Optimal Operation of Smart Water Grids in a future-proof energy system

In this lecture, I will introduce a couple of water grid opportunities in the future energy system, that will be driven by renewable sources. This lecture covers 4 types of water grids: cascaded hydropower operations in a river basin setting, operational water management of a polder system, district heating cooling operations and operation of water transmission pipelines. These water grids have a number of similar challenges for their future-proof operation, despite the different economic sectors and domain specific characteristics. With the increasing share of variable renewable energies, the operation of these water grids will interfere much more directly with the environmental variability and their uncertainties. Another generic challenge for water grids is the delay in the physical transport phenomena. Future-proof control systems need to cope with or exploit these operational delays. The presence of these (highly non-linear) physical transport phenomena and delays is a major difference with power grids. Thirdly, since future water grids need to cope with more economic and environmental variability, the traditional design approach for water infrastructure must be taken to the next level: the design of control systems will get more integrated with the hardware design. A fourth generic challenge addresses the operational control systems of water grids that need to handle multiple objectives. This is obvious for river basins with hydropower reservoirs and operational water management. But also future district heating grids not only need to deliver affordable heat, but also need to minimize the CO2 emission of their assets and need to seduce customers to reach these goals. Finally, all involved water grid operators need to adopt and integrate innovative control strategies in their operations, which might be the key challenge for a successful energy transition. Next to these problems and challenges, I will present recent breakthroughs and future research directions.