NANOMALAYSIA®

NanoMalaysia Berhad

STRATEGIC REPORT 2023

This Strategic Report is available online at www.nanomalaysia.com.my

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About The Report

Purpose of The Report

The NANOMALAYSIA Strategic Report 2023 aims to provide stakeholders with a comprehensive and consolidated assessment of Malaysia's growing nanotechnology, EV component, and Hydrogen sector. Through this report, our primary objective is to highlight the value generated by various programs and initiatives aligned with our strategic direction.

Reporting Scope and Boundaries

Unless otherwise specified, the Strategic Report presents the accomplishments of NanoMalaysia's value-creating activities up to December 31, 2023. It includes data from all NanoMalaysia business units and emphasises the key activities of our core programs. Our reporting principles and methodology adhere to the prescribed requirements governing NanoMalaysia's mandated activities.

Board of Directors Approval

The Board maintains this Strategic Report's integrity throughout the approval process. It recognises its duty to supervise the preparation and presentation of the report and confirms that it has collectively reviewed the contents of the Integrated Report. The Board is satisfied that the report offers a fair representation of NanoMalaysia's performance, showcasing our unwavering commitment to upholding the highest standards of governance and ethics.

Forward-Looking Statements

This report contains forward-looking statements that do not guarantee future developments and results as described within. These statements are subject to various risks and uncertainties and are based on assumptions that may not be accurate. They can be identified by keywords such as "estimates," "believes," "intend," "will," "plans," "outlook," and similar words when discussing future operational or financial performance. We are not obligated to update these forward-looking statements or the report's historical information. However, as time progresses, we anticipate being able to provide more comprehensive data on our focal area.

Feedback

We welcome all constructive comments, thoughts and remarks. These can be directed to:

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Chairman's Statement

Dear Esteemed Stakeholders,

I am delighted to present NanoMalaysia Berhad's Strategic Report for the year 2023, which showcases a year of remarkable achievements, advancements, and strategic growth pathways. As the Chairman of NanoMalaysia Berhad, I am filled with immense pride as we reflect on another year marked by notable milestones and accomplishments.

NanoMalaysia Berhad has made substantial strides in intellectual property, strengthening our portfolio with 13 patents, 16 copyrights, 3 trademarks, 2 industrial designs, and 1 layout design of integrated circuits. These intellectual property assets stand as a testament to our unwavering dedication to innovation and symbolise our relentless drive towards advancing technological progress in the nanotechnology sector.

Furthermore, our strategic partnerships and collaborations have played a pivotal role in furthering our mission to position Malaysia as a distinguished centre for manufacturing cutting-edge electric vehicles and energy storage components and systems. Through various initiatives spearheaded by NanoMalaysia Berhad, we have actively engaged with diverse partners to lead the development and integration of nanotechnology and energy storage technologies, encompassing batteries, ultra-capacitors, solid-state hydrogen systems, energy management systems, and monitoring systems.

With steadfast support from the Ministry of Science, Technology, and Innovation (MOSTI) and other key stakeholders, NanoMalaysia Berhad is poised to spearhead coordination and collaboration among prominent players across multiple sectors in Malaysia. Together with our esteemed partners, we are committed to driving research and development, pilot deployment, testing, certification, and eventual commercialisation of various solutions. As we navigate the dynamic landscape of the nanotechnology ecosystem, NanoMalaysia Berhad remains resolute in our dedication to fostering the widespread adoption of nanotechnology. Our strategic initiatives not only position Malaysia as a frontrunner in low-carbon mobility but also hold profound implications for the future of diverse applications. I sincerely thank our stakeholders, partners, and employees for their unwavering support and dedication. Together, we will continue to propel innovation, sustainability, and progress in the nanotechnology, hydrogen, electric mobility, and energy storage sectors.

Thank you for your continued trust and collaboration.

Prof Emeritus Dato' Ir Dr Mohamad Zawawi Bin Ismail,
Chairman of NanoMalaysia Berhad

CEO's Statement

I am honoured to present NanoMalaysia Berhad's Strategic Report for 2023. This report encapsulates our journey of relentless dedication, innovation, and strategic growth, reflecting our unwavering commitment to driving progress and prosperity in the nanotechnology sector.

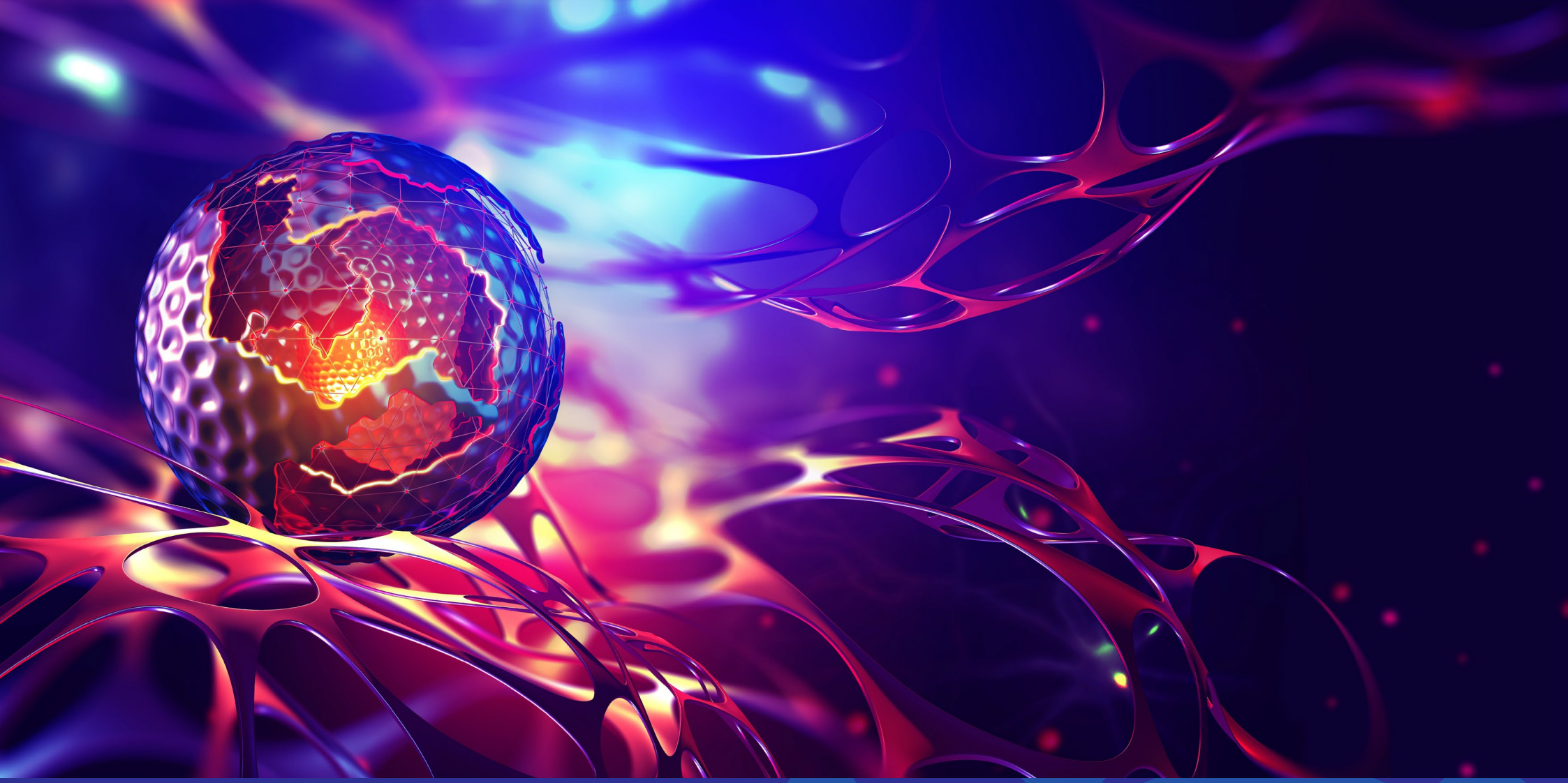
From 2016 to 2023, NanoMalaysia Berhad has achieved remarkable milestones and accomplishments, underscoring our steadfast pursuit of excellence. Our achievements snapshot reveals the successful completion of 92 product development projects and 72 scale-up projects, a testament to our commitment to innovation and technological advancement. Moreover, we are proud to have supported and created 122 joint venture/start-up companies, fostering a vibrant ecosystem of entrepreneurship and collaboration. These endeavours have not only propelled the growth of our organisation but have also contributed significantly to the socio-economic landscape of Malaysia.

One of our proudest achievements lies in the creation of high-value job opportunities, with 7,488 direct and 37,440 indirect jobs expected to be generated over the next five years, as identified by industry partners. This underscores our significant role in driving economic growth and employment creation in Malaysia. In terms of economic contribution, NanoMalaysia Berhad is poised to make a substantial impact, with a projected potential Gross National Income (GNI) contribution of RM 4.17 billion (direct) and RM 20.8 billion (indirect) over the next five years, as identified by industry experts. This reinforces our position as a key driver of the nation's economic prosperity and sustainable growth.

Furthermore, our robust intellectual property portfolio is a testament to our relentless pursuit of innovation. We have developed and filed 235 projects IPs, including 70 patents, 60 copyrights, 21 trademarks, and 4 utility innovations with MyIPO. Additionally, 248 products have been certified under NANOVerify, showcasing our unwavering commitment to quality and excellence. As we reflect on our achievements and look towards the future, NanoMalaysia Berhad remains firmly committed to driving innovation, fostering collaboration, and creating sustainable value for our stakeholders. I sincerely thank our dedicated team, partners, and stakeholders for their unwavering support and commitment.

Together, let us continue to push the boundaries of possibility, catalysing innovation and driving progress for the betterment of society and the nation.

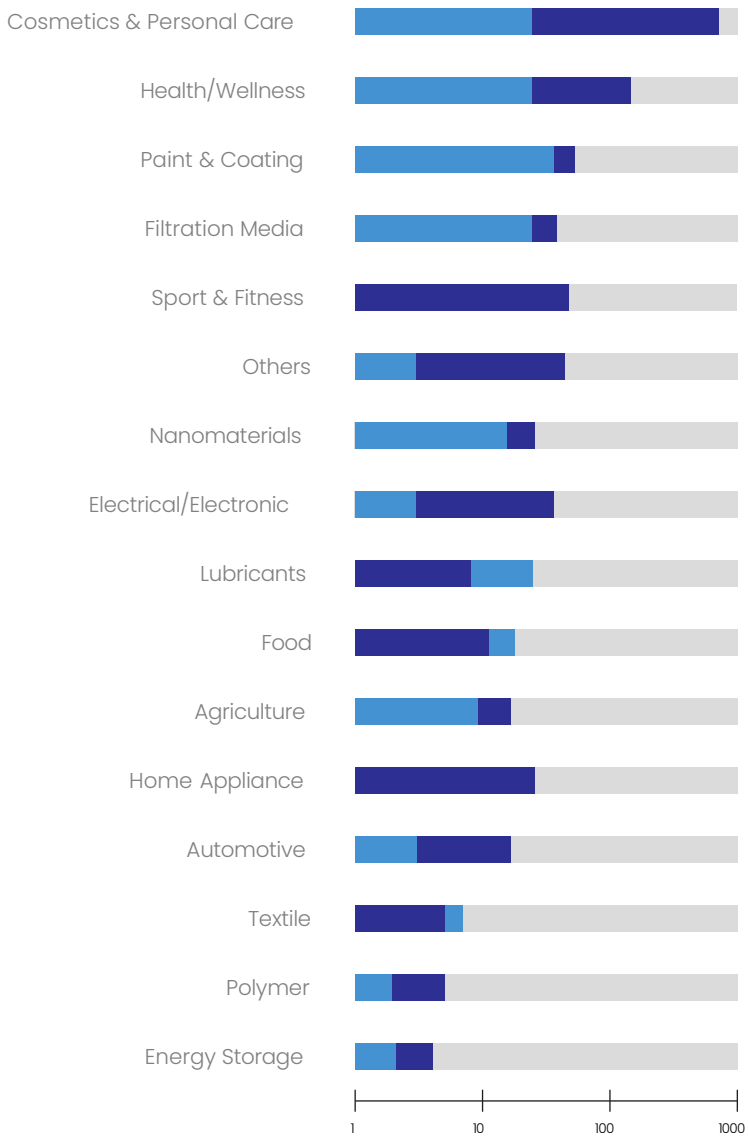
Rezal Khairi Ahmad,
Chief Executive Officer



CHAPTER 1
THE NANOTECH INDUSTRY

Malaysian Nanotechnology Landscape

Malaysian Nanoproducts, By Category In 2022 (NANOVerified vs Potential)



The field of nanotechnology has been gaining traction in Malaysia, with an increasing number of nanotechnology products hitting the market. A total of 248 products were certified from 2015 to 2023, with a significant presence of nanotechnology-verified products across multiple industries. Among the various product categories, health and wellness (39 verified products), paint and coating (37 verified products), cosmetics and personal care (34 verified products), filtration media (26 verified products) and lubricants (24 verified products) stand out as the key sectors where nanotechnology is making its mark.

The paints and coatings industry witnessed a nanotechnology revolution, with 70% verified products highlighting the increasing adoption of nanoscale materials for advanced coatings and paints with enhanced performance properties. A higher number of verified nano products from the cosmetics and personal care, followed by the health and wellness category, showcases a growing interest in utilising nanoscale materials to enhance beauty and personal care and a rising demand for nano-enabled wellness solutions.

Despite a modest number of verified nano-products, sectors like Agriculture, Food, and Lubricants show a promising ratio of verified to unverified products. This may indicate robust regulatory frameworks or a rising consumer inclination towards certified goods in these markets. Notably, verified nanoproducts are low in the Home Appliances and Renewable Energy/Energy Storage categories, indicating these are developing areas for nanotechnology application, potentially poised for future growth.

The disparity in the number of NANOVerified products over unverified products in the market reflects the potential for increased awareness and education regarding the benefits of nanotechnology verification. This could drive consumer preference towards certified nano products. This will ultimately influence companies to adhere to market compliance and innovate their products in line with consumer expectations for quality and safety.

NANOVerified

NON - Verified

Malaysian Verified Nanotechnology

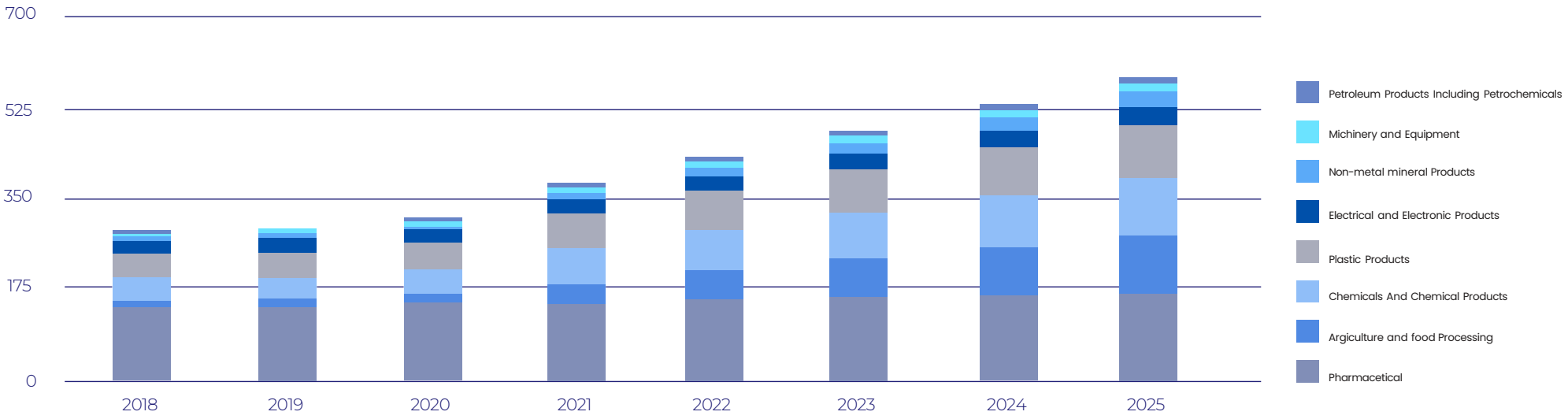
Product Market Revenue (2018-2025, RM mil) (1)

The Malaysian nanotechnology products market generated a revenue of RM503.60 million in 2022, demonstrating resilience amidst the challenges of the COVID-19 pandemic. Projections indicate a steady growth trajectory, expected to reach RM682.96 million by 2025. Forecasts suggest a robust compound annual growth rate (CAGR) of 10.9% during the forecast period of 2024-2025. Within the local nanotechnology landscape, the pharmaceutical and agriculture/food processing sectors are poised to play pivotal roles, each anticipated to command significant market shares. In 2025, the pharmaceutical industry is projected to reach RM193.56 million, while the agriculture/food processing sector is expected to achieve RM127.65 million in revenue.

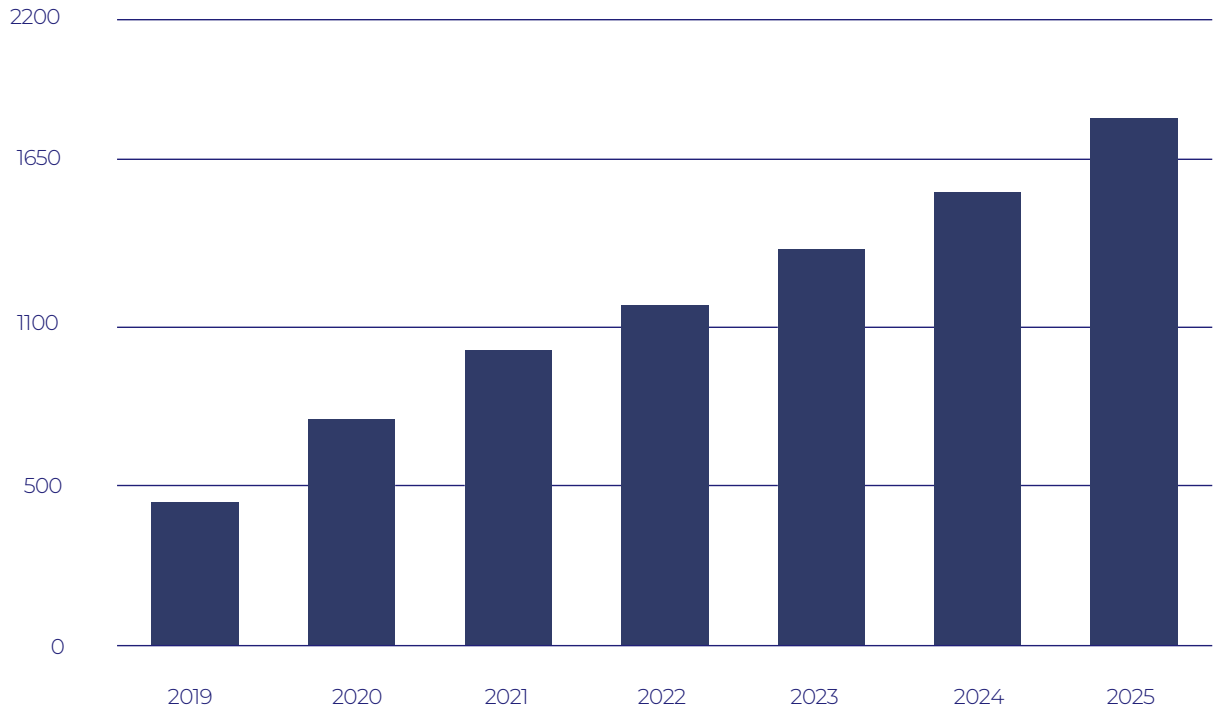
The notable expansion observed in sectors such as pharmaceuticals, chemicals, plastic products, and agriculture/food processing underscores the increasing adoption of nanotechnology. This trend reflects its growing relevance in addressing challenges stemming from the COVID-19 pandemic and enhancing agricultural productivity to tackle food security concerns in Malaysia.

The nanotechnology sector's growth in chemical and plastic products exhibits a consistent upward trajectory. Both sectors are projected to achieve significant milestones, reaching RM126.05 million and RM117.05 million by 2025. Furthermore, the attainment of targets set forth by the National Nanotechnology Policy and Strategy (NNPS) 2021-2030 is evident through the verification of 199 products and 122 companies via the NANOVerify program between 2015 and 2022, surpassing the short-term targets for 2021-2022.

As verified products and companies continue to increase, we anticipate a corresponding rise in revenue and participation across various sectors. This trend underscores the robust expansion of the nanotechnology market in Malaysia, characterised by escalating market values, diverse industry applications, and substantial growth prospects in key sectors. Consequently, the Malaysian nanotechnology market emerges as an enticing investment opportunity for strategic investors.



Growth of Potential Nanotechnology Products in Malaysia



The upward trend in nanotechnology product growth in Malaysia indicates a rising number of nano-products entering the market each year. This signals a growing interest and investment in nanotechnology research and development within Malaysia, with potential economic and technological implications across various industries and sectors in the foreseeable future.

Recognising the significance of certification within the Malaysian market, NVSB is targeting an increase in the number of certifications for 2023. Presently, 199 1,159 products (17.2%) have been certified through the NANOVerify Programme. Nanotechnology certification in Malaysia greatly enhances the market competitiveness of certified products. As competition intensifies, obtaining certification can offer a competitive advantage to products, making them more appealing to consumers and businesses.

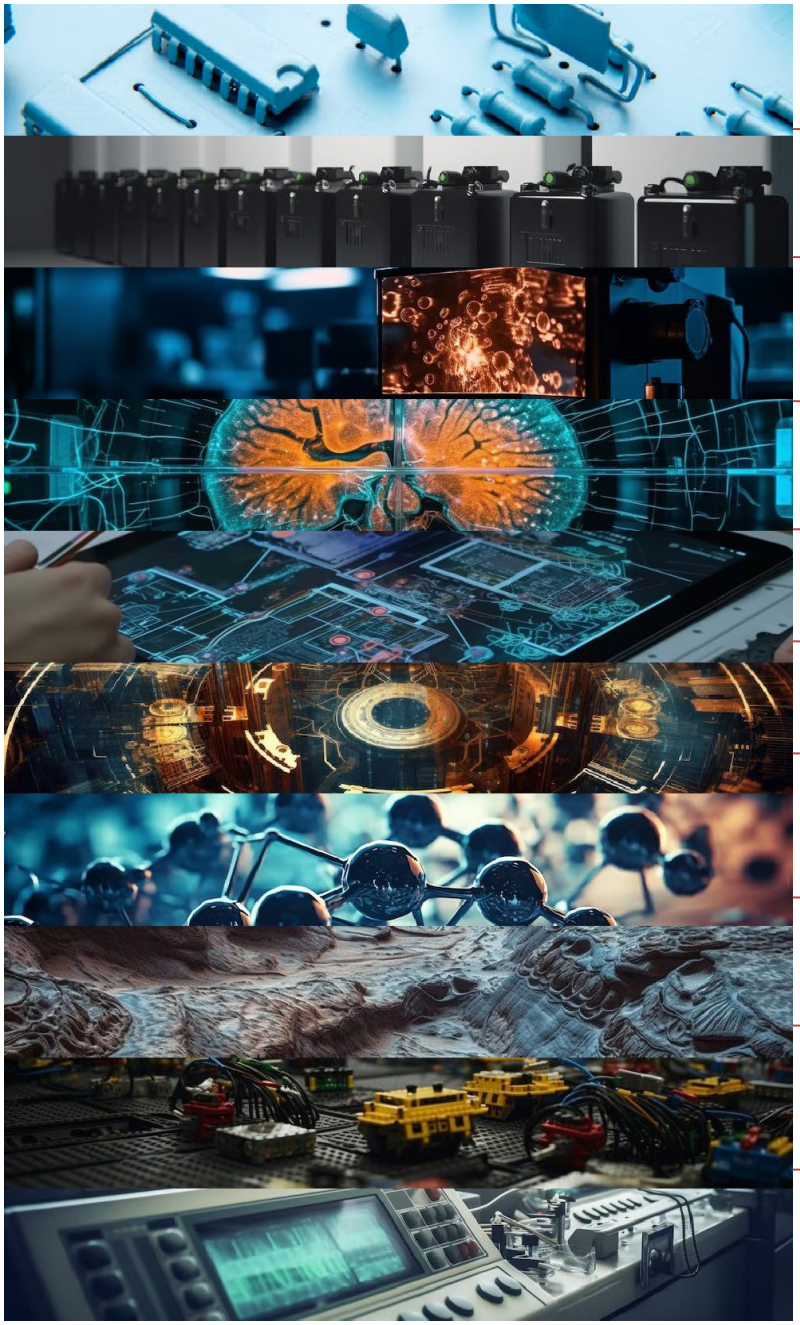
Malaysian Verified Nanotechnology

Product Market Revenue (2018-2025, RM mil) (1)

The global nanotechnology market was valued at USD 79.14 billion in 2023. It is projected to grow from USD 91.18 billion in 2024 to USD 241.2 billion by 2030, exhibiting a CAGR of 17.6% during the forecast period. In contrast, the local nanotechnology market in Malaysia was valued at RM 890 million (approximately USD 188 million) in 2023. The Malaysian nanotechnology market is projected to grow from RM 961 million (approximately USD 202 million) to RM 1.04 billion (approximately USD 228.8 million) by 2025. The exponential market growth can be attributed to several key factors, including technological advancements, the increasing integration of nanotechnologies in various industries, and supportive governmental policies promoting nanoscience research. Environmental applications of nanotechnology, particularly in pollution control and renewable energy, also play a pivotal role in propelling the market forward.

The healthcare sector has captured the largest share (25%) of the global nanotechnology market, mirroring local trends. This is primarily due to the increasing adoption of nanotechnology in developing nano diagnostics, nano-surgical robots, cell repair applications, nano biosensors, imaging and targeted drug delivery. The global increase in chronic diseases and increasing adoption of surgical procedures are expected to drive the demand for nanotechnology in producing surgical instruments and equipment. The electronics and manufacturing sectors follow closely behind with a market share of 20% and 15%, respectively.

Foresight: Emerging Nanotechnology Applications



Next-generation power semiconductors

Accelerated development has increased in wide-gap semiconductor substrates and devices using silicon carbide (SIC) or gallium nitride (GAN), aiming for early implementation.

Next-generation electricity storage devices

There is increased anticipation for the next generation of high-performance batteries, such as all solid-state, multivalent cation, metal-air, and lithium-sulphur (Li-S) batteries.

Bio-Fabrication

The emergence of 3D bioprinting, which allows for freely arranging biomaterials and cells, paves the way for its application in constructing tissues and organs, discovering new drugs, and regenerative medicine.

Neuroimaging

Remarkable technological advances to measure brain activity electrically or optically have led to the development of elucidating mechanisms for deciphering brain functions and data processing.

IoT enabled Artificial Intelligence (AI) devices

The hugely anticipated arrival of a IoT smart society based on AI and Deep Learning Technologies.

Quantum Computing

Super-fast computations through quantum mechanics and quantum gate and quantum annealing systems are expected to have applications in AI.

Porous Framework (PCP, MOF and COF)

These compounds have controllable nano spaces that could be used for highly selective adsorption/ desorption electronic/ionic conductivity and specific reactions

Topological Insulators

A candidate for next-generation electronic devices, it exhibits a unique metallic state at its boundaries (surface in 33D and edge in 2D systems) but not its interior (insulators) and supplies non-dissipative current.

Ohonon Engineering

More focused research on creating new materials and devices that treat heat at the nanoscale as phonons and control heat at origin.

Operando Measurements

There is much interest in developing operando measurements ranging from materials to organisms.

CHAPTER 2

REVOLUTIoNT: Transforming Industry Through Nanotechnology

REVOLUTIoNT

A Revolution 4.0 the Internet of Nano-Things

NanoMalaysia Berhad's REVOLUTIoNT initiative aims to instigate revolutionary changes across various industry sectors through nanotechnology. This state-of-the-art technology holds immense potential to revolutionise sectors such as information technology, homeland security, medicine, transportation, energy, food safety, and environmental science. A notable example is the Internet of Nano Things (IoNT), comprising interconnected nanosensors and nanodevices linked to the Internet.

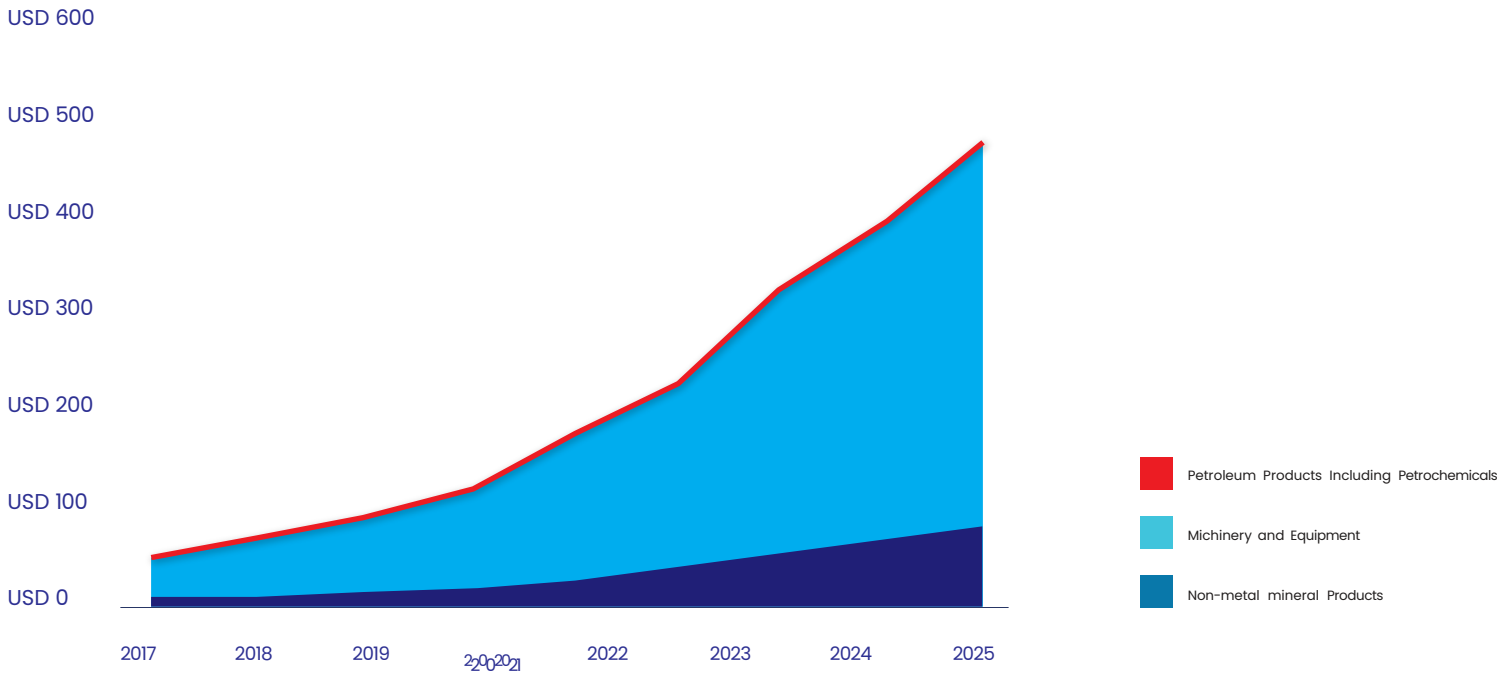
NanoMalaysia Berhad firmly believes that IoNT will catalyse Industrial Revolution 4.0, propelling transformative advancements across industries, businesses, and society. To this end, NanoMalaysia is committed to fostering industry revitalisation and promoting innovation by successfully developing and commercialising nanotechnology in Malaysia.

Global Market Review

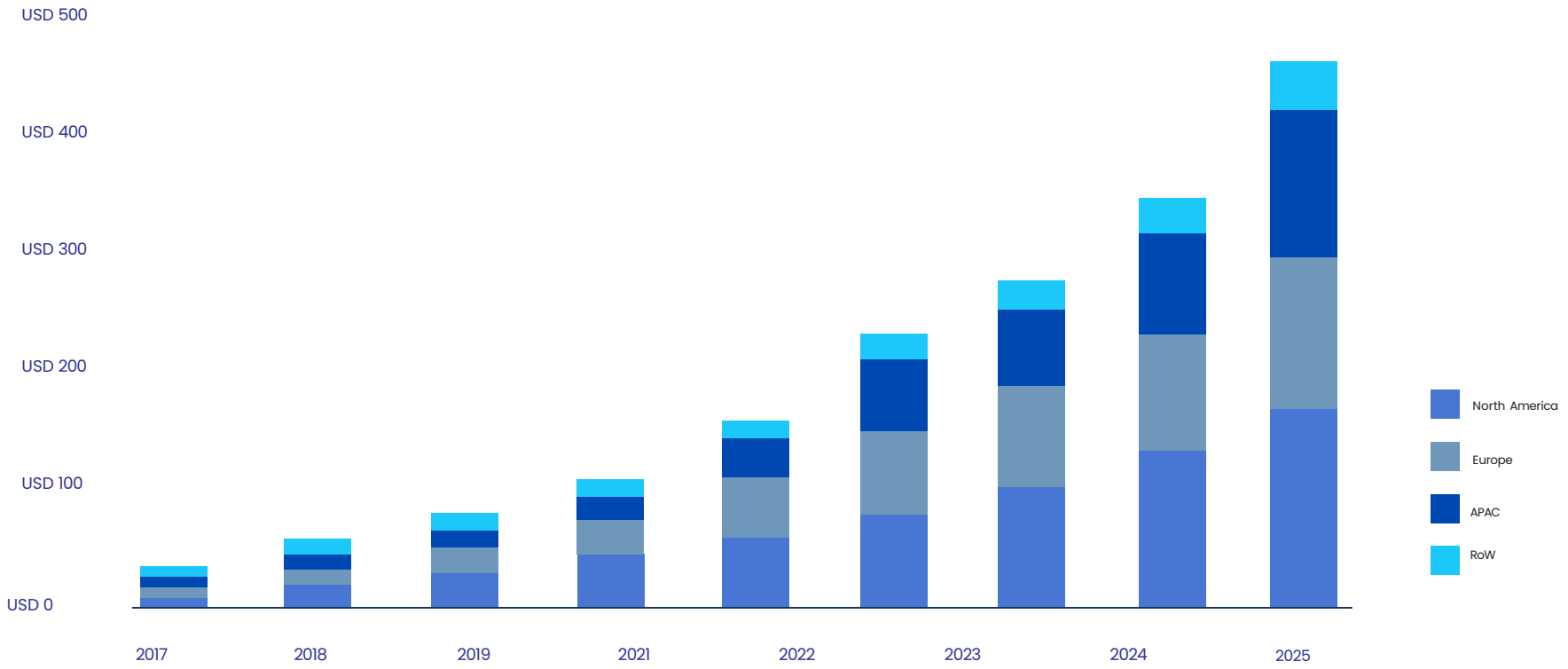
The Global IR4.0 market is projected to experience substantial growth from 2021 to 2025. With market revenue estimated at USD 87 billion in 2019, it is anticipated to exhibit a compound annual growth rate (CAGR) of 32.1% from 2020 to 2025.

The Connected Industry Building Blocks (CIBB), a subset of the IR4.0 market, is poised to capture a considerable share and exhibit substantial growth throughout the forecast period. In 2019, the revenue generated by CIBB reached USD 67.5 billion and is projected to reach USD 404.0 billion by 2025, demonstrating a robust compound annual growth rate (CAGR) of 34.1%. The CIBB comprises six distinct building blocks: cloud platform & analytics, hardware, connectivity, applications, cybersecurity, and system integration.

The IR4.0 Supporting Technologies, which form the technological subset of the IR4.0 market, encompass critical elements such as Additive Manufacturing, Augmented & Virtual Reality, Collaborative Robotics, Connected Machine Vision, Drones/ UAVs, and Self-Driving Vehicles. Despite occupying a relatively smaller market share, these supporting technologies are vital in facilitating the widespread adoption of IR4.0. In 2019, the market revenue for Supporting Technologies amounted to USD 19.5 billion, and it is projected to expand significantly to reach a market size of USD 74.2 billion by 2025. This growth is expected to be driven by a robust compound annual growth rate (CAGR) of 23.7% over the forecast period.
Source: (1) IOT Analytics



Global 4IR Market Size 2017-2025, By Region(1)



In 2019, the APAC region emerged as the dominant market in the global IR4.0 landscape, holding the largest market share valued at approximately USD 30.6 billion. This trend is expected to continue, as the region is projected to witness significant growth, reaching USD 184.7 billion by 2025. This remarkable expansion is forecasted to advance at a robust compound annual growth rate (CAGR) of 33%. Consequently, the influence of IR4.0 in the APAC region is set to extend beyond the forecast period, continuing to shape the global market.

The North American market, encompassing the United States and Canada, is the second-largest market in the IR4.0 landscape. In 2019, the total market revenue for this region amounted to USD 26.35 billion. It is projected to experience substantial growth, with an estimated market size of USD 151.1 billion by 2025. This growth is anticipated to progress at a rate of 32.6%.

The European market, which includes European Russia, reached a valuation of USD 23.7 billion in 2019. It is expected to grow at 31.2% during the forecast period and reach USD 115.7 billion by the end of the forecast period.

