KTH ROYAL INSTITUTE
OF TECHNOLOGY

A Future with Sustainable Energy Systems

The only future we can have!

www.ecs.kth.se semida.silveira@energy.kth.se

Semida Silveira

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

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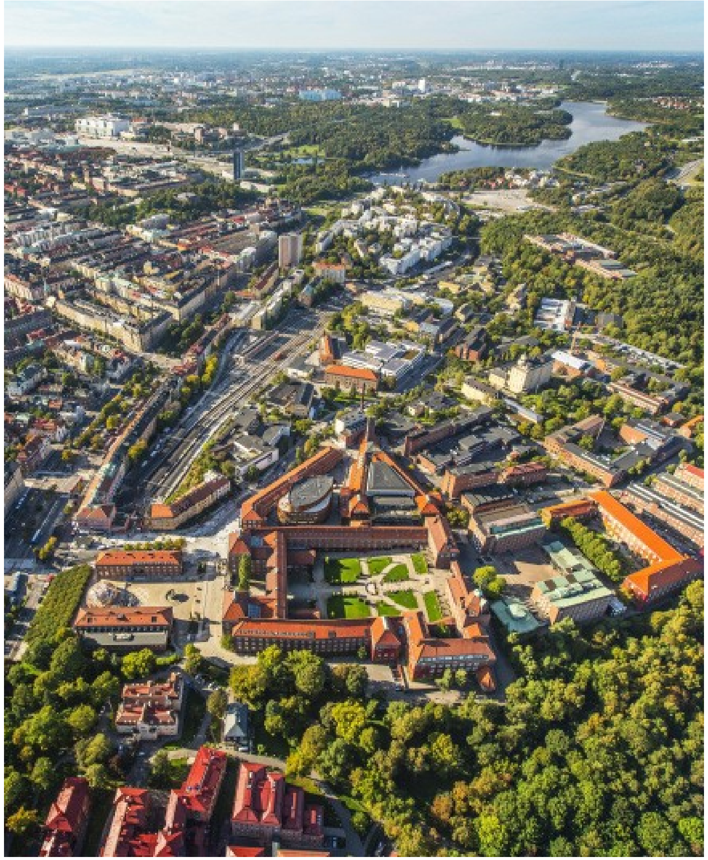
An innovative European technical university

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.

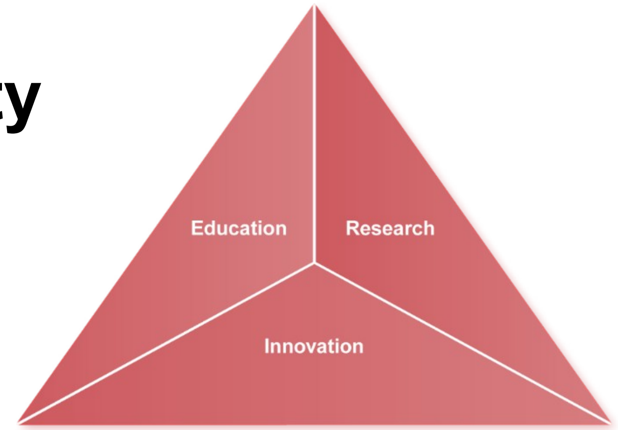
Research focus;

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

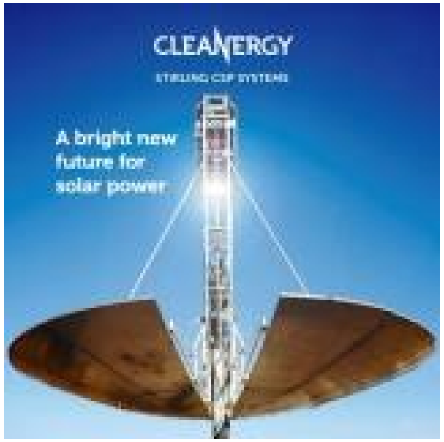
Each year some 300 ideas, born out of KTH's research and education, start the journey from idea to innovation.

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

Poject CSP – Concentrated Solar Power
MAGHRENOV in Marocco



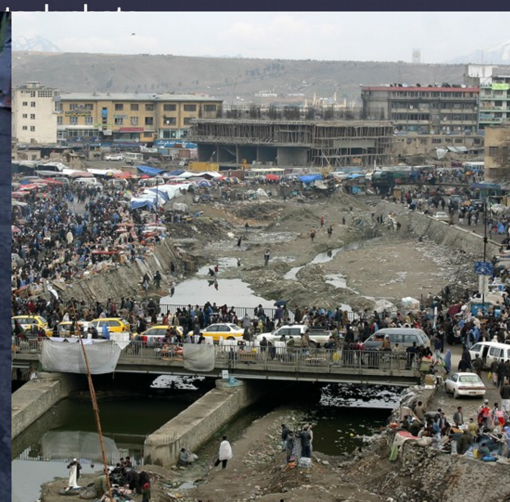
Objective

- Bringing highest solar convergence efficiency **CSP-Stiring 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

