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# Research NEWS

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Jabatan Penyelidikan & Inovasi (JPI)  
Universiti Teknologi MARA



# Ketelusan Perlindungan Alam Sekitar Jayakan Teknologi Berkaitan Karbon

05 May 2025 | Berita Harian

## Ketelusan perlindungan alam sekitar jayakan teknologi berkaitan karbon



Oleh Prof Madya Dr Azlin Mohd Azmi bhrcnana@bh.com.my

**Rang Undang-Undang Pengangkutan, Penggunaan dan Penyimpanan Karbon (RU/UCUSS 2025)** yang dihasilkan Parlimen mencatatkan sejarah penting dalam perjalanan dasar iklim di negara ini.

Di bawah RU/UCUSS, setiap agensi CCS akan ditubuhkan yang bertanggungjawab memelihara operasi pengangkutan, pelesenan, penyuntikan, penyimpanan dan penutupan tapak berkaitan dengan karbon.

RU/UCUSS merokong dasar tenaga dan iklim Malaysia yang lebih luas, memandangkan CCS ditunjukkan secara jelas sebagai antara teknologi utama dalam Pelan Hala Tuju Peralihan Tenaga Negara (NET) dan Pelan Induk Peralihan Baharu (NIMP) 2030.

CCUS merujuk kepada teknologi menangkap pelepasan karbon dioksida daripada kemudahan perindustrian atau dari jana kuasa sebelum dipaparkan ke atmosfera.

Gas ini ditapis secara kekal dalam format geologi yang dalam atau dikurangkan dalam proses pemilahan minyak, pemisahan bahan kimia, pemisahan bahan binaan dan pengalihan bahan api sintetik.

Kerajaan mengutamakan ekonomi CCS boleh menjana sehingga 200,000 pekerjaan merentasi rantaian nilai, daripada pembinaan, operasi, pemangkakan dan pemantauan.

Secara strategik, Malaysia berhasrat memandatkan kepakaran dalam industri minyak dan gas serta rangkaian infrastruktur pipi yang luas, bagi memposisikan negara sebagai hab CCS serantau.

Minat pelaburan kukuh dari Jepun dan Korea

Selatan menambahkan lagi keyakinan terhadap usaha ini.

Teknologi ini turut dianggap penting bagi NIFTR yang merencanakan gas asli sebagai bahan api terlahit utama hingga 2050. Bagi mengurangkan pelepasan karbon daripada industri berat seperti keluli, simen dan jana kuasa gas, CCS menjadi penyelesaian untuk sektor pelepasan sukar dikurangkan.

Pada peringkat global, projek CCS menunjukkan pencapaian berbeza. Projek Sleipner di Norway beroperasi sejak 1996, sering disebut sebagai model berjaya, menyuntik lebih 20 juta tan karbon dioksida tanpa insiden serius, meskipun terdapat laporan mengenai kemalangan pelabur terhadap cabaran teknikal dan ekonomi.

Sekelompok projek Gorgon oleh Chevron di Australia Barat, lain projek pengangkutan dan penyimpanan karbon (CS) terbesar di dunia, gagal mencapai sasaran untuk menangkap 90 peratus karbon dioksida secara konsisten, sebaliknya hanya sekitar 30 peratus untuk lima tahun pertama beroperasi.

Ditambah, teknologi CCS bukanlah tanpa cabaran. Kebocoran gas berkecukupan tinggi dari saluran pipi dan tapak penyimpanan boleh mengancam keselamatan.

Suntikan bawah tanah membawa risiko seismik, terutama di kawasan tektonik aktif. Pembehanjutan tidak sempurna boleh menyebabkan pencemaran air bawah tanah.

pelepasan negara asing sekiranya perlindungan dan penguatkuasaan jangka panjang tidak dilaksanakan dengan tegas.

Menurut Laporan Pemilaian Keenam IPCC (AR6, 2022), CCS dalam sektor tenaga dan perindustrian adalah antara pilihan pengurangan pelepasan paling mahal, dengan kos pengurangan marginal tinggi, mahu AS\$50 (RM416) hingga AS\$100 (RM420) setan tan karbon dioksida setera dengan bekid.

Ini jauh lebih tinggi berbanding tenaga boleh diperbaharui seperti angin dan solar, yang hanya memerlukan kos sehingga AS\$80 (RM345) setan tan karbon dioksida setera.

Microsoft baru-baru ini mengumumkan CCS bernilai AS\$800 juta (RM3.5 bilion) di Baton Rouge, Louisiana, yang memproyeksikan penyimpanan 6.5 juta tan karbon dioksida selama 15 tahun.

