The future needs the railways for a cleaner environment.

Green mobility.

Transportation Systems
“I won’t sell the future for quick profits.”
Climate change, resource depletion, urbanization ...

The world population will continue to grow and, with it, the global economy. The consequences will be not only the depletion of natural resources but also an increase in the levels of environmentally harmful emissions.

Unless action is taken, annual CO\textsubscript{2} emissions will rise to about 85 gigatons by the year 2050.
Behind those key words are key questions which demand answers: How can we cut CO₂ emissions to avoid a climate collapse? What impact do the cities have and how can they do their bit for the world’s climate? How can we prevent the catastrophic depletion of our limited fossil energy resources?

**Climate change – the facts**
Right now, the world’s human population is using up 25% more natural resources than the earth can yield at a sustainable rate. The world climate report from the United Nations clearly shows the consequences of climate change caused by the greenhouse effect. Weather patterns can suddenly change in different parts of the world with serious implications for the water supply in these regions. Another worrying effect is the rise in sea levels due to melting ice caps at the poles.

More than two-thirds of the greenhouse gases responsible for climate change are energy-induced. In other words, they are caused by human energy consumption – arising from the production of electric power and heat, or from the combustion of fuel in transportation. Unless action is taken annual energy-induced CO₂ emissions – the most significant greenhouse gas – will rise to around 85 gigatons by the year 2050.

**Focus on the city**
Two major trends – demographic change and urbanization – are driving these disturbing developments. The world population is rising sharply. According to the latest estimates from the United Nations, world population will reach approximately 7.3 billion by 2015. This population explosion will be accompanied by an expansion in economic activity across the globe – the production, transportation, and consumption of ever more commodities and goods. Global economic activity has a two-pronged effect on the environment: the depletion of natural resources and the production of climate-damaging exhaust gases.

Cities are one of the main culprits in all of this. Although they take up only 0.4% of the earth’s surface, they are responsible for about 80% of climate-damaging exhaust gases. The United Nations expects urban populations to rise drastically. Since 2007, the number of city dwellers is about the same as the numbers living in the country. Urban populations are expected to rise to 60 percent in 2030.

The challenge posed by climate change cannot be avoided. We must take measures to sustain the environment, to reduce the impact and to halt the irresponsible consumption of natural resources. What we need is: efficiency.
Energy-efficient technologies for long-term environmental compatibility

Of all modes of transportation, the railways contribute by far the smallest component to the roughly 26 gigatons of the annual energy-related \( \text{CO}_2 \) equivalents (\( \text{CO}_2 \text{e} \)) of greenhouse gas (GHG) emissions which can be directly influenced by the Siemens portfolio.

Source: IEA World Energy Outlook, Vattenfall, Siemens
With its innovative product range Siemens is doing its part in conserving natural resources. When it comes to the generation, distribution and use of electricity, energy-efficient technologies from Siemens are very sparing in their use of energy reserves such as mineral oil, coal and natural gas, while at the same time cutting greenhouse gas emissions.

**Global responsibility**
Siemens takes its global responsibility very seriously and is actively engaged in promoting a sustainable global business environment. Evidence of this proactive stance can be seen in its participation in numerous international organizations, its listing in the Dow Jones Sustainability Index and – not to forget – the global certification of Siemens’ environmental, health and safety standards. For more information on environmental protection at Siemens, see [www.siemens.com/environment](http://www.siemens.com/environment)

**Energy-efficient products and solutions**
Among the many energy-efficient solutions that Siemens has to offer are power plants with efficiency factors of over 60%, energy-saving power transmission systems, electric motors, luminaries, industrial plant, transportation systems, and many more. The Siemens portfolio can directly impact some 26 gigatons of the total global 44 gigatons of CO₂ equivalents. 5.3 gigatons of that total are produced by transportation, to which the rail contributes only 2% – the smallest component. And there’s a qualitative aspect as well: transporting freight and passengers by rail is the most environment-friendly form of mobility. Our Velaro high speed train, for example, runs on the equivalent of only 2 liters of gasoline per seat and 100 km at 50% passenger load.

