Water saving and plural uses in agriculture: water resources potential for Climate Change mitigation in irrigation management

Scientific Symposium on "Small Solutions for big water related problems - Innovative microarrays and small sensors to cope with water quality and food security"

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Layout

- **Goal** – to identify potential contribution in water resources management in agriculture (Irrigation) for mitigation of Climate Change
- **Index**
  - Political framework: CC policies and WFD
  - Water saving and plural uses
    - Water balance, CWR and earth observation tecniques
    - MMHP in irrigation Consortia
- **Results and discussion**

CC political framework

- **UNFCCC - United Nation Framework Convention on Climate Change (Rio 1992) – Climate common resource**
  - Expressed by Protocol (Kyoto)
  - Obj. ***GHG reduction*** 5,2% (1 period) – Italy 6,5%
- **Agricultural policies (CC)**
  - Food security (demographic growth);
  - ***GHG mitigation***
  - Increase resilience of agr. system to climate change

European framework

- EU Leadership position:
  - 2010 «DG Climate» - ECCP European Climate Change Plan
  - Agr. CC mitigation potential linked to:
    - Renewable energy production;
    - CO_2 capture and storage
  - Europa 2020 (climate-energy 20-20-20)
  - Europa 2030 (**GHG reduction 40%** - 27% renewables)
  - Roadmap 2050 (**GHG red. 80/95%** - Agr. 42/49%)

WFD 2000/60/EU

- No quality issues….

….but «quantitative» and «economic» topics concerning water management in Agri.

- Estimated consumption: 60-80% (South Italy)
- Need to save water:
  - to increase availability for other uses (economic evaluation..)
  - lower volumes of water used in the fields also results in energy savings, and thus lower CO_2 emissions.

Develop innovative solutions and metodologies in water resource management in agriculture (Irrigation) to contribute to CC mitigation goals:

Water savings and Plural uses

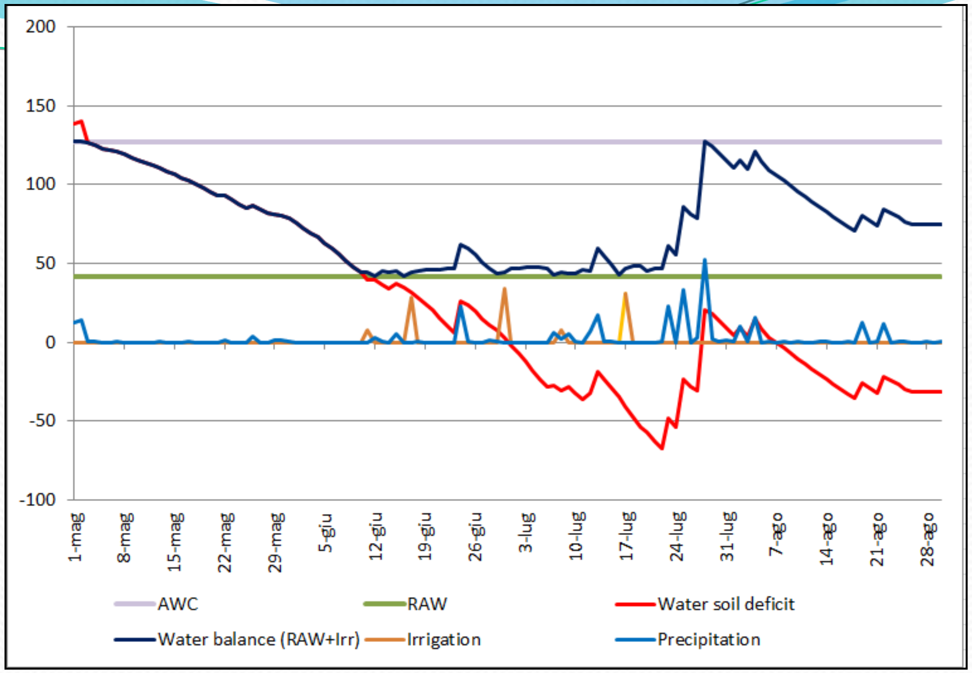
Saving water from irrigation management – CWR (Etc)

- CWR: “total water needed for evapotranspiration (Etc) for a given crop in a specific climate regime” (ICID, 2000)
- Technical approach to evaluate CWR
  - Calculated trough **water balance**:
    - Represent the actual evapotranspiration (value resulting from the actual conditions of water availability in the soil)
  - Calculated through **remote sensing**:
    - Represent the potential evapotranspiration, namely the maximum value for a crop under standard condition - excellent agronomic and water management conditions (FAO metodology).

