



# CAPTOR

## Collective Awareness Platform for Tropospheric Ozone Pollution

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## List of Abbreviations

<b>AP</b>	Access Point
<b>APP</b>	Application
<b>AT</b>	Austria
<b>CAP</b>	Collective Awareness Platform
<b>CPE</b>	Customers Premises Equipment
<b>DiY</b>	Do It Yourself
<b>DSL</b>	Digital Subscriber Line
<b>ES</b>	Spain
<b>ISDN</b>	Integrated Services Digital Network
<b>IT</b>	Italy
<b>SSID</b>	Service Set Identifier
<b>WISP</b>	Wireless Internet Service Provider

## Executive Summary

### Description of the work

Users in the CAPTOR project will use a set of software tools developed during the first phase of the project. Examples are a collaborative learning platform if they want to interact and promote events, or the deployment of a new node following the Do It Yourself (DIY) philosophy among others. This deliverable describes the user requirements for software tools of the CAPTOR project.

### Objectives

The main objectives of the deliverable are:

- Description of the process of acquiring user requirements.
- Description of the user requirements

## 1. Introduction

This document describes the user requirements for the systems used in the CAPTOR project. The document is focused on “what” the system should do, and not on specific design solutions.

The CAPTOR platform integrates the following systems:

- A network of Do It Yourself (DIY) monitoring nodes,
- An open data repository to share the collected data,
- A mobile app used as tool to translate the data resulting from the citizen science instantiations as well as other publicly available data. The app also calls to action to denounce exceedances of concentrations.
- A collaborative learning platform to promote discussion and debates on actions and best practises.
- A webpage that will be used as a dissemination and communication tool.

As the open data repository is accessed by the users only through the application or collaborative learning platform we do not have included it in this document.

## 2. User requirement specification process

### 2.1 Users involved in the process

We have involved the following user collectives in the specification of user requirements:

User collective	No.	Systems	Main issues	Date of meeting	Site
Plataforma per la Qualitat de l'Aire	3.5, 8	<ul style="list-style-type: none"> <li>• Collective learning platform</li> <li>• Mobile app</li> </ul>	Usability	28/01/2016 29/01/2016 08/02/2016 21/03/2016	ES
Ecologistes en Acció Volunteers	7	<ul style="list-style-type: none"> <li>• Collective learning platform</li> <li>• Mobile app</li> </ul>	Usability	04/02/2016	ES
ESAIRE workshop participants	23	<ul style="list-style-type: none"> <li>• Collective learning platform</li> <li>• Mobile app</li> </ul>	Usability	18/02/2016	ES

Legambiente volunteers	6	<ul style="list-style-type: none"> <li>• Collective learning platform</li> <li>• Mobile app</li> <li>• Website</li> </ul>	Usability	30/03/2016	IT
GLOBAL 2000 staff: digital communicator, volunteers coordinator	2	<ul style="list-style-type: none"> <li>• Collective learning platform</li> <li>• Mobile app</li> <li>• Website</li> </ul>	Usability	30/03/2016	AT
Volunteers hosting monitoring nodes	20	Monitoring nodes	<ul style="list-style-type: none"> <li>• Installation</li> <li>• Maintenance</li> </ul>	From 20/06/2016 to 08/07/2016	ES
Air quality agency of Catalonia	1	Monitoring nodes	<ul style="list-style-type: none"> <li>• Installation</li> <li>• Maintenance</li> </ul>	27/04/2016	ES
Air quality agency of Austria	1	Monitoring nodes	<ul style="list-style-type: none"> <li>• Installation</li> <li>• Maintenance</li> </ul>	18/03/2016	AT

Tabla 1. User collectives involved in the process.

## 2.2 User requirement specification procedure

### 2.2.1 Mockups

In order to facilitate the participation of the users in the specification process, we have prepared three mockups with initial base designs for the website, mobile app and collective learning platform. A description of these mockups can be found in the appendix of the document.

### 2.2.2 Meetings with users and questionnaires

In order to serve as a guideline with discussions with users, we have used a questionnaire for the presentation of the prototypes (mockups). The use of scenarios will provide an idea which users access our online portals with what kind of information needs.

1. Introduction of CAPTOR mockups	
Scenario 1: Volunteer who is interested in participating as a host of a sensor or data collector	<p>Imagine you are a citizen from Veneto region. You read about the CAPTOR project in the local newspaper and you are interested to participate. In this case, you could go to the local CAPTOR community platform and obtain information.</p> <p>Now, the volunteer can talk with participants with the same this scenario and through the local CAP from Italy. Show him where he would find all the information about how to participate, the benefits and outcomes from this participation, the connection to other Italian sites and the connection to the wider CAPTOR network (main website).</p>
Scenario 2: Volunteer	Imagine you are a citizen from Lombardy and your daughter told you

<p>who is interested in being informed about daily Ozone pollution data and wants to follow discussions or get updates from the project</p>	<p>that she learned about the CAPTOR project in school. Now you want to download the Captor APP to be regularly informed about Ozone pollution in your region and to participate in ongoing discussion around that. In this case you could download the CAPTOR APP.</p> <p>Now, the volunteer can talk with participants with the same scenario and through the prototype of the CAPTOR App. Which information could she find in the App? What could she do in the App? How could she stay updated?</p>
<p>Scenario 3: Local political stakeholder wants to get an idea about the discussions of citizens and how to react on that.</p>	<p>Imagine you are a local political decision maker and hear about the CAPTOR activities and a growing number of involved citizens in your region who worry about the Ozone pollution. You want to get more information about CAPTOR, the ongoing discussions and solutions that are discussed. In this case you could go to the local CAPTOR community platform and the general CAPTOR website.</p> <p>Now, the local political stakeholder can talk with participants in the local CAPTOR community platform and the general website. What would he/she find here?</p>
<b>2. Questions after the introduction of CAPTOR prototypes</b>	
a) What do you like about planned CAPTOR online activities that were just presented to you?	
b) What did you not like and do you have suggestions on how to improve this?	
c) What do you think are the most important questions that we should answer for volunteers on our website, local platforms and the APP?	
d) Which features do you think are most important for volunteers?	
e) What could we do to motivate their active participation?	
f) Do you think we should offer different content for different target groups (e.g. schools)? All in local language?	
g) What do you think are the most important questions that we should answer for political decision makers on our website, local community platforms and the APP?	
h) Which features do you think are most important for political decision makers?	
i) What could we do to motivate their active participation?	

Tabla 2. Questionnaire used during meetings with volunteers.

### 3. Results

This table summarizes the comments and recommendations given for the three systems and by the different collective of users.

