Report and Recommendation of the President to the Board of Directors

Project Number: 47051-002
October 2015

Proposed Loan
People's Republic of China: Chemical Industry Energy Efficiency and Emission Reduction Project

Asian Development Bank

CURRENCY EQUIVALENTS

(as of 14 September 2015)

Currency unit	–	yuan (CNY)
CNY1.00	=	$0.1569
$1.00	=	CNY6.3734

ABBREVIATIONS

ADB	–	Asian Development Bank
CCB	–	China Construction Bank
CGY	–	Zhonghao Chenguang Research Institute of Chemical Industry
CHC	–	China Haohua Chemical Group
ChemChina	–	China National Chemical Group
CO_2	–	carbon dioxide
DSC	–	Dezhou Shihua Chemical
EIA	–	environmental impact assessment
ESCO	–	energy service company
ESMS	–	environmental and social management system
FIL	–	financial intermediation loan
GHG	–	greenhouse gas
HFC-23	–	fluoroform
Huatai	–	Beijing Zhonghao Huatai Energy Technology
IDA	–	interest differential account
PAM	–	project administration manual
PRC	–	People's Republic of China
PVC	–	polyvinyl chloride
REF	–	revolving escrow fund
tce	–	ton of coal equivalent

NOTE

In this report, "$" refers to US dollars.

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CONTENTS

PROJECT AT A GLANCE

1. Basic Data

Project Number: 47051-002

Project Name	Chemical Industry Energy Efficiency and Emission Reduction Project	**Department /Division**	EARD/EAEN
Country	China, People's Republic of	**Executing Agency**	China National Chemical Corporation Group
Borrower	People's Republic of China		

2. Sector

	Sector	Subsector(s)	ADB Financing ($ million)
✓	**Energy**	Energy efficiency and conservation	100.00
		Total	**100.00**

3. Strategic Agenda

Strategic Agenda	Subcomponents
Inclusive economic growth (IEG)	Pillar 1: Economic opportunities, including jobs, created and expanded
Environmentally sustainable growth (ESG)	Global and regional transboundary environmental concerns Natural resources conservation Urban environmental improvement

Climate Change Information

Adaptation ($ million)	5.00
Mitigation ($ million)	50.00
CO_2 reduction (tons per annum)	14,821,396
Climate Change impact on the Project	Medium

4. Drivers of Change

Drivers of Change	Components
Governance and capacity development (GCD)	Institutional development
Partnerships (PAR)	Official cofinancing Private Sector
Private sector development (PSD)	Promotion of private sector investment

Gender Equity and Mainstreaming

No gender elements (NGE) ✓

5. Poverty Targeting

Project directly targets poverty: No

Location Impact

Urban	High

6. Risk Categorization: Complex

7. Safeguard Categorization

Environment: FI **Involuntary Resettlement:** FI **Indigenous Peoples:** FI

8. Financing

Modality and Sources	Amount ($ million)
ADB	**100.00**
Sovereign Project loan: Ordinary capital resources	100.00
Cofinancing	**81.73**
Commercial Bank - Domestic	81.73
Counterpart	**63.28**
Beneficiaries	63.28
Total	**245.01**

9. Effective Development Cooperation

Use of country procurement systems	No
Use of country public financial management systems	Yes

Source: Asian Development Bank

I. THE PROPOSAL

1. I submit for your approval the following report and recommendation on a proposed loan to the People's Republic of China (PRC) for the Chemical Industry Energy Efficiency and Emission Reduction Project.[1]

2. The proposed project will use the financial intermediation loan (FIL) modality to finance innovative, high-impact technologies and process transformations that will improve energy efficiency and reduce emissions from selected plants of the China National Chemical Group (ChemChina).[2] It will leverage Asian Development Bank (ADB) financing by (i) using a revolving escrow fund (REF) for multiple rollover of ADB funding, (ii) engaging in collaborative commercial cofinancing, and (iii) employing a sector-specific energy service company (ESCO).[3]

II. THE PROJECT

A. Rationale

3. The chemical industry is the second largest industrial energy consumer in the PRC.[4] In 2013, it consumed about 457 million tons of coal equivalent (tce), or about 16.6% of the PRC's total industrial energy consumption. It is also one of the PRC's most energy-intensive industries. In 2013, its energy intensity of 1.78 tce per CNY10,000 output was about 5.5% below the 2010 level but still twice as high as the best international standards. With a target of 20%, the chemical industry is expected to make larger contributions to energy intensity improvement during the period of the Twelfth Five-Year Plan, 2011–2015 compared to the national target across all economic sectors of 16%. The Government of the PRC is expected to take a more stringent approach in the period of the Thirteenth Five-Year Plan, 2016–2020 and beyond to (i) slow the growth in coal consumption and overall energy demand by 2020, and (ii) achieve a peaking in the PRC's carbon dioxide (CO_2) emissions by 2030.

4. The PRC's chemical industry faces unique challenges to further reduce energy intensity because unlike other major chemical producers worldwide, it predominantly uses coal rather than petroleum or natural gas as feedstock and fuel.[5] Coal-based processes are inherently more energy intensive and produce significantly more greenhouse gas (GHG) emissions and local air pollution. Technology innovations and process transformations are essential to further improve energy efficiency and reduce emissions. Many such technologies and process transformations have been researched and successfully pilot tested in the PRC, but their commercial deployment has been delayed by various barriers (para. 7).

