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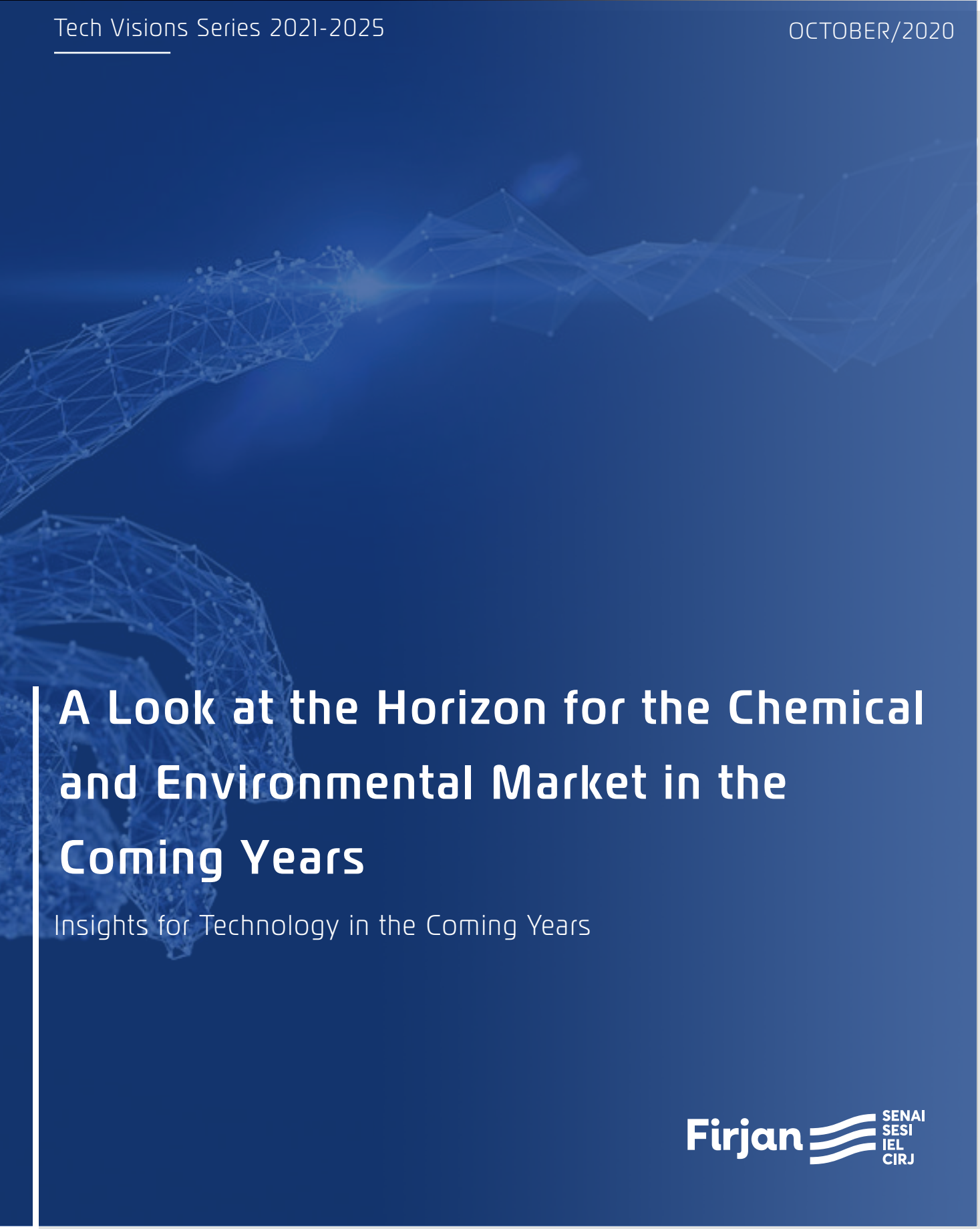

A Look at the Horizon for the Chemical and Environmental Market in the Coming Years

Insights for Technology in the Coming Years

Firjan SENAI SESI IEL CIRJ

Firjan SENAI - Technological Product and Process Management

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01 INTRUDUCTION

The FIrjan`s **Technology Roadmaps** planning began in 2008, with the goal of anticipating visions and developing paths for Firjan SENAI to be the place where companies innovate and solve their technological challenges. Since then, considering a changing world, it has become essential to continue the project in a structured and planned way, given the constant need for technological updating. Which, in short, means preparing to act with a systemic vision, efficiency and speed, building desirable and positive hypotheses for industry in the State of Rio de Janeiro and in Brazil.