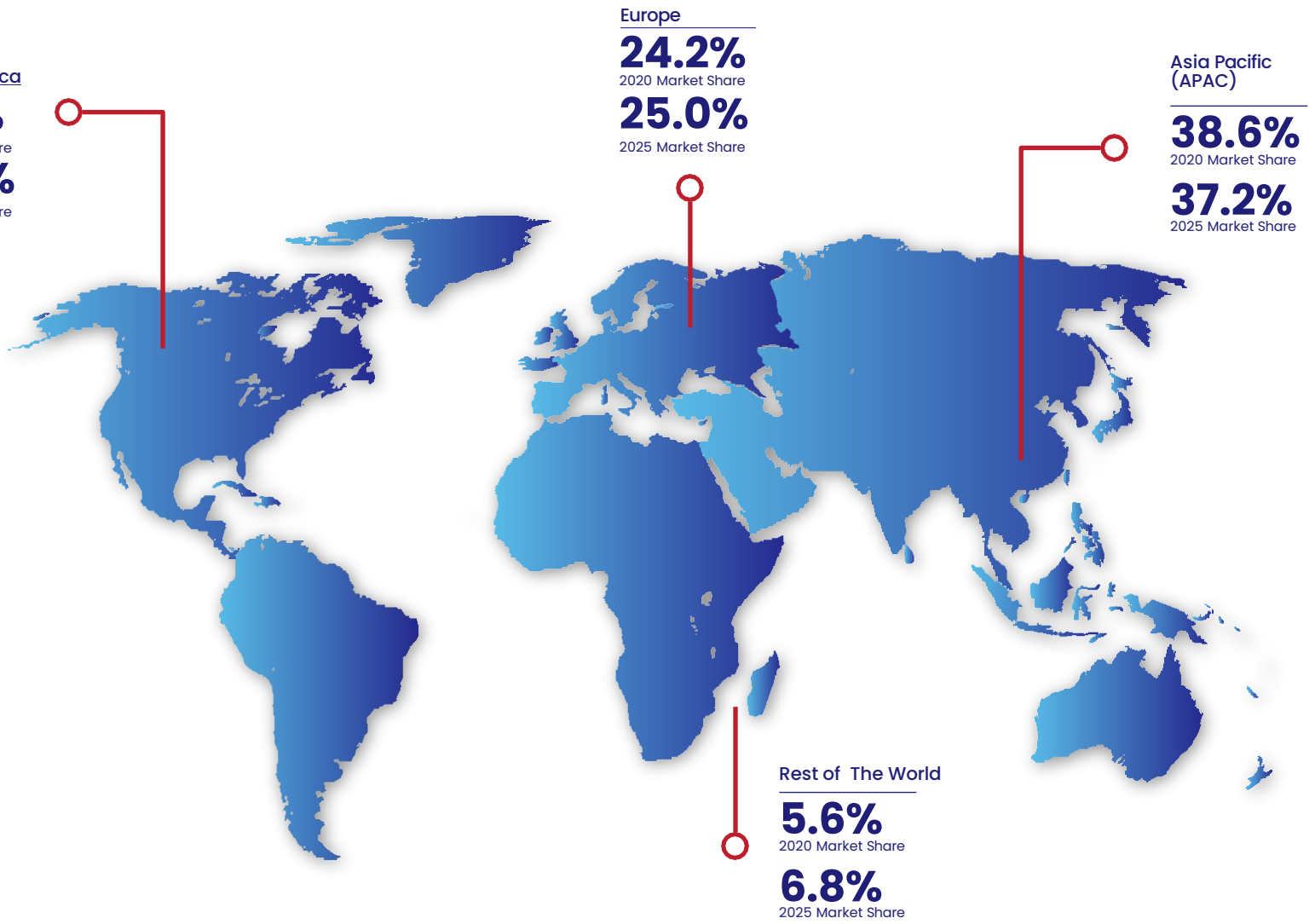
Source: (1) IOT Analytics

2020 Vs 2025 Landscape:

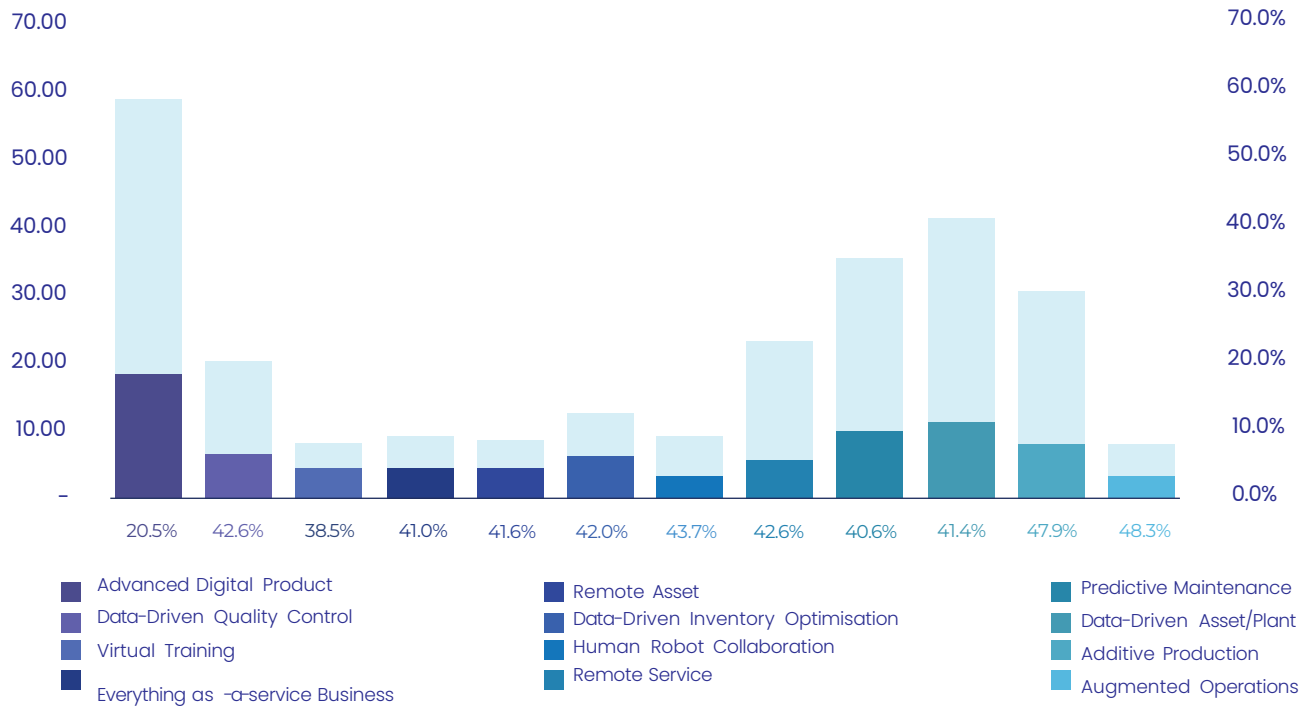
A Glimpse on the IR4.0 Future (1)

The APAC and North American regions are anticipated to exhibit impressive growth rates of 33% and 32%, respectively, strengthening their global positions by 2025. In contrast, Europe and the rest of the world are expected to hold a smaller market share by the conclusion of the forecast period.

Source: (1) IOT Analytics



4IR Use Cases (2020 vs 2025)(1)



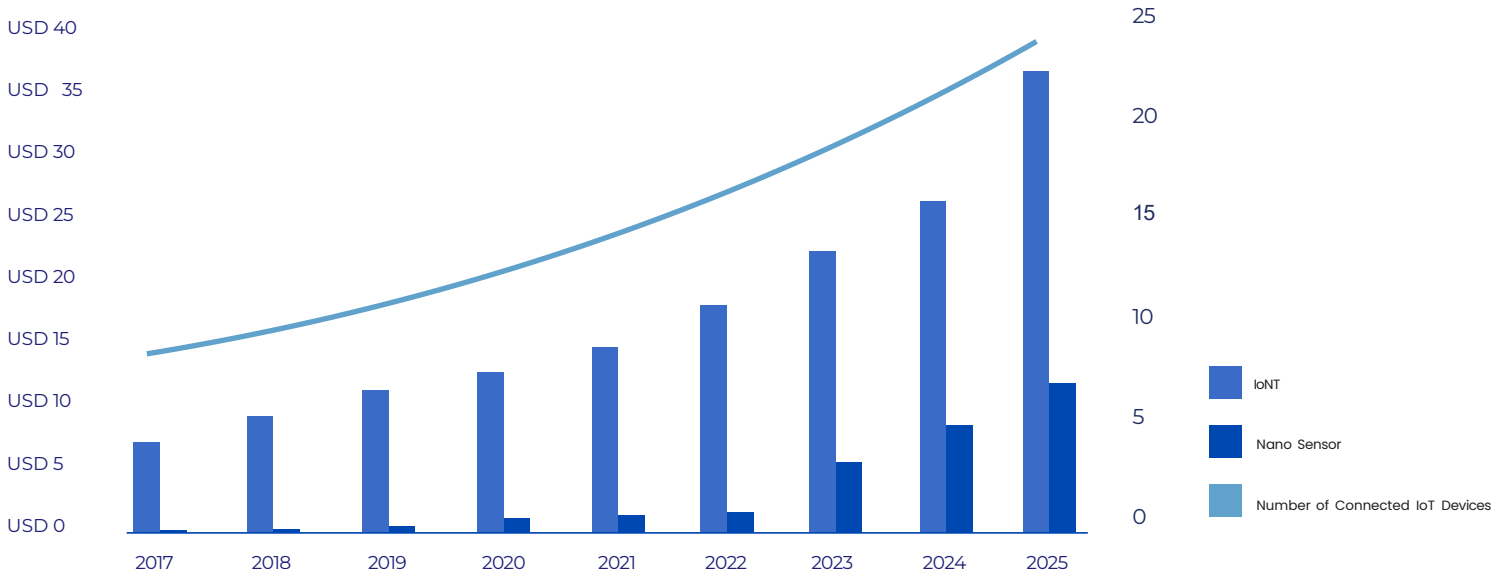
The bar chart depicts the 12 applications of Industry 4.0 (IR4.0) and highlights notable growth and market dominance fluctuations from 2020 to 2025. Among these applications, Advanced Digital Product Development emerged as the primary revenue contributor- tor throughout this period. Starting at USD 16.4 billion in 2020, it will escalate to USD 41.7 billion by 2025. Despite showing a slower growth rate than other applications, Advanced Digital Product Development is anticipated to sustain its leading market position for the next decade to fifteen years if current trends persist.

In 2020, the second use case, Data-driven Asset/Plant Performance Optimisation, boasted a market value of USD 6.11 billion. Projections indicate an impressive compound annual growth rate (CAGR) of 41.4% for this sector. Conversely, Predictive Maintenance secured the position as the third-largest revenue generator, with a total market revenue of USD 5.5 billion in 2020. Forecasts suggest it will surge to USD 30.3 billion by 2025, reflecting a significant CAGR of 40.6%.

Over the next five years, the Additive Production and Augmented Operations use cases are anticipated to grow significantly, with compound annual growth rates (CAGR) of 47.9% and 48.3%, respectively. Nonetheless, their market shares will be comparatively modest in 2020. Consequently, it remains to be seen how these use cases will develop and influence the market in the future. Thorough observation and analysis are required to ascertain their trajectory in the future.

Source: (1) IOT Analytics.

Global Internet of-Nano-Things (IoNT) Market (2017-2025)(1)(2)



The chart provides insights into the impact of the Internet of Nano-Things (IoNT) on the global market over the next five years. The continuous innovation in the nanosensors industry will drive exponential advancements in IoNT. Consequently, there is an anticipated rapid growth in the number of connected IoT devices, increasing from 9.9 billion devices to 21.5 billion devices by 2025. This significant growth highlights the transformative potential of IoNT and its role in shaping the future of the global market.

In 2020, the nanosensors market was valued at USD 1.2 billion, exhibiting a remarkable compound annual growth rate (CAGR) of 53.58%. The market is forecasted to experience further growth, reaching USD 10.26 billion by 2025 [2]. The increasing number of nanosensors in the market is expected to drive the demand in application industries, thereby stimulating the growth of the Internet of Nano-Things (IoNT) market. The IoNT market, valued at USD 12.78 billion in 2020, is projected to reach USD 36.17 billion by 2025, with a CAGR of 24.12%. This demonstrates the substantial growth potential and expanding market for IoNT driven by the demand for nanosensors.

Another technological subset, Nano Positioning Systems, is poised to capitalise on this growth. With a market value of USD 119 million in 2020, it is projected to reach USD 277.3 million by 2025, exhibiting a compound annual growth rate (CAGR) of 18.39%. This indicates a significant expansion for the Nano Positioning Systems market and highlights the increasing demand and adoption of these systems in various industries.

Continuous trends over the forecast period will be significantly influenced by the introduction of new technologies and the increased adoption of the Internet of Nano-Things (IoNT) among both the B2B and B2C sectors. These developments will profoundly impact various industries, shaping how businesses operate, and consumers interact with technology. As a result, the ongoing advancements in IoNT and its integration into everyday life will drive and shape the continuous trends observed in the market during the forecast period.

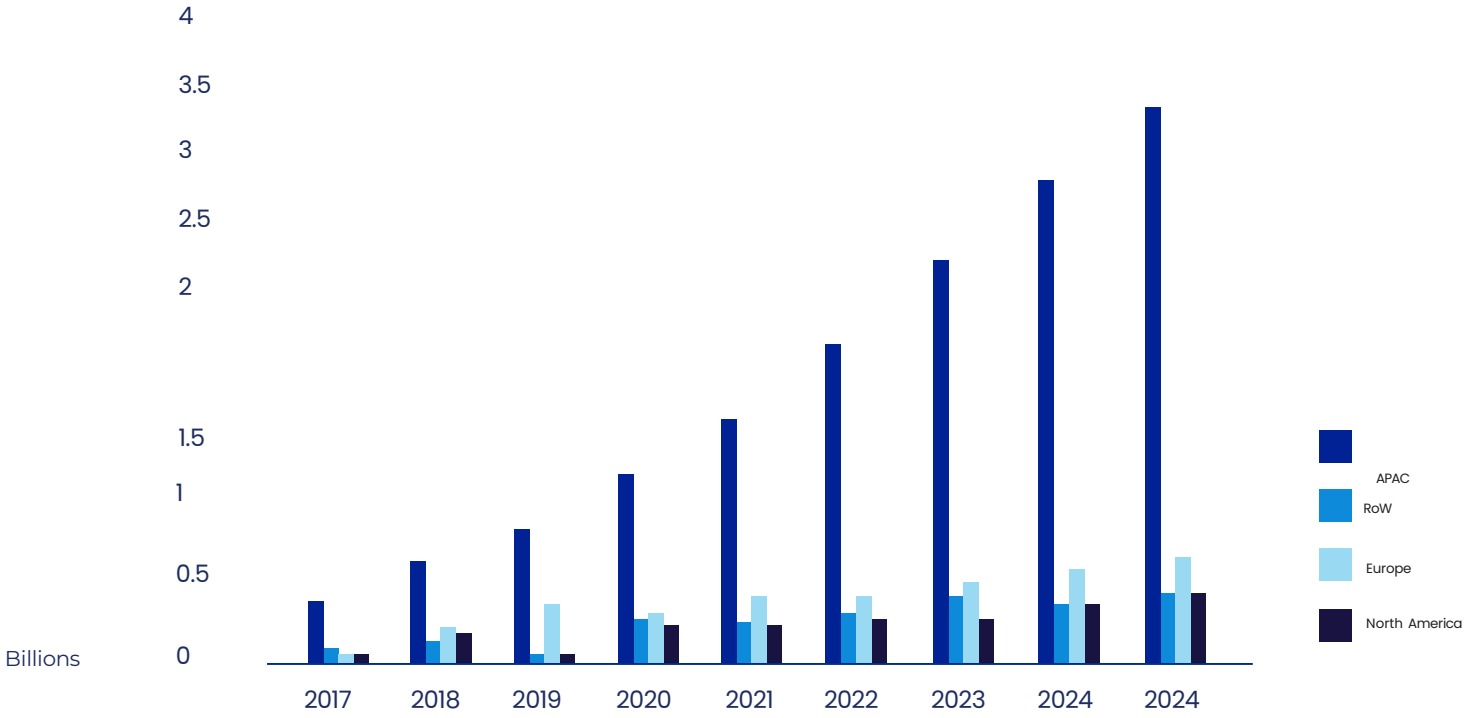
Number of Cellular IoT Connections, by Region (2020-2025)(1)

The chart illustrates the projected shaping of the global market through the increasing adoption of the Internet of Nano-Things (IoNT). According to research conducted by Ericsson in 2018, there is a direct correlation between IoT connections and market growth. The Asia-Pacific (APAC) region will hold the largest market share in 2020 and is expected to remain the most promising region. This can be attributed to the region's large population and numerous economic powerhouses. In 2019, APAC recorded 857.14 million Cellular IoT Connections, and this number is projected to reach 3.39 billion in 2025, representing a growth rate of 23.8% during the forecast period of 2020-2025.

Europe holds the second-largest number of IoT connections, with 260.3 million in 2020. It is expected to reach 678 million connections in 2025, exhibiting a compound annual growth rate (CAGR) of 16.9%. Although Europe's growth rate is similar to North America's, the region has fewer connections. In 2019, North America had 127 million connections, which is anticipated to increase to 331.2 million by 2025.

These trends highlight the significant growth potential and increasing adoption of IoT connections. Regarding market size and growth, APAC leads the way, followed by Europe and North America.

Source: (1)Ericsson Mobility Report



Global Internet of Nano-Things (IONT)

Market(2020-2025) by Sub-Sector

In 2019, the Smart City sub-sector was valued at USD 2.32 billion, and it is projected to reach USD 8.81 billion by 2025, demonstrating a compound annual growth rate (CAGR) of 24.7%. This sub-sector shows significant growth potential as cities increasingly embrace smart technologies to enhance efficiency, sustainability, and quality of life.

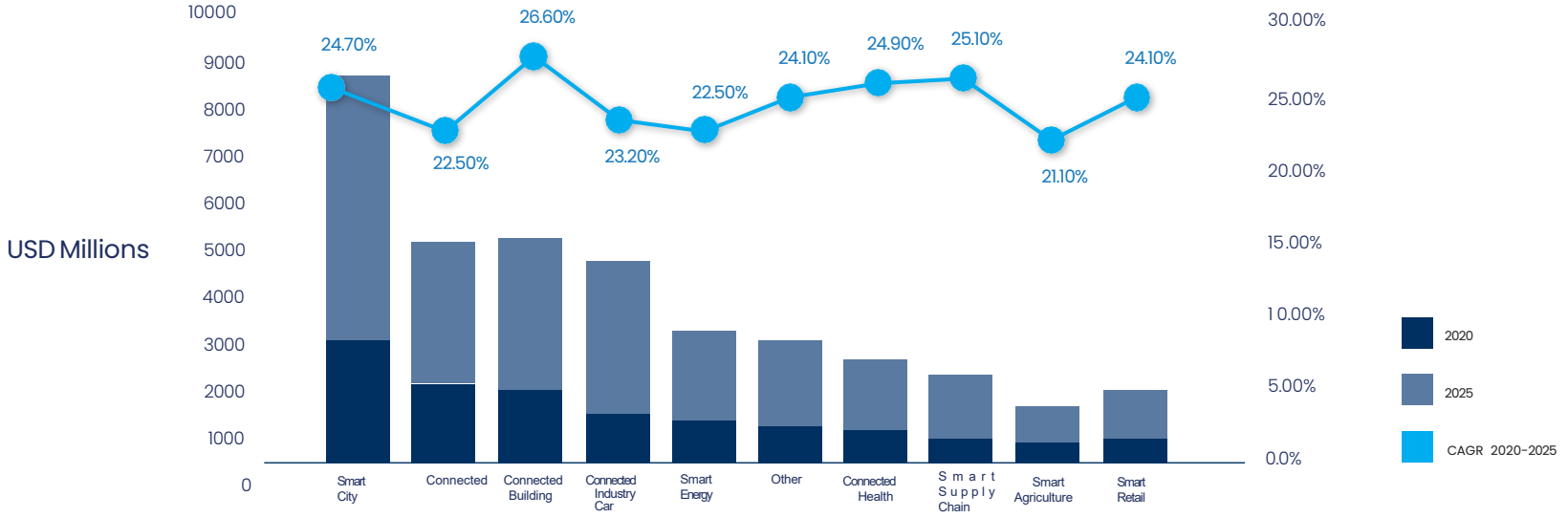
The Connected Industry sub-sector holds the second-largest market share, generating USD 1.61 billion in 2019. It is expected to reach USD 5.3 billion by 2025, with a CAGR of 22.5%. This sub-sector encompasses industries that leverage connectivity and IoT technologies to optimise operations, improve productivity, and drive innovation.

These trends indicate the importance of innovative city initiatives and connected industries, with substantial market growth anticipated in both sub-sectors. As technology advances and cities and industries embrace digital transformation, smart solutions and connectivity demand are expected to fuel the market's expansion.

However, in 2025, the Connected Building subsector is anticipated to surpass both the Smart City and Connected Industry subsector in market size. With a remarkable growth rate of 26.6%, the Connected Building subsector is poised to experience significant expansion and become a key player in the market.

Connected Building refers to integrating smart technologies and IoT solutions in buildings to enhance energy efficiency, security, comfort, and overall operational performance. This sub-sector's rapid growth can be attributed to the increasing adoption of smart building solutions driven by the need for sustainable and energy-efficient infrastructure.

The projected growth of the Connected Building sub-sector highlights the rising demand for intelligent building systems and the transformation of traditional structures into digitally enabled environments. As technological advancements continue to shape the real estate and construction industries, the Connected Building subsector is expected to play a crucial role in the future of smart infrastructure.

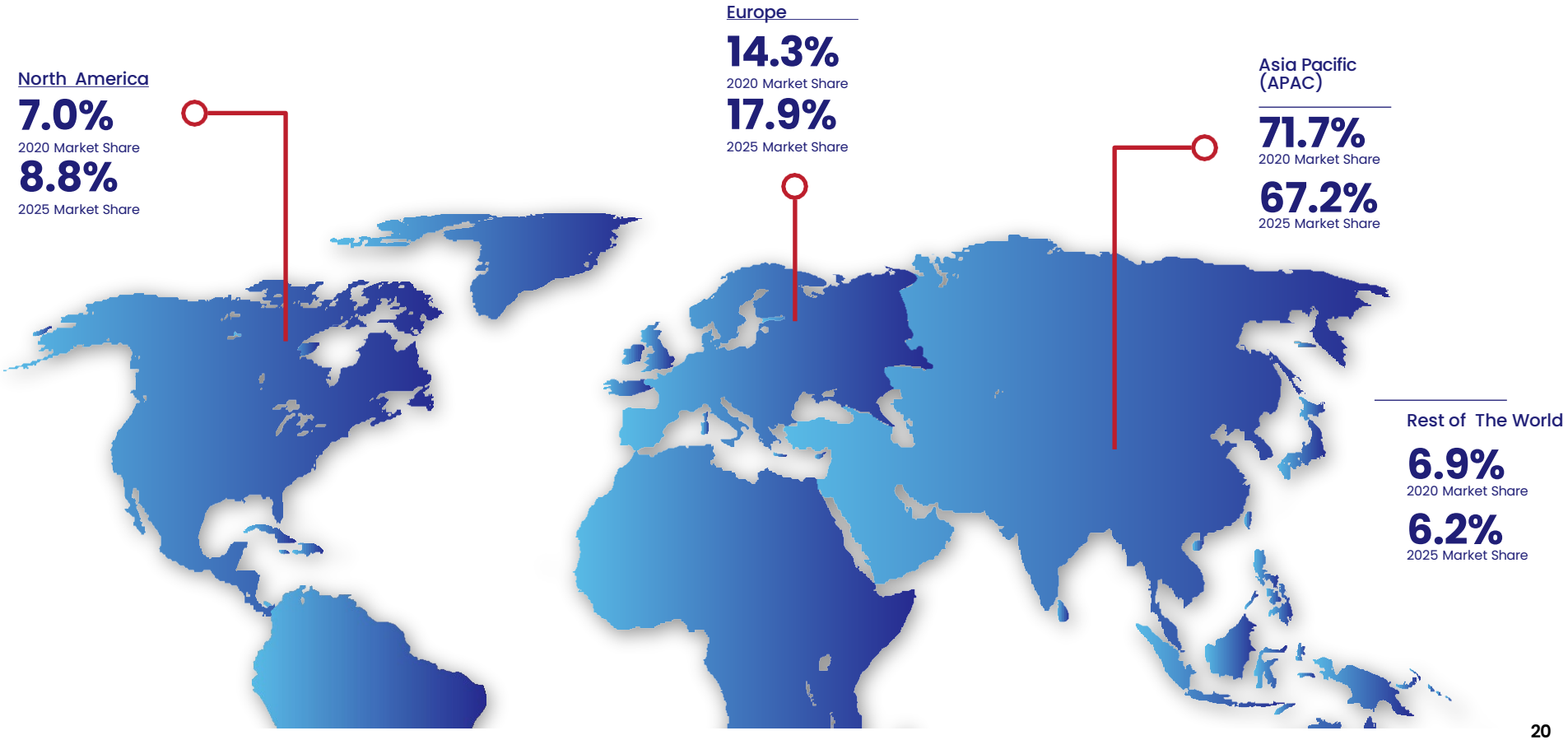


2020 Vs 2025 Landscape:

A Glimpse on the IR4.0 Future (1)

The IoNT (Internet of Nano Things) global market is a notable concentration of key players. North American companies hold a considerable share, closely followed by their European counterparts. However, there's a discernible shift underway as more participants from the APAC (Asia-Pacific) region step into the global arena, aiming to solidify their position and expand their market share in the IoNT industry. This trend is propelled by a significant surge in market revenue within APAC, enticing more contenders to enter the global competition and vie for prominence on the international stage.

During the forecast period, APAC and other global regions are anticipated to substantially increase market revenue, propelled by their remarkable growth rates. In contrast, North America and Europe are forecasted to witness a decline in market share. This transformation can be attributed to the heightened revenue generated in APAC and other regions, underscoring their escalating significance and influence within the market landscape.



Malaysian 4IR Market Insight (2020-2025)(1)(2)(3)

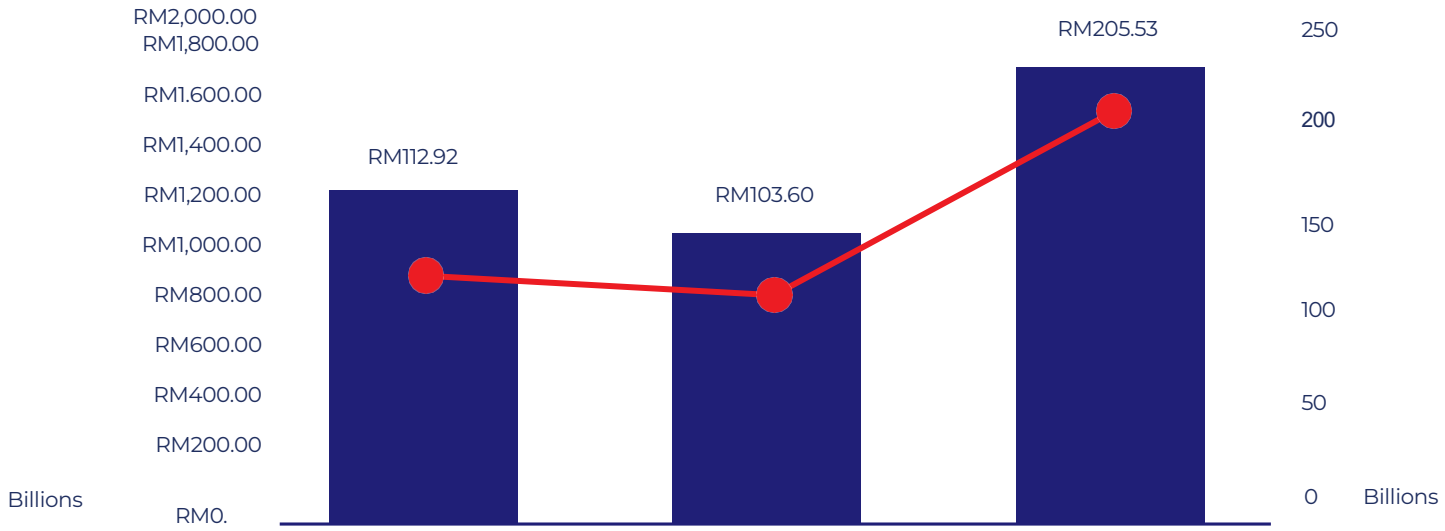
A Glimpse on the IR4.0 Future(1)

In 2019, the Malaysian manufacturing sector boasted a total sales value of RM 1.376 trillion. However, the advent of the COVID-19 pandemic led to an anticipated decrease in total sales, dropping to RM 1.212 trillion in 2021. Despite these challenges, there's a sense of optimism regarding the market's recovery in the post-COVID-19 era, starting from 2022 and extending until 2025. We anticipate a resurgence in market revenue, reaching RM 1.864 trillion during this period.

The COVID-19 pandemic has spurred a transformation within the Malaysian manufacturing sector, prompting a strategic pivot towards high-technology, innovative, and high-value-added industries. This strategic shift encompasses sectors such as Electrical & Electronics, Machine & Equipment, Chemicals, and Medical Devices, aligning with the objectives of the Industry4WRD initiative.

By 2025, the market opportunities for Industry 4.0 (IR4.0) in Malaysia are forecasted to expand significantly, reaching RM 205.5 billion. This growth is primarily driven by the transformation and upscaling efforts of small and medium enterprises (SMEs) as they endeavour to maintain competitiveness within the market. Recognising the pivotal role of disruptive technologies and innovation, these SMEs actively embrace them to leverage their advantages. This proactive stance allows them to adeptly navigate the evolving business terrain and capitalise on the opportunities of Industry 4.0.

Source: [1] IOT Analytics. [2] Industry4WRD National Policy [3] Jabatan Statistik Negara



Malaysian IoNT Market Opportunities (2020 Vs 2025) (In Millions, RM)

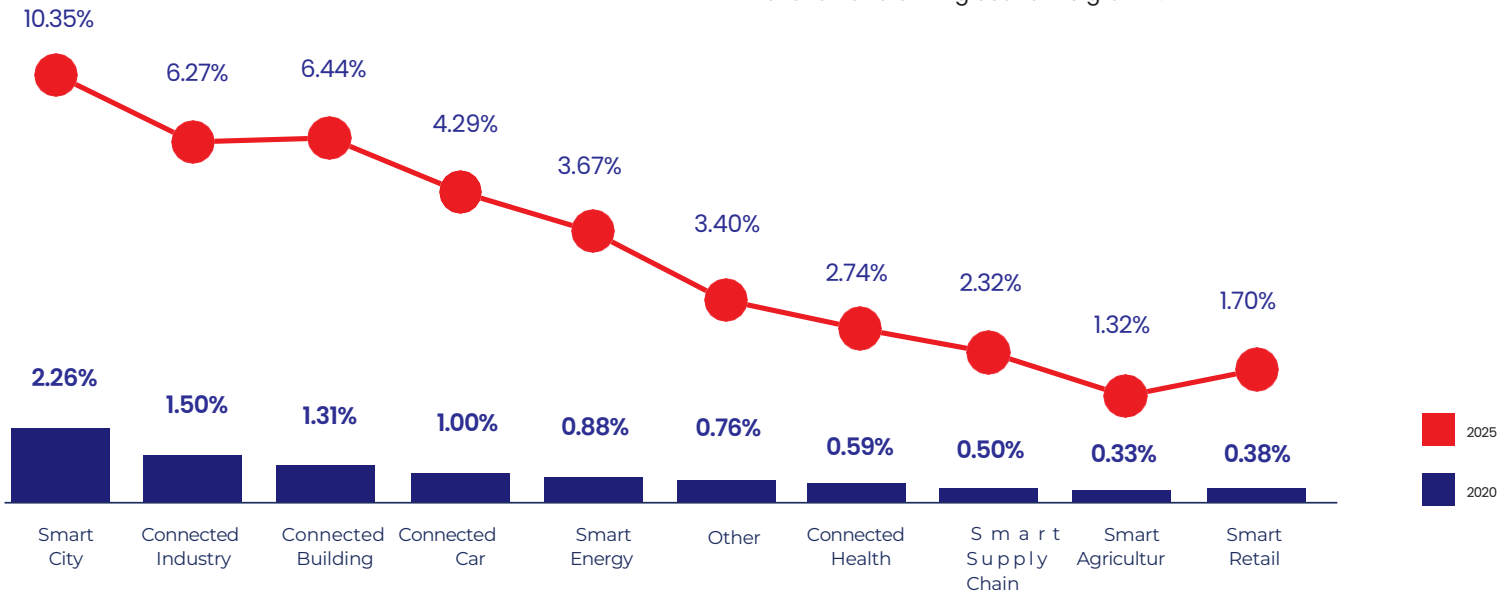
The Internet of Nano-Things (IoNT) market opportunities are projected to grow significantly in Malaysia. By 2025, these opportunities are forecasted to reach RM 42.5 billion, a substantial increase from the estimated value of RM 9.5 billion in 2020. This growth can be attributed to advancements in nanosensor technology and the development of robust ICT infrastructures in the country.

Among the various sectors within IoNT, smart cities are expected to hold the largest market share, accounting for 24.3% of the total IoNT market. This is primarily due to the rapid increase in high-tier urban areas, leading to a greater demand for smart city solutions. The rising number of connected buildings and cars also contributes to the growth of the IoNT market in Malaysia. These segments collectively comprise RM 17.05 billion of the total IoNT market revenue in the country.

The introduction of Internet of Nano-Things (IoNT) technology is set to revolutionise the medical industry, bringing in additional revenue of RM 2.74 billion. This advancement will pave the way for developing intelligent supply chains and innovative retail solutions, creating a new ecosystem projected to generate a market worth RM 4.02 billion by 2025.

Adopting smart agriculture becomes crucial to increasing self-sufficiency levels (SSL) for Malaysia's growing population, particularly with limited agricultural lands. This approach aims to enhance crop yield in quantity and quality. By 2025, the smart agriculture market is estimated to reach a value of RM 1.32 billion.

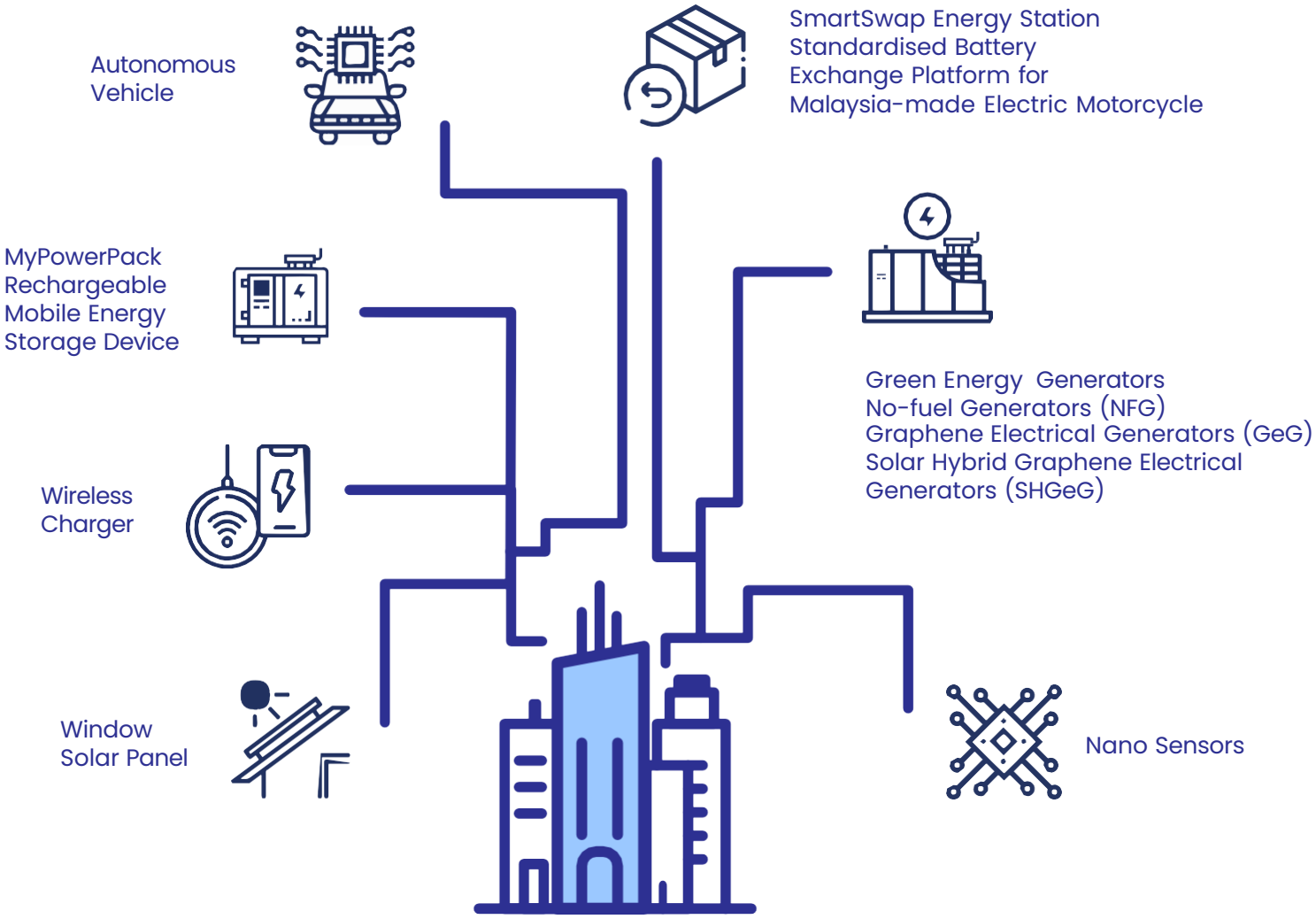
Implementing IoNT and the emergence of smart supply chains, smart retail, and smart agriculture will bring about significant transformations in various industries, fostering innovation and driving economic growth.



