DOOSAN

DOOSAN INFRACORE

ELECTRIC EXCAVATOR IMPACT VALUATION

TIMM Case Study

pwc

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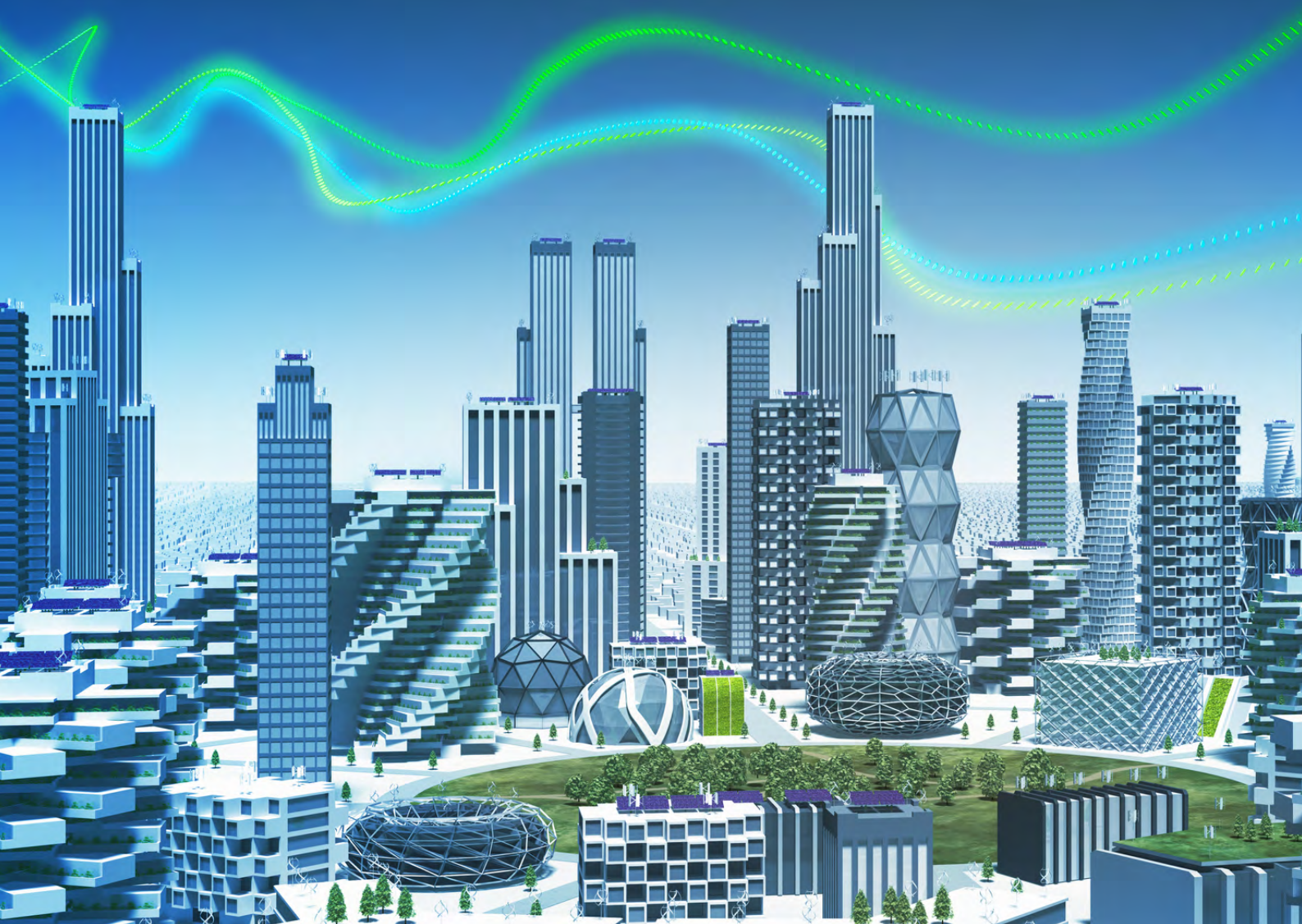


MESSAGE FROM THE CEO

How Doosan Infracore is committed to the world we want to live in

Doosan Infracore has been fulfilling its social responsibilities in such areas of environmental, social, and governance (ESG). We are enhancing the level of such fulfillment across the overall value chain, with a particular focus on our products' social impact when developing and applying technologies.

