Introduction to "Korean Green NCAP"

2024. 04. 19

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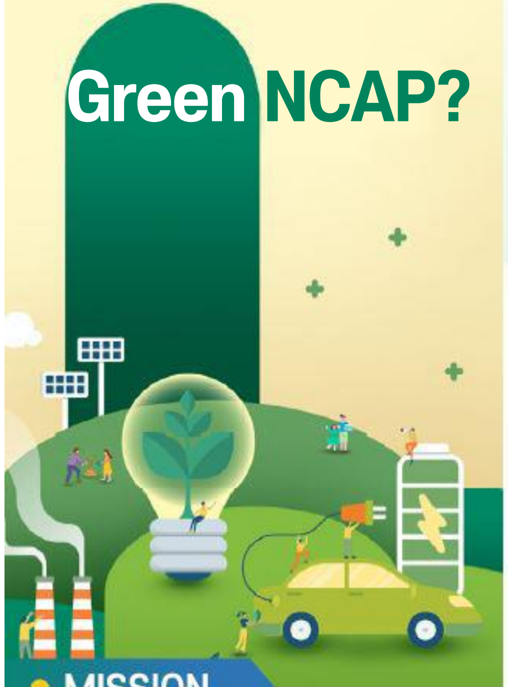
Concept of Korean Green NCAP

Green NCAP?



Holistic new car assessment program which is the most comprehensive system that evaluates the environmental performances of vehicles, including Fuel efficiency, LCA-based GHG emissions and Vehicle interior air quality

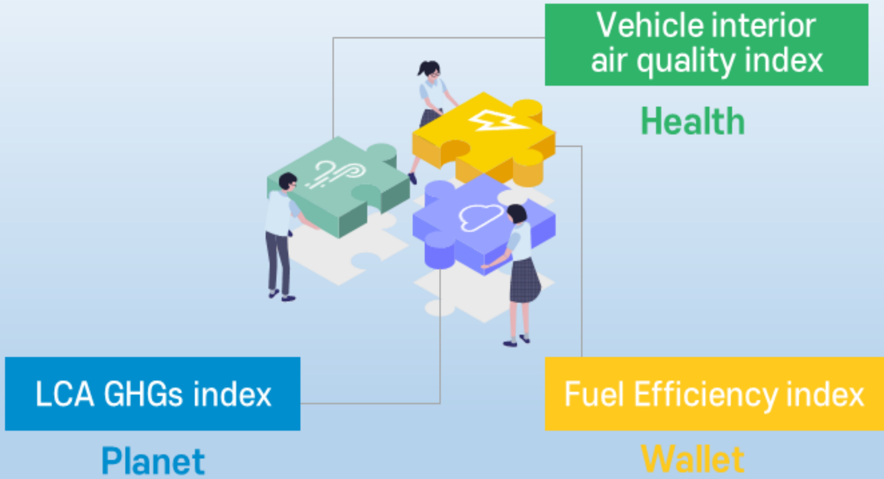
VISION

- **Green remodeling** of the automotive ecosystem to **reduce global warming, maximize energy efficiency of vehicles and improve vehicle interior air quality.**

MISSION

Promote development of green cars and expand green car market by providing comprehensive information of vehicles

Scope of K-GNCAP



1 Overview of Korean Green NCAP Project

Korean Green NCAP

Ministry of Land, Infrastructure and Transport (MOLIT)

Leading institution Korea Automobile Testing & Research Institute (KATRI)

Research team

TS 자동차안전연구원 · 서울대학교 SEOUL NATIONAL UNIVERSITY · K Petro 한국석유관리원 · KIAPI 지능형자동차부품진흥원 · eBluzent Eco & Electrification · 한양대학교 · 이화여자대학교 EWHA WOMANS UNIVERSITY · CNR 탄소중립연구원 Carbon Neutral Research Institute · 서경대학교 · 중부대학교 · ktl 한국산업기술시험원 Korea Testing Laboratory · APM Measuring the Environment (주)에이피엠엔지니어링 · 목원대학교 MOKWON UNIVERSITY · SOLUTIS

