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RINA

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Energy Transition Compass: Where We Are

COP28 left us with many considerations. For the first time, following intense negotiations, representatives of nearly 200 countries approved a global pact that explicitly called for "transitioning away from fossil fuels", and doing so in a "just, orderly and equitable manner."

Beyond this significant deal, which was included in the final text, a variety of other commitments were made over the course of the two-week conference. Signatories also agreed to triple the deployment of renewable energy sources such as wind and solar power and double the rate of energy efficiency improvement by 2030.

Regarding other major commitments, an important one is related to methane emission: on the fourth day of the conference, a cohort of approximately 50 oil and gas producing countries and companies pledged to achieve near-zero methane emissions by 2030. Given methane's extreme potency (30 times the warming potential of carbon dioxide), the reduction of its emissions has been a key focus. Supporting this pledge, $1 billion in grant funding was announced from some of the highest emitting countries in the world.

Furthermore, COP28 highlighted that Nuclear and Carbon Capture are within the basket of solutions. Twenty-two nations joined the Net-Zero Nuclear Initiative, committing to triple nuclear energy capacity by 2050.

What comes next? Addressing the 45% of emissions that arise from how we produce and consume is imperative. Emissions from production processes, deforestation and land-use choices, landfill, incineration, open waste burning are not dependent on the energy source and are still critical to get us on a Paris-aligned trajectory. The circular economy systems transition is key to delivering these emissions reductions and in designing resilience into our economic system.

As the COP28 President said, an agreement is only as good as the implementation that follows. We need to urgently move forward on bringing circular economy solutions to market at scale in tandem with and as part of delivering the energy systems transition.

Globally, however, research demonstrates how far we are from the path toward energy transition.

According to the annual report monitoring the climate mitigation efforts of 63 countries plus the EU, once again this year the top three positions in the ranking have not been assigned, as none of the countries has achieved the necessary performance to contribute to addressing the climate emergency and containing the planet's warming within the critical threshold of 1.5°C. Italy, in particular, has dropped from 29th to 44th place in the list of countries committed to energy transition.

While western countries are pursuing a fair transition to solve the energy trilemma, many eastern countries are also looking for economic growth through the opportunities arising from the energy transition, for which the production of technologies and the processing of raw materials are essential.

The energy transition to achieve decarbonization is probably one of the toughest challenges ever addressed on a global scale: complexity is embedded in the challenge itself. The solution must be a dynamic one which is adjusted periodically and characterized by fair compromises in the short term, and far-sighted projects in medium and long term, and duly supported by a strong commitment by all the stakeholders.

RINA, with its experience in multiple sector markets across the globe, is committed to simplifying these complex problems for customers, offering companies achievable solutions.

RINA's unique set of competences and capabilities enables us to provide companies with a trusted technology-neutral partner. It is our pride to be an active player in the journey towards the achievement of net zero, supporting and accompanying customers and stakeholders in achieving their sustainability goals by facilitating the identification of new reliable solutions - and in doing so validating the technologies for decarbonization.

Through participation in research and development projects, we are contributing to constant innovation, advancing the performance and scalability of new concepts - and enabling a virtuous circle towards climate neutrality.

Many things are happening and, as we can see, the path of this transition is still lengthy. Yet we are heading in the right direction, thanks to a diverse array of contributions, perspectives, solutions. Here in RINA's goZERO magazine you can explore some of them. ■

Carlo Luzzatto
CEO, RINA

Technology readiness for achieving net zero emissions

Technological advancements are at the core of solving the energy trilemma: sustainability, security of energy supply and the availability of clean energy. By harnessing technology, we will be able to devise accessible, affordable solutions.

The energy transition is by no means a linear process, and an unprecedented transformation of the energy system is required to break the link between energy and emissions.

What is the most important action to take?

Firstly, availability of clean energy must be matched with demand. Even as the share of renewables in electricity production increases, renewable energy sources often remain intermittent: supply and demand are not always aligned.

Therefore, efficient energy storage, combined with effective distribution systems, are crucial to achieving a sustainable energy transition and reliably balancing supply and demand.

How can new and emerging energy technologies help balance the variability of renewable energy supply?

Various crucial measures must be implemented to address this challenge. Addressing intermittency requires thoughtful technological solutions.

One aspect to consider is storage solutions, which stand out as the most commonly cited response to balance intermittency.

Another pivotal option is the utilization of hydrogen, offering a solution beyond hydroelectric power and batteries to balance power systems over varying durations. Balancing offer and demand of renewable energy - especially in the case of geographical areas spread around the world - may also involve the conversion of renewable electricity into hydrogen, hydrogen derivates and ultimately into alternative fuels. However, further development is necessary in various field, including ammonia crackers, LOHC, biomass gasification, electrolysis, and offshore H2 production.

Smart grids for energy conveyance provide numerous benefits. They encompass digital solutions for supply and demand, extending beyond large-scale assets to include the demand side. Smart system versatility is crucial as smart grids can optimize the operational efficiency and utilization of transmission and grid infrastructure. Flexibility is their key feature, with networks capable of handling bidirectional energy flow. Network users can contribute energy to the grid (generated by rooftop photovoltaic panels, for example) and charge to and from batteries and fuel cells. Efficiency is supported by smart grid technologies that facilitate demand-side management, real-time adjustments in energy distribution lines and lower energy prices.

Furthermore, the trade of energy will also face major developments granted by technology progress: market-enabling communication between suppliers and consumers will be systematic and continuous, facilitating better decision-making in terms of pricing strategies on the supplier side and energy consumption on the consumer side.

While efficient storage capacity is designed and developed, and reliable and smart grids are adopted as a key enabler of renewable sources exploitation, to be on track in the journey towards net zero emissions, GHG must still be lowered through the deployment of carbon capture utilisation and storage technologies. CCUS can be used as an intermediate measure to collect the CO2 emissions generated, eventually applying the circular economy principle to the carbon dioxide which – at least – should not increase in volume at a global scale. Reutilization of CO2, indeed, encompasses its combination low carbon H2, producing alternative synthetic energy vectors which could facilitate the transition by exploiting existing infrastructures and energy end-users' technologies.

In this scenario, it is imperative also for carbon capture technologies to improve and advance in performance, reliability, and efficiency.

Harnessing technological innovation is the real game-changer for the energy transition and will play a leading role in solving the energy trilemma. ■

Andrea Bombardi
Carbon Reduction Excellence
Executive Vice President, RINA

BIO.

Melissa Verykios

Melissa Verykios is the Chair of the Board of Directors of the Clean Hydrogen Partnership, the EU-backed public-private partnership supporting research and innovation in hydrogen technologies in Europe.
She is also a Member of the Board of Hydrogen Europe, the European Association representing the interests of the hydrogen industry.
Melissa joined Metacon-Helbio in 2017. She is closely involved in the structuring of field pilot projects using hydrogen systems in a range of innovative applications, including telecoms, shipping, and the stationary production of hydrogen and ammonia.
Prior to joining the company, Melissa spent 10 years working in the finance industry in New York and London. She holds a Bachelor's Degree in Economics & Business from the University of Athens, Greece, and a MSc in Finance from the Barcelona School of Economics, Spain.

INTERVIEWS

Creating a viable hydrogen market

Interview with **Melissa Verykios**
Chair of the Board of Directors of the Clean Hydrogen Partnership and Member of the Board of Hydrogen Europe

The short-term outlook for the European energy sector, of a horizon of 1 to 5 years, cements a continued focus on reducing greenhouse gas emissions. We expect many European Union Member States and regions to implement policies and regulations aimed at accelerating the transition to low-carbon energy sources.

The deployment of renewable energy sources, such as wind and solar, is expected to continue growing at a rapid pace. Interesting projections in official reports by Hydrogen Europe and IRENA show the potential growth path in detail.

Meanwhile, incentives and subsidies for renewables are expected to drive investments and to expand the RE market.

The development and deployment of energy storage technologies, such as hydrogen and batteries, will play a critical role in enabling the integration of intermittent renewables into the energy grid. One can only expect that transition measures like alternative low carbon fuels, including hydrogen, will gain additional attention as alternatives to fossil fuels in sectors like transportation and heavy industry.

Hydrogen Europe envisions a combination of renewable energy, battery storage, electrification and, of course, green and clean hydrogen as complementary solutions to our energy transition.

- **Renewable Energy: The renewable energy sector is a clear protagonist in the transition. Wind, solar, and other renewable sources are leading the way in reducing emissions and providing clean electricity.**
- **Electric Vehicles (EVs): EVs and the associated manufacturing, charging infrastructure, and battery production are taking a leading role in decarbonizing the transportation sector. Hydrogen is very well placed especially for heavy-duty transport.**
- **Energy Storage: Energy storage technologies, such as batteries and pumped hydro storage, are vital in integrating variable renewable energy sources into the grid, making them essential protagonists in the energy transition.**
- **Hydrogen Valleys: geographical areas where several hydrogen applications are combined into an integrated hydrogen ecosystem of production distribution and use, improving the economics behind the hydrogen network and triggering a transition, which can then be expanded and interrelated and connected.**
- **Smart Grids and Grid Modernization: The development of smart grids and modernization of the electricity grid are crucial to accommodate the increasing share of renewables and improve energy efficiency.**
- **Circular Economy: Sectors focusing on recycling of materials, reducing waste, and promoting a circular economy are playing a significant role in reducing resource consumption and emissions.**

It is important to note that these sectors are interconnected, and the degree of their impact and prominence can vary by region and over time as policies, technologies, and market dynamics evolve. The European energy transition is a complex and evolving process that will require collaboration across multiple sectors to achieve the overarching goals of carbon neutrality and sustainability.