Water balance

- Explores the interactive relationship between **energy** (radiation) and **moisture** in a fixed a place

- Based on the determination of the **water deficit in the soil,** which is derived by modeling <u>moisture demand</u> (potential evapotranspiration *ETc*) and <u>supply</u> (precipitation and soil moisture storage).



Where the soil is sufficiently wet (water content is between Available Water Capacity - AWC, and Readily Available Water - RAW), the soil supplies water fast enough to meet the atmospheric demand of the crop. As the soil water content drops below RAW, soil water cannot respond to the transpiration demand and the crop begins to experience stress, the occurrence of this condition involves irrigation.

Remote sensing

Based on FAO Metodology

a) Crop coefficient approach

$$ETc = Kc * Eto$$

Where:
Kc is the **crop coefficient**, which is specific for each crop and their grown status (fixed agronomic value)
ETo is the **reference crop evapotranspiration** (hypothetical reference crop)

NDVI Index

Requires the definition of a **linear relationship between NDVI** (Normalised Differences Vegetation Index, derived from the processing of multispectral imagery) and **Kc**.

$$K_c = aNDVI + b$$

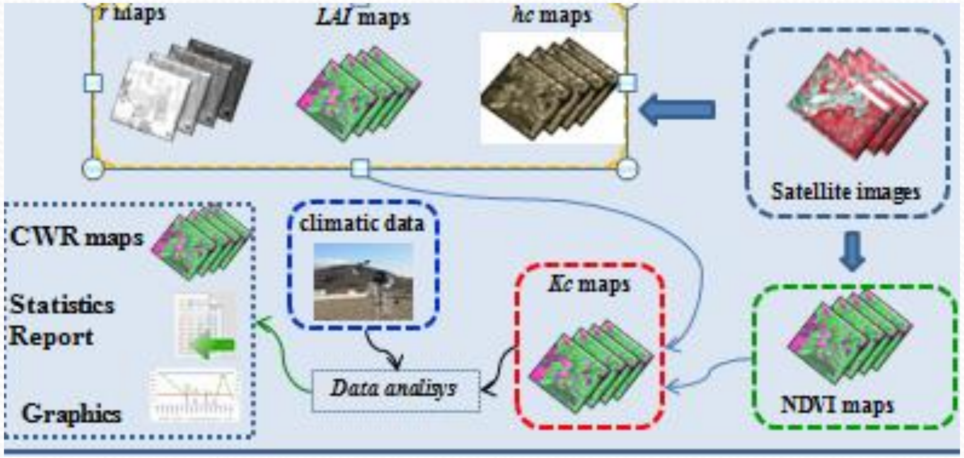
b) Direct ETc calculation

$$Kc = \frac{ET_p}{Eto} = f(S, T_a, RH, U; r, LAI, hc)$$

Where:
Ta is air temperature, *RH* relative humidity, *U* wind speed and *S* incoming short wave radiation, are **climatic data**. Surface albedo *r*, leaf area index *LAI*, crop height *hc* are **vegetation variables**

