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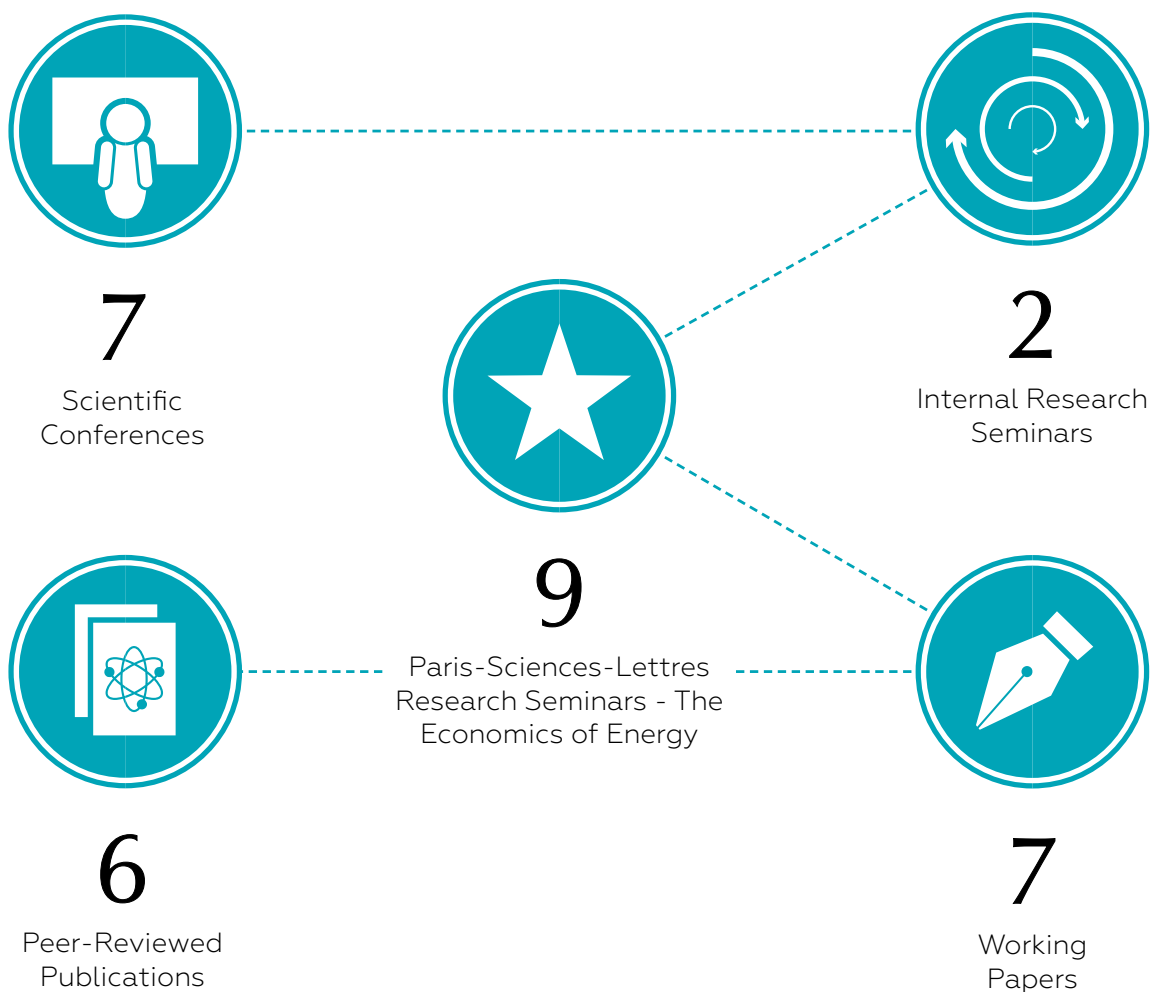
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KEY FIGURES OF THE CEEM

The main balance sheet figures of the Chaire European Electricity Markets reflect the structure and level of its activities.



MESSAGE FROM THE SCIENTIFIC DIRECTOR OF THE CEEM

Since its foundation, the Chaire European Electricity Markets (CEEM) has focused on the observation and analysis of European electricity markets. Current stakeholders are under economic pressure from a combination of stagnant demand and large supply growth coming from wind and solar sources, which effectively have a zero variable production cost in the short term. Since prices are determined by the variable cost of marginal technology (as in all free markets) this imbalance results in lowered prices which do not reflect total or capital costs.

As a result, we see that thermal, nuclear, coal, and gas-fed electricity sources are experiencing a reduction both in load factor and average revenue per MWh. Reducing capacity from programmable sources can only be a measure of last resort since the electrical system depends on them for reserve supply during periods when wind and solar sources are not productive. Faced with declining capital investments and uncertainty about existing capacity, current stakeholders in European electricity markets agree that the current situation is not sustainable.

While this general conclusion is shared by many in the field, the identification and relative weighting of specific underlying factors is still an area of active research, including at the CEEM. Since the beginning of 2015 we have made the transition from descriptive

research to policy proposals for a more balanced restructuring of European electricity markets.

A major international conference on this subject, "Elements of a new target model for European electricity markets: Towards a sustainable division of labour between regulation and market coordination" was held at the Université Paris-Dauphine in July 2015. However, this conference (which presented the work of more than thirty high-level researchers) did not conclusively answer the question of whether the current energy-only market is sustainable with moderate adjustments or if a transition to a new target model is required.

Despite this, the conclusion of the conference identified three research priorities for designing a reform of European electricity markets. Additional research results, both published and on-going, are also key elements of this design.

1. Research Priority 1 : Providing flexibility in the current market - Providing flexibility in the current market is important to manage the intermittent supply from wind and solar photovoltaic (PV) sources, as well as to remunerate energy supply during peak and off-peak periods. This flexibility is a complex service that is available at different scales of power, reaction time, repeated cycles, and rebound effects. This flexibility can be supplied by different sources: electricity

generation units, power storage units, different forms of load management or demand response (DR), or cross-border exchanges and network management. Several incentive schemes are available to stimulate them, principally capacity mechanisms, which reward supply on-demand. This is particularly true during periods of maximal residual demand, which is the total demand minus the supply from intermittent renewables. Complementary incentive schemes include tenders for load-management, off-peak premium pricing, and pricing of energy storage at its social value rather than its market value (which is currently rather low). Together, these form a coherent set of measures to better remunerate the provision of flexibility which go well beyond minor procedural modifications to electricity balancing markets, as welcome as they are.

2. Research Priority 2 : Securing capital investment for low-carbon electricity generation

- An energy-only market, by definition, remunerates only the electricity produced, not the capital investment necessary to produce it. This is an acceptable solution when there is a pre-existing and stable structurally based surplus, which is true for certain types of carbon markets (see below). However, it is not able to stabilize current capacities or attract new investment, particularly in the context of renewable energy sources which tend to decrease wholesale prices. This is an especially important consequence for the development of low-carbon and renewable energy sources such as nuclear and hydroelectric power, which require large capital investments and are therefore the most affected by decreases in price. A solution is to establish long-term price guarantees. Feed-in tariffs already fulfill this function in a selective manner. The generalization of long-term price guarantees for all low-carbon technologies, called *contracts for difference*, should strengthen this policy. We note that these price guarantees do not remove competition from the market. Reverse auctions for long

term electricity contracts effectively constitute a competition *for* segments of the electricity market, rather than competition *within* the market.

3. Research Priority 3 : An intelligent and creative restructuring of the European carbon market

- European carbon and electricity markets are experiencing severe price drops arising from the misunderstood transition from free CO₂ quota allocation to a paid quota system. This drop in carbon prices is concomitant with a drop in electricity prices, which follow suit whenever non-renewable energy sources make up the difference (which is to say most of the time.) Simply increasing the price of CO₂ (through a reduction of quotas or a carbon tax) is likely to encounter resistance from countries where coal is still a major source of electricity. The politically and economically viable solution is to allow European countries to voluntarily distribute new free CO₂ quotas in exchange for a proportional decrease in their total quota. This would raise the price of CO₂, electricity and inframarginal rents, for both non-CO₂ emitting producers and CO₂-emitting producers operating with free quotas. This system depends on the strict adherence of electricity producers.

Such a system would not necessarily work to the detriment of the consumer, who are already subsidizing renewable energy sources through dedicated mechanisms (such as CSPE, EEF Umlage, Renewables Obligation). An increase in wholesale market prices would allow the reduction of these contributions.

The relative weight of each of these three approaches will determine the resulting policy. A few years hence we will be discussing either the reform of the current "target model 1.0" or its replacement by another market design. But this is a debate for future historians. The bottom line is that the policy makers, the European Commission and its member states must reach a consensus as soon as possible on a set of concrete

measures which will guarantee the security of electricity supply for the next decade in the context of progressive carbon reduction and total cost control of power systems.

The CEEM, in cooperation with its partners and academic colleagues, is committed to supporting this process through progress on three fronts: scientific research, public debate, and the training of future managers in the electrical sector capable of dealing with these challenges.



Jan Horst Keppler,
Scientific Director of the CEEM

BRIEF PRESENTATION OF THE CEEM

The Chaire European Electricity Markets (CEEM) is part of an ecosystem of institutions at the Université Paris-Dauphine working on energy matters. It includes the Centre for Geopolitics of Energy and Raw Materials (LEDA-CGEMP), the Master programme in Energy, Finance, and Carbon (EFC), as well as the Chairs of Economics of Climate & Finance and Sustainable Development at the Université Paris-Dauphine. In this context, the CEEM pursues three objectives:

(1) Conducting an ambitious academic research programme,

(2) Providing a discussion forum for academic, industrial experts, and stakeholders,

(3) Contributing to the training of future high level professionals in the electricity sector.

The CEEM is the result of a partnership between the Université Paris-Dauphine, the Paris-Dauphine Foundation, and the four founding partners: Réseau de Transport d'Électricité (RTE), Électricité de France (EDF), EPEX SPOT, and the Union Française d'Électricité (UFE).



The Group

The management team of the CEEM is composed of the following members:



Jan Horst Keppler, CEEM Scientific Director and professor of Economics at the Université Paris-Dauphine, is responsible for the general organization of the Chaire and its research activities.

Fatoumata Diallo,
Project Manager
of the CEEM



Anna Creti, professor of Economics at the Université Paris-Dauphine, leads Research Axis 1 (European electricity market pricing under market quotas) since October 2013.



Dominique Finon, CEEM Scientific Advisor, leads Research Axis 2 (Organization, structural changes, and regulation of European electricity markets).

Patrice Geoffron, professor of Economics at the Université Paris-Dauphine, leads Research Axis 3 (Transport, distribution, and demand).



CEEM Researchers

Marie Bessec, Researcher.

Régis Bourbonnais, Researcher.

Mauricio Cepeda, Researcher.

Cédric Clastres, Researcher.

Anna Creti, CEEM Research Axis 1
Director.

Michel Cruciani, Researcher.

Guillaume Dezobry, Researcher.

Dominique Finon, CEEM Research Axis 2
Director.

Patricia Van Horn Florin, Researcher.

Julien Fouquau, Researcher.

Patrice Geoffron, CEEM Research Axis 3
Director.

Stéphane Goutte, Researcher.

Morwenna Guichoux, Researcher.

Jan Horst Keppler, CEEM Scientific
Director.

Yannick Le Pen, Researcher.

Yuanjing Li, Researcher.

William Meunier, Assistant researcher.

Marie Petitet, Doctoral student.

Thao Pham, Researcher.

Sébastien Phan, Researcher.

Fabien Roques, Researcher.

María-Eugenia Sanin, Researcher.

Charlotte Scoufflaire, Doctoral student.

Antoine Verrier, Doctoral student.

Manuel Villavicencio, Doctoral student.

Julie Hyun Jin YU, Researcher.

PART 1: PRESENTATION OF THE MAIN DECISIONS TAKEN BY THE CEEM

The success of the CEEM rests largely on the support and active collaboration with its partners, RTE, EDF, EPEX Spot, and Groupe Caisse des Dépôts, as well as its scientific collaborations. This collaboration is present at three levels:

- The Steering Committee
- The Scientific Council
- The Review Board

I- Steering Committee

The CEEM is governed by a Steering Committee established by the Charter which binds the Université Paris-Dauphine and the Paris-Dauphine Partnership Foundation to the four founding partners of the CEEM. This Committee defines the program of activities of the Chaire, validates the CEEM annual budget and verifies its budget.

