ISSF INTERNATIONAL STAINLESS STEEL FORUM

Stainless Steel Long Products in Renewable Energy and Energy Saving Applications

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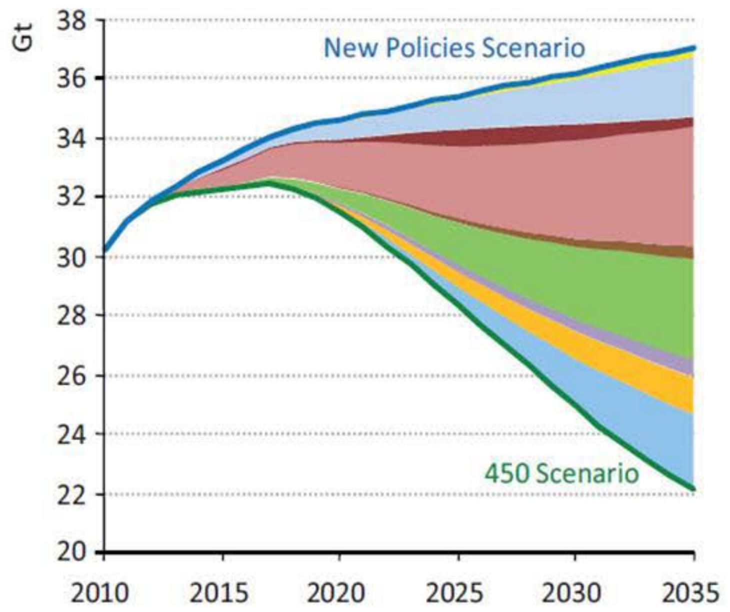
Mitigating climate change is one of the major challenges today.

The development of renewable energy sources and energy savings calls for a wide range of technologies, in which stainless steels prove useful.

Climate Change Mitigation Requires Huge Reductions in CO2 Emissions

Efforts to reduce CO_2 emissions depend on many variables. The IEA has attempted to quantify the effect of the different scenarios. This graph compares the potential effect of the New Policies and 450° scenarios to 2035.



CO_2 abatement	2020	2035
Activity	2%	2%
End-use efficiency	18%	13%
Power plant efficiency	3%	2%
Electricity savings	50%	27%
Fuel and technology switching in end-uses	2%	3%
Renewables	15%	23%
Biofuels	2%	4%
Nuclear	5%	8%
CCS	4%	17%
Total (Gt CO_2)	3.1	15.0

Reductions in carbon dioxide by 2035 will be achieved through:

- Increasing renewable energy's contribution to the energy mix will cut CO_2 by 23%
- Improving the energy efficiency of everything from buildings to appliances will reduce emissions by 40% (the building sector has a prominent role to play)

**450ppm is considered to be the maximum allowable CO_2 concentration in the atmosphere to avoid large climate disruption*

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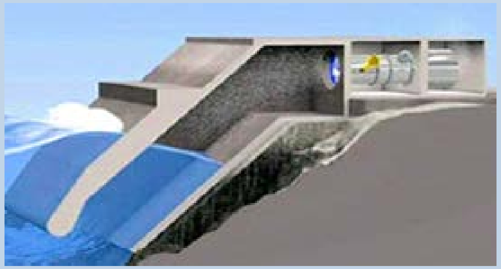
Part I: Renewable Energy Production

Stainless steels can contribute to all renewable energy technologies including:

Biomass

- Biogas
- Biofuels
- Combined Heat and Power (CHP) and Multi Fuel Gasification plants

