

CHALLENGES and INNOVATION of KIMM

YONG-TAEK IM

President

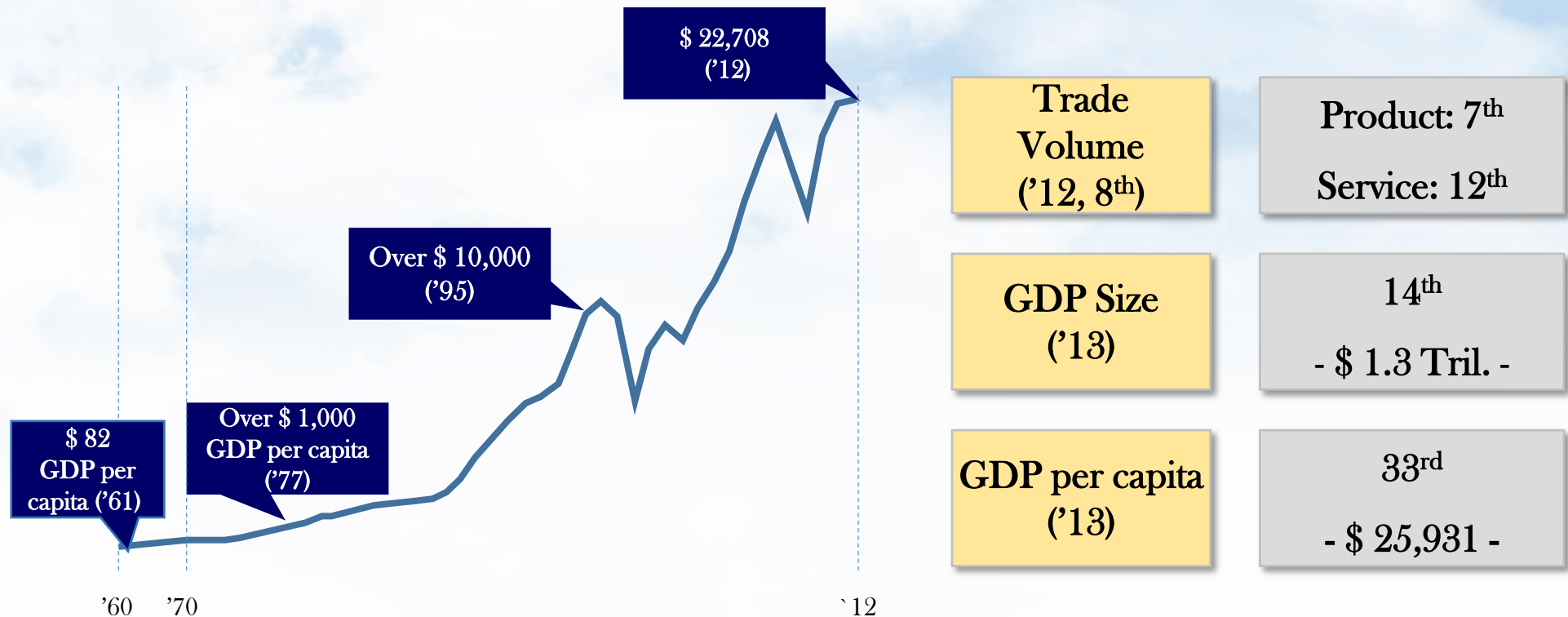
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KIMM KOREA INSTITUTE OF
MACHINERY & MATERIALS

Economic Growth of Korea:

■ A miracle of the Han River:

- Trade Volume¹⁾: 8th in the world (\$ 1.7 Trillion GDP), for the past half-century
- Huge Growth ('63 - '12): GDP (277 times) vs. National R&D Investment²⁾ (18 times)



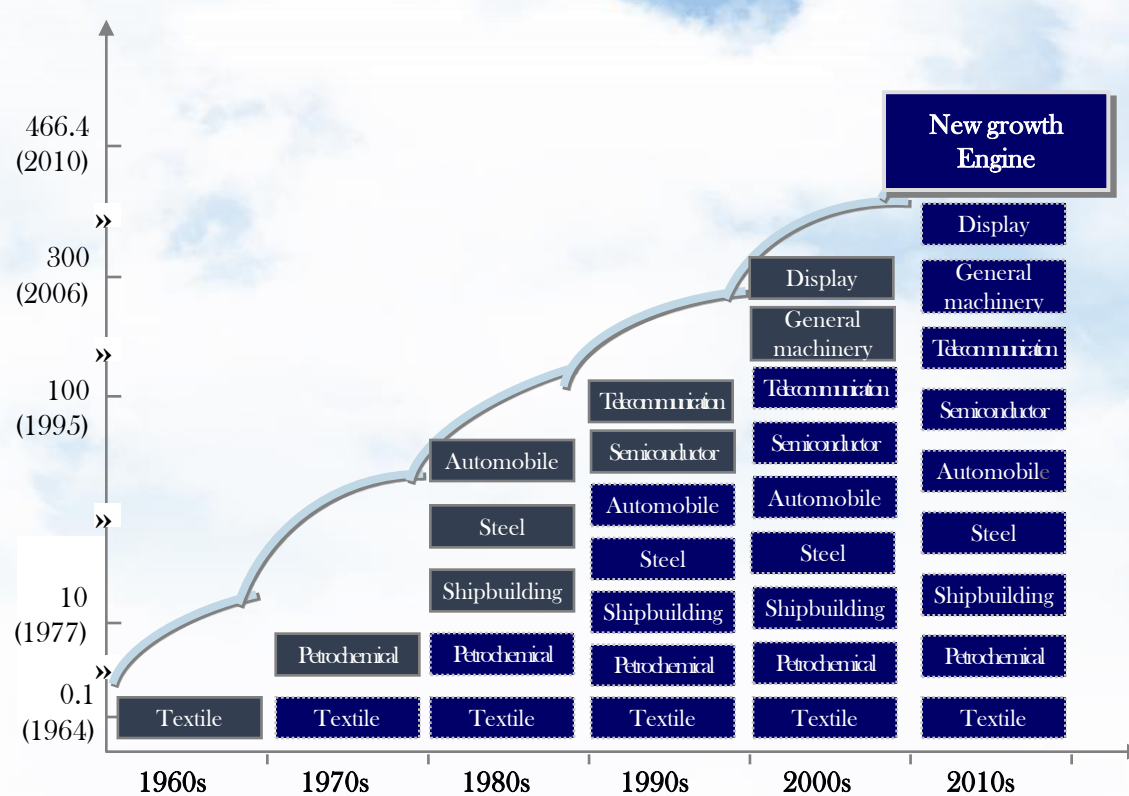
※ Data: KITA (Korea International Trade Association), IMF, etc.

