Nano-Innovation in Korea 2025

National Nanotechnology Initiative Program of Korea(NNI-K)

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and

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Ministry of Science, ICT and Future Planning

I Introduction

II Nano-Innovation in Korea 2025

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1 Introduction

Historical Perspectives on,

(a) Growth of Korea from 1960-2012
(b) Growth of Nanotechnology Activity in Korea
(c) Summary of Key Achievements during the last 15 years

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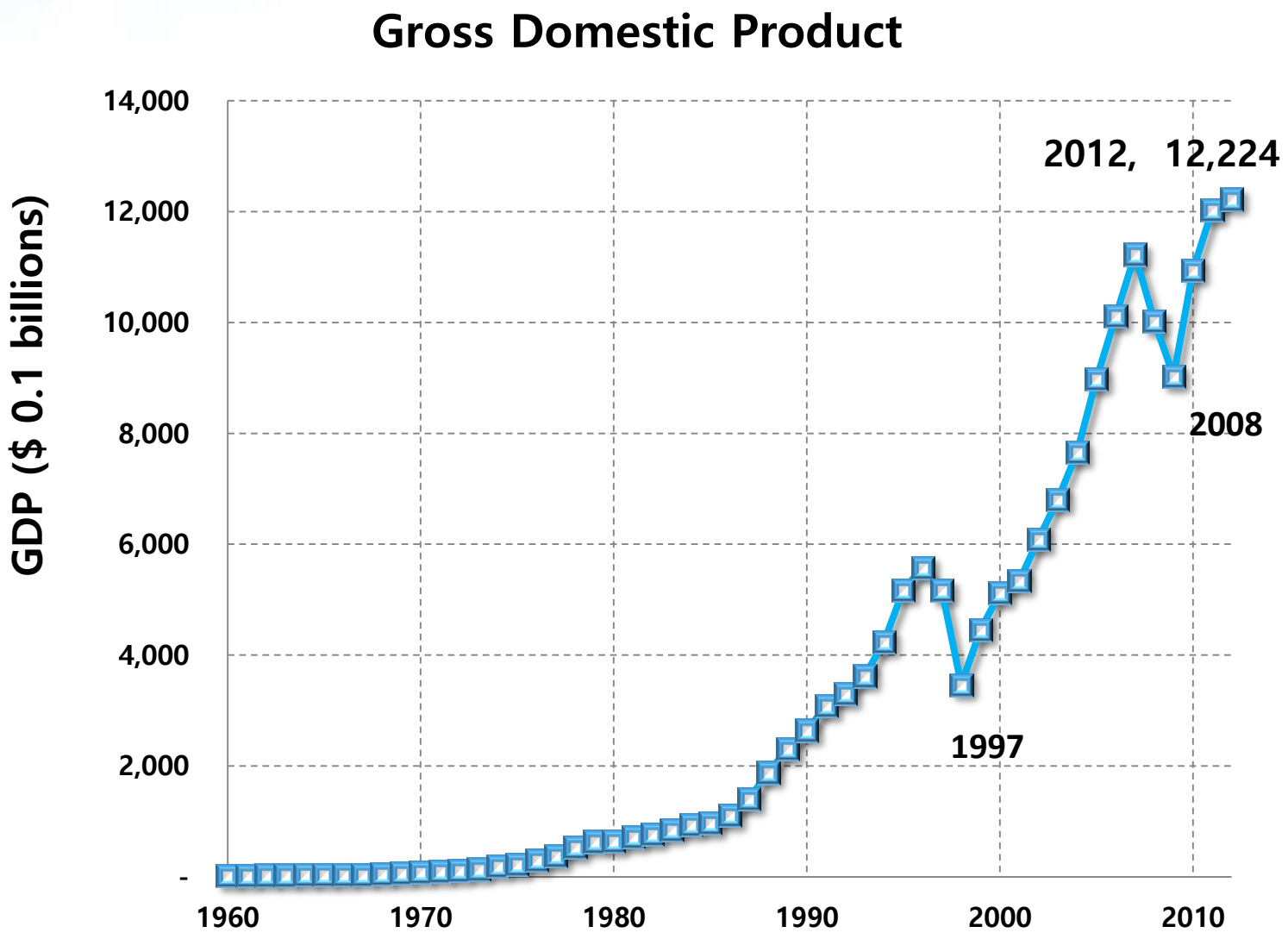
1. History of Korea Growth (1960 – 2012)



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http://kosis.kr/

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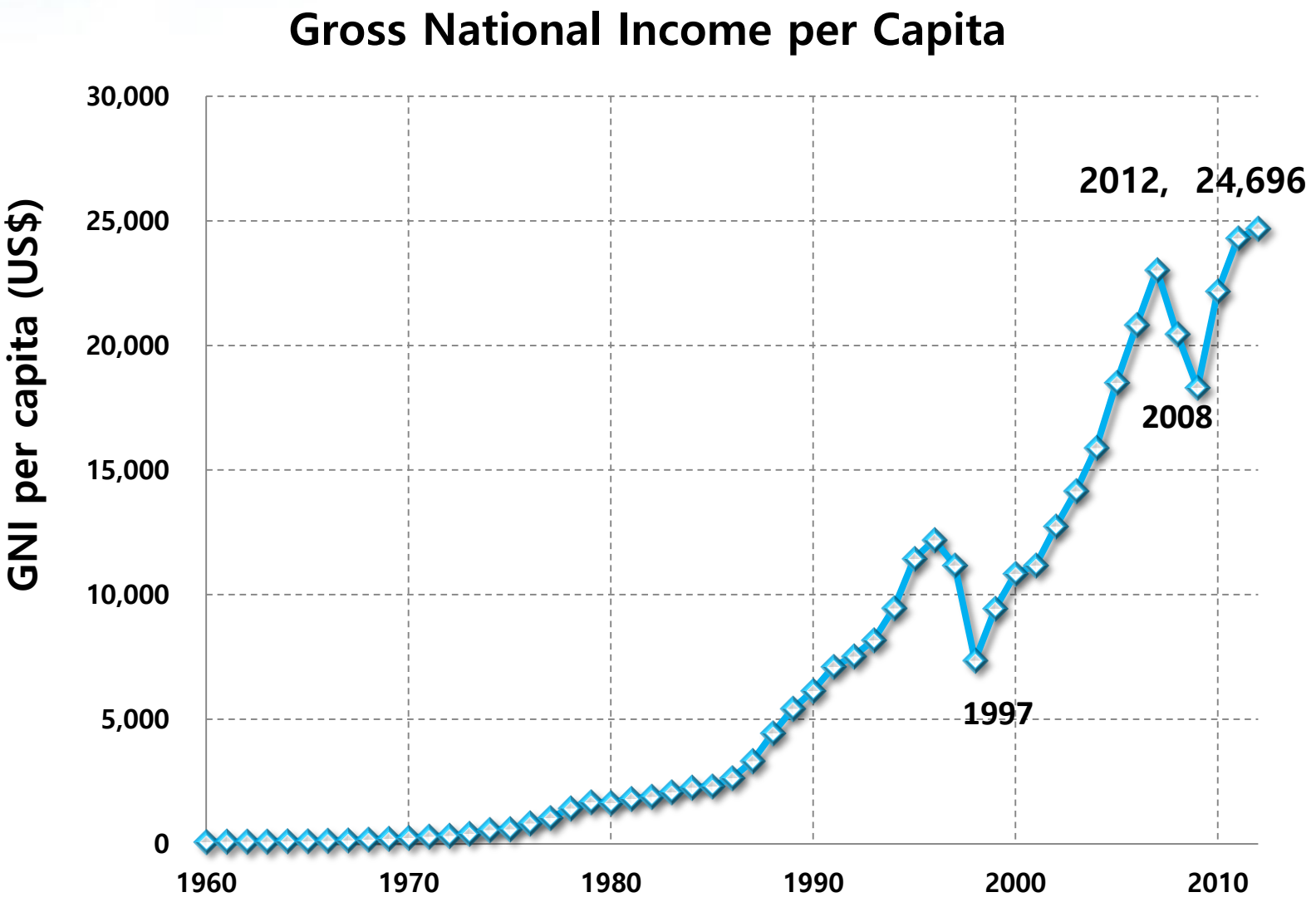

