Iran Nanotechnology
Innovation Council
(INIC)

Progress Review of Iran Nanotechnology Plan

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In Pursuit of Excellence

History and Background

In 2003, the Iran Nanotechnology Innovation Council (INIC) was established in response to the recognition of nanotechnology as a national priority. This council, operats as a government body under the Vice Presidency for Science, Technology and Knowledge-based Economy. The long-term strategy for the development of nanotechnology in the country was formulated by the INIC and received government approval in 2005.

Following the successful implementation of the first ten-year strategic program, two consecutive plans were approved and set into motion. Currently, the third plan, which began in December 2023, is being implemented.

A chronological representation of nanotechnology development plans and their respective core focused areas is shown in the diagram below.

Policies and Strategies

The 3rd national nanotechnology development plan highlights that the progress of nanotechnology in Iran will have a positive impact on the country's development and wealth creation, ultimately leading to an improved quality of life and social well-being. Iran has made significant strides in the field of nano science and technology, producing innovative and high-value products for both domestic and international markets.
According to the 3rd plan, the policies and programs for the advancement of nanotechnology are concentrated on the subsequent objectives:

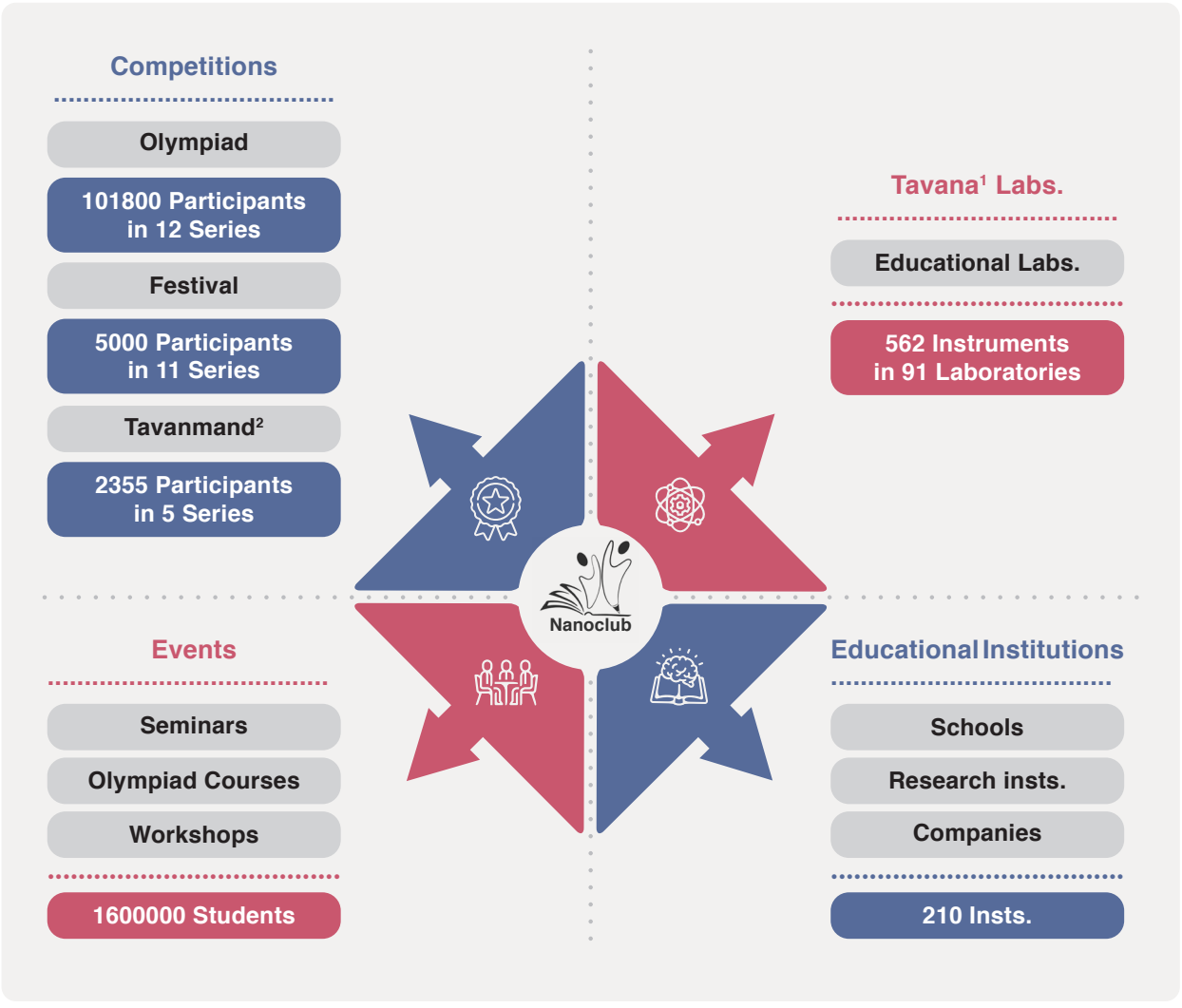
- Advancing the country's position in nano science and technology
- Encouraging innovation through advanced technologies with significant economic and social impacts
- Modernizing current industries through nanotechnology, with a focus on water and environment, energy, agriculture, health, and construction
- Boosting exports and promoting the national nano product brand in regional and global markets
- Improving the quality of life and social impact through the effective use of nanotechnology

