Asset Management – Value Contribution of PSP in Markets with increasing Flexibility Demand

Dr. Klaus Engels
Louisville, KY – July 19, 2012

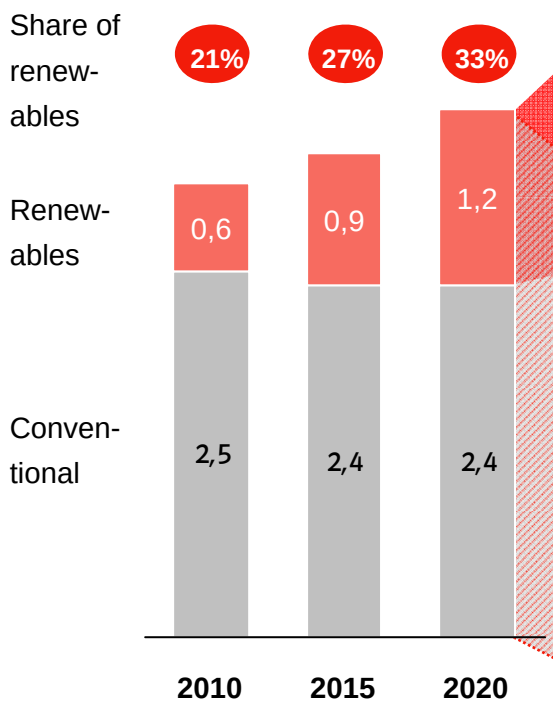
Europe’s generation portfolio can currently comply with a rising flexibility demand, even without being rewarded it

- System demand for technical flexibility will permanently increase within the next years due to growing renewables feed-in and, consequently, rising uncertainty of the residual loads
- Technically Europe’s generation portfolio is already capable to comply with future system requirements without significant upgrade demand
- Within the next decade available portfolio flexibility will shrink by decommissioning conventional plants due to end of lifetime and environmental obligations – the effect differs between regions
- Although essential for the system operator, current market mechanisms do not reward flexibility capabilities of generation assets sufficiently, since mainly capacity and energy are remunerated
- Accordingly, no significant additional flexibility related revenues can be generated – furthermore, the utilization of remaining conventional plants is reduced by increasing renewables feed-in
- Due to it’s value generation from different revenue streams – base and peak load, reserve market, portfolio effect – PSP can benefit from this situation as remaining flexibility source

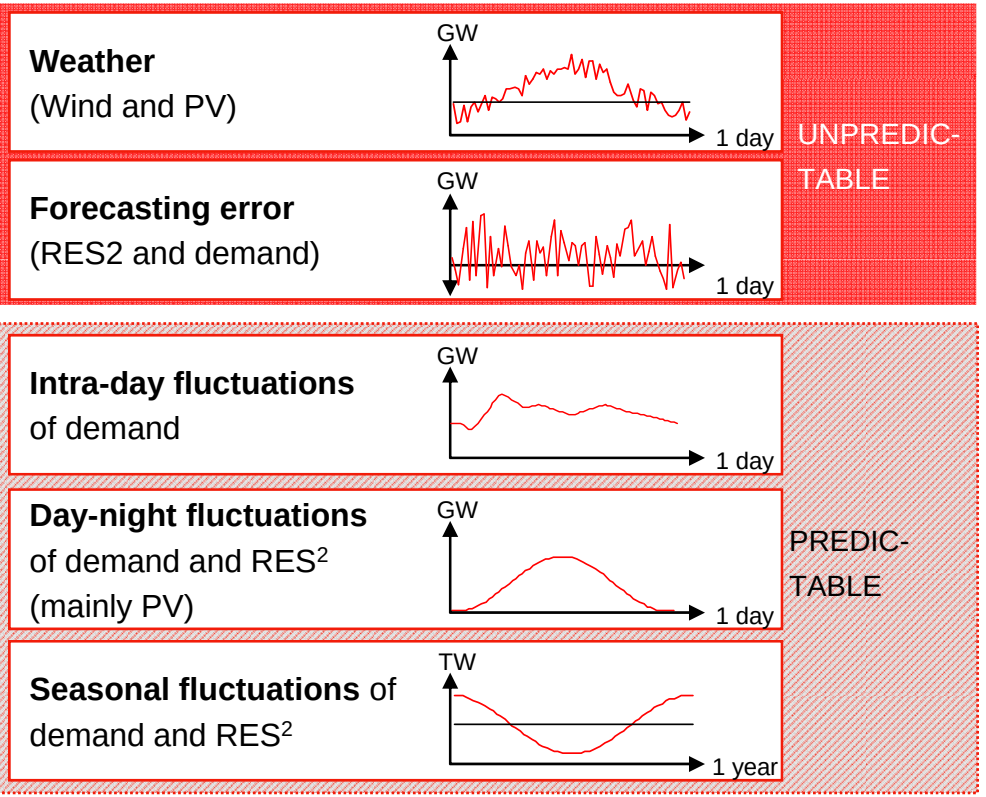
Future energy systems need flexibility to compensate increasing predictable and unpredictable fluctuations