Carbon capture, utilization, and storage technologies will see increased interest and investment, especially in industries with emissions that are difficult to eliminate through other means.

Over the Longer-term (10+ years), the energy sector is preparing for Decarbonization Commitments with an optimistic approach. Many countries are setting ambitious goals for reaching net-zero emissions by mid-century or shortly thereafter.

In the light of Renewable Dominance, renewables are expected to become the dominant source of energy in the long term, with wind and solar playing a central role. Improved energy storage solutions such as hydrogen will be key to their success.

Proudly, the mandate we are setting for the Hydrogen Economy for Green Hydrogen, particularly produced from renewable sources, is expected to become a major player in the long-term energy mix, especially for heavy industry and transportation, creating a stability in the energy market and delivering environmental targets for net zero emissions, following the targets set by FitFor55.

After a fruitful period of research, Nuclear power is expected to experience a resurgence, as advanced reactor designs and renewed interest in nuclear energy as a low-carbon option gain momentum.

Meanwhile, global efforts to combat climate change are likely to drive international cooperation and the implementation of more stringent carbon pricing mechanisms and emissions reduction targets.

In terms of the Hydrogen Economy, we have set sail for Hydrogen technologies to bring economic and social welfare to EU citizens, by generating growth and upskilling the EU workforce. In its strategic vision for climate-neutrality, the share of hydrogen in Europe's energy mix is projected to grow from the current 2%, to 14% by 2050.

Hydrogen is key to the transition, yet a commercial green hydrogen market is complex to achieve, due to the scientific and technological challenges of the use of hydrogen as an energy carrier.

At the Clean Hydrogen Partnership, which is backed by the EU, and Hydrogen Europe, the hydrogen industry association, we are investing our efforts in public advocacy and awareness of the new regulatory frameworks of Member States as European policies on hydrogen production and use are structured.

The Clean Hydrogen Partnership has an entire ecosystem to deliver, which puts significant pressure on budgets, policy, technological breakthroughs and the commercialisation of economies of scale for the transition.

In collaboration with Hydrogen Europe through the European Commission DG RTD and the support of RepowerEU, the Partnership has secured €2.2 billion in subsidies to invest in hydrogen research and innovation projects over a period of 7 years.

To achieve an organic transition and ultimate success, we need to build up the infrastructure for transportation; bring projects to their final investment decision; support many areas like the Hydrogen Bank; address how we tackle development of European technologies; lower interest rates; create guarantees by governments; and, importantly, develop a strong growing domestic market with little uncertainty on the off-taker side.

Ensuring the economic viability of hydrogen-based solutions is crucial. Hydrogen needs to compete effectively with other energy sources in terms of cost and performance to gain broader acceptance.

These priorities reflect the EU's commitment to transitioning to a sustainable, low-carbon energy system, and hydrogen is a central part of this vision.

My company, Metacon-Helbio, which was founded 20 years ago, was one of the first hydrogen companies established globally, and has since developed patented technologies that generate hydrogen through reforming biogas and other hydrocarbons, and turn-key plants for the production of hydrogen through electrolysis. RINA has been a valuable long-term partner. As RINA has grown exponentially in recent years, it is now considered as a one-stop shop for for market analysis, technology intel, EU program support and certification. ■

Scan the QR code to learn more about **Clean Hydrogen Partnership**

INTERVIEWS

Eni: on the path to carbon neutrality

Interview with **Giuseppe Ricci**
Chief Operating Officer Energy Evolution

Photo courtesy of **Eni**

Eni's business model includes a pathway to carbon neutrality that will result in the complete decarbonization of our processes and products by 2050.

This pathway examines emissions throughout the entire value chain of energy products, and will make our operations sustainable in all aspects: environmental, social and economic. It also encompasses energy security.

Our programme includes the following main projects:

1. Diversification of gas supply, the fossil fuel with the lowest carbon intensity, to ensure the availability of gas during the overall pathway of energy transition.

2. Transformation of traditional assets such as refineries, which are being converted into biorefineries to provide a full range of decarbonization products, including HVO, biojet (SAF), bioLPG, and bio-naphtha for chemistry. In 2014, Eni launched the first ever conversion globally of a traditional refinery into a biorefinery, at its Porto Marghera operation in Venice. This was subsequently repeated at the group's Gela refinery which contributed to the decarbonization of hard-to-abate (HTA) transport while preserving the employment, knowhow and local entrepreneurship (social impact).

3. Developing Italy's first hub for Carbon Capture and Storage (CCS) in depleted fields offshore Ravenna. CCS will play a vital role in hard-to-abate industries, where CO2 production is inherent to the industrial process, regardless of the energy mix used. CCS will ensure decarbonization while also guaranteeing the competitiveness of local productive systems. Every country should be able to define its own decarbonization path; France leverages nuclear power; Germany produces wind energy for more than 6,000 hours per year; Italy - along with a varied set of other decarbonization tools - can leverage one of the largest CO2 storage hubs in the continent, enabling the storage of CO2 from HTA industrial districts, not only in Northern Italy but across Europe and the Mediterranean.

4. The development of a hydrogen network, including production plants for both green and blue hydrogen, for industrial use and also in retail/transport business as its commercial availability increases.

5. An increase in renewable capacity, including the completion of more challenging projects such as offshore wind, including floating, and the advancement of new technologies.

At a wider level, a technology-neutral approach will be necessary for a secure energy transition, taking full advantage of all the solutions that can contribute to the EU climate targets, especially in the hard-to-abate sectors.

An ideological approach, focusing solely on total or prevalent electrification, would reduce energy security, increase the cost of energy and lead to a single country dependency for critical raw materials.

Technological neutrality means utilizing all available solutions for decarbonization: renewables and low carbon fuels, like biofuels, bio methane, blue power, blue and green hydrogen, CCS and CCU and circular processes, choosing every technology where effectiveness and efficiency are maximized.

Furthermore, it is very important that the decarbonization capability and cost is evaluated over the entire value chain, in order to ensure all factors are considered.

As mentioned, the most impacted sectors in the energy transition will be the hard-to-abate sectors, which include both the industrial and mobility sectors.

Here, in particular, the decarbonization strategy for these sectors must follow a technology-neutral approach. For example, when considering the transportation sector, its complexity and diversity suggest that the decarbonization strategy cannot be the same for light and heavy transport, maritime, and aviation.

While electrification might prove efficient for urban light-duty transport, heavy-duty road transport, maritime, or aviation, where the weight and bulk of batteries would be prohibitive and distances are significant, will likely require alternative solutions like biofuels HVO (Hydrotreated Vegetable Oil), biomethane, bioLPG, hydrogen, and in the long term also e-fuels which offer enhanced effectiveness and efficiency, thereby reducing costs.

Hard-to-abate industrial sectors such as steel mills, chemical plants, and cement, glass and ceramic factories need to consider complementary solutions such as biomethane and blue hydrogen for power generation, and CCS/CCU to store or utilize the CO2 that is inherent to the industrial process and hence not linked to the energy source.

However, solely relying on green hydrogen can be very costly and challenging to implement for industrial plants that require a continuous energy supply. Blue hydrogen can address this issue when linked to CO2 capture and storage technology.

Even traditional sources like gas can continue to play a crucial role in this transformation process, supported in their decarbonization process by CCS.

RINA and Eni have signed an agreement with the aim of developing joint initiatives to contribute to the energy transition, with a particular focus on the maritime transport sector.

Within this agreement, RINA and Eni will leverage off each other's expertise. Specifically, we strongly believe that Hydrotreated Vegetable Oil (HVO) is a drop-in solution to decarbonize the shipping market in the short/medium term.

We are also exploring other energy carriers such as hydrogen and blue or green ammonia. Our agreement also includes the development of initiatives covering the entire logistic chain of these new energy carriers, and the adoption of certified methodologies for calculating CO2 emissions reduction benefits along the value chain.

We are also looking at conducting experiments and pilot projects related to onboard CO2 emissions capture processes, in order to support sustainability goals in the maritime sector.

By exchanging knowledge and experiences, we aim to develop innovative models for energy supply, starting with the maritime sector, which is diverse and challenging to decarbonize.

