

# Final report





A light gray background illustration. On the left, a stylized figure of a person riding a bicycle. In the upper right, a simple outline of a house. Below the house, on the right side, is a stylized electrical plug. The entire illustration is composed of thick, rounded lines.

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Over a period of six months, the Lindell test family lived a climate-smart lifestyle with the aim of reducing their carbon dioxide emissions from 7.3 tonnes per year, which is roughly the average in Sweden, to a minimalistic one tonne.

## “One Tonne Life” in a nutshell

“One Tonne Life” is a project in which A-hus, Vattenfall and the Volvo Car Corporation joined forces with industry partners ICA and Siemens to create a climate-smart household.

Over a period of six months, the Lindell test family lived a climate-smart lifestyle with the aim of reducing their carbon dioxide emissions from 7.3 tonnes per year, which is roughly the average in Sweden, to a minimalistic one tonne. After an impressive final sprint, the Lindells crossed the finishing line at 1.5 tonnes.

The Lindells exchanged their 1970s home and their almost 10-year-old cars for a newly built, climate-smart wooden house from A-hus and a battery-powered Volvo C30 Electric. Vattenfall provided renewable electricity, new energy technology and energy coaching. ICA and Siemens were industry partners for food and household appliances respectively. Method development and calculation of the family’s carbon dioxide footprint took place in partnership with the Chalmers University of Technology and the City of Stockholm’s Environment and Health Administration.

Transportation and electricity consumption were the areas in which the family made the most progress.

Emissions from transport dropped by more than 90 percent, not least thanks to the fact that the family’s Volvo C30 Electric was recharged with electricity sourced from hydropower. The family’s home from A-hus produced its own electricity and with renewable energy from hydropower, carbon dioxide emissions from purchased electricity were virtually zero.

Carbon dioxide emissions from accommodation were more than halved – and food is the third area in which the family made considerable progress. By not throwing away food and by making wise choices, the Lindells made a significant cut in their carbon dioxide footprint. Varying one’s choice of meat and eating more vegetables are easy ways for anyone to reduce food-based carbon dioxide emissions.

Viewed per category, the Lindells managed to reduce their CO<sub>2</sub> emissions from transport by almost 95 percent, from food by 80 percent, from accommodation by 60 percent and in other areas by 50 percent. All told this means their CO<sub>2</sub> footprint shrank by 75 percent.

## Method

In the project, emissions of the three most important greenhouse gases were calculated – carbon dioxide, methane and nitrous oxide. In addition to the family's direct emissions, emissions caused by the companies producing goods and services for the family were also taken into account. In order to do this, two different methods were combined in a way never previously employed for measuring a family's carbon dioxide footprint. The two methods are lifecycle analysis and input/output analysis.

With lifecycle analysis, the greenhouse gases produced by a product are analysed, for instance from the production of a car or a kilogram of beef. This method takes account of emissions from materials, transportation and other stages in production. In order to estimate the family's emissions from food, their house, public transport, manufacture of their car and so on, we have used lifecycle data.

However, lifecycle analyses do not exist for everything that is consumed by society. For that reason we have used input/output data for other types of consumption, such as taxi trips, clothes and recreational activities. Input/output analyses the flow of money in the economy and distributes Sweden's emissions between its various industries. This gives an average value for emissions from activities such as the buying clothes or books.

Things that the family members buy last for different lengths of time. This too has been taken into account. It would be unreasonable for the family to be burdened with all the emissions generated during manufacture of their house since the building will undoubtedly be around for the next century. For that reason, emissions are distributed throughout each product's lifetime. Emissions from clothes are spread across two years, emissions from production of the car are distributed over a period of 15 years and so on.

The family's ability to get down to one tonne was limited by what is known as the "rucksack", which totals 900 kg per person per year. This "rucksack" contains carbon dioxide emissions that occur when the various products are made, such as the house itself, the solar panels with which it is equipped, the car, furniture and clothing.

For many products, such as conventional houses and cars, the biggest CO<sub>2</sub> emissions take place during usage. However, this does not apply to an electric car or a low-energy house such as the "One Tonne Life" house where most of the carbon dioxide footprint comes from actual manufacture, not usage.