Awareness and Education

High School Students

Iran's activities in promoting nanotechnology among high school students were initiated in 2001, aiming to identify and nurture talented pupils. Since 2008, with the establishment of Nanoclub, these activities have continued under the institution's guidance. To date, 1.6 million high school students have been familiarized with nanotechnology principles and applications through a variety of programs, including competitions, workshops, festivals, and Olympiads. Through these programs, talented pupils are selected to play a role in the nano ecosystem.

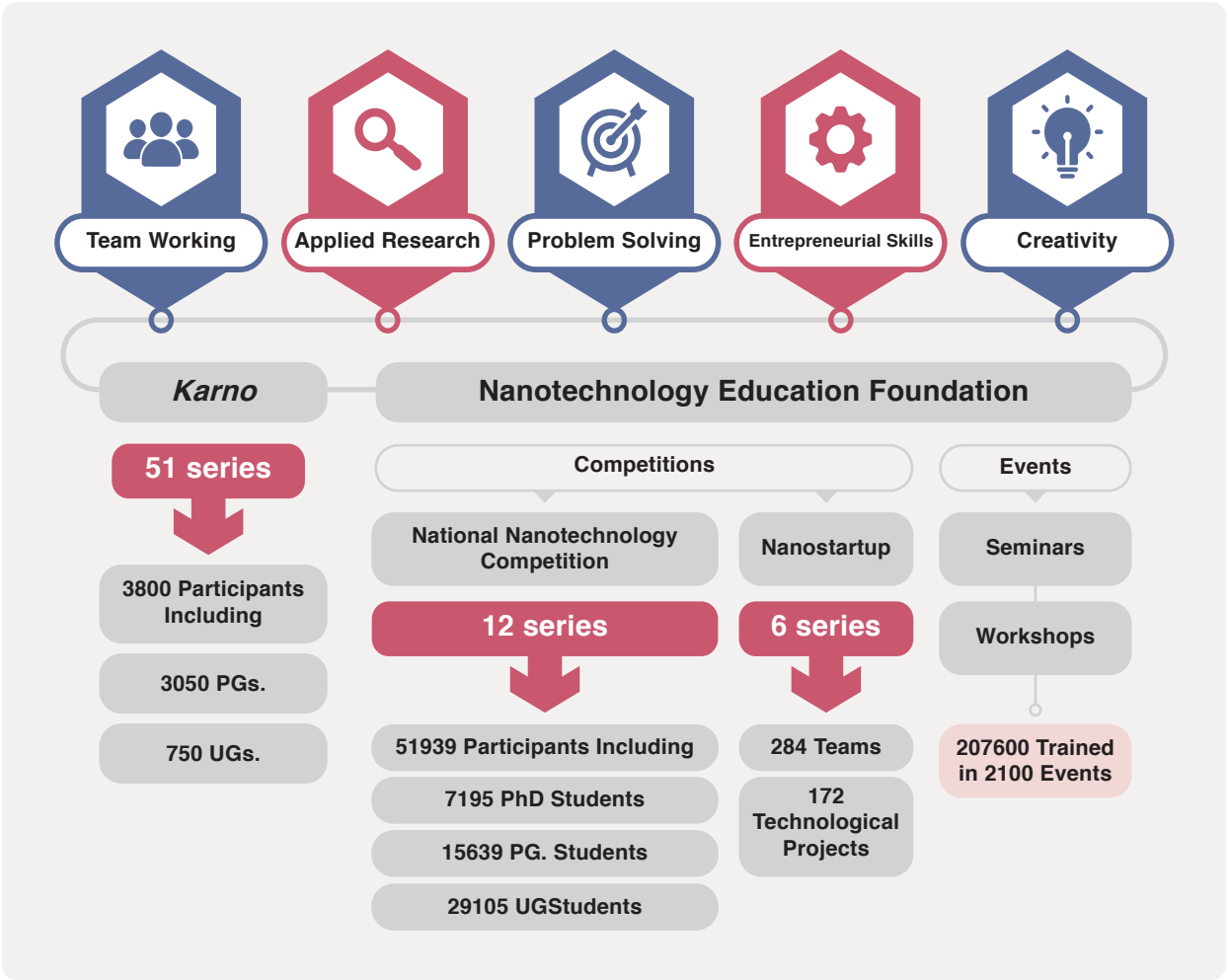
During this period, NanoClub's virtual platform has proved extremely popular, focusing on introducing nanotechnology in simple language. A nanotechnology laboratory network has also been established, equipped with instruments built by Iranian companies, to heighten high school students' engagement and to persuade them towards practical and hands-on experience in nanotechnologies.



