



Norwegian University of  
Science and Technology

# FME on Hydro Power - HydroCen

Chair: NTNU

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Hydro Power of significant importance for  
Brazil and Norway

Exchange rate: 1 R\$ = 2.71 NOK ('e')

# Hydro Power in Norway



- Electricity: ~ 98% hydro power
- Largest in Western Europe, nr 6 in the world (Brazil no 2)
- 30% of hydro power cap. In European Union (50 % of storage)
- Installed capacity : ~ 30000 MW
- Generation average,: ~ 130 TWh
- Average inflow +- 20 %



# Motivation and steps for the “Renaissance”

- Hydro power taken for granted but...
  - Failure of 100 MW unit: 0.5 - 1 MNOK/day – not in repair but value of lost water
  - An minor efficiency improvement for largest producer valued to : 1 BN NOK (2002 – 2012)
- Competence issue: Retirement – industrial focus
- Many plants built: 1950–1985 -> refurbishment
- New challenges / New projects (6TWh): 44 BN NOK
- 2013: The Norwegian Hydro power Centre



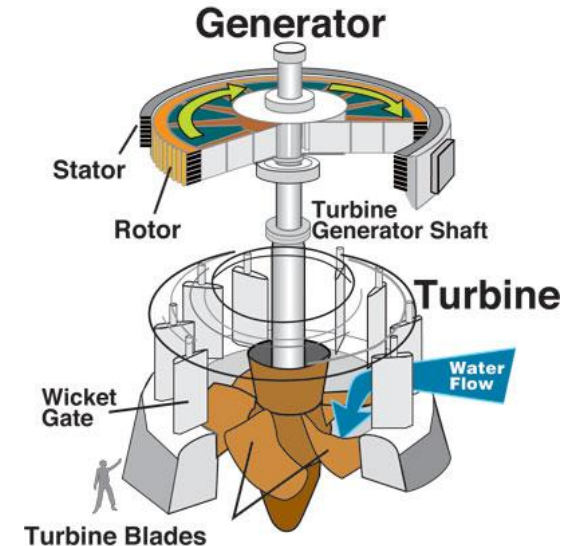
# Participants

- Research 24
  - Universities / Research units
- Industry 30
  - Power producers / Consultants / Vendors
- Different levels of involvement
  - Student and research exchange



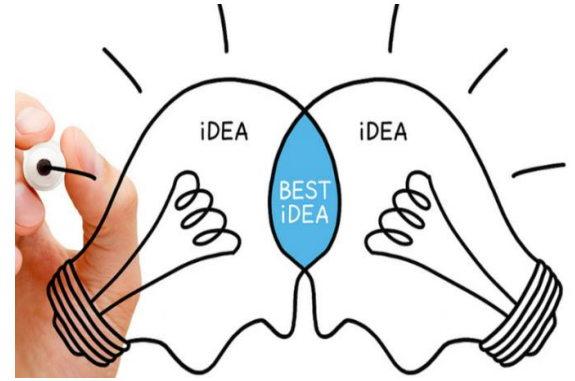
# Major research centre activities

- Dams and Waterways
- Turbine and generator
- Market and services
- Environmental design



# Collaboration opportunities

- Partners in new applications
  - EU Research programmes
  - Norwegian Research Council
- Student exchanges may be financially supported
- Facilitate parallel project activities (PhDs)
- Budgets allocated to partners and activities through the application, however:
  - A part of the funding (20%) allocated later to keep flexibility (Total budget 384 mill NOK / 8 years)