Website	
Users in Italy	<ul style="list-style-type: none"> <li>• Website is the main tool to have information. Therefore, users can access the platform only from the website. There is no need to a facebook page, since a website link could be shared with facebook profiles in post ad hoc.</li> <li>• We think that a similar design and graphic for the website and the platform could facilitate user's understanding. Platform should be integrated in website.</li> <li>• It could be useful to invest some resources to allow the website to emerge on the top of the searching page (e.g. google) if users research "ozone" or</li> </ul>



	<p>similar.</p> <ul style="list-style-type: none"> <li>• Clarify and decide the output of data (e.g. statistic, last year data, period, download data, etc).</li> <li>• The mainpage should be very simple and able for catching attention. First 15 or 20 minutes should attract the user. Maybe link a short video that explains visually the project and the ozone problems.</li> <li>• Website should be a showcase or a window for the potentiality of the project, focus on other local situation, a call for other partners and other stakeholders. Also for other countries, university, etc.</li> </ul>
Users in Austria	<ul style="list-style-type: none"> <li>• Button “join” makes no sense, as you cannot really be active on the general website, should be replaced by “background information”.</li> <li>• Button “events” should only show events important for the project, no local events.</li> <li>• Website is a must, it is enough to give general info on the project, as the activity parts go to APP.</li> </ul>
<b>Collective Learning platform</b>	
Users in Spain	<ul style="list-style-type: none"> <li>• The platform should include the following functionalities: <ul style="list-style-type: none"> <li>✓ Publish and consult classified information (entities, groups, resources, documentaries, etc).</li> <li>✓ Create and subscribe actions/activities (participate in projects, signups in events, etc).</li> <li>✓ Generate request (e.g. change.org).</li> <li>✓ Download apps.</li> <li>✓ Create and participate in discussion groups, to share experiences.</li> <li>✓ Create and participate in forums.</li> </ul> </li> <li>• User profiles should include basic personal data (email, topics of interest, etc).</li> <li>• We should differentiate between “histories” and “experiences”</li> <li>• Regarding “histories”: <ul style="list-style-type: none"> <li>✓ Include options for adding new users to the platform, together with links participation forms.</li> <li>✓ Designate a person or committee in charge to review and accept proposals.</li> <li>✓ Introduce guidelines for accepting histories.</li> <li>✓ Short description on how to include new histories.</li> <li>✓ When the history is uploaded send and automatic message to user.</li> <li>✓ Improve the picture.</li> <li>✓ Map with history location?</li> </ul> </li> </ul>
Users in Italy	<ul style="list-style-type: none"> <li>• In the platform, it will be useful insert a button to “back to the website”, “go to Spain platform” and “go to Austria platform”.</li> <li>• In the main page of the platform, there would be a short and synthetic description about what's the platform, what can do the user if he/she proceeds with registration, or what can the user find on the platform.</li> </ul>
Users in Austria	<ul style="list-style-type: none"> <li>• Visibility of the collected data is not so important, at the beginning there are only few data, so this might be counterproductive.</li> <li>• There should be buttons for “results”, “background information” on ozone, “join” .</li> </ul>

	<ul style="list-style-type: none"> <li>• Discussions: here we should find experts to make discussions interesting.</li> <li>• The button “Posts“ on CAP is strongly questioned, as Posts is mostly related to social media (facebook etc.), should be replaced by News.</li> <li>• What are User Stories? What is that? What for? Can people write their stories?</li> <li>• The difference between Posts and News should be clarified. Events could be announced in “News“.</li> <li>• Should it really be translated into all languages?</li> </ul>
Air Quality agency of Austria	<ul style="list-style-type: none"> <li>• It is important to have experts on board to give input for discussion. It is hard for people to understand data on ozone, they like simple information, so she is in favor of the traffic lights system, but if someone wants more in-depth information that should be accessible through the APP or CAP.</li> <li>• Problem: taking measures against ozone pollution do not succeed in the places where ozone is produced. There are ozone concentrations outside towns. If people who live there change their behavior, e.g. use public transport, there will probably still be the same ozone concentration as it is produced in cities with traffic).</li> <li>• This is a general problem in this project, connected to the question: where are the solutions? (see above APP).</li> </ul>
<b>Mobile app</b>	
Users in Spain	
Users in Italy	<ul style="list-style-type: none"> <li>• It's useful if on website and platform both there's the APP advertising, the existence of the APP should be highlighted.</li> <li>• APP should be free (without registration necessary).</li> <li>• in the home page of APP should be button to choice “go to the map”, “go to the close to you station”, etc.</li> </ul>
Users in Austria	<ul style="list-style-type: none"> <li>• There should be a button “join“ to motivate people to become active.</li> <li>• Question: in which way are the data represented? Do we see all data collected or only the daily data?</li> <li>• Visibility of the collected data is very important!</li> <li>• The system of the traffic light should be explained, as there is no information about it, is very unclear.</li> <li>• Wish of the users: you click on the map and get to “your“ station (we think this is planned anyway)</li> <li>• The App tool should be implemented in the CAP.</li> <li>• Question: what do people do, when they see a red traffic light in their town/village? Where are the solutions? The solutions should be represented, at least discussed (which we know is very difficult).</li> <li>• APP and Collective Learning Platform should be strongly interconnected, the buttons results, join and background info are considered very important.</li> </ul>
Air Quality agency of Austria	<ul style="list-style-type: none"> <li>• If there is a different ozone measurement from Captor nodes to “environmental agency nodes“, people might jump to the conclusion, there is a mistake in measuring, although it probably has different causes. This should also be communicated in the CAP.</li> </ul>
Air quality agency	<ul style="list-style-type: none"> <li>• Avoid including discrepant measurement values for reference stations and</li> </ul>

