CENTRO INTERUNIVERSITARIO
DI RICERCA PER LO SVILUPPO SOSTENIBILE
CIRPS

Academic research group

Field Studies 4 Micro Grid Optimization

Summary

Field Study Abroad

- About us
- Overview
- About Micro Grids
- FS4MGO Academic research group
- Case studies
- Field Study Abroad
- Program – Summer and Winter Editions
- Team
- Internship and job opportunities
- Placement - Alumni
- Contacts

About us

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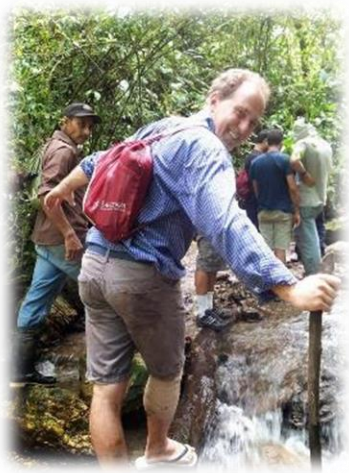
- Andrea Micangeli, professor of **Energy Systems** at Sapienza University of Rome and visiting professor at the State University of New York and at Strathmore University (Nairobi)





SAPIENZA
UNIVERSITÀ DI ROMA

ESF
State University of New York
College of Environmental Science and Forestry

Strathmore
UNIVERSITY

About us

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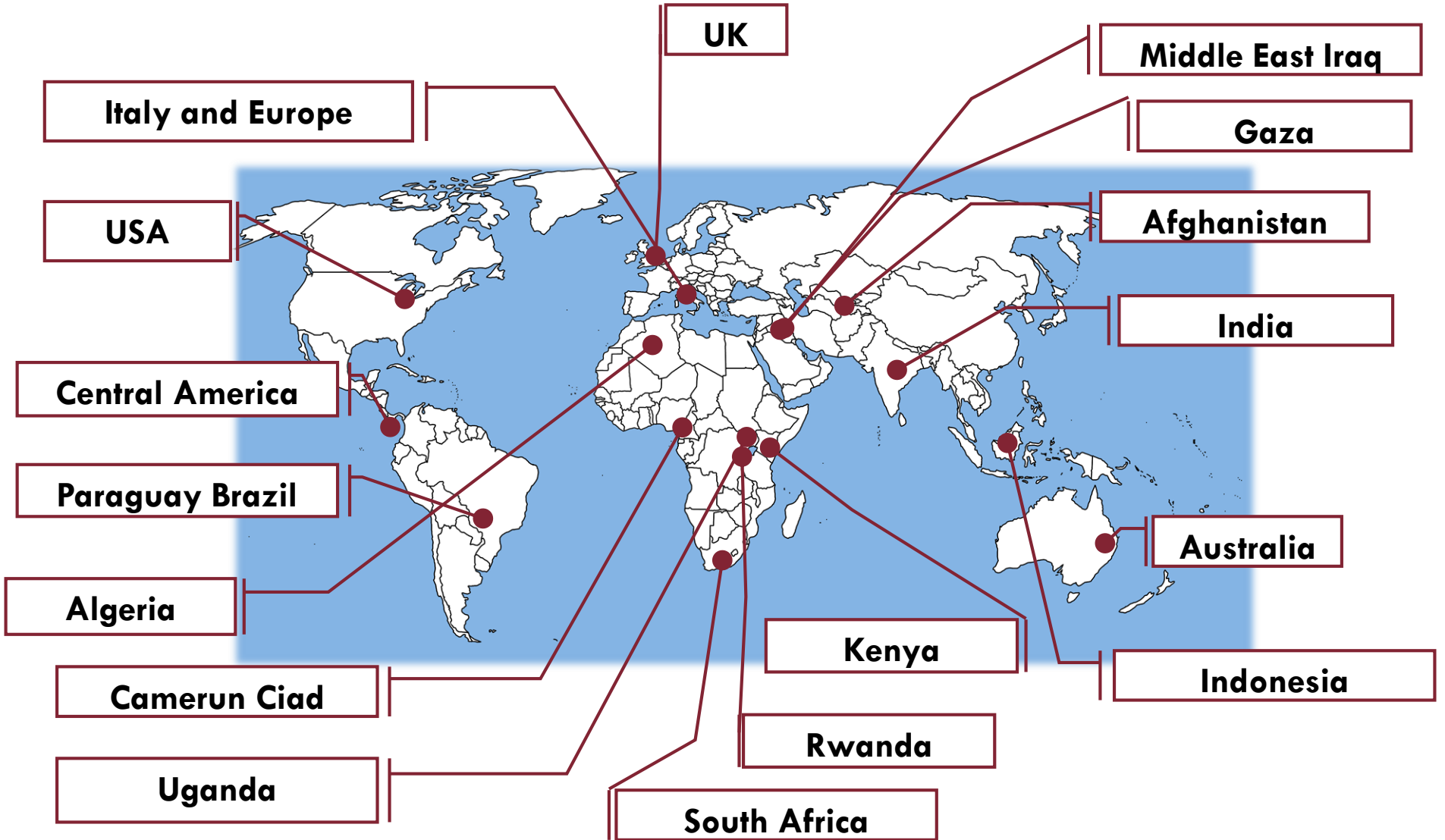
25 years of cooperation and academic research



About Micro-Grids

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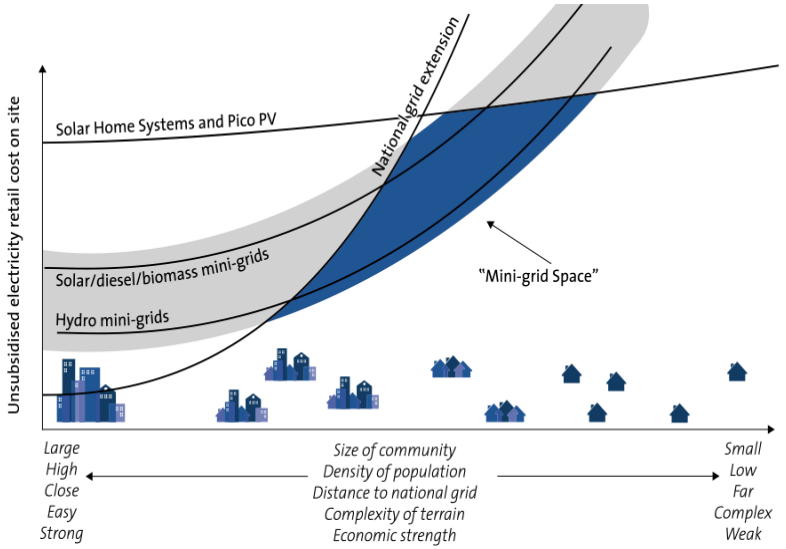
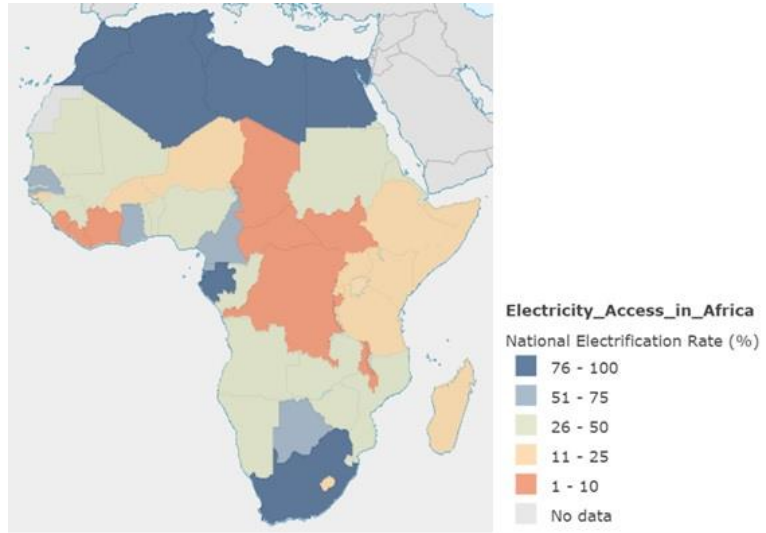
- More than 1 billion people without electricity access ⇨ population growth is outpacing electrification rate
- Distribution companies don't have a working model in rural areas (subsidizes tariffs below supply cost, high distribution costs in disperse and low demand areas, disaffection of customers due to low quality of service)
- Need to **bridge the viability gap** for microgrids





