Cement and Concrete Industry: Multiplier Effect on the Economy and their Contribution to a Low Carbon Economy

A study by Le BIPE for The Concrete Initiative

November 17th, 2015

Cement and Concrete Industry: Multiplier Effect on the Economy and Contribution to a Low Carbon Economy

An industry which contributes to local growth and jobs in a low carbon economy

A Strong Contribution to the European Economy

- In 2012, the Cement and Concrete Industry directly generated €20bn in value added and 384 thousand jobs across the EU28. For the CEMBUREAU region, the direct value added is €22bn and the number of direct jobs is 413 thousand.
- Through its purchases and the spending of its direct and indirect employees, the industry generates a total value added of €56bn in the EU28 and generates over 1.08 million jobs. In the CEMBUREAU region, the total value added is €60bn with 1.15 million jobs created.
- This corresponds to a multiplier effect of 2.8. This means that, in the EU28, for each €1 of value added generated in the Cement and Concrete Industry, €2.8 are generated in the overall economy. A similar effect has also been recorded for the CEMBUREAU region.
- The concrete and cement industry is a strong contributor to the local economy. Increased exports of cement products that are produced in the EU 28/CEMBUREAU region and exported outside this area have maintained production capacity in Europe. Exports are taken into account in the calculation of the multiplier effect since they contribute to the local economy and jobs.
- Although already significant, this multiplier effect only takes into account contributions in the upstream value chain. Hence, the value added at the construction stage of concrete – the work of contractors, builders, concrete workers, carpenters, joiners, finishers, etc. is not quantitatively taken into account. This downstream contribution is illustrated in this study through the low carbon applications offered by concrete.

An essential material in the low carbon economy

- The cement industry has made efforts to reduce its carbon footprint at the production stage: specific emissions related to the cement production process have been reduced by 13% between 1990 and 2013.
- Cement and concrete contribute to the circular economy, notably through the use of recycled materials and waste as a fuels in their production processes
- Thanks to the properties of concrete, the industry contributes to a low carbon economy in Europe through a variety of applications:
  - Sustainable Agriculture
  - Infrastructure
  - Energy and Energy efficiency
  - Sustainable Construction
- Concrete is 100% recyclable thus ensuring an optimal use of raw materials

CEMBUREAU countries: EU28 countries minus {Malta, Cyprus, Slovakia} plus {Turkey, Norway, Switzerland}

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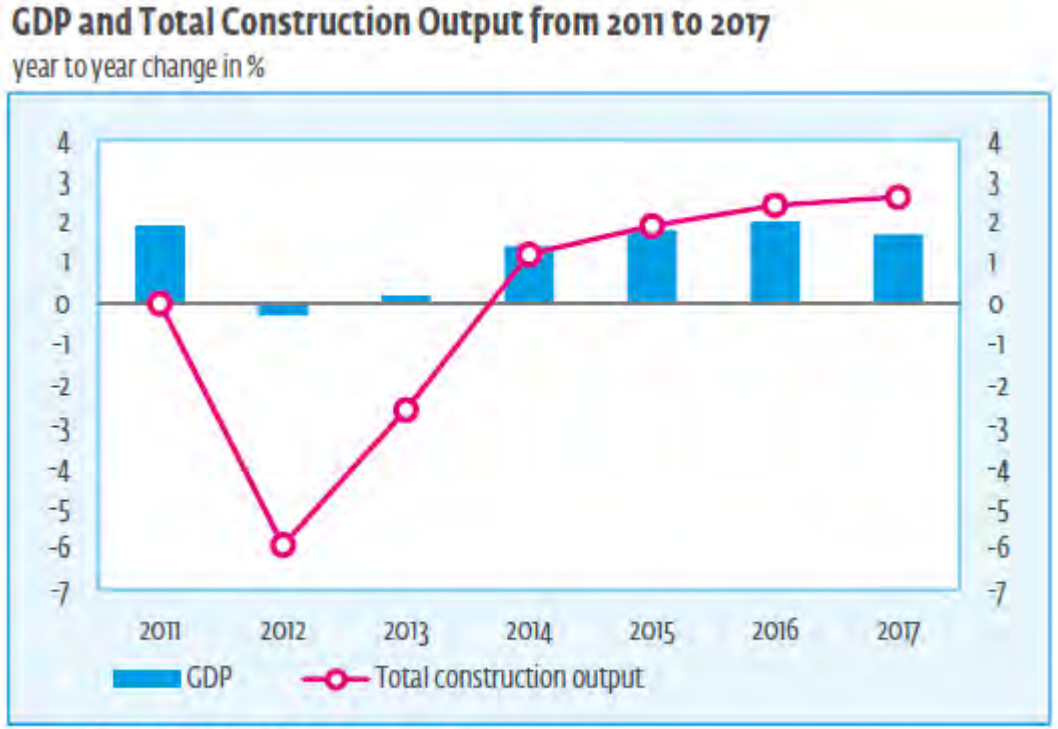
After having suffered from a severe crisis, the construction industry is slowly recovering and growth will follow

- The construction industry has suffered very harshly from the 2012 “double-dip” of recession, after a first severe recession in the aftermath of the 2008 crisis
- With slow economic recovery and the dynamism of Eastern European countries, the construction industry is still recovering and should resume solid growth only by 2017
- These forecasts were presented by the Euroconstruct network in June 2015



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General Approach: using the whole life cycle of concrete to calculate the multiplier effect

$$\text{Multiplier Effect} = \frac{\text{Direct + Indirect + Induced Impacts}}{\text{Direct impact}}$$

1 Raw materials sourcing → 2 Production process → 3 Applications → 4 End of life

Indirect impact
Added value and jobs created at the level of companies providing materials and services to the cement and concrete industry

Direct impact
Added value and jobs created by the production of concrete and cement

Induced impact
Value added generated by all the expenditure of the employees of all actors implicated

Catalytic effect
Externalities of the concrete and cement industry, their contribution to the low carbon economy through their applications and life cycle performance

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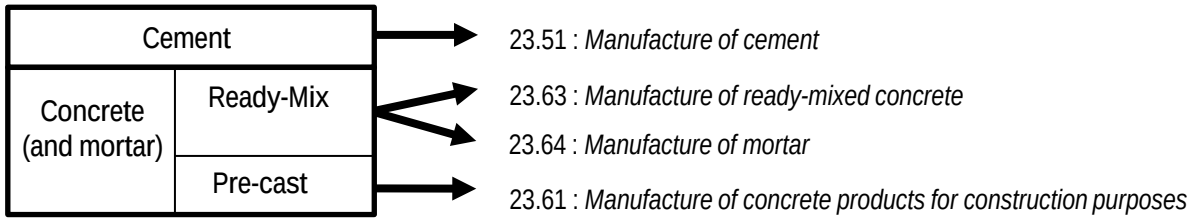
All data used are publicly available

- In order to study the impact of the cement and concrete industry, we chose to focus on four sub-divisions of the Eurostat NACE 2 classification corresponding to the manufacture of the following products:
  - Cement
  - Ready-mixed concrete
  - Mortar
  - Concrete products for construction purposes (e.g. precast concrete)
- The value added and jobs generated by the manufacture of the above products constitute the direct impact of the industry
- Other concrete ingredients, such as aggregates, are taken into account through the purchases of the above products → they are calculated in the indirect impact

Data used

- Eurostat provides detailed data and, in particular, the value added for each sub-sector of the NACE classification.
- Complementary data on productivity per sector have been used in order to convert salaries into jobs and then into full-time equivalents through Eurostat data

Division 23 : *Manufacture of other non-metallic mineral products*



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The concrete and cement industry generates a multiplier effect of 2.8 for the economy of the EU28

Value added

Direct impact	Direct and Indirect impact	Direct, Indirect and Induced impact
20 bn€	45 bn€	56 bn€

Jobs

Direct impact	Direct and Indirect impact	Direct, Indirect and Induced impact
384 Thousand	848 Thousand	1.08 Million

x 2.8

Multiplier effect of the concrete and cement industry in the EU28. For each euro of value added generated in the concrete industry, 2.8 euros of value added are generated in the economy as a whole of the EU28 countries.

These figures correspond to 2012, maximum estimate, with input-output ratios calculated as an average over the 2008-2011 period (latest data available).

The concrete and cement industry generates a multiplier effect of 2.8 on the economy of the CEMBUREAU region

Value added

Direct impact	Direct and Indirect impact	Direct, Indirect and Induced impact
22 bn€	48 bn€	60 bn€

Jobs

Direct impact	Direct and Indirect impact	Direct, Indirect and Induced impact
413 Thousand	901 Thousand	1.15 Million

x 2.8

Multiplier effect of the concrete and cement industry in the CEMBUREAU region.
For each euro of value added generated in the concrete industry, 2.8 euros of value added are generated in the economy as a whole of the CEMBUREAU region.

These figures correspond to the 2012, maximum estimate, with input-output ratios calculated as an average over 2008-2011 period (latest data available).