5. The PRC's chemical industry is a major emitter of air and other toxic pollutants, and GHGs. In 2013, the chemical industry discharged more wastewater, sulfur dioxide, and nitrogen oxides than any other industry in the country. Within the chemical industry, the production of plastics is particularly energy and emission intensive. Fluoropolymer, a synthetic carbon-based plastic commonly used to provide corrosion-resistant coating, is an important source of

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[1] The design and monitoring framework is in Appendix 1.

[2] ChemChina is the largest state-owned enterprise in the chemical industry of the PRC. It owns more than 100 industries and 24 research and development institutes. In 2014, the group's turnover reached CNY244 billion.

[3] ADB provided project preparatory technical assistance. ADB. 2013. *Technical Assistance for Preparing the Chemical Industry Energy Efficiency and Emission Reduction Project.* Manila.

[4] The iron and steel industry is the PRC's largest industrial energy consumer.

[5] Coal is preferred because it is abundantly available and holds a cost advantage in the domestic market.

emissions of fluoroform (HFC-23), a GHG that is 14,800 times more potent than CO_2.[6] HFC-23 incineration technologies are available, but they have not been deployed widely in the PRC because of inadequate regulation and incentives.[7]

6. More than 80% of polyvinyl chloride (PVC) production in the PRC uses coal-derived feedstock[8] and a catalyst based on mercury, a toxic chemical element that persists in the environment once mobilized.[9] PVC production accounts for more than 70% of domestic and nearly 50% of global intentional use of mercury. Moreover, to provide mercury for this industrial use, mercury mining is still practiced in the PRC, posing a major threat to the environment and public health. In 2010, the government issued a notice to phase out the use of mercury in the PVC industry. Research for an alternative catalyst was included in the National Basic Research Program, but to date no alternative catalyst has been demonstrated at commercial scale.

7. ChemChina is the PRC's largest producer of fluoropolymer, PVC, synthetic resins, and fine chemicals. Potent technologies and process transformations that can improve energy efficiency and lead to deep cuts in emissions in the industry have been developed and pilot tested by ChemChina's research and development institutes, such as mercury-free PVC production. However, their scale-up has been difficult because of (i) perceived and real technical risks; (ii) the need for debt financing, which commercial financing institutions with their weak understanding of the financial viability of such projects are unable to provide; (iii) lack of strict regulatory requirements to incentivize investments as relevant technologies have not been demonstrated at commercial scale; and (iv) the lack of a suitable ESCO that can bring together technical know-how and suitable financing.

8. The ESCO sector, which has been effective in driving energy efficiency investments in other countries, is a priority for the government. ESCOs have grown rapidly in the PRC since 2006, numbering more than 5,000 and reaching a turnover of more than CNY165 billion by the end of 2013. But the ESCOs still lack (i) the capacity to finance and implement more complex and larger industrial energy efficiency projects; (ii) access to or knowledge of innovative, high-impact technologies; and (iii) the service standards needed to build trust among financiers and host industries. Also, there are no industry-specific ESCOs with technical expertise in the chemical industry.

9. ADB support will be crucial to address the key issues and barriers identified in paras. 7 and 8 and facilitate to commercial-scale demonstration of strategic technologies. ADB funding supports de-risking of investments and ADB due diligence and enhanced monitoring measures will ensure that technical and other associated risks are adequately managed. Moreover, the business models developed with ADB support will ensure timely replication. Because of the relatively shorter payback period (5 to 7 years) for typical industrial energy efficiency projects, the FIL modality was chosen to allow multiple rollover of the ADB loan over the loan tenor. By further leveraging commercial cofinancing with ADB funding, the project will target a higher impact in improving energy efficiency and emission reduction than would otherwise be possible

[6] In 2013, the PRC emitted nearly 9,500 tons of untreated HFC-23, or nearly 140 million tons of CO_2 equivalent.

[7] HFC-23 destruction involves an energy penalty at the plant level. Its inclusion among the clean development mechanism–eligible mitigation measures led to its use in some plants in the PRC and to disproportionately high clean development mechanism credits earned. But the decision to stop buying such credits from 2013 onwards has drastically stalled the wider adoption of HFC-23 destruction measures.

[8] Although it is more than twice as energy intensive as the petroleum-based process, the coal-based process is more cost-effective in the PRC because of the lower price of coal (about one-third the price of petroleum).

[9] From 2002 to 2013, the PRC's PVC production increased from 3.0 million tons to 12.5 million tons using the coal-based process. As a result, mercury use in this sector increased from 350 tons to about 1,300 tons.

with a project loan. The two subprojects in the first batch will scale up pilot-tested innovative technologies in selected ChemChina plants to (i) reduce energy consumption and eliminate mercury use in one of the largest PVC plants, and (ii) destroy HFC-23 at a major fluoropolymer plant.[10] Packaging HFC-23 destruction at the selected fluoropolymer plant with state-of-the-art energy efficiency measures will (i) support the financial viability of the investment even under a very weak incentive structure and despite the energy penalties for HFC-23 destruction, and (ii) demonstrate a new business model in the process. It will also directly support and demonstrate the commercial viability of industry-specific ESCO financing and services for such projects.

