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NORWEGIAN WATER RESOURCES AND ENERGY DIRECTORATE (NVE)

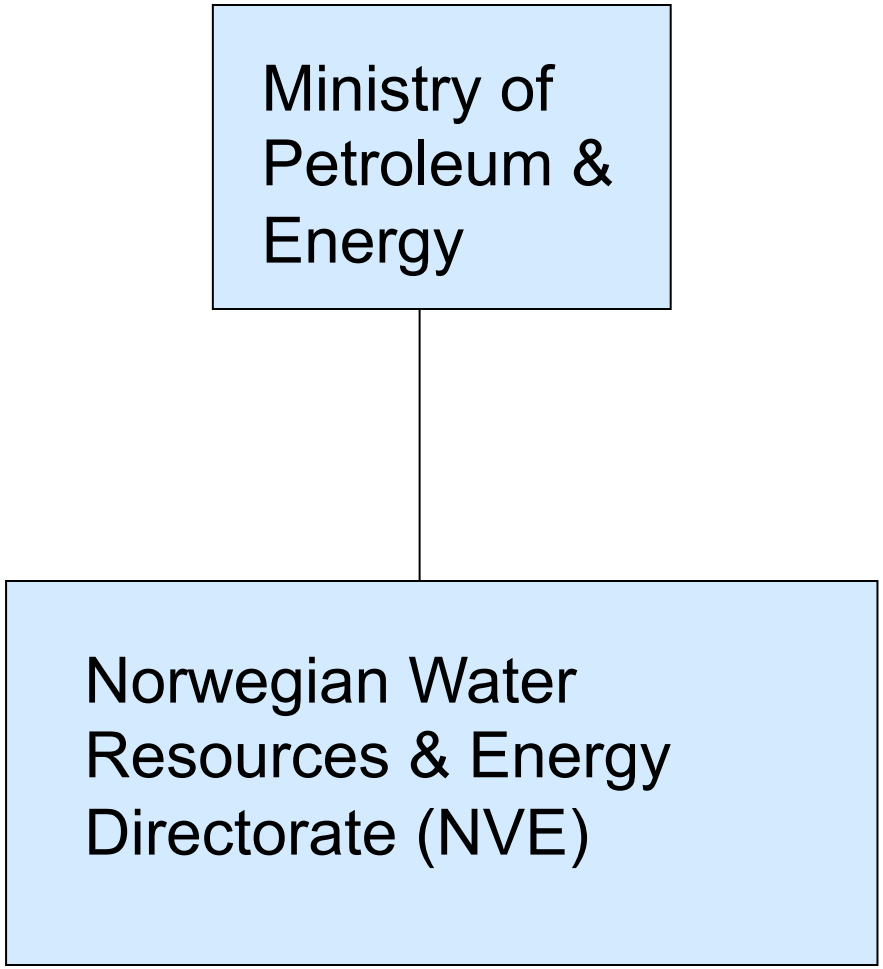
Hydropower development in Norway with special focus on the environment

Jens Aabel

Head engineer

Agenda

- Brief historic overwiev of hydropower development in Norway
- Licensing of hydropower
- Hydropower production today
- Windpower?

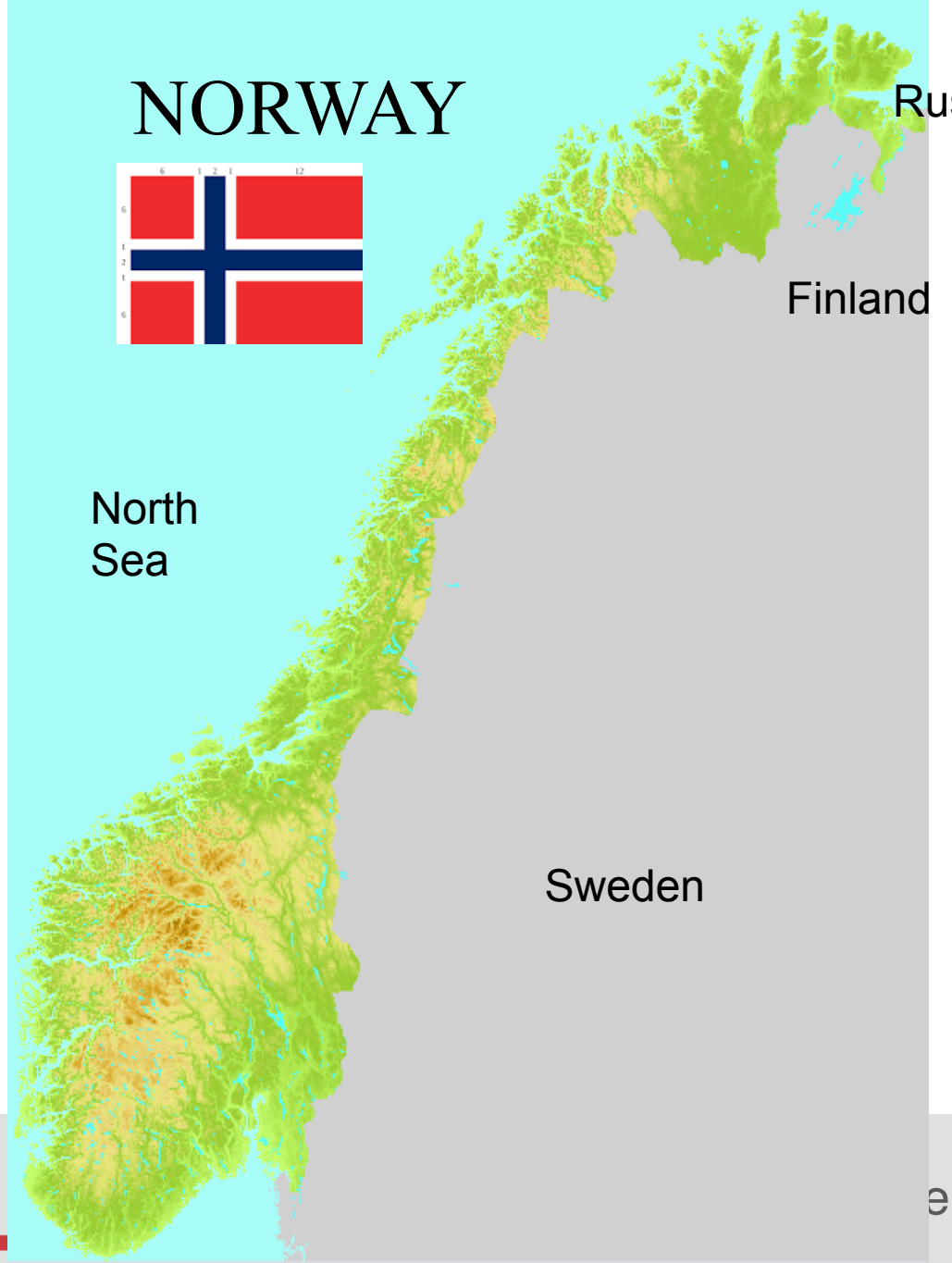

Ministry of Petroleum & Energy
Norwegian Water Resources & Energy Directorate (NVE)

NVEs Mandate

- NVE's mandate is to ensure an integrated and environmentally sound management of the countrys water resources, promote efficient energy markets and cost-effective energy systems and contribute to efficient energy use.

