three tonnes of steam per tonne of caustic soda.

The salt separated from the caustic brine can be used to saturate diluted brine. The chlorine contains oxygen and must often be purified by liquefaction and evaporation.

The membrane cell process

![Diagram of the membrane cell process for caustic soda and chlorine production](http://www.eurochlor.org/media/7812/membrane_300dpi2.pdf)

The two electric connection points of each chlorine production cell, the anode and the cathode, are separated by an ion-exchange membrane. Only sodium ions and a little water pass through the membrane.

The brine is de-chlorinated and re-circulated. Solid salt is usually needed to re-saturate the brine. After purification by precipitation-filtration, the brine is further purified with...
an ion exchanger.
The caustic solution leaves the cell with about 30% concentration and, at a later stage in the process, is usually concentrated to 50%. The chlorine gas contains some oxygen and must often be purified by liquefaction and evaporation.
The consumption of electric energy is the lowest of the three processes and the amount of steam needed for concentration of the caustic is relatively small (less than one tonne per tonne of caustic soda).


Electrical unit consumption of these processes in general are as follows:

Table 4-1 Electrical unit consumption of for caustic soda and chlorine production (1 tonne as NaOH 100%)

<table>
<thead>
<tr>
<th>Process</th>
<th>Electrical unit consumption (kWh/ tonne as 100% NaOH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The mercury cell process</td>
<td>3,300</td>
</tr>
<tr>
<td>The diaphragm cell process</td>
<td>2,750</td>
</tr>
<tr>
<td>The membrane cell process</td>
<td>2,100</td>
</tr>
</tbody>
</table>

※ Electrical unit consumption maybe changed by other conditions. The concentration of caustic soda production is 50%.

1 「Soda technical handbook」 JAPAN SODA INDUSTRY ASSOCIATION (2009)

This table is converted per 1 ton of chlorine, it'll be as follows.

Table 4-2 Electrical unit consumption of for caustic soda and chlorine production (1 tonne as chlorine)

<table>
<thead>
<tr>
<th>Process</th>
<th>Electrical unit consumption (kWh/ tonne as chlorine)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The mercury cell process</td>
<td>3,718</td>
</tr>
<tr>
<td>The diaphragm cell process</td>
<td>3,099</td>
</tr>
<tr>
<td>The membrane cell process</td>
<td>2,366</td>
</tr>
</tbody>
</table>

30
4.2 Simple energy conservation check by data collection in Brazil

An annual report of “Abichlor”, Brazilian chlorine industry association, is offered to data of the caustic soda and chlorine production facilities in Brazil. According to this, there were four mercury cell method caustic soda and chlorine facilities. There were three diaphragm cell method caustic soda and chlorine facilities and there were five membrane cell method caustic soda and chlorine facilities in Brazil as of 2013.

Table 4-3 List of production sites for caustic soda and chlorine in Brazil

<table>
<thead>
<tr>
<th>Empresa / Company</th>
<th>Fábrica / Site</th>
<th>Tecnologia / Technology</th>
<th>Capacidade (t) Capacity (MT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloro - capacidade instalada 2013 Chlorine - 2013 installed capacity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Braskem</td>
<td>AL</td>
<td>D</td>
<td>409.400</td>
</tr>
<tr>
<td>Dow Brasil</td>
<td>BA</td>
<td>D</td>
<td>415.000</td>
</tr>
<tr>
<td>Unipar Carbocloro</td>
<td>SP</td>
<td>D</td>
<td>147.900</td>
</tr>
<tr>
<td>Total Diaphragma / Diaphragm</td>
<td></td>
<td></td>
<td>972.300</td>
</tr>
<tr>
<td>Canexus</td>
<td>ES</td>
<td>M</td>
<td>47.753</td>
</tr>
<tr>
<td>CMPC Celulose Rio-grandense</td>
<td>RS</td>
<td>M</td>
<td>21.000</td>
</tr>
<tr>
<td>Pan-Americana</td>
<td>RJ</td>
<td>M</td>
<td>26.000</td>
</tr>
<tr>
<td>Solvay Indupa</td>
<td>SP</td>
<td>M</td>
<td>160.200</td>
</tr>
<tr>
<td>Unipar Carbocloro</td>
<td>SP</td>
<td>M</td>
<td>100.000</td>
</tr>
<tr>
<td>Total membrana / Membrane</td>
<td></td>
<td></td>
<td>364.963</td>
</tr>
<tr>
<td>Braskem</td>
<td>BA</td>
<td>Hg</td>
<td>70.310</td>
</tr>
<tr>
<td>Pan-Americana</td>
<td>RJ</td>
<td>Hg</td>
<td>14.000</td>
</tr>
<tr>
<td>Produquimica Igarassu</td>
<td>PE</td>
<td>Hg</td>
<td>29.890</td>
</tr>
<tr>
<td>Unipar Carbocloro</td>
<td>SP</td>
<td>Hg</td>
<td>107.100</td>
</tr>
<tr>
<td>Total Mercurio/Mercury</td>
<td></td>
<td></td>
<td>221.300</td>
</tr>
</tbody>
</table>

(Abiclor Annual report 2014 p13)
Table 4-4 Energy conservation effect by process conversion of the mercury cell process for caustic and chlorine production in Brazil

<table>
<thead>
<tr>
<th>Production capacity (tonne as chlorine/ year)</th>
<th>221,300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical unit consumption in the mercury cell process (MWh/ tonne as chlorine)</td>
<td>3.718</td>
</tr>
<tr>
<td>Electrical unit consumption in the membrane cell process (MWh/ tonne as chlorine)</td>
<td>2.366</td>
</tr>
<tr>
<td>Electrical unit consumption by process conversion (MWh/ tonne as chlorine)</td>
<td>1.352</td>
</tr>
<tr>
<td>Energy conservation effect (MWh/ year)</td>
<td>299,198</td>
</tr>
</tbody>
</table>

Table 4-5 Energy conservation effect by process conversion of the diaphragm cell process for caustic and chlorine production in Brazil

<table>
<thead>
<tr>
<th>Production capacity (tonne as chlorine/ year)</th>
<th>972,310</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical unit consumption in the diaphragm cell process (MWh/ tonne as chlorine)</td>
<td>3.099</td>
</tr>
<tr>
<td>Electrical unit consumption in the membrane cell process (MWh/ tonne as chlorine)</td>
<td>2.366</td>
</tr>
<tr>
<td>Electrical unit consumption by process conversion (MWh/ tonne as chlorine)</td>
<td>0.733</td>
</tr>
<tr>
<td>Energy conservation effect (MWh/ year)</td>
<td>712,703</td>
</tr>
</tbody>
</table>

When converting all plants of mercury cell facilities and diaphragm cell ones in Brazil, it'll be reduced 1,012GWh/ year of electric power.

4.3 Simple energy conservation check by data collection in Uruguay
One facility of the mercury cell Chlor-Alkali method is located in Uruguay. Capacity is
14,000 as chlorine per year by investigation of UNEP in 2012. Energy conservation effect by converting to the membrane cell method is as follows:

Table 4-6 Energy conservation effect by process conversion of the mercury cell process for caustic and chlorine production in Uruguay

<table>
<thead>
<tr>
<th>Production capacity (tonne as chlorine/year)</th>
<th>14,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical unit consumption in the mercury cell process (MWh/tonne as chlorine)</td>
<td>3.718</td>
</tr>
<tr>
<td>Electrical unit consumption in the membrane cell process (MWh/tonne as chlorine)</td>
<td>2.366</td>
</tr>
<tr>
<td>Electrical unit consumption by process conversion (MWh/tonne as chlorine)</td>
<td>1.352</td>
</tr>
<tr>
<td>Energy conservation effect (MWh/year)</td>
<td>18,928</td>
</tr>
</tbody>
</table>

### 4.4 Simple energy conservation check by data collection in Peru

One facility of the mercury cell Chlor-Alkali method is located in Peru. Capacity is 120,000 as chlorine per year by investigation of UNEP in 2012. Energy conservation effect by converting to the membrane cell method is as follows:

Table 4-7 Energy conservation effect by process conversion of the mercury cell process for caustic and chlorine production in Peru

<table>
<thead>
<tr>
<th>Production capacity (tonne as chlorine/year)</th>
<th>120,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical unit consumption in the mercury cell process (MWh/tonne as chlorine)</td>
<td>3.718</td>
</tr>
<tr>
<td>Electrical unit consumption in the membrane cell process (MWh/tonne as chlorine)</td>
<td>2.366</td>
</tr>
<tr>
<td>Electrical unit consumption by process conversion</td>
<td>1.352</td>
</tr>
</tbody>
</table>
One facility of the mercury cell Chlor-Alkali method is located in Argentine. Capacity is 14,000 as chlorine per year by investigation of UNEP in 2012. Energy conservation effect by converting to the membrane cell method is as follows:

Table 4-8 Energy conservation effect by process conversion of the mercury cell process for caustic and chlorine production in Argentina

<table>
<thead>
<tr>
<th>Production capacity</th>
<th>120,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical unit consumption in the</td>
<td>3.718</td>
</tr>
<tr>
<td>mercury cell process (MWh/ tonne as</td>
<td></td>
</tr>
<tr>
<td>chlorine)</td>
<td></td>
</tr>
<tr>
<td>Electrical unit consumption in the</td>
<td>2.366</td>
</tr>
<tr>
<td>membrane cell process (MWh/ tonne as</td>
<td></td>
</tr>
<tr>
<td>chlorine)</td>
<td></td>
</tr>
<tr>
<td>Electrical unit consumption by process</td>
<td>1.352</td>
</tr>
<tr>
<td>conversion (MWh/ tonne as chlorine)</td>
<td></td>
</tr>
<tr>
<td>Energy conservation effect (MWh/ year)</td>
<td>162,240</td>
</tr>
</tbody>
</table>

4.6 Summary
The simple energy conservation diagnosis and energy conservation effects when converting all mercury and diaphragm cell methods are converted to the membrane cell method in Brazil, Peru, Uruguay and Argentina were performed by the above. When old-fashioned ion exchange membrane cell process also converted the latest ion exchange membrane cell process actually, about several % of energy conservation effect could be expected, but we assumed that it was non-applicable this time.

Table 4-9 Energy conservation expectation in Brazil, Peru, Uruguay and Argentina

<table>
<thead>
<tr>
<th>The mercury cell (MWh)</th>
<th>The diaphragm cell (MWh)</th>
<th>Total (MWh)</th>
</tr>
</thead>
</table>

34
It is calculated about CO₂ reduction effect by the energy conservation effect using the respective national electrical unit consumption. The electrical unit consumption used the average/combined margin emission factor (EFCM) from a CDM project database of IGES.

