

A Future with Sustainable Energy Systems

The only future we can have!

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Semida Silveira

Professor Energy Systems Planning
Head of Energy and Climate Studies
Director International Affairs, Brazil





An innovative European technical university

Sweden's largest technical research and learning institution

- More than 13,000 full-time students (one-third women).
- Close to 1,800 research students (one-third women).
- Around 3,500 full-time positions (one-third women).
- Five campuses in the Stockholm region.

KTH rests on three pillars; ***sustainability, equality and internationalization***



Innovative thinking, unlimited possibilities

Our work encompasses a wide range of disciplines;

engineering, natural sciences, architecture, industrial management, urban planning, history and philosophy.

Research focus;

energy, transportation, information and communication technology, life sciences and materials.





Broad international recruitment

- Latin America, China, India and Southeast Asia
- Around 500 European and 800 non-European students studying a Master's degree program in 2016
- Around 1000 incoming exchange students 2016
- Extensive student services for international students



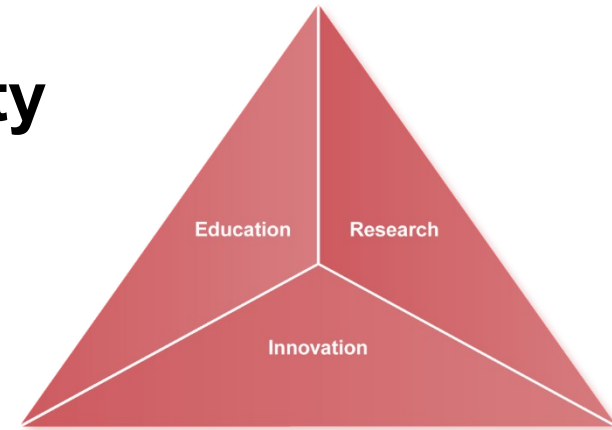


KTH collaboration with society

Strategic partnerships

Long-term dialogue at executive level

Short-term goals on education and research



Mobility

Adjunct professors, affiliated faculty, industry PhD

Adjunct experts, affiliated experts

From idea to innovation








Each year some 300 ideas, born out of KTH's research and education, start the journey from idea to innovation.


An internationally recognised process that includes coaching, legal and financial advice and turns ideas into businesses.



Solar Group Projects

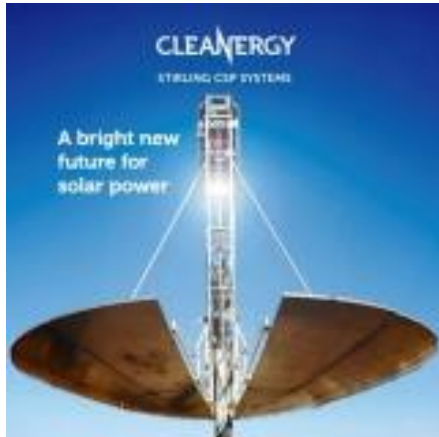
- Tesconsol: investigates cost effective thermal energy storage systems for concentrating solar power plant




- OMSOP: 7th Framework Programme for Research and Development aims to provide and demonstrate technical solutions for the use of state-of-the-art concentrated solar power system (CSP) coupled to micro-gas turbines (MGT) to produce electricity



- Swedish research program TURBO POWER is a centre for gas and steam turbine research constituted as a consortium between technical universities and turbine manufacturers



- CSP Stirling: The project aims to develop, test and verify the effectiveness of solar collector (solar thermal) systems for Stirling-engine based power generation, in which concentrated solar energy replace conventional

CSP Stirling CLEANERGY

Project CSP Concentrated Solar Power MAGHRENOVAR Morocco



Objective

- Bringing highest solar convergence efficiency **CSP-Stirling dish system** to the market (>30%) through Swedish technology edge (Cleanergy AB)
- Providing cost competitive and scalable solar power in the range 11kW – 100 MW
- Providing robust and fully dispatchable solar technology

Business

- Arid areas with water-scarcity are prime niche
- 10-15% Total market share, 200-300MW in Morocco alone by 2020
- TAM: 1000 MEURO



Energy systems must be understood in the context of demand for infrastructure and services





Energy for Sustainable Development



Energy systems efficiency



Bioenergy systems



Urban sustainability

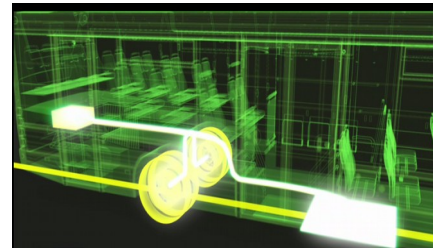
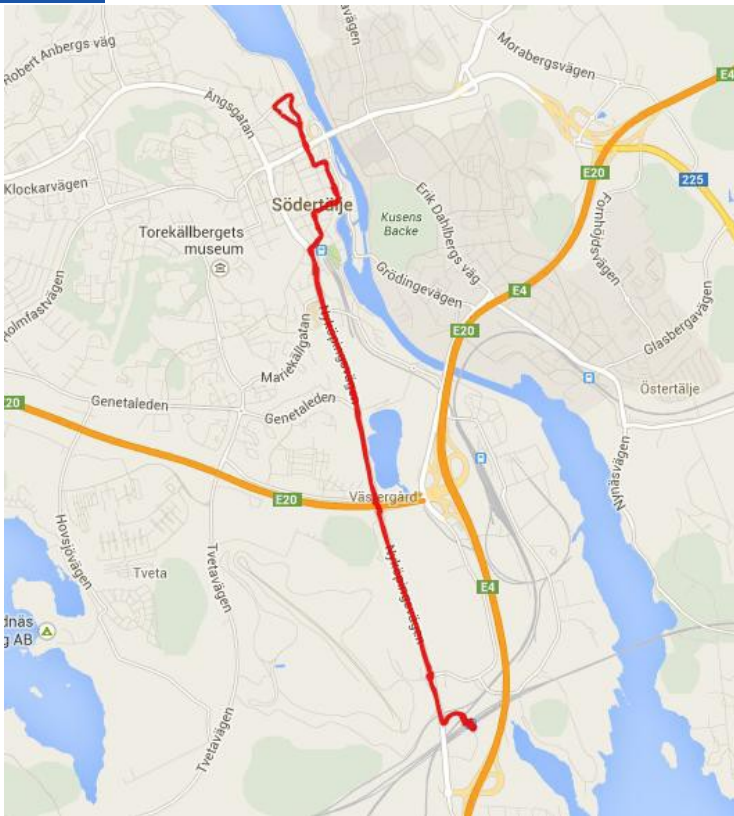
The city as arena for transformational change

