ALPHA BANK

Construction

and the path to sustainability

Sectors in focus

June 2022

Alpha Bank Economic Research

Contents

Executive summary

The construction sector witnessed a marked collapse during the 2010-decade economic crisis, which signified the necessity of reaching a new and more sustainable growth path. The new recovery path of the construction industry should incorporate elements aligned with the principles of sustainability and economic circularity that respond to the actual needs of demand. It should also enfold practices, designs and technologies that enable the sector to grow in agreement with environmental protection and climate change prevention.

- **The construction sector is closely interrelated to and interdependent on various** other sectors of the economy, such as manufacturing, real estate, transport, logistics and energy, and thus directly or indirectly affects and is affected by many aspects of economic activity. The narrow construction sector includes buildings' construction, civil engineering and specialised construction activities.
- **Civil engineering replaced buildings as the largest sector of construction after the** Greek financial crisis of the previous decade and accounts for 37% of the value added, 45% of turnover and 47% of the production value of construction (2019).
- **Construction can be significantly affected by the megatrends that will impact** societies and economies in the following years and include a) sustainability and environmental risks, b) technology and digitalisation, c) population trends and urbanisation, d) markets and regulations, and e) geopolitical developments.
- **The Greek construction industry is on a recovery path, signalled by an improved** performance in various economic figures, such as its value added, the increasing number of building permits and the uptrend in housing prices. Construction cost, remained fairly stable from 2017 until 2020 but increased in 2021. Both the input price for materials and labour cost rose slightly, mainly due to higher energy cost.
- **Investment in the Greek construction sector gained ground in 2020 and 2021,** with the scheduled infrastructure pipeline counting various projects, most of which are in the energy sector, railways and motorways, but also in the former Hellinikon airport and tourist accommodation buildings.
- **Among the funding sources of the Greek construction sector are the National** Recovery and Resilience Plan, the National Development Plan 2021-2025, the National Strategic Reference Framework 2021-2027 and the Electra Programme.
- **Extensive urbanisation is among the main causes of climate change and, in this** regard, policy initiatives such as the European Commission's Renovation Wave, can help improve the energy performance of European buildings and tackle environmental problems. In the EU, buildings consume 40% of total final energy and produce 36% of total emissions, which are mainly generated from energy use, originating from the existing building stock.
- **The construction industry is entering a new, digitalised era which will affect a** broad field of its operations and require special digital and technological skills to support its development. Although construction has been transformed over the years by the adoption of innovative technologies, it remains one of the least digitalised sectors. The adoption of new technologies and eco-innovations can promote competitiveness, improve productivity and reduce production costs.
- **The EC has adopted various policies that apply to the construction sector, such** as the Construction 2020 Strategy and the Directives on Energy Performance of Buildings and Waste. The Construction 4.0 Strategy refers to the adoption of digital solutions and the automation of the various processes within the industry, including the creation of digital construction sites.
- **Energy, climate and waste management strategies related to the construction** industry in Greece, such as the National Energy and Climate Plan, the Buildings' Renovation Strategy and the National Waste Management Plan, have been adapted so as to reflect the main directions of respective EU strategies.
- **Sustainability and resource efficiency are key requirements of the construction** industry and necessary preconditions for its future growth. Sustainability must be propelled and supported by simplified and clear government regulations, ESG criteria for investment in the construction industry and the promotion of circular economy practices in all its processes.
- **Although transparency in public procurement in Greece has improved since** 2017, weaknesses remain. To tackle issues of transparency and corruption, Law 4782/2021 on the "Modernisation, simplification and reform of the public procurement framework" introduced various reforms aimed at achieving the tendering and execution of public contracts more swiftly and effectively.

Role of the construction sector and future trends

The role of construction in the Greek economy

The downfall of the construction sector during the economic crisis of the previous decade designates the necessity of a new growth path for the sector.

- Construction and infrastructure are currently on the path to recovery, signalled by their improved performance in various figures, even during the pandemic-driven crisis. Even so, the impact of the economic crisis and the austerity of the previous decade was profound, as heavy losses were documented in the value added, turnover, employment and investment of the sector.

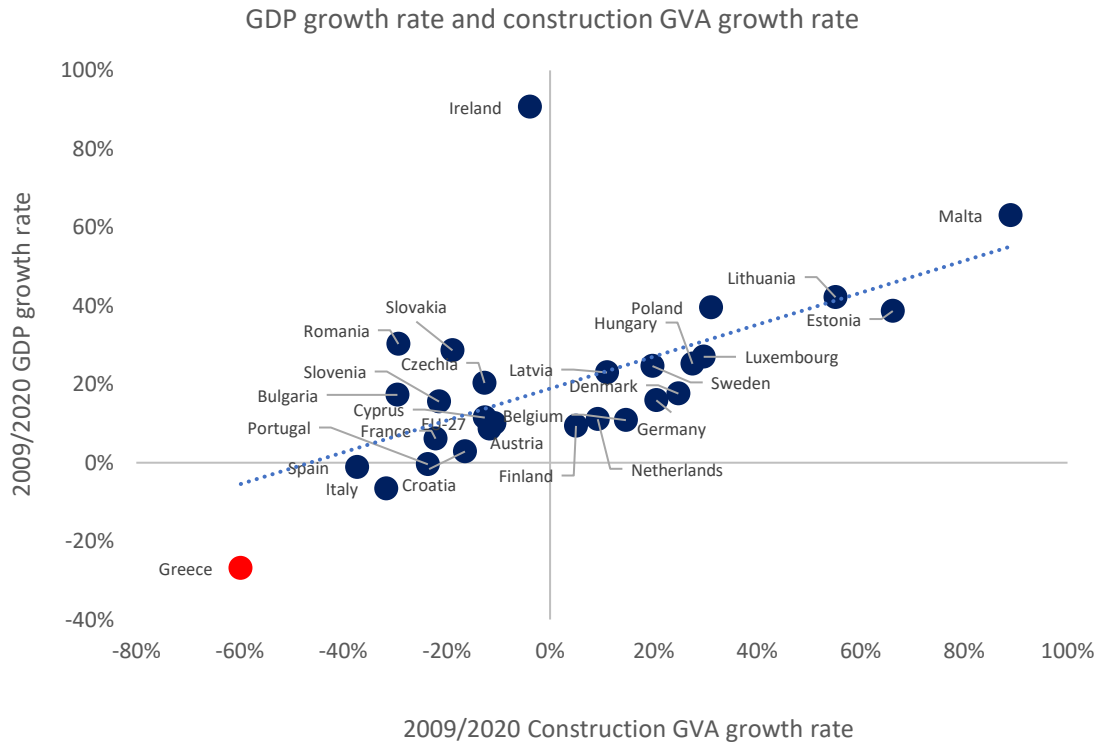
- The Greek construction industry lost 60% of its value added during the 2009-2020 period, while the country's GDP cumulatively fell by 27% over the same period. Due to the interdependence of construction with various other economic sectors and its relation to the wider economy, the factors that contributed to this heavy downfall after the outbreak of the financial crisis in Greece were multidimensional.

The various phases of construction activity in Greece

Organising and hosting the Olympic Games in 2004 was a great opportunity for Greece to benefit from the investments made in construction and infrastructure, and the subsequent boom in tourism during and after the Games. The preparations for the Olympic Games included the construction of large-scale projects, such as the expansion of the Attiko Metro, which also served as a tool for urban development.

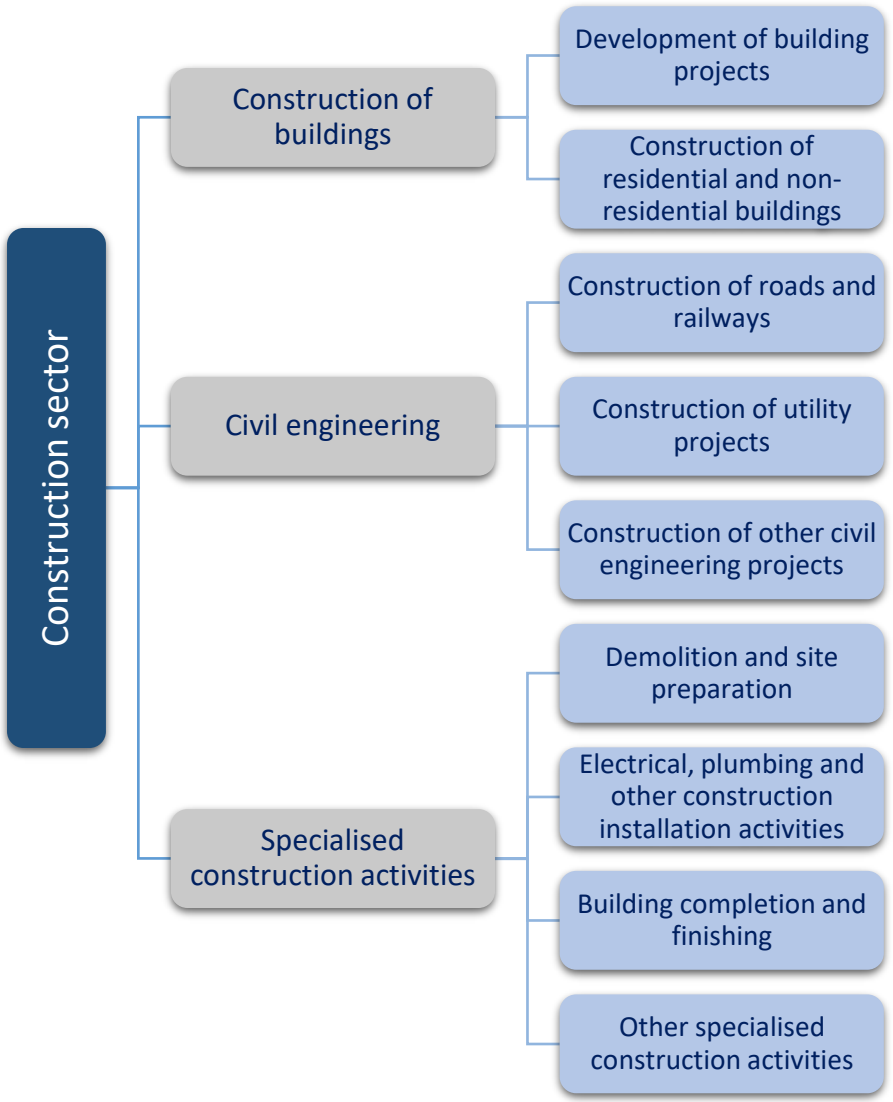
In the years that followed the Olympic Games, there was an explosion in building construction and house mortgages. Major infrastructure projects started being implemented, such as the completion of the major axis of Egnatia Odos, the first privatisation phase of the Piraeus port, and many others. However, all work in progress seemed not to be based on a coherent and structured national strategic plan but consisted rather of scattered plans carried out by various actors.

The collapse of the construction sector during the financial crisis of the 2010s shows the need for a new growth path for the sector. This path must include elements that align with the principles of sustainability and circular economy, as well as respond to actual demand needs. It should also include practices, designs and technologies that enable the sector to grow in accordance with environmental protection and climate change prevention standards.



Source: Eurostat

Perimeter of the construction sector



Source: NACE Rev. 2 classification for construction, Eurostat

The construction sector closely interacts with various other sectors of the economy, constituting a solid basis for growth and development.

- Construction is one of the largest sectors in the EU, accounting for 5% of all activities' GVA and employing more than 13.5 million people or 7% of total employment (2020). The sector includes the construction of buildings and infrastructure projects, as well as building and infrastructure renovations, reconstructions, renewals and upgrades. As such, infrastructure is defined as "the system of public works in a country, state or region, including roads, utility lines and public buildings" (OECD, 2008).
- The construction sector is closely related to various other sectors of the economy, such as manufacturing, real estate, transport, logistics and energy, and thus, directly or indirectly affects many aspects of economic activity.

Narrow and broader definition of the construction sector

- The construction sector is delineated by either a narrow definition, which includes its key subsectors, or by a broader definition that also incorporates activities directly or indirectly related to the narrow construction industry definition (EC, 2019). This report focuses on the narrow construction sector, unless otherwise indicated.
- The narrow construction sector includes the NACE classification sector "F-Construction", which contains three major subsectors: a) construction of buildings; b) civil engineering; and c) specialised construction activities. Construction of buildings includes the development of building projects, and the construction of residential and non-residential buildings. Civil engineering includes the construction of roads, motorways, railways and underground railways, bridges and tunnels, utility projects and other civil engineering projects. Finally, specialised construction activities include demolition and site preparation, test drilling and boring, electrical installation, plumbing, heat and a/c installation, and other installation activities, plastering, joinery installation, floor and wall covering, painting and glazing, roofing activities and so on.
- The broader construction sector includes various other activities related to construction, such as real estate activities, architectural and engineering activities, technical consultancy, as well as certain manufacturing sectors, such as the manufacturing of wood products, clay building materials, cement, lime and plaster.

Future megatrends and the construction industry

Environmental risks, digitalisation, urbanisation and geopolitical developments are among the main trends that can affect the construction industry.

Megatrends are broad and potent global trends that evolve in the macroenvironment. They can develop exponentially over the course of time, shift demand focus and deeply impact economies and societies. We focus on these trends that could affect the macroenvironment of the Greek construction sector from both demand and supply side. Based on the reports of the World Economic Forum (WEF, 2016), the Global Infrastructure Hub (2020) and PWC (2020), we identified and grouped five megatrends that could have an important effect on the construction sector over the following years.

a) Sustainability and environmental risks

- Sustainability requirements of construction and the assessment of environmental risks, such as climate change, greenhouse gas (GHG) emissions, pollution or side effects of natural disasters, such as the spread of infectious disease transmissions, are expected to deeply affect infrastructure, cities and buildings.
- Energy consumption of the building stock accounts for 40% of total final energy consumption. Given waste generation in construction and resource scarcity, circular economy principles, such as recycling and reuse, will minimise waste and keep materials in use. The focus on sustainability of construction shifts demand patterns for built assets and infrastructure and promotes energy efficiency via the use of renewable and clean energy. It also favours the development of advanced construction materials and the design of novel and resilient infrastructure.

b) Technology and digitalisation

- Technological advancements and innovations, as well as developments in digitalisation, such as sensor technology and machinery related to the IoT in the construction industry, offer more advanced benefits and operational structures. Vehicle automation and intelligent transportation systems facilitate the emergence of disruptive new mobility models based on autonomy, while digitalisation and Artificial Intelligence (AI) increase the efficiency of construction techniques. These shifts can have a profound impact on the emergence of smart cities and sharing economies in which construction can play a fundamental role.

c) Population trends and urbanisation

- The increase of population migrating to urban areas has created new clusters of urban economies and large infrastructure investments, as the need for affordable housing increases. It has been estimated that globally, 200 thousand people are moving on a daily basis to urban areas (WEF, 2016).
- The shifting age profile of the population also creates the need to construct or adapt buildings to accommodate the elderly, while also reducing available supply of construction workers (WEF, 2016). Regarding talent and skills, experienced workers, with more technical skills, adaptable to new technologies and digitalisation will be needed.

d) Markets and regulations

- Markets are transformed and construction must adapt to these changes: globalised markets and international trade are shifting demand to big infrastructure projects and emerging economies. Moreover, ageing infrastructure assets, such as railways and roads, need proper maintenance and replacement. As projects increase in size, more stakeholders are involved, thus becoming more complex and inherently riskier.
- Regarding regulatory requirements, environmental, social, and governance (ESG) criteria, are increasingly integrated into new investment decisions, and bring investors long-term performance advantages.

e) Geopolitical developments

- The international environment, global geopolitical security risks, cybersecurity threats, political distrust and the need for transparency could become a source of uncertainty and affect the construction landscape. The Russian military invasion of Ukraine in February 2022 has created instability across the European continent and caused a dramatic surge in gas and oil prices, skyrocketing energy costs. The actual effects of the war on societies, economies and, indirectly, on construction are multifactorial and still unknown.

