



Living in more sustainable

Homes

trends/innovation/levers and beyond

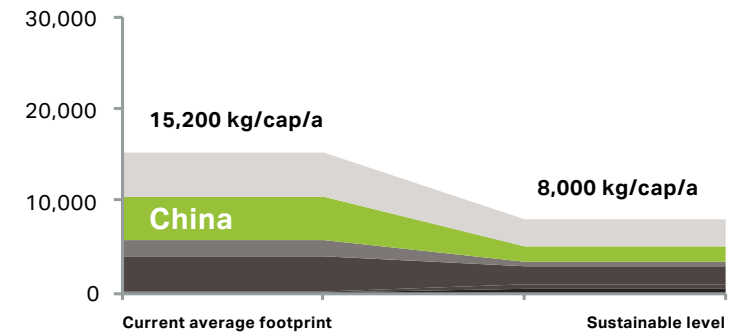
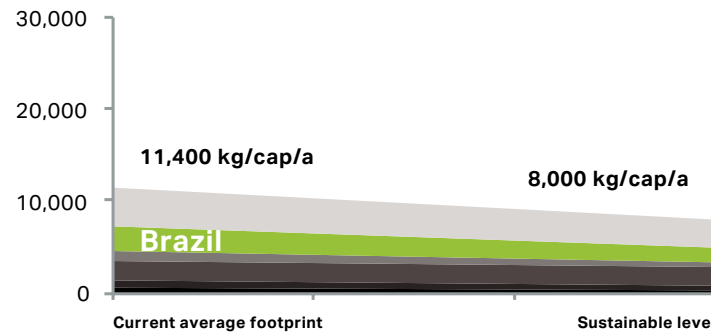
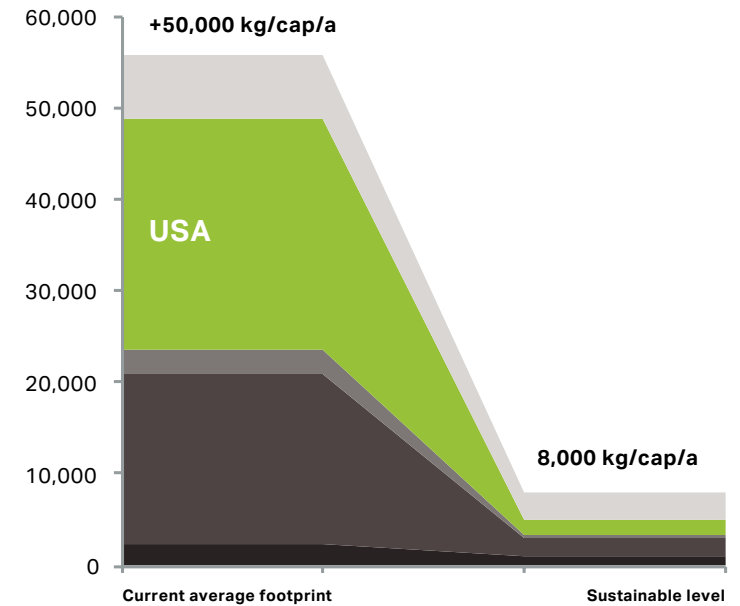
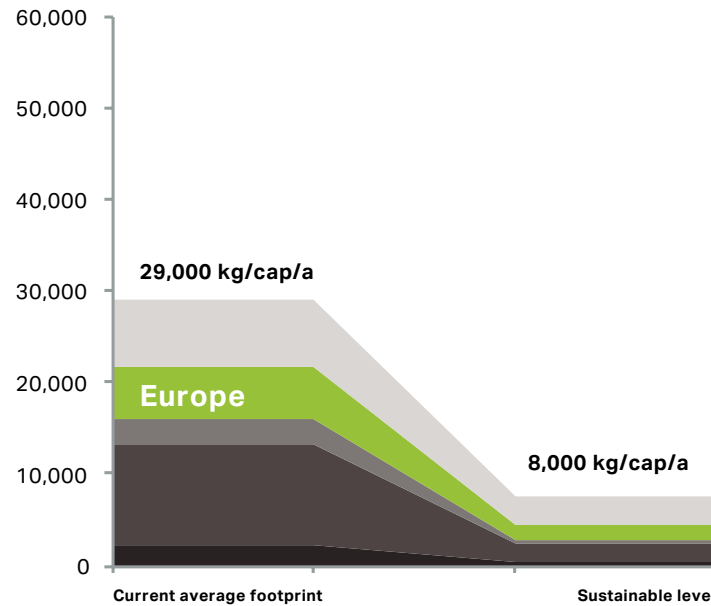
Our homes contribute less to our lifestyle material footprint in Europe than elsewhere. But they are still a major factor

What is a lifestyle material footprint?