University Students

University students are important human resources in nanotechnology and play an essential role in developing this technology. Improving students' skills and abilities has been considered one of the key policies of INIC, resulting in various programs. For example, since 2010, a scientific competition called National Nano Competition has been held annually among students of different university levels. Providing special training to students to lead them towards applied research is a key objective of these programs. To develop entrepreneurial skills and familiarity with the needs of the market, some business courses have been held for graduate students of nanotechnology at various universities Since 2011.

Since 2017, A competition called NanoStartup has helped capable student teams that intend to offer their Minimum Viable Product (MVP). Nanostartup provides facilities for selected teams to develop their idea and connects the teams to other support programs, investors, or customers.



Number of Iran's Nano-articles

115064

2000-2023 (SEP)

Iran's Global Rank in Publishing Nano-articles

7

2000-2023 (SEP)

Iran's Rank in Nano-articles H-index

11

2018-2022

Share of Iran's Nano-articles of Total Iran Articles

19.1%

2000-2023 (SEP)

Share of Iran's Nano-articles of Total Nano-articles

4.6%

2000-2023 (SEP)

Average Annual Growth Rate of Iran's Nano-articles

44%

2000-2023 (SEP)

Iran's Rank in Article per GDP Based on the Purchasing Power Parity

1

2023 (SEP)

Number of Iran's International Joint Nano-articles

26078

2000-2021

Share of Iran's International Joint Nano-articles of total Iran Nano-articles

32.4%

2000-2021

Research and Technology Development

NanoScience

In Iran, about 40,000 experts at MSc and Ph.D. levels, including academic scholars actively partake in nanotechnology research. Ph.D. courses have been organized in 24 universities, and 76 universities organize nanotechnology courses at the MSc level. From 2000 to 2023 [September], Iranian researchers have published more than 115,000 ISI-indexed papers, securing the world's fourth rank in this regard. (see fig1 and table 1).

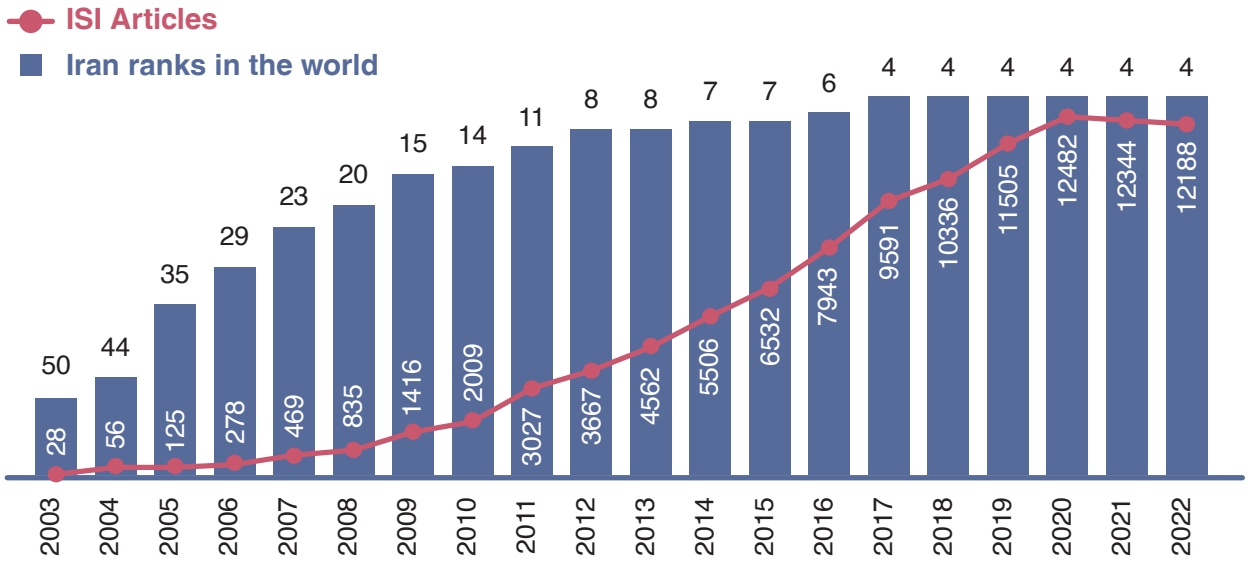


Figure 1. Iran's ISI-indexed nanotechnology articles (number and rank) (2002-2022)

Table 1. 10 Leading Countries in Nanotechnology Publications (cumulative-2000-2023 [Sep])

Rank	Country	Number of nano-articles
1	China	915541
2	USA	433021
3	India	205915
4	Germany	155444
5	Japan	151197
6	South Korea	149497
7	**Iran**	**115064**
8	France	104310
9	UK	93344
10	Russia	87858

Also, the h-index determines both the quantity and quality of scientific research output. 15 leading countries in this index from 2018 to the end of 2022 are shown below. Iran ranks 11th in the world.

