Personal views on present Danish electricity policy

I have been asked to express my views on the present Danish policy for developing the Danish electricity systems.

I am generally in favour of a continuous reduction of harmful emissions, but the good intentions should not exclude reflections on possible consequences for consumer economy, security of supply and international relations.

I am not familiar with details on the system planning. Therefore, my concerns have the form of unanswered questions.

My concerns are mainly within the following areas:

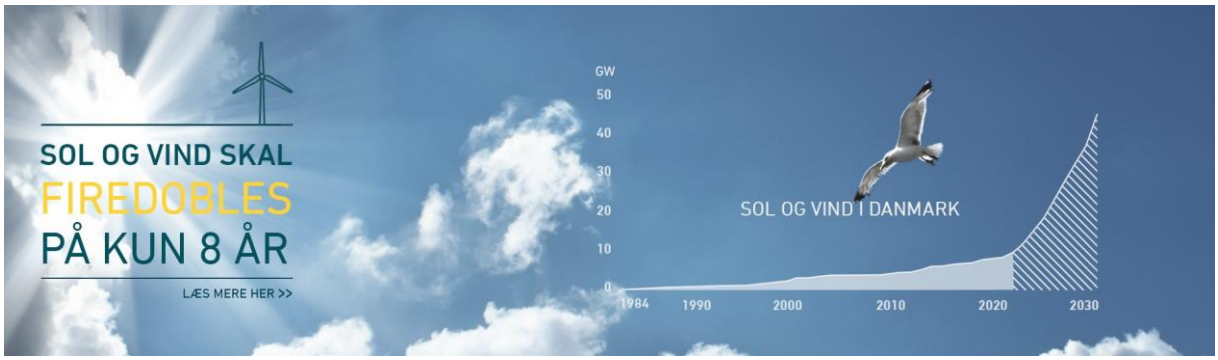
- Security of supply
  - Energy adequacy
  - Dependence on foreign dispatchable capacity
- Fast infrastructure reinforcement
  - Manpower
  - Shortage (and price) of necessary new equipment
  - Environment impact
- Economy
  - Financing the green transition
  - Utilisation of electricity overflow due to fluctuating generation

The future Danish power system

Wind power is considered as the best and cheapest Danish emission free energy source. Therefore, wind and solar power will be used for not only "classical" electricity consumption, but after a conversion process also as replacement for fossil liquid fuels.

The first step of the conversion will be electrolysis into hydrogen.

It will take a much larger generation capacity than the classical electricity consumption.



From Energinet's web site: "Solar and wind must be quadrupled in just 8 years"

This growth will meet both practical and economical challenges.

New framework conditions for security of supply

The oil supply crises in the seventies taught Denmark and particularly the electricity industry to care for adequacy of energy. The basic rules were:

- Design power plants for at least two different fuels
- Develop coal supply infrastructure with large storage capacities
- Maintain large stocks of fuel (several months) in order to reduce price volatility for electricity consumers

The rules were part of the public security criteria until 2013. I wrote about the risk of a supply crisis for natural gas in 2009. Why did the Danish Energy Agency remove the rules on energy adequacy in 2013?

The Nordic countries developed electricity markets in the nineties. Most other European countries followed during the zeros. International "market couplings" were developed subsequently.

Before the electricity markets, agreements on international help during capacity shortages were developed bilaterally (for example DK-DE) or for the Nordic countries within Nordel. Such agreements were based on the installation of a certain dispatchable reserve capacity in each country. Access to foreign reserve capacity reduced the necessary installed reserve for the small Danish power systems considerably. It was a safe arrangement.

Nowadays, the national system operators are supposed to cover capacity shortages from the international electricity markets. The problem is that the introduction of fluctuating power (wind and solar) needs more transmission capacity than dispatchable generation, and that the transmission systems have not been reinforced correspondingly. The result is bottlenecks, which are often transferred to the national borders.

Our larger neighbouring countries can be operated isolated, and they are aware of the risk and of the possible consequences. Denmark cannot cover the demand for electricity in all situations and relies decisively on import[1]. This is theoretical work. The Danish policy feels very unsafe.

