The present situation for Electricity Certificate Market in Norway/Sweden

Impacts on Norwegian Hydropower.

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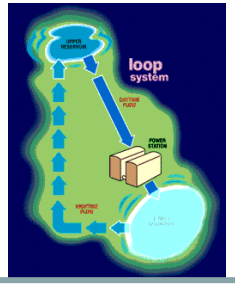
NIVA

uni Research

Renewable energy respecting nature

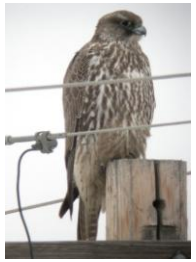
Main topics

Hydropower technology for the future



Environmental design of hydropower

Impacts on birds and wildlife from wind turbines and power lines



Reconciling environmental and energy policy concerns

Content

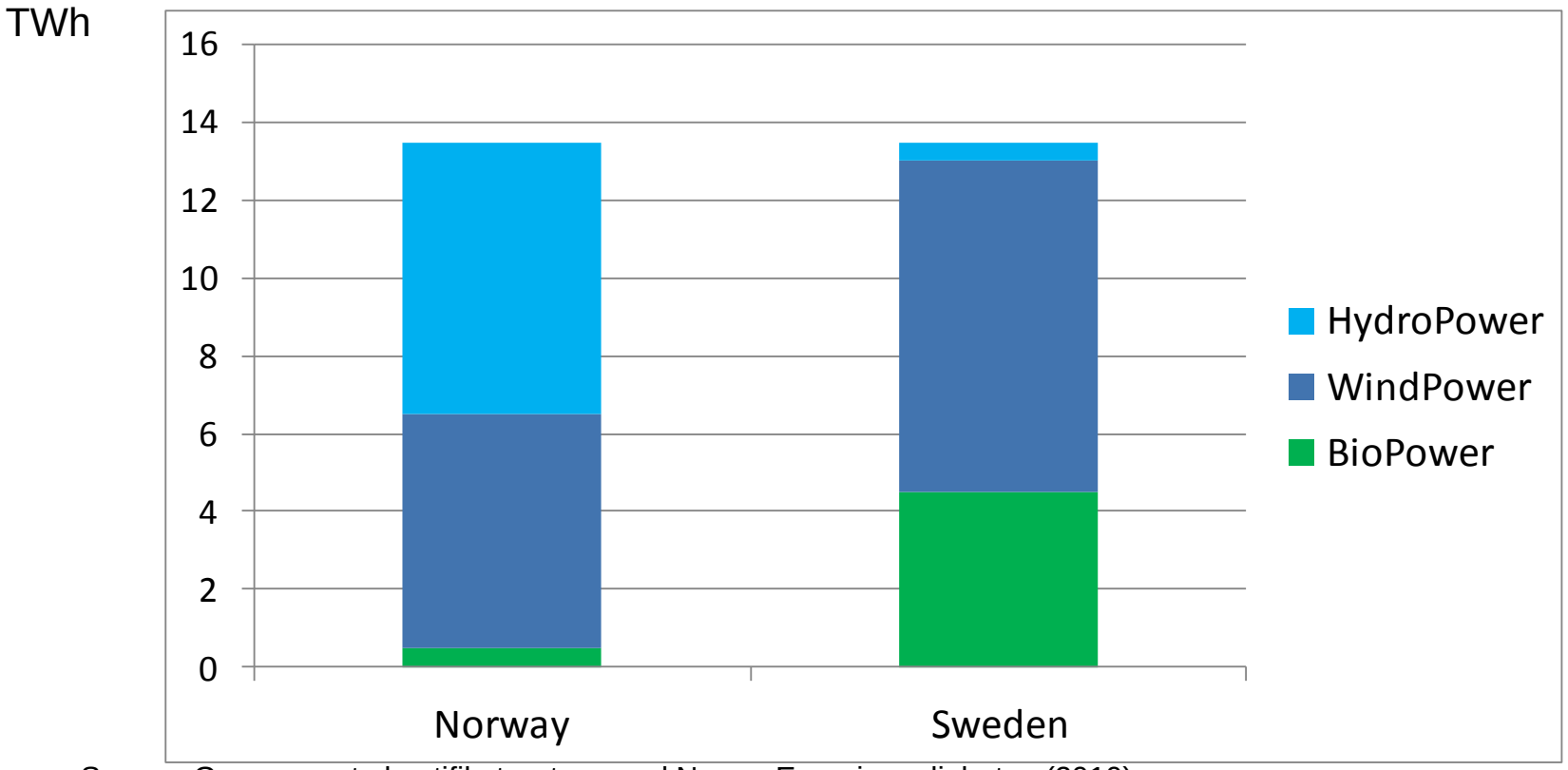
- The market in brief
  - The demand side
  - The supply side
- The impact on Norwegian renewable energy, highlighting hydropower
- Will investments come?

