



CHALLENGES and INNOVATION of KIMM

YONG-TAEK IM

President

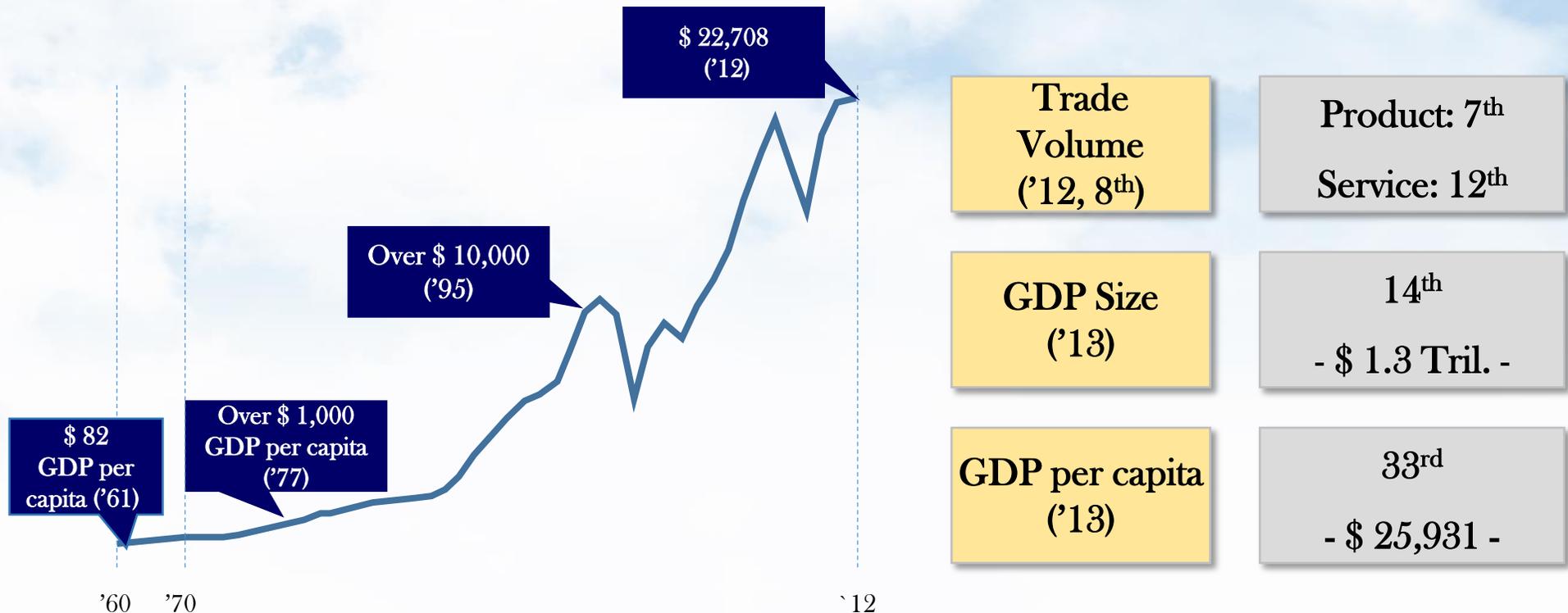
ytim@kimm.re.kr

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)



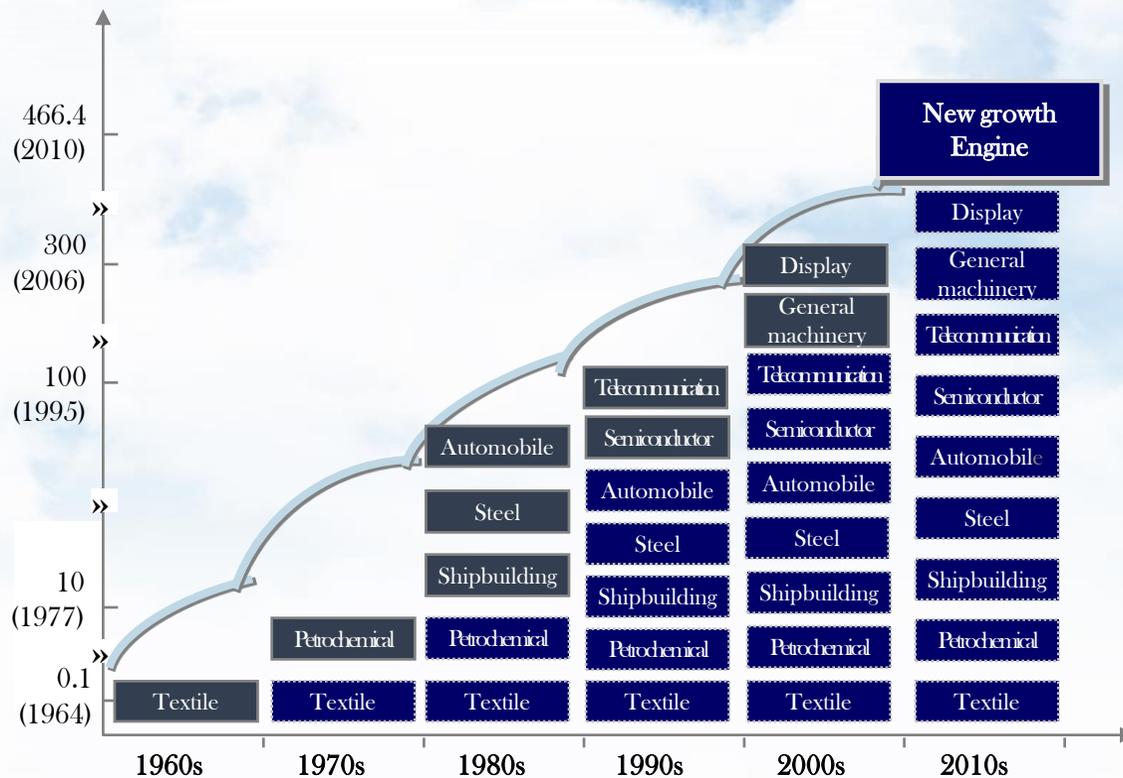
※ Data: KITA (Korea International Trade Association), IMF, etc.