10. ADB has supported three other industrial energy efficiency and emission reduction projects in the provinces of Guangdong, Hebei, and Shandong.[11] The following lessons from the previous projects have been incorporated in the project design: (i) the choice of the FIL modality with 10-year grace period was adopted from previous designs, as this was found best suited for scaling up the impact of ADB assistance; (ii) a more rigorous review of first batch subprojects was conducted to avoid dropping out of one or more subprojects and to ensure timely disbursement; and (iii) a professional ESCO with competent technical staff and access to relevant technologies was chosen as the project implementation unit to support effective selection and appraisal of future subprojects, and reduce associated risks. Unlike the previous projects, the proposed project applies ESCO use from first batch subprojects. This will reduce the risk identified in the previous projects on the likelihood of ESCO engagement.

11. The project is closely aligned with (i) ADB's country partnership strategy, 2011–2015, and the emerging priorities of the next country partnership strategy, which identifies environmental sustainability as a key pillar for ADB support in the PRC and emphasizes support for energy efficiency improvements as a priority area in the energy sector; and (ii) ADB's Energy Policy, which defines energy efficiency as a key measure toward clean energy development.[12]

B. Impact, Outcome, and Outputs

12. The impact of the project will be enhanced environmental sustainability of the PRC's chemical industry. The outcome will be reduced energy intensity and emissions from PVC and fluoropolymer production within ChemChina.

13. The outputs will be (i) more efficient and less hazardous PVC technology demonstrated at commercial scale at the Dezhou Shihua Chemical (DSC) plant, and (ii) energy efficiency and greenhouse gas abatement measures implemented at Zhonghao Chenguang Research Institute of Chemical Industry (CGY).[13]

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[10] The first batch of subprojects selected by ADB met the technical, financial, economic, social, and safeguards criteria explained in the Project Administration Manual (PAM) (accessible from the list of linked documents in Appendix 2). The same selection criteria will be used in selecting subsequent batches of subprojects.

[11] ADB. 2008. *Report and Recommendation of the President to the Board of Directors: Proposed Multitranche Financing Facility and Administration of Grant to the People's Republic of China for the Guangdong Energy Efficiency and Environment Improvement Investment Program.* Manila; ADB. 2011. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the People's Republic of China for the Hebei Energy Efficiency Improvement and Emission Reduction Project.* Manila; ADB. 2011. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the People's Republic of China for the Shandong Energy Efficiency and Emission Reduction Project.* Manila.

[12] ADB. 2012. *Country Partnership Strategy: People's Republic of China*, *2011–2015.* Manila; and ADB. 2009. *Energy Policy, 2009.* Manila.

[13] DSC and CGY are wholly owned subsidiaries of China Haohua Chemical Group (CHC), of which ChemChina has the majority ownership (69.2%).

14. The first subproject will demonstrate a scaled-up application of a successfully pilot-tested mercury-free catalyst to produce PVC at the DSC plant in Dezhou, Shandong Province.[14] After completion, by 2019, the subproject is expected to reduce energy consumption in the DSC plant by 388,521 tce per year, or by 34%. It will also eliminate 35 tons of intentional use of mercury per year by 2019 and avoid 1.359 million tons of CO_2 emissions. The successful demonstration of the new technology is likely to trigger the complete phase out of currently applied mercury-based technology making the replication potential therefore very large.[15]

15. Under the second subproject, comprehensive energy efficiency optimization measures will be implemented, and a real-time energy management system will be installed. These energy efficiency investments will reduce the energy consumption of the CGY plant in Zigong City, Sichuan Province by 10,888 tce per year. The measures will be combined with scaled-up plasma incineration of HFC-23 at the CGY plant.[16] The effective destruction of 890 tons of HFC-23 will avoid emissions of 13.1 million tons of CO_2 equivalent and 1,205 tons of organic fluoride.[17] Net energy savings from the subproject will be 8,905 tce.[18] The packaging of HFC-23 destruction with energy efficiency measures provides a business model for ESCOs that can be replicated in similar plants in the PRC.

16. A newly established ESCO, Beijing Zhonghao Huatai Energy Technology (Huatai), which is fully owned by China Haohua Chemical Group (CHC), will support the implementation of both subprojects in the first batch, and will identify and implement future subprojects applying predefined project selection criteria and the environmental and social management system (ESMS).[19] For the first subproject at DSC, Huatai's services will primarily involve hiring contractors and supervising implementation of the subproject.[20] For the second subproject at CGY, Huatai will, in addition, act as subborrower on the basis of an energy savings performance contract with CGY.[21] The implementation of the project will strengthen Huatai's capacities in different service aspects of the ESCO business. Huatai will be assisted by CHC in effectively facilitating financing, managing procurement, coordinating with and preparing reports to ADB, and promoting good governance and compliance with safeguards beyond the first batch of subprojects. Its capacity will be strengthened as a result.

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[14] The technology was pilot tested in three phases: (i) laboratory scale, (ii) small scale, and (iii) industrial pilot-scale testing of 2,000 tons per year. After validating the test results in August 2014, an independent panel of PVC experts from the PRC determined the technology to be of international standard and approved it for commercial scale-up.

