

E4E
Engineers for Europe
September 1, 2022 - August 31, 2025
Project Ref. Nr.: 101054872 — E4E — ERASMUS-EDU-2021-PI-ALL-INNO

Partner Snapshot [Ordem dos Engenheiros]



ORDEM
DOS
ENGENHEIROS

Developed by: [Ordem dos Engenheiros]

Contents

| | |
|--|-------------------------------------|
| Introduction | 3 |
| The Green Deal and the SDGs | 3 |
| SDG 1 – No Poverty | 6 |
| SDG 2 – Zero Hunger | 7 |
| SDG 3 – Good Health and Well-being | 7 |
| SDG 4 – Quality Education | 8 |
| SDG 5 – Gender Equality | 9 |
| SDG 6 – Clean Water and Sanitation | 9 |
| SDG 7 – Affordable and Clean Energy | 9 |
| SDG 8 – Decent Work and Economic Growth | 10 |
| SDG 9 – Industry, Innovation and Infrastructure | 10 |
| SDG 10 – Reduced Inequalities | 11 |
| SDG 11 – Sustainable Cities and Communities | 12 |
| SDG 12 – Responsible Consumption and Production | 12 |
| SDG 13 – Climate Action | 12 |
| SDG 14 – Life Below Water | 13 |
| SDG 15 – Life on Land | 13 |
| SDG 16 – Peace, Justice and Strong Institutions | 14 |
| SDG 17 – Partnerships for the Goals | 14 |
| Quantitative indicators on the evolving nature of the engineering profession | 15 |
| Qualitative descriptors of the evolving nature of the engineering profession | 16 |
| Evolution of the engineering profession | 16 |
| Opportunities | 17 |
| Needs | 18 |
| Challenges | 18 |
| Conclusions and recommendations | 20 |
| References | 21 |
| Annex 1: Template used for Interviews | Erro! Marcador não definido. |
| Annex 2: Key sentences of the interview responses | Erro! Marcador não definido. |
| Annex 3: Photographs of the events organized for primary research | Erro! Marcador não definido. |
| Annex 4: Resume of information gathered in round tables and dinner-debate | Erro! Marcador não definido. |
| Annex 5: Key sentences of the secondary research | Erro! Marcador não definido. |

1. INTRODUCTION

1.1. The Green Deal and the SDGs

The Green Deal is a package of initiatives that aims to transform European Union (EU) in a just and prosperous society, with a modern and competitive economy, establishing an ecologic transition with the ultimate goal of achieving carbon neutrality by 2050. For that, the Green Deal ensures:

- No net greenhouse gas emissions by 2050;
- Economic growth independent of resource use;
- No person and no place left behind.

For this objectives to be attained, the EU has pledged to reduce the net greenhouse gas (GHG) emissions by at least 55 % by 2030, compared to 1990 levels. It's also possible to see the alignment of the green deal with the Sustainable Development Goals (SDGs) of the United Nations (UN), included in the 2030 agenda, since the green deal will provide (Conselho da União Europeia, n.d.) (European Commission, n.d.) (European Commission, n.d.) (European Comission, n.d.) (ENGINEERS EUROPE (former FEANI), 2021):

- Fresh air, clean water, healthy soil and biodiversity;
- Renovated, energy efficient buildings;
- Healthy and affordable food;
- More public transport;
- Cleaner energy and cutting-edge clean technological innovation;
- Longer lasting products that can be repaired, recycled and reused;
- Future proof jobs and skills training for the transition;
- Globally competitive and resilient industry.

The EU is committed to the refered SDGs and placed the Green Deal at the center of its recovery efforts.

There are 17 SDGs, all intertwined, adopted by all the state-members of UN in 2015, in order to define priorities and aspirations of global sustainable development to be achieved by 2030. ((Business Council for Sustainable Development - Portugal), BCSD, n.d.), (Department of Economic and Social Affairs, UN, n.d.).

The main goal of the SDGs is to assemble global efforts around a set of targets and common goals, mobilizing both developed and developing countries ((Business Council for Sustainable Development - Portugal), BCSD, n.d.), (Department of Economic and Social Affairs, UN, n.d.).

The point of the SDGs is to complete what the previous goals, the Millennium Development Goals (MDG), did not complete, and stimulate action in the following areas:

- People: it refers to ending poverty and hunger, promoting dignity and equality;
- Planet: it's about sustainable consumption and production, combating climate change and natural resources management;
- Prosperity: it concerns personal realization, economic, technological and social progress;
- Peace: to promote a peaceful, just and inclusive society, free from fear and violence;
- Partnership: is related to transversal integration, interconnection and joint mobilization for the most vulnerable. (Department of Economic and Social Affairs, UN, n.d.) ((Business Council for Sustainable Development - Portugal), BCSD, n.d.) (Iberdrola, n.d.)

The 17 SDGs are:

1. No poverty: end poverty in all its forms everywhere;
2. Zero hunger: end hunger, achieve food security and improved nutrition and promote sustainable agriculture;
3. Good health and well-being: ensure healthy lives and promote well-being for all at all ages;
4. Quality education: ensure inclusive and equitable quality education and promote lifelong learning opportunities for all;
5. Gender equality: achieve gender equality and empower all women and girls;
6. Clean water and sanitation: ensure availability and sustainable management of water and sanitation for all;
7. Affordable and clean energy: ensure access to affordable, reliable, sustainable and modern energy for all;
8. Decent work and economic growth: promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all;
9. Industry, innovation and infrastructure: build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation;
10. Reduced inequalities: reduce inequalities within and amongst countries;
11. Sustainable cities and communities: make cities and human settlements inclusive, safe, resilient and sustainable;
12. Responsible consumption and production: ensure sustainable consumption and production patterns;
13. Climate action: take urgent action to combat climate change and its impacts;

14. Life below water: conserve and sustainably use the oceans, seas and marine resources for sustainable development;
15. Life on land: protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss;
16. Peace, justice and strong institutions: promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels;
17. Partnerships for the goals: strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development. (Department of Economic and Social Affairs, UN, n.d.) (República Portuguesa, 2023) (Instituto Nacional de Estatística, I.P., 2023) (Iberdrola, n.d.)

