

International Praise for *The Secrets of Finnish Sauna Design*

Sauna can be good only if it has good LÖYLY. Unfortunately this is not the case in many saunas. It is easy to build a sauna that has good LÖYLY if you know the basic rules. This book will give you the instructions how to design the sauna so that it will have good LÖYLY.

Risto Elomaa,
President,
The International Sauna Association

Although the Finnish sauna and having a sauna bath are long-standing cultural traditions, not much is written on the subject of their design. The author's well-presented survey offers a comprehensive view of the sauna and – in addition – takes the reader on an enjoyable journey to the very center of what it means “to have that sauna experience”.

Hannu Saintula,
President,
The Finnish Sauna Society

Saunas are currently attracting an immense amount of interest around the world. One reason is that Finnish sauna added to UNESCO's Cultural Heritage List in 2020. Also more and more people are interested in their own well-being, and some of these people are seeking out more information about Finnish saunas. This book will give you a good mix of information and tips for building your own Sauna. We at Sauna from Finland wish that as many people in the world as possible could enjoy the authentic Finnish sauna experience.

Carita Harju,
Executive Director,
Sauna from Finland

Read this book, if you want to understand how to create an enjoyable, functional and healthy Finnish sauna bathing experience. Lassi A. Liikkanen is one of the most rigorous sauna gurus of his generation and this book makes his extensive knowledge available to a worldwide audience.

Mika Meskanen,
Co-founder and Chair,
British Sauna Society

I can say without question that we need more books about understanding sauna design concepts. I also know Lassi and his work, which means I know this book will be genuinely helpful — whether you are designing a sauna, or whether you just want to understand more about sauna. This will be a valuable contribution to English-language knowledge, and I encourage as many people to support it as possible. Spread the good heat!

Jack Tsonis,
President,
Australian Sweat Bathing Association

Those seeking to understand sauna, or build their own, will appreciate the deep, Finnish perspective presented in The Secrets of Finnish Sauna Design.

Christopher Rice,
Sauna Hound and Moderator of the
Wood-Burning Sauna Group on Facebook

The Secrets of Finnish Sauna Design

Lassi A. Liikkanen



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The Secrets of Finnish Sauna Design

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Liability Disclaimer

This book intends to provide good and reliable advice but publisher takes no responsibility for consequences of applying information found within this volume. Before building or renovating a sauna, make sure your sauna designs, intended materials, and equipment to be installed are in accordance with local laws and requirements, as well as within the terms of possible insurances. Saunas and their equipment must always be operated by adults or under adult supervision.



The Secrets of Finnish Sauna Design in Brief

1. **Steam**, or löyly (pronounced lur-lou, /'løyly/, ['løyly]), is the essence of Finnish sauna. Comings and goings of löyly keep the sauna air constantly changing, affecting the feeling of heat as well as the scent of the air. In typical conditions, löyly orchestrates an intricate change in the sauna dew point, replacing cooling perspiration of skin with hot condensation.
2. **Heat** comes from the sauna heater and naturally rises to the top part of the sauna room. In a bit of time, the sauna room warms up and becomes the source of radiant heat. However, the real treasure is the pile of hot stones in the heater which store heat to be released during bathing and creation of löyly.
3. **Refreshing air** is an often-missed ingredient in the sauna conditions. Proper ventilation is the best guarantee for prolonged enjoyment of sauna sessions. Components of air quality as well as some details of ventilation remain a mystery, but exploiting the laws of physics help to keep the air fresh.
4. **Interior design** may catch your eye at first, but the overall effects of different interior details to sauna experience is not straightforward. In fact, the key to success is in the correct design of benches and the ceiling. Finnish saunas were traditionally made of wood and this is no coincidence as wood makes a great finish even today.



Preface

Congratulations, you're holding a new type of handbook on Finnish sauna design! For decades Finnish architects and engineers have written excellent books to guide readers in step-by-step sauna design and construction. Until now, however, none have approached design through a holistic perspective that views the complex set of choices through a simple lens: How to design a sauna that provides the best possible Finnish sauna experience for all the details inside the building that affect the experience. This integrative approach is necessary to get a grip of complex set of choices that go into sauna design.

This book provides answers to main questions about Finnish sauna design. It is organized according to three equally important subjects: heating, ventilation, and interior design. The book's content is based on years of intensive study, experimentation, and personal design experience—as well as a volume published in Finnish for sauna-native audiences.

This book is a universal sauna design guide for two prevalent types of saunas: electric and wood-fired saunas. The book has been written to address private sauna builders, those looking for a sauna cabin of their dreams or an integrated sauna to celebrate their home spa. Most of the guidelines are also applicable to the design of large public saunas, and even exotic smoke saunas. They can also inform the buyer of a pre-fabricated sauna.

The design approach of the book is semi-scientific and evidence based. All of the claims I make are based on cited research or prevailing wisdom and best practices in Finland. Admittedly, there are limits to the knowledge about sauna design and construction research, and thus I remark at several points in the book about the fact that there is no sufficient understanding of the topic to favor one solution, product, or principle over another.

With the creation of this book I wish to promote the design and construction of well-functioning, sustainable, and enjoyable Finnish-style saunas globally. A substantial part of this book was written during the Covid-19 epidemic in the dressing room of my private sauna in Miehikkälä, a small town in rural Finland. This proved to me that a sauna is always a good preparation in the times of uncertain future; a good sauna always comes in handy.

How to Use This Book

This is a handbook for designing a well-functioning Finnish sauna. The first chapter of the book explains what the Finnish sauna culture is like in comparison to other, similar baths. It explains what goes into the Finnish sauna ritual, the history of the Finnish sauna tradition, and which innovations have made it the way it is today. Feel free to skip this part if you are only interested in the making of great sauna as of today. This further splits into three separate topics: heating, ventilation, and interior design. These pieces come together as the book showcases some examples of contemporary sauna cabins from Finnish manufacturers.



1.

What Is a Finnish Sauna?

In Finland, a sauna is both a place and an activity. A sauna is an important stage for many events in life, both those that are unique as well as those that are repeating and more frequent. And yet, the amazing number of private saunas in contemporary Finland means these events remain mostly private.





Figure 1. Helsinki Sauna Day event series invited organizations to open up their unused saunas and bring out exotic mobile saunas to the heart of Helsinki. Excited sauna guests are rushing to enter a mobile smoke sauna during the 2019 event.

Sauna as the Way of Life

The importance of sauna in the twenty-first-century Finnish lifestyle is impossible to overstate. According to recent research, up to sixty percent of Finns enjoy sauna at least once a week. This is because it's fun and because they can. Finland is the country with the highest density of saunas in the world. There is approximately one sauna for every two Finns, nearly three million saunas in a country of five-and-a-half million people. The majority of these saunas are in private use and located in houses and apartments—or close to them—giving Finns privileged access to sweat-bathing whenever they desire.

Although Finns have given up the tradition of giving birth in saunas, preferring hospitals for that ritual, most Finns are sauna natives. They become accustomed to sauna activities very early in their lives, often before their first birthday. My own son had his first, short sauna experience at six months. This early exposure and prolonged training has its effect all over the nation. Finns learn to recognize and appreciate a Finnish sauna when they see one. In 2020 the Finns celebrated, as UNESCO included Finnish sauna culture on the World's intangible cultural heritage list.

Most Finns have a sense of what a proper sauna should look like and what the appropriate sauna ritual is. Because of the great number of private saunas, there's some variability into what the detailed ritual is like or what the sauna looks like, but the recognition of saunas grows intuitively. This becomes evident when Finns, having travelled far from their homeland, are often flabbergasted by strange establishments labeled as 'sauna', or even 'Finnish sauna'. These structures seem alien abominations of the concept of a sauna they know from home. Finns are not natural experts in sauna design, but they can quickly sense when something

goes against their ideal view of the Finnish sauna. However, spelling out what makes a good sauna, has required serious study and contemplation from several authors, including myself.

A Good Sauna Goes a Long Way

One of the reasons I've decided to reveal the secrets of Finnish sauna design to a greater public is to have more good saunas around the world; saunas that have an authentic Finnish feeling about them. This is not intended just for traveling Finns, but for the rest of world as well, particularly those living in the very north or the very south, where the natural sources of heat and light are absent for a noticeable part of the year and where saunas can bring comfort and escape from the natural elements.

Sauna design for me means much more than what meets the eye. It is crucial that the sauna works and gives rise to a sensation that makes the user feel just right. What we're after is a facility that enables a refreshing, pleasurable, and health-promoting experience. That's the Finnish sauna at its best!

Sauna as a Room and Sauna as a Building

In the Finnish language, the word sauna has several meanings and can be used as a stem for a noun, verb, or an adjective. An essential distinction concerns the use of sauna in a reference to a building versus a room. The sauna *building* can mean quite a few things. The sauna building can be a simple one-room structure, or a luxury cabin which includes several rooms: showers, dressing room, lounge, toilets, pool, etc. A sauna building can even house several saunas under a single roof. However, in Finland, if a public sauna facility has multiple saunas of different types, these are usually housed within separate buildings, particularly if they have a wood-burning heater.

The sauna *room* refers to a specific, hot room which can be located in a sauna building, in a detached house, or in an apartment. Thanks to the invention of the electric heater,



Figure 2. A floating sauna cabin at Tykkimäki Sauna in Kouvola, Finland and an integrated sauna (room) in a house exhibited during Finnish Housing Fair 2017.

sauna rooms can be found almost anywhere. The first integrated saunas—sauna rooms inside buildings designed for some other use—were located in basements. Nowadays, the residential saunas tend to be located on the top of high-rise buildings (in Finland, this is usually under ten floors). In this book, when I talk about sauna, I am always referring to the hot sauna room, unless otherwise stated.

The Finnish Sauna Ritual

To understand the design requirements of a Finnish sauna, you must understand how the Finnish sauna is used for bathing. If you ask a random Finn, you will be surprised to hear that they “just go to sauna.” If you insist on a longer explanation, you may be outright stunned about the complexity that underlies this “just going” procedure that most people follow approximately once a week, others almost every day.

I have created a diagram (Fig. 3) depicting the stages and actions associated with Finnish sauna bathing following a design tool called customer journey. The sauna journey description includes three main phases: *planning*, *attending*, and *post-sauna*. It names the physical means and locations needed (labelled touchpoints) on the second row, associated actions, and possible worries at each phase in the rows below. The illustration reveals how complicated the Finnish ritual can be. Every person and household can have their own special variations of how they enjoy their sauna. But for everyone, it starts with some planning.

Thanks to the wide availability of saunas, planning is usually straightforward. The answers to questions where you are going, with whom, and when are commonly determined during a weekly routine. Many Finns enjoy the luxury of sauna at home, or are entitled to use sauna at their housing complex’s shared facilities. This means the planning phase only requires



Figure 3. Main parts of the Finnish sauna ritual mapped as a customer journey

SAUNAVUOROT
SAUNA MUUTOKSET: MUNKKINIEMI@GMAIL.COM

	KEISKIVIKKO	TORSTAI	PERJANTAI	LAUANTAI	SUNNUNTAI
11:00-12:00				Laaksovirta As.4	
12:00-13:00				Mattero As.18	
13:00-14:00			Sarviaho As.3.a.2	Helle A.10a	
14:00-15:00	Zander As.8	Notkola As.1	Eklund As.24	Tilander As.12	Spring As.12
15:00-16:00	Heino Aho As.21	Mäntönen As.5	Antonen As.3 A 4a	Maksimain As.6	Meri Riski

Figure 4. Example booking schedule for a housing complex sauna in Finland

taking some time from your personal calendar, and possibly from the booking calendar for the shared sauna. Surprisingly many of these booking systems still rely on old-fashioned pen and paper systems.

Things are bit more complicated for those attending public saunas. Finnish public saunas generally don't take reservations, unless you're reserving a whole sauna for your private use. Renting out full saunas is expensive, prices regularly range from €300 to €1,000 euros (approximately \$350 to \$1,200). Renting is thus not a viable option for bathing among yourself or your family. Instead private groups of friends rent out saunas to celebrate birthdays,

	Private sauna	Housing complex sauna	Rentable sauna	Public sauna	Sports facility sauna
Typical sauna type	Integrated or separate building	Integrated	Integrated or separate building	Separate facility, can include multiple	Integrated next to showers
Right to use based on	Ownership or rental	Monthly recurring billing or per use	One-time fee	Entrance: single or multiple tickets, membership	Complimentary with entrance (one-time or membership)
Cost	From 3 000€ upwards	Around 10€/month	From 300€ upwards	From 10€ to 20€ person	-

Table 1. Most common Finnish sauna entitlement models that make someone eligible for using the sauna



Figure 5. Author's sauna kit on the way to a public sauna event includes slippers, bathing towel, a towel to sit on, water bottle, sometimes shampoo, and a sauna hat.

hen or stag parties, or company-sponsored teams to spend time bonding. However, these private events represent only a small fraction of all sauna visits in Finland, and many people enjoy complimentary sauna services at the gym, swimming pool, or other sports facilities free of charge. In contrast, housing complexes commonly offer a weekly one-hour sauna reservation for under €20 per month, indicating that it is considered an integrated, bundled service or a self-evident right associated with your occupancy. I have outlined the different types of sauna access options in table 1.

After the sauna visit is planned and the date and hour draw near, concrete preparations start. One must carry the sauna supplies (shampoo, body wash, and the like), consider what to wear before, during, and after sauna, consider eating and drinking, and of course figure out how to make their way to the sauna.

After making your way to the sauna, a whole new chapter of bathing begins. In its simplest form, you strip off your clothes, tuck away your personal electronics, and make sure the necessary supplies are available in the sauna. These supplies include water, a pail, and a ladle. Everybody knows the sauna can't proceed without them. But what to wear for sauna?

The practice of nude sauna bathing is and always has been the Finnish standard. However, if you browse through contemporary Finnish sauna marketing photos published during the twenty-first century, you will find images of people wrapped in towels or dressed in swimsuits. I assure you that in private quarters sauna clothing is still not the standard. A swimming suit is purely a new cultural adaptation. Some new public saunas have sauna spaces shared among genders and require the use of a swimsuit.

From an experiential perspective, all regular cotton and polyester (e.g. swim gear) clothing absorb heat radiation, which is an important part of the sauna experience (see

chapter on Heat p. 72-73). This means that they adversely transform the sauna experience. Synthetic fibers can also have a negative impact on sweating. Full body swimsuits are particularly unsuited for sauna bathing as they block the heat, especially if they are wet.

A poll of over ten thousand Finns in 2020 found that fifty-six percent of respondents were against wearing a swimsuit in any sauna, including the public ones. The use of swimsuits in a sauna also introduces a potential hygiene risk, if the sauna bathers don't wash themselves or the suits frequently. Taking a shower and washing up before entering a sauna is highly recommended from both the bather's and sauna's perspective as it keeps things clean, although some people like to scrub themselves thoroughly only after the sauna.

For these anti-swimwear reasons, nude bathing is and has been a practical as much as a liberal choice. As sauna long served as the primary means of thorough cleansing, having any kind of clothing was not an option. Only sauna servants working in the late eighteenth-century public saunas (see Figure 26) wore special clothing, and the few remaining today still do. Sauna caps were a visible part of continental Europe's sauna culture during the medieval times, but they have not been very popular in Finland in past centuries. Currently sauna caps are usually only worn by the sauna enthusiasts, often more as a display of their devotion to the craft, and possibly admiration of history, rather than by necessity, as Finnish saunas are not hot enough to require such protective headdress.

Some foreigners may rightfully entertain the question whether sauna bathing in the nude, particularly in a mixed-gender setting, might give rise to lewd or immoral acts. This type of decay followed by societal sanctions has corroded several sauna traditions outside Finland, such as the Roman baths during the Empire, and Central Europe urban saunas during the Middle Ages. Although there are associations of sex and sauna



Figure 6. Sauna bathing in the nude is still the Finnish standard for private and same gender gathering in Finland. Picture © Narvi



Figure 7. Symbols to communicate dress code and the presence of a mixed-gender facility at a modern public bath Allas Sea Pool in Helsinki.

particularly in Southern Europe today with respect to gays and lesbians, the Finns firmly believe that sauna in Finland is and always has been a very asexual place and practice. Its primary function has been to support life in various other ways, not to be the stage where new life begins. Of course, it would be naive to claim that this is always the case, as the increasing number of privately-owned saunas give everyone the liberty to behave as they like. In a 2016 survey of one thousand Finns, the majority reported never having had any sexual experiences in a sauna.

In public saunas, regardless of whether a swimsuit is required, undressing can raise concerns of privacy and security for some. Finnish locker rooms usually offer storage spaces with actual locks. This is very important detail to consider if your sauna location caters to multiple patrons, as in the case of public saunas.



Figure 8. Lockers equipped with a magnetic key ring worn around the wrist are the standard in new saunas, also at Kuopion Saana, Finland. This provides peace of mind while in the sauna.

Inside the Temple of Sweat

Once the bathing suit or none is chosen and necessary supplies are in place, it's time to get to the real business. The magic happens inside the hot sauna room. In the spirit of Finnish sauna democracy, everyone is free to be seated anywhere they like. The suggestion is to start slowly, and sit down some five to ten minutes so you begin to sweat, and then create steam, or *löyly*, as it is called in Finnish. *Löyly* is simply steam created when water, called *löyly* water (just normal drinkable water, nothing fancy) evaporates from the hot sauna stones.

Only *löyly* reveals the true nature of the sauna. This is why even some Finns are eager to rush straight towards it—behavior that may be unavoidable in a public sauna where everyone enters and leaves at different times. The liberty of democratically deciding when or if you wish to have *löyly* and how much, is a key to Finnish sauna experience and differentiates it from German-style sauna, as we will discover later.

The creation of *löyly* creates a wonderful sensation of burning on the skin, until the feeling dissipates as suddenly as it arrived. The physical explanation is that the rising air humidity temporarily raises the dew point of the sauna above 37°C (or 99°F), the skin temperature, allowing the steam to condensate on the skin in tiny hot droplets of water. Condensation releases thermal energy, which creates a burning sensation.

Aside from making steam and enjoying *löyly*, not much happens inside the Finnish sauna, except perhaps drinking. In fact, one of the old Finnish rules is that you should talk in hushed, gentle tones, show utmost respect towards the holiness of sauna, and avoid signs of 'inappropriate life'. Still in the early twentieth century there were strong beliefs about the guardian spirit, or the elf of the sauna (*saunatonnttu* in Finnish), which required strict discipline from the sauna bathers, regardless of age. Bad things could happen to people who acted rude or disrespectfully, shouted, cursed, or in any way rebelled against the serenity of sauna. I see this pagan belief as an understandable adaptation due to the prevailing culture of shared bathing and limited sauna resources, demanding discipline from people of different age, gender, and social class to experience the sauna time peacefully together.

In just over a century these beliefs have mostly disappeared. Nowadays conversations are common inside saunas. If you enter a Finnish public sauna, you'll find that Finnish people are quite capable of small talk, particularly about sauna. The boundaries of sauna, with the added vulnerability and immediacy of nakedness,



Figure 9. The creation of *löyly*

Sauna climate over 30 minutes when steam is created multiple times

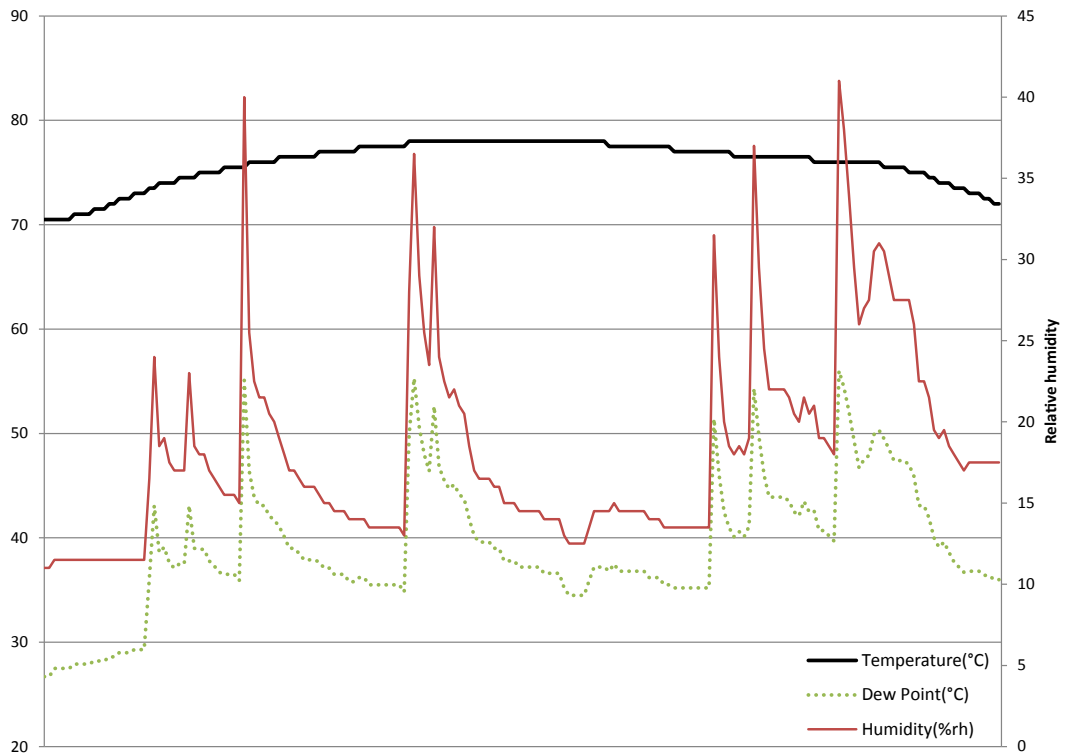


Figure 10. Climate graph depicts the change of relative humidity in response to löyly measured at the standard height (100 cm above top bench), visible as peaks in the red humidity graph. The dew point also rises while temperature remains the same with this slow responding measurement device.



Figure 11. Saunatonnttu, the gnome or elf of sauna. A clay sculpture by an unknown artist in its natural habitat.



are said to give rise to easy, confidential exchanges that are atypical outside the tranquil, confidential environment of sauna. An elderly gentleman told me how he has listened to accounts of old war crimes being retold in a sauna, and only in the sauna. The expectation is that what happens in sauna stays in sauna. During medieval times in central Europe, crimes committed in the vicinity of sauna received more severe punishments. There is no such law in Finland today, but people luckily act as if there still was.

And that is all there is to it. The heat stress will eventually force a person out of the sauna room to cool off. This usually takes anywhere from five to thirty minutes and begins a new important phase in the sauna ritual.

Cooling off is integral to a great sauna experience. In Finland, the average temperature annually is barely above 5°C (41°F). This means that you will usually cool off effectively by just going outside. Thus securing an outdoor access is a key component to a well-designed Finnish sauna. In fact, the big difference between a sauna's hot and humid environment and the air outside allows you to cool down, even if more slowly in warmer climates. It is said that the Finnish recruits in the United Nations Peace Operations have always first built saunas, not only to feel at home, but to get relief from the unusually hot weather away from Finland. If the outside air does not do the trick, cooling can be more effective if there's a cold river, lake, or sea to plunge into, or just a cold shower, all of which will provide an intense cooling experience.

Intense cooling is usually followed by some moderate cooling: people take the time to socialize, read, or just take it easy. Our body core cools slower than our skin. Drinking is common and recommended during cooling breaks; it feels natural, invigorating, and helps to fight dehydration due to sweating. Mild alcoholic beverages, beer or cider, are



commonly consumed in association with sauna, but should be kept to a minimum, and enjoyed only afterwards, due to their health hazards such as accidents and blood pressure related risks.

By the time you start feeling chilled, you are ready for some more heat. Repetition is a fundamental part of the Finnish sauna ritual. Enjoying löyly and cooling off are repeated in a cycle that lasts as long as the person desires. This may mean only a few rounds or a whole day. The aforementioned shared saunas in housing complexes are usually reserved for an hour at a time, which people usually feel is the minimum amount of time for a decent sauna.

There are extra nuances that may color the Finnish sauna experience, and some historic customs have almost disappeared from twenty-first-century sauna proceedings. These include chanting, making offerings to the sauna elf, cupping, and whisking. Whisking is the practice of using bundles of tree leaves for cleaning and massage. Whisking is almost an endangered sauna habit; it is commonly recognized but rarely practiced. For most

Finnish people, collecting a bundle of birch branches for the Mid-Summer festivities remains the sole occasion to do a bit of lashing with this frightening device that tends to scatter leaves all over the sauna floor, but the scent is heavenly. In past decades, sauna scents, cushions, and some gadgets have added new ways to enrich the sauna experience. One thing common among them is that these ‘experience enhancers’ can be bought quite inexpensively and applied without skill or deeper understanding, unlike historically grounded rituals. Maybe the only tradition resistant to change is washing oneself thoroughly at some point during the sauna visit. Many people, including myself, have a feeling that taking a shower or hot bath is an inadequate replacement for a good scrub after some sweating in the sauna.

At some point, it is time to quit. After a prolonged period of moderate cooling, If the dressing room ventilation works well, there is usually no need for a towel to dry up. Getting dressed and leaving the sauna premises without haste is a good way to conclude the ritual. Once you reach the end of the sauna journey, you’ll discover some laundry, and the need to dry garments not regularly laundered—such as the cap and the slippers. I have not mentioned social media, but it is not unusual for sauna goers to post photos of the sauna journey at some point, usually from outside the sauna room. Many consider it a blessing that the sauna climate does not agree with the use of mobile devices, and in 2016 the majority of Finns thought that smartphones should be kept out of the sauna environment. I fully agree with them.



Figure 12. A fine specimen of a Finnish birch whisk made by an awarded specialist Pentti Hakala during the annual July Sauna Festival at Ikaalinen, Finland.

Numerous private beaches and saunas encourage skinny dipping to cool off after sauna. Photo © Narvi







Figure 13. Heating a wood-burning sauna is an important duty. At minimum requiring proper handling of firewood, kindling fire, and keeping watch to make sure flames don't die out before the task is done. It might also be part of a mental preparation for bathing. In the photo, a man is watching over the lengthy process of smoke sauna heating. Photo: Hannu Pakarinen © Finnish Sauna Society.

The Sauna Servants' Point-of-View

What I have just described was the simple version of the sauna journey. Due to the private ownership and operation of the majority of Finnish saunas, there are many people who take care of heating the sauna. When it comes to an electrically heated sauna, this may not require more than the flip of a switch or the touch of a mobile app, but it is very different to deal with wood-fired saunas. Heating up a wood-fired sauna can be a tedious process requiring several hours. At the extreme end, the biggest public smoke saunas in Finland require more than eight hours of heating and nearly constant supervision. This means a very early shift for the caretaker if the sauna is to be ready by early afternoon.

The heating duty is only a part of the sauna operation. The responsibilities begin with securing firewood, setting up the sauna space and the critical supplies, starting the fire, and adjusting the burning process with different air valves. Then there's the work after the sauna: making sure that the sauna dries up properly, cleaning up trash, and even washing the sauna surfaces from time to time. At my own sauna cabin, the sauna bathing ends only when, the following morning, I close all the ventilation hatches, drain the water heater, remove the ash from the ash box, and restock the firewood supply. Quite a list of duties for a few hours of sauna pleasure!

I bring this up because I suspect that many readers are considering becoming sauna owners or operators. As with any well-orchestrated service, in sauna the pleasure of

bathing can appear very simple, but it is only made simple because someone has toiled to do 'the dirty work' before and after sauna.

Sauna for Every Occasion

Finns enjoy sauna frequently. In our recent study fifty-nine percent of Finnish participants visit a sauna at least once a week. Few lucky people go daily or almost every day and just under ten percent never go. Weekends, particularly Saturday, remain the most popular sauna days, but most public saunas are open every day, so there is never a bad day for going to sauna.

One inspiring feature of contemporary Finnish sauna culture is that sauna has been incorporated into most events of life. Celebrating a newborn, getting married, winning a sports match—alright, let's get together in a sauna! Although these special events do not occur every day and are not for everyone, they do accumulate over the course of the year. During these rituals, much socializing tends to happen outside the sauna room, and it is not uncommon that some members of the party skip the sauna altogether for some unknown reason.

Thanks to the ubiquity of sauna facilities, sauna parties are easy to arrange on a whim nearly anytime or anywhere. For example, most public buildings are equipped with a sauna, even a few churches boast a sauna. In Finland, saunas are seen as an integral added service that "just has to be there." Saunas are naturally connected with the sites where they are built, along with dressing rooms, usually one for each gender at a minimum. Bigger swimming halls operated by municipalities may even have a selection of saunas with both genders' dressing rooms.



Figure 14. Hen parties and separate bridal baths at sauna celebrate the bride before the wedding. This is one of the few surviving special sauna rituals. Photo depicts the party, not the intimate parts of the ritual. Photo (©) Sauna from Finland



Figure 15. Many Finnish kids enter the sauna before they can walk. They learn the sauna ritual by heart and are proficient löyly masters before going to school. My son at the age of one preparing the stove for firing.

The combination of a great variety of saunas, and multiple reasons to attend them, adds diversity to the sauna rituals. For instance, although I've personally evolved into a sauna enthusiast who enjoys intense but easy-going sauna experiences which may take an hour or two, this is not considered that long by a connoisseur's standards. However, I also regularly practice 'quick stop sauna' in association with my gym training, and I couldn't even imagine going to the gym without this opportunity. This means that after an hour or so of gym training, I take a shower and then head to a small sauna room. Sweating is easy after a workout and for a start I just sit down for a few minutes. I then make some steam, löyly, two to five times before exiting, usually within the ten minutes of entering.

I also regularly witness another sauna variation where parents with small children attempt to enjoy a family sauna moment. The peacefulness and success of this ritual depends on the parent's judgement as well as the temperament of children. Some children under two years may sit still and enjoy the sauna heat almost as long their parents do, with no indication of discomfort or negative health effects. On the other side, the child may open the door and step inside only to scream "Dad, it's too hot in here" and exit immediately. More often parents try to keep their children busy in an adjacent room or have them play with water on the sauna room's floor. It's a matter of adapting as, statistically speaking, over ninety percent of Finns are satisfied with their regular sauna shifts.

The gist of this story has been the versatility of Finnish sauna. The millions of saunas in Finland are matched with an equal number of personal variations. I hope this story enables the reader to understand what is required of the sauna space to support different types of sauna activities. Luckily, although Finns think that everyone has the right to practice the sauna as they see fit, the variations I am aware of are not very radical. It should be mentioned that, until the

twentieth century, the Finnish sauna had many other types of uses: producing malted grain, giving birth, or bathing the dead—and in fact people may have been living in a single multi-purpose building that could also be used as a sauna. But for the purposes of this book, I am focusing on the design of Finnish sauna only to support enjoyable sweat bathing and its related functions such as washing, not how to design a sauna for all the historical functions.

The Differences Between Finnish and Other Sauna Cultures

As you've now learned about modern Finnish sauna culture, you may ask how does it differ from other types of sauna cultures; are they all the same? Simply put, they are not. The closest resemblance to Finnish sauna culture is found in the Baltics and Russia, which have a similar balance between public and private saunas as in Finland. Historically speaking, the Eastern Finnish sauna culture and the sauna were probably indistinguishable from the western parts of Russia until the twentieth century, as Finland first gained autonomy, then independence from Russia in 1917. The Russian language favors the word 'banya' instead of sauna. I will also use banya to refer to sauna facilities created in the Russian style. There are some old public saunas in Finland which are toned down versions of the banya. In comparison to a rich history of banyas in major Russian cities, a Finnish sauna is humble. For instance, the Sanduny (Сандуны) sauna complex, founded in 1808 in the very center of Moscow, occupies a full block and includes several sauna sections, a laundry, and a restaurant. Nothing as grandiose can be found in Finland, although our latest public saunas such as Löyly Helsinki and Saana of Kuopio are masterpieces of wooden architecture.



Figure 16. Men's second class section sauna in Sanduny, Moscow. Unlike in the press photo shown here, the banya dress code is also clothing optional. Photo © Sanduny (Сандунóвские бани)

When you hear discussions about 'sauna' instead of banya in Russia, it often carries a negative connotation, referring to inferior, small, private, electrically heated, or rentable facilities associated with a bad experience. This is a Russian misconception, not necessarily widely popular, and I would rather emphasize the high level of similarity between banyas and real Finnish saunas. In my experience public banyas tend to have a consistently higher level of humidity than saunas, making the experience very hot and requiring a sauna cap to be worn at all times. The humidity means that you will not experience the creation of löyly as much as in Finnish saunas because the air remains humid all the time. The remainder of the differences depend purely on the way the sauna is being used.

If we examine the culture instead of the buildings, there's one big difference which has to do with whisking. In Russia and in the Baltics whisking is still a standard practice in public saunas, commonly administered by trained sauna assistants who have spent several years practicing their skills and will perform a 'whisk massage' for a fee. You can also freely exercise your own skills and perform whisking as you see fit. This custom naturally spills over to private saunas as well, although the number of private saunas in these countries is lower than that of Finland. Russian banya can also be a very social experience. You can learn more about the nature of Russian baths from the excellent 2019 book by professor Ethan Pollock.



Figure 17. Moscow sauna tribes display a degree of carefully orchestrated socializing. Photo taken Seleznyovsky Baths.

After Russia, probably the world's second largest population of regular sauna bathers can be found in Germany. When discussing cultural similarities from the Finnish perspective, we can speak of a German sauna region. This includes neighboring countries that share a similar sauna concept, such as Austria, Belgium, and the Netherlands, according to the President of the International Sauna Association (ISA), Mr. Risto Elomaa. The German region includes tens of millions of people who share similar expectations of what sauna and its ritual are like. It differs from the Finnish one foremost in formality. In comparison to the quite relaxed and easy-going Finnish ritual, the German public saunas have an explicit code of conduct which is widely followed in most establishments. While patrons may not observe the instructions in all details, their sauna behavior is certainly more orderly and uniform than what you'll ever see in Finland.

In terms of saunas, the Germans don't have similarly distinctive individual buildings or rooms such as the banya, but their public saunas are often extensive sauna centers or sauna



Figure 18. Example of German sauna rules reminder board outside a sauna



Figure 19. Therme Erding sauna world is an extreme example of catering various saunas for many tastes. Photos © Therme Erding.

worlds that contain several saunas with many international flavors. For instance, the world's largest sauna world in Therme Erding boasts twenty-eight different saunas, including their version of the Finnish and Russian baths. In my opinion, the biggest defining factors for the German culture are mixed nude bathing in public saunas and these large sauna centers. This combination has several consequences for the design of sauna spaces and also for the attendant sauna activities.

It is thus more informative to focus on the German sauna customs. In German facilities you can expect to find very detailed instructions of how a sauna bather should conduct their sauna. For instance, a warm foot bath is recommended before entering the sauna. The sauna temperatures are also accurately documented next to the entrance. Although you must enter the sauna without clothes, you find patrons wearing a substantial amount of clothing. In addition to bath robes worn outside saunas, one does not enter a German sauna without a large towel that each patron carefully lays on top of the available wooden benches. This allows Germans to comply with the code of avoiding direct contact between skin and wood, and to protect the wooden surfaces.

After these preparations, the German ritual takes on a predictable but not necessarily monotonous character. People sit or lay on their backs on one of the many levels of the sauna for exactly ten to fifteen minutes, often timed with a rotating hourglass. Utmost discretion is practiced, and people save the chatter to the breaks between sauna sessions. Then we encounter the final major difference which concerns löyly. In the German tradition, löyly democracy is replaced by the löyly rule of the saunamaster or *Saunameister*, who is the only person allowed

to create steam in a German sauna in a ritual known as *aufguss*. The saunamaster enters the sauna carrying a pail and ladle, performs their part of the ritual, and leaves with the paraphernalia in tow, usually followed by the audience which has now completed their sauna round. *Aufguss* performances are very popular and attract large audiences. Since early 2000s *aufguss* has developed into a performance sport called 'show aufguss' with annual world championships.

The German and Russian sauna cultures are the most similar to the Finnish one. As I've now reviewed them, I must emphasize that the differences in terms of the sauna room are surprisingly small! A good Finnish sauna can be used as a stage for both Russian style whisking as well as German *aufguss* if one takes this into account in the early design process. The world of saunas doesn't end here in Europe, but my comparison story does. There are established and flourishing sauna cultures and societies in the other Nordic countries, Eastern Europe, Japan, South Korea, Australia, and across the Americas. In



Figure 20. *Aufguss* has developed into an engaging spectator sport, or art, with its own annual world championships attracting competitors from over 10 countries. A performance in the spirit of Apollo 13. Photo by Jürgen Raab at Obermain Therme.

my opinion these do not add that much breadth to the discussion to be worth introducing in length. However, readers familiar with the Mesoamerican temazcal (or temescal) tradition, still alive at Mexican luxury resorts, will observe several similarities with sauna. I also acknowledge my admiration for the new and dynamic Japanese sauna culture that is being influenced without prejudice by all traditions around the world.

What Is and What Isn't a Finnish Sauna

In this book I discuss Finnish sauna design. I consider sauna as one form of sweat or thermic bathing, in which people expose themselves to hot air, water, or radiation in order to heat one's body and induce sweating. A definition of sauna from the 1999 ISA convention in Aachen states:

Sauna is a hot room with walls preferably made of wood. It is heated by a sauna heater powered by firewood, electricity, gas, or other energy source and equipped with a sufficient amount of sauna stones. Heating can be continuous or single time. The temperature measured at the level of one meter (3'4") above the highest bench is between 70°C and 105°C (160°F – 220°F). The humidity is variable and controlled by throwing water onto the stones.