The project has only studied the effect of the family's carbon dioxide footprint from private consumption, which accounts for most of the individual's climate footprint. A comprehensive picture of the individual's carbon dioxide footprint also includes elements from our shared public consumption, such as schools, roads and other public facilities. In Sweden, this footprint accounts for about 1.8 tonnes of CO<sub>2</sub>, which was not included in the initial starting figure of 7.3 tonnes. In the final future-scenario analysis, however, the effect of the society in which the Lindells live has also been included.

Work on method development, ongoing follow-up and result feedback for the family's carbon dioxide footprint, including this final report, took place in a special team that brought together representatives of all the partners under the leadership of Fredrik Hedenus of the Department of Energy and Environment at the Chalmers University of Technology. He was assisted by M Sc engineering student Anna Björk.

## Final result

The family's emissions from private consumption prior to the project were estimated at 7.3 tonnes\* CO<sub>2</sub> per person per year. Halfway through the project, the Lindells had reduced their emissions to 2.8 tonnes per person per year, with the biggest reductions in transportation and accommodation. By this time the family were living an energy-lean lifestyle in the "One Tonne Life" house and most of their travel was by electric car and public transport.

The family's lowest emissions were in week 20, at 1.5 tonnes of CO<sub>2</sub> per person/year. The biggest difference compared with the intermediate period was that emissions from food were drastically cut. In addition, the Lindells succeeded in lowering their carbon emissions from other categories even more.

Viewed per category, the Lindells managed to reduce their CO<sub>2</sub> emissions from transport by almost 95 percent, from food by 80 percent, from accommodation by 60 percent and in other areas by 50 percent. All told this means their CO<sub>2</sub> footprint shrank by 75 percent.

\* When the project was summed up, it was noted that the base line for air travel in the transport category had probably been overestimated by about 0.5 tonnes. This means that the family started at just below the 7-tonne mark.

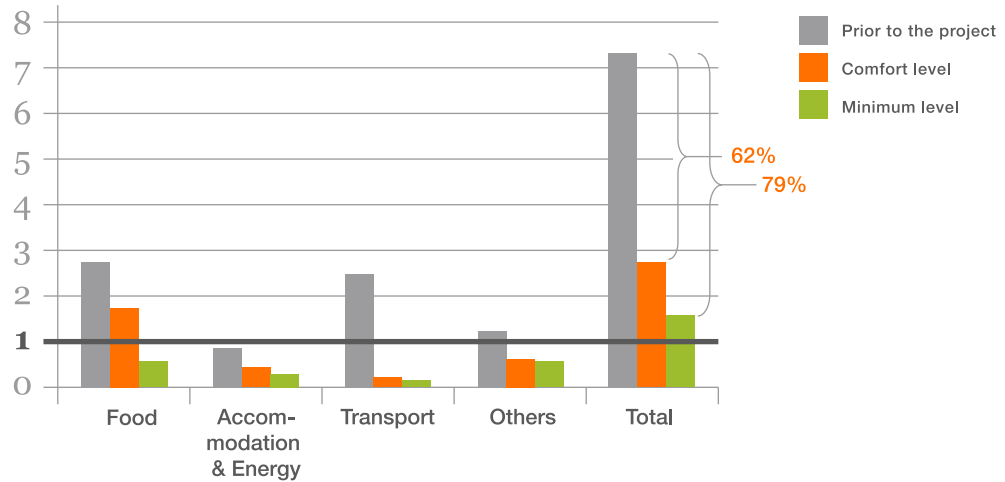
The results consist of two parts in addition to the grey starting level:

Orange level, where the family members were still living a lifestyle that they regarded as normal.

A green minimum level that involved exceptional sacrifices in relation to the normal level.

