

July
8-13
2019

SUMMER SCHOOL

Prospective
Modeling
&
Energy
Transition

CMA

Centre
for Applied Mathematics
sponsoring organization: ETSAP

HANDBOOK

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The 1st INTERNATIONAL SUMMER SCHOOL on Prospective Modeling & Energy Transition

... in a few words

The First International Summer School on Prospective Modeling and Energy Transition was organized by the CMA (Centre for Applied Mathematics) in collaboration with the LTU (Lulea University of Technology) and supported by the ETSAP (Energy Technology Systems Analysis Program). It took place from July 8th to July 13th 2019 at the Sophia Antipolis campus of MINES ParisTech.

Spurred by issues of climate change and economic globalization, prospective modeling is now being considerably reinvested following years of neglect. The connections it bears between numerical or quantitative projection, mathematical economics, public economy and strategic thinking make it a valuable tool in the context of international negotiations on climate.

A variety of analyses and prospective elements can be developed using the TIMES family of models to build informed energy policies which are compatible with the current climate challenges. The TIMES family of models can be used to tackle multi-disciplinary topics, usually in small modeling teams/groups. Proficient use of comprehensive energy system optimization models like TIMES requires expertise of the system in focus, operation research and economics, along with the knowledge of what policy makers need.

To meet these needs, we organized a Summer School for young international PhD students to guide them in identifying methodological keys for drawing up energy transition policies which are compatible with climate issues.

ORGANIZATION

The aim of the First International Summer School on Prospective Modeling and Energy Transition was to present prospective modeling tools.

We started with a presentation of the first prospective modeling tools which were created in the 1960s, which resulted from a dialogue between mathematicians and economists, and which were based on the concept of optimality. Our particular focus was the TIMES family of models.

Next, we told the history of how long-term prospective models have tackled climate issues, which was followed by an interpretation of the contribution that mathematics brought to prospective modeling by developing the models' interdisciplinary approach, combining for example mathematics and economics.

In the context of the energy transition, and using concrete examples, we explored how these tools, which combine applied mathematics and economics skills, have become essential to prospective in its reflection on policies to fight climate change. In other words, our aim was to understand the mechanisms underlying ambitious contemporary energy policies which are at work in selected countries, using studies carried out by local national ETSAP teams partnering the project. We believed this should allow students to assess the transitions which are underway and to identify the obstacles and driving mechanisms involved in their implementation.



PROGRAM

Monday, July 8th	Tuesday, July 9th	Wednesday, July 10th	Thursday, July 11th	Friday, July 12th
<p>From 9:00</p> <p>Welcome address</p>	<p>8:30 – 10:00</p> <p>SWEDEN</p> <p>City vs National perspective</p>	<p>8:30 – 10:00</p> <p>IRELAND</p> <p>Multi-model approaches to energy modelling</p>	<p>8:30 – 10:00</p> <p>GERMANY</p> <p>Heat market and energy transition</p>	<p>8:30 – 10:00</p> <p>SPAIN</p> <p>Fusion as an energy option after 2050</p>
<p>10:30 – 12:30</p> <p>Prospective: philosophy, history and models. N. Maïzi</p> <p>System analysis A. Krook-Riekkola</p>	<p>10:30 – 12:30</p> <p>Energy models: Bottom-up versus Top-Down P. Fortes</p> <p>Looking deeper into Energy systems technologies G. Guerassimoff</p>	<p>10:30 – 12:30</p> <p>Behind black boxes: Optimization basics for energy and climate issues W. De Oliveira</p> <p>Machine learning and hydropower generation V. Sessa</p>	<p>10:30 – 12:30</p> <p>Climate and international negotiations: decarbonized pathway issues S. Selosse</p> <p>Demand: beyond the trivial drivers E. Assoumou</p>	<p>10:30 – 12:30</p> <p>Advanced TIMES features: Stochastic programming P. Seljom</p> <p>Myopic Programming M. Blesl</p>
<p>12:30 – 13:30</p> <p>Lunch</p>	<p>12:30 – 13:30</p> <p>Lunch</p>	<p>12:30 – 13:30</p> <p>Lunch</p>	<p>12:30 – 13:30</p> <p>Lunch</p>	<p>12:30 – 13:30</p> <p>Lunch</p>
<p>13:30 – 15:30</p> <p>Group project</p>	<p>13:30 – 15:30</p> <p>Group project</p>	<p>13:30 – 15:30</p> <p>Group project</p>	<p>13:30 – 15:30</p> <p>Group project</p>	<p>13:30 – 18:00</p> <p>Group project presentation</p>
<p>15:30 – 17:00</p> <p>FRANCE</p> <p>Power-to-gas</p>	<p>15:30 – 17:00</p> <p>PORTUGAL</p> <p>Linking CGE and ESOM (energy system optimization model)</p>	<p>15:30 – 17:00</p> <p>Doctoral students' presentations</p>	<p>15:30 – 17:00</p> <p>NORWAY</p> <p>Transition pathways to a low-carbon energy system</p>	<p>18:00 – 18:30</p> <p>Closing discussion</p>
<p>17:00 – 18:30</p> <p>Group project</p>	<p>17:00 – 18:30</p> <p>Group project</p>	<p>17:00 – 18:30</p> <p>Group project</p>	<p>17:00 – 18:30</p> <p>Group project</p>	
			<p>19:45</p> <p>Social dinner</p>	<p>18:30</p> <p>Farewell cocktail</p>