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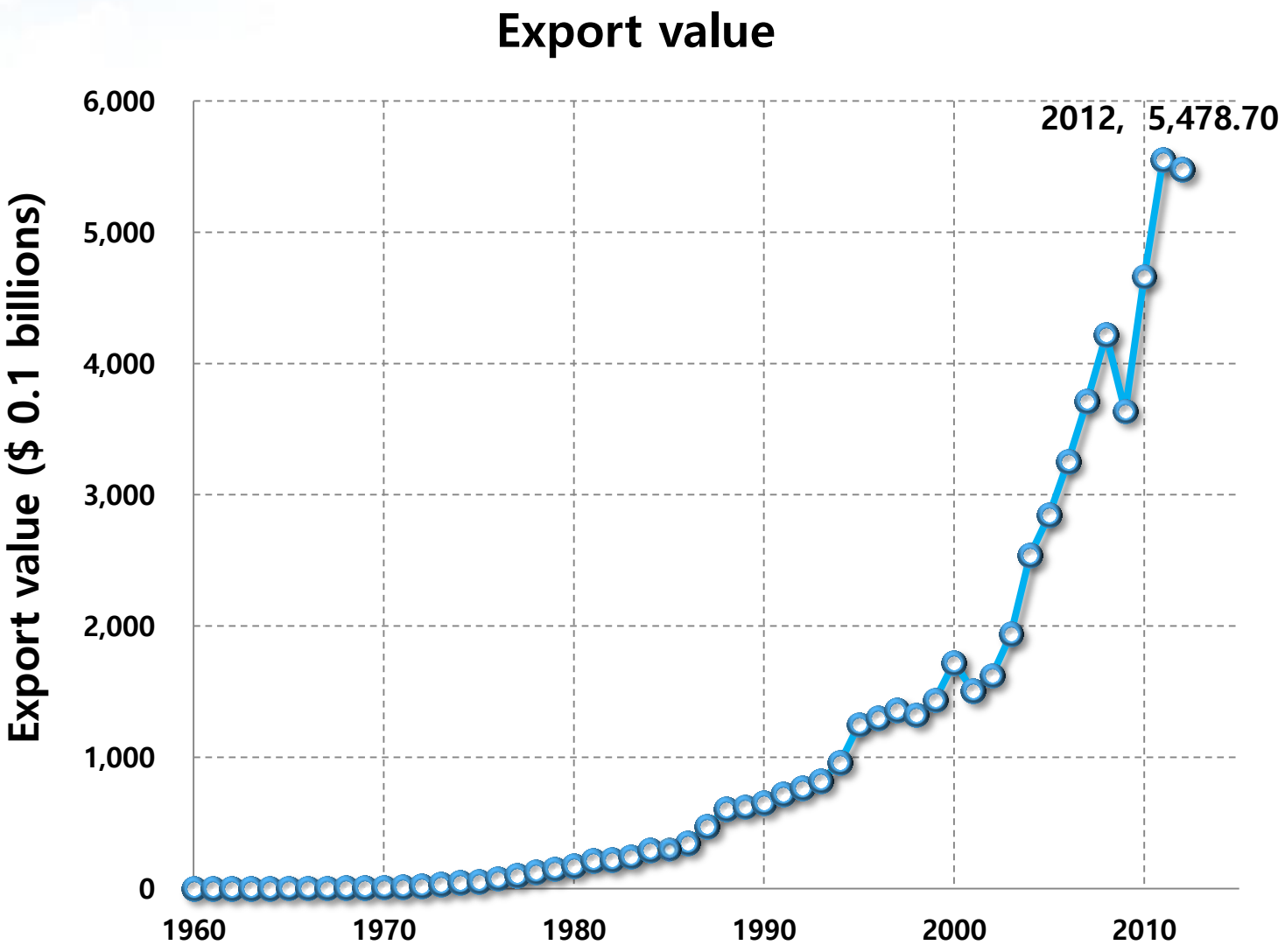

Korea International Trade Association
http://stat.kita.net/

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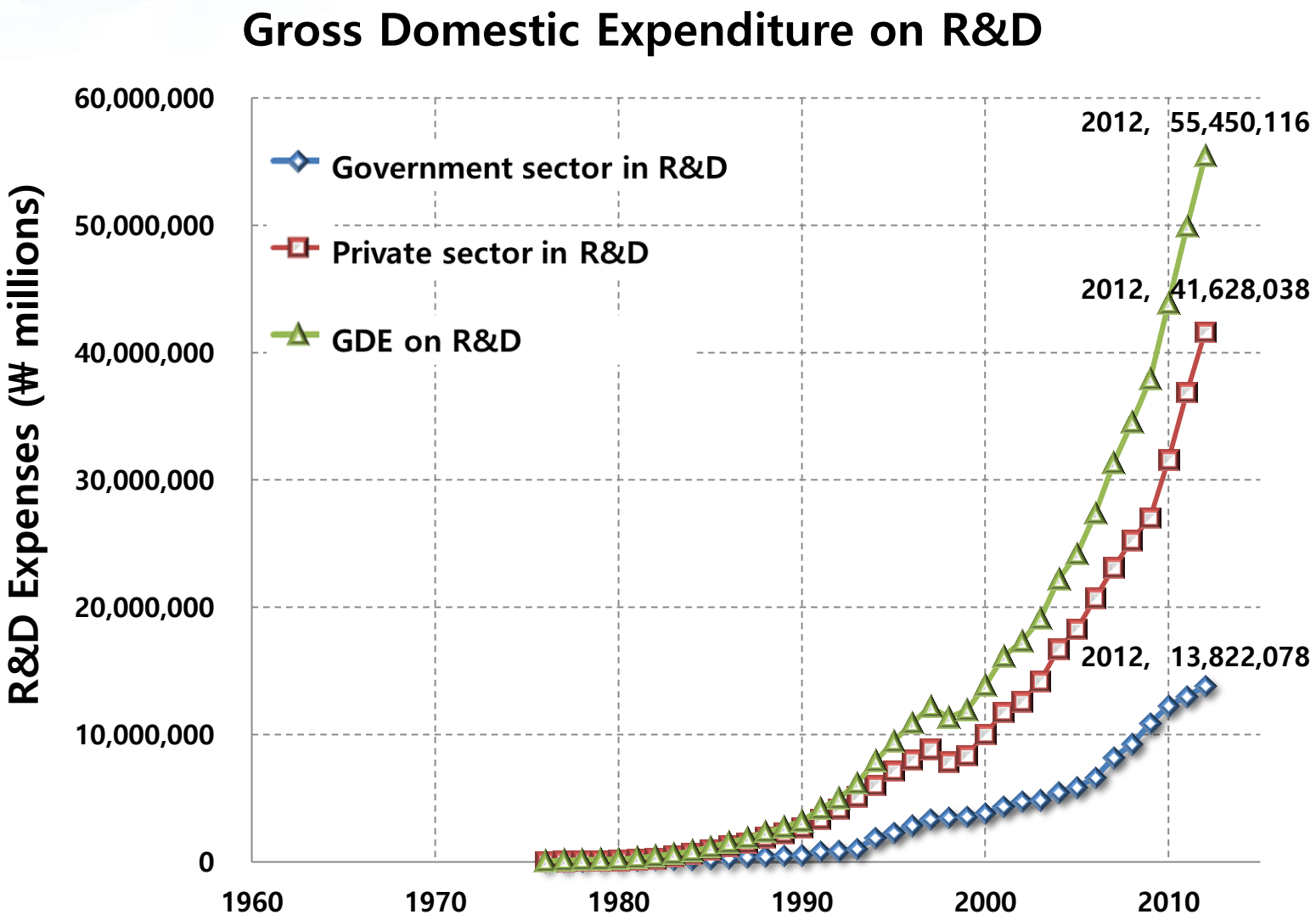