[author's translation from a Finnish text approved by ISA]

For the purposes of this book I consider this definition to be too strict. My opposition is based on the observation of what the Finnish saunas have been like in the past one hundred years, not just ideally. Although the average temperatures recorded in different studies hover between 75°C and 88°C, the mid-twentieth-century sauna cabins recorded much lower temperatures: ranging from 60°C to 80°C. Therefore the relaxation of conditions I entertain for this book include a wider range of temperatures, starting from 55°C and going up to approximately 120°C. The other requirement I'm willing to relax is the wooden interior.

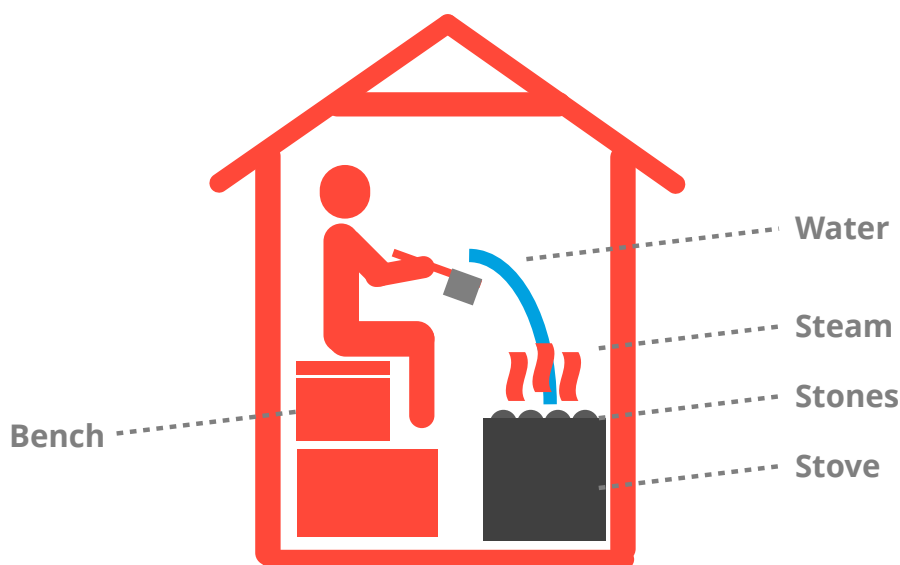


Figure 21. Illustration of core components of a Finnish sauna: heater, stones, benches, water, and steam.



Figure 22. Example products from eBay that are labeled sauna, but have little to do with it. On the left, a “bio sauna” steam box, on the right a “sauna blanket” or electrically heated toaster bag.

Although I recommend untreated wood, it is by no means the only usable wall material for a sauna. There are numerous organic and inorganic materials that can be used to construct the whole or part of the sauna hot room. These include clay, brick, hay, peat, stone, and even ice. But wood remains the standard, others are variations. In a dedicated section of the book (Chapter on Interior design) I will consider the relative merits of these alternatives.

As I’ve now expanded the definition of sauna to include a greater variety of establishments and conditions encountered in Finland, it should be noted that certain sweat baths are clearly



Figure 23. Hybrid sauna refers to a Finnish sauna additionally equipped with infrared heaters. Photo: Harvia

excluded. Old Roman bath facilities (*tepidarium*, *caldarium*, and *laconium*) and modern hammams are such exclusions. This revised definition also excludes steam rooms or baths, and infrared cabins sometimes misleadingly called saunas. Most of these clearly differ from the Finnish sauna: there is no visible heater, there is no way to create steam manually, and their interior consist usually of glass or walls covered with tiles. Due to increasing international interest in infrared therapy, some globally operating sauna manufacturers have begun marketing 'hybrid saunas' referring to a traditional sauna also equipped with infrared panels. As long as the traditional sauna technology is intact, this would qualify as a Finnish sauna as well.

The Origins of the Finnish Sauna

Finland is a nation with a modest documented history. Before its independence in 1917, the regions making up the present Republic of Finland belonged to Sweden and Russia, the latter having the best documented history with respect to saunas. Still, most Finns proudly believe that sauna is an original Finnish invention, one that alone has succeeded in making its way into lexicons worldwide. The most optimistic thinking is that the people who first inhabited the Northern and Eastern parts of the country, and established the permanent habitation after the Ice Age, also introduced sauna to the area. Permanent dwellings became necessary around 5000 B.C. when the seeds of agricultural society were first sown into the Finnish soil. It seems probable that saunas, as the buildings we know today, only became feasible after this time and that origins of this practice arrived from the East.

The history of Finnish sauna culture consists of a combination of factors. According to journalist and author Martti Vuorenjuuri, the Finnish sauna was equally influenced by both medieval, continental sauna bathing culture from the western Europe and the great Russian 'sauna' culture from the East. The continental influence was prominent on the Western coast of Finland through interactions with Sweden. This favored constructing large and tall sauna buildings. In eastern Finland, the rural Russian style inspired smaller and lower sauna huts. These influences were still clearly present in the early twentieth century and have been documented in several books by the architect Risto Vuolle-Apiala. A recent interpretation by Heikki Lyytinen is that the Finnish sauna culture at large is a refinement of Russian and Baltic practices. The lesson we can learn from sauna historians Vuorenjuuri, Mikkel Aaland, and Lyytinen is that the idea of a sweat bath resembling a sauna was independently discovered around the globe, not exclusively in Finland.

Regardless of how the idea of sauna arrived in Finland, it took a firm hold. Etymologically, it appears that the word 'sauna' was in circulation around the Baltic sea south of Finland from some time during the Bronze age (1500-900 B.C.). However, the first archeological evidence of the Finnish sauna, the remains of a heater made of stone, only dates to approximately A.D. 1000. Historical records regarding rectories and the city of Turku, the old capitol, emerge between A.D. 1400-1600. These depict the Finnish sauna culture as lively as the medieval continental European sauna and urban bathing culture was until the fifteenth century. There exist older historical sources and archeological findings from elsewhere in the world.

The sparse history of Finland is an unfortunate shortcoming in recounting the history of sauna. It does not seem possible to spin a story of Finnish sauna history that covers a full millennium as Ethan Pollock has presented for the Russian bath. We can only say that the most significant feature of sauna in Finland is that for the past six hundred years or so it remained intact, and that the most important changes have only taken place in the past two

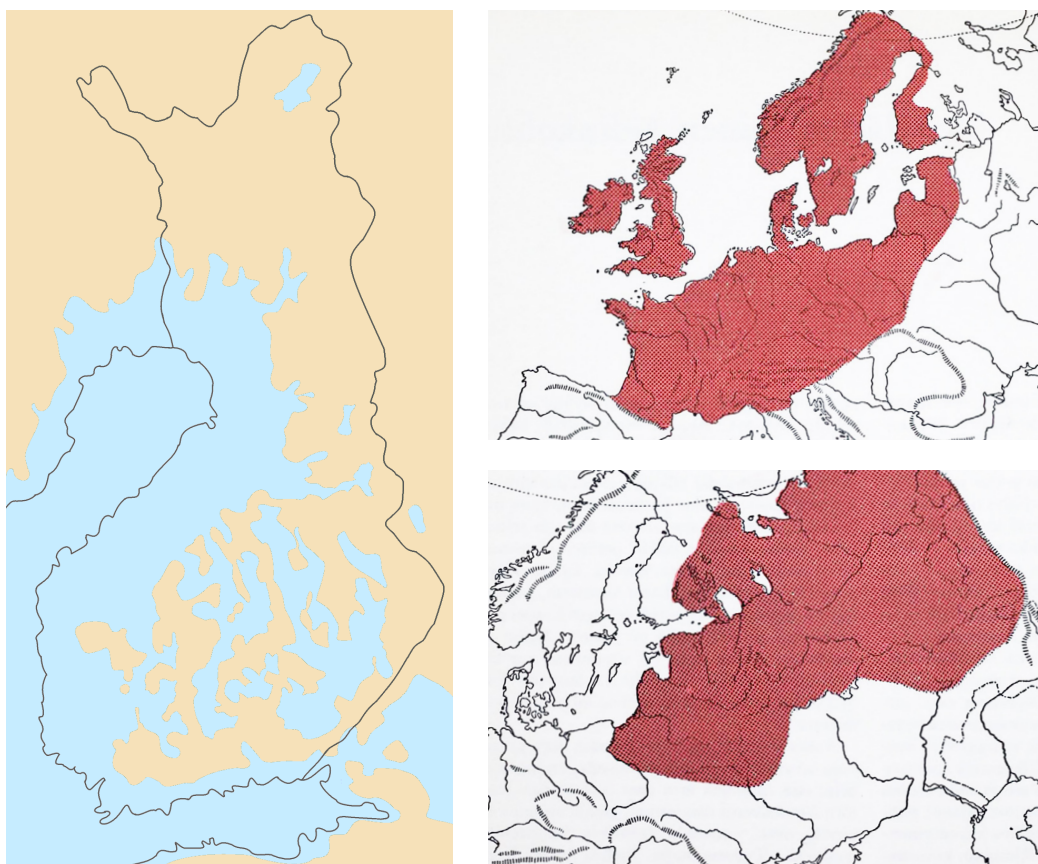


Figure 24. The land mass of Finland after the Ice age has slightly retreated around 9,000 BC and Martti Vuorenjuuri's illustration of Western and Eastern sauna influences in Finland (top and bottom, respectively). Picture source Wikimedia, Oakokko, 2007 and Vuorenjuuri, 1967 reproduced by author on digital intermediate.

hundred years or so. Sauna cultures in continental Europe, and also in Sweden, dwindled. There was a period from the fifteenth to the eighteenth century, called 'three hundred years without a bath' by Georges Vigarello, but the Finns never gave up their beloved practice, despite what the Swedish royalty mandated. For instance, smoke saunas had a bad reputation for being a fire hazard and received a mention in the local city law. Cities required safety distances between saunas and other buildings, a principle that still survives in Finnish legislation to this day.

Focusing on the two most recent centuries of Finnish sauna, we can perceive several changes taking place quite quickly in what is believed to be hundreds of years of steady development since 1000 B.C. During more than three thousand years, the most significant change was the elevation of saunas away from the (presumed) ground and dug pits to log buildings. The log buildings first evolved corner notches and later the use of long-groove fittings, which improved the insulation of the building significantly.

All the key elements of Finnish sauna buildings and bathing culture were firmly in place by the late eighteenth century when Italian adventurer Giuseppe Acerbi made his journey through Finland towards the Ice sea in the north. His colorful notes describe what he experienced in a Finnish sauna. His account goes as follows:

Almost all the Finnish peasants have a small house built on purpose for a bath: it consists of only one small chamber, in the innermost part of which are placed a number of stones, which are heated by fire till they become red. On these stones, thus heated, water is thrown, until the company within be involved in a thick cloud of vapour. In this innermost part, the chamber is formed into two stories for the accommodation of a greater number of persons within that small compass; and it being the nature of heat vapour to ascend, the second story is, of course, the hottest. Men and women use the bath promiscuously, without any concealment or dress, or being in the least influenced by any emotions of attachment.

... there is no other window besides a small hole, nor any light but what enters in from some chink in the roof of the house, or the crevices between the pieces of wood of which it is constructed.

... I could scarcely believe my senses, when I found that those people remain together, and amuse themselves for the space of half an hour, and sometimes a whole hour, in the same chamber, heated to the 70th or 75th degree of Celsius.

... The Finlanders, all the while they are in this hot bath, continue to rub themselves, and lath every part of their bodies with switches formed of twigs of the birch-tree.

... In the winter season they frequently go out of the bath, naked as they are, to roll themselves in the snow, when the cold is at 20 and even 30 degrees below zero.

Acerbi, 1802. Travels through Sweden, Finland, and Lapland to the North Cape. XXII, p. 297



Figure 25. Niemelän torppa, a building part of Seurasaari open-air museum in Helsinki contains one of the oldest known surviving sauna buildings originating from the late 18th century.

The act witnessed by Acerbi in the quotation above follows very closely the formula of the present Finnish sauna ritual: sweating, creating löyly, cooling off, and cleaning oneself.

A credible image of the sauna from later Finnish sources suggests that a sauna was a multi-functional place serving various agricultural functions, “a hospital and a pharmacy”, a dwelling for man and animals, as well as storage. It was probably dependent



Figure 26. Finlandish bath. Illustration from Giuseppe Acerbi's Travels through Finland.



Figure 27. Finnish immigrants built saunas as they settled abroad. This smoke sauna near Cokato, Minnesota from 1868 is possibly the oldest remaining immigrant-built sauna in the USA. Photo © Aaron W Hautala, *The Opposite of Cold* - University of Minnesota Press.

on the prosperity of the neighborhood how many of these functions had to be located in a single building or whether separate buildings could be raised. However, it is clear that agricultural needs involving the use of heat required farmers to continue using saunas for chores other than bathing for a long time. Urban saunas were long dedicated to human cleanliness, but the recreational use of saunas took over only after the 1950s when the last generation of Finns were still given birth in saunas. After that point in time saunas became increasingly an indulgence rather than a necessity. For instance, bathrooms with showers became a standard in small urban apartments only during the 1970s. Prior to this people were expected to wash themselves in a shared bath, for example, in the housing complex's sauna or in a public sauna, which were widely available until the late 1900s. Finland arrived at some kind of a tipping point in March 2020 when, during the Covid-19 pandemic, several housing complex's saunas and all general use public saunas closed down. In our research more than twenty percent of Finns consequentially reduced their bathing. This clearly demonstrated that the sauna was no longer an essential life-support function but a luxury service. In my opinion, Finland reached this point because of some key technological innovations.



Figure 28. Drum heater ready to go at Elanto sausage factory's smokery in Helsinki. In this case heater operates as a smoke sauna heater without a flue in order. Photo: Helsinki City Museum, 1933. Unknown photographer.



Figure 29. The Finnish Defence Forces led the initiative to create a continuously heated wood-burning heater. The design was based on an existing stove and became housed in a make shift, mobile sauna used for disinfection. Photo: Military Museum, Finland.

Sauna Innovations Affecting the Finnish Sauna

The Finnish sauna didn't turn overnight into the kind of domestic institution it is today. It is based on specific periods of innovation. The first notable step was in the late eighteenth century when the smoke saunas with their fire hazards were increasingly replaced by saunas with chimneys. This trend didn't catch on quickly, as it added complexity to sauna construction and probably seemed unnecessary for isolated saunas, which had for centuries fared well without a flue. The next phase at the brink of the twentieth century popularized a new generation of sauna heaters that built upon the existence of a flue. A so called 'pönttökiuas', or drum heater, was an invention enabled by the steel drum. With small modifications the steel drum container, or just folding sheet metal in the hands of a capable blacksmith, a simple heater could be created. This heater would work as a smoke sauna heater, or it could be fitted with a metal top that connected to a flue so the smoke was channeled away.

The most important of these innovation phases took place during the 1930s to 1950s. Two key inventions were made in Finland. First the continuous wood-fired heater was invented in 1934 and then the electric sauna heater in 1938. Both new heaters struck a chord in the Finnish sauna goers. It is irrelevant whether these inventions were first made in Finland, in Sweden (electric) or in Russia (wood-fired), but crucially they were quickly and widely adopted in Finland during 1940s and 1950s as well as developed, produced, and sold by local companies. The previous generations of heaters had been individually crafted by independent masons and blacksmiths. The new generation of heaters immediately gave rise

to literally hundreds of small shops building their own heater brands created in accordance with a mass-production mentality. Real mass production of heaters only became possible by the end of the twentieth century as the companies grew and consolidated with others.

The new wood-burning heater had only one major difference to the previous ones: the fire chamber was isolated from the rocks, and the fumes were directed through channels into the flue. This enabled one to continue heating the sauna while it was in use, in contrast to the previous heaters which had to be heated before bathing. The new wood-fired heater was convenient: it was quick to heat and potentially consumed less firewood than the earlier ones. The short heating time was an important enabler for sauna use as older heater models required hours of heating time which was difficult to find during the workday, particularly during the tough times following the Second World War which left Finland with substantial war reparations to the Soviet Union.

After the war, the functions of sauna became fewer and focused on personal cleanliness and wellbeing. Using a continuous wood-fired or electric heater was well suited to the task as it left the sauna room looking pale white and clean, unlike the soot covered walls of the smoke sauna. Today, when talking about wood-fired heaters, most Finns automatically think of this type of a heater, although it has only been in existence for less than one hundred years. This gives an idea how big of an impact it had. I believe World War II also played a part in making this new type of ‘furnace’ popular as the Finnish defense force developed and deployed a variation of the continuously-fired heater for the purposes of disinfection during the war (see Fig. 29). This was done to rid soldiers and their garments from body lice which carried *Typhus exanthematicus*, a deadly disease during wartime



Te pidätte pehmeästä lölystä...

suomalaisen saunan hiotavan leppoisasta lämmöstä. Tässä Teille toive-kiuas

ASEAn uusi SKA 1 lämpöävaraava kiuas

Tämä sähkökiuas vastaa täysin kertalämmitteistä puukiuasta.

Valmistaja: **Karjalan Sähkö Oy**, Helsinki

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Figure 30. An advertisement from 1957 promoting a new heat storing electric heater, not unlike some models in 2021. The ad boasts how the electric heater fully equals a wood-burning heater, being no better or no worse. Source: Sauna magazine.

conditions. The success of disinfecting saunas presumably made this concept ubiquitous and familiarized the young generation of home-coming soldiers to new, hot, and dry type of a sauna environment enabled by the new heater invention.

The electric heater was an equally disruptive innovation. Technically it was a simple device: just few upward pointing heating elements (another early twentieth-century innovation) surrounded by a metal casing to keep the sauna stones close by. But it had an outsized effect by enabling people to start building saunas in locations where wood-fired heaters could not be installed, such as in urban buildings. This began a change in the design of residential buildings. From the 1940s residential buildings increasingly introduced a sauna as a part of the shared facilities of an apartment building, similar to the laundry room. I have been referring to this when speaking of *housing complex saunas*. But that was just the beginning. By the 1970s architects started incorporating medium or small electrically heated saunas as part of individual houses and apartments. This movement reached its climax in the late 1990s when nearly every new apartment from the smallest studio to the biggest five bedroom penthouse was equipped with a sauna. This development paralleled other bathing technology improvements. Bathrooms in urban Finland appeared during the twentieth century, showers becoming standard equipment only by the 1970s. Before this advancement, the only way for the working class to clean up was to visit a public sauna since only upper-class apartments in the early 1900s were equipped with bath tubs.

Eventually these two heater innovations helped to make sauna ownership and management more feasible for larger groups of people. This paved the way for a sharp increase in the number of private saunas in Finland from hundreds of thousands to over two million. After this increase, sharing the sauna with an extended family, neighbors, or employees was not so important when increasingly people could have a sauna of their own. This development begs the question whether the Finnish sauna culture and the quality of saunas kept up with the rapid increase in numbers. On the other hand, the great number of saunas means that nearly everyone, regardless of their wealth and income, has easy and affordable access to saunas, and society on the whole gets to enjoy health benefits associated with sauna.

Rapid Increase in the Number of Saunas After the Second World War

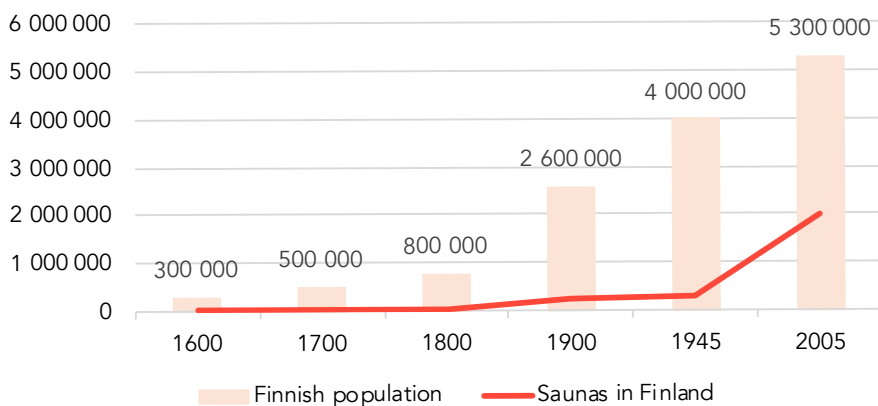


Figure 31. The trajectory of how the number of saunas has developed in Finland, an adaptation of Vuolle-Apiala, 2016.



Figure 32. Modern integrated saunas such the one depicted here combine the electric heater and mechanical ventilation. Photo from Housing Fair 2019 in Kouvola, Finland.

From my perspective, the electric heater has transformed sauna bathing the most. Although the new wood-fired heaters did in many ways best the old ones, they did not completely rid people of the efforts of sauna heating and managing firewood, unlike the electric heater. The new electric sauna next to your bathroom can be heated with the flip of a switch. Consequently electric heating commoditized the sauna. I think something from the spirit of the original, nineteenth-century saunas was lost during the transition to electric saunas. This has revived a new generation of sauna bathers, such as myself, who were initiated to electric saunas only later to seek and appreciate other, older types of saunas.

The latest innovation relevant to electric sauna by its association with certain type of buildings was the widespread utilization of mechanical ventilation (see Chapter 4). This paralleled the rapidly growing number of private, integrated apartment saunas (see Fig. 31). The development started in Finland during the 1950s. By the 1980s mechanical ventilation was the only ventilation explicitly recommended by governmental construction guidelines. This was both a blessing and a curse for saunas. Because integrated saunas with electric heaters often lacked the natural ventilation opportunities that wood-burning heaters in cabins had, the mechanical ventilation could have greatly enhanced the electric sauna experience. Unfortunately, the design and construction of mechanical ventilation solutions appear to have often missed the mark. This can make the sauna worse, not better, by drying the sauna air too much and weakening the *löyly*. I believe this is an important reason why many Finns strongly prefer the wood-fired saunas, even though they might still regularly enjoy the convenience of the electrically heated ones prevalent in public settings.

Since this short period of innovations, only minor inventions have surfaced. These include sophisticated controls for electric heaters, sometimes accessible with a smartphone, heat storing heaters with electronic controllers, and hybrid heaters, but most of these changes have been cosmetic. Most new features have only changed how the sauna interior and heaters



look, and much less how the Finnish sauna works. Overall, I would compare Finnish sauna innovation history to the space race, in which the non-human 1959 moon landing has been until now the unparalleled achievement for over sixty years.

The Finnish Sauna As a Source of Health

Banya bathing “can replace two-thirds of the medicine prescribed by medical science” claimed António Ribeiro Sanches, a Portuguese physician in 1779 after a long study of Russian sauna practices (translation from Pollock, 2019). His book was probably the first extensive scientific volume that connected the use of sauna to medical benefits with academic credibility.

Finns too have believed in the healing power of sauna for a long time. The heat of the sauna induces several rapid bodily changes. There are clear, perceptible events: rising heartbeat, elevated temperature of the skin, then the core body, followed by sweating. Above all, sweating has traditionally been thought of as an essential transfer mechanism, for instance capable of removing an illness from one’s body.

Sauna has long served as a special place of healing in Finland. The smoke saunas were naturally sterile environments, thanks to their method of heating and initial high temperature. This supported their role in pre-hospital era health clinics where different types of treatments, such as whisking and cupping, were administered.

Why is sauna bathing healthy? Scientific research in the past decades has confirmed some beliefs about different types of health benefits. It seems best to compare benefits of regular sauna bathing to the benefits of regular physical exercise, and not only because sauna seems to work like moderate exercise. The research has shown that individuals who enjoy sauna quite frequently, at least four times a week, receive the biggest health benefits such as reduced risk of coronary disease and stroke.

Besides desirable health effects, there is fresh data on the possible causal mechanisms that are responsible for these outcomes: foremost changes in circulatory systems and the

activation of heat-shock proteins. Despite recent progress, neither all positive nor possible negative health effects of sauna bathing are yet known and mechanisms that govern them remain a mystery. It is certain that a well-functioning sauna can provide immediate relaxation and relief from stress, which is a notable achievement on its own.

As researchers around the world continue to investigate saunas' health effects, we learn more about health-promoting sauna habits. Although the details may change, we can safely expect that well-designed and constructed Finnish saunas will help to grasp the maximum health benefits. If a sauna is intolerable, its potential benefits are negligible.

Read More

Printed books and scientific publications

Aaland, 1978

Acerbi, 1801

Blåfield & Blåfield, 2019

Hannuksela & Ellahham, 2001

Hussain & Cohen, 2018

Hussain et al., 2019

Laatikainen, 2019

Liikkanen & Laukkanen, 2020

MacWilliams, 2014

Pearson, 2020

Pollock, 2019

Reinikainen, 1977

Sauna from Finland, 2020

Teeri, 1988

Valtakari, 1988

Vuolle-Apiala, 2016

Vuorenjuuri, 1967

Internet sources:

<https://www.therme-erding.de/> The world's largest sauna center

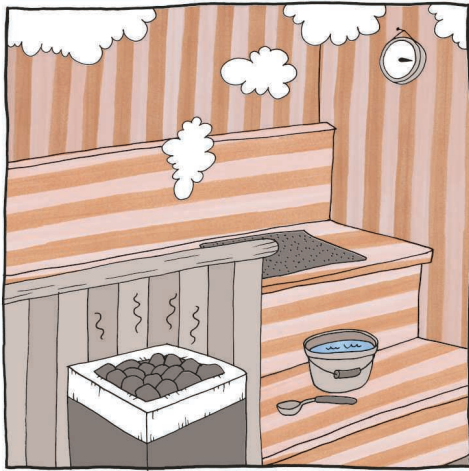
<https://www.aufguss-wm.com/de/> Sauna aufguss world championships

<https://saunainternational.net/> The International Sauna Association, the umbrella for all national associations

<https://www.ilmatieteenlaitos.fi/vuositilastot> The Finnish weather statistics

<https://www.is.fi/kotimaa/art-2000006503502.html> News about a yellow press online study of washing before sauna

Instructions for Finnish Sauna from the Finnish Sauna Society



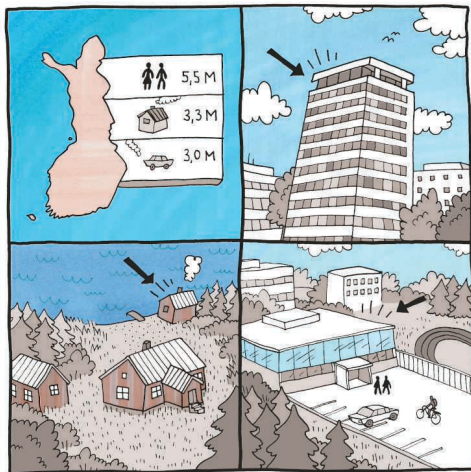
A sauna is a hot room. The air temperature can reach 100 degrees Celsius.

The sauna is heated by the kiuas, a kind of oven filled with stones. The stones and oven are burning hot.



As an institution, the sauna is more than a thousand years old and a big part of Finnish culture. People wash themselves and relax in the sauna.

In the old days, the sauna was where you gave birth and washed the dead (this was still common until the 1930s), since it was the cleanest place in the home. This is why the sauna has such a deeply ingrained meaning for the Finns.



There are more saunas than cars in Finland. Nearly everyone has a sauna in their home. There are also public saunas in Finland: in public swimming pools, sports halls and as independent establishments.

People go to the sauna once a week, sometimes more often.

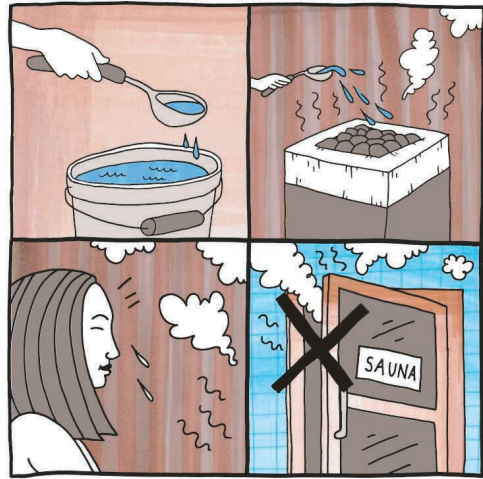


Finnish families go to the sauna together. Men and women, everybody naked. With other people and in public saunas, men and women go to the sauna separately.

People are naked in public saunas too. If you feel uncomfortable with being naked, you can wrap yourself in a towel.



Normal saunas do not have anything to do with sex.



In the sauna, you sit and throw water from a bucket onto the hot stones with a ladle. The water turns into hot steam (löyly), so be careful. Only throw water onto the stones if everyone wants to.

The door of the sauna is kept closed.



It is good to cool off between sessions, for example by taking a shower, sitting outside or swimming in the lake or sea. Everything that cools the body is good for you.

Also remember to drink plenty of water.



Enjoy the löyly and respect others in the sauna.

Welcome to the sauna!



SUOMEN SAUNASEURA
FINSKA BASTUSÄLLSKAPET
THE FINNISH SAUNA SOCIETY



2.

The Great Finnish Saunas

In my sauna philosophy, there are four elements that must be balanced harmoniously to pave the way for a great sauna experience. These are heat, air quality, interior design, and sauna culture & company. When you enter a sauna that combines all of these favorably, you will love it.



Recognizing a Great Sauna

The best sign of a great sauna is the degree of comfort you experience in it. The best saunas are comfortable, secure, and easy to enjoy. The best saunas make you feel like you'd never want to leave. Although recognizing a great sauna is rather simple with a bit of experience, it provides inadequate guidance for design. In my experience, you should be able to spend at least fifteen minutes in a sauna without problems. Under five minutes indicates serious problems, or totally unfit conditions for you. Over thirty minutes is superb, and requires you to take good care of hydration.

There are some values about sauna that Finnish people hold dear and which they expect to find in a sauna. According to several studies, cleanliness and the quality of löyly are very important to Finns. These can be achieved by different means. The Finnish sauna promotion association Sauna from Finland works to guarantee the quality of Finnish sauna services around the world. They have defined eight core values which should be present in a Finnish sauna experience and are also useful in design. These values are:

- *authenticity,*
- *presence & relaxation,*
- *cleanliness,*
- *wellbeing & health,*
- *multisensory experience,*
- *safety,*
- *contrast, and*
- *responsibility.*





Figure 33. The four-leaf clover model of the sauna experience.

For the most part, it is easy to understand how these values fit with Finnish sauna. For instance, *multisensory experience* refers to the fact that a sauna engages all the senses: vision, smell, touch (hot/cold), taste (in a minor way), and hearing. *Contrast* takes several shapes. Sauna as a ritual contrasts with everyday life and the interplay of sweating and cooling off during the ritual provides a contrast in heat perception and bodily response: blood vessels dilating and contracting. *Responsibility* reminds us that the Finnish sauna tradition has for long existed in balance with nature. Sauna of the twenty-first century should continue to be a sustainable source of human vitality, an ecologically and socially responsible facility.

The Four-Leaf Clover Model of Great Sauna Design

In my experience-first sauna design approach, I rely on a model with four facets. I call this the four-leaf clover of the sauna experience (Fig. 33). In this model, the sauna experience consists of heat, air quality, interior design, and sauna culture & company. The final item is not directly subject to design, but the overall design does a great deal to facilitate certain cultural and social events.

The element of heat is the first part of the sauna experience. It can be easily measured with a thermometer, but you can also feel it instantly when you enter the sauna and sit on a bench. The fact that sauna temperature reading has a standard measurement point one meter (3' 4") above the top bench, is not the whole truth and adequate measure of

sauna heating. It is crucial to achieve an even temperature distribution from the lowest to the top level of seating. Good air quality is crucial to the joy of sauna. For designers, it is difficult because air is invisible and intangible. You will perceive the shortcomings of air quality in two ways. Before entering the sauna you may be welcomed, or taken aback, by the scent of the sauna. The more severe problems emerge after some minutes of exposure to sauna. You may start to feel nausea, suffocation, or other forms of unease not normally associated with strong heat stress; all a clear sign that something is wrong with the air.

The interior design element is the easiest one for anyone to appreciate and judge. I use it to label all the remaining parts of the sauna room which don't have anything to do with heating or air. This includes quite a few details. The room has a ceiling, walls, floor, an opening covered by a door, and perhaps a window. Sauna-specific lighting and safety solutions are a standard. Although most components of interior design have a clear function, my thinking emphasizes the design of benches which follow the form of the ceiling. Together these ultimately enable the full delight of löyly and the sauna experience.

The puzzle I'm solving in this book is how to combine the solutions for each of these elements to create an opportunity for a great Finnish sauna experience to take place. Many Finnish people like to talk about the quality of löyly as an essential requirement for a great sauna. As I see it, designing a sauna according to the guidelines presented in this book, as well as using and maintaining the sauna appropriately and always using palatable water with a steady hand to create löyly, will give you pleasant löyly to talk about.

User Needs in Sauna Design

Designing and constructing a sauna should aim at creating something amazing for the people who use it. In my design philosophy, I don't think there is a perfect sauna that fits everyone. There may be saunas that are generally very good for most and I explain their design in this book, but I think special needs and preferences have to be taken into account, particularly if you're planning a sauna for yourself.

How to find the best sauna for you? You need some experience with saunas if you want to understand your preferences. Seek to try out as many different kinds of saunas as you can before commissioning or starting a design project. I think it is impossible to develop your personal taste unless you can experience first-hand different types of saunas and temperature and humidity conditions. In Finland, I find that for instance, instead of the 'standard temperature' range of 75°C to 105°C, there are people who enjoy the sauna at very mild temperatures (55°C to 65°C), and those only at very high ones (above 100°C), high humidity, or very dry air. Would you know before trying which group you belong to?

I know sampling sauna experiences isn't easy outside Finland. Except for the Midwest states in the US where you find pieces of a sauna tradition thanks to Finnish immigrants, real Finnish saunas are not globally conspicuous. Even in Finland finding different types of sauna can pose problems and requires determination. Ironically, the most diverse sauna testing grounds are found in central Europe and the Baltics, in locations which have public 'sauna worlds' where several different types of electrically heated saunas can be found. However, only in Finland can one find a wide selection of wood-fired saunas, smoke saunas, and sauna cabins that are publicly accessible. For example, the recreation center of Kuusijärvi in Vantaa (greater Helsinki region) is one such place. Although traveling to Finland might be fun and feasible some time



Figure 34. Sauna thermometer and hygrometer tell a story about the sauna climate. Finnish thermometers usually range up to 120°C (248°F).



Figure 35. The big smoke sauna building at Kuusijärvi, Vantaa.

in the post-Covid world, I understand it may not be feasible for every sauna builder, and you should look for opportunities closer to your home. Searching and asking around the internet can help. There are numerous sauna-related discussion groups on Facebook, for instance, which can direct you to a sauna hosted by a peer who is proud of their sauna.



Figure 36. A sauna cabin by the lake. This beautiful scene is appealing to most Finns and in fact computer generated by author Jarmo Hiltunen based on a design by Risto Vuolle-Apiala. © Jarmo Hiltunen

Finnish Sauna Types and Their Surroundings/ The First Decisions for Sauna Design

The iconic Finnish sauna is a cabin constructed out of bulky logs. It is bathing in the light of a sunset, on the beach of a lonely, remote lakeside somewhere in rural Finland (see Figure 36). Finnish historian Erkki Fredriksson argues that this type of sauna is in fact the only sauna type which has been undeniably invented in Finland during late the nineteenth century. These dream saunas exist around Finland, although town and country planning regulations have for decades forbidden people from erecting new buildings close to the shoreline. But this ideal sauna cabin is definitely not the only type of sauna prevalent in Finland. As we learned from history, the past hundred years have integrated sauna rooms into all kinds of buildings.

Good Siting, Perfect Location for a Sauna Building

The suitability of a location for a sauna cabin can be determined by answering the following questions:

1. Where can water be found?
2. Is the wood-fired sauna a safe distance away from other buildings?
3. What is the view from the sauna?
4. Should the building provide privacy and cover from the weather?
5. How does the building fit the overall architectural plan (view from outside)?
6. Is electricity available from the grid?

Both convenience and adaptation to environmental conditions have shaped the siting of sauna buildings. An easy access to fresh water has always been essential, especially before running water was available in the tap. Thus saunas were built close to rivers, ponds, springs, or a well. According to author Risto Vuolle-Apiala, saunas resided in the proximity of farm buildings (hundreds of meters or yards) for convenience rather than deliberately further away at rivers or lakes. The front of a sauna commonly faced other buildings, promoting visibility over privacy. Hot springs are not found in Finland and thus the sauna was for a long time one of the few places where hot water was to be found. Fresh water was not only used for bathing and doing laundry, but it was also needed for sauna bathing and making löyly.

