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KEITI

Green Public Procurement in the Republic of Korea:

a Decade of Progress and Lessons Learned

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GREEN PUBLIC PROCUREMENT IN THE REPUBLIC OF KOREA: A DECADE OF PROGRESS AND LESSONS LEARNED

FOREWORD

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Public procurement represents between 15 - 25% of global GDP and offers tremendous opportunities to drive circularity and advance the goal of making consumption and production more sustainable. Indeed, the 2030 Agenda includes a specific target on sustainable public procurement: "*public procurement practices that are sustainable, in accordance with national policies and priorities*".

The UN Environment Programme's 2017 *Global Review on Sustainable Public Procurement* highlighted that sustainable public procurement has reached a turning point. Its relevance as a strategic tool to drive sustainability and transform markets is no longer questioned. We now need to ensure that it is better integrated in broader sustainable consumption and production policies, so that it can deliver on its promise and catalyze new markets and jobs.

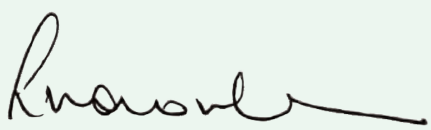
We also need to better monitor progress on sustainable public procurement and measure its impacts to build up the momentum and gather increased support for this transformative tool.

The present study, centered on the exemplary case of the Republic of Korea's Green Public Procurement policy explores the state of the art in impact measurement, with an overview of other successful international experiences.

It also makes useful recommendations on possible innovations to public procurement policy and measuring its impact. The study suggests, for example, the possibility of extending the measurement of sustainability impacts beyond CO_2 and to make an increase use of footprint calculators, which could be harmonized at world level. It also proposes an alternative way of measuring the creation of green jobs and extending impact measurement to energy efficient labelled products. The study examines the contribution that a macroeconomic assessment of impacts, based on a computable general equilibrium model, could make to understanding future policy options and scenarios in Korea.

The UN Environment Programme is actively engaged in the framework of the One Planet Sustainable Public Procurement Programme with monitoring sustainable public procurement and measuring its impacts. UNEP is leading the development of a robust methodology for measuring SDG Target Indicator 12.7.1. The results and conclusions of this study help improve our understanding of how sustainable public procurement can create job, income and climate opportunities for countries and help practitioners and decision makers to further improve their policy and monitoring frameworks.

We hope that the study will contribute to the growing awareness of how sustainable public procurement can transform markets and help achieve the 2030 Agenda. We hope this contribution will inspire and motivate more organizations and countries across the world to further engage and explore the potential of sustainable procurement policies in their development trajectories.



Ligia Noronha

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LIST OF ABBREVIATIONS

BOK	Bank of Korea
C-D	Cobb-Douglas
CPV	Common Procurement Vocabulary
CAGR	compound annual growth rate
CGE	computable general equilibrium
CES	constant elasticity of substitution
CET	constant elasticity of transformation
CPI	consumer price index
EPA	Environmental Protection Agency
EPP	Environmental Preferable Products
EU	European Union
GPIS-I	Green Procurement Information System
GP	green product
GPIS-II	Green Product Information System
GPP	green public procurement
GHG	greenhouse gas
GDP	gross domestic product
ICT	information and communications technology
KCS	Korea Customs Service
KEITI	Korea Environmental Industry and Technology Institute
KITA	Korea International Trade Association
KNSO	Korea National Statistical Office
KSIC	Korea Standard Industrial Classification
KONEPS	Korean Online E-Procurement System
KRW	Korean won
EPEAT	Electronic Product Environmental Assessment Tool
LCC	life-cycle costing
LES	linear expenditure syste,
MoE	Ministry of Environment
OECD	Organisation for Economic Co-operation and Development
PPS	Public Procurement Service
SME	Small and medium-sized enterprise
SAM	social accounting matrix
SCP	sustainable consumption and production
SD	sustainable development
SDGs	Sustainable Development Goals
SPP	sustainable public procurement
TCO	total cost of ownership
USD	United States dollar
WARM	Waste Reduction Model

Currency	*USD 1 = KRW 1,134.5*

EXECUTIVE SUMMARY

Public authorities are major consumers, their procurement accounting for 12% of GDP and 29% on average of total government expenditure in Organisation for Economic Co-operation and Development (OECD) countries[1]. With their purchasing power, public authorities can contribute to market development for sustainable products and services, technological innovation and job creation.

Certain countries, such as the Republic of Korea, the United States of America and Japan, already introduced green public procurement (GPP) as a policy instrument in the 1990s. However, in most cases, the promotion and implementation of GPP policies started as part of overarching sustainable development and sustainable consumption and production (SCP) strategies in response to the call for action at the Johannesburg World Summit on Sustainable Development in 2002.

Over the last two decades, the mission of public procurement has expanded beyond the accomplishment of the primary procurement objective — the delivery of goods and services to fulfil government missions in a timely, economical and efficient manner — to the support of secondary policy objectives, such as sustainable green growth, the promotion of small and medium-sized enterprises (SMEs), innovation, standards for responsible business and broader industrial policy objectives. This has transformed public procurement from a mere administrative procedure to a policy tool[2].

Sustainable public procurement (SPP) is a key strategic component for achieving more sustainable consumption and production patterns and driving innovation and sustainable development. That is why Sustainable Development Goal (SDG) 12 of the 2030 Agenda for Sustainable Development includes a specific target on the promotion of SPP, target 12.7: “Promote public procurement practices that are sustainable, in accordance with national policies and priorities”.

As a transversal policy instrument, SPP reinforces SCP implementation, if it includes supportive and harmonized policy mixes such as labelling and consumer information, mandatory instruments, economic incentives and long-term capacity building[3]. As the scope of SPP policies is widening to increasingly include multiple sustainability objectives[4], SPP contributes to achieving a broad variety of SDG targets depending on each country’s priorities.

OBJECTIVES OF THE STUDY AND APPROACH

The Global Review 2017 reported an increased inclusion of SPP in policy provisions compared to 2013, and the broadening of the scope of SPP policies to increasingly include multiple sustainability objectives in procurement policies. Although progress has been made in monitoring SPP implementation, evaluating total spending on sustainable and green products and services, and estimating outcomes of SPP and GPP policies as quantitative benefits for the environment, the economy and society still represent a significant challenge.

The overall objective of the study is to present the Republic of Korea’s GPP impact measurement methodology, to compare it to others used by other public authorities internationally and to pilot a macro-economic analysis of the economic and environmental impacts of the Republic of Korea’s GPP policy in order to improve the approaches used by the government to estimate GPP impacts and benefits.

Additionally, it contributes to the ongoing work of the One Planet SPP programme by providing guidance, advice and support to governments reforming their GPP policies and measurement approaches. The study also contributes to ongoing international efforts to increase the uptake of GPP policies through the communication of their quantitative benefits.

1 United Nations Environment Programme (2018). Policy Brief: Green Economy. Sustainable Public Procurement for an Inclusive Green Economy.

2 Organisation for Economic Co-operation and Development (2015). OECD Recommendation of the Council on Public Procurement.

3 EUPopp (2011). Policies to Promote Sustainable Consumption Patterns in Europe.

4 Adell, A. et al. (2017). 2017 Global Review of Sustainable Public Procurement.

GPP AS A STRATEGIC DRIVER FOR SUSTAINABLE ECONOMIC GROWTH IN KOREA

In addition to the goal to improve economic efficiency through public procurement, the Republic of Korea uses public procurement strategically for sustainable development. The first nationwide SPP policy was adopted in 1981 for the preferential purchase of veterans' products. Over the years, this strategic use has been extended to other sectors and policies based on national priorities for socioeconomic development and environmental protection.

The Republic of Korea's GPP policy (the Act on Promotion of Purchase of Green Products, 2005) is globally recognized as a best practice example[5]. In line with early GPP policies adopted in Europe and North America, the Republic of Korea's GPP policy has a strong focus on supporting SCP by developing the market for eco-labelled products through public demand.

The policy requires that all government agencies, from central to local governments, public corporations, public institutes, and public education institutions annually submit an annual GPP implementation plan, in which each organization sets its own voluntary target, and a performance report on the amount of green products purchased.

At the national level, GPP implementation involves institutions with different roles: the Ministry of Environment (MoE) is responsible for the overall management of GPP implementation, the Public Procurement Service operates the online procurement system, and the Korea Environmental Industry and Technology Institute (KEITI) plays a central role in awareness-raising, monitoring and evaluation.

The Republic of Korea is a frontrunner in the early use of electronic procurement systems and platforms for GPP implementation and monitoring. The early implementation of the Korean Online E-Procurement System (KONEPS), KONEPS e-shopping malls, KEITI's Green Procurement Information System (GPIS-I) and the most recent developments of the Public Procurement Data System enable GPP data to be automatically collected and reported for all government levels, making the Republic of Korea's GPP monitoring system a world-leading example.

To assess progress in the implementation of the public procurement component of the Act on Promotion of Purchase of Green Products, the MoE monitors two aspects. The first is operations-related, namely the number of public authorities developing GPP implementation plans and reporting on their implementation. The second is the level of actual purchase of green products, calculated by the units and economic volume of green products purchased and the percentage of those green purchases out of total purchases for product groups with the Korea Eco-label and Good Recycled Mark.

With the information gathered on the level of purchase of green products, KEITI calculates the sustainability impact of GPP.

RESULTS OF GPP IMPACT MEASUREMENT IN THE REPUBLIC OF KOREA

In 2017, 97.4% of state agencies submitted their implementation plans for 2018 and all of the 910 organizations reported their performance records for 2017.

The total expenditure on green products by all public institutions increased from USD 759 million (KRW 861 billion) in 2006 to USD 2,945 million (KRW 3.3 trillion) in 2017. The percentage of green product procurement over the total expenditure on those product categories was 47.5%.

The authorities that most contributed to those results were local authorities, with a GPP expenditure of just over USD 1 billion in 2017, around a third of all GPP in those categories. This was despite the fact that their GPP levels were the lowest compared to other types of authorities, as GPP levels over their expenditure in those categories were only 35.2%, compared to 74.8% for public enterprises. This is partly because local governments procure relatively large amounts of building and construction materials with a low GPP rate in relation to the total expenditure in that category.

As an SCP policy instrument, GPP tends to generate greater demand for green products and positively impact green production. The market evolution of green products can be used as an indirect indicator of the success of GPP policy implementation. The number of certified products increased from 2,721 in 2005 to 14,647 in 2017.

5 See OECD: Smart Procurement. Best Practices for Green Procurement, available here: http://www.oecd.org/gov/ethics/best-practices-for-green-procurement.htm

To communicate the benefits of GPP and promote its further implementation, KEITI and the MoE publish impact results each year. In 2017, the reduction of CO_2 equivalent emissions was estimated at 665,000 tons, the economic benefits linked to the reduction of several environmental impacts (such as CO_2 emissions, noise and so on) from total green purchases executed by PPS were USD 35.4 million, and 4,415 new jobs were created in the green economy.

KEITI communicates GPP plans and records for each organization. Results are also communicated using social math or equivalencies to facilitate the comprehension of the general public. For example, CO_2 equivalent emission reductions due to GPP are expressed in terms of vehicle exhaust emission reductions in Seoul over a certain number of days.

COMPARISON WITH GPP IMPACT MEASUREMENT IN OTHER COUNTRIES

As stated in the Global Review 2017 and in prior work done by the One Planet SPP programme, the Republic of Korea is, together with Japan, one of the few authorities that measures environmental outcomes of GPP annually.

In order to identify pros, cons and recommendations for the future, the study briefly presents the benefit measurement approaches of Japan, the state of Massachusetts, the Netherlands and the federal state of Berlin, and compares them with the Republic of Korea's approach.

To estimate outcomes, the methodologies analyzed differ in terms of the definition of a green purchase, its basis, the benefits to be evaluated and the conversion factors and tools used to carry out the evaluation. In some cases, tools developed by certification standards, industry or government initiatives are used. In other cases, tools are developed specifically to estimate SPP benefits. However, in most cases, specific calculation methods are defined instead of specific calculators being developed.

In all cases, the environmental benefits reported include equivalent carbon dioxide concentration (CO_2 eq) emissions. Additionally, some approaches report on avoided air pollutant emissions and material or cost savings. The Republic of Korea also includes job creation in the green economy as an impact indicator.

MACROECONOMIC IMPACTS OF GPP IN THE REPUBLIC OF KOREA

The macroeconomic impact of GPP in the Republic of Korea is analyzed at the national level using a computable general equilibrium (CGE) model. A greenhouse gas (GHG) reduction scenario with the introduction of a carbon tax is compared to three types of green product (GP) promotion policy scenario during the projection period of 2015 to 2030. The first scenario (GPP S1) provides a portion of the carbon tax as a GP production subsidy. Here, the subsidy rate is determined such that the GP supply price declines steadily and the remainder of the carbon tax revenue is transferred to the consumer. The second scenario (GPP S2) assumes that the technological progress rate in the green product sector increases by 1% each year through the scale parameter of green product production technology. The other scenario (GPP S3) is a combination of the first and second scenarios, as technological advances and production subsidies occur simultaneously in the GP sector.

The results are analyzed by comparing impacts on: the macroeconomy, including on GDP, consumption, investment, employment and industrial structure change; the local environment, including on coarse particulate matter (PM10), biochemical oxygen demand (BOD) and industrial waste; and social welfare.

The results of the analysis show that by 2030, the GPP policy scenario would create macroeconomic benefits in the range of USD 56 million (GPP S1) to USD 117 million (GPP S3) in terms of cost savings from GHG mitigation. In addition, it would contribute to increased investment, even in the GHG mitigation scenario. Furthermore, the industrial structure has contributed to the reduction in the proportion of energy-intensive industries, which serve the environmentally-friendly industrial structure.

One result of social welfare[6] is a positive effect on the technological progress scenario (GPP S2). Furthermore, the social welfare level in GPPs S1 and S3 decreased compared to that in the simple GHG reduction policy.

6 The value of social welfare change depends on the change of income level and indirect consumer utility (expenditure).

In addition, the increase in private income level was largest in GPP S2, indicating that consumption levels, including those of green products, had increased. In technological progress scenarios, the transfer of carbon tax revenue was the largest, leading to an increase in consumer income. Therefore, the positive social welfare effect of GPP policy can be induced by concurrently encouraging demand for green products in the private sector, through increased income, and technological progress in the green product sector.

The changes in pollutant emissions for local environmental pollution by scenario varied according to pollution intensity and changes in the industrial structure. Environmental pollution emissions significantly declined in the production subsidy scenario (GPP S1).

ROLE OF THE TWO MEASUREMENT METHODOLOGIES

The study presents two different GPP impact measurement methodologies; a bottom-up approach used by KEITI, and a top-down approach using the CGE model. While KEITI's approach is based on the actual purchase data of each public institution and its benefits compared to non-green products, the CGE model is used to model macro-economic impacts. In this sense, the use of the CGE model facilitates the evaluation of the potential effects of different policy instruments such as subsidized GP production, while KEITI's GPP impact measurement methodology focuses on awareness-raising and the communication of benefits of actual green purchases at the institutional, national and product levels. Therefore, the two measurement methodologies are complementary approaches.

THE WAY FORWARD

The key follow-up activities to strengthen the promotion of green products should focus on the review of the existing product categories of the Korea Eco-label and Good Recycled Mark, to incorporate other priority products and services purchased by public institutions and define policy measures to incentivize private market participation.

The current GPP impact measurement methodology used by KEITI could be improved by updating the benefit calculation methodology and including additional environmental benefits that are calculated but not communicated, such as resource saving and avoided emissions.

To further develop the CGE model approach and the quantification of benefits at the macro-economic level, the most important step forward is to set up a database on the production phase of green products to better define the economic, environmental and social benefits.

At the national level, the overall SPP policy and strategy and the coordination between GPP, energy-efficient procurement and other strategic procurement priorities should be strategically evaluated. At the international level, the collaboration with the One Planet SPP programme should focus on the potential use and development of GPP benefit measurement calculators and the communication of benefits.

CHAPTER 1

INTRODUCTION

1.1. PUBLIC PROCUREMENT: A TOOL FOR SUSTAINABLE DEVELOPMENT AND GROWTH

> "Sustainable procurement is a process whereby organisations meet their needs for goods, services, works and utilities in a way that achieves value for money on a whole life basis in terms of generating benefits not only to the organisation, but also to society and the economy, whilst minimising damage to the environment.[7] "

Public authorities are major consumers, their procurement accounting for 12% of GDP and 29% of total government expenditures on average in OECD countries[8]. With their purchasing power, public authorities can contribute to market creation for sustainable products and services, technological innovation and job creation. Sustainable public procurement (SPP) is recognized as a strategic instrument to deliver environmental, social and economic benefits, especially when considering the whole product life-cycle. Together with fiscal instruments such as special tax provisions, SPP can be a key driver of technological innovation[9], particularly in sectors in which public authorities are the main buyers, such as the health or public transport sectors[10].

Over the last two decades, the mission of public procurement has expanded from the accomplishment of the primary procurement objective, namely the delivery of goods and services to fulfil government missions in a timely, economical and efficient manner, to the support of secondary policy objectives, namely sustainable green growth, SME promotion, innovation, responsible business standards and broader industrial policy objectives. This has transformed public procurement from a mere administrative procedure to a policy tool[11].

Although certain countries, including the Republic of Korea, the United States of America and Japan, introduced green public procurement (GPP) as a policy instrument in the 1990s (see chapter 2), in most cases the promotion and implementation of GPP policies started as part of overarching sustainable development (SD) and sustainable consumption and production (SCP) strategies in response to the call for action at the Johannesburg World Summit on Sustainable Development in 2002. The aim of the call was to decouple economic development from environmental degradation and accelerate the shift to SCP patterns by using public procurement, among other instruments.

To support this, in 2002 the OECD adopted a Recommendation to its Member countries to take greater account of environmental considerations in public procurement, and to develop and apply efficient and effective greener public purchasing policies[12]. In 2003, the European Union also encouraged Member States to adopt National GPP Action Plans[13], and in the same year the international community set up the Marrakech Task Force on Sustainable Public Procurement[14] to promote SPP implementation, especially in developing countries, focusing on environmental, social and economic factors.

As part of SCP policies, the development of GPP policies has been strongly linked to the promotion of eco-labelling schemes and specific environmental features of products (such as recycled content, bio-based ingredients and energy efficiency). This is to stimulate the production and market availability of green products and technologies by creating demand through the purchasing power of public administrations.

7 Definition adopted by the Marrakech Task Force on Sustainable Public Procurement.
8 United Nations Environment Programme (2018). Policy Brief: Green Economy. Sustainable Public Procurement for an Inclusive Green Economy.
9 See OECD: Smart Procurement. Best Practices for Green Procurement, available here: http://www.oecd.org/gov/ethics/best-practices-for-green-procurement.htm
10 OECD (2015). OECD Recommendation of the Council on Public Procurement.
11 OECD (2002): Recommendation of the Council on Improving the Environmental Performance of Public Procurement
12 See: http://ec.europa.eu/environment/gpp/action_plan_en.htm
13 The Marrakech Task Force on Sustainable Public Procurement evolved to the 10YFP Programme on Sustainable Public Procurement
14 United Nations Environment Programme (2014). Sustainability of Supply Chains and Sustainable Public Procurement.

In more recent years, the role of GPP to achieve SCP and other environmental goals has been strengthened by its inclusion in all kinds of sectoral policies (including on climate change, resource efficiency and green growth)[16].

1.2. SPP AS A KEY STRATEGY TO DELIVER SDG 12

The 2030 Agenda for Sustainable Development, adopted in 2015 by 193 Member States, has at its core 17 Sustainable Development Goals (SDGs) and 169 targets. The SDGs build on the Millennium Development Goals and balance the three dimensions of sustainable development: economic, social and environmental.

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

RESPONSIBLE CONSUMPTION AND PRODUCTION

SDG 12, "ensure sustainable consumption and production patterns", with its targets and indicators for decoupling economic growth from natural resource use, is a goal that enables the achievement of many others. Its inclusion in the SDGs recognizes the cross-cutting role of SCP for sustainable development[16], as SCP takes into account environmental, social and economic aspects throughout the whole life cycle of products, works and services.

TARGET 12.1 IMPLEMENT THE 10-YEAR SUSTAINABLE CONSUMPTION AND PRODUCTION FRAMEWORK

IMPLEMENT THE 10-YEAR SUSTAINABLE CONSUMPTION AND PRODUCTION FRAMEWORK

Target 12.1 refers to the implementation of the 10-year framework of programmes on SCP, and the action to be taken by all countries.

The One Planet SPP programme is one of the six programmes of the One Planet network, a recognized implementation mechanism for SDG 12. The One Planet SPP programme is a global multi-stakeholder platform that supports the implementation of SPP around the world and builds synergies between diverse partners to achieve the SDG target on SPP. During the first four years, the One Planet SPP programme was co-led by the United Nations Environment Programme (UNEP), Local Governments for Sustainability (ICLEI) and KEITI.

TARGET 12.7 PROMOTE SUSTAINABLE PUBLIC PROCUREMENT PRACTICES

PROMOTE SUSTAINABLE PUBLIC PROCUREMENT PRACTICES

SPP is a key strategic component to achieve more sustainable consumption and production patterns and drive innovation and sustainable development. SDG 12 therefore includes a specific target on the promotion of SPP, target 12.7: "Promote public procurement practices that are sustainable, in accordance with national policies and priorities".

SPP as a transversal policy instrument reinforces SCP implementation, particularly when combined with supportive and harmonized policy mixes such as labelling and consumer information, along with mandatory instruments, economic incentives and long-term capacity building.

15 Hoballah, A. and Averous, S. (2014). Goal 12 — Ensuring sustainable consumption and production patterns: an essential requirement for sustainable development. UN Chronicle 51(4).

16 EUPopp (2011). Policies to Promote Sustainable Consumption Patterns in Europe.

In this sense, SPP directly contributes to the achievement of specific SDG 12 targets[17]. For example, target 12.2, the sustainable management and efficient use of natural resources, and target 12.4, the environmentally sound management of chemicals and all wastes throughout their life cycle and the reduction of their release to air, water and soil, are key elements of green public procurement policies, through the promotion and acquisition of products and services with a reduced environmental impact, such as eco-labelled products[18].

12.2 By 2030, achieve the sustainable management and efficient use of natural resources

12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment

Target 12.3, the reduction of food waste, can be used as a specific SPP criterion for catering services, for example in schools and hospitals. Target 12.5, reduced waste generation through prevention, reduction, recycling and reuse, is also a basic element in GPP policies and can be achieved through reduced packaging of purchased products and specific technical product criteria that promote circular economy principles. Such principles include design for disassembly and repair, extended product warranties and specific end-of-life criteria that promote product reuse, for example for furniture.

12.3 By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses

12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse

SPP indirectly contributes to the other SDG 12 targets, such as targets 12.6 and 12.8 on information and awareness-raising both for enterprises and citizens, as public authorities act as role models.

12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle

12.8 By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature

17 Adell, A. et al. (2017). Global Review of Sustainable Public Procurement 2017.

18 This contributes also indirectly to target 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.

All actions related to low-carbon procurement, such as minimum or increased energy efficiency requirements for buildings, infrastructure, public transport, vehicles and equipment, also directly contribute to SDG 13: "Take urgent action to combat climate change and its impacts", such as target 13.2 (integrate climate change measures into national policies, strategies and planning), and to SDG 11: "Make cities inclusive, resilient and sustainable", such as target 11.6 (by 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management) when defining pollutant emissions limits for vehicles, machinery and works.

SDG 12 targets are also directly related to the more sectoral targets on water (SDG 6), biodiversity (SDG 15) and industry (SDG 9).

As the scope of SPP policies is widening to increasingly include multiple sustainability objectives[19], SPP contributes to a broad variety of SDG targets depending on each country's priorities, as shown in Figure 1.

SPP also contributes to the fulfilment of other SDGs, such as SDG 7 on affordable and clean energy. The promotion of a 100% green electricity supply for public authorities contributes to target 7.2: "By 2030, increase substantially the share of renewable energy in the global energy mix", while the purchase of energy-efficient equipment and vehicles contributes to the achievement of target 7.3: "By 2030, double the global rate of improvement in energy efficiency".

SPP does not only cover the environmental aspects of SCP. SPP contributes to SDG 8: "Promote inclusive and sustainable economic growth, full and productive employment and decent work for all", through the promotion of social aspects such as the protection of labour rights, decent work and equal pay, the promotion of SMEs and innovation and the eradication of forced and child labour through specific contract clauses in public procurement.

19 UNEP (2017). Global Review of Sustainable Public Procurement 2017.

Figure 1. Potential contribution of SPP to the SDGs[21]

1.3. OBJECTIVES OF THE STUDY AND APPROACH

The 2017 Global Review of Sustainable Public Procurement notes the improved representation of SPP in policy provisions compared to 2013 and the broadening of the scope of SPP policies to increasingly include multiple sustainability objectives in procurement policies. Although progress has been made in monitoring SPP implementation, evaluating total spending on sustainable and green products and services and estimating outcomes of SPP and GPP policies in terms of quantitative benefits for the environment, society and the economy remain a considerable challenge.[20]

Good practice cases of SPP have shown environmental benefits, including reduced greenhouse gas (GHG) emissions, improved resource efficiency, economic savings throughout product life cycles and social benefits in terms of employment, public health and skills development[21]. The contribution of SPP to strategic policy targets is increasingly recognized, but a comprehensive assessment framework for measuring benefits and impacts of SPP has not yet been created[22].

The OECD Council on Public Procurement recommends that the use of public procurement to pursue secondary policy objectives should be balanced against the primary procurement objective through evaluation, the development of an appropriate strategy and the use of impact assessment methodologies to measure the effectiveness of procurement in achieving secondary policy objectives, both at the level of individual procurements and against policy target outcomes[23].

In the Republic of Korea, GPP is included as a policy instrument in the National Environmental Comprehensive Plan (1996-2005, 2006-2015, 2016-2035), the National Basic Plan for Sustainable Development (2006-2010, 2011-2015, 2016-2035) and in the Low Carbon, Green Growth Basic Plan (2009-2013,

20 Ecoinstitut, based on 10 YFP SPP- CI Programmes (WG 4B2 Webinar): Sustainable Development Goals and Public Procurement; how sustainability standards and ecolabels can support the 2030 agenda.

21 UNEP (2018). Policy Brief: Green Economy. Sustainable Public Procurement for an Inclusive Green Economy.

22 O'Rourke, A. et al. (2015). Measuring and Communicating the Benefits of Sustainable Public Procurement (SPP). Baseline Review and Development of a Guidance Framework. UNEP.

23 OECD (2015). OECD Recommendation of the Council on \Public Procurement.

2014-2018), encouraging the use of GPP to achieve the national sustainable development goals.

Since the enforcement of the Act on Promotion of Purchase of Green Products in 2005, the progress of GPP implementation is reported annually, and the effects of shifting from conventional to green products are estimated in terms of CO_2 reduction, job creation and economic benefits linked to the reduction of environmental impacts. The assessment of the economic and environmental benefits of GPP implementation in the Republic of Korea has been key for communicating the positive impacts of GPP and strengthening political support.

The implementation of GPP in the Republic of Korea has also led to a substantial increase of eco-labelled products in the market. Furthermore, since 2010 the scope of preferential purchasing policies for products with green or social attributes has increased, sometimes resulting in competing priorities (see chapter 2).

Although leading countries in GPP implementation – including the Republic of Korea – have been developing methodologies to quantify the associated benefits, a standardized approach is still lacking. Depending on data availability and policy priorities, current assessments are limited to a few potential impacts, such as CO_2 reduction and cost savings from a life cycle perspective. What is particularly lacking is an understanding of the economic impacts of GPP (for example GDP growth, technological innovation, job creation and social welfare).

The overall objective of the study is to showcase the Republic of Korea's GPP impact measurement methodology, to pilot a quantitative analysis of the economic and environmental impacts of the Republic of Korea's GPP policy and to contribute to the development of a comprehensive assessment framework.

Expected outcome and approach

- At the international level, the presentation of the Republic of Korea's GPP impact measurement methodology and the benchmark against other approaches contributes to the ongoing work on measurement and communication of GPP benefits carried out by the One Planet SPP programme.
- At the national level, the results of the study provide guidance, advice and support to the government when reforming its GPP policies and measurement approaches.
- The study contributes to sustainable economic growth and the associated economic, environmental and social impacts that it examines, to the extent that recommended policy reform options are adopted.
- The study also contributes to ongoing international efforts to improve GPP policy uptake through the communication of its quantitative benefits, particularly at the macro-economic level.

STRUCTURE OF THE DOCUMENT

Chapter 2 describes the state of play in the Republic of Korea relative to other countries in the region, as well as those that are widely considered to be at the forefront of the GPP movement. The chapter also examines public procurement processes in the Republic of Korea, including reforms aiming to introduce environmental and sustainability criteria into procurement decision making, the current proportion of procurement that could be considered green, and an emphasis on progress and challenges to overcome to reach the status quo.

Chapter 3 analyzes the methodology currently used by the Republic of Korea to measure the economic and environmental impacts of GPP implementation. In chapter 4, it is then compared against the GPP impact measurement methodologies used by other national and state authorities with a view to provide recommendations to improve the Republic of Korea's impact measurement methodology.

Chapter 5 focuses on the economic and environmental impacts of the green product (GP) sector in the Republic of Korea using a different methodology, the computable general equilibrium (CGE) model.

Finally, chapter 6 summarizes key recommendations from the study and sets out the way forward for improving the current GPP impact measurement methodology used in the Republic of Korea, notably through the CGE approach, issues for further analysis and lessons learned for domestic and international actors.

CHAPTER 2

GPP AS A STRATEGIC DRIVER FOR SUSTAINABLE ECONOMIC GROWTH IN THE REPUBLIC OF KOREA

2.1. GPP IN THE REPUBLIC OF KOREA IN COMPARISON WITH OTHER COUNTRIES

In this section, the state of play of GPP in the Republic of Korea is described in relation to other leading countries in the region, as well as GPP frontrunners worldwide, including the United States of America and certain European countries. The aspects considered are the GPP policy and institutional framework and GPP implementation and monitoring[24].

2.1.1. GPP POLICY AND INSTITUTIONAL FRAMEWORK

In relation to policy support for green public procurement, the Republic of Korea is one of the first countries, apart from the United States of America, to integrate GPP as a policy instrument, namely in the Act on Development and Support of Environmental Technology (1994), one year earlier than Japan with its Action Plan for Greening Government Operations (1995).

Following the call for action at the Johannesburg World Summit on Sustainable Development in 2002, the Republic of Korea passed the Act on the Promotion of Purchase of Green Products (2005) and approved its first Action Plan for the period 2006-2010, making it a frontrunner in the region along with Japan and China. During these years, other countries, including Canada, Mexico and the most developed countries in the European Union, also approved dedicated national GPP policies. In the European Union, this was spurred on by the recommendation to EU Member States to develop action plans for green procurement, set out in the Communication on Integrated Product Policy adopted in 2003.

Regarding environmental policy priorities, the Republic of Korea's GPP policy has a very strong foundation on the purchase of eco-labelled products as part of its sustainable consumption and production policy, similarly to China, Japan and the United States of America. In recent years, GPP frontrunner countries, including the Republic of Korea, have been developing their GPP policies with a view to integrate new environmental policy priorities, such as low-carbon and circular procurement. Additionally, the Republic of Korea has many sectoral procurement policies that cover different sustainability aspects — both environmental and socio-economic — on an individual basis.

In relation to set targets, European GPP plans incorporate quantitative targets at the national level using the percentage of GPP in terms of expenditure and number of tenders with green criteria, in line with the Communication (COM (2008) 400): "Public procurement for a better environment", which sets a common GPP target and framework for EU Member States. Countries that have introduced ambitious national GPP targets include the Netherlands, Austria, France and the United Kingdom.

Initially, the leading Asian countries (the Republic of Korea, Japan, China and Thailand) did not set up national quantitative targets for GPP. However, goals have since been set. Thailand introduced in its second National Plan of Green Purchasing, setting a goal for the central government of at least 90% GPP by 2016, while the Republic of Korea's third Action Plan stipulates a target of at least 60% GPP for the public sector by 2020.

With regard to the enforcement level, GPP frontrunner countries such as the United States of America, the Netherlands, Austria, Belgium and Finland generally set out political commitments and policy goals, but no mandatory legal requirement for GPP implementation. In such cases, GPP policies apply to central government bodies and are recommended for regional and local governments and reinforced through networking, training and the development of guidance and resources. Italy is one of the few countries that has made GPP mandatory at all government levels. In Asia, the Republic of Korea, Japan, China and Singapore have mandatory GPP[25].

24 Main information sources for the comparison are: Adell, A. et al. (2017). Global Review of Sustainable Public Procurement 2017; Adell, A. et al. (2017). Factsheets on Sustainable Public Procurement in National Governments; UNEP (2017). Comparative Analysis of Green Public Procurement and Ecolabelling Programmes in Japan, China, Thailand and the Republic of Korea; Adell, A. and Schaefer, B. (2013). SEAD Guide for Monitoring and Evaluating Green Public Procurement Programs; and European Commission (2018). National GPP Action Plans (policies and guidelines).

25 In the case of Japan, GPP is mandatory for the central government

Cities also play a leading role in GPP implementation. For example, Seoul uses GPP as an instrument for the implementation of a new policy for a disposable plastic-free city. This new policy was approved in September 2018 and aims to reduce the use of disposable plastic products, encouraging the purchase of green products instead. Seoul's target is to reach 70% GPP by 2020 and 90% by 2022, as part of the disposable plastic-free city goal.

The Republic of Korea has a strong institutional framework for GPP implementation, based on the collaboration of key actors: the Ministry of Environment (MoE), the Korea Environmental Industry and Technology Institute (KEITI), the Ministry of Economy and Finance (MOEF) and the Public Procurement Service (PPS). This is in line with the practices reported in the 2017 Global Review of Sustainable Public Procurement, which states that in most countries, all ministries and agencies associated with environmental, economic or financial responsibilities are involved in the development and implementation of SPP policies.

2.1.2. GPP IMPLEMENTATION AND MONITORING

The Republic of Korea is a frontrunner in using and linking electronic procurement systems and platforms for GPP implementation and monitoring. The early implementation of the Korean Online E-Procurement System (KONEPS), KONEPS e-shopping malls and KEITI's Green Procurement Information System (GPIS-I), combined with the most recent developments of the public procurement data system, enable the automatic collection and reporting of GPP data for all government levels, making the Republic of Korea's GPP monitoring system a world-leading example. Chile alone is implementing a similar product data-tracking approach through its e-procurement platform ChileCompra Express.

