INDUSTRIAL ENERGY ACCELERATOR CHINA

China Energy Saving and Low-Carbon Technologies Catalogue and Financial Incentives to Promote Energy Efficiency Technologies

Report for Industrial Energy Accelerator project in China

The Carbon Trust wrote this report based on an impartial analysis of primary and secondary sources. The Carbon Trust's mission is to accelerate the move to a sustainable, low carbon economy. It is a world-leading expert on carbon reduction and clean technology. As a not-for-dividend group, it advises governments and companies around the world, reinvesting profits into its low carbon mission.

UNIDO is the specialized agency of the United Nations that promotes industrial development for poverty reduction, inclusive globalization, and environmental sustainability. The mission of the United Nations Industrial Development Organization (UNIDO), as described in the Lima Declaration adopted at the fifteenth session of the UNIDO General Conference in 2013, is to promote and accelerate inclusive and sustainable industrial development (ISID) in Member States.

The SE4ALL Industrial Energy Efficiency Accelerator is a platform, which supports engagement between leading government officials, business leaders, trade associations, research agencies, and investors to create a clear vision of how to further mobilize energy efficiency in the key industrial sectors. Its objective is to help double the global rate of improvement in industrial energy efficiency by 2030.

The Global Environment Facility was established on the eve of the 1992 Rio Earth Summit to help tackle our planet's most pressing environmental problems. Since then, the GEF has provided over $17.9 billion in grants and mobilized an additional $93.2 billion in co-financing for more than 4,500 projects in 170 countries. Today, the GEF is an international partnership of 183 countries, international institutions, civil society organizations and the private sector that addresses global environmental issues.

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Table of Contents

List of Figures

List of Tables

Executive Summary

With the publication of the Outline of China's Energy Conservation Technology Policy in 2006, China has accelerated the promotion of key energy-saving technologies. The National Key Energy-saving Technologies Promotion Catalogue was launched in 2006 and was first released in 2008 (hereinafter referred to as the "Catalogue"). The Catalogue aims to promote energy-saving technologies across twelve main sectors, ranging from transportation to communications. The Catalogue is managed and collected by the Division of Environmental Resource Protection of National Development and Reform Commission (NDRC). CECEP Consulting Co., Ltd. and the National Energy Conservation Centre (NECC) are responsible for the technical review and update. The catalogue has been reviewed and updated annually until 2018. The Catalogue has been updated a total of 10 times since 2008 and has featured 260 energy-saving technologies.

Since its publication, the Catalogue has effectively promoted the application of key energy-saving technologies and laid a good working foundation for achieving the binding targets of energy conservation and emission reduction. As a result of the Catalogue, other ministries and provincial governments have developed and published further technology catalogues to promote the uptake of energy saving technologies.

As the Catalogue has played an increasingly important role in the promotion of energy-saving technologies in China, few studies or assessments have been carried out to identify the barriers and solutions to further improve and develop the existing Catalogue. This study, led by the Carbon Trust and UNIDO, has contributed to this objective by analysing both the Catalogue in China and case studies of other international technology lists to provide tangible and operational solutions for the existing national catalogue in China and to facilitate the uptake of energy-saving technologies in China.

After an analysis of 14 technology lists worldwide, the report focuses on 6 in-depth case studies. These are the Energy Technology List (ETL) in the UK, the EP-PLUS and the Limitative Technology List in Belgium, the BCTL in the Basque country, the Environment List MIA/Vamil in the Netherlands, the Triple E Product Register in Ireland and the EBRD Technology Selector for 26 countries across Europe, Africa and Asia. Models and frameworks have been used to assess the technology lists/catalogues as well as their supporting financial mechanism. In the process, in-depth desk-based research and over 20 stakeholder interviews were carried out to evaluate metrics such as the rationale, target audience, content, management, technology screening & evaluation process, fiscal incentives, promotional channels, impacts, transparency, drivers and supply chain.

The report is composed of two parts: Lists of Energy-Efficiency Technologies and Equipment; and the Fiscal Instruments to Promote Energy Efficient Products and Energy Technology Lists. The outcome of this report is a set of recommendations for China's national technology catalogue: considering whether the scope and content of the Catalogue be expanded or amplified; if it is necessary to include manufacturer information; if a user-friendly online platform would make the Catalogue more accessible and how to set a clearer process/indicators when screening for technologies. Until now, the state has not issued any type of supporting financial policy for the technologies in the Catalogue, nor has it licensed or issued a certificate to the technology suppliers in the Catalogue. Therefore the report also discussed whether to link direct financial incentives to the Catalogue and how this could best be done. International best-practice on financial mechanisms such as tax incentives, subsidies and green credits are analysed to understand best practise and any the most suitable incentive for the Catalogue.

Part 1: Lists of Energy-Efficiency Technologies and Equipment

Introduction

1.1 Energy Technology lists and product standards

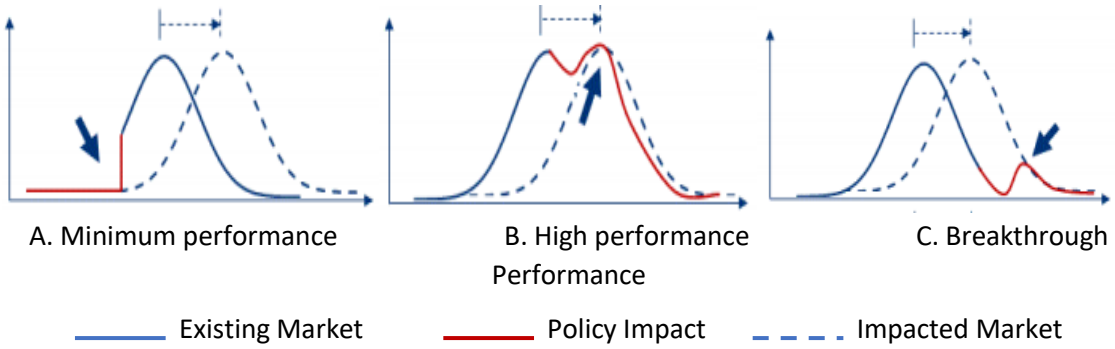
Technology lists are a useful tool to stimulate market uptake of energy efficienct products. Energy technology lists (ETLs) are particularly relevant for promoting standardised equipment and components that have clear-cut and easily defined benefits for energy efficiency, compared to similar alternatives. International experience shows that listing approaches can form an important part of a package of measures to promote industrial energy efficiency (IEE) market transformation. A number of benefits are associated with ETLs.

Trusted lists reduce transaction costs for buyers, sellers, and governments, and stimulate changes in customer buying habits and product manufacturing. ETLs reduce uncertainty in the supply chain by communicating better purchasing options to buyers and highlighting the most energy efficient products on the market. Selecting products from a trusted list reduces transactions costs (e.g. costs related to product search, verification, and procurement). Similarly, placing products on a trusted list reduces cost of sale (e.g. costs to identify customers, developing trust, tendering, product verification, lost sale). By encouraging the use of energy efficient technology, governments reduce transaction costs between buyers and sellers through an '*assess once use many times'* approach.

Technology lists can be used to stimulate different socio-technological market transformations. ETLs usually take one of the three following approaches:

A. Discourage the use of the least efficient products/technologies available on the market, which is usually implemented through *Minimum Equipment Performance Standards (MEPS).*
B. Encourage the use of high performance (i.e. more efficient) products/technologies available on the market , often through implementing *Higher Equipment Performance Standards (HEPS).*
C. Encourage the use of breakthrough performance products/technologies in the market by implementing *Leading Equipment Performance Standards (LEPS).*

Figure 1 ETLs can stimulate three main types of socio-techno market transformation impacts (Source: Carbon Trust)



Regardless of the level of ambition, the use of technology lists places a marker in the sand which stimulates product innovation and in turn delivers market transformation and stimulates economic renewal, i.e. encourages efficiency improvements in all equipment supplied to the market. In all three designs, transformation occurs in the supply chain (dotted curve shifted to the right). By setting EE

performance ambitions, over time, the average performance of all equipment supplied to the market improves. Over time this leads to reduced energy consumption throughout the market.

Replacing an old product with a new product with average EE performance, will result in an average market EE improvement. However, replacing an old product with the most efficient product available with the best EE performance will result in greater EE improvements in the market. Over time these EE increases create transformation across the market. ETLs transform both the supply of products to the market and, over time, the related market activities (e.g. servicing, maintenance, consumables).

Technology lists can be used alongside fiscal incentives to accurately target specific products in the market. For example, fiscal incentives coupled with the technology lists can be used to encourage the purchase of EE products at times when financial barriers might otherwise inhibit action. Due to the proven success of financial incentives to encourage EE product uptake, **this report focuses on energy technology lists that have a financial incentive mechanism linked to them**.

This report differentiates between ETLs and standards or labelling schemes. The latter (hereafter defined as environmental labelling and information schemes – ELIS) can be mandatory government-led schemes, or voluntary industry and non-profit organisations-led schemes. Often ELIS are imposed on manufacturers, who will only be able to sell their products on the market if they meet certain standards. Industry associations also develop ELIS to create a level-playing field between different manufacturers, tapping into their competitive nature to bring about market change.

1.2 Framework assessment for energy technology lists and catalogues

We have summarised and assessed international ETL case studies based on different criteria. Our assessment framework covers sample questions that were answered for each of the ETLs presented in this report. Where possible we have tried to identify similarities between lists to understand the common principles required for a successful technology list. These will inform our recommendations to improve the China Catalogue presented in the following chapter: Recommendations on improving China Catalogue.

Table 1 Assessment Framework for Energy Technology Lists

Criteria	Sample questions to be answered
Rationale	• What is the rationale for the list? (E.g. MEPS, HEPS, LEPS) • Was it created in isolation, or to fulfil a role within a chain of market transformation activities? • Is it a criteria-based list or a criteria/ project and product-based list? • When was it established? • Has the focus of the list changed over time?
Target audience	• Who is the list principally targeting? (E.g. SMEs, industrial energy users) • Is it targeting both suppliers and manufacturers of technologies, or consumers that may purchase the technologies?
Content	• What technology categories are eligible to be featured on the list? (E.g. boiler, lighting) • How are new technology categories considered? • How wide is the scope of the list? (E.g. industrial, commercial, business sectors)

	• What key information is displayed for each product on the list? (E.g. technology indicators, providers, estimated costs) • Are technologies featured on the list domestic or international?
Management	• Who owns, funds and maintains the list? (E.g. main players and their roles) • What is the annual management cost? • How frequent are the updates to the list, what is the rationale behind the updates, and what changes occur to the list? • What are the client services/ operation and administration of the mechanism? (E.g. helpline, support information such as leaflets and PPT) • How is the list communicated and displayed? (E.g. online list, website, document)
Technology evaluation	• Who assesses the product applications? • What is the methodology for technology evaluation and selection, and what are the selection criteria? (E.g. detailed open standards for technology applicants) • Does the list uses a set of qualifying criteria and a qualifying product registry? • What are the assessment criteria for existing technologies on the list, and do criteria change over time? • What is the process of verification? (E.g. listed products with a verification process, or project verification)
Financial incentives[1]	• What are the supporting financial mechanisms to the list and how do they work? • Do the financial incentives vary by technology or application type?
Promotion	• How is the list promoted? (E.g. online campaigns, banners) • What is the role of government, industry associations, and businesses in promoting the list? • How do key actors engage manufactures and end-users of the products, as well as industry associations? (E.g., how do they make indirect benefits clear for manufacturers of listed products, and financial benefits clear for end-users?)
Effect	• What role does the list play in facilitating technology deployment? • What are the main effects of the list? (E.g. increased successful trades, clear emission reduction effect) • Have there been any impact assessments of the list? • Have stakeholders experienced first-hand benefits of the mechanism?

The framework aims to clarify the impact that these individual schemes have, and how efficient they are. Therefore we have highlighted the overall strengths and key characteristics of the schemes, according to indicators such as the scope of the scheme and the scale of economic and environmental impact, as well as the market traction/market intelligence of the scheme.

[1] Note that financial incentives are the focus of Component 2 of this report.

International case studies

This section covers six European and international ETLs as best practice case studies. Even though 'financial incentives' is one of the assessment criteria for the ETLs, this section only briefly covers the financial mechanisms linked to each of the ETLs. For an in-depth review of the financial mechanisms linked to catalogues to incentivise the deployment of high IEE products, please refer to Component 2 of this report.

2.1 Summary of international case studies covered

Geography	UK	Belgium	Basque Country	The Netherlands	Ireland	Middle Europe
Instrument	**Energy Technology List**	**EP-PLUS - Limitative Technology List**	**BCTL**	**The Environment List MIA/Vamil**	**Triple E Product Register**	**EBRD Technology Catalogue**
Rationale	Incentivise the use and development of high energy efficiency products through implementing Higher Equipment Performance Standards (HEPS).	Stimulate businesses to green their production processes and encourage the use of high-performance equipment on the market.	Facilitate the application of Basque environmental policy through technology transfer and deployment of equipment with better environmental performance.	Encourage entrepreneurs to invest in their business operations in an environmentally friendly way and to get innovative environmentally friendly products to market.	Incentivise the use and development of the top 10-15% most energy efficient products in any listed technology category.	Incentivise the use and development of technologies that exceed MPC (MEPS), encourage technology manufacturers to make climate technologies more easily available.
Target audience	Plant and machinery manufacturers and organisations purchasing products in the UK.	Inward investments is a measure aimed at companies who investing in the region.	Predominantly technology users (e.g. SMEs), who are registered in the Basque Country.	All businesses (suppliers and entrepreneurs) in the Netherlands who pay income or corporation tax.	Companies, sole traders and farmers that operate and pay corporation tax in Ireland.	Technology manufacturers,vendors and purchasers in target countries.
Content	~14,000 products across 56 technology categories. Some categories are not	~40 technologies across three categories: Environmental	~92 technologies across six categories: RES and EE,	~280 capital assets across six categories: circular economy, food supply and agricultural	~21,500 products listed under 10 broad categories and 52 associated	~6,000 products across 11 broad categories of technologies ranging from the industrial, building and transport sectors.

Geography	UK	Belgium	Basque Country	The Netherlands	Ireland	Middle Europe
Instrument	**Energy Technology List**	**EP-PLUS - Limitative Technology List**	**BCTL**	**The Environment List MIA/Vamil**	**Triple E Product Register**	**EBRD Technology Catalogue**
	listed on the ETL but still qualify for financial incentives.	technologies and Energy saving technologies, and renewables and cogeneration.	preventing and reducing emissions, water, waste minimising, resource efficiency, and noise reduction.	production, mobility, climate & air, use of space and built environment.	technologies. Products are not limited to Irish suppliers.	
Management	Led by the Department for Business, Energy and Industrial Strategy (BEIS). Managed by the Carbon Trust and ICF on behalf of BEIS, and technically assessed by independent parties. The fiscal elements are managed by HM Revenue and Customs (HMRC).	Managed and verified by the Flemish Government. The list is updated two to three times a year.	The Basque Country government owns the BCTL and is responsible for funding it. A technical committee is in charge of the overall management of the BCTL.	The Netherlands Enterprise Agency (RVO) and the Netherlands Tax and Customs Administration are responsible for operating the schemes. The Ministry of Finance and the Ministry of Infrastructure and Water Management (I&M) fund the schemes.	The Sustainable Energy Authority of Ireland (SEAI) manages, maintains and promotes the register. The Irish Revenue Commissioners receives and manages the financial incentive claims.	The EBRD carries out the general management of the scheme and is responsible for providing credit lines to local financial institutions. The technology catalogue is financially supported by international donors and partners including the GCF.
Technology evaluation	An ETL independent technical team reviews products against set	Technologies are assessed and selected by VITO	A technical committee is in charge of	RVO collaborates with I&M to evaluate products and capital	SEAI are responsible for setting the	Evaluation is done against country-specific MPCs per technology category. A

Geography	UK	Belgium	Basque Country	The Netherlands	Ireland	Middle Europe
Instrument	**Energy Technology List**	**EP-PLUS - Limitative Technology List**	**BCTL**	**The Environment List MIA/Vamil**	**Triple E Product Register**	**EBRD Technology Catalogue**
	criteria, and regularly updates the criteria annually. Qualifying products are added to the list bi-monthly.	based on the sectoral Flemish BAT-studies and similar European studies using cost-effectiveness methodologies.	updating the BCTL (every three to four years). The committee is chaired by the Basque Country Vice-Ministry for Environment.	assets against established criteria. The list is updated annually, amendments may be carried out during the year.	eligibility criteria for the register and maintaining and reviewing the list of eligible products.	technology selector administrator is in charge of validating products. The catalogue is updated at maximum every two years.
Fiscal incentives	Purchasers of products on the ETL are eligible for an accelerated tax relief scheme, the Enhanced Capital Allowance (ECA). Businesses can also claim Annual Investment Allowances (AIAs).	Two financial incentives are available: EP + as a subsidy exempt from corporation tax, and EP-STRES for non-standard investments in green technologies. An additional subsidy bonus (3-10%) is available under some circumstances.	Companies can benefit from a 30% subsidy on the cost of the technology when purchasing technologies listed on the BCTL. In addition, they can also benefit from an ECA.	MIA: companies can deduct up to 36% of the cost of the investment from fiscal profit. Vamil: companies decide when to write off 75% of their investment costs. Incentives vary based on product category. Energy Investment Allowance (EIA) is also available.	Accelerated Capital Allowance (ACA) is available for costs directly related to purchasing the equipment.	The catalogue is linked to the EBRD Green Economy Financing Facility (GEFF) finance, which includes a range of financial mechanisms. The EBRD provides credit lines to local financial institutions to finance green investments.

Geography	UK	Belgium	Basque Country	The Netherlands	Ireland	Middle Europe
Instrument	**Energy Technology List**	**EP-PLUS - Limitative Technology List**	**BCTL**	**The Environment List MIA/Vamil**	**Triple E Product Register**	**EBRD Technology Catalogue**
Promotion	The Carbon Trust and BEIS/HMRC have extensive promotional materials on their websites. There is also a further BEIS site which includes a search function and technical product information.	The list has a dedicated website and information on how to apply can be found on a number of government and consultancy news and information webpages.	The BCTL is published in the Official Gazette of the Basque Country. Ihobe provides info on their website as well.	Information is published in the Government Gazette and the brochures uploaded on the RVO website.	SEAI collates all information relevant to the Triple E Register online. SEAI also hosts the Triple E Product Search Page.	Information on the catalogue is available on EBRD website and social media channels.
Effect	Since its inception, the scheme has assessed ~60,000 products. It is a recognised quality assurance for businesses and a trusted tool for manufacturers.	In 2017 the scheme enabled €100+ million in private green business investments, primarily channelled through SMEs. EP+ works as a green lever.	Each public euro spent generates ~€4 a year in private turnover of investment.	~€11 billion was invested between 2011-2016, supported by the MIA/ Vamil. There was a large multiplier/leverage effect by companies in environmentally friendly assets (1:8-1:11 leverage).	Achievements in 2016: 368 GWh energy saved; 80 $ktCO_2$ saved Expected in 2020: 688 GWh energy saved; 140 $ktCO_2$ saved.	Expected to be one of the key mechanisms for delivering green climate finance under the EBRD's GEFF. As it's only recently been launched, data on its effectiveness is not yet available.

2.2 Detailed case study analysis

UK ETL

Rationale

The UK Energy Technology List is a government-backed list of energy efficient products across a wide range of technology categories. The ETL seeks to incentivise the purchase of energy efficient products. In so doing, the ETL aspires to encourage manufacturers to design more products that qualify as highly energy efficient equipment and create Higher Equipment Performance Standards (HEPS). It has been operational since 2001.

Target audience

The UK ETL targets both manufacturers of energy efficient equipment and organisations who want to purchase new equipment. In order to benefit from the financial incentives associated with the ETL, the Enhanced Capital Allowance (ECA) scheme, businesses must either pay income tax or corporation tax in the UK (see financial incentives section).

Content

Currently, the list contains ~14,000 products, across 56 product categories, with the last update in March 2019.[2] There are also certain categories that are 'unlisted' on the ETL yet may be eligible for ECAs. For some technologies, such as lighting, it is not practical to list all qualified products due to the large number of individual products.[3] When purchasing these products, purchasers will typically need a Statement of Compliance from the manufacturer that the relevant product met the criteria at the date of purchase. There are also some products not covered by the scheme, such as energy storage or energy-generating products like batteries or wind turbines.

Management

The Department for Business, Energy and Industrial Strategy (BEIS) annually reviews the technologies and products that qualify for inclusion. The ETL is managed on behalf of BEIS by the Carbon Trust and ICF, with the latter being responsible for the technical side of the ETL. HM Revenue and Customs is responsible for the tax-related aspects of the ECA scheme.

Technology evaluation

The ETL has established robust energy efficiency criteria for each listed and unlisted technology against which products are assessed. For unlisted categories a supplier can use the technology criteria to determine if a specific product qualifies. The energy saving criteria are set to ensure eligible products represent a significant improvement in energy performance over current standard products. The products listed on the ETL are approximately the top quartile for energy efficiency. There is a website for the ETL search facility called 'Find ETL Products'.

The ETL technical team, ICF, review the products against the criteria to check that the products meet the requirements. Different performance requirements are set for each technology. All products must be tested in accordance with the relevant procedures and test conditions. For most categories, manufacturers need to test their equipment performance to BS EN standards. As the market evolves and energy efficiency generally improves for a technology, the list requirements will change to make

[2] Equipment listed on the ETL falls under the following categories: Air-to-air energy recovery, Automatic Monitoring and Targeting (aM&T) equipment, Boiler equipment, Combined heat and power (CHP) , Compressed air equipment, Heat pumps, Heating, ventilation and air-conditioning (HVAC) equipment, High speed hand air dryers, Lighting, Motors and drives, Pipework insulation, Radiant and warm air heaters, Refrigeration equipment, Solar thermal systems and collectors, Uninterruptible power supplies, Waste heat to electricity conversion equipment.

[3] These 'unlisted' categories are products in the Lighting, Automatic Monitoring and Targeting equipment (aM&T), Air Source Split and Multi-split Heat Pumps, Pipework Insulation and Combined Heat and Power (CHP).

sure that only the highest energy efficient equipment is represented. New products are added to the list twice a month.

Financial incentives

Technologies listed on the ETL qualify for accelerated tax relief in the form of ECAs. The ECA scheme financially incentivises the use of energy efficient equipment to help the UK transition to a low-carbon economy. It provides the customer with a cash flow boost enabling organisations to invest in high performing technologies.

The scheme allows businesses to write off 100% of the qualifying costs[4] on eligible plant and machinery against the taxable profits in the year the investment is made. There is no cap on how much can be claimed for profit making businesses. The First-Year Tax Credit (FYTC) provides a tax credit for loss making businesses who invest in product listed on the ETL.

Equipment that is eligible to be claimed under the ECA must be:

- Listed on the ETL (at the time of purchase);
- Compliant with ETL criteria and the manufacturer has provided a Statement of Compliance (ETL "unlisted" categories); or
- Assessed CHP equipment that has received a certificate of energy efficiency.

Promotion

Both the Carbon Trust and the Government have extensive promotional materials available on their respective websites, such as technology information leaflets, guidance and factsheets for purchasers and manufacturers. The ETL is also promoted at relevant events, such as exhibitions and conferences. Articles relating to the ETL are published in a variety of online and digital magazines. The scheme is also advertised to a wider audience through social media and digital marketing campaigns.

Effect

Since its inception, the UK ETL scheme has assessed ~60,000 products. It has helped move the market towards the most energy efficient plant and machinery. It is a recognised and trusted tool for both businesses and manufacturers.

The wider benefits of the ECA scheme are: the abatement of CO_2 emissions, improving organisations' sustainability credentials, energy and cost savings, reduced payback periods on purchases and accelerated tax relief which serves as a cash flow boost. The energy and cost savings are increasingly beneficial against a backdrop of rising energy prices.

Overall assessment

- The financial incentives reduce barriers to action;
- The list encourages improvements across the market due to incentives for EE products;
- The list has a large range of products and technology categories that are applicable to multiple industries and organisations.

Ecology Premium Plus

Rationale

The Flemish government introduced the Ecology Premium Plus (EP-PLUS) to stimulate businesses to green their production processes, i.e. organise these in an environmentally-friendly and energy-

[4] Qualifying costs include the cost of buying the equipment as well as other direct costs involved, such as the installation and transportation costs of the purchased equipment.

efficient manner (Vlaio, n.d.). EP-PLUS is a policy measure that links to the framework of the European climate and energy policy and the EU Energy 2020 strategy.

EP-PLUS relies on a 'limitative technology list' (LTL) which collates technologies that qualify for the premium. The list contains the most efficient technologies, and those that are deemed to contribute the most to achieving environmental commitments such as Kyoto commitments, the European 20/20/20 targets, and the Flemish environmental policy objectives. The immediate purpose of the development of LTL is to simplify the submission and approval process of EP-Plus and overall it aims at encouraging the use of high performance (i.e. more efficient) equipment available on the market (HEPS).

Target audience

The scheme is aimed exclusively at businesses who have investments in the Flemish Region, therefore only targeting inward investments. Though the list does not target SMEs[5] in particular, a higher level of funding is available for these companies (see financing section).

Content

Technologies listed on the LTL are eligible for investment. If a company wishes to invest in a new technology which does not appear on the LTL, it can submit an application to have it included. The new slimmed-down LTL[6] contains ~40 technologies (down from 150 technologies in previous years), subdivided into three categories: (1) environmental technologies; (2) energy saving technologies; and (3) renewable energy and combined heat and power (cogeneration).

For each of the technologies on the LTL the following information is provided: a technology code and technology name; a brief description of the technology; the essential investment components; an ecological additional cost (as percentage of the acceptable investment components); an ecological number for further categorisation that varies between 1 and 9; an ecoclass (A, B, C or D); and the subsidy percentage according to the size of the organization, differentiated between SMEs and larger companies.

Management

The list is managed and verified by the Flemish government according to the Kyoto commitments, the European 20/20/20 objectives and the Flemish environmental policy objectives. In 2018, the budget of the EP-PLUS was again increased to €20 million. The LTL is regularly updated (two to three times a year) and all versions are available on the scheme's main website.

Technology evaluation

Technologies are selected by the Flemish Institute for Technological Research (VITO) on the basis of sectoral Flemish Best Available Techniques (BAT) studies and comparable lists from other member states, such as the Netherlands. BAT-studies give an overview of the environmentally-friendly and energy efficiency measures in different industrial sectors.

The methodology for technology evaluation is the following:

- The technical and content assessment of the LTL is developed by VITO;
- Technologies are checked against the basic conditions of European environmental guidelines and stricter Flemish standards if applicable;

[5] An SME is an independent company with fewer than 250 employees and with an annual turnover of maximum € 50 million or a balance sheet total of € 43 million.

[6] By ministerial decree of 24 January 2019

- Technologies are then assessed and selected by VITO, based on the sectoral Flemish BAT-studies and similar European studies; and
- The minister is responsible for the final decisions and can adjust the list.

All environmental and energy aspects are translated into a single rating from 1-9 and technologies are also categorized by Eco class. Greater environmental gain and lower additional costs receive a higher score (cost-effectiveness methodology). The cost-effectiveness evaluation method is an adapted and practical method, using environmental and energy benefits to calculate, under one rating, multiple types of environmental and energy gains in a global chain approach. This means that all environmental and energy aspects are taken into account and translated into one environmental score. The cost-effectiveness is the ratio of this environmental score in comparison with the additional costs and is expressed in a number of environmental points per euro of extra investment.

