

SAUNA - A FINNISH TRADITION – FOR HEALTH

by Jouko Suhonen



Picture: Visit Central Finland Stopover

Sauna types:

- Wood burning sauna - traditional Finnish sauna - continuous heating - used on lake sides separately from the family house or as integrated sauna into the house.
- Electrically heated saunas are widely used in gyms, homes and flats – they can be turned on for hours. The glowing metal heating coils spurt positive ions in the air of the sauna which may explain why bathers feel quite dulled after the e-sauna.
- Smoke sauna has no chimney – a big pile of stones is heated for 5-6 hours, stays good for bathing for 5-6 hours. Air in the smoke sauna contains mainly *negative ions!* Negative ions are important for the human body functions and how we feel. An abundance of negative ions in the air we breathe is highly beneficial. Healing function?
- Biogas sauna - environmentally cleanest sauna, CO2 emissions = 0, also CNG (compressed natural gas) or LNG (liquefied natural gas) can be used, these emit 50% less CO2 than coal when burnt.
[- Steam sauna, steam room and infrared sauna are rooms used for therapy.]

Finns enjoy the sauna the whole year around:



Sauna stove or heater consists of:

- Fire chamber - heat sources:
 - dry fire wood
 - biogas burner [purpose designed]
 - oil burner [purpose designed]
- Stove's stone box
 - filled with natural stones
 - filled with ceramic stones (can be heated hundreds of times)
 - electric sauna has resistance loops as heat source surrounded by natural or ceramic stones

The optimal sauna temperature/time to heat?

- Some people like a lower temperature heat such as 75C [\approx 165F], while others prefer a higher temperature as 90C [\approx 190F].
- As a rule of thumb we say that a sauna room will heat to 75C in about 30-40 minutes and to 90C in less than 60 minutes. The larger the sauna the longer time is needed for heating.
- Heat-up time is also based on ambient temperature. A sauna located outside in an air temperature of 10C [50F] will heat faster than a sauna located in the cooler temperature of -7C [20F].
- Whether heating with a wood stove, biogas burner or electric heater, the heat time and temperature range, is similar.
- Some people prefer the smell and sounds of a wood burning stove, fully automatic pellet (pressed wood chips) burning stove is convenient and easy to use. Totally hands-free approach of the electric heater will save a sauna owner's time.

Sauna and swimming - all year around



Water temperature is around 0°C [32°F],
outside temperature 1°F – so refreshing!



Construction hints from the International Sauna Club. \approx 600 different smoke saunas have been tested.

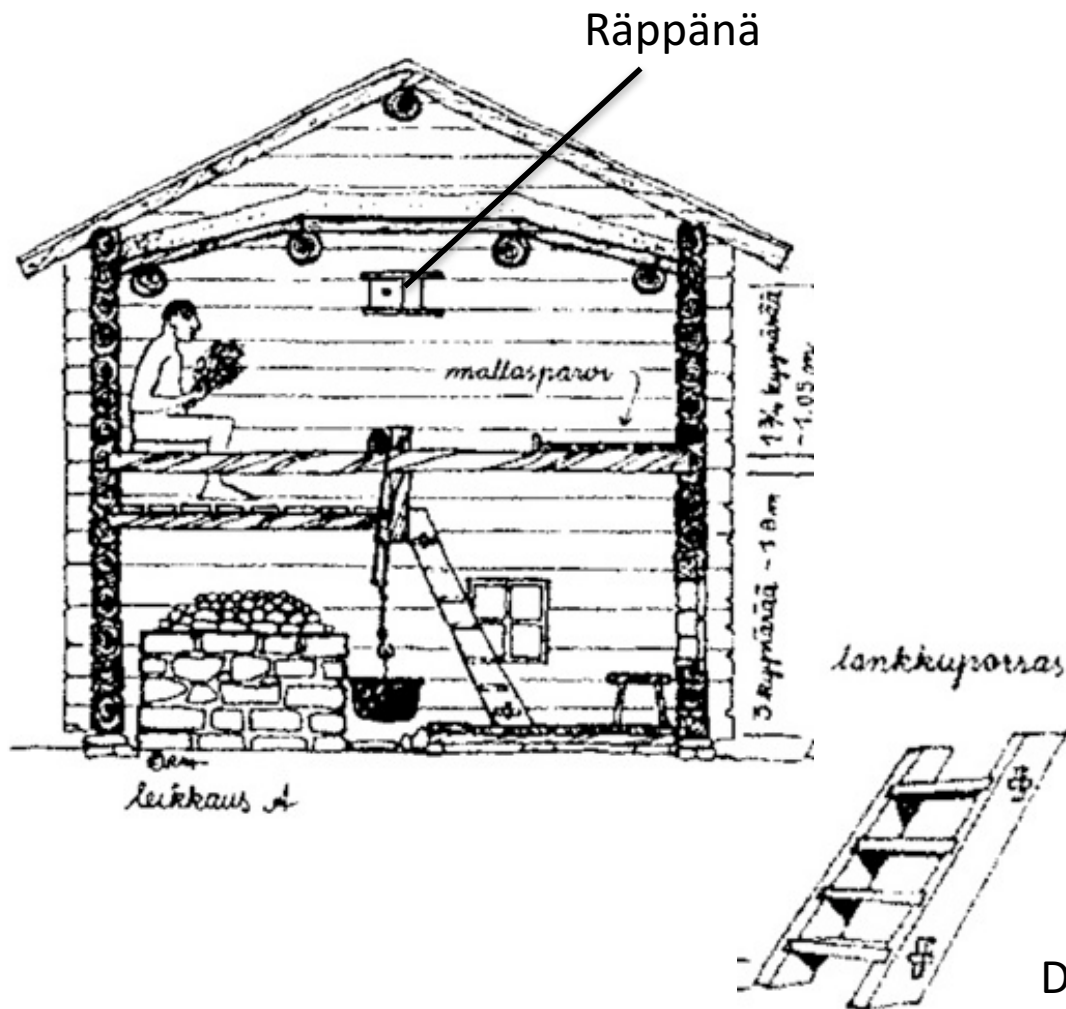
- How to gain the 'löyly'-pocket? [löyly = steam generated by casting water on the hot stones].
- It is important to have enough oxygen to breath - how to aerate a sauna?
- What is the preferable building material for a sauna?
- Which are the best stones for the sauna stove?
- What is the secret of the healing warmth in the 'smoke sauna'?
- How to avoid the smoke sauna's bitter smell called 'kitku'?

