Environmental management & IoT

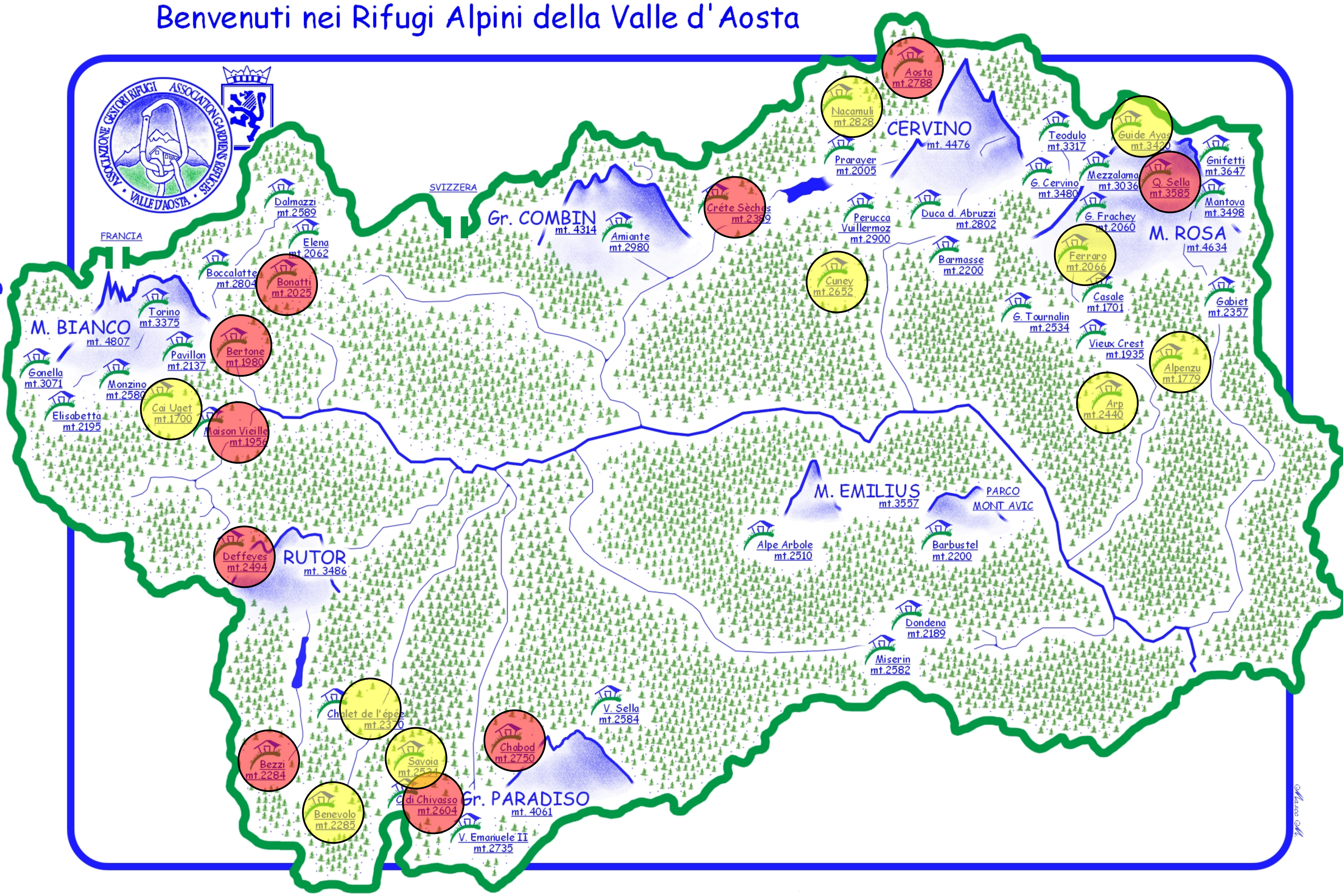
Riccardo Beltramo

Full Professor of Environmental Management Systems

Department of Management

NatRisk - Research Centre on Natural Risks in mountain and hilly environments

Benvenuti nei Rifugi Alpini della Valle d'Aosta



Wilkommen in den valdostaner Berghütten

Welcome to the Aosta Valley mountain shelters

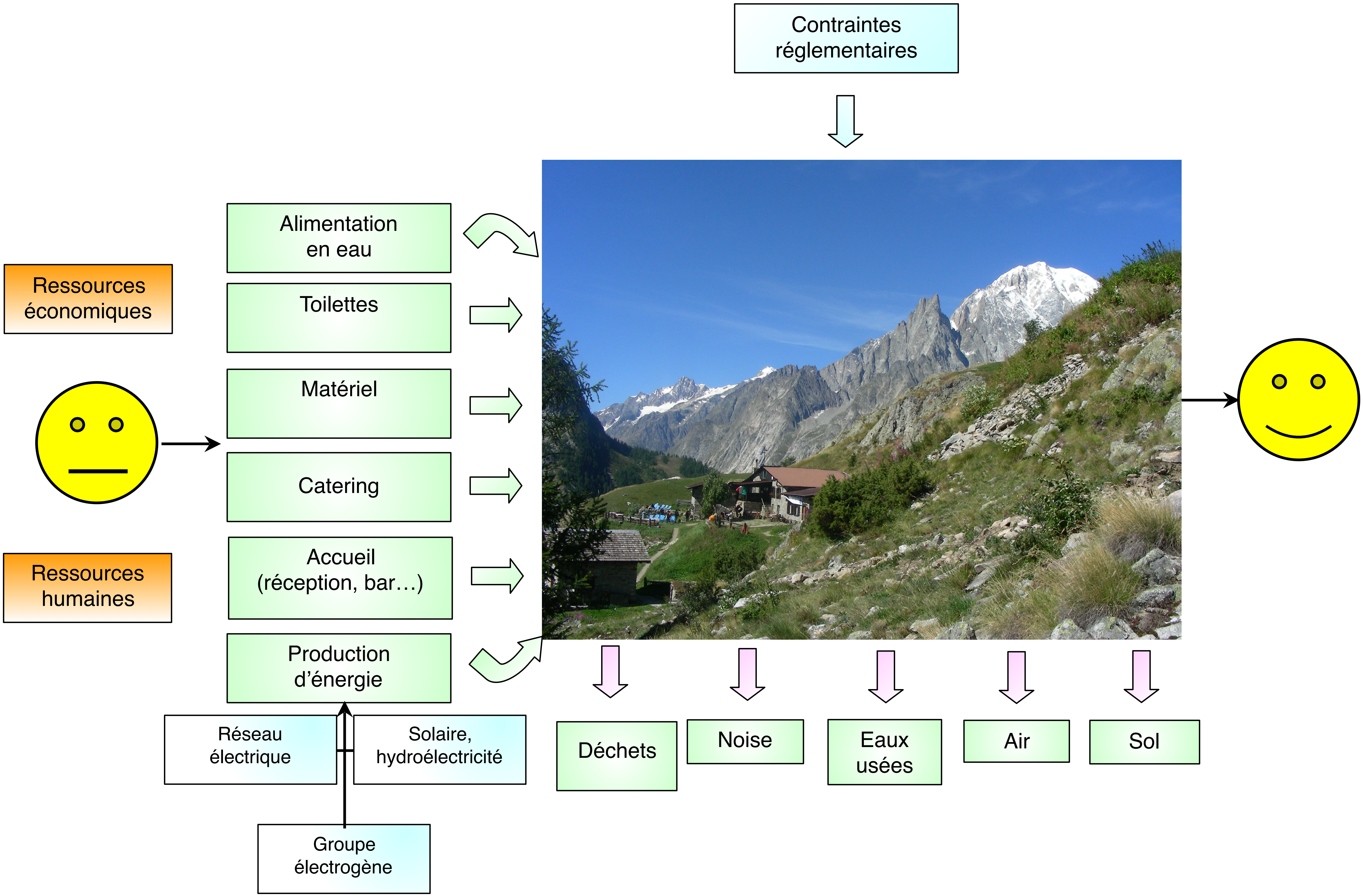
Bienvenus dans les refuges alpins de la Vallée d'Aoste

Prof. Riccardo Beltramo - University of Turin - Department of Management, Area of Commodity Science

International Organization for Standardization
ISO
14001:2015

EMAS

4. Context of the organization



Contraintes réglementaires
Ressources économiques
Ressources humaines
Alimentation en eau
Toilettes
Matériel
Catering
Accueil (réception, bar…)
Production d’énergie
Réseau électrique
Solaire, hydroélectricité
Groupe électrogène
Déchets
Noise
Eaux usées
Air
Sol

4.1 Understanding the organization and its context

The organization shall determine **external and internal issues** that are relevant to its purpose and that affect its ability to achieve the intended outcomes of its EMS.

4.2 Understanding the needs and expectations of interested parties

The organization shall determine:

a. the **interested parties** that are relevant to the environmental management system;
b. the relevant **needs and expectations** (i.e. requirements) of these interested parties;
c. which of these needs and expectations become its **compliance obligations**.

4.3 Determining the scope of the EMS

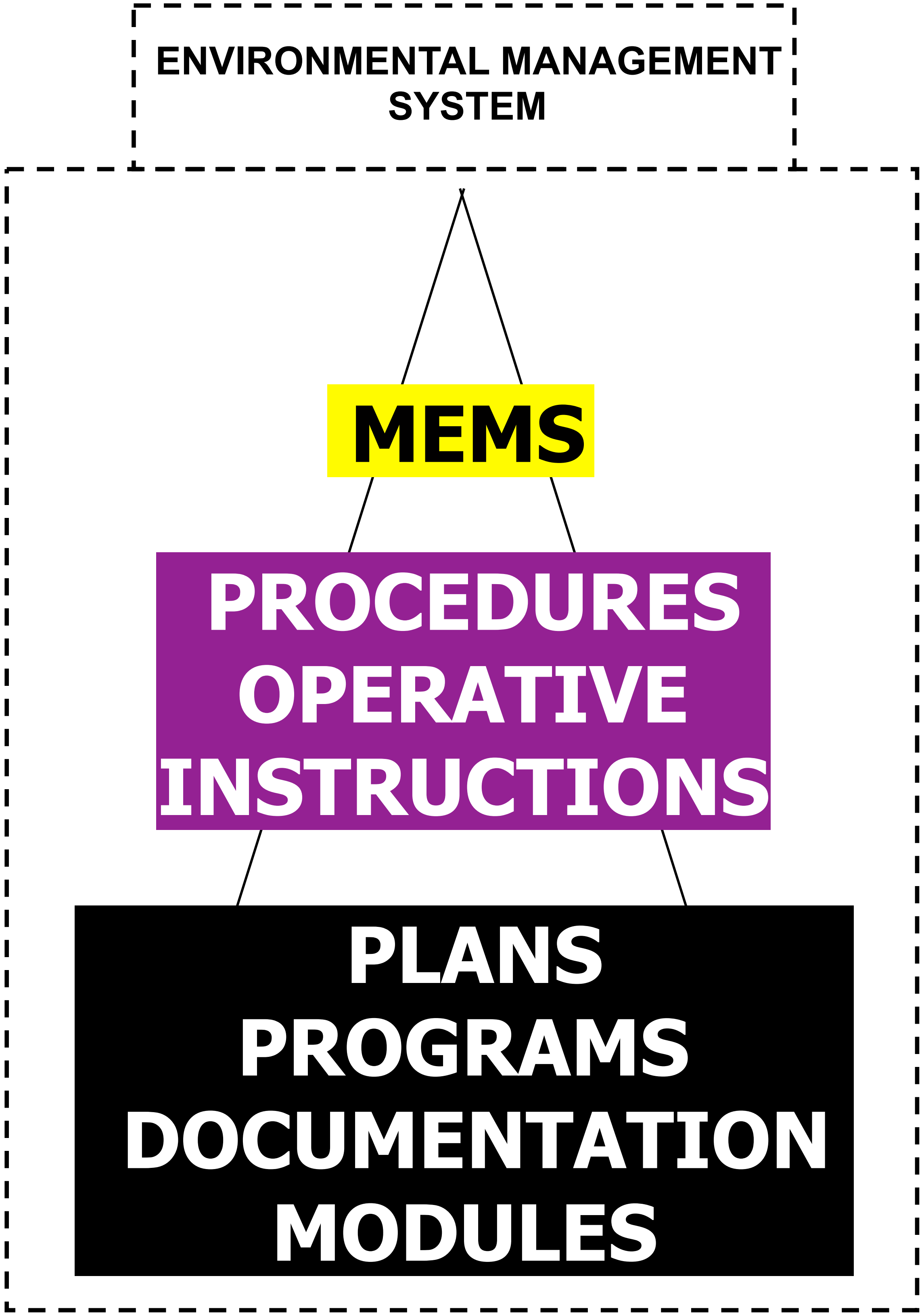
The organization shall determine the **boundaries** and **applicability** of the environmental management system to establish its scope.

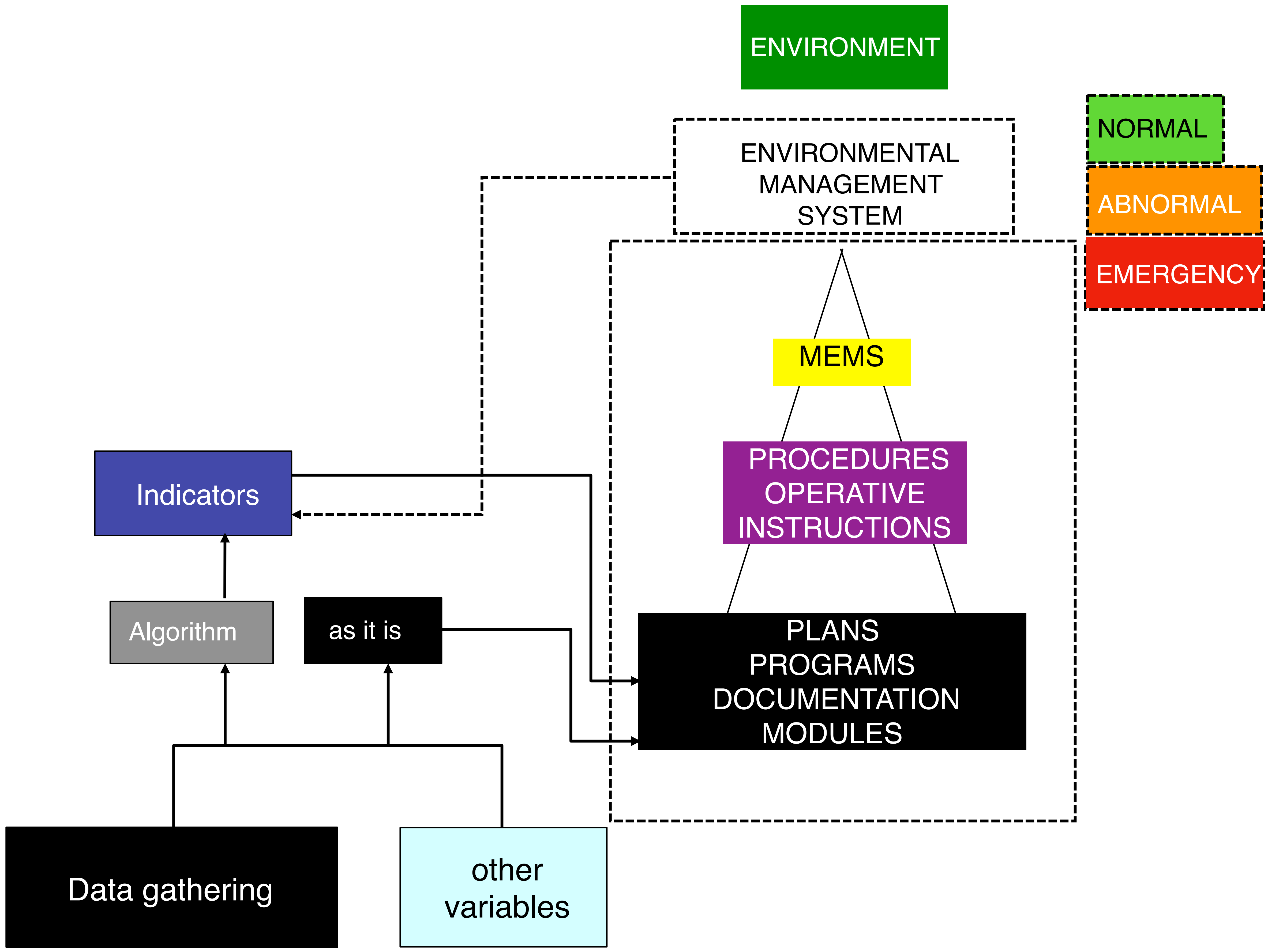
When determining this scope, the organization shall consider:

