
# Materials for Renewable Energy 2010

from 28 May 2010 to 2 June 2010
Erice (Sicily-Italy)
Europe/Rome timezone

**Ettore Majorana Foundation and Centre for Scientific Culture**

**67 students**
10 USA
5 Israel
20 EU (out of Italy)
32 Italy

*From left to right: John Poate, Stewart Polite Jr. (16 years old prodigy student)., Antonio Terrasi, Abdelilah Slaoui, David Ginley and Emanuele Rimini*

SCHOOL TIMETABLE

| | 8:00-8:30<br>8:30-10:30 | 10:30<br>11:00 | 11:00<br>13:00 | 13:00<br>15:00 | 15:00<br>17:00 | 17:00<br>17:30 | 17:30<br>19:00 | Evening |
|---|---|---|---|---|---|---|---|---|
| **Fri. May 28th** | Introduction<br>**L. Orr**<br>*$CO_2$ Global Warming* | Coffee break | **P. Waide**<br>*Energy Balance* | Lunch break | **A. McEvoy**<br>*Energy: The Big Picture* | Coffee break | Seminar or posters or round table | Dinner + chattering and wine |
| **Sat. May 29th** | **J. Poate**<br>*Conventional Technologies* | Coffee break | **M. Hadjieva**<br>*Solar Thermal* | Lunch break | **D. Carlson**<br>*Conventional Photovoltaics* | Coffee break | Seminar or posters or round table | Dinner + chattering and wine |
| **Sun. May 30th** | **B. J. Stanbery**<br>*Photovoltaics Thin films* | Coffee break | **A. Marti'**<br>*Photovoltaics 3rd generation* | Excursion (Lunch bag) | | | | Dinner + chattering and wine |
| **Mon. May 31st** | **H. Atwater**<br>*Si wires and plasmonics for Photovoltaics* | Coffee break | **D. Ginley**<br>*Organic Photovoltaics* | Lunch break | **S. Coffa**<br>*Photovoltaics Industry* | Coffee break | Seminar or posters or round table | Dinner + chattering and wine |
| **Tue. June 1st** | **J. Poortmans**<br>*Photovoltaics Overview* | Coffee break | **D. Cahen**<br>*Fuels via Solar Energy* | Lunch break | **N. Pugliano**<br>*Green Chemistry* | Coffee break | Seminar or posters or round table | Dinner + chattering and wine |
| **Wed. June 2nd** | **D. Ginley**<br>*Storage* | Coffee break | **R. O'Hayre**<br>*Fuel Cells* | Lunch break | **M. Schreckenberg**<br>*Vehicles* | Coffee break | Conclusions | Gala Dinner |


# Materials for Renewable Energy 2012

18-28 July 2012
Erice (Sicily-Italy)
Europe/Rome timezone

**Ettore Majorana Foundation and Centre for Scientific Culture**

**65 students**
29 Italy
10 USA
16 EU (out of Italy)
5 Africa
3 Turkey
1 Israel
1 Brasil

**ERICE 2012 TIMETABLE**

| | 8:30<br>10:30 | 10:30<br>11:00 | 11:00<br>13:00 | 13:00<br>15:00 | 15:00<br>17:00 | 17:00<br>17:30 | 17:30<br>19:00 | Evening |
|---|---|---|---|---|---|---|---|---|
| **Wed.<br>July 18th** | 8:00-8:30<br>**WELCOME**<br>**Lynn Orr**<br>*Energy Overview* | Coffee break | **John Poate**<br>*Critical Materials Issue for the Energy World* | Lunch break | **Jacques Amouroux**<br>*Carbon capture and recycling for energy storage* | Coffee break | Inputs for student team activity and material distribution | Dinner |
| **Thu.<br>July 19th** | **Dannie Jost**<br>*Climate Change Governance and Renewable Energy* | Coffee break | **Salvo Lombardo**<br>*Charge generation and transport in PV* | Lunch break | **Dave Carlson**<br>*Conventional PV* | Coffee break | SEMINAR<br>**Harry Atwater**<br>*Solar Fuels – the Joint Center for Artificial Photosynthesis (JCAP)* | Dinner |
| **Fri.<br>July 20th** | **Gianluca Timò**<br>*Concentrating PV* | Coffee break | **Billy Stanbery**<br>*Thin film PV CIGS, CZTS* | Lunch break | **Cosimo Gerardi**<br>*PV Industry* | Coffee break | Poster session | Dinner |
| **Sat.<br>July 21st** | **Dave Ginley**<br>*Organic/Dye PV* | Coffee break | **Harry Atwater**<br>*Photonic design principles for high efficiency photovoltaics* | Lunch break | **Eli Yablonovitch**<br>*The Opto-Electronic physics which just broke the efficiency record in solar cells* | Coffee break | Poster session | Dinner |
| **Sun.<br>July 22nd** | FREE<br>(Lunch bag) | | | | | | | Dinner |
| **Mon.<br>July 23rd** | **Eli Yablonovitch**<br>*"Electrically Created Fuels"* | Coffee break | **Werner F. Kuhs**<br>*Hydrates* | Lunch break | **Joachim Peinke**<br>*Wind Energy* | Coffee break | SEMINAR<br>**Dave Ginley**<br>*Smart Grid* | Dinner |

