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TTGV Pioneer Project Program
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**TO AVOID BECOMING TOMORROW'S IMPORTER,
WE MUST BE TODAY'S INNOVATOR IN R&D**

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**EVERYONE FROM DECISION-MAKERS TO
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OUR RECENT REPORTS

COMMUNICATION IN THE CONTEXT OF THE CLIMATE CRISIS: A MATTER OF DETERMINATION

*"Those who work hard may get tired, but they no longer
need luck."*

This was the most memorable sentence I took away from a
conversation we had with university students.

It resonates with Aristotle's wisdom—bringing to mind his
famous words: "Choice, not chance, determines destiny."

The young person who shared this thought is an aspiring
engineer, deeply passionate about his field of study. Like many
of us, he carries the weight of concerns about the future. Yet,
instead of succumbing to inertia, he actively asks: "What
should I do?" Individuals like him, with strong communication
skills, inspire hope. Because regardless of the field in which one
works, effective communication can save lives, open doors, and
create opportunities. At TTGV, we act with the awareness of the
crucial role communication plays in our work. Together with a
robust team of experts, we focus on adapting to the necessities
brought by the impacts of the climate crisis and exploring the
opportunities that these necessities may create.

In the three-year period during which we have concentrated on
this field, we have published eight reports, each serving as a
compass. We have provided and continue to provide mentorship
to industrial stakeholders. We have built a thriving community
and have become a driving force enabling entrepreneurs to take
meaningful steps toward their dreams.

**ESRA YAZDIÇ DEMİR**

TTGV, Corporate Communications and
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FOREWORD

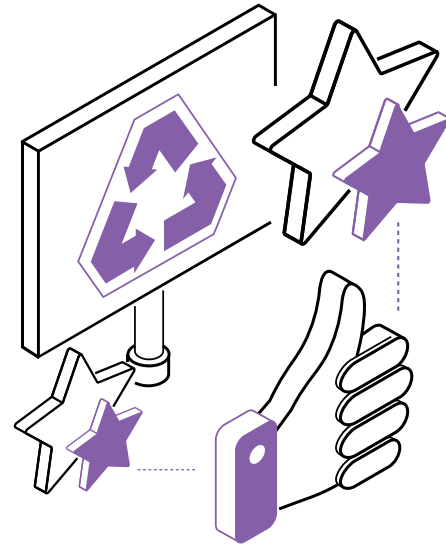
In an institution with a 34-year history, one can truly witness the relentless effort and perseverance that are required to grow from past experiences and avoid losing direction in the future. While doing so, we dedicate ourselves to accurately communicating who we are and creating value through our work.

The work we undertake is, of course, time-sensitive. It is essential to act with the right strategies without missing the train of progress. This is why we approach every issue of our Climate Technologies Bulletin with meticulous care. In this issue, we are proud to present our Deep-Dive Report on Next-Generation Fuel Technologies for Hard-to-Abate Sectors, offering you the opportunity to read the insights of leading figures and experts in this field. Alongside this, you will find interviews containing valuable commentary on battery storage technologies both globally and in Turkey, as well as recent advancements in the field of biotechnology. You will also have the chance to meet the TTGV Climate Lab Climate Pioneers Platform, which brings together seven prominent individuals working in climate technologies in our country, and learn about their aspirations.

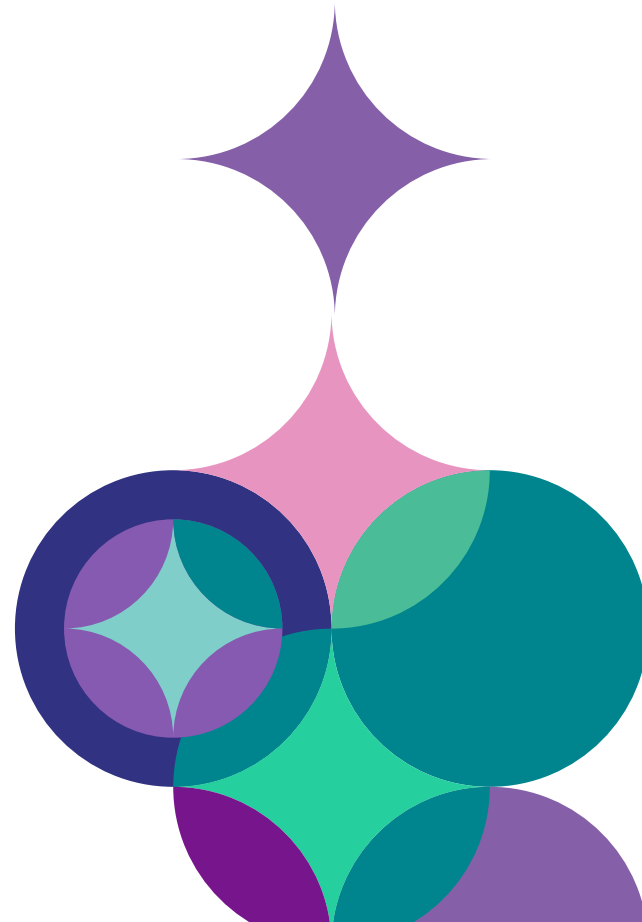
Finally, I encourage you not to miss Ayşenur Atik Bilen's outstanding review of the book "Speed and Scale: An Action Plan for Solving the Climate Crisis Now," which has been added to the Turkish language through TTGV Library this year. We also invite you to watch our interview with the book's author, John Doerr. This book was, in fact, born out of a daughter's plea to her father, sparking one of the world's leading investors to focus on climate change and to direct investments toward this crucial field.

Wishing you an enjoyable read.

Note: I would like to extend my thanks to Zeynep Dicleli Erdoğan, General Manager of Optimist Publishing, for her support in making the John Doerr interview possible.



"Those who work hard may get tired, but they no longer need luck."



TTGV PUBLISHES THE DEEP DIVE REPORT ON NEXT-GENERATION FUEL TECHNOLOGIES

The Türkiye Technology Development Foundation (TTGV) Pioneering Project Program team has prepared the Deep Dive Report on Next-Generation Fuel Technologies to evaluate transformation needs within the scope of emission reduction targets in hard-to-abate sectors and to serve as a strategic resource for Türkiye.

The report examines the technical and economic feasibility of next-generation fuel solutions for sectors with limited potential for electrification, such as heavy freight transport, maritime, aviation, steel, and chemical-petrochemical industries. While highlighting the growing global adoption of electricity-based solutions rooted in solar and wind power, the report emphasizes the necessity for next-generation fuels to serve as a "bridge technology" in the transformation of these sectors. It also underlines that Türkiye is among the countries that will be highly affected by this global paradigm shift, considering its foreign trade volume, energy supply security, and level of technological development.

Prepared under the mentorship of TTGV Director of Innovative Technology Programs Dr. E. Serdar Gökpınar, and authored by program specialists Dr. Burak Baykal, Dr. Cemil Kanat Sarısoy, and Sevtap Gökçe, the report is structured around three core analytical axes:

- A global-level analysis of the priority needs in hard-to-abate sectors,
- Technical, economic, and environmental assessment of next-generation biofuels and synthetic fuel technologies,

- Identification of Türkiye-specific current status, infrastructure, and areas with potential for competitive advantage.

The report adopts a multidimensional approach to evaluate the integration potential of relevant technologies into existing infrastructure, scalable business models, and investment opportunities. It emphasizes that next-generation fuels are of critical importance not only in terms of environmental sustainability but also for economic competitiveness, strategic resource security, and industrialization policies.

This study aims to contribute to the development of collaborations that will enhance Türkiye's technological capacity in this field, support investment trends, and encourage the private sector to take an active role in the green transition.





NEXT-GENERATION FUEL TECHNOLOGIES FOR HARD-TO-DECARBONIZE SECTORS

5 QUESTIONS – 5 ANSWERS

1. Why has TTGV focused on next-generation fuel technologies?

Biofuels and synthetic fuels offer an effective pathway for decarbonizing hard-to-abate sectors—such as aviation, maritime transport, and petrochemicals—by facilitating access to cleaner energy and enabling electrification where physical and technical constraints make direct electrification challenging. Sustainable bioenergy can rapidly reduce fossil fuel-derived emissions in transport, while bio-based feedstocks or renewable hydrogen in the chemical and petrochemical industries can diminish fossil dependency and contribute to circular economy objectives. Technologies such as Bioenergy with Carbon Capture and Storage (BECCS) are particularly important, as they have the potential to achieve carbon-negative outcomes, even under stringent emissions scenarios.

The shift toward **biofuels** is driven by several interlinked factors: mitigating environmental and

economic risks associated with fossil fuels; enhancing energy supply security; and supporting agricultural development. Biofuels reduce dependency on imported fuels, provide resilience against oil price volatility and improve engine performance, while often being exempt from hazardous materials regulations. **Synthetic fuels** are especially promising for heavy-duty transport and energy-intensive industries due to their compatibility with existing infrastructure and low carbon signatures. Achieving meaningful emission reductions in challenging sectors requires a complementary mix of biofuels, synthetic fuels, hydrogen, and CCS. The maturation and widespread adoption of these technologies depend critically on strong policy frameworks, infrastructure planning, public-private collaboration, and global supply chain integration. Accordingly, TTGV has implemented deep dive analysis and has initiated researches for potential target oriented projects focused on scaling up biofuel and synthetic fuel production to support decarbonization in hard-to-abate sectors.

2. What is the difference between Biofuels and Synthetic Fuels?

Among alternative fuels, “**next-generation fuels**” can be defined as those produced from renewable resources using advanced technologies, with the objective of achieving low or zero carbon emissions, and designed to be compatible with existing fuel infrastructures (i.e., drop-in fuels) or usable with minimal modifications. Biofuels are derived from renewable biological materials—such as plant biomass, animal fats, or organic waste—via biochemical or thermochemical processes. A subset known as “advanced biofuels” is derived from non-food feedstocks, such as lignocellulosic biomass, agricultural and forestry residues, algae, and waste oils, using advanced technologies.

Synthetic fuels, by contrast, are produced through catalytic or chemical processes that combine sustainably sourced hydrogen (typically “green” hydrogen) with a carbon-containing feedstock (e.g.,

CO₂ or CO), resulting in carbon-neutral or low-carbon fuels that are compatible with existing infrastructure. Unlike renewable electricity deployment, which often requires substantial investments in new grid, solar, and wind infrastructure, biofuels and synthetic fuels leverage the current internal combustion engine fleet and fuel distribution systems, enabling a more rapid and cost-effective energy transition.

3. Are Biofuels and Synthetic Fuels substitutes or complements to conventional fuels?

The primary aim of biofuel and synthetic fuel production is not necessarily to completely replace fossil fuels in the short term, but rather to provide sustainable alternatives or complementaries to conventional fuels, and to offer optimal low-carbon options in a long-term energy transition. While technically capable of replacing fossil fuels or being blended directly with them, these alternatives serve as transition tools that support existing energy systems. They are particularly valuable in sectors—such as transport, aviation, and maritime—that are difficult or costly to electrify.

Biofuels, derived from sustainable biomass or waste, and synthetic fuels, produced from green hydrogen and recycled CO₂, can significantly reduce fossil fuel usage. Within carbon-neutral goals, these fuels are seen as foundational to sustainable energy systems. In the short-to-medium term, they will act as complements to existing infrastructure, due to their compatibility with current engines and fuel infrastructure. Advanced biofuels require limited modifications to conventional engines, and synthetic fuels offer carbon-neutral performance within established systems. Thus, their role should be viewed as context-dependent and temporally nuanced rather than purely substitutive.

4. What are the challenges and risks to scale up next-generation fuel technologies?

Although biofuel interest is expected to grow over the next decade, supply constraints related to biomass feedstocks and logistical issues tied to raw materials (e.g., waste oils) may limit their long-term market share, especially as mature renewable electricity systems could make synthetic fuels more cost competitive. Regulations like the EU’s ReFuelEU



initiative support the shift toward synthetic fuels, reflecting these trends. However, high costs associated with CCUS (Carbon Capture, Utilization, and Storage) technologies and limited access to green hydrogen currently pose significant barriers to investing in synthetic fuel production. As a result, establishing the necessary regulatory frameworks—especially for synthetic aviation fuels—is crucial to help validate the production processes.

Another key issue for Türkiye will be accurately forecasting natural gas use. A rapid exit from natural gas could jeopardize energy security and electrification efforts, as critical sectors heavily depend on natural gas. Considering Türkiye imports approximately 90 % of its petroleum and natural gas and faces energy supply vulnerabilities, transitioning industrial infrastructure to alternative fuels - such as biomethane - could preserve competitiveness by utilizing existing gas infrastructure.

5. What are the recommendations for Türkiye in developing Biofuel and Synthetic Fuel technologies?

Based on TTGV's comprehensive deep dive analysis, a pre-investment demonstration project for industrial-scale biomethane generation via **"Bio-PtG" (biogas to methane)** is highly recommended. The project would combine biogenic CO₂ and renewable hydrogen in Sabatier reactors within an existing biogas plant, and thereafter supply the biomethane to nearby industrial facilities or injection into the gas grid—offering continued use of the existing gas infrastructure, as well as long-duration storage of renewable energy. For synthetic fuels, Turkey remains at an early stage, without industrial-scale investments or demonstration projects. It is therefore highly worthwhile to initiate a demonstrator project for **Synthetic Sustainable Aviation Fuels (e-SAF)**. This would involve using industrial CO₂ and green H₂ in a semi-pilot-scale Fischer-Tropsch reactor with local catalysts to produce synthetic paraffinic kerosene (SPK) and conduct initial SAF production tests. By unveiling

techno-economic data, such a demonstration would pave the way for larger-scale commercial initiatives and shape Turkey's roadmap toward establishing domestic SAF production facilities.

Turkey's strong solar and wind potential, combined with its **strategic location near European energy corridors**, positions it well for future export of fuels and energy carriers - such as SAF, hydrogen, methanol, ammonia, biomethane, and DME - to key markets in Northern Europe. Given the critical role of the ARA (Antwerp-Rotterdam-Amsterdam) port region and the emissions tied to long-distance SAF imports from North America or Asia (e.g., Singapore, Japan), Turkey is strategically placed to become a vital SAF supplier for Europe by 2030.