A word cloud is centered on the slide, surrounded by a background of interlocking gears. The gears are in various shades of gray and some contain icons: a pound sterling symbol (£), a book, a pie chart, and a handshake. The word cloud itself is composed of various terms in different colors and sizes, including "learning" (large, dark blue), "action-research" (large, brown), "Collaboration" (large, dark blue), "Transdisciplinary" (medium, brown), "knowledge-translation" (medium, brown), "design" (medium, brown), "research integration" (medium, brown), "participatory" (medium, brown), "partnerships" (medium, brown), "applied" (medium, brown), "phenomena" (medium, brown), "complexity" (medium, brown), "multi-sector" (medium, brown), "fieldwork" (medium, brown), "method" (medium, brown), "real-world" (medium, brown), and "scientific" (medium, brown).

learning
Transdisciplinary action-research
Collaboration knowledge-translation design
research integration participatory
phenomena partnerships applied
complexity multi-sector
method real-world fieldwork
scientific



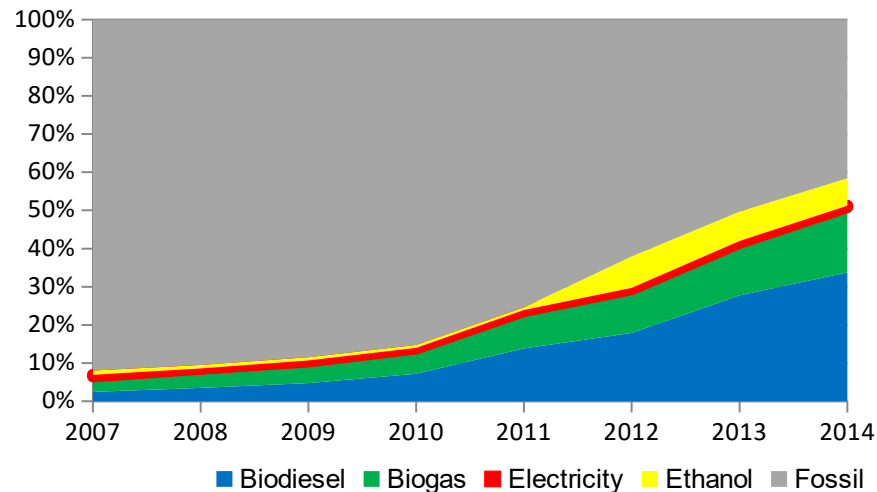
Inductive bus charging project: Line 755 Södertälje



Aim: to implement, test and evaluate the potential of wireless charging for buses in city traffic to reduce emissions, improve energy efficiency and reduce fossil-fuel dependence through electrification.

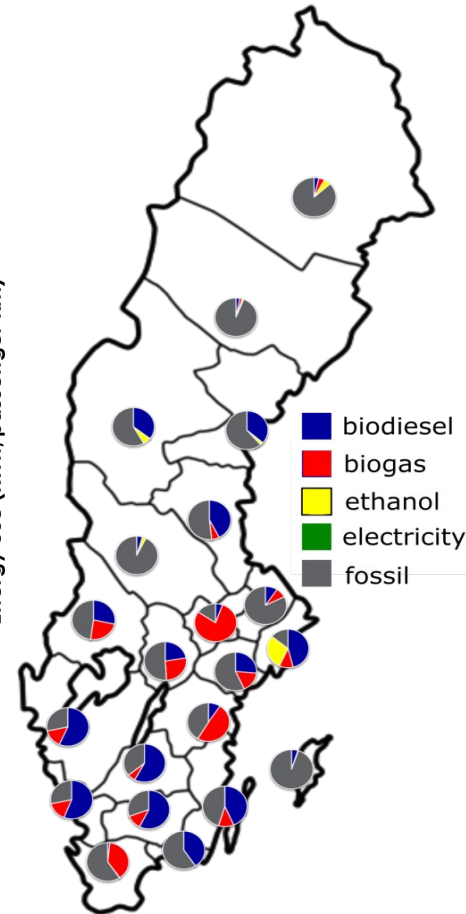
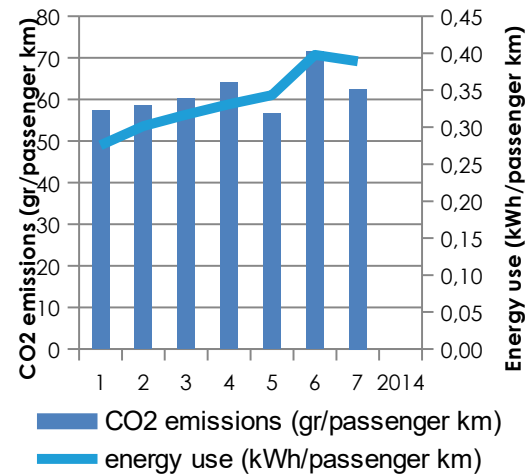
On the road: fossil-free bus fleets in Sweden