Associated with these 17 SDGs are 170 targets and 248 global indicators. In Portugal, comparing the recent year with 2015, we can see that most of the global indicators analyzed (101) had a positive evolution, from which 20 have already reached the target; 28 global indicators have shown a negative evolution; 3 global indicators didn't show evolution; 38 can't be evaluated (78 indicators from the UN list aren't part of the Portuguese list, since they don't apply to our national context, don't have a stabilized methodology and/or there isn't available data), as shown in figure 1. (Instituto Nacional de Estatística, I.P., 2023)



Figure 1: Available indicators in our country to measure progress of SDG implementation.

In figure 2 a summary of the SDGs implementation landscape is presented (Instituto Nacional de Estatística, I.P., 2023):

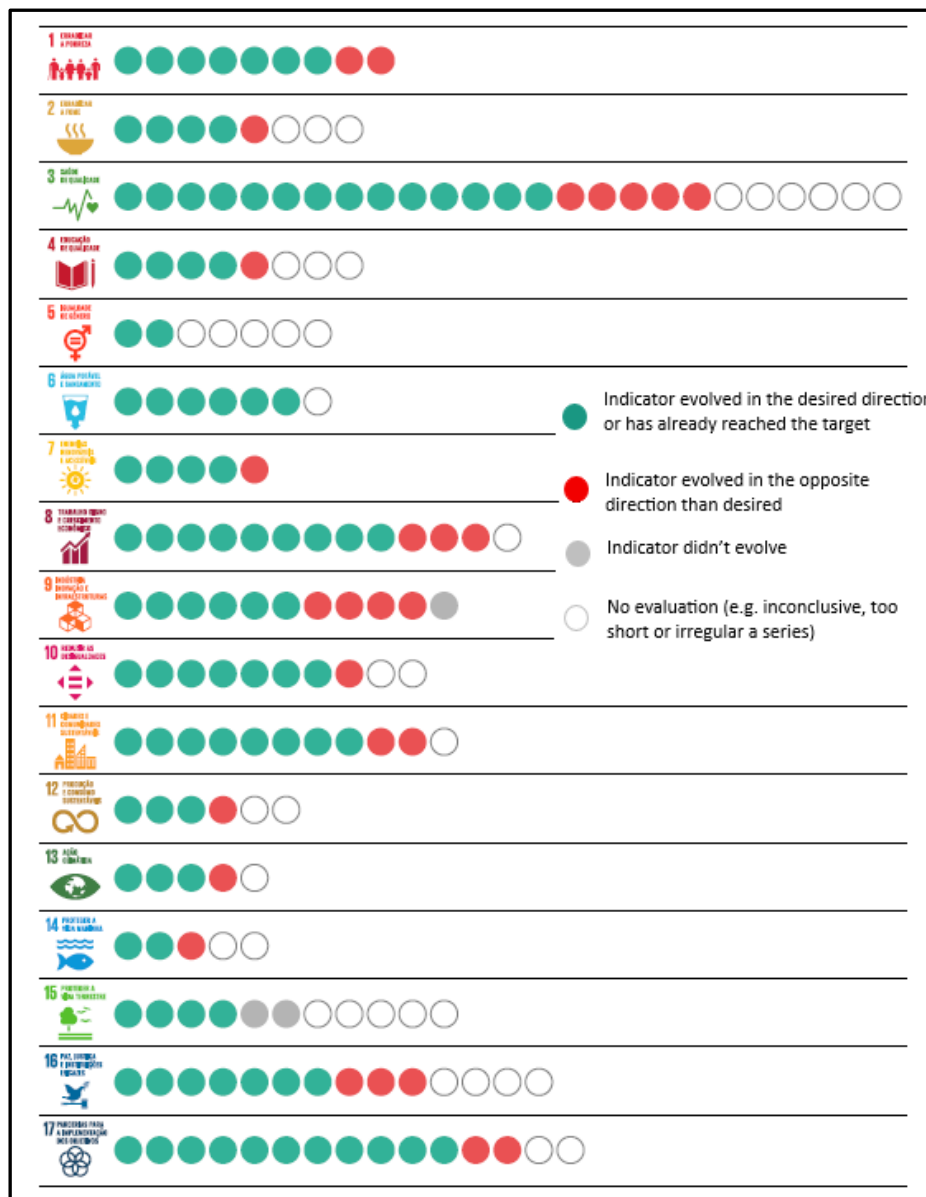


Figure 2: Progress in implementing SDGs in our country.

In Portugal we have already achieved some targets related to SDGs 1, 3, 6, 7, 10, 11, 13, 15, 16 and 17, despite the impact of the COVID-19 pandemic and the war in Ukraine.

- **SDG 1 – No Poverty**

In regard to SDG 1, there has been some favorable progress since 2015, although the data available so far doesn't fully reflect the complete impact of COVID-19 pandemic.

The poverty rate has decreased from 19,0% in 2015 to 16,4% in 2021 and in the area of social protection there's an upward trend in the series for the proportion of the unemployed population (looking for a new job) receiving unemployment benefits since 2017, in particular a substantial increase that was ensured in the first two years of the COVID-19 pandemic. However, between 2015 and 2021, the ratio of "social security old-age pensioners per 1 000 residents aged 65 and over" reduced by almost 10%, and the evolution of the ratio of the number of social security disability pensioners to the working population was just below 30%. The total proportion of public spending on education, health and social protection also increased between 2015 and 2021. It should be noted that between 2019 and 2020 there was a one-off decrease, justified by the growth in total public expenditure (driven by support for businesses in the confinement period) which implied the loss of relative weight of expenditure on essential services, despite its increase, in response to the health crisis. In Official Development Assistance (ODA), there was also an increase in total donations for poverty reduction, compared to the 2015 numbers. On the other hand, the number of deaths attributed to disasters rose significantly in 2020, due to the COVID-19 pandemic (Instituto Nacional de Estatística, I.P., 2023) (República Portuguesa, 2023) (United Nations, n.d.).