Table 4-10 Average combined margin emission factor (electrical unit consumption) in Brazil, Peru, Uruguay and Argentina (t·CO₂/MWh)

<table>
<thead>
<tr>
<th>Host Country</th>
<th>Data Number/CDM-Ref</th>
<th>Average/CMP</th>
<th>Average/CMP (Max/Min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>35</td>
<td>0.294</td>
<td>1.048</td>
</tr>
<tr>
<td>Peru</td>
<td>23</td>
<td>0.600</td>
<td>0.875</td>
</tr>
<tr>
<td>Uruguay</td>
<td>7</td>
<td>0.574</td>
<td>0.914</td>
</tr>
<tr>
<td>Argentina</td>
<td>22</td>
<td>0.518</td>
<td>0.719</td>
</tr>
</tbody>
</table>

Table 4-11 Expectation of CO₂ emission reduction by process conversion of caustic soda and chlorine in Brazil, Peru, Uruguay and Argentina

<table>
<thead>
<tr>
<th>Host Country</th>
<th>Energy reduction(MWh)</th>
<th>Electrical unit consumption (t·CO₂/MWh)</th>
<th>CO₂ reduction (tonne/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>1,011,901</td>
<td>0.294</td>
<td>297,499</td>
</tr>
<tr>
<td>Peru</td>
<td>162,249</td>
<td>0.600</td>
<td>97,344</td>
</tr>
<tr>
<td>Uruguay</td>
<td>18,929</td>
<td>0.574</td>
<td>10,865</td>
</tr>
<tr>
<td>Argentina</td>
<td>642,615</td>
<td>0.518</td>
<td>84,045</td>
</tr>
<tr>
<td>Total</td>
<td>1,388,318</td>
<td>—</td>
<td>489,753</td>
</tr>
</tbody>
</table>

(https://pub.iges.or.jp/pub_file/20170113igesersheetgridefjpxlsx/download)
Therefore about 500,000 tonne/year of CO₂ reduction can be expected when converting all mercury and diaphragm cell methods are converted to the membrane cell method in Brazil, Peru, Uruguay and Argentina.

Evaluation of conversion project

Evaluation of conversion project is important for local companies to be appealed the merit of the membrane cell process installment. The membrane cell process is better than for environment and labor’s health other process due to no usage of hazardous chemicals such as mercury, but in this chapter the payback period is calculated as a economical merit. For simplification, the price of products and purchase of raw materials are same between the mercury cell process and the membrane cell process. There is a report that maintenance cost is lower than the mercury cell process, but the payback period is calculated as a simple project of electrical energy conservation. It is said that the conversion cost is 500 to 700 $/ tonne as chlorine. (UNEP Global Mercury Partnership Chlor-Alkali Area June 2012).

The payback period of conversion project is calculated under the condition that the capacity of the facility is 100,000 ton/ year as chlorine capacity. JETRO shows the data of each country's electrical price for industry. The lowest electrical piece is selected for the calculation due to robust if there are few options.

Table 4·12 Electrical prices for industry in each country

<table>
<thead>
<tr>
<th>Country (City)</th>
<th>Electrical price for industry ($/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil (Sao Paulo)</td>
<td>0.1075*1</td>
</tr>
<tr>
<td>Peru (Lima)</td>
<td>0.06*2</td>
</tr>
<tr>
<td>Uruguay (Montevideo)</td>
<td>0.15</td>
</tr>
<tr>
<td>Argentina (Buenos Aires)</td>
<td>0.046</td>
</tr>
</tbody>
</table>

(https://www.jetro.go.jp/world/search/cost_result?countryId%5B%5D=4700&countryId%5B%5D=4800&countryId%5B%5D=5900&countryId%5B%5D=6300&countryId%5B%5D=11800)

*1 It is different in the electric power unit price depending on the tight situations of the supply of electric power, but the cheapest price was chosen.

*2 It is different in the electric power unit price depending on time, but the cheapest price was chosen.
It is possible to reduce 1.352 (MWh/ tonne as chlorine) by conversion project from the mercury cell process to the membrane cell process. Then the cost merit of the conversion of the 100,000 (tonne / year as chlorine) facility is as follows:

Table 4-13 Merit of electrical cost by process conversion in each country (in case of 100 thousand (tonne/ year as chlorine) capacity)

<table>
<thead>
<tr>
<th>Country (City)</th>
<th>Electrical cost reduction (1,000$/ year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil (Sao Paulo)</td>
<td>14,534</td>
</tr>
<tr>
<td>Peru (Lima)</td>
<td>8,112</td>
</tr>
<tr>
<td>Uruguay (Montevideo)</td>
<td>20,80</td>
</tr>
<tr>
<td>Argentina (Buenos Aires)</td>
<td>6,219</td>
</tr>
</tbody>
</table>

Table 4-14 Comparison of payback year

<table>
<thead>
<tr>
<th>Country (City)</th>
<th>In case of Conversion cost 500 ($/tonne as chlorine (year))</th>
<th>In case of Conversion cost 700 ($/tonne as chlorine (year))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil (Sao Paulo)</td>
<td>3.4</td>
<td>4.8</td>
</tr>
<tr>
<td>Peru (Lima)</td>
<td>6.2</td>
<td>8.6</td>
</tr>
<tr>
<td>Uruguay (Montevideo)</td>
<td>2.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Argentina (Buenos Aires)</td>
<td>8.0</td>
<td>11.3</td>
</tr>
</tbody>
</table>

The obtained payback period is feasible because caustic soda and chlorine are needed for long time due to the basic of the chemical industry. However it is not included in treatment and storage cost for mercury and mercury contaminated equipment.
Chapter 5 Expectation of mercury usage reduction etc.

5.1 Outline of mercury emission from mercury cell Chlor-Alkali process in the world

Reduction in mercury amount of consumption when converting mercury cell method caustic soda and chlorine production process into ion-exchange membrane cell process, is expected in Brazil, Peru, Uruguay and Argentina by Chapter 5.

Mercury is used for caustic soda and chlorine electrolysis in addition to for dry battery, mercury compounds (corrosive sublimate and silver vermilion), fluorescent light, thermometer and electrical measurement appliance and amalgam (for dentistry and alloy) and synthetic chemistry (catalyst).

The release amount to the atmosphere of mercury in 2010 is as follows at each sector according to a report of the UNEP (Technical Background Report for the Global Mercury Assessment 2013). ASGM (Artisanal and small-scale gold mining) and emissions associated with fossil fuel combustion will be 37.1% and 24.7% respectively for the main one of release of mercury to the atmosphere in 2010 in the world according to this. Other main ones are production of nonferrous metals (by copper, lead, zinc, aluminum, mercury and large-scale gold production, 15.5%) and production of cement (8.8%). Discharge from Chlor-Alkali industry is 1.4% of the whole.
Figure 5.1 Proportions of global anthropogenic mercury emissions to air in 2010 from different sectors.

Table 5.1 Global anthropogenic mercury emissions to air from different sectors in 2010. IMPORTANT: These numbers cannot be compared directly with those presented in the 2008 assessment; see Section 2.4.

<table>
<thead>
<tr>
<th>Sector</th>
<th>2010 emission (range), t</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artisanal and small-scale gold mining</td>
<td>727 (410 - 1040)</td>
<td>37.1</td>
</tr>
<tr>
<td>Coal combustion – power plants</td>
<td>316 (204 - 452)</td>
<td>16.1</td>
</tr>
<tr>
<td>Coal combustion – industry</td>
<td>102 (64.7 - 146)</td>
<td>5.2</td>
</tr>
<tr>
<td>Coal combustion – other</td>
<td>56.0 (35.4 - 80.0)</td>
<td>2.9</td>
</tr>
<tr>
<td>Oil combustion – power plants</td>
<td>3.7 (1.7 - 6.1)</td>
<td>0.2</td>
</tr>
<tr>
<td>Oil combustion – industry</td>
<td>3.0 (1.4 - 5.0)</td>
<td>0.2</td>
</tr>
<tr>
<td>Oil combustion – other</td>
<td>2.6 (1.2 - 4.2)</td>
<td>0.1</td>
</tr>
<tr>
<td>Natural gas combustion – power</td>
<td>0.3 (0.1 - 0.5)</td>
<td>0.0</td>
</tr>
<tr>
<td>Natural gas combustion – industry</td>
<td>0.1 (0.0 - 0.2)</td>
<td>0.0</td>
</tr>
<tr>
<td>Natural gas combustion – other</td>
<td>0.2 (0.1 - 0.3)</td>
<td>0.0</td>
</tr>
<tr>
<td>Pig iron production (primary)</td>
<td>45.5 (20.5 - 241)</td>
<td>2.3</td>
</tr>
<tr>
<td>Non-ferrous metal production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Al, Cu, Pb, Zn)(primary)</td>
<td>194 (82.0 - 660)</td>
<td>9.9</td>
</tr>
<tr>
<td>Large-scale gold production</td>
<td>97.3 (0.7 - 247)</td>
<td>5.0</td>
</tr>
<tr>
<td>Mercury production</td>
<td>11.7 (6.9 - 17.8)</td>
<td>0.6</td>
</tr>
<tr>
<td>Cement production</td>
<td>173 (65.5 - 646)</td>
<td>8.8</td>
</tr>
<tr>
<td>Chlor-alkali industry (Hg cell)</td>
<td>28.4 (10.2 - 54.7)</td>
<td>1.4</td>
</tr>
<tr>
<td>Oil refining</td>
<td>16.0 (7.3 - 26.4)</td>
<td>0.8</td>
</tr>
<tr>
<td>Waste from consumer products (landfill)</td>
<td>89.4 (22.2 - 308)</td>
<td>4.6</td>
</tr>
<tr>
<td>Waste from consumer products (controlled incineration)</td>
<td>6.2 (1.5 - 219)</td>
<td>0.3</td>
</tr>
<tr>
<td>Cremation</td>
<td>3.6 (0.9 - 11.9)</td>
<td>0.2</td>
</tr>
<tr>
<td>Contaminated sites</td>
<td>82.5 (70.0 - 95.0)</td>
<td>4.2</td>
</tr>
</tbody>
</table>

* Values rounded to three significant figures.

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the, "OSPAR Convention") is offered to information on European mercury way caustic soda and discharge from chloric manufacturing process, and the initiative of a UNEP and World Chlorine Council are offered to something from other countries.