Doosan Infracore is pursuing continued growth by expanding its development of eco-friendly technologies, while maintaining a level of safety and productivity that exceeds the requirement of the global construction industry.

The construction equipment industry is not free from climate change. Also, relevant environmental regulations are becoming stricter at a fast pace. Doosan Infracore seeks to actively respond to climate change and electrification trend by developing eco-friendly technologies, ranging from engine aftertreatment technology and hybrid powertrain to E-Powerpack, electric excavators, and Concept-X, a future construction site solution.

Doosan Infracore issued a report that analyzed the economic, social, and environmental value of the 3.5-ton diesel excavator and electric excavator, following last year's Concept-X value assessment report, to identify changes that might be brought by future technologies and their impact.

The reliability of the analysis was further enhanced by using PwC's Total Impact Measurement Management (TIMM), which is an integrated impact measurement methodology.

On the back of these efforts, Doosan Infracore will lead innovation of the construction equipment industry, and grow into a company that creates sustainable value for the society, in addition to achieving economic growth. I ask for your continued interest in the changes that Doosan Infracore will make for future generations.

Sohn, Dong Youn

Chief Executive Officer
Doosan Infracore Co., Ltd.

IDENTIFYING THE ISSUES & OUR APPROACHES

Concerns about environmental issues is rising all across the globe including carbon emissions and the resulting global warming and rise in sea levels. In the "2021 Global Risk" Report published by the World Economic Forum (WEF), it is pointed out that climate issues, such as extreme weather conditions and failure to counter climate change, are becoming an existential threat to humankind. Based on a consensus on the seriousness of climate change, the international community is strengthening global cooperation, including the Paris Agreement, and major advanced countries are declaring net-zero and expanding relevant infrastructure investment.

Social and Environmental Issues Surrounding Doosan Infracore

1 Stricter environmental regulations in Korea and abroad

International community is strengthening regulations aimed at practical execution of measures to counter climate change, and accordingly laws and regulations on exhaust gas emissions are becoming stricter in each country. In particular, Stage V emissions standards[1)] were applied in Europe in 2019, resulting in a movement to legalize the prohibition of diesel vehicle entry into major city centers, proving that regulation levels in developed markets are becoming higher. In China and emerging markets as well, the adoption cycle of new emissions standards is being accelerated, and there is increased competition for eco-friendly products in the construction equipment industry to achieve zero emissions.

In Korea, such issues as fine dust and the resulting environmental pollution and harm to citizens' health are becoming more serious. Against this backdrop, the "Year 2020-2024 Comprehensive Plan on Fine Dust Management" was announced as an outcome of upholding and adding greater depth to previous fine dust management measures. This plan fully launches emissions reductions in the non-road transportation sector and strengthens emissions standards for construction equipment, including excavators, by around two-fold. It also states that a system of monitoring exhaust gas generated by construction equipment in actual work conditions will be adopted after 2022, which in turn will lead to stricter exhaust regulations on the construction equipment industry.

2 Government's policy to expand green mobility

In July 2020, the Korean government announced the "Green New Deal policy[2)]" to overcome the economic crisis caused by COVID-19 and the climate and environmental crisis that caused the pandemic, and chose "expansion of eco-friendly future mobility" as one of its major tasks. As part of these efforts, the government implemented a program on replacing old engines of construction equipment aimed at improving environmental impact. It is very active in low carbon, eco-friendly transformation in the construction equipment sector through a program on providing electric excavator purchase subsidies to expand future green mobility.

3 Promotion of investment from the ESG perspective

Investments that consider ESG factors are becoming facilitated all across the globe, amid which there is growing interest in and proportion of eco-friendly business investments. In particular, the EU Taxonomy was announced in 2019 that presents criteria for environmentally sustainable finance. This made more systematic eco-friendly product and technology development imperative in the industrial sector. It is forecast that clean tech-centered R&D investments will grow that can contribute to countering climate change and preserving nature.

