對外合作組織與機構動態報導

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NEW UN STUDY ASSESSES RADIATION EXPOSURE FROM ELECTRICITY GENERATION TECHNOLOGIES

聯合國資訊服務部發表不同發電方式對社會大眾造成的輻射暴露量評估

For information only – not an official document

VIENNA, 8 February (UN Information Service) – The results of a report released today by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) confirmed that for members of the public, annual exposure to radiation resulting from generating electricity (via the coal cycle, nuclear fuel cycle, or other electricity-generating technologies) is small and typically much less than one per cent of the

報告摘要(KEY INFORMATION)

1. UNIS 發表原子能輻射影響相關研究報告指出，不論是燃煤、核能，或其他發電方式，社會大眾每年暴露於因發電所產生的輻射量大約相等，且都遠小於自然界背景值。
2. 美國紐約州布坎南核電廠 2 號機與 3 號機將分別於 2020 及 2021 年關閉的消息已經公布。由於整體電價偏低的緣故，核能產業環境依然困難。與此同時，中國仍積極發展核能。
3. 今年 2 月 23 日，一群八年級的女孩們在阿岡實驗室體驗科學及工程令人振奮的無限可能性。「我們非常興奮能舉辦這樣的活動，激發年輕女孩對科學的熱情，成為繼我們之後、新一代的科學家與工程師。」一名物理學家——同時也是阿岡「科技中的女性」計畫的發起人——Lydia Finney 表示。
4. 今年 2 月 9 日於東京舉行的國際研討會中，與會者分享不同的觀點，以及可能使現今相對穩定的油價上下波動的因素，包括：原油主要供給國可能採取的干預措施、美國總統川普上任後的頁岩油氣發展政策，與中東情勢等。
5. 《自然》〈科學報告〉先前刊出「使用鐵電性材料處理含括多值邏輯資料」的理論圖幅，相較於當前的 01 二位元計算系統而言，這個躍進將可能讓我們在資料處理上更有效率。

corresponding average natural background exposure.

While the doses were very small, the UNSCEAR 2016 Report found that the coal cycle contributed more than half of the total radiation dose to the global public from electricity generation. The nuclear fuel cycle contributed less than a fifth of this. “These results should be seen from the perspective of the share of each technology in worldwide electricity production; 40 per cent of the world’s energy was produced by the coal cycle in 2010, which is the baseline year for the assessment, compared with 13 per cent by nuclear,” said Hans Vanmarcke, Chair, UNSCEAR, on the release of the UNSCEAR 2016 Report. “Of the remaining technologies, the combustion of natural gas and geothermal were important contributors to global public exposure,” he added.

However, overall, the radiation exposure of the workers exceeds that of the public, because of the mining activities that precede any form of electricity generation. Coal miners as a group receive the largest collective dose of radiation, through enhanced exposure to naturally occurring radionuclides. Such exposure has reduced over the years because of better mining conditions.

“Exposure to radiation and its effects on people have always been of interest to the general public and scientists alike,” said Vanmarcke. “We can now make more sound assessments of different electricity-generating technologies, as more complete data have been collected and consistent methods for evaluating the different technologies are available.”

The 2016 Report includes the results of an assessment of the levels of radiation exposure due to different methods of electricity generation (Annex B) using an updated methodology (Annex A). The last such study was published by UNSCEAR in 1993.

The Report, which has four scientific annexes (Annex A, B, C, and D) was published today and is available for free download at http://www.unscear.org/unscear/en/publications/2016.html.

People also want to compare exposures from generating the same amount of electricity. Thus, the Committee also evaluated radiation exposure per unit of electricity generated, using 2010 as a reference year for comparison. It concluded that the values for the two main electricity generation technologies (coal and nuclear) are about the same in the short term. “Over longer times, such as hundreds of years, an accumulation of very small doses from long-lived radionuclides result in larger collective doses from the nuclear fuel cycle,” said Vanmarcke.

The Committee for the first time also assessed the occupational exposure during the plant construction phase for the various electricity generating technologies. Although this component is smaller than those incurred by miners for coal and uranium as fuel, the highest occupational exposure associated with plant construction for the same amount of installed power is for construction of solar energy plants,

followed by wind energy plants. This is because these technologies require larger quantities of rare earth metals and the extraction of the very low-grade minerals needed exposes workers to radiation during the extensive mining operations.