The use of this cost-effectiveness method gives more transparency and has a number of advantages:

- Technology assessment is independent of specific policy objectives, however scientifically substantiated and constant over time;
- All environmental and energy aspects are taken into account; investments are made and viewed in their entirety; and
- Themes from the circular economy are eligible for support.

Financial incentives

Due to the fact that energy efficient products are usually higher cost than standard products, the ecology premium is designed to be a financial incentive (premium) to encourage businesses to make these investments in more efficient products. Ecological investments that are eligible for aid through green certificates and cogeneration certificates are **not eligible** for an ecological premium.

The EP-PLUS is linked to two support schemes:

- **EP +**: This support scheme is for standardized ecology investments and is managed through an online application which uses the LTL as a list of qualifying technologies for the ecology premium.
- **EP-STRES**: This is a more specific support scheme for strategic ecology projects. EP-STRES is a subsidy to investments in green high technology. It covers technologies that because of their unique company-specific character cannot be standardized and therefore are not listed on the LTL (and therefore would not qualify for the standardized EP + scheme).

The ecology premium (EP+) is awarded as a subsidy, and as from 2007, it is **completely exempt from corporation tax**. The amount is determined according to certain factors:

- The nature of the investment;
- The eco-class to which a technology belongs; and
- The size of the company (SME or larger company).

Greater environmental gain and lower additional costs receive a higher subsidiary amount (cost-effectiveness methodology). Technologies with Ecoclass ratings C and D do not qualify for subsidies.

Table 2 Subsidies levels vary according to the type of Investment, size of the company, and Ecoclass and Ecology number

Ecoclass		Environmental	Energy saving	Renewable and co-	Environmental	Energy saving	Renewable and co-

	Ecology number			generation			generation
		SMEs			Other		
A	9	50%	40%	55%	40%	30%	45%
B	6	30%	30%	30%	15%	15%	15%

Promotion

In its original set up EP-PLUS was run through a system of tenders, which companies needed to respond to. Since 2011 a company that meets the criteria (including budgetary capacity), can apply for financial support directly through a dedicated website. The list and information on how to apply can also be found on a number of consultancy/news/information webpages.

Effect

The EP-Plus in 2017 led to more than €100 million in private green business investments. These investments particularly benefitted SMEs, as of the 257 approved applications, 193 were SMEs. Companies received ~€16.5 million in subsidies. In comparison, in 2016, there were 204 applications and only €8 million awarded in subsidies (De Morgen, 2018).

Table 3. EP-PLUS subsidies and resulting investments, in €m

	2014	2015	2016	2017		2018
Application approved (SEM)	856	150	204	257		n/a
Subsidies (Millions of Euros)	40	6.1	8	16.5		20 (Budget)
Total Investment (Millions of Euros)	200	77	57	101		n/a

A member of the Flemish Parliament, Diependaele, stated that "***the ecology premium clearly stands out and works like a real green lever***".

Overall assessment

- Subsidy levels vary according to the type of Investment, size of the company, and the Ecoclass and Ecology number of the purchased product;
- SMEs receive preferential subsidy rates compared to large businesses;
- The list is managed by the Government yet technologies are selected by the largest Belgian research institution active in the fields of energy, environment and materials, as an independent research organization; and
- The support of two fiscal incentives reduces financial barriers to action.

Basque Clean Technologies List

Rationale

The Basque Clean Technology List (BCTL) aims to facilitate the application of Basque environmental policy through technology transfer and deployment of equipment with better environmental performance. It was established in 2004 to promote sustainable development in SMEs, and to help improve the competitiveness of these businesses, in particular in the industrial sector. It is a key instrument to promote Clean Technologies, which links directly with the Basque Strategy for Sustainable Development - Eco Euskadi 2020, which aims to position the Basque Country at the forefront of sustainable development.

The BCTL aims to encourage the uptake of energy efficient technologies by providing tax deductions for those investing in equipment featured on the list. In 1990, Basque country established a tax deduction system for environmental companies, where rigorous technical applications had to be submitted. However, after an exchange with the Dutch government, the Environmental Management Agency of the Basque Government (Ihobe), adapted the MIA/Vamil system to create the BCTL in 2006 (Lehmann, 2018).

Target Audience

The list is aimed predominantly at technology users (consumers) such as SMEs, who can use products on the list to improve their energy efficiency. The scheme covers technologies across a wide range of sectors (in line with the Basque country energy policy). The scheme is only open to companies whose registered office is in the Basque Country.

"*The technologies included in the BCLT are aimed at the priority industrial sectors for the Autonomous Community of the Basque Country such as the metal industry, the chemical industry, or the automotive industry, in addition to having a large number of transversal technologies applicable in all sectors*."

Content

As of 2016[7], the most recent version of the BCTL is available on the Ihobe website and is divided into six main categories (Renewables and energy efficiency; Preventing and reducing emissions; Water; Waste minimising; Resources efficiency; and Noise reduction), covering 92 technologies. Technologies listed on the BCTL have a reference number, and a short description of their potential usage and applicability.

Management

The Basque Country government owns the BCTL and is responsible for funding it in partnership with a number of organisations. The BCTL is published in the Official Gazette of the Basque Country by means of an Order of the Basque Government's Minister of the Environment and Territorial Policy. The scheme has a budget of ~€10 million per year (EREK, n.d.).

A technical committee is responsible for the overall management of the BCTL, with responsibilities covering management, administration, technology selection etc. This includes updating the BCTL and of appraising new applications by companies. The Vice-Ministry of the Environment of the Basque Government chairs the committee, which is composed of representatives of the following entities: the Environmental Office, Ihobe, the Business Development Agency of the Basque Government, the Basque Energy Board; and the Tax Coordination Authority (EUSKADI, 2014).

This BCTL is reviewed and updated every 3-4 years to adapt it to technical developments. Technologies are removed if they fail to meet the latest criteria.

Technology Evaluation

The technologies included are selected by means of active prospecting by the Environmental Department of the Basque Country, with input from the department in charge of industry. Once technologies are selected, the technical committee carries out the final assessment.
In order to be included in the list, the technologies must meet the following requirements:

- Technologies must be developed on an industrial scale and available in the market;
- There must be no available technologies with a significantly better environmental impact;

[7] ORDER of July 13, 2016

- The ultimate goal of the technology must be environmental improvement;
- The current market penetration of the technology must be less than 40%;
- There must be transferability of the technology between companies;
- The minimum investment in the technology must be between €2,000 and €500,000; and
- The amortisation period of more than five years is calculated as an extra investment cost, divided by additional annual savings less additional annual costs.

Financial incentives

When purchasing technologies listed on the BCTL, companies can benefit from a tax deduction of 30% of the investment cost of the technology. However, in accordance with the EU de minimis financing scheme, a maximum of €200,000 can be deducted over three years. In addition to the tax deduction, investors can also benefit from an **Enhanced Capital Allowance**, changing the amortisation time of their investments (Ihobe, 2017).

Promotion

The BCTL is not widely promoted, however it is published in the Official Gazette of the Basque Country by means of an Order of the Basque Government's Minister of the Environment and Territorial Policy. Ihobe and EREK also provide information on their websites on the BCTL, and on how different technologies are assessed.

Effect

Based on currently available data from Ihobe, each public euro spent generates ~€4 a year in private turnover of investment. This figure is even more relevant if considering the few human resources required to design, drive and manage the instrument is on average 0.3 people a year (Lehmann, 2018).

Overall assessment

- The principal target group of the BCTL is SMEs;
- The industrial sector is considered as a priority sector;
- Companies can benefit from ECA as well as from subsidies on the cost of the technology;
- The tax deduction is automatically applied in the annual corporation tax return; and
- The BCTL is entirely managed by the Basque Government through a number of its agencies.

The Environment List MIA/Vamil

Rationale

The Dutch Random Depreciation of Environmental Investments scheme (Vamil) was introduced in 1991, providing for voluntary depreciation on environmental investment. The Environmental Investment Allowance scheme (MIA) was subsequently introduced in 2000 offering a tax refund on environmental investment.

The aim of both of these schemes is to **encourage Dutch entrepreneurs to invest in their business operations in an environmentally-friendly way and to get innovative environmentally-friendly products onto the market.** Both schemes represent ways for companies who are purchasing new environmental technologies to reduce their overall cost.

The Environment List includes a number of investments, which are available for either, and in some cases both, forms of financial assistance and the inclusion of technologies is based on various criteria.

Target audience

All entrepreneurs in the Netherlands who pay income or company tax can benefit from the MIA/Vamil. The schemes are particularly interesting for entrepreneurs in the agricultural sector, shipping, and industry, but also for entrepreneurs investing in sustainable transport and sustainable

buildings. Besides, technology suppliers can attract more clients and get greater market share as the schemes bring tax benefits to their customers.

Content

In the most recent version of the Environment List (2019) there are six technology themes: (1) Circular economy (raw materials and waste); (2) Food supply and agricultural production; (3) Mobility (EVs); (4) Climate and Air; (5) Use of Space; and (6) Built Environment.

Across the different themes, there are ~290 items of environmentally-friendly equipment, or capital assets as they are referred to, listed on the Environment List. These capital assets are more environmentally-friendly than market alternatives, and often go beyond what the law prescribes.

The main information listed in the Environment List is an item code/number for each technology to indicate which tax scheme applies (A to G), the title, the intended use of the technology and a further explanation of what the asset and its components consist of. On the List, one can search for (multiple) keywords, themes and codes.

Management

The Ministry of Finance and the Ministry of Infrastructure and the Environment (I&M) fund MIA and Vamil. The Netherlands Enterprise Agency (RVO) and the Netherlands Tax and Customs Administration are responsible for operating the schemes. RVO supports the compiling of the Environment list and is responsible for technical checks of the applications. The Tax and Customs Administration checks the tax returns and decides whether MIA/Vamil can be applied (Netherlands Entreprise Agency, Tax relief schemes for environmentally friendly investments (Vamil and MIA), 2014).

The MIA budget for 2019 is €114 million (up from €99 million in 2018), and the 2019 budget for Vamil is €25 million, (down from €40 million in 2018). When there is a risk of budget overrun, the Minister of Finance can limit one or both schemes or close applications altogether. This has not happened since 2008 as the surplus budget from one year can be transferred to the following year.

This List is updated annually to include all technologies currently in the market introduction phase as well as those yielding environmental benefits going beyond statutory requirements. If required **amendments may be carried out throughout the year**. Investments that no longer meet the requirements of the MIA/Vamil because of technological advances are removed from the list, or adapted, and new innovative investments are added.

Technology Evaluation

I&M and RVO co-created the Environment List. I&M considers the latest policy topics such as biodiversity and climate change when making changes to the Environment List. Businesses (suppliers and entrepreneurs) can propose that a particular capital asset should be included on the list. After receiving the proposal, RVO will check it against the various criteria and provide advice on the proposal for I&M to make the decision. [8]

The criteria for products to be included on the list are updated annually so it is possible to **stimulate continuous innovation** (Netherlands Entreprise Agency, Tax relief schemes for environmentally friendly investments (Vamil and MIA), 2014).

[8] The business asset must: provide an obvious environmental benefit; be innovative or must still have a small market share in relation to the alternative; be more expensive than the environmentally unfriendly alternative; and the (further) market deployment in the short term must be desirable for this asset. Other requirements include being easily definable in both technical and cost structure terms and having a market penetration level of less than 30%.

Financial incentives

The MIA scheme allows companies to deduct up to 36% of the cost of the environmentally friendly investment from fiscal profit while the **Vamil scheme lets companies decide when to write off 75% of their investment costs**. That in turn offers an advantage in terms of liquidity and interest. For the other 25% of the investment costs companies follow the regular investment rebate (Netherlands Entreprise Agency, Tax relief schemes for environmentally friendly investments (Vamil and MIA), 2014). Claims must be made within 3 months of order placement. **Investments that are required by law are not eligible**.

The financial benefit of the MIA depends on the investment amount, the percentage of MIA investment deduction, and the tax rate the investment deduction applies to. Depending on the legal form of the company, the deduction can be made from the income tax or the corporation tax.

Depending on the sort of business asset, the MIA comprises 36%, 27% or 13.5% of the amount of environmental investments. The List contains three categories of environmental investments:

- Category I: business assets that are used almost exclusively in agriculture (36% MIA);
- Category II: business assets whose rapid introduction on to the market is urgently desirable from an environmental perspective (27% MIA); and
- Category III: business assets whose introduction on to the market is desirable from an environmental perspective, but to a lesser extent than in category II (13.5% MIA).

In a number of cases, there is a limit to the investment deduction or random depreciation. The description of the asset in the List states the applicable percentage. For example, a capping of 50% for the MIA means that you can only apply the MIA benefit to half of the invested amount (Netherlands Entreprise Agency, Milieulijst MIA\Vamil, 2018).

The list is divided into seven categories (business asset codes) in respect of which incentives are applicable for the technology and the level of deduction available through MIA. These categories are:

Table 3 Tax incentives per categories of assets

Category	Tax incentive
A	27% MIA +Vamil
B	13.5% MIA +Vamil
C	Only Vamil
D	Only 27% MIA
E	Only 13.5% MIA
F	36% MIA + Vamil
G	Only 36% MIA

In addition to the MIA and Vamil schemes, the Netherlands also offer **Energy Investment Allowance** (EIA) as a tax relief programme for companies that invest in energy-saving installations, or that make use of sustainable energy. Investments receiving EIA are not eligible for MIA.

Promotion

Every updated Environment List is published in the Government Gazette and the brochures are uploaded on the RVO.nl website, including information on the application process for listing a new technology and financial incentives. The website has other useful tools such as a search function for the technology list and case studies demonstrating various applications of the MIA/Vamil.

A wide range of third parties feature factsheets or articles on their websites relating to MIA/Vamil and how to effectively use the list. The list also targets industrial and environmental sectors by publishing information about MIA and Vamil in specialist journals. Suppliers with equipment on the list also use the list as a marketing tool to demonstrate to businesses how they can reduce their overall purchasing costs.

Effect

In total, almost €11 billion was invested in the period 2011-2016, supported by the MIA/Vamil schemes.

Table 4 Key figures of MIA/Vamil (CE Delft, 2018)

Year	Number of investments in environmentally friendly assets	Size of investments (€ million)	Financial advantage for businesses (€ million)	Government fiscal loss (€ million)
2011	6,139	1,006	80	67
2012	12,974	1,454	131	110
2013	53,582	3,068	282	246
2014	15,191	1,197	102	87
2015	26,160	2,228	179	157
2016	9,931	2,002	165	153
Total	**123,977**	**10,955**	**939**	**819**

This scheme has a large multiplier effect: only a small amount of tax money is needed to trigger many private investments. A recent policy review states that for every €1 the government invests, a further ~€8.2 to €11.9 are invested by companies in environmentally friendly assets.

Given that governments work with lower internal interest rates than the business community does, the fiscal loss of the government budgeted is hence only ~50% of the fiscal support to businesses (CE Delft, 2018). The effectiveness of the schemes, however, may be limited by the existence of free riders, as some investments would have been made even in the absence of the MIA/Vamil schemes.

It is vital that the Environment List is updated for the scheme to function properly. By tightening the criteria at the right time, reducing support percentages, topping up investment amounts and removing or adding technologies, the Environment List ensures the technologies are ahead of the market and achieve greater environmental benefits. The Environment List has been increasingly dynamic during the period 2011-2016, compared to the previous period (2005-2010), being more reactive to market demands and adjusting the criteria accordingly (CE Delft, 2018).

Overall assessment

- The support of two fiscal incentives reduce financial barriers to action;
- Incentives vary according to the category of the capital assets;
- MIA/Vamil use a project rather than product verification process. This adds cost and complexity yet offers richer information on the EE measures implemented by customers; and
- The list is very fluid, with updates occurring at least annually if not bi-annually.

Triple E Product Register

Rationale

The Triple E register is an Irish list of products approved as being energy efficient. The **Accelerated Capital Allowances** (ACA) scheme for Energy Efficient Equipment (EEE) was established, through the

Finance Act 2008, to incentivise companies and sole-traders to purchase highly energy efficient equipment (HEPS).

Target audience

Companies, sole traders, and farmers that operate and pay corporation tax in Ireland can all claim the ACA. The scheme does not focus on a particular company size or industry.

Content

Triple E equipment and systems are listed under 10 broad categories and 52 associated technologies.[9] There are ~21,500 products on the Register. The main information contained in the list is product name, performance, in-depth technical description, and supplier details.

The products listed in the search register for the Triple E product register are not limited to Ireland, for example, there are products supplied from England and Italy. However, **ACA scheme product suppliers are strictly domestic** (SEAI, n.d.).

Management

The Sustainable Energy Authority of Ireland (SEAI) manages and promotes both the ACA and Triple E, through the use of an online site to make the Triple E register more accessible for users and purchasers.

The SEAI manages and maintains the list of qualifying equipment, which is updated regularly in order to keep policy and national objectives aligned with the scheme. The ACA claims are received and processed by the Irish Revenue Commissioners.

Technology evaluation

Products that are eligible for the ACA are listed on the Triple E Product Register. This is a benchmark register of the highest performing energy efficient equipment. It provides a reference for companies who wish to invest in energy efficient products.

SEAI are responsible for setting the eligibility criteria for the register and maintaining and reviewing the list of eligible products, to ensure that **only the top 10 - 15% of products in terms of energy efficiency in any technology category are listed**.

Financial incentives

The ACA is available for costs directly related to the purchasing of the equipment. Expenditure on the technology must be equal to or exceed the minimum expenditure for ACA incentives for the relevant equipment category.

The ACA allows companies to claim for 100% of the purchase value of specified energy efficient equipment in the first year, instead of claiming the standard capital allowance, which is generally given over an 8-year period and at an annual rate of 12.5% of the capital expenditure. The ACA can be claimed for the accounting period in which the equipment was first provided, as long as the equipment is included on the published list at some stage during that accounting period. The equipment purchased must be new and bought for use in a trade. It cannot be leased, let or hired.

[9] Building Energy Management Systems (BEMS), Lighting, Motors and Drives, Information and Communications Technology (ICT), Heating and Electricity Provision, Process and Heating, Ventilation and Air-conditioning (HVAC) Control Systems, Electric and Alternative Fuel Vehicles, Catering and Hospitality, Electromechanical Systems, Refrigeration and Cooling

Promotion

SEAI collates all information relevant to the Triple E Register online. SEAI also hosts the Triple E Product Search Page and allows manufacturers to apply to be featured on the list through their site. The site features a variety of promotional materials such as case studies, news reports and social media posts. Manufacturers such as Ideal Boilers also feature the Triple E Register on their website as a marketing tool to attract customers, along with their listed products.

Effect

A review and cost-based analysis of the scheme was carried out in October 2014. The primary aim of this review was to set out the context and rationale for the scheme, evaluate its overall effectiveness and to make recommendations regarding continuance of the ACA.

Table 5 Achieved and predicted energy savings from ACA policy measure (DCCAE, 2017)

	2016 (achieved)	2020 (expected)
Energy savings (GWh, Primary Energy)	368	688
CO_2 savings ($ktCO_2$)	80	140
Final energy savings (GWh)	196	385

Overall assessment

- The Triple E Product Register was set up following the UK ETL example and those two schemes are therefore very similar.

EBRD- Technology Catalogue

Rationale

The European Bank for Reconstruction and Development (EBRD) Technology Catalogue, launched in May 2018, is part of the EBRD's Sustainable Energy Initiative (SEI) efforts to move countries' operations towards a sustainable model for the production and consumption of energy (EBRD, The EBRD's Energy Strategy, n.d.). It was developed based on pre-existing individual national catalogues across the EBRD region.

The primary aim of the Technology Catalogue is to help the supply of technologies in different countries, through encouraging partnerships between manufacturers and vendors and increasing access to the technologies and products for end-users. The Catalogue is designed as an online shopping-style platform listing the best-in-class technologies from manufacturers around the world. It serves as the basis for 'Technology Selectors', which are country-specific directories of vendors that offer these high performing technologies to businesses and homeowners. Filtering by country shows the technologies that meet the Minimum Performance Criteria (MPC) for that country.

Together, the Technology Catalogue and the Technology Selectors **encourage technology manufacturers and local vendors to make climate technologies more easily available on the ground** and promote cross-border trade in EBRD countries through the Green Trade Finance Programme (EBRD, EBRD launches shopping-style web tool for climate technologies, 2018).

All products listed on the catalogue are technically eligible for EBRD Green Economy Financing Facility (GEFF) finance, which includes a range of financial mechanisms.

Target audience

The catalogue is targeted at all countries in which the EBRD usually operates. In particular, the catalogue is targeted at manufacturers, vendors and users of green technologies. The main aim is for manufacturers to buy into the scheme, to create partnerships with local vendors, and therefore deliver quicker penetration of the technologies into the market and a wider supply chain in each of the countries.

Content

At present there are ~6,000 products on the list, across 11 broad technology categories[10]. Only those technologies that have a guaranteed beneficial impact can be on the list. The majority of technologies are standard technologies that don't need specialist technical expertise, and that have a maximum capital value of $300,000. The list is therefore focused on **easily deployable technologies with a low market penetration.**

For each technology, the catalogue provides a short description, the manufacturer ID, the category of the technology, and specific measures/information that is technology specific.

Management

The EBRD carries out general management of the scheme and is responsible for providing credit lines to local financial institutions so they can finance green investments. Under GEFF, an experienced EBRD team of bankers and technical programme managers (~two to three per country) provide advisory services and ensure consistent quality.

The EBRD provides the infrastructure (the Catalogue platform) yet it is up to the market to develop and own it. New technologies can be registered at any time by manufacturers and vendors. At least, the Catalogue is updated every two years. In addition, every two years from registering a product, manufacturers will need to update the entry to check for new models. The Catalogue follows a self-policing process, in that manufacturers are invited to update their products following updates from competitors.

Technology evaluation

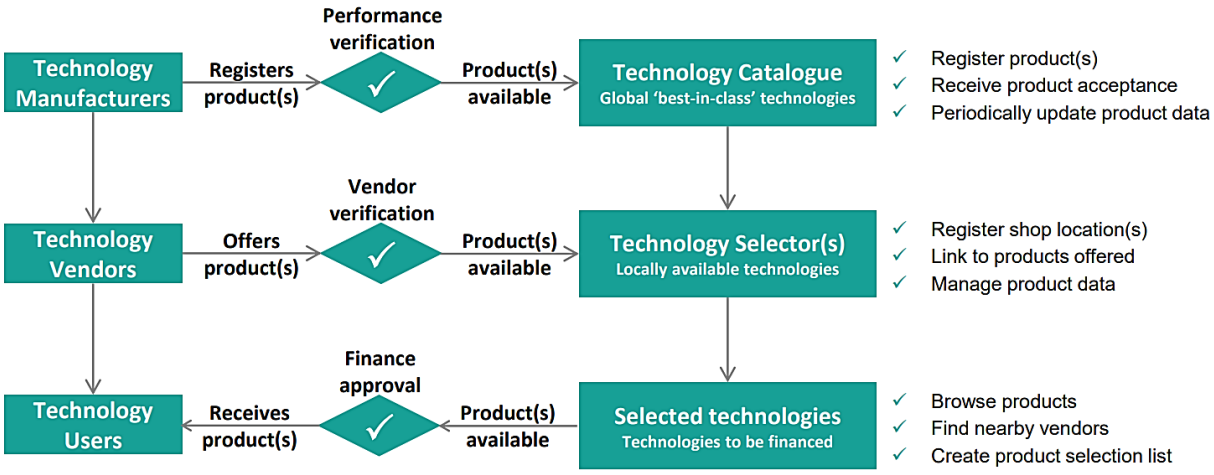
Technology evaluation is based on the MPC of the specific countries. The MPCs require a performance **improvement of at least 20% beyond a baseline** of typical replacement technologies that reflect local market developments including technology costs and market maturity. This means that only the higher performing segment of technologies available on the market are promoted (GEFF, n.d.). This detailed process allows GEFF to demonstrate the benefits of the green economy, and how to turn green projects into sound investments.

After the technologies are registered by manufacturers, they will then be verified by independent technical advisors (Technology Selector Administrator) according to the performance criteria. The advisors also check that the technology is available in at least one of the eligible countries Local vendors can also register and highlight themselves as vendors of the listed products. If local vendors don't find the latest technologies that they are selling, then the vendors can put it on the list until the manufacturer claims it.

Figure 2 Process flow of the EBRD Technology Catalogue[11]

[10] Windows and doors, Insulation, Boilers, Heat pumps, Power and cogeneration, Cooling, Motor and pumps, Process technologies, Transport, Domestic appliances and Lighting.

[11] From the information page of GEFF, link



Financial incentives

The GEFF programme is designed to support the high-performance, green technologies investment and now operates through a network of over 130 local financial institutions across 24 countries supported by around €4 billion of EBRD finance. The scheme is a package of components covering commercial credit lines, technical assistance and donor-funded subsidies.

The catalogue identifies technologies eligible for financing under the EBRD's GEFF. By using GEFF, **the EBRD provides credit lines to local financial institutions so they can finance green investments** in a large number of eligible beneficiaries. Through helping local financial institutions and clients to identify and confirm the eligibility of items for GEFF financing, the catalogue reduces the transaction cost and processing times.

Whilst the main aim of the catalogue is to share information, financial incentives are needed and important to influence customers' behaviours. Financial incentives are considered based on the real and perceived technology risk, for instance for those new technologies with very low market penetration. These technologies would usually benefit from ~15% of investment subsidy.

Promotion

The EBRD posted about the new technology catalogue in the news section of its website with general information about how to use and access the list and how it can benefit businesses. EBRD also promoted the catalogue through its Facebook page with explanatory videos demonstrating how customers can use the Technology Catalogue and the simple search functions. The EBRD is also encouraging local banks to develop case studies showing how a specific technology has helped a customer.

Effect

The Technology Selectors will be one of the key mechanisms for delivering green climate finance under the EBRD's GEFF. It has the potential to reach tens of thousands of businesses and households across the EBRD region.

The EBRD only recently launched the Technology Catalogue (24th of May 2018), so there is limited data on the effectiveness of the tool. As of 2018 the programme had led to 150,000 investments, of which 90% were for standard technologies and the remaining 10% for technologies that required a more detailed assessment. The catalogue is also helping loans and trade departments in local banks with their financing, as well as supporting leasing companies with their activities.

Overall assessment

- The Catalogue is innovative in that it lists energy efficient products and links them with technology selectors, i.e. country-specific directories of vendors;
- The fact that the catalogue is based on national lists, and that technologies are assessed on a country-by-country level ensures that market differences are being taken into account;
- Having a multilateral development bank (MDB) endorsement might extend the reach of the catalogue compared to national government-owned lists;
- Whilst other catalogues are linked to subsidies and tax rebates, the EBRD catalogue features an innovative link to credit lines.

2.3 Comparison Analysis of international cases

Rationale and Target audience

All the international cases discussed here are designed to promote high-performance energy efficient technologies and products through providing reliable information and/or leveraging investments with fiscal incentives to lead the market transformation. The target audiences are mainly the purchasers or technology users, usually local consumers due to the constraints of the accompanying fiscal incentives. In some of the cases such as EP-Plus, SMEs are suited to the scheme through the preferential subsidy rates compared with larger enterprises. Manufacturers and vendors can also use these catalogues as a way of boosting sales and marketing their products.

Content

The number of technologies or products featured in the catalogues range from 40 to 21,500, depending on the scope and category of the lists as well as the accompanying fiscal incentives. The UK ETL, Triple E Product Register and EBRD- Technology Catalogue are lists of individual products which specify the names of the manufacturers for each, making it easy for users to identify where they can purchase the products. In the EBRD case, there is even a Technology Selector which features local vendors of the products. For technologies, the title, category and description of technologies are usually included in the catalogues, and sometimes manufacturer details and performance related information are also featured.

