ICS URGES INDUSTRY TO REJECT REGIONAL CARBON TRADING
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METAMATERIAL FILM TO COOL WITHOUT ENERGY
ICS urged EU Member States last week to reject the proposed regional CO₂ trading system stating its is “disappointed but not surprised” that the European Parliament vote proposing that international shipping (including non-EU flag ships) should be incorporated into the EU Emissions Trading System from 2023.

“This vote for a unilateral, regional measure simply risks polarising debate among IMO Member States which have already agreed to develop a strategy for reducing shipping’s CO₂ emissions in line with the goals of the Paris Agreement on Climate Chang,” said ICS Director of Policy & External Relations, Simon Bennett.

“The vote completely ignores the real progress that has already been made by IMO – which under the Kyoto Protocol, to which EU Member States are signatory, has a mandate to address CO₂ emissions from international shipping.”

IMO adopted technical regulations as long ago as 2011 which will ensure that all ships built in 8 years’ time will be at least 30% more CO₂ efficient than most of the fleet operating today, and the global shipping sector has already dramatically reduced its total CO₂ emissions despite an increase in global trade. (A 10% reduction over a 5 year period was recorded by the 2014 IMO Green House Study, which is the latest available data).

Bennett said: “EU Member States, which are also members of IMO, now have a duty to reject these unhelpful proposals, as they are taken forward as part of the wholesale attempt to reform the EU Emissions Trading System. Trying to include thousands of small shipping companies – including thousands of companies not based in the EU – into a system designed for major EU power generating companies and steel and cement producers is only going to complicate this reform.

“Reducing CO₂ from shipping is a global problem which can only be addressed successfully at global level by IMO.

“As we saw when the EU unsuccessfully tried to impose the ETS on international aviation, non-EU Governments are not going to take kindly to being told that ships flying their flag, when visiting EU ports, may have to pay money into EU schemes designed to help subsidise the closure of European coal mines.” Bennett observed.

ICS says it is working closely with the European Community Shipowners’ Associations (ECSA) in order to persuade EU Member States and the European Commission to reject these proposals, in view of their support for a global solution at IMO.
NCL NEW CRUISESHIPS TO BE BASED ON FINCANTIERI PROTOTYPE

Norwegian Cruise Line's four next generation cruisehips have been entrusted to Fincantieri, which will build the 140,000t leviathans for delivery between 2022 and 2025. An option is available for a fifth vessel with a 2027 delivery. The contract is worth about US$3.3 billion.

The 300m long, 3330 passenger-capacity ships, which will form the backbone of the future NCL fleet, are based on a prototype project developed by Fincantieri, which enhances the consolidated features of NCL’s signature offering of freedom and flexibility, qualified by an innovative configuration for an enhanced passenger experience. In addition, focus was set on energy efficiency, with the twofold aim of optimising consumption at sea and reducing environmental impact, compliant with all the most recent regulations on this matter.

“This new class of ships will continue Norwegian Cruise Line brand’s legacy of introducing meaningful innovation to the cruise industry,” said Frank Del Rio, President and CEO of Norwegian Cruise Line Holdings Ltd. “This order continues to highlight our disciplined newbuild programme, extends our growth trajectory well into the future, enhances our already attractive earnings profile and drives expected long-term returns for our shareholders”.

Commenting the announcement, Giuseppe Bono, CEO of Fincantieri, said: “This outstanding result allows us to include a new prestigious client in our portfolio, which confirms Fincantieri's ability to develop with a flexible approach leading-edge solutions for every segment and demand of the modern cruise industry. We are very proud of the project for these ships: we developed it internally and we presented it to the shipowner, which appreciated it so much to order an entire class.

“Different stakeholders of the export chain have contributed decisively to achieve this goal and they have gained our full recognition. The remarkable value of the order has to be added, obviously, on top of these factors: the Group will benefit from it under economic and workload terms and the order will further extend the utilization horizon of our shipyards, not comparable with any other industrial segment. We are also honoured to significantly support the growth of our country’s economy, which, as we all know, requires a considerable effort to regain its role in the world market”.

Norwegian Cruise Line Holdings is one of the top cruise companies in the world. Besides NCL, it operates the Regent Seven Seas Cruises brand, to which Fincantieri has delivered in Sestri Ponente (Genoa) the ultra-luxury ship Seven Seas Explorer in 2016 and is now building a sister ship with delivery expected in 2020 in Ancona, as well as Oceania Cruises, for which the group has built in Marina and Riviera, respectively in 2011 and 2012.
VARD TO BUILD FISHING VESSEL FOR AKER BIOMARINE
VARD has secured a contract for the design and construction of one krill fishing vessel for Aker BioMarine in Norway. The 130m vessel, a VARD 8 10 design, has been specially developed for sustainable fishing operations in Antarctica.

Webjørn Eikrem, EVP Production and Supply Chain in Aker BioMarine said: "The new krill vessel will be equipped with the latest and most advanced technology. All plans and specifications are developed in cooperation with fishermen from Aker BioMarine and engineers from VARD. The vessel's operations will be energy efficient, with a bio-refinery capable of processing raw krill material in the Antarctic."

Aker BioMarine is a biotech- and fishing company dedicated to securing human and planetary health. The company develops krill-based ingredients for use in nutraceuticals, aquaculture and animal feed. The company supplies biomarine ingredients through a 100% traceable supply chain that it also owns and controls. Aker BioMarine was the first krill company to be awarded Marine Stewardship Council (MSC) certification.

The new vessel is scheduled for delivery in Q4 2018. The hull of the vessel will be built by Vard Tulcea in Romania.

VOITH SCHNEIDER FOR FIVE MINUTE FERRY
Damen has secured an order from Belgium ferry operator VLOOT dab for a new ferry with Voith Schneider propulsion for the Ghent-Terneuzen canal

Even though the journey between the Belgium towns is little more than five minutes, twin Voith Schneider propellers (cycloidal drives) will be installed to give the 25m ferry the manoeuvrability required to navigate this difficult, busy waterway.

Power will be provided by twin diesel engines delivered via reduction gearboxes, and shaft generators will supply electrical power for onboard systems. An emergency generator rated at 14.5kVA will also be installed.

VLOOT dab is a government-owned vessel operator, supplying an operating forty five vessels for the public sector along the coast of Flushing, in the Scheldt area and on the Ghent-Terneuzen canal. The range of vessels is highly diverse, including tugs, work boats, patrol boats, hydrographic research vessels and a variety of ferries.