An important GPP feature in the Republic of Korea is the evaluation system of procuring entities against GPP records. The Republic of Korea is one of the few countries that provides fiscal incentives for GPP implementation. While high-performing local governments are rewarded with a larger budget, public institutions receive a performance bonus. A somewhat similar approach was introduced in France for a period of several years to promote environmental monitoring and performance, but for the central government alone. The concept of economic rewards has also been extended to citizens in the Republic of Korea through the Green Credit Card, which rewards environmentally-conscious consumers with economic incentives based on their green purchases. This is another key element in the promotion of eco-labelled products and a green lifestyle.

The Republic of Korea also promotes supplier engagement and green procurement in the private sector, through voluntary agreements, Eco-Expo Korea and so on, as the expansion of green markets and of companies of the Republic of Korea to the global market is one of the green industry policy goals.

Regarding impact estimation, the Republic of Korea is, together with Japan, one of the few countries to annually measure environmental outcomes of GPP. Apart from those countries, the factsheets in the 2017 Global Review of Sustainable Public Procurement report one-off estimations of environmental benefits in Denmark on the basis of case studies, one-off evaluation exercises from the Netherlands and the state of Berlin, and indirect evaluations through the environmental performance of government facilities and operations in the case of the United States of America and Spain.

2.2. THE REPUBLIC OF KOREA'S GPP POLICY

2.2.1. THE ROLE OF PUBLIC PROCUREMENT IN ECONOMIC DEVELOPMENT AND GREEN GROWTH IN THE REPUBLIC OF KOREA

Beside the strategic goal to achieve economic efficiency through public procurement, the Republic of Korea uses public procurement strategically for sustainable development. The first nationwide SPP policy was adopted in 1981 for the preferential purchase of veterans' products. Over the years, this strategic use has been extended to other sectors and policies based on national priorities for economic development and social and environmental protection.

At present, the Republic of Korea's government aims to promote economic growth, industrial innovation and job creation through public procurement, with an emphasis on boosting industrial competitiveness and promoting the development of new industries, thus encouraging job creation, creating social value and supporting the expansion of domestic SMEs to the global public procurement market[26].

Socioeconomic and environmental policies and acts for public procurement are the responsibility of various ministries. In all cases, the focus is on preferential purchase of products with specific environmental or social characteristics.

SOCIOECONOMIC POLICIES

- The Korea Veterans Health Service Act (1981, Ministry of Patriots and Veterans Affairs), establishes the preferential purchase of veterans' products.
- The Act on Support for Female-owned Businesses (1999, Ministry of SMEs and Startups), promotes the development of purchasing plans and the preferential purchase by public institutions of products manufactured by female-owned businesses.
- Similarly, the Act on the Facilitation of Entrepreneurial Activities of Persons with Disabilities (2005, Ministry of SMEs and Start-ups) facilitates the purchase of goods produced by businesses owned by people with disabilities in order to develop their markets.
- One of the aims of the Social Enterprise Promotion Act (2007, Ministry of Employment and Labour) is to support job creation in social enterprises through the preferential purchase of social enterprise-produced products, including the publication of purchasing plans and result reports.
- The Act on Facilitation of Purchase of Small and Medium Enterprise–Manufactured Products and Support for Development of their Markets (2009, Ministry of SMEs and Startups) aims to increase the purchase of small and medium enterprise-manufactured products through purchasing plans, annual result reports and the establishment of quantitative SME purchasing targets.
- The Framework Act on Cooperatives (2012, Ministry of Economy and Finance), specifies the preferential purchase of goods or services produced by social cooperatives as part of SME promotion.

ENVIRONMENTAL POLICIES

- The Korea Eco-label Programme (1992, Ministry of Environment) was initiated with four selected product groups.
- GPP was introduced in the Republic of Korea under the Act on Development and Support of Environmental Technology (1994, Ministry of Environment), recommending the preferential purchase of products with the Korea Eco-label or Good Recycled Mark certification to public institutions.
- The Act on Promotion of Purchase of Green Products (2005, Ministry of Environment) serves as the basis for the implementation of GPP, voluntary agreements on green business procurement and green store certification, among others.

26 Dawar, K. and Oh, S. (2017). The Role of Public Procurement Policy in Driving Industrial Development. UNIDO Department of Policy, Research and Statistics Working Paper 8/2017.

- The aim of the Framework Act on Low Carbon, Green Growth (2010, Office for Government Policy Coordination) is to achieve a national economy based on low-carbon green growth through green technology and industry development. Public procurement is one of the instruments for the facilitation of green technology and industry development, reinforcing the use of GPP as strategic instrument for market development.
- The Energy Use Rationalization Act[27] (2011, Ministry of Trade, Industry and Energy) and the Regulation on the Promotion of Rational Use of Energy by Public Agencies (2011, Korea Energy Management Corporation) regulate the use of highly energy efficient machinery, equipment and materials, eco-friendly vehicles and renewable energy generation in public organizations.
- Furthermore, as previously mentioned, GPP is one of the policy instruments included in the National Environmental Comprehensive Plan (1996-2005, 2006-2015, 2016-2035), the National Sustainable Development Basic Plan (2006-2010, 2011-2015, 2016-2035) and the Low Carbon, Green Growth Basic Plan (2009-2013, 2014-2018). The fourth National Environmental Comprehensive Plan includes seven strategic action plans for the transition to a low-carbon circular economy. To achieve this, the four main actions are: mitigating GHG emissions using market mechanisms, transitioning to a circular economy, promoting SCP through information and communications technology (ICT) and setting up an innovative ecosystem for the environmental industry. With regard to GPP, the plan includes an action to increase the accessibility of green products and related information through ICT.

An overview of SPP provision in thematic national policies in the Republic of Korea can be found in the 2017 factsheets on sustainable public procurement in national governments. A recent OECD report on the Republic of Korea's Public Procurement Service acknowledges the existence of eight to ten mandatory SPP requirements and up to 46 recommended procurement priorities undergoing development by different ministries, which creates complexity for procurement officers[28].

2.1.2. THE ACT ON THE PROMOTION OF PURCHASE OF GREEN PRODUCTS

The Republic of Korea's GPP policy (the Act on Promotion of Purchase of Green Products, 2005) is globally recognized as a best practice example[29]. In line with early adoptions of GPP policies in Europe and North America, the Republic of Korea's GPP policy focuses strongly on supporting SCP by developing the market for eco-labelled products through public demand.

The policy requires all government agencies, including central and local governments and public corporations, institutes and education institutions, to submit to KEITI an annual GPP implementation plan in which each organization sets its own voluntary target and performance report on the amount, in expenditure and number, of green products purchased.

The various public institutions are governed by their respective acts that regulate the evaluation of GPP implementation based on the provisions of the Act on Promotion of Purchase of Green Products ("Table 1. Legal basis for evaluation of GPP implementation in different public institutions (as of 2018)." on page 13).

27 In addition, in the Guidelines for Energy Use Rationalization Guidelines for Public Organizations, government and public organizations are required to purchase certain products designated by the Ministry of Trade, Industry and Energy, namely: (i) highly energy-efficient machinery, equipment and materials; (ii) products subject to Reduction of Standby Power; and (iii) products with top energy efficiency ratings. The procurement is also coordinated with PPS and added and identified in KONEPS.

28 See: https://read.oecd-ilibrary.org/governance/the-korean-public-procurement-service_9789264249431-en#page104

29 See OECD: Smart Procurement. Best practices for green procurement, available here: http://www.oecd.org/gov/ethics/best-practices-for-green-procurement.htm

Table 1. Legal basis for evaluation of GPP implementation in different public institutions (as of 2018).

	Local government	Public or quasi-government enterprise	Local public enterprise
Number of institutions	245	128	46
Ministry in charge	Ministry of the Interior and Safety	Ministry of Economy and Finance	Ministry of the Interior and Safety
Legal basis	Act on Public Service Evaluation	Act on the Management of Public Institutions	Local Public Enterprises Act
Effective since	2007 -	2010 -	2010 -

In addition, the Ministry of Environment (MoE) must establish an Action Plan for Promotion of Purchase of Green Products every five years.

ACTION PLANS FOR PROMOTION OF PURCHASE OF GREEN PRODUCTS

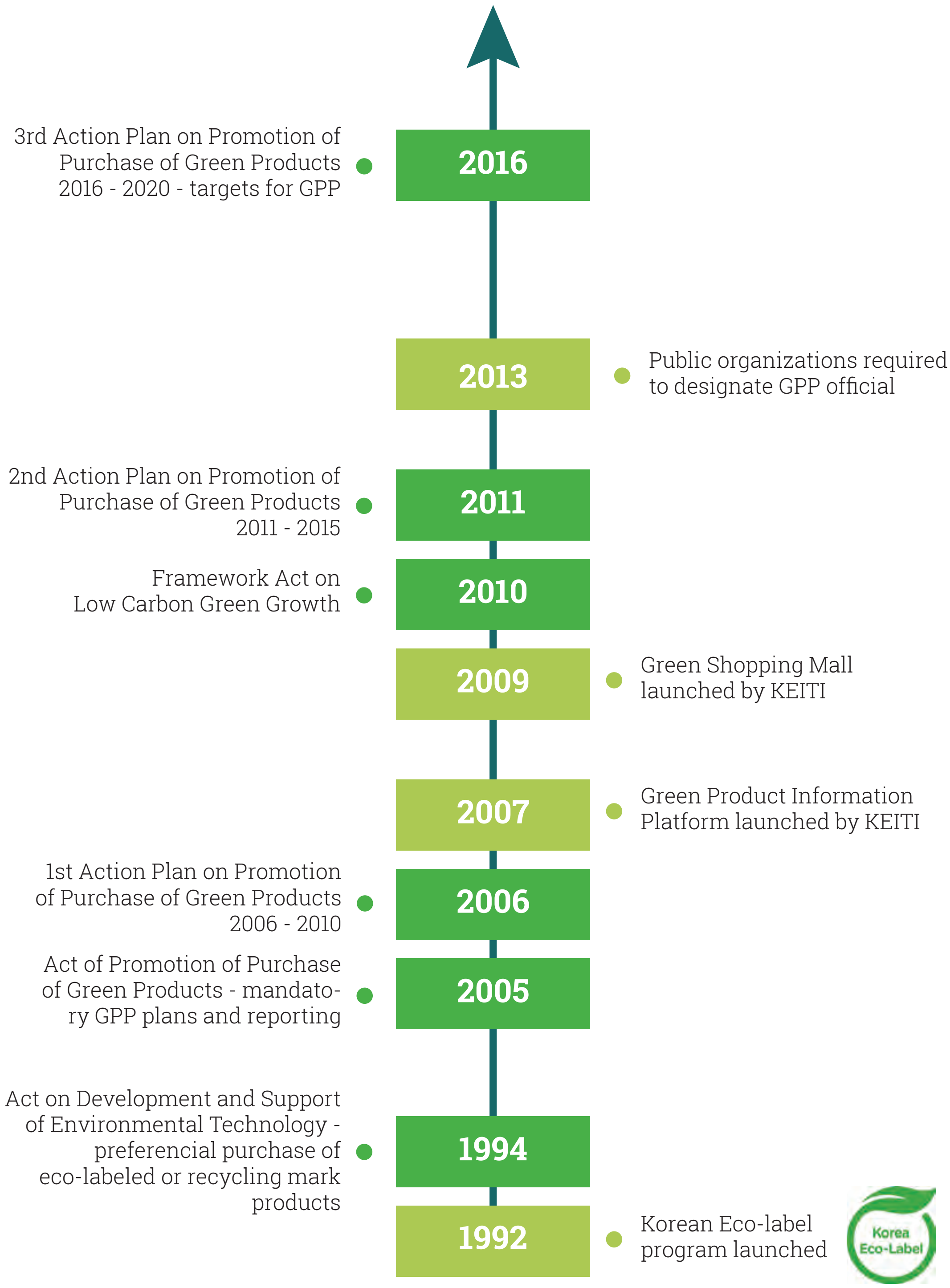
The first Action Plan for Promotion of Purchase of Green Products (2006-2010) focused on the implementation of green procurement in the public sector using eco-labelling as the principal tool.

The second Action Plan (2011-2015) was established to raise awareness on sustainable lifestyles and boost green consumption among general consumers, introducing the Green Credit Card and green store certification as new instruments.

The third Action Plan (2016-2020) covers various policy instruments including GPP, eco-labelling, Green Credit Cards and green store certification. The new goal is to increase the purchase of green products in the public sector, stipulating a target of at least 60% of GPP by 2020.

The major milestones of GPP implementation are illustrated in "Figure 2. Major milestones for GPP implementation" on page 15.

Figure 2. Major milestones for GPP implementation[30]



30 Figure adapted from UN Environment, Ecoinstitut (n.a.). SPP Module 6: Coordination of GPP and Ecolabelling Programs in different countries.

INSTITUTIONAL FRAMEWORK FOR GPP IMPLEMENTATION

At the national level, GPP implementation involves institutions with different roles, as summarized in "Figure 3. Institutional Framework for GPP Implementation in the Republic of Korea34" on page 17 and "Table 2. Responsibilities in GPP implementation" on page 17).

THE ROLE OF THE REPUBLIC OF KOREA'S PUBLIC PROCUREMENT SERVICE

The collaboration between KEITI and PPS is stipulated in the Act on Promotion of Purchase of Green Products as follows:

ARTICLE 12 (ROLES OF ADMINISTRATOR OF PUBLIC PROCUREMENT SERVICE)

(1) Whenever conventional products requested by the heads of public institutions can be replaced with green products, the Administrator of the Public Procurement Service shall request the heads of public institutions to purchase such green products. In such case, the heads of public institutions, if so requested, shall comply with such request unless there is a compelling reason not to do so.

(2) The Minister of Environment and the heads of the relevant central administrative agencies may request the Administrator of the Public Procurement Service to take measures necessary for encouraging the purchase of green products, such as expanding a foundation for the electronic procurement of green products, designating green products as exemplary procurement goods, etc.

The Republic of Korea's public procurement system is a dual system, consisting of a centralized procurement system, executed by PPS of the Ministry of Economy and Finance, and decentralized procurement individually conducted by each public authority. Centralized procurement accounts for 30% of total public procurement, while decentralized procurement represents around 70%[31].

Central government public entities are required to tender through PPS for purchases over certain thresholds, and to buy from PPS those goods or services for which framework contracts are in place[32]. Mandatory use of PPS by local government public entities has been progressively abolished, and such entities can now independently decide whether to use PPS or manage purchases and tendering processes through their own systems, except for those goods or services for which PPS framework contracts exist. Similar regulations apply to other public entities. Nevertheless, the number of public entities registered as users of PPS has steadily increased since 2010.

PPS is also responsible for implementing strategic policy goals through procurement, such as supporting SMEs and promoting the governments' Low Carbon, Green Growth policy by giving preference to green technology products. PPS promotes new procurement approaches such as public procurement of innovation and the integration of life-cycle costing in tender evaluation for energy-intensive products, including office IT equipment, air conditioning, elevators and LED lighting.

KONEPS

In 2002, PPS launched the Korean Online E-Procurement System (KONEPS), which is internationally recognized as a best practice model of public sector innovation. Furthermore, PPS has managed e-shopping malls for procurers since 2006.

KONEPS manages the entire procurement process electronically, including registration, procurement requests, tendering, contracting, payments and monitoring. Furthermore, it serves as a single window for all procurement activities as it is linked to over 190 external database systems, enabling public and private organizations to find and provide all contract-related documents using the platform. In terms of scope and coverage, KONEPS is at the forefront compared to other OECD countries due to its functionalities for contract management and monitoring after the tendering process. This

31 The specific requirements for national, local and other public entities are detailed in the State Contract Act, the Local Government Contract Act and the Act on the Management of Public Institutions.

32 Central government agencies are required to go through the centralized procurement process if their purchases and/or contracts are above the following thresholds: For commodity or service procurements, purchase above KRW 100 million (USD 88,145). For construction projects over KRW 3 billion (USD 2.64 million), or electric or communication projects over KRW 300 million (USD 264,434).

33 Lee, H. (n.a.). Monitoring and Evaluating GPP in the Republic of Korea [slides]. Korea Environmental Industry and Technology Institute.

Figure 3. Institutional Framework for GPP Implementation in the Republic of Korea[34]

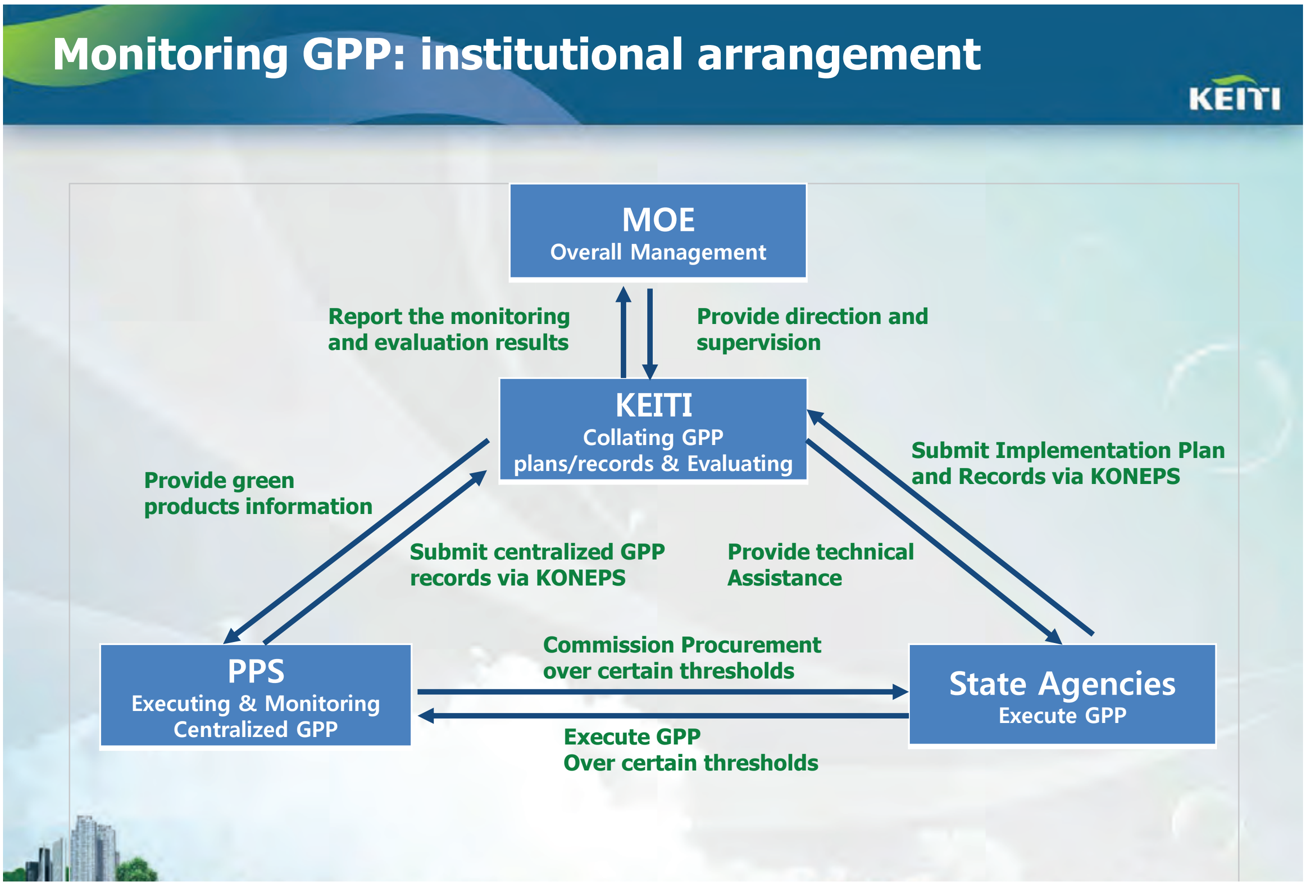


Table 2. Responsibilities in GPP implementation

Governing Institution	Responsibilities
The Ministry of Environment (MoE)	• Overall management of the GPP policy, definition of strategic goals and priorities • Establishment and monitoring of regular five-year action plans for the deployment of the Act
Public Procurement Service (PPS)	• Operation of the Korean Online E-Procurement System (KONEPS) to facilitate actual purchase of green products • Compilation of procurement records of public institutions • Communication of green products information provided by KEITI to public institutions
Korea Environmental Industry and Technology Institute (KEITI)	• Central role in GPP Implementation • Management of the Green Procurement Information System (GPIS-I, http://gd.greenproduct.go.kr/) and the Green Product Information System (GPIS-II, http://www.greenproduct.go.kr/) • Provision of education and awareness raising on GPP • Monitoring and evaluation of GPP records and performance • Transfer of know-how both nationally and internationally • Cooperation with stakeholders including other ministries, NGOs, research institutes and business
Public institutions	• Development of an annual implementation plan with voluntary targets for GPP and institutionalization of GPP in their own organization • Monitoring and reporting of green purchase records to MoE annually Designation of a Green Procurement Official within their own organization (since 2013)

Table 3. Transactions via KONEPS from 2012 to 2017[35]

Transactions via KONEPS		(Unit: million USD)					
Category / Year		2012	2013	2014	2015	2016	2017
Total		58,825	64,133	59,343	65,724	68,813	77,305
Central procurement	E-bid	19,184	21,757	18,049	19,773	18,707	19,561
	Shopping mall	11,026	12,283	11,965	12,413	12,716	14,609
	Total	30,210	34,040	30,015	32,187	31,423	34,171
Autonomous procurement by user entity		28,615	30,093	29,328	33,538	37,390	43,134

concentration of information, combined with the integration into the digital budget and accounting system of the Republic of Korea's Government, makes it easy to monitor purchases.

In 2017, KONEPS had over 52,000 public users and 373,000 supplying companies, and represented 71% of the total government procurement volume. The transactions via KONEPS can be found in Table 3[35].

THE PUBLIC PROCUREMENT DATA SYSTEM

To enable the accurate analysis of procurement policy implementation, the Public Procurement Data System was launched in 2014.

The Public Procurement Data System enables the collection of all procurement data from KONEPS and 24 external e-procurement systems used by public enterprises and specialized entities, and the creation of 102 specific data reports[36]. Datasets are publicly available and include both real-time and time-series data. The system enables public entities to analyze outcomes and improve performance, while enhancing transparency on public spending and monitoring market trends. The components of the systems can be seen in "Figure 4. Components of the Korean Public Procurement Data System" on page 18.

A more detailed description of the Republic of Korea's Public Procurement Data System can be found in the country case of the OECD's Public Procurement Toolbox.

34 Republic of Korea, Public Procurement Service (N/A). Public Procurement Service, Innovating Excellence in Procurement -2016 and 2017 Annual Reports.

35 All amounts have been converted from KRW to USD with a rate of 1$ = 1,134.5 KRW.

36 Republic of Korea, Public Procurement Service (N/A). Public Procurement Service, Innovating Excellence in Procurement -2017 Annual Report.

THE ROLE OF KEITI IN GPP IMPLEMENTATION

To support public authorities in their compliance with the provisions of the Act, KEITI has developed several tools.

In 2007, KEITI launched the Green Procurement Information System (GPIS-I) to facilitate GPP implementation and data reporting (http://gd.greenproduct.go.kr). The GPIS-I website is the main GPP information source in the Republic of Korea and includes the reporting system for the compilation of GPP data from public authorities (see Figure 5, 6 and 7). It also provides graphic representations of the GPP plans, records and associated environmental benefits of individual organizations, as shown in Figure 12.

To provide product-related information to all stakeholders, KEITI established the Green Product Information System (GPIS-II, http://www.greenproduct.go.kr/) in addition to GPIS-I. GPIS-II provides access to resources such as the GPP guidelines, a catalogue of certified products and a list of the best GPP practices by the public authorities of the Republic of Korea.[37]

37 Republic of Korea, Public Procurement Service (N/A). 2015 Annual Report

Figure 4. Components of the Korean Public Procurement Data System

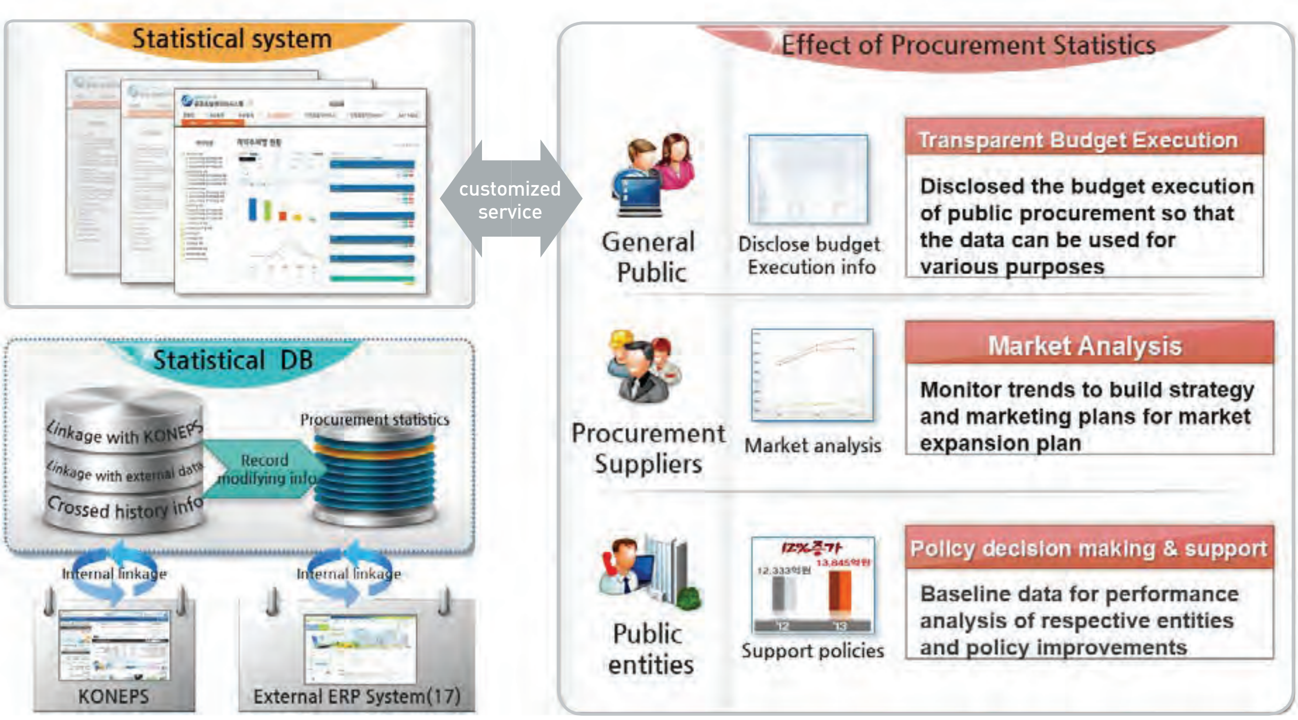


Figure 5. KEITI's Green Desk, submission of a GPP plan and results by public authorities (in Korean)

현재문서 내려받기 | 표준양식 내려받기 | 제출 | 구매계획 수정하기 | 작성계획 올리기

분류검색 | 검색

2013년 감사원 계획 작성표 (금액단위 : 천원)

친환경상품분류		총구매(A) 수량	총구매(A) 금액	친환경구매(B) 수량	친환경구매(B) 금액	비율(% B/A) 수량	비율(% B/A) 금액
합계		6,419	946,066	4,205	758,836	65.5	80.2
사무기기	복사기	20	72,000	10	30,000	50	41.7
	팩시밀리	20	6,900	16	5,520	80	80
가전제품	세탁기	0	0	0	0	0	0
	식기세척기	0	0	0	0	0	0
	냉장고	0	0	0	0	0	0
	공기청정기	0	0	0	0	0	0
	텔레비전 및 비디오프로젝터	15	9,000	15	9,000	100	100
	음식물쓰레기 감량화기	0	0	0	0	0	0
	에어컨디셔너	0	0	0	0	0	0

현재문서 내려받기 | 표준양식 내려받기 | 구매실적 수정하기 | 제출 | 작성실적 올리기

연계시스템합산실적 조회 | 조회결과 내려받기 | 분류검색 | 검색

(A) : 조달청, 이마켓 등 각 연계시스템을 통해 합산된 내역
(B) : "연계시스템 합산실적(A)"에 대한 수정/보완(가감) 내역

2012년 감사원 실적 작성표 (단위 : 천원)

친환경상품분류	연계시스템합산실적(A) 총구매 수량	총구매 금액	친환경구매 수량	친환경구매 금액	실적수정보완(B) 총구매 수량	총구매 금액	친환경구매 수량	친환경구매 금액	총합계(A+B) 총구매 수량	총구매 금액	친환경구매 수량	친환경구매 금액
합계	11,8	1,214,4	6,61	789,78	0	0	0	0	11,8	1,214,4	6,61	789,78
복사기	11	65000	8	23360	0	0	0	0	11	65,000	8	23,360
팩시밀리	17	4476	17	4476	0	0	0	0	17	4,476	17	4,476
세탁기	0	0	0	0	0	0	0	0	0	0	0	0
식기세척기	0	0	0	0	0	0	0	0	0	0	0	0
냉장고	0	0	0	0	0	0	0	0	0	0	0	0
공기청정기	0	0	0	0	0	0	0	0	0	0	0	0
텔레비전 및 비디오프로젝터	1	2582	1	2582	0	0	0	0	1	2,582	1	2,582

Figure 6. KEITI's Green Desk, submission of a GPP plan by public authorities (in English)

Name of the Reporting Institute, (Year)						
Summary Table (Unit : 1,000 KRW)						
Total	Total Procurement (Ordinary+Green)(A)		Green (B)		Percentage (%) (B/A)	
	Quantity	Amount	Quantity	Amount	Quantity	Amount
	0	0	0	0	0	0

Detailed Table (Unit : 1,000 KRW)							
Product category		Total Procurement (Ordinary+Green)(A)		Green (B)		Percentage (%) (B/A)	
		Quantity	Amount	Quantity	Amount	Quantity	Amount
Office/Education/ Visonary/Appliance	Office Equipment	0	0	0	0	0	0
		0	0	0	0	0	0
....	....						

Figure 7. KEITI's Green Desk, submission of GPP results by public authorities (in English)

Summary Table (Unit : 1,000 KRW)								
Total	Procurement executed via PPS(A)		Procurement executed by the organization(B)		Proc. executed via Green Market(C)	Total(A+B+C)		
Name of Umbrella Org.	Total Procurement (Ordinary+Green)	Green Procurement	Total Procurement (Ordinary+Green)	Green Procurement	Green Procurement	Total Procurement (Ordinary+Green)	Green Procurement	%
Name of Subsidiary Org.								
...								

Detailed Table by Product group (Unit : 1,000 KRW)								
Total	Procurement executed via PPS(A)		Procurement executed by the organization(B)		Proc. executed via Green Market(C)	Total(A+B+C)		
Copy Machine	Total Procurement (Ordinary+Green)	Green Procurement	Total Procurement (Ordinary+Green)	Green Procurement	Green Procurement	Total Procurement (Ordinary+Green)	Green Procurement	%
Fax								
...								

Since 2009, KEITI has operated the e-shopping mall Green Market, which is dedicated to green products for public procurers. Green Market serves as a channel for public institutions to make low-volume purchases, which do not necessarily go through PPS as no tendering is required. The amount of green products purchased via the Green Market e-shopping mall has grown 3.2 times over the last six years and it made USD 2.9 million in sales in 2018, as shown in Table 4. These purchases are automatically monitored by KEITI, so public institutions do not need to report them manually.

Table 4. Green procurement via Green Market from 2013 to 2017

Green Procurement via Green Market						
	2013	2014	2015	2016	2017	2018
Total sales (USD)	927,281	1,301,895	1,677,391	2,247,686	3,342,442	2,995,672
Number of product groups	39	39	30	33	31	57

From November 2018, KEITI concluded a memorandum of understanding (MOU) with three maintenance, repair and overhaul companies to open three new online shopping malls to increase green product diversity and consequently price competitiveness.

GPP SUPPORT MEASURES PROVIDED BY KEITI

To support GPP implementation, KEITI provides various resources to practitioners involved in procurement.

In 2006, KEITI established the Standard Ordinance for Promotion of Green Procurement for local governments. At present, a total of 241 out of 245 local governments have established their own ordinance for GPP, recording an ordinance establishment ratio of 98.4%. The Standard Ordinance for Promotion of Green Procurement for education authorities was established and distributed in July 2013.

Nationwide GPP training is also offered to over 6,000 public officials every year. GPP guidelines developed by KEITI are distributed before the training session. Annual nationwide training is provided from November to December for the following year's GPP implementation, and additional training is provided for newly appointed GPP staff. Further training is organized upon request.

KEITI gives administrative support to companies in registering their eco-labelled products in PPS online shopping malls in order to facilitate green product distribution.

KEITI holds annual procurer workshops for the exchange of best practices and improvement of GPP implementation for local governments, public enterprises and quasi-government institutions. The President, Prime Minister and Environmental Minster's Awards are given to those who deliver outstanding performances.

Financial incentives are given as annual high-performance bonuses to public organizations evaluated by a ranking of several indicators, including GPP, which is evaluated based on the percentage of green purchases over the total amount of annual purchases. The higher the GPP, the better the results and the higher the bonus for the organization.

OTHER COMPLEMENTARY ACTIONS BY KEITI

Eco-Expo Korea has been held since 2005, and features various eco-friendly technologies, products, services and other environmental business and government activities. It serves as a platform to raise public awareness on eco-friendly consumption and lifestyles.

The Korea Eco-Business Award is hosted by MoE and operated by KEITI. The award is a reputational incentive to reward organizations or individuals that have contributed to the development of ecological technology and industry, mitigation of climate change, and eco-friendly consumption and production.

The Green Credit Card is an incentive system jointly launched by the Government of Korea and credit card companies to provide economic incentives for environmentally-conscious consumers. Financial incentives are provided for purchasing low-carbon and eco-friendly products, using public transport and saving on utility rates, including electricity, water and gas. The credit card platform serves as a convenient medium to accumulate and use points in daily life, and has attracted more than 16 million users.

2.2.3. DEFINING PUBLIC PROCUREMENT AND GREEN PRODUCTS

The various legal provisions pertaining to GPP implementation lead to the definition of environmental norms and standards for the purchase of green products, as summarized in "Table 5. Environmental scope of green products in GPP regulations in the Republic of Korea" on page 22.

The Act on Promotion of Purchase of Green Products (2005) is the main policy in place to promote GPP in the Republic of Korea, and is based on the promotion of eco-labelled and recycled products. The Framework Act on Low Carbon, Green Growth (2010) reinforces the use of GPP as strategic instrument for market development.