Source: [1] IOT Analytics. [2] Industry4WRD National Policy [3] Jabatan Statistik Negara

REVOLUTIoNT 4IR Building-Block Projects

Supporting the 4th Industrial Revolution



CHAPTER 3

Embracing the Fourth Industrial Revolution

Driving Growth with the Internet of Nano Things: NanoMalaysia's Strategic Approach

NanoMalaysia was established as the premier agency in Malaysia dedicated to advancing the commercialization of nanotechnology. Our fundamental objective is to provide the industry with vital technology and business leadership, ensuring sustainable and long-term growth within the nanotechnology sector.

To realise our strategic growth objectives, we have developed a comprehensive strategy that capitalises on the opportunities presented by the Fourth Industrial Revolution's (4IR) Internet of Nano Things (IoNT). IoNT involves the integration of nanosensors and nanodevices with the Internet, paving the way for new standards based on the Internet of Things (IoT). IoNT will be the primary catalyst for 4IR, driving transformative changes across industries, businesses, and society.

Our primary focus is capturing revenue streams associated with nanotechnology and IoNT-enabled products and applications. This is accomplished through targeted investments of financial and human resources in viable business ventures and projects offering realistic and high-value returns in the medium to long term. Additionally, we prioritise national agendas related to job creation and promoting an environmentally sustainable future.

Our primary emphasis lies in implementing our RevolutIoNT strategic campaign in the short to medium term. This campaign is the driving force to mobilise the local industry and aligns with our overarching vision of spearheading the Nanotechnology Revolution in Malaysia. The RevolutIoNT strategic blueprint encompasses the diverse benefits of nanotechnology, emphasising enhanced and efficient solutions within key sectors such as food and agriculture, wellness, medical and healthcare, electronic devices and systems, and energy and the environment.

To generate returns for our stakeholders, we have developed several programs aimed at catalysing the growth and development of the nascent nanotechnology sector in Malaysia. We support esteemed local and multinational companies based in Malaysia and local small and medium enterprises (SMEs).

These impactful programs were devised by the 12th Malaysian Plan (12MP), which identifies the commercialisation of nanotechnology as a critical driver for high-growth potential, capable of propelling national economic development. Aligned with this strategic vision, we are spearheading initiatives to facilitate the commercialisation of nanotechnology through dedicated projects focused on product development and scaling. By leveraging these initiatives, we aim to fuel the progress and maturation of the nanotechnology industry in Malaysia, fostering a vibrant ecosystem while delivering substantial economic benefits.

NanoMalaysia Programmes

REVOLUTIoNT
A Revolution 4.0 the Internet of Nano-Things

National Graphene Action Plan

Product development and commercialisation programme

Produces intellectual Property and Products Focuses on 5 Key Applications:

- Lithium-ion battery
- Conductive Inks
- Rubber Additives
- Plastic Additives
- Nanofluids

Experimental and Rapid R&D

iNanovation

Product development and commercialisation programme based on broader nanotech innovation

Produces intellectual Property and products focusing on 4 Jumpstart Sectors:

Electronics Devices and System
Food and Agriculture
Energy and Environment Wellness, Medical and Healthcare

Experimental and Rapid R&D

NANOVerify Certification Programme

Strengthen product reputation and credibility in local and international markets by creating positive brand association

Increase consumer awareness

4th Industrial Revolution [Internet of Nano Things (IoNT)

RevolutioNT Strategic Blueprint

Capturing opportunities with NanoMalaysia programmes via product development/scale-up projects and commercialisation activities

People, Planet, Profit

Transitioning from the 11th Malaysia Plan to the 12th Malaysia Plan

11th Malaysia Plan Nanotechnology Commercialisation Programme


Sensors


Fuel Cells

Artificial Intelligence

Radio Frequancy identification


Solar Panels and light Energy Panels


Smart City


Internet of Nano Things (IoNT)


Electric Vehicles


Energy Storage


Autonomous Vehicles


Robotics


3D Printing

12th Malaysia Plan Nanotechnology Commercialisation Programme - REVOLUTIoNT

REVOLUTIoNT
A Revolution 4.0 the Internet of Nano-Things
GRAPHENOVATION iNanovation

HYDROGEN ECONANOMY

NMB's on-site generated H2 technology to create a National Hydrogen Industrial Ecosystem for the energy sector

NREGS
NANOTECH REMOTE ENERGY SYSTEM

NMB's long-range wireless charging technology creates new energy transfer applications for the electronics and automotive sectors

CHAPTER 4

Forging a Sustainable Future: Trends and Impact in Malaysia's Nanotechnology Landscape

Sustainable Development Goals through the Lens of Environmental, Social and Governance.

The United Nations Sustainable Development Goals (SDGs) are harmoniously aligned with the principles of Environmental, Social, and Governance (ESG) criteria, as shown in the Figure below. Both frameworks emphasise fostering a sustainable and inclusive future through responsible business, governance, and societal actions.

In Malaysia, companies increasingly recognise the interconnection between the United Nations Sustainable Development Goals (SDGs) and Environmental, Social, and Governance (ESG) criteria. By embracing ESG principles, Malaysian firms contribute to achieving the SDGs, promoting long-term sustainability, ethical conduct, and inclusive growth while strengthening their competitiveness and resilience in the global market. By examining the effects of the Environment, Social, and Governance (ESG) standards on Malaysian companies, the market data showcases the influence of the United Nations Sustainable Development Goals (SDGs) on these businesses.

Key Drivers and Trends Shaping the UN SDG in the Nanotechnology Market in Malaysia

The growth of the nanotechnology market has generated revenue of RM503.60 million in 2022 and is forecasted to grow to RM682.96 million by 2025. It is supported by initiatives that are in alignment with the United Nations Sustainable Development Goals (SDGs) through the following key drivers and trends:

Sustainability

Nanotechnology offers potential solutions to several sustainability challenges, particularly on the:

- Clean energy production
- Efficient water treatment and
- Advanced healthcare technologies

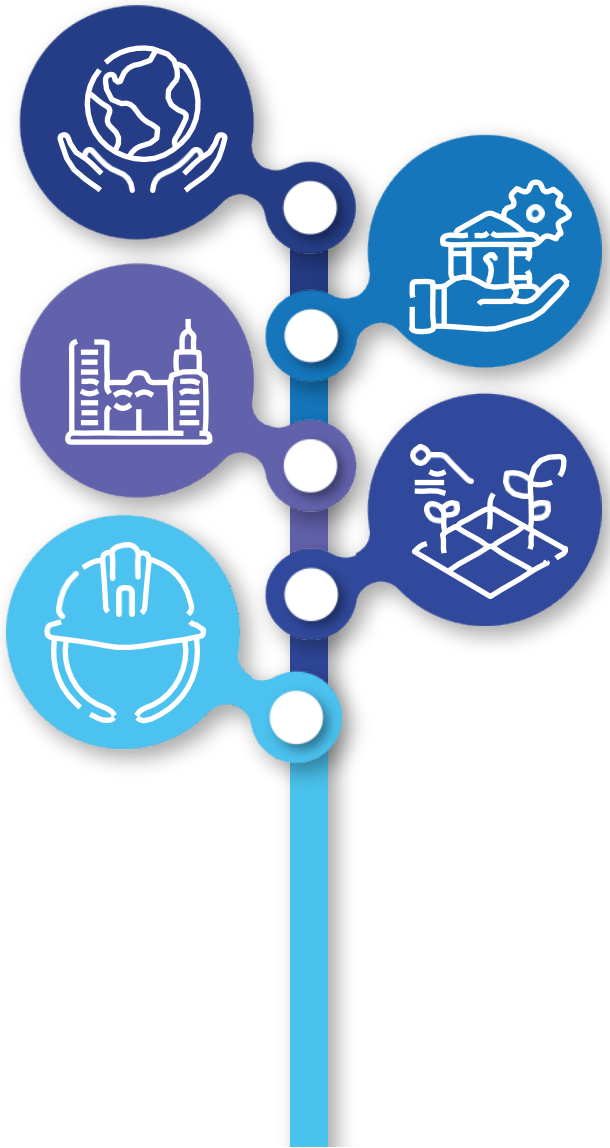
Urban Development

Development of more efficient energy systems, cleaner water, and waste management processes, or even "smart" materials for construction that align with SDG 11 (Sustainable Cities and Communities)

Workplace Safety and Health

Applying nanoparticles to enhance the strength and durability of construction materials reduces the risks of accidents.

Nanotechnology-enabled sensors can detect hazardous conditions in mining operations, promoting safer work environments. The key driver aligned with SDG 9 (Industry, Innovation, and Infrastructure)



Government support through policies, strategies and incentives boost the growth of the nanotechnology market in Malaysia through the National Nanotechnology Policy and Strategy 2021 – 2030. This aligns with SDG 17 (Partnerships for the Goals), which encourages collaboration among diverse stakeholders, including the public, private, and academia, to work collectively towards shared objectives.

Sustainability

Urban Development

Nano-fertilisers and nano-pesticides allow more targeted application, reducing runoff and contamination. This nanotechnology aligns with SDG 2 (Zero Hunger) and SDG 12 (Responsible Consumption and Production).

Key Drivers and Trends Shaping the UN SDG in the Nanotechnology Market in Malaysia

The percentage of Malaysian companies' contribution to the specific SDGs is indicated according to the analytics performed on the impact of UN ESG and SDG on Malaysian companies. The nanotechnology application in achieving the significant contribution to SDGs concerning the role of nanotechnology in specific Sustainable Development Goals, as tabulated in the table, is articulated below:

1. **SDG 2 (Zero Hunger)**: Nanotechnologycan improve agricultural productivity and sustainability, contributing to food security. This can be achieved throughnano-fertilizers for improved nutrient absorption, nano-pesticides for more effective pest control, and nanosensors for precision farming.

2. **SDG 3 (Good Health and Well-being)**: Nanotechnology can drive advances in healthcare by contributing to the development of new treatments and diagnostics. This includes targeted drug delivery systems, nanoscale imaging techniques, and nanomaterial-based sensors for early disease detection.

3. **SDG 6 (Clean Water and Sanitation)**: Nanotechnology can contribute to water purification and desalination technologies, ensuring clean drinking water. Nanoparticlescan be used to remove pollutants and pathogens from water, and nanomaterials can enhance the efficiency of desalination processes.

4. **SDG 7 (Affordable and Clean Energy)**: Nanotechnologycan boost the efficiency and reduce the cost of renewable energy technologies.For instance, nanomaterialscan enhance the performance of solar cells, batteries, and fuel cells.

5. **SDG 9 (Industry, Innovation, and Infrastructure)**: Nanotechnology can lead to the development of advanced materials and processes in various industries, promotinginnovation and sustainable infrastructure. This can include high-strength, lightweight materials for construction or more efficient manufacturing processes.

6. **SDG 12 (Responsible Consumption and Production)**: Nanotechnology can contribute to more sustainable production processes and recyclable products. This can include nano-enhanced recyclable materials or nanocatalysts for more efficient industrial processes.

7. **SDG 13 (Climate Action)**: Nanotechnologycan contribute to mitigation efforts by enhancing energy efficiency and reducing greenhouse gas emissions. This can be achieved through nano- enhanced energy technologies or carbon capture and storage technologies.

Moving Forward

In conclusion, the nanotechnology landscape in Malaysia reflects a promising trajectory, marked by robust growth and impactful trends that align with the United Nations Sustainable Development Goals (SDGs). With the nanotechnology market projected to reach RM682.96 million by 2025, it is evident that nanotechnology is poised to play a significant role in addressing various sustainability challenges.

One key growth driver is nanotechnology's potential to offer solutions across multiple fronts, including clean energy production, efficient water treatment, advanced healthcare technologies, and sustainable construction materials. These applications directly contribute to several SDGs, such as SDG 7 (Affordable and Clean Energy), SDG 6 (Clean Water and Sanitation), and SDG 11 (Sustainable Cities and Communities), underscoring the importance of nanotechnology in achieving broader sustainable development objectives.

Government support through policies, strategies, and incentives further accelerates the growth of the nanotechnology market in Malaysia. The National Nanotechnology Policy and Strategy 2021 – 2030 exemplifies this commitment, aligning with SDG 17 (Partnerships for the Goals) by fostering collaboration among diverse stakeholders to drive collective progress towards shared objectives.

Furthermore, nanotechnology's impact on specific SDGs is evident through its contributions to areas such as agriculture (SDG 2), healthcare (SDG 3), and responsible consumption and production (SDG 12). Nano-enabled solutions, such as nano-fertilizers, nanosensors for precision farming, targeted drug delivery systems, and recyclable nano-enhanced materials, offer tangible pathways towards achieving these goals.

The continued advancement and adoption of nanotechnology hold immense potential to address pressing global challenges, including climate change mitigation (SDG 13) and sustainable infrastructure development (SDG 9). By harnessing the transformative power of nanotechnology in alignment with the SDGs, Malaysia stands poised to make significant strides towards building a more sustainable and resilient future for all.

CHAPTER 5

About NanoMalaysia

NanoMalaysia Berhad (NanoMalaysia) is the leading agency in Malaysia entrusted with advancing the commercialisation of nanotechnology within the country. Formed by the Government of Malaysia in 2011 as a dedicated entity, NanoMalaysia operates as a specialised vehicle to propel the expansion of the national nanotechnology sector. Acknowledging nanotechnology's pivotal role as a catalyst for innovation across various technology-driven industries, it was earmarked under the New Economic Model (2011-2020) as a critical enabler for fostering economic growth.

NanoMalaysia's primary mandate is to extend robust support to commercial entities operating within the nanotechnology industry, enabling their transition toward an innovation-centric economy. Our extensive support ecosystem encompasses a spectrum of initiatives, including global marketing initiatives, talent development programs, provision of financial and infrastructure resources, facilitation of technology and knowledge transfers, and promotion of product innovations harnessing nanotechnology. Through these multifaceted efforts, NanoMalaysia aims to empower businesses, foster technological advancements, and drive economic growth in Malaysia.

As a company limited by guarantee (CLBG) under the jurisdiction of the Ministry of Science, Technology, and Innovation (MOSTI), NanoMalaysia assumes a pivotal role in spearheading the commercialisation of nanotechnology in Malaysia. Our core functions encompass:

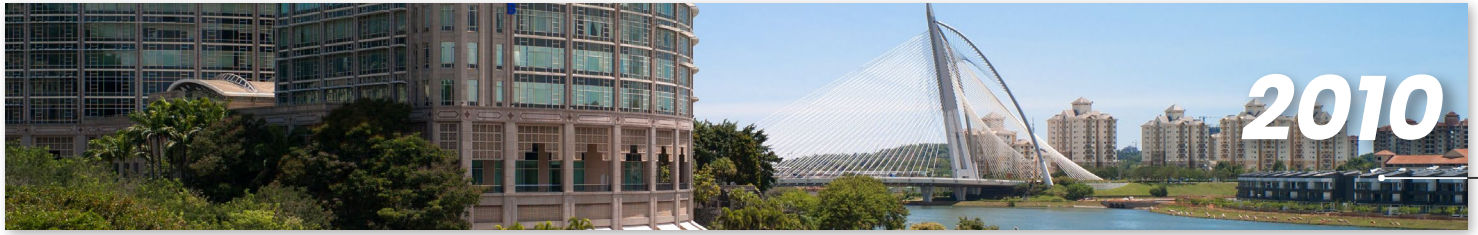
- Driving the commercialisation of nanotechnology research and development.
- Promoting the industrialisation of nanotechnology.
- Facilitating investments in nanotechnology.
- Fostering the development of human capital skills within the nanotechnology field.

Our overarching goal is to expedite the growth of Malaysia's strategic industrial sectors by leveraging nanotechnology applications. We are committed to cultivating a robust, innovation-driven national economy through various initiatives and programs.

Malaysia joined the Asia Nano Forum

The National Nanotechnology Initiative was launched

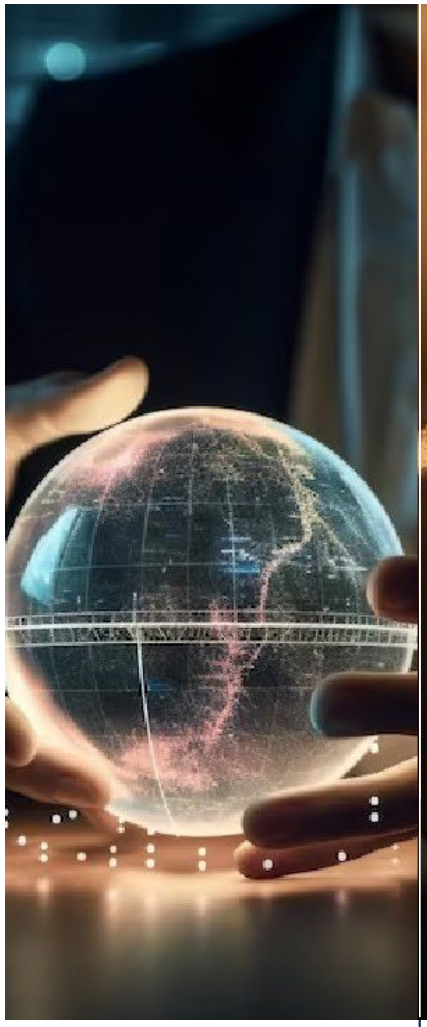
The National Innovation Council identified Nanotech as an important growth engine for Malaysia's New Economic Policy



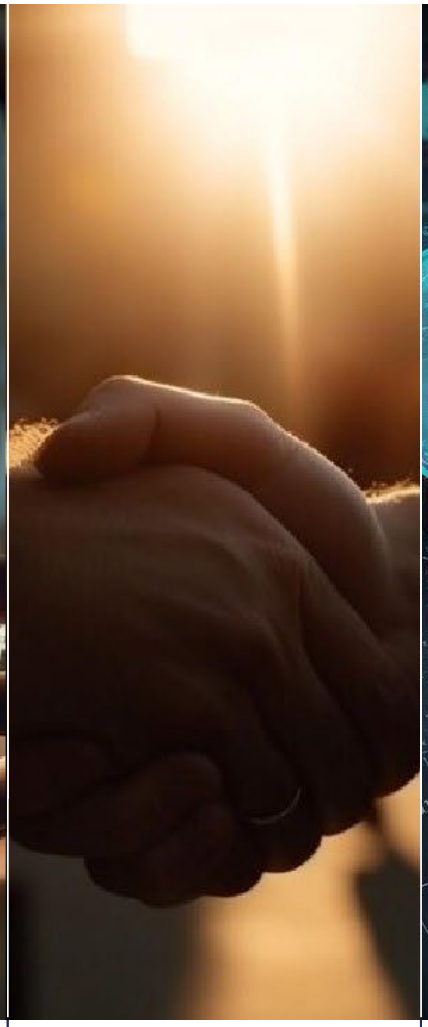
The National Nanotech Directorate (NND) was established and developed NanoMalaysia Programme 2011-2020

NanoMalaysia was introduced during the National Innovation Council (NIC) meeting and incorporated as a Company Limited by Guarantee (CLBG) in August 2011 under section 14(2)(c) of the Companies Act 1965

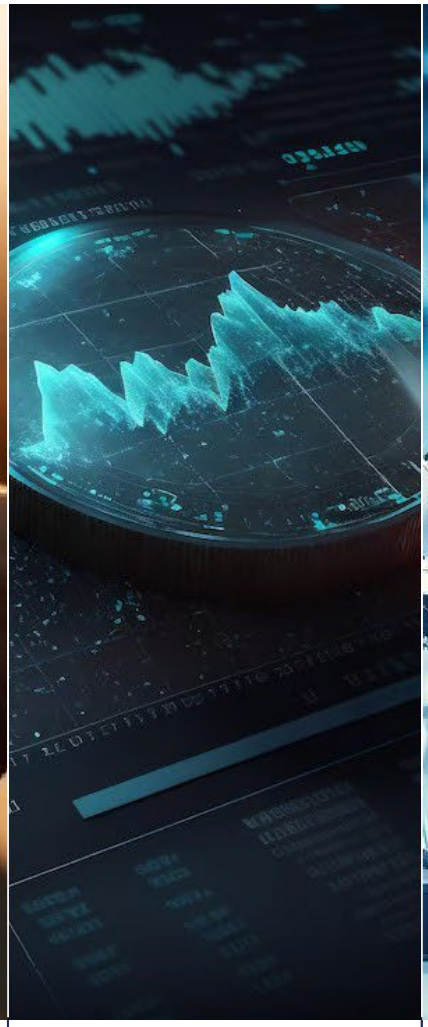
Core Business



To Provide Technology & Business Landscaping



To Identify and Facilitate Business Opportunities



To Facilitate Commercial Investment

To Strategise and Coordinate R&D Commercialisation

To Facilitate Human Capital Development

Our Ecosystem

Vision

To be a Global Leader in Nanotechnology Commercialisation.

Mission

- Energising Industries and Catalysing Economic Growth
- Deployment and Adoption of Nanotechnology in Industries
- Business Growth and Sustainable Development
- Cutting Edge Technological Leadership and Creating True

Board of Directors:

Chairman
Prof Emeritus Dato' Ir Dr Mohamad Zawawi Bin Ismail

Director
Dato' Ng Wan Peng

Director
Encik Zain Azmir Zain Azahari

Director
Professor Datuk Dr A. Rahman Bin A. Jamal

Director
Dato' Ahmad Shukri Bin Hj. Tajuddin

Director
Dr Mohd Nor Azman Bin Hassan

Director
Dr Rezal Khairi bin Ahmad

Company Secretary:

Wong Youn Kim
Acclime Corporate Services Sdn Bhd

Registered Office:

NanoMalaysia Berhad (955265-P) Suite C-5-4, Wisma Goshen Plaza Pantai, Jalan Pantai Bharu 59200 Kuala Lumpur

Official Address:

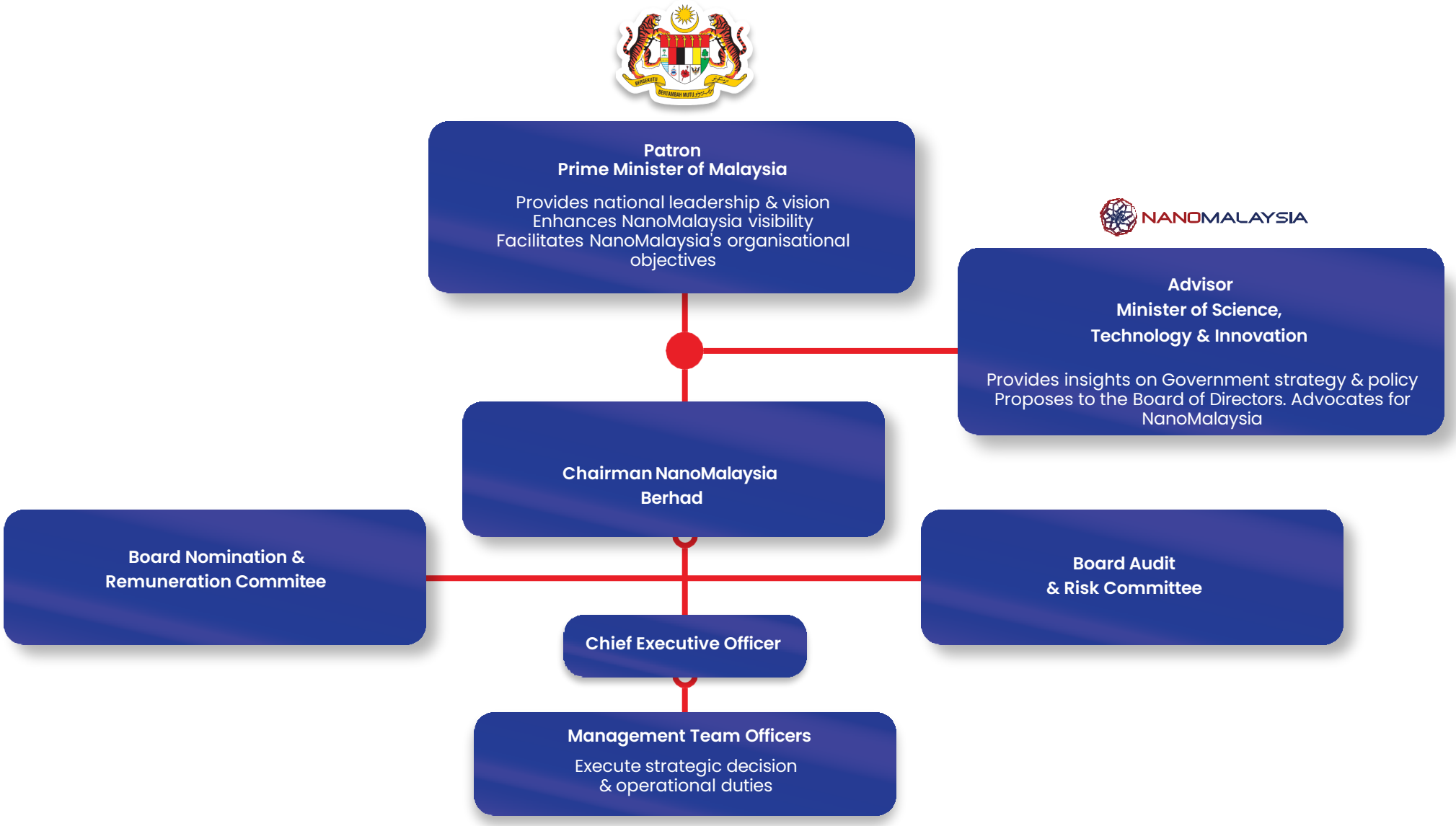
Lot 21.02
Sunway Putra Tower
100, Jalan Putra
50350 Kuala Lumpur

Website:

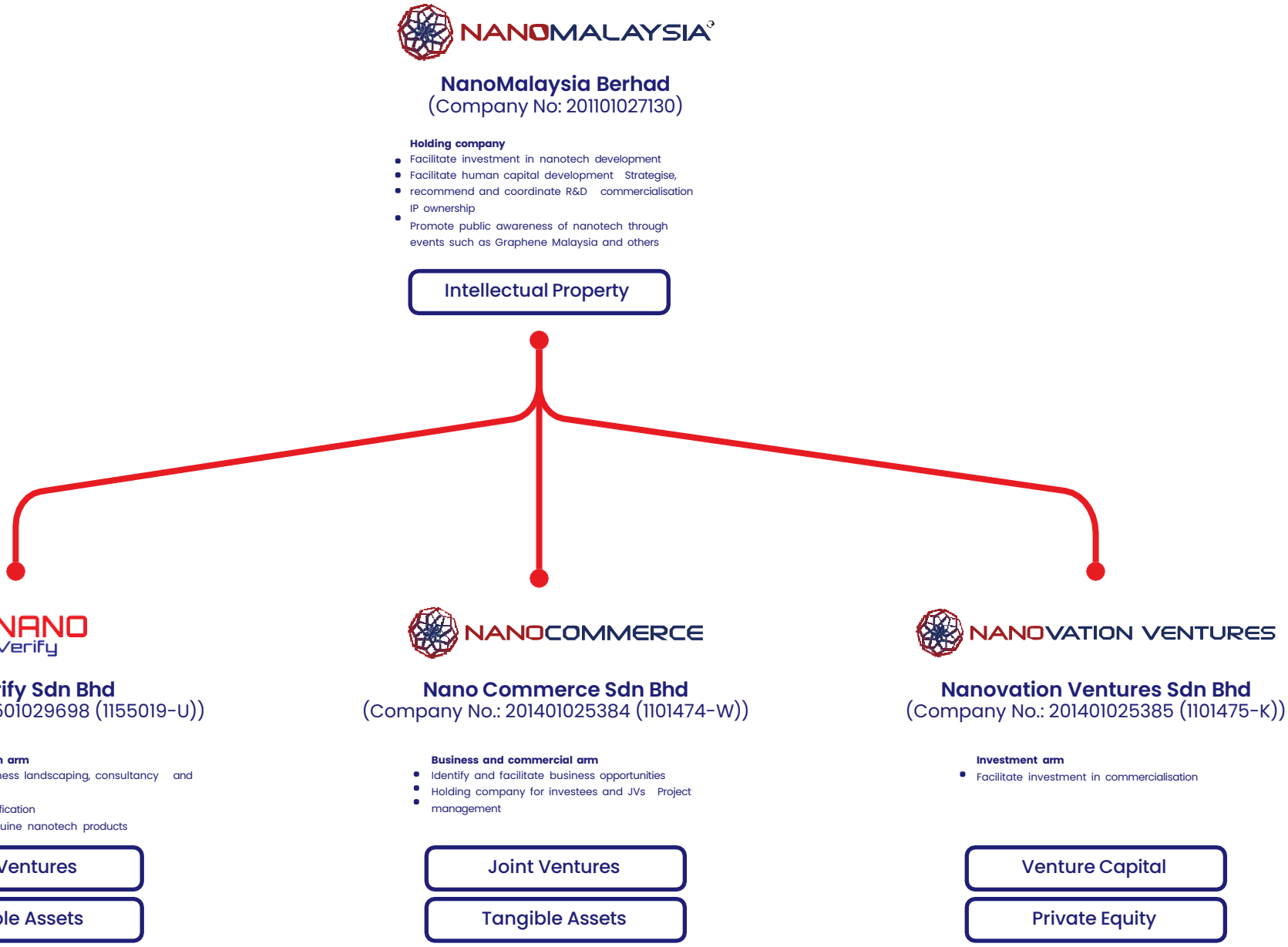
www.nanomalaysia.com.my

Auditor:

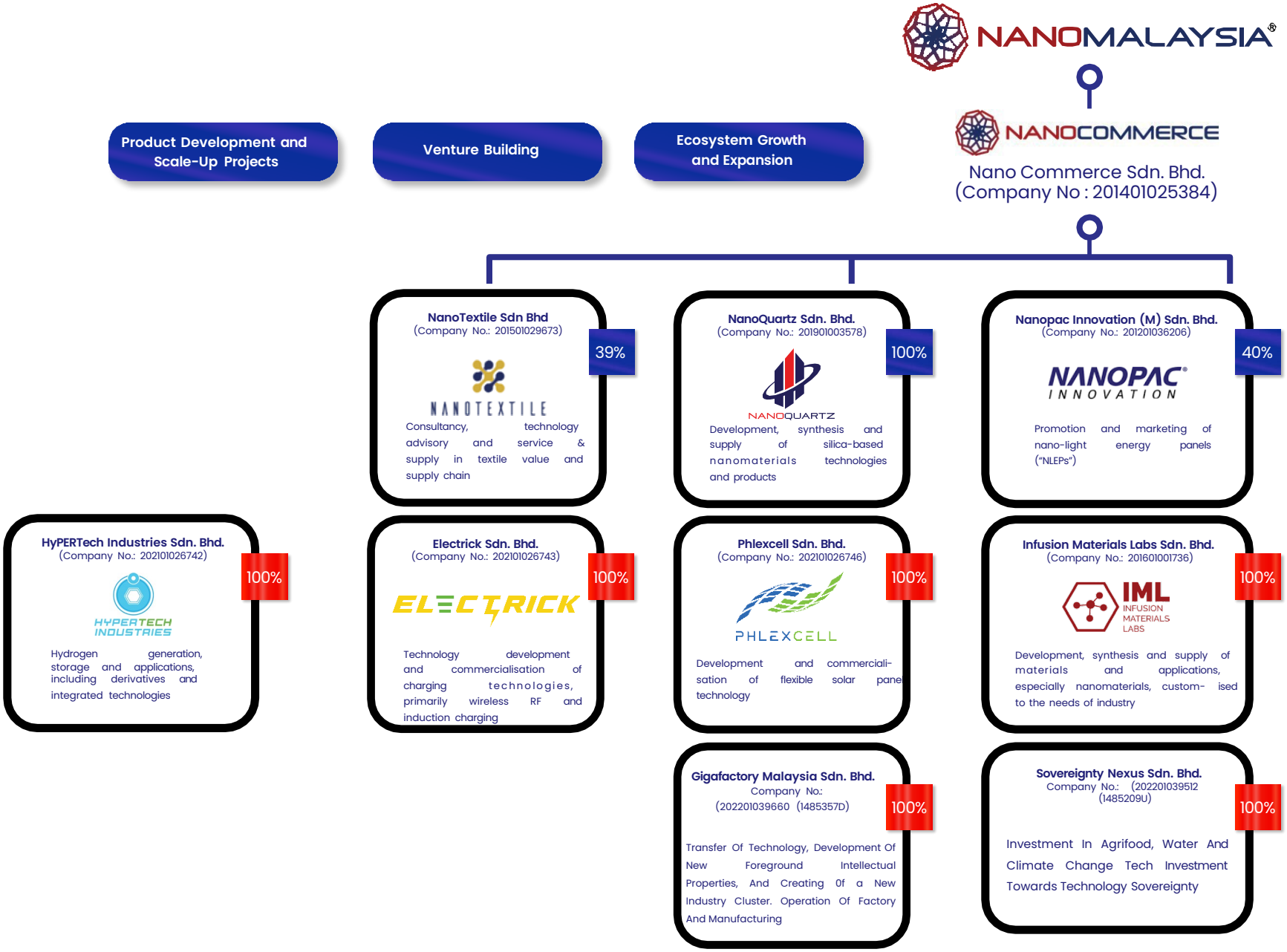
A. Razak & Co
Aftas Corporate Advisory Services Sdn Bhd


Patron
Prime Minister of Malaysia
Provides national leadership & vision
Enhances NanoMalaysia visibility
Facilitates NanoMalaysia's organisational objectives
NANOMALAYSIA
Advisor
Minister of Science,
Technology & Innovation
Provides insights on Government strategy & policy
Proposes to the Board of Directors. Advocates for NanoMalaysia
Chairman NanoMalaysia Berhad
Board Nomination & Remuneration Commitee
Board Audit & Risk Committee
Chief Executive Officer
Management Team Officers
Execute strategic decision & operational duties

Corporate Structure



Subsidiaries and New Ventures



Board Member

From Left

Dato' Ahmad Shukri Bin Hj. Tajuddin Member of Board Audit & Risk Commitee	Dato' Ng Wan Peng Director	Encik Zain Azmir Zain Azahari Director	Professor Emeritus Dato' Ir. Dr Mohamad Zawawi Bin Ismail Chairman	Dr Rezal Khairi Ahmad CEO	Dato' Ahmad Shukri Bin Hj. Tajuddin Member of Board Audit & Risk Commitee

Management Team

Mohamad Hafiz Bin Zolkipli
Chief Operating Officer

Dr. Daniel Bien Chia Sheng
Senior Vice President,
Nanotechnology Programme Delivery Office

Veronica Leong Mun Sum
Vice President
Operational Excellence, Group Operations

Raja Riznal Raja Abidin
Senior Vice President, Corporate Affairs Office

Azniyati Mohd Mansor
Vice President,
Group Human Resources , Group Human Resources

Ir. Tengku Kahar Muzaffar, M.I.E.M., P.Eng, PMP®
Vice President, Strategy and Special Projects Office

Md Hendree Johari
Senior Vice President, Group Finance

Sharizal Shaarani
Senior Vice President, Business Development

CHAPTER 6

NanoMalaysia's Growth

NanoMalaysia's Growth

Phase 01

Since its inception, NanoMalaysia has experienced two distinct growth phases. During the first phase, between 2011 and 2014, we focused on building the brand and refining our market positioning to establish solid foundations and ensure the long-term resilience of our business.

2012-2015
Positioning and Branding

Phase 02

In the first half of the 11th Malaysia plan, our second growth phase covered 2015 and 2018. In this phase, we focused on creating economic value to ensure long-term growth and profitability through various strategic programmes and collaborative partnerships with leading international nanotechnology agencies and companies.

2016-2019
Creating Economic

Phase 03

During the final year of the 11th Malaysia Plan, in preparation for the 12th Malaysia Plan, we focused on spearheading the Nanotechnology Revolution in Malaysia through our fourth Industrial Revolution (4IR) Internet of Nano things (IONT) driven REVOLUTION strategy. Our goal is to achieve financial independence and ensure the long-term sustainability of our business.

