



# Specialization in **Combined Energy Systems** *Multiple energy services from combinations of renewable energy sources*

KIC InnoEnergy | EXPLORE Polygeneration




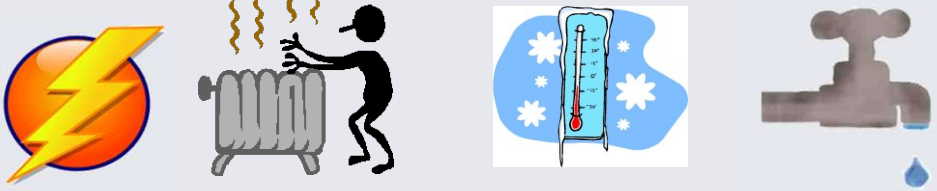
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2016-09-28



# Combined Energy Systems



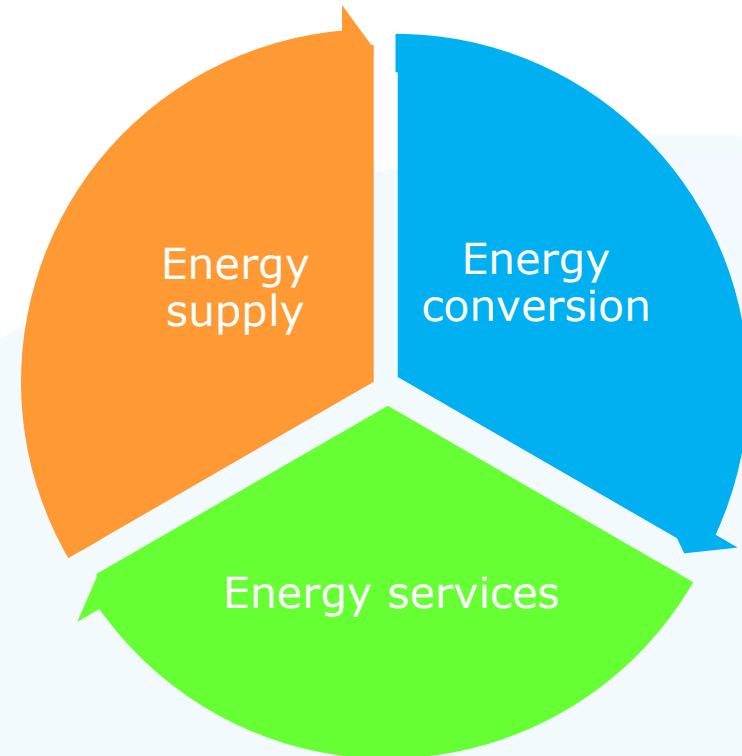
Type	Energy services			
Generation				
Cogeneration				
Trigeneration				
Polygeneration				



# Combined Energy Systems



*The art of combining multiple energy sources to produce various energy services in an efficient, cost effective and sustainable way*



## Keywords for Combined Energy Systems:

*Microgrid/Grid-connected/off-grid, Combination of renewable energy sources, Multiple outputs, High overall efficiency, Interfaces (electrical, thermal, control), Modularity, Re-use of “wasted energy”, Storage, Control, Load prediction, Supply prediction, Supervision, Low maintenance*