Eni and RINA will evaluate various solutions to make marine transportation more sustainable, based on the needs of shipowners and logistics operators in the short, medium, and long term. Along with RINA, Eni is promoting the project "The Route to Net Zero. Together to decarbonize the maritime sector". This project involves the main shipowners' associations, Assarmatori and Confitarma, as well as the three largest ship engine companies. ■

Scan the QR code to learn more about **Eni**

BIO.
Giuseppe Ricci

Giuseppe Ricci is the Energy Evolution Chief Operating Officer, and Director Green/Traditional Refinery and Marketing, of Eni S.p.A.

Giuseppe joined Eni in 1985, after graduating with a degree in chemical engineering, initially working on the study and development of new refining processes at the Sannazzaro refinery, and subsequently in the creation of the joint venture with Kuwait Petroleum at Eni's Milazzo refinery.

Since then, he has held a wide range of positions at the group, including: Director of Eni's Gela Refinery, Senior Vice President of the Industrial Sector for Refining & Marketing, Chairman of the Gela and Milazzo refineries, Executive Vice President for Health, Safety Environment, and Chief Refining & Marketing Officer.

In July 2020, he was appointed to his current role.

Today, in addition to his responsibilities at Eni, he is President of AIDIC (Italian Association of chemical Engineering), and from July 2017 to June 2023 was President of Confindustria Energia.

INTERVIEWS

e-NG: from the desert to your home

Interview with **Marco Alverà**
Co-founder and CEO of Tree Energy Solutions (TES)

Photo courtesy of **Tree Energy Solutions**

The Tree Energy Company (TES) is dedicated to one product where we want to be the leading provider in the world: electric natural gas, or e-NG.

Inspired by trees, which use sunlight, water and CO2 to create oxygen, we are using renewable energy from solar panels and wind turbines to generate green hydrogen, which is then combined with recycled CO2 to create electric natural gas.

This gas can be transformed and transported using the existing infrastructure for LNG, including the pipelines, ships and liquefaction plants.

With a solar-and-wind + hydrogen supply chain we can have a cheap and infinite supply of hydrogen. It is a fast, affordable and feasible decarbonisation method.

e-NG and other e-fuels offer a huge potential as they solve a large number of the problems in the energy transition: they are storable energy with no intermittency, easily transportable using existing infrastructure, have a high energy density that is suitable for hard-to-abate industries, and enable CO2 utilisation and recycling.

The market for e-fuels is potentially huge, at an estimated $5 trillion, that is, larger than today's oil market, and offers an immediate solution for the energy transition.

Indeed, we estimate tomorrow's energy mix, achievable by 2050 or 2060, will be made up of 50% electrification and 50% green fuels, with the latter comprising e-fuels, bio fuels, and fossil fuels with carbon capture and storage.

BIO.
Marco Alverà

Marco Alverà was born in New York, and is the co-founder of Zhero, a renewable energy company as well as shareholder and co-founder and CEO of Tree Energy Solutions (TES), world leading hydrogen and renewable gas player. Marco has more than 20 years of senior management experience in Europe's most relevant energy companies and he is the author of The Hydrogen Revolution, selected as one of the FT's best books of 2021.

He began his career at Goldman Sachs in London before starting and selling a telecom company, and then moving to Enel, today one of the world's largest green electricity companies. He subsequently moved to Eni, where he worked for over 10 until becoming Chief Midstream Officer also supervising the largest European gas portfolio.

From 2016 to 2022 he was the CEO of Snam, where he positioned the company as an international leader in green hydrogen and green gas infrastructure. Since 2017 he has been non-executive Director of S&P Global, where he is also Chair of the Finance Committee. He is also a member of the Executive Board and of the Steering Committee of the Giorgio Cini Foundation in Venice and a Visiting Fellow of the University of Oxford. He is co-founder of the Kenta Foundation, active in promoting gender balance and combating educational poverty. He holds a degree in Philosophy and Economics from the London School of Economics.

TES has already broken ground on four projects. The first in Wilhelmshaven, Germany, backed by the German government, will build and operate a floating LNG terminal. The terminal will receive its first LNG gas this winter, followed by e-NG in the future. This project could eventually supply 10% of Germany's energy needs.

Each of our upstream projects is among the biggest hydrogen projects in the world, at over 500 MW.

When we look at the energy transition in the short-term, rising interest rates and inflated supply chains are creating a crunch that may derail certain projects which may not have been based on a firm footing.

However, in the medium to long term, the outlook is extremely positive: renewable energy will continue to cost less and less, particularly solar energy where prices are already below the equivalent of $80 per barrel of oil.

Scan the QR code to learn more about **Tree Energy Solutions**

We are capable of further reducing solar prices, to as low as $30 per oil barrel equivalent, so the priority now is PPWS – Putting Panels Where it is Sunny.

Governments now need to promote and incentivise green hydrogen made from renewables, and build a system which connects solar and wind power to factories, homes and ships, so that once that connection is established it can last a thousand years.

At an international level, we believe countries will collaborate over these energy matters, as underlined by the recent meeting by Presidents Biden and Xi Jinping in San Francisco where they pledged to cooperate over climate issues.

Unlike the fossil fuel industry, where there is competition for global resources, solar and wind resources can be found everywhere, reducing the geo-political tensions around energy sourcing. This may lessen the need for technology independence in Europe in the area of climate change.

While we think Europe should invest in its own technologies, we believe this is more important from an industrial, rather than climate, point of view, in order to secure jobs and carry out research and development.

We are working closely with RINA in several areas of our business. First, we are collaborating on the Zhero Europe project co-founded by myself and three other energy experts, which is focused on high voltage electrical cables connecting North Africa to Europe.

Meanwhile, TES is highly active in the maritime sphere, where RINA is a global leader. TES is working on a dual carrier ship which can carry both CO2 and CH4, while we also need shipping expertise to ship our own fuels, and for subsea surveys for our infrastructure.

We see RINA as an 'engineering solutions' firm, offering hands-on consulting from strategy to implementation. Like our companies, RINA is dedicated to global excellence.

With e-NG, we believe we are building the fastest, most efficient and affordable way to decarbonize the world energy market.

This is particularly important when looking at global population trends. Five of the ten most populous nations at the end of the century will be in Africa, while in the same period Nigeria's population will exceed that of China. We need to find an energy solution that works not only in Europe, or China, or California, but globally.

In this context, we believe green hydrogen is not one of the energy transitions but the energy transition. It is a 'forever hydrogen'. ■

INTERVIEWS

Decarbonizing the world shipping fleet

Interview with **Claudio Cisilino**
EVP Operations, Corporate Strategy and Innovation at Fincantieri

Photo courtesy of **Fincantieri**

Fincantieri is a world leader in the design and construction of all high-value vessels, specifically cruise ships, defense vessels, and units for the oil & gas and offshore wind sectors. This means we are a system integrator of technological solutions. We therefore have the responsibility to select, size, integrate and finally commission the technologies that allow the ships to respond to the performance requirements requested by the customer.

Precisely because of our role, we feel a deep responsibility to develop and integrate onboard technological solutions that allow us to achieve the decarbonization goals defined by the regulations, in particular the new targets set by the recent updates by both the IMO and the European Commission.

Unfortunately, especially for the most complex ships - for example those that present the most stringent requirements in terms of energy needs involved as well as limits of space and weight, such as a cruise ship where occupying space also means losing potential revenue from passengers - in the short term there is no single technological solution capable of responding alone to the decarbonization needs.

On cruise ships delivered this year we have already achieved a reduction in the carbon intensity index of emissions by over 30% compared to 2008 and we aim to exceed 50% by 2025.

In order to achieve these results, we have worked on a portfolio of technologies adopted on board, both in terms of reducing consumption through for example hydrodynamic optimization of the hull, or the introduction of specific systems such as batteries, shore connection or air lubrification, and also with the adoption of Liquefied Natural Gas as a second fuel.

We are also in the process of adopting liquid hydrogen powering fuel cells to guarantee zero local emissions under certain operating conditions (such as protected environmental areas: fjords in Norway or ports). We are also working with the main suppliers of combustion engines to accelerate the adoption of alternative fuels such as methanol, ammonia and bio fuels.

Looking further ahead, we are also studying nuclear power as a possible solution for commercial ships.

The final goal is to achieve Net Zero Emissions on the most complex ships by 2035.

The European Community, with the approval of FuelEU Maritime and the introduction of the EU ETS scheme from 2024, is pushing hard for the adoption of low environmental impact fuels in the maritime sector.

From our point of view, clarity and stability of regulations are fundamental in an industry like ours where customers must take investment decisions with a horizon of at least 15-20 years, and where incentive mechanisms impact on the affordability and therefore the choice of technological solutions for ships.

The introduction of incentive systems for technological development such as IPCEI on Hydrogen are powerful accelerators of the development and adoption of such new technologies.

It is therefore inevitable that regulations already approved, and those being approved in the coming years, will have an impact on the choice of technologies that will be successful on a large scale.

It is equally fundamental that this huge joint effort between regulator and the marine industry is also supported by a congruent strategy of infrastructure and supply chain creation to guarantee the availability of new fuels in the ports where ships will operate. Otherwise, there is a risk of making the ships which will be delivered in the coming years inoperative or extremely costly, as it is already happening with the adoption on board of shore connection and LNG before there were adequate infrastructures.

