

Transforming Innovation Delivery



In 2010, the government initiated a bill for the establishment of national innovation ecosystem that would spur the creation of new wealth for the nation

“To become an innovative nation we need a mental transformation in the government, industry and the education sectors. This is to shape the attitude of our future generations. This is our mission.” – YAB Najib Razak, Prime Minister of Malaysia.

- The AIM Bill was tabled for its first reading in Parliament on December 13, 2010 before being passed on its third and final reading on December 21, 2010.
- It spells out the rationale and philosophies behind the National Innovation Agency Malaysia (Agensi Inovasi Malaysia, AIM).



Agensi Inovasi Malaysia promotes and manages the wealth of creativity and innovation in the country through 6 approaches

- Under the 'transforming strategic sectors' approach, AIM has successfully developed National Graphene Action Plan (NGAP) 2020 in 2014.
- NanoMalaysia Berhad has been appointed as the lead agency to execute NGAP 2020.



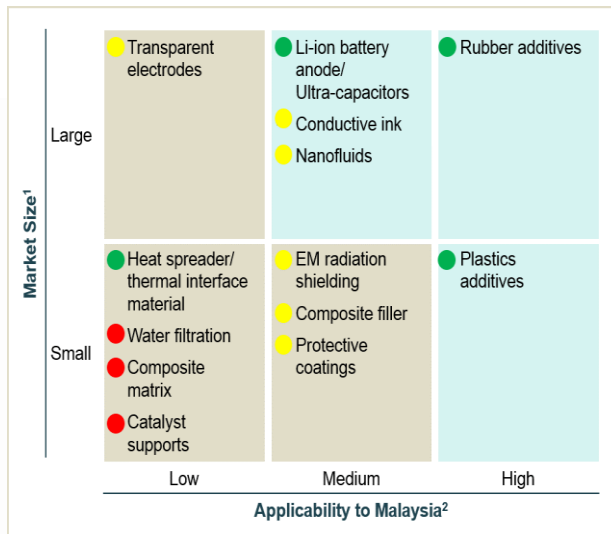
Background of the National Graphene Action Plan 2020 (NGAP2020) from feasibility study to execution of the Action Plan

Feasibility study on Graphene downstream applications relevant to Malaysia



1 Based on **technical feasibility, economic viability, time to adoption, relevance and impact** to Malaysia (2020 timeframe), **five (5) application areas** were prioritized

- 2**
- Lithium ion battery
 - Rubber additives
 - Plastic additives
 - Conductive Ink
 - Nanofluids



April 2014



NANOMALAYSIA™

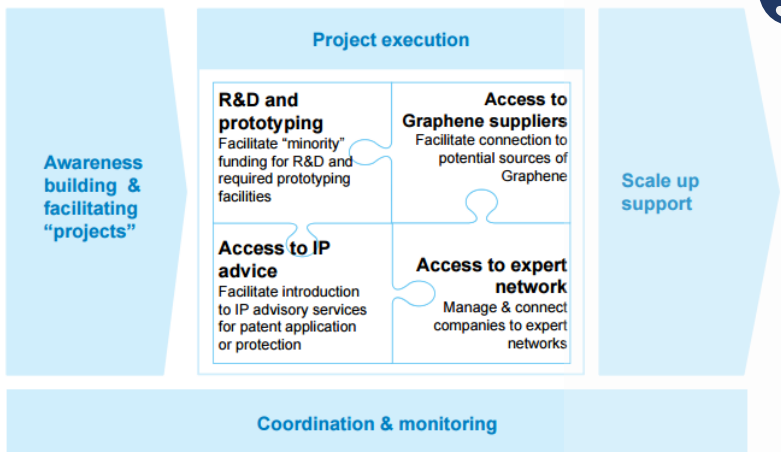
July 2014

3 NanoMalaysia appointed as the Lead agency to execute the NGAP2020








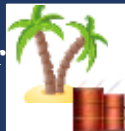

- Role includes:
- Awareness building
 - Project execution
 - Scale support
 - Coordination & Monitoring



