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Abstract	In this document, the strategy of FIREPRIME implementation is detailed, focusing on three main aspects: the summary of findings regarding the socioeconomic profile of local communities, the basic content of the program for each stream in each site (SP, SE, AT) and the governance and stakeholders' structure and roles.

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1. Introduction and objectives

The current document is part of the FIREPRIME project that aims to develop the knowledge, tools and services needed to build and implement an integral program on risk prevention and preparedness across European WUI communities, with the focus on civil protection. These developments will be implemented and tested in local communities of 3 pilot areas: the province of Barcelona in Spain (Mediterranean Europe), Tyrol in Austria (Central Europe), and Gothenburg in Sweden (Northern Europe).

Therefore, the project seeks to increased wildfire risk knowledge and assessments, by considering specific wildfire risk components and its underlying drivers for a given region/area and to increase evidence-based public risk awareness, education and preparedness among the population for wildfires.

In particular, FIREPRIME will contribute to the achievement of these outcomes by:

- Developing and implementing risk assessment tools and guidelines to be applied at property level (households and infrastructures).
- Developing and implementing risk awareness and education activities at community level in the pilot sites by producing educational and interactive material for the public, packaged for application beyond the pilot municipalities.

This deliverable belongs to WP2 “Program architecture and governance” and summarises results of tasks T2.2 and T2.3, whose specific objectives have been:

- To identify the socioeconomic reality of the study areas as well as communities risk perceptions, capacities and willingness to engage in wildfire prevention.
- To outline the contents of FIREPRIME main streams: 1) homeowner safety; 2) community preparedness, engagement and education; 3) resilient infrastructures.
- To establish the governance of the program at pilot scale, connecting and organising key stakeholders collaboration at the three test areas.

This document is structured as follows: the next section provides a summary of the findings from the survey on the socioeconomic profile of the local communities in our three pilot areas. This information is crucial for tailoring FIREPRIME products and services specifically for these different communities. Following that, a summary of the most relevant initiatives for our three main streams—homeowner fire safety, community engagement and education, and resilient infrastructures—is presented. This summary takes into account the findings reported in D2.1 and the discussions from Workshop 1 (held on May 28th-29th in Barcelona) titled “Sketching FIREPRIME - EU WUI Communities’ Needs, Challenges, and Solutions.” Next, a general description of the implementation strategy is presented, with special attention to stakeholder involvement in the three pilot sites. The final sections provide the strategy designed for each stream, including a list of tools and services to be developed, the rationale behind them, and the specific details for each pilot.

2. Socioeconomic profile of local communities

One of the aims of the FIREPRIME initiative is to ensure a more responsive and sensitive integration and implementation of the developed tools, particularly as attuned as possible to the socioeconomic reality of each pilot and creating a more integrated and interdisciplinary perspective.

To achieve this aim, the UOC team has sought ways to collect and consider part of each pilot's social and cultural diversity. In collaboration with the partners responsible for each pilot site, we have gathered available social data about these territories. Open data, ranging from socio-economic and demographic data to various indexes, are primarily used at an institutional level to characterise these places socially. We have specifically looked for variables, dimensions, profiles, and issues relevant to socially and culturally understanding these regions, particularly in relation to fire risk and associated data. Our strategy has been aligned and consistent with the international literature on these issues which highlights the variables driving vulnerability to wildfires, especially socioeconomic indicators, age, migration, education, and housing. In later stages, we will refine and polish these analyses through interviews with key actors and by incorporating community insights from each pilot site.

The work done poses a series of methodological challenges that are worth mentioning:

- Making very diverse data comparable is challenging, especially when different data is collected in each country.
- Sociodemographic and socioeconomic data often focus on broader regions and scales, making it difficult to capture detailed information at the local and community levels.
- Socio-demographic data is valuable for comparing and setting priorities, but it often provides a generalised and overly simplistic view of the study areas. The challenge lies in addressing these potential biases and oversimplifications to ensure a more nuanced understanding.
- One of the critical challenges is to enrich this data by incorporating qualitative and more contextualised social and cultural insights into our implementation actions and tools.

In the following sections, we will share key findings from the data collected from the pilot sites.

2.1. A social approach to the pilot sites

Catalan Pilot Site

The pilot site of FIREPRIME in Catalonia comprises two zones of wildland-urban interface located within the boundaries of the Natural Park of Collserola. On one side is Mas Sauró, part of the Vallvidrera, Tibidabo, and Les Planes neighbourhood² in the Sarrià-Sant Gervasi district of Barcelona (Figure 1). On the other side, there is the neighbourhood and district of La Floresta, which is part of Sant Cugat del Vallès

² To conduct the social characterisation of Mas Sauró, we only have joint data for the three zones that are part of Les Planes within the administrative limits of Barcelona: Mas Sauró, Mas Guimbau, and Can Rectoret. To simplify the reading of this document, we will refer to this area as Mas Sauró, although the data is shared with the other two territories.

municipality. The data collected mostly comes from official statistics from Catalonia³ and the neighbourhood observatory⁴ of Barcelona's city council.



Figure 1. WUI community in Collserola range, Barcelona.

A quick characterisation of data relevant to understanding these neighbourhoods as WUI communities and their relationship with fire risk from a social perspective is presented:

- Mas Sauró has 1,246 inhabitants and a population density of 5,820 inhabitants/km², with a majority age group of 16 to 64 years (72.2%), especially those between 25 and 44 years old (40.8%). There is a demographic decline from the 45-49 age group onwards, more pronounced among the 60-64 and 75-79 age groups. The gender distribution is similar, but there are more men aged 30-59 (354 men to 265 women). La Floresta has 4,955 inhabitants and a population density of 1,439.6 inhabitants/km². The majority age group is also 16 to 64 years old (67.3%), but there are more children (17.4%) than people over 65 (15.3%). The 40-59 age group is predominant (457 people, 33% of the total), and there is no significant demographic decline. Gender differences are notable from age 80 onwards, with more women than men.
- Mas Sauró has 80% forest land and 20% urban land, while La Floresta is 60% urban and 40% forest. Neither area has agricultural land, but La Floresta has small livestock activity. Both exceed Catalonia's average urbanised land of 6.8%.
- In La Floresta, 63% of people aged 16 to 64 are employed, which is 11.1% higher than in Mas Sauró. Additionally, 11.3% of the population in La Floresta are unemployed, 3.3% less than in Mas Sauró. The most common occupations in both areas are service workers, technicians, support staff, and technicians and professional scientists.
- In Mas Sauró, 63.8% of residences are primary homes, compared to 89.1% in La Floresta. La Floresta has a higher rate of homeownership (73.1% vs. 39.9%) and a lower rental rate (20.1% vs. 50.9%).

³ <https://www.idescat.cat/?lang=en>

⁴ https://ajuntament.barcelona.cat/estadistica/angles/Estadistiques_per_territori/Documents/barris/index.htm

- Mas Sauró has a higher proportion of migrants (45.3% vs. 17.5%), with 26.7% arriving in the last five years, compared to 9.1% in La Floresta. Most migrants come from Italy and France, with notable populations from England in Mas Sauró and Germany in La Floresta.
- Catalan and Spanish are the official languages, and in 2011, 4.3% of the population of Mas Sauró did not understand Catalan, compared to 6.5% in La Floresta.
- Education levels are higher in La Floresta, with 57.9% having higher education and 6.8% lacking primary education, compared to 40.2% and 16.6% in Mas Sauró.

Interestingly, these are communities that are aware of wildfire risk. Active community associations organise activities and debates to participate and collaborate with the administration in reducing fire risk. However, we also see conflicts and controversies over risk management, with people who are less involved, newer, or more disconnected from these dynamics. In particular, in these neighbourhoods, especially in Mas Sauró, about a third of the people over 75 live alone, mostly women. This indicator is especially significant in a context marked by sloppy terrain, lack of public facilities, few commercial and meeting spaces, or street maintenance deficits. All these factors might contribute to the isolation of people and homes, especially older adults or those with reduced mobility. Therefore, we will pay particular attention to these ageing processes and populations as they could be important drivers of social vulnerability to wildfires in these areas.

Additionally, these neighbourhoods have a significant presence of people from other countries. They are mainly European citizens from Italy, France, and the United Kingdom. A quarter of these citizens have arrived in the last five years. They can be young families, although many live alone. We will deepen our understanding about the relationship of these neighbours with wildfire risk and community-building dynamics in these areas and whether there are potential challenges in understanding official languages.

Many of these communities score relatively low on social vulnerability indices. Regarding income, education level, or employment, they are not particularly vulnerable neighbourhoods. However, it is interesting to note that the pattern changes when we use residential vulnerability indices. That is when we consider housing problems (substandard housing, public space, urban planning, property abandonment, etc.). Therefore, focusing on housing might be particularly important for this project. Additionally, in Mas Sauró, many residents are tenants. This must be taken into account when designing and implementing home-scale assessments.

These are places that heavily rely on private transport. There is public transport, like small buses or even trains nearby, but people tend to rely on private transport. The sloppy terrain and zigzag streets also hinder pedestrian mobility, bicycle use, etc. We will also focus more intensely on mobility patterns and describe the composition and transformation of such communities at different times of the day, the week, and the year, especially in highly residential areas. Due to the park's proximity, it would also be interesting to pay attention to mobility patterns from visitors and people enjoying leisure activities in and around Collserola.

Finally, we know that some of these communities have radio or even WhatsApp groups to talk and organise around fire risk management. However, we also know that some areas of Collserola still need mobile coverage. We will also have to consider this challenge when implementing the App.