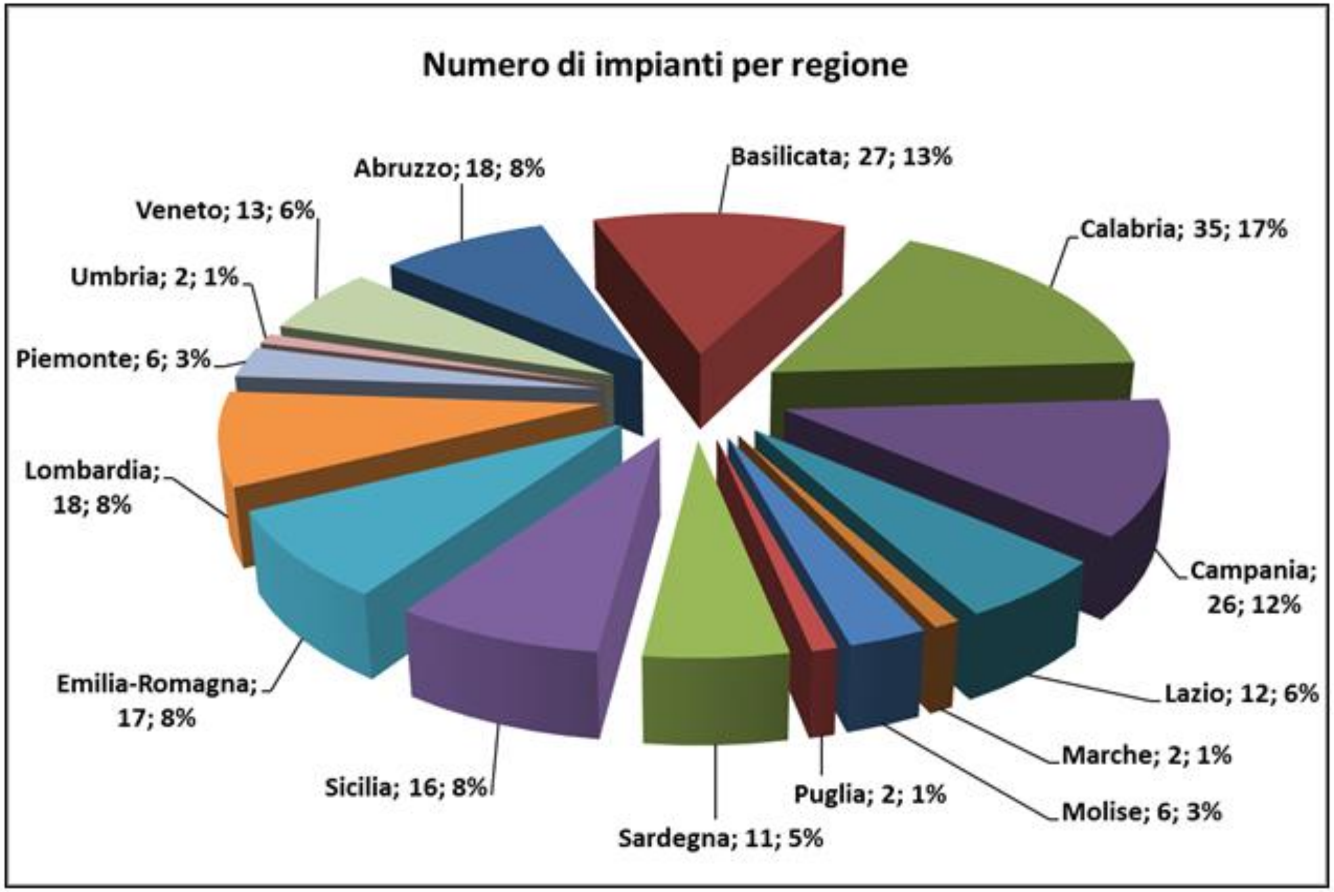
Analytical approach

Vegetation variables r, LAI, hc are estimated from the processing of **multispectral imagery**.



Promoting plural uses

Agensud: MMHP (< 1MWp) survey results (L. 179/2012)