The shipping sector is rightly considered a hard-to-abate one, like the aviation industry with which we share many technological challenges, such as the management of liquid hydrogen on board. In this sense, therefore, the technological challenges won in our sector will be able to represent an accelerator of transition in other mobility sectors.

We believe that a green ship will also be a digital ship. I am referring in particular to the development of the so-called digital twin solutions, and in conjunction with a future transition towards increasingly unmanned vessels.

> “We feel a deep responsibility to develop and integrate onboard technological solutions that will allow us to achieve the net zero emissions goal within 2035.”
>
> **Claudio Cisilino**

We see this parallel because the growth of complexity in vessels, and the limited medium-term availability of new fuels in adequate quantities, will drive a need for cost efficiency through increasing automation, reducing the operating cost of a ship over the full life cycle. Otherwise, there is a risk that new technologies are sustainable at emission level but not at cost level.

The role of RINA is fundamental in this process. We need to work together with all partners in the definition and interpretation of applicable regulations, both for green fuels and regarding digital product development. These regulations often need to be re-written or at least adapted to the new operational management situations.

We also need collaboration by all stakeholders in the distribution of knowledge and technical awareness, in order to identify the technological challenges ahead and the potential constraints to success. ■

Scan the QR code to learn more about **Fincantieri**

BIO.
Claudio Cisilino

Claudio Cisilino was born in Udine, and graduated with a degree in Management Engineering from the University of Udine in 2002. After graduation, he worked between Italy and the US and spent five years as a strategic consultant, including at The Boston Consulting Group.

He began his career at Fincantieri in 2007 in the M&A and Business Development department, and in 2011 was appointed Vice President of Financial Planning and Control.

In 2017, he transitioned to the Merchant Ships Division of Fincantieri, and from 2018 to 2023 served as the SVP Management Director. In January 2023, he was appointed group Executive Vice President of Operations, Corporate Strategy, and Innovation.

In addition to his role at Fincantieri, he has been Deputy Chairman of the Board at Marine Interiors Cabins since 2019. Between 2016 and 2019, Claudio was also a board member of Singapore-listed Vard Holdings Ltd. BIO.

Claudio is married with two children.

INTERVIEWS

Pioneering ‘green steel’

Interview with **Lucia Morselli**
CEO Acciaierie d’Italia

Photo courtesy of **Acciaierie d’Italia**

Decarbonization is an ongoing process in the steel industry that we are tackling head on. At Acciaierie d’Italia’s Taranto steel mill, we have completed a five-year environmental plan representing an investment of about €2 billion, which introduces several very significant emission reduction measures.

We have become a European benchmark for reducing emissions and producing environmentally friendly steel.

The path to decarbonization in the steel industry is definitely a medium to long term journey. We are talking about a time horizon of 10-20 years. There are two aspects to be considered: the environmentally friendly transformation of plants, i.e., the reduction of pollutants that are dangerous to humans and the environment; and the reduction in the plant’s carbon footprint through decarbonization.

Removing CO2 from steel production is still a lengthy process because the transition from coal to a new clean source such as hydrogen via methane is a complex process that requires several steps.

For the time being, the industry is still in a research phase where there is a growing consensus that this clean source could be hydrogen. However, producing hydrogen requires a lot of clean energy that must be derived from renewable sources. An alternative to clean energy production could be nuclear power.

In the meantime, CO2-capturing technologies are also being developed, and will be very useful in the transition phase, together with carbon reduction technologies such as the direct iron ore reduction (DRI) process, moving to progressive electrification.

All these processes require the availability of energy networks, and significant capital for the construction of new facilities.

Steel industry at the forefront of transition

Hard-to-abate industries such as the steel industry will be one of the sectors most impacted by the energy transition in Europe. We are acting on several fronts, convinced that the result can come from a set of synergic actions.

These key actions include reducing consumption, making processes more efficient, introducing CO2-capturing and storage technologies, adopting new production technologies, and supporting the development of alternative, renewable energy. Then, as mentioned, there is the fundamental issue of the electrification of the blast furnaces area through DRI technology.

Important resources, which will contribute to success, are the partnerships we have in place with major players with whom we are developing innovation projects, such as ENI, Fincantieri, SNAM, Paul Wurth, IREN and certainly RINA as well.

A new paradigm with Penisola Steel

Acciaierie d’Italia has defined a new paradigm in steel sustainability by creating, in co-operation with RINA, a scientific platform for the constant monitoring and verification of environmental controls.

“Penisola Steel®,” the brand that defines and certifies the reduced environmental impact of steel produced by Adl’s Taranto plant, is based on this process.

Acciaierie d’Italia’s sustainable Penisola Steel allows our company to differentiate itself from international competitors, particularly those outside Europe.

There is a close synergy between this development and the energy issue, which is key for the need to have large amounts of clean energy available. We are a large consumer of energy and aim to increase the use of renewables to support the Taranto steel mill transition towards a progressive decarbonization of production processes and to reduce the carbon footprint of our products.

In line with European Directives, we are thus promoting and supporting the creation of large renewable energy plants, from photovoltaics to offshore wind power.

I believe that there is not just a single path. We need to seek and encourage the convergence of multiple itineraries.

Promoting technological neutrality

Technology neutrality is also an important subject: this should be at the foundation of the energy transition so that one technology is not favoured over another. Several options must be pursued, in order to find the necessary solutions. In addition, there is an important benefit given by stimulating competition among alternative technologies, a process that can only lead to positive contributions.

Europe is also, of course, prioritising technology independence. There is a close interconnection, not least because technology is now deeply linked to and dependent on the availability of energy. I think Europe is aware that it has to make itself independent in both fields, precisely because of their connection.

In the recent geo-political developments, one aspect that we can consider as positive is that we have a matured awareness of the strategic dimension of both technology independence and energy availability. Proximity is an inalienable value.

Finding synergy with partners

RINA is a very valuable partner for us, a true journey partner with whom we are developing important synergies aimed at projecting activities over the long term.

We have a strong relationship because our collaboration is developed on several fields, including environmental controls, which are the basis of the Penisola Steel brand.

RINA is a partner with relevant expertise in steel research, steelmaking processes and plant engineering aspects. It is also a qualified independent third-party certification body. This comprehensiveness makes it unique. ■

Scan the QR code to learn more about **Acciaierie d’Italia**

BIO.
Lucia Morselli

Since 2019, Lucia Morselli has been the CEO of Acciaierie d’Italia Holding Spa, and Chairman and CEO of Acciaierie d’Italia Spa.

INTERVIEWS

A renaissance for nuclear energy

Interview with **Stefano Buono**
Founder and CEO of *new*cleo
Photo courtesy of ***new*cleo**

What is the short and long term outlook for the energy sector, including the use of nuclear as a new energy source?

"Governments around the world are exploring routes to move away from fossil fuels and decarbonise their energy systems in order to meet legally binding climate goals.

This drive for rapid decarbonisation has turned attention to alternative clean energy sources, including nuclear, which produces an abundant supply of carbon-free electricity.

We've seen first-hand that investors and policymakers are interested in the potential of nuclear to drive down emissions, while supporting efforts to strengthen energy security.

During our ongoing capital raise for € 1 billion, and at industry events, we've had numerous positive conversations about nuclear's potential as a clean power source that does not directly produce any carbon emissions and can reliably plug the gaps created by intermittent renewables.

So, from a long-term perspective, we can see a positive outlook emerging for the development and adoption of new nuclear technologies, particularly small modular reactors, or SMRs.

These SMRs are a new generation of nuclear reactor that are cheaper and quicker to build than conventional plants, with portability and safety benefits. The nuclear sector is undergoing a renaissance, and we are excited to be part of it."

What are the top priorities for Europe in the energy transition?

"In Europe, there is an ongoing debate over which clean energy sources should be used to drive the transition away from fossil sources, and this is generating discussions in both political spaces and public opinion.

It is set against a backdrop of growing demand for energy and volatility in global energy markets. We believe that nuclear energy can complement other energy sources, such as renewables, by providing highly reliable, efficient and almost uninterrupted supplies of energy, particularly when wind or solar is generating less power than expected.

So, we were encouraged to see the European Union include nuclear power within its EU Sustainable Finance Taxonomy.

Another priority for European nations, alongside the energy transition, is ensuring a secure supply of energy, an issue that has come to the fore following Russia's invasion of Ukraine and subsequent gas supply issues.

Broadly speaking, calls for decarbonisation and energy security have led to a rethink of energy policy in Europe, and SMRs are seen as a key tool for future energy systems.

We're also seeing interest in potential industrial applications for SMRs, to help decarbonise specific sectors within the economy.

While we are in the early stages of development for our industrial TL-30 reactor, we are already exploring possible applications for naval propulsion, for instance."

Do you see a connection between energy and technology independence in Europe?

"Just as there are global energy supply chains, there are also global technology supply chains that are fundamental for all types of energy production.

*new*cleo certainly values technology independence just as much as energy independence as a means to ensure stability, for economic as well as geopolitical reasons.

