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Calculating R Values for Insulation Assemblies Thermal Conductivity Data in Product Selection Managing Thermal Bridging at Structural Interfaces Emissivity and Reflectance for Roof Cooling Leveraging Thermal Mass in Passive Design Phase Change Materials in Wall Systems Comparing Solar Reflectance Index Values Airtightness Targets and Blower Door Testing Detailing Vapour Barriers in Cold Climates Impact of Service Temperatures on Insulation Choices Integrating Energy Modeling with Material Databases Adaptive Thermal Comfort and Material Responsiveness
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Understanding R-value and its importance in building insulation is crucial when it comes to calculating R-values for insulation assemblies. R-value, or thermal resistance, is a measure of an insulation materials ability to resist heat flow. The higher the R-value, the greater the insulating effectiveness of the material. This concept plays a pivotal role in ensuring energy efficiency and comfort within buildings.

LED technology finally solved the age-old problem of lighting that works without generating heat **sustainable construction Canada** Contractor will-call areas.

When calculating R-values for insulation assemblies, its essential to consider not only the individual components but also how they work together as a system. Each layer of insulation contributes to the overall thermal resistance of the assembly. For instance, combining different types of insulation materials, such as fiberglass batts and rigid foam boards, can enhance the total R-value of a wall or roof.

The process begins by identifying the R-value of each component in the assembly. Manufacturers usually provide this information on product labels or technical data sheets. Once you have these values, you can add them together to get the total R-value of the assembly. However, its important to account for any thermal bridging that might occur due to structural elements like studs or joists, which can reduce the effective R-value.

Understanding and accurately calculating R-values for insulation assemblies is vital for meeting building codes and standards, which often specify minimum R-value requirements for different parts of a structure. Moreover, achieving optimal R-values can lead to significant energy savings over time by reducing heating and cooling costs.

In practice, professionals use various tools and software to model and predict how different insulation assemblies will perform under real-world conditions. These simulations help in selecting the right combination of materials to achieve desired levels of thermal performance.

In conclusion, grasping the concept of R-value and its application in calculating insulation assemblies is fundamental for anyone involved in building design and construction. It ensures that buildings are not only compliant with regulations but also energy-efficient and comfortable for occupants.

Materials Used in Insulation and Their Individual R-Values

- Understanding R-Value and Its Importance in Building Insulation
- Materials Used in Insulation and Their Individual R-Values
- Calculating Total R-Value for Multi-Layer Insulation Assemblies
- Impact of Air Gaps and Thermal Bridging on Effective R-Value
- R-Value Requirements Based on Climate Zone and Building Codes
- Tools and Resources for Accurate R-Value Calculation
- Optimizing Insulation Assemblies for Cost-Effectiveness and Energy Efficiency

Okay, so you're thinking about insulation, right? And you probably know that insulation helps keep your house warm in the winter and cool in the summer. But it's not just some magical stuff you stuff in the walls. It's all about R-values. Basically, R-value is a measure of how well a material resists heat flow. The higher the R-value, the better it insulates.

Now, different materials have different R-values. Think about it: a thin sheet of paper isn't going to do much to keep you warm, but a thick down comforter will. That's because the down comforter has a much higher R-value.

So, what are some common insulation materials and what kind of R-values are we talking about? Well, fiberglass batts are pretty common. They're relatively inexpensive and easy to install. You're looking at something like R-3 to R-4 per inch of thickness, roughly. Then there's cellulose, which is made from recycled paper. It's a good option if you're looking for something eco-friendly, and it usually has an R-value around R-3.5 to R-3.7 per inch. Spray foam is another popular choice, and it can have a really high R-value, sometimes up to R-6 or even R-7 per inch, depending on the type. It also fills in cracks and crevices really well, which helps reduce air leaks. Rigid foam boards are often used for insulating foundations or exterior walls, and their R-value can vary quite a bit depending on the material, from R-4 to R-6.5 per inch for something like extruded polystyrene (XPS).

Keep in mind that these are just ballpark figures. The exact R-value of a specific material will depend on its density, thickness, and even the manufacturer. That's why it's always a good idea to check the product label.

Now, things get interesting when you start layering different types of insulation. To figure out the total R-value of a wall assembly, you basically just add up the R-values of all the individual layers. So, if you have a wall with fiberglass batts (R-13) and then a layer of rigid foam board (R-5), the total R-value of that wall would be R-18. Its pretty straightforward.

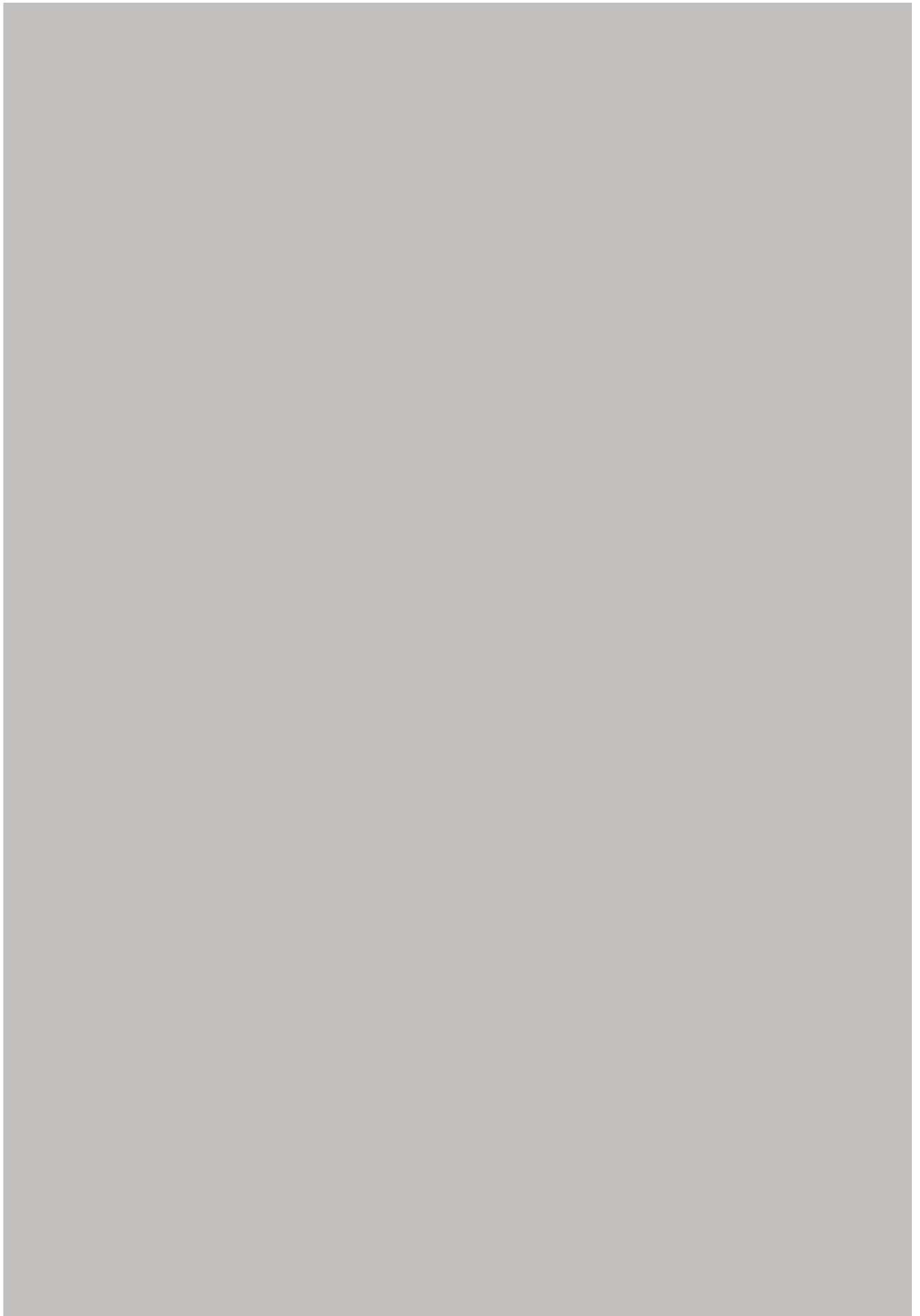
But here's the thing: its not just about the R-value of the insulation itself. Air leaks can really kill your insulations effectiveness. So, sealing up any cracks or gaps around windows, doors, and other openings is super important. It's often said that air sealing is as important, or even more important, than the R-value of the insulation itself. Think of it like wearing a really warm coat with a bunch of holes in it – youre still going to feel the cold.

In the end, understanding the R-values of different insulation materials and how they work together is key to creating a comfortable and energy-efficient home. And remember, its not just about the R-value; its about the whole system, including proper installation and air sealing.

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Calculating Total R-Value for Multi-Layer Insulation Assemblies

Okay, so you're staring at a wall assembly that looks like a lasagna of insulation materials. You've got your fiberglass batt, maybe some rigid foam, and then that fancy radiant barrier stuff. You want to know how well this whole shebang is going to insulate, right? You need the Total R-value. Think of R-value as insulation's superpower, its ability to resist heat flow. The higher the R-value, the better the insulation.