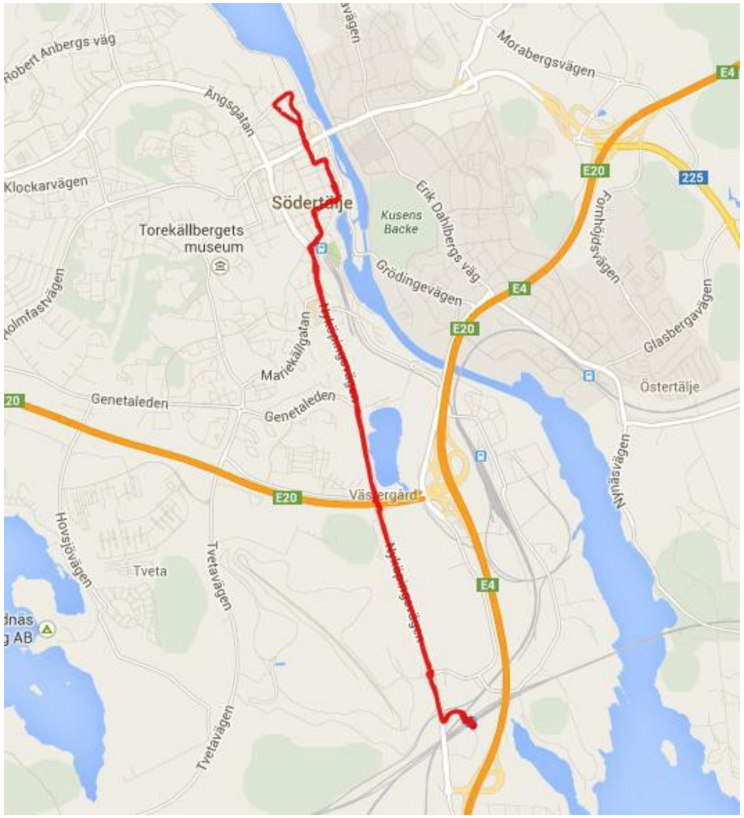

Bioenergy systems

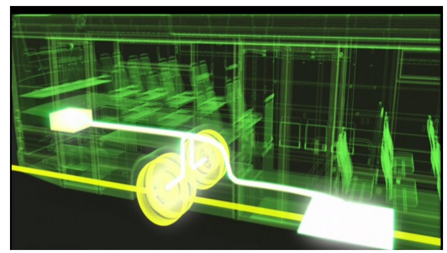

Urban sustainability

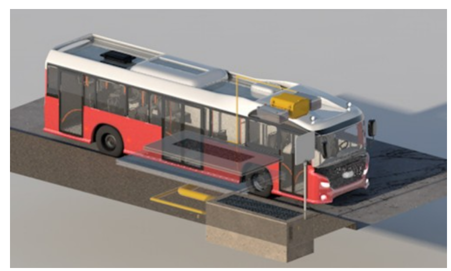
The city as arena for transformational change

