Specialization in Combined Energy Systems

Multiple energy services from combinations of renewable energy sources

KIC InnoEnergy | EXPLORE Polygeneration

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## Combined Energy Systems

<table>
<thead>
<tr>
<th>Type</th>
<th>Energy services</th>
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<tbody>
<tr>
<td>Generation</td>
<td><img src="image1" alt="Electricity Icon" /></td>
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<tr>
<td>Cogeneration</td>
<td><img src="image2" alt="Electricity Icon" /> <img src="image3" alt="Heating Icon" /></td>
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<tr>
<td>Trigeneration</td>
<td><img src="image4" alt="Electricity Icon" /> <img src="image5" alt="Heating Icon" /> <img src="image6" alt="Cooling Icon" /></td>
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<tr>
<td>Polygeneration</td>
<td><img src="image7" alt="Electricity Icon" /> <img src="image8" alt="Heating Icon" /> <img src="image9" alt="Cooling Icon" /> <img src="image10" alt="Water Icon" /></td>
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</table>
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

Field test demos
Spin-out companies
IPR
Products

Company equipment, support and development

Polygeneration lab

Student tasks
PhD candidate tasks
Senior researcher tasks
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

- GENERATION
  - Solar PV
  - Storage
  - Biogas
  - Wind

- MICRO GRID
  - Terminal
  - Telecommunication
  - Transportation

- E4T LOAD
  - Interface to major loads (Household & Commercial)
  - Network Providers: Television, Cellphones, Radio
  - Scooters, Cars, Busses, Boats
  - Power tools: Cordless drill, Cordless saw, Lawn mower

Logos and icons from KTH, STRI, Pamoga, CLEANBIOS, Ahalia, and Alternate Energy Pvt Ltd.
Case study: Andaman & Nicobar islands

Available biomass: Coconut shells, suitable for gasification to produce syngas
Case study: Andaman & Nicobar islands

Biomass to electricity and heat

Pyrolysis gasifier

Coconut residues

Areca nut residues

CHP Stirling engine

Syngas

Electricity

Heat

Biochar

Bedding material
Feed additive

Fertilizer

Polygeneration
Part of Explove Energy
Case study: Andaman & Nicobar islands

Results: Electric power by sources
### 2nd year Specialization in Combined Energy Systems

<table>
<thead>
<tr>
<th>Title</th>
<th>ECTS</th>
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<tbody>
<tr>
<td>Integrated Project of the Year in Sustainable Energy</td>
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<tr>
<td>Small Scale Combined Energy systems</td>
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<td>Dynamics of Innovation in Combined Energy Systems</td>
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<td>Elective courses</td>
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<td><strong>MSc Thesis</strong></td>
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<td><strong>Tot</strong></td>
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Recommended elective courses
2nd year Specialization in Combined Energy Systems

<table>
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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>MJ2477</td>
<td>Energy Policy Planning</td>
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<tr>
<td>MJ2383</td>
<td>Energy System Economics Modelling and Indicators for Sustainability</td>
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<tr>
<td>MJ2405</td>
<td>Sustainable Power Generation</td>
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<tr>
<td>MJ2420</td>
<td>Combustion Theory</td>
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<tr>
<td>MJ2434</td>
<td>Advanced refrigeration and heat pump technology</td>
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<td>MJ2440</td>
<td>Measurement Techniques in Energy Technology</td>
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<tr>
<td>MJ2460</td>
<td>Green Building - Concept, Design, Construction and Operation</td>
<td>6</td>
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<tr>
<td>MJ2462</td>
<td>Achieving Energy Efficiency in Existing Buildings</td>
<td>6</td>
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</tbody>
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MSc Thesis: Local biogas production

Complete pilot digester om 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!