[15] The PRC is party to the Minamata Convention on Mercury, which is aimed at eliminating the intentional use of mercury, and controlling and reducing global emissions of the toxic chemical. Annex B of the convention requires that parties phase out mercury use in the PVC industry in a period of 5 years once the Conference of Parties has established that an alternative catalyst technology has been proven to be technically and commercially viable. Minamata Convention on Mercury. http://www.mercuryconvention.org/Portals/11/documents/Booklets/Minamata%20Convention%20on%20Mercury_booklet_English.pdf

[16] CGY's pilot plant has an incineration capacity of 200 tons of HFC-23 per year. It was set up in 2007 and has since met all performance requirements reliably. Plasma incineration of HFC-23 has co-benefits in the form of avoided emissions of (i) toxic and carcinogenic dioxin, which can cause reproductive and developmental problems, and (ii) organic fluoride, a persistent and non-degradable poison that accumulates in soil, plants, wildlife, and humans.

[17] In 2014, all of ADB's clean energy investments combined avoided about 7 million tons of CO_2 emissions.

[18] The plasma incineration of HFC-23 has an energy penalty of 1,983 tce per year.

[19] The associated costs for the establishment of the ESMS and the required training of project entities will be covered by Huatai, CHC, and ChemChina.

[20] The engagement of Huatai through an energy savings performance contract is beyond the capacity of the first subproject at DSC, which will have a total investment cost of more than $200 million.

[21] Huatai's business plan, developed with ADB support during project preparation, identifies different business models for different energy efficiency projects. Huatai is expected to develop a platform for commercializing innovative energy efficiency technologies at ChemChina and beyond, on the basis of appropriate models.

C. Investment and Financing Plans

17. The project investment cost, including the expected rollover of funds, is estimated at $565.0 million, $245.0 million of which is for the first batch of subprojects (Table 1). [22]

Table 1: Project Investment Plan
($ million)

Item	Amount[a]
Subproject 1	205.7
Subproject 2	39.3
Total[b]	**245.0**

[a] Includes taxes and duties of $19.66 million to be financed from government sources ($7.39 million) and ADB loan resources ($12.27 million).
[b] In mid-2015 cost estimates.
Physical contingencies were computed at 7% for civil works, and 7% for field research and development, training, surveys, and studies. Price contingencies were computed at 1.5% on foreign exchange costs, and 3% on local currency costs; includes provision for potential exchange rate fluctuation under the assumption of a purchasing power parity exchange rate.
Includes interest and commitment charges. Interest during construction for ADB loan has been computed at the 3-year forward London interbank offered rate plus a spread of 0.50%. Commitment charges for an ADB loan are 0.15% per year to be charged on the undisbursed loan amount.
Source: Asian Development Bank estimates.

18. The government has requested a loan of $100.0 million from ADB's ordinary capital resources to help finance the project, including transportation and insurance costs, taxes, and duties.[23] The loan will have a 15-year term, including a grace period of 10 years,[24] an annual interest rate determined in accordance with ADB's London interbank offered rate-based lending facility, a commitment charge of 0.15% per year, a straight-line repayment option, and such other terms and conditions set forth in the draft loan and project agreements. The average loan maturity is 12.75 years; therefore, no maturity premium will be payable to ADB. The subproject borrowers will finance $63.3 million through equity contributions. China Construction Bank (CCB) will cofinance $81.7 million on a collaborative basis.

19. The financing plan for the first batch of subprojects is in Table 2.

Table 2: Financing Plan

Source	Amount ($ million)	Share of Total (%)
Asian Development Bank		
Ordinary capital resources (loan)	100.0	40.81
Counterpart financing	63.3	25.83
China Construction Bank	81.7	33.36
Total	**245.0**	**100.00**

Source: Asian Development Bank estimates.

[22] For the first batch of subprojects, ADB subloan amounts will not exceed 55% of the total subproject investment costs. For subsequent batches, financing from revolved ADB loan proceeds will be reduced to a maximum of 40% of the investment cost to encourage an increased share of cofinancing. Commercial cofinancing will match ADB funds at a ratio of at least 1:1. Equity financing will not be less than 20%. As ADB loan proceeds are expected to be rolled over 1.2 more times during the loan tenor, additional lending of $240 million and total investments of $320 million for future subprojects can be mobilized.
[23] The amount of taxes and duties was determined according to the following principles: the taxes and duties (i) should be consistent with the current country partnership strategy of ADB, (ii) should not represent an excessive share of the project investment plan, and (iii) should apply only to ADB-financed expenditures. Moreover, the financing of the taxes and duties should be material and relevant to the success of the project.
[24] A longer grace period is essential to allow for an effective rollover of ADB loan proceeds.

