

# SusWoodStoves – Sustainable wood stoves through stove, building integration and value chain optimisation



## Newsletter 1-2021

### Introduction

The overall objective is sustainable wood stoves through stove, building integration and value chain optimisation.

The sub-objectives are:

1. Speciation and quantification of particulate and gaseous emission levels from wood stoves for representative stove technologies and operating conditions
2. Reduction of climate and health related emission levels through emission reduction and energy efficiency measures
3. Optimum building integration of stoves
4. Assessment of value chain performance of existing and improved stove technologies and connected systems for different stove-building configurations in Norway
5. Techno- and socio-economic assessments of the current and future role of wood stoves in the Norwegian energy market
6. Development of a roadmap for sustainable wood stoves in Norway
7. Education of highly skilled candidates within this area and training of industry partners
8. Monitoring of activities and state-of-the-art within this area and dissemination of knowledge to the industry partners, and other interested parties when applicable

Previous projects have increased significantly the knowledge about wood log combustion in stoves to enable improving wood stoves with respect to emissions and energy efficiency, as well as combustion stability and optimum room and building integration. However, to ensure a sustainable wood stove future both in the existing building stock and the residential buildings of the future, further knowledge building within emission reduction, energy efficiency increase, proper building integration, and value chain, techno-economic and socio-economic assessments is needed. This will secure the

continued use of wood stoves as an important, comfortable and sustainable heat source in the existing building stock (replacing old/poor stoves) and the residential buildings of the future, providing also substantial socioeconomic benefits. Therefore, SusWoodStoves is established, and is working according to the following hypotheses:

1. The best wood stoves today are much better than some emission factors for new wood stoves in the Norwegian emission inventory indicates - still, they can be significantly further improved (reduced emissions, increased efficiency) by better understanding and controlling the wood log combustion process
2. Proper wood stove design and material choices can much reduce the influence of the typical heat production peak on thermal comfort
3. Wood stoves have the potential to be suitable for heating any kind of residential building if properly designed, sized, selected, installed and operated
4. The best wood stoves have a natural place in a sustainable future
5. Further improvements can be shaped in such a way to maximize benefits for climate change and health, increase the overall sustainability performance of the wood stove value chain in Norway, and make a quantifiable step forward in the country transition to a sustainable bioeconomy

The methodology chosen to address the project objectives and hypotheses are based on:

1. Collection and assessment of existing data
2. Laboratory experiments to provide additional needed data
3. Field measurements and questionnaires to collect end-user behaviour data
4. Use of the derived knowledge combined with modelling and simulations for improvement of wood stoves with respect to energy efficiency, emissions (climate and health focus) and satisfying thermal comfort

SusWoodStoves

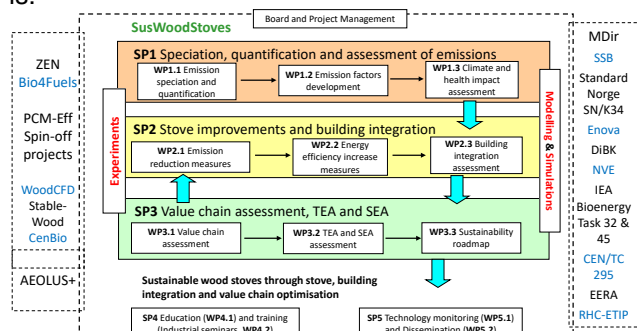
<http://www.sintef.no/SusWoodStoves>

- a Knowledge-building Project for Industry (KSP-K) co-funded by the Research Council of Norway through the ENERGIX-programme.  
Contact: [oyvind.skreiberg@sintef.no](mailto:oyvind.skreiberg@sintef.no)



5. Simulations based on advanced and up-to-date climate and sustainability impact models, with feedback to the stove improvements activities.

The Work Breakdown Structure of SusWoodStoves is:



SusWoodStoves management and work break down structure and project links and information flow.

SusWoodStoves will run for four years (2021-2024) and has a total cash budget of 18.6 million NOK, which is 80% financed by the [Research Council of Norway](#) through the [ENERGIX](#) program and 20% financed by the industrial partners.

## The SusWoodStoves consortium

The project consortium covers all the necessary aspects and includes large and central industrial players in the wood stove area in Norway.

**SINTEF Energy Research** leads the project and focus on speciation and quantification of particulate and gaseous emission levels and reduction of climate and health related emission levels. **NTNU** (Norwegian University of Science and Technology) supervise two PhD candidates and Master candidates, with the main focus being building integration of stoves, assessment of value chain performance of stoves and techno- and socio-economic assessments.