Table 5. Environmental scope of green products in GPP regulations in the Republic of Korea

Regulation	Environmental scope of green products
Act on Promotion of Purchase of Green Products (2005)	• Korea Eco-label and Good Recycled Mark • Inclusion of certified low-carbon products under consideration as of 2018[39]
Framework Act on Low Carbon Green Growth (2010)	• Conceptual definition of green products: products that minimize the consumption of energy and resources and the generation of greenhouse gases and pollutants
Purchasing Guidelines for Promotion of Green Products (2010) by PPS	• Energy efficient products, new or renewable energy products, Korea Eco-label and Good Recycled Mark, Minimum Green Standard products, certified green technology products
Energy Use Rationalization Act (2011) and Regulation on the Promotion of Rational Use of Energy by public Agencies	• High-efficiency energy machinery, equipment and materials, products subject to reduction of standby power and top products ranked by energy efficiency rating

In addition to the Act on Promotion of Purchase of Green Products, according to the Energy Use Rationalization Guideline for Public Organizations, government and public organizations are required to purchase certain products designated by the Ministry of Trade, Industry and Energy. They are high-efficiency energy machinery, equipment or materials, products subject to reduction of standby power and top products ranked by energy efficiency rating.

In line with the Framework Act on Low Carbon, Green Growth, PPS introduced green standard purchasing in 2010 through the mandatory purchase of products that meet the Minimum Green Standard, including office appliances, recycled products, LED lamps and hybrid vehicles. The Minimum Green Standard was developed by PPS and includes products that fall under the Act on Promotion of Purchase of Green Products and the Energy Use Rationalization Act.

In 2013, the total number of Minimum Green Standard categories selected by PPS was 100. The purchase of Minimum Green Standard products increased from less than 1% of the total purchase of goods by PPS in 2010 to 16% in 2014[39].

38 There are three phases of certification under the Carbon Footprint of Products in Korea: the certification of carbon emissions (phase I), the certification of low-carbon products (phase II) and the certification of carbon-neutral products (phase III). Only low-carbon products (phase II) are under consideration for inclusion in the Act. http://www.epd.or.kr/eng/cfp/carbonIntro00.do

39 See: https://read.oecd-ilibrary.org/governance/the-korean-public-procurement-service_9789264249431-en#page102

In the following sections, the analysis focuses on the implementation of the Act on Promotion of Purchase of Green Products and its definition of green products, namely those with the Korea Eco-label and the Good Recycled Mark certification.

2.2.4. PRODUCT CATEGORIES COVERED BY THE ACT ON PROMOTION OF PURCHASE OF GREEN PRODUCTS

According to the Act on Promotion of Purchase of Green Products, green products are defined as:

- certified or meeting the criteria set by the Korea Eco-label;
- certified or meeting the criteria of the quality certificate for recycled products, the Good Recycled Mark; or
- in compliance with other environmental criteria set by the MoE in consultation with the heads of relevant ministries (currently no product categories).

The number of product categories covered has increased over the years as the number of categories has increased for the Korea Eco-label and the Good Recycled Mark. As of December 2018, there are 14,698 GPP-applicable products in 160 categories certified by the Korea Eco-Label and 220 in 12 categories certified by the Good Recycled Mark, as shown in Table 6. Some appear in "Figure 8. Example of product categories covered42" on page 23.

Table 6. Type of green products selected for the green public procurement programme (as of July 2018)

	Korea Eco-label	Good Recycled Mark
Product groups	160 (office supplies, electronic appliances, construction materials, furniture, etc.)[41]	12 (recycled paper, rubber, plastic, etc.)
Number of certified products	14,698 products	220 products
Number of manufactures	3,825	193
Certified by	Korea Environmental Industry and Technology Institute	Good Recycled Institute
Certification authority	Ministry of Environment	Ministry of Trade, Industry and Energy
Website	http://www.ecoi.go.kr	http://www.gr.or.kr

Figure 8. Example of product categories covered[42]

During recent years, some additional sector-specific, GPP-related policies have promoted the procurement of recycled and Korea Eco-label products, particularly in the construction sector. In 2005, the Construction Waste Recycling Promotion Act introduced the requirement of using recycled aggregates certified either by the Korea Eco-label or the Green Recycled Mark when awarding contracts for road construction works.

The Green Architecture Support Act (2013) indirectly promotes construction materials with the Korea Eco-label or Green Recycled Mark, as they are included as criteria in the Republic of Korea's green building certification, the G-SEED certification, which is mandatory for public buildings larger than 3,000 square meters.

2.1.7. RESULTS ACHIEVED

To monitor progress in the implementation of the Act on Promotion of Purchase of Green Products, MoE monitors two aspects:

- Operations-related aspects, meaning the number of public authorities developing GPP implementation plans and reporting on their implementation.
- The level of actual purchase of green products by public authority and product group, meaning the quantity (in units and expenditure) of green products purchased and the percentage of those green purchases over the total purchase for the product groups with the Korea Eco-label and Green Recycled Mark.

With the information on the purchase of green products, KEITI also calculates the sustainability impacts of GPP (see chapter 3).

40 The full list of product groups with the Korea Eco-label can be found here: http://el.keiti.re.kr/enservice/enpage.do?mMenu=2&sMenu=1

41 Lee, H. (N/A) Monitoring and Evaluating Green Public Procurement in the Republic of Korea (slides).

Table 7. GPP indicators 2006 - 2017

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
KEITI Indicators (from KONEPS and directly reported by authorities)												
Total expenditure on green products (million USD)	759	1,184	1,396	1,436	1,447	1,450	1,522	1,801	1,940	2,126	2,508	2,945
% GPP over the total expenditure	58.3	69.3	50.4	40	39.7	32.1	31.3	32.9	39.7	42.2	46.1	47.5
PPS Indicator (only purchases through KONEPS)												
% of GPP over the total (domestic) purchases executed by PPS[44]	4.3	6.0	4.3	5.7	4.7	4.7	6.1	7.5	7.9	7.9	10.0	10.8

The impact on market transformation in terms of the market share of selected green products and the number of products with the Korea Eco-label or Good Recycled Mark certification is not included as an indicator of the Act, but should also be considered as a key performance indicator for the Republic of Korea's GPP policy.

NUMBER OF AGENCIES SUBMITTING GPP IMPLEMENTATION PLANS AND PERFORMANCE REPORTS

The deployment of GPP implementation plans is monitored based on the percentage of public entities that submit their annual GPP implementation plans to MoE by uploading them to the GPIS-I.

The total amount of plans and records cover more than 30,000 public organizations in the country. However, they are not collected individually. Umbrella organizations and regional governments are responsible for the compilation of the plans and records of subsidiary organizations and cities within their boundaries[42].

In 2017, 97.4% of state agencies submitted their implementation plans for 2018 and all of the 910 organizations reported their performance records for 2017.

TOTAL GREEN PURCHASE VALUE BY PUBLIC INSTITUTION

The total expenditure on green products by public institutions increased from USD 759 million (KRW 861 billion) in 2006 to USD 2,945 million (KRW 3.3 trillion) in 2017, as shown in Table 7.

In 2017, the percentage of green products procurement over the total expenditure on those product categories was 47.5%. If figures from KONEPS alone are analyzed, the procurement of green products accounted for about 11% of total purchases conducted by PPS.

As shown in Table 8, local governments have higher GPP expenditure in monitored product categories than other types of authorities (just over USD 1 billion in 2017, which represents 36.2% of total GPP expenditure in those categories). However, GPP levels themselves are low, reaching only 35.2% of GPP over their total expenditure in those categories. This is because their level of greening is higher, although they contribute less to overall GPP compared to other types of authorities. This is partly because local governments procure relatively large amounts of building and construction materials with a low GPP rate in relation to the total expenditure in that category, as presented in "Table 9. GPP performance of 2017 by product group45" on page 25.

42 The number of GPP target organizations varies according to the designation of new public organizations by the Ministry of Economy and Finance (717(2007) -> 802(2009) -> 824 (2011) -> 879(2013) -> 883(2014) -> 894(2015)-> 899(2016) -> 910(2017) -> 918(2018)).

43 http://www.index.go.kr/egams/stts/jsp/potal/stts/PO_STTS_IdxMain.jsp?idx_cd=1376

Table 8. GPP level by type of public organization in 2017

Type of public authority	Total expenditure in product categories with GPP criteria (million USD) (A)	Total expenditure on Korea Eco-label and Good Recycle Mark products in these categories (million USD) (B)	% of GPP over total expenditure (B/A*100)
Central governments	866.5	367.9	42.5
Local governments	3,029.4	1,066.3	35.2
Educational authorities	1,351.2	859.9	63.6
Public enterprises	566.2	423.5	74.8
Quasi-government enterprises	196.3	120.9	61.6
Local public enterprises and organizations	111.2	62.0	55.7
Local research institutes	0.5	0.4	73.9
Others	74.3	44.3	59.7

Table 9. GPP performance of 2017 by product group[45]

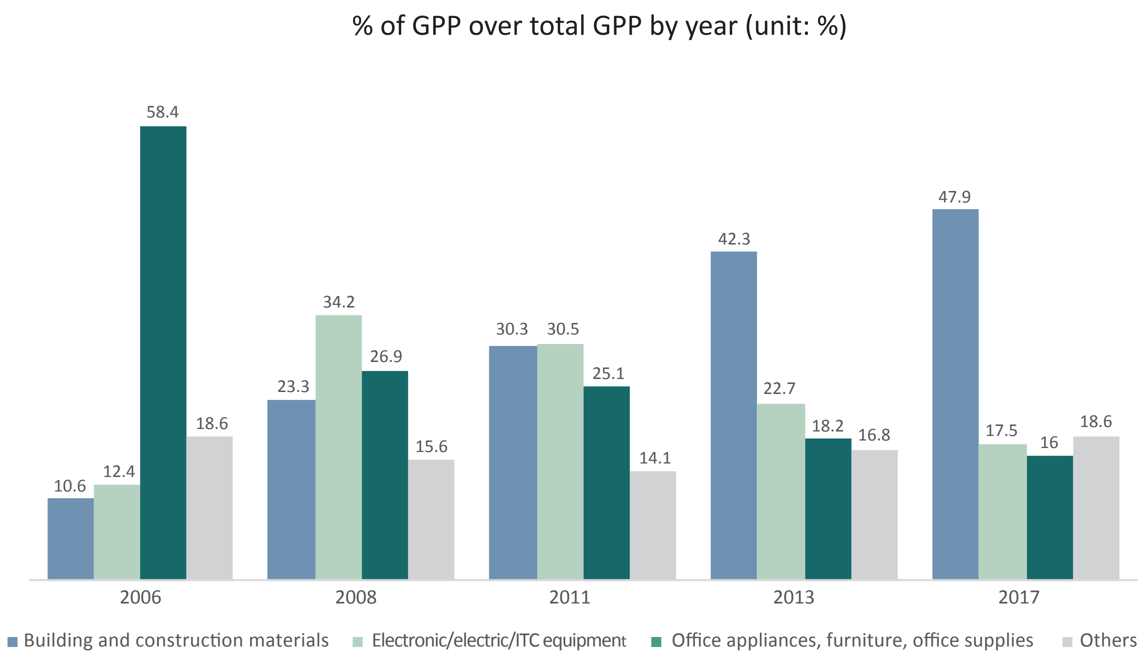
Product group	Total expenditure on green products (million USD)	% of GPP over PP on the product category	% of GPP over total GPP
Building and construction materials[46]	1,410.8	367.9	42.5
Electronic, electric and IT equipment[47]	516.5	1,066.3	35.2
Office appliances, furniture and supplies[48]	470.6	859.9	63.6
Lighting, batteries and electric materials[49]	344.2	423.5	74.8
Other[50]	203.2	120.9	61.6

When the mandatory GPP policy was first adopted in 2006, office appliances, furniture and supplies accounted for more than half of the total GPP, as these products are relatively easy to procure and monitor. Building and construction materials were recorded as the lowest out of total green product procurement (see "Figure 9. Percentage of GPP over total GPP expenditure by product category" on page 26). Given the large amount of government spending on building and construction and the complementary measures taken to promote GPP in this sector, building and construction materials now account for the largest share of GPP (47.9% in 2017), although the GPP rate within this product group is lower than in the other product groups.

According to an online survey of public procurers conducted via GPIS-I in 2018, the biggest obstacles to green product procurement are the lack of diverse specifications required by public organizations and the limited number of green products (57.3%), followed by the lack of awareness on GPP (13.9%) and difficulties in fulfilling other competing procurement priorities (8.9%).

44 Please see annex 1 for more details.
45 Asphalt, concrete, paint, water permeable concrete, windows, drainpipes, wallpaper, etc.
46 Personal computers, monitors, electric cables, etc.
47 Printers, refrigerators, air conditioning, tables, chairs, etc.
48 Street lamps, storage batteries, etc.
49 Cleaning products, chemical products, clothes, bedding, etc.

Figure 9. Percentage of GPP over total GPP expenditure by product category



It is reported that procurers face difficulties in procuring green building and construction materials for a number of reasons, including the following:

- Asphalt concrete should be procured from local suppliers to ensure that the temperature of the heated concrete is maintained during delivery.
- Certain building and construction materials should be procured locally due to high delivery costs.
- The various types and models of building and construction materials required by procuring organizations are not available on the market.
- An additional barrier to the procurement of green products is mistrust of quality, as well as preference for local products by local governments.

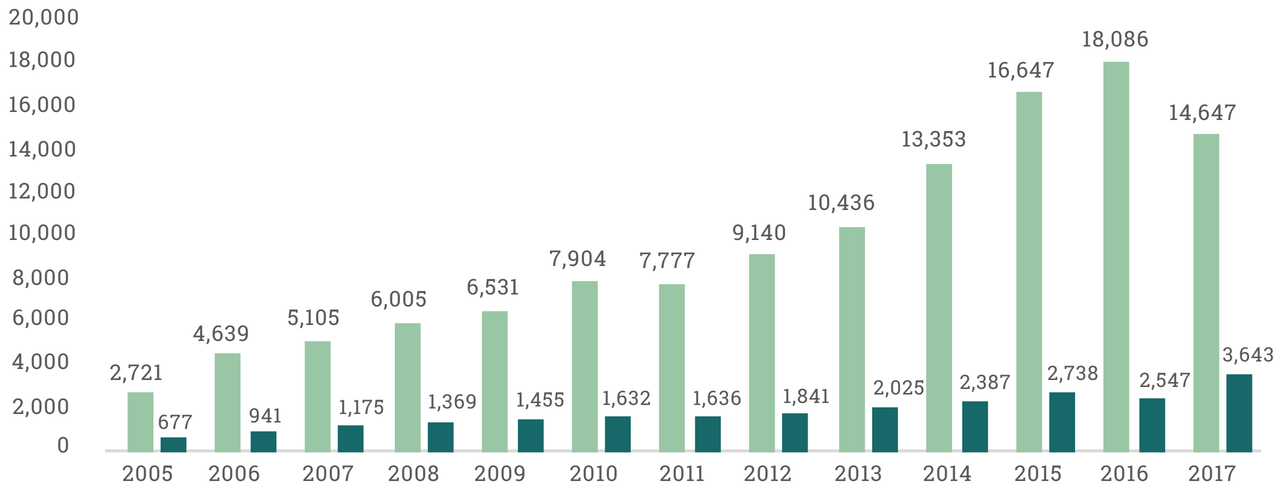
IMPACTS ON MARKET TRANSFORMATION

As an SCP policy instrument, GPP generally creates a greater demand for green products and positively affects green production. Therefore, the green product market evolution can be used as an indirect indicator of the success of GPP policy implementation. As shown in Figure 10, since the approval of the Act on Promotion of Purchase of Green Products in 2005, the number of certified products increased from 2,721 in 2005 to 14,647 in 2017. The sale of Korea Eco-label products increased its market share from USD 3 billion in 2005 to USD 34 billion in 2013.

ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS OF GPP

Based on the aforementioned results of total green purchase by public institutions, KEITI has estimated a series of environmental and socioeconomic impacts and benefits of GPP, which is set out in the next chapter.

Figure 10. Eco-labelled products on the market of the Republic of Korea from 2005 to 2017[50]



50 In order to alleviate burden of companies, KEITI streamlined certification process of Korea Eco-label so that derivatives of a certified product does not need to be certified again. In the figure 10, the number of certified products does not include derivatives, and only covers the original products. Actually the number of certified products increased if we count the number of derivatives.

CHAPTER 3

GPP IMPACTS MEASUREMENT IN THE REPUBLIC OF KOREA

3.1. CURRENT GPP IMPACTS ESTIMATION METHODOLOGY

Since 2005, the sustainability impacts of the Republic of Korea's GPP policy have been measured annually by KEITI, based on the compilation of GPP results set out in the previous section. All government levels are included in the impact estimation. The estimated sustainability impacts are the reduction of CO_2 equivalent emissions, the economic benefits achieved through the reduction of environmental impacts and the number of jobs created through GPP. To communicate the benefits of GPP and promote its further implementation, KEITI and MoE publish the impact results annually.

DATA COLLECTION

As the public procurement system in the Republic of Korea is a dual system combining centralized and decentralized purchases, data is collected via the following respective channels:

- KONEPS for centralized purchases, collected by PPS.
- The Green Market platform for decentralized online purchases, collected by KEITI.
- GPIS-I for all other decentralized purchases, submitted by each public authority and collected by KEITI.

Data is collected from all public authorities targeted in the SPP policy, namely more than 30,000 public organizations aggregated in 919 agencies as of 2018, including the central government, local governments, education authorities, public and quasi-government enterprises and local public corporations. Umbrella organizations and regional governments are responsible for compiling the records of decentralized purchases of the subsidiary organizations and cities within their boundaries.

Upon the submission of purchasing records to KEITI, justifications must be provided if the green purchase record has increased by 50% or more, or decreased by 30% or more, compared to the previous year.

To process the information, all data is integrated into GPIS-I:

- GPP records from KONEPS are provided in an Excel file on a monthly basis and integrated into GPIS-I.
- Data from the Green Market platform is automatically transferred to GPIS-I, as KEITI manages both tools.
- The remaining data is directly entered into GPIS-I by public authorities through an online form that enables them to manually enter procurement information. The information to be provided is the expenditure on green and non-green products in each product group with the Korea Eco-label or Good Recycle Mark, and the number of units purchased.

Since 2017, the purchase records of central governments, local governments, and education authorities are provided annually through their online accounting platforms. This was made possible through cooperation between the ministries responsible for the online accounting platforms of their respective subsidiary entities; the Ministry of Economy and Finance, the Ministry of the Interior and Safety, and the Ministry of Education.

Therefore, central government, local government and educational public authorities are no longer required to manually input procurement data into GPIS-I.

The difference in distribution between green purchases executed by PPS (and reported through KONEPS) and decentralized green purchases is shown in Figure 11. In 2017, the procurement of green products executed by PPS accounted for 87.2% of the total GPP reported to KEITI.

IMPACT ESTIMATION

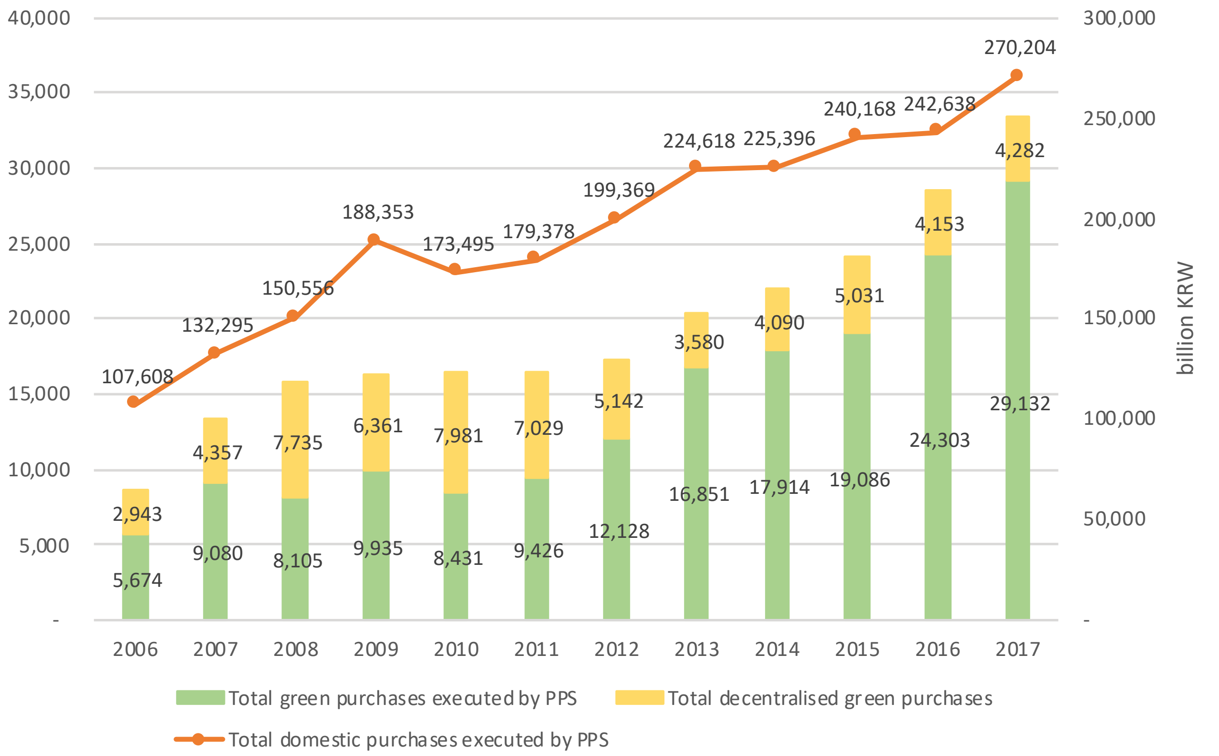
The sustainability impacts measured by KEITI are the reduction of CO_2 emissions, the economic benefits-achieved through reduced environmental impacts, and the number of jobs created through GPP.

REDUCTION OF CO_2-EQUIVALENT EMISSIONS

The reduction of CO_2 equivalent emissions is calculated by comparing eco-labelled products with conventional products using life-cycle assessment data. The estimation is conducted for the 19 eco-labelled product categories listed in Table 10. The indicator is expressed as absolute annual CO_2 equivalent emission reduction.

Data used for the estimation of CO_2 equivalent

Figure 11. Expenditure of centralized and decentralized GPP in the Republic of Korea from 2006 to 2017



emission reduction comes from the national life cycle inventory analysis database and is available for 19 product categories of the Korea Eco-label, including electrical and electronic goods, construction materials, office furniture and toilet paper.

As shown in Table 10, CO_2 equivalent emission reduction is calculated based on the benefits of reducing the environmental impacts specific to each product category, such as energy savings, water savings in the case of washing machines and dishwashers, resource savings including paper in the case of printers and copiers, and reduced waste.

The unit value of CO_2 equivalent emission reductions for environmental elements (such as the use of electricity [1kWh], wood pulp [1kg] and so on) is provided by the national life cycle inventory analysis database. The database was established in 1998 to calculate the environmental performance of infrastructure industry and basic materials.

Table 10. List of products used for measuring CO_2 equivalent reduction (as of 2005) and economic benefits linked to the reduction of environmental impacts

Product Category	Benefits based on	Unit	CO_2-eq emissions reduction factor for the lifecycle (kg)	Lifecycle
Electrical and electronic goods				
Copier	Energy efficiency, savings on paper[51] , waste reduction	One unit of product	210.0	5 years
Laser printer	Energy efficiency, savings on paper, waste reduction		60.0	
Laser facsimile	Energy efficiency, savings on paper, waste reduction		489.0	
Desktop Computer	Energy efficiency, savings on paper, waste reduction		477.0	
Computer Monitor	Energy efficiency, savings on paper, waste reduction		1,000.0	
Laptop computer	Energy efficiency, savings on paper, waste reduction		92.5	
Air Conditioner	Energy efficiency, savings on paper, waste reduction		292.0	10 years
Washing Machine	Energy efficiency, savings on paper, waste reduction		315.0	
Refrigerator	Energy efficiency, savings on paper, waste reduction		671.0	
Plasma television	Energy efficiency, savings on paper, waste reduction		65.3	
Dishwasher	Energy efficiency, savings on paper, waste reduction		61.8	
Construction materials				
Recycled slag products	Use of recycled materials (resource saving)	1kg	0.668	N/A
Thermal insulation materials	Use of recycled materials (resource saving)	1kg (with 70% recycled glass)	0.008464	
Indoor floor coverings	Use of recycled materials (resource saving)	1kg (medium-density fibreboard [MDF])	0.0017720	
Office furniture				
Desk	Use of recycled materials (resource saving)	1kg	0.1202000	N/A
Bookshelf or cabinet	Use of recycled materials (resource saving)		0.1202000	
Office automation (OA) partition	Use of recycled materials (resource saving)		2.7510000	
Hygienic material				
Soap	Use of recycled materials (resource saving)	1kg	8.5260000	N/A
Toilet paper	Use of recycled materials (resource saving)		0.0004637	

51 A Korea Eco-label-certified copier allows double-sided printing so that it contributes to saving paper made of pulp.

ECONOMIC BENEFITS LINKED TO THE REDUCTION OF ENVIRONMENTAL IMPACTS

The reduction of environmental impacts is calculated by comparing proxy eco-labelled products with proxy conventional products.

The proxy eco-labelled products represent the average value of the test results of products meeting the Korea Eco-label criteria for each product category. The proxy conventional product is identified as the average value of the test results of products failing to meet the Korea Eco-label criteria. If no test results are available, the environmental standards defined in the Korea Eco-label criteria are used as representative values for conventional product impacts, assuming that the performance of proxy eco-labelled products meets higher environmental standards.

The following 10 environmental impacts are considered based on data availability: reduction of toxic substances, recycling of resources, energy saving, low noise, ecodesign, reduction of ecosystem toxicity, resource saving, reduction of indoor air pollutants, reduction of outdoor air pollutants and reduction of human toxicity.

Data used for the estimation of environmental impact reduction is based on a 2015 study measuring the environmental benefits of green public procurement.

Initially, 19 product groups were selected to measure CO_2 equivalent emissions based on their large share of GPP and high environmental impact. In 2015, product groups and environmental parameters were expanded to measure comprehensive environmental impacts from a broader list of product groups. At present, the impact reduction is calculated for 134 product categories.

An estimation has been made of the economic savings resulting from reduced environmental impacts, and is expressed as annual monetary value:

(1) The environmental benefits of a product group are calculated as below:

Comparison of test results of environmental parameters between green and non-green products x economic conversion factors of the environmental parameters = average economic savings per unit of product

(2) The economic savings resulting from the environmental benefits of the product group are calculated as below:

Average economic savings per unit of product x total number of products purchased during the year = annual economic saving per product group

The economic benefits are based on the costs of resource saving, energy saving and/or the reduction of air pollutants for quantifiable environmental parameters.

Below is a demonstration of the use of the estimation for the two product categories of personal computers and toner cartridges:

Example 1: Personal computers

Table 11 shows the environment-related criteria for personal computers that are Korea Eco-label-certified. Among the various environmental benefits that can be obtained during the life cycle of a personal computer, only noise reduction and energy savings can be quantified due to data restraints.

i. Noise reduction
Economic savings are calculated by averaging environmental benefits resulting from the noise reduction of a personal computer at different sound power levels (minimum, general and maximum), as shown in Table 12.

ii. Energy savings
Economic savings related to energy consumption during the usage phase of a personal computer are calculated by comparing energy uses between green and non-green products, as shown in Table 13.

iii. Economic savings of an eco-labelled personal computer
The economic savings of an eco-labelled personal computer are calculated by aggregating economic savings resulting from low noise and energy savings (see Table 14).[52]

Table 11. Environmental parameters for a personal computer under the Korean Eco-label

Life cycle phase	Environmental parameters	Monetization of environmental parameters
Acquisition of raw materials	–	–
Manufacturing	Reduction of harmful substances and environmental loads	No
Distribution, usage and consumption	Energy saving	Yes
	Noise reduction	Yes
Disposal and recycling	Reduction of harmful substances and waste	No

Table 12. Economic savings through the reduced noise emissions of personal computers

Noise level	Non-green product (A)[53]	Green product (B)	Environmental benefits (C, A-B)	Conversion factor (D)	Economic savings (E, CxD)	Average economic savings
Minimum	38 dB	34 dB	4 dB	USD 2.82/dB	USD 11.28/dB	USD 15.04
General	46 dB	40 dB	6 dB		USD 16.92/dB	
Maximum	50 dB	44 dB	6 dB		USD 16.92/dB	

Table 13. Economic savings related to energy consumption of personal computers

Electricity price (A)	Electricity savings (B)	Economic savings (C, A x B)	Economic savings throughout the life cycle (5 years)
USD 10.75 cents/kWh	38 kWh	USD 4.09/year	USD 20.43

Table 14. Monetization of environmental benefits for personal computers

	2006	2007	2008	2009	2010	2011	2012	2013
Personal Computer – monetization of environmental benefits related to purchase of green products								
Total number of purchased products	385,673	620,812	443,421	429,074	269,820	307,730	310,370	324,278
Noise reduction (million USD)	5.8	9.3	6.7	6.5	4.1	4.6	4.7	4.9
Energy savings (million USD)	7.9	12.7	9.1	8.8	5.5	6.3	6.3	6.6

52 Given that the noise test results of the non-green product are unavailable, the standards for noise defined in the Korea Eco-label criteria are used as representative values for impacts of conventional products.

Example 2: Toner cartridges

Table 15 shows the environment-related criteria for toner cartridges that are Korea Eco-label-certified.

Among the various environmental benefits that can be obtained during the life cycle of a toner cartridge, only improved recyclability and resource circulation can be quantified due to data restraints.

A. Savings related to resource circulation

The unit price of a green toner cartridge is cheaper than that of a non-green toner cartridge, as the former is remanufactured using an existing toner cartridge. Therefore, when printing out the same number of copies (15,000 pages), the printing cost per page of the green toner cartridge is lower than that of the non-green one. As a result, each green toner cartridge used saves KRW 160,500 (see Table 16).

B. Aggregated economic savings of eco-labelled toner cartridges

Economic savings of eco-labelled toner cartridges are calculated by multiplying the savings per cartridge by the number of purchased products (see Table 17).

Table 15. Environmental parameters for toner cartridges under the Korea Eco-label

Life cycle phase	Environmental parameters	Monetization of environmental parameters
Acquisition of raw materials	—	—
Manufacturing	Reduction of harmful substances and local environmental pollution	No
Distribution, usage and consumption	Resource circulation (facilitation of the use of recycled paper)	No
Disposal and recycling	Improved recyclability and resource circulation (recyclability of synthetic resin parts and packaging materials, facilitation of product separation and so on)	Yes

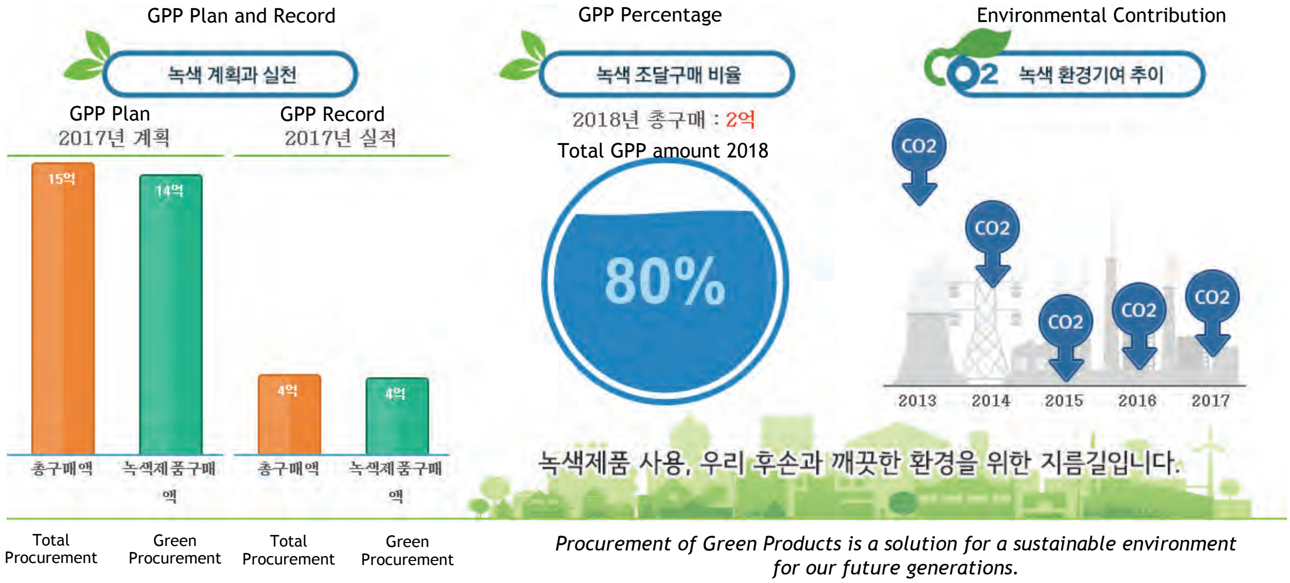
Table 16. Savings related to resource circulation for toner cartridges

	Non-green product (A)	Green product (B)	Monetization of environmental parameters
Cost of printing one page	USD 1.52 cents per page	USD 0.58 cents per page	USD 0.94 cents per page
Total savings for each cartridge used	USD 228.74	USD 87.26	USD 141.47

Table 17. Monetization of environmental benefits for eco-labelled toner cartridges

	2006	2007	2008	2009	2010	2011	2012	2013
Toner cartridges: monetization of environmental benefits related to purchase of green products								
Total purchase amount (million USD)	3,6	3,1	3,6	3,7	3,8	2,5	2,2	1,9
Total number of purchased products	112,379	97,233	113,965	115,861	120,759	80,000	67,816	60,767
Resource savings (million USD)	15,9	13,8	16,1	16,4	17,1	11,3	9,6	8,6
Unit price of a toner cartridge: USD 31,73/unit								

Figure 12. KEITI's green desk, summary of GPP plan and record of an individual organization, including CO_2 emission reduction



CREATION OF GREEN ECONOMY-RELATED JOBS

The creation of green economy-related jobs is calculated by establishing the relationship between total green public procurement expenditure and job creation. The estimation is made using the annual expenditure on green products divided by the employment inducement coefficient, published by the Bank of Korea in 2010.

The coefficient aggregates the number of employees directly hired for the production of commodities equivalent to KRW 1 billion, and the consequent number of employees indirectly hired in other sectors. The coefficient corresponds to 8.3 persons per KRW 1 billion (USD 0.88 million). The job creation in the green economy (without considering potential job destruction in the brown economy) is calculated for all product categories for which GPP is measured.

