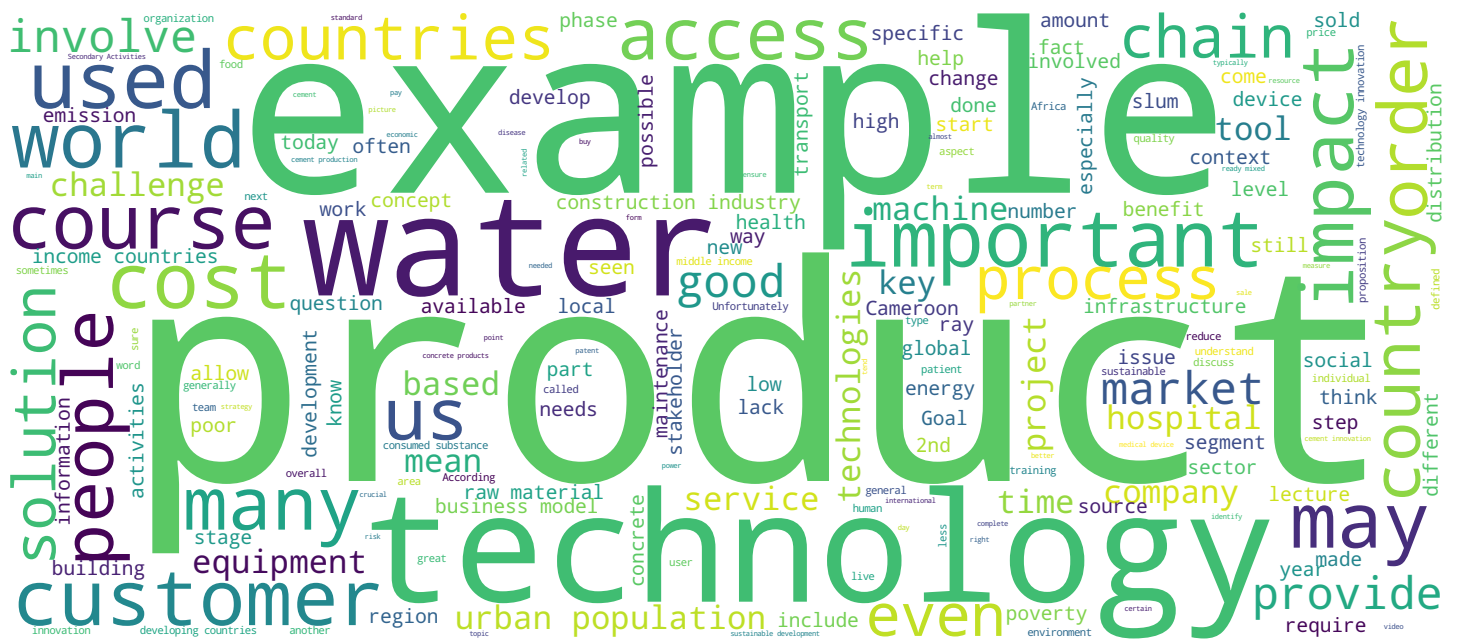




ÉCOLE POLYTECHNIQUE
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EPFL

Construction Industry Value Chain

Technology innovation for sustainable development



Notes

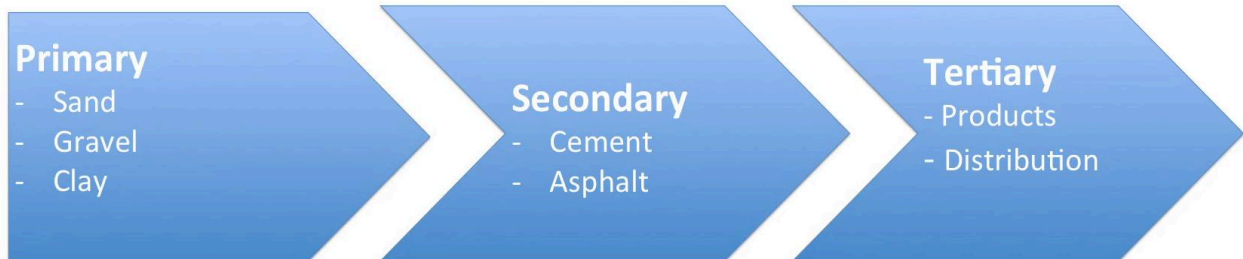
The topic of today's lecture is Construction as an Essential Technology. I start this lecture by asking you a simple question: The most consumed substance in the world is water, but can you possibly guess what the 2nd most consumed substance is though? Let's talk more about construction technologies. Construction technologies are used for the building and assembling of infrastructure. This includes public and private buildings, such as housing, schools, hospitals as well as the construction of roads and bridges. And the industrial infrastructure may include... refineries, mills, power generation, and industrial manufacturing plants. Now in order to arrive at the stage of being able to construct a building, let's take a brief look at the organization or value chain of the Construction Industry.