Launch of National Graphene Action Plan 2020



The 5 shortlisted application areas align well with multiple NKEAs


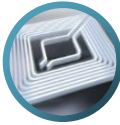



NKEA	Applications	EPP	EPP Objectives	Graphene's role	
Electronics & Electrical 	All		EPP 20: Enabling Industries through Nanotechnology	Focuses on the application of nanotechnology, which has the potential to impact all 12 NKEAs in varying degrees	Graphene is one of the most promising nanotechnology materials
	Li-ion Battery /Ultracap		EPP 18: Enabling Electric Vehicle Component Manufacturing	Fast-track the implementation of the Electric Vehicles (EV) policy; includes establishing a Lithium-Ion (Li-Ion) battery manufacturer in Malaysia	Graphene enables the next generation of fast-charging, high capacity batteries
	Conductive Inks		EPP 7: Increasing Solar Module Producers	Secure multinational module producers and facilitate the establishment of another five joint ventures	Graphene inks helps companies reduce production costs
Oil, Gas, and Energy 	Plastics		EPP 13: Increase Petrochemical Outputs	Help PETRONAS expand its petrochemical business through RAPID project in Johor and SAMUR project in Sabah	Graphene can enable higher performing or cheaper plastics
	Nanofluids		EPP 1: Rejuvenating Existing Fields through Enhanced Oil Recovery (EOR)	Encourage the use of Enhanced Oil Recovery (EOR) –to improve oil recovery from industry norms	Graphene-enabled nanofluids increase the efficiency of oil extraction operations
Palm Oil & Rubber 	Rubber		EPP 9.3: Increase World Market Share of Latex Gloves to 65% by 2020	Boost the natural rubber glove industry's global market share from 62% in 2011 to 65% by 2020	Graphene can be used to make high-quality gloves that are thinner and tougher

SOURCE: PEMANDU

There is significant value in catalysing downstream differentiation through adoption of graphene

Graphene and application market size for 2020¹

USD Billions

Application	Description	Addressable market size	Total downstream market size
 Li-ion battery anode / ultra-capacitors	Hybrid Li-ion batteries + ultracaps can enable fast charging and high energy storage	3	5
 Conductive inks	RFIDs are projected to take off, and Graphene can capture a large portion of the market	1	3
 Plastics additives	Plastics industry is large and Graphene can enable high performance plastics	1	10
 Rubber additives	Tires, gloves, and industrial applications can be enabled by Graphene	8	42
 Nanofluids	Overall market size is big but Graphene will take a longer time to commercialize	1	25

¹ Estimated global sales of the applications which would be Graphene enabled, and estimated global sales of the Graphene integrated into these applications