The Finnish word '*löyly*' equals the evaporating hot steam that rises from '*kiuas*' the stove after water has been thrown on top of its hot stones.

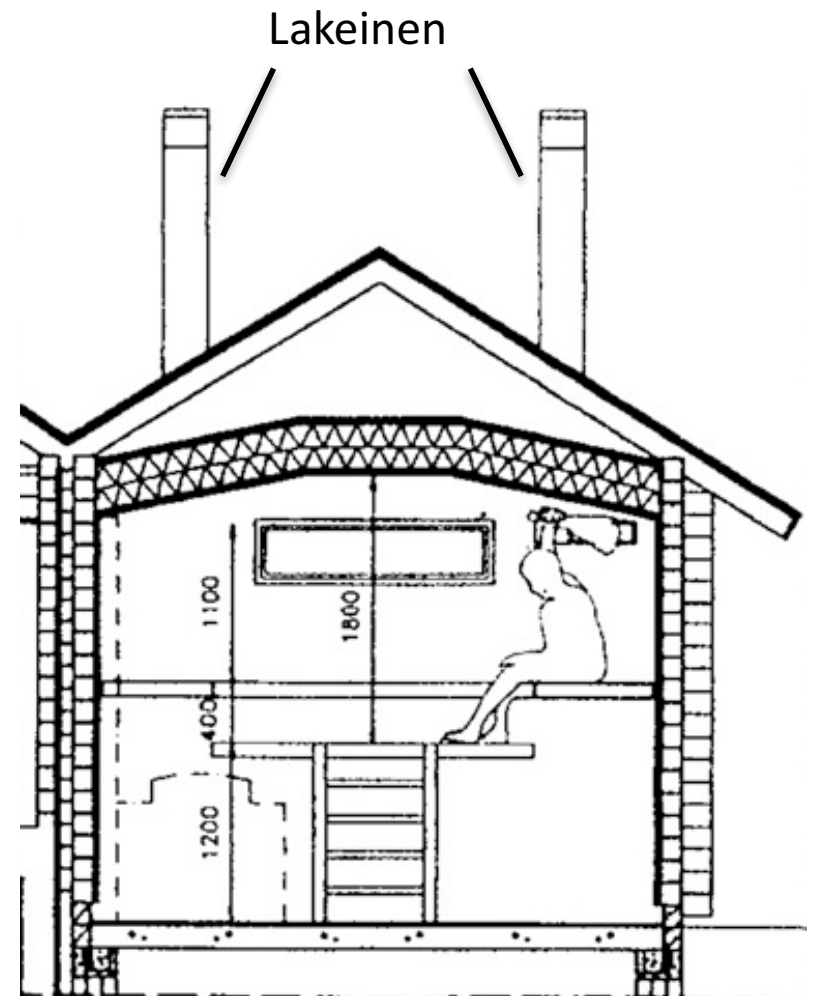


This *löyly* turns sauna room into humid-warm space, capable of relaxing the muscles and worried minds.