1) As of 2012, WTO

2) National R&D Investment Ratio = National R&D Investment / GDP: 0.24% ('61) → 4.35% ('12)

Evolutions of Korean Industries:

Korean export (Bil. \$)



Government R&D:
Search for
new growth engine
for the nation



Private R&D:
Focus on increasing
the productivity and
efficiency of industries

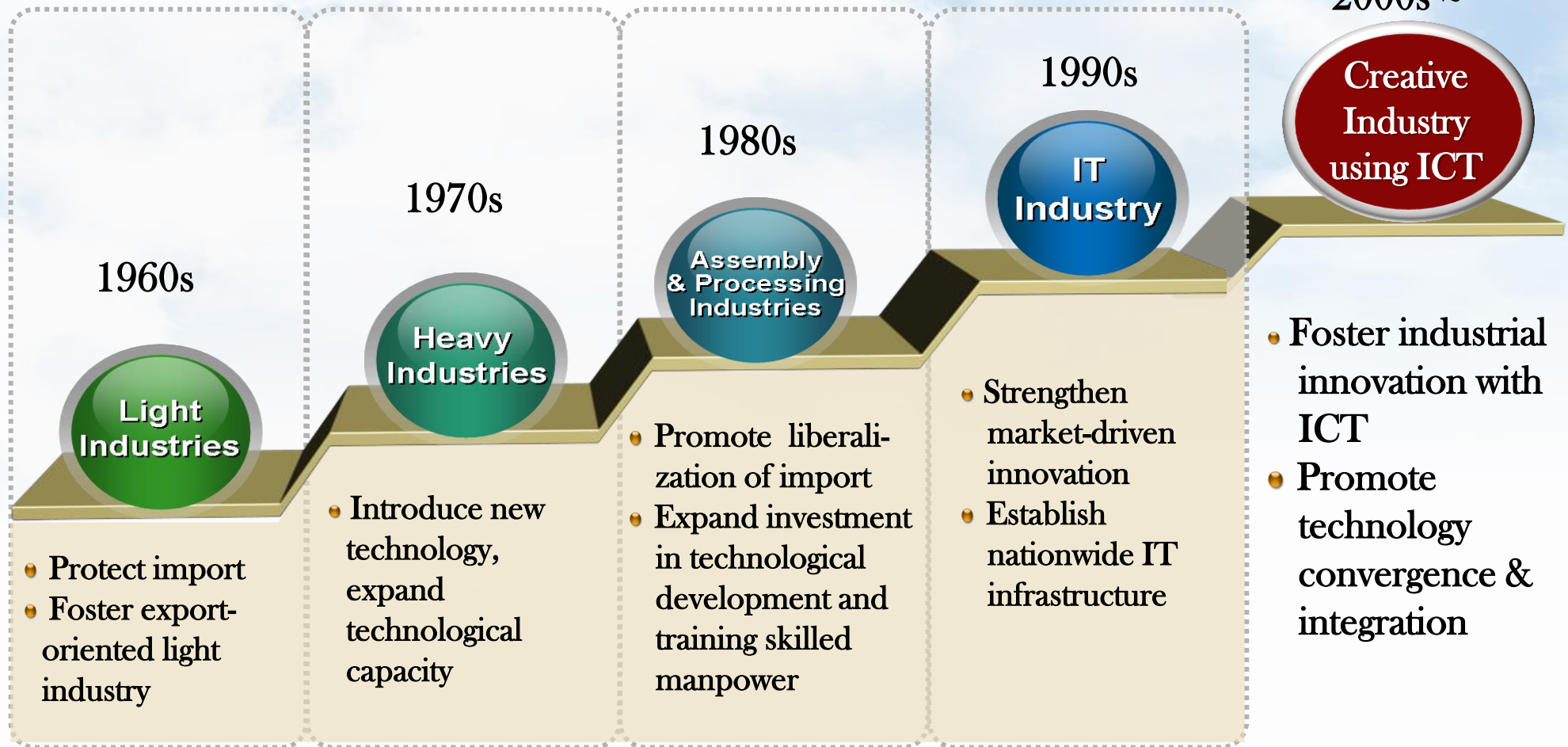
Share of General Machinery & Equipment: (1999) 5.5% → (2012) 6.8%

National S&T Development Plan:

“Planned Economy:
Fast Follower”

