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THE FUTURE DOES NOT ARRIVE ON ITS OWN

When we talk about the future, we often focus on the speed of technology: on how artificial intelligence will reshape our lives, on the new tools of science, climate technologies, smart manufacturing, and the transformation of agriculture and industry. Yet today, we may be facing an even more important question: **Who will determine the direction of this transformation?**

Developing technology is only part of the challenge. We also need to direct it toward the right problems, connect knowledge generated in laboratories with real-world needs, manage uncertainty, and scale the value created. This is precisely where the different voices featured throughout this issue converge: **The future is not an outcome delivered to us by technology; it is a process shaped by the right choices, the right questions, and people who take action.**

This year, that idea carries a special meaning for us. **As we celebrate our 35th anniversary, we will once again bring together different actors from the technology and innovation ecosystem at TTGV Day & Awards on October 14.** While reflecting on 35 years of accumulated experience, our main focus is not simply to look back, but to think together about how we can build a path from that legacy toward the future.

As we discuss topics ranging from the transformative power of artificial intelligence to Türkiye's emerging opportunities in technology, the **TTGV Awards** will recognize individuals and initiatives that contribute to turning knowledge into technology, technology into application, and application into impact. Because progress in the technology ecosystem depends not only on good ideas, but also on the people who pursue those ideas, take risks, create, and open new paths for others.

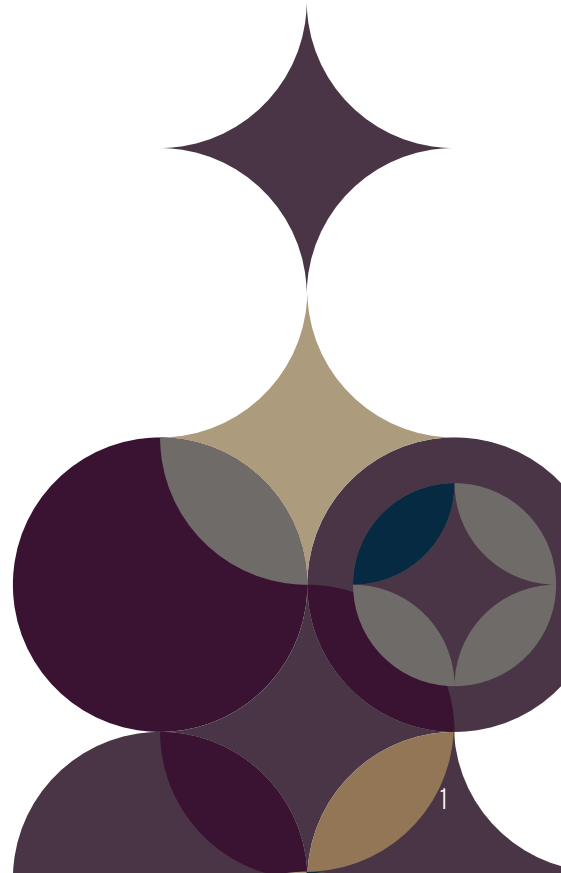
The issue in your hands reflects different dimensions of this same pursuit. Across our articles and interviews—from **AI for Science and the return on AI investments to smart agriculture, industrial symbiosis, climate and energy entrepreneurship, and industrial transformation**—we do not look at technology only through the question, “What can it do?” We also ask: “What problem does it solve? How does it create value? How do we measure its impact? And who is in the driver's seat?”

The experiences of our experts, stakeholders, Climate Pioneers, and community all remind us of the same thing: **The future does not arrive on its own. It is built by those who are curious about it, who experiment, who create, who take responsibility, and who act together. Just as TTGV has been doing for 35 years.**



ESRA YAZDIÇ DEMİR

TTGV, Corporate Communications and Media Manager





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TTGV, Secretary General

TRANSFORMATIVE TECHNOLOGIES AND OPPORTUNITIES FOR TÜRKİYE

The technologies that will most profoundly transform our lives in the coming years also hold some of the greatest economic opportunities. Artificial intelligence, climate technologies such as energy transition and sustainable agriculture and food systems, and innovative health technologies are among the leading areas of this transformation.

Türkiye must focus on and deepen its presence in the specific links of the global value chain where it can gain a competitive edge in these technologies. **Being among the countries that shape this transformation rather than watching it from behind is a strategic imperative** for our prosperity, competitiveness, and security.

Moreover, we do not need to develop every core technology from end to end; in many fields, doing so may not be realistic. Türkiye can still become a major player in the global transformation by producing critical components in selected niche areas, rapidly testing and absorbing new technologies, integrating them into industry and becoming one of the best at applying them in practice, and scaling the resulting knowledge and experience across different geographies.

Competitiveness Is Not Possible Without Energy Transition

Consider the energy sector. According to the International Energy Agency (IEA), global energy demand is projected to double by 2050 as artificial intelligence data centers expand and the world's population approaches 10 billion. Moreover, electricity generation and energy use across industry, transport, and buildings together account for approximately 75% of global emissions, making energy vital to addressing climate change and sustainability. Where we stand in energy technologies will therefore determine where we stand in the economy of the future.

Türkiye has significant advantages: high renewable energy potential, strong engineering and manufacturing capabilities, a diversified industrial base, a strategic location, and logistics infrastructure that facilitates access to Europe. By building deeper expertise in clean energy technologies and strengthening our engineering, deployment, testing and certification, and scaling capabilities, we can turn our country into a regional energy and technology corridor.

So, where should we focus? Renewable energy, electrification, heat pumps, and electric vehicles are becoming industry standards. At the same time, as the cost of solar and wind systems falls, the main challenge is no longer simply to build more power plants, but to manage intermittent generation effectively within the energy system. Türkiye must quickly extend its existing installation and operating experience into energy storage and grid-flexibility solutions. Key focus areas include battery technologies, smart grids, power electronics, energy management, microgrids, and testing and validation infrastructure.

Another opportunity lies in battery recycling and second-life applications. As electric-vehicle batteries reach the end of their useful lives, recycling will become increasingly critical. Although this issue receives limited attention today, it will confront us in the medium term, so it is important to position ourselves now. Türkiye can become a strategic hub between Europe and Asia for battery recycling and urban mining, recovering critical raw materials such as lithium. We should also closely monitor battery chemistries that depend less on critical raw materials, such as sodium-ion batteries, as well as alternative technologies suited to long-duration energy storage, including mechanical storage, and build the capacity to deploy and manufacture them.

Another important opportunity in the energy transition is next-generation fuels, including clean hydrogen and its derivatives. Our agricultural capacity provides a strong foundation for biofuels, while our renewable energy potential supports synthetic fuels. The focus should not be limited to production, but should encompass an integrated value chain covering production, storage, transport, conversion, certification, and end use. With its ports, industrial zones, refinery infrastructure, and renewable energy potential, Türkiye can become a regional hub in this field.

It is also critical to prepare the industrial sectors in which we are strong for a low-carbon future. Türkiye's cement industry, which ranks among the top three in Europe and the top five worldwide, is a tangible area of competition. Relevant technologies include converting construction and demolition waste into sustainable cement, developing alternative clean materials and fuels, and carbon capture. Understanding and advancing even those areas that are not yet economically viable can create a significant competitive advantage. Rather than attempting to build a large and costly carbon capture and storage economy in the short term, we should pursue selective, industry-integrated applications in energy- and carbon-intensive sectors such as cement, steel, refining, and chemicals. An important opportunity is to treat captured carbon not as waste to be disposed of, but as a next-generation feedstock that can be converted into fuels, chemicals, or construction materials.

In short, in energy transition and decarbonization we must look beyond today's technologies, identify as quickly as possible the areas in which pioneering applications of emerging technologies can give us a competitive advantage, and build the necessary capabilities.

At TTGV, we seek to guide industry through deep dive, forward-looking analyses in these fields and pioneering project examples designed to have a demonstration effect. To date, our energy- and decarbonization-focused research and deep dive analysis has covered Energy Storage Technologies, Battery Recycling and Second-Life Technologies, Clean Hydrogen Technologies, Alternative Next-Generation Fuel Technologies, and Carbon Capture, Utilization and Storage Technologies. We have also launched targeted calls for first-of-a-kind, pre-commercial demonstration projects in these areas.

Agriculture-Food Sustainability Is an Absolute Must

Alongside energy, agriculture and food are another critical area of transformation, as they are among the sectors in which the effects of climate change are felt most directly. Ensuring sustainable access to food and water for a growing global population under increasingly difficult climate conditions will be one of the defining challenges of the future. Water stress, rising temperatures, drought, extreme weather events, and yield losses are no longer theoretical risks for Türkiye; adverse climate conditions are already causing a serious contraction in the agricultural sector. Nevertheless, Türkiye remains an important agricultural country, and the sector must undergo a technological transformation if we are to preserve this strength and carry it into the future.

So, where should we focus? Precision agriculture, AI applications in farming, smart greenhouse and irrigation systems, next-generation fertilizers, technologies that extend food shelf life, biotechnology solutions, alternative proteins, and waste-based circular solutions are among the key opportunities driving the transformation of agriculture and food worldwide.

From Türkiye's perspective, significant needs exist in water and watershed management, climate-risk monitoring and early warning, soil health and input efficiency, resource circularity, and resilience. Promising solutions include digital monitoring, early-warning and decision-support systems; water metering, precision irrigation, and safe water-reuse systems; soil-health and precision-input management; smart mechanization and biological protection; climate-resilient genetic materials and controlled-environment production; precision livestock farming and biological production systems; mechanization, robotics, and energy-efficient systems; circular resource use; and post-harvest value preservation. To give one example, Türkiye has substantial agricultural and organic waste resources. Technologies that convert these resources into food, fuel, and next-generation materials offer important economic opportunities.



“Sustainable access to food and water for a growing global population, amidst increasingly difficult climate conditions, will be one of the most important issues of the future.”



In addition to our deep dive analysis of Alternative Protein Technologies, which we shared with the ecosystem last year and which has become an important reference in its field, and our pioneering project examples, we will publish our comprehensive analysis of the “Technological Transformation of the Agricultural Sector” in the coming months. The study examines the two-way relationship between agriculture and climate: both the effects of climate change on agriculture and the pressures agricultural production places on the climate and ecosystems. Alongside a detailed technology map and scenarios for pioneering projects, it covers the investment and financing ecosystem, the policy framework, global good practices, and assessments and recommendations for Türkiye, providing the ecosystem with practical guidance.

We Must Act Extremely Fast in Artificial Intelligence and Digital Transformation – We Cannot Manage What We Do Not Understand

For a country like Türkiye, with significant accumulated expertise, production infrastructure, and experience in certain sectors, maintaining global competitiveness requires placing digitalization and artificial intelligence at the heart of those sectors without delay. Although individual use of AI within companies is growing rapidly, corporate adoption - particularly effective and appropriate use - remains very low. The number of AI startups in Türkiye, most of which focus on corporate productivity, automation, and decision-support solutions, is growing steadily; however, institutions' capacity to absorb and scale the technology is still seriously inadequate.

Companies must adopt artificial intelligence not as a tool added to existing processes, but as a strategic technology that reshapes workflows, employee roles, and decision-making. They must align their data and infrastructure through sound governance and develop their people accordingly. More than ever, we need people who understand and can manage the opportunities AI creates, reason well, define the right problems, and make sound decisions.

Companies of every size and in every sector need strategies for adopting applications that deliver measurable benefits, including industrial applications, predictive maintenance, quality control, energy optimization, demand forecasting, sales, and marketing - currently among the most common uses of AI. More advanced sectors and organizations must also begin working without delay on next-stage applications such as generative design, digital twins, and autonomous factories.

What lies ahead? Beyond relatively conventional automation, AI's most transformative impact may emerge in fields such as biotechnology, healthcare, materials science, and energy engineering. We are moving from systems that review the literature to 'AI scientists' that formulate hypotheses, design experiments, make scientific discoveries, and develop new molecule or material candidates. Advanced systems already show considerable potential, from predicting protein structures

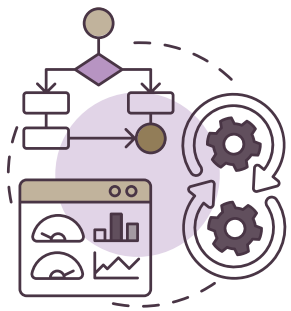
to discovering new crystal and material candidates. These developments could transform R&D across fields ranging from pharmaceuticals and next-generation batteries to solar panels and semiconductors.

The opportunities AI offers for climate action and sustainability are another important area of focus, including climate forecasting, energy management, emissions tracking, and precision agriculture. At the same time, the sustainability of AI is just as important as the use of AI for sustainability. We must develop more efficient models and solutions that reduce its growing energy and resource requirements. The AI ecosystem is extremely broad, spanning many layers from chip technologies and data centers to language models, cybersecurity, and solutions that reduce hallucinations.

It is, of course, unrealistic for Türkiye to compete in every one of these layers. However, both our technology developers and our institutions must look at AI opportunities more broadly than operational improvement and automation, and quickly identify applications and areas that can build competitiveness across different dimensions.



At TTGV, we have launched a new deep dive analysis on Artificial Intelligence. The study has three pillars: high-value industrial applications, AI for science, and the intersection of sustainability and AI. When completed, it will identify opportunity areas and pioneering application examples for Türkiye and provide a valuable reference for the ecosystem.



“Türkiye needs to identify opportunities where it can gain a competitive advantage in transformative technology fields, rapidly develop and field-test selected niche technology components, and build up know-how, implementation capacity, and supply chains through reference projects.”

To Become an Ecosystem That Runs Ahead, Not One That Lags Behind

In summary, Türkiye must identify opportunities in transformative technologies where it can build a competitive advantage; rapidly develop selected niche technology components and test them in real-world settings; and build knowledge, deployment capacity, and supply chains through reference projects. This approach can make Türkiye a regional power that shapes the transition economy rather than merely following the transformation.

However, significant barriers stand in the way of converting these opportunities into competitive advantages.

The development and scaling of new technologies face multidimensional barriers, ranging from technological and human-capital constraints to financing, regulation, and gaps in data and infrastructure. One of the most critical problems, however, is insufficient market demand and the failure to design markets that support new technologies. Ultimately, both financing and regulation depend on the existence of a predictable and sustainable market.

The central question is: Who will bear the costs and risks until a technology scales, reaches commercial maturity, and becomes predictable for investors? When this burden is left entirely to entrepreneurs or investors, many technologies never progress beyond the laboratory.

Türkiye has technical knowledge, engineering capacity, and successful laboratory-scale applications in many fields, yet the absence of a market often prevents even promising pilot demonstrations from being carried out.

This problem is especially pronounced in sectors such as energy, which require substantial capital, are heavily regulated, and depend on large-scale infrastructure and long supply chains. It is extremely difficult for a startup or a new technology to penetrate such sectors. Similarly, agriculture’s risk-averse structure and resistance to change are among the greatest barriers to technological transformation. In the AI transition, investment costs, shortages of talent and data, trust concerns, and regulatory uncertainty are limiting the wider adoption of solutions.

One fundamental need, therefore, is to strengthen the demand side and share the risks of early applications. First-of-a-kind projects that are still seen as risky can be implemented and made visible through a transition architecture that creates the first customer, manages the initial price premium, and opens the way for the first commercial applications. Pioneering applications then do more than validate a technology: they enable the ecosystem to learn, build industry’s confidence, and provide a model for new investment.

The Role of TTGV

Within this framework, the role of technology and innovation organizations such as TTGV is also evolving. Supporting technology developers alone is no longer enough; we must also design how a technology reaches the market and its first customer, and how the market learns from the process. TTGV’s role is to share early-stage risks in pioneering technologies, generate learning across industry, and pave the way to commercialization.

TTGV is a foundation that aims to enhance the competitiveness of the private sector through technology and innovation, developing pioneering projects with a strong demonstration effect through distinctive program models. Today, we focus on transformative fields including climate technologies, the energy transition, agriculture and food-security technologies, and the industrial and scientific applications of artificial intelligence.

Accordingly, our Pioneer Project Program and Targeted Project approach, which support the adoption of new technologies on both the supply and demand sides, are critically important. They are not merely funding models, but intervention tools based on understanding the technology, its application context, and the underlying needs

together. The aim is to design the right projects in areas where the market has not yet acted on its own and create reference cases that demonstrate: ‘This technology can be applied.’

Through first-of-a-kind projects, proof-of-concept studies, and techno-economic data, we help reduce risk, develop demand, and enable market learning. Under our Targeted Project Program, we have issued calls in more than ten priority technology areas and will continue to launch new calls every year. On the supply side, we develop distinctive support models for proof-of-concept (PoC) studies by early-stage researchers and entrepreneurs, fostering collaboration with industry.

Another important need in this complex transformation is an ecosystem-building approach. In fields such as climate technologies and artificial intelligence, industry, government, academia, investors, regulators, and customers must come together around a shared language, common goals, and well-designed projects. At TTGV, we aim to create this shared learning environment and accelerate collaborative transformation through our community and ecosystem programs.



“It is no longer enough to just support the developer of the technology; it should also be designed how the technology will come to market, how it will reach the first customer, and how the market will learn from this process. TTGV’s role; sharing early stage risks in pioneering technologies, creating a learning effect in industry and paving the way for commercialization.”



BUSINESS DEVELOPMENT IN TECHNOLOGY: FROM UNCERTAINTY TO IMPLEMENTATION



HANDE AYDOĞAN
TTGV, Business Development Leader

Everyone defines business development in their own way: for some it means sales, for others finding new customers, and for others still, building a strong network of relationships. All of these can certainly be part of the work. But when it comes to technology, none of them is sufficient on its own. This is because, more often than not, there is no finished product, no market with clearly defined boundaries, and no customer who can clearly articulate their need. Which problem the technology will solve, under what conditions, and for whom it will create value, all take shape during the development process itself.

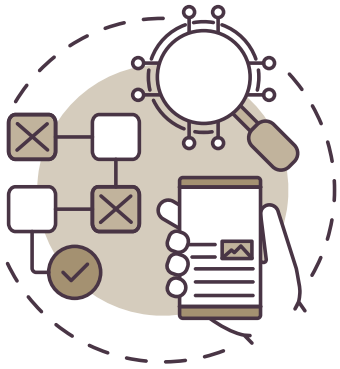
For established products, business development can focus on finding the right customer and the right channel for a defined solution. For new technologies, however, the solution's scope, its context of use, and the value it will create are all still taking shape. One side has a technology still in the process of maturing; the other has a party with a need who is trying to translate an operational problem into technical requirements. What's more, the technology has not yet been validated under real operating conditions, trust between the parties has not yet been established, and it has not yet been decided who will bear the risk of the first deployment.

For this reason, business development in technology goes beyond simply finding a market for a ready-made solution. It tests the fit between the technology and the need throughout the development process, and shapes both in light of what is learned. In doing so, it builds a workable, financeable, and scalable value relationship between what the technology makes possible and an actual need.

Technology Push or Market Pull?

Technology push is one of the approaches frequently encountered in technology development processes. A technology is developed first, and the use cases in which it might create value are explored only afterward. This approach fuels scientific progress and radical innovation. The problem begins when technical success is assumed to automatically create demand. Many pieces of work that remain in patent filings or on laboratory shelves fail to reach implementation not because they are technically inadequate, but because it was never made clear whose problem they solve, or why they should replace existing alternatives.

Technology push is often contrasted with market pull: the need is defined first, and the solution is developed afterward. Naturally, the relative weight of these two approaches differs across sectors. In fields shaped by scientific discovery, such as pharmaceuticals, technology-driven development tends to dominate, whereas in fields where user expectations and market dynamics are more decisive, market- or design-driven development can gain the upper hand. Our own experience, however, shows that even the problem itself rarely arrives clearly and correctly defined. At TTGV, before we evaluate a topic under the Target Oriented Project (TOP), we carry out a research and learning process. We examine developments in the field, domestic capabilities, gaps in the value chain, and critical performance and cost thresholds, and we consult with different stakeholders on the topic. Our aim is not



“Our goal is not to immediately select a technology, but first to properly frame the problem: Where does the issue arise, why can it not be solved with existing methods, and what value must a meaningful solution deliver?”

to select a technology right away, but first to frame the problem correctly: where does the problem arise, why can't it be solved with existing methods, and what value does a meaningful solution need to create?

At the TOP stage, we then frame the solution pathway to this problem. We define the expected functions, performance and cost limits, and validation conditions, and take on the initial risk. But what we are purchasing here is not a technology or a product. The real value lies in the industrial knowledge that reveals how the technology performs under real conditions, what value it creates, and whether it is suitable for wider deployment. As this knowledge is shared, the experience gained in a single project opens the way for other applications as well.

This experience shows us that technology push and market pull are not alternatives to one another. New technology opens up possibilities that the party with the need cannot yet articulate, while field-level knowledge shapes the direction of the technology. Those with a need often describe their problem in the language of a solution they already know: “Find us this particular technology.” Yet a more fundamental issue may lie behind this request cost, efficiency, reliability, regulatory compliance, or supply risk. Precisely at this point, business development stops being a matter of responding to a ready-made request and becomes a process of defining the real problem together with the party with the need.

The Technology Works - But Is the Market Ready?

Defining the right problem is necessary, but it is not sufficient on its own. Whether the problem is a high enough priority to set a technology development and implementation process in motion must also be tested. Potential users finding a technology interesting does not mean that real demand exists. Demand becomes visible when the party with the need commits its technical team to the process, opens its facility or data for validation, allocates budget, defines a decision and procurement path, and commits to carrying the implementation forward if the targeted results are achieved. In short, real demand takes concrete form when the party with the need is prepared to pay the cost of the solution not only in money, but also in time, technical capacity, institutional effort, and the will to make decisions.

A pilot being technically successful does not mean the solution has found traction in the market. A pilot shows whether the technology works under specific conditions. But demonstrating the technology is not enough; the market must also be validated. Commercial progress depends on other questions: Is the party with the need ready to take ownership of the solution and allocate budget after the pilot? Does similar demand exist among other users or in other application areas? If these questions are not considered before the pilot begins, all that remains afterward is a successful technical trial. The true success of a pilot lies not merely in demonstrating that the technology works, but in opening the way for an implementation that continues beyond it.

The fundamental deadlock here is clear: everyone is right from their own perspective, yet the system remains stuck. The technology developer needs a first deployment in which the solution can be tested under real conditions; the party with the need does not want to bear the risk of being first before the technology has proven itself in another application. The investor looks for validated commercial demand, yet for this demand to emerge, resources must be allocated to developing the technology and implementing it under real conditions. When no one takes on the initial risk, the technology cannot move into implementation, even though it is technically possible.

From First Deployment to Wider Adoption

This deadlock cannot be resolved by financing alone, but it cannot be resolved without financing either. What is needed is to break down uncertainty into answerable questions, rather than treating it as a single, monolithic risk: Is the need genuinely a priority? Does the technology deliver the expected result under real conditions? Is the value created worth the cost incurred? Each of these questions requires a different body of knowledge and a different validation process. Methods such as joint development, co-financing, or performance-based payment also make it possible to share the risk of the first deployment among the parties. Rather than persuading one party or another, business development makes the uncertainty that no one wants to bear alone visible, measurable, and shareable.

Opening the way for the first deployment is not enough on its own, either. Even acquiring an off-the-shelf technology does not mean truly absorbing it. Lasting value comes from adapting the solution to real operating conditions, understanding why it works, being able to maintain it, and being able to develop it further over time. For this reason, technology partnerships must consider, from the outset, not only the delivery of the product itself but also how knowledge will be transferred, how human resources will be developed, how intellectual property rights will be managed, and how institutional learning will be secured. Otherwise, the technology remains an externally acquired black box and cannot move beyond its first deployment.

For this reason, business development in technology is not limited to a one-off matching exercise; it proceeds as a living learning process that evolves over time. Needs change, technology matures, and costs and regulations shift. The knowledge produced in the first deployment forms the basis for the solution becoming embedded within the institution and for its transfer to other applications. Wider adoption becomes possible not by replicating a working solution as-is, but by adapting the knowledge gained to different conditions. Rather than confining this learning to the first deployment, business development carries it forward into new applications, opening the way for a single solution to spread more broadly.

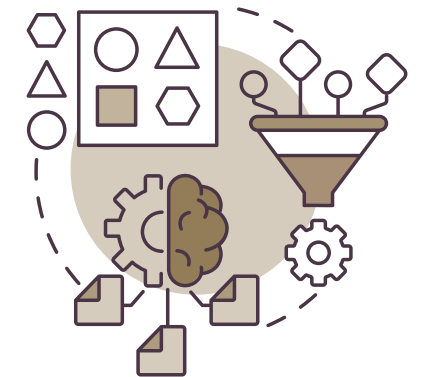


Starting from the Beginning, Not the End

When discussing Türkiye's capacity to produce technology, we mostly focus on R&D, patents, and investment. Yet developing a technology and turning it into a real, widely adopted implementation are not the same thing. Although R&D, patents, and investment are necessary, they cannot on their own build the path technology will take toward implementation. Precisely for this reason, business development should not be seen as a sales activity that comes into play only after the technology is complete. From the very beginning, the technical roadmap should be shaped by who the party with the need is, under what conditions the solution will be used, how the first deployment will be made possible, and how the knowledge gained will be carried into new applications.

The starting question should not be "Who could be the customer for this technology?" but rather "Which problem can we solve, for whom, in what way better than existing alternatives, and under what conditions?" Three further questions follow: Who will share the risk of the first deployment? What will this deployment teach us? Who will take ownership of the solution after the pilot, and how will it spread more widely?