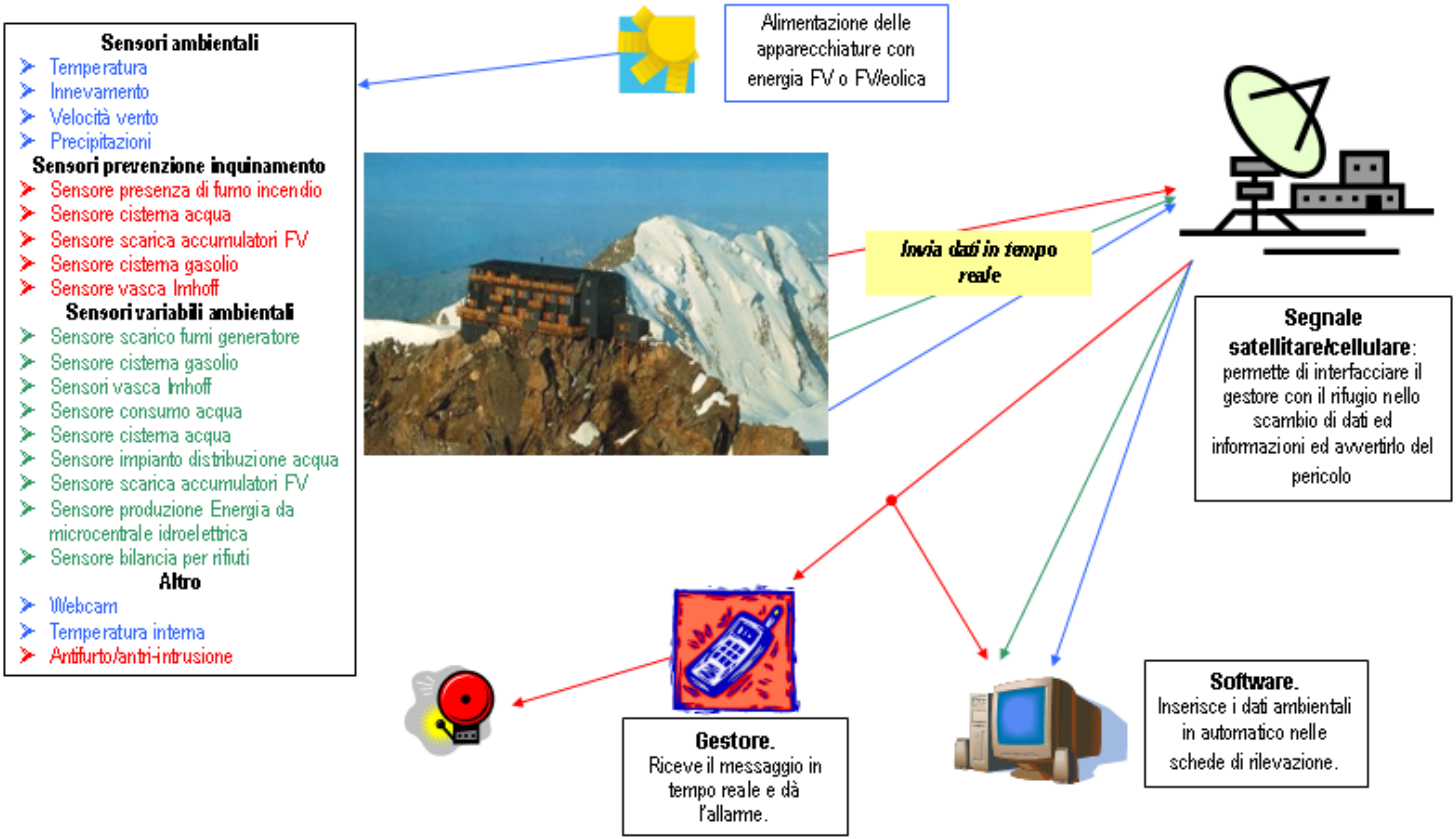
a) external and internal issues;
b) compliance obligations;
c) its organizational units, functions and physical boundaries;
d) its activities, products and services;
e) its authority and ability to exercise control and influence.

4.4 Environmental Management System

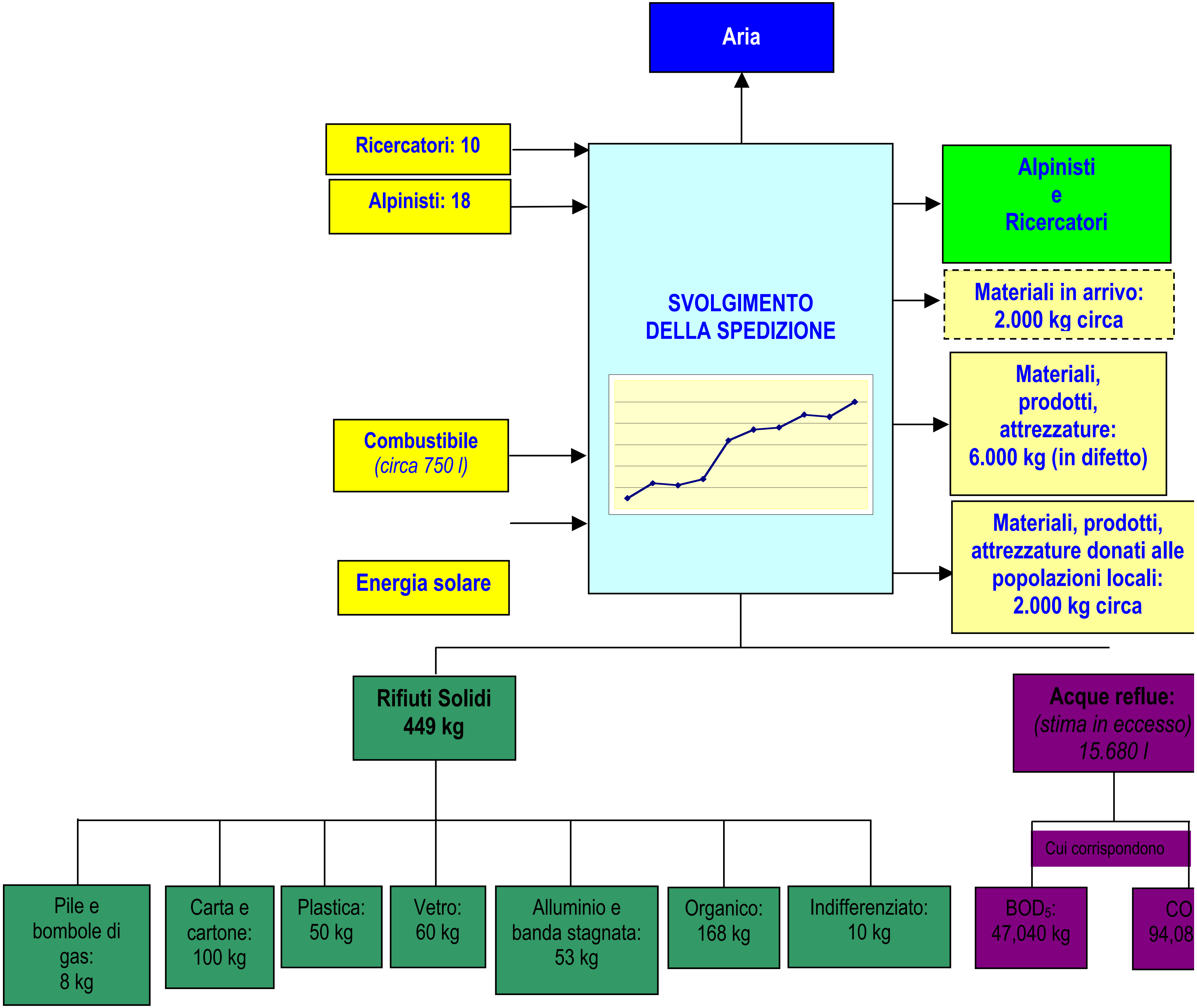
To achieve the intended outcomes, including enhancing its environmental performance, the organization shall **establish, implement, maintain and continually improve** an EMS, including the processes needed and their interactions, in accordance with the requirements of this International Standard.


ENVIRONMENTAL MANAGEMENT SYSTEM
MEMS
PROCEDURES
OPERATIVE INSTRUCTIONS
PLANS
PROGRAMS
DOCUMENTATION
MODULES


ENVIRONMENT
NORMAL
ENVIRONMENTAL MANAGEMENT SYSTEM
ABNORMAL
EMERGENCY
MEMS
PROCEDURES OPERATIVE INSTRUCTIONS
Indicators
PLANS PROGRAMS DOCUMENTATION MODULES
Algorithm
as it is
Data gathering
other variables


Sensori ambientali
Temperatura
Innevamento
Velocità vento
Precipitazioni
Sensori prevenzione inquinamento
Sensore presenza di fumo incendio
Sensore cisterna acqua
Sensore scarica accumulatori FV
Sensore cisterna gasolio
Sensore vasca Imhoff
Sensori variabili ambientali
Sensore scarico fumi generatore
Sensore cisterna gasolio
Sensori vasca Imhoff
Sensore consumo acqua
Sensore cisterna acqua
Sensore impianto distribuzione acqua
Sensore scarica accumulatori FV
Sensore produzione Energia da microcentrale idroelettrica
Sensore bilancia per rifiuti
Altro
Webcam
Temperatura interna
Antifurto/antri-intrusione
Alimentazione delle apparecchiature con energia FV o FV/eolica
Invia dati in tempo reale
Segnale satellitare/cellulare: permette di interfacciare il gestore con il rifugio nello scambio di dati ed informazioni ed avvertirlo del pericolo
Gestore. Riceve il messaggio in tempo reale e dà l'allarme.
Software. Inserisce i dati ambientali in automatico nelle schede di rilevazione.

SCATOL8®


Aria
Ricercatori: 10
Alpinisti: 18
Combustibile
(circa 750 l)
Energia solare
SVOLGIMENTO
DELLA SPEDIZIONE
Alpinisti
e
Ricercatori
Materiali in arrivo:
2.000 kg circa
Materiali,
prodotti,
attrezzature:
6.000 kg (in difetto)
Materiali, prodotti,
attrezzature donati alle
popolazioni locali:
2.000 kg circa
Rifiuti Solidi
449 kg
Acque reflue:
(stima in eccesso)
15.680 l
Pile e bombole di gas: 8 kg
Carta e cartone: 100 kg
Plastica: 50 kg
Vetro: 60 kg
Alluminio e banda stagnata: 53 kg
Organico: 168 kg
Indifferenziato: 10 kg
Cui corrispondono
BOD5: 47,040 kg
CO
94,08


LA MORRA
▲513
BAROLO
▲301
NOVELLO
▲471
MONFORTE
▲480
CASTIGLIONE
FALLETTO
▲350
SERRALUNGA
D'ALBA
▲414
CISSONE
▲660
RODDINO
▲610
SERRAVALLE
LANGHE
▲762
BOSSOLASCO
▲757
CERRETTO
LANGHE
▲687
GRINZANE
CAVOUR
▲260
GALLO
▲193
RODDI
▲284
S. Maria
Annunziata
DIANO
D'ALBA
MONTELUPO
ALBESE ▲564
ALBA
Latitudine 44° 38' 15", longitudine 4° 31' 08"

qualità in quota

UNIVERSITÀ DEGLI STUDI DI TORINO

Progetto V.E.T.T.A.

Valorizzazione delle Esperienze e dei prodotti Turistici Transfrontalieri alle medie ed Alte quote

INTERREG
ITALIA-SVIZZERA ITALIE-SUISSE ITALIEN-SCHWEIZ
Le opportunità non hanno confini

REGIONE PIEMONTE

FESR

RegioneLombardia

ERSAF

qualità in quota

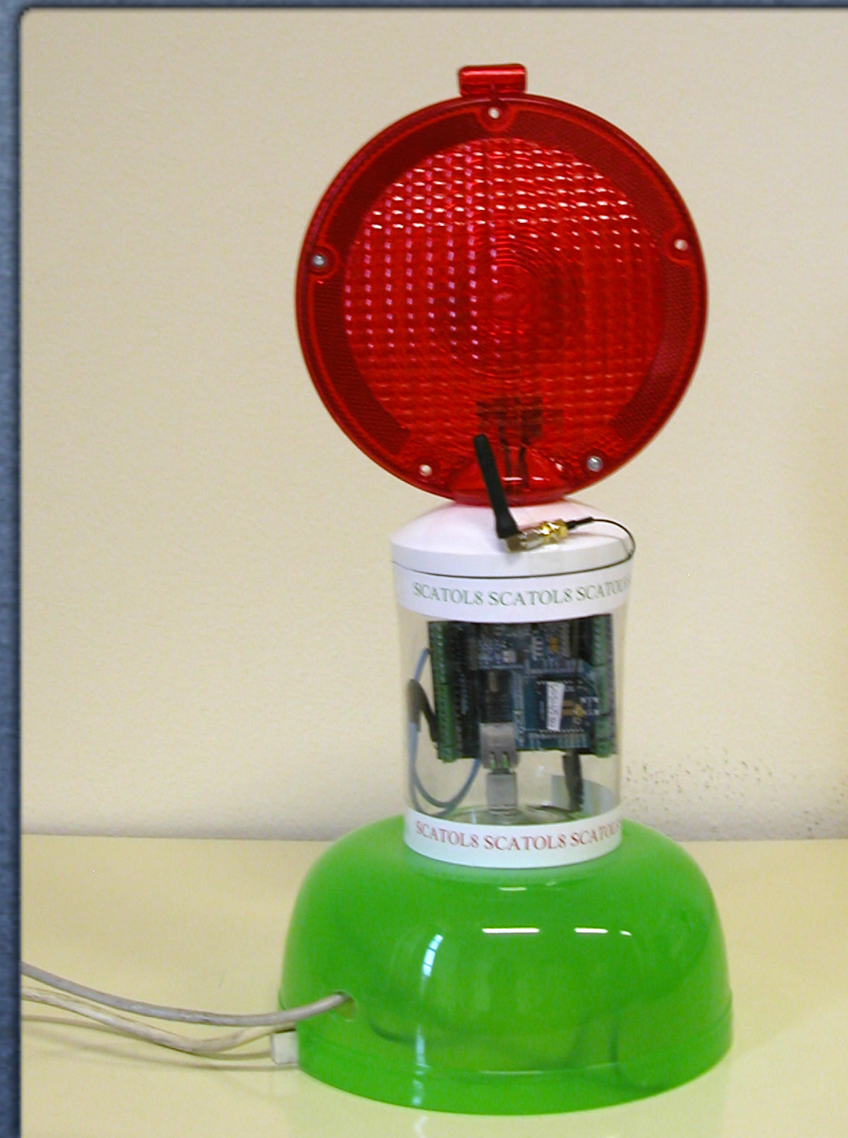
Riccardo Beltramo

ANALISI DELL'OFFERTA

Possibili scenari per l'applicazione dello Scatol8®

Scatol8®

is a **system** conceived to gain **awareness** on the topic of **sustainable development**



Scatol8®

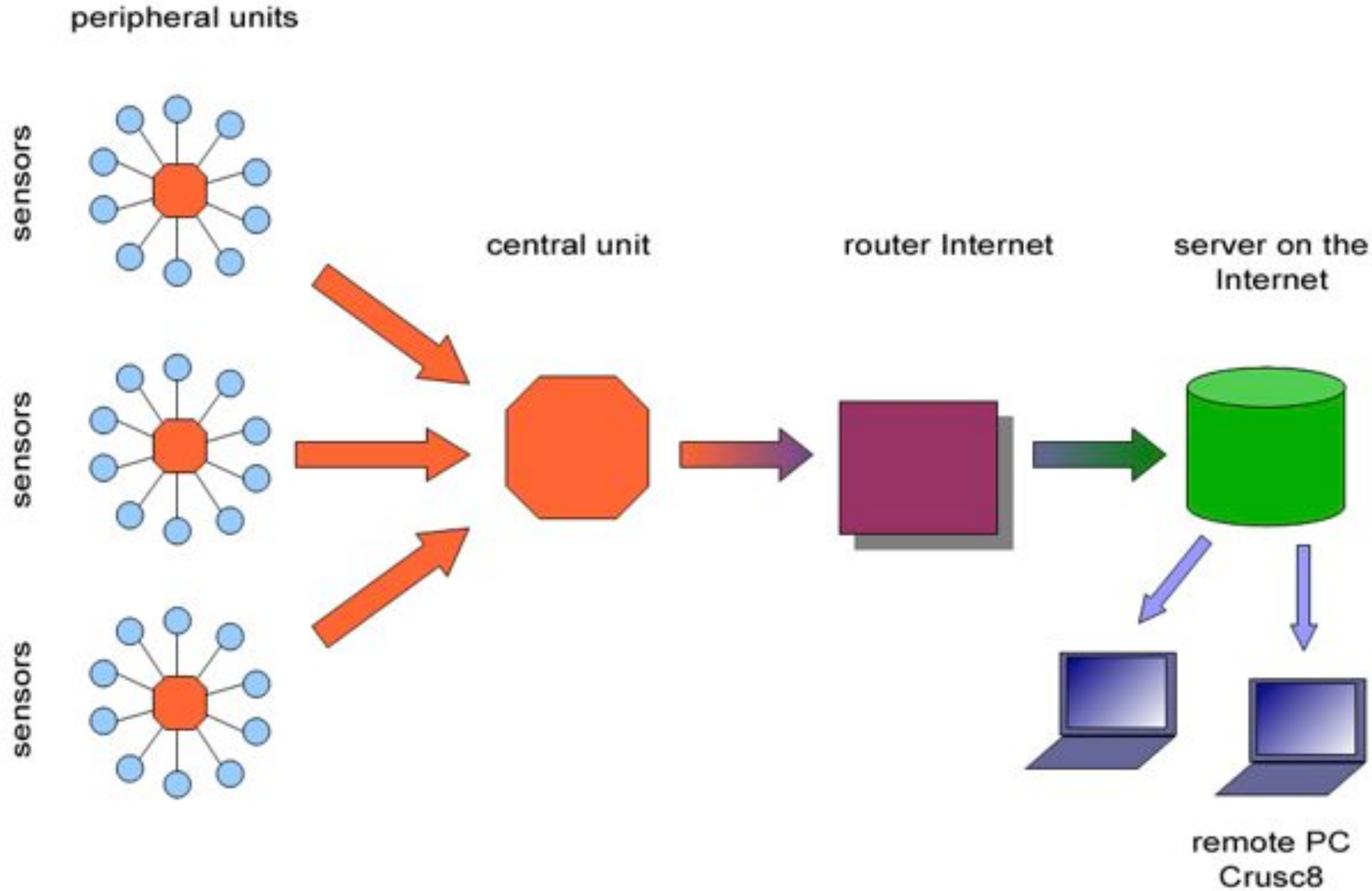
- Records are the key points for checking the system and calculating indicators.

