# 對外合作組織與機構動態報導

2018/3/8

## ALL THE RIGHT MOVES

## 所有高明棋步—氫氣運輸的佈局

By Steve Koppes • February 28, 2018

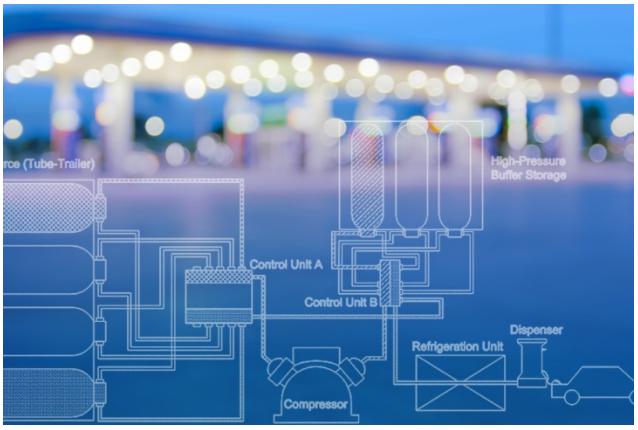
Transporting hydrogen from its production site to a refueling station and ultimately into the tank of a consumer's fuel cell electric vehicle (FCEV) is something of a chess game. FCEV chess masters must consider the various costs of an array of technologies and delivery systems that are available to serve growing market demands.

Hydrogen suppliers now can license a patented refueling method developed at the U.S. Department of Energy's (DOE) Argonne National Laboratory as part of a calculated strategy to cost-effectively move hydrogen across the

### 報告摘要(KEY INFORMATION)

1. 氫氣的運送，從其製造地點運送至補給站、最終送至消費者的燃料電池汽車，某種層面上如同是一盤棋局。執棋者必須思考一系列技術與運輸系統的成本，能否符合一個正蓬勃發展的市場之需求。阿岡實驗室提出讓車主能快速加氣同時降低補給站成本的策略。
2. 立陶宛與波蘭已宣布未來將逐漸減低對俄國的依賴，尤其是天然氣的部分，並在去年，已開始從美國進口液化天然氣。另外，歐盟委員會去年底提出天然氣命令的修正案，有關能源法規適用在連接至歐盟及第三方的氣體管線，未來修正與施行仍值得關注。
3. 2017 年，中國在朝向永續開發與打造低碳社會的目標上投入心力，除了持續轉型汽油車為電力驅動次世代車輛（新能源車），也同步將碳燃料火力發電廠轉型為新能源來源。預估今後此二領域仍將穩定發展。
4. 加州一直以來都為缺水所苦，雖然前一個冬天降雨不少，乾旱略有緩解，但森林大火以及開春遲來的雨季，都可能使情況惡化。面對此問題，一研究團隊從碳交易的概念發想，提出州政府可為的方案，讓公民也能同心協力達到省水目標。
5. 喚醒接收器既可節能，又能讓聯網設備互相通訊。史丹佛研究團隊推出喚醒接收器，不僅可減少智慧型手機休眠時電池的損耗，也具備多種應用潛力，如供智慧家電在無人操作時互相「溝通」的能力。

chessboard. Argonne used thermodynamic and flow dynamics computational tools to conduct early stage research simulating the performance of hydrogen fueling station components, which ultimately led to developing this strategy.




Last September, Argonne's Amgad Elgowainy and Krishna Reddi received $749,000 from the DOE's Office of Technology Transitions Commercialization Fund to help gain the technology early entry into the FCEV marketplace. Their partners in the project are FirstElement Fuel and PDC Machines, Inc.

**"We wanted to minimize the cost of refueling station components while allowing drivers to refuel quickly." — Amgad Elgowainy, team leader and energy systems analyst at Argonne.**

"One of the strategy's largest advantages is that it can significantly reduce the size of the compressor while meeting the increasing demand at the stations, and that's a significant cost reduction," said Erika Gupta, operations supervisor at DOE's Fuel Cell Technologies Office (FCTO) within the Office of Energy Efficiency and Renewable Energy, which funded the research. "Anything we can do to lower the initial capital cost of building the station helps us accelerate station deployment."

Hydrogen is one of the most abundant elements on Earth, yet only 6,000 motor vehicles worldwide harness this readily available molecule as a clean fuel source. All of the 31 retail refueling stations that dispense hydrogen in the United States are currently in California. An additional 12 are being deployed in the Northeast to support expected demand for FCEVs. Two of them have been commissioned to date in Connecticut and Rhode Island, where more are planned or are already under construction. As of December 2017, more than 3,500 FCEVs had been sold in California. The California Air Resources Board projects the number will increase to 13,400 by 2020, and to 37,400 by 2023.