Austrian pilot site

The FIREPRIME Pilot Site in Austria is in the municipality of Haiming, in Tyrol (Figure 2). Of the six parts of the municipality, efforts will be concentrated in Haiming and Ötztal-Bahnhof. A lot of sociodemographic data is available on the scale of the municipality of Haiming, mainly from the databases of Statistics Austria⁵. Nevertheless, some data that is key for wildfire management is missing. For instance, census data shows that almost 25% of households are one-person households. We also know that 16.3% of the population is over 65 years old and that there are nearly 400 people over 75 years old in Haiming, almost 100 of which are 85 years old or older. Nevertheless, knowing more about how many older adults live alone or in the houses most exposed to wildfires would be interesting.

Of the approximately 4,800 hectares of Haiming, the built-up land occupies less than 1% of the total area (7 ha). In addition, the communities of Haiming and Ötztal-Bahnhof are concentrated in two compact urban areas. Beyond urban aspects and physical proximity, it seems that there is an important social fabric in Haiming, as suggested by the fact that there are almost 40 unions focused on culture, arts and sports. Given the relevance of work at the community level, social cohesion and the consideration of social profiles that may experience circumstances of social isolation, it is convenient to continue exploring these questions at the Austrian pilot site.



Figure 2. WUI area in Tyrol, Haiming.

In Haiming, the average annual gross salary of employees employed throughout the year and the average household income are only slightly lower than at a national level, and only 2.6% of the residents are unemployed. However, people also seem to be experiencing especially vulnerable circumstances, as may be the case for single parents, who have the lowest medium income per inhabitant of Tyrol (around one-third less than the average individual medium income). Therefore, when advising people living in the

⁵ <https://www.statistik.at/>

wildland-urban interface to adapt their houses to wildfire risk, we will consider that there may be socioeconomic profiles that have potentially more difficulties carrying out these actions.

Similarly, when advising self-protection actions for households, we will take into account as well that rented houses represent almost half of the total number of residential homes in Tyrol (47%), which means that there may be people with less agency than others to adapt their homes to wildfire risk because they do not own the house where they live.

It stands out that Haiming has a large number of non-residential buildings (around 260), most of which are dedicated to industrial activity and warehouses (68), to commercial activity (39), hotels and the like (39), buildings for cultural, recreational, educational and health activities (24), and office buildings (21). Based on the economic affiliation data of employed people, we also see the importance of the trade sector (19.8% of the 2,409 employed people work in it), construction (12.1%), healthcare and social services (11.1%), manufacturing of goods (9.1%), and education and training (8.1%). This is important because, in the event of a fire, if these infrastructures are affected, it could be particularly problematic for the livelihoods of many residents of Haiming and neighbouring municipalities from which people commute.

Of the 4,808 hectares of extension that Haiming has, almost half are forest land (2,317 ha), most of which are protected forests, others are productive (we do not have data on the type of production). There are also the 'well-being forests', located mainly in mixed areas with the urban area. It is also remarkable the presence of Alpine pastures and mountain meadows (398 ha), multi-cut meadows (244 ha), and croplands (97 ha). However, there is a significant extension of unclassified non-productive land (1,651 ha).

Apart from the agricultural, livestock, and forestry land uses, the Alpine Mountains experience increased recreational and tourist activities during summer. With an average tourist occupancy rate of around 207 beds per 1,000 inhabitants during summer (including hotels, campgrounds, private lodgings and private vacation apartments), Haiming receives many visitors who practice cycling, mountain biking, trekking, and extreme outdoor sports. Consequently, during these months, many people might spread throughout the mountains, thus increasing the risk of involuntary ignitions and posing more significant management challenges for firefighters.

Finally, it is important to note that no significant recent wildfires have occurred at the pilot site or the neighbouring territories. This lack of recent experience with wildfires may result in low-risk awareness and preparedness and scarce knowledge on how to act during a wildfire. Nevertheless, tools, strategies, and community initiatives are articulated around other risks (such as flash floods and avalanches) that can be useful for working on wildfire risk awareness, prevention, and management. For example, a siren system is designed and implemented for crises, and a mobile phone app, KATWARN, implemented in Austria, provides early warnings for diverse hazards in real time, including wildfires. Furthermore, some citizens of Haiming are organised into four groups of volunteer firefighters, which are not particularly focused on forest fire risk but are organised around other risks and relevant civil protection situations, such as urban and domestic fires and support to traffic regulation. There is also a voluntary "Mountain Rescue Service (Bergwacht)" to monitor and protect the natural environment in Tyrol. Future scenarios of increased wildfire risk might increase mountain monitoring beyond winter months.

Swedish pilot site

The pilot site in Sweden comprises three municipalities in Halland County: Kungsbacka, Varberg, and Falkenberg (Figure 3). Most of the information for this report is sourced from the Swedish Central Bureau of Statistics (SCB).

Kungsbacka is the smallest and most densely populated of the three municipalities, with 85,653 inhabitants over 619 km². Varberg follows with 68,325 inhabitants in 898 km², and Falkenberg covers 1,171 km² with a population of 47,108. The municipalities' population density and size gradient somehow correlate with economic conditions. Regarding wealth, Kungsbacka has a higher income rate, lower gainful employment rates, and fewer residents living in low economic conditions. In contrast, the less wealthy population is more concentrated in Falkenberg's southern and eastern parts. This economic disparity is significant for understanding the distribution of resources and the potential vulnerabilities within each municipality.



Figure 3. WUI area in Sweden.

Two distinct patterns emerge when examining the social profiles of the selected municipalities. Coastal and more urban areas, especially in the west of Kungsbacka and Varberg, tend to have higher population density and wealth. As in eastern Falkenberg, rural areas are less dense and less affluent. This more rural profile, including spread rural dwellings and small villages, is generally characterised by greater distances between homes and higher concentrations of elderly populations, who may face isolation due to a lack of difficulties in social connections. Also, these areas tend to have older buildings and a smaller proportion of owner-occupied dwellings, which could also result in a higher vulnerability at the house level. In urban areas, we can observe low income and economic standards. Eventually, some of these zones could be at the urban fringe, colliding with forest patches and grass covers, increasing the potential exposition of these areas towards WUI fires.

Although Sweden is not known for being a country of extreme wildfires, fire has played an important cultural and historic role in shaping its landscapes. In this context, the Swedish Civil Contingency Agency has recorded all fires that have involved suppression efforts since 1996. This data was then compiled and analysed by Sjöström and Granström (2023). Wildfires between 1996 and 2022 are mainly concentrated in coastal areas, close to urban centres with higher population density. At the same time, we can see that most of these fires have not had buildings ignited.

Climate change is expected to increase the risk of forest fires in Sweden. While low-intensity fires predominate, recent years have seen an increase in high-intensity fires, such as those in 2014 and 2018, which burned 13,000 and 25,000 hectares, respectively (Sjöström and Granström, 2023). At a national level, about 41% of recorded fires have no identified cause. Natural causes, mainly lightning, are more common in forested areas, while anthropogenic causes predominate in shrub or grassland areas. This shift in fire intensity and frequency due to climate change necessitates updated risk assessments and fire management plans.

In addition, mitigation factors for the impact of fires on homes have been studied (Vermina Plathner et al., 2023), with significant measures being found to include pruning grass around the building and the absence of non-vegetal fuels surrounding buildings. Along with this, a considerable presence of homes made partially or entirely of wood has also been identified as a risk factor at the property level, which may be an aggravating factor in the context of increasing fires. In connection to this, authors have also shown that the time to arrival of fire services is an essential factor in the total burned area, in which rural sectors are more affected (Vermina Plathner & Sjöström, 2021).

2.2. Recommendations for the implementation of FIREPRIME

Catalan pilot site

Focusing on homes most exposed to wildfire risk in Catalonia is highly recommended. Considering the social complexity of the studied neighbourhoods—characterised by differences in awareness, age, past experiences, economic situations, education levels, and housing conditions—it would be beneficial to complement the property-level risk assessment, generally more focused on physical dimensions (e.g. the identification of flammable materials and fire propagation vectors), with a psychosocial risk assessment. This approach can provide a clearer understanding of “who” lives in these high-risk areas by involving social, cultural and psychological factors in evaluating wildfire risk. Catalonia offers a valuable opportunity to pilot a more integrated and interdisciplinary risk assessment process, incorporating diverse perspectives on exposure, vulnerability, and the capacity to respond to wildfire risk.

The Catalan case also highlights the importance of working at the community level. Analysis of available social data points to several factors that hinder community building and social cohesion in these neighbourhoods, including mobility patterns, residential dynamics, rapid changes within the community, and accessibility issues, to name a few. These issues can lead to social isolation for certain groups, such as older adults living alone, individuals with mobility challenges, and new residents. It is essential to focus on community-building and social cohesion to prevent this isolation. In this regard, fire risk can be an excellent driver of these community-building efforts, increasing social capital, cohesion, and resilience within these communities through regular community preparedness days and activities.

Given the demographic profile of these neighbourhoods, with a significant presence of families with children, strengthening the educational aspect of the project could be strategic. This may involve creating educational and leisure spaces beyond the school environment. Raising awareness about fire risk and promoting these issues can also help reinforce and build community.

Austrian Pilot Site

At the pilot site in Austria, it is critical to put awareness work around wildfires at the heart of FIREPRIME implementation. The fact that the risk of wildfires has yet to be relevant in this territory -although it is expected to be increasingly greater- can hinder the willingness of the population to participate in wildfire prevention and self-protection practices. If the risk is not imminent, homeowners may not even be interested in testing the FIREPRIME app in the first place.

For these reasons, the 'homeowner fire safety' stream and the 'community engagement and education' stream at the pilot site in Austria should go hand in hand. In this sense, beyond its objective of assessing the structural vulnerability to fire of homes, the app can become an awareness tool. For this to be possible, the app must be implemented with a process of accompaniment and engagement with the population. Working at a community scale can facilitate this process. In Haiming, various actors at the local level can become allies, such as the unions and other groups in the social and associative fabric of Haiming, especially the volunteer groups that articulate their activity around risk prevention and management. Other allies in the face of raising awareness are the companies in the industrial, commercial and tourist sectors who can provide information to their workers and clients.