Table 2. 15 Leading Countries in h-index of Nanotechnolog articles (2018-2022)

Rank	Country	5-year h-index	Rank	Country	5-year h-index
1	China	368	9	Saudi Arabia	173
2	USA	326	10	Canada	161
3	Australia	202	**11**	**Iran**	**154**
4	Germany	191	12	India	152
5	Singapore	187	13	Switzerland	142
6	South Korea	186	14	France	137
7	Japan	179	15	Spain	131
8	UK	176			

Academic research

The INIC provides various formats of support for academic research aimed at achieving a product or technology. This includes the Nanostartup and Nanomatch programs, which offer assistance to university talents. Additionally, the INIC supports Startup Accelerators. The teams participating in these programs receive not only support for technology development but also training and business mentoring.
Numerous technology development projects have received supports through these programs, with several hundred already benefiting from it. Among these teams, some have successfully have raised fund while others are currently in the process of commercialization.

Corporate R&D

The Renext program, an initiative of the INIC, offers both financial and non-financial assistance to industrial owners. This program caters to companies with a track record of novel products, expanding their operations, and achieving successful sales. Its primary objective is to mitigate the risks associated with the research and development of new Nano products for these companies. Throughout the program, companies receive not only low-interest financial loans but also technical guidance to aid them in selecting and advancing products with promising market potential. Consequently, this

program has facilitated the development of approximately 90 new products across diverse sectors such as oil, polymer and composite, textile, construction, agriculture, food and packaging industries, as well as equipment and nanomaterials.

Nanotechnology Patents

From 2004 to 2023 [June], 318 patents in nanotechnology have been registered in USPTO and EPO, which comprises about 27 percent of the registered patents by Iran in various fields of science and technology.
From 2004 to June 2023, a total of 318 nanotechnology patents were registered in the USPTO and EPO. This number represents approximately 27 percent of all patents registered by Iran in the fields of science and technology.

