



# HydroCen

NORWEGIAN RESEARCH CENTRE FOR HYDROPOWER TECHNOLOGY

DoE – HydroCen workshop

WEB 2020-06-23

Michael Belsnes .et al.



# ...leading to this workshop

- HydroBalance project and FME CEDREN
- FME HydroCen
  - HydroVision 2019
  - Saltlake workshop
  - MoU signing in Feb. 2020
- Today - fill the collaboration with content
- HydroWires initiative in US & HydroCen and EnergiX in Norway



# Agenda for the meeting

- 16:00 Welcome and introduction (Michael Belsnes, Birger Mo, Sam Bockenbauer)
- 16:15 Collaboration topic: Price formation in future energy markets (Michael Belsnes, Audun Botterud)
- 16:30 Discussion
- 16:45 Collaboration topic: Comparison and co-development of power system models and soft-linking models (Birger Mo, Hans Ivar Skjelbred, Greg Brinkman)
- 17:00 Discussion
- 17:15 Other possible collaboration topics: Market transformation lessons (Abhishek Somani), others...?
- 17:30 Connections with Annex IX (Atle Harby, Audun Botterud, Nathalie Voisin, others)
- 17:45 Open discussion
- 18:00 Adjourn



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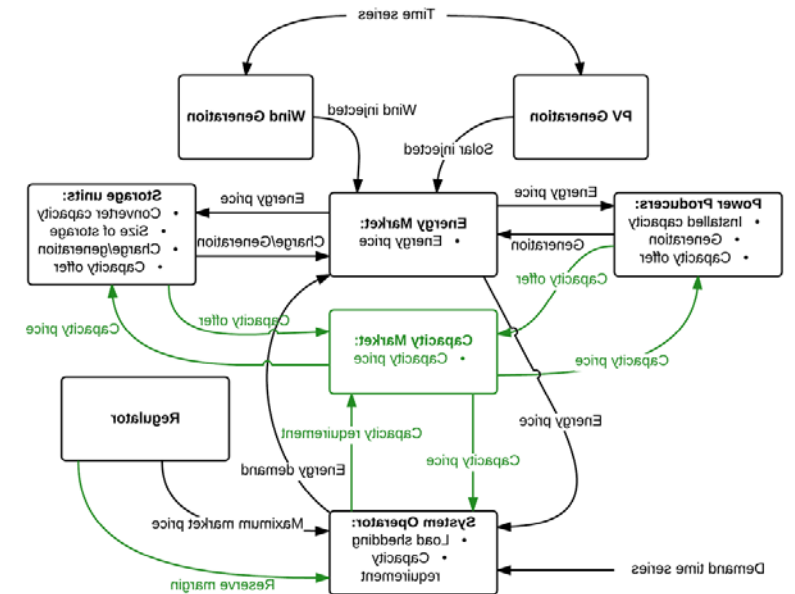
## Price formation and compensation in future power markets

Magnus Korpås NTNU, Audun Botterud  
Argonne/MIT, Michael Belsnes SINTEF



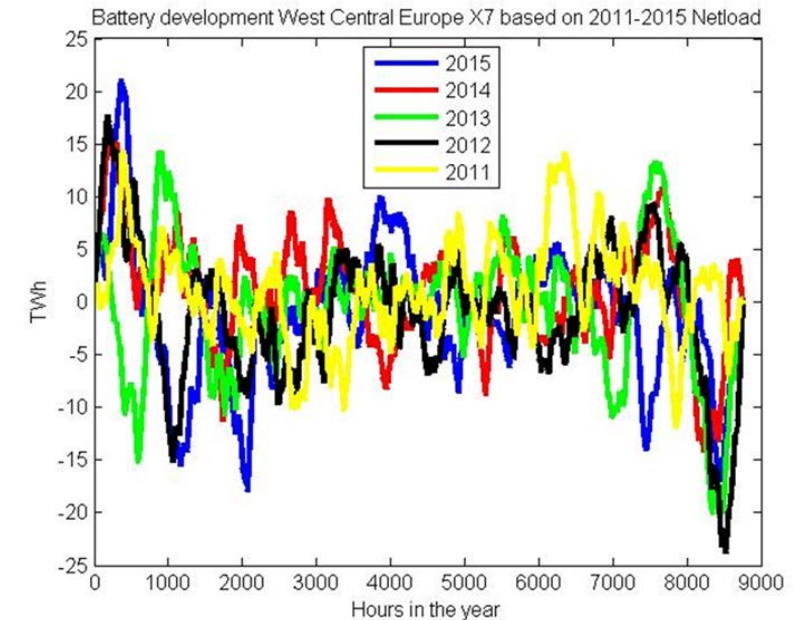
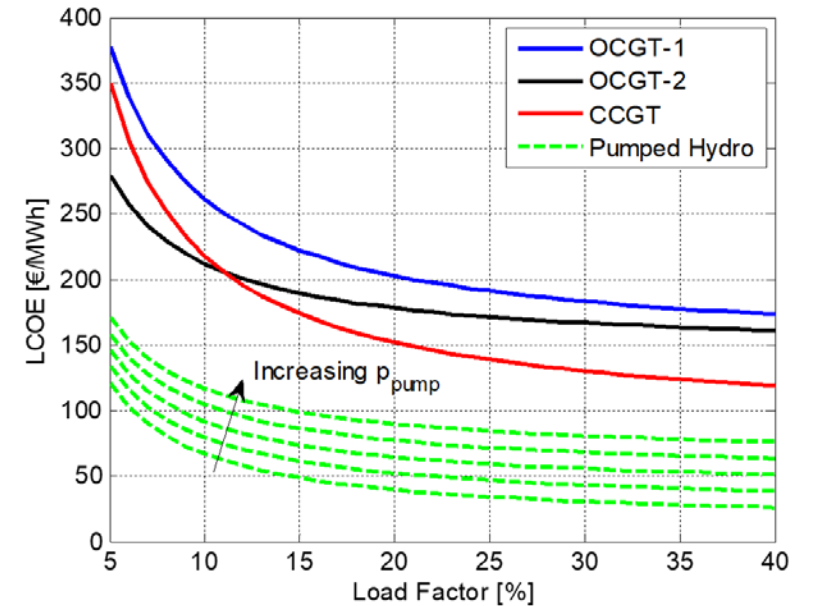
# Objective