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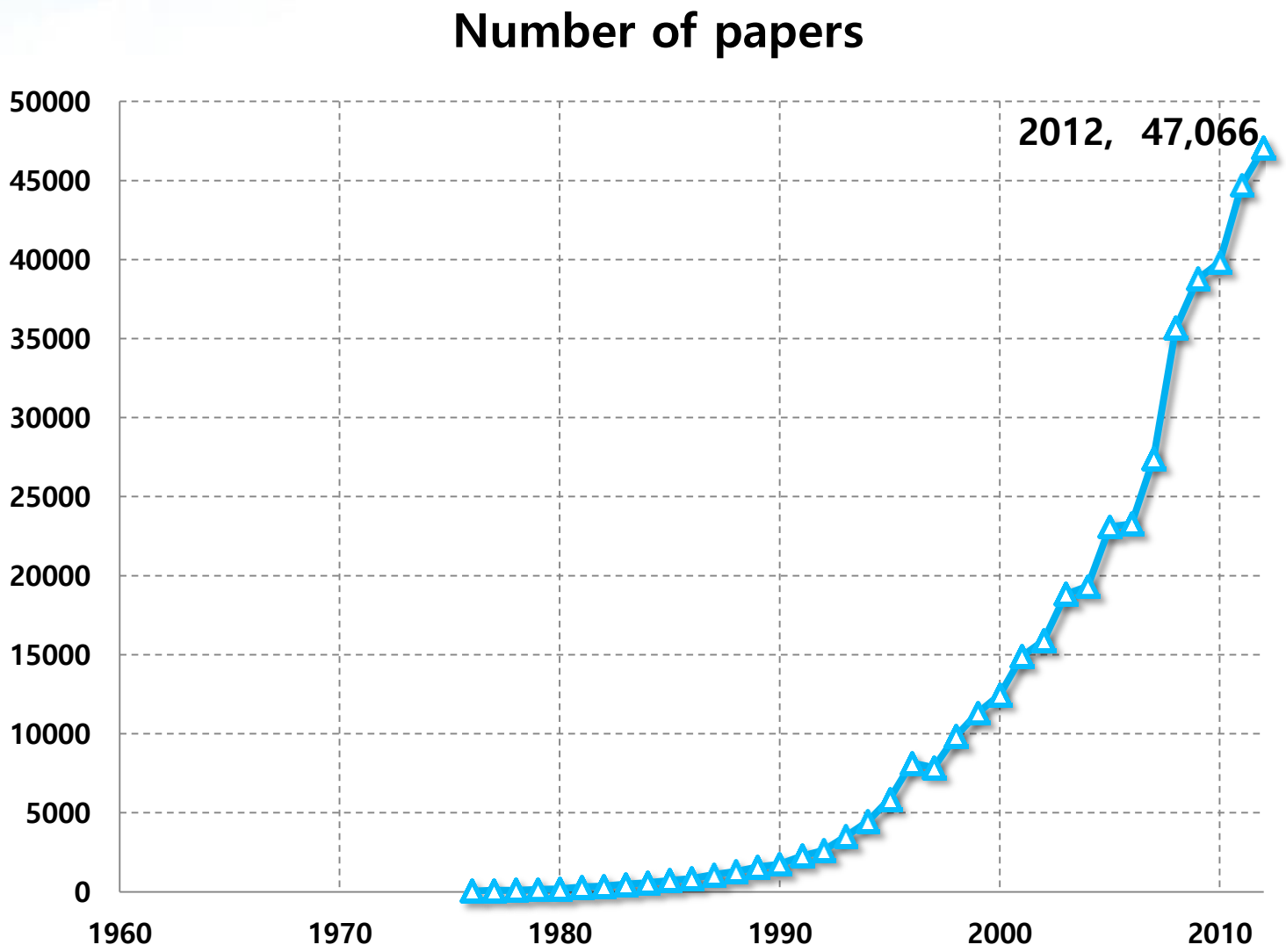

Web of Science
http://apps.webofknowledge.com/

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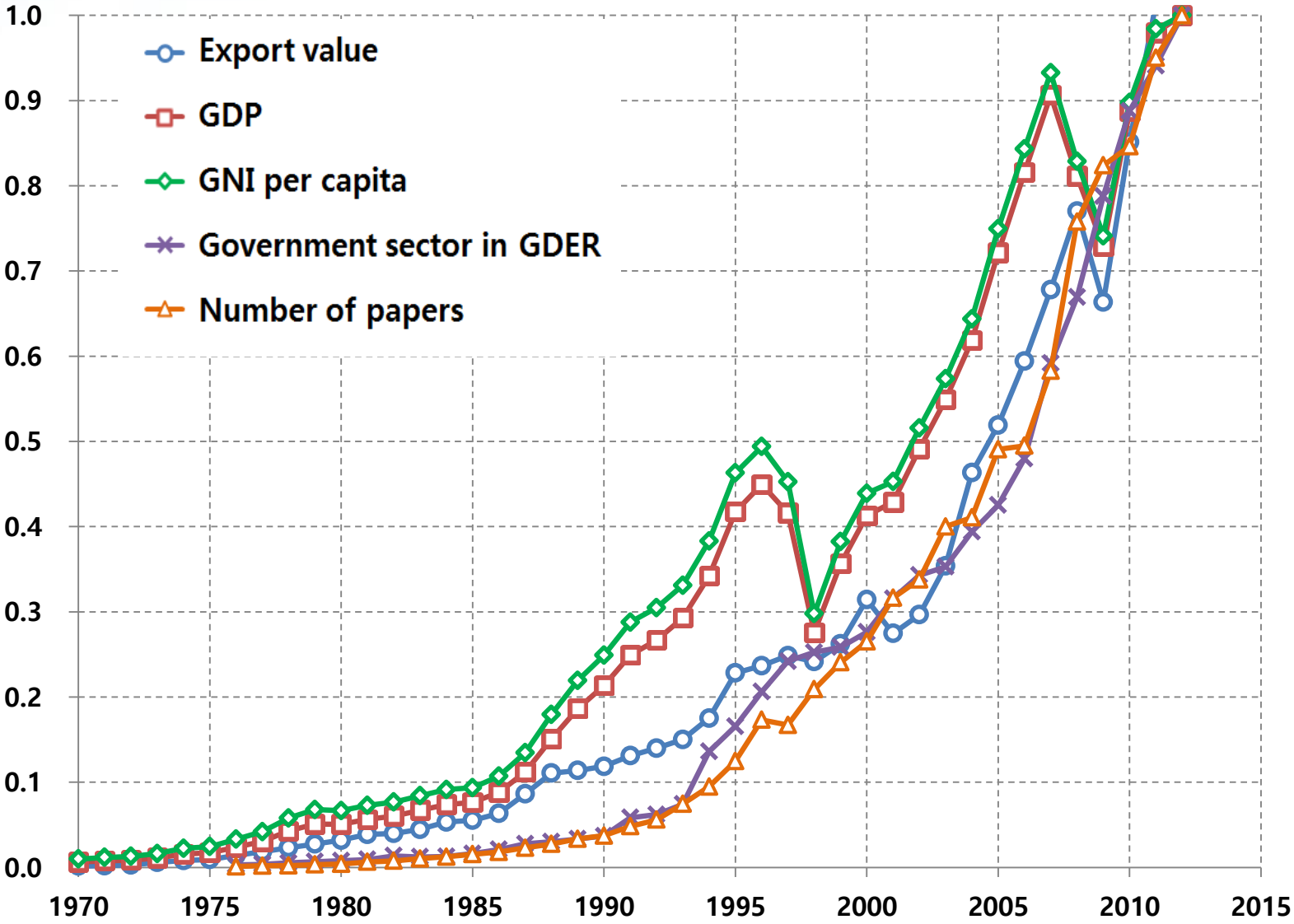