The number of the facilities and production of mercury cell process for caustic soda and chlorine decrease according to this information, but approximately several tens of facilities which discharge mercury to the atmospheres etc. are being still used at all over the world. But an indefinite part is still left in the income and expenditure of the mercury for mass balance in formal information and mercury discharge from mercury cell process.

Figure 5-2 Number of plants and capacity of mercury electrolysis units in USA/Canada/Mexico, Europe, Russia, India and Brazil/Argentina/Uruguay (World Chlorine Council)
A flow of dealings of mercury in the world is illustrated as follows. At the point of mass balance of mercury, it is said that supply from Europe is big to Latin America area.

Figure 5-3 Mercury trade in the world in 2008
5.2 Reduction expectation of mercury usage etc. in Brazil

The productive capacity of mercury cell process of Chlor-Alkali in Brazil is 217,000 tons by material in 2010 of a UNEP (http://www.unep.org/chemicalsandwaste/Mercury/GlobalMercuryPartnership/ChloralkaliSector/Reports/tabid/4495/language/en-US/Default.aspx), and it is the biggest productive capacity in Latin America. This accounts for 50.6% of the plant capacity of Brazil, Argentina, Peru and Uruguay except for Colombia (22,000 ton as chlorine).

Figure 5-4 Production capacity of mercury cell process for caustic soda and chlorine in middle and South America (Brazil) (http://www.unep.org/chemicalsandwaste/Mercury/GlobalMercuryPartnership/ChloralkaliSector/Reports/tabid/4495/language/en-US/Default.aspx)

The next information is obtained by information on a global inventory in mercury cell process facilities of the global mercury partnership of a UNEP. The number of facilities was also 4 in 2012 and in 2010 according to this. The number is not changed. The capacity is 217,000 tons as chlorine. On the other hand, the capacity is 223,000 tons as chlorine in 2010 in figure 5-4 by the following data. It is different between two data source, but there is no significant differences.

Table 5-2 Inventory information of mercury cell Chlor-Alkali facilities in Brazil
Mercury of 3,520 kg is emitted to the air, water, soil and solid waste in 2012, and it's expected that these discharge will be reduced by conversion from mercury cell process to other process.

![Figure 5-5 Proportion of mercury emission of mercury cell Chlor-Alkali facilities in Brazil](https://wedocs.unep.org/bitstream/handle/20.500.11822/13858/Hg-cell_chlor-alkali_facility_global_inventory_table_final.xls?sequence=1&isAllowed=y)

As emission from mercury cell process of caustic soda and chlorine production, solid waste is 54% of the whole emission and emission to air is 46%. It was reports that there were 325 tonne of mercury in mercury cell process Chlor-Alkali facilities in 2012.

The comparison of emission factor of mercury from mercury cell Chlor-Alkali facilities in Brazil and the world average are as follows:
Table 5-3 Emission factor of mercury from mercury cell Chlor-Alkali facilities in Brazil

<table>
<thead>
<tr>
<th></th>
<th>Emissions to Air</th>
<th>Emissions to Water</th>
<th>Emissions to Soil</th>
<th>Solid Waste</th>
<th>SUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil A</td>
<td>7.177</td>
<td>0.031</td>
<td>0.000</td>
<td>8.367</td>
<td>15.575</td>
</tr>
<tr>
<td>Global AVE B</td>
<td>1.178</td>
<td>0.339</td>
<td>0.101</td>
<td>32.395</td>
<td>34.013</td>
</tr>
<tr>
<td>A/B</td>
<td>609.4%</td>
<td>9.1%</td>
<td>0.0%</td>
<td>25.8%</td>
<td>45.8%</td>
</tr>
</tbody>
</table>

Emission factor of mercury from mercury cell Chlor-Alkali facilities in Brazil is almost half compared with emission factor of the world as a whole. But emission factor of air is six times. If this is decreased, the mercury emission to the environment will be reduced.

5.3 Reduction expectation of mercury usage etc. in Uruguay

The productive capacity of mercury cell process of Chlor-Alkali in Uruguay is 14,000 tons by material in 2010 of a UNEP (http://www.unep.org/chemicalsandwaste/Mercury/GlobalMercuryPartnership/ChloralkaliSector/Reports/tabid/4495/language/en-US/Default.aspx). This accounts for 3.3% of the plant capacity of Brazil, Argentina, Peru and Uruguay except for Colombia (22,000 ton as chlorine).

![Map of South America with countries marked](http://www.unep.org/chemicalsandwaste/Mercury/GlobalMercuryPartnership/ChloralkaliSector/Reports/tabid/4495/language/en-US/Default.aspx)

(Unit: 1,000tonne as chlorine)

Figure 5-6 Production capacity of mercury cell process for caustic soda and chlorine in middle and South America (Uruguay)

The next information is obtained by information on a global inventory in mercury cell process facilities of the global mercury partnership of a UNEP. The number of facilities was also 1 in 2010 and in 2012 according to this. The number is not changed.

Table 5-4 Inventory information of a mercury cell Chlor-Alkali facility in Uruguay

<table>
<thead>
<tr>
<th>Capacity 2010</th>
<th>Capacity 2012</th>
<th>No. of Facilities 2010</th>
<th>No. of Facilities 2012</th>
<th>Purchases /Sales</th>
<th>Consumption /Use</th>
<th>Hg on site at facilities</th>
<th>Emissions to Air</th>
<th>Emissions to Water</th>
<th>Emissions to Soil</th>
<th>Solid Waste</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 t Cl₂</td>
<td>1000 t Cl₂</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>UNEP</td>
</tr>
<tr>
<td>Uruguay</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Survey 2012</td>
</tr>
</tbody>
</table>

General notes:
- For countries where data was not available from the UNEP survey or WCC, the 2010 Inventory data is reproduced here. It was assumed that 2012 chlorine capacity and number of facilities was the same as 2010. Those assumed 2012 figures are italicized in the table.
- Blank cells indicate that data was not available or not reported.
- Negative numbers in the purchases/sales column indicate sales; positive numbers indicate purchases.

Mercury of 737kg is emitted to the air and solid waste in 2012, and it's expected that these discharge will be reduced by conversion from mercury cell process to other process. However it was reports that there were 24 tonne of mercury in mercury cell process Chlor-Alkali facilities and this will become an issue to storage due to conversion of mercury cell process.
As emission from mercury cell process of caustic soda and chlorine production, solid waste is 54% of the whole emission and emission to air is 46%. It was reported that there were 325 tonne of mercury in mercury cell process Chlor-Alkali facilities in 2012.

It was reported that there are 24 tons of mercury in mercury cell Chlor-Alkali facility in Uruguay as of 2012. Emissions from process operation are 97% through waste solid and 3% through air.

The comparison of emission factor of mercury from mercury cell Chlor-Alkali facilities in Uruguay and the world average are as follows:

<table>
<thead>
<tr>
<th></th>
<th>Emissions to Air</th>
<th>Emissions to Water</th>
<th>Emissions to Soil</th>
<th>Solid Waste</th>
<th>SUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uruguay A</td>
<td>1.743</td>
<td>0.003</td>
<td>0.000</td>
<td>50.929</td>
<td>52.674</td>
</tr>
<tr>
<td>Global AVE B</td>
<td>1.178</td>
<td>0.339</td>
<td>0.101</td>
<td>32.395</td>
<td>34.013</td>
</tr>
<tr>
<td>A/B</td>
<td>148.0%</td>
<td>0.8%</td>
<td>0.0%</td>
<td>157.2%</td>
<td>154.9%</td>
</tr>
</tbody>
</table>

Table 5-5 Emission factor of mercury from a mercury cell Chlor-Alkali facility in Uruguay
Emission factor of mercury from mercury cell Chlor-Alkali facilities in Uruguay is 1.5 times compared with emission factor of the world as a whole. If emission factor of solid waste is decreased, the mercury emission to the environment will be reduced.

5.4 Reduction expectation of mercury usage etc. in Peru

The productive capacity of mercury cell process of Chlor-Alkali in Peru is 76,000 tons by material in 2010 of a UNEP (http://www.unep.org/chemicalsandwaste/Mercury/GlobalMercuryPartnership/ChloralkaliSector/Reports/tabid/4495/language/en-US/Default.aspx). This accounts for 17.7% of the plant capacity of Brazil, Argentina, Peru and Uruguay except for Colombia (22,000 ton as chlorine).

![Figure 5-8 Production capacity of mercury cell process for caustic soda and chlorine in middle and South America (Peru)](http://www.unep.org/chemicalsandwaste/Mercury/GlobalMercuryPartnership/ChloralkaliSector/Reports/tabid/4495/language/en-US/Default.aspx)

(Unit: 1,000tonne as chlorine)

The next information is obtained by information on a global inventory in mercury cell process facilities of the global mercury partnership of a UNEP. The number of facilities decreased from 2 to 1 in 2010 and in 2012 according to this.

Table 5-6 Inventory information of a mercury cell Chlor-Alkali facility in Peru
The data of mercury emission to air, water, soil and solid waste are not obtained. However it was reported that the production capacity was 120,000 as chlorine in 2012. Each emission factor is estimated by the weighted average of emission factor among Argentina, Brazil and Uruguay.

Table 5.7 Weighted average of emission factor of mercury among three counties (Argentina, Brazil and Uruguay)

<table>
<thead>
<tr>
<th></th>
<th>Capacity 2012 1,000t/Cl2</th>
<th>Emissions to Air</th>
<th>Emissions to Water</th>
<th>Emissions to Soil</th>
<th>Solid Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>120</td>
<td>1.75</td>
<td>0.05</td>
<td>0.02</td>
<td>6.71</td>
</tr>
<tr>
<td>Brazil</td>
<td>226</td>
<td>7.18</td>
<td>0.03</td>
<td>0.00</td>
<td>8.37</td>
</tr>
<tr>
<td>Uruguay</td>
<td>14</td>
<td>1.74</td>
<td>0.00</td>
<td>0.00</td>
<td>50.93</td>
</tr>
<tr>
<td>Weighted average</td>
<td>—</td>
<td>5.16</td>
<td>0.04</td>
<td>0.01</td>
<td>9.47</td>
</tr>
</tbody>
</table>

Mercury emissions to air, water, soil and solid waste are estimated by the emission factor that are obtained above calculation and the production capacity of 120,000 tonnes as chlorine in Peru.