20. The PRC will be the borrower. The loan proceeds will be onlent from the Ministry of Finance to CCB, from CCB to CHC through ChemChina on the terms and conditions in the loan agreement. CCB will charge an onlending fee of 1% on both onlending transactions i.e., from onlending to ChemChina and from ChemChina to CHC.[25] CHC will establish the REF and interest differential account (IDA) at CCB under the REF and IDA account management agreement. [26] CCB will execute subloan agreements in a form and on terms and conditions acceptable to ADB. The interest rate on subproject loans will be the higher of (i) the interest rate payable by ChemChina, or (ii) 90% of the prime rate set by the People's Bank of China for commercial bank loans with the same terms as the subloans.[27] ChemChina will bear the credit risk,[28] while CHC and subborrowers will share currency exchange and interest rate fluctuation risks. Fund flow, implementation, and risk sharing arrangements are described in detail in sections III and IV of the project administration manual (PAM).[29]

D. Implementation Arrangements

21. The implementation arrangements are summarized in Table 3.

Table 3: Implementation Arrangements

Aspects	Arrangements
Implementation period	March 2016–February 2021 (estimated)
Loan closing date	31 August 2021
Financial intermediary	CCB was selected through a competitive process to act as the onlending bank and financial intermediary. It will be responsible for (i) providing a guarantee to the Ministry of Finance; (ii) onlending ADB loan proceeds; (iii) managing the REF and an interest differential account; (iv) executing and implementing subloan agreements with subproject borrowers; (v) managing disbursement, interest payment, and collection of principal; (vi) facilitating timely reporting to ADB and auditing of Statements of Utilization of Funds; (vii) conducting financial due diligence of future subprojects; and (viii) making suitable recommendations to the steering committee on subproject selection. CCB will provide parallel commercial collaborative cofinancing at its own risk, and can make loan pricing and approval decisions freely.
Executing agency	ChemChina will implement the project through CHC, bear the credit risk, onlend loan proceeds to CHC, and supervise overall implementation through the steering committee.
Implementing agency	CHC will implement the project through the project implementation unit established at Huatai. CHC will exercise supervisory control and provide support to Huatai. Huatai will (i) facilitate the implementation of subprojects by helping to prepare quarterly subproject reports and withdrawal applications to be submitted to ADB in accordance with the

[25] This multilayered onlending structure, which has worked well in previous projects, is an established practice in the PRC to provide sovereign guaranteed loans to state-owned enterprises. ADB. 2010. *Report and Recommendation of the President to the Board of Directors: Proposed Tianjin Integrated Gasification Combined Cycle Power Plant Project*. Manila.

[26] The tenor of subloans will be adjusted to the subprojects' payback periods and cash flow characteristics, allowing the rollover of ADB loan proceeds. As funds are onlent at near-commercial terms, a complementary interest differential account will also need to be established. The interest differential will be partially used (up to 40%) to gradually strengthen Huatai's equity base and increase the financing capacity of the ESCO in the future.

[27] The People's Bank of China publishes three reference rates: 1 year, up to 5 years, and beyond 5 years. The applicable reference rate will depend on the chosen term for a subloan. This proposed subloan lending rate does not provide a significant subsidy over the market rates, but gives subborrowers an incentive to invest in energy efficiency.

[28] On the basis of the credit rating and the asset scale of ChemChina, CCB has granted it a credit line of CNY40 billion ($6.5 billion equivalent). The outstanding balance of the $100.0 million ADB loan will be part of this credit line as ChemChina's counter-guarantee for CCB's guarantee to the Ministry of Finance. No further collateral or charging rights are required by CCB.

[29] Project Administration Manual (accessible from the list of linked documents in Appendix 2).

Aspects	Arrangements		
	PAM, (ii) screen and assess future subprojects according to the selection criteria, (iii) ensure compliance with environmental and social safeguards by implementing an environmental and social management system, and (iv) coordinate the implementation of subprojects as needed.		
Steering committee	ChemChina has formed a steering committee comprising representatives of the executing agency, CHC, and CCB. The steering committee will review the compliance of project implementation with the implementation requirements and endorse subprojects for future batches.		
Implementing unit	Beijing Zhonghao Huatai Energy Technology, No. 19 Xiaoying Road, Beijing City, People's Republic of China. A full-time staff of 15 is proposed for the implementing unit.		
First batch of subborrowers	Dezhou Shihua Chemical for subproject 1, and Huatai for subproject 2.		
Procurement	International competitive bidding	1 contract	$34.26 million
	Domestic procedure	24 contracts	$65.44 million
Consulting services	Consultants' qualification selection	2 person-months	$0.30 million
Advance contracting and retroactive financing	Both subborrowers have requested advance contracting and retroactive financing. Retroactive financing of up to 20% is allowed, provided that the expenses are incurred 12 months before the signing of the ADB loan agreement. ChemChina and CHC have been informed that provision of advance contracting and retroactive financing does not commit ADB to financing the subprojects.		
Disbursement	The ADB loan will be disbursed according to the statement of expenditures procedure for financial intermediary loans as defined in ADB's *Loan Disbursement Handbook* (2015, as amended from time to time) and detailed arrangements agreed on between the government and ADB. ADB loan proceeds will be directly disbursed according to defined subloan milestones to the REF and from there to subborrowers of the first batch as shown in figure 3 in the PAM.[b]		

ADB = Asian Development Bank, CCB = China Construction Bank, CHC = China Haohua Chemical Group, ChemChina = China National Chemical Group, Huatai = Beijing Zhonghao Huatai Energy Technology, PAM = project administration manual, REF = revolving escrow fund.

[a] The estimated project implementation period will be from 1 March 2016 to 28 February 2031, because repayment reflows of the ADB loan proceeds will be reinvested in additional subprojects through the REF.

[b] Project Administration Manual (accessible from the list of linked documents in Appendix 2, Figure 3).

Source: Asian Development Bank estimates.