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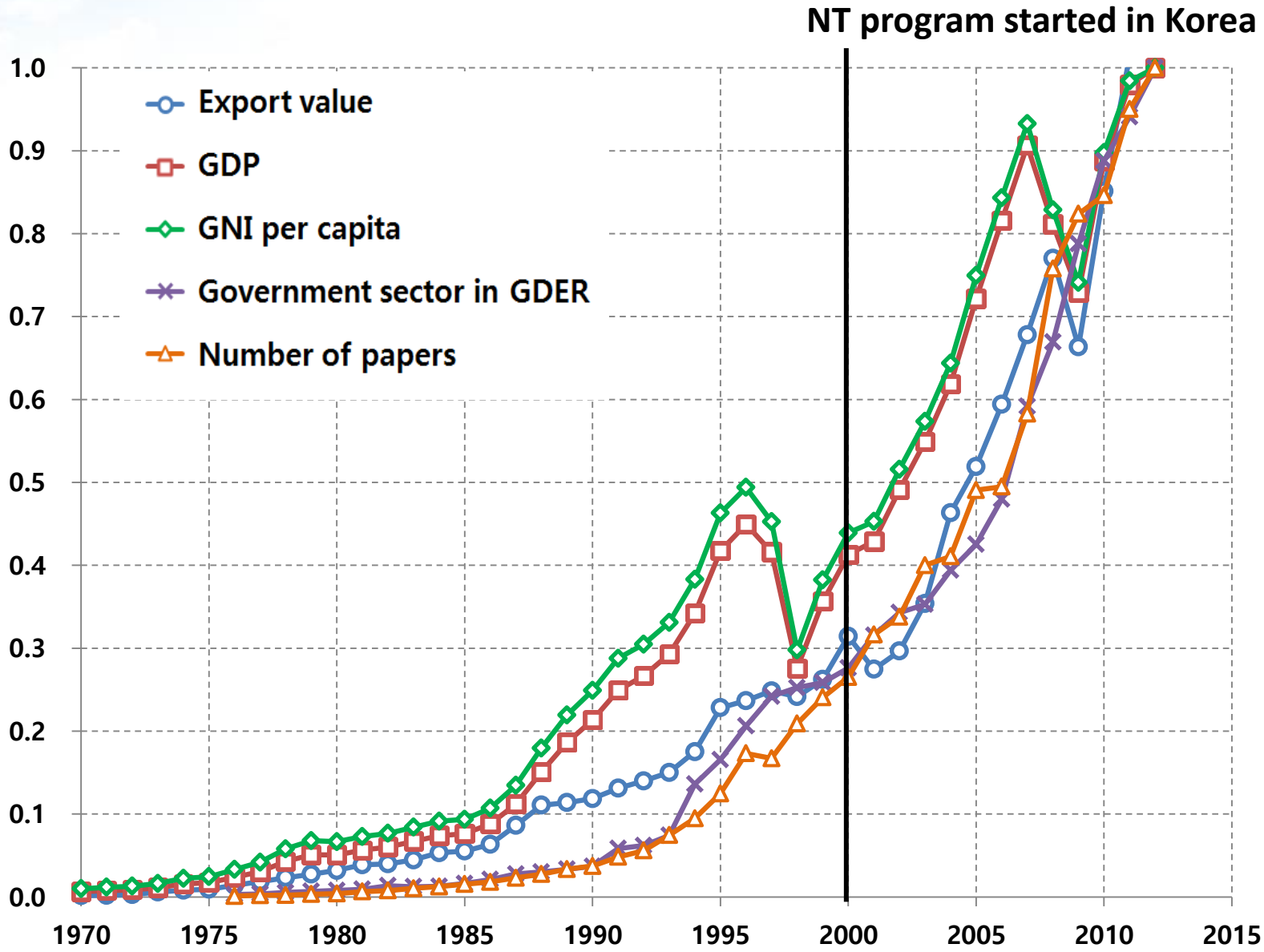