A lifestyle material footprint shows the material intensity of resources that go into the products we consume as part of our lifestyles. All numbers refer to calculated kilogrammes of materials used per person per year.

How are they calculated?

You can find out further details on the calculation of the lifestyle material footprint in our [explanatory document](#). The data we use here for Europe comes from the EU's Spread2050 Project, while the Brazil and India data has been drawn from CSCP and D-Mat analysis following research performed for WBCSD in 2015. The US footprint is an estimate based on CSCP and D-mat internal data on material intensities for Europe, combined with recent US official household consumption data publicly available online.



● Food & nutrition ● The home ● Household goods ● Mobility ● Leisure

In Europe, home footprints are driven by electricity and living space

LIVING SPACE INCREASING

Average living space per person in the EU-15 increased from 31 to 38 m² between 1990-2007.

CONSUMPTION IS RISING

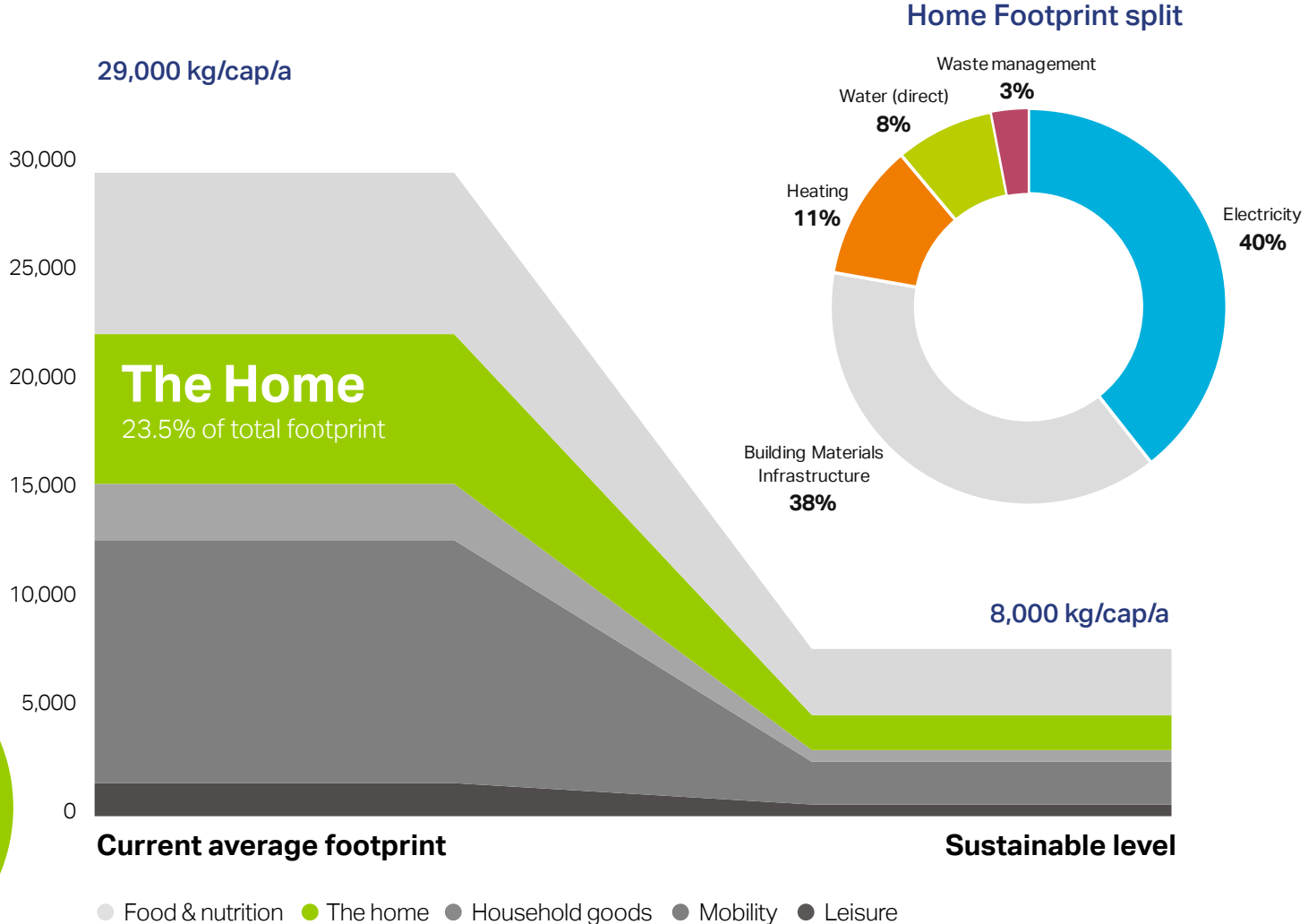
Residential electricity consumption per capita increased by over 27% in the EU-28 in the last 25 years.