Given the predictions that the risk of forest fires is increasing, education about this risk may also be crucial. Schools and other educational centres can be spaces where you can test pedagogical tools and platforms from where you can reach the rest of the population. However, it is crucial to consider that climate change can be controversial in Haiming, so looking for the best way to frame the problem is necessary.

A good strategy for implementing FIREPRIME in Haiming can be to work specifically with the idea of risk exposure. On the one hand, it is possible to try to implement the use of the app and to promote self-protection actions not for all the households in the pilot site but only for those that are most exposed to the risk of wildfires. In any case, it is always necessary to consider the limitations and possibilities derived from socioeconomic factors and the tenure regime of these homes. A pilot test can also be carried out on tourist, recreational, industrial and commercial infrastructures in more critical areas, such as the extreme sports centre near or within a forest area in the south of Ötztal-Bahnhof.

Swedish pilot site

The social information analysed is provided at multiple scales, which allows for detailed analysis and the identification of possible future problems. Examining census units with more detail could provide more specific data about different realities within the selected municipalities. This detailed approach can provide contextual information and meaningful variables for the pilot implementation. It gives a better and more localised understanding of the people facing wildfire risk and its entanglement with other social challenges.

On a property level, studies carried out by Vermina Plathner et al. (2023) could supply great guidelines for a homeowner-level risk assessment. These could be included in the development and implementation of

the app. This background could foster better prevention actions from owners and users, particularly considering second homes and non-owner occupied dwellings, which might face barriers to executing and maintaining some of these measures.

The two social profiles identified could also be related to different fire challenges regarding ignition, intensity, and management of future fires. Therefore, two scales of intervention, community organisation and intersectoral links, should be considered for the specific characteristics of the analysed territories. Understanding existing festivities, gatherings, and traditions can help tailor actions in the territories.

In the coastal, more urban zones, the risk may be associated with new climatic dynamics that could affect cultural practices such as grassland burning, recreational activities, and population flows. Here, it would be necessary to understand further these practices and how they could include involuntary ignition risk. Education and awareness efforts can benefit from this information and target more efficiently local communities. Also, exploring the existence and extension of tourism and visitors could be targeted to deploy awareness measures.

Land management is crucial in rural areas, as it is understanding how community solidarity works, particularly in case of emergency, evacuation, or prevention. In addition, it is essential to consider the social connectivity of older adults living alone and people with non-Swedish backgrounds in rural areas. These populations could face isolation in case of fires or be less familiar with protocols or early warnings, drastically affecting the response time. Additionally, coordinated efforts in landscape management on a larger scale can be beneficial in understanding the scale of livestock practices and forestry, their use of fire, and possible risk activities associated with their normal functioning. Livestock and forest owners associations can also play a crucial role as allies in promoting community engagement and education activities. Finally, the railroad network could also be analysed as a critical infrastructure to be affected by wildfires and an ignition source.

3. Summary of relevant initiatives

During the first task of WP2, relevant wildfire risk projects at international, national, and regional levels were examined to identify synergies and existing solutions that could be implemented in FIREPRIME. Additionally, some of these initiatives were presented in detail during the first FIREPRIME Workshop, held in Barcelona at the end of May. The following subsections provide a summary of the most relevant initiatives for FIREPRIME development.

3.1. Homeowner fire safety

Within the existing initiatives that have been identified as relevant for the homeowner fire safety stream, two are of great interest for the FIREPRIME project, as they can be used as examples when it comes to relevant content and communication strategies directed to the WUI homeowners, given that they have been implemented for several years and at a very big scale. These are Firewise (USA) and FireSmart (Canada), which were presented in detail during the first FIREPRIME workshop.

The Firewise program provides guidance to WUI homeowners and residents through a fact sheet that can be easily found on the NFPA (National Fire Protection Association) website (NFPA, 2024). Recommendations are given on how to manage vegetation within the Home Ignition Zone (HIZ - up to 30 m from the building), how to increase the fire resistance of the building(s) located on a property and how to prepare for evacuation and provide access to emergency vehicles (Figure 4). Great focus is posed on the management of the HIZ, which is divided into three zones (immediate, intermediate and extended zones), and specific recommendations are given for each one. A checklist with 8 steps that help make a home safer from embers and radiant heat coming from a wildfire is also provided.



Figure 4. Firewise guidelines on homeowner fire safety.

The FireSmart program also places great emphasis on protection and preparedness actions tailored to homeowners (FireSmart Canada, 2024). The program provides several tools, including a phone app named “FireSmart begins at home” that aims at engaging homeowners in voluntary wildfire mitigation activities by offering a self-conducted home assessment (Figure 5). The app guides homeowners through a series of questions about their property to help residents identify specific actions they can take on their property to reduce wildfire risks. This self-assessment can also be found in a digital form on the FireSmart website and, as in Firewise, questions include issues on the management of the HIZ (also divided in three zones) and the management and construction characteristics of the building. On the FireSmart website, recommendations are divided into two categories, depending on the magnitude of the work that needs to be performed: there are tips that include simple tasks that do not need a big economic investment, and tips that consist in replacing building elements that entail allocating to the task a significant budget. Additionally, FireSmart provides a free one-hour course on their website, named FireSmart 101, directed at WUI residents with the aim of helping them in understanding the need to protect homes and properties from wildfire and to empower them to take action (see section 3.2 for more information about this resource).

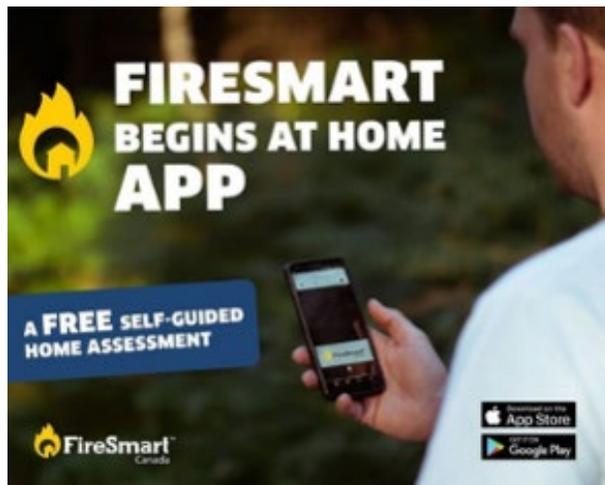


Figure 5. FireSmart Smart Phone App advertisement.

These initiatives, along with those mentioned in Deliverable 2.1 for the homeowner fire safety stream, aim at informing the homeowner regarding the actions that can be taken to reduce a home and a property’s vulnerability to wildfire by providing information and recommendations through tools such as checklists or questionnaires. None of these currently provides a risk or vulnerability scoring for the homeowner, as their goal consists of providing qualitative rather than quantitative information. A gap has here been identified, as there is a need to quantify actions that can reduce a property and a building’s vulnerability to wildfire not only in economic terms, but also in their effectiveness.

3.2. Community engagement and education

The community engagement and education stream is conceived to foster initiatives that encourage active community participation in risk management. This approach aims to empower citizens by involving them directly in various aspects of wildfire preparedness and response. In general terms, there are three types

of initiatives within the community engagement stream: awareness and education, capacity building and collaborative partnerships.

Awareness and Education

Initiatives focusing on awareness and education aim to equip communities, individuals, and decision-makers with knowledge about wildfire risks, mitigation strategies, and the importance of preparedness. By conducting educational programs, workshops, and outreach activities, these initiatives raise awareness about the potential impacts of wildfires on lives and property. They provide information on fire behaviour, evacuation procedures, defensible space maintenance, and the use of fire as a tool. Moreover, educational initiatives often target specific social groups, such as school children, to promote fire safety practices from a young age, ensuring a culture of preparedness.

The main initiatives identified under this stream that could fit directly into the FIREPRIME program are:

- **MeFiTu program:** This is one of the most successful educational programs that PCF has developed and implemented in schools over the last 10 years. It is a one-day educational program consisting in three activities: (1) classroom presentation where topics such as fire ecology and WUI are introduced; (2) Burning of paper trees simulating two forest scenarios (managed and unmanaged forest); (3) field visit adapted to the schools surroundings (recent wildfire, WUI area, mechanical clearings, etc.). The program includes a guide for educators.
- **Stop Disasters Game:** This is an educational simulation game developed by the United Nations Office for Disaster Risk Reduction (UNDRR). The game is designed to teach players about disaster risk reduction and preparedness. This simulation game involves five scenarios, requiring players to save lives by building upon an established community and providing defences and upgraded housing to prepare for an inevitable disaster. Each scenario can be played on easy, medium or hard difficulty levels, and takes between 10 and 20 minutes, depending on the disaster and your skill level.

Capacity Building

Efforts in capacity building move towards empowering communities, residents and infrastructure managers to effectively prepare them on wildfire risk management. These initiatives provide guidelines, training, tools, and resources to enhance prevention, preparedness and response. Moreover, capacity building initiatives usually foster partnerships and networks among residents, local authorities, emergency services, and other stakeholders, enabling collaborative action and shared responsibility in wildfire management.

The main initiatives identified in this stream that could be potentially adapted in FIREPRIME are:

- **FireSmart training course for homeowners:** As mentioned in the past section, FireSmart Canada has developed a free one-hour 101 course, providing an introduction to FireSmart and its principles, helping participants understand the need to protect homes and properties from wildfire, defining the wildland-urban interface, outlining the seven FireSmart disciplines and explaining the FireSmart HIZ concept. There is a short quiz at the end to ensure participants understand the material.