**ERICE 2012 TIMETABLE**

| | 8:30<br>10:30 | 10:30<br>11:00 | 11:00<br>13:00 | 13:00<br>15:00 | 15:00<br>17:00 | 17:00<br>17:30 | 17:30<br>19:00 | Evening |
|---|---|---|---|---|---|---|---|---|
| **Tue.<br>July 24th** | **Giovanni Ricco**<br>*Nuclear Energy I* | Coffee break | **Giovanni Ricco**<br>*Nuclear Energy II* | Lunch break | **Florence Jaudin**<br>*Geothermal* | Coffee break | SEMINAR<br>**Andrea Cuomo**<br>**(President of 3Sun)**<br>*PV Industrial Perspectives* | Dinner |
| **Wed.<br>July 25th** | **William Tumas**<br>*Green Chemistry* | Coffee break | **Anke Weidenkaff**<br>*Thermoelectricity* | Excursion<br>(Lunch bag) | | | | Dinner |
| **Thu.<br>July 26th** | **Laura Meda**<br>*Solar Water splitting* | Coffee break | **David Cahen**<br>*Solar fuels and Artificial photosynthesis I* | Lunch break | **David Cahen**<br>*Solar fuels and Artificial photosynthesis II* | Coffee break | Student team | Dinner |
| **Fri.<br>July 27th** | **Daniele Consoli**<br>*Concentrated Solar Power* | Coffee break | **Ryan O'Hayre**<br>*Fuel Cells Energy Conversion* | Lunch break | **Ryan O'Hayre**<br>*Fuel Cells Energy Conversion* | Coffee break | Student team | Dinner |
| **Sat.<br>July 28th** | **Sabrina Sartori**<br>*Hydrogen storage for vehicular applications* | Coffee break | **Dannie Jost**<br>*Patenting Systems, Patentable Subject Matter, and Prior Art* | Lunch break | *Student team reports* | Coffee break | **Conclusions** | Social Dinner |