The next biggest siting concern was fire safety. Still today, hundreds of years after the first ruling, Finnish regulations demand that a smoke sauna must be erected a safe distance (15 m



Figure 37. Löyly Helsinki, designed by Avanto Architects and completed in 2015, represents exceptional Finnish wooden architecture. This building is bold addition to the urban environment and embraces the shoreline rather than surrounding non-descript buildings.

or 49.2 ft) away from other buildings on the property and even further away from another person's property (20 m or 65.6 ft). The third siting principle, from the twentieth-century sauna architect Pekka Tommila, is that the saunas should face west or south-west (north-west in the Southern hemisphere) to provide a pleasant dose of warm evening light at the door or terrace. The fourth question reminds us of comfort and privacy needs. The orientation is more important if the location is very windy, or very public. The building can be used to provide shelter and privacy from heavy winds, rain, or just the gazes of passersby. Besides human discomfort, winds increase the energy demands on the building and affect how the ventilation and heating work in a wood-fired sauna relying on natural ventilation. Thus the prevailing direction of wind as well as the path of the sun should be taken into consideration.

The fifth siting consideration is the one an architect would probably consider first: how does the sauna building fit into the environment, among nature and other existing buildings. How will it look from the outside? In this book I will show some examples of sauna buildings in Finland, but I generally don't judge a book by its cover and believe it is far more important what's inside than how it looks from the outside.

The final siting question concerns the availability of electricity. This determines which heating, water, and lighting solutions can be utilized. Similar to water, electricity can usually be installed almost anywhere, but the price can be substantial in rural areas. While off-the grid lighting solutions and portable showers have reduced the need for a landline, electric heaters require usually more power than photovoltaic panels and batteries can cheaply provide. In 2020, a prototype called Lytefire built in the Swiss alps demonstrated that solar power collectors could generate thermal output of up to 40 kW and direct this energy to warm up a special type of 'sauna'. Given the limitations in utilizing solar energy due to seasonal and climatic variations, the option to use solar energy for lighting, or to heat up bathing water instead of the sauna room, is currently more feasible.



Figure 38. At my Suvikallio cabin, there is a long, covered veranda or terrace facing a secluded side of the building providing privacy and cover.



Figure 39. Lytefire sauna, a solar-powered prototype from Switzerland is not quite up to Finnish standards, but a brave fresh start. The sauna has a large installation of solar light concentrators directing sunlight to a bundle of rocks through a window. For optimization of energy, the building can be rotated as the position of the sun changes. © Lytefire 2020. Photo by Urs Riggerbach.

A Sauna Inside Your House?

Most Finnish detached houses and apartments have an integrated sauna, making a separate sauna house an unnecessary 'luxury.' Integrating a sauna in the house plan is easy with new buildings but retrofitting sauna is possible as well, as long as the requirements for ventilation and sanitation, described in Chapter 6, can be met. Adding a new wet (and hot) area must be approached with respect as it has the potential to introduce problems, unless the water in all of its forms (liquid and gas) is properly dealt with. An electric heater is usually found in Finnish integrated saunas but a wood-burning heater is also possible, especially if a flue (typically a brick chimney) already exists. Retro-fitting a flue is also possible but the high temperature of exhaust fumes from the heater is a fire hazard known to cause several fires annually in Finland.



Photo Hannu Pakarinen, © The Finnish Sauna Society



How Big Should Your Sauna Be?

The right sauna dimensions depend on two design choices:

- Number of bathers
- Size of rooms supporting the sauna function

Finnish sauna room sizing is based on the number people who should comfortably fit into the sauna at once. Convention suggests that approximately half a square meter per bather (5 ft²) will be required if bathers will be seated on the sauna bench. I recommend having enough room to lay on your back on the top bench, so the benches should include at least one 200 cm (6' 4") long section. Floor space must also be reserved for the steps leading up to the benches and for the sauna heater, considering its fire-safety requirements. Besides these capacity-based calculations, there is no absolute minimum size for a sauna. Most Finnish saunas seat at least four people. This is difficult to achieve without at least 4 m² space (e.g., 2 m x 2 m or approximately 7 ft x 7 ft). Smaller ones are possible, but I don't recommend it.

Spacious saunas are recommended. Many heater types emit high amounts of radiant heat, which creates an unpleasant feeling in the sauna if you are seated too close to the heater. Thus my recommended minimum size is 6 m² (65 ft²; e.g. 2.4 m x 2.5 m). Old Finnish smoke saunas were frequently 3 m x 3 m to accommodate the large heater and a large family. At the other end, the heating requirements (speed and temperature) limit the reasonable sauna size. If you build a 20 m² for four people, it will extract a toll in heating time and your energy bill. As we will learn later, large electrically heated saunas can be very difficult to power if the site has not been prepared for substantial electricity use (for instance, availability of three-phase power). Thus for electrically heated, integrated saunas I am willing to make an allowance for 4 m² room.

The volume of the sauna space is also very important. Adequate ceiling height makes it possible to construct the sauna benches above the level of the top of the heater. This follows a recommendation called '*the law of löyly*' and tries to ensure an even temperature distribution across the space allocated for bathers. If you are building a new sauna, note that you can always lower the ceiling and reduce the volume later on, achieving the opposite is difficult.

Minimum for...	Metric	Imperial
Recommended floor area, cabin	6 m ²	65 ft ²
Matching dimensions	2.4 m x 2.5 m	7.9 ft x 8 ft
Recommended ceiling height	2.5 m	8 ft
Recommended volume	15 m ³	529 ft ³
Recommended floor area, integrated	4 m ²	43 ft ²
Matching dimensions	2m x 2m	6' 8"
Recommended volume, integrated	10 m ²	108 ft ²

Table 2. Recommended Finnish sauna dimensions

So what is a good ceiling height? I'd say go for 250 cm (8' 4"). Then your top bench should be at a maximum of 120 cm (4 ft), at a minimum 100 cm (3' 4") below the ceiling. Exceeding the 120 cm level from the top bench will waste energy and dampen the steam experience.

Taking the inner dimensions together, we find that 15 m³ is a good target for a spacious four-person sauna cabin. Many heater options exist for heating up a sauna of that size. Personal preferences can be used to adjust the dimensions, but keep the changes reasonable unless you've deeply internalized all the lessons of this book.

Shouldn't you just build the biggest sauna you can fit or afford? I personally favor moderately sized saunas because I appreciate well-controlled, dynamic löyly that ranges from mild to severe. The reason is that the bigger the volume of the sauna, the more water must be applied to create as powerful löyly and a bigger heater will be necessary. In a Russian banya called Seleznevskie (Селезневская улица) I have been to an enormous 'sauna' in which several big buckets of water have been thrown into a big SUV-sized heater. I can't imagine how much work goes into heating that monster.

Spaces Supporting the Sauna

The sauna room is seldom the only one within a contemporary Finnish sauna. Bathing and dressing rooms, toilet, and outdoor access are important for a flawless sauna experience. The capacity of these supporting spaces should match that of the actual sauna room. Pekka Tommila suggests that a bathing room should be fifty percent bigger than the hot room, and the dressing room twice as big as the hot room. If you start with the minimal 4 m² hot room (43 ft²), you need a 6 m² bathing room and an 8 m² dressing room. That makes altogether 18 m² of space (194 ft²). Toilet and closets add more space.



Figure 40. A shower area at Löyly Helsinki public sauna, area used by both genders.

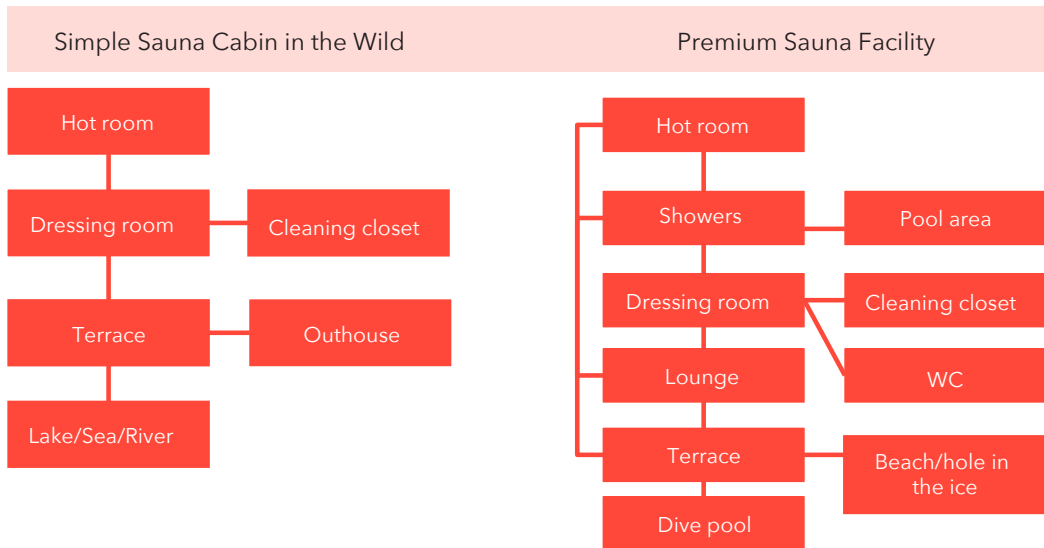


Figure 41. Example combinations of rooms making up a simple or premium sauna facility.

This may sound like a lot, but it is justified, given how much time is spent outside the hot room. If you follow this recommendation, your sauna will feel spacious and not crowded. Of course if your sauna never has more than two people, you may adjust the supporting spaces accordingly, but don't underestimate their significance.

The list of possibly useful supporting spaces includes:

- Bathroom with showers
- Dressing room
- Toilets
- Cleaning closet
- Lounge, a room with a fireplace
- Pool
- Outdoor areas

I will start with the last item. Outdoor access is critical. This enables one to cool down naturally and efficiently and provides a connection to nature. If the climate is as unforgiving as in Finland, you should have some covered terrace next to the front door to make the plunge to the refreshing outside air more pleasant (see Fig. 38). This gives the bather an option to step outside to the pouring rain or jump in the snow blanket if they feel like it, but doesn't make it the only option.

A dressing room is highly recommended if you dream of running the sauna throughout the whole year (in a location where seasonal variations apply). If the sauna is only used during the summer, please observe that there should be dry space for hanging clothes and towels, even if all other space is omitted. The remainder of the spaces should be included in the design depending on ambitions, budget, and space allowance. However, each room's specific function should be considered: if you leave it out, where will the activity take place instead? For instance, maybe the sauna hut's bathroom can be located in the main building. Consult Figure 41 for a description of how facilities connect together.



Figure 42. The characteristic smell and looks of a smoke sauna come from the way it is heated. The fumes enter the sauna room temporarily and add their touch to its surfaces. Photo: Hannu Pakarinen © Finnish Sauna Society.



Figure 43. There's a sauna inside the rear section of this 1970's Ford wagon.

Which Type of Sauna Is the Best: Electric, Wood-Fired, or Smoke Sauna?

The variety of saunas in Finland is overwhelming. There are saunas built into the most fantastic places. These include tents, trailers, decommissioned army vehicles, harvesters, telephone booths, old cars, ferris wheel gondolas, ski lift gondolas, shipping containers, igloos, submarines, ice-breakers, wine barrels, and others. The variety in the appearance of saunas plays a trick, concealing the fact that there aren't that many different types of saunas after all if you inspect them from an experience-first perspective. The way I see it, a sauna must be classified inside out, rather than from the outside in. If the sauna is considered to be a source of relaxation, wellbeing, and purification, we must focus on the qualities that make the biggest difference for the experience overall, not just on what the facility looks like.

The Finns readily recognize only two main sauna types which are called *puusauna* and *sähkösauna*. They can be roughly translated as a wood[-fired] sauna and electric sauna. In both cases, the character of sauna is derived from the manner of heating, either by firewood or electricity. There is also a minority of sauna enthusiasts who swear by the name of *savusauna* (smoke sauna), also known as "the original sauna" in a reference to the nineteenth-century standard saunas. These three have a clear order of preference, smoke sauna being considered by many aficionados as the best, followed by other wood-fired variations. Almost all Finns rank the electric sauna the worst, for both superficial and justifiable reasons, although some avoid smoke saunas. I believe these preferences show a fondness for originality, authenticity, as well as an appreciation for a slow, possibly cumbersome sauna journey over the convenience of a modern electrically-heated sauna.

The debate about the pros and cons of electric vs. wood-fired heating is something I will examine in detail in the chapter about heat. In short, my opinion is that the heater plays only a small part, and I do not think there is a big difference whether you use firewood or electricity to heat the sauna as such. Only smoke saunas stand apart from the rest of the saunas. However, no matter the power source, if a sauna design fails to consider all the leaves of the four-leaf-clover model, the choice of the heater makes no difference.

However, some heating decisions do have a major impact. This is the case for the smoke sauna as an instance of 'single-fired' heat storage heaters/saunas which introduces some important differences to other heating types. These differences affect the whole sauna room much more profoundly than anything else. For one, they cause the temperature of the sauna and of the sauna stones to be the hottest immediately after heating. This in turn means that any materials in the sauna that might negatively react to high temperature will do so and then disappear before the bathers enter the room. With heating solutions that have their maximum heat output and temperature during the bathing (such as the typical wood-burning and electric heaters), the situation is different and may introduce adverse effects.

Special Needs: Bathing, Cleaning, Heating, and Drainage

Sauna bathing is not only about creating steam. As we learned from the history, sauna was for millennia the only place to properly clean up in Finland. The sweating, whisking, and the availability of hot water were all parts of that process. Although nowadays most saunas have an adjacent bathroom with showers, simple sauna cabins may still need to support washing. This may include the need to warm up water, dedicate space for washing supplies, water tanks, and the washing act itself.



Figure 44. Washing supplies at author's Suvikallio sauna cabin.

The sauna room must be kept clean or it will become something other than a source of delight. The storage for cleaning supplies must be designed, too. Whenever you have a stand-alone sauna cabin, you should think about where the brushes, brooms, and other utensils are stored. This does not amount to much space, but if you don't secure a space for them, they appear in the wrong place at the wrong time, and disappear when you actually need them.

The design of wood-fired saunas should consider the storing of firewood and the convenience of heating. The basic requirement is that there must be a place to store at least the daily amount of wood under dry conditions. When this fuel is carried to the proximity of the heater, there must be room to lay it down and operate the heater safely. At least half a square meter (5 ft²) in front of the heater will be needed, possibly more. Note that handling firewood always leaves behind some trash, so cleaning must be considered here, too. The storage must be designed according to local laws and customs. For instance, the Finnish legislation is quite strict and forbids storing stacked firewood lining the outer walls of a building, which is a common practice in Norway and Germany. This does not, however, prevent Finns storing firewood below gables, barely covered beneath the extending roof.

The final invisible, but critical aspect is sewage or sanitation. During the course of sauna bathing, one single person may, via sweating and washing, excrete notable amount of fat through dead skin. The more frequent and popular the sauna, the more waste. Where does that dead tissue end up? On benches, on the floor, and eventually down the drain. The more water you use, the more dire the need to collect and dispose of it properly. The same principle applies as with firewood: follow the local regulations and common sense. Don't let things that don't belong to nature end up in there. Proper sewers also help to keep the sauna hygienic; they fight bad odors escaping from bacteria breeding in the pools of stale, dirty water.



Figure 45. The sauna center of the Finnish Sauna Society has an effective storage and heating system for the huge amount of firewood consumed almost everyday in the basement of the sauna complex.



Figure 46. Storing firewood in a dedicated shed some distance away from the other buildings is the recommended approach in Finland. An intact roof that protects the firewood from direct rain.

Special Requirements for Public Saunas

In Finland, the biggest difference between a public sauna and a private sauna is their size. Private saunas seat rarely over eight people whereas public ones easily exceed sixteen. Otherwise the same principles govern the design of different types of saunas. However, the requirements for the supporting spaces in a public sauna are much higher, although in public saunas the need to consider social interactions is ever present. All of the twentieth-century Finnish public saunas include multiple sauna rooms (at times gender segregated), showers, and separate toilets for men and women, possibly a lounge, reception, and storage space for all required supplies: towels, slippers, and so on. The spaces for men and women are usually almost identical, the women's side possible with a slightly smaller footprint. The twenty-first-century Finnish public saunas have shared saunas and are accompanied by a restaurant or bar which serves the sauna department as well.

Besides the scale, public saunas need to provide the patrons a sense of security inherent in private saunas. In Finnish saunas this is achieved with secure lockers as well as gender segregation. In contrast, in some public Russian banyas you store your valuables at a cloak service. Recently renovated banyas can also have modern lockers. Ultimately security is more about trust than locks and depends quite a bit on people's general expectations of how you as a designer can support this feeling. Always consider local expectations and customs.



Figure 47. Tykkimäki public sauna in Kouvola, Finland opened in 2018. Its large sauna room can seat over 50 people.

The Sauna Life Cycle

A well-built sauna cabin can survive for hundreds of years. In comparison, a poorly designed sauna can show signs of aging and require maintenance in a matter of months. Besides great design and meticulous construction, every sauna requires some upkeep to remain in good operational condition. The typical maintenance tasks and cycles are listed in the following table, with service interval times given for a family-sized sauna cabin used twice a week. In a more frequently used sauna, the service intervals will be much shorter.

Task	Service Interval
Tidying and drying	Every time after use
Thorough cleaning, protective treatment	Quarterly
Inspection of sauna heaters and sauna stones	Once a year
Replacing damaged sauna stones	Every two years
Replacing the heater	Every ten years
Replacing wall panels, refurbishing or replacing benches	Ten to twenty years
Total make over, including inspection of vapor barriers and insulation	Twenty to thirty years

Table 3. Sauna maintenance tasks and their service intervals in a family sauna used twice a week.



Figure 48. Concrete seats last long but eventually give way after years of services.

As Table 3 indicates, the different sauna components have different life cycles and service interval. Only the outer walls are considered part of a permanent structure. Wood flooring, windows, the heater, and even concrete surfaces will need some maintenance after decades of use.

Read More

Printed Books and Scientific Publications

Nordskog, 2010

Tommila, 1994

Rakennustieto, 2017

Liikkanen, 2019

Sauna from Finland, 2021

Internet Sources:

<https://saunafromfinland.com/core-values-of-the-authentic-finnish-sauna-experience/> The values of the Finnish sauna from Sauna from Finland

<https://lytefire.com/en> Solar powered heaters

3.

Heat

The warmth of sauna is experienced by our whole body, from head to toes. Although heat itself is an invisible element of the sauna experience, the sauna heater and sauna stones are usually very noticeable pieces in a Finnish sauna.





Since the invention of fire, heat has been one of the original tools for human survival. In the context of the Finnish sauna, heat is something we expect and welcome in abundance. There are several factors that influence how humans perceive heat. Our body is capable of sensing both skin temperature and deep, core body temperature variations. It can also act in order to stabilize those temperatures, and alarm us to take action with our feet to escape extreme conditions. The most sensitive areas for warm and cold sensations are found in the upper body, head, and in the feet and hands.

Humans are warm-blooded and need mechanisms to help cool off or warm up depending on environmental conditions. We have invented many clever ways to provide shelter from excessive heat, including dips in cold water, avoiding direct sun, wearing protective clothing, and air conditioning. But one key mechanism is built into everyone's body. Sweating helps to cope with excessive heat. As tiny particles of water evaporate from the skin's surface, the skin cools down because the transition of water from liquid to vapor requires thermal energy (heat of vaporization) that is largely extracted from the skin. During the process, perspiration also excretes different types of minerals and other bodily waste, many of which are considered beneficial to get rid of.

Enough about what we can do cool down; for a sauna designer it is important to understand the factors responsible for heating up in a sauna. There are four mechanisms which contribute to the total thermal load faced by the sauna bather:

- *radiant heat,*
- *conductive heat,*
- *convective heat, and*
- *condensation heat.*



Radiant heat is the prevalent type of heat encountered in a sauna. As the sauna is heated up to, say 80°C (176°F), all warm surfaces begin radiating heat notably. In fact, the heat radiation profile in a Finnish sauna is not that different from infrared cabins. The intensity of radiation has a non-linear relationship to the source temperature. This means that we can easily perceive temperature difference due to lack of heating (e.g. unevenly heated sauna) or excessive radiation coming from the heater. For a pleasant feeling of radiant heat, the radiation should be received evenly all around the body. Radiant heat is also best absorbed by the naked human skin.

In conductive heat transfer two surfaces exchange energy through a direct contact. The primary contact in the sauna happens with the bench. Because of the high temperature, we commonly cover the benches in order to insulate ourselves from excessive conduction. If the sauna is very hot, we may need slippers to also keep our sensitive toes away from contact with all hot surfaces.

Convective heat transfer happens when the surrounding air warms our skin or enters our lungs when breathing. Physically it is a variation of conduction: sauna air and human body, a gas and a solid mass. Convection is almost as important as radiant heat to the sauna's overall thermal load. How warm the air feels depends on the air temperature and its speed of motion.

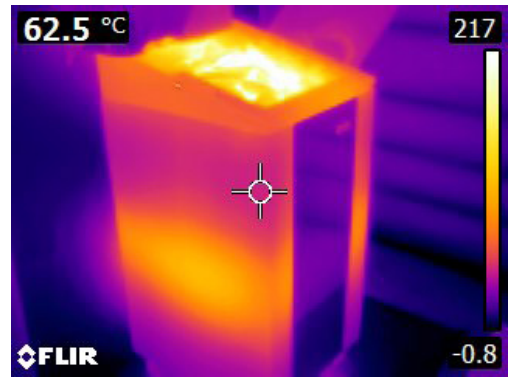


Figure 49. The strong radiation from the heater becomes visible in an infrared image.

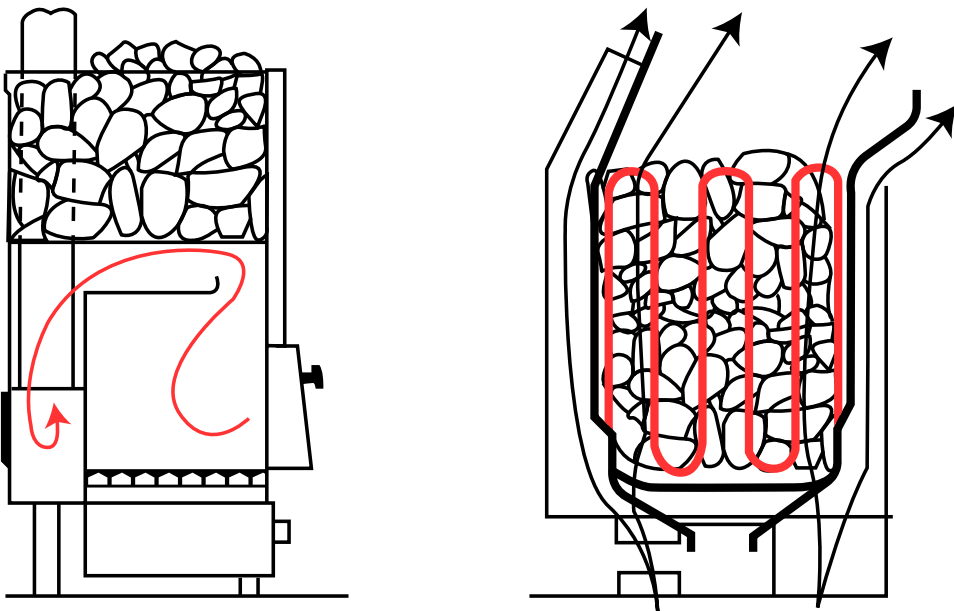


Figure 50. Operation schematic of a continuous wood-burning heater (left) and an electric heater (right). In the latter rising air flows through the stones as well as the metal casing, transferring heat in passing.

If you dare blow air into your fellow sauna bather's ear, this easily creates a burning sensation. This is not because your lungs would be filled by hot air, but because the movement of air removes the boundary layer cooled by conduction from the skin, allowing the heat of the sauna air to interact more effectively with the skin. While these kinds of tricks are not part of the Finnish sauna ritual and the air moves too slowly to be noticed, they do happen with the creation of löyly.

Condensation heat is the final physics principle needed to understand the secrets of löyly. Condensation is the reverse of evaporation described earlier. It is a process in which gas turns into liquid and releases the same thermal energy it took to evaporate. In a sauna, condensation happens when sauna air moist with löyly (water) touches the cooler skin of the sauna bather. Condensation will occur when the bathers skin is less than the current dew point of the moist sauna air. Dew point refers to the temperature at which air has exceeded the concentration of water it can hold, and the water turns back into liquid. The same phenomenon happens when you take a cold drink can from a fridge on a hot day and water droplets appear on the can's surface—you know very well it's not sweating but it sure appears to be. Condensation heat is only a temporary feeling and completely depends on the amount of amount water used for löyly, but it can be intense and sudden.

In a Finnish sauna, the sauna heater must be able to provide these four types of heat. Each heating mechanism has its special relation with how the heater operates. For condensation, it is the heat capacity stored in the sauna stones. For convection, it is in the structure of the heater and the flow of air through the volume of stones, so the air heats up and can circulate in the sauna. Blocking the convection can cause the electric heater to overheat. Radiation is always naturally emitted, and the heater should be constructed to shield the bathers from excessive radiation from surface areas.



Figure 51. The drinks don't sweat, or do they? Condensation of water is commonly observed when a cold objects is introduced to warm environment. Photo by engine akyurt, Unsplash.com.



Figure 52. An old electric heater exposes still working key components: upward pointing heating elements and a few layers of ceramic “stones” which leave air space enough for a good convective flow through the heater.

How Hot Should the Sauna Be?

When introducing the Finnish sauna, I made a reference to the ISA definition of sauna that included the temperature range of 75°C to 105°C (167°F to 221°F). The standard measurement point is one meter (3' 4") above the top bench. I expressed my slight disagreement with this standard since there are people who can enjoy sauna already at a lower temperature, starting from somewhere at 55°C, and some who tolerate temperatures up to 120°C (250°F). This range is unattainable with a single sauna.

At the lower end, the sauna room has to be very evenly heated, otherwise both comfort as well as hygiene will suffer. It is also critical that the steam capacity from the heater's stone volume is adequate to raise the dew point in the sauna temporarily over 37°C (99°F). Different challenges await at the high end of the temperature spectrum. Although temperatures over 100°C (212°F) may seem thoroughly excessive, they are not uncommon in traditional smoke saunas, at least temporarily. But this amount of heat is only tolerable with very low humidity and good air quality. Also, constant supervision and good fire safety precautions are needed to prevent the sauna burning down, if temperatures over 110°C (230°F) are desired. A sauna should never be heated to the point that its wooden parts will ignite, as gasification of wood begins gradually before charring becomes visible, consistently after the surface temperature exceeds 150°C (300°F), and ignite above 250°C (480°F).

The discussion about the right sauna temperature is misleading for several reasons. Before electric heaters, the Finnish saunas never had a fixed temperature. Even today, many wood-



Figure 53. In my sauna studies, I commonly rely on digital thermometers with either built-in data logger or external data logging application. This is for convenience of later observation, traditional thermometers are also quite accurate. On the left a logger by Lascar Electronics, on the right a modified Bluetooth sensor by Ruuvi.

fired saunas may display temperature fluctuations up to 20°C (approximately 34°F) during use because of the differences in heating intensity. More important than the standard point temperature is an even temperature range across the sauna space. Contemporary heaters play only a small part in that: ventilation solutions as well as interior design affect the temperature range (remember the four-leaf clover). The height of the heater becomes especially important if the sauna has natural ventilation because the sauna tends to heat up evenly only in those parts of the room that are above the heater. Here the differences between private saunas heated occasionally and public saunas that are kept warm, say ten to twelve hours every day, are tangible. The longer you heat the sauna, the more even the temperature becomes.

Another reason for skepticism about a single temperature is moisture. Humidity has a very large effect on how warm the sauna air feels. The more humid, the hotter it will feel, also when the dew point has been exceeded and sweating stops. I will elaborate the concept of relative humidity in the *Air Quality* chapter.

Further complicating valid sauna temperature readings is the fact that the even the best thermometer is influenced by air temperature, radiant temperature (surfaces), humidity, and air velocity around it. A perfect sauna temperature reading should consider all these measurement aspects. I haven't heard of anyone seriously discussing whether the sauna temperature should be measured as air or surface temperature. I believe a different type of measure altogether would be appropriate, combining the factors in a way that makes it more subjectively (psychophysically) equivalent across conditions.

On a final note, there is no requirement to heat the sauna room in advance much above usual room temperature (say above 40°C or 100°F), if the stones have stored enough heat. You can experiment heating the sauna with the door and windows open, and close them only after you would normally finish heating. When you enter the sauna, you can feel how different it feels to only have the heater's radiant heat as well as löyly which can quite quickly help to heat the room as well. Cover the heater temporarily with a fire blanket if you must; in any case, a different type of sauna experience is guaranteed.

How Sauna Heaters and Sauna Stones Work Together

The sauna heater and the sauna stones are the combined source of heat for the Finnish sauna. In some sauna literature, the term stove is preferred, but here I use the heater exclusively as I see it a better fit for all applications. The heater generates heat directly and indirectly. Directly it is a source of heat radiation. Indirectly it produces convective heat by warming the air that passes through the heater, and it also heats up the stones that are necessary for creating löyly.

The heat element is quite easy to master. Decades of experience have taught Finns how much energy you need to extract from the heater to fulfill its function. Earlier I discussed the sauna innovations and highlighted that so called constantly fueled or continuously heated heaters were remarkable innovations in history. This is because of the ease which they provide constant (electric) or nearly constant (wood-fired) energy output.

To make an analogy, I like to say that the sauna heater is like a car's engine. The engine powers the vehicle, enabling its smooth travel across different terrains. Engines are fitted according to the vehicle: you don't need a huge V8 for a tiny two-person city car, but to get a truck moving, ten cylinders are well justified. Engines also require engine oil, which in the sauna analogy corresponds to sauna stones that are a regularly serviced part of the engine.

The heater specifications are straight-forward. The heaters' power output relates to the size of the sauna room in 1 kW of thermal power for every 1 m³ of space (35 ft³). This formula was meant for saunas integrated with an apartment and lined with wooden panels. If the sauna includes 'cold' surfaces such as ceramic tiles, concrete, or glass walls and windows, the power demand increases by one kilowatt for each square meter, and if the sauna building does not have standard heating, a full fifty percent more energy is recommended. Note that although these materials increase energy consumption during heating, some of them, for instance a brick chimney, store energy during sauna heating and bathing and release it afterwards affecting the total energy balance. In power calculations for electric heaters, one hundred percent efficiency is presumed and usually achieved as conversion of electricity to heat is very efficient. Manufacturers are expected to follow these guidelines and state approximate range of volumes compatible with the heater (see Table 7 on p. 113).

The maximum power rating of the heater should match the room requirements and not be under or overrated. A car analogy helps to understand why. Consider



Figure 54. The naked engine. An electric mesh heater is simply a combination of some heating elements, wiring and enough casing that the stones will stay in place. Control electronics and sensors commonly reside outside the heater. Photo © Huum.

heating up the sauna as a long drive up a hill to reach a certain altitude; in a sauna, altitude corresponds to a desired temperature. If your car doesn't quite have enough power, it will slow down the ascent and its engine heats up along the way. In a sauna that slow ascent might not be that bad since the stones at least get thoroughly warm—but if the engine is really too weak, you may never get to your destination. But the motor can't be too powerful, can it? It'll just get you where you are going more quickly, correct? If your car reaches the summit very quickly and begins to idle, the oil will barely heat up at all. Sauna heaters can be too powerful as the sauna stones, the oil of this analogy, need time to warm up. They do that more slowly than car engine oil. Sometimes this takes a few hours, depending on the heater construction and stone volume, as the stones must reach a temperature of at least 150°C (302°F), or even 600°C (1100°F) if the heater is single, wood-fired type intended to provide warmth for an extended period. Common stone temperature for continuously heated models is between 250-350°C (480-660°F). Under this range, the steam generation will be slow and mild, above it is very fast and fierce.



Figure 55. This big electric heater is rated at 20 kW. Photo © IKI kiuas.

Overall, sauna heating consumes a lot of energy. In a Finnish detached house equipped with an integrated sauna, the sauna heater is usually the most power-hungry equipment. The Finnish households are estimated to spend over five percent of their utility bill in sauna heating, and almost twenty percent of their firewood doing the same. To make electric heating possible, one needs an appropriate electric system in the house. This requirement can be non-trivial in countries where a 115 V electric system prevails as the ampere rating for a medium-sized sauna with a 16 kW heater will be more than 140 amperes. This is not common and thus restricts the size of the sauna room to ones that work with 9 kW heater and an 80-ampere fuse. In Finland most houses are prepared to provide 3 x 16 Amperes with a 230 V system, which allows one to install a 9 kW heater without problems (matching an 8 to 10 m³ sauna).

The Source of Energy

Like car engines, sauna heaters can derive their energy from multiple types of fuel. Wood-fired and electric heaters are by far the most common, but natural gas or biogas, oil, or wooden pellets have also been used for fuel in Finland. Experiments with hybrid heaters that combine wood and electric heating have been made, but only a single mass-produced model remains on the Finnish market as of 2021. For now, it seems more convenient to have two different types of heaters



Figure 56. Wooden pellets from a Finnish manufacturer used for heating two saunas at Uusi Sauna in Helsinki.

in a sauna instead of one hybrid. Out of the yet marginal energy sources, wooden pellets are a lucrative option because of their high efficiency and relatively low emissions in burning. However, the pellet heaters are currently best suitable for quite large saunas. In Central Europe, gas-powered heaters are common. On the other hand, some countries like Norway have recently banned the use of oil and natural gas from heating use. This may signal a global trend favoring renewable energy sources that also affects sauna heaters.

The thermal power rating is not the only thing that matters. The stone volume is significant because the energy stored in stones is needed for creating steam (*löyly*) and releasing condensation heat. The more stones and stored thermal capacity you have, the less energy from the heater has to be generated during bathing. In fact, the original sauna heaters worked just this way: all energy was stored up in the stones in advance and then released during bathing, just like a toy car with a pull-back motor, or a modern electric vehicle. Heating before or during use introduces another dimension that differentiates the heaters. Heat storing heaters are like fully electric vehicles, continuously heated ones like combustion engine vehicles, and some hybrids provide just enough energy for a smooth start but don't store for a long drive.

The Original Wood-Burning Sauna Heater

The devices nowadays called smoke sauna heaters had a simple idea, based on storing heat. These early heaters were piles of rock, a formation of small and medium-sized rocks with a space beneath for keeping a fire. The stones were heated directly with the flames or the exhaust fumes which ran through the bed of stones. This slowly heated the rocks to a high temperature, possibly 500°C or above (932°F), at which point they started to glow red and it was the time to stop the heating process. All energy needed for bathing was now captured. Red glow indicates that the rocks have burnt clean of any soot and other impurities.

What happens with the fumes after they escape the pile of rocks? In the smoke sauna, there is no flue so the smoke (not the flames), slowly rise toward the ceiling and look for





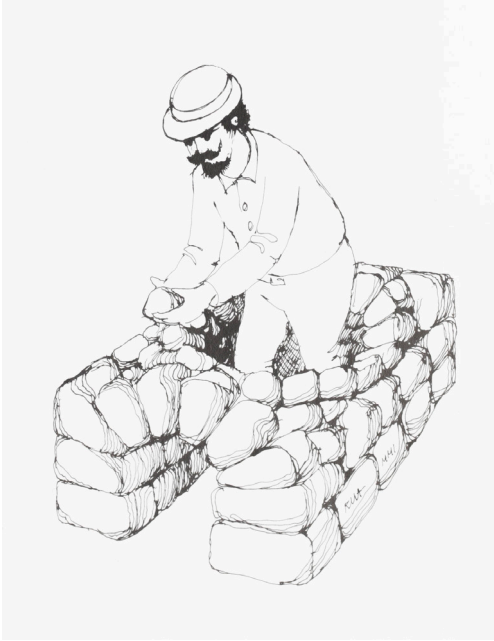


Figure 57. An illustration of how an ancient smoke sauna heater was built from stone by Risto Vuolle-Apiala.

an exit. Smoke saunas traditionally provided small hatches close to the ceiling on one side of the building for the smoke to escape. The fire burnt more intensely after each new batch of firewood and the smoke eventually found its way around the sauna room all the way down to a level of a so-called smoke ceiling. The air beneath this level was rather clear and breathable, but above that level all surfaces were heated and tarnished by the soot. Fires were common among smoke saunas, and still are, because of the heating method and wooden construction. In the light of modern smoke sauna wisdom, the too small hatch was a design error which led to excessive heating of the interior surfaces, accumulation of soot, and thus an increased risk of fire.

After the stones in the heater glowed red or the building had reached a temperature deemed appropriate by the person in charge

of heating, final preparations were made. These included a period of letting the heater sit still and heat up evenly, then throwing some water on the heater with doors and windows



Figure 58. Outdoor museum of Seurasaari in Helsinki hosts Niemelän torppa building, which includes a late 18th-century sauna. Much of interior is original or has been restored to resemblance.

opened to drive out the remaining burn residue and any carbon monoxide left after burning. Now the bathers could hurry in to enjoy a few hours of bathing time. In modern smoke or heat-storing heater saunas, a much longer bathing time can be achieved with insulation of the heater as well as moderate heating of the sauna itself.