Purpose

- Developing test procedures and rating scheme for vehicle environmental performances and establishing Green NCAP system and legislation which could induce technology development of environment–friendly vehicles by manufacturers and expansion of green car market by consumers

- Develop test procedures and rating scheme for evaluating environmental performances and providing information on how green vehicles are.
- Establish an effective technical and institutional support system that can be used to facilitate government policies.
- Develop automotive GHG emissions based on life cycle assessment (LCA)

Period April 19, 2023 – Dec. 31, 2026 (3 years and 9 months)

Funding Total 20M dollars (25 billion won)

2 Project Implementation System

Research Project Goal and Vision

Vision

Green remodeling of the automotive ecosystem to **reduce global warming, maximize energy efficiency of vehicles and improve vehicle interior air quality.**

Goal

Developing test procedures and rating scheme for the most comprehensive vehicle environmental performances and establishing Green NCAP system and legislation

Core values

Environment performances	Reliability	Publicness for consumers

Strategies

Environment performances – Developing test procedures and rating schemes (10 items)

- Developing fuel economy and GHG emissions testing and rating technologies.
- Developing comprehensive performance testing technology for green vehicles.
- Developing LCA methodology and rating technology.
- Developing vehicle indoor air quality (VIAQ) testing and rating technologies.

Reliability – Developing evaluating systems for environment performances (4 types)

- Developing comprehensive performance testing technology for electrified vehicles.
- Developing standardized testing systems for Heavy-duty vehicles
- Developing LCA-based GHG emissions assessment system.
- Developing test platform for evaluating VIAQ

Publicness for consumers – Legislating Korean Green NCAP and developing consumer information provision platform

- Developing Korean Green NCAP systems and legislation.
- Developing an open science platform for providing and communicating related information to the public.

Research items

01 Developing test procedures and rating scheme for fuel economy & tailpipe GHGs

02 Developing LCA-based GHG emissions assessment system & rating scheme

03 Developing test procedures and rating scheme for VIAQ & test platform

04 Institutionalizing Korean Green NCAP and developing commercialization technologies

2 Project Implementation System

Korean Green NCAP research project

Pillar 1 — Fuel Efficiency

1 Developing test procedures and rating scheme for F.E & GHG

- 1-1 Test procedures for real-world fuel/energy consumption and CO_2 emissions for LDV
- 1-2 Scoring methodology and rating system for F.E & CO_2 for LDV
- 1-3 Test procedures and platform based on simulation program for HDV

2 Developing test procedures and information protocols for performance of EV & FCEV

- 2-1 Test procedures, platform and information protocol for energy consumption and driving range according to real-world driving conditions (ambient temperature, HVAC system, loads, etc.)

Pillar 2 — LCA for GHGs (in line with A-LCA IWG)

1 Developing LCA-based GHG emissions assessment system

- 1-1 Standardized LCA GHG emissions and LCA tool
- 1-2 Standardized LCA GHG emissions database

2 Developing LCA-based GHG emissions rating scheme

- 2-1 Korean Green NCAP LCA GHG rating system

Pillar 3 — Vehicle Interior Air Quality (in line with VIAQ IWG)

1 Developing test procedures for Vehicle Indoor Air Quality

- 1-1 Test procedures for VIAQ based on interior air emissions of new vehicles
- 1-2 Test procedures and evaluation methods for real-world driving VIAQ from outside sources

2 Developing rating scheme for VIAQ

- 2-1 Scoring methodology for VIAQ from both interior and exterior sourced pollutants
- 2-2 Rating system for comprehensive Vehicle indoor air quality

3 Developing test platform for evaluating comprehensive VIAQ

- 3-1 Systemized measuring equipment and facilities for evaluating comprehensive VIAQ

Pillar 4 — Legislation and implementation

1 Enacting legislation and implementation

- 1-1 Legislation and implementation of Green NCAP in Korea
- 1-2 Comprehensive legislation of New car assessment program from the perspectives of both Safe and Green vehicles

2 Making consumer information provision platform

- 2-1 Consumer information provision and publicity strategy
- 2-2 Open platform for providing consumer testing information for public services based on dataset of validated tests

3 Research Details of vehicle LCA(Pillar2)

Research objectives — Pillar 2: Develop LCA-based automotive GHG emissions assessment methodology and rating system

Develop LCA-based GHG emissions assessment system

Conceptual design for LCA-based GHG emissions assessment

Conceptual design for vehicle cycle GHG emissions analysis

- Set the scope of the assessment, e.g., system boundary, GHG species, vehicle lifetime, calculation methodologies and data quality requirements.
- List up key materials for automotive products and their standardized pathways.
- Explore carbon-reducing technologies.
- Database development: commercial DB vs. in-house DB.