# International School "Materials for Renewable Energy" 2014 (12-18 July 2014)

12-19 July 2014
Europe/Rome timezone

**Ettore Majorana Foundation and Centre for Scientific Culture**

**76 students**
23 Italy
9 USA
24 EU (out of Italy)
10 Africa
3 Turkey
5 Israel
1 Singapore
1 Thailand


**ERICE 2014 PROGRAM**

| | 8:45<br>10:15 | 10:15<br>11:15 | 11:15<br>11:45 | 11:45<br>12:45 | 12:45<br>14:45 | 15:30<br>16:30 | 16:30<br>17:30 | 17:30<br>18:00 | 18:00<br>18:45 | 19:30<br>23:00 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sat.<br>July 12th** | 8:45-9:00<br>WELCOME<br>*Energy: The Big Picture*<br>*Ahmed Hamza H. Ali* | *Critical materials for energy*<br>*Alex King* | Coffee break | *Nuclear energy*<br>*Claude Degueldre* | Lunch break | *$CO_2$ sequestration and recycling*<br>*Sally Benson* | *Water-energy nexus*<br>*Jörg E. Drewes* | Coffee break | *EU Project "Water"*<br>*Vittorio Privitera* | Dinner |
| **Sun.<br>July 13th** | *Silicon based photovoltaics, technologies and market*<br>*Abdelilah Slaoui* | *Optics for Solar Energy Conversion*<br>*Harry Atwater* | Coffee break | *CIGS-CZTS Solar cells*<br>*Hans-Werner Schock* | Lunch break | *Next Generations PV OPV/QD/Perovskite s/ETA*<br>*David Ginley* | *High-efficiency photovoltaics by nanophotonic design*<br>*Albert Polman* | Coffee break | *Distretto Tec. Sicilia Micro e Nano Sistemi PON Project "Energetic"*<br>*Salvo Lombardo* | Dinner |
| **Mon.<br>July 14th** | *Concentrated Solar Power*<br>*Javier Garcia Barberena Labiano* | *Thermoelectricity Piezoelectricity*<br>*Anke Weidenkaff* | Coffee break | *Geothermal*<br>*Ernst Huenges* | Lunch break | Teams work alone solving problems<br>DG+DC with SB | | Coffee break | Checking problem results | Dinner<br>Poster session |
| **Tue.<br>July 15th** | *Photosynthesis*<br>*David Cahen*<br>*(8:45-9:45)* | *Solar fuels*<br>*William Tumas*<br>*(9:45-11:15)* | Coffee break | *BioFuels*<br>*David Cahen* | Lunch break | **Excursion + Dinner** | | | | |
| **Wed.<br>July 16th** | *Fuel cells*<br>*Ryan O'Hayre* | *Hydrogen*<br>*Sabrina Sartori* | Coffee break | *Wind*<br>*Joachim Peinke* | Lunch break | Teams prepare presentations with supervisors | | | | Dinner<br>Poster session |
| **Thu.<br>July 17th** | *Batteries and storage*<br>*Ryan O'Hayre* | *Smart Grid*<br>*David Ginley* | Coffee break | *Patents and law regulations*<br>*Dannie Jost* | Lunch break | Teams prepare presentations with supervisors | | | | Dinner |
| **Fri.<br>July 18th** | *Lectures by student teams (6 presentations)* | | Coffee break | *Lectures by student teams (3 presentations)* | Lunch break | *Trip to Trapani Beach* | | | | Social Dinner + Prizes |


# International School for Materials for Energy and Sustainability (ISMES IV)

**July 13 – 20, 2015**

**Colorado School of Mines • Golden, Colorado USA**

## Topics

- Global Overview
- Energy Overview
- Critical Materials for Energy
- Energy Analysis
- Unconventional Materials for Energy
- Nuclear Energy Including Fusion
- Gas/Oil/Coal and Fracking
- Solar Energy - PV
- Wind Energy
- Geothermal
- Thermoelectricity/Piezoelectricity
- Building Technology Future
- … and more

## Lecturers

- Harry Atwater :: Caltech
- Sally Benson :: Stanford
- David Cahen :: Weizman Institute
- George Crabtree :: Argonne Labs
- David Ginley :: NREL
- Sossina Haile :: Caltech
- Carolyn Koh :: Colorado School of Mines
- … and more

## Information

**http://csmspace.com/events/ismes**

## Sponsors

COLORADO SCHOOL OF MINES

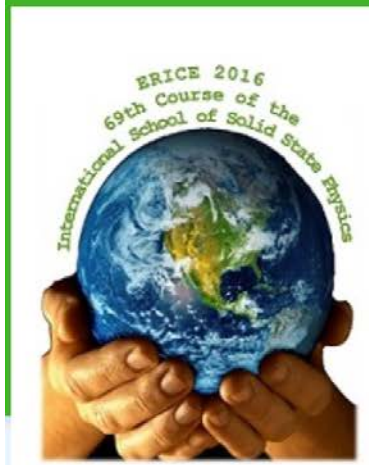
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

RESNICK INSTITUTE
science + energy + sustainability

Stanford | Precourt Institute for Energy

MRS MATERIALS RESEARCH SOCIETY
*Advancing materials. Improving the quality of life.*

E-MRS




# "Materials for Energy and Sustainability-V" 5th course "EPS-SIF International School on Energy" 3rd course 2016, 13-19 July

13-19 July 2016
Erice - ITALY
Europe/Rome timezone

Ettore Majorana Foundation and Centre for Scientific Culture

**79 students (joined with SIF and EPS school)**
16 Italy
5 USA
24 EU (out of Italy)
29 Africa
(EUROSUNMED Project!)
5 Israel

