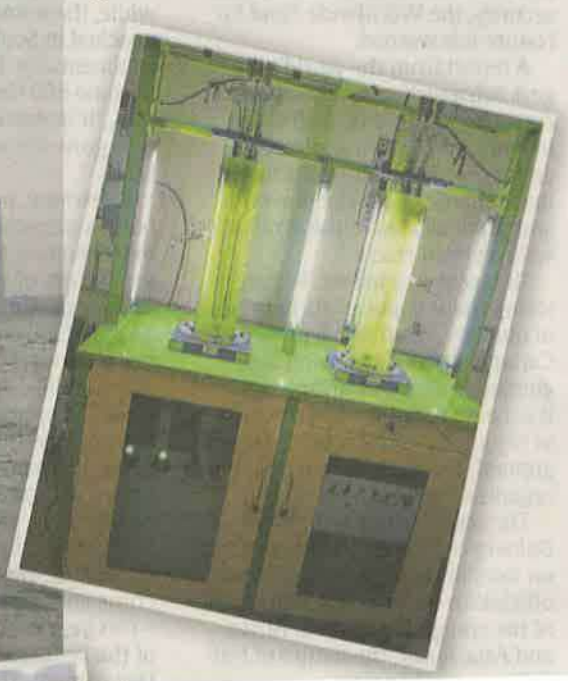
TENAGA NASIONAL BERHAD

THE STAR

DATE	18.12.2012	PAGE	4
DAY	TUESDAY		Ecowatch

Slime to the rescue

Sampling in the sea off the Sultan Azlan Shah coal-fired power plant in Lumut, Perak, reveals five dominant species of microalgae. These have been tested for their carbon-fixing ability.



In the laboratory-scale photobioreactor, experiments are conducted on parameters such as illumination, pH, temperature, CO2 levels and nutrient requirements, to optimise the algal growth and hence, carbon fixation rate.

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Tenaga Nasional is looking at algae in order to green its coal-fired plants.

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THE use of coal to generate electricity is a rather carbon-intensive process: for every tonne of coal burnt, close to three tonnes of carbon dioxide (C02) are emitted. To look at it another way, every 1,000MW of installed capacity is estimated to emit six to eight million tonnes of CO2 per year.

Malaysia burns around 56,000 tonnes of coal each day through its seven coal-fired power plants, two of which are operated by national utility company, Tenaga Nasional Bhd (TNB). CO2 is one of the greenhouse gases that trap heat in our atmosphere, causing it to warm up like a greenhouse.

According to TNB, 26% of the country's total CO2 emissions in 2006 came from the electricity and energy industry sector, and this is chiefly through the use of fossil fuels like coal, gas and distillate.

Unless renewable energy and nuclear power can come into the mix in a meaningful way, the use of fossil fuels will continue to form the bulk of generating capacity, given its abundance and technological maturity. The present heavy reliance on coal is due to its relatively low price compared to alternatives such as natural gas.

Climate scientists argue that there is no time to waste in arresting the accumulation of greenhouse gases in the atmosphere.

The latest Emissions Gap Report, coordinated by the United Nations Environment Programme and the European Climate Foundation, shows that greenhouse gas emission levels are now around 14% above where they need to be in 2020.

The report pointed out that instead of declining, the concentration of greenhouse gases has actually increased in the atmosphere – up around 20% since 2000. The silver lining from this gloomy scenario is that the aim to keep average global temperature rise to less than 2°C is still doable, though governments are increasingly running out of time.

CO2 capture

For TNB, carbon mitigation measures in its operations are priorities, and it is now looking at carbon capture and storage (CCS) at its coal-fired plants. CCS typically involves capturing CO2 at source and then sequestering (or storing) it underground, or in oil wells. There are other forms of CCS that are being looked at, but each form would have its respective environmental impact, cost and safety considerations.

In this regard, researchers at TNB Research (TNB's research arm) are experimenting with marine algae cultivation as a means of biologically capturing (or fixing) CO2.

To remove the carbon, flue gas (exhaust gas after burning of coal) is piped into a photobioreactor housing the algae. During photosynthesis, the algae will absorb CO2 to create biomass (in this case, more algae). This organic matter can offer various value-added downstream products which can be converted into biomass, biofuel, nutritional diets, aquaculture food and fertiliser, to name a few.

In theory, simultaneously capturing and utilising CO2 biologically is a wonderful proposition as it solves the carbon problem while leaving a commercially viable by-product.

Technologies for microalgal cultivation for greenhouse gas mitigation have been studied over the past two decades, especially in Japan and the United States. Based on other researchers' work, it is known that not all algal species give the same performance as far as carbon fixing is concerned. In 2011, TNB researchers started sampling the waters off the Sultan Azlan Shah (SAS) power station in Lumut, Perak, to determine the microalgae species there.