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TTGV Pioneer Project Program Specialist

OUR PROGRAMS



PIONEER PROJECT PROGRAM



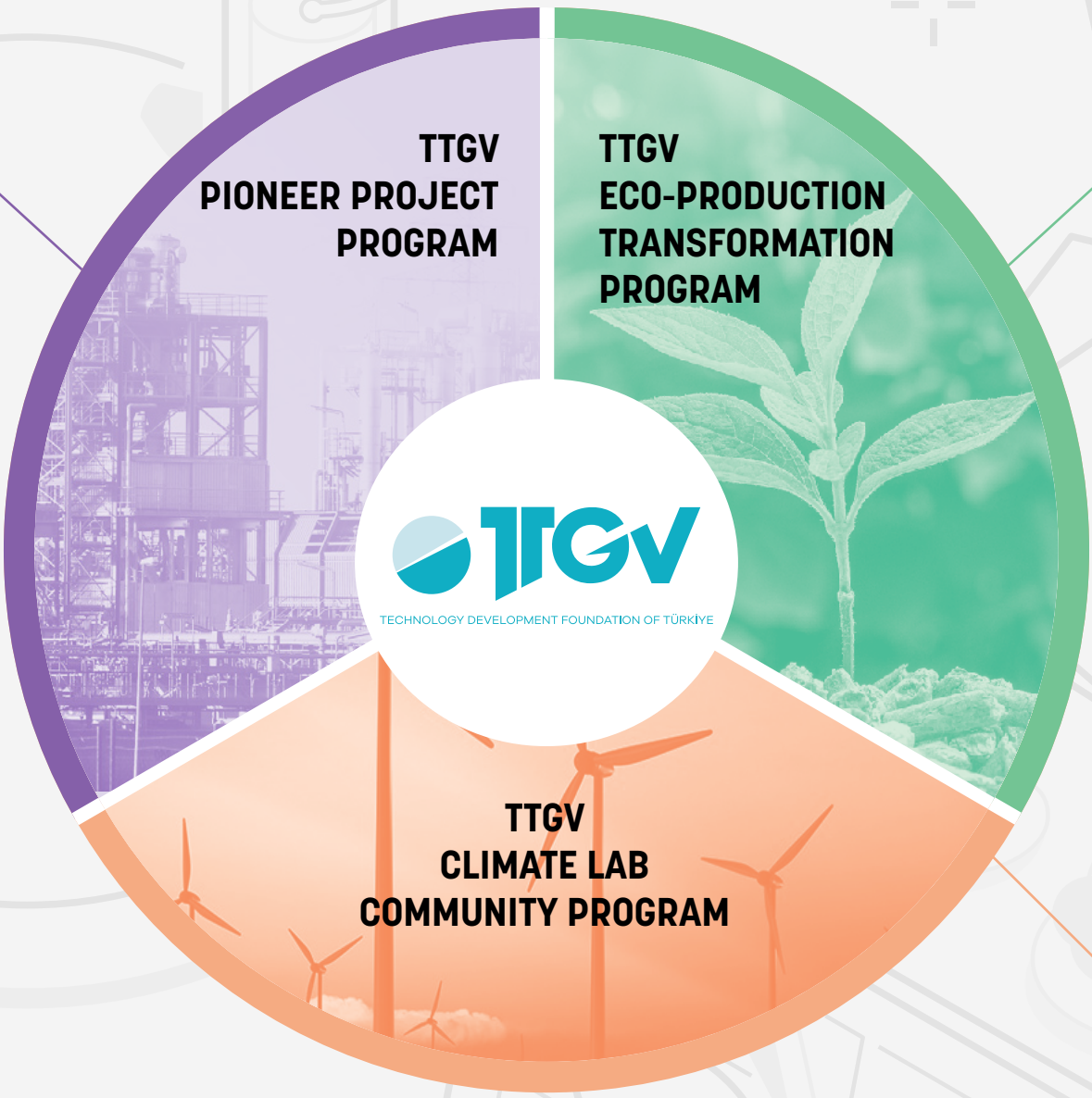
Targeting climate technologies, aims to foster capacity development geared toward early-stage technology evaluation while instilling an economic value creation perspective.



It aims to identify ventures operating in the climate technologies domain that have achieved initial functional outcomes but require support in productization and market validation, and to facilitate their access to industry-specific business development expertise while fostering the establishment of partnerships for field implementation.

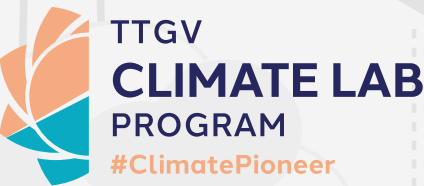


In Türkiye, the program is dedicated to supporting commercially-scaled, first-of-its-kind demonstration projects focused on climate technologies, with a Technology Readiness Level (TRL) of 7 or higher.



ECO-PRODUCTION TRANSFORMATION PROGRAM

The Eco-Production Transformation Program is designed to contribute to the sustainable transformation of the industry and the preservation of its competitiveness within the framework of the clean production paradigm. It achieves this by identifying and developing new project opportunities and by delivering a structural impact for financial institutions through the creation of a comprehensive project value chain that will permanently support the clean production transformation.



CLIMATE LAB COMMUNITY PROGRAM

The Climate Lab Community Program is designed to converge people, technology, and data with a focus on climate technologies. Its objective is to generate tangible knowledge and insights that the industry can leverage, while operating as an experimental laboratory that explores and tests various methodologies.

THE UNSUNG HEROES OF SUSTAINABLE ENERGY TRANSITION: NEXT GENERATION FUELS



“Forecasts predict that renewable energy sources will constitute over 90% of global electricity generation by 2050, becoming the main tools of the clean energy transition expected in many sectors responsible for about 75% of global emissions originating from energy consumption.”



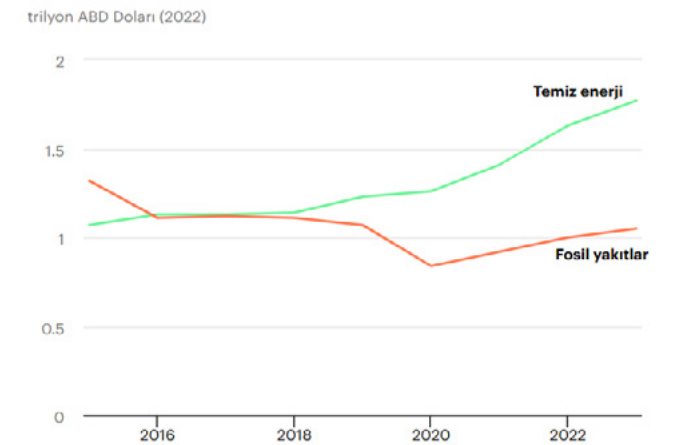
DR. BURAK BAYKAL

Technical Lead, TTGV Pioneering Project Program

Mandatory changes in dominant energy forms in consumption, driven by current needs, are accepted as “energy transitions” or “energy transformations.” Over the past 100 years, broad global energy transformations have occurred such as the shift from coal to oil and natural gas and the rise of nuclear power, all of which deeply impacted energy systems and caused structural changes. The current and ongoing transition from fossil fuels to renewable energy sources like solar and wind, along with electrification, is among the most comprehensive and fastest energy transitions in world history. Past global oil crises and the increasingly felt effects of climate change have repeatedly exposed the fragility of global energy supply and increased interest in renewable sources like solar and wind, considered inexhaustible. Although fossil fuel dependence has not completely ended in many countries, especially China and India, a new era has begun where energy infrastructures, policies, investment priorities, and technology choices are fully changing alongside the accelerated shift to electrification.

The introduction of distributed energy systems, where electricity is generated not from large central plants but many small local or regional sources, the growing need for energy storage, and the transition to smart grids are part of this latest energy transformation. Monitoring investments in the energy sector alone in recent years can give us an idea of the pace of this transformation. Especially after 2018, the majority of global energy investments were made in clean energy, widening the gap with fossil fuel investments.

Forecasts indicate that renewable energy sources will make up more than 90% of global electricity generation by 2050 and will become the fundamental means of the clean energy transition expected in many sectors responsible for about 75% of global emissions from energy consumption.



A Future Outlook on Next Generation Fuels

Efforts by the European Union to reduce natural gas dependency through next-generation fuels and energy carriers, incentives like the U.S. Inflation Reduction Act (IRA) prioritizing fuels, investments in next-generation fuels by oil-rich countries preparing for a post-oil economy, and countries such as Chile, New Zealand, Morocco, Algeria, Egypt, and Singapore striving to transform their solar and wind potential into value-added chemicals and fuels all indicate a profound paradigm shift in the rise of next-generation fuels over the past decade. Considering Turkey's large foreign trade volume and dependency on critical energy sources like natural gas, it is inevitable that Turkey will be among the most affected countries by this global paradigm shift in next-generation fuel technologies.

Given the needs, existing infrastructure, and technological competencies in Turkey, it is essential to identify key topics in next-generation fuel technologies that will enable the private sector to sustain international competitiveness. Therefore, it is crucial for Turkey to be ready for this change both technologically and in terms of regulation and human resources, and to seize investment opportunities simultaneously with global competitors.

For example, Sustainable Aviation Fuels (SAF) are one of the ideal fuel applications expected to create opportunities for Turkey in coming years. SAF synthesized from waste oils, agricultural residues, or green hydrogen based on renewable electricity can provide up to 80% CO₂ reduction over its life cycle compared to conventional jet fuel, offering full (drop-in) compatibility with existing aircraft engines and fueling infrastructure, enabling rapid scaling in civil aviation. Additionally, the European Union's "ReFuelEU Aviation" regulation, which starts with a 2% SAF mandate in 2025, increasing to 6% by 2030 and 70% by 2050, sends a strong demand signal to global markets. The Antwerp-Rotterdam-Amsterdam (ARA) port network, critical for Europe, manages the SAF market. Considering the high costs and extra emissions of shipping SAF from far markets such as North America and Asia (Singapore, Japan) to Europe, Turkey's potential SAF supply is expected to be strategically important for European buyers.

Thus, leveraging Turkey's rich biomass stock and emerging green hydrogen production capability in SAF



production will reduce carbon costs in air transport and position Turkey as a strategic exporter in the growing clean fuel market.

Challenges Beyond Electrification

However, not all sectors can be fully decarbonized by electrification or renewable energy transition alone. Civil aviation, long-distance maritime shipping, heavy long-haul trucking, and energy-intensive industrial sectors such as steel and petrochemicals are among the "hard-to-abate" sectors and are not currently considered fully electrifiable.

These sectors represent about one-quarter of global energy consumption and one-fifth of global CO₂ emissions. Due to their need for high calorific value and easily transportable fuels, they remain deeply dependent on fossil fuels. Moreover, radical technical changes and long investment cycles make direct electrification or rapid conversion via conventional methods difficult. Therefore, comprehensive and multifaceted technological solutions are required for their decarbonization.

At this point, "next-generation fuels," characterized by high energy density, easy transportability, and storability, hold strategic importance as complementary elements to electrification in these sectors. Especially "next-generation biofuels and synthetic fuels" can play a critical role in the sustainable transformation and balancing of energy supply and demand in these sectors where electrification is not feasible.



"The utilization of Turkey's rich biomass stock and its green hydrogen production capability, which will develop over time, in SAF production will both reduce carbon costs in civil aviation and position Turkey as a strategic exporter in the growing clean fuel market."

Biofuels, which can replace or be blended with fossil fuels, are produced from renewable and sustainable biological sources such as plant materials, animal fats, and organic waste via biochemical or thermochemical processes. A subgroup, "advanced biofuels," is produced from sustainable resources like lignocellulosic plant materials, agricultural and forestry residues, algae, and used cooking oils (UCO) via advanced technological processes that do not compete with global food chains.

Synthetic fuels are carbon-neutral or low-carbon alternative fuels compatible with existing fuel infrastructure, produced without fossil resources, typically by combining hydrogen obtained using renewable energy with carbon-containing components (carbon dioxide and carbon monoxide) or atmospheric nitrogen through advanced chemical and catalytic processes.

While renewable energy solutions based on electrification generally require major changes in electric infrastructure and investments in solar panels and wind turbines, biofuels and synthetic fuels can use existing energy infrastructures and are compatible with internal combustion engines or fuel systems. This compatibility lowers the cost of energy transformation and accelerates the energy transition.

Biofuels and synthetic fuels stand out as significant alternatives worldwide, primarily for the transport sector, with the potential to partially substitute fossil fuels initially and eventually replace them over the long term.



SUSTAINABLE AVIATION FUEL (SAF): THE FUEL OF THE FUTURE OR TODAY'S OPPORTUNITY?



YAŞAR YETİŞKİN
ICF Senior Manager

INTERVIEW: Esra YAZDIÇ DEMİR
TTGV Corporate Communications &
Media Manager

The aviation industry is going through a critical energy transition to reduce its emissions. Among the potential solutions, Sustainable Aviation Fuel (SAF) stands out as the most concrete and viable option. But can this fuel truly scale on a global level? And from an investor's perspective, is it a risk or an opportunity?

Achieving a carbon-neutral aviation industry is no longer just an environmental aspiration—it is now a strategic and economic imperative, and a clear policy direction. While electrification and hydrogen propulsion offer promise in the long term to a limited extent due to distance related limitations, low-carbon liquid hydrocarbon fuels such as SAF remain the only practical solution available today. Across the globe—from the United States to Europe, Asia to Turkey—different regions are pursuing diverse strategies supported by a mix of incentives, mandates, funds, and public-private partnerships.

In this in-depth interview, we speak with **Yaşar Yetişkin, Senior Manager at ICF**, who collaborates with stakeholders across the entire SAF value chain — from governments and airlines to investors, fuel producers, airports, OEMs, and NGOs — to explore the global expansion of SAF, its technological maturity, investment risks, and the crucial role of policy and international cooperation in scaling up sustainable aviation.



In which regions is Sustainable Aviation Fuel (SAF) expanding most rapidly on a global scale, and what are the main economic or political factors influencing this growth?

SAF adoption is expanding all over the world with over three hundred announced facilities, yet it is still an emerging low-carbon technology and cannot scale beyond the “valley of death” without solid financial viability and strong, long-term policy support. United States, the United Kingdom, and the European Union host majority of these facilities, given the strong policy support for SAF. In the U.S., the rapid pace of SAF development can largely be attributed to the longstanding support mechanisms for biofuels. These federal and state level incentives, initially designed for ground transport fuels, have been successfully utilized to support SAF. Combined with the federal RFS program, California's Low Carbon Fuel Standard (LCFS) have made SAF economically attractive, positioning the state as a global hub for SAF activity. The new administration brought uncertainties regarding the continuity of policy support for SAF, but the latest updates regarding the likely extension of Clean Fuels Production Credit (CFPC - 45Z) and conditional approval of 3bn USD grant allocation for two SAF facilities can be considered as strong positive signals for SAF.

In the UK and EU, the driving force has been mainly SAF blending mandates. Here, the ambition to lead the global fight against climate change has played a major role. SAF blending mandates such as ReFuelEU and the UK SAF mandate send strong regulatory demand signals to the market. Mandates have started as of 1st January 2025 with 2% SAF blending obligation. Therefore we have been seeing quite a lot of SAF activity in the EU and the UK ahead of this period.

These regions can be considered part of the “first wave” of SAF growth. However, activity is no longer limited to the Global North. Japan, Canada, and Australia are also launching SAF-related initiatives. Meanwhile, countries like China, India, and some South American nations are starting to engage in pilot projects and policy drafting. Turkey, in particular, is seeing promising developments. The draft SAF regulation prepared by the Directorate General of Civil Aviation is a clear sign of strategic intent.

Ultimately, we understand that mandates or incentives are not enough in isolation to scale up an emerging low carbon technology like SAF. We need to utilize carrots and stick together with a hybrid policy approach. The UK is a great example of how SAF policies can continue to evolve to meet emerging market dynamics: the blending mandate and the Advanced Fuels Fund ignited market activity, and the recently proposed Revenue Certainty Mechanism, based on a guaranteed strike-price model to de-risk revenue for UK producers, now aims to accelerate domestic production and bridge the supply-demand gap.

Clear policy direction with long term certainty (both supply and demand side), financial incentives, and cross-sector coordination has been the driver for SAF scale ups so far. Where these elements come together, investors gain confidence and production capacity grows to an extent. The global activity and the scale of the investments we are observing can be considered as evidence that, with the right policy and finance push, SAF is no longer just a “future fuel” - it is a well-recognized, practical and scalable decarbonization tool for aviation today.



From an investor's perspective, what are the biggest risks and opportunities in SAF production and infrastructure? How do you view the role of technology maturity and regulation?

SAF investments could come with meaningful return potential, but they would also carry considerable risk. The risk/return profile is driven primarily by the technology maturity, feedstock availability, regulatory landscape and the market dynamics. As of now, only HEFA (Hydroprocessed Esters and Fatty Acids) technology is considered commercially mature, which we have been utilizing for decades for renewable diesel production already, making it a relatively low-risk technology. However, even HEFA has its challenges, particularly around feedstock availability. Since it relies on fats, oils and greases, feedstock constraints can hinder future scalability. That said, new opportunities are emerging - such as the use of cover crops that don't compete with food production - to diversify and expand HEFA feedstock supply.

Technologies beyond HEFA, such as Fischer-Tropsch (FT), Alcohol-to-Jet (AtJ), and Power-to-Liquid (PtL), are still considered high-risk. Most of the individual process units involved in these pathways are proven, yet their integration and utilization for large scale SAF production is new to us. In fact, some early efforts to scale up FT SAF pathway have already faced significant challenges. Companies like Fulcrum BioEnergy and Velocys, once seen as pioneers, have been struggling due to complex technical and financial setbacks. Even promising facilities like Lanzajet's Freedom Pines site have yet to begin actual SAF production in large quantities. From an independent engineer's perspective, the risk is real, and several years of



successful operation would be required before that risk is considered meaningfully reduced.

