



Pengembangan Metode Eksfoliasi dengan Radiasi *Microwave-Plasma* untuk Peningkatan Nilai Tambah Limbah Tandan Kosong Kelapa Sawit : Karbon Aktif-Graphene

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Outline

- **Motivasi**
 - **Tandan Kosong Kelapa Sawit**
 - **Graphene-Karbon Aktif**
- **Proposal Eksfoliasi dengan Metode Radiasi Microwave-Plasma**
- **Target-aktivitas**
- **Timeline**
- **Budget**
- **Tim Pengusul**



MOTIVASI

Tandang Kosong
Kelapa Sawit

Kandungan Karbon :

- hemiselulosa
- selulosa
- lignin

Potensi :

- Karbon Aktif
- Graphene

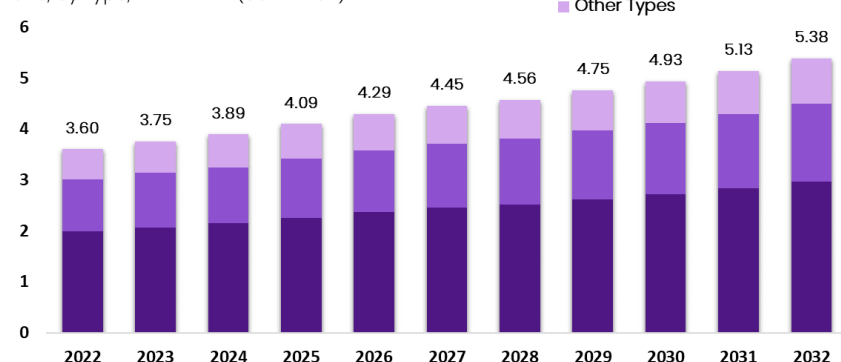
	Harga tiap kg
Karbon Aktif	\$0.58 - \$1.88
Graphene	\$1.50 - \$15.00

Pemanfaatan saat ini :

- Pupuk Organik
- Karbon/Arang Aktif → Briket
- Bahan baku kertas

Global Activated Carbon Market

Size, by Type, 2022-2032 (USD Billion)



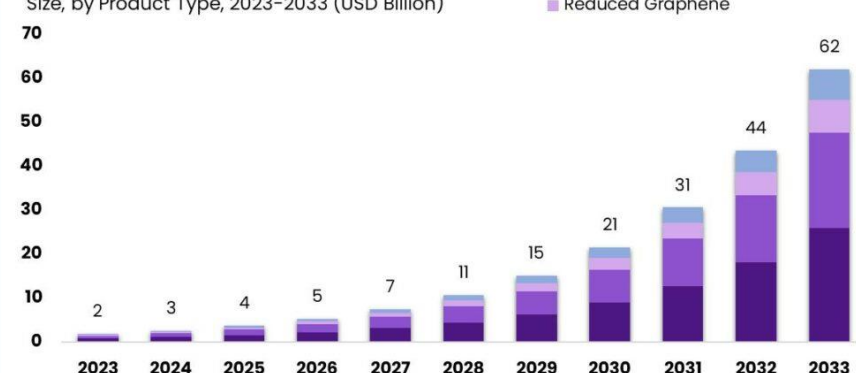
The Market will Grow
At the CAGR of:

4.2% The forecasted market
size for 2032 in USD: \$5.4B

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Global Graphene Market

Size, by Product Type, 2023-2033 (USD Billion)