Blue Energy



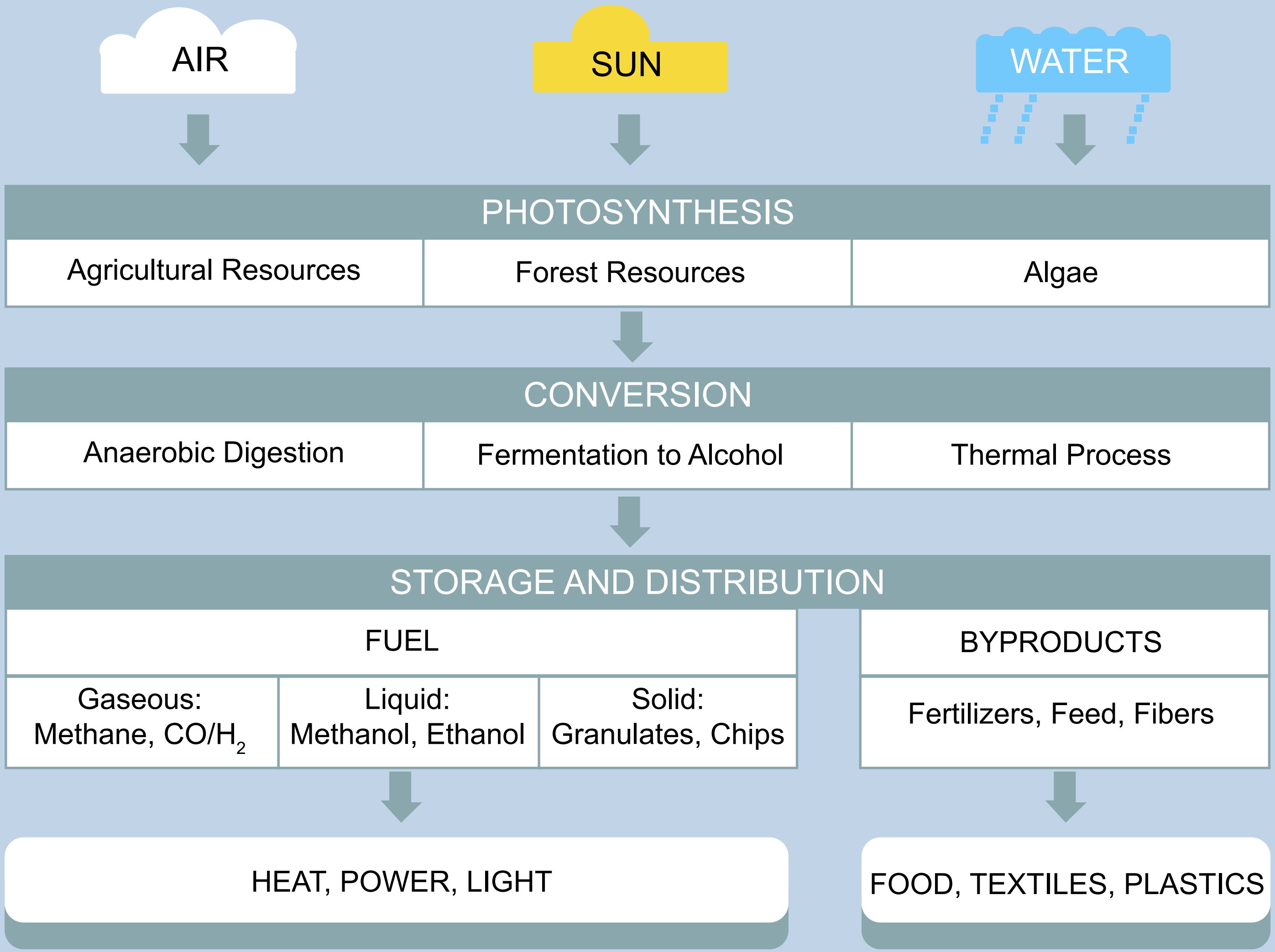
- Tidal and wave energy

Geothermal

Offshore Wind

Solar

Biomass Energy



Biogas Production

Anaerobic disgestion of organic waste by bacteria produces biogas which can fuel an engine coupled with a generator to produce electricity and heat.

Producing energy while reducing organic waste is a very attractive solution. Biogas production is growing quickly worldwide.

Frankfurt Hahn Airport's co-generation plant

Aerial view of the Saxony-Anhalt biogas plant

Exterior view of a stainless steel fermenter tank

Stainless Steels in Biogas Production

Corrosive compounds such as H_2S and ammonia are by-products of the biogas process. Unless corrosion-resistant materials are used, damage to the equipment will occur. It is essential to avoid shutdowns as re-starting the biogas digester is a long and delicate operation, while waste continues to accrue.

Stainless steel is used in biogas plants for digester tanks, pumps, valves and agitators, pipes and fittings.

Digester tanks:
While concrete is currently the most widely used material for fermenter tanks, stainless steel has the following advantages:

- Lower construction costs: a typical tank can be completed within a week
- Minimal logistics - biogas plants can be constructed in almost any area
- No need for repairs thanks to the corrosion resistance of stainless steel
- Gas and water tightness: joints are easy to keep tight; holes are easy to drill; and gas leakage is prevented
- Residual value: at the end of its useful life stainless steel has a scrap value

Inside views of a stainless steel fermenter

Stainless Steel Use in Biogas Production

Pumps, valves and agitators

Pipes and fittings

Stainless steel offers small bending radii and much better heat transfer than plastics.

