FC Powered RBS

"Demonstration Project for Power Supply to Telecom Stations through FC technology"

Grant Agreement 278921

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www.fcpoweredrbs.eu

PROJECT OVERVIEW

- Call topic: “Demonstration of industrial application readiness of fuel cell generators for power supply to off-grid stations, including the hydrogen supply solution” (SP1-JTI-FCH. 2010.4.2).
- Application Area Early Markets

- **Starting Date**: 01/01/2012
- **Duration**: 48M
- **Budget**: € 10,591,649
- **Funding**: € 4,221,270
- **Countries**: Belgium, Denmark, Italy, Switzerland
- **2** systems tested in R&D centers for benchmarking
- **15** real RBS station power generation systems in selected sites field trials.

Project Partners

ERICSSON — Project Coordinator

GREENHYDROGEN.DK

Danotherm Power

European Commission
JRC's Institute for Energy and Transport

European Commission

Dipartimento di Ingegneria Industriale
Università degli Studi di Roma "Tor Vergata"

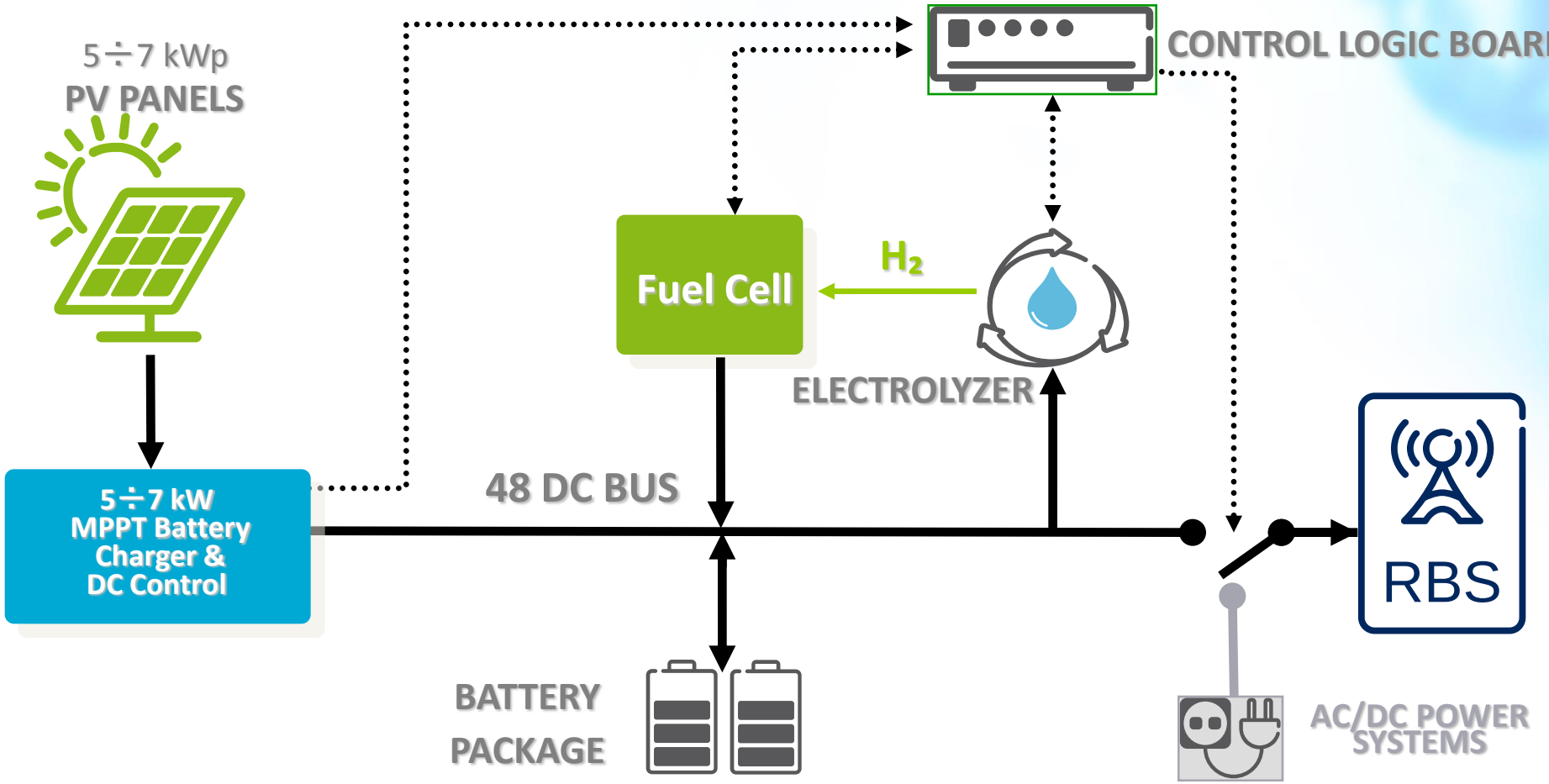
Telecom Operators involved

TIM

3

- Scope: Demonstrate the advantages of a FC stationary application in term of Total Cost of Ownership in telecom off-grid radio sites.
- Assess the market readiness of the FC technology vs the telecom reliability demanding targets

Solution: System Overview



PROJECT TARGETS AND ACHIEVEMENTS (ref. AIP 2010)

Programme objective/target	Project objective/target	Project achievements to-date	Expected final achievement
Demonstrate the advantages of hydrogen and fuel cells compared to the solutions used today	Increasing the hours of unattended operation due to the higher efficiency	Av. # yearly refuelling at site: • 21 with FC Methanol • 28 with FC H2 • 35 with current Diesel solution High efficiency linked to low power requirements (typical of off-grid radio); better scalability than diesel generators	Confirm preliminary analysis and provide details
Show the commercial operator value proposition.	TCO analysis with real business case approach	Preliminary TCO analysis performed based on measurements from field trial (see slide related to TCO)	Assessment of preliminary results and final report
Demonstrate the FC maturity level with a significant number of live installations	15 radio sites	12 radio sites running in real condition on field (see slide 'On field Demo Sites Overview')	As to-date
Show a solid approach for moving forward the standards developments	Real sites integrating the FC with existing telecom technologies following a certification procedure	Standard Certification procedure for the activation and acceptance of FCs on site is available. Telecontrol and Telemetering to get real time data, remote alarms and to control remotely are in place.	As to-date
Dissemination of results	Participation in seminars, press, etc.	Media coverage globally and in Italy. Conferences, events and publications	Reach out the audience with final results