The industrial partners contribute with finances as well as stoves and their extensive industrial knowledge generated through their commercial activities within the wood stove area: Jøtul AS, Nordpeis AS, Norsk Kleber AS and Norsk Varme.

The constellation of project partners is very strong, bringing together leading research organisations within the field and major industrial players.

## Project background

SusWoodStoves, with its focus on sustainable wood stoves, is a response to the open Research Council of Norway KSP call and the topic Environment-friendly energy and its focus on the long term, sustainable development of the energy system, that enhance the competitiveness of Norwegian trade

and industry and accelerate the transition to a low-emission society, including reducing anthropogenic greenhouse gas emissions. It is also directed towards the [ENERGIX](#) program plan and its focus on sustainable utilisation and consumption of renewable energy resources - as biomass, reduction of Norwegian and global emissions of greenhouse gases - from bioenergy, enhancement of Norway's security of supply - through increased use of domestic biomass resources, strengthened innovation in Norwegian trade and industry and the public sector - for the wood stove value chain, further development of Norwegian research and educational institutions - to be able to support innovation efforts in the wood stove industry.

Bioenergy is important in Norway and the current national bioenergy strategy is influenced by e.g. [Klimakur 2030](#), [Klimameldingen](#), [Bioøkonomistategien](#), [Energi21](#) and [Skog22](#). Wood log combustion has long traditions in Norway, constituting above 40% of the total use of biomass for stationary energy purposes, and accounting for about 12% of the domestic heating.

Using wood logs is important for security of supply in Norway, where we today rely heavily on the electricity grid to deliver the needed space-heating for our houses, which are typically wooden (with relatively low thermal mass). With a high nominal power, wood stoves can significantly reduce power peaks in the electricity grid, prevent blackouts and act as backup heating system. In a context of increasing electricity use in households, including electric cars, reducing peak electric power is strategic as it enables to prevent or postpone large investments to reinforce the distribution grid. New houses, as well as retrofit/upgrading of old houses, have increasingly focused on improved energy efficiency (e.g. the [Norwegian passive house standard](#), the [TEK17 regulation](#) and nearly-zero energy buildings from 2020, NZEB). The space-heating effect (power) required for these highly-insulated buildings is drastically reduced, which means that wood stoves for these buildings should be able to deliver a close to constant heating effect to the building as low as ~1 kW, which is much lower than for a new stove in an old house.

Combining heat production, storage and distribution in an optimum way, would make it possible to achieve a substantially more stable heat release and distribution, and with lower heating effect. This was a key focus of the knowledge-building projects [StableWood](#) (2011-14) and [WoodCFD](#) (2015-18), the predecessors to SusWoodStoves. The StableWood studies confirmed that wood stoves have a place in future's buildings, while WoodCFD progressed the knowledge and especially modelling tools significantly, to enable

improving wood stoves with respect to emissions and energy efficiency, as well as combustion stability and optimum room and building integration. Additionally, FME [CenBio](#) (2009-17) made a first effort to assess the wood stove value chain, comparing old and new wood stoves, at nominal and part load operation.

SusWoodStoves builds on the previous work, and will through further knowledge building within emission reduction, energy efficiency increase, proper building integration, and value chain, techno- and socio-economic assessments, contribute to ensuring a sustainable wood stove future both in the existing building stock and the residential buildings of the future.

## Project overview

The project is divided into 5 subprojects (SP), each subproject is itself divided into several work packages (WP).

- Speciation, quantification and assessment of emissions - SP1
- Stove improvements and buildings integration - SP2
- Value chain assessment, TEA and SEA - SP3
- Education and training - SP4
- Technology monitoring and dissemination - SP5

### Speciation, quantification and assessment of emissions - SP1

Addressing sub-objective 1 (Speciation and quantification of particulate and gaseous emission levels from wood stoves for representative stove technologies and operating conditions) and hypothesis 1 (the best wood stoves today are much better than some emission factors for new wood stoves in the Norwegian emission inventory indicates - still, they can be significantly further improved (reduced emissions, increased efficiency) by better understanding and controlling the wood log combustion process).

