A brief presentation of the Department of Energy Technology, EGI
EGI, about 70 ph.d. students

Staff vs. Turnover, Msek (2011)

- Energy Technology: 95 (Staff), 89 (Turnover)
- Industrial Economics and Management: 86 (Staff), 96 (Turnover)
- Machine Design: 100 (Staff), 97 (Turnover)
- Production Engineering: 57 (Staff), 63 (Turnover)
- Materials Science and Engineering: 85 (Staff), 99 (Turnover)
- Industrial Ecology: 37 (Staff), 28 (Turnover)
Recent historical development

**Total turnover, ksek**

- 2008: 50,000
- 2009: 60,000
- 2010: 80,000
- 2011: 90,000
Research at the Department of Energy Technology
The Vision of Dept Energy Technology

To contribute to a sustainable future by inspired teaching and world class research in innovative energy technologies and energy systems.

"... The largest challenge, today, globally, is to create a sustainable development and solve the climate issue. .... “ (KTH development plan, chap 1. line 1)
The Dept of Energy Technology at KTH

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Dr Anders Malmquist

Turbomachinery
Doc Damian Vogt

Fuel Cell Technology
Dr Bin Zhu

Life-long Learning
Prof Torsten Fransson

Chemical Energy Conversion
Dr Catharina Erlich

Thermal Energy Storage
Doc Viktoria Martin

Concentrating Solar Power
Dr Björn Laumert
High-Flux Solar Laboratory Build-up at EKV/KTH

- Unique facility (only 3 other universities have comparable facility worldwide)
- 58 kW Sun simulator with concentrated flux density of 10MW/m² on target

- Providing a stable high temperature heat source for:
  a. Investigating thermochemical process
  b. Testing advanced high temperature materials
- Providing an experiment platform for researching and developing of high temperature solar receivers
- Providing a possibility for experimental investigation of the thermodynamic cycle for high concentration CSP power generation
- Utilization as power source for solar driven processes in polygeneration lab

Target: operational 2012
Highlights 4: Outstanding Lab Facilities

- >250 MSEK infrastructure
- Worldwide, national & European unique facilities

Turbine flutter test facility

3D coolant flow and velocity measurements
New low GWP refrigerants

The project aims to provide data, support and prerequisite information of alternative refrigerants with low GWP at the phasing out of HFC refrigerants for existing and new heating/cooling systems.
CO₂ Commercial Refrigeration and Heating Systems in Supermarkets

CO₂ Transcritical system

NH₃-CO₂ Cascade system

Heat Recovery form Refrigeration system
Small ammonia heat pump
Enhancing energy-efficiency of refrigerators and freezers

Ph.D. project in cooperation with Electrolux, Supported by STEM

IR photograph of inside and back side of refrigerator
Heat pumps with variable speed compressors, fans and pumps – optimum control

New project: FDD Fault Detection and Diagnosis
Solar driven ejector-refrigeration process
WUXI- smart city – smart people

• Sino Swedish Eco City District joint venture.
• 10,000 inhabitants.
• Targets
  – Less than 2 KW per capita avg. primary energy out-take.
  – Less than 2 ton CO2 emissions per capita.
• Selection of measures most economically, technically and environmentally viable.
• Innovative out-of-the box ideas for food, transport and social planning.
• Systems thinking approach.

>150 students in 17 groups!
Innovation and entrepreneurship for efficient energy usage

*Using the city as an arena for innovation*

- By aid of a proposed innovation system model and with a *systems approach*, an urban development project is analyzed with a special focus on whether the project meets a triple beneficial outcome, i.e. a \((\text{WIN})^3\) situation:
  - Market development
  - Innovation
  - Sustainable urban development

- *System dynamics* is also used to analyze the challenges and the presumable additional benefits that will follow in a scale-up situation, hence if it is possible to achieve a \((\text{WIN})^4\) situation resulted by synergistic effects?
Microporous surface for enhancing heat transfer in boiling
KTH Renewable Energy Park, now under construction at EGI
ECS and ESA within KTH