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%

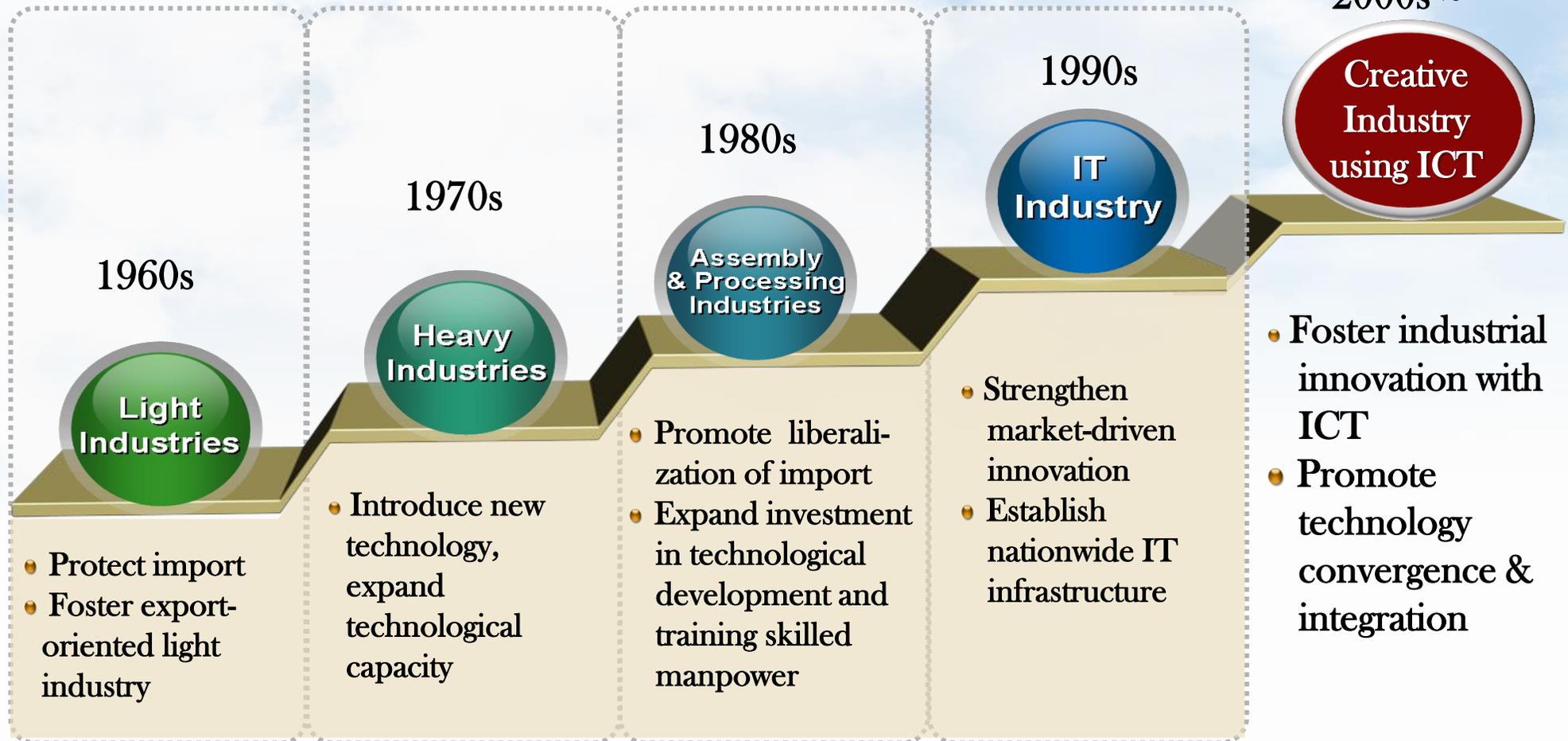
National S&T Development Plan:

“Planned Economy:
Fast Follower”



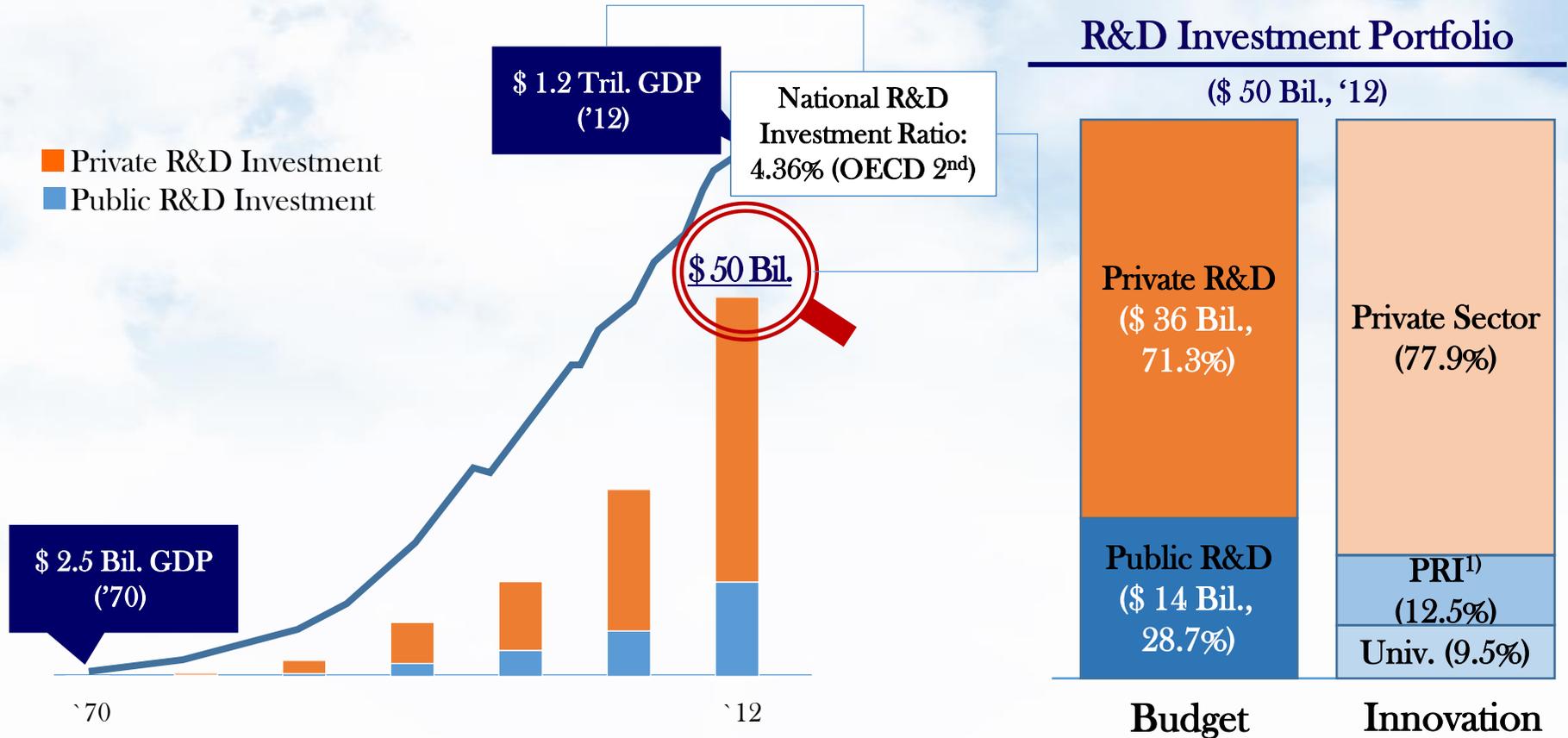
“Creative Economy:
First Mover”

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.