SP1 leader: Chief Scientist [Øyvind Skreiberg](#), SINTEF Energy Research

### Stove improvements and buildings integration - SP2

Addressing sub-objective 2 (Reduction of climate and health related emission levels through emission reduction and energy efficiency measures) and 3 (Optimum building integration of stoves) and hypothesis 1-3 (1) the best wood stoves today are much better than some emission factors for new wood stoves in the Norwegian emission inventory indicates - still, they can be significantly further improved (reduced emissions, increased efficiency) by better understanding and controlling the wood log

combustion process, 2) proper wood stove design and material choices can much reduce the influence of the typical heat production peak on thermal comfort, 3) wood stoves have the potential to be suitable for heating any kind of residential building if properly designed, sized, selected, installed and operated)

SP2 leader: Associate Professor [Laurent Georges](#), NTNU

### Value chain assessment, TEA and SEA - SP3

Addressing sub-objective 4 (Assessment of value chain performance of existing and improved stove technologies and connected systems for different stove-building configurations in Norway), 5 (Techno- and socio-economic assessments of the current and future role of wood stoves in the Norwegian energy market) and 6 (Development of a roadmap for sustainable wood stoves in Norway) and hypothesis 4 (the best wood stoves have a natural place in a sustainable future) and 5 (further improvements can be shaped in such a way to maximize benefits for climate change and health, increase the overall sustainability performance of the wood stove value chain in Norway, and make a quantifiable step forward in the country transition to a sustainable bioeconomy).

SP3 leader: Professor [Francesco Cherubini](#), NTNU

### Education and training - SP4

Addressing sub-objective 7 (Education of highly skilled candidates within this area and training of industry partners).

SP4 leader: Professor Francesco Cherubini, NTNU

### Technology monitoring and dissemination - SP5

Addressing sub-objective 8 (Monitoring of activities and state-of-the-art within this area and dissemination of knowledge to the industry partners, and other interested parties when applicable).

SP5 leader: Chief Scientist [Øyvind Skreiberg](#), SINTEF Energy Research, who also is the SusWoodStoves project leader

## Progress in 2021

In 2021 the efforts have been focused on establishing the project, detailing the annual work plan for 2021 and recruiting the two PhD candidates. Initial scientific work has started and preparations for experimental activities are in progress.

## SusWoodStoves kick-off meeting by web

Due to the Covid-19 virus, the kick-off meeting in 2021 was arranged online, 11 June. The event went smooth, showing that it is possible to carry out such events online, if it is required.

## PhD work

A PhD position in data-driven analysis of the real building performance using wood stoves has been [announced](#). The position is connected mainly to SusWoodStoves SP2.

## PhD work

A PhD position in advancing methods for climate change and air quality impacts in LCA has been [announced](#). The position is connected mainly to SusWoodStoves SP3.

## SusWoodStoves in EERA Bioenergy Newsletter

An article entitled "Sustainable wood stoves through stove, building integration and value chain optimisation" presents SusWoodStoves in a EERA (European Energy Research Alliance) Bioenergy newsletter, [Issue 15 June 2021](#).

## SusWoodStoves publications

Øyvind Skreiberg (2021). Sustainable wood stoves through stove, building integration and value chain optimisation. [EERA Bioenergy Newsletter 15](#):12-13.

Øyvind Skreiberg. New project: [Sustainable wood stoves through stove, building integration and value chain optimisation](#). SINTEF blog 11 May 2021.

Øyvind Skreiberg, Morten Seljeskog. [Dette må du vite om å fyre i den gamle vedovnen på hytta](#). Adresseavisen 2 april 2021.

Øyvind Skreiberg, Morten Seljeskog. [Hvordan fyre smart i den gamle ovnen på hytta?](#) Gemini 30 mars 2021.

Øyvind Skreiberg. [Vedovner og vedfyring – Hvordan sikre hygge, varmekomfort og miljø- og klimavennlighet](#). Forklaring med video. SINTEF blogg 24 mars 2021

Øyvind Skreiberg. Status of wood stove technology and further emission reduction potential. Innoasis Science Talks 9 February 2021.

Franziska Kausch, Øyvind Skreiberg, Morten Seljeskog. [These simple tips will help you reduce your wood-burning stove's environmental footprint](#). SINTEF blog 8 February 2021.

Øyvind Skreiberg. [Folk kan bli flinkere til å fyre rett med ved](#). Stavanger Aftenblad 22 januar 2021.

Øyvind Skreiberg. [Vedfyring i et større perspektiv](#). SINTEF blogg 13 januar 2021.

Øyvind Skreiberg. [Vedfyring i et større perspektiv](#). Stavanger Aftenblad 13 januar 2021.

## Other news

### Standardisation work

To ensure more efficient and sustainable products to the market the Ecodesign directive and the energy labelling regulation will come into force 1<sup>st</sup> of January 2022 with stricter requirements to local space heaters, including wood stoves. Besides requirements to efficiency also requirements are set to PM (particulate matter), CO, OGC (unburned hydrocarbons) and NOx emissions. Norwegian PM emission limits will be tightened from 10 to 5 g/kg. Ecodesign is supposed to be complemented by harmonised products. The harmonisation of the standard for roomheaters fired by solid fuels is on hearing.