- **EduFire Toolkit:** The main objective of the EduFire Toolkit project is developing a set of multidisciplinary teaching resources following a project-based learning methodology, together with activities designed to encourage community participation, aimed at secondary school teachers and students (12-16yr) in relation to real and local challenges related to climate change and wildfire risk reduction. The project takes a transversal approach with concepts around fire, wildfires and climate change and aims to engage with the curricula of different disciplines related to science, technology, engineering and economics. Thus, it demonstrates how they are related to each other while promoting participation, structuring the materials in different levels of concretion according to the level, rhythm and educational needs, considering diversity. All the resources and results of the project are open access, useful as tools to complement the teaching and learning process, and help the educational community to address the problem of climate change, and particularly in relation to highly relevant wildfires.
- **Informative User-friendly websites:** FireSmart provides a user-friendly platform that serves as a repository of all tools and materials, that clearly explains key messages and procedures on wildfire risk management: steps to become a FireSmart community, online course, risk assessment surveys, etc.
- **Burn SMART:** A planned burning guide for small landholders, from the Department of Fire and Emergency Services of Western Australia,⁶ to inform small landholders how to burn to reduce fuel load on their property considering 3 factors: fuel, weather and topography. The guide also includes the steps to undertake before, during and after the burn.

Collaborative Partnerships

These initiatives bring together diverse stakeholders, including government agencies, non-profit organisations, research institutions, community groups, and private sector entities, to pool resources, share expertise, and coordinate action. Collaborative partnerships facilitate knowledge exchange, capacity-building, and collective decision-making processes.

The main initiatives identified in this stream are:

- **Firewise program:** Provides a framework for communities in WUI areas to organise and take measures to improve their understanding of fire risk. Active community participation is promoted, where residents are encouraged to work together with local authorities. The goal is to empower the community to analyse the risk of wildfires and help mitigating it in collaboration with local stakeholders such as firefighters and civil protection authorities. These programs create a board or committee of volunteers to represent the community, including residents and partners such as local forestry agencies or the fire department, as well as a resident leader who will be the program point of contact. The board or committee defines the boundaries of the site and determines the number of individual single family dwelling units involved.
- **FireSmart program:** FireSmart Canada is a national program that helps Canadians increase neighbourhood resilience to wildfire and minimise its negative impacts. It was founded in 1993 to

⁶ https://www.wyalkatchem.wa.gov.au/profiles/wyalkatchem/assets/clientdata/burn-smart-guide_for_land_holders.pdf

address common concerns about wildfire in the wildland-urban interface. The FireSmart strategy combines several types of resources (Phone App, checklists, manuals, brochures, guidelines, online courses, personalised risk assessment, etc.) to be applied both at homeowner level and at community level to increase fire resilience through capacity-building in terms of risk awareness, prevention and preparedness.

- **Aldeias Seguras Pessoas Seguras:** This is an initiative from the Portuguese Civil Protection Authority. Actions are organised in 5 different axes: 1) Protection of urbanised areas – actions aimed at managing vegetation in the urban-wildland interface. 2) Prevention of risky behaviours – awareness-raising actions aimed at reducing the number of fires. 3) Public alert systems: actions aimed at communicating the level of fire risk and what should be done to protect oneself if a rural fire approaches. 4) Evacuation of urbanised areas: actions aimed at preparing and carrying out spontaneous or planned evacuation of an urbanised area in case of an approaching rural fire. 5) Shelters and refuge places – selecting and preparing spaces or buildings for on-site refuge when a rural fire passes by.
- **Preparedness Day:** Wildfire Community Preparedness Day is a campaign that encourages people and organisations everywhere to come together on a single day to take action to raise awareness and reduce wildfire risks. It is held annually in the United States and Canada on the first Saturday in May and promoted by both Firewise and FireSmart programs.

3.3. Resilient infrastructures

The most relevant guidelines and academic review papers relating to wildfire risk in infrastructures were selected and reviewed in past deliverable 2.1 and are listed in Table 1. They mainly include documents related to chemical industries, rail road infrastructure and electrical grids and power stations. Guidelines provided by already implemented and operational strategies and policies were favoured; a brief summary description of these programs is provided below. FIREPRIME plans to create or adapt similar guidelines, inspired by the existing reviewed risk assessment and risk reduction measures, outlining the most relevant information for each selected industry. It is important to note the programs reviewed are focused on not only reducing infrastructure wildfire damage, but also on reducing infrastructure-caused wildfire ignition and subsequent damage; risk-reduction measures address both concerns.

Table 1. List of reviewed relevant initiatives related to critical infrastructure wildfire risk reduction: specifically considering the chemical industry, train rail networks, and electrical power grid network.

	Implemented Risk-Reduction Guidelines/Legislation	Academic/Institutional Research Reviews
Chemical Industry	FireSmart Canada Guidelines for the Oil and Gas Industry – Canada (FireSmart, 2008; FireSmart, 2012).	Wildfires triggering Natech events –Europe (Kern & Krausmann, 2020).
Train Rail Network	Railway Extreme Heat and Fire Risk Mitigation Rules – Canada (Transport Canada, 2022).	Railway Transport Adaptation Strategies to Climate Change at High Latitudes: A Review of Experience from Canada, Sweden and China (Kostianaia & Kostianoy, 2023).

Electrical Grid Infrastructure	Utility Wildfire Mitigation Program - California, USA (Mitchell, 2023; CPUC, 2020).	Three Lines of Defense for Wildfire Risk Management in Electric Power Grids: A Review (Arab et al., 2021).
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3.3.1. Chemical Industry

FireSmart Canada Guidelines for the Oil and Gas Industry – Canada

The guidelines encompass five main parts, each detailing specific aspects of wildfire management and risk mitigation to oil and gas industry infrastructure (FIRESMART, 2012). The risk-reduction guidance provided is mostly focused on creating defensible space, by removing combustibles in three zones around the industrial buildings, concentrically enlarging around the infrastructure perimeter. Furthermore, the guidelines provide supplementary references and information on reliable wildfire management decision support tools; including the Incident Command System (ICS) which is an emergency management system used by fire agencies, links to local wildfire events reliable information (e.g.: the Forest Protection Area, the Natural Resources Canada), the daily Fire Weather Index (FWI), and available wildfire hazard and fuel maps. Supplementary material also include data describing the wildfire behaviour associated with different Canadian vegetative fuel types.

Part I covers the procedures for assessing fire risks in industrial areas, focusing on defining the three different defensible space FireSmart Industrial Zone 3, 2, and 1, and provides detailed steps for risk reduction and fuel-reduction in each zone. Part II outlines the methods for evaluating industrial liability related to fire risks. Part III discusses the processes for assessing and enhancing emergency response capabilities in industrial settings. Part IV provides strategies for mitigating fire risks across the different zones including planning, vegetation management, structural protection, and managing specific hazards like hydrocarbon storage and heavy equipment. Part V focuses on internal and external communication strategies within the oil and gas industry and with other stakeholders, including training and industrial wildfire control plans.

3.3.2. Train Rail Network

Railway Extreme Heat and Fire Risk Mitigation Rules (Transport Canada) - Canada

To respond to concerns on wildfire ignitions by train operations during an extreme wildfire season, Transport Canada established temporary prevention measures in July 2021. In June 2022 the Railway Extreme Heat and Fire Risk Mitigation Rules permanently established these regulations on all train companies. Safety measures mandated focus on railway-related fire prevention, and improving structural and operation resiliency of national railway infrastructure against all natural hazard climate change impacts. Rules are effective from April 1 to October 31, the seasonal wildfire season in Canada.

Railway companies are mandated to develop a Fire Risk Mitigation Plan, to be reviewed and updated at least every five years, incorporating a communication strategy to enable contact with local governments, municipalities, and indigenous communities. There are specific requirements outlined for the mitigation plans required by companies, including establishing measures to: monitor wildfire risk levels using a chosen hazard prediction system with justifiable thresholds; detect and report fires, responding to and collecting public fire reports with a developed communication methodology; manage vegetation and dispose of combustibles from fuel reduction; restrict or halt maintenance work that could cause ignition during extreme wildfire risk periods, coordinating responses to any fires ignited; assess conditions and implement mitigations during active fire events near railway infrastructure.

3.3.3. Electrical Grid Infrastructure

California Utility Wildfire Mitigation Strategy - USA

In 2019 the California Public Utilities Commission (CPUC) created a dedicated Wildfire Safety Division to implement measures and processes to reduce wildfire ignitions from utility infrastructure. The commission focuses on four key general action areas: 1) coordinating guidelines and an annual revision process for Wildfire Mitigation Plans required from utility companies; 2) developing a process and metrics to track and assess the approach, progress, and results of these plans; 3) advancing detailed risk assessments of utility infrastructure; and 4) developing a data and analytic strategies to support the review of the Wildfire Mitigation Plans. The CPUC has published and implemented several tools, including:

1. The Wildfire Mitigation Plan Guidelines - outline the structure and standardized data required.
2. The Utility Wildfire Mitigation Maturity Model and Assessment - methodology to evaluate utility capabilities in reducing wildfire risk.
3. The Utility Survey - collects information relevant to the maturity assessment.
4. A fire threat map - quantifies wildfire hazard related to electrical utility service infrastructure.

The scope of this program furthermore includes technical guidance regarding the regional legal requirements on creating fuel-reduced defensible space around specific electrical provision vulnerable components (electric lines and electric poles). All relevant guidance information is noted and summarised and referenced for the benefit of electric providers who looking to apply similar risk-reduction measures.

4. General description of the implementation strategy

The implementation strategy defined for FIREPRIME encompasses the three streams, which cover homes (*homeowner fire safety stream*), communities (*community engagement and education stream*) and infrastructures and critical entities (*resilient infrastructures stream*). It has been inspired in the relevant initiatives presented above and tailored to the socioeconomic reality of the populations in each pilot area.

In general terms, the homeowner fire safety stream will focus on creating resources such as a phone app and guidelines, which are targeted to WUI residents and are aimed at increasing risk awareness, prevention and preparedness at the microscale (i.e., property) level. These resources will consider the different realities of the three pilot sites (Mediterranean, Alpine and Nordic regions) in order to create as much harmonisation as possible when dealing with wildfire risk and vulnerabilities. Details are provided in section 5.