## The Lindell family's carbon dioxide footprint

CO<sub>2</sub> in tonnes



## Percentage reductions

	Food	Accommodation & Energy	Transport	Others	Total
Comfort level	44%	52%	91%	47%	62%
Minimum level	84%	58%	95%	51%	79%

## The most important measures

	Food	Accommodation & Energy	Transport	Others
<b>The family's comfort level (approx. 2.8 tonnes)</b>	<ul style="list-style-type: none"> <li>Less meat</li> <li>More vegetarian dishes</li> <li>Throw away less</li> <li>Seasonal vegetables and fruit</li> </ul>	<ul style="list-style-type: none"> <li>Energy-efficient house</li> <li>Energy-efficient white goods and household equipment</li> <li>Smarter energy habits (shower, laundry, cooking)</li> <li>Lower indoor temperature</li> <li>Own electricity production</li> <li>Electricity purchased from CO<sub>2</sub>-lean power sources</li> </ul>	<ul style="list-style-type: none"> <li>One car instead of two</li> <li>Electric car charged with CO<sub>2</sub>-lean electricity</li> <li>Public transport</li> <li>Train instead of air for holidays</li> <li>Car-pooling using the electric car</li> </ul>	<ul style="list-style-type: none"> <li>Buy quality, items with a longer lifetime</li> <li>Buy alternatives with a lower CO<sub>2</sub> production footprint</li> <li>Buy second-hand items</li> <li>Cut back on shopping</li> </ul>
<b>The family's minimum level (approx. 1.5 tonnes)</b>	<ul style="list-style-type: none"> <li>Vegan diet, that is to say no meat or fish, replace dairy products with soya and oats</li> <li>Lunch box at work/school</li> </ul>	<ul style="list-style-type: none"> <li>Reduce living quarters at home</li> <li>Extreme economy with water</li> <li>Exceptionally thorough packing of washing machine, very short showers</li> </ul>	<ul style="list-style-type: none"> <li>Rigorous car-pooling with the electric car</li> <li>No travel for recreation or holidays</li> <li>Avoid the bus, take the train or cycle</li> </ul>	<ul style="list-style-type: none"> <li>Cut back on recreation</li> <li>Minimise clothing and other purchases</li> <li>No visits to cafés or restaurants</li> </ul>





## The Lindell test family

The Lindell family consist of Nils, Alicja, Hannah and Jonathan. Here is a presentation of the lifestyle they had before they started looking for a carbon-lean alternative that did not involve too many compromises with their everyday lives. Nils and Alicja Lindell summarised their starting point a follows:

“So far we’ve been good wannabees – we’re aware of the climate problem and want to do something to help. But without a systematic approach our efforts usually take the form of occasional selective measures. In such a situation it’s difficult to feel that what you’re doing is of any real significance.

“But we do have lots of ideas. And now we’ll be better able to make a difference with the house, car and know-how. We’re prepared to change our habits in order to succeed. If it turns out well for us we might even inspire others to change their habits.”



## Nils Lindell

**AGE:** 52.

**PROFESSION:** Organisational consultant, self-employed.

**INTERESTS:** Family and friends, tennis, sailing, skiing and personal development.

**FAVORITE DISH:** Shrimp salad or grilled steak and Italian vegetables.

*"We live a modern urban lifestyle. The children's schools have large catchment areas. Some of their friends live 40 or 50 km away, which makes for a lot of driving. I'm really looking forward to driving an electric car with zero emissions. It will also be exciting to use Vattenfall's smart EnergyWatch system to find out exactly how we use our electricity."*



Nils

## Alicja Lindell

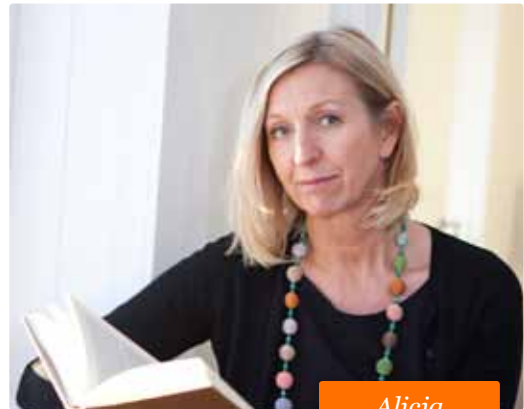
**AGE:** 51.

**PROFESSION:** Deputy head of preschool, currently doing a three-year head teacher course in parallel with her work.

**INTERESTS:** Family and friends, training (Zumba is her favourite), sailing, reading good books, interior decoration and travel.