- **SDG 2 – Zero Hunger**

Portugal's situation regarding SDG 2 is mostly characterized by improvements since 2015.

In monitoring SDG 2 in the national context, it's observed that the trends are advantageous in terms of food insecurity (the proportion of the adult population suffering from moderate or severe food insecurity has decreased from 14.7% in 2015 to 11.6% in 2020), but in terms of obesity we don't have the same results. The proportion of agricultural areas under organic farming has increased slightly. The ODA and other official flows to the agricultural sector have increased since 2015, peaking in 2017. On a less positive note, the indicator of food price anomalies deteriorated in 2020 (from 0,36 in 2015 to 1,37 in 2020) (Instituto Nacional de Estatística, I.P., 2023) (República Portuguesa, 2023) (United Nations, n.d.).

- **SDG 3 – Good Health and Well-being**

About Portugal's situation regarding SDG 3, this is mostly characterized by improvements since 2015. Similar to SDG 1, the assessment of SDG 3 does not yet fully reflect the full impact of the pandemic COVID-19 due to the time lag in the availability of the respective indicators.

Improvements were verified in almost all health-related areas monitored under the SDGs compared to 2015.

The reduction in mortality rates in several areas (infant and neonatal, circulatory system diseases, malignant tumors, diabetes mellitus and chronic respiratory diseases, suicide and road accidents), as well as in teenage fertility rates and incidence of reported cases of HIV and malaria, stand out favorably. Equally positive are the increases in vaccination coverage and in the number of doctors, nurses, dentists, and pharmacy professionals.

On the other hand, there are increases in maternal mortality rates (although within the target range) and in mortality attributed to unsafe water sources or sanitation, lack of hygiene, and accidental poisoning. There is also a decrease in health ODA, despite a counter-cyclical increase in 2020 due to international aid during the COVID-19 pandemic (Instituto Nacional de Estatística, I.P., 2023) (República Portuguesa, 2023) (United Nations, n.d.).

- **SDG 4 – Quality Education**

The fourth SDG presents a favorable evolution in most indicators.

Comparing with 2015, the conclusion rate of middle school and high school education has increased, along with the enrolment rate at 5 years old, meaning that Portugal is close to achieve the target by registering 99,2 % in the school year 2020/2021. These indicators will not have been affected by the pandemic in 2020 and 2021, since they continue to increase. However, the trends have been less favorable for educational outcomes and competencies in some areas, which lack more up-to-date data. Still, the proportion of students with reading proficiency, as measured in the OECD's PISA (Program for International Student Assessment) study, decreased between 2015 and 2018, showing a withdrawal from the target prior to the health crisis. On a more positive note, proficiency in mathematics, measured by the same study, increased. In terms of gender parity, the trend was favorable in reading and math.

Also, it was registered favorable progress in digital skills, with Portugal slightly ahead of the EU27 in the dissemination of digital skills amongst adults. This indicator also shows that there is parity between men and women, with the discrepancies previously recorded having been reduced.

In 2018, the proportion of schools with access to computers for pedagogical purposes, basic drinking water, electricity, Internet, single-sex basic sanitation and with basic handwashing facilities was 100% (Instituto Nacional de Estatística, I.P., 2023) (República Portuguesa, 2023) (United Nations, n.d.).

- **SDG 5 – Gender Equality**

In regard to SDG 5, there has been mostly favorable developments in the monitored areas. In spite these improvements, gender equality remains far from being totally achieved.

It's important to highlight that it exists legal frameworks that promote, enforce and monitor gender equality, as well as the relative parity in the use of Information and Communication Technologies (ICT). However, considering the respective relevance, the good national performance at legal level and in use of ICT may show that progress in gender equality would benefit from a more comprehensive assessment. Therefore, it's suggested that the reading of this SDG should be complemented by additional information included in the analysis of other indicators contained within other SDGs.

However, it's in full participation and equal opportunities at civil and economic level (e.g., political office and leadership positions, respectively) that the greatest disparities are registered. There has been some progress registered in these dimensions: the increase of women in leadership positions when compared to 2015, and in particular, the proportion of women in public administration. This proportion has been over 50% since 2015, even though disparities persist in different levels of responsibility (fewer women in senior management positions compared with management positions) (Instituto Nacional de Estadística, I.P., 2023) (República Portuguesa, 2023) (United Nations, n.d.).

- **SDG 6 – Clean Water and Sanitation**

Related to SDG 6 there has been generally favorable progress.

Several areas approached or reached the target, with particular focus on the level of excellence in the quality of water for human consumption, with 99 % of safe water. Similarly favorable, it was registered a decrease in the percentage of people without adequate sanitary facilities in their homes, as well as the increase in proportion of households served by water supply. It's noteworthy that, within the framework of international cooperation, 100% of transboundary river and lake basins are covered by an operational cooperation agreement, as well as ODA in the areas of water and sanitation, which increased in 2021 compared to 2015 (Instituto Nacional de Estadística, I.P., 2023) (República Portuguesa, 2023) (United Nations, n.d.).

- **SDG 7 – Affordable and Clean Energy**

The evaluation of SDG 7 indicators is mostly positive.

We draw special attention to the goals already achieved or practically achieved in terms of energy matters such as: 100 % of the population has access to electricity and over 95% with primary access to clean fuels and technologies. Equally favourable is the evolution of renewable energy in final energy consumption which by 2021 was higher than the observed in 2015. Our country is also more energy efficient, as it's reflected in the decrease of the energy intensity of the economy compared to 2015 (ratio between total primary energy consumption and Gross Domestic Product - GDP).

On a less positive note, the financial flow to developing countries to support research and development of clean and renewable energy production has decreased, compared to 2015 (Instituto Nacional de Estatística, I.P., 2023) (República Portuguesa, 2023) (United Nations, n.d.).

