

Norwegian technical journal reveals problem in Danish power grids:

## Drifting clouds cause additional electricity cost in Denmark due to a single large solar park

The director of system operation at the Danish TSO, Energinet, Klaus Winther, has told Ellen Synnøve Viseth from the Norwegian technical journal, *Teknisk Ukeblad*, that one large solar park has forced Energinet to purchase additional secondary reserves (aFFR)<sup>1</sup>. Klaus Winther characterizes the additional cost as unreasonable.

Klaus Winther explained during a recent visit to Oslo that the Danes are facing a new challenge due to solar power.

### Hard to predict impact of drifting clouds

Klaus Winther: "If you had asked me three years ago, I would have said we could handle a lot of sun. Denmark has had solar cells on roofs for many years. But I have become wiser."

The problem is, that drifting clouds can create sudden changes of production for a solar park with a high capacity concentrated on a small area. Such changes may happen several times during a day and Energinet must call balancing reserves for each case.

The 300 MW solar plant at Vandel near Billund in Jutland is among the largest solar parks in Europe.

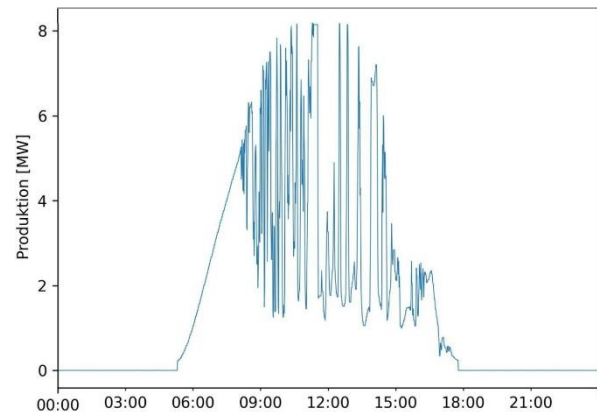


Fig. 1 - Output of 8 MW solar park on 31 August 2023

### The balancing problem

The Transmission System Operators (TSOs) must prepare the daily electricity production to be the same as the expected consumption throughout the day. When deviations occur, the TSO must call for fast reserves to eliminate the difference.

It is an obligation for all TSOs in an interconnected network too contribute to maintaining the necessary balance between consumption and production. A total unbalance would change the frequency, which is supposed to be kept between 49.9 Hz and 50.1 Hz (oscillations per second).

The Danish TSO must purchase reserve capacity for up- and downregulation in order to be able to meet the obligation. The Danish costs of secondary reserves have increased considerably after the commission of the 300 MW solar park.

Klaus Winther says that it is impossible to predict the variations in solar power. Wind power prediction is more accurate. Wind power can be forecasted with good accuracy 48 hours ahead.

<sup>1</sup> Article published in *Teknisk Ukeblad* (in Norwegian) on 6 November 2023

## Towards a different operational pattern

Wind and solar power have created new operational patterns. Solar power plays a significant role during the summer season. Wind plus solar power covered between 8% and 278% of Danish electricity demand in week 28, 2023. The thermal production (CHP) was low due to low heat demand (fig. 2).

The resulting variations were absorbed by the neighbouring countries. The maximum import was 2431 MW (61% of load) and the maximum export was 2822 MW (83% of load).

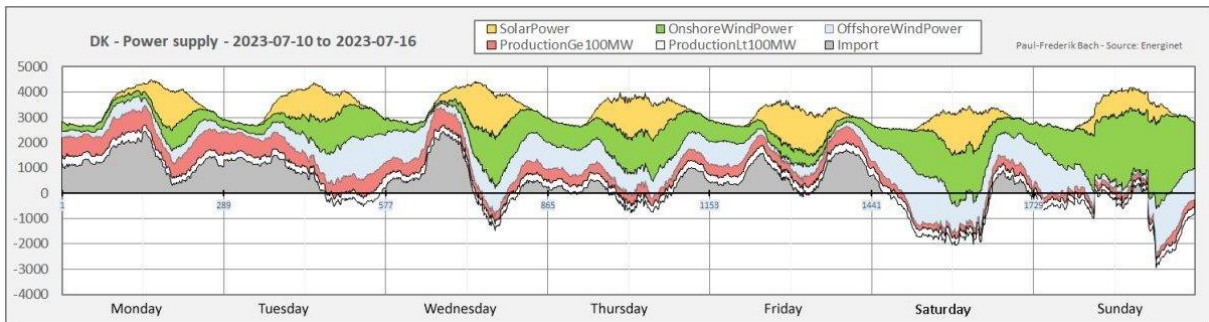


Fig. 2 - Wind plus solar power varied between 8% and 278% of load in week 28 2023. Offshore wind power was curtailed Sunday due to negative spot prices.