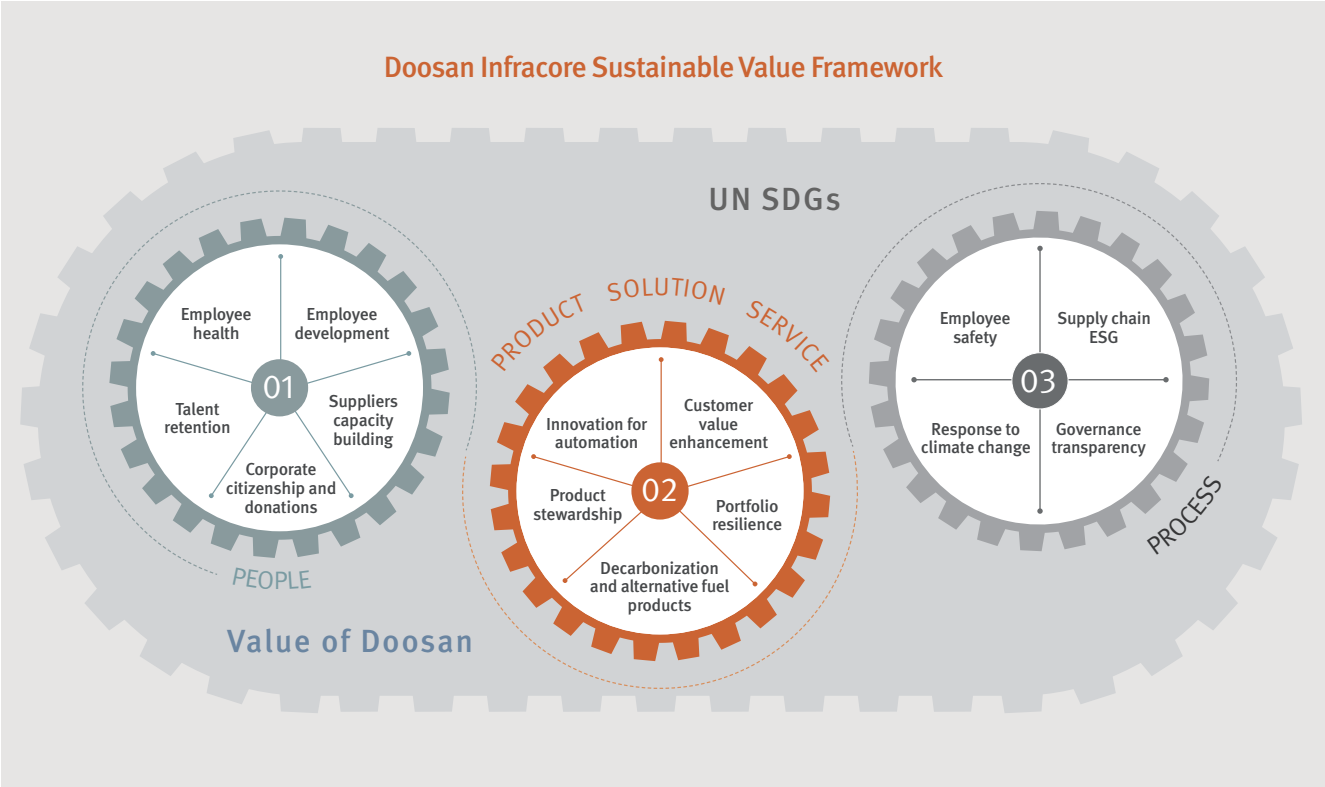
1) Exhaust gas regulations put into effect by the EU in 2019 to restrict particulate matter (PM) emissions by diesel engines

2) Government plan on job and market creation through support for green industry

Moreover, the movement to shift to a low-carbon economy is increasing internal and external stakeholders' interest and needs towards clean technology, including green mobility, and is having an actual impact on the construction equipment industry as well. Doosan Infracore is actively responding to diverse environment changes that are related to industry as well as stakeholder needs, and going further by achieving preemptive technological innovation in line with the spread of clean technology and other global trends.

Doosan Infracore's Strategic Approach

Doosan Infracore actively complies with social responsibilities and strives to enhance internal and external stakeholder value. In 2019, we established the "Sustainable Value Framework", describing our mid- to long-term ESG strategies and objectives, and derived performance indexes in three areas – people, product/solution/service, and process. With the ESG Committee performing a central role, we are systematically monitoring the status of ESG strategy implementation, including product stewardship and response to climate change, and enhancing corporate-wide momentum.



E-Powerpack Business

Doosan Infracore seeks to expand high energy-efficiency and low-carbon product development, thereby securing sustainability-based future growth engines and contributing to the achievement of Korea's Green New Deal objectives. As part of this plan, we focus on the spread of eco-friendly power, starting from the step of planning the technology development direction. In 2019, we strengthened combustion and aftertreatment technology capabilities and expanded the scope of alternative fuel technologies to respond to next-generation emissions standards, while also securing engine electrification technologies, including the hybrid powertrain, to prepare for future engine products.