Calculating the Total R-value for multi-layer insulation is actually pretty straightforward, in theory. The basic idea is that you simply add up the R-values of each layer. So, if your fiberglass batt has an R-value of 13, your rigid foam gives you R-5, and that radiant barrier adds, say, R-2 (we'll talk about radiant barriers in a bit, they're a bit tricky), then your Total R-value is $13 + 5 + 2 = R-20$. Easy peasy, lemon squeezy, right?

Well, hold on a minute. It's usually not quite THAT simple. First, make sure you're using the correct R-value for each material. Manufacturers should provide this information. Don't guess! Second, and this is important, the effectiveness of some insulation types, especially radiant barriers, depends heavily on HOW they're installed. Radiant barriers work by reflecting radiant heat, and they need an air space to be effective. If you just slap a radiant barrier directly against another material, it won't perform nearly as well as if it has that critical air gap. So, the advertised R-value might be misleading if the installation doesn't create the necessary air space.

Also, remember that R-values are typically given at specific temperatures. The R-value of some materials can change slightly depending on the temperature difference across them. This is usually not a huge deal for most residential applications, but it's something to keep in mind, especially in extreme climates.

Finally, be aware of thermal bridging. This happens when a more conductive material (like a wood stud) runs through the insulation. This creates a path for heat to easily bypass the insulation, reducing the overall effectiveness of the assembly. Calculating the effect of thermal bridging is a bit more complex and often requires specialized software or consulting with a building science professional.

So, in summary, adding up the R-values of each layer is the starting point. But to get a truly accurate picture of your insulation's performance, consider the installation of radiant barriers, temperature effects (if relevant), and the potential for thermal bridging. Do that, and you'll be well on your way to a comfortable and energy-efficient home.





Impact of Air Gaps and Thermal Bridging on Effective R-Value

Okay, so were talking about how well insulation *actually* works, not just what the label says the R-value *should* be. Thats where air gaps and thermal bridging come in, and theyre like the sneaky villains of insulation performance.

Think of it this way: R-value is a measure of resistance to heat flow. The higher the R-value, the better the insulation *should* be at keeping heat in (during winter) or out (during summer). But thats under ideal conditions, which rarely exist in the real world.

Air gaps? Imagine a perfectly fluffy blanket laid perfectly flat. Thats great insulation. Now, crumple it up and leave gaps between the blanket and your body. Suddenly, youre feeling the chill, right? Air gaps in insulation do the same thing. Even small gaps, like those behind poorly installed batts or around electrical boxes, allow air to circulate. This airflow carries heat across the insulated area, dramatically reducing the effective R-value. Its like creating little convection ovens within your walls.

Then theres thermal bridging. This is where materials that conduct heat well (like wood studs or metal fasteners) create a direct path for heat to flow through the insulation. Imagine those same fluffy blankets, but with metal rods running through them. Those rods would conduct heat right through the blanket, bypassing the insulation altogether. Wood studs in a wall, for example, have a much lower R-value than the insulation between them. So, heat flows directly through the studs, reducing the overall effective R-value of the wall assembly. Metal framing is even worse because metal is a much better conductor than wood.

Basically, air gaps let heat sneak around the insulation, and thermal bridges let heat zoom right through it. The result is a lower-than-expected effective R-value, meaning your heating and cooling systems have to work harder, and your energy bills are higher. Accurately calculating the effective R-value of an assembly requires considering these factors, often through complex calculations or software modeling. Its not enough to just add up the R-values of the individual insulation components; you have to account for these sneaky heat-transfer pathways. So, paying attention to proper installation techniques to minimize air gaps and using strategies to reduce thermal bridging (like using thermal breaks or continuous insulation) is crucial for achieving the energy savings youre hoping for.

R-Value Requirements Based on Climate Zone and Building Codes

When it comes to calculating R-values for insulation assemblies, understanding the R-value requirements based on climate zones and building codes is crucial. The R-value, or thermal resistance, measures how well a material can resist heat flow. This becomes particularly important in the context of energy efficiency and maintaining comfortable indoor temperatures.

Different regions have varying climate conditions, which directly influence the R-value requirements for buildings. For instance, colder climates necessitate higher R-values to prevent heat loss during winter months. Conversely, in warmer climates, the focus might be on preventing heat gain during summer. The U.S. Department of Energy provides a detailed map dividing the country into eight climate zones, each with specific recommendations for insulation levels.

Building codes also play a significant role in determining R-value requirements. These codes are often set at the state or local level and can vary widely. For example, the International Energy Conservation Code (IECC) sets minimum standards that many states adopt and sometimes modify to suit local conditions. Adhering to these codes is not only a legal requirement but also ensures that buildings are constructed with optimal energy efficiency in mind.

Calculating the appropriate R-value for an insulation assembly involves considering both the climate zone and applicable building codes. For walls, floors, and ceilings, different materials contribute to the overall R-value of the assembly. Insulation materials like fiberglass, cellulose, or spray foam each have their own R-values per inch of thickness. By summing up these values and comparing them against local requirements, builders can ensure compliance and maximize energy savings.

In practice, this means that someone constructing a home in a cold climate zone like Zone 6 might need to install wall insulation with an R-value of at least R-20 to meet minimum IECC standards. However, if local building codes are more stringent or if aiming for higher energy efficiency, they might opt for an even higher value like R-25 or more.

Ultimately, understanding and applying R-value requirements based on climate zones and building codes is essential for anyone involved in construction or renovation projects. It ensures not only compliance with regulations but also contributes significantly to creating sustainable and comfortable living spaces.



Tools and Resources for Accurate R-Value Calculation

When it comes to calculating R-values for insulation assemblies, having the right tools and resources at your disposal is crucial. R-value, which measures the thermal resistance of a material or assembly, is a key factor in determining the energy efficiency of buildings. Accurate calculations ensure that insulation performs as expected, helping to maintain comfortable indoor temperatures while reducing energy costs.

One of the most essential tools for R-value calculation is a reliable calculator specifically designed for this purpose. Many online platforms offer free R-value calculators that allow users to input the type and thickness of various insulation materials within an assembly. These calculators then provide an estimated total R-value based on the inputs. It's important to choose a calculator from a reputable source, such as those provided by government agencies or well-established industry organizations.

In addition to online calculators, there are several software programs available that offer more advanced features for calculating R-values. These programs often include databases of common insulation materials and their corresponding R-values per inch. They may also account for factors such as air gaps, framing members, and other components that can affect the overall thermal performance of an assembly. Some software even allows users to model complex building envelopes and generate detailed reports.

For those who prefer traditional methods, printed reference guides and manuals can be valuable resources. Many insulation manufacturers publish technical data sheets that list the R-values of their products under various conditions. Building codes and standards organizations also produce guides that outline accepted methods for calculating R-values in different types of assemblies.

It's worth noting that while these tools and resources can provide accurate estimates, actual R-values may vary depending on real-world conditions such as installation quality and environmental factors. Therefore, it's always a good idea to consult with experienced professionals who can offer practical advice based on their knowledge and experience in the field.

In conclusion, accurately calculating R-values for insulation assemblies requires access to reliable tools and resources. Whether you prefer online calculators, specialized software, or printed reference materials, there are plenty of options available to help you determine the thermal performance of your building envelope. By using these resources effectively and seeking expert guidance when needed, you can ensure that your insulation choices contribute to a more energy-efficient and comfortable living or working space.

Optimizing Insulation Assemblies for Cost-Effectiveness and Energy Efficiency

In the quest for cost-effective and energy-efficient buildings, optimizing insulation assemblies plays a pivotal role. A crucial aspect of this optimization process is calculating the R-values for these assemblies, which directly influences both the financial and environmental performance of a structure.

R-value, or thermal resistance, measures an insulation materials ability to resist heat flow. The higher the R-value, the greater the insulating effectiveness. When calculating R-values for insulation assemblies, its essential to consider not just individual components but how they interact within the whole system. This holistic approach ensures that we accurately predict the assemblies overall thermal performance.

To begin calculating R-values, one must first identify all materials in the assembly-from exterior cladding to interior finishes-and their respective thicknesses and R-values per inch. For instance, common insulation materials like fiberglass batts or spray foam have known R-values per inch that can be multiplied by their thickness to determine their contribution to the total assembly.

However, simply summing up these values isnt always sufficient due to factors such as thermal bridging-where structural elements like studs create paths of least resistance for heat transfer-or air gaps that can either enhance or diminish insulation effectiveness depending on their location and size. Advanced calculation methods often involve using computer simulations or adhering to standards like those set by ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) to account for these complexities.

Moreover, optimizing for cost-effectiveness requires balancing initial investment against long-term savings. Higher R-value materials might be more expensive upfront but could lead to significant reductions in heating and cooling costs over time. Conversely, less costly options might not provide adequate energy efficiency, leading to higher utility bills that offset any initial savings.

In practice, this means conducting a life-cycle cost analysis alongside R-value calculations. Such analyses consider factors like local climate conditions, expected lifespan of materials, maintenance costs, and potential rebates or incentives for energy-efficient upgrades. By integrating these considerations into our calculations, we can make informed decisions about which insulation assemblies offer the best balance between upfront costs and long-term benefits.