Detailed figures of the multiplier effect on the EU28 and CEMBUREAU

EU28

	Value added generated (€bn, 2012)	Full-time equivalent jobs generated (thousands, 2012)
Direct (1)	19.9	384
Indirect (2)	24.6	464
Induced (3)	11.2	240
Total (1+2+3)	55.8	1088
Multiplier effect (=Total / Direct)	2.8	

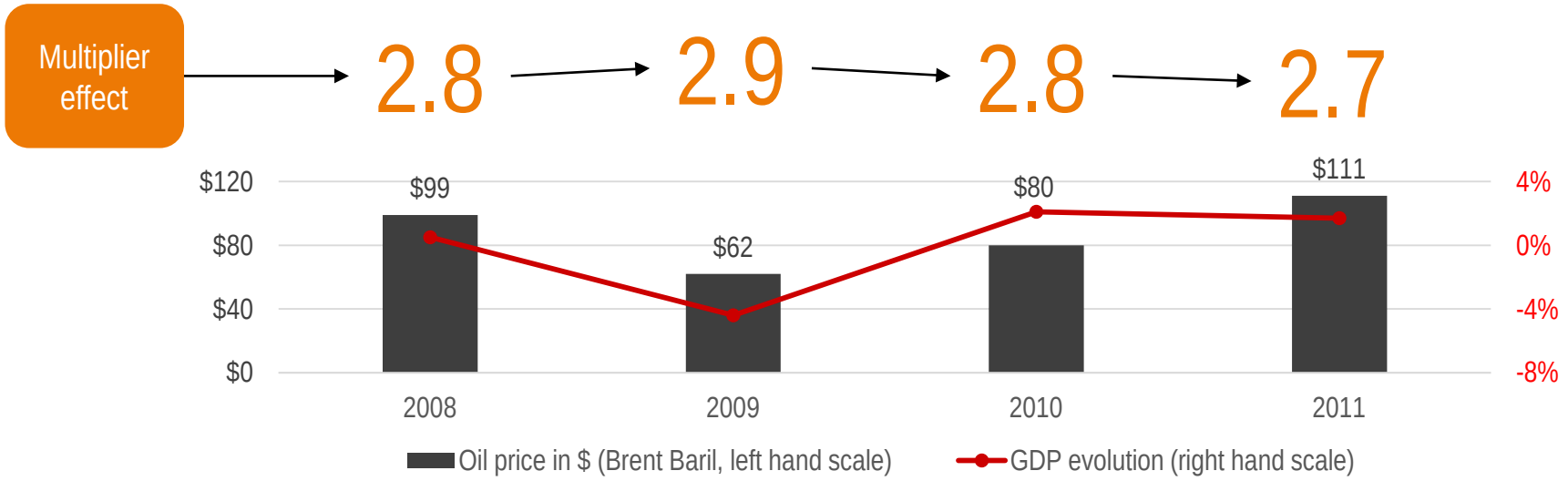
CEMBUREAU

CEMBUREAU region = EU28 minus {Malta, Cyprus, Slovakia} plus {Turkey, Norway, Switzerland}

	Value added generated (€bn, 2012)	Full-time equivalent jobs generated (thousands, 2012)
Direct (1)	21.5	413
Indirect (2)	25.8	488
Induced (3)	11.9	255
Total (1+2+3)	59.4	1156
Multiplier effect (=Total / Direct)	2.8	

The multiplier effect is a structural characteristic of the industry and is independent from the macroeconomic context

Stability of the multiplier effect in various macroeconomic contexts



- The multiplier effect is a structural parameter and remains stable over the four years for which the calculation has been carried out
- The variation of economic parameters, as well as the level of the industry's activity, which has varied strongly between 2008 and 2011, only marginally affects the multiplier effect of the industry

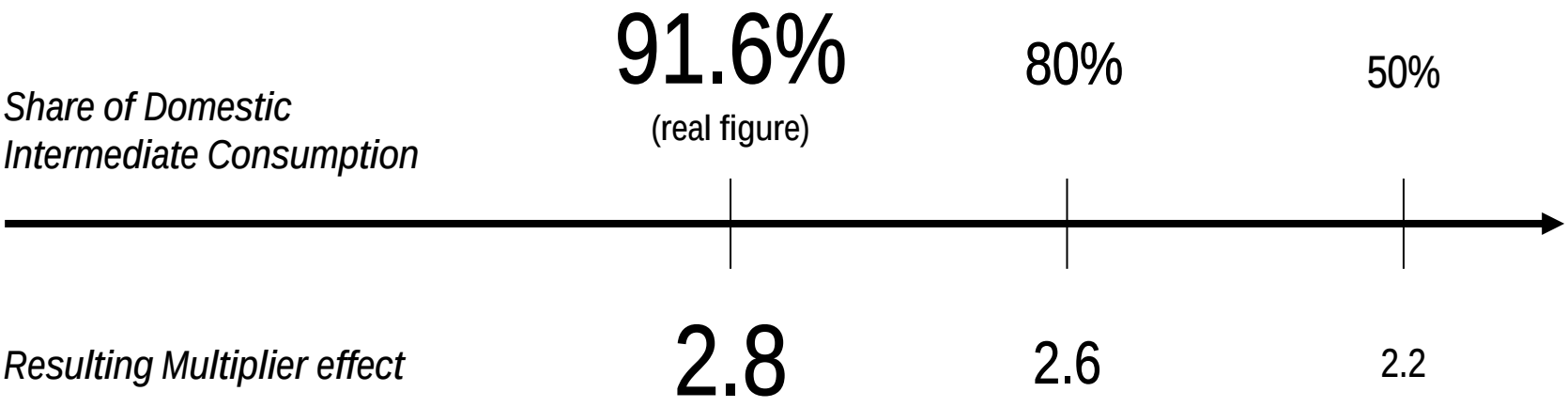
Source: BIPE from Eurostat

Assessment of the impact of the level of “domestic” intermediate consumption of the cement-concrete industry on the multiplier effect (EU28)

At the EU28 scale, the cement and concrete sector is characterized by a high level of domestic intermediate consumption: 91.6% on average between 2008 and 2011.

This level of local consumption has been maintained along with important investments in the EU area since 1990, especially in the optimization of production processes and lowering of the carbon footprint. In order to maintain this level, it is essential that the full supply chain remains in Europe.

The figures below illustrate what the level of the multiplier effect of the cement and concrete industry would be if the share of domestic consumption was lower:



Cement and concrete products that are produced in the EU28/CEMBUREAU region and exported outside this area are taken into account in the calculation of the multiplier effect since they contribute to the local economy and jobs.

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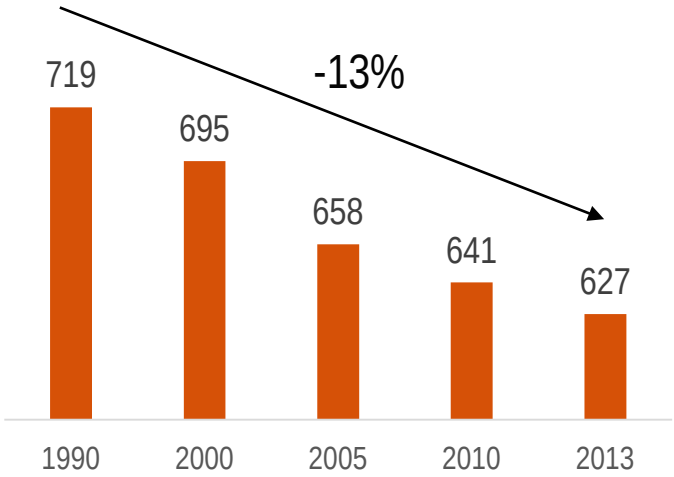
Reduction of CO_2 emissions in the cement manufacturing process

Production of cement

Production of concrete

- The main raw material, limestone, is transformed into clinker in a kiln which heats up the raw materials to 1450° C. Clinker is then ground with gypsum and other materials to produce cement
- 60% of CO2 emissions are released directly from the processing of limestone. Most of the remaining 40% originate from burning fuel in the kiln
- In Europe, alternative fuels represent 36% of the fuel mix of the cement industry, which aims to achieve 60% of alternative fuel use by 2050, of which 40% biomass.
- The cement industry also recycles the mineral content of waste as a raw material in its process, thus saving 6Mt of primary raw materials annually
- In addition to reducing the environmental impact of the clinker production process through the two levers noted above, the clinker content of cement can be reduced significantly by using other main constituents such as limestone, blastfurnace slag, coal fly-ash, and natural pozzolanic materials, based on regional availability.
- With a value of 627 kg CO2 per ton of cementitious, the level of emissions associated with the cement production process is significantly lower than in other regions of the world with large production, such as the United States (737)

Evolution of CO_2 emissions per ton of cement produced in EU28 (kg CO_2/ton Grey and white cementitious*)



Source: WBCSD GNR database**

**Cementitious products = Building materials which may be mixed with a liquid, such as water, to form a cement base substance, and to which an aggregate may be added. This category includes cements, limes, and mortar*

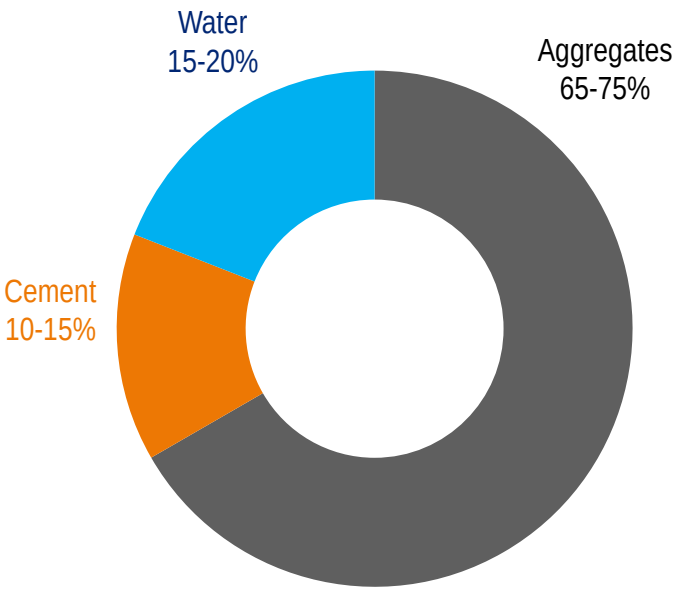
***The definition of cement used in the WBCSD GNR database differs slightly from that in common use. In this document, cement and cementitious products are considered equivalent.*

Concrete: a low carbon product

Production of cement

Production of concrete

Composition of concrete by volume



- Cement is mixed with water, aggregates and chemical admixtures to produce concrete
- Concrete has low transport costs and thus a low transport-related environmental impact
- Today's concrete can reduce energy use and CO2 emissions over the life-cycle of a building by 60% compared to 20 years ago
- Concrete buildings are durable with an expected life of at least 100 years and strong fire resistance
- Ongoing research in the recarbonation of crushed concrete allows for the uptake of up to to 25% of the CO2 emitted during production.