This is reflected in our industrialisation strategy, where we are pursuing a targeted acquisition approach that incorporates expertise from all areas of the nuclear sector into the *new*cleo group as part of an end-to-end business model.

We have just completed our 100% acquisition of SRS-Fucina Group, an addition of over 100 colleagues that bring outstanding expertise in nuclear engineering to our team."

What are the main projects under development at newcleo?

"*new*cleo was founded with the aim of generating safe, clean and sustainable nuclear energy.

We aim to build a new industrial standard in nuclear energy with the best possible safety and sustainability levels by combining existing accessible technologies at competitive costs.

Our reactor design also creates a circular solution for waste. Our reactors will use depleted uranium and plutonium - which is today considered nuclear 'waste' - as fresh fuel for the reactors, thereby significantly reducing existing volumes of radioactive waste and preventing the need for further uranium mining, for the benefit of communities and the environment.

We recently signed an agreement with RINA, alongside the shipbuilding company Fincantieri, to work together on a feasibility study for nuclear naval propulsion - which we're very excited about.

Through this partnership, we will draw on RINA's wealth of experience to assess the practicality of deploying our reactors on a shipping vessel which, if achieved, could help rapidly decarbonise the shipping sector.

The shipping sector still carries around 90% of the world's goods and so, by taking steps towards decarbonising this fossil fuel intensive sector, our partnership with RINA and Fincantieri could make a big impact." ■

Scan the QR code to learn more about ***new*cleo**

BIO.
Stefano Buono

A nuclear physicist and successful entrepreneur, Stefano started his career with Nobel laureate Carlo Rubbia at CERN and CRS4, working for 10 years in the field of Accelerator Driven Systems and nuclear waste transmutation. In 2002, he founded Advanced Accelerator Applications, which was listed on NASDAQ until its acquisition by Novartis for $3.9 bn.

In 2021, he co-founded and incorporated UK-headquartered nuclear technology company newcleo, of which he is CEO.

He is the Chairman of various organisations, and the founder of Elysia Capital, his single family office. He is the author of numerous scientific publications, and received his Master's degree in Physics from the University of Turin.

BIO.

Massimiliano Masi

Massimiliano Masi has 25 years of experience as a senior executive in the international energy market. After graduating in Business Administration at the Bocconi University in Milan, he held Management Consulting roles at Arthur Andersen, specializing in the Power & Utilities sector, advising major international companies.

Massimiliano subsequently joined the energy industry, holding posts in strategy, sales and finance with both IREN and the A2A group, prior to becoming CFO of Edison and CEO of Edipower. In 2019, he moved to Dubai to become Partner & Associate Director at the Boston Consulting Group, working as a Power & Utilities expert for the Middle East.

During his career, Massimiliano has developed a deep experience in issues related to the "energy transition" from fossil fuels to renewables, the circular economy and sustainability and strategic partnerships. He is currently the General Manager of Magaldi Middle East and responsible for the development of Magaldi Green Energy's global renewable energy business.

Scan the QR code to learn more about **Magaldi**

INTERVIEWS

Making the case for Thermal Energy Storage

Interview with **Massimiliano Masi**
General Manager of Magaldi Middle East

Photo courtesy of **Magaldi**

Decarbonizing industry and transportation are top priorities for Europe's energy transition. This will require scaling up renewable power, and deploying new technologies in order to curb emissions. These technologies include batteries, lithium ion and other innovative means to power batteries, Thermal Energy Storage like our own MGTES technology, and carbon capture.

Market design and integration must also evolve to enable a high share of renewables, while maintaining reliability and grid flexibility. Electrification will be key to decarbonizing at the expected pace and reducing CO2 emissions significantly.

At Magaldi, we are bringing to the market one of the most promising TES technologies. Magaldi Green Thermal Energy Storage (MGTES) enables the transition from fossil fuel combustion to fully electrified heat production for industrial use.

By using renewable electricity to generate steam and hot water, MGTES allows industrial processes that traditionally rely on coal, oil, and natural gas to be powered sustainably.

The key innovation of MGTES is its integrated thermal energy storage based on sand fluidized bed technology. This allows the capture and storage of heat for on-demand use 24/7. By charging from renewable sources when generation is high, and discharging heat when required, MGTES provides carbon-free "baseload" heat to replace fossil fuel boilers.

With its high efficiency, modularity, and use of abundant and recyclable materials, MGTES paves the way for deep decarbonization of industrial processes. And by electrifying heat generation and integrating thermal energy storage, MGTES unlocks the potential for industry to achieve net-zero emissions.

Decarbonization will clearly require economy-wide change, but there are some industries which will be more impacted than others. The power sector will be the sector that is most transformed, as Europe transitions from fossil fuels to renewables.

Industrial energy consumption is almost one-third of total energy consumption: 70% of this energy is thermal energy and 90% still comes from fossil fuels. To decarbonize industrial heat, a combination of renewable plus thermal storage is inevitable.

Meanwhile, the mobility sector will need to rapidly adopt EVs and low-carbon fuels. Energy-intensive industries like steel and chemicals will need to implement CCUS and hydrogen. Building efficient domestic electrification will also play a major role.

RINA has been a trusted partner in this journey. Our two companies have collaborated to position MGTES in the Power to Heat applications and start the necessary safety certifications. This has helped us develop innovative solutions and validate our approach.

As the energy transition accelerates, we see our partnership with RINA growing: RINA's thought leadership and technical capabilities will help us accelerate into the TRL 9 of our pluri-patented MGTES based on fluidized sand bed.

More generally, RINA's expertise across the value chain supports technological development, systems integration, quality and LCA analysis, and safety certification. This will become increasingly important as companies implement complex, capital-intensive decarbonization projects across multiple sectors.

RINA's independent assessment capabilities will also be valuable for validating performance and building stakeholder confidence. ■

What is the short-term outlook for decarbonization?

In the short-term until 2030, we would expect renewables to continue their rapid growth, with solar and wind providing over 30% of electricity by 2030, although we believe it will be very difficult to get this figure over 40%.

This will require grid infrastructure buildout and market reforms to ensure LDES is adopted before the tipping point (50%-60% of renewable penetration) of weeks storage is triggered.

Electrification of transport will accelerate, although charging infrastructure deployment will be crucial. Meanwhile, industry will begin adopting technologies like hydrogen, CCUS, and electrification to curb emissions.
Medium-to-large scale demonstration projects will be vital, while batteries and thermal energy storage might work together to complement storage hubs in critical nodes of the grids.
Renewable industrial heating solutions will enter early adoption.

And the long-term outlook?

Longer term, between 2030 and 2050, renewables will dominate the power sector, reaching over 70-80% penetration by 2050. Nuclear and natural gas with CCUS will play a transitional role.

Elsewhere, we predict LDES will be seasonal (e.g. storage solutions should be able to cover entire weeks, 24/7, without renewable generation).

Meanwhile, heavy industry will transition to clean hydrogen and widespread CCUS. Near zero-carbon steel, chemicals and cement will become common.

Buildings will achieve deep efficiency retrofits and rooftop solar power, while heating transitions to electricity and district energy.
The EU is aiming for net-zero greenhouse gas emissions by 2050. This will require economy-wide changes and coordination, which naturally also implies a high risk of failure.

Developing a trained H2 workforce

By **Antonio Manna, Head of Training & Personnel Competence Product Management, RINA**
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Interest in hydrogen as a key element in decarbonization efforts has significantly increased in recent years due to the ambitious objectives set by the European Union to become climate neutral by 2050.

The rapid growth in investment in electrolysis systems, both public and private, and the development of H2 projects, has led to a series of new initiatives to define standards of product, process, safety and skills.

A trained and skilled workforce is a vital prerequisite for achieving the EU's objectives of scaling up local clean hydrogen production and establishing resilient hydrogen ecosystems.

According to research by Hydrogen Europe titled "European Hydrogen Skills Strategy", around 1 million new jobs will be created from the hydrogen value chain by 2030.

This will place considerable pressure on the sector, as large numbers of new workers must be trained, or have their existing skills updated.

In this scenario, RINA can play a key role. The company has long been committed to supporting the implementation of energy transition strategies in both private and public entities.

Thanks to our consolidated know-how in the hydrogen field, assisted by our long experience in the Oil & Gas sector, RINA is the first Italian certification body, and among the first in Europe, to have obtained accreditation for the international standard ISO 22734:2019 dedicated to hydrogen generators (electrolysers) from ACCREDIA.

This standard defines the construction, safety and performance requirements of generators which use electrochemical reactions to produce hydrogen for use in industrial, commercial and residential applications.

RINA can also assist in defining and certifying training paths. There is a current lack of clear and common training and regulatory guidelines to ensure quality standards for the personnel involved in hydrogen activities.

RINA has therefore produced its own training and certification framework targeting re-skilling and up-skilling paths and certification. This programme has a triple function:

- Support the professional development of personnel currently involved in the hydrogen chain
- Contribute to an increase in the employment profiles where demand currently exceeds supply
- Anticipate the professional profiles that will be required in the future

RINA's framework is based on modular training courses that allow for customization and offer flexibility. Learning units can be selected and combined to create personalized learning paths tailored to individual needs and aspirations.