Global Inventory of Mercury-Cell Chlor-Alkali Facilities
UNEP Global Mercury Partnership Chlor-Alkali Area

<table>
<thead>
<tr>
<th></th>
<th>Capacity 2010 1000 t Cl₂</th>
<th>Capacity 2012 1000 t Cl₂</th>
<th>No. of Facilities 2010</th>
<th>No. of Facilities 2012</th>
<th>Purchase/Sales Consumption/Loss Hg on site at facilities t Hg</th>
<th>Emissions to Air kg Hg</th>
<th>Emissions to Water kg Hg</th>
<th>Emissions to Soil kg Hg</th>
<th>Solid Waste kg Hg</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peru</td>
<td>76</td>
<td>120</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2012 WCC Report</td>
</tr>
</tbody>
</table>

General notes:
- For countries where data was not available from the UNEP survey or WCC, the 2010 inventory data is reproduced here. It was assumed that 2012 chlorine capacity and number of facilities was the same as 2010. These assumed 2012 figures are italicized in the table.
- Blank cells indicate that data was not available or not reported.
- Negative numbers in the purchases/sales column indicate sales; positive numbers indicate purchases.

(https://wedocs.unep.org/bitstream/handle/20.500.11822/13858/Hg-cell_chlor-alkali_facility_global_inventory_table_final.xls?sequence=1&isAllowed=y)
Table 5-8 Estimated estimation factor of mercury in Peru (2012)

<table>
<thead>
<tr>
<th>Emissions to Air</th>
<th>Emissions to Water</th>
<th>Emissions to Soil</th>
<th>Solid Waste</th>
<th>SUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>619</td>
<td>4</td>
<td>1</td>
<td>1,136</td>
<td>1,760</td>
</tr>
</tbody>
</table>

Almost of mercury (65%) will be emitted to solid waste and the rest will be emitted to the air (35%).

Figure 5-9 Proportion of mercury emission of a mercury cell Chlor-Alkali facility in Peru (Estimation)

There is no date published regarding storage of mercury in Peru.

5.5 Reduction expectation of mercury usage etc. in Argentina

The productive capacity of mercury cell process of Chlor-Alkali in Argentina is 122,000 tons by material in 2010 of a UNEP (http://www.unep.org/chemicalsandwaste/Mercury/GlobalMercuryPartnership/ChloralkaliSector/Reports/tabid/4495/language/en-US/Default.aspx), and it is the second biggest productive capacity in Latin America. This accounts for 28.4% of the plant capacity of Brazil, Argentina, Peru and Uruguay except for Colombia (22,000 ton as chlorine).
Figure 5-10 Production capacity of mercury cell process for caustic soda and chlorine in middle and South America (Argentina) (http://www.unep.org/chemicalsandwaste/Mercury/GlobalMercuryPartnership/ChloralkaliSector/Reports/tabid/4495/language/en-US/Default.aspx)

The next information is obtained by information on a global inventory in mercury cell process facilities of the global mercury partnership of a UNEP. The number of facilities decreased from 5 to 2 in 2010 and in 2012 according to this.

Table 5-9 Inventory information of mercury cell Chlor-Alkali facilities in Argentina

<table>
<thead>
<tr>
<th>Country</th>
<th>No. of Facilities 2010</th>
<th>No. of Facilities 2012</th>
<th>Capacity 2010 1000 t Cl₂</th>
<th>Capacity 2012 1000 t Cl₂</th>
<th>Purchases/Sales Hg kg Hg</th>
<th>Consumption/Use Hg kg Hg</th>
<th>Hg on site at facilities t Hg</th>
<th>Emissions to Air kg Hg</th>
<th>Emissions to Water kg Hg</th>
<th>Emissions to Soil kg Hg</th>
<th>Solid Waste kg Hg</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>122</td>
<td>120</td>
<td>1045</td>
<td>74</td>
<td>210</td>
<td>2</td>
<td>32</td>
<td>805</td>
<td></td>
<td></td>
<td></td>
<td>2012 UNEP Survey</td>
</tr>
</tbody>
</table>

General notes:
- For countries where data was not available from the UNEP survey or WCC, the 2010 Inventory data is reproduced here. It was assumed that 2012 chlorine capacity and number of facilities was the same as 2010. These assumed 2012 figures are italicized in the table.

Notes on individual data points:
(a): Data only reported for one plant
(https://wedocs.unep.org/bitstream/handle/20.500.11822/13858/Hg-cell_chlor-alkali_facility_global_inventory_table_final.xls?sequence=1&isAllowed=y)

Mercury of 1,023kg is emitted to the air, water, soil and solid waste in 2012, and it’s expected that these discharge will be reduced by conversion from mercury cell process to other process. However it was reports that there were 74 tonne of mercury in mercury cell process Chlor-Alkali facilities and this will become an issue to storage due to conversion of mercury cell process.
It was reported that there were 74 tonne of mercury in mercury cell process Chlor-Alkali facilities in 2012. As emission from mercury cell process of caustic soda and chlorine production, solid waste is 79% of the whole emission and emission to air and water is 21% and 1% respectively.

The comparison of emission factor of mercury from mercury cell Chlor-Alkali facilities in Argentina and the world average are as follows:

Table 5-10 Emission factor of mercury from mercury cell Chlor-Alkali facilities in Argentina

<table>
<thead>
<tr>
<th>Emissions to Air</th>
<th>Emissions to Water</th>
<th>Emissions to Soil</th>
<th>Solid Waste (kg Hg/t-CL2)</th>
<th>SUM (kg Hg/t-CL2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina A</td>
<td>1.750</td>
<td>0.050</td>
<td>0.017</td>
<td>6.708</td>
</tr>
<tr>
<td>Global AVE B</td>
<td>1.178</td>
<td>0.339</td>
<td>0.101</td>
<td>32.395</td>
</tr>
<tr>
<td>A/B</td>
<td>148.6%</td>
<td>14.7%</td>
<td>16.5%</td>
<td>20.7%</td>
</tr>
</tbody>
</table>

Emission factor of mercury from mercury cell Chlor-Alkali facilities in Argentina is one forth compared with emission factor of the world as a whole. However the emission factor of air is 1.5 times, if emission factor of air is decreased, the mercury emission to
the environment will be reduced.

5.6 Summary

Caustic soda and Chlorine are produced by mercury cell process as illustrated in Figure 5.12. The emissions of mercury are mainly as follows:

- Emissions to air
- Emissions to water
- Emissions to soil

And others are:

- Mercury with product
- Mercury with solid waste

![Diagram showing how mercury is used in Chlor-Alkali process](http://www.unep.org/chemicalsandwaste/Mercury/GlobalMercuryPartnership/ChloralkaliSector/Reports/tabid/4495/language/en-US/Default.aspx)

Figure 5.12 How mercury is used in Chlor-Alkali process

The estimates mercury emission will be 7,041kg / year from mercury cell process of Chlor-Alkali in Brazil, Peru, Uruguay and Argentina. If all mercury cell process are converted to ion exchange cell process, the mercury emission will be extinguished. However the amount of storage of mercury will be 423 tonne in the facility of mercury
cell process (the amount is not published in Peru), the treatment of storage mercury and contaminated equipment by conversion will become a big issue.
Chapter 6 Presentation in Workshop

Ion-exchange membrane technology and CTCN was presented in CloroSur technical seminar X at Buenos Aires during 16th to 18th November, 2016. The material of presentation is as follows. The number of attendees is between 70 and 80 mainly Industries.

![Presentation at CloroSur technical seminar X](image)

Figure 6-1 Presentation at CloroSur technical seminar X

Overview of CloroSur technical seminar X

- **Date**: 16-18 November, 2016
- **Time**: 10:30-10:55 including Q&A
- **Attendees**: Chlor-Alkali Industries in South America etc.
- **Venue**: Hotel Hilton Madero (Buenos Aires)
New Flemion® Membranes for Zero Gap Configuration

AGC Chemicals
ASAHI GLASS CO., LTD.

Figure 6-2 Presentation at CloroSur technical seminar X No1

Contents

- Influence of Zero Gap on the membrane
- F-8080A: New Type of F-8080 series for Zero Gap
- Next Generation Membrane

Figure 6-3 Presentation at CloroSur technical seminar X No2
Figure 6.4 Presentation at CloroSur technical seminar X No3

Figure 6.5 Presentation at CloroSur technical seminar X No4
Figure 6·6 Presentation at CloroSur technical seminar X No5

Figure 6·7 Presentation at CloroSur technical seminar X No6
Figure 6.8 Presentation at CloroSur technical seminar X No7

Figure 6.9 Presentation at CloroSur technical seminar X No8
HIGHER H₂ IN Cl₂ AT LOWER CD

H₂/Cl₂ on anode side at low CD in commercial size electrolyzer

- Zero gap shows higher H₂ in Cl₂ than finite gap in same electrolyzer, which indicates more H₂ gas touches to cathode side surface of the membrane.

Figure 6-9 Presentation at CloroSur technical seminar X No8

Contents

- Influence of Zero Gap on the membrane
- F-8080A; New Type of F-8080 series for Zero Gap
- Next Generation Membrane

Figure 6-10 Presentation at CloroSur technical seminar X No9
F-8080 : CE Decrease in Zero Gap

F-8080, 6 kA/m², 32 wt% NaOH, 200 g/l NaCl

Finite gap

Zero gap with fine mesh cathode and elastic cushion

F-8080 in zero gap shows 0.5-1% lower CE than in finite gap at high temperature.

Figure 6-11 Presentation at CloroSur technical seminar X No10

F-8080A : Higher CE at High Temperature

Finite gap (Lab cell) 6 kA/m², 32 wt% NaOH, 200 g/l NaCl

F-8080A shows more than 96 % CE even at 100 °C.

Figure 6-12 Presentation at CloroSur technical seminar X No11
**F-8080A : Higher CE in commercial size nx-BiTAC**

Zero gap (Commercial size nx-BiTAC)

6kA/m², 32wt% NaOH, 200g/l NaCl

![Graph showing CE (%) vs Catholyte outlet temperature (°C) for F-8080A in commercial size nx-BiTAC and F-8080 in Lab with finite gap.]

**F-8080A in commercial nx-BiTAC with zero gap shows high enough CE at high temperature.**

---

**F-8080A : Higher CE in Hydrated Condition**

Lab cell, 6 kA/m², 90 °C, 32 wt% NaOH

![Graph showing CE (%) vs NaCl (g/l) for F-8080A and F-8080.]