Source: WBCSD

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The Concrete and construction sector are essential to meet the EU's objectives

Reducing the ecological impact

- ✓ Key to the circular economy thanks to its recyclability
- ✓ Waste used as a resource in cement manufacturing
- ✓ Less recourse to primary raw materials
- ✓ Sustainable answer to increases in mobility needs

Energy efficiency of buildings

- ✓ Thermal mass optimization
- ✓ Energy consumption reduced

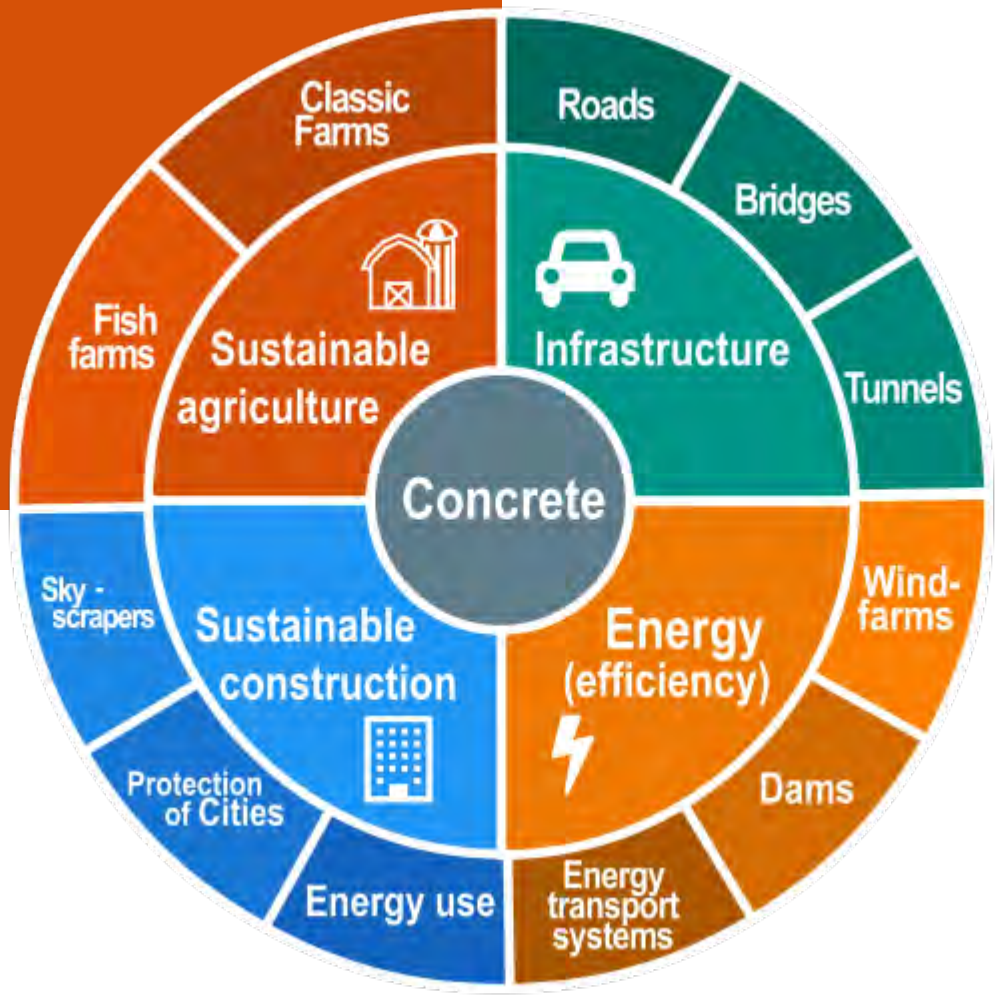
Safety of citizens

- ✓ Durable – lifespan of over 100 years
- ✓ Fire safety
- ✓ Adaptation to climate change

Concrete brings relevant and often necessary sustainable solutions for plenty of applications

The catalytic effect of cement & concrete industry :

Concrete brings relevant and often necessary solutions in plenty of applications regarding major sustainable development issues



Agriculture : fish farms

Main advantages of concrete solutions

- Increased focus on effects from fish farming to preserve natural resources and protect ecosystem
- Concrete tanks built for exposed open sea
- Reduce use of medicaments (medicine) and need to treat the salmon with chemical measures.
- Control on the sludge (feces). Reduced contamination of fjords.
- Investments will be higher, but operating costs in general and maintenance costs will go down.

Focus: Salmon farms in Norway

- Norway is the biggest producer in the world.
- Sea lice, virus and fish escapes are the main challenges.
- Authorities have stopped issuing new production licenses until this is in control.
- Concrete, closed tanks/structures may be an appropriate alternative.

Agriculture: land farms and biogas plants

Main advantages of concrete solutions

- Farming activity needs to preserve safe groundwater and land. Animal welfare is a key priority
- Concrete is waterproof, hence no infiltration of dangerous substances in groundwater
- Concrete offers enhanced safety for animal welfare (limits slipping and injuries)

Focus: World's largest biogas plant in Penkun (Germany)

- 40 modules at 500kW each: 20 MW per hour
- 25,000 cubic metres of concrete
- Each storage tank, 50 meters in diameter, has to resist to 15,000 cubic metres of organic product inside
- Standardised construction

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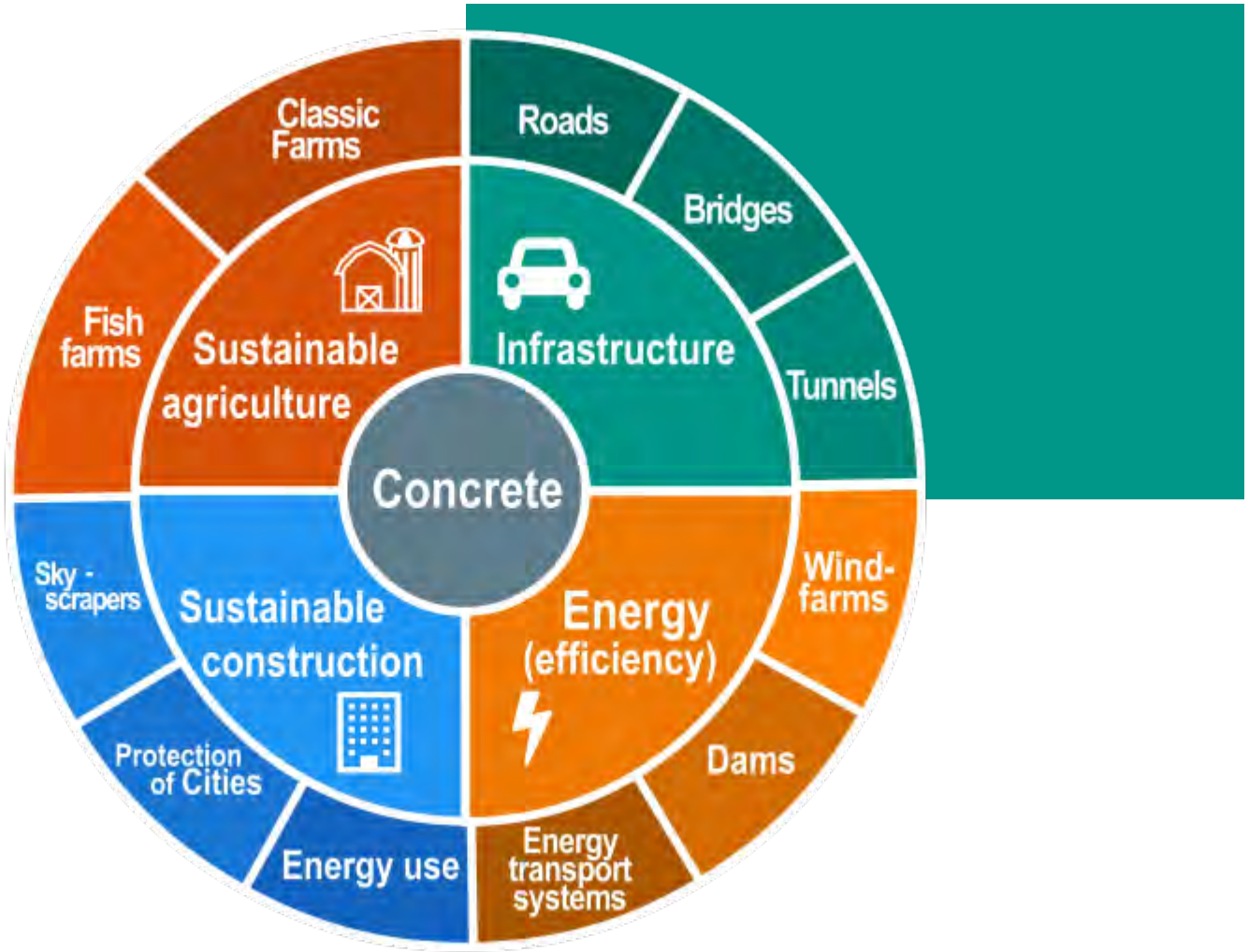


