Solar radiometer calibration and traceability

Current situation in Uruguay

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Outline

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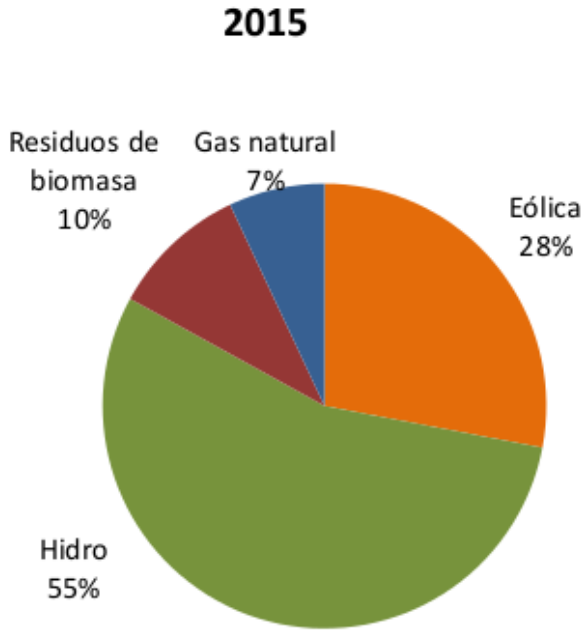
Current primary energy mix in Uruguay

Highlights:

- long-term plan (2030) to increase share of solar, wind and biomass sources in the energy mix
- > 50 % of the energy mix from renewable sources (10 % is the international average)
- > 90 % of electrical generation from renewable sources (hydro, biomass, wind, solar)
- recent: interest in solar energy started in 2007...

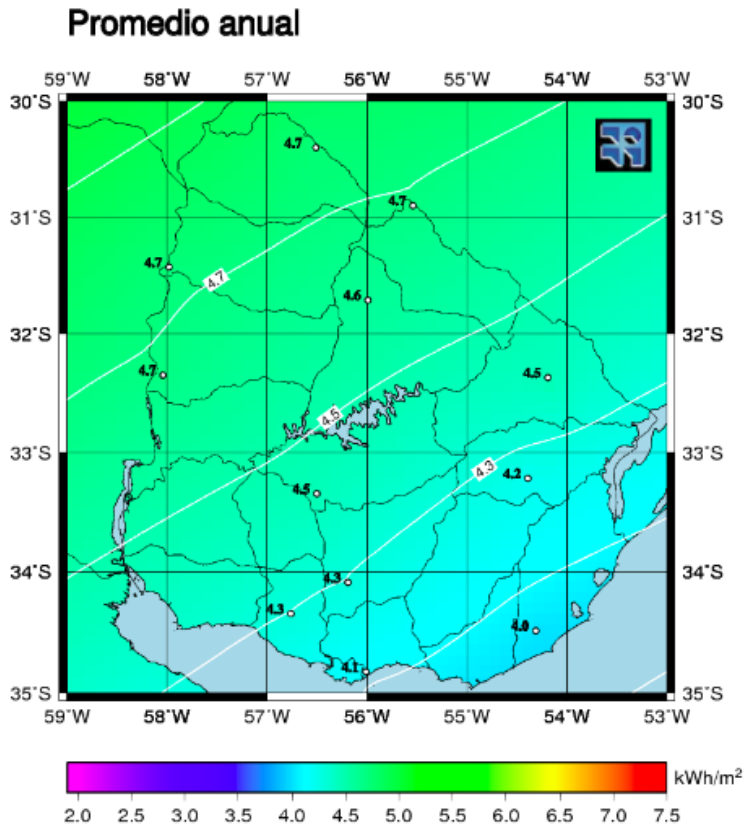


Source: Gov. Report. Energías Renovables, Uruguay XXI, projection made in August 2014

First Solar Map (2009)

Spatial distribution of the solar resource

- provides long-term daily mean GHI at 12 locations
- work by a research team from the National University (Udelar) made public in 2009
- derived from three daily solar radiation series (!) and 12 series of sunshine hours
- No good quality ground data was available!