Prof. Semida Silveira, semida.silveira@energy.kth.se

Inductive bus charging project:Line 755 Södertälje







Energimyndigheten

KTH VETENSKAP OCH KONST

SCANIA

SL

Södertälje kommun

VATTENFALL

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****.*

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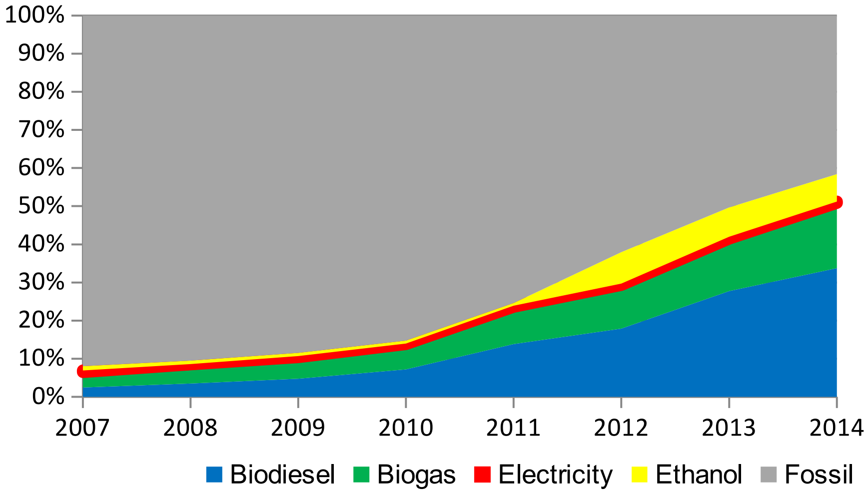
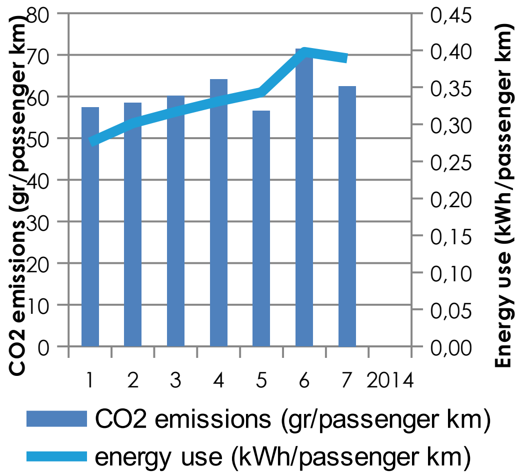
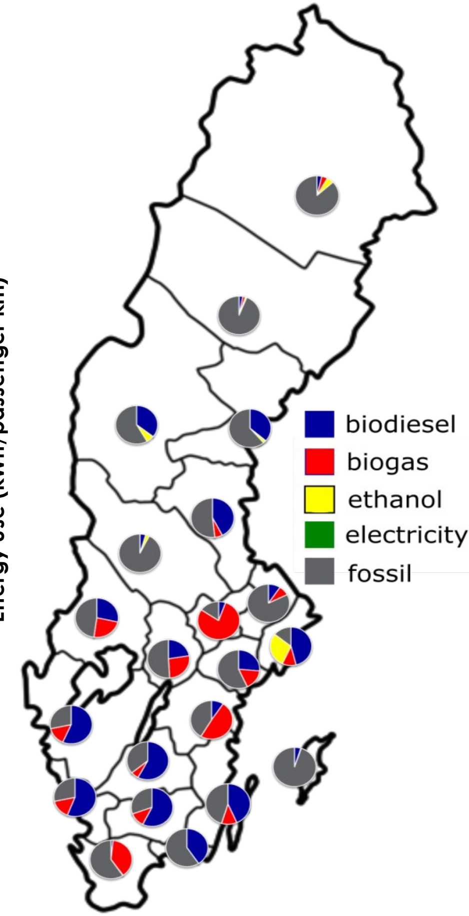
On the road: fossil-free bus fleets in Sweden

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



CO_2 emissions and energy efficiency





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

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.

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

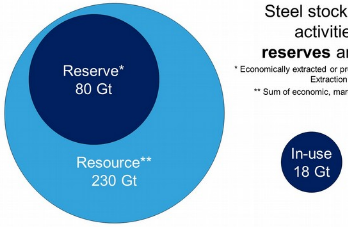
vito
vision on technology
Vision on Technology

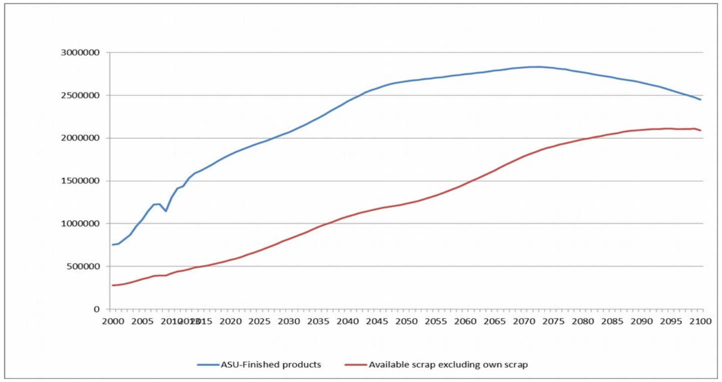
KTH
Royal Institute
of Technology

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

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.





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. CO_2, CH_4 and N_2O explicitly modelled.
- ***NEW:*** Extended with explicit technology representation for iron and steel production and scrap availability.

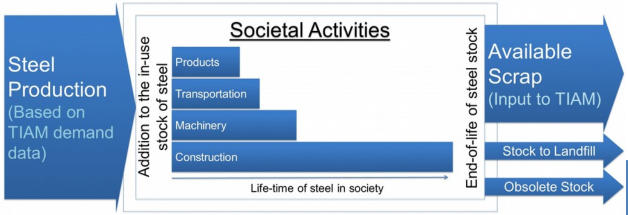
Maintained by Energy Technology Systems Analysis Program (ETSAP), www.iea-etsap.org.