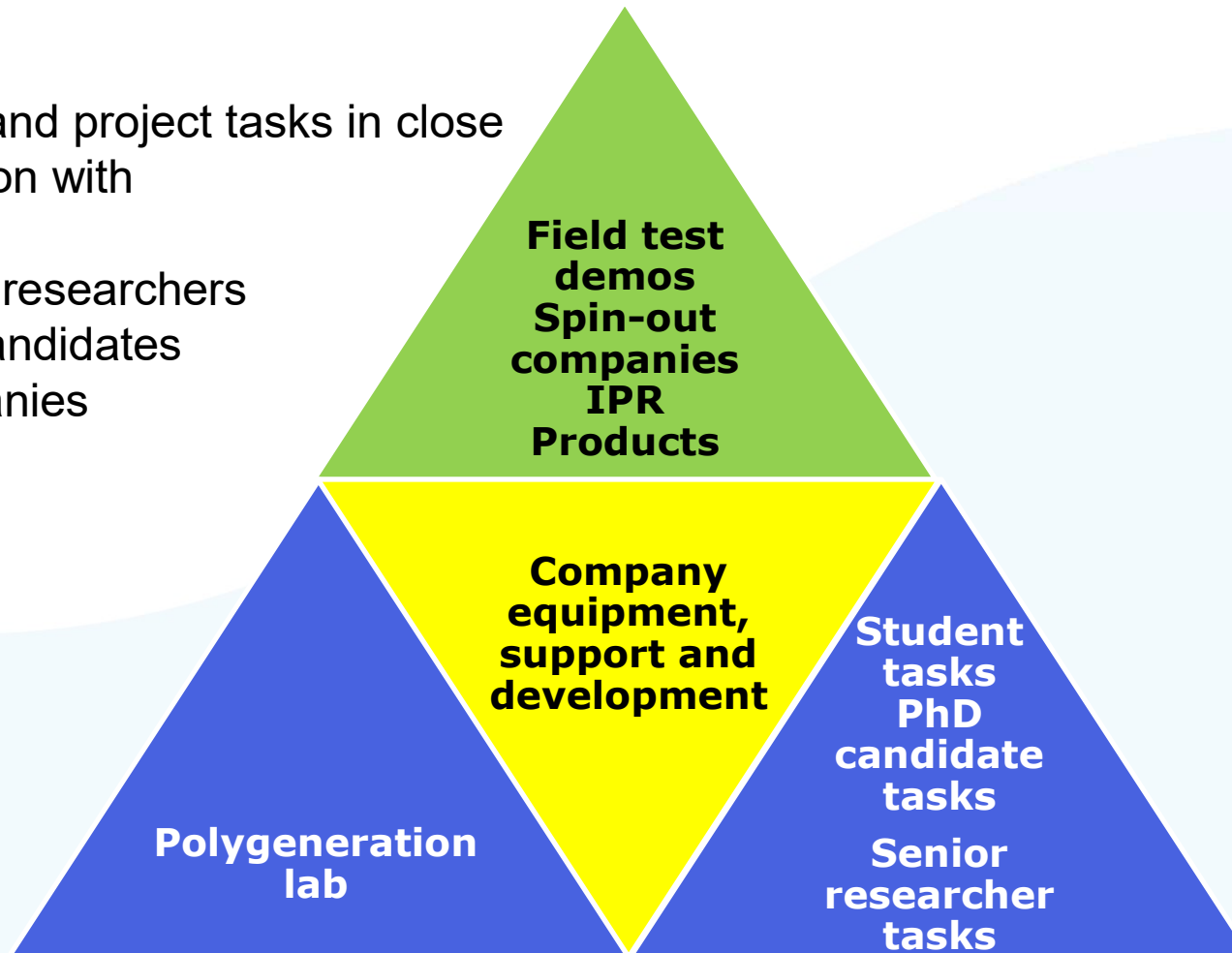


# Select Combined Energy Systems track year 2