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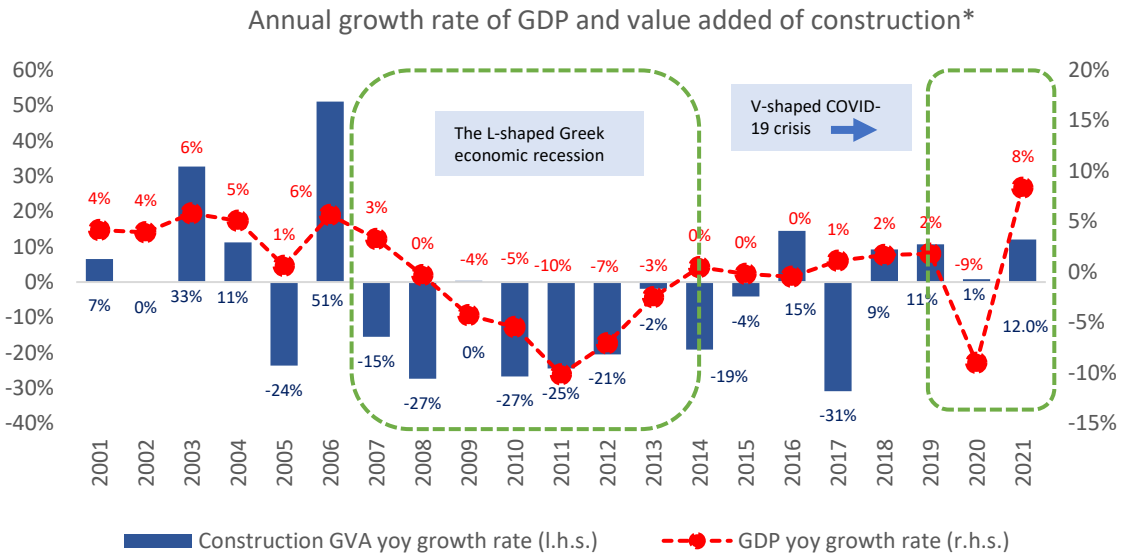
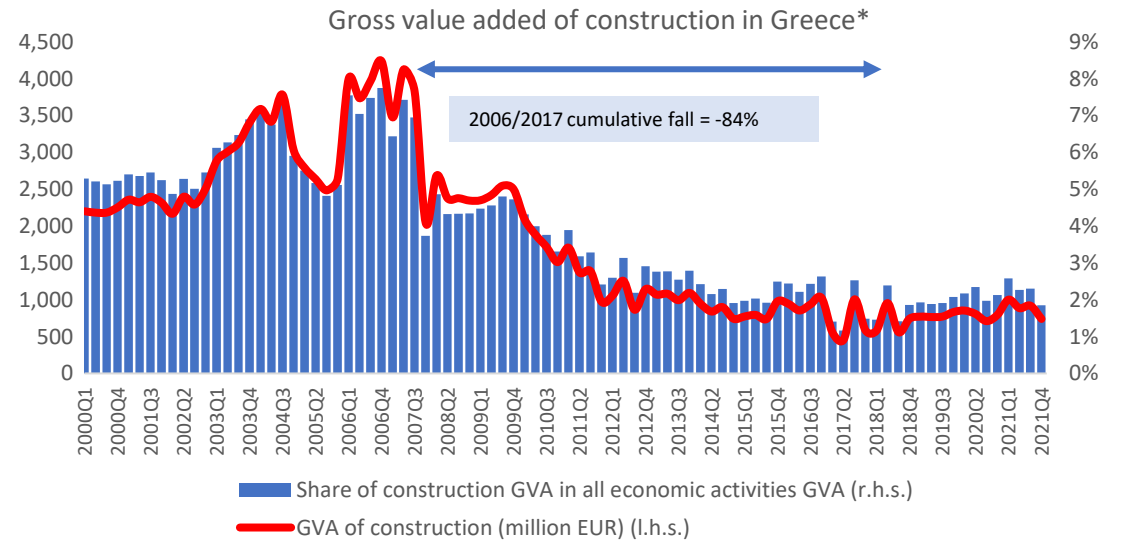
Key figures and importance of the construction sector

The downturn and slow recovery of construction's economic performance





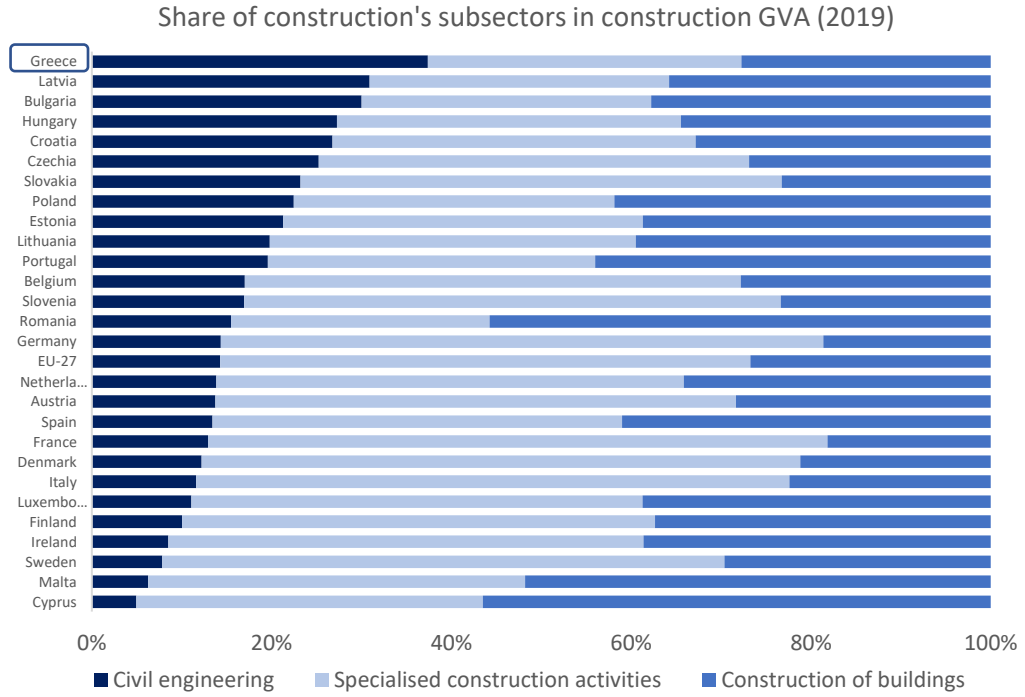
Source: Eurostat

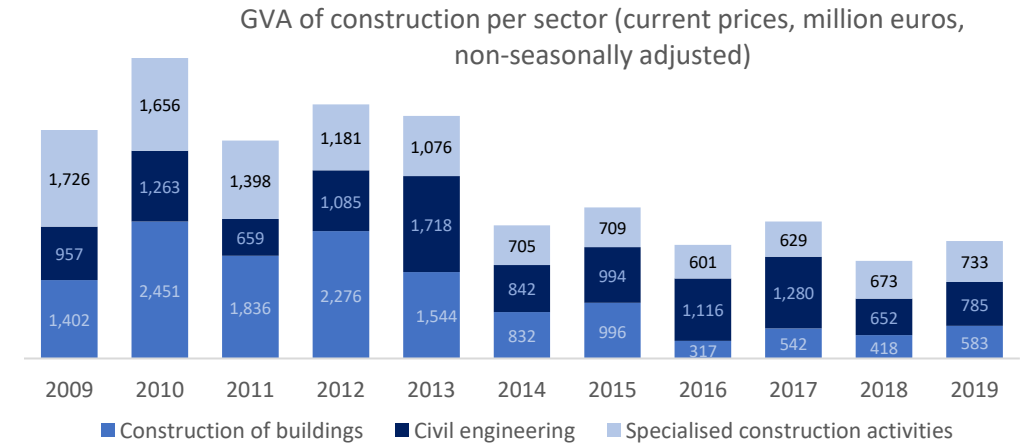
*seasonally adjusted chain linked volumes 2015 from the National Accounts

From 2007 to 2015, except for 2009, the value added of the construction sector decreased, resulting in a heavy cumulative fall.

- The Olympic Games played a crucial role in the surge of construction in the country. From 2000 until 2004, except for 2002, construction GVA went up, while in 2006 it reported a jump of 51% after having fallen by 24% in 2005 (in chain-linked volumes, 2015). The Greek debt crisis led the economy to an L-shaped recession, with a slow recovery starting essentially in 2017. The construction sector was severely hit during the same period and did not really recover before 2018. Construction's GVA exhibited a positive annual growth rate of 15% in 2016, only to fall again by 31% in 2017, before starting to recover in 2018. Cumulatively, from 2006 to 2017, the value added of the sector plummeted by 84%.
- Construction represented a relatively high value-added share in total economy's GVA before the previous decade's financial crisis. In 2006, the sector's share reached 7.5% and then it decreased considerably. By 2017, it had collapsed to 1.6% but then increased slightly, since the growth rate of the sector's value added stood above that of the economy. The production output of the construction sector as a share of total output recorded a similar fall, going down from 12.2% in 2006 to 2.4% in 2017, only to go up slightly to 2.9% in 2020.
- After the outbreak of COVID-19 in 2020, construction's value added increased by 0.8% yoy, showing signs of resistance in the economic downturn due to the pandemic, which negatively affected most sectors' performance and resulted in a GDP decrement of 9%. The 2020 GVA of the broader Greek construction sector totaled more than EUR 4 billion (European Construction Sector Observatory, 2021).
- In 2021, construction showed further signs of recovery in terms of both value added and turnover. The sector's GVA went up by 19.6% in the first nine months of 2021 compared to those of 2020 but recorded a decrease during the last quarter of the year (-7%). Overall, in 2021, construction's value added surged by 12%, largely exceeding the also strong increase in the economy's GDP growth rate (8.3%).
- Construction's turnover was reduced by 5% in 2020 yoy, less than the respective downturn of the total economy (-13%). In 2021, the sector recorded a 9% increase compared to 2020, lower than the surge in all economic activities' turnover (22%).

Value added and turnover division across key construction sectors

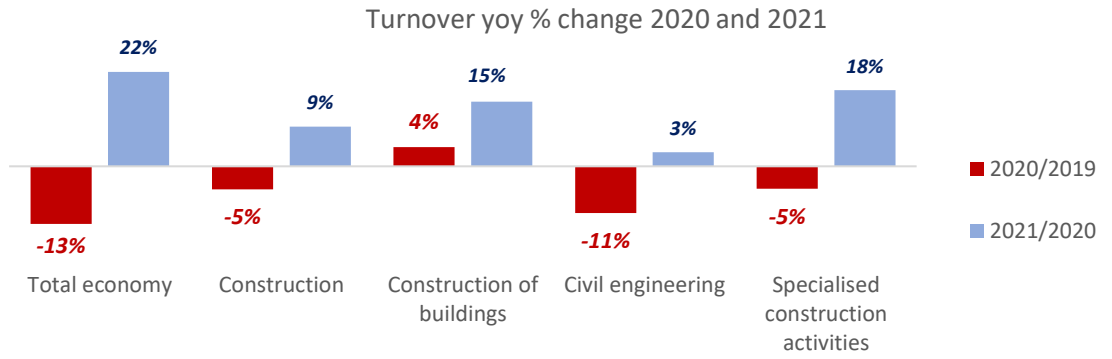




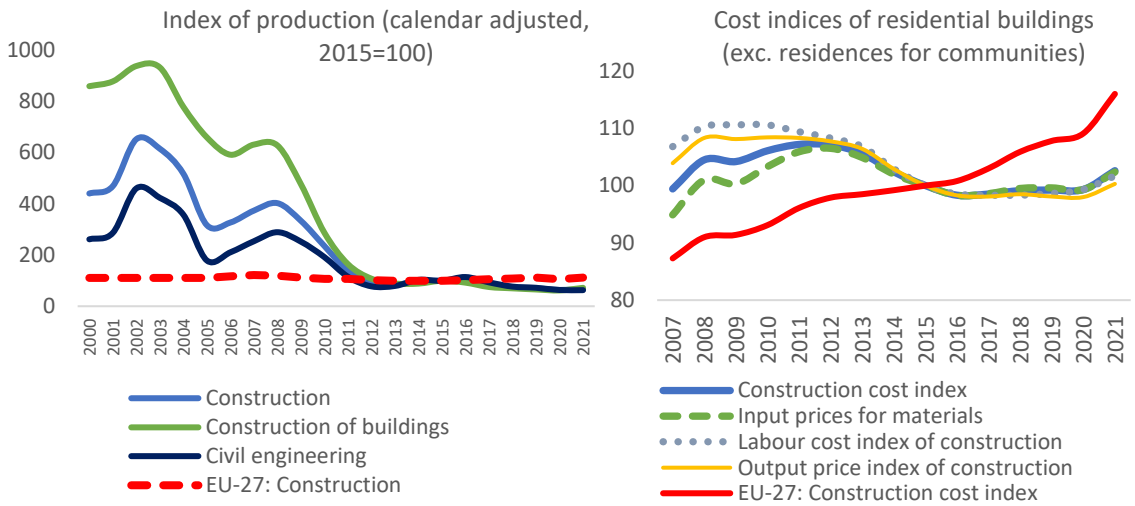
Source: ELSTAT, Eurostat

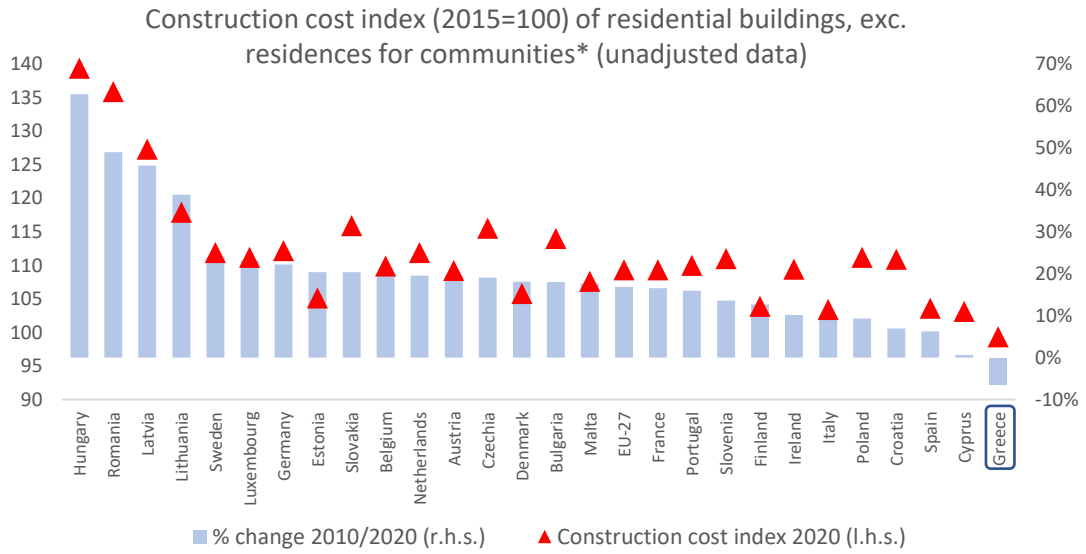
Civil engineering replaced buildings as the largest construction sector in value added terms after the Greek financial crisis.