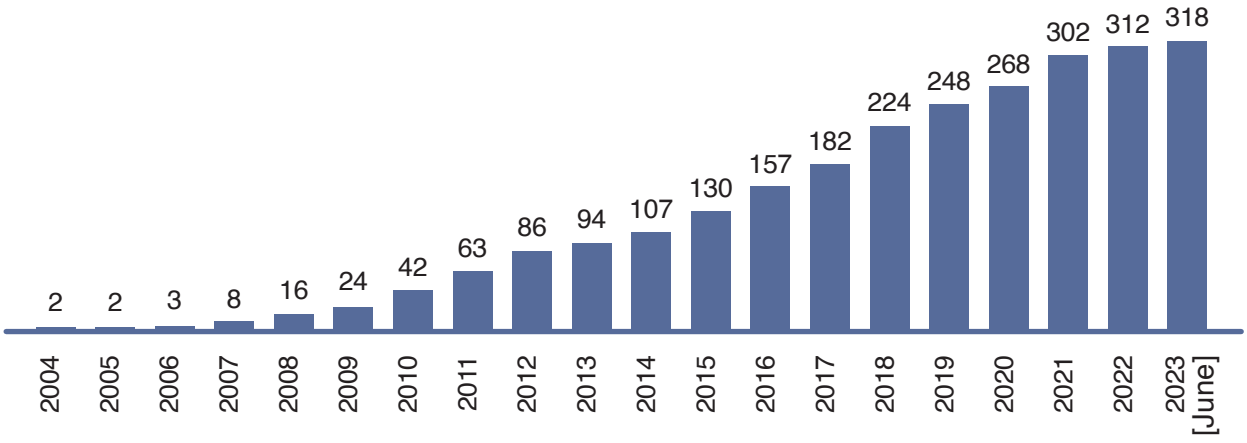
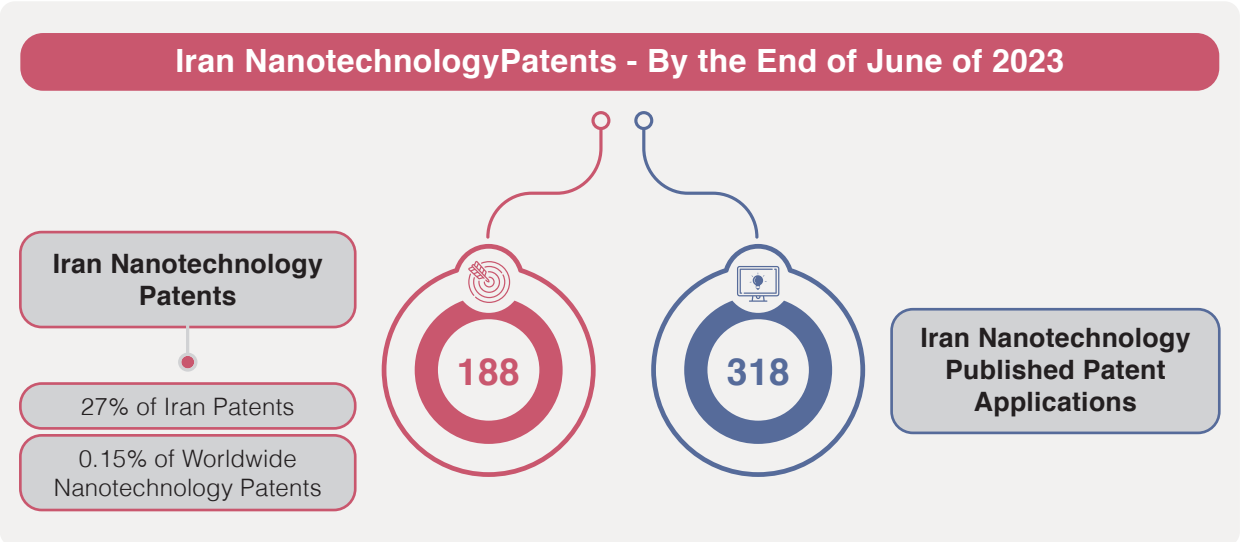
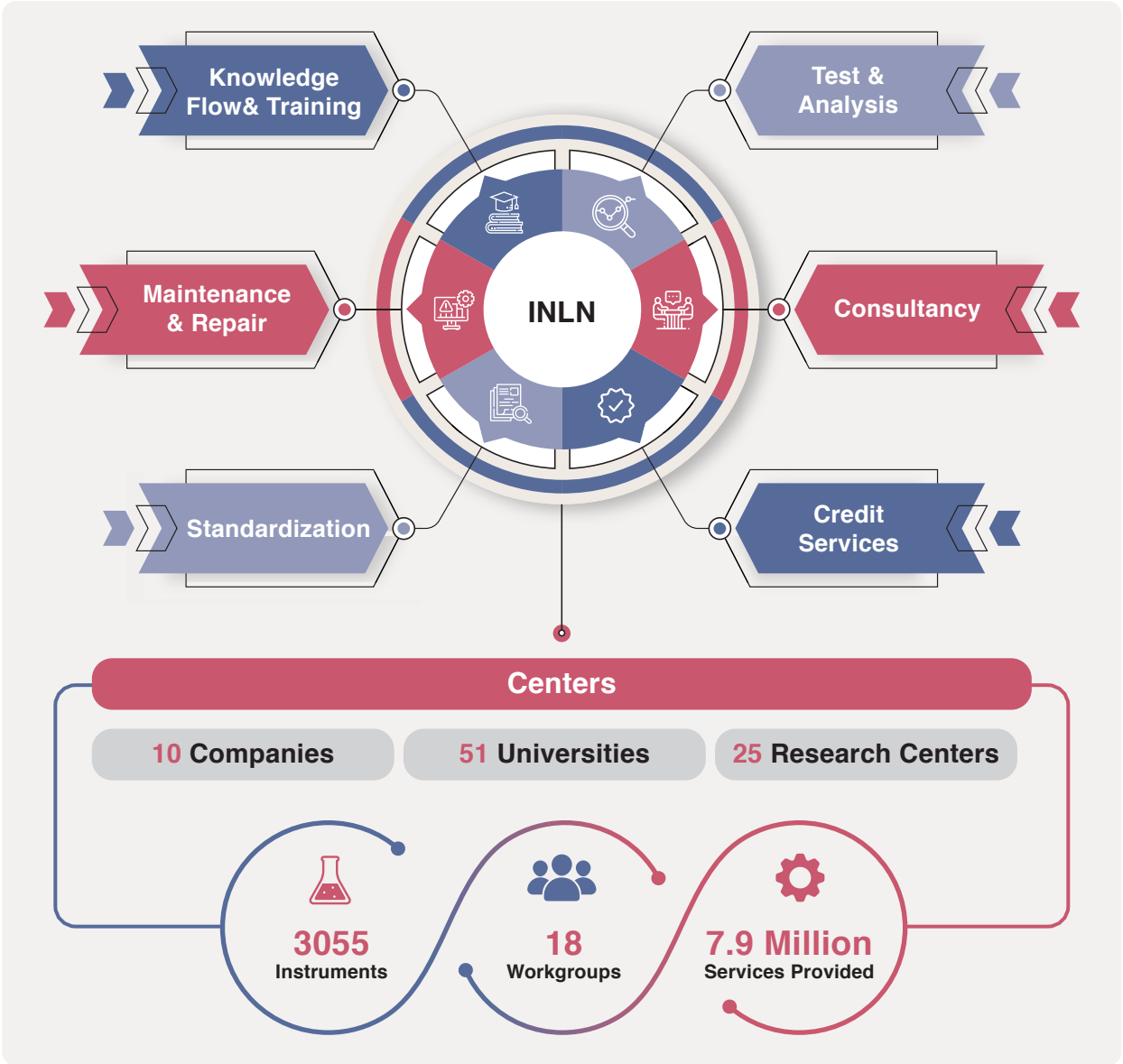


Figure 2. The number of Iran's nanotechnology patents (2006-2023 [June])



Nanotechnology Laboratory Network

Iran Nanotechnology Laboratory Network (INLN) was established in 2004 as a platform for providing nanotechnology laboratory services to researchers and better utilization of the existing labs. INLN provides its members with a unique opportunity to share their capabilities, experiences, and knowledge and provides funding opportunities for the renovation and standardization of facilities at member laboratories. 18 workgroups are currently active in TEM, SEM, X-ray, SPM, standard and calibration, chromatography, element analysis zones, particle size analysis, surface analysis, and thermal analysis. At present, 3,055 nanotech-related instruments supplied through INLN are being utilized in 86 laboratories.