RES[2] feed-in increases need to …

Annual generation EU 27 [in 1000 TWh][1]



… compensate different types of fluctuations

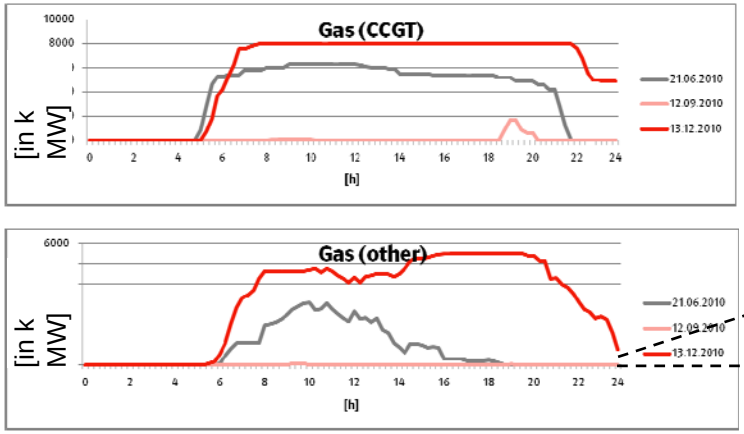


1) Source: E.ON Climate & Renewables (2010)
2) RES: Renewable energy sources

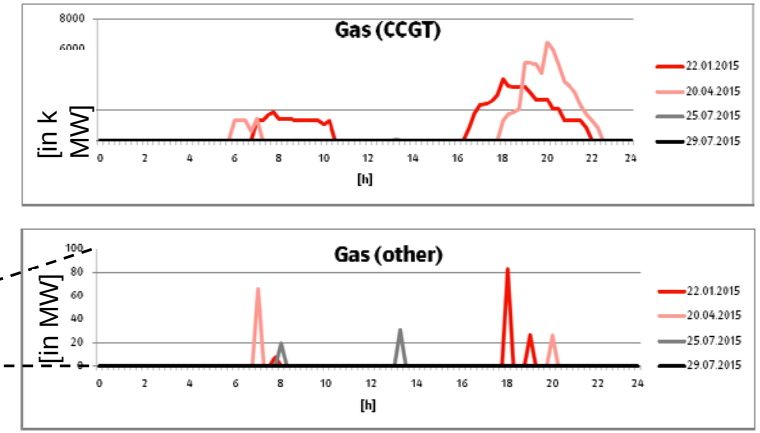
Future economical operation of flexible thermal power plants is probably compromised due to low utilization rate