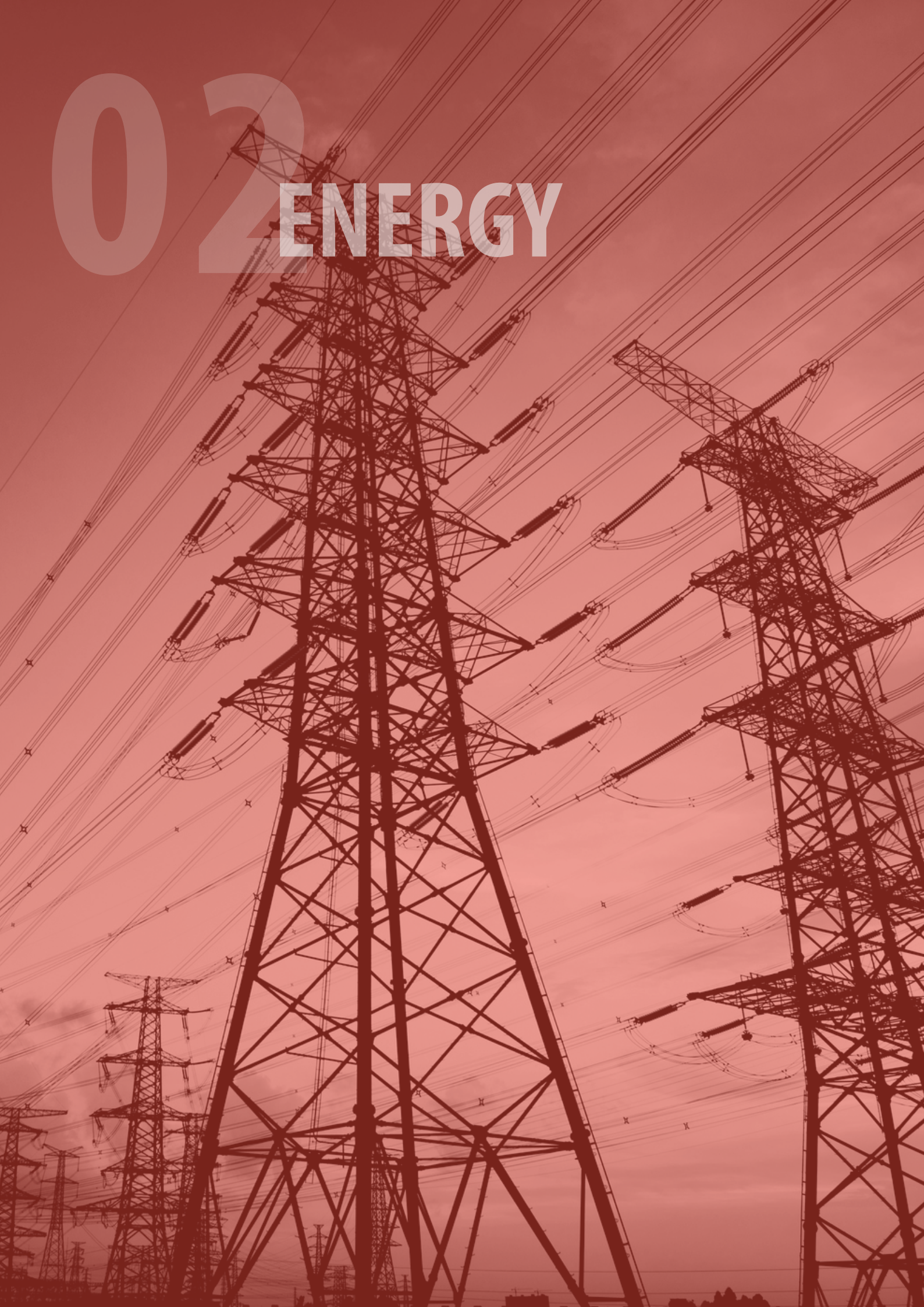
The Technology Roadmapping is a method of planning and management that aims to structure and systematize the technological planning process of the **Firjan SENAI Technology and Innovation Institutes,** based on the construction of trajectories, from choices, that determine the technological directions and result in a portfolio of services and applied research projects that seek to contribute to an increasingly favorable environment for innovation.

Currently, Firjan SENAI operates in three major areas of technological knowledge - **Chemistry, Materials and Digital Technologies** - and believes that it should act in creating paths for technological development and not just follow something already established. Thus, it is essential to identify, understand and map the drivers that will guide these choices

Industry is the engine of innovation in a country and, therefore, Firjan SENAI's commitment is to always prepare it for its challenges, inducing its transformation. **The Tech Visions series** is an organized survey, the result of exploratory research, technical debates among experts and insights generated by the "Coletânia Aquario" provided by Casa Firjan. All together they constitute the referential base of the 21-25 Technology Roadmap of SENAI´s Technology Institutes and Innovation Institutes.