- **SDG 8 – Decent Work and Economic Growth**

About Portugal's situation regarding SDG 8, this is mostly characterized by improvements in the economic and employment situation compared to 2015, which were interrupted in 2020, but resumed since 2021. Some illustrative indicators are: the annual rate of change in GDP per capita (6,9% in 2022), the unemployment rate (6,0% in 2022) and the rate of young people not employed and who are not in education or training (9,4 % in 2022). It's important to highlight that in 2020 public measures to protect employment during confinement, such as simplified layoff, helped to mitigate the negative impact of the pandemic on the labor market, as it's reflected in the performance of the respective indicators. Tourism was particularly affected by the pandemic context, but has since begin its recovery process in 2021, with a 27,3 % increase in its Gross Value Added (GVA).

In contrast, the numbers of non-fatal and fatal accidents at work have increased in the period in question in comparison with numbers of the EU27 (in spite of the favourable progress since 2015). Likewise, in the accessibility of financial services, there was a reduction in the number of other monetary intermediation establishments, which mainly reflects an increase in the relative importance of home banking payments, in detriment of physical access to these services. In international cooperation, there was also a decrease in ODA and Other Public Flows (OPF) for trade support between 2015 and 2021 (83,7%) (Instituto Nacional de Estatística, I.P., 2023) (República Portuguesa, 2023) (United Nations, n.d.).

- **SDG 9 – Industry, Innovation and Infrastructure**

In regard of SDG 9, most of its indicators show a positive evolution compared to 2015.

The increase in the proportion of the GVA of high and medium technology industries in the GVA of the manufacturing industry and of expenditure on research and development in GDP, which is still far from the 3% set in the national target for 2030 is a good progress for this SDG. Likewise, in the area of Research & Development (R&D) and Innovation, the steady increase in the proportion of researchers per 1 000 inhabitants is positive. The intensity of atmospheric emissions of the economy (measured by CO₂ emissions in relation to GVA) also improved, compared to 2015, as did the number of micro and small debtor companies, that decreased in relation to the total number of companies. Finally, the goal achieved in the proportion of population covered by mobile network, which achieved 99,9 % in 2021, should be noted.

On a less positive note, other dimensions, like the area of transport and passengers and cargo (by various modes of transport), after a favourable progress until 2019, changed in 2020 in the sequence of the pandemic situation, moving away from the desired target (for instance, the decrease to less than a third in air transport between 2019 and 2020). In manufacturing, the decline in employment and in proportion of value added of micro industrial enterprises isn't favourable. Still, in 2022, manufacturing maintained its importance in our economy (Instituto Nacional de Estatística, I.P., 2023) (República Portuguesa, 2023) (United Nations, n.d.).

- **SDG 10 – Reduced Inequalities**

The development related to SDG 10 show a positive picture. In 2021 it's possible to observe a trend of growth in median income since 2015, either for general population and for the 40% of population with fewer resources, in spite of the drop registered in 2020 for the latter group. The share of people in households with an income below 50% of median income decreased between 2015 and 2021, once again, despite the increase registered in the first year of the COVID-19 pandemic. The share of GDP also showed favourable progress, increasing in 2020 compared to 2015. The evolution of financial soundness was also positive, specifically with a decrease in non-performing loans.

In the international dimension, our country's assessment improved regarding migration policies that facilitate orderly, safe, regular and responsible migration and mobility of people. ODA, OPF and private support also increased between 2015 and 2021. On the other hand, the evolution of foreign investment is unfavourable, going from a positive balance between 2015 and 2019 to a negative balance in 2020, which became worse in 2021.

In 2021, economic inequality was reduced, but the redistributive impact of taxes on income and wealth and social contributions maintained the unfavourable trend (Instituto Nacional de Estatística, I.P., 2023) (República Portuguesa, 2023) (United Nations, n.d.).

- **SDG 11 – Sustainable Cities and Communities**

Indicators available to SDG 11 still don't reflect the full impact of the COVID-19 pandemic.

Nonetheless, its evolution since 2015 was positive.

The rate of expenses in housing, the evolution of artificial territories *per capita*, the public expense in cultural patrimony and the air quality (in regard of medium content of particles PM_{2,5} and PM₁₀) were favorable.

On the other hand, the pandemic situation increased the number of deaths attributed to catastrophes, registering a significant rise in 2020 and 2021 (from 59 people in 2015 to 12 056 people in 2021). The urban waste collected had an unfavorable evolution in 2020, comparing to 2015. Private expenditure on heritage (e.g., libraries, archives, museums, and other cultural services) interrupted its growth in 2020, going on to display a pronounced decrease (Instituto Nacional de Estatística, I.P., 2023) (República Portuguesa, 2023) (United Nations, n.d.).

- **SDG 12 – Responsible Consumption and Production**

The trends related to SDG 12 don't reflect the full impact of the COVID-19 pandemic. Since 2015 there has been an overall positive evolution, but this SDG has a relatively low availability of indicators, some of which with inconclusive tendencies.

The progress made in domestic material consumption per unit of GDP, as well as in the material footprint is noteworthy and favorable, since it decreased in 2021 when compared to 2015. There's also a favorable trend in the proportion of municipal waste prepared for reuse and recycling (which remains above the values of 2015, in spite of its decrease in 2020 compared to 2019).

On a less positive note, there has been an increase in internal consumption of materials and internal consumption of materials *per capita* between 2015 and 2021. The area of hazardous waste also shows an increase, for instance in sectoral hazardous waste *per capita* or the general trend in various sectors of activity, in which there were increases of varying intensity in the generation of this waste, in 2021 (Instituto Nacional de Estatística, I.P., 2023) (República Portuguesa, 2023).

- **SDG 13 – Climate Action**

The general evaluation of progress related to SDG 13 is mostly positive.