Exemplary operation profile of gas fired power plants

2010

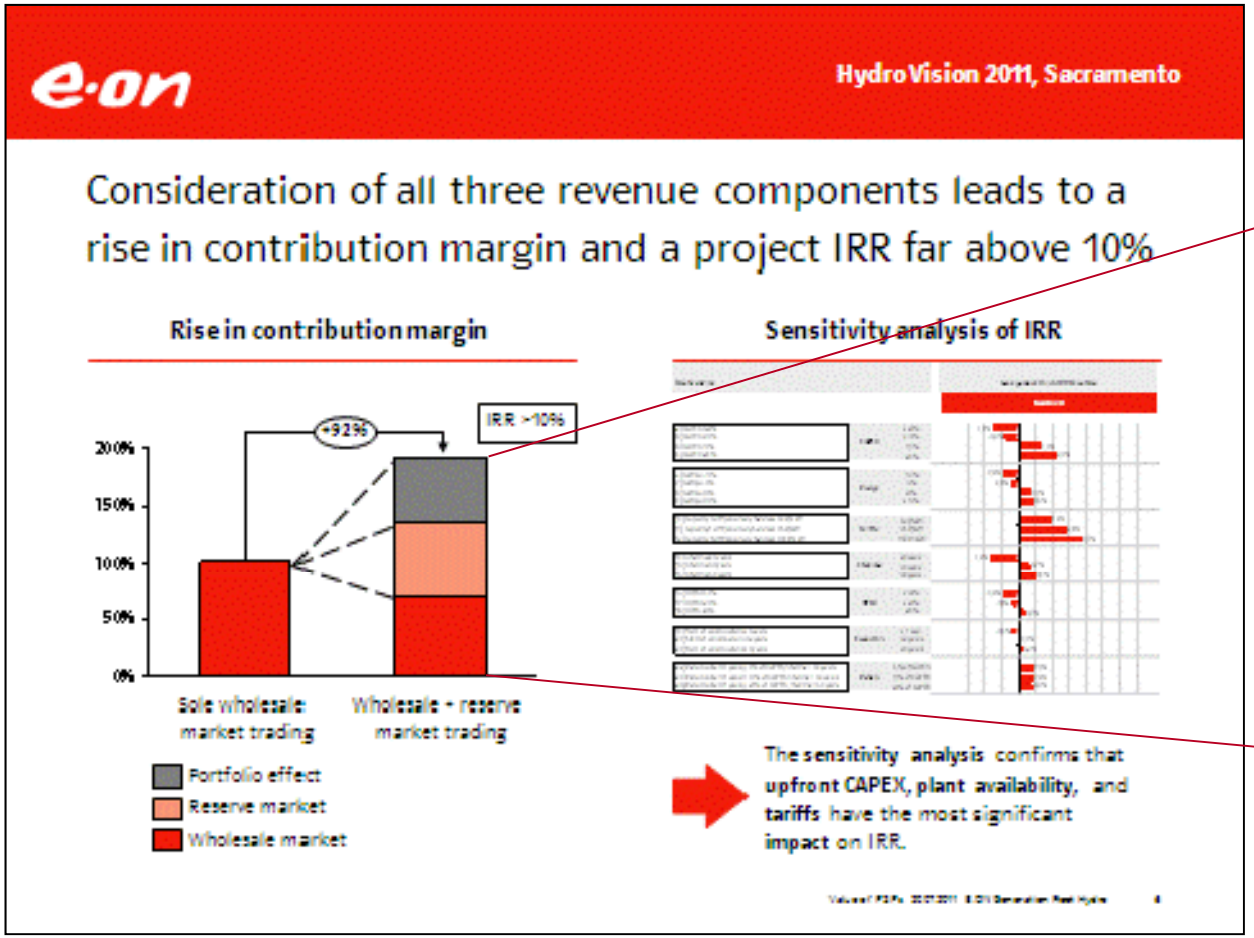


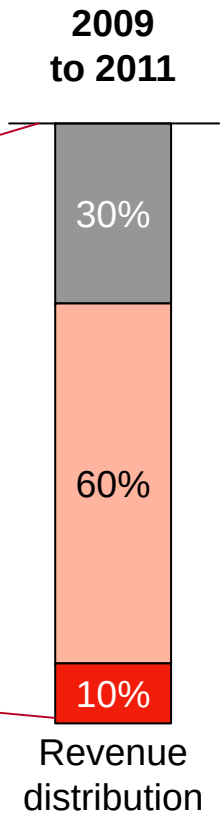
2015



- **Partly, necessity of these installations cannot be shown by statistical data** due to low usage probability, nevertheless, high supply-safety standards justify system integration
- Installations like **highly flexible plants or long-term storages**, which **cannot be operated economically under given market conditions**, require probably **new funding mechanisms**
- **Pumped storage plants** contribute to **different system demands** and benefit from **several revenue streams – profitability can been shown** even under tough conditions

Profitability of PSP is supported by high demand of ancillary services – increasing revenue share accordingly





Pumped storages can still be operated profitably – even in inappropriate and challenging market conditions