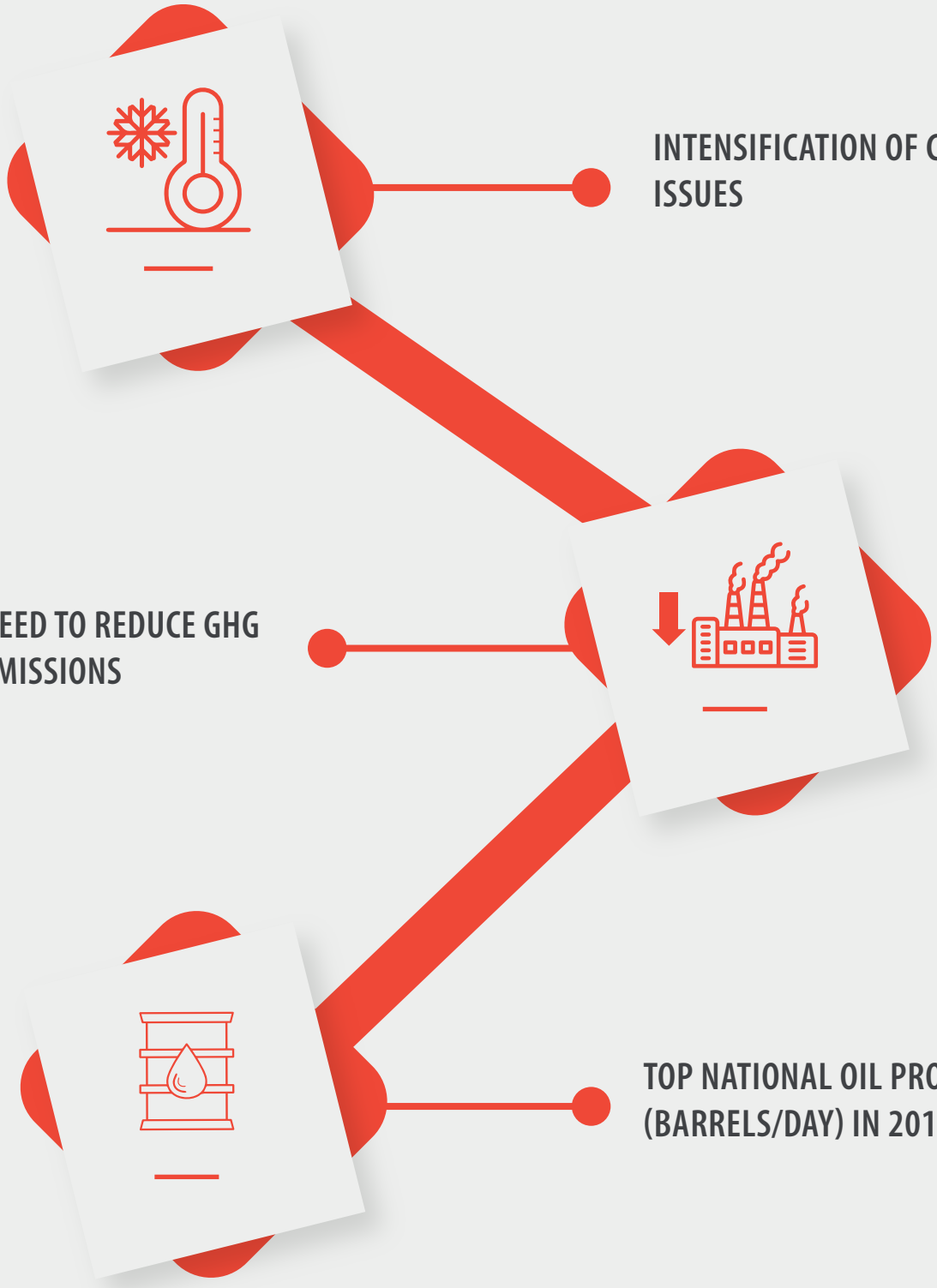
This material is about **Chemistry and the Environment** and aims to present a reflection on the current scenarios and market perspectives that will possibly impact the technology in the coming years. These visions were suggested by renowned people who participated in the technical debates and workshops held in 2019/2020 promoted by Firjan, and understood by the team of experts from the SENAI Green Chemistry Innovation Institute and the SENAI Technological Institute of Chemistry and Environment, considering the forces that are reshaping the current scenarios.

[1]Professionals from the areas of Innovation, Technology, Product, Sustainability, Social Responsibility, experts and consultants with expertise in global trends, in behavior and technology, and professionals from ministerial bodies. See identification in the List of Participants.



02 ENERGY

CURRENT SCENARIO



FUTURE PERSPECTIVES

DEVELOPMENT OF ALTERNATIVES AND RENEWABLE ENERGY SOURCES TO REDUCE GHG EMISSIONS

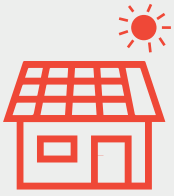
GROWTH OF ENERGY GENERATION BY RENEWABLE SOURCES: GEOTHERMAL, PHOTOVOLTAIC, WIND, CONCENTRATED SOLAR AND BIOMASS

OPTIMIZATION OF ENERGY STORAGE TECHNOLOGIES DUE TO THE INTERMITTANCE OF RENEWABLE SOURCES

TECHNOLOGY ADVANCES OF CARBON CAPTURE, STORAGE AND UTILIZATION (CCU / CCS)

ACCELERATION OF FLEET ELECTRIFICATION

INCORPORATION OF CARBON PRICING IN THE BRAZILIAN AND WORLD SCENARIO



INCREASE IN REMOTE AND DISTRIBUTED ENERGY GENERATION (SMARTGRID)

EVOLUTION OF BIOINDICATORS AND BIOREFINARY

DEVELOPMENT AND FEASIBILITY OF SECOND-GENERATION ETHANOL AND NEW CATALYST

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GREAT RELEVANCE OF OIL AND GAS EXPLORATION IN RIO DE JANEIRO AND BRAZIL

IMPROVEMENT OF TECHNOLOGIES FOR THE USE OF NATURAL GAS AS A SOURCE OF ENERGY AND RAW MATERIAL

GREATER PERFORMANCE OF REAL-TIME ANALYSIS ON THE OIL EXPLORATION

GROWTH OF THE ENERGY EFFICIENCY SEGMENT

GROWTH IN THE APPLICATION OF TECHNOLOGIES TO INCREASE ENERGY EFFICIENCY

03 WASTE

CURRENT SCENARIO

5 MILLION TONS OF WASTE IS DISPOSED IN THE OCEAN EACH YEAR WORLD

BRAZIL IS ONE OF THE 10 LARGEST SOLIDS WASTE PRODUCERS OF THE WORLD. THE WASTE IS MAINLY DESTINED TO LANDFILLS AND OPEN DUMPS

