Energy Modelling Lab's activities in the ETSAP community

Year of 2024

Introduction

Energy Modelling Lab is participating in the Energy Technology Systems Analysis Program (ETSAP), one of the longest running Technology Collaboration programs of the International Energy Agency (IEA). As an active member of the ETSAP community, we have expanded the TIMES framework and network over the past year.

On the modelling side, we have

- Built a new TIMES model representing the district heating system of Greater Copenhagen
- Built a new TIMES model representing the Swedish municipality of Mölndal
- Built a new TIMES model representing the Swedish municipality of Trollhättan
- Built a new TIMES model representing a school and its neighborhood in Arlington, US
- Further developed and extended the TIMES model for Azerbaijan
- Continued to develop the TIMES-Jordan model and generate scenarios
- Updated the TIMES-DK model and used it to develop a model of the Danish island of Bornholm
- Supervised the creation of the TIMES-CITY model representing the Swedish municipality of Gothenburg
- Supervised the creation of a new TIMES model representing an energy island
- Supervised the creation of a TIMES model of a green-field system with investor perspective
- Continued the ETSAP research project to create a new module for TIMES, representing the AFOLU sector (Agriculture, Forestry, and Other Land Use).
- Launched a research project focusing on the financial models of district heating projects and started to build a new TIMES model representing the municipality of Bilbao, Spain, to be used for research project
- Started to update and further develop TIMES-SE representing Sweden

We have had the pleasure of supervising two master's students and a PhD student in using TIMES for different projects. Our participation in the ETSAP activities has offered us opportunities for mutual inspiration and collaboration.

Projects

Energy Modelling Lab (EML) has been expanding and used the TIMES modelling framework for more new projects.

Project	Content
AFOLU *2023 - 2025*	Agriculture, Forestry, and Other Land Use Sector Modelling A research project funded by ETSAP. The result should be a demo model of a new data module representing the AFOLU sector (Agriculture, Forestry, Land Use), that is standardized and flexible and can integrate seamlessly with any TIMES model. It will enable the proper modelling of factors such as the forest capacity of CO_2 uptake or the consequences of replacing crops. *Model: TIMES* *Partners: E4SMA, the Institute for Energy Technology (IFE, University College Cork (UCC) and VITO.*
PtX Sector-Coupling *2023-25*	Best locations of PtX plants As part of MissionGreenFuels, EML is collaborating with 13 partners on the PtX Sector-Coupling and Life Cycle Assessment Project. The expected result of the research is to create better ways to determine optimal ways of integrating PtX into the green transition. To this end we are developing and updating the TIMES-NEU model. *Model: TIMES-NEU* *Client: The Danish Innovation Fund*
Energy Island *2024*	Planning the optimal energy island EML has developed an innovative model enabling the planning of an optimal energy island. The model makes it possible to generate scenarios and explore how to plan for the maximum economic returns for investors and developers. By analyzing various scenarios, we can assess how differing conditions might affect the island's operations, capacity, investment, and profitability. *Model: TIMES-EnergyIsland* *Collaborator: Danish Technical University / MSc student Francesco González Beltrán*
TIMES-DK *2024 - 2025*	Automated TIMES reporting EML has devoted time to developing a more generic method for reporting and organizing data from TIMES into a pivot ready format ideal as input for Excel or other graphical user interfaces based on Python, R, Power BI etc. Automated reporting could save time and reduce the number of manual errors. When linking to other models, data processing can be automated and kept within the GAMS environment. Furthermore, it could increase user control over what data is available after solving a TIMES model. *Model: TIMES-DK* *Lead: Kristoffer Steen Andersen*

Gothenburg *2021-2026*	**City Energy Planning** EML has supervised the building of a tailored energy systems model, the TIMES-NE city model. The model allows us to investigate the impact of the city energy plan on the long-term energy systems development. The model has a representation of developments in the supply and demand side of the heating, electricity, and transportation sectors. The time horizon is from 2018-2050. *Model: TIMES-NE* *Collaborators: PhD student Kushagra Gupta and Professor Erik Ahlgren, Department of Space, Earth and Environment Chalmers University of Technology, Sweden*
Stochastics *2024 - 2025*	**Exploring the use of stochastics** EML is supervising a master's student from the Technical University of Denmark on his thesis exploring stochastics. We have built an energy systems model of a green-field system with investor perspective. The model has set energy demand and needs to invest in green energy solutions. By generating scenarios of cost-optimal solutions and adding constraints like uncertainties about the production capacity and costs of technologies in a systematic way, it's possible to narrow in on the margins of uncertainties. *Model: TIMES-DK* *Supervisor: Kristoffer Steen Andersen*
District Heating *2024 - 2025*	**Financing District Heating Projects** EML has the lead on a research project entitled "Financial Frameworks' Impact on District Heating". The focus is analyzing fundamental structures within district heating finance. One major result will be identifying the best practices and providing authorities, investors, and the scientific community with fundamental insight into sustainable finance's role in district heating deployment. *Model: TIMES-Bilbao* *Donor: IEA Technology Collaboration Programme on District Heating and Cooling* *Coordinator: Daniel Møller Sneum* *Partners: Lund University and Halmstad University, Sweden, Stuttgart University of Applied Sciences, Germany, and Euroheat & Power, Belgium.*