- Scatol8® is a remote sensing network of environmental, landscape and management variables based on free and open technology (hardware and software)

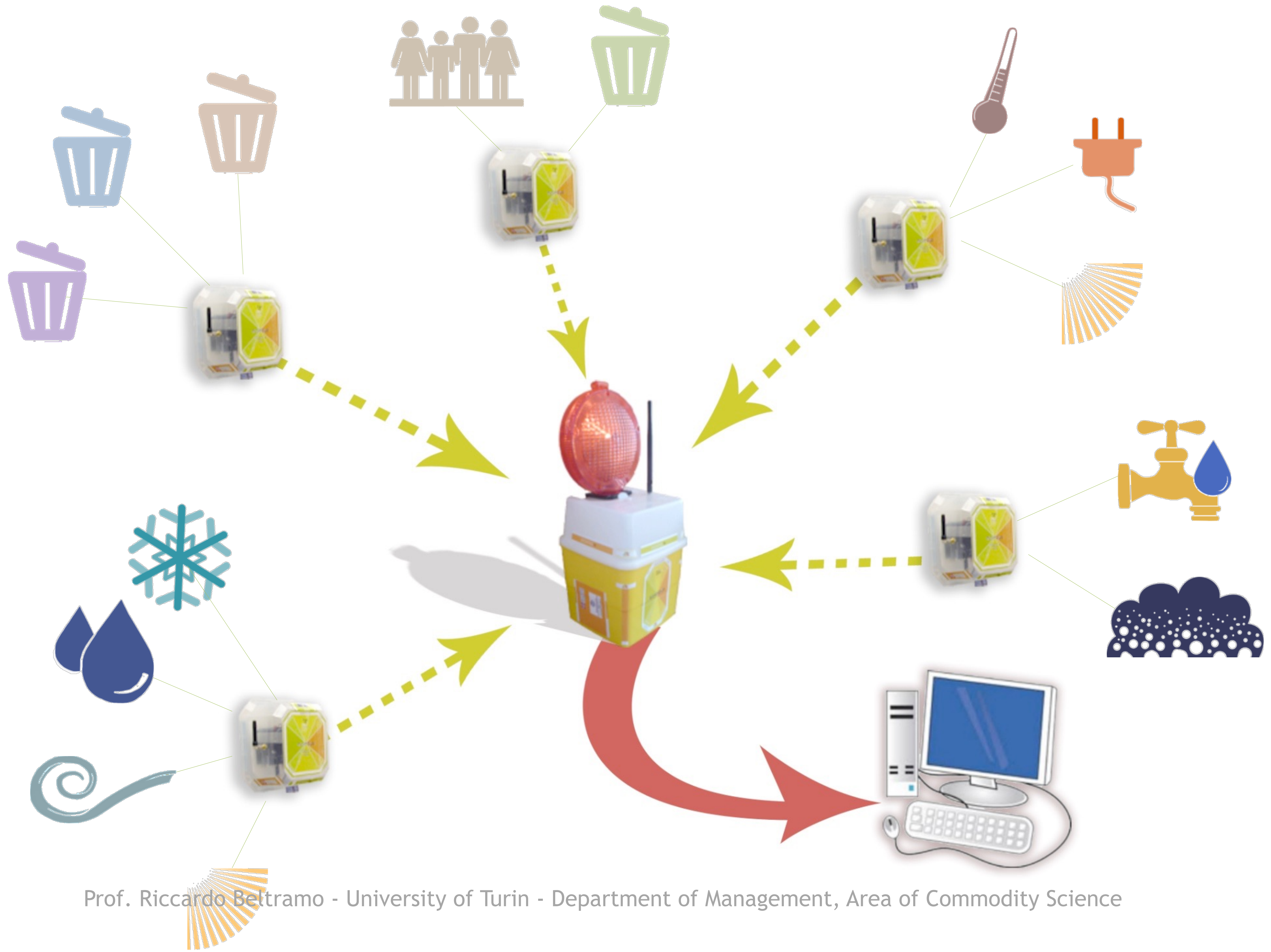
- Scatol8® consists of a central unit and of peripheral units, connected in a network. Sensors are connected to peripheral units which transmit the data to a central unit, connected with a server.

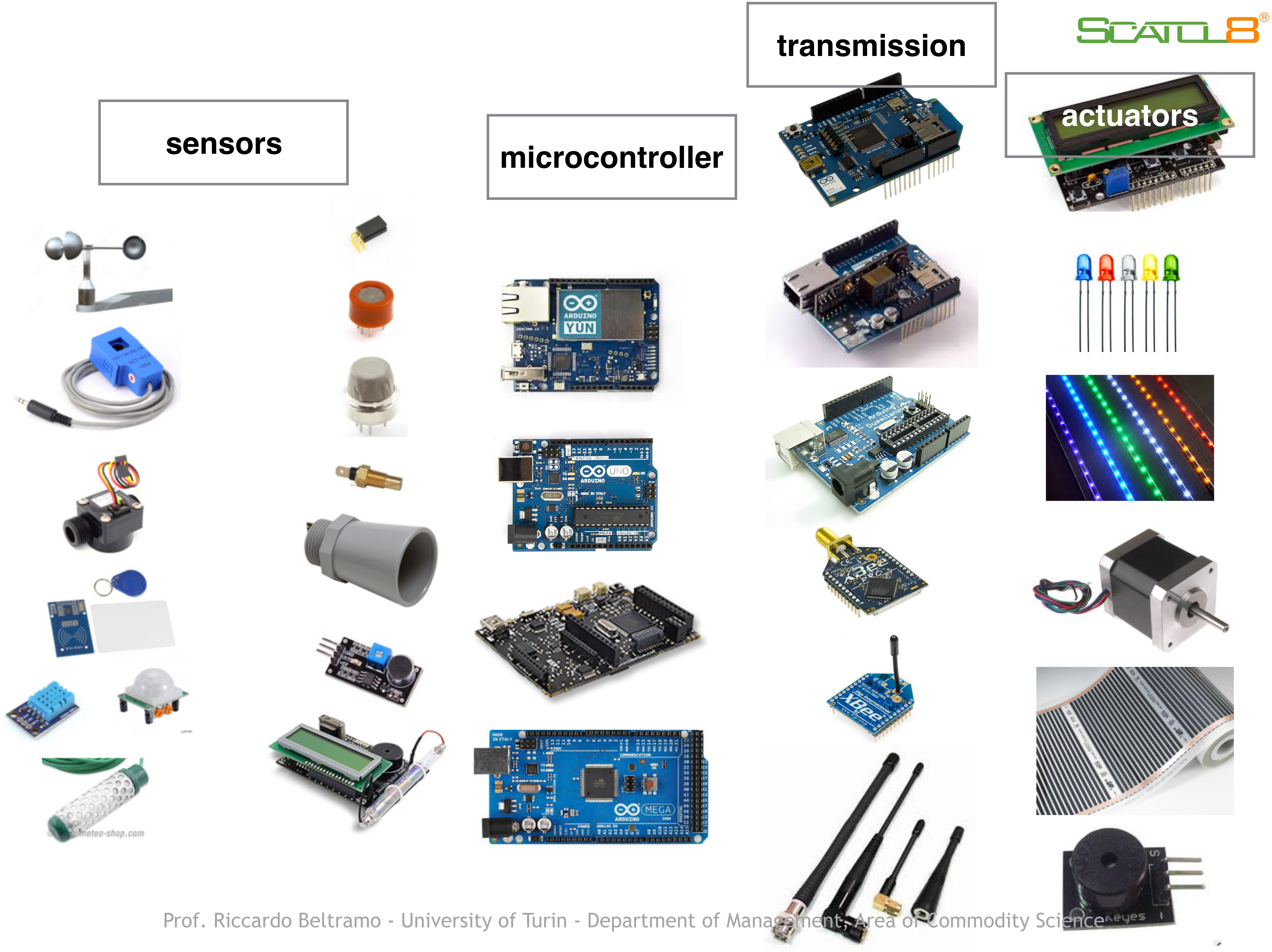
- It is possible to create a real-time monitoring of each measured variable, as well as evaluate their performance over time.

The Scatol8® wireless sensor network



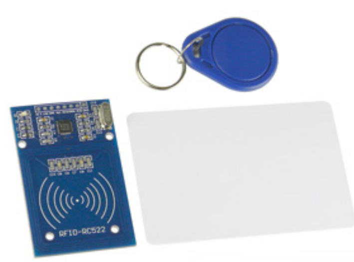
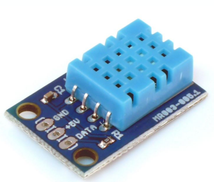
Tailor-made sensors & network



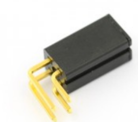

sensors
microcontroller
transmission
actuators
ARDUINO
YUN
UNO
MEGA
XBee
meteo-shop.com
Keyes

Sensors



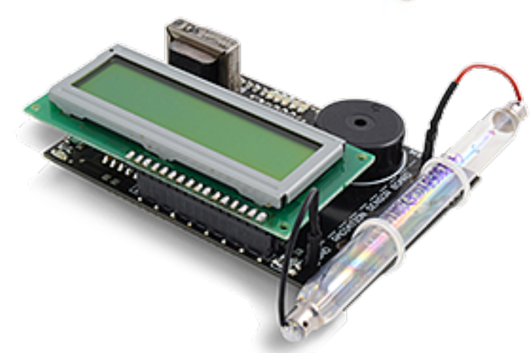




Environmental parameters
Acceleration
Power consumption
Wind direction
Distance
Liquid flow rate
Air quality (presence of smoke, benzene, carbon dioxide, LPG, propane, hydrogen, oxygen, methane, carbon monoxide)
Illuminance
Mass (eg. Production waste)
Movement (eg. Intrusion, counting pieces, etc.).
Oxidation-Reduction Potential
pH
Rain
Atmospheric pressure
Radioactivity (α, β, γ decays)
Noise
Temperature of liquids
Soil temperature
Air temperature
Soil moisture
Humidity
Wind speed
Vibration
Biometric parameters