Industrialization and Commercialisation

Nanoproducts

Currently, there are 1608 nanoproducts in 12 industrial sectors produced in Iran. The rate of growth of nanoproducts is illustrated below.

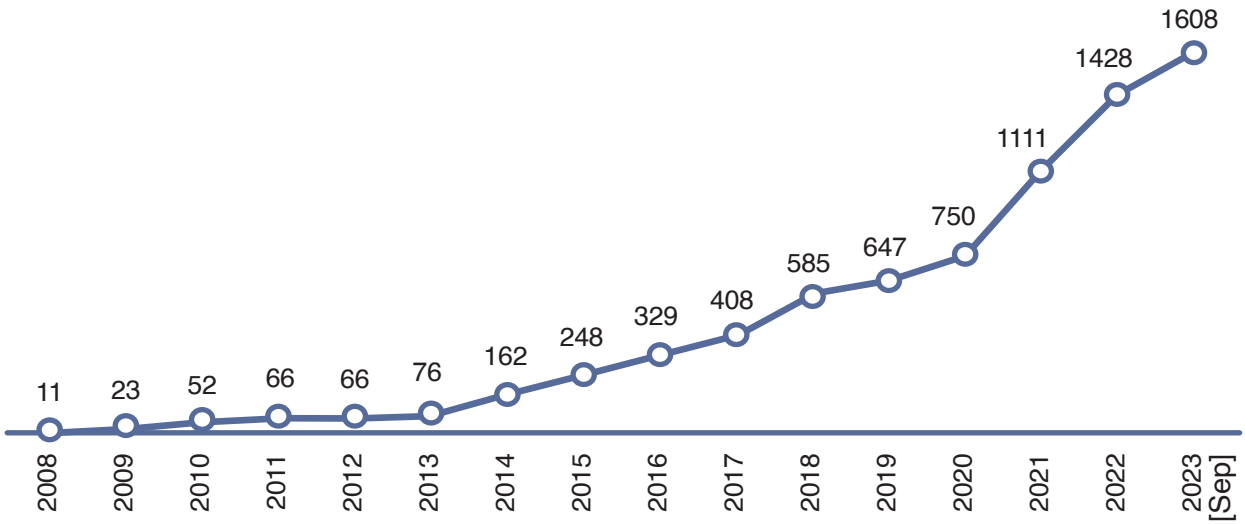


Figure 3. The number of Iran nanoproducts (2008-2023 [Sep])

Nano Market

As the following figure shows, the market size of Iran nanoproducts has been Increased annually in the past seven years.

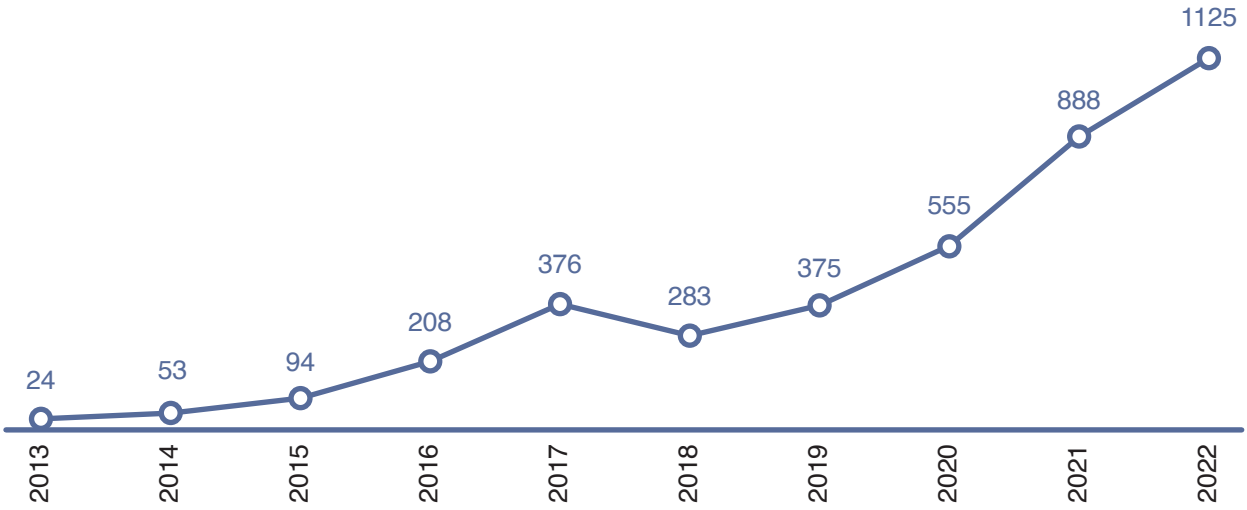


Figure 4. Iran nanoproduct market size (million $) (2013-2022)