NVEs resposibilities

- national power supplies, production and transmission
- national flood contingency planning
- prevention of damage caused by landslides.
- expertise for hydrology in Norway
- experience in development assistance



Area: 385 000 km²

Pop: ~5 mill

58° N – 71 °N

Mean annual precipitation:
Varying from
4000 mm/y in the west
to 400 mm/y in the east

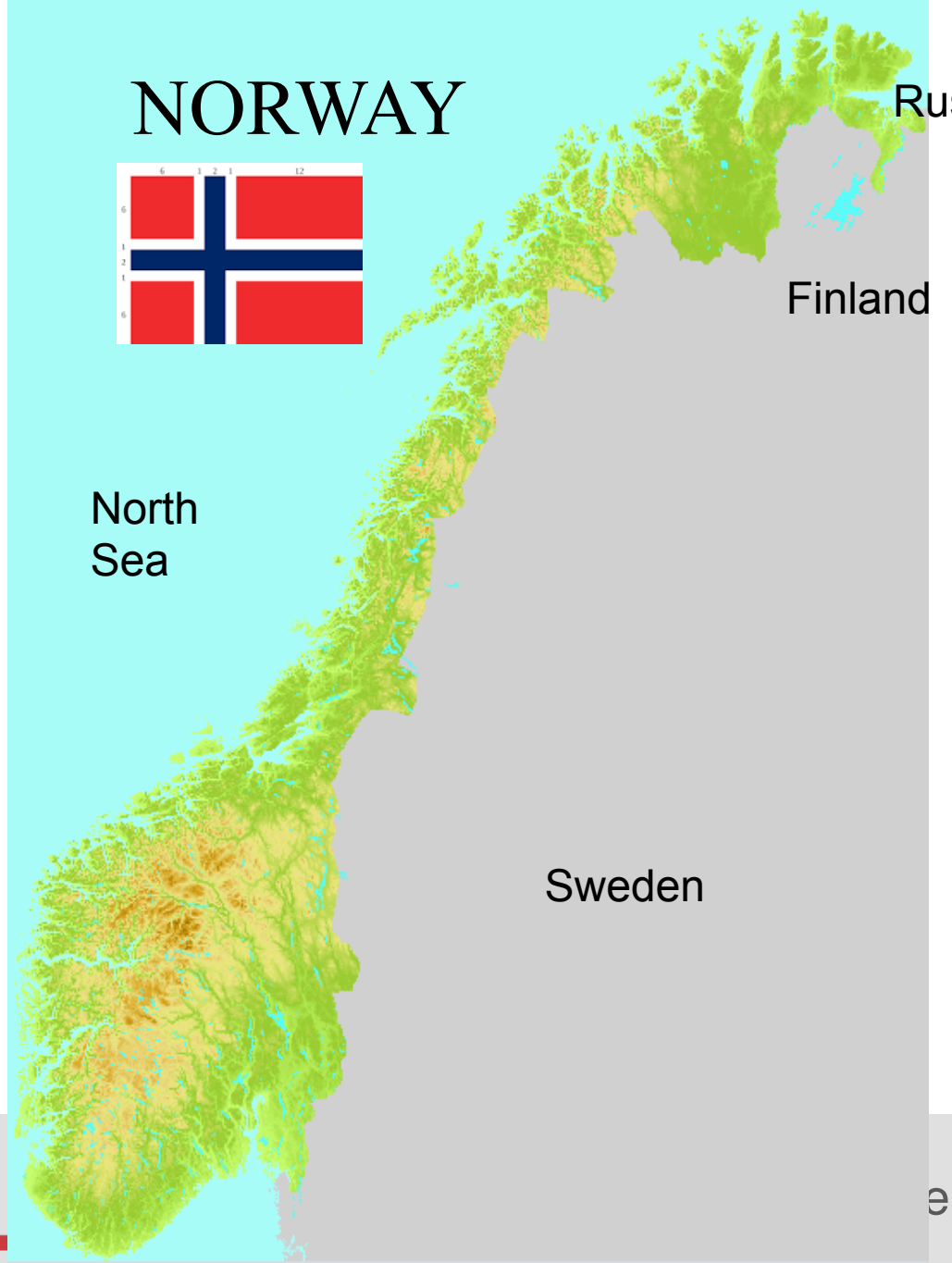
Temperatures:

Below 0 C in the winter season (4-6 months)
15 - 25 C in the summer

Background

1885 -

- first electric hydro power plant in Norway
- supply for the towns and Rural areas, light
- power intensive industry, pulp and paper, chemical, smelting



Area: 350 000 km²

Pop: ~5 mill

58° N – 71 °N

Mean annual precipitation:
Varying from
4000 mm/y in the west
to 400 mm/y in the east

Temperatures:

Below 0 C in the winter season (4-6 months)
15 - 25 C in the summer

1905

- Norway became independent

1906-07

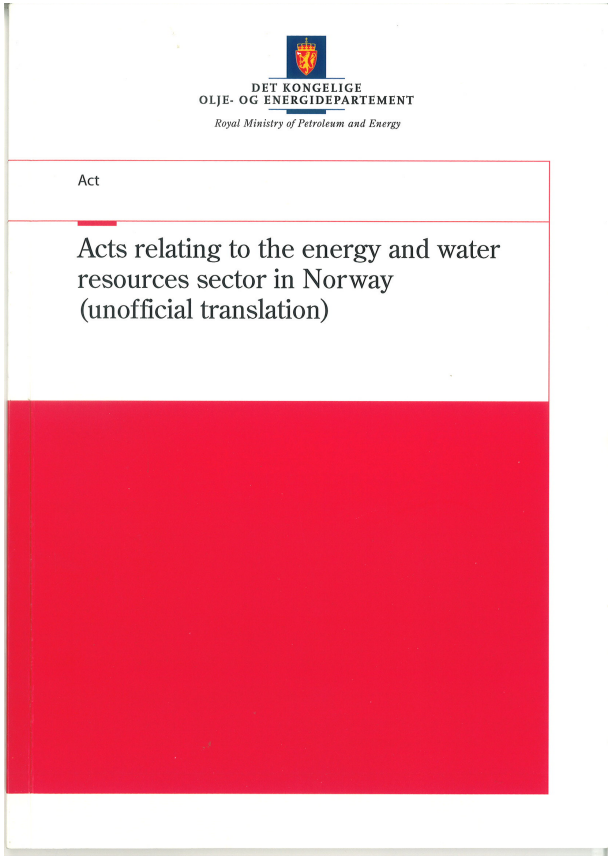
- "Panic Laws"
  secure national control over water resources

-**1917**

- Water regulation act
  - Aqusition act

-**1940**

- Watercourse act



The Right of Reversion

- The right of reversion was introduced into the law and regulations in 1909, and stated in the Industry License Law of 1917. License to own waterfalls for hydropower development is limited to 60 years for private companies where after a compulsory license reversion to the Norwegian State will be implemented
  - Definition of private owned power stations are those with more than 1/3 of the shares owned by private companies.
- The License has no time limit for hydropower owned by public companies
  - Norwegian municipalities, counties, the state and companies owned by them are regarded as public.

The Right of Reversion (2)

- The compulsory return of License is valid for hydropower stations that affect a river with more than 4000 Nature horsepower.
  - Calculation of Nature horsepower is complicated and includes affects of flow taken out of the river and reservoirs affect on the river flow.
  - For all practical issues, small hydro with capacity less than 10 MW is not affected by the Right of Reversion.
- Hydropower plants shall be handed over to the state without any costs and be well maintained.

The Right of Reversion (3)

- The 26th of June 2007 the EFTA Court ruled the Norwegian practice of the right of reversion in conflict with the EEA agreement.
  - Private and public owners shall be treated equally. Norway can still keep the right of reversion, but it must also include public owners.
- The 10th of august 2007 a Provisional Decree passed in the King's Council.
  - It will no longer be given licenses for acquisition of waterfalls and hydropower plants to private actors.
    - A consequence is that plants that have been given back to the state cannot be sold or rented to private actors
  - Such actors can, however, still own one third of public owned hydropower plants
- The Provisional Decree will give transparency and allow time for development of new laws and regulations.