PROJECT TARGETS AND ACHIEVEMENTS (MAIP)

Programme objective/target	Project objective/target	Project achievements to-date	Expected final achievement
Source : MAIP 2008-2013 (2011 release)			
AA4 Early Market - 1-6 kW back-up power system Cost €/kw – 2015: 1,500 €/kW	Not declared in DoW Note: FC planned to be used to substitute the diesel generator	4k€/kW (FC only) 12K€/kW (whole system)	As to-date
AA4 Early Market - 1-6 kW back-up power system Volume in the EU 2015: 8,000 units (1,000 electr)	Not declared in DoW 15 radio sites + 2 Lab sites	Up **&** Running: 12 (2 electr) + 2 Lab sites	As to-date
AA4 Early Market - 1-6 kW back-up power system Efficiency/Energy Consumption 2015: N/A	Not declared in DoW	FC Methanol and H2: on going analysis	Final Efficiency calculation to be performed along with the LCA analysis
AA4 Early Market - 1-6 kW back-up power system Durability 2015: 10,000 h	10,000 h	12,000 h for the first deployed site	> 12,000 h for the first site

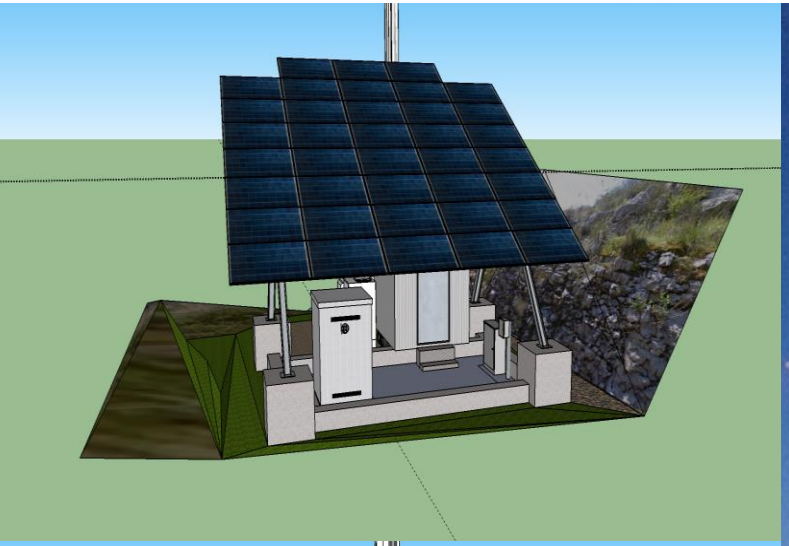
PROJECT ACHIEVEMENTS SUMMARY

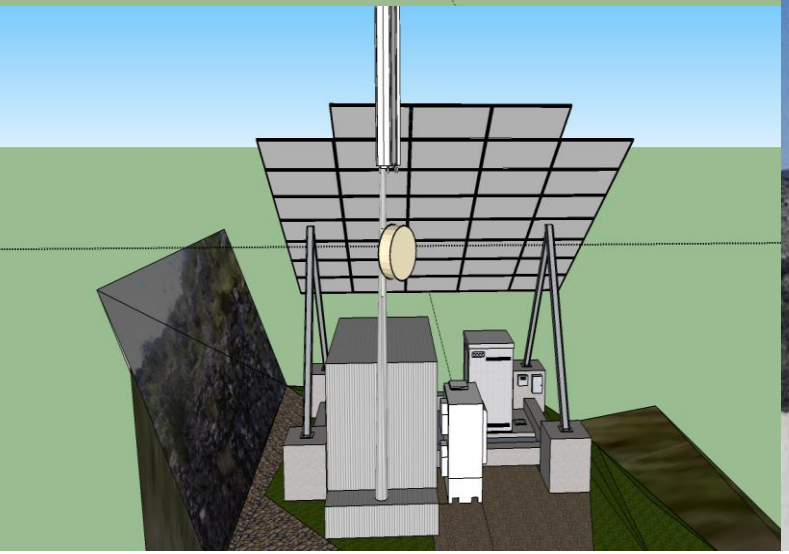
Telecom Operators	› Telecom Operators engagement › Use of Radio Sites in real conditions for the wide demo	2 Operators as users Legal contracts (with terms and conditions)
Solution Design	› E2E Solution Design for Telecom Radio Sites › Test lab validation	2 R&D Test Labs validation activities
Market Readiness	› Operators expectations › Safety Regulations › Legal constraints, Permitting, H2 hosting › Radio sites req.s, acquisition, O&M › FC manufacturers compliance	12 Sites running (av >11 months) 1 Site installed (1 fuel cell by MES n.a.) 1 Site ready, but vandalism
Dissemination Exploitation	› Wide dissemination global/local › Exploitation towards operators across Mediterranean countries	Global dissemination towards media and other operators