2020 & Beyond

Phase 01 :
Positioning and Branding

2011

- Incorporated on 1 August 2011

2012

- Conducted Nanotechnology Enabler Lab to design programmes and identify commercialisation projects
- Signed MOU with Advanced Energy Research and Technology Centre (AERTE) New York and Malaysian Industry-Government Group for High Technology(MIGHT)

2013

- MOU with IBM and the start of IBM star polymer joint research programme
- MOU with Human Life Advancement Foundation formed the iNanovation platform
- Conducted Nanotechnology Enabler Lab 2.0
- The creation of a National Key Economic Area (NKEA) Electrical and Electronics (E&E) Entry Point Project (EPP20) for nanotech applications
- General nanotechnology commercialisation partnership with Russian- based RUSNANO capital

2014

- Led National Graphene Strategy study conducted by Mckinsey & co./Agensi Inovasi Malaysia (AIM)
- Launched The National Graphene Action plan 2020 (NGAP2020) programme
- First NKEA E&E project conducted
- Partnership with Lux Research Inc. to provide nanotech market study
- Collaboration programme with BAE systems
- Incorporated Nano Commerce Sdn Bhd and Nanovation Ventures Sdn Bhd

2015

- Incorporated NANOverify Sdn Bhd
- Launched the NANOverify certification programme
- MOSTI Techno Fund project
  - Cu
  - CNT LED Mounting Substrates with UTP, SIRIM and NANS, LED
- NanoMalaysia CEO appointed as treasure of Asia Nano Forum

2016

- 21 product development and 7 scale-up projects executed
- 27 products developed and 6 products commercialised
- 28 IPs developed
- Launched the annual Graphene Malaysia international event
- MOU with Taiwan-based TANIDA on cross-country nanotech product certification

Phase 02 : Creating Economic Value

11th Malaysia Plan Nanotechnology Commercialisation Programme

Phase 03 : 2020 & Beyond

REVOLUTIoNT
A Revolution 4.0 the Internet of Nano-Things

2017

- 16 product development and 4 scale-up projects executed
- 16 products developed and 6 products commercialised
- 1 patent and 2 copyrights filed by MyIPO
- 23 IPs developed MOU with Nanopolis Suzhou
- NanoMalaysia CEO appointed International Advisor to the China Innovation Alliance of the Graphene Industry

2018

- 14 product development and 8 scale-up projects executed
- 7 products in development
- 2 IPs developed
- 8 patents, 1 utility innovation and 1 copyright filed with MyIPO

2019

- 5 product development and 14 scale-up projects executed
- 5 patents
- 3 utility innovations
- 5 trademarks
- 5 patents and 4 copyrights filed with MyIPO
- 8 products to be commercialised

2020

- 3 product development and 7 scale-up projects executed
- 5 trademarks
- 4 trade secrets
- 5 utility innovations
- 10 patents and 9 copyrights
- 12 products to be commercialised

2021

- 11 product development and 6 scale-up projects executed
- 13 patents
- 3 utility innovations
- 4 trademarks
- 14 copyrights filed with MyIPO
- 34 trade secret
- 10 products to be commercialised

New programmes introduced on 2021

HYDROGEN ECONOMY & TECHNOLOGY ROADMAP

NREGS NANOTECH REMOTE ENERGY SYSTEM

HYDROGEN ECONANOMY

NESTI

EMERGE

REVIVE

CLEVER

2016-2023
Achievements Snapshot

NANO Verify | iNanovation | National Graphene Action Plan | Advanced Materials Industrialisation | REVOLUTIoNT – A Revolution 4.0 the Internet of Nano-Things

Bicep | Graphenovation | HERAIT | NREGS Nanotech Remote Energy System | Hydrogen Econanomy

CLEVER | REVIVE | NESTI | EMERGE

- 122 JV/Start-Up companies supported/created.
- 7,488 (direct) and 37,440 (indirect) high value job opportunities created over next 5 years identified by industry.
- RM 4.17 billion (direct) and RM20.8 Million (indirect) potential GNI contribution generated over 5 years identified by industry.
- 248 products certified under NANOVerify.
- Developed projects resulting in 235 Intellectual Properties
- Filed a total of 70 patents, 60 copyrights, 21 trademarks, and 4 utility innovations with MyIPO, 77 trade secrets with NMB

CHAPTER 7

NanoMalaysia's Programmes

Twelfth Malaysia Plan (12MP) Programmes (2021-2025)

REVOLUTIoNT

A Revolution 4.0 the Internet of Nano-Things

GRAPHENOVATION

Product development and scale-up programme to produce graphene-based IPs and products

iNanovation™

Product development and scale-up programme to produce broader nanotech-based IPs and products

NREGS
NANOTECH REMOTE ENERGY SYSTEM

Product development, scale-up and ecosystem building programme focusing on wireless charging systems

HYDROGEN ECONANOMY

Product development, scale-up and ecosystem building programme focusing on hydrogen production and storage technologies

NESTI

Product development, scale-up and ecosystem building programme focusing on energy storage technologies

REVOLUTIoNT
A Revolution 4.0 the Internet of Nano-Things
GRAPHENOVATION iNanovation

- Pre-commercialisation and commercialisation projects focused on 4IR and IoNT
- Comprising of Graphenovation and iNanovation
- Programme timeline: 2021 – 2025
- Budget ceiling: RM 50 million

HYDROGEN ECONANOMY

- High Impact Project under RMK-12
- To plan and build an early stage eco-system for on-site / on-board hydrogen generation using metal hydride technology
- Applications:
  - Drones
  - EV cars
  - EV motorcycles
  - EV buses
  - Boats
  - Stationary kits for offshore platforms and off-grid locations
- Programme timeline: 2021 – 2023
- Budget ceiling: RM 10 million

NRGS
NANOTECH REMOTE ENERGY SYSTEM

- Pre-commercialisation and commercialisation projects focused on wireless transfer of electrical energy for IoT devices and automotive applications.
- Programme timeline: 2021 – 2023
- Budget ceiling: RM 10 million

NESTI

- Pre-commercialisation and commercialisation projects on nanotech-enabled energy storage systems collaboratively at the national level for mobility, stationary and portable applications, including second life and recycling.
- Programme timeline: 2022 – 2024
- Budget ceiling: RM 10 million

HYDROGEN ECONOMY & TECHNOLOGY ROADMAP

- Strategic partner for developing the Hydrogen Technology and Economy Roadmap for the Government of Malaysia.
- All forms of hydrogen generation, storage and application technologies.

EMERGE

- Malaysia Grand Challenge – Enabling Mobility Electrification for Green Economy
- MOSTI SRF programme focuses on the development of electric vehicle technologies to support low-carbon mobility
- Budget ceiling: RM33mil
- Duration: 3 years (2022-2024)

BICEP Biomass Innovation Circular Economy Programme

- Malaysia Grand Challenge – Biomass Innovation Circular Economy Programme
- Budget ceiling: RM27.5mil
- Duration: 3 years (2022-2024)

REVIVE

- Rapid Electric Vehicle Innovations Validation Ecosystem
- Focus on the conversion of ICE to EV

CLEVER

- Campuses for Local Electric Vehicle Expedited Roll-out
- EV technology validation and commercialisation programme at university campuses as a sandbox platform for study and analysis in closed campus roads and environments.

Driving Innovation :
The role of the Nanotechnology Programme Delivery Office

The Nanotechnology Program Delivery Office facilitates business expansion for enterprises and start-ups engaged in nanotechnology. This support encompasses diverse mechanisms that empower small and medium-sized enterprises (SMEs) to establish themselves in the market by adopting new processes or materials and transitioning from traditional methods to cutting-edge nanotechnology-driven operations.

The office conducts two primary streams of technology development: Graphenovation, which concentrates on graphene-based technologies, and iNanovation, which encompasses technologies not based on graphene.

Under each stream, investment opportunities are extended to assist SMEs and start-ups in broadening their footprint in the nanotechnology sector. These opportunities include venture capital, soft loans, business collaborations, and access to technological expertise and assistance. Additionally, the office invests in nanotechnology businesses, acquiring equity stakes to offer targeted support.

The Nanotechnology Program Delivery Office reinvests the proceeds from its projects and joint ventures into its operations, establishing a self-sustaining cycle of funds and expertise that can be leveraged for further investments in new nanotechnology ventures.

Our strategic approach aims at cultivating complete ecosystems within key sectors, nurturing innovation and technological progress. By maintaining a proactive stance in the Malaysian nanotechnology landscape, we consistently bolster the growth and prosperity of the nation's nanotechnology industry.

Nanotechnology Project Delivery Office

What We Do

1. Building Awareness

Increasing awareness regarding the benefits of commercialising graphene and nanoproducts across the broader ecosystem is crucial to stimulate sectoral expansion and development. NanoMalaysia takes on a pivotal role in this effort by continuously interacting with small and medium-sized enterprises (SMEs) to enrich their understanding of the potential uses of nanotechnology. We actively foster partnerships and collaborations among various stakeholders within the ecosystem, encouraging synergies between industry and academia and facilitating connections between upstream and downstream producers.

2. Executing Initiatives

NanoMalaysia's commitment to effectively executing projects with substantial growth potential has resulted in tangible outcomes that bolster our progress in this field. Our services primarily revolve around supporting companies in the advanced stages of research and development (R&D) and prototyping projects. We offer assistance to companies, partnerships, and joint ventures exploring potential applications enabled by graphene.

The Nanotechnology Programme Delivery Office comprises two main units, each focusing on distinct types of developments: Graphene-based and Non-Graphene based. Under the National Graphene Action Plan (NGAP) 2020, our focus has been on five key areas: Lithium-ion battery anodes/ ultracapacitors, Conductive Inks, Rubber Additives, Plastics Additives, and Nanofluids, all linked to graphene advancements. NGAP 2020 has now transitioned into NGAP 2.0, which emphasizes Fourth Industrial Revolution sectors, including Energy Storage, Energy Generation, Sensor Technologies, and Advanced Packaging.

Moreover, we prioritise the commercialisation of various types of nanomaterials in four significant jumpstart sectors: Electronic Devices & Systems, Food & Agriculture, Energy & Environment, and Wellness, Medical & Healthcare.

3. Product Development and Scale-Up Support

NanoMalaysia is pivotal in providing essential support for companies during the product commercialisation phase, particularly in scaling up their operations. We offer financial investments to companies in need of assistance establishing production-scale facilities. Additionally, NanoMalaysia facilitates collaborative partnerships between pertinent government agencies and industry players, granting businesses access to a wide array of resources, tax incentives, and Entry-Point Projects designed to reduce the scaling-up process.

4. Monitoring and Assessing Progress

NanoMalaysia monitors and assesses progress and growth in the five designated application areas. This rigorous process involves closely monitoring the advancement of projects, primarily when public funds are utilised for research and development and scaling-up endeavours. Additionally, we conduct thorough evaluations of each project's potential impacts, particularly its contribution to gross national income (GNI), investments, and job creation.

Project Highlights

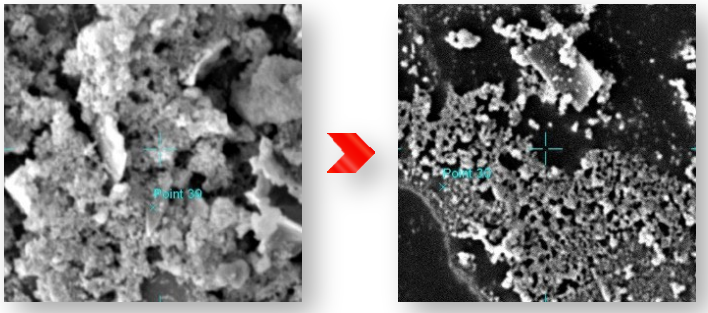
Ammonia and Nitrogen Dioxide Gas Sensors using Graphene from Oil Palm

"Ammonia and Nitrogen Dioxide Gas Sensors using Graphene from Oil Palm Trunk" aims to tackle significant environmental and health challenges posed by air pollutants, specifically Ammonia (NH_3) and Nitrogen Dioxide (NO_2). These pollutants are commonly released during various industrial processes and have been identified as hazardous even at low concentrations over long-term exposure.

The innovation at this project's core lies in developing passive and resistive-based gas sensor platforms. A unique aspect of this project is the functionalisation of reduced graphene oxide (rGO) with metal oxide nanoparticles. This approach enables the development of passive-type sensors by leveraging the high surface area of rGO and nanoparticles, facilitating greater gas molecule attachment and, consequently, higher sensitivity. The production of rGO from oil palm trunks represents a sustainable and innovative approach to material sourcing, turning what would otherwise be waste into a valuable input for high-tech applications.

The market for gas sensors is driven by increasing awareness of industrial air quality management and the health implications of air pollutants alongside stringent environmental regulations. The global gas sensor market is highly competitive, with key players focusing on technological advancements, sensitivity enhancements and energy efficiency. The unique selling

Functionalised Reduced Graphene Oxide (rGO)



Sensor Circuit and Gas Sensor Device

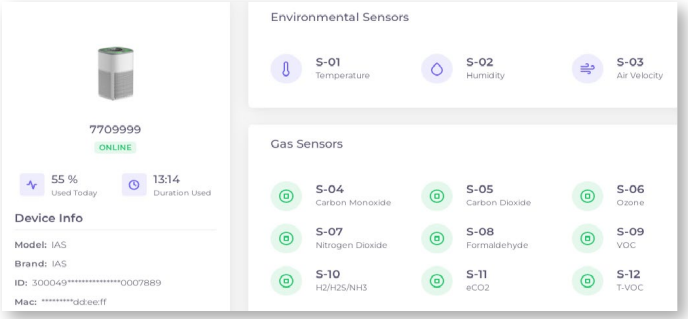
Project Highlights
Intelligent Indoor Air Quality Monitoring

The increasing awareness of indoor air quality (IAQ) issues has led to increased demand for solutions that can monitor and improve the air within enclosed spaces. Ideria's development of an Intelligent Indoor Air Sensing (IAS) system comes at a crucial time. This system, leveraging Metal Oxide Nanoparticles (NPs) and Functionalised Graphene Oxide, aims to offer real-time indoor air quality monitoring. By identifying a range of pollutants, including bioaerosols, particulate matter and volatile organic compounds (VOC), the IAS system is positioned to address the critical need for maintaining healthy indoor environments.

The market potential for such technologies is significant in Malaysia, where over 60% of the population suffers from poor IAQ. Current solutions range from simple, standalone air quality monitors to complex, integrated systems designed for commercial and industrial settings. However, this development can distinguish itself by focusing on real-time, sensitive detection of a broad spectrum of indoor air contaminants, leveraging advanced materials like functionalised graphene oxide and metal oxide NPs. This technological edge could offer Ideria a competitive advantage in domestic and international markets.

Looking ahead, the growth opportunities for Ideria's IAS system are vast. Increasingly stringent IAQ regulations and a growing global emphasis on health and wellness in the built environment will likely drive demand for advanced monitoring solutions. Additionally, the system's applicability in various settings—from residential to commercial and industrial—enhances its market potential. Continuous innovation, such as integrating IoT capabilities for smart building applications or expanding the range of detectable contaminants, could further solidify Ideria's position in the market. Collaborations with regulatory bodies, healthcare institutions, and commercial real estate developers could also facilitate broader adoption and integration of IAS systems, contributing to healthier indoor environments worldwide.

IAS Design



Advantages

- Specifically engineered for real-time indoor air quality monitoring
- Inclusion a cost-effective graphene-based sensors, enabling the detection of bioaerosols alongside gases and pollutants
- Able to detect VOC and bioaerosols using a sensor array

System Feature

- **Connectivity**
  - Wi-Fi
  - Bluetooth
- **12 Sensor Array**
  - Metal Oxide Sensors
  - Graphene
  - Dust Particles
  - TVOC - Ozone
- **Mobile Apps**
- **Plug & Play**
- **AQI & Comfort Level**

Project Highlights

Graphene-Enhanced Automotive Engine Oil

Micratto Technologies Sdn. Bhd (Micratto), a Malaysian start-up company that specialises in nanotechnology-based lubricants in collaboration with NanoMalaysia Berhad (NMB) and Sunway R&D Sdn Bhd, completed the scaling up of Graphene-based lubricant production for automotive applications. A graphene-based lubricant brand called "InfinOil" is a line of lubricants marketed by Micratto. The graphene-enhanced "Phenom Graphene" is an improved engine oil formulation with a higher performance developed under the "InfinOil" branding. Phenom Graphene lubricant was produced by optimising a previous IP owned by NMB for large-scale production under this project.

Phenom Graphene lubricant was specifically optimised via the functionalisation of Graphene Oxide (GO) nanomaterial with amine compounds for maximum homogeneity within the lubricant. This provides enhancements such as reduced wear and tear, improved heat transfer efficiency and stability compared to the standard off-the-shelf lubricant products. The infusion of graphene into the lubricant allows for these improvements due to the intrinsic properties of graphene nanomaterial. Reducing wear and tear will maximise the lifespan of automotive components such as engines, contributing to lower maintenance costs. Improved heat transfer in the lubricant will also enhance automotive efficiency, minimise overheating scenarios, and lower operating temperatures.

The production of Phenom Graphene under this scale-up project was approximately 4000 4L bottles. Of the 4000 bottles, 2000 were fully synthetic lubricants produced following the SAE 5W-40 API SN standards. Another 2000 bottles produced were semi-synthetic lubricants following SAE 10W-40 API SN standards. This initial produced batch is part of Micratto's long- term plan to be a key market player in the lubricants industry. The Malaysian domestic automotive engine oil is expected to grow exponentially from 294.58 USD million in 2023 to 354.97 USD million by 2030, based on a report from Stellar Market Research. Micratto aims to capture a portion of this growing domestic market by selling its Phenom Graphene product. The global automotive engine oil market is also expected to grow continuously, reaching an estimated valuation of USD 44.62 billion by 2027, according to ResearchAndMarkets.com. Micratto could leverage Phenom Graphene's improved properties to break into the global market for maximal commercialisation.

The completed project also aligns with the Ministry of Science, Technology and Innovation (MOSTI)'s PRECISE initiative (People-centric approaches, Research and Development, Enculturation, Capacity building, Investment, and nurturing the Startup Ecosystem), under which Phenom Graphene is expected to serve as a symbol of local start-ups' capability in commercialising their products to the market.

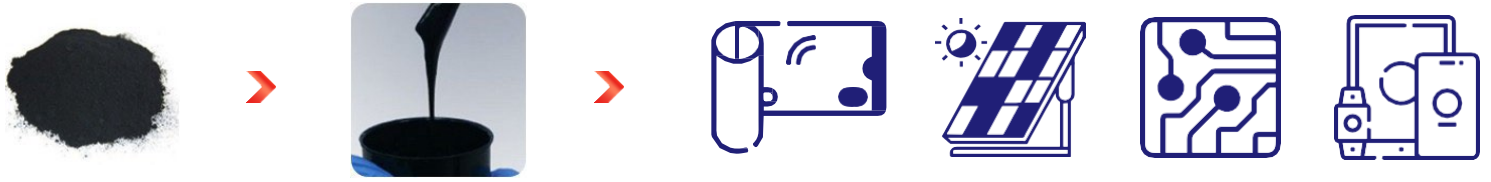
Project Highlights

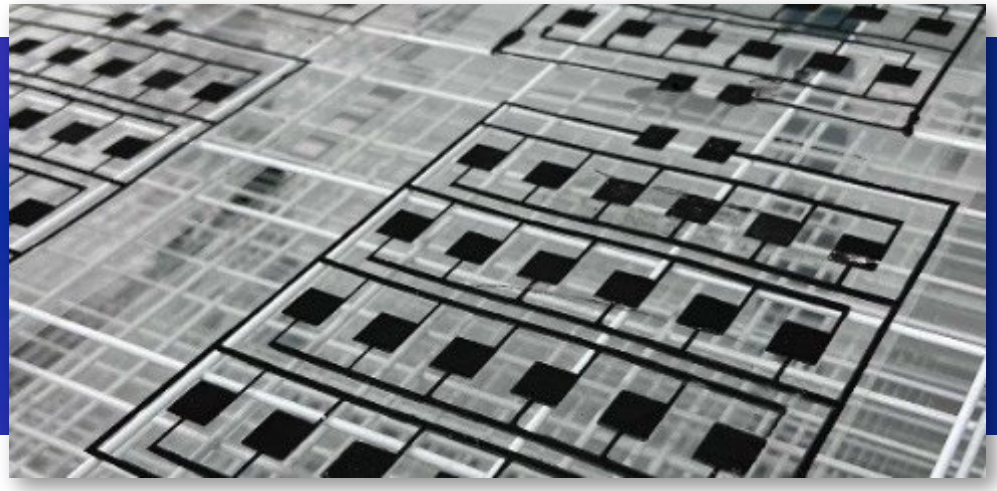
CNT-based Organic Conductive Paste

Serdang Paste Tech Sdn Bhd (SPT), also known as Putra Serdang Paste, was founded in 2017 and is based at Universiti Putra Malaysia. The startup business inside Innohub UPM managed and commercialised new products for the market. Based on their previous research and vast experience working with conductive paste in Malaysia, SPT decided to take the next step and commercialise the conductive paste. They aim to be a pioneer in developing technology using conductive paste in Malaysia and other regional countries.

SPT has collaborated with NanoMalaysia Berhad to scale up, reformulate and commercialise the organic conductive paste (OCP), which they have formulated and patented by their research team under MyIPO. The project's main objective was to reformulate and investigate the performance of organic conductive paste and facilitate SPT in scaling up the production process of organic conductive paste by establishing a low- volume production line. Organic conductive paste is a liquid-based material with used organic binder acting as a vehicle mixed with carbon-based material. It's developed using green processes, is environmentally friendly for electric and electronics applications, and comes with various ratios. The organic conductive paste can be operated at low and high temperatures and quickly applied on any substrate.

Moreover, SPT can provide consultancy, printing services, product manufacturing-based conductive paste, and OCP sales. The developed OCP can be used in various applications, such as photovoltaic solar cells, flexible and wearable devices, printed circuit boards, gadgets, and electronic devices.





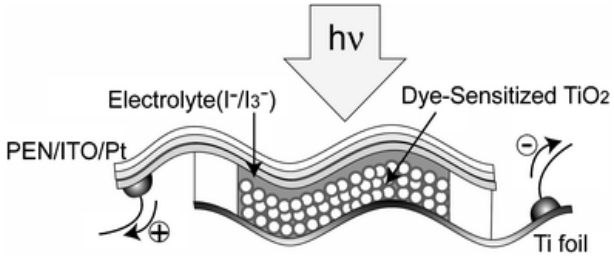
A sample of screen-printed conductive paste from SPT for touch panel application.

The CEO of NanoMalaysia Berhad, Dr Rezal Khairi Ahmad, discussed the future potential of organic conductive paste with the CEO of Serdang Paste Tech, Mr. Asnawi, in the production area.

Project Highlights

Flexible Dye-Sensitised Solar Cells for Light Electronic Charging

This product development project aims to enable self-powered device applications that offer portability, eliminate the need for a battery or wired power connector, and use renewable energy—solar.

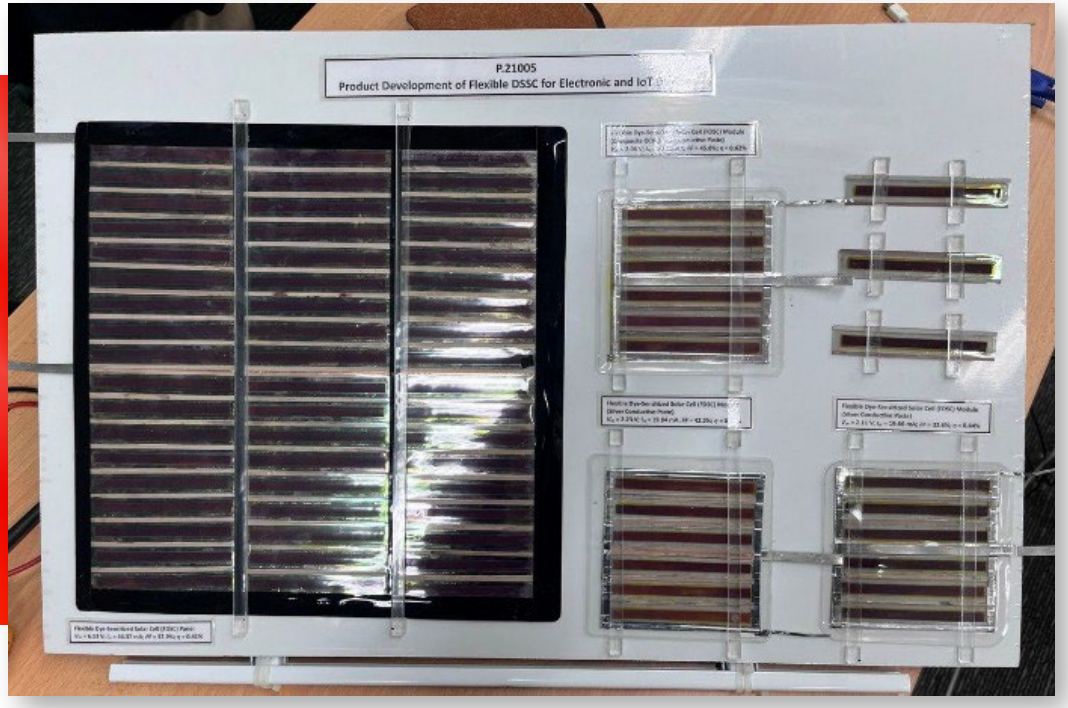


Advantage

- Portable & durable
- Low cost
- Work in low-light conditions
- Able to generate more power using artificial light

Application

- Portable devices
- Smart textile
- Low power Electronic devices
- Wearable devices



Flexible Design

The flexible DSSC panels (30 cm x 30 cm) are adaptable and can be integrated into various applications.

High Voltage and Current

Panel #1 generates an impressive 15.6 V with a current of 21 mA, while Panel #2 offers 5.85 V and 42 mA (Based on 1 Sun measurement, 100 mW/cm2, AM 1.5 G)

Navigating Legal Landscapes:
NanoMalaysia's Expertise in Legal Oversight

- **Legal Oversight and Protection**

We draft and review legal documents and skillfully negotiate with technology recipients, collaborators, and partners to safeguard NMB and its partners' rights and interests. Furthermore, we meticulously identify potential legal risks and develop robust strategies to mitigate them effectively.

- **Company Secretarial Services**

Our expertise extends to managing all matters concerning the Board, and we offer comprehensive company secretarial services. We stay updated with regulatory and statutory changes and policies related to the technology ecosystem.

- **Intellectual Property Management**

NanoMalaysia's intellectual properties (IP) are diligently managed under our purview. We handle the prosecution of patents, trademarks, and copyrights, ensuring robust protection and enforcement of NMB's IP rights against any infringement. Additionally, we provide invaluable support for corporate development activities, including intellectual property due diligence and freedom-to-operate analyses.

- **Commitment to Corporate Governance**

Our dedication to corporate governance is unwavering. We ensure NanoMalaysia's seamless operation within the legal framework, strictly adhering to all relevant laws and regulations. Through advisory roles and extensive awareness initiatives, we foster a culture of governance and integrity throughout the organisation.

- **Identifying and Mitigating Legal Risks**

We are vigilant in identifying potential or actual legal issues across all areas of NanoMalaysia's business. Swiftly and meticulously, we devise comprehensive plans to circumvent any adverse outcomes, safeguarding NanoMalaysia’s reputation.

- **Knowledge Enhancement and Empowerment**

Recognising the importance of legal literacy, we organise various in-house training sessions, sharing sessions, and briefings covering topics such as understanding legal documents, promoting bribery and anti-corruption awareness, and fostering a comprehensive understanding of the intellectual property framework. Through these efforts, we empower all employees and partners with the knowledge to navigate legal complexities effectively. Our steadfast commitment remains to providing robust legal assistance, ensuring compliance, protecting NanoMalaysia and partners, and fostering a culture of integrity throughout the organisation.

Corporate Governance

AIGA 2023 Recognition: NanoMalaysia's Contribution to Integrity and Anti-Corruption Efforts

NanoMalaysia's participation in the Integrity, Governance, and Anti-Corruption Award (AIGA) 2023 signifies its dedication to upholding the highest standards of integrity and governance practices. This prestigious award, initiated by the Malaysian Institute of Integrity (IIM), aims to commend organisations in both the public and private sectors that demonstrate unwavering commitment to fostering integrity, implementing best governance practices, and undertaking anti-corruption initiatives within their operations.

In recognition of NanoMalaysia's steadfast efforts, NanoMalaysia was honoured to receive the Silver Award at AIGA 2023. This accolade is a testament to NanoMalaysia's continuous commitment to ethical conduct, transparent governance, and proactive anti-corruption measures. By receiving this award, NanoMalaysia affirms its position as a leader in promoting integrity and good governance practices within the Malaysian technological landscape, setting a benchmark for others to follow.

Participation in Integrity, Governance, Anti Corruption Award (AIGA)

Corporate Governance

NanoMalaysia's Commitment to Integrity: The Organisational Anti-Corruption Plan (OACP) 2021-2025

NanoMalaysia's Organisational Anti-Corruption Plan (OACP) for the initiative spanning 2021-2025 embodies a robust framework to combat corruption effectively. This strategic exercise underscores our unwavering commitment to upholding integrity and transparency across our operations.

The OACP outlines comprehensive measures to prevent, detect, and address corruption within NanoMalaysia and its associated entities. These measures encompass stringent anti-corruption policies, procedures, and guidelines tailored to mitigate corruption risks effectively.

Central to the initiative is the collective responsibility to cultivate a culture of integrity and ethical conduct among employees, stakeholders, and partners. We aim to instil a shared commitment to ethical behaviour and compliance with anti-corruption standards through extensive awareness campaigns, training programs, and engagement initiatives, making everyone feel included and responsible.

Moreover, the OACP emphasises establishing robust oversight mechanisms to monitor compliance and proactively identify potential corruption vulnerabilities. This includes implementing regular risk assessments, internal controls, and reporting channels to ensure organisational accountability and transparency.

Additionally, the OACP underscores NanoMalaysia's collaboration with relevant authorities, regulatory bodies, and industry partners to strengthen anti-corruption efforts and promote a corruption-free environment within the technology ecosystem.

By adhering to the principles outlined in the OACP, NanoMalaysia reaffirms its unwavering dedication to promoting ethical business practices. This commitment fosters trust and confidence among stakeholders, and advances a corruption-free society, making our integrity a source of confidence for all.

Intellectual Properties

Intellectual property (IP) pertains to any original creation of the human intellect, such as artistic, technical, literary, or scientific. Patent, copyright, and trademark rights are IP rights that provide the creator with an exclusive right to use their creation of mind for a limited period.

IP in nanotechnology

Nanotechnology finds diverse applications across industrial sectors such as energy, transportation, healthcare, manufacturing, materials, and consumer products. Intellectual Property (IP) is a cornerstone in transitioning nanotechnology innovations from scientific realms to the marketplace. IP embodies the potential future economic value for nanotechnology startups, enabling market expansion, brand recognition, competitive positioning, and fostering collaborative ventures.

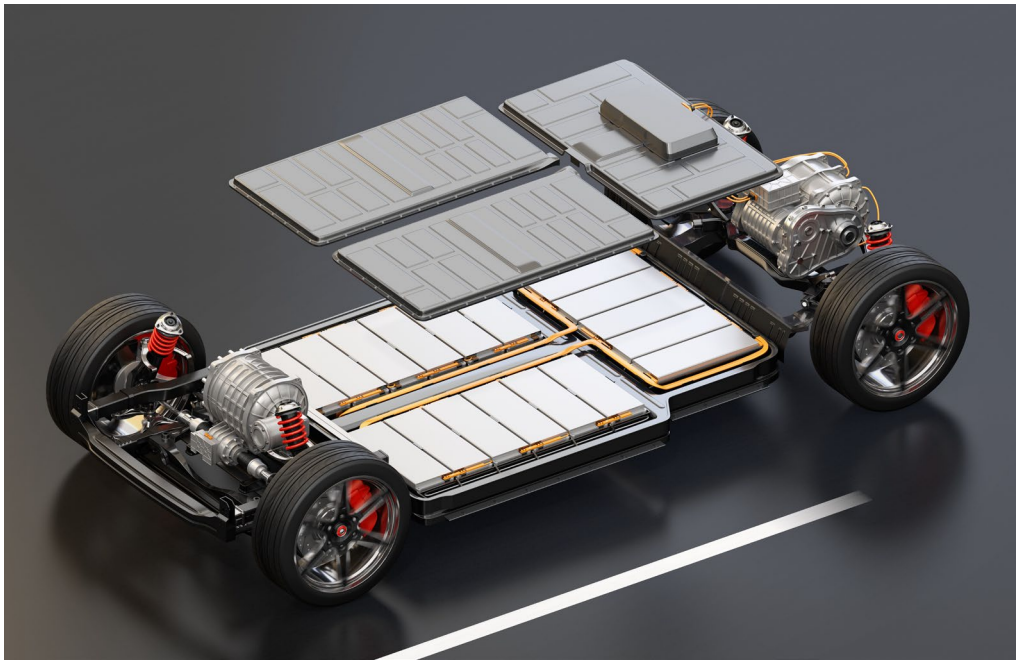
Patents serve as technological indicators for commercial advancement, aiding in securing market share and enhancing competitiveness. However, even in cases where patents are unattainable, other forms of IP rights remain valuable. Trademarks, including certification marks, assure consumers of product quality and reliability while bolstering a company's reputation. Additionally, trade secrets offer a cost-effective means of safeguarding IP for startups engaged in strategic market positioning, demonstrating the breadth and flexibility of IP rights.

Commercialisation of IP

While many jurisdictions prioritise the commercialisation of nanotechnology, achieving successful outcomes in this endeavour has posed significant challenges. One major obstacle is the need for more connection between research institutes and industry, resulting in a slow translation of discoveries from the lab to the market. Additionally, numerous sub-areas within nanotechnology remain in early developmental stages, presenting further hurdles. Another challenge lies in recruiting suitable human resources for R&D and production activities in the field.

CHAPTER 8

NanoMalaysia's Role in Electric Vehicles and Energy Storage Technology



NanoMalaysia's EV and Energy Storage Programmes

NanoMalaysia has dedicated substantial resources and forged partnerships with industry leaders and academic institutions to propel the advancement of critical energy components and technologies. This concerted effort has entailed devising strategies to actualise diverse programs focused on electric vehicles and energy storage technology. Consequently, these technological strides are now integrated into various commercial and industrial projects spanning mobility, stationary applications, and portable uses. The overarching goal is to establish Malaysia as a premier market renowned for its proficiency and prowess in electric vehicles and energy storage technology.

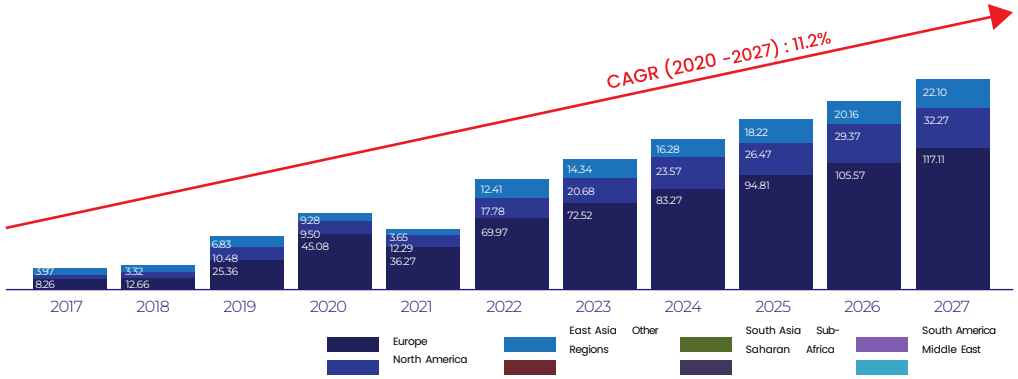
At the core of NanoMalaysia's mission lies the ambition to elevate Malaysia into a distinguished centre for manufacturing state-of-the-art electric vehicles and energy storage components and systems. These cutting-edge technologies are slated for both domestic utilisation and exportation. Nanotechnology is pivotal in augmenting these systems' overall performance, dependability, and efficiency. Through the NanoMalaysia Energy Storage Technology Initiative (NESTI), NanoMalaysia actively collaborates with diverse partners to spearhead the development and integration of energy storage technologies. This encompasses batteries, ultra-capacitors, solid-state hydrogen, energy management, and monitoring systems. Moreover, NanoMalaysia emphasises crafting a high-performance motor controller explicitly tailored for mobile applications.

With active support from the Ministry of Science, Technology, and Innovation (MOSTI) and key stakeholders, NanoMalaysia Berhad (NMB) is set to spearhead the coordination and collaboration among prominent players in the Electric and Micro E-Mobility sector in Malaysia. These players will be essential partners in various facets, including research and development (R&D), pilot deployment, testing, certification, and eventual commercialisation. NanoMalaysia will also capitalise on existing projects and cultivate new alliances to promote the secondary use of batteries for stationary applications, effectively prolonging their lifespan. This initiative aims to seamlessly integrate Green Charging Stations, Battery Swapping, and Nano/Micro-Grid Systems into the Micro and Electric Mobility framework.

As the global electric vehicle (EV) market experiences exponential growth and EV sales increase worldwide, fostering electric micro-mobility adoption becomes paramount. NanoMalaysia's strategic aspiration is pivotal in accelerating the widespread acceptance of electric micro-mobility, laying the groundwork for comprehensive electric mobility adoption. Establishing a robust micro-mobility ecosystem in Malaysia benefits the nation and holds significant implications for the future of transportation. It positions Malaysia as a leader in low-carbon mobility, enhances road safety, and improves commuting convenience across diverse market sectors.

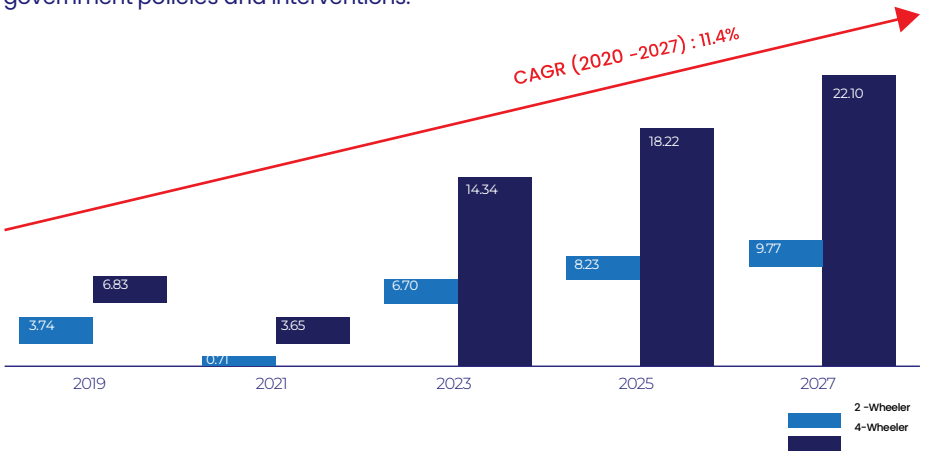
Global EV Market value (2017 -2027) in USD Billion

Europe is currently leading the global drive towards the adoption of EVs, primarily due to its government intervention. Their initiative to ban internal combustion engines in major cities in the near future is bearing fruit.