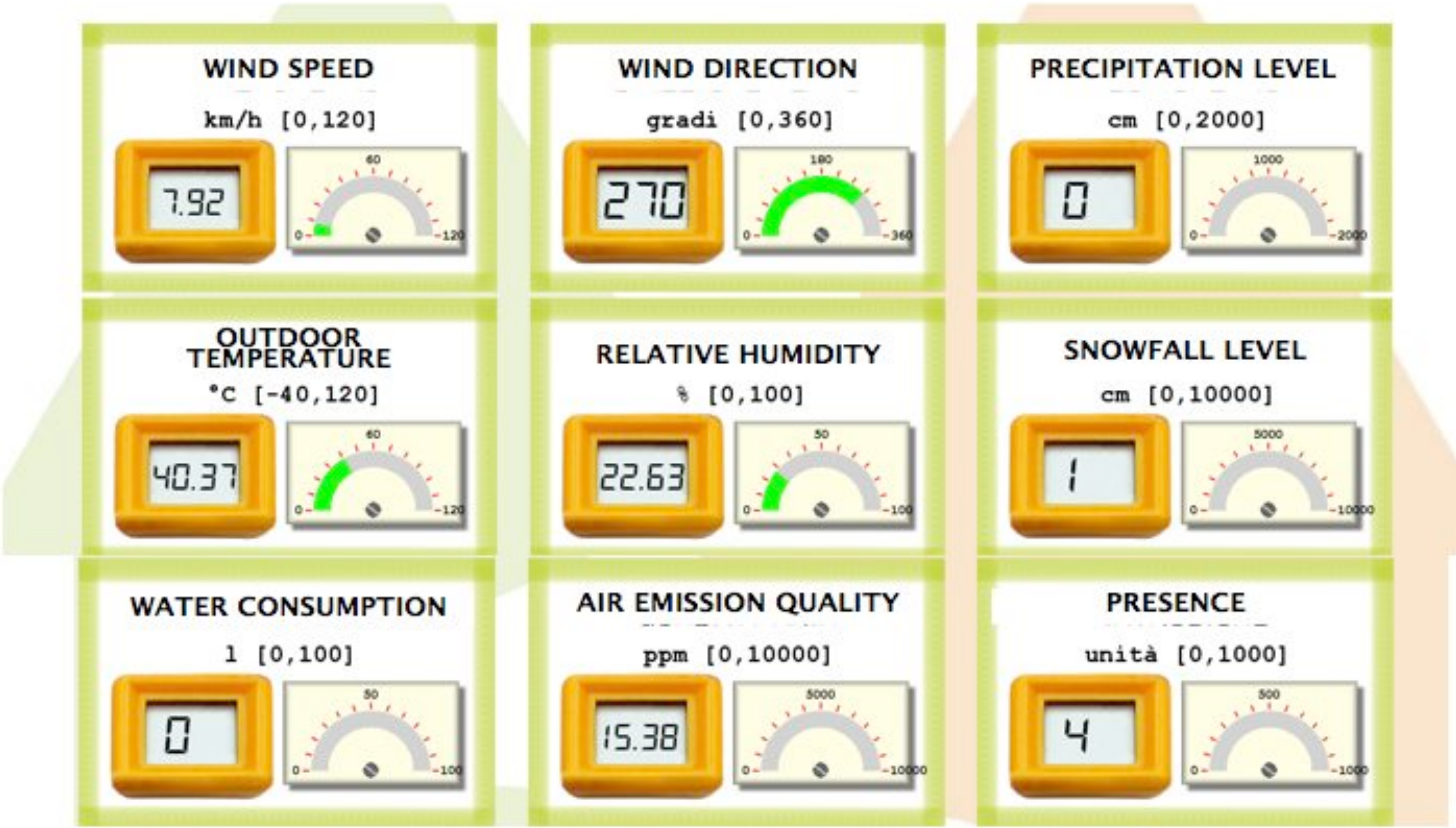






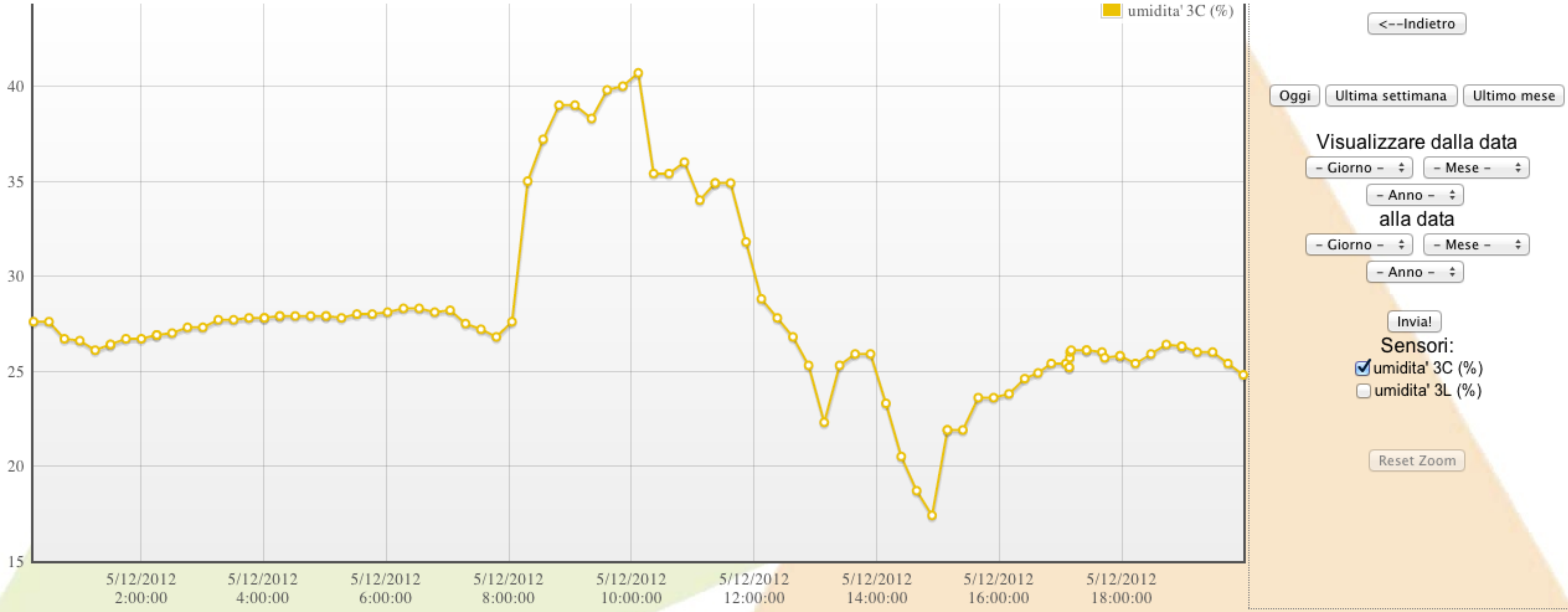
Actuators

Scatol8® --> Crusc8

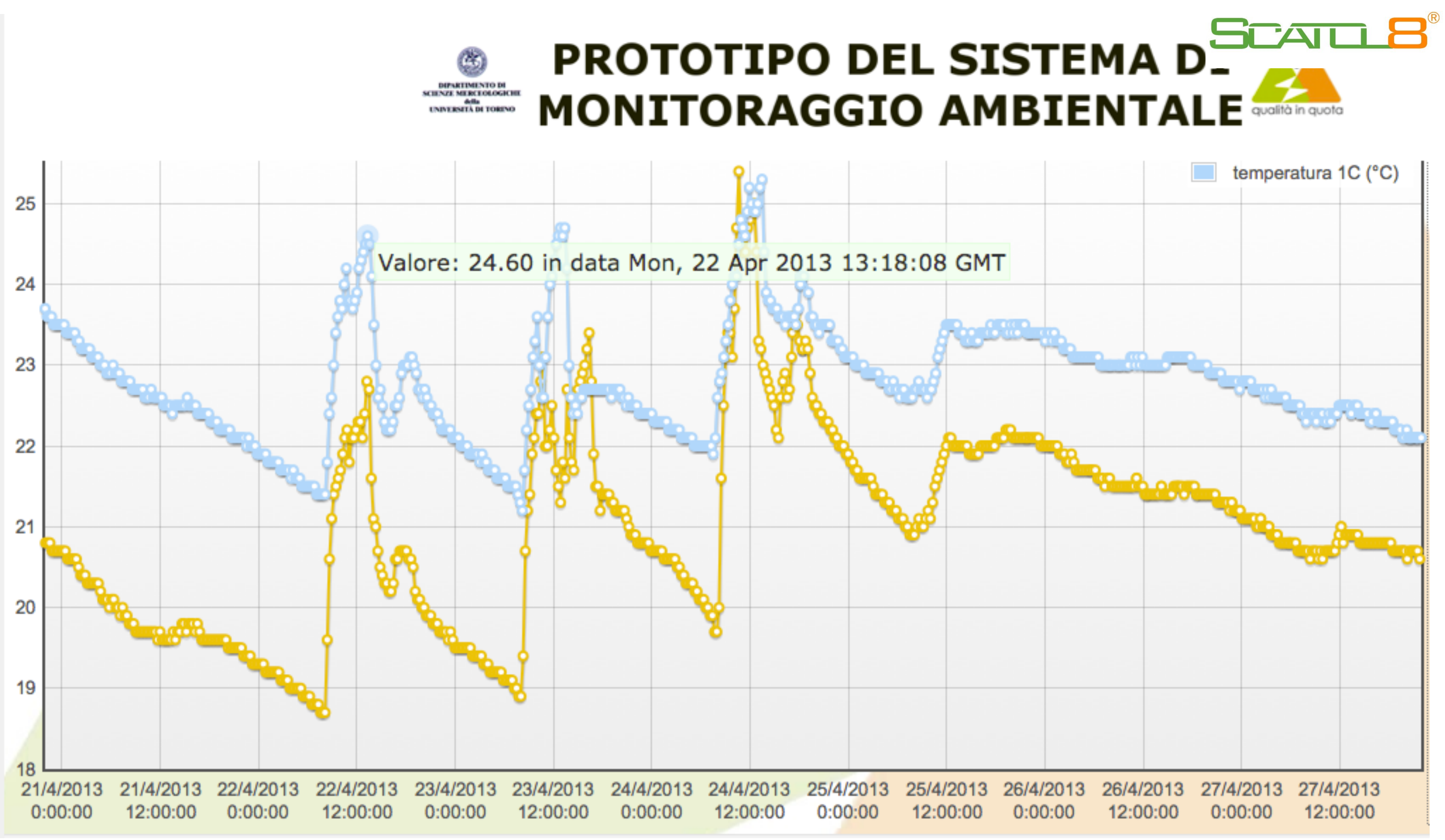


![logo: SCATOL8]

PROTOTIPO DEL SISTEMA DI MONITORAGGIO AMBIENTALE



Data analysis



Data comparison

Scatol8 system's Guidelines

ACCESSIBILITY	MODULARITY	ENVIRONEMENTAL COMPATIBLITY
Hardware and software are fully based on open technologies	The system is constituted from time to time, according to the requirements and specifications of each application	When possible, all electronic devices are placed in recycled containers or made of wood, on individual aestethic taste

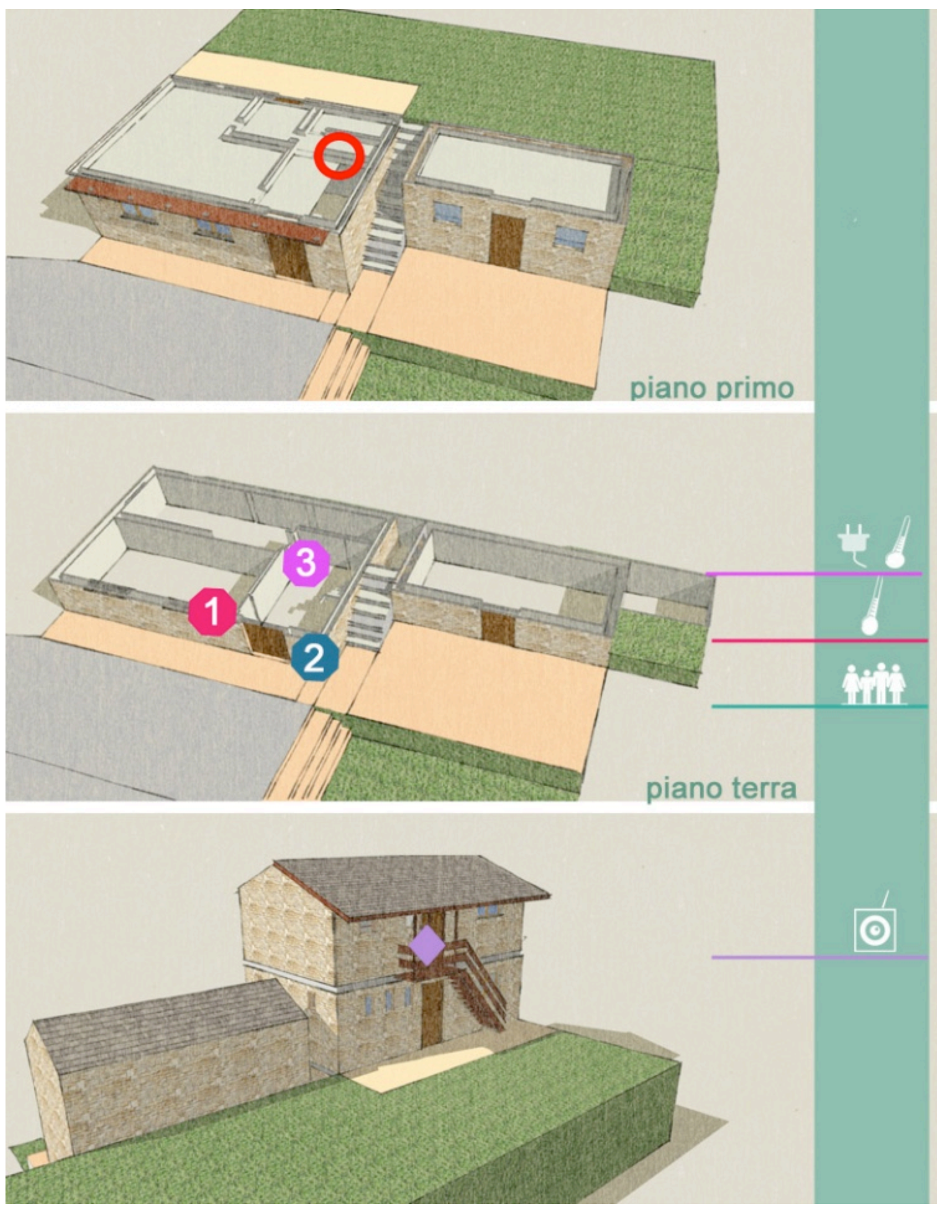
The remote sensing system was tested in four Alpine huts of the VCO:

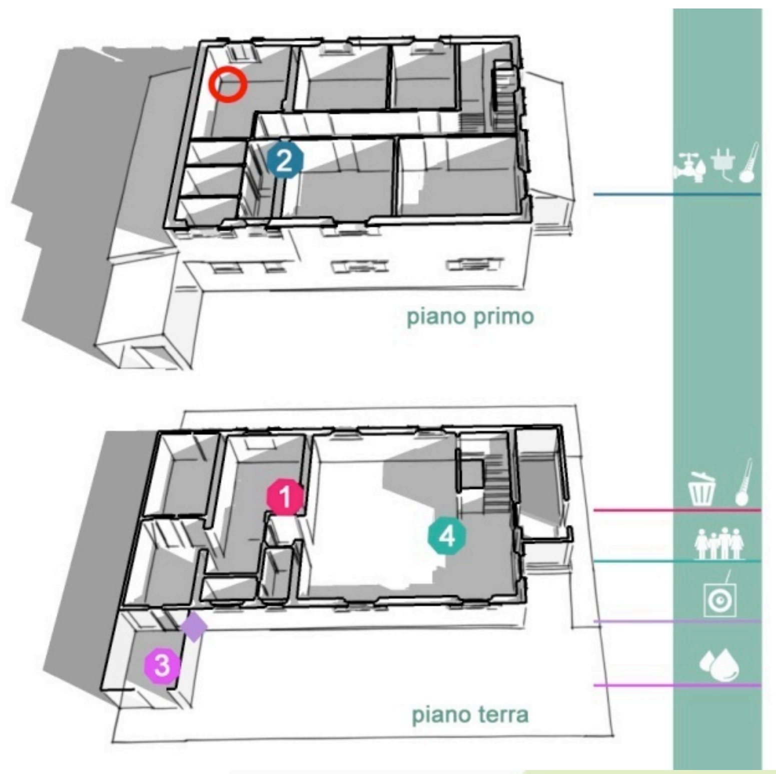
Città di Novara (2011)

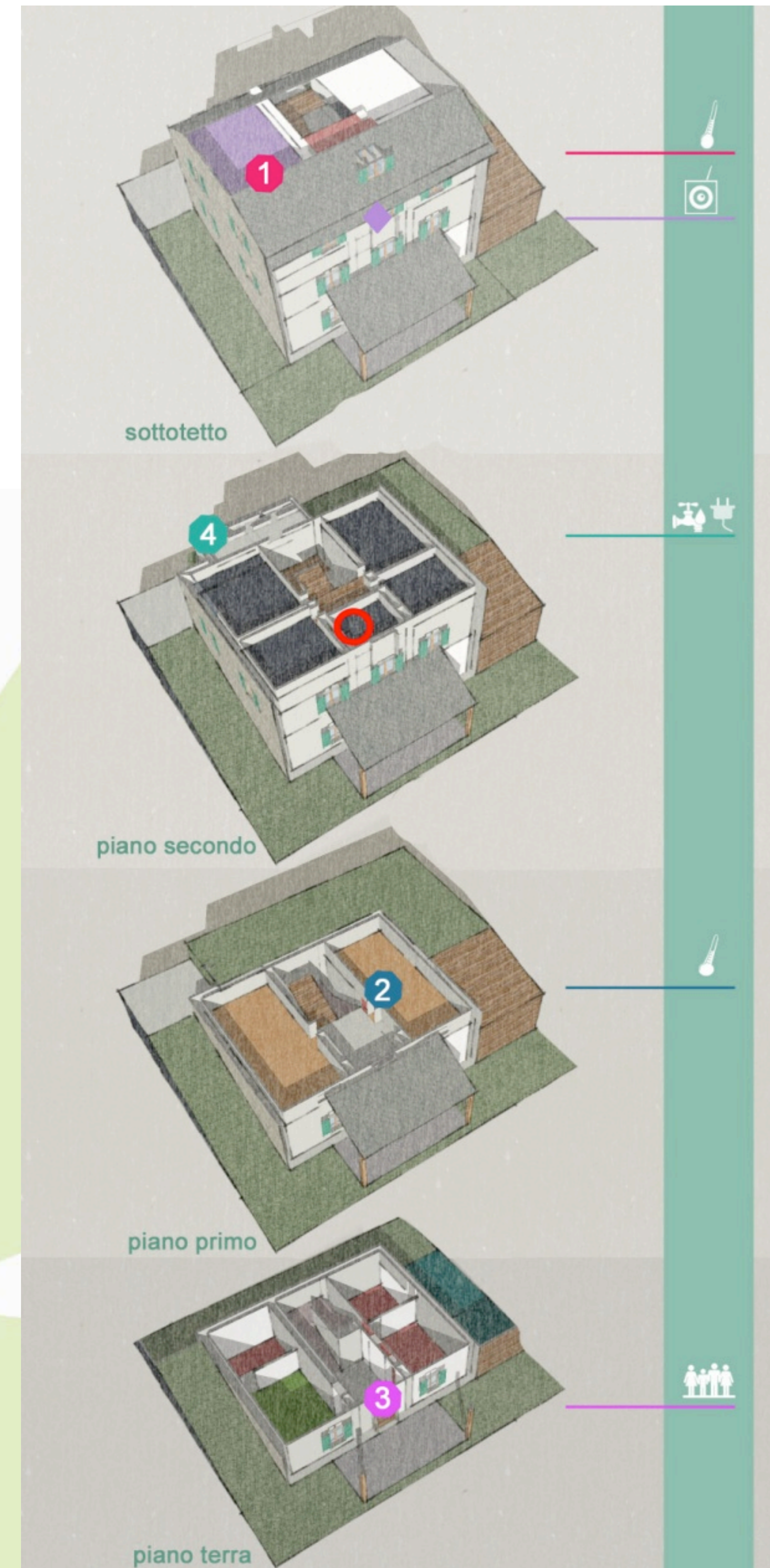
Andolla (2011, 2012)

Enrico Castiglioni (2011, 2012)

Pietro Crosta (2012)







Clockwise:
Rifugi Andolla,
Castiglioni e Crosta

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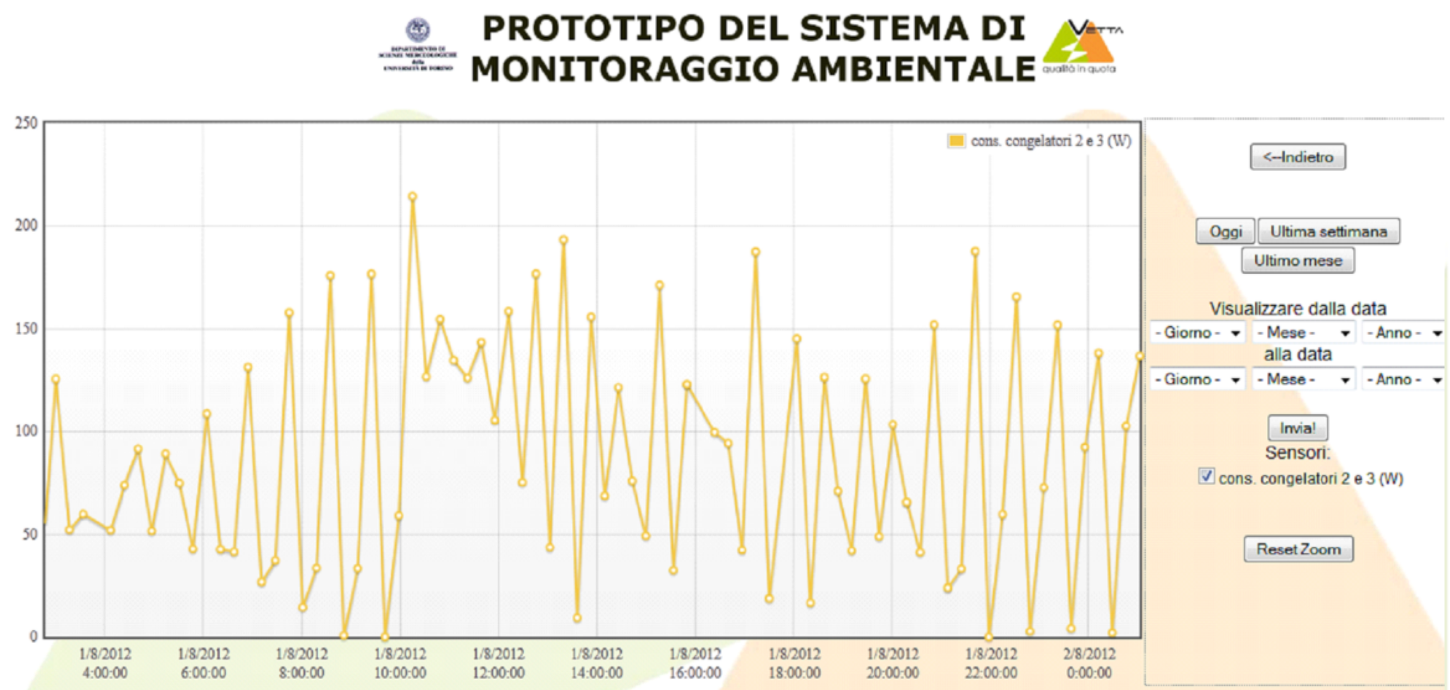

qualità in quota

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Castiglioni
Test

Castiglioni Network Architecture

Rifugio Castiglioni Network configuration:

- Intrusion
- Electric consumption
- Gas
- Waste production
- Luminance
- External and internal humidity
- Liquid flow
- External temperature
- Internal temperature at different heights

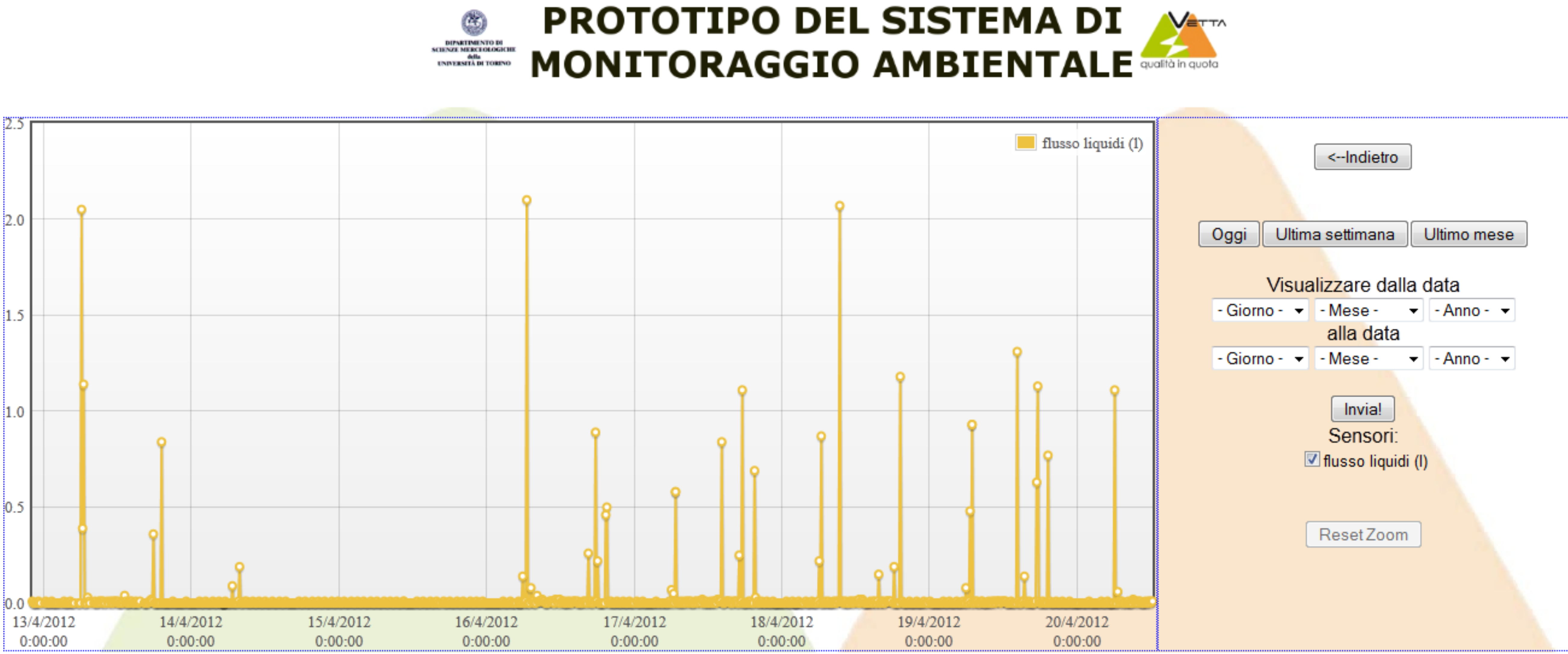
DIPARTIMENTO DI SCIENZE MERCEOLOGICHE della UNIVERSITÀ DI TORINO

PROTOTIPO DEL SISTEMA DI MONITORAGGIO AMBIENTALE

VETTA qualità in quota

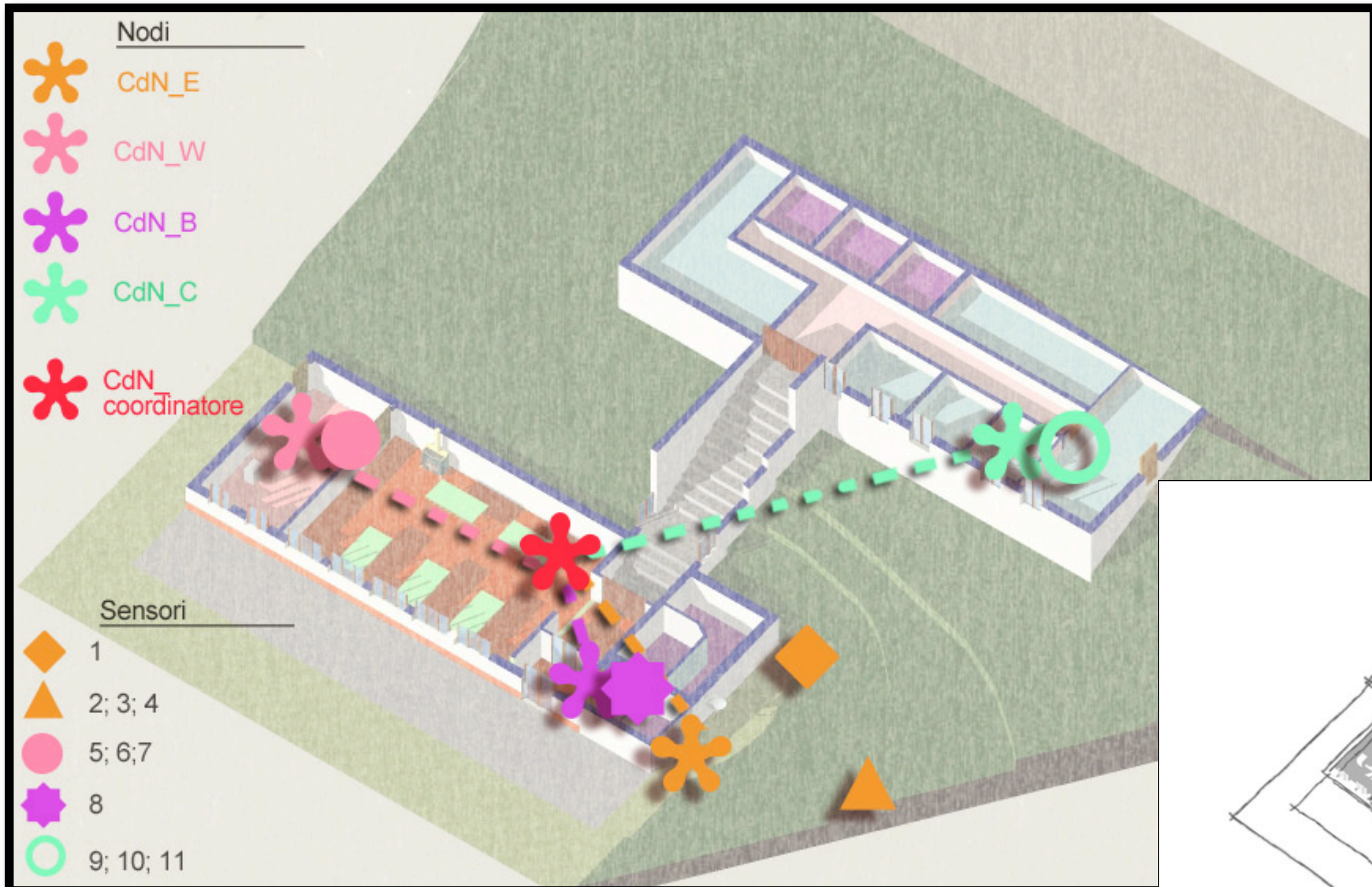
SCATOL8 SRL

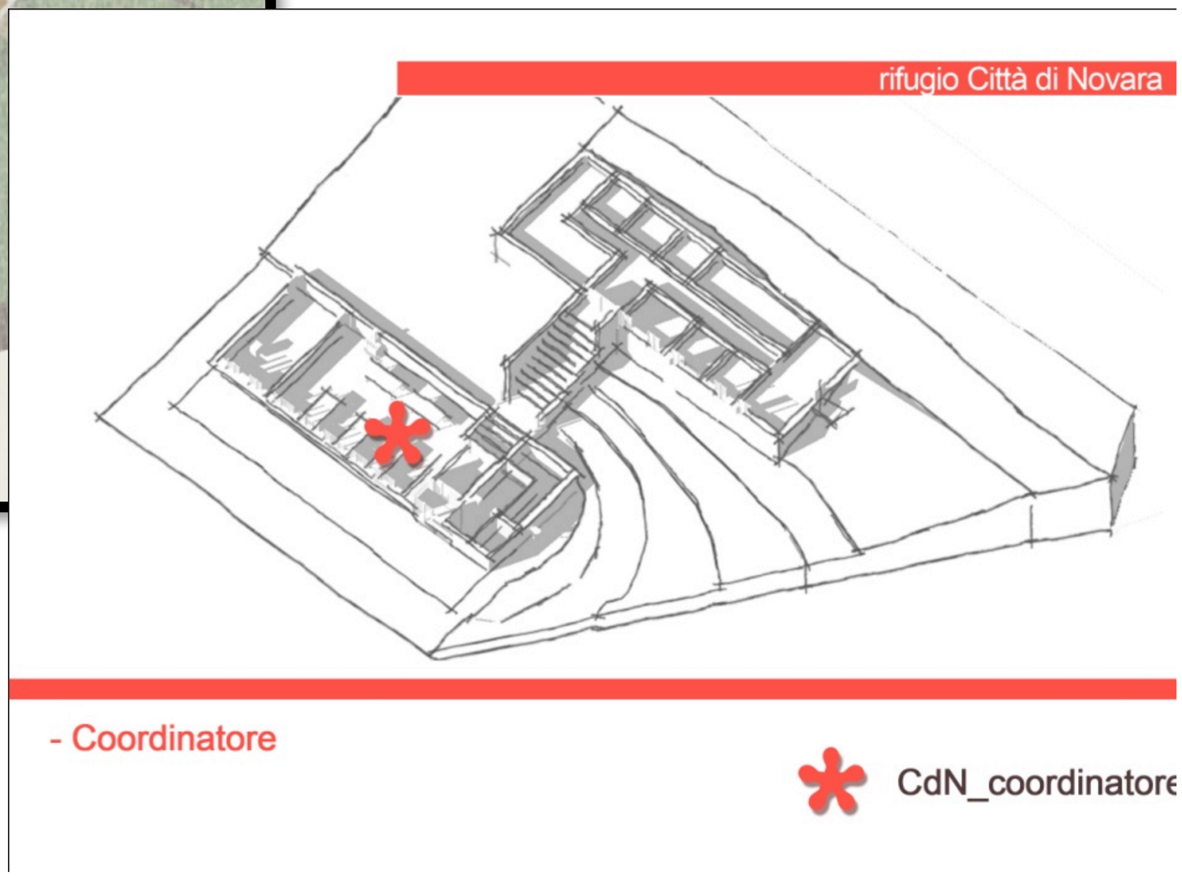
Graphs



SCATOL8

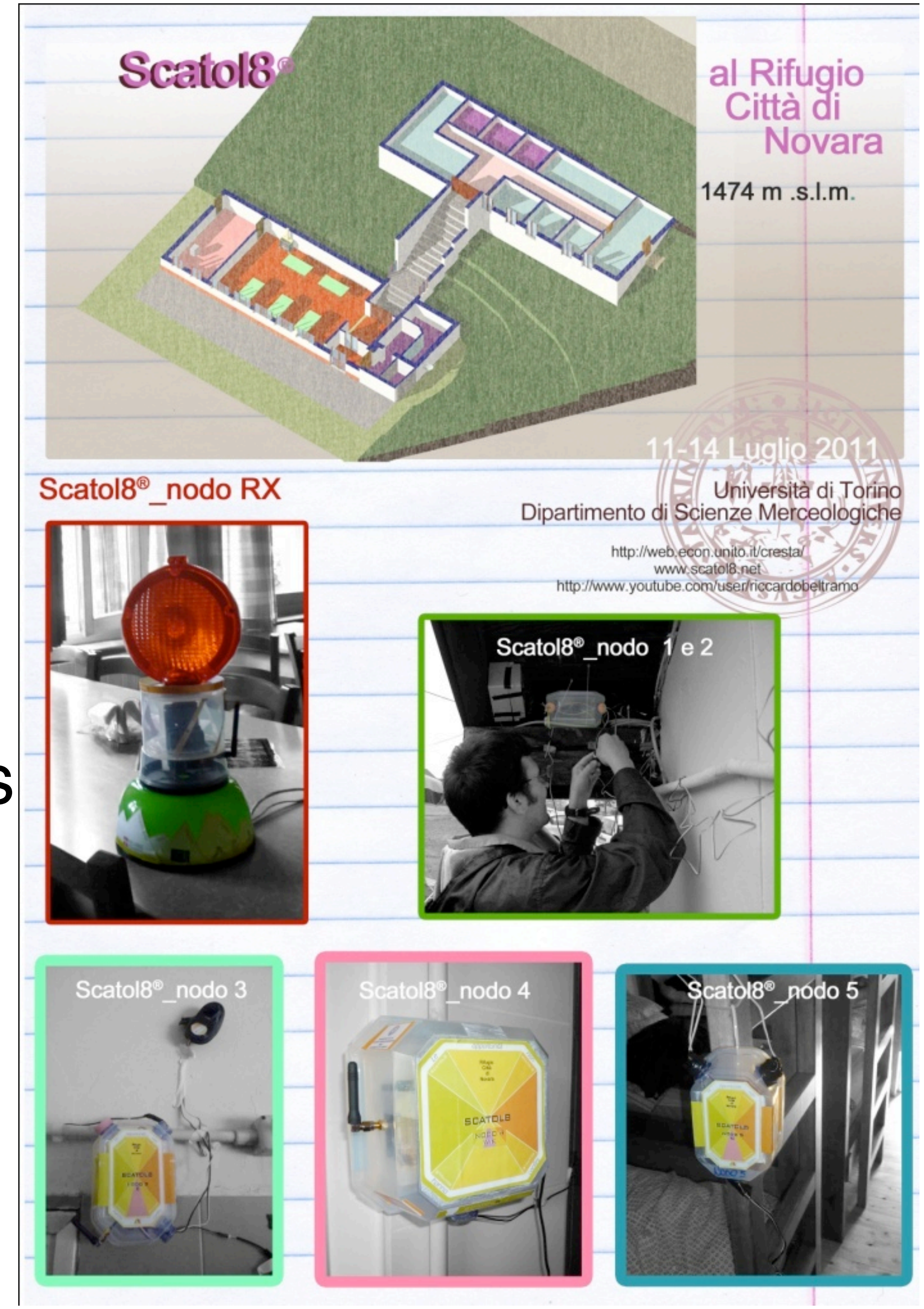
Città di Novara
Network configuration



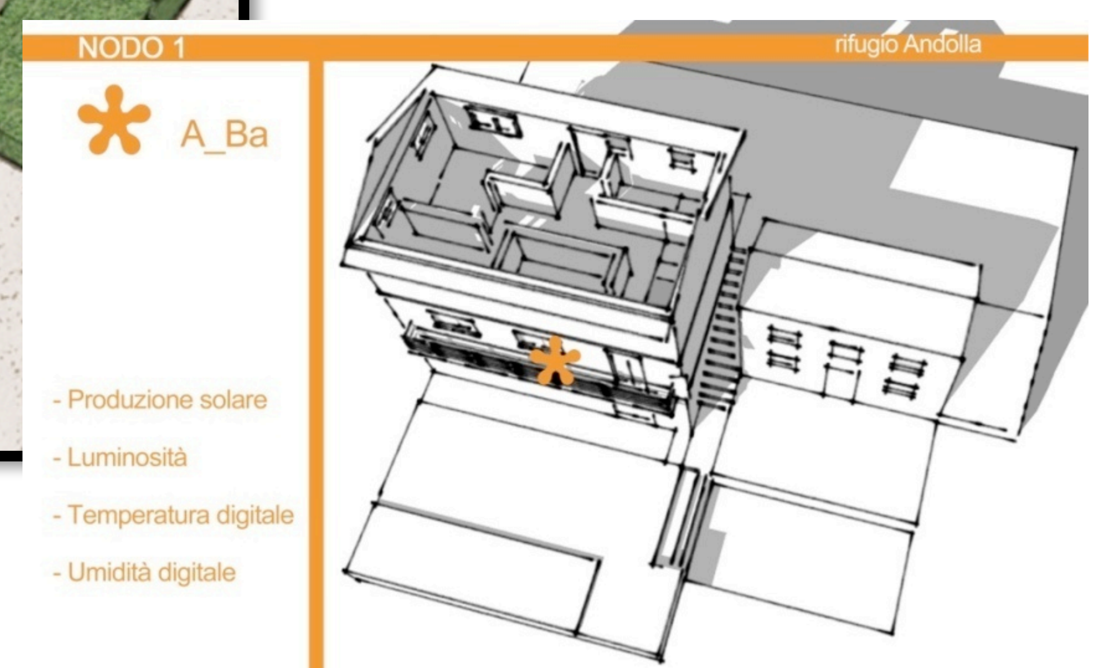


Rifugio Città di Novara configurazione

- Snow level
- Anemometer
- Wind direction
- Rain Gauge
- Kitchen temperature and rooms
- Humidity: kitchen and rooms
- Gas
- Liquid flow