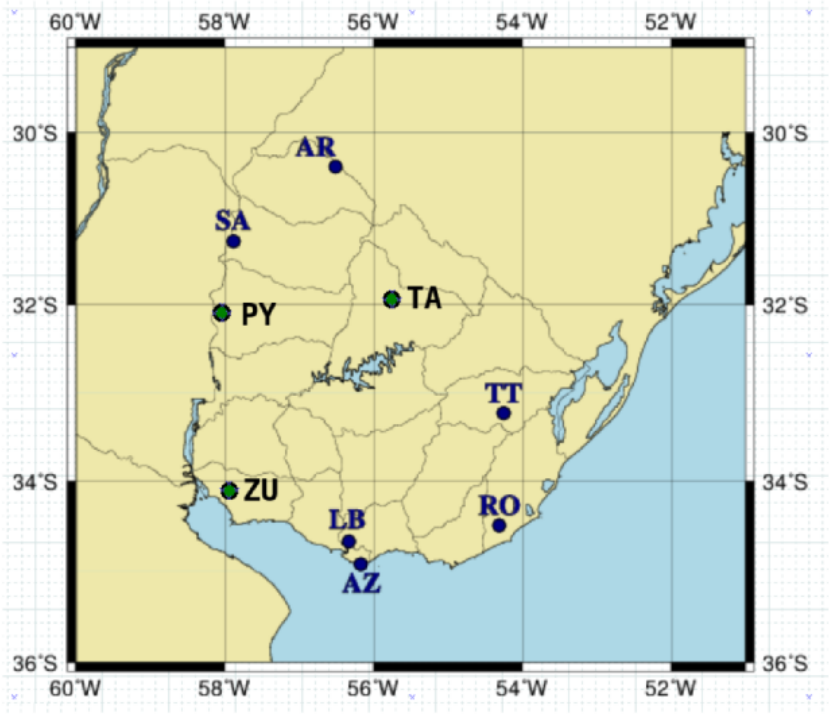


source: Abal et al. (2009)
http://les.edu.uy/

Solar radiation measurement programme (2010 →)

- started operation in 2010
- finantial support from several **local** agencies
- long-term (>10-year) effort
- one-minute interval between data records
- only Secondary Standard or First Class pyranometers
- local dome cleaning
- calibration program
- redundancy for quality control

for more details and data: les.edu.uy



Spatial distribution of solar radiation measurement stations

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Solar Energy Laboratory (LES) http://les.edu.uy

A small, new, university-owned, **research lab**

- Land: 30 000 m^2 located in the north of the country; received in 2013
- Buildings operative since early 2015...
- Small staff (12 people): 3 researchers, 3 PG students, 3 technicians + a few undergrads
- staff splits between the lab and the Facultad de Ingeniería at Montevideo (500 km)
- partial support from the Ministry of Industry and Energy and other agencies

Location

- Rural area in the north of the country (more irradiance)
- 10 km away from Salto city (pop. <100000)
- 500 km away from Montevideo

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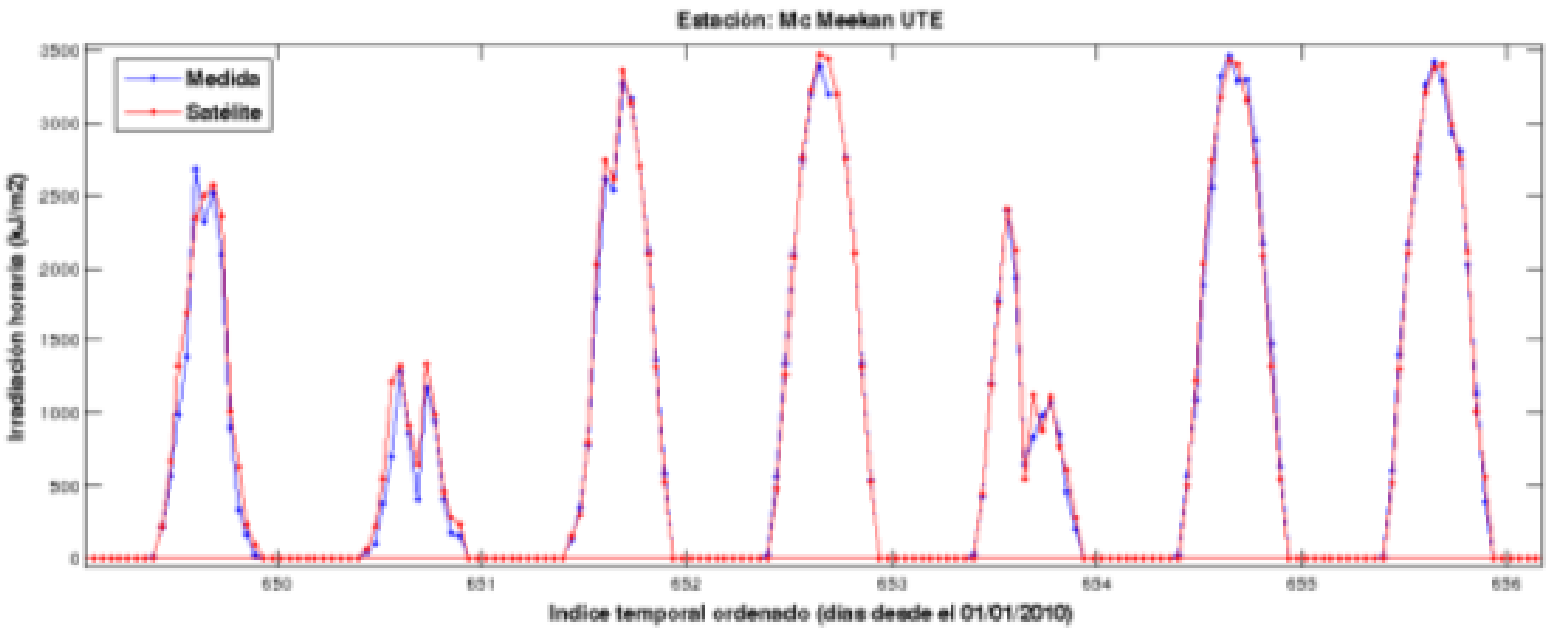
What do we do?