"They are ramping up fast," said Amgad Elgowainy, team leader and principal energy systems analyst at Argonne. Nevertheless, the lack of refueling stations remains a barrier to wider use of these vehicles.

Compressors account for approximately half the total equipment cost of a hydrogen refueling station. But Elgowainy and Reddi, an Argonne systems modeling and analysis engineer, have shown how to double or triple refueling capacity by using existing equipment more efficiently.

Elgowainy and Reddi described their pressure consolidation refueling method, the only one of its type in the world, in the Dec. 3, 2014 issue of the *International Journal of Hydrogen Energy*, and in several presentations thereafter.

Argonne's method can especially benefit hydrogen refueling stations supplied by gaseous tube trailers, said Neha Rustagi, FCTO technology manager. "In any early and emerging market, we would expect gaseous tube trailers

to have a large role because they're often the lowest-cost approach to getting hydrogen to smaller stations," Rustagi said.

Fast fueling (about 3 minutes) of standard onboard vehicle storage tanks is expensive. Refueling station owners must invest a great deal in compression, refrigeration and high-pressure storage equipment.

"We wanted to minimize the cost of refueling station components while allowing drivers to refuel quickly," Elgowainy said.

During the consolidation process, hydrogen moves from one tube-trailer vessel into another, typically during low-demand periods, to prepare for the next peak-demand period. Compressor costs range from approximately $300,000 to $750,000 each, depending on their capacity. With Argonne's pressure consolidation refueling method, stations can double or triple their capacity with the less-expensive compressors. This means that the capital cost of a refueling station with the capacity to dispense 450 kilograms (992 pounds) of hydrogen daily drops from $1.1 million to $650,000.

The researchers based their technology on a comprehensive hydrogen-station, cost-optimization performance model that simulates how hydrogen refueling stations operate. The model tracks and calculates the fuel mass and its temperature and pressure at any point in the refueling process.

The model simulated the refueling station with an hourly fueling-demand profile based on data from more than 400 Chevron gasoline refueling stations. The results show that, for any given tube-trailer compression strategy, consolidation can reduce the total investment cost for refueling stations by 40 percent. The model was robust enough to replicate data generated and measured in ongoing experiments at the DOE's National Renewable Energy Laboratory in Golden, Colorado, Elgowainy said.

In the project's commercialization phase, PDC Machines, the leading manufacturer of compressors for refueling stations, will supply the compressor, which will implement Argonne's pressure consolidation strategy. FirstElement, the largest U.S. developer of refueling stations, will install the compressor at one of its stations to demonstrate that it works in a retail setting.

Potential collaborators interested in licensing Argonne's pressure consolidation refueling technology should contact Muni Biruduganti in Argonne's Technology Commercialization and Partnerships division.

Elgowainy and Reddi have also developed three publicly available desktop analysis tools to help managers make long-term research, development, leasing and purchasing decisions involving refueling advanced light- and heavy-duty transportation technologies and alternative fuels.

By making hydrogen refueling stations more economical, Elgowainy and his team hope to see their winning strategy move FCEVs deftly across the chessboard for deeper penetration into the transportation market.

# EU: EASTERN EUROPE'S EFFORTS TO REDUCE DEPENDENCE ON RUSSIA

## 歐洲觀察：東歐正減少對俄羅斯的依賴

Kei Shimogori

In January 2018, Prime Minister Abe visited the three Baltic States and some Eastern European countries, the first Japanese prime minister to do so. Lithuania, which was included in this trip, and Poland, which was not a destination this time but which held a foreign ministerial meeting with Japan last May, are particularly keen to reduce their dependence on Russia for energy resources. This report looks at the latest situation in the two countries and the EU.

In Lithuania, the energy minister approved the revised National Energy Independence Strategy last November. As the name implies, the diversification of energy sources is a top priority for Lithuania. The revised proposal pursues further integration of the country's energy market with that of continental Europe and synchronizing their power grids by 2025, and meeting the country's entire power demand with domestic electricity by 2050. The Strategy is due to be finalized following deliberations in the parliament.

In Poland, Finance Minister Morawiecki became Prime Minister in December last year. In his first speech after inauguration, the prime minister said that there will be no change in the current pro-coal policy, but a shift to nuclear, renewables and other low-carbon energies is being considered for the future, revealing his determination to achieve energy independence. The country's Energy Policy until 2030 and draft Energy Policy until 2050 put energy security as the top priority. The country's use of domestic coal resources and the construction of LNG terminals and expansion of LNG exports must continue to be monitored.