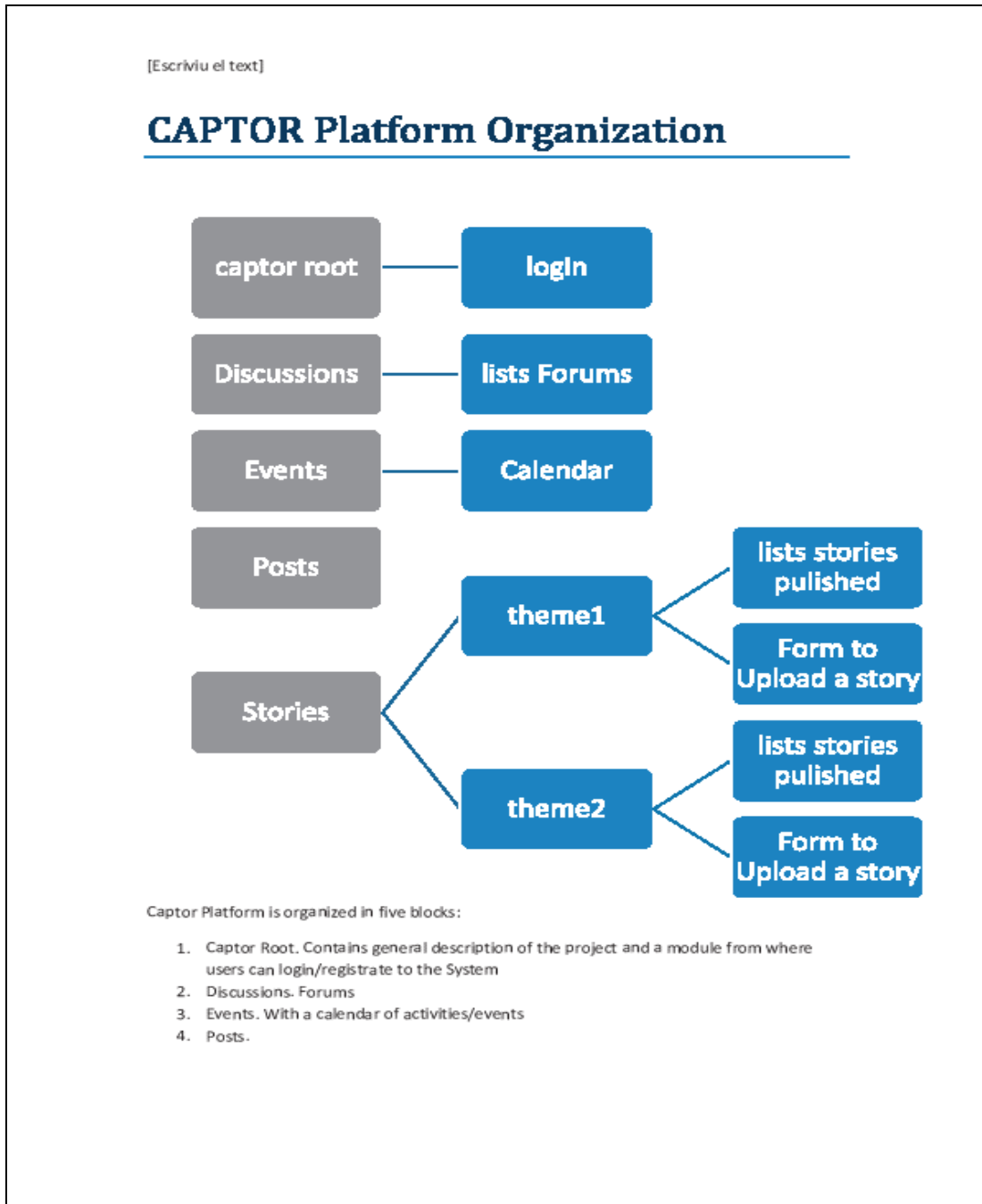
of Catalonia	<p>CAPTOR nodes.</p> <ul style="list-style-type: none"> <li>Clearly indicate that CAPTOR nodes have less accuracy than reference stations.</li> </ul>
<b>Captor nodes</b>	
Volunteers in Spain	<ul style="list-style-type: none"> <li>Most likely, a Guifi.net user will have a wireless AP router to get WiFi coverage for mobile devices (smartphones, laptops, tablets, etc.), like the DSL, ISDN or fiber connection customers of traditional ISPs have.</li> </ul>
Air quality agency of Catalonia	<ul style="list-style-type: none"> <li>Electric power provided by the reference station.</li> <li>Nodes cannot use the reference station WiFi network.</li> </ul>
<b>Other</b>	
Users in Italy	<ul style="list-style-type: none"> <li>Twitter: CAPTOR there will be difference between italian or spanish or austrian? who replies? Who is the responsible of twitter profile and answer? There will be a tweet box on the main page of website?</li> </ul>

Tabla 3. Comments and recommendations given by users for the three systems.

## 4. Conclusions

CAPTOR has finished a first phase of user requirement collection. These user requirements will be incorporated as input into the design phase of the different systems (website, mobile APP, CAPTOR nodes and Collective Learning Platform). These systems should be operative for starting the first monitoring campaign and preliminary versions will be used during the presentation and engagement activities with volunteers.

Appendix I: Collective Learning platform mockup



[Escribiu el text]

5. Stories. Where captor Organization propose topics/themes/ to think about and users can Upload to the System their experiences, actions, opinion related to the topic... and share them and rate them

Figure 1. Captor Platform Organization (CAP)

[Escribiu el text]

# CAPTOR

COLLECTIVE AWARENESS PLATFORM  
FOR TROPOSPHERIC OZONE POLLUTION





## STORIES



Figure 2. Captor Collective Awareness Platform (CAP) design

[Escribiu el text]



**SHARE IT**

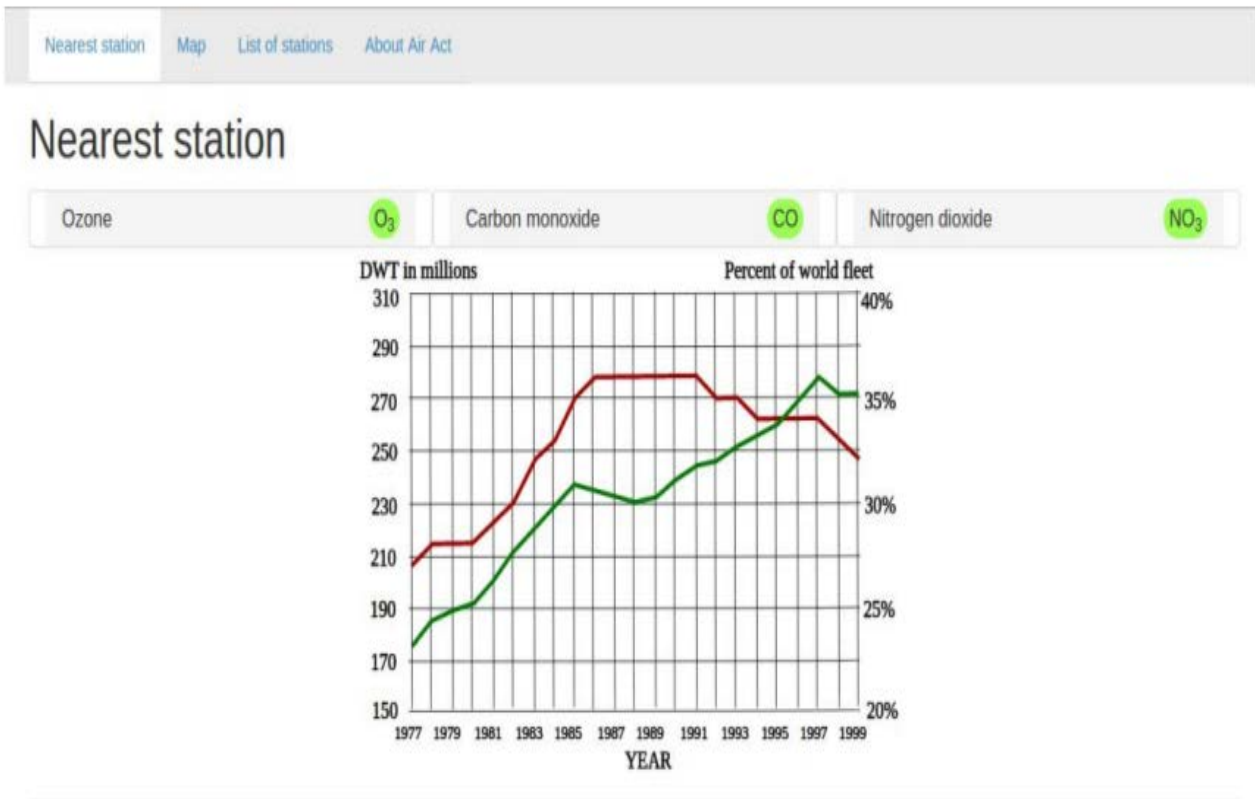
**UPLOAD YOUR STORY**

**Story List**

- 1. Title: Sharing car with neighbours**
  - Image/video**
  - Text....**
  - Contact**
  - Rate**
  - Share**
- 2. Title: App car sharing**
  - Image/video**
  - Text....**
  - Contact**
  - Rating**
  - Rate**
  - Share**

Figure 3. Story List (CAP)

Appendix II: Mobile App mockup



English | Español | Català | Italiano | Deutsch

Figure 4. AirAct design (I)





## Nearest station

- Ozone O<sub>3</sub>
- Carbon monoxide CO
- Nitrogen dioxide NO<sub>2</sub>



English | Español | Català | Italiano | Deutsch

Figure 5. AirAct design (II)



Figure 6. AirAct design (III)



## About Air Act

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consectetur dolore in Ut Ut aliqua deserunt consectetur minim dolore  
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sit reprehenderit dolore elit elit cupidatat sunt voluptate et deserunt  
fugiat.