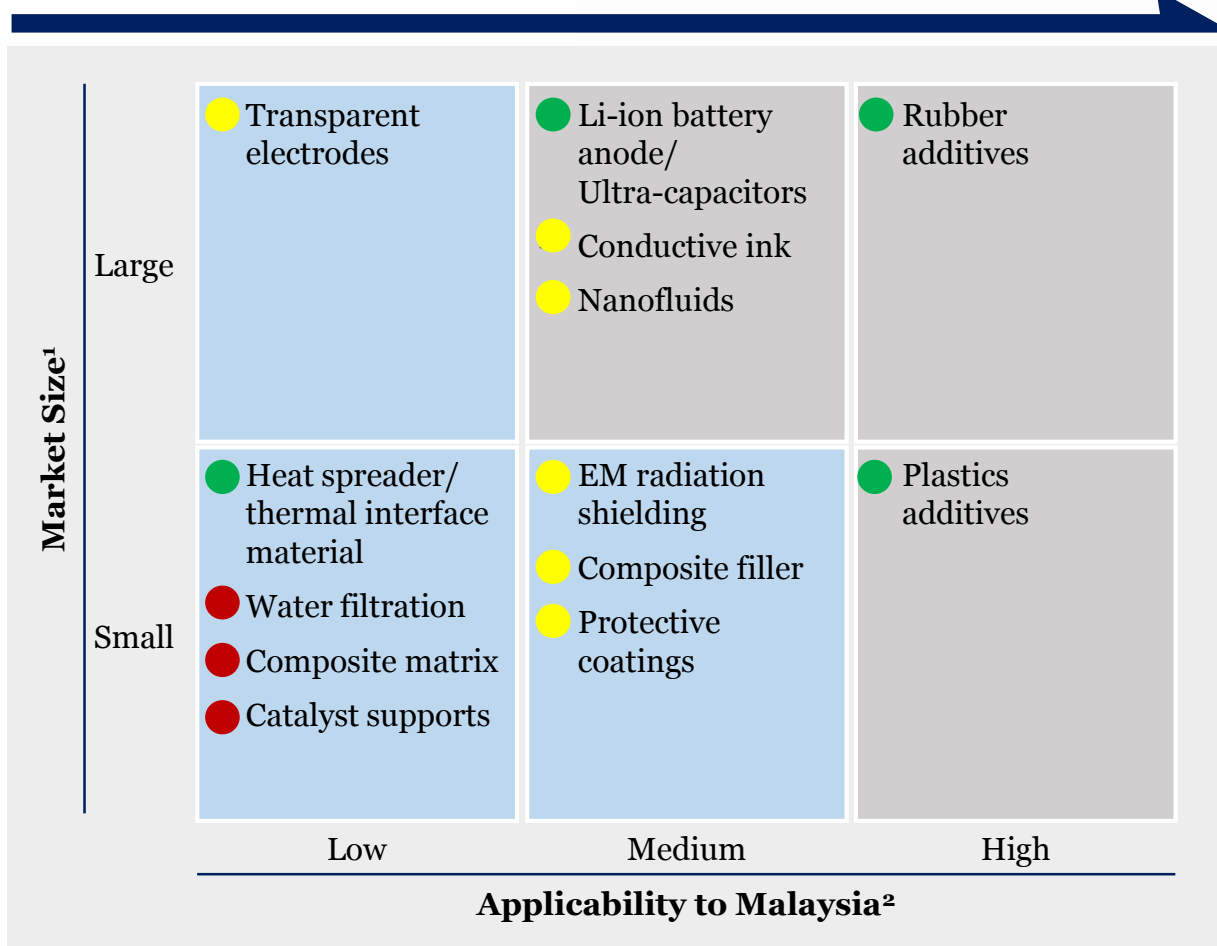
■ Addressable market size
■ Total downstream market size

Through systematic analysis, we narrowed down to 5 technologically and economically feasible applications

Likelihood of successful Graphene commercialization

● High ● Medium ● Low

Market size and applicability to Malaysia



The five applications areas for further consideration are:

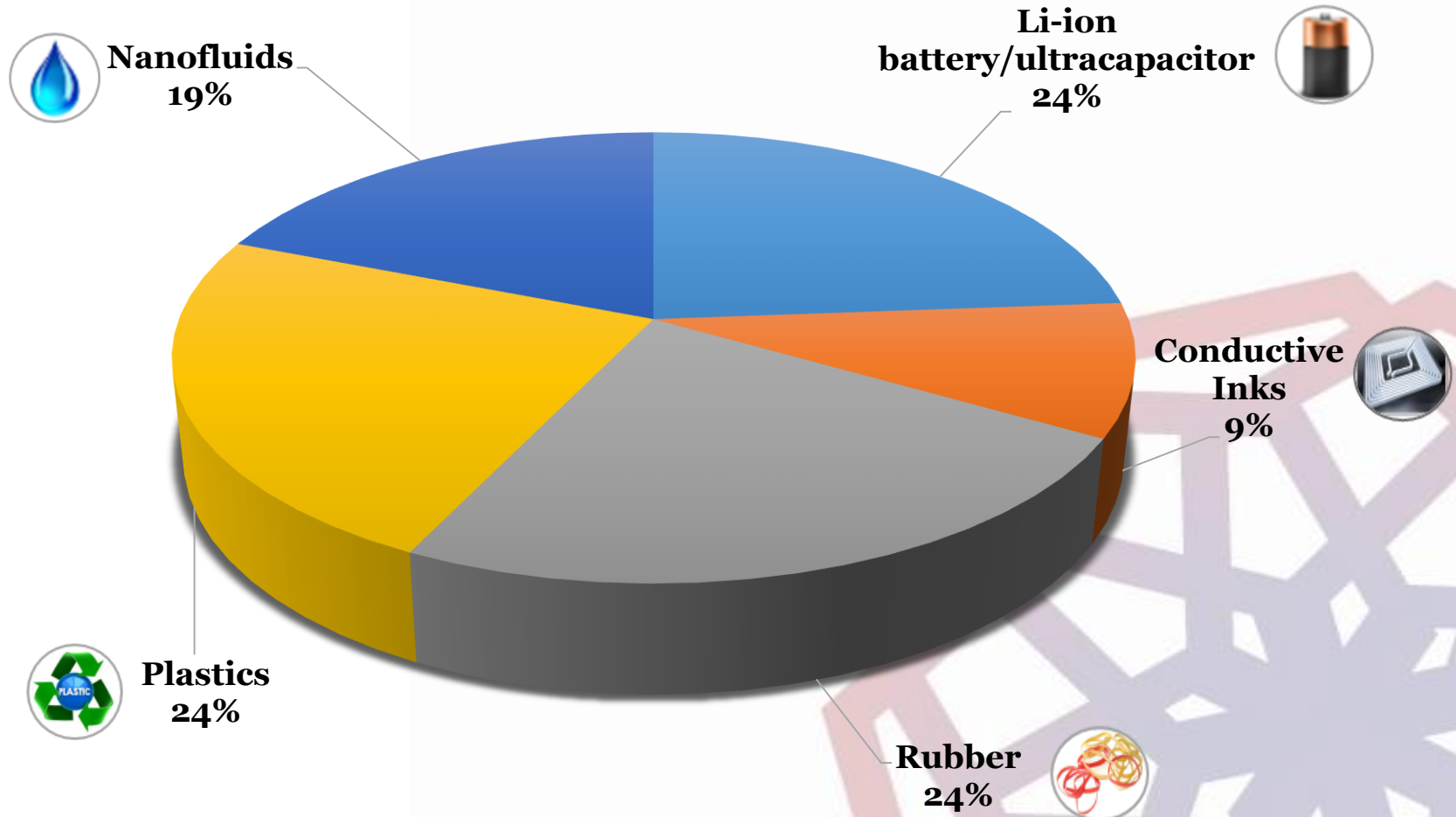
- **Li-ion battery anode / ultra-capacitors**
- **Conductive inks**
- **Rubber additives**
- **Plastic additives**
- **Nano fluids including drilling fluids, lubricants and coolants**

¹ Market size is high if addressed Graphene market size is ~\$1B or higher

² Applicability to MY is based on current downstream players, upcoming policies, and focus of neighboring countries



NanoMalaysia Berhad have secured commitments from a mixture of domestic SMEs and large companies as well as from MNCs for all 5 application areas

Project Distributions for the 5 Application Areas





Progress Update on Li-ion Batteries and Ultracapacitors Application Area


Company		Project Description	Value Proposition
Eclimo Sdn. Bhd.		Integration of graphene-based ultracapacitor – Li-ion Battery Module	Absorb power surges, enabling EV to run closer to 100% capacity
MNA-R Sdn. Bhd.		The scale up production of graphene-based quantum cell for automotive application.	Withstand extreme temperature, environmental friendly, cost efficient
Energy Storage Devices Manufacturer ¹		The scale up production of ultracapacitors and R&D on lithium capacitors for transport and energy application.	Double the energy capacity, 3 times power capacity, shorter recharge time
Advanced Materials Developer for Energy Storage ¹		Development of silicone graphene anodes for the next generation of lithium ion batteries.	Exceptional anode capacity, rapid charging, better thermal dissipation
Public Transportation Urban Transport Solutions Provider ¹		Development of graphene-based ultracapacitor packaging for electric vehicle (EV) applications.	Larger energy capacity, higher power capacity, higher current tolerance

¹ Undisclosed company name due to non-disclosure agreement





Progress Update on Conductive Inks Application Area

Company	Project Description	Value Proposition
Penchem Technologies Sdn. Bhd. 	Development of graphene-based conductive inks for printed circuit board	Exceptional electrical and thermal conductivity
Electronic Adhesive Solution Provider ¹	Development of graphene-based conductive adhesive for automotive industry	Enhanced adhesiveness performance featured with great electrical conductivity