District Heating 2024	**Improving the competitiveness of District Heating**
	The TIMES-Varmelast model is equipped with a detailed representation of the greater Copenhagen district heating area. The model features 98 regions representing relevant district heating supply, transmission, and demand areas. It is solved at an hourly level (8760 hours).
	Model: TIMES-Varmelast *Client: Varmelast*
Mölndal 2024	**Optimizing District Heating**
	EML has built a model representing the district heating network in the Swedish municipality of Mölndal. We have used it to test various scenarios, testing the impact of restraints on the use of biomass, increased use of waste heat and more.
	Model: TIMES-Mölndal *Collaborator: Swedish Environmental Research Institute (IVL)*
Trollhättan 2024	**Supporting the Development of New Investment Plan**
	EML has built a tailored energy systems model of the district heating network system in the Swedish municipality of Trollhättan, the TIMES-TE model. The model features a representation of available energy resources including not yet exploited sources such as wastewater.
	Model: TIMES-TE *Client: Trollhättan Energi* *Project lead: Swedish Environmental Research Institute (IVL) / Kristina Lygnerud*
Arlington 2024	**Renovation of current Heating & Cooling System**
	EML has built a tailored energy systems model of the existing heating and cooling systems in a school and an adjacent neighborhood in Arlington, US, and mapped the potential, local energy resources. By running several scenarios, we could identify feasible and lowest cost solutions for a future system.
	Model: TIMES-Arlington *Client: Brightcore Energy* *Partner: Swedish Environmental Research Institute (IVL) / Kristina Lygnerud*

Jordan 2022-2024	**Low Emission Strategy in Jordan** Energy Modelling Lab has continued to develop the integrated assessment model, the TIMES-JO. The model represents eight key sectors and their interconnections. The model includes a full investment catalog for the entire energy sector and shows the economically optimal, high-impact pathways for decarbonizing key sectors of the Jordanian economy. *Model: TIMES-JO* *Partners: Danish Energy Management (DEM), Water, Energy and Environment Center (WEEC), University of Jordan* *Client: World Bank*
Azerbaijan 2024-2025	**Decarbonizing the Power Sector in Azerbaijan** EML has updated and tailored the TIMES-AZ model to support the designation of low-carbon solutions for Azerbaijan. The full title is "Low-Carbon Solutions in the Electric Power Sector of Azerbaijan Technical Assistance Project". *Model: TIMES-AZ* *Partner: TetraTech* *Client: The European Bank for Reconstruction and Development (EBRD)*

Developments

During the past year, EML has worked on 12 models in total. We have built four new TIMES models, updated and further developed three models, started working on two models, and supervised the creation of three models. We have strengthened our expertise in building models representing local entities such as district heating networks of municipalities, islands, and building complexes.

Furthermore, we have continued developing a new module for the TIMES Modelling Framework representing the AFOLU sector (Agriculture, Forestry, Land Use) in addition to several research projects.

Highlights

- TIMES-Varmelast

EML has made a quantitative impact assessment related to load distribution for Varmelast. The impact assessment is part of the project Load Distribution based on Contract Prices. The aim of the project is to improve the competitiveness of district heating. We based the assessment on the model TIMES-Varmelast.

- TIMES-EnergyIsland

The model can generate scenarios showing the optimal scale of production of various e-fuels such as hydrogen, ammonia, methanol, and kerosene. Likewise, you can probe the most cost-efficient solutions for the management of electricity transmission. The model diverges from the prevalent demand-driven approach by adopting a price-driven strategy. The findings indicate that Germany and Denmark are the most viable markets for exporting the island's electricity. However, producing hydrogen for export to the Netherlands and Belgium appears to be the most lucrative option, given the high industrial demand and pricing in these regions.

- TIMES-JO

We continued the World Bank project aiming to develop the TIMES-Jordan model and generate scenarios supporting the development a National Long-Term Low Emission Strategy and Options Report 2050.

- TIMES-Arlington

EML has built a tailored energy systems model of the existing heating and cooling systems in a school and an adjacent neighborhood in Arlington, US, and mapped the potential, local energy resources. By running several scenarios, we could identify feasible and lowest cost solutions for a future system and support the decision-making process concerning future investments.

- TIMES-BILBAO

In cooperation with Halmstad University, EML is developing the TIMES-BILBAO model to test different financial frameworks' impact on the roll out of district heating projects in cities with different levels of district heating network coverage:
1. The green field scenario with no district heating
2. The emerging market scenario with some district heating
3. The mature market scenario with a well-developed district heating network

The model represents the heating supply, including space heating, hot water for commercial and residential sector, six regions, and eight weeks with hourly resolution.