- Each of the main construction subsectors, i.e., construction of buildings, civil engineering and specialised construction activities, witnessed large downturns during the financial crisis of the previous decade. During 2009-2019, the GVA at factor cost of buildings and specialised construction activities fell cumulatively by 58% respectively (current prices). A much milder fall was recorded in civil engineering value added during the same period (-18%).
- Civil engineering is currently the largest construction subsector in terms of value added, turnover and production value, accounting for shares of 37%, 45% and 47%, respectively (2019). The share of Greek civil engineering value added in construction GVA is the largest among EU countries, whereas that of specialised construction activities is among the lowest.
- In terms of turnover, buildings exhibited the largest cumulative decrease (-62%) in the 2009-2019 period, compared to specialised construction activities (-36%) (current prices), whereas civil engineering recorded a positive cumulative change (30%). In 2020, the COVID-19 pandemic crisis induced a significant yoy fall in turnover in civil engineering (-11%) and a milder decrease in specialised constructions (-5%). On the contrary, buildings showed an upward trend in their 2020 turnover (4%), followed by a stronger increase in 2021 (15%). Specialised construction activities' turnover also revived in 2021 (18%), as did civil engineering projects, but mildly (3%).



Production volume and construction cost





* Data were not available for all EU countries for 2021.

Source: Eurostat

Production volume and producer prices of construction remain at low levels, despite a slight increase in 2021.

Production output

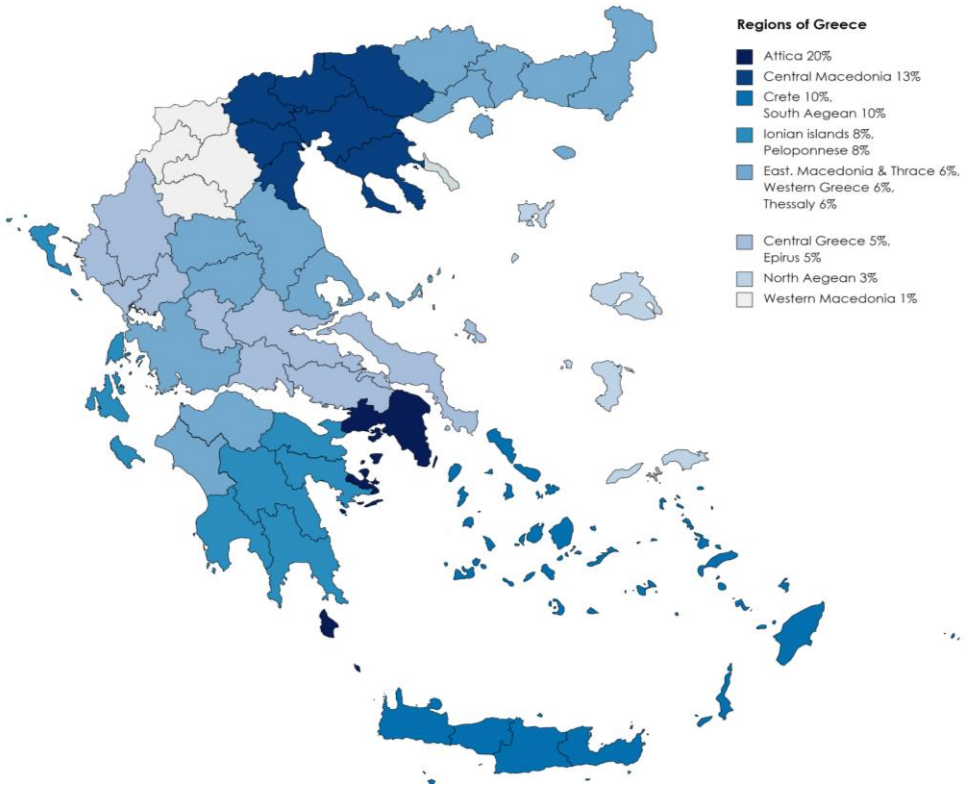
- The actual value of construction output in 2020 reached EUR 7.9 billion, when in 2000 it stood at EUR 30.3 billion and in 2006 at EUR 43.1 billion (chain-linked volumes, 2015). The index of production, which measures changes in the volume of output at given time intervals, stresses the landslide of the sector during the financial crisis of the previous decade, but it also underlines its immense growth before the 2004 Athens Olympic Games. Indicative of the growth of the sector at that time is the height of the production index in 2003, and especially the index of construction of buildings, which reached 620 units, when the respective European average stood at only 116 units.
- During the 2010-2020 period, construction's production index fell cumulatively by 73%. Per sector, the largest fall was recorded in buildings (-78%). Civil engineering production fell by 67%. After the outbreak of the pandemic, the construction production index decreased by 10% in 2020, a slowdown mostly attributed to civil engineering (-12%) rather than buildings (-6%). In 2021, a slow recovery of 6% was recorded, same as that of the EU-27, which was more pronounced in buildings (16%).

Construction cost (producer prices)

- The construction cost or producer prices index in residential buildings shows the price developments "incurred by the contractor to carry out the construction process" (Eurostat). The construction cost index in Greece increased by 3% in 2021, while in the EU-27, it rose by 6% during the same year. Over the 2010-2021 period, producer prices decreased cumulatively by 3% in Greece, while on the contrary in the EU-27, they increased by 25%.
- Construction cost includes the costs of the production factors materials and labour, and consists of two sub-indices, the input price for materials and the labour cost index (wages, salaries and social security charges). Both these indices decreased annually in Greece from 2013 until 2016 and remained relatively stable from 2017 until 2020. In 2021, both the input price for materials and the labour cost index increased slightly (by 3% and 2% respectively), mainly due to rising energy costs.

Dwellings prices and new-built properties

Distribution of new-built properties in NUTS 2 regions (2021)



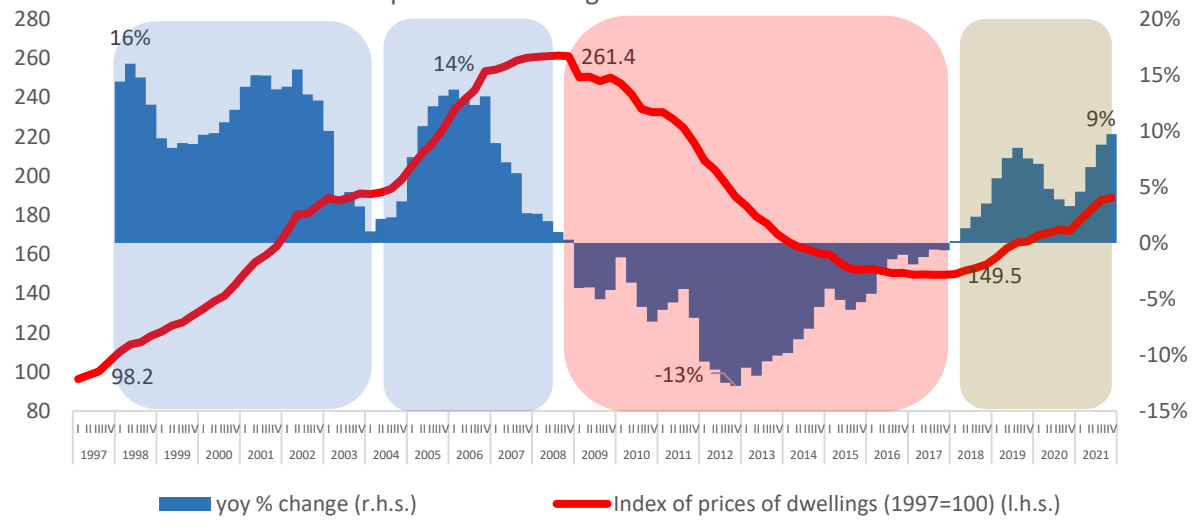
Source: ELSTAT, https://mapchart.net/greece.html

- Also increasing is the number of the new-built properties in Greece, which reached 6,915 in 2020 and 9,888 in 2021, increased by 43% yoy. During the decade 2010-2020, the number of new-built properties fell cumulatively by 70%. Per NUTS 2 regions, over 50% in 2021 was distributed in four regions: 2,015 new properties were built in Attica (20%), 1,248 in Central Macedonia (13%), 992 in Crete and 965 in South Aegean (10% respectively). The regions of Central Macedonia (190%), South Aegean (160%) and Epirus (153%) were those with the highest annual growth rate of new-built properties in 2021.

Residential prices are on an upward trend since 2018, followed by an increase in new-built properties, especially in Central Macedonia and South Aegean.

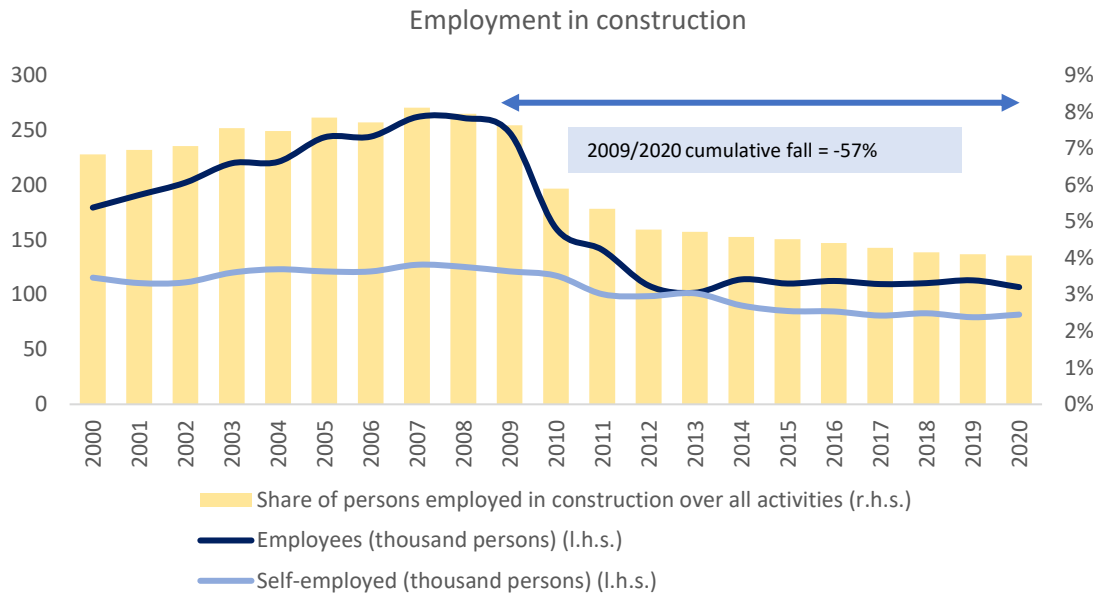
- According to the Bank of Greece price data of residential properties collected by credit institutions, the index of dwelling prices (1997=100, non-seasonally adjusted, includes only apartments since 2006 and all dwellings up to 2005) increased annually by 7% in 2021 (from 5% in 2020, 7% in 2019 and 2% in 2018), reaching its highest level since the end of 2012. On average, the price index was formed at 184.1 units in 2021.
- The upward trend in dwellings prices began in Q1 2018, signalling a new recovery phase, after years of continuous decline. The previous house price phase, which started at the beginning of 2009 and ended in 2017, was determined by an immense cumulative fall of 43% (257 units in 2007 to nearly 150 units in 2017).
- Before the 2009 financial crisis, house prices went through two distinct, but augmentative, phases. House prices followed a strong upward trend from 1994 and up to 2002, with annual growth rates of between 8% and 15%. After the Olympic Games era, they rebounded in the short term before starting their descent in 2009.

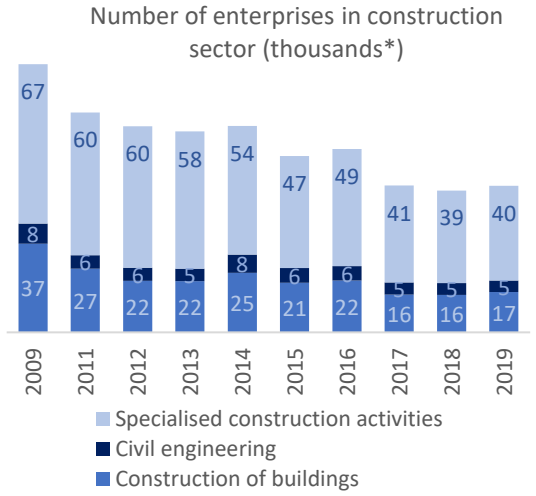
Index of prices of dwellings in urban areas

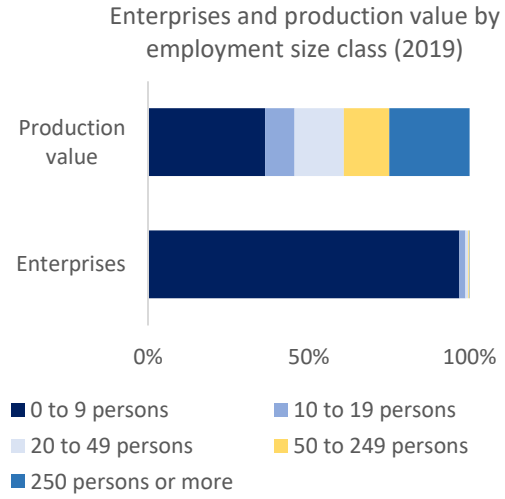


Source: Bank of Greece

Employment and market division in the construction sector







* missing 2010 data

Source: Eurostat

Construction cumulatively lost 57% of its labour force in the 2009-2020 period.