Opposite to the Norwegian standard NS3058/59, the new proposed standard EN16510 does not require testing at low heat output. Without a harmonised test standard three test methods are available: heated filter, dilution tunnel and electrostatic precipitator.

[Franziska Kausch](#) and [Morten Seljeskog](#) at SINTEF Energy Research are representing Norway in wood stove testing standardisation work.

### IEA Task 32 Biomass Combustion

The first [IEA Bioenergy Task 32](#) meeting in 2019, the first year of the current triennium, was arranged in June in Hurdal, Norway. The meeting was combined with a field trip to a 56 MW wood powder fired heating plant at Haraldrud and the Arbaflame steam explosion plant at Grasmo.

The main activities are:

- Testing methods and real-life performance of pellet stoves
- Technical guidelines for design of low emission stoves
- Survey of national strategies for reducing the impact on air quality from residential and commercial wood combustion
- Biomass for process heat in industry
- Biomass-based CHP for balancing an energy system with a large portion of uncontrollable production (intertask project)
- [Workshop on improved combustion in stoves and small biomass boilers](#)
- Workshop on experiences with combustion of pulverised non-woody solid biofuels
- Workshop on experiences with wood chips for large scale CHP production

In the previous triennium, relevant deliverables were:

- [Aerosols from biomass combustion](#)
- [Advanced test methods for firewood stoves](#)
- [Particle emission measurement techniques](#)
- [State of the art on innovative CHP concepts](#)
- [Strategic study for renewable heat](#)

- [Bioenergy for heat - the Hot Cases](#)
- [Workshop on Solid Recovered Fuels](#)
- [Workshop on Biomass Combustion Generated Nanoparticles](#)
- [Workshop on New Emission Measurement Methods](#)

The second IEA Task 32 meeting in the current triennium was arranged 21-24 January 2020 in Graz, Austria, in connection with the 6th Central European Biomass Conference. In connection with the meeting a [workshop](#) was arranged on residential wood combustion. The third meeting was arranged in June 2020 as a virtual task meeting due to Covid-19. In the fall the fourth meeting was planned to be arranged in Copenhagen together with a workshop, but the Covid-19 situation made that impossible. Therefore, a new digital meeting was arranged in December and continued in early 2021, where in addition to the progress of the activities of the current triennium, there were also discussions about possible activities in the next triennium (2022-24), and a draft proposal has in the following months been prepared and submitted. Continued focus on wood stoves is suggested in the draft proposal.

One recent and interesting task event regarding wood stoves was a [webinar](#) entitled "Residential Wood Combustion – Towards Low Emission Systems" arranged for presenting an upcoming task report with the title "Design of Low Emission Wood Stoves".

For information about IEA Bioenergy Task 32 activities, see the webpage and newsletters, and for IEA Bioenergy news, see the [newsletters](#). Øyvind Skreiberg from SINTEF Energy Research is the Norwegian participant in IEA Bioenergy Task 32.

#### **EERA Bioenergy – SP4 Stationary Bioenergy**

The effort in 2019 was focused on revising the SP focus and the description of work, and this work is now finalized. In 2020 an updated [Strategic Research and Innovation Agenda](#) (SRIA) was made for the whole EERA Bioenergy. For more info on EERA Bioenergy, visit the [website](#), and see the [newsletters](#). Julien Blondeau from the Free University of Brussels in Belgium is the leader of SP4 Stationary Bioenergy in EERA Bioenergy, following Berta Matas Güell from SINTEF Energy Research who led this SP for about 5 years.

#### **RHC technology and innovation platform**

The European Technology and Innovation Platform on Renewable Heating & Cooling ([RHC-ETIP](#)) brings together stakeholders from the biomass, geothermal and solar thermal sector - including related industries such as District Heating and Cooling, Thermal

Energy Storage, Hybrid Systems and Heat Pumps - to define a common Research, Development and Innovation strategy for increasing the use of renewable energy technologies for heating and cooling. Previously concrete work has been carried out by the Biomass Panel in the RHC-ETIP connected to giving input to the SET-plan issues paper on renewable fuels and bioenergy, as well as work connected to the Implementation of the biomass technology roadmap of the Biomass Panel. The aim of the latter was to update the progress in R&I priorities identified by the Biomass technology roadmap. This work continues through different efforts. Øyvind Skreiberg from SINTEF Energy Research is a member of the Biomass Panel Steering Committee.