BRAZIL HAS LOW PERCENTAGE OF RECYCLING: ABOUT 1% OF TOTAL PRODUCED

NEW LEGAL FRAMEWORK FOR SANITATION IN BRAZIL

FUTURE PERSPECTIVES

DEVELOPMENT OF POST-CONSUMPTION MATERIALS MANAGEMENT, WASTE REUSE AND TREATMENT TECHNIQUES

EXPANSION OF BIOMASS ENERGY EXPLORATION

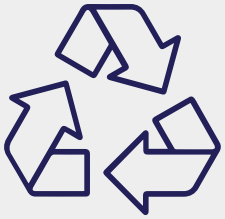
APPLICATION OF NEW TECHNOLOGIES FOR THE TREATMENT OF COLLECTIVE AND INDIVIDUAL WASTE

DEVELOPMENT OF URBAN MINING

DISSEMINATION OF GREEN LOGISTICS

DISSEMINATION OF REVERSE LOGISTICS AND EMERGENCE OF NEW REGULATIONS ON THE TOPIC (ESPECIALLY FOR ELECTRONICS)

TECHNICAL AND ECONOMIC FEASIBILITY OF NEW LEACHATE TREATMENTS



MAKING SELECTIVE COLLECTION A REALITY IN BRAZIL

NEW TECHNOLOGIES FOR RECYCLING – ESPECIALLY OF PLASTICS

NEW CATALYST IN MATERIALS MANAGEMENT

04 WATER SECUTIRY AND SANITATION

CURRENT SCENARIO

ONE OF THE UN'S SUSTAINABLE DEVELOPMENT GOALS (SDGS) IS TO ENSURE THE AVAILABILITY AND SUSTAINABLE MANAGEMENT OF WATER AND SANITATION FOR ALL

LOW PERCENTAGE OF SEWAGE TREATMENT IN THE COUNTRY AND HIGH PERCENTAGE OF TREATED WATER LOSS

THE DEVELOPMENT MAP OF RIO DE JANEIRO STATE HAS AS ONE OF ITS OBJECTIVES THE IMPROVEMENT OF ENVIRONMENTAL SANITATION

20 MUNICIPALITIES OF RIO DE JANEIRO DO NOT DISCLOSE OR HAVE NO DATA ABOUT SEWAGE COLLECTION

MORE FREQUENT WATER SUPPLY CRISES

NEW LEGAL FRAMEWORK FOR SANITATION

FUTURE PERSPECTIVES

DEVELOPMENT OF THE THEMES RELATED TO SEWAGE DISPOSAL

SETTING UP PUBLIC-PRIVATE CONSORTIA AND PARTNERSHIPS TO ENABLE THE PROMOTION OF SANITATION INNOVATIONS

EXPANSION OF SEWAGE COLLECTION AND TREATMENT GUIDED BY THE GOALS OF UNIVERSAL SANITATION

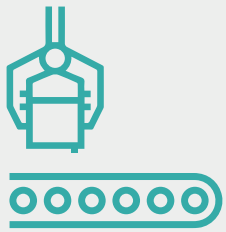
RESEARCH AND APPLICATION OF NEW SEWAGE TREATMENT TECHNOLOGIES, MAINLY AIMING AT SIMPLER AND MORE SUSTAINABLE PROCESSES OVER TIME, THAT IS, REQUIRING LOWER INVESTMENT AND REDUCED ENERGY DEMAND

RAW MATERIAL EXTRACTION AND USE OF BIOGAS AT SEWAGE TREATMENT PLANTS

INTENSIFICATION OF THE DEMAND FOR WATER TREATMENT

GROWTH IN THE USE OF ALTERNATIVE WATER SOURCES BY THE INDUSTRY DUE TO WATER STRESS (SUCH AS REUSE AND DESALINATION)

WATER REUSE PROJECTS FROM WASTEWATER TREATMENT PLANTS.



INVESTMENTS IN WATER EFFICIENCY IN INDUSTRIAL PROCESSES

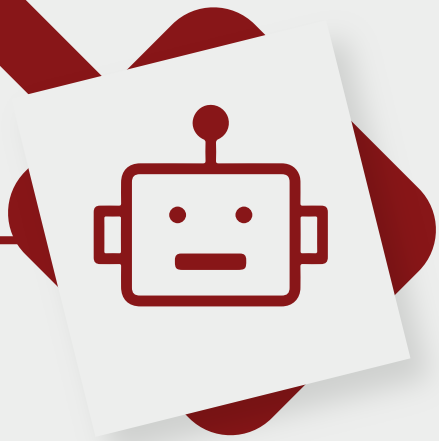
DEVELOPMENT OF SOLUTIONS FOR WATER CONTAMINATION, INCLUDING MICRO-CONTAMINANTS (MICROPLASTICS, PESTICIDES, ENDOCRINE DISRUPTORS, HORMONES, ANTIBIOTICS, AMONG OTHERS)

INCREASE OF OPERATIONAL EFFICIENCY IN SANITATION OPERATIONS - MONITORING AND REDUCING THE PERCENTAGE OF TREATED WATER LOSS