**FAVORITE DISH:** Saffron-flavoured fish casserole.

*"I can cycle to work in 20 minutes, but with a lot of activities to pack into my agenda I often take the car anyway. We can save a lot of carbon dioxide emissions by planning better and more intelligently. We've already become more aware. Now that other people will be monitoring our progress, it'll be fun to come up with solutions that inspire others."*



Alicja

## Hannah Lindell

**AGE:** 16.

**PROFESSION:** Student at senior high school. First year student at the YBC (Young Business Creatives) International Baccalaureate in Nacka.

**INTERESTS:** Spending time with friends, reading, riding, training at the gym and cooking.

**FAVORITE DISH:** Grilled lamb chops with thyme and potato wedges.



Hannah

## Jonathan Lindell

**AGE:** 13.

**PROFESSION:** Student. Seventh grade at the English School in Bromma.

**INTERESTS:** Computers, judo, skateboarding, playing the drums and guitar, spending time with friends.

**FAVORITE DISH:** Spicy spaghetti Bolognese with pasta.

Before the One Tonne Life project, the family lived in a 34 year old villa made of wood and concrete with an exterior façade of dark red brick. Their house is about 200 square metres in size and is heated with direct-acting electricity supplemented with an air-to-air heat pump. Underfloor heating in some of the rooms on the bottom floor.

The Lindells own two Renault Scenic cars, both petrol-powered.



Jonathan



## Accommodation & Energy

During the project, the Lindells reduced emissions from their home and energy consumption by 60 percent. The single most important contributory factor was their new “One Tonne Life” home, which is not only an exceptionally energy-efficient house but also a producer of heating and electricity.

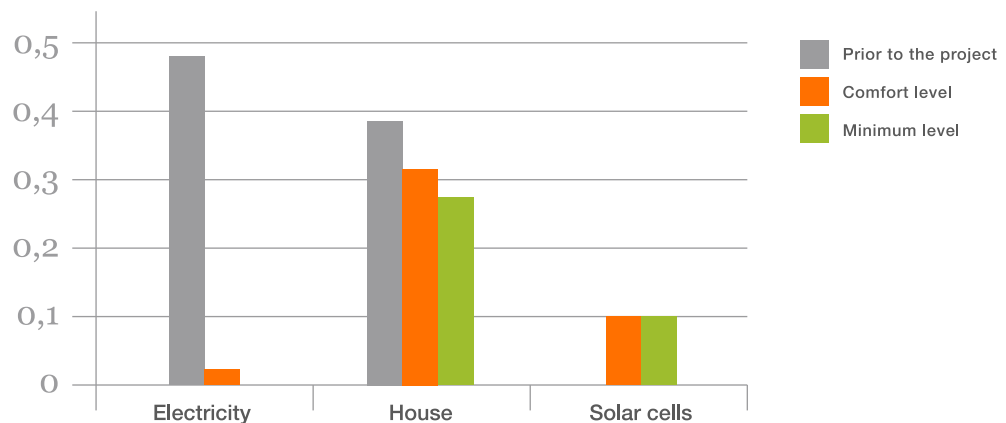
Before the project, the family purchased about 29,000 kWh of electricity a year. During the project this dropped to just 6000 kWh, a reduction of about 80 percent. What is more, on sunny days the house generated a surplus of electricity corresponding to about 1500 kWh a year, supplied to the mains grid for use by other customers. Emissions from construction of the house correspond to about 400 kg of CO<sub>2</sub> per person per year. Maintenance-related emissions must be added to this.

Halfway through the project the family started buying electricity from hydropower. This meant that emissions from electricity dropped considerably since previously, part of their power came from coal-fired stations. As of May the family have started to sell more home-generated electricity to the mains grid than they have needed to buy to run their home.

### *The Lindells on their house*

The best aspect of the house is its combination of modern, attractive design, good function and low energy consumption. What’s more, it’s a great help to have household appliances and white goods that meet the very highest energy standards. There is also the purely financial aspect – the extractor fan alone saves more than a thousand kronor a year in electricity bills.