## ERICE 2016 PROGRAMME

| | 8:45am 10:00am | 10:00am 11:15am | 11:15am 11:45am | 11:45am 1:00pm | 1:00pm 3:00pm | 3:00pm 4:15pm | 4:15pm 5:30pm | 5:30pm 6:00pm | 6:00pm 7:30pm | 7:30pm 0:00am |
|---|---|---|---|---|---|---|---|---|---|---|
| **Wed. July 13th** | 8:30-8:45 **Introduction** *Energy: The Big Picture* *David Ginley* | *Critical materials for energy* *Roderick Eggert* | Coffee break | *Global warming $CO_2$ Capture & sequestration* *Julio Friedmann* | Lunch | *Energy-Water-Sustainability Nexus* *Neal Armstrong* | *Open discussion with students on topics above* | Coffee break | *Poster session* | Dinner + music/drink networking after 9 PM |
| **Thur. July 14th** | *Geothermal power* *Adele Manzella* | *Nuclear power generation now and in the future* *Friedrich Wagner* | Coffee break | *Physics and engineering of wind power systems* *Hermann Josef Wagner* | Lunch | *Photovoltaics I: Principle/materials/ Inorganics* *Abdelilah Slaoui* | *Photovoltaics II: organics/hybrids* *Alexander Colsmann* | Coffee break | *Poster session* | Dinner + music/drink networking after 9 PM |
| **Fri. July 15th** | *Materials and energy genome* *William Tumas* | *Photosynthesis and Solar fuels* *David Cahen* | Coffee break | *Biofuel* *David Cahen* | Lunch | *Concentrated solar power: systems* *Robert Pitz-Paal* | *Concentrated Solar power: components and materials* *Abraham Kribus* | Coffee break | *Poster session* | Dinner + music/drink networking after 9 PM |
| **Sat. July 16th** | *Fuel cells* *Ryan O'Hayre* | *Thermal storage* *Xavier Py* | Coffee break | *Electrical storage* *George Crabtree* | Lunch | **Teams work on Presentations** | | | | Dinner + music/drink networking after 9 PM |
| **Sun. July 17th** | *Thermoelectricity* *Anke Weidenkaff* | *Mechanical Chemical storage* *Robert Schlögl* | Coffee break | *Materials for Buildings* *Matthias Koebel* | Lunch (take away) | **Excursion + Dinner** | | | | |
| **Mon. July 18th** | *Energy and mobility.* *Jo Hermans* | *Power system and market integration of renewable energy* *Georg Erdmann* | Coffee break | *Smart grids* *David Ginley* | Lunch | **Teams work on Presentations** | | | | Dinner + music/drink networking after 9 PM |
| **Tue. July 19th** | *Presentations by student teams* | | Coffee break | *Presentations by student teams* | Lunch | **Free Afternoon** | | | | **Social Dinner + Prizes** |

# International School for Materials for Energy and Sustainability (ISMES VI)

**July 16-22, 2017**

**California Institute of Technology**

**Pasadena, CA**


## 2017 Lecturers

ISMES VI included lectures by world class experts in a broad set of renewable energy to manufacturing.

ISMES VI lectuers were:

- Harry Atwater, California Institute of Technology
- Sally Benson, Stanford University
- David Cahen, Weitzmann Institute for Science
- Yi Cui, Stanford University
- Rod Eggert, Colorado School of Mines
- Chris Gearhart, National Renewable Energy Laboratory
- David Ginley, National Renewable Energy Laboratory
- Sossina Haile, Northwestern University
- Christiana Honsberg, Arizona State University
- Mark Jensen, Colorado School of Mines
- Martin Keller, National Renewable Energy Laboratory
- Steven Low, California Institute of Technology
- Ryan O'Hayre, Colorado School of Mines
- Carol Olson, Energy Research Center of the Netherlands
- Antonio Terrasi, University of Catania
- Bill Tumas, National Renewable Energy Laboratory
- Mike Woodhouse, National Renewable Energy Laboratory
- Eli Yablonovitch, University of California, Berkeley
- Neil Fromer, California Institute of Technology

ETTORE MAJORANA FOUNDATION AND CENTRE FOR SCIENTIFIC CULTURE

*TO PAY A PERMANENT TRIBUTE TO GALILEO GALILEI, FOUNDER OF MODERN SCIENCE AND TO ENRICO FERMI, "THE ITALIAN NAVIGATOR", FATHER OF THE WEAK FORCES*