Following, the community engagement and education stream will implement strategies to empower the local communities, adapting them to the various contexts and needs of the pilot sites. FIREPRIME will focus on wildfire preparedness and response procedures for different target groups in the Spanish pilot, the use of fire as a management tool at property level in Sweden and the co-creation of vulnerability maps as a way to raise risk awareness in Austria. Details are provided in section 6.

Finally, the resilient infrastructure stream will focus on three different infrastructure types, each corresponding to an infrastructure in each pilot region. Considering the main activities in each pilot and the presence of different infrastructure, FIREPRIME will work on a chemical industry (Catalonia), on the train rail network (Sweden), and on an electrical substation (Austria). Details are provided in section 7.

The FIREPRIME implementation strategy relies on the roles and responsibilities of key stakeholders, which will form the basis of FIREPRIME governance at the pilot scale. By organising and sharing wildfire risk governance at the local level, FIREPRIME fosters engagement, mutual trust, coordination, and collaboration among local stakeholders. In the following subsections, the identified key stakeholders and their main roles in FIREPRIME for each pilot site are detailed.

4.1. Stakeholders involvement

4.1.1. Catalan pilot

Three types of stakeholders have been identified:

- **Local Authorities:** These include municipal leaders, fire departments, and other authorities such as natural park management organisations. They play a key role in coordinating risk reduction efforts in all of its phases, enforcing safety regulations, and providing resources and support for fire risk management initiatives.
- **Regional Authorities:** This category includes regional government agencies and organisations responsible for broader sectoral support. They can provide additional resources and expertise to enhance local fire risk reduction efforts and ensure alignment with regional safety strategies.
- **Local Community Groups:** These are organisations, such as neighbourhood associations, local non-profits, and civic groups. They are key in mobilising community members, facilitating education

and training sessions, and fostering a culture of preparedness and resilience within the community.

The interaction and creation of a board committee comprising local authorities, regional authorities, and local community groups will be key to implement wildfire risk reduction actions. This committee will ensure coordinated efforts, share resources and expertise, and foster community engagement. It will also play a crucial role in maintaining the FIREPRIME strategy's sustainability long after the project's lifespan.

For each level, the following organisations have been identified:

- District managers from Barcelona local council as administration representative of Barcelona's districts.
- Collserola Office as representatives of neighbourhoods in WUI areas.
- Barcelona Fire Service, which have competencies in wildfire suppression in Barcelona municipality.
- Collserola Natural Park, with competencies in biodiversity and forest management within the protected area.
- Sant Cugat local council as representatives of local interests.
- Catalan Fire Service, with competences in wildfire suppression in Catalonia.
- Catalan Civil Protection, leading risk awareness campaigns and risk planning in WUI sites.
- Catalan Forest Service, which leads forest management in Catalonia.
- Barcelona regional government with departments in three topics: civil protection, wildfire risk management and urbanism.
- La Floresta scouts, a group of youth that will be engaged as target group and community leaders.
- La Floresta neighbours association, engaged as target group to involve locals in risk management.
- Catalonia Foundation, which is a centre for people with functional diversity that is located near La Floresta, in a WUI site.
- La Floresta school, that will be engaged to promote risk awareness actions among primary school children.
- Forest Defence Volunteers from Sant Cugat, a group of volunteers that have competences in wildfire prevention and first response.
- Collserola Paisatge Viu, which is a recently created association pushing for an enhanced wildfire risk reduction strategy in Collserola.

By the end of September, a workshop with key personnel from these organisations will be held to start planning activities for the homeowner fire safety and community engagement and education streams.

Additionally, key stakeholders for the implementation of the resilient infrastructures stream in Catalonia have already been identified and contacted during the initial months of the project. These include:

- SVC Chemical Storage Services: A chemical company classified as a SEVESO upper-tier establishment. This infrastructure will be the focus of the Catalan pilot, for which guidelines and methods to detect vulnerabilities and increase fire resilience will be developed.
- General Directorate of Civil Protection (Generalitat de Catalunya): The Civil Protection Authority of Catalonia. Key personnel from this agency are already engaged in FIREPRIME and will provide guidance and feedback to ensure the compatibility of FIREPRIME methods with current fire risk planning instruments required in Catalonia.
- General Subdirectorate of Industrial Security (Generalitat de Catalunya): The industrial safety authority of Catalonia. Key personnel from this agency are already engaged in FIREPRIME and will provide guidance and feedback to ensure the compatibility of FIREPRIME methods with the mandatory quantitative risk assessments and safety reports required by the EU SEVESO directive.

4.1.2. Swedish pilot

We have identified seven stakeholders for the Swedish pilot. Contacts have previously been made with all these organisations and we are reaching out to tie connections with appropriate people for work during rest of 2024 and 2025.

- The National Civil Contingency Agency (MSB) who are responsible for guidelines to rescue services, to provide fire danger maps of both forest and grassland fires and to issue warnings during high danger in certain areas. We have contact with the three persons responsible for prevention of wildfires within the organisation.
- The Fire and Rescue Service in the regions (split up between two organisations) who are obliged to suppress wildfires until there is no immediate risk of spread. We have contact with inner command personnel about activities during the autumn.
- The municipality administration who issues information to the citizens and industries in the region concerning burn bans, accessibility for fire engines.
- The homeowner association in the region, which advocates rights, responsibilities and solutions for homeowners. Previous collaborations with the homeowner association in other Swedish regions have been successful.
- The Federation of Swedish Farmers (LRF) and their local branch in the region. This organisation is vital to the work as much of the ignition start in, or close to, agricultural land and the local knowledge and tools of the farmers are increasingly used in suppression activities.
- Södra Skogsägarna (Association of forest owners in south Sweden) is an organisation which organises private forest owners and administrates some of the forest activities such as purchase of timber, contracting of entrepreneurs, distribution of seeds and plants as well as guidelines of forestry procedures and activities for improved economical gain and increased ecological values.
- The Swedish Transport Authority (Trafikverket) who owns and are in charge of the rail road system in Sweden. Trafikverket is responsible for clearing the rail tracks from vegetation and to reduce threats to and from the rail system throughout the nation. We have contact with the person responsible for vegetation clearing as people working with risks along the track to help us support the infrastructure stream.

4.1.3. Austrian pilot

The pilot study area is located in the Austrian federal state of Tyrol. The Austrian pilot is being supported from the earlier stages of the project by national stakeholders including key persons from the civil protection (Austrian Federal Ministry of the Interior) and from the WLV (Forest Engineering Service for Torrent and Avalanche Control) from the Austrian Federal Ministry of Agriculture, Forestry, Regions and Water Management which is responsible for the wildfires in Austria.

At the regional level, contact has been already made with:

- The leader of the Torrent and Avalanche Control Section in Tyrol.
- Key persons from the Centre for Crisis and Disaster Management, Regional Authority of Tyrol.
- Key persons from the Department of Forestry, Regional Authority of Tyrol.
- Key persons from the Fire brigade Association Tyrol.

At the local level, the stakeholders that will be included are:

- The Mayor of the municipality in Tyrol where the pilot study will take place (already contacted).
- The leader of the local voluntary fire fighters group and members of this group (already contacted).
- Citizens from local unions (associations/clubs).
- Key persons from the Electricity Transformer which is located in the area (identified).

Following the first meeting with the core local group, more local stakeholders will be identified. These may include:

- Regional tourism association.
- Representatives of hotel owners.
- Operators of outdoor parks and sport facilities.
- Local officials for building and housing subsidies.

5. Homeowner fire safety

5.1. General strategy

The aim of the homeowner fire safety stream is to empower WUI residents to create defensible spaces and resilient homes. To achieve this, several tools will be developed, adapted, integrated and tested in the different pilot sites, mainly counting on a quantitative risk assessment method for buildings and properties located at the WUI, which includes risk mitigation guidelines at the property level. This method will be implemented and provided in the form of a smartphone app, easy to understand and use, as well as in a non-digital version (i.e., on paper).

5.1.1. Methodology

Within the app, risk will be defined as a function of the hazard a property is exposed to and of its vulnerability to wildfire. The hazard will be defined at the local level by using information that is available either through the EFFIS portal or through local or regional hazard maps. Vulnerability will be quantitatively defined through a fault tree analysis, which considers the different events that might lead to the fire entering, and thus igniting, a building located at the WUI. The fault tree will be built based on some of the tools reported in Deliverable 2.1 that have been developed based on scientific research findings on the mechanisms that lead to WUI building ignitions. It will take into account the different pilot sites environments and realities. Failure probabilities will be assigned to each basic event of the fault tree, through which the probability of fire entrance can be calculated. The advantage of a quantitative methodology lies in knowing how risk can be reduced, and by how much it is reduced, when implementing certain actions.

5.1.2. Homeowner engagement

The homeowner will be presented with a set of questions about its home and property. The content of these questions will include things such as building materials, building maintenance, the presence of fuels within the HIZ and their maintenance level. Examples and images will be provided in order to make the questions as easily understandable as possible. Through the use of the app, homeowners will be able to know the risk score of their property and to know exactly which actions they will need to take in order to reach an acceptable level of risk. The app will not only give a score, but it will also provide examples and tips on how to reduce vulnerabilities for each of the questions/items that are posed. This system will be gamified, to encourage the homeowner to go back to the app, insert the improvements that have been made or that are being planned to then get a new, improved score. Additionally, the option could be given to have a look at the average score of the entire community, with the aim to engage other neighbours.

Additional assistance could also be provided to the homeowners through an advanced home assessment. The homeowner could have the option to ask for a trained volunteer to perform an assessment of the vulnerability of its property and inhabitants in person. This would entail creating a training programme tailored to volunteers that already operate within the wildfire preparedness field.

A non-digital version of the questionnaire will also be made available for the cases in which using a phone app is not feasible. In this case, calculations of the vulnerability score will have to be performed manually, or assistance for this calculations could be given by the trained volunteers.