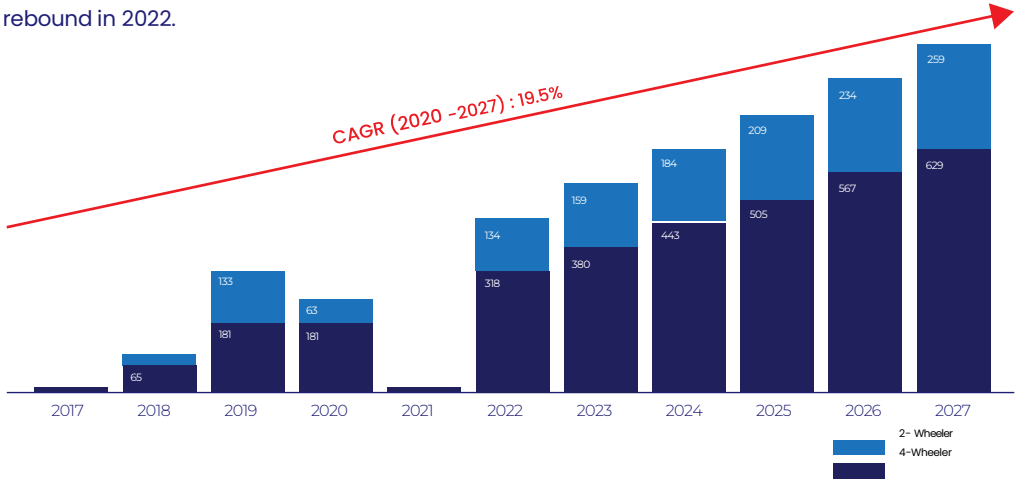
APAC Electric 2-Wheeler and 4-Wheeler Market Revenue (2017 -2027) in USD Billion

The APAC region is a lucrative market for electric vehicles due to its sheer number of inhabitants and supportive government policies and interventions.



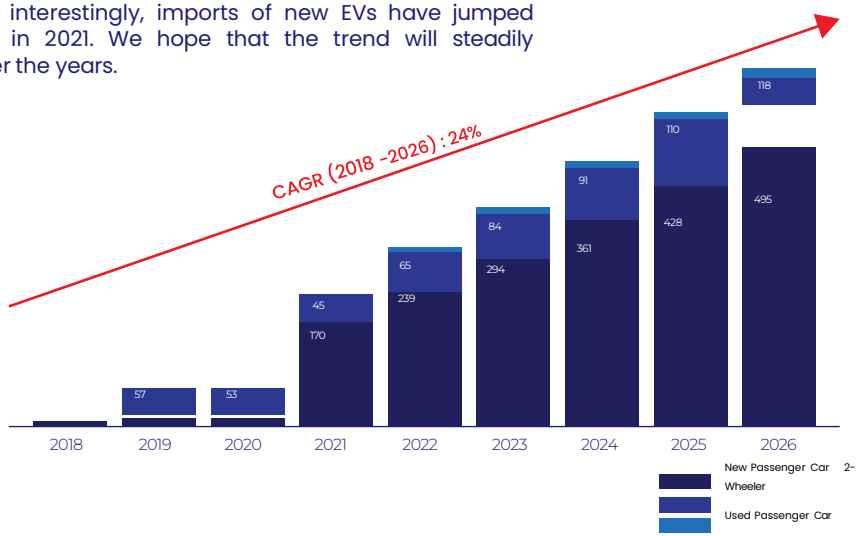
ASEAN Electric 2-Wheeler and 4-Wheeler Market Revenue (2017 -2027) in USD Billion

COVID-19 has impacted ASEAN's trade performance of electric 2-wheelers and 4-wheelers, but it is expected to rebound in 2022.

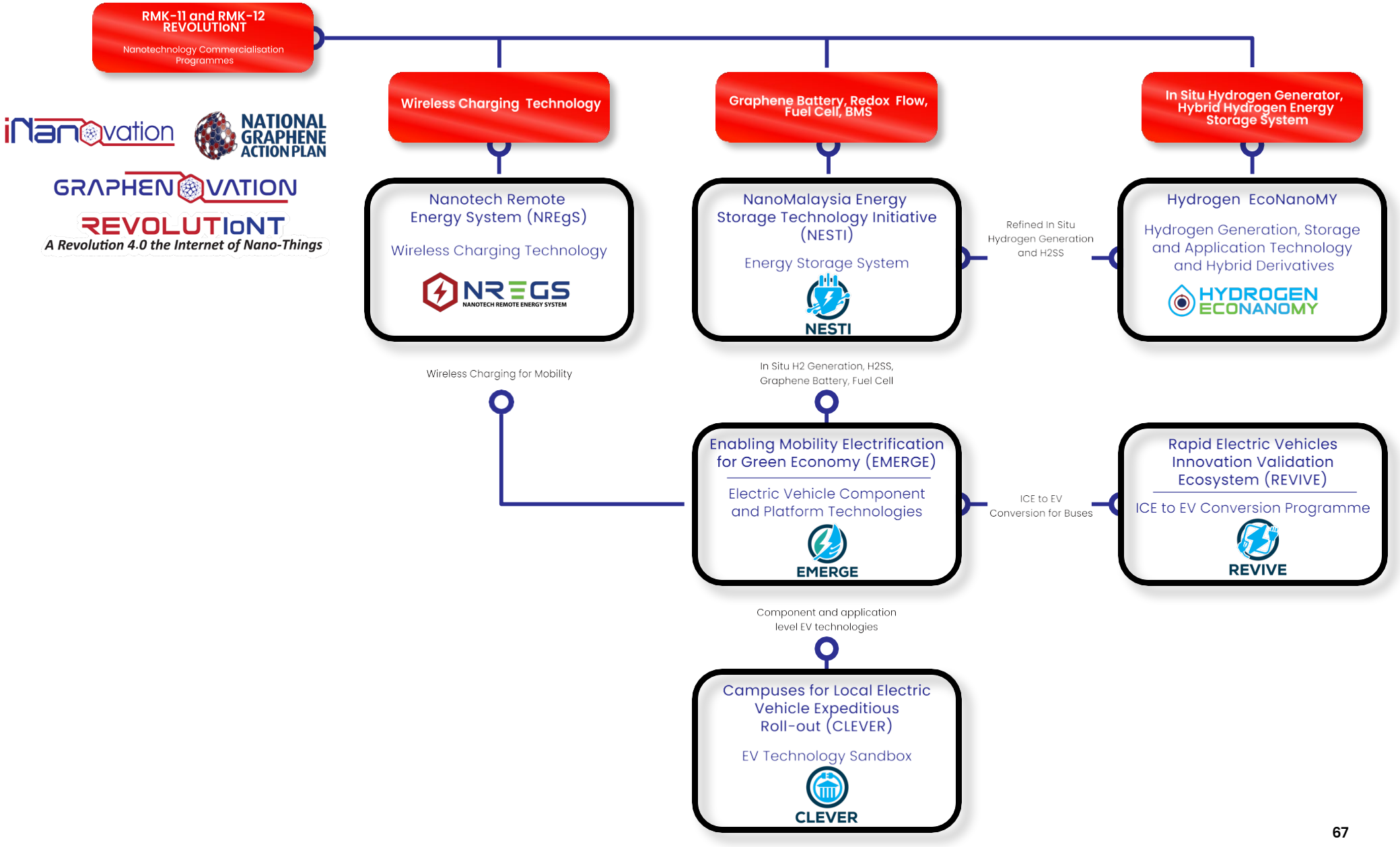


Import Value of New, Used and 2-Wheeler EVs 2018-2026

Despite setbacks from COVID-19 in 2020, Malaysia is expected to recover from the pandemic, and through government subsidies and interventions, the EV market will be expected to rise over the years. More interestingly, imports of new EVs have jumped significantly in 2021. We hope that the trend will steadily increase over the years.



NanoMalaysia's EV and Energy Storage Programme



NANOTECH REMOTE ENERGY SYSTEM

What is Nanotech Remote Energy System (NREgS)

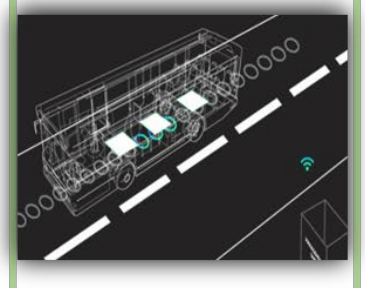
Under High Impacts Projects at NanoMalaysia, NREgS targets game-changing Malaysian innovation for Wireless Power Transfer under the Industry 4.0

Nanotech Remote Energy System (NREgS) is a pioneering initiative by NanoMalaysia, designed to revolutionise wireless power transfer in alignment with the principles of Industry 4.0. NREgS targets far-field and near-field wireless power transmission technologies to usher in a paradigm shift in energy transfer methodologies. Emphasising the optimisation of individual components within wireless technology systems, NREgS aims to surmount the limitations of wired technologies, particularly in areas where wired connections are impractical. By prioritising advancing wireless power transfer projects already at Technology Readiness Level (TRL) 3 or higher, NREgS accelerates its commercialisation process. Additionally, NREgS seeks to alleviate range anxiety associated with traditional wired charging by promoting wireless power transfer solutions, enhancing user convenience and fostering innovative applications. NanoMalaysia further supports developing and commercialising wireless power transfer projects through funding and partnership opportunities, facilitating the seamless transition from research to real-world implementation.

22kW

Static charging

7.5kW



Dynamic charging

1kW

Last mile wireless charging

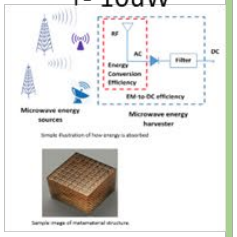
10-17W

Near field charging for electronic devices

<5uW

E-textile charging

+- 10uW



Metamaterial RF absorber

NANOTECH REMOTE ENERGY SYSTEM

Current Projects under NREgS:

NanoMalaysia Autonomous Vehicle Delivery Unit (NAVI-D)

The Electric Autonomous Delivery Vehicle Wireless Charging project addresses the challenge of manually charging last-mile autonomous delivery vehicles, hindering operational efficiency. The project focuses on developing a wireless charging system for these vehicles, termed "Opportunity Charging," during downtime between deliveries. This innovative solution eliminates manual charging, ensuring vehicles are ready for deployment when needed. Key features include a unique wireless charging technology, specialised charging coil design, and an Internet of Things (IoT) enabled Battery Management System (BMS) for efficiently monitoring battery levels.

The project's objectives include developing a Proof-of-Concept (PoC) for the wireless charging technology, creating a prototype user interface for ordering items, and monitoring battery status. The scope encompasses designing and evaluating the wireless charging, battery monitoring, and ordering user interface. The project does not cover mass production, marketing, or sales aspects. Stakeholders involved in the project include UM Power Electronics And Renewable Energy Research Laboratory (UM PEARL) and HelloWorld Robotics Sdn Bhd.

Key milestones achieved include establishing a PoC for the autonomous last-mile delivery vehicle with wireless charging capabilities, implementing an IoT-enabled BMS system, and developing a prototype user interface. Notably, the system has been successfully tested, achieving an efficiency of 85% at 1kW power and autonomously completing delivery routes.




Future plans include introducing the delivery user interface to MRANTI food court vendors and customers, as well as initiating production of last-mile delivery robots and wireless charging docks. Market analysis indicates significant growth potential, with the worldwide autonomous last-mile delivery market expected to reach USD 48.96 Billion by 2027. The estimated price per unit for these delivery vehicles ranges from RM20,000 to RM150,000, with a projected selling price of around RM75,000 based on mass production costs. Partnership opportunities are also anticipated, with an estimated creation of 10 jobs over a 5-year projection, including roles for delivery robot operators and engineers specializing in hardware and software development.

NanoMalaysia's EV and Energy Storage Programmes

What is the NanoMalaysia Energy Storage Technology Initiative (NESTI)?

The NanoMalaysia Energy Storage Technology Initiative (NESTI) is a comprehensive program focusing on the technological development and commercialisation of critical components of energy storage devices. The initiative recognises the importance of energy storage in capturing and utilising energy produced or supplied for later use, contributing to the efficient and sustainable utilisation of energy resources.

NESTI emphasises the development of core components of energy storage devices, including electrodes, electrolytes, and overall structure designs. By advancing these essential elements, NESTI aims to enhance energy storage systems' performance, efficiency, and reliability. Through research and development efforts, the initiative seeks to optimise the design and composition of these components to improve energy storage capabilities and overall system performance. In addition to developing conventional energy storage technologies, NESTI also explores new battery chemistries that utilise alternative raw materials and nanomaterials. This approach promotes resource diversification and reduces reliance on scarce or environmentally challenging materials. By exploring alternative chemistries, NESTI aims to develop energy storage solutions that are sustainable, cost-effective, and environmentally friendly.

NESTI also recognises the importance of recycling and sustainability in the energy storage sector. The initiative investigates innovative recycling techniques and urban- or phytomining technologies to extract valuable materials from used batteries. By implementing efficient recycling processes, NESTI aims to minimise waste and promote the circular economy in the energy storage industry. To facilitate the commercialisation and technology transfer of energy storage solutions, the government has approved the establishment of a one-stop centre under NESTI.

This centre will serve as a hub for commercialisation activities, providing support and resources for technology transfer from research institutions to the market. Establishing this centre demonstrates NESTI's commitment to bridging the gap between research and commercial deployment, ensuring that innovative energy storage technologies reach the market and contribute to Malaysia's sustainable energy goals.

In conclusion, the NanoMalaysia Energy Storage Technology Initiative (NESTI) is a comprehensive program focusing on developing, commercialising, and sustaining energy storage technologies. Through advancements in core components, exploration of new battery chemistries, and implementation of recycling and urban mining techniques, NESTI aims to revolutionise the energy storage industry and contribute to a more sustainable and efficient future.

Who is involved in the NESTI programme?

NESTI will adopt the Quintuple Helix model for broad participation from government agencies (NanoMalaysia, the National Nanotechnology Centre, MGTC, MARii), funding authorities (NanoMalaysia, CRADLE, MTC, KMP, MAVCAP, MDV, MIDA), the research community (MIMOS, UKM, UM, UTHM, UMP), industry (start-ups and SMEs), and end-users (Malaysian EV Owners Club—MyEVOC) to rapidly develop, validate, and commercialise relevant energy storage technologies.

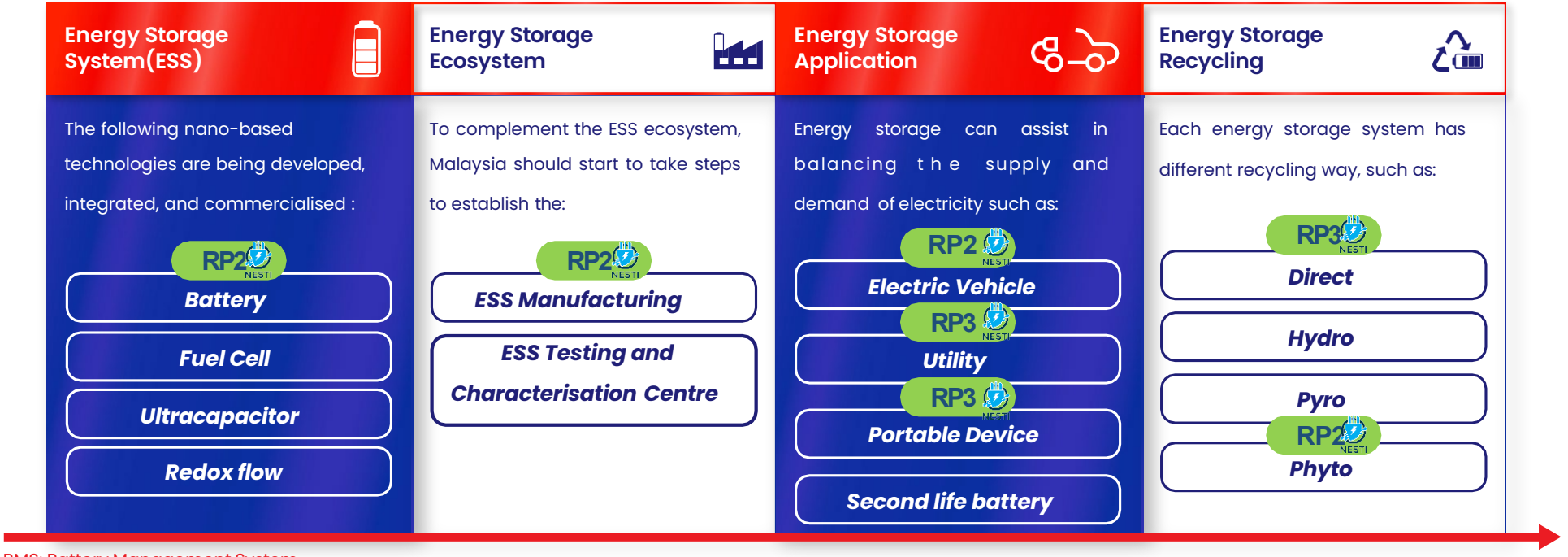
NanoMalaysia's EV and Energy Storage Programmes

NESTI: Key Focus Technologies

A sustainable energy supply storage system is needed because it is considered a critical technology in the transition to a sustainable renewable energy system.

Key drivers for energy supply storage technologies include:

- The growing demand for uninterrupted power supplies in the residential, commercial and industrial sectors and;
- The promising Low Carbon Mobility Blueprint is set to significantly influence the development of the local market. This, along with the regional ASEAN (Indonesia and Thailand) and global electric vehicles (EV) market, will pave the way for a sustainable energy future.



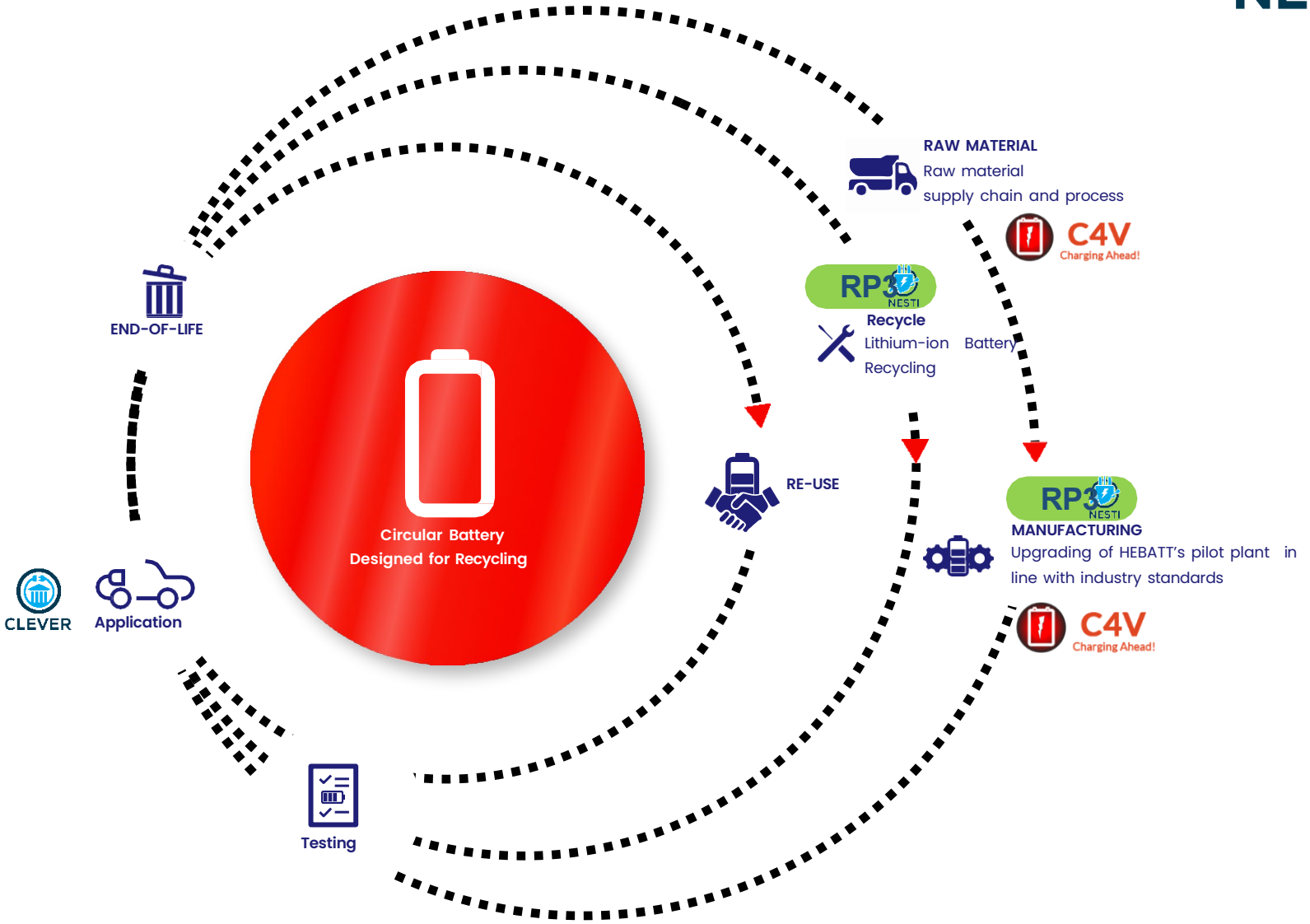
BMS: Battery Management System

Energy Storage System Life Cycle

NESTI: Circular Battery for Sustainable Energy

RP2
Phytomining
- Nickel
- Cobalt

RP3-4
- Development and deployment of electric vehicles and its ecosystem, such as charging stations and BSS
- Stationary application



NanoMalaysia's EV and Energy Storage Programmes

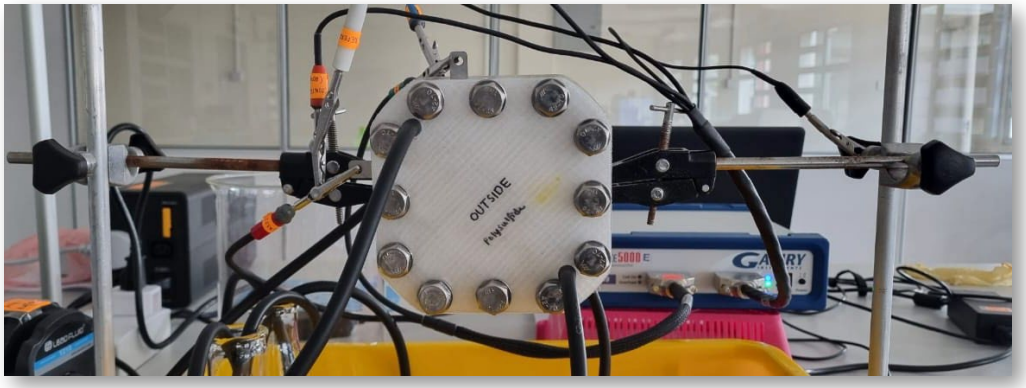
Graphene Redox Flow Battery Development Initiative

Developing a Graphene Redox Flow Battery (GRFB) for energy storage represents a significant advancement in energy storage technology. Traditional lithium-ion batteries face electrode degradation challenges with the energy storage market demanding higher energy and power densities, reducing efficiency over time. To address this, research efforts have shifted towards storing charges in electrolytes rather than electrodes, leading to the emergence of flow batteries. Under the NGAP 2020 programme, a collaborative effort involving NanoMalaysia, NGL Tech Sdn Bhd, Sunway R&D Sdn Bhd, and UPM Bintulu aims to develop graphene-based redox flow batteries. These batteries promise higher electrical output and improved storage capacity that are suitable for utility-scale applications.

The project's key milestones include the fabrication of electrodes, structural and morphological characterisation of electrode materials, electrochemical characterisation of electrodes in different electrolytes, setup of the flow battery system, and determination of flow rate and discharge rate at various currents. Each of these milestones is crucial for ensuring the efficiency and reliability of the GRFB. The stakeholders involved bring diverse expertise to the project, with NanoMalaysia contributing its knowledge in nanotechnology, NGL Tech Sdn Bhd providing expertise in battery technology, Sunway R&D Sdn Bhd offering research capabilities, and UPM Bintulu contributing academic resources.

Moving forward, the project continuation plan involves initiating pilot-scale testing for the developed GRFB. This phase will allow researchers to evaluate the battery's performance in real-world conditions and fine-tune its design for optimal efficiency and scalability. Furthermore, the project aims to advance towards developing a floating energy storage system at a larger scale. This ambitious goal seeks to pave the way for seamless integration into grid-scale applications, where reliable and high-capacity energy storage solutions are essential for balancing supply and demand.

The schematic of a typical flow battery system illustrates the electrochemical cell's design, where chemical energy is provided by two chemical components dissolved in liquid and separated by a membrane. This setup offers advantages such as power density determined by the electrolyte, highlighting the potential of flow batteries, particularly graphene-based ones, in addressing the evolving needs of the energy storage market.



NanoMalaysia's EV and Energy Storage Programmes

Hydrogen-Electric Vehicle-Battery Centre (HEBATT)

The HEBATT Centre is a pivotal initiative within NanoMalaysia's NESTI program, dedicated to developing, and commercialising graphene-based composite batteries. Focused on lithium-ion batteries with ultra-large capacity and rapid charge-discharge capabilities, this centre plays a crucial role in advancing battery technology. A primary objective of the HEBATT is the production of pouch cell batteries, offering advantages such as lightweight construction and high power and energy density. By prioritising pouch cell battery production, the centre aims to elevate battery performance to meet the escalating demand for energy storage solutions across diverse applications. Establishing local battery fabrication facilities for electric vehicles (EVs) and stationary power generation marks a significant milestone. These facilities promote domestic battery production and reduce dependence on imported batteries, contributing to self-sufficiency in the energy storage sector and aligning with the National Green Economy agenda. Leveraging the advantages of graphene-based composite batteries and local fabrication facilities, the HEBATT holds promising commercial potential. Addressing the demand for high-capacity, fast-charging batteries not only meets the needs of EVs but also unlocks opportunities in stationary power generation applications. Ultimately, the HEBATT efforts contribute to industry growth, job creation, and the advancement of sustainable practices within Malaysia's economy.

NanoMalaysia's EV and Energy Storage Programmes

HEBATT Centre Advances Graphene-enhanced Lithium-Ion Battery Production

The HEBATT Centre is pioneering the pilot production of Graphene-enhanced Lithium-ion pouch cell batteries, aiming for a high energy density of 645 Wh/kg per cell and rapid charging capabilities of up to 5C (12 minutes). This project focuses on creating an 18V 10Ah battery pack, involving stages such as optimising slurry composition, coating, upscaling fabrication, and performance testing.

The primary goals are optimising battery composition, coating, and fabrication for upscale batteries, transitioning from 3.6V 2Ah cells to 3.6V 10Ah modules, and developing an 18V 10Ah battery pack with specific performance metrics. The project concentrates on battery technology development, including assembly optimisation and performance testing of the 3.6V 2Ah cell to 3.6V 10Ah module, as well as the assembly and testing of the 18V 10Ah battery pack.

This project is pivotal for battery plant production. It focuses on the advancement and optimisation of battery technology. It aims to achieve battery components and system development milestones, contributing to advancing energy storage technology within the organisation.

The project aims to establish a pilot plant for graphene-enhanced lithium-ion batteries, defining battery cell performance characteristics for different configurations. With high capacity and rapid charging capabilities, this innovation contributes significantly to battery technology advancement. By incorporating graphene, the project enhances battery performance, safety, and reliability, providing a competitive edge in the market. It streamlines production processes, potentially reducing costs and strengthening relationships with suppliers and partners. Furthermore, it positions the organisation as a leader in advanced battery technology and innovation, attracting more customers and investors.

Based on the development of the 18V 10Ah battery pack, plans include leveraging this experience to develop battery packs for various applications, adapting technology for renewable energy storage, implementing automation for production efficiency, enhancing Battery Management Systems (BMS) for monitoring and control, implementing smart battery technology, and conducting rigorous safety testing and certification according to industry standards.

NanoMalaysia's EV and Energy Storage Programmes

Developing Graphene-Infused Lithium-ion Batteries: A Breakthrough in Energy Storage

The Hydrogen-Electric Vehicle Battery Centre (HEBATT) is embarking on a groundbreaking project to revolutionise lithium-ion battery technology. The initiative focuses on developing graphene-infused lithium-ion batteries, heralding a new era of high-performance energy storage solutions.

At the core of this initiative lies the use of graphene, a remarkable material known for its exceptional conductivity and strength. By dispersing graphene within the graphite anode using a water-based binder, researchers aim to enhance battery performance significantly.

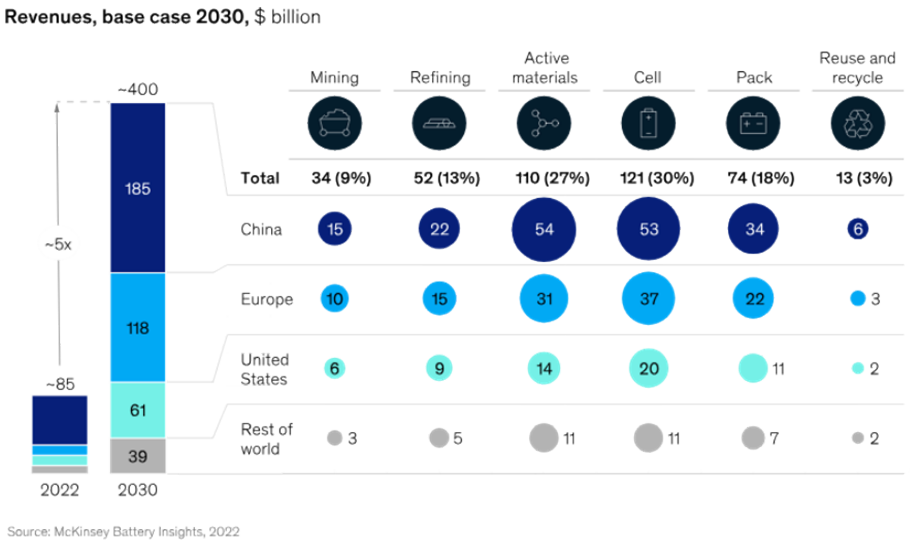
The project follows a rigorous process, which includes optimizing the slurry composition, refining the coating for scaling up the graphite anode, and conducting comprehensive performance tests. The end goal is to produce a battery cell with a voltage of 3.6V and a capacity of 2 Ah, demonstrating unmatched efficiency and reliability. The project's key objectives are to develop graphene-infused single pouch cell lithium-ion batteries and to enhance the energy density of existing battery chemistry and electrode composition.

The project's focus on developing the graphite anode is part of a comprehensive strategy. It aims to achieve synergy with cathode advancements from parallel projects. The target is to produce cells with lower internal resistance and extended cycle life, paving the way for superior energy storage capabilities.

This project holds paramount significance for HEBATT as it spearheads advancements in electrode production. By optimising composition, coating, fabrication, and performance testing, the initiative aims to achieve critical milestones in battery component development. These achievements will contribute significantly to the evolution of energy storage technology. The project offers a unique value proposition by employing a liquid-phase mixing method to disperse graphene within the graphite anode. The optimised composition and formulation promise enhanced battery performance, underscoring the organisation's commitment to innovation and excellence.

Graphene in lithium-ion batteries promises many benefits, including higher energy density, improved safety, and enhanced reliability. This innovation positions HEBATT as a frontrunner in the market and attracts investors and customers seeking cutting-edge solutions. Moreover, streamlining production processes can reduce costs and increase operational efficiency, fostering sustainable growth and development.

Building upon the success of this project, HEBATT envisions scaling up the production of graphene-infused batteries and adapting the technology to incorporate various cathode materials. These strategic initiatives aim to cement the organisation's leadership in advanced battery technology while propelling further research and development activities.



Source: McKinsey Battery Insights, 2022

NanoMalaysia's EV and Energy Storage Programmes

Advancing Lithium-Ion Battery Performance through Graphene Metal-Organic Frameworks (MOF)

In pursuing enhancing lithium-ion battery (LIB) technology, the HEBATT Center has embarked on a groundbreaking project to develop Graphene Metal-Organic Frameworks (MOF). This innovative initiative aims to optimise the performance of LIBs, particularly in capacity and stability, by integrating MOF into cathode materials.

The primary objective of this project is to identify and optimise the most effective MOF materials for application in cathodes. By synthesising MOFs with existing cathode active materials, such as LiNi1/3Co1/3Mn1/3O2 (NCM111), the project seeks to enhance battery performance significantly.

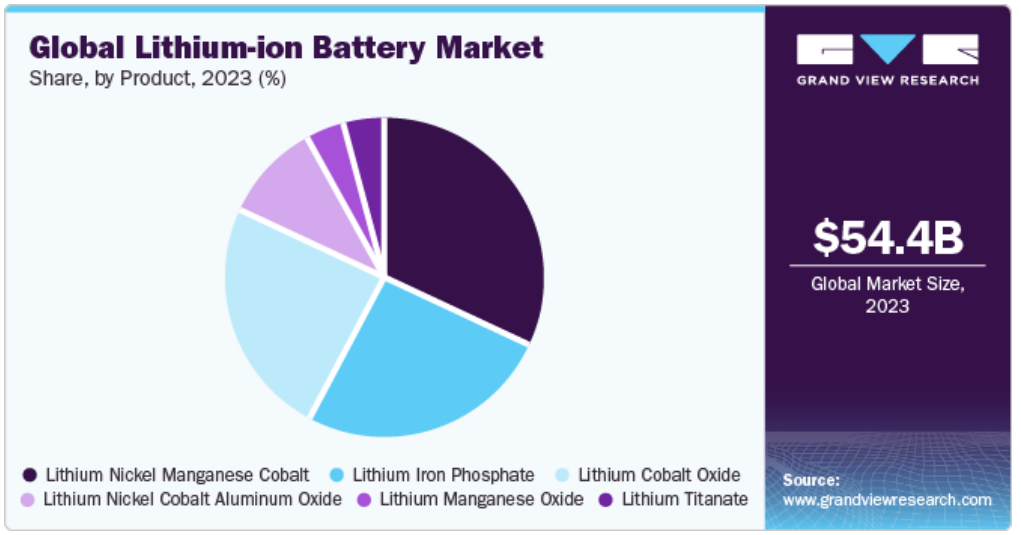
This project is of immense significance for the organisation's objectives of advancing materials for energy storage. The project aims to upscale electrode production by developing and optimising new electrode materials, including composition, coating, fabrication, and performance testing. This will contribute to achieving specific milestones in advancing LIB technology within the organisation.

The project's value proposition lies in developing new active materials utilising MOF and water-based binders. By enhancing battery performance through optimised MOF-NMC111 compositions, the project aims to deliver superior battery performance compared to traditional LIBs.

This project's research and development efforts signify a substantial investment for the organisation. However, the potential impact on the organisation's market positioning is significant. Successful resistance and extended cycle life will pave the way for superior energy storage capabilities.

Implementing advanced LIB technology can increase demand for the organisation's products, differentiation from competitors, and access to new markets.

Building upon the foundation laid by this project, plans include scaling up the production of MOF-NMC111 active materials and electrode production using water-based binders. Additionally, the organisation aims to adapt this technology to other active materials, further expanding its applications and potential impact on the energy storage industry. In summary, the HEBATT Center's project on Graphene Metal-Organic Frameworks represents a pioneering effort towards advancing LIB technology. By leveraging innovative materials and techniques, the project aims to drive significant improvements in battery performance, thereby shaping the future of energy storage solutions.



NanoMalaysia's EV and Energy Storage Programmes

The Aluminum Pouch Cell Battery Pack

The HEBATT Centre continues to push the boundaries of battery technology with its latest project, which is focused on Aluminum Pouch Cell Battery Packs. Departing from the conventional lithium-ion batteries dominating the industry, this project introduces Aluminum Ion Battery (AIB) technology to revolutionise energy storage solutions.

The primary objectives of the project are threefold:

- Develop optimal formulations for electrolytes suitable for AIBs.
- Innovate graphene-based electrodes tailored for AIBs.
- Fabricate AIB battery packs to meet specific performance metrics.

The project's scope encompasses the entire development process, from refining electrolytes and electrode compositions to fabricating pouch cell AIBs. The target is to achieve 1.8V and 0.1Ah per cell, minimising internal resistance and extending cycle life.

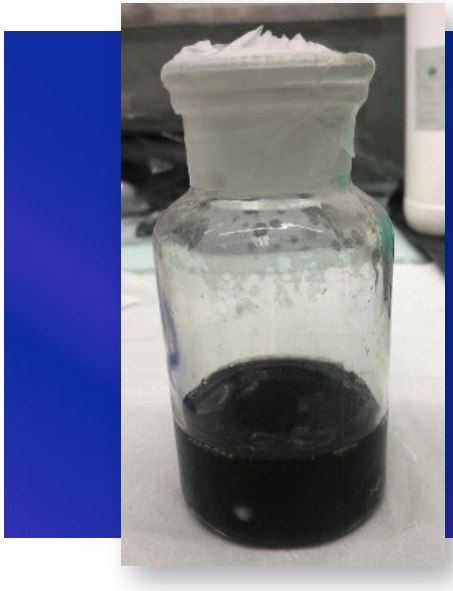
This venture holds significant importance for HEBATT as it seeks to scale up electrolyte and electrode production while optimising battery pouch fabrication. Through meticulous development and testing, the project aims to advance battery components and systems, thus propelling energy storage technology forward.

The project's value proposition lies in creating a graphene-based Aluminum pouch cell battery system utilising a water-based binder. By developing optimal electrolyte formulations and graphene-based electrode compositions, the project aims to enhance battery performance significantly..