III. DUE DILIGENCE

A. Technical

22. The due diligence confirmed that project designs have undergone rigorous and multiple evaluations, and will apply conservative designs with redundant safety and control measures to mitigate any serious technical failure and risks associated with the technical scale-up of pilot projects. It reviewed pilot test results and assessed first batch subprojects to be technically feasible. It further confirmed (i) projected energy savings, (ii) cost estimates, and (iii) adequacy of implementation arrangements and the schedule for first batch subprojects. It assessed technical risks inherent to the scale-up and found them to be manageable. It also found the subborrowers' capacity in managing technical risks to be adequate, and concluded that the associated technical and implementation risks are medium.[30]

B. Economic and Financial

23. **Financial analysis.** A financial internal rate of return of 17.0% was computed for the first batch of subprojects combined.[31] The first batch of subprojects was found to be financially sound under various adverse scenarios, with the financial internal rates of return ranging from

[30] Innovative Energy Efficiency and Emission Reduction Technologies (see list of linked documents in Appendix 2).

[31] Financial Analysis (accessible from the list of linked documents in Appendix 2).

6.2% to 15.1%. Future subprojects will need to meet financial performance and creditworthiness criteria for subborrowers acceptable to ADB (footnote 10).

24. **Economic analysis.** An economic internal rate of return of 20.3% was computed for the first batch of subprojects.[32] If the significant environmental benefits from the incineration of HFC-23 are taken into account and a carbon price at the low end of observed carbon prices on the PRC's pilot carbon markets is assumed, the economic internal rate of return is equal to 41.0%. The analysis shows that HFC-23 destruction in subproject 2 is highly sensitive to the assumed carbon price. The project remains viable, with an economic internal rate of return of 29.0% to 38.1%, under various sensitivity scenarios.

C. Governance

25. **Financial management assessment.** The selected financial intermediary, CCB is the second largest commercial bank in the world in terms of asset value and has satisfactory financial management capability to accomplish the assigned tasks (Table 3). The integrity due diligence showed a strong governance system in place at CCB, which is regularly audited by relevant authorities. The potential risk arising from its association with ADB is low. The assessment prepared for ChemChina, CHC, DSC, and Huatai found the financial management systems in place to be adequate to ensure that loan funds are used for the intended purposes.[33]

26. **Procurement risk assessment.** The assessment showed that CHC has satisfactory experience in procuring contracts of up to $10 million equivalent, following domestic procedures. CHC will undertake all procurement under this FIL loan, except for one contract, according to the established domestic commercial practices and procurement procedures of ChemChina, which are aligned with the procurement laws of the PRC and acceptable to ADB. In the procurement of one large contract for the supply of towers in the amount of $34.26 million equivalent, CHC will comply with ADB's Procurement Guidelines (2013, as amended from time to time) and use international competitive bidding procedures and ADB's standard bidding documents. A professional procurement agent will be hired for project implementation. Loan disbursement procedures have been prepared to ensure that subloan disbursement will be linked to the payment of eligible expenses.[34]

27. **Corruption prevention.** ADB's Anticorruption Policy (1998, as amended to date) was explained to and discussed with ChemChina, CHC, Huatai, CGY, DSC, and CCB. The specific policy requirements and supplementary measures are described in the PAM.

D. Poverty and Social

28. The project will have positive social impact by reducing GHG emissions, expediting the elimination of mercury use, and expediting the phaseout of mercury mining. It will thus help to curb climate change and lessen the hazardous health effects of mobilizing mercury in the environment. The project will be implemented in existing facilities, with social impacts confined to the boundary of the industrial plants. Low-income households and communities will not directly benefit through poverty reduction. The project will also have no gender elements: gender equity or the empowerment of women will not be directly promoted.

[32] Economic Analysis (accessible from the list of linked documents in Appendix 2).
[33] Financial Management Assessment for the Financial Intermediary; Financial Management Assessment for Project Entities (accessible from the list of linked documents in Appendix 2).
[34] Project Procurement Risk Assessment for Project Entities; Project Procurement Risk Assessment for Procurement Agent (accessible from the list of linked documents in Appendix 2).

E. Safeguards

29. **Environment.** The project is categorized as FI, and first batch subprojects are classified as category A for environment. A project environmental impact assessment (EIA) and due diligence was carried out in accordance with ADB's Safeguard Policy Statement (2009).[35] The EIA was posted on the ADB website on 22 May 2015. Following a detailed assessment, both subprojects were found to (i) exclude activities on ADB's prohibited investment activities list; and (ii) present low climate change risk, since climate risks are already incorporated in the engineering design of the existing facilities and new technologies financed under the project.[36] The environmental audit of the existing facilities revealed exemplary management commitment on the part of CGY, as well as excellent practices in environment and occupational health and safety management. DSC, while well managed, needs to further strengthen its environment and occupational health and safety management and practices. Among the corrective actions proposed for DSC in the audit report is the certification of these management systems. The EIA of the component subprojects showed potential adverse impacts to be limited except for (i) construction noise and dust during construction, (ii) air source emissions and fugitive emissions, and (iii) the handling of chemicals and hazardous materials during operation. A comprehensive environmental management plan will enable the subproject companies to reduce or avoid any anticipated impacts. An ESMS will be developed and adopted by ChemChina, CHC, CCB, and Huatai for future subprojects under the project to (i) ensure that future subproject selection is acceptable to ADB; and (ii) enhance effective environmental and social management practices, as explained further in the PAM. Potential future subprojects classified under category A for the environment will not be excluded.[37]

30. **Involuntary resettlement and indigenous peoples.** The project is categorized as FI. First batch subprojects will have no impact on involuntary resettlement and indigenous peoples and ethnic minorities (category C). They will be implemented within the borders of existing industrial facilities and will not entail the acquisition of new land for expansion. Potential future subprojects will be screened in accordance with the ESMS, and those under category A or B for involuntary resettlement and indigenous peoples will be excluded.