VLOOT dab and Damen have a record of working together in the past. Damen vessels in the fleet include a 2706 Stan Patrol, SPN-09, two multi-function Shoalbusters; the Zeeschelde and Zeetijger, and the Simon Stevin, a 36m research vessel.

The new ferry will be named Cyriel Buyssse and is scheduled for delivery in March 2018. The build will take place at Damen Shipyards Hardinxveld in cooperation with Damen Shipyards Gorinchem.
EXCELERATE SIGNS LOI FOR NEWBUILD FSRUS
Excelerate Energy has executed a Letter of Intent (LOI) with Daewoo Shipbuilding and Marine Engineering (DSME) for the delivery of up to seven floating storage and regasification units (FSRUs).

The initial specifications are for 173,400m$^3$ LNG FSRUs with a baseload send-out capacity of 1.0 Bcf/d, but can be modified to suit specific project needs. These vessels will incorporate Excelerate’s proven technologies and industry leading experience, and will represent the most capable and fuel efficient FSRUs in the industry.

Excelerate partnered with DSME on its existing fleet of FSRUs, including the industry's first regasification vessel Excelsior, which have proven to be to be versatile in diverse environments around the world. "Excelerate Energy is very pleased to continue its longstanding relationship with DSME in building the industry's leading FSRUs. These vessels have been proven in long-term service as safe, efficient and reliable components of our comprehensive suite of LNG import solutions," stated Excelerate Chief Executive Officer Rob Bryngelson. "We believe this is the right time to move forward with DSME as we continue to provide LNG import solutions in a timely and efficient manner around the world."

Excelerate has developed and commissioned ten floating LNG import facilities worldwide, with two currently in advanced stages of development in Bangladesh and Puerto Rico. Looking ahead, Excelerate has a significant project development portfolio for floating regasification, which will be supported by these additional vessels in combination with the company’s FSRU conversion strategy.

KEPPEL NAMES ITS FIRST FPSO OF 2017
Keppel Offshore & Marine’s Keppel Shipyard is has christened the Floating Production Storage and Offloading (FPSO) vessel it is building for Yinson Production (West Africa) John Agyekum Kufuor. The FPSO will be chartered by ENI Ghana Exploration & Production to process oil and gas from the Offshore Cape Three Points (OCTP) block located in Offshore Ghana.

Michael Chia, Managing Director, Marine & Technology, Keppel O&M, said: "Over the years, we have strengthened our relationship with our repeat customers, Yinson and ENI, and we are glad to be able to support them once again in providing FPSO solutions to the market. "We have a strong track record of customising FPSOs for a wide variety of fields. FPSO John Agyekum Kufuor is our 27th conversion project for Africa, and 125th overall."

FPSO John Agyekum Kufuor has a storage capacity of 1.7 million barrels, with an oil processing capacity of 58,000 barrels per day. It has a design life of 20 years without dry docking and can be moored in an average water depth of 1,000m with a total topside weight of almost 15,000t.

Lim Chern Yuan, Group CEO of Yinson, added: "There are opportunities in the FPSO market and we are glad to be able to meet those needs with our FPSO solutions. Our trust and confidence in Keppel extends back to 2014 when we worked together on FPSO Lam Son which has served us excellently since. We are therefore confident that FPSO John Agyekum Kufuor will be a valuable addition to ENI Ghana's exploration and production activities, strengthening their presence in Africa."

Keppel Shipyard’s work on the FPSO John Agyekum Kufuor included modification work, new equipment installation complete with associated piping, electrical and instrumental systems, as well as installation and integration of the FPSO process topsides.
SHIP DESIGN
CRYO’S CLEANER FUEL SOLUTION
Norway’s CRYO Shipping has developed a new type of tanker design that will enable ship owners to implement clean and cheap bunkers. By major conversion of offshore vessels into LNG tankers the new company aims to become the world’s largest LNG feeder and bunker operator.

CRYO Shipping, which specialises in regional short sea shipping of liquefied natural gas, will contribute to solve infrastructure challenges with its specially designed LNG tankers. Eventually the company will also look into transport and supply of renewable cryogenic fuel as liquefied biogas (LBG) and liquid hydrogen (LH2). The company aims to establish a fleet of flexible and efficient small-scale LNG tankers to be able to secure supply of LNG to consumers regardless of location. The ships will be able to perform both feeding and ship-to-ship (STS) bunkering operations in all types of waters and ports.

“We are working on a project to convert platform supply vessels into LNG tankers which should be in operation in 2018,” said Nicholai H. Olsen, Managing Director CRYO Shipping. “We have designed the LNG system by using known technology, but combined in a new way. We have also developed a design for newbuildings with a completely new and unique functionality that we aim to contract when our portfolio can meet the investment.”

By 2020 the number of LNG powered ships is expected to be about 1000, with further growth anticipated in the next decade. Today LNG logistics are predominantly done by road transport – giving costly logistics with high environmental – and socio-economical impact. The few small scale LNG tankers that exist today are not designed to meet regularity and supply requirements in a growing LNG market. Use of LNG storage bunkering facilities will result in congested traffic at storage facilities and harbours.

CRYO Shipping’s solution could provide both marine and land-based sectors more efficient operations. Another challenge that the company will be able to resolve is the current uncertainty associated with the cost structure of LNG. This is a critical issue to be resolved in order for the shipping industry to implement LNG in their operation, as concern has been raised about the structural conditions in the LNG industry such as lack of competition and monopoly formations – which has resulted in artificial high prices for LNG.

CRYO Shipping believes that as an independent player it can help create a more competitive playing field essential to the dynamics of the LNG market.

In addition to LNG as fuel CRYO will install battery technology to supply power to the vessels during loading, unloading and S-T-S bunkering.

“Based on preliminary market research, we have received very positive response in the market where LNG suppliers, wholesalers, manufacturers and consumers have shown interest,” said Nicholai H. Olsen. “We are working on specific customer projects that we expect will be announced soon.”
RULES & STANDARDS

SDC TO COMPLETE DRAFT RULES ON FRP IN SHIP STRUCTURES

The IMO Sub-Committee on Ship Design and Construction (SDC) met for its fourth session last week. Key discussion topics included the expected finalisation of draft explanatory notes to the SOLAS chapter II-1 subdivision and damage stability regulations and the completion of draft interim guidelines for use of fibre reinforced plastic elements within ship structures.