[English](#) | [Español](#) | [Català](#) | [Italiano](#) | [Deutsch](#)

Figure 7. AirAct design (IV)

## Appendix III: Website mockup

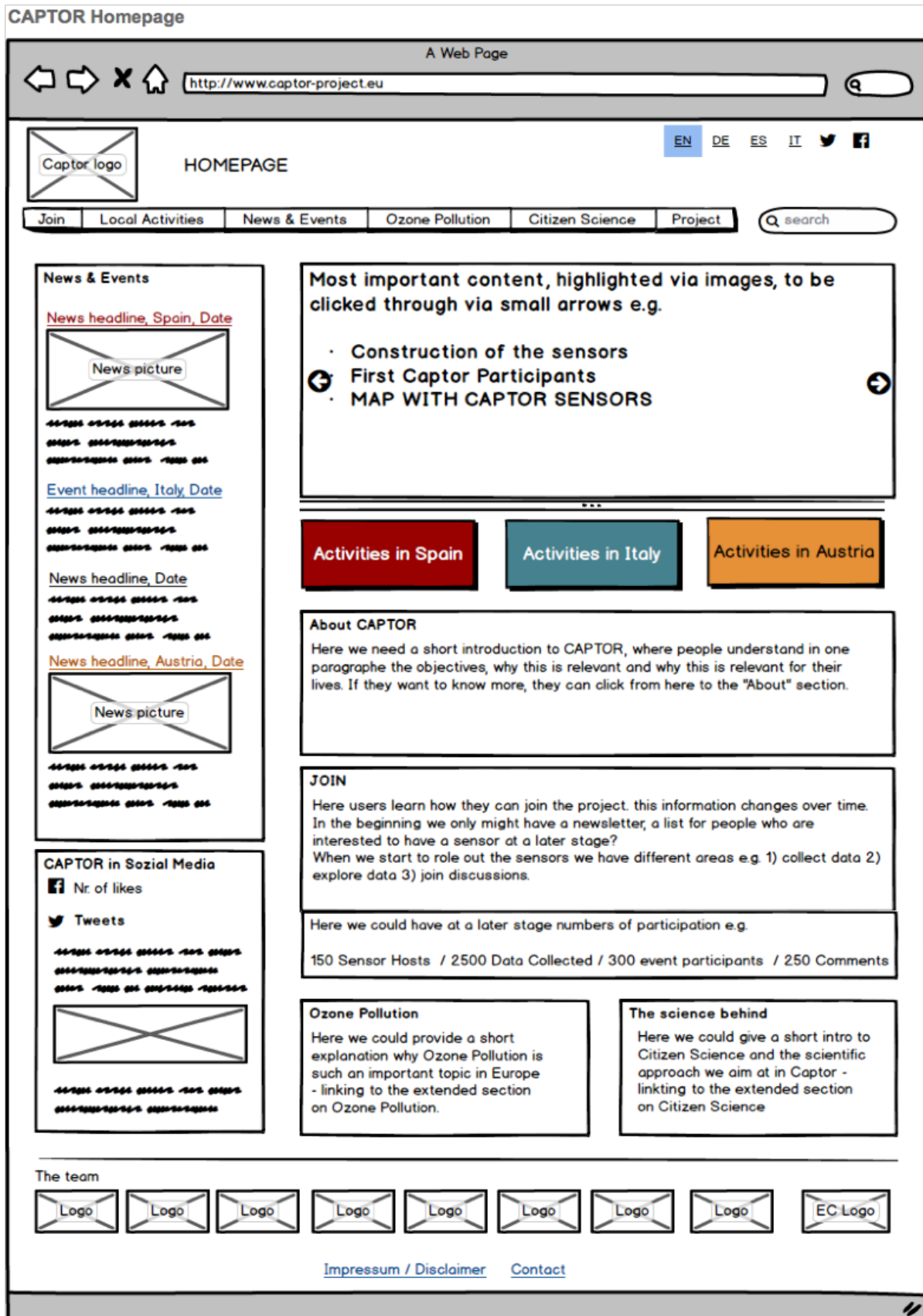


Figure 8. Website design (I)