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

Scrap Availability Assessment Model (SAAM)

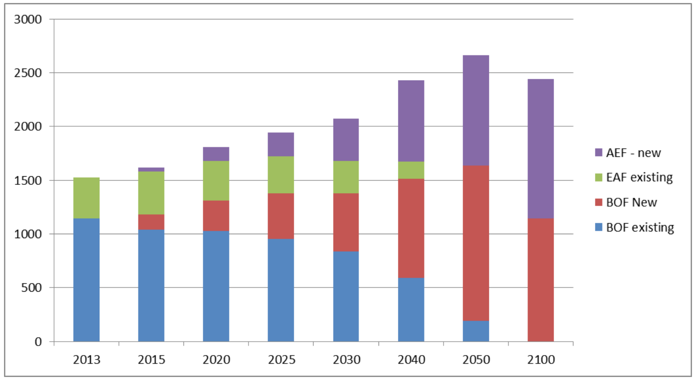
- Provides the amount of scrap made available each year due to products reaching their end-of-life.
- Historic data (1900 – 2005) together with future production levels (steel demand) from ETSAP-TIAM gives scrap availability in the future.
- Provides estimates of the global in-use stock of steel in society.

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

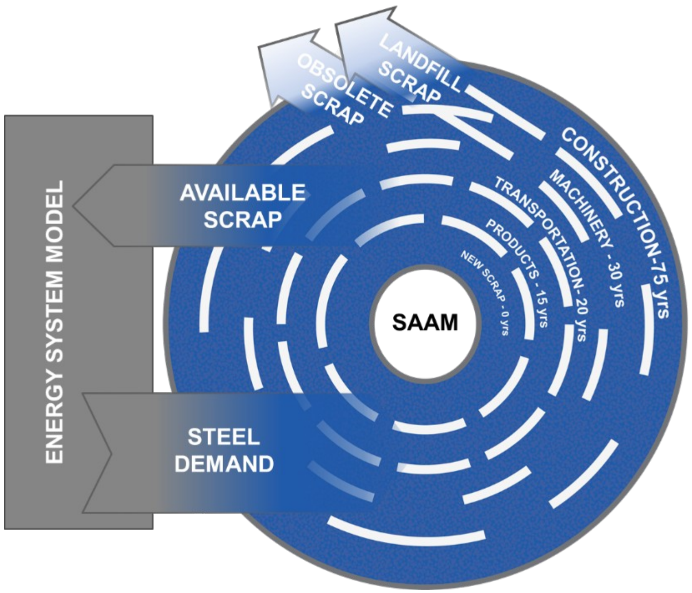


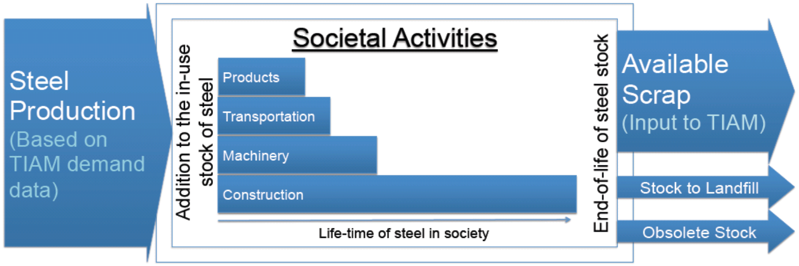
Simplified flow chart for SAAM

World STEEL production by technology

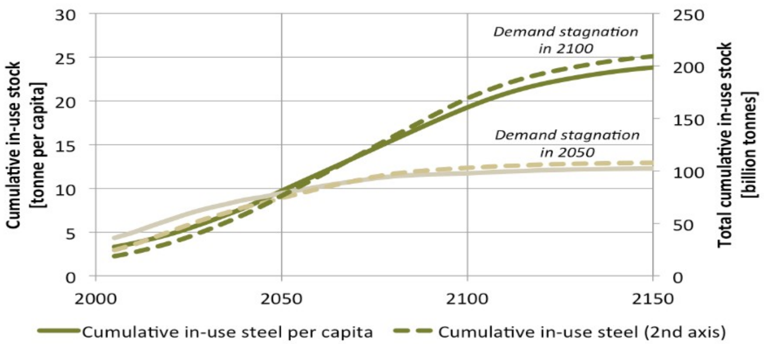


SAAM – Scrap Availability Assessment Model





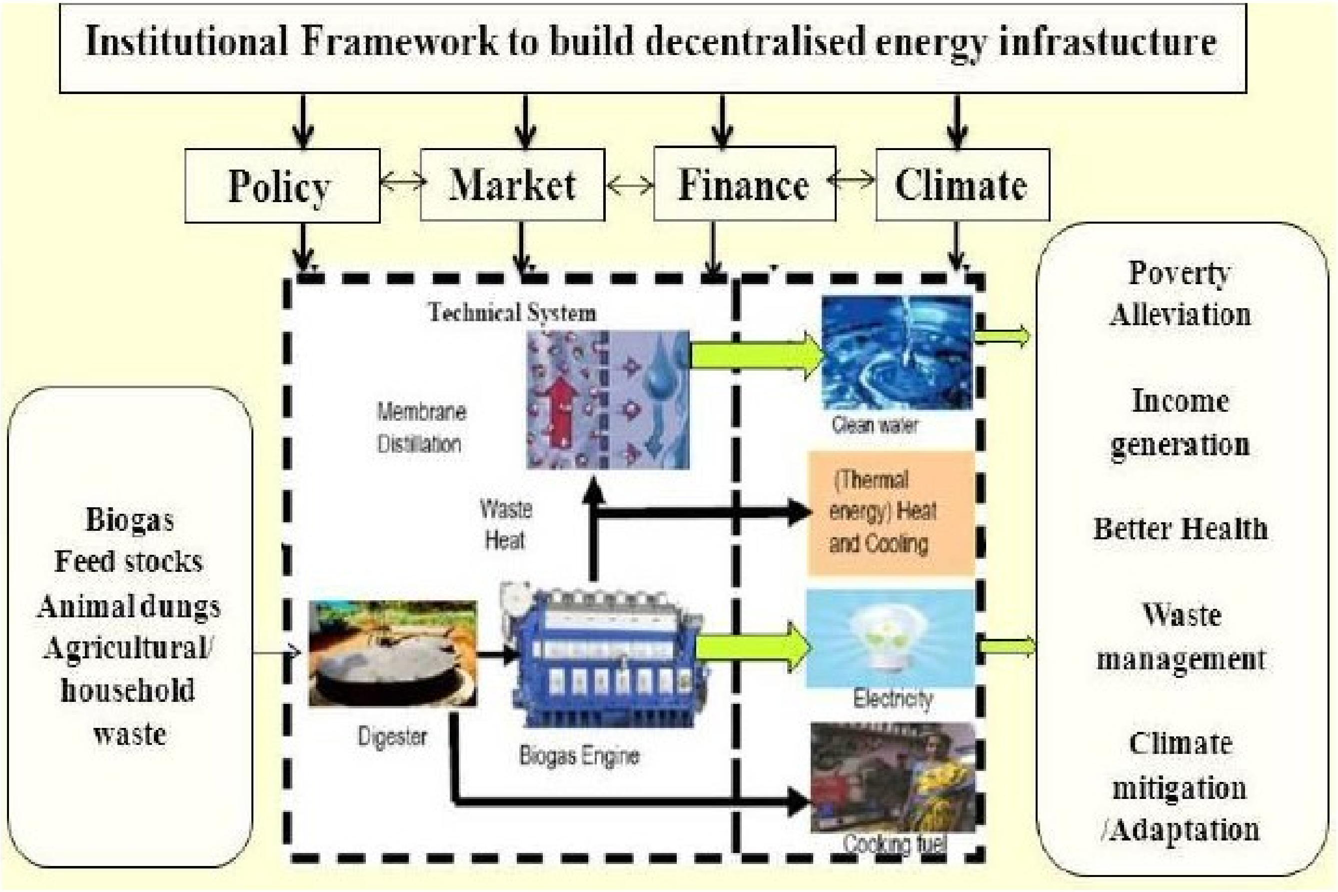
Simplified flow chart for SAAM

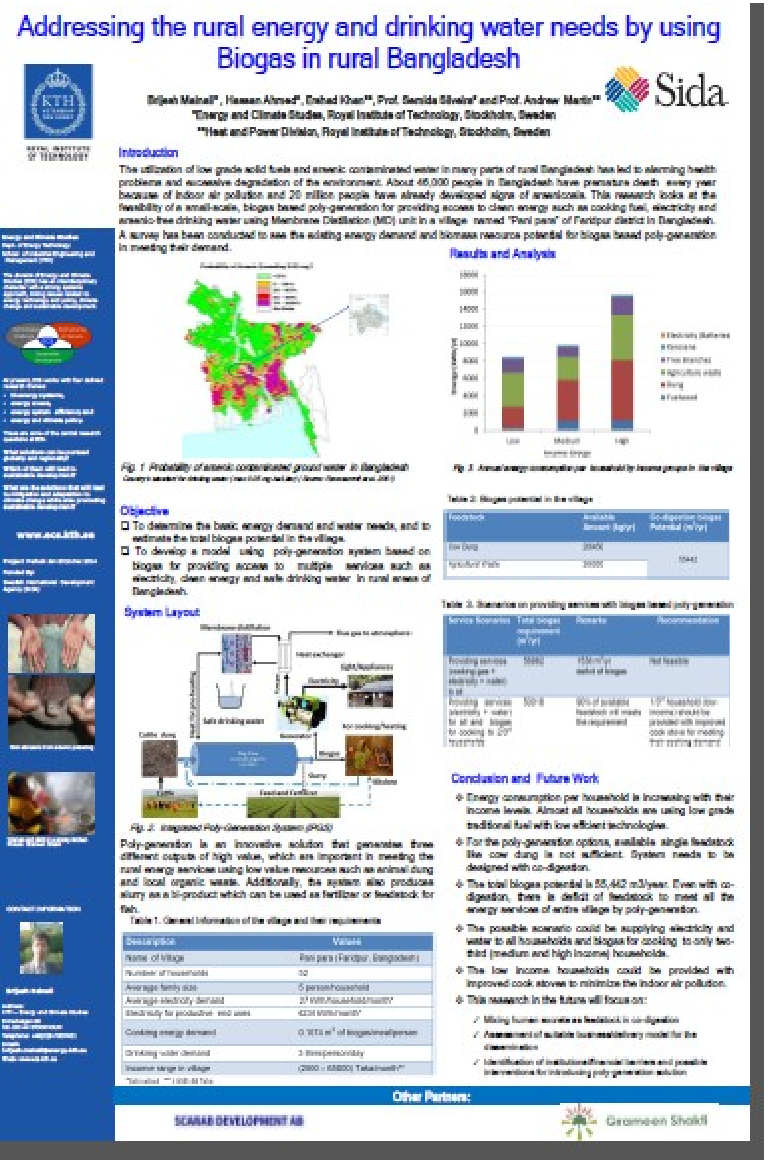


Morfeldt, J., Silveira, S., Hirsch, T., Lindqvist, S., Nordqvist, A., Pettersson, J. and Pettersson, M.: Improving energy and climate indicators for the steel industry – the case of Sweden. In Journal of Cleaner Production, v. 107, pp 581-592, 2015.