To mitigate these risks, long-term offtake agreements are essential. Especially when structured as "take-or-pay" contracts, they provide predictable cash flows that make projects more bankable. In such contracts, the financial credibility of the offtaker matters a lot. Airlines generally do not enjoy top-tier credit ratings, as they operate on thin margins. However some flag carriers or major fuel suppliers tend to have stronger ratings, which can be more attractive to investors. The involvement of energy majors and fuel providers in offtake agreements as fuel suppliers further de-risks investments and unlocks more favourable financing conditions.

Once first-of-a-kind (FOAK) facilities come online and demonstrate consistent performance, the cost of capital is expected to drop, making subsequent projects less risky and more affordable. Regulatory support also plays a crucial role. Without a form of policies -

mandates, price support schemes, public funding etc. - SAF is unlikely to compete on its own. Investors look for more than just technology. They evaluate long-term policy certainty, regulatory alignment, and the presence of risk-sharing models.

Compared to hydrogen or electric propulsion systems, how feasible are low carbon liquid hydrocarbon fuel-based solutions in the medium and long term?

Electric aircraft, hydrogen propulsion systems, and low carbon liquid hydrocarbon fuel-based alternatives like SAF are expected to play a role in decarbonizing the aviation industry, together. Among these, SAF stands out as the most practical and scalable option, both today and in the foreseeable future. The main reason is that it is chemically identical to fossil jet fuel, so it can be used as a drop in fuel with limited to no distribution in downstream logistics activities.

Electric aircraft are promising for short-haul, low-capacity routes. However, due to battery energy density



"Airlines generally do not enjoy top-tier credit ratings, as they operate on thin margins. However some flag carriers or major fuel suppliers tend to have stronger ratings, which can be more attractive to investors. The involvement of energy majors and fuel providers in offtake agreements as fuel suppliers further de-risks investments and unlocks more favourable financing conditions."

limitations, they remain unsuitable for medium-to long-haul commercial aviation. While progress continues in urban air mobility and regional electric flight, batteries are far from replacing jet fuel in larger aircraft.

Hydrogen appears more viable for longer-range flights but faces major infrastructure and integration hurdles. Storing and transporting liquid hydrogen requires extensive redesigns of aircraft and airport refueling systems. The investment and engineering requirements are massive. Moreover, the momentum around hydrogen in aviation has recently slowed. Airbus has delayed its hydrogen aircraft target beyond 2035, and a notable hydrogen aircraft startup recently went bankrupt. Hydrogen's contribution to aviation decarbonization by 2050 has also been reduced in some latest projections. However, its non-CO₂ benefits are well recognized as it is a truly net zero solution.

By contrast, SAF can be blended into existing jet fuel and used in today's aircraft and fueling systems without any modifications. This "drop-in" compatibility makes

it uniquely suited for immediate deployment across global fleets. More importantly, it is currently the only decarbonization solution that works for long-haul and transcontinental flights.

Beyond conventional “biogenic” SAF, synthetic fuels are also emerging. Electrofuels, PtL SAF, or eSAF, use “green” hydrogen and captured CO₂ to create a zero-carbon jet fuel. These solutions represent the future of SAF, allowing the aviation sector to integrate renewable energy and decarbonize deeply without overhauling infrastructure. We also see some hydrogen projects switching to eSAF project, given the strong economic and policy activity around SAF, and eSAF’s ability to provide a faster route for commercialization.

In short, while electric and hydrogen technologies will likely play some/limited role in specific market segments, SAF remains the only scalable, infrastructure-ready, and technically viable solution for mainstream commercial aviation.

How effective is the collaboration between international aviation authorities and the private sector in scaling up SAF use? How do these partnerships shape investment decisions?

Scaling up SAF requires a coordinated approach that aligns policy, technology, and economic viability. Achieving this goal requires a highly collaborative, multi-stakeholder effort, with every segment of the value chain working together. International aviation bodies, national regulators, airlines, airports, producers, academia and investors all have interdependent roles to play. Collaboration between these actors is essential not just for technical deployment, but also for unlocking financing and reducing market uncertainty.

ICAO’s CORSIA scheme has been instrumental in placing SAF on the global agenda as a recognized carbon reduction tool. However, CORSIA alone is not enough. National mandates, regional incentives, and private-sector commitment are all necessary to build a

functioning market. Increasingly, airlines are entering into long-term offtake agreements, providing demand certainty for producers. Airports, too, are stepping in—not just as infrastructure providers, but as active investors.

For example, Luxembourg Airport invested directly in an eSAF producer, while London Heathrow developed its own SAF incentive program and allocated well over 100 million GBP support for SAF so far. These cases show that airports too are embracing a strategic role in the aviation energy transition, as they understand the key role of SAF in ensuring the low carbon growth of the aviation industry. In Türkiye, promising initiatives are also underway. The Türkiye Sustainable Aviation Alliance (TSAA) brings together key players such as Turkish Airlines, Pegasus Airlines, SOCAR, TUPRAS, IGA and many more. The Alliance facilitates coordination on policy, roadmaps, and potential SAF projects, and is a great example to collaborative efforts towards scaling up SAF. The SAF letter of intent

between TUPRAS and Turkish Airlines is another strong example of effective collaboration between an airline and a fuel producer.

These partnerships help distribute investment risk and align technical and financial planning. In capital-intensive sectors like SAF, joint ventures and consortia reduce entry barriers and increase bankability. As a result, investors are more willing to support projects when they see alignment between government priorities and private-sector capabilities.

To conclude, SAF will only scale at the pace required if public and private actors collaborate under a shared vision. It’s not just about fuel—it’s about creating a new industrial ecosystem, and no single player can build it alone.



“SAF is no longer just a “future fuel” - it is a well-recognized, practical and scalable decarbonization tool for aviation today.”

WHY DO WE NEED COMMUNITIES? CLIMATE PIONEERS

#ClimatePioneer



Erdem Coşkun
WAT Motor
R&D Group Manager



Başak Kaftan
Yaşar University
Project and IPR Expert



Semih Dilsiz
Aygaz, Innovation and Intellectual
Property Manager
Greenmile Mobility, Co-Founder



Semi Hakim
Kök Proje & Kök Ventures
Co-Founder



Çağatay Alp Arslan
Vicat Grup Türkiye
Group R&D Chief



Tuğba Uçar Demir
Eczacıbaşı Holding
Senior Innovation Manager



**Assoc. Prof.
Tunç Durmaz**
Yıldız Technical University



ESRA BORAN

TTGV Climate Lab Community Program
Program Specialist

One of the first concepts that comes to mind when talking about communities is developing through learning together. In this journey of development, individuals aim to contribute to societal development while ensuring personal growth through the transfer of knowledge and the development of joint solutions.

Communities are structures that bring together individuals who can contribute at different levels around a common interest and concern. With their dynamic structure, communities provide experiences such as developing creative ideas, collective learning, sharing of knowledge and experience, eliminating tacit knowledge, and problem-solving. As sharing deepens, communities transform into dynamic structures where creative ideas are born, tested, and realized. Communities offer unique environments to anticipate the footsteps of change, witness the experiences of different stakeholders, and act together with a collective group where all of this is blended.

While communities help individuals unleash their creative potential, this accumulation reflects on organizations as higher performance, deeper knowledge infrastructure, and stronger collaborations.

With this understanding, TTGV carries out pioneering efforts through the “Climate Lab Community Program”, which focuses on sharing, knowledge generation, and connecting this knowledge with qualified human capital, and developing ecosystem-oriented solutions with highly aware individuals.

Under the Climate Lab Community umbrella, we come together with stakeholders who believe in the transformative power of technological solutions in the fight against the climate crisis, united by a common vision. We increasingly feel the impact of collaboration, co-creation, and the dissemination of these solutions.

The shared wisdom ground provided by our community enables not only individual development but also systematic transformation. Our new step built on this accumulation is:

“Climate Lab Climate Pioneers.”



“Climate Pioneers is a TTGV Climate Lab platform formed by professionals who aim to make a difference in their own institutions and be part of the solution by activating their knowledge and experiences on climate technologies.”



“The common ground of the Climate Pioneers is climate. But what makes them special is their determination to transform this common concern into concrete solution proposals.”

How Did the Idea of Climate Pioneers Come to Life?

Climate Pioneers Set Out: A Common Ground Called Climate

Clean energy, food safety, waste management, digital transformation... The fields that emerge when we talk about climate technologies span a wide range. These comprehensive technologies not only represent a variety of topics but also emphasize the need for a multidisciplinary approach for solutions.

As TTGV, we look at climate technologies from a more holistic perspective:

- Energy
- Industry
- Mobility
- Agriculture and Food
- Built Environment
- Cross-cutting Technologies (those encompassing intersectoral areas)

Within these thematic areas, we believe that permanent and effective solutions to climate issues can only be developed by thinking together and acting with collective wisdom. Therefore, platforms that bring together different perspectives and encourage collaboration are becoming increasingly important.

With this approach, seven professionals from different fields, united by their awareness and shared insight into the power of interdisciplinary collaboration, came together under the umbrella of Climate Lab Climate Pioneers.



Climate Lab Climate Pioneers

Climate Pioneers is a TTGV Climate Lab platform formed by professionals who aim to make a difference within their own institutions and be part of the solution by activating their knowledge and experience related to climate technologies.

This platform was designed as a dynamic structure where Pioneers, who boldly present creative perspectives and actively take part in climate technologies, come together to inspire, take action for transformation, and create impact through collective wisdom.

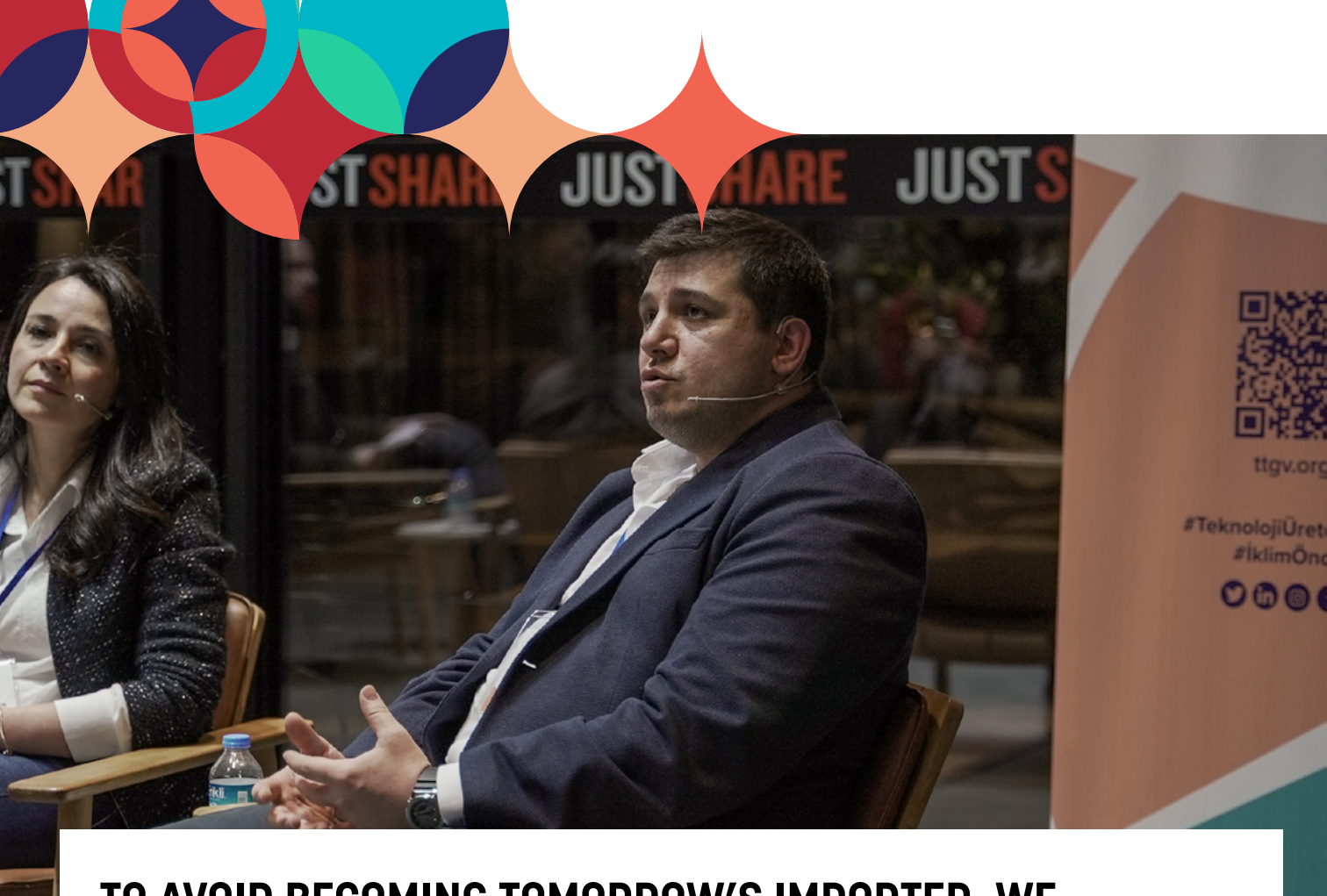
The Pioneers embarked on this journey with the aim of transferring the knowledge and experience they have gained from the field, sharing this accumulation with more people, and contributing to the transformation of our country in this field.

Common Goal: to Inspire and Create Impact

The common ground of the Climate Pioneers is climate. But what makes them special is their determination to transform this common concern into concrete solution proposals. They come from different fields; yet they believe in the power of co-creation, the unifying role of communities, and the potential of their work to create lasting and measurable impact.

This platform not only enables knowledge sharing but also allows for building new relationships, spreading inspiring stories, and transforming learning into a collective value. They take on various roles such as: Supporting community-based learning processes, Strengthening ties with other actors in the ecosystem, Establishing impactful collaborations.

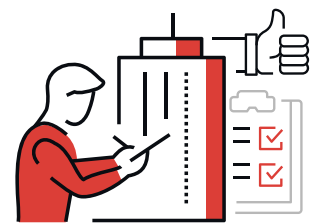
In the journey from idea to impact, Climate Pioneers are ready to lead the transformation of our country in the field of climate technologies, to learn, produce, and act together with all stakeholders from academia to industry.



TO AVOID BECOMING TOMORROW'S IMPORTER, WE MUST BE TODAY'S INNOVATOR IN R&D

ÇAĞATAY ALP ARSLAN

TTGV Climate Pioneer
Vicat Group Türkiye, Group R&D Chief



“Being recognized as a Climate Pioneer has been a powerful source of motivation, as it made me feel that my personal responsibility resonates with a broader social impact.”

Working on climate technology is an ethical duty

The climate crisis has pushed the world into an inevitable transformation. As we all work to adapt our lives to this new reality, we at TTGV have also stepped up and started working in the field of climate crisis and climate technologies. In recognition of your area of work and the value you bring to the field, we have selected you as a “Climate Pioneer.” So, what motivated you to become a Climate Pioneer?

I clearly observe in my technical work that the climate crisis is no longer a prediction about the future—it is a concrete and measurable reality of today. Around nine years ago, my journey of awareness began with R&D projects focused on decarbonization. Since then, I have conducted analyses aimed at reducing process-related emissions in the cement and construction materials sectors. I quantified the impacts of flue gas components and focused on developing innovative solutions. Through carbon capture, utilization, and mineralization technologies, I have worked not only on reducing emissions but also on valorizing waste and contributing to the circular economy. I also took part in collaborative projects across Europe in areas such as hydrogen-assisted systems, plasma reactors, solar energy applications, and the conversion of waste into active phases. Working on these technologies requires not only engineering expertise but also a commitment to climate justice and intergenerational responsibility. Being recognized by TTGV as a «Climate Pioneer» has been a

strong source of motivation for me, as it affirms that my individual responsibility is aligned with a broader social impact.