The Committee also recalled the exposures from radiation accidents. “It is difficult to directly compare exposure from accidents (such as those that occurred at Chernobyl, and more recently at the Fukushima-Daiichi nuclear power station) to those resulting from routine discharges,” said Vanmarcke. “Nevertheless, the Committee reconfirmed that the collective dose to the global population from serious accidents was many orders of magnitude higher than one year’s normal operation of the nuclear cycle.”

While the 2016 Report examines the level of radiation exposure caused by various electricity-generating technologies, its findings cannot alone indicate that any one technology is preferable to another. Countries choose an appropriate mix of technologies based upon a number of factors, which may include radiation exposure.

The 2016 Report (Annexes C and D) also assesses the biological effects of radiation from two internal emitters — tritium and isotopes of uranium, respectively. Internal emitters can be described as radionuclides that have been deposited in body organs and tissues, either via inhalation or by eating. Once in the body, they continue to deliver doses of radiation internally. Doses to organs from these emitters are generally estimated using models that use either environmental or human measurements.

Tritium is a radioactive isotope of hydrogen that occurs both naturally and artificially. It is found mainly as tritiated water in either liquid or vapour form. Exposure of workers results mainly from nuclear reactor operations and other industrial installations. Uranium is a naturally occurring radioactive element that the general public is exposed to due to its widespread presence. Workers are exposed to uranium mainly from mining and from its use as a nuclear fuel. Another area of concern has been the exposure resulting from the use of depleted uranium in munitions.

The 2016 Report concludes that the accumulation of tritium in the organic component of foodstuffs warrants further investigation. It also states that no firm conclusions may be drawn with regard to the carcinogenic effects of tritium. Occupational exposure to various physical and chemical forms of tritium since the middle of the last century varied, from very low to lethal doses. This is why clarification of doses and biological effects of tritium remains topical, especially in the face of the potential dawn of a fusion era. Vanmarcke said: “Tritium exposure in the environment is generally very low, and any effect of such exposure against the background radiation is very small.”

With regard to uranium exposure, the 2016 Report concluded that uranium effects on the kidneys observed in animals and humans are clearly related to the chemical properties of uranium itself. There is no clear demonstration of a causal association between cancer risks and radiological exposure to uranium. It also states

that at the present time, no observed health effects in humans can be linked with radiological exposure to depleted uranium.

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The mandate of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), established in 1955, is to undertake broad reviews of the sources of ionizing radiation and the effects on human health and the environment. Its assessments provide a scientific foundation for United Nations agencies and governments to formulate standards and programmes for protection against ionizing radiation. The secretariat in Vienna, which is functionally linked to United Nations Environment (UNEP), organizes the annual sessions and manages the preparation of documents for the Committee's scrutiny.

DEVELOPMENTS IN NUCLEAR POWER

能源市場與政策趨勢

On December 19, 2016 the US Nuclear Regulatory Commission issued a conditional Combined License for the Construction and Operation (COL) of William States Lee III Nuclear Station in South Carolina to the applicant, Duke Energy.A COL has now been issued for six nuclear new build projects (11 plants). However, construction has started for only two projects (four plants) while more projects had to withdraw their COL (eight projects for 10 plants) due to market circumstances, indicating the difficult business environment.

The situation is difficult not only for new builds but also for existing plants whose construction costs have been depreciated. On January 9, Entergy, the owner and operator of Indian Point Units 2 and 3, announced that it has agreed with the state government to permanently close Unit 2 in April 2020 and Unit 3 in April 2021. As the background to the premature closures, Entergy cited the financial reason of an approx. 45% fall in the wholesale electricity price in the past 10 years to $28/MWh with no prospect of a swift recovery. Both reactors were classified in the top safety category by the NRC in 2016, and have an excellent average availability of more than 90% for the past five years. The fact that even these plants with the highest level of operational safety cannot survive the market situation shows the difficulties facing the

US nuclear business amid severe competition in the power market.