Materials Research Society

European Materials Research Society

# International School of Materials for Sustainable Development & Energy - 1st Course

**Erice (Italy), July 7th – 12th 2018**

***Materials for Energy and Sustainability VII (ISMES VII)***

## *School Directors*

**Antonio Terrasi**

**David Cahen**

**David Ginley**

**Anke Weidenkaff**

**Abdelilah Slaoui**

## *Sponsors e Supporters*

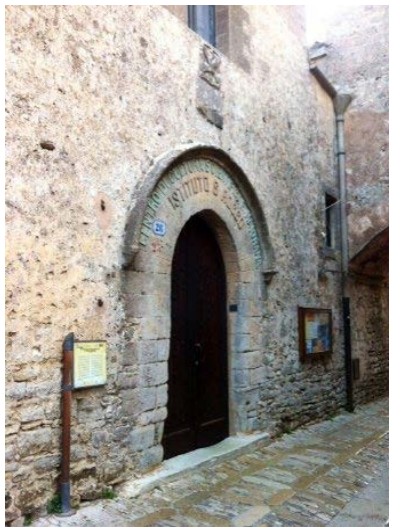
E-MRS · enel · NREL National Renewable Energy Laboratory

MRS Materials Research Society · Dipartimento di Fisica e Astronomia, Catania

EUREC The Association of European Renewable Energy Research Centres · DCA Instruments

2M Strumenti · COMETA · TMA Tecnologie Meccaniche Applicate

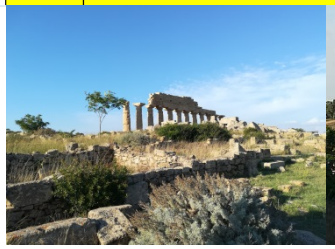
## *Places and locations*

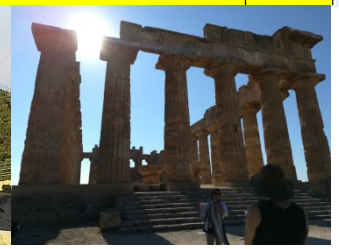


# PROGRAMME

**ERICE 2018 SCHOOL SCHEDULE: Arrival July 6th, Departure 13th**

| | 8:45<br>10:00 | 10:00<br>11:15 | 11:15<br>11:45 | 11:45<br>13:00 | 13:00<br>15:00 | 15:00<br>16:15 | 16:15<br>17:30 | 17:30<br>18:00 | 18:00<br>19:30 | | 19:30<br>24:00 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sat. July 7th | 8:30-8:45 Introduction Energy Climate and Sustainability S. Benson | Energy Water Food Nexus D. Ginley | Coffee break | Approaches to $CO_2$ Mitigation S. Benson | Lunch | 15:00<br>15:45 Critical Materials D. Ginley | 15:45<br>16:45<br>1. Exercises<br>2. Discussion on Energy questions | 16:45<br>17:15<br>Coffee Break | 17:15<br>18:00 Circular Economy Life cycle analysis D. Ginley | 18:15<br>19:00 *Get together* Team formation | Dinner + Marsala room |
| Sun. July 8th | PV Overview technologies D. Ginley | Nuclear Energy and Fusion F. Wagner | Coffee break | Wind Power Systems H.J. Wagner | Lunch | Energy Storage batteries R. O' Hayre | Energy-efficient transport and its future J. Hermans | Coffee Break | Poster session | | Dinner + Marsala room |
| Mon. July 9th | Solar Fuels A. Weidenkaff | Biofuel Biomass I D. Cahen | Coffee break | Biofuel Biomass II D. Cahen | Lunch | Thermal Energy Conversion A. Weidenkaff | Fuel Cells R. O' Hayre | Coffee break | Poster session | | Dinner + Marsala room |
| Tue. July 10th | Materials by Design for Energy Applications W. Tumas | Energy Efficiency and the Grid P. Birkner | Coffee break | Health Issues and air pollution F. Forastiere | Lunch (take away) EXCURSION | | | | | | |
| Wed. July 11th | High efficiency low energy cost Si-HJ photovoltaic modules C. Gerardi | Emerging Trends for 21st Energy Technologies S. Sartori | Coffee break | Teams work on Presentation | Lunch | Teams work on Presentation | | | | | Dinner + Marsala room |
| Thur. July 12th | Teams work on Presentation | | | | Lunch | 15:00-16:00 Antonio Cammisecra ENEL Green Power CEO | 16:00-19:30 Team talks | | | | Gala Dinner |