Climate crisis, climate technologies, and sustainability are major areas of focus both in Türkiye and around the world. So, which topics within this field require active efforts—and why?

Türkiye's industrialization model has long been shaped by high energy consumption and intensive use of natural resources. However, with the introduction of binding international frameworks such as the Paris Agreement and the European Green Deal, the rapid integration of low-carbon technologies into industrial infrastructure has become inevitable. In this context, I can outline three key areas that require intensive R&D and system integration efforts:

1. Carbon Capture and Utilization (CCU) Solutions in Industry
2. Secondary Resource (Raw Material and Fuel) Management and Sectoral Circularity Strategies
3. Data-Driven Digital Monitoring, Modeling, and Decision Support Systems

These areas will play a decisive role in reducing the carbon footprint of high-emission sectors and ensuring compliance with EU regulations. However, technological advancements alone are not sufficient; governance frameworks and economic incentives must also be integrated into these processes to ensure effective implementation.



“Working on these technologies requires not only developing engineering capabilities, but also acting with a sense of climate justice and intergenerational responsibility.”

Three Key Turning Points

In your thematic field, what kinds of transformations, innovations, or breakthroughs do you foresee in climate technologies in the near future? What might their impacts be on your sector?

As one of the most carbon-intensive industries globally, the building materials sector is poised to undergo profound technological transformations over the next decade. These changes will not only reshape production processes but will also redefine product standards and international competitiveness. The three major anticipated turning points are:

1. Carbon Capture and Conversion: Capturing carbon and converting it into fuels or chemicals is critical for reducing emissions and strengthening the circular economy. The integration of modular systems could help move the sector toward a climate-positive future.
2. Integration of Renewable Energy: Incorporating renewable sources such as solar energy and biomass into industrial processes will replace fossil fuels and lead to direct emissions reductions. In high-temperature applications, solar thermal systems and green hydrogen are expected to take the lead.
3. AI-Driven Digital Climate Twins: These systems will enable real-time monitoring of processes to optimize energy use, efficiency, and emissions management—digitizing both production and environmental control.

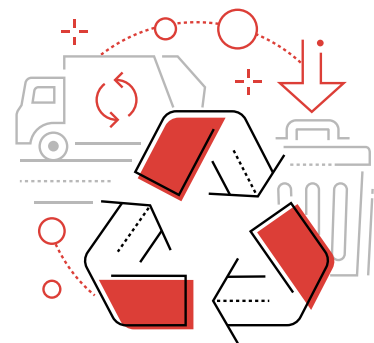
During this transformation, Türkiye must position itself not only as a technology user, but also as a knowledge and solution provider. To achieve this, we must strengthen the links between industry and scientific research, promote interdisciplinary collaborations, and expand financial support mechanisms.

As I often say: If we don't want to be tomorrow's importers, we must be today's R&D pioneers!



TUĞBA UÇAR DEMİR

TTGV Climate Pioneer
Eczacıbaşı Holding Senior Innovation Manager



EVERYONE FROM DECISION-MAKERS TO INDIVIDUALS SHOULD INTERNALIZE THIS PROCESS

The climate crisis has compelled the world into an unavoidable transformation. As we all strive to adapt our lives to this new reality, we at TTGV have also taken responsibility and started working on the climate crisis and climate technologies. In recognition of your field of work and the value you bring to it, we have selected you as a “Climate Pioneer.” So, what has been your motivation in becoming a climate pioneer?

The built environment encompasses the entire set of physical systems that shape our cities, infrastructure, and everyday living spaces. This domain is not only a major contributor to the climate crisis but also one of the most critical areas for transformative solutions. Today, approximately 37% of global greenhouse gas emissions originate from the construction and operation of the built environment. The building materials used—such as concrete, steel, glass, and ceramics—are at the core of this impact.

My motivation in this field stems not only from developing new technologies but also from rethinking how we can reuse existing resources, materials, and discarded products. With advancements in recycling and separation technologies, many materials currently classified as waste actually have the potential to be reintegrated into production. At this point, raising awareness and fostering inter-institutional learning mechanisms is, for me, both a personal and professional responsibility.

“I would especially like to highlight the concept of “residuals.” While “waste” typically refers to materials that have completely lost their function and can no longer be recycled, “residuals” refer to resources that still hold potential for use. Therefore, residual-based production and upcycling technologies should receive greater attention and be brought more prominently into focus.”



“The increasing market value of recycled and symbiotically sourced products could usher in a new era of competition within the sector.”

Material-Based Transformation Is Critical in the Fight Against the Climate Crisis

Climate crisis, climate technologies, and sustainability are key areas of focus both in Türkiye and around the world. So, which topics within this field require active work—and why?

Effective solutions to the climate crisis are not limited to reducing carbon emissions; they also require a fundamental transformation in how we produce, consume, and build. This transformation demands a holistic approach, with active efforts especially needed in long-overlooked areas of the construction sector.

First, material-based transformation is critically important in the fight against the climate crisis. Instead of high-emission construction materials, we need to develop low-emission and sustainable alternatives. This process should be supported by energy efficiency, carbon capture technologies, and the use of alternative raw materials. I would especially like to draw attention to the concept of “residuals.” While “waste” typically refers to materials that have completely lost their function and are no longer recyclable, “residuals” represent resources that still hold potential for reuse. For this reason, residual-based production and upcycling technologies should receive greater attention and become more prominent in the public and industrial agenda.

Secondly, data transparency and traceability are of great importance. To monitor the environmental impacts of materials throughout their life cycles, there is a need to expand the use of digital data infrastructures, material passports, and Environmental Product Declarations (EPDs). In Türkiye, such data is often obtained from abroad at high costs, raising concerns about how accurately they represent our local products. Yet, these traceability mechanisms are essential for cross-sector benchmarking and for developing long-term strategies.

Moreover, I believe that climate solutions must be adapted to local contexts. It's not only about large-scale, one-size-fits-all technologies; solutions tailored to local

resources and needs must also be developed. Approaches such as industrial symbiosis, local collaborations, and the optimization of material flows between institutions can generate significant impact—both economically and environmentally.

In addition to technological transformation, public awareness and behavior change are also of critical importance. From decision-makers to individuals, everyone must internalize this process. We must support the transformation by building communities, learning together, and making successful examples visible. Simple actions—such as separating household residuals and actively participating in recycling—are the individual complements of systemic change. The success of this process depends on collective will.

What kinds of transformations, innovations, or breakthroughs do you foresee in the near future in terms of climate technologies within your thematic area? What might their impacts be on your sector?

Significant transformations related to climate technologies are on the horizon in the built environment. With the European Green Deal and national regulations, carbon footprint reporting is becoming mandatory in the construction sector. This requires transparent, digital, and environmentally traceable production processes. At the same time, bio-based and carbon-negative materials—particularly those produced from agricultural residues—are offering not only environmental benefits but also economic opportunities. Start-up collaborations and AI-powered residual-input matching systems could help make industrial symbiosis scalable. As the market value of recycled and symbiotic-source products increases, a new era of sectoral competition may emerge. This transformation will not only reshape sustainable production, but also redefine business models and cost structures. All of these observations stem from a long-standing awareness of existing needs. And I believe that there are many others who want to be a part of this transformation. If you share the same hopes and concerns, let's think and create together. Because this journey only becomes meaningful when we walk it together.

A NEW IDENTITY IN BIOTECHNOLOGY: THE INDUSTRIAL SCIENTIST



CAN KAYACILAR
Founder of Localvore
Biotechnology

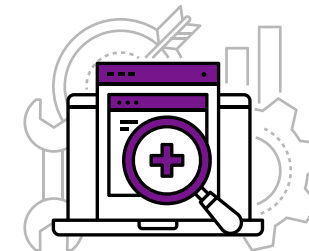
INTERVIEW: Esra YAZDIÇ DEMİR
TTGV, Corporate Communications and
Media Manager

Biotechnology in Türkiye holds great potential, particularly in agriculture- and food-based projects, it faces significant structural barriers when it comes to transforming this potential into industrial production. At this very juncture, a new scientific stance emerges—one that bridges academia and industry: The Industrial Scientist.

We engaged in an in-depth conversation with **Can Kayacılar**, the researcher and entrepreneur who introduced this concept and who has dedicated his work to sustainable and scalable production processes. Kayacılar is the founder of **Localvore Biotechnology**, which operates within the **Türkiye Food Innovation Platform** located on the **TÜBİTAK Marmara Research Center** campus. Our discussion extended far beyond the introduction of an innovative title. We explored the strategic steps Türkiye must take to advance its biotechnology landscape; how agricultural waste can be transformed into value-added products; the future of fermentation technologies; why domestic protein production is of such critical importance; and the reasons why investors often struggle to grasp the full potential of biotechnology.

You refer to yourself as an Industrial Scientist. Could you elaborate on this title, which offers a different perspective to those who perceive biotechnology solely as laboratory work?

One of the biggest challenges in Türkiye, particularly in projects related to food and agriculture, is industrial scalability. In other words, it is crucial to be able to scale the production of a product from one kilogram to one million kilograms—to envision, design, and plan for production at the scale of thousands of tons even when the project is still in its experimental, test-tube phase. I have observed that this is one of the most significant problems facing the biotechnology field in Türkiye, and I have witnessed many projects disappear over time simply because they could not reach the industrial level. For the sustainable development of our country, it is essential to have projects that are not only innovative but also industrially scalable. In fact, all of my research to date has been built around this very principle: ensuring that scientific ideas can be realized at industrial scales. There has been a pressing need for a bridge between academia and industry in this regard. It was precisely from this perspective that I coined the previously unused title “Industrial Scientist” for myself. The Industrial Scientist can be seen as someone who approaches industrial production through the lens of a scientist and a researcher—someone who directly applies science as a tool in the design of industrial processes, while keeping societal benefit at the heart of their vision.



“For the development of our country, it is particularly important to have projects that are industrially scalable. In fact, I have built all of my research to date around this very principle—ensuring that they can be realized at industrial scales.”

Türkiye is also the land where the field of “biotechnology” was born, just like in the rest of the world.

How is the field of bio-entrepreneurship and biotechnology progressing in Türkiye? You have prepared and publicly shared a study titled the “National Biotechnology Proposal.” Could you tell us about the content of this study and why it is important? In your view, what are the key areas in which progress must be made in this field in our country, and what steps should be taken to move forward?

The lands on which Türkiye was founded are, in fact, the very lands where the field of biotechnology first emerged on a global scale. The term biotechnology was introduced into scientific literature in the early 1900s by Karl Ereky, who served as Hungary’s Minister of Food. In a paper focused on increasing the productivity of farm animals, Ereky defined biotechnology as “the technology that transforms raw materials found in nature into socially beneficial products through the use of technology.” This definition marked the entry of biotechnology into the scientific lexicon. Despite being the birthplace of biotechnology, Türkiye has, over time, forgotten its traditional knowledge base and has become increasingly dependent on imports in the biotechnology sector. For instance, the enzymes we use to ferment yogurt, to produce lactose-free yogurt, or to bake fluffier bread are all imported. Similarly, although synthetic pesticides—a major issue in agriculture—are being replaced by natural pesticides across the world, Türkiye has not yet developed its own natural pesticide technologies and continues to rely on imports in this area.

Our country should prioritize the development of value-added products from sources often considered agricultural waste—such as the pulps from factories that produce food raw materials (for example, fruit concentrate factories), the thousands of species of medicinal and aromatic plants that grow in Türkiye, or the plant residues left behind in fields and greenhouses after cultivation.

By value-added products, I refer to extracting all the bioactive plant-based compounds found in these by-products using biotechnological extraction methods, then purifying these compounds, and ultimately using

them in new products across various sectors such as food, dietary supplements, dermocosmetics, and biomedical applications. In short, it is about developing final products from these extracted and purified components. This is, in fact, what we as a country need to do to move forward in biotechnology.

In order to carry out the development of final products, it is essential to design innovative extraction instruments and methods derived from plant-based raw materials. Moreover, to ensure the widespread adoption of these technologies, we must accelerate efforts to simplify them and make them more applicable to industrial settings. In this context, there is a particular need for process engineering capable of separating plant-based proteins, plant-derived peptides, antioxidant compounds, and—something that must never be overlooked—dietary fibers from one another, and enabling their production at different standardized levels. At Localvore Biotechnology, this is precisely the area we are focusing on. We are working on an extraction process we call sequential extraction. Through this method, it becomes possible to extract, in sequence, the aromas, fixed oils, plant-based proteins, and both soluble and insoluble fibers from a single plant seed.

Challenges of Biotechnology Investments

What are the main barriers faced by bio-entrepreneurs in Türkiye in securing investment, commercialization, and scaling processes? What strategies can be implemented to overcome these challenges? What structural reforms and support mechanisms should be prioritized to accelerate the development of the biotechnology and bio-entrepreneurship ecosystem in our country?

One of the biggest challenges faced by young entrepreneurs who wish to start businesses in the field of biotechnology in Türkiye is that investors often struggle to fully understand the projects. This is largely because most investors do not come from

backgrounds in biology, chemistry, biotechnology, or molecular biology. As a result, it can be quite difficult for entrepreneurs to explain their projects in a way that resonates with investors, who in turn fail to envision the future potential of these investments.

The second and perhaps most critical challenge is that biotechnology investments inherently require facility investments. Regardless of whether the project is at the pilot scale or the industrial scale, all biotechnology initiatives fundamentally need physical infrastructure. This means that while investors are already having difficulty grasping the nature of the projects, they are also hesitant to commit to high-cost, high-risk facility investments. The contrast with software investments illustrates this clearly: in software, an application, a game, or a digital solution can grow in scale as it generates revenue, and even though software investments carry risk, investors can easily sell their stake and move on. This is much harder to do in biotechnology.

To overcome these obstacles, biotechnology must be more widely communicated to all segments of society, and its social benefits and real-life impact must be made more visible to both the public and investors. For instance, an investor considering a plant-based protein project may have done some research but may never have personally encountered or used plant-based protein products. This disconnect leads investors to approach biotechnology ventures with greater caution.

Although government and EU support for biotechnology in Türkiye is substantial, in order to fully benefit from these supports, more widespread work needs to be done both in academia and industry on issues such as the valorization of plant-based waste—one of the world's pressing problems—the exploration of the biological functions of plant proteins and peptides, and the development of high value-added products from medicinal and aromatic plants.

Investor education in the field of biotechnology should be prioritized

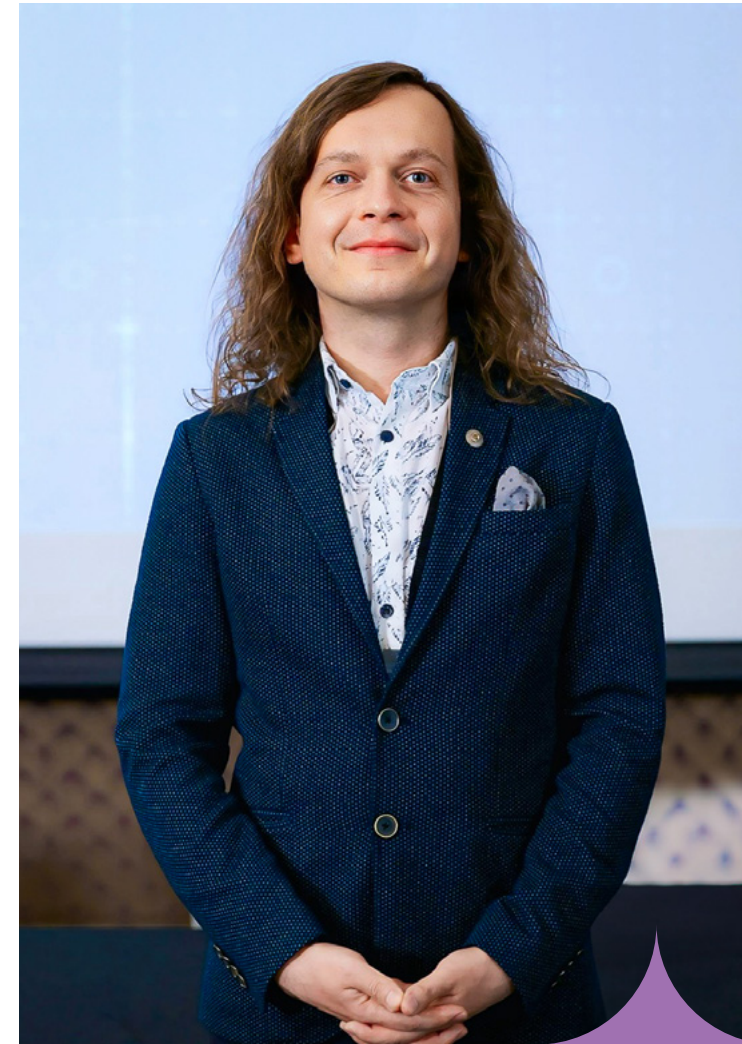
What Should Be Done to Overcome These Barriers?