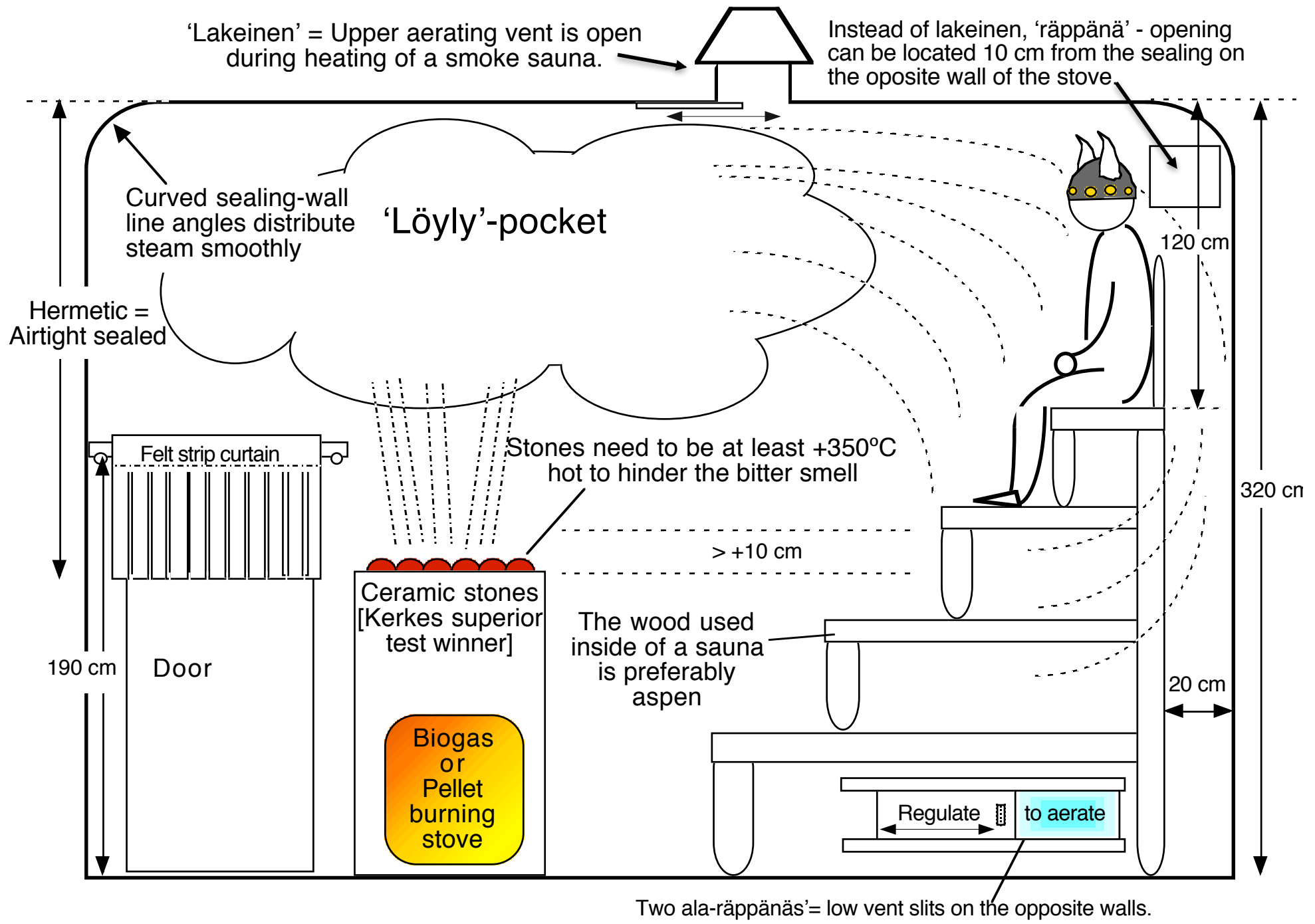
Traditional hämäläis-satakuntalainen sauna



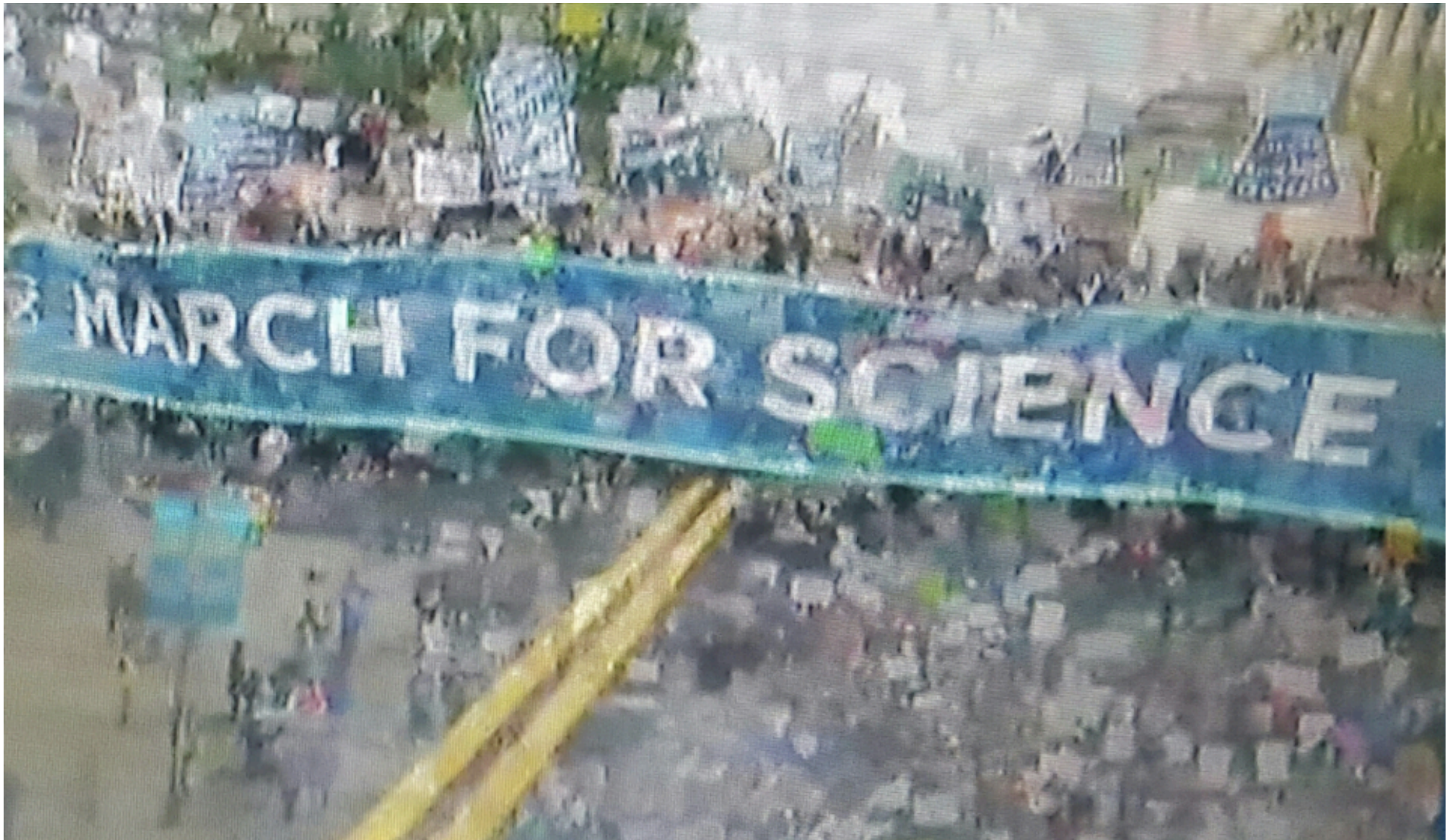
Modern version



Drawings: Risto Vuolle-Apiala



Citizens trust science! – Sauna Science!