**F-8080A shows higher CE in weak brine.**

---

Figure 6.13 Presentation at CloroSur technical seminar X No12

Figure 6.14 Presentation at CloroSur technical seminar X No13
Features of F-8080A

1. Higher stability for zero gap
   • Especially, higher CE at high temperature

2. Higher CE against hydrated state
   • higher CE in weak brine

3. Same voltage and durability as F-8080
   • Low voltage and high durability
   • Fine adjustment of F-8080 which has proven reliability

Figure 6-15 Presentation at CloroSur technical seminar X No14

Contents

• Influence of Zero Gap on the membrane

• F-8080A: New Type of F-8080 series for Zero Gap

• Next Generation Membrane
  • Lowest Voltage
  • Higher CE in Wider Range
  • Higher Durability against I/Ba

Figure 6-16 Presentation at CloroSur technical seminar X No15
Figure 6-17 Presentation at CloroSur technical seminar X No16

Figure 6-18 Presentation at CloroSur technical seminar X No17
Figure 6-19 Presentation at CloroSur technical seminar X No18

Figure 6-20 Presentation at CloroSur technical seminar X No19
Figure 6-21 Presentation at CloroSur technical seminar X No20

Optimized Fiber Arrangement

Conventional Cloth
F-8080/F-8080A

Optimized Cloth
Next generation

PTFE Fiber
Sacrificial Fiber

Making use of optimized fiber arrangement, this makes next generation membrane shows lowest voltage.

Figure 6-22 Presentation at CloroSur technical seminar X No21

Higher CE in Wider Temperature Range

6 kA/m², 32 wt% NaOH, 200 g/l NaCl

Next Generation
F-8080
F-8080A

Next generation membrane shows higher CE not only at high temperature but also at low temperature.
Next generation membrane shows higher CE in weak brine. It is suitable for electrolyzers which have less inner circulation of brine.

Figure 6-23 Presentation at CloroSur technical seminar X No22

Next generation shows higher CE in weak and strong caustic.

Figure 6-24 Presentation at CloroSur technical seminar X No23
Durability against I/Ba

Next generation membrane has higher durability against I/Ba.

Note: Same durability against Ca as F-8080

Furthermore!
Figure 6-27 Presentation at CloroSur technical seminar X No26

Frequent Load Tensile Test

Total number of frequent load tensile test until membrane breaking
(Sum of the value to various direction. Load : 60 % of tensile strength)

Next generation membrane is more robust than F-8080 and F-8080A.

Figure 6-28 Presentation at CloroSur technical seminar X No27

Next Generation Membrane: Fx-634

1. Lowest voltage
   - 50 mV lower voltage than F-8080 and F-8080A
   - Optimized fiber arrangement

2. Higher CE in both hydrated and dehydrated state
   - Suitable for zero gap and finite gap
   - Suitable for electorolyzer which has less inner circulation of brine

3. Higher durability against I/Ba

4. Better robustness

Large quantity of Fx-634 will be delivered from 2Q 2017.
Summary

- **Influence of Zero Gap on the membrane**
  - Higher temperature due to less heat removal

- **F-8080A : New Type of F-8080 series for Zero Gap**
  - Advanced F-8080 for higher temperature and weak brine, for hydrated state.
  - Fine adjustment of F-8080 which has proven reliability.

- **Next Generation Membrane : Fx-634**
  - 50 mV lower voltage than F-8080/F-8080A
  - Higher CE in both more hydrated and more dehydrated state
  - Durability against I/Ba and better robustness

---

**Information of CTCN**

(Climate Technology Centre and Network)

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Figure 6-29 Presentation at CloroSur technical seminar X No28

Figure 6-30 Presentation at CloroSur technical seminar X No29
• Expected energy consumption reduction by converting into membrane is 20-30%.

<table>
<thead>
<tr>
<th>Electrolysis Process</th>
<th>Mercury</th>
<th>Diaphragm</th>
<th>Membrane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy efficiency</td>
<td>as 1.0</td>
<td>0.8-0.9</td>
<td>0.7-0.8</td>
</tr>
</tbody>
</table>

Potential financial scheme by UNFCCC

• COP 18 in 2010 established the Technology Mechanism.
• Climate Technology Centre & Network (CTCN) is the operational arm of the Technology Mechanism.

Figure 6-31 Presentation at CloroSur technical seminar X No30

Figure 6-32 Presentation at CloroSur technical seminar X No31
The CTCN’s mission is “Stimulating technology cooperation and enhance the development and transfer of technologies to developing country Parties at their request”

**Services:**
1. *Technical assistance* to developing countries
2. Knowledge sharing and training
3. Fostering collaboration on climate technologies (including linking climate technology projects with financing opportunity)

---

**Overview of CTCN Services**

- **Climate Technology Centre and Network**
  - 1. Technical Assistance
  - 2. Information and Knowledge
  - 3. Collaboration and Networking

*Facilitate and enhance the transfer of climate technologies*

- Environmentally sound technologies deployed
- Greenhouse gas emissions reduced and resilience to climate change increased
- Targets in INDCs achieved

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*Figure 6-33 Presentation at CloroSur technical seminar X No.32*

*Figure 6-34 Presentation at CloroSur technical seminar X No.33*
CTCN Technical Assistance

Fast and short (3 pages) application process for countries.

Provided:
- To developing countries upon their request
- Free of charge (value up to 250,000 USD)
- State of the art and locally relevant expertise
- To academic, public, NGO, or private entities...

Figure 6-35 Presentation at CloroSur technical seminar X No34

Thank you for your attention

Figure 6-36 Presentation at CloroSur technical seminar X No35
Chapter 7 Creating draft of CTCN application form

7.1 Outline of CTCN application
The project aimed to introduce the latest ion exchange membrane method at chlorine alkali plants in the four countries of Brazil, Peru, Uruguay and Argentina, and investigated the option to support technology dissemination based on local needs. Utilization of CTCN technology support was proposed as one of these support options. In addition, the actual capital investment cost is on the order of 100 million dollars, and local operators have cited the need for financial support, but since the actual project cost is not covered under CTCN technical support, it is necessary to procure funds collectively at the final technology introduction stage. The following is the image of the schedule leading to actual projects and the position of CTCN technical support among them.

![Image of schedule leading to actual project and positioning of CTCN technical assistance](Figure 7.1.png)

As shown here, as a main content of CTCN technical support, we are considering technical detailed investigation, elaborate cost accompanying this, and financing for actual business.

7.2 Preparing a CTCN Application Form for Brazil

7.2.1 Outline of the proposed CTCN application
By establishing an agreement with stakeholders in this survey, the CTCN application for Brazil will be prepared. The CTCN application drafting by supported by the Japanese study team. The main outline of the proposed CTCN application is shown in the Annex C. The proposed CTCN Technical Assistance will also study the financial mobilization options, including the Green Climate Fund (GCF) and other public /
private funds.

7.2.2 Submission process for submission of a draft CTCN application within Brazilian government

Submission of CTCN technical assistance form is country-led and must be conducted by the NDE. In the case of Brazil, private sector stakeholders began to exchange information on technical and financial needs to prepare project proposals.

In this project, discussions between industry representatives (Braskem) and ABICLOR (Associação Brasileira da Indústria de Álcalis, Cloro e Derivados) were held. The results of analysis of the needs were conveyed to the Ministry of the Environment and the conclusion that the ownership of the project should be in the Ministry of the Environment came to a conclusion. The Ministry of Environment, which became the owner of the project, is responsible for submitting CTCN technical support proposal to Brazilian NDE of Brazilian Ministry of Science and Technology Innovation (MCTI).

MCTI accepts proposals throughout the year, and if the proposal is accepted, it will organize a panel of experts to evaluate the content focused on emissions reduction. Other considerations include the balance between adaptation and mitigation projects and national priorities. When the evaluation is completed and the project is approved, NDE officially applies the project for CTCN technical support.

Application for CTCN technical support is currently being prepared by MMA with the cooperation of other stakeholders. The process is summarized in the following figure.
7.2.3 Process for CTCN Technical Assistance approval (detailed program specification of support program · bidding etc.)

The application for CTCN Technical Assistance is as follows:

NDE sends technical support application form to CTCN. The Climate Technology Center (CTC) conducts the initial review and requests additional information as necessary.
After that, the CTC creates a Request Expert Team (RET) and sends it to the consortium's technical resource pool, the expert judges the feasibility of the project and decides the amount to contribute to the project.

Finally, the project is classified as either a quick response (50,000 USD or less) or a response project (250,000 USD or less). Through this step, CTC calls for an open bidding process in which the proposal is evaluated competitively. An organization that won the project can undertake a project.
7.3 Information gathering on CTCN technical support project at COP 22

Information on CTCN technical support project was compiled at COP 22 of UNFCCC held in Morocco (Marrakech) in December 2016. Specifically, the team participated in CTCN side events and exchanged views on individual projects with officials of the CTCN secretariat, and confirmed the consistency of this project and the CTCN support project.

7.4 Future support towards CTCN application, etc.

The first plan of the aforementioned CTCN application was provided to the Brazilian Ministry of Environment in the second field survey. At this time, the team has confirmed how to proceed with the CTCN application in the future as follows.

- The Ministry of the Environment and Abiclor will discuss and examine the missing information, information to be added, etc. in the first draft of the CTCN application form and increase the completeness of the proposed CTCN application proposal.
- The Ministry of Environment will coordinate with the Ministry of Science, Technology, Innovation, and Communications (NDE). For the first proposed CTCN application form, the team will also request opinions from NDE and make the corresponding corrections.
- Submission of the final draft of the CTCN application form to the NDE is targeted at the end of March 2017. At the finalization stage, coordination with the Japanese research team will be conducted.

The main support contents from Japan in the above process are as follows.

- Finalization of the CTCN application form: In order to complete the first draft of the CTCN application form, the team will contact the Ministry of Environment and Abiclor to confirm progress and drafting as necessary.
- Adjustments: Indirect support such as providing information on the latest trends at CTCN to the Ministry of the Environment for Brazilian inter-ministerial coordination, including NDC of CTCN. In particular, as the latest trend in CTCN, we will provide information on the decision-making process up to CTCN budget allocation and decision-making decision and speed up adjustment within ministries and agencies.
- Deliberation at CTCN: Once the CTCN application is submitted from Brazilian NDE to CTCN, follow-up of this case will be held at the international negotiation site. The team will also contact the NDE of CTCN in Japan to carefully advance deliberations on this case.
- CTCN project tender process: After CTCN approves this proposal, A tender process for
project implementation is scheduled to be conducted by UNIDO. The team will prepare the application in the future and continue to obtain funds for the project implementation as well.
Chapter 8 Compilation of the report

For this project, the feasibility of the CTCN project was researched in Brazil, Uruguay, Peru and Argentina. Future prospects, schedule, tasks to utilize CTCN found through research is shown below.