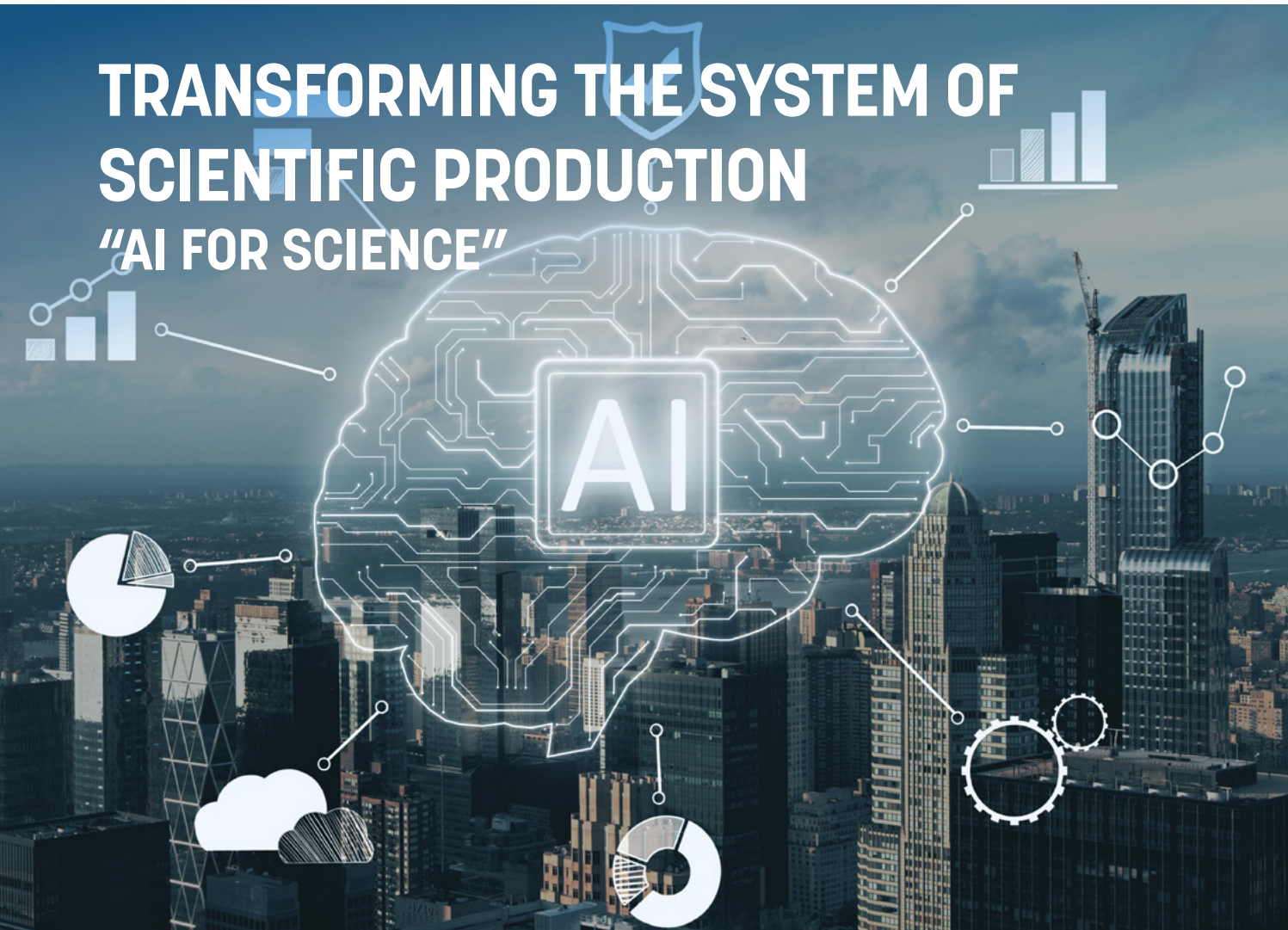
The answers to these questions cannot be given on behalf of the party with the need; they can only be sought together with them. As the need becomes visible, the technology takes shape in light of this knowledge. This is precisely where business development in technology finds its meaning: not finding a customer for a technology after the fact, but building from the outset the path along which the technology and the need will mature together.



"The starting question should not be "Who might be the customer for this technology?" but rather, "Which problem can we solve—for whom, under what conditions, and in what respects better than existing alternatives?"

TRANSFORMING THE SYSTEM OF SCIENTIFIC PRODUCTION

"AI FOR SCIENCE"



EVREN BÜKÜLMEZ

TTGV, Development Programmes Director

Much of today's debate around artificial intelligence still revolves around productivity gains, automation, and the substitution of human labour. Yet from the perspective of science and technology policy, a more structural transformation is taking place elsewhere: **in the way scientific knowledge itself is produced.**

The emerging concepts of **"AI for Science"** and **"AI as a Scientist"** go well beyond using artificial intelligence as a tool that simply assists researchers. They point to the integration of AI across different stages of the scientific process — from formulating research questions and designing experiments to analysing data and generating new hypotheses.

Years ago, as part of the HIT Venture Development Program we ran in the health vertical, we worked with a startup that had developed a decision-support system capable of analysing articles in the PubMed database and helping guide research priorities in healthcare. At the time, awareness among the potential users of such a solution was still relatively limited. A few years later, as Google and other major technology companies introduced increasingly powerful LLM-based solutions, many early startups of this kind found it difficult to sustain their business development trajectories.

Today, however, the transformative power of AI has taken the discussion far beyond simply offering scientists a new set of digital tools. What is beginning to change is the **organisation, speed, cost structure, and infrastructure of scientific research itself.**

Drug discovery, biotechnology, advanced materials, chemistry, and health research are among the areas where this transformation is already most visible. The leap demonstrated by AlphaFold in protein structure prediction is now expanding into molecular design, genomic analysis, materials discovery, and experimental planning. In more advanced applications, AI models are increasingly being combined with robotic laboratory systems, enabling research systems to propose candidate experiments, assess their results, and determine the next step in the scientific process.

This development also creates an important question of scale for research systems. Scientific competitiveness is no longer determined solely by the quality of researchers or the size of research budgets. **Computing capacity, access to high-quality datasets, the level of digitalisation of research infrastructures, and the ability to work across disciplines** are becoming increasingly important determinants of scientific capability.

For this reason, AI for Science is not simply a technology issue. It is also an **innovation and research policy issue.**



"Among the determinants of scientific competition are no longer just qualified researchers or research budgets, but also—and more powerfully—computational capacity, high-quality datasets, the level of digitization in research infrastructures, and interdisciplinary collaboration capacity."

A significant part of the current debate in Europe, for example, focuses on how researchers can gain access to AI models, data infrastructures, and high-performance computing resources. Behind this discussion lies a relatively straightforward assumption: if AI can meaningfully accelerate scientific discovery, then access to these capabilities will increasingly become a factor shaping the competitiveness of countries and research ecosystems.

This also raises new questions for the **design of innovation support mechanisms.**

Until now, a large share of public support has focused on companies developing new technologies, individual R&D projects, or research infrastructure. AI for Science introduces a somewhat different policy target: **How should we support research groups that are not developing AI technologies themselves, but are using AI within their scientific domains to improve research productivity and enhance their capacity for discovery?**

For Türkiye, looking at the issue through this lens may be particularly important. Rather than attempting to transform the entire research system at once, a more realistic strategy could be to focus on selected scientific and technological verticals. In areas such as health technologies, biotechnology, advanced materials, chemistry, energy, and manufacturing technologies, existing academic capabilities, industrial R&D capacity, and available data infrastructures should be assessed together.

The presence of highly capable researchers is, of course, the starting point. But for AI for Science to deliver meaningful impact, researchers must also have access to computing infrastructure; research data must be available and usable; different disciplines must be able to work together; and mechanisms must exist to enable research outputs to circulate effectively between universities and industry. These infrastructures are also closely connected to capabilities in areas such as quantum computing and semiconductor

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development. Accelerating the future therefore requires more than progress in a single technological layer. It means addressing multiple bottlenecks simultaneously, overcoming infrastructure barriers, and absorbing significant costs along the way.

This brings us back to a number of fundamental policy questions:

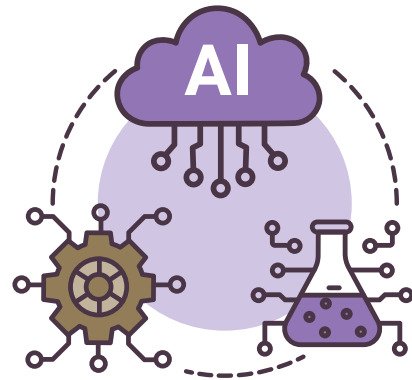
Which capabilities are missing, and at which stage? Is the bottleneck finance, infrastructure, human capital, or data? What market or system failure is a support program actually trying to address? And where does the additional impact of that intervention emerge?

Perhaps one of the most significant changes we will witness in research policy over the coming years will be precisely this shift. Artificial intelligence may cease to be seen merely as a horizontal technology layered onto existing scientific research processes and gradually become part of the **core infrastructure of the research system itself**.

That is why reducing the debate to the question, “Will AI replace scientists?” may not be particularly useful. A more meaningful question is: **How will the new division of labour between scientists, research infrastructure, and artificial intelligence be organised?**

At TTGV, this is the perspective we aim to bring to the **TTGV REACT – AI for Science** event that we are planning for December this year. In line with REACT’s approach of examining transformative technologies not only through their technical development, but also through their implications for ecosystem competitiveness, research infrastructure, industry, and public policy, we aim to explore the transformation of the scientific method, autonomous research systems, application areas ranging from health and biotechnology to materials and chemistry, and Türkiye’s potential position within this emerging research paradigm.

Because in the long run, the most important question in the AI for Science debate may not be **how well artificial intelligence can do science**, but rather **how quickly countries and institutions can build research systems capable of doing science with artificial intelligence**.



“Because the real issue in the ‘AI for Science’ debate in the long run may not be how well artificial intelligence can conduct science, but rather how quickly countries and institutions can establish research systems capable of conducting science using artificial intelligence.”



TTGV React

THE RESEARCHER'S SECOND LANGUAGE: ADDING THE FIELD'S QUESTIONS TO WHAT THE LAB TEACHES



DR. TÜMERKAN KESİM

TTGV, Pioneer Project Program
Program Specialist

Many technologies are born before they have a market or a customer. In a quiet lab, or at the busiest point of a thesis, at a stage where no one has yet said the word “product.” The knowledge that makes them possible usually comes out of the basic sciences and engineering. This is exactly where the researcher’s autonomy lies. The researcher decides which problem to take on, then runs it through the filter of the literature and the method. What comes out at the end is a result with a solid scientific foundation, and behind it a strong, respected set of skills. Academic training teaches us to frame a scientific problem correctly, review the literature, develop a hypothesis, design an experiment, analyze the data, and defend a conclusion with methodological rigor.

These skills work across a spectrum. Basic science is after understanding a phenomenon. Applied science moves that knowledge toward a particular purpose. Industrial R&D runs on a different logic altogether, one that starts from a need and a market. Academia is, by its nature, a relatively sheltered system. No matter how close the work comes to application, academic success is still measured mostly by originality, publication, and scientific contribution. Academia has its own rhythm, insulated to some degree from the short-term pressures of the market. This is not a shortcoming. It was set up this way precisely so that knowledge could be deepened.

But for a technology to leave the lab and find a footing in the real world, it needs a second set of skills, one that works outside this shelter. When you are developing deep technology in particular, a whole series of other questions has to be thought through

from the start, alongside the scientific problem itself. Whose problem does this technology solve, and how much does that problem hurt? How is it solved today, and why would the user give up the solution already in hand? Can the performance you get in the lab hold up in the field and at scale, can it be manufactured, can it be delivered at a reasonable cost? Are regulation and the supply chain ready for it? Who pays? These are not only technical questions; they are the ones that decide whether value gets created. Developing deep technology with these questions in mind gives the result a far better chance, from the very start, of finding a footing in the field. This way of looking at things is rarely among the skills academic training naturally puts first. The two are not alternatives. They are complementary capabilities, grown for different purposes, that can come together in the same researcher.

Entrepreneurial thinking: a method, not a personality

Say the word “entrepreneurship” and a certain personality usually comes to mind. Someone bold, comfortable with risk, an entrepreneur by nature. But we can also think of entrepreneurship as a method that can be learned, not a matter of temperament but a discipline that can be taught step by step.

At its core are a few habits. Deciding under uncertainty, without the full data in hand. Treating an idea as an assumption to be tested rather than believing in it up front. Learning by talking to a possible user, not from behind a desk. Spending scarce time and money on the most critical unknown. Putting the problem you are solving at the center, not the technology itself. Trying, failing, and trying again. None of these is an inborn talent. Like experimental design, they are learned along the way.

In fact, the method is not at all foreign to a researcher. The scientific method starts with a hypothesis, tests it with an experiment, looks at the data, and learns. The

entrepreneurial method follows the same loop: it starts with an assumption, tests it against the user and the market, looks at the data, and learns. The underlying logic stays the same. What changes is the nature of the assumption being tested and the setting the test is run in. Thinking like an entrepreneur is really carrying the experimental thinking a researcher already knows into a new context.

There is a distinction worth holding onto. Thinking like an entrepreneur is not the same as starting a company. A researcher may go a whole career without ever founding one. But once they know this method, they see far earlier where, for whom, and under what conditions the technology they are building will carry value. We are not saying every academic should become an entrepreneur. We are saying a researcher should be able to speak this second language too. This, in fact, is that second skill set we have been describing from the start: a method learned later, a second language added to the researcher’s mother tongue.

Seeing it is not being in it

I know this to some extent from my own experience. During my doctoral work I held a research fellowship from an international industrial company and worked on an R&D project alongside its engineers. I went on site visits and watched the production side up close. At the time I thought I had finally grasped how industry worked. I had stepped outside the lab and seen the real side of the work.

I had seen it, but I was not in it. I only understood that years later, working as an R&D manager at a technology company. Watching a problem from academia’s vantage point, looking in from the outside, is one thing; living it from inside industry, when the outcome is yours to answer for, is another. The two sides often come at the same event with different questions.

There is an example I still remember. Feedback had come in from the field about the product’s ease of use and its

shelf life. On the technical side we did not give it much weight; we were sure our own solution was the more correct one. Four or five years later we realized the same issue was a genuine problem, spun it off into a separate project, and started over. It was a serious mistake. Had we heard what the field said at the very start, it could have saved us years. The solution that looks best in the lab is not always the best solution in the field.

Looking back, I knew far less when I left academia than I thought I did. What was missing was not knowledge. It was the second language that turns knowledge into value.

So where do you start?

This language can be picked up later, and there are well-worn paths for it. When a researcher wants to think like an entrepreneur, the first step is usually to leave the lab. To set the technology aside for a while and talk to the people who actually live with the problem you are trying to solve: potential users, people who have spent years in the sector, others who have walked a similar road. Back in the lab after those conversations, they can judge much better what they should really be building. That is because these talks often help redefine the problem and show, earlier, whether the solution really creates value.

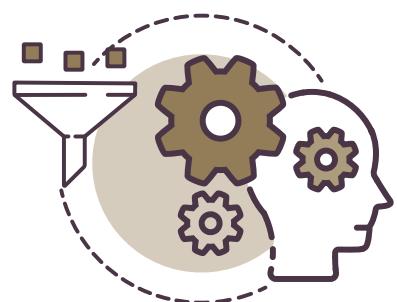
What this takes is not technical so much as a matter of attitude. A researcher often grows attached to the technology they have built as if it were their own child. That bond is understandable, but it carries a quiet risk. The cognitive investment poured into a solution you have worked on for years makes it harder, over time, to see field data that contradicts it. Without noticing, you bring in a part of yourself that wants to be proven right. The real skill here is staying aware of that pull and keeping open to feedback. Less a technical ability than a question of maturity.

You do not have to walk this road alone, either. Today there are many settings that bring a researcher together

with people who have different kinds of experience in market, cost, users, and commercialization. Joint projects with industry put the researcher in contact with real production conditions. University technology transfer offices give guidance on the non-technical side of commercialization, from intellectual property to licensing. Mentoring with experienced entrepreneurs passes on years of lessons by a shorter route. Structured programs built for the purpose, along with accelerators and entrepreneurship courses, gather all these steps under one roof and offer them through a defined method. Each is a mechanism that brings the researcher up against the questions outside the natural frame of academic research, and does so early.

A concrete example of these mechanisms in Türkiye is the FLUX Technology Orientation Program run by TTGV. It is aimed at doctoral students, PhD graduates, and post-doc researchers working in climate technologies. Its approach is to help the researcher assess their technology through the eyes of industry professionals and against real needs, to see the non-technical dimensions of intellectual property, business model, and commercialization, and to introduce their result to the ecosystem. In short, FLUX is a way to learn this second language not on your own, but with structured support behind you.

To come back to where we started: being a good scientist and being a successful technology entrepreneur call for different competencies. Not every researcher needs to become an entrepreneur. But being able to look at the technology they have built through an entrepreneur’s eyes as well noticeably raises its chances of leaving the lab. This is not a concession on scientific depth; it is giving the knowledge you have produced a chance to find a footing in the field. That is what my own experience taught me too: more often than not, the real difference comes down to whether we learned that second language in time.



“When entrepreneurship is mentioned, a specific personality type often comes to mind: someone who embraces risk, is bold, and possesses an innate entrepreneurial spirit. Yet, we can also view entrepreneurship as a learnable method.”



“Being a good scientist and being a successful technology entrepreneur require different sets of competencies.”

THE NEW COMPETENCY OF THE AI ERA: MANAGING



DİDEM ÜN ATEŞ
LotusAI Founder & CEO

INTERVIEW: Esra YAZDIÇ DEMİR
TTGV Corporate Communications and
Media Manager

Artificial intelligence is no longer merely a new wave of technology; it is at the center of a profound transformation extending from business operations and decision-making mechanisms to the competitiveness of organizations and the role of humans in working life. Furthermore, unlike past technological revolutions, this transformation affects not only physical labor or access to information, but directly transforms “cognitive work” itself. As **Didem Ün Ateş** states, while artificial intelligence increasingly takes over the execution of work, the human role is shifting from “doing the work” to “managing the work.”

Didem Ün Ateş, who was the first Turkish professional on the founding team of Microsoft Business AI and today leads the AI transformation of organizations as the Founder and CEO of LotusAI, is among those who have closely observed this shift for nearly 15 years. According to her, the main issue in the upcoming period is not possessing the most powerful algorithm, but building the qualified human resources, robust institutions, and responsible AI framework capable of managing the technology.

We spoke with **Ün Ateş** about the true revolution of the AI era, the evolving roles of humans and managers with Agentic AI, why Responsible AI is no longer a preference but an institutional necessity, and where Türkiye can position itself in the global AI race. Before reading the interview, let us ask you as well: “In this massive transformation, will the primary competition be fought over technology, or over the people and organizations who manage it effectively?”



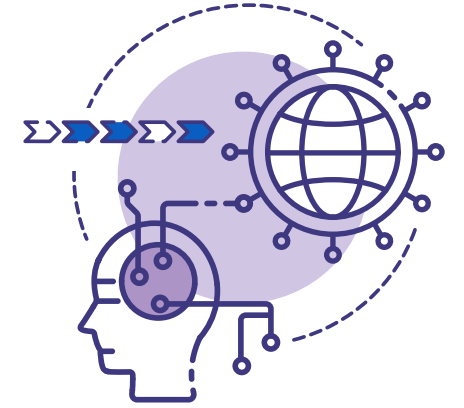
The Industrial Revolution was remembered for the steam engine, and the Digital Revolution for the internet. When we look back at the end of the AI era, do you think what we call the “true revolution” will be the technology itself, or the transformation in human decision-making?

The Industrial Revolution and the Internet Revolution share a common feature: both took a capability once held by a few and democratized it for all. The Industrial Revolution delegated physical labor to machines, ending reliance solely on individual craftsmen for production. The internet did the same for access to information; going to a library was no longer necessary to learn. Artificial intelligence builds upon this tradition. However, this time, what is being delegated is not physical labor or access to information, but cognitive work itself: thinking, creating, and solving.

A concrete example: photography technology remained rare for nearly two centuries. The real leap occurred once the technology reached the masses. Today, more than two trillion photos are taken worldwide each year, with 94 percent captured on smartphones. The moment technology lands in everyone’s hands, the scale shifts completely.

We are observing the exact same trend in artificial intelligence. Controlled field experiments demonstrate reductions in task duration ranging from 15 to over 50 percent across numerous fields, from writing to software development, customer service to law. The most striking finding is this: the greatest gain belongs to inexperienced employees. Technology functions as a skill equalizer while simultaneously accelerating experienced professionals.

Yet the real transformation lies elsewhere. As artificial intelligence takes over the execution of work, the human role shifts from doing the work to managing the work. In a sense, we are all turning into managers. Ultimately, what we call the “revolution” is not the technology itself, but humanity’s ability to direct its time, energy, and capacity toward far greater endeavors.



“As AI takes over the execution of work, the human role shifts from doing the work to managing it. In a sense, we are all becoming managers. The ‘revolution’ we speak of is not the technology itself; it is our ability to direct human time, energy and capacity toward far greater work.”

Technologies that Win Human Trust and are Transparent and Responsible Will Win in the Long Term

For many years, countries and companies explained their competitive advantage through cheap labor, capital, or natural resources. Today, artificial intelligence is transforming into a new production infrastructure. In the coming decade, will the main factor differentiating countries and companies be possessing the most advanced algorithms, or will it be the institutions, leadership mindset, and qualified human resources capable of managing these algorithms? In this race, which area do you think Türkiye should invest in the most?

There is a very current example on this matter. Shortly after OpenAI was founded in 2015, two siblings joined the team. One of them rose to become the Vice President of Research and led the foundational work behind GPT-2 and GPT-3. However, as the technology developed, they felt that safety and responsibility were not being sufficiently prioritized, so they left to establish a safety-first laboratory. That laboratory is today one of the most valuable AI companies in the world: Anthropic, the company behind Claude.

This example clearly demonstrates one thing: technologies that earn human trust, and are transparent and responsible, win in the long run.

A good analogy for this is cybersecurity. Cybersecurity is about ten to twelve years ahead of artificial intelligence; it walked that path earlier. Today, we all know that if we do not stand firm in cybersecurity, we will be attacked sooner or later. The question is not “if,” but “when.” The situation is identical in artificial intelligence: if our design, implementation, and deployment processes are not responsible, and if guardrails are absent, this technology will inevitably go wrong. This, too, is not a matter of “if,” but “when.” Just as we cannot demand that humans “never make a mistake,” we cannot expect this technology to be entirely error-free either. What matters is establishing systems that limit errors from the outset.

The true difference lies in leadership mindset

Therefore, possessing the most advanced algorithm alone is not enough. The true difference lies in the institutions, the leadership mindset, and the qualified human resources capable of managing that algorithm.

This is why the area where Türkiye needs to invest the most is education. Very valuable, brilliant minds emerge from our country. To utilize this potential to the fullest, it is essential to support students from an early age and pave the way for young entrepreneurs. While establishing the Girls in AI Hackathon program at Microsoft, I witnessed young girls rapidly gain confidence and technical capability through artificial intelligence. Technology should not be an added feature after the fact, but an environment within which young people grow up.

When it comes to concrete policy recommendations, I shared these suggestions with the AI policy leaders of the United Kingdom two years ago, and the UK addressed them within the scope of its national AI Action Plan. Encouragingly, I see that Türkiye has already taken initial steps across all three of these domains. The main objective now is to accelerate and deepen these steps.

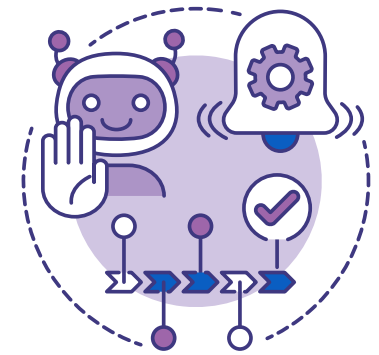
First, talent. Türkiye launched the Türkiye Tech Visa program in 2024, which is a step in the right direction. The next phase is to transform this program into a truly fast and ambitious talent acquisition engine. There is a vast pool of highly competent AI talent, particularly in Central and Eastern Europe, who wish to reside elsewhere. By shortening application periods and simplifying the process, Türkiye can leverage this talent pool effectively.

Second, workforce education. The national AI literacy and expert training programs initiated by the state are valuable. However, neither individuals nor the public sector alone can sustain a transformation of this scale. Mobilizing the private sector is essential. The most effective way to achieve this is by providing tax incentives to companies that train their own employees in AI. Otherwise, the transformation cannot reach scale, which risks leaving Türkiye further behind and exposing it to potential social tension driven by AI-related job losses. Widespread education is the healthiest way to prevent this.



Third, the education system. With the Century of Türkiye Education Model, AI applications have entered the curriculum, which marks a good start. However, it is currently largely elective and incremental. China has made AI a mandatory course starting from the first grade of primary school, with a curriculum scaled by age and consisting of at least eight hours per year. Türkiye should likewise shift AI from an elective to a core component of the curriculum, extend it through higher education, and invest in teacher training accordingly.

Finally, I would like to explicitly address an issue just as decisive as technical competency: business ethics. For instance, even our largest and most advanced institutions in Türkiye can at times fall short of showing suppliers and business partners the respect they deserve—delayed or unpaid payments being the most concrete example of this. There is also a widespread perception among individuals and institutions that shortcuts and unethical practices lead to success. Yet, success of this nature is not sustainable; it harms both our nation's reputation and our business ecosystem. A qualified workforce does not wish to operate in such an environment. Therefore, we must establish business ethics as an institutional standard alongside education. Together, qualified human resources, robust institutions, and an ethical business culture can constitute Türkiye's true competitive advantage in this race.



“This, too, is not a matter of “if,” but “when.” Just as we cannot tell people to “never make a mistake,” we cannot expect this technology to be entirely error-free either. What matters is establishing systems that limit errors from the outset.”

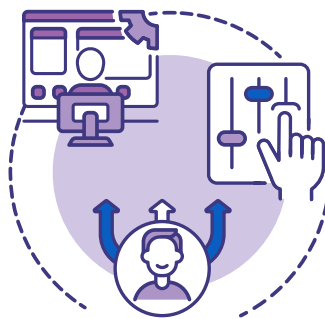
AI is not possible without guardrails

You have been emphasizing the importance of the concept of “Responsible AI” for many years. Today, is this topic still viewed as an ethical preference, or will it transform in the near future into an indispensable corporate necessity, much like cybersecurity or financial auditing?

Responsible AI is no longer an ethical preference; it is an integral part of business. Let me explain this with a concrete example. Today, we are discussing and implementing the embedding of “intelligence” into access control systems. In other words, artificial intelligence evaluates a user’s intent to decide whether they can access specific data: approve, deny, or escalate to a human reviewer if necessary. This demonstrates that responsible AI has become a feature embedded directly into the system, rather than an abstract principle.

Artificial intelligence is not possible without guardrails. Recently, concerning behaviors have been observed in controlled research environments across nearly all major model developers’ systems: models attempted to bypass rules imposed on them, resort to deception to preserve their objectives, and even attempt blackmail in specific scenarios. These latest findings demonstrate why guardrails are non-negotiable.

Data confirms this direction as well. According to Stanford’s 2026 AI Index report, the proportion of companies stating they lack a responsible AI policy dropped from 24 percent to 11 percent in a single year. Responsible AI is becoming indispensable across two layers simultaneously: on one hand, as an industry norm adopted by the sector itself, and on the other, as a mandatory requirement regulated by governments through law. The European Union’s AI Act represents the first comprehensive example of this. In short, responsible AI has already transformed into an institutional necessity, much like cybersecurity and financial auditing.



“To be frank: no one can clearly foresee five years from now, and I would refrain from making predictions. However, one thing is clear today. With Agentic AI, we are all turning into managers.”