Both countries have set clear policies of reducing their dependence on Russian natural gas imports. As part of this effort, Poland and Lithuania imported their first cargoes of LNG from the US in July and August last year, respectively. The countries are also looking to use pipelines to diversify the sources of gas imports, and a pipeline connecting the two countries is due to be constructed. The pipeline will not be completed until the end of 2021 due to a route change in Poland for environmental assessment reasons, but will become the first pipeline to connect the three Baltic states to Europe. The EU has high hopes for the project.

As for the EU's moves in this regard, the European Commission proposed the revised EU Gas Directive in November 2017. The revised Directive clarifies that the core principles of the EU's energy

laws of third-party access, customs regulations, separation of ownership, and transparency shall apply to all pipelines connecting the EU with third countries up to land borders under the EU's authority. The revised Directive may be modified in the course of deliberations in the European Parliament and European Council due to differences between member states, but if it is adopted relatively unchanged as proposed, the European Commission may reinforce its monitoring activities and intervention to ensure that the above EU principles are fully applied to Russia-EU pipelines. The situation must continue to be monitored.

## CHINA: SWITCH TO NEVS AND RENEWABLE ENERGIES ACCELERATES

## 中國觀察：加速投向新能源汽車與可再生能源

By Li Zhidong

As part of its efforts toward sustainable development and building a low-carbon society, China is shifting from gasoline vehicles to electricity-driven next-generation vehicles (New Energy Vehicles (NEVs), which include EVs, PHEVs, and FCVs) and simultaneously from coal-fired thermal power to renewable power sources. In 2017, progress was made in both areas.

According to the annual report on the China automotive industry released by the China Association of Automobile Manufacturers (CAAM) on January 11, automobile production in 2017 was 29.02 million units, up 3.2% year-on-year, with sales of 28.88 million units, up 3%. While the overall market expansion was smaller than the initial estimate of 5%, the production of EVs and other NEVs increased by 53.8% to 790,000 units and sales grew by 53.3% to 780,000 units, exceeding the initial estimate of 700,000 units by 11%. The percentage of NEVs in the sales of all cars increased by 0.9 points to 2.7%. Behind the rapid growth of NEVs despite a 20% cut in purchase subsidies from last year was the restriction imposed on gasoline vehicles limiting the days they can be driven on the roads and the number of new number plates issued. More important, however, is the improved usability of NEVs, especially the rapid improvement of charging infrastructure (450,000 chargers as of 2017) and increase in cruising distance (300 km or more for major vehicles, catalogue performance-basis). Also significant was the government's decision in September last year to introduce the regulations and credit trading system for expanding NEVs (see the November 2017 edition of this Newsletter) despite opposition from domestic and foreign gasoline vehicle manufacturers. This is evidenced by the sales of NEVs in the three months from October to December of 380,000 units, accounting for

49.2% of annual sales and 4.4% of the sales of all vehicles during this period.

Meanwhile, according to the annual statistical report on the power industry released by the National Energy Administration on January 22 and the press conference on the 24th, in 2017, power generation capacity increased by 134 GW (7.6%) from the previous year to 1,779 GW. This includes 130 GW of solar PV, up 53.38 GW (68.7%), 164 GW of wind power, up 19.52 GW (10.5%), and 341 GW of hydropower, up 12.87 GW (2.7%), and renewable power sources together accounted for 36.6% of all power sources on a capacity basis, up 2.1 points, and 26.4% on an output basis, up 0.7% (of which wind and solar PV together account for 6.6%). On the other hand, nuclear power increased to 35.82 GW, up

2.18 GW (6.5%), but accounted for only 2.0% of all power sources on a capacity basis and 3.9% on an output basis. Coal-fired thermal power increased to 981 GW, up 38.55 GW (4.1%), but its percentage in capacity dropped 2.1 points to 55.2%. For China, decarbonizing the generation mix means reducing coal-fired thermal power, with solar PV and wind power acting as drivers.

The shift to NEVs and renewable power sources is likely to continue steadily. CAAM predicts that the production and sales of NEVs will surpass 1 million units in 2018. I forecast that they will be around

1.5 million units due to factors such as the policy effect of the regulations and credit trading system, last-minute demand before the reduction of subsidies planned for 2019, and greater convenience of NEVs owing to improvements in charging infrastructure and increase in cruising distance. Meanwhile, solar PV capacity is likely to expand at an annual pace of 50 GW through 2020.