Management

Most of the schemes are led and funded by governments, except the Technology Catalogue from EBRD, which is managed by the multilateral policy bank itself and funded by international donors and partners. When the catalogues are combined with fiscal incentives, multiple government agencies are required to collaborate to run the scheme. On a management level, the schemes are usually managed by government agencies or independent third parties. For example, the UK ETL is managed by the Carbon Trust and ICF on behalf of BEIS, and the RVO (a government agency) and the Netherlands Tax and Customs Administration are responsible for operating MIA/Vamil.

Technology Evaluation

Technology evaluation is one of the most important steps in managing the catalogues and accompanying financial schemes, which ensures the high-performance technologies in selected sectors are promoted. Regular and frequent updates are required to make sure the catalogues reflect the evolving market.

Even though most of the catalogues are led and funded by governments, independent third parties or independent technical experts are often commissioned to conduct the technology evaluation. For example, ICF, a strategic consulting company, is responsible for the technical support for the UK ETL such as the products assessment. Similarly, the technology evaluation for LTL in EP-Plus is also

developed by an independent Flemish research institution (VITO). For the EBRD catalogue, independent technical advisors are used to verify the technology applications. However, there are also cases where the government agencies are responsible for the technology or product assessments.

The technology criteria are usually based on the efficiency performance and market maturity. We have seen some common principles appearing as follows:

- High-performance products: All of the catalogues require high energy efficiency or less environmental impact than the market average alternatives. For example, the products listed on UK ETL are approximately the top quartile for energy efficiency and only the top 10 - 15% most energy efficient products can be listed on the Triple E Product Register. And at least 20% energy efficiency improvement beyond local baseline is required for the GEFF.
- Low market penetration: With the aim of market transformation to new high-performance technologies, the technologies or products featured in the catalogues must have a low market penetration. The market share required to feature on the list is less than 30% and 40% for the MIA/Vamil list and Basque Clean Technologies List respectively.
- Market availability: The technology lists are usually used to promote mature technologies, which are developed on an industrial scale and available in the market.
- Detailed and clear criteria: In several cases, the evaluation criteria to be featured on the list are clear and detailed. For the UK ETL, different performance requirements are set for each technology and testing requirements are also listed clearly.

Financial incentives

All the international cases covered here are linked with supporting financial incentives such as tax deduction and investment subsidies, and some of them are designed to provide technical eligibility for financial supports. The fiscal incentives will be further discussed in Part 2.

Promotion

Several approaches have been adopted to increase awareness of the catalogues. The government agencies and commissioned organizations play the most important role in promoting the catalogues. Here we summarise some practices and examples of promotional activities carried out by the various schemes:

- An official webpage for the list featuring relevant information: The webpage should cover all useful information such as the technology information, the guidance for technology suppliers and purchasers, technology evaluation criteria and application process. Besides the basic information, other information such as case studies and functions such as search for products can further help the promotion of the technologies or products. In most of the cases, the webpages are well designed and populated with information which is easily accessible.
- Search function for products or technologies: A design for the search function will make the catalogue more user-friendly, especially for catalogues with thousands of products. For example, the purchasers can use the technology, product name, and manufacturer as keywords to search for a specific product.

- Promotional materials and channels: Each list uses a variety of promotional materials such as leaflets, factsheets, articles, reports, case studies and videos. These materials are disseminated through multiple channels including digital magazines, webpages, social media, and relevant events. In some cases, manufacturers also promote the catalogue on their own websites or products to attract customers, e.g. Ideal Boilers featured the Triple E Register on their website along with their listed products.

2.4 International product labelling/ standards programmes

Countries around the world have established a series of product labelling and standards programmes to drive the plant and machinery market towards higher energy efficiency. Hereafter we briefly touch upon a few of these schemes. Their commonality is that these are not technology lists or catalogues, but schemes and programmes that set performance criteria for technologies. Mostly these schemes have no direct link to financial incentives. Whilst some are targeted at end-users to reduce information asymmetries, others have been clearly established to drive innovation amongst manufacturers who risk being fined and seeing their inefficient products banned from the market.

Table 6 International product labelling/ standards programmes

Scheme	Description
European Eco-design Programme	The Ecodesign directive forms part of broader EU policy, in combination with the Energy Labelling Regulation[12]. Both legal acts aim to: 1. Increase the energy efficiency of products and the level of protection of the environment; 2. Promote the free movement of energy related products in the EU; 3. Provide consumers with information that allows them to choose products that are more efficient (European Parliament, 2017). The harmonised standards are rule that have been adopted by the European standardisation bodies, CEN and CENELEC, and duly established Technical Committees to provide presumption of conformity. The Eco-design Directive has established a consultation forum to consult stakeholders on the implementation of the directive. The list of members includes representatives from EU countries, industry and civil society.
Blue Angel, Germany	This environmental label (ecolabel) was established by the German Government in 1978. It is a market-conform instrument of environmental policy that is used on a voluntary basis. It focuses on environmental and health-related aspects. Every label is awarded by an independent jury. All Basic Award Criteria are valid for a specified, usually, 3-to-4-year period, and then reviewed. Since its creation, 12,000+ products and services from around 1,500 companies have obtained the Blue Angel label (Blauer Engel, n.d.).
Equipment Energy Efficiency (E3) Programme	The E3 is a cross-jurisdictional programme between Australia and New Zealand. Similar to standards in other countries it requires all product models to be registered by manufacturers and labelled. Initially focused on domestic white wear, the focus shifted to include industrial and commercial products. Categories of products are periodically updated (~5 years) following stakeholder demands.

[12] Which in 2017 replaced the 2010 Directive on energy labelling

Scheme	Description
	The three main aims of the E3 programme are to: 1. Improve the energy efficiency of new appliances and equipment, and the energy performance of products that have an impact on energy consumption; 2. Reduce appliance and equipment related greenhouse gas emissions by complementing other actions by jurisdictions; and 3. Reduce energy bills for households and businesses in a cost-effective way by driving improvements to the energy efficiency of new appliances and equipment sold. Consumers have been the main target of the E3 programme and have been said to trust the label as being government-backed and verifiable.
USA Appliance and Equipment Standards Programme	Under this programme [13], the Department of Energy, through the Buildings Technologies Office, sets minimum energy efficiency standards for a wide range of products, at levels which achieve the maximum improvement in energy efficiency that is technologically feasible and economically justifiable. **The Program's Federal standards pre-empt product efficiency regulations at the state and local level, reducing regulatory burden for manufacturers and providing them with a larger national marketplace** (US Department of Energy, 2017).
Japan Top Runner Programme	The Top Runner was established following the revision of the Energy Conservation Law in June 1998. The Programme was introduced to establish energy consumption efficiency standards for machinery, equipment, and other items, and is a stable energy conservation measure in Japan (Enecho, 2015). It is a system of target setting for manufacturers who then face repercussions in case of non-compliance (public disclosure of non-compliance of companies from the Minister of the Environment, orders and fines). The work and co-ordination of committees, sub-committees and working groups constitute a key part of the Top Runner cycle. The fundamental tasks of these committees and groups are to reach practical and workable agreements on, first, methods for measuring products' energy performance, and, second, reasonable standard levels and compliance periods (Nordqvist, 2006). The Top Runner program has developed a culture of research and development and rapid market deployment, incentivising continued improvement beyond agreed targets, and encouraging competition. Another benefit is that the regulatory burden is shared with the industry, which is a key part of a policy-making process that is flexible, adaptable and responsive to technology or market changes. The ambitious

[13] Which followed the Federal Energy Policy and Conservation Act (EPCA) of 1975, and the Energy Policy Act of 2005 as well as the Energy Independence and Security Act of 2007 (EISA)

Scheme	Description
	standards force manufactures to invest in innovation and a long-term planning horizon makes this achievable (FuturePolicy.org, n.d.).

China Catalogue and Gap Analysis

3.1 Analysis of China National Key Energy-saving Technologies Promotion Catalogue

Table 7 Analysis of China National Key Energy-saving Technologies Promotion Catalogue

Criteria	National Key Energy-saving Technologies Promotion Catalogue
Rationale	The National Key Energy-saving Technologies Promotion Catalogue was launched in 2006 and was first released in 2008. The catalogue aims to promote energy-saving and emission-reduction work across the whole industry and encourages enterprises to adopt advanced energy-saving and low-carbon technologies.
Target audience	The target audience of the Catalogue includes both technology manufacturers and energy-using organisations. The target manufacturers featured on the Catalogue are domestic enterprises with independent technical intellectual property rights. The target end-users are the enterprises/organizations investing or purchasing these technologies and products, mainly in the industrial field such as the power sector and iron and steel industry. Most of the customers are large companies due to the high capital investment required to invest in the bespoke high performing equipment featured in the Catalogue.
Content	The Catalogue covers all sectors, and is divided into 12 industries including coal, electricity, iron and steel, non-ferrous metals, petroleum and chemical, building materials, light industry, textile industry, machinery, building, transportation, information and communications. Each featured technology is listed in a summary catalogue accompanied by a technical report. The technical description in this report contains 8 key sections including the current status and existing problems of energy consumption in the industry where the technology is located, technical description (including the principles, key technologies and process flows), key technical indicators, achievements, typical cases and promotion potential analysis.
Management	The Catalogue is managed and collected by the Division of Environmental Resource Protection of National Development and Reform Commission (NDRC). CECEP Consulting Co., Ltd., together with the National Energy Conservation Centre (NECC), is responsible for the technical review and update. The catalogue is reviewed and updated annually. Since 2008, the Catalogue has been updated 10 times and has featured 260 energy-saving technologies.

Criteria	National Key Energy-saving Technologies Promotion Catalogue
Technology evaluation	The technical review consists of 5 steps as follows; organizational preparation, initial technical evaluation, technical re-evaluation and demonstration, technology defence and investigation, and the release of the Catalogue. The energy-saving technologies entering the Catalogue are required to meet the 6 access conditions and shall not be within the scope of 3 veto conditions. On that basis, the technology is evaluated and selected by experts from corresponding industrial sectors. The evaluation criteria usually do not change, but experts will be organized to regularly remove technologies from the Catalogue with high industry penetration rate and outdated technical indicators.
Financial incentives	The NDRC has not formulated any special financial support policies and regulations for the technologies included in the Catalogue or issued supporting documents for the enterprises. But priority[14] is given to technologies selected in the Catalogue when applying for national energy-saving and emission reduction funds within national budgets and local energy-saving and emission reduction funds.
Promotion	NDRC publishes the Catalogue on the official website every year, and sends the updated Catalogue to the local-level government agencies such as Development and Reform Commission (DRC), State-owned Assets Supervision & Administration Commission (SASAC), and industry associations. In addition, NECC carry out energy conservation promotion activities based on the Catalogue.
Effect	Since its publication, the Catalogue has been widely used and promoted in relevant sectors. During the "Eleventh Five-Year" and "Twelfth Five-Year", it was an important tool for China to achieve energy conservation and reduction targets. Endorsed by the national government, the Catalogue reduces the transaction cost and risks for enterprises seeking to invest in high-efficiency technologies. It also plays an important role in increasing the influence of manufacturers and improving their market competitiveness.

Rationale

In 2006, China published the *Outline of China's Energy Conservation Technology Policy*, and in 2007, the *Energy Conservation Law of the People's Republic of China* was first revised. In response to the above document requirements, and in order to speed up the promotion of key energy-saving technologies, **National Development and Reform Commission (NDRC) developed the "National Key Energy-saving Technology Promotion Catalogue" (hereinafter referred to as the "Catalogue") to encourage energy-intensive enterprises to adopt advanced energy-saving technologies and new equipment to improve energy efficiency**. The Catalogue is a technologies list, not a list of individual products. It is open to technologies from all sectors, however the technologies currently featured in the Catalogue are broadly divided into twelve categories as follows: coal, electricity, iron and steel,

[14] Though all applicants need to be evaluated, the technical review process for technologies in the Catalogue is relatively relaxed because they were already reviewed when they enter the Catalogue.

non-ferrous metals, petroleum and chemical, building materials[15], light industry, textile industry, machinery, building, transportation, information and communications. It is one of the most authoritative and influential comprehensive technical catalogues in China.

As the Catalogue is influenced by the current industrial structure and energy use structure in China, the featured technologies are mostly distributed in industrial fields with high energy consumption.

Target audience

The technology suppliers featured in the Catalogue include central enterprises, local state-owned enterprises, private enterprises, universities and research institutes. Among the featured enterprises, there are large state-owned enterprises, small and medium-sized private enterprises, as well as some research institutes and universities. According to statistics, technologies supplied by private SMEs[16] accounted for more than 50%[17] of the Catalogue.

The target consumer groups of the Catalogue are mainly energy-intensive businesses, but also include some transportation, communication and civil facilities. Most of the customers are large companies due to the high capital investment required for the bespoke high performing equipment featured in the Catalogue. In addition, Energy Service Companies (ESCOs) are also users of the Catalogue, and they are also important players for promoting energy-saving technologies.

Content

Since the "Eleventh Five-Year" Period, NDRC has updated the Catalogue ten times. A total of 260 **high efficiency technologies** were selected in the Catalogue from more than 4,000[18] proposed technologies by the end of 2017. The Catalogue is open to all sectors with the technologies divided into twelve categories/industries. The technologies featured in the Catalogue are usually advanced and complex such as "Sintering Waste Heat Power Generation Technology" for the steel and iron industry, "High-efficiency Water Storage Central Air-conditioning Technology" for the construction industry and "Engine Smart Cooling Technology" for the transportation industry. The distribution of technologies in each category is often related to the current state of the country's industrial structure and industry development.

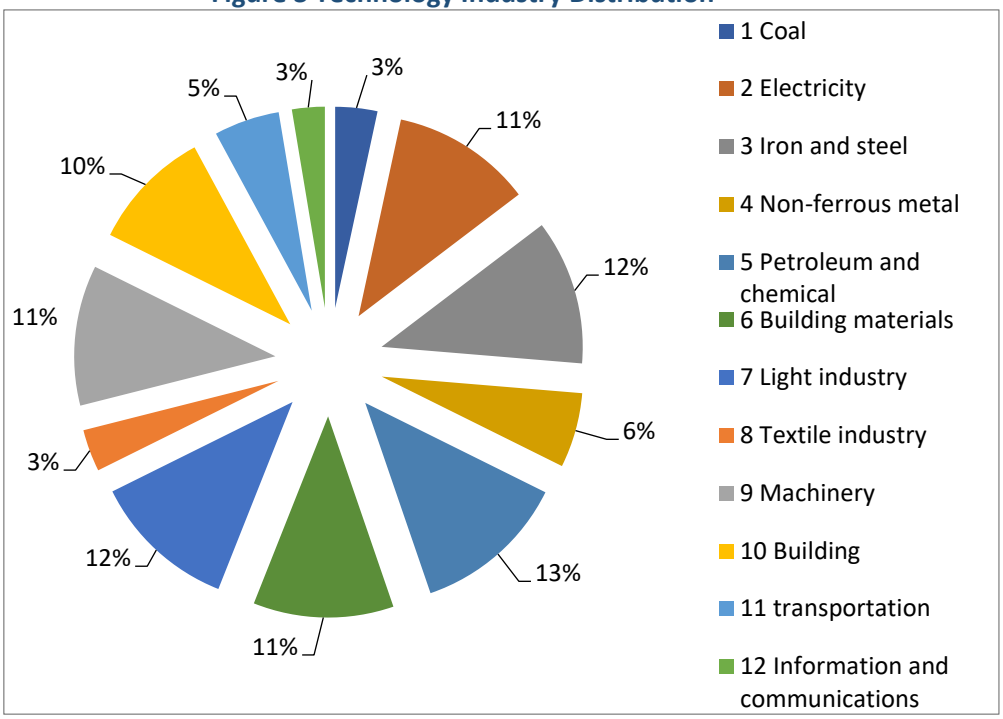
[15] Technologies in "building materials" refer to the technologies used in the building material production process, while "building" refer to technologies like air conditioning technologies, distributed energy system for building energy supply.

[16] Enterprises with less than 1,000 employees or less than 40 million yuan of business income are small and medium-sized enterprises.

[17] Technical statistical information of CECEP

[18] Technical statistical information of CECEP

Figure 3 Technology Industry Distribution[19]



According to CECEP's statistics, the Catalogue has a relatively high proportion of technologies in the following seven industrial categories: electricity, iron and steel, petroleum and chemicals, building materials, light industry, machinery and construction. The proportion of technologies by sector varies over time as China's industrial structure changes. According to the analysis in Figure 3, the technologies of the 7 featured industries account for about 79% of all technologies listed in the catalogue. Non-ferrous metals and the transportation industry account for slightly less, and coal, textiles and communications industries account for the least.

In terms of content, the Catalogue file consists of a summary table and a technical report. The summary table is a list of all technologies with their technical summaries. The summary table allows the reader to quickly understand the core content of the technologies and to find the technology they need. The technical report is a detailed description of each technology, which contains:

(1) The technical name, which is simple, clear and easy to understand;

(2) The category of technology and scope of application, such as "construction industry, heating and cooling for buildings" for a high-efficiency water storage central air-conditioning technology;

(3) The current status of energy consumption and carbon emissions of the sector, which is mainly background information for each technology sector, including the energy consumption and existing problems in that sector, as well as the potential impacts of using the technology on the sector;

(4) Technical content, including technical principles, **key technologies and process flows.** This section features a concise description of the differences between the energy saving potential of listed technologies and the current market average technologies. The process flow part is usually displayed in graphic form, making it easier for the reader to understand the process and how to achieve energy savings;

[19] Internal sources from CECEP Consulting

(5) The main technical indicators, usually 3-5 indicators that reflect the technological advancement and energy saving rate of the technology;

(6) Technical appraisal, award status and application status, usually includes patents and technical appraisals of the scientific and technological achievements, so as to verify the maturity and reliability of the technology. In addition, this section also briefly describes the national and international applications for each technology;

(7) Example technology applications, usually consist of two examples. Each example features the overall scale of the project, the basic conditions for the project construction, engineering and technical content, major equipment, project investment, construction cycle, economic benefits, energy conservation and emission reduction performance;

(8) Potential energy savings and emission reductions, in which the market penetration over the next five years is evaluated and forecasted, and the corresponding energy savings and emission reductions potential of the technology are estimated.

Management

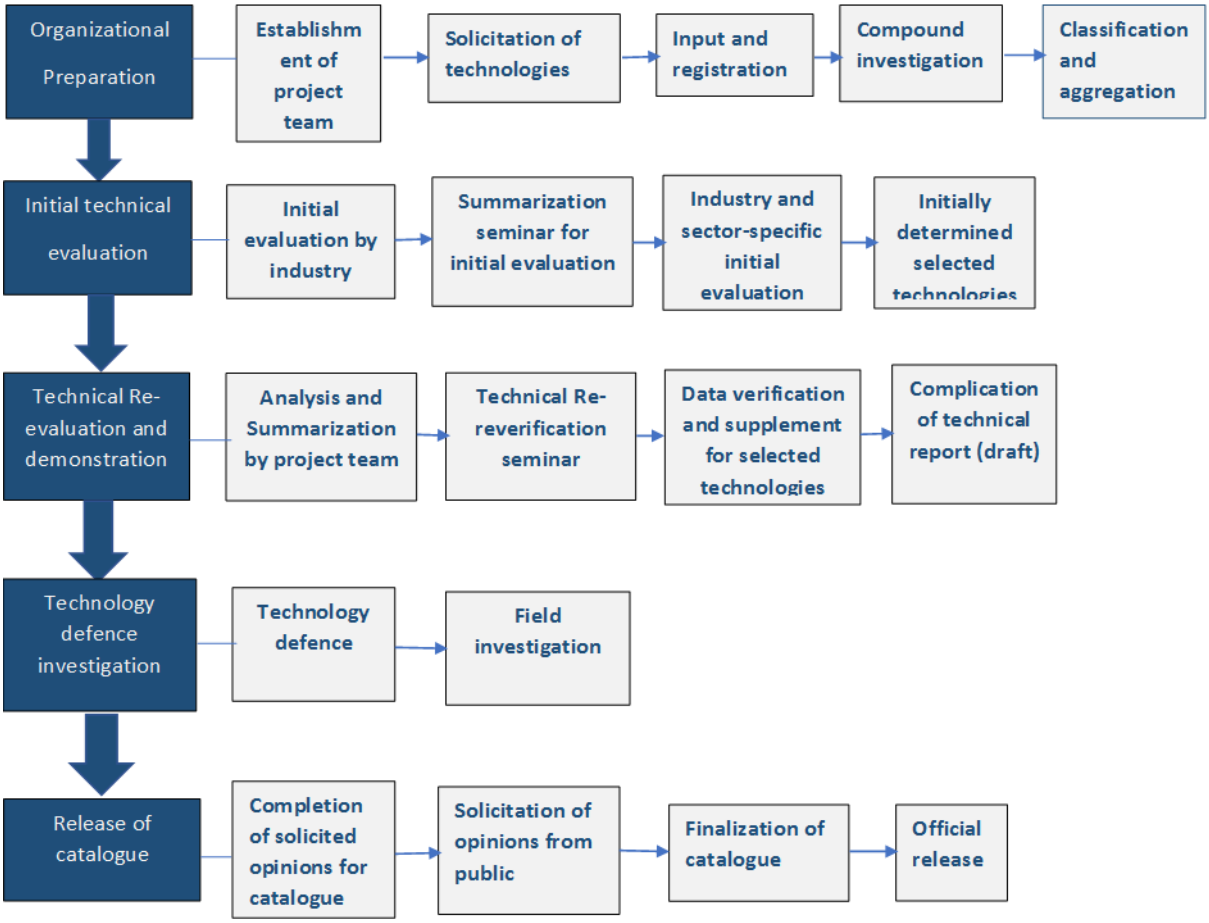
The Division of Environmental Resource Protection of NDRC (DERP) lead on the development of the Catalogue and are responsible for the publication of the Catalogue. Since the launch of the Catalogue in 2006, commissioned by DERP, CECEP Consulting Co., Ltd. together with NECC, have updated the Catalogue 10 times (once a year, with the exception of 2018 where the Catalogue was not released due to the NDRC's institutional reform)**.** NDRC releases the request document to start the technology update and application process every year, which describes the principles and scope of eligible technologies and provides the application formats. CECEP is responsible for assessing and screening new technologies, supported by NECC, to add new technologies to the Catalogue. Each batch of technologies has been thoroughly checked and reviewed, thus ensuring the scientific, objectivity and fairness of the preparation and evaluation of the Catalogue. The review and elimination of existing technologies in the Catalogue has been conducted by NECC annually since 2014, supported by CECEP. The review process for existing technologies aims to remove the outdated technologies and update the technical description if needed. For example, technologies with a penetration rate of more than 80% are not eligible to be featured on the Catalogue.

The promotion of the Catalogue is led by the DERP, while NECC and CECEP Consulting Co., Ltd. are responsible for supporting the promotion and maintenance of the Catalogue. NECC is responsible for industry-specific technical promotion and they conduct a series of conferences and exhibitions based on the technologies in the Catalogue. There is no regular assessment of the effect of the Catalogue. Commissioned by NDRC and ADB, CECEP Consulting Co., Ltd. carried out a comprehensive assessment of the technologies in the Catalogue in 2016**.**

Technology evaluation

The technology evaluation process for screening new technologies is carried out by CECEP. **The assessment and selection processes are comprised of five steps: organizational preparation, initial technical evaluation, technical re-evaluation and demonstration, technical defence and investigation, and the preparation for release (Figure 4).** Each step has a number of actions. At the same time, each step is completed by a number of working groups for different industries, to ensure that the technical review and assessments are objective and reasonable, and that the assessment process is fair and equitable.

Figure 4 Review process of National Key Energy-Saving Technologies Promotion Catalogue



Since the publication of the Catalogue, the access conditions have not changed. **The energy-saving technology entering the Catalogue is required to meet the six access conditions and shall not be within the scope of three veto conditions.** The six requirements are as follows:

(1) The energy-saving technology should be applicable and advanced domestically (better than the highest index in the industry standard);

(2) The technical energy-saving mechanism is clear, with energy saving and increased efficiency as the main features;

(3) Manufacturers should own the core technology products and equipment;

(4) The intellectual property rights must be clear, and the supporting materials and data are informative and reliable;

(5) The technology must be mature and reliable. In principle, there must be more than two typical practical application cases;

(6) The technology must be economical and reasonable, and the application range is wide. It is estimated that the energy saving potential in the next 5 years will be around 100,000 tce/year.

Technical veto conditions:

(1) Energy-saving technologies already featured in the “National Key Energy-saving Technology Promotion Catalogue”

(2) Energy-saving technologies with an industry penetration rate of over 80%

(3) New energy and renewable energy technologies

The manufacturer of the technology is required to provide the corresponding authoritative certification documents (such as a patent and appraisement of scientific and technological achievements (provincial level and higher)) as detailed in the access conditions. Industry experts then carry out a comprehensive evaluation specific to each industry and in line with relevant standards. The experts review the energy efficiency of the whole system alongside the economic benefits of the technology.

CECEP is responsible for the management of the whole process. As for the use of experts, each technology is usually evaluated independently by different industry experts and through several rounds of seminars. If the technology is highly controversial, then the project team and the review experts will conduct further field research. If the technology is not controversial, then the technology will go directly to the defence stage, which is the final review of the technology. The defence is divided into two sections, reporting and Q&A. Experts will ask the reporting person from the manufacturer questions during the Q&A time, and industry experts will fill out evaluation opinions if there are no objections after the defence.

Financial incentives

Until now, the state has not issued any type of direct supporting policy for the technologies in the Catalogue, nor has it licensed or issued a certificate to the technology suppliers in the Catalogue. The technologies in the Catalogue may be subject to some general financial incentives, but there is no "privilege" in obtaining these financial incentives. **Despite this, the Catalogue has been taken as an important technology source when China formulates central fiscal budget investments, energy saving technical reconstruction incentives and various other energy saving subsidies.** Therefore, the technologies in the Catalogue are usually in the scope of a range of incentives and subsidies (such as "central budgetary investment and energy-saving technology reconstruction incentives", "energy-saving technology reconstruction incentives"), though they are not specific for technologies in the Catalogue. Technology purchasers can apply for these funds when investing in energy saving products. The following is a brief analysis of the financial funds used in energy conservation in recent years in China.

During the "Eleventh Five-Year" period, China's central financial incentives invested a total of 101.6 billion yuan, of which 30.5 billion yuan were central budgetary investment and energy-saving technology reconstruction fund. The above 30.5 million investment and fund is highly correlated with the Catalogue, enterprises using this technology can apply for them. Other incentive funds are only for individual industries, such as construction or transportation.

During the "Twelfth Five-Year" period, China selected "Ten-thousand Enterprises" [20] to improve their energy efficiency, and used all the financial incentives for energy conservation technology transformation to support the "Ten-thousand Enterprises" energy-saving technology campaign. The total investment of "Ten-thousand Enterprises" energy-saving technology reform exceeded 120 billion yuan, of which the state financial subsidy accounted for about 10%. According to CECEP's data, about 70% of the technologies used in this project in the iron and steel industry were featured in the Catalogue. In addition, for five other industries (non-ferrous metals, petroleum and chemical, building

[20] In 2011, the NDRC and other 12 ministries jointly issued the" Implementation Plan of the Energy Conservation and Low-carbon Action Plan for 10,000 Enterprises". Ten thousand enterprises refer to key energy-intensive enterprises with an annual comprehensive energy consumption of over 10,000 tce and an annual comprehensive energy consumption of over 5,000 tce designated by relevant departments.

materials, construction, and transportation), more than 30% of the technologies used in the project were also featured in the Catalogue.