Looking ahead, the project sets its sights on several key areas:

- Electrolyte: Upscaling in-house production of ionic liquid-based electrolyte solutions for cost-effectiveness.
- Electrode: Expanding in-house graphene production for cathode materials to improve cyclability and extend cycle life.
- Safety: Prioritising awareness and protocols for Aluminum-based battery safety to ensure reliability and user confidence.

In conclusion, the Aluminum Pouch Cell Battery Pack project at HEBATT Centre represents a bold step towards advancing battery technology. Through innovation, collaboration, and a commitment to excellence, this initiative aims to shape the future of energy storage solutions, driving progress and sustainability in the industry.



Al electrolyte

Al electrode

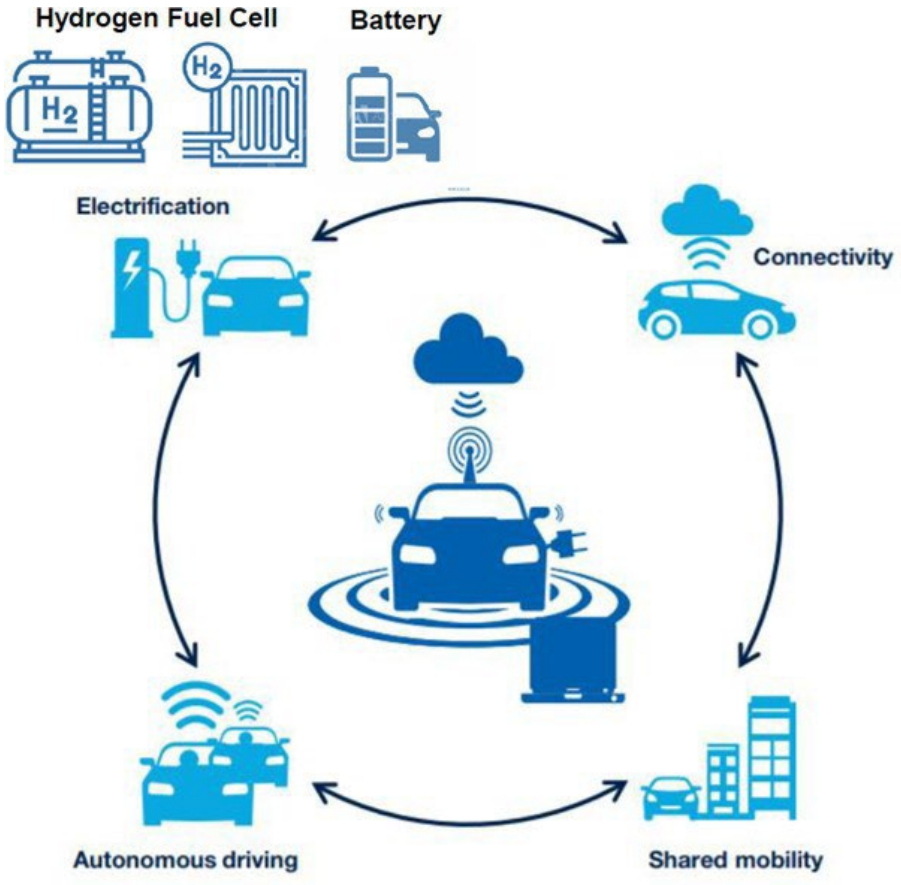
NanoMalaysia's EV and Energy Storage Programmes

EMERGE

What is Enabling Mobility Electrification For Green Economy (EMERGE)?

The program focuses on electrifying mobility and smart mobility for various electric vehicles (EVs) using energy storage and generation system technology to disrupt and introduce EVs locally and generate an ecosystem surrounding low-carbon mobility efforts. Enabling Mobility Electrification for Green Economy, or EMERGE, is a MOSTI Strategic Research Fund program focusing on developing and commercialising EV-related technologies on both component and application levels.

Conversion of ICE Buses to Battery and Fuel Cell Electric Vehicles	***Graphene-based Super Batteries or Mid Drive EV Bikes***
Renewable Energy Charging and Refueling Station	***Smart Mobility Autonomous Transportation Network***
Nanotech-Enhanced Membranes and Electrodes into Fuel Cells	***Nano-based Liquid Cooling for Thermal Management System***
AC-DC Converters for e-Mobility and Nanogrid Applications	***Graphene-based Electric Motorcycles***



NanoMalaysia's EV and Energy Storage Programmes

CLEVER

What is Campuses for Local Electric Vehicle Expeditious Roll-out (CLEVER)?

Campuses for Local Electric Vehicle Expeditious Roll-out (CLEVER) is a technology and market validation programme to deploy EV-related technologies at selected university campus grounds as technology sandboxes for closed environment studies. A task force under CLEVER will facilitate technology, set up regulations, amend insurance, and user acceptance data before mass-scale investment and deployment to the Malaysian market.

Initiatives under CLEVER

ICE to EV Conversion (REVIVE)

Converting a conventional vehicle into an electric vehicle to be deployed on campuses, such as two-wheelers (motorbikes) and four-wheelers (cars, buses)

Battery Swapping Sandboxing

This is an effective approach to supplying power to EVs while mitigating long waiting times in a battery charging station.

Fast Charging Technology

An effective and sustainable transition into e- mobility will require the deployment of fast-charging infrastructure to keep pace with the growth of BEVs on the road

Off-Grid Charging

Development of an off-grid electrical vehicle charging station hybridised with renewable sources such as solar panels.

Pilot Testing of NMC-LFP Batteries

Pilot testing of locally made batteries under Malaysia' s environment such as environmental and operational.

Small Scale EV Deployment

A small-scale deployment of EVs such as e-bicycle, e-scooter, moped can be economically manageable to universities' resident

NanoMalaysia's EV and Energy Storage Programmes

CLEVER

Technology validation program and commercialisation of EV technology on university campuses as a sandbox platform for research in a closed environment.

The data collected, and applications improved through this program will facilitate industrial facilitation (MITI-MIDA), set regulations (MOT-JPJ), insurance matters (PIAM), technology development and improvement (MOSTI-NMB) and user safety before being used on the road Malaysian public holiday.

Off-Grid EV Charging System is accompanied with Nano Solar Panel, EV Fast Charging Panel 50 kW (ABB), Li-on Battery & Ultracapacitor (EXICOM & Skeleton Technologies) & Nano Light Energy Panel Roof system (NLEP)

EduCity ISKANDAR | UNIVERSITI TENAGA NASIONAL | UTHM Universiti Tun Hussein Onn Malaysia | UTM UNIVERSITI TEKNOLOGI MALAYSIA | UNIVERSITI MALAYA | Universiti Malaysia PAHANG

Rakan Industri

evc | NANOPAC INNOVATION | UNIVERSITI MALAYA | MNA Energy | PETRONAS

Pilot Implementation and Scale-Up Projects

Technology Development Program	Current Activity	Potential Collaboration with Universities	Terms of Use
• Low Power Mopeds into Electric Motors • Conversion ICE-EV • Battery Management System Battery • Exchange System	• 2-wheel electric vehicle Ecosystem Validation (Micro Mobility) – Hyundai/ThamLEV/EcoRide/Eclimo	• Universiti Malaya (UM) • Universiti Islam Antarabangsa (UIA) • Universiti Teknikal Malaysia Melaka (UTeM) • EduCity	• Battery standards • UNECE R136 – electric power train • safety requirement
• Conversion of ICE-EV bus • Fast charging platform	• Endorsement of hydrogen hybrid storage system technology for electric buses (EMERGE) – HyPERTech Industries	• Universiti Malaya (UM) • Universiti Islam Antarabangsa (UIA) • EduCity	• 55 UNECE standards for new EV bus VTA • 12 UNECE standard retrofit/conversion to EV. (R10, R13, R18, R28, R39, etc.)
• Infra Electric Motor • "Off Grid" Charging Station • Conversion ICE-EV go-kart • Consumer commercial vehicle conversion – Perodua	• Conversion of 2 units of Mitsubishi Pajero to EV (REVIVE) – Malaysia Public Works Department • ICE to EV vehicle (REVIVE) – Inventira	• Universiti Tenaga Nasional (UNITEN) • Universiti Malaya (UM) • Universiti Teknologi Malaysia (UTM) • EduCity	• UNECE standards as a reference, but some countries introduce their own standards, including: • USNCAP – battery chemical spill inclination test • JNCAP – IPXX protection rating for EV components

NanoMalaysia's EV and Energy Storage Programmes

What is the Rapid Electric Vehicles Innovation Validation Ecosystem (REVIVE)?

REVIVE, a pioneering program initiated by NanoMalaysia, stands at the forefront of the automotive industry's paradigm shift towards sustainable mobility. Focused on converting Internal Combustion Engine (ICE) vehicles into Electric Vehicles (EVs), REVIVE aims to establish robust processes and procedures to ensure the seamless transformation of vehicles into road-worthy and safe EVs.

Introducing the EV Kit: A Standardised Solution

The EV Kit is at the heart of REVIVE's conversion process. It is a standardised set of main EV components that ensures consistency and reliability across all converted vehicles by compiling essential elements such as motors, batteries, DC-DC converters, inverters, and control units. This standard approach streamlines the conversion process and enhances performance and safety standards.

Objectives of REVIVE

- **Establishing Conversion Processes and Procedures:**

By defining clear processes and procedures, REVIVE aims to ensure the seamless and safe conversion of ICE vehicles into EVs. Emphasis is placed on meeting all roadworthiness aspects, including safety, performance, maintenance, and insurance requirements.

- **Fostering Economic Growth and Innovation:**

Beyond its immediate goal of vehicle conversion, REVIVE envisions the creation of a new local economic niche. REVIVE aims to propel Malaysia to the forefront of the EV industry by producing EV components and cultivating regional technology and innovation.

- **Developing Local Talent and Expertise:**

Central to REVIVE's mission is the development of local talent and expertise in EV technology. By providing opportunities for skill development and knowledge enhancement, REVIVE seeks to nurture a pool of competent professionals capable of driving Malaysia's EV ecosystem forward.

NanoMalaysia's EV and Energy Storage Programmes

The quest for sustainable transportation solutions is gaining momentum globally, and Malaysia's NanoMalaysia Berhad is at the forefront with its groundbreaking initiative, REVIVE (Rapid Electric Vehicles Innovation Validation Ecosystem). As the automotive landscape evolves towards electrification, REVIVE is a pioneering program dedicated to converting Internal Combustion Engine (ICE) vehicles into Electric Vehicles (EVs) while ensuring safety, performance, and compliance with regulatory standards.

Collaborative Efforts for Transformation

NanoMalaysia Berhad has forged strategic partnerships with key stakeholders, including the Road Transport Department (JPJ), Land Public Transport Agency (APAD), Ministry of Higher Education (MOHE) universities, General Insurance Association of Malaysia (PIAM), local start-ups, and Small and Medium Enterprises (SMEs). This collaborative effort aims not only to validate and deploy

Progress Update: Steering Towards a Sustainable Future

In recent developments, REVIVE has made significant strides towards realising its objectives:

- **Extended EV Bus Conversion Project:**

Collaborative discussions with APAD have resulted in an agreement to prolong the EV bus conversion project, considering the extension of the buses' lifetime beyond the current 15-year limit.

- **Drafting EV Conversion Guidelines:**

Working closely with JPJ, REVIVE is actively reviewing and drafting comprehensive EV conversion guidelines for various passenger vehicle categories. The aim is to establish clear regulations to govern the conversion process, ensuring safety and compliance.

- **Enhancing Safety Standards:**

Engagements with the Malaysian Institute of Road Safety Research (MIROS) have provided invaluable insights into safety considerations and hazards associated with passenger vehicles post-EV conversion. This proactive approach underscores REVIVE's commitment to prioritising safety.

- **Compliance and Homologation:**

To address concerns regarding battery disposal and certification, REVIVE collaborates with authorised partners such as TUV SUD Sdn Bhd to ensure compliance with standard regulations. Additionally, efforts are underway to gather certifications and homologation services essential for EV conversion.

- **Regulatory Approval Process:**

Progress is being made towards obtaining overall approval from the Ministry of Transport (MOT) for the EV conversion process and guidelines. These regulatory milestones are crucial for legitimising the conversion process and facilitating the widespread adoption of EVs in Malaysia.

- **Post-Conversion Legalisation:**

Discussions with PUSPAKOM are underway to streamline the process of legalising EV-converted vehicles for road use. This initiative aims to ensure that converted vehicles adhere to regulatory standards and are fit for public roads.

A Glimpse into the Future

As REVIVE continues to chart its course towards a sustainable automotive future, its collaborative approach and steadfast commitment to safety, innovation, and regulatory compliance remain unwavering. By harnessing the collective expertise of its partners and stakeholders, REVIVE is poised to catalyse the transition towards electric mobility, driving Malaysia towards a

NanoMalaysia's EV and Energy Storage Programmes

REVIVE

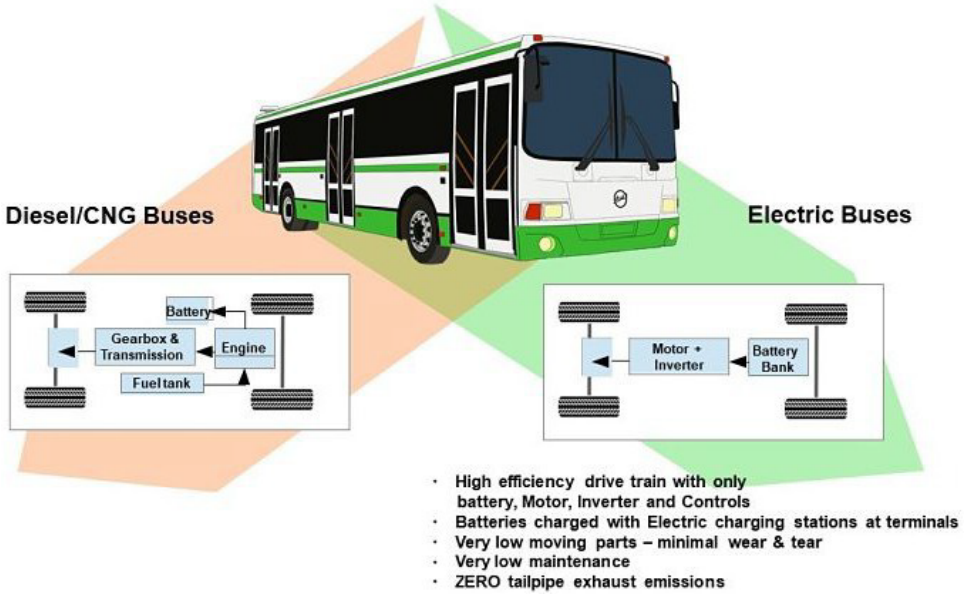
What is the Rapid Electric Vehicles Innovation Validation Ecosystem (REVIVE)?

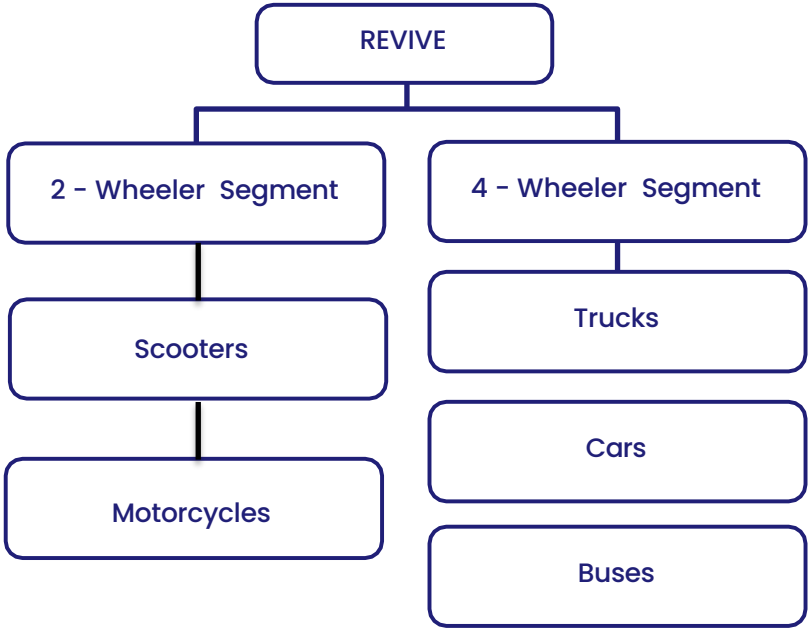
REVIVE, focusing on ICE to EV conversion, aims to establish processes and procedures for converting ICE vehicles to road-worthy and safe EVs and ensure that all aspects of road-worthy cars are met with regard to the converted vehicles, e.g., safety, performance, maintenance, insurance, etc. This program is a spin-off initiative of EMERGE that will focus on ICE to EV conversion.

The objective of REVIVE is to establish:

1. Processes and procedures for conversion of ICE vehicles to roadworthy and safe EVs
2. Ensure that the converted cars meet all roadworthy car standards, e.g., safety, performance, maintenance, insurance, etc.

NanoMalaysia Berhad will collaborate with JPJ, APAD, MOHE universities, PIAM, local start-ups, and SME partners to validate and deploy converted vehicles on the road. This initiative will provide reskilling and upskilling of the Malaysian technical workforce, thus creating new jobs.

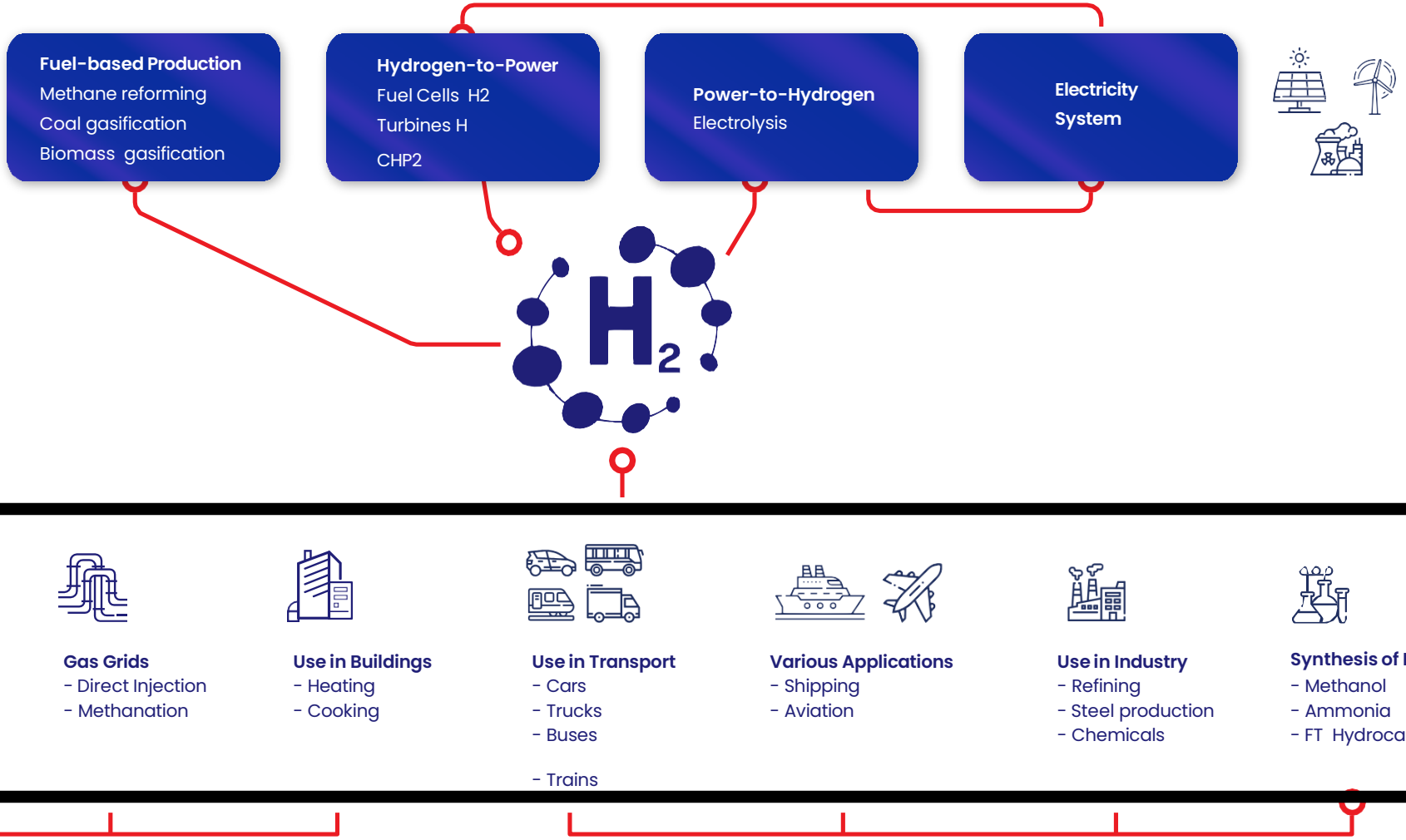




NanoMalaysia's EV and Energy Storage Programmes

What is the Hydrogen EcoNanoMY Programme

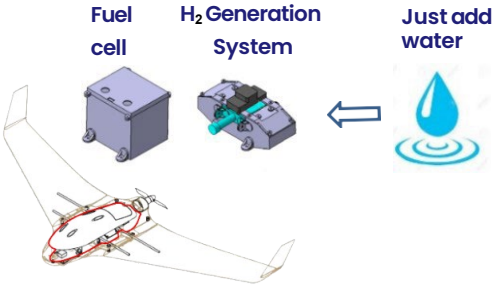
The Hydrogen EcoNanoMY programme, which NanoMalaysia Berhad facilitates, aims to develop and produce local game-changer technology, enabling cost-efficient hydrogen on-demand and on-site production. It also examines the ecosystem surrounding the value chain and addresses market interest in the hydrogen economy, including technology locally and internationally.



Technology Initiatives

Hydrogen Paired Electric Race Car

Hydrogen Paired E-Bikes



On-Board H2 Generation System for UAV and Precision Agriculture

Development & Optimisation of Nano-Catalyst for Rapid Hydrogen Production

Recycling of by-products of Solid State Hydrogen Chemicals

Chemical Hydride Refuelling System for Onboard Hydrogen Reactors

Hydrogen Hybrid Energy Storage System on commercial electric bus

Hydrogen Hybrid Energy Storage System on ships & & Marine Applications

Nano-enhanced Efficiency Membranes & Electrodes for Electrolyser

End-to-end ecosystems are developed for nanomaterials applications.

Hydrogen EcoNanoMy

NanoMalaysia's local hydrogen energy ecosystem platform aims to establish a robust framework for large-scale hydrogen generation within Malaysia. At its core, the program harnesses nanotechnology to innovate and implement indigenous hydrogen technology, fostering the security and efficiency of hydrogen production processes.

The program aims to develop an on-demand, on-site hydrogen generation system. This decentralised approach eliminates the logistical challenges associated with long-distance transportation and storage of hydrogen, thereby enhancing overall security and efficiency. Through the integration of nanotechnology, the program seeks to optimise the performance and reliability of hydrogen generation systems, ensuring a steady and sustainable hydrogen supply.

Furthermore, the program underscores the development and integration of devices and systems that utilise hydrogen as a primary fuel source across various industrial applications. This encompasses a spectrum of technologies, including fuel cells, hydrogen-powered vehicles, and other hydrogen-based innovations. The program aims to catalyse the transition towards a cleaner and more sustainable energy landscape across diverse sectors by promoting the widespread adoption of hydrogen along the hydrogen economic value chain.

NanoMalaysia's EV and Energy Storage Programmes

Pilot Facilitation of Graphene-Based Admixture for Construction Application

The Development of Sustainable Hydrogen using Nanocatalyst-driven Photochemical Production initiative aims to address the pressing need for cleaner hydrogen (H2) production methods in Malaysia. Currently, the H2 production landscape heavily relies on steam reforming of fossil fuels, resulting in substantial carbon dioxide (CO2) emissions. Globally, H2 production contributes a staggering 830 million metric tons of CO2 emissions annually, equivalent to the combined output of Indonesia and the UK.

This innovative project seeks to revolutionise hydrogen production by harnessing the abundant solar energy available in Malaysia to drive water-based H2 generation. Central to the initiative is introducing a groundbreaking technological advancement—transforming traditional photocatalytic suspension systems into a continuous flow system, known as the photocatalytic sheet reactor. This pioneering approach achieves a dual purpose, enabling simultaneous H2 evolution and chemical synthesis within a single device.

CHAPTER 9

Our Verification Programme

NANOVerify Programme

NANO *VERIFIED* MARK ONLY FOR GENUINE NANOTECHNOLOGY PRODUCTS

NANO *VERIFIED* MARK

Various nanotechnology products and applications are available for commercial use today. Product manufacturers have recognised that incorporating even small amounts of nanomaterials into their existing products can substantially enhance their properties or even develop entirely new properties. This presents consumer goods manufacturers with a unique product selling point, setting them apart in the competitive marketplace. Applications span numerous sectors, including electronics, energy storage, textiles, and food packaging materials.

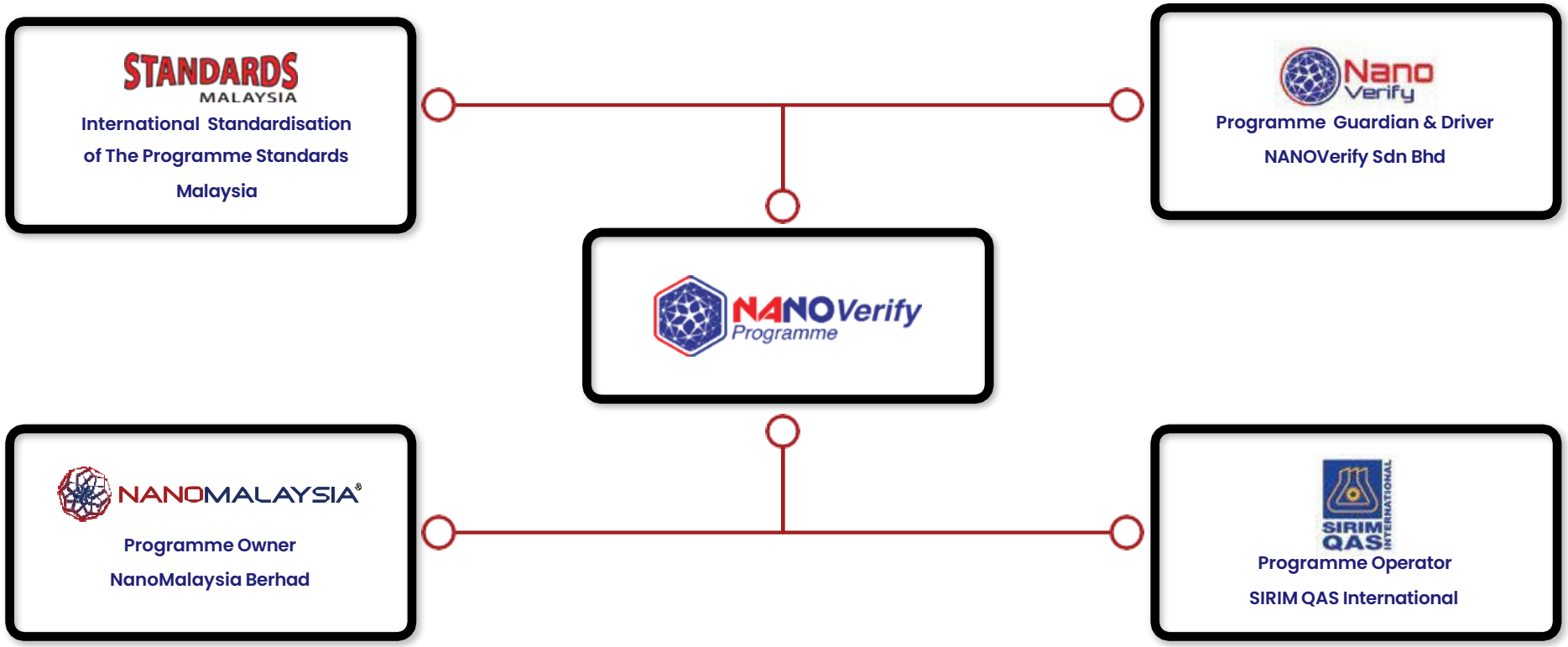
While consumers stand to benefit significantly from this market trend, the primary concern is ensuring the credibility and reliability of these nanotech products. Nanotechnology, being a relatively new field in Malaysia, requires the protection of consumers from unscrupulous manufacturers who may falsely claim that their products feature nanotechnology-enabled benefits when they do not. As a result, NanoMalaysia launched the NANOVerify Programme to address these concerns.

The NANOVerify Programme aims to establish standards and guidelines for nanotechnology products, ensuring they adhere to stringent quality and safety measures. By implementing these standards, consumers can feel confident in the nanotechnology products they purchase, knowing that a reliable certification programme backs them.

To further support the growth of the nanotechnology industry, the NANOVerify Programme collaborates with various stakeholders, including research institutions, industry players, and government agencies. Through education, outreach, and collaboration, the programme seeks to promote the responsible development and application of nanotechnology in various industries.

By doing so, the NANOVerify Programme fosters an environment where nanotechnology can flourish and reach its full potential, benefiting manufacturers and consumers. Through its ongoing efforts, the programme continues to play a vital role in driving the growth and evolution of the nanotechnology industry, paving the way for innovative products and applications that are both reliable and credible.

NANOVerify



NVSB has been diligently collaborating with key industry associations and companies, locally and internationally, to pursue their vision of being a reference body for nanotechnology and consultation in Asia by 2025.

To realise this ambition, NVSB is on track to achieve Accredited Certification Body (ACB) status, which is crucial for offering internationally recognised certifications by ISO/IEC 17065. Should the project succeed, NVSB will be the world's first and only accredited certification body operating a nano product certification scheme, thus solidifying Malaysia's position as a frontrunner in nanotechnology commercialisation (through certification) and, ultimately, enhancing the global visibility of Malaysia's nano ecosystem.

As part of its efforts to support the National Nanotechnology Policy and Strategy (NNPS) 2021-2030, overseen by the Ministry of Science, Technology, and Innovation (MOSTI), NVSB has also forged strategic partnerships throughout the ASEAN region. These collaborations aim to promote the NANOVerify Programme as the de facto ASEAN nanotechnology certification scheme, in alignment with NVSB's vision statement. Such partnerships will enable Malaysia to participate in and further strengthen the regional nanotechnology market by providing essential certifications.

NanoVerify Programme Certification Process

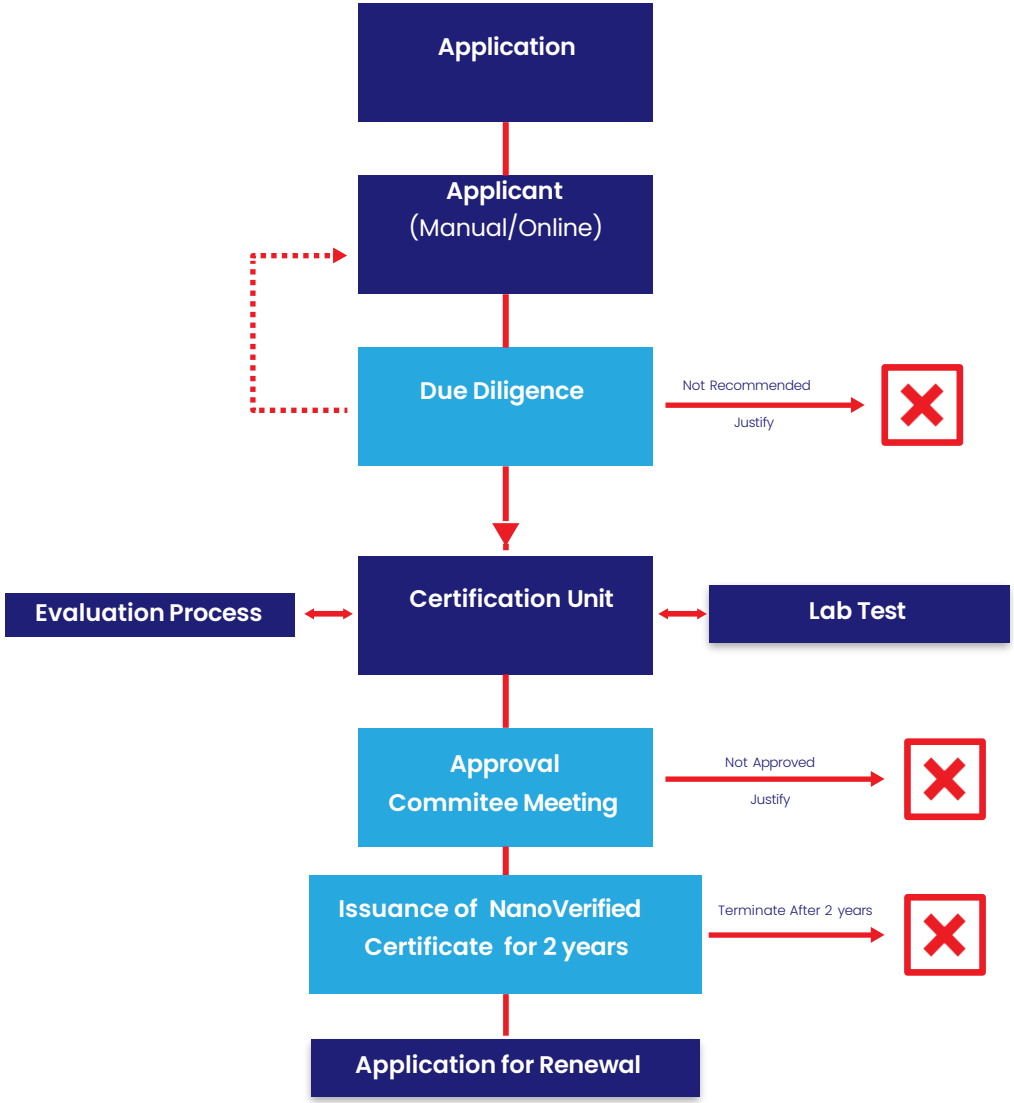
NANOVerify Type 5 Scheme

The application process for the NANOVerify Programme is straightforward: companies are to submit their application forms and payment receipts to the programme secretariat. The secretariat will then conduct a pre-qualification and due diligence to ensure the eligibility of the product to be verified. Upon satisfactory completion of the due diligence process, a memo will be issued to the applicant, and the application will be assigned to relevant auditors to initiate the product certification process.

A conformance audit will be conducted at the applicant's manufacturing premises to witness the incorporation of nanomaterials into the product. The auditor will collect product samples to be tested at an MS ISO/IEC 17025 accredited laboratory to characterise and assess the functionality of the nanomaterials within the product. Upon receiving the lab report and resolving any non-compliance issues, the application will be brought to the attention of the Approval Committee for review and approval. Upon approval, successful applicants will be awarded a certificate of conformance and granted permission to use the NANOVerification mark.

NANOTrust and GRAPHENEVerify Type 2 Scheme

The application process for NANOTrust and GRAPHENEVerify Type 2 Schemes is similar to NANOVerify Type 5, beginning with submitting application forms, relevant documents, and payment to the secretariat. The only difference is the absence of production line audits, emphasising strict and thorough end-product testing. This testing requires sizing, characterisation, and identification of the nanomaterial in the final product using Transmission Electron Microscopy (TEM) for sizing and characterisation of the nanomaterial, accompanied by Raman Spectroscopy, Gas Chromatography-Mass Spectrometry (GCMS), and Dynamic Light Scattering (DLS) methods to identify the composition of the nanomaterials.



Outcomes of The NANOVerify Certification Programme

Product Certification Facilitions	**RM4.4 million**	2015-2023 Certifications
Local Market Penetration	**17%**	248 Certified Products (out of 1464 Nano-products)
Increase of Revenue	**RM178.8 million**	2015-2023 NanoVerified Companies
NanoVerified Products (2015-2021)	**248**	From 168 Companies
Overall Impact on Revenue	**+84%**	2015-2023 NanoVerified Companies

Revenue Increase (2015-2022) and Facilitation Amount (2015-2023), By Sector

The NANOVerify Programme has a positive impact on revenue across multiple sectors. The most significant increase in revenue was observed in the Pharmaceutical sector, which experienced an impressive 159% growth. The Biotechnology, Agriculture, and Food Processing sectors also saw substantial revenue increases, at 104% and 83%, respectively.

On the other hand, the Petroleum Products, including Petrochemicals and Machinery and Equipment sectors, experienced relatively lower revenue growth, at 23% and 12%, respectively. Despite this, all sectors demonstrated positive growth, highlighting the NANOVerify Programme's effectiveness in driving nanotechnology product sales.

Regarding the facilitation of certification grants, RM 4,375,000 was received across all sectors, with the Chemicals and Chemical Products sector receiving the highest amount, RM 1,546,300. In contrast, the Plastic Products sector received the lowest facilitation amount, RM 85,400.

Overall, the NANOVerify Programme has significantly boosted the sales of nanotechnology products across different sectors, with varying degrees of impact on revenue growth and financial support received. Moving forward, NANOVerify aims to obtain the MS ISO/IEC 17065 Accreditation and expand the NANOVerify Programme into the ASEAN region.

NanoVerified Products Highlights

MIMOS Graphene Anti-static Ink (Mi-GraphASC) (GV2020020)

A topical-type anti-static coating containing advanced 2-dimensional alkoxysilane-functionalised graphene nanoplatelets (GNP) nanomaterial and specifically formulated to have functional coatings onto flexible surfaces in order to reduce or eliminate build-up of electrostatic charge.

PALM KERNEL SHELL BASED SINGLE LAYER GRAPHENE (GV2020029)

A genuine certified single-layer graphene has various applications, especially in electric and electronic industries. It has high electrical conductivity and better thermal performance in comparison to the conventional graphene.