Barriers to the fast growth of electricity production

The maximum Danish electricity load was 6 GW in 2022. The production capacity was 6 GW dispatchable and 9 GW non-dispatchable. By 2030, the dispatchable capacity will be 4 GW and 53 GW non-dispatchable[2].

The challenge will be that the electricity infrastructure must be reinforced in the same rate as the production capacity, while the growth of energy production will be lower. The production capacity is planned to become 3.8 times higher from 2022 to 2030 in order to deliver just 1.6 times higher production.

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[1] Energistyrelsen: Klimaaftaleanalyse 1, Hovedrapport: Elforsyningssikkerhed frem mod og efter 2030. Januar 2022, resumé side 2:
Udlandsforbindelser vurderes dog under alle omstændigheder, at være en vigtig del af forsyningssikkerheden, når der omstilles til grøn energi. Det skyldes, at elsystemet bedre kan udnytte fx forskelle i vejrsystemerne mellem forskellige lande, når sol og vindkapacitet spredes over større geografiske områder

[2] Based on AF22, preliminary version from September 2022, for final version from January 2023 see https://ens.dk/sites/ens.dk/files/Hoeringer/af22_-_offentligt_datasaet_-_endeligt.xlsx

The capacity growth will require unparalleled resources in work force and new equipment. Delivery times for submarine cables and other key components are already now very long for all relevant production facilities. The prices are correspondingly high. It is hard for the electricity industry to keep the necessary work force just for maintaining existing equipment.

Onshore high voltage transmission and conversion facilities are visible in the flat Danish landscapes. Plans for new construction work are met with understandable resistance. It can take 10 or 20 years to find acceptable solutions for a new project.

It is doubtful if the entire power system can be quadrupled in just 8 years under such circumstances.

The Danish targets in the energy policy are the results of a competition on ambitions between political parties. All parties want to be more ambitious than any other party is. Practical and economic consequences have not been considered until afterwards.

How to finance the green transition in Denmark?

In order to increase the Danish military budget by 3 billion DKK, the Danish government has decided to cancel one annual holiday. The plan has caused strong public debate and resistance, even from labour unions.

After the debate on the cancelled holiday, it is understandable that the decision makers hesitate with a presentation of a budget for the green transition.

The politicians are probably looking for other financing sources than the Danish state budget.

The green transition is supposed to include four energy islands until 2040. The first one, Bornholm, is supposed to operate with 3 GW capacity throughout 2030 and produce 13.65 TWh. An energy island in the North Sea is said to cost about 200 billion DKK. This is another league than the Danish military budget.

The budget may include private investments, but the investors expect somebody to cover their cost afterwards. My concern is that electricity consumers are picked out as a financial source, at least for the infrastructure investment.

The expected production from four energy islands is supposed to be 61 TWh in 2040. This is said to replace oil and gas from the North Sea. If we assume an efficiency at 50% for conversion of electricity to a liquid fuel, the resulting output will be about 110 PJ, which is 9% of the Danish oil and gas production about 2005. There is a long and expensive way to a full replacement of the North Sea oil and gas production.

The budget for this gigantic project may be available somewhere, but for me it is one of the unanswered questions.

The non-dispatchable and fluctuating production will cause imbalances. The result will be shortage in some hours and overflow in other hours. The imbalances must be counterbalanced by exchange with neighbouring countries, flexible demand and curtailment of production.

The overflow estimates are 12 TWh (max 18 GW) in 2030 and 26 TWh (max 31 GW) in 2040. The question is if this overflow is supposed to be exported or utilised within Denmark. The high peak values will probably lead to curtailment of most of this production because the investment in a corresponding transmission capacity will be unprofitable. The 26 TWh are about 75% of Denmark's present electricity consumption per year.

The current plans in AF22 have been balanced with large overflows and small shortages. This balance implies an overcapacity of wind and solar power.

The total installed capacity is planned to be 86 GW in 2040 for serving a maximum load about 13 GW plus 17 GW flexible PTX load. Nevertheless, simulations indicate shortages up to 7.3 GW. The question is how economy will be for an 86 GW supply system with a 13 GW traditional load.

The practical problem will be to maintain a fair balance between demand, production capacity and infrastructure in a world with bottlenecks in the supply of equipment, shortage of labour force and public resistance against new installations.