3.2. RESULTS OF PAST MEASUREMENT EXPERIENCES

Since 2006, KEITI has collected and published data on the CO_2-eq emission reductions achieved, the economic benefits linked to environmental impact reduction and the number of green jobs created. The results from 2006 to 2017 are shown in Table 18.

An output of GPIS-I is graphic representations of the GPP plans and records of individual organizations and the associated environmental benefits obtained, as shown in Figure 12.

Results are also communicated using social math or equivalencies to facilitate the comprehension of the general public. For example, CO_2 equivalent emission reductions due to GPP are expressed in terms of vehicle exhaust emission reductions in Seoul over a certain number of days.

Table 18. Results of impact estimation Results of impact estimation from 2006 to 2017

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
KEITI Indicators (from KONEPS and directly reported by authorities)												
Total expenditure on green products (million USD)	759.3	1,184.4	1,396.2	1,436.4	1,446.6	1,450.4	1,522.3	1,800.9	1,939.5	2,125.8	2,508.2	2,945.3
% GPP over the total expenditure in GPP related categories	58.3	69.3	50.4	40	39.7	32.1	31.3	32.9	39.7	42.2	46.1	47.5
Reduction of CO2 equivalent emissions from the shorter list of green products (in thousands of tons)	316	495	624	620	538	544	491	532	543	469	568	665
Economic benefits linked to environmental impact reduction (million USD) from total purchases executed by PPS	4.8	6.2	5.8	6.3	5.8	6.3	16.0	24.2	33.7	36.5	30.4	35.4
Job creation (individuals)[54]	619	4001	1995	379	96	36	677	2624	1305	1754	3601	4115
PPS Indicator (purchases through KONEPS only)												
% of GPP over the total (domestic) purchases executed by PPS[55]	4.3	6.0	4.3	5.7	4.7	4.7	6.1	7.5	7.9	7.9	10.0	10.8

53 Job creation is expressed as "additional job creation" compared with last year. In the first year of implementation (2005) job creation has been calculated for the total expenditure on green products.

54 http://www.index.go.kr/egams/stts/jsp/potal/stts/PO_STTS_IdxMain.jsp?idx_cd=1376

CHAPTER 4

GPP IMPACT MEASUREMENT IN OTHER COUNTRIES

4.1. WHY MEASURE SPP IMPACTS?

The public sector has an exemplary role to play in order to foster societal change and public procurement has a significant impact on the economy. Public procurement is thus recognized as an important strategic tool for achieving sustainable development goals.

Because of the environmental, social and economic benefits expected of SPP policies, governments have been developing and implementing them for many years now. However, very few governments have defined methodologies for quantifying and communicating these benefits or outcomes[56], even though presenting them can have many advantages. It can help to garner support within an organization to continue and expand SPP implementation; it can help in obtaining valuable insight and informing SPP implementation to maximize results; it can help to address stakeholder interests and concerns; and it can help to ensure accountability to the citizenry for the way in which policy goals are met[57].

4.2. APPROACHES FOR MEASURING SPP IMPACTS

When estimating and communicating the benefits of SPP, different approaches and methodologies have been used depending on, inter alia, the objectives of the authority conducting the evaluation.

In some cases, organizations have estimated the **potential benefits of implementing SPP** in order to build the case for SPP and to guide actions from a cost-benefit perspective. This is the case of the state of Berlin, presented in section 4.3 below, and other examples, listed in Table 19.

In other cases, however, benefits are estimated in respect of **actual sustainable purchases and contracts** to communicate estimated outcomes achieved thanks to actual sustainable procurement. In these cases, the scope varies from single purchases or tendering processes (often presented as case studies) to the assessment of overall SPP policies and programmes (usually linked to the monitoring of SPP implementation, i.e., of the actual level of SPP achieved by the public administration). This is the approach taken in the Republic of Korea, presented in chapter 3, and in Japan, the Netherlands and the state of Massachusetts, presented in section 4.3. Other examples of single case studies are listed in Table 19.

To estimate outcomes, the methodologies also differ in terms of what is defined as sustainable, what the baseline is, the referent against which sustainable products are compared, what benefits are estimated, and what conversion factors or tools are used to evaluate benefits. In some cases, tools developed by certification standards or industry or government initiatives are used (such as the Paper Calculator or Energy Star Savings Calculator). In others, tools (such as the ones developed as part of the GPP 2020 project, funded by the European Union, or the cost-benefit analysis and impact reduction indicators tool developed by the Government of Colombia and linked to its SPP criteria) are developed specifically to estimate SPP benefits. In most cases however, no specific tools are developed; instead, specific calculation methods are defined, as discussed in section 4.3.1, for example.

55 In the SPP Global Review of 2017, with data from 2014, only 9 of the 27 national governments that monitor SPP implementation report SPP outcomes. See: Adell, A.et al. (2017). Global Review of Sustainable Public Procurement 2017. United Nations Environment Programme. Also in the literature review conducted in 2015 within the Working Group on Measuring and Communicating the Benefits of SPP of the 10YFP SPP Programme, only 22 of the 158 documents analyzed featured examples of measured results. See Annex 2 of the report: O'Rourke, A. et al. (2015). Measuring and Communicating the Benefits of Sustainable Public Procurement (SPP). Baseline Review and Development of a Guidance Framework. United Nations Environment Programme.

56 O'Rourke, A. et al. (2015). Measuring and Communicating the Benefits of Sustainable Public Procurement (SPP). Baseline Review and Development of a Guidance Framework. United Nations Environment Programme.

Table 19. Different examples of approaches to the evaluation of SPP benefits

Potential benefits of implementing SPP	• European Commission (2007). Costs and Benefits of Green Public Procurement in Europe. Part 1: Comparison of the Life Cycle Costs of Green and Non Green Products. • Government of Chile (2014). Manual on Sustainable Public Procurement - With a Focus on Cost-Benefit Analysis (CBA). • International Institute for Sustainable Development (2016). Green Public Procurement in China: Quantifying the Benefits.
Benefits of actual sustainable procurement	• United Nations Environment Programme and Wuppertal Institute Collaborating Centre on Sustainable Consumption and Production (2011). Sustainable Public Procurement in Urban China: How the Government as Consumer Can Drive Sustainable Consumption and Production. • United Nations Environment Programme (2012). The Impacts of Sustainable Public Procurement: Eight Illustrative Case Studies. • Danish Environmental Agency (2013). Business Cases: Green Procurement. Green Procurement and Green Products Generate Growth. • GPP 2020 (2016). Tender Compilation: Mainstreaming Low-Carbon Procurement.

In the next section, we present briefly the benefit measurement approaches of Japan, the state of Massachusetts (United States of America), the Netherlands and the state of Berlin (Germany) in order to compare them with the approach of the Republic of Korea, to identify pros and cons, and to discuss recommendations for the future.

The Republic of Korea's approach focuses on measuring the benefits of the country's GPP policy and not of other socially responsible or sustainable public procurement policies. The selection of the four cases examined for comparison was therefore based on the corresponding public authorities' approaches to estimating the environmental benefits of GPP.

4.3. MEASUREMENT OF THE IMPACTS OF THE SPP POLICIES OF SELECTED PUBLIC AUTHORITIES

4.3.1 IMPACT MEASUREMENT IN JAPAN[57]

Japan is one of the world's pioneers in promoting green public procurement. In 1994, the Government of Japan published its action plan on green government operations, which included GPP commitments and reporting requirements. In 2000, the Government reinforced its engagement by introducing the Act on the Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities (Act No. 100 of 31 May 2000, also known as the Act on Promoting Green Procurement).

Since 2001, Japan has monitored GPP implementation to evaluate policy results and since 2006, it has established a method for estimating the effects of GPP on the environment. The estimation process is carried out annually and is applied only to central government agencies. GPP policy is mandatory for said agencies, which must report quantitative GPP data, unlike the other public sector entities covered by the policy.

TYPE OF DATA USED

Japan's methodology for estimating environmental impacts requires information on the amount of green products purchased versus non-green (conventional) products purchased. Therefore, data on the number of purchased products (both green and conventional) are required.

Even though the central Government has to report on more than 260 products listed in its basic GPP policy (which provides the specific GPP criteria for procurement), benefits are calculated for 19 product categories, including office stationery, imaging

57 Detailed explanations of the methodology can be found here (in Japanese): https://www.env.go.jp/policy/hozen/green/g-law/jisseki/reduce-effect_h28.pdf

equipment, appliances, climatization equipment, indoor lighting, vehicles, tires, textile products, and building solutions and materials.

DATA COLLECTION PROCESS

To monitor policy implementation, each ministry and incorporated administrative agency has to track and report purchases of each product category included in the GPP policy.

The system for data tracking differs from one entity to another depending on the entities' internal systems. However, to collect and aggregate data, the Ministry of the Environment provides a standardized reporting form (a spreadsheet) on which each agency enters the number of products purchased each month (both green and in total) and which calculates annual data automatically.

After the end of each fiscal year, all organizations submit the form to the Ministry of the Environment, which then prepares aggregated results for the whole of the central Government.

IMPACT ESTIMATION

Definition of green products and baseline

For each selected product category for which environmental impacts are estimated, an average or proxy green product has been defined. This definition uses as a reference the minimum green specifications set in the GPP policy based on which agencies report their green purchases. Those specifications are established in a consultation process with relevant stakeholders which, whenever relevant, works with sustainability standards and eco-labels.

For example, for plastic files, the green proxy must contain at least 40% recycled plastic. For photocopying machines, green products are those complying with the energy efficiency requirements set by the Energy Star programme, and the proxy green product has been defined as a monochrome copier with an output of 40 images per minute and an annual consumption of 150.8 kWh/year.

To estimate the benefits of GPP, each year's green purchases are compared not against the procurement of conventional products, but against the level of GPP in 2000, the year prior to the enforcement of the Act on Promoting Green Procurement, used as the baseline. As no actual GPP data were available then, the baseline level of GPP is assumed to be equivalent to the domestic market share of green products that year for the different product category for which environmental benefits are estimated. This was estimated based on data provided by the industry.

ENVIRONMENTAL IMPACT CALCULATION

Environmental benefits are estimated in terms of greenhouse gas emissions (in CO_2 equivalent) reductions.

For energy-consuming products or products that can affect energy consumption (such as tires), CO_2 eq emissions are estimated based on energy consumption during the use phase for a certain number of years, depending on the product and the emissions factors of the energy source used.

For non-energy-consuming products (such as stationery or textiles), different factors are considered in order to transform the environmental specification into CO_2 eq emissions based on available data. For example, for recycled plastic in stationery, environmental savings are derived from recycling instead of burning the plastic. For textiles, energy consumption for the production of recycled versus virgin polyethylene terephthalate (PET) fibres are used to calculate benefits.

The basic calculation formula for estimating the environmental benefits of each product category is the following:

> **Total number of products purchased during the year * (% that is green – % of market share of the green product in 2000) * conversion factors of the green product characteristics to CO_2 eq emissions * years of use of the product**

To illustrate its use, below we present the application for two product categories.

COPYING EQUIPMENT	
Total number of products purchased in 2016	11,266
Percentage of green products purchased from the total in 2016	99.57%
Percentage of the market share of green products in 2000	33.3%
Annual power consumption of products in 2000	302 kWh/copier
Annual power consumption of proxy green products in 2016	150,8 kWh/copier
Electricity emissions factor	0.518 kg CO_2 eq/kWh
Years of use of the product	5
Impact reduction obtained with the green purchases	11,266 * (0.9957-0.333) * (302-150.8) * 0.518 * 5 = 2,924 Tone CO_2 eq saved

PLASTIC OFFICE BINDERS	
Total number of products purchased in 2016	13,541 (made of both plastic and paper)
Percentage of plastic binders from the total (plastic and paper) based on domestic shipment volumes of plastic and paper files, as no actual data on only plastic files are available	24.9%
Percentage of green products purchased from the total in 2016	97.9%
Percentage of the market share of green products in 2000	29.1%
Minimum recycled plastic contained in green plastic folders	40%
Average weight of plastic folders based on market data	100 g/folder
Emissions if the plastic was burned instead of recycled	2,765 kg CO_2 eq/Tone
Years of use of the product:	not applicable
Impact reduction obtained with the green purchases	(13,541*0.249) * (0.979-0.291) * 100/1,000,000 * 0.4 * 2,765 = 0,256 Tone CO_2-eq saved

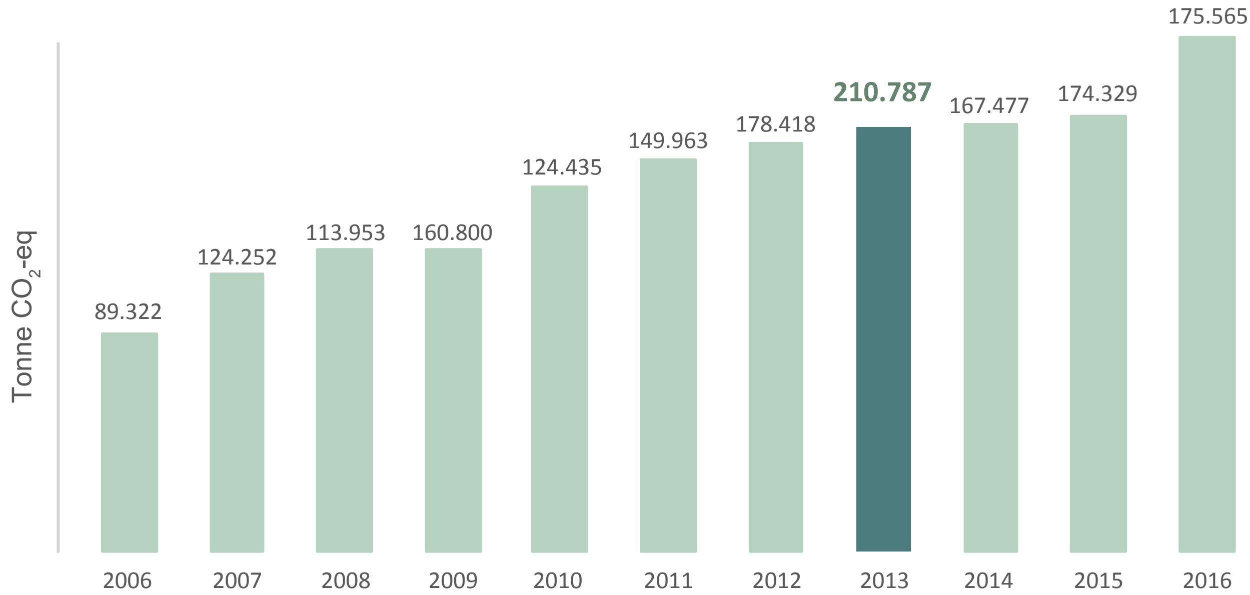
RESULTS ACHIEVED

Based on annual purchases of selected products, GPP level and the different conversion factors for each product category, the following CO_2 eq emissions reductions were achieved in 2016 (Table 20) and Figure 13 presents the estimated annual impact reductions since 2006:.

Table 20. Environmental benefits derived from GPP by Japan's central Government in 2016

Product category	Benefits based on	Annual savings (Tone CO_2 eq/year)	Years of use	Total savings (Tone CO_2 eq)
Office stationery (made of recycled plastic)	Avoided incineration emissions	742	–	742
Gas duster or canned air	Use of non-fluorocarbon propellants	18,591	–	18,591
Imaging equipment	Higher energy efficiency	585	5	2,924
Facsimile	Higher energy efficiency	178	5	891
Appliances	Higher energy efficiency	1,941	10	19,407
Air conditioning	Higher energy efficiency	1,115	10	11,149
LED lighting fixture	Higher energy efficiency	3,426	10	34,260
LED lamps	Higher energy efficiency	1,271	10	12,711
Compact fluorescents	Higher energy efficiency	1,583	5	7,917
Vehicles	Higher energy efficiency	3,869	7	27,084
Tires	Reduced rolling resistance	104	3	312
Workwear	Use of recycled PET fibres	29	–	29
Bedding	Use of recycled PET fibres	189	–	189
Work gloves	Use of recycled PET fibres	81	–	81
Photovoltaic systems	Renewable energy	104	15	1,562
Solar water-heating	Renewable energy	–	15	–
Green roof	Reduced energy demand	289	15	4,341
Blast furnace cement	Lower embedded emissions	–	–	–
Transformers	Higher energy efficiency	1,669	20	33,376
	Total	35,767	–	175,565

Figure 13. Estimated environmental benefits derived from GPP by Japan's central Government (2006-2016)



4.3.2. IMPACT MEASUREMENT IN THE STATE OF MASSACHUSETTS[58]

In 2009, the state of Massachusetts (United States of America) passed Executive Order No. 515, Establishing an Environmental Purchasing Policy, to help the state's Executive Departments expand their environmentally preferable purchasing.

Since 2011, the state publishes annual reports on the accomplishments of the Environmentally Preferable Products (EPP) programme (equivalent to GPP). The report includes information on estimated cost savings and environmental benefits achieved with the procurement of green products in order to demonstrate the immense value of the EPP programme and present its business case.

TYPE OF DATA USED

To estimate environmental and economic benefits of GPP, the state gathers information on specific products or services which are acquired, used or managed through statewide contracts (used by state agencies and other public entities) and for which benefits calculators exist.

In 2016, information was gathered on, inter alia, the following: information technology (IT) equipment (e.g., computers, tablets, monitors, multifunctional devices), lightbulbs (compact fluorescent and LED lamps), recycled or remanufactured products (e.g., toner cartridges, motor oil, antifreeze, paper products), and waste selectively collected for recycling.

Data is collected on the number of products directly purchased or used in service contracts and on the amount of waste generated. Benefits are also estimated for green cleaning services, based on the amount of green cleaning products and microfibres used in the given service.

DATA COLLECTION PROCESS

In the tendering documents for those contracts that have products or services relevant to EPP monitoring and benefit estimation, vendors are required to report sales or waste management (in the case of the solid waste and recycling contract and the hazardous waste contract) on a quarterly basis. This makes it possible to track GPP levels and to make sure that vendors comply with contract specifications.

Each year, the EPP programme reviews the bid requirements and vendors' reports. The programme uses an internally developed tool to systematically pull relevant data to determine cost savings and environmental benefits. Because this is a time-

58 More detailed information on the methodology and results can be found here: https://www.mass.gov/service-details/epp-annual-reports-progress-reports-and-other-publications

consuming undertaking, in 2016, a standardized vendor-reporting form and an accessible database were developed to help streamline the data. In October 2018, an online vendor-reporting system was launched to ensure that vendors provide all required information and that they do so in a standardized manner.

IMPACT ESTIMATION

Definition of green versus conventional

The state uses publicly available online tools to estimate the benefits of public procurement of green products versus the public procurement of non-green alternatives (except for cleaning products); the benefits vary from product to product. Each of these tools (see list below) provides its own definition of a green product and the definition of a conventional or non-green product against which the green alternatives are compared.

Environmental impact calculation

The tools used to estimate GPP benefits are the following:

- Energy Star Savings Calculator – a tool developed by the United States Environmental Protection Agency (EPA) and Department of Energy to estimate the energy and operating costs savings of energy-efficient office equipment
- Electronics Environmental Benefits Calculator – a tool developed by the United States Environmental Protection Agency to estimate the environmental benefits of greening the purchase, use and disposal of electronics, including EPEAT-registered equipment
- EnviroCalc – a tool created by Massachusetts' own EPP programme staff and designed to estimate the environmental benefits of purchasing recycled-content and energy-efficient products (such as lightbulbs)
- EPA Waste Reduction Model (WARM) – a tool created by the United States Environmental Protection Agency to calculate the greenhouse gas emissions produced by waste management processes (source reduction, recycling, combustion, composting, anaerobic digestion and landfilling) in respect of a wide range of material types commonly found in municipal solid waste

Each tool measures different types of environmental benefits. All the tools estimate energy savings and greenhouse gas emissions reductions (in metric tons of carbon equivalent).

Depending on the tool and product in question, other benefits estimated include the reduced use of water, primary materials (including wood), toxic materials, air emissions, water emissions or landfill space, and the reduced generation of municipal and hazardous waste.

Benefits from the use of green cleaning products are determined by calculations using impact-reduction factors from different sources. The benefits estimated are greenhouse gas emissions reductions, water conservation and hazardous material reduction.

Economic impact calculation

The benefit tools for energy-consuming products also calculate the cost savings achieved, over product lifetime, by the procurement of energy-efficient products.

Compact fluorescents and light-emitting diodes (LEDs) consume less energy during operation and, because of their longer useful life, incur lower labour costs associated with lamp replacement, all of which results in economic savings

For toner cartridges, economic savings are calculated by comparing the average cost of remanufactured cartridges to the average cost of similar original equipment manufacturer (OEM) cartridges.

RESULTS ACHIEVED

Table 21 and Table 22 show some of the benefits from selected green products and waste collection processes for fiscal year 2016, based on annual purchases and determined using various benefit calculators.

As illustrated in Table 22, to help communicate impacts to a non-technical audience, the state uses equivalency factors, in an approach also known as "social math", to express benefits in more understandable terms (e.g., annual emissions from cars, waste generated by households, acres of wood plantation). In some cases, such as that of the EnviroCalc tool, these equivalencies are provided directly; in others, the EPA Greenhouse Gas Equivalencies Calculator is used.

Table 21. Estimated benefits in fiscal year 2016

Benefit	IT equipment	Efficient light bulbs	Recycled and remanufactured products	Selective waste collection for recycling
Cost savings (USD)	915,088	20,656,932	393,975*	–
Energy savings (kWh)	8,860,852	122,057,431	140,551,024	–
Carbon dioxide emissions (MTCE)	2,509	66,121	77,092	14,696
Tool used	Energy Star EPEAT	EnviroCalc	EnviroCalc	EPA WARM

* Only data from remanufactured toner cartridges

Table 22. Estimated benefits from recycled and energy-efficient products according to the EnviroCalc tool (fiscal year 2016)

Environmental benefit	Amount	Equivalent to
Weight of material recycled	53,781 Tone	Annual solid waste generation of 25,268 households
Trees saved	354,024 units	3,540 acres of wood plantation
Landfill space saved	169,306 cubic yards	8,465 loaded garbage trucks
Electrical energy saved	118,017,224 kWh	Annual electricity usage of 10,407 households
Electrical costs saved	USD 16,522,411	
Labour costs saved	USD 4,134,521	
Non-electrical energy saved	479,580 million BTU	Energy content of 82,686 barrels of oil
Greenhouse gas emissions saved	154,551 tons CO_2	Annual tailpipe emissions of 30,349 cars

4.3.3. IMPACT MEASUREMENT IN THE NETHERLANDS[59]

The Netherlands has had a dedicated sustainable public procurement (SPP) policy in place since 2007. Since then, regular monitoring of SPP implementation has been conducted to evaluate the achievement of the SPP objectives set for all public authorities in the country. Also, some preliminary studies have been conducted on the impacts avoided by SPP, for example, in transport-related contracts[60].

In 2017, the Ministry of Infrastructure and Water Management commissioned a study to establish a methodology for calculating the sustainability impact of SPP which could be used for policy evaluation. According to the study[61], the methodology should use information which can be easily collected by contracting authorities to allow organizations to measure their SPP benefits themselves.

59 Detailed explanations of the methodology can be found in the 2018 National Institute for Public Health and the Environment document entitled Measuring the Effect of Sustainable Public Procurement, available here: https://www.rivm.nl/bibliotheek/rapporten/2018-0069.html

60 Natuur & Milieu (2016). Benchmark: Duurzaam Inkopen van Vervoer, available here: https://www.natuurenmilieu.nl/wp-content/uploads/2017/02/NM-Benchmark-Duurz-Ink-Vervoer-261016-4-ia.pdf

61 See page 20 of the report.

Table 23. Sampling of tenders for the product category of vehicles

Product category	Sub-categories/strata	No. identified tenders (and % over the total)	No. selected tenders (stratified sample)
Vehicles (274 identified tenders in total)	Purchase of vehicles	198 (72%)	7
	Leasing of vehicles	47 (17%)	2
	Maintenance and parts	29 (11%)	1

TYPE OF DATA USED

In order to estimate environmental benefits, the study focuses on eight product categories related to:

- Transport, which includes vehicles, transport contracts and services (on-demand transport, school transport, postal services, and so forth), and business trips abroad
- Energy, which includes gas, electricity and solar panels
- Occupational clothing, namely, special and ordinary workwear, footwear and accessories
- For each category, information on the actual number of green products purchased or used in service contracts was required.

DATA COLLECTION PROCESS

Data is collected in a four-step process based on tendering documents and final actual procurement.

First, calls for tenders for the selected product categories were identified and collected for analysis. The source used to identify calls for tenders was the statewide electronic tendering platform TenderNed, and only tenders published during the period 2015-2016 were selected[62].

The selection was made using the European Union Common Procurement Vocabulary (CPV) codes associated with each product type and specified in each call for tenders. The CPV codes for each product type are those listed in the SPP criteria documents[63] developed by the Government and used as a basis for the SPP monitoring exercise.

The long list of tenders identified was reviewed to ensure that all tenders really corresponded to the relevant product categories, as some had been given the wrong CPV codes. The result was a "clean" list of tenders. For the "clean" list, a sample of 10 tenders for each product category was taken by using a stratified sample approach based on different subcategories/strata identified for each product category and randomly selecting tenders within each stratum (see example in Table 23).

Afterwards, the text of sampled tenders was examined to determine whether tenders included sustainability criteria or not (based on the Government SPP criteria documents mentioned before, the International Labour Organization conventions, or social return[64]) and to determine contracts' economic value.

Finally, interviews with contract managers were held (in some cases only via email) to gather information on what was ultimately delivered (to ensure that the sustainable tender led to a sustainable delivery), the amount finally acquired or used, and the specific characteristics of the deliverables.

For example, for vehicles, contract managers were requested to provide data on: the number of cars acquired; the types of fuel used and their corresponding Euro standards and CO_2 emissions; the estimated mileage driven annually; the ultimate value of the contracts; and the actual use of biogas in gas vehicles.

IMPACT ESTIMATION

Even though the study measures the implementation of both environmental and social criteria in tendering documents, the calculation of benefits focuses only on environmental effects.

Definition of green versus conventional

For each of the eight product categories, the minimum Dutch green public procurement (GPP)

62 This period was selected because the SPP Action Plan 2015-2020 was approved by the Government in 2015.

63 Criteria documents can be found here: https://www.pianoo.nl/nl/node/11229

64 That is, the creation of work opportunities for people at risk of social exclusion such as people with disabilities, the long-term unemployed, and so forth.

Table 24. Estimated benefits throughout the duration of the contracts and/or lifetime of product

Product category	NO_x avoided (kg)	Particle matter avoided (kg)	CO_2 eq avoided (ton)	CO_2 eq compensated (ton)
Occupational clothing*	–	–	–	–
Electricity	–	–	3,800,000	–
Solar panels	–	–	1,100,000	–
Gas	–	–	–	1,360,000
Business trips	–	–	–	33,000
Transport services	20,000	1,700	17,000	170
Vehicles	8,000	–	6,000	–
Total	28,000	1,700	4,923,000	1,393,000

*No benefits could be estimated because data on the quantity and weight of materials were not available for most of the sampled tenders.

criteria set are used to define what qualifies as green. The non-green, or conventional, alternative is also defined differently depending on the product group.

For example, business trips deemed green involve the compensation of CO_2 emissions (green "product"). Green vehicles are those that comply with the Euro 6 standard and that either use petrol or are hybrid or electric. The non-green alternative is a Euro 5 and diesel vehicle.

However, these definitions are reconsidered for new evaluation periods in order to adjust to regular changes in the market over time (e.g., the Euro standards).

Environmental impact calculation

For all product categories, environmental benefits were estimated in terms of greenhouse gas emissions (in CO_2 equivalent). Other benefits were also calculated for certain categories. For example, for transport services and vehicles, the avoidance of other pollutants (namely, NOx and particle matter) was also estimated, as were savings in fossil raw material consumption resulting from some contractual stipulations requiring biogas instead of diesel or regular gas. Other benefits linked to the use of recycled materials and reuse after product end of life could not be estimated because of a lack of quantitative data.

Benefits that could be estimated were calculated for the duration of the contract period (in service contracts) or throughout the lifetime of the product (in case of purchases).

The approach and impact factors were set for each product group.

For example, electricity benefits are calculated by multiplying the annual consumption and percentage of renewable energy in each contract by CO_2 equivalent (CO_2 eq) emission factors provided in https://www.co2emissiefactoren.nl and comparing them if no green electricity has been purchased.

For vehicles, data on actual CO_2 emissions per kilometre and the annual mileage of each vehicle was requested. Where no data on mileage was provided, an average mileage by type of vehicle was applied. By multiplying the CO_2 emissions by the mileage and duration of the contract for each vehicle and establishing a comparison to an equivalent non-green alternative (defined as a diesel Euro 5 vehicle), the benefits (tank-to-wheel) were estimated. The emissions from the production and transport of fuels (well-to-tank) were also estimated and added to the estimation.

RESULTS ACHIEVED

The results achieved with the sampled tenders in each stratum were then extrapolated to the entire "clean" list of tenders by multiplying them by an extrapolation factor based on the percentage in economic terms that the sampled tenders analyzed represent over the total "clean" list. They are summarized in Table 24.

Additionally, the use of biogas in some transport services and vehicles is estimated to have prevented the consumption of 13,000 tons of oil equivalent of fossil raw material.

4.3.4. IMPACT MEASUREMENT IN THE STATE OF BERLIN[65]

Pursuant to the state of Berlin's Tendering and Public Procurement Act of 2010, public authorities are obliged to consider environmental criteria in their tendering process and offers must be assessed based on their life cycle costs.

To assess the potential benefits of green public procurement (GPP) and to identify areas in which greater environmental relief could be achieved, in 2014, the state commissioned a study[66] designed to evaluate the potential environmental and economic savings offered by green - as opposed to conventional - procurement if all stock and purchases were green. Therefore, the study does not present the current level of GPP and benefits achieved, but rather, the potential that GPP could have.

TYPE OF DATA USED

In order to estimate the environmental and economic benefits of GPP, the study focuses on 15 product categories related to office equipment, office consumables, lighting, buildings, transportation and waste management, which would represent 20-25% of the procurement volume of the state of Berlin and its state-owned companies. The full list of categories is available in Table 25.

The selection of the 15 product categories was based on the list of approximately 100 categories mentioned in the state's administrative regulation on procurement and the environment. Selection took into consideration estimated procurement volume, environmental impact and cost-reduction potential, and data availability before the final list was decided upon in collaboration with the German Federal Environment Agency.

DATA COLLECTION PROCESS

In order to estimate the potential benefits of GPP, data on the existing stock and annual purchases for the 15 selected product categories was needed. Given that there were no statistical data on the total stock of products or on the annual procurement volumes for the whole of the state administration, data from different sources and studies were used to estimate how many products exist in the state administration and what quantities are purchased each year. Information on the number of employees in the administration and the net floor area of state and district properties was used to extrapolate such figures.

For example, for refrigerators, the ratio was 1 per 50 employees. For electricity, the estimated supply mentioned in the framework agreement was used as a reference.

IMPACT ESTIMATION

Definition of green versus conventional

For each of the 15 product categories, the costs and environmental impacts of purchasing a conventional versus a green product are compared. This is done by defining an average or proxy conventional product and a proxy green product.

For the selection of conventional products, a product corresponding to the current state of the art was chosen using different sources. For the green alternative, products complying with strict environmental standards were selected.

For example, for computers, a conventional product was one complying with the European Union's Ecodesign Directive, which sets minimum energy efficiency requirements. The green alternative was one complying with the German Blue Angel ecolabel, which sets stricter energy efficiency requirements. For paper, the conventional product was virgin fibre paper; the green one was 100% recycled. For bed textiles, conventional cotton sheets were compared to organic cotton sheets.

Environmental impact calculation

To estimate the environmental impact of green versus conventional products, the study mainly analyzed greenhouse gas (GHG) emissions (in CO_2 equivalent) during the use phase (i.e., analysis was based on energy consumption and emission factors of the different energy sources [either electricity or fuel]). For non-energy-consuming products (such as paper or textiles), existing life-cycle assessments were used to assess the environmental impact during manufacturing.

65 Detailed explanations for the methodology can be found here (in German): http://www.stadtentwicklung.berlin.de/service/gesetzestexte/de/download/beschaffung/Endbericht_SenVBerlin_Umweltentlastung_final.pdf

66 Oeko-Institut (2015) Umwelt- und Kostenentlastung durch eine umweltverträgliche Beschaffung. Senatsverwaltung für Stadtentwicklung und Umwelt (link above)

Table 25. Environmental and cost impact factors for the 15 product categories analyzed

Product category	Unit	Effect	Annual savings per unit	Savings compared to a conventional product
Computers	One unit	Costs Greenhouse gases	EUR 13 41 kg CO_2 eq	7 % 32 %
Multifunction devices	One unit	Costs Greenhouse gases	EUR 50 120 kg CO_2 eq	6 % 47 %
Copy paper	100,000 sheets	Costs Greenhouse gases	EUR 142 80 kg CO_2 eq 1,500 kg wood	13 % 100 % 15 %
Refrigerators and freezers	One unit	Costs Greenhouse gases	EUR 7 40 kg CO_2 eq	8 % 48 %
Dishwashers	One unit	Costs Greenhouse gases	**- EUR 14** 41 kg CO_2 eq	**-9 %** 21 %
Indoor lighting	Work post	Costs Greenhouse gases	EUR 15 21 kg CO_2 eq	19 % 22 %
Textiles	Set of sheets	Costs Greenhouse gases	**- EUR 2** 0.4 kg CO_2 eq	**-23 %** 46 %
Cleaning supplies	1,000 litres	Costs Greenhouse gases	EUR 2 10,000 m3	7 % 36 %
Buildings	m2	Costs Greenhouse gases	EUR 5 12 kg CO_2 eq	5 % 42 %
Flooring	1,000 m2	Costs Greenhouse gases	EUR 86 180 kg CO_2e	0,4 % 55 %
Electricity	100,000 kWh	Costs Greenhouse gases	**- EUR 650** 31,000 kg CO_2 eq	**-2 %** 47 %
Street lighting	Lamp	Costs Greenhouse gases	EUR 533 956 kg CO_2 eq	33 % 45 %
Waste treatment	Ton	Costs Greenhouse gases	**- EUR 8** 4 kg CO_2 eq	**-9 %** 3074 %
Vehicles	One unit	Costs Greenhouse gases	EUR 198 240 kg CO_2 eq	6 % 17 %
Construction machinery	One unit	Costs Greenhouse gases	**- EUR 1,105** 3620 kg CO_2 eq 5,5 kg particles	**-6 %** 41 % 90 %

Note: Figures in red show where there has been a cost increase rather than savings when acquiring green products.