Living energy-efficiently is not difficult. It’s easy to keep the house warm. We haven’t felt that the house gets too warm in the summer, nor have we noted any problems with stale air or similar problems. We’ve lived just as we always do. It’s only a matter of thinking things through, for instance filling the washing machine to capacity and so on.

Tonnes CO<sub>2</sub> equivalent/person and year*The Lindells on energy*

We've become really aware during the project. We monitored EnergyWatch several times a day and tried to chart and minimise our energy consumption. It was surprisingly easy to live energy-smart yet comfortably.

The choice of renewable electricity was naturally important for our total climate footprint. It feels good to have renewable electricity in our wall sockets. It was also really satisfying to produce our own electricity and heating – it's great to know that other people can use the energy produced by our house.

*The Lindells on household appliances*

The new white goods are much faster and simpler than the ones in our own home. The refrigerator keeps the food fresh for longer, so we don't throw away as much food as we used to. The cooker is also convenient, with its different zones, and it is really fast. The oven is simple and easy to work with.

Owing to our concern for the climate, we've started to focus on washing all the dishes in the machine since it is better from the CO<sub>2</sub> viewpoint. Not only that, we were advised to use just half as much detergent – there's no need for more.

*Comments from A-hus*

Our goal and contribution in this project as a builder of wooden houses was to develop and construct a climate-smart house with unimpaired comfort, good function and an attractive design. A massive CO<sub>2</sub> reduction of 60 percent from the house and positive feedback from the family indicate that we've succeeded well in our aims.

*Comments from Vattenfall*

The Lindells succeeded in cutting their energy usage by more than 80 percent. This was achieved partly with the help of a highly energy-efficient house and partly because the house produces its own solar energy. This means that the carbon dioxide footprint from production of the house and its components including its solar panels becomes relatively more significant. Which in turn emphasises the holistic perspective of living climate-smart – it's not just carbon dioxide emissions from use of a product that should be taken into consideration but also emissions from its manufacture and the product's lifetime.

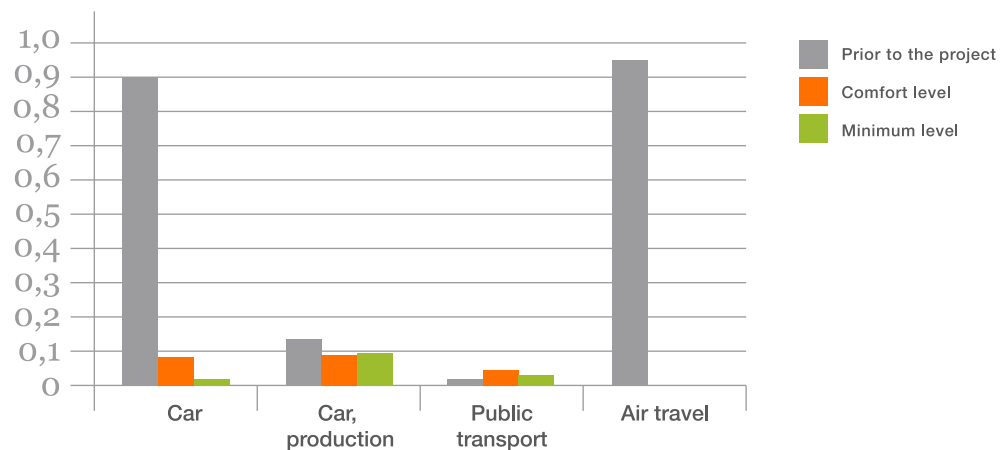




## Transport

In 2010 the Lindells covered a lot of mileage in their two petrol-powered cars, and also flew to Greece for holiday. Since the family chose a skiing holiday in Åre in Sweden instead of the Alps, emissions from transport were minimised.

The other important measure is that the family switched from two cars to just one, and in fact have driven less than one-third as much as they did before the project. Instead, they have car-pooled more and used public transport. To this should be added the fact that the electric car is not only energy-efficient – the Lindells also chose to buy electricity from hydropower, which reduced their greenhouse gas emissions to about 0.9 g/km instead of about 200 from each of their previous cars. The combination of lifestyle changes and new technology meant that emissions from transport were cut by almost 95 percent.