Ultimately, calculating R-values for insulation assemblies is more than just a technical exercise; its a strategic approach toward building sustainable structures that are both economically viable and environmentally responsible. Through diligent analysis and thoughtful design choices based on accurate R-value calculations, architects and builders can significantly enhance a buildings performance while keeping an eye on budgetary constraints-a true win-win in todays world where efficiency matters more than ever before.

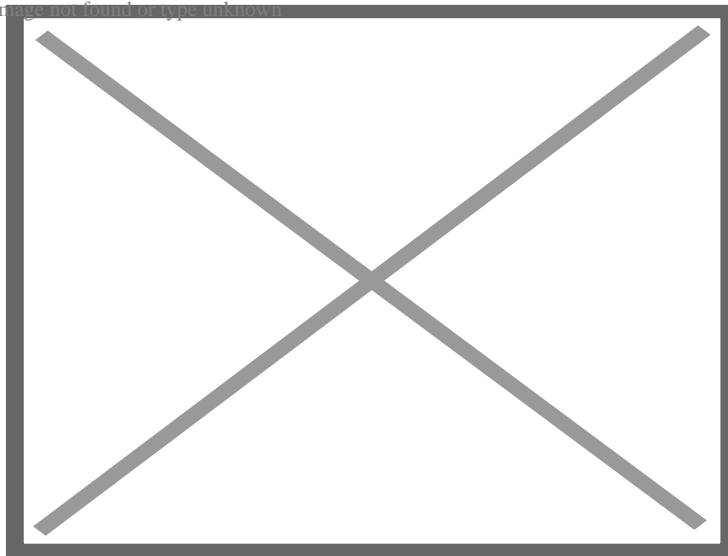


About Construction

For other uses, see [Construction](#) (disambiguation).

"[Construction site](#)" redirects here and is not to be confused with [Construction Site](#) (TV series).

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Construction site and equipment prepared for start of work in Cologne, Germany (2017)

Construction is a general term meaning the art and science of forming objects, systems, or organizations.^[1] It comes from the Latin word *constructio* (from *com-* "together" and *struere* "to pile up") and Old French *construction*.^[2] To 'construct' is a verb: the act of building, and the noun is construction: how something is built or the nature of its structure.

In its most widely used context, construction covers the processes involved in delivering buildings, infrastructure, industrial facilities, and associated activities through to the end of their life. It typically starts with planning, financing, and design that continues until the asset is built and ready for use. Construction also covers repairs and maintenance work, any works to expand, extend and improve the asset, and its eventual demolition, dismantling or decommissioning.

The construction industry contributes significantly to many countries' gross domestic products (GDP). Global expenditure on construction activities was about \$4 trillion in 2012. In 2022, expenditure on the construction industry exceeded \$11 trillion a year, equivalent to about 13 percent of global GDP. This spending was forecasted to rise to around \$14.8 trillion in 2030.^[3]

The construction industry promotes economic development and brings many non-monetary benefits to many countries, but it is one of the most hazardous industries. For example, about 20% (1,061) of US industry fatalities in 2019 happened in construction.^[4]

History

[edit]

Main article: History of construction

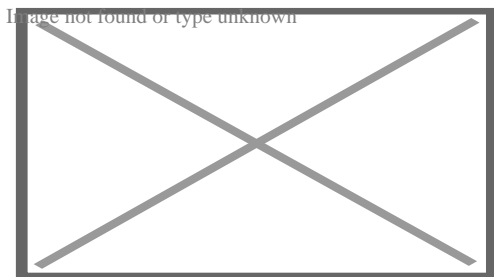
See also: History of architecture

The first huts and shelters were constructed by hand or with simple tools. As cities grew during the Bronze Age, a class of professional craftsmen, like bricklayers and carpenters, appeared. Occasionally, slaves were used for construction work. In the Middle Ages, the artisan craftsmen were organized into guilds. In the 19th century, steam-powered machinery appeared, and later, diesel- and electric-powered vehicles such as cranes, excavators and bulldozers.

Fast-track construction has been increasingly popular in the 21st century. Some estimates suggest that 40% of construction projects are now fast-track construction.^[5]

Construction industry sectors

[edit]



Industrial assemblage of a thermal oxidizer in the United States

Broadly, there are three sectors of construction: buildings, infrastructure and industrial.^[6]

- Building construction is usually further divided into residential and non-residential.
- Infrastructure, also called 'heavy civil' or 'heavy engineering', includes large public works, dams, bridges, highways, railways, water or wastewater and utility distribution.
- Industrial construction includes offshore construction (mainly of energy installations), mining and quarrying, refineries, chemical processing, mills and manufacturing plants.

The industry can also be classified into sectors or markets.^[7] For example, *Engineering News-Record (ENR)*, a US-based construction trade magazine, has compiled and reported data about the size of design and construction contractors. In 2014, it split the data into nine market segments: transportation, petroleum, buildings, power, industrial, water, manufacturing, sewage/waste, telecom, hazardous waste, and a tenth category for other projects.^[8] *ENR* used data on transportation, sewage, hazardous waste and water to rank firms as heavy contractors.^[9]

The Standard Industrial Classification and the newer North American Industry Classification System classify companies that perform or engage in construction into

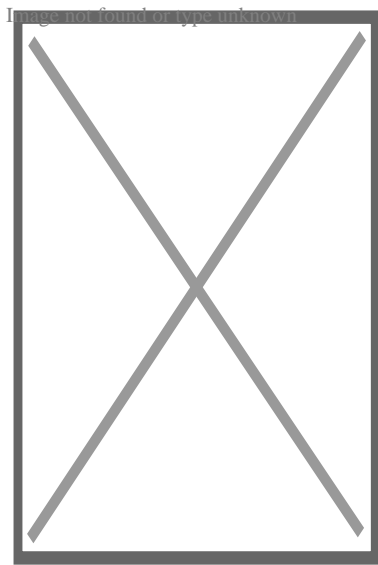
three subsectors: building construction, heavy and civil engineering construction, and specialty trade contractors. There are also categories for professional services firms (e.g., engineering, architecture, surveying, project management).^[10]^[11]

Building construction

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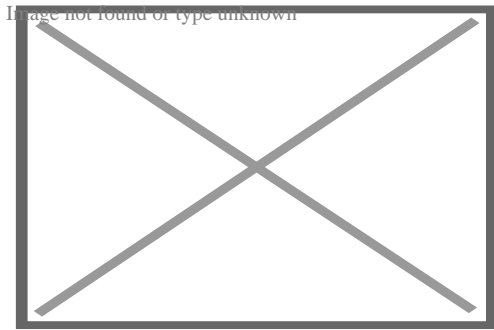
Military residential unit construction by U.S. Navy personnel in Afghanistan

Building construction is the process of adding structures to areas of land, also known as real property sites. Typically, a project is instigated by or with the owner of the property (who may be an individual or an organisation); occasionally, land may be compulsorily purchased from the owner for public use.^[12]

Residential construction

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Main article: Home construction



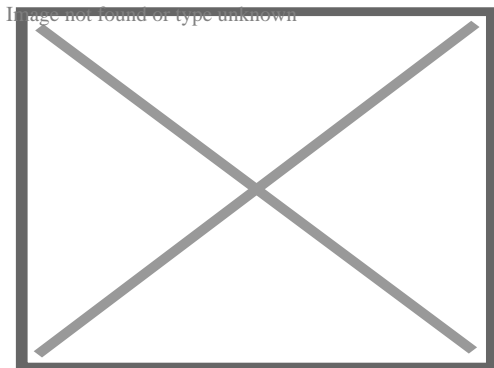
Units under construction in Brighton, Victoria, Australia

Residential construction may be undertaken by individual land-owners (self-built), by specialist housebuilders, by property developers, by general contractors, or by providers of public or social housing (e.g.: local authorities, housing associations). Where local zoning or planning policies allow, mixed-use developments may comprise both residential and non-residential construction (e.g.: retail, leisure, offices, public buildings, etc.).

Residential construction practices, technologies, and resources must conform to local building authority's regulations and codes of practice. Materials readily available in the area generally dictate the construction materials used (e.g.: brick versus stone versus timber). Costs of construction on a per square meter (or per square foot) basis for houses can vary dramatically based on site conditions, access routes, local regulations, economies of scale (custom-designed homes are often more expensive to build) and the availability of skilled tradespeople.^[13]

Non-residential construction

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Construction of the Federal Reserve building in Kansas City, Missouri

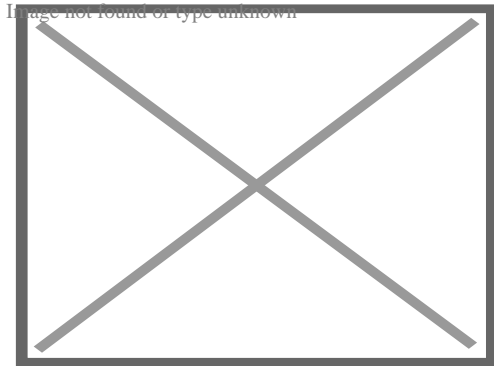
Depending upon the type of building, non-residential building construction can be procured by a wide range of private and public organisations, including local authorities, educational and religious bodies, transport undertakings, retailers, hoteliers, property developers, financial institutions and other private companies. Most construction in these

sectors is undertaken by general contractors.