Fuel share (%) in Swedish public buses 2007-2014



from 8%.... to 58% in seven years

CO₂ emissions and energy efficiency



Xylia, M. and Silveira, S.: On the road to fossil-free public transport: the case of Swedish bus fleets. Energy Policy, vol 100, pp. 397-412. 2017.

How to decarbonize European steel production?

A global perspective using ETSAP-TIAM and SAAM.

Wouter Nijs, VITO
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Johannes Morfeldt and Semida Silveira, KTH-ET
johannes.morfeldt@energy.kth.se

Taking an integrated approach on energy use and scrap availability to identify cost optimal pathways for decarbonizing European steel production.

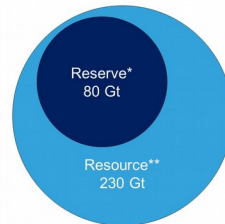
ETSAP-TIMES Integrated Assessment Model (ETSAP-TIAM)

- Global energy model based on TIMES.
- Models 15 global regions with the time horizon of 2100.
- Including thousands of technologies for production, transmission and distribution of energy.
- Includes a climate package for modelling implications of global emission targets. CO₂, CH₄ and N₂O explicitly modelled.
- **NEW:** Extended with explicit technology representation for iron and steel production and scrap availability.

Maintained by Energy Technology Systems Analysis Program (ETSAP), www.iea-etsap.org.



ETSAP-TIAM regional representation
Source: Feyn et al. (2011)



Steel stock **in-use** in societal activities and available in **reserves** and as a **resource**.

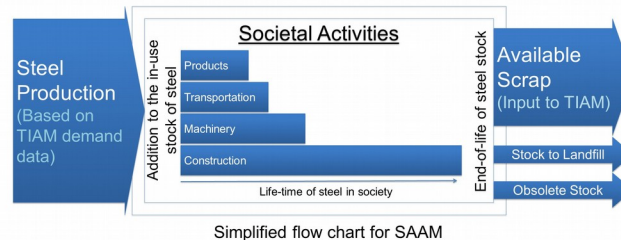
* Economically extracted or produced at the time of determination. Extraction facilities are in place and operative.
** Sum of economic, marginally economic and sub-economic resources.



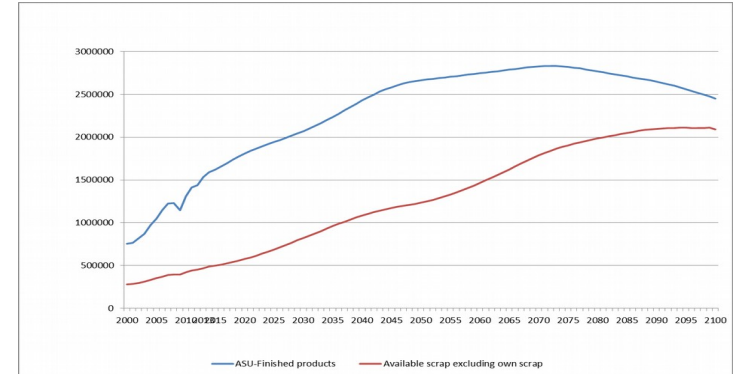
Scrap Availability Assessment Model (SAAM)

- Provides the amount of scrap made available each year due to products reaching their end-of-life.
- Historic data (1900 – 2005) together with future production levels (steel demand) from ETSAP-TIAM gives scrap availability in the future.
- Provides estimates of the global in-use stock of steel in society.

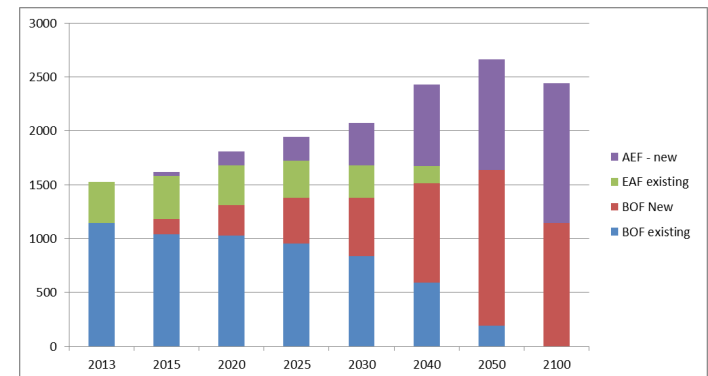
Developed by KTH-ET and VITO within the scope of ESA².