¹ Undisclosed company name due to non-disclosure agreement





Progress Update on Nanofluids Application Area

Company	Project Description	Value Proposition
Specialty Lubricants Manufacturer ¹	Development of graphene-based lubricants for improved thermal conductivities properties.	Dynamic optimum stability and reduce wear and friction
Formulator and manufacturer of specialty chemicals for oil and gas industry ¹	Development of graphene-based emulsion solution for crude oil flow assurance	Lower degree of crystallization to increase fluid flow
Lubricant manufacturer for automotive application ¹	Development of graphene-based lubricant additive for automotive application.	Greater thermal conductivity and heat stability. Optimum dynamic stability
Oilfield Specialty Chemicals and Additives Manufacturer ¹	Development of graphene-based chemical additives for drilling fluids.	Withstand extreme pressure and temperature and prevent crystallization – ensures great fluid flow

¹ Undisclosed company name due to non-disclosure agreement





Progress Update on Plastics Application Area




Company	Project Description	Value Proposition
SOL Polymer Sdn. Bhd.	Development of graphene-based component for thermoplastic engineering polymer	Cost efficient with improved heat sink properties
Military Armored Vehicles Manufacturer ¹	Development of graphene based unmanned aerial vehicles (UAV)	Lighter bodyframe, equipped with EMI shielding and lightning protection
Automobile Manufacturer ¹	Development of graphene-based reinforced polymers nanocomposites for automotive component	Superior properties such as strength, modulus, barrier and flammability
Plastic Coating Manufacturer ¹	Development of graphene-based coating for heads-up display (HUD) application	Improved hardness and abrasion resistance (to prevent crack)
Concrete Manufacturer ¹	Development of graphene-based concrete admixture for construction.	Enhanced abrasion resistance and weathering performance of concrete

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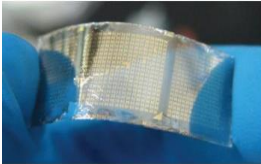
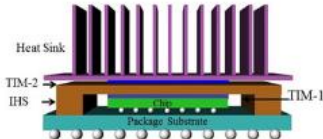

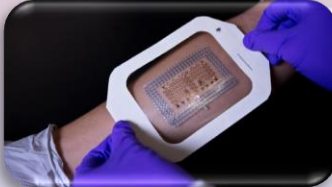
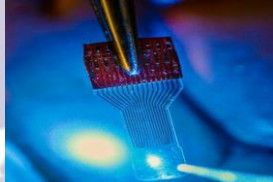
Progress Update on Rubber Application Area

Company		Project Description	Value Proposition
Goodway Integrated Industries Berhad (GIIB)		Development of graphene-enabled masterbatch for automotive application.	Superior rolling, abrasion and thermal resistance tires and rubber parts
Top Glove Berhad		Development of graphene-enabled latex gloves.	Thin, tear-proof and high conductivity surgical gloves
GB Sekhar Sdn. Bhd.		Development of graphene-based technical compounds, rethreading and tire compounds.	High performance tires
Diptech Industries Sdn. Bhd.		Development of graphene-based latex compound for medical device application.	Thin and superior medical airway device
Condom Manufacturer ¹		Development of graphene-based condom	Ultra thin and anti-tear condom

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What's next... Beyond 5 key application areas

Application Area	Related Industry	Advantages of Graphene	Value Proposition
Transparent Electrodes	Energy	Transparent conductive film with high flexibility, high clarity and resistance to oxidation	
Thermal Management Solutions	Electrical and electronics	Double the thermal conductivity of a routinely employed industrial grease with the addition of graphene	
Catalyst Supports	Chemical	High aspect ratio of graphene allows for more surface area on which catalysts can be supported, allowing for better catalysts loading	
Anti-Bacterial Medical Dressings	Medical Application	The thin strong and flexible graphene on bandages/dressings may promote clotting of wounds, including wounds due trauma, hemorrhaging, bleeding disorder, and some cancers	
Sensor Applications	Chemical	Large surface area of graphene enhances the sensitivity of gas sensor, allowing it produce better performances and accuracy	

THANK YOU

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