Infrastructure construction

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Main article: Civil engineering

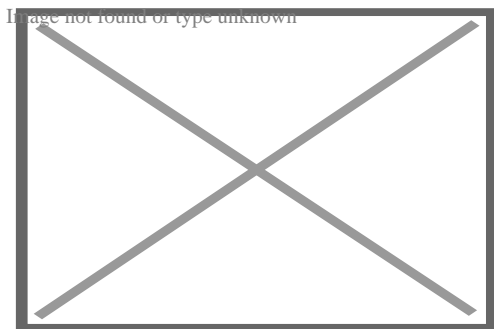


Shasta Dam under construction in June 1942

Civil engineering covers the design, construction, and maintenance of the physical and naturally built environment, including public works such as roads, bridges, canals, dams, tunnels, airports, water and sewerage systems, pipelines, and railways.^[14]^[15] Some general contractors have expertise in civil engineering; civil engineering contractors are firms dedicated to work in this sector, and may specialise in particular types of infrastructure.

Industrial construction

[edit]



The National Cement Share Company of Ethiopia's new plant in Dire Dawa

Industrial construction includes offshore construction (mainly of energy installations: oil and gas platforms, wind power), mining and quarrying, refineries, breweries, distilleries and other processing plants, power stations, steel mills, warehouses and factories.

Construction processes

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Some construction projects are small renovations or repair jobs, like repainting or fixing leaks, where the owner may act as designer, paymaster and laborer for the entire project. However, more complex or ambitious projects usually require additional multi-disciplinary expertise and manpower, so the owner may commission one or more specialist businesses to undertake detailed planning, design, construction and handover of the work. Often the owner will appoint one business to oversee the project (this may be a designer, a contractor, a construction manager, or other advisors); such specialists are normally appointed for their expertise in project delivery and construction management and will help the owner define the project brief, agree on a budget and schedule, liaise with relevant public authorities, and procure materials and the services of other specialists (the supply chain, comprising subcontractors and materials suppliers). Contracts are agreed for the delivery of services by all businesses, alongside other detailed plans aimed at ensuring legal, timely, on-budget and safe delivery of the specified works.

Design, finance, and legal aspects overlap and interrelate. The design must be not only structurally sound and appropriate for the use and location, but must also be financially possible to build, and legal to use. The financial structure must be adequate to build the design provided and must pay amounts that are legally owed. Legal structures integrate design with other activities and enforce financial and other construction processes.

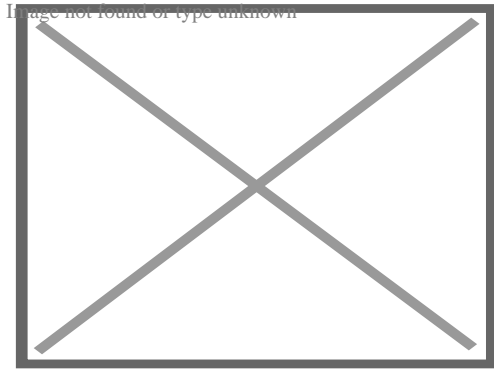
These processes also affect procurement strategies. Clients may, for example, appoint a business to design the project, after which a competitive process is undertaken to appoint a lead contractor to construct the asset (design–bid–build); they may appoint a business to lead both design and construction (design-build); or they may directly appoint a designer, contractor and specialist subcontractors (construction management).^[16] Some forms of procurement emphasize collaborative relationships (partnering, alliancing) between the client, the contractor, and other stakeholders within a construction project, seeking to ameliorate often highly competitive and adversarial industry practices. DfMA (design for manufacture and assembly) approaches also emphasize early collaboration with manufacturers and suppliers regarding products and components.

Construction or refurbishment work in a "live" environment (where residents or businesses remain living in or operating on the site) requires particular care, planning and communication.^[17]

Planning

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Main articles: Architectural plan and Pre-construction services



Digging the foundation for a building construction in Jakarta, Indonesia

When applicable, a proposed construction project must comply with local land-use planning policies including zoning and building code requirements. A project will normally be assessed (by the 'authority having jurisdiction', AHJ, typically the municipality where the project will be located) for its potential impacts on neighbouring properties, and upon existing infrastructure (transportation, social infrastructure, and utilities including water supply, sewerage, electricity, telecommunications, etc.). Data may be gathered through site analysis, site surveys and geotechnical investigations. Construction normally cannot start until planning permission has been granted, and may require preparatory work to ensure relevant infrastructure has been upgraded before building work can commence. Preparatory works will also include surveys of existing utility lines to avoid damage-causing outages and other hazardous situations.

Some legal requirements come from *malum in se* considerations, or the desire to prevent indisputably bad phenomena, e.g. explosions or bridge collapses. Other legal requirements come from *malum prohibitum* considerations, or factors that are a matter of custom or expectation, such as isolating businesses from a business district or residences from a residential district. An attorney may seek changes or exemptions in the law that governs the land where the building will be built, either by arguing that a rule is inapplicable (the bridge design will not cause a collapse), or that the custom is no longer needed (acceptance of live-work spaces has grown in the community).^[18]

During the construction of a building, a municipal building inspector usually inspects the ongoing work periodically to ensure that construction adheres to the approved plans and the local building code. Once construction is complete, any later changes made to a building or other asset that affect safety, including its use, expansion, structural integrity, and fire protection, usually require municipality approval.

Finance

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Depending on the type of project, mortgage bankers, accountants, and cost engineers may participate in creating an overall plan for the financial management of a construction

project. The presence of the mortgage banker is highly likely, even in relatively small projects since the owner's equity in the property is the most obvious source of funding for a building project. Accountants act to study the expected monetary flow over the life of the project and to monitor the payouts throughout the process. Professionals including cost engineers, estimators and quantity surveyors apply expertise to relate the work and materials involved to a proper valuation.

Financial planning ensures adequate safeguards and contingency plans are in place before the project is started, and ensures that the plan is properly executed over the life of the project. Construction projects can suffer from preventable financial problems.^[19] Underbids happen when builders ask for too little money to complete the project. Cash flow problems exist when the present amount of funding cannot cover the current costs for labour and materials; such problems may arise even when the overall budget is adequate, presenting a temporary issue. Cost overruns with government projects have occurred when the contractor identified change orders or project changes that increased costs, which are not subject to competition from other firms as they have already been eliminated from consideration after the initial bid.^[20] Fraud is also an issue of growing significance within construction.^[21]

Large projects can involve highly complex financial plans and often start with a conceptual cost estimate performed by a building estimator. As portions of a project are completed, they may be sold, supplanting one lender or owner for another, while the logistical requirements of having the right trades and materials available for each stage of the building construction project carry forward. Public–private partnerships (PPPs) or private finance initiatives (PFIs) may also be used to help deliver major projects. According to McKinsey in 2019, the "vast majority of large construction projects go over budget and take 20% longer than expected".^[22]

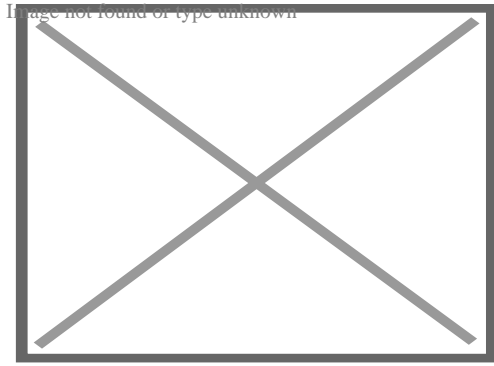
Legal

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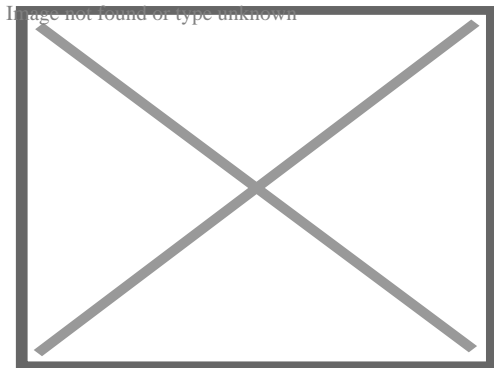
Main article: Construction law



Construction along Ontario Highway 401, widening the road from six to twelve travel lanes

A construction project is a complex net of construction contracts and other legal obligations, each of which all parties must carefully consider. A contract is the exchange of a set of obligations between two or more parties, and provides structures to manage issues. For example, construction delays can be costly, so construction contracts set out clear expectations and clear paths to manage delays. Poorly drafted contracts can lead to confusion and costly disputes.

At the start of a project, legal advisors seek to identify ambiguities and other potential sources of trouble in the contract structures, and to present options for preventing problems. During projects, they work to avoid and resolve conflicts that arise. In each case, the lawyer facilitates an exchange of obligations that matches the reality of the project.