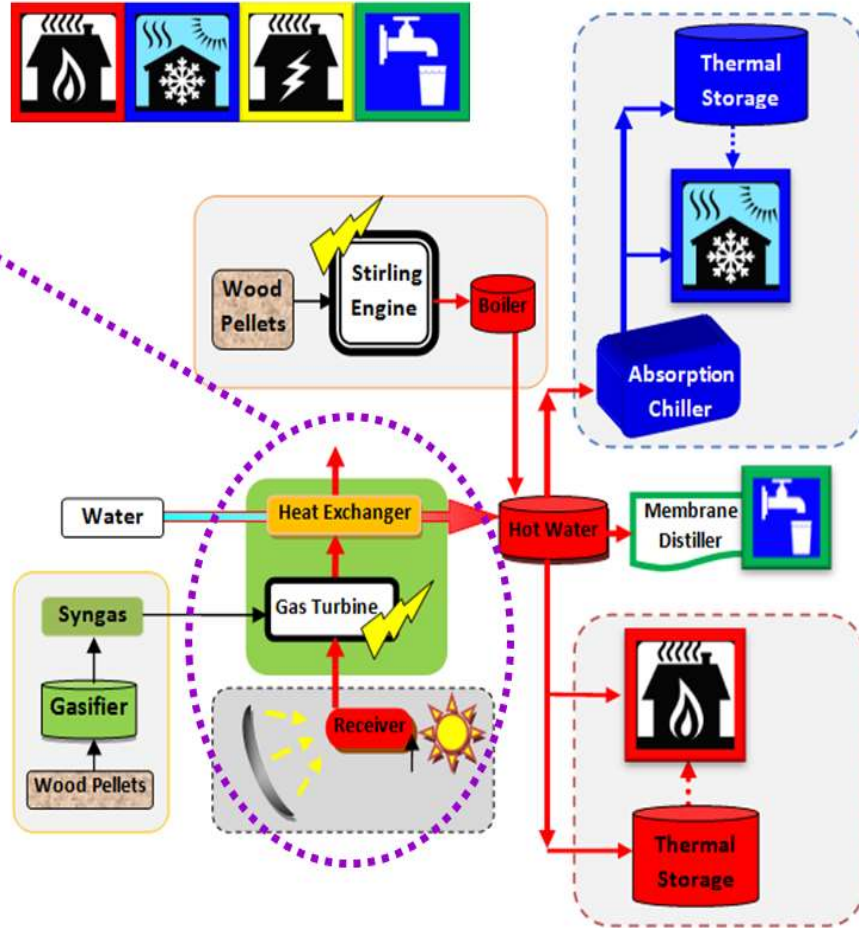
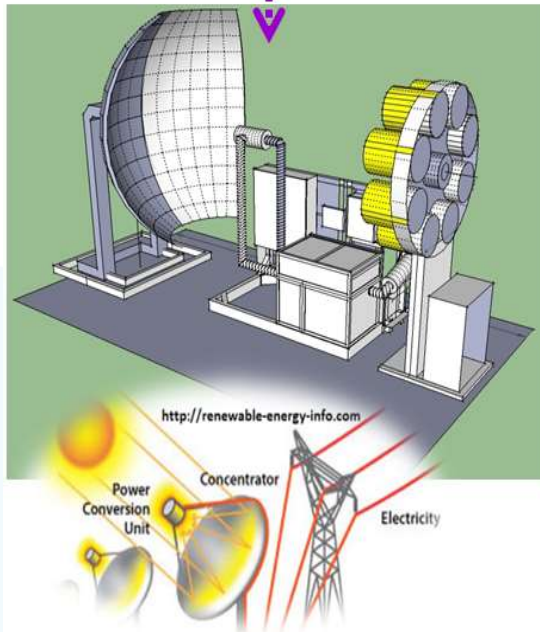
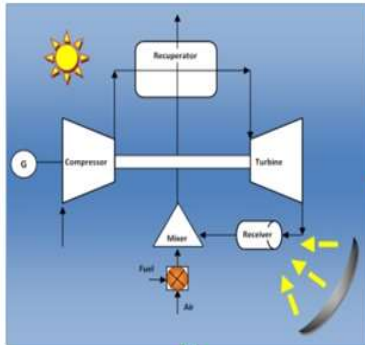