RENEWABLES ALREADY AHEAD OF COAL

EU-28 Gross electricity production by fuel in 2013:¹

- 27% Nuclear
- 27% Renewables
- 26% Coal and lignite
- 17% Natural and derived gas
- 2% Oil
- 1% Other fuels.

The challenge:
Reaching an environmentally sustainable level will require a 76% reduction in the average European home footprint.



What does a Europe with sustainable homes look like?

Living more sustainably will require dramatic reductions in impacts, but what can we achieve today? How far do current technologies take us? What business models, policies and behaviors will be required? We have asked these questions to help us imagine what more sustainable homes will look like.

People live in resource-efficient homes such as “Factor 2” houses. They’re designed with eco-materials and incorporate circular economy principles. Where possible smart, renewable and net-zero energy and water facilities are in place. Living space is optimised through intelligent design. Communities share resources and space that’s currently acquired and used individually, allowing more people to enjoy a high quality of life in a smaller overall space.



Solution pathways

delivering more sustainable homes are already available today

Home solutions



1 Renewable energy use



2 Smart space use



3 Resource efficient buildings

1 Resource efficient buildings

The hotspot Resource-heavy buildings

Moving from a conventional to a “Factor 2” house, which requires half the amount of resources to build, has the potential to reduce the average home footprint by 19%, and the total average European lifestyle material footprint by 4.5%.

In terms of resources and emissions savings, better construction and better use of buildings have the potential to influence 42% of our final energy consumption, circa 35% of our total GHG emissions, 50% of extracted materials, and reduce water consumption by up to 30% in some regions.²

Examples of existing solutions that can deliver Factor 2 homes

Products

Advanced materials such as insulation, insulating paints, recycled steel beams, smart glass⁴ and thermal bimetals.⁶

Innovative heating solutions including micro heat pumps and solar energy generation integrated into pre-fabricated timber facades.⁷

Ventilation, including self-regulating ventilation systems with a heat recovery system, and cross-ventilation integrated into building design.⁴

Biophilic design, such as green walls (see image) for water cooling.⁶

Cool roofs that keep the building cooler, lowering energy needs from air conditioning and reducing the collective ‘heat island’ effect in urban areas.⁴

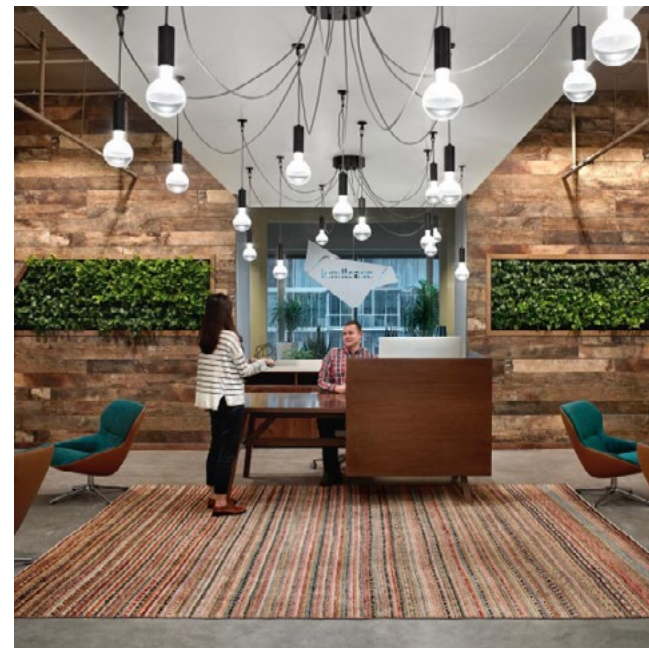
Business models

Licensing or renting solutions, such as renting lighting or heating systems instead of owning them.⁶