Moreover, in 2020 we reviewed the expansion into the plug-in hybrid electric vehicle (PHEV) and fuel cell electric vehicle (FCEV), and fully launched the adoption of eco-friendly power sources, including the establishment of an E-Powerpack roadmap and commencement of development of an electric excavator that runs on electric battery. Doosan Infracore expands its business to include E-Powerpack business, thereby leading electrification of the Korean construction equipment industry.

INTRODUCING HOW WE LOOK AT IMPACT

Impact Valuation Outline

Doosan Infracore seeks to fulfill its responsibilities as a member of society and an economic player by minimizing the environmental impact of business operations while maximizing positive influence on society. To identify the social and environmental impact that our products have and to run our business in a more sustainable direction, we measured the economic, social, and environmental value that will be created by our electric excavator, which is our leading eco-friendly product group. In consideration of the range of impact of the overall process from a product's manufacturing step to its usage step, we included Doosan Infracore as well as suppliers and customers in the scope of value measurement.

SUBJECT OF IMPACT VALUATION

Eco-friendly future mobility – Electric excavator

DEVELOPMENT BACKGROUND
Counter climate change based on eco-friendly technology and consider worker safety and health

KEY FEATURES

- Replace the diesel engine by using an E-Powerpack
- Supply power to a motor that activates hydraulic systems through a battery pack
- Generate less exhaust, noise, and vibration, making it adequate for work in a sealed space and city center

Zero-Emission Prevent the emissions of CO_2 and air pollutants for it does not use fuel and does not generate exhaust

Convenience Increase maintenance convenience for less consumables are required, such as fuel, engine oil, and filter needed for engine use, and also reduces pollution

Quietness Provide a pleasant operation environment and minimize construction-related noise for it generates neither vibration nor noise

Prototype of 1.7-ton electric excavators (DX17ZE)

Impact Valuation Framework

CATEGORY \ VALUE CHAIN	Supply Chain	Operations	Use Phase
	Manufacturers of parts for electric excavators	Doosan Infracore	Electric excavator users
Economic Impact on current or future GDP	Improve net profit	Acquire tangible/ intangible assets	Reduce operating expenses
Social Impact on countries, regions, and individuals		Increase tax revenues	Reduce costs of health insurance benefits and work loss costs Reduce noise and vibration
Environmental Impact on natural environment and human life value		Reduce wastes	Reduce GHG emissions Reduce discharge of air pollutants

Doosan Infracore's Strategic Approach

Impact Valuation Formula and Measurement Basis

Measurement Index	Definition	Measurement Method	Proxy Data
Net profit	Final profit that a supplier generated by supplying excavator parts	Supplier's material costs for the corresponding product x Average value of the return on sales of the business category (other machinery and equipment industry)	• Other machinery and equipment industry (SME) return on sales: 3.38%[1)]
Tangle/ intangible assets	Reduction in the value of tangible/intangible assets (recognized as value that will be created in the future)	Estimated depreciation costs based on tangible/intangible asset investment plan	• Tangible/intangible asset investment plan from 2021 to 2025
Operating expenses	Maintenance costs that are incurred regularly when a customer uses the product	Sum of excavator fuel costs or electricity usage fees and other consumables costs	• Diesel price: KRW 1,314.9/L[2)] • Electricity charging fee: KRW 121.8/kwh[3)]
Tax revenue	Amount of government tax revenues generated by non-income expenditures of employees	Amount paid as tax from among non-consumption expenditures of employees related to the corresponding product	• Average non-consumption expenditure (tax) amount of regular employee households: KRW 5.78 million[4)]
Costs of health insurance benefits	The government's budget for health insurance benefit expenditures caused by impact on the human body triggered by air pollutants	Health insurance benefit costs paid for by the government in relation to ambulatory care for respiratory system disease of product drivers and local residents caused by air pollutants	• No. of outpatients for respiratory disease per 1kg of PM2.5: 0.81 person[5)] • Ambulatory benefit costs for respiratory disease: KRW 3,887,222 million[6)] • No. of days of hospital visits by outpatients with respiratory disease: 167,017,932 days[6)]
Work loss costs	Work loss costs due to negative impacts of air pollutants on human body	Wage loss caused by equipment operator's hospital visits due to respiratory disease caused by air pollutants	• Average daily wage of a construction worker in 2020: KRW 167,900[7)]
Noise	Level of noise generated in using product	Negative impact on the human body and impact on reduced productivity, etc. in operator noise state	• 74dB(A) Environmental prices: 108 euro[8)] • 80dB(A) Environmental prices: 120 euro[8)]
Vibration	Level of vibration generated in using product	Impact on the mental health of operator at rpm 2200	• Social cost for vibration damage: KRW 510,000[9)]
Greenhouse gas (GHG)	GHG that is emitted in the process of product use	GHG emissions of diesel excavator by air pollutant x Eco-cost[10)]	• CO_2 Eco-cost: 0.116 euro/kg • CH_4 Eco-cost: 3.538 euro/kg • N_2O Eco-cost: 30.74 euro/kg
Air pollutants	Air pollutants that are emitted in the process of product use	Air pollutant emissions of diesel excavator x Eco-cost[10)]	• CO Eco-cost: 0.24396 euro/kg • NOx Eco-cost: 5.35 euro/kg • TSP Eco-cost: 5.50 euro/kg • PM 2.5 Eco-cost: 35 euro/kg • PM 10 Eco-cost: 7.98 euro/kg • Soot Eco-cost: 5.50 euro/kg
Waste	Substances that are recyclable in the process of product discard	Percentage recyclable from among raw materials contained in electric excavator battery x Eco-cost[10)]	• Lithium Eco-cost: 2.79 euro/kg • Cobalt Eco-cost: 42.4 euro/kg • Nickel Eco-cost: 11.81 euro/kg • Manganese Eco-cost: 0.45 euro/kg