Morfeldt, 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





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Original Research Article

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

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

Ershad Ullah Khan / *Andrew R.* Martin

RESEARCH ARTICLE

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)

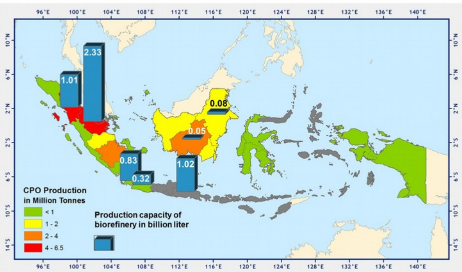
- KTH, Energy and Climate Studies
- Gadjah Mada University (UGM)
- Stockholm Environmental Institute (SEI)
- Swedish Energy Agency
- Indonesian Energy Council
- Indonesian Oil Palm Institute

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)



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

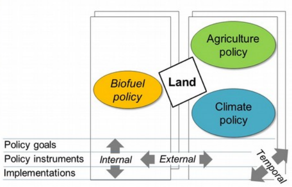
- ✓ Government effort is tied to biodiesel blending target of 30% by 2025 for transport, commercial and power sectors
- ✓ The commitment is linked to reduce dependence on oil imports and domestic crude oil scarcity

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

Coherence of Policy Goals & Instruments

How policy coherence is evaluated in relation to land?