Community building

Over the past year, Energy Modelling Lab has been expanding the modelling community, by taking in students, training new employees, receiving colleagues from abroad, and using a science influencer to increase our reach-out.

- In June 2024, EML received a delegation from Taiwan and made a presentation of the TIMES modelling framework.

The delegation had representatives from the National Science and Technology Council, Taiwan (NSTC), Science and Technology Division, Taipei Representative Office in the EU and Belgium, The National Applied Research Laboratories, NAR Labs, The National Central University, The National Taiwan University, The Ocean University, and Taiwan Institute of Economic Research (TIER).

- EML organized a workshop on the TIMES modelling framework for Ukrainian researchers in August 2024.

- EML received a delegation from Japan in August 2024 and made a presentation of the TIMES modelling framework.

- Kenneth Karlsson participated in IEW2024 in Bonn, hosted by IRENA.

- A video on energy systems modelling and TIMES was published on YouTube.

The video was made by science influencer Maria Jarjis and got more than 6300 views (https://www.youtube.com/watch?v=Qt_zASNqD3c).

- One master's student modelling an island

Kenneth Karlsson supervised a master's student from the Technical University of Denmark on his thesis resulting in a functional model of an energy island.

- One master's student exploring stochastics

Kristoffer Steen Andersen has supervised a master's student from the Technical University of Denmark on his thesis exploring stochastics, resulting in a TIMES-model of a fictitious factory.

- PhD student modelling Gothenburg in Sweden

Kenneth Karlsson has continued to co-supervise a PhD student from Chalmers University resulting in the creation of the TIMES-CITY model.

Energy Modelling Lab attended several events on-site and online.

- Semi-annual ETSAP meeting in Singapore (24th– 25th of October 2024)
  (Kenneth Karlsson and Kristoffer Steen Andersen participated on-line).

Kristoffer Steen Andersen, senior consultant, presented a project proposal entitled "Open- source automated TIMES reporting tool".

The meeting was following the standard agenda, but we can mention some highlights from the 13 presentations:

o "Decarbonizing Singapore's Energy: Emissions and Cost Comparison of Hydrogen Technologies." Dr. Ginny Lee Yin Jin, Senior Scientist, Singapore Institute of Manufacturing Technology, A*STAR

o "Global Mitigation Potential Atlas: Tool to Enhance International Collaboration for GHG Mitigation." Dr. Aloisius Rabata Purnama, Scientist, Singapore Institute of Manufacturing Technology, A*STAR

o "Integrating the Extractive Industry into TIMES: A Key Step Towards Including Circular Economy." Dr. Juliana Barbosa, LNEG, Portugal

o "Data-to-Deal: Developing an Energy Modelling Analytical Workflow to Enhance Political and Financial Decisions." Ms. Naomi Tan, Climate Compatible Growth

o "Supporting municipalities with modeled based policy support - When to provide which kind of information?" Dr. Anna Krook-Riekkola, Luleå University of Technology, Sweden

- 94th ExCo-meeting online meeting (25th of October 2024)
  (Kenneth Karlsson participated online in the ExCo meeting)

The meeting was following the standard agenda, with no special things to report.

- Semi-annual ETSAP meeting in Bonn (24th – 25th of June 2024)
  (Kenneth Karlsson, Kristoffer Steen Andersen, and Till ben Brahim participated in the workshop on-site).

Kristoffer Steen Andersen, senior consultant, made an interesting presentation entitled "Automated TIMES reporting: A generic tool for effective reporting and linking TIMES models."

The meeting was following the standard agenda. Of the 27 highly relevant presentations, we can mention some highlights:

o "From Theory to Practice: Modeling Biomass Supply and Carbon Dioxide Removal for Climate Goals." Ms. Sophie CHLELA, Mines Paris-PSL, Centre for Applied Mathematics

o "Potential transformation and impacts of solar PV global supply chain." Dr. Can Cui, ETH Zurich

o "Modelling of energy supply infrastructures in the German energy system." Mr. Peiwen Zhang,

o Institute of Energy Economics and Rational Energy Use, Uni Stuttgart

o Quantifying mineral demand for the energy transition in the US power sector using the TIMES US Model." Dr. James Glynn, Energy Systems Modeling Analytics

Networking
We had the opportunity to meet with international colleagues and be inspired by discussing developments in detail.

- 93rd ExCo-meeting in Bonn (25th of June 2024)
  (Kenneth Karlsson from EML participated on-site in the ExCo meeting)

The meeting was following the standard agenda, with no special things to report.

Contact

You can read more about the projects mentioned above, our other projects, and our publications on www.energymodellinglab.com. Feel free to contact us if you have any questions or would like to start up a collaboration.

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