The members of the Steering Committee are:

Jan Horst Keppler (CEEM Scientific Director and President of the Steering Committee)
Thomas Veyrenc (Markets Department Director, RTE)
Pierre Bornard (Senior Executive Vice-President, Vice-Chairman of the

Management Board of RTE)
Marc Bussieras (Group Strategy Director, EDF)
Jean-Paul Bouttes (Head Economist, Development and International Relations, EDF)
Jean-François Conil-Lacoste (Chairman of the Management Board, EPEX SPOT)
Nicolas Blanc (Department of Finances, Strategy and Holdings, Groupe Caisse des Dépôts)
Sandra Bouscal (Director of the Paris-Dauphine Foundation, Université Paris-Dauphine)
Patrice Geoffron (Research Professor at the Université Paris-Dauphine)
Jean-Arnold Vinois (Honorary Director of the European Commission and Special Advisor to Commissioner, non-voting member)
Alfred Voss (CEEM Scientific Council President, Institute for Energy Economics at the University of Stuttgart, non-voting member)
Dominique Finon (CEEM Scientific Advisor, and CIRED-CNRS (Observer))

Major decisions of the Steering Committee

Steering Committee Meeting of 2 April 2015, 10h00-12h00, Université Paris-Dauphine, Room A 703, 7th Floor, New Wing.

Scope of CEEM Research Activities

The Steering Committee revisited the scope of CEEM research, namely the introduction of legal analysis of the energy sector. Current CEEM research is focused on wholesale electricity markets in three areas:

1. **Econometrics** : Pricing in European electricity markets;
2. **Market design** : Organization, regulation, and structural changes in European electricity markets
3. **Transport and demand** : Transport, distribution, smart grids, electricity storage and demand management.

The Committee recommends that the CEEM promote cooperation between economists and engineers in these research areas in order to produce technical and economic analyses. In this context, the Committee recognizes the collaboration between the CEEM and Cédric Clastres, assistant professor at Université Pierre Mendès-France (Economy UFR), and also welcomes the addition of Guillaume Dezobry as a researcher in Research Axis 3. He is assistant professor in public law at Amiens, attorney at law, expert in energy law, and author of the CEEM working paper “Les lignes directrices concernant les aides d’État à la protection de l’environnement et à l’énergie pour la période 2014-2020” (Guidelines for state aid in environmental protection and energy for 2014-2020).

CEEM Partnership Charter amendment

The Union Française d’Électricité (UFE) expressed its desire to withdraw from the CEEM Partnership Charter in order to focus its budgetary resources on developing other relationships important for achieving short term priorities. Following a review by the Scientific Director and the Paris-Dauphine Foundation, this request was

submitted for approval to the Steering Committee (governing body of the CEEM). After discussing the procedures and consequences of withdrawal, the Committee unanimously approved the UFE’s departure, retroactively effective from January 1 2015. The Committee concludes that the terms and obligations of the Charter remain unaffected.

Review of the CEEM 2014 Financial Report and the 2015-2017 Projected Budget

The Committee’s review of the 2014 Financial Report finds that the CEEM has been generally moderate in its spending. The Committee notes that it is essential for the CEEM to maintain an adequate number of qualified doctoral students, including those with an engineering profile. The Committee’s budget review yields a unanimous approval of the 2014 Financial Report as well as the 2015-2017 Projected Budget.

CEEM Events

The Committee approved the CEEM Events agenda for the second semester of 2015, particularly the Target Model 2.0 conference scheduled for summer 2015.

Steering Committee of 7 October 2015, 9h30-12h30, Université Paris-Dauphine, Espace One, 1st Floor.

CEEM Partnerships and Charter amendment

1. RTE : Pierre Bornard, appointed member of the Steering Committee, will retire on 31 October 2015. After this date Thomas Veyrenc and Cédric Leonard will be the RTE representatives of the Committee.

2. Establishment of a new partnership between CDC (Groupe Caisse de

Dépôts) and CEEM founding partners RTE (Réseau de Transport d'Électricité), EDF (Électricité de France) and EPEX Spot on 2 November 2015. In connection with CEEM research objectives, the CDC has defined 4 research themes :

- Economic changes in electricity and environmental policy based on trends in electricity prices;
- Trends in European electricity prices : potential risks and regulatory responses;
- Infrastructure of the energy transition in the context of developments in renewables, storage, load management and data management;
- Capacity markets (particularly French) for assuring efficient security of supply.

Operations of the CEEM

Jan Horst Keppler and Dominique Finon wish to organize an afternoon networking event for CEEM doctoral students in February or March 2016, with possible invitation of external energy sector doctoral students.

CEEM Copyright Policy and Author Compensation

The Paris-Dauphine Foundation and the CEEM recently consulted the WeLaw legal firm about author compensation with the goal of developing a copyright agreement applicable to all Paris-Dauphine Foundation scientific production.

Review of the CEEM 2015 Financial Report and the 2015-2017 Projected Budget

The 2015 CEEM Financial Report as of 31 December will be presented to the Steering Committee at the next 2016

meeting. The projected budget for 2015-2017 includes the new membership of Groupe Caisse des Dépôts, which will provide complete (three-year) financing for all current CEEM doctoral students. The Committee unanimously validated the 2015-2017 projected budget.

Presentation of the schedule for the 2017 Partnership Charter Renewal

Jan Horst Keppler addressed the question of renewing the CEEM Partnership Charter beyond June 2017. He informed the Committee members that he would like to meet with them in the coming months for internal discussions on a new version of the Charter based on the current one. Partners are invited to review their areas of research interest in order to prepare for the Charter renewal. The Committee approved the schedule and meeting format.

II- Scientific Council

In addition to the Steering Committee, whose formation is prescribed by the partnership Charter, the CEEM also has a Scientific Council. This Council consists of high-level researchers who define the main areas of research and ensure that a high standard of methods and protocols are followed.

The Scientific Council is composed of the following members:

Prof. Alfred Voss, Institute for Energy Economics (University of Stuttgart), Scientific Council President

Prof. William D'Haeseleer, University of Leuven Energy Institute

Prof. David Newbery, Electricity Policy Research Group (Cambridge University)

Prof. John E. Parsons, Centre for Energy and Environmental Policy Research (MIT)

Prof. Jacques Percebois, CREDEN
(Université de Montpellier)

Jan Horst Keppler, CEEM Scientific
Director, Université Paris-Dauphine

Anna Creti, CEEM Research Axis 1
Director, Université Paris-Dauphine

Dominique Finon, CEEM Research Axis 2
Director and CNRS-CIRED

Patrice Geoffron, CEEM Research Axis 3
Director, Université Paris-Dauphine

research with other institutions, such
as l'École des Mines, the University of
Leuven, and the University of Stuttgart.

Joint meeting of the Steering Committee and the Scientific Council

Scientific Council members suggested
that the CEEM organize a joint meeting
for discussion and debate with the
Steering Committee.

Main decisions of the Scientific Council Meeting of 27 March 2015, 15h00 – 17h00

Université Paris-Dauphine,
Espace One, 1st floor

New doctoral student

The Scientific Director of the CEEM
informed the Committee of his project
to recruit a new doctoral student for
research on empirical studies of capacity
mechanisms in September 2015.

Activities of the CEEM

The Scientific Council congratulates
the CEEM for addressing relevant
topics through quality research and
communication, particularly the Target
Model 2.0 Conference of 8-9 July 2015.

Partnerships

The Scientific Director of the CEEM
informed the Committee of UFE's
(l'Union Française d'Électricité) intent
to withdraw from the CEEM for financial
reasons, as well as Groupe Caisse des
Dépôts' intent to join.

Presentation of CEEM doctoral research

Two CEEM doctoral students were
invited to present their research at this
meeting of the Scientific Council. Manuel
Villavicencio presented "Analyzing the
optimal development of electricity
storage with increasing RES-E
shares" and Marie Petitet presented
"Investments in electricity generation
in the context of the energy transition:
the need for new rules and market
designs". The members of the Council
applaud these initiatives and are very
interested in the development of these
research projects. Many questions were
addressed to the doctoral students, with
the Council concluding that students
are welcome to further discuss their
research with the Council if need be.
The Council highlighted the importance
of valorizing CEEM doctoral research,
including the possibility of collaborative

III- Publication Review Board and CEEM Copyright Policy

The CEEM Review Board, composed of partners and members of the Chaire, is responsible for reviewing articles produced through CEEM scientific research. Only material approved by the Review Board is eligible for the CEEM research incentives program.

The members of the Review Board are :

Jan Horst Keppler, CEEM Scientific Director, Université Paris-Dauphine

Thomas Veyrenc, Market Department Director, RTE

Cédric Léonard (Center for Market Models and Economic Studies, RTE)

Marc Bussieras (Director of Group Strategy, EDF)

Audrey Mahuet (Head of Market Design and Customer Relations, EPEX Spot)

Patrice Geoffron, Research Professor at Université Paris-Dauphine

Yannick Le Pen, Assistant Professor of Economics, Université Paris-Dauphine

Vincent Pichon, Groupe Caisse des Dépôts

In 2015 the Review Board has been regularly involved in publishing CEEM scientific research. Seven papers on several topics relating to European electricity markets were submitted for review to determine their eligibility for appearing in CEEM publications. Six working papers were published in peer-reviewed journals (The Energy Journal, Energy Economics, Revue de l'Énergie, and Electrical Power and Energy Systems). Thus far, the review procedure for working papers and other publications has been transparent and efficient.

PART 2: CEEM PROGRAMME OF RESEARCH

In 2015 the CEEM has continued to invest in the training of the future experts and managers of the electricity sector, supporting a growing number of doctoral students and promising research projects.

I- Doctoral Theses

A. Capacity Remuneration Mechanisms : Analytical Assessment of Current Experiences and Lessons Learned for Future Market Designs

*Doctoral Student : Charlotte Scouflaire
Supervisor : Jan-Horst Keppler*

As more and more observers are questioning the ability of energy-only electricity markets to ensure security of supply, capacity remuneration mechanisms appear as a possible regulatory solution. Indeed, the poor investment climate and numerous mothballing announcements over recent years suggest that the remuneration provided by energy-only markets is not sufficient to incentivize the development of optimal capacity. While security of supply is a high-profile political objective, it is also an externality, which makes its value difficult to estimate.

As the debate over Capacity Remuneration Mechanisms increases, academic publications tend to focus on studying the need for them. Few are those who seek to analyse empirical data in order learn from past experiences.

As part of the thesis entitled "Capacity remuneration mechanisms: analytical assessment of current experiences and lessons learned for future market design" we will conduct an international empirical study to analyze this experience. To achieve this, the study will identify and classify existing capacity remuneration mechanisms and their legal framework. Since security of supply is the stated objective of capacity remuneration, these two variables are expected to show a positive correlation. However, there is no consensus on the subject. Therefore, we will examine publicly available data and market knowledge in an econometric study covering several countries in order to identify a possible relationship between capacity remuneration, market functioning, and supply security. Based on preliminary results, we will conclude on the real need for capacity remuneration and the appropriate tools for achieving an optimal level of supply security.

B. Analyzing the Optimal Development of Electricity Storage in Electricity Markets with High RES-E Shares

*Doctoral Student : Manuel Villavicencio
Supervisors : Jan-Horst Keppler and Dominique Finon*

The second year of doctoral work was devoted to the development of a mathematical model for the long-term planning of electrical power generation taking into account investment in electricity storage mechanisms and other flexibility sources. Three formulations were developed, implemented in code and validated regarding their capability to efficiently represent the links between short and long-run issues of the power system. These models were used to calculate the optimal social investment in different generation and electricity storage technologies. Each model formulation includes progressively more detail, requiring correspondingly longer computation time.

The preliminar MILP formulation, combining binary and integer numbers, proposed at the end of the first year, was presented during a visit to the Energy and Environment Department of the Catholic University of Leuven. Modeling experts from this laboratory gave important feedback on our approach, which allowed us to improve the model. A linear model was suggested to ensure size tractability and robustness when integrating operational constraint for computing power investment decisions.

These changes were implemented in code and preliminary results were presented at the CEEM Scientific Council Meeting of 27 March 2015. This review approved the approach and suggested improvements to the model.

The majority of goals set for this period were achieved and are listed below.

- Comparison and adjustment of parameters and costs from different sources: cross-referencing cost data from various sources (NEA and JRC reports, DIW cost publications, Intertek APTECH report on cycling cost).
- Distinguishing features of French hydro-electric technologies (run-of-river, reservoir, PHS). Hourly production data were analyzed to distinguish different types of hydroelectric energy and differentiated into the model..
- Integration of storage technologies in the optimization model. Five bulk storage technologies were introduced in the portfolio of investment choices.
- More accurate modeling of intermittency using a probabilistic approach for modeling imbalance sources. Reserve requirements were also modeled to accommodate the intermittency of renewables in the investment calculations.
- Collection of raw data from individual electricity generation plants for grouping into clusters. This is no longer necessary since the shift from MILP to LP formulation permits the use of technology level data.
- Representation of cross-border trade with interconnection constraints: a simplified representation of the import - export was implemented using a fixed average price constrained by the capacity of the interconnection lines. Improvements to this strategy are still under development.