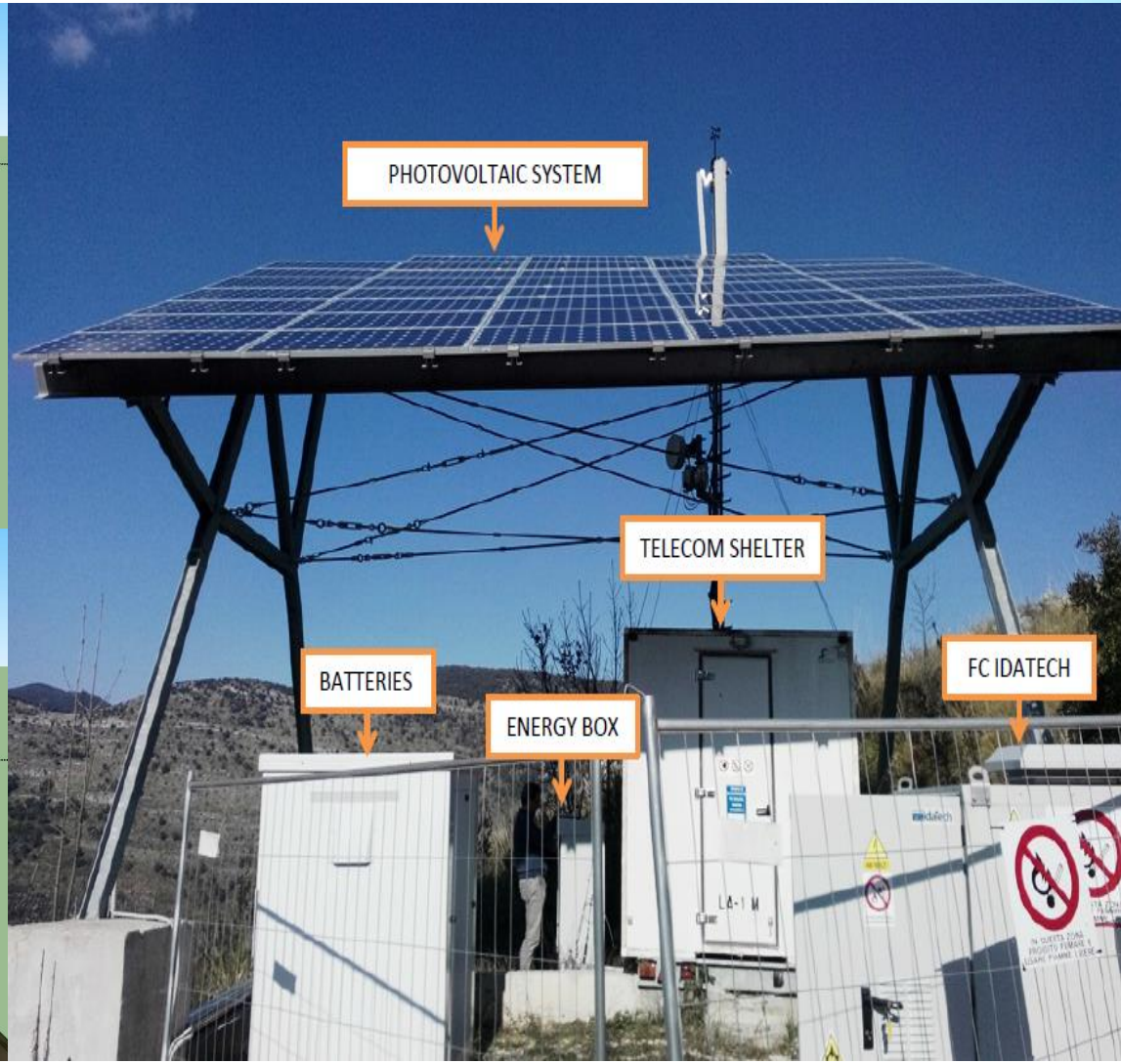
ON FIELD DEMO SITES OVERVIEW

N.	User	Location	District	FC type	Status	Started
1	TIM	Sonnino	Latina	Ballard Methanol	**Up & running**	**01-June-2014**
2	TIM	Fiano Romano	Roma	H2 Dantherm	**Up & running**	**25-Set-2014**
3	TIM	Borgo Grappa	Latina	H2 Dantherm GH Electrolyzer	**Up & running**	**04-Nov-2014**
4	TIM	Colle Turchina	Viterbo	H2 Dantherm	**Up & running**	**17-Nov-2014**
5	TIM	Sasso	Roma	H2 Dantherm	**Up & running**	**19-Nov-2014**
6	TIM	Baschi 2	Viterbo	H2 Dantherm	**Up & running**	**24-Nov-2014**
7	TIM	Sant'Oreste	Roma	Ballard Methanol	**Up & running**	**02-Dec-2014**
8	TIM	Campoleone	Latina	H2 Dantherm	**Up & running**	**30-Apr-2015**
9	3 Italia	Bari Circonvallazione	Bari	H2 Dantherm	**Up & running**	**15-Nov-2015**
10	3 Italia	Bari San Giorgio	Bari	H2 Dantherm	**Up & running**	**15-Nov-2015**
11	Energy Partner	S.Angelo in Vado	Pesaro Urbino	H2 Dantherm GH Electrolyzer	**Up & running**	**10-Nov-2015**
12	TIM	Bagni VT	Viterbo	H2 Dantherm	**Up & running**	**03-Nov-2015** (initially MES, now Dantherm technology)
13	TIM	Pofi	Frosinone	H2 MES	**Installed**	Not integrated - MES left FC by MES not released
14	3 Italia	Bari Capurso	Bari	H2 Dantherm	**Not installed**	Ready, but destroyed by vandals