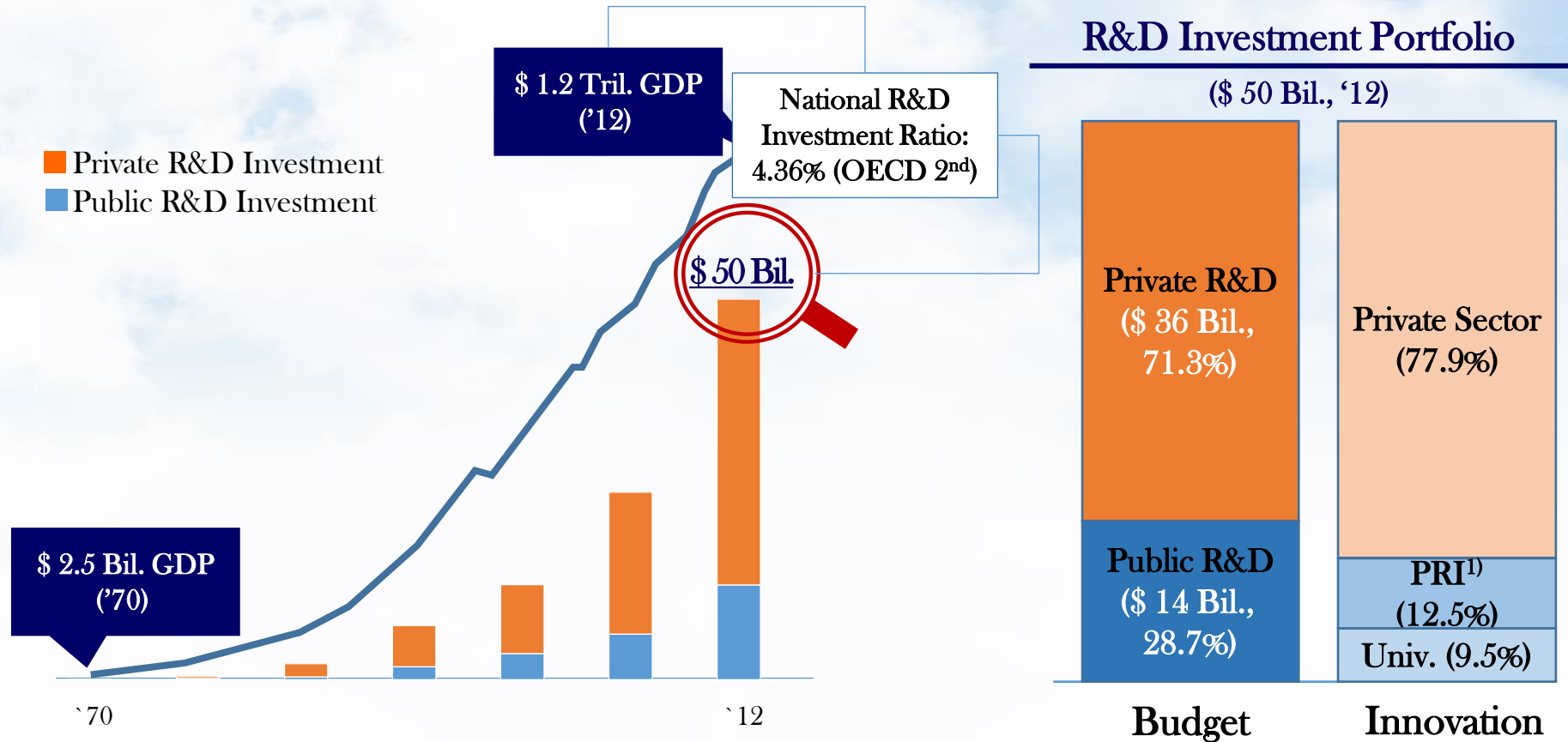
“Creative Economy:
First Mover”

2000s ~



National R&D Investment:

- Economic growth by industrialization through R&Ds
- New roles and mission of the public research institutes (PRI)



※ National R&D project survey report (KISTEP, 2012), etc.

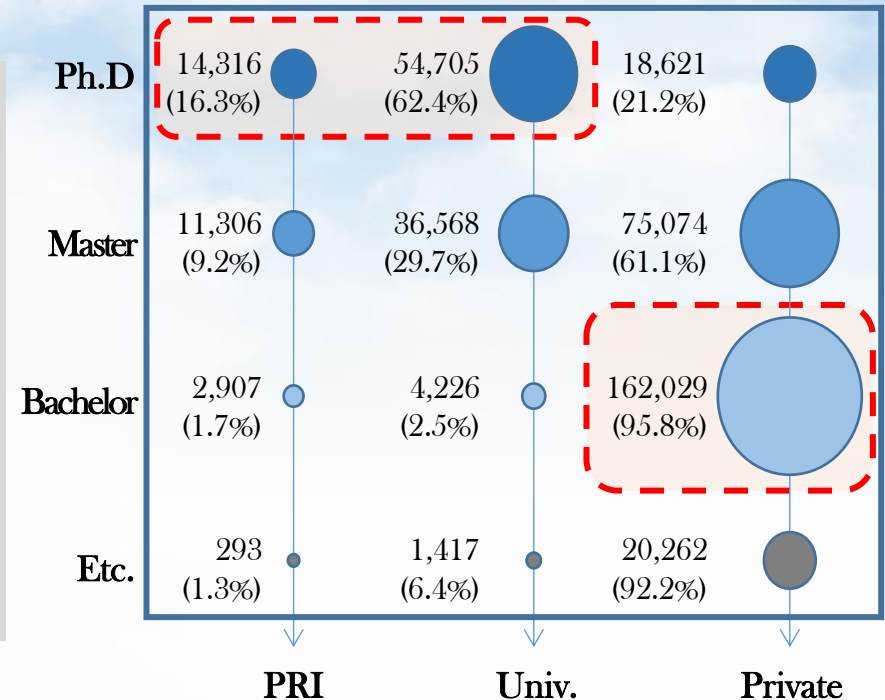
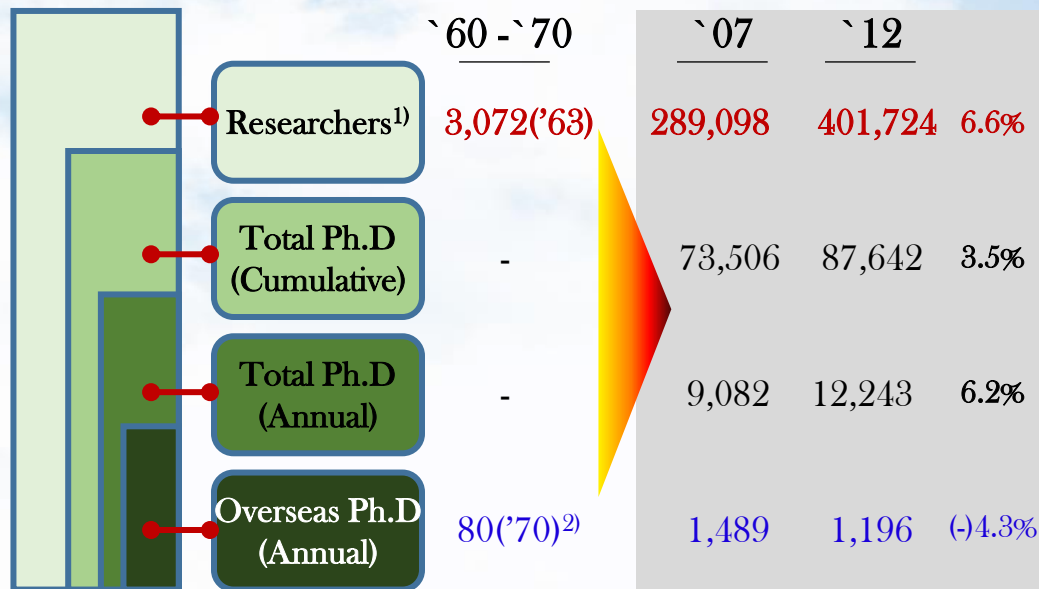
1) PRI: Public Research Institute (PRI), composed of GRI (Government Research Institute) 92% and NRI (National Research Institute) 8%

Change of R&D Manpower:

■ Over 400,000 research scientists in 2012 (6th in the world)

- Around 130 times increase compared to 1963: 3,072 ('63) → 401,724 ('12)

Statistics of Research Scientists



※ Data: NTIS, National R&D project survey report (KISTEP, 2012), etc.