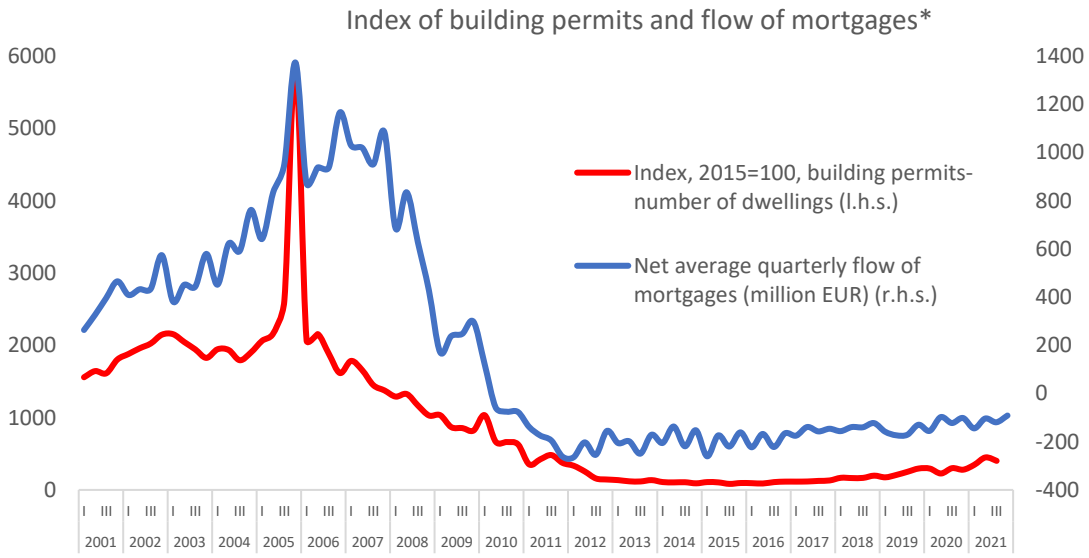
Employment in construction

- Employment in construction increased from 2000 until 2007, creating many jobs for the Greek economy. Only in 2003, before the Olympic Games, the persons employed grew by 8.4%, while in 2007, they reached 389 thousand. However, from 2008 and until 2013, employment in the sector was continuously downsized. Indicative of the crisis is that in 2010 alone, it shrunk by ¼. During the pandemic crisis, employment in the sector fell by 2% and 1% in 2020 and 2021 respectively, to a total of near186,000.
- In 2020, nearly 57% of the employed persons in the construction sector were employees and 43% self employed (68% and 32% respectively in 2008). Only 6% of the employed are women (2020) a share that has only slightly increased since 2008 (2%). The vast majority of the employed are craft and related trades workers (70% in 2020), followed by sector professionals (8%), plant and machine operators and assemblers (8%), elementary occupations (5%), clerical support workers (4%), technicians and associate professionals (3%) and managers (2%).
- Regarding employment in the three key sectors of construction, the majority (53%) is employed in specialised construction activities, followed by the 30% who work in buildings and the rest (17%) in civil engineering (2019). The labour force division among these sectors a decade ago was quite different, since buildings had the lead (45%), followed by specialised construction activities (41%). Civil engineering, although the smallest sector in terms of employment, has the highest apparent labour productivity, i.e., GVA/person employed (at EUR 31.7 thousand in 2019), whereas specialised construction activities have the lowest (EUR 9.8 thousand).

Construction firms

- In 2019, over 61 thousand enterprises operated in the construction sector, reduced by 45% cumulatively compared to 2009. Most of these firms belong to specialised construction activities (65% in 2019), whereas 27% operate in the construction of buildings and 8% in civil engineering. Although the construction ecosystem is overwhelmingly dominated by micro firms (97%) up to 9 persons, ¼ of the production value of the sector is derived from large firms (more than 250 persons).

Construction of buildings



Source: Eurostat, Bank of Greece

*Net flows are derived from changes in outstanding balances adjusted for exchange rate differences, write-offs and reclassifications.

Building permits and mortgage flows still stand at significantly lower levels than those before the financial crisis.

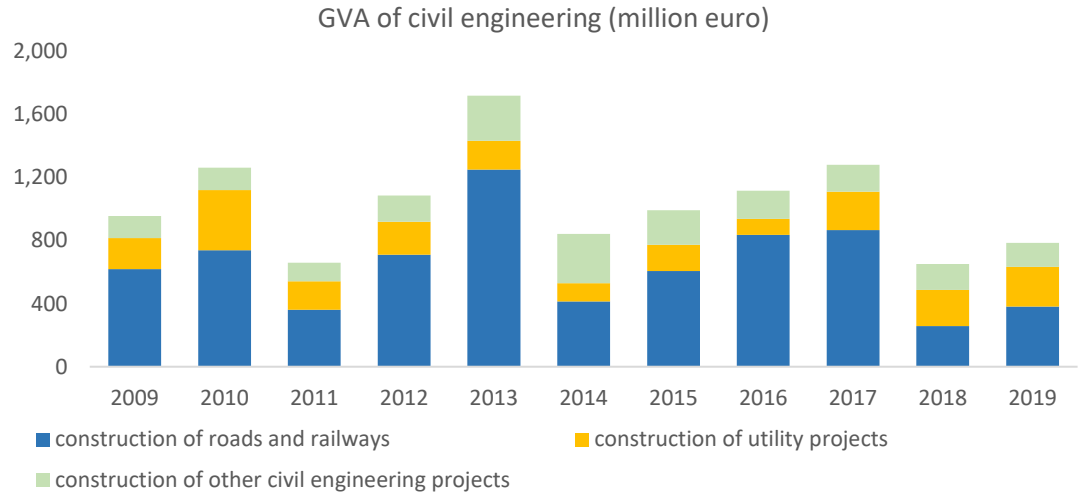
Construction of buildings

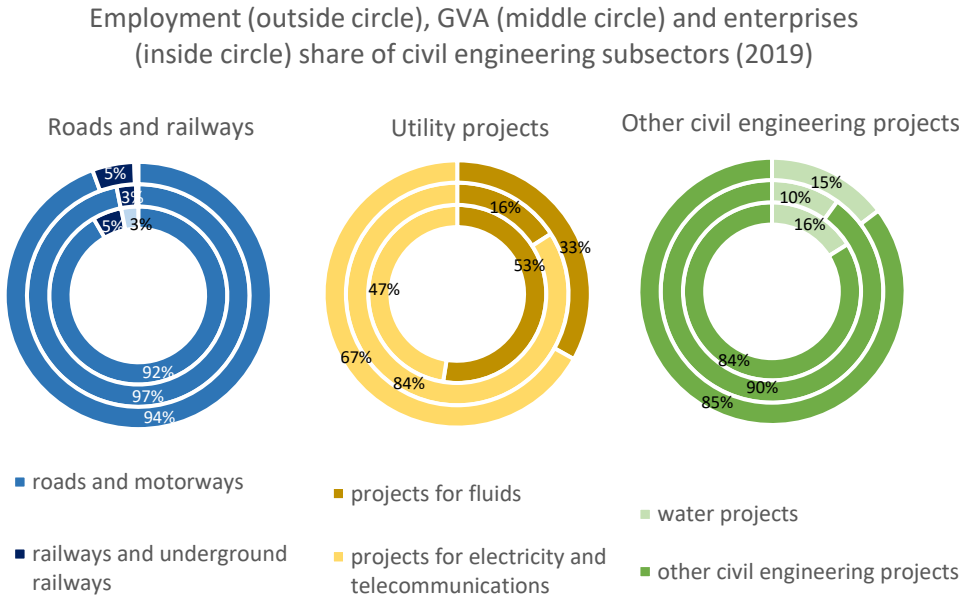
- Construction of buildings refers to the general construction of buildings of all kinds and includes two subsectors: a) the development of building projects and b) the construction of residential (single-family houses, multi-family buildings) and non-residential buildings (industrial production, office, airport and religious buildings, hospitals, schools, hotels, stores, shopping malls, restaurants, indoor sports facilities, parking garages, and warehouses). The development of building projects refers to the combination of financial, technical and physical means needed in order to materialise construction projects for future sale.
- Construction of buildings employs 42,430 people in 16,917 enterprises (2019). Construction of residential and non-residential buildings dominates the sector, since it comprises 98-99% of total GVA, turnover, persons employed and enterprises (2019).

Building permits

- Buildings permits correspond to the final planning stage and provide public authorisation to start working on a building project. Building permits were indicative of the construction boom of the previous decades in Greece. The corresponding building permits index (2015=100) experienced a continuous rise from 2001 until 2005. After its peak in Q4 2005, it recorded a sharp fall and then followed a decade of decline. In 2021, it reached a ten-year high, while in Q3 2021 it rose by 33% yoy, maintaining an upward trend that began towards the end of 2016. A similar trend was recorded in mortgages. The financial crisis of 2008 had a severe negative impact on mortgage flows, which turned negative in 2010, and have not yet recovered.
- Following the current recovery of the economy, the actual number of private building permits went up by 26% from January to October 2021, compared to the same period in 2020, and totalled 19,352 permits of 4.9 million m^2. During the 2010s, private building permits issued in Greece fell by 63%. In 2007, they stood at 79,407 (of 20 million m^2), whereas by 2014 the number of permits issued had fallen to 13,434 (2.5 million m^2).

Civil engineering





Source: Eurostat

Civil engineering sector specialises in the construction of various, mostly public, infrastructure works.

- Civil engineering employs nearly 24,800 people in 4,800 enterprises (2019) and includes infrastructure projects (roads, rails), urban and regional planning, structures, such as bridges and tunnels, water engineering stations and water management. These projects are divided into three subsectors: a) construction of roads and railways, b) construction of utility projects and c) other civil engineering projects.

Roads and railways

- The construction of roads and railways is dominated by the subsector of roads and motorways, which includes the construction of motorways, streets, roads, other vehicular and pedestrian ways, surface work on streets, roads, highways, bridges or tunnels. This subsector comprises 97% of the value added, 94% of the persons employed and 92% of the enterprises of roads and railways. Railways and underground railways account for only 5% of employment and 3% of the value added, while the participation of the construction of bridges and tunnels is marginal.

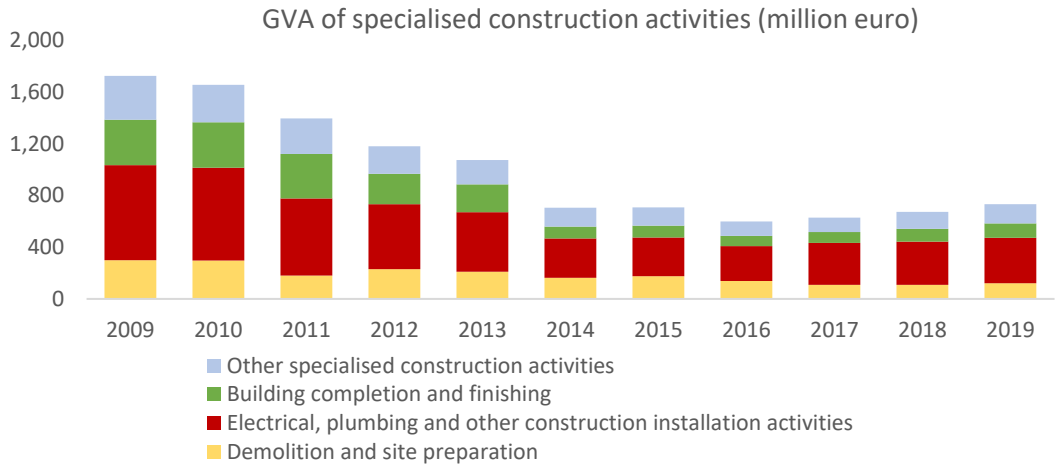
Utility projects

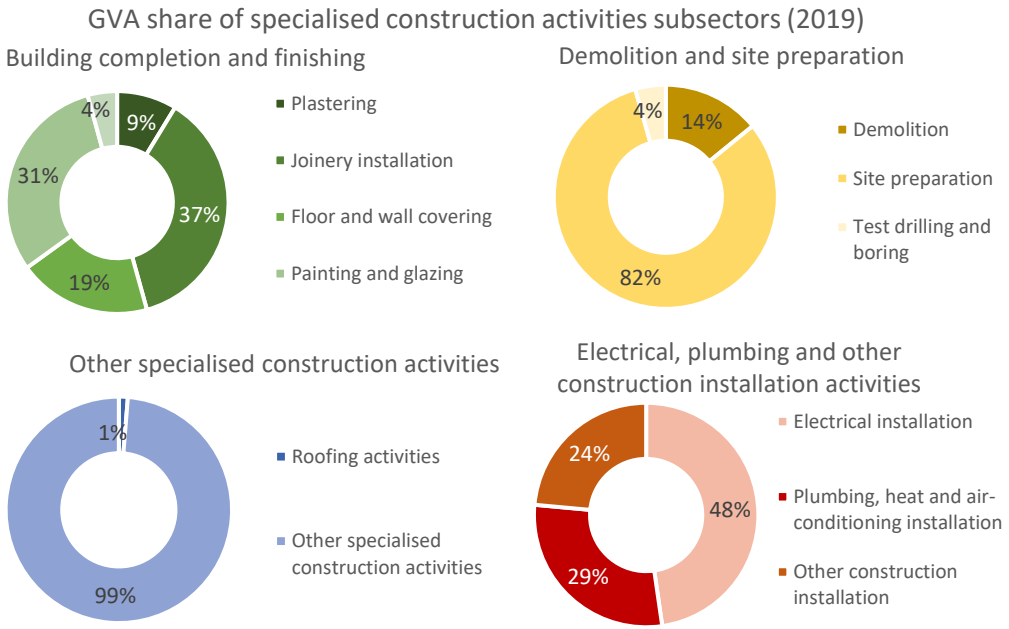
- Utility projects include the subsectors of construction of the distribution lines for fluids and for electricity and telecommunications. All buildings and structures that consist integral parts of these systems, such as long-distance and urban pipelines, water main and line construction, reservoirs, sewer systems and power plants and so on, are also included. Utility projects account for ¼ of the employment in civil engineering and 32% of its value added. The subsectors of electricity and telecommunication works correspond to 84% of the value added of utility projects and 67% of its employment.

Other civil engineering projects

- Other civil engineering projects comprise 31% the persons employed and 19% of the value added of civil engineering projects. They include water projects, such as waterways, harbour and river works, dams and dykes, and the construction of other civil engineering projects, such as refineries, chemical plants, outdoor sports facilities and so on, which constitute the largest part of other civil engineering projects in terms of GVA (90%) and employment (85%).

Specialised construction activities





Source: Eurostat

Specialised construction activities employed 75 thousand people in nearly 40 thousand enterprises in 2019.

- Specialised construction activities are a miscellaneous sector, which includes four subsectors of supplementary construction processes for "the construction of parts of buildings and civil engineering works or preparation therefore" (NACE Rev. 2).