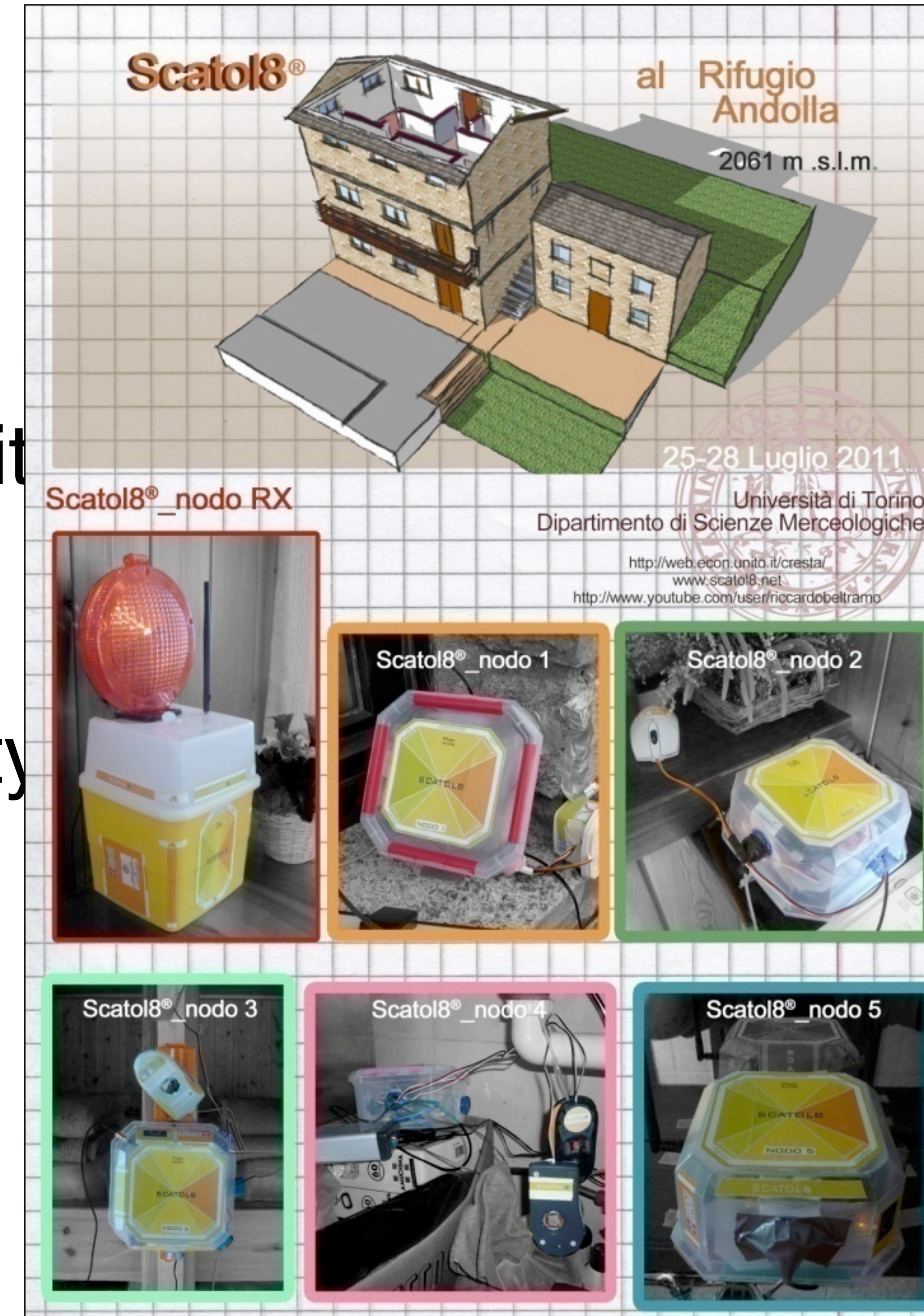
Rifugio Andolla
Network configuration



SCATOL8

Rifugio Andolla
Network Configuration

- Solar production
- External luminance
- External temperature and humidit
- Electric stove consumption
- Internal temperature and humidity
- Waste production
- Gas
- Liquid flow



IS THE INTERNET OF THINGS HELPFUL TO MANAGEMENT SYSTEMS IMPLEMENTATION?

DEMING CYCLE PLAN

RELATIONS BETWEEN SCATOL8 AND EMS		
	DIRECT CONTRIBUTION	INDIRECT CONTRIBUTION
PLAN		
4.3.1 – Environmental aspects	★	
4.3.2 – Legal and other requirements		★
4.3.3 – Objectives, targets and programme(s)	★	

DEMING CYCLE DO

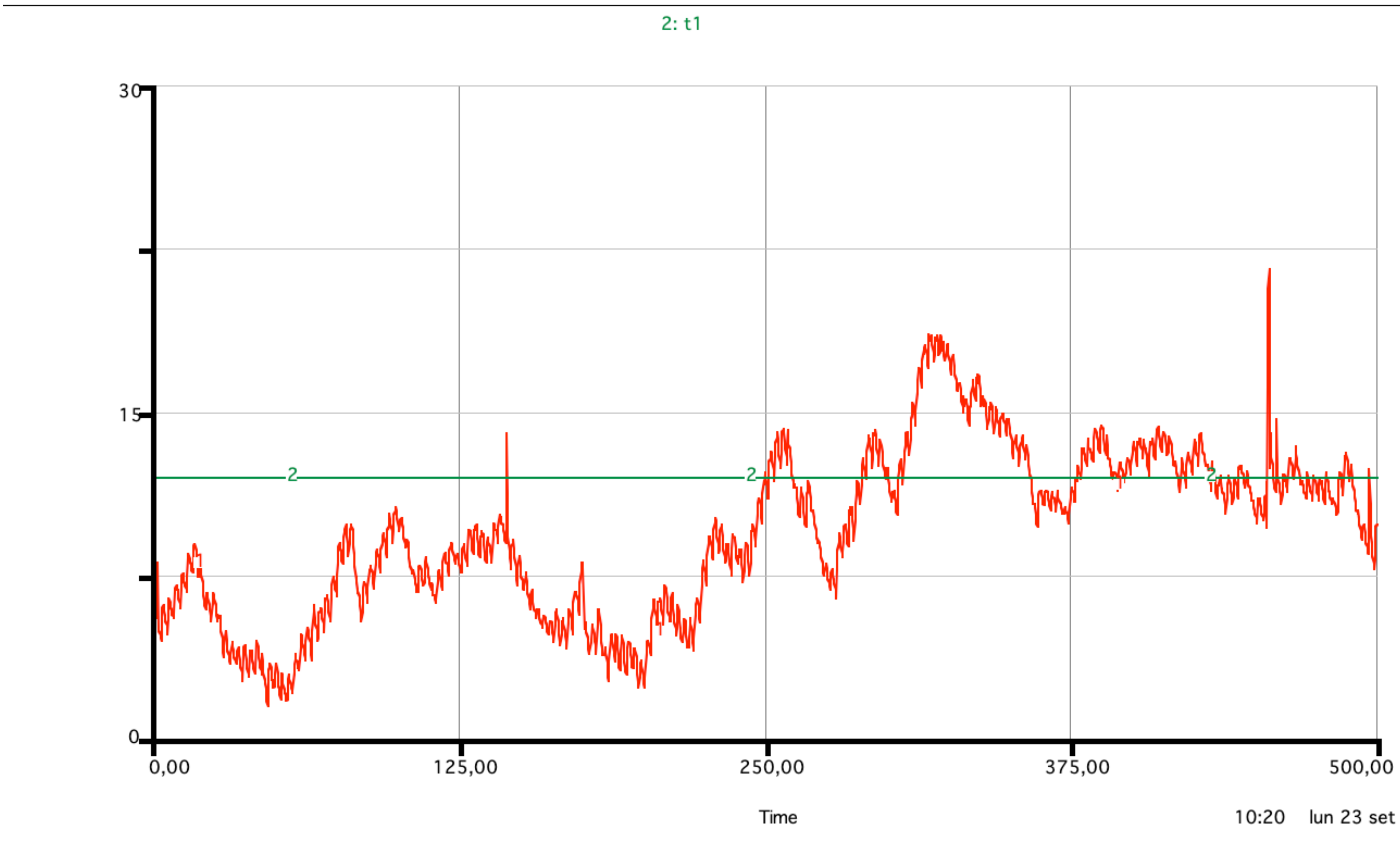
RELATIONS BETWEEN SCATOL8 AND EMS		
	DIRECT CONTRIBUTION	INDIRECT CONTRIBUTION
4.4.1 – Resources, roles, responsibility and authority		
4.4.2 – Competence, training and awareness	★	
4.4.3 – Communication	★	
4.4.4 – Documentation		
4.4.5 – Control of documents		
4.4.6 – Operational control	★	
4.4.7 – Emergency preparedness and responses	★	

DEMING CYCLE CHECK

RELATIONS BETWEEN SCATOL8 AND EMS		
	DIRECT CONTRIBUTION	INDIRECT CONTRIBUTION
4.5.1 – Monitoring and measurement	★	
4.5.2 – Evaluation of compliance	★	
4.5.3 – Non-conformity, corrective and preventive	★	
4.5.4 – Control of records	★	
4.5.5 – Internal audit	★	

DEMING CYCLE ACT

RELATIONS BETWEEN SCATOL8 AND EMS		
	DIRECT CONTRIBUTION	INDIRECT CONTRIBUTION
The Top management should review the EMS at planned intervals for ensuring its adequacy, effectiveness and suitability		★



2: t1
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2
0,00
125,00
250,00
375,00
500,00
Time
10:20 lun 23 set 2

Reports

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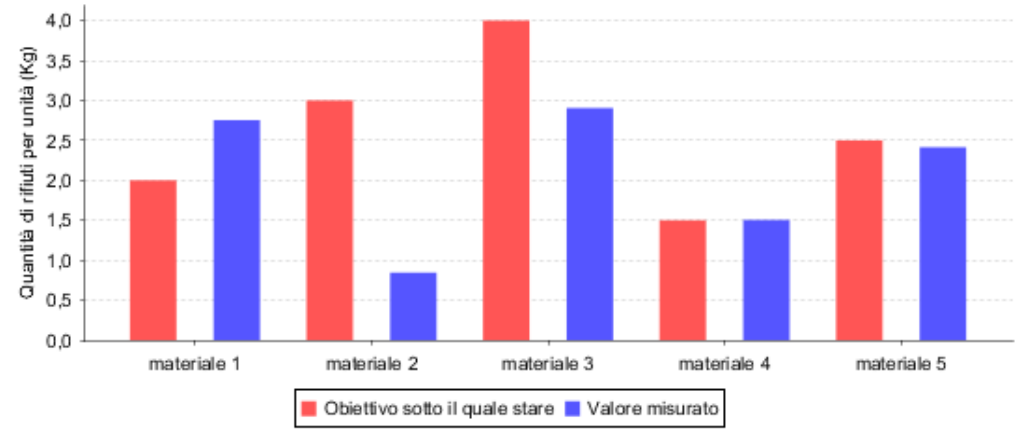
	Azienda X Sistema di Gestione Ambientale Registo indicatori rifiuti LUGLIO 2017	REGSGA9.1.2-1 Pagina 1/1

Riferimento
9.1.2 del Manuale del Sistema di gestione Ambientale
REGSGA9.1.2-1 - Registro indicatori rifiuti



materiale 1:

Obiettivo	2.0 Kg
Produzione (Kg per unità):	2.7529411764705882

materiale 2:

Obiettivo	3.0 Kg
Produzione (Kg per unità):	0.8450704225352113

materiale 3:

Obiettivo	4.0 Kg
Produzione (Kg per unità):	2.9047619047619047

materiale 4:

Obiettivo	1.5 Kg
Produzione (Kg per unità):	1.5046728971962617

materiale 5:

Obiettivo	2.5 Kg
Produzione (Kg per unità):	2.4140969162995596

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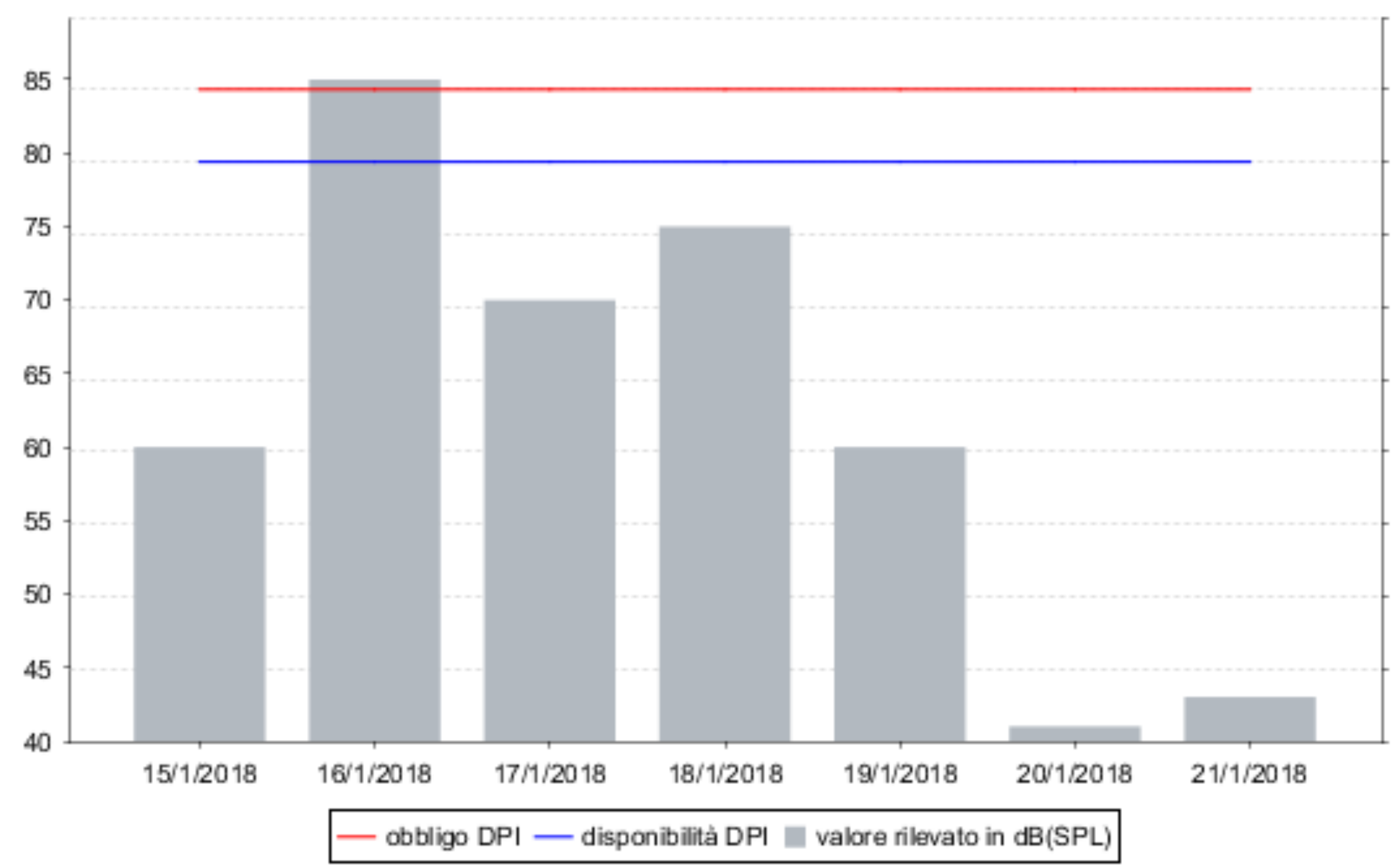
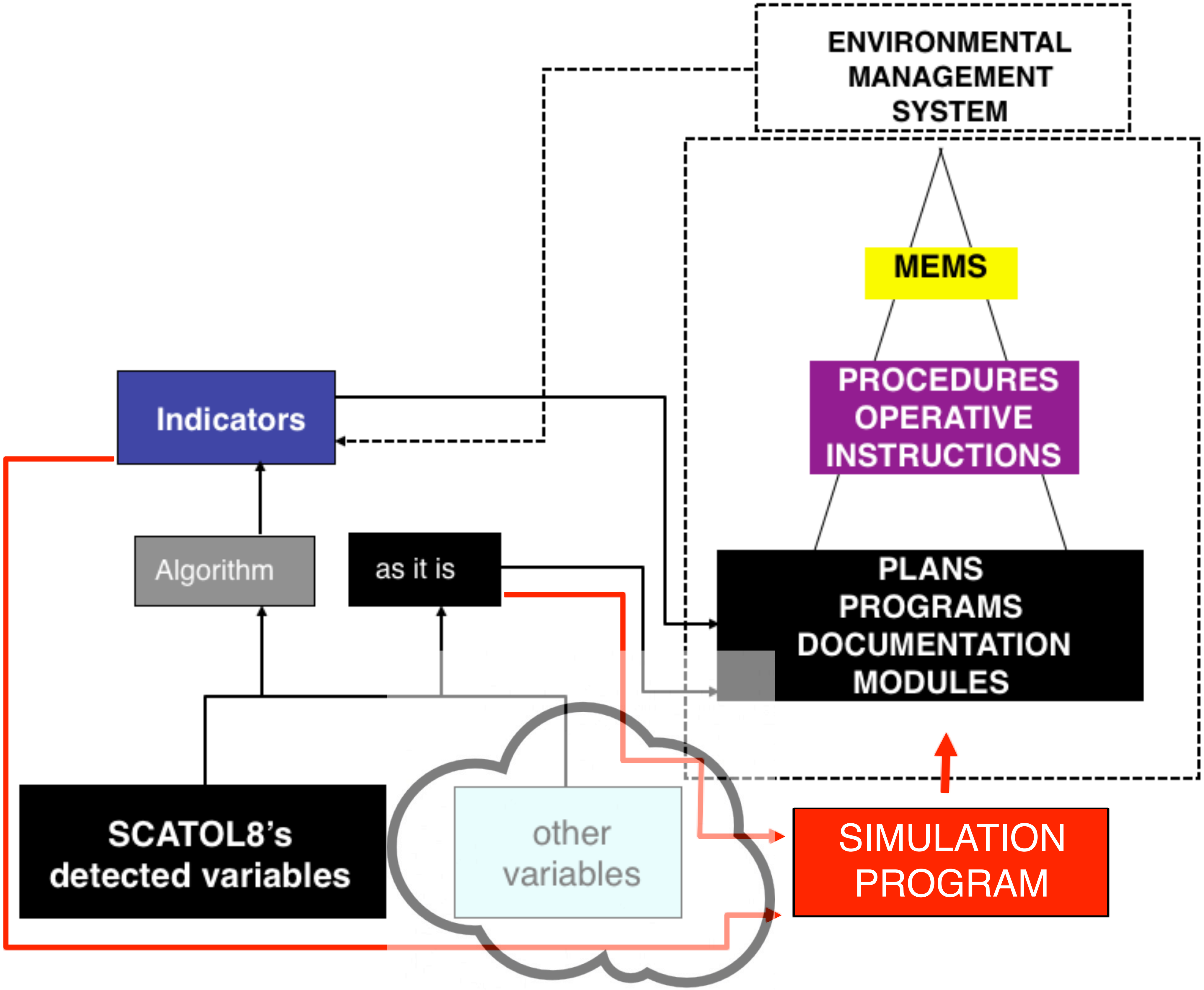
DI TORINO