**Green mobility**
As world-class railway systems supplier, Siemens Transportation Systems offers a wide range of rolling stock, components and rail automation and electrification solutions for environmentally compatible rail-based modes.

**Railways – an attractive and clean alternative**
A number of factors play an important role when it comes to making railways attractive and ensuring that even more people and freight will be carried by rail in future. For example, dependable and punctual connections, user-friendly design, safety and security on the trains, in the stations and during operation, ease of maintenance and low lifecycle costs.

No less important is the smooth interaction of all modes of transportation made possible by integrated, intermodal mobility solutions.

We offer leading-edge technologies to support these solutions – technologies based on 160 years of experience in transportation and railway systems.
Complete mobility – Green mobility

We take a balanced holistic approach to rail-based mobility – from mass transit to regional to main-line services for people and goods. We have positioned our product portfolio to meet the needs of transportation and logistics operators. They are the ones who make sure people and goods are transported safely and swiftly – be it across cities, within regions or over long distances. Reliability, safety, attractiveness and efficiency are our top priorities and benefit the operators and the environment.

Mega Cities & Urban Transport
Especially critical to the economic success and the future of urban centers is the traffic network. The development of competitiveness, quality of life and environmental protection in urban areas is unthinkable without a functioning mass transit service.

This is exactly where our solutions come in. By providing attractive transit services that offer reliability and security in the vehicles, in the stations and on the lines. By improving passenger information.

By increasing the transport capacities and availability of rail vehicles. By installing fully automated systems that can adjust more flexibly to changing demand.

Commuter & Intercity Transport
We connect congested urban areas and make it easy for people to transfer to other attractive means of transportation. Millions of people around the world are leaving the car at home to take the train. Thus rail is making a real and vital contribution to habitat protection and making city centers and regions equally good places to live in.

Airport Links & People Movers
Airport links and people movers built by Siemens are providing convenient and reliable connections not only to and from, but also within airports. They are economically efficient, comfortable and have a very low carbon footprint.

Main Line & High Speed
We set standards for efficiency, environmental protection, and reliability and safety with our state-of-the-art trainsets for long-distance travel and high-speed connections. For distances up to 500 km, for instance, a Velaro train emits only about one-third of the quantity of CO₂ that an airplane does – and the overall journey time is shorter.

Freight & Traction
High performance and flexibility are the critical metrics for freight transport. We are ahead of the pack in this field thanks to our cargo management systems and locomotive platforms. Take, for example, our multi-system electric locomotives for cross-border transport and our very quiet and energy-efficient diesel locomotives that meet low emission requirements.
Our customers can rest assured that with Green mobility they are getting energy-efficient systems that go easy on resources. They can also be certain that these solutions are designed for a sustainable business environment throughout all stages of the lifecycle. Here are some of the solutions we are talking about:

**Eurorunner**
Up to 13 dB(A) quieter and up to 16% more economical

**Velaro**
Only 2 liters per seat over 100 km

**Automatic route setting system ZLS 901**
Fewer stops mean lower energy consumption

**Sitras SES**
Saves up to 300 tons CO₂ by storing braking energy

**Syntegra powered bogie**
Uses no oil, makes less noise, is lighter in weight and energy-efficient

**Oslo Metro**
With 95% recyclability, still useful at the end of its service life

**Transrapid**
Traveling at 400 km/h, around 75% cleaner than an airplane

**Combino Plus**
Eco-friendliness and lots of space to help reduce traffic congestion
Green mobility on a roll

Fast and thrifty: Velaro consumes equivalent of only 2 liters per seat over 100 km

Velaro, the third generation of our high-speed multiple unit trains, was designed right from the start with sustainability in mind. This platform not only ensures purely optimal energy usage and meets the specified performance requirement, it also features ecologically optimized systems and components.

Its converted energy consumption is equal to only 2 liters of gasoline per occupied seat over 100 km at 50% passenger load, but that is only one aspect among many. Take the floors, for example, we use wood from sustainable forestry instead of composite materials. The air-conditioning systems run on environmentally friendly, non-ozone-damaging coolants. We have found an environment-friendly alternative to mineral oil for cooling the transformer on the Velaro E, for instance, and generally do not use materials, tools and substances that pose a risk to human health and the environment.