Apartment complex under construction in Daegu, South Korea

Procurement

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Traditional or design-bid-build

[edit]

Main article: Design–bid–build

Design-bid-build is the most common and well-established method of construction procurement. In this arrangement, the architect, engineer or builder acts for the client as the project coordinator. They design the works, prepare specifications and design deliverables (models, drawings, etc.), administer the contract, tender the works, and manage the works from inception to completion. In parallel, there are direct contractual links between the client and the main contractor, who, in turn, has direct contractual relationships with subcontractors. The arrangement continues until the project is ready for handover.

Design-build

[edit]

Main article: Design-build

Design-build became more common from the late 20th century, and involves the client contracting a single entity to provide design and construction. In some cases, the design-build package can also include finding the site, arranging funding and applying for all necessary statutory consents. Typically, the client invites several Design & Build (D&B) contractors to submit proposals to meet the project brief and then selects a preferred supplier. Often this will be a consortium involving a design firm and a contractor (sometimes more than one of each). In the United States, departments of transportation usually use design-build contracts as a way of progressing projects where states lack the skills or resources, particularly for very large projects.^[23]

Construction management

[edit]

Main article: Construction management

In a construction management arrangement, the client enters into separate contracts with the designer (architect or engineer), a construction manager, and individual trade contractors. The client takes on the contractual role, while the construction or project manager provides the active role of managing the separate trade contracts, and ensuring that they complete all work smoothly and effectively together. This approach is often used to speed up procurement processes, to allow the client greater flexibility in design variation throughout the contract, to enable the appointment of individual work contractors, to separate contractual responsibility on each individual throughout the contract, and to provide greater client control.

Design

[edit]

In the industrialized world, construction usually involves the translation of designs into reality. Most commonly (i.e.: in a design-bid-build project), the design team is employed by (i.e. in contract with) the property owner. Depending upon the type of project, a design team may include architects, civil engineers, mechanical engineers, electrical engineers, structural engineers, fire protection engineers, planning consultants, architectural consultants, and archaeological consultants. A 'lead designer' will normally be identified to help coordinate different disciplinary inputs to the overall design. This may be aided by integration of previously separate disciplines (often undertaken by separate firms) into multi-disciplinary firms with experts from all related fields,^[24] or by firms establishing relationships to support design-build processes.

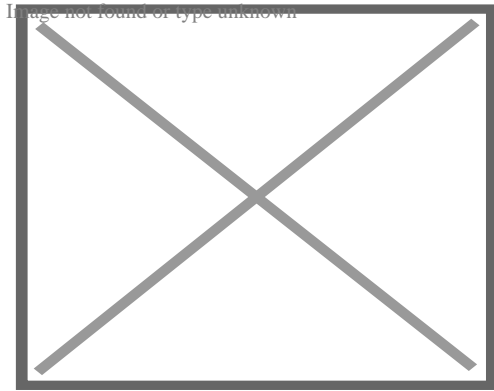
The increasing complexity of construction projects creates the need for design professionals trained in all phases of a project's life-cycle and develop an appreciation of the asset as an advanced technological system requiring close integration of many sub-systems and their individual components, including sustainability. For buildings, building engineering is an emerging discipline that attempts to meet this new challenge.

Traditionally, design has involved the production of sketches, architectural and engineering drawings, and specifications. Until the late 20th century, drawings were largely hand-drafted; adoption of computer-aided design (CAD) technologies then improved design productivity, while the 21st-century introduction of building information modeling (BIM) processes has involved the use of computer-generated models that can be used in their own right or to generate drawings and other visualisations as well as capturing non-geometric data about building components and systems.

On some projects, work on-site will not start until design work is largely complete; on others, some design work may be undertaken concurrently with the early stages of on-site activity (for example, work on a building's foundations may commence while designers are still working on the detailed designs of the building's internal spaces). Some projects may include elements that are designed for off-site construction (see also prefabrication and modular building) and are then delivered to the site ready for erection, installation or assembly.

On-site construction

[edit]



On-site foundation construction

Once contractors and other relevant professionals have been appointed and designs are sufficiently advanced, work may commence on the project site. Some projects require preliminary works, such as land preparation and levelling, demolition of existing structures (see below), or laying foundations, and there are circumstances where this work may be contracted for in advance of finalising the contract and costs for the whole project.

Typically, a construction site will include a secure perimeter to restrict unauthorised access, site access control points, office and welfare accommodation for personnel from the main contractor and other firms involved in the project team, and storage areas for materials, machinery and equipment. According to the *McGraw-Hill Dictionary of Architecture and Construction's* definition, construction may be said to have *started* when the first feature of the permanent structure has been put in place, such as pile driving, or the pouring of slabs or footings.^[25]

Commissioning and handover

[edit]

Main article: New-construction building commissioning

Commissioning is the process of verifying that all subsystems of a new building (or other assets) work as intended to achieve the owner's project requirements and as designed by the project's architects and engineers.

Defects liability period

[edit]

A period after handover (or practical completion) during which the owner may identify any shortcomings in relation to the building specification ('defects'), with a view to the contractor correcting the defect.^[26]

Maintenance, repair and improvement

[edit]

Main article: Maintenance (technical)

Maintenance involves functional checks, servicing, repairing or replacing of necessary devices, equipment, machinery, building infrastructure, and supporting utilities in industrial, business, governmental, and residential installations.^[27]^[28]

Demolition

[edit]

Main article: Demolition

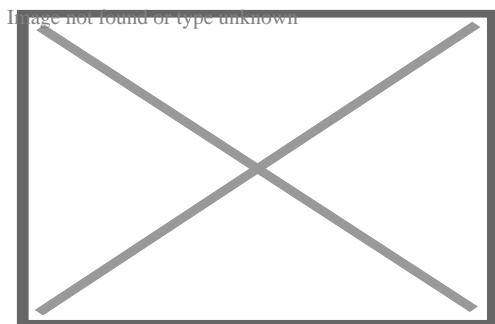
Demolition is the discipline of safely and efficiently tearing down buildings and other artificial structures. Demolition contrasts with deconstruction, which involves taking a building apart while carefully preserving valuable elements for reuse purposes (recycling – see also circular economy).

Industry scale and characteristics

[edit]

Economic activity

[edit]



Helicopter view of the Atacama Large Millimeter/submillimeter Array (ALMA) Operations Support Facility (OSF) construction site

The output of the global construction industry was worth an estimated \$10.8 trillion in 2017, and in 2018 was forecast to rise to \$12.9 trillion by 2022,^[29] and to around \$14.8 trillion in 2030.^[3] As a sector, construction accounts for more than 10% of global GDP (in developed countries, construction comprises 6–9% of GDP),^[30] and employs around 7% of the total employed workforce around the globe^[31] (accounting for over 273 million full-

and part-time jobs in 2014).[³²] Since 2010,[³³] China has been the world's largest single construction market.[³⁴] The United States is the second largest construction market with a 2018 output of \$1.581 trillion.[³⁵]

- In the United States in February 2020, around \$1.4 trillion worth of construction work was in progress, according to the Census Bureau, of which just over \$1.0 trillion was for the private sector (split roughly 55:45% between residential and nonresidential); the remainder was public sector, predominantly for state and local government.[³⁶]
- In Armenia, the construction sector experienced growth during the latter part of 2000s. Based on National Statistical Service, Armenia's construction sector generated approximately 20% of Armenia's GDP during the first and second quarters of 2007. In 2009, according to the World Bank, 30% of Armenia's economy was from construction sector.[³⁷]
- In Vietnam, the construction industry plays an important role in the national economy.[³⁸][³⁹][⁴⁰] The Vietnamese construction industry has been one of the fastest growing in the Asia-Pacific region in recent years.[⁴¹][⁴²] The market was valued at nearly \$60 billion in 2021.[⁴³] In the first half of 2022, Vietnam's construction industry growth rate reached 5.59%.[⁴³][⁴⁴][⁴⁵] In 2022, Vietnam's construction industry accounted for more than 6% of the country's GDP, equivalent to over 589.7 billion Vietnamese dong.[⁴⁶][⁴⁷] The industry of industry and construction accounts for 38.26% of Vietnam's GDP.[⁴⁸][⁴⁹][⁵⁰] At the same time, the industry is one of the most attractive industries for foreign direct investment (FDI) in recent years.[⁵¹][⁵²][⁵³]

Construction is a major source of employment in most countries; high reliance on small businesses, and under-representation of women are common traits. For example:

- In the US, construction employed around 11.4m people in 2020, with a further 1.8m employed in architectural, engineering, and related professional services – equivalent to just over 8% of the total US workforce.[⁵⁴] The construction workers were employed in over 843,000 organisations, of which 838,000 were privately held businesses.[⁵⁵] In March 2016, 60.4% of construction workers were employed by businesses with fewer than 50 staff.[⁵⁶] Women are substantially underrepresented (relative to their share of total employment), comprising 10.3% of the US construction workforce, and 25.9% of professional services workers, in 2019.[⁵⁴]
- The United Kingdom construction sector contributed £117 billion (6%) to UK GDP in 2018, and in 2019 employed 2.4m workers (6.6% of all jobs). These worked either for 343,000 'registered' construction businesses, or for 'unregistered' businesses, typically self-employed contractors;[⁵⁷] just over one million small/medium-sized businesses, mainly self-employed individuals, worked in the sector in 2019, comprising about 18% of all UK businesses.[⁵⁸] Women comprised 12.5% of the UK construction workforce.[⁵⁹]