F. Risks and Mitigating Measures

31. There are no outstanding major risks. The identified risks and mitigation measures are summarized in Table 4 and described in detail in the risk assessment and management plan. The integrated benefits and impacts are expected to outweigh the costs.[38]

Table 4: Summary of Risks and Mitigating Measures

Risks	Mitigating Measures
Poor performance, cost overrun, or implementation delay for scale-up application of first-of-its-kind process transformation at DSC	Extensive pilot testing and multiple scale-up of pilots have proved the efficacy of the technology.[a] Third-party verification of test results has also confirmed the soundness of the technology, and the chosen scale-up is within technically acceptable limits. DSC will deploy a team of qualified implementation consultants supported by a special task force of CHC's most experienced PVC experts.
Industry-inherent risk of occupational	A environmental compliance audit performed during project preparation

[35] Environmental Impact Assessment (accessible from the list of linked documents in Appendix 2).
[36] Climate Change Risk Assessment Note (accessible from the list of linked documents in Appendix 2).
[37] Financial Intermediary: Environmental and Social Management System Arrangement (accessible from the list of linked documents in Appendix 2).
[38] Risk Assessment and Risk Management Plan (accessible from the list of linked documents in Appendix 2).

Risks	Mitigating Measures
hazards to workers, the local population, and the environment as a consequence of an unanticipated accident	reviewed and confirmed the adequacy of the environmental, occupational, and health and safety management and emergency response systems at the DSC and CGY plants. Near-zero fatality and accident-free operation of both plants for the past 10 years further attest to the soundness of the systems. The ESMS will ensure that similar high standards are applied in future subproject selection.
Risk of financial losses of Huatai, which may further weaken its position and lessen the effectiveness of project implementation and rollover of funds	A market survey and business model prepared for Huatai's business plan indicate Huatai's large energy efficiency investment needs and growth potential. CHC transferred to Huatai experienced personnel with extensive expertise in the chemical industry. Capacity for energy savings performance contracting and energy service company business was strengthened during project preparation.

CHC = China Haohua Chemical Group, CGY = Zhonghao Chenguang Research Institute of Chemical Industry, DSC = Dezhou Shihua Chemical, ESMS = environmental and social management system, Huatai = Beijing Zhonghao Huatai Energy Technology, PVC = polyvinyl chloride.

[a] The technology was pilot tested in three phases: (i) laboratory scale, (ii) small scale, and (iii) industrial pilot-scale testing of 2,000 tons per year. After validating the test results in August 2014, an independent panel of PVC experts from the PRC determined the technology to be of international standard and approved it for commercial scale-up.

Source: Asian Development Bank.

IV. ASSURANCES AND CONDITIONS

32. The government and ChemChina have assured ADB that the implementation of the project shall conform to all applicable ADB policies, including those concerning anticorruption measures, safeguards, gender, procurement, consulting services, and disbursement as described in detail in the PAM and the loan documents.

33. The government and ChemChina have agreed with ADB on certain covenants for the project, which are set forth in the loan agreement and the project agreement.

34. No withdrawals will be made from the loan account unless, to the satisfaction of ADB, (i) the subproject agreements have been duly executed and delivered between CHC, CGY and Huatai and between CHC and DSC, (ii) the subloan agreements have been duly executed and delivered between CCB and DSC and between CCB and Huatai, and (iii) the ESMS has been established in a manner satisfactory to ADB.

V. RECOMMENDATION

35. I am satisfied that the proposed loan would comply with the Articles of Agreement of the Asian Development Bank (ADB) and, acting in the absence of the President, under the provisions of Article 35.1 of the Articles of Agreement of ADB, I recommend that the Board approve the loan of $100,000,000 to the People's Republic of China for the Chemical Industry Energy Efficiency and Emission Reduction Project, from ADB's ordinary capital resources, with interest to be determined in accordance with ADB's London interbank offered rate (LIBOR)-based lending facility; for a term of 15 years, including a grace period of 10 years; and such other terms and conditions as are substantially in accordance with those set forth in the draft loan and project agreements presented to the Board.