1945 -

- Rebuilding the country after World War II

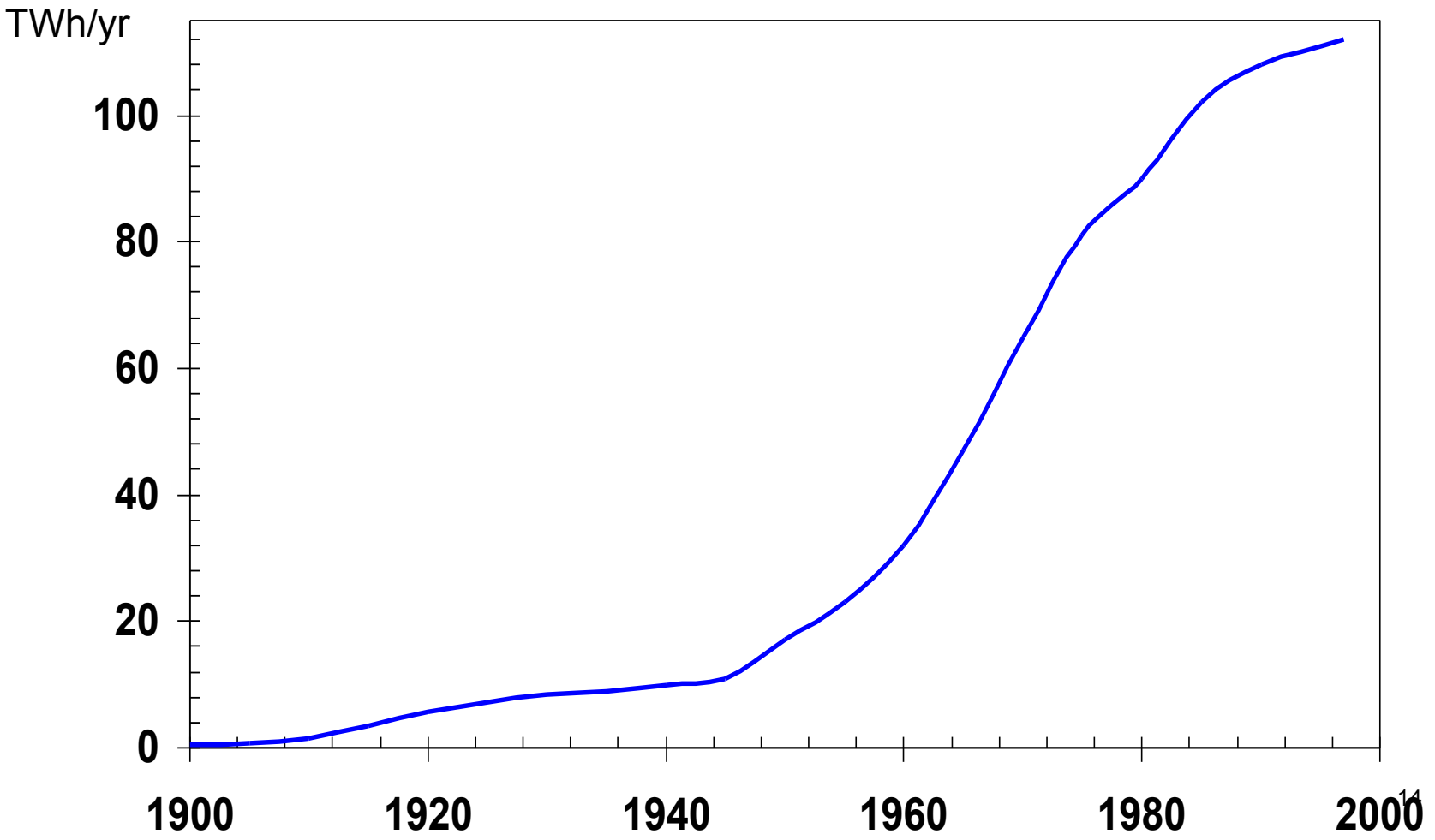
- Growing demand for electricity

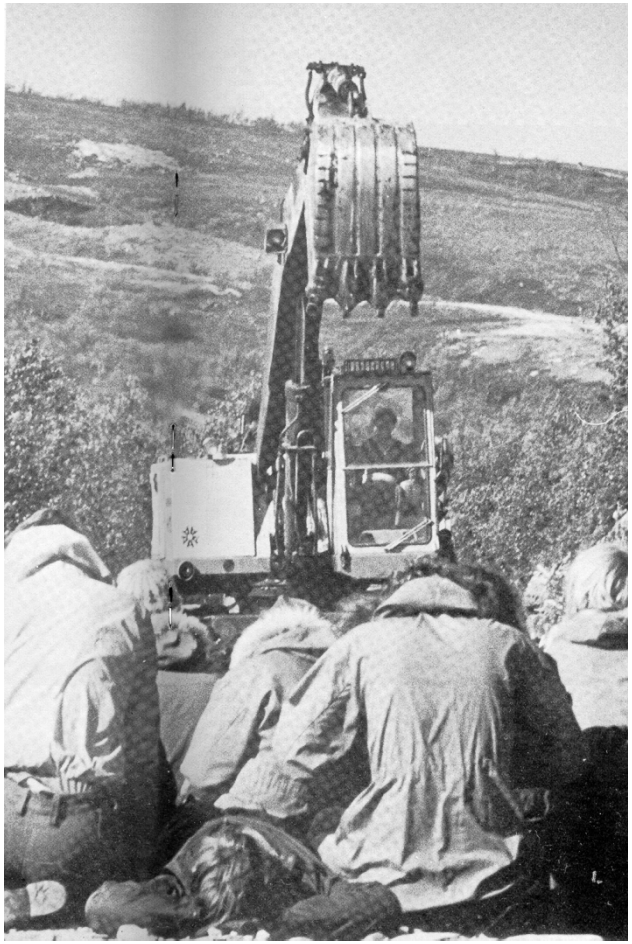
- rapid development of new hydropower plants