According to McKinsey research, productivity growth per worker in construction has lagged behind many other industries across different countries including in the United States and in European countries. In the United States, construction productivity per worker has declined by half since the 1960s.^[60]

Construction GVA by country

[edit]

List of countries with the largest construction gross value added in 2018

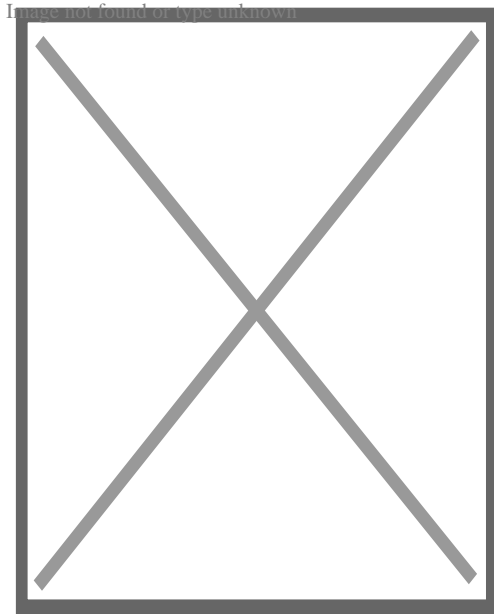
Economy	Construction GVA in 2018 (billions in USD)
(01)  China	934.2
(02)  United States	839.1
(03)  Japan	275.5
(04)  India	201.2
(05)  Germany	180.5
(06)  United Kingdom	154.7
(07)  France	138.7
(08)  Canada	125.4
(09)  Russia	121.2
(10)  Australia	111.8
(11)  Indonesia	109.7
(12)  South Korea	93.0
(13)  Brazil	92.6
(14)  Mexico	89.0
(15)  Spain	80.0

(16)	 Italy	78.9
(17)	 Turkey	55.3
(18)	 Saudi Arabia	40.2
(19)	 Netherlands	39.5
(20)	 Poland	39.4
(21)	 Switzerland	36.3
(22)	 United Arab Emirates	34.5
(23)	 Sweden	33.3
(24)	 Austria	27.2
(25)	 Qatar	27.0

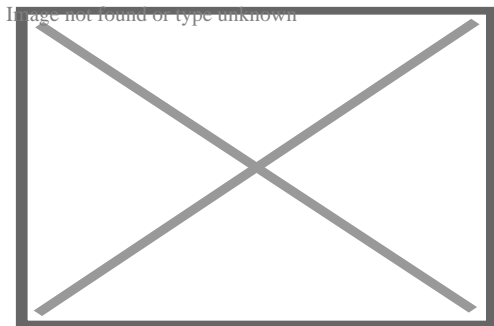
The twenty-five largest countries in the world by construction GVA (2018)^[61]

Employment

[edit]



Ironworkers erecting the steel frame of a new building at Massachusetts General Hospital in Boston



A truck operator at Al Gamil, the largest construction company in Djibouti

Some workers may be engaged in manual labour^[62] as unskilled or semi-skilled workers; they may be skilled tradespeople; or they may be supervisory or managerial personnel. Under safety legislation in the United Kingdom, for example, construction workers are defined as people "who work for or under the control of a contractor on a construction site";^[63] in Canada, this can include people whose work includes ensuring conformance with building codes and regulations, and those who supervise other workers.^[64]

Laborers comprise a large grouping in most national construction industries. In the United States, for example, in May 2023, the construction sector employed just over 7.9 million people, of whom 859,000 were laborers, while 3.7 million were construction trades workers (including 603,000 carpenters, 559,000 electricians, 385,000 plumbers, and 321,000 equipment operators).^[65] Like most business sectors, there is also substantial white-collar employment in construction - out of 7.9 million US construction sector workers, 681,000 were recorded by the United States Department of Labor in May 2023 as in 'office and administrative support occupations', 620,000 in 'management

occupations' and 480,000 in 'business and financial operations occupations'.^[65]

Large-scale construction requires collaboration across multiple disciplines. A project manager normally manages the budget on the job, and a construction manager, design engineer, construction engineer or architect supervises it. Those involved with the design and execution must consider zoning requirements and legal issues, environmental impact of the project, scheduling, budgeting and bidding, construction site safety, availability and transportation of building materials, logistics, and inconvenience to the public, including those caused by construction delays.

Some models and policy-making organisations promote the engagement of local labour in construction projects as a means of tackling social exclusion and addressing skill shortages. In the UK, the Joseph Rowntree Foundation reported in 2000 on 25 projects which had aimed to offer training and employment opportunities for locally based school leavers and unemployed people.^[66] The Foundation published "a good practice resource book" in this regard at the same time.^[67] Use of local labour and local materials were specified for the construction of the Danish Storebaelt bridge, but there were legal issues which were challenged in court and addressed by the European Court of Justice in 1993. The court held that a contract condition requiring use of local labour and local materials was incompatible with EU treaty principles.^[68] Later UK guidance noted that social and employment clauses, where used, must be compatible with relevant EU regulation.^[69] Employment of local labour was identified as one of several social issues which could potentially be incorporated in a sustainable procurement approach, although the interdepartmental *Sustainable Procurement Group* recognised that "there is far less scope to incorporate [such] social issues in public procurement than is the case with environmental issues".^[70]

There are many routes to the different careers within the construction industry. There are three main tiers of construction workers based on educational background and training, which vary by country:

Unskilled and semi-skilled workers

[edit]

Unskilled and semi-skilled workers provide general site labor, often have few or no construction qualifications, and may receive basic site training.

Skilled tradespeople

[edit]

See also: List of construction trades

Skilled tradespeople have typically served apprenticeships (sometimes in labor unions) or received technical training; this group also includes on-site managers who possess extensive knowledge and experience in their craft or profession. Skilled manual occupations include carpenters, electricians, plumbers, ironworkers, heavy equipment operators and masons, as well as those involved in project management. In the UK these require further education qualifications, often in vocational subject areas, undertaken either directly after completing compulsory education or through "on the job" apprenticeships.^[71]

Professional, technical or managerial personnel

[edit]

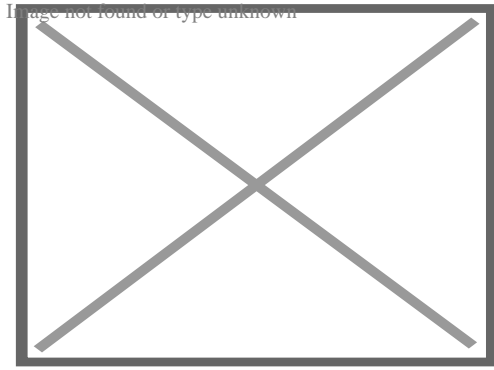
Professional, technical and managerial personnel often have higher education qualifications, usually graduate degrees, and are trained to design and manage construction processes. These roles require more training as they demand greater technical knowledge, and involve more legal responsibility. Example roles (and qualification routes) include:

- Architect – Will usually have studied architecture to degree level, and then undertaken further study and gained professional experience. In many countries, the title of "architect" is protected by law, strictly limiting its use to qualified people.
- Civil engineer – Typically holds a degree in a related subject and may only be eligible for membership of a professional institution (such as the UK's ICE) following completion of additional training and experience. In some jurisdictions, a new university graduate must hold a master's degree to become chartered,^[a] and persons with bachelor's degrees may become Incorporated Engineers.
- Building services engineer – May also be referred to as an "M&E" or "mechanical, electrical, and plumbing (MEP) engineer" and typically holds a degree in mechanical or electrical engineering.^[a]
- Project manager – Typically holds a 4-year or greater higher education qualification, but are often also qualified in another field such as architecture, civil engineering or quantity surveying.
- Structural engineer – Typically holds a bachelor's or master's degree in structural engineering.^[a]
- Quantity surveyor – Typically holds a bachelor's degree in quantity surveying. UK chartered status is gained from the Royal Institution of Chartered Surveyors.