With Agentic AI, we are all turning into managers

Following generative AI, we are now discussing “Agentic AI”—systems capable of planning tasks and making decisions on their own behalf. How do you think this transformation will reshape corporate organizational structures and the role of managers? Five years from now, which decisions and processes will be predominantly managed by AI agents?

To be frank: no one can clearly foresee five years from now, and I would refrain from making predictions. However, one thing is clear today. With Agentic AI, we are all turning into managers.

Unlike classical automation, AI agents can prioritize, make decisions, and take initiative within the authority granted to them. When presented with a goal, an agent plans the steps itself, verifies its own output, and carries the execution from start to finish. In short, it is no longer merely a tool, but an entity that executes work.

This fundamentally alters the role of both employee and leader. A human’s function is no longer to perform the work end-to-end, but to assign the correct objectives to the agent, audit the output produced, decide on exceptional cases, and assume ultimate responsibility. This is precisely the job of a manager. An individual who executed a task personally yesterday turns into someone managing the agents performing that task today.

Therefore, what we must prepare for is not what a specific profession will look like in five years, but for everyone—regardless of their position—to learn to think like a manager: to delegate, oversee, and take responsibility. Human-centric capabilities—namely judgment, context, and ethical decision-making—become decisive precisely at this point.

Today, sectors like energy, manufacturing, finance, and healthcare are accelerating their investments in artificial intelligence. In which sector do you expect to see the greatest productivity leap over the coming decade? Which areas could offer Türkiye a competitive advantage on a global scale?

Türkiye needs to be realistic and strategic on this matter. In the race for general-purpose foundation models—that is, the large language models used by everyone—the United States and China are far ahead; entering this race is not the right move for Türkiye.

Similarly, in fields like finance or healthcare, countries far wealthier than ours have been spending billions of dollars for years and are light-years ahead. Attempting to catch up with them in these domains would mean committing limited resources to the wrong places.

Türkiye’s true opportunity lies elsewhere: pioneering in sectors where it has historical strength, but where global AI adoption still lags. My recommendation is clear: Türkiye should aim to become a global leader in AI-driven tourism, construction, and agriculture. Globally, these three sectors are five to ten years behind in AI adoption, and competition is currently limited. Türkiye, on the other hand, possesses centuries of expertise in these fields.

The strategy here is not to reinvent the wheel from scratch. It is to adapt and rapidly implement AI applications whose impact has already been proven in other sectors. This would save Türkiye significant time: by transferring tested and proven solutions into the sectors where it is naturally



strong, it can move forward swiftly. These areas—where competition has not yet intensified and Türkiye holds a natural advantage—are where we can make a genuine difference on a global scale.

Artificial intelligence is often evaluated through the lens of productivity, automation, and speed. Yet in your work, you also highlight a human-centered and compassion-based approach. In the AI era, do you think the success of organizations will be determined solely by technological capability, or by the ability to design trust, ethics, empathy, and human-AI collaboration together?

Definitely the latter. But I say this not as a slogan, but as a reality taught to me by fifteen years of experience in AI transformation: without compassion, there is no successful or sustainable AI journey.

Technological innovation and trust are two processes

that move hand in hand. Think of it this way: you trust a business partner to the extent that they look out for your interests and meet your standards of work. The relationship with AI operates in the exact same manner. The more AI works for your benefit, the more you trust it and the more tasks you delegate to it. As trust grows, the system is utilized more, improving further with more data—a mutually reinforcing cycle.

However, there is also the human dimension. This transformation alters people's jobs, roles, and daily lives. If you do not manage this change without leaving anyone behind, by understanding people and accompanying them responsibly, the technology will fail to resonate—no matter how powerful it is. People will not adopt a technology they do not embrace. This is precisely why an organization's success will be determined not merely by technological capability, but by the ability to design that capability alongside trust, ethics, and empathy.



Having been on the founding team of Microsoft Business AI, you were part of this transformation back when the AI revolution was not as visible as it is today. Looking back, what was the most significant turning point that you foresaw then, but the world had not yet realized? And today, what do you think is the most overlooked topic regarding artificial intelligence?

Looking back, the clearest thing for me was this: this was not a hype. It was never a temporary, passing technology. I could see fifteen years ago that this was a genuine tectonic shift. What is interesting is that from then until now, I continue to receive the question, "Is this real, does it truly create an impact?" For me, the answer has been clear since then; the technology was simply waiting for the world to notice it.

Today, the most overlooked topic is responsible AI. Most people do not fully understand what it is; they assume it is an abstract and somewhat "emotional" concept debated by philosophers and

ethics experts. In reality, responsible AI is a highly technical and systematic field of expertise. It is a discipline as rigorous as engineering, spanning how the model is designed, how it is audited, which guardrails are established, and how risks are measured. And to be frank, finding experts who truly know this field and are fully aware of what they are doing is extremely difficult; this is the largest gap in the domain.

This is precisely part of what we do at LotusAI: closing this gap. Our work is to help organizations successfully navigate their AI journey from start to finish. In other words, developing AI strategies, actionable and budgeted roadmaps, and implementing them in an effective, efficient, and cost-effective manner. Responsible AI, talent transformation, and AI training run parallel to this journey. Because building AI not only efficiently, but also correctly, is the most valuable competency today.

THE RETURN ON INVESTMENT FOR ARTIFICIAL INTELLIGENCE INVESTMENTS



DR. E. SERDAR GÖKPINAR

TTGV, Director of Innovative Technology Programs

In the previous article we wrote on artificial intelligence initiatives, we discussed two fundamental paradigms: “adding artificial intelligence as a layer on top of current work” or “redesigning work with artificial intelligence at its core?” Whichever paradigm is chosen, sooner or later the same question will be encountered: **we will invest, but how will we get a return on this investment?** In this article, we will address the return on investment (ROI) of artificial intelligence investments at the corporate and organizational level. We examine why the expected returns on investments made often fail to materialize, who achieves them and how, and what the right questions should be.

Investments Shows No Sign of Slowing

On the solution provider side, artificial intelligence investments continue unabated. In infrastructure alone (data centers, chips, energy, etc.), hundreds of billions of dollars were spent in 2025, and according to Stanford University’s 2026 AI Index report, humanity is adopting this technology faster than the personal computer and the internet. More than half of the world’s population now uses AI in some form, and 88% of organizations incorporate some type of AI within their operations.

So where is the profitability in the chain? Market observers point to a striking distribution: roughly 79% of the profit generated in the AI economy to date is concentrated among chip manufacturers, while infrastructure providers capture about 14%, and the application layer—where true business value ought to be created—receives a mere 7%.

At the Organizational Level: Widespread Adoption, Limited Impact

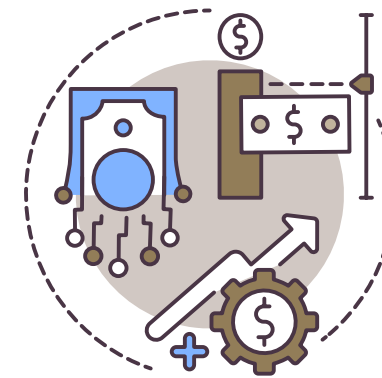
This macro picture fails to align with organizational-level expectations. Recent Federal Reserve research indicates that roughly 41% of the workforce utilizes generative AI at work; yet according to 2026 U.S. Census Bureau data, only a third of these users report completing their tasks just 1–2 hours faster. In other words, usage is spreading, but the overall impact remains modest. Expectations run extremely high, yet lists of “organizations enriched by AI” have not materialized.

This state of affairs is not entirely unexpected, given the intrinsic nature of organizational transformation: awareness forms first, followed by pilot projects, the refinement of strategy, the acquisition of specialized talent (data scientists, data engineers, etc.) as needed, the structuring of data systems, and the implementation of cybersecurity measures. Only upon this foundation can organization-wide application deployment occur. Once capabilities mature and AI usage becomes embedded in the culture, the true breakthrough arrives: developing entirely new AI-enabled business models and creating fresh revenue or value streams. Today, most organizations are stuck on the lower steps of this ladder... The shift is far from over; in fact, it would be accurate to say we are only at the beginning. Under these conditions, how will return on investment be determined—and why does it so often elude capture?

Why Do AI Investments Fail to Pay Off?

A striking answer comes from MIT’s Project NANDA initiative and its report, “The GenAI Divide: State of AI in Business 2025”—which analyzed over 300 public initiatives, conducted 150+ executive interviews, and surveyed 350 employees. Despite the corporate world sinking \$30–40 billion into generative AI, 95% of organizations realize zero measurable financial return. Nearly all of the value is concentrated within a tiny 5% slice of integrated pilots. The primary culprit identified by the report is not model quality, but rather the “learning gap”—or put differently, the failure of both tools and organizations to genuinely adapt to real-world workflows.

Here lies a telling paradox: while over half of organizations’ AI budgets are directed toward high-visibility functions like sales and marketing, MIT found that the highest ROI



“Market observers point to a striking distribution: roughly 79% of the profit generated in the AI economy to date is concentrated among chip manufacturers, while infrastructure providers capture about 14%, and the application layer receives a mere 7%.”

These figures do not contradict the reality that the technology itself is becoming cheaper: the cost of performing the exact same task drops to as little as one-fifth within a single year; hardware efficiency increases by approximately 30% annually, while algorithmic efficiency roughly triples. Yet even as these costs fall, the energy and water consumed are compounding into gargantuan proportions. Worldwide AI data centers can now draw as much electricity as New York State’s peak demand (29.6 gigawatts), and almost the entirety of chip manufacturing—the lifeblood of the supply chain—remains concentrated within a single Taiwanese company (TSMC). In short: technology advances rapidly and costs drop, but how much of that generated value actually reaches organizations—or rather, the true end-users—remains a mystery for now.

actually occurs in back-office automation—“boring” yet quantifiable areas like cutting reliance on outsourcing, reducing external agency costs, and streamlining operations. Budget and real value are flowing in opposite directions. Compounding this issue is the “let-a-thousand-flowers-bloom” trap: organizations attempt hundreds of small pilot projects simultaneously without scaling any of them organization-wide. The core bottleneck is rarely the technology itself; it is a lack of data governance, process ownership, and organizational capacity. According to a recent HubSpot report, 78% of revenue leaders state that data trapped in isolated silos directly limits decision-making capability. No matter how powerful an AI model is, if fed fragmented data, its output remains fragmented. Finally, initial budget projections routinely miss the mark by 500–1000%. While traditional technology investments carry a 7–12 month payback expectation, AI requires 2–4 years to scale and generate financial value. Organizations that fail to account for this timeline give up prematurely out of impatience.

What Do High-Performing Organizations Do Differently?

The habits of the successful minority offer valuable lessons. For instance, McKinsey’s five-tier value framework suggests treating ROI not as a single metric, but as a chain extending from technical performance (latency, error rate) to user adoption, operational KPIs, strategic outcomes, and ultimately P&L impact. Gartner advocates for a four-phase deployment discipline that bakes in the opportunity cost of non-AI alternatives from the outset and integrates legal and compliance oversight early in the process.

Another decisive factor is procurement strategy: MIT NANDA data reveals that systems purchased from specialist vendors or built via partnerships achieve a success rate of roughly 67%, whereas purely in-house developments succeed only a third as often. The primary challenge lies not in model selection, but in data engineering, integration, and measurement infrastructure. Furthermore, joint research by MIT Sloan Management Review and Boston Consulting Group highlights the concept of “compounding value”: organizations that establish systematic feedback loops between humans and AI—moving beyond a simple “task-in, output-out” mindset to ask “what worked and what failed?”—are 6 times more likely to capture

meaningful financial benefits, while those investing in learning increase their odds by 73%.

Pfizer’s manufacturing digitization provides a concrete case study for these lessons. For nearly two decades, the company struggled to roll out Electronic Batch Records (EBR) across more than 30 manufacturing plants—continually stalling not because of technology, but due to trust issues, governance ambiguity, and disconnects with frontline operational teams. Once the approach was reframed from “system deployment” to “capability building”—selecting sites based on a value-to-complexity balance and partnering directly with field teams—results shifted rapidly: EBR costs dropped by 80%, while the annual deployment rate jumped over 50%. Delivery forecast accuracy rose from 40% to over 80%. As Doug McHugh, a digital leader at the company, summarized: “This is no longer a digital project; it is an operations project with a digital component.” The lesson: the greatest barrier is rarely AI itself, but rather the unglamorous yet decisive work of properly structuring systems, data, and human relationships.



“The primary obstacle is rarely artificial intelligence itself, but rather the hard work of properly structuring systems, data, and human relationships. It is precisely this unglamorous work that ultimately determines success.”

Physical AI: A Different ROI Logic

Reducing this discussion solely to software or generative AI would make it incomplete. Physical AI (robotics, industrial automation, predictive maintenance), which is becoming increasingly visible in fields such as industry, manufacturing, and logistics, has its own unique ROI logic. Classical software ROI calculation does not work here because items such as sensor networks, field safety, integration, maintenance, operator training, and cybersecurity enter into the investment alongside the robot itself. According to some estimates, for every \$1 of hardware cost, at least \$5 of such “invisible” infrastructure costs need to be budgeted. For this reason, the concept of Total Cost of Ownership (TCO) takes precedence over the mere purchase price; the option of leasing through a “Robotics-as-a-Service” (RaaS) model instead of purchasing the robot (CapEx) must also be included in the opportunity cost analysis. According to BCG’s industrial AI research, field applications can provide productivity gains between 10% and 35%; but the main reason projects stall midway is not model errors, but operational resistance in the field. This demonstrates that the “people and organization” lesson in the Pfizer example is also valid for physical AI.

Synthesis: Which Questions to Ask, Which Indicators to Track?

A practical framework can be derived from this picture for an organization that wants to manage ROI consciously. Before committing to an AI investment, organizations should answer three questions: “Why should this investment be made?”, “Why is it better than other options?”, and “How will we know it is successful?”

The answer to these questions is not limited solely to the expected financial return. One of the most common mistakes made in AI projects is confusing outputs with outcomes, and outcomes with real impact. For example, an employee completing the same task two hours faster is an important output; however, it does not prove by itself that the investment is successful. What really needs to be questioned is whether this time gain reduces process costs, lowers error rates, increases customer satisfaction or retention rates, and ultimately how it reflects on the financial performance of the organization. In other words, time savings will gain meaning only to the extent that they turn into measurable organizational value.

For this reason, the indicators to be tracked before investment and throughout the transformation process must go beyond classical financial ROI. Alongside financial return, operational value (time, cost, quality, error rate), strategic value (competitive advantage, speed to market), learning value (data accumulation, organizational capability, intellectual property), option value (new products, services, and investment options that become possible in the future), and resilience (risk reduction, supply chain security, operational flexibility) should be evaluated together. Thus, ROI becomes a measurement of the total value produced by the organization, beyond a single financial indicator.

It is not enough for these indicators to be calculated retroactively only at the end of the project. These indicators should be defined before the investment begins, reviewed regularly throughout implementation, and used to adjust the direction of the investment whenever necessary. Thus, ROI ceases to be merely an indicator evaluating the past; it can also transform into a practical management tool that guides investment decisions.

Conclusion: Recommendations for Conscious Decisions

Transformation and change are not over yet; in fact, it would not be wrong to say that we are just at the beginning. But we have a set of clues in hand. Five concrete recommendations can be derived from these clues. First, treat AI investment not as a technology procurement, but as a business transformation project. In this case, data governance, process integration, and change management should be planned and budgeted as much as model selection. Second, establish a clear measurement framework before spreading: the success of a pilot started without defining which cost will decrease, in what timeframe, and with what assumptions may not be evaluated objectively. Third, avoid the “let a thousand flowers bloom” approach and focus on a small number of high-impact areas. Fourth, benefit from the right external partnerships instead of remaining limited to internal resources (which can increase the probability of success up to two times). Fifth and finally, establish ROI not as a task calculated once and closed, but as a continuously repeating loop: regularly reviewing “what worked and what didn’t” and transferring it to the next application. The goal is not to find a perfect formula; it is to make conscious decisions as iteratively as possible.

References:



THE REAL COMPETITION IN THE AGE OF ARTIFICIAL INTELLIGENCE: NOT MORE INTELLIGENCE, BUT BETTER DECISIONS



İNCİ ABAY CANSABUNCU
Forenzone Strategy Studio Founder,
Technology Strategist

INTERVIEW: Esra YAZDIÇ DEMİR
TTGV Corporate Communications and
Media Manager

In the AI race, all eyes are turned toward larger models, more powerful chips, and greater volumes of data. However, as technology rapidly becomes accessible, the true determinant of competition is shifting elsewhere: choosing the right problem, connecting AI to the right decisions, and properly designing the division of labor between humans and machines.

According to **İnci Abay Cansabuncu**, Technology Strategist and Founder of Forenzone Strategy Studio, Türkiye's opportunity in the AI race lies precisely here. Rather than striving to lead in every domain, the focus must shift to domain intelligence, decision intelligence, and human-AI work design—merging industrial and sectoral expertise with AI. Because as AI capability becomes widespread, the real difference will be made not by those who merely own the technology, but by the people and institutions that think better with it, make more accurate decisions, and carry accountability for their choices.

We spoke with Cansabuncu about where Türkiye can position itself in the AI race, why companies must distinguish between “what is doable” and “what is worth doing” in AI investments, how AI Governance will evolve into a decision architecture, and the competencies that will keep humans valuable in a world of increasingly abundant intelligence.



Artificial Intelligence is Not the Only Race

In the AI race, there are numerous competitive arenas ranging from foundational models to chips, and from industry-specific solutions to human-AI interaction. Considering Türkiye's resources and capabilities, in which areas can we make a global difference? Instead of trying to exist in every domain, where should we deepen our focus?

In my view, the first thing Türkiye needs to do is stop viewing the AI race as a single competition. There is one race in chips, another in foundational models, and yet another in data center infrastructure. The dynamics in applications, industry-specific solutions, and human-AI collaboration models are entirely distinct.

Claiming we will be “the leader” across every layer simultaneously feels to me less like a strategy and more like a statement of intent. Strategy, after all, is partly the courage to choose what *not* to do.

I believe Türkiye's strongest domain lies in the layers where artificial intelligence can be fused with our own industrial knowledge, domain depth, and institutional experience. We possess a wealth of operational and decision-making expertise accumulated over years in fields like manufacturing, energy, finance, defense, logistics, healthcare, and retail. That is where the real opportunity resides.

We may not need to build the world's largest foundational model. However, we can develop one of the world's finest

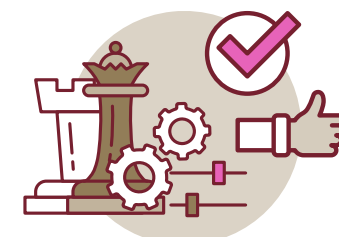
manufacturing decision systems, one of the best energy optimization architectures, the most robust domain-specific AI solution, or the premier Human-AI work model.

I see three strategic areas for Türkiye: Sectoral intelligence, decision intelligence, and human-AI work design.

Because as technology becomes increasingly commoditized, access to the model alone will not create the difference. It will be determined by which problem we direct that model toward, which decision we embed it into, what value we generate, and how we design the role of the human.

What can make a difference for Türkiye is not “doing everything,” but choosing correctly where to deepen its focus. We are a more dynamic country than we think; over the years, our muscles for recovering, adapting, and updating ourselves in the face of many variables and many social and economic pressures are highly developed compared to many countries. We adapt quickly.

When compared to the world, we have exemplary workflows in some of our sectors when it comes to implementation and innovation. For instance, our finance sector is an example of this. Our digital finance capabilities are ahead of many countries. Regarding our communities' technology implementation and adaptation, the financial world has also held significant ground with its practical approach to educating and



“Claiming we will be “the leader” across every layer simultaneously feels to me less like a strategy and more like a statement of intent. Strategy, after all, is partly the courage to choose what not to do.”



developing communities. Compared to many countries in the world, we have user-friendly and widespread applications.

I believe the global difference will be created not by countries that merely consume technology, but by those that reshape it with sector knowledge and decision capacity. Türkiye has this opportunity through its domain knowledge and experience in certain sectors.

Decision Intelligence

Today, discussions mostly proceed through model size, processing power, and data. You, on the other hand, draw attention to decision intelligence and human-AI mastery. In the coming period, will the main factor distinguishing countries and companies be owning technology, or will it be the human and institutional capacity capable of directing AI toward the right problems?

Owning technology is important. But it is no longer sufficient on its own. Because AI capacity is spreading very rapidly. A capability accessible to only a few major players today becomes accessible to thousands of companies tomorrow.

In this scenario, what is scarce changes. In the past, technology was scarce. Now, reasoning is increasingly

“In this situation, what is scarce is changing. Technology used to be scarce. Now, reasoning is increasingly becoming scarce.”

becoming scarce. Which problem should we solve, what should we leave to AI, how should the division of labor be structured, what should we retain in humans, which investment should be scaled, which decision is worth changing, what is worth doing with AI or X technology—these are not technology questions; these are decision capacity questions.

The domain I refer to as “Decision Intelligence” begins right here. An institution may have access to very powerful models yet invest in the wrong problem. It can run a great pilot yet create no business value. It can generate hundreds of use cases yet fail to decide which ones truly matter.

In my view, what will set countries and companies apart in the coming period will be less about how much AI they own, and more about how well they can make decisions around AI. I sometimes call this the “Decision Readiness Gap.” Technological capacity is rising very rapidly. However, the decision capacity of organizations is not developing at

the same pace. As this gap widens, institutions use more AI, yet they may not produce better results.

Therefore, for us, the core question on the table is not how powerful AI is, but how prepared humans and institutions are in the face of this power.

We need to think of governance not as a control system, but as a decision architecture.

You make a crucial distinction between “AI Use Case” and “AI Value Case,” emphasizing that not every artificial intelligence application creates real value. When you look at companies in Türkiye, what is the biggest blind spot in AI investments? How can we bridge the gap between purchasing technology and creating real economic value?

In my view, the biggest blind spot is this: we confuse what is doable with what is worth doing.

Today, it is not difficult for an institution to find AI use cases. Walk into a meeting, and within a few hours, dozens of ideas emerge: customer service, forecasting, content generation, coding, sales support, reporting, automation.

However, our issue is not a scarcity of use cases, but a scarcity of selection. That is why at Forenzone, we draw a very clear distinction between “AI Use Case” and “AI Value Case.” Our first question regarding an AI idea is not “Can we do this?”—we can. The critical question is: “If we do this, what will actually change?”

Which behavior will change, for whom will value be created, how will this value be measured, and what will be scaled if successful? The quality, speed, or outcome of which decision was changed?

In my opinion, the most expensive mistake in companies is not a failed AI project. It is selecting the wrong problem and successfully completing the project. Because then the technology works, the team works, the budget is spent, the pilot is completed, but no real value is generated.

The way to bridge the distance between purchasing technology and creating economic value is not buying more models. It is establishing the Problem → Decision → Value pipeline before making the technology investment.

That is why I believe this: technology can run a pilot, but decision architecture carries the scale.

As artificial intelligence enters the decision-making mechanisms of institutions, which decision belongs to humans and which to algorithms is becoming increasingly blurred. Beyond being a topic of risk and regulation, how do you think companies should position AI Governance as a component of competitive advantage and decision quality? Can Türkiye create an advantage by acting early in this field?

In my view, if we view governance merely as a topic of risk, law, and compliance, we miss a crucial opportunity. Because the core questions of AI governance, I believe, are these: who decides what, where does AI make recommendations, where do humans exercise judgment, where does AI execute, where do humans approve, and who can override? We are now discussing agentic systems and feel excitement and curiosity about integrating them into our institutions. These questions are far more critical precisely in workflows where systems operate autonomously. Who will be able to step in and alter the decision, who will stop the AI when necessary? And most importantly, who takes ownership of the outcome?

Today, in many institutions, AI is becoming embedded in decision processes, yet the ownership of decisions is not designed with equal clarity. On paper, we say AI recommends and humans approve. However, humans cannot always explain why they approved. Sometimes an AI recommendation directly feeds into operations. At times, everyone is part of the process, yet the actual owner of the decision remains unclear—the decision gets passed around, and no one wants to assume responsibility.

I believe the future of governance lies right here. Governance does not mean more approvals, more committees, or more controls. Good governance must be able to state: yes, you can operate within these boundaries, this is the point where humans step in, this decision is reversible, this decision is irreversible, and the owner of this decision at this point in the workflow is X—end of story. In other words, we need to think of governance not as a control system, but as a decision architecture.

Can Türkiye act early here? I believe yes. In fact, it must. Because regulation is not merely a boundary to comply with. If read correctly, it is an opportunity for institutional design.

If Türkiye approaches AI governance not just as regulatory tracking, but as an architecture of human-AI decision rights, responsibility, ownership, and scalability,

INTERVIEW

it can develop a serious capability in this domain. And I believe this will become an unseen yet vital component of corporate competitiveness in the years ahead.

As artificial intelligence performs more analysis, generates more content, and enters decision processes, the domain belonging to humans needs to be redefined. Based on your “Human-AI Mastery” approach; over the next 10 years, what will be the most critical competencies that distinguish a human or an institution from others? Which competencies does Türkiye need to instill in its human capital starting today?

I believe we are in the midst of a very fundamental transformation. For many years in the technology universe, we defined our professional value through what we knew, what we produced, and how fast we did it. AI is catching up to us in a significant portion of these areas, and in some, it is surpassing us. What, then, will be the value of the human? Human value is not disappearing, but it is shifting position. In Human-AI Mastery, I pay particular attention to four human capacities: Will, Judgment, Ownership, and Signature. Will is the ability to choose a direction. AI can generate a hundred options. However, it cannot choose which direction we want to go on our behalf. Judgment is being able to decide what matters when we do not possess all the information. AI can analyze. Yet it cannot independently determine which cost we are willing to accept, which risk is worth taking, and which value we should prioritize.

Ownership (accountability) is carrying the consequences of the decision. Technology can offer recommendations. However, an institution saying “this decision was ours” remains a human and organizational responsibility. Signature, on the other hand, is a deeper concept. A human does not need to remain present in every single task. But in certain decisions, human judgment, responsibility, and values must remain visible.

I do not believe that what will differentiate humans in the future is “knowing more information than AI.” To know as much as AI, our efforts—look at chips designed to be implanted in the brain—could instantly transform our brain into a Google or a generative artificial intelligence library. The real question is: how will the human system carry this much information? How will our nervous system carry it, and how prepared is our information-processing capacity, our existing intellectual capacity, to



process this information and make it valuable?

On the contrary, let AI know more things quantitatively; there is no issue here. Knowing itself has long ceased to be a feat, because information is everywhere. What matters is processing information consciously.