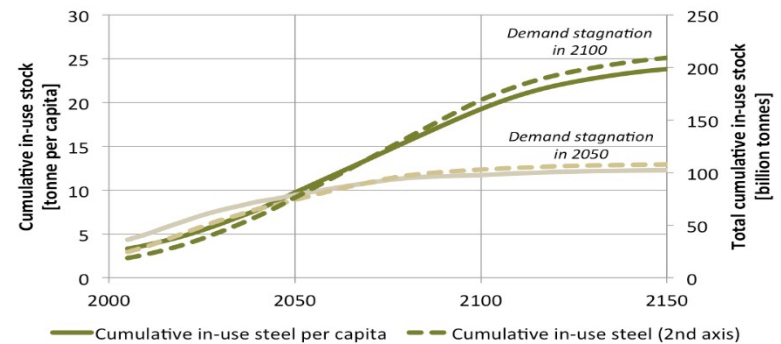
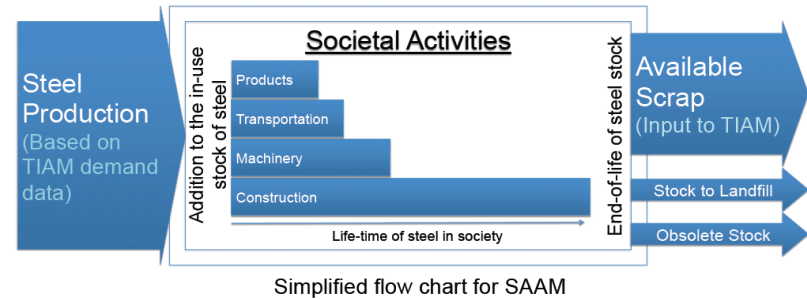
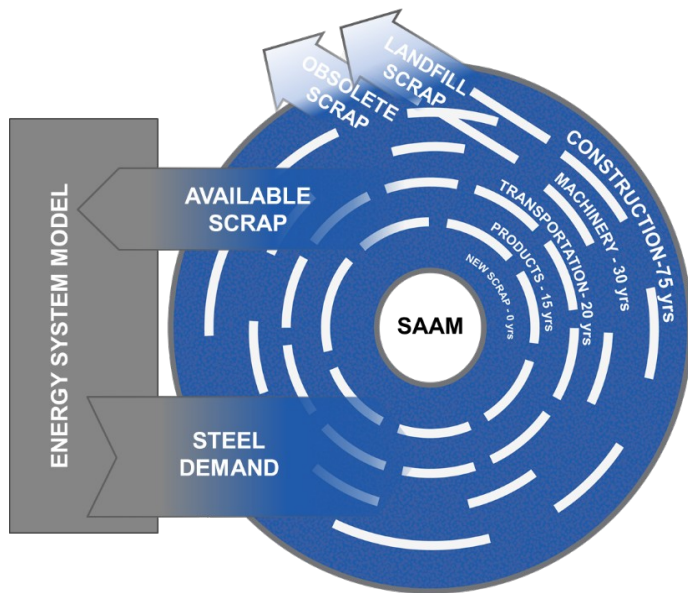
KTH
Royal Institute
of Technology



World STEEL production by technology



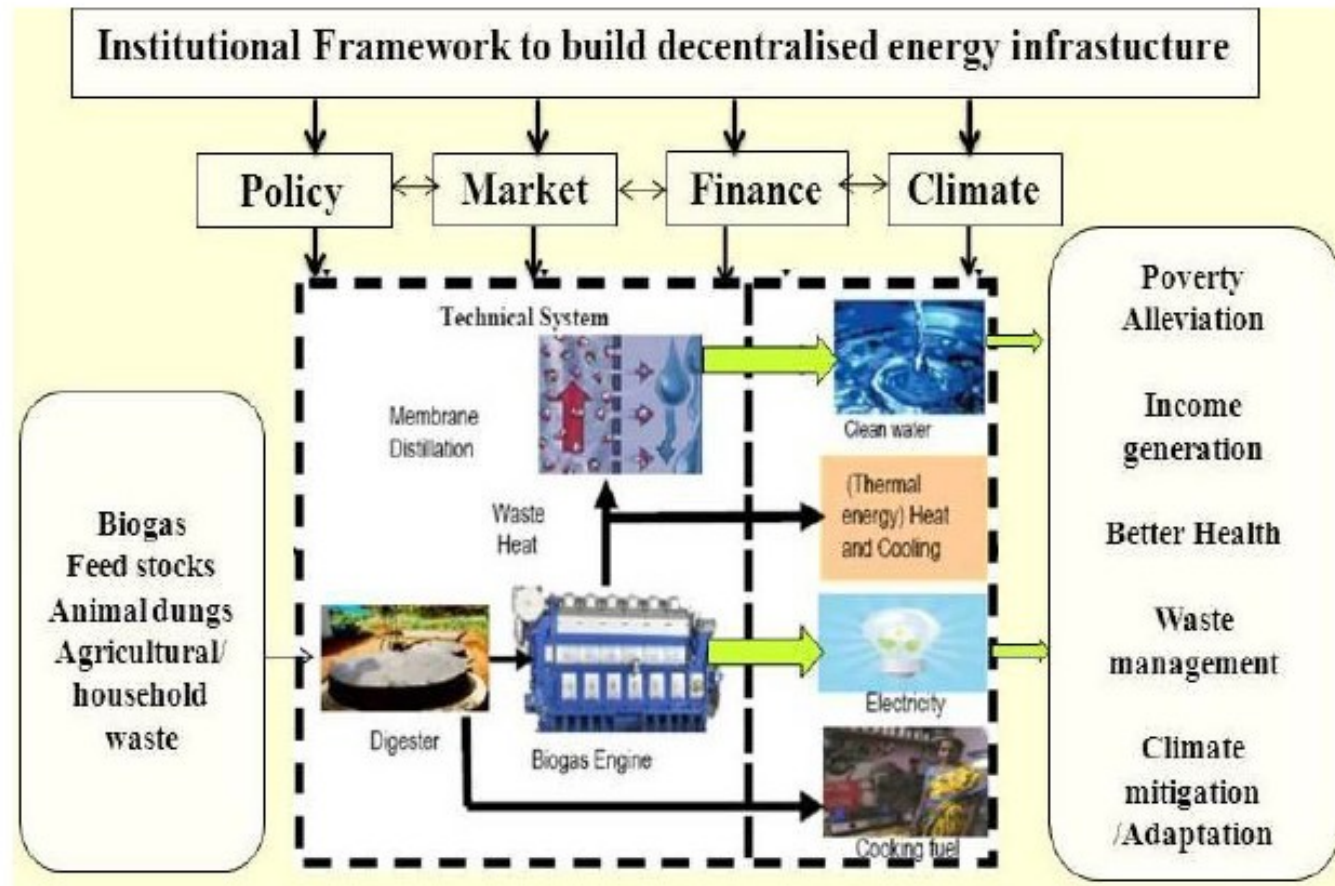
SAAM – Scrap Availability Assessment Model