About Micro Grids

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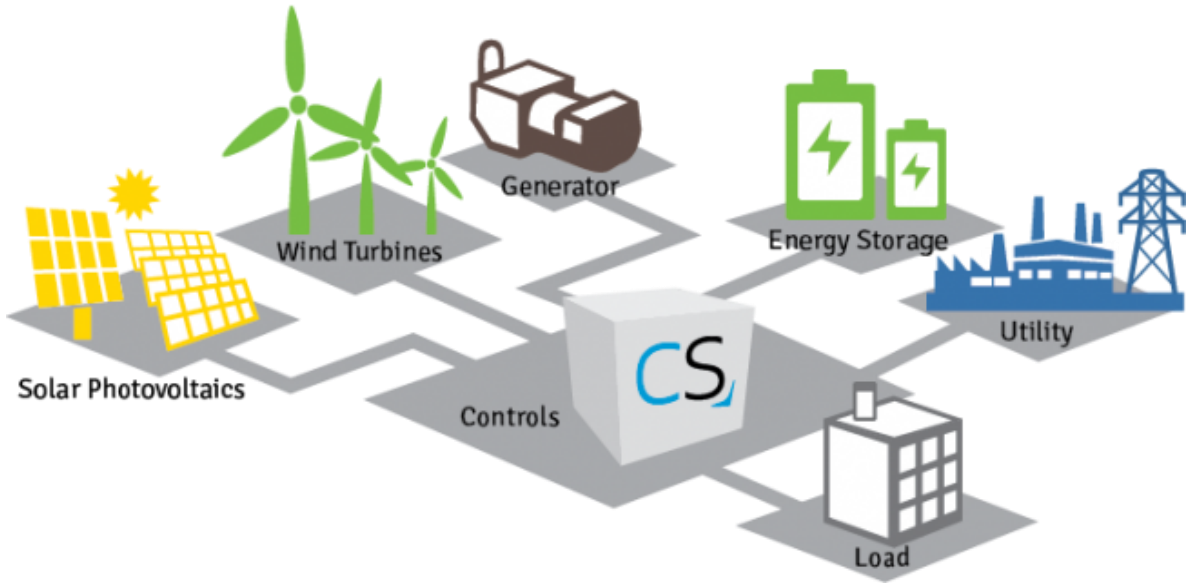

Academic research group FS4MGO

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- Along with the Universities of Italy, and US, Rwanda, Uganda, Tanzania and Kenya, in East Africa, as well as Honduras and Costa Rica in Central America, are supporting the Field Data Collection and Analysis:
  - *M. Sisul* , Columbia NYC, US, **Socio-economic impact evaluation guidelines**
  - *D. Poli, D. Fioriti, P. Cherubini, V. Gambino, R. Giglioli,* Pisa, IT, **Load forecasting models**
  - *T. Endreny, T. Volk*, State University of N.Y, US, **Environmental Energy Impact**
  - *I.P. Arriaga, P. Duenas, S. Lee,* MIT, US, **National electrification planning and regulation**
  - *S. Stritzke*, University of Oxford, UK, **Business models for microgrids**
  - *A. Micangeli, R. Del Citto, C. Tacconelli,* Italy, **Multi-source generation systems design**
  - *E. Ntagwirumugara, C. Ushizimpumu, F. Mujjuni, I. Da Silva,* East Africa, **Field Data Collection**
  - *W. Henriquez, E. Trejo, E. Brenes,* Central America **Supporting Data Analysis**

FS4MGO – Outstanding events

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enel Green Power

Susann Strizke

FS4MGO, Smith School of Enterprise and Environment, University of Oxford.

Dr Susann Stritzke is a Research Associate in renewable energy at the Smith School of Enterprise and the Environment where she is focused on studying the impact of solar energy initiatives in Sub-Saharan Africa.

Susann holds a Masters Degree in Political Science, Psychology and Law from the Technical University Dresden which has been complemented by studies at the Graduate Faculty of the New School University in New York.

For her PhD in Political Science Susann performed an indepth analysis of parliamentary performance in Zambia and Sub-Saharan Africa. Prior to her engagement, Susann has gained profound professional experience as an International Account Manager for the Technology Sector at a global corporation. She is also managing solar and hydro energy projects in South Africa and Zambia.

FS4MGO – Results and Publications

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Electric Power Systems Research 160 (2018) 419–428

Contents lists available at ScienceDirect

Electric Power Systems Research

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

Stochastic sizing of isolated rural mini-grids, including effects of fuel procurement and operational strategies

Davide Fioriti [a,*], Romano Giglioli [a], Davide Poli [a], Giovanni Lutzemberger [a], Andrea Micangeli [b], Riccardo Del Citto [b], Ignacio Perez-Arriaga [c], Pablo Duenas-Martinez [c]

[a] DESTEC, University of Pisa, Largo Lucio Lazzarino, 56122 Pisa, Italy
[b] DIMA, University of Rome "Sapienza", Via Eudossiana 18, 00184 Roma, Italy
[c] MIT Energy Initiative, Massachusetts Institute of Technology, 77 Massachusetts Avenue, 02139 Cambridge, MA, United States

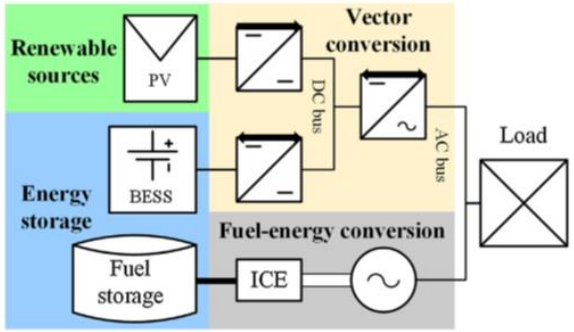

Fig. 1. Typical design of a rural mini-grid.

