



**eprice**

ENABLING THE FUTURE ENERGY SYSTEM

PRICE-BASED  
CONTROL  
OF ELECTRICAL  
POWER SYSTEMS

# FACTS & FIGURES



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<b>PROJECT TITLE</b>	Price-based Control of Electrical Power Systems (E-Price)
<b>PROJECT COORDINATOR</b>	Eindhoven University of Technology, The Netherlands
<b>FUNDING PROGRAMME</b>	European Seventh Framework Programme (FP7), Small or medium-scale focused research project (STREP), ICT for energy efficiency [ICT-2009.6.3]
<b>DURATION</b>	36 months from 1st February 2010
<b>EFFORT</b>	337 person-months
<b>TOTAL COSTS</b>	€ 3.387.277
<b>EC CONTRIBUTION</b>	€ 2.448.000
<b>CONSORTIUM</b>	8 partners from 3 countries 3 academic and 5 industrial partners
<b>PARTICIPANTS</b>	Eindhoven University of Technology, The Netherlands University of Trento, Italy Swiss Federal Institute of Technology, Switzerland Operational Research Systems S.R.L. (ORS), Italy KEMA N.V., The Netherlands APX-ENDEX, The Netherlands ABB Switzerland LTD., Switzerland TenneT TSO B.V., The Netherlands



# E-PRICE MOTIVATION & OBJECTIVES

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Technological and societal developments over recent decades encouraged the use of an increasing quantity of renewable energy sources (wind, solar) for the production of electric energy. People are starting to generate their own energy, becoming producers themselves. At the same time the predictability of both production and consumption of electric energy will decrease, introducing larger imbalances in the electricity network. The current energy production system inadequately copes with this unpredictability and will soon reach the limit for secure and reliable operation. This is the main motivation for E-Price.

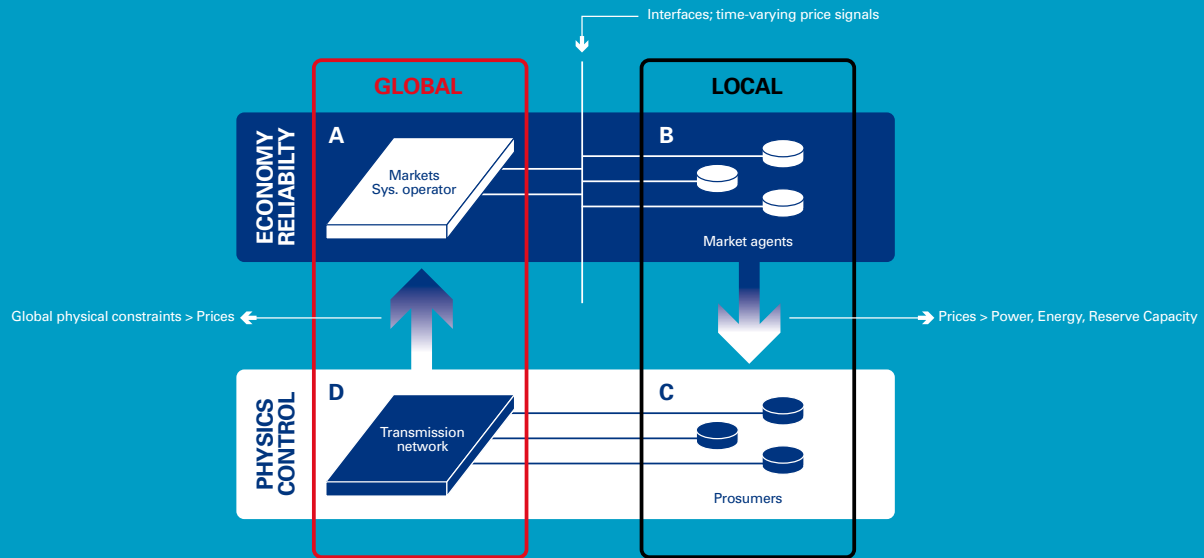
E-Price is a three-year European research project aiming to develop a reliable, an efficient and a societally-acceptable control concept for the EU energy market. E-Price sets a new standard by introducing a feasible price-based control strategy. Its ambition is to be at the

very heart of future developments that fully facilitate the increasing amounts of less-predictable renewable energy sources.