Some current research lines:

- Satellite-based **solar resource assessment**
- Modeling and characterization of **solar thermal prototypes**
- Characterization of **solar resource from ground data**
- Short-term **forecasting of solar radiation** variability (nowcasting)



What do we do?

We provide a few services (previously unavailable in Uruguay):

- We run (since 2010) a continuous **solar radiation measurement network**, currently with 8 sites.
- local 16-year local **GOES image data bank** (2000-2015) downloaded from NOAA
- **Calibration of pyranometers** and pyrheliometers under norms ISO 9847:1992 and ISO 9059:1990
- **Measurement of thermal efficiency** of solar collectors under norm UNIT-ISO 9806-1:1994 and solar systems under UNIT-ISO 9459-2:1995
- Ground data and **on-line products for solar energy** (Solar Maps (2009 and 2015), TMY, daily data for several sites, etc)
- Advice and support on **good practices for solar radiation measurement**.

Calibration of radiometers

- outdoor calibration platform
- **norm ISO 9847:1992** "Calibration of field pyranometers by comparison to a reference pyranometer"
- two **Kipp & Zonen CMP22** pyranometers are reserved as Secondary Standards
- one of them calibrated at **PMOD/WR**C in 2014
- the other has its factory calibration from 2014.

Outdoor calibration platform

Pirheliometer calibration

- **norm ISO 9059:1990** "Calibration of field pyrheliometers by comparison to a reference pyrheliometer"
- Solys2 tracking system fitted with sunshine sensor (fine corrections)
- Pyrheliometer Kipp & Zonen CHP1 reserved as Secondary Standard
- with factory calibration (2015)

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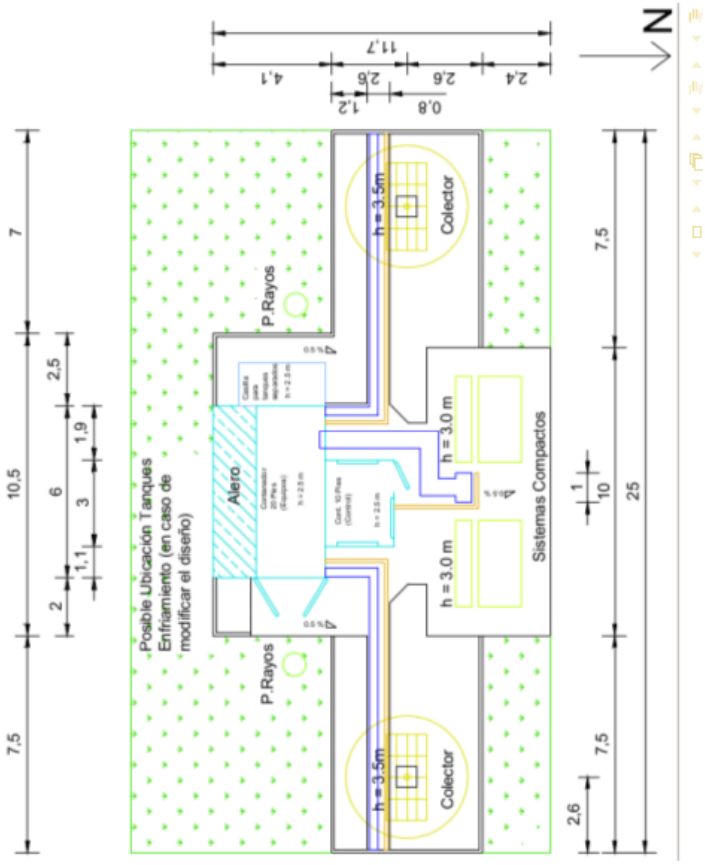
Some comments and questions