Ini ditermakan kepada model AS\$100 (RM42) bagi setiap tan karbon dioksida, mengukuhkan bukti CCS kekal sebagai teknologi mitigasi termahal.

Secara umumnya, RU/UCUSS menetapkan asas kepada potensi pembangunan ekosistem pengurangan karbon yang transformatif. Bagaimanapun, CCS perlu dilihat hanya sebagai alat pelepasan, bukan pengganti kepada pelepasan dalam tenaga solar tenaga angin dan inisiatif fovekapan tenaga yang terukuti sebagai teknologi mitigasi berkesan.

Tugas sebenar kini bermula bagi memastikan ketelusan, membina kapasiti teknikal, mengatkuasakan perundangan alam sekitar dan mengatkuasakan keperayaan orang ramai, agar tidak mengulangi kegagalan pernah berlaku pada peringkat global.

Senoga Malaysia memulakan lembaran baharu ini dengan dipacu gubahan inovasi, integrasi dan ketelusan yang tinggi.

# Fuel Diversification Critical to Future Proof Malaysia's Electricity Supply

19 June 2025 | The Malaysian Reserve

## Fuel diversification critical to future-proof Malaysia's electricity supply

Shifting to secure, balanced energy mix takes time and demands political will, long-term planning and consistent action

By ANWAR ANWAR

**AS MALAYSIA** sets a low carbon future, energy experts are warning that the country's heavy dependence on a few fuel types - particularly gas and coal - could become a major vulnerability to disruption.

"The current energy mix is heavily diversified energy mix that blends traditional fuels with renewables, distributed power generation and micro-utility power."

When that might sound like a lot of options, the balance is simple. If we want our lights to stay on, we have to have our energy mix stable and resilient. The goal is to have more than one source or technology of fuel generation against the nation's ambition of achieving net-zero carbon emissions by 2050.

Both experts agreed that Malaysia plan to shift away from coal must be handled carefully. Relying the process could lead to increased air pollution, which would damage the environment and future generations.

"We need to diversify our energy mix to include more renewable energy sources like solar, wind, and hydro. This will help reduce the emissions from the coal power plants. Some of the modern plants have incorporated renewable high capacity power plants."

Others, like carbon capture and storage (CCS), which is still under development, need more research to be fully understood, he added.



Our electricity generation is still almost 50% coal-based, says Anwar Anwar



According to Ahmad Faiz, biomass is flexible and an untapped potential

**The Danger of Putting All Your Eggs in One Basket**

Malaysia's heavy reliance on gas and coal for electricity generation is a major concern. The country's energy mix is heavily skewed towards these two fossil fuels, which is a significant vulnerability. The experts warn that this reliance could lead to a major energy crisis if either gas or coal supply is disrupted.

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Others, like carbon capture and storage (CCS), which is still under development, need more research to be fully understood, he added.

**Energy is Personal: From Rooftop Solar to Backyard Wind**

Energy is not just a commodity; it's a personal responsibility. As we move towards a more sustainable future, it's crucial to explore all available options. From rooftop solar panels to backyard wind turbines, every citizen has a role to play in reducing their carbon footprint and contributing to a greener energy mix.

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**Biomass and Micro-Hydro: The Hidden Powerhouses**

While solar and wind are the most visible renewable energy sources, biomass and micro-hydro are often overlooked. Biomass, derived from agricultural waste and wood, offers a steady and sustainable energy source. Micro-hydro, generated from small-scale water flows, provides a clean and reliable power source in rural areas.

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Others, like carbon capture and storage (CCS), which is still under development, need more research to be fully understood, he added.

He added that SMR, which is compact and designed with inherent safety features, should be deployed in remote areas or islands. SMR can be used to replace large oil plants power generation in remote areas. In handling capacity gas, SMR can be used to replace gas plants. At the same time, they help reduce reliance on gas-fired plants and address the intermittency challenges associated with solar energy.

Meanwhile, Auliyah said the public needs to understand that net-zero goals don't mean zero energy. It's about using what we need and what we can't use, and nuclear energy can be part of that balance.

**Planning, Politics and Public Will**

Both experts pointed out that achieving a resilient, low-carbon energy future will require long-term planning and consistent action. It's not just about technology; it's about the political will and public support needed to make the transition. The government must lead by example, investing in research and development, and creating a supportive regulatory environment.

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## Unit of Research Communication & Visibility

Department of Research & Innovation,  
Level 5, Bangunan Canseleri Tuanku Syed Sirajuddin,  
Universiti Teknologi MARA, 40450 Shah Alam. Selangor



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