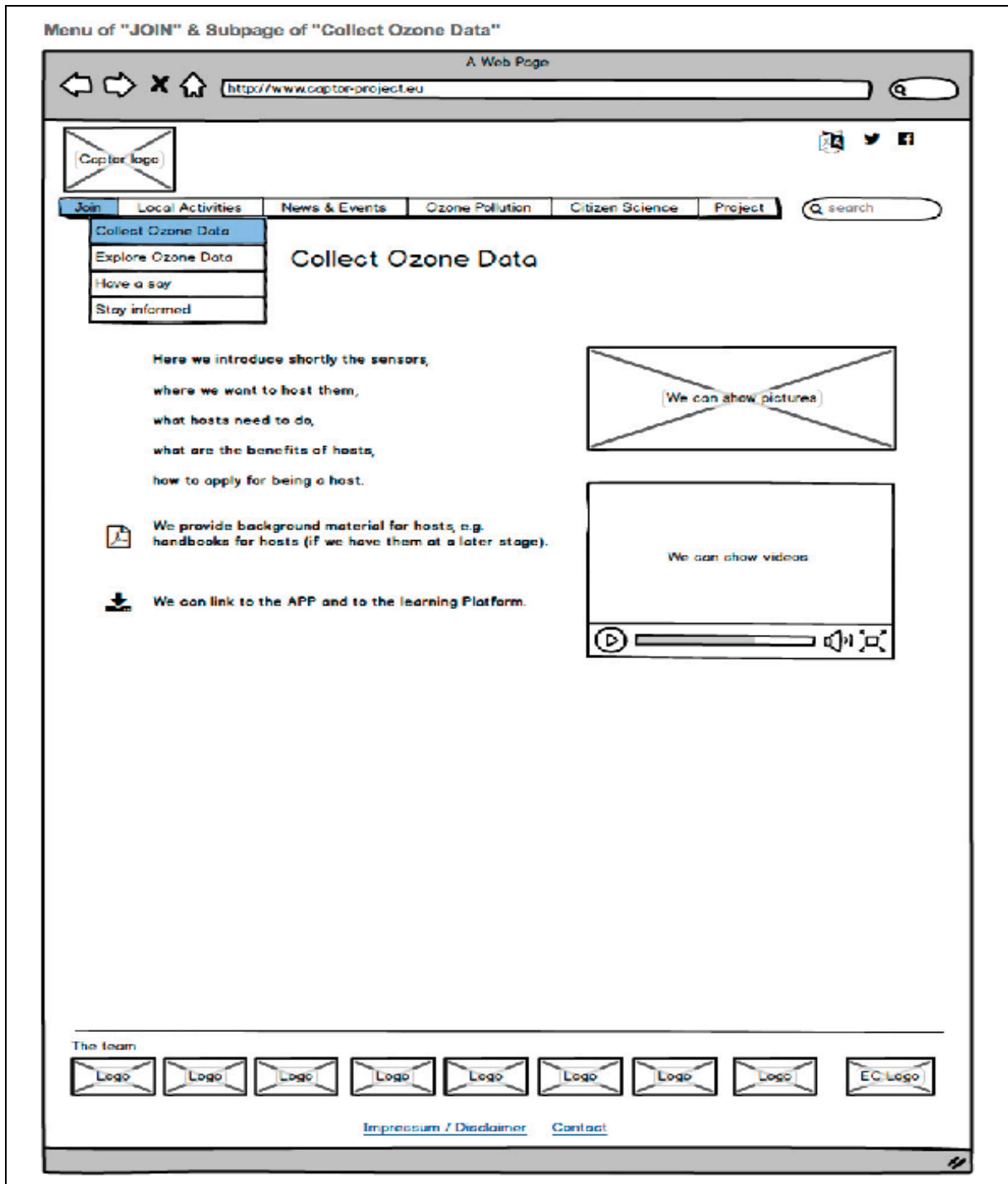


Figure 9. Website design (II)

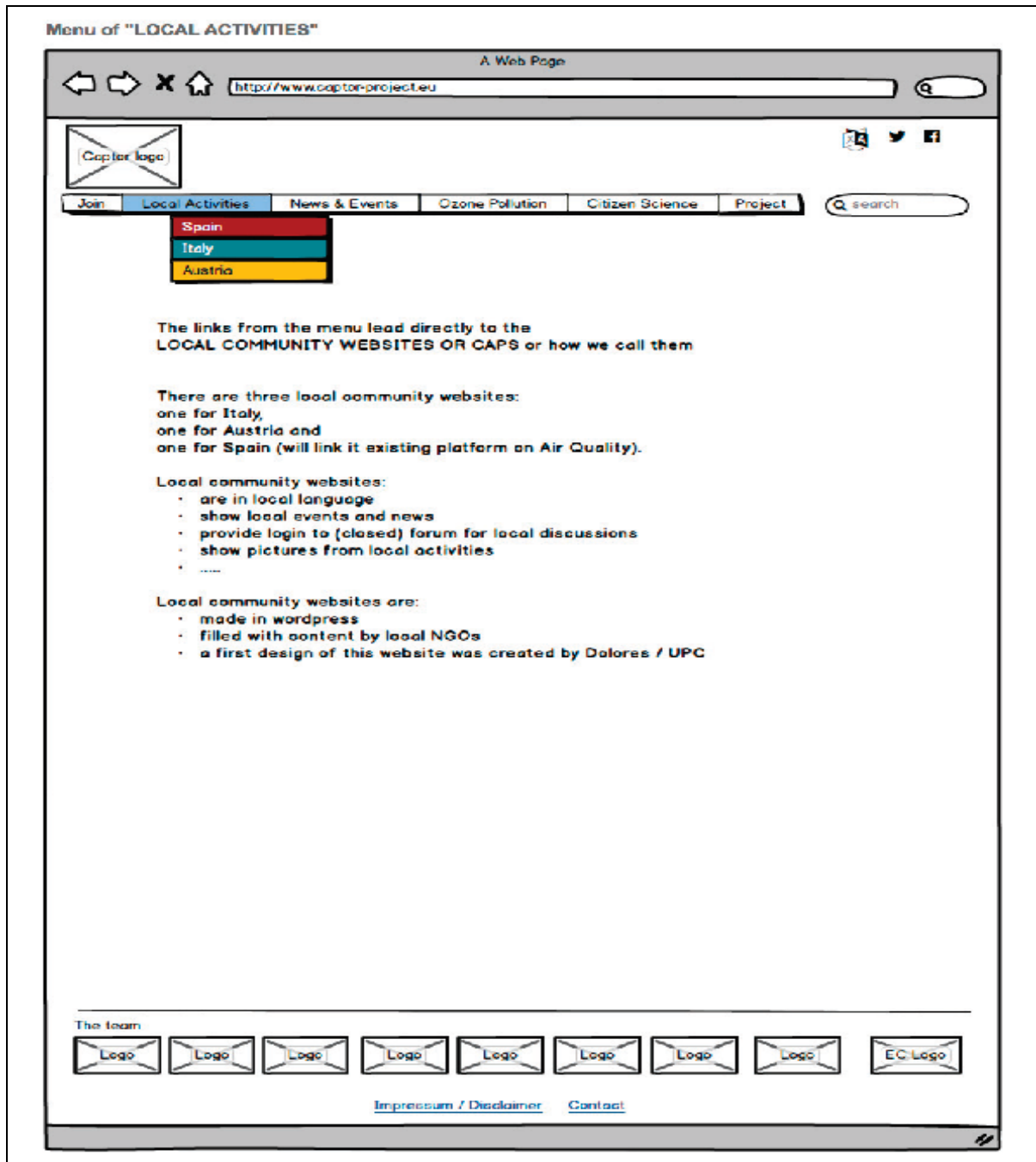


Figure 10. Website design (III)