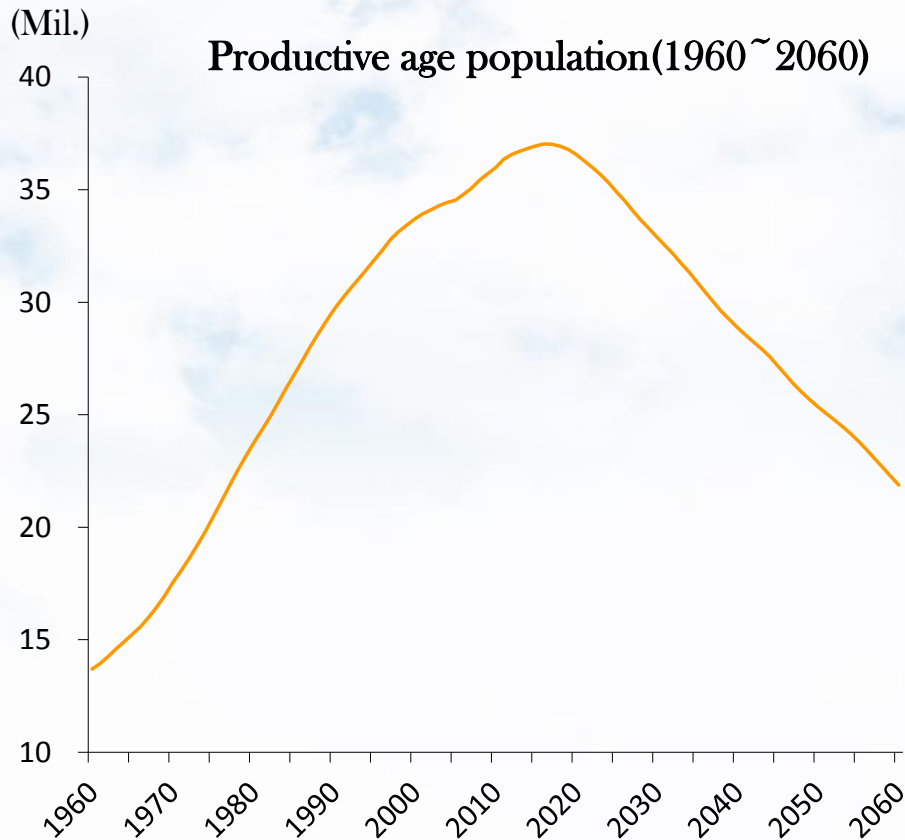
1) Exception: Research assistants (Total researchers: 562,601 persons, including research assistants)

2) Ph.D. from overseas: 29 persons in 1965, 80 persons in 1970

Socio-economic Changes:

■ Labor shortage due to birth rate drop

■ Decrease of number of students majored in natural sciences or engineering



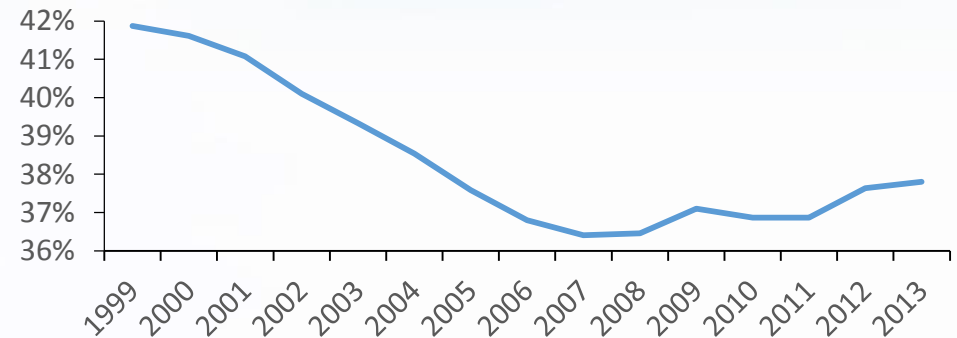
Source: Statistics Korea

Performance in mathematics: 554
5th in the world, 1st in OECD (avg.: 490)

Percentage of adults (25 - 34 yrs old)
who have attained tertiary education: 66%
1st in OECD (avg.: 39%)

BUT,

Share of admission in natural sciences or engineering



Source: Korean Educational Statistics Service

Changes of Mission & Roles of GRIs Worldwide:

OECD (1989)

- Implement strategic and public mission for government
- Develop long-term national R&D assets (knowledge and human resources)
- Establish and apply R&D infrastructure for public domain (defense and environmental sector, etc.)

ITIF, Center for American Progress, and Heritage Foundation (2013)

- Develop a specific capability or meet a national interest that is not available in the private sector
- Carry out complex & multidisciplinary research for national science initiatives that private sector is unwilling to engage with and universities are often incapable of undertaking

Source: OECD(1989), The Changing Role of Government Research Laboratories, Paris., ITIF, Center for American Progress, and Heritage Foundation (2013), 'Turning The Page Reimagining The National Labs In The 21st Century Innovation Economy'

Comparison of Models of GRIs:

	Fraunhofer, Germany	National Lab., USA	GRI, Korea
Foundation	<ul style="list-style-type: none"> Non-profit organization funded by Local Government 	<ul style="list-style-type: none"> Established and funded by federal government 	<ul style="list-style-type: none"> Established and funded by government
Mission	<ul style="list-style-type: none"> Advancement of applied research for economic growth and social development 	<ul style="list-style-type: none"> Mission-oriented research for the public interest 	<ul style="list-style-type: none"> Mission-oriented research for economic growth and basic science
Governance	<ul style="list-style-type: none"> Gesellschaft (alliance strategy) 	<ul style="list-style-type: none"> Government owned, contractor operated (GOCO) 	<ul style="list-style-type: none"> Government owned, government operated (GOGO)
Funding	<ul style="list-style-type: none"> Public & private 	<ul style="list-style-type: none"> Mainly public 	<ul style="list-style-type: none"> Public & private

Source: OECD(1989), The Changing Role of Government Research Laboratories, Paris.