The Twenty-First-Century Sauna Heater Types And Their Properties

Much has changed since the times of the original sauna heater. At first, carefully constructed piles of rock were replaced by brick and masonry heaters. It seems probable that this happened already during the late Medieval period. The next change happened as the smoke was piped into a flue which greatly, but not completely, reduced the risk of fire. This is clearly visible during the 1800s. By the early twentieth century, so called metal drum heaters were created with a simple flue connection to a brick chimney, as described in the *History of Sauna Innovations* in the first chapter. These types of heaters were popular in the early twentieth century. One late, well matured brand, Aitokiuas, still remains in production almost unchanged since the 1950s. But the majority of Finns are ignorant about this breed of heaters. They are instead familiar with the second generation, the continuous wood-fired heater. It changed the game during the 1950s and became synonymous with the wood-burning sauna for generations of Finns born after that period.

The heater options in the early twenty-first century Finnish market are plenty. While the number of companies making heaters has greatly declined in the past fifty years, there is still no shortage of different models. However, I acknowledge that the sauna heater market is not truly global, and sauna consumers around the world do not enjoy the same freedom of choice as the Finns do (although some heaters are not available here either). The following properties differentiate the heaters.



Figure 59. Aitokiuas family picture including models from the smallest 47 cm (18.5") to the biggest 110 cm (3'8") diameter models.

When comparing models, one should be aware of the following properties that affect heater performance, and thus the sauna experience:

- Thermal power output
- Stone volume
- Height
- Appearance
- Usability

Additionally, there are differences in some functional properties. These are less important for the sauna experience, but may be critical for selecting the heater:

- Required safety distances
- Usefulness in shared use
- Availability of optional equipment (e.g. water boiler)
- Flue connection size and orientation*
- Efficiency and emissions*

**wood-burning heaters only*

The heater properties are only loosely associated with heater types. The heater types can be divided based on the energy source, and secondly on the mode of heating. Furthermore, there are hybrid variations, which combine either different sources of energy, different heating modes, or both. The resulting combinations are outlined in Table 4.

Energy source/ Heating mode	Wood	Electric	Gas	Hybrid
Single-fired/ heat storage	Limited selection, tedious heating, convenient bathing	n/a	Appropriate for large saunas when gas available. Expensive, effective, clean, simple	n/a
Continuous	Popular, great selection, demanding for bathing	Very popular, affordable, simple		Flexible, expensive
Hybrid	n/a	Limited selection, requires some heating in use. Expensive	n/a	Smoke-electric hybrid

Table 4. Sauna heater types and their general properties by energy source and heating mode.

There are simply too many Finnish heater brands and models to introduce them all (see the More Reading section at the end of this chapter), so I will instead present the main archetypes of heaters Finns currently use, with representative examples from well-known native brands. These fall into the following broad and mutually non-exclusive categories

Ten Sauna Heater Archetypes

Electric Heaters

- Basic heaters,
- Pillar heaters,
- Mesh heaters,
- Flat heaters,
- Design heaters, and
- Heat-storing heaters.

Wood-Burning Heaters

- Basic heaters,
- Mesh heaters,
- Single-fired wood heaters, and
- Smoke sauna heaters.

The introductions start from the electrical heater which utilizes large electric resistance elements for heating the stones, although you can't always tell that from the outside.

Basic heaters (electric)

Basic heaters have been available since the 1950s. They are still produced by several manufacturers and remain popular in integrated saunas. The device is relatively small, usually fixed to the wall, and open at the top. The stone capacity is minimal, the safety distances are short, and the heater is usually quite affordable (€200 to €500 MSRP range in Finland).



Figure 60. The basic electric heaters are modestly sized, attached to the wall and resemble Scandinavian mailboxes. Photo © Narvi.

Pillar heaters (electric)

A breed of heaters devised in the early twenty-first century are recognized by tall, slim looks, and are floor-standing. Similar to the basic heater, they are only open at the top. The stone volume can be considerable and safety distances minimal so the heater can be integrated with the benches. The main issue is the excessive height. This heater is the most expensive, yet common heater, with a price range from €600 to €2,000.

Mesh heaters (electric)

Mesh heaters are open at the sides, revealing the considerable stone volume. Although mesh heaters tend to be tall like pillar heaters, they arguably release more radiant energy at levels beneath the top of the heater, making them easier to fit into low rooms, just don't expect this effect to be very strong. Prices range of €200 to €1,000.

Flat heaters (electric)

Heaters that look like rock panels attached to the sauna wall were popular during the 1990s. They have short safety distances, use little space, and are not very tall. Currently selection is very limited and prices range from €500 to €1,500.



Figure 61. Pillar heaters have distinctive, tall design with elegant exterior. Tulikivi brand is relatively new and innovative: they are using molded rock exterior to stand out. Photo © Tulikivi



Figure 62. Mesh heaters are structurally similar to pillars, but their open structure makes them visually different. Photo © Magnum / Tähtisaunat



Figure 63. Flat electric heater looks unusual. It requires minimal floor area by attaching to the wall. Photo © Sauna Granit



Figure 64. Design heaters are either extremely eye-catching or almost invisible. This IKI Float heater was design by Finnish designer Eero Aarnio. Photo © IKI Kiuas.

Design heaters (electric)

There are few unique heaters with distinctive looks that I have dubbed design heaters. Design heaters are usually marketed in association with a known industrial designer and are available in only limited varieties. Prices vary; on average they are more expensive than other types.

Heat-storing heaters (electric)

Heat-storing heaters are insulated and have a cover above the rock volume to keep the thermal energy inside while not in use. These heaters have also been available for over sixty years. The heater constantly consumes power (around 100 W) to keep the stone volume hot, but operates at full power only after the hatch is opened. Prices range from €1,000 to €2,500 for home-sauna models.



Figure 65. Heaters that store thermal energy require a large stone volume as well as proper insulation. The stones are hidden under the lid. TyloHelo Saunatonnttu [Saunagnome] is an iconic model hiding mostly underneath the benches. Photo © TyloHelo.



Figure 66. This wood burning Veto heater has been around from 1950's. The outside has been carefully modernized in small parts, including the light shade. Photo © VETO kiuas.



Figure 68. Drum heater is still alive in the twenty-first century. Contemporary models created by blacksmith Mika Häkkinen.



Figure 67. In Finland, IKI was the first company to introduce the mesh shape for heaters, soon followed by almost all domestic and close-by manufacturers. IKI Original is a low standing model. © IKI Kiuas

Basic heaters (wood-fired)

The basic wood-fired heater design goes back to the 1950s and many manufacturers still produce models which look much like they used to. Modernized models include a glass window in the firebox door. These heaters have a limited stone volume, are of medium height, and have medium safety distances. The heater stands on the floor. Available in various designs and power ratings from 16 kW to 50 kW and prices starting from €250.

Mesh heaters (wood-fired)

Mesh heaters have become one of the most popular heater types in Finland during the past three decades. Their open structure helps to heat the sauna more effectively, compensating for their height. These heaters pack a considerable volume of stone, slowing down the heating process but giving back the energy during and after use. Power ratings from 10 kW to 24 kW and prices from €300 to €2,000.

Single-fired wood-burning heaters (wood-fired)

The energy storing wood-burning stove was the original model but it is now only a marginal heater. The selection is narrow, limited to a single brand. These heaters can also be custom made. They are usually very tall and require the careful choice of correct stone volume and overall thermal mass to match the sauna. Available for saunas from 10 m³ to 90 m³ (350 ft³ to 3,200 ft³), prices from €1,600 to €9,000.

Smoke sauna heaters (wood-fired)

Smoke sauna heaters are usually a hobbyist product, and custom made by a brick mason. A few companies also produce commercial models. The choice and design of smoke sauna heaters is also based on the volume of the sauna room. The cost of a smoke sauna heater typically reaches a few thousand euros, and is completely dependent on the design and construction costs.

Special Heaters

Aside from these ten archetypes, there are some heaters that can only be described as special heaters. They are very rare even in Finland. For professional use, there are heaters with higher power ratings and special features. For instance, SaunaSampo produces a heat storing electric heater they describe as a “Mercedes” of heaters. It incorporates a fan for forced convection. Once the lid covering the big stone volume is opened, the sauna room is heated very quickly.



Figure 69. Smoke sauna heaters are usually made of brick and mortar and their designs are almost always unique. This is a re-made heater from the novel sauna village in Jämsä, Finland.



Figure 70. SaunaSampo is the most sophisticated and expensive electric heater available in Finland. Heater includes a lid controlled by an electric motor and it hosts plenty of rocks as well as fans in the bottom.

Among wood-fired heaters there is a heater that I believe may yet see a bright future. This is the wood-pellet burning, single-fired heater. It can function as a smoke sauna heater if desired, but produces so clean a smoke that the resemblance with an old-fashioned smoke sauna heater is minimal.

Facing the Difficult Choice of a Heater

The choice of heater is a difficult one. Finnish consumers are burdened by a panoply of choice as there are hundreds of mass-produced heaters available from twenty-three Finnish brands, created by twenty companies. Additionally, a handful of foreign companies from the Baltics and Germany also offer heaters in Finland. The top four global heater brands are listed below. Together they represent approximately one fourth of the global market, the rest belonging to small brands all over the world (Harvia Plc., 2018). The Russians have a strong tradition of creating wood-fired heaters, but those are not widely distributed. In the EU this is partially due to regulations concerning the emissions, efficiency, and safety.

The biggest manufactures globally:

- Harvia (Finland)
- TyloHelo (Sweden)
- EOS (Germany)*
- Termofor (Russia)

**Harvia acquired the majority of EOS in March, 2020*

I can say outright that the finding the perfect heater is impossible. Instead, start looking for a good enough heater, which you may hopefully retire after a happy relationship after some ten or twenty years which is the typical replacement interval for Finnish home sauna heaters. This average may not be very representative since the actual lifespan of the heater is dependent on the build quality, proper use, and, most importantly, the amount of use. Robust models can last decades in moderate use, worst ones die out in just a few years. I am a firm believer that heaters made in Finland, indicated by the trademarked Finnish Key Flag, are of excellent and durable

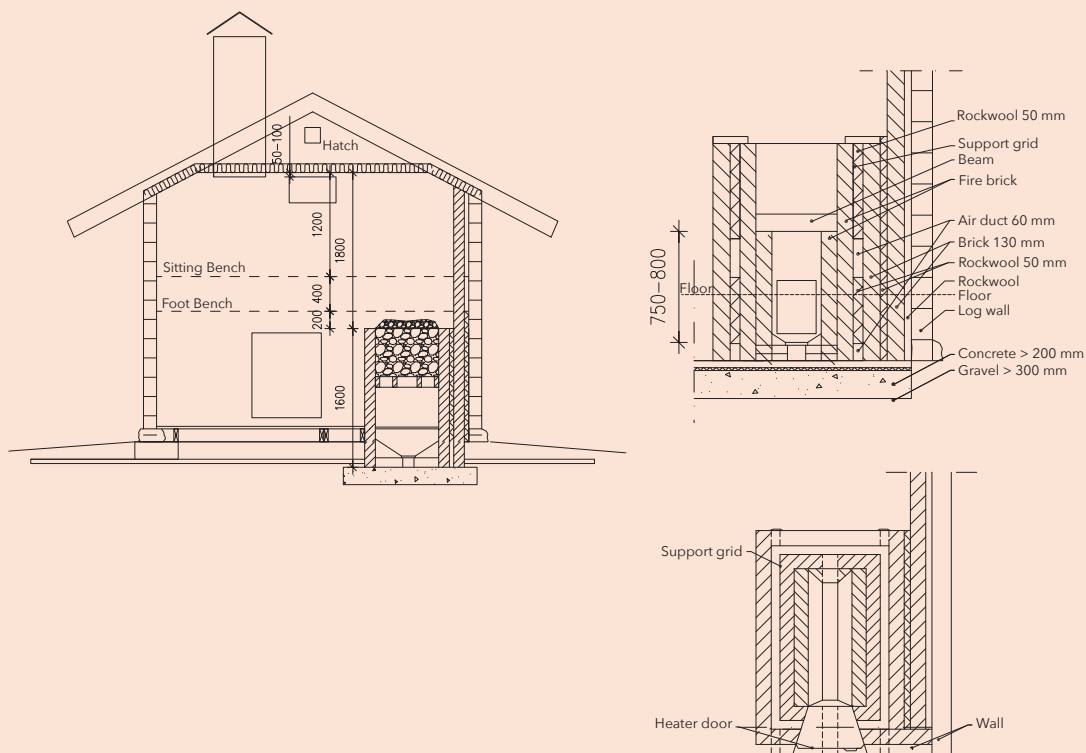


Figure 71. Juha Telkkinen's heater is a fine example of a modern Finnish smoke sauna stove which is designed to optimize efficiency and minimize emissions.

The Art of Smoke Sauna Heaters

Smoke sauna heaters are a unique category of individually designed and handcrafted masonry products. Their most prominent feature is the open space for stones and the lack of a flue. Smoke rises from the firebox through the stones and freely enters the sauna room. The design of smoke sauna heaters has slowly, but steadily evolved over centuries. The contemporary design favors heaters that resemble modern fireplaces. The firebox is up to 90 cm (3') tall to allow for clean and efficient burning with air ducts providing secondary and even tertiary combustion air. The heater has a double-wall structure consisting of a core and a shell, so that the core is made out of firebricks surrounded by an insulation layer, separating it from the shell. The core is built to withstand extremely high temperatures, capture heat, and expand notably during heating. The outer shell surrounding the insulation is typically made out of regular bricks, but could be natural stone—referencing the historical designs. On top of the modern heater you will find a lid that can cover the open stone space. It performs two functions. First, when only slightly opened at the end of the heating process, it temporarily boosts the heater's interior temperature so the stones will burn thoroughly clean. Second, it helps to moderate the heating of the sauna room both during use and between periods of use. The latter allows contemporary heaters to provide warmth for over twenty-four hours after a single, intense heating! This requires careful design and making sure the lid is closed after every session of sauna use.

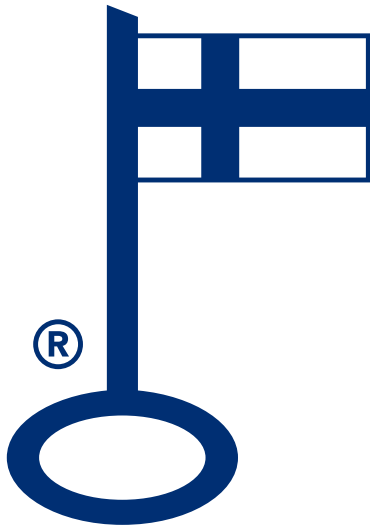


Figure 72. Finnish Key Flag Symbol identifies products that are of Finnish origin.

quality, although I have no data to support my claims. A Finnish brand alone does not guarantee the product is actually made in Finland, only products carrying a Key Flag symbol come with a guarantee of Finnish origin. When thinking about the heater investment, note that although the heater may seem expensive, it usually never amounts to more than twenty percent of the total cost of the building sauna, and is often much less.

In my experience, some differences across brands and models do exist and correlate with price. However, selecting the right type of a heater is more important. Quality differences in electric heaters are related to durability of heating elements as well as the control electronics. Both can be replaced if needed. In wood-burning heaters, the quality of metal and of craftsmanship affect how long the heater will last. There are performance differences among wood-burning models which are partially documented in a so called CE compliance and performance label. Electric heaters of similar power rating are expected to perform equally, as long as they remain in working order.

Which Type of a Heater Is the Best for My Sauna?

To find a good heater for your sauna, start by answering the following questions:

1. How powerful a heater do I need?
2. What energy sources are available and what's your preference?
3. How frequently and for how long do I need to keep my sauna warm?
4. Who would take the time to heat the wood-burning heater?
5. Is the stone volume big enough for the space?
6. How tall is the heater relative to the ceiling?
7. How much space do I have for the heater?

Everything starts with the power rating. The small-to-medium sized saunas with a volume of 9 m³ to 16 m³ have the most heater options. In Finland, a wood-burning heater will likely be installed in the biggest saunas; outside Finland you may discover a stack of electric heaters and an unusual primary fuse at large facilities. Of course, burning wood is not always an option. In some parts of the world, firewood can be scarce, or the local government may have taken a strong stance against all wood-burning appliances. For instance, in 2019 Krakow in Poland banned domestic wood burning. Wood pellets are a promising new renewable fuel, but to use them, you need to be able to purchase or produce them.

Take into consideration the intended use of the sauna, i.e. for how long and how frequently the sauna will be in use. In Finland, most public saunas that are open ten hours or more everyday are always powered by electric heaters. A continuous wood-burning heater is not a good option, as it requires constant feeding. However, single-fired wood burning



Figure 73. Finnish hardware stores usually carry a wide selection of heaters, helping customers to browse the selection in real world dimensions.

heaters can be designed to withstand up to eight hours of bathing, although several hours are needed for heating. If you are looking for modest sauna sessions lasting only one or two hours at a time, then your options are less constrained. In fact, a single-fired wood-burning heater with its long heating time may now seem less interesting unless they store heat for so long that you can enjoy them the next day, or at least the following morning. Some people like to spend a bit of time in sauna every day, sometimes staying only ten minutes, sometimes half an hour. These people may find that an electric heat storage heater is good for their needs, because it heats up quite quickly and ends up consuming less energy than a similarly rated heater used every day. The question of who takes care of heating is significant also for private sauna owners. If you feel too busy or incapable of fueling the heater, e.g. due to physical disabilities, it is better to opt for an electric heater.

The next three questions are details that apply to all types of heaters. The amount of stones is again related to the size of the sauna room. There are no clear guidelines on how many stones you need for a continuously ‘fired’ heater, but my recommendation is that you should have at minimum some 6 kg of stones for each cubic meter of sauna (13 lbs for every 35 ft³). For heat storage heaters, such as the smoke sauna heater, a recommendation of approximately 15 kg (33 lbs) per 1 m³ exists. This seems to be the minimum to guarantee a few hours of relaxed bathing. Unfortunately, there are no detailed formulas to calculate heat storage capacity for an arbitrary duration. The heat-storage design should also take into consideration total thermal mass of the wood-burning heaters that have a fire chamber made out of bricks that also store heat. In fact, a reference modern smoke sauna heater design from author Juha Telkkinen (see p. 91) includes approximately 600 kgs (1320 lbs) of stones, surrounded by 2,000 kg (4,400 lbs) of brick mass. This mass will not heat up evenly but over some six hours of heating, it does absorb a lot of energy. In contrast, most continuous wood-fired heaters have insignificant mass of their own, so the stone volume is very important to guarantee a good supply of löyly.

The next important question is how to fit the heater in the sauna room. Most important is the vertical dimension and the height of the heater. This is due to the so called Law of Löyly coined by the Finnish author Sakari Pääli. This ‘law’ dictates that your feet should rest on a level above the top of the heater or otherwise the steam will be uneven and your feet will feel cold—they are very sensitive to temperatures. I recommend adding at least 10 cm (4”) on top of this recommendation. In the chapter five about interior design, we will learn that the distance from the foot bench to the highest level of the ceiling should be at least 145 cm (4’ 10”). This means that according to the Law of Löyly and my adjustment, your heater should be located at least 155 cm (5’ 2”) below the ceiling, or more. In practice this suggests that a high ceiling is always preferable.

The horizontal space around the heater has to be also taken into consideration. To ensure fire safety and reduce the risk of burns the heaters require safety distances that are determined through a test protocol and are unique to each model. The current heaters have quite short safety distances, from just few centimeters to 30 cm (2’ to 1’). No material that can burn should be placed closer. The safety distance can be decreased by installing protective sheaths that reduce the safety distances further, although these should be certified for use with the specific heater model.

These considerations should help you to get started with heater decisions. Remember, you can have several heaters in a single sauna. With electric heaters, it is not any more difficult than having a single heater. With wood-fired heaters, multiple heaters also multiply the heating effort. Installing multiple heaters requires, of course, adequate space and further expands the safety distances.

Are Wood-Burning Heaters Superior to Electric Heaters?

Many Finnish people prefer wood-burning heaters, or particularly the wood-burning sauna, *puusauna*. I personally don’t believe there is a fundamental difference based on the method of heating. Thus the wood-burning heater was not on the earlier list of important heater properties. To make a generalization about the wood-burning heater virtues, you could say that they are powerful devices that can be operated anywhere you can find firewood. They include some experiential qualities normally absent from electric heaters such as the sight, sounds, and scents of fire. They can also improve sauna air quality, but this is not always guaranteed as we will learn in the next chapter. Electric heaters are much more convenient than wood-burning ones and give stable performance over time. A brief comparison of the features can be found in Table 5. In my opinion, the inferior qualities associated with electric heaters by Finns is a product of heater placement in saunas that have issues with other key elements: air quality, interior design, or outdoor access.

Important Heater Options and Supplementary Equipment

Sauna heaters can and sometimes need to be outfitted with optional equipment. Electric and wood-burning heaters have very different options. Electric heaters will benefit the most from having a control panel placed outside the sauna room. Instead of physical, the

	Electric, continuous	Electric, heat- storing	Wood-burning, continuous	Wood-burning, single
Pros	Simplicity Usability, Energy efficiency in use, sustainability	Quick warm-up cycle Large stone volume	High power output Good selection of heaters Can help in ventilation Renewable energy source	Simple during bathing
Cons	Too many models to choose Stone volume variable	Expensive	Laborious Emissions	Few models Long heating time before bathing May leave soot
Stone tempera- ture	Medium 200- 350°C; 390- 660°F	Medium 200- 350°C; 390- 660°F	Moderate 150-300 °C; 300-570°F	High 250-600 °C; 480-1100°F

Table 5. Summary table of pros and cons of different types of heaters

controller can be digital such as a mobile application. Here the biggest concern is safety. Electric heaters have caused several fatal fires in Finland in circumstances where some combustible material on top of the heater caught fire when the heater activated without anyone noticing it. This could happen if you start the heater remotely. Solutions for safe



Figure 74. Electric and wood-burning heaters may look nearly the same. The examples from Narvi NC product family. Photo © Narvi.

An electric and wood-burning heater side to side at Viimsi Spa, Tallinn, Estonia.





remote operation are just becoming available. The next most useful option is the temperature sensor outside the heater that aids in controlling sauna temperature. Some heaters also have an internal sensor for measuring the temperature of the stones. Different types of integrated steam generators are also available. These typically involve a small, hand-filled water basin that vaporizes water when the heater operates normally. This represents a step towards semi-automatic or remotely triggered water dispensers which enable the user to create löyly by touching a button. Dispensers can be installed inside or outside the heater. Wood-burning heaters require a flue. It can be a traditional brick chimney or a modern steel flue. From the other options, the most important equipment for many sauna cabins is a water boiler with a capacity to heat from ten to sixty liters (2.6 US gal to 15.9 US gal) of water. The boiler can be integrated into the heater or attached to the steel flue. There are some options as to how the boiler is integrated with the heater:

- the water tank can be located next to the firebox, transferring energy by conduction,
- a heat exchanger coil can be installed inside the heater to capture energy, or
- a donut-shaped tank can be installed surrounding a round heater.



Figure 75. A wood-burning heater with aside and a flue water boiler, potential combined capacity up to 100 liters (26 gallons). Photo © Misa

The integrated tank is very effective and quite popular, but has the downside of being too powerful. This results in the boiler generating steam and boiling sound uncontrollably if heating continues for a while. The other alternatives as well as the flue heater are less powerful. The flue boiler and the donut-shaped tank consume only energy that would otherwise escape or would have a minor effect as radiant energy. The flue heater is easiest to use with a steel flue, but it may also fit in with a brick chimney if there is room for a long connecting steel pipe between the top of the heater and the connection to the flue.

There is also a new invention, a sophisticated heat-storing flue that integrates with the heating system of the whole building to provide extra energy. It captures thermal energy from the full length of the flue, generating up to 4 kW's of thermal power using a built-in heat exchanger.

The rest of the heater options are safety devices. Regardless of the energy source, the heater gets very hot and some precautions may be needed to



prevent contact between people and its hot surfaces. Many heater models offer wooden safety rails for this purpose. For wood-burning heaters, there are also safety metallic sheaths or walls that can be used to prevent surrounding structures from heating up too much. Solutions are available that cover 270° around the heater, including the surface underneath to protect the floor, leaving only the heater's front visible.

Figure 77. Heaters are usually available with some options to finishing. Narvi Style heaters enable covering the heater with ceramic tiles of your choice. Photo © Narvi.

Appearance and Usability Considerations

The differences in the appearance of the heaters are easy to pick for anybody. In choosing a heater for your personal use, you should also give some weight to the appearance of the heater along with other considerations. However, if you are looking to create a great Finnish sauna experience, having a cool looking heater must not take precedence over the other considerations. There's nothing wrong with having an attractive heater if it makes you feel good, but an ugly heater might perform its function just as well.



Figure 76. An electric heater at Viimsi Spa (Tallinn, Estonia) covered with brick wall and masqueraded as a wood-burning one.



Figure 78. External control panel adds both usability and safety to heater operation. Photo © Harvia

The focus on a heater's appearance is not surprising in Finland, where consumers are in the habit of keeping heaters in sight. This is justified by the needs of creating *löyly*. However, elsewhere in the world it is more common to partially cover up the heater with a sheathing surface that hides the heater, or masquerades it to look like something else entirely. This is perfectly acceptable, but just remember to observe the safety distances and leave an opening near the floor level so the natural convection does not get blocked.

The usability of the heater is ultimately paramount for safety. Usability refers to ease, effectiveness, efficiency, satisfaction, and error-free use. Here electric heaters are in many ways superior to wood-fired ones. This concerns foremost heating but also bathing. If you enjoy the experience of tending the fire, then wood-fired heaters are almost equally usable. Electric saunas maintain a regulated temperature effortlessly, require nothing from the bathers, present only minor hazards for people and the building, and have less chances for user errors, which does not mean they are completely safe. Usability difference among electric heaters relate to their control mechanisms, some of which can be tricky to use.

What an electric-heater buyer should pay attention to is what kind of controls are available and whether the controls are integrated or separate from the heater. The standard controls include a timer and temperature/power setting. The temperature setting is meaningful only if the heater has an external temperature sensor (wired or wireless) placed in the ceiling or at the standard height. The manufacturers insist on placing the sensors in the ceiling, which gives higher readings and maximizes safety, but maybe misleading with a reference to the standard measurement point. The most advanced models offer control over the stone temperature in addition to the sauna room temperature, and can be operated with a mobile application. What a consumer needs to understand is that most electric heaters, as they are sold, do not include these external controller and sensors, and the price for the full kit, known as the sauna heating appliance in sauna business jargon, is usually much higher than for the heater alone.

Indeed, a fancy controller, a combination of a power unit, the control panel, and sensors, can be twice as expensive as a cheap heater.

The wood-fired heaters have a multitude of challenges when it comes to usability and heating. Heating the sauna is a special type of a duty many Finnish sauna owners treat like a hobby. Several aspects influence the usability of woodburning. The most important is the placement of the heater and direction of feeding the fire. Regular heaters are operated within the sauna room, but tunnel heaters (a.k.a. through the wall heaters) are operated from an adjacent room or from the outside. These are particularly popular in Russia. Many tunnel heaters include a façade that makes them look like small fireplaces. For example, at my Suvikallio cabin, several guests have mistaken my sauna heater for a fireplace.

The tunnel heater can be of any wood-burning heater type. These heaters are connected to the main body of the heater residing in the sauna room via a 'tunnel' through the wall. This makes a difference for both wood scraps that scatter on the floor as well as allowing someone tending the fire to stay outside of the sauna room while it is heated. There is also a minor amount of heat (under five percent) transmitted in the direction of feeding; this energy may not compensate for the loss of energy created by the draft of fresh air required by the burning process when the incoming air is very cold. However, the tunnel that extends the fire chamber is bad for the ergonomics of the heater, firewood has to be placed further away in the heater's firebox requiring kneeling down to operate the heater. For heavy use, wood-fired heaters have been custom built so that they can be operated from a basement below the sauna room at a convenient height. For instance, the Finnish Sauna Society houses six wood-burning saunas under one roof and all of them are operated from the basement (see Fig. 45) at a convenient level of about 120 cm (4 ft).



Figure 79. Lonna Island Sauna wood-burning heaters are operated from the outside.

Can Remote Operation of an Electric Heater be Safe?

In Finland, the great number of private saunas along with a high level of technical infrastructure and knowhow has spawned inventions for remotely controlling electric heaters since 1990's. Currently there are four brands offering some remote control on the Finnish market: Harvia, Huum, Narvi, and TylöHelo. All involve a wifi connection and a dedicated smart phone app. These provide the ultimate ease to heating a sauna. But there is risk involved. Numerous domestic fires are traced back to private sauna facilities (remote operated or not). Some of the incidents occur because the heater activates while some combustible material, often laundry, has been placed on top of the heater and catches fire. An open door can also cause abnormal heating and a fire hazard. For these reasons, Finnish regulations currently require typical consumer remote control to respond to either hazard: covering the heater or opening of the sauna door. In either case heating must automatically stop.

The current requirements are not fool proof and it is expected that the security demands will increase when these devices become more common place. However, older generations of technology operating with an hourly or weekly timer are not void of risks either. The best fire insurance a sauna owner has is to always make sure to leave the sauna in a safe condition: nothing on top of the heater and the door closed.



Figure 80. In 2016, Estonian Huum pioneered the use of mobile application to remotely control sauna heater. Photo © Huum.

Wood-Burning Heaters: Emissions, Efficiency, and Sustainability

Commercially produced wood-burning heaters have been a success in Finland since the 1950s. However, still in the early 2000s the sauna heaters were by far the worst performing wood-burning devices in terms of emissions and efficiency in the studies carried out by Finnish researcher Jarkko Tissari. In 2013 EU requirements regarding the performance level of continuous wood-burning heaters came into effect in Finland. Based on the latest experimental results the efficiency and emissions of wood-burning heaters have improved. The test standards underlying the so called CE label set moderate requirements for thermal efficiency, carbon monoxide (CO) emissions, and safety. They require the manufacturer to demonstrate compliance with testing. This has removed the worst heaters from the market and required modifications to old models.

Although the heaters have improved, the thermal efficiencies of the modern sauna heaters are still not up to the level of other non-sauna wood-burning heaters and may in fact be inferior to the old smoke sauna concept. In the EU and Finland, the authorities have been particularly concerned about fine particle emissions (PM2.5), containing e.g. black carbon (BC) and polycyclic aromatic hydrocarbons (PAHs) which contribute to global warming and air-related health problems. These emissions are not currently considered as part of the CE label requirements and it is practically impossible for a consumer to know how any given heater performs, regardless of what its marketers say. The rule of thumb is that the less smoke you can see, the less emissions there are overall. The color of the smoke is indicative: brown or opaque gray smoke is a bad sign. The observations should be made during moderate or warm weather, in the cold of winter you will just see water vapor condensing to white clouds.

In my opinion, the problem is not so much that engineers don't know how to burn logs better. Relatively low emissions and high thermal efficiencies can be achieved with the latest combustion techniques. However, in batchwise continuous combustion, combined with the unusual requirements for a sauna heater (e.g. temporarily high power output, storage of heat in the stones, low prices of the heater), ideal combustion conditions are difficult to achieve. One promising solution is to burn wood pellets instead of logs to reduce particulate emissions and improve efficiency. Unfortunately for saunas, there are commercial solutions neither in the power class nor in the price range favored by consumers.

CE		
Narvi Oy 12		
EN 15821:2010 Multi-firing sauna stoves fired by natural wood logs for space heating in residential buildings Kota Luosto, Luosto VS, Inari, Pallas		
Fire safety (initiation, risk to adjacent elements)		Pass
- including declared safety distances to combustible materials:	Back Side Ceiling	350 mm 300 mm 1 280 mm
Emission of combustible products		Pass
Surface temperature		Pass
Release of dangerous substances		NPD
Cleanability		Pass
Flue gas temperature		392 °C
Mechanical resistance		Pass
Thermal output and Energy efficiency, as:		
- carbon monoxide emission at 13 % O ₂		Pass (0,11 %)
- total efficiency		Pass (69 %)
- flue draught		12 Pa
- thermal output (i.e. nominal space heating output)		16 kW
- refuelling loads		8.5 kg
Durability		Pass

Figure 81. Kota Luosto heater CE-label.

There is also the question whether wood-burning heaters, that always produce some emissions including carbon dioxide (CO²), are sustainable? Opinions about this are a matter of national politics. In Finland, forests are cultivated dutifully, and the renewal rate of the forests is monitored. Under these conditions I believe heating saunas with wood-based fuel is a sustainable choice. However, in parts of the world where deforestation is an issue, the choice of energy is controversial and opting for an electric heater is certainly more sustainable if clean energy can be attained that way. The solar sauna concept introduced earlier is unfortunately not yet a feasible solution for all times and locations, but will hopefully mature into something useful.

Sauna Stones

Earlier I used analogies describing the sauna heater as a car engine, and comparing the sauna stones to engine oil. The engine oil analogy is accurate as far as the suitability, durability, and necessity are concerned. Sauna stones are an integral part of the Finnish sauna and they require regular inspection and maintenance to keep the heater running. Negligence in maintaining the sauna stones can cause several problems, slow down the heating process, damage the electric heating elements, and waste energy.

Although the stones are the piece of sauna equipment that has the shortest life span, it's not that short. In domestic-use scenario of operating a sauna twice a week, you can expect to enjoy the stones to last at least for a few years. A heater that is used every day for long periods requires inspection at least every three months. Modest service intervals require that you have equipped the heater with appropriate sauna stones to start with. The suitability depends on several factors.



Figure 82. Changing stones to an electric heater.

Properties of Appropriate Sauna Stones

There are very clear requirements to what makes a stone suitable for sauna use. These are listed according to their importance:

- Durability,
- Safety,
- Size,
- Appearance and form,
- Thermal capacity, and
- Thermal conductivity.

First is durability: the stones must be able to endure the sauna conditions and typical use. This involves temperatures ranging from 150°C to 600°C (300 to 1100°F) although the



Figure 83. It does not get worse than this. A granite stone has totally collapsed under 500°C (930°F) heating. You don't want this to happen inside your heater.

typical temperature range is 150°C to 300°C (300°F to 600°F). Some rocks, such as varieties of red granite common in Finland, disintegrate before reaching 500°C and are thus not usable in heaters that reach high temperatures. The old Finnish method of testing the durability of stones was to heat candidate stones on an open fire and see if they crack or crumble in the process. If not, they pass. In fact, there are no widely standardized methods for assessing the sauna stone durability in Finland. To fill the gap, I have created the Saunologia stone durability test protocol 1.0/2019. This new proposal is just being adopted by the industry. It comes with bit of empirical support that it can simulate real use and discriminate between weaker and stronger stone varieties. My research has revealed that even though all stones eventually break, there are important differences when and how that happens. The preferred, graceful degradation happens when the stones split neatly into smaller pieces. Unfortunately, many varieties crumble and create small dust particles that are dangerous for the heater and have unknown health effects for bathing, for instance, if they should float in the air.

Second and equally important stone property is safety. The stones should not emit any harmful gases or substances while in use. Natural rocks can include all kinds of compounds, some of which may become airborne at the temperatures found inside the heater. Radiation, harmful minerals such as asbestos, or any other hazardous substance should not be present in the stones. Once more, the specific methods for detecting these issues are not widely deployed; general petrophysics and geological methods must be applied. In Finland, stone producers screen their products for the presence of asbestos, which is naturally found in Finnish base rock and known to be released into the air heating and making steam.

The stones must also be of the right size. In Finland, the heater manufacturers have opted for a system of three sizes (see Fig. 85):

- *small* (5 cm to 10 cm; 2" to 4"),
- *medium* (10 cm to 15 cm; 4" to 6"), and
- *large* (over 15 cm; above 6").

This size system is suggestive. The stones produced from natural rock with an industrial stone crushing process never come out in precisely the same size or form. The only exception is the ceramic stones that can be manufactured with exact dimensions. The right size matters. Most electric heaters use the small stones, wood-fired heaters the medium and large stones. Single-fired wood-burning heaters use the biggest stones that can weigh tens of kilos (30 lbs or more) each. Electric heaters are designed to work with small stones whereas a large single-fired wood-burning stove may choke if it is filled with only tiny stones.

The sauna stones common to Finland come in a variety of colors, shapes, textures and sizes (see Fig. 87). Most of the natural stones are dark grey or almost black. The shapes are irregular, rough, and usually more elongated than globular. Rounded variations of most popular natural stones are also available. The rounded shape affects steam creation slightly as the surface area of the stone is reduced with the smoothing of the naturally jagged stone surface. In single-fired wood burning heaters the rounded and smooth shape is beneficial, so less soot accumulates on the rock. In electric heaters, rounded shape prevents resistor element damage. The proper convection of all heaters requires that the air can pass through



Figure 84. In an easy durability trial, I exposed a selection of stones to up to 750°C (1380°F) for a short period of time. This should be nothing for durable stones. Regardless of what the object is made of, they have deep red glow after some 600°C (1110°F) Celsius.



Figure 85. The three sizes of Finnish sauna stones produced from natural stone: small, medium, and large. All samples are made of olivinediabase.

the volume of rocks. Round ball-like shapes ensure that the stones will not block the air current as might happen with a misplaced flat stones.

The importance of the stones' appearance depends on the heater model. The 'closed' heater models obstruct all but the topmost stones from view, thus their appearance doesn't matter. You can use so-called decorative stones on the top and more durable stones in the lower layers. In Finland, the white dolomite stone has become popular in modern private saunas, despite its serious shortcomings in durability. In open heaters that expose the stone volume completely, the situation is different and everything you put in the heater is visible and affects the appearance considerably.