HYDROPOWER IN NORWAY

Mean annual production

1997:
112 TWh/yr





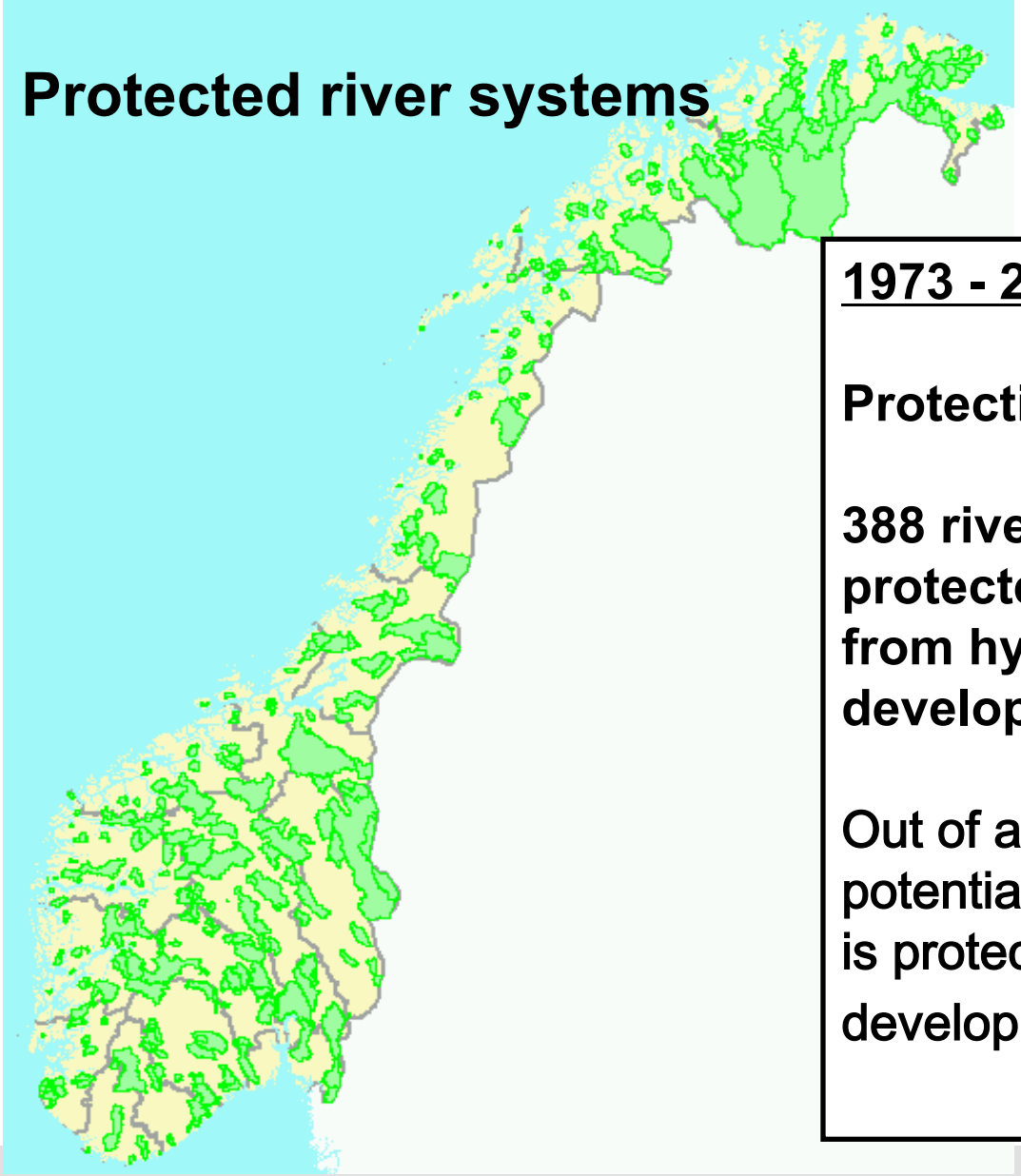
1960's

- Growing public concern about the environment
- Conflicts, demonstrations
- Demand for EIAs
- Alternatives
- Mitigation measures

1969

- Early notification
  interested parties invited to comment
  on the plan and the need for EIA
- Protection plan

Protected river systems



1973 - 2009

Protection Plan I - VI

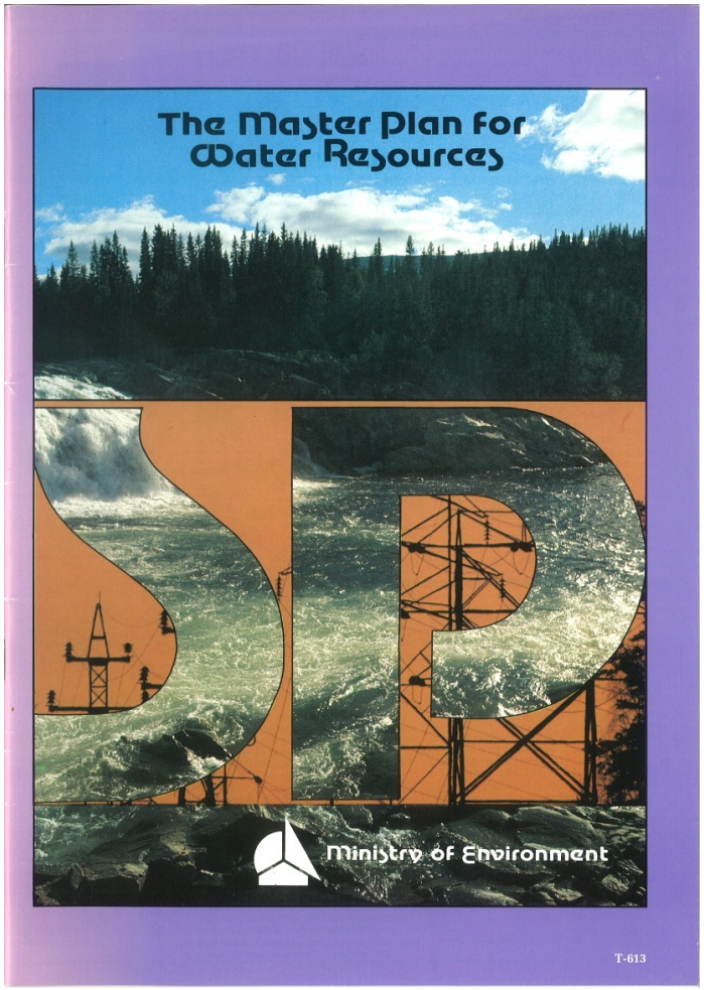
388 river systems are protected from hydropower development

Out of a total, theoretical potential of 212 TWh, 50 TWh is protected against HP development

1984 - 92

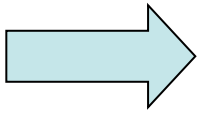
- Master Plan for the remaining hydropower resources.

- Priority grouping of projects depending on economy and environmental impacts.



1990 New Energy Act

- Energy price set by the Market (not by the Parliament)
- Access for everybody to the Grid
- No obligation for regional Powercompanies to guarantee production



Small Hydro (< 10 MW)

What is a license ?

(hydro power development)

- **A special permission granted by the authorities to develop and run dams and power plants specified in the license**

A license includes:

- **conditions and**
- **rules of operation**

RESPOSIBILTY IN LICENSING

- Responsible for the licensing process: NVE (competent Authority)
- Co-operate with the Directorate for Nature Management/Min. of Environment (Protection plans/Master plan for hydropower) (concerned Authority)
- Granting Authority large hydro: Norw. Government (council of Ministers)
- Granting Authority small hydro (<10 MW): NVE (Appealable)

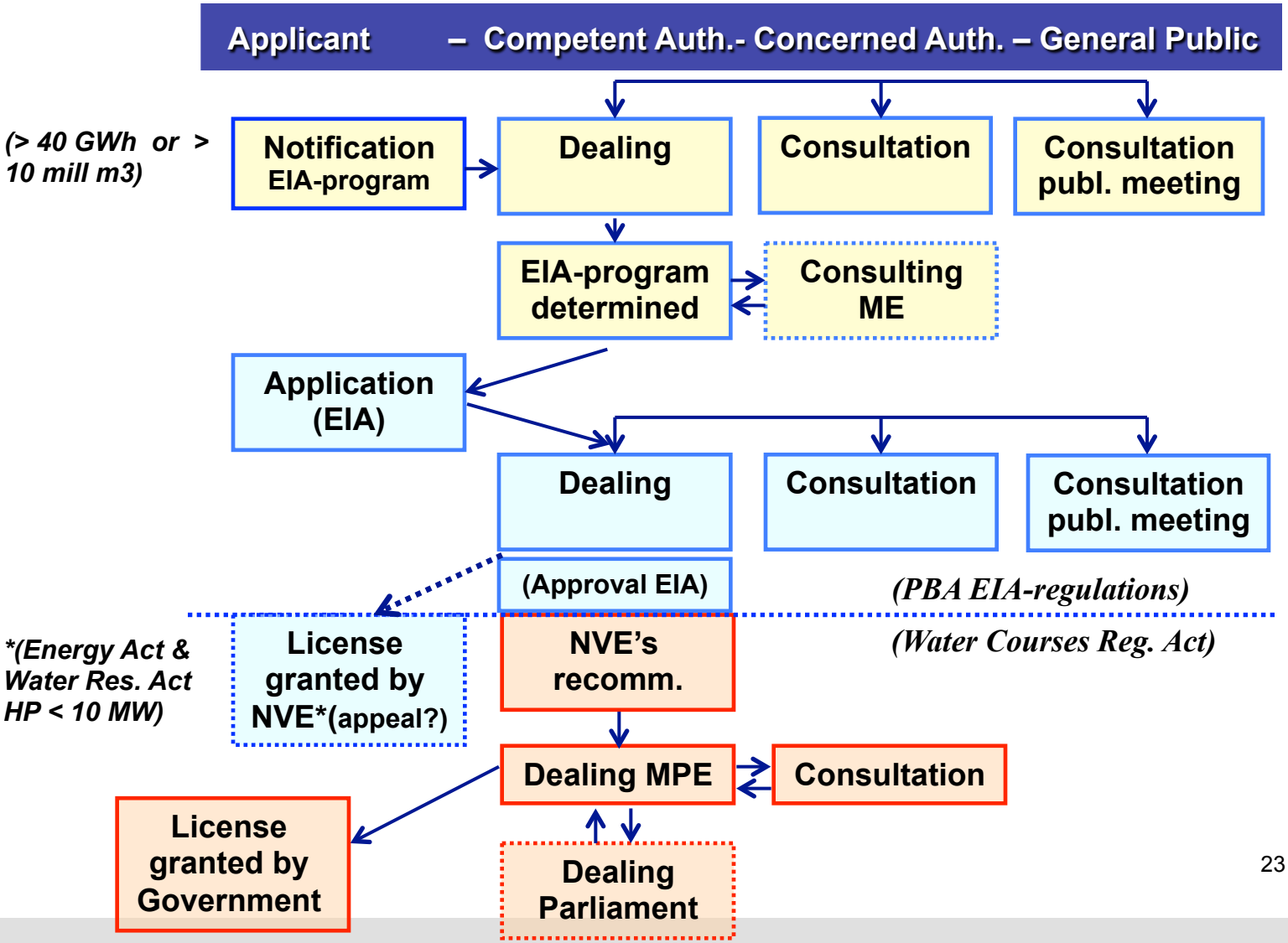
Handling of hydropower applications - main phases