China's presence in the international community is increasing year by year, and will continue in 2017. On January 8, China General Nuclear Power Group (CGN) connected Yangjiang Unit 4 (1,080 MW) in Guangdong Province to the grid and began to generate electricity. The plant completed a safety review

and construction began in November 2012 after the Fukushima Daiichi accident, suggesting no

December 23, construction began on Fangchenggang Unit 4 as a second unit of China's domestic reactor Hualong-1 and the first plant under the Thirteenth 5-Year Plan. This speed is in marked contrast with the UK which is yet to start plant construction despite stating the need for new builds and incorporating a roadmap in a White Paper on Nuclear Power in 2008.

Regarding the much-feared gap in safety technology levels between domestic reactors in China and those in OECD countries, this may no longer be a concern since the UK's Department for Business, Energy & Industrial Strategy (BEIS)

major change in China's need for nuclear development despite the accident. On

requested a generic design assessment of Hualong-1 (UK code UK-HPR1000) on January 10. Looking back, Japan first introduced nuclear design technology from Europe and the US before setting domestic standards from the 1980s, eventually achieving a technological level recognized by Europe and the US. Twenty years on, China is following the same path. While the rise of China may be a worry, would it be proper for the existing nuclear powerhouses to intervene politically to thwart China in

standardizing and exporting its reactors? The developments must be closely monitored as part of this historic change.

ARGONNE HOSTS 15TH ANNUAL INTRODUCE A GIRL TO ENGINEERING DAY

美國阿岡國家實驗室主辦的「科學工程女孩日」已邁入第十五年

Eighth grade girls learned about the exciting possibilities in science and engineering at the annual Introduce a Girl to Engineering Day Thursday, Feb. 23, 2017, at the U.S. Department of Energy's Argonne National Laboratory.

"We were very excited to host this event and inspire young girls to become the next generation of scientists and engineers, " said Lydia Finney, a physicist at Argonne and the Women in Science and Technology program initiator.

The day-long event was an entertaining and interactive way to introduce girls to science and engineering pursuits. Over one hundred young girls from the Chicagoland area heard from leaders at Argonne, met with a mentor, toured the laboratory's one-of-a-kind research facilities,

joined seminars led by female Argonne employees and watched demonstrations of 11 experiments by Argonne scientists and engineers.

“The girls enjoyed our hands-on experiments from different areas across the laboratory – from predicting the weather to demonstrating cryogenics used at the Argonne Tandem Linac Accelerator System, or ATLAS,” said Emily Zvolanek, a GIS analyst in Argonne’s Environmental Science Division and six-time coordinator of the annual event.

The activities culminated in a team car-design challenge that allowed the girls to test their problem-solving skills as they prepared to race model vehicles.

The event is one of two annual day-long sessions geared toward inspiring young women to pursue science and technology and is one of dozens of educational programs hosted by Argonne each year.

Sponsorship for the event is provided by the Argonne Education Outreach Council along with Argonne's Division of Educational Programs and Women in Science and Technology program.

Argonne National Laboratory seeks solutions to pressing national problems in science and technology. The nation's first national laboratory, Argonne conducts leading-edge basic and applied scientific research in virtually every scientific discipline. Argonne researchers work closely with researchers from hundreds of companies, universities, and federal, state and municipal agencies to help them solve their specific problems, advance America's scientific leadership and prepare the nation for a better future. With employees from more than 60 nations, Argonne is managed by UChicago Argonne, LLC for the U.S. Department of Energy's Office of Science.

The U.S. Department of Energy's Office of Science is the single largest supporter of basic research in the physical sciences in the United States and is working to address some of the most pressing challenges of our time. For more information, visit the Office of Science website.

PROSPECTS FOR FUTURE OIL/ENERGY SITUATION: 26TH INTERNATIONAL PANEL DISCUSSION

石油/能源的未來展望：第 26 屆國際研討會

On February 9, the 26th International Panel Discussion took place at Nikkei Hall on the future oil/energy situation, cosponsored by JX Nippon Oil & Energy Corporation, JX Nippon Research Institute, Ltd. and the Institute of Energy Economics, Japan. The panelists at the meeting

were FACTS Global Energy Group Chairman Fereidun Fesharaki, Sierra Oil & Gas Chief Executive Officer Ivan Sandrea and Nikkei Shimbun columnist Yuzo Waki. I served as moderator. In the 26th international panel discussion on the matter, the panelists discussed a short-term and medium to long-term international oil market outlook and natural gas problems including the Asian LNG market under a new situation including the international oil market after a coordinated oil production cut agreement between the Organization of the Petroleum Exporting Countries and non-OPEC oil producing countries and the inauguration of the U.S. Trump administration. In the following, I would like to summarize the points that were particularly impressive to me at the panel discussion.