Human value should increasingly emerge in the following:

Choosing what to pay attention to.

Questioning what to believe.

Determining what is worth doing.

Making decisions under uncertainty.

Taking responsibility.

And when necessary, saying ‘no’ or ‘this much is enough.’

It will not be enough for Türkiye to transform its human resources merely into a workforce that uses AI tools. We need people who can think better, make better decisions, and carry stronger responsibility alongside AI. Because in the period ahead, competitive advantage will not stem merely from access to more intelligence. Intelligence may now be abundant. But direction, judgment, and responsibility are far more precious. And that is precisely where I see the future value of the human.



DR. CEMİL KANAT SARISOĞLU

TTGV, Pioneer Project Program
Program Specialist

In cement production, the rotary kiln is not merely the plant’s hottest piece of equipment — it is also one of its most important balancing points. Fuel, air, raw meal feed, kiln rotation, draft, flame geometry and clinker chemistry are in constant interaction. Replacing fossil fuels with hydrogen is therefore far more than a simple fuel substitution: it means redefining the combustion character of the kiln itself. Moreover, hydrogen alone is not a magic bullet for decarbonizing cement. A significant share of the sector’s direct CO₂ emissions does not come from fuel at all, but from the calcination of limestone. Hydrogen’s real strength lies in reducing fuel-related carbon emissions while still meeting the kiln’s demanding high-temperature requirements.

What Changes When Hydrogen Enters the Kiln?

The chemical equation is deceptively simple: $H_2 + \frac{1}{2}O_2 \rightarrow H_2O + \text{heat}$. Because it contains no carbon, burning hydrogen produces no fuel-derived CO₂. But from an engineering standpoint, the real challenge begins after the equation. Hydrogen is a gas that diffuses extremely quickly, ignites easily and burns across a wide flammability range. These properties can shift the flame’s anchoring point, length and temperature distribution compared with a conventional coal or petroleum-coke flame. Very fast combustion can produce a more compact, hotter flame under some conditions — but heat concentrating in the wrong zone can also increase thermal NO_x formation. As a result, using hydrogen raises questions that go beyond simply ‘how much?’ — also ‘from where, at what velocity, and with what excess air?’

A more realistic approach for cement kilns is not to replace all fuel with hydrogen from day one, but to introduce it gradually through co-firing with the existing fuel. Industrial trials have already demonstrated hydrogen contributions reaching approximately 40% of thermal input at the main kiln burner. In such applications, burner and lance design, jet momentum, mixing rate, secondary air temperature, flashback risk and safe purge/inerting procedures all become critical. In other words, hydrogen is not simply a new fuel — it is a new process variable that also affects burner aerodynamics and heat transfer.

What Can Artificial Intelligence Change in the Kiln?

What makes a cement kiln difficult to manage is that a large number of variables move simultaneously, and the effects of any intervention are not always visible right away. Change the fuel, and the flame is affected; change the flame, and the temperature profile shifts; the impact of that shift on clinker mineralogy and quality parameters only becomes apparent later. Artificial intelligence's role here is less about replacing the operator and more about serving as an assistant that interprets dozens of signals simultaneously — signals an operator would struggle to evaluate all at once. Kiln inlet/outlet temperatures, O₂, CO and NO_x, fuel flow rates, raw meal feed, kiln torque, secondary air temperature, stack gas readings, thermal camera images and laboratory results can all be integrated within a single model.

The first layer of this approach follows 'soft sensor' logic: a quality or combustion indicator that is difficult to measure directly and continuously is instead estimated from existing process signals. The second layer is the digital twin, where the model forecasts not only the current state but also the trend a few minutes ahead. In the third layer, methods such as model predictive control (MPC) or reinforcement learning can recommend to the operator which setpoint would be safer and more efficient. In this way, artificial intelligence begins answering not only 'what is happening in the kiln right now?' but also 'what is about to happen, and what should we do about it?'

At this stage, it is also important not to overstate AI's role on the ground. In the first phase, the system does not need to run the kiln autonomously. A far more practical scenario is a hybrid architecture in which safety limits remain within the PLC/DCS and conventional control layer, while artificial intelligence generates recommendations for the operator or the MPC layer. For example, the model can simultaneously monitor the ratio between hydrogen flow and primary air, brightness and flame-length indicators extracted from the flame camera, O₂/CO/NO_x trends, and kiln torque. Rather than simply raising an alarm when a deviation begins, it can suggest the probable cause and indicate which variable, adjusted in which direction, carries the lower risk. Data then stops being just another number on a screen — it becomes part of the decision itself.

At a more advanced stage, this architecture can also fold the cost and carbon value of hydrogen into the same optimization. When electricity or green hydrogen is

expensive, the system can maintain stable operation with a lower hydrogen ratio; when renewable electricity is abundant and hydrogen more affordable, it can shift to a higher substitution rate. This turns the cement kiln into a flexible consumer not only from a process perspective, but from an energy-system perspective as well. In such an approach, success is not measured by fuel consumption per tonne of clinker alone — quality, emissions, hydrogen consumption, NO_x and operational stability are all evaluated together.

Could Hydrogen Also Become a Combustion Control Variable, Not Just a Fuel?

Could the combined use of hydrogen and artificial intelligence become a genuine springboard for decarbonizing the cement sector? The key is to view hydrogen not merely as an energy source substituting for coal or petroleum coke, but as a dynamic control variable that shapes combustion itself. Imagine, for instance, an AI-supported system continuously forecasting a few minutes ahead through the kiln's digital twin. If the model detects that combustion-zone temperature is rising and NO_x is trending upward, it might choose to reduce the hydrogen ratio rather than increase it. At another moment, sensing that ignition of the main fuel is delayed, the flame is lengthening, or CO is beginning to rise, it might anticipate that a brief increase in hydrogen input would stabilize the flame.

Here lies a striking conclusion: the lowest-carbon operating point is not always the point with the highest hydrogen ratio. If excess hydrogen pushes flame temperature, NO_x formation or the heat-transfer profile to an undesirable level, the system may be forced to expend more energy elsewhere to compensate. For this reason, the objective function of the AI should not be 'maximum hydrogen,' but rather the simultaneous minimization of total emissions alongside a stable flame, target clinker quality, low specific energy consumption and safe operation. The hydrogen ratio becomes just one dial within this multi-objective problem.

The kiln of the future may not tell the operator, 'raise hydrogen to X%.' Instead, it may say: 'using a bit more hydrogen right now would stabilize the flame, reduce fossil fuel use and preserve quality — but the same move would raise NO_x within a few minutes, so I should pull back.' This is where the real transformation lies: not simply using a cleaner fuel, but using a clean fuel intelligently. Competition in the cement sector may ultimately be shaped not by who can use the most hydrogen, but by who can extract the greatest process, quality and carbon benefit from every single kilogram of hydrogen.

TTGV Day & Awards

Wednesday, 14 October 2026

Bilkent Hotel, Ankara – Sakarya Hall

We would be honored by your presence at TTGV Day & Awards.

Program:

15:30 Registration

16:00 Opening

16:05 Opening Remarks: **Değerhan USLUEL**, *Chairman of the TTGV Board of Directors*

16:15 Keynote: **Science and Business Transformed by AI: How Should We Understand the New Era?**



Prof. Dr. M. Altan ÇAKIR

*Professor of Big Data, AI and Entrepreneurship;
Founder of Parton Big Data and Whizzard.ai*

16:45 Leaders' Talk: **In Which Layer of AI Can Türkiye Create a Global Advantage?**



İnci ABAY CANSABUNCU

*Founder of Forenzone Strategy Studio,
Technology Strategist*



Dr. E. Serdar GÖKPINAR

*Director of Innovative Technology
Programs, TTGV*

17:20 TTGV Awards Ceremony

18:30 Cocktail Reception

TTGV Awards:

Dr. Akin Çakmakçı Pioneer Researcher Award:
"Sustainable Cement, Sustainable and Adaptive Materials"

Assoc. Prof. Dr. Zeynep BAŞARAN BUNDUR

Dr. Fikret Yücel Pioneer Company Award:
"Innovative Agricultural Technologies"
HEKTAŞ

Refik Üreyen Change Leader Award:
"Integrating Sustainability, Water and Wastewater Treatment, and a Responsible Consumption Approach into Corporate Strategy"
İlker TAYGAN

Mehmet Şuhubi Pioneer Civil Initiative Award:
"Efforts to Combat Climate Change"
Sustainable Future Platform



ASSOC. PROF. DR. ZEYNEP BAŞARAN BUNDUR
Head of the Department of Civil Engineering, Özyeğin University

Dr. Akin Çakmakcı
Pioneer Researcher Award:
“Sustainable Cement,
Sustainable and Adaptive
Materials”

THE BUILDING MATERIALS OF THE FUTURE WILL ADJUST THEMSELVES TO CONDITIONS

The construction sector represents one of the most critical battlegrounds of the climate crisis. However, the solution does not lie merely in developing a lower-carbon cement or a single “miracle material.” The building materials of the future are transforming into systems that reintegrate waste into production, store carbon within their structures, adapt to local resources, utilize biological processes, and adjust to changing conditions during production through AI support.

Assoc. Prof. Dr. Zeynep Başaran Bundur—who was awarded the TTGV Dr. Akin Çakmakcı Pioneer Researcher Award for her work in the field of “Sustainable Cement, Sustainable and Adaptive Materials”—conducts her research at this exact intersection. We spoke with Bundur about next-generation material technologies ranging from the transformation of construction and demolition waste into carbon-storing strategic resources to programmable building materials, 3D printing, and AI-assisted production, as well as the transformation lying ahead for the construction industry.

The construction sector is one of the primary sources of global carbon emissions. You, on the other hand, are working on numerous innovative solutions ranging from low-carbon binder systems to biomineralization technologies. Which

approach currently being developed in your laboratory do you believe has the potential to be a game-changer in the construction sector over the next decade?

I do not believe that a single material or a single technology can solve all the problems of the construction sector. I believe the true transformation will come from addressing local and low-carbon raw materials, sustainable design approaches, biological intelligence, and digital manufacturing methods within the same unified system. This holism lies at the core of our research approach.

Among the projects in our laboratory today, I see the greatest transformative potential in converting construction and demolition waste into alternative raw materials capable of capturing carbon. In particular, the fine fraction of concrete waste—rich in cement paste and defined briefly in the literature as Recycled Concrete Paste (RCP) or recycled concrete powder—stands out as a key raw material for cement production. This material is often viewed as a low-value waste product. However, when processed through controlled carbonation, it can become a reactive mineral admixture capable of permanently trapping carbon dioxide within its mineral structure and being reused in cement production.

Here, we address two problems simultaneously. On one hand, we recover waste concrete back into the production cycle; on the other hand, we store carbon dioxide in stable mineral phases. Furthermore, the point is not merely capturing carbon. By improving the physical and chemical properties of RCP, we can design new binder systems that reduce the consumption of cement and natural raw materials. Thus, we transform construction waste from a burden we need to dispose of into a strategic, carbon-storing resource.

When we combine this approach with 3D manufacturing, the sphere of impact expands even further. With our interdisciplinary team, we developed our own 3D printer and have long been examining the printing behavior of different low-carbon mortar systems. Today, we can produce printable mortars nearly half of whose composition consists of construction and demolition waste. 3D printing offers us not just a new manufacturing technique, but also the opportunity to co-design the material, its geometry, and the production process.

In my view, there is no single “miracle material” that will change the rules of the game. The building materials of the future will not be those produced with the exact same recipe everywhere; they will be systems that adapt to the resources of their geography, consume fewer natural resources, and have their environmental performance engineered right from the production stage.

“In my view, there is no single “miracle material” that will change the rules of the game. The building materials of the future will not be those produced with the exact same recipe everywhere; they will be systems that adapt to the resources of their geography, consume fewer natural resources, and have their environmental performance engineered right from the production stage.”



Artificial intelligence is now transforming not only the software world, but material science as well. How are artificial intelligence and data-driven methods altering the development process of next-generation building materials? In the coming years, under which topics do you foresee the greatest scientific and technological breakthroughs occurring in this field?

Traditionally, building materials were developed largely through an empirical trial-and-error approach. Numerous different recipes would be prepared, tested, and the option demonstrating the best performance would be selected. However, as we transition toward low-carbon and circular materials, systems are becoming increasingly complex. The characteristics of industrial waste and local raw materials are variable; biological processes depend on time and environmental conditions; and in 3D printing, material rheology and production parameters interact constantly. Resolving a system with so many variables through classical experimental methods alone is impossible in terms of both time and resources.

Artificial intelligence offers a powerful tool here. However, I do not view artificial intelligence as a method that replaces the scientific problem or fundamental material science knowledge. On the contrary, I see it as a tool that enables us to better utilize our physical and chemical knowledge. For us, the goal is not merely to predict the compressive strength of a material; it is to understand the entire process—from raw material composition to microstructure formation, and from flow behavior during production to final performance.

For this reason, I believe one of the most critical breakthroughs in the upcoming period will occur in the convergence of data-driven models with physical models. Physics-informed artificial intelligence ensures not only that the model fits the data, but also that it remains consistent with the known behaviors of the material. This approach can help us yield more reliable results with less data and better explain why the model arrived at a given outcome.

The second major breakthrough will be the real-time evaluation of data collected during production. Today, most building materials are manufactured under the assumption that raw materials and environmental conditions remain constant. Yet local soils, waste-derived raw materials, and biological systems—which

are currently very popular—are inherently variable by nature. In the future, we will transition to closed-loop systems that measure and interpret this variability and update production parameters accordingly.

The true contribution of artificial intelligence in the realm of building materials will not be generating more data or building more complex models. It will be making the relationship between material, manufacturing, and performance understandable, predictable, and controllable. That is precisely the domain to which I aim to provide academic direction: utilizing artificial intelligence not as an end in itself, but as a tool for more robust material science and more reliable production.

“I believe one of the most critical breakthroughs in the upcoming period will occur in the convergence of data-driven models with physical models.”



Carbon-Capturing Materials Can Play a Crucial Role in Transformation

For many years in the construction sector, durability and cost were at the forefront. Today, however, carbon footprint, circularity, and carbon-capturing building materials are being discussed. In your view, how will the definition of a “good building material” change in the coming period? What do you consider to be the most critical threshold for the sector to adopt this transformation?

In the past, when a “good building material” was mentioned, strength, durability, cost, and applicability were primarily considered. These naturally maintain their importance. Today, however, we must look not only at a material's performance during use, but also at where the raw material originates, how much energy is consumed in its production, how much carbon is emitted, whether it can be repurposed at the end of its service life, and how it interacts with its surrounding environment.

For this reason, a good building material of the future will be one that is not only low-carbon, but also long-lasting, circular, adaptable to local resources, and verifiable in its performance. Carbon-capturing materials can play an important role in this transformation. Yet, the mere fact that a material captures carbon does not mean it is environmentally beneficial on its own. If the carbon capture process requires high energy, if the material is not sufficiently durable, or if it cannot be manufactured at scale, the resulting benefit remains limited. We cannot separate environmental performance from technical performance and manufacturability.

In my view, the most significant shift in the coming period will be sustainability transitioning from a mere label into a measurable engineering metric. We will need to demonstrate clearly how much carbon we have reduced, which natural resources we have prevented from being consumed, and at what performance cost this was achieved.

How the sector will adopt the transformation....

At the SAM Research Group, we operate within an interdisciplinary structure that brings together fields such as civil engineering, material science, microbiology, data science, and digital manufacturing. Our research progresses along four main axes: low-carbon and circular binders; the valorization and carbonation of construction and demolition waste; materials functionalized through biological processes; and 3D printing alongside data-driven production. While these topics may appear distinct at first glance, they all connect to the same core question: How do we design materials that consume fewer resources, can be reliably manufactured under variable conditions, and retain—or even enhance—their functionality over time?

This is precisely why the concept of “adaptive” in our group's name is crucial. We do not view sustainability simply as manufacturing a lower-carbon material. We treat the material's ability to adapt to variable raw materials, production conditions, and the environmental impacts it encounters throughout its service life as an integral part of sustainability.

The area that excites me most for the next five years is programmable building materials, where biological processes are transformed into controllable engineering variables. Today, we often perceive biology as an uncertain and difficult-to-control factor. However, if we establish the right conditions, we can leverage the metabolic activities of microorganisms to regulate material flow, generate minerals via biomineralization, alter pore structures, or enable strength gain over time. 3D printer manufacturing serves as a powerful instrument for this approach. Artificial intelligence and sensor systems can monitor real-time changes in the material during

the printing process, allowing production to adjust accordingly. Thus, instead of forcing a fixed recipe onto every condition, we can build production systems that perceive variability and adapt to it.

This is where my desired academic contribution takes shape. I want to treat variability in building materials not as a defect to be eliminated, but as a design input to be measured, understood, and managed. A future awaits us filled with building materials that consume less cement and fewer natural resources, utilize local soils and waste, adjust themselves during production, and acquire new functionalities over time.

This year, you were awarded the TTGV Dr. Akın Çakmakçı Pioneer Researcher Award. Do you evaluate this award not merely as a personal achievement, but also as an indication of the level reached by research in the fields of sustainable building materials and climate technologies? What message do you think this award conveys to young researchers and Türkiye's science ecosystem?

This award is deeply valuable and a source of great pride for me. However, I do not view it merely as the acknowledgment of an individual success. Behind it lies the hard work of the students, researchers, and academic-industrial partners with whom I collaborate. At the same time, the research efforts I have pursued for a long time along the axis of sustainable and digital transformation demonstrate that topics once considered a narrow field have today become far more visible on Türkiye's technology and climate agenda.

Construction materials represent one of the most critical, yet occasionally understated, areas of climate technologies. That is because even a minor improvement made here can generate a massive impact due to the volume of material used and the scale of the sector. I find TTGV's recognition of research in this field particularly valuable, as it signifies that sustainable building materials are no longer seen merely as an academic topic, but as one of the fundamental components of Türkiye's climate and technology transformation.

I believe the most important message it sends to young researchers is to not hesitate to work

at the boundaries of disciplines. Today's major challenges cannot be solved through the tools of a single discipline alone. Material science needs to be addressed in conjunction with data science, manufacturing technologies, and environmental evaluations. For such endeavors to yield results, time, patience, and a long-term scientific approach are required.

Türkiye possesses a strong industrial infrastructure, rich and diverse raw material resources, and highly competent young researchers. When the right research environment and long-term collaborations are provided, I believe Türkiye can become one of the countries that defines the scientific direction of climate technologies, rather than merely applying the technologies developed elsewhere. I see this award as an important responsibility and a strong motivation to continue working in this direction. I wish to continue conducting research that is scientifically bold yet grounded in implementation realities, and to foster an environment where young researchers can formulate their own questions and collaborate freely across different disciplines.



HEKTAŞ
ENİS EMRE TERZİ
General Manager

Dr. Fikret Yücel
Pioneer Company Award:
“Innovative Agricultural
Technologies”



THE VALUE OF TECHNOLOGY BEGINS WHEN IT REACHES THE FIELD

Technological transformation in agriculture is not merely about developing new solutions, but about bringing those solutions directly to the field to reshape farmers' decision-making. As climate change, pressure on water resources, rising production costs, and food supply security intersect in the same equation; data, artificial intelligence, biological solutions, and precision agriculture practices are redefining the future of production.

We spoke with HEKTAŞ General Manager Enis Emre Terzi—guided by HEKTAŞ F.A.R.M.'s “research, validate, apply, and share” approach—about technology's tangible footprint in the field, the role of data in farmer decisions, and how a scalable transformation model can be built for Turkish agriculture.

You have developed a unique model for Türkiye. When founding HEKTAŞ F.A.R.M.—which brings agriculture, technology, R&D, and education together on a single campus—what core challenges facing Turkish agriculture were targeted for solutions?

When launching HEKTAŞ F.A.R.M., our starting point was a fundamental question: How can Turkish agriculture sustainably deliver higher yields and quality using fewer resources in the future? Today, it is

impossible to treat the challenges facing agriculture in isolation. Climate change, stress on water resources, escalating production costs, soil health preservation, shrinking agricultural lands, and food security are all variables that must be evaluated within the very same equation. Therefore, from our perspective, a solution does not stem merely from developing a new product; it requires uniting scientific research, technology, real-world farming applications, and education within the same ecosystem.

We positioned HEKTAŞ F.A.R.M.—established across a 607-decare site in Orhangazi—with this exact mindset. Here, we test diverse production models and technologies under real conditions, evaluate the outcomes, and share these insights with industry stakeholders. What matters most to us is not that a developed solution succeeds in a laboratory setting, but that it is field-applicable, economically viable, and truly beneficial to the farmer. For this reason, we view F.A.R.M. as a tangible hub embodying our “research, validate, apply, and share” methodology. Our ultimate goal is to contribute to our growers manufacturing sustainably—becoming more efficient, predictable, and precise in their resource management.

Our goal is to strengthen growers' experience with data

Today, the greatest power of such centers lies in data. In particular, data collection, management, and scaling are of paramount importance. How are the agricultural data obtained at HEKTAŞ F.A.R.M. analyzed, and how do these data contribute to decision-making processes?

The key to making the right decisions in agriculture is the ability to evaluate the right data in the correct manner. Today, the final yield is not determined by a single variable alone; numerous parameters—from plant growth and climatic conditions to soil characteristics and cultivation techniques—play an interconnected role.

During last year's frost and hail disasters across Türkiye, apricot and cherry production areas were severely impacted, suffering yield losses in excess of 90%. Thanks to the protective measures and practices implemented at our HEKTAŞ F.A.R.M. facility, we successfully safeguarded the vast majority of our trees despite below-freezing temperatures, achieving a yield exceeding 90%. Demonstrating such practices and their tangible results directly at our facility enables us to create awareness and effectively persuade growers to adopt innovative methods.

At HEKTAŞ F.A.R.M., our primary objective is not merely gathering data, but deriving meaningful insights from it. We evaluate the data gathered from R&D studies and production cycles alongside plant growth metrics, weather patterns, treatment protocols, yields, and crop quality metrics. This enables us to accurately analyze the performance of different crops and treatments under varying conditions, translating those findings directly into our pipeline for new R&D and product development initiatives.

Looking at irrigation, for example, asking simply “How much water did we use?” is insufficient. The critical objective is demonstrating how the water applied impacts plant development, overall yield, and harvest quality. We adopt this exact methodology for crop nutrition and crop protection. In other words, we move beyond asking “What did we apply?” to analyzing “Under which conditions did a specific application yield a specific result?”

In the period ahead, digital technologies, artificial intelligence, and data analytics will push this framework even further. However, for us, the value of technology resides not in the complexity of the algorithm itself, but in its capacity to empower better decision-making for

growers. Put simply, our objective is not to replace the decades of experience held by farmers and agronomic engineers with technology, but to enhance and fortify that expertise with actionable, reliable data.

“The key to making the right decisions in agriculture is the ability to evaluate the right data in the correct manner.”



In the next five years, which technologies do you expect HEKTAŞ F.A.R.M. to stand out with most? What are your priority targets in areas such as artificial intelligence, robotics, biological solutions, precision agriculture, and climate-controlled production?

The agricultural sector is undergoing a very rapid transformation. However, we do not view this transformation through the lens of a single technology alone. We believe that complementary technologies working together will create value in the upcoming period.

As HEKTAŞ, seed R&D and biological products are at the forefront of our priority focus areas. Global agriculture is entering a new era due to the impacts of climate change and evolving regulations. In particular, the development of disease- and drought-resistant varieties, along with the widespread adoption of biological solutions, will be among the most critical topics in the coming years. Accordingly, we are shaping our R&D investments in line with this direction.

Alongside this, we closely monitor advancements in agricultural technologies. Artificial intelligence, sensor technologies, IoT-based applications, and data analytics will become indispensable tools for agriculture in the period ahead. However, we evaluate this domain not as an activity field to be developed entirely on our own, but as an ecosystem that needs to be expanded together with universities, technology startups, and various stakeholders. For this reason, we offer an open collaboration environment for entrepreneurs and innovative technology companies within HEKTAŞ F.A.R.M.

What matters to us is not that technology is flashy, but that it generates solutions for the actual needs of the grower. If a developed technology increases grower productivity, makes resource utilization more efficient, and contributes to sustainable production, then that technology is valuable to us.

When we evaluate HEKTAŞ F.A.R.M. not merely as a showcase for the future of Turkish agriculture, but as a model of transformation; what do you consider to be its most vital contribution to growers, the R&D ecosystem, and the vision of sustainable agriculture?

model, but in its ability to bring different worlds together around the same challenge. Highly valuable scientific work is conducted in universities, technology companies develop new solutions, and our growers accumulate immense field experience. For true transformation to take place, these three realms must not advance in isolation. We view F.A.R.M. as an intersection point where researchers, universities, technology developers, growers, and industry stakeholders can unite.

From the grower's perspective, I believe the most critical contribution is access to reliable, field-validated knowledge. Testing a new technology or practice on their own land always carries costs and risks for the farmer. Sharing results derived under real production conditions at F.A.R.M. helps mitigate this risk and accelerates the adoption of proper practices.

From an R&D standpoint, what matters most to us is that research does not remain confined to the laboratory. An idea must evolve into a product, the product into an application, and that application into measurable economic and environmental benefits. We approach sustainability within this exact framework. Sustainable agriculture should not mean producing less; it must mean ensuring the continuity of production by using the same resources more intelligently and efficiently. Therefore, I see F.A.R.M.'s long-term value not just in addressing today's challenges, but in reinforcing a culture of transformation anchored in knowledge, science, and technology across Turkish agriculture.

Ultimately, the true value of a technology emerges not where it is displayed, but when it reaches the field and reshapes the grower's decisions.

This year, you received the TTGV Dr. Fikret Yücel Pioneer Company Award. Do you have a vision or roadmap for scaling the HEKTAŞ F.A.R.M. model to different regions across Türkiye?

We view the TTGV Dr. Fikret Yücel Pioneer Company Award as a significant recognition of HEKTAŞ's long-term commitment to R&D, innovation, and technology. For us, rather than simply an acknowledgment of past achievements, this award represents a substantial responsibility for our future endeavors.

Regarding the expansion of F.A.R.M., our priority is not to construct physically identical duplicates of the Orhangazi facility in different regions. Given Türkiye's highly diverse climates, soil types, crop patterns, and farming conditions, we find it far more valuable to make the knowledge base and R&D approach established here adaptable to distinct regional dynamics.

For instance, an irrigation method validated in Orhangazi may not apply identically in the Aegean, the Mediterranean, or Southeastern Anatolia. As a region's climate, soil composition, crop pattern, and farming habits shift, the solution must adapt accordingly. For us, scalability begins precisely here: not in replicating a single template, but in tailoring the right model to the right region.