The three model formulations were developed and are currently used as computational methods for performing sensitivity analyses for testing the extent of penetration of renewable energy sources, as well as the variations of electricity demand and the cost of CO₂ emissions, among others. These analyses should result in academic publications providing an opportunity to discuss model structure and empirical literature

on energy policy evaluation in the electricity sector. Together, these form a part of the objectives for the third year of this doctoral research.

C. Long Term Dynamics of Power Systems with Variable Renewables and Adequacy Constraints

Doctoral Student : Marie Petitet

Supervisors : Jan-Horst Keppler and Dominique Finon

First year results

This thesis develops the study of private sector investment decisions in electricity generation and on the sensitivity of the electricity mix to market mechanisms. This research is based on a model using the System Dynamics approach. This tool allows the simulation of the growth of the production base over several decades through a representation of investment decisions made on the basis of profitability estimates of different technologies based on future expectations of a representative private investor. The first year was focused on the study of the profitability of wind energy without support. This study resulted in a CEEM working paper :

Petitet, M., Finon, D., Janssen, T., 2014. « Carbon price instead of support schemes: wind power investments by the electricity market." CEEM *working paper*, no. 2014-09, Paris-Dauphine University.

Second year results

A first generation of capacity mechanism models was developed which set capacity price as a function of the difference between the certification level and the obligation level. This model was presented at the annual Conference on the European Energy Market :

Petitet, M., 2015. "Ensuring security of electricity supply: how capacity obligation impacts investments including demand response opportunities?" In Proceedings of the 12th international conference on the European energy market (EEM), Lisbon.

In the second year, capacity mechanism modeling was improved to include a representation of endogenous supply capacity. In this representation, the capacity price is set by the intersection of the supply curve and the demand curve (which is considered to be inelastic). This resulted in a new study that will be submitted to the CEEM. This paper analyzes the case of a mature market with introduction of exogenous wind power and stable demand supported by energy efficiency measures. It also develops a comparison between an energy-only market with or without scarcity pricing, and the introduction of capacity mechanisms.

The determination of price in a capacity market was the focus of our study. This document clearly distinguishes the criteria applied to existing capacity from those suitable for development of future capacity.

We also studied different approaches to analyze the production base in order to evaluate the contribution of dynamics systems modeling in comparison to other approaches such as optimization, total cost analysis, and screening curves. More recently, we also studied risk aversion in investment decisions. This model was developed to incorporate a representation of risk aversion with a utility function and the certainty equivalent.

Third year results

The third year of doctoral research will be devoted to the study of risk aversion in investment decisions. This builds on the previously developed model and will better define the scope of the study on the basis of preliminary results. The integration of risk aversion will allow

the re-analysis of the first two studies (market development of wind power and capacity mechanism effects) to estimate the effect of this additional representation.

Finally, the writing of the thesis manuscript should begin in the next few months in order to stay on schedule. The goal is to schedule the defense for before the close of 2016, with a rehearsal scheduled for spring 2016.

D. Evaluating the Economic Potential of Load Management under Technical and Social Constraints

*Doctoral Student : Antoine Verrier
Supervisor : Jan-Horst Keppler*

Context

Economic theory states that the lack of price responsiveness to demand for electricity reduces market efficiency, particularly in the determination of optimal short term prices. Making electricity demand more flexible would generate economic benefit for all agents in the value chain. However, because of technological and regulatory barriers, the electricity consumer cannot directly see the wholesale price and adjust his demand accordingly. The solution we see emerging in many markets is the load management aggregator, which modifies the demand of its portfolio based on wholesale market signals within constraints defined in its consumer contracts.

The load management industry is still under construction. The viability of the aggregator business model is still under debate. In most cases, the cost of investing in the infrastructure to manage and aggregate loads over several consumer sites remains higher than the potential revenue. While load management has great technical

potential in Europe, and particularly in France (where a large part of peak power demand is due to flexible loads) its economic potential is yet to be demonstrated.

Therefore it seems logical to evaluate the business case of a load management aggregator.

Research questions

“What is the business case for load management in an energy-only market ?”

How should load management be remunerated in energy markets? This question refers to the technical potential available in a given market, which is modified by several other factors. How much load management is available for a given market? How competitive is load management compared to existing production technologies? What are the levels of peak demand? How will the penetration of intermittent and non-dispatchable energy sources affect the market valuation of load management?

Here we will present a case study of the French electricity system, which combines good technical potential for load management, an ambitious renewables integration policy, and, according to RTE, a potential structural supply problem for meeting peak demand in the coming years.

Tools

“Modeling of a wholesale energy market incorporating load management as a system resource.”

Introduction

The model consists of minimizing the operational cost of the production base (of a given electricity mix) to meet demand. Conventional thermal plants

and storage technologies are available to meet this demand. Optimization returns, at each time step, the quantity of power delivered by thermal plants and available storage technologies: hydro-storage with a simple reservoir, and pumped storage in an ETPS (Energy Transfer Pumping Station) model.

Modeling uncertainty of demand

In an ideal world, storage management is simple. From the perspective of optimization it is easy to calculate the optimal strategy to minimize the objective function (here, the total operating cost of the system). The deterministic version of such a model can function as a benchmark for calculating an upper bound for storage valuation, which will be higher than realistic values.

For a more realistic approach, we will also model uncertainty in demand levels. In an uncertain environment the storage management strategy is non-trivial. Given a finite amount of storage capacity and uncertain future demand, should we release and/or pump the water from the reservoir now or later on ?

The stochastic version of the model also assigns an opportunity cost to storage technologies, which reduces their value as compared to their representation in the deterministic model.

Details of load management modeling

Load management is modeled as ETPS (Energy Transfer Pumping Stations) and turbine-only hydraulic reservoir stations. Industrial, commercial, and residential sectors are represented. Within the industrial sector we distinguish metallurgy, aluminum, paper, cement, chemicals, and other expenses (costs not required for industrial production).

If the sector has a potential for load-shifting, it is modeled as an ETPS. If it

has potential for load-shedding, it is modeled as a reservoir.

Variable costs of turbine-only stations are assigned. They differ depending on the sector and represent the utility loss to the consumer as a delay or a reduction in demand. In the case of load-shifting the variable cost is low, whereas for load-shedding it is high. The actual cost values are derived from the literature and the experience of industry experts.

The reservoir size of a load management asset is directly related to its technical potential power, the duration of a load management event, and the maximum number of load management events specified by contract according to the following formula: Potential x Duration x Number of events = Reservoir size (in MWh).

Case Study

Our case study is conducted on the French system. The study period covers one year and the optimization is done in 52 time steps, one for each week. Demand is modeled as being deterministic within each week, but stochastically variable from one week to another.

Implementation and resolution of the model

The model is coded in GAMS. Exact solutions for the stochastic model cannot be computed in reasonable time. In order to find good solutions we will use the SDDP (stochastic dual dynamics programming) algorithm, often used to solve large scale optimization problems under uncertainty.

E. New Dynamics in the Electricity Sector: Consumption-Growth Nexus, Market Structure, and Renewable Power

Doctoral Student : Yuanjing Li
Supervisor : Anna Creti

Abstract

The objective of this thesis is to study new developments in electricity markets and their impacts in the electricity sector. It discusses critical issues from the perspectives of macroeconomics, structural configuration, and a transition to renewable energy sources. More precisely, three topics emerge: the nexus between electricity consumption and economic growth, the impact of vertical integration between power generators and retailers, and the market impact and integration issues of intermittent renewable generation. By studying these three topics, it provides answers to the key challenges of supply security, competitiveness and sustainable development in the energy sector. By giving new research directions in energy economics, it serves to inspire related policy debates.

Keywords

Electricity consumption, causality, vertical integration, forward contract, wind power, renewable integration, day-ahead market, intraday market.

F. Market Power in European Electricity Markets: The Case of French and German Wholesale Electricity Markets

Doctoral Student : Thao Pham
Supervisor : Sophie Méritet

Abstract

The last two centuries have witnessed an exceptional revolution in the organization of electric power markets worldwide. The industry's organization has changed from vertically integrated monopolies under regulation to unbundled structures that favor market mechanisms, known as the reform process in Europe. The shift to reliance on market prices (given the concentrated structures and the particular characteristics of the electricity industry) raises the possibility that some parties could influence market prices by exercising their market power. The issues of «market power» in a given industry have been abundantly explored in the literature of Industrial Organization since the late 1970s but theoretical and empirical studies of «market power in electricity markets» have only been developed recently. In this thesis, we attempt to carry out research on market power questions in deregulated wholesale electricity markets in Europe, including the methods of defining and measuring it. We carry out empirical studies in two of the biggest liberalized electricity markets in Europe: France (2009-2012 data) and Germany (2011 data), using econometric regressions and electricity simulation models as our main methods. The subject is particularly relevant in the context of energy transition in Europe (*Transition énergétique* in France and *Energiewende* in Germany).

Keywords

Market power, liberalization, wholesale electricity market, Europe, France, Germany.

II- Research Support

Research subject : « Determination of Maximum Electrical Interconnection Capacity as a Function of Variable Renewable Production »

William Meunier (15/09/2015 – 29/01/2016)
Supervisor : Jan-Horst Keppler

Introduction

Since 2010, the share of renewables in the German energy mix has been increasing. Renewable energy sources have two major characteristics: they are intermittent (subject to weather conditions) and cannot supply a constant amount of electricity, which makes them unpredictable.

Electricity interconnections between France and Germany have a limited capacity. Thus, there are times when we cannot transmit as much electricity as desired. This saturation of capacity has two consequences:

- First, this causes a divergence in prices on either side of the border,
- Second, this divergence causes a deadweight loss of social surplus.

Research context

The purpose of this research will be to determine which investments on interconnections capacity would be needed to offset the net loss. Therefore, we will develop methods for determining the investment price for electrical interconnections (and therefore the corresponding capacity) which will equalize the total surplus (from the consumers and producers of electricity).

This work will be based on the supply and demand curves from EPEX Spot. The

first objective will be to automate the hourly calculation of the total surplus from hourly aggregate curves. This will be applied to data from 2011 and 2014 for the Franco-German border in order to measure the impact of large-scale renewables development in Germany. Raw data from EPEX Spot is processed with statistical analysis software. Processed data will then be exported to Excel so that the model can be used and modified by a regular use of the Microsoft Office suite.

The second objective will be more specific research into investment costs on electricity interconnections that will refine the model and, time permitting, an analysis of the consequences of the development of interconnections on prices in neighboring countries.



PART 3 : CEEM SCIENTIFIC PRODUCTION

Scientific research on European electricity markets has been a central activity of the CEEM. The scientific production of 2015 shows that CEEM researchers continue to publish their work in leading international journals. Most of the working papers are available only in English.

I- Working papers

Hedging Strategies in Energy Markets: The Case of Electricity Retailers

Raphaël Homayoun Boroumand (Associate Professor, Department of Applied Economics, Paris School of Business), **Stéphane Goutte** (Université Paris 8 (LED), Researcher of the Chaire European Electricity markets), **Simon Porcher** (London School of Economics and Political Science) and **Thomas Porcher** (Économiste et professeur à Paris School of Business)

Keywords

Electricity; Risk; Retailer; Hedging; Portfolio; Intra-day; VaR; CVaR.
JEL classification: C02, L94, G11, G32.

As market intermediaries, electricity retailers buy electricity from the wholesale market or self generate for re(sale) on the retail market. Electricity retailers are uncertain about how much electricity their residential customers will use at any time of the day until they actually turn switches on. While demand uncertainty is a common feature of all commodity markets, retailers generally rely on storage to manage demand uncertainty. On electricity markets, retailers are exposed to joint quantity and price risk on an hourly basis given the physical singularity of electricity as a commodity. In the literature on electricity markets, few articles deals on intra-day hedging portfolios to manage joint price and quantity risk whereas electricity markets are hourly markets. The contributions of the article are twofold. First, we define through a VaR and CVaR model optimal portfolios for specific hours (3am, 6am, . . . ,12pm) based on electricity market data from 2001 to 2011 for the French market. We prove that the optimal hedging strategy differs depending on the cluster hour. Secondly, we demonstrate the significantly superior efficiency of intra-day hedging portfolios over daily (therefore weekly and yearly) portfolios. Over a decade (2001-2011), our results clearly show that the losses of an optimal daily portfolio are at least nine times higher than the losses of optimal intra-day portfolios.