This train will convince you in every respect: over 160 trainsets sold, a considerably lower environmental impact during production, operation and later during recycling. And, of course, an unforgettable ride for up to 604 passengers at a speed of 350 km/h.
Flying cleaner at ground level:
At 400 km/h the Transrapid produces 75% less CO₂ than an airplane

The Transrapid system also opens up an impressive, ecologically-based dimension in guided ground transportation. It represents the first major breakthrough in railroad engineering since the steam engine. The Transrapid maglev doesn’t run on conventional tracks, it levitates over a special guideway – at speeds up to 500 km/h. And even when it brakes, there is no contact.

Consequently, the Transrapid needs no brake linings, overhead contact lines or tracks which are subject to wear. At the same time, it uses very little energy. This is made possible by the contactless operating drive system featuring next-generation power electronics, the automatic operations management system, low-weight maglev vehicles, and almost ideal aerodynamic vehicle and guideway contours.

Compared to a medium-range aircraft, the Transrapid emits about 75% less CO₂ per available seat kilometer (ASK) even when traveling at 400 km/h. There is no rolling and starting noise with the Transrapid. And since it is very quiet – only 81.5 dB(A) at 250 km/h – it is an ideal form of transportation for quick trips in congested urban areas.

Its lightweight design means less loading of the systems, components and tracks. This greatly reduces lifecycle expenditures. And the metro trains are still worth something at the end of their service life: almost 95% of the materials used in the trains can be recycled. With its outstanding overall ecobalance, the Oslo Metro really exemplifies our understanding of Green mobility: easy on the environment during production, operation and recycling. So far we have supplied 63 trains – each with a maximum capacity of 678 passengers.

Valuable to the end:
The Oslo Metro with 95% recyclability

We are setting standards in environmental compatibility with the Oslo Metro. The trains are of lightweight construction and optimized in terms of energy and ecological aspects. Compared to the predecessor vehicles, the new Oslo Metro saves around 30% energy by means of, among other things, the regenerative brake system.
Eco-friendly revelation in space:
The Combino Plus is the longest low-floor tram in the world

The 100% low-floor tram Combino Plus is a good example of a very environmentally-friendly vehicle. Its regenerative brake system can recover up to 30% of the energy used. The electric brake is another trump card to play for the environment – it’s wear-free. Because it has no brake linings, there is no wear – with the result that there are no fine particulates spewing into the environment. And thanks to its new bogies, the Combino Plus is much quieter than its predecessor.

A significant plus for the attractiveness of the Combino Plus is its modular system. As many as eight modules can be coupled together to adapt transport capacity exactly to the operator’s requirements and to form trams with a maximum length of 72 meters. The Combino Plus for Budapest, for example, is almost 54 meters long and is currently the longest tram in the world with a transport capacity of 10,000 passengers per hour and direction. By offering such enormous space, these low-floor trams allow passengers to enjoy an enhanced degree of riding comfort. Why take the car into the city when you can just hop on the next tram?

The quiet powerhouse:
The Eurorunner makes 13 dB(A) less noise than previous locomotives

More and more countries are adopting strict regulations for pollutants, fine particulates and noise emissions produced by vehicles. The diesel-electric locomotive Eurorunner ER20 from Siemens fulfills these stringent environmental regulations. Its state-of-the-art, electronically-controlled diesel engine is indeed pulling its weight for the environment:

Compared to previous locomotives, this model offers substantially lower emission levels – producing approximately ten tons of fine particulates over its entire service life – and lessens the burden on the environment. The ER20 produces 70% fewer emissions than the older diesel locomotives. The fact that it uses 16% less diesel fuel is good news not only for the environment but for the operator as well.