Also on the agenda was the further development of a draft new SOLAS chapter and related Code on the safe carriage of more than 12 industrial personnel on board vessels engaged on international voyages; work on evacuation analysis for passenger ships; and the ongoing development of second generation intact stability criteria. The Sub-Committee also looked at the development of draft guidelines on safe mooring arrangements, as well as on the selection, identification and use of mooring lines and on their inspection and/or maintenance.

CLASSNK RELEASES NEW PRIMESHIP-HULL

ClassNK has released the latest version of its design support software PrimeShip-HULL (HCSR), developed in response to the IACS Common Structural Rules for Bulk Carriers and Oil Tankers (CSR BC & OT). The new version incorporates the latest rule amendments to CSR BC & OT and in order to speed up design evaluation, shortens the calculation times in the prescriptive calculation software and offers a new function to preview reports in the direct strength assessment software, improving overall performance and usability.

The new version builds on the success of ClassNK’s existing software by enhancing a number of features. It incorporates the latest rule amendments to CSR BC & OT applicable to ships for which a construction contract has been made on or after 1 July 2017, and can now apply applicable design rules based on the date of contract input by the user.

In the prescriptive calculation software the calculation time has been reduced and the initial design function for quick sectional evaluation can now link with other sectional data in order to automatically extract longitudinal parameters, reducing the potential for inputting errors.

Moreover, the prescriptive calculation software now has enhanced data linkage functions with 3D-CAD software NAPA Steel. This enhanced function now makes it possible for 3D model data of NAPA Steel to be imported into the initial design function and members’ data modified in the full ship design function to be imported back to NAPA Steel, a feature which is expected to significantly reduce the man hours required for structural evaluations in NAPA Steel.

The direct strength assessment software now includes a detailed setting for outputting images when creating reports, in addition to extra display options and a preview function. The software can also recalculate the required thickness of structures based on modified parameters of the buckling panel in order to generate a reinforcement plan for stiffener buckling.

With the addition of these new and improved features, users can benefit from further reductions in evaluation time and greater support in the design of safer ships compliant with CSR BC & OT.

NEW STANDARD FOR RELIABLE DP CAPABILITY

DNV GL presented its new standard for assessing the station keeping capability of DP (dynamic positioning) vessels at the European Dynamic Positioning Conference in London yesterday.

The ability to assess and compare the position-keeping capability of a ship equipped with dynamic positioning technology is vital during the planning and design phases, and provides valuable operational decision support. The DNVGL-ST-0111 standard is the first to provide a unified approach to these assessments, ensuring verifiable results and increasing transparency in the market.

“In the past few years many in the industry had been calling for a new standard that could account for advances in technology and provide reliable data to support owners, operators and other stakeholders in selecting, assessing and benchmarking vessels. This prompted us at DNV GL to take action. We worked very closely with just under 20 industry stakeholders from Norway, the Netherlands and the United Kingdom in developing DNVGL-ST-0111, resulting in a standard that truly represents industry-wide best practices,” said Aleks Karlsen, Senior Principal Specialist DP Systems Control Systems at DNV GL – Maritime, in his presentation at the European Dynamic Positioning Conference.
“One of the greatest challenges in this field is to be able to compare the DP capability of different vessels. In order to do this, we have developed the Level 1 in the standard, which sets strict requirements for the calculation methodology, enabling consistent vessel comparisons. The other challenges in our industry are the needs for vessel- and operation-specific DP capability assessments and methods that are able to provide DP capability results in realistic dynamic conditions,” added Luca Pivano, Principal Specialist DP Simulations, Marine Cybernetics Advisory at DNV GL – Maritime.

To cover this, DNV GL has also developed two additional levels in the new standard, providing full flexibility for the stakeholders to choose from based on their needs.

The DNVGL-ST-0111 standard defines clear and consistent requirements for DP station-keeping capability assessments, the calculation method documentation and the presentation and verifiability of the results. Addressing both the intact vessel condition and the worst-case single failure conditions, it also corresponds to the vessel’s dynamic positioning class notation. The standard defines three different DP capability levels, each requiring a specific assessment method. The calculations use the Beaufort wind scale as well as significant wave height, wave period and current speed data as input.

DP capability plots are generated for each level, and the results of the assessment are expressed with a DP capability number in the format of DP Capability-LX (A, B, C, D), where X is 1, 2 or 3 corresponding to the analysis level. The standard also defines two additional DP capability assessment levels, allowing for the inclusion of site-specific environmental data and external forces (Level 2-Site and Level 3-Site).

In support of the new standard, DNV GL has also developed a web application, which helps users calculate DP capability numbers for Level 1 and is available free of charge on the DNV GL customer portal “My DNV GL”. It assists users with entering all the required information and feeds back a visual representation as well as a report of the Level 1 numbers in near-real time. Users may then request DNV GL approval of the results through the online tool.

In addition, DNV GL’s Marine Cybernetics Advisory team also provides services and a web tool based on cloud computing to assess a vessel’s DP capability according to Level 2, Level 3 and their site versions.

SERVICE & MAINTENANCE

WÄRTSILÄ TO MAXIMISE AVAILABILITY OF PGS’S SEISMIC VESSEL FLEET

Wärtsilä and PGS Geophysical have signed a service agreement that makes Wärtsilä the preferred service supplier for engines and other Wärtsilä equipment. According to the agreement, Wärtsilä will take care of the maintenance of engines and propulsion systems on board PGS’s fleet of eight seismic vessels, securing maximum uptime as well as safe and economic operations.

The three-year agreement was signed in December 2016 and it includes an option for two extra years. In the first phase of the contract Wärtsilä will optimise the operations and maintenance of the Wärtsilä engines and propulsion systems. This allows PGS to optimise its operational costs over the lifecycle of the vessels.

Four of the vessels are also connected to Wärtsilä’s Condition Based Maintenance solution (CBM). The CBM balances safe operations with optimum engine performance and extended times between overhauls. Automatic transfer of data from the installations to the CBM centre enables online monitoring and troubleshooting of the engines on board. Wärtsilä analyses the data and provides advice on the optimisation of operating parameters as well as preventive maintenance recommendations.

In the second phase of the contract Wärtsilä and PGS will identify how PGS can utilise Wärtsilä’s digital solutions to further secure maritime uptime and minimise risk and costs.
“We are very proud to announce this new cooperation that makes Wärtsilä the preferred partner for PGS. Ensuring the availability and reliability of a large, globally operating fleet requires a wide service network, which we are able to offer. With Wärtsilä’s advisory service and support, PGS is able to concentrate on what they specialize in – offering seismic services for their customers,” said Hans Petter Nesse, Director, Service Unit Norway, Wärtsilä Services.