Concrete roads: reducing lighting needs while optimizing fuel consumption

Main advantages of concrete solutions

- The low stiffness of the road impacts fuel consumption
- Concrete absorbs less heat due to a low albedo effect
- Higher stiffness of concrete creates lower deflection when cars and trucks pass over it leading to a 4% reduction in fuel consumption

Automated guidance vehicles using a (colored) concrete pavement in Spain

4%

Reduction in fuel consumption on concrete roads thanks to less deflection of concrete

(source: MIT, 2011)

Bridges

Main advantages of concrete solutions

- Need to link people through long-lasting infrastructure
- Concrete structures are guaranteed for at least 100 years and are virtually maintenance free

Focus: 3rd bridge on the Bosphorus (Turkey)

- Istanbul highway by-pass project to improve traffic flow
- Cable-stayed bridge, 1875m long, 322m high
- The project specifications required a guarantee of a 100 year lifetime with very low maintenance ➔ only concrete allowed for this

Tunnels

Main advantages of concrete solutions

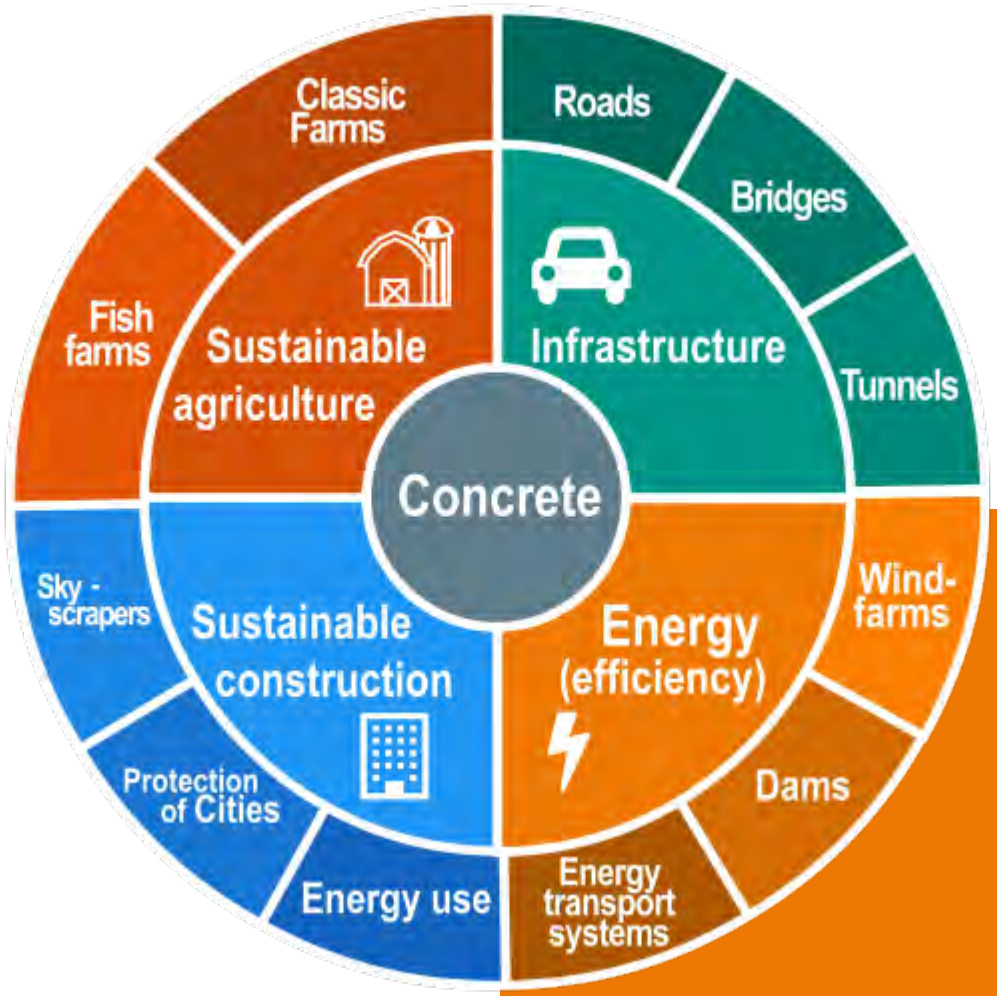
- Infrastructure investments are part of the Juncker Plan to boost growth and jobs in Europe
- Tunnels require specially adapted concrete mixes providing strength, high impermeability, chemical inertia and fire resistance
- Concrete also allows for the reduction of electrical energy consumption for lighting

Focus: The Gothard Project – 58km (Switzerland)

- Difficult geological conditions ➔ specially adapted concrete mixes
- Concrete allows for a 100 year lifespan
- The onsite recycling of excavated material for use as aggregates significantly enhances the resource and energy efficiency of the project

The catalytic effect of cement & concrete industry :

Concrete brings relevant and often necessary solutions in plenty of applications regarding major sustainable development issues



Onshore and offshore wind farms: foundations and masts

Main advantages of concrete solutions

- Renewables will form a large part of our energy mix (EU objective: 20% of renewable energy by 2020)
- Concrete is resistant to the marine environment (off-shore windmills) has a design and construction flexibility and is resistant to deformation
- Allows for very high towers: higher efficiency while remaining cost-competitive

Focus: EOLIFT Project – very high concrete wind towers (France)

- Pre-cast concrete mast high-rise (100-140m) able to support high power turbines (3-6MW).
- Lifting: innovative method of elevating the mast "from below" instead of using a high-capacity crane.

Hydroelectric dams

Main advantages of concrete solutions

- Hydropower is an essential part of the decarbonized economy and reduction of GHG
- Concrete is the only material that resists high water pressure and can provide long-term durability

45%

Share of renewable energy coming from hydropower in the EU28

Energy transport and distribution, and wastewater collection

Main advantages of concrete solutions

- Ageing and non-performing networks of water pipes increase the risk of accidents, create water loss
- Concrete pipes are resistant to leaks and infiltration / high performance concrete allows for thinner tubes and better magnetic absorption
- Allows for long durability without maintenance

Focus: buried very high-voltage power line connection between France and Spain

- Concrete used for pipes and tunnels of a buried high-voltage power line over 65km (a record) with a power of 2000MW direct current (a record)
- This project helped avoid 1Mt of CO2 emissions

Source: RTE

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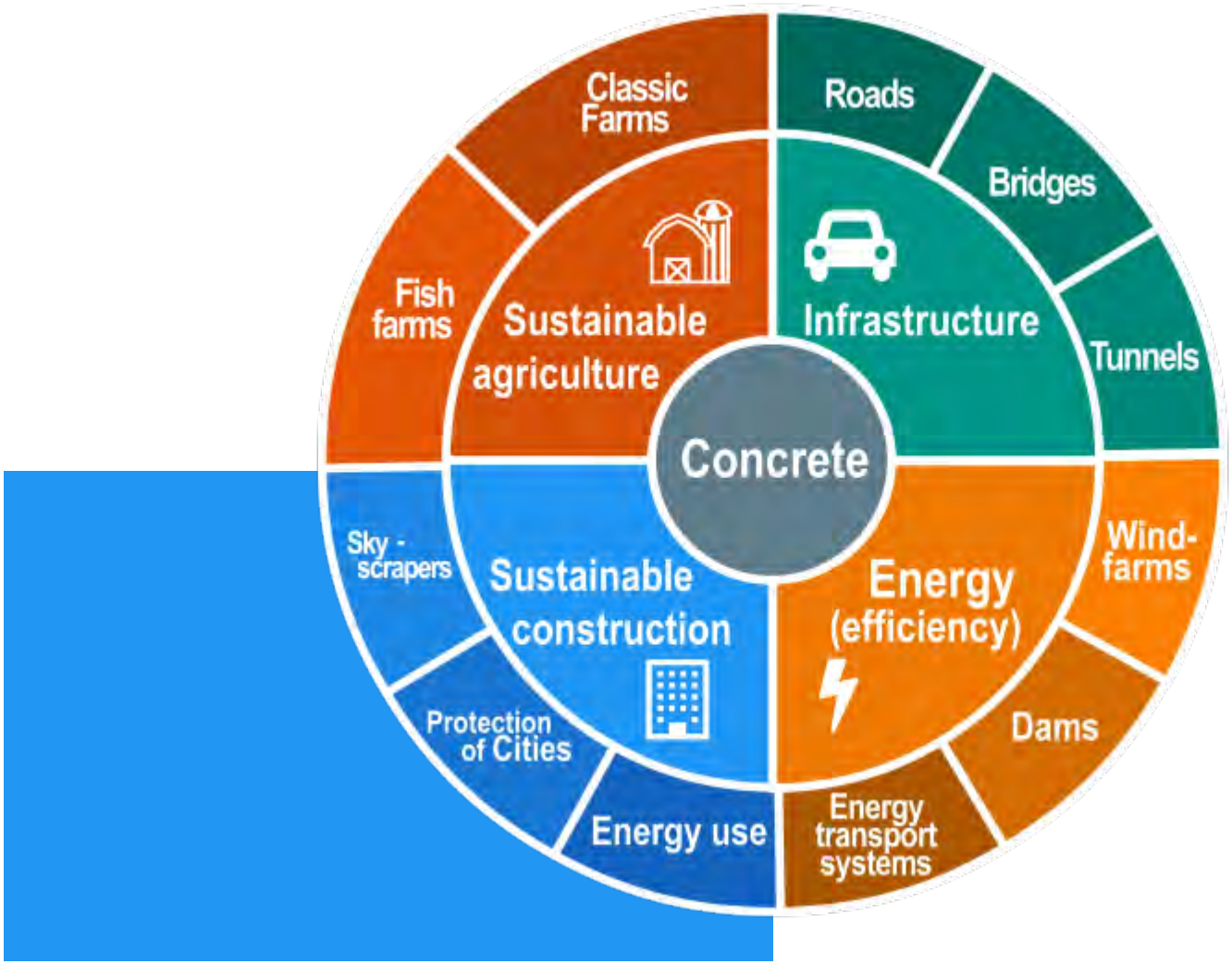