Electrical, plumbing and other construction installation activities

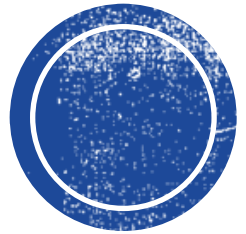
- Electrical, plumbing and other construction installation activities is the largest subsector of specialised construction activities in terms of enterprises (over 16,000 units or 41% of total in 2019), with nearly 35,000 persons employed (46% of total). They produce ½ the GVA of specialised construction activities and 43% of its turnover.
- Electrical installation, which includes electrical wiring and fittings, telecommunications wiring, computer network and cable television wiring, including fibre optic, satellite dishes, lighting systems, electric solar energy collectors and many other features, is the largest subsector of electrical, plumbing and other construction installation activities, with nearly 7.5 thousand enterprises and over 16 thousand persons employed (2019).

Demolition and site preparation, building completion and finishing and other specialised construction activities

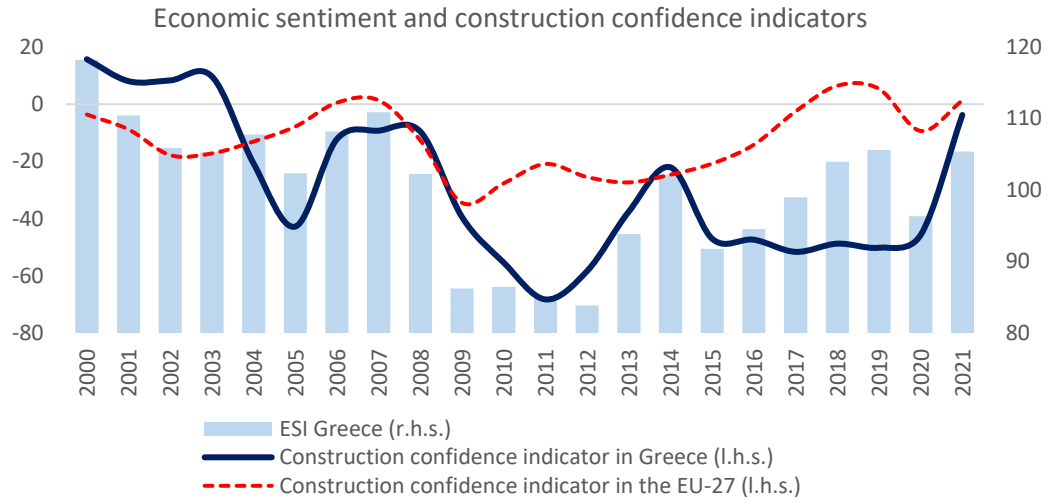
- Demolition and site preparation accounts for 17% of the GVA of specialised construction activities and employs over 10,000 persons (2019). Site preparation, which includes demolition of buildings and other structures, excavation, landfill, levelling, grading of construction sites, trench digging, rock removal, blasting, etc., represents 82% of GVA, turnover and employment in demolition and site preparation.
- Building completion, which includes plastery, joinery installation, floor and wall covering and painting and glazing, numbers nearly 12,000 enterprises and 18,000 employed persons and represents 15% of the specialised construction activities' GVA.
- Other specialised construction activities, including roofing activities, construction of foundations, steel bending and bricklaying, stone setting and others, comprise 20% of specialised construction activities value added and employ over 12,000 people.

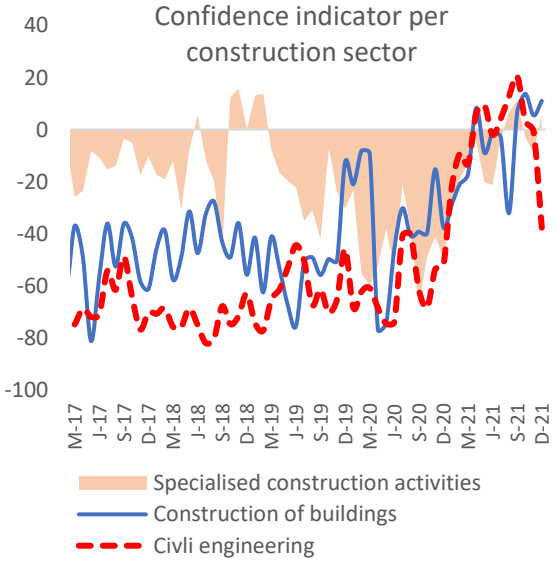
ALPHA BANK

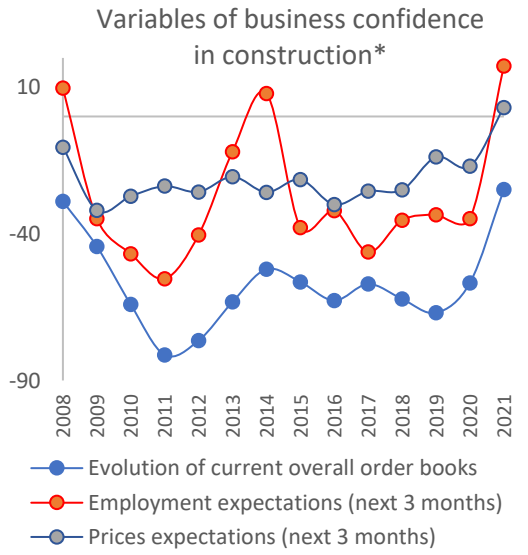
Investment activity and financing prospects



Business confidence outlook in the construction sector







Source: European Commission DG-ECFIN

* Price expectations are not a variable of the business confidence index of construction

In 2020, despite the pandemic peak, the negative business confidence indicator slightly improved and, in 2021, significantly rebounded.

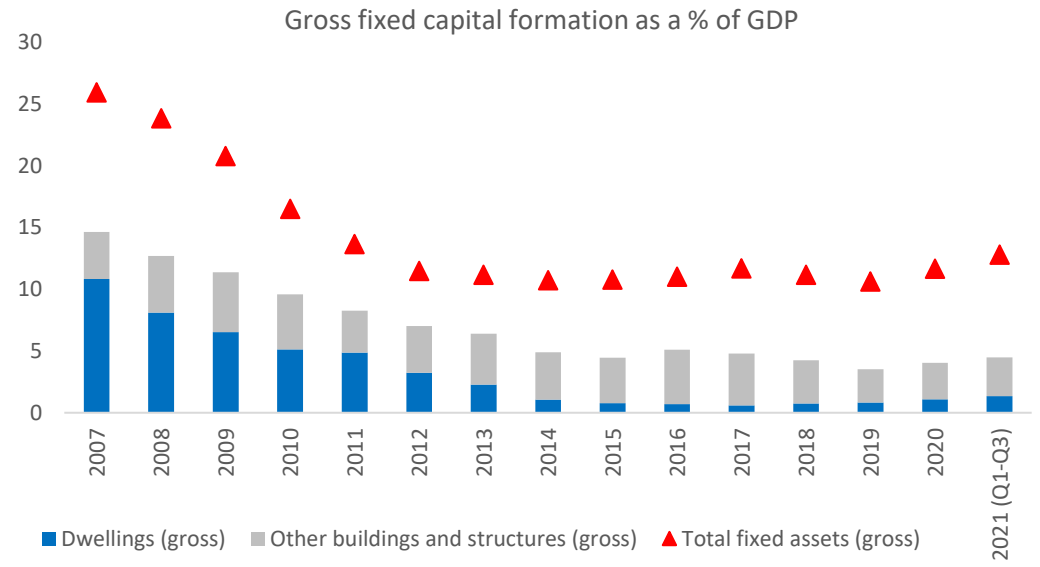
Economic sentiment and construction confidence indicator

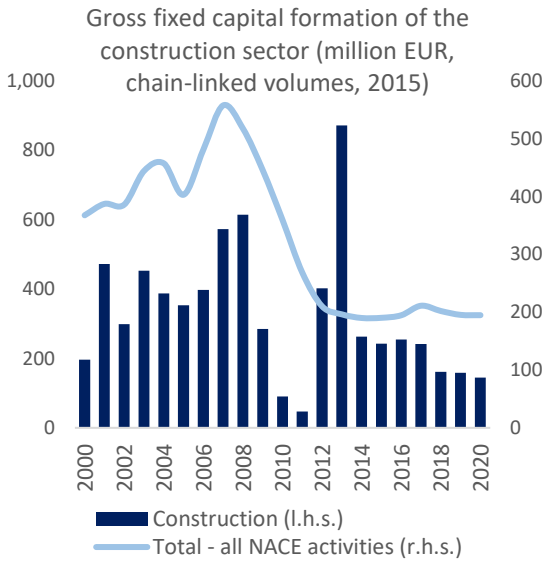
- The large drop in consumption growth and revenues during the previous financial crisis was evident in the large contraction in the business confidence indicator of the European Commission DG-ECFIN surveys. From 2007 to 2011, the balanced construction confidence indicator lost 59 units, only to regain ground slightly in the following years.
- Since 2004, business confidence balance in construction remains negative, being the lowest among the indicators of other economic sectors. For example, in 2019, it reached on average -50 units, while the respective indicators of industry (0 units), services (14 units) and retail trade (16 units) were much higher. In 2020, despite the pandemic peak, the negative business confidence indicator slightly improved to -46 units, whereas in 2021 it gained 42 units, an improvement also evident in Greece's composite Economic Sentiment Indicator (ESI). This significant rebound brought construction confidence standing closer to the corresponding European average, while also fuelling, along with other sectors, an improvement in the Greek ESI in 2021 (construction has a weight of 5% on the ESI).

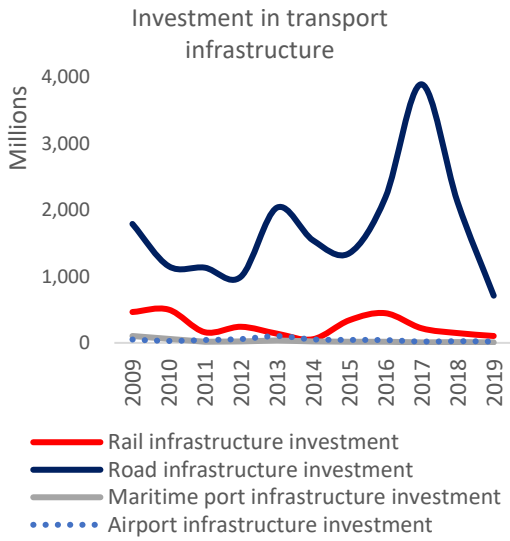
Business confidence per variable and construction sector

- In 2021, employment prospects and overall order books improved, as the economy restarted after the pandemic crisis peak and lockdowns. Indicative of the more optimistic view are the positive balances of employment and order books expectations after a long period of negative performance. Sector price movement expectations in 2021, affected by the inflationary pressures and increasing prices in energy and many other products, are also on an upward trend, exhibiting an average positive balance throughout the year.
- The specialised construction activities business confidence indicator was higher over the last years compared to the two other indicators, construction of buildings and civil engineering. The latter, although it grew significantly in 2021, recorded a large fall in December, losing 37 points.

Gross fixed capital formation and investment activity







Source: Eurostat, OECD

Construction investment activity collapsed by 80% from 2007 to 2019.

Economy's gross fixed capital formation in dwellings and other buildings and structures

- Gross fixed capital formation (GFCF) of total economy is a measure of investment activity, which mainly consists of "resident producers' acquisitions, less disposals, of fixed assets during a given period." (ESA 2010). The economy's investment in construction works is classified into several types, which include dwellings and other buildings and structures, including major land improvements.
- Before the financial crisis in Greece, all economic activities' investment in the form of dwellings, i.e., "buildings that are used primarily or entirely as residences" (ESA 2010), and other buildings and structures consisted 55% of total fixed assets or 14.7% of GDP (2007). Dwellings constituted nearly 11% of GDP in 2007, amounting to EUR 24.9 billion (chain-linked volumes 2015), and other buildings nearly 4% of GDP.
- During the Greek financial crisis, GFCF in construction collapsed by 80% from 2007 to 2019, to only slightly regain ground in 2020 and 2021. This devasting fall was largely driven by dwellings, since they cumulatively lost 94% of their investment value, reaching EUR 1.8 billion in 2020 or only 1% of GDP. In 2021 (Q1-Q3), investment in dwellings was slightly increased to 1.4% of GDP.
- Total inland transport infrastructure investment fell by 64% during the 2009-2019, decade, although it recorded a significant jump in 2017 due to a large peak in road infrastructure. The latter consists of the vast majority (87%) of total inland infrastructure investment, followed by rail (13%), airport (3%) and maritime port (1%) (2019).

Investment activity in the construction sector

- Investment in the Greek construction sector fell considerably as of the beginning of the 2009 financial crisis and up to 2011, to regain losses in 2012 and 2013, and to then stabilise at lower levels. Between 2009 and 2020, the value of investments in the construction sector fell by 49%. The gross operating rate, an indicator of profitability equal to the share of gross operating surplus over turnover, stood at 8% in 2019 (7.2% in 2009), while the investment rate in the sector (investment/value added) was equivalent to 12.3% (18% in 2009).

Funding of construction projects and access to finance

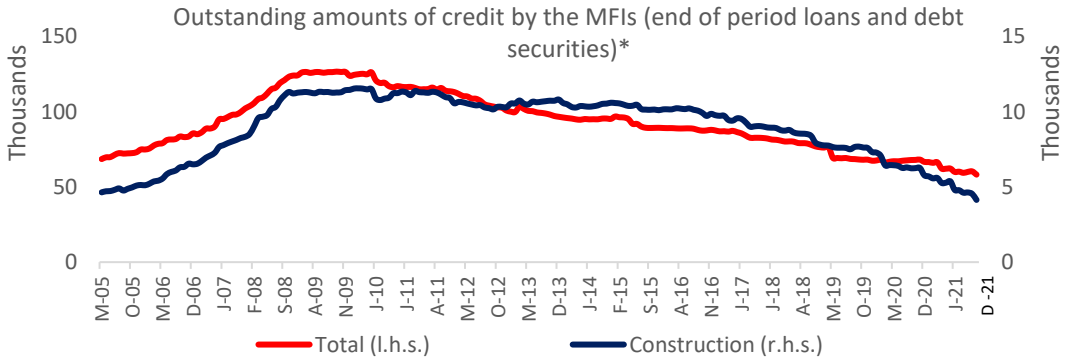
The NRRP and other programmes direct financial sources to the construction sector, in which over ¼ of firms seem to be financially constrained.