First and foremost, investor education in the field of biotechnology should be prioritized. The knowledge base of investors in biotechnology must be enhanced to ensure better understanding and more informed decision-making.

Secondly, it is essential to establish “pilot production centers” where experimental laboratory studies can evolve into pilot-scale applications. These could include facilities such as plant-based protein extraction centers, botanical extract extraction and purification plants, standardization centers, and functional food pilot production centers. Thirdly, for entrepreneurs who have moved beyond the initial stages, there is a need for “emerging product support” programs and regulatory frameworks that will help products transition from laboratory scale to pilot production and testing. In other words, there should be easily accessible support mechanisms specifically aimed at pilot production, enabling industrial scalability from the outset.

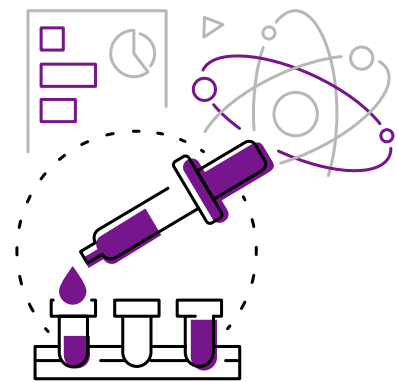
How can collaboration between entrepreneurs, universities, and investors be made more effective and efficient to ensure the success of bio-entrepreneurship in Türkiye? Considering global biotechnology trends—such as gene editing, synthetic biology, and biomaterials—what niche areas could Türkiye focus on to enhance its competitiveness?

Building on its cultural heritage, Türkiye possesses remarkable strengths, particularly in the field of biotechnology. Traditionally, there is a deep-rooted knowledge of fermentation technologies and how to carry out the fermentation of foods. By combining this traditional expertise with modern scientific knowledge and innovative technologies, Türkiye has the potential to take a major leap forward in fermentation-based technologies, which today form the foundation of some of the most talked-about developments in the global food industry—such as the production of food through bioreactors.



The second—and in my view, the most significant—strength lies in waste valorization. As a society, we come from a culture where waste has historically been minimized, where leftover food, clothing, and other materials have always been reused, repurposed, and transformed into something of value. In biotechnology, this cultural mindset finds its modern expression particularly through plant-based extraction technologies. Using these technologies, we can develop new food formulations, dietary supplements, and high value-added products for biomedical and dermocosmetic applications by utilizing bioactive compounds derived from agricultural and plant-based waste.

From this perspective, Türkiye holds great potential to be active in multiple biotechnology subfields—agriculture, food, and health. To ensure the success of these activities, one of the most important priorities is the establishment of collaborative partnerships built around shared goals. Rather than competing against one another, fostering a culture of solidarity and mutual benefit in the business world will help unleash Türkiye's full potential in biotechnology.



“To enhance the digestibility and bioavailability of plant-based proteins, “hydrolyzed plant proteins” are emerging as the plant-based and functional protein sources of the future.”



Beyond the protein content of plant protein isolates or concentrates, their functional properties—such as water-holding capacity and foaming ability—as well as their digestibility—that is, the degree to which the amino acids within the proteins can be utilized by the human body—play a crucial role in their integration into food products. In your opinion, which new technologies and processing methods could Türkiye adopt to produce foods with high protein content, enhanced functionality, and improved digestibility?

This question has indeed provided us with the opportunity to approach the topic of plant-based proteins from the right perspective. Although Türkiye has an intensive plant-based agricultural production, we currently lack a clear roadmap for plant protein extraction, which means that most of what we produce remains merely plant-based raw material. To enable domestic production of plant-based proteins, it is essential to cultivate protein-rich plant species specifically for the purpose of protein extraction. In addition, to enhance both the digestibility and bioavailability of plant proteins, hydrolyzed plant proteins are emerging as key plant-based and functional protein sources of the future. Hydrolyzed plant proteins, along with bioactive peptides derived from them, are likely to play a crucial role in raising awareness of functional plant proteins in Türkiye.

From plant-based raw materials, it is necessary to first purify plant proteins, then apply biotechnological methods to obtain hydrolyzed proteins, and finally to identify the biological functions of the resulting peptides. This

approach allows for the development of plant proteins with enhanced biological functionalities such as antioxidant, antidiabetic, antiviral, antibacterial, and anticancer activities. Therefore, we need to adopt a biotechnological perspective in the development of functional plant proteins. While Türkiye is highly capable in terms of machinery and equipment for developing such technologies, the country lags behind in enzyme production technologies, particularly in the production of protease enzymes used to break down proteins. The local production and cost-effective availability of these enzymes would not only facilitate protein hydrolysis but would also add significant value to plant-based protein production. It is essential for Türkiye to focus on these niche areas in order to strengthen its position in the biotechnology sector.

In recent years, the production of alternative proteins through precision fermentation using microorganisms optimized with genome editing systems such as CRISPR-Cas9 has gained significant momentum worldwide. What kind of roadmap should Türkiye adopt to advance fermentation-based alternative protein production?

I firmly believe that Türkiye should follow in the footsteps of leading countries in the field of gene editing technologies. Around the world, CRISPR gene-editing technology has opened the door to numerous advancements, from the treatment of diseases to increased agricultural productivity and the development of innovative food ingredients. This technology is becoming increasingly widespread, and

its impact is being felt across various sectors more and more each day. Türkiye must strengthen its position in biotechnology by focusing on gene editing technologies and innovative production methods, particularly through sustainable production in bioreactors. As the world moves rapidly forward using targeted fermentation technologies and CRISPR-based gene editing, Türkiye also needs to take decisive steps in this direction. To achieve this, it is essential to establish strong collaboration between the government, private sector, and academia. Additionally, I believe that the current Biosafety Law should be revisited, particularly in terms of its regulations on CRISPR technologies at the production level, especially for industrial-scale applications. Updating the legal framework in this area will be crucial for Türkiye to advance and remain competitive in this rapidly evolving field.

Alternative protein production sits at the intersection of multiple disciplines, including protein engineering, microbial systems, fermentation optimization, product formulation, and regulatory frameworks. In your opinion, where does the most significant competency gap lie in Türkiye that prevents the effective implementation of this holistic approach? Is it the lack of technical infrastructure, the shortage of skilled human resources, or the bottlenecks in scaling processes that pose the greatest challenge?

In my opinion, the biggest challenge in the field of Industrial Biotechnology, particularly in targeted fermentation, is the lack of widespread pilot-scale

production trials in Türkiye. The absence of facilities where pilot production trials adaptable to industrial applications can be conducted, combined with the shortage of human and financial resources required to operate these facilities, represents a major gap in the ecosystem. We know that Türkiye has been exporting highly skilled professionals in biotechnology, bioengineering, and molecular biology to the global market. Therefore, rather than a shortage of human resources, the core issue lies in the inability to carry out pilot-scale productions, the lack of dedicated production facilities, and the insufficient establishment of economic support mechanisms to sustain these operations. I believe addressing these gaps—by enabling pilot production capabilities, building the necessary infrastructure, and creating robust financial support mechanisms—should be among Türkiye's most urgent priorities in this field.

Bioactive compounds derived from agricultural by-products such as olive leaves, fruit pomace, and grape seeds are increasingly gaining prominence in the functional food and nutraceutical markets. In your writings, you often emphasize that Türkiye holds significant potential to achieve both the scientific standardization and the industrial commercialization of such compounds. In this context, what do you consider to be the most critical stages in transforming these by-products into functional ingredients? Specifically for Türkiye, should the focus be more on extraction technologies or fermentation-based methods to enable this transformation?

In my view, Türkiye's priority in advancing biotechnological upcycling should first focus on plant-based extraction technologies, followed by the development of production

methodologies and processes that enable the standardization of the extracted bioactive compounds. Extracting and purifying valuable components from agricultural waste and the country's rich plant biodiversity—components that can protect and enhance public health and carry us into the future—would bring significant added value to Türkiye. In particular, Türkiye must recognize the reality that we have substantial production capacity in thyme, bay leaves, and carob, among others, and that through advanced extraction and purification technologies, these resources can be elevated to higher value-added products. We need to develop projects and act swiftly to transform this potential into tangible outcomes. At Localvore Biotechnology, this is precisely the focus of our work. We have adopted a “sequential extraction” methodology, where instead of isolating only a single group of compounds from a leaf or fruit, we aim to separate all valuable components—such as aromas, antioxidants, plant proteins, soluble fibers, and insoluble fibers—using smart extraction technologies from the same plant material. In doing so, we are working towards zero-waste production models and the necessary process designs, through various projects and industrial production trials. In my opinion, following the advancement of extraction technologies, Türkiye should also pay careful attention to targeted fermentation technologies. To ensure the development and wider adoption of these technologies, the main focus should not just be on human resources but on the local development of bioreactor technologies. This includes not only the bioreactors themselves but also the complementary technologies that make a bioreactor function—such as pumps, sensors, and motor systems—all of which need to be developed domestically.



PRELIMINARY RESEARCH REPORT ON BATTERY RECYCLING AND SECOND-LIFE TECHNOLOGIES

The TTGV Pioneering Project Program team has published the Preliminary Research Report on Battery Recycling and Second-Life Technologies. Prepared to provide a multidimensional assessment of the strategic importance of these technologies for Türkiye, the report analyzes their technical and economic feasibility in a time when electric vehicles and energy storage systems are rapidly expanding. It explores Türkiye's dependency on imported critical raw materials, domestic capacity opportunities, and potential recovery scenarios.

Prepared under the mentorship of TTGV Director of Innovative Technology Programs Dr. E. Serdar Gökpınar, and authored by program specialists Ediz Kaan Önem and Rabia Önen Tüzgel through an examination of national and global developments, the report offers a comparative analysis of the current regulatory framework and international practices. It identifies prominent opportunities and provides a technology outlook tailored to Türkiye's context.

Highlighting the sector's critical role, the report emphasizes that battery recycling and second-life applications offer significant opportunities not only in terms of environmental sustainability but also in economic value creation, strategic resource security, and industrial policy development. This study aims to provide insights that will support progress in these fields and foster collaborations that can help unlock Türkiye's potential.



PRELIMINARY RESEARCH REPORT ON BATTERY RECYCLING AND SECOND-LIFE TECHNOLOGIES 5 QUESTIONS – 5 ANSWERS



“The average lifespan of electric vehicle batteries varies between 7 and 10 years. Therefore, today’s sales will mean thousands of tons of waste batteries in the 2030s, and the amount of global waste batteries is expected to increase 140-fold between 2020 and 2040.”

1. Is access to critical raw materials only possible through mining?

Global demand for batteries has surged, putting intense pressure on metals such as lithium, cobalt and nickel. Today most of these metals come from a handful of countries; in 2022 China processed over half of the world’s lithium and refined cobalt. Relying only on mines exposes us to volatile prices and political risk. Modern recycling plants can recover more than ninety five percent of these valuable materials from spent batteries at high purity. By expanding urban mining, we tap the resources already contained in used batteries and reduce our dependence on new extraction.

2. Why does Turkey need to take battery recycling to the next level?

Turkey’s demand for batteries is growing rapidly, yet nearly all key ingredients including lithium and cobalt and often entire battery modules are still imported. This reliance raises costs and leaves us vulnerable if supplies tighten. Meanwhile, the European Union’s 2024 battery regulation requires producers to reclaim

specific shares of metals such as lithium, nickel and copper. To keep exporting to Europe without extra barriers and to stay competitive worldwide, Turkey must build domestic recycling expertise and infrastructure. Investing in local processing will cut import bills, stabilise prices at home and ensure smooth compliance with international rules.

3. What does second life battery use mean and when does it make sense?

When an electric vehicle battery falls to around half or two thirds of its original capacity, it may no longer meet automotive performance standards but still holds significant energy. Instead of recycling it immediately, these batteries can be repurposed for less demanding roles. After safety inspections for swelling or leaks and tests to measure remaining capacity and internal resistance, technicians rebalance the cells, adjust cooling settings and update the control software for the new application. Following standards such as UL 1974 and IEC 63330, these refurbished packs can power home energy systems, small community grids or backup units in data centres, extending their useful life before final recycling.

4. How does Turkey’s booming electric vehicle market change its recycling needs?

Electric vehicle sales in Turkey have accelerated, meaning batteries sold today—which generally last seven to ten years—will return as waste in large volumes by the early 2030s. Global forecasts predict that retired vehicle batteries will increase roughly one hundred and forty times between 2020 and 2040. At present Turkey lacks sufficient capacity to handle this influx. To avoid a backlog of spent packs and to meet Europe’s mandated recovery targets, Turkey must speed up investment in both large scale recycling facilities and second life programmes. This strategy will convert a future waste challenge into new economic and energy security opportunities.

5. Are recycling processes only about protecting the environment or do they also make economic sense?

Recycling batteries not only reduces pollution and conserves natural resources but also delivers clear economic benefits. Our research shows that high value materials such as lithium carbonate can be reclaimed with up to ninety five percent efficiency

and at a purity suitable for new battery production. This cuts import costs and lowers manufacturing expenses. Moreover, growing recycling and second life industries creates green jobs, drives innovation and strengthens collaboration between universities and manufacturers. In this way battery recycling becomes both an environmental necessity and a strategic driver of industrial growth in Turkey.



Prepared by:
RABİA ÖNEN TÜZGEL
TTGV Pioneer Project Program Specialist

ON THE THRESHOLD OF THE BATTERY ECONOMY: SUSTAINABILITY OR. SCARCE ORE?



EDİZ KAAAN ÖNEM

TTGV Pioneer Project Program
Program Specialist

The world's energy map is being redrawn. At the center of this transformation is no longer just energy production, but also efficiency, technology, and sustainability. And at the heart of this shift lies battery technology. From electric vehicles to energy storage systems, from micro-mobility to grid management—rules across many sectors are being rewritten.

The global battery market is expected to exceed \$400 billion by 2030. But this is not only a major economic opportunity; it also carries serious responsibility. As critical raw materials like lithium, cobalt, and nickel—the very building blocks of technological progress—become increasingly concentrated in specific regions and combined with monopolized production processes, the global economy's access to these resources grows more fragile. The real issue is not just reaching these materials—but managing access in a sustainable, fair, and strategically sound way.

Turkey has the potential to be more than just a passive observer in this transformation—it can become a shaper of it.

The 129% growth in electric vehicle adoption, nearly 6,000 applications for energy storage investments, and strong momentum in the micro-mobility sector are not merely signs of rising consumption; they also signal an emerging technology vision. Yet this exciting growth brings a key question to the forefront: **How can we transform this rapid trend of consumption into a long-term strategy for production and resource management?**

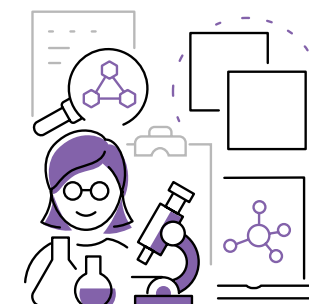
The answer lies in the concept of a circular economy and the structural mechanisms that support it. In particular, battery recycling and second-life applications can not only reduce Turkey's dependency on imported resources but also transform waste batteries into value through **urban mining (urban ore)**.