Saturday, July 13th : Social Event

A FEW WORDS

... about the program

The Summer School lasted six days (from July 8th to July 13th 2019). After five days of work, a social dinner was planned on Friday night and social activities took place on Saturday.

Activities included lectures and conferences, participants' presentations, reading sessions and group exercises. Lectures given by ETSAP members presented the perspectives on long-term energy and climate issues of several countries such as Norway, Portugal, France, Sweden, Germany, Ireland and Spain. At different levels, global issues and islands were also addressed.

Participants had to present a version of their research work (10-minute presentation / 15-20-minute discussion) and received valuable feedback from fellow students and university faculty members.

In groups, participants had to work on a prospective study project during the week. On Friday afternoon, participants gave an oral presentation of their project which could be considered as the possible first draft of an academic paper for submission to an international peer-reviewed journal (the most advanced proposals could be continued in collaboration with the organizers up to their submission).



FACULTY



NADIA MAÏZI
CMA MINES ParisTech, France

Nadia Maïzi, Professor at MINES ParisTech and Director of the Center for Applied Mathematics (CMA), is an expert in energy system modeling, optimization and prospective analysis. Since 2008, she is the Co-Director of the ParisTech Chair Prospective Modeling for Sustainable Development and acts as French delegate on the ETSAP (Energy Technology System Analysis Program) run by the IEA (International Energy Agency). Moreover, since 2009 she is leading the ParisTech delegation on the UNFCCC (United Nations Framework Convention on Climate Change). In addition, Professor Maïzi is Head of Studies for the Advanced Master's degree OSE (Energy Systems Optimization).



ANNA KROOK-RIEKKOLA
LTU, Sweden

Anna Krook-Riekkola is an Assistant Professor at Luleå University of Technology (LTU) in Sweden. Her field of research is energy system analysis and modelling with a focus on long-term energy and climate policy assessment. She has worked with the MARKAL/TIMES modelling framework since 2001 and developed TIMES-Sweden – an energy system optimization model of the comprehensive Swedish energy system – first as a part of a European model within two EU projects and then as part of her PhD. Her work also includes methodological modelling, e.g. linking national CGE models with TIMES-Sweden, and developing a generic TIMES-city model (ongoing EU project). She has worked with EU energy system evaluation (at the EU Joint Research Centre in the Netherlands), and has provided policy support to the Swedish government and the Swedish EPA using TIMES-Sweden to explore climate-neutral pathways. Her teaching experience includes courses on sustainable energy systems, environmental systems analysis and sustainable development.

FACULTY



SANDRINE SELOSSE
CMA MINES ParisTech, France

Dr. Sandrine Selosse has been a researcher at the Centre for Applied Mathematics (CMA), part of MINES ParisTech France, since May 2008. Her research activities focus on long-term modeling of energy systems and assessment of international energy and climate policy issues.

In particular, she implements and develops extensions for the bottom-up world energy system model, TIAM-FR (TIMES Integrated Assessment Model), a TIMES family model from the Energy Technology Systems Analysis Program (ETSAP) under the aegis of the International Energy Agency (IEA). Moreover, she plays a central part in the running of the Chair Modeling for Sustainable Development, created in 2008, for which she also coordinates interactions with industrial partners. This collaboration between academic, institutional and industrial actors aims to develop decision-making tools for energy and climate issues. Sandrine also teaches classes on long-term energy system modeling and international climate negotiations.



EDI ASSOUMOU
CMA MINES ParisTech, France

Dr. Edi Assoumou has been a researcher at the MINES ParisTech Centre for Applied Mathematics (CMA) since 2007. His research activities focus on energy system analysis and the development and articulation of models of different spatial and temporal resolutions. He has been involved

in several EU and French projects where his research has covered sustainable transport, urban energy systems, energy and lifestyles, power systems transition, flexibility in gas systems and Life Cycle Analysis. In particular, Edi Assoumou is an experienced TIMES modeler and coordinates the development of the French TIMES model and its sectoral modules as well as the EU power system model.