* Euro exchange rate: Rate based on trading on January 4, 2021

1) 「Relationship Ratios of Income and Expenses (10th Korean Standard Industrial Classification)」, Bank of Korea (2019)

2) Korea Petroleum Association (Average of Year 2018, Year 2019, January-August 2020)

3) KEPCO (2020, Average light load/heavy load/fast/slow charging fees)

4) 「Survey of Household Finances and Living Conditions」 Statistics Korea, Bank of Korea, Financial Supervisory Service (2020)

5) 「Research on Impact on Respiratory System Disease by PM2.5 Emissions」 , Korea Environmental Policy and Administration Society (2017)

6) 「National Health Insurance Statistical Yearbook」 National Health Insurance Service, Health Insurance Review & Assessment Service (2019)

7) 「Results of Comprehensive Life Survey of Construction Workers」, Construction Workers Mutual Aid Association (2020)

8) Environmental Prices Handbook EU 28 Version, CE Delft (2018)

9) 「Research on Environmental Damage Evaluation Methods and Reasonable Adjustment Measures for Compensation Calculation Criteria」, Aeroacoustics & Noise Control Laboratory (2007)

10) Ecocosts 2017 V1-8 midpoint tables, TU Delft (2017)

MEASURING OUR IMPACT ON THE WORLD

Economic, Social, and Environmental Value of Electric Excavator

We used PricewaterhouseCoopers(PwC)'s Total Impact Measurement Management (TIMM), which is an integrated impact measurement methodology, and analyzed the economic·social·environmental value of our 3.5-ton diesel excavator and electric excavator during their respective lifecycle[1]. We afterwards calculated the electric excavator's benefit improvement level compared to the diesel excavator, through which we confirmed that impact value[2] of around KRW 27.46 million is generated per one 3.5-ton electric excavator.

[1] Assuming average usage of 750 hours a year for five years

[2] The difference in economic, social, and environmental value between the 3.5-ton electric excavator and the diesel excavator

Measurement Result by Index

(Unit: KRW 10,000)