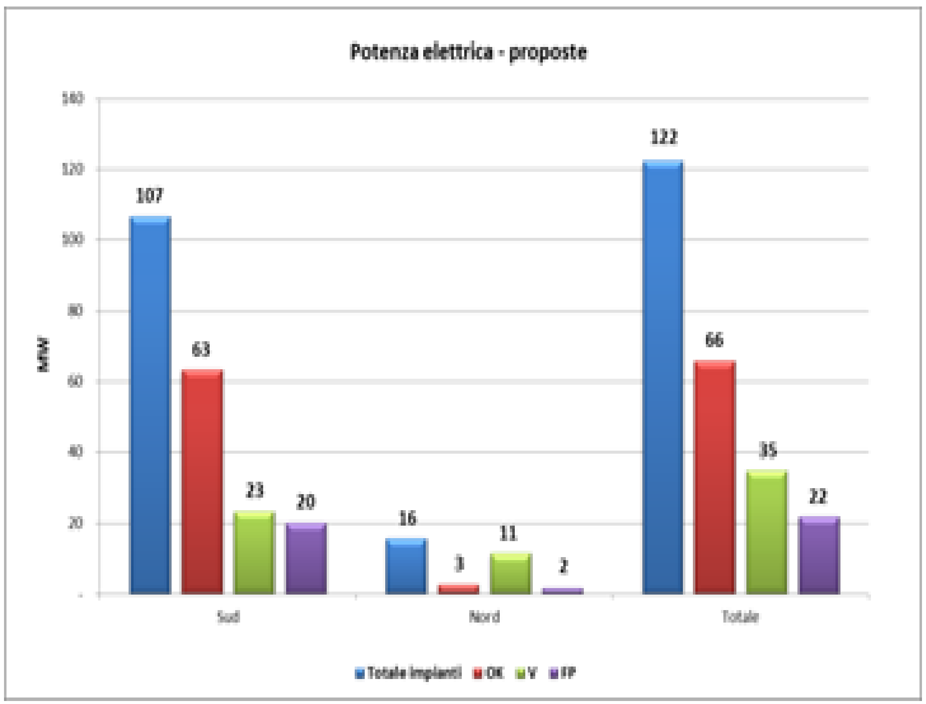


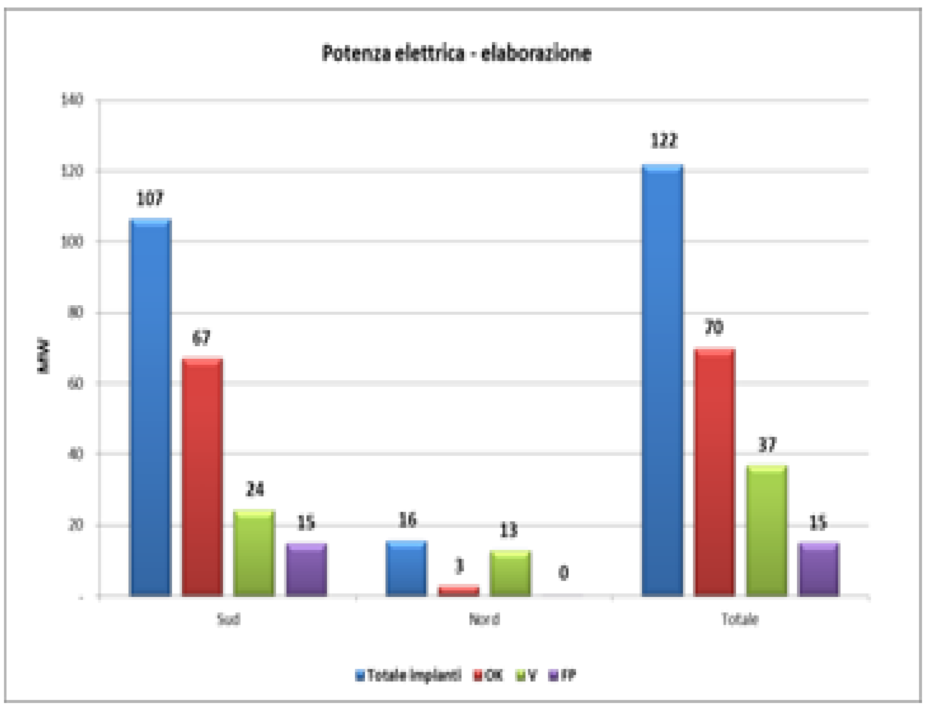
Fonte: MiPAAF - G.C. ex Agensud, 2012

155 South
56 North

Power

- **<u>Total power</u>** of **211 plants** was **122 MW**, of which 106 MW respectively (South Central) and 16 MW (North Central).