Thermal capacity and conductivity are two related stone properties. Dense, heavy stones hold thermal energy the best, as the thermal capacity seems to correlate strongly (> 0.9) with the density of the rock. The secondary aspect of the stone is that it must be able to release and transmit energy, to support heating through conduction and convection, as well as to vaporize water. Thermal conductivity should thus be high (see Table 6).

Stone variety	Density (kg/dm ³)	Conductivity W m ⁻¹ K ⁻¹)
Olivine-diabase	3.00	1.94
Peridotite (Finnish)	3.10	2.91
Vulcanite	2.78	2.52
Olivine	3.52	2.42

Table 6. Examples of thermal capacity and conductivity for few Finnish stone varieties



Figure 86. I personally love the looks of rounded natural stones. Looking carefully you may notice that I have actually only covered the top layer of the heater with the rounded stones.

Examples of Stones Used in Finland

For a long time in history, everyone had to find their own sauna stones. Beaches, river bottoms, and similar places where rocks had lain for thousands of years and repeatedly tested by the forces of water and ice, were favored locations for collecting dark, solid looking stones. Some people still do this, but results can vary as it's difficult to ensure the stones meet the durability and safety requirements. Most Finns nowadays turn to commercially produced sauna stones.

In practice, few rock types have turned out commercially viable material for sauna stone production. Since the 1950s there have been two periods of different dominant stones, both from a branch known as magmatic rock. The first period was from the family of peridotite, the latter ongoing period that of so-called olivine-diabase also known as dolerite outside Finland. The peridotite was a superior market leader in its own time, probably until the 1980s when its production became increasingly difficult; the sources depleted, or the risk of asbestos contamination became too high. A new alternative called olivine-diabase, lighter in tone and in weight, soon took the market.

Two other stone varieties have also survived the decades, although never achieving big commercial breakthrough. These are vulcanite and olivine. Each has their own characteristics which are at times better than those of olivine-diabase. For instance, olivine is denser and vulcanite conducts heat better. Overall, olivine-diabase is the good-enough solution that is not too bad by any characteristic, and because it is so affordable, it has become very popular. In comparison to a sizeable industry built around heaters, there are only three noteworthy Finnish companies producing sauna stones.

Outside Finland, particularly in Russia, the rock options are more varied. Red quartz, greenish jadeite, and several white varieties are available. In fact, there is no strict rule saying that you must use rock-based products for 'stones'. Russian companies produce cast iron 'stones' as well as white aluminum oxide pieces for sauna use. In Finland, some public saunas have successfully used artificial produced fused cast alumina-zirconia-silica bricks instead of rocks. This ceramic compound is extremely heavy and durable, but not commonly used in saunas.



Figure 87. Different Finnish sauna stone types in pictures. Their commercial names are (A) Olivine-diabase. (B) Peridotite. (C) Vulcanite. (D) Red granite (decorative). (E) White dolomite (decorative). (F) Olivine. (G) Ceramic stone by Tiileri. (H) Rounded olivine-diabase.

In Finland ceramic sauna ‘stones’ have been produced since the 1990s. Two brands are currently available: Kerkes and Tiileri (see Fig. 109 and 110). The former started the ceramic business by using a ceramic process to create relatively light, brownish stones with different regular rounded shapes. The shape itself is a major benefit, but the main selling argument relates to claims about the durability and safety of the ceramic stone, needed to justify the over ten times higher price per kilo (in Finland, approximately €5/kg). According to a study I conducted in 2020, both ceramic products are more durable than natural stones, and Kerkes is clearly stronger of the two. The fact that over seventy percent of Finnish public saunas have switched to using this product also supports the durability claim. Kerkes is the most durable and also shows graceful degradation by not crumbling into small, difficult to remove dust. Ceramic stone proponents also claim their product as being safer. The safety argument is based on absence of unknown ingredients in ceramic process in comparison to the unknown content of natural stones and their production tolerances . There are reasons to believe that people sensitive to nickel or other metals, or those with asthma or with other sensitivities may experience symptoms originating from the particles emitted from heated natural stones. In those cases, trying out stones made from non-rock-based material can be useful. However, I believe that in most cases, the effect is so small that if the sauna ventilation is good, the air quality problems from the stones will never be noticed.

Stones for the Rest of the World

The biggest issue with the stones described here is that transporting the stones outside Finland is not a simple matter. The only railroad leading out of Finland goes to Russia and eventually to China, which both have plenty of their own rock, including the precious peridotite which is nearly depleted in Finland. Ground transportation allows trading rocks



Figure 88. Kerkes is the only stone product engineered to optimize heater performance and lifespan. The Kerkes model range includes several sizes and shapes but only a single clay-like color. Specimen on the left is a natural stone for comparison.



Figure 89. Mount Shasta stones were first picked by a Finnish native who had moved into North California and was desperate to find a good solution for his sauna. He has relocated back to Finland, but maintains a license to collect the stones from the park.

inside Europe, but shipping stones to distant Asian or American destinations is expensive as the rocks are heavy, and their value is low in comparison to their weight. The price of the stones tends to increase several times along the way, which does not help to motivate users to frequently inspect and renew the stones. Thus I encourage sauna builders in Oceania or the Americas to investigate their local market for stones that might be suitable for sauna use. You may benefit from consulting your national geological survey or similar institute to find out if information regarding desirable rock properties already exists about readily available stones. Igneous (magmatic) rocks used in Finland are a good starting point. As one success story, a Finnish immigrant to the United States discovered a promising magmatic rock from the Mount Shasta area in California (Fig. 89).

Is Löyly Better with Certain Types of Stones?

In marketing sauna stones, colorful language can be used to illustrate the properties of the stones and their health effects. However, there is little evidence that different types of stones produce notable effects. Overall, I believe commercial sauna stones mostly survive in the market because of the lack of negative experiences. The varieties of stones for sale on the Finnish market have been selected because they have survived the market test well enough. Unfortunately, even the durability of the stones has not been tested thoroughly using scientific methods, as I described earlier, which is why I invented my own test protocol. Therefore I recommend everyone to experiment themselves to find out if you get a different subjective experience from different varieties, but don't let yourself be fooled too easily.

Correct DIY Sauna Stone Installation and Care

Anyone can succeed in the sauna stone installation by following four simple rules:

1. Place the stones pointing upwards if they are elongated
2. Don't jam the stones between electric heater elements
3. Don't fit the stones very tight; leave a bit of air between them, especially in electric heaters
4. The heater stone volume in the heater manual is for reference only; use as many stones as fit snugly

These rules guide you to an installation in which air flows nicely between the rocks from the bottom to the top, ensuring convection heating works properly. Notice that the stones move around and 'seek their place' in the heater every time you heat it up. It is not uncommon to see the stone surface level deflate after a new installation has been through a couple of heating rounds. You can add more stones if this happens. Avoid creating a big pile of stones on top of the heater if you desire to get more intense löyly, as this might also be detrimental to your heater if the weight gets excessive. It's okay if you have not been able to fit the amount of stones indicated in the heater manual (+/- 15%).

The inspection and replacement of stones should be done regularly. Make a note when the stones were last inspected and set up a reminder for yourself to follow the schedule. During the inspection, you will appreciate a loose fitting installation. Otherwise you will need a hammer or crowbar to remove them. Inspect and replace as follows:

1. Take most of the stones out of the heater (say eighty percent) so you can inspect them all
2. Discard all stones that have visible signs of wear; compare to fresh ones to notice the difference and replace with new ones
3. Re-install

Sometimes the water used in creating löyly will leave some residue on the top stones, for instance calcium, over time. Once stones get covered with minerals, they should be replaced even if they are otherwise intact. It may well turn out that most of the stones are still in great shape and don't require replacement. You



Figure 90. Time for a change. The stone on the right has accumulated a white layer around it and should be replaced.

can then consider extending the next inspection bit further. Usually the stones on the top in an electric heater get the biggest hit and have to be replaced first, but the stones on the bottom survive longer. This is reversed for some wood-burning heaters in which the hottest surfaces are those closest to the fire box and adjacent to the flue channels.

You can find good instructions videos on YouTube with the Finnish keyword 'kiuaskivien vaihtaminen'.

Volume of the Sauna Room	Rated Power Output
5 m ³	< 3.5 kW
6 m ³	4 to 5 kW
10 m ³	6 to 8 kW
12 m ³	9 to 10 kW
16 m ³	11 to 13 kW
20 m ³	14 to 16 kW
25 m ³	17 to 20 kW

Table 7. The recommended power output for sauna rooms of different sizes adapted from ISO 60335-2

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Printed books and scientific publications

- | | |
|---------------------------------------|----------------------------------|
| Harvia, 2018 | MacQueron & Leppänen, 2017 |
| Helamaa, 1999 | Parsons, 2004 |
| Forsman, 1997 | Vuolle-Apiala, 2016 |
| Liikkanen, 2020 (Saunologia.fi) | Telkkinen, 2020 |
| Liikkanen, 2019 (Saunologia.fi) | Tissari et al., 2019 |
| Liikkanen LA, 2019 | Tissari, Väättäinen et al., 2019 |
| U. S. Department of Agriculture, 1964 | |

Internet sources:

- <https://www3.uef.fi/en/web/fine/simo> University of Eastern Finland, Fine particle and aerosol technology laboratory studies emissions of wood-burning sauna heaters.
- <https://www.saunasampo.fi/> Saunasampo is the producer of “smart” convection heater
- <https://www.bloomberg.com/news/articles/2019-09-12/to-cut-air-pollution-krakow-targets-coal-and-wood> Krakow banned wood burning
- <https://www.sauna.fi/saunatalo/vaskiniemen-saunat/> Finnish Sauna Society’s saunas presented
- <http://shastastones.com/en/> Mount Shasta Californian sauna stones



The background of the page is a dark, atmospheric photograph of a sauna. In the foreground, a metal frame holds several large, smooth, grey stones. Above the stones, a thick plume of white steam or smoke rises, filling the upper two-thirds of the frame. The lighting is dim, creating a sense of heat and humidity. The overall tone is moody and artistic.

4.

Air Quality

There is nothing more refreshing than a breath of cool air. The sauna air maybe hot, but it becomes unbearable if it is not refreshed during sweating. Invisible and intangible, air quality is a notable challenge to master in a Finnish sauna.

The Signs of Fresh Air

On initial approach, the first experience of sauna is not a sight, touch, or a sensation of warmth. It is the scent which easily finds its way outside the heat of the sauna and greets the visitor before the sauna door. This scent should be welcoming, conveying the sense of cleanliness, nature, and pleasant experience. Even a neutral scent is preferable to any foul odor that bespeaks of bad upkeep and poor hygiene.

Usually we get accustomed to the sauna climate and the characteristic scent dissipates quickly. After this, other factors of air quality take precedence over how it affects the sauna experience. This chapter deals with the different parameters that may affect the perceived quality of sauna air. The discussion comes down to a long list of potential air quality factors and two different ventilation solutions that are used to secure air quality. I will start clarifying what is fresh air and the significance of humidity for sauna air.

What is Fresh Air?

Finland enjoys great air quality overall and here the natural point of reference for fresh air is the air outdoors. It is usually quite cold. In other parts of the world, the fresh air inside a building might originate from an air filtering system that takes out the pollutants and particles present in the outdoor air and turns out actually healthier than plain outdoor air. Air contains approximately twenty-one percent oxygen (O_2) and under one percent carbon dioxide (CO_2). Ideally, the air that we breathe in a sauna should be no worse. You should always avoid circulating air from other rooms to the sauna if possible, as it is never as fresh. The challenge is that air doesn't keep fresh for very long. When you enter the sauna, you introduce sources of decreasing air quality: your breathing consumes oxygen and generates carbon dioxide, sweating can bring additional odors, and if you just had a shower, air and your hair might carry the scent of shampoo. Therefore, the air must continuously be refreshed.

Löyly Is in the Air

The ideal sauna air is a mix of fresh air and some pleasant löyly, that is water, in the air. Humidity is the measure of vaporized water in the air. It is usually measured on a relative scale from zero to one hundred percent with a hygrometer, hence relative humidity (RH) is the figure usually mentioned when describing the sauna environment. Relative humidity is preferred to absolute humidity because the capacity of air to hold water radically changes with temperature. For instance, when the air temperature rises from 20°C to 100°C (68 to 212°F), the maximum amount of water that can be absorbed by the air grows thirty-three times. Because of this reason relative humidity is the preferred measure. However, in the sauna environment RH can also be misleading and references to absolute humidity are sometimes used.

When relative humidity is combined with air temperature we achieve a good picture of the climatic conditions of a sauna. In a Finnish sauna the relative humidity ranges from five to fifty percent RH. This is different from baths such as the steam room or infra-red cabin, which either have a constant very high or very low humidity. At extreme temperatures, such as 120°C, even ten percent RH can be way too much. Excessive moisture not only creates unimaginable heat stress through condensation energy, but also replaces oxygen in the air (see Fig. 91). Absolute humidity changes over a long and short time, due to löyly and relative

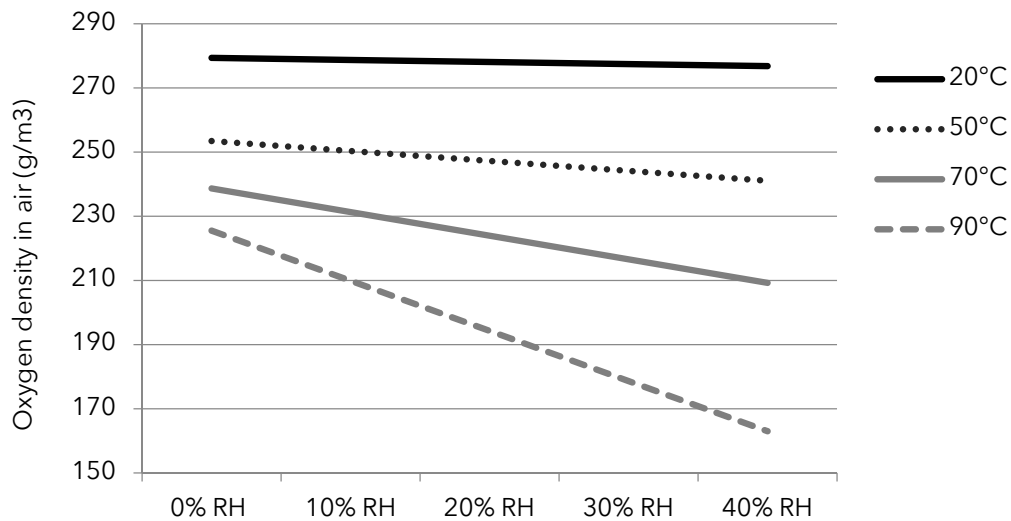


Figure 91. The amount of oxygen in the sauna air can be depleted if the sauna air gets very hot. Chart reproduced from Burger & Konya, 1973.

humidity fluctuates due to temperature changes. These changes give rise to a sense of löyly arriving and leaving on the skin because of the condensation effect described earlier. The feeling of löyly subsides as the dew point drops, that is, humidity drops (see Fig. 10 on p. 20 for visualization). How long the löyly lasts depends on the insulation, ventilation, and sauna room materials. Good insulation and a reasonably low volume of ventilation allow löyly to linger around, which many prefer.

Another physical observation about the löyly or steam in a sauna is that löyly can remain totally invisible if the sauna is hot and the water is dispensed carefully. But if the sauna temperature is low, or uneven, a cloud of mist can be observed when creating löyly, indicating that the cloud of water vapor rising from the heater contains more water than the air nearby can temporarily hold. As the vapor continues to rise, it usually becomes invisible as the warmer air higher in the room is capable of fully capturing and holding the water. Generally speaking, the need to use more water is reduced as the temperature of the sauna is increased. For reference, typical Finnish ladle holds some 2.5 dl (1 cup) of water, and two such servings are usually enough for a small 10 m³ sauna.

Finnish sauna enthusiasts worked in the 1960s and 1970s to create a sophisticated graphical representation of the sauna conditions as a function of temperature and heat. These are illustrated in Figure 92. The intention was to visualize the difference of Finnish (Region A in the figure) vs. other bathing cultures (German sauna: B region) as well as to identify the ideal Finnish sauna conditions. Unfortunately, this work was neither properly documented nor finished, so today we don't have a specific model. Architect Risto Vuolle-Apiala has been the last person to continue this line of work as he has complemented the figure by adding empirical observations from old Finnish saunas recorded in the 1950s as well as later studies of integrated and housing complex saunas from the 1980s and 1990s. This study (Fig. 92) explains the variable conditions of Finnish saunas that are clearly more humid and less hot than, for instance, Central European sauna manufacturers think. You can understand this if you compare Figures 92 and 94. The latter represents an interpretation of a 'sauna' environment by spa and sauna manufacturer Klaf's from their SANARIUM concept. In fact, Finnish sauna ranges from 'sauna' to the 'tropical bath' on the Klaf's scale.

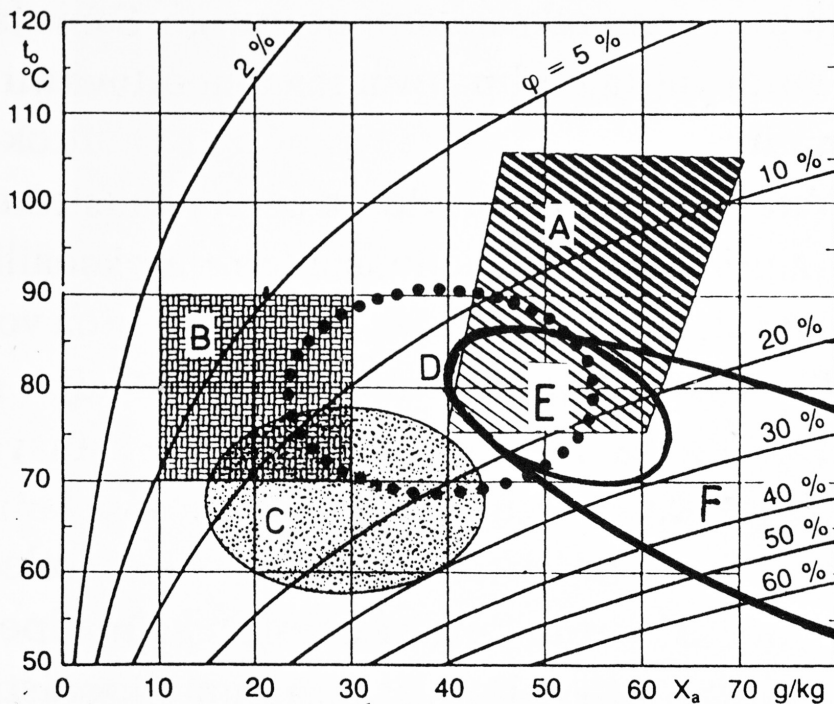


Figure 92. An illustration of sauna conditions in reference to temperature, relative, and absolute humidity. This graph originally included region A for the Finnish sauna climate recommendation, B for the German sauna. Risto Vuolle-Apiala added empirical observation from Finnish smoke saunas E at the start of bathing and F by the end of bathing. C describes integrated saunas in apartments, D housing complex saunas, both measured in late 1980s, early 90s.

What Else Is in the Air?

Other factors affecting the air quality are the concentrations of oxygen and carbon dioxide. Oxygen is desired, carbon dioxide is not. There is no research to indicate the specific requirements of sauna air and we can only speculate whether people are more sensitive to these factors in sauna than elsewhere, thus I can't endorse any specific concentration, such as maximum 1000 ppm for CO_2 , or minimum 15% O_2 . From general knowledge of indoor air quality, we can say that accumulation of carbon dioxide is more crucial than the lack of oxygen. After these two, we have a number of potentially important but poorly investigated factors. The effect of different types of ions, whether originating from the heater-and-stones combination, or from dissolving salt or other crystals, has been debated. Only two studies about ions in the sauna air exist, and the evidence is far from clear: do ions introduce real benefits or cause new problems? Studies of ions in other contexts have been unable to establish them as beneficial or harmful. With all wood-burning sauna heaters there is a risk of carbon monoxide poisoning and the inhalation of other dangerous combustion gases and particulate matter, if the heating system malfunctions. Proper use and regular inspections are the best remedy against these defects, some of which are easy to detect by smell, such as leaking smoke, some deadly and odorless, like carbon monoxide.

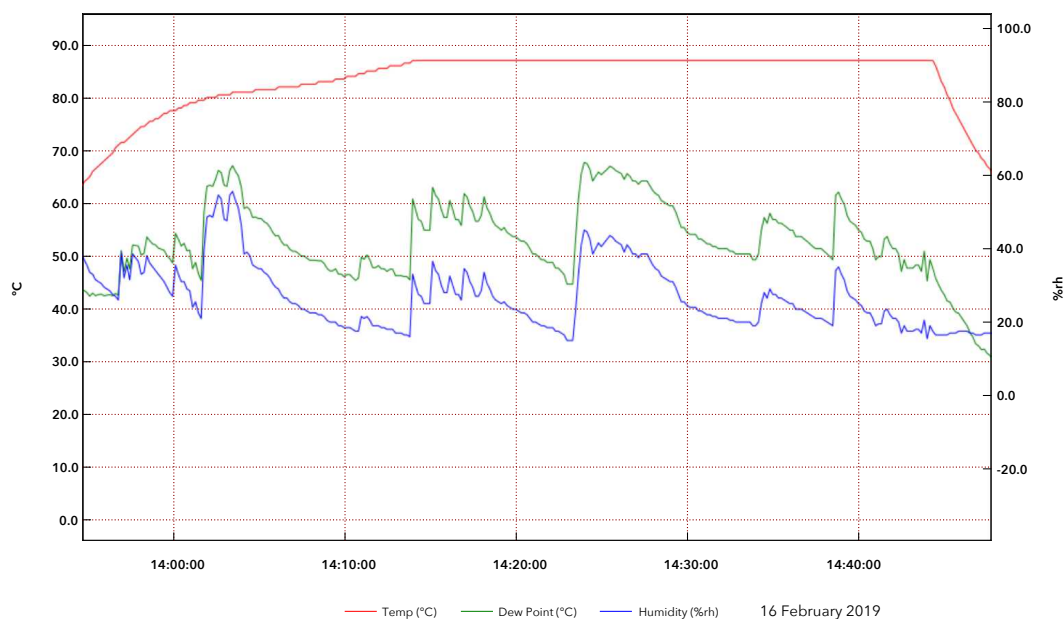


Figure 93. Graph illustrating the influence of (extreme) löyly on relative humidity and dew point. Recorded at Helsinki, Helsinginkatu Urheilhalli public sauna.

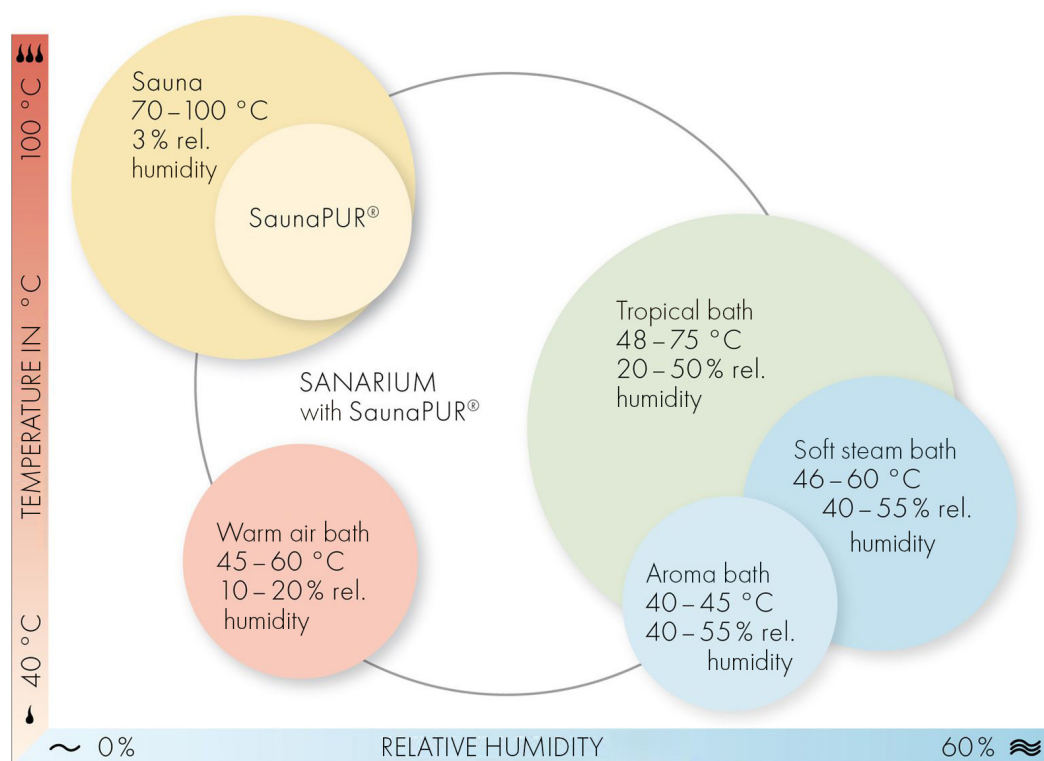


Figure 94. The different types of climate zones setting the character of the bath are well visualized in this KLAFS SANARIUM diagram.

Is Finnish Sauna a Dry or Wet Bath?

Some people may wonder does my description of Finnish sauna mean it is a dry or wet bath? The answer is that it is both. The amount of steam created and the starting temperature determines the balance. The higher the air temperature, the more likely it is that the sauna turns out dry. Experientially the dew point temperature of sauna climate is the key to explaining whether it will feel hot and dry, or warm and humid.

Different types of harmful substances can exist in structures and materials found in sauna, or contained in the water used for löyly. Formaldehyde from certain wood-based products, particularly plywood, asbestos from badly chosen stones, various chemicals from plastic sauna equipment or even coating that does not withstand sauna temperatures. Some of these, such as plastic, may be recognized from the smell, others might be imperceptible

(asbestos), or only detected by sensitive people. Finally, certain sauna habits involve mixing different fragrances to löyly water, for instance, and some Finns use beer for this purpose. However, as these substances hit the hot stones, they may react and create new, potentially harmful compounds in the process and degrade the air quality.

As I've now given plenty of reasons to worry, I must say that the relative risk of these hazards is unfortunately unknown. I believe that in a typical Finnish sauna with its usual furnishings the most important factors for subjective quality of air are temperature, humidity, and carbon dioxide content. For everything else there can be much individual variation in sensitivity to their adverse effects. Of course, known carcinogenic agents such as asbestos, particulate matter, and formaldehyde should always be avoided. Most issues can be prevented with good design and construction, which include a proper ventilation system that guarantees fresh air and the effective removal of undesired components from the sauna air.

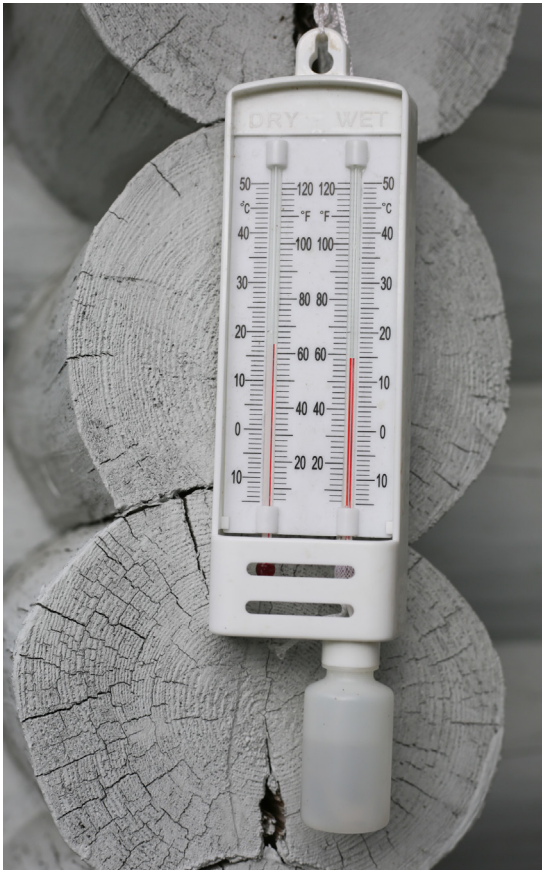


Figure 95. One method to measure humidity is using a wet-bulb temperature which takes into account the effect of vaporizing water. Wet-globe temperature is lower than “dry-bulb” temperature as long as RH is under 100%. The device in the photo is ill-suited for sauna climate.

Flow, Air Mixing and Temperature Stratification

The existence of ventilation is not enough; it must also provide an adequate flow of fresh air and mix it well with the air already in the sauna. This sounds simple but does not just happen in every sauna. Good mixing is much more difficult to achieve than an adequate flow.

Starting with the flow, the Finnish recommendations for sauna ventilation have been changing over the past seventy years. Currently sauna is treated no different from other living quarters. The current Finnish regulations require that ventilation operates at the speed of six liters of air per second per person (1,6 gal/s/p). This reminds us how sauna design must start by considering the maximum occupancy. For instance, in a four-person sauna, you need 1,440 liters (1.44 m³; 50 ft³) of air every minute. Alternatively, one could talk about the hourly rate of exchanges: how often within an hour the full volume of the room air is replaced. Here, the old recommendations were in the range of three to six times per hour. However, these types of specifications can induce a flow fallacy and lead to ignorance about mixing, which has no similar specification. But mixing is absolutely necessary; we do not want to immediately remove the air that just entered, only the old, stale air.

The reason why mixing is difficult under sauna conditions lies in the phenomenon of air stratification. As we know, hot air balloons rise from the ground because the hot air inside the balloon is lighter than the air outside the balloon. A sauna interior is bit like a balloon. Hot air naturally rises to the top and cooler air remains close to the floor. There are several air layers of different temperature inside the room, with a possible difference of up to 60°C (140°F). Now, remember that the fresh air we welcome to the sauna is always cooler than the sauna



Figure 96. Hot air lifts the balloon. Same effect causes the hot air to occupy the top section of a sauna room. Photo: Free-Photos, Pixabay.

air. At the start of the heating chapter I explained how convection and conduction play a role in heating the room. The convection and movements of the air connect it to ventilation. Effective ventilation must fight the stratification and help to warm up, elevate, and consequently mix the fresh air among the strata of air at different temperatures inside the sauna. If this doesn't succeed, the fresh air will remain in the bottom layers and not mix adequately.

Ventilation as an integral part of the building is not the only possible solution for stratification. The air movements can be enforced inside the sauna with solutions that move the air: from mechanical ventilators to handheld fans. Propellers that spin freely, powered by natural convection, can be installed above the heater. These have been on the Finnish market for some time. In my experience their effect is too modest. Appliances relying on forced convection are more effective and there exists a sauna concept called 'convection sauna', intended for people with motor disabilities. In a convection sauna a disabled person in a wheelchair can enjoy the sauna on the floor level. It sucks in hot air and löyly from near the ceiling and directs it through channels built inside the walls to floor level (see Fig. 97). This almost totally mitigates stratification, levels the sauna temperature, and allows to build seats at a standard height regardless of ceiling height.

The downside of the convection sauna is that it requires considerable planning and custom hardware. For this reason, they are very rare and not widely recognized in Finland. Luckily, an Estonian company called Saunum has created an electric device that can be installed in a regular sauna for a similar effect. It draws air from high up in the room, mixes it with air in the sauna and moves the warm and humid mixture to the floor level (Fig. 98).



Figure 97. Convection sauna at Invalidiliitto premises in Helsinki look almost like any other sauna, except for the benches replaced by regular wooden seats.

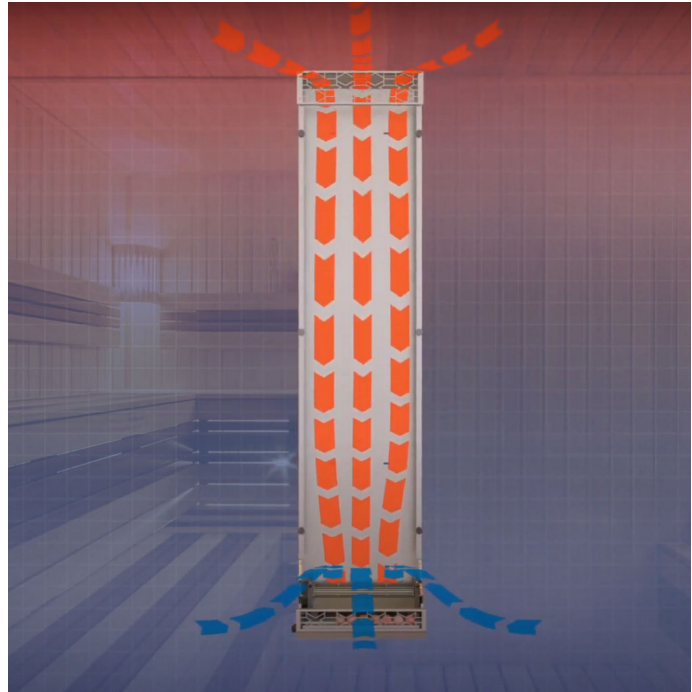


Figure 98. Saunum Base devices circulates hot air from to top blowing it out at a floor level. The illustration demonstrates how Saunum reverses the effects of stratification.

The good mixing has one side-effect, which is energy efficiency. It seems that a sauna that works well from the perspective of air quality may end up consuming more energy than one that doesn't, unless you counter it by reducing the target temperature. Mechanical ventilation systems can employ heat exchangers that reduce the energy loss, but they are not designed to operate with the hot and humid air of sauna, reducing their effectiveness. The only general rule to minimize energy loss is to avoid extracting the hottest air from the ceiling level. If any vents are placed there, they should be closed or adjusted to the minimum required by comfort when the sauna is in operation.

Ventilation Solutions for a Sauna

There are two principally different forms of ventilation: mechanical ventilation and natural ventilation. In mechanical ventilation system, fresh air enters and leaves the sauna room through channels, forced by ventilation machines, usually powered by electricity. In natural ventilation, wind, gravity and the laws of physics create a flow of air through the sauna room. The choice which one to use is not always yours to make. In Finland, most integrated saunas follow the ventilation system of the main building. If it is a stand-alone sauna cabin, the requirements may be relaxed, but as a rule, always check your local regulations before further planning. Besides the regulation, the heater choice also affects the ventilation options. The wood-burning heaters require a considerable supply of air during heating. According to research from University of Eastern Finland, contemporary heaters have, on average, an air coefficient closer to 3, which means that burning 1 kg of dry wood requires 10 m³ of air (10,000 liters; 350 ft³). This air is consumed unevenly depending on how strongly the fire burns at any given time. If the heater is constantly burning, it will create a mechanical extraction system with a high flow

and require an unusually large flow of incoming air to work. Typical small house mechanical ventilation, that is HVAC (heating, ventilation, air conditioning) systems, can't provide this flow. Hence a special inlet that lets the air flow freely is recommended, otherwise unexpected airflows and a negative indoor air pressure will occur.

Typical applications of mechanical ventilation differ from natural ventilation; the former is often utilized in the same location as electric heaters: where an existing HVAC system is already in the building and natural ventilation is difficult or illegal to arrange. In Table 8 I have collected typical recommended applications of both. Generally, the suggestions for dedicated sauna buildings favor natural ventilation and for integrated saunas mechanical ventilation. The latter is justified by the needs to prevent humidity and heat from damaging surrounding structures through escaping moisture.

	Integrated sauna	Sauna cabin	Public sauna	Mobile sauna
Recommended	Mechanical	Natural	Mechanical	Natural
Possible	Natural	Mechanical	Natural	Mechanical

Table 8. Typical applications of mechanical and natural ventilation in different types of saunas

Despite the short history of mechanical ventilation, it has become the better understood system of the two. The Technical Research Center of Finland (VTT) carried out a detailed study of mechanical ventilation in the 1990s, which is the only scientific source of ventilation recommendations available. There have been no equivalent studies of natural ventilation. I will next describe these systems in detail. A brief summary of their differences in terms of strengths and weaknesses is found in Table 9. It includes a variation of mechanical ventilation in which only air extraction is mechanized and resulting negative pressure sucks in fresh air.

	Mechanical (full)	Mechanical (only exhaust)	Natural
Pros	Constant performance Research-based design recommendations Stand-alone	Ensures flow	Durable Near-maintenance free Silent
Cons	Energy consumption Additional cost for equipment and operation Relies on electricity Noise	Creates vacuum conditions Relies on electricity Noise Energy waste	Performance depends on environment Hard to predict performance Vent placement is demanding

Table 9. Pros and Cons of ventilation options

Mechanical Ventilation in Detail

Mechanical ventilation is a system that draws air from outside the building and circulates it inside through a system of ducts, heat exchangers, dampers, and fans. The circulation is completed with the help of an exhaust fan that pulls out the stale air. In Finland, these systems are nowadays standard with all detached houses. To succeed with mechanical ventilation, the flow must meet the standard, and the vents for supplying and extracting the air must be placed at the correct locations in the sauna for good mixing.