Such fluctuations must affect the spot market. The Danish spot prices for a typical day in 2023 were high in the morning and in the late afternoon, but lower at noon. Klaus Winther expects this trend to become more evident in the future.

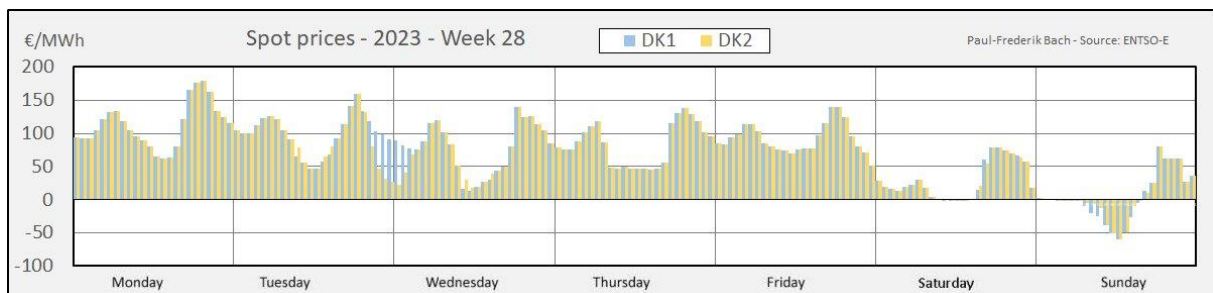


Fig. 3 - Low spot prices at noon due to solar power

The Danish Energy Agency expects the capacity of solar cells in Denmark to increase from 3 GW in 2023 to 18 GW in 2030<sup>2</sup>. New solar cell parks up to 600 MW are expected. It is hard to imagine how such a system can be controlled. It is unlikely that efforts to develop corresponding new flexible demand will succeed. It will require invention, development and implementation of new system control measures.

## The story retold by Swedish media, but still ignored in Denmark

Pontus Nyman from the Swedish business journal, *Tidningen Näringslivet*, found the story interesting and made his own interview with Klaus Winther. The Swedish article had this title: *The system operator's alarm about the electrical system - then blackout threatens*.

Klaus Winther emphasizes that international cooperation and new interconnections will be central parts of the future solution of the challenges from increasing fluctuation production.

<sup>2</sup> Energistyrelsen: Analyseforudsætninger til Energinet 2022

Pontus Nyman discusses advantages and disadvantages of interconnections. Exchange of power should be an advantage to both parties, but Swedish interconnections with the continent made the price level in Germany "infect" the Swedish electricity market with very high spot prices in South Sweden. For that reason, Sweden has chosen to pause the planned new connection to Germany, the "Hansa Power Bridge".

### **The risks of an ambitious Danish climate policy**

Danish politicians take pride of supporting an ambitious climate policy. But what are the implications of being ambitious?

Stable electricity supply has become a habit. Stability and security of the power systems are based on experiences, accumulated internationally during decades. Fundamental changes of the supply system create new risks. The rush to reach very high shares of wind and solar energy has dulled attention to the robustness of the electricity supply.

Being ambitious means going ahead of everybody else and moving into unknown territory, where frontrunners will meet unpleasant surprises with power failures, delays and budget overruns.

The solar power variations described in this paper is a less serious example of unforeseen technical and economic problems.

Denmark has an impressive record of ambitious public projects with technical problems, delays and budget overruns. Recent cases were large hospitals, railway signals and new trains.

International unrest has at long last created some interest in the vulnerability of Denmark's communication and energy infrastructure. The time has come to analyse these risks and ensure a careful development minimizing vulnerability and technical and economic risks.