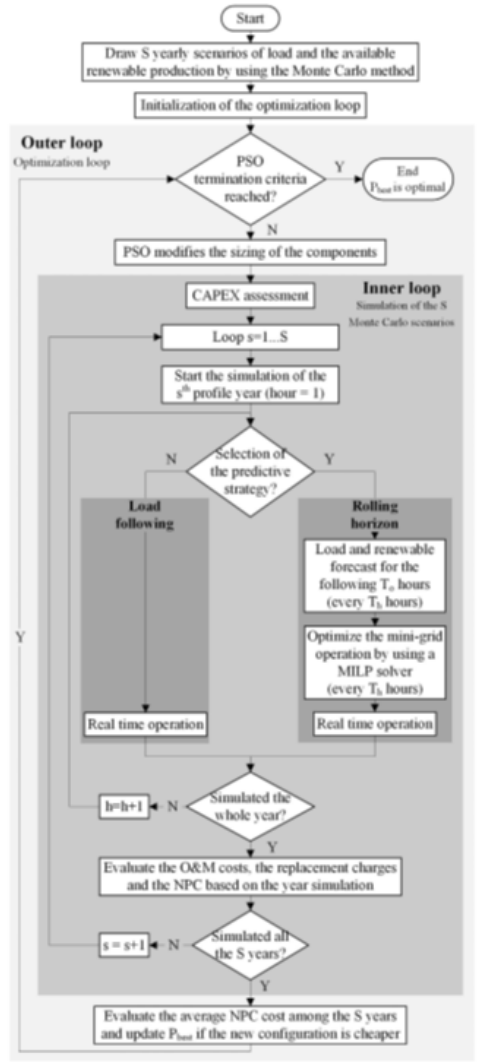

Fig. 3. Scheduling and operation of resources.

FS4MGO Ongoing Activities

CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

- FSA activities comprise **data acquisition campaigns**, both technical and socio-economic, on target communities that become the case studies for the **FS4MGO** academic research.

Case Studies: East Africa Micro Grids

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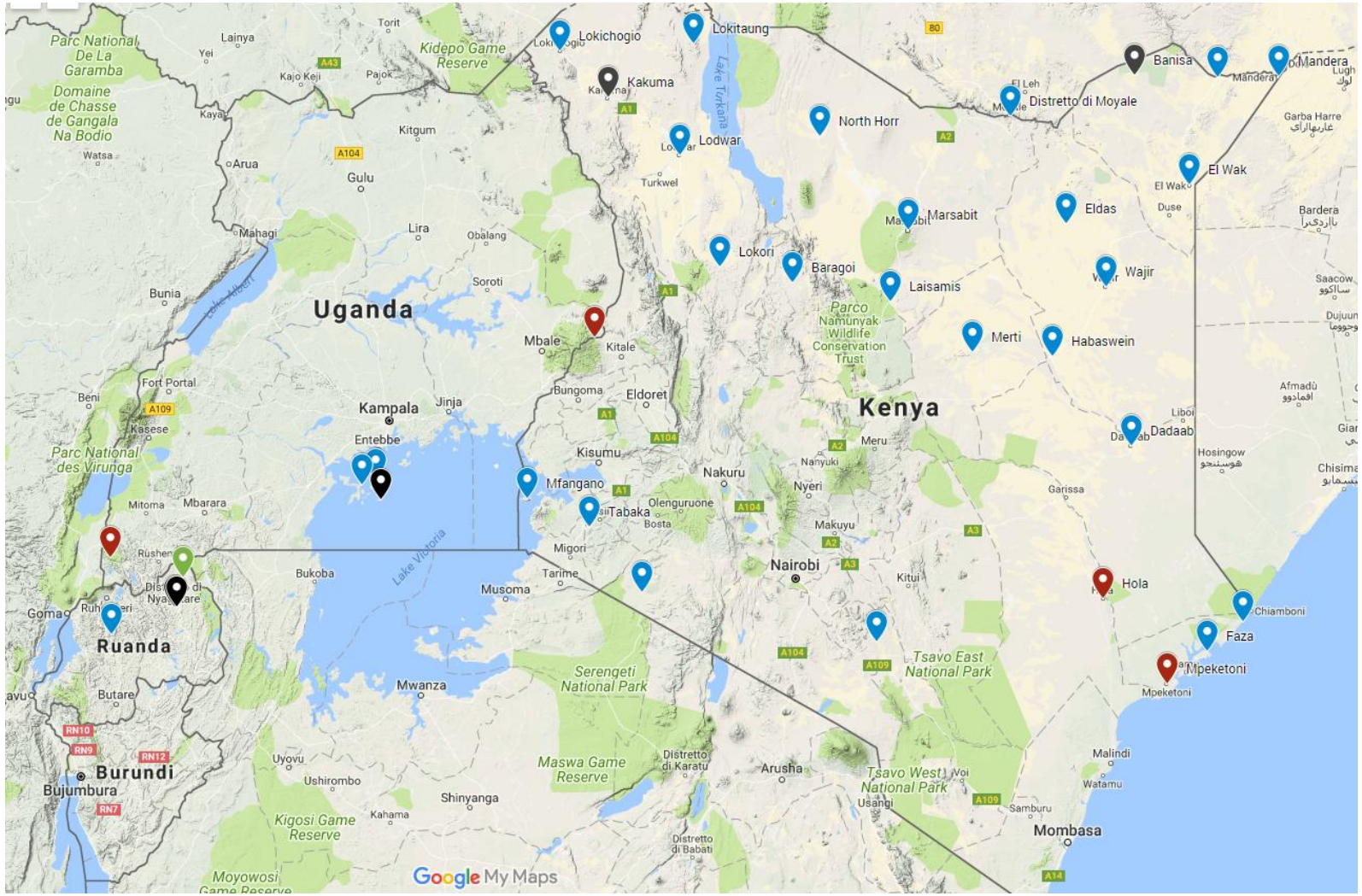
- 34 plants across Kenya, Rwanda and Uganda. We are also obtaining data access to 3 plants in Tanzania.
- The group is also active in Central America, currently in process of installing remote monitoring in three micro-hydro plants in Honduras



Light Blue: in Operation; Black: in construction/commissioning Red: now grid connected Green: still greenfield

Field Study Abroad - Overview

CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

- Field Study Abroad is a **1 month journey** in developing countries, where main activities held are field visits to rural communities, traditional classes, technical workshops, institutional meetings and academic conferences.