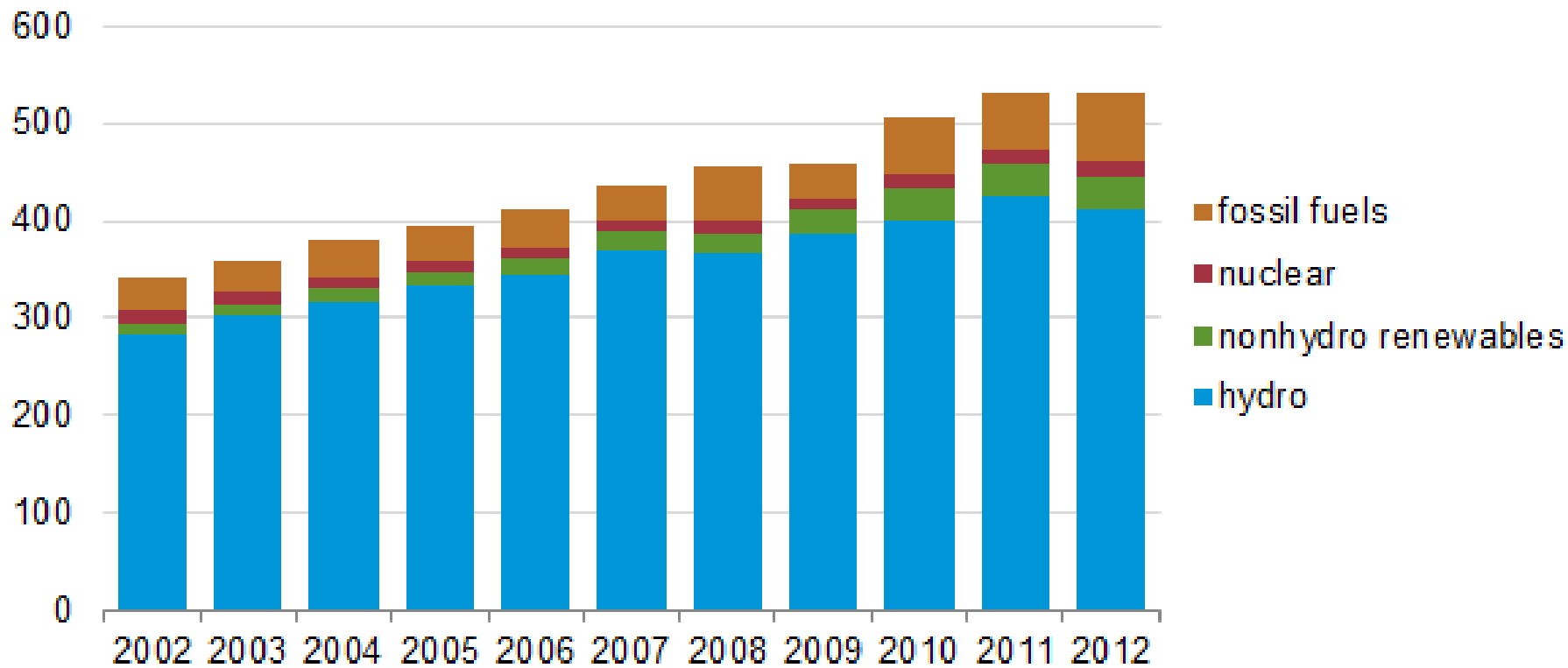


***THANKS FOR YOUR ATTENTION***

Information: <http://www.ntnu.edu/energy>

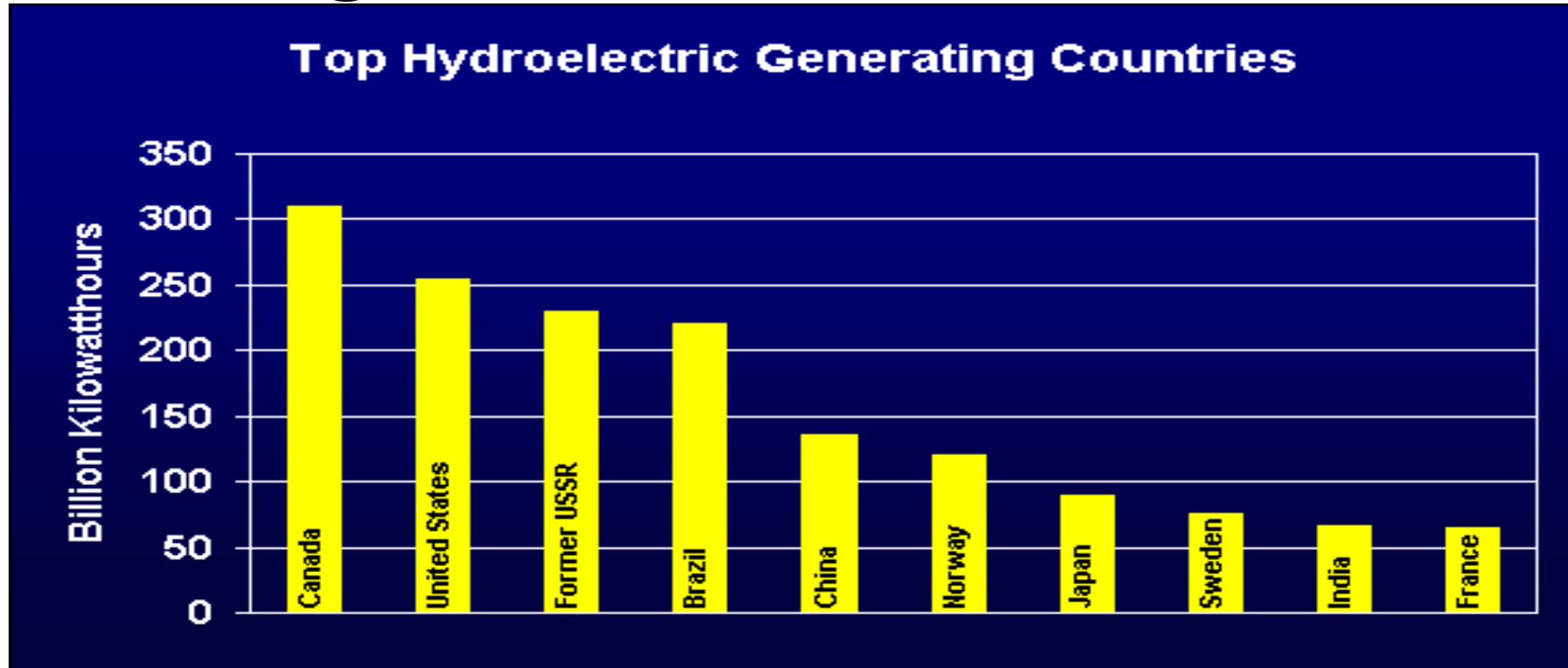
## Brazil's electricity generation by fuel type (2002-12)

billion kilowatthours





# Ranking from 1996



# Dams and Waterway

- Develop new technology for headrace tunnels, penstock, air cushion chambers and enlarging the waterway
- Develop methods, solutions and measures to improve dam constructions and dam safety
- Minimize the influence of sediments in water reservoirs through cost-effective and environmental sustainable solutions
- Optimal use and availability of water along a watercourse in a multipurpose perspective

# Turbine and generator

- Develop new technical solutions for variable speed operation for future hydropower plants
- Enable calculation of the fatigue loads on turbines
- New technology for retrofitting reversible pump turbines in existing power plants
- Reliable operation and lifetime for high head turbines and evaluation criteria for generator insulation

# Market and services

- Develop methods and tools for estimation of remaining useful life, failure probability and risk and component degradation
- Develop methods, tools and guidelines for future design/redesign alternatives for upgrading and expanding hydropower
- Demonstrate how knowledge, new technology, methods and tools from HydroCen supports new solutions and value creation
- Implement models for optimization of new hydropower technology
- Establish a model for calculating revenues from hydropower capabilities and develop methodology for a planning model combining the revenue model with: design and maintenance strategy, technology options and environmental impact

# Environmental design

- Identify opportunities and challenges in national and European energy, water and environment policies, regulations and directives for Norwegian hydropower industry of relevance for future operations and markets
- Expansion of the “environmental design in regulated salmon rivers” concept to include multiple user interests
- Develop tools for estimating and compensating lost ecosystem services in rivers and reservoirs