Changes of Roles of GRIs in Korea:

1960 - 70s : Test, evaluation, inspection, ...

1980 - 90s : Domestic production and establishment of R&D infrastructure, ...

R&D

2000s - : Technology convergence, ...

Future : ?

- R&D Collaboration and convergence among PRIs
- Development of key or core technologies for industry
- Technology for social infrastructure

Development of private R&D capabilities

Negative publicity for roles and competence of GRIs

Efficient distribution of national R&D budget

New R&D governance of GRIs

- International cooperation with advanced R&D institutions
- Challenge for global problems
- Market-driven research

External environment

Management

New Governance of GRIs in Korea:

- National Research Council of Science & Technology (NST) was established in 2014 to improve the research productivity of GRIs
- 25 institutes
- 16,457 research scientists (including part-time researchers: 5,624)
- 4,428M US\$ research budget (Government-supported contribution: 43%)



Mission and Goal of KIMM:

Mission:

To contribute to economic growth of the nation by performing R&D on key technologies in machinery and materials, conducting reliability test evaluation, and commercializing the developed products and technologies

Goal:

To become a global research institute in the field of mechanical engineering by introducing a new governance system to foster knowledge, innovation, motivation, and marketability, resulting in improving the research productivity and capability

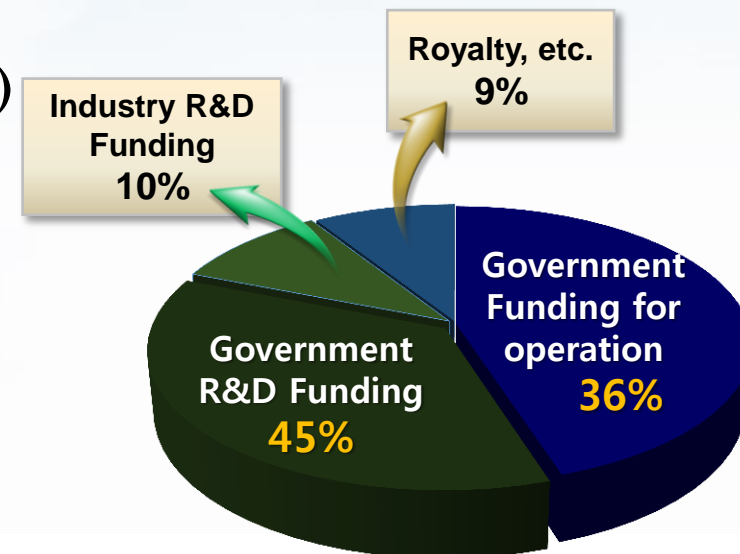
Overview of KIMM:

History:

- 1976, Founded as the Korea Test Institute of Machinery & Metals
- 1996, Spin-off: KARI (Aerospace)
- 1999, Spin-off: KORDI (Ocean)
- 2007, Subsidiary: KIMS (Materials)

Personnel & Budget:

- Employee (FT): 344 (Ph.D: 255 (74%), MS: 55 (16%))
- Employee (PT): 230 (Ph.D: 42 (18%), MS: 77 (33%))
- Budget ('14): 149M USD



Advanced Manufacturing Systems:

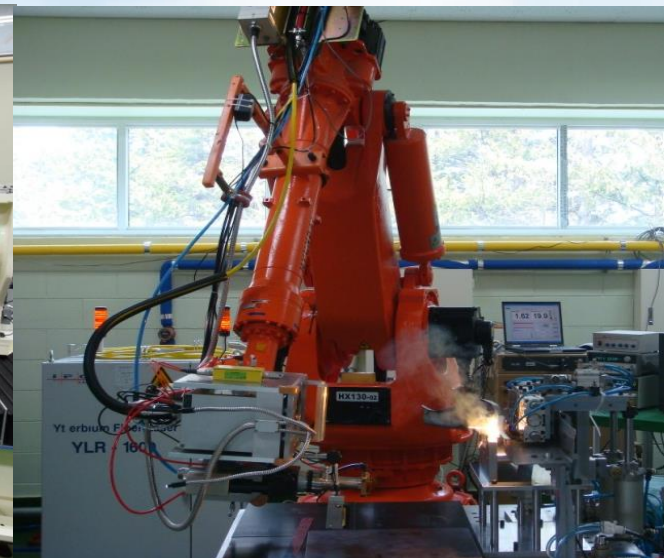
- Ultra-Precision Machines and Systems
- Laser & Electron Beam Application
- Printed Electronics
- Robotics and Mechatronics



Gravure-offset Printed Silver Grating



Precision Pitch Line-Patterning



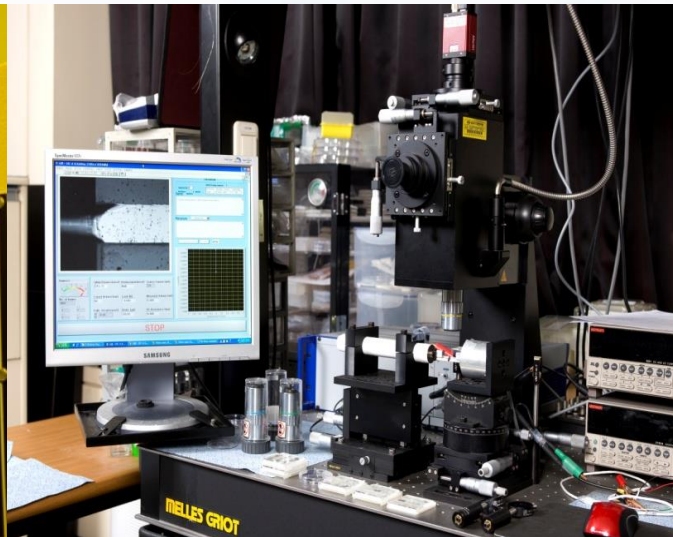
Remote Laser Processing

Nano-Convergence Mechanical Systems:

- Nano Manufacturing Technology
- Nano Mechanics
- Nature-Inspired Nano Convergence System