- Establish method(s) for calculating consistent market prices in the future renewable power markets. Hydro is part of a mix but not dominant
- Norwegian perspective ensured in:
  - Pribas, priceforecasting in Norway
  - IBM with dual-market long-term operation
  - SHARM with multimarket short-term operation
- Understand and discuss how market design impact on compensation in the dimensions of services delivered to the grid and capabilities of the technologies.



# Value

- Establish a open toolbox for analysing power/energy markets dominated by:
  - Wind, Solar, energy storage, empowerment (DMS), renewable combustion ++, H2, heat p2g, electrification
- Help the power industry to adapt to the energy system development in Europe
- Understand and discuss cost recovery in markets dominated by renewables – impact from design and regulation



# Background EU perspective

1. Integration into a single European energy system
2. Legal, policy & regulatory framework and market design
3. Technology acceptance and energy citizenship
4. Macro-economic aspects and competitiveness
5. Fair and inclusive transition
6. Circularity
7. Digitalization



# The project will:

- Establish models for energy pricing, reserve pricing with different start-up times and durations times, modelling of flexible demand from the main demand sectors including the process industry.
- Build competence on how to modelling new power and storage technology and how these technologies will complement each other in the future power markets.
- Impact on markets from forecasting errors in (short-term) climate data.
- Do a validation of the toolbox through case studies of the future European markets with workshops with stakeholders in Europe, US and Norway to get feedback on the results.
- Compare different technologies according to their footprint based on circularity
- Consider different stages in the market development that follows from the energy transition.
- Produce three Ph.d's in the following topics:
  - Future Power markets,
  - Renewable Technologies
  - Transition modelling.



# ELECTRICITY MARKET MODELS FOR THE FUTURE POWER GRID: A US-EUROPEAN REVIEW

## ▪ Background

- Rapid transformation in the resource mix
  - Large-scale expansion of zero-marginal cost, variable, renewable resources
- Do current electricity markets provide adequate price signals and cost effective system solutions?
- Is hydropower and other flexible technologies fully compensated for the range of services they provide to the grid?
- *Are existing electricity market models able to analyze these questions?*

## ▪ Proposed work

- Evaluate and compare existing models for electricity market analysis (US, Norway, Europe)
  - Categorize models (e.g. production cost simulation, expansion planning, hydro-thermal coordination)
  - Ability to represent emerging dynamics in electricity markets; challenges in establishing required datasets
  - Ability to model prices for energy and other grid services
  - Can they be used to assess the viability of hydropower and other flexible technologies?
- Identify most important areas where improvements are needed
  - Support enhancements of existing models and development of new models

## ▪ Timeline and deliverable

- Start soon, 6 months of work
- Journal manuscript ready for submission



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# ValueFlex



# ValueFlex – pre-project in HydroCen

- Initiated on request from the industry organization EnergiNorge



**Purpose of the project**



# Mapping possibility for future value potential

- Expected market design development in Europe
- Cost development for alternative production technologies, flexible demand, batteries and other storage technologies, transmission technology
- Hydropower in the transition period
- Hidden values can be both costs and values
  - Emissions CO2 reductions
  - Flood reduction, loss of lure floods
  - Recreational access, loss of attractions
  - Jobs and industry in the districts



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