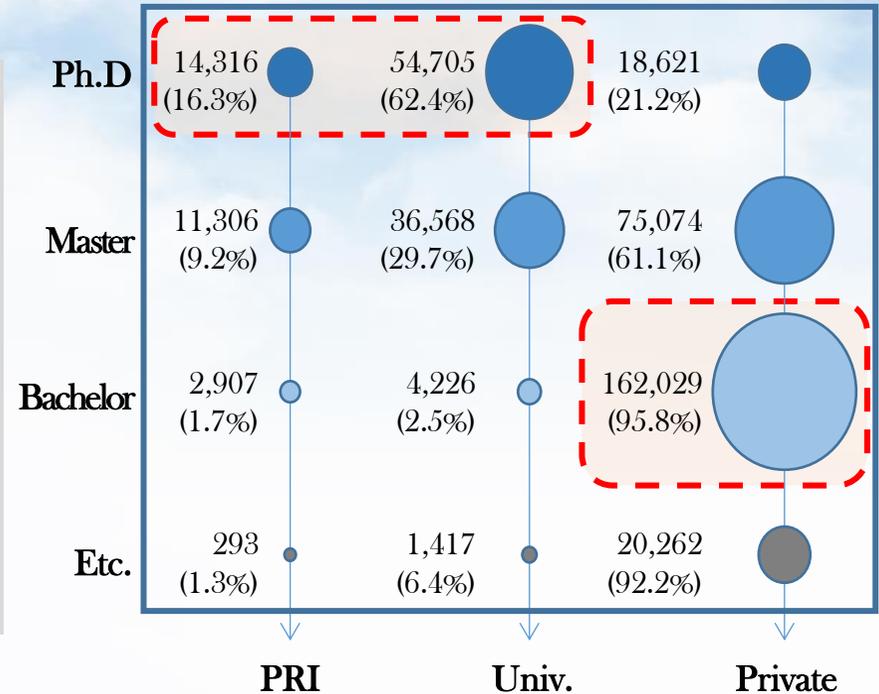
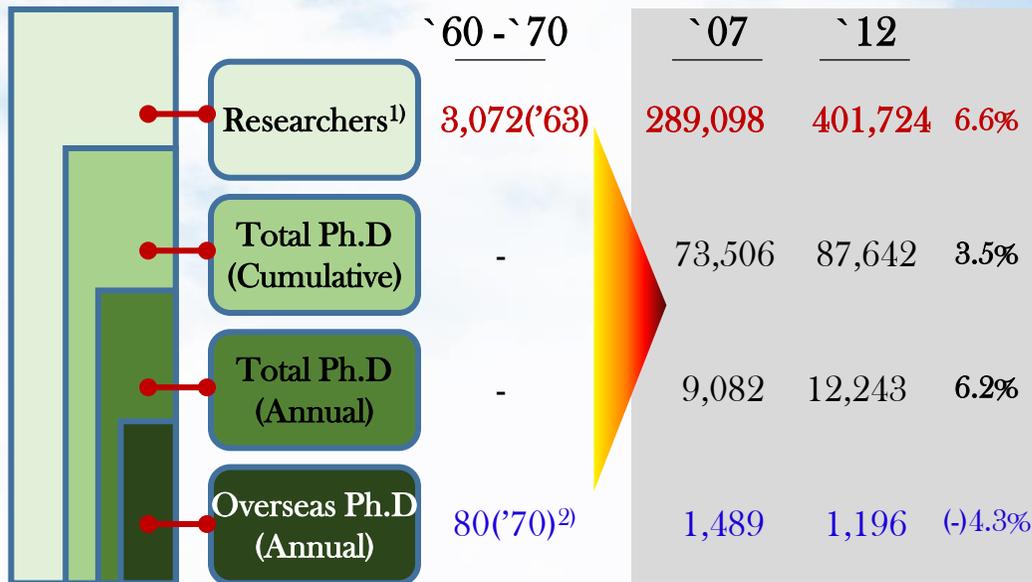
1) PRI: Public Research Institute (PRI), composed of GRI (Government Research Institute) 92% and NRI (National Research Institute) 8%

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.

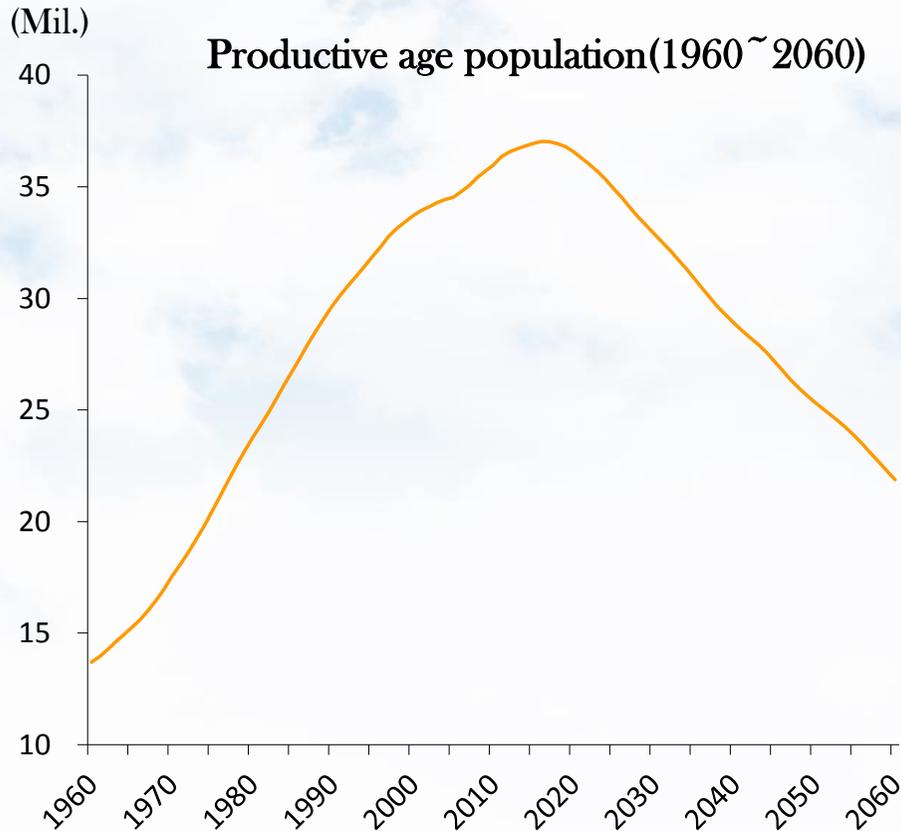
1) Exception: Research assistants (Total researchers: 562,601 persons, including research assistants)