The Swedish-Norwegian certificate market
Investment period: 01.01.2012 - 31.12.2020

- Market based instrument
- Technology neutral scheme
- 13.2 TWh to be financed in each country within 2020; in total 26.4 TWh

- Green value of the new production shared equally between Norway and Sweden for use in EU Renewable Energy Directive
- Norwegian target in the Directive: Up from 58 to 67.5 % renewable share of energy consumption.

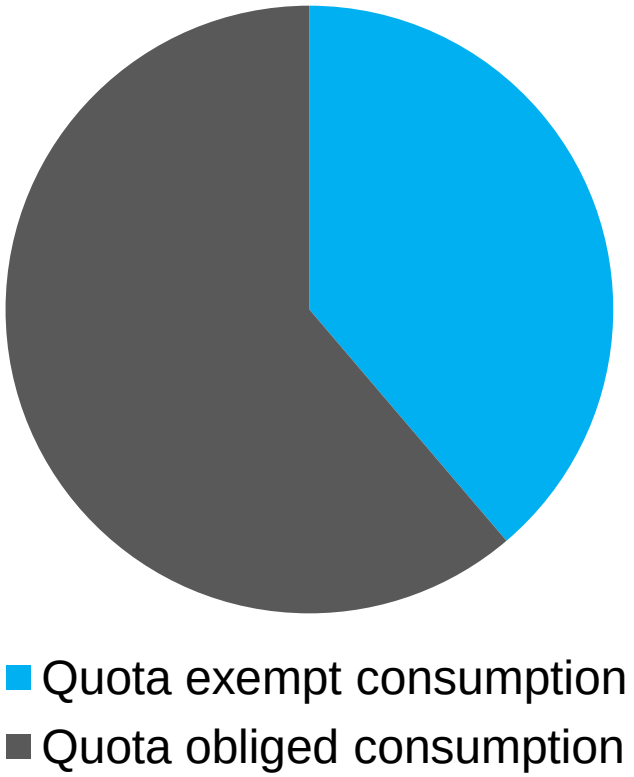
Possible contribution of different technologies in the two countries to reach the target of 26.4 TWh