Summary



0m 03s

Construction Industry Value Chain



Technology innovation for sustainable development



It can basically be divided into three sectors. The first sector is Primary Activities, which involve the extraction, processing and use of raw materials from the earth. The second one is Secondary Activities, which includes the manufacturing of finished goods and the actual construction activity itself. While the third sector is Tertiary Activities, which is essentially logistics and distribution. Now some of the world's largest construction materials companies are actually vertically integrated across all three sectors. In other words, they carry out all the activities from primary to tertiary. Extracted materials may include sand, gravel, limestone, slates, clay, gypsum, feldspar, quartzite and more. One of the main Secondary Activities is making cement. Cement can be made by heating clay and chalk to fuse these materials together. The resulting fused materials are then ground into powder, that then forms cement. Cement is a key ingredient in concrete. And concrete is the 2nd most consumed substance in the world after water.

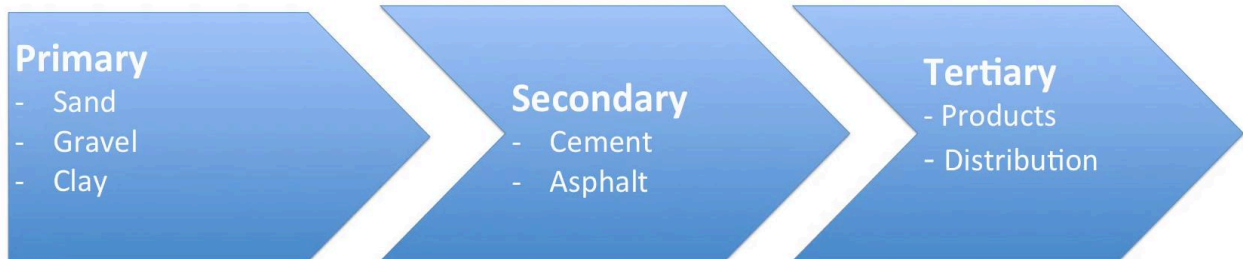
Notes

Summary



1m 18s

Construction Industry Value Chain



Aggregates + Cement + Water => Concrete

Technology innovation for sustainable development



Concrete is made from aggregate, cement and water and can either be mixed directly on building sites or supplied ready-mixed from a concrete plant. And aggregates are made from sand, gravel and crushed rock and they provide the base for all types of construction products. Besides concrete, other products produced in the Secondary Activities include asphalt and concrete products. Tertiary Activities, on the other hand, involve the distribution of raw materials and finished goods to customers for the construction of various types of buildings and transportation links: Cement is sold in bulk to make ready-mixed concrete and concrete products, but it is also sold in bags to builders' merchants for individuals to buy. Ready-mixed concrete and concrete products are sold to residential, commercial and public contractors. By 2030, there will be about 3 billion people in need of proper housing and access to basic infrastructure. Which means we need to complete about 96,000 housing units per day.