Wind Up with Continuous Intraday Electricity Markets? The Integration of Large-Share Wind Power Generation in Denmark

Fatih Karanfil (Assistant Professor of Economics, Université Paris Ouest Nanterre la Défense) and **Yuanjing LI** (Doctorante, CEEM)

This paper suggests an innovative idea to examine the functionality of an electricity intraday market by testing causality among its fundamental components. As fluctuations of poorly predicted wind power generation are challenging the stability of the current electricity system, an intraday market design can play an important role in managing wind forecast errors. Using Danish and Nordic data, it investigates the main drivers of the price difference between the intraday and day-ahead markets, and causality between wind forecast errors and their counterparts. Our results show that the wind and conventional generation forecast errors significantly cause the intraday price to differ from the day-ahead price, and that the relative intraday price decreases with the unexpected amount of wind generation. Cross-border electricity exchanges are found to be important to handle wind forecast errors. Additionally, some zonal differences with respect to both causality and impulse responses are detected. This paper provides the first evidence on the persuasive functioning of the intraday market in the case of Denmark, whereby intermittent production deviations are effectively reduced, and wind forecast errors are jointly handled through the responses from demand, conventional generation, and intraday international electricity trade.

Keywords

Intraday market; Wind power; VAR; Causality; Impulse response function
JEL codes: C22; Q41; Q42.

Is the Depressive Effect of Renewables on Power Prices Contagious? A Cross Border Econometric Analysis

Sébastien Phan (Research assistant-Energy Policy Institute at Chicago, and CEEM research fellow) and **Fabien Roques** (Associate Professor, CGEMP Université Paris Dauphine, and CEEM Associate Researcher)

European power markets have become more integrated and the implementation of market coupling has reinforced the efficiency of cross-border trading. This paper investigates empirically the impact of renewables growth in Germany on German and French power price volatility. We find that renewables depress power prices on average and increase volatility not only domestically but also across borders. We also leverage market resiliency data to investigate the impact of increases in interconnection capacity. We find that power price volatility would decrease in France despite some contagion effects of volatility from German renewables production. Our findings have important policy implications as they demonstrate the need to coordinate cross-border support policies for renewables in order to mitigate the impact of volatility on power prices in coupled power markets.

Keywords

Electricity market, renewables, market coupling, GARCH

Impacts of Subsidized Renewable Electricity Generation on Spot Market Prices in Germany: Evidence from a Garch Model with Panel

Thao Pham (LEDa-CGEMP Université Paris-Dauphine) and **Killian Lemoine** (LEDa-DIAL Université Paris-Dauphine)

Electricity generated by renewable energy sources creates a downward pressure on wholesale prices through - the so-called “merit order effect”. This effect tends to lower average power prices and average market revenue that renewables producers should have received, making integration costs of renewables very high at large penetration rate. It is therefore crucial to determine the amplitude of this merit order effect particularly in the context of increasing burden of renewable support policies borne by final consumers. Using hourly data for the period 2009-2012 in German electricity wholesale market for GARCH model under panel data framework, we find that wind and solar power generation injected into German electricity network during this period induces a decrease of electricity spot prices and a slight increase of their volatility. The model-based results suggest that the merit-order effect created by renewable production ranges from 3.86 to 8.34 €/MWh which implies to the annual volume of consumers’ surplus from 1.89 to 3.92 billion euros. However this surplus has not been re-distributed equally among different types of electricity consumers.

Keywords

German electricity markets, intermittent generation, Feed-in tariff, Merit-order effect, GARCH, panel data.

Revisiting Short-Term Price and Volatility Dynamics in Day-Ahead Electricity Markets with Rising Wind Power

Yuanjing LI (Doctorante, CEEM)

This paper revisits the short-term price and volatility dynamics in day-ahead electricity markets in consideration of an increasing share of wind power, using an example of the Nord Pool day-ahead market and the Danish wind generation. To do so, a GARCH process is applied, and market coupling and the counterbalance effect of hydropower in the Scandinavian countries are additionally accounted for. As results, we found that wind generation weakly dampens spot prices with an elasticity of 0.008 and also reduces price volatility with an elasticity of 0.02 in the Nordic day-ahead market. The results shed lights on the importance of market coupling and interactions between wind power and hydropower in the Nordic system through cross-border exchanges, which play an essential role in price stabilization. Additionally, an EGARCH specification confirms an asymmetric influence of the price innovations, whereby negative shocks produce larger volatility in the Nordic spot market. While considering heavy tails in error distributions can improve model fits significantly, the EGARCH model outperforms the GARCH model on forecast evaluations.

Keywords

Wind power, day-ahead price, volatility, GARCH
JEL: C32, L94, L52.

The Need for Flexibility Markets : Adapting the Design of Electricity Markets to Renewable Energy Production

Dominique Finon (CEEM Scientific Advisor, and CIREN-CNRS)

Renewable energies – wind and photovoltaic – are expected to take a very important place in the production of certain European electrical systems. The variability of their contribution makes maintaining the system's physical balance a challenge beyond a certain production level. Aside from necessary technical improvements, the transformation of the system requires improving the operation of various energy markets (day ahead, intraday, reserve, and adjustment) both for the operation of the system and to facilitate investment in flexibility resources (flexible thermal sources, load management, and storage). However, current adjustment markets do not provide proper valuation of the scarcity of flexibility. The current definition of flexibility products are inappropriate for large scale supply from renewables. Additional problems include the lack of remuneration for certain flexibility services, the lack of markets, the difficulty of trading flexibility products between systems, and the lack of harmonization. Markets need to be improved to address these issues by expanding the range of flexibility services and creating demand by empowering the producers of renewable energy.

Guidelines for State Aid for Environmental Protection and Energy: 2014-2020

Guillaume Dezobry (Assistant Professor at Université d'Amiens, Lawyer at Paris bar, and CEEM Associate Researcher)

Adopted on 9 April 2014, published on 28 June 2014, and effective 1 July 2014, the new guidelines on state aid for environmental protection and energy for 2014-2020 are an important document for the energy sector in general and for the development of renewable energy in particular. These guidelines reflect the intention of the European Commission to amend and harmonize support mechanisms for renewable energy.

II- Peer-Reviewed Publications

ENERGY JOURNAL



The Impacts of Variable Renewable Production and Market Coupling on the Convergence of French and German Electricity Prices
Vol. 37, N° 3 (2016), pp. 343-359

Jan Horst Keppler (Scientific Director, CEEM, Université Paris-Dauphine), Sébastien Phan (Research assistant- Energy Policy Institute at Chicago, and CEEM research fellow) and Yannick Le Pen (Assistant Professor of Economics, Université Paris-Dauphine, and CEEM Associate Researcher)



Carbon Price Instead of Support Schemes: Wind Power Investments by the Electricity Market
Vol. 37, N° 4. (2016), pp. 109-140

Marie Petitet (CEEM Doctoral Student, RTE, Dominique Finon (Scientific Counsellor, CEEM, and CIRED-CNRS), and Tanguy Janssen (Markets Department Economist, RTE)

ENERGY ECONOMICS



An Analytical Approach to Activating Demand Elasticity with a Demand Response Mechanism
N°52 (2015), pp. 195–206

Cédric Clastres (Assistant professor at PACTE-EDDEN laboratory, Université Grenoble-Alpes, and CEEM Associate Researcher) and Haikel Khalfallah (Assistant professor at PACTE-EDDEN laboratory, Université Grenoble-Alpes)



Hedging Strategies in Energy Markets: The Case of Electricity Retailers
N° 51 (2015) 503–509, Septembre 2015

Raphaël Homayoun Boroumand (Associate Professor, Department of Applied Economics, Paris School of Business), Stéphane Goutte (Université Paris 8 (LED), Researcher of the CEEM), Simon Porcher (London School of Economics and Political Science) and Thomas Porcher (Economist and professor at Paris School of Business)

ELECTRICAL POWER AND ENERGY SYSTEMS



Assessing Long-Term Effects of Demand Response Policies in Wholesale Electricity Markets
N° 74 (2016) 142–152

Mauricio Cepeda (CEEM, Université Paris-Dauphine) and Marcelo Saguan (Microeconomix)



Le besoin de marchés de la flexibilité : l'adaptation du design des marchés électriques aux productions d'énergies renouvelables
N° 622, 11-12/2014

Dominique Finon (Scientific Advisor, CEEM, and CIRED-CNRS)



PART 4 : CEEM EVENTS

In 2015, the Chaire European Electricity Markets (CEEM) continued to organize both scientific conferences and public events addressing energy policy issues for a wide audience of experts and stakeholders.

I. Scientific Conferences

A. Conference on *Quelle évolution de la tarification des réseaux pour envoyer les bons signaux économiques ?*

Wednesday 28 January 2015, 16:00 - 19:00, Université Paris-Dauphine, Room Raymond Aron

Electricity networks will play a vital role in the energy transition process at the European, national, and local level. Congestion costs have risen sharply in several countries over recent years and network operators are making substantial investment plans to strengthen their networks.

One key issue in the energy transition is location signals, which are important for planning production and investment. There are two approaches for location signaling. The first relies on energy prices and differentiation by network zone or node. The second relies on a connection

tariff and/or a zone-differentiated producer network.

Discussions on location signaling are already underway at the French and European levels. This is visible through the revision of European market zones conducted by ACER and ENTSO-E. The Energy Regulation Commission (CRE) is also studying the implementation of location signaling, particularly through geographically differentiated access fees.

In this context, the objective of the conference was to identify areas of improvement and analyze French and European network pricing issues from the perspective of producers and network operators. The CRE attended the conference debate as an expert witness but did not comment on the proceedings.

Programme and presentations

<http://www.ceem-dauphine.org/agenda/fr/78b991c49a41fdb4cea212e9a5dcfe183339180>

B. Conference on National Energy Policies with Respect to Capacity Remuneration Mechanisms (CRM) in the Context of European Targets

*Monday 9 March 2015, 14h00 - 18h40,
Université Paris-Dauphine, Room
Raymond Aron*

A half-day conference organized by the BENELUX and the French Association des Économistes de l'Énergie (AEE) in cooperation with the Chaire European Electricity Markets (CEEM) of the Université Paris-Dauphine.

Conference objective

The European power sector is facing challenging times. In particular, stagnant demand and renewable energy sources developments have created a situation of oversupply situation which affects the economics of thermal power plants and is causing the closure or mothballing of some of them. This situation is causing a risk to the security of supply of the

electricity system because these thermal assets are necessary to counterbalance RES intermittency. The aim of this conference is to analyze this issue by zooming in on one of the solutions that is put forward by some: a capacity remuneration mechanisms.

This conference was chaired by Thomas Huerre (F-AEE), François Boisseleau (B-AEE) and Jan Horst Keppler (CEEM).

Programme and presentations

<http://www.ceem-dauphine.org/agenda/fr/f341cef95751294c6b027af9cfabc830b4ac0c5f>

C. Seminar on Lessons to the European Power Sector from the USA

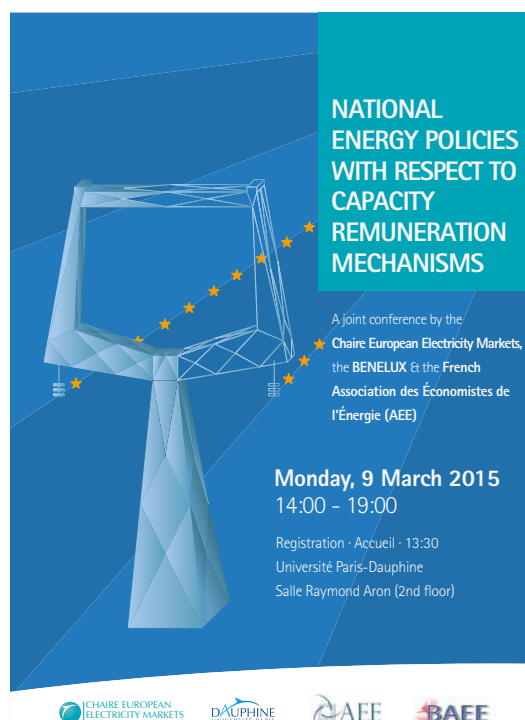
Thursday 26 March 2015, from 17:00 to 19:30, Université Paris-Dauphine, Room A 709 (New wing)

Conference objective

Electricity markets in both Europe and the United States are experiencing great challenges and opportunities. The challenges are due to the variability of variable renewables such as wind and solar PV which complicate ensuring the balance of demand and supply at all times. The opportunities are mainly due to the greatly improved capabilities for demand side management (DSM). Compared to Europe, the United States have a broader range of regulatory regimes that are experimenting with different solutions.