05 AGRIBUSINESS

CURRENT SCENARIO

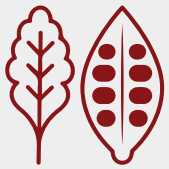
BRAZIL IS THE THIRD LARGEST AGRICULTURAL EXPORTER IN THE WORLD



LITTLE APPLICATION OF TECHNOLOGY IN THE COUNTRYSIDE

FUTURE PERSPECTIVES

GROWING DEMAND FOR HEALTHIER AND HIGHER QUALITY PRODUCTS

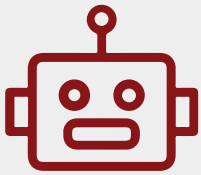


EXPANDING DEMAND FOR ORGANIC PRODUCTS

ALTERNATIVE PROTEINS AND THE FUTURE OF MEAT

BRINGING INDUSTRY AND COUNTRYSIDE CLOSER

BIOFERTILIZER MARKET EXPANSION



GROWTH IN THE USE OF TECHNOLOGIES FOR FOOD PRODUCTION

EMERGENCE OF NEW AGRICULTURAL TECHNIQUES SUCH AS PRECISION FARMING AND THE GROWTH IN THE USE OF HYPERSPECTRAL REMOTE SENSING

INCREASED DEMAND FOR ALTERNATIVE IRRIGATION SOURCES AND RATIONAL USE OF WATER RESOURCES

POPULATION CONCENTRATION DRIVING THE DEVELOPMENT OF URBAN AGRICULTURE AIMING TO PROMOTE THE APPROACH OF PRODUCTION AND CONSUMPTION POLES

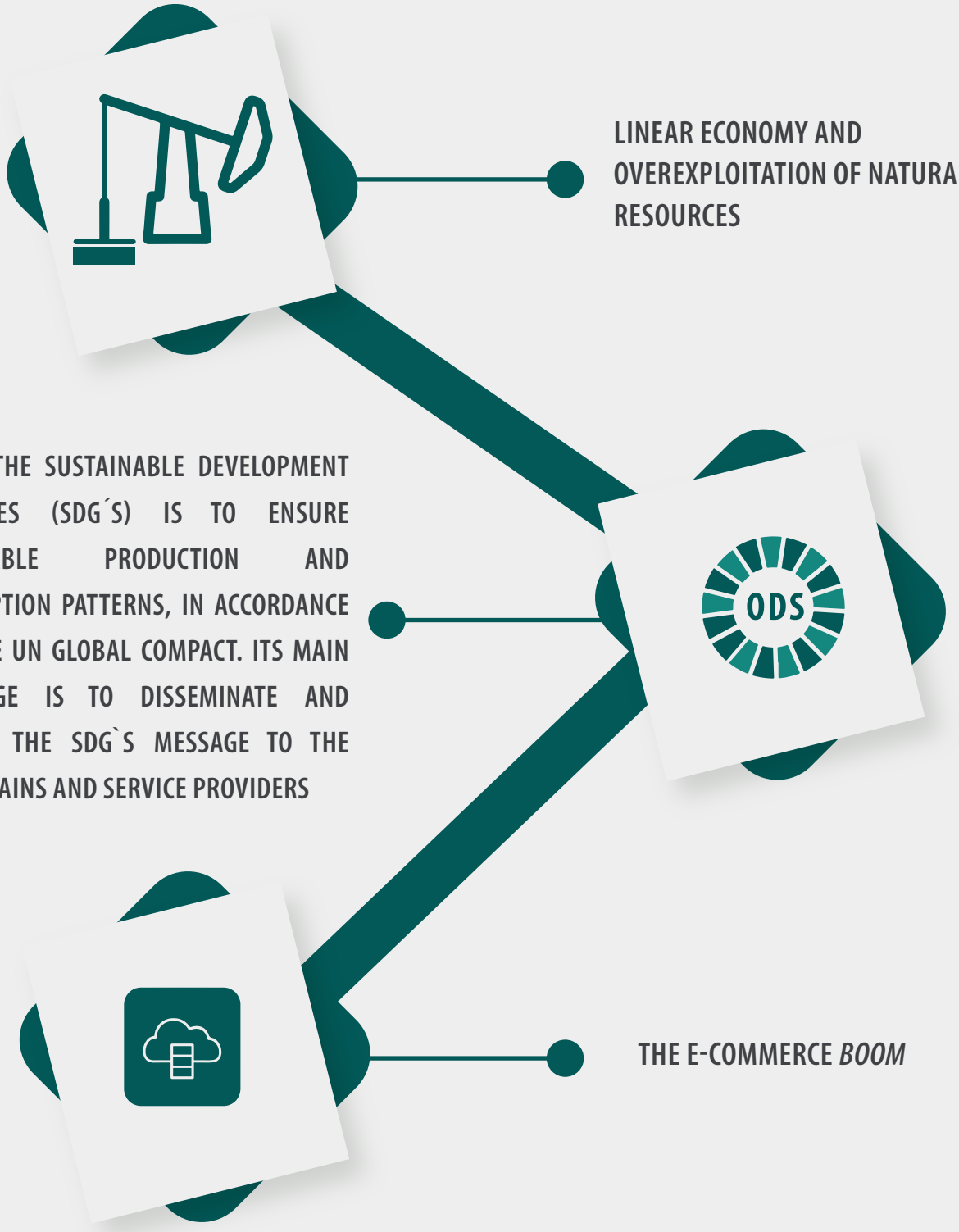
EMERGENCE OF LESS PESTICIDE-INTENSIVE AGRICULTURAL TECHNIQUES, SUCH AS SYNTROPIC AGRICULTURE AND PERMACULTURE