Tonnes CO<sub>2</sub> equivalent/person and year*The Lindells on transportation*

We just loved the electric car. There weren't any problems with it at all and we'd really like to keep it! The Volvo C30 Electric is quiet, comfortable, pleasant and feels really safe. Not only that – it's alert and fun to drive.

It was simplicity itself to recharge the car. In practice, we've only ever hooked the car up to the mains when we returned home, we've never needed to charge it during the day. One charge was always sufficient for our daily needs.

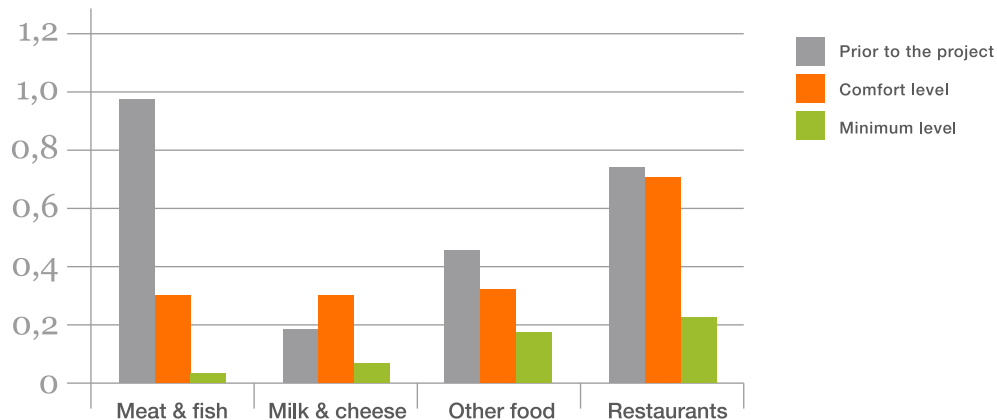
*Comment from the Volvo Car Corporation*

The project proves that an electric car recharged with renewable energy offers considerable scope for reducing the climate impact of a normal family without impairing quality of life. The results show that we are on the right track in our product development. Electric cars are a natural transport medium in a sustainable society. Of the family's total rucksack of 900 kg, production of the electric car accounts for 95 kg.

The family have also had access to a pool car when necessary. Since pool cars are a service purchased by many people, many people accordingly share the climate impact from production of these cars.

*Comment from Vattenfall*

The transition to electricity as a fuel for the family's car was a major contribution to reduction of carbon dioxide in the transport category. Both owing to more effective energy utilisation because the electric motor has a far higher efficiency rating than a combustion engine does, and also because the electric car could be run on carbon dioxide-lean energy from renewable electricity sources. This confirms that electrification of the transport sector is an important tool in the establishment of a sustainable society.

Tonnes CO<sub>2</sub> equivalent/person and year

## Food

Climate impact from food is caused by carbon dioxide emissions, methane from cows' stomachs and the handling of fertiliser, and nitrous oxide from fertilised arable land. The Lindells received information regarding emissions from different types of food, tips on how to avoid wasting food as well as inspiration for cooking tasty and attractive meals.

The first thing the family did was to:

- minimise the amount of food they throw away by using leftovers to cook tasty dishes, and also by storing fresh foods properly so they last longer
- eat seasonal vegetables and fruits. Half a kilo of fruits and vegetables a day is good for the environment as well as one's health
- vary their choice of meat and opt for fish and vegetarian meals one or more times a week. Chicken and pork are better meat choices from the climate viewpoint, but when animals graze out in the open, they perform a vital undergrowth clearing service that benefits many plant and animal species.

Through these measures, the family halved their climate-impacting emissions from food.

Towards the end of the project, the family decided to try and minimise their emissions from food as much as possible. They stopped eating meat and fish, replaced dairy products with soya and oats products, and only ate seasonal vegetables. They stopped eating lunch in school and work canteens, taking a lunch box from home instead. This way they cut their emissions from food by 80 percent compared with their baseline before the start of the project.

### *The Lindells on food*

The biggest difference is that we've reduced our consumption of meat and dairy products. We've even tried climate detox! That was an interesting experience but it's not something we'll do for more than a fortnight a year.