- Architecture and Built Environment
- Biotechnology
- Computer Science and Communication
- Electrical Engineering
- Engineering Sciences
- Information and Communication Technology
- Chemical Science and Engineering
- Technology and health
- Education and Communication in Eng Science

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ECS – objectives
(research, education, societal impact)

- develop **interdisciplinary** research combining **energy, climate and sustainable development** in search for **systems solutions**;
- link technical and scientific knowledge with **policy actions** and **development options** at regional, national and global levels;
- provide support for **decision making** in public and private organizations;
- strengthen the energy planning component of **engineer education** at KTH to promote energy sustainability
- build **institutional capacity** with a strong team and alliances to speed up the **energy transition** and achieve impact on society
Research themes at ECS

- Bioenergy systems
- Electricity access
- Energy efficiency
- Urban change
- Energy and climate policy
Conditions for transforming waste to energy in La Paz and El Alto
Sugarcane bioenergy systems

**Sugarcane**

- **Juice**: 14% by-product, 80-90 L
- **Sugar**: 4-5% by-product
- **Trash**: tops and leaves, 28% (wet)

1. **Bagasse**: 28% (wet), 100-150 kWh/t-cane

2. **2 G-Ethanol**

Energy equivalent: 1 tonne of sugarcane = 1.2 barrel oil (source: UNICA, 2008)

1.2 boe = 7,034 MJ
BeWhere model: sugarcane biorefinery

- Transport fuel in Brazil
- Conventional or reference option
- Port in Brazil
- Biofuel export
- 2G option
- Port in EU
- Transport fuel in EU
- Power generation
- Electricity option
- Cane biomass supply point
- Cane biomass
- 1G ethanol
- 2G ethanol
- Bioelectricity to grid
- Substituted fuel and/or power
Smart grid

Energy management systems

HVDC

Energy Storage

Decentralized renewable power generation

Electromobility and telematics

Active building and internet of things (Intelligent Electronic Devices, IED)

Source of figure: www.stockholmroyalseaport.com
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<th>Project</th>
<th>Dimensions</th>
<th>Geographic focus</th>
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<td>identified trends for energy efficiency improvements</td>
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ECS – Energy and Climate Studies at KTH

Building knowledge with research, education and outreach

Bioenergy systems
Energy access
Energy systems efficiency
Urban Change

Building scientific and institutional capacity

Master’s theses
Problem evaluation
Case-studies
Applications

Research projects
PhD or Postdoc
Key regions of interest
Case-studies / comparisons
Conceptual and methodological development

Inducing change

Energy and climate policy analysis and monitoring

Outreach
Cooperation with key actors
Conference participation
Seminars
Debates
Networks
Policy makers briefs
Popular science publications

Making difference!

Impact on industry, policy and society
Know-how and technology transfer
Legal frameworks
Policy analysis

Delivering

Outreach
Cooperation with key actors
Conference participation
Seminars
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Networks
Policy makers briefs
Popular science publications

Outputs
Strategic partnerships
Funding activities
Scientific publications
International exchange
Conferences
Seminars
Courses
Seminars
Applications for funds
Examinations

Disseminating knowledge

Basis for continued excellence in research

Basis for continued impact

System shift towards sustainability

Linking with global and national agendas / cooperation within other KTH efforts

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Energy and climate policy analysis and monitoring

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Division Energy Systems Analysis
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Finding CLEWs

CLEW - Integrated Climate, Land Use, Energy and Water Modelling

- Local GHG emissions (incl. fossil fuels, farming, fertilizer use or use of biofuels)
- Foreign induced GHG emissions (especially: induced land-use changes)
- Crop yields and related energy balance
  - Carbon content and storage in plants and soil
  - Input of water, fertilizer, energy during growth period and harvesting
- Water for irrigation
- Water for hydropower
- Water for cooling powerplants
- Water used for biofuel production
- Water use during resource extraction
- Local Energy use (e.g. energy for farming, production of local biofuels or hydropower)
- Foreign induced energy use (imports and exports, fossil fuel extraction)