In 2015, the state promoted the Interim Measures for the Administration of Energy Saving and Emission Reduction Subsidy Funds (CJ [2015] No. 161), which provided a basis for the allocation of China's “13th Five-Year” energy-saving and emission reduction financial incentive funds. It is predicted that during the “Thirteenth Five-Year” period, the amount of national energy conservation subsidy will be the same as that of the “Twelfth Five-Year”, around 100 billion yuan. But as the overall level of China's process and technology continues to improve, the subsidies will likely decline in the future.

Promotion

In addition to being published on the official website of the NDRC, the Catalogue is issued to the provincial and municipal level development and reform commissions, and is sent to the State Asset Supervision and Administration Commission (SASAC) and various industry-level associations in the form of letters, and is distributed to the enterprises by the SASAC and the industrial associations, in order to form a full coverage publishing network.

In order to further promote the Catalogue, during the “Eleventh Five-Year Plan” and the “Twelfth Five-Year Plan” period, **the NDRC used the Catalogue as a technology source and carried out various forms of promotion of energy-saving technologies.** This played a positive role in promoting national energy conservation and emission reductions.

(1) IPEEC "Double Top Ten" Project

In order to promote the penetration of advanced energy-saving technologies and practices and promote global energy efficiency, NDRC and the Australian Department of Industry, Innovation and Science selected and promoted the international project titled "Top Ten Energy-saving Technologies and Practices” (Double Top Ten).

Using the National Key Energy-Saving Technologies Promotion Catalogue as the technology source, the Chinese Experts Group selected China's "Double Top Ten". The publication of the list of "Double Top Ten" expanded the international influence of China's energy-saving technologies and created favourable conditions for the further popularization and application of related technologies both nationally and internationally.

(2) Energy-saving Technology Promotion Campaigns

A. Industry Technology Promotion Conferences

In order to further strengthen energy efficiency and accelerate the promotion and application of energy-saving technologies, the NERP entrusted NECC to organize industry-specific energy-saving technology promotion conferences with industry associations and research institutes, with representatives from energy-saving technology enterprises, key energy-using units, energy-saving service agencies, and local energy-saving centres. Since 2014, conferences have been held to promote energy-saving technologies and energy-saving practices for buildings, communication, petrochemical, steel, electric power and other relevant industries.

B. Energy Saving Technology Exhibitions

In order to build a platform for the exchange, display, and project cooperation of domestic and international energy-saving and low-carbon innovative technologies and equipment, and to promote the new energy-saving technologies and products, NECC together with partners jointly hosted the China International Energy-Saving Low-Carbon Innovation Technologies and Equipment Expo (Briefed as "EC EXPO"). The EC EXPO covered nearly 1,000 technologies such as high-efficiency industrial boilers, energy-saving motors and drives, and low-temperature waste heat utilization. Most of these

were listed in advanced energy-saving, low-carbon promotional technology catalogues developed by various ministries and provinces. The event gained interest from investors and steered the direction of energy-saving and environmental protection industries.

C. Energy-saving Technology Publications

CECEP Consulting Co., Ltd. published the Assembly of National Key Energy-saving Technologies Promotion Catalogue (2008-2010), Implementation Guide for National Key Energy-saving Technologies Promotion Catalogue (1), and the Assembly of National Key Energy-saving Technologies Promotion Catalogue (2011-2012) between 2011 and 2013. These publications promoted the wider dissemination of the Catalogue, which increased the public's understanding of key energy-saving technologies. At the same time, these publications were a good way to publicize the manufacturers of technologies featured in the Catalogue. Many enterprises used these publications as a tool to promote their products to customers.

(3) Key Energy Conservation Projects

During the "Eleventh Five-Year" and the "Twelfth Five-Year" period, to achieve the energy conservation and emission reduction goals formulated by the government, ten key energy-saving projects and ten key energy-saving and emission reduction projects were implemented to promote energy-saving technologies. The Catalogue covers all the industry areas and technologies adopted in these projects, playing an important role in the promotion of these projects. In addition, through the implementation of key energy-saving projects, a large number of energy-saving technologies in the fields of industry, construction and transportation have been promoted rapidly.

The above activities are not only an important means for the government to publicize the Catalogue, but also China's measures to promote energy conservation and emission reductions. With the development of the promotion activities, the influence of the Catalogue is increasing, and it has gradually become one of the most influential catalogues in China. These promotional activities also help purchasing organisations choose energy-saving technologies, reducing their transaction costs.

Effect

Since its publication, the Catalogue has effectively promoted the application of key energy-saving technologies and laid a good working foundation for achieving the binding targets of energy conservation and emissions reduction. At the same time, after years of development, the Catalogue has been increasingly valued by the Chinese government and has received extensive attention from wider society. It plays an increasingly important role in the development and uptake of energy-saving technologies in China.

During the "Eleventh Five-Year" period, the Chinese government implemented "Top Ten Key Energy-Saving Projects"[21]. Through the implementation of the projects, an energy saving capacity of 340 million tce was achieved by the end of the "Eleventh Five-Year" period, accounting for 54% of the total energy saved (630 million tce). This played a key role in successfully reaching the energy conservation goal and was a strong support for the "Top Ten Key Energy-saving Projects". At the end of the "Eleventh Five-Year" period, the estimated technical energy saved in Catalogue was about 50 million tce, accounting for about 8% of the total energy saved[22].

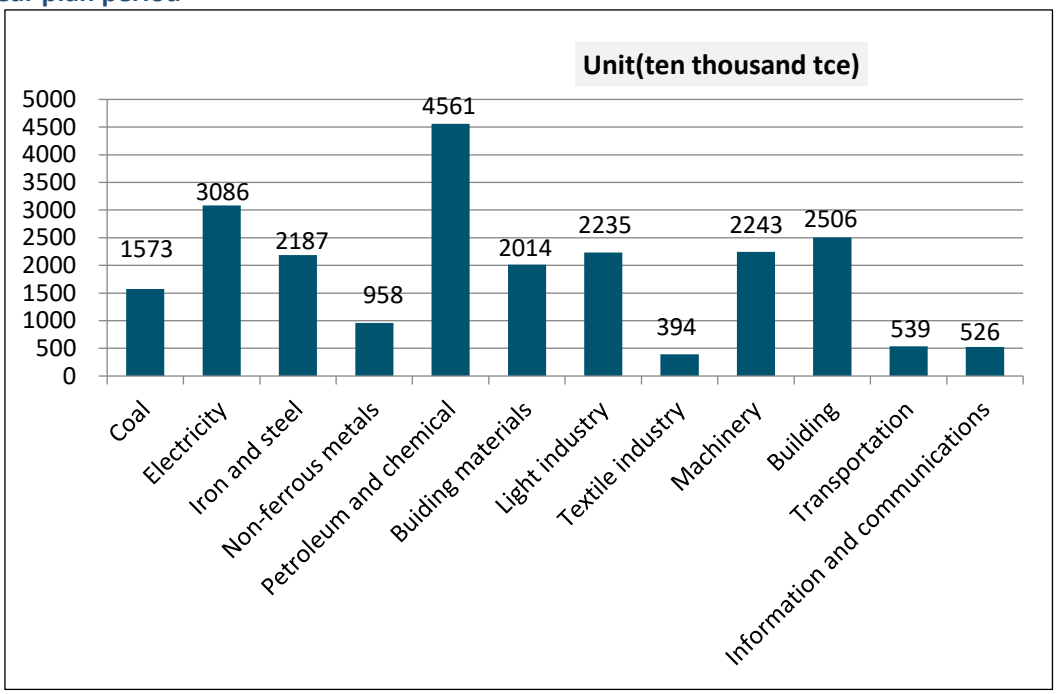
[21] Coal-fired industrial boilers (furnaces) renovation projects, regional cogeneration projects, waste heat and pressure utilization projects, conservation and alternative petroleum projects, motor system energy-saving projects, energy system optimization projects, building energy-saving projects, green lighting projects, government agency energy-saving projects, and energy-saving monitoring and technical service system building projects.

[22] Technical statistical information of CECEP

During the “Twelfth Five-Year” period, China’s energy consumption per unit of GDP decreased by 18.2%. With the extensive promotion of technologies in the Catalogue, the Catalogue has gradually increased its contribution to energy conservation throughout China. At the end of the “Twelfth Five-Year Plan” period, the estimated energy conservation achieved with technologies in the Catalogue was about 120 million tce, accounting for 18% of total energy saved[23].

The "General Work Program for Energy Conservation and Emission Reduction in Eleventh Five-Year " proposed that "by 2020, the national energy consumption per 10,000 yuan of GDP will fall by 15% compared with 2015", so the total energy saving in China during the "Thirteen Five-Year" period will be generally the similar to that of the “Twelfth Five-Year” period. Considering various influencing factors, it is expected that the energy-saving effect of the technologies in the Catalogue will be about 20% of the total energy saved[24] in the whole society, equating to approximately 230 million tce. The energy saving potential of the Catalogue in various industries is shown in figure 5.

Figure 5. A prediction of energy saving potential of technologies in the Catalogue during the 13th five-year plan period[25]



The Catalogue has also had an increasing impact on energy-intensive industries and potential consumers. Due to the increased promotion of the Catalogue by industry associations and government departments at all levels, the Catalogue has become an important tool for large-scale energy-intensive enterprises to select highly efficient technologies with lower risks and transaction costs. In particular, technologies that have pilot projects endorsed by the government have received widespread attention in the industry and have been widely promoted.

The Catalogue has also been influential for manufacturers in the various industries featured in the Catalogue. The Catalogue has gradually become an important marketing tool for the manufacturers. Under the vigorous promotion by NECC and associations, the manufacturers have gradually improved their industry’s reputation and influence. Figure 6 shows the comparison of market share of 30 typical

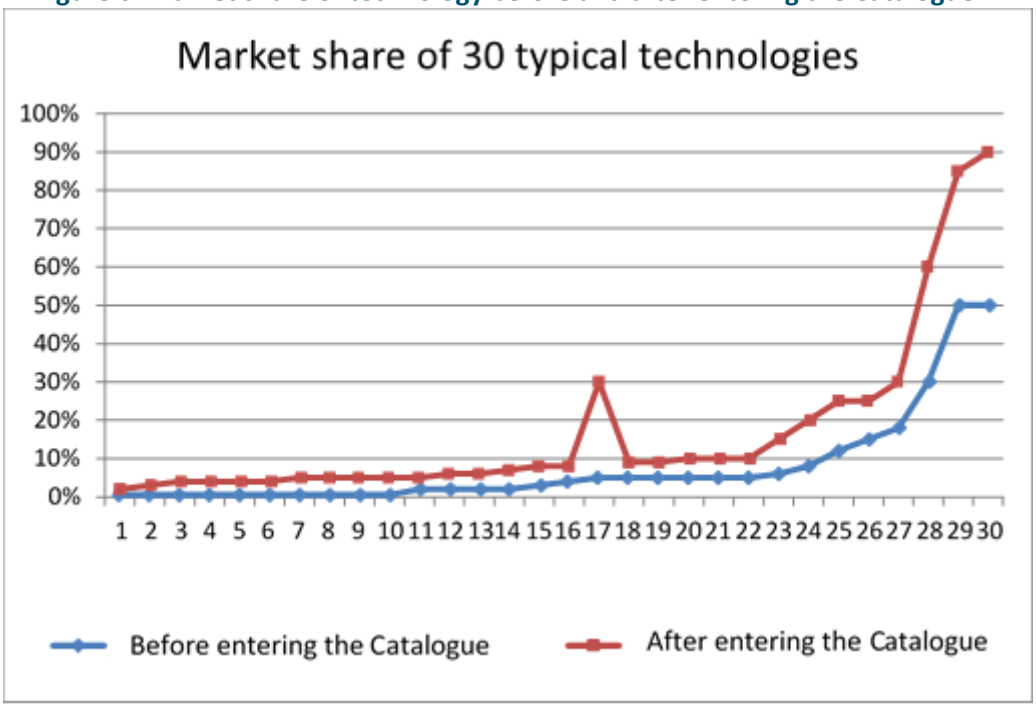
[23] Developing Innovative Financing Mechanism and Incentive Policies to Promote Demand-Side Management in the Electricity Sector TA. CECEP, 2017

[24] Relative energy- saved, which is based on the per unit GSP energy consumption reduction.

[25] National Key Energy-saving Technologies Promotion Catalogue (2017), Compiled by CECEP.

technologies before and after entering the Catalogue for approximately 3-5 years and a significant increase of market penetration after involved in the Catalogue appeared, which demonstrates that the Catalogue promoted the market promotion of new technologies

Figure 6. Market share of technology before and after entering the Catalogue [26]



[26] Developing Innovative Financing Mechanism and Incentive Policies to Promote Demand-Side Management in the Electricity Sector T. CECEP, 2017

3.2 Case studies of other catalogues

Level	National Level			Regional Level	
	Ministry of Industry and Information Technology of the People's Republic of China (MIIT)	Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD)	Ministry of Transport of the People's Republic of China (MOT)	Beijing	Zhejiang
Name of catalogue	Recommended Catalogue of Energy-saving Electromechanical Equipment (Products)	Catalogue for Promotion of Energy Efficiency Retrofit of Existing Buildings	Recommended Catalogue of Energy-saving Products (Technologies) for In-use Vehicles and Vessels Promoted Emphatically Nationwide	Recommended Catalogue of Energy-saving and Low-carbon Technology and Products in Beijing	Promotional Catalogue of Energy-saving Technology and Products in Zhejiang
Rationale	The catalogue is designed to promote **the** uptake **of energy-saving products in the industrial field and as a tool to guide economic restructuring by adjusting to market needs**. The catalogue was compiled in 2008, and was first published in 2009. The catalogue has been updated 7 times to date, adding a total of 1,437 high energy efficiency products to the catalogue.	The catalogue is designed to promote the transformation and application of scientific and technological achievements in the construction industry. It is also used to promote the uptake of energy-efficient products in the construction industry. The catalogue was created in 2009, and first published in 2010. Up to now, only one version has been published, featuring 68 energy efficient	The catalogue is designed to manage and promote the energy-saving products used in transportation vehicles, and to promote energy saving in the wider transport industry. The catalogue was created in 1995, and several batches were published in each five-year period, including three batches during the Ninth Five-Year Period (1996-2000), two batches respectively during the 10th Five-Year Period, the 11th Five-Year Period and the 12th Five-Year Period. 56 energy efficient and energy-	This catalogue is a continuation of the "Recommended Catalogue of Energy-saving, Water-saving and Emission Reduction Technology in Beijing", which is designed to increase the promotion and uptake of the energy saving and carbon reduction technologies. The catalogue is also used to mobilize the enterprises and organizations to adopt new technologies, new equipment and new processes, thereby further promoting energy efficiency and carbon reduction in Beijing. The catalogue was created in 2011, and has been updated annually until 2018 and has featured a	The catalogue is comprised of two lists, the first is designed to promote energy efficient technologies and the second is designed to promote energy efficient products. The Catalogue aims to contribute to the energy reduction targets of Zhejiang Province. The catalogue was created in 2005, and is updated annually. To date it has been updated 9 times up until the end of 2015, and has featured a total of 614 energy efficient and energy

Level	National Level			Regional Level	
	Ministry of Industry and Information Technology of the People's Republic of China (MIIT)	Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD)	Ministry of Transport of the People's Republic of China (MOT)	Beijing	Zhejiang
		technologies used in the construction industry.	saving technologies were selected in the two batches during the 12th Five-Year period.	total of 472 energy-efficient and energy-saving technologies.	saving technologies and products.
Target audience	Products featured in the catalogue are mainly used in industrial manufacturing enterprises. The target market is energy-intensive manufacturing industries. Other consumers include organizations from the construction, transport and civil sector.	Technology suppliers include large state-owned enterprises as well as medium and small private enterprises, and some research institutions. The target market are customers in the Chinese construction industry, both construction companies as well as individuals for domestic uses. Although China is the target market, international organizations can also purchase technologies featured in the Catalogue.	The featured products are energy saving products for the transportation sector. Manufacturers of these products include not only large-scale state-owned enterprises, but also medium- and small-sized private enterprises; the target customer groups are mainly Automobile Sales Service shops and ports.	The manufacturers include not only large-scale state-owned enterprises, but also medium- and small-sized private enterprises, etc. The target group of consumers are mainly energy-intensive enterprises and organizations in Beijing, Tianjin and Hebei.	As the focus of the energy-saving areas in the province vary each year, the focus on technologies in the catalogue also change year to year. Some technologies and products manufactured outside of China are featured in the catalogue. Manufacturers featured in the catalogue include large-scale state-owned enterprises, as well as medium- and small-sized private enterprises. The target group of consumers are mainly energy intensive organizations in the Zhejiang Province.

Level	National Level			Regional Level	
	Ministry of Industry and Information Technology of the People's Republic of China (MIIT)	Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD)	Ministry of Transport of the People's Republic of China (MOT)	Beijing	Zhejiang
Content	The categories of products changes year by year based on the policy trend and market need. For example, there were four categories in the first version, including internal combustion engines, industrial boilers, electric motors and general equipment. In the second version, it increased to seven categories, covering internal combustion engine, industrial boiler, fan, pump, transformer, heat treatment equipment and compressor. The catalogue is a technical summary of selected specific products, which includes the name and	Technologies featured on the list include building materials, energy-efficient equipment and renewable energy equipment, doors and windows, wall insulation and heating and cooling equipment. The catalogue includes the name and performance of the technologies, application scope, and information about the technical consulting unit. Actually, technologies featured in the catalogue can be provided by different manufacturers, but only the information of applicant company is listed in it.	The products listed in the catalogue are mainly parts and oil products used in power systems, lubricating systems, control systems, and cleaning systems of vehicles (automobiles and ships), such as fuel additives, lubricant additives and energy-saving devices. The catalogue is a specific product list with detailed information of the products and manufacturers including product name, model, brand, contact information and address.	The catalogue covers technologies in four main categories: energy conservation and emissions reduction, circular economy, climate change action and other low carbon and energy efficiency technologies. The **energy conservation and emission reduction category** includes energy saving technologies such as high-performance heating and cooling and energy storage, and pollution control and treatment technologies such as desulfurization and denitrification technologies. **The circular economy category** includes the recycling of urban solid waste, scrap cars, electronic waste treatment and green remanufacturing technologies. **The climate change action category** includes reduction of	The main technology sectors include transport, industrial and the construction industries, and new energy[27] including renewable energy and clearer production technologies[28]. The catalogue published contains two parts: a technology list and a list of specific products, among which the former mainly includes technology name and category and the latter contains the specific product name, model and manufacturer details.

[27] Non-traditional energy, mainly refer to solar, wind, biomass, geothermal, tidal, hydrogen and nuclear.

[28] Technologies that reduce the emissions of pollutants such as dust, sulfur dioxide, nitrogen oxides (S02, NOx) during industrial production processes.

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	parameters of the technology, performance standards, and manufacturer information.			greenhouse gases emissions, carbon capture, utilization and storage, and other technologies which can contribute to the development of low-carbon cities, communities, parks and enterprises. Besides, the integrated solutions are also included in the scope of the catalogue. The catalogue contains a summary of each technology, which includes the name and characteristics of the technologies, application scope, and information of the applicants. Each technology can be provided by a number of manufactures.	
Management	This catalogue is led and managed by the Energy-saving and Comprehensive Utilization Division of MIIT. The collection of products is carried out by the regional Commission of Economy and	The catalogue is published and managed jointly by the Ministry of Housing and Urban Rural Development of the People's Republic of China (MOHURD) (Department of Building Energy Conservation	The catalogue is managed by the Law Department and the General Office of the MOT, under which an energy management office is set to take full responsibilities, and the regional department (bureau) of transport and relevant enterprises are	The catalogue is led and managed by the Department of Resource Conservation and Environmental Protection under Beijing Municipal Commission of Development and Reform. It works together with the Science and Technology Commission, the Commission of Economy and	The catalogue is led and managed by the Zhejiang Commission of Economy and Information Technology. The Commission of Economy and Information Technology at the municipalities and counties (cities, districts) organizes the initial review

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	Ministry of Industry and Information Technology of the People's Republic of China (MIIT)	Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD)	Ministry of Transport of the People's Republic of China (MOT)	Beijing	Zhejiang
	Information Technology and industrial associations. The Resource Utilization Center of Machinery Industry is responsible for the technical screening and review. The catalogue is reviewed and updated once every year, and has been updated annually from its creation in 2009 until 2016. In 2017, the catalogue was updated to *National Recommended Catalogue of Industrial Energy-saving Technical Equipment*, adding a technical report with a case study for each technology.	and Technology) and the Ministry of Finance of the People's Republic of China (MOF) (Department of Countryside Science and Technology). The Science and Technology Development Promotion Center of the Ministry of Housing and Urban-Rural Development is responsible for the technological screening and review. The catalogue has not been updated since it was first published.	involved in the management of the collection.	Information Technology, the Bureau of Finance, the Administration of Quality Supervision and the Financial Bureau and Administrative Committee of Zhongguancun Science Park to source experts to review the technology applications.	of the application, and then the Commission of Economy and Information Technology sources experts to review the product applications after the preliminary review.
Technology evaluation	In order to be featured in the catalogue, products are assessed against fixed criteria. Industry	The focus of technology evaluation includes the advancement and applicability of	The technology application unit shall submit an "Application Form" to the department of the provincial	The application can be a technology, a product or an integrated solution. The principle requirements for the	The technical evaluation criteria of the catalogue contain three parts. First, the enterprise is required to be a

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	experts evaluate the technologies and assess whether they meet the criteria and industry standards. In general, the criteria are fixed and feature factors such as the energy-saving potential, the technological advancement, whether it's mature for market promotion and suitable for multiple industries. The technology categories of the collection will vary annually according to the industrial demand in that year.	technology and independent intellectual property rights, which are selected by experts according to current industry needs. The technology selection and evaluation are conducted by the Science and Technology Development Promotion Center.	transport administration, which shall then be submitted to the energy management department of the MOT after it has been reviewed. After the energy management department has reviewed the application, it will be sent to designated testing centers to test the energy efficiency of the product. The energy management department then organizes experts to review the results. In general, the technical evaluation criteria of the catalogue do not change. The main evidence that is required for review is a patent certificate, an energy saving test report, the production and service capacity of the enterprise and any further evidence of the technology's performance.	technology/product/integrated solutions include the following: 1) it must be advanced and innovative, 2) the technology must be mature, safe and stable, 3) it must be leading in performance domestically, 4) it must provide significant energy savings and emission reductions, 5) it must have a wide range of applications.	legally operating business; second, the technology or product will need to be independently certified by a third party; finally, the intellectual property rights of the enterprise should be clearly detailed. The experts will select technologies and products to add to the catalogue according to the requirements of Zhejiang Province.

Level	National Level			Regional Level	
	Ministry of Industry and Information Technology of the People's Republic of China (MIIT)	Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD)	Ministry of Transport of the People's Republic of China (MOT)	Beijing	Zhejiang
Financial incentives	The MIIT has not formulated relevant financial support policies specific for the catalogue. In addition, the ministry provides funds for energy conservation and emission reduction every year, and the enterprises investing in the products in the catalogue will have "priority" to claim such funds. These priorities are mainly reflected in the review stage of the product or projects, and technologies featured in the catalogue are more likely to receive such funds.	In terms of financial incentives, the MOHURD and MOF have not formulated any specific financial support for the technologies in the catalogue, However, there are existing subsidies relating to the retrofitting of existing buildings, launched by the MOF and local governments, for which products in the catalogue are suitable.	The MOT has not formulated relevant financial incentives for the technologies in the catalogue. However, as the catalogue features manufacturers of energy efficient technologies, the catalogue plays an important role in market promotion for these organizations.	Beijing Municipal Commission of Development and Reform has not created fiscal incentives for technologies featured in the catalogue. However, in recent years, the regions of Beijing, Tianjin and Hebei have had a huge demand for energy-saving initiatives and environmental protection technologies, so the publication of the catalogue has allowed manufacturers to promote their technologies economically.	Zhejiang Commission of Economy and Information Technology has not formulated relevant financial incentives for the technologies in the catalogue, but the catalogue is an important tool for Zhejiang to promote energy conservation and emission reduction so it is of great significance for the technology promotion of enterprises.
Promotion	The MIIT publishes the updated technology catalogue annually online, and distributes the catalogue to the Local Commission of	In 2010, the catalogue was officially released, and distributed by the MOHURD to the Departments of the Housing and Urban-	The catalogue has been updated on average every two years since the "Ninth Five-Year" period, and certificates have been given to the product suppliers for a	Beijing Municipal Commission of Development and Reform publish the technologies who have met the relevant criteria on its official website, and then distribute it to relevant departments, institutions	Zhejiang Commission of Economy and Information Technology publish the catalogue on its official website. The catalogue is distributed to local

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	Economy and Information Technology and various industrial associations in order to promote energy efficiency and the use of the catalogue.	Rural Development at all levels to award licenses to technology suppliers. The MOHURD lead the promotional activities such as exhibitions.	validity period of two years. After two years, manufacturers can reapply to remain in the catalogue if they still meet the criteria.	and state-owned enterprises. It also manages the promotional activities mainly in the form of exhibitions and online publications.	governments at all levels, and is embedded in their procurement processes. The Zhejiang Commission of Economy and Information Technology also takes the lead in promoting the catalogue. The main forms of promotion are exhibitions and online publications.
Effect	Since its creation, the catalogue has attracted extensive attention from the industrial sector. It has become an important tool for energy-intensive enterprises to aid the selection of products, and an important means for manufacturers to promote their products.	The catalogue was released at the beginning of the 12th Five-Year Period, which provided a strong support for China to vigorously promote the energy-saving transformation of existing buildings during the 12th Five-Year Period. Although some technologies in the catalogue are outdated, the catalogue still has great influence in construction industry.	Due to the fact that the catalogue has been in use since 1995, it has established influence in the transportation sector and plays an important role in promoting technological advancements in transportation in China.	Since its publication, the catalogue has been highly valued by the government of Beijing, Tianjin and Hebei. It has become an important tool to promote energy conservation, emission reduction and air pollution control in Beijing, Tianjin and Hebei.	Since its publication, the catalogue has been highly valued by Zhejiang Province and has become an important means for Zhejiang Commission of Economy and Information Technology to promote energy conservation and emissions reduction. Some local governments have also used the catalogue in their procurement processes.

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Overall Assessment (experience and lessons learned)	This Catalogue is the best-known catalogue in China's industrial field, and it plays a significant role in promoting the application of boilers and high-efficiency motors and other general equipment in China and promoting the country's energy saving and emission reduction goals. However, the lack of effective publicity, promotion methods, follow-up management, and specific fiscal and tax incentives, results in the fact that the promotion of the catalogue is not as widespread as it could be.	This Catalogue is well-known in the field of construction in China, which has comprehensively promoted building energy conservation during the "Eleventh Five-Year" and "Twelfth Five-Year" period because of the large demand for technologies in the Catalogue. In recent years, the technologies in the field of building materials and construction are increasingly mature, and the cost effectiveness has become the more important factor influencing the material selection decision. So, the Catalogue has not been updated since the first version.	This Catalogue is a well-known and longest running catalogue in China's transportation industry. The type of products featured in the catalogue are relatively limited, mainly including vehicle oil additives, environmental protection and mechanical devices, with the core automotive components not covered. This Catalogue grants certificates to the product suppliers which is more helpful for market promotion compared to its counterparts.	This Catalogue evolves from "Beijing Energy Conservation and Water Saving Technology Catalogue" to promote energy conservation and emission reduction in the Beijing-Tianjin-Hebei region. The Catalogue collects technologies across the whole country, aiming to promote energy conservation and emission reduction as well as technology application. The Catalogue is more specific to the target market and uses multiple publicity approaches, so the technologies in the Catalogue are relatively better promoted compared with others.	The Catalogue is more focused on promoting energy conservation and emission reduction in Zhejiang Province, which also contains some advanced foreign technologies. Since the catalogue has a clear target market and has been high valued and promoted by the local government, the technologies and products included in it are better promoted in Zhejiang Province.