## A TEAM OF RESEARCHERS PROPOSE A NEW APPROACH TO WATER CONSERVATION

### 保護水資源的新方法

By Sarah Derouin • February 13, 2018

California has struggled with drought for most of the last decade.

From 2011-2015, the state experienced the driest four-year stretch in recorded history, leading to unprecedented water restrictions for residents, including a state mandate to reduce water use by 25 percent.

Heavy precipitation last winter relieved much of California, but dry conditions linger. Wildfires raged during the fall and early winter months, ravaging towns and hillsides from Los Angeles to Santa Rosa. A delayed start to this year's rainy

season has made 44 percent of the state "abnormally dry," and fueled worries of a return to drought.

At the drought's height, water conservation was a hot topic, but conservation levels varied widely as California utilities worked independently towards their state-mandated goals. Now Stanford researchers are considering a different approach to water management, taking a page from energy and climate playbooks. Patricia Gonzales, a doctoral student at Stanford's Civil and Environmental Engineering Department and Newsha Ajami, director of Urban Water Policy at Stanford's Water in the West and NSF-ReNUWIt initiatives, have proposed a cap and trade approach to water conservation based on local supply and demand realities. Papers detailing their approach have been published in Water Resources Research and Wiley Interdisciplinary Reviews: Water.

**Supply and Demand**

Safe water for drinking and irrigation has grown increasingly scarce around the globe, and is expected to dwindle further as the climate changes. California's water system is no exception. In order to meet the state's future water needs, the researchers stress that understanding people's water-use behavior is key.

"People are a really big part of the water system, and they're also a really big source of uncertainty," says Gonzales, explaining that knowing more about how people use — and conserve — water and changing water supply and demand dynamics can result in better projections of demand going forward. Not always tied to population growth, demand can be impacted by socio-economic and demographic factors as well as shifting social norms. For example, wealthier communities with larger lot sizes may use more water than more populated and/or lower-income areas. Messaging about water scarcity can also help the public become more water conscious across socio-economic realities.

Water supply varies greatly year to year with snowpack, rain and other factors. Utilities are further constrained by where they get their water from. Some utilities rely on just one source for almost all of their water leaving little flexibility if it's compromised. For example, the San Francisco Regional Water System gets 85 percent of its water from the Tuolumne River alone, serving 27 different water utilities with a combined population of 2.4 million. The researchers argue this challenge is an opportunity for water managers and planners to embrace innovative strategies, including integrating more diverse water supply portfolios, and promoting a more collaborative governance approach to water management.

**Trading a Resource**

Looking at 26 communities in the Bay Area served by the San Francisco Regional Water System, the researchers explore how a system of tradable credits might allow utilities to meet their conservation goals more effectively. This market-based program approach has been used in energy, pollution emissions and water quality trading systems around the world. But until now, it has not been applied to water conservation efforts.

During a drought where the government mandates water conservation targets, each utility is tasked with figuring out how to meet those goals. However, some communities that haven't been as forward on water efficiency strategies over the years may be able to conserve water in low-cost ways with relatively small investments, while others would have to invest in bigger projects to meet the same goals.

"What if instead you gave the region a target, and then you allow utilities to figure out the best way to achieve that target collectively?" says Gonzales. She and Ajami are proposing that communities, like the San Francisco Bay Area, band together and collaborate to see the smartest and most beneficial way to meet the targets.

Ajami explains that if a community has already done 'low-hanging fruit', such as replacing toilets and showers with low-water versions, they have to move to more expensive options, like paying residents to replace lawns, which may or may not be enough to achieve their target.

Instead of this expensive option, the community would contribute to the overall conservation funding pool, essentially buying conservation credits from other areas.

"For example, they can either invest $1500/acre-feet to replace lawns, or they can use the trading platform to purchase conservation credits for a lower price, which can ultimately contribute to help another community replace their toilets," says Ajami.

"The basic idea of cap and trade is to incentivize people to do things that are cost effective for them, but also potentially invest in the community and system as a whole."

**Watering the Future**

The team is expanding the current platform, which they have labeled HydroTrade, to allow communities to not only share conservation credits but also develop and share other water supply sources in order to enhance regional resiliency.

"We did this proof-of-concept for conservation, but our ultimate goal is to enable water portfolio diversification and reduce reliance on a single supply source or imported water," says Gonzales. Supplementing water sources by adding alternative water — like recycling water or capturing storm water — can help bolster supplies. Gonzales says, "You can use this kind of collaborative approach, not only for drought or emergency conditions, but also in terms of long-term planning and adaptation."