## *Many topics covered*

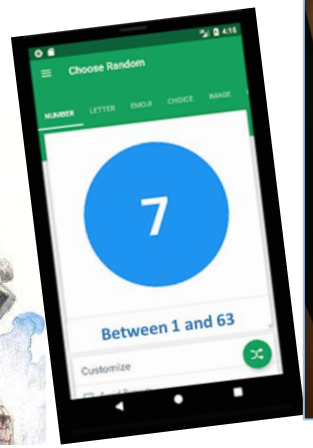
**Materials science and technology applied to the generation, storage, and use of green energy sources for sustainable development.**

**Global warming, $CO_2$ sequestration, water-energy, nuclear energy, solar thermal and photovoltaic power, photosynthesis and biofuels, fuel cells, wind energy, thermoelectricity, energy storage, electrical grid, and mobility/transportation.**

**25 hours of lectures**
**2 poster sessions**
**Student Teamwork**
**Excursion**

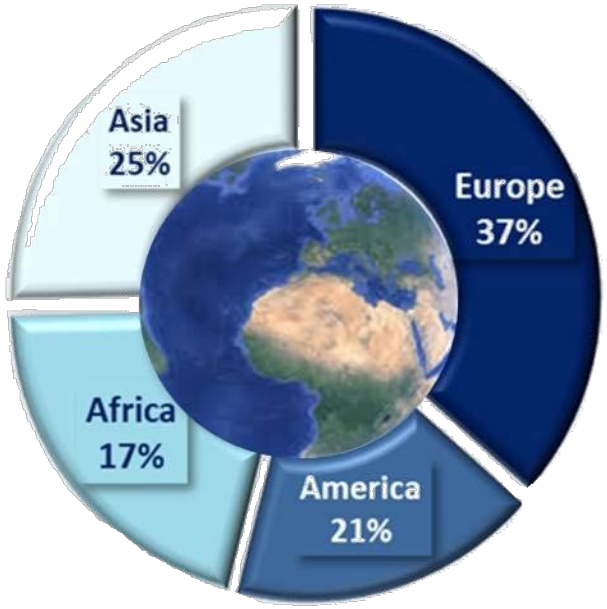

# How we manage *LECTURES AND STUDENTS*

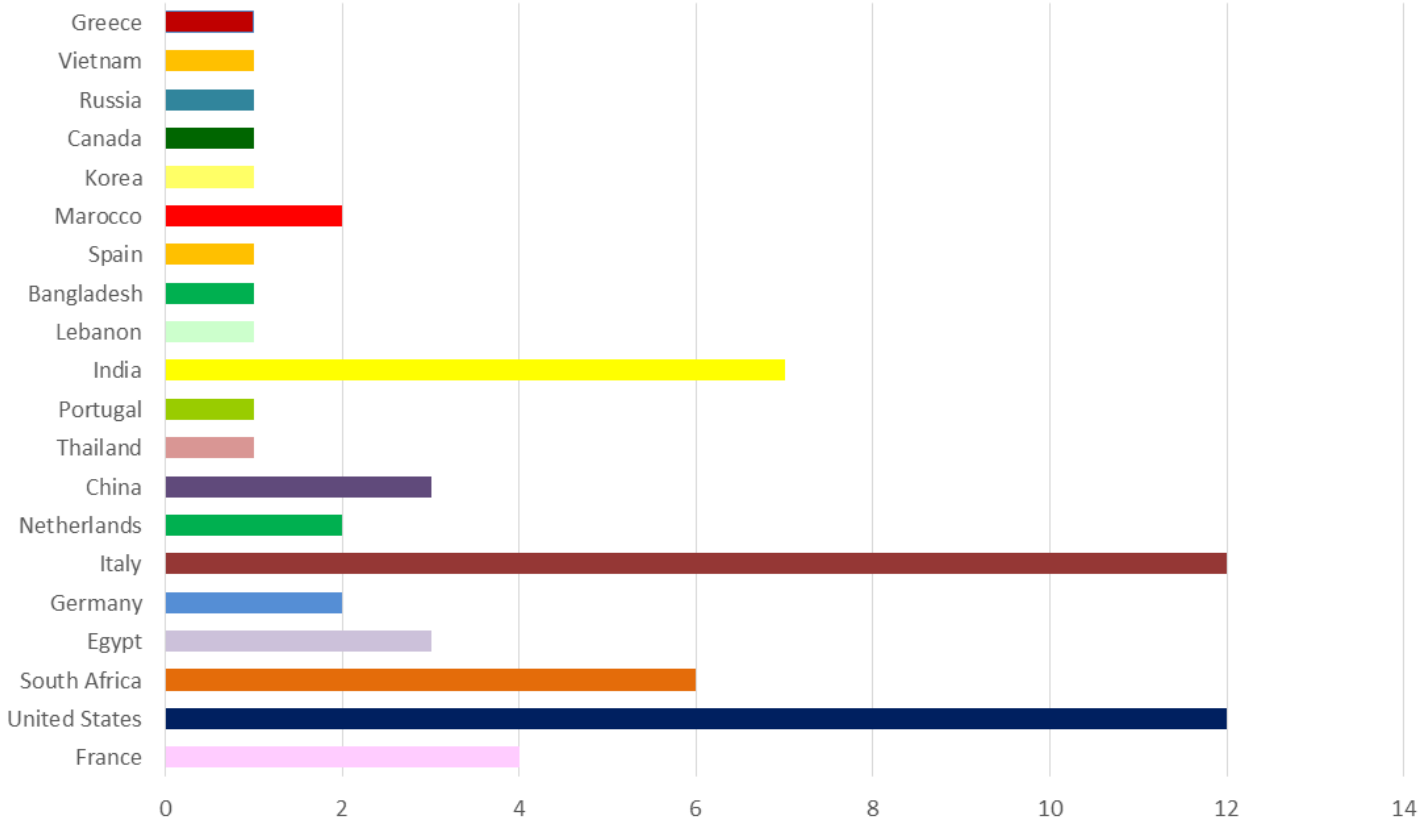
**Every day seats were randomly assigned to the students to increase their interactions and to avoid the formation of small groups based on native language or scientific background**



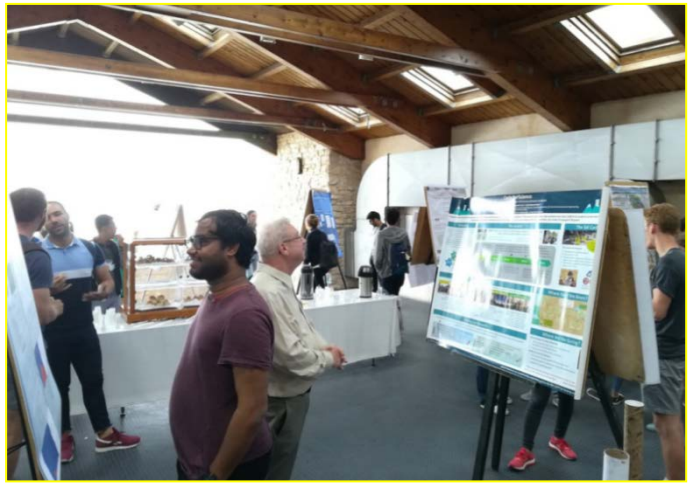


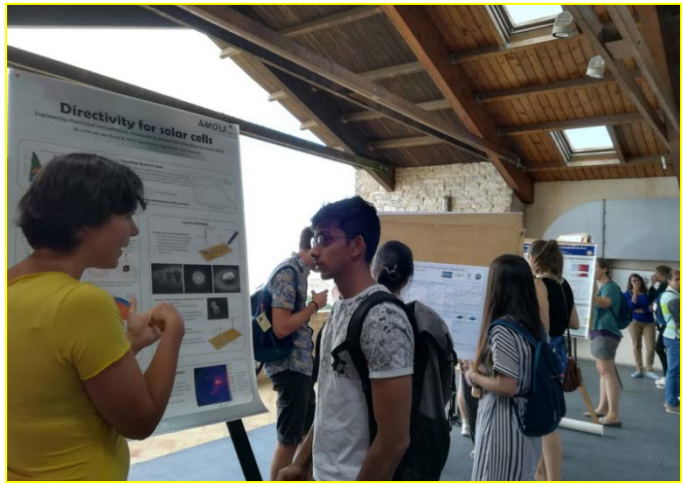
# Who attended ?? : *63 STUDENT FROM 20 DIFFERENT COUNTRIES*