Major strategic planning and funding programmes

- The broader construction sector participates in various actions included in four pillars of the National Recovery and Resilience Plan (NRRP, Greece 2.0)—green transition, digital transformation, employment social cohesion, private investment and transformation of the economy—playing a leading role in the green transition.
- The NRRP specifies policy areas and domains related to building renovation, construction of new energy-efficient buildings, urban environment and bioclimatic restructuring, RES, water management and waste treatment infrastructure, among others. The plan includes 36 actions with an estimated budget of nearly EUR 8 billion, in which the construction sector participates, along with other sectors (IOBE, 2021). Among the projects funded via the NRRP are the creation of electricity storage systems, the undergrounding and upgrading of the electrical grid, the "Saving 2021" programme (domestic, business, public sector), urban regeneration, electromobility, renovations and modernisation of hospitals, railway network upgrading, biodiversity protection actions, among others.
- Moreover, infrastructure development and the completion of ongoing projects stand out as one of the five objectives of the National Development Plan 2021-2025, implemented with the financial resources from the Public Investment Program. Infrastructure development focuses on three objectives related to the improvement of networks, transport and supply chains, with 11 priorities being highlighted, regarding ICT infrastructure, energy networks, buildings, ports, waterways, rail and air infrastructure. The budget for the Sectoral Development Programme 2021-2025 of the Ministry of Infrastructure and Transport is EUR 2.6 billion and accounts for 38% of all sectoral programme funding. In addition, the Greek Ministry of Energy plans to subsidise energy efficiency upgrades of public buildings via the Electra program by providing EUR 500 million until 2025.
- Other funding vehicles, like the EFSI/EIB scheme and the new National Strategic Reference Framework (ESPA) 2021-2017, are also supporting construction and infrastructure projects. The EFSI has approved 22 projects worth EUR 2.4 billion, which are expected to trigger EUR 8 billion in investments (EC, 2021).

Access to finance

- In 2020, nearly 70% of investment funding for construction firms came from internal financing, which is higher than the EU average (63%). External financing was close to 30% and a very small percentage was intra-group financing (EIB, 2021). Regarding external financing, nearly 60% were bank loans, the highest share compared to other sectors, and 30% from grants.
- Regarding credit from domestic Monetary Financial Institutions (MFIs), there has been a marked reduction in outstanding amounts after the 2009 financial crisis outbreak, which has continued until today. This was related to the limitation in construction activity after the crisis and the broader credit and deleveraging problems faced by most of the Greek business sector (IOBE, 2021). At the end of 2021, the outstanding credit balances (end of period loans and holdings of debt securities) for the construction sector stood at EUR 4.1 billion down from 11.5 billion at the beginning of 2010.
- Construction firms are the most likely to be financially constrained (22%), a higher percentage than that of other sectors (16% on average) (EIB, 2020). The availability of financing was reported as a long-term barrier by 87% of construction firms, the highest among economic sectors.



Source: Bank of Greece

* Including securitised loans and corporate bonds serviced by credit institutions.

Prospects, drivers and barriers of construction investment

Economic prospects, innovation and digitalisation are among the key factors that affect investment activity in the construction sector.

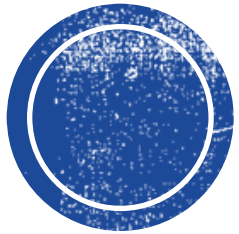
Key projects in infrastructure and urban development

- Between 2014 and 2019, 40 projects worth EUR 8.9 billion in the transport, energy and water infrastructure sectors were completed, of which 79% had to do with motorways (PWC, 2020). In 2019, 5 projects of total value EUR 566 million were completed. Nevertheless, the Greek investment gap in infrastructure compared to the EU average is estimated at 0.8 p.p. of GDP or EUR 1.5 billion annually during 2009-2019 (PWC, 2020).
- The scheduled infrastructure pipeline covers 118 projects with a EUR 43.4 billion budget, either in progress or planned but not yet funded, with completion time being 2030 (PWC, 2020). A total of 54 projects worth EUR 13.5 billion are in an initial planning phase with unknown completion dates. The distribution of the upcoming projects is as follows: nearly 58% energy sector, 34% railways and motorways, 4% airports and ports, and 4% waste management. Out of the 20 energy projects, 12 of them pertain to energy interconnection, such as TAP, IGB, EuroAsia, Ariadne and EastMed, and 8 to electricity production infrastructure, such as wind and photovoltaic parks, and power stations.
- Regarding transport infrastructure projects, the upgrade of 14 regional airports by Fraport has been completed, while various ports and marina hubs are also in the works. According to PWC (2020), EUR 8.7 billion have been allocated to railways, out of which EUR 5.3 billion to urban railways (e.g., Line 4 of Attico Metro, Thessaloniki Metro, Athens Tramway expansion to Piraeus) and EUR 6 billion to motorways. Although rail electrification is planned to be extended by converting and adding 754 km to the national network, electrified lines in Greece account for only 30% of railways, which is lower than the EU average (58%) (PWC, 2020).
- A positive development is the start of the first 5-year implementation phase of the development of the former Hellinikon airport site, which includes infrastructure projects worth EUR 450-500 million. Moreover, Greek and foreign investments are funding the construction of new hotels and the renovation of various buildings in Athens and many Greek islands. 131 new hotels opened in 2020 and 2021, while a EUR 2 billion investment in new hotels is expected in Attica in the next two years.

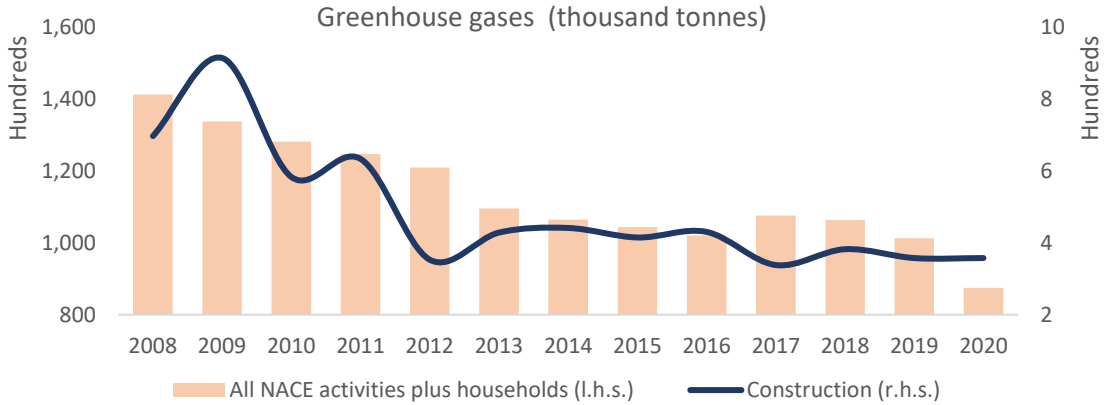
Investment drivers and barriers

- As for the factors that affect investment activity in the construction sector, economic prospects and developments, as depicted in growth rates, business confidence, and available income and employment are among its main drivers (EC 2019, 2021, IOBE, 2021). Demographic changes, housing demand and access to housing, energy efficiency and renovation demand, the need for maintenance and the expansion of public infrastructure, as well as the extent of innovation and digitalisation are also cited among the leading drivers that can impact investment activity (EC, 2019).
- There are also constraints that hinder construction development and sustainable investment growth. Among the more pronounced are the barriers related to financing access, especially for small firms, inadequate public project planning and preparation, regulatory uncertainty and labour insufficiencies or skills shortages (EC, 2019). Infrastructure projects in Greece face obstacles related to preparation, execution and operation (EC, 2021). The EC Construction Observatory for Greece also cites the following drawbacks: a conservative trade credit approach, since a large percentage of payments is made in cash; the late payment and longer payment terms by firms, especially after the outbreak of the pandemic (48% of the total B2B sales in 2021); and the timely and costly building permits and license acquisitions (EC, 2021).
- The Doing Business 2020 Report placed Greece at the 86th position in the “Dealing with Construction Permits” category, since it takes 180 days (152 OECD average) and 17 administrative procedures (12.7 OECD average) to build a warehouse. According to the Global Infrastructure Hub, Greece largely improved its funding capacity, but “it will continue to struggle to attract quality infrastructure investment without further improvements in its creditworthiness”. In the 2019 Global Competitiveness Report, Greece ranked 39th among 141 countries for its transport infrastructure, and 37th for all infrastructure network and quality, scoring better in airport (27th) and liner shipping connectivity (28th), and worse in road connectivity (73rd) and railroad density (46th).

Sustainable construction and eco-innovation



The environmental impact of the construction sector



Source: Eurostat

Air emissions

- Carbon dioxide and other harmful emissions from the construction sector in Greece accounted for 0.4% of emissions from all activities (2020), reduced by nearly ½ compared to 2008. Polluting emissions from all economic activities decreased by 38% during the same period.
- In the EU, GHG emissions from construction cumulatively decreased by 9% during the period 2008-2020, accounting for nearly 2% of total economic activities' emissions. Regarding CO_2 emissions from existing building stock, which are mainly generated by energy use, these account for 36% of total emissions (EC, 2020). For example, GHG emissions related to heating and cooling of households only, represent 6% of total emissions (2020). Globally, in 2020, construction activities and existing buildings produced 37% of energy and process-related CO_2 emissions (UNEP, 2021).

Energy consumption

- Energy consumption of the building stock in Greece accounts for 40% of total final energy consumption (IOBE, 2021), the same percentage as the European average (EC, 2020). On a global scale, existing buildings account for 36% of energy consumption (2020) (UNEP, 2021).

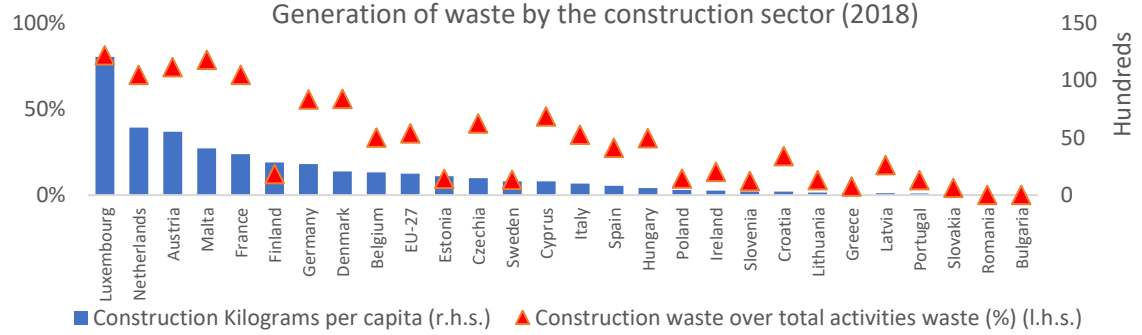
Sustainable construction is estimated to contribute to a 55% reduction of GHG emissions by 2030 compared to 1990 levels (EC, 2020).

Consumption of materials

- Materials consumed by the construction sector and the building stock in the EU account for 50% of all materials consumed by all economic activities (Norouzi et al., 2021). It has been estimated that by 2060 1/3 of the global material demand increase will come from construction and buildings (UNEP, 2021).

Waste generation

- Waste from the construction sector in Greece (such as scrap metal, used cement or wood products) stood at 213 kg/capita or 2.3 tonnes in 2018 and represented 5% of total waste, the fourth lowest percentage in the EU-27 (36%). It is worth noting that waste generated from mining and quarrying, a sector closely related to construction, accounts for 56% of total waste generation.
- The recovery of construction waste in Greece takes the form of backfilling and paving of rural roads. Over ½ the construction waste is collected in order to be recovered via 100 specialised units, which cover 63% of the NUTS 2 regions of the country (2018) (National Waste Management Plan, 2020). The recovery rate (part of collected waste prepared for re-use, recycling or subjected to material recovery) stood at 97% (2018), higher than the corresponding EU average (88%).



Source: Eurostat

Construction and sustainability guidelines

In 2020, the European Commission launched the New European Bauhaus project, which focuses on the transformation towards "living together sustainably" and how this can be achieved in the future.

Sustainable construction

- Extended construction activities and urbanisation have a significant impact on energy, climate change and the environment, causing extensive damage to the whole ecosystem (UNEP). The construction industry, being one of the most important sectors of economic activity, is also a large consumer of materials, such as minerals and other natural resources, and energy, as well as being a generator of GHG emissions and waste.
- Sustainability in the construction industry means a) reduced carbon footprint over the lifespan of buildings, infrastructure and construction sites, via more energy efficient constructions; b) building with renewable energy sources; and c) practice circular economy principles in materials, recyclability and waste minimisation. Sustainability guidelines in construction will support tackling urgent environmental challenges and climate change, while at the same time helping the sector retain its competitiveness and its role as a backbone of the economy (EC, 2020).

Processes of construction sustainability

- There are various innovations and techniques that promote sustainability in the construction industry. These include a) utilising technologically advanced, renewable and recyclable, robust and light materials; b) using sustainable building procedures and environmentally friendly practices; c) reducing the use of raw materials; d) effectively managing construction waste and extensively using recycling practices; e) the construction of green buildings; f) renovation projects that transform old buildings; and g) conserving energy by increasing the use of renewable energy sources and fuels (Construction21, 2021).
- Regarding the materials used in the sector, there are plenty of innovations that can reshape the future of construction towards more sustainable, energy saving and eco-friendly options. These include materials such as transparent wood, aluminum foam, LED/OLED lighting, hydrogel, breathe blocks, hydrophobic cement, bamboo reinforced concrete, plasma rock and others (https://constructiondigital.com/).

Benefits of construction sustainability

- *Environmental benefits:* Small and large companies can benefit from adapting projects with the use of renewable energy, recycled building materials and green buildings construction that will support waste generation reduction, GHG emissions and carbon footprint limitation (Goconstruct, 2020).
- *Financial benefits:* Sustainable, green buildings allow end users to save more on costs in the long run than traditional buildings, although they usually have a larger initial cost regarding to the materials and processes in the initial stages of a project (Goconstruct, 2020).
- *Social benefits:* Green buildings and sustainable construction can affect health and wellbeing, as well as improve workers' productivity due to a better working environment, surroundings and noise protection (Goconstruct, 2020).

The New European Bauhaus

- The New European Bauhaus project pertains to the built environment and emphasizes the importance of climate challenges, accessibility, social cohesion, digital construction and sustainable bio-resources. The project promotes innovative solutions in climate-friendly architecture and materials as key factors for the future of a sustainable built environment. It is based on the historical Bauhaus movement that emerged in 1919 and which brought together artists, designers, architects and craftsmen to come up with creative new approaches to building requirements. This transdisciplinary view is also very needed today to face the challenges arising from current transformations (EC, 2021).
- The aim of the project is to create a green, digital and resilient construction ecosystem, fostering ''socially and aesthetically promising, green and digital solutions, technologies and products'' (EC, 2021). The project sets out a) sustainability guidelines, including climate goals, net-zero pollution, and biodiversity conservation; b) aesthetics and functionality; and c) inclusion, valuing diversity, equality for all, accessibility and affordability.

The Renovation Wave of construction

The European Commission has launched the Renovation Wave initiative, in order to improve the energy performance of European buildings and help tackle environmental challenges.