Nano-imprint Lithography System



Nano-mechanical Testing



Nature-inspired Mechanical System

Environment & Energy Systems:

- Eco-Engineering System
- Internal Combustion Engine
- Plant Safety Engineering
- Reliability Engineering for Nuclear Equipments



Gaseous Fuel Injection System



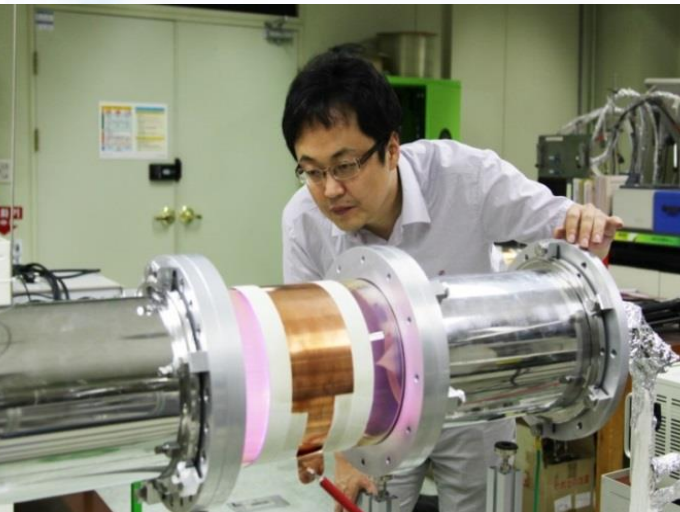
Oxyfuel Combustion Power Plant



Reliability Evaluation for Nuclear Equipment

Extreme Mechanical Systems Engineering:

- Plasma Engineering
- Extreme Energy Systems Engineering
- Extreme Thermal Systems Engineering



Industrial Plasma Tech.



Ground Pilot for Geologic Storage of CO₂



Hydraulic Design Tech. for RCP

Mechanical Systems Safety:

- System Dynamics
- System Reliability
- Magnetic Levitation and Linear Drive



Modeling & Simulation for
Mechanical Systems



Wind Power Accelerator System



Magnetic Levitation Train

Regional R&D Centers:

- Medical Devices and Green Energy (Daegu)
- Laser Technologies (Busan)
- LNG and Cryogenic Technology (Gimhae)



Active/smart robot for upper-limb stroke rehabilitation



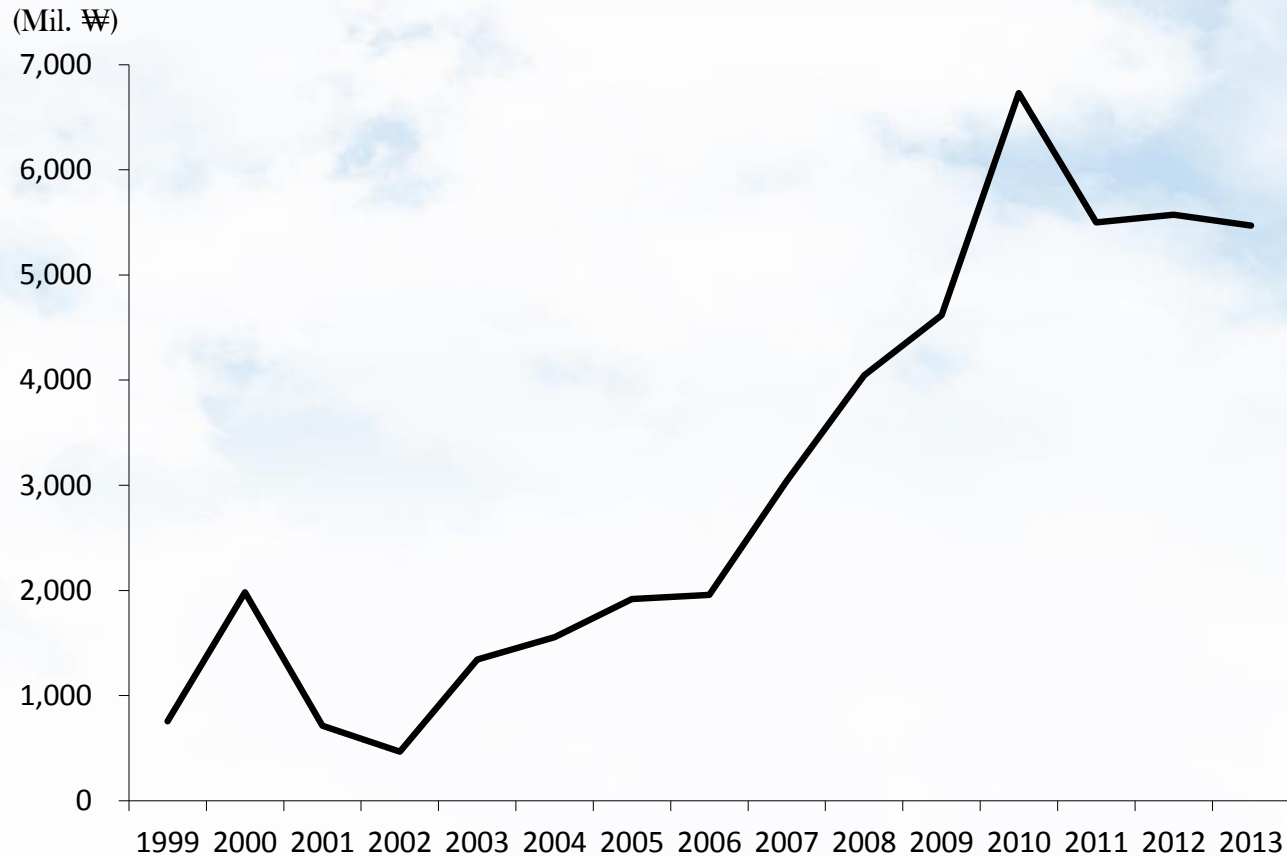
Aerial View &
Laser Welding Systems



LNG and Cryogenic Test Facility

Technology Transfer:

License-fees



Spin-off Companies

TEMS Co. Ltd.

DI Tech Co. Ltd

SelfTech Co. Ltd.

NEI Co. Ltd.

JPE Co. Ltd.