- 1. Notification phase
- 2. Application phase
- 3. Recommendation/decision phase

Relevant acts (criteria) – HP licensing

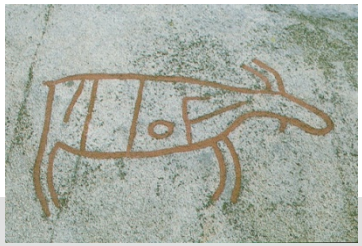
- **Acquisition Act**
  - Waterfalls with a potential exceeding 4000 nat.hk
- **Watercourse Regulation Act**
  - Reservoirs/diversions exceeding 500 nat.horse power
  - Run-off-river hydropower stations average production > 40 (30) GWh/year
- **Water Resources Act**
  - Public interests significantly affected
  - Extraction of water reduces defined low flow
- **Energy Act**
  - Voltage 1000 Volts (AC) or more
- **Plan and Building Act – EIA regulations**
  - Development/reservoirs average prod. > 40 (30) GWh/year
  - Establishing reservoirs with cap. exceeding 10 mill m^3
- **Pollution Control Act**
- **Cultural Heritage Act**
- **Nature Diversity Act**

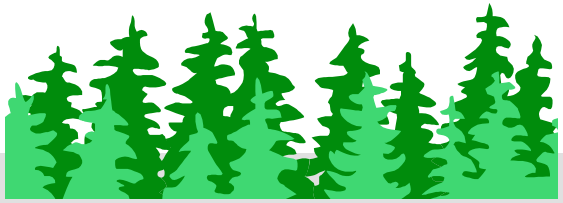
HP licensing process



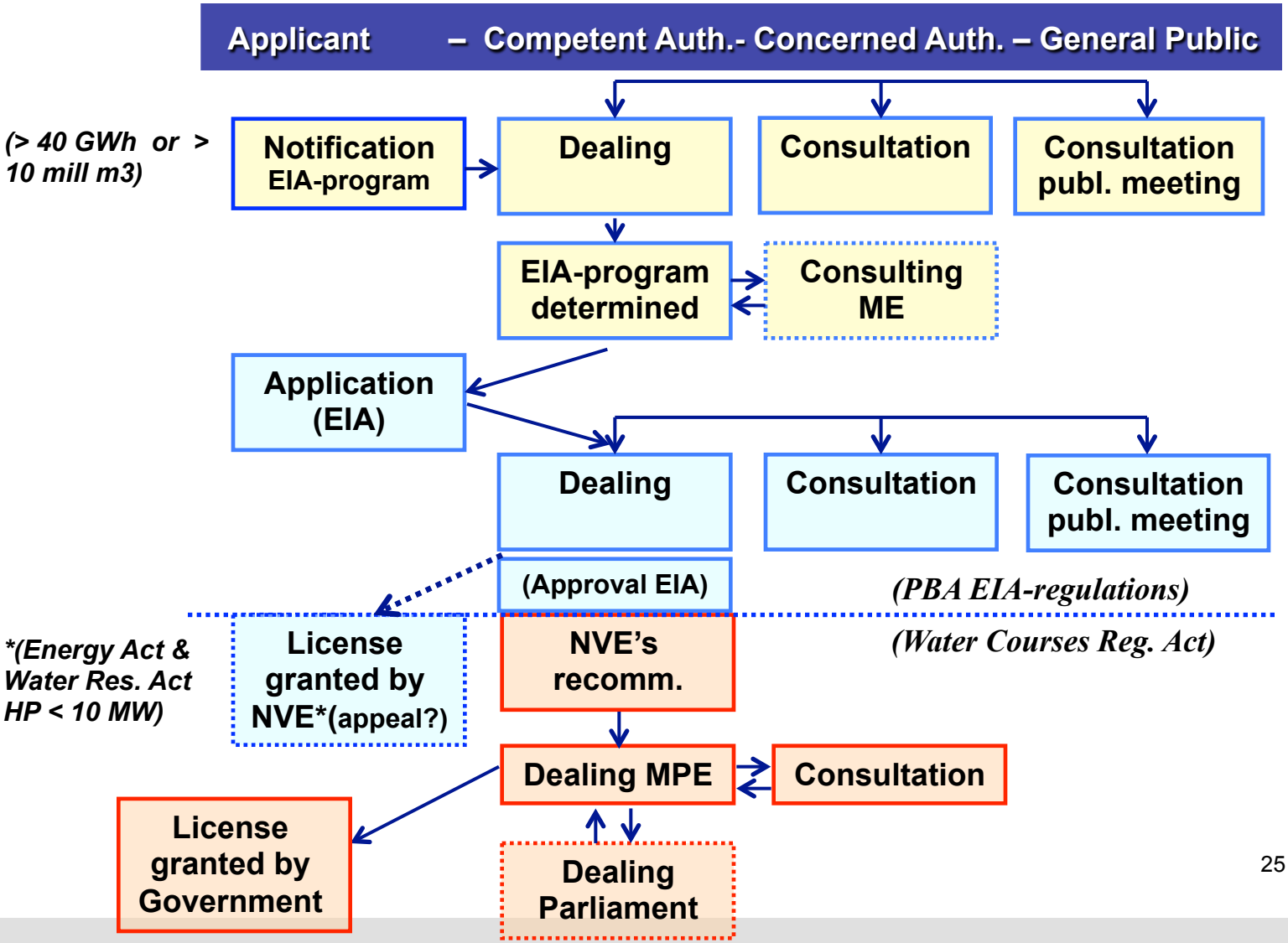
Impact assessment (EIA)

Environment	Natural resources	Community
* Hydrology	* Agriculture	* Industries
* Geology	* Forestry	* Population
* Landscape	* Fresh water resources	* Service
* Local climate	* Marine resources	* Local financials
* Water quality	* Minerals & gravel	* Infrastructure
* Fresh water biology		* Social conditions
* Terrestrial biology		* Health
* Cultural monuments		* Outdoor life





HP licensing process



Focal Issues in licensing

- Environmental, Cultural and Social Impacts
- Secure delivery of Energy
- New Renewable Production

Licensing today

Main question:

Is the project environmentally acceptable? Is benefit for public and private interrest > disadvantages? Mitigating global warming.