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



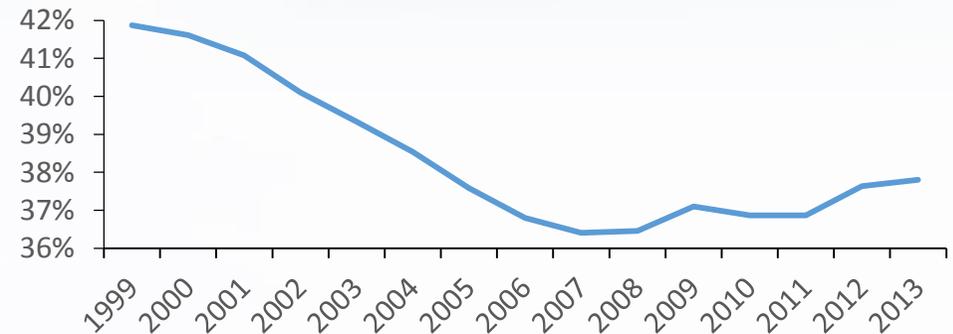
Source: Statistics Korea

■ 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

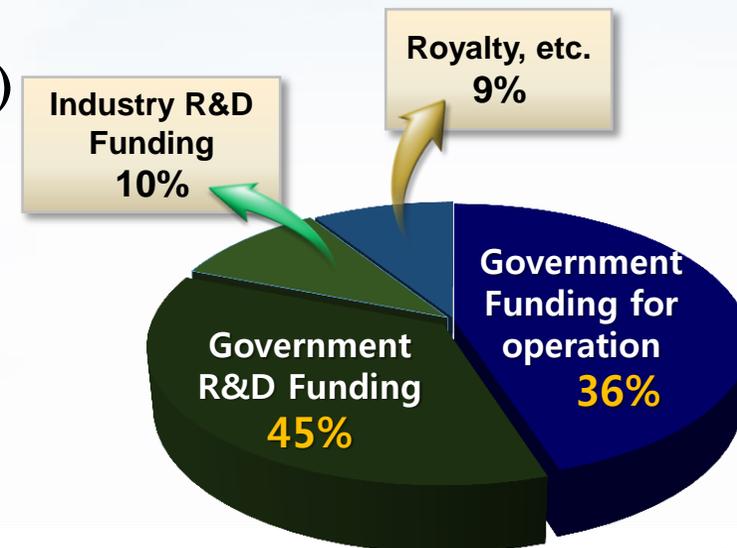
Overview of KIMM:

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:

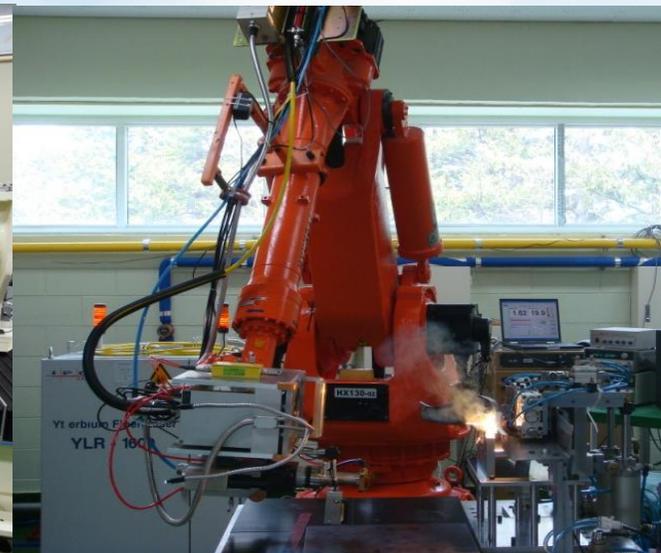
- Ultra-Precision Machines and Systems
- Laser & Electron Beam Application
- Printed Electronics
- Robotics and Mechatronics