FACULTY



GILLES GUERASSIMOFF
CMA MINES ParisTech, France

Gilles Guerassimoff is a Professor at MINES Paristech and works at the Centre for Applied Mathematics (CMA). He is the Director of the Advanced Master's Degree in Energy Systems Optimization (OSE). He has a long experience in training and managing educational programs in close relation with academics and industrials, and has given lectures on energy systems for several institutions. His expertise in energy system modelling, control and prospective led to several project for the modeling of energy systems in order to make prospective studies for decision making or algorithms design for the automation in smart cities.



PATRICIA FORTES
FCT Nova, Portugal

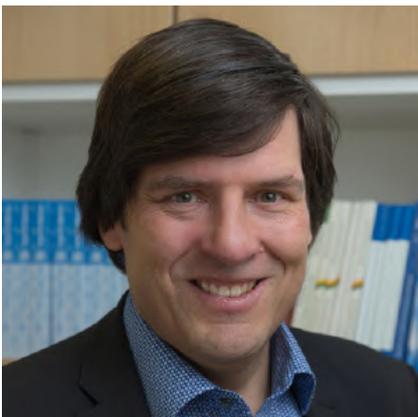
Patrícia Fortes is a post-doctoral researcher in the fields of energy systems and energy economics, working at CENSE/NOVA University Lisbon research center. Her research explores the transition to low-carbon energy systems, focusing on technological changes, macroeconomic impacts and energy-climate policy analysis. She has more than 10 years' experience in energy system and computable general equilibrium modelling, in particular the link between the technological TIMES and economic GEM-E3 models for Portugal. She has worked at the European Commission's Joint Research Center in Seville (2015) on the development of the POTEnCIA model (Policy Oriented Tool for Energy and Climate Change Impact Assessment) and cooperated in multiple national and international research projects on energy-economy-environment modeling. She also has extensive experience of energy-climate policy support thanks to her work with the Portuguese Ministry of the Environment and Energy Transition. She has a PhD in Environment from NOVA University Lisbon (2014).

FACULTY



PERNILLE SELJOM
IFE, Norway

Pernille Seljom (PhD) has been a research scientist at the Institute for Energy Technology since 2008. She has a Master of Science (2006) in Energy and Environmental Engineering and a PhD (2017) in Operations Research from the Norwegian University of Science and Technology (NTNU). Ms Seljom's thesis was dedicated to improving the representation of intermittent electricity generation and temperature-dependent heat demand using stochastic programming in TIMES models. Seljom is an experienced TIMES modeller. In addition to using TIMES to analyze the transition of the energy system, she assists other institutions in developing their own TIMES models. Her current research focus includes the role of flexibility in a future decarbonized energy system, incorporating competition and interaction between various supply and demand flexibility measures, from a Norwegian and European perspective.



MARKUS BLESL
IER Stuttgart, Germany

PD. Dr. Markus Blesl is head of the System Analytical Methods and Heat Market (SAM) department at the Institute for Energy Economics and Rational Energy Application (IER), part of the University of Stuttgart. He graduated in physics from the University of Stuttgart in 1995 and obtained his PhD on spatially high-resolution modelling of local energy systems from the same university in 2002. In 2014, he habilitated with a thesis entitled, "Combined Heat and Power Generation in the Heat Market of Germany and Europe – an Energy System and Technology Analysis" and received the *venia legendi* for Energy System and Technology Analysis. His main areas of work include the analysis and evaluation of energy technologies for coupled and uncoupled power and heat generation, as well as the further development and application of energy system models.

FACULTY



FIONN ROGAN
UCC, Ireland

Fionn lectures in Energy Systems Modelling and Energy Engineering at the School of Engineering in University College Cork. He is also a researcher at the Energy Policy and Modelling Group in the SFI MaREI research centre. Fionn has worked with a number of energy system models and has published papers on multi-model approaches combining energy simulation with energy optimization modelling. His other research interests include citizen engagement with energy systems modelling, ex-post analysis of energy policy, and energy innovation. Fionn has provided technical advice and contributed to a number of reports that have directly informed climate and energy policy formation in Ireland.



YOLANDA LECHON
CIEMAT, Spain

With a PhD in agricultural engineering from the Polytechnic University of Madrid, Yolanda Lechon has been head of the energy unit at Energy System Analysis since 2013. Her main research activities have focused on the economic evaluation of external costs and benefits associated with the production and consumption of energy; the application of ExternE methodology to evaluate the externalities of energy and transport; Life Cycle Sustainability Assessment of energy technologies and processes with a special focus on biomass; biofuels and solar thermal technologies; environmentally and socially extended economic input-output modelling to evaluate socioeconomic and environmental effects of energy technologies; and energy system modelling using techno economic partial equilibrium optimization models. She has participated in several European Commission and national research projects and has acted as a reviewer on several international R&D programs, and is co-author of more than 80 papers and book chapters and more than 60 contributions to conferences and workshops.