Policies

Nearly 90 countries worldwide have now included building sector actions in their Nationally Determined Contributions (NDCs) in support of the COP21 Paris Agreement.⁸

A coalition of over 90 states and non-state actors has formed the Global Alliance for Buildings and Construction to raise awareness of the building sector’s huge climate action potential.⁸



126 likes TW

hastingsarchitecture On track to be #Nashville's first #WELL-Certified space, Lendlease's new office is an agility-based work environment that subscribes to a #biophilic philosophy 🌿 #1201demonbreun aerialInnovations_tn Amazing space! onectly Love that green living wall! uabuilders Significant!

 Add a comment... ⋮

1 Resource efficient buildings



Trend

Green building doubling every three years

Market growth: The global green-building sector continues to double every three years and emerging economies such as Brazil, India, Saudi Arabia and South Africa are expected to be engines of green-building growth, with development varying from two-fold to six-fold over current green building levels.³

In the US, operational cost savings and tax credits have spurred the sector's rapid growth over the last decade. No government mandates were needed. From about \$10 billion in 2005, green construction spending is projected to reach almost \$250 billion in 2018.⁹

Consumer demand: Increasing demand over the last 20 years has pushed the world's green building market to a trillion-dollar industry in 2016, a surge that has led to a corresponding increase in the scope and size of the green building materials market, which is expected to reach \$234 billion by 2019.³

Space heating currently accounts for more than one-third of global energy use in buildings and will continue to be a major energy-consuming end use to 2050. Space cooling is a smaller portion (roughly 5% today) of global energy demand in buildings. However, it is the fastest-growing end use in buildings and could increase by as much as tenfold by 2050 in some warm-climate, rapidly emerging economies.⁸ For instance, in Brazil, new easier access to credit has led to significant increases in the use of home AC units.



The innovation frontier

Internet of things and circular solutions

Leveraging investments in eco-innovations: Only a small share of innovation investments by companies in the construction sector are related to eco-innovation. In Europe, 35% of construction companies invest less than 10% of their innovation investments in eco-innovations, and only 5% report investing more than 50% of overall innovation spending on eco-innovations.¹⁰

Internet of things and cognitive building solutions.^{11,6}

Products and solutions for construction design such as augmented reality software.¹¹

Solutions for renovating and retrofitting buildings.¹²

Upcycled, circular economy and cradle-to-cradle solutions will demand the co-creation of new targeted **socio-technological solutions** i.e. combining technology with social and behavioural realities (e.g. recycling). New interdisciplinary R&D opportunities will be revealed.¹¹

Innovative business models that support the supply of performance-based or service-based solutions.

Solutions to improve building-envelope efficiencies – including ramping up the energy performance of heating and cooling equipment and reducing growing global demand for mechanical conditioned thermal comfort (e.g. through natural cooling solutions).⁸

2 From 40 m² to 20 m² personal space

The hotspot "Living large" – excess living space

Reducing living space from 40m², the average living space per person in Europe¹⁰, to 20 m² has the potential to reduce the average European home footprint by 19% and the total average European lifestyle material footprint by 4.5%. Halving the living space has a similar effect to moving into a Factor 2 house.

Average CO₂ emissions from European floor space is 54 kgCO₂/m² per year based on CO₂ emission factors for different energy products and for electricity production (so not taking into account construction-related emissions). This means 20m² less living space would result in around 1,000kg less CO₂ per year related to energy consumption at home – equivalent to an average car being driven for nearly two days non-stop.¹⁴

Examples of existing solutions

Products

SmartSpace SoMA in San Francisco is a complex of sub-300sq ft apartments. The urban infill lot provides 23 studio apartments with full kitchens and fold-out beds. The project is currently aiming for LEED Platinum certification and has secure bike parking along with an on-site City CarShare lot.¹⁸

Business models

Co-housing based on membership. For example, the co-housing model 'Gaining by Sharing' in Norway or 'WeLive' in the US.¹⁹

Flexible shared co-working spaces offering all the advantages of office life while allowing individuals and small businesses to work independently and without big overhead costs.⁶