Although according with provisory estimates for 2020, our country has reduced their GHG emissions by 1,5% since 1990 and 32,9 % since 2005, there's a need for further progress to meet the target of a

55% reduction (compared to 2005 data) by 2030. In 2020, the decrease in GHG emissions was accentuated due to the COVID-19 pandemic that began in that year and that determined a decrease in economic activity and circulation in the various modes of transport. This assessment is based on the past progress and doesn't take into account developments after 2020. The pandemic situation conditioned the number of deaths attributed to catastrophes, which rose significantly in 2020. The score attributed to Portugal regarding the adoption and implementation of the national strategy for Disaster Risk Reduction (DRR) in line with the Sendai Framework has increased since 2015 (Instituto Nacional de Estatística, I.P., 2023) (República Portuguesa, 2023).

- **SDG 14 – Life Below Water**

The available data for SDS 14 is still limited in scope, which limits the overall assessment.

Portugal has a maximum rating regarding the degree of implementation of international instruments aimed at combating illegal, unreported and unregulated fishing. Correspondingly, the indicator for the degree of implementation of a legal/regulatory/policy/institutional framework that recognizes and protects the right of access of small-scale fishing registered an increase. Regarding fisheries management, in 2022, for the third consecutive year, all stocks subject to assessments were considered sustainable. In the Autonomous Regions of Madeira, in 2022, in the stocks subject to national analytical assessment, persisted the unsustainable exploitation of horse mackerel. On the other hand, the black scabbardfish is being exploited in a sustainable exploitation.

On a less positive note, it should be noted that the proportion of R&D investment in marine technology as a proportion of total investment in intellectual property has decreased (Instituto Nacional de Estatística, I.P., 2023) (República Portuguesa, 2023).

- **SDG 15 – Life on Land**

The available data for SDG 15 is of limited actuality, which limits the overall assessment. However, the information for the indicators that can be used to assess progress since 2015 is mostly favorable.

Our country is amongst the countries that have adopted legislative, administrative and policy frameworks to ensure the fair and equitable sharing of benefits, having relevant national legislation and allocating adequate resources for the prevention or control of exotic invasive species. Portugal has a National Biodiversity Strategy and Action Plan (NBSAP) and has set national targets in accordance with the Aichi Biodiversity Target 2 of the Strategic Plan for Biodiversity 2011-2020. Biodiversity values are integrated into the national accounts systems, defined with the

implementation of the System of Environmental Economic Accounts (SCEA). The ODA allocated to biodiversity recorded a favorable trend (Instituto Nacional de Estatística, I.P., 2023) (República Portuguesa, 2023).

- **SDG 16 – Peace, Justice and Strong Institutions**

Most SDG 16 indicators have showed favourable trends when compared to 2015. Deaths caused by homicide have decreased, as well as the corruption perception index, which decreased slightly. The number of women leaders in the Public Administration sector and women elected to the National Assembly increased, compared to 2015, but there was a decrease of 4,5 % between the 2022 and 2019 elections. There was also an increase in the number of firearms seized, surrendered/recovered by the police, more than doubling between 2015 and 2021.

Against the desirable evolution, there is an increase in the proportion of preventive prisoners (significantly in 2020). Likewise, between 2015 and 2021, the number of human trafficking crimes increased. However, it's to be noted that in 2020, in the context of a pandemic, this number fell by almost half, compared to the previous year. A direct consequence is that the proportion of people who feel safe walking around alone after dark has decreased (Instituto Nacional de Estatística, I.P., 2023) (República Portuguesa, 2023).

- **SDG 17 – Partnerships for the Goals**

The developments regarding SDG 17 are mostly positive.

The tax burden and the percentage of the State Budget financed by taxes have registered favorable trends (in the context of target 17.1 - strengthen domestic resource mobilization - the upward trend is favorable as it aims to improve the national capacity to collect taxes and other sources of revenue). Digitalization-related indicators also show a favorable trend, with an increase in broadband Internet access at a fixed location and in the percentage of adults using the Internet.

The total ODA and the proportion of ODA to Gross National Income (GNI) increased. ODA for statistical capacity building in developing countries decreased slightly, conditioned by the suspension of in-site activities during the COVID-19 pandemic. With a less positive evolution, it should be noted that the Foreign Direct Investment (FDI) and the weight of remittances from emigrants and immigrants in GDP decreased (Instituto Nacional de Estatística, I.P., 2023) (República Portuguesa, 2023) (United Nations, n.d.).

2. QUANTITATIVE INDICATORS ON THE EVOLVING NATURE OF THE ENGINEERING PROFESSION

In our country, presently, we have a total of 61 422 engineers registered in “Ordem dos Engenheiros” (OE), distributed by 12 specialties as shown in table 1 (Ordem dos Engenheiros, 2023):

Table 1: Engineers registered in OE by specialty.

| Specialty | Total |
|-------------------------------------|-------|
| Agronomic Engineering | 2610 |
| Environmental Engineering | 2192 |
| Civil Engineering | 29231 |
| Electrotechnical Engineering | 11439 |
| Forest Engineering | 637 |
| Geographical Engineering | 477 |
| Geological and Mining Engineering | 1184 |
| Computer Engineering | 1030 |
| Materials Engineering | 463 |
| Mechanical Engineering | 9067 |
| Marine Engineering | 142 |
| Chemical and Biological Engineering | 2950 |
| Total | 61422 |

Facing the evolution of the specificity in engineering programs, OE created 5 more specialties: biomedical engineering, food engineering, industrial management and engineering, aeronautic and spacial engineering and quality and security engineering, hoping to attract more engineers, especially more young engineers.

3. QUALITATIVE DESCRIPTORS OF THE EVOLVING NATURE OF THE ENGINEERING PROFESSION

For the primary research, we conducted a series of interviews (template used for the interviews in Annex 1 and a resume table in Annex 2), two round table discussions, one of which with a dean and one president of an engineering school, and a dinner-debate (there are some photographs of all the events in Annex 3 and a resume of information gathered at these events in Annex 4). For the secondary research we proceeded, as requested, with desk research (resume table in Annex 5).

