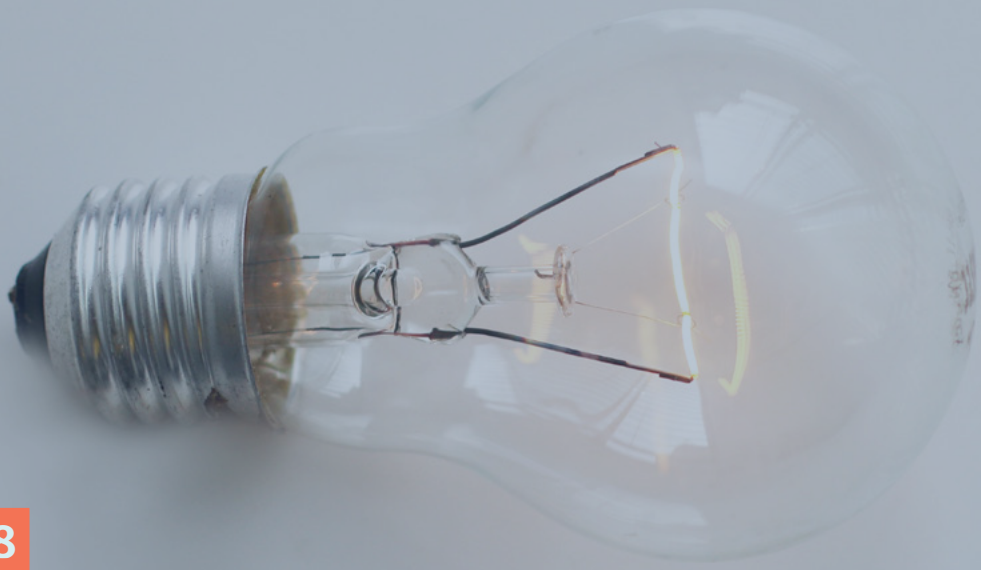
WORKSHOP

ENERGY DAY



APRIL 16. 2018

9:00-9:40 > *Registration & Welcome Coffee / MONT Lobby*

9:40-11:00 > *Session 1: Optimization in Energy / MONT 03*

- **Mathieu VAN VYVE (CORE, UCLouvain)**
  Revisiting minimum profit conditions in uniform price day-ahead electricity auctions

  We examine the problem of clearing day-ahead electricity market auctions where each bidder, whether a producer or consumer, can specify a minimum profit or maximum payment condition constraining the acceptance of a set of bid curves spanning multiple time periods in locations connected through a transmission network with linear constraints. Such types of conditions are for example considered in the Spanish and Portuguese day-ahead markets. This helps describing the recovery of start-up costs of a power plant, or analogously for a large consumer, utility reduced by a constant term. A new market model is proposed with a corresponding MILP formulation for uniform locational price day-ahead auctions, handling bids with a minimum profit or maximum payment condition in a uniform and computationally-efficient way. An exact decomposition procedure with sparse strengthened Benders cuts derived from the MILP formulation is also proposed. The MILP formulation and the decomposition procedure are similar to computationally-efficient approaches previously proposed to handle so-called block bids according to European market rules, though the clearing conditions could appear different at first sight. Both solving approaches are also valid to deal with both kinds of bids simultaneously, as block bids with a minimum acceptance ratio, generalizing fully indivisible block bids, are but a special case of the MP bids introduced here. We argue in favour of the MP bids by comparing them to previous models for minimum profit conditions proposed in the academic literature, and to the model for minimum income conditions used by the Spanish power exchange OMIE.

- **Philippe CHEVALIER (CORE, UCLouvain & N-SIDE, Louvain-la-Neuve) and Olivier DEVOLDER (N-Side, Louvain-la-Neuve)**
  Advanced analytics: A key enabler for the energy transition

  The transition towards renewable sources of electricity production leads to a dramatic increase in uncertainty on energy markets. The uncertainty now comes not only from consumers but also increasingly from producers as more and more intermittent wind and photovoltaic producers are integrated to the grid. Using examples from N-SIDE projects, we will illustrate how different advanced analytics techniques can be leveraged and combined to help consumers, producers and grid operators to be ahead of the game in this new energy world. From Dynamic Dimensioning of Balancing Reserves, to European Integration of Electricity Markets, to Flexible Consumption of Industrial sites, this presentation aims to show the key role that Machine Learning, Statistics and Optimization technologies play in helping shape the future of our energy system.