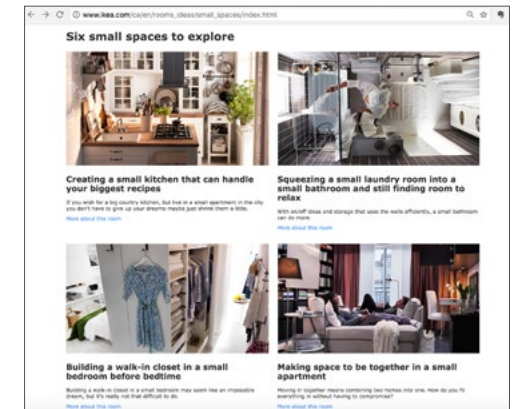
Mobile office spaces where digital nomads can work in the middle of nature. For instance, Kantoor Karavan offers solar-powered trailers complete with Wi-Fi and other necessities. Workers can simply bring their laptops and plug in, individually or in groups. Use can be paid in kind.²⁰

Policies

The German public initiative Mehrgenerationenhaus (or "Multigenerational house") supports innovative co-housing schemes to foster interplay between generations, exchange of skills and social cohesion, with a federal budget for 2015 of about €16 million.²¹

Communications

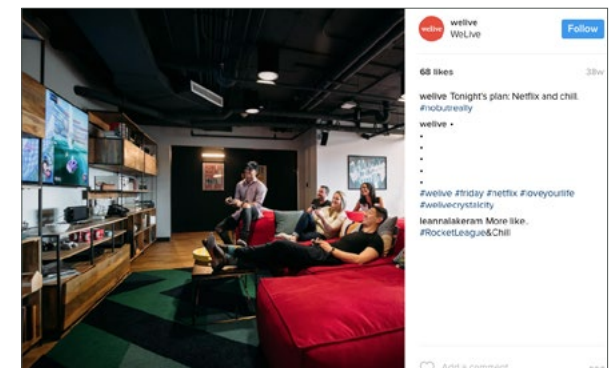
IKEA offers solutions based around 25m² of living space per person.



Source: Ikea



Source: Kantoor Karavan



2 From 40 m² to 20 m² personal space



Trend

Innovation districts and co-housing & working

Innovation districts: In many European cities there's a shortage of suitable housing, leading to high rental and real estate costs. Lifestyles are also changing, bringing new or revamped formats for real estate, for instance, student housing, retirement villages, nursing homes and multi-generation houses. "Innovation districts", characterized by physically compact and technically-wired spaces, good transport links and mixed-use housing, office and retail solutions, are on the rise across major cities worldwide.²²

Co-housing market growth: 8% of Danish households are now "co-housing" and 5-10% of new homes constructed are operated by a housing cooperative.²³

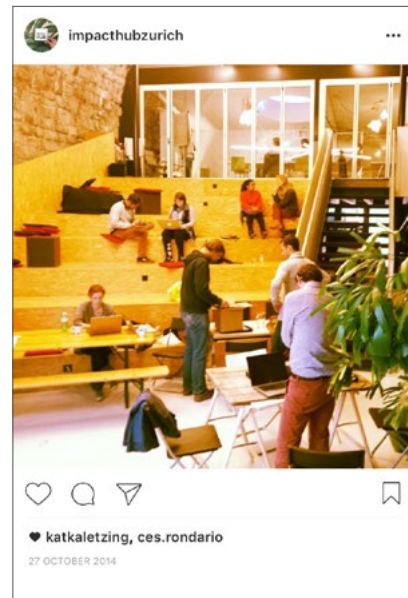
Co-working market growth: According to online magazine *deskmag*, which conducts an annual Global Co-working Survey, the number of co-working locations like The Trampery, TechHub, and Central Working grew by 36% in 2015, and the number of members grew by 46%.⁶



The innovation frontier

Smart design

Make the use of smart and shared space aspirational: Shared and reduced-space use is still associated with 'alternative lifestyles'. Co-housing developers are often hindered by biases and assumptions about what co-housing is. There is an opportunity to innovate the way smart- and shared-space is communicated, to make it more aspirational and therefore commercially attractive.²⁴



Make co-housing mainstream by getting real-estate developers on-board: In the US, architectural firms and real-estate developers are becoming more specialized in co-housing residential models.²⁵ Benefits of co-housing to people like senior residents and students have a commercial value, and realising such value can make co-housing more appealing to businesses.