8.1 Future Prospects and Schedule

[Brazil]
An initiative was founded for the company and the Ministry of the Environment to promote the project.
In the future, we will follow up at the Brazilian side and the Japanese side with the aim of realizing the CTCN technical assistance project.
In parallel, we will continue to support various public and private financing related to climate change.

[Uruguay]
Procurement of public funds for climate change countermeasures proved to be limited.
We will continue to consider technology transfer and capital investment fund procurement on a private basis, based on the cooperative relationship between the business operator and the Environment Directorate.

[Peru]
For the time being, we found that the capacity of the relevant authorities, including the Ministry of the Environment, is limited.
In the future, first of all, we will investigate the technical needs of business operators and work towards the dissemination of advanced technologies in Japan.

[Argentina]
Continue to investigate business needs and government policies, etc. and continue to act towards the dissemination of advanced technologies in Japan.

8.2 Challenges to access CTCN as identified through this study

Matching between prioritized governmental policy areas and specific low carbon technology (There are some cases which this doesn't match).
Government policy formulation and implementation capacity (Lack of personnel in departments and experience of international financing).
Latin American countries have different backgrounds and situations even though in the same region. It is necessary to build an individual matching approach. Since CTCN’s FS is extremely small compared to the cost required for actual business, it is important to follow the path. CTCN is sovereign and some company pay careful attention towards involving with governments etc.

8.3 Financing Support
This project which introduces Ion exchange membrane method, contributes to energy saving from its feature of electricity reduction and mercury countermeasure from its feature of dehydrating mercury technology.

<Funds related to energy conservation>
· It is expected that funds will be obtained from private financial institutions and venture capital as a general loan project because investment recovery is expected from the reduction of electricity cost. As an example, domestic banks such as BNDES and green finance such as MGM Innova should be considered.
· Utilization of low interest rate system and tax preferential treatment etc. for capital investment for introducing advanced low carbon technology could be considered. A two-step loan from the World Bank, the American Development Bank, etc. could also be considered.
· Use of various international support systems to support the dissemination of global warming countermeasure technology to developing countries. As an example, funds such as GEF, GCF should be considered.

<Fund for promoting dehydrating mercury>
· The GEF is preparing funds for supporting projects in developing countries in the fields of chemical substances and waste management. The financial mechanism of the Minamata Convention on mercury is also offered through the GEF. This is a grant aid for capacity-building and survey other than actual implementation of project.

JBIC is a fund procurement option other than the above two, with the aim of supporting Japanese companies’ overseas activities. It is possible to finance at an interest rate lower than the local general interest rate. The core technologies of ion exchange membrane and electrolytic cell which are used in this project are made in Japan by Japanese companies. This matches the scope of JBIC financing.
In this survey, the procurement strategies of these funding options were presented to local stakeholders in accordance with the medium / long term schedule concerning the introduction of ion exchange membrane technology. As in the example of the figure below, the period until the goal of the complete elimination of mercury law in 2025 is defined as the agreement formation stage (Preparation in the figure), technical detailed investigation · conversion planning stage (Feasibility Study in the figure), construction stage (Technology Deployment in the figure), and examined the funds option according to the activities of each stage.

Figure 8·1 Example of funding options procurement strategy
For Brazil, the following example is considered as a specific financing option.

JBIC should be followed up concretely among the aforementioned funding options. In addition, local contents such as electricity distribution that is not within the range covered by JBIC is handled by domestic banks, although in Brazil, from the results of the experience of BNDES providing co-finance to a similar project, JBIC loan is an option we would like to continue considering.

Regarding the acquisition of international funds as well, follow up will follow tracing the flow of contributions from Japan to secure funds. This fiscal year, we specifically worked on acquiring CTCN support, but it is desired that Japan would also act concretely to acquire funding from the GEF as well. By doing so, it is expected that Japan's advanced low-carbon technology will spread overseas and contribute to mitigating climate change.

(End of Report)
Appendix

A. List of bibliographic survey source

B. Presentation for stakeholders

C. CTCN request submission draft
A. List of bibliographic survey source

Brazil
[Brazil – Energy Saving Policy]
Brazil Energy efficiency report
(https://library.e.abb.com/public/c6d0b52cc84505a2c1257be80052c5a7/Brazil.pdf).

BRIC’s up energy efficiency: energy and climate policies in Brazil, Russia, India and China
(https://library.e.abb.com/public/c6d0b52cc84505a2c1257be80052c5a7/Brazil.pdf).

Public policies for energy efficiency in Brazil
(http://www.esaf.fazenda.gov.br/cooperacao_tecnica/acoes_de_cooperacoes/i-dialogo_financas/pl_seminario).

Chapter 3: Outlook of Brazil and its development trend（ブラジルの概況と開発動向）
(https://www.mofa.go.jp/mofaj/gaiko/oda/shiryo/hyouka/kunibetu/gai/brazil/pdfs/kn09_03_01.pdf#search=%E5%9B%BD%E5%AE%B6%E6%B0%97%E5%80%99%E5%A4%89%E5%8B%95%E8%A8%88%E7%94%BB%EF%BC%88PNMC%EF%BC%89%E3%83%96%E3%83%A9%E3%83%B8%E3%83%AB).

Trade and Environment Review 2009/2010

[Brazil – Activities by Industries]
Goldman Sachs
(http://www2.goldmansachs.com/japan/gsitm/column/emerging/brics_sp/brazil.html).

[Brazil - Economic Situation Surrounding Industries]


[Brazil - Policy Related to the Minamata Convention]
Caustic Soda Market in Brazil: 2016-2020 Review
(http://www.researchandmarkets.com/research/2zvts/caustic_soda).


Peru
[Peru – Energy Saving Policy]
Peru – Energy policy, laws and regulations handbook, volume 1, strategic information and basic laws


Energypedia (https://energypedia.info/wiki/Peru_Energy_Situation).

[Peru – Activities by Industries]
Overview of major industries in Peru (JETRO)


[Peru · Economic Situation Surrounding Industries]
JBIC

[Peru · Policy Related to the Minamata Convention]

Argentina
[Argentina – Energy Saving Policy]
IEA (http://www.iea.org/policiesandmeasures/pams/argentina/).

[Argentina – Activities by Industries]
[Argentina · Economic Situation Surrounding Industries]

[Argentina · Policy Related to the Minamata Convention]
UNIDO

Uruguay
[Uruguay – Energy Saving Policy]
Renewable Energy Policy Brief Uruguay


INDC
(http://www4.unfccc.int/submissions/INDC/Published%20Documents/Uruguay/1/INDC%20Uruguay%20(English unofficial%20translation).pdf).

Ministerio de Industria, Energia y Mineria de Uruguay (MIEM), Direccion Nacional de Energia (DNE).

(http://www.dne.gub.uy/web/energia/~miem-publico-material-de-difusion-del-plan-nacional-de-efficiencia-energetica).
B. Presentation for stakeholders

(1) Example for related ministries and agencies

Contents
- International framework and Chlor-alkali industries
- Mid/Long Term Programme proposal
- CTCN Project Proposal
International framework and Chlor-alkali industries

- **Minamata Convention & UNFCCC**
  - Framework Convention on Climate Change
- **Chlor-Alkali industry in South America**
  - **Installed Capacity of Chlor-Alkali Facility - 2012**
    - World: 18% Mercury, 11% Diaphragm, 71% Membrane
    - Latin America and Caribbean: 20% Mercury, 49% Diaphragm, 31% Membrane
    - Brazil: 14% Mercury, 63% Diaphragm, 23% Membrane

**World Chlorine Council Phase Out of Mercury Use**

- Challenges...
  - Currently, 6 plants use mercury cell, require phasing out by 2025.
  - Excess Mercury from the decommissioning needs to be disposed of in an environmentally sound manner. Minamata convention does not allow for reuse or other measures.
  - Company opinion regarding challenges:
    - “Investment cost for exchange of technology is very high”
    - “Uncertainty in the new environmental permit is blinding the process”
  - Fate of the mercury after decommission is unclear at this moment.

**Mercury-free Cell - Ion Exchange Membrane**

- **Process & Project Boundary**
- **Electrolytes & Membrane**
- **Energy Consumption Comparison**
  - Mercury:
    - Production process: 50%, Cacodyl 50%, NaCl concentration in caustic: 3,500
    - Anode: 10 - 40 ppm, 2.30V
  - Membrane:
    - 15% reduction in labor costs for operation & maintenance

**Business Benefits**
- Mercury free
- 20-30% reduction of energy use and CO2 emissions
Mid/Long-Term Programme proposal

Timeline (tentative)
- Preparation 2017
- Feasibility Study 2018
- Technology Deployment 2020

Preparation phase (today – March 2017)
- Stakeholder consultations with government, private, donor communities
- Project proposal drafting for CTCN, GEF, etc.
- Quick assessment on Mercury & GHG reductions
- Supported by METI

Feasibility Study phase (Approx. 2017 – 12 months TBC)
- On-site survey, Technical designing & Cost Estimating for Chlor-Alkali industries by EPC
- Financial feasibility assessment for Chlor-Alkali industries by potential investors
- GHG & mercury reduction forecasts, stakeholder consultations & project proposal drafting (continued)
- CTCN (tentative)

Technology Deployment phase (Approx. 2018 – 36 months TBC)
- Support to install ion-membrane cells
- Training etc. for plant operators and managers
- Technical assistance regarding used-mercury management (decommissioning, soil, etc.)
- GEF, JBIC, GCF, private loan, etc.

Preparation phase (today – March 2017) - supported by METI -

<table>
<thead>
<tr>
<th>Participants</th>
<th>Roles</th>
</tr>
</thead>
</table>
| ASC          | Lead project manager
|              | • Preliminary assessment re. energy saving & mercury reduction |
| OECO         | Co-manager
|              | • Assistance to draft implementation plan for Chlor-Alkali sector |
|              | • CTCN proposal drafting |
| Glorusur     | Regional manager for South America
|              | • Coordination in Peru & drafting implementation plan for the Chlor-Alkali industries to be included in the CTCN proposal |

(TENTATIVE)
January 2017
- 2nd Visit to South Am
- Continue discussions with government and private sectors re. CTCN project proposals and beyond

November 2016
- Glorusur Expo in Buenos Aires, Argentina
- Interviews with Chlor-Alkali producers

Approx.
March 2017
- Final draft CTCN project proposals

Photos by OECO
Feasibility Study phase (Approx. 2017 – 12 months TBC)
- Supported by CTCN (TBC) -

CTCN technical support on climate technologies
1. Technical assessments, including technical expertise and recommendations related to specific technology needs.
2. Identification of technologies, technology barriers, technology efficiency, as well as piloting and deployment of technologies, etc.