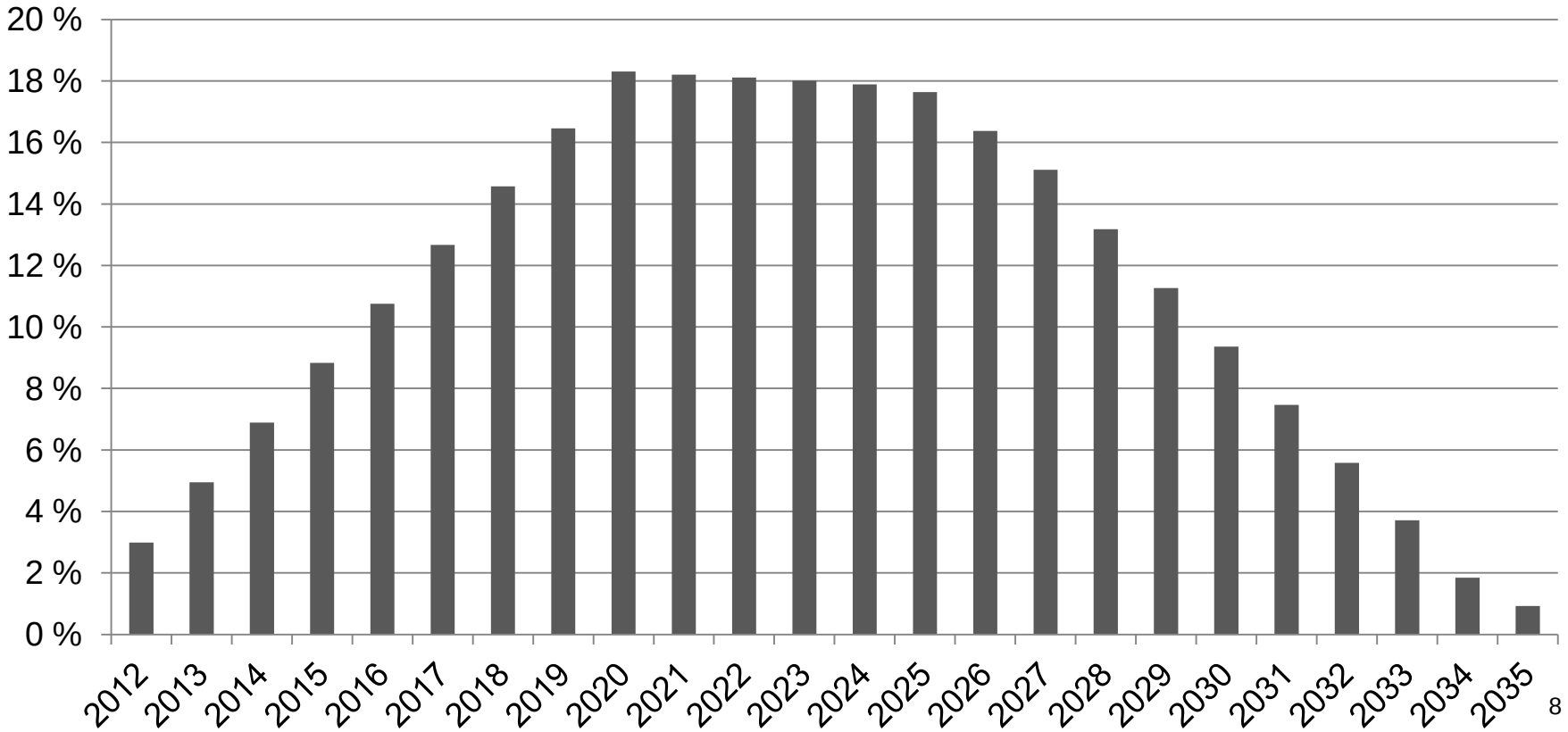
Source: Gemensamt elcertifikatsystem med Norge, Energimyndigheten (2010)

The Demand side

- IT is compulsory to buy the certificates for:
  - All power suppliers delivering electricity to final consumers
  - Consumers that purchase electricity through bilateral agreements
  - Consumption of self-produced electricity
- For a given share of their consumption/sales