First, the panelists and I broadly agreed that the present international oil market has remained in a boxed range and that crude oil prices are likely to move within a $50-60 or $50-55 per barrel range in the immediate future. This view is based on a new market reality brought about by OPEC's decision to cut oil production in late November 2016 and its later agreement with non-OPEC oil producing countries on a coordinated production cut. The bottom of the boxed range is supported by the effects of the production and supply adjustments and hopes placed on them, while the ceiling is capped by high-level oil inventories, a possible increase in U.S. shale oil production and speculations on the possibility. The panelists noted that the crude oil market would remain in relative stability because the present situation is likely to be unshakable at this moment.

As a matter of course, there are various factors that could change the stability. The coordinated oil production cut made a good start as OPEC achieved more than 80% of their production cut target in January. However, the percentage or the compliance of the agreed cut could fall to 70%, 60% or lower levels as indicated by past practices. Meanwhile, there is a potential possibility that an unexpected supply disruption could emerge to affect the oil supply-demand balance. Other important factors that should be watched carefully include the emergence of world economy risks, the impact of crude oil prices' recovery above $50/bbl on U.S. shale oil production, the effects of the Trump administration's shale oil production promotion policy (and expectations and speculations about the policy) as explained later.

As oil prices remaining above $100/bbl until the first half of 2014 had been unsustainable, prices well below $50 or lower levels would be unsustainable for oil producing countries' budgets and economies and investment to cover future demand growth, the panelists pointed out. If downward pressure arises on crude oil prices for some reasons, major oil producing countries such as Saudi Arabia may conduct verbal market intervention or actual intervention (maintaining or enhancing production adjustments) as necessary. Attention may be paid to what factors would affect the boxed range expected to remain in the immediate future and how the boxed range itself would change (whether the boxed range would rise in line with "rebalancing" in the oil market).

Second, the biggest matter of concern at the panel discussion was how the inauguration and policies of the Trump administration would influence energy markets, as I had expected. Criticisms against and judicial decisions on U.S. President Donald Trump's executive order to temporarily entry ban from seven Middle Eastern and African countries have attracted global attention. At a time when the world is shaken by the moves of the Trump administration, how the new U.S. administration's energy and environmental policies could change the international energy situation is the biggest matter of concern to energy market stakeholders.

At the panel discussion, the panelists discussed the matter from a wide range of viewpoints. Regarding the first point of effects on crude oil prices, the discussion indicated that downside and upside factors for oil prices are mixed. Cited as an important downside factor for crude oil prices was President Trump's shale oil development promotion policy. This policy includes the removal or ease of regulation for shale resources development, the development of relevant infrastructure and the opening of federal land to development. Some of these measures have been put into practice or specified in executive orders. The policy will undoubtedly help expand U.S. oil supply, although how production and supply would increase and how fast the policy's effects would arise may have to be considered. Meanwhile, President Trump's protectionist trade policy could exert negative impacts on the world economy, trade and investment to affect global economic growth, working to decelerate oil demand growth, although the Dow Jones industrial average on the New York Stock Exchange has topped 20,000 in the so-called Trump Rally. The two factors will loosen the supply-demand balance, exerting downward pressure on oil prices.

Cited as the first upside factor for oil prices was growth in geopolitical risks in the Middle East under the new U.S. administration's Iran and Middle East policy. The administration is well expected to take a tougher policy against Iran. Tehran's possible reactions to such policy, its effects on Iran's domestic situation, growing U.S.-Iran tensions and rising regional tensions will be potential upside factors for oil prices as far as other conditions remain unchanged. The Middle Eastern situation could be complicated further, depending on how the U.S. administration would engage with Middle Eastern problems and whether the administration would take a unilateralist or interventionist approach. From financial viewpoints, the panelists noted that commodity investment could expand if the Trump administration's economic policy expands budget deficits to accelerate inflation and that the Trump administration's financial deregulation could encourage market players to expand leveraged investment to influence oil prices. In this way, the Trump administration's policies will influence international energy markets and crude oil prices through various paths. While this report focuses on Trump policies' influences on crude oil prices, these policies are expected to influence natural gas, coal, renewable and nuclear energy markets and global warming. Analyzing the impacts of

Trump policies will remain significant for how to view the future energy situation.