3.1. Evolution of the engineering profession

According to the research, the engineering profession is increasingly becoming more and more dynamic, expedited by the manufacturing sector, as well as government and services enterprises, accompanying the evolution of the economy and society. The future of the engineering profession is dependent not only, on the ability of the engineers to meet the economic and industrial demands, but also depends on the ability to innovate, diversify and drive the economic and industrial operational trends. The future of the engineering profession is ever more aligned with environmental sustainability and the green transition, demographic changes, advances in technology and the globalization of value chains.

Engineers will be fundamental to attain the SDGs goals, so that a just, sustainable, efficient and competitive transition can be achieved. Engineers will be responsible for design, develop and implement several solutions in several areas, such as energy, water, air, agriculture, mobility, infrastructure, transportation, construction, technology and AI.

There are all the time more and more new engineering disciplines, leading to new engineering roles, each time more specific, that didn't exist before, which conducts to a change in the nature of engineering and where engineers work – less site and more office. So, as more engineers join the field and the industry evolves, so does the job opportunities, the needs of employers and the challenges faced by engineers. Nowadays, to stay competitive in the job market, both aspiring engineers and engineers who want to advance in their careers need to build a strong and diverse set of skills, so they can be set apart in a highly competitive job market.

3.2. Opportunities

As opportunities for the engineering profession, the research done show that, since there are some challenges, there are also several opportunities.

Since engineers have abilities fundamental to decision making processes and to induce political decisions, there's an opportunity for engineers to enroll in that route, which leads to the engineering perspective to be more accounted for by political decision-making bodies, promoting a better coordination.

In the meantime, there's an opportunity to promote CPD (Continuous Professional Development), through microcredentials, coaching and other forms of acquiring soft skills in order to complement hard skills, already developed. For that, industry itself can help by training and upskilling their own engineers, which in turn gives them more confidence to perform their duties and decreasing the probability of those same engineers leaving that company (for not being able to progress in their careers).

For engineers that are still not formed, HEIs have an opportunity to reform the engineering programs in order to achieve a better balance between soft and hard skills, between theoretic and practical knowledge, as well as to respond more promptly to the industry needs. For this goal to be achieved its suggested to promote a closer cooperation between HEI's and Industry, for instance by encouraging more students to be more involved in their areas of engineering, cooperating with companies of their field of engineering, which, in that process, might recruit an engineer. This student is, by then, embedded in the company's policies, or the company gains new skills and perspectives brought by the young training engineer, even though he ends up working for another company. Either way, it's a win-win situation.

Another opportunity for the engineering profession is to recruit more engineering students by promoting the engineering profession at an earlier age stage. For that, it's suggested that children should begin to be exposed to the engineering profession at a tender age, since the role of an engineer in everyday life is not as visible as, for example, that of a doctor.

To promote an increase in the numbers of female engineers, it is suggested that role-models are very important. It's also imperative to dissolve the pay gap between men and women engineers as well as to improve workplace policies and practices that strengthen women's careers in engineering, in order to give them more support to develop their careers.

3.3. Needs

According to the research made, it was possible to identify several needs related to the engineering profession. One of the main needs identified was to have a stronger bridge of sharing and communication between higher education and industry, so that higher education can better respond to the evolution of industry and its needs. One of the most pointed out flaws was the need to incorporate and balance hard and soft skills in the programs of higher education, such as research and critical thinking, computer sciences, artificial intelligence (AI), internet of things (IoT), sustainability, circular economy, renewable energies, risks and project management, data analysis and synthesis, design thinking, communication, leadership, entrepreneurship, teamwork, social responsibility, problem-solving, planning and organization, innovation/creativity, emotional intelligence, passion transmission, stress management, adaptability, humanistic and social values, since they complement each other, in order to achieve a more well-adjusted engineer.

Each engineer should be able to choose, according to his needs, the soft skills, microcredentials, post-graduations, coaching programs and masters that are most appropriate to develop in his work field.

Since there is a severe shortage of engineers, there's also a need for senior engineers to reskill, through the programs referred above, so that they can respond to the future needs of industry.

3.4. Challenges

With AI development, there will be some negative impact in terms of decrease in tasks of engineering competencies. In face of the increase in virtual professional practice (digital nomads), there is a risk that humans will unlearn to interact physically and emotionally with their peers and with society in general. It's also a risk that professionals will come to believe in the truths provided by channels/platforms, such as chat-GTP and others to come, and be driven by algorithms that may be misleading, which in turn leads to them to stop reasoning for themselves.

Considering these potential risks, in addition to the need of formation in soft skills, one of the most common challenges faced by engineers today is to expand their spectrum of competencies beyond the field of engineering towards a more holistic view and approach, complementing what they learned in their engineering courses. Another angle is to adapt the engineering programs to the new demands of industry, in order for the engineers of the future to leave HEIs better equipped to face the job market. This means that in one case or the other, there needs to be a perfect balance between soft skills and hard skills, theory and practice of engineering in the field. Some references

suggest that for that goal to be achieved, maybe could implemented 6-years engineering programs, of which it would result a 4-year bachelor's degree plus a 2-year master's degree, giving HEIs more room to embed soft skills engineering programs, since they consider that an engineering program of 3 years doesn't give enough competencies to a complete professional engineer. They also suggest that there should be a correspondence between a given number of theoretical hours and practice hours in a professional/entrepreneurial environment, which justifies the increment of engineering programs in 1 year at the 3-year post-Bologna degree.

An additional challenge faced by the engineering profession is the low number of students of engineering. To tackle this challenge, its suggested that children should be exposed to professional engineers and their role in society from an early age, for instance by coloring engineering themed books, visiting schools and companies. The key concept is that young people who know more about what engineers do are more likely to considerer a career in engineering.

There's also a lack of engineers in the decision-making process at the political level, mostly in feminine gender. Engineers possess a great ability to design, analyze, manage and gauge different options and put them into perspective, which makes them perfectly equipped to have an active role in inducing political decisions and participate in public political discussions.