Creating new finance models: Although financial structures for co-housing are diverse, it's still challenging for a group of people to get construction loans or special mortgage conditions. So they often need a lot of cash upfront to kick off a co-housing project. Innovative finance models are needed in order to enable new housing schemes to become mainstream.²⁶



3 Net zero water use and 1,000 kWh renewable energy use (p/a)



The hotspot "Pouring it on" water and energy use

Currently, average European water and energy consumption is over 50,000 l/year and 6,860 kWh/year respectively. If we can reduce that to net zero water use and a cap of 1,000 kWh of renewable-based electricity use, we could potentially reduce the average European home footprint by 54% and the total average European lifestyle material footprint by 13%.



Trend Cost reduction and more

Clean new electricity: In 2015, for the first time, renewables accounted for a majority of new electricity worldwide, with more than half of the total \$286 billion investment in wind, solar and other renewables taking place in countries such as China, India and Brazil.³⁴

Generation increase: Excluding large hydroelectric plants, 10.3% of all electricity generated globally in 2015 came from renewables, about double the amount in 2007.³⁴ Renewable energy production continues to rise in the EU: in 2014, renewable energy provided 16% of gross final energy consumption, up from 8.5 % in 2004. Over the same period, gross electricity generated from renewable sources reached 27.5%, up from 14.4%.



The innovation frontier Technology scale-up

Cost reduction of renewables: The average global cost of generating electricity from solar panels fell 61% between 2009 and 2015 and 14% for land-based wind turbines. It is forecasted that, by 2020, India could provide solar energy up to 10% cheaper than electricity generated by burning coal.³⁴

Scaling up technology: Storage technologies – e.g. batteries that are able to store energy for use when the sun is not shining and the wind isn't blowing, are still expensive, though their costs are falling.^{35,36}

The operation and design of power systems needs to be transformed to integrate high shares of wind and solar. System integration measures are essential to give power systems sufficient flexibility: these include stronger grids, the availability of plants ready to dispatch power at short notice, incentives for system-friendly deployment of renewable technologies, demand-response and energy storage. Without such measures, variable renewables risk being idled in times of abundant generation and lose effectiveness as decarbonization options.³⁷

3 Net zero water use and 1,000 kWh renewable energy use (p/a)

Examples of existing solutions

Energy products

For instance, MIT's ultra-thin, flexible solar cells deliver 6 watts of power per gram of weight and are as light as a soap bubble.²⁹

Water products

For instance, grey water recycling solutions within domestic homes in combination with rainwater harvesting systems³⁰ and on-site sewage treatment.⁴

Services & infrastructure

Such as providing district heating through waste heat (98% of Copenhagen's district heating system, for example).³¹

Super efficient districts

Such as the low-energy and passive home-based quarter "Vauban" in Freiburg, Germany.³²

Policies

For example, the energy transition policies under the Energiewende in Germany.³³



Shower System Recycles and Cleans Water

Solution by **Orbital Systems**

ENVIRONMENTAL
Orbital Systems' shower unit slashes water consumption of showering by almost 90% compared to conventional showers.

SOCIAL
The shower unit creates awareness on water usage in people's daily lives.

ECONOMIC
By reducing water and energy consumption, the Orbital Systems shower unit lowers customers' utility bills.

Developed: Sweden
Deployed: Estonia

"ORBITAL SYSTEMS IS AN EFFICIENT TECHNOLOGY INNOVATION WHICH ALLOWS FOR BOTH **FASTING PROFITABILITY** WHILE CONTRIBUTING TO A **MORE SUSTAINABLE PLANET**."
Niklas Zennaro, Mentor and Investor, Orbital Systems

→ **Orbital Systems' efficient shower unit saves up to 90% water and 80% energy, while increasing comfort and hygiene.**

This solution is an innovative water recycling technology for homes and public recreational buildings. Orbital Systems states that the shower unit can save over 90% on water by **pumping it through a filter and reusing it during the same shower**. The water is purified to drinking quality, and in most cases leaves it cleaner than the original tap water.

For a 10-minute shower, the system uses just five liters of water while an ordinary shower would use 150 liters of water. The water is already heated and therefore the system uses up to 80% less energy than regular shower systems.

Why a Sustainia100 solution?
Showering is one of the largest sources of water use in Western homes. Orbital Systems has developed a solution that addresses this issue without disrupting the comfort of everyday living. The solution has already been installed in several public recreational centers in Sweden, and has proven to clean water effectively at an affordable price.