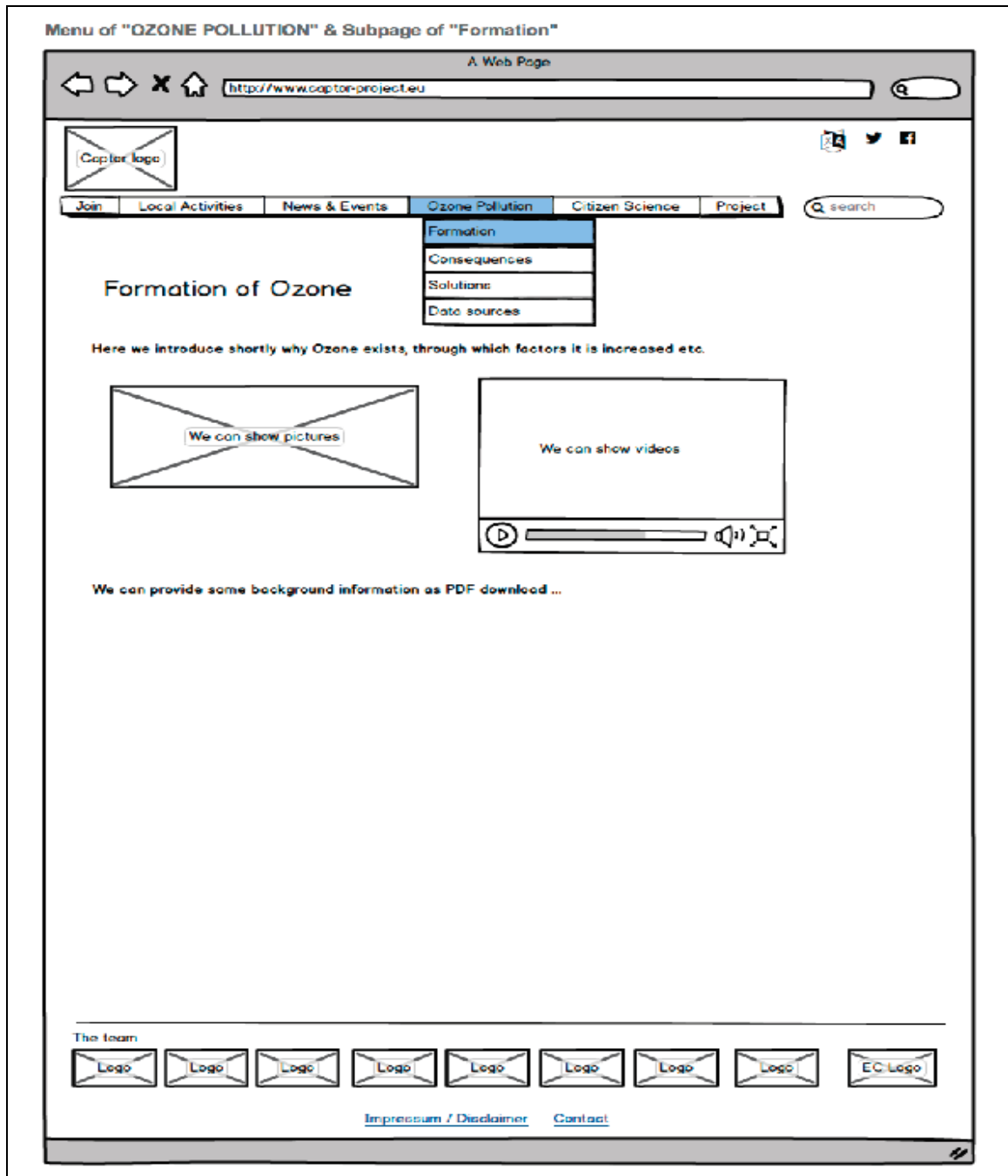


Figure 11. Website design (IV)

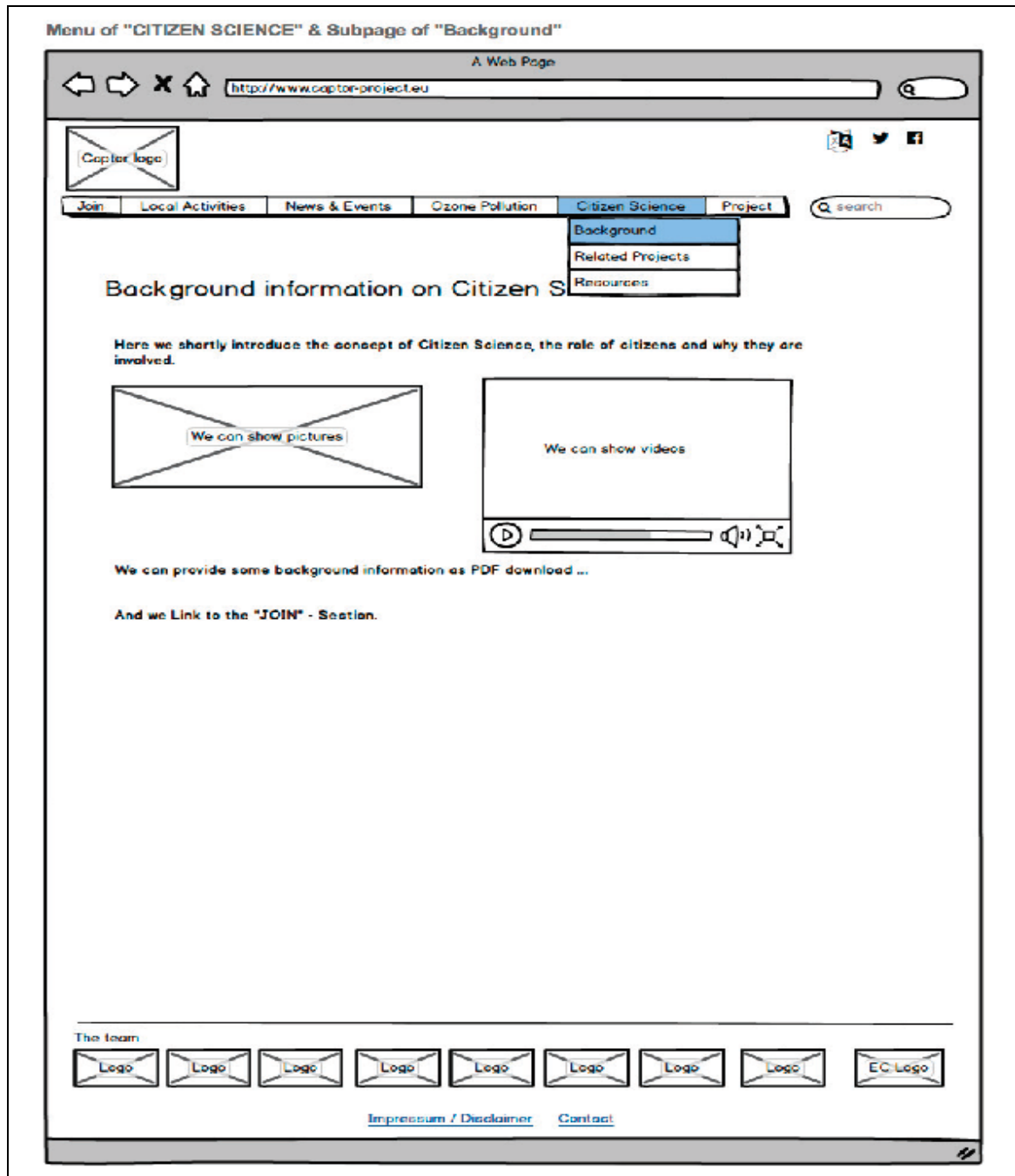


Figure 12. Website design (V)