X

MONOCULTURE TYPICAL OF THE BRAZILIAN SCENARIO, AND DRIVEN BY PUBLIC POLICIES TO ENCOURAGE THE PRODUCTION OF BIOFUELS

06 BUSINESS MODELS AND CONSUMPTION

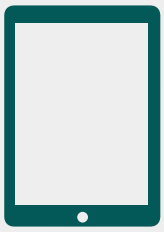
CURRENT SCENARIO



FUTURE PERSPECTIVES

CHANGES IN CONSUMPTION PATTERNS

EMERGENCE OF NEW BUSINESS AND CONSUMPTION MODELS, SUCH AS *CHEMICAL LEASING*



GREATER DEMATERIALIZATION OF THE ECONOMY AND THE TENDENCY TO REPLACE PHYSICAL PRODUCTS AND SERVICES WITH DIGITAL VERSIONS

ACTIVISM OF PEOPLE AND COMPANIES WITH SUSTAINABILITY

NEW FORMS OF CONSUMPTION

- *CONSCIOUS CONSUMPTION*
- *SHARING*
- *VEGANISM*
- *ORGANIC*

NEW PRODUCTION MODELS

INTERNALIZATION OF CIRCULAR ECONOMY CONCEPTS IN THE INDUSTRY AND IN THE MARKET

MAKING INDUSTRIAL SYMBIOSIS BUSINESS AS USUAL

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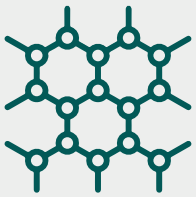
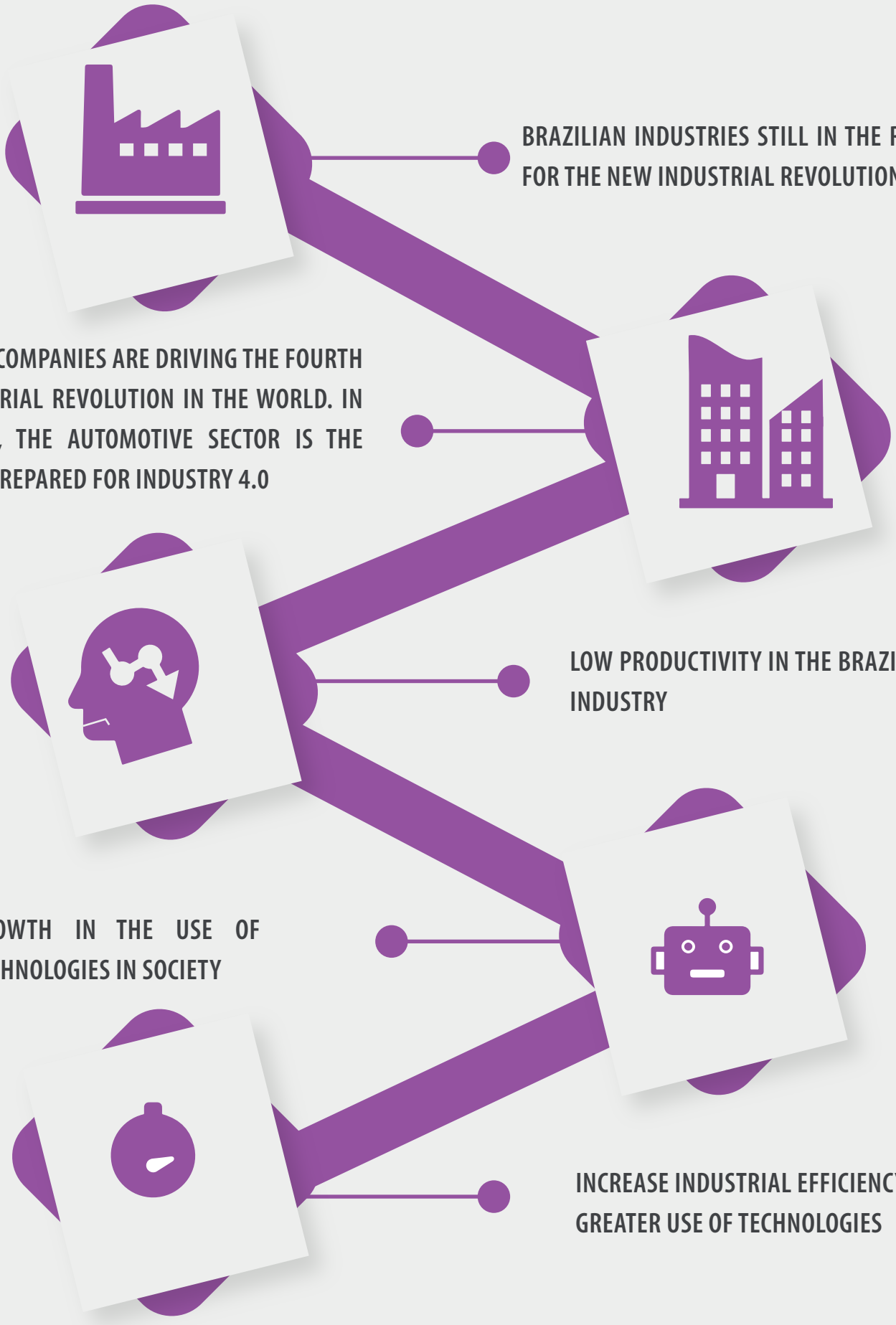