- In the past eleven editions, more than **200** youth participated in the FSA held in Eastern Africa and Latin America

Team Work

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Multi-Cultural Awareness

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Hands-On Learning

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Discover…

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...and Engage Yourself

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Awards

- Last march, at the presence of the President of the Italian Republic, the FSA received the *Italia Decide award* for **«Innovation in teaching and higher education»**

Key words

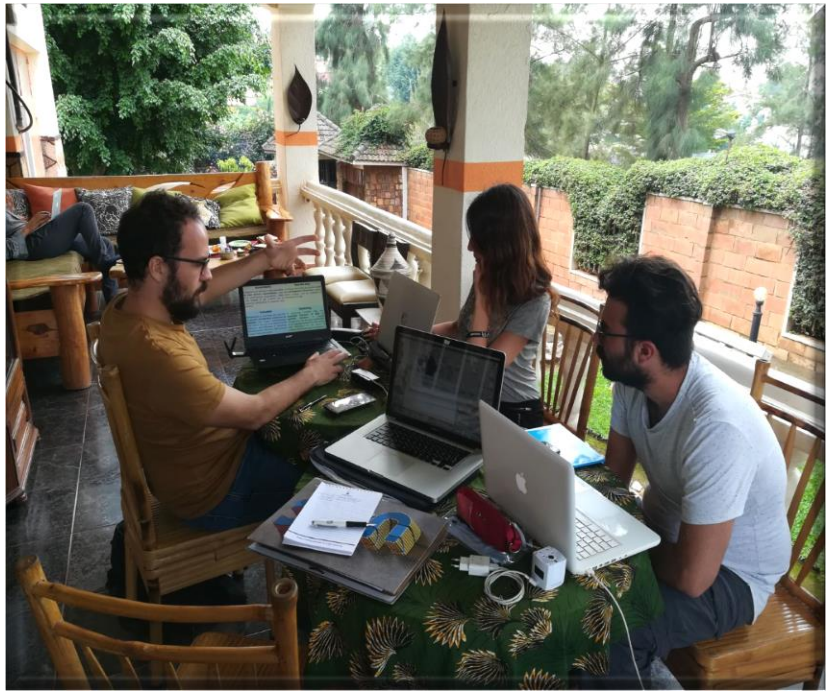
CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

Learn, research and work in developing communities

Course mode: students & teachers

CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

- Frontal standing classes, team project works, and class lectures



Course mode: Learning-by-doing

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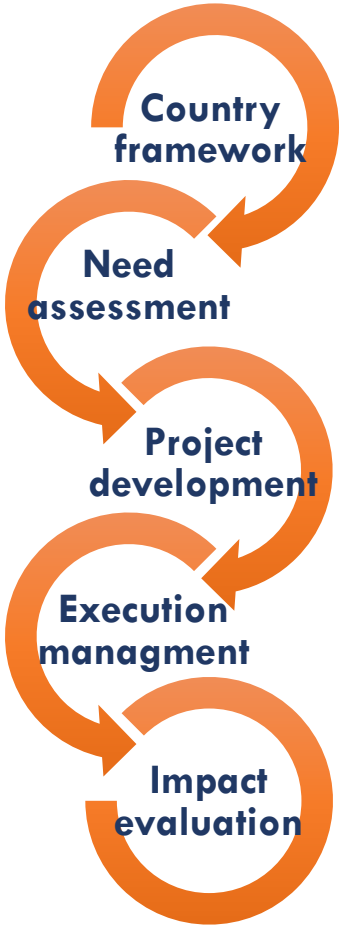
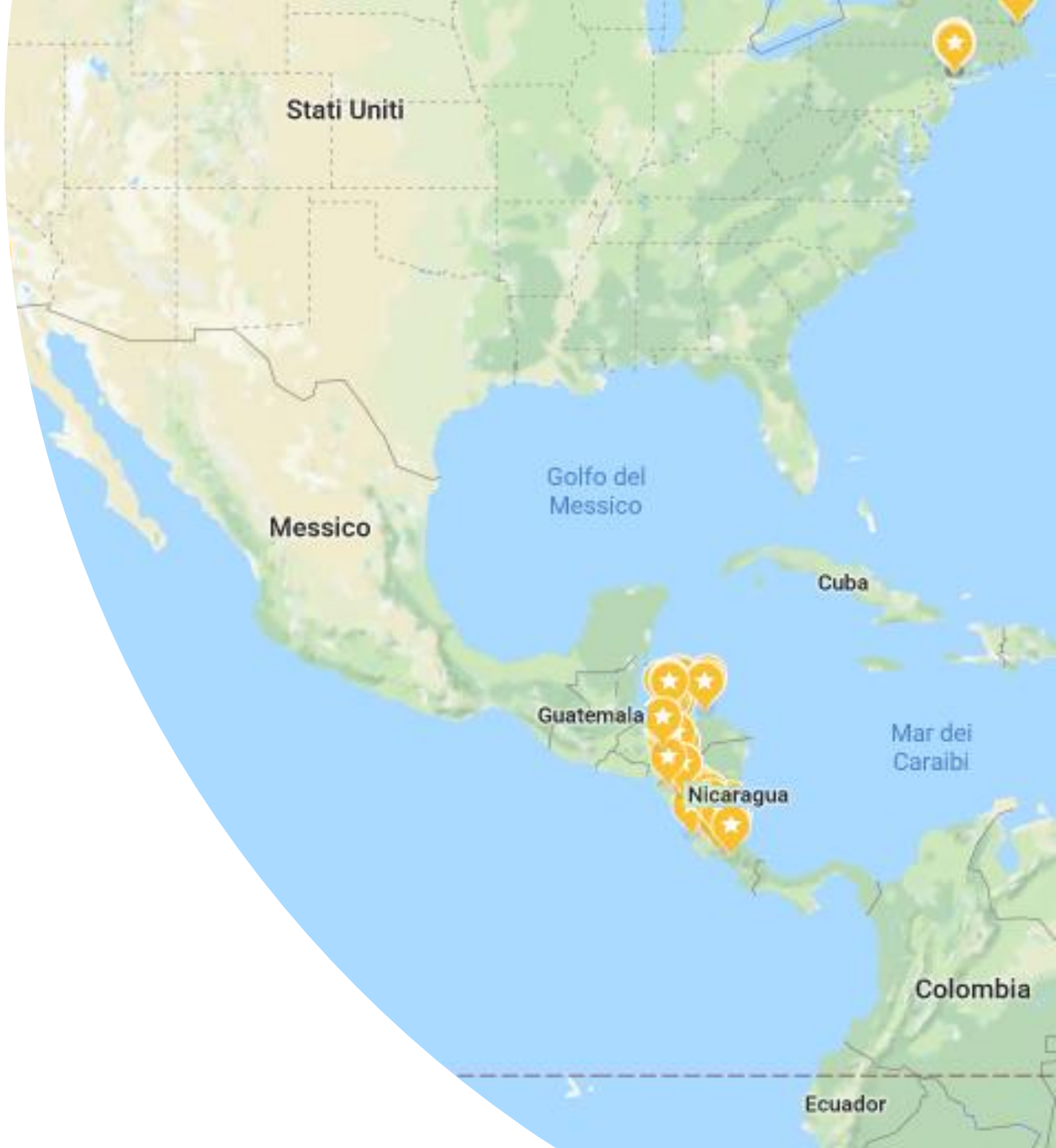