5.2. Specific strategy for Collserola

The communities that will be involved in this stream will be “La Floresta”, belonging to the municipality of Sant Cugat, and “Mas Sauró”, belonging to Barcelona, both located in Collserola range, which has a Mediterranean wildfire regime with summer as the main fire season.

The first step in the implementation strategy is to select a representative sample of homeowners (15-20) to test the wildfire vulnerability assessment tool (app and non-digital version). The tool is designed to evaluate various aspects of home safety, including structural vulnerabilities and the home ignition zone. By focusing on a heterogeneous group of homeowners, we aim to gather comprehensive data that reflects a wide range of living conditions and preparedness levels.

Homeowners will be provided with detailed instructions on how to use the tool for the initial assessment, and results on the vulnerabilities and overall risk scores for each home will be gathered. Following this, follow-up meetings will be organised with participants to discuss their overall vulnerability (including infrastructure and social vulnerabilities), gather feedback on the tool and overall user experience, in addition of discussing potential risk reduction measures based on the assessment outcomes. Parallel to the tool testing phase, training program for local volunteers (2-4) on tool usage and extended assessment will be implemented, such as members of forest defence groups.

The homeowner fire safety stream will be also linked to community preparedness initiatives, because enhancing individual homeowner preparedness directly contributes to the overall safety of the community. In addition, the data and insights gathered from the vulnerability tool will play an important role in shaping community preparedness activities.

5.3. Specific strategy for Sweden and the Swedish west coast

Previous studies show that the engagement such as using an app for wildfire protection of properties or even other simple risk mitigating activities in gardens is low in Sweden. Engagement is first triggered when citizens are exposed to high consequences (Eriksson et al. 2023), There might be many years between such events, during which the engagement of property protection from wildfire hazards will decrease in relation to other hazards. However, we feel that there is a need of assuring the applicability of algorithms and the App structure, for use on municipal, fire service or national levels, as well as for it to be readily available should interest arise locally or nationally due to new events or risk levels.. Therefore, FIREPRIME partner leader of the implementation program in Sweden (RISE) will first evaluate two areas using the smartphone app and then present the results to the municipalities and homeowners associations.

The first community to be assessed is Berga, which is outside of the study area further to the East. In a previous DG-ECHO funded project (WUVIEW) the area was thoroughly assessed in terms of garden characteristics, distances between buildings and fuels, building characteristics and materials and with plenty of photos. This makes it a suitable area for RISE to test the app on the 70+ addresses within the community to gain insight on what a characteristic level of risk is in a Swedish semi-rural settlement (Figure 6).

Thereafter, RISE will test the app on a smaller area within the study region to see if results are in line with those in Berga. Since the two areas differ in term of population density, weather patterns and fire service resources, comparing the two areas will test the wider applicability of the algorithms. Results will be

presented to the municipalities and homeowner association in aggregated format with clear examples and guidelines on how to reduce vulnerabilities.

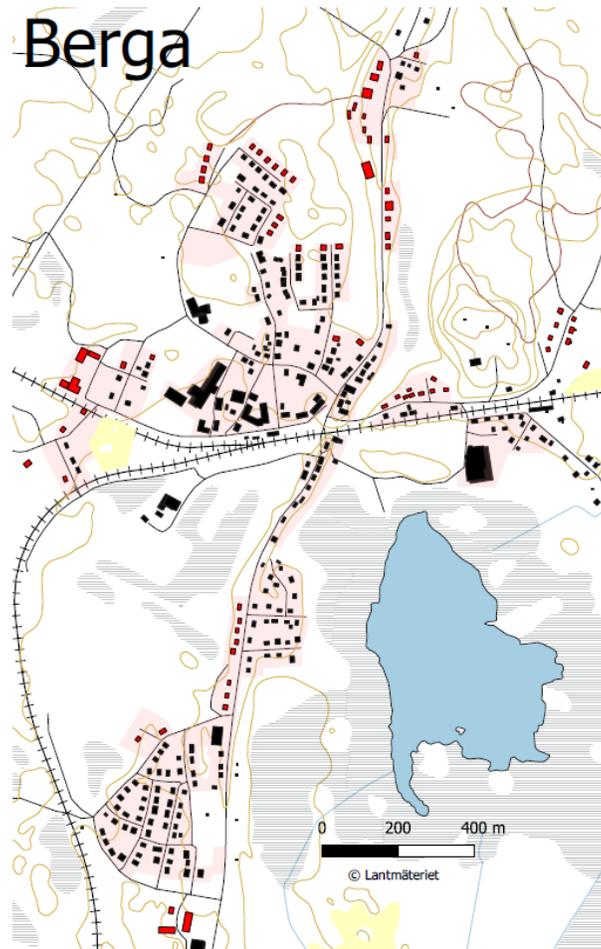


Figure 6. Map of Berga with the properties in the survey marked in red.

5.4. Specific strategy for Tyrol

The pilot study area in Tyrol (municipality of Haiming) is a typical wildland-urban interface area. It is characterised by a variety of building uses including residential, commercial, touristic buildings, industry and typical infrastructure (railway line, road and electricity network, etc.). The area is characterised mainly by residential single-family houses. Nevertheless, the area is also touristic meaning that the population changes throughout the year.

The homeowner safety in this pilot study will mainly focus on the stepwise application of the mobile App:

- Step 1: Feedback on the structure of the App for self-assessment and identification of special local characteristics of buildings that have to be included.
- Step 2: Implementation of the App: the App may be implemented by some of the stakeholders to test its efficiency.

- Step 3: Feedback on the use of the App and recommendations for improvement. Following the implementation of the app feedback from the stakeholders to the partners may be used for the improvement of the App.

This steps will take place in two workshop/meetings with the stakeholders. Additionally communication will be maintained by telephone, email, and video conference. In the first workshop/meeting the FIREPRIME tools will be presented and in the second (following the application by volunteers) feedback will be given and recommendations for improvement and adjustment to the Austrian reality.

Guidelines (e.g. flyers format) and recommendations for the reduction of the vulnerability of buildings may be distributed through the local volunteer fire fighter of the municipality (in connection to the community engagement and education stream).

Special characteristics of buildings may include:

- Wooden features that are common in traditional housing in Tyrol (e.g. balconies, shutters and wall panelling).
- Wooden fences or surrounding walls.
- Roofs that have a relatively large overhang which may trap the flames between roof and the building envelop.
- Large wooden agricultural buildings attached to residential buildings containing combustible materials (wood, animal feed) or expensive machinery.

6. Community engagement and education

6.1. General strategy

FIREPRIME will be implementing various activities under the community engagement and education stream, aimed at raising wildfire risk awareness and empowering communities. In that sense, the primary objectives of this stream are to engage local stakeholders (including residents and authorities) in proactive wildfire management and to develop/adapt and implement community-wide risk assessment protocols, risk awareness and education material and activities.

This community engagement stream will be piloted in the three distinct regions: Collserola, Tyrol, and Göteborg. With a common approach, each pilot will target different groups and employ adapted strategies tailored to the local context. The main groups targeted across these pilots will include local homeowners, youth, children, and other specific groups relevant to each community. Each group will receive specific guides to ensure they are well-prepared to handle wildfire risks effectively. Overall, the idea is to empower these local groups to take a leading role in wildfire management once the project is completed.

The following sections will focus on describing specific target groups and potential activities and approaches to be implemented in each pilot. An added value of the FIREPRIME project, particularly considering future exploitation, is the ability to capture and analyse the similarities and differences in the impacts of these activities across various regions. This comparison will provide valuable insights into the different approaches required for effective wildfire risk community engagement in different EU regions.

6.2. Specific strategy for Collserola

For the community engagement and education stream, the communities with which FIREPRIME consortium will work are “La Floresta” and “Mas Sauró”. In that sense, FIREPRIME will target four main groups:

- Youth: The objective for the youth is to engage with a local scout groups, known for organising community activities. By training these scouts in wildfire risk reduction principles we aim to equip them with the knowledge and skills to lead the FIREPRIME strategy. This ensures they can sustain and promote fire safety efforts in the community even after the project's completion, fostering a culture of preparedness and resilience.
- Children: FIREPRIME will target 8 to 12 year-olds. This will be addressed through non-formal education, involving two key institutions. On one hand, the local scouts group, and on the other, an Open Center for children, which organizes activities during out-of-school hours when schools are closed but parents are still working.
- Homeowners: The community, specifically homeowners, will be engaged through two Preparedness Days organised in 2025. During these events, we will meet to discuss fire safety protocols, conduct community risk assessments, and to develop potential action plans.

FIREPRIME Community engagement and education stream will be developed through the following activities, all summarised in Table 2:

- Training of local scout group: FIREPRIME will empower the youth community to take advantage of the weekly meeting that scouts organise. In that sense, all the activities with the rest of the target groups will be planned and organised together with the scouts. The objective is twofold, to educate youth and to make them the local leaders of wildfire risk reduction. To do that, FIREPRIME will use the educational units and exercises developed under the framework of EduFire project, that tackle topics such as WUI fires, fire ecology or community preparedness among others.
- Community risk assessment: FIREPRIME will perform a simplified community risk analysis inspired by the method developed by Vacca et al. (2023). This analysis will highlight the main weaknesses of the community, giving room for potential risk reduction measures.
- Educational activities: FIREPRIME is going to promote risk awareness among children of the community. To do that, we have engaged with two local key institutions, the local scouts group and the Open Center of Children. The PCF portfolio of educational activities (e.g. MeFitu) will be implemented there (Figure 7). On the other hand, we will leverage regular local events, such as fairs and community meetings, by offering a time slot for the local scouts group to organize a wildfire risk awareness activity for children.
- Two Wildfire Preparedness Days.
 - May 2025: Before summer season, FIREPRIME will introduce to citizens the Smart Phone App and its initial usage. The event will be focused on ignition potential and best practices for preparedness and response in case of wildfire. FIREPRIME will take advantage of an existing local workshop that is organised every May in La Floresta before the fire season.
 - October 2025: After the fire season, there is going to be a follow-up on Smart Phone App (gamification – rewards). The event will be focused on fire prevention and fuel reduction at plot scale, awareness, and useful tips.
- Volunteering activity: FIREPRIME will organise a wildfire risk reduction volunteer activity to promote actions around the centre for people with functional diversity, such as smart gardening and risk awareness actions.