FACULTY



WELINGTON DE OLIVEIRA
CMA MINES ParisTech, France

Wellington De Oliveira has been working as a researcher and teacher at the MINES ParisTech Centre for Applied Mathematics (CMA) since 2017. His research focuses mostly on optimization, including nonsmooth optimization, stochastic programming, mixed-integer optimization, energy and power systems management. He has been combining theoretical research in optimization with practical issues of relevance for the industry of energy. Currently, he is interested in the mathematical aspects of intelligent power systems; more specifically, in the optimal interactions between classical power generators and smart grids.



VALENTINA SESSA
CMA MINES ParisTech, France

Valentina Sessa received a Master's degree in automatic control engineering and a PhD in information engineering from the University of Sannio, Benevento, Italy, in 2010 and 2013, respectively. After a one-year postdoctoral fellowship at the Department of Engineering, University of Sannio, she took up a postdoctoral position at IMPA (Instituto Nacional de Matemática Pura e Aplicada), Rio de Janeiro, Brazil. From August 2015 to June 2017, she was assistant professor at the Department of Electronic and Telecommunications Engineering at the State University of Rio de Janeiro (UERJ) where she taught two courses: automatic control and mathematical models for electrical engineering. She presently works as a research engineer at Mines ParisTech, Sophia Antipolis. Ms Sessa's current research interests include analysis of non-smooth dynamical systems, in particular piecewise linear and complementarity systems; modelling and control of power electronic converters; numerical algorithms for complementarity problems; and global optimization. More recently, she has focused her research on machine learning techniques applied to energy problems.

SOCIAL ACTIVITIES

GALA DINNER PARTY - JULY 11TH

On the Thursday evening took place a gala dinner party at the Plage Keller, famous beach restaurant located in the beautiful surroundings of the Cap d'Antibes.



FAREWELL COCKTAIL - JULY 12TH

Because all good things come to an end, we celebrated the last day of the Summer School with petit fours and Champagne!



DISCOVERING THE FRENCH RIVIERA - JULY 13TH

For those who could stay with us a bit longer, we went sightseeing around the Côte d'Azur the next day. The beautiful area surrounding Sophia-Antipolis offers a wide choice of activities. On Saturday 13th, we invited our students to come and discover some of the most interesting spots the French Riviera has to offer. We first visited the 16th century-built Fort Carré in Antibes which offers a 360-degree panoramic view over the sea and the Alps, and is surrounded by a 4 acre protected park surrounded by typical Mediterranean fauna and flora. We then went to the beautiful village of Saint-Paul-de-Vence and visited the Maeght Foundation which hosts an important collection of work by famous modern and contemporary artists within a unique architectural ensemble and gardens.



FEEDBACK

According to a survey conducted by the CMA at the end of the 1st International Summer School on Prospective Modeling & Energy transition :

 **90 %** of the students said they gained deeper knowledge in **TIMES** and **energy modeling tools** thanks to the Summer School

 **95 %** of the students said that they **extended their network** by meeting other students and experts working on the energy transition analysis during the Summer School

 **95 %** of the students said they would **recommend a second edition of the Summer School**

 **60%** of the students considered the **group project** as the highlight of the Summer School



TESTIMONIALS

« The Summer School was an interesting and intense experience in a friendly environment, an unique opportunity to get valuable knowledge and contacts in the TIMES community. »

« There was a real collection of senior researchers and experts in the TIMES community, presenting and lecturing during the Summer School. So much experience in one place at the same time ! »



CHRISTOFFER WADSTRÖM

PhD Candidate
Linköping University
SWEDEN

« Thanks to the prospective study project which was conducted in groups, I was allowed to gain new knowledge and concepts. »

« I would for sure recommend this Summer School as it has a rich, inclusive and fruitful program. It was a complete package gathering presentations of the participants' research work, different case studies and methodologies. »



NAIMA CHABOUNI

Research Associate
Research Center in
Applied Economics for
Development
ALGERIA

« I really enjoyed getting in touch with people working on the same field as me from all across the world, and sharing experiences as we were learning about TIMES and its useful applications for the energy transition challenges. »

« I was an absolute beginner at TIMES before attending the Summer School and there I was able to learn all about its basic functions and capabilities, as well as the state of the actual research that is being done in many countries across Europe. »



RUBÉN CANALEJAS

PhD Candidate
Hydrogen Foundation
for the Development
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