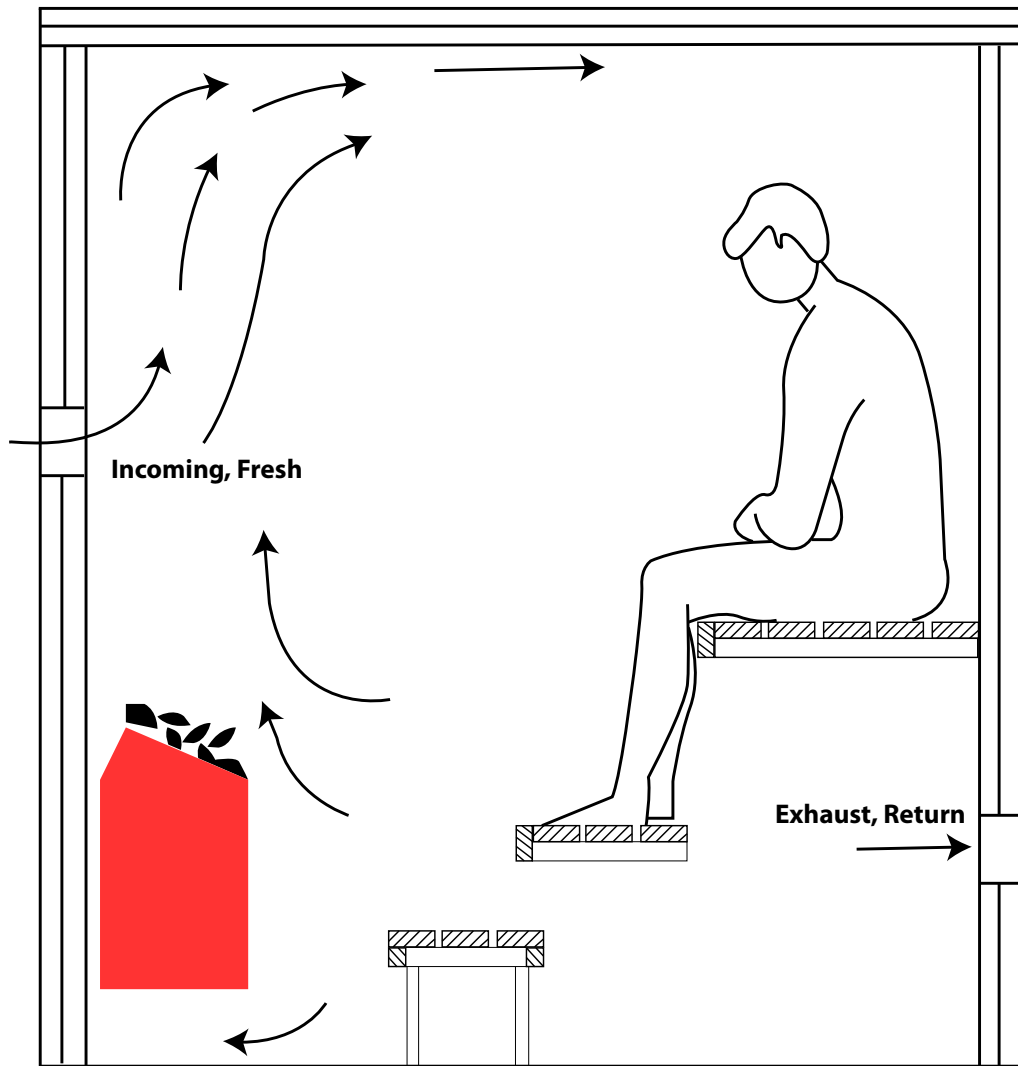


Figure 99. The recommended mechanical ventilation arrangement according to VTT.

Luckily, we can rely on a VTT research report which documents a series of experiments with a tiny sauna cabin (Äikäs & Holmberg, 1992). The study documented the optimal placing for supply and return vents to achieve even temperature distribution.

The recommended configuration for fresh and exhaust air ducts is that the fresh air should flow in from above the heater, preferably not at the ceiling but at a point close to the heater (e.g. 50 cm, or 2' above). The return vent should be located below the level of the foot bench (see next chapter and *bench design* section). Additionally, the sauna should be equipped with an exhaust vent in the ceiling that can be opened after sauna bathing to remove moist air, and closed before heating up and using the sauna again. See Figure 99.

Mechanical ventilation is straightforward to implement for HVAC engineers. The exhaust part may require a special solution to fit inside the wall. In Finland, a telescopic, aluminum 'sauna duct' is often used behind the sauna wall wood paneling to extend the duct running above the ceiling to the required level closer to the floor. Mechanical sauna

ventilation is harder to implement if your sauna room is too big to operate with a single vent, or so small that it tends to get drafty (under 3 m²; <30 ft²).

The mechanical ventilation should have adjustable flow controlled either electronically or mechanically in the duct. This can be tricky with small houses that commonly have a single machine running the whole ventilation and air conditioning system. But if you can accommodate this wish, you should definitely do it. Adjustable ventilation provides flexibility to tune the system to achieve ventilation flow that feels best. As mentioned, in Finland the regulations give a starting point what the flow should be to meet the requirements, but this says nothing about whether this flow will turn out excessive or insufficient in practice as the sauna-specific mixing is not considered. Unfortunately no guidance for subjective comfort exists.

Natural Ventilation and Its Delicacies

Gravity and the laws of physics have effortlessly and successfully solved ventilation needs for thousands of years in the history of Finnish sauna. Natural ventilation is sensitive to many environmental variables that don't affect mechanical ventilation. These include in the approximate order of significance:

1. outdoor temperature,
2. wind speed,
3. wind direction,
4. atmospheric pressure, and
5. humidity.



Figure 100. You get the first sense of the ventilation power of the wood-burning heater when you strike a match and see its flame bending towards the fire chamber because of the initial, weak draft.

I must emphasize that the operation of natural ventilation is in mathematical terms probabilistic; when designed properly it will usually work as intended most of the time, but not always. When there's a heavy storm outside, the flow of air may suddenly be reversed. Because of the sensitivity of natural ventilation to environmental conditions, the existence of control mechanisms (hatches, adjustable vents, etc.) is even more important than with mechanical ventilation. For instance, having vents on the opposite walls of a lake-side sauna cabin might be good idea, so you can close one and open another if a storm pushes in from one side. To make a generalization from the mechanical ventilation research: mixing works best if you can deliver the fresh air just above the heater's top level. The trick is fighting the laws of physics and in preventing this inlet from turning into an outlet.

In sauna cabins equipped with continuously wood-burning heaters, natural ventilation is a simple and convenient option. Because these heaters consume a great deal of air, the ventilation flow requirement is easily satisfied, leaving only the mixing problem. With electric heaters, natural ventilation is more difficult to arrange successfully. It can be done, but poor energy efficiency can result. Overall, there is no exact science underlying the solutions of natural ventilation, and the best guideline is to leave room for adjustments in use.

As I review the potential solutions for electric and wood-burning saunas, I rely on known working examples and best practices utilized in Finland. I do not guarantee one hundred percent satisfaction without some trial and error. The potential issues and shortcomings are discussed along each option. However, you should never omit ventilation altogether just because it is not easy to design.

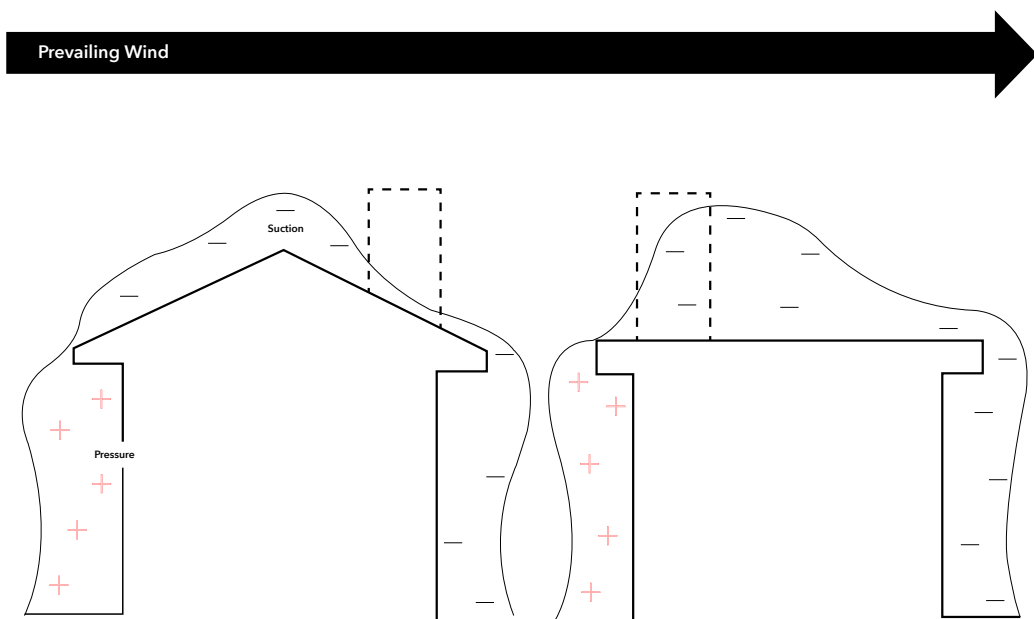


Figure 101. Wind influences natural ventilation and draft in a wood-burning heater. Design should consider the prevailing direction of wind, placing flue and ventilation outlets on the side of negative air pressure. Adapted from Konya & Burger, 1973.

Smoke saunas at Finnish Sauna Society sauna house all rely on natural ventilation and serve their patrons well.





Natural Ventilation in an Electric Sauna: Cross-Ventilation

The location of the electric sauna determines how it can be best ventilated. If the sauna is integrated in a house with no direct access to outdoor fresh air, the options are limited. If the electric heater is found in a separate cabin, then some of the options that will be listed later on for wood-burning saunas are also applicable. The one simple solution I call cross-ventilation is always possible. Cross-ventilation involves having an incoming air vent underneath the heater and the adjustable exhaust vent high up in the opposite wall. Air will naturally escape due to heat and moisture. To compensate for the escaping air, fresh air flows in from underneath the heater, where the convective current generated by the heater has the best chance to mix it with the room air. However, it depends somewhat on the heater how well this works.

Natural Ventilation in a Wood-Burning Sauna

There are several known good and simple natural ventilation solutions for sauna cabins. If the wood-burning heater is located in an integrated sauna, then channeling fresh air from outdoors becomes more complicated and you must adapt the following advice. For separate sauna buildings, the following are tested and tried solutions for receiving fresh air:

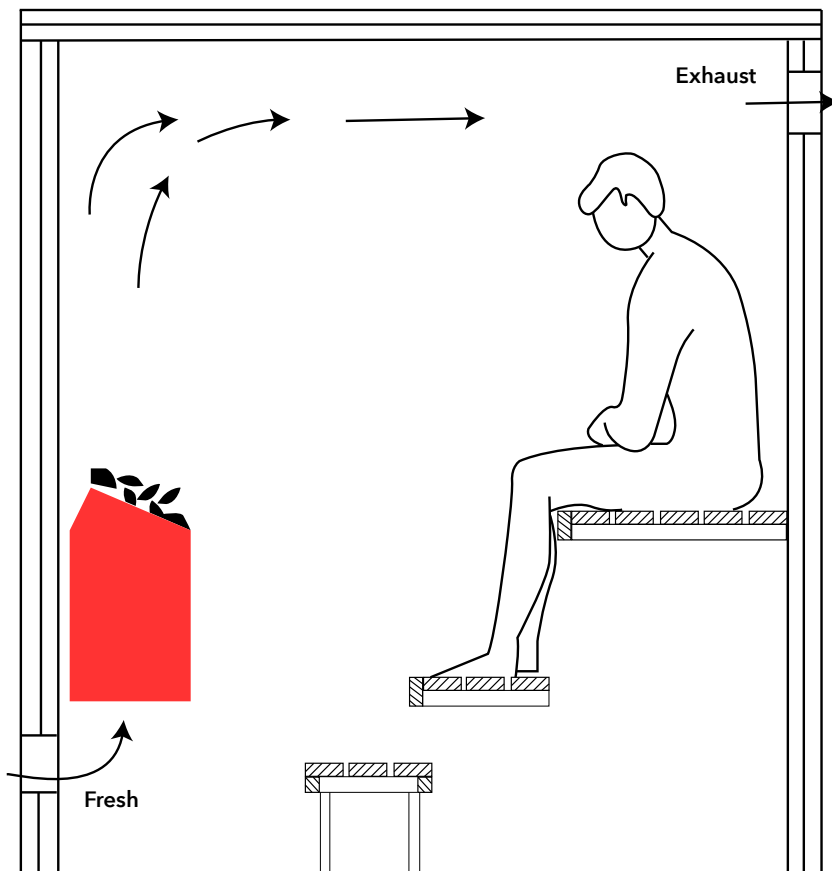


Figure 102. Cross-ventilation.



Figure 103. Semi-open floor has real cracks between the solid wooden floor planks. Seeing outside is secondary to the large open area.

1. Semi-open floor: wood planks have 10 mm (25/64") gaps between them so fresh air is introduced from the space underneath the floor, which is connected to outside air.
2. Floor-level ventilation: inlets/outlets are low in the walls, very close to the floor. Similar to option (1) but also possible when the floor is solid. This involves preferably several adjustable vents facing different directions.
3. Underground air duct: inlet with metal pipe rising above and next to the heater.

The first two options, semi-open floor and floor-level ventilation, are somewhat similar as they both rely partially on the creation of löyly to provide an air mixing mechanism. The idea is that when water suddenly vaporizes from the sauna stones, its volume will increase over one thousand times: one liter of liquid becomes over one thousand liters of gas. This temporarily over-pressurizes the sauna room, forcing the existing air to escape. If the sauna door is poorly shut, it may bang open and if the expansion is powerful enough, you can feel it in your eardrums. This piston effect temporarily drives out air from the vents, only to be pulled back in moments later. It is also expected that the heater will help to elevate the cool air and slowly mix it with the room air, as in the cross-ventilation case. This air exchange requires a notable area of the ventilation openings near the floor level. In the case of an integrated sauna, this could happen via a 'missing' bottom part of a door that leaves some 20 cm (8") open for the air to travel to adjacent room.

The semi-open floor (Fig. 103) that resembles a duckboard allows air flow evenly throughout the area of the floor. This requires that the sauna cabin is placed on pillars. The open floor presents

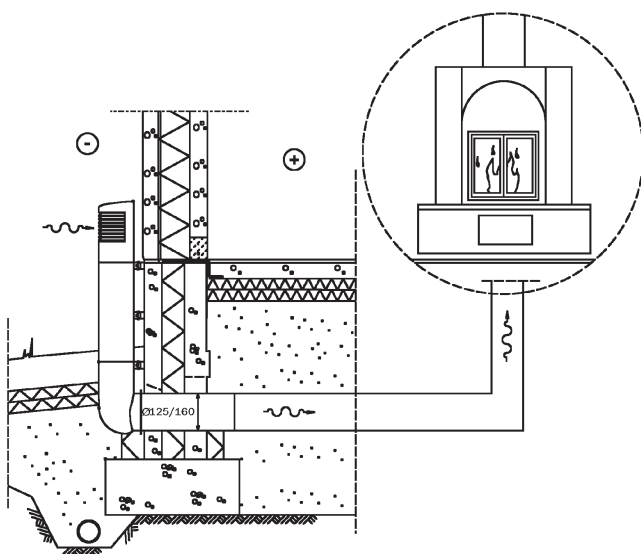


Figure 104. Underground air duct 'Ross' from the outside and the inside of sauna room manufactured by Finnish VILPE. The installation is well hidden from the outside.

a challenge for greywater disposal if there's water being used for washing inside the sauna room. You can build a swimming pool type of a basin underneath the semi-open floor area to capture the leaking water if necessary. Old Russian bathhouses used a similar solution by artificially raising the floor planks above the actual concrete floor foundation. An alternative to gaps between wooden blanks is to leave a good gap (15 mm or so; over ½") between the floor and the walls. This gap should be covered from the side to prevent any water running freely into the gap, entering sensitive places and causing structural damage.

Floor-level ventilation works best if you can construct two or more adjustable vents close to the floor. This can be arranged even when the sauna is founded on a solid, flat foundation, and when the sauna room walls are also the outer walls of the building. The area of the vents should be quite big, for a moderate sized sauna approximately the size of a shoe box (around 600 cm²; 6 ft²). These vents must be adjustable, so an appropriate ventilation flow can be achieved regardless of weather conditions.

The underground air duct (Fig. 104) can transfer fresh air to a sauna room regardless of whether it is surrounded by a building's outer walls. It has to be constructed along with the foundations of the building. The air duct has



Figure 105. Air duct ending above the top of the heater is recommended.



Figure 107. A large vent in connected to a brick flue. (©) Livady Architects



Figure 108. Adjustable vent close to the ceiling is ideal for exhaust as it should be operated everytime sauna is in use.



Figure 109. Vents usually look pretty awful, but there is no necessity for this – they could also look like this Cariitti TAIVE wood-covered example.

effective, a constantly fueled wood-burning heater is needed to provide the extra pull of the fresh air.

Natural ventilation solutions discussed this far have mostly focused on the problem of fresh air delivery and mixing. It should be mentioned that you can also improve the sauna air quality by the clever mechanism of air extraction. The previous ventilation examples have presumed that all of the exhaust air is extracted through the wood-burning heater's flue. This usually works quite well because the heater firebox sits close to the floor, even though possibly further away from the benches. However, you can also have a separate flue for extracting air to boost and stabilize extraction. An extraction flue comes easy if you have a brick chimney because they can house several flues and one of these can be dedicated to the sauna exhaust. When the exhaust is placed next to the heater flue, it warms up naturally and starts to exhibit a updraft effect. Thanks to this, air will be removed effectively. This flue should have adjustable openings both at the floor and



Figure 110. Fresh air vent can be located in the ceiling and is always open.

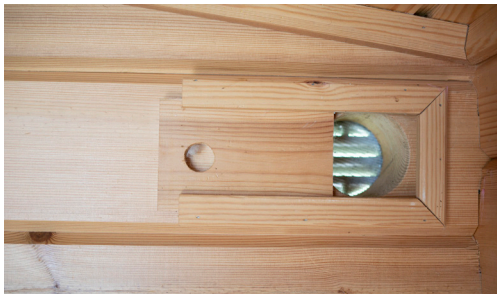


Figure 112. Traditional ventilation hatch in sauna cabins was made out of wood and open a channel straight through the wall into outside. The wood can be finished along with the rest of the interior.



Figure 111. VeskuAir is a Finnish innovation that improves the incoming fresh air flow by leading it closer to the heater and adding a mechanism that prevents löyly from blocking the flow.
Photo: © Vesa Leskisenoja.

ceilings levels. If you are planning to use a heat storage heater, a single-fired wood-burning heater, or a tunnel heater, then this type of extraction mechanism is much more important, as the heater doesn't provide the convenient, automatic exhaust.

And remember, natural ventilation should always include a hatch close to the ceiling. This is both used for after-bathing drying as well as adjusting the ventilation during use, if needed.

Read More

Printed Books and Scientific Publications

Alexander et al., 2013
Graeffe et al., 1976
Nore et al., 2015
Perez et al., 2013
RT, 2017
Tissari et al., 2019
Vuolle-Apiala, 2016
Zeich et al., 2015
Äikäs & Holmberg, 1992

Internet Sources

<https://www.klafs.com/sanarium-with-saunapur.html> KLAF's SANARIUM sauna climate system
<https://saunum.com/Saunum-air-circulation-systems-for-convective-sauna>
<https://cris.vtt.fi/en/publications/temperature-and-ventilation-of-the-finnish-sauna>
[https://www.who.int/news-room/fact-sheets/detail/ambient-\(outdoor\)-air-quality-and-health](https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health)

5.

Interior Design

There is no denying the pleasure of feasting your eyes on a painstakingly hand-crafted sauna interior, the comfort of carefully carved alder benches, or the scent of a warm wooden interior. Surprisingly, even the ceiling plays a part for the great löyly experience, along with other numerous interior design choices.



Good interior design is the final link to ensure a well-working sauna and enjoyable löyly. The sauna benches are the most visible part of interior design, along with the selection of materials and finishes for the ceiling, walls, and benches. Although interior design affects how the sauna looks, it is foremost crucial for its function and usability. It turns out that several interior design decisions have an effect on the sauna experience. These factors include, in the order of importance:

- ceiling,
- benches,
- interior materials and their treatment,
- walls,
- floor,
- door,
- windows,
- lighting, and
- safety equipment.

Additionally, there are considerations for accessibility, usability, and special needs, but those don't systematically translate into specific, visible parts of the sauna.

Notice that as this book now presents the final sauna elements, there is no detailed discussion about vapor barriers or insulation. This is an intentional omission for an experiential sauna design book as they don't directly affect the sauna experience (but see page 159 for a reference solution). However, I strongly recommend taking these factors into account in design and construction. Proper insulation guarantees energy efficiency, and a vapor barrier surrounding



Figure 113. Dome ceiling of an underground vault sauna model called Holvisauna.

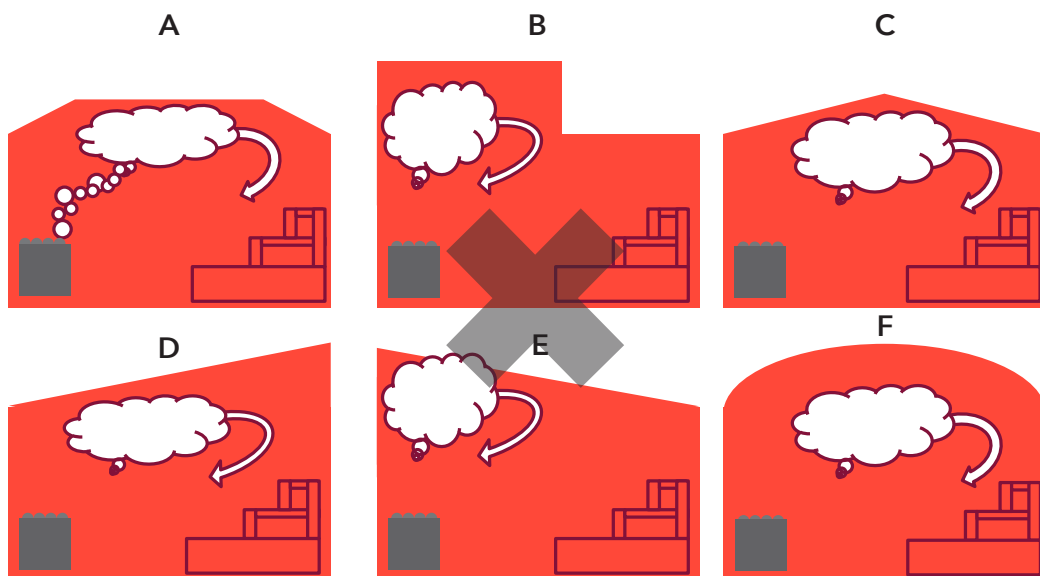


Figure 114. Illustration of recommended (A,C, D, and F) and avoidable ceiling models (B and E).

the sauna room prevents moisture escaping from the sauna. These two are intertwined: if you add insulation, you will also need a vapor barrier. This is very important with integrated saunas. In Finland, there are clear regulations that concern the insulation and construction of wet areas such as saunas. Other countries may have their own regulations. If they don't exist in your country, remember that the laws of physics still apply. You must not neglect what happens with the heat and humidity trying very hard to escape from the sauna room. Simple sauna cabins will usually survive with only minimal insulation, preferably in the ceiling and in the walls. To be energy efficient, a sauna should be quite airtight, that is, if you can see daylight through the wall or corners, that's not good.

The Ceiling

Even though few notice it at all, a ceiling is a critical structure in a sauna. For one, the ceiling is a guide for löyly. From the stones, löyly heads straight up, hits the ceiling and then continues its escape towards the highest and most remote spots around the ceiling. If you take a seat further away from the heater, you may be surprised that löyly gets to you first before descending on bathers seated closer to the heater. These movements of löyly have consequences for how you design the ceiling. You need to guide the löyly towards the sauna bathers, making it accessible for them. You have to avoid trapping the löyly so it slows down (too much) and cannot traverse freely throughout the space. And if you are cunning, you can manipulate the flow of löyly with the design of the ceiling (see Fig. 115).

There are several variations of ceilings that function well for distributing löyly across the room. These are depicted in Figure 114. The ideal ceiling shape is a dome or a half dome which has no corners to slow down löyly. The next best types are those without sharp corners (approximating a dome), resembling a mansard or gambrel roof. Then we have the flat ceiling type, which is the most common and easiest to construct. It is a fair solution but can trap löyly in the corners. Next we have the risky tilted shapes. Tilting a flat ceiling can be



Figure 115. Löyly guide, a piece of wood fixed perpendicularly to the ceiling, in the way of löyly.

done successfully if you take into consideration the location of the benches and the heater. If you tilt the ceiling towards the wrong direction, löyly will be led away from the bathers and be lost. The same goes for all other uneven or not level ceiling models; they are not recommended, particularly with more extensive bench structures.

If the ceiling has already been constructed but there are problems with löyly, some remedies exist. Löyly guides can be created out of 5"x2" wooden blanks (or even smaller) to direct löyly, to slow it down and make it less fierce. With a flat ceiling, you can add a wide (8" or so) board in the corner where the ceiling and the wall meet to ease the movements of löyly.

I will discuss the appropriate materials for the ceiling along with other sauna surface materials, but I will now mention the roofing materials, which are significant for the sauna experience in a cabin, even though they are outside the sauna room. Roofing materials and the insulation between the ceiling and the roof determine how natural sounds of rain and wind will be heard inside the sauna. For most Finns, the desired acoustic environment is mostly dry. This suggests that one should use roofing that doesn't make much noise, unlike most metal solutions. This usually means a trade-off between durability and comfort. For my cabin I chose asphalt composition shingles instead of metal. Metal would likely outlast other materials, require little service, and be bit more fire safe. Clay tiles are also long lasting but require maintenance. Traditional Estonian saunas had roofs made out of hay (see pages 166-167), which is definitely silent, but also a fire hazard when combined with a wood-burning heater.

Sauna Benches

Sauna benches and the ceiling are a matched pair. As we have learned, hot air and löyly naturally rise towards the ceiling. To enjoy their company, we must elevate ourselves as well—or use technology that counters the laws of physics. In the Finnish sauna tradition,

different types of sauna benches have been constructed for this purpose. The design rules governing the benches are quite straightforward but may turn out to be in conflict with other sauna plans, thus complicating the design. These rules include guidance for the measurements, layout, materials, and even their construction.

The design of benches once again starts with consideration for users. How many people should fit in the sauna at the same time? Are they all seated, or do they want to lie down? Should there be possibilities to sit at different vertical levels? Are there special rituals to be performed in the sauna, such as whisking, *aufguss*, or cupping therapy? Answers to these questions influence the bench design.

My recommendation for private saunas is always to make enough space to allow people to try out different places and orientations. Enjoying the sauna on your back can be transformative for some people as it guarantees an even heat and löyly across your body, as well as removing your head from the hottest heat. Your brain may appreciate receiving a better supply of blood and oxygen that would normally gather in your lower limbs, thanks to expanding blood vessels, and gravity. However, those who regularly experience vertigo when standing up, or have cardiovascular disease, should try the laid-back position carefully as the blood pressure drop may induce fainting when sitting up.

Sauna Benches: Dimensions and Measurements

In the chapter about heat and air quality, I mentioned the law of löyly and hot air stratification (see pp. 94 and 121). They are also important for bench design. The vertical dimension is of primary importance. The traditional Finnish design presumes a sitting posture and assumes



Figure 116. German tradition favors enjoying sauna in a supine position, in Finland two levels of sitting benches were long considered adequate options. The picture displays both options. Photo © Therme Erding

that there are two bench levels: a top, sitting bench and a lower, foot bench. These follow normal ergonomics recommendations and the top bench should be 40 cm to 45 cm (16" to 18") above the foot bench.

Large saunas can have multiple levels of benches, in which case they usually have the same 45 cm (1' 6") height difference. Notice that 45 cm is too much for a regular climb riser (height of the step) so if there are three or more levels of seating, you need to add steps and bring the vertical rise per step to a reasonable level, say 22.5 cm (9"). A practical climb riser is anything between 15 cm to 30 cm, depending on the length of the horizontal dimension (tread, or stair depth). In Finland, the following formula for determining an ergonomic gait is:

$$2 \times \text{climb riser} + 1 \text{ tread} \approx 66 \text{ cm (24" or 2' 2")}$$

For example, a 15 cm riser should be accompanied by a 36 cm tread. In sauna benches, tread that long is usually difficult to arrange and may be compensated for by interleaving the steps.

The top bench position is determined relative to the ceiling. It should be within a range from 100 cm to 120 cm (3' 4" to 4') below the ceiling, preferably closer to 120 cm. This recommendation is based on the fact that an adult's sitting height is about fifty percent of their total height. In Finland, ninety-eight percent of people will just fit in the 100 cm space, and 120 cm is very comfortable without the threat of ever hitting their head on the ceiling. Using an international comparison, the Finnish population is no shorter than an average Westener, so there will hardly be a good reason to exceed this dimension to accommodate taller individuals. However, on the other end, 120 cm is just enough for whisking yourself but about the maximum if you desire to get powerful löyly and good energy efficiency. The more height you add above 120 cm, the more you waste energy and create a buffer for

Sauna Interior Dimensions

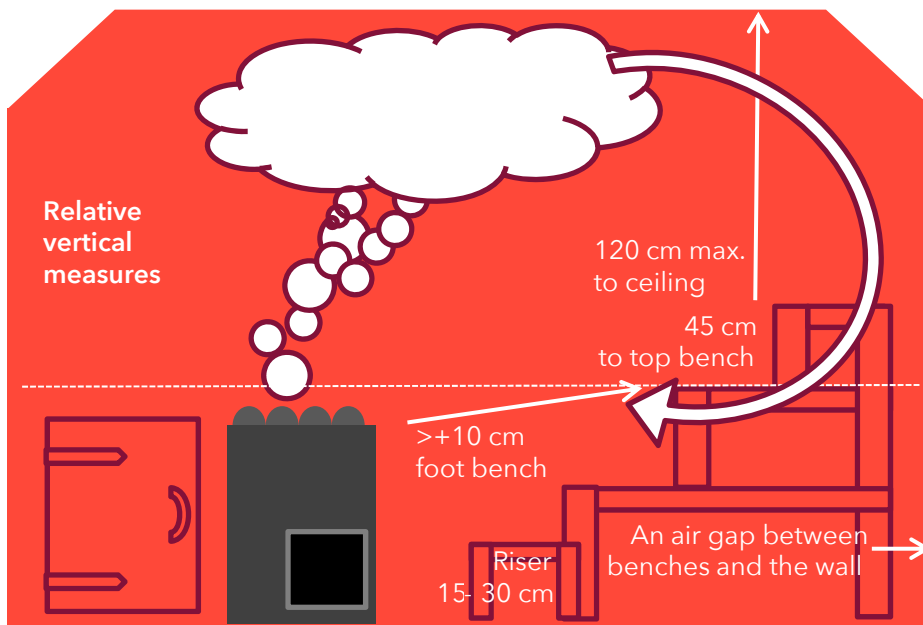


Figure 117. Illustration of bench vertical dimensions and climb riser.

löyly. For instance, the Russian banya tradition favors a much more spacious upper section above the foot level, so professional whiskers can stand and whisk without ever hitting the ceiling. This means that the ceiling is at least 180 cm above the top bench. This results in very slow and soft löyly which has to be manually guided downwards.

Thus far we've been counting downwards from the ceiling and the top bench. Next we have to take into consideration the law of löyly and determine if our design obeys the law. We know that the foot bench level is now at least 145 cm (4' 10") below the ceiling, so ascertain how tall the heater is and add at least 10 cm and preferably 20 cm as a safety margin (4" or 8"), to be on the safe side. Is the adjusted heater height higher than the foot bench, and does your design obey the law?

If it does, great, if not, you've reached a critical point in the design. To fix the issue, consider the following options: can you raise the ceiling or can you lower the heater by choosing a different model or installing it differently? If not, maybe you should consider some mechanical solution to reduce stratification as described in the *Air Quality* chapter.

The horizontal dimensions of the benches are governed by ergonomic guidelines collected in the Table 10. Besides ergonomics, they reflect the Finnish attitudes towards personal space. Although Finns like to keep their distance in public spaces, in a sauna they tolerate a rather close proximity, even with total strangers. This means that some measures, such as the recommended seat width of 60 cm (2') is, in global terms, probably an average between Asian and American standards of comfort and more than a typical business class airplane seat. Seat depth should be also 60 cm (2'), or even 90 cm (3') if we would like to allow a person to put their feet on the bench. The width and depth are transposed if the person takes a lying-down position, in which case the measures should resemble those of a snug bed with a width from 180 cm to 200 cm (from 6' to 6' 8") and a depth, at minimum, of 60 cm.

Let's add up the numbers. Using the example of a four (adult) person sauna cabin, it becomes clear that we need some 240 cm



Figure 118. Example bench structure from a typical 4 m² electrically heated residential sauna. The elevations starting from the lowest step are approximately +25 cm (10"), +25 cm (10"), +15 cm (6"), and +40 cm (16") raising the top bench altogether 105 cm (42") from the floor. The lowest level of benches in a small sauna is usually a movable stool so it can be easily removed for cleaning.

(8') of bench width (with a single bench). If we would like to make it possible for two adults to lay on their backs, then we need some 360 cm (12'), possibly on two different levels, in maximum two sections of 6' each. For instance, having a 240 cm (8') wide bench on two levels (60 cm deep; 2') would achieve this.

Target	Measure: metric	Imperial
From the top bench to the ceiling	100-120 cm	3'4" to 4'
Bench height	40-45 cm	1'
Step riser (step height)	30-35 cm	12" to 14"
Step run (tread)	25-35 cm	10" to 14"
Bench width per person	60 cm	2'
Foot Bench room	> 30 cm	> 1'
Bench depth, seated	45-60 cm	1'6" to 2'
Bench depth, feet up	80-90 cm	3' to 3'4"
Bench width/depth for laying on one's back	180-200 cm	6' to 6'8"

Table 10. Suggested measurements for different bench segments.

Sauna Benches: Layouts and Safety

We have now discovered how much seating area the benches should provide. The next task is to design a layout that meets these demands. There are nowadays a handful of common layouts used in small and medium sized saunas. If the sauna gets larger or is based on something other than a rectangular floor plan, it will be necessary to create a custom design inspired by the basic layouts. The layouts are named based on viewing the bench in plan, i.e. when looking directly from above:

- I-model or the back-wall bench,
- II-model, platform, or opposite benches,
- L-model, and
- U-model

The I-model or the 'back-wall' is the old standard. It occupies the length of a single wall, usually opposite the entrance, and may contain several levels, at minimum the top bench and the foot bench. This model is simple to design and construct by either fixing it to the wall or letting it stand freely on the sauna floor. The L-model and U-model benches are variations of the I-model. In both variations, the bench makes a corner and extends to one (L-shape) or two other walls (U-model). Otherwise they are similar to the I-model, just more complicated to construct.