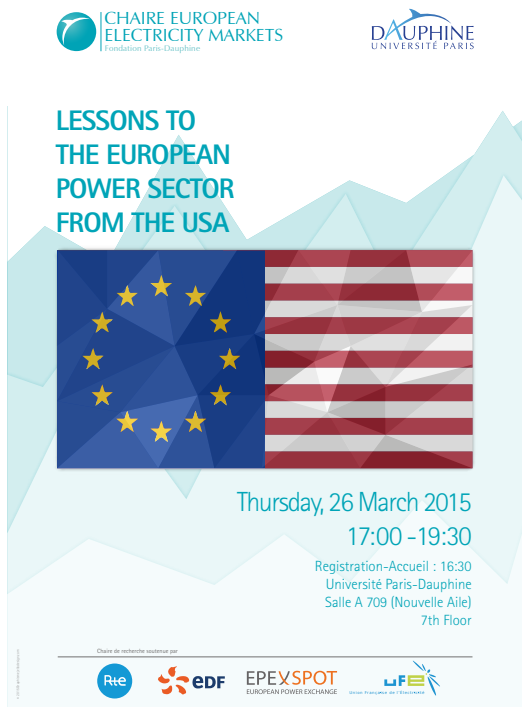
In this conference, Graham Weale presented the latest US developments to see whether they contain any lessons for European electricity markets.

John E. Parsons (Professor of Finance, MIT and FERC Visiting Scholar) made a presentation on *US Electricity Markets: What's New?*



Programme and presentations

<http://www.ceem-dauphine.org/agenda/fr/9a280ae527b3854e914d55f4a6d1cbfa3574cdc6>



D. Conference on the report for François Hollande, entitled *Énergie, l'Europe en réseaux : perspectives de coopérations dans les réseaux énergétiques européens*

Monday 4 May 2015, 17:30 - 19:30, Université Paris-Dauphine, Room Raymond Aron

Networking European Energy

A report commissioned by French President François Hollande on European energy networks was presented at Université Paris-Dauphine on 4 May 2015. This work, led by Michel Derdevet with the assistance of Dauphine

researchers, makes recommendations on cooperation between electricity networks, which will be key to the European energy transition.

The Chaire European Electricity Markets (CEEM) and the CGEMP invited Michel Derdevet, Secretary General of ErDF, to examine the conclusions resulting from a European tour consisting of 80 hearings. According to the mission statement issued by François Hollande regarding the energy transition, networks are the “vectors of two major developments. They will ensure both the necessary interconnections in Europe, particularly in the context of renewable energy development, and contribute to necessary improvements in energy efficiency through smart grids.”

The twelve proposals of the report are intended to bring about a coherent and pragmatic European approach to networks structured around three main lines:

- Restoring security of supply and cooperation between network operators as well as in the local communities leading the energy transition;
- Reinforcing the coordination of regulatory and financial incentives to optimize infrastructure costs while also investing in the territory traversed by this strategic infrastructure;
- Promoting Europe as a leader in energy innovation, giving new impetus and dimension to its R&D through standardization, the creation of an energy data platform, the development of wireless charging highways for electric vehicles, and the foundation of a European Energy Association.

While large supply growth will be positive in a broad sense for producers and consumers, it will have a significant impact on distribution which will require compensation mechanisms between losers and winners. The innovative

nature of this process will also require a European approach to supply security, which has yet to be developed.



Report, programme and presentation

<http://www.ceem-dauphine.org/agenda/fr/8eee2f8445e01bbaefabbde1a91c8a583324fda1>

E. Workshop on Renewables and Electricity Prices: Modeling Approaches

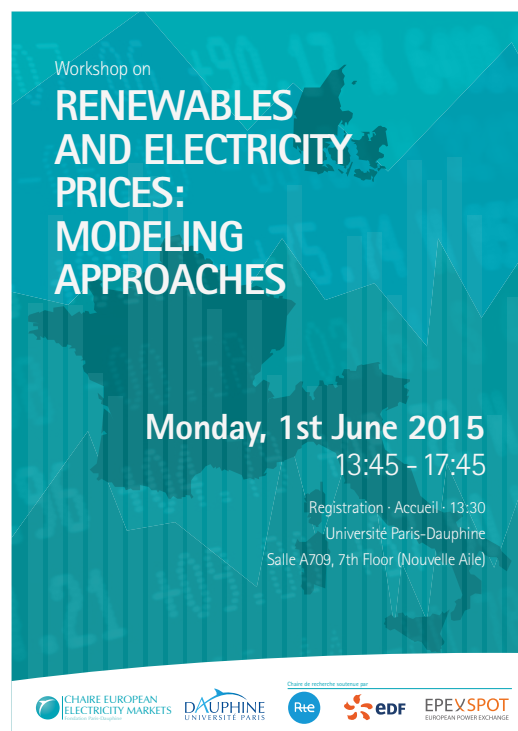
Monday 1st June 2015, from 13h45 to 17h45, Université Paris-Dauphine, Room A 709, New wing

Workshop Objective

This workshop was devoted to the presentation of different case studies (Italy, France, and Denmark) and different methodologies to assess the latest trends in electricity pricing and impact of intermittent electricity sources on day-ahead markets.

Speakers mainly from CEEM Axis 1 researchers presented the work actually carried out at CEEM on these topics:

- Renewables and Electricity Intra-day Pricing in Denmark
- Trading the 15 minutes products – theory and experience
- Renewables, Zonal Pricing and Congestion Costs in Italy
- Impact of Wind Production Profiles on Electricity Prices in 2030



Programme and presentations

<http://www.ceem-dauphine.org/agenda/fr/cd752583fcdc1f460f6f30e878cf-fa9e56f6ca6b>

F. Conference on Elements of a New Target Model for European Electricity Markets: Towards a Sustainable Division of Labour between Regulation and Market Coordination

Wednesday 08 July 2015 and Thursday 09 July 2015, Université Paris-Dauphine, Room Raymond Aron (2nd Floor)



The CEEM and its partners RTE, EDF, and EPEX Spot organized the international conference “Elements of a new target model for European electricity markets: towards a sustainable division of labor between market regulation and coordination” on 8-9 July 2015. This event was held in the Room Raymond Aron at Université Paris-Dauphine and was attended by over 120 participants.

Several papers were presented over five sessions. They were selected on the basis of clearly defined criteria established by a selection committee composed of Jan Horst Keppler (Scientific Director – CEEM,

Université Paris-Dauphine), Dominique Finon (Scientific Advisor – CEEM, CIRED-CNRS), Fabien Roques (Partner – Compass Lexecon, CEEM), and Manuel Baritaud (Senior Energy Analyst – IEA).

In addition to general observations on trends and problems of electricity markets, visiting scholars and scientists debated topics related to “Renewables Investment and Support, Value of Renewables, Capacity Markets, Nodal Pricing, and Thermal Plant Flexibility and Retail.” The conference ended with a conclusive roundtable discussion.

The full summary of the conference, program, and presentations are available on the CEEM website at the following address:

<http://www.ceem-dauphine.org/agenda/fr/c289c388e4079c7755735d52346d5daf0d11dec>

For more details, please see the Appendix.

G. Conference on Effets sur l'emploi des choix dans le secteur électrique: Smart Grids et transition énergétique

Monday 26 October 2015, 14:00 - 18:15, Université Paris-Dauphine, Room Raymond Aron (2nd floor)

The development of electrical and energy systems are at the center of public debate in France, Europe, and across the world, as evidenced by the intensity of the legal debate and negotiation at COP 21.

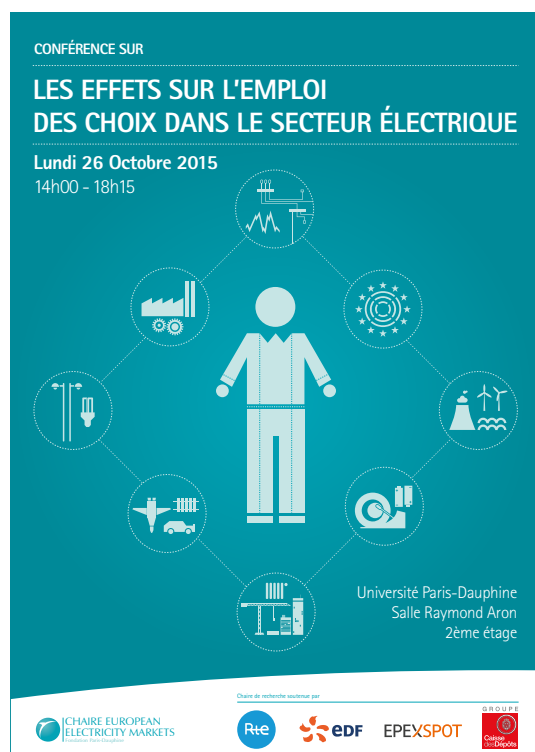
The electrical system is classified by the government as a major front for the energy transition through the increased use of electricity and the decarbonisation of electricity production. This brings many new challenges to the electrical system, including the variability of renewables production and changes in production

location. Innovation is at the heart of ambitious public policies designed to address these challenges. The solutions, generally termed smart grids, consist of many techniques including demand flexibility, electricity storage, and computerization of electricity transport and distribution networks.

Public support for these specific solutions, and the renewable energy sector in general, has consequences on economic growth and employment. The domestic employment effects of the energy transition are a major concern for policymakers.

initiative was based on the publication of a report on the socio-economic evaluation of smart grids which included a section on employment effects.

This conference had two main objectives : to compare the perspectives on the work presented, and to determine the current state of knowledge and discuss possible methodologies and their scope of activity. The discussions of this conference are intended to provide a basis for future work on understanding the effect of electricity sector development choices on employment, particularly for policymakers.



The analysis of the effect of electricity sector developments on employment is a difficult task which has just begun. In this context, the CEEM and its partners organized an international conference where several French organizations and European guests could discuss this subject. Several analyses were presented to accompany debates on the energy transition in different countries. This

Programme and presentations

<http://www.ceem-dauphine.org/agenda/fr/9f83342aa8ac60b6903247795407e9a93fa820bf>

II- Internal Research Seminars

As part of its activities, the Chaire European Electricity Markets (CEEM) holds two to four open research seminars per year. These seminars were initially devoted exclusively to the work of doctoral students and researchers of the Chaire, as well as work presented by qualified external scholars working on the same subject. They have concerned electricity market econometrics, simulation models of markets by the System Dynamics approach, the value of storage, etc. In 2014 the seminar series has evolved towards an opening to external participants and a broadening of the audience through targeted invitations. The vocation of these seminars was extended to highly specialized issues requiring the use of complex and formalized methods: market econometrics for short-term forecasting, cross-border participation of foreign

capacities in capacity mechanisms, efficiency of zonal transmission pricing, etc. These issues are part of the Chaire's research program and they are defined in relation to the interests of Chaire partners for these particular issues. The presentations are then accessible for all the invited attendees. These seminars are coordinated by the Scientific Advisor of the CEEM, Dominique Finon.

This year, two seminars were held, the first in May 2015 on the plant-level modeling of power markets; and the second in December 2015 on the determinants of prices on intraday markets and the opportunities to improve their effectiveness at increasing utility resulting in the development of variable intake RES. The key points of the presentations and discussion are summarized below.

A. 6th seminar: Plant Level Modeling of the Power Market: between Long and Short Term Planning

Tuesday 19 May 2015, from 16:00 to 18:00, Université Paris-Dauphine, Room P 301, 3rd Floor

Erik Delarue, Energy Institute, KU Leuven
Integrating Short-Term Operational Behavior in Long-Term Planning Models for the Electricity Sector

Marko Aunedi, Department of Electrical Engineering, Imperial College, London
Whole-Systems Assessment of the Value of Energy Storage in Low-Carbon Electricity Systems

Current electricity systems are exposed to increased variability and intermittency because of the rapid development of renewable energies. This issue is translated to the electricity market as an amplified need for flexibility on the supply side. Operational models use detailed representation

of the power system (mixed integer programming formulations) to solve the optimal dispatch of available power units and with this, define the cycling schedules for the next hours according to their technical limitations (short term planning). Meanwhile, capacity planning models use an aggregated representation of the power system to capture the capacity adequacy issues (long term planning) and assess the economics of new generation technologies.

Therefore, facilitating the integration of renewable energies means assuring that enough capacity and flexibility are both available on every instant. Consequently, a MIP formulation of the unit commitment problem (UCP) allows to comprehensively evaluating the market potential of flexibility sources, such as electricity storage and demand-response.