For the three years period 2019-21 there is a special focus on work to be carried out in horizontal working groups (HWG) that focus on contributing to 1) vision (finalized in 2019), 2) research and innovation priorities (finalized in 2020) and 3) deployment and implementation strategy (in 2021) documents. Øyvind Skreiberg chairs the HWG 100% Renewable Buildings, where a number of members from the different RHC-ETIP panels are contributing to the HWG. The work progressed well and HWG 100% Renewable Buildings submitted in 2019 their contribution to HWG Vision 2050, which finalized the [Vision 2050](#) based on input from all the HWGs, including also 100% Renewable Districts, 100% Renewable Cities and 100% Renewable Industry. In 2020, focus has been on defining research and innovation priorities, and a [Strategic Research and Innovation Agenda](#) (SRIA) has now been finalized. In 2021, the focus is on developing an Implementation and deployment strategy, where a [co-creation workshop](#) was arranged dedicated to industry and research experts as well as public authorities, to identify and verify research & innovation trends and priorities of renewable heating and cooling sectors recently.

As a continuation of the SET-Plan work, workgroups were established to provide specific input to the SET-Plan work, e.g. Action 5 Energy Efficiency in Buildings with the sub-action 5.2 Heating and Cooling Technologies for Buildings and Action 8 Renewable Fuels and Bioenergy. The work and an endorsed implementation plan were finalized. Øyvind Skreiberg was involved in the Action 5 work, representing the Biomass Panel. The work is now continued, focusing on the implementation of the SET-Plan, both for Action 5 and 8.

See the RHC-ETIP [news](#) webpage for other news.

### Recent events

29th European Biomass Conference & Exhibition, 26-29 April 2021, Marseille, France. e-conference  
<http://www.eubce.com/>

IEA Task 32 Webinar: [Residential Wood Combustion – Towards Low Emission Systems](#), 6 May 2021.

### Upcoming events

Bioenergidagene 2021, 22-23 November 2021, Gardermoen, Norway. + e-conference.  
<http://www.bioenergidagene.no/>

30th European Biomass Conference & Exhibition, 2022, date and place to be announced.  
<http://www.eubce.com/>

### Links (click on the links or logos to get there)

[WoodCFD](#)

[SKOG22](#)

[Energi21](#)

[Renewable Heating and Cooling ETIP](#)

[EERA Bioenergy](#)

[IEA Task32 Biomass Combustion](#)

[IEA Task45 Climate and Sustainability Effects of Bioenergy within the broader Bioeconomy](#)



## SusWoodStoves

### Økt bærekraft for vedovn verdikjeden

#### Bakgrunn

Vedfyring er viktig i og for Norge, og bidrar betydelig til boligoppvarming og avlastning av strømmettet, samt til energiforsyningsikkerhet når strømmen faller ut. Men, vedfyring bidrar også til luftforurensning, og det er et behov for å øke bærekraften til vedfyring gjennom optimalisering av ovn, bygningsintegrasjon og vedovn verdikjeden, som er prosjektets hovedfokus.

#### Mål

- 1) Spesifisering og kvantifisering av utslipp av partikler og gasser fra vedovner for representative ovnsteknologier og operasjonsbetingelser,
- 2) Reduksjon av klima- og helsepåvirkende utslipp gjennom tiltak for utslippsreduksjon og virkningsgradsøkning,
- 3) Optimal bygningsintegrasjon av vedovner,
- 4) Vurdering av verdikjede ytelsene til eksisterende og forbedrede vedovnsteknologier og tilknyttede systemer for forskjellige ovn-bygning konfigurasjoner i Norge,
- 5) Tekno- og sosioøkonomiske vurderinger av nåværende og fremtidig rolle til vedovner i det norske energimarkedet,
- 6) Utvikling av et veikart for bærekraftige vedovner i Norge,
- 7) Utdanning, og kursing av industripartnere,
- 8) Overvåking av aktiviteter og forskningsfronten innen området og disseminering av kunnskap til industripartnere og andre aktører.



**Prosjekttittel:** Sustainable wood stoves through stove, building integration and value chain optimization (SusWoodStoves)

**Prosjektleder:** SINTEF Energi AS

**Partnere:** NTNU, Jøtul AS, Nordpeis AS, Norsk Kleber AS, Norsk Varme

**Prosjektperiode:** 2021-2024

**Type:** Kompetansebyggende prosjekt for næringslivet

**Finansiering:** 18,6 mill. kroner (15,1 fra NFR)

**Prosjektnummer:** 319600