PUBLISHED: 5 FEBRUARY 2016 | ARTICLE NUMBER: 16005-16008

research highlights

MARINE ENERGY

In deep water

Renew. Energy **89,** 515–525 (2016)

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Marine energy technologies generate electricity by harvesting energy from waves or tides. Together with wind and solar, marine energy is thought to be an important element in the renewable energy mix required to achieve decarbonization in the coming decades. However, marine technologies are still in their infancy, meaning their potential contribution to the energy mix remains under debate. Focusing on Europe, Alessandra Sgobbi and co-workers from the European Commission's Institute for Energy and Transport have now assessed the deployment of marine energy up to 2050 as a function of possible technological improvements and CO_2 emission reduction policies.

The effects of cost reduction and energy conversion efficiency improvements are modelled under two scenarios: one that assumes a 20% reduction in CO_2 emissions compared with 1990 levels, and one in which CO_2 emission are reduced by 80%. The researchers concluded that, for both scenarios, wave energy remains uncompetitive in the range of parameters considered. On the other hand, tidal energy might become cost-effective by 2030 if its efficiency can be improved by 40% over current expectation or if costs can be reduced by 50%. To achieve these outcomes, annual investments of €0.1 to 1.1 billion are needed. The researchers also propose that research and development efforts should be directed towards increasing the conversion efficiency as the most effective strategy. *ED*

CATALYSIS

Fuel from air

J. Am. Chem. Soc. **138,** 778–781 (2016)

Pulling carbon dioxide out of the atmosphere and converting it into fuel or other useful chemicals is the aim of carbon capture and recycling technologies. Methanol is one possible product of such technologies, and it is attractive because it can be blended with transportation fuels, used in direct-methanol fuel cells or exploited as a hydrogen storage medium. As such, a 'methanol economy' has been proposed where methanol is used as an energy carrier to replace fossil fuels. Now, George Olah, G. K. Surya Prakash and colleagues at the University of Southern California, have developed a homogeneous catalyst system that allows carbon dioxide captured from air to be converted directly into methanol without intermediate steps.

Using a ruthenium-based catalyst and a polyamine, the researchers showed that a mixture of carbon dioxide and hydrogen could be efficiently converted into methanol in a one-pot process. Carbon dioxide is captured by the polyamine before being hydrogenated by the ruthenium catalyst. Importantly, the catalytic system could be used to generate methanol from synthetic air containing as little as 400 ppm of carbon dioxide, the typical concentration in the atmosphere. The researchers found that 79% of the carbon dioxide could be converted into methanol. The reaction proceeds at relatively mild temperatures (125–165 °C) and the catalyst can be recycled up to five times with little loss in activity. *JG*

SUPERCAPACITORS

Performance doping

Science **350,** 1508–1513 (2015)

The ability to quickly charge and discharge electrical energy makes supercapacitors ideal devices for short-term energy storage. However, supercapacitors do not usually possess high specific capacitance (the electric charge stored per unit mass or volume) and thus high energy density. Carbon-based electrode materials have a capacitance of merely around 300 $F\,g^{-1}$. Fuqiang Huang and colleagues at Shanghai Institute of Ceramics, Peking University and University of Pennsylvania have now reported a nitrogen-doped porous carbon electrode that possesses a capacitance of 855 $F\,g^{-1}$ and a supercapacitor based on the electrode that stores an energy of 41 $W\,h\,kg^{-1}$ or 19.5 $W\,h\,l^{-1}$.

The electrode features nanoporous walls consisting of a few graphene-like sheets in which a certain amount of nitrogen atoms occupy the original carbon lattices due to nitrogen doping. Huang and colleagues showed that those nitrogen atoms, adjacent to defects on the graphene-like sheets, are mainly responsible for the fast redox reaction in electrochemical cells. The electrode is also hydrophilic, meaning that an aqueous electrolyte can easily wet it, lowering the interface resistance and increasing the electrical conductivity. These properties, along with the high surface area of the electrode arising from its porous characteristics, explain the exceptionally high capacitance. *CZ*

ENERGY CONSERVATION

The power of information

Energy Econ. **54,** 173–181 (2016)

Monthly energy bills tend to only give customers information on their overall usage without detailing the costs of specific appliances at different times of day. Conversely, in-home displays provide real-time information, which can allow consumers to optimize their usage. Such displays have been shown to lead to a reduction in household energy consumption, but what underpins this behavioural change remains unclear. Now, Nori Tarui at the University of Hawai'i at Mānoa and collaborators attempt to disentangle whether the change is driven by learning effects or by the presence of constant reminders (that is, by saliency effects).

The researchers undertook a randomized control experiment, measuring the electricity consumption of 65 households in Honolulu under different conditions over 90 days. A control group only received their standard monthly bills, while two treatment groups were given in-home displays for different periods of time. Average electricity consumption reduced by up to 11% for the treatment groups, although the effect diminished over time. Moreover, the researchers found statistically significant evidence that this reduction stemmed from learning about usage through the display, but no clear evidence for saliency effects. These findings suggest that targeting learning may be a more effective route to lowering energy use than providing constant notifications. *ND*

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