- Internal evaluation concentrates on biofuel policy area
- External evaluation explores the intersection across sectoral policy area
- Temporal evaluation assess consistency and predictability of policies over time

The policy goals are:

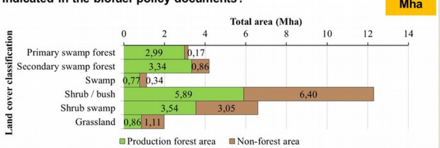
Biofuel policy:
Achieve biodiesel blending rate of 30% by 2025 in various sectors of the economy for energy security

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? **29 Mha**



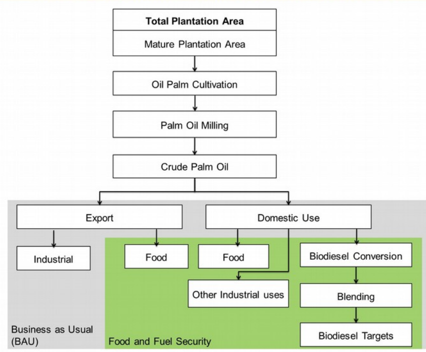
What is actually available for future expansion of palm biodiesel feedstock production? **20 Mha**

Land cover classification	Conservation forest	Protected forest	Limited production forest	Permanent production forest	Convertible production forest	Non-forest area
Primary dry forest	10.8	13.0	7.8	3.7	1.8	1.0
Primary swamp forest	3.4	8.3	11.2	8.2	3.3	4.1
Secondary swamp forest	1.1	1.0	1.7	0.7	0.6	0.2
Primary mangrove forest	1.5	0.6	0.6	2.1		
Secondary mangrove forest	0.4	0.6	0.1	0.1		
Shrub / bush			1.6	3.0	1.3	6.4
Shrub swamp			0.5	1.9	1.1	3.0
Grassland			0.1	0.3	0.5	1.1
Swamp	0.4	0.1	0.1	0.3	0.3	0.3