B. 7th seminar: The Issue of Intraday Market Design Confronted to the Development of Variable RES Generation Production

Tuesday 8 December 2015, from 14h30 to 16h30, Université Paris-Dauphine, Room A 709 (New Wing), 7th Floor

Christian Pape (Assistant Professor, Duisburg University)
Are Fundamentals Enough? Explaining Price Variations in the German Day-Ahead and Intraday Power Market

European electricity market participants are encouraged to balance intraday deviations from their day-ahead schedules via trades in the intraday market. Together with the increasing production of variable renewable energy sources, the intraday market is gaining importance. The fundamental equilibria between every hour's supply stack and aggregated demand in 2012 and 2013 are modeled to yield hourly price estimates.

The major benefits of a fundamental modeling approach are the ability to account for non-linearities in the supply stack and the ability to combine time-varying information consistently. The empirical results show that fundamental modeling explains a considerable share of spot price variance. However, differences between the fundamental and actual prices persist and are explored using regression models. The main differences can be attributed to (avoided) start up-costs, market states and trading behavior.

(Paper co-authored with Simon Hagemann and Christoph Weber, Professor).

Stéphane Goutte (Assistant Professor-Université Paris-8 and Chaire EEM) and Philippe Vassilopoulos (Head of Product Design, EPEX SPOT)

Intraday Options: a Design Feature Addressing Capacity Flexibility

Several choices of modelling analysis of efficiency of the intraday option for flexibility services are envisaged. They will be presented in relation to the feasibility of each. The design of the intraday option that is chosen is then presented with its parameters, how they act on its valuation and what its possibilities have flexibilities in terms of capacity. Modeling perspectives will be presented in conclusion.

(Paper co-authored with Anna Creti (Professor, Université Paris-Dauphine and Chaire EEM).

III- Paris-Sciences-Lettres Research Seminars on the Economics of Energy

The Paris-Sciences-Lettres (PSL) Research Seminars on the Economics of Energy are jointly organized by the CERN (MINES PARIS TECH), the CGEMP (Université Paris-Dauphine), the Chaire European Electricity Markets (Université Paris-Dauphine), and i3 (Institute for Interdisciplinary Innovation), all members of PSL. They are animated by François Lévêque (MINES PARIS-TECH), Dominique Finon (CEEM,

and CNRS-CIRED) and since September 2015, Patrice Geoffron (CGEMP-LEDA, Université Paris-Dauphine). The goal of these seminars is to present work on several issues in energy economics research: competition in the electricity and gas markets, long-term contracts and the role of short-term markets, econometrics of different energy markets (electricity, gas, oil) and their relation with growth, the effectiveness of energy efficiency and promoting renewable policies, the prospective analysis of long-term policies, etc. One part of these seminars focuses on issues more specific to electricity markets (see table for the 2015 series of seminars).

TABLE. THEMATIC LIST OF THE PARIS-SCIENCES-LETTRES RESEARCH SEMINARS ON THE ECONOMICS OF ENERGY- 2015

SEMINARS	DATE	PARTICIPANTS
ELECTRICITY SECTOR		
Large Scale Development of Variable Renewables in Electricity Markets: Static and Dynamic Effects on the System	10 February 2015	92
L'économie de l'effacement dans les marchés électriques	11 March 2015	118
L'économie de la transition énergétique dans le secteur électrique	06 May 2015	83
L'irruption des renouvelables intermittentes dans les mix électriques : entre marché et politiques	16 December 2015	
NON - ELECTRICITY SECTOR		
La politique énergétique de l'Union Européenne en débat	12 January 2015	117
L'efficacité des actions de maîtrise de l'énergie	15 April 2015	78
The Relationship between Oil Price and Macroeconomy	10 June 2015	61
L'efficacité économique du développement des gaz de schiste	7 October 2015	101
Les modes de recyclage d'une taxe climat-énergie : entre efficacité et équité	18 November 2015	64

The PSL Research Seminars on the Economics of Energy seek to make the classical issues of energy economics (neglected in recent years in favor of climate policy and energy transition issues) more visible to the academic community and among energy experts. Therefore, any of these seminars address the major economic changes in the electricity markets stemming from the introduction of large-scale renewable energy with variable production.

Two papers are presented at each session, one from a senior researcher, and one from a junior researcher. The seminars' intended audience is academic researchers as well as professional economists (energy companies, consultants) and officials from administrations.

A. 18th session : La politique énergétique de l'Union européenne en débat

Monday 12 January 2015, 16h30 - 18h30, École Mines Paris Tech

At this meeting **Jean-Michel Glachant** (Professor at l'Institut Universitaire Européen and Director of the Florence School of Regulation) presented his paper entitled « A new energy policy for the new European Commission? ». **Dominique Finon** (Scientific Advisor, CEEM and CIRED-CNRS), co-author of the article « The European market and climate and energy policies, two irreconcilable goals » (Revue de l'Énergie n° 620 – August 2014, with **Fabienne Salaün**) was a panel member at these presentations.

The seminar focused on the re-evaluation of the pillars of energy policy established by the previous Commission. Partial revisions or fundamental reforms are now necessary. What key components must change in order to meet European energy policy goals for 2020-2030.

The seminar identified five main issues:

- The internal electricity market : Is there a European remedy for the European crisis?
- The internal gas market : Why is the last mile so long?
- 28 different national policies for achieving 20-20-20 by 2030 : Where will this lead the EU?
- A new governance for energy policy : Is there an appropriate framework for a new European energy policy?
- A minimal policy for energy security and energy diplomacy : Unification or division of energy?

B. 19th session : Large Scale Development of Variable Renewables in Electricity Markets: Static and Dynamic Effects on the System

Tuesday 10 February 2015, 16h30 - 18h30, Université Paris-Dauphine

The program of this seminar consists of two presentations exploring the opportunities of large scale variable renewables development and their cost relative to a counterfactual scenario without renewable development, and the economic value of RES production units. The presentations made by the various speakers are summarized below and fully published on the CEEM Website.

Marco Cometto, Senior Analyst, OECD-AEN

System Costs of Large Scale Development of Variable Renewables Generation: Building an Assessment Methodology

This presentation focused on the methodology adopted by the OECD Nuclear Energy Agency for estimating

the effects of the introduction of large share of variable renewables in the electricity system. We discuss an approach for estimating the economic value and the optimal penetration level of renewables in a generation system.

(From the 2013 OECD-Nuclear Energy Agency report *Nuclear Energy and Renewables: System Effects in Low-carbon Electricity Systems* co-authored by **Marco Cometto** and **Jan-Horst Keppler**).

Jonas Egerer, Research fellow at the DIW (Berlin)
Power System Transformation toward Renewables: the Modelling of Investment Scenarios for Germany

The exogenous introduction of variable renewables at large scale in an electricity system upsets short term and long term optimization parameters of the system. We analyze distinctive investment scenarios for the integration of fluctuating renewables in the German power system. Using a combined model for dispatch, transmission, and investment, three different investment options are considered, including gas-fired power plants, pumped hydro storage, and transmission lines. We find that geographically optimized power plant investments dominate in the reference scenarios for 2024 and 2034. In scenarios with decreased renewable curtailment, storage and transmission requirements significantly increase. In an alternative scenario with larger investments into storage, system costs are only slightly higher compared to the reference; thus, considering potential system values of pumped hydro storage facilities, a moderate expansion of storage capacities appears to be a no-regret strategy from a system perspective. In the long run, infrastructure investments gain importance in the context of an ongoing energy transition from coal to renewables. Because of long lead times, planning and administrative procedures

for large-scale projects should start early.

(Paper written with **Wolf-Peter Schill** and published in 2014 in *Economics of Energy and Environmental Policy*, Volume 3, Number 2).

C. 20th session : L'économie de l'effacement dans les marchés électriques

Wednesday 11 March 2015, 16:30 - 18:45,
École Mines Paris Tech

This seminar consists of two presentations. The first was from **Thomas-Olivier Léautier** (Toulouse School of Economics) on the economic value of load management and the lack of an economic means to subsidize it. The second was from **Cédric Clastres** (EDDEN-PACTE, Université de Grenoble) on scenarios in which the activation of consumer demand could be of social benefit during the interaction between two interacting electricity systems.

Thomas-Olivier Léautier (Toulouse School of Economics) spoke on the topic « L'effacement de la « prime à l'effacement » ».

This presentation discussed a new and important issue for the electrical industry : making electricity demand responsive to the market price, which is a scarcity signal. From this perspective, government involvement should be limited to the establishment of the institutional framework for efficient technical solutions. This implies not subsidizing certain sectors at the expense of taxpayers and consumers, such as the runaway subsidies seen for some renewable energy sources. Increasing the share of renewable energies in the electricity mix to reduce CO2 emissions is another important issue. European governments have sought to achieve this by distributing poorly calculated subsidies. This

resulted in a massive increase in electricity prices as well as an increase in CO₂ emissions per MWh produced in Europe for the benefit of just a few wind turbine developers.

The presentation of this paper is available on the CEEM website.

Cédric Clastres (EDDEN-PACTE, Université Grenoble) presented *An Analytical Approach for Demand Activation with Demand Response Mechanisms*.

The aim of this paper is to analytically demonstrate the circumstances under which activating consumer elasticity of demand could increase social welfare. It builds on existing literature for studying the use of price signals in eliciting demand response through an analytical approach. Here, we develop an analytical Nash model to quantify the effect of implementing demand response via price signals on social welfare and energy exchanges.

Prior results show that the trade-off between local production and export of energy depends on the opportunity cost of energy and the global efficiency of the power generation technology. The novelty of this research is the identification of an optimal region for price signaling in which demand response leads to an increase in social welfare. This optimality region is negatively correlated with the degree of competitiveness of the power generation technologies and with the market size of the system. We also show that when we consider the impact only in terms of consumers' surplus, more aggressive demand-response (DR) can be adopted. However the intensity of the DR program is negatively correlated with elasticity of demand.

(Co-authored with **Haikel Khalfallah**).

The corresponding presentation is available in English on the CEEM website.

D. 21st session : L'efficience des actions de maîtrise de l'énergie

Wednesday 15 April 2015, 16:30 - 18:30, Université Paris-Dauphine

This seminar consists of two presentations. The first analyzes the effects of vehicle labeling and the bonus-malus system from 2003 to 2008. The second analyzes the moral hazard associated with upgrading housing insulation and methods for reducing it.

The content of this seminar is available in English only. The general nature of key questions and the corresponding response from the speakers are summarized below. The texts of these presentations are available in full on the CEEM Website.

Isis Durrmeyer, CREST

Disentangling Sources of Vehicle Emissions Reduction in France: Analysis of the Effects of Energy Labels and Feebate on 2003-2008

In this paper, we investigate whether French consumers have modified their preferences towards environmentally-friendly vehicles between 2003 and 2008 with the obligation of indicating energy labels by the end of 2005 and then the label based on CO₂ emissions of new vehicles in 2008. Our results show that there has been a shift in preferences towards low-emitting cars. We also stress a large heterogeneity in the evolution of preferences between consumers. Our results suggest that such policies have been efficient tools to shift consumers' utility towards environmentally-friendly goods, the shift in preferences accounting for 20% of the overall decrease in average CO₂ emissions of new cars on the period.

(Working Paper CREST submitted, co-authored with **Xavier D'Haultfoeuille** - CREST, and **Philippe Février** - CREST)

Louis-Gaëtan Giraudet, ENPC & CIRED
Double Moral Hazard and the Energy Efficiency Gap in the Home Energy Retrofit Market

We investigate how moral hazard problems can cause sub-optimal investment in energy efficiency, a phenomenon known as the energy efficiency gap. We focus on contexts where both the seller and the buyer of an energy savings technology can take hidden actions. As a result, neither energy efficiency nor energy savings are contractible. We formalize the double moral hazard problem and discuss how it can help rationalize the energy efficiency gap. We then compare two policy instruments: minimum quality standards and energy-savings insurance. Using a stylized model of the U.S. retrofit industry, we found that for a large range of market environments, a minimum standard tends to outperform an energy-savings insurance. We also show that the welfare gains from undoing the double moral hazard are substantially larger than those from internalizing carbon dioxide externalities associated with underlying energy use.

(Working Paper Haas Institute of Berkeley University co-authored with **Sebastien Houde**, University of Maryland).

E. 22nd session : L'économie de la transition énergétique dans le secteur électrique

Wednesday 06 May 2015, 16:30 - 18:30,
École Mines Paris Tech

This seminar consisted of two presentations:

Christian von Hirschhausen, (Professor of Economics – TU Berlin University of Technology)

Germany on its Way to Paris COP21 – Recent Developments and Future Strategy of Decarbonizing the German Electricity Sector.

Marc Bussieras (Director of the Economics Center, Strategic and Prospective Management, EDF)

Comparison of two contrasted energy transition policies in the EU: the British case vs the German case

These presentations are available on the CEEM website.