Sauna bathing (Hannuksela M & Ellahham S)

- is well tolerated by most healthy adults and children
- causes transient cardiovascular and hormonal changes
- does not influence fertility and is safe during pregnancy of healthy women
- may in long-term lower blood pressure and improve left ventricular ejection fraction
- may improve asthma, bronchitis, rheumatic disease, psoriasis itching and atopic dermatitis
- is *not recommended* in severe heart conditions: unstable angina pectoris, recent myocardial infarction, and severe aortic stenosis
- is seldom associated with sudden death
- and alcohol consumption is associated with hypotension, arrhythmia and sudden death

The effects of sauna use on human longevity

(T Laukkanen JAMA Intern Med 2015, Apr)

- 20 year follow up of 2315 Finnish men, 42 – 60 years of age, a comparison between those who used sauna once a week and those who used sauna 4-7 times per week.
- Average sauna temperature was around +80°C [+174°F].
- Humidity was produced from splashing water on hot rocks [= 'löyly'], sessions lasted ≥ 20 minutes.
- Frequent bathers' death rate from CVD was 50% reduced compared to those who used sauna only once a week.
- Frequent bathers' also had a 40% reduction in mortality from all causes.

SAUNA USE HAS CHARACTERISTICS OF EXERCISE: the heart rate increases up to 150 beats/min. → improvements in blood pressure, endothelial function and ventricular function.

[CVD = cardio vascular disease]

Sauna bathing is inversely associated with dementia and Alzheimer's disease in middle-aged Finnish men.

(T Laukkanen Age Ageing 2017 Mar)

- Setting: prospective population-based study.
- Methods: same cohort as in the CVD-study: 2315 healthy 42-60 aged men [baseline].
- Results: during the 20.7 years of median follow-up 204 were diagnosed to suffer on dementia, 123 to have Alzheimer's disease.
- Hazard ratios for dementia were in 2-3 sauna use/week group = 0.78 [meaning that there is a 22% reduction of the risk of getting D or A], 4-7 sauna uses/week group = 0.34 [corresponding 66% risk reduction of getting diseased] compared with men who used sauna only once a week.
- Conclusion: moderate to high frequency use of sauna was associated with reduced risks of dementia and Alzheimer's disease.

People don't like to get hot – except in the *beneficial* SAUNA! – **Few more surprises!**

(Rhonda Patrick)

- Increasing your core temperature for short bursts dramatically improves performance.
- Heat acclimation promotes physiological adaptations that result in increased endurance, easier acquisition of muscle mass, and a general increased capacity for stress tolerance.
- Heat acclimation on the brain: growth of new brain cells, improvement in focus, learning and memory, and ameliorating depression and anxiety.
- Increasing core temperature induces the “runner’s high” via an interaction of opioid peptides (dynorphin/beta-endorphin).
- Hyperthermic conditioning improves performance during endurance training activities → adaptations in cardiovascular and thermoregulatory mechanisms.

Physiological adaptations via SAUNA use:

(Rhonda Patrick)

- Improved cardiovascular mechanisms and lower heart rate.
- Lower core body temperature during workload (surprise!).
- Higher sweat rate and sweat sensitivity as a function of increased thermoregulatory control.
- Increased blood flow to skeletal muscle (known as muscle perfusion) and other tissues.
- Reduced rate of glycogen depletion due to improved muscle perfusion.
- Increased red blood cell count (likely via erythropoietin).

Hyperthermic conditioning / Sauna use

(Rhonda Patrick)

Blood flow to the heart, skeletal muscles, skin, and other tissues will be optimized in trained and untrained individuals. In the next workout as the core body temperature elevates, endurance is enhanced.

Effects of the heat acclimation:

- Plasma volume and blood flow are increased (cardiovascular benefit).
- Glucose, esterified fatty acids, and oxygen are supplied, lactic acid is removed. Up to 50% reduction of glycogen use (muscular benefit).
- Sympathetic nervous system activation → blood flow to the skin → sweat rate increase (thermoregulatory benefit).

After skating and skiing, - after any sport sauna bathing is very healthy and to be recommended.



Exercise and heat synergize to induce muscular growth.

(Rhonda Patrick)

- Muscle hypertrophy involves both the increase in the size of cells and in their strength.
- Shift in the protein synthesis-to-degradation ratio, a balancing act between NEW protein synthesis and degradation of existing proteins takes place.
- Heat acclimation reduces the amount of protein degradation → net protein synthesis increases → muscles grow via:
 - Induction of heat shock proteins.
 - Induction of growth hormone.
 - Improved insulin sensitivity.

Oxidative phosphorylation: Mitochondria use oxygen from the blood to produce ATP (= energy).

- By-product of this process: oxygen free radicals such as superoxide and hydrogen peroxide, generally referred as “oxidative stress” = major source of protein degradation.
- Heat induced heat shock proteins [HSPs] induce a protective stress response by promoting heat shock factor 1 – gene expression → stress resistance.
- HSPs scavenge free radicals and support cellular antioxidant capacity [via glutathione maintenance].
- HSPs repair misfolded = damaged proteins to ensure them to have their proper structure and function.
- 30-minute intermittent hyperthermic exposure can persist for up to 48 hours after heat shock.