3.3 Gap Analysis of China Catalogue

Barriers to Energy Efficiency Technology Promotion in China

China has promoted energy-conservation since the 1980s achieving significant outcomes, however there are still some barriers to the promotion of energy conservation technologies. Here are common problems and obstacles faced by different industries as follows:

- **From a policy perspective, current EE technology promotion related policies in China are mostly at a macro-level.** Also, the unclear promotional channels and organizational entities, as well as limited information exchange and broadcast channels significantly hamper the effective promotion and uptake of advanced EE technologies in China.
- **The slowdown of Chinese economic growth affects the motivation of enterprises in energy-saving retrofit.** Affected by the decline of economic growth, steel and iron, construction materials, petrochemical and other industries are faced with overcapacity and have arduous restructuring tasks, which lead to poor economic returns. This results in a limited budget for energy conservation investment and lack of drivers for energy-saving technical retrofit. Also, the slow development of the energy-saving service industry supporting the energy intensive industries also limited the investment in and promotion of energy efficient technologies.
- **Reduced financial support for energy-saving technical retrofit.** In recent years, Chinese government has paid more attention to eliminating backward capacity with supporting policies and fiscal incentives, while the funds for energy conservation have been reduced year by year due to the limited efficiency of the subsidies and burden to government budget. Therefore, it is more difficult for enterprises to obtain incentive funds on energy saving projects. In addition, private enterprises, especially SMEs, have more financing challenges because of this increased difficulty accessing subsidies as well as higher financing cost compared with state-owned enterprises.
- **The potential technical risks hinder the adoption of new EE technologies by enterprises.** The uncertainty of potential users about the maturity and economic benefit of EE technologies compared with the traditional ones directly affect the decision of enterprises for adopting the technologies. And as the technical retrofit projects might affect the safe and stable operation of the entire production line, both the Designers and the Owners prefer the safe traditional technologies rather than the new ones to avoid the potential risks. In many cases, the lack of knowledge and information on EE technologies makes some enterprises hesitant to invest in these technologies, even though they are actually mature and stable enough.
- **There is a need for increased awareness of energy efficiency in businesses, although it has improved in recent years.** With short term financial performance having a high priority and increased pressure for profit, as well as the day to day imperative of producing products or supplying services, the attention and resources devoted to energy saving activities is limited. In addition, many enterprises lack the resources for effective energy management, e.g. lack of professional management personnel and lack of knowledge of EE technologies, impeding the adoption and investment in these technologies.
- With fewer "low hanging fruit" due to the progress of energy conservation work in the past years, **it has become more difficult to do energy conservation work than previous years** considering the higher costs and more complicated technologies**.** To further promote energy efficiency improvement, enterprises often need to upgrade their production lines or invest in more advanced EE technologies, which requires greater investment and expertise.

Gap Analysis of the Catalogue

To promote energy conservation and emission reduction, the ministries and provincial governments have developed and published various technology catalogues to promote application of energy saving technologies. We have analysed the *National Key Energy-saving Technologies Promotion Catalogue above,* which is one of the most influential catalogues in China. An in-depth gap analysis of the Catalogue has been described in this section.

Technology Collection and Application

The technology collection and application process are very complex, involving several organizations, with limited time for manufacturers to prepare the required documents. The technology request is officially released by the NDRC and issued to provincial governments, and then to municipal governments and finally to the enterprises. In turn, the submissions from manufacturers also need to pass through various levels of government agencies and finally to NDRC, which is time consuming. In addition, the submission period between the request release and the deadline is usually only one month. Considering the time spent for the flow of the request and submission documents through each organization into consideration, the time left for manufacturers to prepare the required documents is very short.

In addition, the technology application window for the Catalogue update is not fixed every year, and can fall in any month. This hinders manufacturers who are unable to plan in advance to prepare for the annual updates and prepare their required documentation.

There is a lack of motivation and guidance for companies to submit applications. The request document only contains a very high-level description of the technology scope and application form, without description of the objective of the catalogue, nor guidance for applicants. The document neither states the important role of the Catalogue nor the benefits for the manufacturers. Also, except for the request document, there is no other materials designed to attract or guide companies to submit technologies.

Technology Evaluation and Screening

The assessment criteria, screening criteria and process lack transparency. There are no clear and detailed criteria for each industry, and only general principles for some entry requirements. The evaluation process is highly dependent on the knowledge and experiences of experts in each industry. Though it might be more flexible and specific for each submitted technology, it leads to lack of transparency and makes it hard for manufacturers to submit eligible technologies. Besides, there are no public channels to obtain the information of the screening process and the related organizations / institutions engaged in the process and their roles. Therefore, the fairness of the assessment for annual update might be questioned and the credibility of the Catalogue might be influenced.

The requirement that the annual energy saving potential of the technology must reach 100,000 tce (based on an estimated market penetration ratio), **limits the main customers to large enterprises due to the high capital investment for most technologies**. It's harder for SMEs to use the Catalogue as a reference to select high-performance technologies. In addition, there are more technologies in energy-intensive industries in the catalogue, with few technologies for other sectors.

The technologies in the Catalogue are selected on a merit-based system. The number of technologies featured in each industry is usually limited to three/four per year, meaning that some high performing technologies might not be featured in the Catalogue for several years, despite meeting the requirements.

Content of Catalogue

The technical report in the Catalogue contains 8 parts, and approximately 1500 to 2000 words in total. This makes it difficult to clearly describe the complex technologies. In addition, some of the early report descriptions are relatively basic and not particularly informative.

As a technology list, there is no information of the technology/product suppliers in the Catalogue, which is the practical reference for customers to select suppliers in the market. Since the eighth batch of the Catalogue, the name of technology supplier is only mentioned in the application case study section in the technical report of the Catalogue.

Some technologies are also included in catalogues established by MIIT, MOHURD, MOT, MOST. However, due to the different focus, evaluation criteria, and presentation of each catalogue, the lack of coordination among different ministries result in varied technical descriptions of the same technologies in different catalogues.

The technologies in the Catalogue are listed one by one without classification, making it hard for the customers to find the technology they need.

Supporting Policy and Fiscal Incentives

The policies related to energy-saving technologies issued by the Chinese government are mainly macro-level policies, lacking specific promotion and implementation plans. At present, there is no supporting policy directly related to the Catalogue. Also, the Catalogue is rarely mentioned in other policies related to energy efficiency.

The government has not issued any specific fiscal incentives to support the promotion of technologies in the Catalogue. Though they have been involved in some general fiscal incentive policies, there is no clear indication that the technologies in the Catalogue have priority.

Catalogue Promotion

The energy-saving technology information exchange and transmission channels are also relatively limited, which largely restricts the effective promotion and application of China's advanced energy-saving technologies. Currently, the Catalogue is only promoted through NECC, industry associations and other social organizations mainly through the distribution of the Catalogue, exhibitions and training sessions.

The National Development and Reform Commission does not award any honorary title to the enterprises with selected technologies, so they do not have “certification documents” with which they could promote their products and the Catalogue. This also leads to the problem that some enterprises with inferior technologies also claim they can provide the technology listed in the Catalogue.

Tracking and Reporting

There are currently no official tracking or regular assessments of the effects of the Catalogue once a technology has been featured. There are seldom in-depth research or literatures describing the impact of the Catalogue. It is unclear whether the Catalogue plays the expected role and whether it is widely promoted. Therefore, it’s hard to identify effective improvements, and to further design promotional activities and develop specific supporting policies and fiscal incentives.

Recommendations on improving China Catalogue

Technology lists have proved to be a useful and important tool to simulate market transformation in terms of energy efficiency, especially for the standardised equipment and components. Technology lists can reduce the transaction costs for both purchasers and manufacturers as well as avoid the

technical risks. Also, they can be linked with fiscal incentives to expand the impact and to overcome the financial barriers for EE technology investment. Although the China Catalogue is focused on the most advanced technologies with large emission reduction potential rather than standardized general technologies, it has still played a very important role in past ten years on energy conservation especially for energy-intensive industries.

Usually government-backed lists have an intrinsic value in that they lend themselves to **addressing long-term economic rather than to short-term competitive impacts**. They enable government to encourage specific market developments.

4.1 Principles and Recommendations

Content

- **Achievable ambition**: **Ambition needs to be far enough ahead of current practice to affect transformation, as well as allow enough technologies or products on the list.** This means setting performance standards that are high enough above current market standards to accelerate improvements, but not so high that the list becomes irrelevant and inaccessible to local markets;
- **Responsive to market dynamics**: In order to maintain effectiveness over a period of time, the China Catalogue must be capable of responding dynamically to changing market conditions, (e.g. tightening performance requirements or removing technologies), and **needs therefore to be updated at regular intervals based on a clear set of criteria**. Sufficient movement in the technologies on the Catalogue is critical for the proper functioning of the scheme. This includes tightening criteria at the right time, increasing investment amounts, removing technologies or products and adding new technologies or products;
- **More comprehensive**: With the Catalogue as a competitive list, only the top three (or four) advanced technologies for each category can be added into the Catalogue every year. It's better to expand the selected technologies and ensure all energy efficient technologies meeting the requirements can be featured in the Catalogue. Also, we recommend the addition of low-cost technologies to the Catalogue, which are more accessible to SMEs and would result in a wider potential customer base;
- **Greater inclusivity**: The Catalogue can be used more widely by including all products along with the corresponding manufacturer information that meet the criteria for each technology. The purchasers can select products directly through the Catalogue and the manufacturers would be able to use it as a marking tool and promote their products on the Catalogue to potential customers;
- **International reach**: By including more international technologies and products, the Catalogue could feature more technologies and increase the uptake of energy efficient products.

Management

- **Accessibility**: Increasing the accessibility of the Catalogue to both manufacturers and purchasers is key to improving the quality of the Catalogue and usability of the product. The technology request and submission process should be simplified and more straightforward. For example, moving the Catalogue and related materials into an integrated online platform would make it easier to be used more widely;

- **Transparency:** By increasing the transparency of the management and evaluation processes, manufacturers and purchasers can better understand the high standards required by the Catalogue. A clear and structured evaluation process can help manufacturers in their applications by understanding the timings of updates to the Catalogue. Also, it's easier to supervise the process and improve the credibility of the evaluation process as well as the Catalogue.

Technological Evaluation

- **Establish clear criteria**: By establishing clear criteria for assessment the Catalogue can establish HEPS and raise the industry bar for energy efficiency standards. The creation of definable criteria will also encourage further applications by manufacturers for inclusion on the list, due to the fact that they can evaluate whether they will be accepted based on the criteria and can guarantee a return on their resources and time investments. It would also help to improve the credibility of the Catalogue.

Supporting Policy and Fiscal Incentives

- **Supporting policy:** Policy support plays an important role in promoting EE technologies in China. The Catalogue can be involved in key energy conservation related policies and combined with other government-led energy saving initiatives, used as a trusted technology source. With the emphasis on national policies, the Catalogue will draw a lot of attention from local government agencies and businesses;
- **Financial mechanisms**: As there are currently no financial incentives linked with the Catalogue in place, it is an important tool to increase the uptake of energy efficient products. These will be explored further in Part 2. It will also be helpful to develop direct link between the Catalogue and current fiscal incentives.

Promotion

- **Reinforcement:** Market transformation is a complex process, which requires a package of different energy efficiency interventions applied together. There needs to be a higher degree of promotion of the Catalogue to ensure uptake, such as developing supporting policies and fiscal incentives, mobilizing more professional stakeholders and making it more accessible to businesses;
- **Networks:** It is advisable to build a network of key stakeholders from industrial associations, relevant third-party institutions and enterprises, and to link the Catalogue to already established networks. This will be mutually beneficial as the industrial professionals can feedback regarding the Catalogue and improvements that would help them, while at the same time these networks can function as a marketing tool for the Catalogue;
- **Procurement:** Companies as well as public entities are encouraged to embed the Catalogue into their procurement processes to ensure their business buys energy efficient products. By using the Catalogue, which includes details of each technology's energy efficiency, businesses will reduce the time it takes them to select new equipment and ensure that they are investing in high performing products;
- **Marketing:** Further marketing of the Catalogue is required to encourage investment in energy efficient technologies and increase use of the Catalogue, with more flexible and attractive channels and materials. A variety of online tools are available to promote the Catalogue once it has been digitised and further promotion of the list can be carried out through various events and workshops.

Tracking and Reporting

- **Reporting and evidence:** The development of tracking and reporting tools is key to improving the Catalogue and evaluation process. The digitisation of the Catalogue will provide data on the Catalogue's users, both purchasers and manufacturers, which can be used to improve and streamline their user experience. Independent third-parties can be engaged to conduct evaluation on the effect of the Catalogue and provide recommendations for improvement.

In addition to the above, we recommend that:

- **A good proportion of the budget is ideally allocated to technology and market intelligence**, i.e. to technical intelligence projects for instance. Intelligence is used to set progressively ambitious, but reachable, EE performance targets, as well as to develop corresponding criteria for different industries. This approach stimulates waves of product innovation by manufacturers in the long term.
- **More support should be given to SMEs for investing in energy efficient technologies.** SMEs usually face more challenges around energy efficiency improvement such as higher financing costs and limited knowledge and experience compared to large state-owned companies. By featuring more technologies suitable for SMEs in the Catalogue combined with fiscal incentives, SMEs will be more encouraged to invest in energy efficient products.
- **The Catalogue should coordinate with other catalogues and energy efficiency standards for industrial equipment.** China also has energy efficiency standards for some general equipment such as boilers and heat pumps, with performance criteria for different efficiency grades. The standards are also designed to remove the outdated equipment and promote high-performance equipment. This will make it easier for manufacturers to improve their products to achieve multiple energy efficiency standards in conjunction with fulfilling the criteria specified in the Catalogue.

4.2 Practical Next Steps

To improve the Chinese Catalogue and further fulfil its potential, the following practical steps can be considered:

Relaunch the Catalogue. The Catalogue, which is usually updated annually, was not updated last year for the first time in 10 years, due to an institutional restructure. As the Catalogue has been widely recognized as a useful tool to promote the market transformation of energy efficient technologies, the Catalogue will need to be redesigned and relaunched. The Catalogue should continue to promote high-performance technologies and products in China, aligning with China's vision of an ecological civilization.

Expand the scope and content of the Catalogue to amplify its audiences and impacts. Replace the merit-based approach with an eligibility-based approach, which is based on a set of clear criteria and ensures that all technologies meet the requirements to be listed in the Catalogue. In the past, most technologies featured in the Catalogue were solely used in energy-intensive industries which required large capital investments. With economic developments and market changes, we suggest broadening the range of featured technologies and paying more attention to the light industries, construction and transportation sectors.

Include information on all relevant manufacturers of products featured in the Catalogue. With the current Catalogue, users still struggle to find the products in the markets. It's better to include information on both the products and the manufacturers for each technology. In order to facilitate

this, we suggest developing clear requirements such as testing standards and third-party certification for products. It can be run by a third party under the commission of the government. To reduce liability for recommending certain products, the Catalogue should clearly state that only the energy efficiency of the products has been independently tested and verified, while responsibility for the overall performance lies with the manufacturers and installers of the products.

Develop a user-friendly online platform, with key functions to display the technology, product and manufacturer information, receive application submissions and search for eligible products. The platform should be designed to increase the accessibility of the Catalogue for both manufacturers and purchasers. All key information regarding the Catalogue should be easy to find on the platform, such as the request document, the criteria, application guidance and case studies. The manufacturers should be able to follow a straightforward process to submit an application and check the progress of their applications online. Products should be easy to find through the platform's search function. The platform can be developed and run by a third party selected by the Chinese government.

Update the current principles and criteria with more quantitative indicators. Some internal common criteria can be considered, such as requiring high performance products with low market penetration. For example, the criteria should specify that only products in the top 10-15% for energy efficiency can be featured on the Catalogue, as opposed to the current criteria of absolute energy savings. Detailed criteria for each industry should be developed to improve the transparency of the assessment and motivate more manufacturers to apply to be featured in the Catalogue. Also, the criteria should be updated regularly to ensure it is reflective of the current market and highest standards.

Design fiscal incentives or link current incentives with the Catalogue. Financial support is one of the most important drivers for investment in energy efficient products. Well-designed mechanisms have significant leveraging effects, increasing private investments in this area. This will need to be coordinated between different government agencies. These recommendations will be explored further in Part 2.

Increase the promotion of the Catalogue through multiple channels and networks. The Catalogue requires further promotion in order to gain greater influence in consumers' purchasing decisions and to realise the wider goal of increasing energy efficiency. Several measures can be considered to accelerate the promotion:

- Firstly, the Government should consider the Catalogue when design energy efficiency related policies or initiatives, highlighting its importance as a trusted source of information on energy efficient products;
- Secondly, encourage public agencies as well as businesses to embed the Catalogue into their procurement process;
- Thirdly, engage with relevant established third-party networks, such as industrial associations, to support the promotion of the Catalogue and the uptake of energy efficient products;
- Promotional and educational materials should also be developed and spread through different channels, including social media;
- Case studies should be gathered from manufacturers and purchasers in order to advertise the potential energy and cost savings that can be achieved through adopting products listed in the Catalogue.

Allocate budget for tracking and assessing the impact of the Catalogue. The tracking and reporting can usually be conducted by independent third-parties. A digital tracking and reporting tool also can

be designed to collect information from manufacturers and consumers. Based on the evaluation, the improvement recommendations can be proposed to update the Catalogue.

Part 2: Fiscal instruments and financial measures to promote energy efficient products and Energy Technology Lists

Introduction

1.1 Why do we need finance to promote energy efficient products and technologies?

Economic instruments to foster the deployment of energy efficient (EE) products and technologies encompass those policy instruments that relate to fiscal, financial, and other economic incentives and disincentives. For the purpose of this research we focus our attention on fiscal instruments and financial measures only. Examples of these types of financial instruments can be seen in Figure 7 below.

Table 7. Economic instruments for fostering energy efficiency

Economic instruments for energy efficiency		Description	Reflections
Fiscal incentives	Tax incentives	These might be in the form of tax breaks, tax discounts, accelerated tax relief and tax depreciation.	Tax incentives require the involvement of governments. The involvement of governments can provide greater acceptance of energy efficiency schemes and an increase in the uptake of energy efficient products.
	User charges	A charge imposed, usually by a public authority, on the use of resources, services or infrastructure. The provision of these services is in part financed by the user charges.	Increasing user charges for resources can provide a financial incentive for reduced consumption.
	Subsidies	A form of government incentive, which is a financial aid issued to support policies.	Financial support through subsidies can reduce the financial burden on purchasers, enabling them to invest in high performing products which are usually more expensive than market average.
Financial measures	Credit line/ loans	Injection of capital from a donor, multilateral development bank (MDB), government or private institution, to a financial intermediary who is able to on lend to their clients. Provides a ring-fenced source of capital that incentivises lending, particularly when provided at concessional rates or when facilitating unsecured lending.	On-lending often requires a well-established financial sector. It needs a strong, stable banking sector with relationships with the target market and across the supply chain. It requires technical assistance throughout supply chain – a lack of lending is not always due to lack of available capital.
	Insurance	A contractual obligation for SMEs to be reimbursed if the performance of the technology is below set	Insurance can mitigate high perceptions of risk on the behalf of financiers (like a guarantee) and end-users (unlike a

		expectations. This could underpin the guarantee of repayments for unfamiliar technologies such as some used to deliver higher energy efficiency.	guarantee). It encourages banks and consumers to invest in upgrades with longer payback periods and/or that could involve high upfront.
	Guarantee	A mechanism that acts as a reserve for losses incurred by financiers lending to relevant projects. This is often provided for a premium that the beneficiary has to pay. The presence of donor funds may enable the facility to be provided at a concessional rate or underwrite the first losses with grant finance that expects no return.	A guarantee needs careful design to ensure it is effective at de-risking energy efficiency ventures. Concessional terms facilitated by donors are often crucial to success. It is effective for incentivising lenders in markets where energy efficiency is not familiar. Prior capacity building in energy efficiency will improve the effectiveness of the guarantee. It requires strong and liquid banking sector to provide its own credit. It must be simple – cost and requirements can be onerous and off-putting for banks.
	On-bill financing	Integrating investment costs with pre-existing bills, where energy savings prevent the former exceeding the latter over the payback period.	Hassle-free regular repayment plan that can be subsumed into normal energy bill or tax payments – supporting take-up. Trust in institutions providing finance is important for ensuring participation.
	Leasing (operating and capital)	Operating lease: Contract for using an asset – ownership responsibilities lie with lessor (rental). Capital lease: Contract for using an asset where ownership responsibilities effectively transferred to lessee.	Generate demand for investing in energy efficiency and for accompanying finance. Can offset effect of energy subsidies (which dampen interest in energy efficiency).
	ESCOs	Companies that provide customers energy savings solutions that pay for themselves (and provide a return to the ESCO) through the savings on energy bills they generate. The ESCO typically guarantees the performance of energy efficient solutions and may or may not provide customers directly with finance for the investment.	The ESCO model is best suited to sectors with large and consistent energy bills– for example, municipalities or large energy intensive industries. In contrast, for SME markets with their relatively small, less predictable energy bills ESCOs are less suitable.

			ESCOs often lack their own collateral, preventing them accessing debt financing for growth. The inherent unfamiliarity and complexity of their business model to end-customers can also limit take-up.
	Unsecured lending	An example of unsecured lending is a revolving fund. Any repayable investment vehicle whereby the repayments and/or proceeds of initial investments are reinvested in further eligible projects.	Can magnify the amount of capital injected into the market, particularly if combined with criteria limiting the term of individual investments. Can lead to the market being dominated by, or reliant on, the revolving fund entity rather than building broader capacity in the financial sector or technical supply chain.
Market-based Instruments	Carbon pricing (white or green credits)	A cost applied to carbon pollution to encourage polluters to reduce the amount of greenhouse gasses they emit.	It encourages lower-carbon behaviour and raises money that can in part finance green projects.
	Emissions trading schemes	A market-based approach to controlling pollution by providing economic incentives for achieving emissions reductions.	Polluters are required to pay for their emissions and the less polluting organisations are rewarded for their resource efficiency as they are able to sell their emissions credits.

Financial incentives have been widely seen as effective in addressing a number of **barriers that impede energy users from purchasing more energy efficient products**. These barriers are:

1. **Access to finance**
   Energy efficiency financing represents a relatively small and non-conventional niche business, compared to, for instance, infrastructure financing. It is also often perceived as riskier and there is therefore a lack of capacity or inclination to invest in energy efficiency in the supply chain or local financial sector. A shortage of suitable mechanisms to address the various risks of industrial EE projects, coupled with little experience in financing such projects, constrains banks from providing credit in a systematic and large-scale way for industrial EE projects. China's slowing economic growth creates even higher barriers to EE financing.
   Potential Incentives: insurance, guarantee, leasing, ESCOs, revolving fund

2. **Capital intensity and low return on investment**
   As indicated in Part 1 of the report, most ETLs are set up to encourage high energy performance products (HEPS) that only have limited market share and are less competitive than their market counterparts. Traditionally energy users would aim for products with lower upfront costs and ignore differences in improved environmental credentials. Increasingly users consider the potential energy saving effects of adopting new technologies or equipment. The main barriers remain high upfront costs, long pay-back periods and uncertain returns. Financial incentives play a key role in scaling-up nascent markets and helping end users to overcome the lack of upfront capital.
   Potential Incentives: credit lines/loans, tax relief, subsidies, grants, on-bill financing

3. **Awareness and commitment**
   Technical assistance such as capacity building and personnel training activities are key to most EE projects. Technical components are instrumental in helping energy users adopt higher energy saving technologies. This is because many energy users (especially SMEs) have knowledge gaps and struggle in evaluating their energy saving potential and the cost-benefits of adopting products listed on ETLs. Gaining such information and skills can motivate energy users to use ETLs in their purchasing decisions. The same holds true for local financial institutions and in particular loan and trade departments within banks. Financial institutions may be reluctant to finance energy efficiency projects that are unfamiliar to them and especially so if the lending is to a higher credit risk group such as SMEs, which often lack a track record of successful borrowing and repayment and/or lack collateral. Greater information mitigates the real and perceived technology risks.
   Potential Incentives: grants, ESCOs, subsidies, tax relief, guarantees, leasing

4. **Technical solutions and expertise**
   The lack of skills and standardization across projects including assessments, installation, monitoring & verification can be a further barrier to energy efficiency. Capacity building in this area, accreditation of technologies and suppliers and standardization of the procedures can work to overcome this barrier. Introducing technical regulations for equipment and energy consuming systems and trusted technology/product lists can improve the uptake of energy efficient products.
   Potential Incentives: white certificate schemes, subsidies

1.2 What is the link between financial incentives and technology lists?

By pre-defining eligible products in an ETL, the subsequent financial approval process can be streamlined. This helps to reduce administration and transaction costs, because the assessment of whether a particular technology meets the efficiency requirements is completed prior to and independently of the financial incentives in order to add the product to the list. Therefore, it doesn't have to be repeated each time a financial decision is made. This helps a fiscal programme to be rapidly scaled up and allows financial decision makers to take immediate action when allocating resources. For example, consumers who purchase products listed on the UK ETL have to have proof from the manufacturer that the product was listed at the time of purchase. This allows them to claim for an ECA without the need for further assessment of the product.

The impact of technology lists can be expanded if coupled with fiscal instruments and financial measures to enable purchase of EE products at times when financial barriers otherwise inhibit action (as described earlier). The use of innovative financial instruments and mechanisms can help address the risks associated with financing and help leverage private finance for EE projects. This could open the door for private sector investment by creating options to present investment opportunities in an attractive risk–return package. Fiscal incentives that lend themselves to working with ETLs include subsidies, tax reliefs, grants and tariffs. Increasingly we see other fiscal incentives such as credit lines linked to ETLs.

Table 8. Type of financial mechanisms that lend themselves well to ETLs

Type of Financing	Mechanics	Leverage created by	Evidence of Success
Credit lines	Credit lines address the limited liquidity in EE markets, increasing the willingness of financial institutions to lend to, and end-users to invest in, EE projects	EBRD Technology Catalogue	Under GEFF Programme, over €4.5 billion of finance been provided a network of 130 local FIs across 26 countries since 2006, with 9 million tonnes of CO_2 expected emissions avoided annually. The new Technology Selector platform launched in 2018 is designed as an important mechanism supporting the climate finance.
Tax reliefs	Tax breaks give incentives to invest in EE projects or equipment through providing tax rebates related to the amount invested	UK ETL The MIA and Vamil schemes ACA Triple E Product Register Basque technology list	The ETL and ECA scheme has resulted in the abatement of 88 million tonnes of CO_2 since its creation in 2001.
Subsidies	Subsidies and grants are disbursed to lower the price of an investment, i.e. reduce capital costs	Ecology Premium Plus Basque technology list	EP Plus has strong multiplier effect on mobilizing green investment, with over €101 million investments has

			been mobilized in 2017 with €16.4 million grants. Through tightening the criteria, the mechanism can leverage the green investments effectively.