If a license is granted:

Focus on conditions that can mitigate or eliminate environmental impacts

Conditions - serving public interests

- In the licence, conditions can be stipulated as deemed necessary to serve the public interests
- The conditions cover both the construction and operating phase
- The conditions give wide authorisation to relevant sector agencies, such as the NVE and Directorate for Nature Management, to impose environmental and other measures, conducting surveys, and for monitoring and control
- Compensation to affected landowners/private interests is **not** included in the conditions, but is settled through amicable agreements with the developer and/or by the court of appraisement

A granted HP licence contains a set of conditions (terms) regulating the whole "life" of the licence:

- Duration
- Construction deadlines
- Approval of plans, inspection, etc.
- Annual fees and industrial funds
- Compulsory power to the municipalities
- Natural features and cultural monuments
- Fishing, hunting and outdoor recreation
- Erosion, clearing up of regulation zones etc.
- Preventing pollution
- Roads, passages, foot paths
- Hydrological measurements
- Rules of operation, minimum/environmental flow
- Irregularities/violations, penalty
- Revision of conditions

Economic compensation (1/2)

- The licence conditions include various provisions for paying compensation to the local communities that are affected by the hydropower development
- The local municipality (authority) is entitled to a certain part of the electricity production ("license power") payable at production cost only. Originally, the idea was to secure power for local electrification of households and small scale industry, but is now seen as a form of compensation for permission to use the resources, and environmental disadvantages (8,6 TWh ~ USD 300 mill)

Economic compensation (2/2)

- The licence holder will also have to pay a defined **annual fee** (based on the potential mean annual production) to the local municipalities and to the state. 25% of the total fee is paid to the central government and 75% to the affected local municipalities. (USD 25 mill + USD 100 mill)
- Another general condition defines a special **development/ industrial fund** (single payment) to the affected municipalities. Within a framework decided by the government, the local authority decides the use of the funds in order to develop local industry and/or businesses.
- A development fund will be calculated based on the production rate (kWh) and scope of impacts. During recent years, development funds have been in the range of 0.5 - 5 mill. USD

Mitigating measures

- Minimum water flow (or environmental flow) is regarded as one of the most important mitigation measures to reduce negative impacts from hydropower regulation in rivers
- Purposes:
  - Preserve biological diversity
  - Maintain landscape quality
  - Maintain sufficient water for other water-users
  - Recipient, reduce pollution (dilution)
  - Maintain groundwater level
  - Prevent salination

RULES OF OPERATION

- Highest and lowest regulated level

- Seasonal restrictions on regulation levels

- Minimum water supply to the rivers

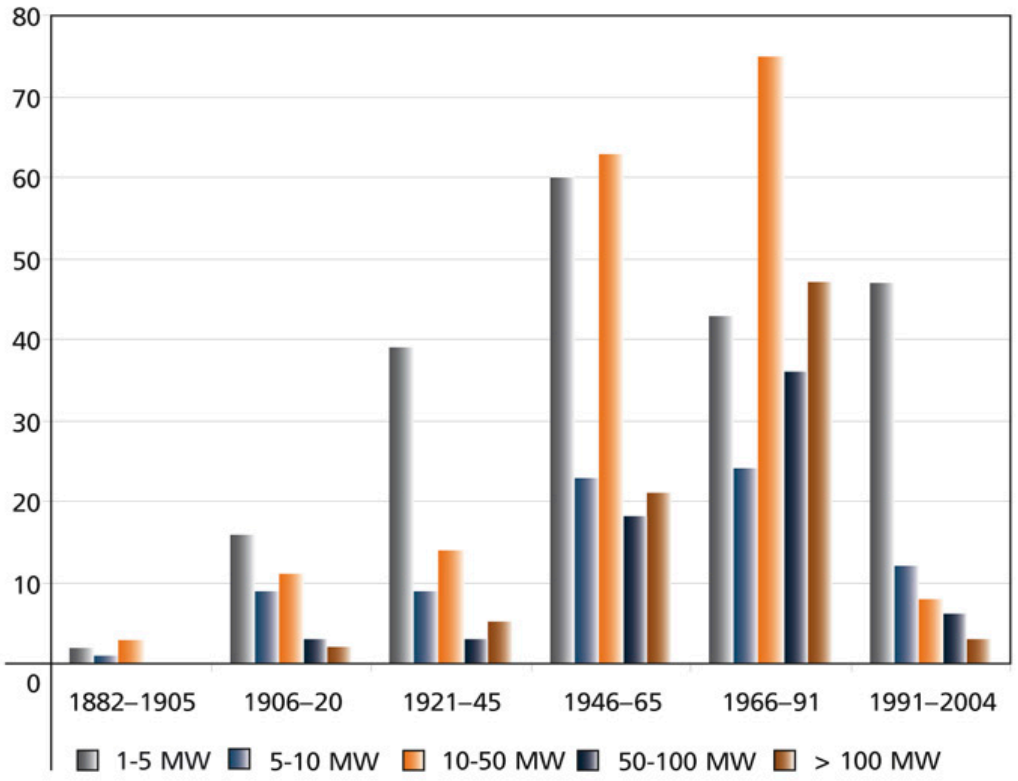
- Regulation during floods

Existing Hydro power plants in Norway

- **Mini and Micro plants less 1 MW: In total ~500 plants**
- **Small hydro between 1 and 10 MW: ~400 plants existing and approximately 650 schemes are in the licensing queue**
- **More than 300 larger than 10 MW, and approximately 80 of these are larger than 100 MW**

The Norwegian Hydro Power System

- **Installed capacity : 30,000 MW**
- **Mean generation capacity 130 TWh/year, which is approximately 98 % of electricity production in Norway**
- **Mean utilization time: 4,200 hours (Plant factor 0.48)**