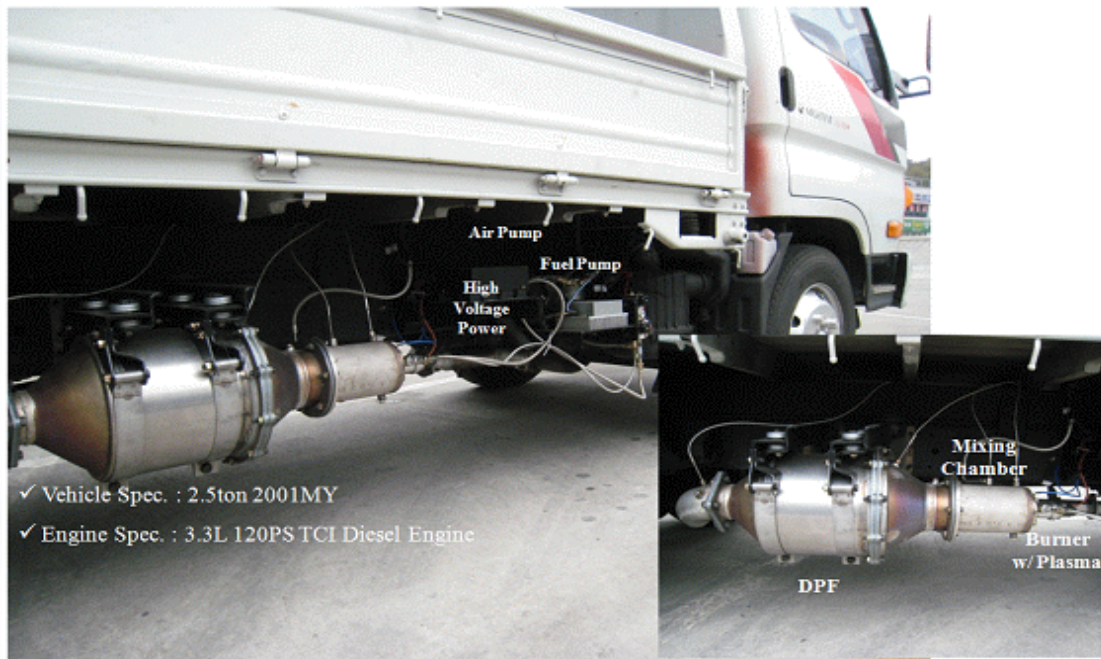
Major Accomplishment: EcoBee

World's 2nd Commercialized Urban Maglev:

- Commercial Service at the Incheon Int'l Airport (6.1km) to be expected soon
 - MOU with Gordon Atlantic Co. for the service in the State of Leningrad in Russia
- Eco-friendliness with low noise, low vibration and no pollutants
 - No risk of derailment or electromagnetic hazard
 - Low maintenance and operation costs



Plasma Burner and Reactor (continued):



Plasma assisted burner for regenerating DPF (Diesel Particulate Filter)



Plasma reactor for abatement of PFCs gases emitted from the semiconductor manufacturing process

Challenges:

■ Renovation of the Internal R&D Operating System:

- Promotion of Flagship Projects
- Increase of World Class Leading Edge Research Groups

■ Globalization:

- Promotion of Global Network and Working Environment
- Global Commercialization of Maglev and Sharing the Experiences

■ Improvement of Public & Laboratory Safety:

- Enhancement of Laboratory Safety

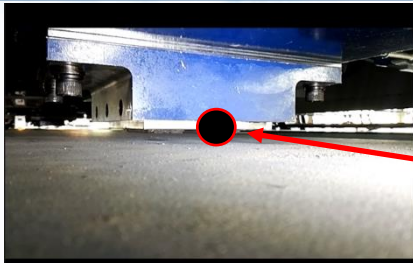
■ Increase of the Research Productivity (royalty income / R&D budget):

- 6.6% (2013) → 7.6% (2017)

Innovation: High-Speed Magnetic Vehicle Technology

KIMM's Technologies

- Magnetic Levitation Vehicle:**
- Stable Levitation Control (10mm)
 - Lighter and Reliable Vehicle



10mm

Levitation Control



Test Magnetic Vehicle(2014.10.)

Applications

Super High-Speed Transportation:

- Max. operating speed: 500km/h
- Inter-City/State/National Link



Status

Test Vehicle Built:

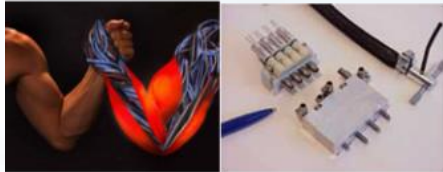
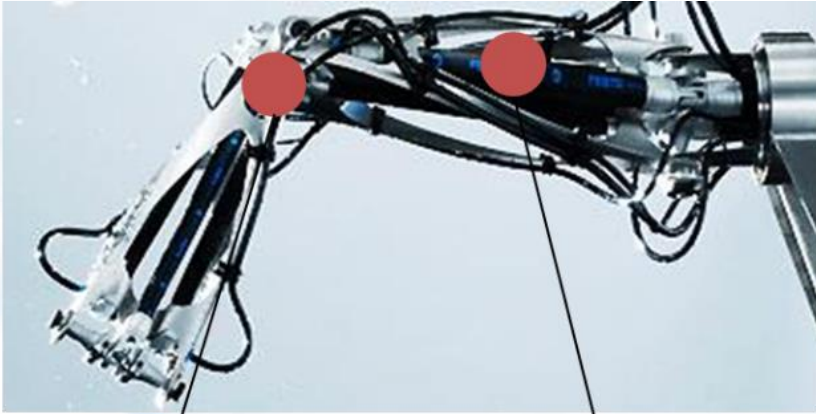
- Design Speed: 550km/h
- Running Tests

Features

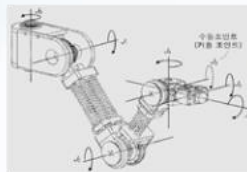
Vehicle without wheels:

- Eco-friendliness
- Higher Efficiency
- Cost Effectiveness

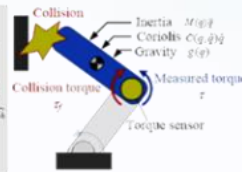
Innovation: Industrial Robot and Medical Devices