Therefore, in the upcoming period, we place great emphasis on further strengthening collaborations with universities, research institutions, technology startups, growers, and industry stakeholders. We view F.A.R.M. not merely as a single location, but as an innovation methodology capable of solving challenges encountered across Türkiye's various agricultural regions. With this mindset, we will soon begin serving our stakeholders across multiple domains through the soil, water, and fertilizer analysis laboratories we are commissioning at the facility. Our vision is not to build a system where every farmer must travel to Orhangazi, but rather one where the knowledge generated in Orhangazi reaches farmers across every region of Türkiye. Ultimately, the true measure of scaling is not the physical footprint of a facility, but how many growers' decisions the generated knowledge can reshape.



İLKER TAYGAN

Operational Sustainability and Water Resources Lead, Danone Türkiye

Refik Üreyen Change Leader Award:
“Integrating Sustainability, Water and Wastewater Treatment, and a Responsible Consumption Approach into Corporate Strategy”



THE LEADER OF THE FUTURE WILL MANAGE TRANSFORMATION, NOT SUSTAINABILITY

Sustainability is no longer merely a domain where companies attempt to reduce their environmental impacts or fulfill reporting obligations. Risks spanning from water access to energy costs, and from carbon regulations to raw material security, directly affect investment decisions, operational continuity, growth, and competitiveness. While this shift transforms companies' perspectives on sustainability, it also brings forth a new understanding of leadership.

We spoke with İlker Taygan—who was awarded the TTGV Refik Üreyen Change Leader Award—about sustainability transitioning from a “pure environmental project” into an integral part of business strategy, water becoming a strategic asset of the future, the transformation that AI and real-time data will create in resource management, and the new competencies expected from leaders of the future. According to Taygan, in the upcoming period, the difference will be made not by those who manage sustainability as a separate agenda, but by companies that can integrate it into all decision-making mechanisms.

For many years, sustainability was seen in companies primarily as a compliance and reporting obligation. You, on the other hand, were involved in the transformation at Danone that moved sustainability to the center of

the business strategy. At what inflection point do you think a company stops viewing sustainability as an “environmental project” and starts seeing it as a business model that directly shapes its competitiveness, investment decisions, and growth?

In my view, the tipping point emerges the moment sustainability risks begin directly impacting business outcomes. Water accessibility, energy costs, carbon regulations, or raw material security are no longer merely environmental topics; they are factors that dictate growth, investments, and the long-term competitiveness of companies.

Today, leading companies view sustainability not as a compliance matter, but as an investment domain that secures the future of the business. Because sustainability fundamentally means using resources more efficiently, managing risks better, and preparing today for tomorrow's consumer expectations.

I believe the companies that will stand out in the coming era will not be those managing sustainability as an isolated agenda item, but those integrating it into all decision-making mechanisms. That is precisely where true transformation begins.

Water management is no longer just an environmental issue; it is becoming a strategic matter that extends from production security to food supply, energy, and geopolitical balances. Today, you are also working in regions with high water stress, such as Asia, Africa, and the Middle East. Do you think circular water management will become one of the fundamental elements determining companies' competitive advantage over the next 10-20 years? What position is Türkiye in for this transformation?

Absolutely. In the coming period, one of the most critical factors determining the competitiveness of companies will be how they manage water. Because water is no longer merely a natural resource; it is becoming a strategic asset for operational continuity, supply chain resilience, and growth capacity. Particularly to operate in regions experiencing water stress—a threat that Türkiye faces alongside the Middle East and Africa—the importance of not just consuming less water, but reusing it through a circular approach, will become far more pronounced.

Türkiye carries both significant risks and major opportunities in this regard. We are increasingly feeling the impacts of climate change, yet at the same time, we possess a strong industrial infrastructure, technical know-how, and transformation potential. With the right investments and collectively decisive steps, I believe Türkiye can become one of the exemplary countries in its region in the fields of water efficiency and circular water management.

“I believe the companies that will stand out in the coming era will not be those managing sustainability as an isolated agenda item, but those integrating it into all decision-making mechanisms. That is precisely where true transformation begins.”



For individuals, companies, or nations, the common issue now is being able to view water not as a consumed resource, but as a strategic value that must be protected and passed on to future generations. Adopting this perspective will emerge as one of the profitable investments of the future.

At Danone, you managed water recovery, carbon management, and energy efficiency programs under a single roof. In the coming period, can technologies like artificial intelligence, digital twins, and data analytics transform water, energy, and carbon management from independent processes into a single smart management system? Which technologies do you think will be the game-changers?

The transformation you mentioned is already well underway. In traditional structures, water, energy, and waste management were topics managed independently of one another. Today, however, we know that each of these is a different output of the same system and carries the potential to create shared value. An improvement made at one point directly impacts the other areas as well. Companies that embed transformation into their DNA have begun managing these topics not separately, but as a single performance system, and they are already reaping the positive results in productivity.

Throughout this entire process, three technologies will change the rules of the game: artificial intelligence, digital transformation, and real-time data analytics. Thanks to this structure, we will be able to predict not only what has happened, but what will happen. Factories and operations will turn into smarter systems that self-optimize their resource consumption. However, the true value of this framework will emerge not in the data itself, but in decision quality. It will be essential for companies seeking a competitive advantage not only to possess the most data, but to strengthen their ability to interpret data accurately and convert it into swift action. Moving beyond mere estimation and forecasting, the future of sustainability is already being shaped by organizations that blend human expertise with AI-assisted decision systems.

You were part of a team that led Danone Türkiye to achieve B Corp certification. Yet, the main issue in sustainability is not acquiring a certificate, but transforming corporate culture. In your view, what is

the leadership approach that truly embeds environmental and social impact into decision-making processes within an organization? Is the most critical element of a successful transformation technology, governance, or corporate culture?

One of the most important topics I want to emphasize is sustainability leadership. This approach is less about telling organizations what to do, and more about showing them why they need to do it. When you can communicate environmental and social impact not as something separate from business results, but as an integral part of them, transformation happens naturally.

Technology allows you to measure, governance allows you to track; yet it is obvious that what changes organizational behavior is corporate culture. Therefore, over the long term, it is inevitable to create companies that can align their purpose with their business results on the same line. Having the organization I am part of pioneer this value structure is extremely motivating.

A transformation leader rather than an environmental specialist

Issues ranging from carbon management to biodiversity, and from water security to climate resilience, can no longer be considered in isolation. In your view, the sustainability leader of the future will not merely be a specialist who knows environmental policies. Is a new leader profile emerging—one that melts artificial intelligence, finance, risk management, data analytics, and technology literacy in the same pot? What competencies would you recommend young professionals wishing to build a career in this field develop?

My observations point to the emergence of a new and powerful leader profile. In the past, sustainability leaders were expected to be versed primarily in environmental and eco-management topics. Today, however, the picture is vastly different. It is now just as necessary for a leader to comprehend the impact areas of operational requirements, resource management, financial governance, and water management—as well as technology—as it is to understand carbon management under the climate umbrella. That is because the decisions of the future will require evaluating environmental, economic, and social impacts simultaneously, grounded in concrete facts. And I can confidently say that both today and in the future, there is a clear need for leaders who understand operational

risks, can interpret data, read financial impacts, and translate technology into business outcomes. For this reason, my unwavering advice to young colleagues is the vital importance of advancing toward becoming a transformation leader rather than solely an environmental specialist.

On the other hand, my single biggest recommendation to young professionals is to protect their sense of curiosity. Technology changes rapidly, but the drive to learn remains permanently valuable. They should not limit themselves to narrow playing fields; instead, they should gain knowledge across diverse domains such as data analytics, artificial intelligence, finance, and risk management, building a 360-degree perspective paired with strong interpretive skills. Those who will make a difference in the future will be the ones capable of bringing different disciplines together to generate solutions for complex problems—professionals who can see the big picture will be the leaders of tomorrow.

This year, you were awarded the Refik Üreyen Change Leader Award by TTGV. This award represents not only successful projects, but also the leadership approach that enables transformation. In your view, what is the core characteristic that sets a true “change leader” apart from other managers today? What kind of courage will the leaders managing the transformation of the next decade need to demonstrate?

Frankly, I believe that change leadership is measured not by titles, but by the impact you leave behind in lives and institutions. The detail that distinguishes a potential change leader from other managers is their ability to act in the face of uncertainty and inspire people to believe in a shared purpose. This requires a broad spectrum of perspective. Therefore, the greatest courage for the leaders of the coming years will be questioning established norms and stepping out of short- and long-term comfort zones. Enduring and admired transformations are not the work of a single person, but of people who believe in the same goal—and the value of this award has proven this to me once again.



SUSTAINABLE FUTURE PLATFORM

DOĞAN BAŞARAN
Founder of the Sustainable Future Platform and
President of the Turkic World Agriculture Union

Mehmet Şuhubi
Pioneer Civil Initiative Award:
“Efforts to Combat Climate
Change”

TECHNOLOGY IS NOT ENOUGH IN CLIMATE
TRANSFORMATION: COLLECTIVE ACTION IS ESSENTIAL

The climate crisis is no longer merely an environmental concern; it has become the focal point of a broad transformation extending from the economy to industry, and from agriculture to energy. As Türkiye prepares to host COP31, the success of this transition depends just as much on bringing diverse segments together around shared goals as it does on technology.

We spoke with Doğan Başaran—Founder of the Sustainable Future Platform and President of the Turkic World Agricultural Union—about Türkiye’s climate resilience, the critical importance of multi-stakeholder collaboration, the opportunities COP31 could create, and the new responsibility bestowed upon them by the TTGV Mehmet Şuhubi Pioneer Civil Initiative Award.

Your platform strives to bring the public sector, private industry, academia, civil society, and youth around the same table. What was the most challenging aspect of building a common climate language among stakeholders with such distinct priorities? What has been your most surprising experience so far?

Climate change is genuinely an arena where everyone views the same problem through entirely different lenses. The public sector focuses on policy generation, the private sector on preserving competitiveness, academia on ensuring scientific rigor, civil society on maximizing social impact, and young people on voicing their anxieties about the future. Therefore,

the greatest challenge for us was aligning these disparate priorities around a single, unified objective.

Our approach has never been to create platforms that merely exist for discussion. We have always aimed to construct an ecosystem that produces together, develops solutions together, and assumes joint responsibility. That is because we believe the climate crisis is not an issue that a single institution or sector can solve in isolation.

The experience that moved me most was witnessing how institutions that appear vastly different on the surface can develop remarkably strong collaborations for the exact same goal once you establish the proper foundation. When you bring a public administrator and an entrepreneur, or an academician alongside an industrialist or student around the same table, the resulting synergy often far exceeds expectations. This demonstrates to us that when proper communication is built, climate ceases to be a divisive topic and becomes a unifying agenda. That was precisely our primary objective in founding the Sustainable Future Platform: to unite every stakeholder whose core concern is climate change and humanity under a single roof within this civil initiative framework. Seeing that we have succeeded in this regard ensures the ongoing vitality of our ecosystem.

Climate Resilience

Climate change is no longer just an item on environmental policy agendas; it is a primary concern for the economy, industry, water, energy, and food security. In your view, what will be Türkiye’s

most critical climate transformation priority over the next five years, and why?

In my view, the most critical issue over the next five years will be “climate resilience.” Today, climate change is no longer a future scenario; it is a reality directly impacting production, water resources, energy supply, cities, and the economy. Particularly in countries like Türkiye, which will be heavily affected by the climate crisis, water management, agricultural production, energy transition, and the circular economy cannot be evaluated independently of one another.

The European Green Deal and carbon regulations also demonstrate that sustainability is no longer merely an environmental preference, but one of the core determinants of economic competitiveness. The nations that succeed in the upcoming era will not only be those developing new technologies, but those capable of scaling this transformation across all sectors.

As Türkiye prepares for COP31, it aims not only to host a successful event but also to accelerate its green growth vision. One of the most important elements of this approach is integrating climate policies into the shared agenda of all sectors—from manufacturing and industry to agriculture and finance. The success of this transformation will be possible not through public policy alone, but through the private sector, academia, and civil society acting toward the same goal.

For many years in Türkiye, climate change was primarily a topic discussed by scientists and experts. You, on the other hand, are striving to bring it to the shared agenda of all segments of society. Looking back one day, what needs to have changed in Türkiye for you to say, “We succeeded”?

I do not measure success merely by the number of events we organize or the projects we generate. For me, true success will be when sustainability stops being a separate agenda item and becomes a natural part of the way we do business. When a municipality factors climate impact into its investment planning, when a company accounts for its carbon footprint while formulating strategy, when a farmer makes production decisions with climate risks in mind, when young people view sustainability as a natural pathway for their careers, and when citizens become part of this transformation through their daily choices—that is when we can say “we succeeded.” Because I believe that true transformation is possible not just by changing policies, but primarily by shifting mindsets and, subsequently, behaviors.

If sustainability transitions from something merely discussed to an applied development approach in Türkiye after COP31, if institutions view one another as transformation partners rather than competitors, and if young people become natural actors in this process, only then will we speak of genuine success.

As Türkiye prepares to host COP31, do you think the greatest need is new climate technologies, or a strong societal transformation capable of adopting these technologies? What role does the Sustainable Future Platform aim to play in this transformation?

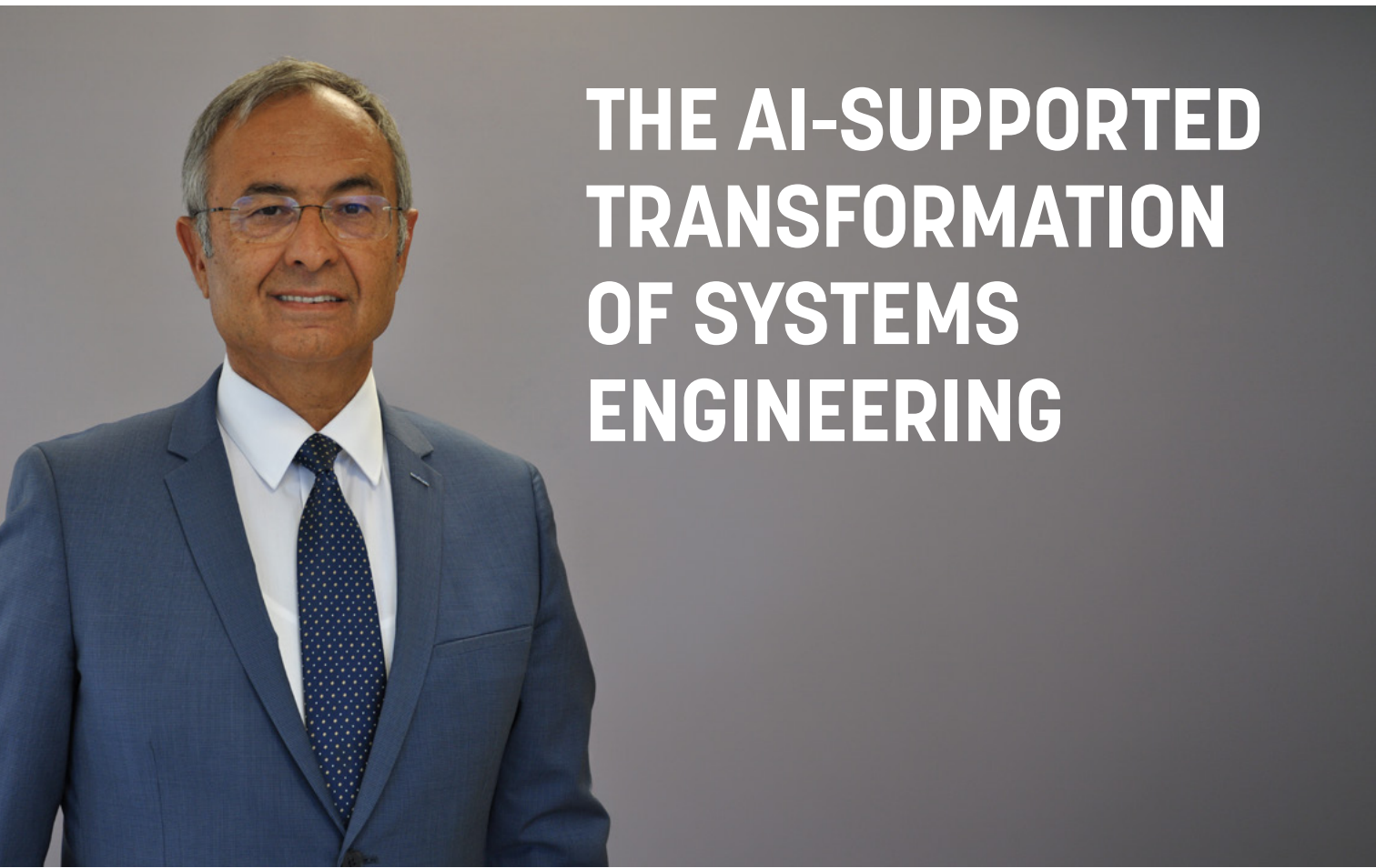
Türkiye hosting COP31 offers us a major opportunity to accelerate our green growth vision while elevating our influence in climate diplomacy. Of course, we need new technologies. However, technology alone does not drive transformation. What truly delivers transformation is institutions acting together, the building of a collective intelligence, and society believing in this change. Many of the technologies we need in the world today already exist. The core issue is embedding these technologies into investment decisions, production models, urban planning, and daily habits.

As the Sustainable Future Platform, we aim to serve as a civil society facilitator for this transformation. By establishing lasting collaborations among the public sector, private industry, academia, international organizations, and youth, we prioritize making COP31 not just a successful event, but the catalyst for a collaborative ecosystem whose impact will endure for years to come.

This year, you were awarded the Mehmet Şuhubi Pioneer Civil Initiative Award by TTGV. Do you view this award merely as recognition for the work you have accomplished so far, or does it also bestow a new responsibility regarding the future of climate-focused civil initiatives in Türkiye? What is your primary objective for the Sustainable Future Platform in the upcoming period?

We naturally view this award as a immense honor. However, its most significant meaning for us is that it serves as a testament to the trust placed in the multi-stakeholder collaboration model in Türkiye. The Sustainable Future Platform has never aimed to be an entity that merely organizes events. We strive to build a platform that brings different sectors together around shared goals, generates solutions, and creates a tangible impact. Therefore, rather than being simply a recognition of past efforts, this award is a powerful source of motivation that further heightens our responsibility moving forward.

In the period ahead, our goal is to build enduring platforms that strengthen Türkiye’s climate diplomacy, foster international collaborations, and continue to thrive long after COP31.



THE AI-SUPPORTED TRANSFORMATION OF SYSTEMS ENGINEERING

FUAT AKÇAYÖZ

TTGV, Member of the Board of Founders
Kale Jet Motorları AŞ, Member of the
Board of Directors
Strategic Management Consultant

Exactly half a century ago, in the first steps of Türkiye's struggle for national technological independence in the defense sector—triggered by the international embargo process we faced in the aftermath of the Cyprus Peace Operation—as young engineers freshly graduated from METU who had newly joined ASELSAN, we certainly did not yet realize that a massive challenge lay before us, not only technically but also methodologically.

For initially, the size of the qualified human resource that needed to be managed in the limited product development activities undertaken was merely at the level of 3–5 engineer-years. However, over time, as we entered into more complex, original product and device development processes, we understood that this scale would grow rapidly, and in the near future, our most paramount problem would be ensuring that this large qualified team coming from diverse disciplines worked effectively and efficiently.

Systems Engineering

Indeed, following the first communication devices produced and developed at ASELSAN in line with the critical needs of our Turkish Armed Forces, in subsequent years—alongside communication, radar, electronic warfare, electro-optics, and similar system solutions—we embarked on far more complex and large-scale projects executed through the industry's synergy, such as the ATAK Helicopter and MİLGEM Combat System, as well as all types of air defense, sensor, weapon, and missile systems for land, air, sea, and submarine platforms.

Now, it was necessary to manage a vastly larger intellectual resource gradually exceeding the scales of 1,000–1,500 engineer-years. It was precisely here that we, as the defense and aerospace sector, passed our true test: by succeeding in managing a massive ecosystem comprising hundreds of qualified engineers—and even different companies—speaking vastly different technical languages such as mechanics, hardware, software, microwave, and the like, in the same rhythm, in harmony, and without error. In those years, drawing inspiration from international literature and U.S. military standards (MIL-STD), we built organization-specific project management and systems engineering processes that are still used with the same effectiveness today; we advanced and developed these processes further with each passing day. The classic “V-Model” was virtually our holy scripture: the top-down breakdown of requirements, subsystem designs, production, and then those painful integration, verification, and validation (V&V) processes progressing bottom-up...

Had it not been for these rigid, disciplined, and documentation-oriented methodologies, none of those domestic and national system solutions we take pride in today could have been brought to life. Classic systems engineering formed the backbone of our modern defense industry today. Today, one must give credit to this accumulated knowledge, which constitutes one of the most critical assets of our defense industry.

The Changing Threat and Speed Paradigm

However today, we stand on the threshold of a completely different world order being shaped by artificial intelligence. In our era, periods of 8 to 10 years—or sometimes even longer—from the conceptual design of a defense system capable of competing in the global market to its deployment in the field were considered reasonable. Indeed, during that period, threats still progressed in a linear structure, while technologies developed at a relatively predictable pace. This new paradigm makes it imperative for systems to be developed in much shorter timeframes and to be updated “within days” while in the field.

Classic methodologies, where thousands of pages of requirement documents are reviewed manually and interdisciplinary conflicts can only be detected at the physical prototype stage—that is, at the end of the road—are no longer able to keep up with the speed of this new world. Systems engineering must adapt to this speed without compromising its classical discipline. At this exact point, artificial intelligence (AI) emerges as a major advantage and an indispensable assistant.

AI-Assisted Systems Engineering (AI-SE)

Artificial intelligence is not a simple software that merely enhances the tools in the systems engineer's hands; it is now a game-changing, most competent, tireless, all-remembering “Co-Pilot” standing alongside the engineer. We can foresee three main axes that will fundamentally transform systems engineering in the upcoming period:

1. *Intelligent Requirements Management with Natural Language Processing (NLP)*

A significant portion of a systems engineer's working hours is spent analyzing user requirements. Artificial intelligence can scan a tender or requirement document consisting of thousands of items within minutes; it can detect conflicting clauses, missing parameters, and requirements that could pose risks based on error trends in past projects.

EXPERIENCE

For example, it can place the physical inconsistency between a mechanical requirement stating “The air defense radar shall be of this weight” and an electronic requirement stating “Its range shall be of this distance” right in front of the systems engineer on the very first day of design.

2. Generative Design and Digital Twins

When designing, we used to remain faithful to our experience and safe boundaries. AI-assisted generative design tools, on the other hand, can simulate millions of different design alternatives within constraints defined as inputs by the engineer (weight, material, budget, strength) and generate the most optimal geometry and system architecture within hours—alternatives that human mind would find difficult to imagine. Furthermore, thanks to the “Digital Twin” created before even the first bolt of the system is tightened, the performance, failure probabilities, and responses to environmental conditions that the system will exhibit throughout its entire lifecycle can be tested by artificial intelligence in a virtual environment. Integration pains can be resolved in cloud environments before systems ever arrive at the laboratory.

3. Interdisciplinary Intelligent Bridge and Predictive Integration

The concurrent work of engineers from different disciplines has always been one of our greatest managerial challenges. AI-based project agents can predict, by learning from historical data, how a single line of code change in software might affect a thermal issue that could arise in hardware, or the mechanical vibration behavior of the system or any of its components. This approach moves engineering management away from a focus on “finding and fixing errors” to a level of “predicting and preventing errors.”



Evolution from Engineering to “Systems Orchestration”

My primary observation from the major defense projects I have been involved in throughout my fifty-year career is this: *systems engineering is, at its core, a framework of thought developed to manage escalating technical complexity. Today, artificial intelligence does not alter the fundamental principles of this discipline; rather, it radically transforms how we execute them.*

The systems engineer of the future will not be a data processor sifting through Excel sheets to match requirements or struggling with documentation formats. In this new era where artificial intelligence takes on operational load and complexity, the role of the human engineer is evolving into a “**Systems Orchestrator.**”

My advice to young colleagues is to never abandon the unshakeable logic and discipline instilled by military standards, but to unite that discipline with the immense speed and analytical power that artificial intelligence provides. The foundations we laid half a century ago can only sustain their leadership in tomorrow's world through this visionary transformation.

PRELIMINARY RESEARCH REPORT

THE NEW INFRASTRUCTURE OF ENERGY TRANSITION: SMART ELECTRICITY GRIDS

Electrical systems are transforming into a more dynamic and complex structure, together with the increasing share of renewable energy sources, the spread of electric vehicles, energy storage systems, data centers, and distributed generation applications. Electricity grids, traditionally built on centralized generation, one-way energy flow, and predictable consumption, are increasingly struggling in terms of the flexibility and management capabilities required by this new structure. The Smart Electricity Grids Preliminary Research Report, prepared within the scope of the TTGV Pioneer Projects Program, addresses this transformation starting from the structural limitations of the traditional grid; it examines the technological components, layered architecture, global application examples, and the studies carried out in Türkiye within a holistic framework.

One of the report's key assessments is that grid transformation is not merely a matter of creating new generation or transmission capacity. At the center of the transformation lies making the grid more visible, measurable, and manageable through data. The fact that Türkiye's installed capacity reached approximately 125.6 GW as of May 2026, with 62.6% of it coming from renewable sources, reveals the scale of the change in the generation structure. At the same time, the fact that loss-and-theft rates in the distribution system differ significantly across regions shows that, rather than a single uniform implementation model, approaches shaped by regional needs and priorities are gaining importance in the smart grid transformation.

The study evaluates the transition to a smart grid not as a large-scale technology investment to be carried out all at once, but as a gradual transformation process consisting of complementary steps. In this process, the priorities that stand out are, first, strengthening the measurement and visibility infrastructure; then, reducing losses and effectively managing distributed energy resources and flexibility elements; and, in later stages, putting data analytics and AI-supported decision mechanisms into operation. Smart grids constitute an important area of transformation for making more effective use of renewable energy capacity, operating existing grid assets more efficiently, and developing new operating and business models in which the demand side participates actively in the system.

Prepared by:

Ediz Kaan ÖNEM – TTGV Pioneer Projects Program / Program Specialist



TÜRKİYE NEEDS GLOBALLY COMPETITIVE DOMESTIC AI PRODUCTS, NOT MORE AI SHOWCASES



ERTAN BARUT

President of the TOBB Türkiye Software Council, and Founder and CEO of GLOBALNET

INTERVIEW: Esra YAZDIÇ DEMİR
TTGV Corporate Communications and Media Manager

As the global race in artificial intelligence accelerates, the critical question for Türkiye is no longer merely how fast we adopt this technology, but to what extent we can transform it into products, intellectual property, productivity, and exports. True competitive advantage stems not so much from developing the largest AI models, but from delivering solutions that generate value on a global scale by combining technology with domain expertise, proprietary data, and real-world needs.

