The Role of Pumped Storage Power Plants in the National Grid

Agenda

1. Key Figures of the European Energy Market欧洲能源市场的主要特征
2. Key Figures of the Austrian Energy Market奥地利能源市场的主要特征
3. Key Figures of VERBUND / Providing Services主要数据的一体化/提供服务
4. Optimal Operation of VERBUND‘s Hydro Power Plants优化运行一体化的水力发电厂
5. Pumped Storage Power Plants – fields of application抽水蓄能电站应用领域

VERBUND provides

- Balancing energy
- Reactive power
- Energy and Power in Emergency Situations
- Black start capability
- Congestion management capabilities (possibility for redispatch)

for the Austrian transmission system operator

3. Balancing Management in the UCTE

- Every trader (retailer, commercial market participant) need a plan to cover his forecasted demand. At the end of the (day ahead) planning process his generation, trades and consumption must be in balance.

- In the synchronous UCTE area the load frequency control balance the fluctuating demand.

- The Transmission System Operators (TSO) are in charge of the load frequency control.

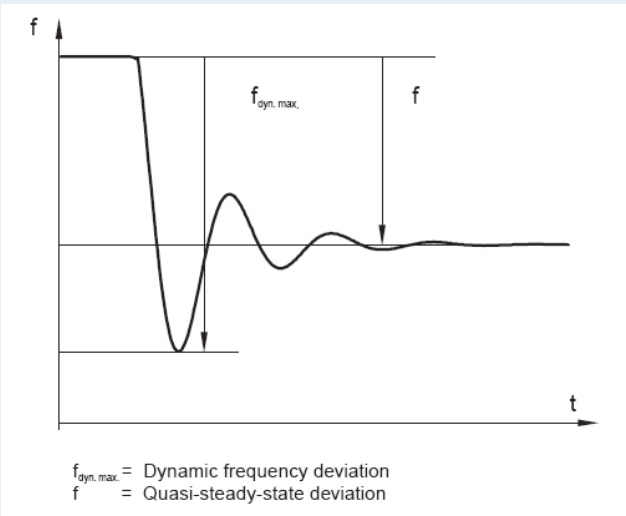
- There are different components of the load-frequency control
  - Primary Control
  - Secondary Control
  - Tertiary Control

- The TSOs have to procure the services for Primary Control, Secondary Control and Tertiary Control from generators (depending on the market system).

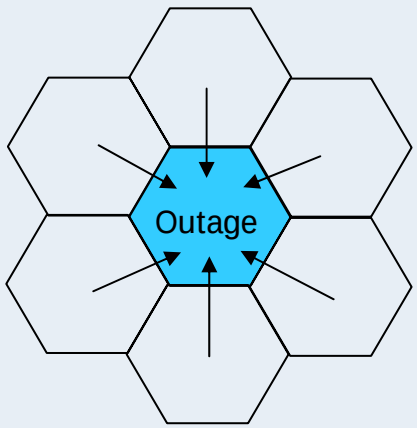
3. Primary Control

- Primary control is activated if the frequency deviation exceeds more than ±20mHz.
- Primary control immediately restores the balance between generation and load. The system frequency is stabilized at a quasi-steady-state value different from the frequency set point value (50 Hz). (1)
- All TSOs in the synchronous area (UCTE area) have to participate in Primary control (principle of solidarity) (2)
- The total Primary Control Reserve in the synchronous UCTE area is 3000 MW.

(1)



(2)



Source: UCTE Operation Handbook

3. Secondary Control

- Secondary Control maintains the
  - balance between generation and demand (consumption) within a specified area called control area

  as well as
  - the system frequency.

- Secondary Control makes use of a centralized controller (Automatic Generation Control, AGC). The Secondary Controller is operated automatically, on-line and closed-loop.

- Secondary control
  - balances the power deficit inside a control area
  - adjusts a frequency offset
  - makes primary control reserve fully available again
  - controls the sum of energy exchange of a control area.

3. Tertiary Control

- In case of a large unbalance Tertiary Control Reserve is required to restore and free up Secondary Control Reserves.
- Tertiary Control is activated automatically or manually. Most TSOs activate Tertiary Control manually.
- Operation of Tertiary Control can be bound to the time frame of scheduling. Around 15 min after activation of Tertiary Control Tertiary Control Power restores the Secondary Control Range