Figure 7. MeFitu activity undertaken by PCF.

Table 2. Summary of the participation of different target groups (rows) and their roles in FIREPRIME activities (columns) in La Floresta community.

	EduFire toolkit	MeFiTu	Community risk assessment	Preparedness day	Volunteering activity
Youth	Participation as a target group	Participation as community leaders		Participation as community leaders	Participation as community leaders
Children		Participation as a target group			Participation as volunteers
Homeowners			Participation as a target group	Participation as a target group	Participation as volunteers

The main steps for the community engagement and education stream in Collserola are as follows:

- Contact local and regional authorities: We will reach out to local and regional authorities to introduce the FIREPRIME project, discuss its objectives, and explore their potential participation.
- Engage target group representatives: We will get in touch with representatives of the different target groups, including homeowners, youth, children, and other specific community members, to understand their needs and perspectives on wildfire risk management.
- Adapt activities to local needs: Based on the feedback and insights gathered from authorities and target group representatives, we will adapt our planned activities to better suit the local context.
- Train local community leaders: Training local community leaders, such as the scouts group, will be key to fostering broader community involvement.

6.3. Specific strategy for Swedish west coast

Our plan is to invite Swedish stakeholders to a workshop during spring 2025 in which we discuss responsibility around settlements and around burning activities. Recent research shows that most buildings burning in Sweden are ignited in small fires that originate from different types of burn activities (grass litter, garden residue or other waste). We want to bring up a few examples for discussion within a workshop which we have identified as typical for fires that threat or ignite the Swedish building stock. Through story-telling and images we will discuss responsibilities and how things could be improved for risk mitigation. The workshop will be held in Swedish for better engagement.

Within the work of WP5, guidelines on how to manage houses and gardens for better passive protection as well as recommendations for safe burning activities will be produced. These will be based on scientific results from the study but presented in an accessible non-scientific jargon. Content will focus on risk assessment, appropriate tools and state of surroundings (gardens) before burning. The guidelines are thereafter intended for distribution by the Swedish Civil Contingencies Agency, from which most municipalities receive their guidelines for recommendations. These guidelines have a higher potential for reach compared to the mobile app since they are more focused on simple rules, reminders of safety during burn activities and reach a broad audience through the authorities. They are to be aligned with and applicable also to the other Nordic countries as well as the Baltic states for a broader base of

dissemination. All these countries have many commonalities in terms of the built environment, climate and vegetation even though Sweden is the most researched country in terms of wildfire hazard.

We are in contact with the fire and rescue service to utilise one of their own community awareness raising events, such as a “touch the truck day”, to spread these short leaflets and other information on burning and homeowner risk mitigation. This will provide us with a wider reach and a stronger momentum for communication compared to an event initiated by the consortium alone.

6.4. Specific strategy for Tyrol

The implementation strategy for the community engagement and education stream will include:

- Demonstration of the App to the members of a local association. The municipality of Haiming in Tyrol has 39 associations (social clubs) with different focus ranging from sports and arts to volunteer groups. The association of the volunteer fire fighters will be one of the groups (68 active members).
- Making of a vulnerability map, based on the App. The App can be implemented for more buildings and the results can be displayed on a map, which will act as a basis for raising awareness and educating the public. We plan to use the App in a newly built residential area west of the trainstation (Ötztal Bahnhof) and apply it to at least 60 buildings.
- Additionally, information material which will be produced within FIREPRIME and may be translated and provided to 1) members of the collaborating association; 2) volunteer fire fighters; and 3) places with vulnerable population (e.g. schools and old people’s homes) (indicatively, the fourth class of the Mittelschule in Haiming has 36 kids).

7. Resilient infrastructures

7.1. General strategy

The resilient infrastructure stream objective is to produce practical guidelines, inspired by materials produced by the reviewed initiatives that can inform and guide private companies and public regulatory programs in reducing wildfire risk to critical infrastructures. Furthermore, contact and specific vulnerability assessments will be initiated with three selected critical infrastructure organisations, one in each pilot site. The objective with these guidelines is to structure them based on end-user needs. The guidelines sections are planned to include:

1. A **wildfire hazard exposure** analysis methodology presentation, based on applicable and state-of-the-art approaches. The analysis will be conducted for each pilot site infrastructure.
2. Information and guides on **fuel-reduction best-practices** methods: focused on how to create defensible space surrounding the assets in question.
3. Summary of **critical vulnerable components**, their common failure modes, and of available **vulnerability analysis and reduction methods**. This part will vary in approach and level of detail for each pilot site infrastructure selected.
4. Monitoring, reviewing, and reporting. This section will share the processes established by reviewed initiatives to **transparently monitor and communicate wildfire risk** for each critical entity.

Section 7.2 outlines how critical infrastructure is defined in FIREPRIME, and introduces the specific pilot sites infrastructures selected. The risk-reduction resources and planned methodologies (wildfire hazard assessment, and fuel-reduction guidelines) are also outlined, as these are common between all pilot sites selected. Sections 7.3 - 7.5 focus on the vulnerability analysis part of the guidelines, which will be more specifically tailored for each pilot site infrastructure; the vulnerability assessment method and material summary is provided and the immediate next action steps for each pilot site are listed.

7.2. Critical infrastructures considered

There is a considerable number of resources concerned with protecting critical infrastructure from natural hazards and climate change impacts, including wildfire hazard (Forzieri et al., 2018; Sfetsos et al., 2021; Wells et al., 2022). The Sendai Framework on Disaster Risk Reduction identifies critical infrastructure resilience as a “key component” of disaster risk reduction, and defines critical infrastructures as “physical structure, facilities [and] networks ... [that provide essential services] to the social and economic functioning of ... society” (United Nations Office for Disaster Risk Reduction, 2020). Based on this definition, and on the infrastructure already impacted by wildfires specifically, FIREPRIME defines critical infrastructure as *the physical structures, and associated networks, with high potential impact on population and environment in case of wildfire damage*.

To further practically define which critical infrastructures FIREPRIME considers, three general critical infrastructure classes are identified which are deemed as most urgently vulnerable to wildfire hazard: the Chemical Industry, Utilities Providers, and Public Infrastructure. More specific examples of related industries that fall within each category are identified and summarised in (Figure 8).

The chemical industry category, for example, includes water supply networks, which have been notoriously impacted by post-wildfire run-off contaminants, and Seveso plants which involve dangerous substances which have high potential impact in case of ignition. Stakeholder interviews indicated a particular concern can be chemical plants involving hazardous substances just below Seveso threshold

limits; these industries are not required to follow the strict safety requirements imposed by the Seveso directive, but still involve high-risk process equipment and substances. Utilities providers are known to be impacted by wildfires and can cause wide-reaching impact and disruption if their operation is impeded. Public infrastructure is defined as structures most involved and used by the population, often especially the vulnerable population. The infrastructures listed as examples of public infrastructure include schools, hospitals, and touristic infrastructure that is most concerned with the safe evacuation or sheltering of vulnerable population, and transport infrastructure that is used daily for various societal needs.

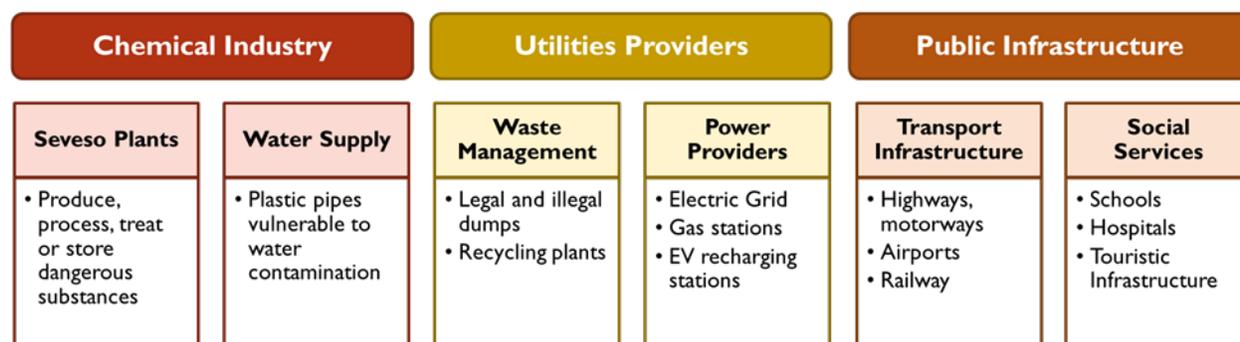


Figure 8. Classification used in FIREPRIME for Critical Infrastructure with general infrastructure classes, and specific industry examples, of infrastructure urgently vulnerable to wildfire damage.

Examination of the critical infrastructure organisations present in each pilot site, and historical wildfire accidents involving critical infrastructure, lead to the selection of one infrastructure type from each general category. The final selected infrastructures are listed in Table 3. Note that, due to the UPC research team’s interest and experience related to the chemical industry wildfire risk quantification, an industrial site located close to the Collserola pilot location was chosen for the Spanish pilot site infrastructure. The SVC Chemical Storage installation selected located and operating in Barcelona province, and provides interesting opportunities for wildfire risk reduction investigations.