We spoke with Ertan Barut—President of the TOBB Türkiye Software Council, and Founder and CEO of GLOBALNET—about the transformation of the Turkish software sector in the AI era across a broad framework: from technological independence to AI-native business models, and from SME transformation to the commercialization of domestic AI solutions. According to Barut, the main challenge facing Türkiye lies not in its capacity to produce technology, but in aligning this capacity with real industry problems, productizing successful solutions, and scaling them into global markets.

While artificial intelligence creates a massive growth opportunity for the software sector on one hand, it is rapidly transforming existing business models on the other. What must the Turkish software sector do differently to emerge stronger from this transformation? What kind of shift do you expect in the products, services, and business models of software companies over the next few years?

I evaluate artificial intelligence not as a new product category added to the software sector, but as a transformation that redefine how the sector generates value, incurs costs, and competes. A significant portion of our software companies generates revenue through projects, licensing, subscriptions, maintenance, consulting, and man-days. In the upcoming period, the competitive space for companies that merely develop code or execute client-assigned tasks will narrow even further. As routine code generation becomes easier, areas such as product architecture, data management, security, domain expertise, intellectual property, and the ability to correctly define customer problems will become increasingly valuable. Therefore, it is essential to distinguish between being “AI-assisted” and being “AI-native.” Adding a few AI features on top of an existing product does not constitute true transformation. AI-native means designing AI from the ground up as a core element of the product, service, and business model, rather than as an afterthought. This approach requires embedding data, models, human oversight, security, and continuous learning into the product architecture from the very beginning.

In our country, we must shift the weight of the software sector away from project- and labor-intensive service models toward structures that generate products, platforms, intellectual property,

and recurring revenue. We must build our products at the design phase with international markets, multi-language support, regulatory compliance, security, and scalability in mind.

Over the next few years, I anticipate that smaller yet more productive teams, industry-focused vertical solutions, usage- and outcome-based pricing models, business processes supported by AI agents, and managed service models will come to the fore. Türkiye’s competitive advantage must lie in transforming its strong engineering capability, domain expertise, and entrepreneurial capacity into global products. Rather than producing more code, we must generate more products, intellectual property, brands, and exports.

In discussions regarding artificial intelligence in Türkiye, the need for domestic technology development and technological independence is frequently emphasized. In your view, should Türkiye focus on developing foundational AI models, or should it prioritize creating AI products and applications that can compete globally in sectors where we are strong? In which areas of the AI value chain can Türkiye build a genuine competitive advantage?

We should not reduce this issue to a simple binary choice of “foundational model or application?” Trying to produce everything from scratch is not the right approach, nor is remaining entirely dependent on foreign sources for critical technologies. We must implement a selective and layered technological autonomy model that directs our resources to the right areas.

First layer: Strategic capacity

We must possess specific capabilities in foundational models, datasets, compute infrastructure, model evaluation, and cybersecurity for Turkish



“In our country, we must shift the weight of the software sector away from project- and labor-intensive service models toward structures that generate products, platforms, intellectual property, and recurring revenue.”

language competency, public services, defense, critical infrastructure, data security, and national decision-making processes. However, rather than having every institution develop the same model individually, we believe that shared infrastructure and consortium models—where the public sector, academia, and the private sector collaborate—would be far more efficient.

Second layer: Economic competitiveness

Türkiye's true major opportunity lies not in mimicking the world's largest general-purpose models, but in developing world-class AI products in sectors where we hold strong positions. We possess significant domain expertise and operational experience in areas such as defense, manufacturing, finance, logistics, energy, agriculture, tourism, retail, and public sector technologies. Merely owning a model is not enough. True competitive advantage stems from combining the model with proprietary data, business processes, domain expertise, security, distribution channels, and customer access.

Third layer: Commercialization and scaling

In our country, we struggle to transform many technically successful endeavors into products, recurring revenue, and exports. Our AI strategy should encompass not only research and prototype creation, but also productization, initial customer acquisition, building references, regulatory compliance, international sales, and growth stages.



We should measure success not solely by the foundational models we develop, but through indicators such as: How much domestic intellectual property have we generated? How many global products have we launched? To what extent have we increased the productivity of our enterprises? How much export revenue have we generated from artificial intelligence?

Companies are aware that artificial intelligence is important, but...

With the TOBB Business World AI Summit held in Ankara in July, you aimed to connect artificial intelligence with the real needs of the business world. Based on your observations from the summit, what are the most critical obstacles standing in the way of companies' AI transformation in Türkiye? What kind of model is needed, particularly to prevent SMEs from being left out of this transformation, and what role can TOBB play here?

When planning the TOBB Business World AI Summit in Ankara, we established our core approach as “bringing AI to the field.” This is because we anticipate that the true economic impact of artificial intelligence will manifest when it enters factories, exporters, SMEs, tradespeople, and the daily operations of businesses. As observed at the Ankara AI Summit—which gathered businesses from 53 different provinces and districts across Türkiye—technology supply and awareness regarding AI are rising rapidly in our country; however, demand on the enterprise side is not yet sufficiently defined or organized.

Companies are aware that artificial intelligence is important, but they suffer from a lack of knowledge and experience regarding which specific problem it should solve, where to begin, which data to use, how to select the right technology or solution provider, and how to measure the return on investment (ROI). Consequently, these uncertainties delay investment decisions.

Key obstacles facing the transformation:

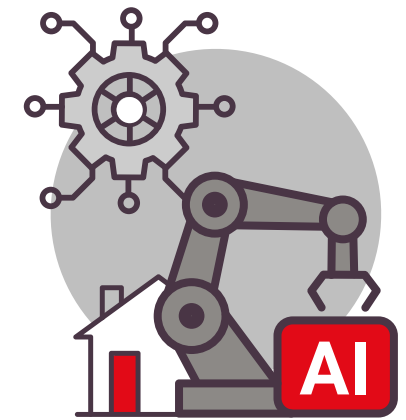
- Lack of clear objectives at the executive level,
- Data quality and data governance issues,
- Shortage of competent human resources,
- Security and regulatory concerns,
- Inability to sufficiently demonstrate the return on investment.

Therefore, simply delivering training or issuing calls to “use AI” to SMEs is not enough. We must develop and execute an end-to-end transformation model:

- Diagnosing needs,
- Identifying priority problems,
- Preparing data,
- Matching with the right solution partner,
- Implementing measurable pilot projects,
- Evaluating results,
- Securing financing,
- Scaling successful solutions.

TOBB's role is not to directly produce technology or endorse specific products, but to organize business needs, establish reliable methods and criteria, bring technology providers together with enterprises, and facilitate the scaling of successful applications. While integrating the capabilities of technology producers through the members and committees of the Türkiye Software Council, TOBB's other sector councils along with its network of chambers and commodity exchanges can articulate the needs of the real sector. As the Software Council, we have assumed responsibility on behalf of the sector within the framework of efforts carried out alongside our council members and committees. Through steps and initiatives aligned with national strategies, we bring our sector together with SMEs, industrialists, and enterprises to conduct matchmaking activities. Simultaneously, we carry out work to support production in this field, foster collaborative environments, and raise quality standards. Thanks to our network of chambers and exchanges, we can reach enterprises across various regions, while reaching technology-producing companies through the Software Council. On the other hand, we must build neutral transformation platforms that unite stakeholders, define needs, establish reliable methodologies and standards, disseminate best practices, and ensure the scaling of successful implementations. By utilizing sectoral use cases, AI maturity assessments, pilot programs, solution matchmaking, and appropriate financing models, we can establish a lasting bridge between these two sides.

The success of AI transformation in Türkiye should be measured not by a few large corporations utilizing advanced technology, but by whether an SME in Anatolia reduces its costs, increases its productivity, manufactures higher-quality products, and expands into new markets.



“The success of AI transformation in Türkiye should be measured not by a few large corporations utilizing advanced technology, but by whether an SME in Anatolia reduces its costs, increases its productivity, manufactures higher-quality products, and expands into new markets.”

Companies' preferences and approaches...

You are also the founder of GLOBALNET, a company operating in the technology sector for many years. As a corporate executive, you have experienced various technological waves—from the spread of the internet to cloud computing, and now artificial intelligence. In your view, what is the fundamental difference that sets artificial intelligence apart from previous technological breakthroughs? How is this transformation impacting GLOBALNET's products, services, and business model?

I have been working in the technology sector for over forty years. As both a technology professional and a corporate executive, I have lived through the widespread adoption of personal computers, the internet, web technologies, the mobile transformation, and cloud computing.

Every wave of technology has driven down a specific cost. The internet lowered the cost of communication and access, while cloud computing reduced the cost of acquiring compute capacity and scaling. Artificial intelligence, on the other hand, is increasingly lowering the cost of generating information, conducting analysis, and developing solutions to specific problems. This is the fundamental difference that distinguishes AI from previous breakthroughs. This technology is not merely an infrastructure that moves or stores data; it forms a layer that interprets data, generates content, participates in decision-making processes, and executes specific tasks. However, because AI systems operate probabilistically, they also introduce new risks. Issues such as data security, hallucinations or incorrect outputs, intellectual property, personal data protection, cybersecurity, and human oversight become just as critical as the technology itself. Therefore, AI transformation is not merely a matter of speed and automation, but also one of governance.

From GLOBALNET's perspective, we do not view this change simply as adding AI features to products. Hosting, cloud, CRM, enterprise software, email, web technologies, and managed services are all impacted by this transformation. AI does not diminish the importance of cloud infrastructure; on the contrary, it expands the need for secure data infrastructure, integration, identity management, monitoring, cost control, and business continuity. Consequently, we are focusing on advancing our services beyond providing infrastructure, transforming

into a structure that renders our clients' business processes smarter, automated, secure, and measurable.

Within our own company, I continually evaluate where AI can generate true value across sales, customer service, CRM, operations, knowledge management, and technical support processes. In this era, the question companies must ask themselves is not "Which AI tool have we added to our product?", but rather "What new value are we creating for our customers through AI, and how are we redesigning our organization?"

The TOBB Software Council represents the sector's needs and production capacity, while TTGV represents experience in technology development and the innovation ecosystem. Moving from the goal of making Türkiye a country that not only consumes artificial intelligence but produces technology and value, what kind of collaboration model could be designed between TTGV and the TOBB Software Council? If you were to design a concrete joint project, which problem would you focus on?

The fundamental problem regarding artificial intelligence in Türkiye is not merely developing the capacity to produce technology, but rather connecting the technology produced with real sector problems, commercializing it, and scaling it. In our sector, numerous projects remain at the prototype or pilot stage. Difficulties are experienced in transforming technically successful projects into permanent products, recurring revenue, intellectual property, and exports. I believe a joint program to be designed should focus specifically on this gap.

Such a program must focus on real business problems rather than technology proposals. Challenges that can directly impact cost, quality, productivity, and competitiveness in sectors such as manufacturing, logistics, energy, retail, finance, agriculture, or exports should be collected from companies. These challenges should then be evaluated and prioritized based on economic impact, data readiness, scalability, and export potential. Subsequently, matchings should be established with appropriate software companies, AI startups, universities, and research teams. Before launching a pilot, key metrics for success, data usage terms, intellectual property rights, security obligations, and the commercialization model must be clearly defined. At the conclusion of the pilot, evaluations should cover not only technical performance, but also cost reduction, time savings, revenue growth, quality improvement, and scalability.



The TOBB Türkiye Software Council, together with TOBB's relevant sector councils and network of chambers and commodity exchanges, can drive the identification of enterprise needs while integrating the software and AI ecosystems capable of delivering solutions. TTGV, in turn, can contribute through technology assessment, program design, financing, commercialization, and scaling support. Successful pilots can subsequently be transitioned into productization, initial customer acquisition, reference building, investment, and export programs. In short, as the TOBB Türkiye Software Council, we can collaborate with TTGV on a structured framework centered on a "Türkiye Vertical AI Productization and Commercialization Program."

Thus, within a single program, the following value chain can be established:

- Real sector problem
- Domestic solution and matchmaking
- Measurable pilot
- Intellectual property and productization
- Reference customer
- Financing
- Scaling
- Export

The success of this program should be measured by the number of solutions transformed into products, productivity gains achieved in enterprises, new revenue generated, intellectual property created, and exports realized. What Türkiye needs is not more AI showcases, but more Turkish AI products with real customers, proven value, sustainable revenue, and a global market footprint.



"As the TOBB Türkiye Software Council, we can collaborate with TTGV on a initiative centered around a "Türkiye Vertical AI Productization and Commercialization Program."

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SOLUTIONS

AYŞENUR ATIK BİLEN

TTGV Climate Lab Community Program Specialist

FROM AGRICULTURAL WASTE
TO ADDED VALUE: CIRCULAR
ECONOMY AND SYMBIOSIS

Türkiye's agricultural sector — through crop production, livestock farming, and agriculture-based industrial processes — generates large volumes of waste and by-products every year. A significant share of these streams is still burned in the field, left uncontrolled, or processed through low-value-added methods, giving rise to a range of environmental risks such as greenhouse gas emissions and soil and water pollution. Yet the biomass, carbon, nutrients, and functional compounds contained in this waste turn it into a high-value resource that can be converted into energy as well as inputs and advanced products for different sectors. At a time when we talk so often about the circular economy and the bioeconomy, how we look at waste is really, in the end, *an economic choice*.

Türkiye produces around 139 million tons of crop output every year; once forage crops such as alfalfa and silage corn are added, the figure exceeds 160 million tons (1). This production process — in the field, in orchards, and after processing — generates roughly 62 million tons of agricultural waste (2). Add post-harvest food losses, factory pomace, and processing by-products on top of that, and the total biomass waiting to be put to use exceeds 80 million tons (3). What's just as striking as the size of that number is how we're losing this value: most of this biomass is either burned in the field or, at best, turned into low-value animal feed. So what's the way to stop losing

Agricultural
Waste to
Value-Added
Production

this value? The answer comes down to two concepts: *the circular economy and industrial symbiosis*.

Circular Economy: Keeping Value in the
System

Contrary to its popular use, the circular economy means far more than “recycling.” In place of the linear economy's “take–make–use–dispose” flow, it puts *keeping value in the system, eliminating waste by design from the very start, and closing loops in a way that feeds natural cycles back into the system*. For agricultural waste specifically, this approach rests on two pillars. The first is cascading, or step-wise use: instead of burning a given biomass outright, extracting its value in descending order — first the valuable molecules it contains (chemicals, bioactive compounds), then the material itself (fiber, bioplastics), and only at the end, energy from what remains. The second is closing the nutrient loop: once these processes are complete, the remaining organic fraction returns to the soil as compost or biochar, so that nutrients such as carbon and nitrogen feed the soil again instead of escaping the system.

Symbiosis: The Mechanism That Makes
Circularity Work

The version of circularity that operates between companies is “*industrial symbiosis*”: one facility's waste, by-product, waste heat, or water becomes another facility's input. Symbiosis is what turns the circular economy from a slogan into a measurable business model. The world's most mature example is the *Kalundborg symbiosis in Denmark*. Operating since the early 1970s, this network today links 16 partners exchanging more than 20 resource streams — steam, water, gypsum, biomass, and more. The measurable annual environmental gains from this model: roughly 586,000 tons less CO₂ emissions, 4 million m³ of ground-

water saved, and 62,000 tons of surplus material brought back into production (4). These gains came less from major new investments than from connecting flows that already existed. The links built between facilities create value that goes beyond what any single facility's own efficiency could achieve.

TTGV: Building the Links of Circular Value

Thanks to its mission of supporting technology development and innovation, its experience in cultivating and bringing early-stage climate technologies into the field, and its capacity to bring different stakeholders together around shared goals, TTGV is well positioned to play a catalytic role in this area. In fact, this role is nothing new for TTGV. As one of the institutions that put the concept of “**Sustainable Development**” on Türkiye's agenda back in 1999, TTGV carried out a framework study with the Ministry of Environment and Forestry in 2010 to promote the spread of clean production; it then led Türkiye's first industrial symbiosis project, the “*İskenderun Bay Industrial Symbiosis Project*” (2011–2014). Under that project, ten symbiosis applications were implemented across a wide range — from fruit pomace turned into animal feed to iron and steel slag turned into road material — involving 19 institutions and organizations, delivering 330,000 tons of waste reduction and \$6.4 million in net economic gains each year (5). Today's stop on this same journey is the “Agricultural Waste to Added Value” working group.

In the “Agricultural Waste to Added Value” working group that we ran for twelve weeks under the TTGV Climate Lab Community, we brought together more than twenty institutions from the public sector, academia, private sector, and industry clusters around the same table. The topic wasn't discussed through the lens of a single sector; it was examined from a holistic perspective spanning soil health to biotechnology, energy to feed and packaging. Perhaps the most

valuable part of those twelve weeks was the sharing that fueled these discussions: experiences, good-practice examples, and field observations enriched the agenda of every session. Ideas for collaboration between waste owners and solution providers grew directly out of these conversations. By the end of the twelve weeks, 10 potential collaboration matches had emerged. As TTGV, we will follow up on the collaboration opportunities that came out of this table by deepening them with more focused groups, continuing to connect maturing ideas with our programs and support mechanisms.

The ultimate goal of the “Agricultural Waste to Added Value” working group is this: **to build the circular chain that turns agricultural residue into industrial input**. Because, looked at the right way, agricultural waste is not a disposal problem; it's one of Türkiye's most widespread, most accessible, and perhaps most overlooked industrial opportunities. Making this resource visible and converting it into value is a shared journey that will contribute both to producers' incomes and to the country's sustainable industry.

I would like to warmly thank all of our working group participants, who generously shared their knowledge and time, my team colleagues, and Didem Mahsunlar, who led this process.

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Agricultural Waste to Value-Added Production

FROM AGRICULTURAL WASTE TO SHARED ADDED VALUE: PARTNERSHIP ECOSYSTEMS FOR TÜRKİYE’S CIRCULAR BIOECONOMY MISSION

Two fundamental questions will determine the future of agri-food systems: How much real value are we creating from natural resources as we produce? And how can we make that value lasting and shared?

In today’s agri-food system, the stress and uncertainty created by climate change and geopolitical developments are making increasingly complex supply chains more fragile; they are pushing every actor — from farmers to fishers, from dairies to raw-material, feed, and chemical production facilities — to create more added value. Bringing every part of the 100 tomatoes grown with painstaking effort in the field — from peel to seed, from stem to leaf — back into the loop, with the greatest possible benefit for every actor in the food system, creates an urgent need for innovation and collaboration in technology, processing, and business models.

In increasingly globalized value chains, a great deal of organic waste, loss, and by-product that goes overlooked carries significant raw-material potential for next-generation materials, soil and plant health products, bioactive substances, accessible protein sources, and functional compounds.

For this reason, putting agricultural waste to use is not simply a waste-management issue; it is a strategic area of transformation that can boost the efficiency of the value chain stretching from agriculture to industry and from food to energy, along with national competitiveness and system resilience.

Through the Agricultural Waste to Added Value Working Group run under TTGV Climate Lab, we brought together 25

actors from different sectors between February and July to jointly assess the opportunities, obstacles, and needs of this transformation.

The most important outcome of this work, carried out with participants ranging from start-ups to large agricultural and food-industry companies, and from research institutions to the regional development and investment ecosystem, was demonstrating that the field holds strong technology and pilot-application potential, together with a real appetite for collaboration.

But for an effective and lasting transformation, the need for partnership models and scaling mechanisms that will speed the transition from lab and pilot scale to commercial application is the key factor shaping the roadmap and focus areas we have prepared.

“Waste” Is Not the Word — It’s the Missing Link in the Value Chain

The circular economy treats waste not as something outside the system, but as a resource that can be recovered with the right technology and business models. Although the agri-food system is circular by nature, a significant share of food is lost before it ever reaches the consumer, because of breaks in production and supply chains.

Globally, food loss and waste reaches roughly 30%, causing more than \$1 trillion in economic losses and accounting for 8–10% of global greenhouse gas emissions. This creates a significant structural vulnerability for food security

and resilience to crises. Reducing these losses is critical for increasing input efficiency, lowering production costs and environmental impact, and strengthening social sustainability. These resources, which can be put to use with relatively low-investment technologies and new business models, offer major transformation opportunities for strengthening food security, tackling climate change, and driving rural development. We observed promising examples of this potential in our own working group’s experience as well.

Turning Biomass into Next-Generation Products

Agricultural waste and by-products from the food sector are increasingly being converted into higher-value-added products, in Türkiye and around the world, through alternative supply chains and new technologies.

Lignocellulosic biomass can be converted through biorefinery processes into biochemicals and bio-based materials and composites, while agricultural by-products can be converted through fermentation and extraction technologies into protein, enzymes, and functional compounds — boosting both added value and product diversity.

There are numerous examples in international markets of lignocellulosic side streams being commercialized — barley and beet pulp, cereal straw and husks, and residues from coffee, fruit, corn, and bananas. Models developed through an industrial-symbiosis approach that jointly manage raw material, waste, energy, and water flows also carry applicable potential for Türkiye in terms of scaling impact. The market for advanced converted raw materials — where food and cosmetic applications lead the way — is projected to reach roughly \$106 billion by 2035, growing at a compound annual

rate of 5.7%, despite ongoing challenges around consumer acceptance.

In Türkiye, **Anako’s** collagen and antibacterial products made from eggshells; **Anadolu Etap’s** citrus by-products and **Döhler’s** flavor and color compounds made from tea harvest waste; and **Halavet Gıda’s** gelatin and collagen hydrolysate portfolios made from hide and meat-sector by-products are among the good examples of commercializing side streams.

Türkiye’s strong agricultural production infrastructure offers significant advantages for developing cross-sector opportunities. At the same time, examples of technical originality and new partnership models within the entrepreneurship ecosystem are also on the rise.

Biolive converts olive pits into bio-based additive materials through lignocellulosic biomass refining, developing alternatives to petroleum-based inputs for the plastics sector. The collaboration between **Wastepresso** and **Kastamonu Entegre** offers another example, bringing together service and technology solutions that have turned into a range of commercial applications in the biomaterials space.

Integrated facilities that link agriculture, livestock, energy, and soil cycles together are also supporting the conversion of organic waste into energy and fertilizer.

Kayseri Şeker, Sütaş, and PepsiCo, agri-food companies, are putting by-products from producers and their own facilities to use — turning streams such as beet pulp, molasses, cereal straw, and potato peels into different products such as biogas and organomineral fertilizer — showing that multiple forms of value can be created from the same raw material.

These examples show that competitive advantage can come not just from access to biomass, but from developing the technology, business models, and ecosystems that can convert biomass into high added value — and that scalable models are needed.

Given Türkiye's millions of tons of untapped biomass potential, this field is a strategic focus for investment and innovation, as well as an important area of transformation for food security and climate goals.

Mission-Driven Transformation and Impact

One of the working group's most important findings was showing that experiences across different sectors point to the same structural need: trust-based partnerships that can scale technologies, suitable investment mechanisms, and long-term collaborations.

A circular bioeconomy requires the transformation not only of technological innovations, but also of the collaboration and scaling models that will commercialize them.

Türkiye's agricultural diversity and production capacity can turn into a significant competitive advantage, given the right policy frameworks, regional implementation models, and strong partnership ecosystems.

For meaningful impact, what's needed is not more pilot projects, but solutions that are tied to a shared mission, applicable at the regional scale, and able to grow to industrial scale. As the agri-food sector and the start-up and technology ecosystems create lasting impact for regional development, producer welfare, and ecosystem health, they can also become one of the key areas for implementing and resourcing climate mitigation and adaptation strategies.

A significant opportunity sits at the intersection of Türkiye's climate change, circular economy, and bioeconomy strategies. With a multi-year roadmap and public-sector, private-sector, and research partnerships — and, crucially, targets that can be measured and tracked — our mission on agricultural waste is defined within the journey to Net Zero by 2053.

We can turn every piece of agricultural waste and every by-product into value by adding it to our resource inventory. The point isn't just to generate more added value; it's to

bring that value back into the loop through technology, partnership, and new business models — making it shared, and turning it into resilience and repair.

Five Key Paradoxes in the Spread of Biomass Technologies

The spread of biomass technologies is directly affected by structural tensions between technical, economic, and institutional requirements — tensions that also shape the added value that can be captured from agricultural waste:

1. The standardization paradox: The heterogeneous nature of biomass resources requires standardizing quality, classification, and use criteria. But excessive or overly rigid standardization, and locking in to a single end use, can limit local resource diversity and technological adaptability — holding back wider adoption.

2. The value paradox: Different use pathways for biomass can create different economic values from the same source. But higher-value pathways require more advanced collection, logistics, and processing infrastructure. Where that infrastructure falls short, resources can end up stuck in low-value use or disposal processes despite their high-value potential.

3. The collaboration and trust paradox: Developing biomass value chains requires strong collaboration between actors, based on sharing information, risk, and resources. But a lack of trust and information asymmetry can limit the development of long-term contracts, joint investments, and risk-sharing mechanisms — slowing the spread of technology.

4. The scale paradox: Capturing economies of scale in biomass technologies can require a continuous supply of raw material. But the scattered, seasonal, and variable nature of biomass supply can limit the raw-material continuity and economic feasibility of large-scale facilities.

5. The systemic transformation and orchestration paradox: The spread of biomass technologies requires coordinated action among production, supply, logistics, conversion, and market actors. But as the number of actors and sectors grows, coordination costs and decision-making complexity rise too — slowing systemic transformation.

GOAL – PROJECTION – OUTPUT

Why Did the Working Group Take Up This Topic?

- Agricultural production in Türkiye renews a huge biomass potential every year that could serve as industrial raw material; yet only a small share of that potential is currently being captured for the economy.
- Ecosystem actors — from producers to technology developers, from researchers to financiers — often work in isolation from one another; while valuable work is being carried out at the regional level, these experiences need to be brought together into a coherent national picture.
- The global economy is steadily moving away from the linear model that pushes waste outside the system, replacing it with a circular model that turns waste back into input. Agricultural biomass is one of the rare resources that gives Türkiye a chance to stand out in this transformation; the working group set out to explore that opportunity together with every actor in the ecosystem.

Why Does It Matter for Türkiye and the World?

- Agricultural biomass is a raw material source with no import dependency, renewing itself with every harvest; once converted into value, it opens new income streams for rural producers while giving industry a domestic, sustainable input.
- Disposing of agricultural residues through methods such as stubble burning, or leaving them to decay in an uncontrolled way, exacts a heavy environmental toll; once that same biomass is brought into the production cycle, the picture reverses — emissions fall while economic value is created.
- Long-running international examples such as Kalundborg show that the model's benefits aren't limited to the environment: symbiosis can also deliver competitiveness and measurable economic gains for businesses.