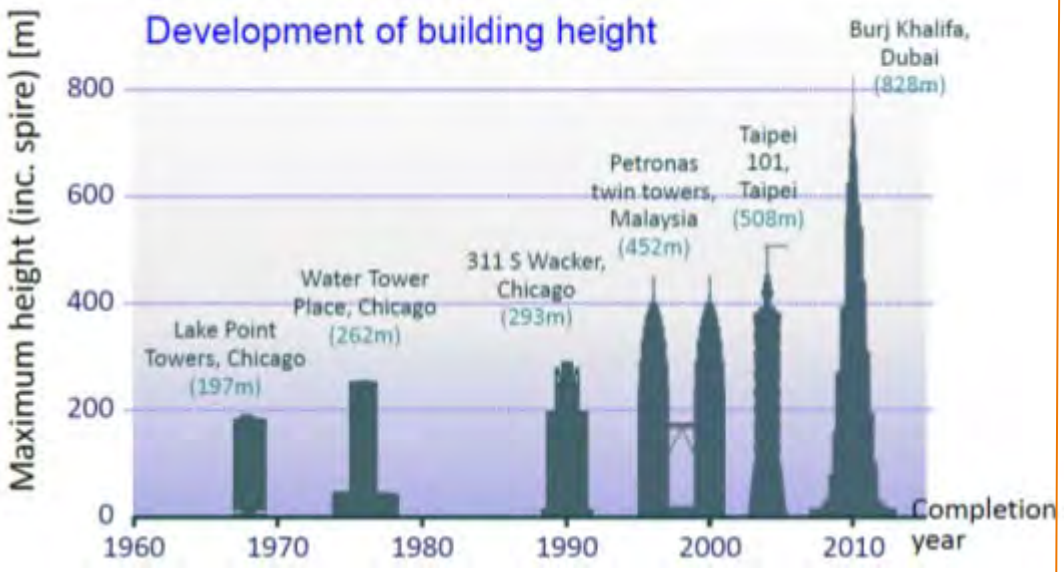
Energy use in buildings

Main advantages of concrete solutions

- The buildings sector represents 40% of C02 emissions in the EU
- Concrete is the material of choice: the thermal mass of concrete allows for lower energy consumption
- Today, concrete buildings can be built achieving a 60% saving in energy consumption compared to buildings built 20 years ago

Skyscrapers

High Strength Concrete (HSC)



Source : Center for Advanced Cement-Based Materials

Main advantages of concrete solutions

- Increasing urbanization trend in Europe: 84% of people will live in cities by 2050
- Concrete allows for high-rise construction resistant against fire, earthquakes and wind loads

Focus: HypergreenTower project - 246m height (Paris, France)

- Entirely prefabricated, removable, re-usable parts
- An ultra-high performance mesh concrete envelope that reduces :
  - The amount of raw materials needed for the construction
  - The weight of the interior structure
  - Heating and cooling requirements by regulating the ventilation of the tower

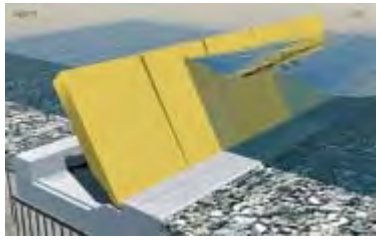
Protection of cities

Main advantages of concrete solutions

- Adaptation to climate change / protection of cities
- Durable, resilient to high water pressure, impermeability

Focus : The MOSE project to save VENICE

- Venice faces the “acqua alta” phenomenon several times a year
- 78 prefabricated removable concrete boxes (20m x 30m x 5m) have been installed to form a dyke. They are controlled from land thanks to IT systems and can be lifted on demand
- Venice will be protected from major flooding for at least a century, even in the most pessimistic scenario with a sea level rise of up to 60 cm



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A 100% recyclable product with a low environmental impact

- Concrete can be recycled at the end of its life in various applications, the main one being the replacement of natural aggregates thus helping improve the resource efficiency of concrete:
  - For the production of ready-mixed or precast concrete
  - As aggregates in civil engineering projects

- The share of recycled aggregates used varies strongly between Member States

Cement and Concrete Industry: Multiplier Effect on the Economy and Contribution to a Low Carbon Economy

The concrete industry and the digital economy go hand in hand

RFID technology in concrete allows to

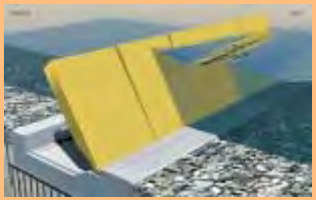
- Track the safety of buildings and infrastructure
- Acquire data about tensions and vibration in real-time
- Schedule timely maintenance
- Share all results via the web
- Optimize the lifecycle assessment of buildings

Focus: Datacenters

- Concrete is a relevant solution for buildings such as datacenters that need a long life durability and the best security. It also reduces the energy required for the cooling system.

Focus IT and infrastructures

- IT systems coupled with concrete allow for removable resistant structures that are needed in plenty of applications such as dams, breakwater, energy plants …



Cement and Concrete Industry: Multiplier Effect on the Economy and Contribution to a Low Carbon Economy

Methodology - Main steps for assessing the multiplier effect

Direct impact

- The direct impact is calculated through the sum of the value-added of the four sub-divisions taken into account. It is directly provided by Eurostat at EU28 level. Value added is the commonly used indicator for calculating multiplier effect in all sectors and industries, notably because it prevents double counting.

Indirect impact

- We use the input-output table provided by Eurostat concerning domestic consumption. This way, only local production is taken into account. Please note that products exported outside of the EU28 are also taken into account thanks to this methodology.
- Eurostat also provides the total amount of intermediate consumption for each of our four products. This allows for the calculation of the share of these products in the division. The input-output table is then used in order to calculate the intermediate consumption of our products in each sector. The sum of the value added corresponding to this intermediate consumption constitutes the first rank indirect impact.
- Given the very local character of the cement and concrete industry, this operation has been conducted a second time: we have calculated the value added of the companies providing the providers of the industry. This constitutes the second rank indirect impact. For example, the production of concrete requires the purchase of aggregates, which will be taken into account in the first rank direct impact. The production of aggregates itself requires the purchase of energy, the production of which also generates value added. The additional value added corresponding to that energy production is considered in the second rank intermediate consumption for the production of concrete.
- The addition of first rank and second rank intermediate consumption gives the total indirect impact.

Induced impact

- Final household consumption expenditure is known through Eurostat. The value added related to this consumption is distributed through the various sectors and transformed into value added input-output tables. We thus have the value-added generated by consumption expenditure in each sector. The sum of that value-added for all sectors gives the induced impact.

Direct jobs

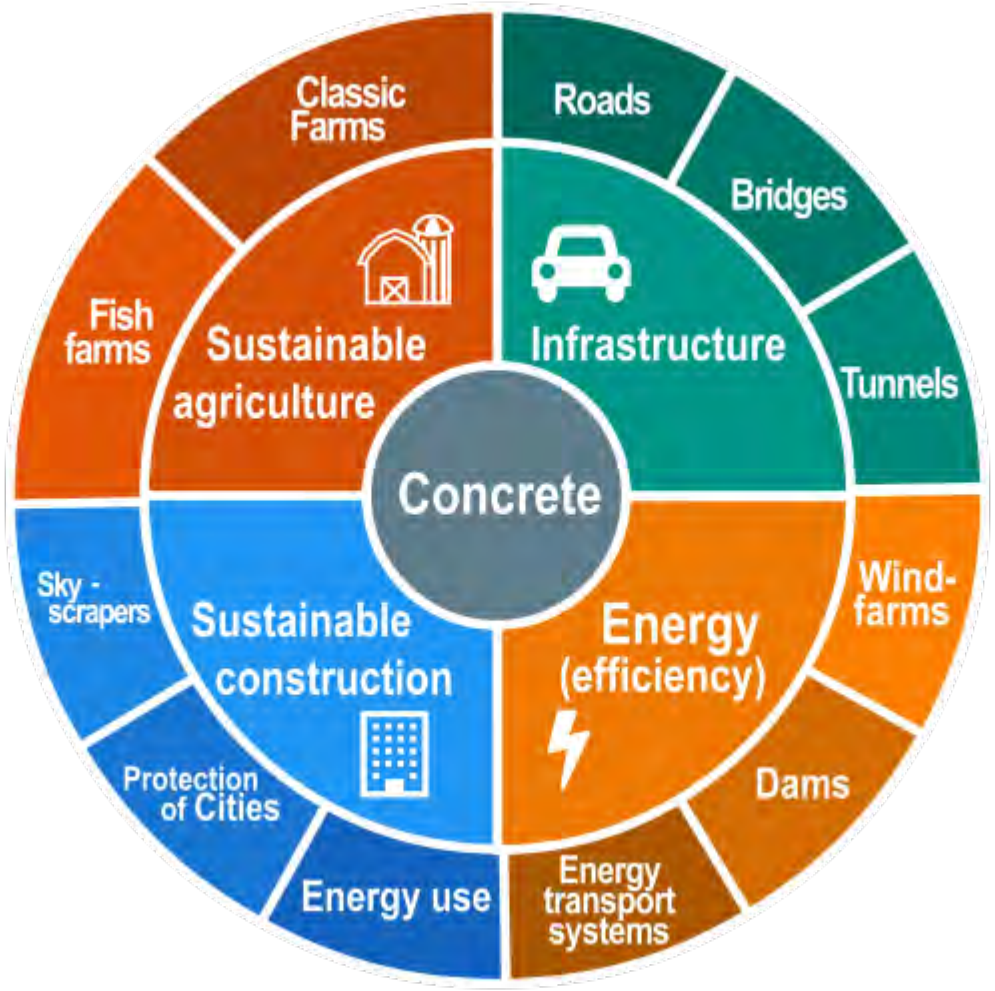
- Direct jobs are available in Eurostat for the EU28 for our four sub-divisions in terms of full-time equivalents.