Sauna use causes a robust release in growth hormone [GF] [dependent of time, temperature and frequency].

- Hyperthermic conditioning increases insulin-like growth factor-1 [IGF-1] production in the liver, in skeletal muscles and other tissues.
- IGF-1 in blood regulates effects of GF of the body.
- Heat stress triggers a massive release of GF which inhibits muscle protein oxidation [=protein degradation, anti-catabolic effect] → increase of net protein synthesis.
- 20 min sauna at 80°C [176°F] + 30 min cooling + 20 min sauna → GF elevation 2-fold over baseline.
- 15 min sauna at 100°C [212°F] + 30 min cooling + 15 min sauna → GF elevation 5-fold over baseline.
- 2 x 60 min sauna at 80°C [176°F] dry heat a day for 7 days → GF elevation 16-fold on the third day.

Increased Insulin Sensitivity

- Regulates glucose homeostasis [promotes the uptake of glucose into muscle and fat tissue].
- Regulates protein metabolism [less than IGF-1]:
 - Increases protein synthesis [uptake of aminoacids].
 - Decreases protein degradation [proteasome inhibition].
 - Inhibitory action > degradation.
- Hyperthermic conditioning may promote muscle growth by improving insulin sensitivity and decreasing muscle protein catabolism.
- Hyperthermic treatment might re-sensitize to insulin and increase so the glucose transport from blood into skeletal muscle [decreased glucose uptake by skeletal muscle is one of the mechanisms that leads to insulin resistance!].

Elevated HSP mediated effects

- Prevention of muscle atrophy.
- Increase of muscle regrowth/repair.
- Protection against muscle breakdown due to severe overuse [HPS32 may protect against rhabdomyolysis].
- HSP70 may be responsible of 15% increase in longevity.
- Protection on various types of stress.

More sauna induced hyperthermia effects

- Robust activation of the sympathetic nervous system.
- Hypothalamic-pituitary-adrenal [HPA] axis effect.
- Increase in norepinephrine [helps with focusing and attention] .
- Increase in prolactin [promotes myelin growth → brain functions faster = key in repairing nerve cell (neuron) damage].
- Brain-derived neurotrophic factor [BDNF] increase → growth of new brain cells, ability to retain new information, ameliorates certain types of depression and anxiety.

Sauna use reduces mortality due to inducing HSPs that hinder proteins from the misfolding and forming aggregates. Further heat stress activates FOXO3-longevity gene. (Rhonda Patrick)

- Human metabolism and immune system create reactive oxygen and nitrogen byproducts that damage proteins, DNA and membrane lipids → damaging aggregates →:
 - Heart failure
 - Alzheimer's disease
 - Atherosclerosis
 - Parkinson's disease
 - Cardiomyopathy
 - Huntington's disease
- HSPs repair and maintain the critical 3-D protein structure.
- The longevity through increased polymorphic expression of the FOXO3-gene [rs2802292] → 2.7-fold greater chance of living up to 100 years of age [mice with increased expression of homologue FOXO3 live up to 30% longer].
- FOXO3 [= a transcription factor] turns on stress resistance, DNA repair and tumor cells killing genes.

Attention deficit hyperactivity disorder [ADHD] and autism spectrum disorder [ASD] help from sauna?

- Norepinephrine response to exercise is blunted in children with ADHD.
- Norepinephrine reuptake inhibitors [NRI] are frequently prescribed to treat ADHD among other therapeutics.
- Use of heat stress and subsequent acclimation should be tested for its effectiveness as an alternative therapeutic approach to treat children with ADHD and ASD.

Medical schools might be interested to study the intriguing and speculative health benefits of the planned environmentally sustainable sauna.

Environmental issues



Wood-burning:

- Canada and USA. Some groups wish to ban wood-burning whereas others are trying to convince opponents that clean-burning technology is environmentally friendly.
- "The physical and chemical properties of particulate matter from wood-burning have great influence on how these particles may affect our health. Worsening of cardiovascular diseases and respiratory diseases such as asthma and chronic obstructive pulmonary disease are the main concerns," says Anette Kocbach Bølling from the Norwegian Institute of Public Health.

There are several factors that determine how complete the combustion process is in a stove:

- Type of fuel (wood versus pellets)
- Moisture content
- Draft
- Combustion technology in the stove (new clean-burning versus old, conventional stove)

Three classes of wood-burning particles based on their physical and chemical properties and the combustion conditions:

- The particles emitted from poor combustion conditions ("smouldering" combustion) contain relatively large amounts of **unburned organic substances** from the wood, some of which **may be carcinogenic**, such as polycyclic aromatic hydrocarbons (PAHs). These particles are quite water soluble and are assumed to be removed relatively quickly from the lungs.
- With improved combustion conditions ('burning with flames'), carbon particles with an insoluble core are formed. Depending on how good the combustion conditions are, the carbon particles have varying amounts of organic compounds on the surface. These particles are likely to remain in the lungs for longer periods of time since they are insoluble.
- With complete combustion, for instance in **pellet stoves**, all the organic material in the wood is broken down in the combustion chamber. Non-combustible substances (ash) will be emitted from the chimney, these are mainly **water-soluble salt particles** like potassium sulphate. *When these particles are deposited in the lungs, they will dissolve quickly in the lung lining fluid and thus be removed.*

How do these different particles affect our health?