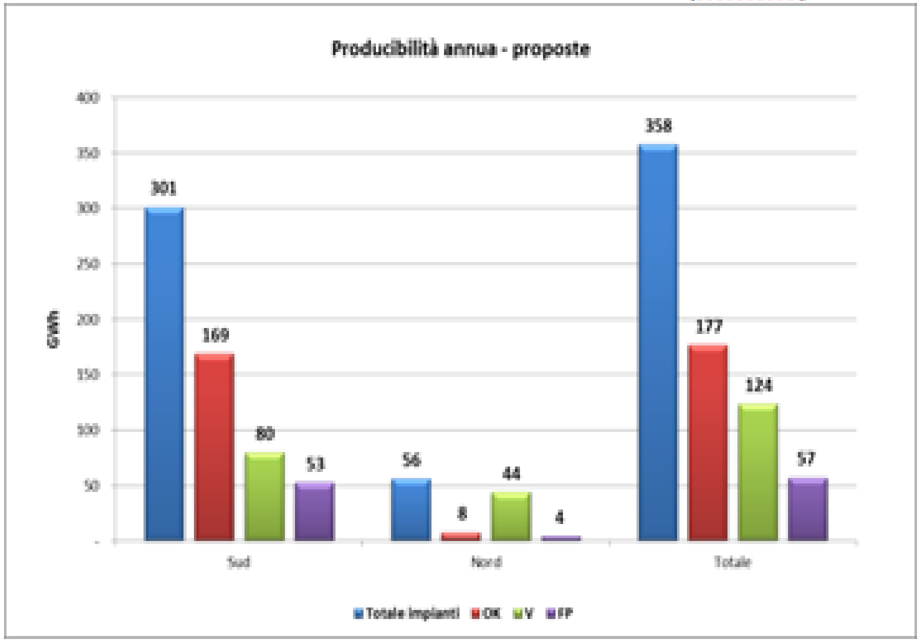


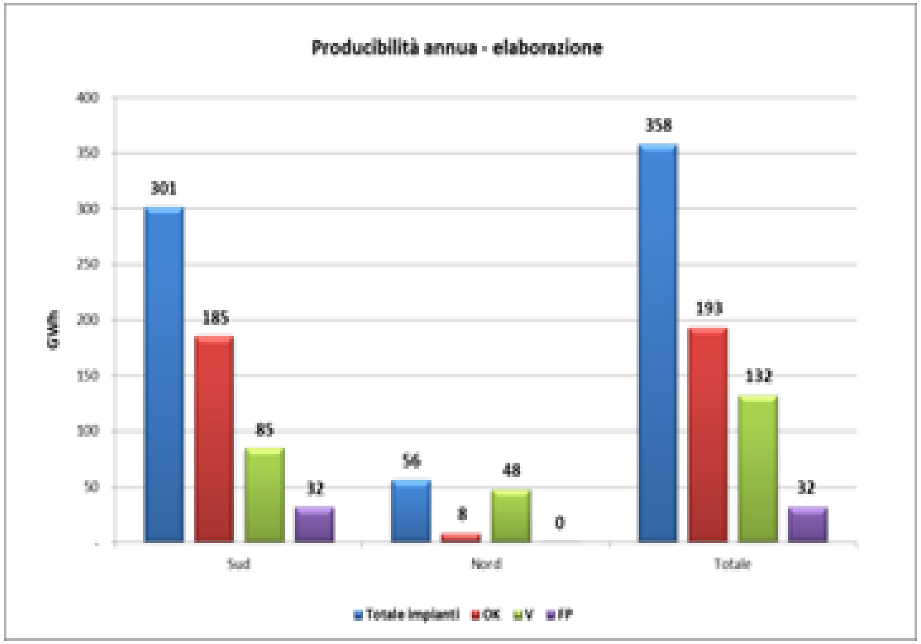


Fonte: MiPAAF - G.C. ex Agensud, 2012

Capacity

<u>Annual potential capacity</u> is about **358 GWh** with plant average of 1.9 for the Center South and 1.0 GWh Centre North