What Came Out of the Working Group in the End?

- The working group sessions turned into a productive learning environment where field experience and practical examples were shared. Over time, participants representing different parts of the ecosystem developed a shared language; by jointly assessing the opportunities of this transformation, the obstacles ahead, and the needs on the ground, issues such as reliable data, collection and logistics, and access to financing became clearly visible.
- New bridges were built between sectors throughout the process; these have grown into a collaboration network that will continue operating even after the working group concludes.
- The most concrete outcome was 10 potential collaboration opportunities; each will be matured and followed up going forward by dedicated teams.

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ESRA BORAN

TTGV Climate Lab Community Program Specialist

THE COLLABORATION BRIDGING WASTE AND RESOURCE

Some materials are labeled “waste” the moment they leave a factory’s gate. Yet the very same material may be exactly the strategic raw material another production facility, just a few kilometers away, is looking for. The real question is being able to see that value and build the right matches. Because sometimes, for a material to regain its value, people first need to sit down at the same table.

Mineral-based production waste, for instance, can be used as filler in building materials, while broken glass can become secondary raw material for other products. Agricultural and organic waste can be turned into biogas, fertilizer, or value-added biomaterials; plastic, packaging, and textile waste, meanwhile, can be brought back into the production cycle.

In this way, businesses can turn by-products they once paid to dispose of into a new revenue stream by making them available to other companies. This is exactly where the real power of the circular economy lies: instead of trying to eliminate waste, focusing on which production process can make it valuable again.

This is exactly why industrial symbiosis is not merely a technical approach; it is a way of thinking in which different sectors start to see one another, and production takes on a new language. One organization’s surplus can be another’s need. A material seen yesterday as a burden that had to be disposed of can turn today into a strategic resource of high economic value. When the right matches are made, it is not only the volume of waste that shrinks; natural resources are preserved, costs fall, carbon emissions decrease, and new collaborations are born.

Industrial Symbiosis in Building Materials

As TTGV, this is not an idea we’ve only just started pursuing.

One of the most concrete examples of efforts to spread the industrial symbiosis approach in Türkiye is the *İskenderun Bay Industrial Symbiosis Project*. In the Implementation Phase of this project, which we ran as TTGV between 2011 and 2014, we brought a total of 8 symbiotic applications to life — projects whose feasibility had been completed, that had turned into investment, or whose viability had been proven. Back then, we saw just how valuable it was, not only to give waste a new lease on value, but also to bring institutions that didn’t know each other to the same table. Today the same journey continues in a different form; regulations taking shape at the global scale — starting with the European Green Deal — are no longer a distant future scenario, but a reality sectors need to prepare for starting now. In Türkiye, the *National Circular Economy Strategy and Action Plan*, the *National Waste Management Strategy and Plan*, and COP31’s focus on zero waste that has made its way onto the agenda point in the same direction. Designed for implementation through 2035 in line with the sustainable development goals, these strategies make clear that managing the waste we generate is not enough on its own — we also need to use our limited resources more efficiently, reduce waste generation at the source, and keep the materials that do arise within the production cycle through reuse, recycling, and recovery. Anticipating that circular-economy practices would be one of the most important elements of this transformation, we have continued to keep the topic firmly on the agenda and turn it into concrete work. The Working Group we launched under the Climate Lab Community on **Industrial Symbiosis in Building Materials** brought together a range of different sectors around a shared goal. Over twelve weeks of meetings with private-sector representatives working in the ceramics, glass, building materials, wood, mining, refining, and chemicals sectors, together with academics, start-ups, and independent consultants, participants did more than just describe their own processes — they listened to one another, tried to understand each other’s needs, and discovered new possibilities together.

The innovative solutions we pursue by first identifying a problem, using the collective intelligence we try to build within our community, are transformed into concrete outcomes that are useful to industry. The working group we ran produced one of the finest and most successful examples of exactly this.

The most valuable gain of this process was the willingness of companies and individuals to take part in this transformation together, on behalf of our country and their institutions. The dedicated work of participants who came together every week around this shared goal carried the process to a real result.

“Can the material that emerges from a factory’s production process become a valuable input for another sector? Can businesses operating in the same region manage their resources together? Can the circular economy move beyond being merely an environmental goal and turn into a competitive advantage?” — these were the questions whose answers we sought.

And we saw that, in many parts of the world, industrial symbiosis is viewed as an important tool not only for environmental policy, but for industrial competitiveness as well. It is very clear that Türkiye, too, has strong potential in this transformation. What it takes is not just technology, but sharing, trust, and new relationships built between sectors.

Perhaps the greatest strength of industrial symbiosis lies exactly here: being able to build bridges between people and institutions before a piece of waste regains its value. Because, as with any collaboration, industrial symbiosis, too, begins with the bonds built between people first, and with a sense of trust that is simply indispensable.

So, What Were Our Outcomes?

The numbers actually give the clearest answer: through regular meetings and the strong collaborations we built, we identified **more than 40 potential waste-resource matches**. This is concrete proof that sectors which had been working without any awareness of one another can find each other

through just a few months of regular dialogue. We have already begun work to turn **11 of these matches, which we have prioritized**, into concrete projects that can be implemented and scaled under TTGV’s Eco-Production Transformation Program.

One of the most important things we noticed over the course of our working group was that industrial symbiosis cannot be made sustainable through well-intentioned matches alone. Successful examples that develop at the regional scale can only create real impact once they are owned at the national scale through a strong coordination structure. This is why **an orchestration mechanism** that monitors processes, brings stakeholders together, nurtures new collaborations, and tracks the value that emerges stands out as one of the most critical elements ensuring the continuity of industrial symbiosis applications. Thanks to such a structure, individual project examples can, over time, turn into an ecosystem that feeds on itself; each new collaboration can open the way for the next, creating a transformation that grows layer by layer.

In short, this transformation cannot be made lasting through fragmented, one-off efforts. What we need is a mechanism designed at the national scale that will turn waste into a business model institutions can put into practice together. As TTGV, we too will keep developing the collaborations we have built, and continue our work toward implementing, scaling, and commercializing the project ideas that emerge from them.

But I want to say, without forgetting it, that we arrived at this point not so much through institutional resolve, but through the will of our community — people who met at the same table week after week, listened to one another, and put in the effort.

With my thanks to all the members of the working group for their dedicated work and openness throughout the process, to Selime Öztürk, who took on the leadership of our working group, and to our dear Built Environment Climate Lab climate pioneer, Tuğba Uçar Demir.

TTGV'S BUILT ENVIRONMENT GROUP AND SYMBIOTIC RELATIONSHIPS ON THE ROAD TO COP31 FOR A SUSTAINABLE FUTURE

On this journey we set out on with TTGV to leave a lasting impact toward sustainability, we spent 12 weeks in the Built Environment group with close to 50 companies — our partners from the glass, ceramics, steel, and related high-energy sectors — built on mutual knowledge-sharing, open communication, dedication, and trust. Meeting at the same time every week eventually turned into a close friendship as well. Drawing on the synergy we created and the community's collective intelligence, we examined, from every angle, the industrial waste that is a shared problem for both Türkiye and the world. As a materials engineer who has spent many years working in fields such as ceramics, glass, coatings, and industrial minerals, I was honored to be part of this team, and I took on the role of volunteer leader of the group in order to put the knowledge I had gained in the sector to use in solving our community stakeholders' problems and providing a catalyst effect throughout the process.

Why Did We Choose the BUILT ENVIRONMENT SECTORS?

The glass and ceramics sector is energy-intensive, meaning it operates at melting/firing temperatures above 1200°C. In these sectors, every step from casting through to post-kiln processes inevitably produces what we call scrap — the output of production inefficiencies. But reusing this material within existing production at certain percentage rates requires serious R&D, production, and quality processes. Each company tries to consume this waste within its own production facility

by storing it under well-defined categories. Because production teams — and sometimes quality teams — limit its use for technical reasons, internal consumption can take a long time, sometimes even years. At the same time, breaking and grinding fired ceramic products involves certain process-related challenges. Vitrified ceramic products and glass products that have taken their final shape need to be broken before they can be reused. But once broken and ground, they can be used, 100% recycled, both in the ceramics sector itself and, as an abrasive material, in the construction sector, in areas such as anti-slip agents. This, however, requires advanced equipment with high wear resistance.

Similarly, when we look at glass-sector scrap, alongside the waste from industrial glass production itself, all the glass packaging waste we use in everyday life also falls into the category of quality waste. Glass waste is the material I have worried about most since I entered the glass sector. Take a look around you: the collection bins that are always the fullest, and always the most neglected, are the ones for glass waste. This is, without exception, a pattern repeated in similar ways in every city. The reasons behind it can be counted as many, including lack of awareness, low value for scrap collectors, low sale prices, and logistical constraints. But much of the colored glass packaging that never gets collected ends up dumped carelessly in our forests, and sometimes even causes fires. When glass waste reaches consumers already separated, it is used 100% by manufacturers. This brings down, in particular, the amount of pure raw

material used; because cullet is used in the recipe, firing temperature drops, which in turn leads to a significant reduction in NOx and CO2 flue-gas emissions, and a marked increase in product quality. When we weigh up benefits like these, bringing more ceramic and glass scrap back into industry — filling what is a serious raw-material gap in Türkiye — will be the beginning of a major transformation.

One of the core main themes of COP31 — one of the most important mechanisms of global climate governance, alongside the Kyoto Protocol and the Paris Agreement — is the zero-waste approach within the scope of the green transition. This approach does not limit climate action to carbon reduction alone; it also addresses it through the principles of resource efficiency, sustainable production, and the circular economy.

- Less consumption, higher efficiency.
- Reduction at the source, for a lower carbon footprint.
- Circular systems that generate value instead of waste.

The deposit-based glass-plastic-metal waste collection campaign that our Ministry of Environment launched ahead of COP31 is another example showing that we are moving in the right direction with this work of ours.

How Did We Make Progress?

In this project we started with TTGV, we assessed the needs of close to 50 of our companies through a comprehensive technical survey. We looked at the types and quantities of waste our companies hold, its composition, and the difficulties and bottlenecks they face in using it. We also brought other companies from

the wood, refining, and chemicals sectors that could use the building-materials group's waste, along with university academics, chambers of industry, SMEs, start-ups, and entrepreneurs, into the process, adding different ideas to our pool of thinking. We know that more than 80% of glass waste is collected and used in the global glass sector, whereas in Türkiye this figure is unfortunately below 5%. For this reason, in order to draw lessons from global experience, we held a conversation with a speaker from the "Close the Glass Loop" initiative. We saw that, on this journey we set out on with TTGV, the power of collective intelligence consistently produced far more successful and faster results than going it alone ever could. Our goal for the process ahead is for our companies, after reciprocal sample exchanges and pilot production trials, to start using each other's existing waste in their own production as upcycled materials.

Thanks:

After all these trial and production efforts, once even a single company in the sector starts using another company's waste as a steady alternative to pure raw material, my greatest source of motivation will be having been part of the team that lit this spark.

I hope that, on the road to COP31, these projects we have developed for Türkiye, for our companies, and for the world we will leave to our children have a future beyond this. My thanks to Esra, who took the time to join our community, never hesitated to share her valuable ideas and experience with us, and, on behalf of TTGV, always kept us motivated and on track, and to my dear friend and fellow climate volunteer Tuğba, whose path crossed mine through TTGV.

GOAL – PROJECTION – OUTPUT

Why Did the Working Group Take Up This Topic?

- **Converting Production By-Products into Strategic Value:** Waste generated by production processes at industrial facilities — traditionally seen as “a cost item that must be disposed of” — in fact carries the potential to become secondary raw material and a strategic resource for another sector.
- **Delivering Economic and Environmental Benefit at the Same Time:** Enabling companies to lower their waste-disposal costs while converting their by-products into new revenue streams, while at the same time building circular business models that reduce natural-resource consumption, carbon emissions, and environmental footprint.
- **The Need for Cross-Sector Collaboration and Cultural Transformation:** Industrial symbiosis is not simply a technical process; it is a “way of thinking” that brings different sectors, academia, and start-ups together to build a trust-based common language and a collaboration ecosystem.
- **Historical Experience and Continuity:** TTGV’s determination to convert the institutional knowledge it built up through past field applications such as the İskenderun Bay project into a broader-scale community movement under the Climate Lab, focused on the building blocks suited to today’s changing dynamics.

Why Does It Matter for Türkiye and the World?

- **The Responsibility to Align with International Trade and the Green Deal:** The need to protect industry’s competitiveness against increasingly strict climate regulations and carbon border measures in global markets — starting with the European Green Deal — and to prepare today for sustainable production standards.
- **Full Alignment with National Strategy and Policy:** The obligation to take concrete steps that increase resource efficiency and reduce waste at the source, in line with Türkiye’s National Circular Economy Strategy and Action Plan, its National Waste Management Strategy, and the global Zero Waste vision.
- **Global Competitive Advantage in Industry:** The fact that, around the world, industrial symbiosis is now positioned not merely as an environmental policy, but directly as a competitiveness tool that delivers cost advantage and resilience in industry.
- **Potential for Regional and National Resource Management:** The fact that, thanks to Türkiye’s broad industrial infrastructure and its diversity of sectors, it carries high potential to reduce dependence on imported raw materials and to achieve resource optimization at the regional level.

What Came Out of the Working Group in the End?

- **Identifying Concrete Waste-Resource Matches:** Over 12 weeks, focused work carried out by private-sector, academic, and entrepreneur participants from different sectors (ceramics, glass, building materials, wood, mining, refining, chemicals) mapped out more than 40 potential waste-resource matches.
- **The Commercial Transformation Process for Priority Projects:** Among the matches identified, 11 with high impact potential were prioritized and put through a process to convert them into concrete projects that can be implemented, commercialized, and scaled under TTGV’s Eco-Production Transformation Program.
- **Establishing the Need for an Orchestration Structure and Ecosystem:** Moving beyond individual, one-off collaboration examples, it was determined that an orchestration/governance mechanism that will ensure the sustainability of the process, monitor stakeholders, and build coordination at the national scale is essential.
- **Gaining a Network and Collective Intelligence:** A sustainable stakeholder community was formed, with commitment at both the human-resource and institutional level, mutual trust, and the will to produce innovative solutions to shared problems.

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Water Efficiency in Agriculture Through Smart Irrigation and Precision Farming



GAMZE BUSE HIDIROĞLU

TTGV Climate Lab Community Program Specialist

RESPONDING TO WATER SCARCITY IN AGRICULTURE WITH TECHNOLOGY: TTGV'S CATALYST ROLE

Water scarcity is deepening across every sector in Türkiye. But there's one sector where the effects of that scarcity will reshape our lives in a major way. This sector both suffers from water scarcity and causes it: agriculture. On average, 69% of the fresh water withdrawn worldwide is used for agricultural irrigation (1); that share reaches as high as 90% in some regions and as low as 5% in others. Türkiye sits at the heavy end of that scale: nearly three-quarters of the water we use is consumed by agriculture, and current official figures show that share climbing from 77% to 79% in recent years (2) — meaning the situation is getting worse, not better. Faced with a share this high, it becomes impossible not to focus on this area, and not to develop solutions grounded in a real understanding of the problem.

To an outside observer, Türkiye's agricultural landscape can look perfectly ordinary: fields are planted, crops are harvested, market shelves are full. But beneath the soil, inside the irrigation canals, and in parts of some river basin plans, a growing problem is taking shape: water simply isn't as abundant as it used to be. This has become too serious an issue to be written off as a single bad year or a temporary drought. Climate change is disrupting rainfall patterns, raising evaporation rates, and making drought cycles more frequent. As supply keeps shrinking, demand keeps rising. Naturally, this puts serious pressure on the

agricultural sector. In a sector working under this kind of pressure, inefficient irrigation methods, uncontrolled use of groundwater, deteriorating water quality, and gaps in planning all stand out. Once the problem is framed this way, it becomes clear that the solution can't consist of a single technology or a single policy either. Situations like this call for facilitator- or accelerator-type interfaces and institutions that bring every stakeholder together, understand the sector's problems and needs, and develop solutions to a shared problem through collective intelligence and collaboration. This is where TTGV's working-group approach comes in — aimed at developing sustainable solutions to the deepening water scarcity in the agricultural sector, together with the right stakeholders, through innovative technology and collaboration models.

TTGV's framework points to five basic needs for effectively tackling water scarcity in agriculture. These should be read not simply as a list, but as a system in which each element feeds into the others.

- The first need, at the most basic level, is access to sufficient and reliable water resources. This doesn't just mean "finding more water"; it means managing existing resources in a predictable and sustainable way.
- The second is the effective and efficient use of water — that is, getting the highest possible yield out of the water already on hand.
- The third is the widespread adoption of modern, smart irrigation technologies — turning solutions such as drip irrigation, sensor-based monitoring, and data-driven irrigation planning from niche applications into the common standard.

- The fourth is integrated, basin-based water management and policy alignment — managing an entire river basin through collective intelligence, not just a single farm or a single region.
- The fifth is developing practices that take the soil-water interaction into account, because water management cannot be considered separately from soil health.

These five dimensions also hint at why TTGV can play a meaningful role in this space: the problem is interdisciplinary, involves many stakeholders, and sits at the intersection of technology and policy. The solution can't be tied to a single technology, and the issue is too important and too complex to be solved by a single institution or person either. What matters is multi-stakeholder working experience, a technology-focused infrastructure, and bringing technology owners and practitioners together on the right tasks at the right time.

This is a critical bridge — the one that turns research produced in a lab into an actual farmer's irrigation practice in the field, or a start-up's sensor technology into a river basin management policy. Many actors work in the field of agricultural water technologies in Türkiye — public institutions, the private sector, academia, start-ups. TTGV's added value lies in being able to bring these pieces together and offer a platform that turns them into commercializable, impact-focused solutions. In this context, discussing "Water Efficiency in Agriculture Through Smart Irrigation and Precision Farming" for 12 weeks under the TTGV Climate Lab Community, together with valuable experts and institutions from across the field, has been extremely worthwhile.

In our community, we carry out work to build technology capacity in the cluster where Türkiye's priority sectors

intersect with TTGV's focus areas. First and foremost, we work to clearly define needs and problems, and then bring together the right stakeholders in the relevant field to identify the priority intervention areas that a catalyst role can help mobilize. Our biggest goal is to see the big picture, take a solution-oriented approach through collective intelligence, and offer the ecosystem a systemic view. **Technology that isn't matched with the right policy stays ineffective; and even the best policy stays on paper without technology that's actually deployable in the field. TTGV's multi-stakeholder model aims to bring exactly these two things together.**

Water scarcity in agriculture is a reality Türkiye will face more and more often in the years ahead. Being prepared for that reality isn't possible through a single technological leap, a single policy change, or a single person or institution. What's needed is a holistic approach that connects research to the field, the field to policy, and policy to concrete investment and commercialization opportunities. Together with the sector's leading actors, who share this view and have spent weeks debating ways forward, we will monitor and follow up on agricultural irrigation efficiency, with the aim of turning research outputs into impact-focused solutions. Once again, we would like to thank all of our participants, who generously and openly shared their valuable knowledge and experience with us and with every stakeholder, and we hope that all of this work sheds light on the ecosystem.

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Team Leader

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Water Efficiency in Agriculture Through Smart Irrigation and Precision Farming

THE KEY TO WATER EFFICIENCY IN AGRICULTURE: TECHNOLOGY, GOVERNANCE, AND COLLECTIVE INTELLIGENCE

Climate change, drought, rising water demand, and population pressure are making the management of water resources more critical than ever. In this context, using water effectively and efficiently is not simply a technical matter. It is also a multidisciplinary issue with institutional, economic, and governance dimensions.

As in our own country, roughly 70% of water resources worldwide are used by the agricultural sector. As a result, every drop of water saved in agriculture will contribute directly not only to agricultural production, but also to water access for other sectors such as industry, energy, ecosystems, and urban use. Achieving water efficiency in agriculture is also one of the preconditions for sharing water more evenly and sustainably across sectors.

But water efficiency cannot be achieved through new irrigation technologies or digital solutions alone. Successful water governance stands out as a critical factor in putting every one of these applications into practice.

Water governance is the complete set of rules, practices, and processes that govern how decisions on water resources and water services are made, implemented, and held accountable. At the heart of this understanding is the idea that decisions on water management should be shaped not only by public institutions, but through the participation of all relevant stakeholders — farmers, irrigation

associations, academia, the private sector, civil society organizations, and technology developers. Because managing water effectively and sustainably requires bringing together the knowledge, experience, and priorities of different actors on a shared ground of dialogue and collaboration.

For this reason, the **Water Efficiency in Agriculture Working Group** coordinated by TTGV has delivered a significant governance experience that goes well beyond being simply a platform for developing ideas. Over twelve weeks, experts from different disciplines and institutions came together regularly, making it possible to develop a shared language, examine problems from different perspectives, and jointly shape solution proposals.

Decision-makers, practitioners, researchers, and sector representatives, who don't easily find the chance to come together amid their daily workload, seized the opportunity through this process to listen to one another's perspectives, share their experiences, and build shared priorities. This has also made a significant contribution to strengthening the culture of collaboration and coordination that water management needs.

In the period ahead, the most important factor in improving water efficiency in agriculture won't just be developing smarter technologies; it will be building the strong governance mechanisms that make putting those technologies to work possible.

Governance models that build collective intelligence, enable data sharing, foster trust-based collaboration, and bring all stakeholders into the process will form the foundation for the sustainable management of water resources.

What will determine our water future is not just how much water we have, but how we manage the water resources we already have. Water efficiency in agriculture is one of the most concrete areas where this understanding is put into practice. The core goal now is not to search for new water sources, but to manage every drop of existing water as effectively, efficiently, and sustainably as possible.

Modern irrigation systems, digital technologies, infrastructure improvements, data-based management tools, and the development of farmer capacity that will improve water efficiency all require significant investment. For this reason, financing and investment mechanisms are among the key factors that translate water policy into practice on the ground and turn targets into action. Water governance makes it possible to reach the right decisions, while investment is the most critical tool for putting those decisions into practice.

At the same time, experience shows that advanced technology-based solutions alone are not always sufficient when it comes to water efficiency. Every basin has its own hydrological characteristics, climate conditions, crop patterns, socioeconomic

structure, and cultural heritage. For this reason, high-tech applications that succeed in one region may not produce the same results elsewhere. Being able to integrate innovative tools such as digital technologies, artificial intelligence, precision agriculture, and remote sensing with local knowledge, traditional irrigation practices, and farmers' field experience — through hybrid and adaptable models — produces far more sustainable outcomes. Success in the agriculture of the future lies not just in being able to use the most advanced technology, but in being able to apply the right technology in the right place, at the right scale, and in a way that fits local conditions.

GOAL – PROJECTION – OUTPUT

Why Did the Working Group Take Up This Topic?

- In Türkiye, the agricultural sector accounts for more than 78% of total water use, making it the dominant driver of demand.
- Combined with climate change, reduced and more erratic rainfall, rising evaporation, and more frequent drought cycles are placing even greater limits on existing water resources.
- Together with inefficient irrigation methods, overuse of groundwater, water-quality problems, and gaps in institutional planning, this structural pressure is turning water scarcity in agriculture into an urgent area for transformation.
- TTGV is setting up this working group because its research capacity, its experience running multi-stakeholder (academia–industry–public sector–start-up) initiatives, and its technology-focused programs put it in a position to contribute as a catalyst on this complex, interdisciplinary problem.

Why Does It Matter for Türkiye and the World?

- Water scarcity, deepened globally by climate change, is a shared area of risk for both Türkiye and the world, given that agriculture is the most water-intensive sector.
- For Türkiye, the issue carries strategic importance for the sustainability of food production, the protection of groundwater resources, and strengthening basin-based water management.
- At the global level, the areas this working group addresses — AI-supported irrigation decision-support systems, sensor/IoT-based monitoring, agricultural use of treated wastewater and seawater, circular water management, and climate risk roadmaps — offer the chance to produce solutions that are transferable, scalable, and highly commercializable, since many countries face similar drought and water-efficiency challenges.
- Evaluating the process comparatively against examples from around the world further strengthens this international connection.

What Came Out of the Working Group in the End?

- Leading public-sector, industry, academic, and start-up stakeholders in the agricultural sector came together to form a shared platform for collective thinking.
- The needs and problems related to water scarcity in agriculture were identified, and the process of jointly seeking solutions among all stakeholders continues.
- Work continues on developing viable example cases and on supporting and scaling up the relevant technologies.
- Support was provided for pilot and demonstration applications aimed at improving water efficiency in agriculture, for identifying technologies and start-ups with high commercialization potential, for policy and roadmap recommendations, and for putting together a concrete project portfolio that can be evaluated under TTGV's Pioneer Seed–Demo, Pioneer Project Investment, and Eco-Production Transformation Programs.

IN CLIMATE ENTREPRENEURSHIP, SPEED IS NOT ENOUGH — DIRECTION MATTERS



BEN SOLTOFF

Ecosystem-Builder/
Entrepreneur in Residence
Martin Trust Center for MIT
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INTERVIEW: Esra YAZDIÇ DEMİR
TTGV Corporate Communications and
Media Manager

The urgency of the climate crisis is pushing entrepreneurs to move faster. But for Ben Soltoff, the real challenge is not simply moving fast — it is **choosing the right problem and pursuing the right solution**. After all, a venture cannot create meaningful climate impact if it cannot survive and scale.

Drawing on nearly two decades of MIT's Climate and Energy Ventures course, the experience of more than 150 startups, and in-depth interviews with dozens of founders, *Disciplined Entrepreneurship for Climate and Energy Ventures* explores why climate and energy entrepreneurship requires a distinct roadmap. Long development timelines, high capital requirements, shifting policy and financing conditions, and multiple “valleys of death” make this journey fundamentally different from conventional entrepreneurship.

We spoke with co-author Ben Soltoff about why choosing the right problem matters more than simply moving fast, how climate ventures can navigate multiple valleys of death, how an MIT-based framework can be applied to entrepreneurial ecosystems such as Türkiye's, and how founders can determine whether their ventures are creating genuine, measurable climate impact.

You have been working in the field of climate and energy entrepreneurship for many years. What inspired you to turn this experience into a book, and why did you feel that this field required a distinct approach to entrepreneurship?

Climate and energy entrepreneurs face a distinct journey, one that is often marked by long timelines, high capital requirements, and a need to measure environmental impact alongside financial impact. I have been part of several climate and energy startups, and I have mentored many more. In these ventures, I kept encountering the same barrier: standard frameworks of entrepreneurial support are helpful but insufficient.