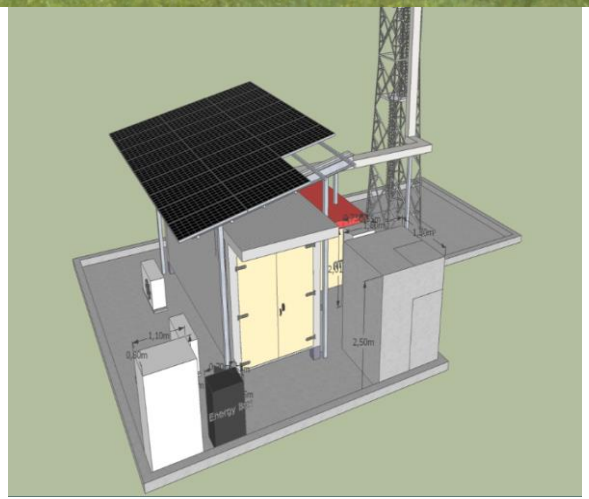
SONNINO INSTALLATION LAYOUT



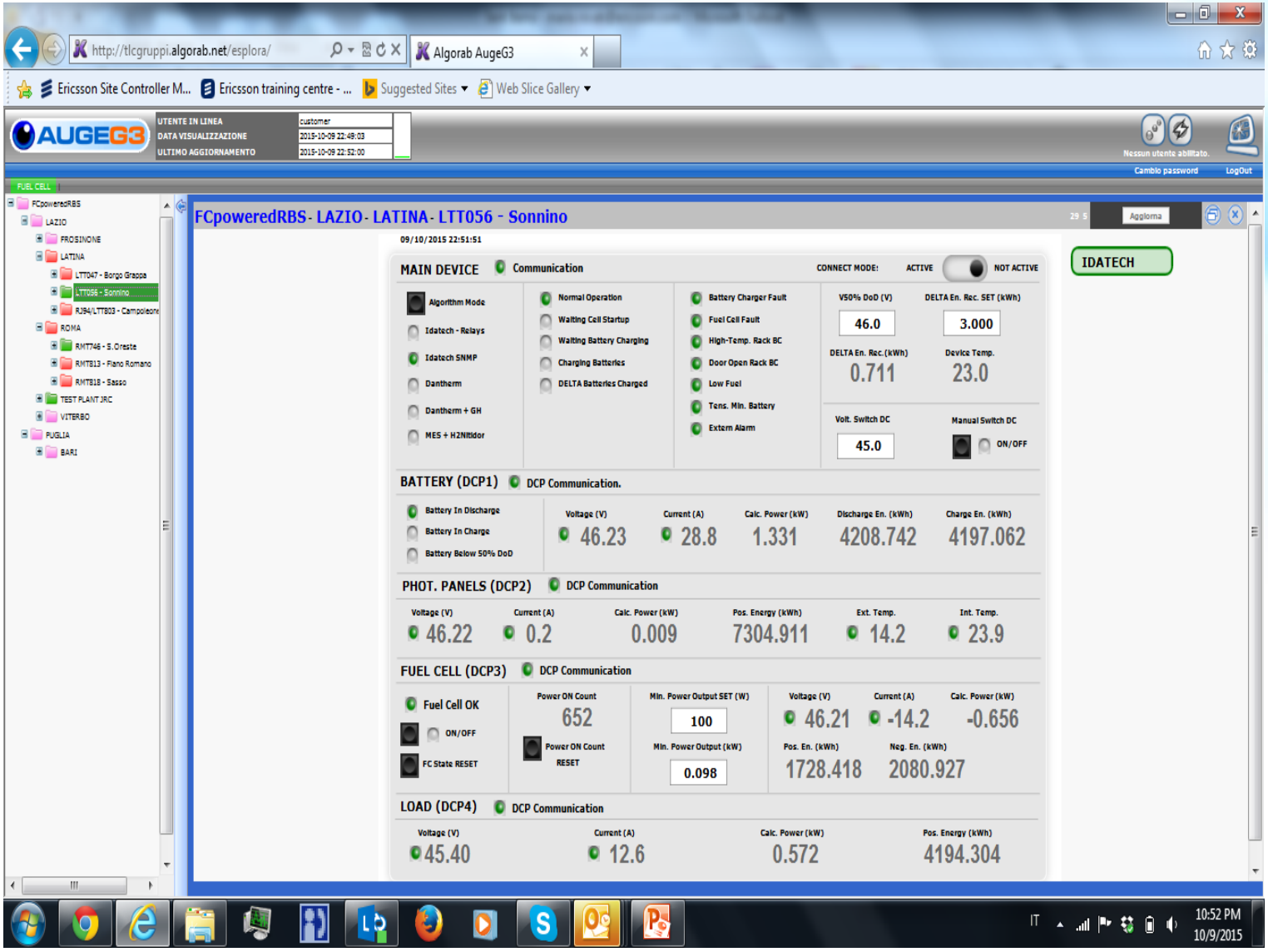




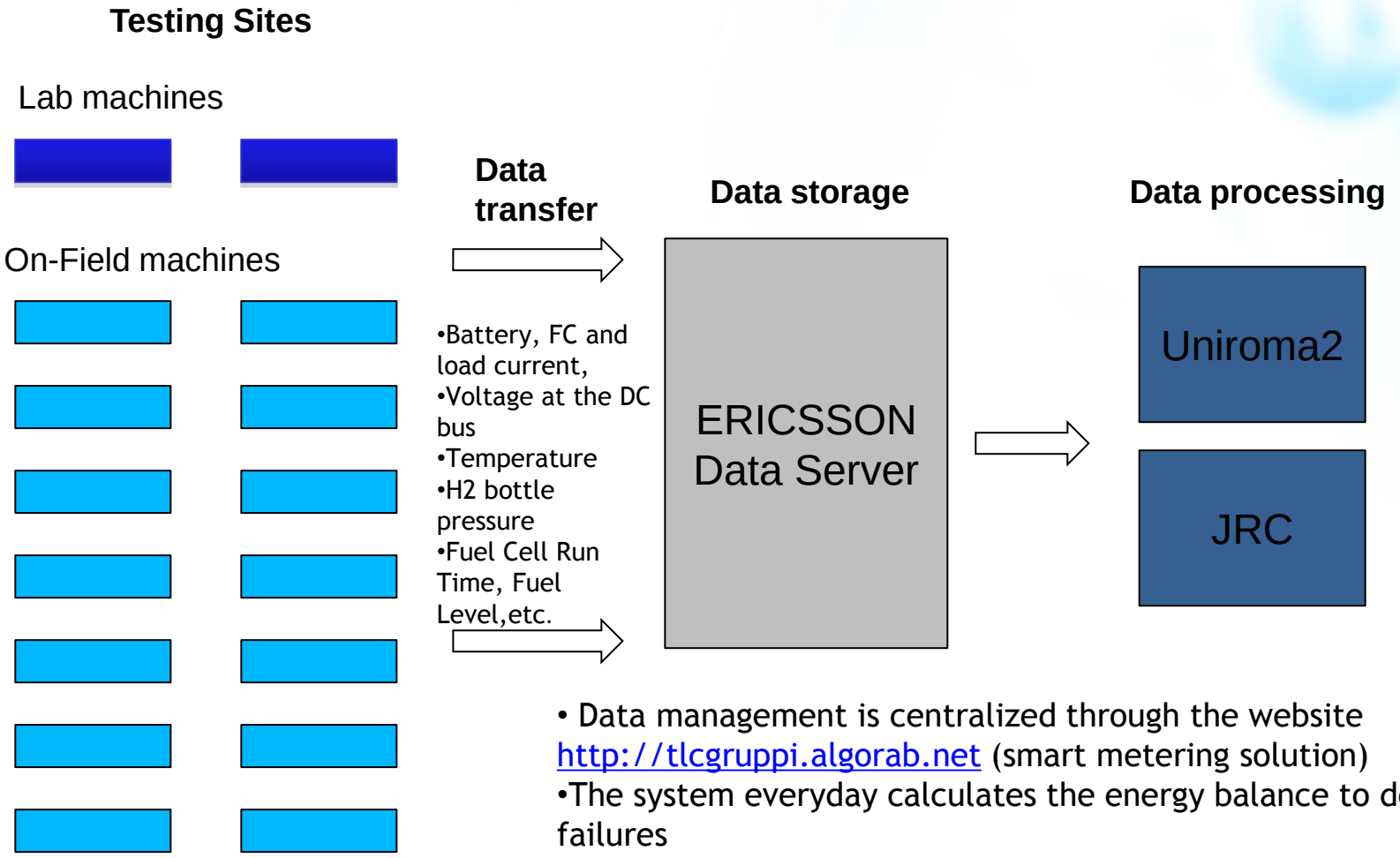
FIANO ROMANO INSTALLATION LAYOUT



SMART METERING SOLUTION



DATA ANALYSIS METHODOLOGY

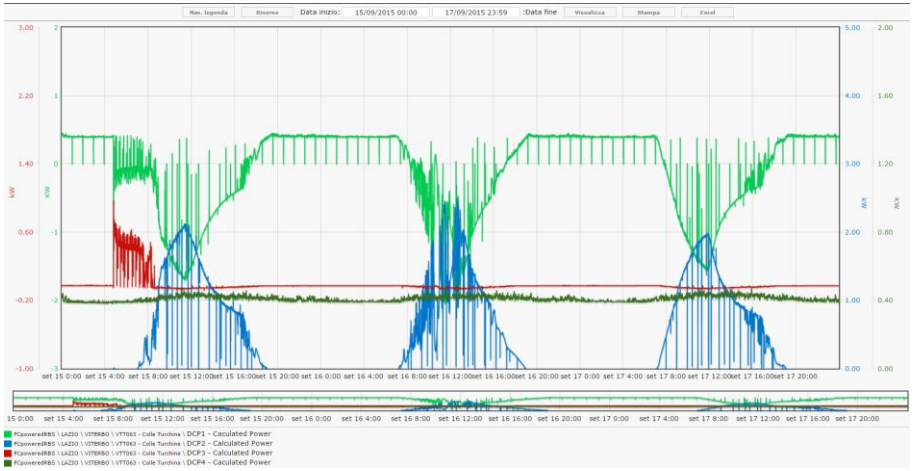


• Data management is centralized through the website http://tlcgruppi.algorab.net (smart metering solution)
•The system everyday calculates the energy balance to detect failures
•The data system is capable of providing plots on the web for all the different parameters of interest over time