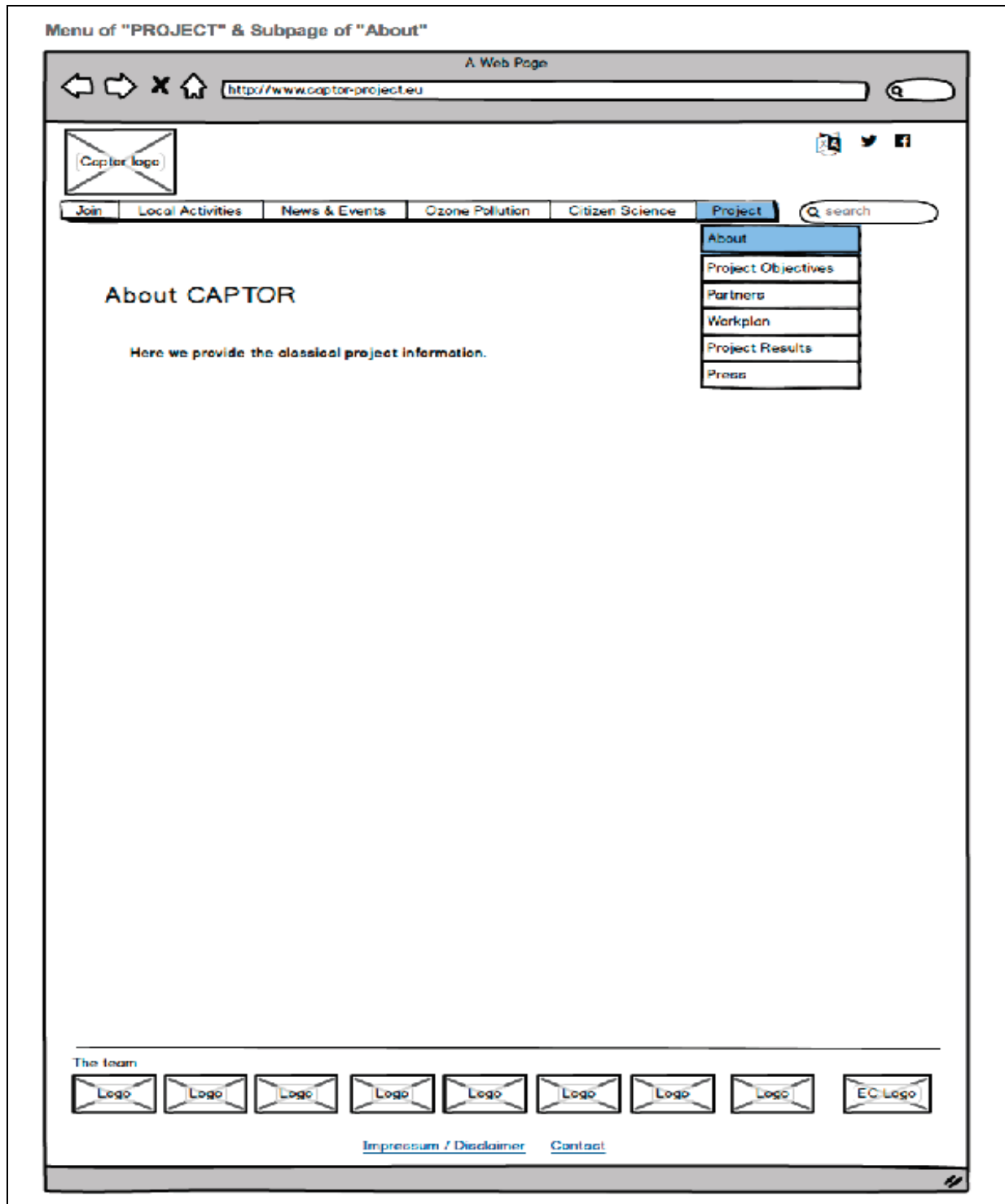


Figure 13. Website design (VI)

## Appendix IV: Guifi network

### On connecting CAPTOR/RAPTOR devices to domestic networks in the Guifi.net environment

Guifi.net is a telecommunications network where individuals, organizations, enterprises, administrations, etc. can join by investing, deploying, maintaining and using the infrastructure, as stated in the Free, Open and Neutral Network Compact, the regulation for this which regulates the participation in the network and the community. Guifi.net originated in Gurb (Osona, Catalunya) in the early 2000s and rapidly grew to cover large areas of Catalunya, as other preexisting community networks joined in. Currently, it accounts more than 34.000 active nodes (i.e. geographical locations with network hardware).

From the technical point of view, Guifi.net is an IP network -like the Internet- built mostly with IEEE 802.11 wireless links and, since 2010, with fiber optics links for both the core of the network (the trunk) and the end users locations (the access network). The Guifi.net network -especially its part built on WiFi technology- should not be seen as a HotSpot where to connect end user devices (like a café or a library offering a free WiFi connection), but as a network between houses and buildings (i.e. a rooftop-to-rooftop network) that interconnect to another village or town, etc. to reach in the end a point of specific interest (an Internet connection up-link, an interesting service provider. etc.). Users, of course, can connect their devices (like desktop computers, laptops, etc.) to Guifi.net: they just need to run a cable from their rooftop CPE<sup>1</sup> to inside their homes and connect it to their device. The network down from the rooftop is not part of Guifi.net, but it is the users' private domestic network, and it is exactly the same as the private domestic network a customer of a traditional ISP<sup>2</sup> may have. Most likely, a Guifi.net user will have a wireless AP<sup>3</sup> router to get WiFi coverage for mobile devices (smartphones, laptops, tablets, etc.), like the DSL<sup>4</sup>, ISDN<sup>5</sup> or fiber connection customers of traditional ISPs have.



Figure 14. (Left) ISP wireless router provided, (Right) Guifi.net wireless router.

- 
- 1 CPE: Customer's Premises Equipment
  - 2 ISP: Internet Service Provider
  - 3 AP: Access Point
  - 4 DSL: Digital Subscriber Line
  - 5 ISDN: Integrated Services Digital Network

Figure 15(left) shows a typical wireless router provided by the Spanish ISP Telefónica to its broadband customers. The device works as an IEEE 802.11b/g WiFi AP and features an ADSL modem to operate as CPE. Figure 15(right) shows a wireless router inside the home of a Guifi.net participant. The device works as an IEEE 802.11a/b/g/n/ac WiFi AP and connects via cable to the outdoor router (the rooftop CPE). In terms of Internet connectivity for end-user devices, both devices are equivalent.

Individuals and organizations participating in the CAPTOR project that volunteer to host a CAPTOR or a RAPTOR device at their home, workplace, etc. either participating or not in the Guifi.net network, are expected to already have Internet access in their premises. Whether this is provided via DSL, ISDN, fiber, WISP<sup>6,7</sup>, 3G/4G, most probably, end user devices will access the Internet directly by means of a wireless AP router (providing an SSID<sup>8</sup> and protected by a password). If a wireless AP is not available, Internet connectivity will most likely be provided via an Ethernet cable.

The CAPTOR/RAPTOR sensing devices are built based on Arduino boards, which are tiny embedded microcomputer boards with extremely low power consumption especially suitable for this type of functions that require very low computing resources and long-term operation. Network connectivity (e.g. to access the Internet) can be added to an Arduino board by means of add-on boards (daughterboards) providing IEEE802.11 WiFi or IEEE802.3 Ethernet. When adding the required network connectivity to the CAPTOR/RAPTOR devices to transmit the read data to a central server over the Internet, the wireless interface is preferred for these reasons:

- WiFi is readily available at almost all the locations where Internet is available
- WiFi provides much more flexibility, as it allows installing the sensing device almost anywhere in a house (including outdoors) only needing an electricity outlet
- WiFi provides more than enough bandwidth to meet the data transmission requirements of the sensing devices

In comparison, if Ethernet connectivity was chosen for the CAPTOR/RAPTOR devices, an Ethernet network cable should be layed from the user's network CPE to the location of the sensing board, implying a difficult and expensive installation work (drilling holes on the walls, running cable, etc.).