Conceptual design for fuel cycle GHG emissions analysis

- Set the scope of the assessment, e.g., system boundary, GHG species, fuel and energy category, calculation methodologies and data quality requirements.
- List up the standardized pathways.
- Explorer the futuristic fuels and their usage, e.g., biodiesel, clean hydrogen, e-fuels, EV charging patterns, power generation mix change, etc.

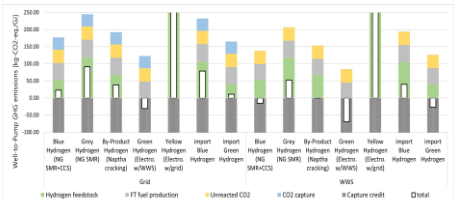
Build analysis foundation and develop evaluation programs

Build and develop LCA foundation

- Build baseline fuel and vehicle cycles pathways and compile available database.
- Develop calculation framework in a program, considering future expandability.
- Evaluate the exemplary vehicles for rating system development.

Consider new fuel production pathways and fuel charging and usage patterns

- Analyze regional and temporal variability in fuel cycle GHG emissions electric and hydrogen vehicles.



Fuel cycle results according to hydrogen production method

Develop LCA-based GHG emissions rating system

Conceptual design for LCA-based GHG emissions rating system

Conceptual design for LCA-based GHG emissions rating system

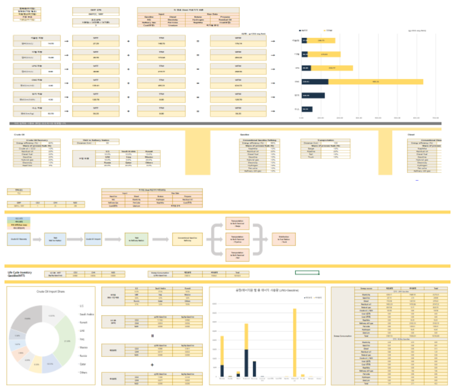
- Set a direction for rating system based on analysis of foreign LCA-based policies.
- Develop LCA GHG emissions upper/lower limit criteria and prepare a proposal on the rating system.

Set a direction through exchange with European Green NCAP

Develop standardized LCA database and program for institutionalization

Establish a protocol for maintaining LCA database and program

- Determine standardized pathways and parameters for evaluation of LCA-base GHG emissions.
- Establish a protocol for updating key variables and assessing their data quality.
- Build, design, and deploy LCA program for Korean Green NCAP.



Prototype of LCA program for Korean Green NCAP

3 Research Details of vehicle LCA(Pillar2)

Results of 1st year of R&D project

Directions for updating key factors of LCA GHGs emissions

[Temporal Relevance of Production Process-Related Data]

- Reflection of contemporary technology and energy efficiency improvement

When technological advancements lead to an increase in energy efficiency of a specific process, such as a decrease in the ratio of process fuel to inputs or an increase in the output ratio, these improvements are reflected in the LCA

[Geographical Relevance According to Regional Characteristics]

- Diversity of Producing Countries

If there is a diversity in the countries importing raw materials and fuel products, it is necessary to reflect the differences and diversity of greenhouse gases emitted from the processes conducted

- Energy mix by region

Each country or region has a different mix of energy sources, and if the proportion of renewable energy sources is significant, data updates are required to reflect these particularities

[Set Evaluation Scope]

- System boundaries

The system boundary addressed in the first year is limited to the lifecycle of automobile fuels and includes only the direct energy flows (their upstream emissions) related to production, distribution, and consumption of fuel