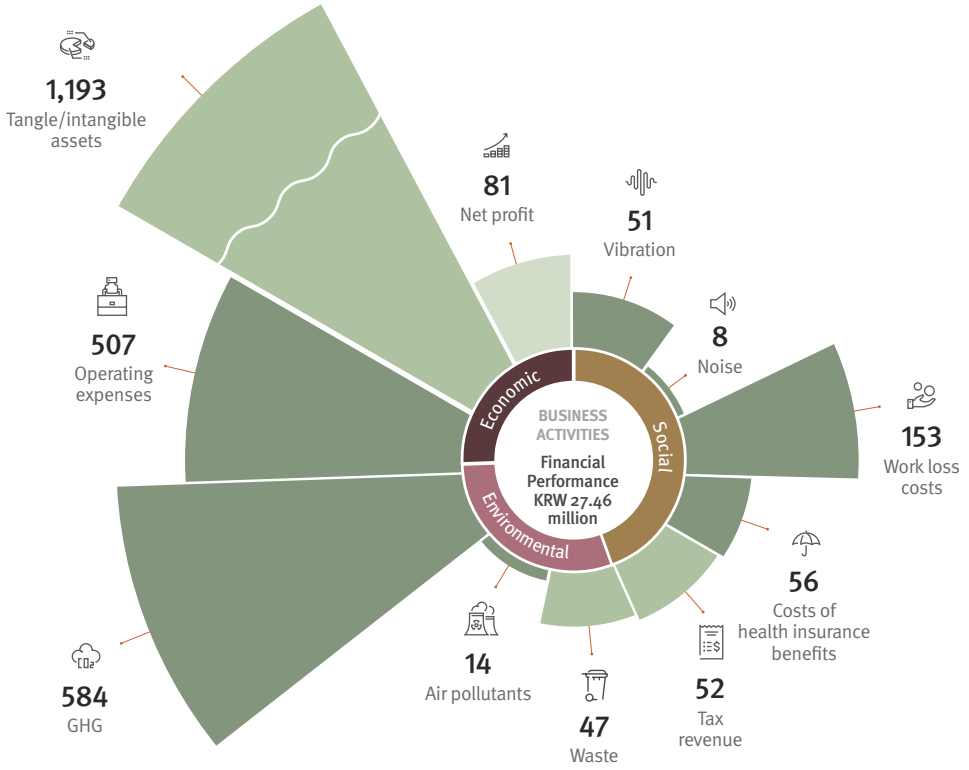
Classification	Indicator		VALUE CHAIN			IMPACT VALUE[3]
			Supply Chain	Operation	Use Phase	
Economic	Net profit		●			81(3.0%)
	Tangle/intangible assets			●		1,193(43.4%)
	Operating expenses				●	507(18.5%)
Social	Government	Tax revenue		●		52(1.9%)
		Costs of health insurance benefits due to respiratory diseases[4]			●	56(2.0%)
	Citizen's health	Work loss costs due to respiratory diseases[4]			●	153(5.6%)
		Noise			●	8(0.3%)
		Vibration			●	51(1.9%)
Environmental	GHG				●	584(21.3%)
	Air pollutants[4]				●	14(0.4%)
	Waste			●		47(1.7%)
Total Impact Value						**2,746**

[3] All figures specified as result values above were rounded off, and therefore there may be singular number difference in the sum of figures.

[4] Separated the primary environmental pollution impact of air pollutants as the environmental index, and secondary human impact, such as health and work loss caused by respiratory system disease, as the social index for measurement.

Impact Valuation (Unit: KRW 10,000)

VALUE CHAIN Supply Chain Operation Use Phase



Value Add-up

Per one electric excavator

Approximately KRW 27.46 million

Creating a value of KRW 27.46 million per each electric excavator from the economic, social, and environmental perspective, compared to the diesel excavator

(Assuming average usage of 750 hours a year for 5 years)

Estimations on GHG Reduction Impact of Electric Excavator Market Expansion

4,260 Units

Estimated mini excavator market size in 2025[1]

Transition rate to an electric excavator[2]	GHG reduction	GHG reduction effects of the transition to electric excavators	
10%	16,155 (tCO_2eq)	46 Operate solar power plants with an area that equals the area of 46 units of the Jamsil Baseball Stadium a year	2.45 Plant 2.45 million of 30-year-old pine trees a year
30%	48,465 (tCO_2eq)	137 Operate solar power plants with an area that equals the area of 137 units of the Jamsil Baseball Stadium a year	7.34 Plant 7.34 million of 30-year-old pine trees a year
50%	80,775 (tCO_2eq)	229 Operate solar power plants with an area that equals the area of 229 units of the Jamsil Baseball Stadium a year	12.24 Plant 12.24 million of 30-year-old pine trees a year

[1] The total excavator market for 2020 was calculated based on the number of excavators registered in 2019 and 2020 and the number of excavators whose registration was cancelled in 2020 from the Ministry of Land, Infrastructure and Transport's statistical materials on the construction equipment status. Afterwards, the mini excavator market ratio was reflected to sum up the total number of mini excavators in 2020 and the excavator market CAGR for the last five years (2015-2020) was used to forecast the mini excavator market in 2025.

[2] To help with reader understanding, the rate of transition from diesel excavators to electric excavators was set arbitrarily.