FSA SUMMER EDITION – AUGUST/SEPTEMBER CENTRAL AMERICA

2018 Summer Program



2018 Summer Program

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AUGUST the 7th TUE – Departure

USA

- **8 WED** - Arrival in NY
- **9 THU** - Columbia Univeristy morning visit - Flight to San Pedro Sula

Honduras

- **10 FRI -** Transfer from San Pedro Sula to La Ceiba (CURLA)
- **11 SAT** – Transfer to Quinito, Caribbean Village
- **12 SUN -** Field work Quinito -Hydro mini-grid
- **13 MON -** Field work Plangrande - Hydro mini-grid
- **14 TUE -** Transfer to Copán Ruinas
- **15 WED -** Morning visit to Maya Ruins, afternoon arrival in Chiquimula

Guatemala

- **16 THU -** Field work Chiquimula, Solar irrigation systems for farmers
- **17 FRI -** Field work Chiquimula, University San Carlos renewable project
- **18 SAT -** Transfer to Tegucigalpa

Honduras

- **19 SUN -** Morning lecture and Transfer to El Diptamo
- **20 MON -** Field work El Diptamo Hydro mini-grid
- **21 TUE -** Field work El Diptamo community – La Muralla
- **22 WED -** Transfer to Tegucigalpa
- **23 THU -** Meeting in UNDP
- **24 FRI -** Meeting with RE.TE. NGO/Ministry of Environment
- **25 SAT -** Transfer to La Cruz

Costa Rica

- **26 SUN** - Sports and leisure time on the Pacific San Blas - Guanacaste
- **27 MON –** Visit to Guanacaste
- **28 TUE -** Meeting with Women Rights House - Fundacion Rahab
- **29 WED –** Workshop with Women Rights House - Fundacion Rahab
- **30 THU -** Transfer to San Ramon Technical High School
- **31 FRI -** Workshop in San Ramon Technical High School

SEPTEMBER 2018

- **1 SAT -** Lectures and working groups in San Josè, visit to Crystal Green Hotel
- **2 SUN** - Leisure time – national parks and seaside in Jaco
- **3 MON** - Visit to Chucas Hydro Power Plant
- **4 TUE** – Group works – Thesis and project works follow-ups, Closing ceremony

USA

- **5 WED -** Transfer to Boston
- **6 THU –** Morning Lecture at MIT, return in Italy

GUATEMALA - Solar pumping for irrigation, Chiquimula

CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

Description:

- Solar pumping systems for farmers in the Maya region

Phase:

- Baseline evaluation

Actions:

- Preliminary sizing
- Water availability estimation
- Irrigation system optimization
- Community hearing and meeting with farmers

HONDURAS – El Diptamo Micro-Hydro for forest preservation

CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

Description:

- 15 kW micro-hydroelectric project powering 40 households and coffee farmers in a La Muralla National Park

Phase:

- Operation and maintenance

Actions:

- Community consumption evaluation
- Components maintenance
- Forest management in tropical areas
- Coffee farming system analysis

HONDURAS – Quinito, Micro Hydro for a community in the Caribbean

CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

Description:

- 24 kW micro-hydroelectric project powering 55 households in a remote fishermen community

Phase:

- Operation and maintenance

Actions:

- Installation of smart meters for remote data acquisiton
- Installation of a low-consumption computer lab

COSTA RICA – Women Rights House - Fundación Rahab

Description:

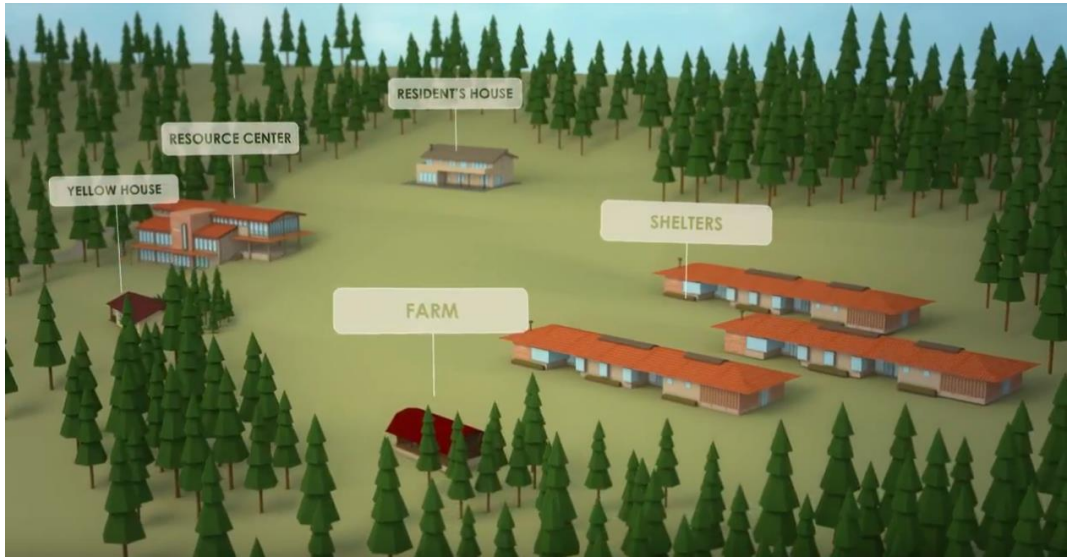
- Housing, schooling and work activities powered by renewable energies for women victims of sexual violence

Phase:

- Planning and design

Actions:

- Three phases:
  1. Remodeling of the resource center, construction of the resident's house, construction of a shelter unit (10 families)
  2. Further remodeling of resource center and construction of another shelter
  3. Further remodeling of resource center and resident's house and construction of another shelter



COSTA RICA – iTree software for carbon neutrality, Piedades Sur

CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

Description:

- Evaluate the impact of trees (Pollution removal, carbon storage and Sequestration, Avoided Runoff, Energy Saving and Structural value) in a vocational institute in Costa Rica with the iTree software suite.