Courses and project tasks in close cooperation with

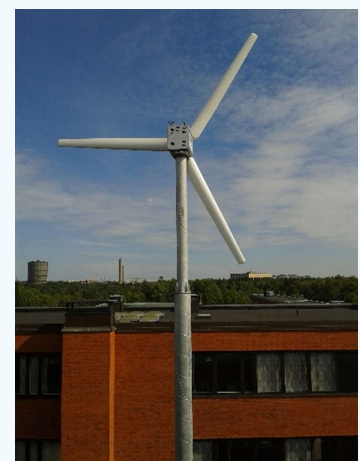
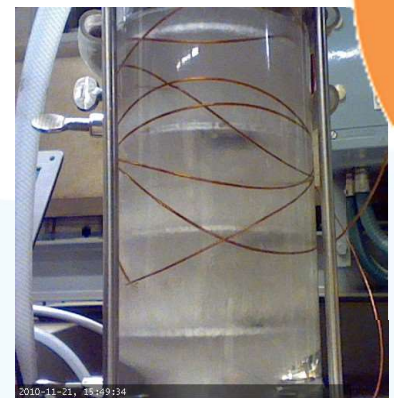
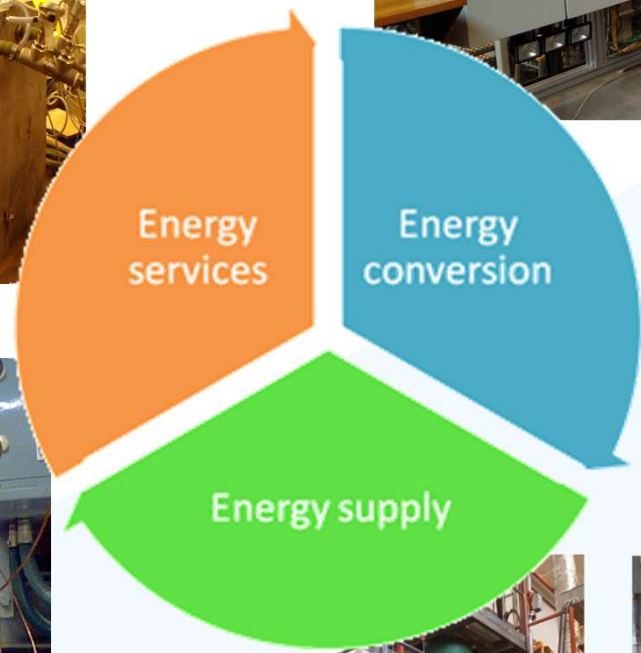
- Senior researchers
- PhD candidates
- Companies



# Polygeneration lab



# Polygeneration lab



# Case study: Microturbine based CSP



Parabolic mirror for a Concentrated Solar Power (CSP) driven Micro Gas turbine.