People living near railroad tracks have less noise to put up with, as the ER20 is up to 13 dB(A) quieter than previous locomotives. In fact, its noise levels are often way below the permissible limits. To date, there are about 180 locomotives in operation in four countries.
Good news for the environment:
The Syntegra bogie uses no oil, is lighter, makes less noise and is energy-efficient

Syntegra, the new-generation powered bogie for rail vehicles with axles directly driven by synchronous motors, is a winning innovation for the environment. Traction, running gear and braking technologies are combined in this bogie to form a highly integrated mechatronic system. This means a weight reduction of approximately 30% over conventional bogies and an increase in the degree of efficiency of the drive to 96%.

Combined with an efficient brake energy recovery system, the new drive design saves approximately 20% energy compared to traditional bogies. What’s more, Syntegra doesn’t need oil as a lubricant, it is wear-resistant and therefore easy to maintain and, finally, is about 80% quieter than conventional drives.

Valuable braking:
The Sibac ES mobile energy storage system

Sibac ES marks a further step towards greater environmental compatibility and economic efficiency in mass transit. Sibac ES enables the energy generated during braking to be stored on board the vehicle. This energy is then used when the vehicle reaccelerates, thereby reducing the load on the traction power supply, stabilizing the line voltage and minimizing the use of expensive peak power. The vehicle is therefore able to cut its primary energy import by as much as 30%. For example, a triple-articulated Combino Plus tram can thereby reduce its CO₂ emissions by 50 tons a year. Sibac ES also allows vehicles to operate without an overhead contact line. This has a positive effect on cityscapes in that, for example, transit vehicles can now cross picturesque city squares free from contact wires and catenaries or travel underneath structures where overhead lines cannot be installed.

Sibac ES also improves the energy-saving advantage of diesel-electric drives. The system stores the energy released during braking and makes it available again during acceleration. This allows the diesel engine to always run in an optimum and economical speed range. Alternatively, Sibac ES acts as an energy source, such as during short stops at signals. This reduces noise emissions and fuel consumption and thus CO₂ and NOₓ emissions.
Braking for the environment: The Sitras energy storage system and inverter

Unlike the mobile, onboard Sibac ES energy storage system, Sitras SES is permanently integrated into the traction power supply system. Consequently, excess energy that has been recovered within a network, e.g. from braking, is temporarily buffered and released again when required.

Sitas SES has been successfully installed in numerous mass transit systems. Two operating modes are available. On the one hand, Sitras SES can be used as a temporary buffer store. The energy recovered when the vehicles are in braking mode is stored and made available for subsequent use. Depending on the system installed, up to 500,000 kWh of the primary energy requirement can be saved, corresponding to almost one-third of the annual consumption. This reduces annual CO₂ emissions by about 300 tons.

On the other hand, Sitras SES acts as a voltage stabilizer, especially during traffic peaks, to prevent the line voltage from dropping below a critical level. As a result, Sitras SES greatly increases voltage stability in the power system and thus prevents downtimes due to power outages. In addition, fewer voltage drops means fewer losses in the system.
We use Sitras TCI thyristor-controlled inverters in the electric power supply for DC traction to 1.5 kV DC nominal voltage in order to make DC substations fitted with diode rectifiers recuperative. The big benefits: energy fed back into the system during braking can not only be used in the specific section of the power system but also transmitted to the connected medium-voltage power system via the substation. This prevents power losses. And other remote loads, such as vehicles operating on other line sections or elevators, escalators and lighting, can be powered with this energy.

In addition, Sitras TCI allows lower rated braking resistors to be used in the vehicles, for the connected medium-voltage networks ensure virtually unlimited receptivity. Even existing substations can be upgraded easily with Sitras TCI.

The environment is also a major beneficiary of operational savings: Depending on system size and design, Sitras TCI can reduce the annual primary energy consumption by up to 1.5 million kWh, whereby power utilities can save around 900 t of CO₂.

Solar energy signals the way ahead: Solar powered LED signal lights

With our innovations we also optimize railway systems and subsystems in detail. Take signaling equipment, for example: by integrating photovoltaic energy and installing sophisticated, but energy-saving LEDs, we have developed new, environment-friendly LED signal lights. In fact, one of our customers has replaced 12,000 mechanical semaphore signals with these new LED lights.