The Orbital Systems shower unit purifies shower water to drinking quality level, pumps it back up in the system in a recycling loop, and discards the water after shower session is ended.

Source: Sustaina100 2014

Solution pathways

Summary

1



Resource efficient buildings

Hotspot: resource-heavy building (19% footprint reduction potential)

Solutions: advanced materials, cool roofs, rental & policy

Trend: green building doubling every three years

Innovation frontier: internet of things & circular solutions

2



From 40 m² to 20 m² personal space

Hotspot: excess living space (19% footprint reduction potential)

Solutions: small-space design, co-housing models & policy

Trend: innovation districts & co-housing & co-working

Innovation frontier: smart space and new finance models

3



From average to net zero water use and 1,000 kWh RE use yearly

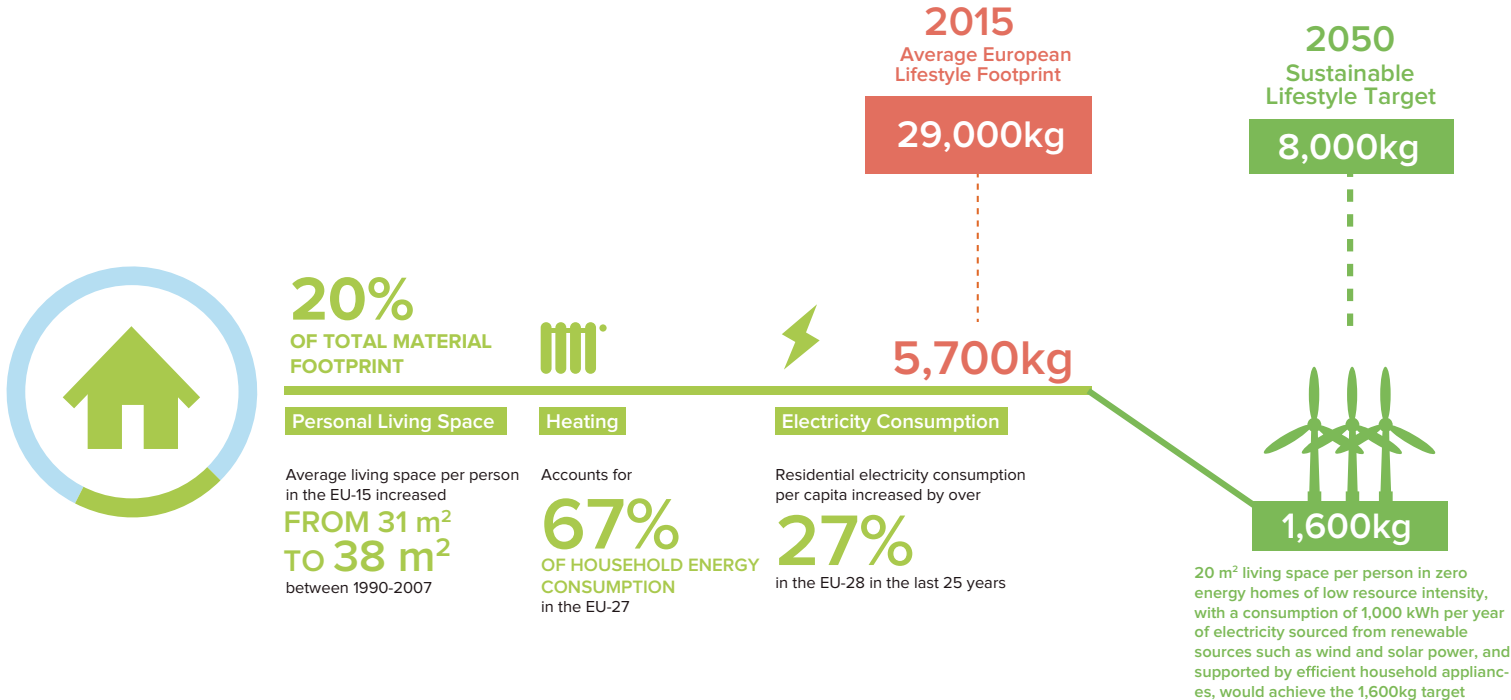
Hotspot: water and energy use in home (54% footprint reduction potential)