Phase:

- Presentation of the results in the WFUF conference in Mantova (nov. 2018)

Actions:

- Development of iTree energy module
- Evaluation of shading benefit on extending battery life
- CO_2 captured and stored measurement systems analysis

i-Tree™

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COSTA RICA – Green Hotel Crystal, San José

CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

Description:

- Photovoltaic system for energy efficiency

Phase:

- Operation and maintenance

Actions:

- Monitoring
- Load management

FSA WINTER EDITION – DECEMBER/JANUARY
EAST AFRICA

UGANDA - Kitobo Hybrid Mini-grid

CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

Description:

- 230 kW photovoltaic plant with 520 kWh vanadium flow storage system + 80 kVA back-up diesel genset
- Rural development on small islands

Phase:

- Commercial operation

Actions:

- Load management optimization
- Demand growth ramp-up
- Sustainable agricultural development on small islands analysis and startup

About Absolute Energy

CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

- Absolute Energy (AE) is an innovative investment company focused on rural development with a holistic approach through access to productive energy.
- In addition to the Kitobo Micro Grid, AE is about to reach construction phase for another island in Uganda and two villages in Rwanda, and already has a pipeline for new projects in these countries

absolute energy

UGANDA – Kalongo Hospital PV plant

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Description:

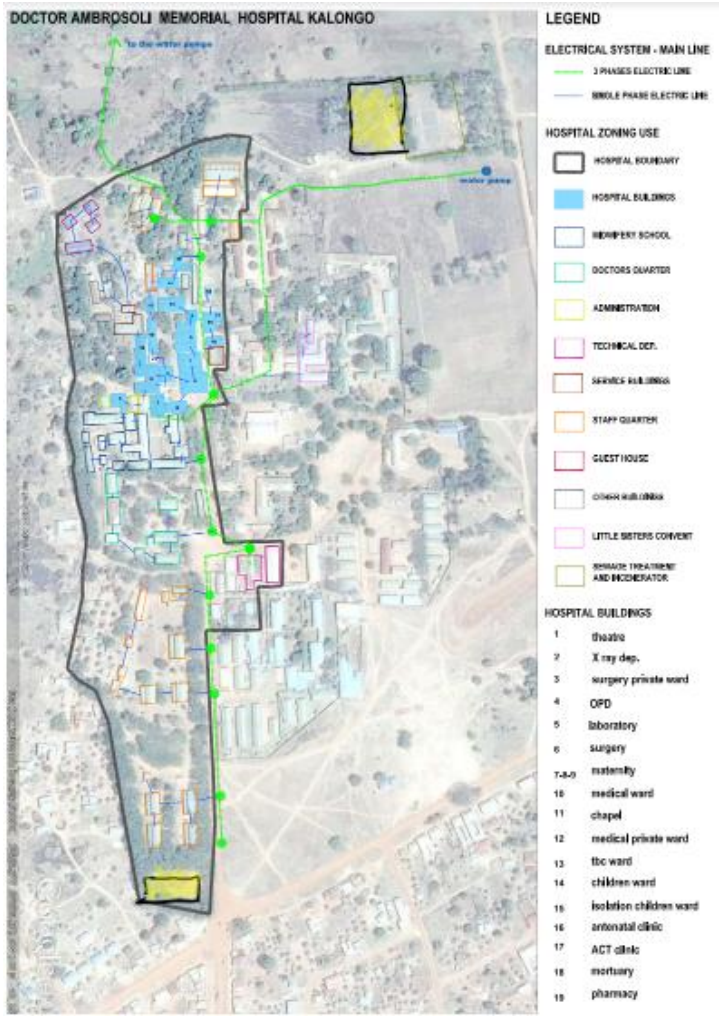
- Ambrosoli Hospital is a compound in Northern Uganda with unrealiable power supply

Phase:

- Preliminary survey

Actions:

- Load analysis
- System sizing and budgeting



UGANDA – Solar lanterns with Makerere University

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Description:

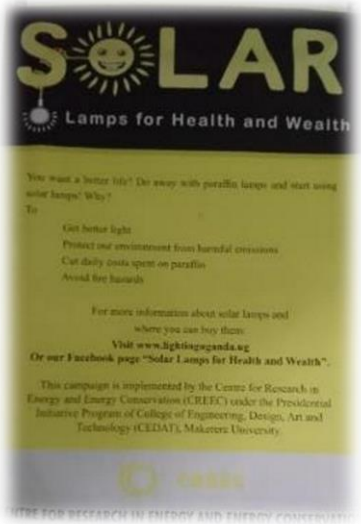
- Makerere University has a laboratory to create special lanterns for fishermen

Phase:

- Agreement signing and start-up

Actions:

- Material pricing
- Electrical sizing and production



RWANDA – Rutenderi Productive village

CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

Description:

- Rutenderi is an off-grid village based on maize agriculture economy

Phase:

- Executive design

Actions:

- Thermal load analysis
- Water supply system design
- Agricultural activities energy and appliances demand analysis
- Productive activities enhancing

RWANDA – Off-grid site identification

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Description:

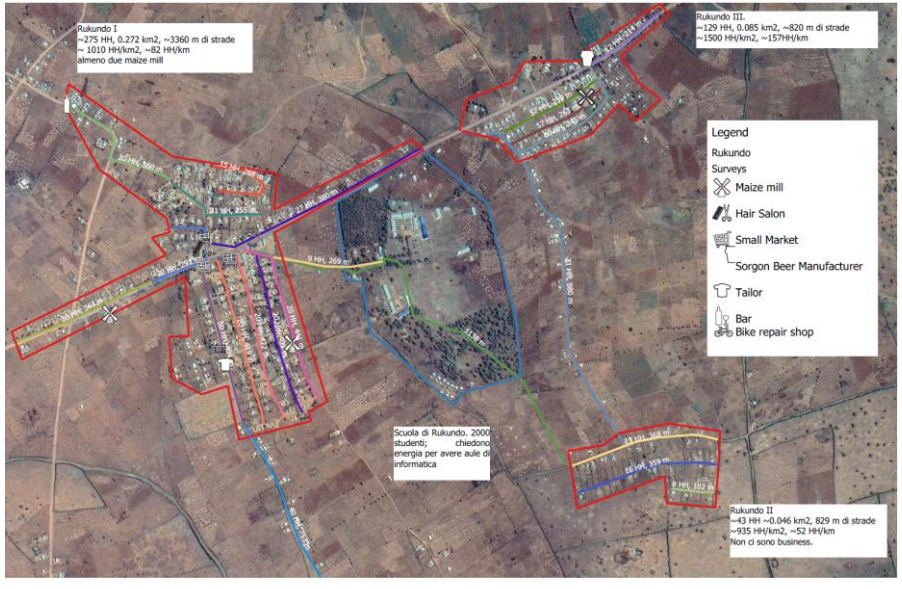
- Rwanda has an electrification rate of 20%

Phase:

- Site identification

Actions:

- Indicator selection targeting productive areas
- Resource mapping
- Preliminary design
- Scouting financing opportunities
- Link up with agriculture products processing and water supply