1.3 Framework to assess financial mechanisms linked to lists

For any financial incentives to better support ETLs, it is critical that: 1) **the financial mechanism is clearly defined and well understood**; 2) **fundamental market and policy drivers well-aligned with the mechanism are in place**, and if not, efforts are needed to strengthen them; 3) **the supply chain to deliver energy efficiency is mapped**, and barriers across the supply chain are analysed comprehensively and prioritised; 4) mechanisms are developed with technical solutions implemented in concert**;** 5) steps are taken so that once public support ends, the supply of, and demand for, finance for energy efficiency continues. To this regard we have assessed the international case studies as well as the China Catalogue, according to their: **integration with ETLs, targets, management, transparency and predictability, drivers, supply chain, impact and sustainability**.[29]

Our assessment framework with sample questions we answered for each of the finance mechanisms linked to catalogues is provided in Table 9 below.

Table 9. Assessment Framework for financial mechanisms and incentives

Assessment criteria	Sample questions to be answered
Rationale (integration with ETLs)	- What is the main barrier the mechanism intends to address? - When was the mechanism established? - Has the focus of the mechanism changed over time? - How does it link to the energy technology list or catalogue?
Management	- Who designed the mechanisms? - Who funds/ manages/ administers the mechanism? - Who else is involved in promoting the mechanism? E.g. industry associations, local financial institutions - What is the scale of the scheme? E.g. total amount of subsidies/rewards issued
Transparency and Predictability	- Are the requirements to benefit from this scheme clear? - What are the main procedures for market players to benefit from the mechanism? - Are there effective monitoring and evaluation procedures to identify who is benefiting from the incentives and in what way?
Drivers	- Are there other policies supportive of the financial mechanism? E.g. is it linked to other policies/ being referred to or signposted? - Are there any market drivers that favourable the financial mechanism?

[29] Based on a Carbon Trust EE financing report: Available, Attractive, Too slow.

Supply chain	- Are financial intermediaries e.g. local banks, leasing companies, utilities playing a role in the mechanism? - Are suppliers and equipment and service vendors e.g. ESCOs playing a role in the mechanism?
Impact	- What have the main effects of the mechanism been? E.g. trade, emission reduction effect - Have there been any impact assessments done? - What are feedbacks, assessment, comments on the overall functioning of the incentive? E.g. comments issued by third parties/ interviews
Sustainability	- Can the mechanism lead to additional investments? E.g. can it be coupled with other incentives? - Does the mechanism have the potential to lead to follow-on programmes?

International best practice/ case studies

The following pages elaborate on the international case studies presented in Component 1, by focusing the attention on the financial incentives linked to the ETLs. We present the case studies according to the type of financial mechanism they can be linked back to (as per Table 8).

The analysis evaluates the case studies through the lens of our framework outlined in Table 9 above, before making recommendations on how best to employ these instruments and the required accompanying technical assistance needed in a Chinese context.

Geography	UK	The Netherlands	26 countries in Europe, Africa and Asia	The Flemish Region of Belgium
Instrument	**Enhanced Capital Allowance (ECA) Scheme (Tax credit)**	**The MIA and Vamil Schemes (Tax reduction)**	**Green Economy Financing Facilities (GEFFs) and Sustainable Energy Finance Facilities (SEFFs) (Credit lines)**	**Ecology Premium Plus (Subsidies)**
Rationale	Financially incentivise the use of energy efficient equipment by providing customers with a cash flow boost, allowing purchasing business to write off 100% of the qualifying costs of the eligible plant and machinery.	Based on the Environmental List, the schemes provide tax breaks to encourage business to purchase environmentally friendly technologies, thereby simulating the dissemination and market penetration of these products.	The EBRD extend credit lines to local partner financial institutions (PFI) for on lending to business and homeowners so they can invest in higher performance climate and environmental technologies.	The government provides subsidies to companies, resulting in a reduced initial cost of products and an improved return on the ecological investment.
Management	Managed by the UK Department for Business, Energy & Industrial Strategy (BEIS). All claims for ECAs are administered by Her Majesty's Revenue and Customs (HMRC).	Principally led and funded by the Ministry of Finance and the Ministry of Infrastructure and the Environment. Administered by Tax and Customs Administration, with technical support from Netherlands Enterprise Agency (RVO).	Supervised and controlled by EBRD in-house staff. Specific tasks are carried out by local implementation teams with the support from consultants.	Managed and controlled by the Agency for Innovation and Entrepreneurship (VLAIO).
Transparency and Predictability	NAO criticized that the ECA mechanism lacks transparency. Approximate figures of ECA claims are released by HMRC. However, the figures are not separated by technology, manufacturer or any other factor.	The process is straightforward. A combination of targeted and random inspections is used to prevent fraud and misuse. RVO and/or one or more involved ministries assess the environmental benefits.	The procedures are simple, and credit decision-making processes are fast, attracting sub-borrowers. The link to the Technology Catalogue and Selector simplifies the eligibility assessment and reduces the transaction cost for all parties. Verification consultants verify the use of	The relevant requirements, criteria, and application and payment procedure are clearly listed on the VLAIO website, ensuring a high level of certainty and transparency. All applications must be made online, and require the investment to be independently checked.

			funds and the energy savings achieved.	
Drivers	The scheme is part of the UK government's plan to reach the target reduction of greenhouse gas emissions by 30% by 2020/21, compared to a 2009/10 basline. The government has also issued other supporting policies, including Energy Performance Certificates (EPC), energy labels, smart meters, and energy audits.	In the coalition agreement 'Confidence in the future', the Dutch Cabinet set out its aim to achieve an emission reduction of 49% by 2030. The schemes contribute to this target.	EBRD's internal policies and strategic frameworks such as Sustainable Energy Initiative (SEI), the political willingness to tackle climate as Eastern Europe's political desire to align with EU directives and regulations, similar market barriers for energy efficiency investments in some middle- and low-income nations.	The main policy drivers for EP-Plus include the European 20-20-20 targets and the Flemish Climate Policy Plan.
Supply Chain	The ECA has had positive effects by encouraging energy-users to adopt ETL-listed products, resulting in a shift in the supply chain.	Technical and equipment suppliers are encouraged to submit proposals for new environmentally friendly technologies to be added to the next Environmental List.	Liquidity in energy efficiency markets is encouraged by credit lines that are provided at commercial rates by the EBRD. Significant technical assistance is provided to financers and the target market for project identification, assessment and verification.	Technology and equipment suppliers can help their clients to access the subsidies, which in return stimulates their business.
Impact and Sustainability	The mechanism has enabled the abatement of approximately 88 million tonnes of CO_2 since the creation of the ETL in 2001. It is estimated the scheme has supported approximately £500m	The schemes have succeeded in redirecting investment in assets towards the environmentally friendly alternatives, with a large multiplier effect.	Since 2016, the EBRD has provided over €4.5 billion for business and households through a network of 130 local FIs across 26 countries. According to a special report, the SEFFs have had a positive impact on investment	From 2011 to 2017, around €130 million has been granted to companies to support their investment in environment, energy saving and renewable energy products. Huge private

	of energy efficiency investments each year.		in energy efficiency and renewable energy.	investment has been mobilized by the subsidy.

2.1 Tax Breaks

Tax breaks can greatly reduce a taxpayer's liability and provide savings through tax deductions, tax credits, tax exemptions and other incentives. Tax reliefs are applicable to the purchasers of plant and machinery equipment specified on technology lists:

- **Tax deductions** are expenses that can be subtracted from gross income to reduce the taxable income of taxpayers;
- **Tax credits** reduce taxpayers' tax liability dollar-for-dollar and have a greater impact than deductions, which only reduce the amount of income subject to taxes; and
- **Tax exemptions** occur where a tax for a certain item or type of income is reduced or eliminated. This form of tax break allows enterprises to exclude a portion of income from taxes or exclude certain types of income from their tax return.

UK ETL: Enhanced Capital Allowance (ECA) scheme (Tax credit)

Rationale (Integration with ETLs)

The ECA scheme financially incentivises the use of higher energy efficient equipment to help the UK transition to a low-carbon economy. The scheme was born out of the Climate Change Levy (CCL) Package and addresses businesses' request for a fiscal incentive to redistribute CCL payments. Available since 2001, it encourages businesses to invest in energy-saving equipment.

There are three key features for ECAs: (1) all businesses are able to claim ECAs, regardless of size, industrial or commercial sector or location as long as they pay UK corporation tax; (2) ECAs permit the full cost of the investment in specified technologies to be relieved for tax purposes against taxable income of the period of the investment; (3) qualifying technologies have to meet defined energy efficiency criteria and be listed on the UK ETL. This financial incentive provides customers with a cash flow boost by allowing purchasing businesses to write off 100% of the qualifying costs of the eligible plant and machinery against the taxable profits in the year the investment is made (Figure 8).

Figure 8 Worked example of an Enhanced Capital Allowance

Scenario A	Scenario B
You spend £10,000 on a new electric motor and claim standard capital allowance, at the 18% rate, and pay a 19% corporation tax. Savings: under this scenario, the tax relief would be £342 in the first year. Further tax relief could be claimed in subsequent years.	**You instead decide to invest in a higher efficiency motor listed on the ETL and therefore claim ECA** Savings: under this scenario, the ECA gives an immediate one-off 100% of the available tax relief of £1,900 that year. In other words, an ECA can provide a cash flow boost of £1,558 for every £10,000 you spend in the year of purchase, with no need to claim further relief in future years.

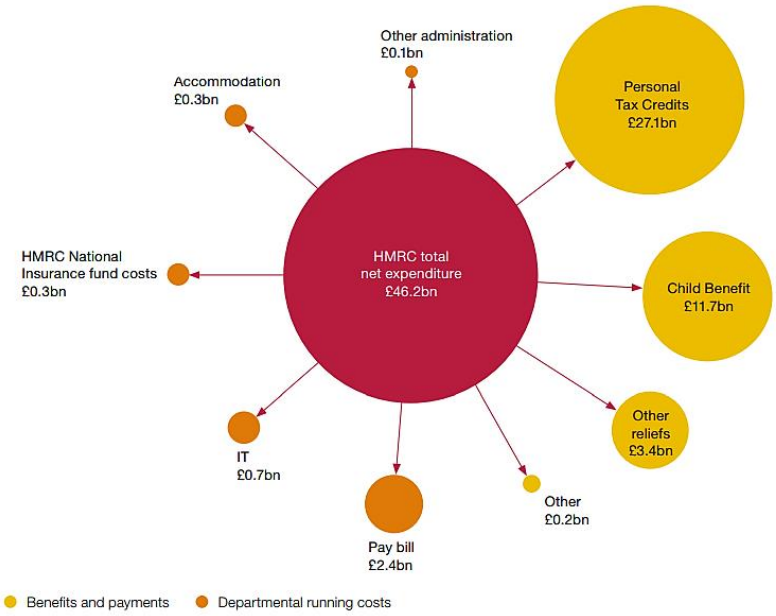
Management

The ECA scheme is managed by the UK Department for Business, Energy & Industrial Strategy (BEIS). Endorsement from government (by tax laws and policy) has ensured the validity of ECA scheme.

The process to claim tax rebate is quite straight-forward as claims for ECAs are made in the same way as other capital allowances. The administrative costs are small as Her Majesty's Revenue and Customs (HMRC) administer all claims for ECAs. Figure 9 shows HMRC's net expenditure in 2016-2017. The total

administrative cost for all relief accounts is around 7.3% and the management cost for managing ECA is expected to be far less than that (NAO, A Short Guide to HM Revenue & Customs, 2017).

Figure 9 . Breakdown of HMRC's total net expenditure 2016-17



Transparency and Predictability

The amount claimed for ECAs each year cannot be traced back to the products purchased as that information is not required when claiming the tax relief. Approximate figures are released by HMRC for ECA claims, although these figures are not separated by technology, manufacturer or any other factor. Reports by the NAO in 2014 and the Committee of Public Accounts in 2015 concluded that HMRC needed to improve how it monitors and reports on tax reliefs. HMRC's monitoring of tax reliefs is not yet systematic or proportionate to their value or the risks they carry. The NAO recommended that HMRC should publish all relevant information on the cost and impact of tax reliefs in a more accessible way (NAO, Her Majesty's Revenue & Customs Annual Report and Accounts 2015-16, 2016).

Drivers

Policy moves by government form an important signal to markets, businesses and investors active in energy intensive sectors. Examples include:

- **Energy Performance Certificates (EPC)**, which rate the energy efficiency of a property, must be displayed when a property is for sale or let;
- **Energy labels** must be attached to certain products to indicate their energy efficiency;
- **Smart meters**, which help people to view their energy use in real time, are being rolled out to all households in Britain by the end of 2020; and
- **Energy audits** must be completed by large businesses under the Energy Savings Opportunity Scheme (EC, UK 2017 National Energy Efficiency Action Plan and Annual, 2017).

A positive attitude from government is key in leading decision makers to take energy-saving approaches such as upgrading their production line with high performing plant and machinery equipment. It was argued that ECAs, by reducing the cost of retrofit projects, would have a significant impact on ensuring the UK meets its energy saving targets.

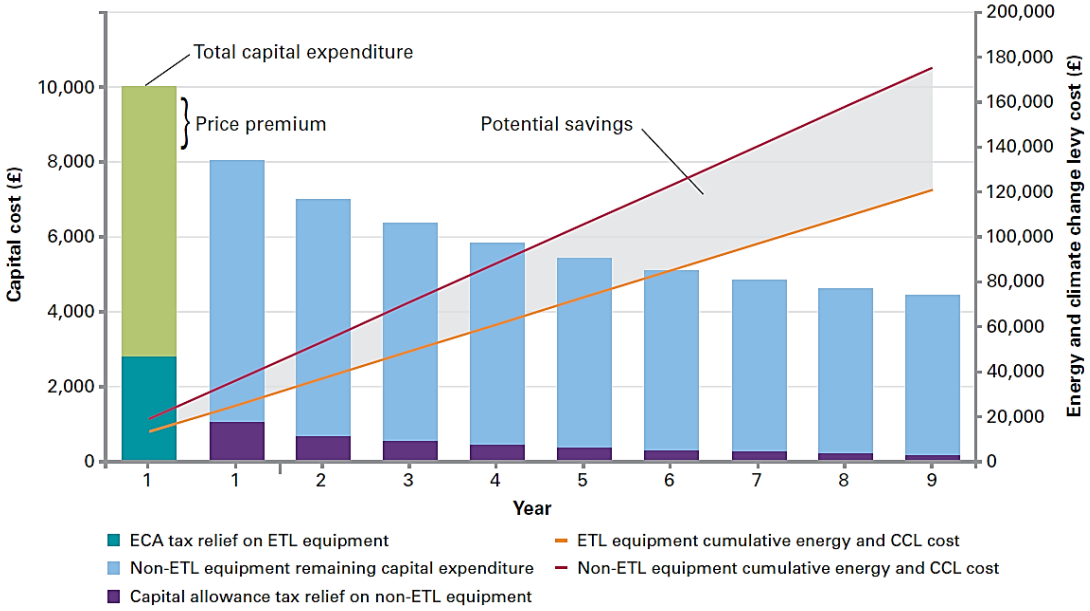
Supply Chain

The ETL and ECA scheme was designed to guide energy users in selecting high performing products and equipment by reducing their initial investment costs. As an incentive scheme alongside the UK ETL, the ECA scheme has had positive effects by encouraging energy-users to adopt ETL-listed products, resulting in a shift in the supply chain.

Impact and Sustainability

The ECA benefits businesses in the form of a cash flow boost resulting from the reduction of the business' tax bill of the year in which the investment is made. This has enabled the abatement of approximately 88 million tonnes of CO_2 since the creation of the ETL in 2001. The ECA will come to an end in 2020 and revenue saved by HMRC will be used to fund the Industrial Energy Transformation Fund. The closure of the ECA is unrelated to its effectiveness as an incentive to increase the uptake of energy efficient products. However, the ETL has functioned to date alongside a financial incentive. It is difficult to predict the continued success of the ETL without the financial incentive from April 2020 onwards.

Figure 10 Comparison of the tax benefit, energy and climate change levy cost between ETL equipment and non-ETL equipment



Overall assessment

- The UK ETL works to improve market average energy efficiency by increasing the uptake of high performing products;
- Since 2001 the ETL has has resulted in the abatement of 88 million tonnes of CO_2;
- The accompanying ECA scheme provides a financial incentive for customers to invest in energy efficient products;
- The ETL is also used as a marketing tool by manufacturers to demonstrate that their products have been independently verified as the top quartile for energy efficiency. The closure of the ECA might result in decreased uptake in energy efficient products from April 2020 onwards due to the higher cost of energy efficient products compared to market average.

The MIA and Vamil Schemes (tax deduction)

Rationale (Integration with ETLs)

Similar to the ECA Scheme for the UK ETL, the MIA and Vamil schemes are tax break schemes to encourage businesses to purchase environmentally-friendly technologies, thereby stimulating the dissemination and market penetration of these products.

Vamil encourages the uptake of energy efficient equipment by allowing purchasers to determine the rate of depreciation. This not only makes high performing products more affordable, but purchasers can opt to increase the write-down of their investment in the years following purchase, which reduces reported earnings in those years and the subsequent taxable profits. The net benefit is approximately 4-5% of the total investment.

The use of the MIA incentive is solely as a tax deduction tool, allowing a partial write-off of an investment in energy efficient technologies against tax. This is deducted from the taxable profits of the business within the calendar year of purchase. The percentage of the deduction depends on three factors; the energy efficiency of the product, the innovative nature of the technology and the price of the product compared to an average performance alternative.

Management

The delivery of the Vamil and MIA incentives are principally led and funded by the Ministry of Finance and the Ministry of Infrastructure and the Environment. The administration of the 'tax regulations' is done through the Tax and Customs Administration, with technical support from Netherlands Enterprise Agency (RVO).

Transparency and Predictability

The process to apply for a tax break through the MIA/Vamil is quite straightforward. A combination of targeted and random inspections is used to prevent fraud and misuse. The assessment of the environmental benefits is carried out by RVO and/or by one or more involved ministries to ensure the transparency of the scheme. The way in which this assessment takes place depends on the type of technology.

Drivers

The two schemes are said to have contributed to the sustainability ambitions in the coalition agreement 'Confidence in the future' where the Dutch Cabinet set out its aim to achieve an emission reduction of 49% by 2030 (Gov.nl, 2017). The emphasis of the policy was reflected by the investment in Vamil and MIA.

Supply chain

As tax break schemes operated by the tax authorities, MIA and Vamil don't engage any financial institutions in the mechanism. Technical and equipment suppliers are encouraged to submit proposals for new environmentally-friendly technologies on the next Environment List, which can help their customers to get tax benefit.

Impact and Sustainability

In 2017, the number of applications and the total investment amount reported for MIA and Vamil schemes have been increased to around 13430 and €3.4 billion compared with previous year. The investments supported by these schemes are mainly spent on sustainable buildings, mobility, sustainable agriculture and circular economy, with the total investment increased by 70% for mobility and circular economy compared than 2016, highly driven by the national policies.

An evaluation of MIA/Vamil in 2018 for period 2011-2016 concluded that **the MIA\Vamil has succeeded in redirecting investment in assets towards the environmentally friendly alternatives**. Total investment from 2011 to 2016 was nearly €11 billion with about €939 million financial benefits for business and €819 million government fiscal loss (CE Delft, 2018). Another ex-post evaluation carried out by Ecorys for the period 2005-2010 show that there were 57,937 investments made under the schemes, which resulted in a total investment of €8.5 billion and claims of just under €1 billion. The overall cost, with respect to reduced tax revenues, was found to be in the region of €715 million. (Ecorys, 2013).

Though the effectiveness of the scheme has been influenced by the existence of free-riders, the percentage of free-riders is limited compared with other tax or subsidy schemes. Total investments with the schemes amounted to almost € 5.5 billion in the period 2014-2016 and reduced to € 3.3-4.7 billion if correcting the investment for 'free-rider' effect. To mitigate the free-rider effect, the Environment List needs further improvement ensuring only high-performance and leading technologies can be included, also over-stimulation should be avoided.

From the business community perspective, the cost-effectiveness is also high. Companies spent about 1 to 4 hours on an application, which is only equal to 2.7% of the financial benefits. **The schemes also show positive influences on supplier behaviours.** For example, the Environment List has been used as a marketing tool and the sales-increasing effect led by the tax benefits also encourage the suppliers to develop further environmentally-friendly assets.

Overall assessment

- The MIA and Vamil are tax deduction schemes based on the Environment List, providing predictable financial benefits for environmentally friendly investments;
- The schemes have succeeded in redirecting investment in assets towards the environmentally friendly alternatives, with a large multiplier effect;
- The Environment List plays an important role in the schemes, and the government can guide investment direction and limit the free-rider effect through management and update of the list; and
- The cost-effectiveness is high for entrepreneurs thanks to the straightforward and simple application process.

2.2 Credit Line

A study by the Carbon Trust in collaboration with the Climate Investments Fund (CIF) to better understand the effective use of concessional climate finance in scaling up investment in energy efficiency produced the following definition of credit lines:

"A credit line is the injection of capital from a donor, Multilateral Development Bank (MDB), government or a private institution to a financial intermediary who is able to on-lend to their clients." (Carbon Trust & CIF, 2018).

The credit line is considered as an effective means of providing the needed liquidity for medium to long-term financing in energy efficiency market. The attractive terms of the original loan can be set by the originator to incentivize lending to energy efficiency, e.g. concessional rates and/or longer tenors. By ring-fencing their use and providing attractive terms, credit lines can encourage financiers to go beyond business-as-usual, and lend to energy efficiency projects, by offsetting the extra transaction costs associated with expanding into a new market.

International institutions and governments require a significant level of certainty in the 'strength' of the chosen intermediary to handle and repay the credit line. Therefore, on-lending often requires a well-established financial sector, and it is highly beneficial if the intermediary has positive existing relationships with the supply chain and access to the bankable pipeline.

Case Study

Green Economy Financing Facilities (GEFFs) and Sustainable Energy Finance Facilities (SEFFs) (Credit lines)

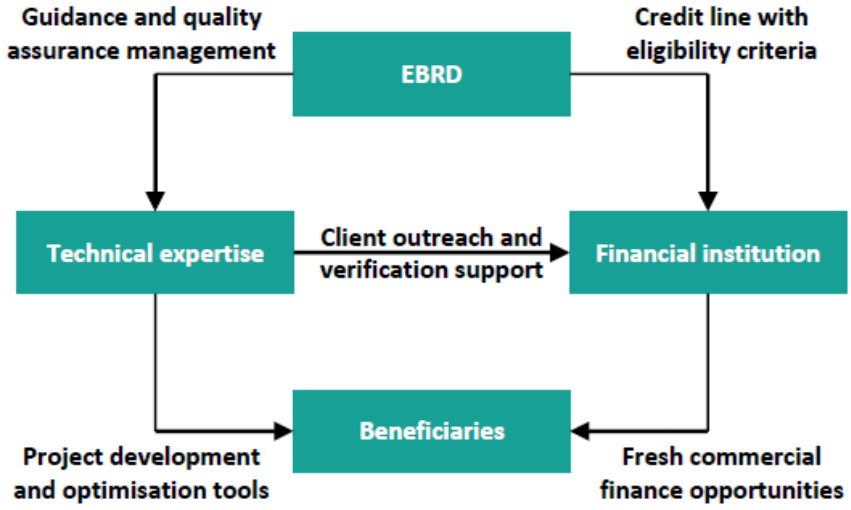
Rationale (Integration with ETLs)

The EBRD's GEFFs, previously known as Sustainable Energy Finance Facilities extend credit lines to local partner financial institutions (PFI) for on-lending to businesses and homeowners so that they can invest in higher performance climate and environmental technologies. (EBRD, EBRD Sustainability Report 2017, 2018) Now the GEFFs operate in 26 countries in Europa, Africa and Asia. Working through local financial network, GEFFs can outreach to a lot of small and medium sized green opportunities and develop durable local financing markets by raising the capacity of local partners.

The Catalogue and Technology Selectors play as one of the key mechanisms for delivering climate finance under the EBRD's GEFFs.

GEFFs go far beyond simple lines of finance by combining technical guidance to support project development and build capacities of local financial institutions and clients. According to a 2016 EBRD evaluation report, one of the distinctive element of SEFFs is the provision of credit lines accompanied by grant-financed technical assistance, and in many cases incentive payments to the ultimate beneficiaries, mainly SMEs (EBRD, Special study: The EBRD's Sustainable Energy Finance Facilities (SEFFs), 2016).

Figure 11 Business Model of Green Economy Finance Facility (GEFF)



Management

The GEFF programmes operate as networks including EBRD internal staffs with supervision and control, local implementation teams, more than 130 participating financial institutions, vendors and technology suppliers, and over 120,000 SMEs, business and individuals financed, supported by a series of international donors and partners. EBRD in-house staffs include GEFF managers, Financial Institutions team in Headquarters and Resident Offices. Under the EBRD's supervision, dedicated local implementation teams, mainly depending on consultants, carry out technical eligibility assessments,

facility management, project development support, identification of new client opportunities, marketing toolkit development and verification.

Transparency and Predictability [30]

Adapted from SEFFs which previously had multiple websites, aesthetics and procedures in different countries, GEFF brings a single look, a single website and standard procedures while maintaining flexibility to tailor facilities to local country conditions. Clear guidance on the criteria and application process are listed on the GEFF website.

After the application form has been submitted to the PFI, the financial check and technical check will be carried out. Technologies selected from the online Technology Selector are all eligible for financial investment and don't need further approval, which reduces the transaction cost and simplifies the process. For complicated projects, the eligible assessments will be carried out by the local implementation teams. After the technical eligibility check and the creditworthiness assessment from the PFI, the financing will be provided. GEFFs also provide investment incentives for successfully implemented and verified projects. The ex-post verification is conducted by a verification consultant, confirming the correct use of funds and expected achievement of energy saving.

Drivers

The energy context and market barriers are similar across many of these Eastern European and North African countries, which has laid the foundation for the wide-reaching GEFF programme. The most important internal and external drivers include EBRD's environmental policies and strategic frameworks, regional and national political desire and policy attention, and similar market barriers.

- GEFF is designed to be consistent with **EBRD's internal policies and strategic frameworks** including Energy Operation Policy, environmental and social policies, country strategies, Sustainable Energy Initiative (SEI), Sustainable Resources Initiative (SRI) and Green Economy Transition (GET) approach. It has been included as a key delivery mechanism under the GET approach which aims to increase the share of the green business volume from an average 25% to 40% by 2020.
- Globally, the political willingness to deal with climate change also led to more interest in energy efficiency and renewable energy financing. For those in Eastern Europe, there has been **political desire to align with EU directives and regulations**, as Eastern European countries sought EU membership, but their carbon intensity ranged from two to four times the EU-15 average.
- The GEFFs operated mainly in former Soviet Union, Central Asia and the Southeast Mediterranean regions, where countries are predominantly middle- to low-income nations, and **have similar market barriers for energy efficiency investments**. Four categories of impediments have been identified as financial barriers, technical barriers, awareness and knowledge barriers and regulatory and legal barriers (EBRD, Special study: The EBRD's Sustainable Energy Finance Facilities (SEFFs), 2016).

Table 10 Market Barriers in EBRD Countries on Energy Efficiency Investments

Categories	D
Financial barriers	Absence of adequate pricing to incentivize investments and to attract financial capital.
Technical barriers	Lack of capacity of local financial institutions and clients to identify and develop energy efficiency investments.

[30] The EBRD indicates that GEFFs were originally referred to as SEFF, the change was made in 2017 as the facility extended its scope to local businesses in purchasing high-performance technologies. Therefore, we used SEFF to test the indicators set in the evaluation framework.

Awareness and knowledge barriers	Low recognition among stakeholders about the benefits and financial viability of energy efficiency projects.
Regulatory and legal barriers	Regulatory distortions that didn't incentivize energy efficiency investment.