NANOTECHNOLOGY CONSOLIDATION

07 DIGITAL TRANSFORMATION AND INDUSTRY 4.0

CURRENT SCENARIO



FUTURE PERSPECTIVES

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DIFFICULTY TO ENSURE FINANCIAL RETURN

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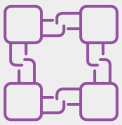
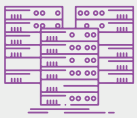
DEMAND FOR PEOPLE WITH NEW SKILLS



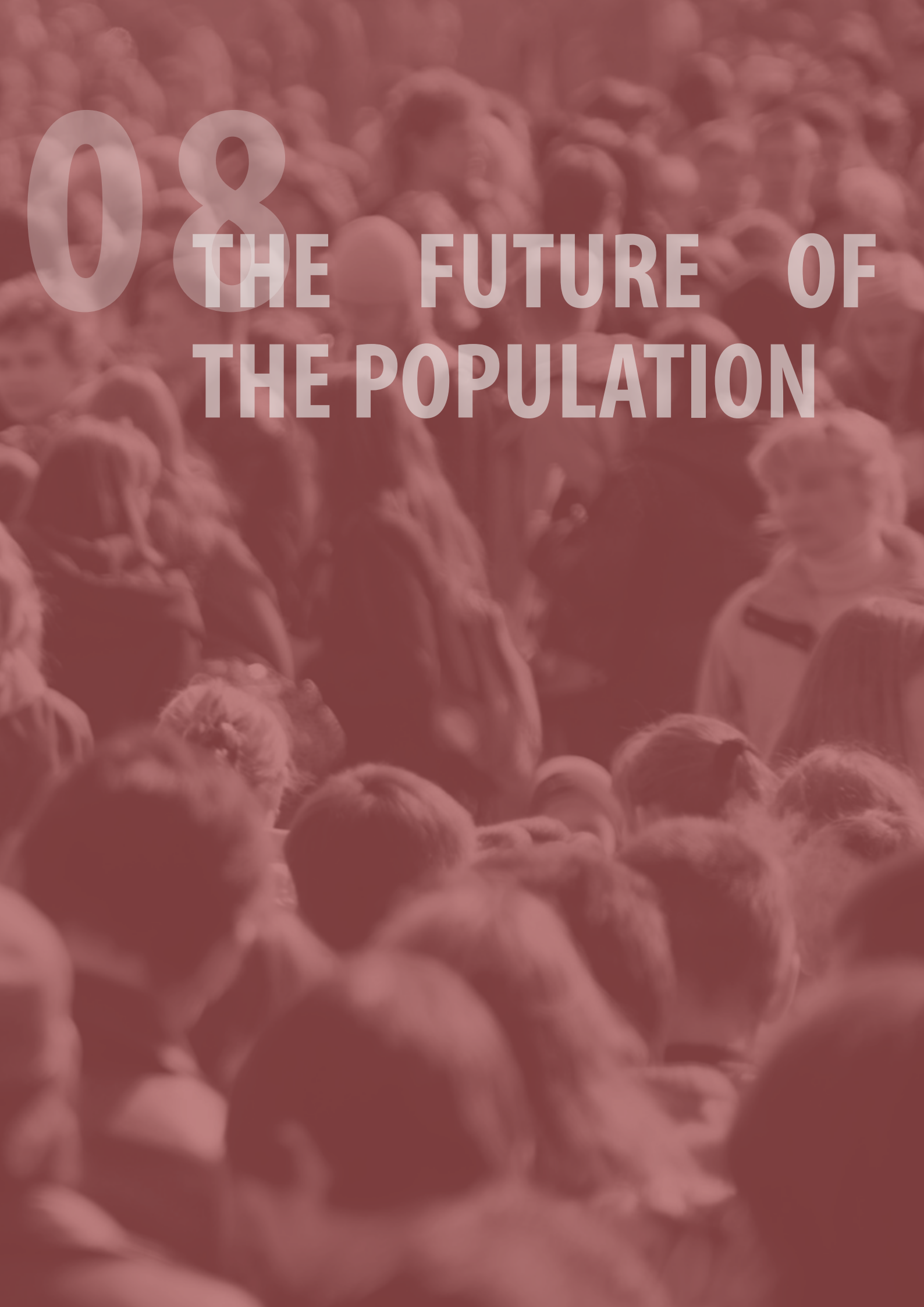
INCREASE IN THE *BLOCKCHAIN* APPLICABILITY



DATA SECURITY DEVELOPMENT
(IN BRAZIL, NEW DATA PROTECTION LAWS-LGPD)