Morfeltdt, J., Silveira, S., Hirsch, T., Lindqvist, S., Nordqvist, A., Pettersson, J. and Pettersson, M.: Improving energy and climate indicators for the steel industry – the case of Sweden. In *Journal of Cleaner Production*, v. 107, pp 581-592, 2015.

Morfeltdt, J., Nijs, W. and Silveira, S.: The impact of climate targets on future steel production – an analysis based on a global energy system model. In *Journal of Cleaner Production*, v.103, pp. 469-482, 2015.

The poly-generation approach applied in Bangladesh context





Addressing the rural energy and drinking water needs by using Biogas in rural Bangladesh

Brijesh Mainali*, Hameen Ahmed^a, Ershad Khan^a, Prof. Semida Silveira^a and Prof. Andrew Martin^a
^aEnergy and Climate Studies, Royal Institute of Technology, Stockholm, Sweden
^aHeat and Power Division, Royal Institute of Technology, Stockholm, Sweden



Introduction

The utilization of low grade solid fuels and arsenic contaminated water in many parts of rural Bangladesh has led to alarming health problems and excessive degradation of the environment. About 46,000 people in Bangladesh have premature death every year because of indoor air pollution and 20 million people have already developed signs of arsenicosis. This research looks at the feasibility of a small-scale, biogas based poly-generation for providing access to clean energy such as cooking fuel, electricity and arsenic-free drinking water using Membrane Distillation (MD) unit in a village, named "Pani para" of Faridpur district in Bangladesh. A survey has been conducted to see the existing energy demand and biomass resource potential for biogas based poly-generation in meeting their demand.



Fig. 1. Probability of arsenic contaminated ground water in Bangladesh. Country's location for study area (near 23.8°N, 90.1°E) (Source: Government of Bangladesh).

Results and Analysis

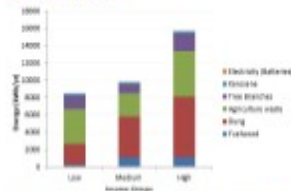


Fig. 3. Annual energy consumption per household by income groups in the village.

Table 2: Biogas potential in the village

Feedstock	Available biomass (kg/yr)	Self-digestion biogas potential (m ³ /yr)
Cow dung	20000	15442
Agricultural waste	20000	15442

Table 3: Scenario on providing services with biogas based poly-generation

Service scenario	Total biogas requirement (m ³ /yr)	Remarks	Recommendation
Providing services: cooking gas + electricity + water	55,442	154 m ³ /yr deficit of biogas	Not feasible
Providing services: electricity + water	5000	90% of available biogas will meet the requirement	1.07 household (one person) can be provided with improved cooking gas above for meeting their cooking demand

Conclusion and Future Work

- Energy consumption per household is increasing with their income levels. Almost all households are using low grade traditional fuel with low efficient technologies.
- For the poly-generation options, available single feedstock like cow dung is not sufficient. System needs to be designed with co-digestion.
- The total biogas potential is 55,442 m³/year. Even with co-digestion, there is deficit of feedstock to meet all the energy services of entire village by poly-generation.
- The possible scenario could be supplying electricity and water to all households and biogas for cooking to only two-third (medium and high income) households.
- The low income households could be provided with improved cooking gas above to minimize the indoor air pollution.
- This research in the future will focus on:
 - Mixing human excreta as feedstock in co-digestion
 - Assessment of suitable business/delivery model for the co-digestion
 - Identification of institutional/financial barriers and possible interventions for introducing poly-generation solution

Objective

- To determine the basic energy demand and water needs, and to estimate the total biogas potential in the village.
- To develop a model using poly-generation system based on biogas for providing access to multiple services such as electricity, clean energy and safe drinking water in rural areas of Bangladesh.

System Layout

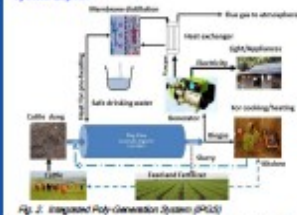


Fig. 2. Integrated Poly-generation system (PGS).

Poly-generation is an innovative solution that generates three different outputs of high value, which are important in meeting the rural energy services using low value resources such as animal dung and local organic waste. Additionally, the system also produces slurry as a bi-product which can be used as fertilizer or feedstock for fish.