•Data are treated on an integral basis toward the calculation of the TCO

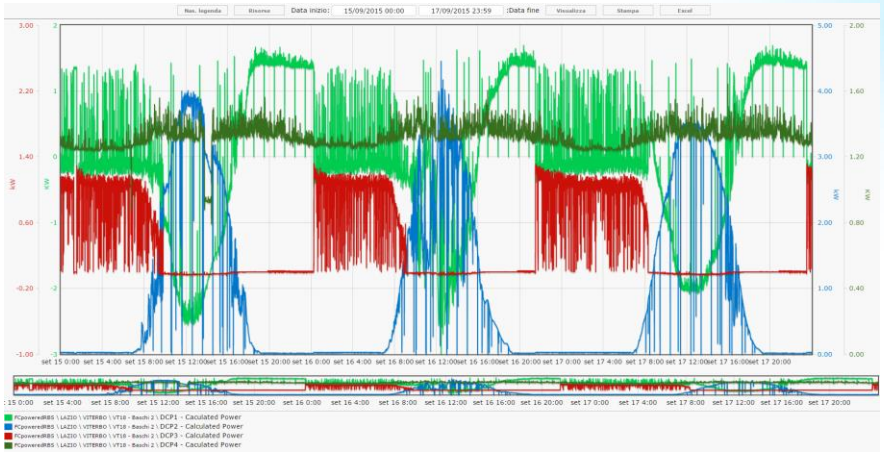
Energy fluxes data toward TCO calculation

- Analysis of detailed measurements allows the evaluation of instantaneous and global performances, providing a better understanding of the system over time
- Each site has peculiar characteristics (in terms of load, solar radiation profiles, ambient conditions,etc) and thus different fuel consumption profiles, affecting TCO on a per site basis