Indirect and Induced jobs

- Thanks to the productivity by sector, value added in each sector can be transformed into jobs. Eurostat provides the ratio between jobs and full-time equivalents in each sector, which allows for the transformation of total jobs into full-time equivalents. The sum of the full-time equivalents generated in all sectors gives the indirect and induced jobs.

Cement and Concrete Industry: Multiplier Effect on the Economy and Contribution to a Low Carbon Economy

Concrete brings relevant and often necessary solutions in plenty of applications regarding major sustainable development issues



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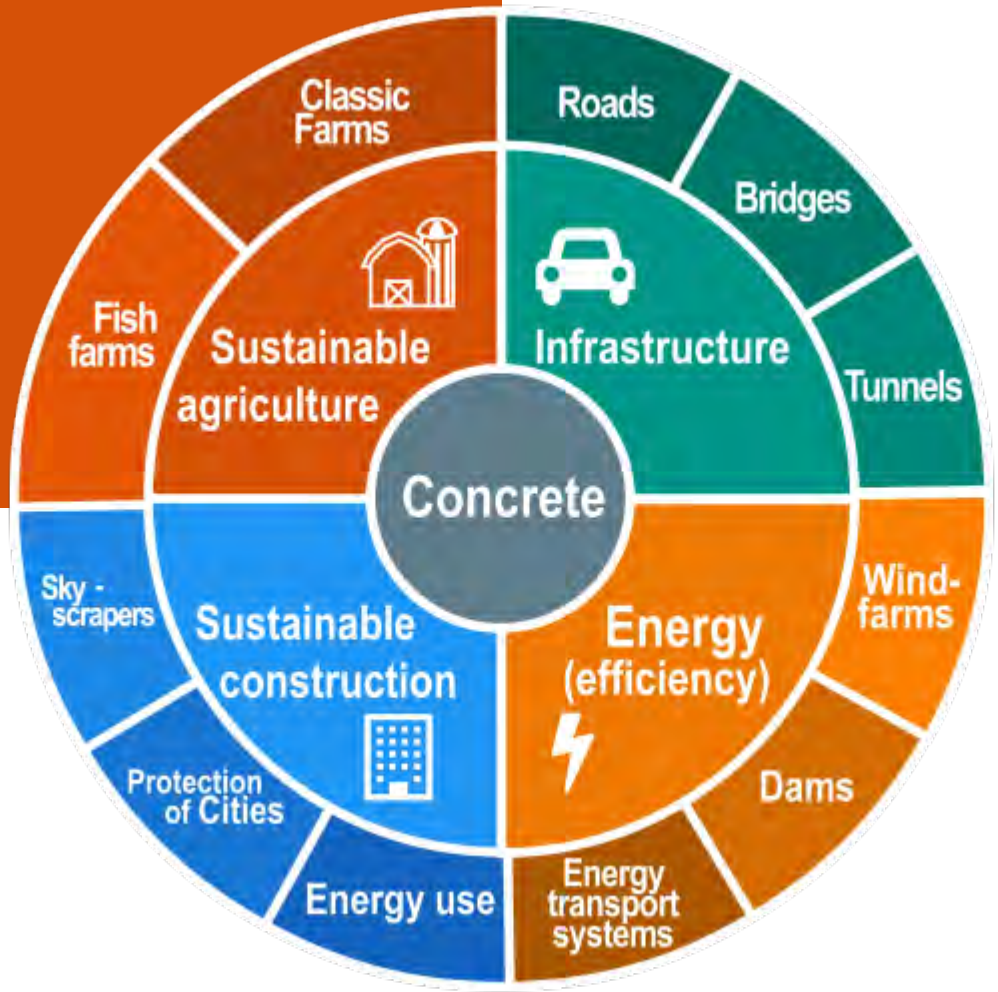


Agriculture : fish farms

Context and issues

- Conventional fish farming activity in fjords and open sea faces two main challenges:
- First:
  - Sea lice; which require extended chemical treatment
  - Virus; require extended use of medicaments
  - Escapes; which threaten wild salmon in rivers
- Second:
  - Sludge from open net-cages (mainly feces) contaminates fjords and disrupt the ecosystem
- The second challenge is not yet dominant in the public discussion
- Fish farming is expected/planned to grow significantly in the upcoming decades in a context of declining natural food resources

Main advantages of concrete solutions

- Concrete tank structures are robust and may be constructed for open sea locations
- All sludge and feces are under control and can be treated in a sustainable way on shore and re-used (an example can be as alternative (biomass) fuels for the cement industry).
- Escapes are reduced and the degeneration of the natural salmon is avoided.

Technical & economic properties of concrete mobilized

- Durability
- Resilience
- Low cost
- Ease of implementation
- Floating
- Does not rust

Focus: Salmon farms in Norway

- Norway is the biggest producer of salmon in the world, and has an ambition to multiply per 2 or 3 its production in the upcoming years.
- Currents floating farms are made with floaters in plastic materials and with open net cages.
- The Norwegian government has stopped giving new production licenses until the challenges described under the first item above is under control.
- Concrete structures/closed tanks may be an appropriate alternative.

Agriculture: land farms and methanation

Context and issues

- Farming activity generates several pollutants (such as animal waste, nitrates,…) that could :
  - contaminate land and groundwater
  - attack the building foundations and structures
- In Europe: increasing concern about animal welfare The development of energy production on or near farms sites (methanation) that involves secure facilities (storage of dangerous products that may burn or even cause an explosion and gas liberation)

Main advantages of concrete solutions

- Concrete is waterproof : it prevents land and groundwater infiltration of dangerous substances. All these products can then be collected and treated.
  ➔ The animal waste can then be re-used as a natural fertilizer or input for renewable energy production.
- Methanation: resistance to acid/alkaline and corrosive products
- Relevant solution against evaporation and infiltration losses in irrigation process
- Offers better conditions for animal safety and comfort :
  - concrete floor limits animals slipping and injuries
  - offer the possibility to have much more space per animal: more resistant material that supports the weight of the structure and the animals
- For the farmers : more economic and easy to implement solution

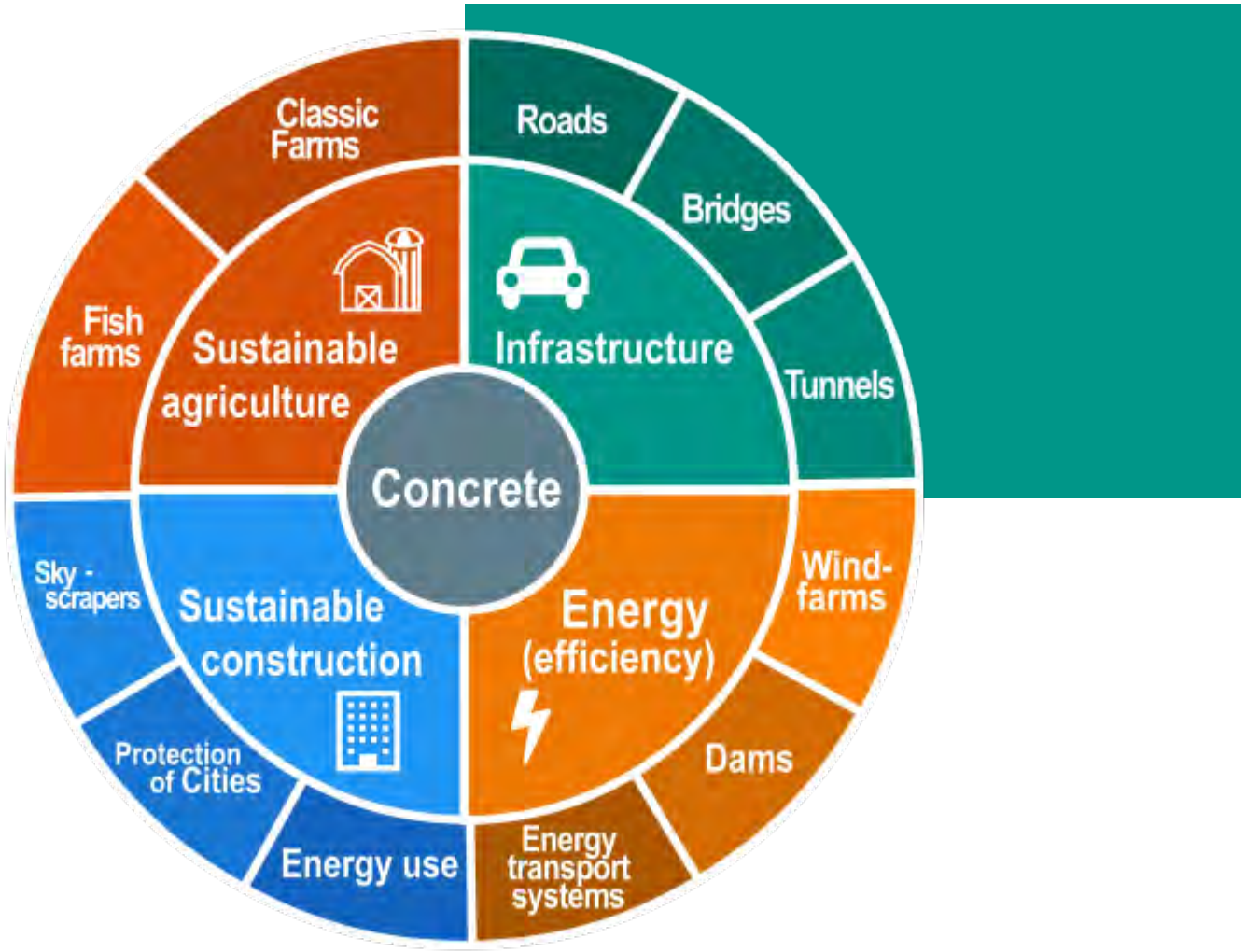
Technical & economic properties of concrete mobilized

