



# Rollen til norsk fornybar kraftproduksjon i 2050

## Scenarier for Norge som leverandør av balansekraft eller stor leverandør av fornybar energi

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SINTEF Energi

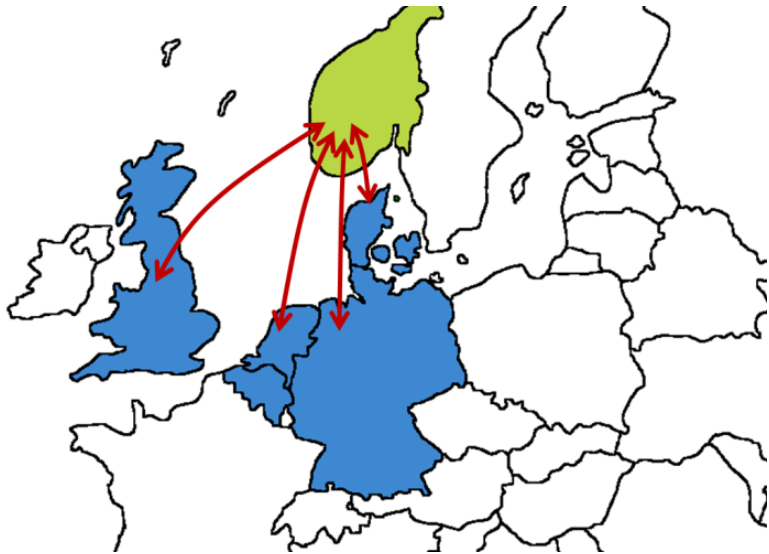
CEDREN-seminar hos Miljødirektoratet, 15. april 2015



# HydroBalance – Miljømessige, tekniske, økonomiske og samfunns- messige utfordringer

Okt 2013 - Okt 2017

Budsjett 25 Mio NOK



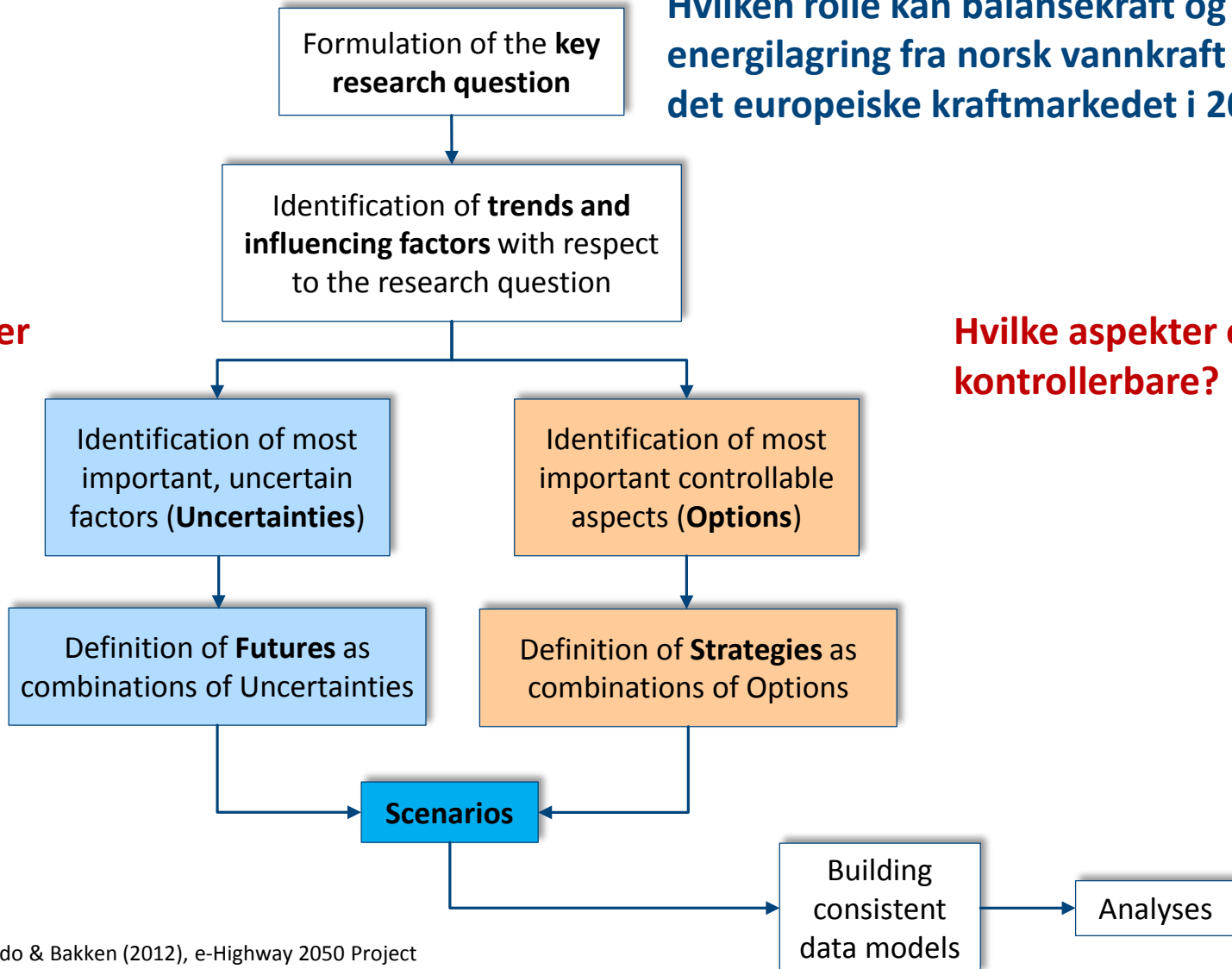
- Scenarier for ulike fremtider til det norske vannkraftsystemet i 2050
- Analyser, simuleringer og case-studier av
  - energisystemet
  - energimarkedet
  - miljøkonsekvenser
  - regulatoriske rammeverket og samfunnsaksept
- Lage et veikart