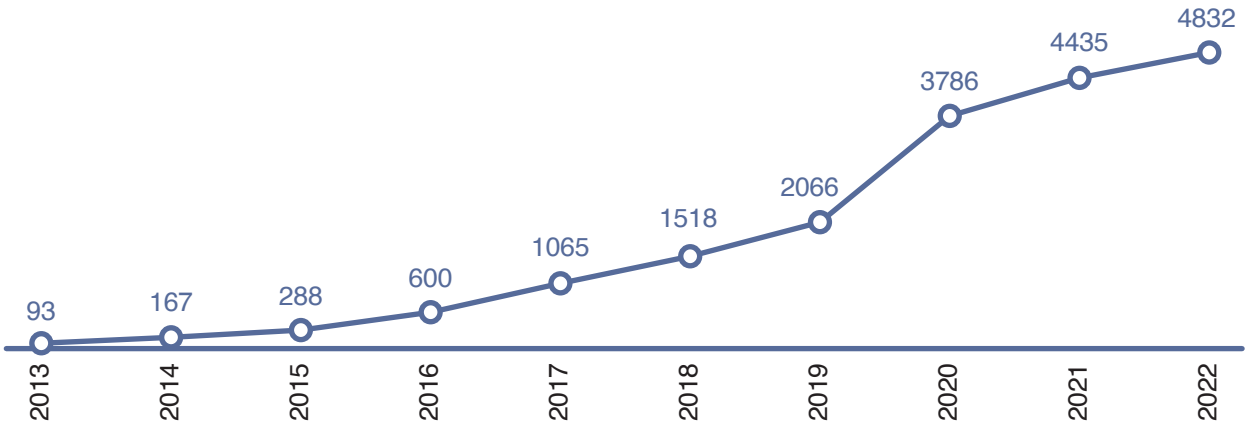


Figure 5. Iran nanoproducts market, PPP[1] (Million $) (2013-2022)

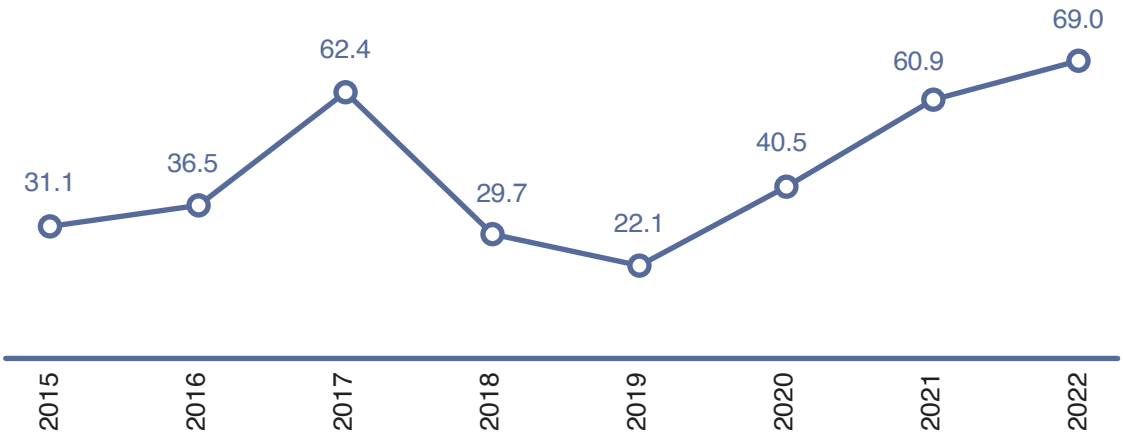


Figure 6. Iran nanoproduct export size (million $) (2015-2022)