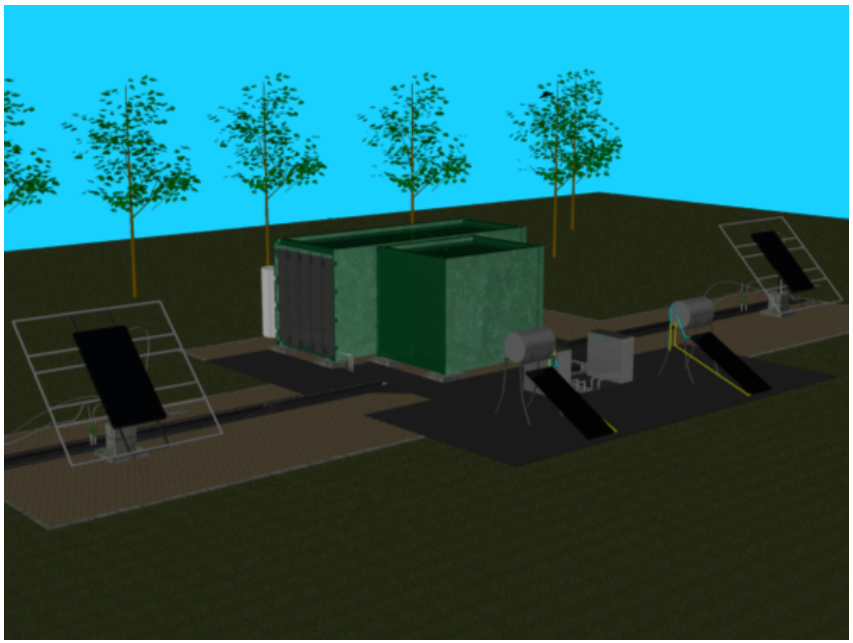
- We need a low-cost **regional calibration scheme** for secondary standards, traceable to the WRR
- We need to perform calibration intercomparisons (needed for acreditation under norm ISO 17025)
- Norms seem outdated (more than 20 years...).
  Any plans for actualization or new norms ?
- How do we calibrate fotovoltaic radiometers ?

Outdoor thermal efficiency certification facility

- financing from Min. of Industry and Energy (MIEM-Uruguay)
- locally designed by LES with technical assistance from CENER (Spain)
- two lines for solar collectors (under UNIT-ISO 9806-1:1994)
- two lines for compact solar systems (under UNIT-ISO 9459-2:1995)
- complements other qualification and physical tests at LATU (Uruguay's metrological institute)
- requires yearly calibration of all its sensors (including 8 radiometers)



Current status



3D rendering of layout

state of affairs as of April 2015

BECS is scheduled to start operation in the next summer: 2015-2016

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Traceability

- at present, **we do not provide traceable calibrations** or certifications
- we aim to work as a **delegate calibration laboratory** for LATU (good enough for Uruguay)
- in 2016, we plan to iniciate the acreditation procedure under norm **UNIT-ISO/IEC 17025:2005** "Requisitos generales para la competencia de laboratorios de ensayos y calibración"
  - solar radiation calibration (pyranometers, pyrheliometers)
  - thermal efficiency measurements of solar colectors and systems

Final Remarks

We have **strong interest** in:

- intercomparisons for radiometer calibration
- intercomparisons for thermal efficiency of solar collectors
- a local, affordable scheme for traceable calibration of Secondary Standard radiometers
- an update of norms ISO 9847 and 9059
- training opportunities (such as this one)

Thanks!

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