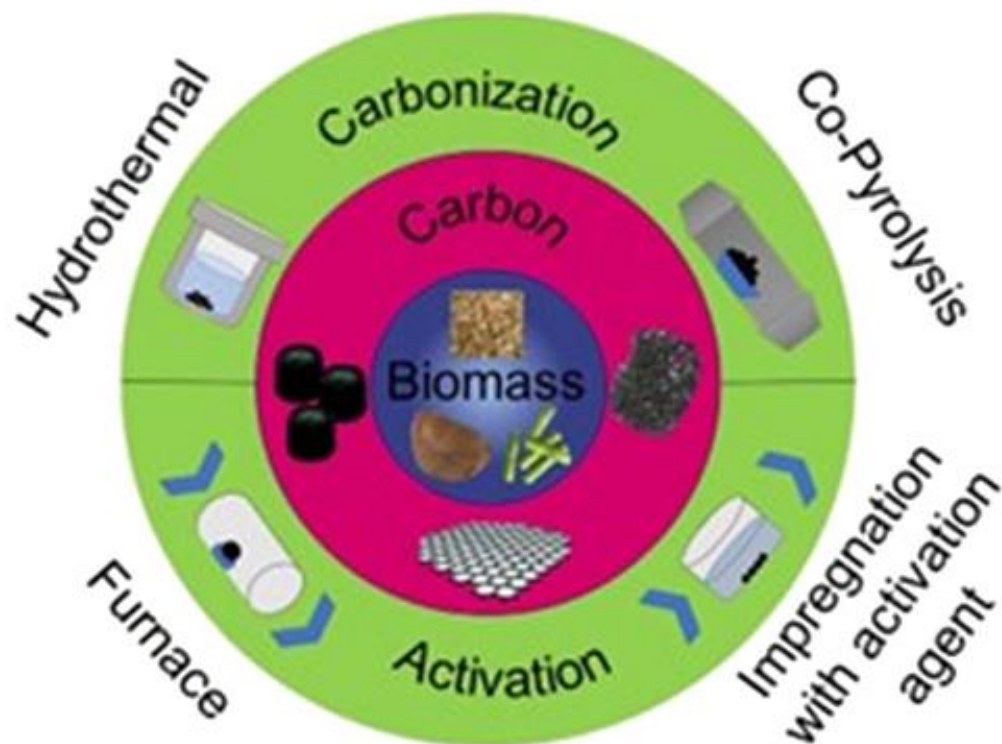


The Market will Grow
At the CAGR of:

42.5% The Forecasted Market
Size for 2033 in USD: \$62 B

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Motivasi-Pengolahan Biomass



Tantangan Selama ini Proses :

- Proses : waktu Lama
- Quantity Sedikit/skala terbatas



Proposal :

Hybrid Metode Exfoliasi Biomasa dari
Tandan Kosong Kelapa Sawita
dengan Radiasi Microwave-Plasma :
Karbon Aktif - Graphene

Roadmap

Tahun	2020-2023	2024-2026	2026-2028
Tahapan	Sintesis dan optimasi proses	Functionalized dan Akselerasi	Implementasi & Aplikasi
Aktifitas	- Exfoliasi Elektrokimia - Precursor graphite (Rod, Powder) - Voltage, Current, Ph - Machine Learning	- Electrolyte $\text{Fe}(\text{NH}_4)_2\text{SO}_4$ - Nitrogen Doping <u>Biomass Resources</u> - Pengembangan Metode <u>(Microwave-Plasma), Solvothermal</u>	- Penyimpan Energi (Supercapacitor & Batteries) - Energy Conversion (Piezogenerator, Fuel-cell) - Pengembangan sensor Kelembaban
Target/Capaian	Graphene sintesis (Journal Carbon (Q1), Journal Defect Diffusion Forum, (Q3), Alchemy (Sinta 2))	- HKI (Paten Sederhana) - Jurnal Q2 - Materi Pembelajaran	- Jurnal Q2 - Buku Pengayaan - Paten - Materi Pembelajaran

Proposal

Synthesize Graphene

- Exfoliated Method**
- **Electrochemical**
 - **Microwave**

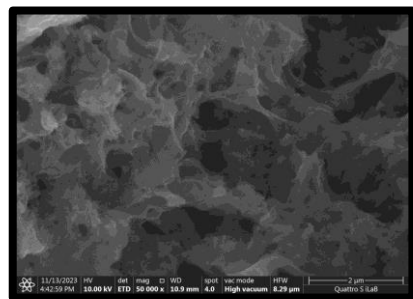
- Precursor**
- **Biomass Waste**

Electrolyte Modify

Synthesize 2021-2024

**Solvothermal
Microwave-plasma**

Surface Modification



Post treatment improvement

Mass Production

Coating strategy

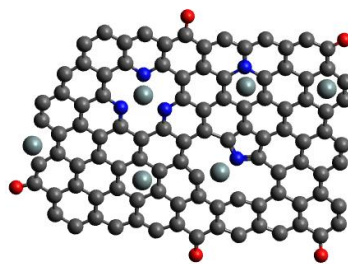
Composite

Cost control

Material
Properties

Machine Learning Model

Optimizing



Target

Energy Storages

- **Supercapacitor**
- Anode Batteries

Energy Conversion

- Piezo generator
- Thermo generator
- Fuelcell

Sensor

- Humidity sensor

Supporting Education field

- Book
- Supplement materials

Sustainable Development (SDGs)