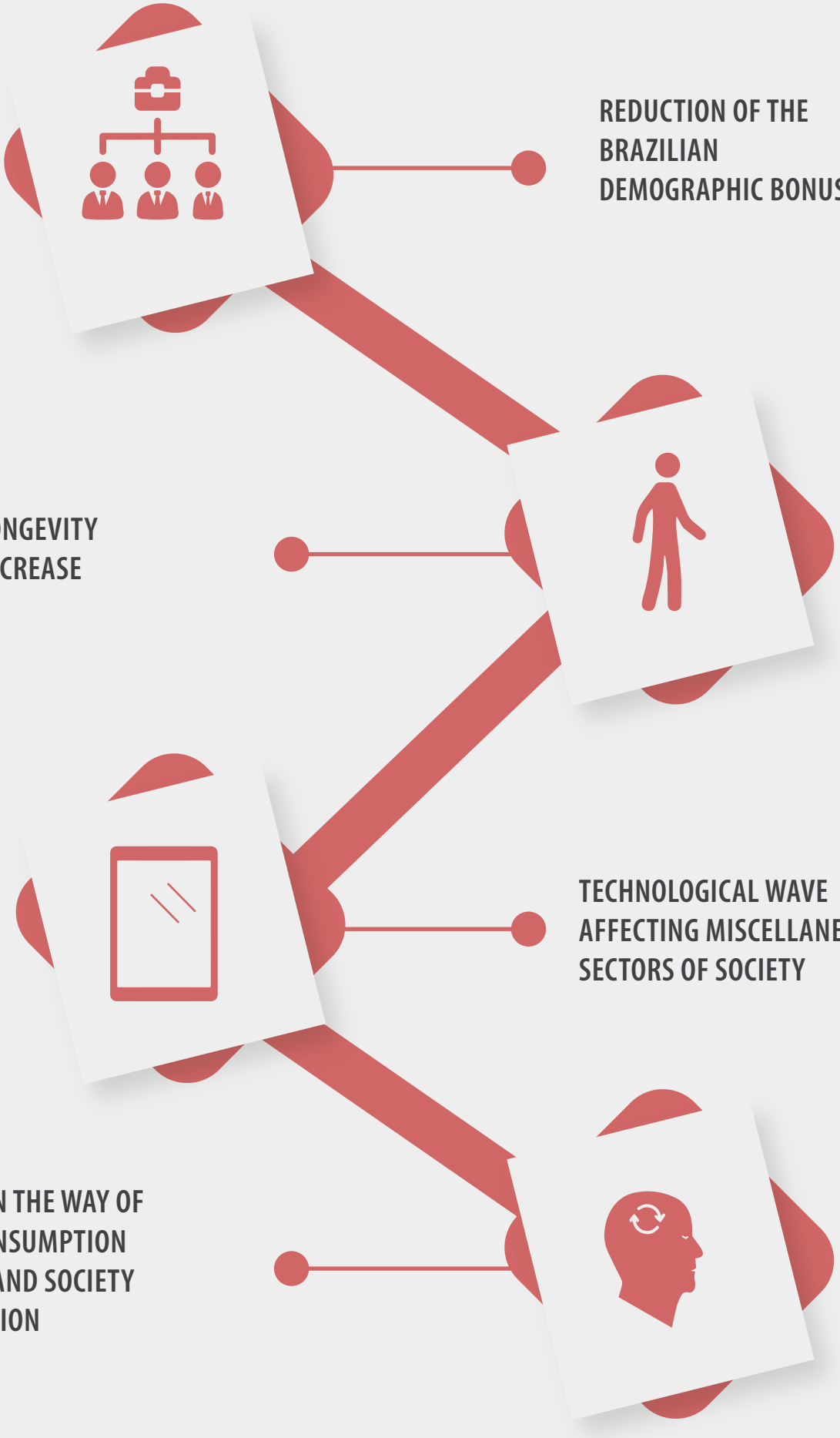
BENEFITS

- AGILITY
- CUSTOMIZATION
- INCREASE IN PRODUCTIVITY
- COST REDUCTION
- PRODUCTION CHAIN TRACEABILITY
  (THAT MUST EVOLVI WITH BLOCKCHAIN TECHNOLOGY)
- QUALITY ASSURANCE



08 THE FUTURE OF THE POPULATION

CURRENT SCENARIO



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NEW IMPACTS ON HEALTH, SOCIAL SECURITY SYSTEMS, EDUCATION AND WORK

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TRANSFORMATION OF HEALTH CARE WITH GREATER APPLICATION OF TECHNOLOGY

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GROWING IN THE USE OF WEARABLES AND REAL-TIME MONITORING

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NEW GENERATIONS
NEW MINDSET
PURPOSE - DRIVEN
ECONOMY

EDUCATION

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CONCLUSION

The final objective of this publication was to summarize the technological visions about the future perspectives that will guide the market of Chemistry and Environment in the coming years identified in the workshop that brought together people of notorious knowledge in this segment.

We observed that factors such as climate change, sustainability and technology were identified as cutting across several themes and presented as drivers of changes related to different markets. New production and consumption models, aligned with circular economy and sustainability concepts, are also expected to play a leading role in the market direction in the coming years. As well as the establishment of renewable energy and others developments needed to mitigate climate impacts are the main trend in energy.

In parallel, the possibilities of reinserting the raw material into the production chain, such as the effectiveness of reverse logistics, the increase in the percentage of recycling, and the practice of urban mining, are presented as factors that will influence the waste scenario, in addition to the expected growth in the energy reuse of biomass.

Finally, water security, identified as one of the main drivers of the sanitation market given the trends of increased water-related appreciation and awareness, is accompanied by the expectation of developing technologies that enable (technically and economically) the use of alternative water sources by industry and agribusiness.

NOTE: It is important to emphasize that the information contained in this publication was obtained during workshops in open debate format with the participation and technical contribution of invited experts. Further information about drivers and trends can be requested to the Firjan SENAI Technological Product and Process Management team.

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