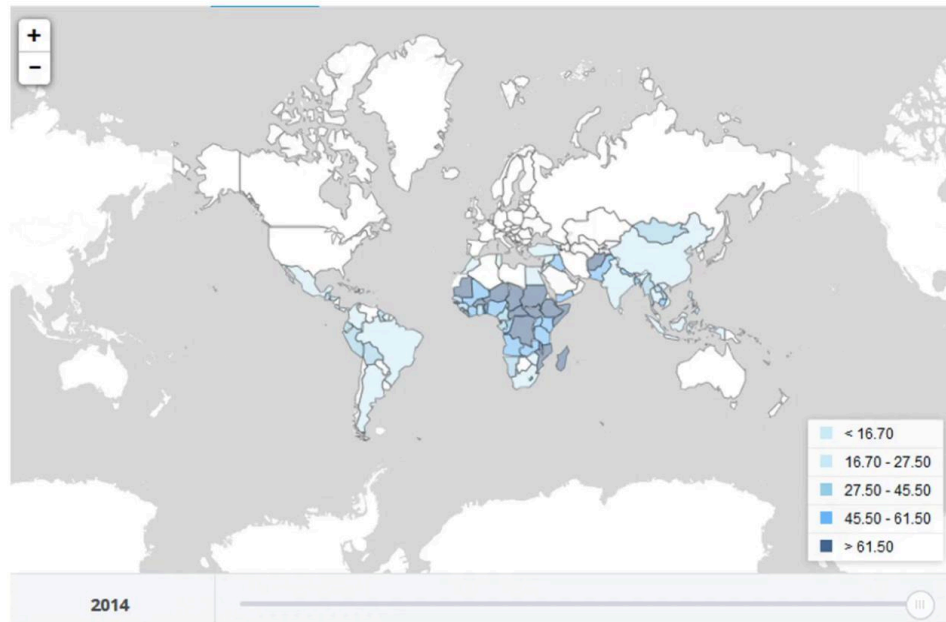
Notes

Summary



2m 32s

% Urban Population Living in Slums



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What exactly is the driver for this housing crisis? Of course, there are various factors, but urbanization is the principal culprit! The graph on the screen shows the percentage of urban populations living in slums and we'll talk more about this subject in the next slide.

Notes

Summary



3m 44s



- 90% Urban Growth @LMICs (70M/yr).
- Urban population to double in LMICs.

Urban population in slums:

- Asia: 30%
- Africa: 62%
- Central Afr. Rep: 96%

Technology innovation for sustainable development



According to the World Bank estimates in 2011, over 90% of urban growth is occurring in the developing world, adding an estimate of 70 million new residents to urban areas each year. During the next two decades, the urban population is expected to double in the two poorest regions in the world, South Asia and Sub-Saharan Africa. Unfortunately, a significant portion of the urban population in these regions do not have proper housing and live in slums. For example, in Asia, 30% of the urban population resides in slums, and this continent is currently home to half of the urban population of the world. While in Africa, about 62% of the urban population live in slums, And the Central African Republic is the country that has the highest proportion of urban population living in slums, which is 96%. Therefore, there is a massive task ahead to build enough houses, in order to provide a dignified home for all. And this challenge is highest in the poorest regions of the world.

Notes

Summary



4m 00s



- 90% Urban Growth @LMICs (70M/yr).
- Urban population to double in LMICs.

Urban population in slums:

- Asia: 30%
- Africa: 62%
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Technology innovation for sustainable development



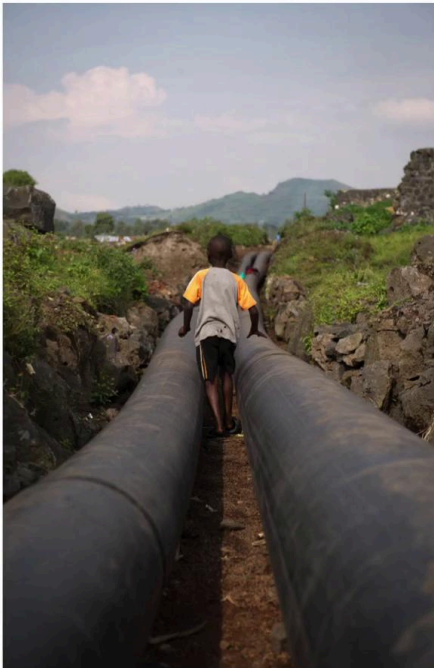
So, whatever solution is proposed has to be cost-effective and affordable. But unfortunately, the construction industry, as we will discuss shortly, has been a major contributor to non-sustainable environmental actions.

Notes

Summary



5m 12s



Building Use:

- 50% of all global energy.
- 50% of all global water.