PGS operates globally from the company headquarters in Oslo, Norway. The company provides 3D images of the subsurface that oil companies use to find oil and gas reserves. The company provides a broad range of seismic, electromagnetic and reservoir services, including acquisition, imaging, interpretation and field evaluation.

“Marine geophysics is a highly specialised and technology-driven area, and the reliability and safety of our fleet is essential, as it ensures that we can deliver these services, as promised, to our customers. We are confident that we in turn can rely on the maritime solutions and expertise of Wärtsilä. We are looking forward to the coming years of fruitful cooperation,” said Håkon Matheson, Global Sourcing Manager PGS Geophysical.

**DECK EQUIPMENT**

**WALK-TO-WORK SYSTEM INSTALLED ON OLYMPIC ORION MPSV**

Olympic Shipping has chosen Kongsberg Maritime’s new K-Walk integrated vessel gangway solution for installation aboard the Multipurpose Offshore Vessel (MPSV), Olympic Orion.

Designed to significantly increase efficiency and safety for Walk-to-Work duties, K-Walk will be integrated with the advanced Kongsberg Information Management System (K-IMS) and the existing K-Pos Dynamic Positioning system onboard Olympic Orion, which will be upgraded as part of the installation in the latter half of 2017.

Olympic Orion will utilise the innovative K-Walk solution following its launch as part of Kongsberg’s new Integration Strategy. The system takes a new approach to increasing productivity and efficiency for Walk-to-Work vessels by improving operability of key systems on board. In addition to full integration with K-IMS to enable mission and route planning for increased service capability within a wind farm, the system interconnects with the DP and a planning station. The system extends vessel availability by increasing the operational weather window.

Through integrated mission planning, automated vessel manoeuvring and gangway hook-up, K-Walk introduces a step-change for increasing efficiency and productivity of the Walk-to-Work operations that are integral to Wind Farm Construction and Maintenance projects.

While providing a completely safe, motion compensated gangway for the fast transfer of personnel and materials, integration enables more efficient approach and settlement at wind turbines and more effective logistics. The system is activated prior to entering a wind turbine’s safety zone, reducing vessel speed and launching the K-Walk hook up process during approach. Because of the integration with the DP, the gangway is able to move into position while the vessel is still moving, positioning it safely as the vessel arrives on station.
The integration of K-Walk with K-IMS is a unique approach that enables in-depth mission planning, resulting in increased productivity and efficiency by finding the most preferred route for increased service capability within the wind farm. The system will be fully connected with Olympic Orion’s DP system, offering increased operability with a new condition based operator environment, which requires less manpower and has minimal training requirements. The K-Walk solution for Olympic Orion will also improve time for mobility and safety with an integrated lift system for transfer of people and goods, including electric trolleys (under design) for movement of pallets across the gangway. Overall, K-Walk significantly enhances operational time efficiency, which improves productivity with the ability to serve more wind turbines within the same time frame.

“We are very satisfied to select Kongsberg Maritime’s new fully integrated Gangway solution for our MPSV Olympic Orion,” said Bjørn Kvalsund, COO, Olympic Subsea. “We also see a potential to install this integrated Gangway solution on board several of our existing vessels in order to provide W2W services into an expanding and interesting market segment.”

Stene Førsund, Executive Vice President, Global Sales and Marketing, Kongsberg Maritime, added: “Olympic Orion embodies the future that we envisioned with the launch of our Integration Strategy last year and we are delighted to work with Olympic Shipping for our cutting-edge new K-Walk solution. K-Walk provides Olympic Orion with total oversight of route planning and gangway hook-up operations. It enables better real-time and long-term management decisions, and empowers safer, more predictable, and efficient operations through reduced human interaction and automation based on the deep integration of critical systems on board.”

NOISE & VIBRATION
SIKA AND DELTA TO TACKLE STRUCTURE BORNE NOISE

SikaFloor Marine, the marine division of Sika, the marine acoustics technology and solutions company, is collaborating with acoustics specialist, Denmark’s DELTA Acoustics to tackle the issue of quantifying the reduction of structure borne noise by measuring the damping properties of their flooring solutions for commercial vessels.

“The practice for producing measurable values for airborne and impact noise reduction on ships is well established and the performance of these various systems can be quantified, however, there is currently no ISO standard for measuring structure borne sound and damping properties for marine floors and bulkheads,” said SikaFloor Marine’s Tony Jenkins. “Working with DELTA, we are now able to measure this reduction of magnitude and provide this information to the acoustic experts involved in the design of vessels.”

DELTA Acoustics’ Leif Ødegaard said: “We have a long tradition of working with various transport modes to help reduce noise and vibration. Marine vessels are inherently designed to be stiff structures but they also need to be lightweight. This means that noise sources such as propulsion systems and generators act as sources of vibrational energy that can manifest throughout the vessel as structure-borne noise. Our acousticians are able to measure structure borne noise on ships by using a specially built tool to calculate vibrations. The impact of the vibrations is then assessed from different types of sources. We are also able to produce audio files that
accurately reflect how a future source of noise will sound in a given landscape. This helps companies like Sika when developing its flooring solutions and advising the best products to use to combat noise in a specific area of a ship.”

SikaFloor Marine produce an extensive range of flooring systems, from thin lightweight systems, to heavy duty for the most demanding environments that are class leading in airborne, impact and structure-borne noise loss. All SikaFloor Marine systems are A60 rated, fully IMO approved and all the systems are tested to the US ASTM standards and recognised by the Japanese maritime standards.

**BALLAST WATER**

**HAI CHEUNG TO BUILD SEACURE UNDER LICENCE**

Evoqua Water Technologies’ has expanded its global partnership network by joining forces with Hai Cheung, a leading marine equipment supplier to the Chinese market, to build its SeaCURE BWMS under licence.

Hai Cheung will initially support Chinese shipyards with the supply and service of Evoqua’s SeaCURE BWMS. But in a second phase of the agreement, the Hong Kong-based engineering company will then produce the SeaCURE system under licence to facilitate demand from Chinese yards.

Following the ratification of the IMO Convention, the demand for a complete ballast water treatment solution, including design, installation and aftermarket support will grow. An expansive international network of organizations, sharing knowledge and expertise, is the best way to meet this market demand.

Gus Hou, Hai Cheung’s manager for the marine equipment business, said: “We are delighted to have formed this relationship with Evoqua. By combining the knowledge of our two organizations we will provide a robust and bespoke service to all our customers in the area.