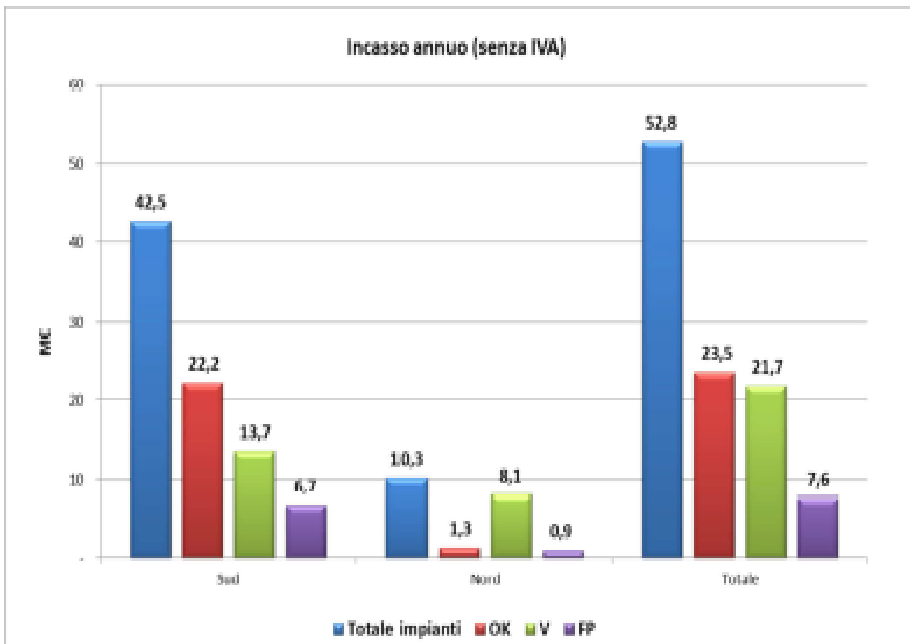


Fonte: MiPAAF - G.C. ex Agensud, 2012

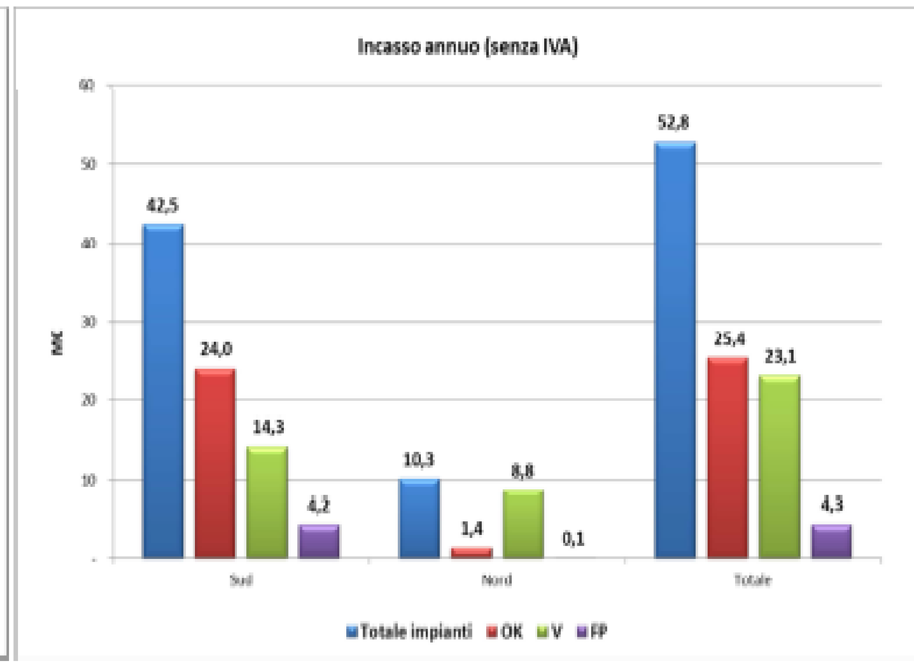
Revenues

<u>Annual revenues</u> according to incentives (Feed in tariff - €/kWh), power of granting and type (basin/fluent) of plant is **52,4 M€**, with plant average of 0,3 M€ for the Center South and 0,2 M€ for Centre North.