F. 23rd session : The Relationship between Oil Price and Macroeconomy

Wednesday 10 June 2015, 16:00 - 18:30,
Université Paris-Dauphine

This seminar consisted of two presentations. The first was by **Claudio Morana** (Professor, Bicocca University of Milano and **Eni Enrico Mattei** Foundation) focused on the relationship between oil prices and macroeconomic stability, with a particular emphasis on the role of the variability of oil prices. The second presentation, by **Veronica Acurio Vasconez** (doctoral researcher at the Sorbonne Economics Center, CES) on the effect of oil price shocks in a Keynesian growth model.

The programme of this seminar is available in English only. The full presentations made by the various speakers are summarized below and published on the CEEM Website.

Claudio Morana, Professor, Bicocca University of Milano and Fondation Eni Enrico Mattei
The Oil Price-Macroeconomy Relationship since the Mid-1980s: A Global Perspective

In this presentation the oil price-macroeconomic relationship is investigated from a global perspective, by means of a large scale macro-financial-econometric model. In addition to real activity, fiscal and monetary policy responses and labor and financial markets are considered as well. We find that oil market shocks would have contributed to slowing down economic growth since the first Persian Gulf War episode. Among oil market shocks, supply side disturbances were the largest contributor to macro-financial fluctuations, accounting for up to 12% of real activity variance. The latter shocks would have exercised recessionary effects during the first and

second Persian Gulf War and 2008 oil price episodes; preferences, speculative and volatility shocks contribute also to exacerbate the recessionary episodes. As long as oil supply will keep expanding at a lower pace than required by demand conditions, a recessionary bias, determined by higher and more uncertain real oil prices, may then be expected to persist also in the near future.

Paper published in *The Energy Journal* (2013), Vol.34, n°3.

Veronica Acurio Vasconez, Doctoral researcher, Centre d'Économie de la Sorbonne (CES)
The Effects of Oil Price Shocks in a Neo-Keynesian Framework with Capital Accumulation

The economic implications of oil price shocks have been extensively studied since the 1970s'. But no dynamic stochastic general equilibrium model was available that captures two well-known stylized facts: 1) the stagflationary impact of an oil price shock, and 2) the influence of the energy productivity of capital on the depth and length of this impact. We build, estimate and simulate a neo-keynesian model with capital accumulation, which takes the case of an economy where oil is imported from abroad, and where these stylized facts can be accounted for. Moreover, the Bayesian estimation of the model on the US economy (1984-2007) suggests that the output elasticity of oil might have been above 10%, stressing the role of oil use in US growth at this time. Finally, our simulations confirm that an increase in energy efficiency significantly attenuates the effects of an oil shock —a possible explanation of why the third oil shock (1999-2008) did not have the same macro-economic impact as the first two ones.

Published in the CES Working Paper 2014.99, co-authored with **Gaël Giraud**, and **Florent Mc Isaac**.

G. 24th session : L'efficacité économique du développement des gaz de schiste

Wednesday 7 October 2015, 16:30 - 18:30,
École Mines Paris Tech

The proceedings of the seminar are summarised below. The seminar was conducted entirely in English.

Katheline Schubert, Professor at Université Paris 1, Paris School of Economics
Should we Extract the European Shale Gas? The Effect of Climate and Financial Constraints

This presentation was made in English. It is summarised below and available for download on the CEEM Website.

In the context of the deep contrast between the shale gas boom in the United States and the recent ban by France of shale gas exploration, this paper explores whether climate policy justifies developing more shale gas, taking into account environmental damages, both local and global, and addresses the question of a potential arbitrage between shale gas development and the transition to clean energy. We construct a Hotelling-like model where electricity may be produced by three perfectly substitutable sources: an abundant dirty resource (coal), a non-renewable less polluting resource (shale gas), and an abundant clean resource (solar). The resources differ by their carbon contents and their unit costs. Fixed costs must be paid for shale gas exploration, and before solar production begins. Climate policy takes the form of a ceiling on atmospheric carbon concentration. We show that at the optimum tightening climate policy always leads to bringing forward the transition to clean energy. To address the question of the arbitrage between shale gas development and the transition to clean energy, we assume that the social planner has to comply with the climate constraint without increasing energy expenditures. We show that when the price elasticity of electricity demand

is low, a binding financial constraint leads to an overinvestment in shale gas and postpones the switch to the clean backstop. We calibrate the model for Europe and determine whether shale gas should be extracted, depending on the magnitude of the local damages.

The corresponding Working Paper PSE n°2015-50 (co-authored with **Fanny Henriet**, PSE) is available on the Website of Paris School of Economics.

Aurélien Saussay, Economist at the OFCE
Can the US Shale Gas Revolution Be Duplicated in Europe?

The possible existence of large shale deposits in Europe has fostered speculation on whether the US shale revolution, and its accompanying macroeconomic impacts, could be duplicated in Europe. However, a number of uncertainties, notably geological, technological and regulatory, make this possibility unclear. We present a techno-economic model to analyze the main determinants of the profitability of shale wells and plays. We calibrate our model using production data from the leading American shale players. We estimate three shale gas production scenarios exploring different sets of geological and technical hypotheses for the largest potential holder of shale gas deposits in Europe, France. Even considering that the geology of the potential French shale deposits is favorable to commercial extraction, we find that under assumptions calibrated on U.S. production data, natural gas could be produced at a high breakeven price, but over a 45 years' timeframe would have a net present value of around 1% of 2012 French GDP. However, the specificities of the European context could increase drilling costs and further decrease this low profitability. In absence of extreme well productivity, it appears very difficult for shale gas extraction to have an impact on European energy markets comparable to the US one.

This presentation is available for downloading on the CEEM Website. The corresponding Working paper, OFCE n° 2015-10, Avril 2015, is available on the Website of Paris School of Economics.

H. 25th session : Les modes de recyclage d'une taxe climat-énergie : entre efficacité et équité

Wednesday 18 November 2015, 16:30 - 18:30, Université Paris-Dauphine

A summary of each presentation is given below.

Frédéric Gonand, Associate professor, Université Paris-Dauphine
Fostering Renewables and Recycling a Carbon Tax: Joint Aggregate and Intergenerational Redistributive Effects

The paper assesses and compares the difference of effects on growth and intertemporal welfare of carbon tax and renewables promotion policies. It relies on a computable general equilibrium model with overlapping generations. The main result is that an increasing share of renewables in the energy mix and a fully recycled carbon tax have opposite (though limited) impacts on activity and individuals' intertemporal welfare in the long run. The recycling of a carbon tax fosters consumption and labour supply, and thus growth and welfare, whereas an increasing share of renewables does not. Results also suggest that a higher share of renewables and a recycled carbon tax trigger intergenerational redistributive effects, with the former being relatively detrimental for young generations and the latter being pro-youth. The policy implication is that a social planner could usefully contemplate the joint implementation of higher quantitative targets for the future development of renewables and a carbon tax fully recycled through lower proportional taxes. (Working Paper Chaire Climate (CEC) n° 2014-08).

The text of this presentation is available in English and is published on the CEEM website.

Emmanuel Combet, Post-doctoral researcher, International Center for Research on Environment and Development
La fiscalité carbone-énergie au risque des enjeux d'équité

This presentations aims to show how the negative social impact of a carbon tax is related to the specific use made of the tax revenue. First we will emphasize the gap between the short-term perceived impact and the long-term real impact. The real effects of a carbon tax on poverty and inequality are not only determined by its initial burden on the budget, nor only limited to the extent of demand reduction by affected households. The impact also depends on how the carbon tax revenue is used and the macroeconomic effects of these policies.

Using a hybrid general equilibrium model with revenue-based discrimination of consumer groups we evaluate the long-term performance of several carbon tax revenue redistribution schemes based on their macroeconomic effects (growth and employment) and specific redistributions. Here we compare five redistribution types (national debt repayment, tax reductions, partial or total guaranteed basic income , and generalized tax credits) and their results in order to define basic mechanisms for future policy formulation.

(Article published in Revue Française d'Économie vol.25, n°2, co-authored with **F. Gherzi** and **J.-C. Hourcade**).

The outline of this presentation is available on the CEEM website.

I. 26th session : L'irruption des renouvelables intermittentes dans les mix électriques : entre marché et politiques

Wednesday 16 December 2015, 16:30 - 18:30, École Mines Paris Tech

The content of this seminar is available in English only. The presentations made by the various speakers are summarized below and published on the CEEM Website.

Stefan Ambec, Research Director at INRA, Research scientist at IDEI Toulouse

Decarbonizing Electricity Generation with Intermittent Sources of Energy

We examine the impact of public policies that aim to decarbonate electricity production by substituting fossil fuel energy with renewable sources that are intermittent such as wind or solar power. We consider a model of energy investment and production with two sources of energy: a clean intermittent one (e.g. wind), and a polluting reliable one (e.g. coal). We first characterize the first-best energy mix and its decentralization with a Pigouvian tax. Next we introduce several policy instruments. A carbon tax decreases electricity production while, at the same time, it increases investment in wind power. The tax may increase total production capacity since the retailing price of electricity does not depend on energy availability, windmill capacity must be backed-up with thermal power plants. Renewable portfolio standards (RES) and feed-in tariffs (FIT) enhance investment into intermittent sources of energy. However, they both might boost electricity production beyond the efficient level, in which case they must be complemented with a tax on electricity consumption. Lastly, we consider the case of a monopoly thermal power producer. We show that the introduction a competitive fringe of wind power producers makes the thermal power

producer reduces further production capacity which increases electricity price. Two instruments are needed to implement the first-best: a price cap and a tax on fossil fuel.

TSE Working Paper, n° 15-603, September 2015, co-authored with **Claude Crampes**

Julien Jacqmin, HEC Management School / University of Liege, Research associate at LAMETA, Montpellier

Non-Renewable and Intermittent Renewable Energy Sources: Friends and Foes?

This paper studies the links between renewable and non-renewable intermittent energy sources in the production of electricity. More precisely, we argue that the relationship between the natural gas price and capacity investments in solar and wind power energy is far from univocal. We find that this relationship is not linear but is better represented by a bell-shaped curve. Hence, for relatively low gas price, the two modes of production are substitutable. After a price threshold is reached, the two are complementary. A theoretical model explains this as the trade-off resulting from two forces: the input price differential of these two modes of production and the risks related to the unpredictable nature of the intermittence of renewable energies. Using U.S. state level data from 1998 to 2012, we find that this relationship is robust to various empirical specifications.

Working Paper LAMETA n° 2014-09, co-authored with **Edmond Baranes** and **Jean-Christophe Poudou**

Sessions planned for the first semester of 2016

27th session, entitled « L'entrée de l'éolien dans les marchés électriques », Wednesday 13 January 2016, 16h30 - 18h30, Université Paris-Dauphine (Amphi 5, 2nd Floor)

Marie Petitet (CEEM Doctoral student), *Carbon Price instead of Support Schemes: Wind Power Investments by the Electricity Market*

Presentations by **Thomas-Olivier Léautier** (TSE), *Do Costs Fall Faster than Revenues? Dynamics of Renewables Entry into Electricity Markets*



IV- Upcoming Events 2016

Scientific Conferences

Conference on Energy, the Market and the Law: A European Dialogue between Economists and Lawyers

Tuesday 12 January 2016, Université Paris-Dauphine, Room Raymond Aron

Conference on What changes to Network Tariffs Will Send the Right Economic Signals for the Energy Transition?

Conference organized by the Association of Energy Economists (AEE) in cooperation with CGEMP, the Chaire European Electricity Markets (CEEM) and the Chaire of Governance and Regulation of Université Paris Dauphine, Thursday 28 January 2016, Université Paris-Dauphine, Room Raymond Aron

Colloquium on Electricity Market Designs for Low Carbon Technologies

Monday 14 March 2016, Université Paris-Dauphine, Room A 709 (New Wing, 7th floor)

Conference on Electric Vehicles

14 June 2016, Université Paris-Dauphine, Room Raymond Aron

CONFERENCE

ENERGY, THE MARKET AND THE LAW

A EUROPEAN DIALOGUE BETWEEN ECONOMISTS AND LAWYERS

Tuesday 12 January 2016
14h00 - 18h30



Université Paris-Dauphine
Salle Raymond Aron
2nd floor

CHAIRE EUROPEAN ELECTRICITY MARKETS
Fondation Paris Dauphine

Chaire de recherche associée par


Rte EDF EPEXSPOT

WORKSHOP

MARKET DESIGNS

FOR LOW-CARBON ELECTRICITY GENERATION

Monday 14 March 2016
14h00 - 18h30



Université Paris-Dauphine
Salle A 709, Nouvelle Aile
7th floor

CHAIRE EUROPEAN ELECTRICITY MARKETS
Fondation Paris Dauphine

Chaire de recherche associée par

Rte EDF EPEXSPOT

Internal Research Seminars

Power Markets with High Share of Variable Renewables: Analytical Tools for Studying Efficient Adaptations

Tuesday 12 April 2016, Université Paris-Dauphine, Room A 709 (New Wing, 7th floor)


Smart Grids and Flexibility Provision: Which Specific Value of Flexibility Services by Decentralised Demand- Response Products in Active Distribution Grids?