RINA'S certification framework is aimed at a wide range of professionals involved in hydrogen processing activities, and across many different sectors from hard-to-abate industries, to utilities and energy companies, and industries involved in the storage, transport and components of hydrogen.

Differentiation is made between management profiles (Project Manager, Plant Manager) and technical operational (Operation and Maintenance Technician, Plant inspector). Certification is achieved by demonstrating the possession of specific requirements in terms of work experience, studies, and training completed.

Defining best practices, training requirements and career progression will be essential for the development of the hydrogen supply chain, and its ability to reach its full industrial and technological potential. ■

ENEL Green Power Case study

In 2023, ENEL Green Power, the renewables arm of the ENEL energy group, launched a collaboration with RINA aimed at identifying the training needs of its technical personnel working in H2, both in Europe and worldwide.

The first step in the collaboration was to identify the professional profiles and skills that would be needed by ENEL for the management and maintenance (O&M) of green hydrogen production through electrolysis technology.

Based on the findings, the partners co-designed a modular training package for staff.

The training package proposed by RINA's experts had several principal objectives:

- To transmit basic knowledge relating to green hydrogen to all ENEL employees and increase their awareness of the role of hydrogen in the energy scenario
- To promote safety practices in line with the relevant safety regulations and policies
- And to increase staff awareness of the guidelines, processes and procedures relating to operational maintenance, enabling a homogeneous work model and operational excellence

A modular and blended system was chosen to accommodate different skill levels, languages and time zones.

Meanwhile, the training included e-learning with free content and quizzes, live webinars and in-depth discussions with experts, as well as remote face-to-face training with an H2 plant to get practical experience on security and maintenance issues.

Scan the QR code to learn more about **ENEL Green Power**

Ensuring hydrogen safety

By **Claudio Ceccherini, Major Accident Hazards & Fire Prevention Senior Engineer, RINA**
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Hydrogen is set to play a key role in the energy transition due to its chemical and physical characteristics, which are significantly different from most common hydrocarbon fuel gases, such as natural gas and propane.

The risks associated with hydrogen use are closely related to its characteristics, and it is necessary to evaluate them carefully when designing, constructing, and operating plants.

In terms of fire and explosion hazards, hydrogen's most distinctive characteristic is its flammability range, which is very wide, within 4 percent (LFL) and 75 percent (UFL), as well as its very low Minimum Ignition Energy (MIE) of 0.017 milliJoule. These two characteristics combined mean that hydrogen can easily ignite upon release.

At atmospheric pressure and ambient temperature hydrogen is gaseous with a very low density (0.0838 kg/m3), about 14 times lower than air. The low density of hydrogen results in high buoyancy (the tendency to disperse rapidly upwards) that can be an advantage in terms of safety, since in case of release hydrogen disperses upward and dilutes in air, reaching concentrations below the LFL in a short time.

The low density of hydrogen means, however, that it is necessary to compress it to a high pressure (up to 700-1000 bar) to reduce its volume and to be able to handle it within reasonable volumes, and there are safety issues related to the use of pressurized equipment (PED).

When burning, hydrogen flame emits low levels of radiation in the infrared range (no heat is perceived by people), and most of the radiation is emitted in the ultraviolet range. As a result, it is poorly visible to the naked eye, especially in daytime.

The design of plants and layout is crucial: attention must be given to the context, and it is recommended to proceed with a Quantitative Risk Analysis (QRA) to identify credible accident scenarios and assess the consequences.

Since concrete applications for green hydrogen plants are still limited, risk perception associated with this type of plant is limited. It is crucial not to underestimate the risks, and to rely on the applicable technical standards.

RINA has invested a lot in studying the safety of hydrogen, which is demonstrated by a recent collaboration. In 2022, RINA and the Dipartimento dei Vigili del fuoco del Soccorso pubblico e della Difesa civile signed a memorandum of understanding (MoU) with the aim of carrying out studies and research into the field of energy transition and safety.

The agreement provides for initiatives related to the interchange of technical information and experience in the field of fire and explosion risk assessment, as well as the formation of study and research groups, thus enabling RINA and Vigili del Fuoco to enhance each other's expertise.

Within this framework, in 2022 RINA participated as an external expert in the Working Group that led to the publication of the important Ministerial Decree of July 7, 2023, "Technical rule of fire prevention for the identification of risk analysis methodologies and fire safety measures for the design, construction and operation of hydrogen production plants by electrolysis and related storage systems." ■

Advancing renewables through certification

By **Laura Severino, Head of Decarb & Chain of Custody Product Management, RINA**
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Since 2009, Europe has set renewable energy targets for its Member States. The current Renewable Energy Directive of 2018 (known as RED II) mandates that 32% of gross final energy consumption must be met by renewable sources by the year 2030, with a dedicated target share of 14% in the transport sector.

On 20 November 2023, the Third Renewable Energy Directive (Directive 2023/2413, known as RED III) entered into force. This is an amending Directive that does not modify all the articles of RED II. Member States have 18 months from this date to transpose the directive into national law.

RED III sets more ambitious renewable energy targets for 2030, in line with the EU carbon neutrality target of 2050 set by the Green Deal and its goal to reduce GHG emissions by 55% in 2030.

The new targets mandate at least 42.5% of gross energy by renewables by 2030, and 29% in the transport sector. Alternately, the transport sector can also comply by achieving a greenhouse gas intensity reduction of at least 14.5% by 2030.

The renewable fuels that count to reach the targets are: Liquid Biofuels (to be used in the transport sector); Liquids Bioliquids (in the power generation, and heating and cooling sectors); Solid and gaseous biomass fuels (in power generation, heating and cooling, and transport); Recycled carbon fuels (RCF) (transport sector); and finally Liquid and gaseous fuels from renewable non-biological sources (RFNBO) (transport sector, and subsequently all sectors including industry when RED III is adopted).

Particularly favoured, with additional sub-targets, are fuels deriving from feedstocks like waste or residue or non-edible raw materials (listed in Annex IX of the RED II) and RFNBO. This is because they do not compete with the food sector, and the derived waste does not go into landfill. Furthermore, procuring the waste involves little to no cost, and is sourced locally.

There remain, however, concerns about the wider impact and true sustainability of individual fuels over the full supply chain. What are the total greenhouse gas savings, what is the impact from changes in land use, the social impact, the threat to biodiversity, and in the case of waste and by-products, the risk of fraud?

To meet these concerns, the Renewable Energy Directives set criteria under which these fuels can be certified. These cover the entire supply chain and provide a guarantee of fuels' real sustainability. Complying with the criteria is a prerequisite for receiving government support.

RINA Services S.p.A, is the ideal partner for the certification of fuel sustainability according to the Renewable Energy Directives. Specialised in environmental certification, inspection, testing for the agro-forestry, energy, environmental, chemical sectors, it is accredited by a range of certification schemes*.

By verifying the true benefits of renewables over the entire supply chain, certification will contribute to an efficient energy transition, in line with Europe's targets. ■

** RINA Services S.p.A. is accredited by ACCREDIA for the certification of biofuels and bioliquids, according to the national scheme established by Decree 14.11. 2019 and is recognised, respectively by ISCC System GmbH and by 2BS Consortium, for the certification of biofuels, bioliquids, biomass fuels for uses other than transport, advanced biofuels, biofuels with low ILUC risk, renewable fuels of non-biological origin for transport, known as RFNBO* and fuels from recycled carbon, known as RCF*, according to the voluntary schemes approved by the European Community according to the RED 2 Directive (Directive 2001/2018/EC) ISCC EU and 2BS. (*for RFNBO and RCF, recognition of the schemes by the European Community is pending). RINA Services S.p.A. is also recognised by ISCC System GmbH for the certification of sustainable aviation fuels, known as SAF, according to the ISCC CORSIA scheme, one of the schemes approved by ICAO (International Civil Aviation Organization) for certification according to the sustainability criteria defined by CORSIA.*

N Italy: a Replicable Micro Hydrogen Ecosystem

By **Bruno Marcos Sodiro, Innovation For Power Generation and Hydrogen Project Manager, RINA**
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In the quest for a sustainable and eco-friendly future, hydrogen has emerged as a promising solution to decarbonize energy systems.

The TH2ICINO project, which stands for 'Towards H2ydrogen Integrated eConomies In NOrthern Italy', is a groundbreaking initiative aimed at supporting the deployment of micro hydrogen economies in the European Union (EU).

This prototype hydrogen ecosystem in Northern Italy has the potential to set the stage for replicable micro hydrogen ecosystems across Europe.

The TH2ICINO project focuses on four key pillars of the hydrogen value chain: hydrogen production, storage, distribution, and consumption. Its holistic approach to sustainable hydrogen production and utilization sets it apart as a pioneering effort in the region.