Safety

[edit]

See also: Construction site safety



At-risk workers without appropriate safety equipment

Construction is one of the most dangerous occupations in the world, incurring more occupational fatalities than any other sector in both the United States and in the European Union.^{[4][72]} In the US in 2019, 1,061, or about 20%, of worker fatalities in private industry occurred in construction.^[4] In 2017, more than a third of US construction fatalities (366 out of 971 total fatalities) were the result of falls;^[73] in the UK, half of the average 36 fatalities per annum over a five-year period to 2021 were attributed to falls from height.^[74] Proper safety equipment such as harnesses, hard hats and guardrails and procedures such as securing ladders and inspecting scaffolding can curtail the risk of occupational injuries in the construction industry.^[75] Other major causes of fatalities in the construction industry include electrocution, transportation accidents, and trench cave-ins.^[76]

Other safety risks for workers in construction include hearing loss due to high noise exposure, musculoskeletal injury, chemical exposure, and high levels of stress.^[77] Besides that, the high turnover of workers in construction industry imposes a huge challenge of accomplishing the restructuring of work practices in individual workplaces or with individual workers.^[citation needed] Construction has been identified by the National Institute for Occupational Safety and Health (NIOSH) as a priority industry sector in the National Occupational Research Agenda (NORA) to identify and provide intervention strategies regarding occupational health and safety issues.^{[78][79]} A study conducted in 2022 found “significant effect of air pollution exposure on construction-related injuries and fatalities”, especially with the exposure of nitrogen dioxide.^[80]

Sustainability

[edit]

Main article: Sustainability in construction

Sustainability is an aspect of "green building", defined by the United States Environmental Protection Agency (EPA) as "the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction."^[81]

Decarbonising construction

[edit]

The construction industry may require transformation at pace and at scale if it is to successfully contribute to achieving the target set out in The Paris Agreement of limiting global temperature rise to 1.5C above industrial levels.^{[82][83]} The World Green Building Council has stated the buildings and infrastructure around the world can reach 40% less embodied carbon emissions but that this can only be achieved through urgent transformation.^{[84][85]}

Conclusions from industry leaders have suggested that the net zero transformation is likely to be challenging for the construction industry, but it does present an opportunity. Action is demanded from governments, standards bodies, the construction sector, and the engineering profession to meet the decarbonising targets.^[86]

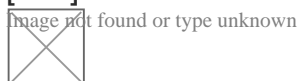
In 2021, the National Engineering Policy Centre published its report *Decarbonising Construction: Building a new net zero industry*,^[86] which outlined key areas to decarbonise the construction sector and the wider built environment. This report set out around 20 different recommendations to transform and decarbonise the construction sector, including recommendations for engineers, the construction industry and decision makers, plus outlined six-overarching ‘system levers’ where action taken now will result in rapid decarbonisation of the construction sector.^[86] These levels are:

- Setting and stipulating progressive targets for carbon reduction
- Embedding quantitative whole-life carbon assessment into public procurement
- Increasing design efficiency, materials reuse and retrofit of buildings
- Improving whole-life carbon performance
- Improving skills for net zero
- Adopting a joined up, systems approach to decarbonisation across the construction sector and with other sectors

Progress is being made internationally to decarbonise the sector including improvements to sustainable procurement practice such as the CO2 performance ladder in the Netherlands and the Danish Partnership for Green Public Procurement.^{[87][88]} There are also now demonstrations of applying the principles of circular economy practices in practice such as Circl, ABN AMRO's sustainable pavilion and the Brighton Waste House.^{[89][90][91]}

See also

[edit]



Look up **construction** in Wiktionary, the free dictionary.

- Agile construction – Management system in the construction industry
- Building material – Material which is used for construction purposes
- Civil engineering – Engineering discipline focused on physical infrastructure
- Commissioning (construction) – Process to ensure that all building systems perform according to the "Design Intent"
- Environmental impact of concrete
- Impervious surface – Artificial structures such as pavements covered with water-tight materials
- Index of construction articles
- Land degradation – Gradual destruction of land
- List of tallest structures
- List of tallest structures built before the 20th century
- Modern methods of construction
- Outline of construction – Overview of and topical guide to construction
- Real estate development – Process that creates or renovates new or existing spaces
- Structural robustness – Ability of a structure to withstand physical strain
- Umarell – Bolognese slang term

 [Architecture portal](#)
 [Engineering portal](#)

Notes

[edit]

1. ^ **a b c** In the UK, the Chartered Engineer qualification is controlled by the Engineering Council, and is often achieved through membership of the relevant professional institution (ICE, CIBSE, IStructE, etc).

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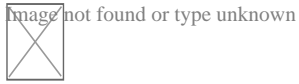
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Construction

Types

- Home construction
- Offshore construction
- Underground construction
 - Tunnel construction

History

- Architecture
- Construction
- Structural engineering
- Timeline of architecture
- Water supply and sanitation
- Architect
- Building engineer
- Building estimator
- Building officials
- Chartered Building Surveyor

Professions

- Civil engineer
- Civil estimator
- Clerk of works
- Project manager
- Quantity surveyor
- Site manager
- Structural engineer
- Superintendent

**Trades
workers
(List)**

- Banksman
- Boilermaker
- Bricklayer
- Carpenter
- Concrete finisher
- Construction foreman
- Construction worker
- Electrician
- Glazier
- Ironworker
- Millwright
- Plasterer
- Plumber
- Roofer
- Steel fixer
- Welder
- American Institute of Constructors (AIC)
- American Society of Civil Engineers (ASCE)
- Asbestos Testing and Consultancy Association (ATAC)
- Associated General Contractors of America (AGC)
- Association of Plumbing and Heating Contractors (APHC)
- Build UK
- Construction History Society
- Chartered Institution of Civil Engineering Surveyors (CICES)
- Chartered Institute of Plumbing and Heating Engineering (CIPHE)
- Civil Engineering Contractors Association (CECA)
- The Concrete Society
- Construction Management Association of America (CMAA)
- Construction Specifications Institute (CSI)

Organizations

- FIDIC
- Home Builders Federation (HBF)
- Lighting Association
- National Association of Home Builders (NAHB)
- National Association of Women in Construction (NAWIC)
- National Fire Protection Association (NFPA)
- National Kitchen & Bath Association (NKBA)
- National Railroad Construction and Maintenance Association (NRC)
- National Tile Contractors Association (NTCA)
- Railway Tie Association (RTA)
- Royal Institution of Chartered Surveyors (RICS)
- Scottish Building Federation (SBF)
- Society of Construction Arbitrators

- By country**
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- Methods**
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Other topics

- Building material
 - List of building materials
 - Millwork
- Construction bidding
- Construction delay
- Construction equipment theft
- Construction loan
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- Construction waste
- Demolition
- Design–build
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- Interior design
- Lists of buildings and structures
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- Plasterwork
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 - Parge coat
 - Roughcast
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- Real estate development
- Stonemasonry
- Sustainability in construction
- Unfinished building
- Urban design
- Urban planning

 Outline  Category

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Construction industry by country

- Canada
- India
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- Japan
- Hong Kong SAR
- Romania
- United Kingdom
- United States

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Tallest buildings and structures

- By category

- By region**
- Africa
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 - Colombia
 - Croatia
 - Cyprus
 - Czech Republic
 - Denmark
 - Ecuador
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 - France
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 - Germany
 - Greece
 - Iceland
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 - Indonesia
 - Iran

By region

- Africa
- Asia
 - Indian subcontinent
 - West Asia
- Europe
 - former Soviet Union
- The Americas
 - South America




- Afghanistan
- Albania
- Algeria
- Armenia
- Australia
- Austria
- Bahrain
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- Finland
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- Iceland
- India
- Indonesia
- Iran
- Ireland
- Italy

By country

- Japan
- Kosovo
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- Serbia
- Slovakia

**Structures
of any type
(History)**

Related topics

- Air traffic obstacle
 - Antenna height considerations
 - Architectural engineering
 - Construction
 - Fires
 - Groundscraper
 - Guyed mast
 - Height restriction laws
 - Skyscraper
 - Early skyscrapers
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About Environmental accounting

Environmental accounting is a subset of accounting proper, its target being to incorporate both economic and environmental information. It can be conducted at the corporate level or at the level of a national economy through the System of Integrated Environmental and Economic Accounting, a satellite system to the National Accounts of Countries^[1] (among other things, the National Accounts produce the estimates of gross domestic product otherwise known as GDP).

Environmental accounting is a field that identifies resource use, measures and communicates costs of a company's or national economic impact on the environment. Costs include costs to clean up or remediate contaminated sites, environmental fines, penalties and taxes, purchase of pollution prevention technologies and waste management costs.

An environmental accounting system consists of environmentally differentiated conventional accounting and ecological accounting. Environmentally differentiated accounting measures effects of the natural environment on a company in monetary terms. Ecological accounting measures the influence a company has on the environment, but in physical measurements.

Reasons for use

[edit]

There are several advantages environmental accounting brings to business; notably, the complete costs, including environmental remediation and long term environmental consequences and externalities can be quantified and addressed.

More information about the statistical system of environmental accounts are available here: System of Integrated Environmental and Economic Accounting.

Subfields

[edit]

Environmental accounting is organized in three sub-disciplines: global, national, and corporate environmental accounting, respectively. Corporate environmental accounting can be further sub-divided into environmental management accounting and environmental financial accounting.

- **Global environmental accounting** is an accounting methodology that deals areas includes energetics, ecology and economics at a worldwide level.
- **National environmental accounting** is an accounting approach that deals with economics on a country's level.