Gravure-offset Printed Silver Grating



Precision Pitch Line-Patterning



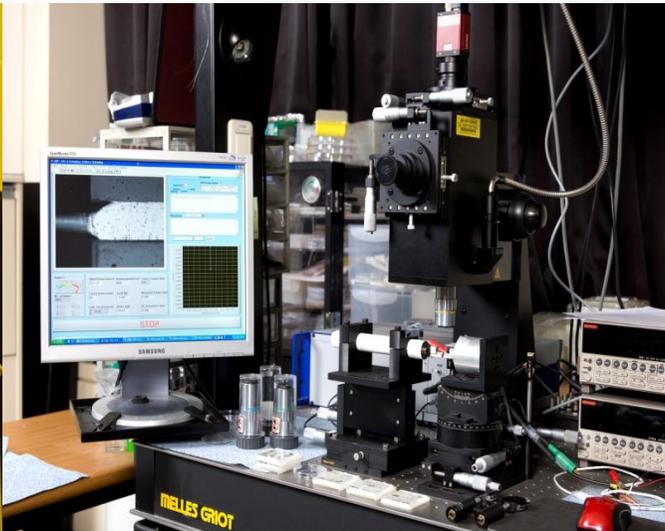
Remote Laser Processing

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



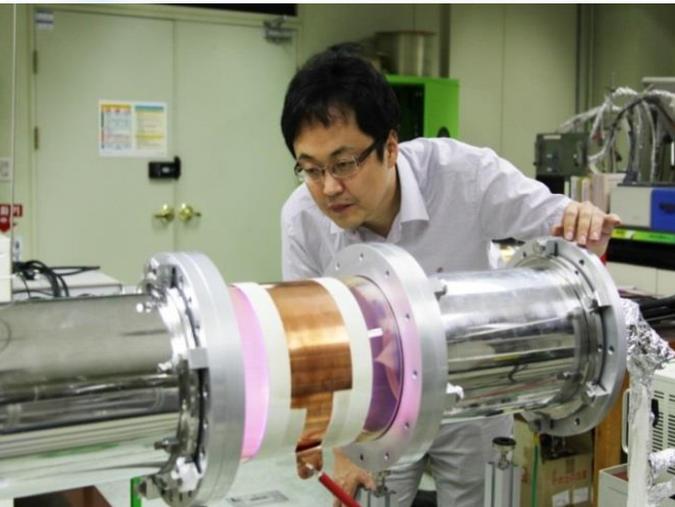
Oxyfuel Combustion Power Plant



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



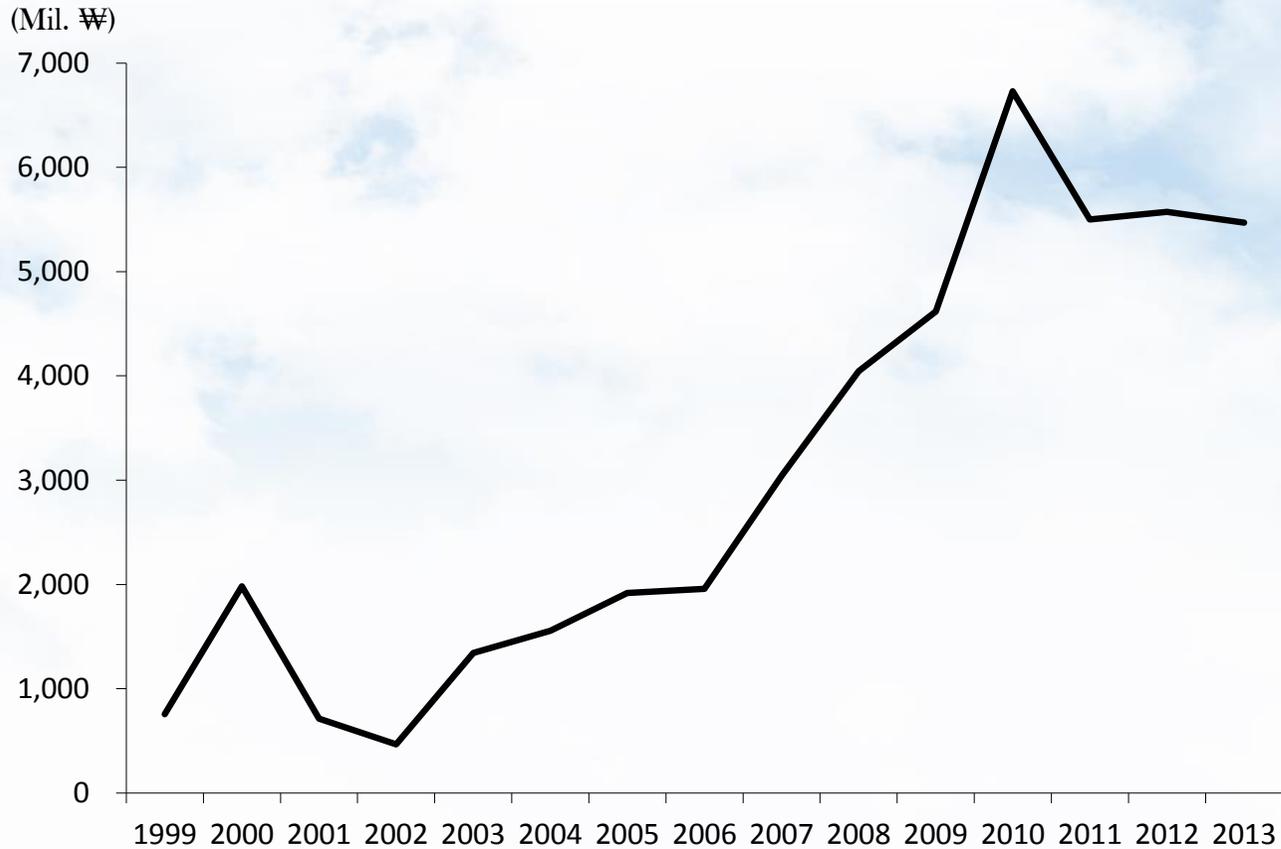
Aerial View & Laser Welding Systems



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



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):