Revenue schemes

1. Arbitrage between high and low spot market electricity price situations – original purpose of pumped storage plants (shrinking)
2. Ancillary Services as system support (increasing)
   - Reserve market contribution (primary, secondary and tertiary control)
   - Short start-up times, high load gradients and black start-up capability for short term reserve products, frequency control and grid
   - Voltage control with almost no active power necessary (hydraulic short-circuit)
3. Portfolio effect – combined optimization of hydro-thermal portfolio operation with efficiency and flexibility increase

Increasing Importance and Profitability of pumped storage plants

Backup

Contact details and CV

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Curriculum Vitae

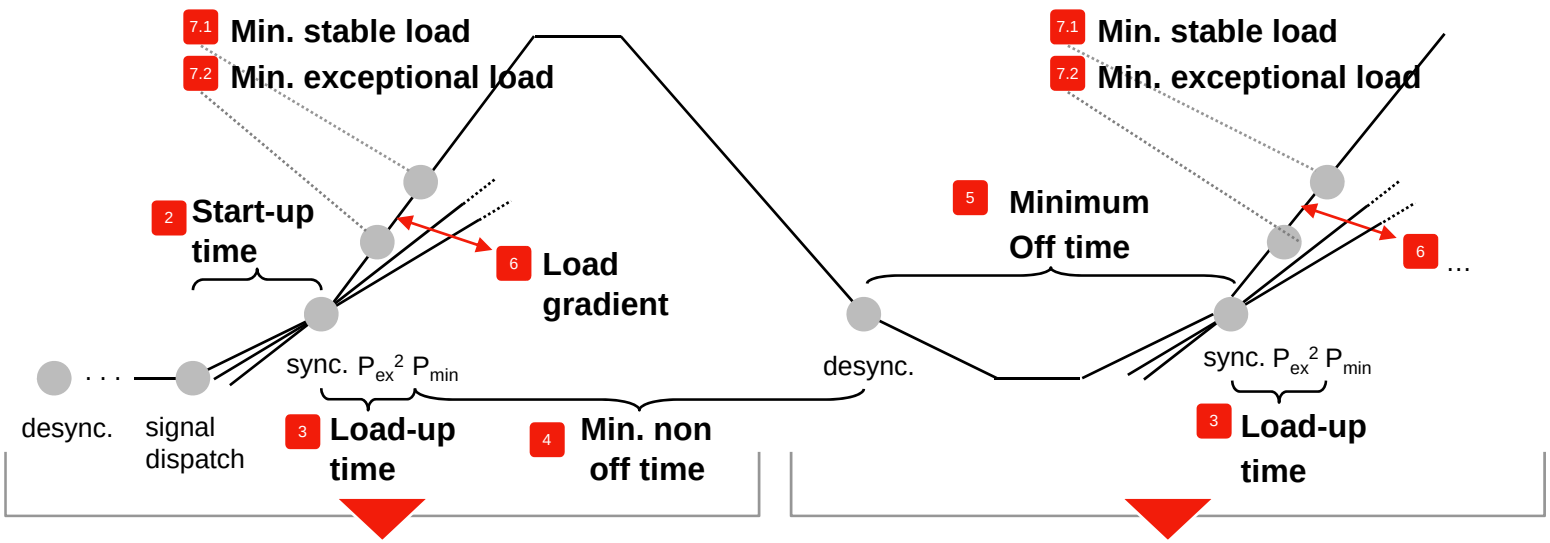
- University Degree in **Electrical Engineering**, RWTH Aachen University, Germany
- University Degree in **Economics**, FernUni Hagen, Germany
- 1997 – 2002 Academic assistant and **PHD studies** at RWTH Aachen University
- 2002 – 2004 **Asset Manager Transmission Grid** RWE Energy AG, Dortmund
- 2005 – 2008 **Project Manager** Roland Berger Strategy Consultants, Dusseldorf/Munich
- 2008 – 2010 **Head of Business Development** E.ON Wasserkraft, Landshut
- since 2010 **Vice President Asset Risk and Governance Hydro**, E.ON Fleet Management Generation
- Recently invited to **Advisory Working Group for the study “Modeling and Analysis of Value of Advanced Pumped Storage Hydropower in the U.S.”** of DoE