The II-model consists of two benches facing each other on opposite sides of the space. The benches can be connected to one another so that the foot bench is a single platform spanning from wall to wall. The platform idea is very old, dating back to smoke saunas with tiny stools to sit on. The platform model is nowadays very popular among new integrated

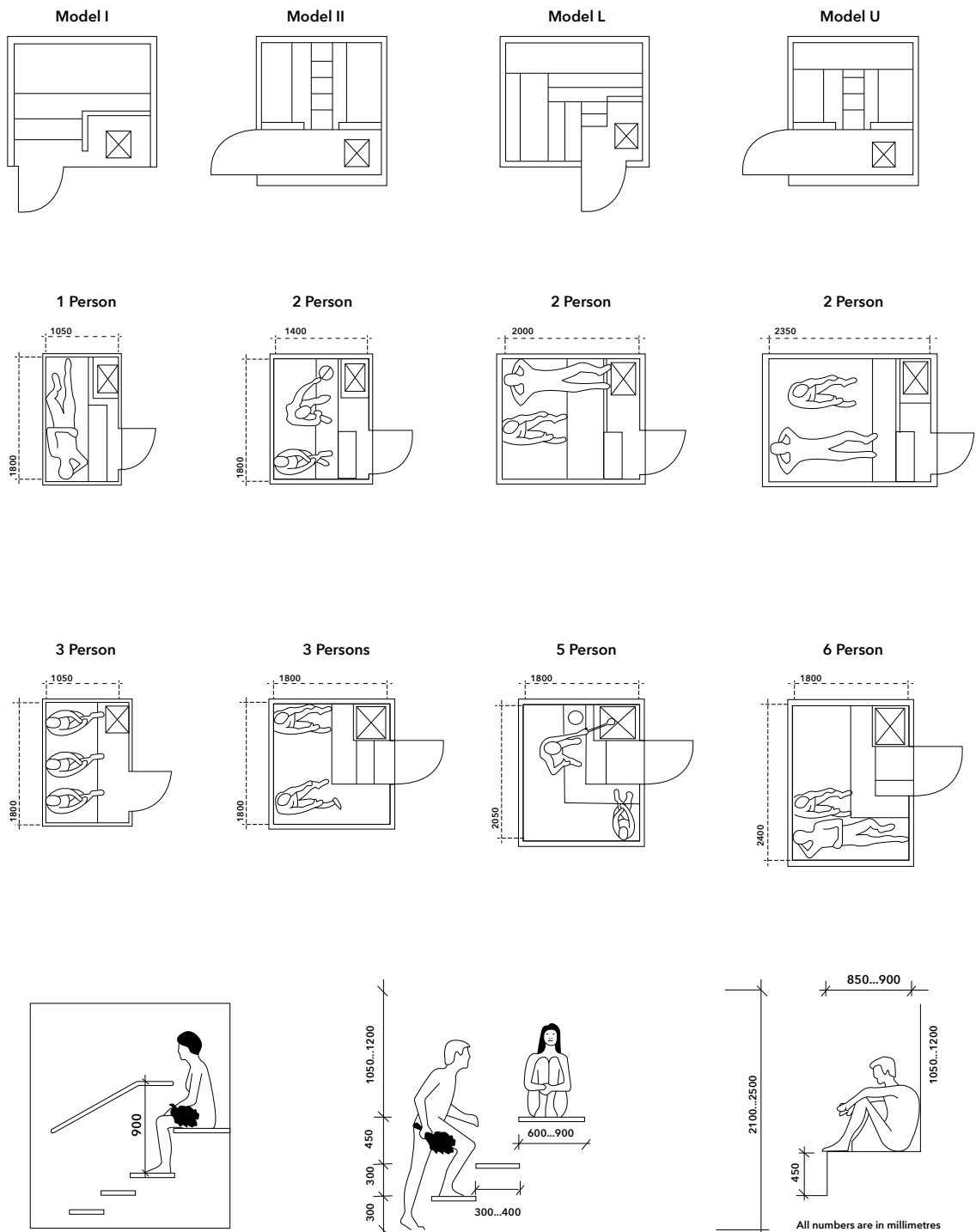


Figure 119. Illustration of bench layout models: I, II, L, and U-shapes. An adaptation of Liikkanen, 2019 and Konya & Burger, 1973. http://fiverr.com/online_work24



Figure 120. Back support, hand rail, and a heater guard rail made of out alder.

saunas, which may also include an integrated electric heater reaching through the platform in the middle of the space between the two top benches. This is a modern development. The benefit of the II-model is that you can fit in more people and, for instance, in a 2 m x 2 m (7' x 7') sauna that has two 2 m-wide benches, it accommodates at least six people. The biggest issue of this design is that it easily goes against the law of löyly especially in a small sauna. These benches also are much more laborious to clean and maintain, as particularly the space underneath the uniform platform maybe nearly inaccessible, unless the platform is tall enough.

With all bench models there is a need to add handrails, safety railings, and some manner of back rest. The rails add an important part for comfort, safety, and accessibility of the sauna. Back rests provide comfort and also help prevent the bather from touching the wall, assuming the back rest will be easier to keep clean or replace than the wall of the sauna.

Bear in mind cleaning and serviceability. In Finland benches are usually modular constructions, so they can be removed in reasonably sized pieces for cleaning. There are also models which have swing mechanisms to facilitate cleaning. In public saunas, the cleaning is a daily chore. Also note that the bench structure affects the air circulation in the sauna. Keeping the bench construction as open as possible and some 5 cm to 10 cm (2" to 4") away from the walls helps to maintain good air circulation and even löyly. A valuable hint from Finnish carpenters is to never leave any metal parts visible around the benches, because they get too hot to touch and also allow water to penetrate the wood over time. Thus all screws holding benches together should be attached from underneath.

Benches bring with them accessibility considerations. Even if the sauna is intended for private use, basic accessibility should be secured by keeping the climb riser moderate and handrails always installed next to any step. These will be valuable for anyone with temporary

or permanent reduced mobility, even if healthy adults don't need to use them constantly. In Finland, accessibility also means that seriously disabled individuals should be able to enjoy the sauna. I already mentioned convection saunas which remove the need to build a high bench structure. An alternative that can be fitted into a regular room is the 'elevator bench' which has an electric lift mechanism to raise the bench from a regular, low sitting height to a meter or so higher. If the sauna is designed for a paraplegic with lower limb paralysis who has good arms, then a special arrangement of seat levels can enable him or her to ascend to the top bench just using hands. In fact, many Finnish paraplegics take special comfort from sauna as it helps them to warm up their lower body, which in turn improves sleep, among many other benefits.

There is no absolute need to follow any traditional model in bench design. Alternative bench variations can be made imaginatively into almost any shape or with any material: from

How is Sauna Possible for People with Special Needs?

In Finland, people with several motor disabilities, such as quadriplegics, have been able to enjoy sauna for some time now. In fact, people with lower body paralysis (paraplegia) perceive great benefit from sauna. There are four offered to overcome the problem of allowing a person in a wheelchair to enjoy the heat and steam in full. The first one is a motorized bench which can lift a person from a regular sitting level to high up in the sauna. The second is a special arrangement for installing the heater below regular floor level, lowering the temperature differences across the room. The third option available for individuals with paraplegia is to design benches with moderate riser so the person can elevate to themselves using only their hands. And the final solution is the convection sauna which circulates warm air and löyly inside the sauna room, removing the need for special heater or bench solutions. Note that a wide door (90 cm, 3') and adequate floor area must be reserved for wheelchair users.



Figure 121. Motorized bench lifts a paraplegic person from sitting on a regular height to higher up in the room. The solution is quite expensive. Photo © Taitotiimi.



Example of an accessible home sauna space exhibited at Finnish housing fair 2020.



hammocks to rocking chairs. However, whatever way you decide to provide seating comfort, you should follow the principles outlined above, and remember the law of löyly. The different types of chairs maybe tempting but they are impossible to match with a reasonable ceiling height, so you inevitably lose the best of löyly if you decide to abandon the traditional elevated bench—unless you can mitigate the stratification issue by other means or build a very tall sauna.

Sauna Benches: Materials and Their Requirements

To sit comfortably on a hot surface, the seat must not burn your privates. To achieve this, materials must conduct heat modestly, i.e. they should be good insulators. Sauna benches are commonly made out of wood, which serves this purpose well. There are some differences between varieties of wood, aspen being the lightest in weight and color, and thus the best in this regard. However, aspen has the shortcoming of being very sensitive to stains and to lose its bright tone in exchange for a dull gray shade only colored by patterns of mold. Durability is not only a matter of looks but also of composure: aspen doesn't easily rot and remains functional long after losing its beautiful appearance. Durability can be improved by thermal treatment. Different thermally treated wood variations are the current standard in Finnish saunas. So called thermo wood variations have a darker, brownish tone and a distinctive scent. The scent can be quite strong and anyone planning to use such a bench material, for instance lining your whole sauna interior with thermo aspen, would do well to check out the material in person to observe if this scent is pleasant. Thermal treatment alters the wood; for example, evergreens lose sap. This suggests using materials such as Finnish spruce and pine which are otherwise sap-risky materials for sauna benches or the ceiling. Untreated spruce free of knots has been used



Figure 122. These “benches” are made of cotton fabric which can be easily removed for washing. The overall arrangement has a difficulty in satisfying the law of löyly.



Figure 123. Samples of wood which were heated to sauna temperature and moistened to reveal their scent

successfully. Thermal treatment also makes the wood lighter and therefore improves insulation.

Thermopine has become one of the most popular bench material options in Finland, also due its moderate price. It is claimed to be the most durable material, though no research exists. But spruce, ash, and even birch have been used in bench construction. The African abachi was for a long time a clear market leader during the twentieth century but has since almost disappeared from Finland. Now the common exports include North American varieties, such as red cedar (*thuja plicata*) or Monterey pine (*pine radiata*). Many types of wooden materials can be used for sauna benches, although the ones indicated by dealers as intended for sauna use are the safest. For instance, redwood or eucalyptus are unsuitable as they pose health risks: redwood during construction and eucalyptus in use. Whatever material you intend to use, please investigate its suitability in advance. Table 11 provides some suggestions for suitable timber products.

The final factor affecting sauna bench material selection is hygiene. A part of the invisible magic of the sauna is that if the surfaces heat up to temperatures exceeding 55°C (130°F),

North America	British Isles	Australasia
Eastern white pine Sugar pine White cedar Ponderosa pine Western red cedar Incense cedar Redwood (hazardous cutting dust)	Yellow pine Whitewood Ponderosa pine Western red cedar Redwood, Scots pine (select, clear only) Central American cedar	European whitewood Western yellow pine Red cedar Western red cedar Red Baltic (select, clear only) Queensland kauri pine

Table 11. Timbers recommended for sauna construction from Konya and Burger in 1973.



Figure 124. Steam rooms commonly utilize stone or tile seats not common or recommended for sauna.

those surfaces will automatically become sterile over time and kill viruses or bacteria possibly imported by bathers. Wooden materials heat up easily and possess antibacterial properties derived from so called volatile compounds, providing a good basis for hygiene.

Benches can also be made out of concrete and covered with ceramic tiles. These solutions favored in public saunas are excellent in durability as they can tolerate heat and humidity without problems for decades. The situation is contradictory regarding hygiene and comfort. Because ceramic materials conduct heat effectively, this type of seat becomes too hot to sit on around 50°C (122°F). The solution used in steam rooms is a water-cooling system inside the benches. This makes the seats more comfortable but removes the hygiene benefits. The concrete benches can be covered with wooden boards or light seat covers. This creates a new design challenge and compromises the benefits of the concrete structure as these wooden parts become the new replaceable and serviceable parts of the bench. However, this may still be preferable.

Sauna Benches, Ceiling, and Walls: Coating or Natural Finish?

Different types of coatings and protective agents designed for sauna surfaces have become available and popular in the past twenty years or so. Currently on the Finnish market there are three slightly different types of products called sauna finish, sauna wax, and sauna oil. These enable you to ‘paint’ the different surfaces of the sauna room to achieve almost any imaginable color combination. In a hilarious illustration of this potential is the unique sauna found in the basement of the central Helsinki Burger King restaurant toned with the company’s three brand colors.

The sauna coating innovation was to come up with products that can endure the extreme temperature of the sauna without degrading. This has made it possible to protect the wooden surfaces and give them new shades. However, there is a difference between what is possible and what is desirable. There are several arguments that can be made against applying any coating on top of wooden surfaces and only few in favor. It must be noted that the following arguments lack hard empirical evidence when it comes to the behavior of the coating solutions under sauna conditions. However, this goes both ways, and coating producers naturally would like people to buy their offerings.

The arguments in favor of coating are focused on the appearance which shouldn't be belittled, particularly in integrated saunas. In small modern Finnish houses, integrated saunas have become a part of the 'home spa' experience in which the benches may present over fifty percent of the visible surfaces. The treatment provides a protective layer for the wood, which makes it easier to clean, or in theory, to renew the coating while keeping the wooden structure underneath intact. Some products also contain anti-mold agents. But there are also at least three potential issues with these products.

Although the sauna coating meets the product requirements for indoor use in terms of emissions, such Volatile Organic Compounds (VOC), all standard coating test methods have been designed for usual room temperatures, approximately 20°C (68°F), not the sauna's 70°C to 120°C range. This means that although the product withstands the heat, the real emissions and behavior in the sauna environment is unknown. Some of the paints are acrylic based and people sensitive to plastic compounds may react to this property alone. The second downside is that coating hinders the natural hygroscopic properties of wood which otherwise work in favor of the steam experience.

The third questionable outcome of the surface treatment is that it is a one-way road. The coating is difficult to remove from wooden panels. It will be easier to replace the panels all



Figure 125. Wooden duckboard covering the tiled bench is a possible solution applied at Uusi Sauna, Helsinki, men's section.

The Breathing Construction Material

Wood is naturally a hygroscopic material which means that it can either absorb water (humidity) from the air and in return release heat, or release water (desorp) and absorb thermal energy from the air. It depends on the environmental conditions which way the process operates (known as a moisture sorption isotherm in physics). This function is beneficial for the Finnish sauna in which changes in humidity are constant. Large, untreated wooden surfaces become a buffer for löyly, attenuating the condensation on skin and in turn heating the structures in the sauna. The resulting effect is found desirable and probably one of the reasons why untreated wooden surfaces were mentioned also in the ISA sauna definition. However, the danger of coating agents is that they will create a non-permissible membrane on wood and prevent the hygroscopic function. There are also other hygroscopic materials that achieve some of the same functions as wood. Clay, hay, peat, and even concrete to some extent can do that. Unfortunately, only concrete, with its known industrial appearance, is readily usable in most types of saunas.

In contrast, saunas or banyas covered with ceramic tiles provide no hygroscopic buffer and provide more raw, strong, and unforgiving löyly. You can imagine the difference by wearing breathable cotton vs. non-breathable polyester clothing during a hot summer day. Many sauna coating products contain acrylic and you may easily end up creating a too thick membrane if you to apply several layers of coating on sauna walls to achieve an opaque finish out of a semi-transparent sauna coating.



Figure 126. Some Finnish saunas have been successfully created from concrete. This underground vault sauna walls are plain concrete.



Figure 127. Burger King Sauna in Helsinki includes identifiable color palette as well as a TV behind a window.

together. If you coat a solid wooden wall, i.e. the shared exterior and the interior wall, you may ruin your sauna permanently. The same can happen if you don't check in advance how a tinted coating behaves. You need to always test outside the visible surfaces to ensure the desired outcome, as coating tinting is not a one hundred percent reliable process. The final precaution is that untreated wood gives out a natural scent that most Finns find pleasant. If you seal off the surface, the scent will be minimized or completely lost.

Although I'm very critical of coating solutions in general, I don't suggest banning them completely. For instance, the sauna floor doesn't heat up much and has little interaction with löyly, so it can be safely treated. There are also treatment solutions that contain exclusively dye or color pigments, not oil, wax, or other substances that are normally present to bind the dye to the treated surface and seal off the porous surface of the wood. For instance, I expect spirit-based wood dye products to achieve a solid tint without the negative side effects, as they caution about the need to 'seal the wood' with a separate substance. The challenge is to guarantee that the alternative products survive during sauna temperatures. For example, traditional whitewash (chalk paint without acrylic compounds) is also a hygroscopic paint that can stand high temperatures and has been successfully used.

The downside of untreated wood is that the surfaces remain sensitive and even if you skip the coating agent, it is still advisable to regularly treat wood with, for instance, paraffin oil (kerosene; petroleum-based) that creates a temporary protective layer to reduce the wood from absorbing water sprays or human 'oil' and getting wet and dirty. Other types of oil, for example kitchen chopping board oil, can also be tried. These won't be nearly as effective protectors as actual coating agents and have to be reapplied regularly—at least annually in a residential sauna used once a week.

Once again, whichever agent you choose, experiment in advance and use perhaps a household oven to simulate sauna temperature with a sample. My recommendation is that if



Figure 129. I have used a spirit-based based black tint to treat the wall of my log sauna with no perceptible downsides. Two layers were applied to achieved almost opaque finish.

you really like a colorful sauna, you can consider a single colored wall made out of ceramic elements, Himalayan salt panels, glass tiles, or similar. Avoid treating all of your walls, the ceiling and the benches so as to preserve some natural wood to buffer the steam and retain the scent of wood.

Finally, although this book is strongly focused on matters inside the sauna room, I must emphasize that the dressing room, and even the washroom, will be affected by the hygroscopic performance of the wall surface material. When people exit the hot room, they come out literally steaming hot. If they decide to cool off in a dressing room, this room should be able to deal with the humidity brought in by the bathers. Good ventilation and the right materials help.

Sauna Walls

Many points relevant to sauna room walls have already been made. In terms of sauna experience, the upper part of the walls is the most critical in keeping heat and humidity inside the sauna. The steam pocket (*lölytasku* in Finnish) refers to an imaginary volume of air-tight space in the sauna located approximately above the top level of the heater, once more following the law of *löyly*. When *löyly* is created, there will be considerably more steam inside the pocket, and very little outside because of the higher and more even average temperature inside the pocket.

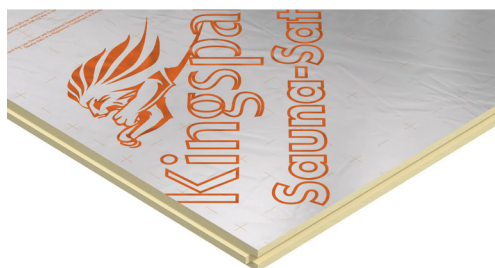


Figure 128. Polyurethane insulation board (PIR, a flame resistant version of PUR) is a modern, effective, and moisture proof solution applicable to saunas where needed. A widely known product Sauna-Satu is only 30 mm thick, well insulating (0,022 W/(m·K)), fire safe, and easy to install. Photo © Kingspan.



Figure 130. Tent saunas have been used in the sauna heating championships at Peurunka, Finland. Insulation is insignificant when the thermal power is available in abundance. Photo from the 2019 event.

The walls are there to secure the steam pocket which requires insulation and adequate thermal transmittance. This is nowadays measured with the U-value or its inverse, the R-value. However, in saunas that are not used daily or in the heart of winter, the energy efficiency difference between bad and excellent insulation is quite small in practice. That is why poorly insulated solution such as tent saunas can work—even though they are easiest to operate during the warm seasons when poor resistance does not matter so much.



Figure 131. Glass wall and door combination is nearly transparent and fools the camera as easy as the eye.



Figure 132. Rock element wall in a modern integrated sauna rises from floor to ceiling behind the heater.

Earlier statements about sauna materials and their treatment applies to the walls as well. Walls have the largest surface areas and they have consequently the biggest impact on how the sauna behaves. In contrast to benches, there's a huge design trend regarding integrated saunas in Finland, which favors the use of glass walls and doors. This solution is attractive for two reasons. First is the transformed look of the sauna and the adjacent rooms. Transparent walls make the space feel like one big room and also boost the lighting level. The second reason in favor of glass walls and doors is their superior durability. Glass outlives most other materials used in a sauna and only requires cleaning, so except for accidents, it will outlast everything else. The biggest drawback is that these walls are made of single glass which provides poor insulation. This results both in heat loss as well as dangerously hot surface areas. Glass also lacks the desirable hygroscopic properties of wood. While a typical Finnish implementation of glass wall and door combination can be improved when it comes to insulation using additional sealants, I don't recommend creating a glass cube sauna. Having a single wall made of out of glass and carefully constructed to minimize heat loss is still an acceptable compromise for the quality of löyly.

Rock and glass composite materials can also be used to create 'effect' walls in a sauna. In the past decade it became fashionable in Finnish integrated saunas to have a rock wall element behind the heater. These provide an appealing look, but they come with the same cons as the solid glass walls, and with the added problem that porous and jagged surfaces are more difficult to clean than solid glass. If you are shopping for this type of decorative wall, make sure the wall elements are specified for use in sauna conditions, because some 'rock' elements are not actually rock, or the glass material may have plastic adhesive that doesn't withstand sauna temperatures.

Waterproofing and Vapor Barrier in a Typical Finnish Integrated Sauna

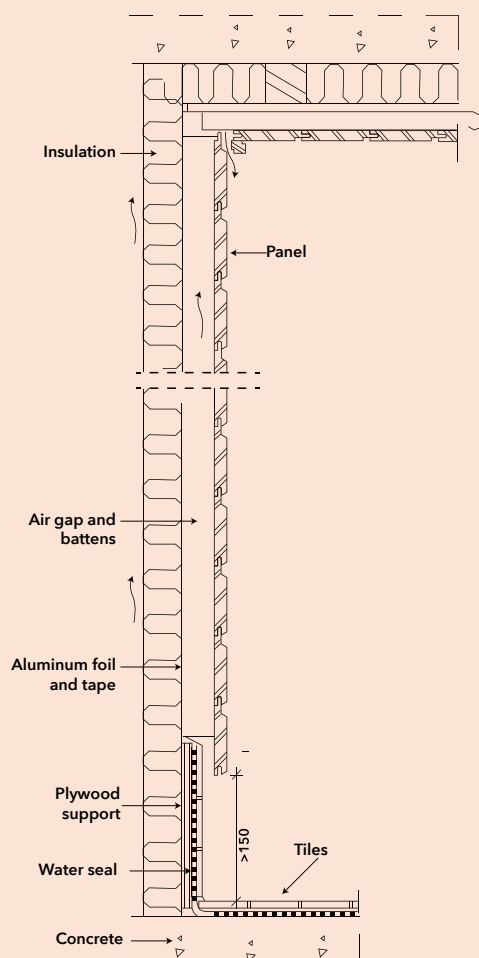
For the reference, I am providing the basic design of an integrated sauna wall construction when it comes to dealing with water in its different forms. This type of structure is commonly used in apartment saunas, but not necessary with sauna buildings made out of solid log.

In short, liquid water ends up on the floor and is then directed to a drain. Copious volumes of water vapor are generated when creating löyly. It attempts to break through every hole it can find. Vapor barrier and ventilation are used to keep vapor from escaping into the building fabric. Water vapor condensing within the building fabric can degrade the structure and promote the growth of mold, bacteria and fungi.

In detail, the construction includes several layers with distinct functions. Going inside out from the floor, there are ceramic tiles on the floor on top of a water seal layer which has been applied as a coating on top of the concrete floor. The concrete may embed electric or hydronic heating that guarantees keeping the floor dry. The water seal rises from the floor at least 10 cm (4") up the wall, or the full height of the wall if the wall has tiles as well. Note regular water seal does not withstand excessive radiant heat of the heater.

Inspecting a completed wall (or ceiling) we will only notice the wooden paneling, which is anywhere between 14 to 28 mm (appr. ½ to 1") thick. This paneling will stop water spray from getting further but may temporarily get wet. Beneath the paneling, there are nailing battens forming a vertical air gap of at least 25 mm, at maximum 50 mm running from the floor to the ceiling. The air gap ventilates the back side of the panels. The paneling starts at minimum 50 mm, or higher, above the floor and terminates some 10 to 20 mm (1") below the ceiling paneling so any vapor gets back inside the room. Wall framing for horizontal paneling makes this easy, but staggered horizontal nailing battens are required with vertical paneling to allow floor to ceiling air gap.

Behind the air gap you have the vapor barrier, classically a combination of aluminum paper and aluminum tape on top of insulation and actual wall structure. With paper, the joints should overlap at least 150 mm (6"). Nowadays a 30 mm PIR board with aluminum surface on one side, tongue and groove ready, is commonly used for its convenience. Tape is used to treat any gaps and through joints: ventilation, drain, electricity, et cetera. The ceiling follows same construction, but due to its higher heat exposure, it should always be well insulated.



The Sauna Door

The door to the sauna is a necessary but usually unexciting detail. In the ideal situation, the door frame should remain below the level of steam pocket. This would guarantee minimal heat and löyly loss under all circumstances. However, as modern doors in Finland stand 200 cm (6' 8") tall, this ideal is difficult to realize, because the ceiling level should then be at least 350 cm (11' 4") above the floor, or you should arrange the entrance differently, for instance, with stairs from the floor below. As a compromise for accessibility, a door of regular height and a minimal sill is usually chosen. In large saunas, you can have multiple doors if it seems desirable for controlling the people flow or ensuring fire safety.

Some Finnish sauna cabins make an exception and have adopted an old-fashioned door design in which the door is only 80 cm (2' 8") tall and as wide. The door sill is exceptionally high at 40 cm, which in turn forces the sauna bather to watch their step and enter the room with a sideways bow. The resulting 120 cm (4') door frame height means that the steam pocket integrity can be guaranteed with a modest ceiling height; accessibility, though, is compromised.

A simple solution for keeping the steam pocket intact, but maintaining a regular door height, is to hang a carpet or heavy 'löyly curtain' to cover the top part of the door frame, as in Figure 133. This will slow down the steam enough so that it doesn't fully leak out, even if the door should be open at the moment of löyly. Another ventilation-related issue is that the door may leave an opening between the door and the sill.

Don't forget the safety function of the door. A door is the primary escape route when the heat inside the room becomes unbearable, or at worst, the sauna catches fire. For this reason, the sauna door must always open towards the outside and have no locking or latch mechanism that cannot be opened from the inside without a key. Handles for pushing and



Figure 133. Löyly curtain partially covers the door, minimizing the loss of löyly should the door leak.

pulling are recommended. Outside Finland people have followed other traditions and installed locks to their sauna cabin doors. This has resulted in unfortunate fatal incidents. The door should be equipped with some closing mechanism that keeps it shut while there is no traffic. In addition to simple wooden latches, there are numerous solutions for doing this. I've installed a large magnet to the Suvikallio sauna door that provides a bit of extra force and prevents the cabin door from opening unintentionally when a generous amount of löyly is created. There are commercially available alternatives to the same end available.

The material of the door has all the requirements of the other sauna surfaces. Traditional Finnish sauna doors were wooden, contemporary doors are made of glass. Glass doors are somewhat cheaper to manufacture and take less space logistically, so they are commercially superior. Added value in a sauna comes only from its improved robustness. Glass door is particularly useful for a family sauna if the children don't spend as much as time in the sauna as adults who can supervise them through the glass. The glass should be tinted or have some markings on it to prevent bathers from stumbling into it. I personally prefer wood doors that have a glass window insert.



Figure 134. Door closing magnet substitutes more complicated spring-loaded or hydraulic door closer that might not survive for long under sauna conditions.

The Sauna Floor

The sauna floor is the first point of contact when we enter the sauna. If you are barefoot, you receive an immediate sensation of the temperature, wetness, and cleanliness of the sauna. A good sauna floor is safe and reliable; it is not slippery, pitch black, burning hot, or ice cold. Once more, wood is a great material for flooring. Because sauna floors neither heat up—as the other surfaces do—nor does it interact with löyly, there are more options for the floor material. The floor is actually one of the surfaces for which I don't systematically insist on using wood.

The floor takes the biggest amount of mechanical stress as well as moisture. In the sauna cabins where sauna is also used for washing, the amount of water



Figure 135. Tiled floor is well-suited for an integrated sauna as long as the tiles have appropriate slip resistance ratings.



Figure 136. Glass door and walls support family sauna use as transparency enables parents to observe what goes in the private bath. The door must be kept shut.

can be considerable. For this reason, sauna floors require an adequate slope of one to two percent towards the drain so the floor can dry out quickly. I also recommend treating a wooden floor with a finish that makes it more water resistant, such as an oil-based coating. Some Finnish cabin manufacturers use boat lacquer or varnish to create a seamless and solid surface. This is fine as long the surface does not become too slippery.

The detailed construction of the sauna floor depends on which type of sauna we are talking about. If it is an integrated sauna, then a concrete floor possibly with integrated heating, a tiled floor or polished concrete is a natural choice. When it comes to sauna cabins, the situation is less clear. If you build a cabin on a concrete slab and don't keep the cabin warm all through the seasons, then the concrete will remain at a temperate that is uncomfortably cold throughout most of the year, at least in the Finnish climate. This renders it a poor choice for sauna experience. It is impossible to heat up the concrete floor only with sauna heat. The only way to make it comfortable is to install an electric heating system in the concrete. Trying to cover up the concrete with a wooden duckboard above it will make for a complicated floor structure and raise the floor level, potentially creating new problems. Without totally isolating the concrete using PU sheets, for instance, this will not be successful. For these reasons, I don't recommend concrete floors for sauna cabins in a year-round infrequent use much outside the tropical zone.

When it comes to tiled floors, there is a wide selection of tiles available and it should be possible to find options compatible with the rest of the interior. However, the tile selection must be narrowed according to tile slip resistance ratings. These ratings describe the tiles' friction and typical application. International standard ISO 10545 and German standard DIN 51130 / 51097 provide the basis for slip resistance ratings. Tiles must be rated for use in wet rooms which can be indicated by 'Group C', 'R11, R12, R13' or 'Class 2', depending

on which rating system is being used. For safety reasons, do not use tiles with inferior rating or no rating at all.

Another consideration is tile tolerance toward freezing, if the tiles are installed in a cabin that may witness under 0°C (32°F) indoor temperatures. Tiles themselves are fine with the high sauna temperatures, but please note that the temperature directly underneath the heater may increase to hundreds of degrees Celsius higher than anywhere else. If waterproofing material is installed underneath the tiles, it should withstand the heat. This is probably not the case and if so, the heater should be raised on a safety platform, a steel plate for instance, that separates it from the floor.

The final floor detail is a drain, which is required to expunge water from the wet area. This must be considered even in the smallest cabins as water can find its way to wooden structures and eventually cause rot. In my sauna cabin I have a wooden floor (1" thick, with a two percent slope) split into two parts with an aluminum gutter installed below the opening to collect grey water. The gutter has plastic pipe leading to a plastic collector drywell dug in a pit next to the sauna, a solution chosen based on local requirements. I always wipe away excess water from the floor to the gutter after use. My sauna cabin foundation is elevated, which has made these arrangements easy. This solution works surprisingly well even in -20°C (subzero Fahrenheit) temperatures, with no issues of grey water freezing or the floor being too cold. The poor heat conductivity of wood combined with good air circulation makes it quite easy to heat the surface inside the sauna room while the other side of the floor surface might be still below the freezing point. This is not possible with other floor materials. In my cabin, the small concrete slab underneath the heater (chosen for its strength) hardly ever feels comfortably warm around its edges despite receiving a greater amount of radiant heat.



Figure 137. Combination of natural and different types of artificial light can create a pleasant and harmonious atmosphere. Photo © Cariitti, Taive

Sauna Windows and Lighting

Natural light is an integral part of the Finnish sauna tradition. Small windows close to the floor level have provided light since the time of smoke saunas. In consequence, the traditional ambience of saunas used to be dim, or even dark. Evenly distributed, low lighting (under 10 lux) is still acceptable as it helps to calm you down and support a peaceful state of mind. For safety and comfort reasons I recommend a decent amount of lighting, possibly making lighting intensity adjustable electronically.

Ascending and descending sauna steps requires good lighting. So does interacting with the heater, for example, to create löyly or to siphon out hot water from the water boiler. The impact on safety is largest for the almost fifty percent of myopic individuals who would normally wear eyeglasses, which are cumbersome and uncommon in a sauna. Dark conditions make shortsightedness worse because pupils dilate (see Fig. 139). As a general rule, all critical safety areas in the sauna should have some form of lighting. If possible, provide a secondary lighting installation with conventional lighting intensity (up to 100 lux) for sauna cleaning and maintenance.

Windows are always a good solution for sauna lighting. For an off-grid sauna cabin, they might be all you need, if you can supplement the lack of natural light with candles and lanterns during the darker periods of the year in those parts of the world where this applies. There are some things to notice with sauna windows. First, modern windows with very high energy efficiency may be filled with argon or krypton gas that might expand with sauna temperatures and break the window. The sauna window should be openable from the inside so you can use the window for extra ventilation, e.g. to dry the sauna after use. For

this purpose it should be equipped with a wooden handle.

Another design consideration concerns the visibility and privacy provided by the windows. Modern saunas in blogs or Finnish sauna marketing materials feature big windows with beautiful vistas. What's more pleasant than feasting your eyes on a serene lake side scene? But remember to consider the visibility to the inside. During the darker seasons, even modest interior lighting can reverse the mirror effect of the windows and reveal the interior of the sauna to the outside. It depends on the siting whether this maybe an issue. The transparency can be mitigated by installing a filter screen on the outside or using frosted glass, but a smaller window size or window high up in the room may achieve the same limited view from the exterior but may be enough for viewing the outside.

In Finland there are several months in the year when there's hardly any natural light available. Here's where modern lighting technology can come to the rescue. LED lights allow creative lighting in a sauna with intensities that don't destroy the sauna atmosphere. Just make sure all electric cabling and electronics you install can withstand sauna temperatures. For instance, standard LED lights won't survive very long if you put them in the ceiling, where as LED lights produced specifically for sauna application can stand high temperatures.



Figure 138. Wooden window handle ensures that the window can be conveniently opened even when the sauna is hot.



Figure 139. How a shortsighted person sees in a sauna: a simulation of impaired vision I created to demonstrate my vision without corrective lenses.



Old Estonian sauna with hay roofing at Saaremaa.





Figure 140. First generation LED and fiber lighting created spotlight effects, the new versions illuminate smooth arcs and planes. The source of light itself can be hidden. This installation uses 3,000 K LEDs.

The small size of the LEDs or fiber optic lights allows you to selectively light up the critical parts of the sauna room—or get creative. Electric lighting, regardless of how you implement it, still needs careful design as the installations have to be planned in advance. For instance, placing fiber optics in the walls or in the ceiling means you must make preparations in advance to accommodate their installation. Fiber optics and LED solutions have a long life expectancy, so embedding them into permanent structures such as walls should not force you to take down the walls prematurely, unless you get tired of the design.

Within LED lighting, there are several variations. LED lights first replaced fiber-optic projections in which light was being transmitted through thin glass fibers from a powerful projector on the other end of the fiber bundle. This created a pointed light source. Nowadays we can use individual LED lights to similar effect. But there are also varieties of linear LED lights that hide the single light dots, instead providing illuminating bars or beams of light. All of these solutions are very directional, meaning that the light must be carefully pointed. Several LED units can be combined as long as you pay attention to maintaining consistent color temperature, all with preferably high color rendering index (CRI). I personally prefer warm, orange toned lights rated at the lower end of the temperature spectrum, from 2,000 to 4,000 Kelvin. They emphasize the warmth of sauna with a tone reminding of a fireplace.

Traditional incandescent light bulbs have also been widely used in saunas although they don't appear very graceful after LED solutions. Bulbs were naturally heat resistant and provided omnidirectional light. However, as the European Community has severely restricted the use of inefficient lighting such as incandescent bulbs, this further limits the usefulness of the old technology and favors LED-based solutions.

Sauna Safety: Preventing Accidents and Electric Hazards

In Finland there are specific regulations and electric installation standards regarding how electric appliances should be installed inside the sauna. For instance, all appliances and wiring 100 cm (3' 4") above the floor must have a special temperature rating. The rating is +125°C for appliances and +170°C for wires (250°F and 350°F, respectively). No electric appliances must be placed within 50 cm (1' 8") of the heater horizontally and nothing vertically above it. All electric appliances in a sauna must have an IP rating for wet environments, that is IPx4 or higher (IP44, IP45, IP55, etc.). The rules are in place to prevent fire and electric hazards and should be taken as good advice and fair warning also outside Finland.

You may wonder whether an electric heater is a hazard? After all, a heater consumes a substantial amount of electric power and sits inside the sauna. Some people have been fooled to think so and even forbidden the use of water and creation of löyly for fear of electric shock. But don't worry, a professionally manufactured and installed electric heater is a completely safe appliance, and pouring a ladle of water on the stones while it is in operation provides no electric shock risk to the user. In Finland no incidents involving electric shock have ever been reported despite hundreds of thousands of electric heaters in use. The reason is that the live parts of the heater's electric system are never exposed. Although you may see the red glowing resistors inside the heater, that is not the electric current and has no voltage. The current is flowing inside the glowing part, in a resistor of small diameter thread which you won't be able to touch.

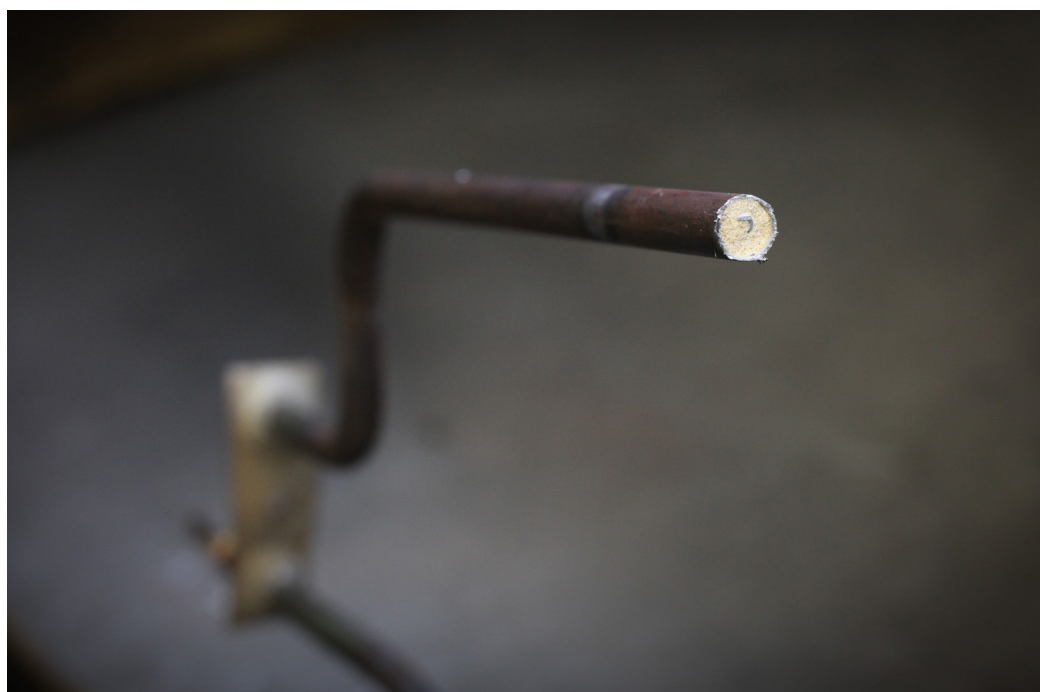


Figure 141. The broken down resistor reveals what's inside the resistor element. The thin cord in the middle is where the electric current flows, well insulated by a sheath.