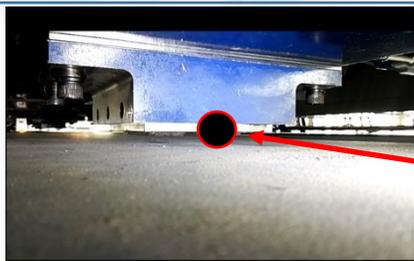
- 6.6% (2013) → 7.6% (2017)

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:

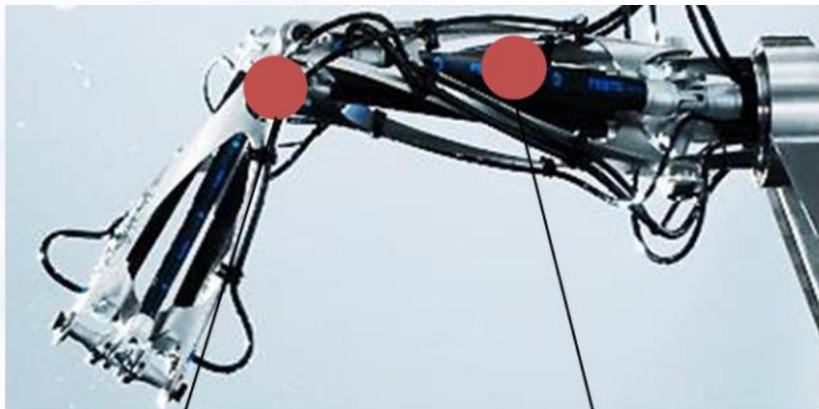
- Design Speed:550km/h
- Running Tests

Features

Vehicle without wheels:

- Eco-friendliness
- Higher Efficiency
- Cost Effectiveness

Innovation: Industrial Robot and Medical Devices



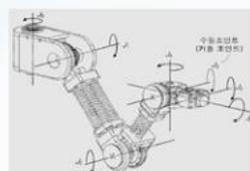
Needle type master robot



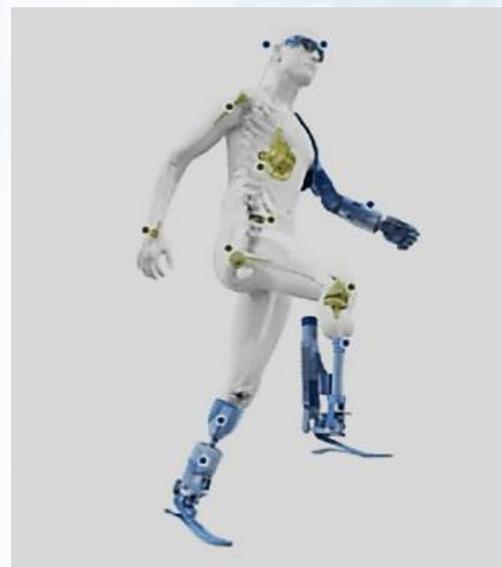
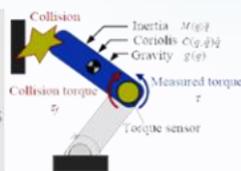
Personal mobility vehicle