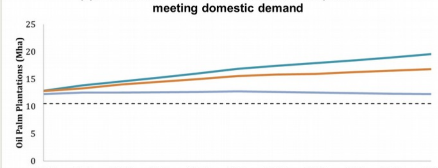
Color code	Description
Yellow	Land allocated to deliver biofuel policy goal
Green	Land allocated to deliver agriculture policy goal
Blue	Land allocated to deliver climate policy goal

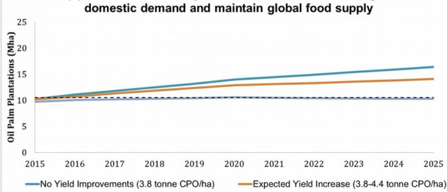
Securing Sustainable Feedstock

How do we determine demand for Indonesian CPO?



How much land is required to supply CPO demand?



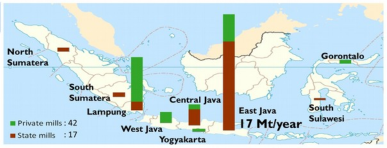


Fuel Ethanol in Indonesia: benefits and strategies.

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.



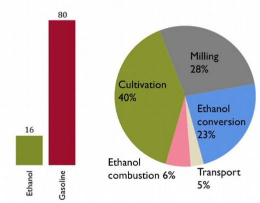
Sugarcane processing in Indonesia: 33 Mt/year

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

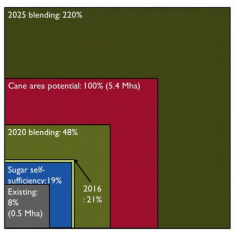
Key Findings



Emissions (gCO_{2eq}/MJ) and their share

Environmental and socio-economic benefits

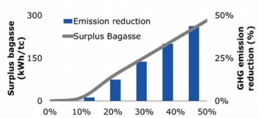
- GHG emissions: 80% reduction compared to gasoline
- GDP contribution: US$ 5 billion for blending target in 2016.
- Foreign exchange saving: 1% (US$ 600 million)
- Direct job generation: 1.8 million rural people (25% unemployment reduction)



Land requirement

Strategies for improvement

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



Land availability

- Land potential for cane farm: 5.4 Mha (existing land area: 8%)
- No land available for 2025 blending targets

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 (ITM)

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:
SEI Stockholm Environment Institute
Balai Pengkajian Teknologi Pertanian

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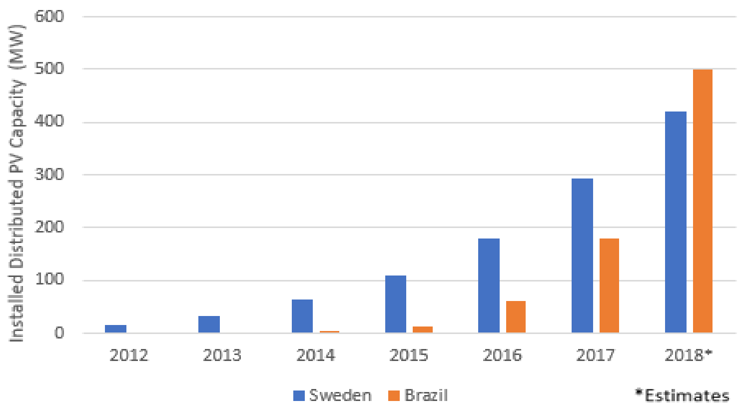
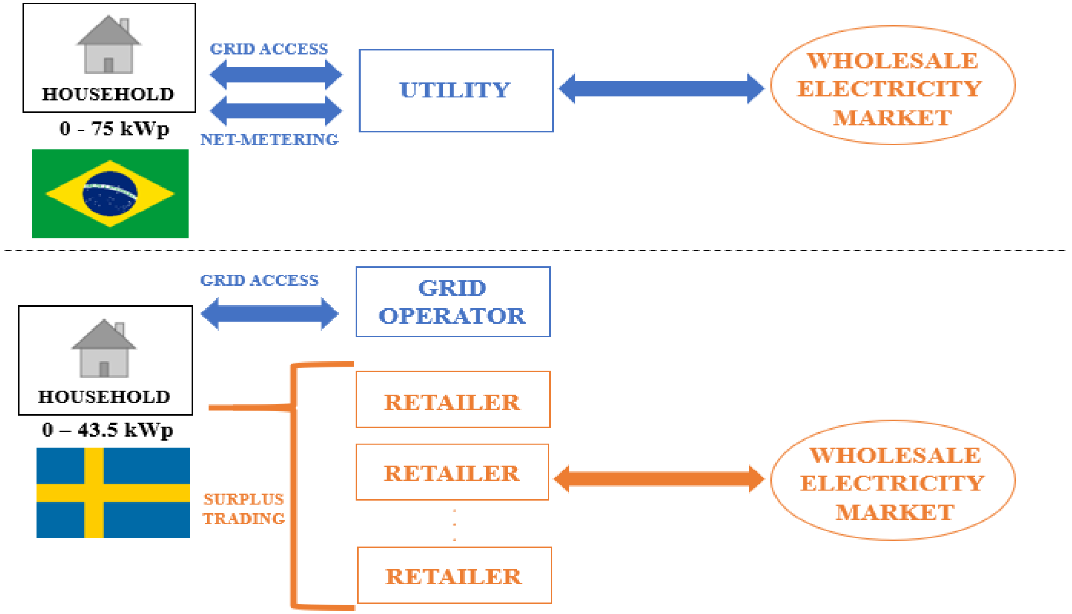
PV opportunities in Sweden and Brazil