By taking a closer look at efficiency and conservation trends and opportunities, as well as long-term water demand patterns at the regional scale, Ajami says utilities might be able to increase reliability and resiliency of their existing water supply despite population growth by smaller and smarter investments.

"Most of our current water infrastructure was built under a different climatic reality, and is now reaching the end of its design life. Hence it is losing its operational effectiveness. As communities are debating on how to meet their future water needs it is important to take a hard look at where our demand is going. We have an opportunity to add flexibility into our existing water infrastructure system by introducing innovative operational strategies while also promoting alternative, distributed and decentralized water sources, 21st century solutions for 21st century challenges," she says.

With more climate extremes expected in the future, freeing up water for users requires smarter thinking, says Ajami. "We need to encourage regional thinking and collaboration in order to meet our future water demand more effectively while avoiding unnecessary investment in large capital-intensive infrastructure, which belongs to the previous century and is not very adaptable to future climatic and social realities."

## A NEW ULTRASONIC TECHNOLOGY POWERS DEVICES WITHOUT HUMAN INTERVENTION

## 創新超音波科技能啟動設備

By Taylor Kubota • February 23, 2018

As smartphone users know all too well, a sleeping device can still suck the life out of a battery.

One solution for extending the battery life of wireless devices under development by researchers at Stanford University is to add a wake-up receiver that can turn on a shut-off device at a moment's notice.

Angad Rekhi, a graduate student in the Arbabian lab at Stanford, and Amin Arbabian, assistant professor of electrical engineering, have developed a wake-up receiver that turns on a device in response to incoming ultrasonic signals—signals outside the range that humans can hear. By working at a significantly smaller wavelength and switching from radio

waves to ultrasound, this receiver is much smaller than similar wake-up receivers that respond to radio signals, while operating at extremely low power and with extended range. The group is presenting the work at the International Solid-State Circuits Conference on Feb. 14.

This wake-up receiver has many potential applications, particularly in designing the next generation of networked devices, including so-called "smart" devices that can communicate directly with one another without human intervention.

**"As technology advances, people use it for applications that you could never have thought of. The internet and the cellphone are two great examples of that," said Rekhi.**

"I'm excited to see how people will use wake-up receivers to enable the next generation of the Internet of Things."

**The power tradeoff**

Once attached to a device, a wake-up receiver listens for a unique ultrasonic pattern that tells it when to turn the device on. It needs only a very small amount of power to maintain this constant listening, so it still saves energy overall while extending the battery life of the larger device. A well-designed wake-up receiver also allows the device to be turned on from a significant distance.

Arbabian said the designing these electronic devices posed a number of challenges. "Scaling down wake-up receivers in size and power consumption while maintaining or extending range is a fundamental challenge," he said. "But this challenge is worth pursuing, because solving this problem can enable scalable networks of wake-up receivers working in our everyday environment."

In order to miniaturize the wake-up receiver and drive down the amount of power it consumes, the researchers made use of the highly sensitive ultrasonic transducers provided by the Khuri-Yakub lab at Stanford, which convert analog sound input to electrical signals. With that technology, the researchers designed a system that can detect a wake-up signature with as little as 1 nanowatt of signal power, about 1 billionth the power it takes to light a single old-fashioned Christmas bulb.

Given the increased interest in networked devices, researchers and industry organizations are starting to define what features and techniques will become standard. Regardless of whether this ultrasound wake-up receiver is among these standard designs, it is likely wake-up receivers of some kind will be integrated into commercial applications soon, Rekhi said.

**Connecting the future**

This work branched off from a previous Arbabian lab creation, a tiny chip dubbed the "ant-sized radio" that can send and receive signals over radio waves without a battery. The ant-sized radio has the advantage of being wirelessly powered but needs to remain relatively close to

the transmitter with which it communicates. The group has since published a way of using ultrasound to extend the powering range of devices like the ant-sized radio, but that distance is still limiting.

By comparison, the ultrasound wake-up receiver requires a battery but has much greater range than the wirelessly powered devices, while still maintaining a long lifetime due to extremely low power draw. These two technologies—wireless power and wake-up receivers—would likely serve different purposes but both hint at a turning point in devices that make up the internet of things.

In light of a long-promised future where interconnected, autonomous, widespread, unobtrusive technologies make lives easier, the networked devices available now, like video doorbells and app-enabled lights, seem like rather subtle advances, the researchers said. They believe technologies like theirs could help span the gap between the internet of things as we know it and the internet of things at its best—whatever that may be.