- *Particles from complete combustion* (salts) seem to have the *least effect on lung cells* in culture and are removed most quickly from the lungs. **The amount of particles emitted from complete combustion is relatively small, so overall these particles seem to have limited influence on human health.**
- When it comes to emissions from burning of logs in old stoves versus stoves with new clean-burning combustion technology, we don't have enough knowledge to distinguish between the health effects of particles from smouldering and flaming combustion. The only thing we can say with certainty is that **emissions are reduced by improved combustion conditions** and that we are thus exposed to smaller amounts of particles when new stoves are used. More research is needed to be certain of how particles from different combustion conditions affect our health.
- *Several of the major cities in **Norway** have programs to replace old, conventional stoves with new clean-burning ones. The purpose is to reduce emissions of particulate matter and contribute to cleaner air.*

Human activities pollute! Healthy Sauna doesn't pollute!

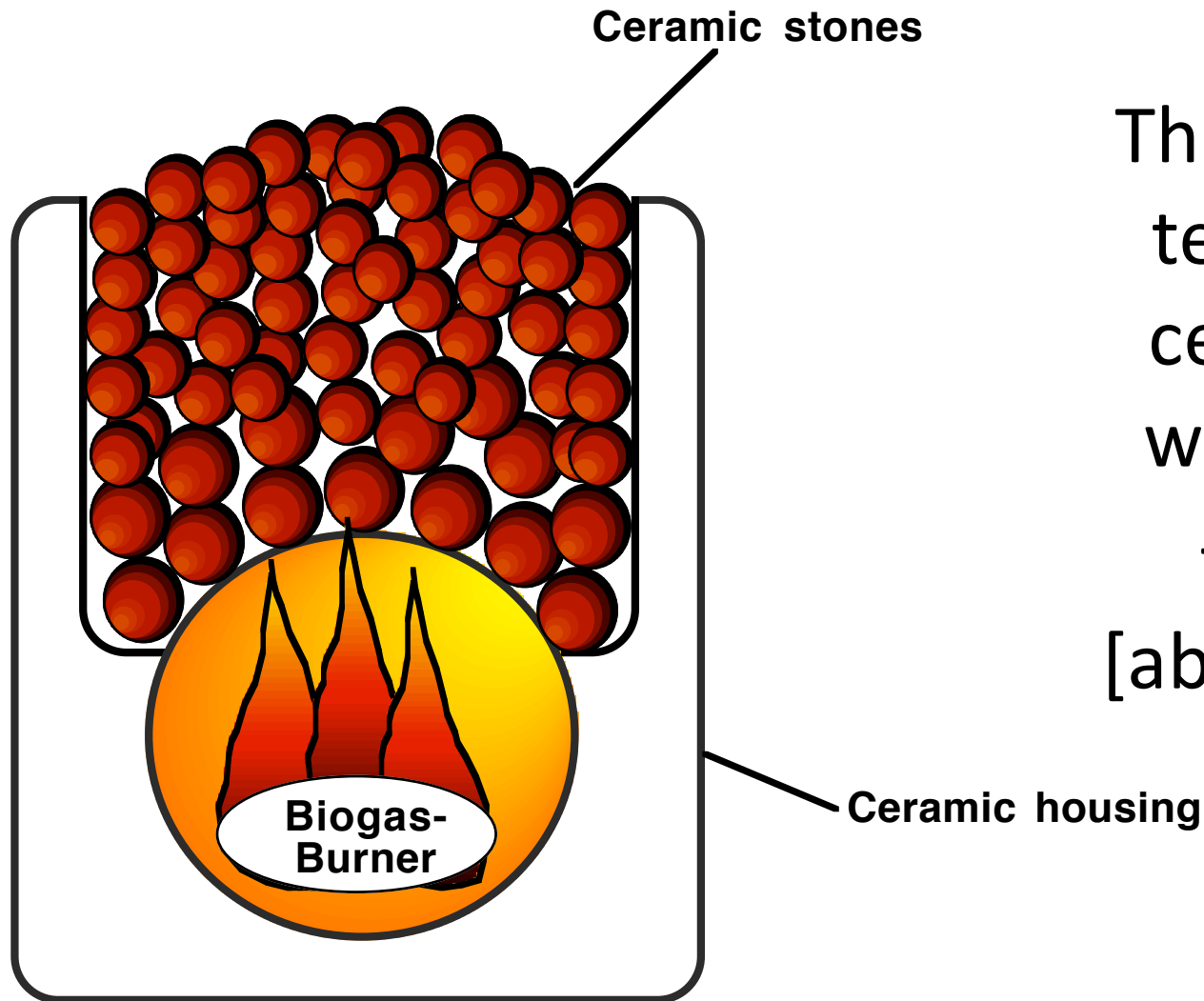


The microscopic particles smaller than $2.5 \mu\text{m}$ in \emptyset cause serious health risks. Breathing air in Delhi corresponds to smoking 44 cigarettes a day.

Biogas heated sustainable sauna – Would it be feasible?

- Biogas has less negative effects than wood burning on the environment.
- Biogas is one of the cleanest fuels available.
- Biogas is good for the climate and the air we breath because it generates only very low emissions of toxic hydrocarbons, nitrogen oxides and soot particles and does not contribute to emissions of fossil CO₂.
- Biogas is renewable, a product of waste materials such as sewage, municipal solid, agricultural, and industrial waste.
- Biogas can be injected into the gas grid for distribution to dispersed fuelling locations and to be used for different purposes.
- Biogas is formed from fresh organic material and recycled in the biosphere, no additional fossil CO₂ is being produced!