“Over the next three years, we want to grow the business in China and become the first choice for electrochlorination equipment in this market.”

Lars Nupnau, Evoqua’s Director for Global Business Development, added: “By expanding our partnership network to China we have ensured that shipowners across the globe can enjoy consistent levels of expertise and support under the Evoqua name.”

Evoqua’s SeaCURE system is an electrochlorination Ballast Water Management solution that has been developed to meet the IMO and USCG regulations, in all three salinities.

The system is based around three main pillars of filtration, electrochlorination and proprietary ORP-control logic. Utilising the trusted Chloropac electrolyser, the system produces hypochlorite through the electrochlorination process to provide effective ballast water management.

The in situ generation from natural seawater avoids purchasing and handling of bulk chemicals, thereby reducing operating costs and removing safety risks.

**USCG TYPE APPROVAL TRIGGERS ALFA LAVAL PUREBALLAST RETROFIT ORDER**

As a direct consequence of its type approval by the U.S. Coast Guard (USCG), Alfa Laval PureBallast 3.1 has been selected for ballast water treatment on vessels owned by STAMCO Ship Management. The agreement is expected to generate orders worth around €2.2 million to be booked during Q1 2017. Under the agreement, PureBallast 3.1 systems will be retrofitted on 11 RoRo vessels in the STAMCO Ship Management fleet.

“This order is directly tied to the USCG type approval of PureBallast,” said Anders Lindmark, Head of Alfa Laval PureBallast, Alfa Laval Marine Division.

“Since the type approval was announced, Alfa Laval has seen a clear increase in the number of inquiries about the system.”

The USCG Type Approval Certificate for the PureBallast 3 family was issued on 23 December 2016, making Alfa Laval one of the first suppliers with a USCG-approved system. With the IMO Ballast Water Management (BWM) Convention entering into force in September 2017, the issue of supplier capability has become urgent in other areas as well.

“The high interest in PureBallast is a clear sign that the retrofit market is opening up,” Lindmark said. “Alfa Laval is well prepared, not only with type approved systems, but also with a decade of experience and a worldwide organization ready to deliver.”
Optimarin has signed a new agreement with Fincantieri Bay Shipbuilding (FBS) in Sturgeon Bay, Wisconsin for the delivery of two 500m³/h capacity Optimarin Ballast Systems (OBS).

The agreement will see both systems installed on a 155,000-barrel capacity clean products barge, with delivery scheduled for August 2018.

Optimarin CEO Tore Andersen said: "Repeat orders are one of the best endorsements any supplier can have. And when they come from a company of Fincantieri’s standing it really is a cause for celebration. They’re one of the premier specialised shipbuilders in the industry, with huge experience and a reputation to match.

“They choose our technology because it is market proven, simple, easy to install and maintain, and compliant with the most rigorous regulations in the world. It gives them, and their customers, complete peace of mind for safe, predictable and environmentally responsible operations. In a sector that is still relatively young, the reassurance that our 20-plus years of expertise gives yards, owners and operators can’t be overstated.”

Optimarin has been focused on developing BWT technology since its formation in 1994. Renowned as the company to install the first ever commercial system – on the Princess Regal in 2000 – it also became the first supplier to receive full USCG approval in December 2016.

"This was a massive step forwards for the business," Andersen explained. "We were already busy, but since that point enquiries have gone through the roof and our order pipeline is developing at a rate that has surprised even us. The industry knows that we are now leading the way in compliance, as well as expertise, and that, for any shipowner that wants the optimal flexibility for their global fleets, is of paramount importance.

"With USCG’s tough standards and IMO’s ratification of the Ballast Water Management (BWM) convention, BWT is an issue that no shipping company can afford to ignore. We’re here to help them find the best, safest and most compliant way forward for their vessels. That’s our only focus, and I think the industry appreciates that level of dedication and proven experience."

Optimarin has now received orders for around 500 OBS systems, with more than 300 installed worldwide. Over 100 of these have been retrofits, delivered in conjunction with global engineering partners Goltens and Zeppelin Power Systems.

Last year was the firm’s most successful ever, as, fuelled by its success with the USCG, it won contracts for over 120 BWT units.

“We expect 2017 to be even better,” Andersen added. “The order pipeline is strong, our technology and compliance credentials are second to none, and the industry has a genuine need. We expect to have more orders to announce in the very near future.”

Alongside approval from IMO and USCG, Optimarin’s technology is certified by a comprehensive range of classification organisations, including DNV GL, Lloyd’s, Bureau Veritas, MLIT Japan, and American Bureau of Shipping.

**FIRST ORDER FOR HITACHI TIER III SCRUBBER**

Hitachi Zosen Corporation has received an order from Dalian Marine Diesel for two high-pressure selective catalytic reduction (SCR) systems. The order represents the first commercial order for exhaust gas removal equipment compliant with Tier III nitrogen oxide (NOx) emission by one of Japan’s leading manufacturers of large marine diesel engines.

Due for delivery in October and November of 2017, the SCR systems will be installed in chemical tankers owned by a European shipping enterprise. Dalian Marine Diesel was contracted to manufacture the marine diesel engines by Chinese shipyard AVIC Dingheng Shipbuilding.

"Hitachi Zosen is the only commercial distributor officially approved by the world’s leading licensor of large low-speed marine diesel engines, MAN Diesel & Turbo SE (Germany). We aim to make our marine SCR system the de facto standard of equipment compliant with Tier III environmental regulations," said Jitsuhiro Yamaguchi, director of the Marine Machinery & SCR Systems Business Unit.

The Hitachi Zosen SCR system uses a catalyst to render harmless NOx contained in the exhaust of diesel engines during operation. The company offers high-pressure and low-pressure SCR systems for installation upstream and downstream of the turbocharger, respectively, for a flexible line-up to meet customer needs.
K-LINE'S CO₂ REDUCTION TARGET CERTIFIED AS “SCIENCE BASED”
K-Line's CO₂ reduction targets have been proven to be scientifically consistent with the levels agreed under the Paris Agreement, following certification from the Science Based Target Initiative (SBTi).

In March 2015, K-Line introduced its long-term environmental vision, K-LINE Environmental Vision 2050 “Securing Blue Seas for Tomorrow” and set an environmental target to reduce shipborne CO₂ emissions by half before 2050.

"We set the interim target to reduce CO₂ emissions by 10% for 2019 and successfully accomplished this ahead of the schedule the target, in 2015, setting a new interim target to reduce CO₂ emissions by 25% for 2030. At this time, this milestone has been certified with SBTi, said K-Line.