The quota curve



THE SUPPLY SIDE
Certificate entitled production, Norway

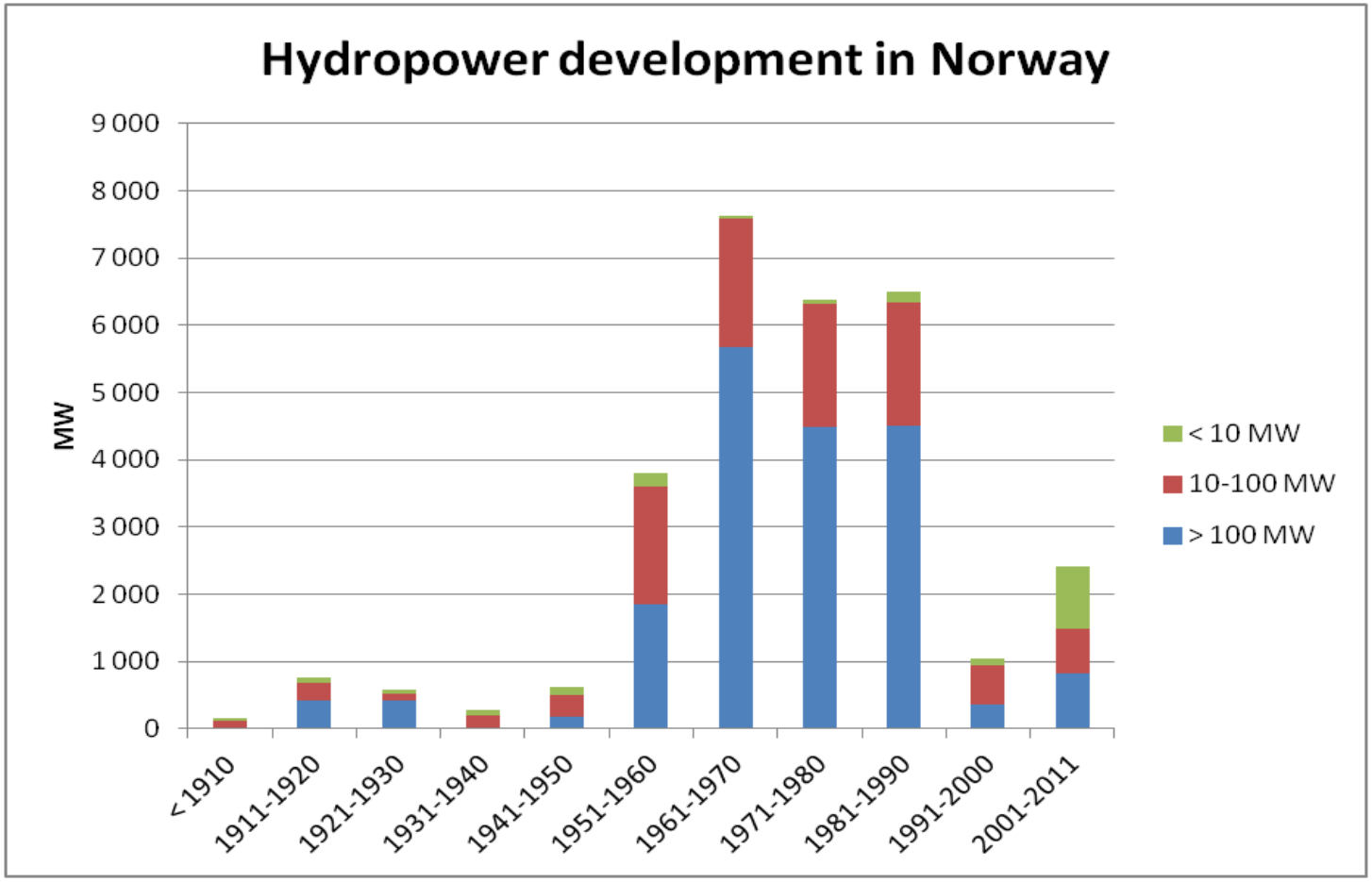
- All new renewable electricity production where construction began after 7th of September 2009
  - Hydro power smaller than 1 MW – 1st of January 2004
- A new plant is entitled to certificates for a period of maximum 15 years
- 1 certificate per MWh
- Certificate price has typically been approx. 25 €/MWh, but must be seen together with the power market. 85 €/MWh is considered necessary to trigger investment in Wind Power on land

Global Environment - Local Environment

Status Licensing

- Licenses given last 5 years
  - Hydropower: 3.7 TWh of which 1 TWh is in operation
  - Windpower: 5.9 TWh of which ~1 TWh is in operation/under development
- Licenses given in 2012:
  - Hydropower: 145 schemes, 644 MW, ~1 700 GWh
  - Windpower : 9 wind farms, 678 MW, ~2 000 GWh

- Hydropower energy generation: ~50% small hydro, ~20% upgrading existing large hydro, 30 % new hydropower plants with capacity over 10 MW

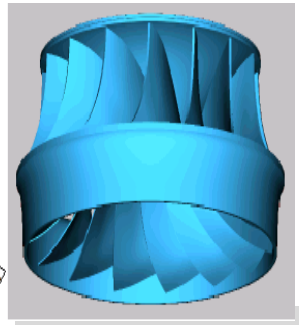

Hydropower development in Norway
MW
9 000
8 000
7 000
6 000
5 000
4 000
3 000
2 000
1 000
0
<1910
1911-1920
1921-1930
1931-1940
1941-1950
1951-1960
1961-1970
1971-1980
1981-1990
1991-2000
2001-2011
< 10 MW
10-100 MW
> 100 MW

Hydropower upgrading

- Reduced head loss and increased efficiency
- More water – hydrology related
  - Reduce loss of water
    - Increased flow capacity
    - Increased reservoir capacity
  - Increase inflow by for example diverting water from nearby catchment
- Increased head and/or reservoir capacity
- **Simulation models are needed for documentation of benefits caused by increased capacity**