E-Price uses expertise to develop innovative products and methods in co-creation with private and public parties. The interdisciplinary team of specialists from European universities and industry will look beyond present boundaries and fixed structures.

E-Price will offer an integral solution as the standard framework for trade in electrical energy, satisfying European Union policy goals. This will bring about a market and control concept that gives incentives to all participants to follow their own interests while still satisfying the societal requirements on reliability, efficiency and transparency. It will bring about a structural change in the way electricity will be produced and used in the future.

# CONCEPT



The project proposes a price-based control approach as a coherent methodological framework to ensure the feasibility, the reliability and the efficiency of the future European power system, anticipate and support market-based operation and decentralized decision making. It is enabled by state-of-the-art ICT technologies and by utilizing (beyond-) state-of-the-art decentralized and distributed control systems theory and modern optimization techniques. In our approach, ICT interfaces, control laws and behavioural protocols will be holistically analyzed and systematically designed as distributed solutions to time-varying global optimization problems.

In the E-Price project we propose a systematic scientific approach

to formulate ICT and control requirements and solutions for price-based control of future power systems. At the heart of our approach are modelling, analysis and synthesis of the interplays between:

1. the interconnected physical power system (C and D in figure), with time varying power requirements as prominent signals; and the economical layer (A and B in figure) with time varying price signals as the prominent information carriers;
2. local objectives of producers/consumers (prosumers) (B and C in figure) and global balance, transmission network limits and reliability constraints (A and D in figure).

# PROJECT RESULTS

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- Goals for power system balance on the global (e.g. national, European) level systematically formulated in a unifying mathematical framework as global, time-varying, potentially stochastic, constrained optimization problems.
- Control solutions implemented in software prototypes integrated with a simulation model of the Dutch power system.
- Definitions of ICT interfaces and infrastructure.
- Proof of concept through simulation case studies on the model of the Dutch power system.



# E-PRICE PARTNERS

## EINDHOVEN UNIVERSITY OF TECHNOLOGY

Eindhoven, the Netherlands / Department of Electrical Engineering / Control Systems Group (Project coordinator): control system design for networked and embedded systems in general and electrical power systems in particular. / Electrical Energy Systems: research on intelligent electricity networks, which is motivated by the economic and technological changes that will influence the structure of the future power system.

## UNIVERSITY OF TRENTO

Trento, Italy / Department of Mechanical and Structural Engineering: real-time optimization for control of dynamical processes, with a focus on the development of numerical algorithms and software tools, and their application to real-life problems of industrial interest.

## SWISS FEDERAL INSTITUTE OF TECHNOLOGY

Zurich, Switzerland / Department of Information Technology and Electrical Engineering / Automated Control Laboratory: algorithmic theory to advance the state-of-the-art high-speed dynamic optimization, analysis of the impact of ICT infrastructure on control performance.

## OPERATIONAL RESEARCH SYSTEMS S.R.L. (ORS)

Alba, Italy / ORS: developing software solutions, with specialized, yet easy-to-use applications that allow even technically inexperienced users to benefit from the most sophisticated mathematical techniques, above all in optimization and statistical analysis. Providing a full range of services, including highly sophisticated software solutions for finance, energy and industrial sector.

## KEMA N.V.

Arnhem, The Netherlands / Departments Markets & Regulation and Future Energy Systems: development and implementation of concepts for price control, based on an in-house developed dynamic simulation model and power system experience, which allows for the evaluation and assessment of the designed algorithms.

## APX-ENDEX

Amsterdam, the Netherlands / APX-ENDEX: advisory role as one of Europe's most experienced energy exchanges for electricity and natural gas in the Netherlands, the United Kingdom and Belgium, to assure the development of efficient, integrated and robust energy markets structures.

## ABB SWITZERLAND LTD.

Baden-Dättwil, Switzerland / ABB Corporate Research: advisory role to assure that the solutions and algorithms developed by the project are industrially relevant and feasible for implementation in current and future computer systems for power network supervision and control.

## TENNET TSO B.V.

Arnhem, The Netherlands / Systems Operations Monitoring & Development: Dutch grid administrator and member of the ENTSO-E (European Network of Transmission System Operators for Electricity), TenneT will be monitoring and advising the research activities with a special focus on practical, implementation and regulatory aspects.

**PROJECT CONTACT INFO**

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