Economic, Social, and Environmental Value of Electric Excavators

Economic

The production of electric excavators will expand sales channels and diversify the products of our suppliers, thus increasing their net income, and the creation of this win-win value will lead to stable growth. As the products are used, we can reduce or eliminate the expenses from diesel engine consumables such as fuel, engine oil, and filter replacements, thus substantially lowering the fixed costs involved in product maintenance and contributing to improvements in economic efficiency for our customers.

KEY STAKEHOLDERS

Suppliers, Customers

Link to UN SDGs

Social

R&D, production, and quality management of electric excavators will increase employment and wages, generating additional income for those employed and ultimately increasing government tax revenues. As products are used, levels of noise and vibration are reduced compared to diesel excavators, thus improving drivers' psychological and physical health and minimizing inconvenience to nearby local communities. Compact electric excavators are mainly used in downtown areas, where residents are highly sensitive about air pollution issues, and using an electric excavator is effective for preventing impact on the human body, such as respiratory disease of drivers and nearby local residents that is caused by discharge of air pollutants. This also reduces costs related both to drivers missing working days and to government health insurance expenditures resulting from care for respiratory disease.

KEY STAKEHOLDERS

Government, Customers, Local Communities

Link to UN SDGs

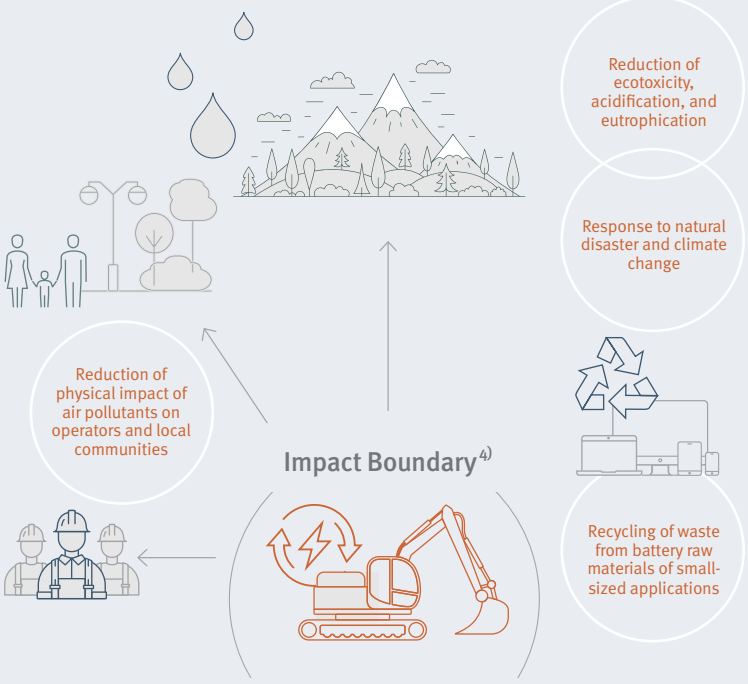
Environmental

An electric excavator equipped with the E-Powerpack has various environmental value. It reduces greenhouse gases (GHG) compared to the use of a diesel engine, and minimizes the environmental impact on air, water, and soil from ecotoxicity[1], acidification[2], and eutrophication[3]. By responding to climate change, it can prevent other damages such as the destruction of ecosystems and deterioration in food supplies. It also enables easier collection and recycling of raw materials from waste batteries to be used for small-sized applications, which helps with preventing the depletion of resources and promoting a circular economy.