Supply Chain

Credit lines are provided at commercial rates by the EBRD to address illiquidity in energy efficiency markets. Credit lines can be used to address energy efficiency in any sector due to their inherent flexibility. Institutions charged with on-lending the capital can disburse their funds in ways that they are most comfortable with (depending on the terms set by their creditor). Most of the financial institutions are private banks, with a few examples of leasing companies and micro-finance institutions.

Except the credit lines, GEFFs provide significant technical assistance to financers and the target market for project identification, assessment and verification, carried out by local implementation teams. In some cases, donor funded incentives are also included to help the sub-borrowers and financiers to overcome specific market barriers. The model on one side uses the networks of PFI distribution channels to reach a significant number of beneficiaries, on the other side enhance the capacity of PFI and reduce their upfront costs of green investments. Technologies suppliers and local vendors are also engaged in as sales partners through Technology Catalogue and Selector.

Impact and Sustainability

Under the GEFF programme, the EBRD has provided over €4.5 billion of finance for businesses and households through a network of 130 local FIs across 26 countries since 2006. More than 120,000 subprojects in the SME, corporate and residential sectors have been supported, with 9 million tonnes of CO2 expected emissions avoided annually. (EBRD, Sustainability Report 2017, 2018)

As a blended finance facility, GEFF combines and integrates commercial loans with technical assistance and small grants. The technical assistant is seen as invaluable to financiers, helping to reduce the perceived risk of energy efficiency investments and build their awareness and capacity. A survey shows that 90% of training participants think it's "very useful" or "extremely useful". For every euro invested in technical assistance, the SEFFs leverage €83 in private sector investment. (ADB Institute, Energy Efficiency Finance Programs: Best Practices To Leverage Private Green Finance, 2018) Every euro spent on grants mobilised €6.3 of sustainable energy investments.

According to the special report on SEFF in 2016, the SEFFs have had a positive impact on investment in energy efficiency and renewable energy. The main impacts appear to be increased awareness of energy efficiency and renewable energy opportunities; transfer of skills to PFIs; demonstration effects (particularly in the residential sector); and the use of high-performance technologies than commonly used ones. (EBRD, Special study: The EBRD's Sustainable Energy Finance Facilities (SEFFs), 2016)

Overall assessment

- The scheme combines commercial credit lines with technical assistant and donor-funded incentives through local implementation teams to achieve the transition impacts.
- Hundreds of branches of PFI's networks have been engaged to reach the beneficiaries in local markets.
- The simple procedures and fast credit decision making process have been seen the main attraction for sub-borrowers.

- The link to Technology Catalogue and Selector simplifies the eligibility assessment and reduces the transaction cost for all parties.
- Through adjusting the incentives and benchmarks and making more effects on skills transfer and capacity building, the model can lead to long-term sustainability.

2.3 Subsidies

Energy efficiency subsidies are widely used around the world for energy conservation and emission reduction. Broadly, grants, rebates or tax-relief are forms of subsidies given from the government to companies/end-users to reduce the up-front cost and improve cash flow to provide incentives for voluntary investment in energy efficiency. Here we use a narrow definition of subsidy to mean a grant or rebate provided by a government to companies/end-users to reduce the initial investment cost and increase the returns for energy efficiency investments.

Case Studies

Ecology Premium Plus (subsidies)

Rationale

The Ecology Premium Plus is a financial compensation from the Flemish government to companies, aiming to stimulate them to invest in an environmentally-friendly and energy efficient production processes in the Flemish Region. Through providing subsidies for part of the extra cost of such investments, EP-Plus can reduce the initial cost and improve the return of the ecological investment.

The EP-Plus came into effect on 1 Feb 2011 as an open application scheme, updated from a previous Call scheme. Also, the ecology investments with support through combined heat and power certificates and/or green energy certificates have been removed from the EP-Plus, reducing overlap with other support mechanisms. All enterprises in the Flemish Region which invest in technologies listed on the LTL can apply for the subsidy, however there is an increased focus on SMEs.

Management

The EP-Plus is managed and controlled by the Agency for Innovation and Entrepreneurship (VLAIO), a governmental agency of the Flemish government for all entrepreneurs in Flanders. The VLAIO can verify the compliance with the legal support conditions since the application has been submitted and make a decision to refuse the subsidy or recover the awarded subsidy.

In 2017, €16.5 million in subsidies was awarded to companies, which was double that of the subsidies awarded in 2016 (€8 million). And in 2018 the budget of the EU-PLUS was again increased to €20 million. The subsidy amount is determined by the additional cost of the essential investment components, the type of technology, the eco class and the size of the company, ranging from 15% to 55% of the additional investment cost. The maximum subsidies granted to a company amounts to a maximum of €1 million over a period of three years from the filing date of the first positively decided aid application.

There are several restrictions around timings of projects, such as an enterprise must make the investments within 6 months after the decision to grant support has been made, and must be completed within 3 years of the decision date.

Transparency and Predictability

The aid scheme offers companies more legal certainty and transparency because a company that meets the set criteria within the budgetary possibilities is assured of the aid and knows exactly the amount of the subsidy in advance. The requirements for eligible application, the criteria of amount,

and the application and payment procedure are clearly listed on the VLAIO website, and all applications must be made online.

The subsidy is paid to the company in three installments, at the start, during, and at the end of the investment (EC, A framework for Member States to support business in improving its resource efficiency, 2015). An independent check of the required files will take place before the final payment of the full grant, which usually takes 3 months.

Drivers

As a policy instrument to leverage ecological investment in Flemish Region, the EP-Plus is designed and guaranteed by legal frameworks including European regulation, framework decree, government decision and ministerial decisions. The main policy drivers for EP-Plus include the European 20-20-20 targets and the Flemish Climate Policy Plan, which are the high-level principles for the selection of technologies for the LTL.

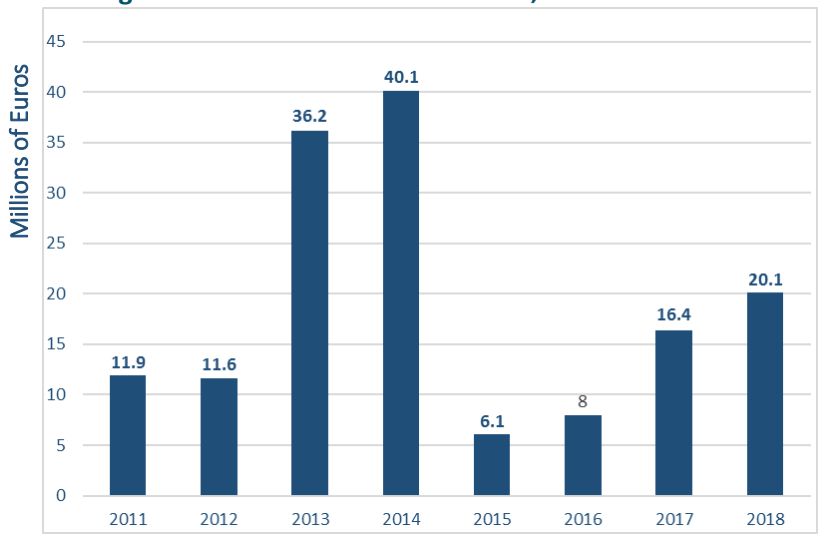
Supply Chain

EP-Plus runs as a policy instrument providing direct subsidies from the government to companies, the budget for which comes from the Flemish state. Although technology and equipment suppliers are not formally engaged in the subsidy application process, they can help their clients to access the subsidies, which in return stimulate their business. Both investors and suppliers can submit requests to add new technologies to the LTL.

Impact and Sustainability

With the support of EP-Plus, around €130 million has been granted to companies to support their investments in environmental, energy saving and renewable energy products from 2011 to 2017. In November 2014, to maximize the effectiveness of their limited budget, and to support only the most efficient technologies, the government reduced the number of technologies in the LTL from more than 150 to around 30, and cut the budget considerably. Since 2015, the total amount has been increased year by year, with more projects awarded funding.

Figure 12 Grant Awarded of EP-Plus, 2011-2018



In 2017, the total private investment mobilized by the subsidy is over €101 million, nearly double that of 2016. Around two of thirds of subsidies are granted to SMEs (193 of 257 approved application). The percentage of grants awards in the total investment amount is 16.5%, showing a strong multiplier effect.

"***The government has the duty to use tax money as efficiently as possible. Through tightening the criteria, the premium has the greatest incentive effect, without compromising on environmentally-friendly investments by companies.***" stated by Diependaele, a member of the Flemish Parliament in 2015. Last year, he added that "***the ecology premium clearly stands out and works like a real green lever***".

Overall assessment

- Subsidies are given to cover part of the extra-cost for ecological benefits compared with traditional investments, with the grant amount determined by the type of Investment, size of the company, and Eco-class and Ecology number;
- The application process is very clear and straightforward, through a online application system, ensuring more certainty and transparency;
- As a policy instrument, it is managed by the government and guaranteed by a legal framework, yet the technologies are selected by an independent research organization; and

2.4 Reflection on common energy efficiency financial mechanism

Table 11 Reflection on common energy efficiency financial mechanism

Financial Mechanism	Key Barriers Addressed	Reflections
Insurance: A contractual obligation for SMEs to be reimbursed if the performance of the technology is below set expectations. This could underpin the guarantee of repayments for unfamiliar technologies such as some used to deliver higher energy efficiency.	• Perceived high technology risk discourages lenders from financing particularly longer payback energy efficiency projects. • Energy efficiency is not a top business priority for end-users, and they can be sceptical about their savings potential.	• Can mitigate high perceptions of risk on the behalf of financiers (like a guarantee) and end-users (unlike a guarantee). • Encourages banks and consumers to invest in upgrades with longer payback periods and/or that could involve high upfront
Guarantee: A mechanism that acts as a reserve for losses incurred by financiers lending to relevant projects. This is often provided for a premium that the beneficiary has to pay. The presence of donor funds may enable the facility to be provided at a concessional rate or underwrite the first losses with grant finance that expects no return.	• Poor creditworthiness of clients requiring finance, who often lack the collateral or revenue streams to secure a loan. • Financial institutions may be reluctant to finance energy efficiency projects that are unfamiliar to them and especially so if the lending is to a higher credit risk group such as SMEs, which often lack a track record of successful borrowing and repayment and/or lack collateral. • If guarantees help encourage financial institutions to offer	• Needs careful design to ensure it is effective at de-risking energy efficiency ventures. • Concessional terms facilitated by donors often crucial to success. Effective for incentivising lenders in markets where energy efficiency is not familiar. • Prior capacity building in energy efficiency will improve effectiveness of guarantee. • Requires strong and liquid banking sector to provide its own credit. • Must be simple – cost and requirements can be

	unsecured lending, they may tackle the lack of energy efficiency project financing available.	onerous and off-putting for banks.
Credit line: Injection of capital from a donor, multilateral development bank (MDB), government or private institution, to a financial intermediary who is able to on lend to their clients. Provides a ring-fenced source of capital that incentivises lending, particularly when provided at concessional rates or when facilitating unsecured lending.	• Financial institutions lacking liquidity (short and long-term) and/or inclination to invest in energy efficiency projects.	• On-lending often requires a well-established financial sector. • Concessional to trigger a market; non-concessional to sustain a market. • Needs strong, stable banking sector with relationships with the target market and across the supply chain. • Requires technical assistance throughout supply chain – lack of lending is not always due to lack of available capital.
On-bill financing: Integrating investment costs with pre-existing bills, where energy savings prevent the former exceeding the latter over the payback period.	• The lack of upfront capital and lack of trust in energy savings as value for property owners.	• Hassle-free regular repayment plan that can be subsumed into normal energy bill or tax payments – supporting take-up. • Trust in institutions providing finance is important for ensuring participation.
Leasing (operating and capital): Operating lease: Contract for using an asset – ownership responsibilities lie with lessor(rental). Capital lease: Contract for using an asset where ownership responsibilities effectively transferred to lessee.	• The high upfront costs of energy efficient equipment. • A lack of awareness/trust • from end-users in energy • efficient technology. • Unwillingness/inability of end-users to secure finance against their limited collateral.	• Generate demand for investing in energy efficiency and for • accompanying finance. • Can offset effect of energy subsidies (which dampen • interest in energy • efficiency).
Revolving fund: Any repayable investment vehicle whereby the repayments and/or proceeds of initial investments are reinvested in further eligible projects.	• Lack of capacity or inclination to invest in energy efficiency in the supply chain or local financial sector.	• Can magnify the amount of capital injected into the market, particularly if combined with criteria limiting the term of individual investments. • Can lead to the market being dominated by, or reliant on, the revolving fund entity, rather than building broader

		capacity in the financial sector or technical supply chain.
Energy Service Companies (ESCOs): Companies that provide customers energy savings solutions that pay for themselves (and provide a return to the ESCO) through the savings on energy bills they generate. The ESCO typically guarantees the performance of energy efficient solutions and may or may not provide customers directly with finance for the investment.	• Lack of familiarity and trust from end-users and investors in energy savings. • Difficulties or disinclination to join different elements of the technical and financial supply chain to realise solutions.	• The ESCO model is best suited to sectors with large and consistent energy bills– for example, municipalities or large energy intensive industries. • In contrast, for SME markets with their relatively small, less predictable energy bills ESCOs are less suitable. • ESCOs often lack their own collateral, preventing them • accessing debt financing for growth. • The inherent unfamiliarity and complexity of their business model to end-customers can also limit take-up.

China's financial incentives to promote energy efficiency technologies

3.1 Analysis of China's financial incentives

China faces similar barriers to the promotion of energy efficient technologies and products (EET&Ps) as other international cases. The newly introduced EET&Ps face similar obstacles such as relatively high initial investment costs and lack of well-trained personnel required to operate the products. The conflict between cost and benefit of adopting an EET&P as well as the uncertainty of its performance, hinder the acceptance of these technologies and products. Organisations are unlikely to adopt EET&Ps without previous demonstration projects or other financial incentives. **Therefore, unlike developed countries, which mainly solve energy efficiency (EE) problems through market means; at present the government holds the primary role in intervening in the EE industry's development in China**. Macro policy instruments, especially fiscal and tax incentives, are important tools in the area.

Generally speaking, there are few financial mechanism directly aimed at accelerating the uptake of EET&Ps in the China National Key Energy-saving Technologies Promotion Catalogue (referred as the Catalogue) described in part 1. There are several explanations for this lack of financial incentives. For example, some subsidies and financial incentives are obtained by reaching certain emission reduction targets as opposed to through purchasing specific equipment. Also due to the nature of the Catalogue, a technology might be listed without specifying the manufacturer of the product to avoid a possible conflict of interest. Therefore incentives directly relating to the Catalogue have not yet been implemented.

In spite of the absence of policies promoting the Catalogue, China released several different types of financial mechanisms that promoted the EE industry as well as EET&Ps indirectly during the 11th(2006-2010) and 12th(2011-2015) Five Year Plan (FYP) periods. These included **tax breaks, national subsidies and green credit**, which are also considered three of the most effective ways to positively influence the EE industry's development. They address the main barriers such as reducing economic costs as well as facilitating financing for enterprises. Many of these policies will continue to be used in the 13th

(2016-2020) FYP, with the main focus and purpose unchanged. These three financial incentives will be explored further in this section alongside relevant case studies.

3.2 Tax Breaks: Enhance Energy-Saving Measures & EPC Development Policy

The national energy conservation and emission reduction (ECER) FYP was first officially issued as one of China's key targets during the 11th FYP period by NDRC and the State Council. **During this period and the following 12th FYP intensive preferential fiscal and tax policies were issued by the government,** to promote energy conservation and implementation of EET&Ps. Most of them have been effective until recently and were hugely influential (see detailed analysis in the case study for this part).

Tax breaks play a vital role as the government hopes to mobilize investment in energy efficiency through tax means. Tax policies such as tax reduction and exemption for energy-saving projects, tax credits or accelerated depreciation[31] for energy-saving equipments and VAT exemption on R&D of EET&Ps, are accelerating EE industry development.

The case study below will further illustrate how tax breaks foster EE industry's development by introducing a tax reduction and exemption policy focusing on Energy Performance Contracting (EPC) which has substantial potential to improve the IEE sector, due to its high energy consumption and energy waste. EPC is also a key area for development since 11th ECER FYP and experienced rapid growth due to favourable policies.

Introduction

EPCs are widespread tools in developed countries to promote energy conservation through market mechanisms. It is also widely used in China's energy service industry. Before the release of this mechanism in April 2010, the scale of ESCOs in China was relatively small, and could only provide limited services. By introducing tax reduction and tax exemption for those energy-saving projects carried out by eligible ESCOs, the Chinese government hoped to attract more enterprises and drive investments in the area. Through these mechanisms, the qualified ESCOs could:

- Be exempt from **business tax** for the taxable income from the EPC projects.
- Transfer the **VAT** taxable goods in the project to energy-using enterprises.
- Be exempt from **income tax** from the 1st-3rd year, and halved from the 4th-6th year on a legal tax rate of 25% (this is called Three Frees and Three Halves (TFTH)).

The requirements for qualifications of ESCOs are explained further in the "Transparency and Predictability" section.

Although the tax break policies do not directly use the technology catalogue referred to in part 1, it does refer to a category list and specifies beneficial technologies. Many technologies listed in the Catalogue also fall within those specifications. See more details in the "Transparency and Predictability" section.

Rationale

The main purpose of the mechanism is to accelerate the expansion of energy service industry through tax incentives, and thus improve energy efficiency.

[31] Depreciation is an enterprise expense, inversely proportional to the enterprise taxable income, so accelerate depreciation cannot reduce the amount of tax payers' tax burden, and it makes enterprise tax payment time delayed, similar to tax deferral. For taxpayers, the delay amounts to an interest-free loan from the government, even though the total tax bill remains unchanged.

The mechanism was adjusted in 2013, broadening the range of TFTH and further clarifying the beneficiaries of **the** tax preferential policies, but the main focus and purpose remain unchanged.

Management

This tax break policy was designed and released by General office of the State Council, NDRC, MOF, People's bank of China, and State Administration of Taxation, who are also in charge of updating and revising corresponding laws. This policy was applied at a national level, and the actual implementation requires the cooperation of the Bureau of Finance (BOF) and the Departments of Environmental & Energy (DEE) in local governments (both city level and provincial level).

Transparency and Predictability

The beneficiaries will have to meet the below requirements, and went through inspection by related departments such as local tax authorities and the DEE who then make decisions on whether the applicants are eligible for tax reliefs. The requirements are clear and involve several different aspects, shown below in Table 1.

Table 12 Refered requirements on different type of tax breaks

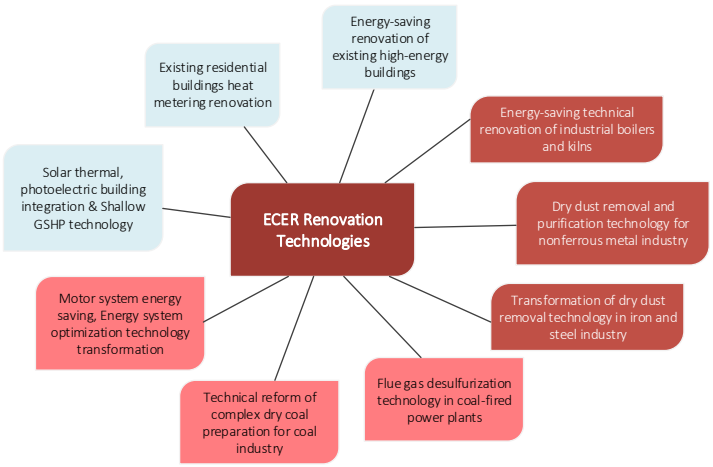
Business Tax & VAT Exemption	Income Tax Exemption and Reduction
▪ The technology has to meet *the General principles of EPC technology* ▪ EPC's contract format and content have to meet certain national criteria[32]	▪ The technology has to meet *the General principles of EPC technology* and within the EWS Category List ▪ Amount of energy or water saved is no less than 1000 standard coal per year ▪ EPC's contract format and content have to meet certain national criteria[33] ▪ Company registered capital no less than 1 million RMB ▪ ESCOs investment proportion no less than 70%

It is important to note that technologies used in EPC projects have to fit the standards stated in the "Category list of enterprise income tax preferences for environmental protection, energy saving and water saving projects" (referred to as the EWS Category List)[34]. Compared to the Catalogue in Part 1, the former suggests technologies suitable for a wider audience, while the latter focuses more on the assessment of each technology's performance. Although the Catalogue covers 12 sectors, and many EE technologies in the Catalogue, such as shallow geothermal energy utilization, industrial kiln reformation, dry dust removal overlap with the range required by the EWS 4th category, the Catalogue might be too specific to be applied to EPC projects. However, the example, shown in the "micro case" example, from a business perspective shows that the Catalogue can function more as technical guidance that provides best practice for energy-users. Figure 1 shows the qualified EPC projects type per EWS Category List requirement.

[32,3] The contract form between energy-user and ESCO should be "energy-saving benefit sharing", the format and content of the contract should be in line with the national contract law as well as "the general principals of EPC technology" issued by the state administration of quality supervision and the state administration of standardization.

[34] EWS Category List is a excel list published by SAT, specifying the technology range that can enjoy tax break policies. It has five categories, including public sewage treatment, public waste disposal, and comprehensive utilization of methane, energy-saving technology renovation and sea water desalination. For tax break on eligible ESCOs project, they should be in line with the technology type in category 4, upgrading of ECER technologies.

Figure 13 Qualified EPC projects type per EWS Category List requirement on energy saving technology reformation section (ones in the blue box are the types that not very relative to IEE sector)



(Source: EWS Category List, 4th category)

Drivers

As mentioned previously, in China central government plays a leading role in promoting energy conservation and the EPC industry. The General office of the State Council firstly published a notification "Accelerating the implementation of EPC and the development of the energy conservation service industry", this tax break policy was then jointly issued by MOF and State administration of taxation. The policy is also in line with the 11th, 12th, and 13th five-year plan, which stated that the government shall use preferential tax means to assist EE industry and EET&Ps development.

Supply Chain

The tax break policies are usually implemented by tax or financial authorities in government, and if necessary, a third party energy saving audit institution will be engaged to help the local tax/financial department to verify claims regarding energy savings. As beneficiaries, ESCOs also participate in this policy framework. Financial institutions aren't usually engaged in the mechanism.

Impact and Sustainability

The scale of the energy service industry is closely related to the national policy guidance. A combination of encouraging policies (tax breaks) and punitive policies (environmental tax) influence the energy service industry and ESCOs. As a win-win business model, the EPC itself could integrate finance and technology, forming a rapidly developing industry, while simultaneously reducing operating and manufacturing costs for energy-users. The EPC projects could achieve great social and environmental benefits, see Table 2's figures. In recent years China's energy conservation service industry has experienced a rapid expansion, and has become an important force in promoting an energy transformation and achieving emission reduction goals.

Data in Figure 2 shows that the value of energy-saving service industry and investment in EPC projects almost doubled in the years following the tax break policy in 2010. And in 13th FYP period (2016-2020), as mentioned previously, the tax policies are in favour of EPC and energy service industry and are developing but at a steady rate.

Figure 14 Development/Investment in EPC industry before/after the Schemes published

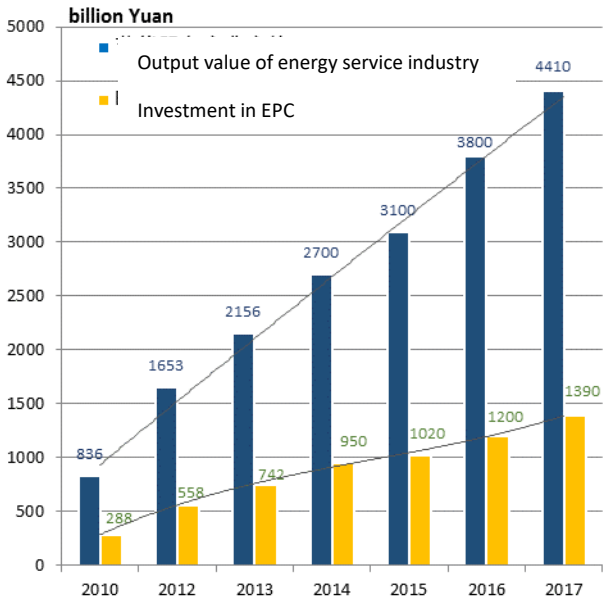


Table 13 Emission reduction effect brought by EPC projects

unit: million tons	2006	2010	2013
EPC projects annual standard coal saving capacity[35]	0.86	10.65	25.6
EPC projects annual CO_2 emission reduction	2.15	26.62	63.99

(Data source: collected by CECEP Consulting)

The value of energy service industry in recent years has grown at an average annual rate of 20% ~ 30%.[36] It is predicted that the industry will be valued at more than 700 billion Yuan by 2020. In the 13th FYP period, the government will continue their investment and policy support, and investment in the EPC project is expected to reach 185.7 billion Yuan, with a value of 282.1 billion Yuan. This indicates a good developing trend within the area. Organisations are gradually growing aware of the benefits of EPC, we could expect less government interventions and more market regulations in the future.

Although there is little data currently on how this policy directly influences the Catalogue and the EET&Ps within it, it can be inferred that this will widen the market for EET&Ps.

Micro case (at company level)

A company whose main business is utilizing industrial waste heat for district heating stated that based on their estimates, the project will have 0.5-1 year shorter payback period based on TFTH policy.

3.3 Subsidies: Energy Conservation and Emission Reduction Subsidy (ECER subsidy/funds)

Another measure to stimulate energy conservation and emission reductions are subsidies and fiscal funds. These were further developed during the 11th FYP (2006-2010) and 12th FYP (2011-2015) periods. In the 11th FYP period, the government issued several policies regarding subsidies for energy-

[36] Yingying Pei et al., *Analysis of the development status and trend of energy saving service industry*

saving technology renovation, backward production capacity elimination, and industrial enterprise energy management centre construction demonstration projects within industrial EE sector. Funds were also allocated for EPC and energy conservation services.

Later in 2015 during the 12th FYP period, central government established a more comprehensive and inclusive subsidy policy. Subsidies for Energy Conservation and Emission Reduction (ECER funds), replaced the original policies issued in 11th FYP period that aimed to support different aspects in EE industry. The ECER fund functioned as a special fund to support ECER in the long term.

Subsidies in the 11th FYP were difficult to apply for. For example, EPC projects originally required approval from both NDRC and MOF to obtain financial incentive funds. This resulted in a time consuming and complicated application process, since the applicants first had to turn in their application materials to the city level governments, if successful, then to the provincial government, and finally the national level government (NDRC, MOF). Now with the establishment of ECER funds, subsidies are allocated directly to the local department for ECER projects, speeding up the process and enhancing the capital turnover capacity of ESCOs. This streamlined process also suits government better as by delegating the approval process to local governments they can work with local industries and accelerate the implementation of key projects.

The ECER subsidy will continue during the 13th five year period.

Introduction

ECER funds and the corresponding administration measures were implemented in May 2015. The funds were financial subsidies which were given by the higher level government to the lower level government in order to achieve specific economic and social development goals. Combined with the national ECER funds, local government also allocated supporting funds to jointly promote its ECER development.

The ECER administration measure stated three ways of using the fund:

- **Financial Aid:** According to the nature of the qualified project, the investors and the total amount of investment, full amount, quota or proportional subsidy shall be given.
- **Replace subsidies with awards:** According to the evaluated energy saving, emission reduction and completion of established tasks, the relevant districts, counties and units shall be given special fund awards.
- **Discount loans:** For projects implemented with bank loans or government relending funds, discount interest support shall be given according to the loan amount, length of life and interest rate.