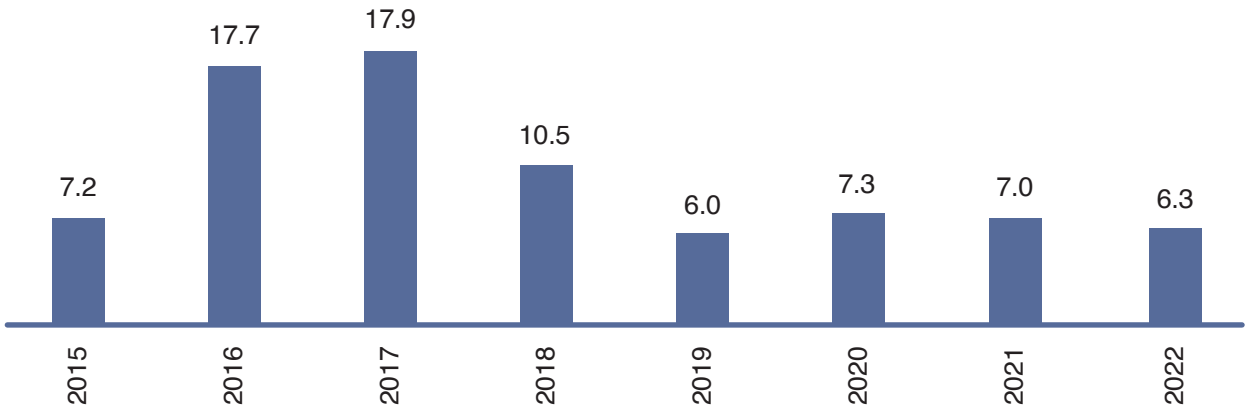


Figure 7. Share of export in the total market (%) (2015-2022)

1. Purchasing Power Parity: This metric compares different countries' currencies through a basket of goods approach.

International Cooperation

INIC actively collaborates with international organizations and networks involved in the realm of nanotechnology, alongside engaging in bilateral partnerships with other nations. These collaborations encompass various domains, including education, standardization, safety, joint research, and joint investment. Noteworthy international cooperation activities undertaken by INIC are outlined below.

Nanotechnology Standards

Iran Nanotechnology Standardization Committee was established in 2006 with the objective of advancing standards within the realm of nanotechnology. This committee actively participates as a member of ISO's technical committee on nanotechnologies (ISO/TC229).
As of September 2023, the committee published 159 national nanotechnology standards. Additionally, under Iran's leadership, 11 international nanotechnology standards have been published within ISO/TC229.

Table 3. International nanotechnology starndards under Iran's leadership (2010-2023 [Sep])

Number	Title	Year
ISO/TR 11360	Nanotechnologies — Methodology for the classification and categorization of nanomaterials	2010
ISO/TS 16550	Nanotechnologies — Determination of silver nanoparticles potency by release of muramic acid from Staphylococcus aureus	2014
ISO/TS 18110	Nanotechnologies — Vocabularies for science, technology and innovation indicators	2015
ISO/TS 20787	Nanotechnologies — Aquatic toxicity assessment of manufactured nanomaterials in saltwater lakes using Artemia sp. Nauplii	2017
ISO/TS 21236-1	Nanotechnologies — Clay nanomaterials — Part 1: Specification of characteristics and measurement methods for layered clay nanomaterials	2019
ISO/TS 21237	Nanotechnologies — Air filter media containing polymeric nanofibres — Specification of characteristics and measurement methods	2020
ISO/TS 21975	Nanotechnologies — Polymeric nanocomposite films for food packaging with barrier properties — Specification of characteristics and measurement methods	2020
ISO/TS 23459	Nanotechnologies — Assessment of protein secondary structure during an interaction with nanomaterials using ultraviolet circular dichroism	2021

Table 3 Continued. International nanotechnology starndards under Iran's leadership (2010-2023 [Sep])

Number	Title	Year
ISO/TS 23650	Nanotechnologies — Evaluation of the antimicrobial performance of textiles containing manufactured nanomaterials	2021
ISO/TS 4988	Nanotechnologies — Toxicity assessment and bioassimilation of manufactured nano-objects in suspension using the unicellular organism Tetrahymena sp.	2022
ISO/TS 10818	Nanotechnologies — Textiles containing nanomaterials and nanostructures — Superhydrophobic characteristics and durability assessment	2023

Other bilateral and multilateral international cooperations

INIC has been an active member of the Asia Nano Forum and has propsed and contributed in several initiatives in education, standardization, laboratory cooperations, and nanosafety.

International Nanotechnology Olympiad (INO) was an inititive of Iran which was welcomed by several countries from Asia and Europe. The first event was held in 2018 and the second event expected to be held in 2024. INIC has also supported various institutions in provision of nano education services abroad at public, academic and professional levels.

Asia-Europe Dialogue on Nanosafety is another initive of INIC which was welcomed by key nanosafety players from EU and Asia and it's sixth round was held in Germany in June 2023 while the first event was held in Tehran in 2017. A subsequent proposal from INIC on establishment of an international network for nano safety cooperation named INISS also is taking momentum by contribution of several stakeholders from different countries. ECO NANO is another joint project between INIC and ECO organization that is designated to boost cooperation among ECO region countries in the field of nano.

In bilateral relations, currently there are mutual agreements between Iran and countries such as Indonesia, Malaysia, Cuba, Thailand, Philippine, Oman, Brunei, South Korea, China, Armenia, Turkey, Bolivia, Slovenia, Russia, and Colombia covering various joint activities. Regarding the infrastructure, Iran has contributed by donating laboratory instruments made in Iran to several countries including Cuba, Tajikstan, Venezuella, and Bolivia.

Coating Process in PVD Machine

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