Colle Turchina site av. load 420 W, 15-17 Sept. 2015



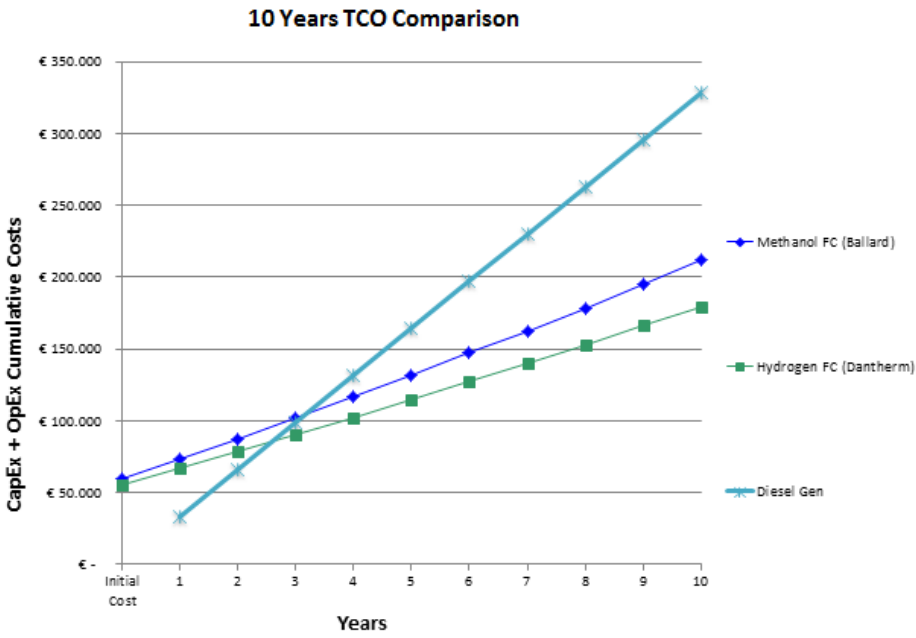
Baschi site av. load 1400 W, 15-17 Sept. 2015



Fuel cell : measured power in W (RED line)
PV: measured power in W (BLUE line)
Battery Package: measured power in W (GREEN line)

Showing the commercial value proposition in telecom market

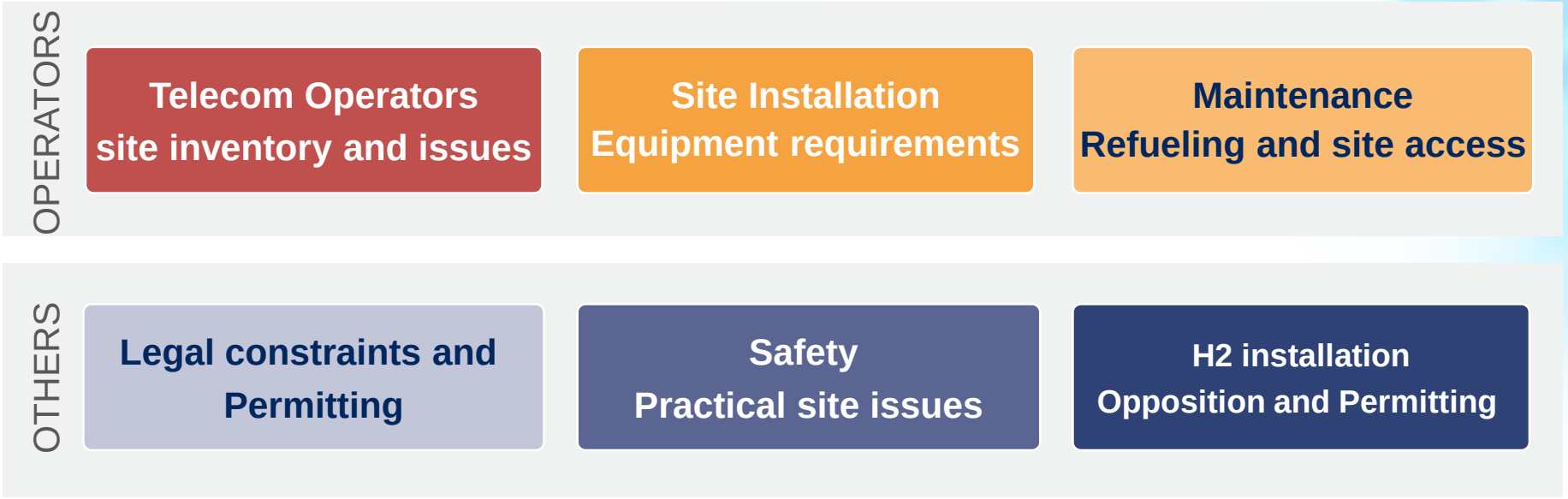
- Fuel Cell technologies meeting the demanding requirements of Telecom sector (technical, authorization, etc.), widely demonstrated in real conditions at operators radio sites
- Total Cost of Ownership analysis over 10 years (TCO: upfront investments and operational costs) to benchmark economically the FC hybrid systems vs off-grid radio sites current solution (i.e. diesel generator rent and refueling service).
- Payback calculation results:
  - FC H2 vs diesel: payback in almost 3 years
  - FC Methanol vs diesel: payback in 3 years
  - Increasing saving after payback time



Preliminary results of TCO analysis, to be finalized at project end

RISK AREAS and LEARNT LESSONS

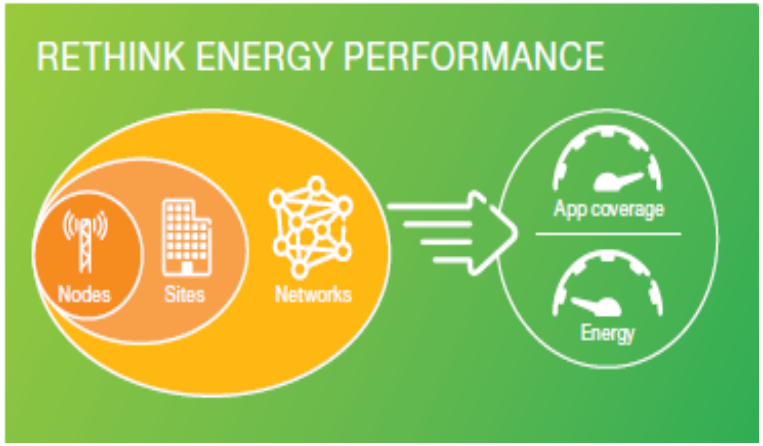
Adopting Fuell cells in the market handling critical challenges



Generating learnt lessons for next projects to push further
FC technologies in the telecom market

DISSEMINATION (1/4)

ERICSSON SUSTAINABILITY & CR Annual Report 2014



Read more:
http://www.ericsson.com/res/thecompany/docs/corporate-responsibility/2014-corporate-responsibility-and-sustainability-report.pdf

FOR REMOTE AREAS, EXPLORING NEW APPROACHES

In a project funded by the European Union (EU), Ericsson and partners are exploring how fuel cell technology can power off-grid telecom stations. With growing penetration of mobile services, the number of remotely located radio base stations (RBS) is on the rise. Unable to connect to the electricity grid, they rely instead on batteries and diesel generators that can generate substantial carbon emissions. FCpoweredRBS, led by Ericsson, is a large-scale demonstration activity in collaboration with the EU Joint Research Centre, and includes mobile operator Telecom Italia and 3 Italia. The project looks at the viability of fuel cells and other types of alternative energy supply as an alternative to standard power sources. A fuel cell is a device that generates electricity by a chemical reaction.