Agitator

Biogas drying unit

Screw pump with stainless steel piping

Biofuels production

The production of bioethanol and biodiesel has increased rapidly, particularly in Brazil and the USA. Stainless steels are widely used in biofuel production as they exhibit excellent corrosion resistance in the harsh process conditions. They also offer good strength, ductility, toughness and ease of fabrication.

Standard austenitic grades 304L and 316L are suitable for most biofuel plants. However, duplex, super austenitic and nickel alloys are used in specific applications.

280 MW corn bioethanol plant (West Burlington, USA)

Bioethanol production equipment

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Bioethanol Production Equipment

Stainless hopper for bioethanol plant

Steam system in ethanol ligno cellulosic pre traatment

Bioethanol plant in Guatemala

Stripper/Rectifier, fully assembled, fabricated using 304 stainless steel

CHP and Multi Fuel Gasification Plants

Any material that can be burnt can be used to produce heat or steam for electricity production. Wood-fuelled power plants and some municipal incinerators already generate energy this way.

More sophisticated systems are also gaining marketshare. Integrated multi-fuel gasification technologies enable the production of syngas* from any calorific waste (wood residues, municipal solid waste, used rubber tires, plastics...). The gas can be used to generate energy using a gas engine or turbine.

Stainless steels are used in various parts of these plants for their corrosion and heat resistance.

*Syngas typically consists of H_2, CO_2, CH_4 and N_2 in varying proportions

10 MW wood residue CHP plant (Vaxjö, Sweden) which uses gasification

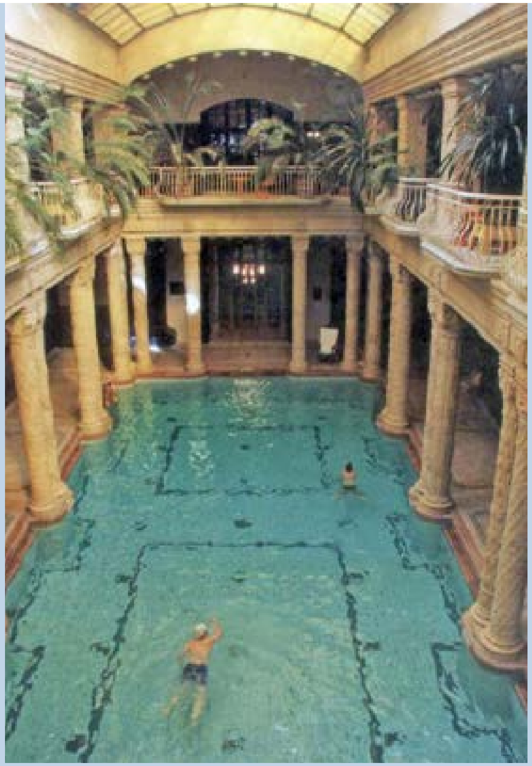
9 MW wood residue CHP plant (Rouen, France) which uses combustion to generate energy

Geothermal Energy

Hot water from natural springs has been used by mankind for millennia. Heated between 50 and 80°C in underground aquifers, the hot water is now used for district heating, fish farming and greenhouse heating.

It is only recently that the technology required to take advantage of the huge potential of high temperature, deep geothermal is available while heat pumps offer sustainable heating for homes and buildings.

Geyser in Iceland



The swimming pool of the Hotel Gellert (Budapest, Hungary) is heated using hot water from natural springs

High temperature sources

High temperature steam is necessary for efficient geothermal electricity production. Natural locations are scarce and usually far from major consumer centres. These factors have led to the limited development of this technology.

However, Enhanced Geothermal Systems (EGS) can tap the heat lying at depths of up to 3,000 metres. Plants which can utilise this energy to produce steam are now available and may lead to a renewed interest in geothermal energy in coming years.

10 MW Ribeira Grande binary unit (Azores Islands, Portugal)

1.5 MW binary EGS power plant (Soultz-sous-Forêts, France)

Stainless steel use

The superheated water produced in geothermal sources (including EGS) is aggressive and requires corrosion resistant materials to ensure long and trouble-free operation.