Also, a greater representation of women in engineering and in decision-making positions would bring benefits in terms of innovation, balance, common sense, peace, safety and accessibility of new inventions. For this to become a reality, it's very important the existence of role-models, even to attract more young girls to a career in engineering. Less than two in ten engineering students are women, and women make up for only 15% of the university-qualified engineering force. To make matters worse, there is a difference of up to 24% between payments made to men and women engineers in comparison with 13% across all industries, a situation to be corrected in the future.

To close this section, there's also report of a high turnover, low salaries and an increased attractiveness for engineers to change to management positions and better paying industries.

4. CONCLUSIONS AND RECOMMENDATIONS

The engineering profession is going through a phase of rapid evolution, with the development of the virtual world and AI, which causes the disappearance of old concepts and the appearance of new ones related to the engineering profession.

Considering this, it's essential to adapt the teaching programs of engineering to the new demands of the job market.

It's increasingly more necessary to find balance between hard and soft skills. Leadership, entrepreneurship, communication, teamwork, problem-solving, research and critical-thinking, planning and organization, innovation/creativity, computer sciences are considered the most important soft skills for an engineer.

Microcredentials and post-graduations are crucial for engineers to quickly get up to speed on the latest trends and developments, so they can accompany the evolution of their areas of expertise.

It was also possible to identify the opportunity to recruit more students for engineering programs by exposing them to the concept of the engineering profession and its contribution to everyday life from an early stage. It's as well very important to increase the number of female engineers, as suggested.

5. REFERENCES

- (Business Council for Sustainable Development - Portugal), BCSD. (n.d.). *Objetivos de Desenvolvimento Sustentável*. Retrieved June 14, 2023, from *Objetivos de Desenvolvimento Sustentável*: <https://bcsdportugal.org/objetivos-de-desenvolvimento-sustentavel/>
- A4M-EUMAT. (2020, September). The role of materials in the post-covid society.
- Australia, P. (2023, March 8). *Australia faces engineering skills crisis by 2040*. Retrieved July 2023, from https://www.professionalsaustralia.org.au/PA/Latest_News/Australia_faces_engineering_skills_crisis-by_2040.aspx
- Blog Comunidade Santander. (2022, September 01). *Emprego garantido? Como escolher um curso superior com saída*. Retrieved July 2023, from <https://www.santander.pt/salto/cursos-com-maior-empregabilidade>
- Business Europe. (2022, June 21). *Labour Force and Skills Shortages: how to tackle them?* Retrieved from <https://www.busineurope.eu/>
- CIHT - Chartered Institution of Highways & Transportation. (2022, November 9). *The engineering sectors ongoing battle with the skills shortage*. Retrieved July 2023, from <https://www.ciht.org.uk/blogs/the-engineering-sectors-ongoing-battle-with-the-skills-shortage/>
- Conselho da União Europeia. (n.d.). *Pacto Ecológico Europeu*. Retrieved June 26, 2023, from <https://www.consilium.europa.eu/pt/policies/green-deal/>
- Department of Economic and Social Affairs, UN. (n.d.). *Sustainable Development*. Retrieved June 14, 2023, from The 17 Goals: <https://sdgs.un.org/goals>
- Design Solutions. (2022, March 10). *The evolution of engineering jobs*. Retrieved July 2023, from <https://designsolutionsmag.co.uk/the-evolution-of-engineering-jobs/>
- ENGGPRO. (2019, August 11). *6 Most Common Challenges Facing the Engineering Sector Globally*. Retrieved July 2023, from <https://www.enggpro.com/blogs/6-most-common-challenges-facing-the-engineering-sector-globally/>
- ENGINEERS EUROPE (former FEANI). (2021, December). The UN Sustainability Goals: The role of FEANI/ ENGINEERS EUROPE and the European engineering community.
- ENGINEERS EUROPE. (2021, December). The UN Sustainability Goals: The role of FEANI/ENGINEERS EUROPE and the European engineering community.
- European Commission. (n.d.). *Delivering the European Green Deal*. Retrieved June 26, 2023, from https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/delivering-european-green-deal_en
- European Commission. (n.d.). *A European Green Deal*. Retrieved June 26, 2023, from https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en
- European Commission. (n.d.). *The EU and the United Nations - Common Goals for a Sustainable future*. Retrieved June 26, 2023, from <https://commission.europa.eu/strategy-and->

policy/international-strategies/sustainable-development-goals/eu-and-united-nations-common-goals-sustainable-future_en

- Glassdoor. (2021, June 29). *The Most In-Demand Engineering Soft Skills*. Retrieved July 2023, from <https://www.glassdoor.com/blog/guide/engineering-soft-skills/>
- Iberdrola. (n.d.). *O que é a Agenda 2030*. Retrieved June 15, 2023, from A importância da Agenda 2030 e os Objetivos de Desenvolvimento Sustentável (ODS): <https://www.iberdrola.com/sustentabilidade/comprometidos-objetivos-desenvolvimento-sustentavel/o-que-e-agenda-2030>
- IET - Institution of Engineering & Technology. (2023, January 12). *Engineering Skills crisis: a multi-pronged problem*. Retrieved July 2023, from <https://eandt.theiet.org/content/articles/2023/01/engineering-skills-crisis-a-multi-pronged-problem/>
- IET - Institution of Engineering and Technology. (2021, December). *Half of new engineering recruits lack the right skills*. Retrieved July 2023, from <https://www.theiet.org/media/press-releases/press-releases-2021/press-releases-2021-october-december/16-december-2021-half-of-new-engineering-recruits-lack-the-right-skills/>
- Indeed. (2023, January 19). *Soft Skills for Engineers: Definition and Examples*. Retrieved July 2023, from <https://ca.indeed.com/career-advice/career-development/soft-skills-for-engineers>
- Indeed Editorial Team. (2023, March 11). *Indeed*. Retrieved July 2023, from <https://www.indeed.com/career-advice/resumes-cover-letters/essential-engineering-skills>
- Institution of Mechanical Engineers. (2022, December 08). *Government urged to tackle "shocking" skills shortage by adding engineering to curriculum*. Retrieved July 2023, from <https://www.imeche.org/news/news-article/government-urged-to-tackle-shocking-skills-shortage-by-adding-engineering-to-curriculum>
- Instituto Nacional de Estatística, I.P. (2023). *Objetivos de desenvolvimento sustentável - Agenda 2030 Indicadores para Portugal - 2015-2022*. Lisboa.
- Knowhow. (2023, May 26). *Why is there a shortage of skilled workers in the engineering industry?* Retrieved July 2023, from <https://knowhow.distrelec.com/civil-engineering-and-infrastructure/why-is-there-a-shortage-of-skilled-workers-in-the-engineering-industry/>
- Landry, L. (2023, January 05). *6 Business Skills every engineer needs*. Retrieved July 2023, from <https://online.hbs.edu/blog/post/business-skills-for-engineers>
- Lantada, A. D. (2020, November). Engineering Education 5.0: Continuously Evolving Engineering Education. *International Journal of Engineering Education*, 36(6), 1814-1832. Retrieved June 10, 2023, from https://www.researchgate.net/publication/345141439_Engineering_Education_50_Continuously_Evolving_Engineering_Education
- Mannan, R. (2021, March 10). *Overcoming the Shortage of Engineers*. Retrieved July 2023, from <https://newengineer.com/blog/overcoming-the-shortage-of-engineers-1509925>
- Michael Page. (2019, January 28). *Jobs outlook: Engineering jobs*. Retrieved July 2023, from <https://www.michaelpage.com.au/advice/market-insights/market-updates/jobs-outlook-engineering-jobs>