Location: ENEA, Rome, Italy

# Concentrated Solar Power (CSP) test facility



## Externally fired microturbine

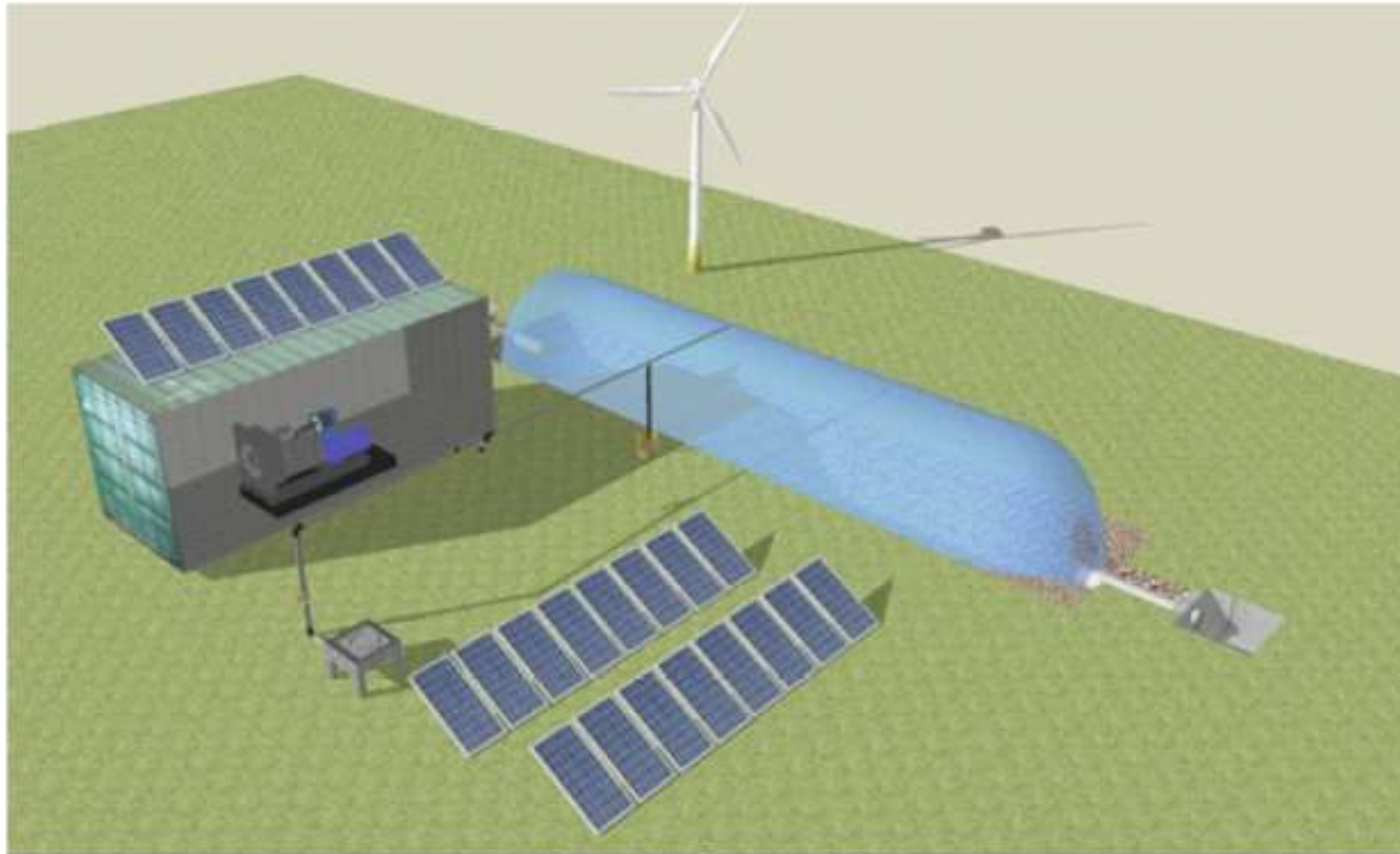


## Solar simulator and heat receiver





# MSc Select: Project of the Year – Emergency Energy Module demo



# Summer internship



Emergency Energy Module demo installation at KTH Campus, Drottning Kristinas Väg 46