11:00-11:30 > *Coffee break / MONT Lobby*

11:30-12:50 > *Session 2: Equilibrium Models in Energy / MONT 03*

- **Yves SMEERS (CORE, UCLouvain)**
  Transmitting scarcity signal in the day ahead market: A stochastic equilibrium analysis

  Restructured electricity markets are commonly organized around a “two settlement system”. An energy (or balancing) (EU) market clears in real time (RT) and an energy market clears in Day Ahead (DA). The DA concentrates the bulk of transactions, while the RT serves to adjust the system for all unplanned deviations. Prices in these markets are meant to signal the scarcity of existing capacities and hence ultimately inform on the need for investment (this is the analogous of the short run vs. long run marginal cost of Boiteux in the conventional system). The two settlement system raises the question of where the scarcity signal should be measured (DA or RT?). The objective of the US market design is to make DA a forward market of RT as this is seen as the true measure of

scarcity. This is done through "Virtual Trading", a financial market which has an impact on physical operations in DA. The EU system is less formal and accounts for the problem by allowing for opportunity costs in DA offers, that may also conflict with market power issues. We discuss the two approaches though stochastic equilibrium problems, where the risk aversion of agents (between DA and RT) is modeled by coherent (Artzner et al.) risk functions. These models raise tricky problems of existence and multiplicity of equilibrium. The methodology is used in the following talk. (This work was conducted with I. Abada and G. de Maere d'Aertrycke from ENGIE.)

- **Anthony PAPAVASILIOU (CORE, UCLouvain)**
  Market design considerations for scarcity pricing

  The remuneration of flexible capacity in electricity markets with significant levels of renewable energy capacity has become an increasingly challenging aspect of electricity market design. Scarcity pricing has been touted as a means of mitigating this challenge within the context of an energy-only market design. A crucial aspect of scarcity pricing is the back-propagation of real-time scarcity signals to earlier forward markets, so as to provide adequate incentives for long-run investment. The successful back-propagation of scarcity signals hinges on a variety of specific short-term electricity market design choices, including (i) the trading of reserve capacity in real time, (ii) the existence of virtual trading, and (iii) the timing of the clearing of reserve capacity and energy in day-ahead markets. In this presentation we propose a family of stochastic equilibrium models for addressing how each of these market design choices affects the back-propagation of scarcity signals, and we discuss the performance of these designs on a small numerical example.

12:50-14:00 > *Lunch / MONT Lobby*

14:00-16:00 > *Session 3: Regulation and Economic Policy / MONT 03*

- **Per AGRELL (CORE, UCLouvain)**
  Strategic behavior by energy networks under yardstick regulation

  Frontier-based yardsticks, as applied in European energy network regulation, are not immune to strategic behavior. Under yardstick regulation, the operator is gauged against a cost target set by the other firms in the sector. Many regulators have implemented frontier-based yardsticks, where the cost function is defined by the most efficient firms (called peers). Conventionally, it has been assumed that the computational complexity and the uncertainty of the exogenous outputs would prevent peer manipulation. This paper shows that when it is possible to predict peers in advance, firms can manipulate the frontier to their advantage. We single out cross-ownership and horizontal mergers as two plausible means to achieve such strategic objectives even in large industries. Using data for the electricity distribution in Norway under a stable frontier-based regulation, firm behavior consistent with our predictions is identified. We also complement the Bogetoft-Wang (2005) model for decomposing merger gains under non-parametric productivity analysis to include a new measure for strategic incentives, merger-related peer gains. The paper concludes by suggesting policy options to improve regulatory practice and to avoid distorted incentives. (Joint work with Dr. Jonas TEUSCH, OECD.)

- **Ignacio ARAVENA (CORE, UCLouvain)**
  Transmission capacity allocation in zonal electricity markets

  We propose a novel framework for modelling zonal electricity markets, based on projecting the constraints of the nodal network onto the space of the zonal aggregation of the network. The framework avoids circular definitions and discretionary parameters, which are recurrent in the implementation and study of zonal markets. Using this framework, we model and analyze two zonal market designs currently present in Europe: flow-based market coupling (FBMC) and available-transfer-capacity market coupling (ATCMC). We develop cutting-plane algorithms for simulating FBMC and ATCMC while accounting for robustness of imports/exports to single element failures, and we conduct numerical simulations of FBMC and ATCMC for a realistic instance of the Central Western European system under 768000 different operating conditions. We find that FBMC and ATCMC are unable to anticipate congestion of branches interconnecting zones and branches within zones, and that both zonal designs achieve similar overall cost efficiencies (0.4% difference in favor of FBMC), while a nodal market design largely outperforms both of them (5.8% better than FBMC). These findings raise the question of whether it is worth for more European countries to switch from ATCMC to FBMC, instead of advancing directly towards a nodal design. (Joint work with A. Papavasiliou and Y. Smeers.)

- **Axel GAUTIER (ULg, LCII and CORE, UCLouvain)**
  Integrating renewables into the grid

  The increasing deployment of decentralized production units (DPU) connected to the distribution grid changes the behavior of consumers and the role of the grid in the energy system. This paper explores the relations between the consumers and the grid and investigate how tariffs should be adapted to take into account the new interactions.

Organized by Anthony PAPAVASILIOU (CORE, UCLouvain)

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