For some product categories, other environmental effects were also determined (namely, diesel particle emissions, water consumption and wood consumption). Table 25 shows the impact factors used in the study.

Economic impact calculation

The economic impact was assessed based on life-cycle cost differences, considering acquisition as well as operational costs (linked mainly to energy consumption) and disposal costs whenever relevant.

Table 26. Extrapolation of environmental and economic impacts and costs

Effect	Annual savings	Savings compared to a conventional product
Cost savings	EUR 38 million	3.8 %
Wood savings	9,300 metric tons	100 %
Diesel particle reduction	12 metric tons	90 %
Greenhouse gas reduction	355,000 metric tons	47 %

Acquisition costs were mainly determined using an Internet price search engine and calculating the average value of all listed products complying with the product properties defined. As far as possible, the useful life for each product category was based on what was set out in the state's administrative regulation on procurement and the environment.

Cost factors used in the study are expressed per year and as the difference between green and non-green products (see Table 25).

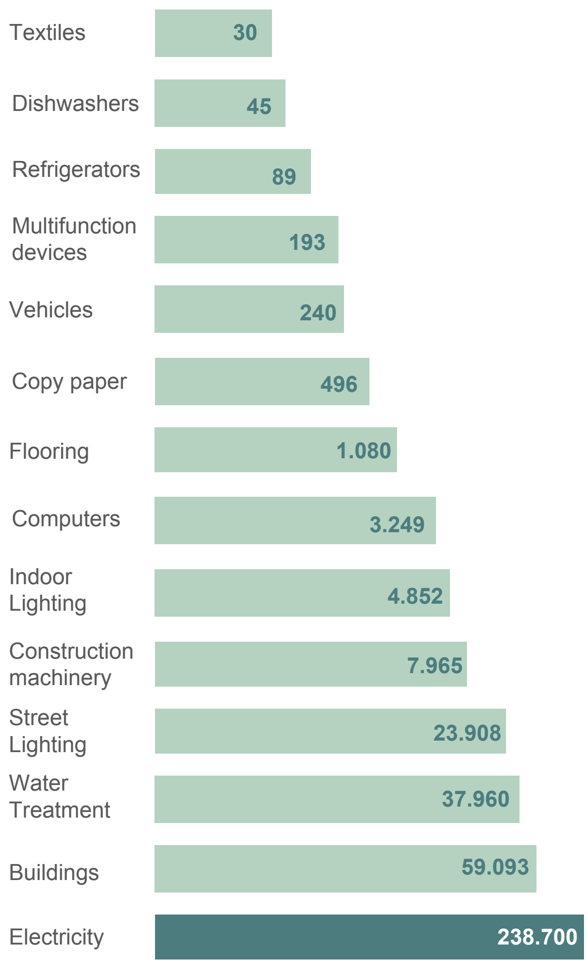
RESULTS ACHIEVED

The study used the environmental and cost impact factors and estimated current stock and annual procurement data (for the 15 product categories) to calculate the potential benefits of a scenario in which all existing stock and purchases are green. The aggregated results are presented in Table 26.

Environmental relief

As shown in Table 26, taken together, all-green alternatives contribute to a greenhouse gas reduction of about 47% as compared to conventional alternatives. This equals some 355,000 tons of CO_2 equivalent per year (once adjusted to remove double counting[67]) and corresponds approximately to the greenhouse gas emissions produced by the consumption of natural gas and district heating in all state-owned facilities. Results by product group are presented in Figure 14[68].

Figure 14. Extrapolation of the GHG emission reduction if all procurement and stock were green



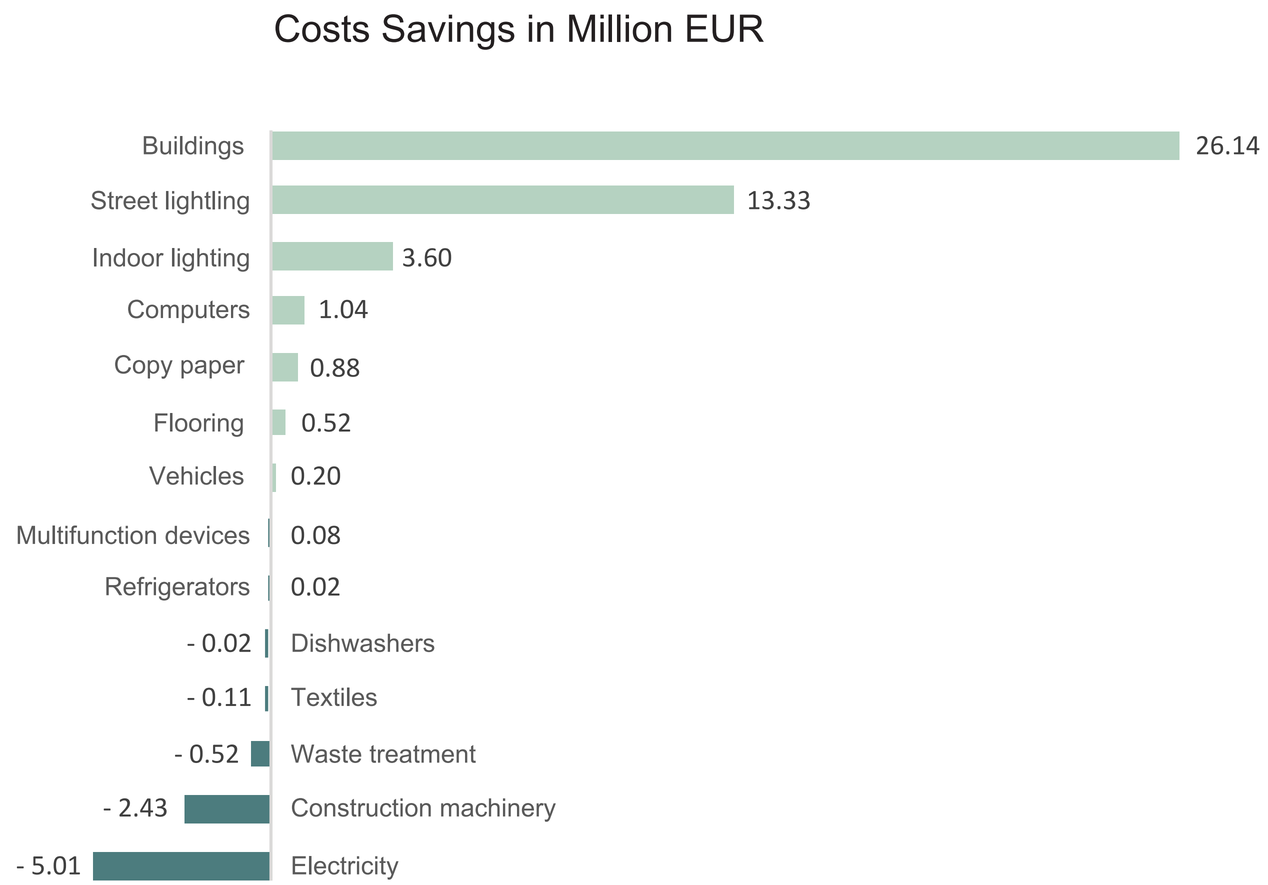
67 Greenhouse gas reductions cannot be added because if green electricity is used, the greenhouse gas savings of efficient electrical appliances will be reduced, since no conventional electricity is used. Simple addition would lead to double counting.

68 The minimum and maximum levels of greenhouse gas savings differ approximately by a factor of 8,000; for this reason, results are presented on a logarithmic scale.

COST SAVINGS

As shown in figure 15, life-cycle costs of green variants are cheaper in 10 out of the 15 product categories. In some cases (e.g., computers or vehicles), this is due to lower operational costs that compensate for higher acquisition costs; in others (e.g., paper and cleaning products), this is due to lower acquisition costs from the start. Despite the higher life-cycle costs for the remaining five product categories, environmentally friendly purchasing methods are recommended for the corresponding products because either their potential environmental benefits are substantial or the additional expense they entail is low. Furthermore, extrapolation to all stock and annual procurement clearly shows that the savings associated with the 10 product categories outweigh the additional expenses associated with the other five categories and could lead to savings of about 38 million euros per year.

Figure 15. Extrapolation of the contribution to cost savings if all procurement and stock were green



4.4. COMPARISON OF THE DIFFERENT APPROACHES

A plain reading of the different methodologies presented above and for the Republic of Korea (chapter 3) reveals the great variety of scopes, data sources, assumptions and so forth used to estimate GPP outcomes. The main characteristics of each approach are summarized below (Table 27).

PURPOSE OF THE APPROACHES

The first difference that can be observed between the cases presented is that of origin and objective.

In the Republic of Korea, Japan and the state of Massachusetts, the methodology has been in place for many years and is built on the existing monitoring of GPP implementation based on actual purchases and/or use of green products (as is the case in Massachusetts) as reported annually.

In the Netherlands, the approach is not yet in place. For the moment, there has been a one-off test aimed at defining a possible methodology for evaluating the effect of SPP. The proposed methodology is greatly influenced by previous GPP-level monitoring exercises based on tender analysis.

Finally, in the case of the state of Berlin, the approach was, from the start, a one-off exercise that does not try to calculate and communicate the benefits of real GPP implementation in the state, but rather to provide a cost-benefit analysis to highlight the potential benefits of implementing GPP.

These aspects greatly influence the approaches adopted by each authority.

PRODUCT CATEGORIES FROM WHICH BENEFITS ARE ESTIMATED

Most (if not all) supplies, services and works can be procured taking into consideration environmental criteria; in addition, the level of GPP can be monitored for an extended range of product categories. However, when estimating the sustainability outcomes of GPP, most authorities work with a **smaller number of product categories**.

The selection of these categories depends on, inter alia, relevance to overall public procurement expenditure, environmental priorities and the availability of data for the estimation of outcomes. That is why all authorities selected **energy-consuming products** and products that can be made of **recycled material or remanufactured**, apart from other products more specific or relevant to each authority's circumstances.

The exception is the Republic of Korea, which evaluates benefits for 134 of the 160 product categories for which the level of GPP is monitored. However, this has been done only since 2015; previously, only benefits from 19 categories were estimated.

DATA REQUIRED AND DATA GATHERING

All approaches to estimating the benefits of GPP are based on **the number of products** either purchased (the Republic of Korea and Japan) or purchased and/or used in service and works contracts (Massachusetts and the Netherlands), or are based on estimated stocks and annual consumption (Berlin).

The method of obtaining this information is what differs more from case to case. While the Republic of Korea, Japan and Massachusetts use total annual procurement data, the Netherlands obtains the information for only a sample and extrapolates it to the total annual tenders. The state of Berlin estimates total stocks based on (indirect) sources and studies not requiring actual procurement data (except for electricity, where procurement data has been used for its simplicity, as a framework contract provides the energy for the whole administration).

When authorities monitor the level of GPP based on actual purchases of green products or on service and works contracts (as is the case in the Republic of Korea, Japan and Massachusetts), these data have already been collected, making the benefits easier to estimate (the same report on the level of GPP can be used to estimate benefits). However, when GPP monitoring focuses on tender documents that include green criteria (as is the case in the Netherlands), a second step is required to obtain the information.

Furthermore, when purchases come from centralized framework agreements or are directly conducted through online platforms (as in the Republic of Korea and Massachusetts), data can be more easily obtained. When the scope extends to decentralized purchases, data gathering is more time-consuming.

Table 27. Summary of the approaches used by the five public authorities presented in order to measure SPP benefits

Aspect	Republic of Korea	Japan	State of Massachusetts	Netherlands	State of Berlin
Frequency	Annual (since 2005)	Annual (since 2006)	Annual (since 2012)	Annual (since 2017/18)	One-off (in 2014/15)
Scope	All public sector	National government	Statewide contracts	All public sector	State government
Data required	No. products	No. products	No. products + Amount of waste	No. products	No. products + Product stock + Amount of waste
Data used	Actual annual purchases	Actual annual purchases	Actual annual purchases in supply contracts +Actual amount of products used in service contracts +Waste generated	Purchases or products used in a sample of contracts	Estimation based on different reports, number of employees and building surface (except for electricity, which is the amount contracted)
Data gathering	E-government mall/shop +Online form for decentralized purchases	Reports by authorities (standard reporting form)	Reports by SWC vendors (standard reporting form)	e-Tendering platform +Interviews with contract owners	Internet search and existing studies +Data provided by the state
Definition of green and conventional	Using proxies Based on national GPP criteria	Using proxies Based on national GPP criteria	Using proxies Based on national GPP criteria	Using proxies Based on national GPP criteria	Using proxies Defined for the study
Calculation of benefits	Using own calculations	- Using own calculations - Substracting from the actual level of GPP the baseline from year 2000	Using external calculators + own calculations	- Using own calculations - Extrapolating from a sample to all identified tenders	- Using own calculations - Applied to all existing stock and consumption
Environmental benefits reported *	CO_2 eq emissions	CO_2 eq emissions	- CO_2 eq emissions - Others (energy, water and [toxic] material savings, avoided air and water emissions, etc.)	- CO_2 eq emissions -Others (avoided air emissions and fossil raw material savings)	- CO_2 eq emissions - Others (avoided air emissions, water and wood savings)
Socio-economic benefits reported	- Cost savings (from use costs and some externalities depending on the product) - Jobs in the green economy	None	Cost savings (lower acquisition, labour and/or use costs depending on the product)	None	Cost savings (using life-cycle costing, i.e., including acquisition, use and disposal costs)

* All calculated for the duration of the contract period or lifetime of the product whenever relevant

To streamline this process, it is important to have a **standardized reporting form** for gathering data; if possible, the form should be online and have pre-set conditions and terminology to ensure the quality and completeness of data. According to the state of Massachusetts:

> "Even through the standardized reporting form, data consistency remains an issue. Vendors use disparate terminology in their reports, omit GPP data, and place data in wrong columns, resulting in time-consuming data analysis."

DEFINITION OF GREEN VERSUS CONVENTIONAL PRODUCTS

For the estimation of outcomes, all methodologies require the selection of green attributes to define what a green product is in comparison with a non-green or conventional one. In all cases, this definition is based on requirements set at SPP/GPP policy level, administrative regulations or in developed SPP/GPP criteria documents. In the case of the Republic of Korea, the attribute established in the policy is a direct one: compliance with the Korea Eco-label or the Good Recycled Mark. However, in the other cases, green products are defined case-by-case, depending on the product category, for which a list of different criteria is normally defined **(see, for example, the Netherlands' SPP criteria documents here**: https://www.pianoo.nl/nl/node/11229).

When several criteria apply, most approaches select **one priority attribute**, based on which benefits will be estimated **(for example, energy consumption, recycled content, organic origin)**. Only when the condition is compliance with a specific certification (such as the Korea Eco-label in the Republic of Korea or the EPEAT in Massachusetts) does the evaluation of benefits take several attributes into consideration.

Moreover, when defining the characteristics of green and non-green products for estimating outcomes, **proxy or average figures are often used,** since the specific characteristics of purchased products are not reported because of the complexity this information would add. **For example, authorities might report whether computers comply with the energy consumption requirements set by Energy Star, but they do not report on the actual annual energy consumption of purchased equipment.**

The only exception was the Netherlands, where the specific characteristics of products were required. This made data provision by contract managers arduous (despite being required from only a small sample of tenders) and in some cases, the lack of data led to the inability to estimate benefits. **For example, in occupational clothing, basic information, such as the tonnage of clothing procured, was not available. Therefore, SPP benefits could not be quantified.**

BENEFIT ESTIMATION

To compare green and conventional products, **different data sources and baselines** are used. In Japan, the calculation of benefits uses as a baseline the level of GPP and, whenever relevant, product performance as of 2000. However, because the Netherlands and Berlin were the sites of one-off studies, there, green products are compared against a conventional product currently available in the market, which eliminates double-counting the effect of general technology progress. In Massachusetts, benefits are mostly calculated using calculators; when those are updated, "green" and "conventional" refer to current standards, and when those are not updated, then benefits might be calculated using different time standards. In the Republic of Korea, two studies (the first one in 2007, and the most recent one in 2015) set the impact factors for green and non-green products which are used to estimate benefits over the years. The standard is thus based on the standard for the year the studies are conducted.

The type of benefits estimated in each country influences and is influenced by the selected product categories for which outcomes will be assessed, the priority attributes based on which benefits will be estimated, and available impact factors for converting those attributes into impact indicators.

Regarding environmental benefits, in the cases analyzed, all authorities reported environmental outcomes in terms of **greenhouse gas emissions** (in CO_2 equivalent), adding some other indicators (such as energy, water or materials use and pollutant emissions) when they were available. The authority that reported more types of benefits was the state of Massachusetts, thanks to the use of calculators developed either internally (such as the EnviroCalc) or by other organizations (such as the EPEAT calculator, the Energy Star calculator, or the EPA's WARM Calculator) which develop these tools for other purposes. Nevertheless, they are very useful for estimating GPP benefits.

Regarding socioeconomic benefits, three out of the five cases (the Republic of Korea, the state of Massachusetts and the state of Berlin) estimate economic savings due to GPP. In the state of Berlin, they are calculated based on total cost of ownership (TCO); that is, considering acquisition, use and disposal costs whenever relevant. However, the Republic of Korea is the only case to consider not only direct costs linked to product use, but also the costs of environmental externalities during the life cycle of the products (life-cycle costing).

On the other hand, only the Republic of Korea estimates job creation in the green economy sector. In contrast to what is the case for environmental benefits, the estimation of job creation is not based on annual GPP expenditure. It is based on a comparison to GPP expenditure variation vis-à-vis the previous year, which does not permit a visualization of the total number of jobs in the green economy resulting from GPP.

CHAPTER 5

ECONOMIC IMPACTS OF GPP IN THE REPUBLIC OF KOREA

5.1. INTRODUCTION OF A NEW METHODOLOGY TO MEASURE ECONOMIC AND ENVIRONMENTAL BENEFITS OF GPP

A green product (GP), as defined by the Low Carbon, Green Growth Framework Act of 2010, refers to any product that minimizes the input or consumption of resources, including energy, and the generation of greenhouse gases (GHGs) and other pollutants. Green products as defined by the Act on Promotion of Purchase of Green Products of 2005 cover both eco-labelled and Good Recycled Mark products.

Following the introduction of mandatory GPP in 2005, the GP market reached an increasing compound annual growth rate (CAGR) of 11.1% by 2016. Government-led demand-expansion policies, which exceeded KRW 2 trillion in GPP market size in 2014, are showing tangible results.

This trend shows that GPP is expanding in the public purchase market in spite of barriers such as the relatively high prices of certain green products and complaints regarding the quality of some green products. In addition, this GPP trend is surprising, as it was achieved under competitive conditions, with other regulations on public procurement in place, such as those associated with energy efficiency or social responsibility[69].

The recent GP market formation in the Republic of Korea can be explained by strong government capacity. The Ministry of Environment establishes a master plan for encouraging green product purchasing every five years, detailing a variety of policies aimed at promoting green production, distribution and consumption[70]. Furthermore, the introduction of eco-friendly products that reflect technological progress to meet national environmental targets or standards has driven increased green market demand. These policies are then applied in various environmental sectors, such as air, water and waste. Most importantly, policy goals include social, as well as economic and environmental benefits.

As the green product market grows, various methodologies are being developed to assess its performance. In particular, it is essential that stakeholders pursue sustainable development and environmental policy to anticipate how, and to what extent, GPs will affect the economy and the environment through GP market expansion. For example, implementing greenhouse-gas reduction policies can entail economic costs. However, if green products and services contribute to GHG reduction, their market expansion can create economic and environmental benefits. Furthermore, as GPs replace existing market goods, increasing the purchasing utility for green consumption goods will contribute to increased social welfare.

Some studies have analyzed how GPP policy directly or indirectly affects the economy and environment using various methodologies[71]. However, most of this research focuses on the quantitative and qualitative impacts on the economy and environment based on a specific product, rather than considering the GPP market as a whole. In addition, such research fails to deal with the macroeconomic impact of the GPP policy at national level. Thus, most of the methodologies use the partial equilibrium[72] analysis approach. This approach considers specific markets and their relatives, while others are fixed or constant. For example, KEITI (2007, 2015) conducted a study on the environmental benefits of green purchasing to evaluate the performance of the green purchasing system of public institutions. A product-based bottom-up approach was used. However, not all green products were considered, and only the environmental benefits of eco-labelling were estimated because of data restriction.

Thus, quantitative analyzes of the economic benefits of GP are usually based on a bottom-up approach with GP units. However, GPP policy analysis based on macroeconomic factors such as gross domestic product (GDP), investment, consumption and industrial structure is rare.

69 Green public procurement may not be a priority for some procurers or organizations (OECD 2015).

70 Singh, Culver and Bitlis (2012)

71 Dall, Grutner, Wenzel and Thomsen (2014); Kariuki Nderitu and Ngugi (2014); International Institute for Sustainable Development (2015); U.S. Green Building Council (2015); KEITI (2015), see table 1

72 Because of data restriction, the GP market could not be considered in general equilibrium. The partial approach is useful for analysing specific GP market or product-based effects, while the general equilibrium approach has the advantage of measuring the integrated GPP policy effects at the national level.

Table 28. Literature survey

Aspect	Dall et al. (2014)	Kariuki Nderitu and Ngugi (2014)	US GBC (2015)	IISD (2015)	This research (2018)
Theme	Socioeconomic comparison of green and conventional products	Effects of green procurement practices on organization performance in manufacturing industry (Kenya)	Green building economic impact study in the United States	GPP contribution to sustainable development in China	Economic and environmental impacts of GPP policy in Republic of Korea
Methodology	Bottom-up comparative static	Bottom-up regression analysis	IMPLAN model Top-down (input–output)	IISD GPP model bottom-up (system dynamics)	Top-down integrated model (CGE model)
Sectors / Products	5 pairs (TV, washing machine, textile service, bookshelves, copy paper)		National economy (14 sectors)	Air conditioners, lighting, car, paper, and cement	National economy with 19 sectors (including GP sector)
Scenarios	Comparative effects of introducing green products		Direct, indirect, induced effects at national, state level	Baseline Light green (moderately ambitious GPP) Dark green (ambitious GPP)	Business as usual Policy (GPP policy under GHG mitigation)
Analysis	Comparative analysis	Estimating the effect of capital expenditure	Economic impact of green construction (GDP, jobs)	Comparative impacts (fiscal, environmental, health)	Comparative impact (economic and environment)

In addition, there has been no integrated, comprehensive analysis of environmental pollution emissions or the social effects of GPP policy.

Furthermore, GPP policies can affect various markets through front and rear industrial activities and final demand. When we consider market-related effects of national policy, consideration of feedback impacts from other markets is also required.

Therefore, it might be useful to conduct research on the economic, environmental and social effects of GPP policy in an integrated way in order to support sustainable green market promotion. An analysis of the impacts of industry, GDP, and consumption has not been undertaken. Additionally, the impacts of green production on GHG policy, the effects of technology development, and demand projection with regard to the command and control policy of the Government of the Republic of Korea were not considered because of Government data and methodology limitations. Methodological limitations of quantitative analysis exist because of the restriction of data availability. Even though there are such difficulties, economic, environmental and social effects of the GPP policy by means of statistical and methodological development have been identified.

The purpose of this study is threefold. The first objective is to construct a computable general equilibrium (CGE) model for the GP sector that distinguishes green products from any given production activities by using a detailed data mining procedure. The second objective is to develop the model and set up GPP scenarios. The third objective is to project and analyze how GPP policies have an effect not only on macroeconomic variables, but also on a varied range of environmental pollution forms and social welfare change.

5.2. QUANTITATIVE METHOD OF ANALYSIS

INTRODUCTION

The strength of the general equilibrium methodology (GEM) rests in its superiority over partial analysis for analyzing not only comparative static policy effects in the short term, but also macroeconomic effects such as industrial structure change, consumption, investment, gross domestic product (GDP), change in labour demand, trade balance, and change in the level of social welfare — in consideration of the whole economic system. GEM constructs a model of overall national or regional economic flow using large amounts of data such as input-output tables (disaggregated), national accounting, and consumer expenditure.

It is also convenient for extending the scale of analysis; for example, it is possible to extend the scope of disaggregated sectoral effects if detailed data is obtained. Additionally, it may be possible to merge with a bottom-up approach (KEITI, 2015) and extend towards other sectoral effects, such as environmental analysis using various exogenous multipliers.

Computable general equilibrium (CGE) modelling attempts to use general equilibrium theory as a tool for the analysis of resource allocation and income distribution issues in market economies. Since the beginning of the 1990s, CGE modelling has been widely used for analysis of environmental policy and natural resource management issues[73].

Even though some econometricians are critical of the CGE approach, and many of the typical features of CGE applications are in the experimental stage, CGE methodology nonetheless offers advantages for environmental policy modelling[74]. CGE modelling has been applied to analyze GHG mitigation policy and used extensively in the analysis of environmental policy effects on the economy, the environment and society in the Republic of Korea.

There have been a number of studies regarding energy-economic and economic-environment CGE models in order to analyze GHG policy in the Republic of Korea. Y.Y. Kang (1998) and S.J. Kang (1999) developed and analyzed the economic effects of various GHG emission reduction scenarios, including the carbon tax and energy subsidies. These studies provided good examples of how the Republic of Korea has applied CGE models specifically for nested energy structures. Moreover, Kim et al. (2002) added to the scenarios pollutants such as SOX and PM10, as they can have an ancillary effect on reducing GHGs. A cost-benefit analysis was performed with regard to utilization of the health benefits[75] of GHG abatement scenarios in addition to the economic costs.

Kang and Kim (2007) constructed a recursive and dynamic national computable general equilibrium model that allows for analysis of the economic impacts of various market-based environmental policy interventions. It includes its own original modelling components, such as separate environmental protections and resource recycling activities, as well as recursive dynamic features. These components contribute greatly to enlarging the scope of quantitative environmental policy analysis. Their results show that the investment effect for the environmental industry can contribute in the long run to the recovery of GDP loss due to reductions in greenhouse gas emissions. In addition, the introduction of new and renewable technology in the resource recycling industry may simultaneously accelerate GDP growth and improve the environment.

Kim and Shin (2011) investigated the economic effect of a green tax by using a simple computable

73 Bergman, L. 2005. CGE modeling of environmental policy and resource management. In *Handbook of Environmental Economics vol. 3. 1st Edition*. 3(3).

74 For example, introduction of exogenous parameters such as elasticity of substitution for various nested production technologies might affect the results of the CGE model. Therefore, it is important to choose the appropriate parameter values. In addition, CGE models usually focus on the real side of the economy and thus do not include markets for financial assets (Dixon and Parmenter 1996). Nevertheless,the CGE model has been used continuously to analyze economic feasibility and impact related to environmental policy, especially analysing market distortions and externalities. Environmental CGE models have focused on climate change or acid rain problems and deal essentially with externalities and policies aimed at internalizing externalities. However, CGE models designed for analysis of this type of natural resource management issue are likely to differ substantially in many respects from a CGE model designed for analysis of problems related to externalities (Bergman 2005, p. 1276).

75 Some studies regard health benefits as an ancillary benefit or co-benefit of GHG emission reduction. For more details, see Kim et al. (2002) and Dessus and O'Connor (1999).

general equilibrium model. The introduction of the green tax decreases the GDP; however, given the reduction target, the green tax[76] involves less GDP loss. In addition to this, the green tax promotes the consumption and production of new and renewable energy. This would have the effect of stimulating the new energy industry. The green tax transforms the industrial structure into a low energy-consuming one. In terms of carbon emissions, the green tax induces emission abatement mainly through energy conservation and structural changes.

GPP policies are not simply related to the green market, and there are various issues linked with others. For example, the price of green products can play a role as a substitute for, or be complementary to, that of existing goods, which can lead to a change in the overall commodity market. Green product production and consumption are also related to greenhouse gas emissions and can affect GHG policy. Therefore, this can have a feedback relationship that affects production or overseas markets. Considering this policy effect, there is a need to deal with various economic institutes and markets.

This study has considerable scope for following prior research methodology in that it reflects GHG mitigation policy simultaneously with various GPP policy options, although the themes are completely different. This research therefore compared the economic impact of the GPP policy under the Republic of Korea's GHG mitigation scenario to examine the macroeconomic benefits of GP procurement. Of course, the market scale of GPs does not account for a large part of the national economy, which may limit the effects of GPs. Nevertheless, the Republic of Korea has been pursuing a mid- and long-term GP market revitalization policy. It is important to evaluate the analytical methodology and its impact on macroeconomic and environmental perspectives, since these kinds of policy impacts do not show up in the short term[77]. In particular, the Republic of Korea has already presented voluntary GHG reduction scenarios, and it is therefore important to assess the contribution of GPP policy under the GHG reduction policy in terms of policy feasibility. First, we computed the national GHG reduction costs and quantitatively compared the economic impact of the GPP policy scenario. GHG mitigation costs were calculated at the national level by introducing a hypothetical carbon tax [78]

This research follows CGE modelling methodologies by constructing a top-down, sequential dynamic[79] and single country multi-sector model with the GHG mitigation target in the Republic of Korea. However, this model has features which are different from those of previous GPP performance review studies and GHG analysis models of the Republic of Korea. Our model focuses on the various economic, environmental and social impacts of GPP policy in order to stimulate the GP sector with GHG mitigation time. This study calculates the level of consumer welfare in the national economy as a social effect. Most importantly, constructing the GP sector anew is an important trial and differential method for national CGE modelling.

DATA

The social accounting matrix (SAM) shows transaction flow for the national economy by sectors and institutes in a given period. All data sets we need in this modelling can be recognized via SAM. There is no principle by which SAM is generated except the rule that the row must be equal to the column sum for each corresponding account. This can be called the consistency or equilibrium condition of SAM, because we typically assume that the economy is equilibrating in the CGE model. The base year of this research is the year 2014, in consideration of data availability.

76 The green tax is intended for the subsidizing of carbon taxes in order to produce renewable energy while a simple carbon tax is intended for the transfer of all tax revenue to consumers.

77 The green growth model should be mainly based on the dynamic long-term perspective in order to consider R and D activities, resource flows and environmental policies (Kim 2014).

78 This study does not intend to estimate GHG mitigation cost in the Republic of Korea, but to measure how cost-effective GPP policy is. Therefore, considering all other GHG mitigation policies (such as market-oriented measures, emission trading, renewable energy promotion policy and CDM) is beyond the scope of this study. Thus, this research assumes that the carbon tax is introduced as a representative variable for estimating GHG reduction cost.

79 In the model, each agent has myopic behaviour. The sequential dynamic CGE model essentially comprises a series of static CGE models that are linked between periods by exogenous and endogenous variable updating procedures. Many applied general equilibrium models tend either to be based on single period optimization assumptions or to use this structure in a discrete sequential manner to model dynamic process (Annabi et al. 2004; Diao et al. 1996).

Table 29. Main data and source

Data	Source
Input-output table (2014) – commodity flow National accounting (2014) – direct tax, saving Financial statement analysis (2014)- depreciation	Bank of Korea
Household survey (2014) Total service survey (2014) Wholesale and retail trade survey (2014) Mining and manufacturing statistics (2014) Public procurement statistics (2014-2016)	Korea National Statistical Office
Export-import statistics (2014) – total foreign trade Tariff and trade statistics (2014) – tariff and trade statistics	Korea International Trade Association, Korea Customs Service
Integrated environmental and economic accounting and green GDP IV (2014[82]) – air, water, waste coefficient	Korea Environment Institute (KEI)
Green product statistics (purchase and firm information)	Korea Environmental Industry and Technology Institute
Yearbook of energy statistical survey (2014) - Energy use (quantity term), carbon ton per unit ton of energy (**www.keei.re.kr**): IPCC value	Korea Energy Economics Institute

Typically, GPs in the market are durable, non-toxic, made of recycled materials, or minimally packaged[80]. However, there is a difference between the definition and scope of GPs according to institutions and policies by country, as well as economic entities such as academia, industry and consumers. This study defines GPs as products certified for environmental marking (Eco-label, EL) and recycled products (Good Recycled, GR) in the Republic of Korea. The GP market includes GPs registered as procured by the Government, municipalities, public institutions and companies or voluntarily consumed by private consumers. However, the GP market corresponding to voluntary private-sector consumption is very small, and GPs in the Republic of Korea are therefore highly dependent on public procurement.

As we mentioned above, this model introduces the GP industry as an independent sector in our market system. Therefore, a total list of data and sources is indicated in Table 29. Constructing CGE modelling for the GP sector presents some data availability limitations with regard to building input sets because there is no Korean Standard Industrial Classification (KSIC) code for green products.

Another main problem is that it is hard to distinguish net GP supply and use data from each constructed sector. To do this, we use data from firms producing green products with GPP purchase data from KEITI, matching the firm number and KSIC code (see Figure 16). After code matching, we can find the GP proportion from total output. Sectoral output, except for GP output, may then be established.

80 Durif et al. (2010). Of course, there are no completely green products, as all products use energy and resources and create by-products and emissions during manufacture, transport to warehouses and stores, use, and eventual disposal. Therefore, the term "green" is relative and describes products that have a lesser impact on the environment than do their alternatives (Ottman 1998, p. 98).