	Azienda di mockup Sistema di Gestione Ambientale Registro misurazioni del rumore medio GENNAIO 2018	REGSGA9.1.1-1 Pagina 3/5

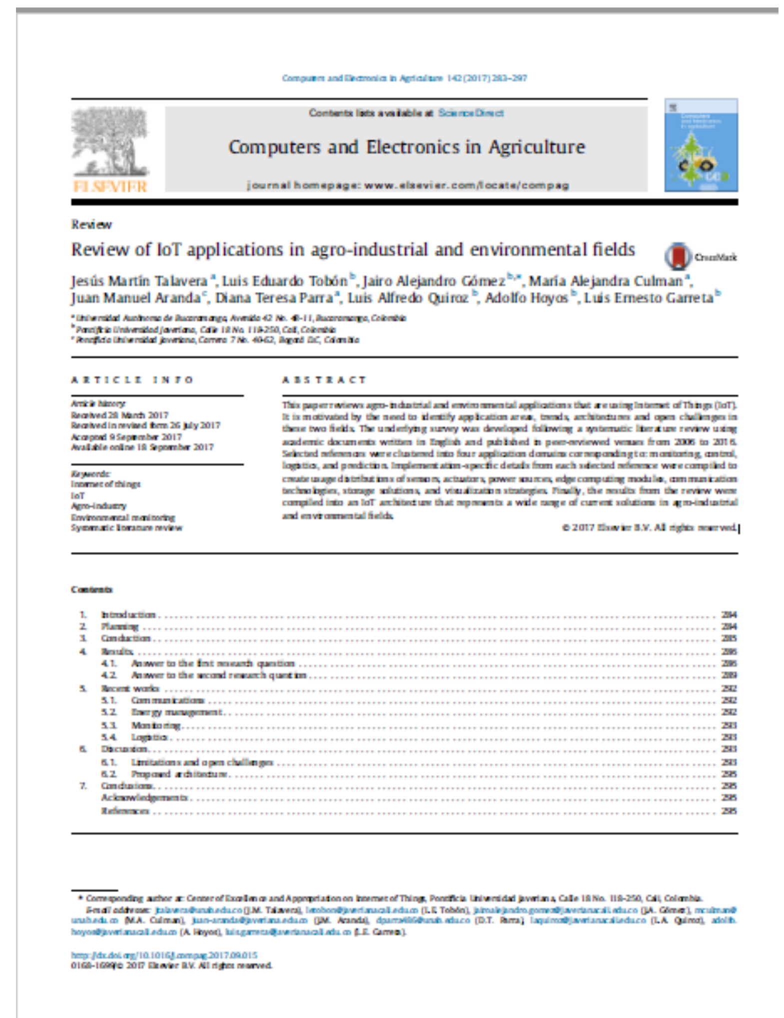
Riferimento
9.1.1 del Manuale del Sistema di gestione Ambientale
REGSGA9.1.1-1 - Registro misurazioni rumore medio area 2




ENVIRONMENTAL MANAGEMENT SYSTEM
MEMS
PROCEDURES OPERATIVE INSTRUCTIONS
PLANS PROGRAMS DOCUMENTATION MODULES
Indicators
Algorithm
as it is
SCATOL8's detected variables
other variables
SIMULATION PROGRAM

Review of IoT applications in agro-industrial and environmental fields

- Computers and Electronics in Agriculture 142 (2017) 283–297
- Jesús Martín Talavera, Luis Eduardo Tobón, Jairo Alejandro Gómez, María Alejandra Culman, Juan Manuel Aranda, Diana Teresa Parra, Luis Alfredo Quiroz, Adolfo Hoyos, Luis Ernesto Garreta



Computers and Electronics in Agriculture 142 (2017) 283–297

Contents lists available at ScienceDirect

Computers and Electronics in Agriculture

journal homepage: www.elsevier.com/locate/compag

Review

Review of IoT applications in agro-industrial and environmental fields

Jesús Martín Talavera[a], Luis Eduardo Tobón[b], Jairo Alejandro Gómez[b,*], María Alejandra Culman[a], Juan Manuel Aranda[c], Diana Teresa Parra[a], Luis Alfredo Quiroz[b], Adolfo Hoyos[b], Luis Ernesto Garreta[b]

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Agro-industry
Environmental monitoring
Systematic literature review

ABSTRACT

This paper reviews agro-industrial and environmental applications that are using Internet of Things (IoT). It is motivated by the need to identify application areas, trends, architectures and open challenges in these two fields. The underlying survey was developed following a systematic literature review using academic documents written in English and published in peer-reviewed venues from 2006 to 2016. Selected references were clustered into four application domains corresponding to: monitoring, control, logistics, and prediction. Implementation-specific details from each selected reference were compiled to create usage distributions of sensors, actuators, power sources, edge computing modules, communication technologies, storage solutions, and visualization strategies. Finally, the results from the review were compiled into an IoT architecture that represents a wide range of current solutions in agro-industrial and environmental fields.

Contents

* Corresponding author at: Center of Excellence and Appropriation on Internet of Things, Pontificia Universidad Javeriana, Calle 18 No. 118-250, Cali, Colombia.

http://dx.doi.org/10.1016/j.compag.2017.09.015

Objective

- Present a systematic literature review about agro-industrial and environmental applications that are using Internet of Things (IoT)

Results (1/2)

- Q1) What are the main technological solutions of the Internet of Things in agro-industrial and environmental fields?

Monitoring (62%)
Control (25%)
Logistics (7%)
Prediction (6%)

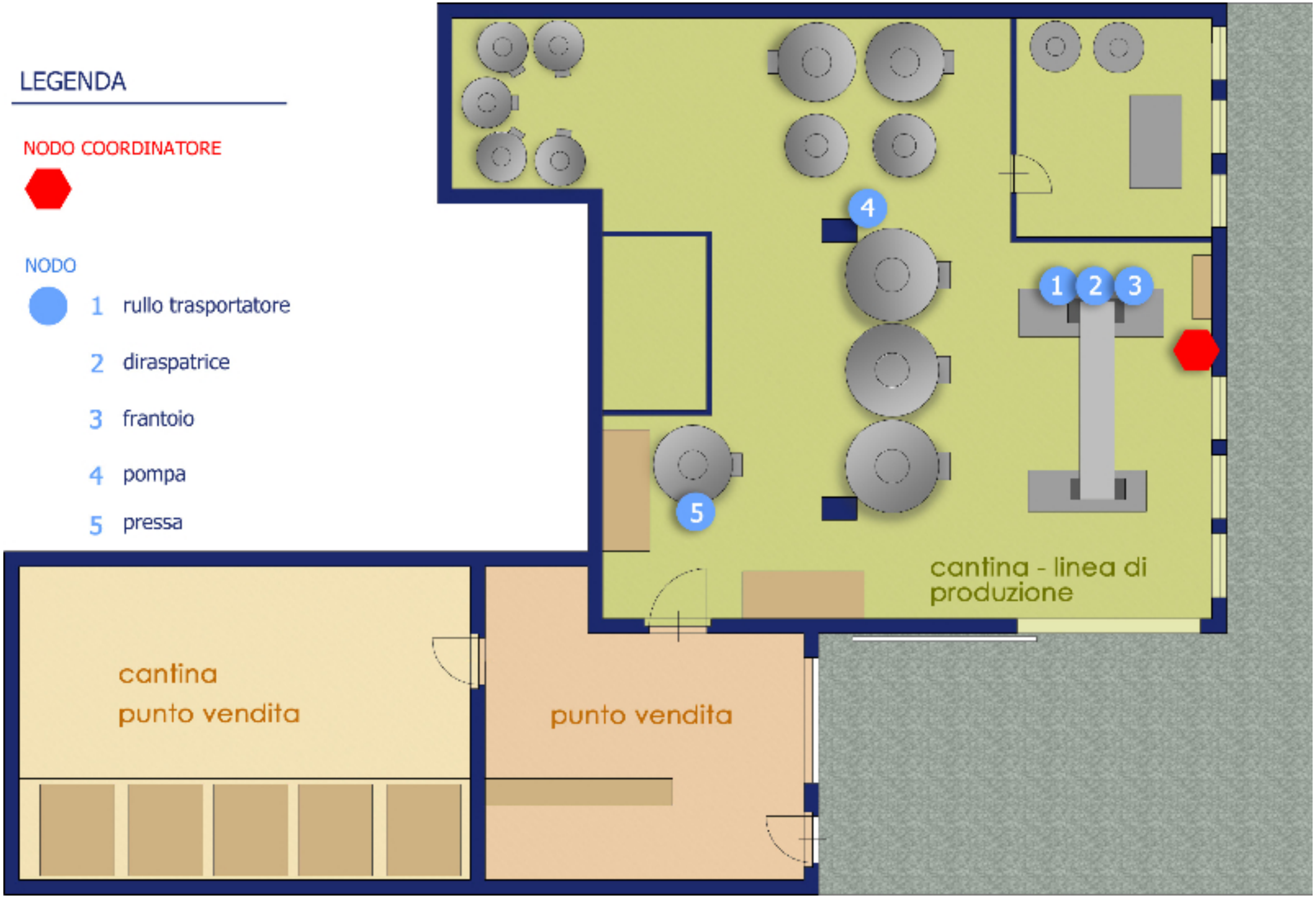
Results (2/2)

- Q2) Which infrastructure and technology are using the main solutions of IoT in agro-industrial and environmental fields?
- Sensing variables:
  1. about 26% of analyzed studies sense temperature
  2. humidity 16%
  3. physicochemical properties 11%
  4. radiation 10%
- Actuator devices: 60% are for irrigation
- Power sources: most monitoring applications prefer rechargeable batteries connected to solar panels
- Communication technologies: 41% Wireless Personal Area Network (WPAN), 36% cellular, others are Lan or RFID/NFC
- Storage: 93% own implementation, 7 cloud services

Nebbiolo Wine Producers Winery
Carema (TO)

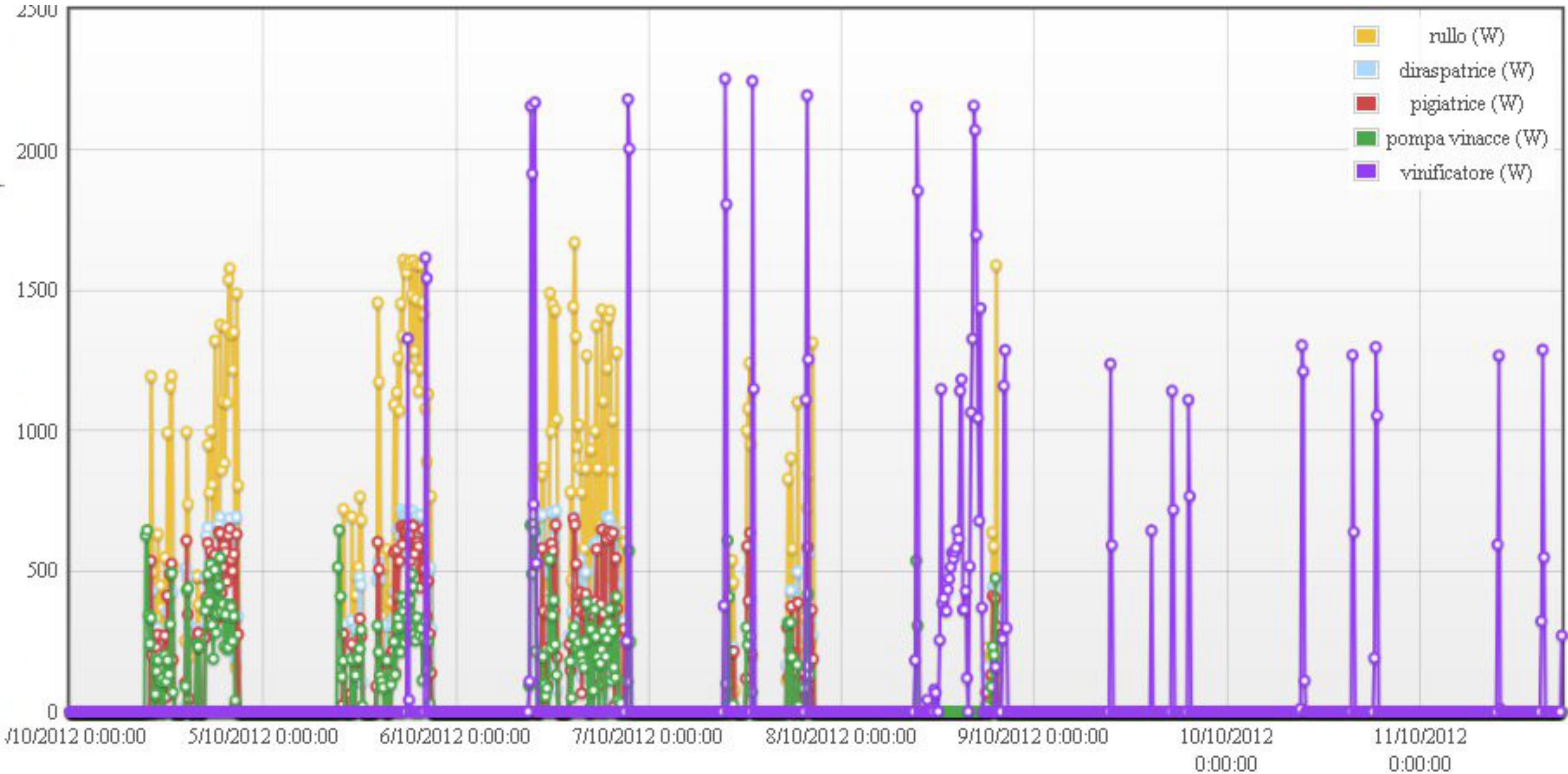
SCATOL8

Nebbiolo Wine Producers Winery Carema (TO)



Nebbiolo Wine Producers Winery
Carema (TO)

Nebbiolo Wine Producers Winery Carema (TO)



Precision Agriculture: Predicting Vineyard Conditions, Preventing Disease

Wireless sensor networks enable many new opportunities and innovations in the field of Predictive systems.