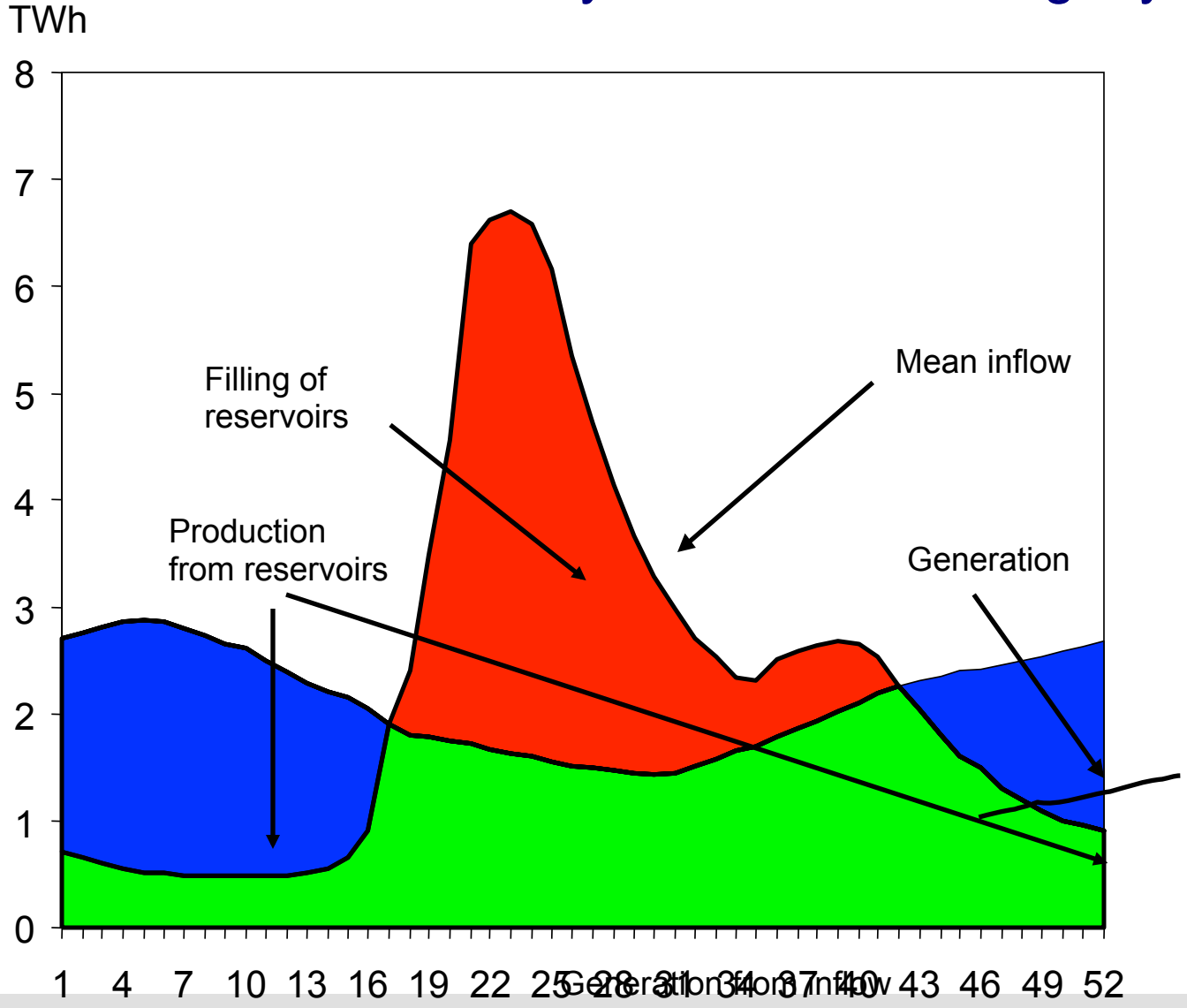


Figur 2. Her vises hvordan dagens kraftverk er fordelt etter epoke og størrelse. Kraftverkene er gruppert etter dagens størrelse i MW, mens de er plassert i epoke etter året de ble satt i drift.

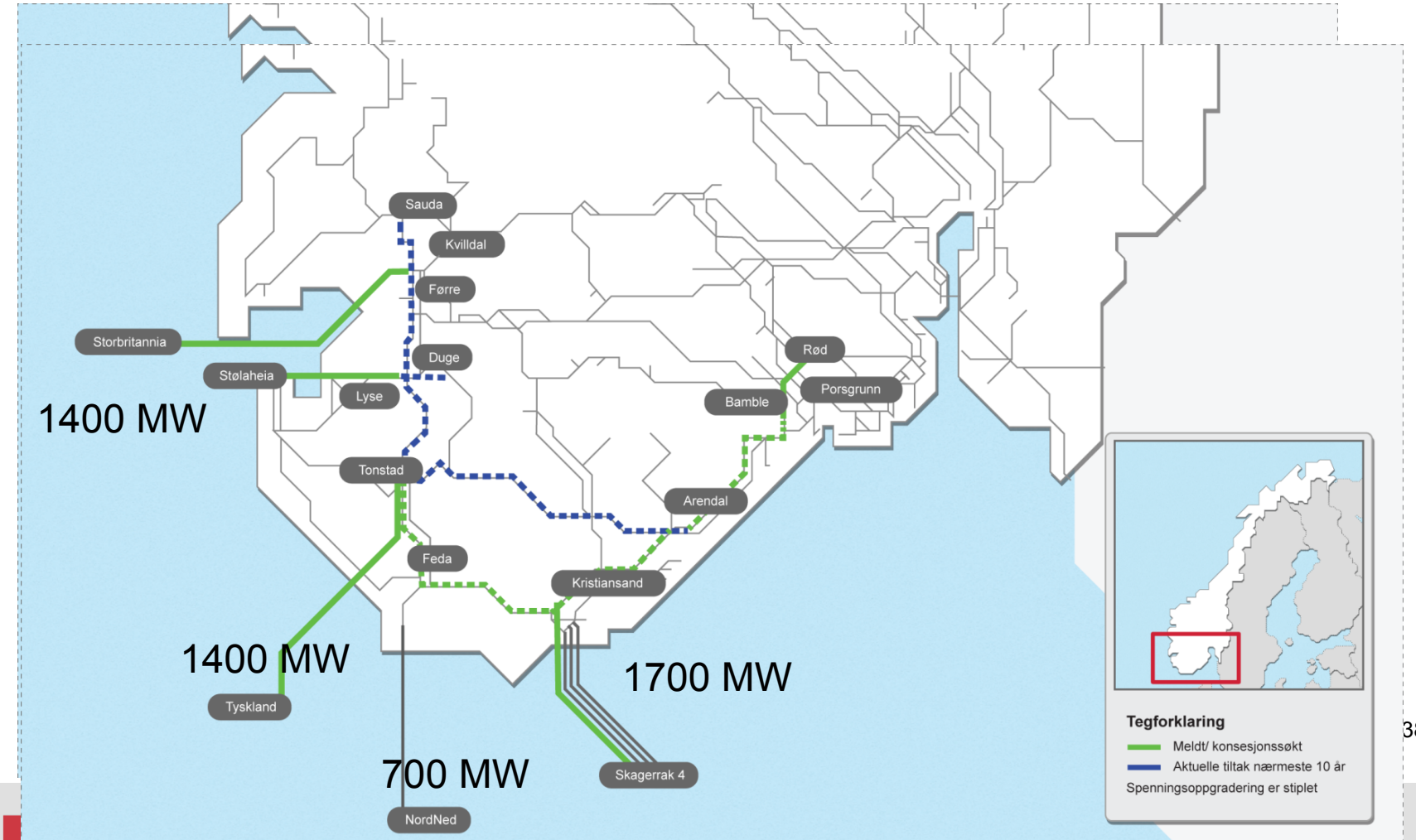
The Norwegian Hydro Power System

- **Reservoir capacity: 85 TWh (62 bill. m^3)**
- **Reservoir capacity is about 70% of mean production capacity**
- **Approximately 50% of total reservoir capacity in Europe**