Table 3. List of infrastructure organisations selected in each pilot site, and their related general infrastructure class

	Chemical Industry – Seveso Plants	Public Infrastructure - Transport	Utility Providers – Electricity provider
<i>Type infrastructure</i>	Storage, control and supply of chemical and pharmaceutical products.	Train Railway Network	Electrical substation: a 380-kV switching station and a 220-kV switching station.
<i>Company / Stakeholders</i>	SVC Chemical Storage Services	Swedish Transport Authority (Trafikverket)	Austrian Power Grid (APG)
<i>Location</i>	Sant Vicenç de Castellet, Bages (Barcelona)	Sweden	Wiesrainstraße 22. 6430 Haiming, Austria
<i>Spatial Scale of Analysis</i>	Local – close surroundings and specific critical components	National	Local – regional wildfire hazard, and general vulnerability – reduction methods.

7.3. Wildfire risk-reduction guidelines plan

As outlined above, three specific guidelines for wildfire risk assessment and reduction will be produced, one for each infrastructure selected. The content will be inspired by the material and information produced by the three American programs reviewed; summarised in section 3.3. Guidelines will include the most relevant and applicable methodologies and resources for the selected European infrastructures and will specifically include information on the following topics:

- Wildfire Hazard Assessment.
- Fuel-reduction Information and Guidance.
- Vulnerability Assessment of Specific components.
- Monitoring, Reviewing, and Reporting.
- Identified Gaps and Future Needs.

Below we briefly summarise the current plan and approach for each guideline section. The wildfire hazard assessment method, and the fuel-reduction guidelines are common for all pilot sites infrastructures; alternatively, the vulnerability assessment section will be industry-specific and vary between each pilot site.

7.3.1. Wildfire hazard assessment

According to state-of-the-art wildfire risk assessment methods, predictive wildfire spread simulation programs (e.g.: FlamMap, Burn-p3, BurnPro, Landis) are the most applicable and effective characterisation tools to quantify wildfire hazard (Scott et al., 2013; Severino et al., 2024). These softwares can include various empirical fire spread models, that make assumptions on wildfire behaviour based on field and experimental research findings, and are used to calculate fire spread for the input data (local topography, land cover, and climatic data).

The most commonly used, open-source, program in the wildfire hazard response and reduction field, FlamMap (ver 6.2) is selected as the tool to be presented and potentially applied for the wildfire hazard characterisation (Finney, 2006). FlamMap outputs possible wildfire spread perimeters and related fire intensity parameters, including: fireline intensity, flame length, rate of spread and heat per unit area, as well as the burn probability of a wildfire reaching a given map pixel. These output parameters allow quantification of possible wildfire exposure. Conservative wind and temperature scenarios will be inputted to comment on the wildfire risk on the selected infrastructures. The immediate next action steps for this section are given below:

- Collect relevant input data for each pilot site (fuel maps, wind/climate data, topography).
- Run simulations to investigate: most vulnerable regions, most hazardous wind scenarios, possible areas in need of fuel-reduction

7.3.2. Fuel-reduction guidance

Strategic fuel reduction around assets is an established and effective wildfire risk-reduction measure; also referred to as creating defensible space. This measure protects assets from possible flame exposure from the wildfire front, although it does not address firebrand exposure hazard. Related resources from both the Canadian FireSmart *Guidelines for the Oil and Gas Industry*, and the California Utility Wildfire Mitigation Program include guidance on creating defensible space that is applicable for critical

infrastructure. The FireSmart Guidelines focus on outlining how defensible space fuel-reduction zones around industrial buildings can be created. Information on vegetation clearance around power lines and power poles is additionally available through the Californian Resources. Relevant defensible space information will be summarised in this section of the guideline, providing appropriate references to more resources; this section is envisioned to be applicable to various industrial buildings and assets, across the different categories. Guidelines will include explanation regarding which wildfire exposure threats this risk-reduction addresses and limitations. The reviewed guidelines also involve guidance on how to conduct this fuel-reduction to limit further ignitions; this is identified to be of particular importance in the Swedish pilot site so related information will be provided in the railway guidelines.

7.3.3. Vulnerability assessment

The guidelines section regarding specific components' vulnerabilities, related vulnerability assessments, and vulnerability-reduction methods is the most technically-specific portion of the guidelines and will therefore vary between each industry most significantly. The overall objective is to provide useful and vetted technical and operational resources that organisations in Europe can leverage to start their infrastructure vulnerability reduction process. This will inform the closing guidelines section on identified gaps and research needs. Below more information on the vulnerability assessments planned for each pilot site, and associated needed data are outlined.

Chemical Storage Company - Catalonia

Through previous research work, UPC has identified critical chemical industry components specifically vulnerable to wildfire: pipelines and storage tanks. An event tree analysis will be conducted for these two general types of components to specify damage pathways due to wildfire for each.

Already established wildfire hazard quantitative estimation tools will be applied for a worst-case wildfire exposure scenario on the specific layout of the SVC Chemical Storage installation from the Spanish pilot site. Vulnerable equipment will be identified and risk mitigation actions proposed.

The next immediate action steps and required data to conduct this analysis are:

- Contact chemical plant officials to interview regarding specific wildfire safety concerns, and retrieve information about risk management planning and specific critical components in question.
- Create event trees for pipeline and storage tank components, outlining damage pathways from wildfire exposure to these critical components.
- Provide guidelines on how to mitigate wildfire risk.

Rail Network - Swedish west coast

A summary of the activities and climatic conditions associated with wildfire damage and ignition to and by rail networks will be summarised in the guidelines. Specific identified railway vulnerable components and damage pathways are summarised from literature.

RISE has collected all the relevant data for the hazard and vulnerability analysis: a map of historical wildfire ignitions related to the rail network in Sweden, and national fuel maps (Figure 9).

The next immediate action steps and required data to conduct this analysis are:

- Summarise known railway vulnerabilities and railway activities that have been related to igniting wildfires.
- Review railway-related ignition data and fuel maps, to conduct statistical analysis finding correlation between data.
- Retrieve any other necessary data to run FlamMap simulations for Sweden and relate outputs to ignition data findings.
- Review documents from the Swedish Transport Authority that apply to risk mitigation along tracks.
- Generate guidelines on how to reduce wildfire risk adapted to FIREPRIME stakeholders.

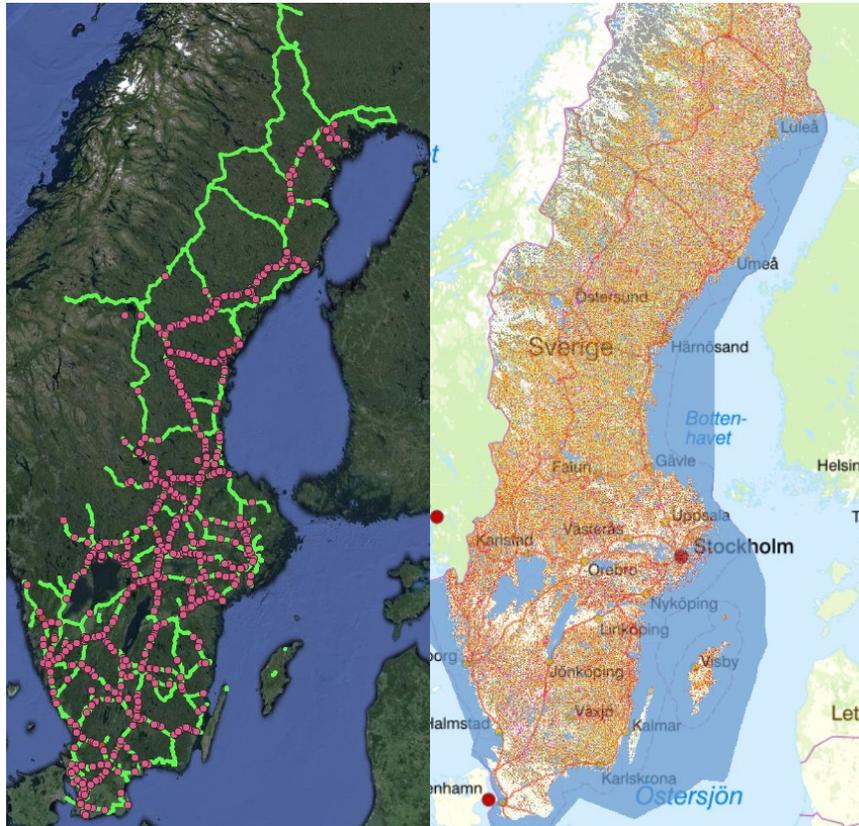


Figure 9. Left – Railroad system (green lines) with last ignitions during last 25 years (red dots). Right – Fuel map of Sweden (10 x 10 m resolution) (MSB 2024).

Electrical Substation - Tyrol

The focus here is the West Tyrol substation, which feeds into the Tyrolean distribution grid via grid coupling transformers. The substation receives energy from two other power plants and is connected to Germany and Switzerland.

Given the severe wildfire impact created by electrical providers in the USA, and related legal actions, there is a very large amount of technical research, often funded and developed by utility companies themselves, related to how to increase grid resilience and reduce vulnerability (Arab et al., 2021). The vulnerability assessment section for this guideline, therefore, will focus on summarising already known and research wildfire-caused damage to the electrical grid components.

The next immediate action steps and required data to conduct this analysis are:

- Summarise already documented common causes of wildfire ignition and damage to electrical infrastructure.
- Contact relevant substation officers to propose our guideline plans to check if any additional vulnerabilities or end-user questions should be considered.

As far as the second point is concerned, there will be two rounds of interviews with the contact person (which has been already identified). The interview will be structured as follows:

1st Interview:

- Existing wildfire security plans and guidelines or security measures.
- Feedback on vulnerable elements and characteristics of the plant that need to be considered in the guideline.
 - Which elements need to be intact to ensure continuity of service?
 - How can they be affected by fire?
- Special discussion on cascading effects in the event of a wildfire impact on the plant.
 - How important is the continuous operation of the plan locally, regionally, nationally and at the European level?
 - Which countries and Austrian regions are dependent on it?

2nd Interview:

- Feedback on FIREPRIME guideline and proposal of changes and additions.

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