Stainless steels are generally used for critical components such as

- Condensers
- Flash units
- Filters
- Heat exchangers
- Piping
- Pumps and Valves

Low temperature district heating

Hot water from geothermal wells is usually laden with chlorides, fluorides, sulphates and other mineral compounds. Materials which can resist the effects of these chemicals are required.

Stainless steel offers the best performance/cost ratio for:

- Heat exchangers
- Piping
- Pump shafts
- Valves

Heating exchangers and circulation pumps in a geothermal district heating system (Klamath Falls, USA)

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Heating homes from the ground

Heat pumps offer a reliable and inexpensive way to heat homes with geothermal energy.

Typical stainless steel applications in heat pumps include:

- Heat exchangers (usually using grade 316L)
- Frames to protect the pumps against harsh weather conditions (often using grade 304L)




Offshore Wind Energy

Offshore wind energy production capacity is growing quickly.

Larger wind farms (+1,000 MW capacity), bigger turbines (6 MW), direct drive generators, and sophisticated monitoring and maintenance systems are some of the technologies currently being deployed to decrease costs and make offshore wind energy cost-competitive.

Onshore installations close to the sea also benefit from these technological advances.

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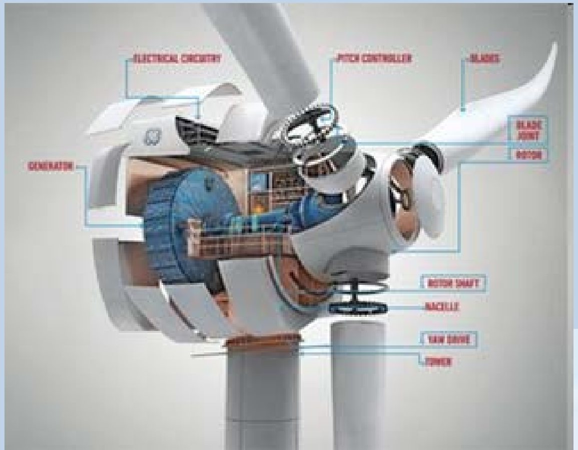
Stainless Steel Use

Offshore wind energy installations are built to last up to 30 years in a corrosive seawater environment. They are designed to require little maintenance due to the difficulty and high cost of carrying out repairs.

Stainless steel is already used in offshore wind applications such as electrical boxes, fasteners, davit cranes, safety cables, braided hoses and fittings. The need to minimise maintenance and a trend to increase the useful life of wind turbines to 50 years is likely to result in the development of more stainless steel applications.



Fastener applications on a typical turbine

Davit crane

16 m tubular tower

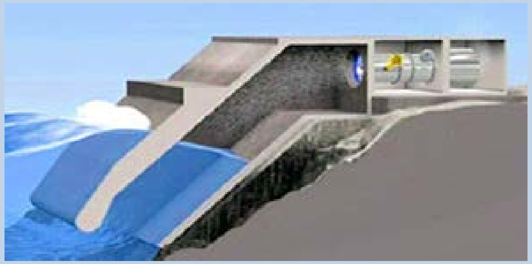
Blue Energy

Tides, sea currents and waves can theoretically provide energy forever. However, harnessing the potential of blue energy in a cost-effective manner has only been achieved in a few cases.

Various systems have been designed and some of them are in the pilot stage of testing (see Wavegen© below). Others are only at the prototype stage (see Pelamis© below).

As the best technologies emerge, so will the applications for stainless steel. However, protection from seawater corrosion, bio-fouling and abrasion make it an ideal choice for many of the systems these power plants will require.

Stainless steel will provide lasting, maintenance-free solutions.



Wavegen© wave system (Limpet, Scotland)

Pelamis© floating snake system.