History of NT policies in Korea

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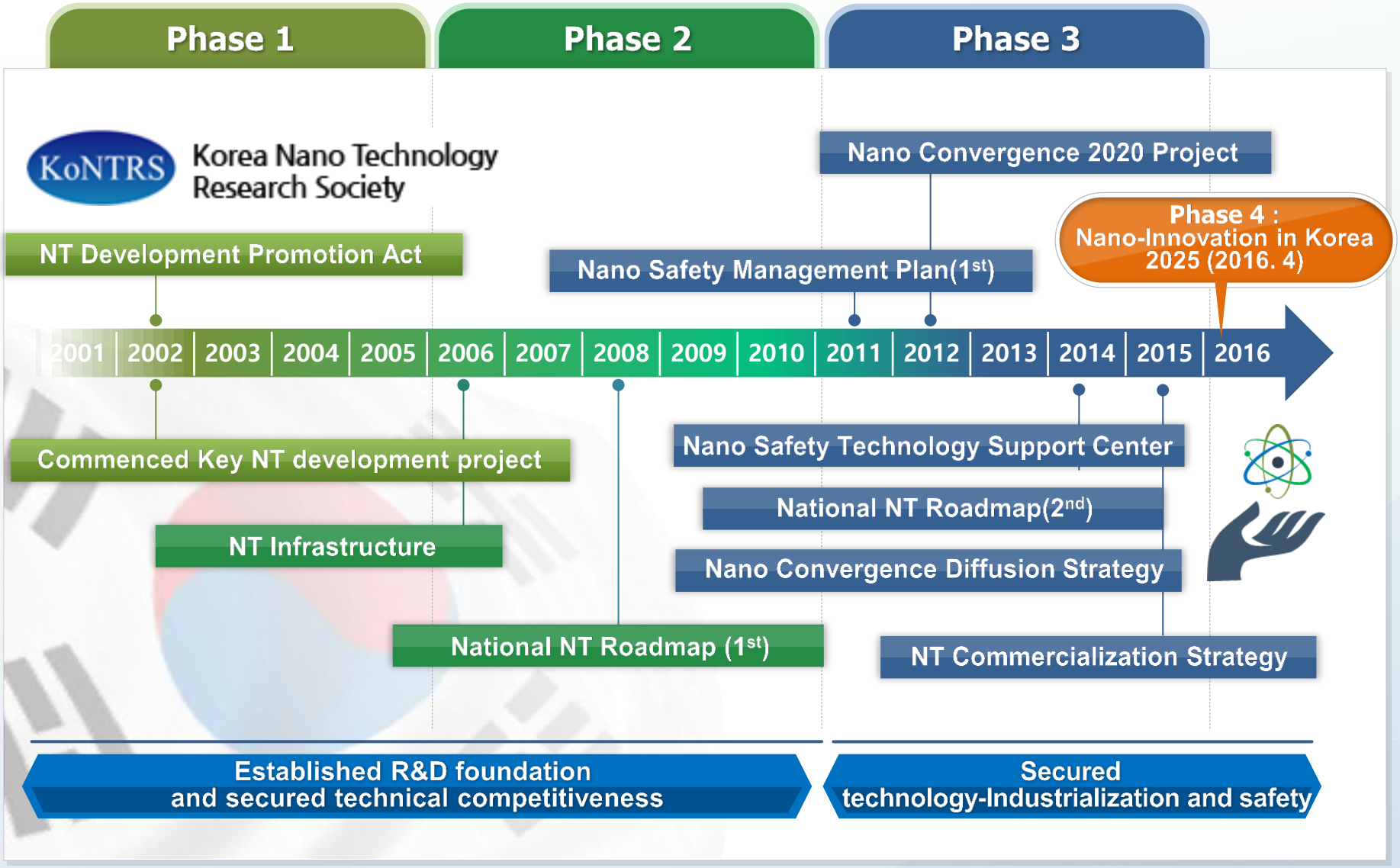

KoNTRS Korea Nano Technology Research Society

Established in 2002

Major Activities

- NANO KOREA Symposium — Every year since 2004
- Nano Convergence — Publication of Nano Journal
- National Nano Technology Road Map
- Management of Basic NT Education Program
- e-Nanoschool
- Network Activation — Development of regional policy agenda in connection
- International Cooperation

Progress(Phase 1- 4)

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Phase1 (2001~2010)

Vision 1. Entering **TOP3 Advanced** NT countries
2. Developing **New Technology Market** through convergence
3. Realizing a safe and prosperous society

Strategy Establishing the foundation for industrialization

Phase2 (2006~2015)

Vision Establishing infrastructure and entering **Top5 Advanced** NT countries

Strategy Design infrastructure for Fab service and securing 10 top NTs

Phase3 (2011~2020)

Vision Being a **First Class Country** accomplishing sustainable growth through the innovation in NT

Strategy
1. Diffuse innovation-driven nano industrialization
2. Secure advanced NT for the future
3. Expand infrastructure of promote innovation through NT

Phase4 (2016~2025)

Vision Building a **Global Nano Powerhouse**

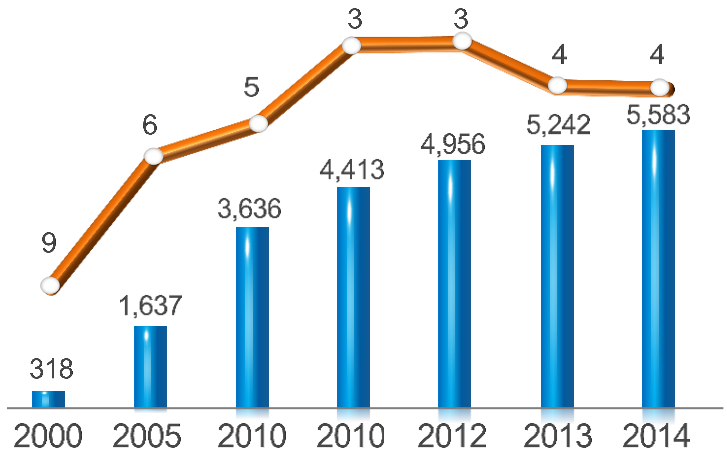
Strategy
1. Developing future technologies 30
2. Advanced HR, Maximize infrastructures application
3. Reinforcing social and ethical responsibility

3. Key Achievements (1/3)

- Secured world-class scientific capabilities
  - No. of NT-related SCI papers: 9th (2000) → 4th (2014)
  - No. of patents registered at USPTO*: 8th (2000) → 3rd (2014)

Papers

- **Significant Growth in the number of NT-related SCI papers**

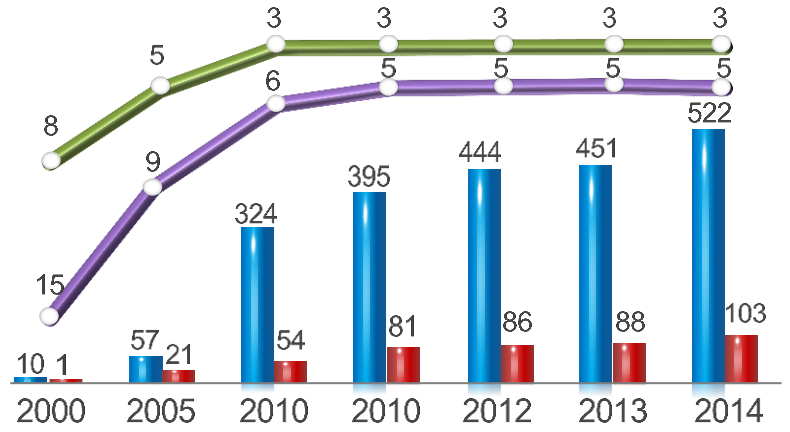


Source: National Nanotechnology Policy Center (NNPC), Nanotechnology Yearbook 2014

Patents

- **Significant Growth in NT related patents registered**

Total 522 in 2014 (15.7% growth from the previous year)



Source: : NNPC, Nanotechnology Yearbook 2014, Nanotechnology Patent Trends (2015)

* USPTO: United States Patent and Trademark office

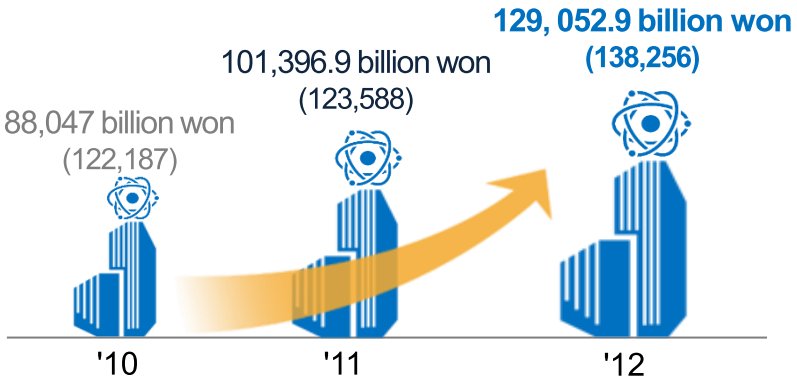
3. Key Achievements (2/3)