Technology innovation for sustainable development



So, it would be ideal if the adopted building construction solutions of tomorrow were also environmentally sustainable. Now speaking of sustainability in the construction industry, what is the environmental impact of construction activities to our dear universe in fact? The construction industry is involved in creating the physical assets which are the basis of virtually every aspect of development, but the construction sector is also one of the largest exploiters of natural resources. Around half of all non-renewable resources that humankind consumes 119 00:06:09,872 --> 00:06:12,022 are used in construction, making it one of the least sustainable industries in the world. Apart from its share of fossil fuel use, the construction industry is a heavy user of several metals, whose remaining exploitable reserves are limited. Almost 50% of all global energy is used in buildings.

Notes

Summary



5m 28s



Building Use:

- 50% of all global energy.
- 50% of all global water.

Contribution to pollution:

- 40% to drinking water.
- 50% to landfill waste.
- 50% to ozone depletion.

Technology innovation for sustainable development



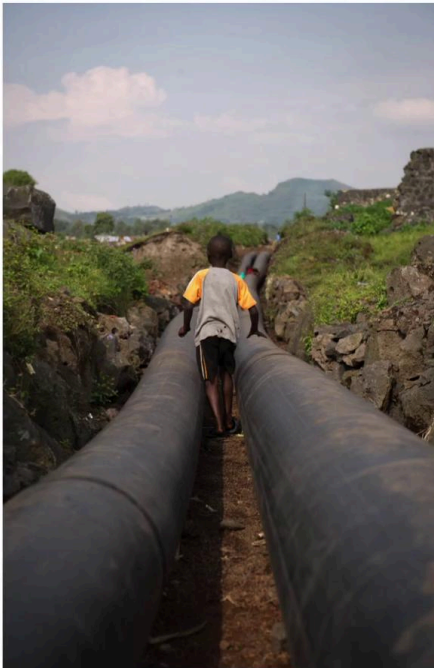
And about 50% of all global water used is also utilized in buildings. Construction activity contributes to the loss of soil and agricultural land through activities such as: Quarrying and mining for the raw materials used in construction. Conversion of agricultural land to other uses, whether for urbanisation, for roadbuilding, dams or other civil engineering projects; And it may also be degraded as a result of the local pollution or waste generation associated with construction and building materials production. Buildings contribute 40% to drinking water pollution, and 50% to landfill waste. Furthermore, construction contributes to air pollution through emissions of dust, fibre, and toxic gases from site activities and building materials production processes. And it contributes 50% to global ozone depletion by the use and release of chloro fluorocarbons in buildings, and by the emission of carbon dioxide and other greenhouse gasses. Thus the construction industry contributes significantly to each of the areas of environmental stress.

Notes

Summary



6m 31s



Building Use:

- 50% of all global energy.
- 50% of all global water.

Contribution to pollution:

- 40% to drinking water.
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Technology innovation for sustainable development



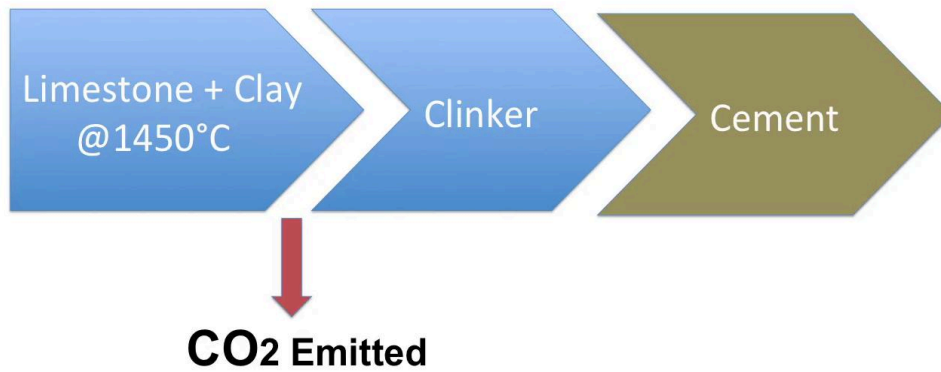
As we saw in our early slides, cement is the key ingredient for making concrete, which is the main material for making buildings and other infrastructure and the 2nd most consumed item after water. However, one out of every 20 tonnes of human-made CO₂ that enter the atmosphere comes from the kilns of cement factories.