Assistance features
- to developing countries at the request of their NDEs
- free of charge (with a value up to 250,000 USD)
- to academic, public, NGO, or private sector entities
- for a broad range of adaptation and mitigation technologies

How it works
- Academic, government, NGO and/or private sector representatives work with their National Designated Entity, the CTCN focal point selected by each country, to identify the type of technical assistance they need
- The NDE conveys the request to CTCN
- A team of climate technology experts from the CTCN, its Consortium, and Network work with the NDE, provides a solution that is tailored to the needs of the individual country

https://www.ctcn.org/technical-assistance

Participants

<table>
<thead>
<tr>
<th>Roles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CTCN NDE</strong></td>
</tr>
<tr>
<td>- Submit request to CTCN for assistance in installing energy-efficient Chlor-Alkali technologies</td>
</tr>
<tr>
<td>- Coordination with CTCN</td>
</tr>
<tr>
<td>- Support the Chlor-Alkali Industries to implement its plans in line with national priorities and policies</td>
</tr>
<tr>
<td><strong>Chlor-alkali maker</strong></td>
</tr>
<tr>
<td>- Receive on-site survey, in-depth engineering designs/cost estimates,</td>
</tr>
<tr>
<td>- Financial planning</td>
</tr>
<tr>
<td>- Coordinate with national mitigation / climate change strategies</td>
</tr>
<tr>
<td><strong>ASC</strong></td>
</tr>
<tr>
<td>- Energy efficiency Technical expert from CTCN (TBC)</td>
</tr>
<tr>
<td>- Provide technical assistance to the Industry re. In-depth engineering/cost estimation, membrane maintenance</td>
</tr>
<tr>
<td>- Provide technical assistance re. GHG emission estimate, mercury reduction forecast, etc.</td>
</tr>
<tr>
<td><em><em>OECC</em> (Accredited CTCN member)</em>*</td>
</tr>
<tr>
<td>- Climate technology experts team from CTCN (TBC)</td>
</tr>
<tr>
<td>- Provide technical assistance to government/private stakeholders on mitigation / climate change strategies,</td>
</tr>
<tr>
<td>- Assist NAMA / NDC &amp; national/local governments</td>
</tr>
<tr>
<td><strong>Engineering/Procurement/Construction (EPC)</strong></td>
</tr>
<tr>
<td>- Commissioned engineer (TBC): On-site survey, in-depth engineering designs and cost estimation</td>
</tr>
<tr>
<td><strong>Financial sector (Banks, etc.)</strong></td>
</tr>
<tr>
<td>- Commissioned entity (TBC): Financial planning for conversion for the chlor-alkali manufacturers</td>
</tr>
</tbody>
</table>
Annex

Photos by OECC

About OECC...

- Established in 1990: Based in Tokyo, Minato-ku. Beijing office was established in 2006.
- OECC’s activities to support developing countries in close cooperation with the Government of Japan and international organizations include:
  - Dispatching technical experts,
  - Supporting development and implementation of master plans, and
  - Providing training in the field of climate change, energy, and environmental pollution control.
- For climate change field, OECC’s activities include:
  - Formulating and implementing adaptation / mitigation projects (INDCs and NAMAs),
  - Dispatching experts to negotiation teams for international conferences,
  - Promoting new market mechanisms e.g. the Joint Crediting Mechanism of Japan (JCM), and
  - Developing and implementing technology transfer projects.
- OECC consists mainly of consultancy firms, local governments, construction companies, electronic manufacturers, etc.

OECC website: [http://www.oecc.or.jp](http://www.oecc.or.jp)
Thank you for your attention...

- Dr. Yuichiro Ogata, Asahi Glass Co., Ltd.
  <yuichiro-ogata@agc.com>
- Hayashi, OECC Japan
  <hyashi@oecc.org.jp>
(2) Example for Chlor-Alkali Industries

Idea Notes: International Financial Schemes for Mercury Conversion and Sound Management of Mercury

Dr. Yuichiro Ogata, Asahi Glass Co. Ltd.
Yayoi Hayashi, OECC Japan

Mid/Long-Term Programme proposal

Timeline (tentative)

- Preparation: 2017
- Feasibility Study: 2018
- Technology Deployment (Hg Conversion): 2020
- Technology Assistance (Hg Disposal): 2023

**Preparation phase (today – March 2017)**
- Stakeholder consultations in Brazil, project proposal drafting for CTCN, GEF, etc. by AGC & OECC

**Feasibility Study phase (Approx. 2017 – 12 months; Tentative)**
- On-site survey, Technical designing & Cost Estimating by AGC, EPC, etc.
- Financial feasibility assessment for Chlor-Alkali Industries by potential investors

**Technology Deployment phase (Approx. 2018 – 36 months; Tentative)**
- Installation of ion-membrane cells, operation training in the field by AGC, EPC, etc.

**Technical Assistance on Hg Management (Approx. 2018-)**
- Technical assistance on on-site risk assessment and handling (soil, Hg waste, Hg safe storage, etc.) by Nomura Kojaan (tentative)
### Feasibility Study phase (Approx. 2017 – 12 months - Supported by CTCN (TBC) -

<table>
<thead>
<tr>
<th>Participants</th>
<th>Roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ministry of the Environment</td>
<td>• Submit request to CTCN for assistance in installing energy-efficient Chlor-Alkali technologies&lt;br&gt;• Coordination with CTCN&lt;br&gt;• Support the Chlor-Alkali industries to implement its plans in line with national priorities and policies</td>
</tr>
<tr>
<td>AGC/OECC* (*accredited CTCN member)</td>
<td>Climate technology experts team from CTCN (TBC)&lt;br&gt;• Assist drafting implementation plan e.g. ion-membrane cells&lt;br&gt;• Assist technology customization&lt;br&gt;• GHG reduction estimate &amp; mercury reduction estimate (co-benefit)&lt;br&gt;• Staff training</td>
</tr>
<tr>
<td>EPC</td>
<td>Commissioned expert (TBC)&lt;br&gt;• Provide specialized engineering expertise to ion-membrane cell deployment incl. on-site survey, in-depth engineering designs and cost estimation</td>
</tr>
<tr>
<td>Private funds</td>
<td>Voluntary expert (TBC)&lt;br&gt;• Financial feasibility assessment and financial planning</td>
</tr>
<tr>
<td>Clorosur</td>
<td>Commissioned expert (TBC)&lt;br&gt;• Synergy in South American Industries &amp; WCC</td>
</tr>
</tbody>
</table>

### Funding sources

<table>
<thead>
<tr>
<th>Fund Name</th>
<th>Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Technology Center &amp; Network (CTCN)</td>
<td>- Via Ministry of Science, Technology, Innovation &amp; Communication, Brazil&lt;br&gt;• Funding type: Technical Assistance&lt;br&gt;• Limited available fund ($ 250,000 USD)</td>
</tr>
<tr>
<td>Green Climate Fund (GCF)</td>
<td>- Via Accredited Entities (IDB, etc.)&lt;br&gt;• Funding type: loan, guarantee, equity, etc.&lt;br&gt;• Aimed at Low-carbon technology transfers, etc.&lt;br&gt;• Government involvement = Only indirect role</td>
</tr>
<tr>
<td>Global Environment Facility (GEF)</td>
<td>- Via MMA Brazil&lt;br&gt;• Funding type: loan (?), grant (?), others (?)&lt;br&gt;• Multi-focal approach&lt;br&gt;• Aimed at Capacity Building, limited available fund ($ 10 million USD per all Brazilia)</td>
</tr>
</tbody>
</table>
Annex

Mercury-free Cell - Ion Exchange Membrane -

<table>
<thead>
<tr>
<th>Production process</th>
<th>Caustic soda Concentration</th>
<th>NaCl concentration in water</th>
<th>Energy consumption AC kWh NaCl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>50%</td>
<td>Approx. 10ppm</td>
<td>3.600</td>
</tr>
<tr>
<td>Membrane</td>
<td>32%</td>
<td>10~40 ppm</td>
<td>2.300*</td>
</tr>
</tbody>
</table>

*Indicating the energy consumption to concentrate caustic soda up to 32%. Source: Aomi Class Co., Ltd.
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  > Providing training in the field of climate change, energy, and environmental pollution control.
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OECC website <http://www.oecc.or.jp>

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Thank you for your attention...

- Dr. Yuichiro Ogata, Asahi Glass Co., Ltd.  
  <yuichiro-ogata@agc.com>
- Yayoi Hayashi, OECC Japan  
  <yhayashi@oecc.or.jp>
Please fill in the form in the grey spaces, by following the instructions in italic.

<table>
<thead>
<tr>
<th>Requesting country:</th>
<th>Brazil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Request title:</td>
<td>Feasibility Study (FS) of Energy-Efficient Caustic Soda Production Process</td>
</tr>
</tbody>
</table>

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).)

<table>
<thead>
<tr>
<th>National Designated Entity</th>
<th>Request Applicant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Márcio Rojas da Cruz (To be confirmed)</td>
<td>Ms Leticia Reis de Carvalho</td>
</tr>
<tr>
<td>Coordinator for Global Climate Change</td>
<td>Director, Department of Environmental Quality</td>
</tr>
<tr>
<td>Ministry of Science, Technology and Innovation</td>
<td>Ministry of the Environment, Secretariat of Climate Change and Environmental Quality</td>
</tr>
<tr>
<td>+55 61 2033 7923</td>
<td>+55 61 2028 2070</td>
</tr>
<tr>
<td>Email: <a href="mailto:cgmc@mcti.gov.br">cgmc@mcti.gov.br</a>, <a href="mailto:mrojas@mcti.gov.br">mrojas@mcti.gov.br</a></td>
<td>Email: <a href="mailto:Leticia.carvallho@mma.gov.br">Leticia.carvallho@mma.gov.br</a></td>
</tr>
<tr>
<td>Postal address: Esplanada dos Ministérios, Bloco E. Brasília · DF, Brazil. 70067-900</td>
<td>SEPN 505 – Bloco B – Sala T-20 – Terreo 70730-542 – Brasília·DF</td>
</tr>
</tbody>
</table>
Technology Needs Assessment (TNA):

{Select one of the three boxes below:}

☐ The requesting country has conducted a TNA in .... (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.}

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.)}

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}

Industry (Chemicals)

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.}

- The goal set in the Paris Agreement which aims at reaching global warming levels below 2°C from pre-industrial levels within this century, and to pursue efforts to limit the temperature increase to 1.5 °C, poses considerable challenges to the industrial sector to control their emissions and to pursue a more efficient use of energy.