Increase of Efficiency and Flow Capacity of Turbines

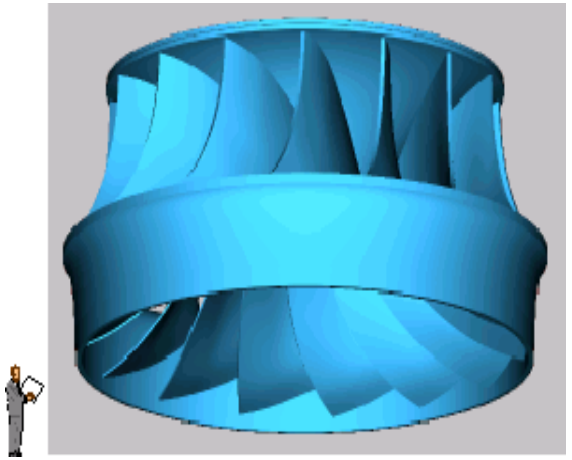
- Normal maintenance and re-establish a plants original technology will not be subject for Certificates.
- Accepted standards
  - Model test IEC 60193 or field measurement IEC 60041
    - Situation before and after change of technology must be documented
    - Reduction for wearing by use of simple formula or by documentation of original situation



The following simple formula may be used for wearing if the original situation can not be documented: $Y = 86,5 – 0,043\ X$

Y is reduced efficiency due to wearing in percent from commission or last upgrading. X is year for commission or last upgrading.

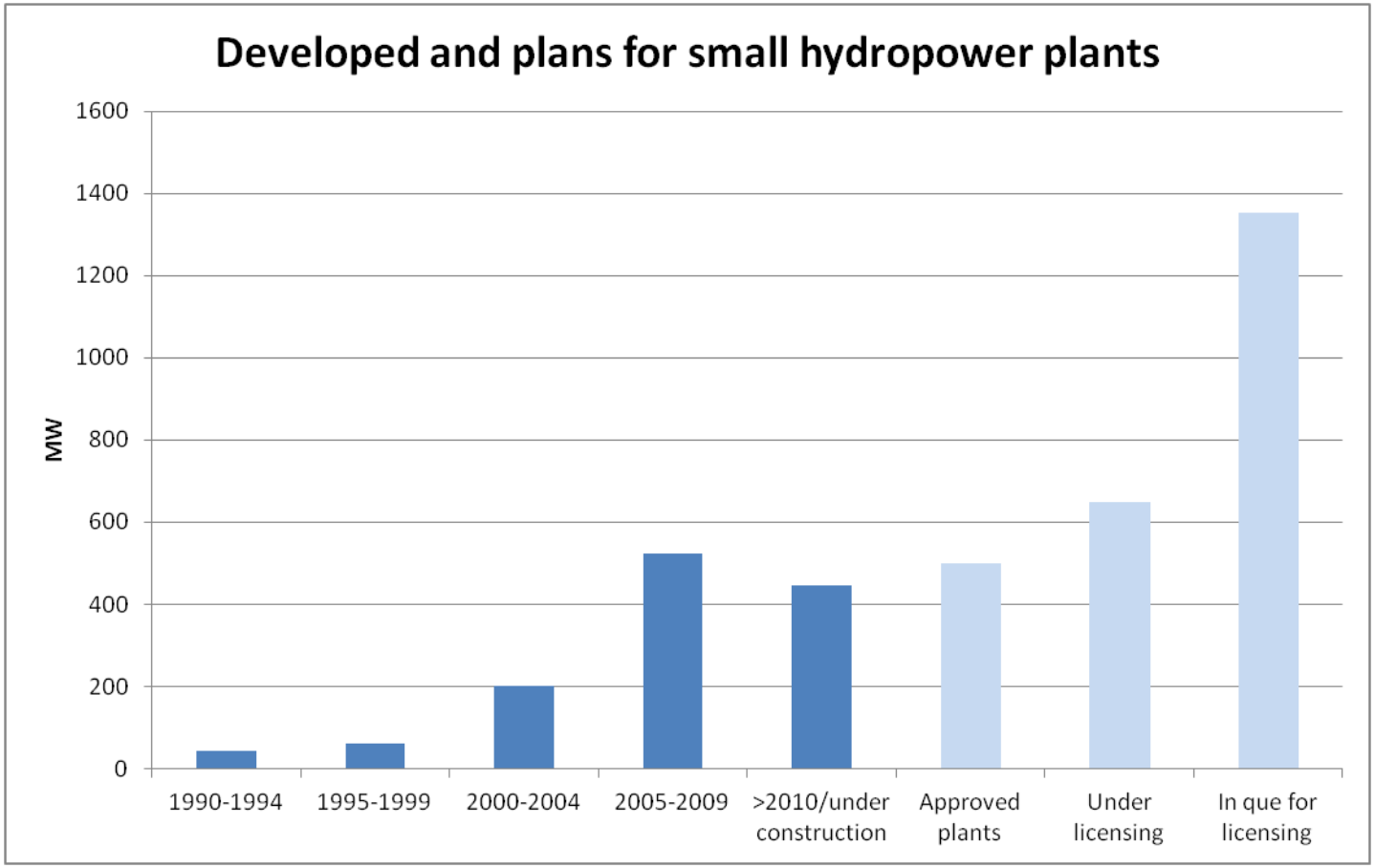
Increase of Efficiency and Flow Capacity of Turbines