**High power density
artificial muscle module**



**Low power actuator
using elastic mechanism**



Needle type master robot



Ankle-foot prosthesis



Personal mobility vehicle

Innovation: Meta Materials Research

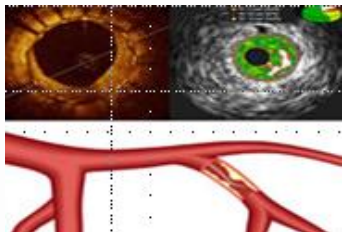
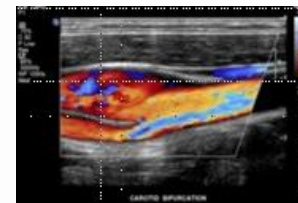
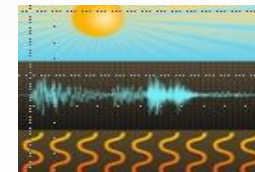
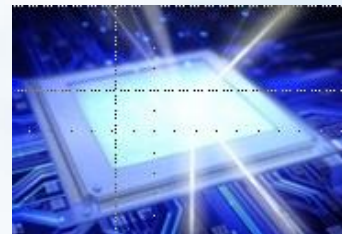
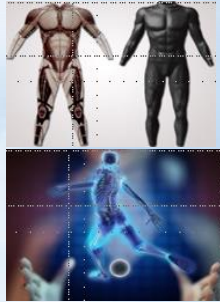
National Research Center for Wave Energy Control:

■ Global Frontier Project:

- Funded by the Korean Research Foundation (111M US\$)
- Period: 2014-2022 (9years)

■ Meta Materials System Engineering (MMSE) based on the control of electromagnetic & magneto-hydrodynamic wave energy:

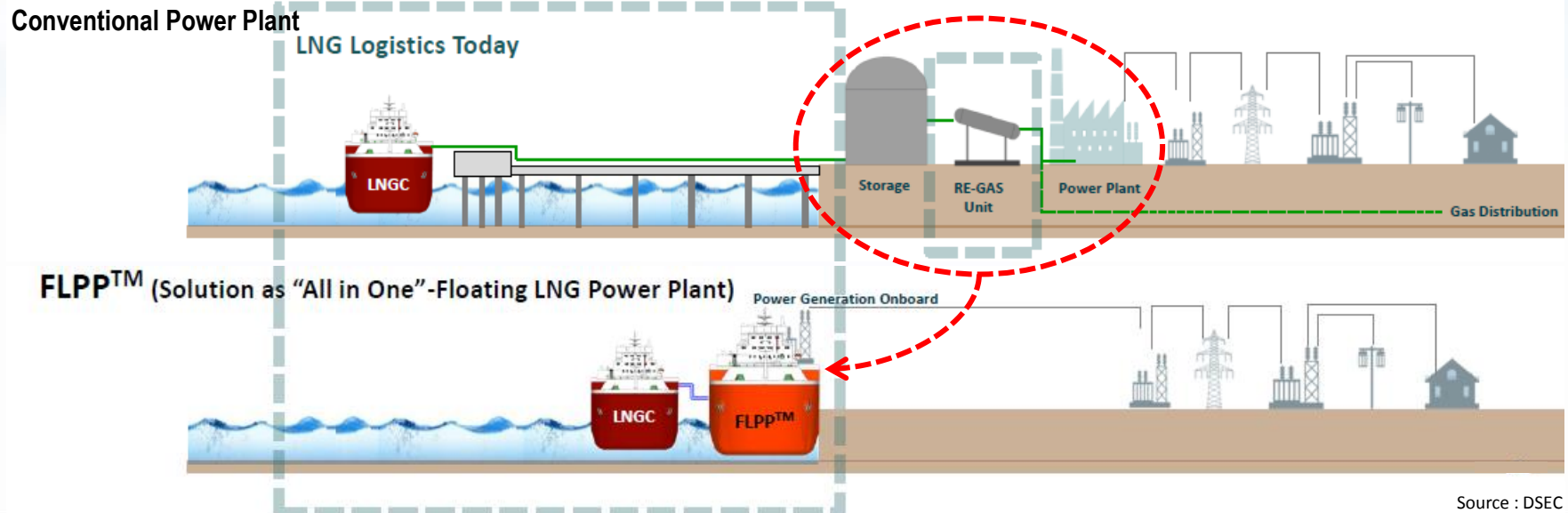
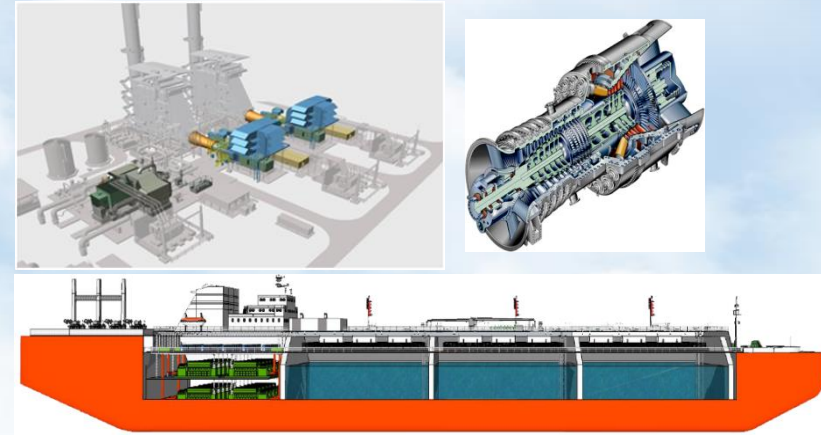
- Convergence with Machinery
(MMSE of electromagnetic & magneto-hydrodynamic wave + Machine industry)
- Convergence with Information & Communication Technology
(MMSE of electromagnetic wave + ICT industry)
- Convergence with Energy Technology
(MMSE of electromagnetic & magneto-hydrodynamic wave + Renewable energy)
- Convergence with Bio/Medical Technology
(MMSE of electromagnetic & magneto-hydrodynamic wave + Next-generation bio/medical industry)



Innovation: Floating Power Plant

Combined cycle power plant (100 - 1,000MW) with LNG storage tanks and regasification unit:

- Environmentally friendly: 40% CO₂ reduction
- High flexibility: location-free, NIMBY-free
- Fast track: 30months from EPC contract



Source : DSEC

Institutional Spirit Building:

Knowledge: technology development for future needs

Innovation: value creation by integrating and convergence

Motivation: development of interactive culture for better communication and harmony

Marketability: market-oriented R&D



Thank you!