Even if the electrical hazards are insubstantial, there are physical safety considerations in a sauna. Four safety solutions have already been mentioned:

- the adequacy of lighting around potential places of hazard,
- a non-slip floor,
- guard rails that stop you from falling from the benches, and
- handrails that support going up the stairs.

However, there are more risks to mitigate.

The biggest concerns are the risks of minor burns from the heater and the water boiler. The heater risk is dependent on how hot the heater gets on its outer edges. Electric heaters have a more even heat distribution around the heater whereas the wood-burning heaters may have hotspots in the proximity of the firebox (see Fig. 49 on p. 73). But there is quite a bit of variation and you must inspect the heater specifications for safety distances to get an idea how hot the sides of the heater can get. The heater is usually never safe to lean on, so some protection should be installed in its vicinity. Rails or sheaths surrounding the heater can help to secure it from accidental touch of a finger or hip. If you care about the appearance of the sauna, the design of these safety measures requires some planning. For instance, most sheaths are by default made of shiny stainless steel or matte black metal. Ready-made heater safety rails may be available only in single finish, wood or black-painted metal. Wooden safety rails will have to be custom made by a carpenter if you like to maintain a uniform look and use the same material throughout. If the wood-burning stove is very hot, the wooden parts may deteriorate quickly or even char. In Finland, regular sauna bathers never get major burns in sauna, unless they are heavily intoxicated.

Finally, remember that accessibility is part of the physical security, even though it is also a separate factor that guarantees equal enjoyment of the sauna for as many people as possible. Accessibility solutions can now be listed:

- the benches,
- hand railings,
- easy to operate wide (90 cm, 3') door without a sill or with a low sill, and
- to be wheelchair accessible, at least 150 cm (5') diameter of free space just outside the door for the wheelchair to turn around (or more if required by national standards).

The Final Touch with Supplementary Sauna Parts: Washing Accessories

Although the accessories used for creating löyly and washing are not a permanent part of the sauna, they find their way into the sauna space and influence how it looks. Because these instruments unavoidably enter the sauna, the wise designer makes some preparations for them.

The löyly creation requires water and a way to dispense it on the sauna stones. Water must be high quality, preferably drinkable. Cold or warm, it matters not as long as it is in good supply, at least some five liters per hour (1 gal/h), although this is totally dependent on the size of the sauna as well as the starting climate conditions. Löyly creation is usually



Figure 142. Washing supplies can be arranged neatly if the required space has been designed.

achieved with a combination of a pail and ladle. Here the pail is the key as people like to prepare at least two or three liters of löyly water when they enter. The pail will be kept ready at hand, so there should be space for the pail on the benches, possibly on the foot level to keep it handy. In big saunas there will likely be a need for multiple pails. Most ladles can be stored in the pail. Water eventually runs out and the sauna designer must figure out where the supply of water will be located. Most integrated saunas have a dedicated faucet just outside the sauna room in the shower, but it is also possible to run a cold-water line into the sauna room. In fact, there's a product that combines the water tap and the pail with a solution integrated in the benches.

Having hot water close by helps in sauna cleaning. The old Finnish saunas were built close to natural



Figure 143. Flue water boiler, a 60-year-old design.



Figure 144. Portable, battery-powered shower unit.



Figure 145. Men's washing facilities directly underneath the elevated sauna section at Rajaportti Sauna, Tampere, Finland.

fresh water sources, so water could be easily fetched and only modest amounts were stored in big wooden buckets inside the sauna. This adds some complexity to the interior design. For washing approximately one square meter (11 ft²) of floor area has to be dedicated, including some low-standing benches and preferably a small chair. Dedicated space is needed to hold the supplies during the old-fashioned washing ritual.

There must be a solution for heating hot water and storing tens of liters of cold water, containers for mixing the water, holders for soap and shampoo as well as some accessories for pouring the water. In practice, the volumes of water consumed under these primitive/barebone washing conditions are much less than what people would consume in a regular shower. Consumption remains below 15 liters (4 gallons), usually under 10 liters per person (for a mix of hot and cold water). The flue water boilers and heater-integrated water boilers have a limited capacity of usually under 30 liters and cannot serve very big sauna audiences. For this reason, some cabin owners choose to install a separate wood-burning water boiler which can hold up to 80 liters of hot water, sometimes still placing it inside the sauna room. This will be enough for at least 20 people. But it becomes increasingly difficult to serve large saunas without modern, usually electrically powered water boilers. A new, simple but effective water-saver is a battery-powered portable shower. This device plugs into a regular USB charger, and it also useful for off-the grid operation.

Washing oneself, or someone else's back as the old custom was, in the sauna can be very uncomfortable due to the heat, if this function hasn't been taken into consideration in design. There are at least two ways to make washing more pleasant. The best way is to have a very tall sauna. One Finnish sauna construction design favored saunas which had practically two floors. The upper floor, which served as the 'foot bench', was elevated approximately two meters above the floor, leaving plenty of space beneath, for instance for washing. Because

the temperature in the lower level is also naturally cooler, washing was comfortable. The other solution is to simply place the washing spot as far away from the heater as possible to minimize radiant heat and to maximize safety. This can be combined with a special low seat, in Finnish a 'washing stool', so when seated you wash yourself 'at lower altitude' and thus be less affected by the temperature.

All in all the washing supplies can take a lot of space, and their storage in sauna cabins must be taken into consideration. Otherwise they will clutter the room, be lost, or be in the way, making the washing experience inconvenient and reduce the joy of the sauna overall.

Do Löyly Accessories Fix a Bad Sauna?

Besides washing accessories, in Finland you can discover a big number of devices supposedly created to help you get more out of the sauna experience. I call all of these löyly accessories. These include the following:

- Special ladles,
- sauna textiles and seat covers,
- sauna pillows,
- sauna thermometer and hygrometers,
- mechanical fans,
- water dispensers, and
- löyly scents

I will skip ladles altogether and start from the most effective and functional one. Sauna textiles are a key interior design solution for many integrated saunas. In Finland, durable cotton and linen textiles and towels can be purchased in a wide range of colors and patterns. These can be used to either support and emphasize the other interior design choices or create a strong effect on their own. In the Finnish tradition the use of towels to cover and protect the wooden benches is not as deeply ingrained as it is in the German tradition (see the introductory chapter). I find the Germans very smart in this regard, because the outcome of not having a similar rule is that napkin-like disposable plastic seat covers have become prominent in many Finnish saunas, not only at spas and swimming halls, but also in many private ones. In my opinion, these are disgraceful and repulsive and do not belong in a Finnish sauna. They are a source of plastic waste and frustration as they don't even work that well. The high-end Finnish saunas offer their patrons a small cotton towel as a seat cover. This is almost as good as bringing your own towel and provides some visual harmony as well. In a private sauna, the owner can decide how to deal with the matter, but it makes sense to always cover the benches. At my cabin I have four big towels always at hand for covering the benches. The textiles can be regularly washed and replaced so you can try out some new flavors for the interior design when you feel like it.

A Sauna pillow is a great comfort for those who like to lay down. They are not that common in Finnish saunas as the sauna is traditionally enjoyed in a seated position. I personally prefer the cotton-linen mix pillows over wooden sauna pillows. A cloth pillow is easy to wash and replace, making it a flexible decoration for sauna. Sauna thermometers in contrast are something you find in almost every Finnish sauna. Thermometers are usually simple mechanical devices and may not be fully accurate in their readings. However, for most Finns, it is just enough to observe the high temperature, regardless how comparable this number

is between different saunas. For a person operating a wood-burning, continuously heated sauna observing the rising temperature can be a necessary cue to start bathing. Finns don't normally use flue or stone temperature meters in their wood-burning saunas. Hygrometers are not very usual either; they serve little purpose, and their accuracy is questionable. Both hygrometers and thermometers are too slow to notice any change due to löyly, but rather indicate slow trends in the sauna climate.

Various löyly water dispensers are also available. Ranging from simple mechanical dispensers to sophisticated electronic sauna climate controls, they do the principally the same thing: facilitate the creation of löyly with some automation. Nearly automatic löyly creation is somewhat at odds with the tradition in which people would take turns making löyly. However, as the majority of Finns nowadays live alone and enjoy their sauna in private, assisted löyly creation has the potential to transform the sauna experience



Figure 147. Covering the benches with a towel quickly introduces a new visual tones to sauna. Photo © Jokipiin Pellava.



Figure 146. Saunapallo (literally translates as sauna ball), simple but effective for slow dispensing of water.



Figure 148. Custom made, remotely operated water dispenser on top of the heater.

the few devices with an adequate container volume (appr. 3 liters, or 0.75 gallons) to provide a long and subtle löyly experience. From the high-technology end we discover automated dispensers which are connected to a pressurized water source, such as a water tap. These connect to a control system which dispenses water, usually through a nozzle as a spray through an automated or semi-automatic process. In the Kastee control system, the user can set a desired humidity and the dispenser then sprays as much water inside the heater as necessary to achieve the target. Some dispensers, such as Harvia Autodose, include a feed for löyly scents as well as a remote button for operating the dispenser manually. This type of function can be useful to improve accessibility if the sauna heater is located far away from the benches. In big saunas, mechanical dispenser systems which include simple water pipes running to the heater from the proximity of the bench, can be handy too.

In Finland, the most widely appreciated scent in saunas is that of birches, derived from fresh leaves of a sauna whisk. An imitation of fresh plants, löyly scents provide the

biggest temporary pleasure for bathing. They don't have to be administered by a dispenser; a few drops in the sauna pail will do the trick. They are quite easy to experiment with and to discover new scents that can support the multisensory sauna experience. However, some people are concerned that the scents may react chemically when they hit the sauna stones and heat up. Although no research exists on actual effects, a safer way is to spray the scents directly into the sauna air, and not use the heater and löyly for delivery. Using only products with known, safe ingredients is recommended. I advise caution and to start modestly. If you experience irritation of your eyes, skin, or other discomfort, stop altogether or



Figure 149. Russian and Finnish sauna scent specimens.

reduce the proportion of the scent at least by half and try again. Some Finnish scents I've tried are too repulsive for me to use even in small quantities. I personally enjoy Russian scents (nastoyka) which tend to contain a quite pure mix of natural ingredients such as mint, lemon, or eucalyptus, and an alcohol solvent.

The Smoke Sauna Interior

The smoke sauna interior design involves some special solutions to improve fire safety and avoid issues created by soot accumulating on interior surfaces. Safety comes first, as the smoke saunas have a notorious reputation of catching fire at least once during their lifespan. Often this is first and last time, and thus very undesirable. After all, saunas are commonly made out of wood, and the difference between the temperature in which smoke saunas operate and when wood gasifies and eventually ignites is not that big. Luckily the typical reasons for fires are nowadays understood well enough in practice, if not yet in theory, so fire risks can be minimized. The risk can also be almost completely removed if the biggest factor, the human, is replaced by automation and a heater operating with wooden pellet burner, for instance. The sauna can also be fully constructed out of concrete which does not burn.

Precautions required by fire safety have three aspects: *big enough smoke exhaust, protecting combustible surfaces from heat, and controlled air flow.*

The first requirement calls for openings in the ceiling or high in the walls for venting fumes. The hot smoke rises up and must be able to escape quickly before it heats up the interior too much, causing charring and eventually burst of flames. The size of the openings is relative to the size of the heater. The rule of thumb is that the vent area should be equal to that of the heater's firebox grate. A traditional Finnish exhaust in the ceiling called "lakeinen", looking from the outside much like a chimney, has the advantage of being insensitive to the direction of wind which affects hatches placed on the walls. On the other hand, a new idea is to use a window with hinges placed so that it opens down and towards the outside of the building, so it won't be sooted during heating.

Second precaution is to cover the wooden surfaces close to the heater and above it with non-combustible sheets. Structures that collect soot and are difficult to clean must be avoided when installing protection, filling cavities with insulation such as rockwool is possible. And the final step in passive fire safety is to make sure the steam pocket is intact and has no major air leaks. Uncontrolled air flows during heating may give rise to charring or combustion of wood especially during heavy wind conditions.

Besides safety, lighting is another major difference in smoke sauna interior. Some form of lighting is strongly encouraged as the smoke sauna interior otherwise becomes pitch black over time, introducing discomfort and new hazards due to diminishing visibility. Because of the soot, lights can't be installed high up in the sauna. Even if the smoke extraction is designed according to recommendations, there is always some soot flying around, sticking and covering surfaces over time. Installing the lights and windows closer to the floor level is possible. Windows can also be covered during heating, or a single outward opening window can be used as described earlier. Traditionally candles or lanterns have been also used. Because of the tendency of soot to eventually cover all surfaces in a smoke sauna, many builders prefer creating foldable or removable benches which can avoid catching soot during heating.

This more than one-hundred year-old smoke sauna exhibits a characteristic (too) small hatch high up in the wall from which the smoke escapes during heating. Photo: Hannu Pakarinen © Finnish Sauna Society





Figure 150. Northern Pails Zone, a Bluetooth speaker provides multiple functions and a decent sound quality for sauna.

Music and Movies in the Sauna?

Auditory and visual landscape of Finnish sauna has traditionally been serene, silent, and minimized the stimulation of the regularly overloaded visual and auditory senses. This is what Finnish sauna patrons have learned to expect and still do according to research. However, around the world there are variations of “sauna” which include opportunities to listen to music or watch television. Introducing these technologies to sauna needs some special arrangements which are easier for audio than for video. In both cases, the starting point is that the media source selection and control electronics have to be located outside the sauna room. Wireless technologies come in handy, in future smart assistants and voice control will likely do the same. Waterproof passive speakers can be placed in the sauna, but one has to remember the wiring similar to fiber-optic light installation. Alternatively, one can have a wireless speaker, such as the Finnish *Northern Pails Zone* unit, brought into the sauna for temporary use. The new solution on the market is a Bluetooth speaker embedded inside the integrated sauna’s interior wall. It conducts sound to the room through the wall paneling. This means the speaker will become totally invisible and is operated wirelessly, for instance as in the Wave Sound (Wave.com) sound Bluetooth module.

Having a video screen in the sauna requires more changes to the interior design. Common display devices do not have the required IP-rating to be used in the sauna and thus you need to create a window in the sauna and place the display panel or projection screen outside behind that. With both audio and video, the big question is eventually *not how to make it work* but what kind of content should you have in sauna. This is where my opinions end. It is very much dependent on the people and their preferences as well as the desired overall experience if it is even suitable. In the modest Finnish installation, natural sounds along with

videos of aurora borealis or similar natural phenomena have been tried. The success is very context sensitive and I don't personally long for such extras.

That is all regarding sauna interior design. With the previous sections, we've covered all necessary parts of the sauna design from the ground to the top, giving several ideas on how to succeed with interior design. I have outlined a number of big choices, these you must make for yourselves or find a sauna/design professional to help. But following the overall guidance provided in this chapter, your success is guaranteed. Remember, it's not the best, it's a very good sauna you're aiming at.



Figure 151. Small solar electricity system is enough to provide energy for lighting in a small off-grid cabin.

Read More

Printed Books and Scientific Publications

Konya & Burger, 1973

Liikkanen, 2019

Nore et al. 2015

Internet Sources

Products

<https://ledify.fi/en/portfolio/saunaled-lighting/> Example LED light designed for use in sauna temperatures

<https://kastee.fi/> Finnish sauna humidity control system

<https://www.zonespeaker.com/> Finnish Bluetooth speaker for sauna use

<https://harvia.fi/en/about-us/newsroom/harvia-studied-finnish-and-german-sauna-preferences-one-thing-unites/> Study about Finnish and German consumer sauna preferences by Harvia in 2020.

https://en.wikipedia.org/wiki/Average_human_height_by_country Average human height across the world

https://en.wikipedia.org/wiki/Moisture_sorption_isotherm

<https://www.woodproducts.fi/articles/antibacterial-properties-wood-should-be-leveraged-construction>

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Author's Pinterest Boards for Interior Design Inspiration:

<https://fi.pinterest.com/alliikkanen/saunan-valaistus-sauna-lighting-saunologiafi/>

<https://fi.pinterest.com/alliikkanen/saunan-lauteet-sauna-benches-saunologiafi/>

<https://fi.pinterest.com/saunologi/saunan-sein%C3%A4t-walls-sauna-saunologiafi/well>



6.

Examples of Contemporary Finnish Sauna Cabins

This chapter presents examples of commercially produced Finnish saunas that demonstrate how one may fit the bits and pieces presented in previous chapters together. I have chosen the examples for their approximate fit of my design ideals, but I am not endorsing these models or manufacturers over the other thirty or so brands available in Finland (see <https://saunologia.fi/sauna-label/> for Saunologia Sauna label program). The example models and photos are provided by manufacturers. Prospective customers are advised to always make sure what type of furnishing and finishing is included in the delivery.

(All photos and layouts by manufacturers.)

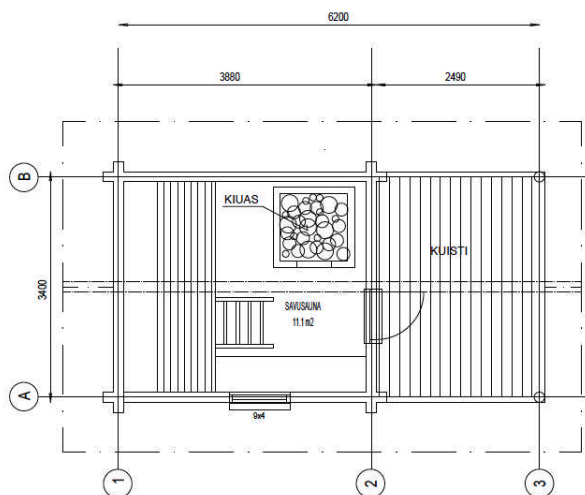




Hirsityö Heikkilä Viljami

Viljami is a very traditional design by the Finnish architect and smoke sauna historian Risto Vuolle-Apiala. Created with superb craftsmanship, Hirsityö Heikkilä log buildings are unique pieces of wooden construction. Viljami is designed to be a large family sauna, heated with a big smoke sauna heater. Robust construction using quality Finnish wood means this building is investment that can sustain centuries. The computer modeled version of the design appears in this book's cover.

<http://www.hirsityoheikkila.fi/en/>

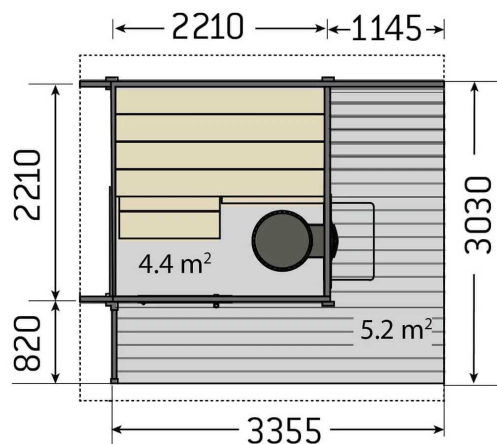




Harvia Solide 1

Finnish Harvia produces a range of modern outdoors saunas, available in several variations across the globe. Solide 1 is available on both sides of Atlantic in similar versions. The Finnish original designed by Vesa Vehmaa includes an ingenious design for a wood-burning tunnel heater surrounded by a frost glass wall providing both lighting and fire safety. Solide 1 has several configuration options and is available in some regions with larger models Solide 2 and 3 that are more spacious.

<https://harvia.fi/en/product/solide-1-outdoor-sauna/>





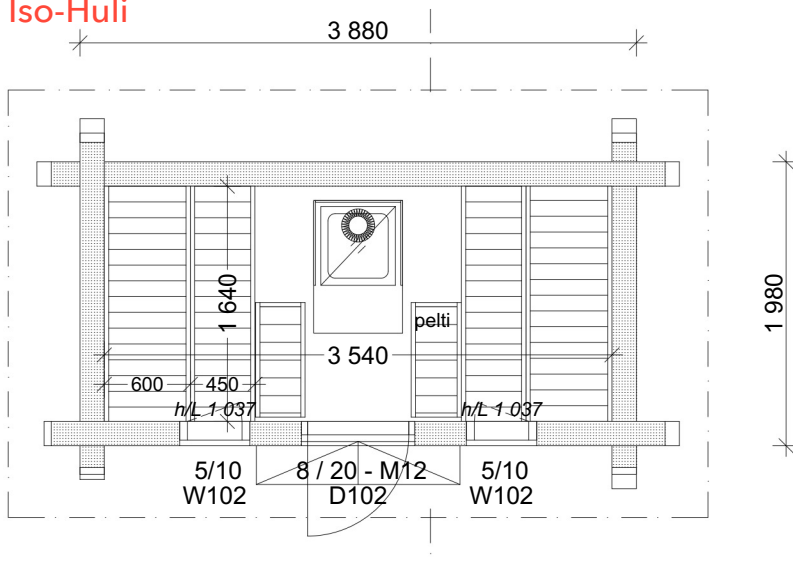


Huliswood Iso-Huli and Vasta-Huli

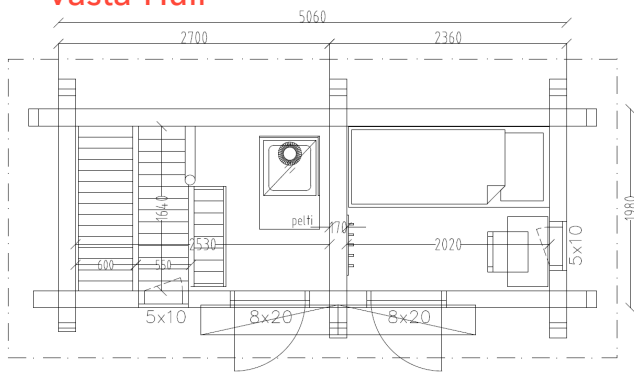
Huliswood company specializes in creating tailored log buildings out of rounded “kelo” pine wood. Kelo is centuries old wood from high latitudes and has a unique feeling to it. Huliswood has exported custom log buildings for long, but their Huli-sauna range is new. Iso-Huli includes a family size sauna finished with kelo and a slightly smaller dressing/guest room. Vasta-Huli model extends the sauna room by a meter (3’), enabling to double the sauna seating capacity. All models are delivered fully furnished.

<https://huliswood.fi/en/huli-sauna/>

Iso-Huli



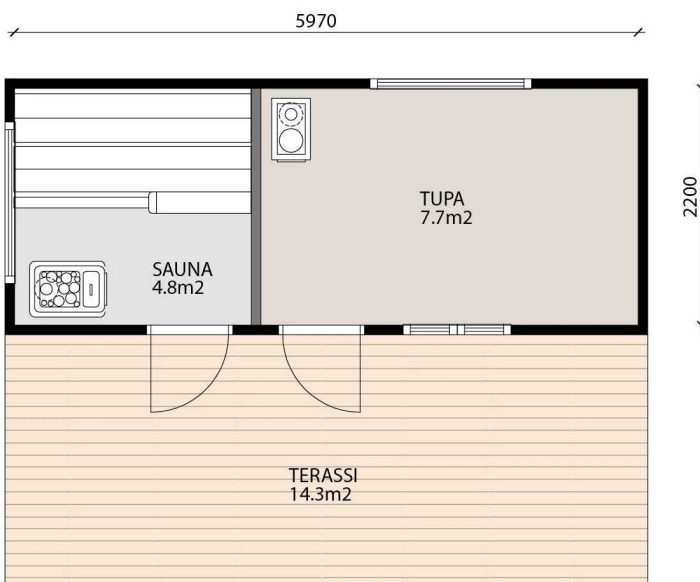
Vasta-Huli



Salvos Väinämö Range

Salvos is a modern Finnish log building company that can very easily create variations of basic models according to customer specifications. The basic dimensions stay similar, but arrangement of rooms, doors, and windows can be customized. Manufacturer currently lists 25 readily available variations of Väinämö, also available fully furnished. Salvos saunas include several clever details, making it a choice with great value for price.

<https://www.salvos.fi/en/>





On the Superiority of a Log Sauna

In Finland there is a shared belief in the superiority of saunas constructed out of heavy, solid logs. This idea may be founded on thinking of what traditional saunas from one or two hundred years ago looked like, but does it have any credence in the twenty-first century? Having massive wooden walls does make up for good insulation, particularly when the wall is at least seven or eight inches thick. The untreated solid interior wall is also beneficial as I suggested in the section about Sauna Materials under Interior Design. Particularly if the sauna cabin is at other times unheated and has thus absorbed humidity from the air, there's a good chance that it will release some moisture when heating up. This is where, in my opinion, the true vices of log saunas end and the rest of the arguments in favor are mostly speculative or wrong.

First, we have to acknowledge that log saunas are somewhat more complicated to design, construct, and maintain than common alternatives. The foremost complication is log shrinkage—the tendency of massive wood to compress in diameter when it dries out and ages. Settling of logs happens more quickly at first, then decreases, shrinking approximately five percent maximum in (imaginary) diameter. This has an impact on the construction of roof, windows, benches, and door frames so that they can continue to function even though the walls around and under shrink. For instance, if you designed the ceiling to have a 200 cm (6'8") distance to the floor, in ten years this might



Figure 152. Budget can vary. The famous publicly operated 'sauna-anarchist' saunas collective known as Sompasauna in Helsinki have been mostly built with left over materials. In the photo from 2018, this sauna has a solid log frame.



Figure 153. Sauna building made from flat-carved logs. The facade has been boarded. Lonna Island, Helsinki.

have decreased by 10 cm (4"). Another downside of log construction is that, despite its good insulation, it tends to take a longer time to heat up. This is apparent with round logs that can increase the wall surface area up to fifty percent, which will inevitably soak up more heat during heating, even if it is released later. For the sauna interior, I thus recommend flat-carved logs.

Another thing to notice is the log construction does not by itself solve ventilation issues. This is a myth born out of ignorance towards old building traditions. Properly crafted log walls are quite airtight, and they will not let noticeable quantities of air pass through. Small leaks of moisture and hot air do not suffice for ventilation. However, it is recommended that the lowest rounds of logs don't have any insulation or sealing material between them, not so much to enable air flow but to prevent any mold taking hold if the wall should get wet. Some ventilation solution such as those described in the Natural Ventilation section under Air Quality will be needed.



7.

Summary and Future Saunas

The Finnish sauna has survived through centuries by both retaining its forms as well as evolving into new directions, thanks to several technological innovations. Now we consider how you can make sure Finnish sauna magic comes true with your new sauna.



What Goes into Great Löyly?

The well-designed and meticulously constructed sauna building sets the stage for good löyly and vitalizing sauna experiences. Proper heating, intact stones, pure water, and a clean sauna help you to experience the magic of löyly every time you sit on the bench and pour water on the stones. That's really all that matters.

In this handbook, I've followed a systematic path of describing all the elements that may have an impact on the sauna experience. This presentation format is a compromise between balancing all factors you have to consider and ones that matter the most. I aimed for comprehensiveness which may have been overwhelming, so I think it is appropriate to remind and highlight the priorities in how you can solve the design challenges related to saunas. You should start by making the biggest decisions first, and then dive into each area of detail:

1. Overall sauna facilities: how big and tall are they, what supporting spaces are available?
2. Heating solution (heater choice) and requirements of flue/electricity.
3. Ventilation solutions.
4. Interior design: bench configuration.
5. Ceiling and wall materials.
6. Windows and lighting.
7. Door(s), floor, and foundation.

If you are not a professional architect or building engineer, I strongly suggest hiring one to help create the detailed sauna plan. After all you've learned in the previous chapters, you should be well informed to set the requirements for your sauna, help co-design it, and challenge the designer about their preconceptions regarding saunas (which outside Finland can be quite a few). Please remember that this is a sauna design guidebook focused on the sauna room details, not a general construction manual.

How to Create the Perfect Finnish Sauna Experience Anywhere in the World

Your options to acquire, build, purchase a Finnish sauna depend on whether you're looking for an integrated sauna or a cabin. In theory, both varieties can be imported from Finland to anywhere in the world. The price of transportation can be substantial for cabins, even heaters can be expensive—or slow—to ship. However, that is not impossible as even air freight might be bearable at least for equipping a commercial sauna. There's nothing wrong with building your Finnish type of sauna with domestic materials from Asia or America as long as these materials meet the requirements. The most complicated part is the heater and stones combination. As previously mentioned, different electrical systems around the world mean that electric heaters intended for the Finnish grid can't be readily used everywhere, even though multi-voltage solutions are available. A mediocre wood-burning heater can be custom made, particularly the steel mesh design is not very difficult to replicate. Finding good sauna stones may be difficult. Luckily all of these materials have suppliers in North America, Asia, and Europe so some solution can always be found, although choices may not

be nearly as varied as in Finland. I encourage you to develop your variations of the Finnish sauna with care. The further you customize your sauna design, the more important it is to keep in mind that you don't lose all of the essential elements that give the Finnish sauna its magical character.

If you wish to recreate an exotic sauna variation, such as the smoke sauna or a clay sauna, you may need to consult Finnish experts in the detailed design and construction, as I've decided to focus this book on the most common and best recognized sauna concepts.

What Is The Future for Saunas?

In Finland the past one hundred years have seen a radical evolution of sauna culture and technology. The Finnish sauna culture has developed almost randomly and unpredictably throughout the years. It has unfortunately lost some of its charm and its role as a foundation for society even though the number of saunas is at an all time high. This became obvious during the recent Covid-19 pandemic which closed down public saunas and many community saunas. As a result almost one fourth of Finns reduced their sauna bathing. The fact that



Figure 154. Finnish saunas usually retain a down-to-earth, humble attitude to their surroundings. Swedish artists Bigert & Bergström created this conspicuous Solar Egg (sauna) which does the opposite and definitely catches your eye. Photo © Bigert & Bergström.

this could be done, indicates that saunas do not serve a necessary function for the nation anymore, they are not essential. It also indicates that Finns nowadays have a more private sauna culture than ever before, and public sauna access is not a sacred right as it was still during the 1950s. Luckily, all Finnish public saunas reopened after the epidemic closures, repeating history as it has often happened since Medieval times and outbreaks of many epidemics. As I'm finishing this book in April 2021, we're unfortunately back to a period of closed doors.

Aside from infectious diseases that have threatened the reputation of saunas in the past, there's another fear as well. This is sustainability. Particularly wood-burning saunas have come under scrutiny for the disproportionate amount of emissions they produce. There are ongoing research efforts to investigate and reduce fine particle emissions. It remains to be seen if product development can speed up before the legislature takes action to demand improved performance and radically reduced emissions. This could possibly lead to a practical ban on wood-burning heaters. In some parts of the world this is already a reality, but in Finland it would be bigger shock than Covid-19. Then again, wood-burning is considered carbon neutral despite its CO² emissions. It will be interesting to see if, for instance, solar-powered saunas can find an audience in the parts of the world where sunshine is predictably present throughout the year. In Finland the long, cold dark winter is made bearable for many by the virtue of having access to saunas, and the little solar energy would be stored.

What to Expect from a Life of a Sauna Owner?

Do you already have a sauna? Congratulations if you do! If you possess a real Finnish sauna that follows most of the recommendations I've given here, I am certain this will increase your happiness and wellbeing over time, possibly even more than winning the lottery. Although the human mind has an awful tendency to adapt to new circumstances and adjusts quickly, the intensity of sauna heat and the pleasure of good löyly keeps on giving high levels of satisfaction long after the novelty has worn off, unlike commodities such as new cars or new technical gadgets. But a sauna also comes with obligations.

Keeping a sauna comfortable over time requires regular cleaning and maintenance, as was discussed in a section about the *Sauna Life Cycle*. Wood-burning sauna and smoke sauna enthusiasts will have to devote a new, regular part of their life not only for bathing but for all things required to operate a wood-burning sauna. People have managed that for centuries; it can be done. Keep good care of your sauna and it will take good care of you.

Owning and operating a sauna usually provides no big surprises over time. If you continue to keep it in good condition, it will age gracefully and not become outdated any time soon, unlike a new car. A sauna is a reliable investment when properly designed and constructed. If you still hesitate, go out and try to experience as many saunas as you can before committing yourself to the project. Once you get the feeling that "I really love this," then return to this book and figure out how to recreate that success in your own Finnish sauna.

Make your sauna dream come true!



Need More Information?

Was there something crucial missing? Would you like to read more about Finnish sauna, say about construction or use? Please provide your feedback about this book at Saunologia's web page: <https://saunologia.fi/book-feedback> and let me know about your thoughts.

If you are considering a sauna acquisition, construction, or renovation and need personal guidance or design support? My Saunologia's Finnish sauna consultation services are there to help you! We provide personal help in plain English! It is our pleasure to help you with projects of all sizes remotely and on site anywhere you need in the world. If you want to guarantee a great Finnish sauna experience from your design, contact us first, prevent costly design mistakes, and ensure a blissful sauna experience for public or private use.

For purchasing a pre-fabricated sauna, you can help yourself and visit the Saunologia Sauna label page for up to date information about which cabins have been approved. The program will begin 2021 and information about will be available at: <https://saunologia.fi/sauna-label>





Supplements:

Finnish Heater Brands

Alphabetical list of sauna heater brands based in Finland as of January 2021. Enlisted brands produce a fixed product line. Heavy duty electric are intended for public saunas in all day use.

Aino. Electric heaters.

Aitokiuas. Wood-burning (heat storing).

Harvia. Electric, wood-burning, infrared heaters, cabins, water boilers, and accessories.

Hehku-kiuas. Electric and wood-burning heaters.

HPK/HST. Electric heaters (heavy duty).

IKI. Electric and wood-burning heaters.

Kastor. Wood-burning heaters.

Kota. Wood-burning heaters, water boilers.

Magnum. Electric heaters.

Misa. Electric and wood-burning heaters.

Mondex. Electric (incl. flat) and wood-burning heaters.

Narvi. Electric and wood-burning heaters.

Parra. Wood-burning heaters.

Peltisepänliike Mika Häkkinen. Wood-burning heaters (classical).

Sauna Granit. Electric heaters (flat).

Saunasampo. Electric heaters (heavy duty).

Sydän-kiuas. Wood-burning heaters.

Teräskiuas. Wood-burning heaters.

Tulikivi. Electric and wood-burning heaters.

TyloHelo. Electric heaters.

Veto. Electric and wood-burning heaters.

Acknowledgements

The road to the completion of this book is in my opinion more exciting than the story of the book itself. This book would not have been written without some unpredictable events on the way. With a US-based Finn Eero Kilpi, we organized a crowdfunding campaign in 2019 which didn't yield enough funds to secure the project but proved there was some international interest for the topic. Soon after I received a grant for writing the book from the Finnish Association for Non-fiction writers which allowed me to start preparing the book in early 2020. After completing the draft, I was able to convince Culicidae Architectural Press about the project in Fall 2020. And finally, the Finnish Sauna Society dedicated a small grant for finalizing the project in late 2020. My employers during 2020-2021, Qvik and Supermetrics, both showed leniency allowing me to take off time to work on the project.

Besides material support, I've several people to thank for being able to wrap this up in a relatively short time. I thank the generosity of several authors, researchers, and specialists who have kindly donated their time to help me in the process of writing and informing the development of the book. These include Jarmo Hiltunen, Bryon MacWilliams, Jarkko Tissari, Sampsa Väättäinen, Timo Vesala, Lauri Nurro, Jarmo Hiltunen, Risto Vuolle-Apiala, Jake Newport, Erkki Fredriksson, Risto Elomaa, Jari Laukkanen, Heikki Lyytinen, Ethan Pollock, Unto Hakkarainen, Vesa Hatakka, Aaron Hautala, and others. Gavan Smith volunteered a huge effort to help finalizing the manuscript.

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Special thanks to my beloved family: Riikka, Alvar, and Ava who made the drawing of Suvikallio cabin.



Literature

The books are available only in either Finnish or English version. Parallel editions are noted. For books, there's a couple of sentences describing their content. Author's translation of the original Finnish title in brackets [].

Aaland Mikkel, 1978/2017. *Sweat. The Illustrated History and Description of the Finnish Sauna, Russian Bania, Islamic Hammam, Japanese Mushi-Buro, Mexican Temescal, and American Indian & Eskimo Sweatlodge*. Cyberbohemia Press, California.

A classic anthropological and historical study of bathing cultures around the world.
Kindle edition available, print sold out long-ago.

Acerbi Joseph, 1802. *Travels through Sweden, Finland, and Lapland to the North Cape in the years 1798 and 1799*. Joseph Mawman: London. Available digitally at <https://www.doria.fi/handle/10024/69486>

A unique travel diary illustrated with exhilarating engravings that also depict a sauna from the late 18th century Finland.

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Key Unit Conversion Tables

Temperature

Celsius	Fahrenheit
-40	-40
-20	-4
0	32
20	68
37	99
50	122
60	140
70	158
80	176
90	194
100	212
110	230
120	248
150	302
200	392
300	570
500	930
600	1110

Dimensions: Area and Volume

Metric	Imperial
1 m	3' 4"
2 m	6' 8"
3 m	10'
4 m	13' 4"
5 m	16'
10 m	100'
20 m	200' / 32 yards

1 m ²	10.8 ft ²
4 m ²	43 ft ²
6 m ²	65 ft ²
10 m ²	108 ft ²
16 m ²	173 ft ²
20 m ²	215 ft ²
25 m ²	270 ft ²
30 m ²	324 ft ²
50 m ²	540 ft ²

10 m ³	350 ft ³
20 m ³	700 ft ³
30 m ³	1060 ft ³
50 m ³	1770 ft ³
100 m ³	3530 ft ³

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