23 June 2016, Université Paris-Dauphine, Room A 709 (New Wing, 7th Floor)

Paris-Sciences-Lettres Research Seminars on the Economics of Energy

27th session, entitled « The Introduction of Wind Power to Electricity Markets »

Wednesday 13 January 2016, 16h30 - 18h30, Université Paris-Dauphine (Amphi 5, 2nd Floor): Presentation by Thomas-Olivier Léautier (TSE) on *Do Costs Fall Faster than Revenues? Dynamics of Renewables Entry into Electricity Markets* and Marie Petitet (CEEM Doctoral student), *Carbon Price instead of Support Schemes: Wind Power Investments by the Electricity Market*



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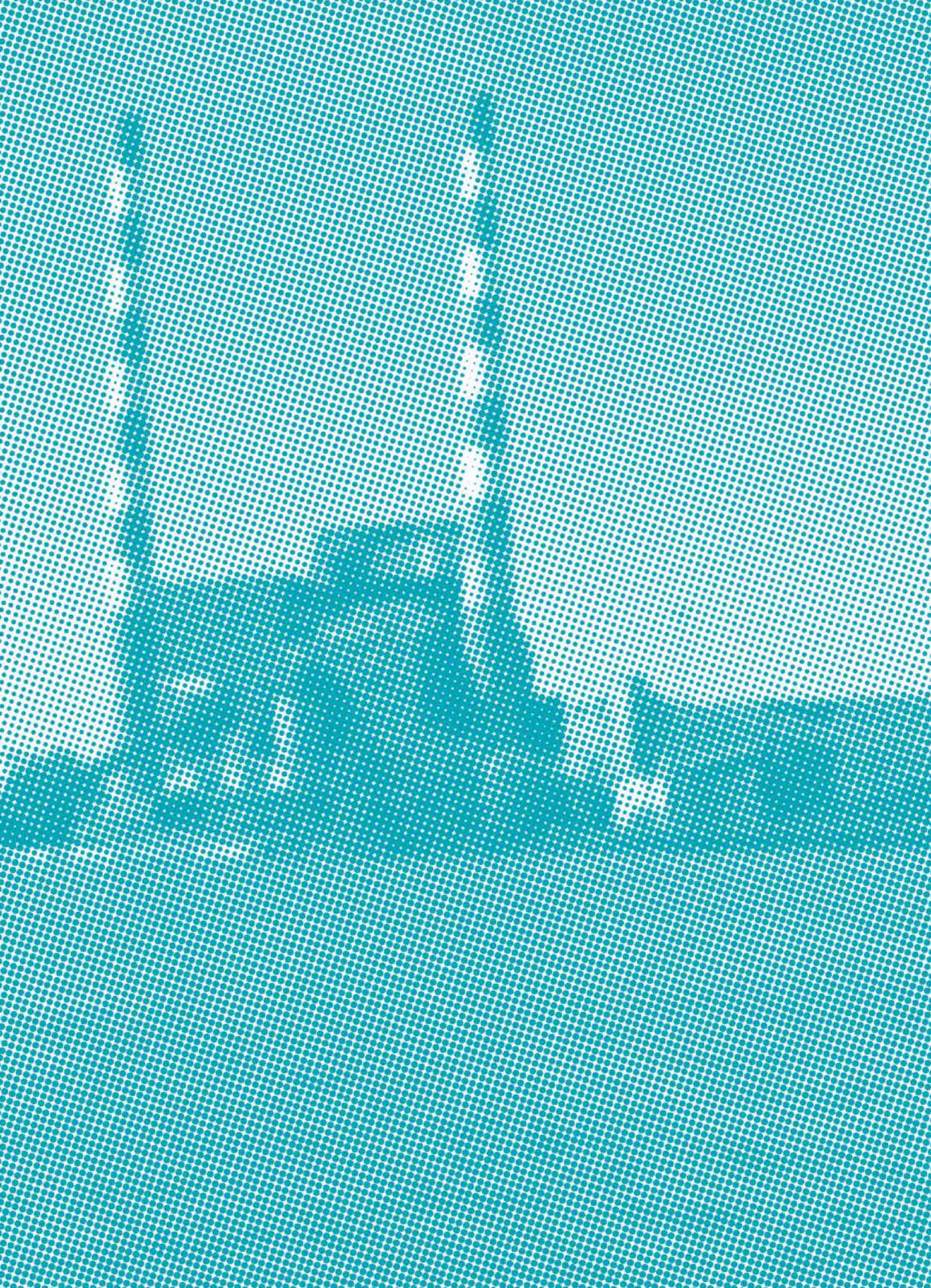
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APPENDIX

Focus on the conference “Elements of a New Target Model for European Electricity Markets: Towards a Sustainable Division of Labour between Regulation and Market Coordination”

Conference Objective

Thirty years of European electricity market liberalisation have a mixed record. Despite efficiency gains and improved dispatch, competitive electricity markets in their current form have failed to convince that they can deliver superior results to regulated systems in terms of investment, security of supply and environmental performance. At the same time, technologies and behavioural modes are evolving fast. Accompanying these changes, a wealth of academic and applied research has improved understanding of individual issues but a coherent consensus model for future European electricity systems, a new target model, is still outstanding.



This international conference aims at bringing together the results of current research that might become part of a New Target Model for European electricity markets in the near-future.

The need for such a New Target Model arises since current energy-only markets appear to be unable to deliver desired levels of capacity and greenhouse gas emission reductions through the deployment of low carbon equipment, even where carbon pricing exists. At current levels of demand elasticity, aligning prices on short term marginal cost will not allow new equipment to recover its fixed costs and to help to trigger sufficient investment in different types of capacity without significant reductions in



the convenience and security of electricity supply. This structural issue has been compounded by the injection of RES-E at zero short-term marginal cost which led to a dramatic fall in wholesale forward prices and load factors for conventional plants. Remuneration of generators for flexibility in intraday, balancing, adjustment as well as for guaranteed capacity by new capacity mechanisms has increased as expected, but not nearly enough to compensate for revenue losses in forward markets. Improvements in the design of trading for flexibility services and the installation of capacity mechanisms are a subject of much research. However hampered by intrinsic volatility they might still not be capable of delivering desired levels of investment. Also carbon pricing has in its current form proven unable to spur investment in low carbon technologies with high fixed costs.

Increasing numbers of experts thus consider that it may be necessary to abandon the idea of marginal cost pricing in forward markets and to turn into the opposite direction, namely long-term arrangements that guarantee fixed revenue flows through a public agency, independent regulator or

systems operator. Such arrangements, in particular the competitive auctioning of long-term contracts offering remuneration at average costs are particularly relevant for technologies with large capital expenditures, i.e. low carbon technologies such as renewables, hydropower or nuclear. They would be complemented by decentralised short-term coordination in competitive markets organising least-cost dispatch and the provision of flexibility and system services.

From this general vision of a New Target Model follow immediately a number of urgent questions that require intensive research and study before a deep restructuring of European electricity markets could be advanced as a serious proposal:

In any mechanism aiming to ensure adequate levels of investment and capacity, questions are: what should be the planning procedure to assess investment needs, given external and internal uncertainties as well as endogenous dynamic effects? Appropriate modelling tools,

performance criteria and institutional arrangements would all need to be determined. In terms of modelling topics such as dynamic optimisation with and without RES-E, price formation under uncertainty and the short-term flexibility markets or network optimisation all offer new and exciting research questions.

What is the optimal design of long-term contracts for capacity and energy provision? Should auction mechanisms be technology-neutral, include implicit carbon prices or be prescriptive in terms of technology choice? Can the new long-term financing mechanisms be reconciled (a) with existing support mechanisms such as feed-in tariffs (FITs) or contracts for difference (CfDs) and (b) the working of markets for flexibility and system services? Which mix of price instruments (carbon tax), quantity instruments (ETS) or targeted support for RES-E and nuclear can best be combined with long-term capacity provision in order to achieve emission reductions in the electricity systems at socially acceptable costs?

The introduction of large amounts of variable renewables disturbs market operations and increases the need of flexibility services. How can one align the private and social values of flexibility provision? What would be efficient designs on the intraday, reserve and balancing markets? What would be the conditions to make new revenues with sales of flexibility services, sufficient to trigger investment in flexible resources in storage, demand response, and gas turbine?

How shall increase needs for investment in transport or distribution due to RES-E be dealt with? What is the proper way of establishing a socially optimal level of network and interconnection capacity? To which extent can trade-offs between production and location be organised through uniform network tariffs, zonal or locational pricing? To which extent will rules for the curtailment of wind-power and PV plants during periods of over-supply be integrated in system optimisation? There remains a strong need for updated transmission planning.



Theory has yet to catch up with the technical, structural and behavioural changes that modify the framework for determining optimal amounts and an efficient cost allocation for network capacity and distribution grids.

What is the proper structure of end-user tariffs in the financing of both the fixed and variable costs of capacity, energy and the system services provided by TSOs and DSOs? What shall future prosumers pay for the insurance services provided by their network? Is there still a role for residential tariffs, or will retail competition by energy service providers be able to square the costs of generation and transport with customer bills? How can the demand-side be properly integrated in the working of the system?

No single conference could answer all or even a majority of these questions, which in themselves constitute a subset of the issues surrounding a New Target Model. Yet the CEEM conference on 8-9 July 2015 aims at being part of a dynamic process in which the theoretical framework for a third way between central planning and market provision will gain in completeness, depth and consistency.



Organisation

Following the conference key note speech, the workshop was organised in five sessions over one day and half. The organisers were inviting papers to each of the five sessions of the conference. The CEEM financed participation of selected authors. A concluding roundtable identified elements of progress towards a future Target Model 2.0 for electricity markets in the EU and the possible barriers raised by antitrust and state aids legislations.

Organisation and Selection Committee

Jan Horst Keppler (Scientific Director-CEEM, Université Paris-Dauphine), Dominique Finon (Scientific Advisor- CEEM, and CIRED-CNRS), Fabien Roques (Partner- Compass Lexecon and CEEM), Manuel Baritaud (Senior Energy Analyst, IEA)

For a complete summary of the conference as well as the program, abstracts, and presentation materials, please visit the CEEM website at the following address:

<http://www.ceem-dauphine.org/agenda/en/c289c388e4079c7755735d52346d-5dadf0d11dec>



Project of a Special Section "Towards a new market regime in low carbon power sector" in Energy Policy (JEPO)

Jan Horst Keppler (Scientific Director-CEEM, Université Paris-Dauphine) and Dominique Finon (Scientific Advisor-CEEM, and CIRED-CNRS): Background and Objectives of the Conference: "Elements of a New Target Model for European Electricity Markets", and the 5 following selected papers:

1. David Newbery (Research Director-Cambridge Electricity Policy Research Group, and Research Fellow-Imperial College London): *"UK Electricity Market Reform: Intelligent Market Decarbonisation or Back to Central Planning?"*

2. Fabien Roques (Senior Vice President at Compass Lexecon and Associate Professor, Université Paris-Dauphine) and Dominique Finon (Scientific Advisor - CEEM, and CIRED-CNRS): *"Key Questions of the Restructuring of Electricity Markets with Respect to Decarbonisation Objectives, Risk Management, Long-Term Coordination and Redistribution »*

3. Miguel Vasquez (Professor of Economics, Universidade Federal Fluminense, Brazil) et alii : *"Electricity Auctions with Integer Decisions"*

4. Andreas Erhenmann (ENGIE), Gauthier de Maere (ENGIE) and Yves Smeers (Université catholique de Louvain): *"Investment and Early Retirement with Incomplete Markets for Risk: the Need for Long-Term Contracts"*

5. Jan Horst Keppler (Scientific Director-CEEM, Université Paris-Dauphine): *"First Principles, Market Failures and Endogenous Obsolescence: the Dynamic Approach to Capacity Mechanisms"*





CHAIRE EUROPEAN ELECTRICITY MARKETS

Fondation Paris-Dauphine

Université Paris-Dauphine
Place du Maréchal de Lattre de Tassigny
75775 Paris Cedex 16

Fatoumata Diallo, CEEM Project Manager
Email : fatoumata.diallo@fondation-dauphine.fr
Tél. : +33(1)44.05.45.54

www.ceem-dauphine.org