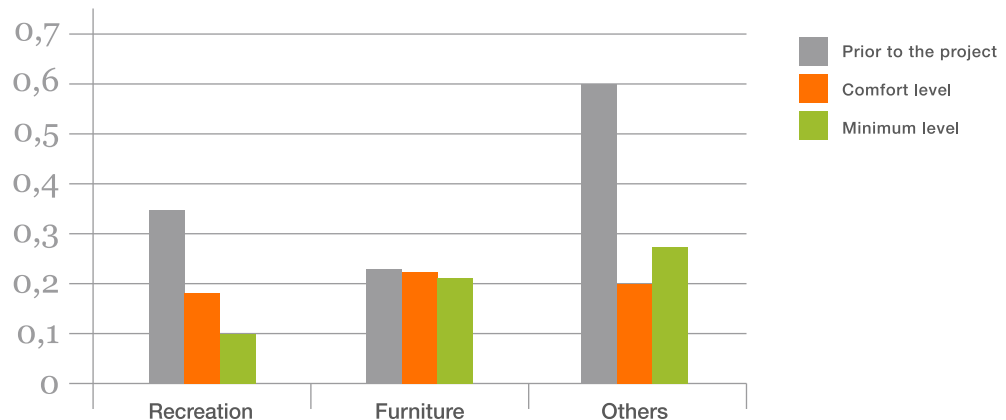
From the climate viewpoint it was interesting to learn that locally produced food does not necessarily mean it has low CO<sub>2</sub> emissions. On the contrary – locally produced meat may be worse for the climate than imported vegetables.

We'd like to see quick-reference guides in stores that provide more information on how to choose food to minimise climate impact. Many would like to do this, but it's important to provide the right know-how and to dispel the myth that it's expensive, tricky and difficult to eat climate-smart.

### *Comment from ICA*

Work on reducing the climate impact of food was implemented gradually since it requires quite a lot of patience to make lasting changes to one's diet. During the project, we also monitored the nutritional value of the food the family ate so that in the beginning the family not only halved their climate-impacting emissions from food but did so while eating more nutritious and healthy meals. If more people were to adopt the initial relatively simple steps described here, it would have a fairly large effect on both climate and health.



Tonnes CO<sub>2</sub> equivalent/person and year

## Others

This category includes things such as insurance, the hairdresser, clothes and furniture. In this category the family did not have any new technology to help them improve their choices. Instead, what they did was to consume less of the most emission-intensive activities and, if they wished, focus more on the less climate-impacting activities.

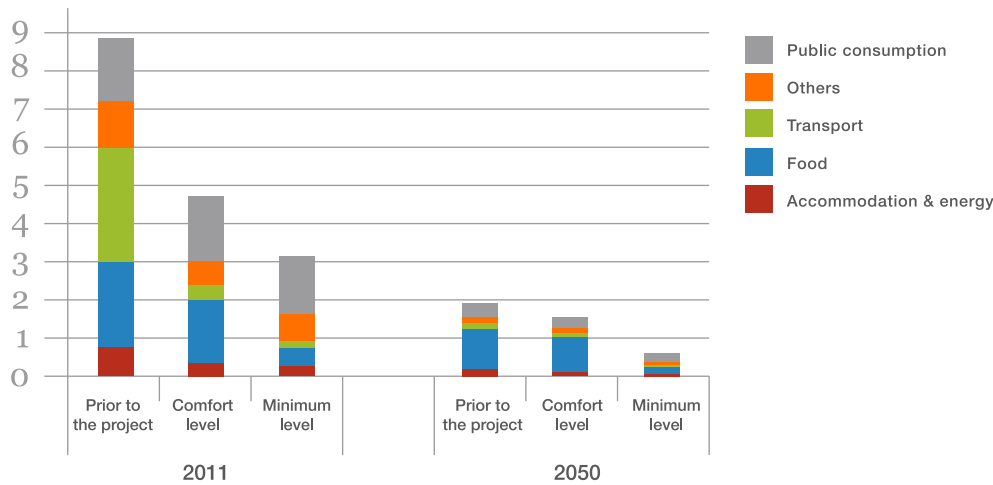
The reason why shopping generates emissions is because companies that manufacture goods or provide services use trucks that run on diesel, electricity produced wholly or partially from fossil fuels, or industrial processes powered by gas and/or oil. The individual consumer has very little scope for influencing these emissions.