- GHG species

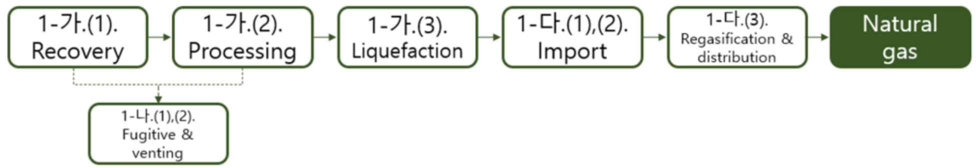
In Korea, the AR4 standard GWP100 is applied to three types of greenhouse gases (CO_2, CH_4, and N_2O) that are reportable in the transportation sector for UNFCCC reporting (plan to apply the outcomes from A-LCA IWG)

There is a need to update key variables to correspond to ISO 14040/44 data quality determination criteria

Establishment of data update protocol

✓ Provides schematic representations of the upstream unit processes involved in the analysis for natural gas, coal, uranium, oil, electricity, etc.

Example of Life cycle of Natural gas



✓ In the context of natural gas, parameters are obtained through analyses based on authoritative literature or reports concerning the recovery process, processing, liquefaction, fugitive emissions & venting, flaring, as well as transmission and distribution

✓ To guide updates via additional sources, describe the strengths and limitations of the data used through our own data quality assessment of the listed data

Example of Efficiency in Recovery Process

Process	GREET 2022(U.S)	Toyota report(Japan)	JEC report(EU)	Ultimate Efficiency
Efficiency(%)	96.4	98.7	99.0	98.0

Evaluation Category	Evaluation Result	Reasons
Temporal relevance	H/L	The GREET/JEC report reflects the latest values, the energy supply and demand system is similar to Korea's, and the referenced Japanese literature is about 20 years apart.
Regional relevance	M	By using the average value of the efficiency of data related to natural gas from major energy consumers such as the United States, Europe, and Japan, it was used as an international average
Technical relevance	H	Coverage of the recovery process presented in each literature is on the same line
Others	-	CH4 fugitive & venting emissions and flaring CO2 emissions based on country specific data

3 Research Details of vehicle LCA(Pillar2)

Results of 1st year of R&D project

Develop fuel cycle evaluation program

[6 vehicle fuels]

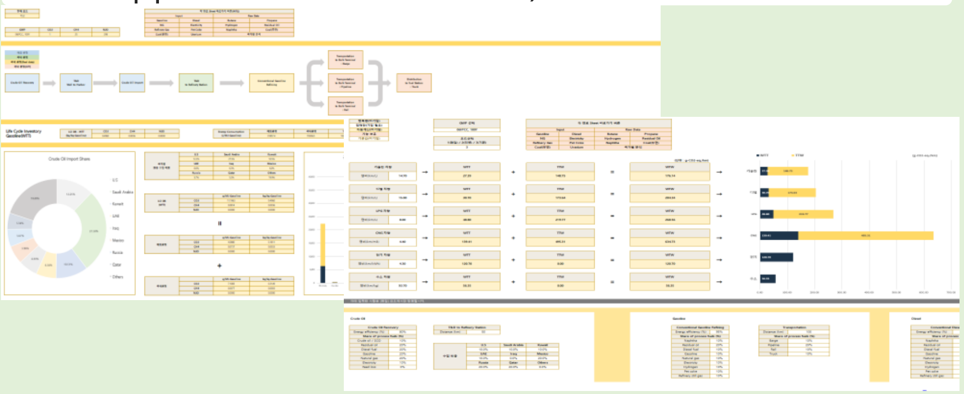
- GSL / DSL / Butane (LPG) / Natural Gas (CNG) / Electricity / Hydrogen
- Well-to-Tank (WTT)

[14 process fuels]

- GSL / DSL / Butane / Natural Gas / Hydrogen / Electricity / Refinery Gas / Residual Oil / Petcoke / Naphtha / Propane / Bituminous Coal / Anthracite / Uranium
- Well-to-Gate (WTG)

[Fuel cycle evaluation scope]

- WTW: WTT + TTW
- TTW Emissions: Currently based on emission factors (later, combined with tailpipe emissions data from Pillar 1)



Fuel cycle evaluation program

Conceptual design for vehicle cycle evaluation

[Calculate mass of material based on curb weight and composition]