Cytonex Non-Invasive Stem Cell Kit (NV2022035)

A stem cell kit that helps in therapeutic regenerative treatment for various diseases and conditions such as diabetic complications, kidney diseases, osteoarthritis, spinal cord injury as well as wellness.

Optimize tissue function by maintaining tissue homeostasis, releasing growth factor and modulating immune system.

ZANDEC ANTISEPTIC SOLUTION (NTW2023001)

This product is an antiseptic solution. It is a nanosilver-based solution for cleaning the skin and wounds. It helps to kill or prevent the growth of microorganisms. It can be used as a photocatalytic coating.

ATHEMIN ATHEDROP (NV2022039)

A curcumin-based food supplement that effectively reduces inflammation by inhibiting inflammatory molecules. It also aids by regulating key enzymes and pathways in the body.

Nutridyan Moringa Collagen Peptide Functional Drink (NT2020089)

It is a functional drink which rich in isothiocyanate, a natural alternative for the long-term treatment of arthritis. It has Joint-supporting properties, helping to restore damaged cartilage. It also supported by antioxidants and anti-inflammatory effect

Impact on Revenue, by Industry 2015-2023

NVSB Activities in 2023

The Official Launch of NANOTrust and GRAPHENEVerify Certification and Award Ceremony to Industry Players (May 2023)

The launch of NANOTrust and GRAPHENEVerify product certification schemes. The ceremony was officiated by YBhg Datuk Arthur Joseph Kurup, Deputy Minister of Science, Technology and Innovation (MOSTI)

Strategic collaboration with PT Nanotech Indonesia Global (June 2023)

Strategic collaboration with PT Nanotech Indonesia Global (NIG) marks a significant milestone in the regional nanotechnology business. This strategic collaboration aims to establish a 'Gold Standard' in nanotechnology certification, shaping the industry and driving prosperity. This partnership aligns with Malaysia's MADANI framework, fostering trust and technological advancement.

NVSB Activities in 2023

Dialogue session on Nanotechnology's Unique Value Propositions in Cosmetic Industry (July 2023)

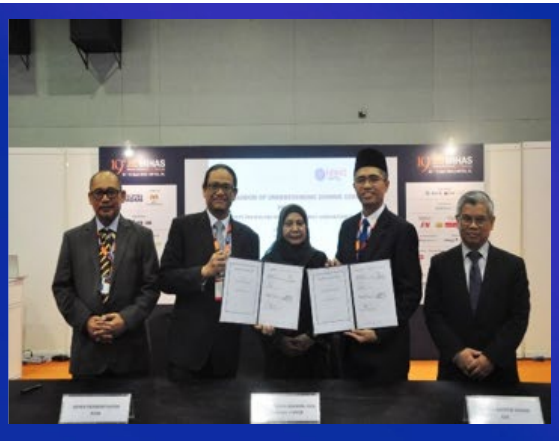
Official Visit to His Excellency Tuan Yang Terutama Tun Dato' Seri Utama Ahmad Fuzi Bin Haji Abdul Razak, Yang Di-Pertua Negeri Pulau Pinang (August 2023)

Official Visit to His Excellency Tuan Yang Terutama Tun Dato' Seri Utama Ahmad Fuzi Bin Haji Abdul Razak, Yang Di-Pertua Negeri Pulau Pinang, to discuss the utilisation of nanotechnology to further improve Penang, for the benefit of the rakyat.

NVSB Activities in 2023

Memorandum of Understanding (MoU) between Nano Verify Sdn Bhd (NVSB) and Halal Development Corporation Berhad (HDC) (September 2023)





Through this MoU, NVSB and HDC aim to be at the forefront of developing innovative Halal products by incorporating advanced nanotechnology, ensuring transparency and building stronger consumer confidence. The MoU was officially signed by HDC's CEO, Mr Hairol Ariffein Sahari. At the same time, NanoVerify was represented by Mr Johan Iskandar Hasan, Managing Director of NVSB, in the presence of YBhg Datuk Fadilah Baharin, Chairman of NanoVerify, witnessed by Mr Hanisofian bin Alias, Chief Industrial Development Officer of HDC, and Mr. Wan Mohd Rozi bin Wan Ab Rahman, Manager of Corporate Strategy at NanoVerify.

Memorandum of Understanding (MoU) between Nano Verify Sdn Bhd (NVSB) and Halal Syariah Integrasi (HIS) (December 2023)

NanoVerify Sdn Bhd (NVSB) and Halal Syariah Integrasi (HIS) signed a memorandum of understanding to explore avenues for joint engagement. HSI is an Indonesian organisation that facilitates training, certification, and consultation within the halal and sharia sectors, encompassing halal products, service concepts, and related fields.

Through this partnership, NVSB and HIS aim to enhance halal product certification standards and leverage regional promotional activities. This will also involve co-branding superior halal-certified products with valid nanotechnology certification under the NANOVerify Programme.

NVSB Activities in 2023

Memorandum of Understanding (MoU) between Nano Verify Sdn Bhd (NVSB) and BSB Nanotechnology Joint Stock Company (December 2023)

NanoVerify Sdn Bhd (NVSB) signed an MoU with BSB Nanotechnology Joint Stock Company, a company based in Vietnam. Both NVSB and BSB Nanotechnology Joint Stock Company join forces to identify ways to explore nanotechnology opportunities, including technical and commercial arrangements in Malaysia and Vietnam, whilst leveraging on collaborations with international certification bodies and direct certification of new products in Vietnam through the NANOVerify Programme.

NANOVerified Companies 2023

CHAPTER 10

Monetising Technology

Business Objectives

Spearheading The Nanotechnology Revolution by Re-energising Industries

Driving Economic Growth and Commercialisation

Strengthening The Ecosystem and Enhancing Competitiveness

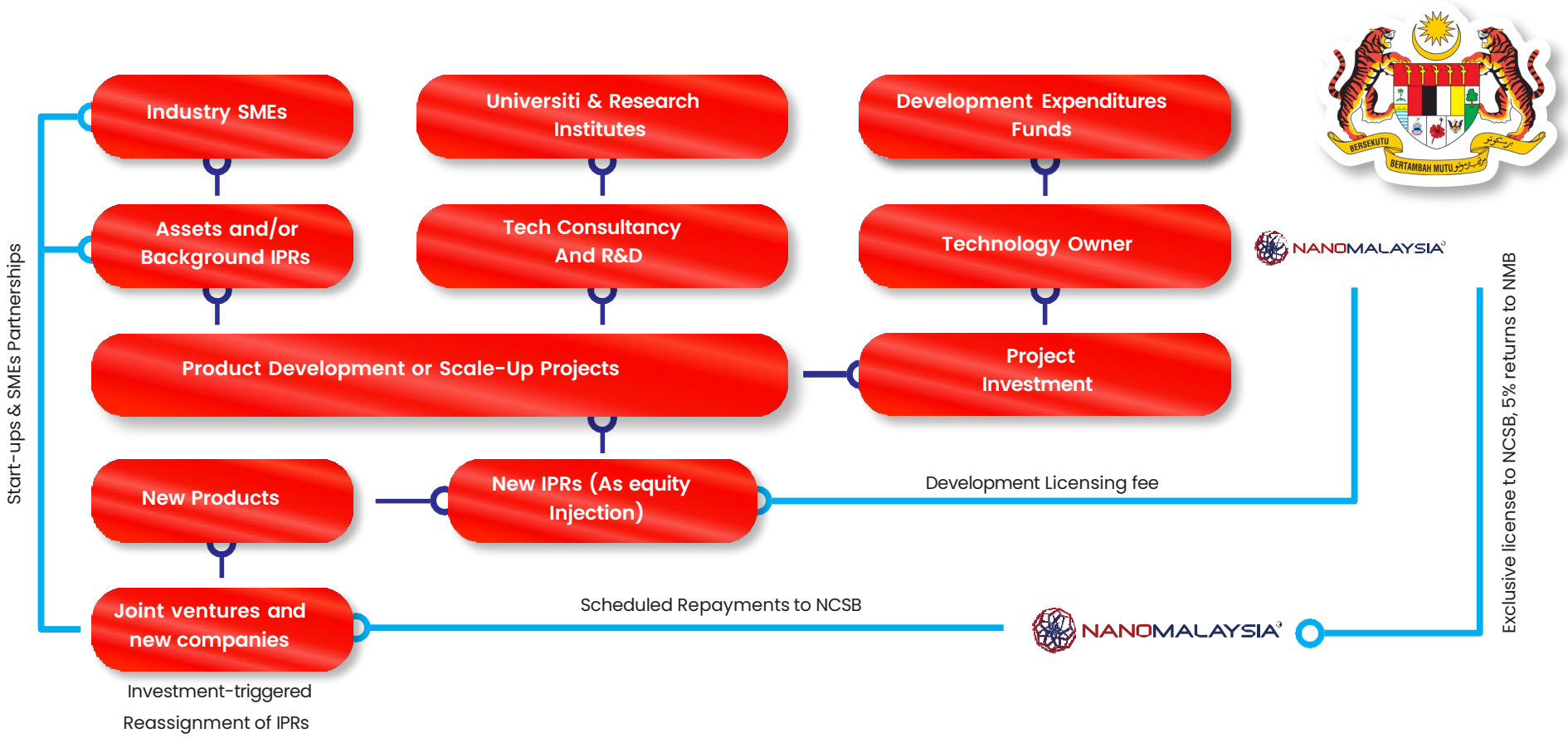
Increasing Public Awareness

At NanoMalaysia, our primary focus is cultivating long-term sustainable growth within four key strategic sectors with immense value creation and profitability potential. These sectors, known as our Jumpstart sectors, have been identified based on their significant opportunities for driving innovation and generating favourable financial returns.

We actively manifest our strategic intent through a wide range of business activities conducted by NanoMalaysia throughout the year. We have implemented a comprehensive and structured project management workflow process to maximise value creation and ensure our endeavours align with our objectives. This systematic approach enables us to plan, execute, and monitor our projects, optimising their outcomes and driving successful results.

Our comprehensive business model shows our unwavering commitment to executing our strategy. By adhering to a disciplined approach and staying focused on our objectives, we have established robust business fundamentals and fostered our organisation's long-term resilience. This commitment ensures that we remain on track, navigate challenges, and capitalise on opportunities that arise, positioning us for sustained growth and success in the ever-evolving business landscape.

NanoMalaysia's Venture Builder: From Idea to Market



Transforming Nanotech Concepts into Commercial Reality

NanoMalaysia's Venture Builder model is a unique approach to supporting startups in the nanotechnology industry. Unlike traditional venture capitalists who invest in existing companies, NanoMalaysia acts as a venture builder by working with startups from the early stages of idea development to building prototypes and eventually scaling up to the market. NanoMalaysia's venture builder model aims to maximise the potential of each venture and provide sustainable business development in the nanotech industry. It offers startups financial support, access to resources, expertise, and government recognition and assistance in the commercialisation process.

NanoMalaysia's Venture Builder: From Idea to Market

NanoMalaysia operates on a business model of strategic investments in diverse projects and initiatives. This model fosters collaboration with business owners, universities, research institutes, and other industries. This collaborative approach is designed to enhance the resources available during crucial phases of development and scale-up. NanoMalaysia provides comprehensive assistance to its esteemed partners, spanning across six critical areas: Global marketing

- Human capital
- Infrastructure
- Products
- Technology and knowledge
- Financial support

In addition, acting as a trusted intermediary between government entities and industries, NanoMalaysia facilitates significant government recognition and assistance for companies engaged in collaborative ventures. This recognition and support extend well beyond monetary investments, offering substantial value that surpasses financial contributions. NanoMalaysia's commitment lies in ensuring its partners' success by providing a comprehensive suite of resources and expertise.

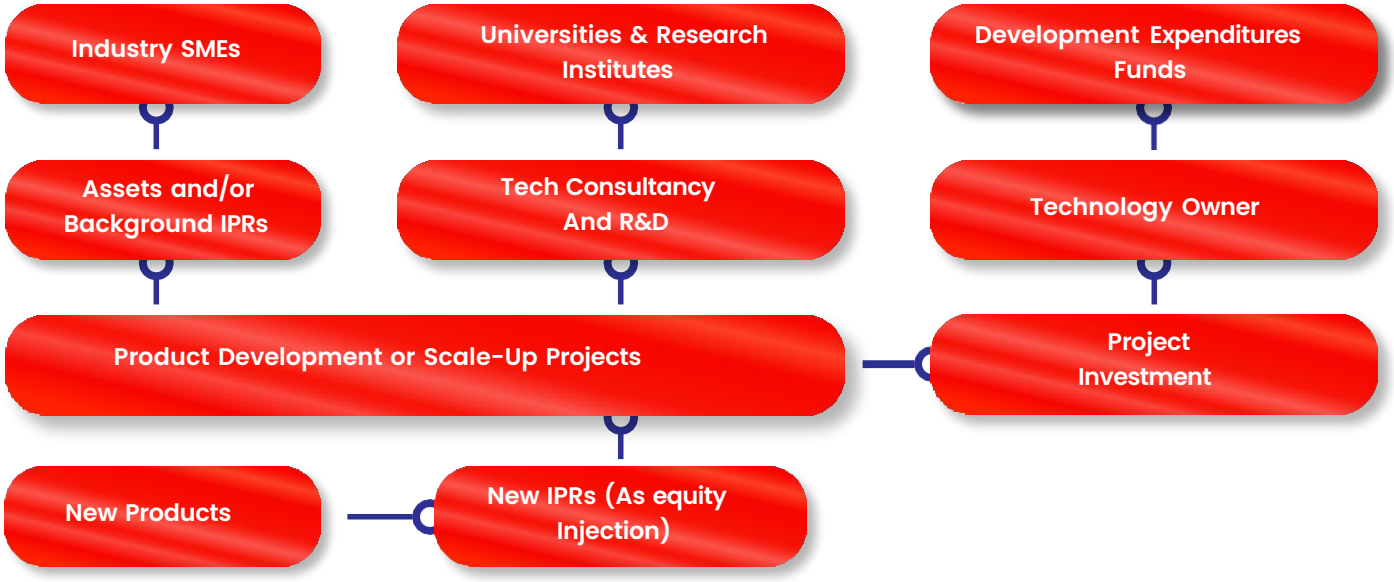
There are two brackets in NanoMalaysia's Venture Builder model which is:

1. The Development Stage:

NanoMalaysia's Venture Builder Model begins with the Development Stage, catering to entrepreneurs with nano-based product ideas but lacking a prototype. During this phase, NanoMalaysia collaborates closely with the entrepreneurs to evaluate necessary materials and resources for prototype development. Investments are channelled through NanoCommerce Sdn Bhd, NanoMalaysia's subsidiary company. To safeguard the partners' legal and commercial rights, NanoMalaysia creates Intellectual Property (IP) for the project, thereby protecting the technology from potential theft. This IP can be repurposed or used for pilot production. In case of quality issues, NanoMalaysia assists in prototype improvement, ensuring a robust and market-ready product.

2. The Scale-Up Stage:

Entrepreneurs who already possess a prototype but require support to bring the product to market can use NanoMalaysia's Scale-Up Stage. Leveraging their expertise in nanotechnology, NanoMalaysia assists with technology licensing and manufacturing materials for the project, encompassing sub-components, components, or complete systems. Market validation is conducted if necessary to ensure product-market fit. NanoMalaysia further facilitates the introduction of the finished product to the target audience, including consumers, prosumers, and industry professionals, thus providing exposure and market access.



NanoMalaysia's Venture Builder: From Idea to Market

The Venture Builder Model takes three (3) standard commercialisation approaches jointly with the Business Partners.

a. Sale of Equipment Model: The Sale of Equipment Model is an offer to the Business Partners to own the equipment. In this step, NanoMalaysia will assist the Business Partners in seeking further funding from external sources or investors to start the manufacturing facility lines, including setting up the marketing and distribution channels to sell the nanotechnology products.

b. Licensing Model: NanoMalaysia will also offer a Licensing Model parallel to the Sale of Equipment Model. The Licensing Model (exclusive or non-exclusive) with the right to sub-license aims to generate larger income based on the fair market value of the Intellectual Property, as mutually agreed by the Business Partners.

c. Equity Model: In this option, NanoMalaysia will subscribe equity in the Business Partners company or jointly establish a new joint venture company to commercialise the Nanotechnology Intellectual Property. NanoMalaysia will assign the Equipment and license the Nanotechnology Intellectual Property to the Business Partners or joint venture companies.

The Venture Builder Model aims to mitigate the risk and challenges of the Nanotechnology Intellectual Property along the journey of Valley of Death reaching the market. The multiple business models are progressive and provide constructive steps towards "Commercialisation", i.e., the Venture Builder Model.

Post-Deployment Support:

After successful product deployment, NanoMalaysia continues to provide invaluable support to entrepreneurs, enhancing their prospects for success in 4 ways:

1. **Funding:** NanoMalaysia facilitates connections with local funding agencies, enabling entrepreneurs to secure additional funding for production equipment and fueling further growth.

2. **Licensing:** When other entities express interest in utilising the technology developed through the project, NanoMalaysia assists in sublicensing and opening up new revenue streams and partnerships.

3. **Joint Venture:** NanoMalaysia can help forge strategic partnerships by involving additional stakeholders or investors. This collaborative approach allows for shared investments, leveraging the strengths of multiple parties to achieve mutual success.

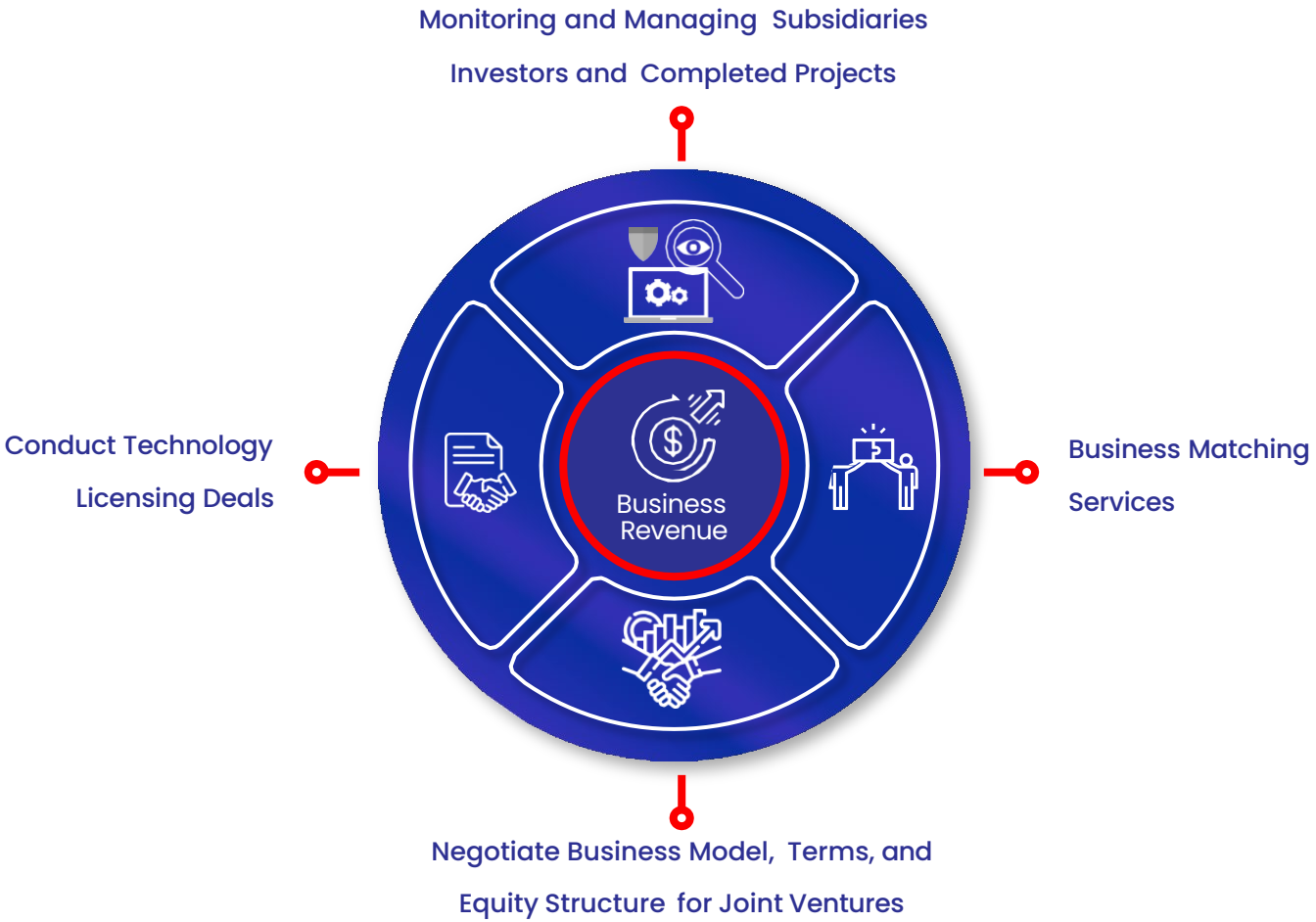
4. **IP Sale:** Upon project completion, entrepreneurs can sell the Intellectual Property or collaborate with NanoMalaysia to explore new applications, markets, or technology enhancements. This cooperative effort ensures that entrepreneurs maximise the potential of their technology and products.

These four factors catalyse each project's success, exemplifying NanoMalaysia's commitment to maximising each venture's potential in collaboration with its esteemed partners.

Enabling Growth Through Strategic Partnerships

Spearheading The Nanotechnology Revolution by Re-energising Industries

NanoMalaysia has achieved significant milestones in driving commercialisation activities through fruitful collaborations and joint ventures. These activities have contributed to our business revenue and played a pivotal role in fostering the sustainable growth of the local nanotechnology sector.



CHAPTER 11

2023 Highlights

Integrity, Governance, and Anti-Corruption Award (AIGA2022)

NanoMalaysia Berhad was awarded the Anugerah Gangsa at the Integrity, Governance, and Anti-Corruption Award (AIGA2022) for its exemplary work culture and commitment to integrity in the workplace. The AIGA2022, hosted by Institut Integriti Malaysia (IIM), acknowledges public and private organisations for their dedication to integrity, good governance, and anti-corruption measures. Dr. Rezal Khairi Ahmad, CEO of NanoMalaysia, accepted the award during a ceremony at Institut Integrity Malaysia, Kuala Lumpur. This recognition comes after NanoMalaysia launched its Organisational Anti-Corruption Plan (OACP) in February 2022 to foster organisational transparency and integrity.

MANDATE CEREMONY OF YB TUAN CHANG LIH KANG

The Mandate Ceremony for YB Tuan Chang Lih Kang, Minister of Science, Technology, and Innovation (MOSTI), was held at the MRANTI Auditorium. YB Datuk Arthur Joseph Kurup, Deputy Minister of MOSTI, MOSTI's top management, agencies under MOSTI, and industry partners were also present. During the event, the ministers visited the NanoMalaysia booth, where Dr. Rezal Khairi Ahmad, CEO of NanoMalaysia Berhad, explained the displayed products.

NANOTECH JAPAN 2023

In January 2023, NanoMalaysia Berhad showcased Malaysian nanotech companies at Nanotech 2023, held at Tokyo Big Sight, Japan. The pavilion was inaugurated by the Malaysian ambassador to Tokyo, Japan, H.E. Dato' Shahril Effendi Abd Ghany and featured companies offering nanotechnology products developed or certified by NanoMalaysia, including Blue Snow Engineering Sdn Bhd, iDeria Sdn Bhd, Alnair Photonics, and Alnair Labs. Dignitaries included Prof. Emeritus Dato' Ir. Dr. Mohamad Zawawi Bin Ismail, Chairman of NanoMalaysia, Dr. Rezal Khairi Ahmad, CEO of NanoMalaysia, Dr. Ruslinda A. Rahim, Director of the National Nanotechnology Centre, and Mr. Shamsul Amir Azman, Deputy Director of MIDA Tokyo.

MOU WITH NANO4SOCIETY OF THE NETHERLANDS

NanoMalaysia strengthened its partnership with Nano4Society by signing an MOU in Tokyo following an LOI exchange in Amsterdam in 2022. Nano4Society, succeeding NanoNextNL, is a nanotechnology ecosystem in The Netherlands.

NanoMalaysia was represented by its Chairman, Prof. Emeritus Dato' Ir. Dr. Mohamad Zawawi bin Ismail and CEO Dr. Rezal Khairi Ahmad, Raoul A. Oostenbrink and Prof. Dr. Ir. Wilfred G Van Der Wiel represented Nano4Society.

SCIENCE, TECHNOLOGY, AND INNOVATION (STI) CARNIVAL

NanoMalaysia participated in the Science, Technology, and Innovation (STI) Carnival organised by MOSTI at the SITC Hall, UPSI, Tanjong Malim, which YB Chang Lih Kang officiated. Various STI activities and interaction programs with the local populations were held.

OFFICIAL VISIT: MOSTI MINISTER TO NANOMALAYSIA BERHAD

The Minister of Science, Technology & Innovation (MOSTI), YB Tuan Chang Lih Kang visited NanoMalaysia Berhad for an official visit. NanoMalaysia's Chairman, Prof. Emeritus Dato' Ir. Dr. Mohamad Zawawi Bin Ismail and CEO Dr. Rezal Khairi Ahmad showcased the company's work in nanotechnology industrialisation and commercialisation in Malaysia and was briefed on NanoMalaysia's commercialised products and ongoing projects by its partners.

MOU NMB x XIAMEN UNIVERSITY ON BICEP

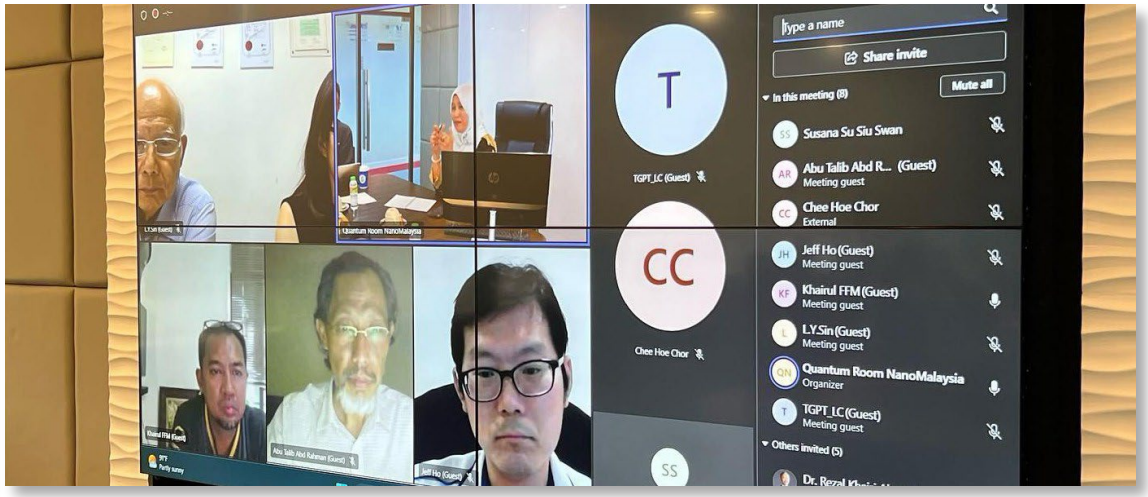
NanoMalaysia Berhad and Nanoquartz signed an MoU with XMU Jiageng Education Development in February 2023 to collaborate in the Biomass Innovation Circular Economy Programme (BICEP) at Xiamen University Malaysia. YB Tuan Chang Lih Kang, Minister of MOSTI, witnessed the signing.

EUROPEAN UNION – INDO-PACIFIC REGIONAL CONFERENCE

The conference united government and industry leaders from the Indo-Pacific region to discuss hydrogen's future as an energy source, covering sources, strategies, consumption, and export capacities. Moderated by Mr. Matthew Baldwin, Deputy Director General of the Directorate General for Energy, European Commission, speakers included government representatives including YBhg. Datu Dr Muhammad Abdullah Bin Haji Zaidel, Deputy State Secretary Sarawak (Economic Planning & Development), Mr. Satya Yudha, Member of the National Energy Council, Indonesia, and Dr Ho-Mu Lee, Energy Policy Advisor, MOTIE Korea (virtual participation), along with NanoMalaysia's CEO Dr. Rezal Khairi Ahmad and Mr. Yuichi Saotome, General Manager of Hydrogen Asia & Oceania Region at Energy Innovation Initiative Department (EII).

MALAYSIA NANOTECHNOLOGY INDUSTRIAL GROUP

The Malaysia Nanotechnology Industrial Group (MNIG) held its inaugural meeting to discuss plans for 2023. This gathering allowed members to engage in productive discussions, share insights and ideas, and foster friendship, equality, and cooperation.



OFFICIAL VISIT: MOSTI DEPUTY MINISTER TO NANOMALAYSIA BERHAD

The Deputy Minister of Science, Technology & Innovation (MOSTI), YB Datuk Arthur Joseph Kurup, visited NanoMalaysia Berhad for an official visit and was met by NanoMalaysia's CEO, Dr. Rezal Khairi Ahmad. Dr. Rezal updated YB Datuk Arthur on NanoMalaysia's projects and commercialisation activities. The visit was also joined by the National Nanotechnology Centre (NNC).

CELEBRATING INTERNATIONAL WOMEN'S DAY

NanoMalaysia honoured its female employees by organising a sharing session and gathering on International Women's Day. Female Staff were invited to share their professional journeys, were given flowers, and everyone wore purple to celebrate women's contribution to society.

MOU NMB x BIFORST

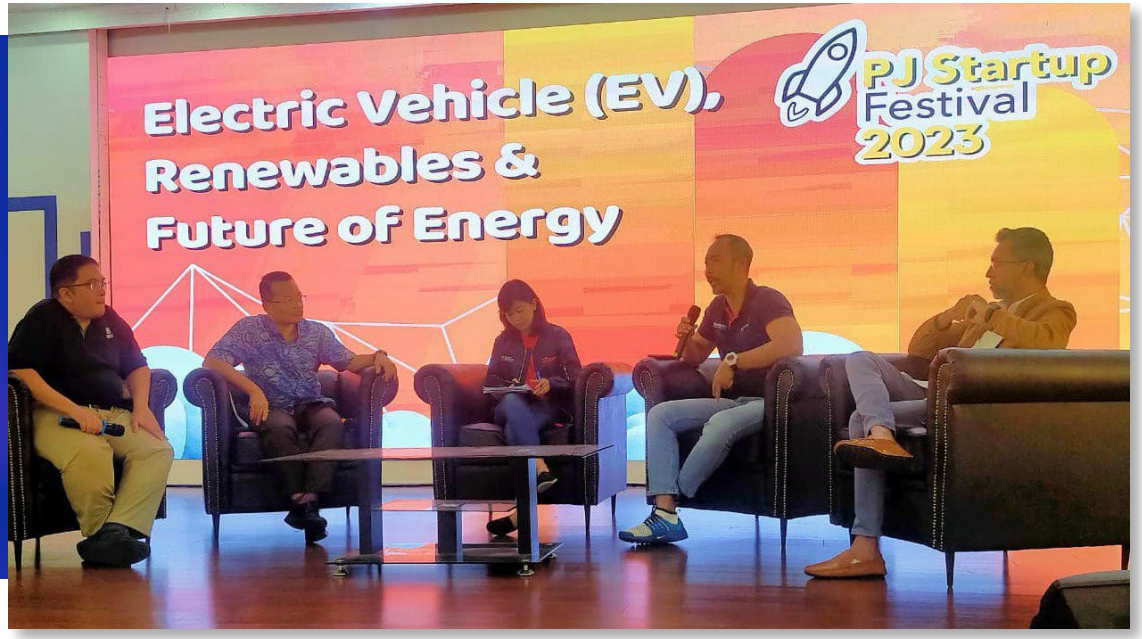
NanoMalaysia partnered with Biforst to spearhead carbon-free transportation by adapting NanoMalaysia's Hydrogen Hybrid Energy Storage System ("H2SS") on its transportation fleet. The agreement was signed by NMB CEO Dr. Rezal Khairi Ahmad and Biforst Group MD Datuk Hamie Appala Nakkiah, witnessed by Minister Chang Lih Kang, NMB Chairman Prof. Emeritus Dato' Ir. Dr. Mohamad Zawawi bin Ismail, and Biforst Chairman YTM Dato' Muhammad Hj Abdullah at the Malaysia Technology Expo 2023 (MTE 2023).

SHARING OF NANOMALAYSIA'S IP EXPERIENCE

Mr. Hairul Hafiz Hasbullah, Vice President of Group Legal, represented NanoMalaysia to share the company's IP journey during the launch of Valuing IP Sdn Bhd's IP valuation software for the ASEAN market at the Kuala Lumpur Convention Centre in March 2023.

FLORAPONIC FARM MALAYSIA

The Minister of Science, Technology and Innovation (MOSTI), YB Tuan Chang Lih Kang, inaugurated the Floraponic Farm Malaysia @ Manong (FFM @ Manong), a large-scale nanotechnology-based aquaponic site in Manong, Perak, in March 2023. FFM @ Manong is a collaboration between NanoMalaysia and Flora Niaga Sdn Bhd (FMSS) to ensure food security in Malaysia.



PJ STARTUP FESTIVAL 2023

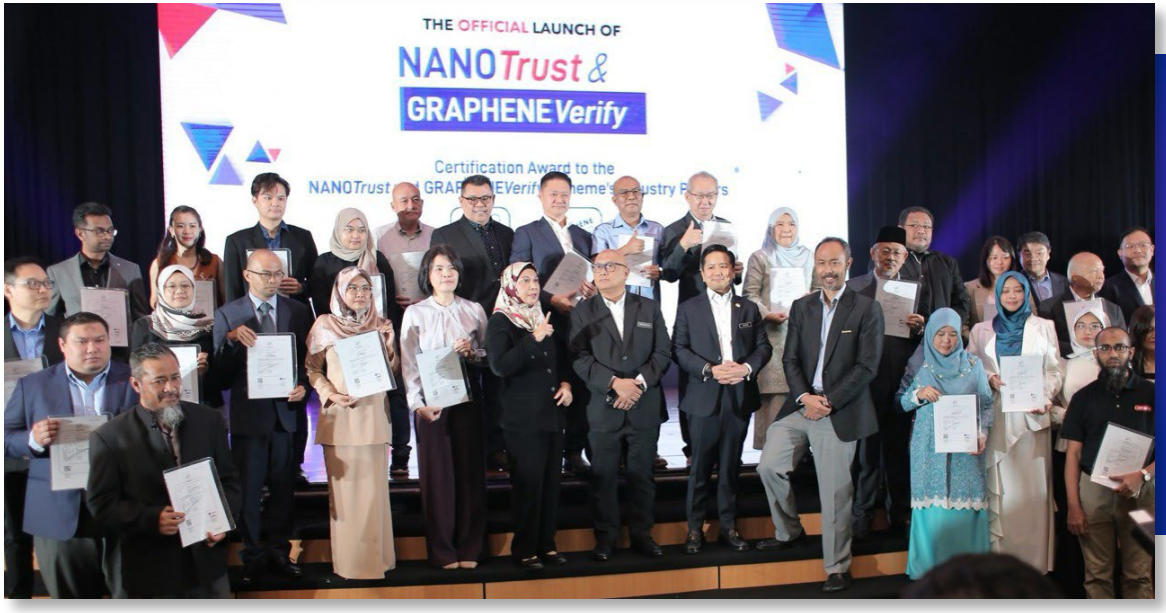
NanoMalaysia participated in the PH Startup Festive by joining a panel discussion on Electric Vehicle, Renewable & Future of Energy. The panellists included YB Nik Nazmi Nik Ahmad, Minister of Natural Resources, Environment and Climate Change; Ramachandran Muniandy, CEO of Asia Mobility; and Mohamed Ridzuan Mohamed, Director of Research at Khazanah Nasional. NanoMalaysia was represented by CEO Dr. Rezal Khairi Ahmad.

ESTABLISHING THE ASEAN BATTERY NETWORK IN BALI, INDONESIA

NanoMalaysia signed an MoU with the Singapore Battery Consortium (SBC), the National Center for Sustainable Transportation Technology (NCSTT) from Indonesia, the Thailand Energy Storage Technology Association (TESTA), the Electric Vehicle Association of the Philippines (EVAP), and the National Battery Research Institute (NBRI) during the first ASEAN Battery & Electric Vehicle Technology Conference (ABEVTC) in Bali, Indonesia. NanoMalaysia was represented by CEO Dr. Rezal Khairi Ahmad.

LAUNCH OF NANOTRUST AND GRAPHENEVERIFY PROGRAMME

NanoMalaysia Berhad (NMB) launched two groundbreaking product certification schemes, NANOTrust and GRAPHENEVerify on 15 May 2023. These schemes, part of the NANOVerify Programme, enhance consumer trust in nanotechnology products, promoting the growth of nanotechnology in Malaysia. The NANOTrust and GRAPHENEVerify Product Certification Schemes provide SMEs with nano- based products an opportunity to secure a credible seal of trust. This enables wider market penetration both locally and abroad and contributes to the dynamic nanotechnology ecosystem envisioned in the National Nanotechnology Policy and Strategy 2021-2030 (DSNN).