# Emergency Energy Module Demo at KTH campus



# MSc Select Students on a field study in Kenya to explore a demo site (summer 2013)



# Case study: Andaman & Nicobar islands



# Case study: Andaman & Nicobar islands

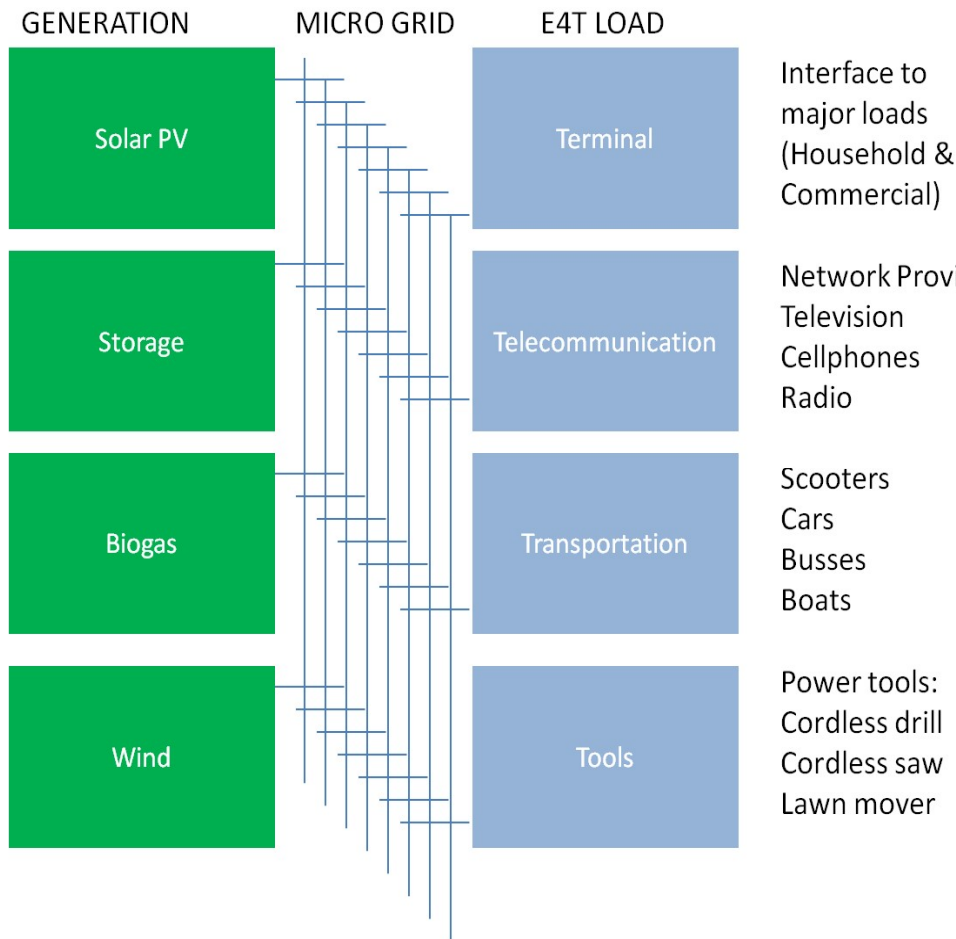


- Today heavily dependent on diesel generators
- Prestudy on a renewable based energy system
- Multiple energy services:  
Electricity, cooling and clean drinking water

# Case study: Andaman & Nicobar islands



## E4T Microgrid Concept



STRII

KTH VETENSKAP OCH KONST

Pamaja CLEANTECH AB

CLEANBIOS INNOVATIONS

Ahalia

Alternate Energy Pvt.Ltd.