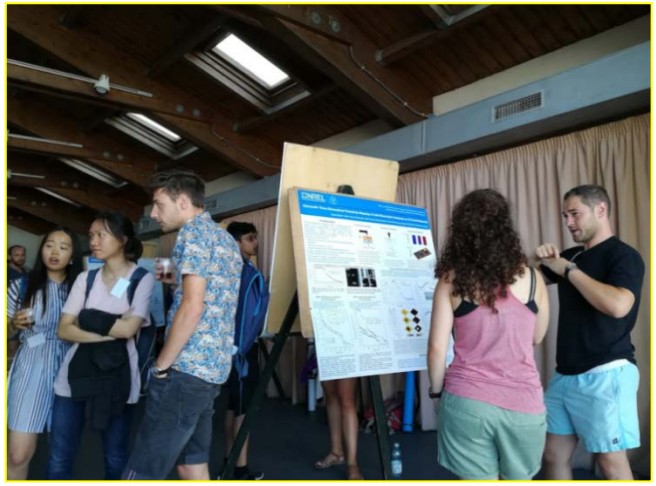


# POSTER SESSIONS: *52 POSTER PRESENTED*





**83% of students presented the results of their scientific research**

**STRONG SCIENTIFIC INTERACTION AMONG STUDENTS**

# FINAL AWARD CEREMONY







ETTORE MAJORANA FOUNDATION AND
CENTRE FOR SCIENTIFIC CULTURE
International School of Materials for Sustainable Development & Energy
1st Course
Materials for Energy
and Sustainability -VII
Erice (Italy), July 7th – 12th 2018

# International School for Materials for Energy and Sustainability (ISMES VIII)

**ISMES VIII**

**July 21-27, 2019**

**California Institute of Technology**

**Pasadena, CA**

## Topics

ISMES VIII will present a broad perspective of the inte

- Energy, Climate, and Sustainability
- Water, Food, and Materials
- Photovoltaics
- Solar Fuels
- Battery Energy Storage Technology
- Nuclear Energy and Fusion
- Deep Decarbonization
- Techno-economic Analysis
- Materials Recycling and Resource Strategies
- Hydrogen and Renewable Energy Storage
- Life Cycle Analysis
- Biofuels

Confirmed lecturers include:

- Harry Atwater, California Institute of Technology
- Sally Benson, Stanford University
- Adam Bratis, National Renewable Energy Laboratory (NREL)
- David Cahen, Weizmann Institute for Science
- Yi Cui, Stanford University
- Rod Eggert, Colorado School of Mines
- David Ginley, National Renewable Energy Laboratory (NREL)
- Kelsey Horowitz, National Renewable Energy Laboratory (NREL)
- Mark Jensen, Colorado School of Mines
- Audrey Lee, Sunrun
- Franklin M. ("Lynn") Orr, Jr., Stanford University
- Mary Ann Piette, Lawrence Berkeley National Laboratory
- Albert Polman, AMOLF
- Morgan Putnam, REsurety, Inc
- Sabrina Sartori, University of Oslo
- Paul Veers, National Renewable Energy Laboratory (NREL)
- Anke Weidenkaff, Fraunhofer ISC

# ISMES – IX Sept. 4-9 2022, University of Catania

**ISMES IX in Numbers**

**Catania September 5th – 9th**

**Organizers: MRS & E-MRS**

**Sponsors: University of Catania, EUREC, Enel Green Power**

- 39 students from 9 Countries
- 10 Speakers (Italy, USA, Germany, Sweden).
- 3 Speakers from Industry
- 16 h of lectures
- 4 h of poster session
- 2 h of practical session (H2 production and batteries)
- 1 h exercises
- 10 h of independent work by 8 student teams with a final challenge presentation.
- 2h of guided tour at Enel Green Power Innovation Hub&Lab
- TOPICS:
  - (a) Energy as a global challenge
  - (b) Geothermal heat: conversion and storage
  - (c) Critical Materials
  - (d) Circular and sustainable materials
  - (e) Energy transformation (wind, biofuels, transportation)
  - (f) The Terawatt Challenge (PV)
  - (g) Nuclear Energy: fission and fusion
  - (h) Batteries
  - (i) Electrification
  - (j) Solar fuels, Green H2
  - (k) Fuel Cells