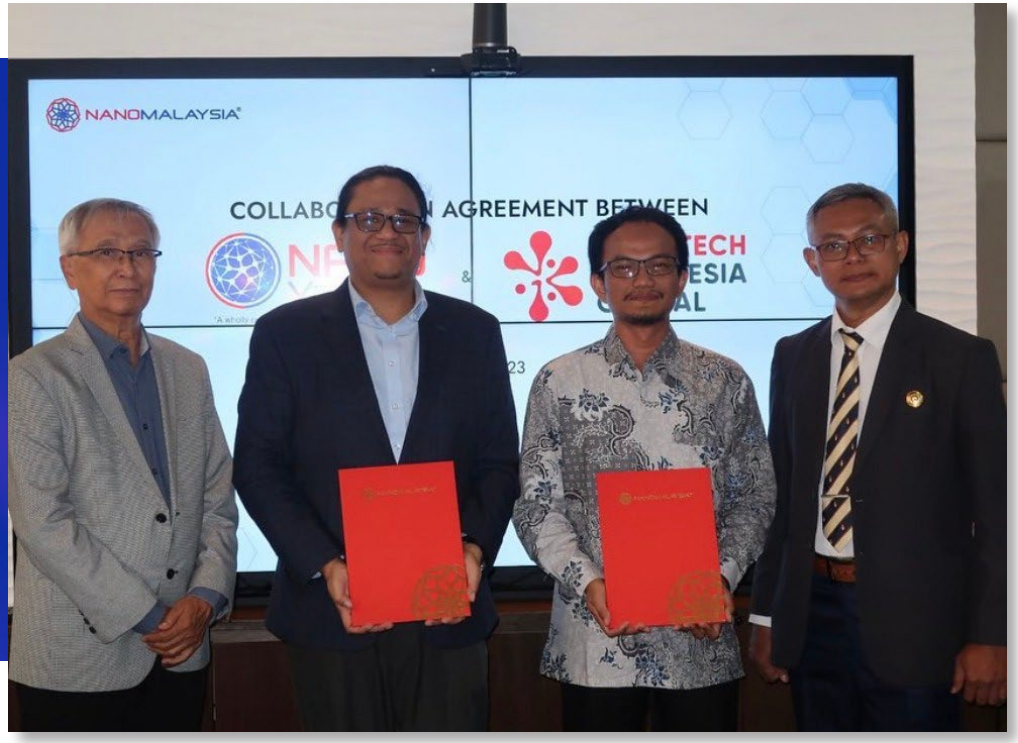


ASEAN GREEN HYDROGEN CONFERENCE 2023

Dr. Rezal Khairi Ahmad, CEO of NanoMalaysia, represented the company as a panellist in energy strategies and green hydrogen production during the ASEAN GREEN HYDROGEN CONFERENCE 2023 held in Kuala Lumpur.

2023 LANGKAWI INTERNATIONAL MARITIME AND AEROSPACE EXHIBITION (LIMA2023)

NanoMalaysia participated in the 2023 Langkawi International Maritime and Aerospace Exhibition (LIMA2023) held at the Mahsuri International Exhibition Centre in Langkawi, Kedah. Participating under the Ministry of Transport, NanoMalaysia Berhad's representative showcased the Hydrogen-paired Electric Race Car (HyPER) and Nanomaterial-based Multispectral Camouflage to YAB Dato' Seri Anwar bin Ibrahim, the Prime Minister of Malaysia..



MOU NIG INDONESIA

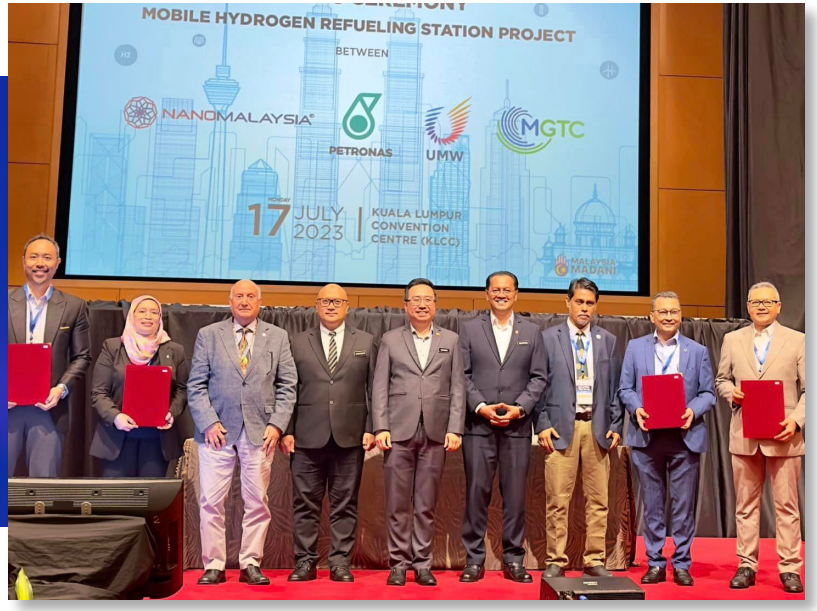
NanoMalaysia's subsidiary NanoVerify Sdn Bhd (NVSB), signed a strategic agreement with PT Nanotech Indonesia Global (NIG) to collaborate on shaping the nanotechnology business in the region. This collaboration aimed to establish a regional "Gold Standard" in nanotechnology certification. The signing ceremony was held in NanoMalaysia's office in Kuala Lumpur.

LAUNCH OF EZYCART

The Minister of Science, Technology, and Innovation (MOSTI), YB Chang Lih Kang, launched the ezyCart, a smart shopping cart projected to revolutionise the retail industry, at the Redtick Supermarket in Putrajaya. Developed by NanoMalaysia in collaboration with Retailetics Sdn Bhd, EzyCart offers a personalised shopping experience based on feedback from shoppers and retailers. Equipped with software for seamless data collection and analysis, the smart shopping cart entered the trial phase in several supermarkets after a successful prototype launch in 2022.

THE STAR ESG AWARD

NanoMalaysia was awarded the Gold award at the ESG Positive Impact Awards 2022, organised by Star Media Group, to recognise NanoMalaysia's commitment to sustainability and effective partnerships.



Mobile Hydrogen Refueling Station (MHRS) Project Signing Ceremony

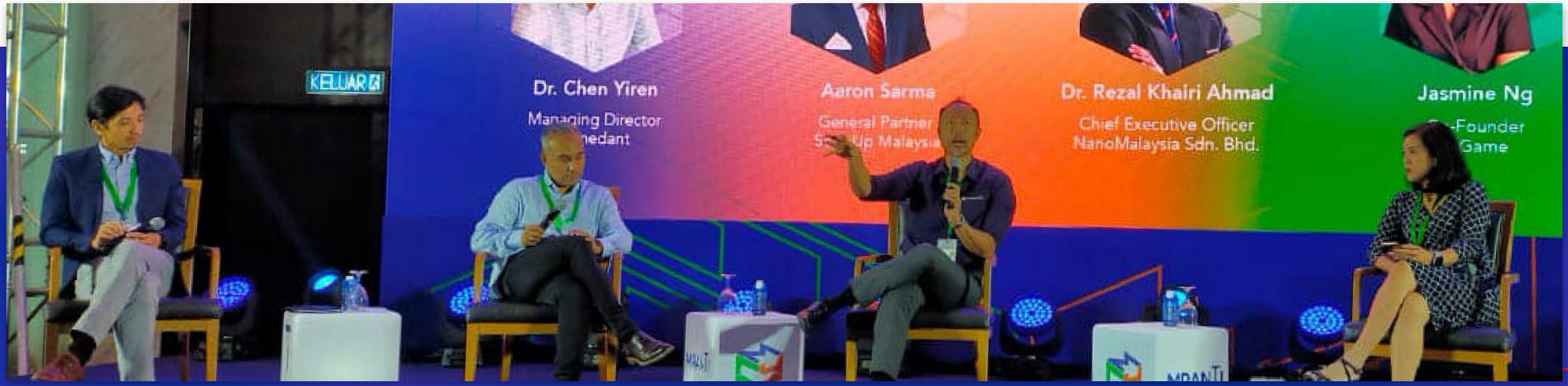
The Minister of Science, Technology, and Innovation, YB Chang Lih Kang, witnessed the project signing ceremony of the Mobile Hydrogen Refueling Station (MHRS) between NanoMalaysia, PETRONAS, UMW, and Malaysia Green Technology and Climate Change Corporation (MGTC) during the World Renewable Energy Congress (WREC) XXII 2023, held at the Kuala Lumpur Convention Centre in July 2023.

International Battery Summit 2023

NanoMalaysia's CEO, Dr. Rezal Khairi Ahmad, represented Malaysia as a panellist at the International Battery Summit 2023.

MALAYSIA COMMERCIALISATION YEAR 2023 (MCY 2023)

NanoMalaysia joined MCY 2023 as an exhibitor and panellist. Dr Rezal Khairi Ahmad, CEO of NanoMalaysia Berhad, shared insights during Panel Session 4 tackling the theme 'CROSS-BORDER COLLABORATION: M alaysia's ROLE IN GLOBAL INNOVATION.



GREEN WAQAF INITIATIVE

NanoMalaysia participated in the Green Wakaf Initiative to plan up to 200 trees in East Malaysia. The "From Saplings to Forests" event was held at the Graduate School of Business, Universiti Kebangsaan Malaysia, and was attended by YB Syahredzan Johan, Bangi MP.

LAUNCH OF THE HYDROGEN ECONOMY & TECHNOLOGY ROADMAP (HETR)

On 5 October 2023, the Deputy Prime Minister, YAB Datuk Seri Fadillah Yusof, launched the Hydrogen Economy & Technology Roadmap (HETR) during the International Greentech and Eco Products Exhibition and Conference Malaysia 2023 (IGEM 2023).

The HETR was intended to support the National Energy Policy 2022-2024, which envisaged the development of a hydrogen economy in Malaysia. This followed the launch of Malaysia's National Energy Transition Roadmap on 29 August 2023, in which hydrogen was identified as one of the six energy transition levers that would drive the country's efforts to be a net-zero nation by 2050.

NANOKEBANGSAAN 2023

NanoMalaysia Berhad and the Malaysia Nanotechnology Industrial Group (MNIG) exhibited at NANOKEB 2023, organised by the National Nanotechnology Centre (NNC). YB Datuk Arthur Joseph Kurup, Deputy Minister of MOSTI, inaugurated the event at Bangi Resort Hotel.

DASSAULT SYSTEMES TRANSPORTATION & MOBILITY EVENT

Dr. Rezal Khairi Ahmad, CEO of NanoMalaysia, participated in the Dassault Systèmes Transportation & Mobility Industry Event at Le Meridien Kuala Lumpur in KL Sentral. This event focuses on the transportation and mobility sector and gathers industry professionals to discuss key topics and innovations.

LAUNCH OF HYPEREACTOR

NanoMalaysia, together with HyPERTech Industries Sdn Bhd, Universiti Kebangsaan Malaysia's Fuel Cell Institute, and ADMatix Solutions Sdn Bhd, launched the HyPEReactor, a solid-state-based hydrogen reactor. The Minister of Science, Technology, and Innovation, YB Chang Lih Kang, unveiled the reactor in Shah Alam.

MALAYSIA EV TECH 2023

NanoMalaysia organised Malaysia EV Tech 2023 to showcase the country's strong commitment to advancing its electric vehicle sector.

LAUNCH OF THE TVET CENTRE AT UNIVERSITI MALAYSIA PERLIS (UNIMAP)

NanoMalaysia participated in the Launch of the TVET Centre at Universiti Malaysia Perlis (UNIMAP). Datuk Seri Mohamed Khaled Nordin, Minister of Higher Education, visited NanoMalaysia's booth.

CHAPTER 12

Creating a Sustainable Future: Economic, Environmental, and Social

Overview

NanoMalaysia is deeply committed to creating a sustainable future encompassing economic prosperity, environmental stewardship, and social well-being. At the heart of its mission lies a dedication to leveraging nanotechnology and related advancements to drive positive change across various sectors. Through strategic initiatives and partnerships, NanoMalaysia aims to address pressing societal and environmental challenges while fostering economic growth and innovation.

Economically, NanoMalaysia is pivotal in driving the nation's economic development by commercialising nanotechnology. By supporting startups, facilitating investments, and fostering collaboration between industry players, NanoMalaysia stimulates job creation, enhances productivity, and strengthens Malaysia's position in the global market. Its focus on high-growth potential ventures aligns with national agendas for sustainable economic growth and competitiveness.

Environmentally, NanoMalaysia is committed to promoting sustainability and mitigating environmental impact through innovative solutions. By harnessing nanotechnology, NanoMalaysia develops eco-friendly products and technologies that reduce resource consumption, minimise waste, and address environmental challenges such as pollution and climate change. Initiatives in renewable energy, water purification, and sustainable agriculture demonstrate NanoMalaysia's dedication to preserving the planet for future generations.

NanoMalaysia's Gold Standard in the ESG Practices

NanoMalaysia Berhad is proud to affirm its commitment to Environmental, Social, and Governance (ESG) principles, recognising them as fundamental pillars in driving sustainable development. As countries and businesses worldwide prioritise sustainability goals, NanoMalaysia is dedicated to being a changemaker in this transformative landscape.

At NanoMalaysia, we understand that embracing ESG principles is not just a corporate responsibility but an opportunity to lead by example and drive positive change in our communities and environment. Our dedication to sustainability has been recognised through the prestigious "Gold" award at the ESG Positive Impact Awards 2022, organised by Star Media Group.

We were honoured with this accolade in the Innovative Partnerships category under the SMEs to Mid-Tier Company section. This award underscores NanoMalaysia's commitment to sustainability and our ability to foster effective partnerships. Our innovative partnerships have led to tangible and sustainable impacts on communities and the environment, showcasing our leadership in promoting responsible business practices. Collaboration is key to achieving sustainable outcomes, and our partnerships are built on mutual benefit and long-term commitment. By working with stakeholders, we strive to create innovative solutions that address societal and environmental challenges while driving positive change.

This recognition is a testament to NanoMalaysia's dedication to sustainability and inspires us to continue excelling in our pursuit of making a positive social impact. We remain committed to integrating ESG principles into our business operations, driving innovation, and creating value for all stakeholders while contributing to a more sustainable future.

Cultivating Sustainable Partnerships for Environmental Conservation

NanoMalaysia Berhad's commitment to Environmental, Social, and Governance (ESG) principles extends beyond mere rhetoric; it is ingrained in our corporate ethos and drives our actions. Our recent collaboration with Green Waqaf UKM at the "From Saplings to Forests" event exemplifies our dedication to fostering sustainable partnerships for environmental conservation.

The "From Saplings to Forests" event, held at the Graduate School of Business, Universiti Kebangsaan Malaysia, garnered significant success. YB Syahredzan Johan, Bangi MP, inaugurated the event. Focused on the "Harnessing the Power of Waqf for Environmental Conservation" forum, the event provided a platform to discuss innovative approaches to environmental stewardship and community engagement.

NanoMalaysia Berhad proudly sponsored a key initiative, underscoring our commitment to sustainable initiatives. Our partnership with Green Waqaf UKM transcends financial support; it represents a shared vision to create a sustainable rainforest ecosystem. By sponsoring the planting of 200 trees, NanoMalaysia exemplifies its dedication to combatting climate change, restoring ecosystems, and fostering community engagement.

NanoMalaysia Berhad's Organisational Anti-Corruption Plan (OACP) 2021-2025

In November 2020, NanoMalaysia embarked on its inaugural initiative under the National Anti-Corruption Plan (NACP) to enhance public service delivery effectiveness. The cornerstone of this initiative is the Organisational Anti-Corruption Plan (OACP), a comprehensive blueprint delineating integrated actions to root out corrupt practices within NanoMalaysia.

The primary objective is to cultivate a culture of professionalism and integrity among all members of NanoMalaysia Berhad, ensuring high standards of conduct and efficiency. NanoMalaysia Berhad's OACP 2021-2025 is the anti-corruption policy underpinning the commitment to upholding integrity in all organisational and administrative services. Crafted through four workshop sessions facilitated by the Malaysian Institute of Integrity (IIM), this framework reflects NanoMalaysia's unwavering dedication to implementing and adhering to anti-corruption measures.

The OACP addresses internal governance, integrity, and anti-corruption issues, pinpointing areas requiring attention at every level of operation within NanoMalaysia. Departments and divisions have delineated execution timelines to ensure the plan's successful implementation. Furthermore, the OACP serves as a primary reference and guiding document for all departments and divisions, directing the implementation of respective strategies in the fight against corruption.

Organisational OACP Plan

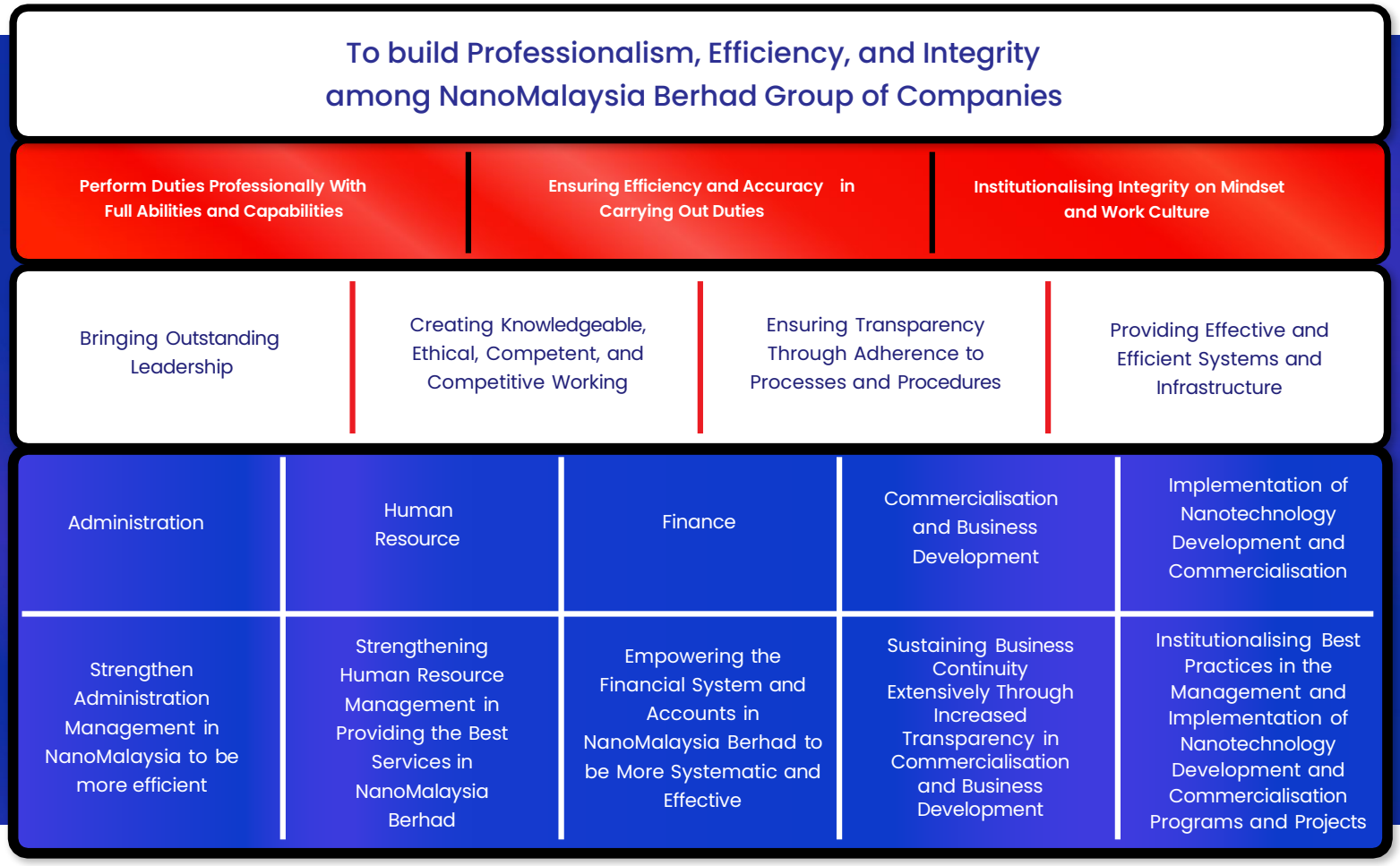
In accordance with the strategies used in the plan, there are five (5) strategies used in the OACP Plan 2021-2025 as follows:

5

Organisational OACP Strategic Plan

1. Strengthening More Efficient Administrative Management at NanoMalaysia Berhad
2. Strengthening Human Resource Management in Providing the Best Services in NanoMalaysia Berhad
3. Strengthening the Financial System and Accounts at NanoMalaysia Berhad to be More Systematic and Effective
4. Sustaining Business Continuity Extensively Through Increased Transparency in Commercialisation and Business Development
5. Institutionalising Management Best Practices and Implementation of Nanotechnology Programs and Special Projects

NanoMalaysia Berhad Anti - Corruption Plan Framework



Corruption and unethical practices pose significant challenges at both societal and institutional levels, affecting the public and private sectors alike. When individuals entrusted with responsibilities fail to discern right and wrong, the state's pillars and values are threatened. NanoMalaysia Berhad is resolute in its commitment to combatting such practices collaboratively. We are determined to safeguard our institution from actions that could undermine our mission of fostering transparency and efficiency in pursuing organisational objectives.

This commitment is reflected in the values of integrity, transparency, accountability, and good governance upheld by every member of NanoMalaysia Berhad. These principles form the bedrock of our operations, guiding each employee in fulfilling their entrusted duties with diligence and honesty.

Efforts to implement and monitor these initiatives will be meticulously carried out, ensuring that NanoMalaysia Berhad remains an agency under the Ministry of Science, Technology, and Innovation (MOSTI) untainted by corruption. Through these concerted efforts, we aim to uphold the highest standards of ethical conduct and maintain the trust of our stakeholders.

Building a Waste-to-Wealth Supply Chain Ecosystem via the Biomass Innovation Circular Economy Programme (BICEP)

The "Waste to Wealth" programme from biomass waste is a valuable and high-impact green initiative (Circular Economy) program that is described as a game-changer that can drive and increase Malaysia's per capita income, which can have positive impacts on key sectors such as electronics, renewable energy, health, infrastructure, transportation, aerospace, chemistry and so on. The facilitated projects will utilise biomass waste from agricultural activities in Malaysia to produce high-quality advanced materials and products that have various benefits, such as advanced materials (graphene, nanocellulose, nanosilica) bio-composites, IoT devices, electric vehicle components as well as fuels for renewable energy such as hydrogen. The dumping of this biomass waste needs to be reduced to protect the environment from air and soil pollution. Various companies and research institutions will collaborate in this program, which involves sectors such as agriculture, manufacturing, medicine and gas & oil. Through this collaboration, new intellectual property can be generated for licensing and used to produce new products and applications to generate substantial revenue and profit returns.

BICEP Biomass Innovation Circular Economy Programme

Plantation Residue

Mill Residue

Advanced Materials (nano) Production

Nanocellulose

Graphene

Supply Chain Value Creation – from Waste to Wealth

NA NOTECH - DRIV EN 4TH INDUSTRIAL REVOLUTION

INTERNET OF NANO - THINGS

Combination of the terms
4th Industrial Revolution (4IR) driven by Nanotechnology & Internet of Nano-Things (IoNT)
Renewable Energy (RE) + Electric Vehicles (EV)

REVOLUTIoNT
A Revolution 4.0 the Internet of Nano-Things

A nanotechnology commercialization program – providing end-to-end solutions for 4IR & Internet of Nano Things (IoNT)

A nanotechnology commercialisation programme

Phase 1 (2016 -2020)

4IR building-block projects

- Solar window
- Flexible circuits
- RFID tagging
- Aquaponics 4.0
- Swiftlet farming

REVOLUTIoNT
A Revolution 4.0 the Internet of Nano-Things
NANOMALAYSIA

- Autonomous vehicles
- Electric vehicles
- Energy storage
- Smart urban farming
- Precision agriculture
- Smart cities

Phase 2 (2021 -2025)

4IR

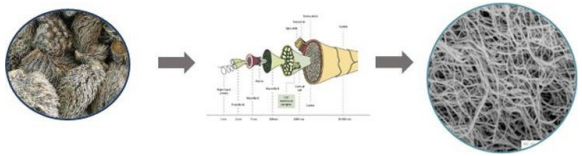
- Nano sensors
- Communication Devices
- High Density Memories
- Faster Processors
- Advanced Materials
- Enhanced Energy Storage
- Efficient Energy Sources
- Water Generation & Purification
- Precision Farming

Creating Economic, Environmental and Social Value

Waste to Wealth – Oil Palm Waste to NanoCellulose, Graphene

1. **Production of EFB Based Crystalline NanoCellulose (CNC)**

Production of CNC from EFB with a pilot plant capacity of 25 kg of CNC per month (or 300 kg per year)



2. **Hydraulic Fracturing Fluid and Well Cleaning Fluids for Oil and Gas Applications**

Development and scale-up of CNC-based hyraulic fracturing fluid (HFF) and CNC-based salt resistant agent for oil and gas and gas sector applications.

HFF & Salt Resistant Agent

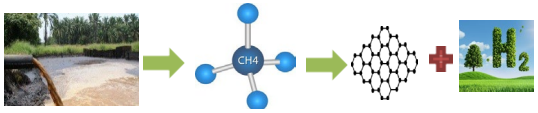
3. **UV-Curable Coatings (UVCCs) for Paint and Coating Application**

Modification and optimisation process of CNC hydrophobic properties for paint and coatings

UVCCs Paint and Coating

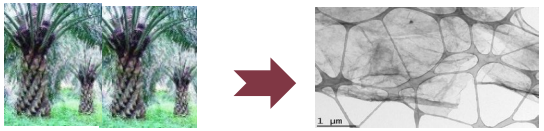
4. **Graphene & Green Hydrogen from Biomethane**

Graphene is produced using biomethane through the "methane cracking process," which generates green hydrogen as a by-product that can be used to support the hydrogen ecosystem.



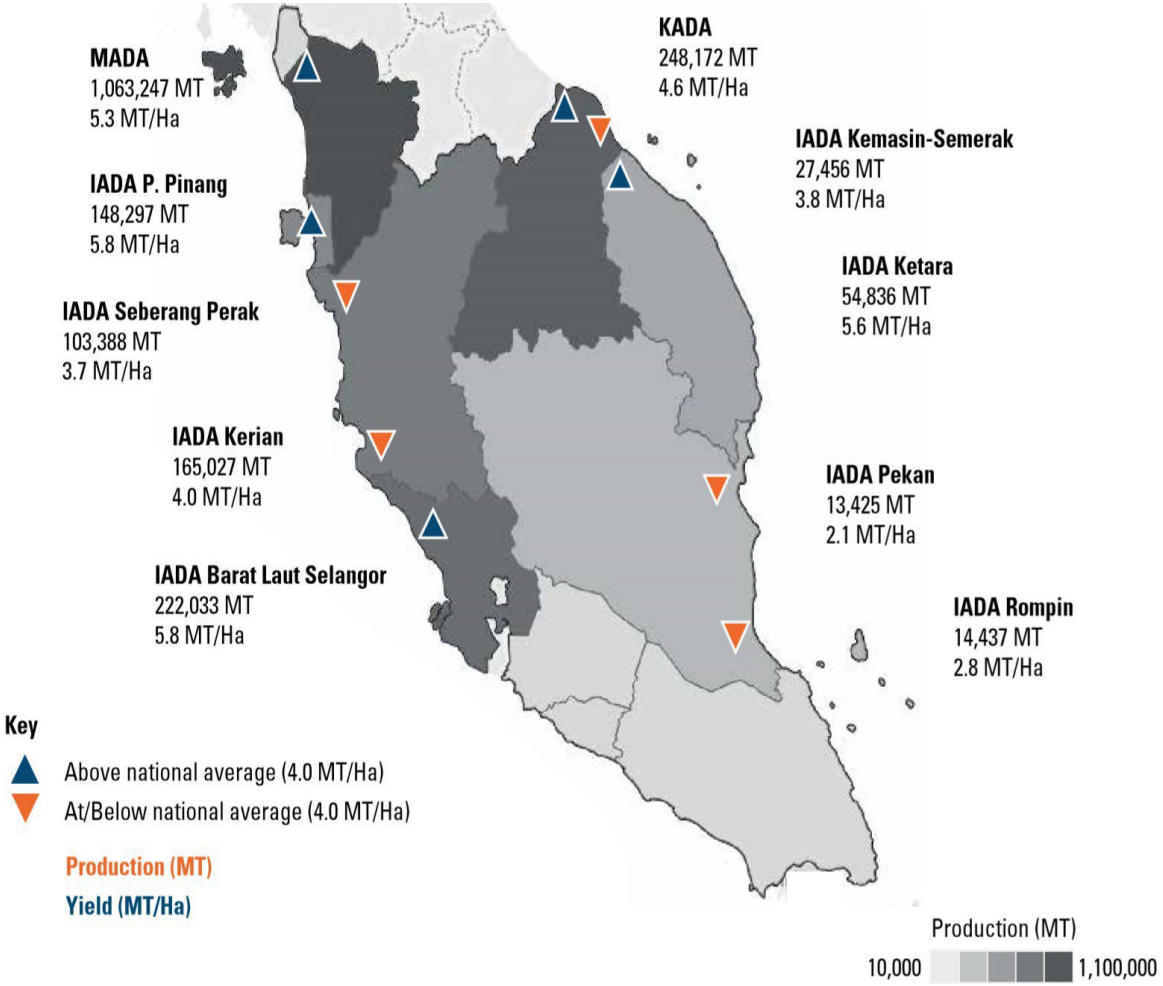
5. **Production of Reduced Graphene Oxide (rGO) from Oil Palm Trunk**

Optimisation and production scale-up of rGO from oil palm trunk as supply application development and product manufacturing.



Paddy Biomass – Malaysia's Perspective

- Paddy production in Malaysia was estimated at 2.9 Million Tonnes.
- Rice husk generated is estimated at 22% or 638,000 Tonnes.
- A major issue raised by rice husk disposal is the environmental and health hazards caused by the open burning of rice husks.
- Turning waste into precious products is crucial for Malaysia to address its current environmental and economic issues.



Disposal by rotting and open burning is hazardous to the environment and health.

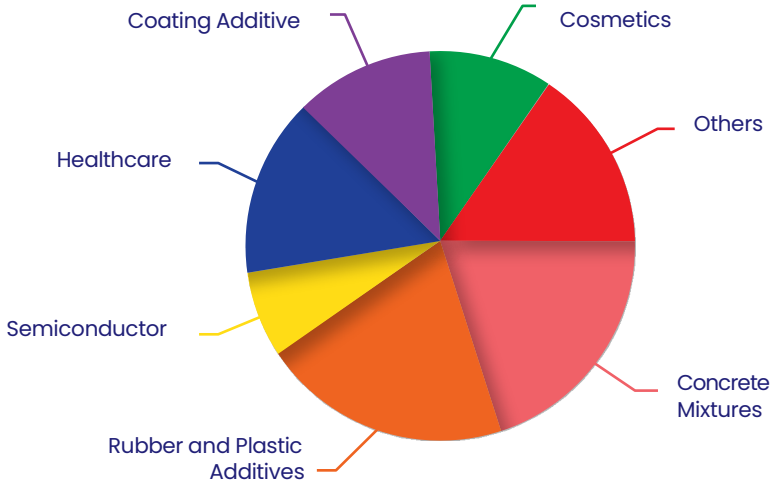
Source :
Khazanah Research Institute Report
FAOSTAT

Waste-to-Wealth – From Rice Husk to Nano Silica

Rice Husk Ash (RHA) contains the highest amount of silica, a base commodity for Nanosilica, Zeolites, and Aerogel, compared to other agricultural products. RHA includes 75% to 95% Silica.

	Global	Malaysia
Total Paddy Production (2017)	769.7 MT	2.9 MT
% Rice Husk	169.3 MT	0.638 MT
Potential RHA (15%)	25.4 MT	95,700 Tonnes

Raw material with high purity is available in Malaysia.. our own RICE HUSK!



Source :

1. HTF Market Intelligence
2. Maximise Market Research
3. Ameri Research

Paddy | Rice Husk | Nano Silica

Global Nano Silica market is expected to reach USD 5.14 billion by 2025, at a CAGR of 7.6%

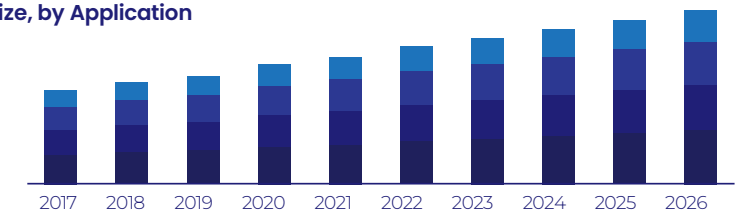
- Grand View Research

Global Rice Husk Ash market is worth USD 1.64 billion by 2025, at a CAGR of 5%

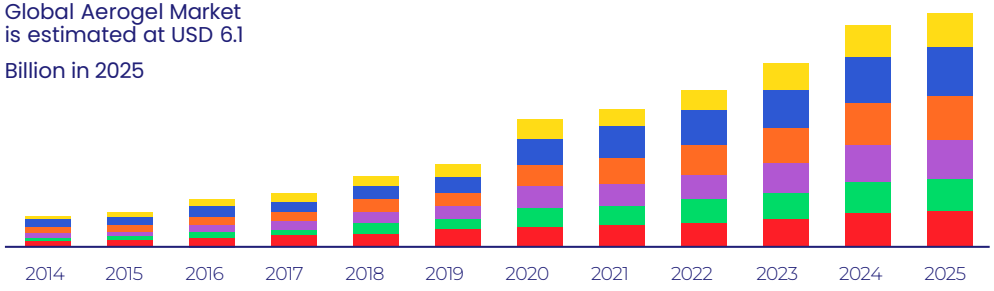
- Transparency Market Research,

Global Zeolite Market Size, by Application

USD 38.5 Billion by 2026 at CAGR of 4.44 %



Global Aerogel Market is estimated at USD 6.1 Billion in 2025



CHAPTER 13

Strategic Partnerships: Driving Innovation and Collaboration

Universities

Reseach Institutes

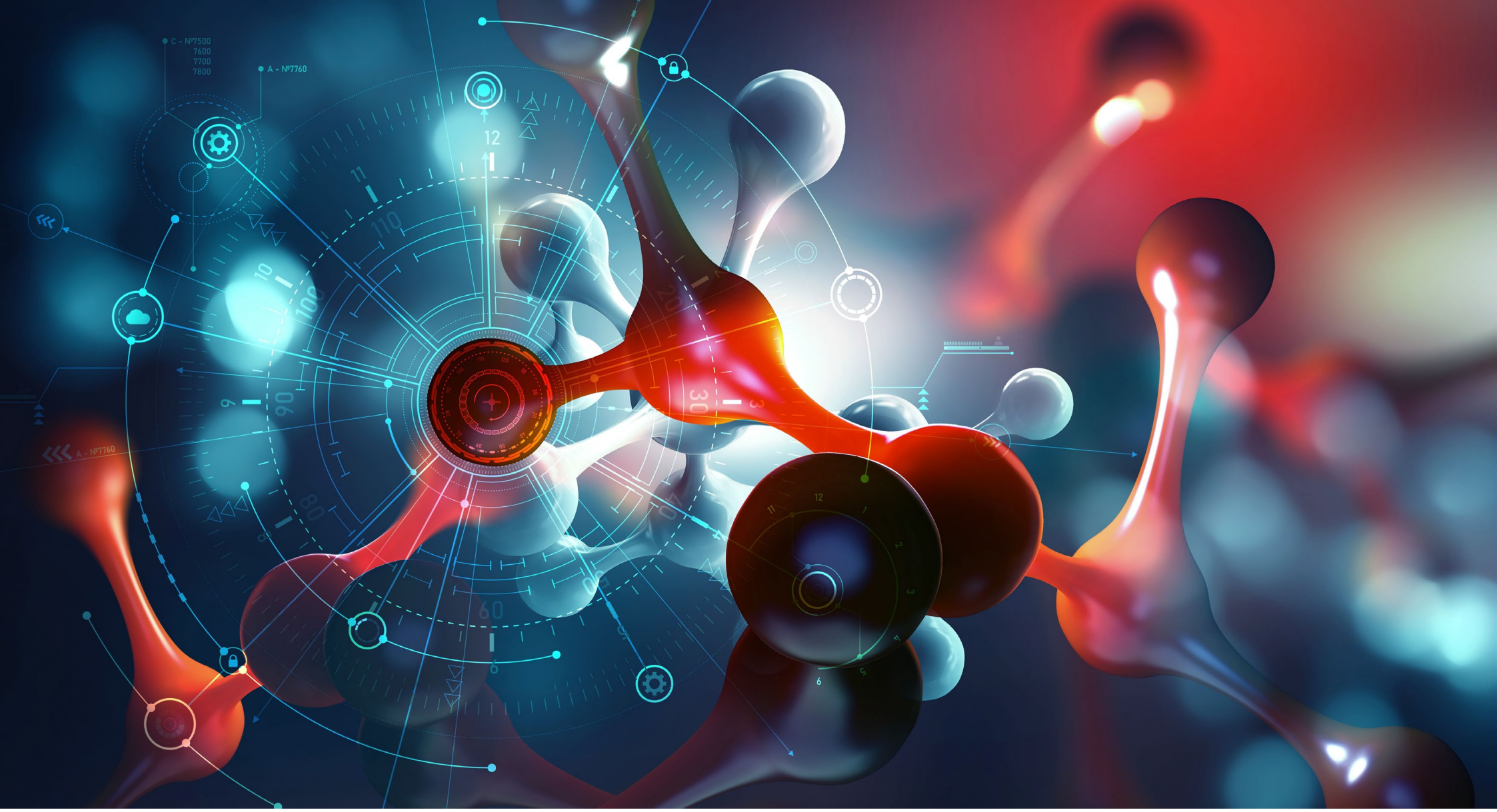
Funding and Incentives Authorities

Agencies

Our Ecosystem

International Patners

Programme Collabrators



This Strategic Report is available online at www.nanomalaysia.com.my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