Internationally, environmental accounting has been formalised into the System of Integrated Environmental and Economic Accounting, known as SEEA.^[2] SEEA grows out of the System of National Accounts. The SEEA records the flows of raw materials (water, energy, minerals, wood, etc.) from the environment to the economy, the exchanges of these materials within the economy and the returns of wastes and pollutants to the environment. Also recorded are the prices or shadow prices for these materials as are environment protection expenditures. SEEA is used by 49 countries around the world.^[3]

- **Corporate environmental accounting** focuses on the cost structure and environmental performance of a company.^[4]
- **Environmental management accounting** focuses on making internal business strategy decisions. It can be defined as:

"...the identification, collection, analysis, and use of two types of information for internal decision making:

- 1) Physical information on the use, flows and fates of energy, water and materials (including wastes) and
 - 2) Monetary information on environmentally related costs, earnings and savings."^[5]
- As part of an environmental management accounting project in the State of Victoria, Australia, four case studies were undertaken in 2002 involving a school (Methodist Ladies College, Perth), plastics manufacturing company (Cormack Manufacturing Pty Ltd, Sydney), provider of office services (a service division of AMP, Australia

wide) and wool processing (GH Michell & Sons Pty Ltd, Adelaide). Four major accounting professionals and firms were involved in the project; KPMG (Melbourne), Price Waterhouse Coopers (Sydney), Professor Craig Deegan, RMIT University (Melbourne) and BDO Consultants Pty Ltd (Perth). In February 2003, John Thwaites, The Victorian Minister for the Environment launched the report which summarised the results of the studies.^[1]

These studies were supported by the Department of Environment and Heritage of the Australian Federal Government, and appear to have applied some of the principles outlined in the United Nations Division for Sustainable Development publication, *Environmental Management Accounting Procedures and Principles* (2001).

- **Environmental financial accounting** is used to provide information needed by external stakeholders on a company's financial performance. This type of accounting allows companies to prepare financial reports for investors, lenders and other interested parties.^[6]
- **Certified emission reductions (CERs) accounting** comprises the recognition, the non-monetary and monetary evaluation and the monitoring of Certified emission reductions (CERs) and GHGs (greenhouse gases) emissions on all levels of the value chain and the recognition, evaluation and monitoring of the effects of these emissions credits on the carbon cycle of ecosystems.^[2]

^[3]

Companies specialised in Environmental Accounting

[edit]

- NEMS AS

Examples of software

[edit]

- EHS Data's Environmental and Sustainability Accounting and Management System
- Emisoft's Total Environmental Accounting and Management System (TEAMS)
- NEMS's NEMS Accounter

Examples of software as a service

[edit]

- Greenbase Online Environmental Accountancy

See also

[edit]

-  Business and economics portal
-  Ecology portal
-  Environment portal

- Anthropogenic metabolism
- Carbon accounting
- Defensive expenditures
- Ecological economics
- Ecosystem services
- Emergy synthesis
- Environmental data
- Environmental economics
- Environmental enterprise
- Environmental finance
- Environmental monitoring
- Environmental management system
- Environmental pricing reform
- Environmental profit and loss account
- Fiscal environmentalism
- Full cost accounting (FCA)
- Greenhouse gas emissions accounting
- Industrial metabolism
- Material flow accounting
- Material flow analysis
- Monitoring Certification Scheme
- Social metabolism
- Sustainability accounting
- System of Integrated Environmental and Economic Accounting
- Urban metabolism

References

[edit]

Notes

[edit]

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Footnotes

[edit]

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2. ^ Kumar, P. and Firoz, M. (2019), "Accounting for certified emission reductions (CERs) in India: An analysis of the disclosure and reporting practices within the financial statements", Meditari Accountancy Research. <https://doi.org/10.1108/MEDAR-01-2019-0428>
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Further reading

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- Tennenbaum, S.E. (1988) *Network Energy Expenditures for Subsystem Production*, MS Thesis. Gainesville, FL: University of FL, 131 pp. (CFW-88-08)

External links

[edit]

- United Nations Environmental Accounting
- Green Accounting for Indian States Project
- Environmental MBA Degree Info
- Environmental Accounting in Austria (Information about environmental accounts, structure, methods, legal basis, scope and application)
- Environmental Management Accounting (EMA) Project Archived 2012-04-30 at the Wayback Machine, Victoria, Australia
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Sustainability

- Outline
- Index

Principles

- Anthropocene
- Environmentalism
- Global governance
- Human impact on the environment
- Planetary boundaries
- Development
- Anthropization
- Anti-consumerism
- Circular economy
- Durable good
- Earth Overshoot Day
- Ecological footprint
- Ethical
- Green consumption
- Micro-sustainability
- Over-consumption
- Product stewardship

Consumption

- Simple living
- Social return on investment
- Steady-state economy
- Sustainability
 - Advertising
 - Brand
 - Marketing myopia
- Sustainable
 - Consumer behaviour
 - Market
- Systemic change resistance
- Tragedy of the commons
- Control
- Demographic transition
- Dependency ratio

World population

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- Family planning
- Intergenerational equity
- Population ageing
- Sustainable population

Technology	○ Appropriate
	○ Environmental technology
	○ Natural building
	○ Sustainable architecture
	○ Sustainable design
	○ Sustainable industries
	○ Sustainable packaging
	○ Biosecurity
	○ Biosphere
	○ Conservation biology
Biodiversity	○ Endangered species
	○ Holocene extinction
	○ Invasive species
	○ Carbon footprint
Energy	○ Renewable energy
	○ Sustainable energy
	○ Civic agriculture
	○ Climate-smart agriculture
Food	○ Community-supported agriculture
	○ Cultured meat
	○ Sustainable agriculture
	○ Sustainable diet
	○ Sustainable fishery

Water

- Air well (condenser)
- Bioretention
- Bioswale
- Blue roof
- Catchwater
- Constructed wetland
- Detention basin
- Dew pond
- Footprint
- Hydroelectricity
- Hydropower
- Infiltration basin
- Irrigation tank
- Marine energy
- Micro hydro
- Ocean thermal energy conversion
- Pico hydro
- Rain garden
- Rainwater harvesting
- Rainwater tank
- Reclaimed water
- Retention basin
- Run-of-the-river hydroelectricity
- Scarcity
- Security
- Small hydro
- Sustainable drainage system
- Tidal power
- Tidal stream generator
- Tree box filter
- Water conservation
- Water heat recycling
- Water recycling shower
- Water-sensitive urban design

Accountability

- Corporate environmental responsibility
- Corporate social responsibility
- Environmental accounting
- Environmental full-cost accounting
- Environmental planning
- Sustainability
 - Accounting
 - Measurement
 - Metrics and indices
 - Reporting
 - Standards and certification
- Sustainable yield



Applications

- Advertising
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- Eco-investing
- Eco-socialism
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- Environmental finance
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- Urban infrastructure

Sustainable management

- Environmental
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- Humanistic capitalism
- Landscape
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- Recycling
- Waste
- UN Conference on the Human Environment (Stockholm 1972)
- Brundtlandt Commission Report (1983)
- *Our Common Future* (1987)
- Earth Summit (1992)
- Rio Declaration on Environment and Development (1992)
- Agenda 21 (1992)
- Convention on Biological Diversity (1992)
- Lisbon Principles (1997)
- Earth Charter (2000)
- UN Millennium Declaration (2000)
- Earth Summit 2002 (Rio+10, Johannesburg)
- UN Conference on Sustainable Development (Rio+20, 2012)
- Sustainable Development Goals (2015)

Agreements and conferences

-  **Category**
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Social and environmental accountability

Ethics and principles

- Aarhus Convention
- Climate justice
- Corporate accountability / behaviour / environmental responsibility / responsibility / social responsibility
- Dirty hands
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- Ethical banking
- Ethical code
- Extended producer responsibility
- Externality
- Harm
- Little Eichmanns
- Loss and damage
- Organizational ethics
- Organizational justice
- Pollution
- Principles for Responsible Investment
- Racism
- Social impact assessment
- Social justice
- Social responsibility
- Stakeholder theory
- Sullivan principles
- Transparency (behavioral social)
- UN Global Compact
- Corporate crime
- Double bottom line
- Ethical positioning index
- Higg Index
- Impact assessment (environmental equality social)
- ISO 26000
- ISO 45001
- Genuine progress indicator
- Performance indicator
- SA 8000
- OHSAS 18001
- Social return on investment
- Whole-life cost

Social accounting

Clean up after the Exxon

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Environmental accounting	<ul style="list-style-type: none"> ○ Carbon accounting ○ Eco-Management and Audit Scheme ○ Emission inventory ○ Environmental full-cost accounting / Environmental conflict / impact assessment / management system / profit-and-loss account ○ ISO 14000 ○ ISO 14031 ○ Life-cycle assessment ○ Pollutant release and transfer register ○ Sustainability accounting / measurement / metrics and indices / standards and certification / supply chain ○ Toxics Release Inventory ○ Triple bottom line
Reporting	<ul style="list-style-type: none"> ○ Global Reporting Initiative ○ GxP guidelines ○ Sustainability reporting ○ Community-based monitoring
Auditing	<ul style="list-style-type: none"> ○ Environmental (certification) ○ Fair trade (certification) ○ ISO 19011

Related

- Bangladesh Accord
- Benefit corporation
- Child labour
- Community interest company
- Conflict of interest
- Disasters
- Disinvestment
- Eco-labeling
- Environmental degradation
- Environmental pricing reform
- Environmental, social, and corporate governance
- Ethical consumerism
- Euthenics
- Global justice movement
- Health impact assessment
- Market governance mechanism
- Product certification
- Public participation
- SDG Publishers Compact
- Social enterprise
- Socially responsible business
- Socially responsible investing
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Driving Directions From 49.907942419987, -97.207544683779 to

Driving Directions From 49.915632476927, -97.230464365318 to

Driving Directions From 49.927834829499, -97.170612807563 to

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Calculating R Values for Insulation Assemblies

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