Key parameters describe technical plant flexibility across the E.ON Group

Category		Parameters	Definition
Start	1	Limitation # of starts	Number of starts allowed per time interval
Cycle time	2	Start-up time	Time from dispatchers signal (call Trading) until synchronization
	3	Load-up time	Time from synchronization until minimum stable load point
	4	Minimum non off time	Time from minimum stable load to desynchronization
	5	Minimum off time	Time between desynchronization and synchronization (special case of restart right after desynchronization, start-up time hot included)
Load	6	Load gradient	Gradient for load changing measured in MW/ min
	7.1	Minimum stable load	Minimum load for stable operation, fulfillment permit requirements
	7.2	Minimum excep-tional load	Lower load point than minimum stable load (P_{min})
	8	Control band	Different reserve products can be delivered within control band

Illustration of flexibility parameters

Cycle time and load parameters displayed (2-7.2)[1]



Shutdown and standstill after desynchronization

Depending on the time between desynchronization and the signal from dispatch to restart the power plant, the start-up time is differentiated in **start-up time hot/ warm/ cold.**

Restart right after desynchronization

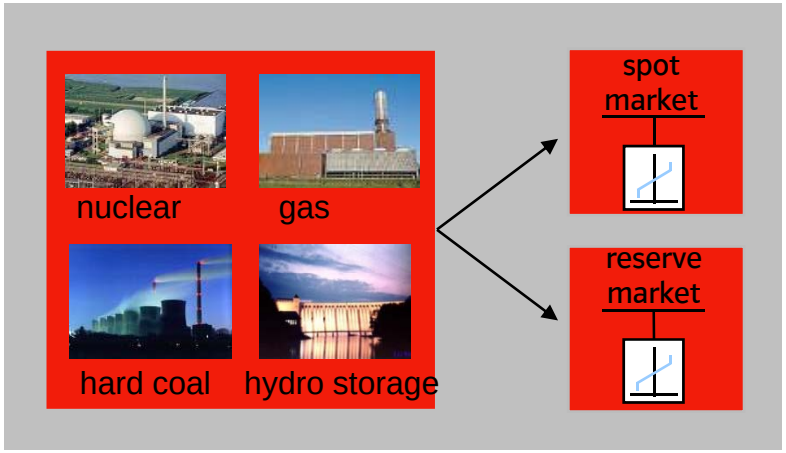
In this special case the restart of the engine starts right after desynchronization. The time between desynchronization and synchronization is defined as **minimum off time**; the start-up time hot is included.

1. Parameter 1: limitation number of starts and 8: control bands are not displayed
2. Pex - Minimum exceptional load - abbreviation of project

Background Portfolio Effect

- A power plant portfolio operates in two markets, the spot and the reserve market, whereas there is an optimum way of market participation and respective power plant scheduling in order to reach the maximum contribution margin with the existing portfolio (→ pooling) .
- Different technical characteristics lead to different tasks of power plants. Due to its technical qualification (short start-up times and high flexibility in operation) a pumped storage plant can provide reserve market products in a more efficient way than for instance a thermal power plant.
- If an existing (thermal) portfolio is extended by a pumped storage plant, the HPP can take over part of the role of the TPPs in regards of reserve capacity provision → synergies within this hydro-thermal portfolio can be achieved.
- The increased degree of freedom for scheduling of TPPs leads to a higher amount of energy available for spot market trading and hence higher efficiency due to increased load, both effects forming the so-called portfolio effect.
- The following illustrates the origination of the portfolio effect by showing the changes in power plant scheduling taking place if an existing thermal portfolio is extended by an HPP.

Consideration of the portfolio effect



- Combining different plant types such as PSPs, which may be used flexibly, with baseload capacity that has low variable generation costs, offers significant synergy potential whenever an **optimisation between scheduled energy and reserve products** is a task.
- The higher degree of freedom achieved in the portfolio by integrating an additional PSPP can particularly be used for a **portfolio-optimised** provision of reserve capacities and reserve energy.

Portfolio effect

- → **Higher spot market revenues of TPPs**
- → **Higher efficiencies of TPPs**

- Generation capacity previously tied up for providing reserve capacity become available for the spot market (esp. thermal plants)
- Due to a better load point higher efficiencies can be achieved
- Side conditions: Liquid spot market (no repercussion on electricity prices), illiquid reserve market

In order to capture the portfolio effect a comprehensive portfolio simulation is required rather than a stand-alone valuation.