High power density artificial muscle module



Low power actuator using elastic mechanism



Ankle-foot prosthesis

Innovation: Meta Materials Research

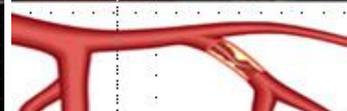
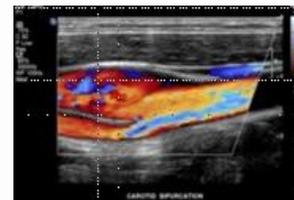
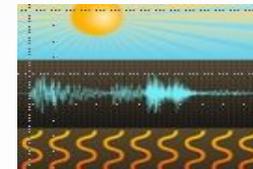
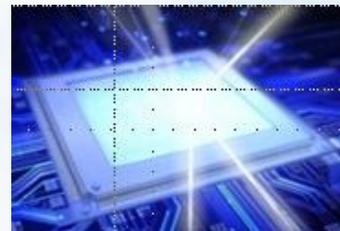
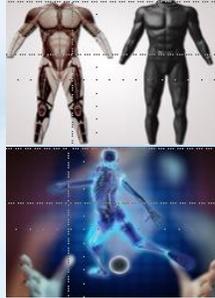
National Research Center for Wave Energy Control:

■ 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:

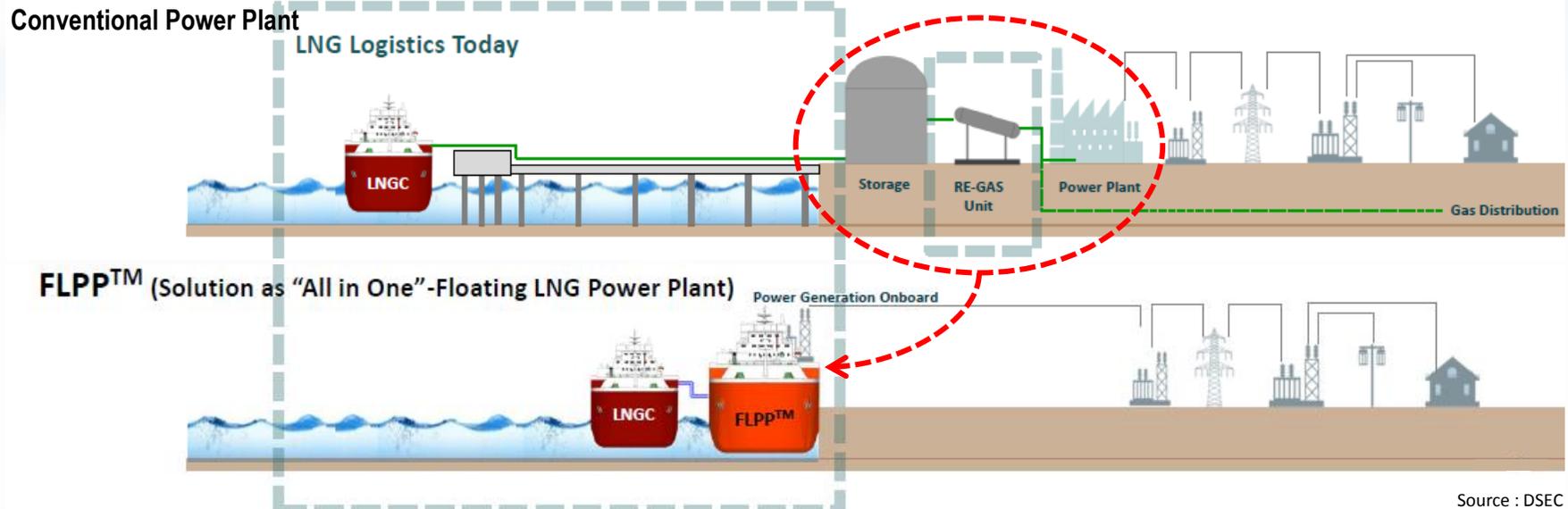
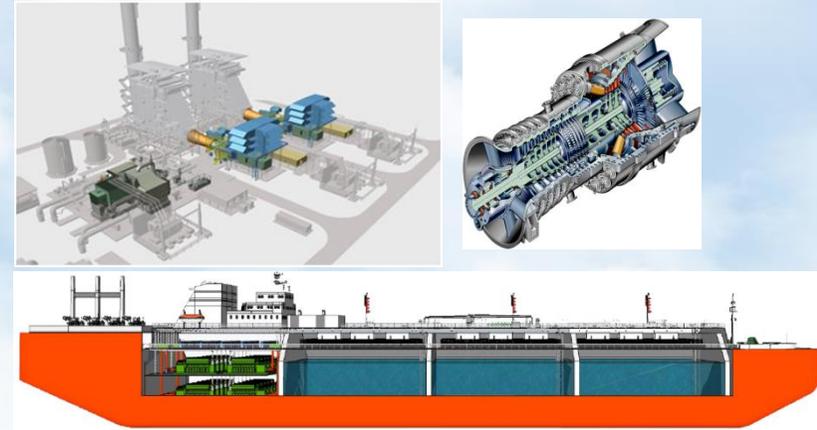
- Convergence with Machinery
(MMSE of electromagnetic & magneto-hydrodynamic wave + Machine industry)
- Convergence with Information & Communication Technology
(MMSE of electromagnetic wave + ICT industry)
- Convergence with Energy Technology
(MMSE of electromagnetic & magneto-hydrodynamic wave + Renewable 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: 30 months 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!