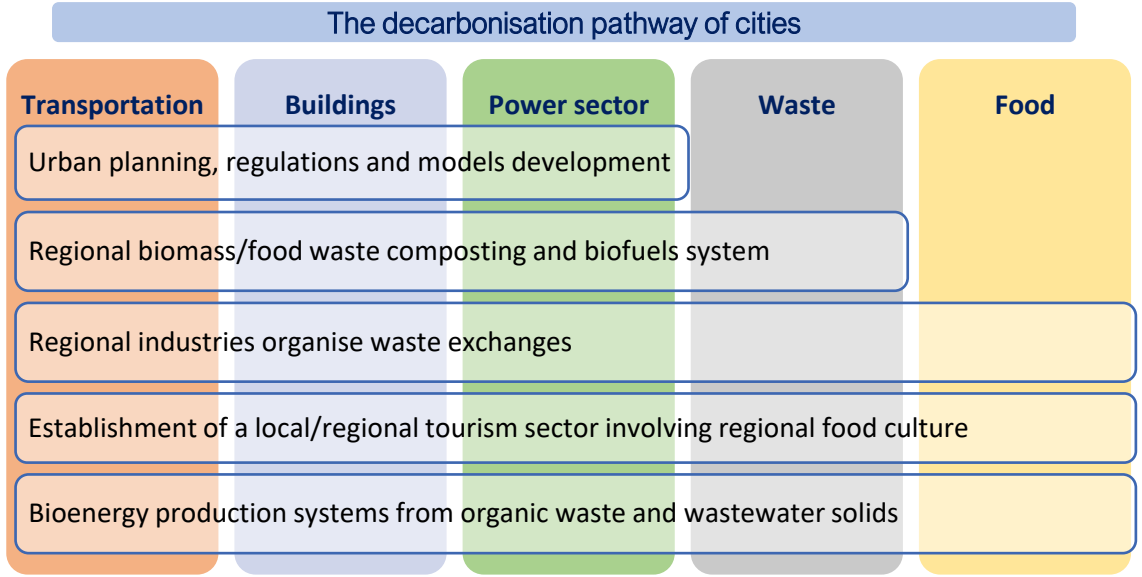
- The building stock of EU countries reflects Europe's history and its various architectural and cultural backgrounds. However, many European buildings are considered "old", since 85% of them were built before 2001 and more than 90% of all buildings will continue to exist beyond 2050 (EC, 2021, BPIE, 2020). The renovation of buildings, which refers to the partial or total structural and technical repair or modernisation of building stock, is therefore necessary. More importantly, what is also required is the energy renovation of buildings at more than 75% of the existing building stock (EC, 2020).
- Annually, 11% of EU building stock goes through some kind of renovation. The annual average energy efficiency renovation rate, i.e., renovations that aim at the reduction of energy consumption, is only 1%, while the annual average deep energy efficiency renovation rate, which refers to renovations that can reduce energy consumption by at least 60%, stands at 0.2% (EC, 2020, 2021).
- The EC, in order to encounter the low energy renovation rates at a European level, launched the Renovation Wave Strategy in 2021, as part of the European Green Deal and the Fit for 55 package for a climate neutral Europe by 2050. This initiative aims to enhance buildings' sustainability for the future, double their annual energy renovation rates by 2030 and promote deep energy efficient renovations (EC, 2020). The Renovation Wave includes various policies, measures and tools, such as ways to measure renovation benefits, minimum energy performance standards, support for renewable energy sources in heating and cooling, funding and technical assistance, and the promotion of green mortgages (EC, 2020).
- The goal of the Renovation Wave initiative is to be oriented towards sustainable key principles, such as a) energy efficiency; b) affordability; c) decarbonisation and integration of renewables; d) life-cycle thinking and circularity; e) health and environmental standards; f) tackling the challenges of the green and digital transition; and g) respect for aesthetics and architectural quality (EC, 2020).
- The Renovation Wave initiative focuses on three priority areas, which include the following:
  1. *Addressing energy poverty and worst-performing buildings*. Energy poverty is a major challenge for 34 million Europeans who cannot keep their homes heated adequately. Poorly performing buildings are related to energy poverty, as well as to wellbeing and health.
  2. *Renovating public buildings.* An initiative related to the renovation of administration, education, healthcare and social housing buildings designed to increase annual renovation requirements. In this context, the development of green public procurement criteria for public buildings is also examined. The renovation of public buildings can lead the renovation wave and serve as a reference point of the EU's Renovation Wave initiative.
  3. *Decarbonising heating and cooling*. This will be achieved by modernising relevant building systems, many of which are old and inefficient, and by increasing the share of RES in the heating and cooling of buildings, accelerating the decarbonisation of the EU building stock.
- The Renovation Wave initiative can benefit construction activity, despite a drop of 12% in investment in highly energy-and-resource-efficient equipment in 2020 compared to 2019. In addition, since construction is a largely labour-intensive sector, the stimulus provided by the buildings' renovation can create 160,000 green jobs in the industry by 2030 and generate growth opportunities in the renovation supply chain (EC, 2020).
- The Renovation Wave will be complemented by other EU renovation projects, such as the BUILD UP skills initiative and the BUILD UPON^2 project that will contribute to the reduction of energy consumption and GHG emissions, as well as support the shift towards a climate neutral economy by 2050. The BUILD UP skills initiative seeks to increase the number of skilled building professionals who can carry out high-energy performance renovations and construct near-zero energy buildings. The BUILD UPON^2 project currently has 8 participating pilot cities, among which are Dublin, Padova and Leeds; and aims to promote buildings renovation and the decarbonisation of the building stock.

Building green cities

Urbanisation has an immense environmental impact on land use, air and water pollution, increased resource and transportation demand, solid waste and sewage and, as such, is identified as one of the five main drivers of environmental change (Global Environment Outlook, UNEP, 2021).

- As a result of their rapid expansion, urban areas around the world are expected to have more than 2 billion new inhabitants by 2050 and house 70% of total population. Between 1975 and 2015, the global urban population grew by 2.4 billion, raising its share of the world population from 38% to 54% (UNEP, 2021). In Europe, it is estimated that 85% of people will live in cities by 2050, a trend that will generate an even higher demand for buildings, and further stress out material resources, biodiversity and ecosystems (EC, 2020, 2022).
- Globally, cities produce 80% of total GDP, consume 75% of total natural resources, and generate 50% of total waste and 72% of total GHG emissions, although they cover only 3% of the Earth's land surface (UNEP, 2021, EC, 2020). Consumption of natural resources in cities is expected to rise to 90 billion tonnes in 2050, from 40 billion tonnes in 2010 (Ellen MacArthur Foundation, 2019).
- The contribution of cities to the generation of GHG emissions and energy consumption is closely related to their urban density and structure. Urban planning, development and use of buildings has a significant impact on resource consumption and urban living conditions (Ellen MacArthur Foundation, 2019).
- Design and construction play a fundamental role in creating or transforming a city into a green, urban area. Less traffic, via better transportation systems, less air and water pollution, via electromobility and better water quality standards, less people and waste, via valid recycling programs, more green spaces, such as large community parks, more sustainable and environmentally friendly buildings, and more non-motorised transport, such as bike lanes, are some of the prerequisites for a green city's transformation. In 2020, the top 5 green cities in the world included Vienna, Munich, Berlin, Madrid and Sao Paulo (www.gvi.ie).
- The greening and decarbonisation of urban areas requires systemic and sustainable changes in transportation, buildings, energy use, food and waste, as well as the development of new low carbon systems. These systems, in order to reduce carbon use and promote efficiency maximisation, can be integrated across operations and infrastructure of the above areas as follows (UNEP, 2021):

1. *Bioenergy production* from organic waste and wastewater solids, including methane capture, addressing the problem of urban methane emissions.
2. *Urban planning and development*, in order to establish energy-efficient buildings, transit-oriented development and limit transportation requirements.
3. *Regional biomass/food waste composting and biofuels* that fuel transportation and energy sectors.
4. *Organising waste exchanges between regional industries* to reduce the carbon footprint of supply chains.
5. *Establishing a local/regional tourism sector* and develop a regional food culture, thus lowering transportation emissions and repurposing building stock.



Source: Global Environment Outlook for cities, United Nations Environment Programme, 2021

Circular economy practices in the construction industry

As one of the largest consumers of energy and raw materials, the construction industry can take advantage of the various, innovative circular approaches in the design, material reuse, management of waste and high-quality recycling in both built environment and infrastructure projects.

Circular economy practices for the construction sector

- The construction industry can become a field in which various circular economy techniques are adopted and applied. Although construction waste recovery rates in Greece and many other EU countries are high, these are mainly based on low-grade recovery applications, such as backfilling and paving of rural roads. Increasing waste prevention and achieving higher and more qualitative recycling and reuse of by-products and materials requires various circular economy techniques applied to buildings, cities, infrastructure, materials, demolition, energy efficiency, energy saving options and space sharing.
- Circular economy in the construction sector involves the interaction and collaboration of all stakeholders, i.e., of end users, construction companies, designers, manufacturers, suppliers and recyclers (Ellen Macarthur Foundation and ARUP, 2019). The Smart Prosperity Institute (2021) recognises various circular practices for the construction sector, which include the following:

1. *Reduction of resource consumption via eco-design* by a) designing buildings for disassembly; b) sourcing sustainable materials; c) using energy efficient products and systems; d) applying renewable energy systems; and e) process optimisation, such as just-in-time construction (i.e., material ordering on an as-needed basis) and the use of prefabricated buildings.
2. *Intensification of product utilisation* via a) sharing economies, i.e., sharing of labour, tools, materials, information and other assets; and b) short-term renting of specialised construction equipment.
3. *Building and components life extension* through a) maintenance methods that can adapt to and be resilient against climate change; b) donations and reselling of unused assets and materials; and c) the refurbishment of buildings.
4. *Providing new uses to resources and materials* by a) using and reusing recycled materials of other industries; b) recycling and composting; and c) energy recovery using construction waste as fuel.

Circular economy for urban areas and city planning

- Circular economy practices for designing and building urban areas are closely related to the principles guiding the creation of green cities. Among these practices, the Ellen MacArthur Foundation (2019) identifies the following:

1. *Designing compact, dense, mixed-use and transit-oriented cities:* a) less dense cities, resource and energy savers regarding transport energy and energy for the heating and cooling of buildings, and b) mixed-use and transit-oriented development, so as to optimise residential, business and recreational spaces, within walking distance of public transportation.
2. *Local material flows* that support the collection, reuse and redistribution of resources in local areas, such as water, organics, industrial by-products, building elements and household recyclables.

Circular economy for buildings and materials

- Circular economy in building design and material selection can improve the uses of buildings and the way they interact with their surroundings. Circularity focuses, among others, on a) adaptability and flexibility (e.g., modular units, moveable interior walls); b) nature-inspired, bioclimatic design; c) strategic material sourcing, including local sourcing, use of renewable, safe and healthy materials for residents, recyclable or recycled, and locally available materials; and d) resource-efficient construction techniques, like prefabricated building elements and 3D printing (Ellen Macarthur Foundation, 2019).
- Regarding building maintenance on a predictive and timely manner, circular principles can keep materials and components in use via new business models, such as product-as-a-service in which users don't buy products but pay for their use, while providers are responsible for the product's maintenance. Digital technologies, e.g., smart meters and connected devices, building refurbishment and adapting buildings for new uses, are also among the circular economy techniques for building maintenance (Ellen MacArthur Foundation, 2019).

Digitalisation, eco-innovation and Construction 4.0

Technology-driven changes, such as digitalisation and environmentally innovative procedures play a key role in the construction sector's sustainability, by strengthening its competitiveness, productivity and energy efficiency and contributing to a greener building future.

Key digital technologies

- On a global scale, construction is the second least digitalised sector after agriculture (EC, 2019). Although the sector has been transformed over the years via the adoption of innovative technologies, in the EU it remains one of the least digitalised sectors (EC, 2021).
- However, in an era in which the construction industry is expected to expand significantly and construction-related projects are becoming more complex and sophisticated, the adoption of new technologies and integrated software platforms can promote competitiveness, improve productivity and reduce costs. The Digitalisation of the Construction Sector report (EC, 2021) distinguishes three main, digital and interconnected categories in the various stages of a construction project, which include:

1. *Data acquisition*: it indicates the availability of data at all stages of a construction project and includes a) sensors collecting data and monitoring the performance of a construction project such as sites, buildings and machines; b) Internet of Things, for the internet connection of appliances, devices, sensors and vehicles, allowing for data exchange, communication and remote control; and c) 3D Scanning, i.e., the creation of 3D models of objects, buildings and infrastructures.
2. *Digital information and analysis: they* connect data acquisition and automation processes and analyse the available data. This is processed by using a) Building Information Modelling (BIM); b) virtual/augmented reality, which incorporates virtual elements into real surroundings or directly visualises the whole environment; c) Artificial Intelligence (AI), applied, for example, in the design phase of a project; and d) digital twins, i.e., real-time digital representation of a physical building or infrastructure. BIM is a highly collaborative process in which construction professionals work together to design a project, share data, operate and manage building information of a construction project throughout its life cycle within a 3D model.
3. *Automation processes:* these include the use of a) robotics, which execute operations such as laying floor tiles or bricks, lifting and placing heavy objects; b) 3D Printing, i.e., the process of creating an object by adding layers of materials, such as plastic, metal, wood or concrete, upon one another by using CAD (Computer-Aided Design) or BIM; and c) drones, which help map construction sites.

Construction 4.0

- Construction 4.0 incorporates key digital technologies to the sector that bring together real time data, interconnectivity and information sharing, as well as machine-learning and automation processes. As such, Construction 4.0 is the counter part of Industry 4.0 (4th industrial revolution) for the construction sector and refers to the adoption of digital solutions and the automation of the various processes within the industry. It includes the creation of digital construction sites, with projects being monitored by using various technologies, signifying the shift from mass customisation projects and the emergence of a green and sustainable construction industry (Jazzar, M.E., et al, 2020).

Eco-innovation

- Eco-innovation is "any innovation that reduces the use of natural resources (including materials, energy, water and land) and decreases the release of harmful substances across the whole life-cycle" (EIO, 2020). Eco-innovations in the construction sector in particular refer to innovative systems, applications, use of materials and processes that support decarbonisation, help reduce air emissions and act as energy savers.
- Eco-innovations that address the use of advanced digital solutions and new technologies for achieving sustainability targets are termed digital eco-innovations. Construction digital eco-innovations are the processes and digital technologies that drive efficiency and innovation and, at the same time, mitigate the environmental footprint of buildings and cities (Volkova, T., et al, 2019).

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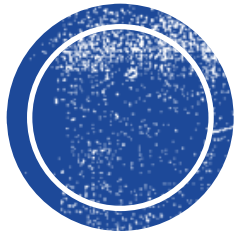
Regulatory and strategic framework of construction



European regulatory framework of the construction industry

The European Commission has adopted various policies for the construction industry, buildings or infrastructure, recognising the need to move towards the greening, energy efficiency and digitalisation of the sector.