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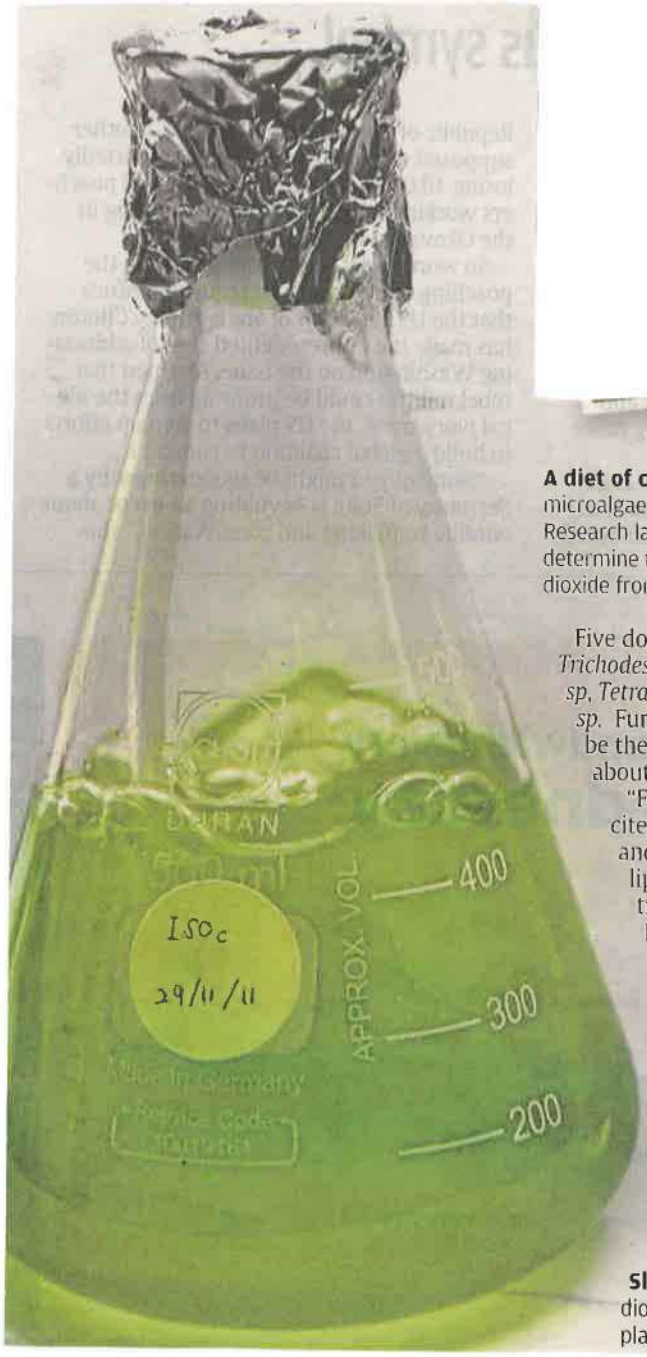

A diet of carbon: Various species of marine microalgae are being cultivated at the TNB Research laboratory in Bangi, Selangor, to determine the one that can best capture carbon dioxide from coal-fired power plants.

Five dominant species were found: *Trichodesmium thiebautie*, *Nannochloropsis sp*, *Tetraselmis sp*, *Chlorella sp* and *Isochrysis sp*. Further analysis found *Isochrysis sp*, to be the most dominant species, forming about half of the population.

"Four of these species are commonly cited in literature as having satisfactory and good qualities on biomass yield, lipid content, antioxidant properties and nutritional values," said Muhammad Nazry Chik, principal researcher for the project.

"The benefits of using algae versus other technology is that the captured CO2 can be utilised and need not be transported elsewhere for storage. However, this technology is still new, and nothing on a large scale has been employed to date," he said.

After subjecting the *Isochrysis*, *Tetraselmis* and *Nannochloropsis oculata* algae species to a series of CO2 fixation rate experiments under controlled conditions in a photobioreactor, it was found that *Isochrysis* has the highest average fixation rate (at 1.46 g/day). Knowing the species' ability to fix CO2 will pinpoint the best species to be utilised in the CO2 capture application of a power plant.

Species selection

The TNB researchers have also built a laboratory-scale photobioreactor to enable more experiments to be conducted. The growth rate of microalgae relies on various culture parameters such as illumination, pH, temperature, amount of CO2 supplied and nutrient. Knowing the right amount of each of these parameters is crucial for the algae growth and hence, the fixation rate.

As such, the experiment was designed to vary each of these parameters and the growth performance was recorded. Future research will involve optimisation of the photobioreactors' operating parameters, for example, lighting, pH, temperature and CO2 loading rate, to further improve the carbon fixation rate.

"We will not close the door on other algal species as there are thousands of them out there, and *Isochrysis* just showed itself to be the best among three species only.

"This project has contributed to capacity building in terms of isolating the species, culturing and monitoring the growth of the algae, and designing the photobioreactor. It represents a proactive effort by TNB in mitigating CO2 emission using a more sustainable method," said Nazry, who added that the study is being funded internally with a cost of close to RM1mil.

TNB's upcoming initiatives involve design and development of a pilot photobioreactor plant at a coal-fired power station. Among the by-products of the process that are worth considering for future research and development is biodiesel, derived from microalgae which have undergone the photosynthesis process.

Now, who would have predicted that algae, normally dismissed as just green slime that fouls up bodies of water, could have such potential in halting global warming?

Slimy solution: The microalgae *Isochrysis* has been found to be efficient at capturing carbon dioxide, making it a choice candidate in the plan by Tenaga National Berhad to use the marine plant to mitigate carbon emissions from its coal-fired power plants.