- Michael Page. (2023, May 18). *What are the most important engineering soft skills?* Retrieved July 2023, from <https://www.michaelpage.com.au/advice/career-advice/career-progression/what-are-most-important-engineering-soft-skills>
- Naves, L. (2023, July 11). As admiráveis tecnologias de um futuro muito próximo. *Diário de Notícias*. Retrieved July 2023, from <https://www.dn.pt/sociedade/as-admiraveis-tecnologias-de-um-futuro-muito-proximo-16674299.html>
- OECD. (2023, January). Labour and Skills shortages in the agro-food sector. *OECD Food, Agriculture and Fisheries Paper*, 189.
- Olushola Akinshipe, O. A. (2022, August 17). Engineering Skills Shortage: A Bane to Better Performance in the Construction Industry. *AIP Conference Proceedings*.
- Ordem dos Engenheiros. (2023, June 30). Retrieved July 2023, from Estatísticas: <https://www.ordemengenheiros.pt/pt/a-ordem/colegios-e-especialidades/estatisticas/>
- Peña, T. (2021, July 20). *O ensino da Engenharia que existe e ainda não existe*. Retrieved July 2023, from O Ensino de engenharia que existe e ainda não existe: https://ionline.sapo.pt/artigo/741168/o-ensino-da-engenharia-que-existe-e-ainda-nao-existe?seccao=Opiniao_i
- Peña, T. (2023, March 14). *Inteligência Artificial e desafios na formação avançada e na investigação*. Retrieved July 2023, from https://ionline.sapo.pt/artigo/794619/intelig-ncia-artificial-e-desafios-na-formacao-avancada-e-na-investigacao?seccao=Opiniao_i
- Pereira, J. G. (2023, July 04). *Cabeças 4.0 - em busca da superação*. Retrieved from LinkedIn: <https://www.linkedin.com/pulse/cabe%2525C3%2525A7as-40-em-busca-da-supera%2525C3%2525A7%2525C3%2525A3o-jorge-gamito-pereira%3FtrackingId=XoHtQDi2RIGlfDp4yki0KQ%253D%253D/?trackingId=XoHtQDi2RIGlfDp4yki0KQ%3D%3D>
- Piwai Chikasha, K. R. (2021). Industrial Engineers of the Future - A concept for a Profession that is Evolving. *Technology and Engineering Systems Journal*, 6(4), 72-79.
- Randstad. (2019, January 22). *Uk Engineering facing skills crisis: where are the jobs?* Retrieved July 2023, from <https://www.randstad.co.uk/career-advice/job-skills/uk-engineering-facing-skills-crisis-where-are-jobs/>
- Reis, C. (2019, September 08). *Colocações. Engenharias no pódio e cursos que ninguém quis*. Retrieved July 2023, from <https://www.dn.pt/vida-e-futuro/colocacoes-no-superior-engenharias-no-podio-e-nos-cursos-que-ninguem-quis-11277726.html>
- República Portuguesa. (2023). *Relatório Voluntário Nacional 2023*. Lisboa.
- Schaefer, W. (2023, April 24). *Develop "Soft Skills" to Enhance Your Engineering Career*. Retrieved July 2023, from <https://www.engineering.com/story/develop-soft-skills-to-enhance-your-engineering-career>
- Silva, W. M. (2019, September 03). *Soft skills para engenheiros: qual sua importância*. Retrieved July 2023, from <https://www.linkedin.com/pulse/soft-skills-para-engenheiros-qual-sua-import%C3%A2ncia-machado-silva/?originalSubdomain=pt>

Smith, J. (2022, October). *The biggest challenges facing the engineering sector*. Retrieved July 2023, from <https://www.prospects.ac.uk/jobs-and-work-experience/job-sectors/engineering-and-manufacturing/the-biggest-challenges-facing-the-engineering-sector>

Tertiary Education Commission. (2020, June 12). *Jobs in skill shortage and labour shortage*. Retrieved July 2023, from <https://www.careers.govt.nz/job-hunting/whats-happening-in-the-job-market/jobs-in-skill-shortage-and-labour-shortage/>

United Nations. (n.d.). *SDG Country Profile - Portugal*. Retrieved June 26, 2023, from <https://unstats.un.org/sdgs/dataportal/countryprofiles/prt#goal-1>

World Economic Forum. (2023, May). *Future of Jobs Report 2023*. doi:ISBN-13: 978-2-940631-96-4