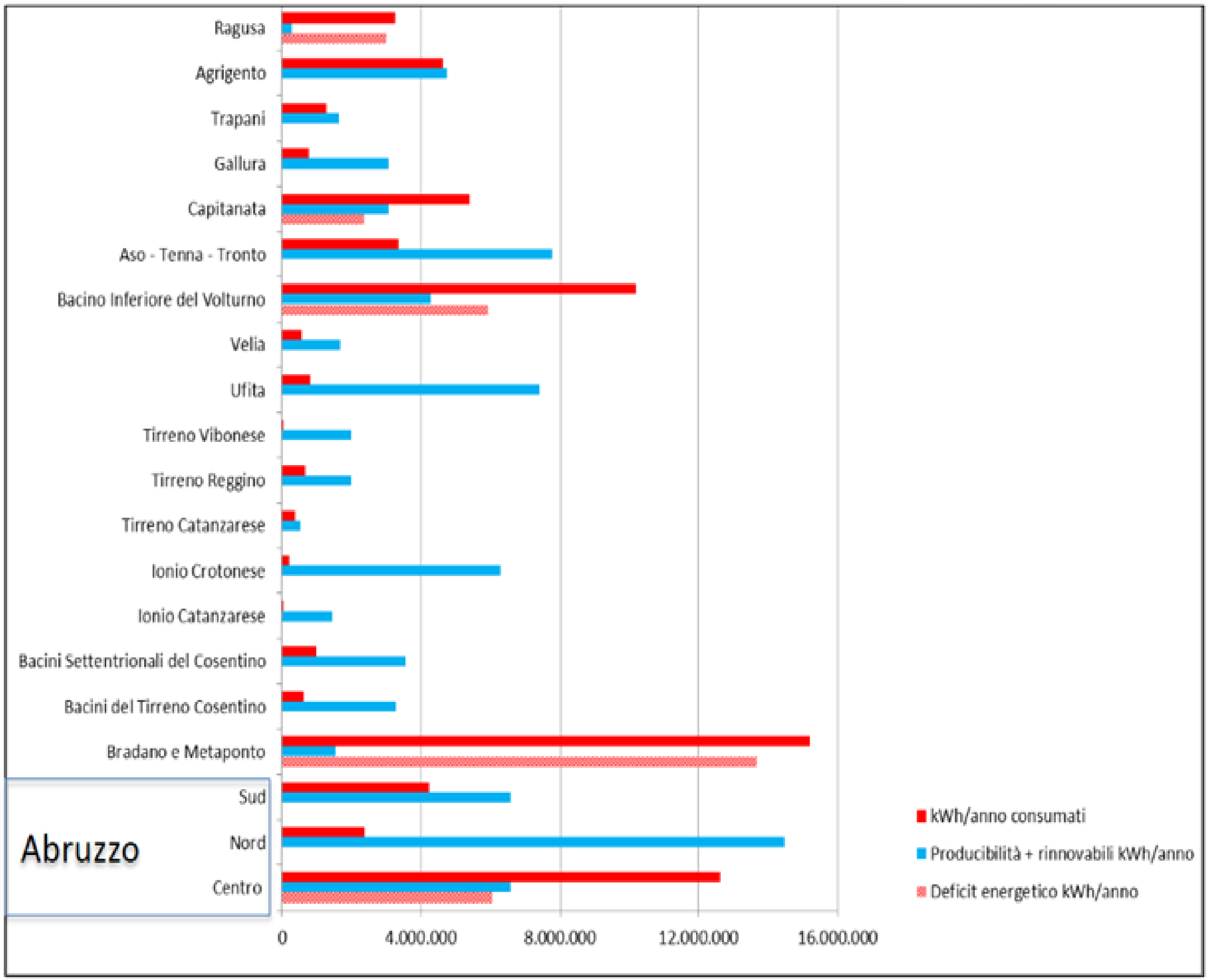
Proposti



Prima elaborazione



Potential and perspectives



Fonte. Elaborazioni INEA su dati MiPAAF G.C. ex Agensud, 2012

National potential

Today in Italy the whole hydropower production is about 45,000 GWh/year and irrigation in Consortia, with its potential 680 GWh/year from mini hydropower plants, could cover about 1,5% of national hydropower production, producing <u>environmental end economic positive impacts.</u>

Results and Discussion

Saving water

Case study in Sannio Alifano irrigation Consortia (EU FP7 Sirius project):

average saving of 20% of water resource consumed in corn crops has been achieved in 6 pilot farms (near 63.800 m^3) thus lower costs for irrigation.

Considering an estimated energy needs of 0,04 kWh/m^3 of water delivered, water saving obtained reflects in reduced energy consumption of 2.552 kWh/year for corn crops in pilot farms (thus lower energy costs).

It can be translated, adopting national emission coefficient for thermoelectric energy production (510 gCO_2/kWh, ISPRA, 2009), in 1,3 tCO_2 avoided.

Main constraints: High efficiency of irrigation systems – Consumption based irrigation rates – farmers availability in adopting innovative approaches

Plural uses

Environmental and economic benefits. Hydropower is the source that provides the best environmental performance in terms of the relationship between energy expenditure for the construction of plants and energy returned during their life time (EROEI Index).

Increasing of environmental and economic performances from the reduction of energy expenses for irrigation delivery, which reflects in lower rates paid by farmers and CO_2 avoided as consequence of increasing of national renewable energy production (approximatively 360.000 tCO_2 avoided).

Still needed. Clarification of authorization processes (subjection to the VIA – Environmental Impact Evaluation) and classification of plants (basin/tank or flowing/water systems, not subject to registration).

Thank you for your attention!!!

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