# Scenariobygging: tilnærmingen

Hvilken rolle kan balansekraft og energilagring fra norsk vannkraft spille på det europeiske kraftmarkedet i 2050?

Hvilke faktorer er viktige?

Hvilke aspekter er kontrollerbare?



Source: Huertas-Hernando & Bakken (2012), e-Highway 2050 Project

# Valg av scenarioene

	Strategies	Strategy 1	Strategy 2	Strategy 3	Strategy 4
Futures		Active climate policy	Moderate expansion	Value creation	Nordic only
Future 1	Medium Demand	<b>1</b>	<b>2 = A</b>	<b>3</b>	4
Future 2	Niche market	<b>5</b>	6	<b>7 = C</b>	8
Future 3	Various flexibility	<b>9 = B</b>	<b>10</b>	<b>11</b>	12
Future 4	Critical supply	13	14	15	<b>16 = D</b>

Fremheverte tall:  
Relevante scenarioer

Grå bakgrunn:  
Scenarier med  
lignende resultat

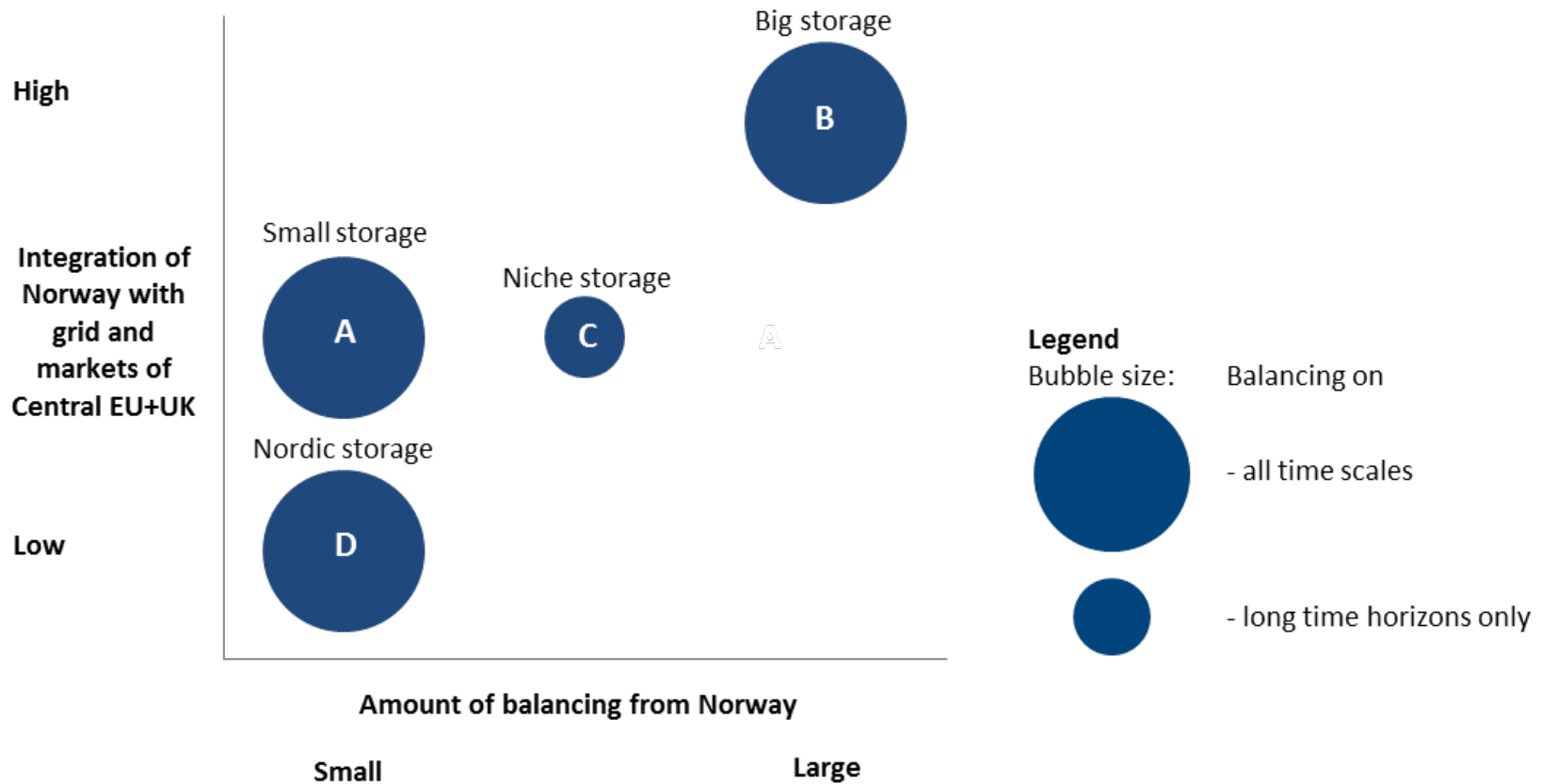
Ramme: Fire utvalgte  
scenarier