- Resilience
- Does not rust
- Ease of implementation
- Waterproof
- Low price
- Resistance to aggressive substances

Focus: World's largest biogas plant in Penkun (Germany)

- 40 modules at 500kw each : 20 mw per hour
- 230,000 hectares of farmland around
- 25,000 cubic metres of concrete
- Each storage tank, 50 metres of diameter, has to resist to 15,000 cubic metres of organic product inside
- Standardised construction

Concrete brings relevant and often necessary solutions in plenty of applications regarding major sustainable development issues



Concrete roads: reducing the urban heat island effect while optimizing fuel consumption

Context and issues

- Roads represent a significant share of cities surfaces. The absorbance of heat contributes to the urban heat island effect, which in turn leads to additional energy consumption in cities
- In addition, the stiffness of the road has an impact on the fuel consumption of the vehicles that roll over it through the phenomenon of deflection

Main advantages of concrete solutions

- Concrete is a material with a low albedo, which means that it does not absorb as much heat as other materials
- It presents very good durability and resistance characteristics which make it a good material for use in road construction
- The generalized use of concrete in city roads could lead to a significant reduction in Global Warming Potential due to that effect
- In addition, the higher stiffness of concrete creates a lower deflection when a car or truck drives over it
- This lower deflection leads to about a 4% reduction in fuel consumption on concrete roads

Technical & economic properties of concrete mobilized

- Low albedo
- Durability
- Stiffness and low deflection under pressure

4%

Reduction of fuel consumption on concrete roads thanks to less deflection of concrete

(source: MIT, 2011)

Bridges

Context and issues

- The expansion of cities, congestion, and the development of the road and railway network may require the construction of new and bigger bridges.
- Such megastructures require an important quantity of material and energy. The objective is to make them last at least 100 years and avoid their demolition and their reconstruction in the meanwhile.

Main advantages of concrete solutions

- Can guarantee a 100 year lifespan
- Is nearly maintenance free :
  - doesn't need surface coating and treatments
  - less chemical products used
  - less energy used for maintenance intervention
- In this type of application requiring resistance to a high level of stress, the use of self-compacting concrete reduces execution times and environmental footprint.

Technical & economic properties of concrete mobilized

- Durability
- Resistance
- Inert

Focus: 3rd bridge on the Bosphorus (Turkey)

- Istanbul highway bypass project to improve traffic flow
- Cable-stayed bridge, 1875m long,322m high
- Requirement in the specifications: guarantee 100 year lifespan and very low maintenance ➔ only concrete allows for this

Tunnels

Context and issues

- Investments in infrastructure across Europe is a priority for the Juncker Plan (from 2/3 to 3/4 of the resource envelope); with the main objectives to boost jobs creation and economic recovery, to strengthen Europe's productive capacity and infrastructure and to build a more interconnected single market.
- Tunnels can be an appropriate part of the solution for the European mobility issues such as decongesting the road traffic, reducing distances and save time for the transportation of citizens and goods; provided cost control, environmental respect and the citizen safety.

Main advantages of concrete solutions

- improving emergency response conditions
- sustainability of the structure (guarantee of 100y lifetime)
- maintenance operations which are quicker and easier
- increase in visibility due to the clarity of the concrete
- reduction of electrical energy consumption for lighting
- limit the spread of fire for a long time
- the concrete capacity to holding the adhesion contribute to reducing vehicle fuel consumption

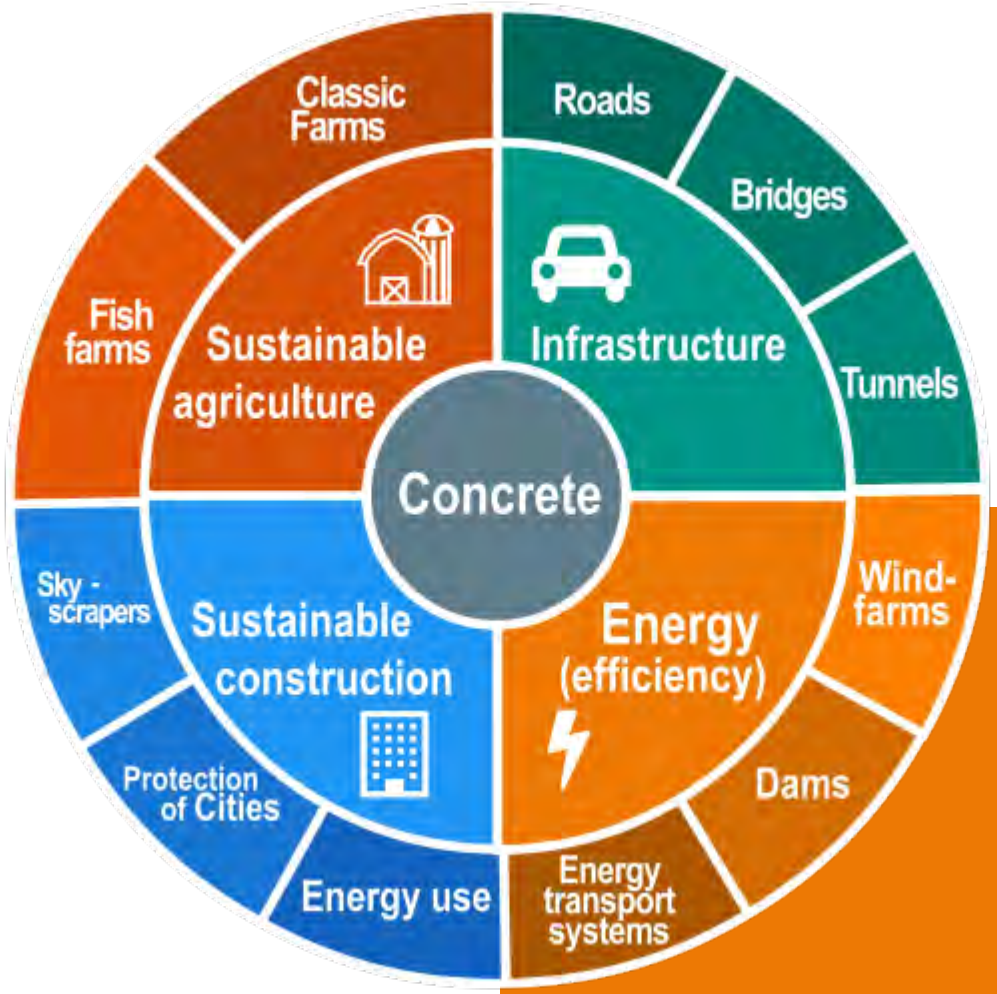
Technical & economic properties of concrete mobilized

- Fire resistance
- High performance
- Adaptable to the construction site constraints
- Inert, non-flammable
- Clear color

Focus: The Gothard Project (Switzerland)

- The longest railway tunnel with 58km
- Difficult geological conditions ➔ specially adapted concrete mixes: strength, high impermeability, and chemical and fire resistance
- Concrete ensure a 100 years lifecycle
- The onsite recycling of excavated material for use as aggregates significantly reduces resource use and the need for transportation.

Concrete brings relevant and often necessary solutions in plenty of applications regarding major sustainable development issues



Onshore and offshore wind farms: foundations and masts

Context and issues

- Development of wind power production (EU objective : 20% of renewable energy by 2020)
- Requirement to develop competitive installation (economic viability) : offshore production // very high mast (>100-150m) and large diameter of blades (up to 130m) for more power efficiency and thus lower E&M costs
- The wind speed increases exponentially with the height
- Transport issues: the diameter allowed on public highways is limited

Main advantages of concrete solutions

- Allows for very high towers: higher efficiency
- Concrete masts: better resistance to deformation thanks to flexibility
- Less maintenance required
- Lifetime of the structure + 100% recyclable
- Easy road transportation and shipping of parts
- Cost-competitive and economical projects

Technical & economic properties of concrete mobilized

- Material durability
- Marine environment resistance
- Duty to fatigue (movement cycles)
- Cheaper solution for big structures + material price stability
- Design and construction flexibility

Focus: EOLIFT Project – very high concrete wind towers (France)

- Developed by Freyssinet
- Pre-cast concrete mast high-rise (100-140m) able to support high power turbines (3-6MW).
- Industrialization: design of a temporary factory (removable) near the site to produce the concrete elements and reduce transportation
- Lifting: innovative method of elevating the mast "from below" instead of using a high-capacity crane.