KENYA – Micro Grid Academy

CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

Description

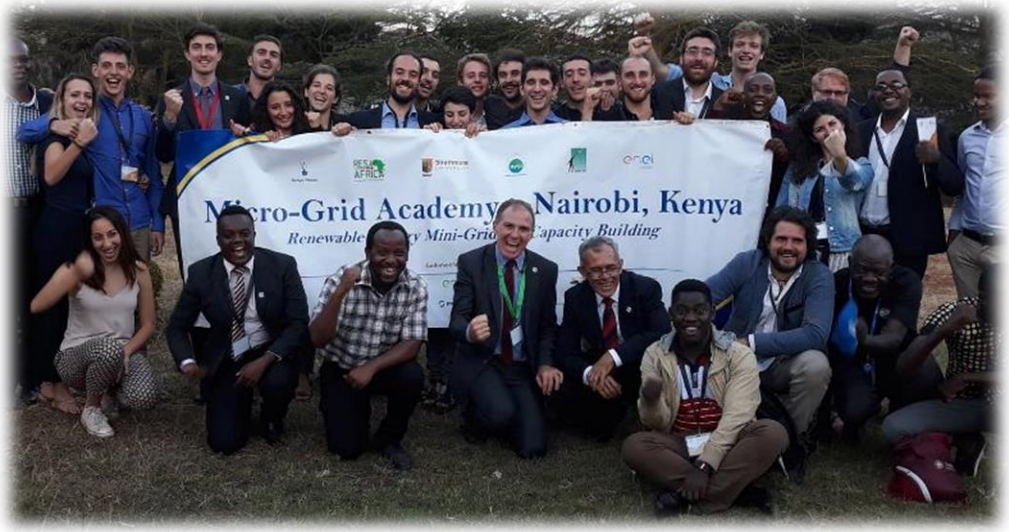
- The MGA is a new capacity building platform, that provides theoretical and practical trainings on energy access and decentralised renewable energy solutions to young East-African and international technicians and engineers

Phase

- The MGA was integral part of FSA X and XI

Actions

- Deployment of a **real 30 kW hybrid mini-grid** in KPLC Institute of Energy Studies & Research, Nairobi



KENYA – Micro Grid Academy

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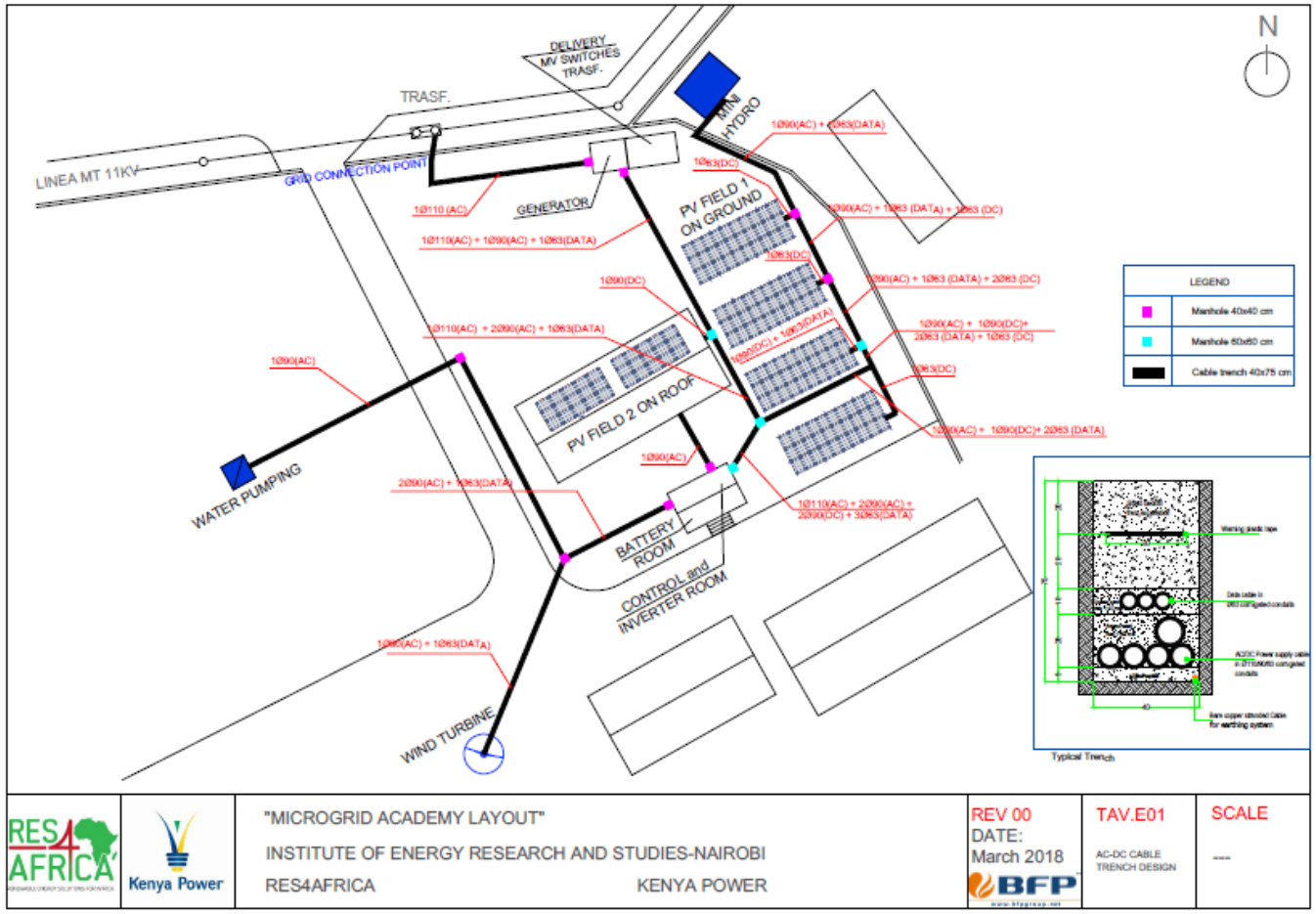
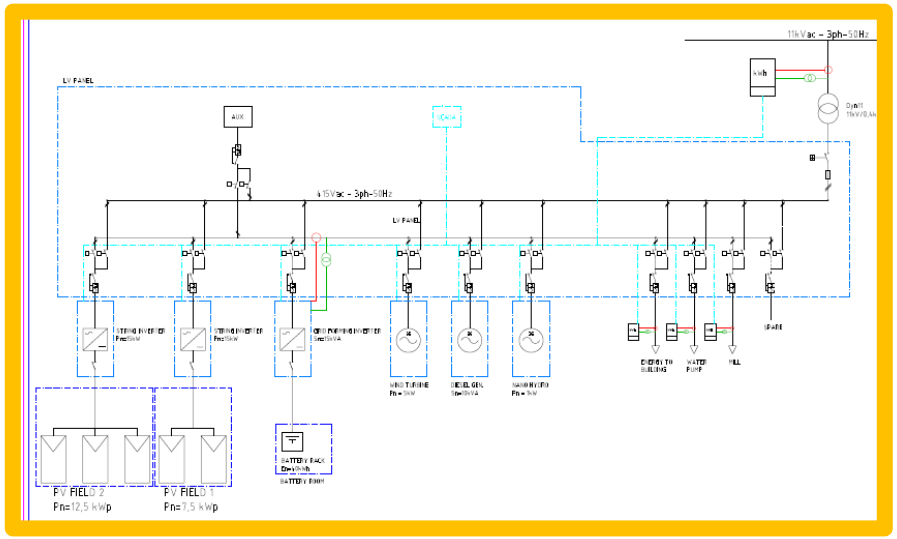


- Solar-PV: 30 kWp
- Wind: 1-5 kW
- Energy Storage: 12 kWh
- Nano-hydro: 0,5 kW
- Diesel back-up component: 5-7 kW



About RES4Med&Africa

CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

RES4MED&Africa built a vast member network from ***across the RE value chain*** **seeking to invest in Med & SSA**

Added value: network gathers broad **RE public-private** sector perspectives & expertise

On site team

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Andrea Micangeli

Professor of Renewable Energy Systems at University of Rome, Strathmore University of Nairobi, State University of New York. Andrea has 25 years experience in International Cooperation for Development.