‘An aim is to develop a high-temperature clean burning all-ceramic CAD-CAM-3D-printed sauna stove with enduring ceramic stones.’ (Jouko Suhonen)

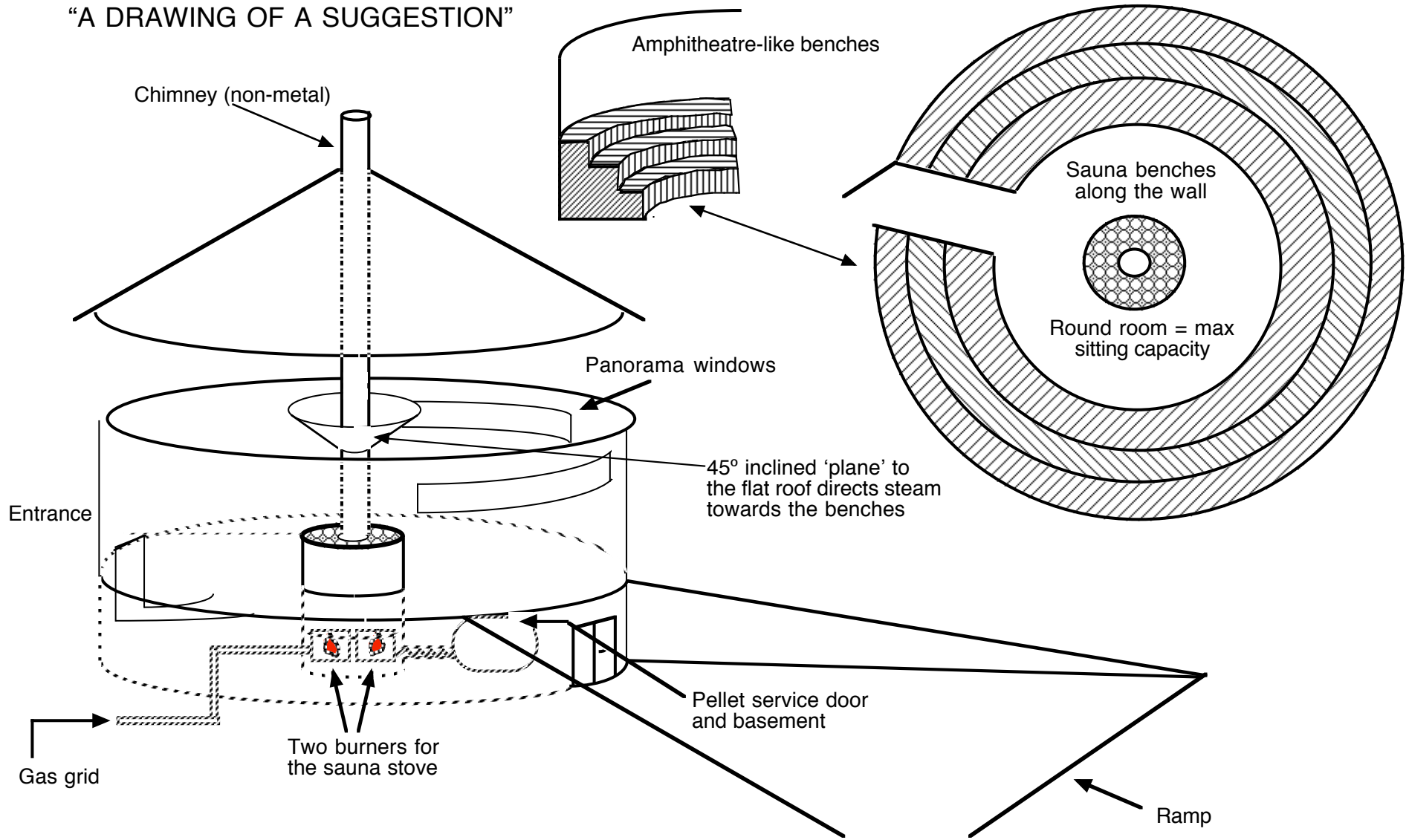


The ultra-high-temperature ceramics can withstand up to 2000°C [about 3800°F].

Biogas heated sauna in Kouvola, Finland



“A DRAWING OF A SUGGESTION”