- Calculate material mass using generic composition and curb weight for major components
- Mass by Material = Curb weight × Percentage by Material

[Calculate upstream emissions of material]

- Calculate upstream emissions of material using material-specific LCI DB and mass of material
- Upstream Emissions of Material A = Mass of Material A × LCI DB of Material A

[Calculate cradle-to-gate emissions of a vehicle]

- Emissions from materials + emissions from generic parts and vehicle production processes

(Future directions)

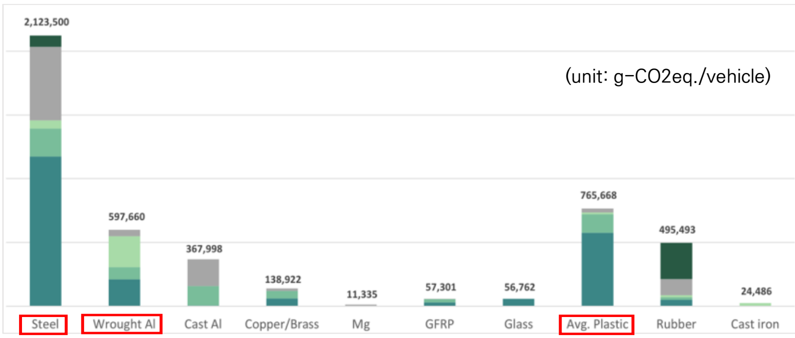
- This is the starting point as a primer to set up a rating scheme.
- The outcome of A-LCA IWG will be adopted to finalize the guideline.
- Better rating results can be possible through workable guideline and thus manufacturers can submit their LCA results for Green NCAP.

3 Research Details of vehicle LCA(Pillar2)

Results of 1st year of R&D project

Advanced LCA-based performance evaluation

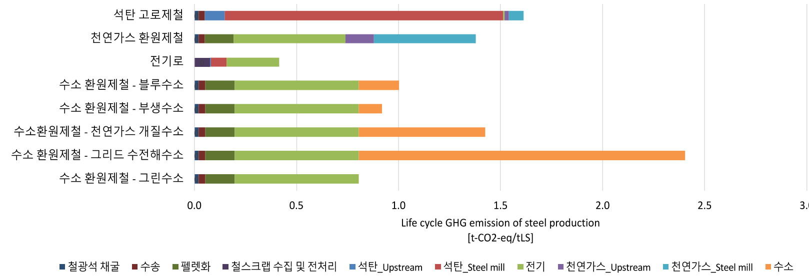
- To evaluate the potential of carbon-reducing material and manufacturing technologies in vehicle cycle emissions, five major materials with the highest GHG emissions over vehicle cycle are chosen.
  1. Steel
  2. Average Plastic
  3. Wrought/Cast Aluminum
  4. Carbon Fiber-Reinforced Plastic
  5. Battery



GHG emissions by materials of ICEV

Vehicle category	ICEV	BEV	FCEV
1st	Steel	Li-ion Battery	Steel
2nd	Average Plastic	Steel	Carbon Fiber-Reinforced Plastic
3rd	Wrought Aluminum	Average Plastic	Average Plastic
4th	Rubber	Rubber	Wrought Aluminum
5th	Cast Aluminum	Wrought Aluminum	Rubber

- Coal-based steel making 〉 Natural gas-based steel making 〉 Hydrogen-based steel making – blue hydrogen 〉 Electric furnace (*Calculated using average generation mix in Korea)
- GHG emissions from hydrogen reduction steel vary widely depending on production methods for hydrogen



- Establishment of an algorithm for analysis of regional and temporal variability of GHG emissions throughout the life cycle of electric vehicles

$$Total\ GHG(t, t_{c,i}, t_{purchase}, r_{charge}, x) = \frac{1}{FE(T(t,x)) \times \beta_{d,D}(D(t - t_{purchase}))} \times$$