- Korea emerging as a key NT industrial country
  - No. of NT companies: 504 (estimated at around 1,000)
  - Korea is the third after the U.S. and Germany in the diversity of NT products (Woodrow Wilson Center, 2014)

NT Convergence Industrial Companies

- **No. of NT convergence industrial companies**
  - Total 504 in 2012
    [Nano Materials(43.3%), Nano Equipment/Devices (28.6%), Nano Electronics(16.7%), Nano Bio/Medicine(11.5%)]
  - Total 138,000 jobs created in 2012
    (11.9% growth from the previous year)

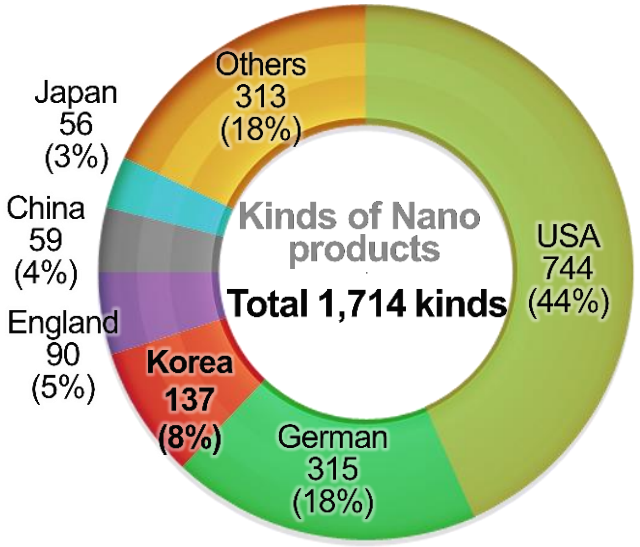
* Sales (No. of employees)



Source: MOTIE, Nano Convergence Industry Survey (2013~2014)

Product in NT

- **Kinds of Nano products worldwide**
  - 1,714 kinds in 2014 (Korea produced 137 types, ranked the 3rd in the world)



Source: Woodrow Wilson Center, Project on Emerging Nanotechnologies (2014.8)

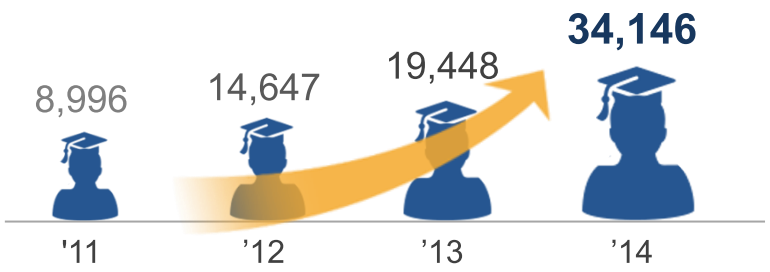
3. Key Achievements (3/3)

Human resources for research communities and industries

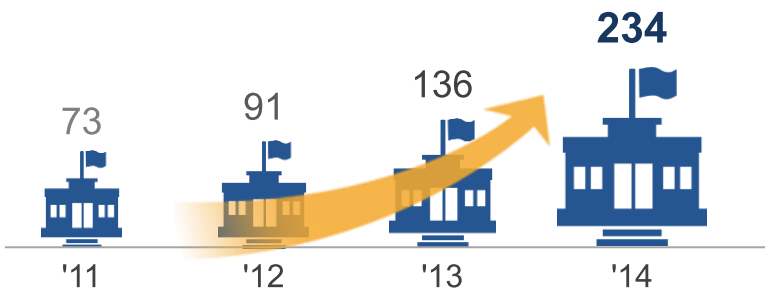
- 8,158 core researchers and 138,256 industrial manpower

Developing human resources in NT

- **No. of college students enrolled in NT related departments**



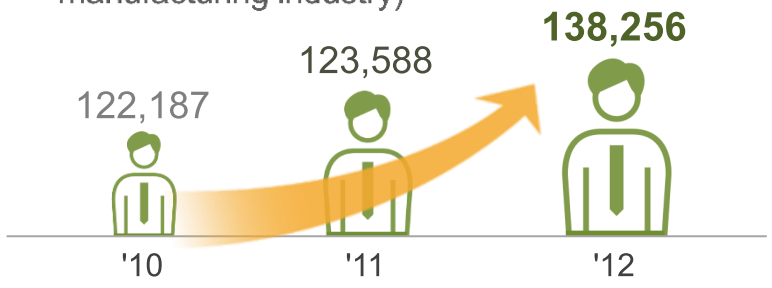
- **No of NT related departments among Korean University**



Researchers/industrial manpower

- **Researchers in NT**
  - Total 8,548 in 2014 (18% annual average growth)

- **Manpower in NT convergence industries**
  - Total 138,256 in 2012 (5% of the whole manufacturing industry)



Source: NNPC NT Organization Survey (2013), MOTIE Nano Convergence industry Survey (2013~2014)

3. Key Achievements

2 Nano-Innovation of Korea 2025

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Contents

I. Background

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1 Background for NNI-K

Technical Innovation

▶ Increased Need to NT against Future Environmental Changes

- Excessive information, issues of energy and climate, increase lifespans
  ➡ Increased demand to utilize NT
- Nanotechnology : Source of next gen. technical innovation
  ➡ Overcoming technical limitations of manufacturing industry+ Eco-friendly growth

Revenue per person **in manufacturing** KRW **530** million

over **1.7** times

Revenue per person **in nano convergence industry** KRW **930** million

Leading Technology

▶ Strategy to lead the diffusion of Nano-Convergence

- Joining NT leading country group(investment for past 15 years)
- Electronics ➡ Full fledged utilization of NT(large companies)
  Nano materials, equipment & energy/bio industry ➡ Early stage of growth
- Manufacturing industry needs to spread nano-convergence and enhance investment in leading technologies

Legal Basis

▶ NT Development Promotion Act

- Establishing foundation for researching NT and systematic development and nurturing of nanotechnology
- Enacted every 5 years

I. Background

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2 Future Challenges related to Nanotechnology

	1 Expanded information processing and nano electronics	2 Nano-bio technologies For wellbeing-oriented and aging society	3 Climate change and nano energy/environmental technology
ISUUES	Hyper-connected society Big data Intelligence/ unmanned electronics	Healthy Life Better quality of Life	Abnormal Climate changes Water Shortage
SOLUTIONS	Need for high performance elements capable of processing tons of information with speed and low power consumption	**Need to develop technologies for early diagnosis of diseases**, improvement or replacement of **weakened damaged human tissues**	A need to provide eco-friendly energy sources and technology to purify air and water
	Big USD **3.8** billion (2013) Big USD **384** billion (2020 Expectations)	**81.4** AGE (2012) Average lifespan **73** AGE (2012) Healthy life	CO2 **37%** Reduction Goal 2030

II. Local and Global Status and Policy Directions

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1 Current status of NT in Korea and Overseas

Global Trends — Establishing Sustainable Environment and Securing Source Technology

- **U.S.** — Nano Signature Initiative
- **E U** — Horizon 2020
- **China** — Made in China 2025

Korea Status — Improved Research Capability of NT and Growth of related Industries

- Pursuit of catch-up strategy in R&D and investment from 2001 resulted in **improved research capability of NT and growth of related industries**

Technology Level

25% (2001) → 81% (2014)

Specialized HR

7,383 (2010) → No. of univ. students(related NT) 34,146 (2015)