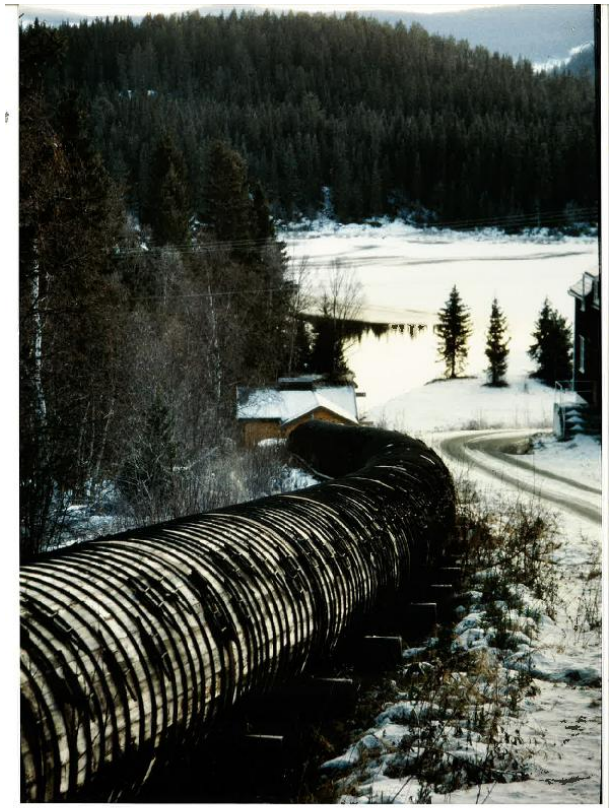
- Model tests or field measurements are recommended, but a simple formula can be used as an alternative for high and low head schemes (Pelton/Francis/Kaplan)
- $Y = 175 – 0.087\ X$
  - Y is increased efficiency in percent and X is year for commission or last upgrading
  - The formula includes reduction for wearing

Hydropower over 10 MW

- ~ 8 TWh under licensing
- Highlighting upgrading
  - Need approximately 3 TWh
  - Because of completely new plants total investment ~3500 million €


Developed and plans for small hydropower plants
MW
1600
1400
1200
1000
800
600
400
200
0
1990-1994
1995-1999
2000-2004
2005-2009
>2010/under construction
Approved plants
Under licensing
In que for licensing

License Small Hydropower



- Approximately 860 schemes in Licensing queue. Generation capacity more than 7.5 TWh
- Target to treat all within 2017
- Need 4 TWh to be developed before end 2020
  - Means 50 schemes 2.5MW/10GWh schemes each year in 8 years
  - Total investment ~2700 Million €