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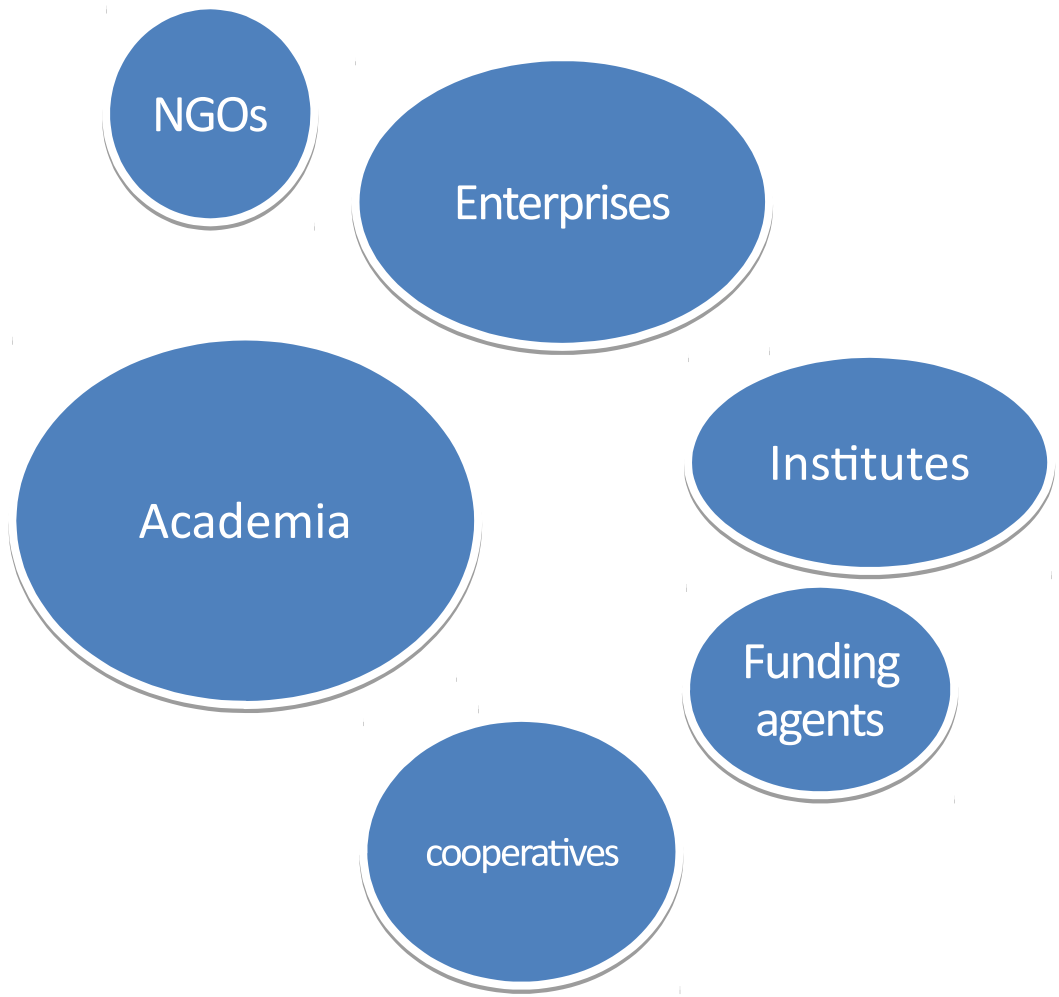
Project partnerships needed to achieve multiple benefits in development



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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

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