At the core of the TH2ICINO project is the creation of an innovative concept for green hydrogen production. Utilizing the potential of renewable power sources and local assets, the project aims to decarbonize at least two sectors within the region. The objective is to produce a minimum of 500 tons of hydrogen annually, with the potential for even higher production.

To ensure the feasibility, scalability, and replicability of the micro hydrogen ecosystem, TH2ICINO utilizes the Master Planning Tool (MPT), based on the Artelys Crystal Super Grid platform1.

This tool is custom-tailored to the requirements of EU Hydrogen Valleys (H2V) and will be integrated into a comprehensive software suite. The MPT serves as a guide for local and regional decision-makers and companies within the hydrogen sector to develop and deploy similar micro hydrogen economies while adapting to geographical constraints and leveraging existing assets.

Emissions monitoring and CO2 savings are vital aspects of the TH2ICINO project. The goal is to reduce emissions by a

substantial 4,400 tons of CO2 annually. This reduction will not only establish the valley as an eco-friendly zone but also set a benchmark for tracking the technical growth strategy over time.

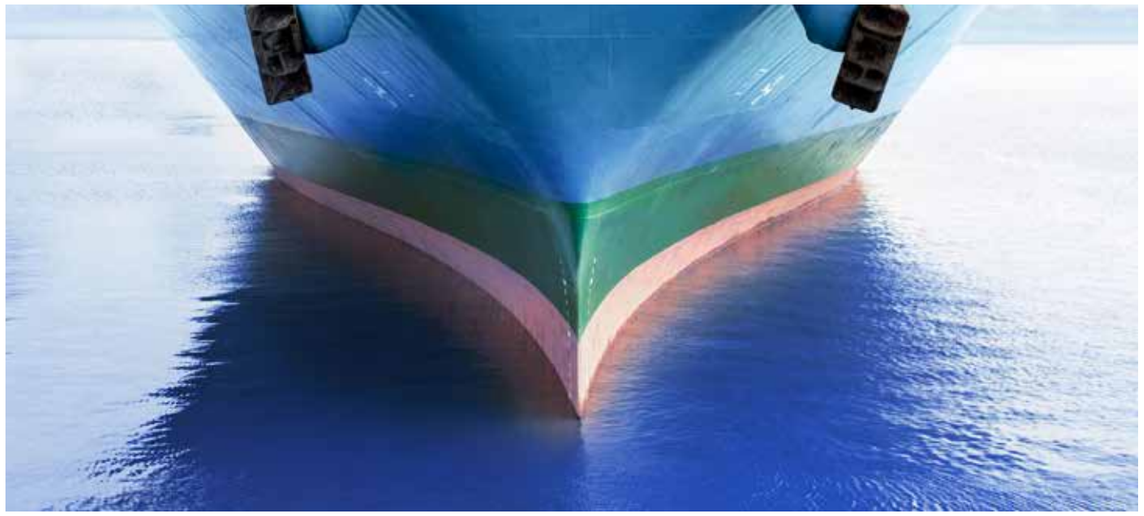
The TH2ICINO project's demonstration phase is a pivotal step in showcasing the feasibility and practicality of the proposed micro hydrogen ecosystem. It involves various demo cases, and use cases to define business models, diversify the valley's assets with different technology choices, and identify non-technical barriers for future expansion.

Notably, the involvement of SEA Milano Airports, operating Malpensa International Airport (MXP), presents an exciting opportunity to integrate hydrogen into aviation.

The proximity of MXP to hydropower stations along the Ticino River positions it as a pioneer in decarbonizing air travel. Passenger mobility companies operating in the area also have the potential to become hydrogen consumers, strengthening the entire value chain.

The TH2ICINO project aspires to contribute to the broader goal of establishing sustainable hydrogen-based economies in Europe. Its replicable nature, coupled with the development of the Master Planning Tool (MPT), offers valuable insights and practical guidance for the implementation of micro hydrogen economies and their potential for scalability.

By focusing on emissions monitoring and the demonstration of various use cases, the project emphasizes its contribution towards achieving a clean energy future. The journey towards hydrogen integrated economies in Northern Italy is not only a regional endeavor but also a pioneering example for Europe and the world. ■



Exploring nuclear solutions for shipping

By **Giuseppe Zagaria, Marine Italy Region Technical Director, RINA**
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In July 2023, the International Maritime Organization (IMO) revised its initial 2018 greenhouse gas emissions reduction strategy and set a new net zero target of 2050 for shipping.

In parallel, the "Fit for 55" package, a comprehensive set of directives designed by the European Parliament, will ensure Europe becomes the first climate neutral continent by 2050.

This new era for shipping will require companies to closely monitor their fleets in order to meet progressively more stringent emission requirements, while avoiding pollution penalties.

Each shipping company will be required to adopt a 'techno-economic' strategy that is appropriate for its individual business model and fleet operating profile, and the use of alternative fuels and advanced technologies will play a leading role going forward.

In the shipping industry, nuclear solutions are now being viewed with increasing interest as a potential means of meeting decarbonization goals.

Although nuclear installations have existed onboard ship for several decades both in the naval fleet and on ice breaking vessels, its application in the merchant fleet has been restricted by a range of factors, including public opinion, cost, technical operation, port management, and contractual compliance.

However, a new generation of small and modular nuclear reactors is paving the way for potential new energy solutions for merchant shipping, particularly for those ships which have a significant power demand and long sailing periods.

The new generation of nuclear power offers promising benefits: a substantial reduction in emissions, a significant increase in the refueling timespan, higher safety standards, and reduced waste compared with traditional nuclear reactors.

Because of their size and modularity, it may be possible to build these new reactors almost entirely in a controlled facility and then installed module by module in the ship's engine room. This would replace the traditional method of building the reactor onboard ship while under construction in the shipyard.

Due to their flexibility, nuclear reactors can play an important complementary role, supporting alternative fuels and battery technology. In some cases, they can act as a catalyst in the Power-to-X industry, enabling the growth of new fuel infrastructures.

For instance, onshore or floating electrolyzer facilities powered by nuclear reactors could produce hydrogen, methanol, or ammonia, without emissions. Meanwhile, floating nuclear power sources could directly recharge batteries or provide energy to onshore power supply infrastructures in ports.

In this potential scenario, a ship powered by a nuclear reactor could itself become the power source, transferring electric energy to the port.

The potential adoption of nuclear solutions in the shipping industry will inevitably have regulatory implications, requiring an update to the current framework.

The nuclear ship chapter contained in the SOLAS (Safety of Life at Sea) Convention and Code of Safety for Nuclear Merchant Ships can be used as a starting reference point. However, a process of updating will be necessary to effectively regulate nuclear installations onboard marine units, requiring multilateral coordination among flag states, port states and coastal states. ■

Dakar bus project shows biofuel benefits

By **Ginevra Rossetti, Head of Mobility & Logistics, RINA**
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In 2022, RINA Consulting was commissioned by CETUD (the Executive Council of Urban Transport of Dakar) to study the technical, economic and financial feasibility of a biofuel conversion chain to supply Dakar's bus fleet using local vegetable, animal and household residues.

RINA conducted a multi-criteria analysis of the different potentially exploitable biofuel chains in Senegal, and proposed recommendations on the final choice based on project diagnosis and benchmarking. The study also assessed the feasibility of such production, with an identification of the entire supply chain up to final user.

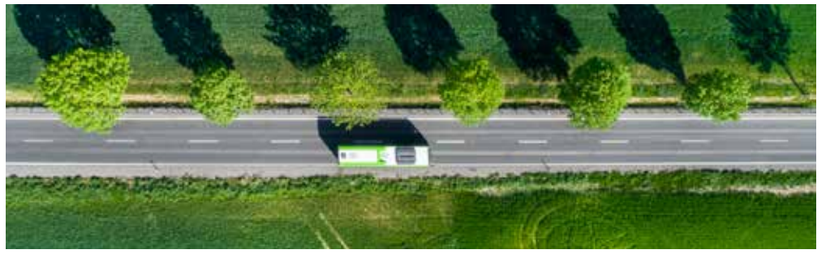
After the diagnostic phase, attention was focused on the Municipal Solid Waste (MSW) to biomethane chain, considered the most promising for urban transport use in Senegal and in particular in the Dakar metropolitan area.

Indeed, the anaerobic digestion process of these wastes and the valorization of biogas into biomethane offers obvious advantages by exploiting widely available materials that are generally directed to landfills.

Furthermore, the method promotes a virtuous recovery of dangerous and polluting materials, with the additional benefit of reducing CO2 and GHG emissions over the life cycle. By making available by-products (digestate) which can in turn be resold and reused, the method contributes to the creation of an economy circular (residues > biofuel > fertilizer > agricultural raw materials > residues).

Wastewater and food industry waste can also be used in these proposed production units without modification. While they are not a necessary addition, they could be added to the raw materials in the production units, were they to become more readily available in the coming years.

Given that the technology needed for Municipal Solid Waste (MSW) to biomethane production is largely proven and carries few technical uncertainties, it was not considered necessary to consider a small-scale pilot installation.