Nano Convergence Industry

The Market size of nano-abled products has grown enough to be recognized as a separate industry
→ Experiencing rapid growth

Sales	USD 121 billion '13	* Average yearly growth of 18.5%
Jobs	151,000 people '13	* Average yearly growth of 7.1%
Companies	541 '13	
Investments	USD 24 billion '13	* Average yearly growth of 15%
Revenue per person	USD 0.08 billion '13	* 1.7times of manufacturing industry

NT Industrialization

Most companies are based in the nano materials(46.3%, 24 companies) but are suffering from relatively negligible revenue, and industrialization of nano bio technologies is particularly weak

- **Nano electronics** — Active application of nano elements for displays, components and memory devices and etc.
- **Nano process** — Most equipment are imported, **causing weak expansion of nano convergence**
- **Nano materials** — Largest companies in this field(234), **Most are SMBs with negligible revenue**
- **Nano bio** — Growth of Bio/healthcare industry expected, **Requirements such as validation and clinical trials as obstacles to commercialization**
- **Nano energy/ environment** — **Expanded application of NT to overcome barriers of efficiency, especially for secondary batteries**

2 Policy Directions

NT Industrialization diffusion

Create Innovation in the Manufacturing Industry through of NT utilization

- Develop new markets by facilitating commercialization of NT
  - Selecting NT capable of creating new industries
- Establish support systems to reduce burdens of companies in the commercialization process
- Make up critical missing links in the commercialization process
  - Nano bio: Evaluation support for Nano-bio technology validation
  - Nano materials: Linking Support for nano materials and related companies

Leading NT Innovation

Lead the Development of Future NT as a Nano-advanced Country

- Secrue technologies for overcoming limitations to resolve future issues
  - Promote source/applied researches and Challenge Project
  - Strengthen strategic investment in basic research in NT and Build the development promotion-system

Nano Innovation-based expansion

Build the foundation for continued growth of NT and related industries

- Establish international cooperation system, Cultivate core R&D HR and on-site experts
- Nano safety management system, System to support reduced cost and time for NT development

III. Vision and Goals

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Vision

Being a First Class Country accomplishing sustainable growth through **the Innovation in NT**

Realization of innovative technology for manufacturing industries

- **92%** Technology Level (U.S standard 100)
- **12,000** Core Research HR

Goal (2025)

Global leader in nanotechnology industrialization

- **12%** Ratio of the sales revenues by nano-abled products
- **1,000 industries** No. of nano convergence company

3 Major Strategies and 12 Projects

1 Diffuse Innovation-driven Nano Industrialization

① Secure core technologies for Industrialization promotion

② Support technology Commercialization of the company

③ Strengthen infrastructure for the proliferation of nano-convergence

④ Overcome the barriers for commercialization

2 Secure Advanced NT for the Future

⑤ Promote strategic basic research in NT

⑥ Develop 30 core subjects in NT

⑦ Promote 「Nano Challenge」 projects in 4 majors categories of NT

⑧ Rationalize national investment in NT

3 Expand Nano Innovation Infrastructure

⑨ Cultivate on-site type 'Nano specialists'

⑩ Build neo-global cooperation system

⑪ Secure nano-safety management system

⑫ Build information system for innovation support

IV. Tasks

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1 Innovation-driven Nano Industrialization

▶ Facilitating Commercialization of Highly Matured Technological Fields

Task 1 Secure core technologies for industrialization promotion

➡ Expansion of nano consolidated growth model by securing core technologies in strategic areas

Promotion industrialization of 7 Key Technology

- Securing core technologies for developing new global markets

7 Key Technology

① 3D nano-electronics device
② Environmental IoT nano-senor
③ Food safety nano-sensors
④ Functional nano-fibers
⑤ Preciousmetal-free catalysts
⑥ Rare earth-free nano-materials for industrial use
⑦ Low-energy water treatment system

Expected results

Sales revenue of USD 13 billion

Graphene commercialization promotion

- Preoccupying global markets by establishing the supply chain of graphene and through strategic commercialization of applied products*

* Electromagnetic shield film, corrosion-resistant, multi-functional coating, high performance barrier film, graphene-based touch panel, graphene-based OLED panel and super capacitor electrode

Create **20** Global companies

Goal of **2025**

Sales revenue of USD 17 billion

Task 2 Support technology commercialization of companies

➡ Facilitating new businesses by commercialization of excellent technologies and attracting investment into SMBs

Support to R&D for commercialization

- Support to resolution of issues regarding commercialization and product development

Facilitating private investment of SMBs·venture companies

- Establishing and operating dedicated organizations for attracting investment

IV. Tasks

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▶ Establishing Industrial Ecosystem for Reinforcing Competitiveness of SMBs

Task 3 Strengthen infrastructure for the proliferation of nano convergence

➡ Establishing foundation to complement lacking R&D infrastructure of companies

Expanding nano fab processes and improving their efficiency

- Development/support to new process platforms to enable IoT

Vitalization of nano innovation cluster

- Vitalization of nano clusters for nurturing companies and promoting technical consolidation

Task 4 Overcome the barriers for commercialization

➡ Establishing environment for industrial growth in nano materials and bio industries

Establishing a supply chain by linking nano material manufacturers with companies in demand of such materials

- Developing nano material industry by vitalizing cooperation and linking among companies

Linked support to commercialization of nano bio technologies

- Eliminating obstacles to commercialization and support per type of technology

IV. Tasks

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2 Secure Advanced NT for the Future

▶ Securing Leading Technologies for Creating Future Demand and Reinforcing Strategic Investment

Task 5 Promote strategic basic research in NT

➡ Establishing base research ecosystem and promoting strategic investment

- Preparing development strategy for base nano research
- Reinforcing private/governmental cooperation

Task 6 Develop of 30 core subjects in NT

➡ Commencing base/applied researches of promising technologies per nano based industry

- R&D in consideration of market and reinforcing connection among departments

Future NanoTechnology 30

Nano electronics (6)	Nano-bio (5)	Nano-energy and environment (7)	Nano-materials (6)	process, measurement & equipment (6)
▪ Ultra-low power memory	▪ Advanced production in agricultural and fishery products	▪ Nano solar cell	▪ Quantum dot	▪ Flexible element process
▪ High speed, low power logic elements	▪ Healthy products	▪ A secondary battery of the nanostructures	▪ Nano-carbon material	▪ Nanostructure patterning
▪ Environmental nano-sensors	▪ Nano-diagnostics	▪ Nanostructured fuel cell	▪ Printed electronics biomimetic materials	▪ High-resolution measurement
▪ New concept nanomaterials	▪ Nano-analysis of bio-molecules	▪ Nano structured membrane	▪ Environmental catalyst materials	▪ Nano-lamination process
▪ Flexible element	▪ Intelligent medical nano treatments	▪ Thermoelectric device	▪ Rare-earth catalyst	▪ Hybrid inspection
▪ Optical nano-devices		▪ Energy harvesting	▪ Rare-earth free materials	▪ Smart process
		▪ Sea water energy conversion		