Despite opting for WiFi connectivity for the CAPTOR/RAPTOR devices is clearly the way to go, a few problems may arise at specific locations. These issues are addressed in this document. WiFi signal coverage at home may dramatically change from one room to another, since walls and objects reflect and attenuate the propagation of radio waves at these frequencies:

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6 WISP: Wireless Internet Service Provider

7 Many of the ISPs operating in the Guifi.net network are actually WISPs

8 SSID: Service Set Identifier, i.e. the human-readable name of a Wireless like “MyWiFi\_atHome”

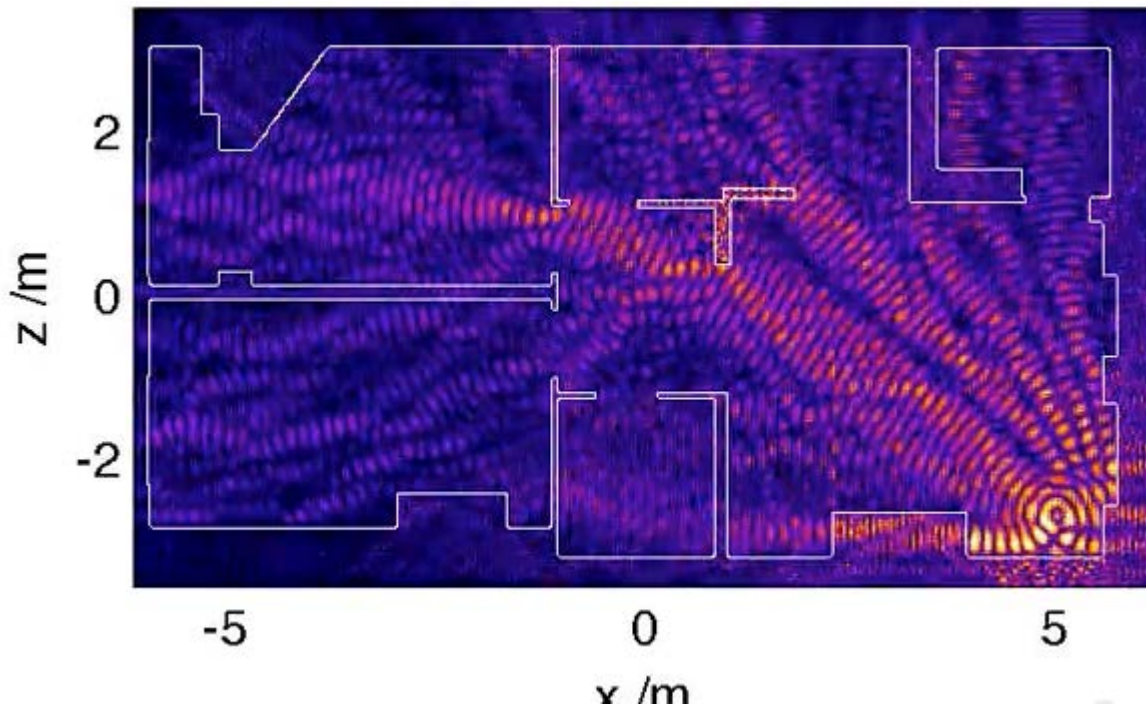


Figure 15. WiFi signal propagation.

Figure 16 shows a simulation of WiFi signal propagation inside an apartment, by Jason Cole. The WiFi router is placed in the bottom right corner. Walls and other objects can reflect and, mostly, attenuate radio waves propagation at WiFi frequencies.

If CAPTOR/RAPTOR devices are to be placed outdoors, the number of walls between the device and the indoor WiFi router may limit the signal quality. To assess whether a specific location is suitable for placing a sensing board (in terms of WiFi coverage), the following rule of thumb can be applied:

- If a smartphone can connect to the WiFi network, then it is a suitable location for the CAPTOR/RAPTOR device

The rationale behind this is that both smartphones and the sensing devices contain the same type of integrated, miniature WiFi antennas, having very similar sensitivity and transmission power capabilities. Therefore, if a smartphone can connect to the WiFi network, the sensing board will have the same challenges/possibilities to connect to the WiFi network. The positive side of this is that, while a smartphone may need a steady WiFi connection to download and transmit a high volume of data (pictures, video streaming, mail, etc.), the CAPTOR/RAPTOR devices only need to transmit numeric data from the sensors reads at regular intervals, so not having a very strong and steady WiFi signal coverage isn't definitely a showstopper.

It could happen, however, that WiFi signal coverage from the WiFi router at the CAPTOR/RAPTOR board installation location was insufficient. In this case, two solutions are proposed.

To overcome poor reception of the WiFi signal at the board installation place, the user could opt for a *Wireless range extender*. This tiny and cheap device is used to extend the WiFi signal coverage to places of the home the main WiFi router can not reach. It is typically installed mid-way from the WiFi router and the area without coverage, so that it can connect correctly to the WiFi router and also provide WiFi coverage to the area that lacked it. The device is easy to configure, an

## CAPTOR

can be found at retail computer stores, etc. Typical prices range from 15 € to 40 €, depending on the components quality and the included features:



Figure 16. TP-Link RE200

Figure 17 shows a TP-Link RE200, a tiny Wireless network range extender. Most of them are plugged directly to an electricity outlet in the wall.

While the Wireless range extender solution should prove valid for most of the scenarios, other - more complex- solutions could be applied in case of need. For instance, the CAPTOR/RAPTOR board could be deployed with a dedicated WiFi router in the middle. This WiFi router would have these functions:

- To connect to the user's WiFi AP router and therefore to the Internet
- To provide a dedicated WiFi AP for the exclusive use of the CAPTOR/RAPTOR sensing device

The price for such “WiFi gateway in-the-middle” would be between 12 € and 30 €, depending on the model and features. At the expense of this extra amount of money, the benefits of such solution could be many. For instance, the CAPTOR/RAPTOR devices would not be need to be configured each one for the specific wireless network of the place where they would be deployed, but they would all have the same configuration to connect to the WiFi gateway. Instead, the WiFi gateway would be configured specifically for/by each user hosting in according to his/her domestic network configuration. This would be very convenient, as the configuration of the WiFi gateway can be performed via a web browser by a non-*technie* user (for example following a simple tutorial). Instead, changing the WiFi settings of the CAPTOR/RAPTOR device would require reflashing the firmware, which is a slightly more technically-demanding task.



Figure 17. (Left) Arduino Board, (Center) WiFi gateway, (Right) Wifi AP Router

A “WiFi gateway”, Figure 17 (center), is the same hardware as the “Wireless range extender” discussed above, acting as a cable-less gateway between an Arduino board (left) and the domestic WiFi AP router (right). When using it with a fully open and customizable firmware, like OpenWrt<sup>9</sup>, it can work as a wireless AP, a range extender, a WiFi gateway, etc.

To sum up, it is clear that choosing WiFi connectivity for the CAPTOR/RAPTOR devices over Ethernet cable connectivity is the best option:

- It provides the needed bandwidth and requirements
- It is the most flexible solution
- It is the easiest option for end users
- It is the cheapest option
- WiFi is a commodity technology nowadays

However, it could happen that WiFi connectivity is not good enough at the specific place outdoors where the device is to be installed, because of the distance to the indoor WiFi AP router, the walls in the middle, interferences, etc. In this case, solutions to overcome these limitations are provided by the usage of:

- Wireless network range extenders, to extend the WiFi signal coverage indoors and outdoors so that it reaches the deployment location
- Wireless gateway, to provide a dedicated AP for the CAPTOR/RAPTOR board while also connecting, at the same time, to the user's WiFi AP router

Last, but not least, for locations of great interest for placing sensing devices where Internet access is not available, solutions based on WiFi mesh and point-to-point networks can be considered - Guifi.net has expertise in this type of deployments-, as well as GSM-based connectivity by means of specific add-on Arduino boards or dedicated hardware.

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9 OpenWrt: a Linux distribution for embedded network devices. <http://www.openwrt.org>