These efforts must be seen not just through an environmental lens, but as strategic and proactive steps. The fact that Turkey's domestic mineral resources are limited makes the **urban mining** approach even more valuable. Critical materials recovered from end-of-life

batteries can serve as input for secondary production or be converted directly into economic value. This could position Turkey not only as a consumer but also as a competitive global player in raw material supply.

Another area gaining attention and growing in importance is second-life battery use—repurposing used batteries in energy grids, emergency systems, or microgrids. Under the European Union's Battery Regulation, utilizing these applications has now become a legal requirement.

This can generally be summarized in two pathways: **Recycling or Second-Life Use**. However, as in many other countries, making this model economically viable is still at an early stage in Turkey. Bringing together the secondary raw materials obtained through battery recycling and the economic benefits derived from second-life use within a coherent and sustainable techno-economic framework is essential for selecting the right application areas and methods.



“Critical raw materials obtained from batteries that have reached the end of their useful life can be used both as inputs in secondary production and can be directly transformed into economic value. This can make Turkey not only a consumer but also a player in global competition in raw material supply.”

An End-to-End Value Chain Is Needed to Thrive in the Future Battery Ecosystem

Legislation alone is not sufficient to build this structure. A viable ecosystem requires scalable applications, an accessible and manageable battery pool, standardized safety testing, and a system that encourages open data sharing.

While Turkey has strong potential in this field, growth will only be possible through model projects, mandatory or guiding standards, and awareness initiatives. The structural decisions made today will directly determine how resilient and sustainable tomorrow's energy systems will be. Therefore, Turkey must aim not only to produce batteries, but to become a country that gives batteries—and the critical materials inside them—a second life. To bring this vision to life, structural steps must be taken to address the fundamental challenges in the **battery recycling sector**. **Structured battery collection networks** should be established, and legal responsibilities clearly defined. Overcoming core issues—such as fragmented **collection efforts**, the burden of **dormant battery stockpiles**, product traceability, and the development of digital battery management systems—is essential. These are among the most critical bottlenecks facing the transition. If we can complete this chain as a functioning ecosystem, Turkey will not only shape the present—but also take its place among the countries shaping the future.

Let's not forget: **“In a world of limited resources, our ability to think and transform is unlimited.”** Activating this ability is a responsibility not just for today, but for the future.

THE ENERGY OF THE FUTURE IS HIDDEN IN THE BATTERY: TÜRKİYE CAN STEP AWAY IN THE LITHIUM SULPHUR RACE



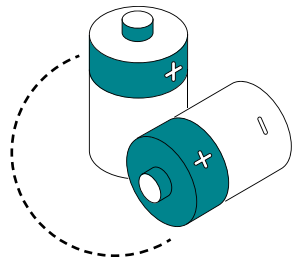
DAMLA EROĞLU PALA

Boğaziçi University
Department of Chemical
Engineering Faculty Member

INTERVIEW: Esra YAZDIÇ DEMİR
TTGV Corporate Communications and Media Manager

On a global scale, the energy transition has become not only a technological imperative but also an environmental and economic necessity. The shift away from fossil fuels in transportation, the need to ensure the continuity of renewable sources, and the aim to reduce carbon footprints have all led to an increased demand for energy storage solutions like never before. One of the prominent technologies in this field is lithium-sulfur batteries, which stand out with their high energy density, low cost, and environmentally friendly nature. But can these innovative batteries truly offer a lasting solution to the energy challenge? We seek the answer to this question in this exclusive interview with **Associate Professor Dr. Damla Eroğlu Pala**, a faculty member at Boğaziçi University's Department of Chemical Engineering, who has dedicated her career to battery technologies, made a name for herself through her research at prestigious institutions in the United States, and was awarded the 2022 L'Oréal-UNESCO "For Women in Science" award.

"The development of batteries with high energy density and low cost plays a critical role in addressing the energy challenges of our time."



Climate technologies have become a top priority on the agenda of almost every country. This is not only a necessity but also a set of opportunities. What led you to pursue work in this field? With what kind of curiosity or motivation did you decide to specialize in energy and battery technologies?

While pursuing my PhD at Columbia University in the United States, I first took part in a project supported by General Electric and the New York State Energy Research and Development Authority (NYSERDA). In this project, I developed a model that accounted for a critical degradation mechanism in a rechargeable sodium-iron chloride battery. My interest in and foundation for battery technologies began with this project.

Later during my PhD, I focused on a different project supported by Boeing, which involved the electrodeposition of nickel-ceramic composite coatings as an environmentally friendly alternative to chromium- and cadmium-based coatings used for corrosion resistance in aircraft. This project also had strong environmental sustainability and industrial application aspects, but I realized that the subject that truly excited me was battery technologies.

Therefore, I decided to carry out my postdoctoral research at Argonne National Laboratory in the U.S., a leading institution in the field of battery technologies. My research there focused on the techno-economic modeling of rechargeable batteries developed for use in electric vehicles. During this time, I was also involved in the "Joint Center for Energy Storage Research (JCESR)," a project supported by the U.S. Department of Energy, which brought together 14 institutions and globally renowned experts in the battery field.

Working on such a comprehensive and interdisciplinary project significantly enhanced my technical expertise in batteries and gave me the opportunity to collaborate with the field's leading scientists. The use of rechargeable batteries in electric vehicles can help reduce carbon emissions and decrease dependence on gasoline. Furthermore, when used in smart grids, rechargeable batteries can enable more effective utilization of sustainable energy sources like solar and wind.

For this reason, the development of batteries with high energy density and low cost plays a critical role in solving the energy challenges of our time. Conducting research on a topic with such strong environmental, social, and societal impact brings me great satisfaction.

In 2022, you received an award in the field of Physical Sciences as part of the L'Oréal-UNESCO "For Women in Science" program. You are working on the development of lithium-sulfur batteries with higher energy capacity and longer lifespan, aiming to reduce carbon emissions and dependence on gasoline. How are the developments progressing in this field both globally and in Turkey?

In recent years, lithium-sulfur batteries have gained significant importance in the development of high energy density, low-cost rechargeable batteries intended for use in electric vehicles and smart grids. This is primarily due to sulfur's high specific capacity, affordability, abundance in nature, and non-toxic nature. Lithium-sulfur batteries offer approximately five times the theoretical specific energy of the widely used lithium-ion batteries. However, their energy density and cycle life remain limited.

As a result, research efforts worldwide have been rapidly advancing with a focus on improving the energy density and cycle life of lithium-sulfur batteries. A review of the literature over the past decade shows that lithium-sulfur technology has become the most extensively studied chemistry among post-lithium-ion battery technologies. In addition, the emergence of start-ups in this field globally signals rapid technological progress.

For instance, U.S.-based Lyten plans to establish a \$1 billion lithium-sulfur battery gigafactory in Nevada to support the production of affordable electric vehicle batteries and reduce dependence on critical raw materials. Stellantis has partnered with Zeta Energy to develop lithium-sulfur batteries for commercial EV applications, targeting lower costs, reduced weight, and faster charging. Meanwhile, Molyon—a Cambridge University spin-off using molybdenum disulfide-stabilized sulfur cathodes—recently raised €4.3 million to develop battery cells for robotics and drones.

In Turkey as well, research into lithium-sulfur batteries has increased significantly in recent years. Recently, through an academic collaboration between Boğaziçi University and Marmara University, we established a start-up called SpinCell Teknoloji with the support of TÜBİTAK BİGG. Together with Assoc. Prof. Mustafa Şengör, Dr. Ayşegül Kılıç, and Fatih Altun, our aim is to translate our academic research into products by developing lithium-sulfur batteries with high energy density.

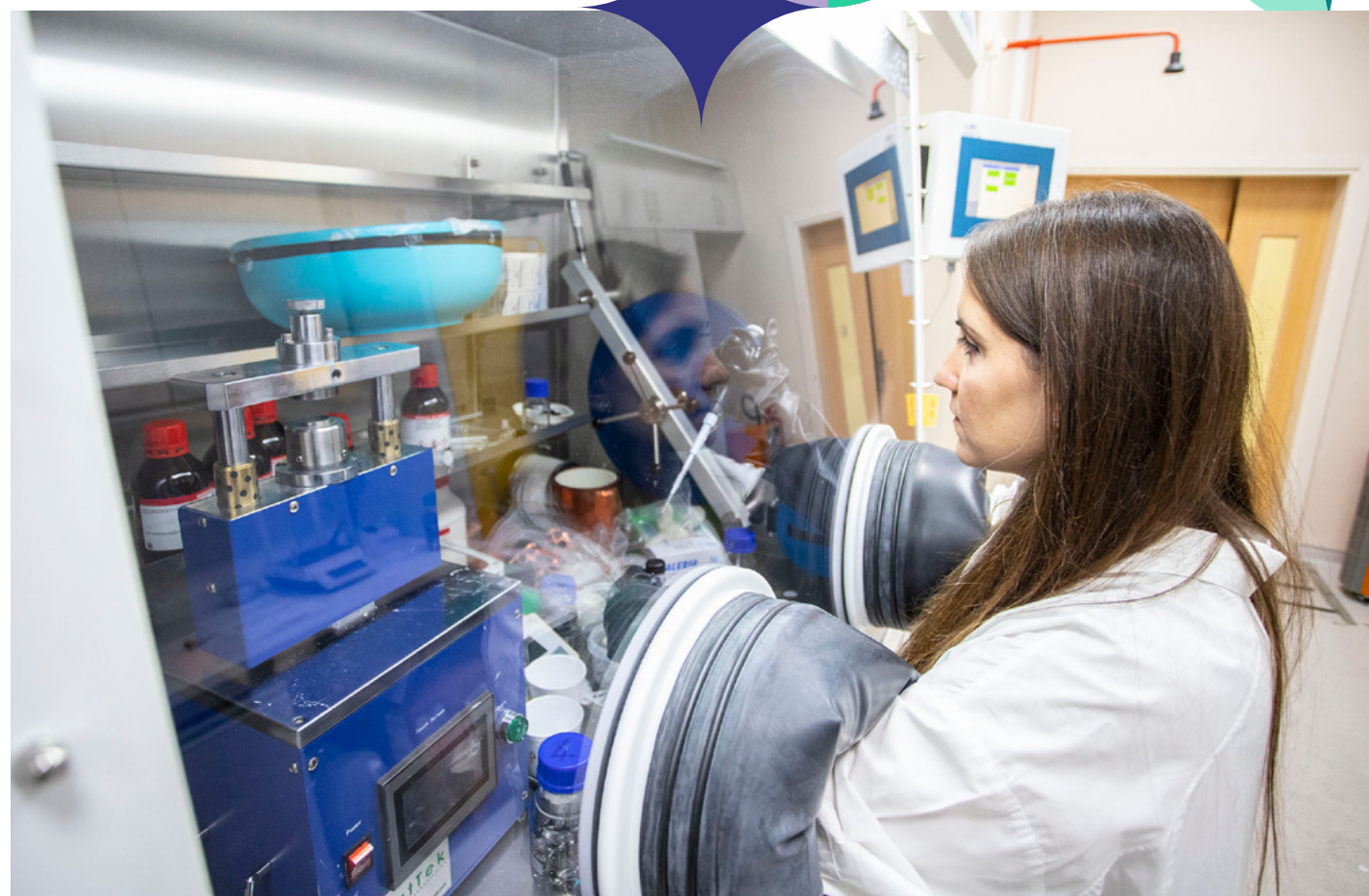
What are your thoughts on the opportunities and challenges faced by researchers in Turkey working on advanced energy technologies and new energy storage materials?

In Turkey, I see several opportunities, such as the ability of scientists from different disciplines to collaborate in academia and the creation of a supportive environment for academia-industry cooperation. A multidisciplinary approach is crucial for the development of next-generation energy technologies. For instance, battery systems require the combined expertise of chemistry, physics, materials science, chemical engineering, and mechanical engineering. Similarly, for these technologies to be commercialized, industry involvement is vital—especially when it comes to key performance metrics like energy density and cost. I believe the collaboration mechanisms in Turkey between academia and industry function quite well. As for the main challenges we face in advancing science and technology, I would highlight budget constraints and long lead times, especially when it comes to acquiring equipment and chemicals.

What kind of transformation do you foresee in energy storage technologies on the path to a carbon-neutral future? How would you define the role of lithium-sulfur batteries in this transformation?

Energy storage technologies are absolutely critical in achieving a carbon-neutral future. First and foremost, the use of batteries in electric vehicles can significantly reduce carbon emissions, as approximately one-third of global energy demand comes from transportation. Additionally, the effective storage of solar and wind energy will enable a significant share of energy production to come from sustainable sources.

However, achieving this goal requires the development of battery technologies that offer high energy density at low cost. Lithium-sulfur batteries stand out in this regard due to sulfur's high specific capacity, affordability, natural abundance, and non-toxic nature. Moreover, in lithium-sulfur batteries, sulfur is used as the active material in the cathode. Sulfur is both abundant and low-cost in Turkey, which gives the country a strategic advantage. If the existing challenges related to cycle life can be addressed, lithium-sulfur batteries could be produced more easily in Turkey compared to lithium-ion alternatives, making them a key player in the transition to sustainable energy.

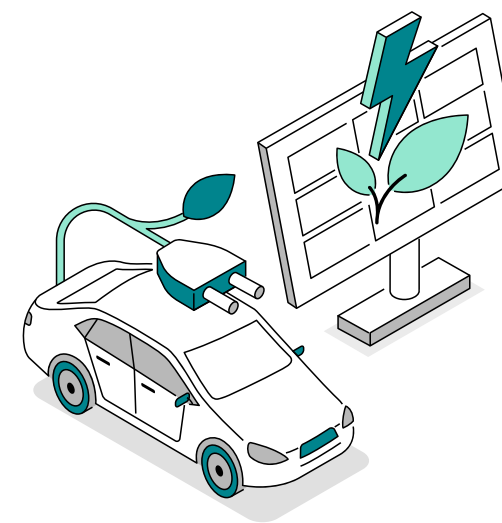


Their Cycle Life and Energy Density Are Not Yet at the Desired Level.

Recently, we have seen the emergence of innovative material designs—such as hybrid polymer network-based cathodes—aimed at addressing the issue of lithium polysulfide dissolution. How do such designs improve the cycling stability of batteries and enhance their energy density?

The biggest obstacle to the commercialization of lithium-sulfur batteries is that their cycle life and energy density have not yet reached the desired levels. This can be explained by several underlying factors. First, both sulfur and the resulting product, lithium sulfide, are electrically insulating solids. Their precipitation on the cathode surface reduces electronic conductivity and passivates the reaction interface, which in turn limits the utilization of active materials. Second, during charging, intermediate reaction products known as soluble polysulfides form at the cathode and migrate to the anode, where they react with lithium metal.

These reactions result in either deposition on the anode surface or re-diffusion back to the cathode. This so-called polysulfide shuttle mechanism significantly lowers the Coulombic efficiency of lithium-sulfur batteries, leading to self-discharge and degradation of the anode surface. In addition, the morphology of the lithium metal anode changes over repeated cycles, increasing the active surface area and accelerating undesirable side reactions with the electrolyte. These reactions deplete both the lithium metal and the electrolyte, further degrading cell performance. All these mechanisms contribute to rapid capacity fading and a substantial reduction in cycle life. To mitigate these issues, current cell designs often rely on excessive amounts of electrolyte and carbon materials. However, the increased use of such inactive components substantially lowers the overall energy density. Recent research shows that the most effective approach to enhancing the energy density and cycle life of lithium-sulfur batteries lies in innovative material design. The most common approaches focus on the



“The biggest economic barrier, in my view, is our dependence on foreign sources for both technological know-how and raw materials. While cell production has recently begun in Turkey, I believe we cannot overcome the economic challenges unless we develop the technology domestically.”

design of conductive materials such as carbon for the cathode, as well as on electrolyte engineering. Through innovative cathode material design, it is possible to enhance the electronic conductivity and surface area of the cathode, while also trapping the polysulfides that dissolve in the electrolyte—preventing them from migrating to the anode. Additionally, these designs allow for much higher sulfur loadings in the cathode and help accommodate the volume changes that occur during cycling. Similarly, with innovative electrolyte formulations, higher Coulombic efficiency in lithium metal cycling can be achieved, battery safety can be improved, and the polysulfide shuttle mechanism can be suppressed. Our recent experimental studies are also focused on both cathode and electrolyte design. For example, we are working on lithium-sulfur battery development using sulfolane and ionic liquid-based electrolytes, as well as metal-organic framework-based cathodes. These include vanadium- and cobalt-modified Ketjen Black, titanium disulfide-based structures, and nickel-sulfide cathodes produced via electrodeposition.