81 This research was conducted using 2005 IO data as base-year data. Updating is needed.

Figure 16. Principle of GPP data matching with KSIC

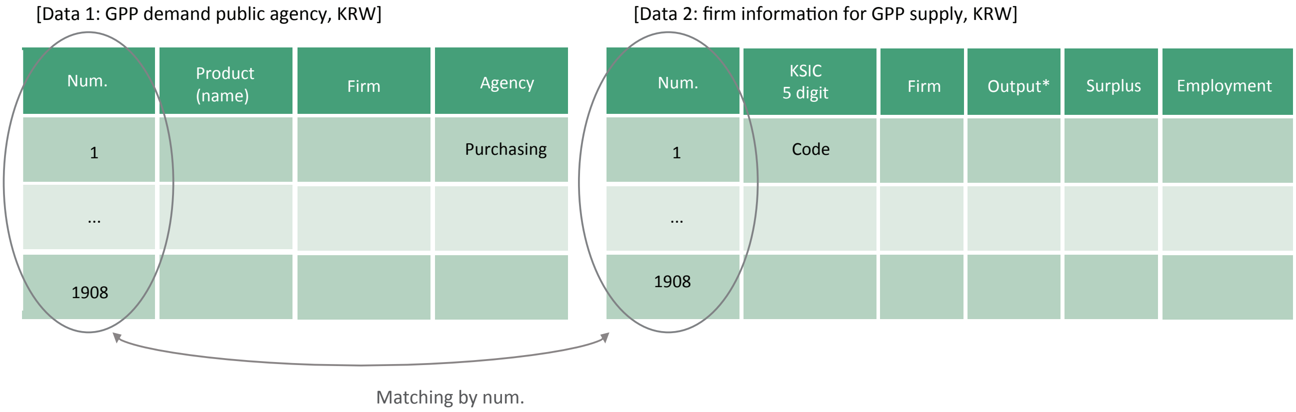
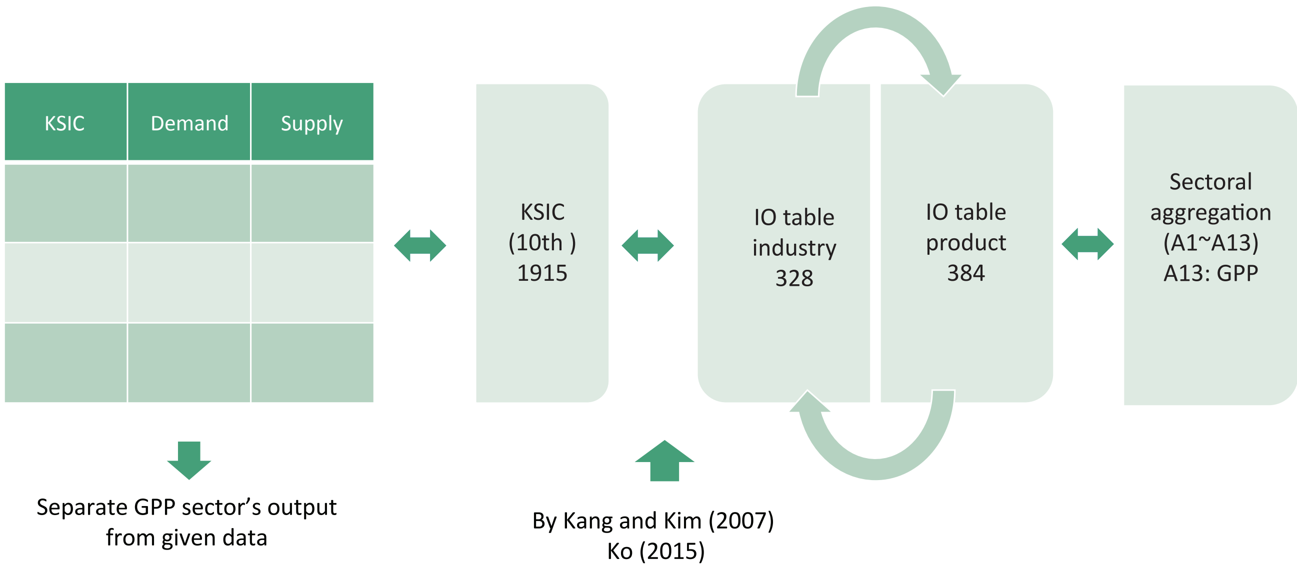


Figure 17. Method of separating GPP data in SAM



To determine the total output value of the GP sector, we need to input the intermediate transactions between the GP sector and other sectors and the final demand for green goods[82]. Value added and capital stock come from the firm information data.
In addition, integrated single public institution sector demands the output of GP intermediately. We know how public institutions purchase GP goods in the base year, 2014, from the KEITI data, as intermediate demand. However, there is little information regarding the intermediate cost of goods in GP sectors.

This means that we cannot easily estimate how the GP sector uses resources, including energy, to produce the unit output of GPs. Input of energy to the sector could be assumed by industrial average[83].

In addition, we can obtain average employment income, surplus and capital formation of GP production firms from KEITI's data. Other intermediate inputs are assumed to be the same as the competitive market average.

82 The meaning of "green products" is the same throughout the paper.

83 This research focuses on analysing the impacts of the Republic of Korea's GPP mandatory supply. The model thus uses information regarding energy saving associated with the purchasing of green products (KEITI 2007) and does not consider production technology for making green products on account of data limitations.

Table 30. Summarized SAM of the model

	Production		Factors	Final demand				Row sum
	Activities	Markets		H	G	I	F (EX)	
Activities								Total output
Markets								Total demand
Factors								Income
H1)								H income
G2)								G income
I (=S)3)								Total saving
F (IM)4)								Foreign outlay
Column sum	Total input	Total supply	Outlay	H outlay	G outlay	Total invest	Foreign revenue	

1) Household, 2) Government, 3) Investment = Saving, 4) Foreign (import, export)

Once the GP input is set up, GP demand must be constructed. We only know the GP demand from public companies, institutions and government agencies, and we know intermediate GP demand from the public market. However, there is no statistical data on private GP demand from firms and households in the Republic of Korea. Intermediate demand from private companies for green products defined in this research (EL, GR) is difficult to estimate. Meanwhile, household green-product purchasing may be estimated by using Green Card[84] usage information accumulated since 2011. KEITI provides the estimated market value of GP household demand induced by the Green Card system. It is necessary to consider the voluntary substitution effect of green products when the amount of green products purchased by households is considerable[85]. Where this is the case, the consumer transformation matrix may be constructed to take into account the substitution effects of purchasing green products for household consumption[86].

After data collection, the SAM is developed using input data from sources such as the national account, input-output table and financial statement analysis from the Bank of Korea (BOK)[87], household surveys, total service surveys, mining and manufacturing statistics, and wholesale and retail trade surveys from the Korea National Statistical Office (KNSO), GPP data from KEITI, export-import statistics from the Korea International Trade Association (KITA), tariff and trade statistics from the Korea Customs Service (KCS), and so on. Also, the SAM is based on data from the year 2014.

Finally, GP demand for each industry sector can be determined by a principle of supply-demand equilibrium, Walras' law, in the SAM.

Our analysis of the model includes not only global air pollution and CO_2, but also local air pollutants, PM10, NOX, water (BOD), and industrial waste. To integrate CO_2 emissions, we used industry energy-use data and the fossil-fuel emission factor. The total and sectoral CO_2 emission level was calculated by the unit of tons of carbon and determined endogenously by fossil fuel demand in each industrial sector.

84 The Green Card system is an economic incentive system introduced by the Ministry of Environment in July 2011 (Moon 2014; KEITI 2012).

85 In practice, between firms and households there will be a difference in GHG emissions resulting from energy saving because public institutions are obliged to purchase many electronic products, such as eco-friendly computers and printers, which are more energy efficient than general products. However, green products that are affiliated with Green Cards are mostly household goods.

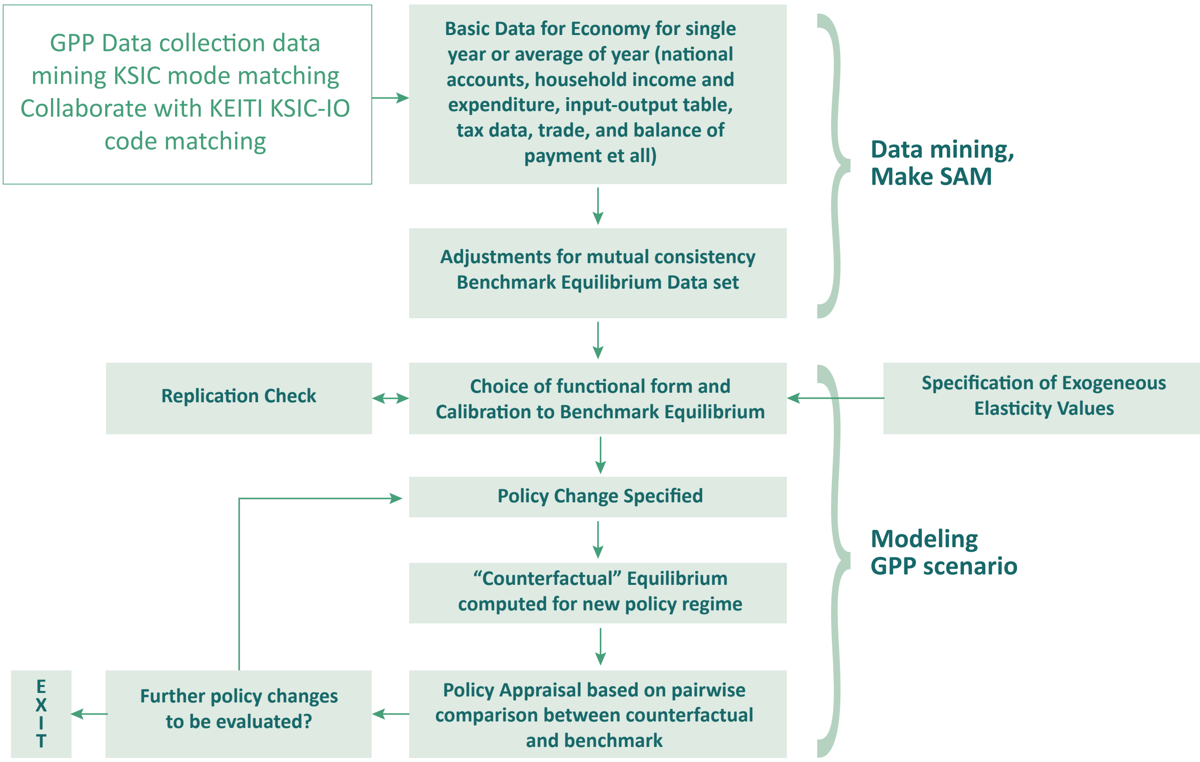
86 Households consume green products in the Republic of Korea. However, the value of this consumption is estimated to be less than 1% of total GP market in this study. Since private GP consumption is important to new market growth, the value is incorporated even if it is low.

87 Modified firm data obtained by KEITI is from Nice Credit Information Co., Ltd.

Table 31. Sectoral classification

Classification		N	Sector code	Description	Korea IO code
Production sectors	Competitive industry	1	A1	Agriculture, fishing, forest, mining	1-27, 30-34
		2	A2	Non-energy-intensive manufacturing	35-98, 249-273
		3	A3	Energy-intensive manufacturing	111-248, 275
		6	A6	Public institutions	274,276,279, 281,282,284, 335,346,347, 360-363, 365-366, 368-371
		7	A7	Construction	287-301
		8	A8	Transportation services	304-317
		9	A9	Others	277, 278, 280, 283, 285, 286, 302-303, 318-334, 336-345, 348-359, 346, 347, 372-384
	Non-competitive energy	4	A4	Imported oil	28
		5	A5	Imported gas	29
	Competitive energy	10	A10	Coal and coal products	99-100
		11	A11	Oil products	101-106, 108-110
		12	A12	Gas products	107
	GPP	13	A13	Green product (EL, GR)	New
Basic production factor		14	L	Labour	
Final demand and balance of payment sectors		15	K	Capital	
		16	H	Household	
		17	G	Government	
		18	I	Investment	
		19	F-EX	Export	
			F-IM	Import	
			FBOR	Foreign saving or investment	

Figure 18. Flow chart of analysis



Other domestic pollution emission was exogenously connected with the current CGE model using emission coefficients and the emission ton per industry output. The corresponding initial values were derived from research by the Korea Environment Institute, Integrated Environmental and Economic Accounting, and Green GDP IV[88] .

After all the data were input adequately, we needed to adjust the SAM balance and conduct a benchmark check. For this modelling work, we followed the method put forward by Robinson et al.[89] (1997) to equilibrate the SAM.

The current model has 13 markets and activities in production (Table 31)[90].

ANALYSIS PROCEDURE

This research involved the construction of a simple sequential dynamic CGE model based on the economy of the Republic of Korea, including the GP sector, for application to various GP expansion policies. Figure 18 shows the typical flow of the applied CGE model with regard to policy analysis.

The economy under consideration is assumed to be in equilibrium — the so-called "benchmark equilibrium". The parameters of the model were chosen through a calibration procedure. Once all the parameters were specified, the model could reproduce the given data set as an equilibrium solution[91]. Then, the generated parameter value could be used to solve the alternative equilibrium concerned with any changed policy scenarios. This is the "counterfactual" equilibrium in Figure 18. Policy evaluations could then be compared with counterfactual and benchmark equilibrium.

88 Korea Environment Institute (2006)
89 Robinson, S. and El-Said, M. (1997). Estimating a Social Accounting Matrix Using Entropy Difference Methods. International Food Policy Research Institute.
90 Substantially, non-competitive energy sectors (A4, A5 in table 31) are not engaged in production activity because the corresponding commodities in the Republic of Korea are almost entirely imported from foreign countries. We treated these sectors as intermediate goods in the model.

91 This is the replication check referred to in figure 2-1, which serves as an important computer code accuracy test. If this check fails, then a programming error has been discovered and written code must be fixed further. Not all parameters can pass through the calibration procedure; some are directly introduced from previous studies or estimated from a specific econometric method (John and Whalley 1992)

Calibration can be understood as the requirement that the entire model specification be capable of generating base-year equilibrium observations as a model solution[92]. Therefore, the counterfactual equilibrium of the model could establish equilibrium data with its parameter values.

If the CGE model simulates policy analyzes, the functional form may be important. For example, for the C-D (Cobb-Douglas) function, we only need the above calibration procedure, but if we take the CES (constant elasticity of substitution) or LES (linear expenditure system) functions, exogenously given elasticity values, which are usually based on a literature survey, are required because we typically only have monetary terms of data for the base year.

In our model, we used functions such as Leontief, C-D, CES, and CET (constant elasticity of transformation). Therefore, parameter values were obtained not only from the calibration procedure, but also from various literature surveys.

92 John and Whalley (1992)

5.3. THE MODEL

MODEL STRUCTURE

The following categories of goods and technologies are included in the model: final produced goods, domestic goods, export goods, import goods, Armington[93] goods, composite factor goods, intermediate goods (including green products and non-energy intermediate goods), energy composite goods, and fossil energy composite goods.

The model has a nested production structure with an energy-specific input tree, as per Figure 19. It is assumed that the final goods value (xt_i) is produced by Leontief technologies (Lef) using composite factor goods (xr_i) and non-energy composite intermediate goods ($m_{i,j}$). The composite intermediate goods value is created by Leontief technology using competitive production sectors, two non-competitive import sectors, and the GPP sector (see Table 31). The final produced goods value is used not only by final demand but also by intermediate demand. The composite factor goods value is generated by constant elasticity of substitution (CES) production technology using labour (L_i), capital (K_i), and energy composite goods (e_i). The energy composite goods value is produced by CES technology using three different forms of fuel, such as coal, oil, and gas: the competitive energy sector (see Table 29). In addition, the final produced goods value is converted to the domestic and exported goods value by the constant elasticity of transformation (CET) technology.

The government imposes a production tax on firms, an income tax on households, the carbon tax on the use of fossil fuel (if introduced), and tariffs on total imports from foreign sectors. The government revenue is then distributed for government consumption, government saving, and transfer payments to households in a fixed proportion.

The household is myopic and maximizes utility in each period. The utility in each period is assumed to be a Cobb-Douglas function of both household saving (SH) and the consumption (ch_i) of Armington goods. Thus, expenditure on the consumption of each Armington good is a fixed proportion (δ_i) of total disposable income. The household disposable income is obtained by subtracting a proportional income tax from the household income. The household income consists of revenues from factor supply and transfer payments from the government.

The foreign sector supplies the imported goods and demands the exported goods. It also provides foreign savings. Foreign savings are assumed to be negatively proportional to the imported amounts. The exchange rate equilibrates the foreign exchange market. The supply of foreign exchange consists of exports (xx_i) and foreign saving (SF), while the demand for foreign exchange consists of the imported goods (xm_i).

The market equilibrium condition is specified in terms of demand and supply of the Armington goods. The demand side consists of the total demand of intermediate goods in production sectors, household and government consumption demand, and investment demand. Thus, the equilibrium production level is determined by the quantities demanded. This is because the supply curve is horizontal at the unit cost level, since the production technology is homogeneous of degree one. Labour and capital supply from the household sector is equal to the total factor demand of the production side. The price of domestic goods (pd_i) is determined by the zero profit condition of the product transformation. The price of the Armington goods (ps_i) is determined by a CES-type weighted average of the prices of domestic and imported goods.

Total saving consists of household saving, government saving, and foreign saving. In this model, we assume that total investment is determined by total saving. Thus, our model is savings-driven. We close the model by allowing the outflow of capital to be equal to the net foreign trade surplus. The exchange rate is to be constant throughout the entire analysis. Therefore, our model can have either a trade surplus or trade deficit. We have listed the main content of the system of equations, variables, and parameters as an appendix.

93 Under the Armington assumption, the imported goods and the domestic goods are incompletely substitutable. See John and Whalley (1992), p. 81, pp. 230-232.

94 Figure 20 shows the flow diagram for quantity variables in the CGE model.

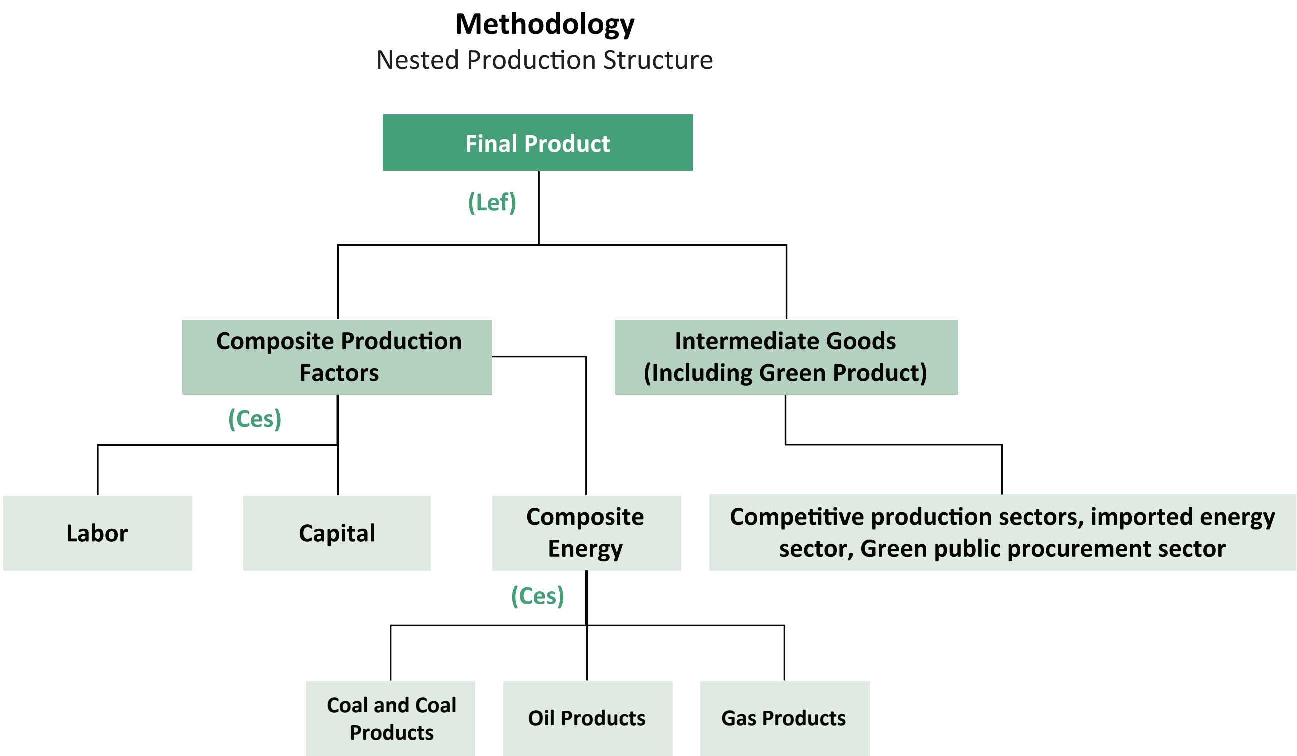
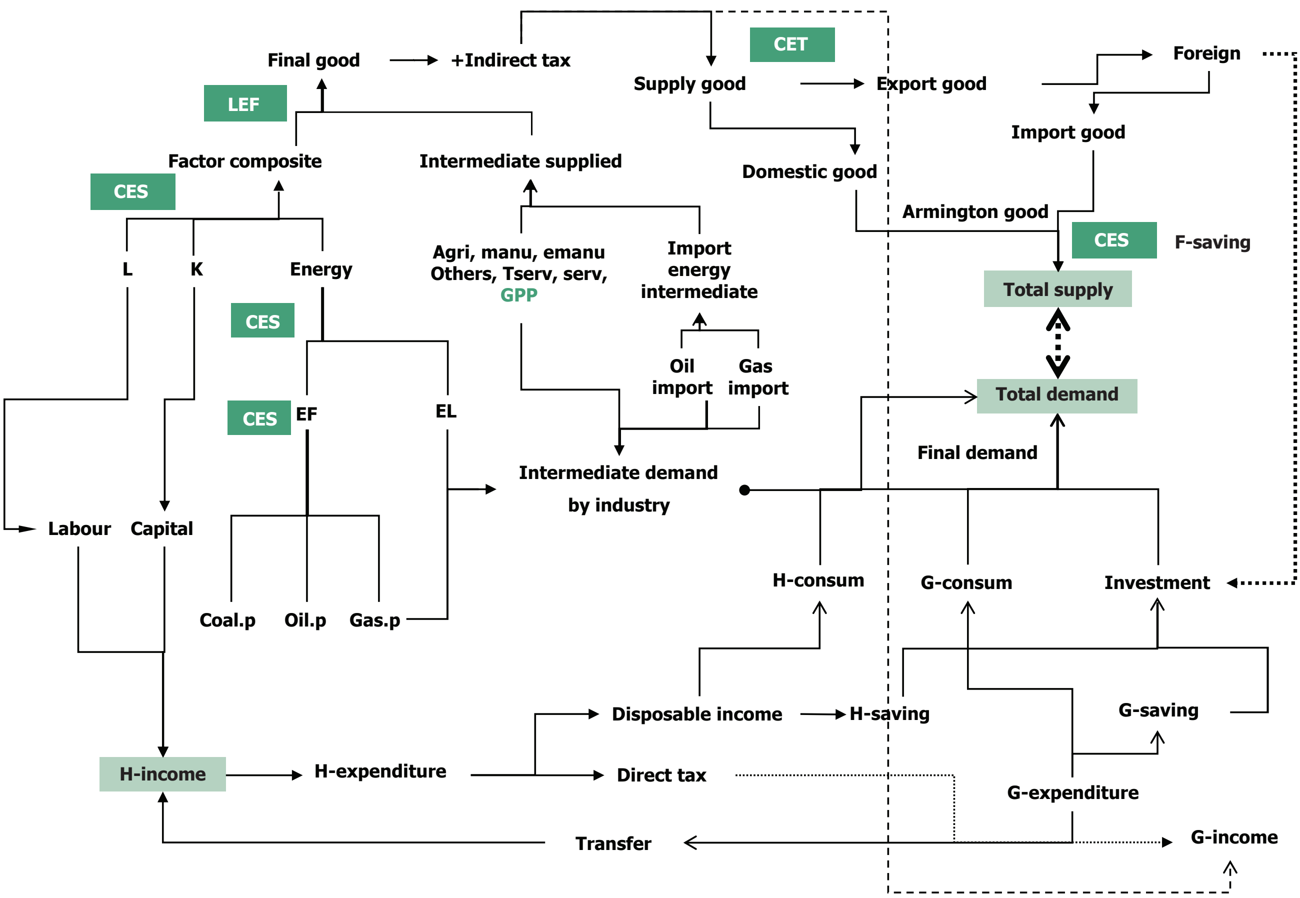


Figure 19. Nested production structure **Figure 20**. Model flow diagram[95]



In this model, each production level and price is determined endogenously, except for the price of imported goods. In addition, we introduce the CPI (consumer price index) as the numeraire of the model, and the value is fixed. Generally, a numeraire is required, since the model is homogeneous of degree zero[95] in CGE model prices. All simulated prices and income changes should be interpreted as changes vis-à-vis the numeraire price index.

DYNAMIC FEATURE

This study calculates recursively the annual equilibrium state of the economy from 2014 to 2030, with 2014 being the base year[96]. The target year 2030 represents the goal for the current GHG mitigation scenario in the Republic of Korea.

We assumed that total investment is determined by Leontief technology using each investment demand. The depreciation rate comes from BOK financial statement analysis. This model supposed the annual constant supply of labour provided by KNSO population outlook data[97].

Therefore, annual capital accumulation is as follows:

$$KS_t=(1-\delta_t)\, KS_{(t-1)}+IV_{(t-1)}$$

KS_t : Capital stock in period t

δ_t : Depreciation rate in period t

IV_t : New investment in period t

$$LS_t=(1+n_t)\, LS_{(t-1)}$$

KS_t : Labor stock in period t

n_t : Population growth rate in period t

ENVIRONMENTAL LINKAGE

We introduced CO_2 as a global environmental pollution factor in order to consider greenhouse gas (GHG) mitigation policy in the Republic of Korea. The carbon tax is concerned with policy variables in reducing greenhouse gas emissions. In this model, carbon tax is imposed on primary energy usage. The model deals with total fossil fuels that have been used domestically for a year, but has not explicitly considered the energy conversion sector[98].

Although this model did not generate green product specifications[99] for the production process because of data limitations, we considered the effect of GP demand. The Republic of Korea GPP study (2015) shows that final demand for GP products can decrease the unit value of electricity demand compared to non-green goods. We can calculate the unit coefficient of CO_2 reduction by GP demand using accumulated information[100]. In addition, this study enables us to calculate exogenously the change in local environmental pollution emissions as changing the production level using an emission coefficient created and modified from previous studies[101].

BASIC ASSUMPTION

This analysis assumes that all agents are myopic. In other words, it does not function as an intertemporal dynamic model[102], which means that the model computes the static general equilibrium for each period sequentially.

95 A doubling of the value of the numeraire would double all prices but leave all real quantities unchanged.

96 Sequential dynamic models do not have intertemporal aspects. This means that consumers only maximize their utility depending on the current state of the economy. They do not consider future welfare (discounted to present value). For details, see Dellink et al. (2004). However, the sequential dynamic model has some advantages. It enables us to calculate the transition path from the initial balanced state of the economy to a new equilibrium state, which is of particular importance for policy-making. Typically, the inclusion of the new path may have a significant impact on any specific policy recommendation to be drawn from the analysis.

97 y2005 - y2050 annual population prospecting scenario (mid-level population projection)

98 The electricity sector is not divided by independent energy resource sector in the model because of limited data for the electricity demand of the green product sector. It was hard to construct the nested production structure including the electricity sector. In addition, the electricity sector is almost included to public institution sector which have to purchase green product. To describe this feature will be next subject with more disaggregated firm data.

99 GP can be defined as (energy) resource efficiency in the production process, energy saving, and environmental efficiencies such as recycling, reuse, reproduction in final demand (stage of use and disposal, KEITI).

100 KEITI calculated CO_2 emission reduction from the consumption of GPP goods annually (from 2014).

101 Chu et al. (2015). We need to re-estimate an updated sectoral emissions coefficient to match up with the sectors in this model.

102 Intertemporal dynamic models are based on optimal growth theory, whereby the behaviour of economic agents is characterized by perfect foresight. The assumption is that they know all about the future and react to future changes in price. In this case, households maximize their intertemporal utility function under wealth constraints to determine their consumption schedule overtime. For the long-term policy perspectives, the intertemporal dynamic model was usually accepted as long as data were available.

Table 32. Policy scenarios

Names		Explanation
GHG policy	GHG S	GHG emission level decreases every year until 25.7% reduction compared to BAU in target year through carbon taxes (see figure 2)
GPP policy	GPP S1	Carbon tax revenue transfers to GP production as subsidy production cost (50% of GP price comprises subsidies); the rest of the tax revenue transfers to consumers
	GPP S2	Technological progress in GPP sectors by 1% every year for projection period; 100% of carbon tax revenues are transferred to consumers
	GPP S3	GPP S1 + GPP S2, hybrid scenarios; the rest of the tax revenue transfers to consumers

These static equilibriums are interconnected by the evolution of the capital stock, which changes over time as investment is added to the capital stock[103]. Thus, population growth rate, depreciation rate and labour productivity (the adjustment parameter in the labour supply process) were given annually for the projection period. Until 2030, total population is projected to increase but the population growth rate is decreasing, reflecting population projection statistics from KNSO. This did not reflect the government's policy goal to promote childbirth, and just introduced the estimated results of mid-level population projection.

The average depreciation rate of the entire industrial sector based on BOK data is around 3% in the year 2014 and is maintained as such over the projection period. In addition, it is assumed that the prices of export and import goods are exogenously constant.

Even though we developed a 16-year simulation, there exists a real growth rate from 2015 to 2017. Therefore, we adjusted some macroeconomic parameters (the labour productivity and depreciation rate) to accomplish a nominal rate of GDP growth by 2017[104]. In addition, GHG emissions will steadily increase in business-as-usual scenario. This assumption reflects the analysis results105 for GHG emission forecasts from the energy sector of Korea Energy Economics Institute.

103 Refer to the dynamic feature section above.
104 This can be checked in figure 23.
105 Korea Energy Economics Institute (2017) forecasts that the Republic of Korea's GHG emissions in the year 2030 will peak at the current level of technology and will decline thereafter.

SCENARIOS

This study compares the economic impact of the GPP policy under the Republic of Korea's GHG mitigation scenario to examine the macroeconomic benefits of GP procurement. Of course, the market scale of GPs does not account for a large part of the national economy, which may limit the effects thereof. Nevertheless, the Republic of Korea has been pursuing a mid- and long-term GP market revitalization policy. It is important to evaluate the analytical methodology and its impact on macroeconomic and environmental perspectives, since these kinds of policy impacts do not show up in the short term[106].

In particular, the Republic of Korea has already presented voluntary GHG reduction scenarios, and it is therefore important to assess the contribution of GPP policy under the GHG reduction policy in terms of policy feasibility. First, we computed the national GHG reduction costs and quantitatively compared the economic impact of the GPP policy scenario. GHG mitigation costs were calculated at the national level by introducing a hypothetical carbon tax.

This research considers the case of a 25.7%[107] reduction in carbon emissions in the Republic of Korea domestically by 2030 via the imposition of carbon taxes on the use of fossil fuels. This is a voluntary commitment of the Government of the Republic of Korea.

106 The green growth model should be mainly based on the dynamic long-term perspective to consider R and D activities, resource flows, and environmental policies (Kim 2014).
107 The Republic of Korea's GHG emission reduction target in domestic fields (2015)

Thus, the study constructed four types of policy scenarios vis-à-vis business as usual (BAU) in the economy of the Republic of Korea[108]. One is the GHG mitigation scenario (GHG S), where there is a simple carbon tax[109] for the purpose of reaching the GHG emission reduction target of the Republic of Korea. Tax revenue is simply transferred to the household. Other scenarios concern GPP policy promotion (GPP S) under GHG S.

The model applied three types of GP promotion policy[110] scenario during the projection period of 2015–2030. The first scenario (GPP S1) provides a portion of the carbon tax as a GP production subsidy. Here, the subsidy rate is determined such that the GP supply price declines steadily and the remainder of the carbon tax revenue is transferred to the consumer. The second scenario (GPP S2) assumes that the technological progress rate in the GP sector increases by 1% each year through the scale parameter of GPP production technology. The other scenario (GPP S3) is a combination of the first and second scenarios, whereby technological advances and production subsidies occur simultaneously in the GP sector (GPP S1+ GPP S2).

We also can consider extended current government command and control policy for the GP sector, whereby the GPP rate for public institutions increases throughout the projection period. This scenario could be based on a master plan for encouragement of GPP by the Act on the Promotion of Purchase of Green Products of 2005. The method of increasing the mandatory target of total GPP demand[111] might be fixed for the analysis period. The study calculated the proportion of GPP to be achieved by 2020 at 60%, reflecting the Republic of Korea's third master plan for promoting GPP[112].

108 The Ministry of Environment (MOE) of the Republic of Korea announced the modified GHG mitigation scenario around the end of June 2018. However, it is still being publicized, and the voluntary reduction target is not expected to change very much. Therefore, this research considers officially existing reduction targets to be GHG mitigation scenarios.

109 It cannot reflect all of Korea's GHG reduction policies in the model. Carbon tax is introduced in this model as a hypothetical integrated policy variable covering Korea's greenhouse gas reduction policy.

110 This has the same meaning as GPP (green public procurement) policy in the Republic of Korea because current GP promotion policy has almost been implemented by GPP.

111 The Republic of Korea's GPP policy is legally required to enforce mandatory demand. However, there are not many policies to attract voluntary market participation of GPP suppliers.

112 The problem is that we do not possess information about the total level of green product procurement. We only have the value of GP procurement for the year 2015. Therefore, firstly, we calculated the CAGR (=3.08% from the year 2010 to 2017) of total public procurement for products for the Korea National Statistical Office. Next, we calculated the total green procurement scale by the year 2030, assuming the average growth rate of 3.08% over the forecast period (from the year 2015 to 2030). Under such conditions, the green public procurement ratio reaches 60% in the year 2020, increasing 4% from the year 2017. In 2015, 2016 and 2017, KEITI had total increases in GPP of, respectively, 9.6%, 18% and 5.4%.

5.4. ANALYSIS RESULTS

This research analyzes the economic, environmental and social impacts of GPP policy under GHG mitigation policy in the Republic of Korea. The study is divided into three analysis sections. Firstly, it compares macroeconomic impacts such as GDP, consumption, investment, employment and industrial structure change by each scenario. Secondly, it analyzes the comparative local environmental impacts such as PM10, biochemical oxygen demand (BOD) and industrial waste. Thirdly, the social welfare effects are compared and analyzed by calculating equivalent variations in each scenario.

MACROECONOMIC IMPACTS

The BAU projection in the Republic of Korea (Figure 21) is stable, with a compound annual growth rate (CAGR) of 2.5% over the projection period because this research does not consider any other exogenous effects, such as international energy price change, technological progress, or other policies. The GHG scenario shows that total emissions would decrease about 330 million CO_2 ton in the year 2030 (Figure 22)[113].

This study compares the macroeconomic effects of GPP policies with the effect of a simple carbon tax. Real GDP is reduced by 0.596% under GHG S, while it is reduced by 0.586% - 0.593% under the GPP scenarios.

With a carbon tax imposed to reduce GHG[114], the GDP level compared to BAU was projected to decrease by 0.596% in 2030. The economic benefits of GPP policy scenarios were calculated by estimating the difference from GHG S. The analysis results show that the GPP policy scenario would bring about macroeconomic benefits in the range of USD 56 million (GPP S1) to USD 117 million (GPP S3)[115] in terms of cost savings from GHG mitigation by 2030 (figure 8). This implies that GP market expansion policy, especially production support policy, can be positive under GHG mitigation policy.

In addition, it contributed to the increase in investment even under the scenario of GHG mitigation (Annex, figure A1). Total investment was highest in assuming technological progress (GPP S2) in the GP sectors.