Notes

Summary



Emerging Innovations – LC3 Cement



LC3 Concrete Blocks & House



Technology innovation for sustainable development



The sources of emissions in cement production are actually threefold: One, from the production of the electrical energy used to grind the raw materials; Two, these raw materials, such as limestone and clay, are then heated to 1450 in a kiln in order to form a compound called clinker, which is subsequently crushed and blended with gypsum to make cement. The heating process of this step is also a major source of emissions. Now the third source is from the process emissions.

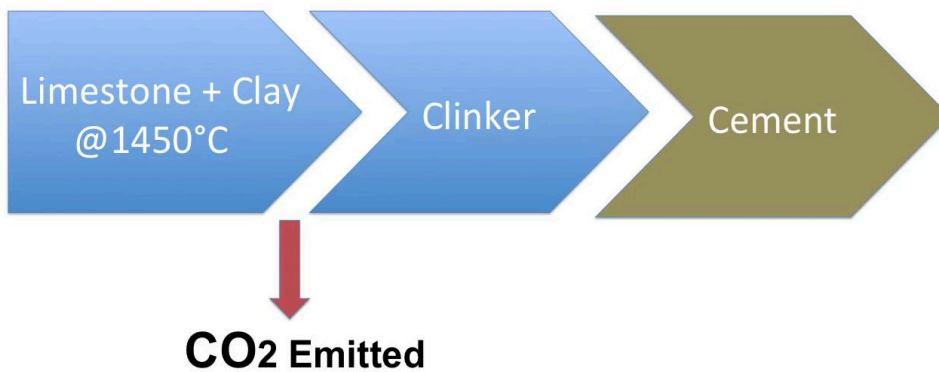
Notes

Summary



8m 17s

Emerging Innovations – LC3 Cement



LC3 Cement – Clinker use reduced by 50%
LC3: Low Carbon Low Cost Low Capital

Technology innovation for sustainable development



For example, when the limestone is heated, it is converted into lime and CO₂. And these emissions actually represent up to 65% of total emissions linked to cement production. So, all together, if we can reduce the amount of clinker used in making cement, we should potentially reduce the amount of CO₂ in the atmosphere.

Notes

Summary



8m 59s

Emerging Innovations – LC3 Cement

LC3 Concrete Blocks & House

LC3 Cement – Clinker use reduced by 50%
LC3: Low Carbon Low Cost Low Capital

- 30% reduction in CO2 emissions
- Uses low-cost input materials
- Not capital intensive



Technology innovation for sustainable development



And now there is a new cement innovation in fact that is based on this concept. Specifically it is based on a blend of limestone and calcined clay, and it is called LC3. Now, in the LC3 cement, the amount of clinker needed has been reduced by 50%. So, overall, the LC3 cement innovation is attractive due to the following features and benefits: One, it can reduce the CO2 emissions associated with cement production by about 30%, Two, it is made using limestone and low-grade clays that are in abundant supply and tend to be readily available. Three, it is cost effective and does not require capital intensive modifications to existing cement plants. LC3 can be produced with existing manufacturing equipment, thus only requires a marginal additional investment for the calcining equipment. So, altogether, this cement innovation seems particularly suited to the developing countries as well, as it meets the criteria we mentioned before relating to cost and sustainability. And there are currently ongoing pilot implementation projects in India and Cuba, which are showing highly promising results and are being used to build houses, as shown in the pictures on this slide.

Notes

Summary



9m 27s

LC3 Cement – Clinker use reduced by 50%

LC3: Low Carbon Low Cost Low Capital

- 30% reduction in CO2 emissions
- Uses low-cost input materials
- Not capital intensive

LC3 Concrete Blocks & House



Technology innovation for sustainable development



You can obtain more information on this exciting project at www.lc3.ch. In the references, I have also included a link to another interesting innovative building technology. The Moladi Construction System.

Notes

Summary





Technology innovation for sustainable development



At the beginning of this lecture, I asked the question as to what the 2nd most consumed substance after water? And I'm sure you have the answer by now, but in case you don't, then the correct answer is: Concrete. As symbolized by the picture you see on the slide which is a water tank and a concrete house. Water and shelter represent, perhaps, the most important foundations of contemporary humanity! Goodbye.

Notes

Summary



11m 26s