KEY STAKEHOLDERS

Government, Customers, Local Communities

Link to UN SDGs

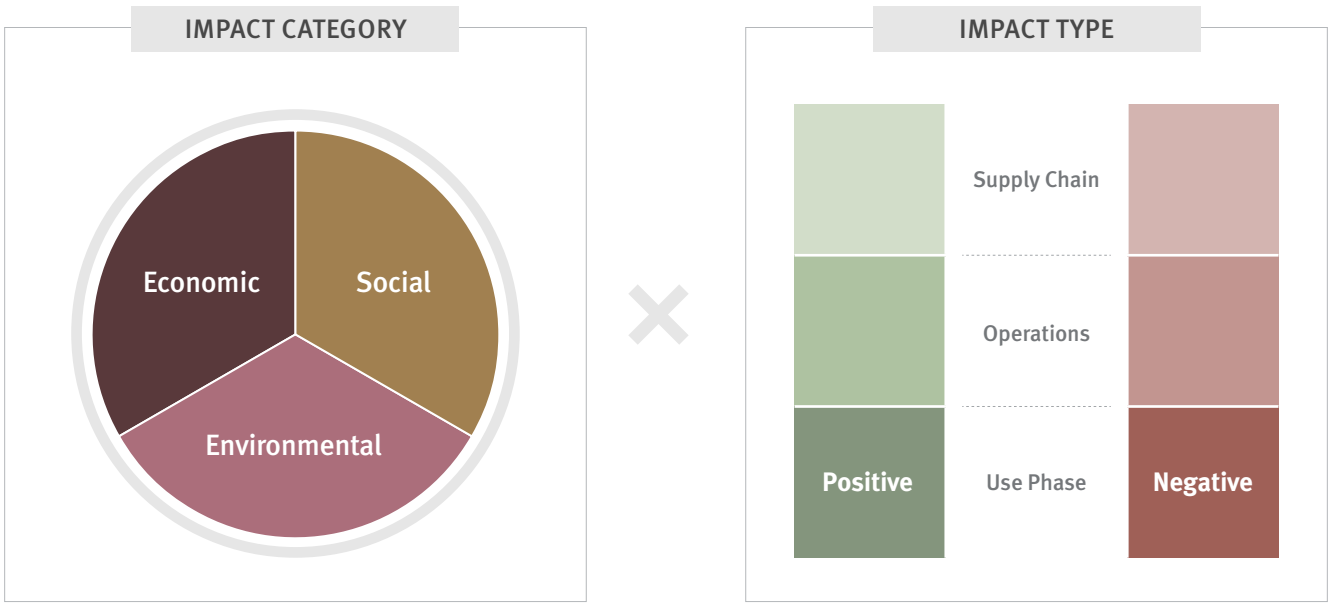


[1] Phenomenon whereby certain chemical substances negatively impact the function, stability, and life forms within an ecosystem
[2] Phenomenon whereby water and/or soil become acidic due to an increase in hydrogen ions
[3] Excessive growth of nutrients in aquatic ecosystems such as rivers and oceans, leading to green tide and red tide algae
[4] Based on the environmental, social, and economic cost calculation logics defined in the 「The Model of the eco-costs and the s-eco-costs for E-LCA and S-LCA」 by TU Delft

METHODOLOGY

Outline of TIMM(Total Impact Measurement Management) Methodology

TIMM is the unique integrated impact measurement and management methodology of Pricewaterhouse Coopers (PwC) that measures positive or negative impact created by a company in the process of business activities. TIMM categorizes the impact range according to the economic, social, and environmental category, and impact refers to the degree of positive·negative change in the company, supply chain, and product users according to the financial outcome and non-financial outcome of business activities.



Major Premise and Considerations of Value Measurement

1. Value was measured based on a reasonable hypothesis by using the company's own performance data as the basis and by utilizing existing research and official statistics from national institutions and international organizations. As such, monetary value for the corresponding year may change in the future. In addition, because the integrity of the results cannot be fully verified, they cannot be regarded as part of an official financial disclosure.

2. Doosan Infracore developed the prototype model of the 1.7-ton electric excavator in 2020, and plans to mass-produce the 1.7-ton and 3.5-ton electric excavator after 2023. As such, where it was not possible to confirm actual raw data for the products in existing conditions, we used 1) actual measurements from equipment with similar specifications and 2) estimates for the time of mass production.

3. Where it was difficult to confirm proxy data that could reasonably reflect product impact, we excluded the respective index from the measurement to ensure credibility of the results. In cases where there were multiple proxy data, we used data with the highest credibility for the calculations. When a significant difference in credibility could not be determined, the most conservative data was used.

4. Indices which cannot be managed by Doosan Infracore, including the environmental impact of energy sources, product assembly and transport, were excluded from the measurement to ensure credibility of the results.

5. In the case of the acquisition of tangible/intangible assets, measurements were made for new investments only, excluding current investments.

6. Tax benefits which may arise from product development were excluded from the measurement. We reflected the taxes paid by people employed in product development (excluding production workers because accurate estimates were not possible) ahead of full-scale mass production in 2023.

7. In the case of the waste index, recycling handling costs were excluded from the measurement because the recycling market for electric batteries is in its early stages compared to diesel engines, and so reasonable comparisons of the costs that arise in the recycling process are difficult. Measurements were therefore made assuming reductions in the use of resources through raw material recycling.

8. For noise measurement, the noise value of an electric excavator was measured using mule equipment, before the prototype equipment, and was measured without the use of sound-absorbing materials or other noise reduction measures. Noise levels in actual mass-produced products are expected to be lower.

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