# Case study: Andaman & Nicobar islands

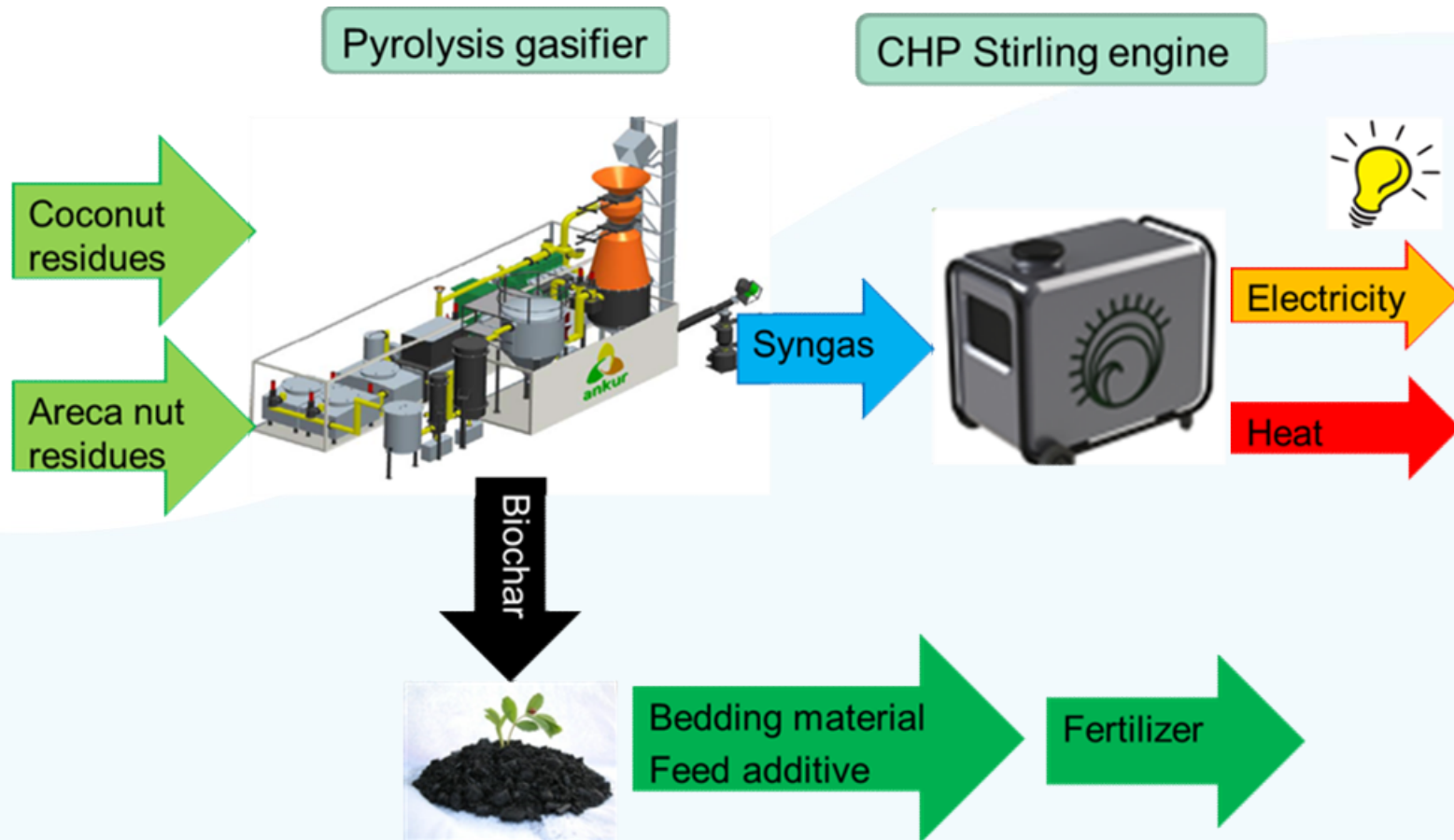


Available biomass: Coconut shells, suitable for gasification to produce syngas

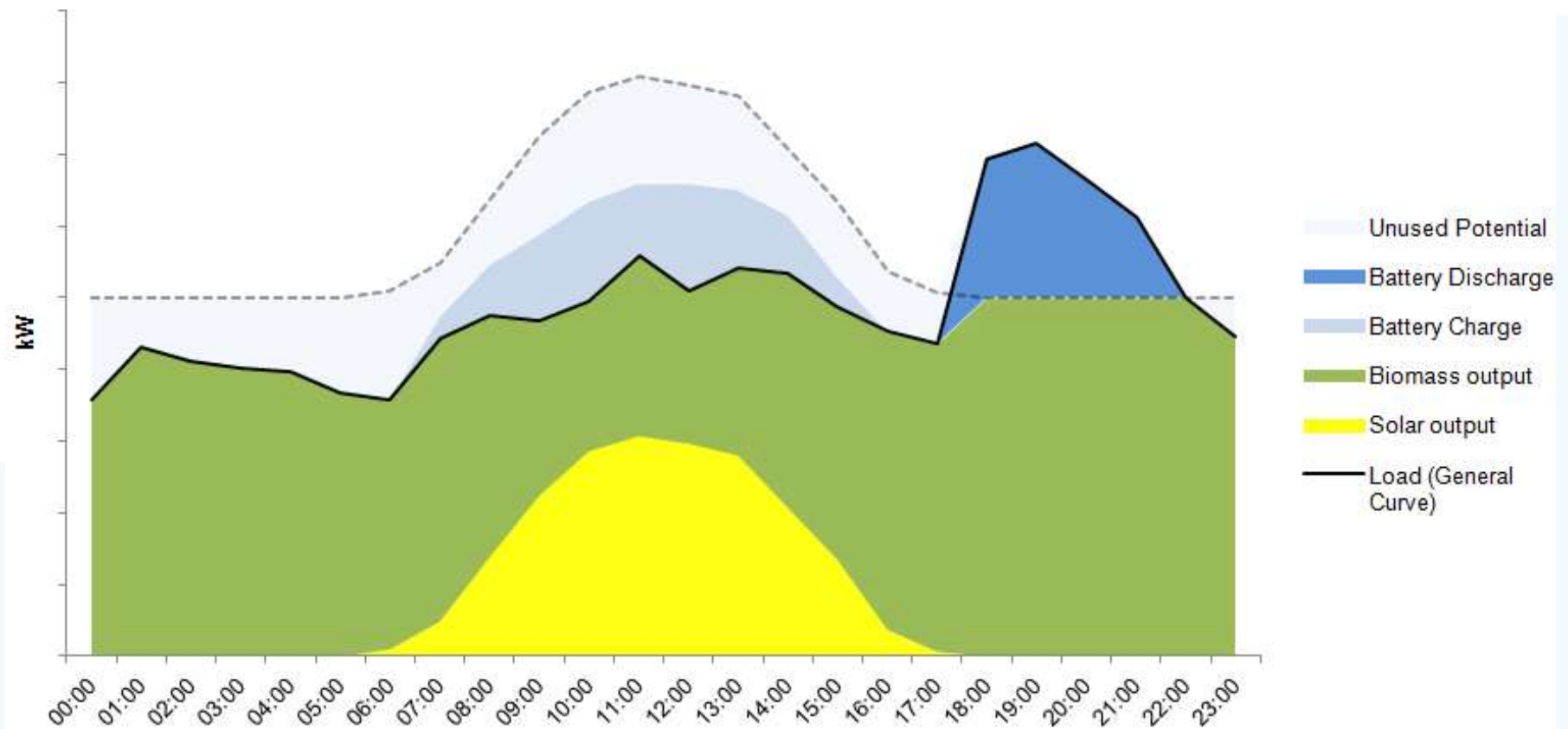




## Biomass to electricity and heat



## Results: Electric power by sources



# 2<sup>nd</sup> year Specialization in Combined Energy Systems



Title	ECTS
Integrated Project of the Year in Sustainable Energy	6
Small Scale Combined Energy systems	6
Dynamics of Innovation in Combined Energy Systems	6
Elective courses	12
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➔ MSc Thesis	30
Tot	60



# Recommended elective courses

## 2<sup>nd</sup> year Specialization in Combined Energy Systems



Course code	Course Name	Total ECTS
MJ2477	Energy Policy Planning	6
MJ2383	Energy System Economics Modelling and Indicators for Sustainability	6
MJ2405	Sustainable Power Generation	9
MJ2420	Combustion Theory	6
MJ2434	Advanced refrigeration and heat pump technology	6
MJ2440	Measurement Techniques in Energy Technology	3
MJ2460	Green Building - Concept, Design, Construction and Operation	6
MJ2462	Achieving Energy Efficiency in Existing Buildings	6



# MSc Thesis: Local biogas production



Complete pilot digester on test at KTH campus

MSc thesis project by Marie Janet Eustace

Feasibility study of a stand-alone small-scale digestion systems to produce biogas for local use, (Eustace 2012)



# Welcome to



## KTH – Kungliga Tekniska Högskolan

Thanks for your attention!