

CAPACITY MECHANISMS

More flexibility reduces cost

Energy **117**, 300–313 (2016)

The increased penetration of renewable energy (RE) has depressed electricity prices, reducing the profitability of conventional (coal- and gas-fired) plants that, in some cases, have been forced out of the market. However, the intermittency of RE means that flexibility, which only conventional generation is able to provide, is required in the system. To solve this conundrum, regulators are increasingly providing capacity payments to support flexible conventional generation. Tuomas Rintämäki and Ahti Salo from Aalto University, Finland, and Afzal Siddiqui from University College London, UK, develop a complementarity model showing that optimal capacity payments can decrease re-dispatching volumes and reduce the cost of RE integration.

The researchers use a bi-level programming model in which contractual positions are aggregated at the upper level (day-ahead market), and transmitted to the system operator at the lower level, which computes the imbalances between actual measurements of grid injections and withdrawals in real time. The researchers apply their model to the German system, divided into 18 nodes, to assess the impact of different policies and scenarios. In a situation with high RE generation, capacity payments make gas-fired plants available in the day-ahead market thus offsetting the variability of intermittent generation. This reduces re-dispatch costs and volumes in the physical market and allows the system to respond better to forecast error.

AR

ENERGY CONSERVATION BEHAVIOUR

Savings without billing

Energy Policy **98**, 19–32 (2016)

Providing residents with feedback that compares their household energy use to similar homes has been shown to reduce energy consumption. However, such feedback is typically provided in the context of an energy bill, so in addition to intrinsic motivation to reduce energy consumption to comply with social norms, there are also financial incentives. To determine whether social normative feedback alone is sufficient to promote energy conservation, Qingbin Cui and colleagues from the University of Maryland, USA, conducted a four-month study in a military community where households are individually metered but residents do not pay for their utility usage.

Households received home energy reports that included a bar chart comparing their household monthly electricity consumption to the average consumption of their neighbours, and the average consumption of the most efficient 20% of their neighbours. Compared to a control group, households that received feedback on how their electricity use measured up to their neighbours' had average energy savings of 3.4% over a three-month period. Thus, providing information on social norms is an effective tool for facilitating energy conservation behaviour, even in the absence of financial consequences. This has implications for policy interventions in similar settings where individuals are not billed for the electricity they use, such as university dormitories and office buildings.

JR

SOLID OXIDE FUEL CELLS

Low temperature cathodes

Energy Environ. Sci. <http://doi.org/btck> (2016)

Solid oxide fuel cells (SOFCs) offer an efficient means of producing electricity through the oxidation of fuels. However, SOFCs often operate at high temperatures (typically 700–1,000 °C), which not only causes issues for device durability but also requires the use of expensive components. Low-temperature SOFCs are therefore more desirable — in particular, developing cathode materials with increased oxygen reduction reaction (ORR) activity is crucial. Although a number of perovskite-based cathode materials have been recently proposed with promising power densities at relatively low temperatures (around 600 °C), their performance deteriorates quickly at lower temperatures primarily due to the loss of ORR activity. Now, Jianhua Tong and Ryan O'Hayre and colleagues in the USA report a $\text{BaCo}_{0.4}\text{Fe}_{0.4}\text{Zr}_{0.1}\text{Y}_{0.1}\text{O}_{3-\delta}$ (BCFZY0.1) cathode with exceptional performance, enabling a peak power density of 0.97 W cm⁻² at 500 °C with long term (2,500 hours) stability.

Compared to other common perovskite cathodes such as $\text{Ba}_{0.5}\text{Sr}_{0.5}\text{Co}_{0.8}\text{Fe}_{0.2}\text{O}_{3-\delta}$ (BSCF), BCFZY0.1 has a larger lattice parameter, implying increased mobility of oxygen ions. The substitution of $\text{Co}^{3+}/\text{Co}^{4+}$ by larger Zr^{4+} and Y^{3+} cations with invariant oxidation states could also help improve cathode stability and contribute to the enhanced ORR activity at low temperatures. Additionally, the researchers found that the cathode is stable in environments containing H₂O and CO and possesses good thermal cycling stability in a full cell under aggressive operating conditions.

CZ

Written by James Gallagher, Jenn Richler, Alessandro Rubino and Changjun Zhang.

OXYGEN REDUCTION REACTION
Counting active sitesNat. Commun. **7**, 13285 (2016)

Developing lower cost alternatives to the catalysts containing precious metals used at the electrodes of polymer electrolyte fuel cells is key to increasing their commercial viability. One family of materials that has emerged as a promising candidate to catalyse the cathodic oxygen reduction reaction are those based on iron, nitrogen and carbon (Fe–N/C). Despite intense investigation of these materials, easily and accurately measuring the number of active sites — those locations where the catalysis occurs — has remained a challenge. Now, Anthony Kucernak and colleagues at Imperial College London, UK, and IPEN, Brazil, show that the number of active sites in Fe–N/C catalysts can be quantified using an *in situ* electrochemical methodology.

The technique exploits the strong interaction between nitrite anions (NO_2^-) and metal centres to poison the catalytic sites in Fe–N/C materials. Subsequently, the nitrite is electrochemically stripped, which recovers the catalyst's activity and leads to a measurable transfer of electrons, allowing the number of adsorbed anions and therefore the number of active sites to be calculated. Metal-free catalysts are unaffected by the process. The reaction rate per active metal site can thus be determined: this can help to rationalize trends in performance and aid design of improved catalysts. The method only requires standard electrochemical characterization equipment and is relatively facile to execute.

JG