Carlo Tacconelli

PhD student at Universty of Rome, is an environmental engineer with 10 years of experience in sustainable technologies and project management in developing countries.

Paolo Cherubini

PhD student at Universty of Pisa, is a chemical engineer with background in water & sanitation and mini-grids for rural electrification in East Africa.

Marco Ricci

PhD candidate in Energy and Environment. He has been conducting his research in the field of sustainable technologies in Costa Rica.

Remote support

CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

Riccardo Del Citto

PhD candidate at the University of Rome - Didactic coordinator and students thesis' supervisor

Nicola Stenico

PhD student at the University of Perugia - East Africa field assistant

Valeria Gambino

PhD student at the university of Florence - Research group coordinator and students thesis' supervisor

Emiliano Cesaretti

Agronomist, project development support

Internship and job opportunities

CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

- FSA teams up with many stakeholders, counting on a broad network of entities which can host FSA participants for internships or work opportunities. Past FSA participants undertook stage with:

enel Green Power

UNDP

RES4AFRICA RENEWABLE ENERGY SOLUTIONS FOR AFRICA

absolute energy

Kenya Power

SONNSOLAR Su ahorro en energía

Placement - Alumni

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Daniele Viganò

- Execution project and construction of El Díptamo mini-hydro - Honduras

CÁLCULO CAUDAL									
Fecha	Medidor	D	z+s	h	h-z-s	L	v	f_A	Caudal
		"	"	"	"	"	*m/s*		*l/s*
26/04/2016	Fromm/Viganò	8	3,25	9,3	6,05	11,75	1,69	0,494	**27,3**
11/05/2016	Fromm/Viganò	8	4	9,3	5,3	9	1,38	0,505	**22,8**

Tabella 1. Misure di portata.

- After Filed Study Abroad got a contract as project manager in Eritrea for a PV system project with Work System Srl

Relazione finale

Novembre 2016

ridef 2.0 reinventare l'energia

ENERGIE RINNOVABILI PER L'ELETTRIFICAZIONE RURALE NEI PAESI IN VIA DI SVILUPPO

Progetti di cooperazione internazionale in Honduras e Uganda

A cura di: ***Daniele Viganò***
Matricola 843268

Tutor: dr. Andrea Micangeli
Ente ospitante: CIRPS / Università Sapienza Roma

Alumni

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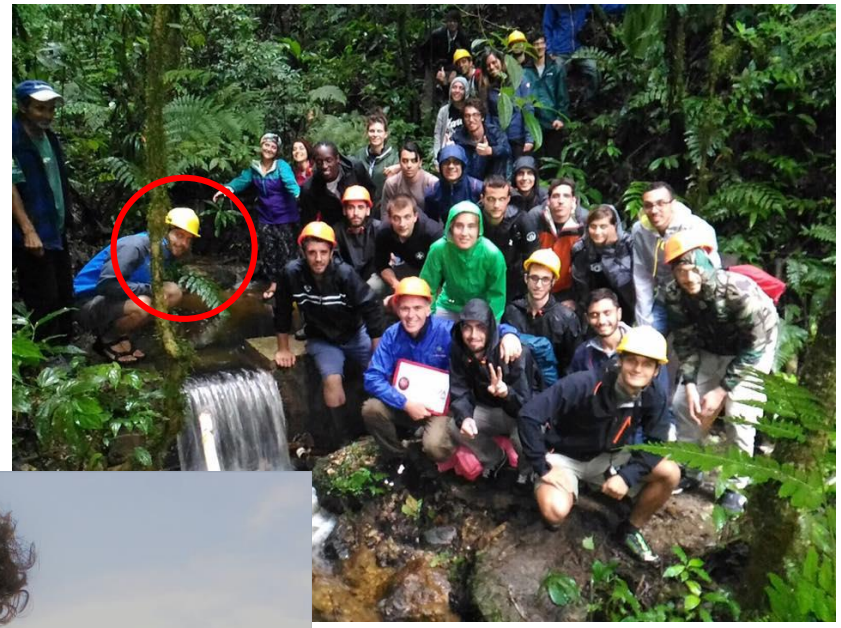
Nicola Stenico

- Took part at FSA IX in Central America
- Had an interview with CEFA for a 1 year contract while he was in Costa Rica, in August. He was admitted as a PhD student in Perugia and began working in Tanzania the next November



Alumni

CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

Chiara Buzzico

- She got her bachelor degree on May 3rd discussing a thesis on hybrid mechano-chemical storage systems for rural minigrids in Africa (in publication). On May 14th she began working in the Asset Area for Green Utility SPA in Rome.

GREEN UTILITY

Tesi di laurea in Ingegneria Energetica

Analisi e Ottimizzazione di Microgrid in isola:

l'Impianto di Kitobo in Uganda

CANDIDATO
Chiara Buzzico
matr: 0203461

RELATORE
Prof.ssa Cristina Cornaro
CORRELATORE
Prof. Andrea Micangeli

Alumni

CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

Saverio Frullani

- Took part in the FSA VII in central America. Did his master thesis on his field experiences in Kenya and is now working as a project coordinator for RES4Africa

Saverio FRULLANI
Mini-Grid Studies
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The Micro-Grid Academy (MGA) is a regional capacity building platform based in Nairobi, Kenya, that provides theoretical and practical training on energy access and decentralised renewable energy solutions to young East-African and international technicians, entrepreneurs and engineers.The project is a joint initiative between RES4Africa, Kenya Power Lighting Company (KPLC), AVSI Foundation, Strathmore University and St. Kizito VTI.

As stated by Saverio Frullani, RES4Africa Project Coordinator, the MGA aims to enhance access to energy in rural communities fostering local enterprise and job creation, while positively impacting health and education services, female empowerment, climate change mitigation, reliable water and food production and energy security, in line with the UN Sustainable Development Goals (SDGs). The training activities will be supported by a real 30 kW hybrid mini-grid to be installed on-site thanks to the contribution of RES4Africa members.

Alumni

CIRPS CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE

Sofia Maccario

- Took part in the FSA XI in East Africa. She will obtain her master's degree in October and is beginning an internship in Enel Green Power, Business Development Sector

Contacts

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THANKS FOR THE ATTENTION!