Stephen Groff
Vice-President

7 October 2015

DESIGN AND MONITORING FRAMEWORK

Impact the Project is Aligned with:

Environmental sustainability of the PRC's chemical industry enhanced
(Guidelines on Energy Conservation and Emission Reduction in the Petroleum and the Chemical Industry Sectors [a])

Results Chain	Performance Indicators with Targets and Baselines	Data Sources and Reporting	Risks
Outcome Energy intensity in and emissions from PVC and fluoropolymer production within ChemChina reduced	By 2022: a. 70% of PVC production of ChemChina uses mercury-free, energy-efficient technology (2013 baseline: 0%) b. HCF-23 emissions from ChemChina's production of fluoropolymer reduced to 0% (2013 baseline: 85%) c. Revolving escrow fund invests at least an additional $100 million in second batch ChemChina subprojects (2015 baseline: not applicable)	a-b ChemChina sustainability report, Huatai annual report, CGY annual report, and CHC annual report c. CHC annual report	New technologies below performance standards Industry-specific ESCO model not operational within this time frame Insufficient incentive mechanisms to adopt energy efficiency measures Commercial cofinancing not forthcoming
Outputs 1. More efficient and less hazardous PVC technology at commercial scale at DSC plant demonstrated	By 2019: 1a. DSC reduces energy consumption in the PVC production process by 388,521 tce per year (2013 baseline: 1.18 million tce) 1b. DSC eliminates 35 tons of intentional use of mercury per year (2013 baseline: 35 tons) 1c. DSC avoids 1.359 $MtCO_2e$ of related CO_2 emissions (2013 baseline: 3.192 $MtCO_2e$)	1a–c. Environmental monitoring report; loan review missions and project performance reports; operations statistics	Poor performance of new catalyst, cost overrun, and implementation delay Industry-inherent accident risk with potentially substantial hazards for workers, the local population, and the environment as a consequence of an accident

Results Chain	Performance Indicators with Targets and Baselines	Data Sources and Reporting	Risks
2. Energy efficiency and greenhouse gas abatement measures at CGY plant implemented	By 2018: 2a. CGY plant incinerates 1,090 tons of HFC-23 per year to avoid emissions of at least 13.1 $MtCO_2e$ per year (2013 baseline: 200 tons per year), and to avoid 1,205 tons of organic fluoride emissions per year (2013 baseline: 1,205 tons per year) 2b. CGY's annual energy consumption is reduced by 8,905 tce (2013 baseline: 75,696 tce per year) 2c. CGY adopts ESCO model for investing in energy efficiency (2015 baseline: 0)	2a. Production statistics from CGY; data from the project's environmental monitoring report; loan review mission and project performance reports 2b. Loan review missions and project performance reports	Energy efficiency gains and emission reduction lower than expected

Key Activities with Milestones

Output 1: More efficient and less hazardous PVC technology demonstrated at commercial scale at DSC plant

1.1 Implement process transformation in the first PVC production chain (Q2 2017)
1.2 Implement process transformation in the second PVC production chain (Q2 2018)

Output 2: Energy efficiency improvement and greenhouse gas abatement measures implemented at CGY

2.1 Construct and commission two plasma cracking furnaces with a treatment capacity of 1,000 tons of HFC-23 (Q2 2016)
2.2 Replace 12 old vacuum dryers with one twin-screw extruder dryer for post-treatment of 1,500 tons of fluororubber per year (Q2 2017)
2.3 Replace 53 vapor steam dryers with two state-of-the-art far-infrared tunnel dryers for post-treatment of 7,500 tons of polytetrafluoroethylene per year (Q2 2017)
2.4 Install energy management control system and 150 intelligent digital meters (Q3 2017)
2.5 Retrofit energy-inefficient equipment, including fans, ducts, chillers, air handling units, air compressors, nitrogen purification units, motors, and cracking furnace burners (Q4 2017)
2.6 Conduct study tour to enhance knowledge of latest energy-efficient technologies in the chemical industry (Q4 2017)

Inputs

ADB: $100,000,000 (loan)
Government: $ 63,280,000
China Construction Bank: $81,730,000 (loan)

Note: The government will provide counterpart support in the form of counterpart staff, office accommodation, office supplies, secretarial assistance, domestic transportation, and other in-kind contributions.

Assumptions for Partner Financing

Not applicable.

ADB = Asian Development Bank, CHC = China Haohua Chemical Group, CGY = Zhonghao Chenguang Research Institute of Chemical Industry, ChemChina = China National Chemical Group, CO_2 = carbon dioxide, DSC = Dezhou Shihua Chemical, ESCO = energy saving company, HFC-23 = fluoroform, Huatai = Beijing Zhonghao Huatai Energy Technology, $MtCO_2e$ = million tons of CO_2 equivalent, PRC = People's Republic of China, PVC = polyvinyl chloride, tce = ton of coal equivalent.

[a] Government of the People's Republic of China, Ministry of Industries and Information Technology. 2013. *Guidelines on Energy Conservation and Emission Reduction in the Petroleum and the Chemical Industry Sectors*. Beijing.

Source: Asian Development Bank.

LIST OF LINKED DOCUMENTS

http://www.adb.org/Documents/RRPs/?id=47051-002-3

1. Loan Agreement
2. Project Agreement
3. Sector Assessment (Summary): Energy
4. Project Administration Manual
5. Contribution to the ADB Results Framework
6. Development Coordination
7. Financial Analysis
8. Economic Analysis
9. Country Economic Indicators
10. Summary Poverty Reduction and Social Strategy
11. Environmental Impact Assessment
12. Financial Intermediary: Environmental and Social Management System Arrangement
13. Risk Assessment and Risk Management Plan

Supplementary Documents

14. Innovative Energy Efficiency and Emission Reduction Technologies
15. Financial Management Assessment for Project Entities
16. Financial Management Assessment for the Financial Intermediary
17. Project Procurement Risk Assessment Report for Project Entities
18. Project Procurement Risk Assessment Report for Procurement Agent
19. Climate Change Risk Assessment Note