Solutions: domestic renewables, grey water & infrastructure

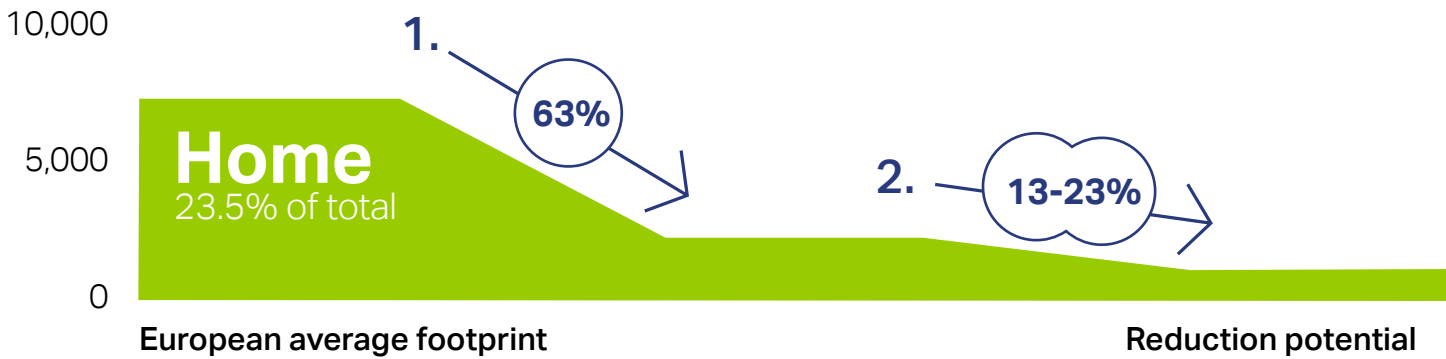
Trend: cost reduction for renewables & higher adoption

Innovation frontier: scaling up renewables generation and batteries

Home footprint and reduction potential



1. A home 100% powered with renewable sources of energy, with 80 m² of area shared by a family of 4 people, would have the potential to reduce the average European Home Footprint by 63%, getting close to the 76% goal.
2. If that home was also designed to "Factor 2" standards, the reduction would be 86% - taking us even further than the 76% needed to reach a sustainable level.



Other benefits (sweetspots) provide even more incentives for moving to more sustainable homes

Resource-efficient buildings save money, improve quality of life and even increase productivity.

It's estimated green buildings enable 14% savings in operational costs over five years for new buildings and 13% savings over five-years for retrofit and renovation projects.¹⁵ Furthermore, the sales value of buildings increases.⁴

In a 2013 survey by BREEAM, 60% of client organisations whose buildings had been certified reported improved occupant satisfaction, comfort and indoor air quality in those buildings.²

Research also indicates better ventilation, lighting and heat control, improves workers' performance and could significantly boost productivity in monetary terms.⁵

Smaller, smarter living spaces can also improve quality of life and save costs.

In a study by the Co-housing Association of the US, co-housing was found to increase quality of life and even physical health across all ages.¹⁵

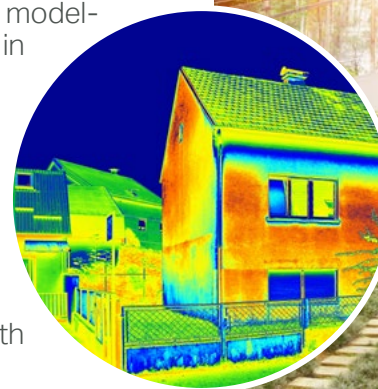
A survey of 200 co-housing residents in the US showed cost savings a month were a minimum of \$200 per household, with some saving over \$2,000. With the addition of solar energy systems, residents at Nevada City Co-housing are actually earning money on their electric bills.¹⁶

For most Americans, 1/3 to 1/2 of their income is dedicated to the roof over their heads.¹⁷ Living in smaller homes means lower costs.

Net zero water and energy investments give a great return as well as being good for public health.

In a 2012 study by the Association for Public Service Excellence (APSE) UK about the impacts of renewable energy schemes on local economies, researchers discovered a £1 investment in renewable energy schemes delivered an average £2.90 in benefits, an almost threefold return on investment.²⁷

Generating electricity from renewables reduces the need for fossil fuel generation, decreasing emissions. According to model-based simulations done in the US, this can lead to savings ranging from US\$5.7 million to US\$210 million annually per renewable energy project (depending on type, size and location) in monetized public health benefits.²⁸



Most existing resource efficient buildings to date are office buildings, so most literature available on the topic, incl. with regards to its benefits, are based on office experience. We consider that it would also be valid in the home realm.



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Home

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