SBTi is a joint initiative established by CDP and other organisations in order to promote the achievement of science-based emission-reduction targets for greenhouse gases, and the existence of SBT is adopted as a part of evaluation item in CDP.

As of 13 Feb, 2017, 211 companies around the world have declared to implement SBT, of which 35 companies' targets have been certified by SBTi.

As a world-leading marine transport operator, "K" Line continues to aim at providing more environmentally-friendly and efficient transportation services for more people all over the world and is making every effort to improve its corporate value.

LNG
WORLD'S FIRST PURPOSE-BUILT LNG BUNKERING VESSEL DELIVERED
ENGIE, Fluxys, Mitsubishi Corporation, and NYK have taken delivery of the world's first purpose-built liquefied natural gas bunkering vessel (LBV) from Hanjin Heavy Industries Yeongdo shipyard in Busan, Korea. It will run on LNG for her maiden voyage, after a few days of loading LNG delivered by trucks at the shipyard.

Zeebrugge in Belgium will be the home port of the vessel, named ENGIE Zeebrugge. From there, the 5,000m³ LNG capacity LBV will supply LNG as a marine fuel to ships operating in Northern Europe. The two LNG-fuelled pure car and truck carriers (PCTC) operated by United European Car Carriers will be its first customers.

ENGIE Zeebrugge will load LNG at Fluxys' LNG terminal in Zeebrugge, where small carriers with capacities from 2000m³ can dock at the recently commissioned second jetty.
As international regulations on emissions for ships tighten, LNG is expected to become an important alternative fuel for the maritime industry. Currently, the bunker market amounts to approximately 250 million tons of heavy fuel oil per year. The challenge in making LNG grow in the bunker market is to develop sufficient supply infrastructure to support the increasing number of LNG-fuelled ships that are expected to come into operation. ENGIE Zeebrugge, in this respect, marks a milestone in the development of the European LNG bunkering chain. While LNG-fuelled ships up to now have been largely dependent on fixed bunker locations or the limited bunkering capacity of LNG trailers, ENGIE Zeebrugge, the first purpose built LNG bunkering vessel, has been designed to service a variety of LNG-fuelled ships.

Last September, ENGIE, Mitsubishi Corporation and NYK launched “Gas4Sea”, a brand name for marketing ship-to-ship LNG bunkering services worldwide, firstly via the ENGIE Zeebrugge in Northern Europe. Under the brand, the three partners intend to support the development of LNG as a marine fuel, thus contributing to an environmentally friendly maritime industry.

The requirements applicable to ships for controlling NOx, SOx and CO₂ emissions are getting stricter year by year. As from January 2015, regulatory emission limits for SOx have been reduced by the International Maritime Organisation (IMO) from 1.0% to 0.1% in the so-called Emission Control Areas (ECAs, which include the North Sea, the Baltic Sea area and areas around North America). More recently, according to a decision by IMO, emission limits for SOx will be reduced outside the ECAs from the current 3.5% to 0.5% as of January 2020.

Due to its favourable emission profile, the widespread adoption of LNG as a marine fuel is viewed as one way of curbing emissions of SOx and other harmful emissions in the shipping industry.

GTT TANKS FOR MARAN GAS FSRU
GTT has received an order from Daewoo Shipbuilding & Marine Engineering (DSME) to equip a floating storage and regasification unit (FSRU) with its NO96 cryogenic membrane containment system. The vessel will be built at DSME’s shipyard in Geoje, Korea, on behalf of Maran Gas Maritime, a Greek management company. This 173,400 m³ vessel will be the first FSRU to be added to the Maran Gas Maritime fleet. Delivery is scheduled for 2020.

“GTT is very pleased to continue its excellent partnership with DSME and Maran Gas Maritime. This new order demonstrates their high confidence in our NO96 technology, which fits LNG carriers as well as other LNG storage vessels such as FSUs, FSRUs, FLNGs,” said Philippe Berterottière, Chairman and CEO of GTT. The global FSRU market consists of 24 units currently in service. It is a very dynamic segment particularly well suited for new importing countries for which FSRUs constitute an economic alternative and a flexible solution.
NEW ISO STANDARD FOR LNG BUNKERING

The International Standards Organisation has introduced a new standard for LNG bunkering operations.

The new ISO 20519 standard is intended to help operators select vessel fuel providers that meet defined safety and fuel quality standards.

In recent years, the ships and vessels fuelled with LNG have become larger, transit greater distances and may bunker in a greater number of ports in different countries. As a result, the number of parties involved in LNG bunkering is growing rapidly. Standardising safety practices had become necessary to ensure that, no matter where the bunkering took place, there would be a common set of requirements that were understood across the board – from LNG provider to ship personnel said the organisation.

ISO 20519 contains requirements that are not covered by the IGC Code, including:

- Hardware: liquid and vapour transfer systems
- Operational procedures
- Requirement for the LNG provider to provide an LNG bunker delivery note
- Training and qualifications of personnel involved
- Requirements for LNG facilities to meet applicable ISO standards and local codes

“The requirements of ISO 20519 can be incorporated as a management objective into existing management programmes and provide verifiable compliance,” explained Steve O’Malley, Chair of technical committee ISO/TC 8, Ships and marine technology, subcommittee SC 11, Intermodal and short sea shipping, and Convener of TC 8 working group WG 8 that developed the standard.

This is important, he says, because “the requirement to comply with ISO standards is often incorporated into business contracts and may also be referenced by local regulations”.

The working group that developed ISO 20519 included specialists from the maritime industry, equipment manufacturers, the Society for Gas as a Marine Fuel (SGMF), trading companies, class societies, international registries and the US Coast Guard.

The use of LNG as a vessel fuel is relatively new, so the standard will need to be brought up to date periodically to incorporate lessons learned over time and technological changes. To facilitate this, a group has been created to track LNG bunkering incidents and help identify when the standard should be updated.

ECOSPEED FOR RRS SIR DAVID ATTENBOROUGH

Subsea Industries’ Ecospeed hull protection system has been selected for RRS Sir David Attenborough, the polar research ship under construction at the Cammell Laird shipyard in Birkenhead, Liverpool, UK.

The £150million contract to build the vessel, which Cammell Laird won against stiff international competition in 2015, represents the biggest commercial shipbuilding contract in Britain for 30 years. The ship has been commissioned by the National Environment Research Council (NERC) and will be operated by British Antarctic Survey (BAS).