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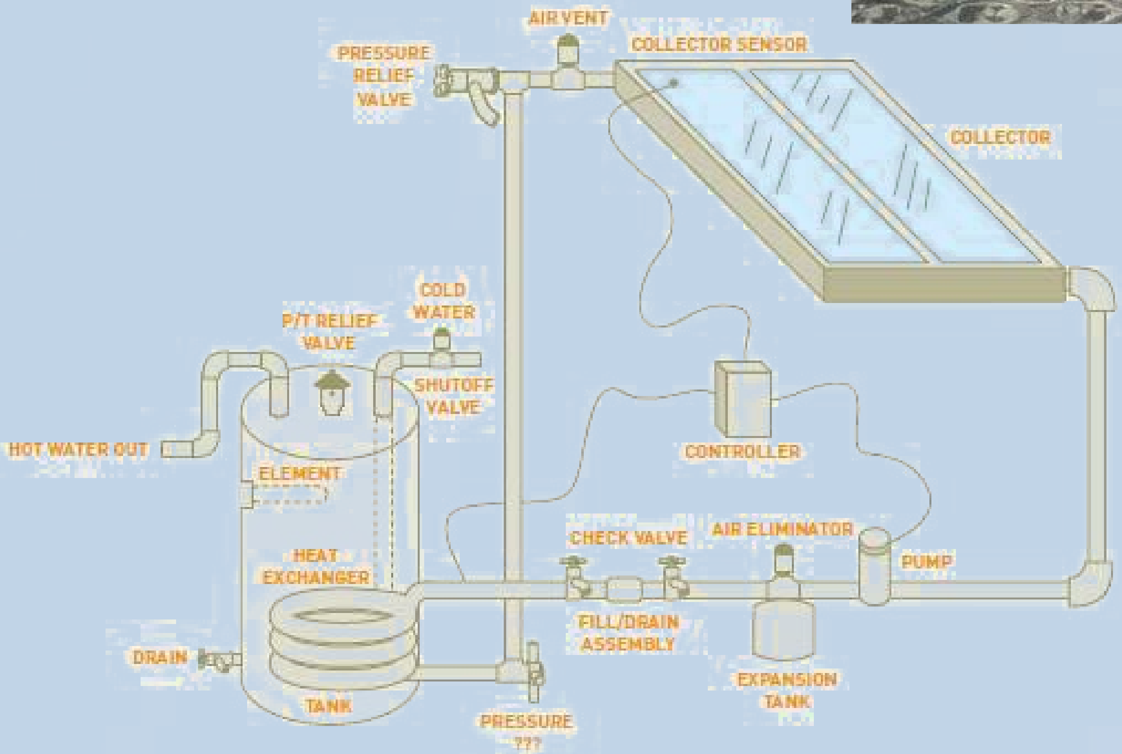
Solar Energy

Thermo-solar systems are designed to produce hot water directly from the sun. They are the most widespread application for this type of renewable energy. Even in moderate climate zones and colder seasons, state-of-the-art solar installations can provide most of the hot water needed by a building's occupants.

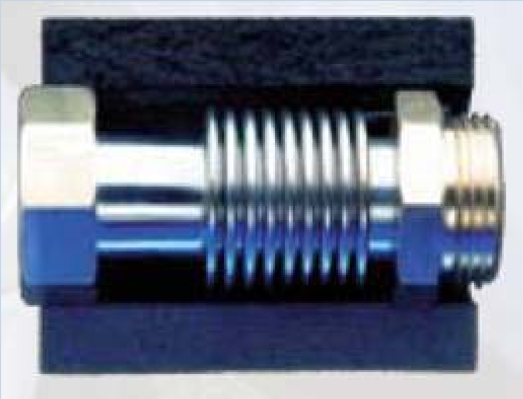


Thermo-solar: Stainless Steel Use

Stainless steels are used for their hygienic properties, corrosion resistance and durability. They are formed in thin-walled tubes and sheets with complex shapes to maximise heat transfer. Organic and other coatings are applied to maximise sunlight absorption.

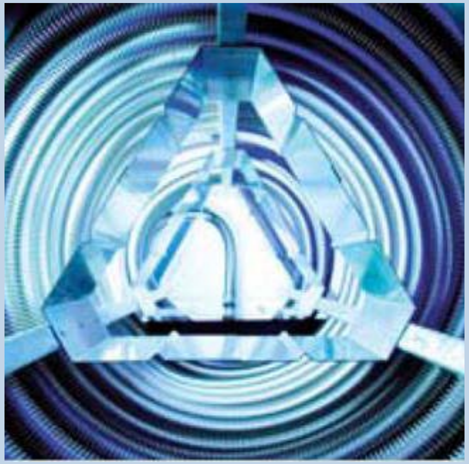
Stainless steels are typically used in:

- Exterior and interior shells of water tanks
- Heat exchangers, tubes and connectors
- Cushion absorbers
- Frames and fasteners.