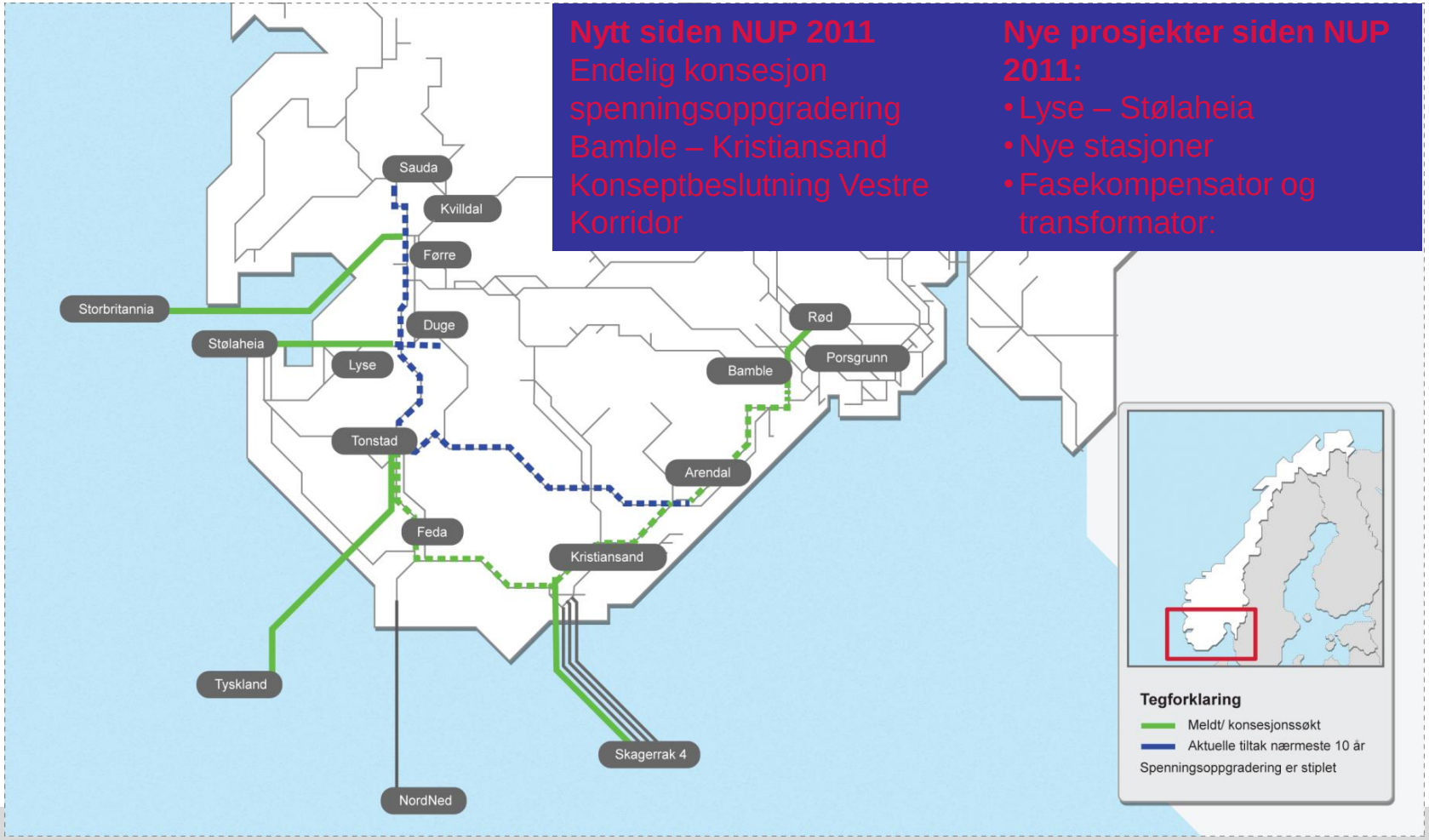
New generation capacity demands increased capacity in the transmission system

- Driving forces for new transmission
  - Security of supply
  - Increased consumption
  - New generation capacity

Licensing in NVE

- Over 1500 km High Voltage
  - Ofoten–Varangerbotn (745)
  - Storheia–Trollheim (127)
  - Kollsnes–Modalen (105)
  - Rød–Bamble (35)
  - Lyse–Stølaheia (73)
  - 315 km upgrading voltage (300→420 kV)
  - 170 km cables to other countries
- Ca. 800 km Medium Voltage
- Ca. 130 affected municipalities