The Economic Barriers to Battery Commercialization

Today, the commercial production of lithium-sulfur batteries remains limited. What technical and economic challenges must be overcome for these batteries to reach mass production, and how do you evaluate the obstacles faced during this process?

To enable the widespread adoption of lithium-sulfur batteries, it is essential to improve both their practical energy density and cycle life. In these systems, material and cell design are critically important for overall battery performance. Therefore, deeply understanding the relationship between material and cathode design and their impact on cell- and system-level performance is crucial for advancing lithium-sulfur batteries to the desired level. From an economic perspective, the most significant barrier is the dependency on foreign sources for technological know-how and raw materials. Although cell production has recently begun in Turkey, I believe we will not be able to overcome the economic challenges unless we develop and produce the core technology domestically.

Key Recommendations on Battery Design

Regarding the future development of lithium-sulfur batteries, which new material and design strategies do you foresee as improving their performance and increasing their chances of commercial success?

critical factors at the material, cell, and system levels. Existing literature largely focuses on improving the capacity and cycle life of lithium-sulfur batteries. While high capacity and cycle life are vital to performance, lithium-sulfur batteries must also be designed with energy density in mind in order to compete with today's lithium-ion batteries.

Therefore, future battery designs must incorporate very high sulfur loading levels and minimal electrolyte content. At this point, innovative electrolyte and cathode material designs will enhance the performance of these batteries and improve their commercial viability.

Among the most prominent recent approaches are solid-state electrolytes, sulfur cathodes encapsulated in nanocarbon structures, and three-dimensional cathodes that eliminate the need for binders and current collectors.



We know that there have been next-generation battery manufacturers in Europe who received major investments but eventually withdrew from the market. There are also investments in this field in Turkey. What do you think we should do to ensure this process progresses positively? What should be done for sustainable battery technology?

For the development of next-generation battery technologies, both interdisciplinary collaborations within academia and academia-industry partnerships are highly important. In batteries, many chemical and electrochemical processes occur simultaneously. Therefore, a multidisciplinary approach in academia gains significant importance in the development of next-generation batteries. In addition, for a technology to be sustainable, the contribution of industry is critical. The industry should adopt a long-term perspective and invest not only in currently commercial battery systems but also in emerging chemistries that are likely to be commercialized within the next decade.



When comparing Europe, Asia, and Turkey in terms of scaling early-stage technologies to commercial levels, what do you think Turkey is doing well, and what could be improved?

Turkey must make significant research investments in next-generation post-lithium-ion technologies. In terms of the commercialization of lithium-ion batteries, both Europe and Turkey have fallen behind. However, we have a greater chance to stand out in technologies that have only recently been commercialized or are not yet commercialized. For instance, sodium-ion batteries are an emerging technology that follows lithium-ion systems and has only recently entered the commercialization phase—Turkey could play a key role in this area. Similarly, I believe both academia and industry in Turkey should prioritize next-generation lithium-sulfur batteries as a core research focus.



China currently dominates the battery technology sector. In this context, how should Turkey position itself? How can it establish a presence in the race for new technologies?

The most critical issue here is reducing dependency on imported critical raw materials used in batteries. Only by doing so can Turkey become competitive. For instance, in lithium-ion batteries, there is significant foreign dependence on key materials—such as lithium metal used in the anode and metals like nickel, cobalt, and manganese found in the metal oxides of the cathode. Being able to source these critical raw materials domestically in Turkey would create a major strategic advantage. In addition, it is essential to invest in research focused on next-generation post-lithium-ion technologies. We have a greater opportunity to gain a competitive edge in technologies that have not yet been commercialized.

FROM AN INVESTOR'S PERSPECTIVE: COMMON MISTAKES IN STARTUP PITCH DECKS



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We often observe that entrepreneurs, while preparing their investor presentations (commonly referred to as pitch decks), sometimes include statements that raise questions in the minds of investors or fail to mention critical information altogether. This can lead investors to perceive the founding team as either overly optimistic or not sufficiently experienced.

We have categorized the most frequently encountered mistakes into four main themes. While these themes are not entirely new, we aimed to provide entrepreneurs with a different perspective by revealing how these mistakes are perceived by investors. We hope these insights will be particularly helpful for early-stage startups as they refine their investor presentations.

1. Inadequate Research into the Realities of Global Expansion

Many entrepreneurs aim to expand abroad to access larger markets, generate foreign currency-based income, or overcome growth-delaying obstacles such as collection difficulties in Turkey or customer-specific technical development requests. While this is a highly valuable goal for most investors, especially those not restricted by local investment mandates, presenting such ambitions briefly and without supporting data in a pitch deck may result in the entrepreneur missing an opportunity to effectively communicate their vision—or worse, raise doubts about their realism.

When startups do not clearly explain why they've chosen a particular market, the rationale behind the selection, the go-to-market strategy, target customer segments, distribution channels, and team structure responsible for execution, investors may assume these elements haven't yet been thought through. This may create the impression that the startup is pursuing investment without a solid strategy, and that the investment might be spent on a non-scalable GTM plan or unnecessary operational expenses.

Founders should justify their target regions and countries with data. Doing so helps investors understand that the founder has considered a wide range of variables in the target market—language, cultural differences, regulations, legal infrastructure, competition, customer behavior, sales cycles, local work culture, potential for local partnerships, and the need for local incorporation or awareness of regional investor expectations. This suggests the strategy is shaped by thoughtful analysis rather than vague ambition.

Additionally, investors generally want to know whether the entrepreneur has conducted competitive analysis in the target markets and gathered early validation that the product is in demand. Engaging with potential customers and sharing feedback received provides a signal of meaningful preparation and highlights why and how the product will gain traction.

While international expansion is an exciting journey for any founder, investors want to see more than just intent. Investors regularly meet startups with similar global ambitions and have witnessed how quickly poorly strategized ventures can burn through capital. It is understandable that the target market or strategy may evolve, but what matters to investors is whether the founding team is agile and informed enough to adapt with a clear vision and flexibility.

2. Unrealistic Revenue Expectations in Global Markets

It is of great importance for founders to justify global revenue projections based on real inputs —such as conversations with potential customers, feedback received about the product, user behavior analysis, pipeline development, and the likelihood of users switching from incumbent competitors. This helps investors assess how well the founders understand their target geographies and how competent they are in collecting, interpreting, and strategizing around market insights.

However, many entrepreneurs frequently set highly ambitious revenue goals in a short time without any customer interactions or proof-of-concept in global markets. Such projections often reduce the credibility of the startups' financial plans.

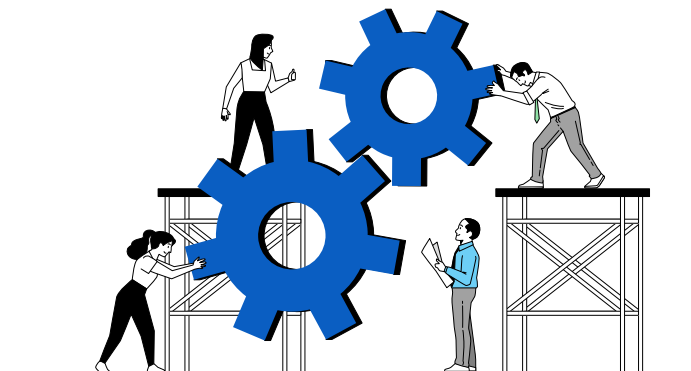
Rather than overly optimistic forecasts, investors prefer teams that prioritize adapting to the market, develop strategy based on field data, and focus on sustainable growth. Since it takes time to understand user behavior, set up sales channels, and achieve product-market fit in new markets—and because the early post-investment phase is often more about learning and adaptation than revenue generation—it is critical that projections combine ambition with realistic, data-driven planning.

3. Allocating Excessive Resources to Product Development Without Understanding Customer Demands

A common critical mistake among founders is to focus on the development process for a long time and at high cost by trying to make their products “perfect” before launching them to the market. Regardless of how advanced the product features are, if it doesn't meet a real need or fit market dynamics, it is unlikely to succeed with commercialization.

Therefore, it's essential to understand the target customer segment and the market's actual needs early on. Releasing an MVP (Minimum Viable Product) as early as possible and collecting feedback from real users helps shape the product based on concrete data about what works and what needs improvement.

Engaging directly with customers and collecting user feedback throughout the development process enables simultaneous product refinement and commercialization. This approach helps the startup operate more efficiently in terms of both time and budget, while also preventing the misallocation of significant resources into development before validating market demand.



“Investors are more likely to support teams that adapt to the market, develop strategies based on data from the field, and focus on sustainable growth, rather than seeing big turnover projections in a short time.”

4. Inefficient and Rapid Growth of the Team

After raising funds, many startups assume that scaling the team is the fastest and most effective path to growth. While this may be true in some cases, it's important to remember that each new hire is not just a salary line item—they also bring coordination, onboarding, communication, and management overhead.

In order for the founding team to properly manage the most important resources such as time and money, it is recommended that instead of the first reflex after investment being rapid expansion of the team, a good analysis should be made of which areas the company really needs human resources, thus preventing possible wrong hires.

Hiring without defining KPIs for each position often leads to operational inefficiencies and increased OPEX, which accelerates burn rate and shortens the company's runway. Comparing team size against current and projected revenue, and optimizing revenue per employee, are strategies that reduce risk and help companies make smarter long-term decisions about which roles are essential.

Investors don't look for large teams—they value lean but effective organizations with the right skill sets. Focused, efficient, and strategically growing teams instill far more confidence.



TTGV LIBRARY

At TTGV, we aim to enhance the understanding of the diversity within our ecosystem, proactively shape technology-focused agendas, bring together different stakeholders and areas of expertise, and uncover high-impact, real needs in the field of technology. Guided by this overarching vision, our expert team reviews both the relevant literature in their respective fields and significant international books published in recent years. Through their assessments, they identify noteworthy works that have not yet been translated into Turkish. We take great pride in contributing to the Turkish literature by making these valuable resources accessible in our native language.



AYŞENUR ATIK BİLEN
TTGV Program Assistant

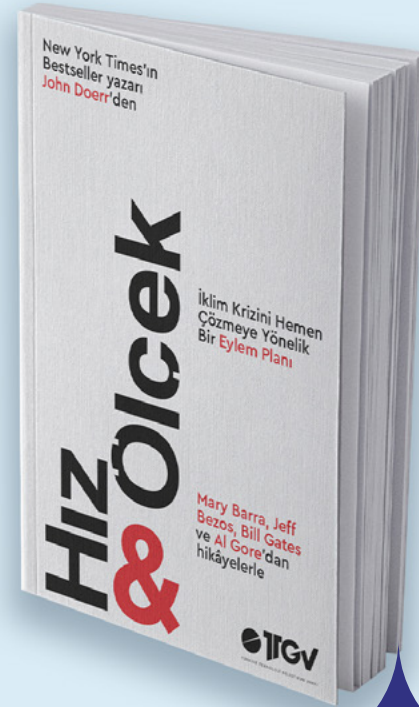
SPEED & SCALE: AN ACTION PLAN FOR SOLVING OUR CLIMATE CRISIS NOW

“I’m scared and I’m angry! Your generation created this problem. You better fix it.”

These words of this 15-year-old girl to her father are not just a personal warning; they stand as a powerful call to action directed at all leaders, entrepreneurs, and decision-makers. *Speed & Scale: An Action Plan for Solving Our Climate Crisis Now*, written by John Doerr, thoroughly examines the scope of the climate crisis and explores possible solutions from every angle. At TTGV, our motivation for translating this work into Turkish stems from a clear and strong belief: it is not possible to tackle a global challenge like the climate crisis without the use of advanced technologies and innovative solutions. We believe that **the response to the climate crisis cannot rely solely on ideas—it must come through measurable and collective action.**

Climate change is not only an environmental issue; it is also at the center of investment, technology, entrepreneurship, policy, and global security agendas. Yet one fundamental question remains unanswered: **“How can meaningful change truly happen?”**

As Doerr puts it plainly: **“A future without a goal is no future at all.”**



Speed & Scale lays out specific, achievable, and trackable targets for tackling the climate crisis. The OKR (Objectives and Key Results) methodology—comprising 10 main objectives and 55 key results—transforms the goal of reaching net zero emissions by 2050 from a mere aspiration into a concrete roadmap and actionable plan. In this book, OKR is presented not just as a management tool, but as a model for systemic transformation.

Objectives and Measurable Indicators

In the fight against climate change, we don't need more words—we need data and a plan. Is the net zero goal just a lofty ideal, or a realistic path forward? This book has the answer.

Each goal defined in the book directly corresponds to one of the essential areas of transformation in the fight against the climate crisis: electrifying transportation, decarbonizing the grid, improving food systems, preserving nature, circularizing industry, removing carbon from the atmosphere, reinforcing legal frameworks, activating social movements, and mobilizing innovation and financial resources.

While these may initially sound like technical solutions, they are, in fact, far more than that: each represents **a sphere of responsibility, a call for investment, and a collective mission.**

Speed & Scale not only outlines **what needs to be done**, but also answers the questions of **how and to what extent action must be taken**. Each target is tied to measurable outcomes designed to reduce global carbon emissions by gigaton levels. *This is not a strategy that remains at the conceptual level—it is a transparent, trackable, and implementation-ready action plan.*

This approach breaks down climate goals into manageable components. In doing so, it clarifies areas of responsibility for policymakers, the private sector, and societal actors alike. It replaces uncertainty with clarity, and wishful thinking with concrete action. Each of these targets is not merely a technical output—they also represent zones of responsibility and calls for investment.

Since its establishment in 1991, the Technology Development Foundation of Türkiye (TTGV) has been committed to fostering lasting change by harnessing the transformative power of technology and innovation. Our mission is to bring together stakeholders from science, technology, and both the supply and demand sides of the ecosystem, in order to generate effective, innovative solutions to complex challenges.

Climate change, with its deeply interwoven causes and consequences, represents one of the most complex issues confronting our civilization today. We consider it essential to frame this challenge within the right context and to establish actionable, measurable, and trackable goals toward meaningful solutions. In this regard, we value the investor perspective—

not only for the financial resources it offers, but also for its capacity to match opportunities with solutions and to promote a holistic understanding of the problem. With the Turkish publication of John Doerr's *Speed & Scale: An Action Plan for Solving Our Climate Crisis Now* under the title *Hız ve Ölçek: İklim Krizini Hemen Çözmeye Yönelik Bir Eylem Planı*, TTGV aims to support the diffusion of innovative thinking across Türkiye's technology and innovation ecosystem, and among key decision-makers.

We believe this work will not only serve as a valuable resource for institutions and companies, but also inspire individuals—and ultimately contribute to advancing Türkiye's climate ambitions.

In this regard, *Speed & Scale* is not merely a book; it serves as a strategic guide that strengthens the intellectual foundation of climate action and catalyzes implementation across various levels.

- **It presents a data-driven, actionable, and transparent plan grounded in accountability.**
- **It emphasizes the role of innovative technologies in supporting effective climate solutions.**
- **It recognizes the importance of engaging not only governments, but also investors, communities, and individuals as active stakeholders.**
- **It offers an inspiring and practical roadmap particularly relevant for countries like Türkiye, which are directly exposed to the risks of climate change.**

As John Doerr emphasizes: **“Ideas are easy. Execution is everything.”**

The era we are living in represents a critical turning point—not only for the climate, but also for our collective sense of responsibility. Meeting this challenge requires more than awareness; it demands decisive action. **Today, we have access to a wide range of tools, technologies, and models to address the climate crisis. What remains missing is a shared commitment to mobilize these solutions—not just through individual efforts, but through institutional decisions, regulatory frameworks, and broad societal engagement.** At TTGV, we take pride in being not merely observers of this global transformation, but proactive contributors and catalysts for change.