With these, **pest prevention and irrigation can be administered when necessary**. The end result is improved management, better grape quality, and lower costs.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Cà Mariuccia
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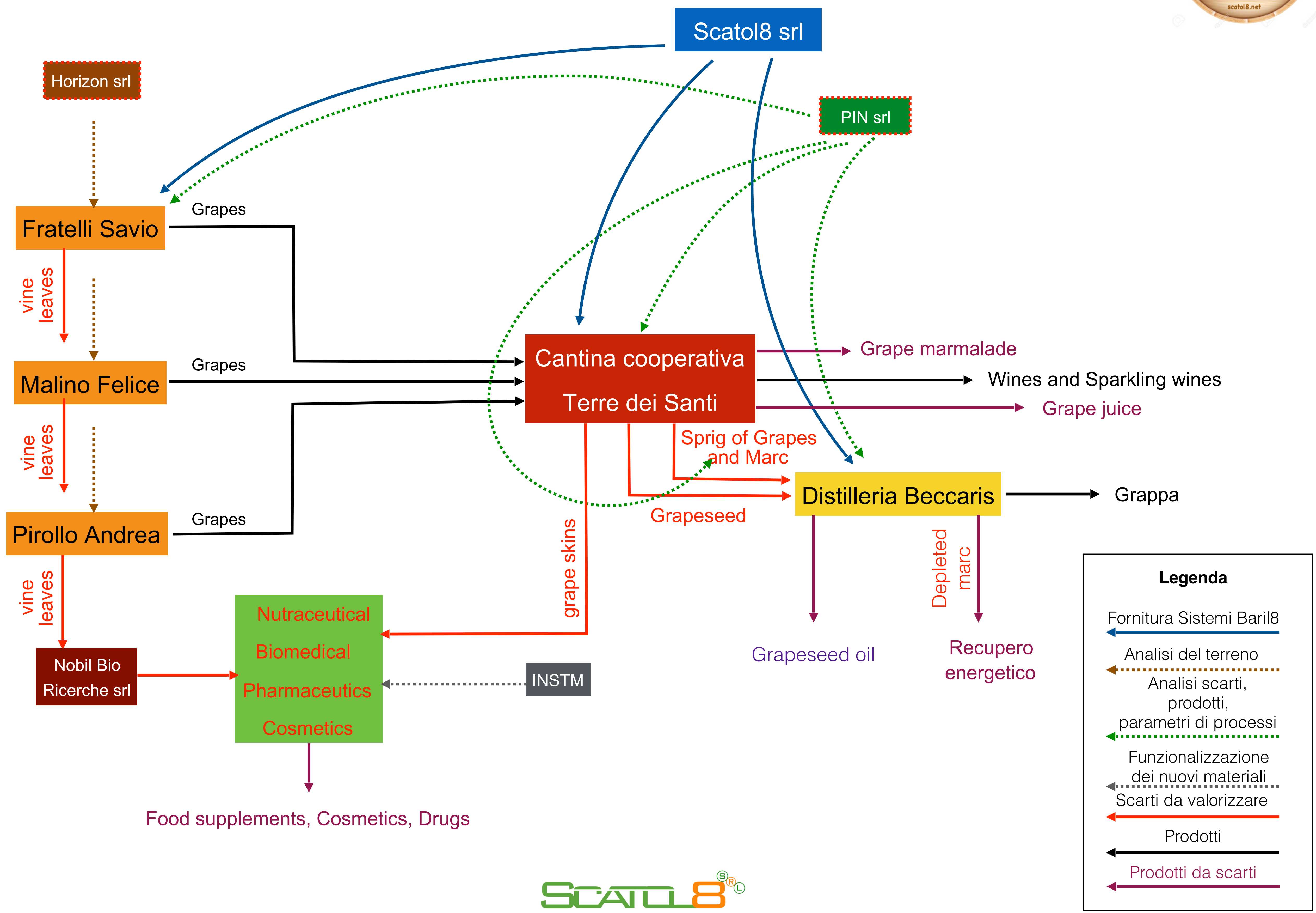
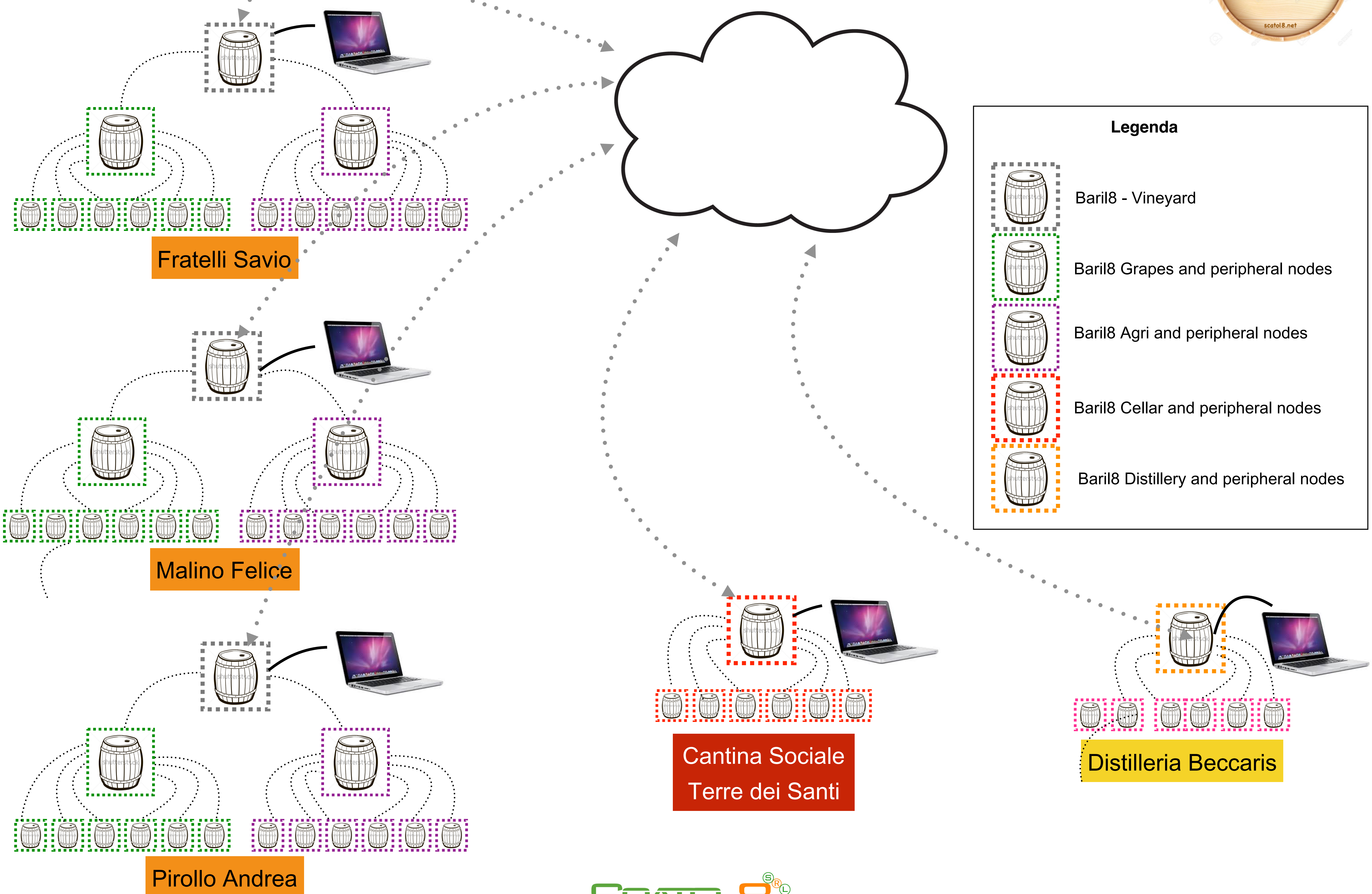
Baril8 - System for the introduction of innovative models of circular viticulture, for production of sustainable territorial quality features

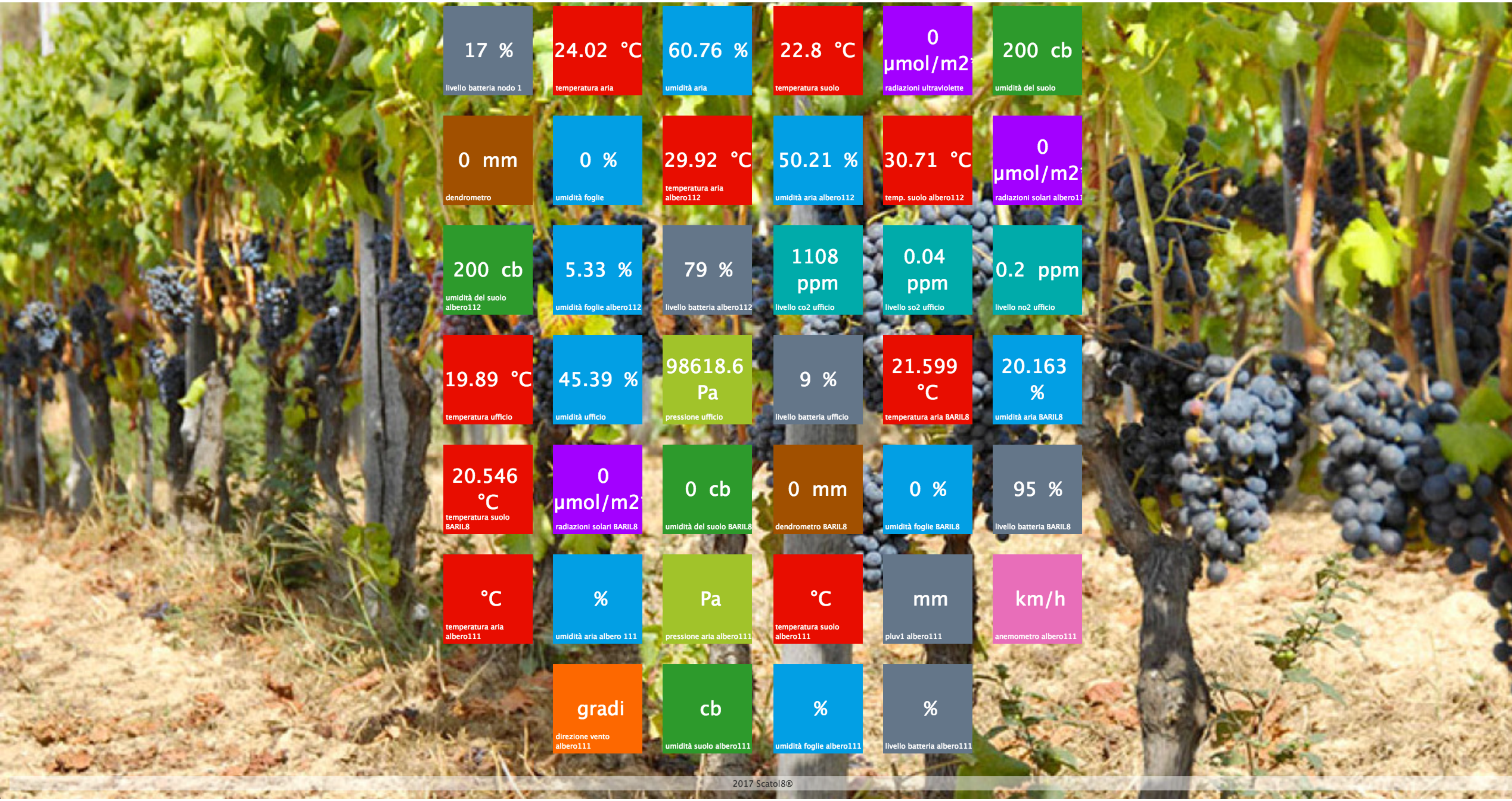
The planning scheme



Baril8 - System for the introduction of innovative models of circular viticulture, for production of sustainable territorial quality features

The architecture of the system




17 %
livello batteria nodo 1
24.02 °C
temperatura aria
60.76 %
umidità aria
22.8 °C
temperatura suolo
0 µmol/m2
radiazioni ultraviolette
200 cb
umidità del suolo
0 mm
dendrometro
0 %
umidità foglie
29.92 °C
temperatura aria albero112
50.21 %
umidità aria albero112
30.71 °C
temp. suolo albero112
0 µmol/m2
radiazioni solari albero11
200 cb
umidità del suolo albero112
5.33 %
umidità foglie albero112
79 %
livello batteria albero112
1108 ppm
livello co2 ufficio
0.04 ppm
livello so2 ufficio
0.2 ppm
livello no2 ufficio
19.89 °C
temperatura ufficio
45.39 %
umidità ufficio
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pressione ufficio
9 %
livello batteria ufficio
21.599 °C
temperatura aria BARIL8
20.163 %
umidità aria BARIL8
20.546 °C
temperatura suolo BARIL8
0 µmol/m2
radiazioni solari BARIL8
0 cb
umidità del suolo BARIL8
0 mm
dendrometro BARIL8
0 %
umidità foglie BARIL8
95 %
livello batteria BARIL8
°C
temperatura aria albero111
%
umidità aria albero 111
Pa
pressione aria albero111
°C
temperatura suolo albero111
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km/h
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gradi
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cb
umidità suolo albero111
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2017 Scatol8®

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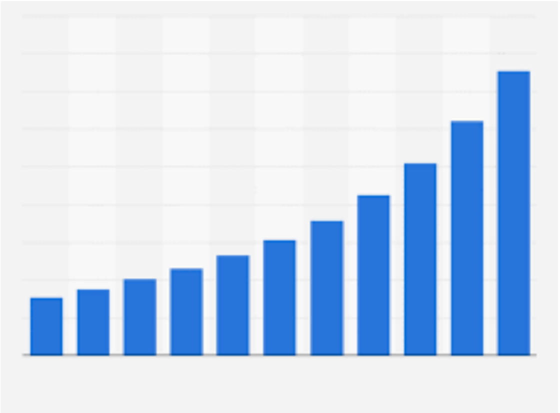
Forecasts



- IHS forecasts that the IoT market will grow from an installed base of **15.4 billion devices in 2015** to **30.7 billion devices in 2020** and **75.4 billion in 2025** (Source: IoT platforms: enabling the Internet of Things, March 2016)

- **The smart agriculture market is expected to grow from $5.18 billion in 2016 to $11.23 billion by 2022, according to Markets and Markets.** (Source: marketsandmarkets.com)

From no data to a deluge of data…. Walmart

- Employees: 2,3 million
- Turnover (2016): 482 billion dollars
- 11.500 stores in 28 Countries
- 260 million customers
- Walmart handles around **30 Petabytes of information**

Agriculture big data characterization

- **Volume** (V1): The size of data collected for analysis.
- **Velocity** (V2): The time window in which data is useful and relevant. For example, some data should be analyzed in a reasonable time to achieve a given task, e.g. to identify pests (PEAT UG, 2016) and animal diseases (Chedad et al., 2001).
- **Variety** (V3): Multi-source (e.g. images, videos, remote and fieldbased sensing data), multi-temporal (e.g. collected on different dates/times), and multi-resolution (e.g. different spatial resolution images) as well as data having different formats, from various sources and disciplines, and from several application domains.
- **Veracity** (V4): The quality, reliability and potential of the data, as well as its accuracy, reliability and overall confidence.
- **Valorization** (V5): The ability to propagate knowledge, appreciation and innovation.

Source: Chi, M., et al., 2016. Big data for remote sensing: challenges and opportunities.

Agriculture areas and big data usage

No.	Agri-area	No. of papers	V1 (Volume)	V2 (Velocity)	V3 (Variety)
1.	Weather and climate change	4	M	M	H
2.	Land	5	H	L	M
3.	Animals' research	4	M	H	L
4.	Crops	3	M	M	L
5.	Soil	2	M	L	L
6.	Weeds	1	L	H	L
7.	Food availability and security	4	M	L	M
8.	Biodiversity	1	M	L	H
9.	Farmers' decision making	2	H	M	H
10.	Farmers' insurance and finance	5	H	M	M
11.	Remote sensing	3	H	M	M

Source: A. Kamilaris, A. Kartakoullis, F. X. Prenafeta-Boldú; A review on the practice of big data analysis in agriculture

Opportunities / Barriers

- Higher Effectiveness
- Higher Efficiency
- Involvement of the supply chain
- Customer focus

- Investments
- Lack of Knowledge
- Cultural acceptance

Consequences

- Newcomers (Data mining, Data Scientists, Business Intelligence)
- Startups
- New hybridization of SME's
- Agri-Enterprise concentrations
- Higher Standardization


Thank You for Your kind attention!
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