Water Inflow and Electricity Generation during a year



The TSO (Statnett) work on detailed plans



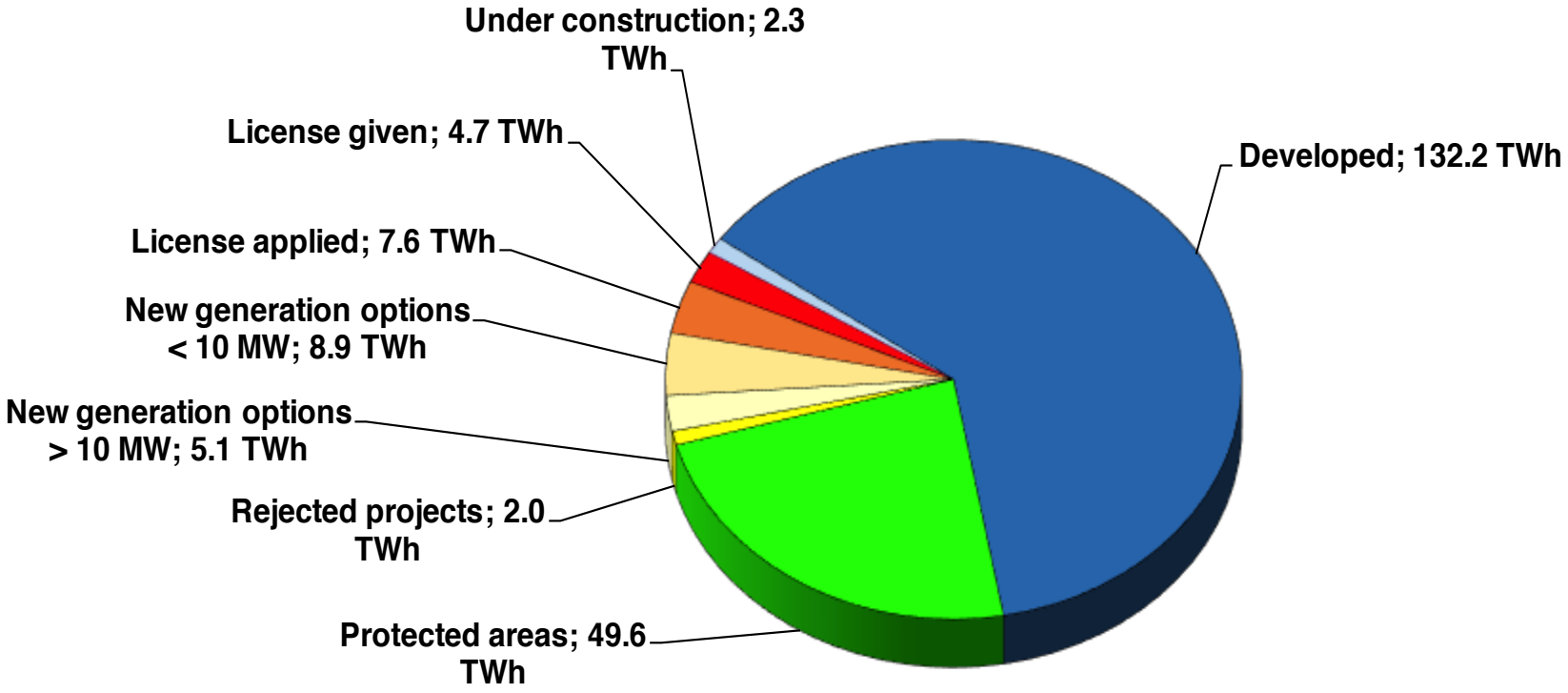
HP development today

- Electricity in Norway:
  - Production > Consumption
  - Demand has leveled out
  - Prices are low (~10 us cent /kwh)
  - Strong focus on environmental impacts

Why continue developing?

Hydropower potential as of 01.01.2016

Mean annual generation capacity 212.5 TWh, referred to hydrological period 1981-2010




The world needs more renewable energy to handle climate change

International Commitments

- El-certificates (Sweden)
  - 26,4 TWh within 2021
- Renewable Directive (EU)
  - 67,5 % renewable energy
- Water Directive (EU)
  - Water regulations
- Convention of Biological Diversity (Global)
  - Act of biological diversity

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

New Hydropower

- There are still options for new hydro, but not large scale harnessing high head waterfalls
- Increased precipitation and thereby waterflow and search for more renewable electricity generation capacity will have impact on economic evaluation of new schemes

2012 – 2018 Hydropower over 10 MW

- The new Government`s declaration 8 October
  - Develop a strategy plan for implementing of the approximately 8 TWh potential of renewal and upgrading hydropower plants

tje@nve.no

Small Hydropower

- Small Hydro is considered gold for many farmers
- 2013 :
  - 828 applications for license in NVE (1 -10 MW)
  - 2300 MW
  - 7,3 TWh

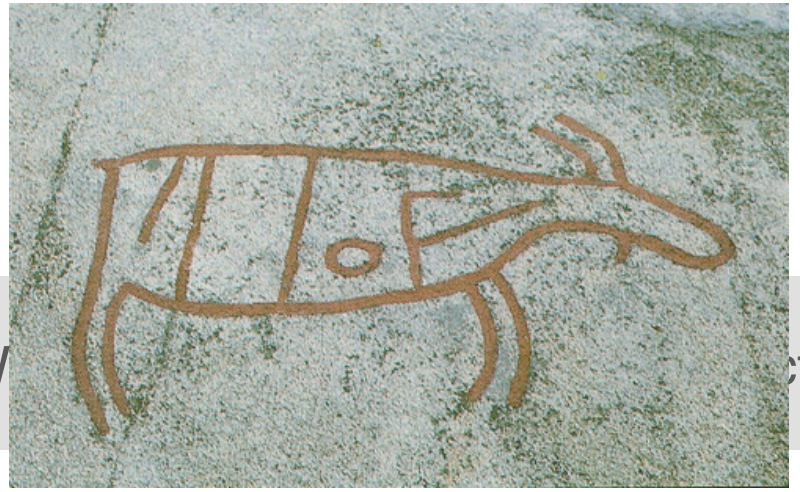
Status windpower

- Granted Licence to 47 Projects with total Production of 10 TWh.
- 1,5 TWh constructed or under construction
- 17 projects with 4,5 TWh production is appealed to the Ministry of Petroleum and Energy
- 15 projects of totally 4 TWh production have a legally valid License and are ready for construction


Gracias por
su atención

Natural features and cultural monuments

- The conditions state that destruction of **natural characteristics, landscape areas**, ancient monuments etc. should be avoided during the construction phase
- Before starting construction work, the licence holder shall find out whether protected **cultural monuments** are affected, in which case the responsible authorities shall be notified immediately.
- Ensure that the natural **living conditions** for fish (recruitment, migration etc.) and other **fauna and flora** in the area are affected as little as possible, and compensate for any damage.
- Obligation to pay for **scientific surveys** in the areas affected by the development project and cover expenses for inspections etc.



Fishing, hunting and outdoor recreation

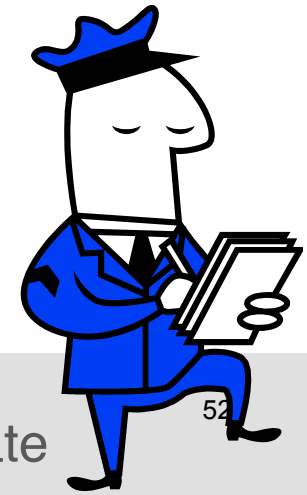
- Ensure that values for fishing, hunting and outdoor recreation are maintained
- Obligation to pay an annual amount to the affected municipality for the promotion of fish/game/outdoor recreation
- The amount relating to fish/game shall be spent according to provisions adopted by the Municipal Council. For the benefit of outdoor recreation, the amount shall be spent pursuant to provisions adopted by the Directorate for Nature Management
- The licence holder will cover expenses for inspections etc.

Thresholds etc.

- In parts of the river with substantial change in water flow and level, the MPE can instruct the licence holder to build thresholds, implement measures to adjust biotopes, river course adjustments, clearing operations, etc. to reduce harmful effects
- The adjustments shall be based on a total plan taking into account both private and public interests related to the river system

Compliance – violation of conditions/terms

- The licence holder is responsible for acting in compliance with conditions/terms stated in the license
- If the terms are violated, the licence holder is obliged to (on the request of the Ministry of Petroleum and Energy) **bring matters into agreement** with the terms
- Violation of the terms may become subject to a **fine/ penalty**
- Repeated or continued violation can lead to **withdrawal of the license**



Revision of conditions

- **After 30 years** it is possible to request a revision of the licence conditions.
- NGOs and affected municipalities, **representing public interests**, can then send a formal request to NVE stating the needs for revision, and suggested priority issues/areas
- The purpose of revision is to **update and "modernise"** the conditions in order to meet new environmental requirements
- Revision is thus **limited to environmental issues**, e.g. minimum/environmental flow, environmental funds (new)
- Limiting reservoir levels (HRWL / LRWL), economic compensation, and private-law issues are normally not subjected to revision.

Experiences with the Norwegian procedures (1):

Local benefits and development:

Compulsory delivery of power to local community
- 10% of total production
- rural electrification
- development of local industry

Annual fees and funds
- the local community gets a share of the profit
- incentive for local development

These tools have been important to achieve acceptance for new projects from affected communities

Experiences with the Norwegian procedures (2):

Benefits:

- public participation
- good at identifying environmental impacts resulting in appropriate mitigation measures
- local economic benefits

Drawbacks:

- high costs
- time consuming

Impact assessments

- important to focus on important issues!

Crucial information may be drowned in pages of unimportant details