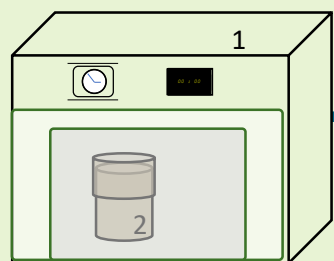
- Affordable and clean energy
- Quality Education

Tandan Kosong
Kelapa Sawit

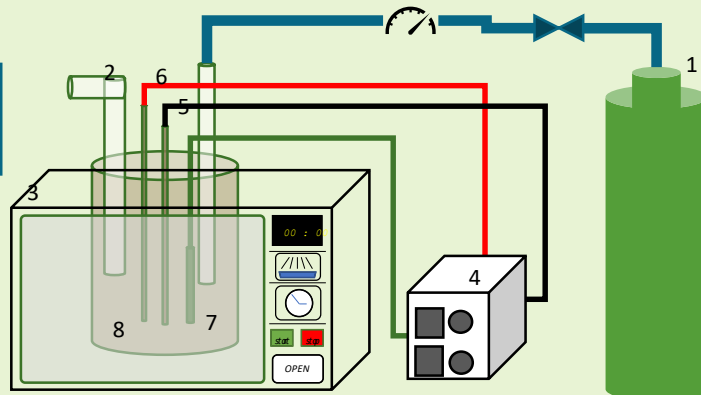
Karbon Aktif

graphene

Metode



1. Oven
2. Autoclave
3. Vacuum Pump



Functionalized - Plasma

1. Gas Input
2. Gas Output
3. Microwave Oven
4. Plasma generator
5. Plasma electrode
6. Plasma electrode
7. Thermocouple
8. Chamber

Materials Properties

- Morphology → SEM/TEM
- Crystallinity → XRD
- Defect Carbon → Raman
- Chemical element → EDX/XRF
- Surface Chemical Bonding → FTIR/XPS
- Porosity → BET
- Wettability → Contact Angel
- Conductivity → 4 point probe

Y_{n+1}

Application

Filter/membrane

Humidity Sensor

Energy Storages

Conductive Ink

Energy Conversion

- Anode LiBs
- Supercapacitor

Timeline

No	Activity	1	2	3	4	5	6	7	8	9	10	11	12
	Y_n												
1	Persiapan	x											
2	Bahan Baku		x										
3	Sintesis material			x	x	x	x		x				
4.	Karakterisasi Material					x	x	x	x	x	x		
5.	Diseminasi											x	x
	Y_{n+1}												
1	Sintesis material	x	x	x									
2	Karakterisasi Material		x	x	x								
3.	Pembuatan Prototipe		x	x	x	x							
4.	Pengujian Prototipe					x	x	x	x	x			
5.	Bahan Diseminasi								x	x			
6.	Pelaporan										x	x	x

Target-Aktifitas

No	Tahapan	Aktifitas	Luaran-Hasil	
1	Synthesis Material	Optimasi Solvothermal Method	Karbon Aktif	
2	Post Treatment	- Optimasi Microwave - Optimasi Microwave-Plasma	Graphene	
3	Karakterisasi material	Morphology ; Crystallinity ; Defect Carbon ; Chemical element; Surface Chemical Bonding ; Porosity; Wettability; Conductivity	Material Properties	
4	Application Testing	Electrochemical Test	Energy Storages	

Budget

No	Activity	Y _n (Ribuan Rp)	Y _{n+1} (Ribuan Rp)	Keterangan
1	Bahan habis pakai	40.000	30.000	
2	Peralatan Pendukung	50.000	50.000	
3	Karakterisasi materials	50.000	55.000	
4.	Paten/HKI	1.000	1.000	
5.	Publikasi	10.000	10.000	
6.	Perjalanan Dinas	10.000	10.000	
7.	Honorarium	40.000	40.000	
8.	Manajemen	10.000	10.000	
	Total	211.000	201.000	

Manpower



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