Hydroelectric dams

Context and issues

- The European Commission Energy Roadmap 2050 explores the transition of the energy system in ways that would be compatible with a greenhouse gas reduction target of 80-95% by 2050 while also increasing competitiveness and security of supply.
- As a means of production that is 100% renewable, hydropower is an essential solution within the framework of the EC 2050 Energy Roadmap.
- Hydropower also increases the stability and reliability of electricity networks and hence allows for promoting the use of other less predictable renewable energy sources such as wind or solar power

Main advantages of concrete solutions

- Concrete is the only material that can provide resistance to high pressure, resilience to water and most of all the affordability that makes investments in this type of civil engineering work sustainable
- Given the life span of this type of investment (typically from 60 to 100 years or even more), concrete is the only material that can guarantee such durability with the lowest level of risk for the integrity of the structure

Technical & economic properties of concrete mobilized

- Inert material
- Simplicity / flexibility
- Draining properties
- Pressure resistance
- Resistance to water
- Durability

45%

Share of generated renewable electricity coming from hydropower in EU28 in 2013

(source: European Commission, 2015)

Energy transport and distribution, and wastewater collection

Context and issues

- Wastewater collection (and water distribution to a lesser extent):
  - Ageing and non performant European networks: issue of waterproofness and the risk of pipes breaking due to fluid and geologic pressure ➔ very important need to renew the networks
  - Significant leaks issues:
    - loss of important quantities of drinking water ➔ need to produce more drinking water, use more energy for pumping and transport
    - Ground infiltration of wastewater ➔ may pollute the environment
  - Some regions need to get water from more distant zones➔ need for new and longer pipes ➔ issue for sustainable construction
- Power transport and distribution issues
  - Power line loss by heating
  - Risk of accidents
  - Non-buried HV lines : Potential risks on people health due to magnetic fields and landscape impacts

Main advantages of concrete solutions

- Concrete can reduce linear power loss
- Buried concrete pipes can contribute to magnetic absorption and reduce risks for people
- Concrete pipes are resistant enough to reduce leaks of water and possible infiltration
- New high performance concrete leads to thinner tubes ➔ less material used for construction ➔CO_2 emissions avoided
- Allows long durability without maintenance

Technical & economic properties of concrete mobilized

- Magnetic absorption
- Ease of implementation
- Pressure resistance
- Thermal capacities
- Durability

Focus: buried very high-voltage power line connection between France and Spain

- 65km buried HV electrical line (a record)
- 2000MW direct current (a record)
- 700M€ investment (of which 225M€ from EC)
- 1Mt of CO_2 avoided
- Doubles the existing transfer capacities
- Concrete used for pipes and tunnels

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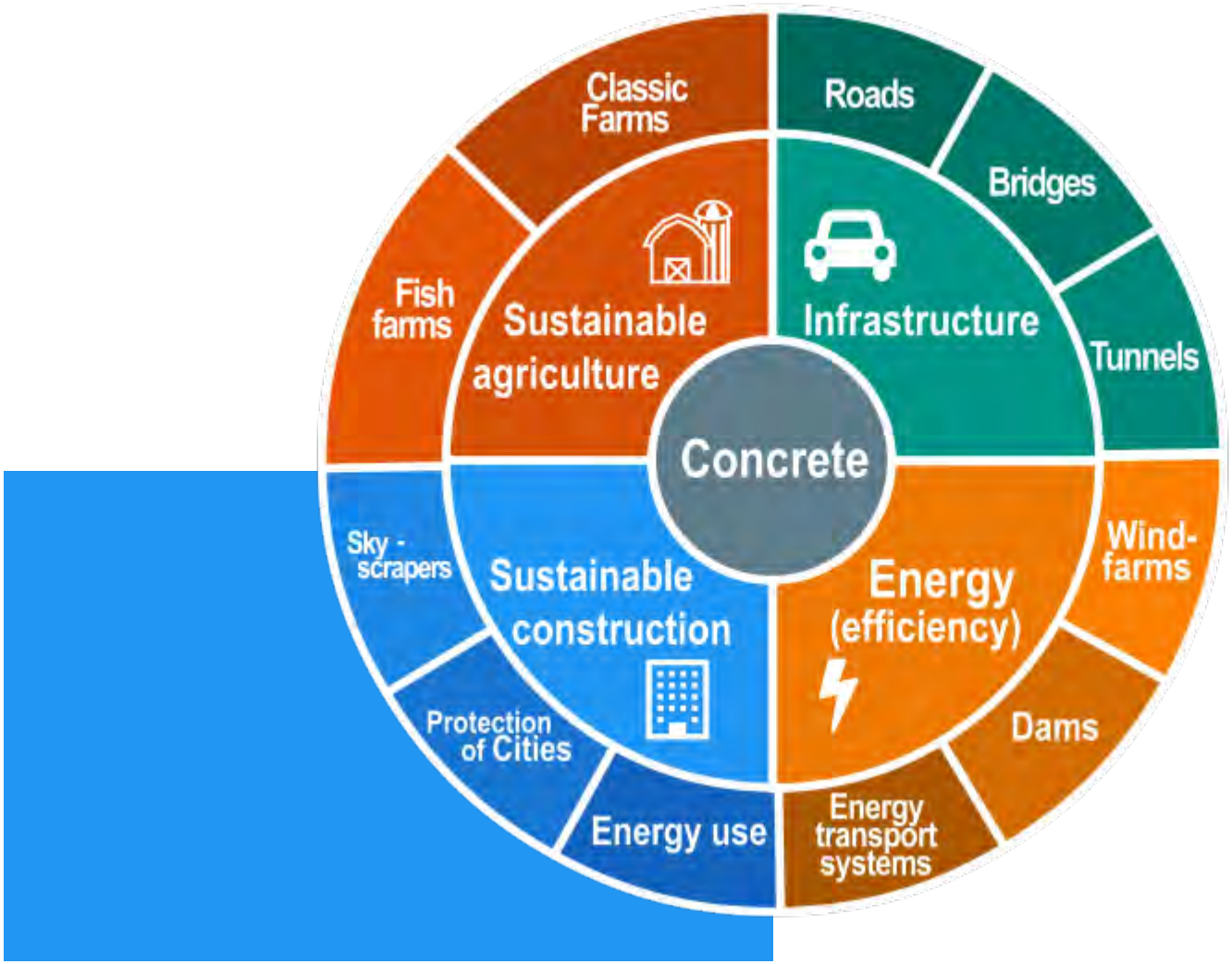
Concrete brings relevant and often necessary solutions in plenty of applications regarding major sustainable development issues



Energy use in buildings

Context and issues

- The low carbon economy roadmap of the European Commission suggests that by 2050, the EU should cut emissions to 80% below 1990 levels, and that this transition should be done in an affordable way
- As a large contributor to carbon emissions, the housing and office buildings sector needs to cut its emissions by around 90% by 2050.

Main advantages of concrete solutions

- Concrete can help build energy performant buildings through its high thermal mass. Its high insulation properties reduce the need for HVAC systems and thus reduce energy use and CO2 emissions over the life time of the building
- These properties make concrete a relevant material for innovative performant building standards such as zero energy building or passive houses
- Today's concrete can reduce energy use and CO2 emissions over the life-cycle of a building by 60% compared to 20 years ago;
- Concrete also allows for the construction of energy efficient buildings at an affordable price, an essential criteria to respect the social aspect of sustainable development

Technical & economic properties of concrete mobilized

- Durability
- High thermal mass
- Insulation properties
- Competitiveness of concrete

Skyscrapers

Context and issues

- 73% of the European population lives in urban areas, 84.3% expected for 2050 (UN)
- Metropolization of Europe.
- Fast growth of supertall buildings (300m+) across the world : The number has almost tripled in the last seven years (today : 101) (source AGCS) - this phenomenon may amplify in the upcoming years
- ➔ strong need for developing skyscrapers the cities
- ➔ major sustainable construction issues

Main advantages of concrete solutions

- Allows for very high construction
- Can guarantee a100 years lifespan
- Resistant against :
  - fire
  - earthquake
  - wind loads
- High performance concrete allows less material use and so less weight for the structure
- Technical performances for stability of the structure and for bracing
- Little maintenance needed

Technical & economic properties of concrete mobilized

- High performance regarding loads supported
- Fire resistance
- Massive material

Focus: HypergreenTower project - 246m hight (Paris, France)

- The materials used, fully prefabricated and recyclable, enable rapid and secure construction, without dust
- Entirely removable, reusable parts
- Ultra-high performance mesh concrete envelope that reduces :
  - the amount of raw materials needed for the construction
  - the weight of the interior structure
  - heating and cooling requirements by regulating the ventilation of the tower

Protection of cities

Context and issues

- With climate change European cities may face further and potentially more severe natural disasters: storms, high tides, tsunami, floods, landslides, …
- The big concern for authorities is the security of inhabited areas and the safety of citizens
- Such natural disasters may also damage infrastructure and buildings and involve a huge cost of reconstruction
- In this context, cities need to put in place the best protection systems meanwhile respecting the existing ecosystems: permanent or removal breakwaters, riverbanks, drainage systems

Main advantages of concrete solutions

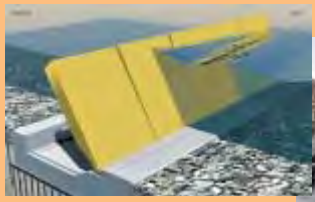
- Resilience to the pressure of huge volumes of water
- Resilience to landslides
- Does not spread any substance in the water
- Draining concrete can be used to prevent or reduce the impact of floods thanks to water regulation and absorption.
- Concrete is a relevant solution for desalination factories: protection of soil against sulfate and chloride contents, fire protection, resistance to corrosion.

Technical & economic properties of concrete mobilized

- Impermeability
- Inert
- Simplicity / flexibility
- Draining properties
- Pressure resistance
- Marine environment resistance
- Durability

Focus: The MOSE project to save VENICE

- Venice faces the “acqua alta” phenomenon several times a year
- 78 prefabricated removable concrete boxes (20mx30mx5m): controlled from land thanks to IT systems
- Venice will be protected from major flooding for at least a century, with a raising of the sea level up to 60 cm (pessimistic scenario)



Thank you!

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