There are obvious benefits for the operator and the environment. Firstly, these signal lights do not need a separate power supply cable. And, secondly, the propane gas supply previously required for revenue service is no longer needed either. Owing to the high reliability and improved durability of these new systems and components, the operator can now extend maintenance intervals to ten years.
No more needless waiting: The Simis LC level crossing system reduces waiting times for cars by some 50%

Simis LC shows how you can also do your bit for the green cause with a level crossing. A special Simis LC software function optimizes activation time – thus reducing barrier closing times by 20 seconds. This is equivalent to a reduction in barrier closing times of approximately 50% at speeds of 120 km/h.

The benefits: shorter waiting times for road traffic and reduced emissions at railroad crossings. Moreover, Simis LC is operated electromechanically and without oil lubrication. This is a definite plus for the natural habitat because – in contrast to traditional hydraulic barrier machines – there are no oil leaks should an accident occur.

On the right track for the environment: The electromechanical S 700 point machine operates extremely reliably without lubricants and fuels

The track system plays a vital role in an ecological analysis of the railway. If points fail, trains will have to wait but still have to be supplied with electrical power. Siemens electromechanical point machines help reduce delays caused by failures and maintenance and ensure trouble-free operation of the track system. The S 700 saves on lubricants and fuels and prevents leakage losses and the resulting pollution of the soil.

An additional benefit for operator and environment is the point diagnostic system Sidis W. It is a computer-aided early warning and control system that enables the operating status of the system to be monitored and therefore allows the points to be maintained when their status demands it. Unnecessary starting is thus avoided.
Fewer stops mean less energy consumed: The dynamic automatic route setting system ZLS 901 ensures optimum line utilization

From a commercial and ecological point of view, it is the goal of every operator to maximize the utilization of his track network by upping train frequencies. Nevertheless, operational reliability must be assured at all times. This is what the Siemens automatic route setting system ZLS 901 was made for.

It optimizes route configurations and thus precludes unnecessary stops at red signals, especially on busy main routes. This lowers energy consumption and minimizes emissions to the ground at stops. Routes can be configured to accuracies on the order of seconds with ZLS 901. The track topography and timetable for every train can be stored in the system and used to make the most out of revenue service.
We can only ensure our future mobility by sensibly networking all transportation modes. Siemens has all necessary capabilities and technologies to design and realize these integrated, intermodal transportation solutions. Attractive solutions that can transport people and freight with utmost safety and environmental friendliness.
Complete mobility – Networking improves efficiency

Highly networked transportation systems can do wonders for the environment. Perfectly coordinated air, road and rail connections will induce more people and logistics companies to switch to the railways. At the same time, intelligent traffic management systems can ease traffic congestion and reduce emissions caused by traffic.

**Intermodal solutions**
Siemens is the only rail systems provider that has all the necessary technologies in-house to design and realize integrated, intermodal mobility projects. This know-how spans traffic, fleet and tunnel management, through telematic applications, systems for information, parking guidance and tolling, and security and control technologies for buildings and plant, up to cargo management systems for optimizing transport and logistics chains.

For more information on integrated mobility solutions at Siemens, see: www.siemens.com/mobility

**London: A case in point**
London is a good example of the benefits of integration. Several hundred Desiro UK type regional multiple-unit cars from Siemens were put into service in London in 2001. These commuter rail vehicles brought great relief to Central London and paved the way for the introduction of a city toll which, by the way, was also installed by Siemens. Today, London enjoys traffic that moves smoothly without major congestion and much cleaner air.

**Green and clean: The future of mobility**
Siemens is thinking ahead to the future – the future of mobility. We are working today on the innovations both for the immediate and distant future with our “Picture of the Future” model. This is a method of predicting future social, environmental and technical developments. Rail journeys will be more comfortable and more convenient, and freight transport by water and rail will form the backbone of global trade – reliable and easy on the climate.
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descriptions of the technical options available, which
do not always have to be present in individual cases.
The required features should therefore be specified in
each individual case at the time of closing the contract.