- One of the sectors affected is the chlor-alkali industry which produces caustic soda. Caustic soda is a basic chemical product, essential to a vast variety of down-stream industries and end users including household (visual reference will be inserted). However, production of caustic soda requires consumption of electricity. Electrolysis technology is used to ionize salt. It is believed that only the electrolysis process consumes about 30% of the electricity used by a plant.

- Technological innovation in the chlor-alkali manufacturing process has developed, from the mercury process towards more energy efficient technologies such as the diaphragm and membrane processes. The latest membrane process can save as much as 30% of electricity vis-à-vis mercury process.

- As for Brazil, this is the 6th biggest producer of chlor-alkali in the world (visual reference).

- According to preliminary studies, there are 5 chlor-alkali producers operating in 7 different locations in Brazil. Among these 7 locations, 4 plants are still using mercury cells in their
production processes: Unipar Carbocloro located in Sao Paulo, one of the biggest chlor-alkali producers in Brazil, followed by Braskem S.A. located in Bahia, Produquimica located in Pernambuco, and Katrium Industrias Quimicas S.A. (previously Pan-Americana) located in Rio de Janeiro.

- Although conversion to membrane process can benefit from a considerable reduction in energy consumption, it has proven to be considerably costly (in the range of hundred million dollars). Hence, channeling financial support is needed to conduct the conversion work.

- The exact financial needs vary depending on in-depth engineering designs. In order to identify the most appropriate technical design for each chlor-alkali plant, an international expert team will be indispensable.

- In addition, all these actions need to be coordinated with the stakeholders, especially the climate and environmental authorities, in order to properly align with national strategies and environmental goals. To this end, it is desirable that a climate mitigation action such as introducing energy efficient membrane technologies will be quantitatively accounted through MRV schemes. This is another area where an international technical expert will play an important role to fulfill the task.

- Furthermore, chlor-alkali industries are facing the challenge of the mercury phase-out target by year 2025, as declared in the Minamata Convention on Mercury. It is believed that international technical assistance will help industries to achieve the assumed international responsibilities.

- As described above, a feasibility study is planned with the CTCN Technical Assistance for: 1) In-depth analyses of technology conversion, which includes: a) In-depth engineering designing to install membrane cell processes and b) detailed cost estimations for these works; and 2) alignment with national climate change strategies, including MRV development and coordination with the concerned authorities.

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

(Please describe here past and ongoing 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.)
<Past and on-going processes, projects and initiatives>

1) Promoting energy efficiency for the industry sector

a) Brazilian government

(to be filled by OECC with ref. the Third communication to the UNFCCC)

b) Industries/associations (to be filled by Abiclor?)

(Conversions works already in progress by individual industries’ initiatives, technical guidance published by Abiclor with assistance from World Chlorine Council, etc.)

c) Collaboration between the private sector and the government to raise the issue’s profile within the national priorities

- The chlor-alkali industries, industry associations, and Brazilian government have succeeded in raising the conversion process as one of the most important national environmental priorities. They have advocated the importance of conversion to membrane technologies, by jointly organizing workshops with government agencies, consulting with foreign assistance programs, and presenting the issue at the international fora.

**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.)

**Nature of the CTCN technical assistance: Feasibility Study**

The CTCN technical assistance will support a feasibility study (FS) for the Brazilian chlor-alkali industries to convert from the energy consuming process to a highly efficient membrane process. This FS will consist of two parts, as follows:

1) In-depth analyses of technology conversion:

a) In-depth engineering designing: Technical experts will survey the chlor-alkali plants and
conduct an energy efficiency evaluation of the current technology processes being used for the caustic soda production. This evaluation will include energy audits to determine current energy consumption, as well as the detailed engineering designs to fit each of the plant. (There will be a technical assessment for waste mercury management, which will be carried out in parallel to the present FS.)

b) Detailed cost estimation: The FS will estimate the costs associated with technology conversion for each plant. The costs will include import expenses of membrane electrolysis cells and their installation works, along with their auxiliary equipment which needs to be replaced, e.g. brine purification and caustic compressors, etc. These results will be translated into estimation of energy and costs savings for the company.

2) Alignment with national strategies for climate change mitigation actions and sustainable development

- This project to install membrane cells will contribute Brazil to achieve global climate change goals under the United Nations Framework Convention to Climate change (UNFCCC) in terms of emissions reduction. In order to make sure that the chlor-alkali industry’s initiatives are reflected in national strategies, an appropriate climate change mitigation accounting will be necessary. In this regard, the precise engineering designs and the energy saving data resulting from the present FS will be integrated in Brazil’s climate change mitigation actions and MRV.

- In addition, this project will contribute the Brazil’s efforts towards fulfillment of the Minamata Convention on Mercury, in terms of phasing out of mercury from industrial uses.

**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.)

<Medium-term impacts>

Given the huge amount of investment required for the industries to complete the technology conversion, the results of the FS i.e. the detailed technical engineering and precise cost analyses, will help the industries access to various funds.
<Long-term impacts>

In the successful scenario of fund raising and installation of membrane processes, the expected long-term benefits will be:

i) Approx. 30% reduction of energy use and CO2 emissions.

ii) 15% reduction of labour costs for O&M (operation and Maintenance), ibid.

iii) Mercury phase out, and resultant environmental & social benefit within and beyond Brazil

From the climate change mitigation perspective, approximately 75,000 tCO2/year of CO2 reduction (estimates) is expected from installing the membrane processes in 4 sites, if not more from converting other plants from less efficient processes (e.g. diaphragm) into more efficient membrane processes.

The project is expected to assist achieving Brazil’s Intended National Determined Contributions (INDC), where the goals to reduce GHG emissions by 37% below 2005 levels in 2025, are expected to come from the industrial sector, through promotion of new standards of clean technology and enhancement of energy efficiency measures and low carbon infrastructure.

Also in terms of long-term impacts, the conversion experience in Brazil could be replicated to other Latin American countries, e.g. Peru and Uruguay, where the mercury processes are still used in the chlor-alkali industry.

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).

After completion of the present FS, channeling funds required for the proposed technology introduction will be conducted. The conversion works will take place as outlined below:

i) Expected Period: Approx. 36 months
ii) Scope:
- Installation of membrane cells at 4 sites*
- Training etc. for plant operators and managers
- Technical assistance regarding excess mercury management (decommissioning, contaminated site, etc.)
- Others as necessary.

Note (*): Candidate 4 sites (caustic soda manufacturing plants) are shown below.

( ): Values in parentheses indicates annual production volume of caustic soda.

iii) Financing plan (to be developed during the FS):
- Private financial sources (private banks, shareholders, etc.)
- Public finance (multi/bilateral sovereign loans, Brazilian financial programs, UN assistance etc.)

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
<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Role to support the implementation of the assistance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ministério da Ciência, Tecnologia, Inovação e Comunicação (TBC)</strong></td>
<td>National Designated Entity (NDE) to the CTCN: Application of the project and general coordination with the CTCN</td>
</tr>
<tr>
<td><strong>Ministério do Meio Ambiente (MMA) (TBC)</strong></td>
<td>Project owner and implementing entity (TBC): Institutional strengthening; coordination with national government agencies involved, as well as with the CTCN; support the chlor-alkali industries to implement its plans in line with national priorities and policies</td>
</tr>
<tr>
<td><strong>Abiclor (Brazilian chlor-alkali industry association)</strong></td>
<td>Co-owner and co-implementing entity (TBC): Technical coordination between the Brazilian chlor-alkali manufacturers and the expert team, technical advisory to national strategy development such as NAMA / MRV strategy / GHG inventory / etc.</td>
</tr>
<tr>
<td><strong>Brazilian Chlor-alkali manufacturers</strong></td>
<td>Recipient (TBC): Receive on-site survey, in-depth engineering designs / cost estimates, financial planning, national strategy planning such as NAMA, MRV, etc.</td>
</tr>
<tr>
<td><strong>Asahi Glass Co., Ltd. (AGC)</strong></td>
<td>Commissioned FS technical expert (TBC): Technical advisory to the Brazilian manufacturers related to converting the mercury process (in-depth engineering and cost estimation), GHG emission estimates, mercury reduction forecast, etc.</td>
</tr>
<tr>
<td><strong>Overseas Environmental Cooperation Center, Japan (the OECC)</strong></td>
<td>Commissioned FS technical expert (TBC): Technical advisory to the Brazilian stakeholders (state agencies and industries) related to national strategy development such as NAMA / MRV strategy / GHG inventory / etc.</td>
</tr>
</tbody>
</table>
**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.).*

(TBC) national development plans, poverty reduction plans, technology needs assessments (TNAs), LEDS, NAMAs, TAPs, NAPs, sectorial strategies and plans, etc. (TBC)(to be filled by MMA?)

**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.).*

<2016 March (TBC)>
- Brazilian chlor-alkali industry association requested financial support in order to convert the manufacturing process into more energy efficient membrane process from mercury process.

<2016 April (TBC)>
- Brazilian government wrote a request letter to the Japanese Embassy requesting for financial support for Brazilian chlor-alkali industry for converting the mercury process.
A team of Japanese experts proposed to the Brazilian government (Ministry of the Environment (MMA)), a project to be financed by CTCN.

Brazilian Ministry of the Environment and the chlor-alkali industry organized a consultation meeting with the Japanese experts and the Ministry of Science, Technology, Innovation and Communication (MCTI).

Japanese experts will visit the Braskem facilities and discuss participation in the project.

Japanese experts will hold meetings with the Brazilian government to discuss application process to the CTCN and other funds.

Expected timeframe:

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

Feasibility Study Period: Approx. 12 months, expecting to start in 2017

Main activities of the FS:

- On-site survey & technical designing and cost estimation.
- Financial feasibility assessment by potential inventors.
- GHG reduction forecasts, MRV development, Assistance to develop NAMA & reflection in the Brazilian INDC.
- Environmental & Social Impact Assessment / stakeholder consultations
- Others

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 weblinks 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.

- Documents concerning national priorities, national development plans, poverty reduction plans, technology needs assessments (TNAs), LEDS, NAMAs, TAPs, NAPs, sectorial strategies and plans, etc., etc,

(To be filled by MMA?)

**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:
Date:
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