The panel discussion also provided interesting arguments on improving oil-refining margins in Asia and the world, their favorable effects on downstream sector earnings and the significance of business strategies based on such change, as well as what LNG strategies would be required for Japan, Asia and individual companies to procure LNG more flexibly and competitively at a time when the Asian LNG market is expected to remain a buyer's market. Thus the panel discussion gave me an invaluable opportunity for the author, not only as a moderator of the discussion, but also as a researcher.

NEW STUDY OF FERROELECTRICS OFFERS ROADMAP TO MULTIVALUED LOGIC FOR NEUROMORPHIC COMPUTING

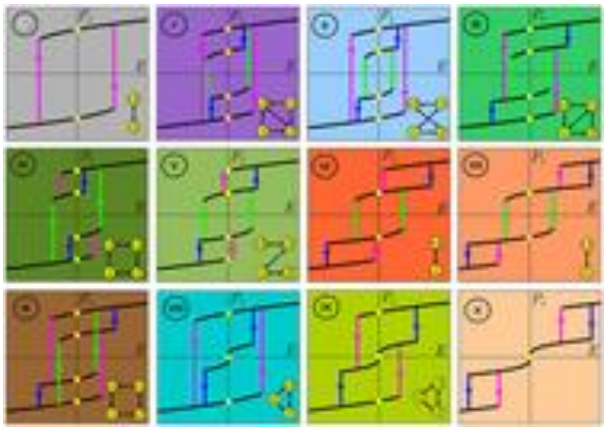
鐵電性材料研究新進展——多值邏輯作為神經型態工程學之路標

Research published Wednesday in *Nature Scientific Reports* lays out a theoretical map to use ferroelectric material to process information using multivalued logic – a leap beyond the simple ones and zeroes that make up our current computing systems that could let us process information much more efficiently.

The language of computers is written in just two symbols – ones and zeroes, meaning yes or no. But a world of richer possibilities awaits us if we could expand to three or more values, so that the same physical switch could encode much more information.

"Most importantly, this novel logic unit will enable information processing using not only "yes" and "no", but also "either yes or no" or "maybe" operations," said Valerii Vinokur, a materials scientist and Distinguished Fellow at the U.S. Department of Energy's Argonne National Laboratory and the corresponding author on the paper, along with Laurent Baudry with the Lille University of Science and Technology and Igor Lukyanchuk with the University of Picardie Jules Verne.

This is the way our brains operate, and they're something on the order of a million times more efficient than the best computers we've ever managed to build – while consuming orders of magnitude less energy.



"Our brains process so much more information, but if our synapses were built like our current

computers are, the brain would not just boil but evaporate from the energy they use," Vinokur said.

While the advantages of this type of computing, called multivalued logic, have long been known, the problem is that we haven't discovered a material system that could implement it. Right now, transistors can only operate as "on" or "off," so this new system would have to find a new way to consistently maintain more states – as well as be easy to read and write and, ideally, to work at room temperature.

Hence Vinokur and the team's interest in ferroelectrics, a class of materials whose polarization can be controlled with electric fields. As ferroelectrics physically change shape when the polarization changes, they're very useful in sensors and other devices, such as medical ultrasound machines. Scientists are very interested in tapping these properties for computer memory and other applications; but the theory behind their behavior is very much still emerging.

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The new paper lays out a recipe by which we could tap the properties of very thin films of a particular class of ferroelectric material called perovskites.

According to the calculations, perovskite films could hold two, three, or even four polarization positions that are energetically stable – "so they could 'click' into place, and thus provide a stable platform for encoding information," Vinokur said.

The team calculated these stable configurations and how to manipulate the polarization to move it between stable positions using electric fields, Vinokur said.

"When we realize this in a device, it will enormously increase the efficiency of memory units and processors," Vinokur said. "This offers a significant step towards realization of so-called neuromorphic computing, which strives to model the human brain."

Vinokur said the team is working with experimentalists to apply the principles to create a working system.

The study, titled "Ferroelectric symmetry-protected multibit memory cell," was published February 8. Research was supported by the U.S. Department of Energy Office of Science (Materials Science and Engineering Division) and the European Commission.