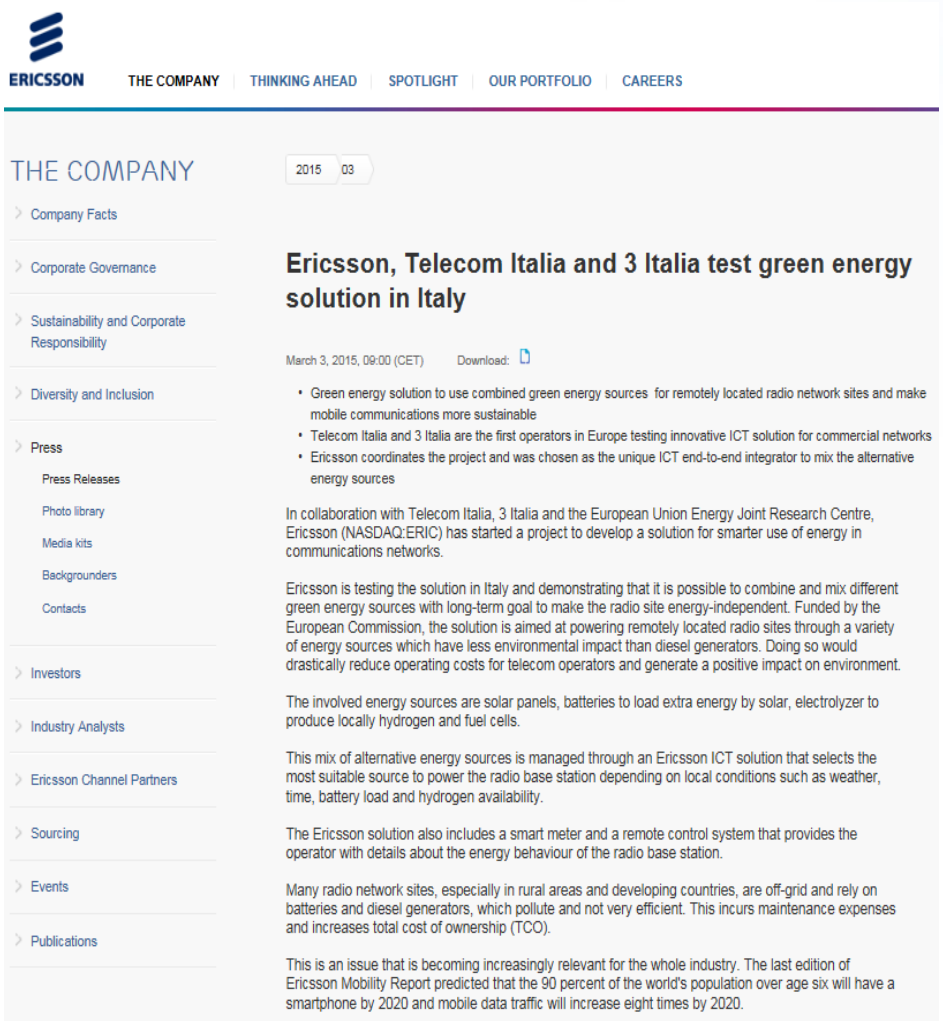
Integrated solution

In ongoing field trials, the power supply of several radio base stations is replaced with a new energy supply based on a solution that integrates different components (fuel cells, photovoltaics and batteries). The goal is increased energy efficiency and improved total cost of ownership. Results show that the amount of unattended hours can be increased, thanks to efficient use of the alternative energy sources and the storage potential of hydrogen. This means lower operational costs and positive impact on the environment for the operator.

Alternative energy sources are selected based on local conditions such as weather conditions, time of day, battery load, and hydrogen. Electrolyzers contribute to generating hydrogen locally, with the aim of making the radio site energy-independent in the longer term.

Final project results are expected during 2015.

DISSEMINATION (2/4)



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2015 03

Ericsson, Telecom Italia and 3 Italia test green energy solution in Italy

March 3, 2015, 09:00 (CET) Download:

- Green energy solution to use combined green energy sources for remotely located radio network sites and make mobile communications more sustainable
- Telecom Italia and 3 Italia are the first operators in Europe testing innovative ICT solution for commercial networks
- Ericsson coordinates the project and was chosen as the unique ICT end-to-end integrator to mix the alternative energy sources

In collaboration with Telecom Italia, 3 Italia and the European Union Energy Joint Research Centre, Ericsson (NASDAQ:ERIC) has started a project to develop a solution for smarter use of energy in communications networks.

Ericsson is testing the solution in Italy and demonstrating that it is possible to combine and mix different green energy sources with long-term goal to make the radio site energy-independent. Funded by the European Commission, the solution is aimed at powering remotely located radio sites through a variety of energy sources which have less environmental impact than diesel generators. Doing so would drastically reduce operating costs for telecom operators and generate a positive impact on environment.

The involved energy sources are solar panels, batteries to load extra energy by solar, electrolyzer to produce locally hydrogen and fuel cells.

This mix of alternative energy sources is managed through an Ericsson ICT solution that selects the most suitable source to power the radio base station depending on local conditions such as weather, time, battery load and hydrogen availability.

The Ericsson solution also includes a smart meter and a remote control system that provides the operator with details about the energy behaviour of the radio base station.