Table 1. General information of the village and their requirements

Description	Values
Name of Village	Pani para (Faridpur, Bangladesh)
Number of Households	52
Average family size	5 person/household
Average electricity demand	27 kWh/household/month
Land area for production and uses	4234 kWh/m ² /year
Cooking energy demand	0.301 m ³ of biogas/household/year
Drinking water demand	3 liter/person/day
Income range in village	(2000 – 65000) Taka/year

* Estimated ** 1 US \$ = 85 Taka

Other Partners:

SCARAB DEVELOPMENT AB

Grameen Shakti



Contents lists available at ScienceDirect

Sustainable Energy Technologies and Assessments

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

Original Research Article

Techno-economic analysis of small scale biogas based polygeneration systems: Bangladesh case study

Ershad Ullah Khan^a, Brijesh Mainali, Andrew Martin, Semida Silveira

Department of Energy Technology, Royal Institute of Technology (KTH), 100 44 Stockholm, Sweden



Periodica Polytechnica
Mechanical Engineering

58(1), pp. 47–53, 2014

DOI: 10.3311/PPme.7422

<http://www.pp.bme.hu/me/article/view/7422>

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RESEARCH ARTICLE

Water purification of arsenic-contaminated drinking water via air gap membrane distillation (AGMD)

Ershad Ullah Khan / Andrew R. Martin

RECEIVED 28 AUGUST 2013; ACCEPTED 14 JANUARY 2014

- KTH Royal Institute of Technology
 - Energy and Climate Studies (ECS)
 - Heat and Power Technologies (EKV)
- Grameen Shakti
- Scarab Development AB

Sizing the bioenergy potential in Indonesia



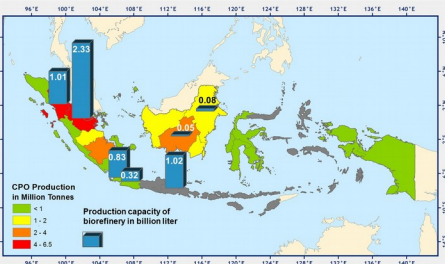
- Assessment of bioenergy potential (considering agricultural development, land use, vulnerability to climate change)
 - Identification of bioenergy options (i.e. bioethanol, biodiesel, biogas) - multiple applications and scales
 - Environment and socio-economic impacts / comparing options (i.e. life-cycle analysis, welfare generation)
-
- KTH, Energy and Climate Studies
 - Gadjah Mada University (UGM)
 - Stockholm Environmental Institute (SEI)
 - Swedish Energy Agency
 - Indonesian Energy Council
 - Indonesian Oil Palm Institute

CONDITIONS FOR A SUSTAINABLE DEVELOPMENT OF PALM-OIL-BASED BIODIESEL IN INDONESIA

Fumi Harahap, Carl Palmen, Semida Silveira, Dilip Khatiwada
Division of Energy and Climate Studies, KTH Royal Institute of Technology, Sweden

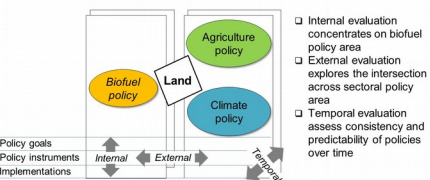
WHY BIODIESEL IS IMPORTANT FOR INDONESIA?

CPO production (Million tonnes/year) and biodiesel production (billion liter/year)



COHERENCE OF POLICY GOALS & INSTRUMENTS

How policy coherence is evaluated in relation to land?

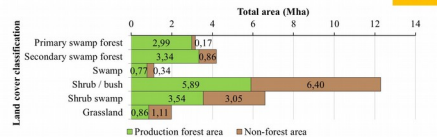


The policy goals are:

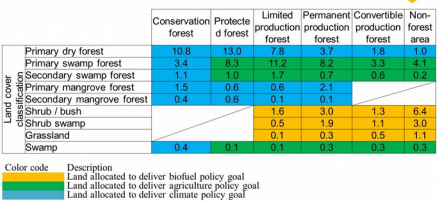
- Biofuel policy:** Achieve biodiesel blending rate of 30% by 2025 in various sectors of the economy for energy security
- Agriculture policy:** Ensure food security targeting annual growth rate of 2-5% of agricultural crops production by 2019
- Climate policy:** Reduce 23% of GHG emissions from land use change in forestry sector and peatland from business as usual by 2020

What are the impacts of sectoral policy interactions on land?

What seems available for palm biodiesel feedstock production indicated in the biofuel policy documents?



What is actually available for future expansion of palm biodiesel feedstock production?



Abundant feedstock production

- ✓ Number one palm oil producer in the world
- ✓ 27.7 Million tonne of CPO produced in 2013, occupying 10 million hectare of land
- ✓ 70% of CPO were exported, only 11% used to produce biodiesel
- ✓ 3.8 tonne per ha of average yield from cultivation

Commitment to sustainable biofuel development

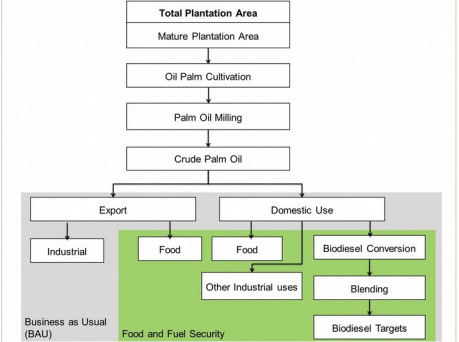
- ✓ Government effort is tied to biodiesel blending target of 30% by 2025 for transport, commercial and power sectors
- ✓ The commitment is linked to reduce dependence on oil imports and domestic crude oil scarcity