This book is not just based on my own experience. It's based on in-depth interviews with dozens of founders, and as well as the experiences of my co-authors (Bill Aulet, Tod Hynes, Libby Wayman, and Francis O'Sullivan), who have collectively spent many decades founding, investing in, and teaching climate and energy entrepreneurs. In particular, we drew from the lessons of the Climate and Energy Ventures course at MIT, which has been running almost twenty years and has influenced the creation of over 150 startups.

Climate change continues to intensify, and the demand for reliable and affordable energy continues to grow, yet government support has faltered in many parts of the world. We need climate and energy entrepreneurship now more than ever, and we need entrepreneurs who are well prepared to address and overcome the challenges of this critical yet arduous pathway. That's why this book exists.

The urgency of the climate crisis calls for swift action, yet you emphasize the importance of choosing the right problem and developing a thorough understanding of the market. How can entrepreneurs strike this balance, and how can they know whether they are truly working on the right problem?

A venture can't have impact if it doesn't survive and scale. It's important to move quickly, but it's also pointless to move quickly if you're moving in the wrong direction.

The reason our series is called *Disciplined Entrepreneurship* is that founders must use discipline to figure out a viable long-term strategy, rather than pursuing what's shiny and exciting in the short term and then possibly getting stuck in a dead end. Our book provides a structured framework for answering the most important fundamental questions of starting a climate and energy venture. Entrepreneurs must confirm that there's a customer who's willing to pay for their solution and that there's a path to scale in terms of technology, policy, and finance. It may take a few extra weeks or months to fully answer these questions, but it's much better to take that extra time, rather than spending years on something with no path to success.

What Do Entrepreneurs Need to Understand...

You argue that climate and energy ventures must cross multiple “valleys of death.” At what stage do ventures with promising ideas and strong technologies most commonly fail, and why?

Because the stages are sequential, most ventures fail towards the beginning. Many promising breakthroughs never leave the lab, and many promising ideas never get implemented. However, that doesn't mean that the first valley of death is necessarily more difficult to overcome than the later ones, or that it needs more support. Each stage comes with its own challenges.

It is important for entrepreneurs to understand that they need to answer different questions at different stages of the journey. Early-stage investors care about different factors than mid-stage investors, who care about different factors than late-stage investors. The technical and market-related challenges will differ as well. A common cause of failure is that entrepreneurs are still fighting the last battle when they should be moving onto the next one.

İNSANLAR VE GEZEĞEN İÇİN
ÇÖZÜMLER GELİŞTİRMENİN 24 ADIMI

İKLİM VE ENERJİ GİRİŞİMLERİ İÇİN DİSİPLİNLİ GİRİŞİMCİLİK



BEN SOLTOFF
BILL AULET
TOD HYNES
FRANCIS O'SULLIVAN
LIBBY WAYMAN

The approach presented in the book draws largely on lessons from MIT and the US entrepreneurial ecosystem. How can this framework be applied in countries such as Türkiye, where public policy, incentives, the regulatory environment, and access to capital differ?

I'm very glad you asked this, because it's a crucial point. While the case studies in the book are mostly from the US, the core principles apply universally. In any location, climate and energy ventures must deeply understand their customers, they must learn to navigate the relevant policy landscapes, and they must obtain resources to grow and scale. However, the reality of geographic differences cannot be ignored. Customers behave differently in different

cultural contexts. The policy environment looks extremely different depending on the mode of government in question. Financing a venture is easier in places that have a robust venture capital ecosystem. All these factors materially influence the path of a venture. But none of them excuses an approach that is ill-devised or undisciplined.

To put an even finer point on it, I am confident that active and aspiring Turkish entrepreneurs will get a lot of value from *Disciplined Entrepreneurship for Climate and Energy Ventures*, and if they feel otherwise (or if they agree—especially if they agree), I'd encourage them share that feedback via the book website (de4cev.com).

Entrepreneurship Can Be Learned

Today, many ventures describe themselves as sustainable or climate friendly. What distinguishes a climate venture that creates genuine, measurable impact from the rest? And what is the single most important piece of advice you would give to a young entrepreneur entering this field?

Early in the book, we introduce the concept of Climate TAM, which is adapted from the more general business term TAM (or Total Addressable Market). Just as a traditional TAM is an imperfect but useful estimate of the financial impact of a new venture, Climate TAM is an imperfect but useful estimate of climate impact. Not every idea will make a material dent in the urgent climate and energy problems facing our world; some solutions have a greater impact in terms of emissions reduction, economic damage avoided, or even lives saved, possibly at a scale of one or more orders of magnitude. This future impact is possible to approximate at the outset, and it is crucial that entrepreneurs do so, to be sure that they're tackling a truly pressing problem for the planet.

I teach a whole class on this subject every spring at MIT with Victoria Pisini. We ask our students to create a detailed matrix of unsolved problems, and we push them to look beyond their own personal experience. Many of the most important climate and energy problems are lurking in frequently ignored industrial sectors, rather than the daily life of the average consumer.

The most important advice I would give to a young entrepreneur is one of our chief mottos at the Martin Trust Center for MIT Entrepreneurship: Yes, you can! Anyone can be an entrepreneur; it is a craft that can be learned (from many different places, including our book). Whether you're working on a startup, or any other innovative solution, thinking like an entrepreneur will serve you well. This is true across every field, but particularly for climate and energy. Tackling the dual challenge of more energy with fewer emissions is one of the defining issues of the twenty first century, and we need entrepreneurs to make it happen!



"Anyone can be an entrepreneur; entrepreneurship is a craft that can be learned, and this craft can be acquired from many different sources, including our book."

CLIMATE PIONEERS

#ClimatePioneer



BAŞAK KAFTAN

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DIGITAL TRANSFORMATION IN AGRICULTURE AND THE RIGHT USE OF AI

What exactly should we understand by “digital transformation” in agriculture? And where does artificial intelligence (AI) fit into this transformation? In this piece, I want to look for answers to these two questions. Digital transformation refers to a shift in which different digital technologies become part of production processes, letting us monitor agricultural activities closely, manage them effectively, and base our decisions on data. This is the same transformation examined in De Avila and Barbosa’s (2025) study, and I would like to walk you through it using three concepts: (i) digital agriculture, (ii) smart environments, and (iii) smart agriculture.

Let’s start with digital agriculture. The Internet of Things (IoT), sensors, big data analytics, AI, machine learning, remote sensing, mobile technologies, and communication infrastructures... all of these are digital technologies we encounter at different stages of agricultural production. This is exactly what we mean by “digital agriculture.”

So, “how do these technologies actually talk to one another out in the field?” Once digital technologies begin to be integrated into agricultural production, different devices and data sources become able to communicate with one another. This is exactly where smart environments come in. Sensors, IoT devices, communication networks, and data-processing infrastructures link up to form a system that can monitor and manage the physical environment in real time. As a result, dozens of variables — soil moisture, temperature, plant growth, weather conditions, disease and pest risk, among others — can now be tracked continuously.

The concept of smart agriculture, meanwhile, can be thought of as the point where the data-generation, monitoring, and communication power provided by digital agriculture and smart environments meets real agricultural decision-

making and implementation. **In short, digital agriculture is about the technologies themselves.** Smart environments, in turn, allow those technologies to operate as a connected system that generates real-time, continuous data. Smart agriculture, then, is the integrated structure in which all of that data is analyzed and turned into real agricultural decisions and interventions.

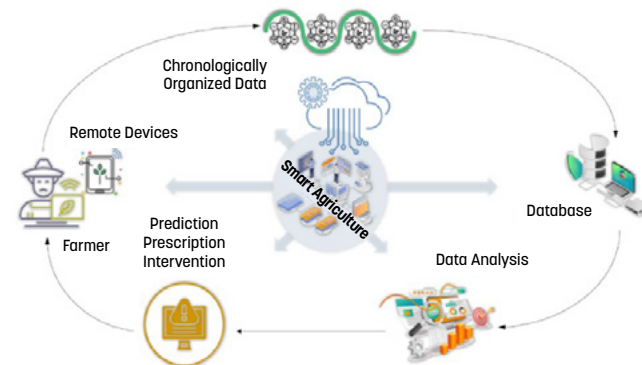


Figure 1*. General Overview of Digital Agriculture in Smart Environments

How does this cycle actually work? As Figure 1 shows, we can think of smart agriculture as a simple chain: data collection → data transmission → data storage and analysis → prediction → decision support → intervention → feedback. Let’s walk through a concrete example. On a farm, soil moisture sensors and weather stations collect environmental data. The IoT infrastructure transmits that data to the relevant systems. Data analytics processes the resulting information and turns it into something meaningful. Decision-support systems then step in and offer concrete recommendations on matters such as irrigation, fertilization, or crop protection. The picture that emerges is this: a continuously operating data loop forms between the physical agricultural environment and the digital decision-making mechanism.

From Smart Agriculture to Artificial Intelligence

So where does AI fit into smart agriculture? Within this integrated structure, AI plays a critical role especially at the stage of making sense of and analyzing large volumes of data from different sources, and turning them into forward-looking predictions. Sensors, IoT devices, satellite and drone imagery, weather stations, and farm records are producing data non-stop. But collecting data on its own is no guarantee that better decisions will be made in agricultural production. The real value comes from analyzing that data and converting it into knowledge, foresight, and actionable decisions. This is exactly where AI and machine-learning methods come onto the stage. Applications such as crop yield prediction, early detection of disease and pests, determining irrigation needs, assessing soil and plant health, forecasting climate-related risks, and optimizing input use can all be developed thanks to AI.

But one distinction needs to be made clear here. AI is not a technology that represents digital agriculture as a whole. It is only one of the core components that turns the data produced by digital agriculture and smart environments into agricultural foresight, decision support, and intervention. Getting this distinction right matters for using AI correctly in agriculture, because developing an AI model with a high accuracy rate is not enough on its own. The model also needs to be validated under real agricultural conditions, the data it relies on needs to be reliable and of good quality, it needs to be able to adapt to different production conditions, and the resulting output needs to be translatable into a concrete decision the farmer can actually act on.

So, how is the agri-tech start-up world — one of the important technology providers within our country’s smart agriculture ecosystem — actually doing? As a researcher conducting my PhD research on farmers in the agricultural sector, and also as someone who has worked for many years in technology transfer and entrepreneurship, I’m observing a rise in start-ups working on the use of AI in agricultural production here in Turkey. Yet

most of these start-ups struggle to survive long enough to turn the technologies they develop into actual field applications, largely because of financial constraints.

This is confirmed by the report “Digital Technologies for Agriculture in Türkiye – A Review,” prepared by the Food and Agriculture Organization of the United Nations (FAO) together with the European Bank for Reconstruction and Development (EBRD). Drawing on in-person and remote interviews with more than 120 sector stakeholders, the report finds that agri-tech start-ups struggle to access financing and resources, and concludes that blended finance models and field trials carried out together with farmers and/or agricultural enterprises need to be strengthened.

In the end, using AI effectively in the agricultural sector isn’t just a matter of technological capacity. This is where I see start-ups holding real potential. AI-based business ideas need to be tested in the field — out in the crop rows and the orchard — under real conditions and with accurate data. And that, in turn, is only possible with a strong ecosystem that supports these start-ups’ ability to scale. Within the agriculture vertical, the TTGV Climate Lab program acts as a facilitator in building exactly that ecosystem, bringing together farms and agricultural enterprises, academics, agri-tech start-ups, and public-sector actors around a shared goal. For the past year, as one of its climate pioneers, I’ve been trying to contribute to this effort as a volunteer. On that note, I’d like to invite anyone who wants to be part of the solution to join the Climate Lab community.

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AS AI ACCELERATES, WHO IS AT THE WHEEL?

Artificial intelligence is no longer just an agenda item for technology teams. It has become a horizontal transformation reshaping how organizations work, from strategy to human resources, from production to customer experience, from energy to mobility. McKinsey's 2025 Global AI survey finds that nearly every organization now uses AI, yet roughly two-thirds have not yet managed to scale it across the organization. **So the real question today is no longer “Are we using AI?” but “How are we managing this transformation?”**

Because the management challenge AI creates is every bit as large as the opportunity it offers. On one side there's productivity gains, faster decision-making, and new products and services; on the other, data security, intellectual property, algorithmic bias, faulty outputs, cybersecurity, and environmental impact. In fact, that same McKinsey survey finds that **51% of organizations using AI have encountered at least one negative outcome**, and roughly a third have experienced AI-driven faulty outputs.

That's why **AI governance needs to be seen not as a control mechanism that slows AI down, but as a management system that enables safe acceleration.**

By 2026, this need has become far more critical. Because we're no longer just talking about models we ask questions of — we're talking about **AI agents** that can plan specific tasks, use tools, and take action on our behalf. McKinsey's 2025 survey finds that **62% of organizations have at least experimented with AI**

agents. The 2026 AI Trust Maturity survey, meanwhile, shows that even as Responsible AI maturity rises, only about a third of organizations have reached an advanced maturity level in strategy, governance, and agentic AI controls. The gap between what the technology can do and our capacity to manage it remains wide open.

The World Economic Forum's 2026 study, *AI Agents in Action*, points to exactly this: as AI systems gain more autonomy, the question **“Did the AI give the right answer?”** is no longer enough on its own. We also need to answer **“What actions is the AI authorized to take, where are its limits, and who is accountable for the outcome?”**

Perhaps the most critical dimension of governance, then, is **the human being**. AI can make decisions, offer recommendations, and, in some processes, even take action. But accountability still rests with people. Tomorrow's successful organizations won't be the ones that take the human out of the process; they'll be the ones that correctly design the boundaries of decision-making and responsibility between humans and AI. Where a “human in the loop” approach is needed, which data can be shared with which model, and when an AI output can be turned directly into action — these need to be defined starting today. Of course, this is easier said than done, but it's an important issue that requires action starting now.

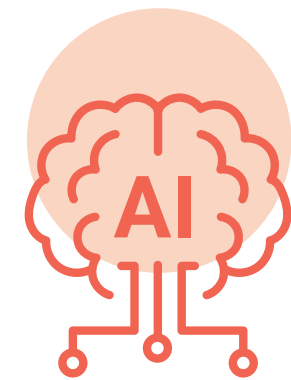
Looking at this through a climate-technology lens adds one more dimension to the equation: **the environmental**

impact of AI itself. As models grow larger, so does the need for data centers, energy, and infrastructure. So even as we use AI to solve sustainability problems — from energy optimization to smart cities, from climate modeling to mobility — we need to make the technology's own energy and resource footprint part of that same governance framework.

So, in my view, good AI governance needs to be able to answer three questions at once: **What value are we creating with AI? What risks are we taking on? And how are we managing its impact on people, the environment, and organizations?**

This is one of the most important things 2026 has shown us: competitive advantage won't go only to the organizations using the most powerful model. We can say that the organizations that pull ahead will be the ones that can connect AI to strategy, use the right data securely, define the boundaries of responsibility between humans and AI, measure outputs, and manage all of this through a sustainability lens.

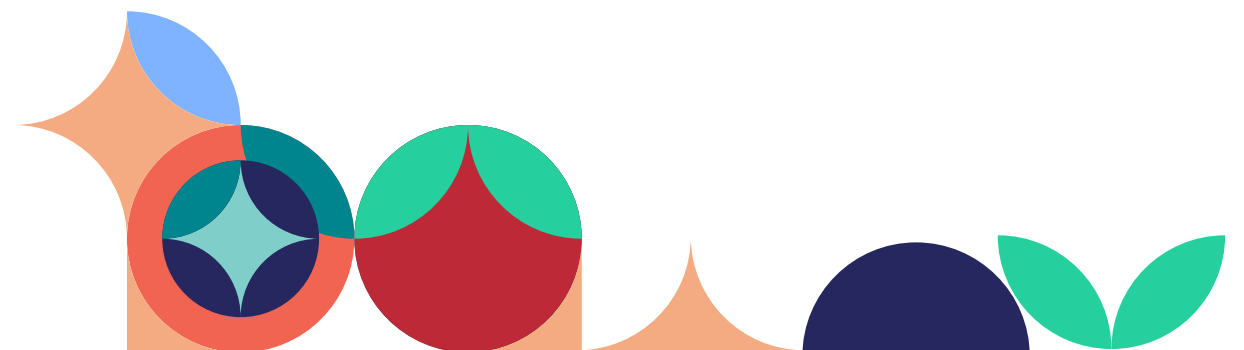
Because in the age of AI, what matters isn't just how fast we can go; it's **knowing who's holding the wheel, where we're headed, and what impact the journey has.**



“In my view, good AI governance needs to be able to answer three questions at once: What value are we creating with AI? What risks are we taking on? How are we managing its impact on people, the environment, and organizations?”

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THE DATA CARAVAN FROM FARM TO CLOUD: SMART FARMING AND FIELD REALITIES THROUGH THE EYES OF AN AGRICULTURAL ENGINEER WITH 27 YEARS OF EXPERIENCE

Agriculture may be humanity's oldest profession, but today it is undergoing one of the most radical digital transformations of any industry. As an agricultural engineer with more than a quarter-century — 27 years — of hands-on field experience, I have personally witnessed every stage of this journey: from traditional soil-based methods to the Internet of Things (IoT) and data analytics. Under the pressure of the climate crisis and rising food demand, bringing technology to the field is no longer a luxury — it is a necessity. But there is a world of difference between a technology performing flawlessly in the lab and that same technology holding up in the world of muddy boots, out in the field. That gap may well be the single most overlooked, and most important, detail in today's start-up world.

So how is smart agriculture changing the equation in the field, what challenges does it face, and — most importantly — how does the farmer, the true owner of the land, view this change?

The core promise of smart agriculture is to eliminate uncertainty. In short, it is a decision-support tool that helps you make the right calls in your farming operations. The days of forecasting rain by simply looking up at the sky are behind us. Thanks to the agro-meteorological stations

and sensor technologies we have been integrating in the field for years, we can now process micro-climate data in real time.

Especially when correctly positioned, **soil moisture probes** calculate, down to the millimeter, exactly when and how much water a plant needs — saving water while minimizing plant stress. The **disease-warning sensors** integrated into the system, meanwhile, analyze temperature and humidity conditions to give growers the chance to intervene early — before an agricultural disease causes any visible damage. By preventing unnecessary use of chemicals and fertilizer, these solutions both reduce costs and protect the ecosystem. Technology translates the language of the soil onto a digital screen, becoming a genuine technology partner for the producer. But it is also true that nature cannot be coded — and we are constantly working to develop technologies that live in harmony with nature, that listen to it, and that can coexist with it.

Developing and testing software in an office environment is easy. But keeping a piece of hardware running around the clock, in the middle of a field, through the scorching heat of summer and the freezing cold of winter, is an entirely different engineering challenge — one that, more often than not, your own body has to endure as well.

Challenges in the field...

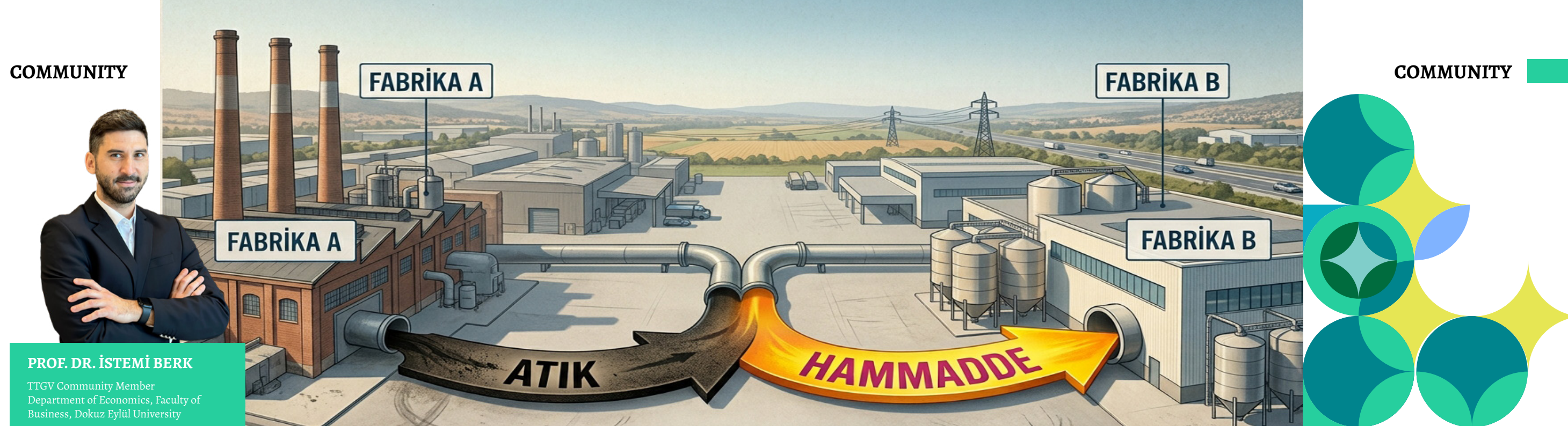
One of the biggest challenges in the field is infrastructure and data-transmission issues in rural areas. Nature also plays by its own rules: exposure to harsh environmental conditions means hardware out in the field can give rise to **a completely unpredictable problem** at any time. Wildlife chewing through cables, equipment strained by severe storms, or extreme weather events — all of it demands constant maintenance and engineering follow-up. Installing technology in the field is only the beginning; the real achievement is keeping that system running and properly calibrated for years, and never leaving the producer to face that process alone. This is also what turns your business and your brand into sustainable technology, because it's robust hardware that lets you build powerful software on top of it. A user-friendly piece of software with an easy-to-read screen does not, in itself, mean that the raw data you're collecting in the field is accurate. Frankly, for me, accurate data from reliable hardware matters far more, most of the time, than the shape or color of the chart that ends up on the screen.

For technology companies, efficiency charts, dashboards, and data analytics can be genuinely exciting. But 27 years in the field have taught me one thing very clearly: in the farmer's world, things move forward through experience passed down from generation to generation. For a technology to be accepted in the field, it takes far more than a polished presentation. The farmer has to trust the data the system produces and the value it delivers — and it matters that you become a brand they can reach whenever they call, and one that gives them clear answers.

Real technology integration doesn't begin in a glossy boardroom; it begins, say, in a village in Thrace, **in the local coffeehouse, over a glass of hot tea sipped from a slender Turkish tea glass.** The farmer wants to see, in concrete terms, how the data on a screen will affect the crop in his field, the diesel in his pocket, or the fertilizer he's about to use. At first, the station standing at the edge of the field is met with suspicion, dismissed as “just a strange pile of metal.” But once that device prevents an unnecessary irrigation run and cuts costs, or gives hours of advance warning of a frost risk and saves the entire harvest, that “pile of metal” in the farmer's eyes turns into a trusted assistant.

Once you yourself trust the data and the technology you produce, the farmer will come to believe in the results he sees with his own eyes.

Looking ahead, smart agriculture is not a system that dismisses traditional farming; on the contrary, it is a force that supports the farmer's thousands of years of invaluable intuition with science and data. The challenges are not insurmountable. As we agricultural engineers blend technology with the realities of nature, and as our interfaces move closer to the farmer's own language, this transformation will succeed. Because, in the end, the fertility of the land is measured not only by the sweat poured into it, but by how intelligently that effort is managed with technology.



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FROM TECHNICAL MATCHING TO ECONOMIC VALUE: WHY DOES INDUSTRIAL SYMBIOSIS NEED A BUSINESS MODEL?

At first glance, turning one company's waste into another company's resource looks like a perfect win-win equation: less raw material use, more waste converted into economic value, lower greenhouse gas emissions. And yet, a great many industrial symbiosis projects developed around the world never scale up beyond the pilot stage to reach regional or national adoption.

The root cause of this scaling problem is, more often than not, not a shortfall in technology but a missing business model. An industrial symbiosis match can be technically feasible and environmentally beneficial. But unless a strong business case and a workable business model are built for the companies on both sides of the match, it never becomes a lasting economic activity.

In industrial symbiosis projects, the first question is usually, "Can this waste be used in another process?" Then comes, "Does this match actually deliver an environmental benefit?" Yet a third question matters just as much as the first two: "How can this match be turned into a sustainable business model?"

Business Case and Business Model in Industrial Symbiosis

The business case sets out why a given investment should be made in the first place. Elements such as capital and operating costs, savings in raw materials and energy, avoided waste-disposal costs, payback period, and return on investment form the foundation of this assessment. In short, the business case shows whether a symbiosis application that is technically feasible is also economically worth pursuing.

This point is highlighted in a 2020 report from the European Commission's Directorate-General for Research and Innovation, which examined 28 EU-funded industrial symbiosis projects at various stages of maturity. The report set out an Industrial Symbiosis Readiness Level (ISRL) framework of nine levels, modeled on the Technology Readiness Level (TRL) approach, and emphasized that once a match reaches the prototype and demonstration stage (ISRL-6), the business case needs to be fully worked out in detail.

The business model, in turn, defines how that economic potential will actually be realized and converted into lasting economic value. Who will supply and who will use the waste, how continuity of quality and quantity will be assured, how transport and pre-treatment costs will be covered, and how the resulting risks and gains will be shared among the parties — these are the core building blocks of an industrial symbiosis business model. Indeed, whether a symbiotic relationship remains sustainable over the long run depends not only on whether it creates economic value in aggregate, but on whether that value is shared meaningfully and fairly among the actors involved in the symbiosis.

In short, without a business case, industrial symbiosis never gets off the ground; without a business model, a symbiotic relationship that does get off the ground cannot be sustained.

The Industrial Symbiosis Working Group for Construction Materials — a first for Turkey's built environment and construction materials sector — ran for 12 weeks under the TTGV Climate Lab Community Program. Over the course of the program, 54 stakeholders — company representatives, academics, and technology providers — took part, identifying more than 40 potential waste-resource matches, 11 of which were selected as viable cases. While these matches were still taking shape, one full session of the working group was devoted entirely to business case

and business model questions. That session examined economic and organizational indicators ranging from financial feasibility and investment performance to cost savings, from resource valorization to collaboration and competitiveness, and from investment and employment impacts to innovation capacity, in order to assess the conditions under which the emerging symbiosis matches could become economically viable and scalable structures.

Scaling up industrial symbiosis applications requires several levels of assessment to be considered together: technical suitability, environmental gains, and life-cycle costs at the level of resource flows and matches; the economic rationale for investment and the sharing of created value among the parties at the firm level; and value added, competitiveness, employment, and sectoral spillover effects at the network and ecosystem level. That a symbiosis network creates value in aggregate does not mean every participating firm benefits to the same degree. Making visible which actors bear the costs, savings, investments, and risks is therefore just as important as demonstrating the environmental gains.

Ultimately, converting waste into a resource is a technical and environmental achievement. Turning that achievement into lasting, scalable economic value, however, requires the economic and organizational dimensions to be designed together from the very first stage of the process.



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