Construction 2020 Strategy

- In 2012, the European Commission adopted the Construction 2020 Strategy as part of the Europe 2020 initiative for the sustainable competitiveness of the construction sector. Construction 2020 recognises that sustainable competitiveness of the sector is fundamental for its growth and employment in new market opportunities, and for achieving energy, climate change and environmental objectives (EC, 2012, 2021).
- Construction 2020 emphasises the improvement of a) investment conditions, especially those related to energy efficiency in buildings renovation; b) the skills and qualifications of the human capital; c) resource efficiency and environmental performance, focusing on low GHG emissions, and higher recycling of construction and demolition waste; d) the regulatory framework in order to strengthen the construction market; and e) the international competitiveness of European construction companies (EC, 2021).

Construction Products Regulation

- The Construction Products Regulation (EU 305/2011) lays down harmonised conditions for the marketing of construction products in the EU and for "conditions for the placing or making available on the market of construction products by establishing harmonised rules on how to express the performance of construction products in relation to their essential characteristics and on the use of CE marking on those products" (EU, 2011).
- This regulation includes requirements of construction products which are reflected in product standards, technical approvals, and other technical specifications and provisions related to these products (EU, 2011).
- The focus of the regulation is on ensuring that professionals, public authorities and consumers are provided with reliable information in order to compare the performance of products from various manufacturers and countries (EC, 2022).

Energy Performance of Buildings Directive

- The Energy Performance of Buildings Directive (2010/31/EU), amended in 2018 (2018/844/EU), aims to boost the energy efficiency of EU buildings by promoting a more energy-efficient building sector in order to reach the energy and environmental targets set by the European Green Deal. In 2021, the EC proposed a recast of the Directive so as to be harmonised with the Fit for 55% Package (EC, 2022).
- According to the Directive, EU members must a) ''set cost-optimal minimum energy performance requirements for new buildings, for existing building stock undergoing major renovation, and for the replacement or retrofit of building elements like heating and cooling systems, roofs and walls''; and b) establish long-term renovation strategies aimed at decarbonising national building stock by 2050, according to the energy efficiency targets set by the NECPs.

Waste Framework Directive

- The Waste Framework Directive (2008/1998/EC) promotes a) the reuse of construction materials and products; b) the setting up of systems that support reuse activities; c) the reduction of waste generation in processes related to construction and demolition; and d) selective demolition to enable the removal and safe handling of hazardous substances, reuse and high-quality recycling. The Directive established a minimum 70% target by 2020 for the reuse, recycling and material recovery of construction and demolition waste, including backfilling operations.

Digitalisation policies

- The digitalisation of the construction sector in the EU is supported by policies such as the Renovation Wave, the Directive on the Energy Performance of Buildings and the European Green Deal, funded by programmes such as Horizon Europe, Digital Europe programmes, the Recovery and Resilience Fund and InvestEU (EC, 2021).

Regulatory framework for land use and building activity in Greece

Construction activity depends on the Greek spatial and urban planning framework, as well as on various other building regulations.

National Cadastre

- The National Cadastre, established in 1995, "records legal, technical and other information on real estate and rights over it, under the responsibility and guarantee of the State" (National Cadastre, 2022). Currently, 54% of Greece's total property rights are "at the stage of public consultation or at a later stage", whereas it is estimated that, by October 2022, they will reach 71% (EC, 2022).
- The Hellenic Cadastre a) records the location, shape, boundaries and size of each real estate property; b) registers all transactions that create or modify rights, restrictions and responsibilities on them after controlling the legality of transactions; c) reveals and systematically records State-owned land; and d) records rights created through usucaption, which, especially in rural and mountainous areas of the country, is a common way of acquiring ownership due to informal transfers (National Cadastre, 2022).

Spatial and Urban Planning Framework

- Spatial planning pertains to the distribution of activities in spaces and organises land uses to balance demand for development with the protection of the environment and social economic objectives (EC, 2018). In Greece, spatial planning was regulated by L.2742/1999 on "Spatial Planning and Sustainable Development" and includes both regional and specialised plans.
- Urban planning is regulated by L.2508/1997 on "Sustainable Residential Development" and includes regional plans and special urban plans for projects or programmes (IOBE, 2021). It covers residential areas, areas of production and business activities, and areas of special protection. Urban planning includes spatial planning and development, land uses, building terms and limitations, boundaries of urban settlements, road networks and transport (L.2508/1997).
- In addition, L.4269/2014 on "Spatial and Urban Reform-Sustainable Growth" and L.4447/2016 on "Spatial Planning-Sustainable Growth" focus on the acceleration of planning and on the reduction of overlaps and contradictions between different spatial, regional and urban plans (IOBE, 2021).

Building Regulations

- The main regulation for building activities in Greece is the General Building Regulation included in L.4067/2012. The General Building Regulation refers to the terms and conditions for the development of construction projects within or outside urban settlements, and aims to protect the physical, natural and cultural environment (IOBE, 2021).
- The General Building Regulation is complemented by various other building regulations, including provisions on building classifications, the safety and resilience of structures, structural elements such as walls, openings and windows, and facilities such as plumbing, heating and lifts (IOBE, 2021).

Building Permits

- Building activities can be executed only after the issuance of a building permit. All processes and procedures for the issuance and control of building permits, as well as electronic procedures, are regulated by L.4495/2017 on "Control and Protection of the Built Environment".
- The issuance of a building permit focuses on several factors, such as a) the land type and size; b) the building form and size; c) the building's position with respect to the land, in relation to neighbouring properties and buildings; d) the land-to-building ratio, which determines the permitted building area; e) the coverage ratio, which refers to the maximum land area that can be used for construction; and f) the building height or the number of floors that are permitted on a land plot or a region.

Public construction works

- Public construction works are regulated by L.4412/2016 and L.4782/2021 on "Public Procurement of projects, provisions and services". These regulations foresee that construction companies are evaluated mainly based on their offers. To this regard, the most economically advantageous offer is preferred, though other various quality, environmental and social criteria are also weighed.

National energy, climate and waste construction strategies

The Greek energy, climate and waste strategies related to the construction sector have been adapted to the corresponding EU strategies.

National Energy and Climate Plan

- The National Energy and Climate Plan (NECP), introduced in 2019, focuses on energy efficiency improvements by 2030, mostly in buildings and transportation. It aims to achieve a 12%-15% energy efficiency improvement of the total number of buildings in the residential, public and services sectors.
- According to the NECP, the building sector's energy efficiency can be maximised via a) the renovation and modernisation of buildings, using, among others, energy-efficient and low-emission heating systems, improved insulation materials, and renewable energy sources to cover electricity, heating and cooling needs; and b) the use of digital technologies in the construction and management of buildings (IOBE, 2021, NECP, 2019).
- In addition, the NECP includes initiatives related to, on the one hand, spatial urban planning, which aims to promote the sustainable use of land, and to, on the other, the improvement of the public urban space micro-environment (NECP, 2019).

Buildings' Renovation Strategy

- In 2021, following the National Energy and Climate Plan, a new long-term building renovation strategy was introduced, replacing the previous respective strategies of 2014 and 2018. The new renovation strategy focuses on renovating residential and commercial buildings, private or public, and targets to achieve high energy efficiency of buildings by 2050 and zero GHG emissions.
- The strategy takes into account the age and number of buildings, the climatic zones of the buildings, as well as their energy consumption (EC, 2021). This will allow for the economically efficient transformation of the building stock to near-zero energy consumption buildings in the future, using renewable energy produced on site or close to the buildings.
- A plethora of buildings in Greece were constructed before 1980, when the regulation on thermal insulation was initially introduced. In particular, 56% of residences (2015: 4,631,528 buildings, 95% of total buildings) and 39% of service sector buildings, which consist mainly of hotels, restaurants, schools, hospitals, offices, warehouses and stores (2015: 221,643 buildings, 5% of total buildings), were built before 1980 (Buildings Renovation Strategy, 2021).
- In addition, public sector buildings of the Central Government, Decentralised Administration, Local Authorities and Legal Entities governed by Private or Public Law (estimated at 112,000 in 2011) are considered to be high energy consumption buildings.

Construction and demolition waste management

- Given that the economy will grow, construction and demolition waste will continue to increase in the following years. Construction and demolition waste management, as well as general waste management, are regulated by two laws: L.4042/2012, which is based on the EU's Waste Framework Directive (2008/98/EC), and L.4819/2021, which incorporated two other EU Directives on waste management.
- The above legislative framework includes regulations concerning the obligation to separate collection of various categories of construction and demolition waste, such as wood, bricks, tiles, stone, metals, glass and plastics, in order to facilitate their high-quality recycling and reuse.
- In addition, the National Waste Management Plan 2020-2030, introduced in 2020, includes specific targets for construction and demolition waste reduction. These targets include a) a 70% recovery of construction waste; b) full geographical coverage of the country with specialised recovery units for construction waste and the rationalisation of these units; c) separate collection of excavation waste and concrete residuals after the completion of construction projects; d) a requirement for an alternative management of construction waste in public and private construction projects; and e) the development of markets for secondary materials generated by processing construction and demolition waste.

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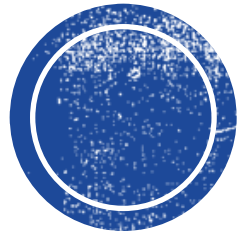
Policy recommendations and SWOT analysis



Policy recommendations and future direction of the construction industry

Sustainability, digitalisation and procedural transparency can drive a positive outlook for investment in the construction sector over the following years.

Propel sustainability by emphasising circular economy practices

- Sustainability addresses at least five dimensions related to a) the renovation and modernisation of the existing building stock, so as to render buildings more energy efficient and reduce their energy consumption; b) the adoption of stricter standards and regulations for new buildings; c) green cities infrastructure and spatial urban planning; d) investment in construction and demolition waste management, and recycling treatment units; and e) the use of eco-innovative construction practices and recyclable or recycled materials.
- Sustainability and resource efficiency are key requirements of the construction industry and necessary preconditions for its future growth. Sustainability must be propelled and supported by simplified and clear government regulations, the adoption of the appropriate ESG criteria for investment in the construction industry and the promotion of circular economy practices in all processes. Raising public awareness about the benefits of living in green cities and energy efficient buildings, and support funding for energy transformation (such as the "Saving at home" programme) and the use of renewable energy technologies, are also actions that can reinforce the construction sector's direction towards a more sustainable future (Renovate Europe, 2021, Korkos, 2021).

Open up to digitalisation by endorsing digital and technological skills

- Construction enters a new, digitalised era which will affect a broad range of its operations and require special digital and technological skills to support this transformation. According to the Education and Training Monitor, there is a lack of digital skills in Greece, which impacts job opportunities of Greek graduates (EC, 2020, 2021). The Greek authorities underscore the need to accelerate digital transition via NRRP funds allocated towards the digital transformation and, especially, to the public sector: 23% of the estimated funds will be devoted to digital objectives, and the development of digital literacy and digital skills training. In the same vein, the Draft Budget Plan 2022 recognises that the digital transition brings challenges "in terms of bridging the possible gaps in the diffusion of digital technologies and skills among industries, business sizes and workforce groups".

On the road to transparency and the transformation of public procurement

- Public procurement is the purchase of goods, services and works by governments and state-owned enterprises, and it accounts for 12% of GDP in OECD countries (OECD). In infrastructure construction projects, public procurement has often taken the form of Public Private Partnerships (PPPs).
- Public procurement transparency implies the availability of information concerning the procurement process from involved parties, i.e., the contractors, suppliers and service providers. Transparency in infrastructure public procurement allows for less corrupt, neutral and fair procedures, and encourages wide participation of stakeholders. It is a necessary precondition for fair competition, efficient risk allocation, effective outcomes, innovation and a value for money public budget (Global Infrastructure Hub-GIH, 2020).
- Although transparency in public procurement in Greece has improved since 2017, weaknesses remain (GIH, 2020). The country's performance in public procurement is characterised as "highly corrupted", suffering from "widespread and high-corruption risks", usually in the form of bribes, irregular payments and favouritism as common processes in the awarding of public contracts (GAN Greece Corruption Report, 2020, EC, 2021). However, corruption is reported as apparent in other public entities as well, such as land administration for building permits and property rights (GAN Greece Corruption Report, 2020).
- To tackle transparency issues, Law 4782/2021 on the "Modernisation, simplification and reform of the public procurement framework" introduced various reforms aimed at achieving the tendering and execution of public contracts more swiftly and effectively. In addition, the new action plan for the National Strategy on Public Procurement for the period 2021-2025 also emphasises initiatives regarding the digitalisation of public procurement processes, by expanding the use of e-procurement and the introduction of e-services, the reduction of bureaucratic obstacles and the simplification of the procedures, so at to enhance competition and open up the procurement market to SMEs (ICLG, 2022, KG Law Firm, 2021).

SWOT analysis of the construction sector

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Strengths

- Construction is an important sector, with valued added for the Greek economy
- A strong pillar of growth in the previous decades, supporting economic development
- Relatively resilient sector during the COVID-19 pandemic crisis
- Increasing demand as a driver for the residential property market and for tourism infrastructure investments
- Experienced firms, technical know-how and internationally competitive potential
- Skilled engineering workforce
- Good performance in infrastructure airport and liner shipping connectivity
- National strategy plans that set the context for the development of the sector

Weaknesses

- Numerous and complicated regulations and incomplete National Cadastre.
- Weak recovery of investment activity in dwellings and other buildings
- Investment gap in infrastructure compared to the EU average
- Struggle to attract quality infrastructure investment due to the need for further improvements in the country's creditworthiness.
- Weak performance related to road and railways infrastructure
- Low ranking in ''Dealing with building permits''
- Companies have liquidity constraints and face insufficient access to credit, with delays in payment
- Delays in the completion of investment projects due to bureaucracy
- Limited use of digitalisation and cost-efficient new technologies
- Negative average flow of mortgage loans

Opportunities

- Investing in sustainability requirements and circular economy business models to reduce generated waste and increase reuse and materials' recycling
- EU policies for reducing GHG emissions create opportunities for investment in green, energy-efficient buildings, green cities and eco-innovative solutions
- Deploy the "Renovation wave" related projects on upgrading the existing building stock
- Exploit available, cost-efficient, construction-related digital technologies
- Funding from EU Programs, such as NRRP and the NSRF 2021-2027
- Completion of key projects in infrastructure and urban development (such as the Hellinikon airport regeneration), many of which are in an initial planning phase
- Construction as a priority in the National Development Programme 2021-2025
- Public-Private Partnerships as another financing tool for construction projects

Threats

- Environmental risk, climate change, GHG emissions, pollution, natural disasters
- Shifting population age profile and lack of digital skills posing job risks
- High taxes (ENFIA) in real estate and high VAT in construction activities (24%)
- Barriers related to financing access for small enterprises
- Extension of the beginning and completion dates of many scheduled infrastructure projects, including tourist infrastructure
- Low transparency and reported corruption in public procurement procedures
- Increased risk of global economic recession due to geopolitical tensions
- Risk of stagnant inflation and high energy prices in the medium term

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