Connectors

Hot water tank exterior



Corrugated stainless steel tube

Solar panels with cushion absorbers

Concentrating Thermal Systems

Solar power plants have been developed which utilise parabolic mirrors to concentrate the sun's rays. They are highly suited to hot or semi-arid climates.

Corrosion-resistant stainless steel mirrors and support structures offer a combination of optimum precision and long life expectancy.

Photovoltaic Cells

Stainless steels are ideal for photovoltaic (PV) installations as they provide good visual and architectural integration on roofs and facades. They also outlast the panels which contain the PV cells without any need for maintenance.

Flat stainless steel roof with integrated amorphous PV cells

Stainless steel fasteners for PV panels

Part II: Energy Savings

Stainless steels are used in energy saving applications because they offer:

- Corrosion resistance
- Fire resistance
- Aesthetics
- Reduced maintenance

Climate Change Mitigation

Energy savings will reduce CO_2 emissions by 27% by 2035.

The building sector will play a prominent role in realising this target.

Corrosion resistance, fire resistance, aesthetics, and reduced maintenance are some of the properties of stainless steel which have seen it used in an array of energy-saving applications.

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Sunshades and screens

Stainless steel sunshades and screens shield windows and doors from direct sunlight, reducing heat penetration and the need for cooling - especially in hot climates.

Woven stainless shading for the atrium of a school building reduces daytime glare and the amount of air conditioning required to cool the space in summer. Other metal sunshade products were unsuitable as they did not offer the visibility required.

This stainless steel screen for an external stairwell allows natural light to penetrate and air circulation. If another type of screening material was used, additional energy could be required to drive electric lighting andd ventilation systems.

Vertical Gardens

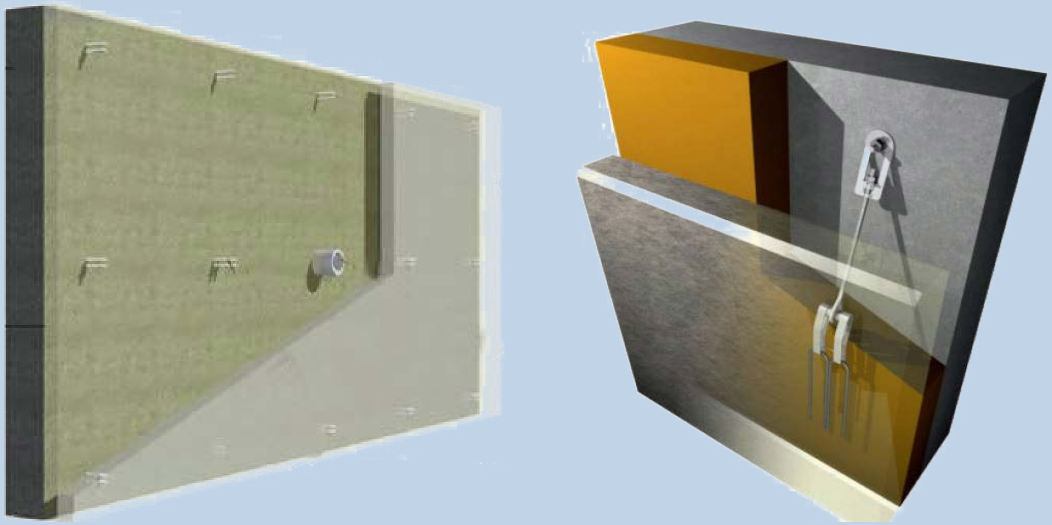
Stainless steel trellis systems provide an ideal climbing structure for plants. They transform the heat-retaining surfaces of a building into a beautiful, cooling vertical garden.

Vertical gardens have been proven to reduce peak temperatures in city buildings during heat waves.

Improved Insulation

Insulated balcony connector

Balcony inserts which include stainless rebar reduce heat loss from balconies and ensure an even temperature inside.



Insulating sandwich panels use stainless steel fastening systems.

Passive Buildings

Passive houses and buildings do not require additional energy input for heating, ventilation and air conditioning.

They are becoming increasingly popular thanks to advanced materials, new products, optimised design and efficient monitoring systems.

The costs of incorporating these systems into new buildings are typically recovered within five years.

Commissioned in 2011, the Pearl River Tower (Guangzhou, China) will be the first building of this size to produce more energy than it requires.

References and links

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Biomass

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Energy Savings

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