The TSO (Statnett) work on detailed plans

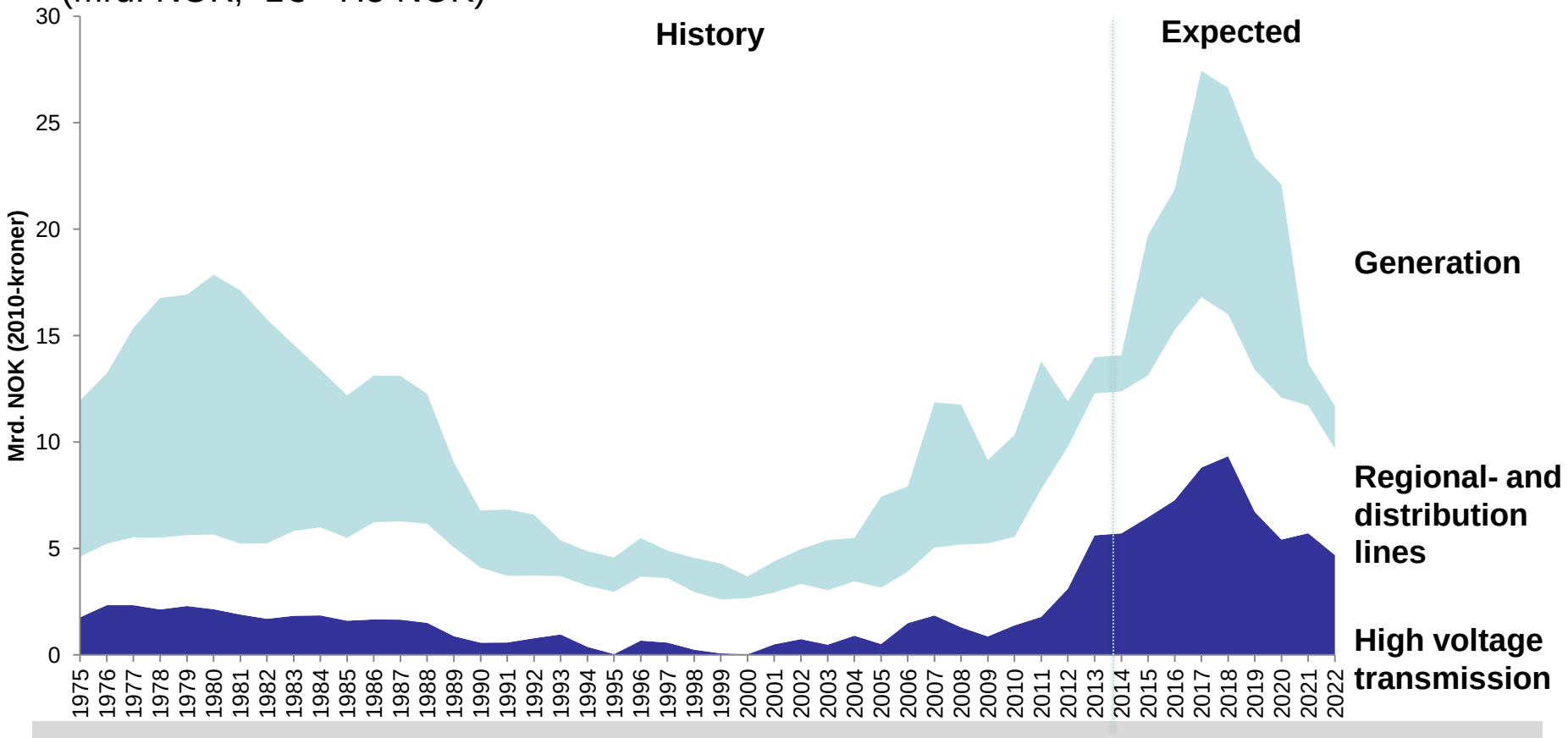


Can Norway reach new generation capacity of 13.2 TWh in the next 8 years ?

- Last 5 years:
  - Construction of 5 TWh hydropower has been completed
  - 1TWh wind power has been implemented
- The next 8 years:
  - New hydro-, bio- and wind power generation capacity financed in Norway/Sweden to reach the target of 26.4 TWh
  - 50 % implemented in Norway means approximately 8 TWh new hydropower and 6 TWh new wind power constructed
- Constraints:
  - Transmission capacity
  - Engineering and construction capacity

Norway sees the highest investment volume for renewable electric energy for decades

Investment in the power system
(Mrd. NOK, 1€ ~7.5 NOK)



Kilde: Statnett, SSB, NVE, NUP 2011, RKSUer, THEMA Consulting Group
*Investeringskostnadene for øvrige sentralnettseiere ikke med

Thank you for listening

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