The Lindells focused primarily on limiting their consumption, and quite simply shopped less. Towards the end of the project they also decided to stop a number of their recreational activities, thus further cutting their emissions. All told the family succeeded in halving their emissions of greenhouse gases from shopping in the “Others” category.

### *Comment from the City of Stockholm*

The “One Tonne Life” project has given us a unique opportunity to see how cuts in greenhouse gas emissions can be implemented in everyday life. The project has also allowed us to verify that it is possible to come down to sustainable levels without impairing one’s quality of life. Good technical solutions are one of the preconditions for living climate-smart. Sensible choices of goods and services are another. The project showed that today’s spearhead technology can dramatically reduce climate impact from accommodation and car travel. But in order to achieve absolute sustainable levels, it is also necessary to adopt a well-thought-out lifestyle, for instance through car-pooling and careful journey planning, along with reduced consumption of meat and dairy products. In “One Tonne Life”, information has been crucial to the family’s positive lifestyle changes.



Tonnes CO<sub>2</sub> equivalent/person and year

## A look at the future – what happens if we adjust society to fit in with the Lindell family?

On behalf of the “One Tonne Life” project, the Chalmers University of Technology analysed the effect of projecting the Lindells about 40 years into the future, by which time society, including energy infrastructure, transport, construction sector and food industry, can be expected to have undergone changes that would make them compatible with the long-term target of one tonne.

The following assumptions were made:

Electricity production in the future will be largely based on hydropower, which will account for almost half of all electricity production. One-fifth of electricity will come from windpower and a somewhat smaller proportion will come from bio-energy and nuclear power respectively. Solar cells will supply about one percent of electricity in the future.

Tomorrow’s vehicles will in the main be powered by electricity or biofuel, as well as a small proportion of fossil fuel. Heavy industry will continue to rely partly on fossil fuels, but with the implementation of carbon dioxide capture and storage. Industry will also increase its use of bio-energy. The heating requirements of homes will decrease in the future as we will be building more energy-efficient houses and they will primarily receive their heat from heat exchangers and solar energy.

Food is the category that generates the greatest emissions of methane and nitrous oxide. Methane is generated primarily from cows’ stomachs and the handling of fertiliser, while nitrous oxide comes from fertilisation of arable land. These emissions can be reduced by altering animal feed, increasing productivity and optimising the quantity of fertiliser. If these measures are introduced, greenhouse gas emissions from beef can be reduced by about 15–20 percent.

The first bar in the graph illustrates greenhouse gas emissions from before the project started.



**FOOTNOTE:** Analysis of the future also includes carbon dioxide from public consumption, hence the higher figures.

The second bar in the graph corresponds to the comfort level when the family has access to the very best available technology but with unchanged lifestyle. The last bar corresponds to the minimum level when the family members change their lifestyle and largely exclude meat and dairy produce from their diet.

By using the best available technology with today's energy system, emissions of greenhouse gases can already be almost halved. If the same measures were adopted in a future energy system, the reduction would be far smaller. This is because the measures the family take today differ more from the current system than will be the case in the future.

Towards the very end of the project the family changed their lifestyle, for instance by excluding meat and milk from their diet. The graph shows that in percentage terms, this measure would have a greater effect in the future than it does today. The reason is that food accounts for a much greater proportion of emissions in the future scenario than it does at present. This is because the technical scope for reducing these emissions is less than emissions from the energy supply system.

The results show that several things are needed concurrently in order to get down to one tonne of CO<sub>2</sub> per person and year. For one thing, it is necessary to modify the energy system, but with that measure alone emissions in this scenario would be about 2 tonnes per person per year. Only when lifestyle changes are added – with diet playing a major role – can total emissions be reduced to about one tonne.

So all in all, a genuine "One Tonne Life" would appear to require effort both by companies and by politicians – as well as by the individual.





[www.onetonnelif.se](http://www.onetonnelif.se)

*The One Tonne Life project is an initiative by:*



*In cooperation with:*