IV. Tasks

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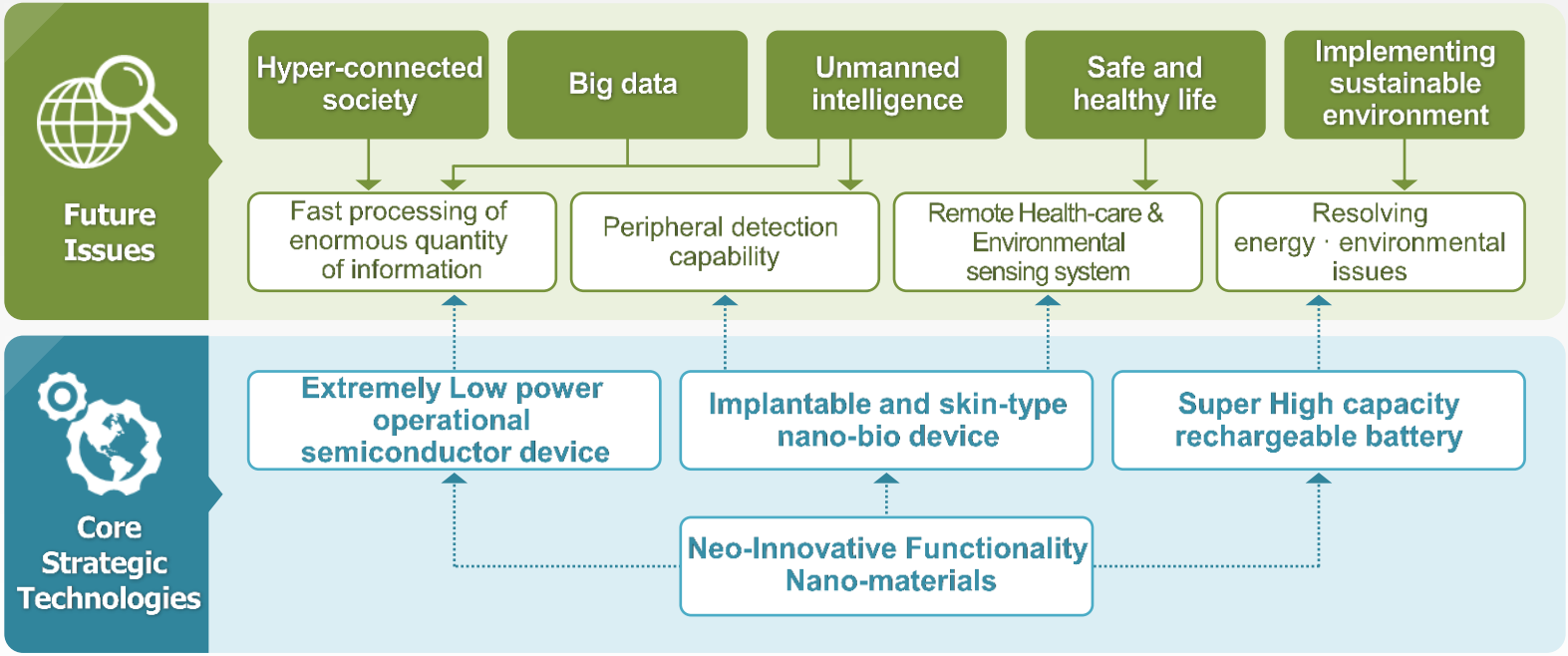
▶ Securing Technologies to Overcome Limitations to Create Future Demands

Task 7 Promote「4 nano challenge」projects in 4 major categories of NT

➡ Preemptive development of core strategic technologies to resolve future issues and innovating manufacturing industry



Task 8 Rationalize national investment in NT

➡ Systematic and efficient securing leading technologies and improving effectiveness of application to industries

- Reinforcing strategic features of national nano technological map and connection among nano-based industries

IV. Tasks

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3 Expand Infrastructure to Promote Innovation through NT

▶ Establishing Foundation for Advancement of NT and Related Industries

Task 9 Cultivate on-site type 'Nano-Specialists'

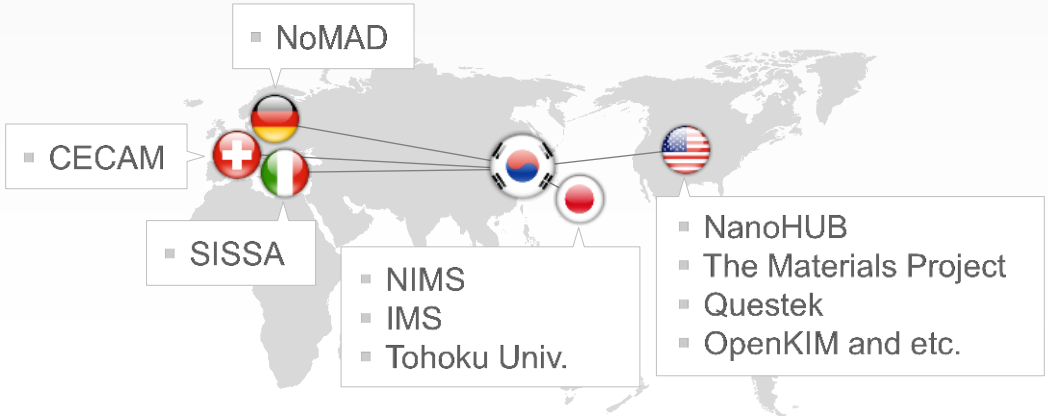
➡ Training professional HR to meet demands and improving camaraderie

- Training next-gen professional HR
- Training HR for customized to industrial demands
- Improving public familiarity of NT

Task 10 Build neo-global cooperation system

➡ Leading establishing process of international operation as a leading country of NT

- Evolution into a leader from global cooperator
- Providing cooperation for nano based industrialization and support for entry into global markets



IV. Tasks

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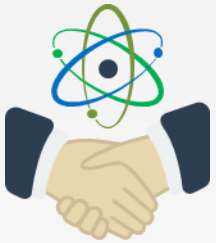
▶ Establishing Support System to Reduce Burden on Companies in the Commercialization Process

Task 11 Secure nano safety management system

➡ Establishing management system for safe society and industrial growth

- Standardization of nano safety assessment technology and expanding international cooperation
- Establishing corporate support system to respond to nano safety regulations
  ※ Operation of EU **Nano Safety Cooperation Center**(Established in 2015, KIST-In Europe)
- Establishing foundation for systemization of nano safety management
  ※ Established 2nd Nano Safety Management Plan(2016)



Task 12 Build an information system for innovation support

➡ Establishing support systems to reduce burdens on companies in the commercialization process

- Unifying and improving nano information system
  ※ Establishing nano knowledge information system(Linkinng Nanonet and Nanoin)
- Establishing open calculation nano science platform

Phase 1 Developing and public opening of test platform for secondary batteries(2015~)

Phase 2 Building a platforms for non-precious metals and non-rare elements nano-materials, environmental/food nano sensors(2016~)

Phase 3 Expansion into promising industries

V. Expected Improvements

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▶ Relate Nano Technology R&D Results To Industries

- Improving competitiveness of domestic manufacturing by commercializing nano technologies and R&D results
- Creating new growth initiative by intensive facilitation of core strategic technologies

▶ Creating Nano-based New Industries

- Creating new jobs through growth of nano-related companies and facilitating manufacturers
- Improving quality of jobs by adding values to corporate activities

▶ Development of NT for Future Generations

- Establishing sustainable society living with future generations by securing nano-based energy/environmental technologies

12%
Ratio of nano-convergence products

5,000 cases
Number of patents approved in U.S.

1000 industries
No. of nano-convergence companies

250,000 people
No. of people in nano-related industries

92%
Technical level

12,000 people
Core R&D personnel

Goals designated for 2025

Thank you very much

Nano-**I**nnovation in **K**orea 2025

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