On the contrary, the direct construction of an industrial-sized facility was considered suitable for the pilot plant, using three development phases:

- An initial pilot plant for 365 m³/h biofuel production for 127 buses, requiring a raw material quantity of 22 thousand tons per year of MSW;
- An expansion of this production site to service a total of 381 buses, requiring two additional plants of the same size on the same site;
- A second full-size production site needing more than 110 thousand tons per year of MSW, enabling the operation of another 635 biomethane buses.

Based on the implementation of these three phases, total production of biomethane could reach approximately 24 million m³ per year. This capacity could potentially power the entire fleet included in the CETUD project for the Dakar bus network. ■

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Water's role in green hydrogen production

By **Natalia Pierozzi, Carbon Reduction Excellence Senior Technical Manager, RINA**
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As the world moves towards net zero by 2050, green hydrogen will play an important role in the future sustainable energy mix. However, generating large volumes of green hydrogen also requires large volumes of water, together with large amounts of renewable electricity.

Crucial questions regarding water utilization are beginning to emerge: How much water is required? What level of water quality is necessary? And from what sources should the water be obtained?

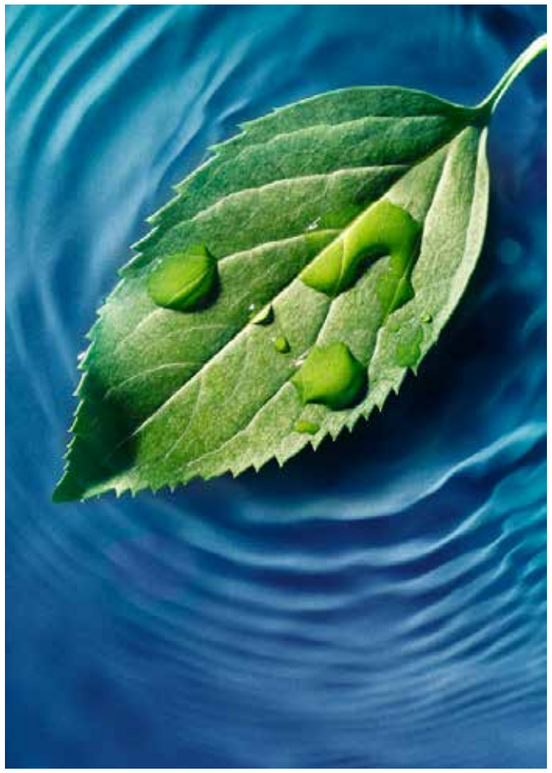
From a stoichiometric perspective, 1 kilogram of hydrogen requires the input of 9 kilograms of ultrapure water. This value increases to approximately 20 kilograms when inefficiencies are considered.

In addition to this, we need to account for the cooling water used to control equipment temperature. Here, it is more difficult to calculate an exact figure, but as a general rule of thumb, it is roughly twice the amount required for electrolysis.

For most of the smaller projects completed so far, water from the drinking water network is used. However, as hydrogen plants increase in size, this approach becomes unsustainable and the other main raw water sources have to be adopted: groundwater, treated wastewater and seawater.

The projected 409 million tonnes of green hydrogen needed by 2050 in IRENA's 1.5°C pathway would require around 7–9 billion cubic metres (m3) of water per year, less than 0.25% of current freshwater consumption. According to these figures, water does not present a bottleneck for scaling up electrolysis.

However, it's interesting to note that many regions rich in the renewable sources that are fundamental for green hydrogen production also face water scarcity issues. More than 70% of green hydrogen projects are planned in Africa, the Middle East, Australia, and Latin America.



For large installations in these countries, it is likely that seawater will be the only viable sustainable source of water. The desalination of water can as a byproduct also address critical local needs like the generation of tap water, providing communities with access to freshwater. However, conversely the issue of disposing of the wastewater or brine produced by the seawater treatment has to be carefully managed, in particular for large scale (GW) installations.

An alternative to seawater desalination could be direct sea water electrolysis, a technology under development that may play an important role in the future.

For a fast and secure development of large-scale green hydrogen production, it is crucial to take into account water usage requirements at an early stage of the project.

This will encompass elements such as the risk related to water security, environmental and social concerns, and the need to adopt an integrated approach that considers water supply and disposal, power needs, cooling technologies, and project location. ■

Methanation: from ugly C02 to beautiful CH4

By **Paolo Paci, Engineering Solutions Project Management Director, RINA**
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In the battle for cleaner, more sustainable energy sources, methanation has emerged as a captivating technology that could play a pivotal role in reducing carbon emissions.

Methanation, with its magical transformation power, is a chemical process that converts carbon dioxide (CO2) and hydrogen (H2) into methane (CH4), with a side release of pure, sparkling H2O.

In other words, with methanation, villainous carbon dioxide is transformed into desirable methane and, furthermore, the process exploits the excess energy from renewables, converting it into a substance that can be stored and used when most needed.

The science behind methanation is compelling. With a metal-based catalyst, the so-called Sabatier reaction allows the transformation of the primary reactants into methane and water. This can be tapped for many useful purposes, the most obvious ones being the reduction of greenhouse gases and the storage of precious excess energy into valuable methane.

Methanation could potentially play an even bigger role by being not only net zero but carbon negative. Methanation can reduce the overall quantity of circulating CO2, for example, in association with the popular Direct Air Capture technology.

What are the drawbacks? Why has methanation not yet made a bigger impact in the fight for decarbonization?

There remain several challenges still to be addressed before we can exploit the full potential of methanation. These include: the cost of (green) hydrogen production, the efficiency of the methanation process, the economic viability of methanation, and the actual scalability of the technology to larger industrial levels.

These days, governments, research institutions and private organizations including RINA are investing increasing time and money to overcome these challenges, in a bid to advance the adoption of methanation technology, and reduce the associated capital and operational costs of methanation.

Policies and incentives are being introduced in Europe and beyond to support the development and deployment of green hydrogen and methanation technologies, as part of efforts to achieve climate targets.

Various demonstration projects are also being developed worldwide, aimed at showcasing the feasibility and benefits of methanation.

All of these projects will play a vital role in increasing the general awareness and acceptance of the technology.

In this generations-long fight against climate change, we can only hope that the challenges are overcome in order that methanation can take its place in the panel of technological solutions which can work to make the world a greener and safer place. ■

Funding as a key driver of sustainable development

By **Daniele Pozzo, Strategic Streams Director, RINA**
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The energy transition is a complex and challenging process that will require significant investment. The European Union (EU) is committed to supporting this transition, and has a number of funding programmes in place to help businesses, governments, and other organisations invest in clean energy and decarbonisation technologies.

These programmes include (non-exhaustive): Horizon Europe, dedicated to research and innovation, with a budget of €95.5 billion, covering the period 2021-2027; LIFE Programme, entirely focused on environmental, climate, and energy objectives, with a total financial envelope of €5.43 billion within the period 2021 - 2027; Innovation Fund, dedicated to the demonstration of innovative low-carbon technologies. The budget is linked to EU-ETS (Emission Trading System) and may amount to €40 billion from 2020 to 2030; Modernisation Fund, supporting the moderinisation of energy systems and improvement of energy efficiency in 13 lower-income Member States. The total revenues amount to €57 billion from 2021 to 2030, assuming a carbon price of €75/tCO2; Just Transition Fund, supporting the areas most affected by the transition towards climate neutrality and for preventing an increase in regional disparities, with a total budget of €19.32 billion from 2021 to 2027.

There are also smaller funds such as the European Regional Development Fund (ERDF), European Social Fund Plus (ESF+), Cohesion Fund, European Agricultural Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF).

In addition to EU funding programmes, there are also several national schemes available in Europe to support the energy transition. These vary from country to country, but they typically cover a wide range of areas, including renewable energy, energy efficiency, smart grids, clean transport, and carbon capture & storage (CCS).

The funding programmes help to:

- bridge the funding gap. This is especially important in developing countries and regions, where the cost of clean energy technologies may be prohibitive.
- de-risk investments in clean-tech. This is important because clean energy technologies are often new and unfamiliar, and investors may be hesitant to invest in them without financial support from the government.
- scale up investments in clean-tech. By providing financial support to a large number of projects, EU funding instruments can help to drive down the cost of clean energy technologies and make them more competitive.

[1] *RINA support in public funding programmes*

It is important to underline that applying to EU and national funding programmes requires the integration of different skills and competences, including:

- Strategic planning skill to create specific business strategies and models in regard to the company's overall long-term goals aligned to the funding programme objectives.
- Technical skills to assess project feasibility from a technical point of view.
- Financial skills to assess project feasibility from a financial point of view.
- Environmental impact assessment competences to assess the project impact on reducing greenhouse gas (GHG) emissions and climate change. For instance, "Do No Significant Harm (DNSH) assessment" is required in all tenders by the Italian Recovery and Resilience Plan (PNRR).

RINA provides comprehensive support in the preparation and submission of applications for the main EU and national funding programmes.

If funding is granted, RINA can also contribute to the subsequent implementation of projects using its specialist technical-engineering and economic-financial skills. ■

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