This study additionally calculated the proportion of GPP to be achieved by 2020 at 60%, reflecting the Republic of Korea's third master plan for promoting GPP. Therefore, while the market for GPs sharply increases, the economic benefits have decreased. In other words, all the supply is consumed by the public sector procurement demand, but unless there is a change in the other conditions, the exogenous increase in obligation could lead to relative market inefficiency. Therefore, expansion of GP market activities should be accompanied by policy measures that improve technological progress, certification support and other such policies[116] that attract voluntary participation in the market to generate efficient national economic benefits.

The carbon tax on fossil fuel use changed the industrial structure in a more environmentally friendly way. The share of energy-intensive manufacturing industry decreases by around 0.44% by the year 2030 (Table 6).

113 In the model, we calculated the emission level as a ton of carbon. Carbon ton * 44/12 = CO_2 ton (see figure 8). The GHG emission amounts calculated in the model are similar to the actual GHG emission amounts officially announced (approximately 690 million CO_2 tons, equivalent to 189 million carbon tons) for the year 2016.

114 Most GHG reduction analyzes using carbon tax for the national CGE model suggested a GDP loss for the economy of the Republic of Korea. However, the precise value or range of GDP loss depends on various macroeconomic assumptions and modelling techniques. In Oh (2013), GDP is reduced by 0.72-0.76% for a 30% reduction in emissions relative to the BAU scenario in 2030. In Kim (2012), the GDP is reduced by 0.45% for a 30% reduction in GHG emission relative to the BAU in 2020.

115 KRW 63.3–132.2 billion (USD 1 = KRW 1,134.5). The economic benefit is estimated to be around 6.6% of total GP market output for 2014. It has been shown that GPP policy (GPP S3, hybrid scenario) can reduce total GHG reduction cost by 1.08% in 2030.

116 Since most suppliers of green procurement products are small and medium-sized enterprises (SMEs), it is necessary to develop policies that encourage technology development and production assistance. Boosting private demand requires expanding various policies into the movement, such as increasing the scale of green points, expanding distribution channels, promoting public awareness and education, and providing marketing support. Voluntary demand on the private side could be the best way to attract GP supply.

Figure 21. Business as usual (BAU) projection

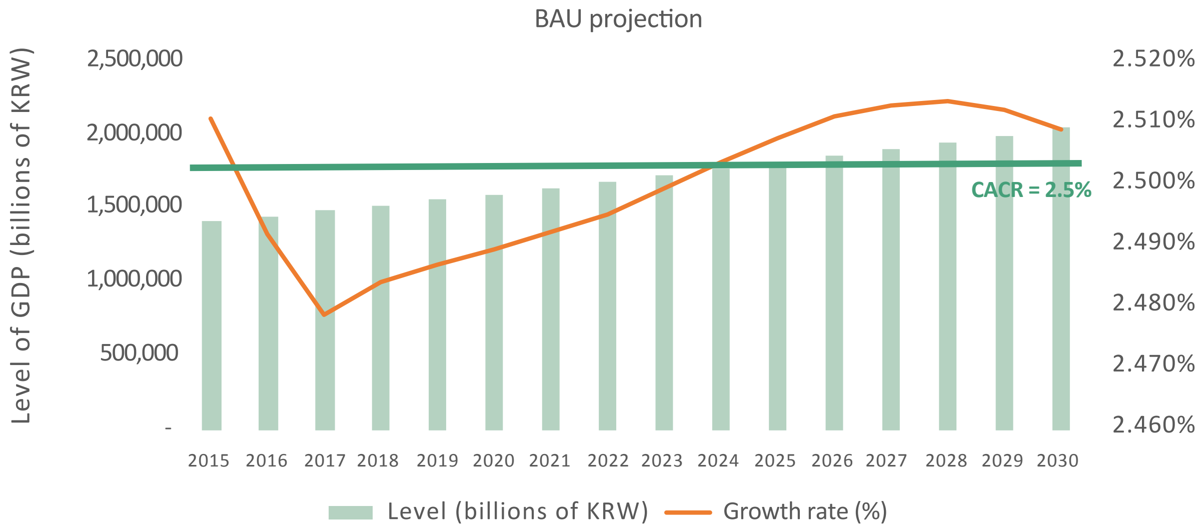


Figure 22. GHG scenario

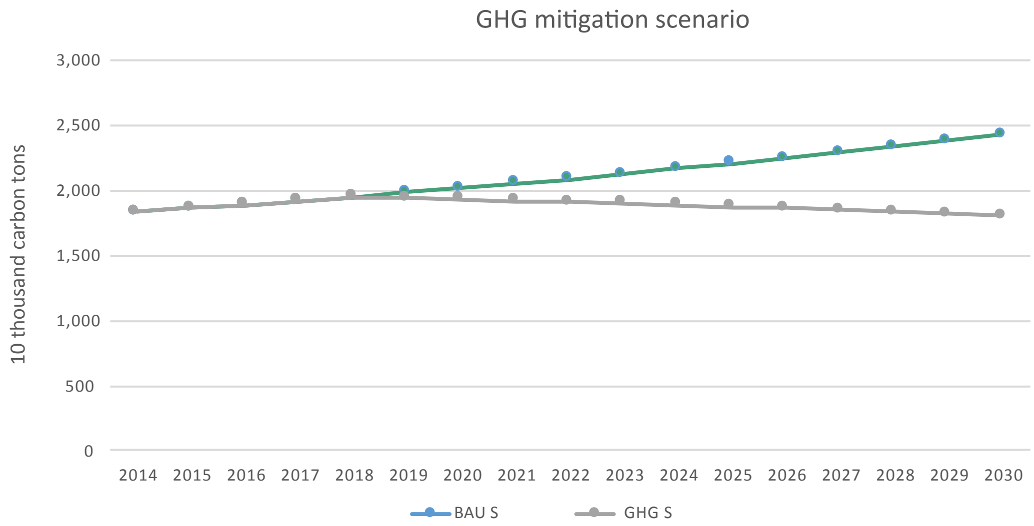


Figure 23. GDP gains in GPP policy scenarios compared to GHG S

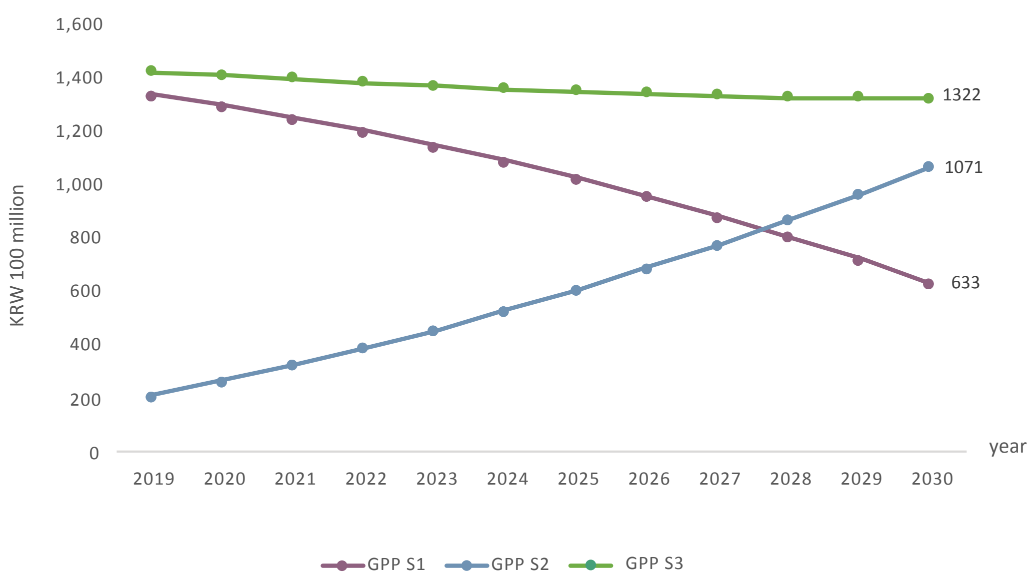


Table 33. The industrial structure under the GPP scenarios

Year	Agriculture	Manufacturing 1 Non-energy intensive	Manufacturing 2 Energy intensive	Public	Construction	Transportation	Services
BAU	1.575%	15.476%	30.608%	11.324%	5.515%	3.710%	28.322%
GHG S	1.587%	15.939%	30.169%	11.453%	5.531%	3.662%	28.625%
GPP S1	1.587%	15.936%	30.165%	11.463%	5.531%	3.661%	28.623%
GPP S2	1.587%	15.939%	30.170%	11.452%	5.531%	3.661%	28.624%
GPP S3	1.587%	15.937%	30.167%	11.459%	5.531%	3.661%	28.622%

Table 34. Local environmental emission changes versus GHG scenario at y2030

Environmental indicators	GPP S1	GPP S2	GPP S3
BOD	**-0.036%**	0.013%	**-0.014%**
NOx	**-0.015%**	0.009%	**-0.003%**
PM10	**-0.020%**	0.010%	**-0.005%**
Industrial waste	**-0.024%**	0.012%	**-0.006%**

The proportion of agriculture, non-energy intensive manufacturing, services, and the public sector increases while the proportion of relatively energy-intensive manufacturing industry and transportation services decreases. In the case of GPP scenarios, the S1 and S3 scenarios are more beneficial than the simple GHG reduction scenario. Therefore, GP policy promotion could contribute to a more environmentally industrial structure under the GHG mitigation era in the future, even if the current market scale is not large enough in the economy of the Republic of Korea.

ENVIRONMENTAL IMPACTS

This research analyzes the emission effects of local pollutants in addition to carbon emission. The regional pollutants are biochemical oxygen demand (BOD), nitrogen oxide (NOx), particulate matter (PM10, particulate matter under 10μm) and industrial waste. Induced effects of each form of environmental pollution were calculated by using the emission coefficient value of each industry as an exogenous variable[117].

The changes in pollutant emissions for local environmental pollution by scenario varied according to pollution intensity and how the industrial structure changed. Environmental pollution emissions showed significant abatement under the production subsidy scenario (GPP S1). For example, for changes in BOD emission, total BOD emission declined because of the significant decrease in production in energy-intensive industries (A3), despite the increased proportion of industry with high pollution intensity (A2). This means that total pollution emissions decreased when the effect of the change in an industry with low pollutant emission intensity was greater than that for an industry with high intensity. In the case of GPP S2, the pollutant emissions increased because industry output with high emission intensity increased[118].

117 For environmental pollution emission coefficients by industry, refer to table A3 in the annex. These coefficients were adjusted from a study (Chu et al. 2015) which was based on 2010 data. Since this study is based on the 2014 data set, it may be said that emissions of regional pollutants are over-calculated when environmental technical progress is considered. Therefore, the rate of change of pollutant emission due to the policy effects may be more significant than a more accurate emission estimate from policy scenarios. New estimations of each form of pollution emission based on the year 2014 are necessary for calculating accurate pollution emission levels for GPP policy.

118 Even in industries with low pollution emission intensity, if the decrease in output is sufficiently large, the total pollution emissions can be reduced. Conversely, industries with high pollutant emission intensity can have a huge impact on the change in total emissions with even a small increase in output (GPP S2).

SOCIAL WELFARE

The CGE model is often used to analyze and evaluate the economic, social and environmental impacts of government policies. To measure the assessment of social welfare of government policy with the general equilibrium model, it needs to introduce an indicator. In the model, we calculate the equivalent variation (EV) as an indicator of the social welfare effects of GPP policy[120]. This is to confirm quantitatively the positive perception of consumers and social welfare by introducing GPP policy under the GHG mitigation policy, carbon taxation.

One result of social welfare[121] was a positive effect in the technological progress scenario (GPP S2); in addition, the social welfare level in GPP S1 and S3 decreased in comparison with the simple GHG reduction policy (Table 8). This was because private consumption demand for GPs in the model was so small that it did not contribute an increase in private consumption, even if the market size in the GP sector was large. In addition, the increase in private income level was largest in GPP S2, indicating that consumption levels, including with regard to GPs, had increased. In technological progress scenarios, the transfer of carbon tax revenue was the largest, leading to an increase in consumer income.

Table 35. Social welfare change in the year 2030

Equivalent variation	GPP S1	GPP S2	GPP S3
Versus GHG	-7,382	208	-5,169

5.5. KEY FINDINGS AND IMPLICATIONS

This research aims to analyze the impacts of GPP policies in the Republic of Korea on the economy, the environment and social welfare by constructing a sequential dynamic CGE model on the GP sector.

Despite the lack of official national statistical surveys on GPs, this study constructed the GP sector, the GP product supplier, as an independent sector by using firm data for producers of GPs in the Republic of Korea. Data from 2014 for approximately 1,907 firms were classified into 13 industries based on the Korean Standard Industrial Classification (KSIC) and input–output (IO) matching, and then the process of extracting and integrating the GP sector was carried out. Although the GP sector was established as an independent production sector in the social accounting matrix (SAM), which comprises the basic data for the CGE model, the data did not clearly reflect the GP production structure for aspects such as the energy input structure. We built a simple sequential dynamic CGE model and forecast for the period 2014–2030. In addition, the model reflected GHG reduction mechanisms in GP consumption and constructed the GP production and public procurement sectors separately. The model's input data estimated that the green procurement product market size of the Republic of Korea in 2014, the base year, was about USD 1.939 million.

The model applied three types of GP promotion policy scenarios during the projection period of 2015–2030. The first scenario (GPP S1) provided a portion of the carbon tax as a GP production subsidy. Here, the subsidy rate was determined such that the GP supply price declined steadily and the remainder of the carbon tax revenue was transferred to the consumer. The second scenario (GPP S2) assumed that the technological progress rate in the GP sector increases by 1% each year through the scale parameter of GP production technology. The other scenario (GPP S3) was a combination of the first and second scenarios, where technological advances and production subsidies occur simultaneously in the GP sector.

Activation of GP policies (S1, S2, S3 and S4) under the GHG mitigation era in the Republic of Korea was found to help reduce the GHG mitigation cost. GDP loss reduction (economic benefit) was calculated to range from USD 56 to 117 million by the year 2030 in GPP S1 and S3 respectively, which covers about 1.08% of total GHG cost. The GPP policy also contributed to the transition to an environmentally friendly industrial structure under the GHG mitigation policy. Furthermore, the industrial structure contributed to a reduction in the proportion of energy-intensive

119 Before implementation of the policy, if the level of social welfare increases (decreases) due to policy implementation, it can be estimated as the same level (monetary term) of subsidy or tax as policy implementation. In other words, for example, let us say that consumer utility increases after policy implementation; it is an equivalent variation to calculate the effect of paying a certain amount of money to consumers to give same level of welfare with policy instead of implementing government policy. For detailed methodology for calculating EV, see Annex d).

120 The value of social welfare change depends on the change in income level and indirect consumer utility (expenditure).

industries, which serve the environmental friendly industrial structure. In terms of labour demand, the GPs sector relatively increased in the production subsidy scenario (GPP S1). However, with the exception of the technological progress scenarios, consumption growth did not have a positive impact because the model's basic data reflected a very small proportion of the private consumption of GPs.

Additionally, the study calculated the proportion of GPP to be achieved by 2020 at 60%, reflecting the Republic of Korea's third master plan for promoting GPP. Therefore, while the market for GPs has sharply increased, the economic benefits have decreased in the CGE model. In other words, all the supply is consumed by the public sector procurement demand, but unless there is a change in the other conditions, the exogenous increase in obligation could lead to relative market inefficiency. Therefore, expanding GP market activities should be accompanied by policy measures that improve technological progress, certification support and other such policies[121] that attract voluntary participation in the market to generate efficient national economic benefits.

The changes in pollutant emissions for local environmental pollution by scenario varied according to pollution intensity and how the industrial structure changed. Environmental pollution emissions showed significant abatement under the production subsidy scenario (GPP S1). For example, for changes in BOD emission, total BOD emission declined because of a significant decrease in production in energy-intensive industries (A3), despite the increased proportion of industry with high pollution intensity (A2). This means that total pollution emissions decreased when the effect of the change in an industry with low pollutant emission intensity was greater than that in an industry with high intensity[122].

One result of social welfare[123] was a positive effect in the technological progress scenario (GPP S2); in addition, the social welfare level in GPP S1 and S3 decreased in comparison with the simple GHG reduction policy. This was because private consumption demand for GPs in the model was so small that it did not contribute an increase in private consumption, even if the market size in the GP sector was large. In addition, the increase in private income level was largest in GPP S2, indicating that consumption levels, including with regard to GPs, had increased. In technological progress scenarios, the transfer of carbon tax revenue was the largest, leading to an increase in consumer income. Therefore, the positive social welfare effect of GP promotion policy can be induced by concurrently encouraging GP demand in the private sector as a result of an increase in income and technological progress in the GP sector.

The model estimates the macroeconomic perspective at around 2.5% of CAGR in the Republic of Korea. We did not consider technological progress and international energy price change in the BAU projection. In addition, because of data limitations, the GP market size might be underestimated. In other words, it does not reflect the voluntary demand for GP by household sector. Taking account of these factors, the estimated economic benefit could be larger if further resource efficiency in production processes is considered[124]. These assumptions show that the analytical results of the model might be underestimated. Nonetheless, it can be seen that State-led or demand-driven GPP policy could positively affect economic growth while contributing to achieving the Republic of Korea's climate-change mitigation targets.

The Republic of Korea's GP promotion policy is expected to increase the size of the GP market through mandatory public demand for GPs and to effect national economic benefits by contributing to climate action. However, the demand and market outlook for GP suppliers remains unclear because the

121 Since most suppliers of green procurement products are small and medium-sized enterprises (SMEs), it is necessary to develop policies that encourage technology development and production assistance. Boosting private demand requires expanding various policies into the movement, such as increasing the scale of green points, expanding distribution channels, promoting public awareness and education, and providing marketing support. Voluntary demand on the private side is the best way to attract GP supply.

122 Even in industries with low pollution emission intensity, if the decrease in output is sufficiently large, the total pollution emissions can be reduced. Conversely, industries with high pollutant emission intensity can have a large impact on the change in total emissions with even a small increase in output.

123 The value of social welfare change depends on the change of income level and indirect consumer utility (expenditure).

124 This model does not reflect resource input specifications such as energy and labour in GPP production because of data restrictions. This research was applied to analyze the GHG reduction effect due to GPP demand change. We can expect that if the efficiency of GP production is reflected in the model, according to the definition of GP, the effect may be further increased.

investment conditions are insufficient for SMEs with short-term profit expectations. If the Government has a clear direction for market expansion, there needs to be a policy for SMEs to attract and invest in the green procurement market. In addition, 98% of GP suppliers are SMEs. KEITI reported in 2015 that the diversity of GPs is one of the biggest obstacles to increasing GP consumption. Therefore, various policies or incentives for SMEs should be established so that SMEs can participate and invest in the green procurement market. Avoiding inefficiency in the mandatory purchasing of GPs will require making efforts to induce voluntary participation in the GP market on both the supply and demand sides simultaneously.

To boost the supply of GPs, supportive measures from private suppliers, such as subsidies and R and D support for technology development and investment, will be important. According to recent economic trends and issues analysis[126], as reported by the National Assembly Budget Office (NABO) in the Republic of Korea, research and development investment will likely attract a GP supply. Research and development, subsidies and other resources for policy implementation will be available in various ways. The efficient redistribution of existing environmental taxes is one way to secure such necessary financial resources. After determining adaptable mandatory purchasing, it is also important to consider allocating the remaining resources to local government for the purposes of technological development, product certification, and enhancing the price efficiency of SMEs that produce GPs. Various supply incentives and production subsidies for GP firms can also be considered. Overall, it is important to make more strategic policy alternatives alongside efforts to establish mandatory GPP in order to drive voluntary supply market expansion.

To boost GP demand, policymaking for the voluntary participation of the private consumer should be actively pursued. Consumer confidence in GPs is relatively low because of low product reliability[127]. To overcome consumer mistrust, marketing strategies such as advertising and publicity, regulatory and verification systems, and encouraging social responsibility among suppliers should be important. In particular, establishing a monitoring system for the production, distribution, consumption, disposal, and recycling of GPs, the results of which can be shared with companies and consumers, is recommended.

5.6. CAVEATS PERTAINING TO THE METHODOLOGY AND THE WAY FORWARD

This research is being undertaken on a trial basis because there is so much room for improvement. Improving the performance evaluation of sustainable GP procurement policies at a macroeconomic level requires the following step-by-step methodological development.

Firstly, relevant ministries and procurement agencies should conduct and manage the statistical investigation or monitoring of production and demand for GPs at the firm level. This analysis is still limited in terms of supply characteristics, since it is difficult to determine GP producers' input structure for GP production. In other words, data on the characteristics of GP supply (in terms of intermediate inputs such as labour, capital, energy, and R and D) should be collected; the corresponding activities contribute to the final production of GP at the firm level. Those data constitute an important factor in the analysis of essential information such as information on the production technology for GPs. This means that we should know, for example, what quantities of energy resources are used in GP production processes, how much has been invested in the production of GPs, and how many skilled workers are involved in the production process. It is also important to consider how to actively utilize existing statistical survey systems such as the SME technical statistics survey for the purposes of policy development for participant incentives among SMEs.

Secondly, product recycling information is required for integrated analysis of GP promotion policy with regard to the environment and economy. GPs include recycled goods, and it is difficult to quantify the

125 National Assembly Budget Office (2019). NABO Economic Trends & Issues (75).

126 Third Master Plan for Promoting Green Product Purchasing, 2015, the Ministry of Environment, Republic of Korea.

economic benefits of using resources because we know neither how much recycled material is used in the production of GPs nor how GPs are used after the disposal process[127]. The use and recycling of resources for the production of goods can take place within the framework of the United Nations System of Environmental-Economic Accounting (SEEA)[128]. It can be helpful to develop analysis methodologies by linking the physical environment account to the existing economic and social accounts.

Thirdly, improving the policy evaluation methodology by differentiating GP technology is necessary[129]. If the technology applied to GPs can be differentiated from traditional technology, the application of a dynamic optimization model that reflects the internalization of technological progress should also be developed in the long term.

127 This approach enables an integrated analysis of resource recycling effects and waste recycling impacts. See Kang et al. (2006, Korea Environment Institute and NIES).

128 Bovenberg et al. (1995)

129 See Kim (2014), Aghion and Howitt (2008), Bovenberg et al. (1995, 1996)

CHAPTER 6

POLICY RECOMMENDATIONS AND THE WAY FORWARD

6.1. SUMMARY OF KEY FINDINGS AND POLICY RECOMMENDATIONS

THE GPP IMPLEMENTATION PROCESS IN THE REPUBLIC OF KOREA

STRENGTHS OF THE REPUBLIC OF KOREA'S OVERALL APPROACH

The Republic of Korea has been using public procurement strategically to promote sustainable development for more than two decades. Because of its long experience with and continuous implementation of this procurement approach, the Republic of Korea is globally recognized as a best practice example in GPP implementation and monitoring.

Successful GPP implementation is possible through a strong institutional framework, based on the collaboration between MoE, KEITI, the Ministry of Economy and Finance and the Public Procurement Service (PPS), the development of annual implementation plans for all public authorities and compulsory green product purchase and reporting.

Supporting tools are provided both by KEITI and PPS. One of the strengths of the approach lies in the high number of annually trained purchasing officials and the continuity of training courses over the years. More than 30,000 public organizations provide their GPP plans and records every year, reporting on a total expenditure on green products of nearly USD 3 billion in 2017.

Between 2005, when mandatory GPP was introduced, and 2016, the green products market has had an increasing compound annual growth rate (CAGR) of 11.1%. These government-led demand-expansion policies, which exceeded KRW 2 trillion of GP market size in 2014, are producing tangible results.

One of the distinctive and noteworthy features of the approach taken by the Republic of Korea is the early use of electronic procurement systems and platforms for GPP implementation and monitoring (see next point).

AREAS FOR IMPROVEMENT

- New Korea Eco-label or Good Recycled Mark product categories could be established for priority products and services that are regularly purchased by public institutions[130].
- Until now, service contracts have not been included in GPP reporting, although the use of eco-labelled products in service contracts is included in tender specifications. The Korea Eco-label actually has criteria for hotel and car-sharing services. New certifications for services used in public procurement could be developed to fulfil procurers' needs and strengthen GPP and eco-label implementation.
- To increase the impact of sustainable consumption and production (SCP) policies on market transformation, it is necessary to promote greater consumption of green products in the private sector. A marketing strategy aimed at strengthening private consumers' trust in green product quality could be carried out, publicizing the environmental, economic and social benefits of green products and thereby reinforcing the Green Credit Card system.
- Capacity building on the supply side is needed to accompany demand-driven market growth for green products. Since most suppliers of green products are SMEs, policies that encourage technology development should be developed. Supplier engagement and incentives for SMEs to attract and invest in the green products market should be considered, as is the case for support for green product certification or R and D support for technology development.
- As a complement to the Republic of Korea's approach, in order to promote green procurement practices, formalized networking structures of both public procurers and private companies, similar to Japan's Green Purchasing Network or to the Danish Forum

130 The expansion of the scope of green products and the increase in their number and quality to strengthen SPP implementation have also been recommended by the Organisation for Economic Co-operation and Development (OECD Environmental Performance Reviews: Korea 2017).

on Sustainable Procurement, could be established. The Dutch Green Deal is another outstanding approach to promoting green procurement practices in the private sector.

- It could be worthwhile for the Republic of Korea to consider developing an overall integrated strategy for sustainable public procurement that would cover all the individual issues currently promoted through different acts and regulations, led by the Prime Minister's Secretariat.

THE ACTUAL GPP IMPACT MEASUREMENT METHODOLOGY USED

STRENGTHS OF THE REPUBLIC OF KOREA'S OVERALL APPROACH

There are many reasons for which the Republic of Korea's GPP monitoring system sets an example for the world: its combination of the Korean Online E-Procurement System (KONEPS) and its e-shopping malls, KEITI's Green Procurement Information System and the recent public procurement data system that enables automatic data tracking. The integrated e-procurement system makes it possible to gather data through standardized reporting forms from different sources.

The Republic of Korea is, together with Japan and the state of Massachusetts, one of the few public authorities that has had a GPP impact measurement methodology in place for many years; moreover, the methodology is based on actual purchases. Historical series of GPP data are available for periods of more than 15 years.

The Republic of Korea is also one of the few countries with compulsory reporting for all public authorities. Reporting is linked to fiscal incentives for GPP implementation through the annual performance bonus for public institutions and local governments.

Another strength of the methodology is the use of a clear definition of what a green product is, namely, a product certified with the Korea Eco-label or the Good Recycled Mark.

The comparison of different approaches showed that only in the Republic of Korea is an estimate of green-economy job creation included as an indicator.

AREAS FOR IMPROVEMENT

- Environmental benefits beyond CO_2 could be reported, as such benefits are estimated during the measurement process.
- The baseline data for measurement of the CO_2 and environmental benefits of the target product groups should be updated regularly (e.g., every five years) to align with the current market trends.
- The case study of the state of Massachusetts showed that the use of calculators facilitates the reporting of types of environmental benefits beyond CO_2. The harmonization of existing environmental benefits calculators or the development of new ones could make it possible for other organizations, such as private companies, to report their green procurement benefits when aligned with the Act. International collaboration on such development could be useful.
- The job creation indicator is based on the Employment Inducement Coefficient, published by the Bank of Korea in 2010 (8.3 jobs/KRW 1 billion). The coefficient is based on average industry data and is therefore not precise[131]. Employment in the green product sector should be measured differently, using more precise estimation for the environmental industry in the Republic of Korea. Additionally, the calculation approach could be modified from "additional green job creation" to "green job positions" and be based on actual GPP expenditure and not only on variations with respect to previous years (cumulative job creation).
- The GPP impact measurement methodology actually only includes Korea Eco-Label and Good Recycled Mark Products. Other eco-friendly procurements, like energy efficient products, could be recorded in partnership with PPS. Coordination between Ministries, led by the Prime Minister's Office, would be needed to get the whole picture.

131 For more details, see chapter 3.1, on the current GPP impact estimation methodology.

THE USE OF THE COMPUTABLE GENERAL EQUILIBRIUM MODEL

THE BEST SCENARIO FOR THE OBTAINMENT OF BENEFITS

This study takes a top-down approach using CGE modelling to analyze the impacts of various GPP policy scenarios on the economy, the environment and social welfare in the Republic of Korea. This methodology has the advantage of examining macroeconomic impacts quantitatively in an integrated manner.

This study compared and analyzed the economic impacts of three types of GPP extension policies under the Republic of Korea's voluntary GHG mitigation scenario, contemplating a 25.7% reduction versus business as usual in the domestic field by 2030. In the first scenario, a subsidy is provided to the GP producer. The second scenario assumes natural technological progress in the GP production sector. The third is a combination of the first and second scenarios.

The analysis shows that the GPP policy scenario would bring about macroeconomic benefits in the range of USD 56 million (GPP S1) to USD 117 million (GPP S3) in terms of cost savings from GHG mitigation by 2030. In addition, it contributed to the increase in total investment even under the scenario of GHG mitigation. Furthermore, the industrial structure contributed to the reduction in the proportion of energy-intensive industries, which serve the environmental friendly industrial structure.

One result of social welfare[132] was a positive effect in the technological progress scenario (GPP S2). The positive social welfare effect of GPP policy can be induced by concurrently encouraging green product demand in the private sector on account of the increase in private income. In technological progress scenarios, the transfer of carbon tax revenue was the largest, leading to an increase in consumer income. Therefore, the positive social welfare effect of GPP policy can be induced by concurrently encouraging GP demand in the private sector on account of the increase in income and the technological progress in the GP sector.

The changes in pollutant emissions for local environmental pollution by scenario varied according to pollution intensity and how the industrial structure changed. Environmental pollution emissions showed significant abatement under the production subsidy scenario (GPP S1).

AREAS FOR IMPROVEMENT

- Firstly, relevant ministries and procurement agencies should conduct and manage the statistical investigation or monitoring of production and demand for GPs at the firm level. This analysis is still limited in terms of supply characteristics, since it is difficult to determine GP producers' input structure for GP production. Green product (GP) data should cover both the production phase (supply side) and the use phase (demand side). It is therefore necessary to recall the characteristics of GP supply in terms of intermediate input such as labour, capital, energy and research and development.
- It is also important to consider how to actively utilize existing statistical survey systems such as the SME technical statistics survey for the purposes of policy development for participant incentives among SMEs.
- Secondly, product recycling information is required for the integrated analysis of GPP policy with regard to the environment and economy. GPs include recycled goods, and it is difficult to quantify the economic benefits of using resources because we know neither how much recycled material is used in the production of GPs nor how GPs are used again in the disposal process. The use and recycling of resources for the production of goods can take place within the framework of the United Nations System of Environmental-Economic Accounting (SEEA). It can be helpful to develop analysis methodologies by linking the physical environment account to the existing economic and social accounts.
- Thirdly, improving the policy evaluation methodology by differentiating GP technology is necessary. If the technology applied to GPs can be differentiated from traditional technology, the application of a dynamic optimization model that reflects the internalization of technological progress should also be developed in the long term.

132 The value of social welfare change depends on the change of income level and indirect consumer utility (expenditure).

ROLE OF THE TWO MEASUREMENT METHODOLOGIES

The study presents two different GPP impact measurement methodologies: a bottom-up approach used by KEITI, and a top-down approach using the CGE model. Whilst KEITI's approach is based on the actual purchase data of each public institution and the benefits of green products as compared to non-green products, the strength of the CGE model lies in the modelling of macroeconomic impacts. In that sense, the use of the CGE model facilitates the evaluation of the potential effects of different policy instruments (such as carbon taxes or mandatory GPP), whilst KEITI's GPP impact measurement methodology focuses on awareness raising and the communication of the benefits of actual green purchases at the institutional level. Therefore, the two measurement methodologies are complementary to one another.

THE WAY FORWARD

The key follow-up activities for strengthening the promotion of green products should focus on the revision of the existing product categories of the Korea Eco-label and Good Recycled Mark with a view to incorporating priority products and services purchased by public institutions and defining policy measures to incentivize private market participation.

The current GPP impact measurement methodology used by KEITI could be improved by updating the benefit calculation methodology and by including additional environmental benefits that are calculated but not communicated (such as resource saving and avoided emissions).

To further the CGE model approach and the quantification of benefits at the macroeconomic level, the most important step forward is to set up a database on the production phase of green products to better define the economic, environmental and social benefits.

At the national level, the overall SPP policy and strategy and the coordination between GPP, energy-efficient procurement and other strategic procurement priorities should be strategically evaluated. At the international level, the collaboration with the One Planet Network SPP programme should focus on the potential use or development of GPP benefit measurement calculators and the communication of benefits.