The shipbuilder awarded a coatings contract to Subsea Industries, a pioneer in non-toxic hard-coatings, based on the unrivalled performance of its Ecospeed hull coating system on the Royal Research Ships Ernest Shackleton and James Clark Ross.

"Sir David Attenborough required a fully ice-strengthened coating for operations in Antarctica as well as providing effective antifouling between the Polar Regions, without being harmful to the environment,” said Rob White, Senior Marine Engineer at British Antarctic Survey. “Ecospeed fulfils that requirement.”
In six seasons operating RRS Ernest Shackleton with Ecospeed coating, BAS had to touch up Ecospeed only in areas of mechanical damage and carry out minor repairs around the bow, the most susceptible area to ice impact. Following the performance on Ernest Shackleton, the hard coating was applied in 2015 to the hull of sistership, RRS James Clark Ross. Results were again exemplary.

"After two seasons there was only minor hull growth, which was removed with a hull power wash," said White. "When operating in the Southern Ocean, there is very little biofouling and during the rest of the year any growth that does accumulate is easily dealt with. This ensures a clean efficient hull and reduces the transportation of invasive aquatic species across different regions."

As a government funded organisation, BAS had to find a coating solution for Sir David Attenborough that was effective, easy to maintain and could provide savings across its operating budget. A pre-requisite was an environmentally-sound hull coating that would reduce fuel consumption without detriment to performance in ice.

"Our docking schedules are alternate years so the coating had to be maintainable in-water as well as in drydock," White said. “With Ecospeed, there are no special docking requirements or specialist equipment, which means that any remedial work can be part of the vessel’s normal refit schedule. The coating’s simple application and maintenance procedures also help drive down the vessel’s through-life costs.”

Manuel Hof, Production Executive and NACE Coating Inspector, Subsea Industries, explained: “The coating is proven to reduce fuel consumption so the vessel is not burning as much fuel, thus reducing ship exhaust emissions and Sir David Attenborough’s carbon footprint. It also correlates directly to lower operational costs.”

Rob White went on to reveal that other hull coatings had been previously applied to both Ernest Shackleton and James Clark Ross, but these conventional coatings required additional anti-fouling treatments to prevent the build-up of hull growth.

"These coatings were expensive and did not last long in ice," he said. “But since using Ecospeed and following the recommended annual maintenance, the requirement for additional hull treatments has been removed. It also eliminates the pollution of polar waters with heavy metals and hull contamination during research activities, which is extremely important to the scientific work NERC and BAS carry out. The vessel’s presence cannot interfere with the local environment."

Indeed, the deposit of metallic elements and chemicals in the polar environments is addressed in the recently introduced IMO Polar Code, with Guideline G-23 stating that "no pollutants should be carried directly against the shell in hull areas at significant risk of ice impact”.

While this guideline does not specifically legislate against the use of traditional “soft” coatings for polar shipping, Rob White believes a tough, durable and long-lasting coating is required for hull plating...
integrity. “Ecospeed bonds very well to the bare steel on application and provides a tough effective barrier against the sea and ice,” he said.

“From the experience we have gained through using Ecospeed on Ernest Shackleton and James Clark Ross we were adamant that the hull coating for the newbuild should also be Ecospeed. Through-life costs, ease of maintenance and the environmental benefits help reduce operational costs and makes Sir David Attenborough a better research ship for polar science,” said White.

Subsea Industries Chairman Boud Van Rompay said: “We are delighted that Cammell Laird, BAS and NERC have once again selected Ecospeed for a new polar research vessel. The hard coating completely mitigates against the leaching of chemicals into the marine environment and this, along with other ‘green’ technologies will make Sir David Attenborough one of the most environmentally-safe ships afloat.”

The 15,000gt research vessel, scheduled for operational duties in 2019, will be one of the most advanced polar research vessels in the world. Two nine-cylinder and two six-cylinder Bergen B33:45 engines in diesel electric configuration will provide power to propulsion motors driving 4.5m diameter controllable pitch propellers. The 128m long vessel will be capable of 60 days at sea without re-supply, covering a range of 18,898 nautical miles at 13 knots.

**PRIME MOVERS**

**TROPICAL SHIPPING ORDERS COMPLETE MAN DIESEL & TURBO PACKAGE**

Tropical Shipping, a provider of logistics solutions to the Bahamas and Caribbean, has ordered a series of MAN propulsion packages for four 100TEU containerships under construction in China.

Each vessel will be equipped with an MAN B&W 6S60ME-C8.5 main engine, complete with TCA66-21 turbocharger and an SCR (Selective Catalytic Reduction) module to achieve Tier III compliance. The propulsion package also features three MAN 6L23/30 Holeby GenSets with MAN TCR14 turbochargers, as well as the latest generation of CP propellers, the VBS1550-5 Mk5, which is a five-bladed design combined with the MAN Alpha rudder-bulb concept.

Tropical Shipping has also ordered two 300TEU container vessels, each powered by 1 × MAN 27/38 engines, with TCR turbochargers. The new vessels are due to enter service from June 2018.

Bjarne Foldager, Vice President – Promotion & Sales, Two-Stroke Business –MAN Diesel & Turbo, said: “The marine market is currently very challenging but, in winning orders like this, we see some green shoots of recovery. Tropical Shipping has chosen to expand its fleet with proven technology from our portfolio and I am confident they will be served well by it.”

The 23/30 engine is one of MAN Diesel & Turbo’s most successful workhorses, and has a half-century history of operational stability with over 12,000 sales to date. The engine is popular with shipowners for its reliability and ‘forgiving’ service demands.

Applications for the engine include tankers, bulk carriers and product tankers as auxiliary engines. The engine is mostly HFO-driven with gas and marine oil also used in special environmental areas.

The 23/30 engine is optimised for part-load operation, typically at 40-65%, and features an MEP that is <20 bar. As a result, the engine experiences reduced operative stress – compared to its competitors – meaning a decreased demand for spare parts and significantly reduced running costs over its lifetime.
**PROPPELLERS**

**HHI DELIVERS ITS 5000TH SCREW**

Hyundai Heavy Industries’ Ulsan facility produced its 5,000th propeller last week. The 77t, 10.6m diameter propeller is scheduled for installation to a 300,000dwt VLCC under construction for Athens-based Thenamaris.

HHI has the largest slice of the global ship propeller cake, with the market share of 31%, as of 2015.

Since the production of its first propeller in 1985, HHI has achieved major production milestones with 100th propeller in 1987, 1,000th in 1999 and 2,000th in 2005. Since 2000, HHI has been producing 200 plus propellers annually. HHI also won Guinness World Record for the heaviest propeller in 2001 with a 102 ton propeller, then the heaviest one.