Automatic smoke sauna uses wood pellets

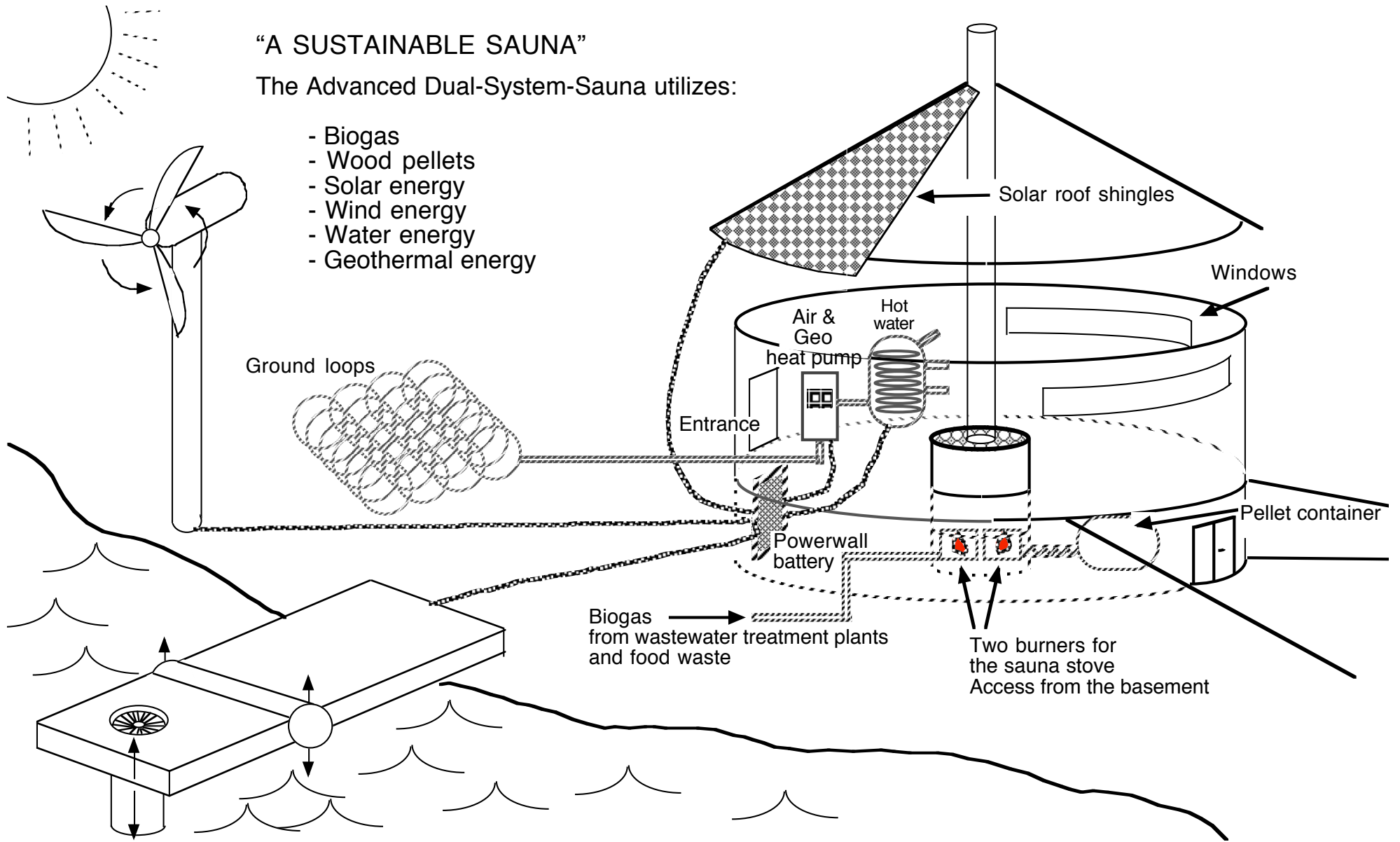


Safety: Thermostat turns off the furnace, over heating is not possible. [www.http://hake.fi/](http://hake.fi/)

"A SUSTAINABLE SAUNA"

The Advanced Dual-System-Sauna utilizes:

- Biogas
- Wood pellets
- Solar energy
- Wind energy
- Water energy
- Geothermal energy



Modern technology + old buildings



Unused buildings could be modified
to pilot saunas.

Sauna combined with UVB LED-phototherapy to fight the vitamin D deficiency

- LEDs are more efficient and effective in producing vitamin D3 in human skin compared to sunlight.
- The optimal range of LEDs emitting UVB radiation for vitamin D production was found to be between 293 and 298 nm.
- **The 293 nm LED** has been found to be 2.4 times more efficient in producing vitamin D3 in human skin than the sun in less than 1/60th the time.

Kalajian et al. Ultraviolet B light emitting diodes (LEDs) are more efficient and effective in producing vitamin D3 in human skin compared to natural sunlight. Sci Rep 2017, 7: 11489. doi: 10.1038/s41598-017-11362-2.



In the sauna large areas of skin are exposed!

For the past half century, the polluted waters have been accepted as a *fact*.
Vitamin D deficiency has been a public burden!

Many lakes and rivers are swimmable again!



When the *facts* change,
we change our minds:

Non-polluting, vitamin
D supercharging public
saunas will become
accepted - *new reality*.

*Health benefits
will be huge!*

Picture: Topher Baldwin/Charles River Conservancy

Stone sauna

Vaulted sauna can be placed partly under the ground, e.g. in a suitable slope or river embankment.



Aim is wellbeing; zero harm; I'd like to set goals for a health promoting sauna – and the environment matters! – Collaboration opportunity? – Anybody interested?



www - links:

Wood-burning stoves: Harmful or safe?

<https://www.sciencedaily.com/releases/2012/01/120116095814.htm> (Anette Kochbach Bølling, Norwegian Institute of Public Health, January 2012)

Deutsche Anforderung zu Staub- und Kohlenmonoxidemissionen von Anlagen für Holz, Kohle und Heizöl.

https://de.wikipedia.org/wiki/Verordnung_%C3%BCber_kleine_und_mittlere_Feuerung_sanlagen (Kleinfeuerungsanlagenverordnung, 1974)

The online exhibition of natural gas burners. <http://www.directindustry.com/industrial-manufacturer/gas-burner-103393.html>

High-temperature ceramics.

<https://www.sciencedaily.com/releases/2003/10/031020055530.htm>

Savusaunan nokeentuminen (Demo video: Burning chambers must be high enough to avoid the soot development in a smoke sauna or any sauna with wood-burning stoves.)

<https://www.youtube.com/watch?v=ebsd8prclk8> (Juha Telkkinen)

The effects of sauna use on human longevity.

<https://www.youtube.com/watch?v=aHOIM-wlNjM> (Rhonda Patrick)

<https://saunologia.fi/blogi/seppo-leskinen-ja-savusaunan-seitseman-salaisuutta/#gref> (Seppo Leskinen)

LÖYLY: A wooden envelope [shell] covers several saunas + restaurant in Helsinki.

<https://www.google.fi/search?q=l%C3%B6yly+from+the+air&oq=l%C3%B6yly+from+the+air&aqs=chrome..69i57.8126j0j1&sourceid=chrome&ie=UTF-8>

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Sauna bathing is inversely associated with dementia and Alzheimer's disease in middle-aged Finnish men. Laukkanen T, Kunutsor S, Kauhanen J, Laukkanen JA. *Age Ageing*, Mar 1;46(2):245-249, 2017.