Intentionally blocked

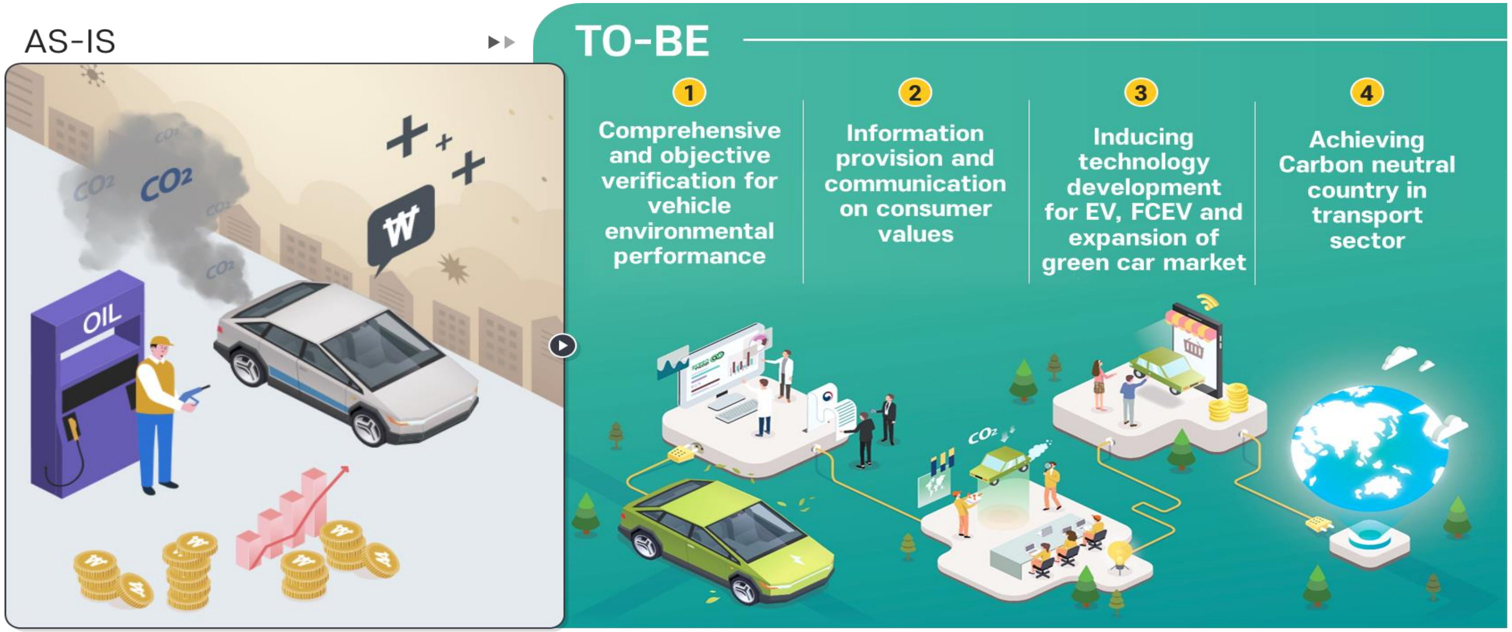
Intentionally blocked

$$\left(\sum_k \left(GHG_{Feedstock,k}' + GHG_{Fuel,k}'\right) Genmix_k(\tau, x)\right) d\tau$$

- ✓ $FE(T(t,x))$: Fuel economy prediction based on the average daily temperature in the area (vehicle information + area information)
- ✓ $\beta_{d,D}\left(D(t - t_{purchase})\right)$: Battery discharge efficiency changes over time (vehicle information)
- ✓ $\frac{1}{\beta_c\left(D'(t - t_{purchase}), C(r_{charge})\right)}$: Battery charge efficiency changes over time after purchase (vehicle information)
- ✓ $\left(\sum_k \left(GHG_{Feedstock,k}' + GHG_{Fuel,k}'\right) Genmix_k(\tau, x)\right)$: Electricity generation mix (grid information) and its lifecycle GHG emissions at a given time in a given region

4 Expectations & Future Plans

Expected To-Be model



Future Plans

Year of research	Year 1	Year 2	Year 3	Year 4	Implementation
	2023	2024	2025	2026	2027~
Phase in	Designing the concept of test procedures and rating system	Developing test procedures and rating system	Validating test procedures and rating system	Running a pilot program and enacting legislation	Implementing and enhancing the system

Development of testing technologies for Korean Green NCAP

Thank you

Q&A