Moreover, HHI applied furan resin process to large propeller casting for the first time in the world in 2003. The process named 'Furan method' is a foundry technology used as a binding agent for casting enabling it to make propellers cheaper and faster.

HHI said: "With the goal of developing 25% lighter propellers by 2018, we are currently developing new type of propellers made of composite material. We will continue to make efforts to keep our standing in the global market with tireless technology development and quality improvement.”

**THRUSTERS**

**DAMEN TAKES ITS 1000 ROLLS-ROYCE THRUSTER**

Rolls-Royce has delivered its 1000th azimuth thruster to Damen in what marks a milestone achievement in a relationship that spans more than 30 years.

The 1000th and 1001st Rolls-Royce US 255 FP azimuth thrusters, each with a power of 2525 kW, will be installed to a new Damen ASD2913 tug, meeting customer demands for high bollard pull and cost efficiency.

Damen's first ASD tug design with Rolls-Royce US azimuth thrusters was delivered in 1993 but the relationship between Rolls-Royce and Damen goes much further back.

Ronald Lindeman, Rolls Royce, Marine Head of Sales, Central Europe West, said: "In 1983, before its acquisition by Rolls-Royce, Rauma-based Aquamaster supplied the first retractable thruster for installation to the anchor handling tug Damen Dragon Fly.

"In 2002 the ASD 2810 tug design was introduced and is today one of the world’s most popular tug designs. More than 420 Rolls-Royce azimuth thrusters have been delivered to this series.

"The milestone delivery of the 1000th and 1001st US units underscores our partnership with Damen, our biggest customer for this type of thruster.”

Aila Lainio, Rolls-Royce, Marine Area Sales Manager, who has twenty years’ experience at the Rauma thruster plant, said: “You can say that Damen has become part of our life now. Rauma has produced a wide range of azimuth thrusters for Damen’s various tug designs. The ASD design and the Rolls-Royce US-type azimuth thrusters make a unique combination.”

She added: “We have worked closely in cooperation with Damen over the years to develop the optimum azimuth thruster range for tugs. We have a very creative and talented team in Rauma. Whenever Damen presents new requirements, we accept the challenge of developing solutions that allow us to continue being Damen’s first choice for propulsion equipment. We continually invest in research and development to optimise...
thruster performance and environmental efficiency. Ultimately we endeavour to design the best propulsion solution for all of our customers.”

Lindeman added: “We are constantly developing our azimuth thrusters to reach the customers’ expectations. Rolls-Royce is investing £44 million in our production plant in Rauma to further strengthen our position as the leading supplier of azimuth thrusters. The work to transform the facility in Finland is underway and is due for completion in 2020.”

Damen’s 1000th and 1001st Rolls-Royce US-type thrusters were delivered at the end of the year for installation in Romania.

**RESEARCH**

**METAMATERIAL FILM TO COOL WITHOUT ENERGY**

A team of University of Colorado Boulder engineers has developed a scalable manufactured metamaterial — an engineered material with extraordinary properties not found in nature — to act as a kind of air conditioning system for structures. It has the ability to cool objects even under direct sunlight with zero energy and water consumption.

When applied to a surface, the metamaterial film cools the object underneath by efficiently reflecting incoming solar energy back into space while simultaneously allowing the surface to shed its own heat in the form of infrared thermal radiation.

The new material could provide an eco-friendly means of supplementary cooling for thermoelectric power plants, which currently require large amounts of water and electricity to maintain the operating temperatures of their machinery.

The researchers’ glass-polymer hybrid material measures just 50 micrometers thick and can be manufactured economically on rolls, making it a potentially viable large-scale technology for both residential and commercial applications.

“We feel that this low-cost manufacturing process will be transformative for real-world applications of this radiative cooling technology,” said Xiaobo Yin, co-director of the research and an assistant professor who holds dual appointments in CU Boulder’s Department of Mechanical Engineering and the Materials Science and Engineering Program. Yin received DARPA’s Young Faculty Award in 2015.

The material takes advantage of passive radiative cooling, the process by which objects naturally shed heat in the form of infrared radiation, without consuming energy. Thermal radiation provides some natural nighttime cooling and is used for residential cooling in some areas, but daytime cooling has historically been more of a challenge. For a structure exposed to sunlight, even a small amount of directly-absorbed solar energy is enough to negate passive radiation.

The challenge for the CU Boulder researchers, then, was to create a material that could provide a one-two punch: reflect any incoming solar rays back into the atmosphere while still providing a means of escape for infrared radiation. To solve this, the researchers embedded visibly-scattering but infrared-radiant glass microspheres into a polymer film. They then added a thin silver coating underneath in order to achieve maximum spectral reflectance.

“Both the glass-polymer metamaterial formation and the silver coating are manufactured at scale on roll-to-roll processes,” added Ronggui Yang, also a professor of mechanical engineering and a Fellow of the American Society of Mechanical Engineers.

“Just 10 to 20 square meters of this material on the rooftop could nicely cool down a single-family house in summer,” said Gang Tan, an associate professor in the University of Wyoming’s Department of Civil and Architectural Engineering and a co-author of the paper.

In addition to being useful for cooling of buildings and power plants, the material could also help improve the efficiency and lifetime of solar panels. In direct sunlight, panels can overheat to temperatures that hamper their ability to convert solar rays into electricity.

“Just by applying this material to the surface of a solar panel, we can cool the panel and recover an additional one to two percent of solar efficiency,” said Yin. “That makes a big difference at scale.”

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The engineers have applied for a patent for the technology and are working with CU Boulder’s Technology Transfer Office to explore potential commercial applications. They plan to create a 200-square-meter “cooling farm” prototype in Boulder in 2017.

The invention is the result of a $3 million grant awarded in 2015 to Yang, Yin and Tang by the Energy Department’s Advanced Research Projects Agency-Energy (ARPA-E).

“The key advantage of this technology is that it works 24/7 with no electricity or water usage,” said Yang “We’re excited about the opportunity to explore potential uses in the power industry, aerospace, agriculture and more.”

Co-authors of the new research (pictured above) include Yao Zhai, Yaoguang Ma and Dongliang Zhao of CU Boulder’s Department of Mechanical Engineering; Sabrina David of CU’s Materials Science and Engineering Program; and Runnan Lou of the Ann and H.J. Smead Department of Aerospace Engineering Sciences.