Through the publication of the Turkish edition of *Speed & Scale*, our goal was not limited to translation alone. We sought to disseminate the strategic mindset, accumulated knowledge, and action-oriented perspective that the book embodies. We hope *Speed & Scale* will inspire all stakeholders across Türkiye's innovation ecosystem as we collectively advance toward a sustainable, technology-driven future.

AN AWAKENING SPARKED BY A YOUNG GIRL'S CALL TO HER FATHER "YOUR GENERATION CREATED THIS. YOU BETTER FIX IT."



JOHN DOERR
Investor, Author

INTERVIEW: Esra YAZDIÇ DEMİR
TTGV, Corporate Communications and
Media Manager

"I'm scared and I'm angry. Dad, your generation created this problem. You better fix it." These were the words that compelled **John Doerr—one of the world's most influential investors**—to write *Speed & Scale: An Action Plan for Solving Our Climate Crisis Now*. After watching former U.S. Vice President Al Gore's documentary *An Inconvenient Truth*, Doerr witnessed the fear on the face of his then-15-year-old daughter and listened as she expressed her emotions. That moment made him realize that the climate crisis is not a future issue—it is a crisis of the present.

Determined to understand the climate crisis and invest in its solutions, Doerr began researching the topic, learning about it, and persuading those around him.

We spoke with Doerr about the ideas and writing process behind his book, which has been translated into Turkish by TTGV.

"...but the economic opportunity to be had in solving the climate crisis is severely underhyped. Ultimately, it is cheaper to save the planet than it is to ruin it."

We Are the Last Generation with a Chance to Fight this Crisis

What does the world have to face in the climate crisis?

We are running out of time. The time to act is now – this is the last generation that could stop the climate crisis. Climate change amplifies inequities, so the world must face the destruction of our most vulnerable communities first as those who suffer the most from the effects of climate change are marginalized populations and countries with less industrialization.

The world must also expect immense change as a result of the speed and scale of our solutions that is necessary to save the planet. This is economically daunting, and our industries will transform, but the economic opportunity to be had in solving the climate crisis is severely underhyped. Ultimately, it is cheaper to save the planet than it is to ruin it.



What message would you like to send to people in Turkey who are working and interested in this field?

There is a leader inside of everyone. Individual actions are necessary, but collective action is what will get us through this period of climate uncertainty. Those who are working in and are interested in this field must mobilize others into action and inspire them to create change.

TTGV NEWS

We Participated in the Sustainable Food Systems Workshop

Our Precursor Project Program Specialist, **İpek Ceren Yeşildağ**, took part as a panelist at the Sustainable Food Systems Workshop organized by the Ankara Development Agency.

In her panel speech, she highlighted the critical role of alternative protein technologies in strengthening sustainable food systems and ensuring food security.



We Discussed Türkiye's Role in the Hydrogen Sector at the WIN EURASIA 2025 Panel



On the first day of the WIN EURASIA 2025 International Fair, our Precursor Project Program Technical Lead, **Dr. Burak Baykal**, participated as a panelist in the session titled "The Global Hydrogen Ecosystem and Turkey's Role", held within the dedicated Hydrogen and Fuel Cells area.

During the panel, which focused on the evaluation of hydrogen technologies and the value chain from both global and national perspectives, all speakers shared their insights on the necessary actions and requirements for the widespread adoption of clean hydrogen technologies. In this context, **Dr. Burak Baykal** also shared the latest developments and technology trends in the field of hydrogen technologies in Turkey with the audience.

We Hosted the Battery Recycling and Second-Life Technologies Panel



In line with the findings of our Preliminary Research Report on Battery Recycling and Second-Life Technologies, sector experts, stakeholders, and key figures from the ecosystem came together at the Battery Recycling and Second-Life Technologies Panel, which we held in Ankara.

The panel, hosted at CoZone in Ankara, provided a platform to discuss policy recommendations, practical applications, and the future of battery technologies within the framework of the circular economy. Topics included regulatory developments, technology trends, second-life applications, and industry-academia collaborations, all aimed at enhancing the sustainability of battery technologies.

We Organized the Climate Technologies Panel in İzmir



In collaboration with Yaşar University, we organized the Climate Technologies Panel at the İzmir Historical Gasworks Factory to bring attention to climate-focused agriculture and food technologies, commercialization opportunities, and international cooperation prospects.

The panel explored innovative approaches within the food and agriculture ecosystem, global collaboration opportunities under the EIT Food framework, and available grant models. Participants also discussed the technological transformation across the value chain and evaluated commercialization opportunities.



The 36th Founders' Board Meeting of the Technology Development Foundation of Turkey Was Held

The 36th Founders' Board Meeting of the Technology Development Foundation of Turkey (TTGV) was held in Ankara, starting with the opening speech by TTGV Chairman of the Board, **Mr. Değerhan Usluel**. In his address, Mr. Usluel provided an overview of the Foundation's activities throughout 2024 and shared insights into the initiatives implemented over the past year.

As part of the meeting, the 2024 Activity Report, the Audit Report, and the 2025 Work Plan and Budget were presented for the Founders' Board's approval and were unanimously adopted. In addition, the members of the Board of Directors and the Audit Board were discharged by unanimous vote.

Former TTGV Board Member Mr. **Güngör Yıldızbayrak** was elected as a new member of the Founders' Board.

TTGV Awards' Winners Announced

Winners of the 2025 TTGV Awards:

Dr. Akın Çakmakçı Leading Researcher Award:

Assoc. Prof. Dr. Damla Eroğlu - Boğaziçi Üniversitesi

Dr. Fikret Yücel Leading Company Award:

DB Tarımsal Enerji Sanayi ve Ticaret A.Ş.

Refik Üreyen Change Leader Award:

Dr. Vahide Nuran Mutlu - SOCAR Türkiye

Mehmet Şuhubi Leading Civil Initiative Award:

Boğaziçi University Climate Change and Policy Application and Research Center (İklimBU)

The awards will be presented to their winners at a ceremony to be held on Wednesday, October 15, 2025 at Ankara Bilkent Hotel and Conference Center. We congratulate the winners.



From Linearity to Circularity: TTGV Presented Its Green Transformation Vision at TESEM II

As the Technology Development Foundation of Turkey (TTGV), we believe in the transformative power of technology in achieving sustainable development goals and remain committed to advancing the green transformation of industry. In this context, our Eco-Production Transformation Program Specialist, **Beyza Akyol**, made a valuable contribution at the 2nd TESEM – Turkey Electronics Industry and Electronics Engineering Congress held in Bursa. During the session titled “R&D, Green Transformation, and Sustainability in the Electronics Industry”, she delivered a presentation on “Green Transformation in Industry: From Linearity to Circularity”, where she outlined the imperatives of industrial green transformation, circular economy approaches, and TTGV's current initiatives in this field. The presentation also emphasized the importance of transitioning from linear production models to circular models and highlighted the need to integrate circular perspectives into eco-design processes.

We Highlighted Our Carbon Solutions Generating Economic Value on the National Stage



Our Precursor Project Program Specialist, **Dr. Güniz Gürel**, shared our approaches supporting the decarbonization of industry at the National Carbon Capture, Utilization, and Storage (CCUS) Workshop.

During the workshop, we presented our in-depth analysis report titled “Carbon Capture, Utilization, Storage (CCUS) and Carbon Dioxide Removal (CDR) Solutions with Economic Value Creation Potential”, and engaged with participants to evaluate the technological opportunities and implementation pathways in this field.



Addressing Entrepreneurs' Access to Finance: We Reiterated Our Call for Collaboration

The panel titled “The Road to Investment: Unlocking Financial Resources”, held as part of the Entrepreneur Workshop organized by Arya Investment Platform, explored entrepreneurs’ access to finance from the perspectives of the public sector, private sector, and investment funds. The event brought together key figures contributing to the entrepreneurial ecosystem.

The panel was moderated by Sedef Erdoğan, Growth Lead at Arya Investment Platform, and featured distinguished speakers including our Secretary General Dr. A. Mete Çakmancı; Cavide Pehlivan, Director of KOSGEB Tekmer; İmran Gürakan, CEO and Co-Founder of LEAP Investment; and Elif Koşok, Executive Board Coordinator of TÜBİTAK Venture Capital Funding Group.

In his speech, Dr. Çakmancı emphasized that TTGV is a pioneering public-private partnership supporting R&D, innovation, and environmental technology projects within the private sector. He highlighted TTGV’s contribution to both economic and environmental transformation through its programs, adding: “Institutions developing technology, academics, and investors can benefit from our support. We are open to collaboration with entrepreneurs and investors,” thereby renewing TTGV’s call for cooperation.

From Strategic Autonomy to Green Transition: We Contribute to Shaping the Future of European Industrial Policies



As a member of the Taftie network, TTGV’s Director of Development Programs, **Evren Bukulmez**, participated in the Taftie Insight Session and Working Group Meeting hosted by Business Finland. The meeting addressed key topics such as the reshaping of European industrial policies in light of changing global geopolitical dynamics, strategic autonomy, dual-use technologies, competitiveness, green transformation, and the integration of innovation policies with industry.

At TTGV, we remain committed to fostering deeper discussions on the interaction between innovation and industrial policies and to contributing to the development of joint solution proposals.

Eco-Design at the Dawn of a New Era: TTGV Takes a Pioneering Step Towards Sectoral Transformation



In line with its sustainable development vision, the Technology Development Foundation of Turkey (TTGV) has taken a significant step to promote design approaches that minimize environmental impact in Turkey. The Eco-Design Stakeholder Meeting held on June 17th brought together various stakeholders to assess the needs and opportunities in this field and to discuss global developments within the context of Turkey.

A Global Transformation: Eco-Design Becomes a Legal Requirement

With the European Union’s new Ecodesign for Sustainable Products Regulation (ESPR), eco-design has evolved beyond environmentally conscious product design and has become a legal obligation. The new regulation mandates criteria such as durability, reparability, energy efficiency, and recyclability of products. Moreover, the introduction of the Digital Product Passport (DPP) will enable transparent tracking of product information. This framework aims to standardize sustainable production by integrating with other European green regulations such as CBAM, CSRD, and the EU Taxonomy.

The Situation in Turkey: Growing Awareness Amid Structural Challenges

Although there is considerable potential for eco-design in sectors such as textiles and steel in Turkey, significant implementation challenges persist. In the textile sector, product diversity and fast fashion culture hinder the design of simple, long-lasting products. In the steel industry, striking a balance between recyclability and material quality is critically important. Across all sectors, transparent data infrastructure, reliable life cycle assessments, and consumer awareness are key factors for the success of eco-design initiatives.

TTGV’s Vision and Objectives

This meeting marked more than just an initial step—it reinforced TTGV’s guiding and facilitating role in advancing eco-design and creating collaborative environments where individuals and institutions can exchange knowledge and generate ideas. The diverse perspectives shared by participants from different sectors emphasized the importance of collective intelligence, collaboration, skills development, and internalizing eco-design principles for the effective implementation of sustainable production practices. Eco-design should not be viewed solely as an environmental issue, but also as a strategic competitive advantage. Maintaining a strong position in export markets will increasingly depend on developing products that comply with these new regulations. With practices like the Digital Product Passport (DPP) expected to impact approximately 25% of Turkey’s exports, it has become imperative for TTGV to align its support mechanisms in this direction.

Through this initiative, TTGV aims to foster the development of institutional knowledge and reflexes that integrate environmental sustainability into product development processes. The goal is to move beyond a project-based approach and embed eco-design as a natural element of strategic decision-making, organizational culture, and business processes, thereby laying the groundwork for this transformation for manufacturers and stakeholders in Turkey.

OUR RECENT REPORTS



Alternative Protein Technologies Deep Dive Analysis Report - Summary

As part of the Pioneer Projects Investment Program, “Alternative Protein Technologies” was selected as the fourth deep dive analysis topic. A comprehensive research effort was conducted between November 2023 and March 2024. Through engagement with nearly 100 industry experts and organizations, the study carried out an extensive examination of alternative proteins, integrating their socio-cultural, ethical, and societal dimensions. This deep dive addressed systemic issues, opportunities, and threats associated with the current global food system, while thoroughly exploring the technological landscape of alternative proteins. In addition to a comparative evaluation of regulatory frameworks and investment trends in both global and Turkish contexts, the study also identified emerging sectoral dynamics and future directions. Based on these findings, strategic recommendations tailored to Türkiye’s ecosystem were proposed, along with potential project scenarios that reflect the transformative potential of alternative protein technologies.



Clean Hydrogen Technologies Deep Dive Analysis Report - Summary

In alignment with its 2053 net-zero carbon emissions target, Türkiye aims to establish a carbon-neutral economic model through the integration of hydrogen technologies. This strategic direction holds critical significance in terms of both decarbonization and achieving energy independence. The Clean Hydrogen Technologies report prepared by TTGV presents a deep dive into the technological advancements and challenges associated with the production, transportation, storage, and utilization of hydrogen. The analysis further explores Türkiye’s renewable energy potential and examines the country’s strategic opportunities to emerge as a global player in green hydrogen production.



Summary Report on Grid-Scale Long-Duration Electrochemical Energy Storage for Increasing the Share of Renewable Energy in Türkiye’s Energy Mix

In support of the development of Pioneer Projects, a structured process has been established—extending from idea generation to project investment and scaling. As the initial/pilot focus area within this framework, “Grid-Scale Long-Duration Electrochemical Energy Storage for Increasing the Share of Renewable Energy in Türkiye’s Energy Mix” has been selected.



Sustainable Cement Production Deep Dive Analysis Report - Summary

As part of the Pioneer Projects Investment Program, the topic “Sustainable Cement Production for the Decarbonization of the Building and Construction Sector” was selected for deep dive analysis between July and October 2023. This study examines the current landscape and ongoing projects related to decarbonization and sustainable cement production within Türkiye’s cement industry. The report provides an overview of the global and Turkish cement sectors, analyzes production methods and the associated value chain, and explores decarbonization pathways for the industry. Furthermore, the report elaborates on the contribution of innovations to emissions reduction and highlights regulatory and policy frameworks that can facilitate the scaling of these innovations.



Climate Technologies Radar - Version 3.0

Developed through an extensive literature review grounded in global trends and Türkiye’s strategic priorities, the Climate Technologies Radar (Version 3.0) presents a comprehensive mapping of key technological domains. The framework is structured around five vertical sectors: Industrial Production, Energy, Mobility and Transportation, Agriculture and Food, and the Built Environment. Cross-cutting themes are examined in detail, including water resource management, waste management and circular economy, land management, carbon dioxide removal solutions, digitalization and digital transformation technologies, climate risk management, and finance and business models.

Deep Dive Analysis Report - Carbon Capture, Utilization and Storage (CCUS) and Carbon Dioxide Removal (CDR) Solutions with Economic Value Creation Potential - Summary

Within the scope of TTGV’s Pioneer Project Program, a comprehensive deep dive analysis was conducted on the current landscape and future outlook of Carbon Capture, Utilization and Storage (CCUS) technologies and Carbon Dioxide Removal (CDR) solutions, which are expected to play a critical role in decarbonization efforts—following energy efficiency and renewable energy sources.

Prepared between April and November 2024, the study closely examines global and national developments in the field, focusing on key dimensions such as technological applications, policy frameworks, and carbon markets.

Developed from a techno-economic perspective, the deep dive report assesses the potential, feasibility, and integration pathways of CCUS technologies and CDR solutions into business models within decarbonization plans. As an executive summary, this report is intended to serve as both a strategic resource and a guiding reference for Türkiye to fully leverage the benefits of these emerging technologies.





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