Rationale

ECER fund is a national fiscal mean that been used to **promote energy conservation, improve energy efficiency, and encourage enterprises' participation.** The corresponding administration measure of ECER fund is aimed at **standardizing and strengthening the management of the usage of the funds**. Through the ECER's implementation the allocation process is improved and streamlined. The subsides are no longer passed through city government and provincial level to the NDRC and MOF, but directly allocated to municipals who are also in charge of the allocation of subsidies. The funds are also used more efficiently as local government are better placed to decide where to put effort and capital to further implement IEE improvements.

The main areas supported by the MOF and ECER funds are presented in Figure 3. Due to the general descriptions of the main areas there is overlap of technologies between the funds and the Catalogue,

especially relating to the “ECER in key sectors, industries and regions” and “ECER key technologies demonstration, promotion, and upgrade”.

However, simply meeting the requirements for the fund or purchasing technologies listed in the Catalogue does not guarantee access to subsidies. Local government has the authority to determine the allocation of subsidy funds depending on the city’s development demand for that year. Also financial support is dependent on both the resultant improvements in energy efficiency and the overall environmental and social effects of the projects or technologies. Thus the supported project types may vary by municipality but are still in line with the general principles set by state government.

Table 14 National ECER funds covered area

- **ECER Comprehensive demonstration of fiscal policies**
- **ECER basic capacity and public platform construction**
- **ECER in Key areas, industries and regions**
- **Innovation in ECER systems and mechanisms**
- **ECER key technologies demonstration, promotion, and upgrade**

(source: Administration measures of ECER funds published by MOF)

Management

The local DRC and Environmental Protection Department determine the projects selected, set overall performance targets and compile annual expenditure plans for the allocation of funds. The MOF will assess the submitted proposals by local governments and will issue the required funds for the selected projects. Local finance departments are responsible for managing the funds to ensure they are used for ECER projects. Total value of the funds issued by central government are listed in Table 3 below.

Table 15 Recent Years ECER funds amount (nationally)

unit: billion Yuan	2016	2017	2018 2019
ECER funds arrangement	19.86	33.937	32.366 36.457

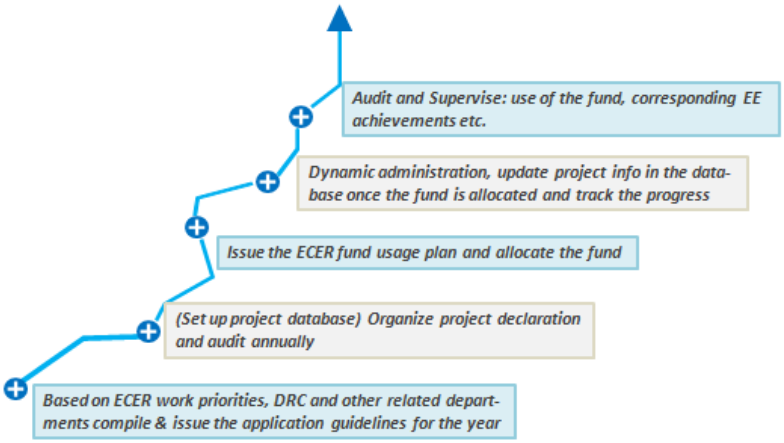
(Data source: MOF official website)

Transparency and Predictability

The Administration Measure of ECER Fund is general guidance for the use of the funds and aims to improve their use within the ECER area. Local finance departments set up provincial/city administration measures to manage ECER funds. MOF together with other related ministries perform the MRV (Monitor, Report and verification) process to ensure the proper use of the central fund at provincial level. Similarly, municipals also have an MRV system, which aims to check if the fund has been used effectively and whether the projects achieved the EE improvement targets. This top-down system ensures the rationality and fairness of the process. The evaluation criteria such as project cost/benefit, energy-saving amount, and resource utilization is defined although it is not yet quantified or publicly available. This makes it difficult for projects to evaluate whether or not they might be able to obtain the subsidy.

The main procedure for fund management in Beijing is illustrated as below. Other cities share a similar mode to the ECER fund management process: Prepare annual budget plan - Project declaration and audit – Issue the fund arrangement – Allocate the fund – Audit and supervise.

Table 16 Beijing ECER fund management procedure



Drivers

The ECER fund is consistent with the country strategies such as 11th, 12th, and 13th ECER FYP, which had targets to improve the fiscal and tax incentives available, as well as the use of green finance to support the ECER industry's development.

Supply chain

The national fiscal subsidies are usually designed and issued by the NDRC and MOF, and led by the local Bureau of Finance (BOF), DEE and DR. The majority of applications are for construction and implementation projects. Financial institutions play no role in the mechanism.

Impact and Sustainability

During the 12th five-year plan period, the energy conservation and environmental protection industry grew at an annual rate of 15%-20%, about 2-3 times of the target GDP growth rate in the same period (Report: Analysis of the environmental protection impact on economy, 2015). As the main focus of the 12th FYP was financial incentives, it can be assumed that this was a contributing factor to the growth.

Considering the current situation in China, which has an industrial energy consumption approximately 40% higher than the world's advanced level on average (Metallurgical research institute, 2015), improving energy efficiency in the industrial sector will still be a focus point of future FYPs. According to expert predictions, in the next ten years, the growth rate of China's ECER industry is expected to reach more than twice the GDP growth rate. Investments during the 13th five-year plan period are expected to exceed 17 trillion Yuan, and the annual growth rate of the value will reach more than 15%.

Based on our interview with a Beijing company whose main business is focusing on the utilization of Ground Source Heat Pump (GSHP). One of its projects used "Shallow geothermal energy utilization technology" to provide heat instead of traditional coal-fired boilers for about 83,000 m2 area. The technology is on the National Technology Catalogue. The projects use this renewable source to provide heat instead of traditional coal-fired boilers, they received a total of 3.11 million Yuan in subsidies; approximately 3.11% of the investment, and achieved 839.4 standard coal reductions per year.

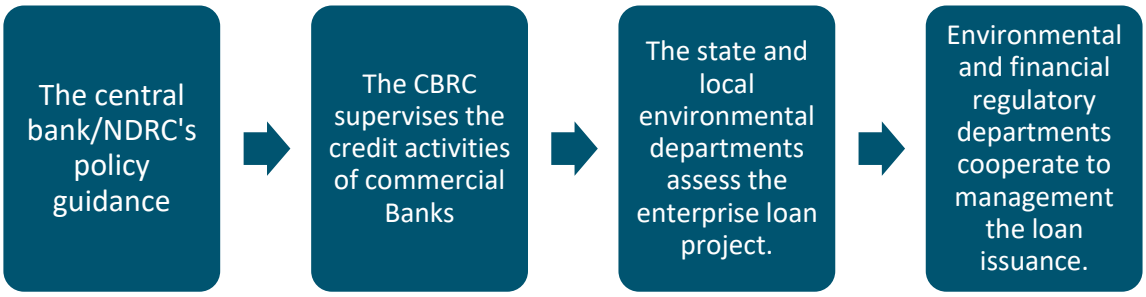
The company indicated that they used the Catalogue as an important tool when upgrading their equipment and the Catalogue helped them to demonstrate the energy saving impact when applying for the ECER subsidies. The company's feedback shows that although the Catalogue is not referenced in ECER fund policy, it has some influence on the technologies' chosen and purchased by organisations. From our research at a company level, the Catalogue provides reliable technology suggestions and assessments for companies that are in need of improving their energy efficiency. If a company would like to lower their operational cost by introducing an EE technology,

Micro Case (at company level)

3.4 Green Credit/Loan: Guideline on Energy Efficiency Credits (GEEC)

Green credit means commercial banks effectively promote sustainable development by guiding funds to support environmentally-friendly industries and enterprises. The environmental protection department forward the energy and environmental information for organisations to the bank and enter the bank's credit system for reference. Banks establish thresholds for enterprises and credit support is denied for high energy consumption and polluting projects. This serves to stop damaging developments and expansion of certain industries at the source. Typically, green credits involve the following government and financial organizations

Table 17 Government and financial organizations involved in green credit



Green credits are still at early stages of development in China. They were first mentioned in a policy document in 2007 (*Environmental protection policies and regulations to prevent green credit risks*), and started growing rapidly with supporting policies issued by NDRC as well as the People's Bank of China. Following these policies, most provinces, major policy Banks and major Commercial Banks in China have developed policies, programs and tools to support industrial ECER. Nowadays green credit has become one of the main areas of China's banks and financial institutions.

Introduction

GEEC is a document issued by CBRC and NDRC providing guidance for banks and energy users to issue or apply for energy efficiency credit (EEC). EEC is the credit financing provided by financial institutions to support energy-using organisations to improve energy efficiency and reduce energy consumption. The guideline states that the main areas for project support are industrial energy

conservation, building energy conservation, transportation energy conservation, and other areas relating to energy conservation projects, services, technologies and equipments.

Compared to tax and fiscal policy, GEEC as well as other policy documents are less prescriptive and are more guidelines for banking institutions, aiming to sustain the development of EE credit.

Rationale

The main purpose of GEEC is to improve the role of financial institutions in promoting energy conservation, emission reduction and green development. And also effectively alleviate the problems of insufficient guarantee, asset light businesses and the financing difficulties of ESCOs. Due to the long investment cycle, large capital demand, slow investment return, and the lack of a well-regulated service market, most ESCOs face the dilemma of "difficult and expensive financing".

GEEC emphasizes that banking financial institutions should increase credit support for the key EE projects on the premise of effective risk control and business sustainability, especially for the projects that have been listed on the National catalogue of key energy-saving and low-carbon technologies. However, there's no database or other summary of how many credits have been issued based on the projects existing in the Catalogue.

Management

The guideline is designed by the China banking regulatory commission (CBRC) and the NDRC in 2015. CBRC supervises and administers the energy efficiency credit business for banking financial institutions in accordance with law. The NDRC is responsible for supervising and administering the energy conservation work carried out by key energy-using units, energy-saving service companies and third-party energy-saving auditing institutions.

Transparency and Predictability

The guideline specifies that projects and enterprises have to go through a series of inspections before they are determined as qualifying for energy efficiency credit. These inspections include the borrower's financial situation, the energy-using units' operation condition, and eligibility for preferential government policies. And as mentioned above, CBRC and NDRC are in charge of the management and supervision of this credit issuance.

Borrowers are required to submit relevant materials; once the project is recognized as eligible based on DEE's acknowledgement, financial institutions will confirm the amount of loans; the two parties sign the loan contracts and then the funds are issued.

Drivers

There are several policies issued by CBRC, NDRC, DRC and bank institutions in support of green credits. As a relatively new field there is substantial potential in promoting ECER, and green finance has been incorporated in many work plans and regulations. Including but not limited to the 12th and 13th five-year ECER work plan.

Table 18 Government & Commission Financial Institutions

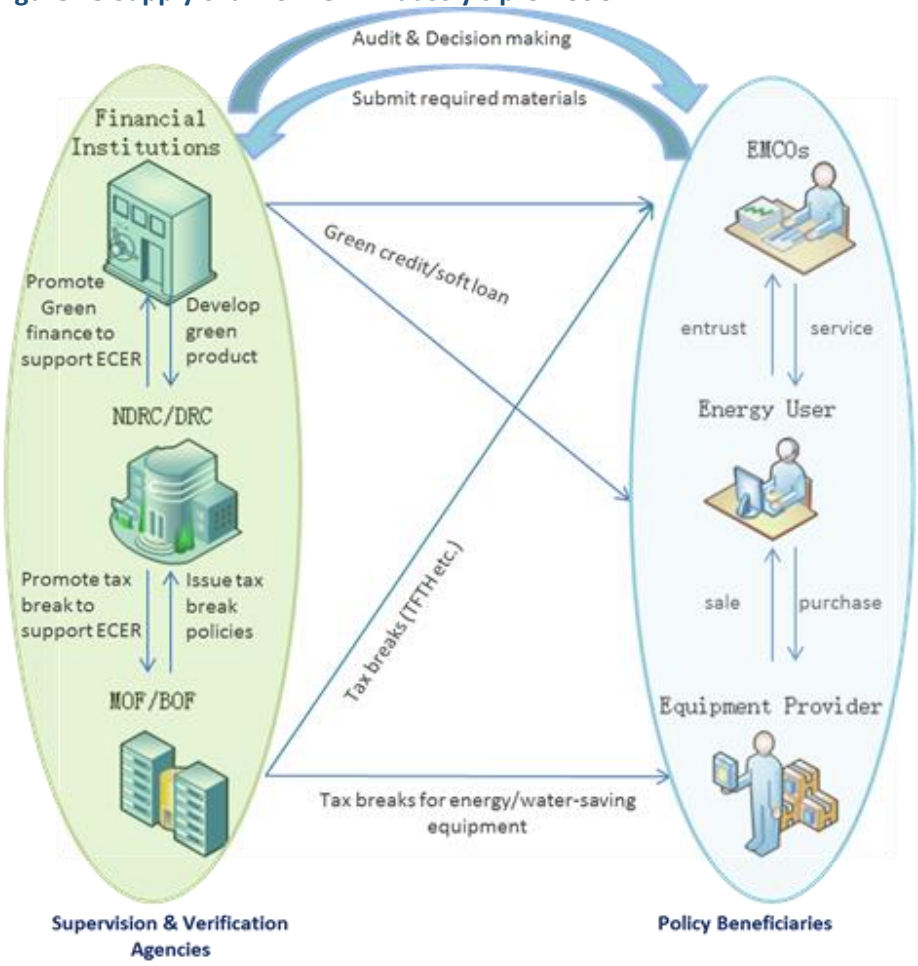
Government & Commission	Financial Institutions
Green credit guidelines-2012, by CBRC	Outline for implementing green credit – 2011, by ICBC
Guidelines on Energy Efficiency Credits - 2015, by NDRC and CBRC	China construction bank energy-saving emission reduction credit guidelines – 2012, by CCB

List of Green Bond Support Projects (2015 edition) – 2015, by PBC and Green finance committee of China	Agricultural bank of China on the implementation of green credit work – 2013, by ABC
Green Bond Issuance Guidelines – 2015, by NDRC	

Supply Chain

Since green credit requires the participation of several organizations, unlike tax and fiscal policy, we drew a more comprehensive figure to show how the three mechanisms work together under the guidance of central government. As explained previously and showed at the left side of Figure 5, usually the State Council and NDRC will issue general guidance policies regarding the promotion of the EE industry and EET&Ps through financial means, and then MOF, tax authorities, and financial institutions design mechanisms to realize the goal, such as tax breaks, fiscal funds and green credits. They also bear the responsibility of supervising the policy implementation as well as determining the beneficiaries. The right side of the figure showed interactions between energy users and ESCOs.

Figure 15 Supply chain of ECER industry's promotion



Impact and Sustainability

Green credit has achieved remarkable results and has developed as a national support social benefit tool. As shown in Table 5, the loans have increased year on year since 2013, as have the corresponding energy savings.

Table 19 Green credit on industrial energy and water saving project

	2013.06	2014.06	2015.06	2016.06	2017.06
Loan balance (billion Yuan)	289.9	347	366.9	404	505.7
% in ECER green credit	8.50%	8.34%	7.38%	7.25%	7.74%
Standard coal saved(t)	9063	18730182	18139229	21488312	23348192

(Data source: CBRC public disclosure)

From June 2013 to June 2017 the green credit balance within ECER area of 21 major banking institutions in China reached 6.53 trillion Yuan, accounting for 9% of all loans, among which the balance of industrial energy and water saving projects loans reached 505.7 billion Yuan in 2017. The percentage decline of ECER green credit, shown in Table 6, is due to the increase in overall loan balance during these years. These projects and service loans have significant environmental benefits. It is estimated that the annual emission reduction of carbon dioxide is 43,221,523.2ton, chemical oxygen 375,727 tons, ammonia nitrogen 15,524.5 tons, sulphur dioxide 1,162,022.3 tons and nitrogen oxides 414,849.3 tons in 2017 (CBRC public disclosure in 2017).

With continuous national policy support, such as the GECC, and as a new and influential area for financial institutions, green credits are benefitting both enterprises and the environment, and being established as a potential key part of future developments. Also, as a rare policy that explicitly refers to the Catalogue, the GECC enables organisations to receive loans which they might have struggled to obtain otherwise, and also acts as an accelerator for investment in EE products listed in the Catalogue. However, there is a lack of data regarding how much it contributes to the promotion of the Catalogue and further research needs to be done in the area.

3.5 Gap Analysis for existing fiscal incentives linked with technology catalogues in China

China has launched a series of supporting mechanism in achieving its energy efficiency and saving targets set continuously from the 11th five year plan to 13th five year plan. Financial incentives directly relates to technologies are subsidies, tax and electricity pricing ladder. When looking into policies and regulations, however, it is easy to notice that none of the incentives has direct links to the national energy saving catalogue issued by NDRC. Enterprises described the national catalogue as “informational” but lacked the incentive to implement the technology recommendations.

The experience in building mutual supports between informational tools and financial mechanism can be drawn from international cases. Some schemes and ETLs only have information, others only financial incentives, but these are not as effective in increasing the uptake of energy efficient products as those with a combined catalogue and financial incentive.

For subsidy incentives aiming at technology scale-up, the application procedures are deemed as long and difficult. To claim government rewards for energy saving retrofit projects, the company needs to submit energy saving report with third-party verification and then approved by energy saving and financial departments. And in most cases, the rewards are often gained by large or state-owned enterprises, and SMEs are often not qualified or reluctant to apply for the subsidies.

In addition, many energy-intensive organisations have limited access to loans from financial institutions which is a significant barrier to energy efficiency. They would hope government to transfer supporting mechanism from direct subsidies to risk guarantee fund or energy conservation fund that enable them to gain loans and other financial supports more easily.

3.6 Conclusion on financial incentives in promoting China's energy-saving technologies

We have explored several financial mechanisms that brought energy efficiency improvements to China, within which we recognise links between the incentives and the Catalogue. Typically, the incentive policies specify a range of eligibility criteria or categories, and the technologies listed on the Catalogue usually fall into these ranges. However, as the Catalogue is not directly linked to the policies, procuring products from the Catalogue does not entitle purchasers to priority when obtaining the financial incentives.

Although the **Catalogue was designed as an independent tool for technology-saving options, energy users believe it helps to increase their chances of obtaining incentives and use it as a reference tool when applying for incentives.** The Catalogue is acknowledged by technology purchasers and users as a reliable reference, and it has often been used as technology benchmark for policy-making. Based on our research, technology purchasers tend to believe technologies on the Catalogue hold a higher chance for getting tax and fiscal support, because the technologies were verified and approved by the same authorities (such as NDRC) that also designed the financial policies.

3.7 Feasibility Study

Our research on the national key energy saving technology promotion mechanism and the corresponding questionnaire for technology manufacturers (60 companies, 70% are private, 16% are state-owned, others are foreign), showed that 95% of enterprises believe there is urgent need to develop relevant fiscal and tax policies to promote EE technologies[37]. Therefore, it is important to develop financial mechanisms that take the present national technology catalogue into consideration.

In China, there are preferential policies for some "start-up" technologies and key projects requiring high initial investment, such as *Rare Earth Permanent Magnet High Efficiency Core-free Motor, Ice Thermal Storage Technology* et al. The government (NDRC, MIIT et al.) set special fund, subsidies and other financial means to support their development. However, it is hard to introduce similar financial measures for the Catalogue as it presently stands, due to the issues mentioned previously in Part 1. The end goal for the EE industry is to adopt market-oriented incentives with reduced government intervention. Although the Catalogue requires that featured technologies have a market share of less than 80%, some technologies could still hold a large market share. Therefore it is unnecessary and potentially unfair to create financial mechanisms to support the whole Catalogue, rather than focusing on the less developed technology markets.

To further and better promote the Catalogue with financial incentives, some improvements need to be done:

- **Further classification of the Catalogue.** Not only divide the Catalogue by sector, but also by industry maturity, technology creativity and reformation difficulty. In the last decade, China has made great achievements in energy conservation, mainly due to the increased focus on improving the IEE sector. In future, it will be harder to achieve the same level of progress and more time and investment will be needed. Thus, financial support should be dedicated to technologies with low market shares, or sectors that are currently lacking in R&D funds. It is also worth considering setting up a special fund to support technology diffusion.

[37] Data source: Research on promotion mechanism of national key energy saving technology and innovative financing mode, by CECEP Consulting, 2017

Establish a post evaluation mechanism. It's important to assess the Catalogue's performance and make adjustments accordingly so that high quality and applicability can be guaranteed. Therefore the corresponding fund can be targeted and more efficient at the same time.

Recommendations

The recommendations are separated into two sections: *Tax Incentives and Subsidies* and *Financial Mechanisms*, followed by practical next steps.

4.1 Tax Incentives and Subsidies

Rationale

The rationale for most financial supporting schemes for technology lists are quite straight forward: to increase investment in listed technologies. In many cases, **government support is still an important financial tool to promote technology catalogues**. In the cases where the technology lists were created and managed by governments, tax breaks and subsidies are popular accompanying incentives. The recipients of tax rebates and subsidies are also usually restricted to local companies and taxpayers.

There should be a public portal for suppliers to submit proposals and be included in the catalogue. In both ECA and Vamil schemes, suppliers can apply to be included in the list, and it would increase the dynamics of the list, ensuring latest technologies to be included in the list.

Management

In terms of management, tax and subsidies are usually administered by government departments or agencies. Cross-department cooperation is sometimes required. The use of tax incentives and subsidies managed by the government gain the schemes **a certain level of interest and buy-in from local stakeholders.** This support from government gives programmes credibility and increases awareness of the scheme.

Transparency and Predictability

The application process for financial incentives should be clear and straightforward to make the process streamlined and easy for purchasers to use. To claim an ECA, purchasing businesses need to mark a box in their tax forms and if required show certificates of conformity for their purchased products. A similar process is required to make a claim for Vamil. Simplified approaches help to accelerate the application process. This removes a potential barrier when claiming financial incentives, although as such minimal evidence is collected, this streamlined process hinders reporting on factors such as the success of the schemes or the types of products claimed for.

Drivers

Linking the tax incentives and subsidies with other policies increases support for the programme and can create greater market awareness of the incentives available. A positive attitude from government is key in leading decision makers to take energy-saving approaches such as upgrading their production line with high performing plant and machinery equipment.

Supply Chain

The use of specialized energy consultants to analyse the impact of energy efficient products and advise investors and purchasers could potentially ensure the effective implementation of these schemes.

The involvement of stakeholders such as vendors or suppliers is important in providing greater awareness of the scheme among customers and to increase the scheme's reach. Although they might

not be directly involved in the financial incentive, marketing the scheme to potential customers will benefit them indirectly through increased sales.

Impact and Sustainability

As mentioned streamlined processes might hinder reporting on factors regarding the scheme's impact. However, **gathering feedback on the programme is important to gain a greater understanding of the programme's impact** financially and in reaching emission reduction targets. Conducting market research, stakeholder feedback workshops and engaging with purchasers can provide some qualitative feedback on the success of the scheme. Quantitative data regarding tax incentives and subsidies claimed are useful in understanding how wide reaching the scheme is and the impact.

4.2 Financial Mechanisms

Rationale

Keep the eligibility criteria for potential projects wide enough to allow for an array of projects. For example, one of the successes of the GEFF programme is due to its flexible nature. The programme gave participating banks enough freedom so that they were comfortable expanding into new markets. In contrast to the tax incentives, the GEFF loan is available to companies in wider regions. This also allowed the market demand to determine which projects should be financed, aiding the disbursement of funds on the one hand; and helping to identify particularly difficult sectors on the other. The flexibility of the programme allowed it to adapt to different circumstances and paved the way for more targeted programmes for the areas of the market that were initially harder to reach.

Management

Ensuring that there is **accessible technical assistance to stakeholders**, is an important part of financial mechanisms such as the GEFF programme. The EBRD, as part of the GEFF framework, established project implementation teams who support local financial institutions and their clients. The expertise, which was initially free of charge to each bank, was fundamental in building the necessary capacity and expertise to drive change in the market. Assistance from local expert team increases the flexibility and responsiveness of the EBRD and results in effective implementation of the scheme.

As many financial institutions in China are deemed to lack the technical capacity required for green finance related projects, the component of technical assistance in the EBRD case is especially effective.

Transparency and Predictability

Monitoring and evaluation systems such as random inspections are essential to prevent fraud and misuse. It is also important for the administrative departments to conduct assessments on the environmental benefits of supported projects to ensure the transparency of the scheme. Transparency in application process is also important in government-led financial incentive schemes.

Drivers

For energy efficiency financing schemes led by banks or financial institutions, **it is important that the schemes are designed to be consistent with the institutions internal strategies**. This is to ensure that the schemes can operate with sufficient and continuous support and resources.

When the target market is widespread across a large and diverse region, more factors including **political awareness and varying market barriers should be considered when designing the scheme**. For example, the GEFF framework operates mainly in Europe where countries face similar barriers to energy efficiency.

Supply Chain

Building relationships with participatory financial institutions is a key factor for success. Due to the GEFF programme's strong relationships with the financial sector, a large number of banks were convinced to participate in the scheme. It helped drive a significant change in the banks, whereby dedicated teams were dealing with sustainable energy finance –another important pillar of the programme.

For financial instruments such as credit lines, **substantial technical assistance throughout the supply chain is indispensable** to stimulate disbursement and engender sustainable change. A lack of lending is not always due to the lack of available capital, but often due to problems developing a bankable pipeline. Meanwhile, a strong, stable banking sector that holds existing relationships with the target market and across the supply chain can make disbursement and, therefore, impact easier.

Impact and Sustainability

All financial mechanisms mentioned are successful in incentivising investment in energy efficient products. The **sustainability of the scheme should be focusing on how the market will continue without concessions**. Credit lines can test out market strengths and weaknesses by monitoring where the capital flows, highlighting areas of success that need less attention and those that struggling for future initiatives to target. The GEFF scheme enabled the EBRD to test which sectors were easier to reach, and which required more attention – potentially leading to follow-on programs that could address the greater need.

4.3 Practical Next Steps

Provide clear guidance on existing incentives

It is helpful to include more specific descriptions and terms of existing regulations and guidelines regarding energy efficiency improvements. Energy saving targets were set as one of China's Nationally Determined Contributions (NDCs) and were included in the 11th, 12th and 13th five-year plans. The supporting subsidies and tax incentives are triggered when energy-intensive enterprises meet the energy saving targets. Such impact-oriented methods give energy users a degree of flexibility in exactly how they reduce their energy consumption. By linking the current available incentives to the technologies listed in the Catalogue, it would increase the promotion of energy efficient technologies and provide the opportunity for a wider audience, such as SMEs, to benefit from the financial support available.

Create a website portal to make incentives more accessible

Since 2015, the application process for subsidies has become simpler as energy-intensive enterprises would only need approval from the provincial-level rather than the state-level. Despite the improvements, the process is still time consuming especially when compared to claiming the ECA in the UK, which only requires evidence of purchase. Lessons from the ECA and other financial mechanisms indicate that assessibility and convenience of applying for financial rewards are important factors for energy users, as tedious processes reduce their motivation to take part in the scheme.

Hire a technical team for verification and capacity building

As demonstrated by EBRD's GEFF scheme the advice of consultants and technology specialists greatly improves the user experience, reducing the time commitments required by users of the scheme and simultaneously encouraging the uptake of energy efficient products. By introducing a

technical team, the financial incentives will be available to a wider audience who previously might not have had the knowledge and expertise to get involved in such a scheme.

Engage the private sector

Private sector engagement is crucial to inform the design and implementation of financial incentives. To avoid crowding out private investment, financial incentives should add value to or address gaps and barriers associated with private investment. Effectively designed financial incentives benefit the market and avoid any potential impacts that could lead to market distortion (Walters et al. 2015; Bardouille et al. 2012). Engaging the private sector can help policymakers understand market gaps, identify opportunities to support private investment and market development, and avoid market distortion.

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