Indonesia biodiesel fact and figures in 2014

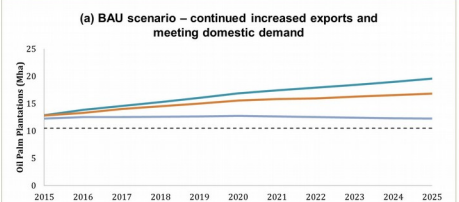
- ✓ Processing capacity of 5.6 billion liter/year
- ✓ Producing 3.3 billion liter, 48% used in the country, the remaining was exported
- ✓ Substituting 6.7% of diesel fuel in transport sector, not meeting the set target

SECURING SUSTAINABLE FEEDSTOCK

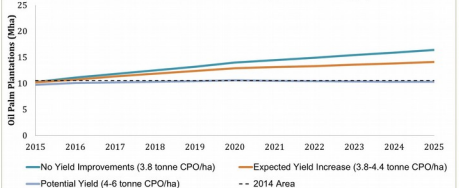
How do we determine demand for Indonesian CPO?



How much land is required to supply CPO demand?



(b) Food & fuel security scenario - meet biodiesel target, domestic demand and maintain global food supply



FUEL ETHANOL IN INDONESIA: benefits and strategies.

Kummamuru Venkata Bharadwaj
Victor Samuel

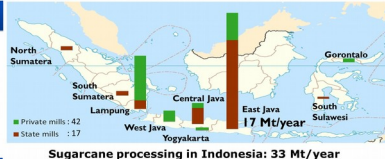
Dilip Khatiwada
Semida Silveira

INTRODUCTION

- Fossil liquid fuel **dominates** energy consumption.
- Indonesia increasingly **imports** fossil fuel.
- The government sets ethanol **blending targets** (20%) in 2025.
- Sugarcane is the **3rd largest crop** with by-product (molasses) as potential feedstock for ethanol.

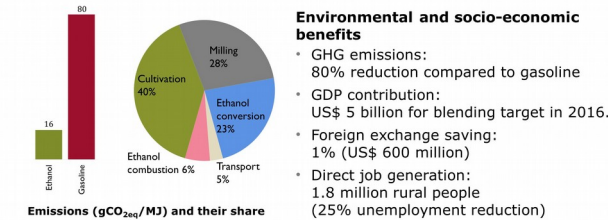
OBJECTIVES

- To evaluate the **environmental** and **socio-economic** sustainability of fuel ethanol production.
- To develop a **strategy** and an **action plan** for the development of fuel ethanol in Indonesia in synergy with the sugar industry.



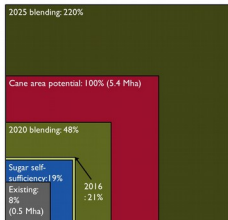
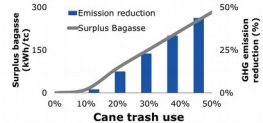
Stakeholder consultations and visit to sugar mills

KEY FINDINGS



Strategies for improvement

- Cane trash use and farm mechanization reduce emissions, increase energy value and bio-electricity
- Stakeholders engagement and policy support needed.



CONCLUSION

- Molasses-based fuel ethanol **emits less GHG emissions** than gasoline.
- **Local sugarcane land potential is insufficient** for ethanol blending mandate in 2025.
- Fuel ethanol production can **contribute to GDP, save foreign exchange, and reduce unemployment**.
- **Farm mechanization, cane trash use, and biogas production** can improve performance.

Energy and Climate Studies
Dept. of Energy Technology
School of Industrial Engineering and
Management (ECS)

The division of Energy and Climate
Studies (ECS) has an interdisciplinary
character with a strong systems
approach, linking issues related to
energy technology and policy, climate
change and sustainable development.

At present, ECS works with four defined
research themes:

- **bioenergy systems,**
- **energy access,**
- **energy systems efficiency, and**
- **energy and climate policy.**

These are some of the central research
questions at ECS.

What solutions can be pursued
globally and regionally?

Which of them will lead to
sustainable development?

What are the solutions that will lead to
mitigation and adaptation to
climate change while also
promoting sustainable
development?

Collaborating partners:



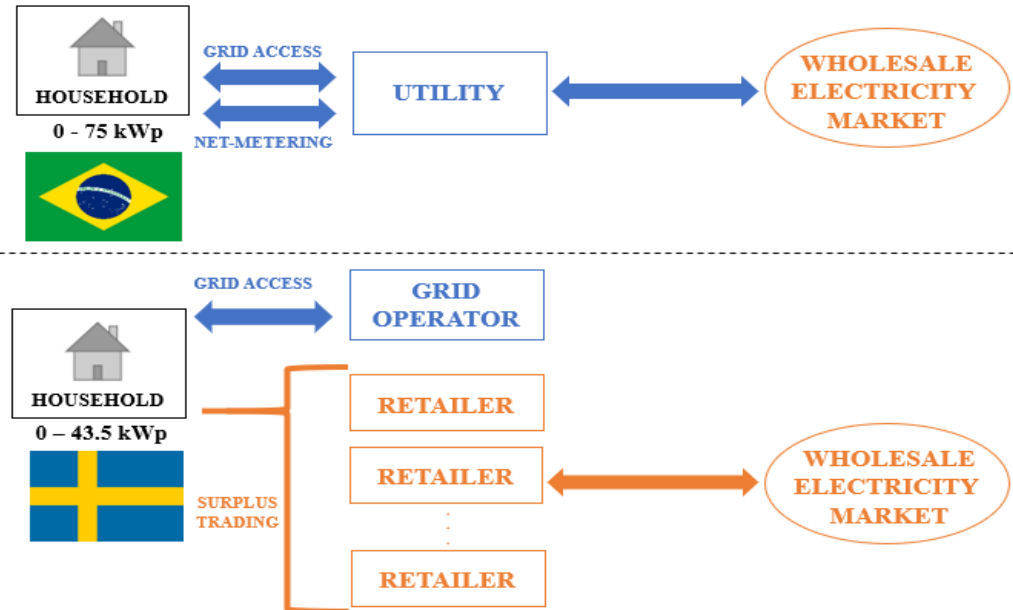
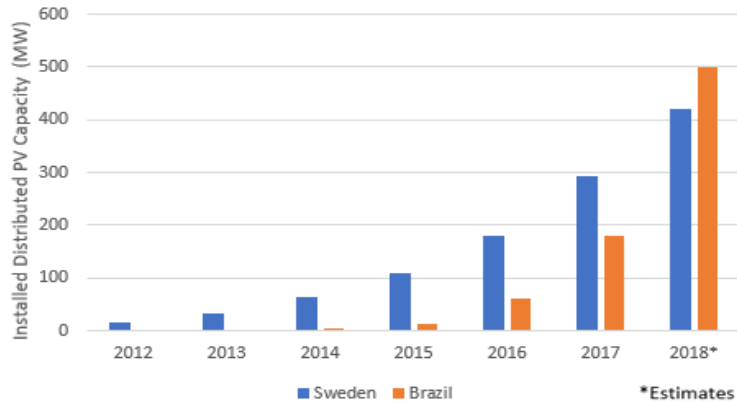
Balai Pengkajian
Teknologi Pertanian

Contact:

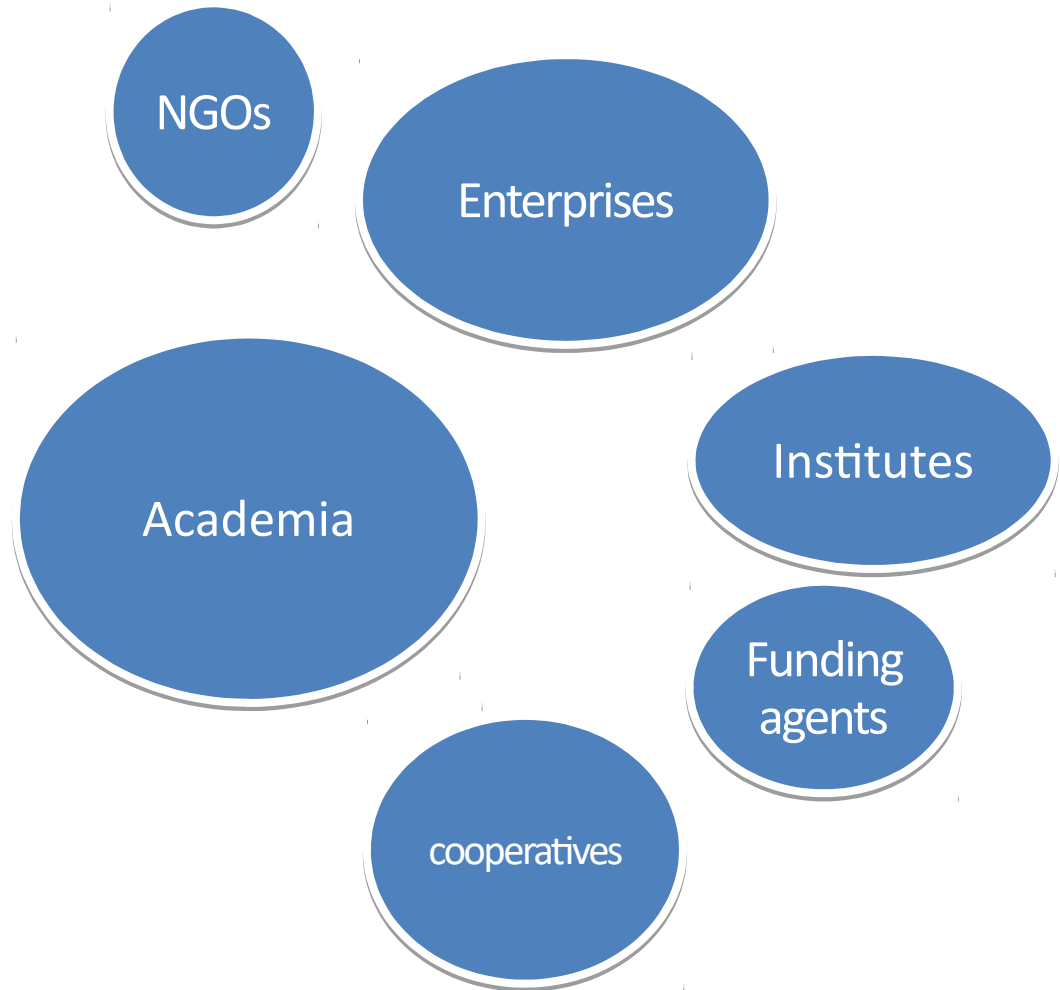
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PV opportunities in Sweden and Brazil



Project partnerships
needed to achieve
multiple benefits in
development





How can international cooperation materialize?

- Add-on to on-going planning efforts, and catalyze efforts
- Innovation in a triple-helix model (academia, public and private stakeholders)
- Screen infrastructure and technological options in different policy contexts and business models
- Benchmark to promote low-carbon solutions
- Create new knowledge and contribute to developing the vision of a smart and sustainable city



Thank you for your attention

www.ecs.kth.se

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