Many radio network sites, especially in rural areas and developing countries, are off-grid and rely on batteries and diesel generators, which pollute and not very efficient. This incurs maintenance expenses and increases total cost of ownership (TCO).

This is an issue that is becoming increasingly relevant for the whole industry. The last edition of Ericsson Mobility Report predicted that the 90 percent of the world's population over age six will have a smartphone by 2020 and mobile data traffic will increase eight times by 2020.

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RESULTS MAGAZINE

N°38

DECEMBER 2014/JANUARY 2015

research*eu results magazine N°38 / December 2014/January 2015

SPECIAL FEATURE

INTERVIEW

FUEL CELLS TO CONNECT OUR SMARTPHONES TO THE OUTSIDE WORLD

The potential of hydrogen and fuel cell applications goes way beyond the development of green cars. The FCPOWEREDRBS team is determined to prove this with a Fuel Cell technology to power off-grid telecom stations. They believe not only that this solution is better than standard generators, but also that it provides a significant advantage in terms of 'Total cost of ownership' (TCO).

Read More:

http://www.ericsson.com/thecompany/press/releases/2015/03/1898842

DISSEMINATION (3/4)

ictBusiness.it
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Verdi e sostenibili: così cambiano, con Ericsson, le telecomunicazioni

La soluzione Ict dell'azienda svedese è il "cervello" che orchestra un sistema di alimentazione green, basato su diverse fonti di energia, testato sul campo in diverse stazioni radio di Telecom Italia e 3 Italia. Acqua e aria, insieme alla tecnologia, permetteranno di ridurre l'impatto ambientale delle reti telefoniche.

Pubblicato il 14 aprile 2015 da Valentina Bernocco Pagine: 1, 2

Energia · Rinnov

RINNOVABILI | PETROLIO | GAS | GREEN LI

PROGETTO ITALIANO SOSTENUTO DALL'EUROPEAN UNION ENERGY JOINT RESEARCH CENTRE

Rinnovabili per le antenne radio: il progetto di Ericsson, Telecom e 3 Italia

- La volontà è quella di sfruttare un mix di energie alternative per produrre idrogeno e celle a combustibile per alimentare le stazioni radio base, soprattutto nelle zone rurali e nei Paesi emergenti, che ad oggi sfruttano il diesel.
- SPECIALE Sviluppo sostenibile

MIRIAM CARRARETTO | mercoledì 11 marzo 2015 - 19:00 commenti

Mi piace | Condividi 2 | Tweet 2 | G+1 0

Tutto su: Rinnovabili | Ambiente | Salute | Sviluppo sostenibile | Smartphone | Efficienza energetica | Ericsson | Telecom Italia | Italia | TLC

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A CURA DI LUCA SALVIOLI | 16 APRILE 2014

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Tecnologie ▸ Energia ▸ Le fonti rinnovabili per le antenne radio: il progetto Ericsson, Tim e 3 Italia

Torna alla home del dossier

Le fonti rinnovabili per le antenne radio: il progetto Ericsson, Tim e 3 Italia

11 marzo 2015

Un mix di energie rinnovabili per per produrre idrogeno e celle a combustibile per alimentare le stazioni radio base, specie nelle zone rurali e nei Paesi emergenti. Il progetto nasce da una collaborazione tra Ericsson, Telecom Italia, 3 Italia e lo European Union Energy Joint Research Centre.

Ericsson sta testando la nuova soluzione, finanziata dalla

TECNOLOGIA / MOBILE WORD CONGRESS

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MOBILE WORLD CONGRESS

Le reti mobili pulite nascono in Italia

Ericsson testa nel nostro Paese le prime stazioni radio green

DISSEMINATION (4/4)

CONFERENCES AND PUBBLICATIONS	
Conference	• Poster and Public presentation to the European Fuel Cell Conference 2013 (Rome Dec 2013) http://www.europeanfuelcell.it/ • Accepted to the 36th International Communications Energy Conference (Vancouver – Oct 2014) http://www.intelec2014.org/ • Poster and Public presentation to the European Fuel Cell Conference 2015 (Naples Dec 2015) http://www.europeanfuelcell.it/
Publications	• Paper : ”FUEL CELL BASED POWER SYSTEMS TO SUPPLY POWER TO TELECOM STATIONS” published in the International Journal of Hydrogen Energy, Issue 39, 2014 • Paper : “POWER SUPPLY TO TELECOM STATIONS THROUGH FC TECHNOLOGY” Accepted for publication by INTELEC, 2014

SYNERGIES WITH OTHER PROJECTS AND INITIATIVES

- Ericsson participation to **ONSITE** project and UniRoma2 participation to **FITUP** for synergies, LCA methodology and lesson learnt sharing;
- Connection with **PEMBeyond** project for FC introduction in TLC market;
- Sharing experiences on FC trial organization and experiences:
  - workshop on Apr 24th 2014 in Istanbul, together with the **FITUP** project, at the Bilgi University
  - workshop on Feb 25th 2015 in Barcelona together with FCH JU projects **HYPER**, **SUAV** and **H2TRUST**

HORIZONTAL ACTIVITIES

- Three days course "*FC POWERED RBS: Solution Introduction*" at the Ericsson Rome Training Center;
- Course "*ElectraGen ME Expert training*" at Ericsson lab: three days to secure training to field operators on the Hydroplus FC (Integration/Commissioning and Operation/Maintenance);
- Job Training by Dantherm to field operators on FC Integration/Commissioning of H2 FC
- Web based streaming sessions published on the project web site.

EXPLOITATION PLAN/EXPECTED IMPACT

Exploitation activities:

- Some partners (e.g. Ericsson and Dantherm/Ballard) already started engagements and sharing of experience and results towards several telecom operators in EU countries
- Ericsson is widening the exploitation in the market in Maghreb
- This project is at TRL9 since:
  - Actual end-2-end integration of all system components demonstrated in operational environment in real conditions
  - Main achievements in this project consist in showing the benefits of FCs in telecom market. Next step is to bridge the wide demo activity in real conditions towards a sustainable business meeting the market requirements
  - Next step is commercialization