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ANNEXES

KOREA ECO-LABEL (as of August 2018)

Product category	No. of certified products	Product category	No. of certified products
EL101. Printing paper	133	**EL205**. Ballast for High Pressure discharge lamps	82
EL102. Office paper	62	**EL207**. Electric cables	104
EL103. Adhesive paper tapes and adhesive paper sheets	12	**EL208**. Electric hand-dryer	–
EL104. Toner cartridges	318	**EL209**. LED lamp for general use	86
EL106. Paper products for office use	1	**EL210**. LED lighting luminaire	1,35
EL107. Document files	44	**EL211**. LED light source package and module	–
EL108. Stationery	2	**EL221**. Water-saving faucet	823
EL141. Copy machine	82	**EL222**. Water-saving showerhead and water-saving components for faucet	98
EL142. Printer	186	**EL223**. Water-saving toilet	251
EL143. Facsimile	4	**EL225**. Water meter	270
EL144. Personal desktop computer	135	**EL226**. Automatic temperature-control system for heating	–
EL145. Laptop computer	19	**EL227**. Pipe for water supply	1
EL146. Digital projector	35	**EL228**. Urinals	53
EL147. Computer monitor	108	**EL229**. Bidet	15
EL150. Paper shredder	26	**EL241**. Paints	810
EL171. Electric cold- and hot-water dispensers	–	**EL242**. Wallpaper	66
EL172. Furniture	813	**EL243**. Thermal insulation materials	470
EL173. Gas cabinet heater	–	**EL244**. Waterproofing agents for construction	76
EL174. Office partition	49	**EL245**. Water-permeable concrete pavements	120
EL175. Chairs	158	**EL246**. Indoor floor coverings	314
EL177. Chairs and tables for educational institutions	104	**EL247**. Assembly-type floor heating system	4
EL179. Auxiliary parts for furniture	2	**EL248**. Finishing materials for wall or ceiling	141
EL201. Fluorescent lamps	7	**EL249**. Soundproofing products for building floors	4
EL202. Ballast for fluorescent lamps	3	**EL250**.Window	1,82
EL203. Ballast for high-pressure Discharge Lamps	2	**EL251**. Adhesive	47

Product category	No. of certified products	Product category	No. of certified products
EL252. Decorative synthetic resin sheets	47	**EL316**. Leather products	–
EL253. Access floors	58	**EL317**. Cool and warm thermal fabric	–
EL254. Textile goods for decoration	13	**EL321**. Sanitary paper	296
EL255. Lining paper	–	**EL322**. Air freshener	28
EL256. Decorative synthetic leather	5	**EL323**. Imitation jewellery	–
EL257. Artificial turf and other turf components	144	**EL324**. Baby diapers	–
EL258. Wood for floor decking treated with preservative	1	**EL325**. Toys	2
EL259. Sealants for sealing and glazing in buildings	68	**EL326**. Varnishes	–
EL261. Gas boilers	34	**EL327**. Indoor floor mats of foamed plastic	5
EL262. Heat pump systems	22	**EL328**. Rubber gloves	–
EL263. Heat recovery ventilators	3	**EL329**. Baby care and moving supplies	–
EL264. Sprinkler head for fire-fighting	–	**EL330**. Paint for DIY (do-it-yourself)	2
EL265. Light-emitting diodes display board	93	**EL401**. Air conditioners	12
EL266. Industrial gas boilers	–	**EL402**. Washing machines	–
EL267. Uninterruptible power supply	–	**EL403**. Dishwashers	2
EL301. Soaps for laundry and kitchen	19	**EL404**. Refrigerators	–
EL302. Powder laundry detergents	30	**EL405**. Kimchi refrigerators	–
EL303. Household detergent	145	**EL406**. Electric vacuum cleaners	–
EL304. Commercial dishwasher detergents	116	**EL407**. Air cleaners	1
EL305. Multipurpose cleaner	66	**EL408**. Electric kettles and electric coffee-makers	–
EL306. Fabric softeners	17	**EL409**. Multi-air-conditioners	–
EL307. Liquid laundry detergents	64	**EL431**. Television sets	62
EL308. Shampoo and rinse	5	**EL432**. Video media players	–
EL309. Cosmetic soap	2	**EL433**. Mobile phones	–
EL310. Body wash	2	**EL483**. Beds	220
EL311. Clothing	33	**EL491**. Gas ranges	4
EL312. Bags	3	**EL501**. Tires for passenger cars	9
EL313. Shoes	1	**EL502**. Tires for trucks and buses	10
EL314. Woven / knitted goods and simply processed goods	7	**EL503**. Gasoline engine oil	3
EL315. Bedding	11	**EL504**. Diesel engine oil	1

Product category	No. of certified products	Product category	No. of certified products
EL505. Two-cycle engine oil	–	**EL725**. Synthetic resin moulding material for structures	7
EL506. Anti-freezing solutions for car	1	**EL726**. Wood plastic composite products	62
EL507. Non-asbestos transportation parts	6	**EL727**. Biomass synthetic resin products	51
EL508. Filters for air cleaners	1	**EL741**. Copper alloys for forging	6
EL509. Windshield washers for automobiles	3	**EL742**. Copper alloys for casting	15
EL551. Fishing sinkers	2	**EL743**. Recycled construction materials	708
EL552. Fishing baits	–	**EL744**. Recycled slag products	186
EL553. Printed matter	–	**EL745**. Blocks, tiles and panels	498
EL602. Printing inks and writing inks	16	**EL746**. Aggregate and fine powder	109
EL603. Industrial batteries	48	**EL761**. Re-supplementary products	5
EL604. Buoys for fish culture	5	**EL762**. Waste reduction device	–
EL605. Industrial cleaners	8	**EL763**. Electrical and electronic parts	5
EL606. Packaging materials	91	**EL764**. Batteries	–
EL607. Water-treatment agents	88	**EL765**. Fire extinguisher	10
EL608. Deodorant	157	**EL766**. Standard waste bag	283
EL610. De-icer	34	**EL767**. Food waste reduction device	6
EL611. Lubricants	22	**EL768**. Foam fire extinguishing agents	6
EL612. Industrial lithium-ion battery	4		
EL651. Freezing and refrigerating showcases	–		
EL652. Vending machines	–		
EL653. Low-noise construction machinery	1		
EL654. Ready-mixed concrete recycling water treatment system	–		
EL655. Cleaning device for parts and equipment	6		
EL656. Refrigerant recovery machine	–		
EL657. Multi-layered movable scaffolding	4		
EL701. Oil product	2		
EL702. Solar water heater	–		
EL703. Solar-powered or self-generating products	31		
EL704. Electric motorcycle with two wheels	–		
EL721. Plastic products	299		
EL722. Recycled rubber products	212		
EL723. Recycled wood products	121		
EL724. Biodegradable resin products	112		

GOOD RECYCLED MARK (as of October 2018)

Category	Specification	No. of certified products/materials
Recycled paper	Newspaper, copy paper, etc.	14
Residue from processed marine products	Fertilizer	9
Residue from vegetables	Fertilizer	1
Organic waste	Fertilizer, soil conditioner, feed sustenance	13
Recycled rubber	Playground flooring material, tire powder, rubber power for artificial turf	8
Recycled metal	Nickel-cadmium cell, recycled indium, recycled tin, etc.	5
Recycled wood	Particle board, recycled multi-use panel, etc.	11
Recycled textile	Sound-absorbing material	1
Recycled ceramics	Asphalt concrete, blocks, insulation, etc.	140
Recycled glass	Insulation	3
Recycled plastics	Water meter cover, water valve cover, security blocks, drain board, insulation, etc.	14

GPP RATE PER PRODUCT GROUP (2017; unit: USD)

Product group		Total expenditure in product categories with GPP criteria (A)	Total expenditure on green products in these categories (B)	% of GPP over total expenditure (B/A * 100)
Office appliances, furniture, office supplies	Copy machine	51,601,147	38,856,488	75.3
	Facsimile	1,431,699	1,014,748	70.9
	Dishwasher	21,102,432	2,460,136	11.7
	Refrigerator	989,194	0	0
	Air purifier	16,977,985	1,059,584	6.2
	TV	112,434,111	61,529,155	54.7
	Food waste reduction device	112,429	1,581	1.4
	Air conditioner	144,455,712	24,956,452	17.3
	Desk and table	174,282,439	89,419,264	51.3
	Chair	186,024,206	75,307,654	40.5
	Furniture	235,651,463	108,105,451	45.9
	Bed	20,866,926	12,162,739	58.3
	Kitchen furniture	7,780,434	4,320,840	55.5
	Other furniture	15,883,231	1,639,415	10.3
	Office partition	47,344,171	26,766,301	56.5
	Printing paper	5,580,636	4,597,966	82.4
	Office paper	20,042,922	10,096,445	50.4
	Paper products for office use	269,216	269,216	100
	Stationery	54,159	4,576	8.5
	Other office supplies	12,951,523	8,038,688	62.1
Sub-total office appliances, furniture, office supplies		1,075,836,035	470,606,701	43.7

Product group		Total expenditure in product categories with GPP criteria (A)	Total expenditure on green products in these categories (B)	% of GPP over total expenditure (B/A * 100)
Electronic/ electric/ITC equipment	Personal desktop computer	407,752,440	358,502,264	87.9
	Laptop computer	74,894,035	62,462,726	83.4
	Printer	32,371,269	27,117,438	83.8
	Computer monitor	83,947,238	63,340,501	75.5
	Digital projector	10,814	10,814	100
	Toner cartridges	15,961,839	5,102,214	32
	Re-supplementary products/ink	3,928	3,928	100
Sub-total electronic/electric/ITC equipment		614,941,562	516,539,884	84.0
Lighting, battery, electric materials	Industrial batteries	11,852,897	3,349,705	28.3
	Fluorescent lamps	97,582,829	53,600,141	54.9
	Lighting luminaire	474,872,419	282,278,343	59.4
	Ballast for lamps	123,171	123,171	100
	Street lamps	4,993	4,993	100
	Electric cables	3,534,403	3,400,717	96.2
	Other electric materials	8,654,728	1,427,818	16.5
Sub-total lighting, battery, electric materials		596,625,439	344,184,888	57.7
Building and construction materials	Asphalt concrete	1,167,029,114	270,397,089	23.2
	Water-permeable concrete pavements	28,703,229	5,429,586	18.9
	Slag cement	6,764,150	3,819,132	56.5
	Drainpipe	314,798,974	71,892,355	22.8
	Sump	824,733	67,006	8.1
	Paving block	363,851,323	187,953,623	51.7
	Assembly-type reinforced concrete block	76,944,972	16,706,026	21.7
	Other block	74,922,271	14,870,927	19.8
	Aggregate	2,586,334	998,183	38.6
	Tiles	29,922,644	11,460,060	38.3
	Brick	33,688,475	20,877,026	62
	Boundary stone	112,668	112,668	100
	Protective panel	4,040,487	90,963	2.3
	Windows	356,196,580	330,995,743	92.9
	Paint	114,311,289	67,519,286	59.1

Product group		Total expenditure in product categories with GPP criteria (A)	Total expenditure on green products in these categories (B)	% of GPP over total expenditure (B/A * 100)
Building and construction materials	Wallpaper	11,389,115	11,243,447	98.7
	Thermal insulation materials	90,310,322	63,120,875	69.9
	Waterproofing agents for construction	35,128,068	4,510,695	12.8
	Indoor floor coverings	139,538,735	104,567,680	74.9
	Rubber floor coverings	170,759,364	103,896,452	60.8
	Assembly-type floor heating system	317,625	172,486	54.3
	Finishing materials for wall or ceiling	207,586,416	49,428,905	23.8
	Adhesive paper tapes and adhesive paper sheets	2,176,636	2,168,463	99.6
	Decorative synthetic resin sheets	375,112	375,112	100
	Other construction materials	204,514,514	68,124,941	33.3
Sub-total building and construction materials		3,436,793,149	1,410,798,729	41.0
	Others	469,233,812	203,100,033	43.3

ANNEXES OF CHAPTER 5

This section includes simultaneous equation systems with explanations to support the GPP CGE model in the Republic of Korea. Some important exogenous parameters may be contained as annex subsections. Additionally, we conducted production multiplier effects using an input-output table that is applied to SAM. Finally, the annex includes estimated SAM.

a. Mathematical statement and formulation of the CGE model	
Sets	
i,j ε A1...A13,	sectors (commodities and activities)
gp ε A13,	green product sectors
f ε L, K,	factors
ie ε A10, A11, A12,	primary energy sectors (fossil fuels)
Parameters	
σs_i,	Constant elasticity of substitution (CES) between domestic and import goods (Armington)
σt_i	Constant elasticity of transformation (CET) between domestic and export goods
σr_i,	Constant elasticity of substitution (CES) between value added (labour, capital, energy)
σe_i,	Constant elasticity of substitution (CES) between fossil fuel energy (coal, oil, gas products)
αm_i, αsd_i ,	Armington function share parameters, import and domestic goods respectively
αx_i, αtd_i ,	transformation function share parameters, export and domestic goods respectively
$\alpha f_{f,i}$,	value added function share parameter for factor f in sector i
αe_i ,	value added function share parameter for energy composite in sector i
$\alpha fe_{ie,i}$,	energy production function share parameter for energy ie in sector i
$aa_{i,j}$,	input coefficient of intermediate goods i in sector j
axb_i ,	input coefficient of composite factors in sector i
as_i ,	shift parameter of Armington function
at_i ,	shift parameter of CET function
ar_i ,	shift parameter of value-added production function
ae_i ,	shift parameter of composite energy production function
pwm_i, pwx_i ,	import, export price respectively (foreign currency)
$deltah_i$,	share parameter of consumer utility function (Cobb-Douglas Utility function)
$deltag_i$,	distribution parameter of government consumption
thr ,	direct tax rate for household income
shr ,	household saving rate
sgr ,	government saving rate
sfr ,	foreign saving rate
tpr ,	government transfer rate to household
tcri ,	tax rate for sector i
b_i ,	Leontief coefficient of total investment function
$weight_i$,	weight of consumer commodity i in the CPI
emf_i ,	carbon emission coefficient
d_gp ,	carbon emission reduction coefficient of green product demand

Exogenous variables	
$\overline{end_f}$,	quantity supplied of factors
$\overline{CPI}$,	consumer price index
Endogenous variables	
xs_i ,	quantity of total (domestic) supply of goods
xm_i ,	quantity of imports of goods
xd_i ,	quantity of sold domestically of domestic output
xx_i ,	quantity of export of goods
xt_i ,	quantity of output
xr_i ,	quantity of composite production of factors
ps_i ,	price of total (domestic) supply of goods
pm_i ,	import price (domestic currency)
pd_i ,	price of sold domestically of domestic output
px_i ,	export price (domestic currency)
pt_i ,	price of output
pr_i ,	price of composite production of factors
e_i ,	quantity of composite energy
pe_i ,	price of composite energy
$m_{(i,j)}$,	quantity of demand of intermediate goods i in sector j
$qf_{(f,i)}$,	quantity of demand of factor f in sector i
$qf\ a_f$,	quantity of factor f aggregated
pf_f ,	average price of factor f
HY ,	amount of household income
ch_i ,	quantity of household consumption of goods i
cg_i ,	quantity of government consumption of goods i
SH ,	amount of household saving
DI ,	amount of household disposable income
TR ,	amount of government tax revenue
IDT ,	amount of indirect tax
DT ,	amount of direct tax
SG ,	amount of government saving
TP ,	amount of transfer payment
IV ,	amount of total investment
IT ,	real investment
PI ,	price of investment
ii_i ,	sectoral investment
SF ,	amount of foreign saving
CT ,	amount of carbon tax
tc ,	carbon tax rate
ems_i ,	level of carbon emission in sector i
tems□,	total level of carbon emission (exogenously given when GHG, GPP scenario applied)
sdr ,	subsidy rate of green product production (“0” value when BAU and GHG scenario applied)

Equations

$$xs_i = \sum_j m_{i,j} + ch_i + cg_i + II_i$$

$$xm_i = \frac{1}{as_i}\left[\frac{as_i ps_i \alpha m_i}{pm_i}\right]^{\sigma s_i} xs_i$$

$$xd_i = \frac{1}{as_i}\left[\frac{as_i ps_i \alpha sd_i}{pd_i}\right]^{\sigma s_i} xs_i$$

$$\frac{xx_i}{xd_i} = \left[\frac{pd_i}{ps_i}\frac{\alpha x_i}{\alpha td_i}\right]^{\sigma t_i}$$

$$xt_i = at_i\left[\alpha td_i xd_i^{\left(\sigma t_i - 1/\sigma t_i\right)} + \alpha x_i xx_i^{\left(\sigma t_i - 1/\sigma t_i\right)}\right]^{(\sigma t_i/\sigma t_i - 1)}$$

$$xr_i = axb_i xt_i$$

$$m_{j,i} = aa_{j,i} xt_i$$

$$qf_{f,i} = \frac{1}{ar_i}\left[\frac{ar_i pr_i \alpha f_{f,i}}{pf_f}\right]^{\sigma r_i} xr_i$$

$$\sum_i qf_{f,i} = \overline{qfa_f}$$

$$ps_i = \frac{1}{as_i}\left[\alpha sd_i^{\sigma s_i} pd_i^{1-\sigma s_i} + \alpha m_i^{\sigma s_i} pm_i^{1-\sigma s_i}\right]^{1/(1-\sigma s_i)}$$

$$pm_i = er\overline{pwm_i}$$

$$px_i = er\overline{pwx_i}$$

$$pt_i = \frac{1}{at_i}\left[\alpha td_i^{\sigma t_i} pd_i^{1-\sigma t_i} + \alpha x_i^{\sigma t_i} px_i^{1-\sigma t_i}\right]^{1/(1-\sigma t_i)}$$

$$pt_i[1 - tcr + sdr] = \sum_s aa_{s,i} ps_i + axb_i pr_i$$

$$pr_i = \frac{1}{ar_i}\sum_f \left[\alpha f_{f,i}^{\sigma r_i} pf_f^{1-\sigma r_i} + \alpha e_i^{\sigma r_i} pe_i^{1-\sigma r_i}\right]^{1/(1-\sigma r_i)}$$

$$pe_i = \frac{1}{ae_i}\sum_{ie}\left[\alpha fe_{ie,i}^{\sigma e_i} ps_{ie}^{1-\sigma e_i}\right]^{1/(1-\sigma e_i)}$$

$$\mathrm{HY} = \sum_f pf_f\left[\sum_i qf_{f,i}\right] + TP$$

$$\mathrm{DT} = \mathrm{thr}\sum_f pf_f\left[\sum_i qf_{f,i}\right], DI = HY - DT$$

$$\mathrm{SH} = \left[1 - \sum_i delta_i\right] DI$$

$$ch_i = \frac{delta_i DI}{ps_i}$$

$$\mathrm{IDT} = \sum_i tcr_i pt_i xt_i$$

$$\mathrm{TR} = \mathrm{IDT} + \mathrm{DT} + \mathrm{CT}$$

$$\mathrm{CT} = \sum_{ie} emf_{ie}\, tc\, xs_{ie}$$

$$\mathrm{TP} = \mathrm{tcr}\,(IDT + DT) + \mathrm{CT} - (\mathrm{sdr}\, pt_{gp} xt_{gp})$$

$$\mathrm{SG} = \mathrm{sgr}\,(\mathrm{IDT} + \mathrm{DT})$$

$$cg_i = \frac{deltag_i(TR - TP - SG)}{ps_i}$$

$$\mathrm{IV} = \mathrm{SH} + \mathrm{SG} + \mathrm{er} * \mathrm{SF}$$

$$\mathrm{er\ SF} = \mathrm{sfr}\left(\sum_i xm_i pm_i\right)$$

$$\sum_i xx_i pwx_i + SF = \sum_i xm_i pwm_i$$

$$\mathrm{it} = \frac{IV}{pi}$$

$$ii_i = b_i it$$

$$\mathrm{pi} = \sum_i b_i ps_i$$

$$ems_{ie} = emf_{ie} xs_{ie}$$

$$\mathrm{tems} = \sum_{ie} ems_{ie} - xs_{gp}\, d\_gpp$$

$$\overline{\mathrm{CPI}} = \sum_i weight_i ps_i$$

b. Model parameters[133]

Table A1. Elasticity of substitution

	σr	σe	σs	σt
A1	1.2	0.7	1.2	-1.11
A2	0.9	0.7	0.9	-0.99
A3	0.7	0.6	0.9	-0.9
A4	0.4	0.4	2	-1.5
A5	0.4	0.4	2	-1.5
A6	0.7	0.7	0.7	-0.99
A7	0.4	0.4	2	-1.5
A8	0.7	0.6	0.9	-0.9
A9	0.7	0.7	0.7	-0.99
A10	0.4	0.4	2	-1.5
A11	0.4	0.4	2	-1.5
A12	0.4	0.4	2	-1.5
A13*)	0.7	0.6	0.9	-0.9

Data source: Values from Shin and Kim (2011)
*) Same as manufacturing sectors in Shin and Kim (2011)

Table A2. Environmental pollution emissions coefficient

Unit: ton/100million KRW

sectors	BOD[1)]	Nox[2)]	PM(10) [2)3)]	Waste (industry)[4)]
A1	1.8502	0.0217	0.0017	0.0833
A2	4.8892	0.0380	0.0052	8.5256
A3	0.5023	0.2901	0.0396	33.6996
A4	0.0000	0.0000	0.0000	0.0000
A5	0.0000	0.0000	0.0000	0.0000
A6	0.0207	0.4924	0.0275	7.0688
A7	0.0000	0.6788	0.0304	10.9963
A8	0.0000	3.6432	0.2011	54.8015
A9	0.0167	0.3743	0.0279	12.0553
A10	0.0446	1.7347	0.2368	0.0761
A11	1.5141	0.2948	0.0403	6.1420
A12	0.0174	0.6783	0.0926	0.0298
A13	1.0036	0.2451	0.0303	24.7536

1) Tons of emission load (before treatment)
2) Emission ton
3) Particulate matter 10
4) Ton of industrial waste

133 All other parameters except these were calibrated within the model.

Table A3. Carbon emission coefficient

Emission coefficient (TC/TOE) 1)			Carbon reduction coefficient from green product demand (ton/100 million KRW)
coal	oil	Gas	d_gp
1.06	0.8	0.64	0.0492*

1) Shin and Kim (2011), Kang and Kim (2007)
* Estimated from KEITI data (given)

c. Multiplier effects of input-output relationship in market-based SAM

Generally, SAM distinguishes between production activities and market commodities. Activities are entities that produce goods and services, and commodities are those goods and services produced by activities[134]. However, our SAM is constructed by product. This means that one activity produces one commodity. We used unconstrained multiplier analysis, which uses the simplest kinds of multiplier models because they make a number of limiting assumptions[135].

In this section, we consider the multiplier effects of production sectors. Therefore, the analysis is similar to the IO model[136]. The only difference is that employment coefficients are calculated using various assumptions because the number of employees in the green product sector defined in this study is unknown. We used the data from NRCS (2010) as a basic assumption[137]. In this study, labour multiplier effects were calculated on the assumption that the proportion of the green product production sector was 10% (L1), 5% (L2), 2.5% (L3), and 1% (L4), respectively.

The production multiplier effect of the green product sector was the highest at 2.49. This means that output of green products increases by 2.49 units as one unit of final demand increases. In addition, the value added multiplier is 0.33, which means that if USD 1 of final demand is generated, then the value added of the green product created by 0.33$. This result is derived from the assumption that the green product sector to be procured is not imported. In other words, since the green industry sector has relatively less import[138] input than others, the industrial multiplier effect due to the increase in the final demand unit is the largest.

The employment multiplier effects of the green product sector were significantly higher regardless of scenario. Of course, the larger the employment coefficient, the greater the employment multiplier effect by scenario. In addition, when we evaluate output per employment, even the L4 scenario is higher than the industrial average. This means that the estimated output of green product sectors in this study have relatively higher labour productivity.

This research does not reflect the characteristics of the production structure of the green product sector, but it shows that the current market scale of green products can also have an impact on the domestic market. However, for more narrow and complete analysis, accurate input structure and employment statistics for green products are essential.

134 Pyatt (1988), International Food Policy Research Institute (2010)
135 SAM multipliers are an extension of the classic Leontief input-output (IO) model. The difference between the SAM model and IO model is that SAM can treat final demand accounts as endogenous variables while the IO model does not. Basic limitations and assumptions include the following: all prices are fixed and any changes in demand will lead to changes in physical output rather than prices; economic resources are unlimited so that any increase in demand can be matched by an increase in supply; additionally, the multiplier model assumes that all structural relationships between sectors and households in the economy are unaffected by exogenous changes in demand, which means that input coefficients remain unchanged (effects are linear, i.e., partial equilibrium model). These limitations provide sufficient justification to use more complex SAM-based modelling methods, such as CGE models, which drop the assumption of fixed prices and endowment unconstraint, linearity, and partial equilibrium linkage. See International Food Policy Research Institute (2010) and Parra et al. (2008).
136 In this study, we did not consider whole multiplier analysis using final SAM, but calculated the multiplier effect from the input-output relation constructed for SAM creation. Thus, every multiplier comes from input coefficients from the product part of the IO table.
137 Kang et al. (2010) projected a number of green jobs from the total green industry in the Republic of Korea. They projected that the number of employers in the green industry would reach 4.9% of total employment.
138 In real SAM in the model, the import of the green product sector actually has “0” value (see annex, table on SAM).

Table A4. Multiplier effects of input-output relationship

Sectors	Multipliers					
	Production [a)]	Value added (factors) [b)]	Employment c)			
			L1[d)]	L2[e)]	L3[f)]	L4[g)]
A1	1.5538	0.3461	1.2106	1.2107	1.2108	1.2108
A2	2.4262	0.2916	1.5946	1.6048	1.6099	1.6130
A3	2.4381	0.3406	3.3747	3.4196	3.4421	3.4556
A4	1.0002	0.0001	0.0004	0.0004	0.0004	0.0004
A5	1.0029	0.0032	0.0011	0.0011	0.0011	0.0011
A6	1.6323	0.6610	3.0155	3.0158	3.0159	3.0160
A7	2.4559	0.3571	5.9311	5.9321	5.9326	5.9329
A8	2.0571	0.4012	5.4962	5.4962	5.4962	5.4962
A9	1.8155	0.6743	11.7973	11.8001	11.8014	11.8023
A10	2.2505	0.2405	0.1527	0.1527	0.1527	0.1527
A11	1.8868	0.0594	0.0590	0.0590	0.0590	0.0590
A12	1.5253	0.0243	0.0562	0.0562	0.0562	0.0562
A13	2.4942	0.3301	36.6265	18.3132	9.1566	3.6626

a) Induced coefficient of production (multiplier effect of production), amounts of industrial output creation from 1 unit of final demand increase
b) Induced coefficient of value-added (multiplier effect of factors), amounts of value-added creation from 1 unit of final demand increase
c) Induced coefficient of labour (multiplier effect of employment), induced employment per KRW 1 billion of final demand increase
d) Assuming 10%, e) Assuming 5%, f) Assuming 2.5%, g) Assuming 1%

d. Mathematical formulation evaluating social welfare change

This section introduces how to calculate the social welfare effect according to policy change in the model. We discuss the equivalent variation (EV). In the social welfare section, "EV" refers to consumer subsidy or tax level corresponding to government policy.

p^0, M^0 are price and income level respectively, before policy implementation.
p^n, M^n are price and income level respectively, after policy implementation.
V = (p,M), indirect utility function, u, utility

So, we can define the EV as follows: $V = (p^0, M^0 + EV) = V(p^n, M^n)$

Indirect utility level can be measured by expenditure function e(p,u) quantitatively, derived from the consumer expenditure minimization problem.

Let u = V (p^n, M^n), the consumer utility after policy implementation, then consumer expenditure to reach same welfare level before policy is		$e(p^0, V(p^n, M^n)) = \frac{M^0}{V(p^o, M^o)} V(p^n, M^n)$,[140]	
then, the EV is[139]	EV = e(p0,V(pn,Mn)) - M0		

139 Consumer expenditure function is the same form as the cost function of firms. In the case of the CES (constant elasticity of substitution) utility function, $e(p,u) = p_x x^* + p_y y^* = [\alpha^\sigma p_x^{1-\sigma} + (1-\alpha)^\sigma p_y^{1-\sigma}]^{\frac{1}{1-\sigma}} u = \frac{M^0}{V(p^o, M^o)} V(p^n, M^n)$, where x^*,y^* optimal demand of two goods, σ, the constant elasticity of substitution among two goods in CES type utility function.

e. Tables and figures (quantitative analysis results)

Table A5. Total consumption changes of GPP policy scenarios

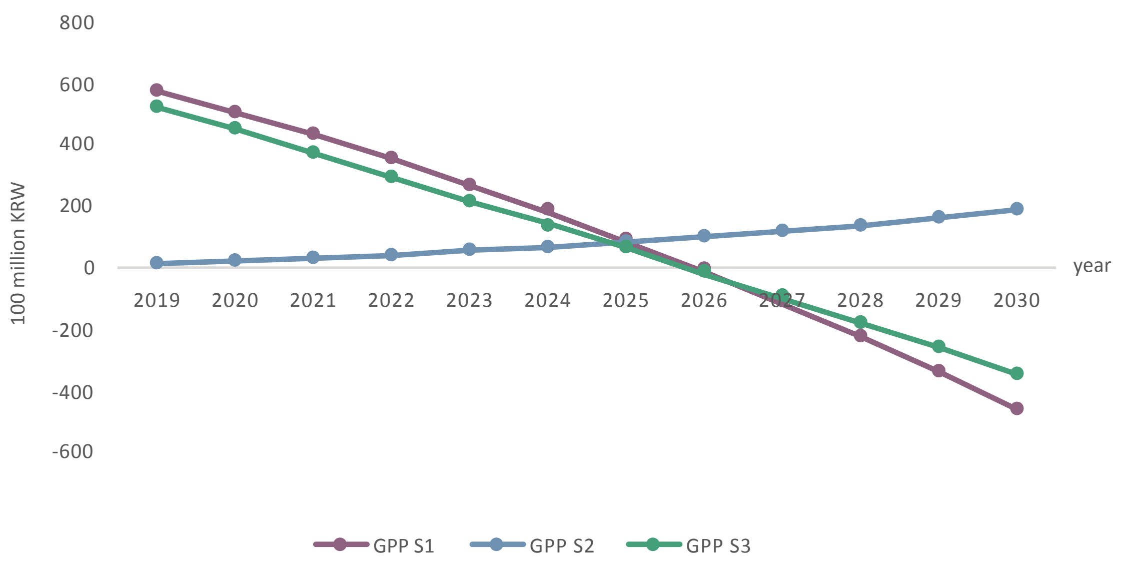

Table A6. Total investment changes of GPP policy scenarios

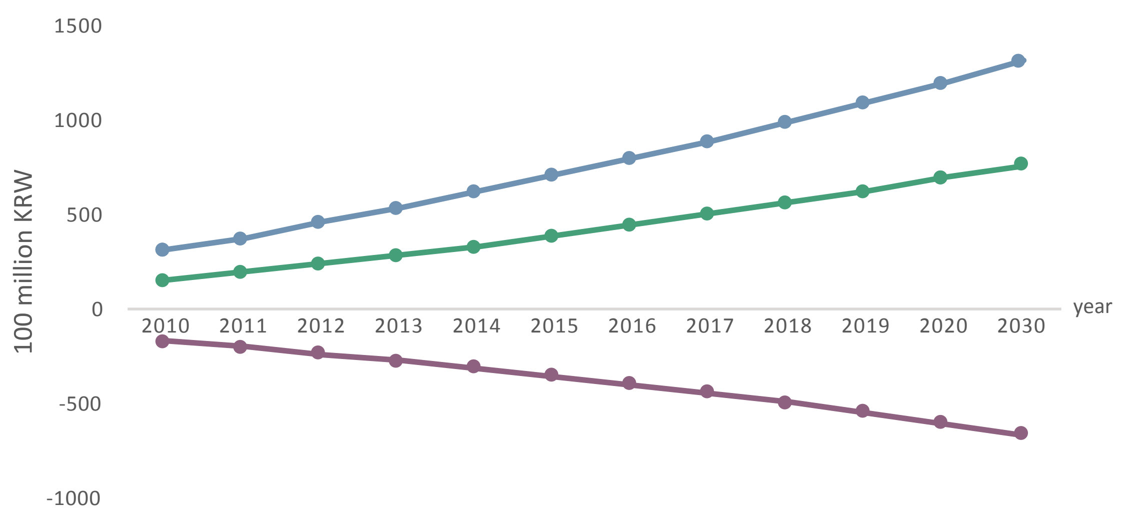

Table A7. Social accounting matrix (SAM)

Unit: KRW 100 million

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	L	K	H	G	CAP	F
A1	3,346,040	36,618,176	25,007,913	0	0	630,276	1,499,328	10,368	7,004,028	4,040,466	10,133	104	59,366	0	0	23,739,865	0	1,633,906	598,661
A2	10,924,216	169,542,876	34,897,901	999	676	9,447,147	5,435,202	8,376,154	60,685,542	60,829	488,010	25,578	162,130	0	0	175,014,936	0	45,947,463	110,597,009
A3	5,105,432	119,483,664	643,904,148	1,683	12,360	25,866,331	84,979,760	6,728,267	80,659,807	413,667	8,437,716	411,353	847,591	0	0	83,231,665	0	88,176,672	275,783,115
A4	0	0	0	0	0	0	0	0	0	0	96,343,289	3,194,578	0	0	0	0	0	358,313	0
A5	0	0	0	0	0	32,249,048	0	0	0	0	0	0	647	0	0	0	0	1,145,851	0
A6	841,411	6,189,435	30,341,359	1,017	8,193	11,746,257	3,569,136	2,910,212	49,264,173	14,305	705,744	23,579	52,988	0	0	170,038,297	99,140,529	15,737,265	821,796
A7	75,409	270,629	527,113	1,000	615	2,715,385	76,823	166,041	3,189,040	14,467	79,548	1,153	3,532	0	0	0	0	186,379,756	38,419
A8	1,143,225	11,080,212	22,732,045	1,419	7,822	3,878,251	1,324,429	18,515,263	28,196,637	231,932	3,127,988	81,458	44,351	0	0	40,952,123	0	493,583	22,486,566
A9	2,859,721	53,613,897	74,720,854	2,580	15,982	43,989,969	25,127,538	19,723,235	204,308,772	462,608	8,215,478	400,764	250,921	0	0	507,433,414	17,528,348	110,803,574	35,978,057
A10	93,632	6,446	6,646,390	0	0	48,546	10,227	39,604	124,717	6,000	0	0	7,762	0	0	169,220	0	0	41,186
A11	2,220,144	5,124,354	55,251,498	1,009	2,470	4,522,681	2,436,353	23,808,529	13,099,176	90,400	6,903,101	124,348	65,709	0	0	20,723,673	0	267,335	39,885,097
A12	30,926	445,919	1,334,684	0	334	703,609	61,962	1,506,457	2,951,185	1,177	603,410	19,730	3,129	0	0	2,195,116	0	258,603	279,867
A13	0	0	0	0	0	1,916,651	0	0	0	0	0	0	0	0	0	27,188	0	292,080	0
L	5,050,279	69,367,377	102,720,157	1,234	6,810	159,300,315	52,197,828	26,453,392	244,662,795	39,892	1,330,276	24,612	340,683	0	0	0	0	0	0
K	27,444,009	57,382,760	151,551,047	11,415	98,298	79,496,745	13,162,535	21,443,057	317,092,481	1,516,136	6,644,492	144,015	381,524	0	0	0	0	0	0
H	0	0	0	0	0	0	0	0	0	0	0	0	0	661,495,650	676,368,514	0	56,664,905	0	0
G	1,931,217	3,022,356	963,236	999	1,246	8,964,926	3,627,511	5,784,153	23,765,205	169,704	1,883,007	83,188	15,586	0	0	166,446,176	0	0	0
CAP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	204,557,396	43,324,728	0	203,612,277
F	43,132,969	99,458,567	273,444,886	99,872,825	33,240,740	5,929,559	30,298	18,832,572	70,432,154	132,147	39,753,685	5,861,648	0	0	0	0	0	0	0

For more information, contact:

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The study, centered on the exemplary case of the Republic of Korea's Green Public Procurement (GPP) policy explores the state of the art in impact measurement, with an overview of other successful international experiences. An important chapter of the study is dedicated to the possible contribution that a computable general equilibrium model could bring to the assessment of potential GPP benefits.

The study makes useful recommendations for the improvement of the Republic of Korea's Green Public Procurement policy and it impacts' measurement. It suggests, for example, the possibility of extending the measurement of environmental impacts beyond CO2 and of making an increase use of footprint calculators, which could be harmonized at world level. It also proposes an alternative way of measuring the creation of green jobs and extending impact measurement to energy efficient labelled products.

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