## Utvalgte scenarioene:

- A – Liten lager
- B – Stor lager
- C – Nisjelager
- D – Nordisk lager

# Fire scenarioer med tre dimensjoner

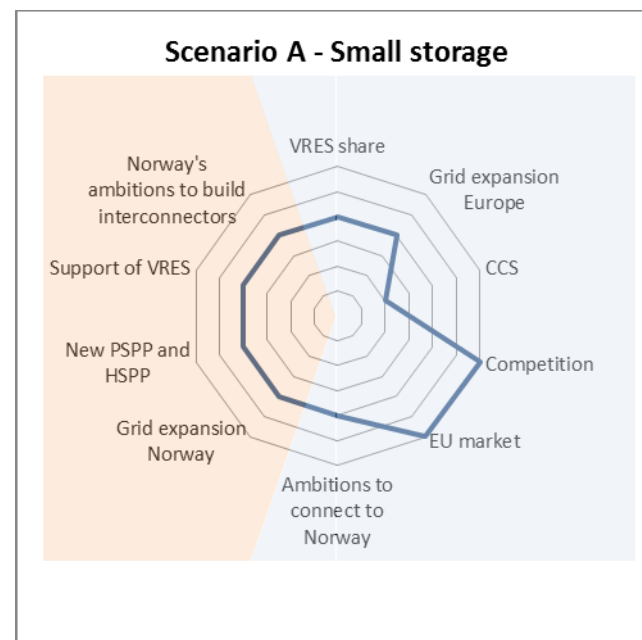
## Main scenario characteristics



# Scenario A – Liten lager

Uncertainties in Future 1	Medium Demand
Technology	
Variable RES share of electricity generation	Medium
Expansion of European transmission grid	Moderate
Deployment of CCS	Yes
Market	
Competition from alternative flexible technologies	Low
EU regulatory framework and market integration	Fully integrated
Policy	
Ambitions of countries to connect to Norway	Moderate
Options in Strategy 2	Moderate expansion
Expansion of Norwegian transmission grid	Moderate
New and upgrade of existing hydro plants	Moderate
Support of variable RES in Norway	Moderate
Ambitions of Norway to build interconnectors	Moderate

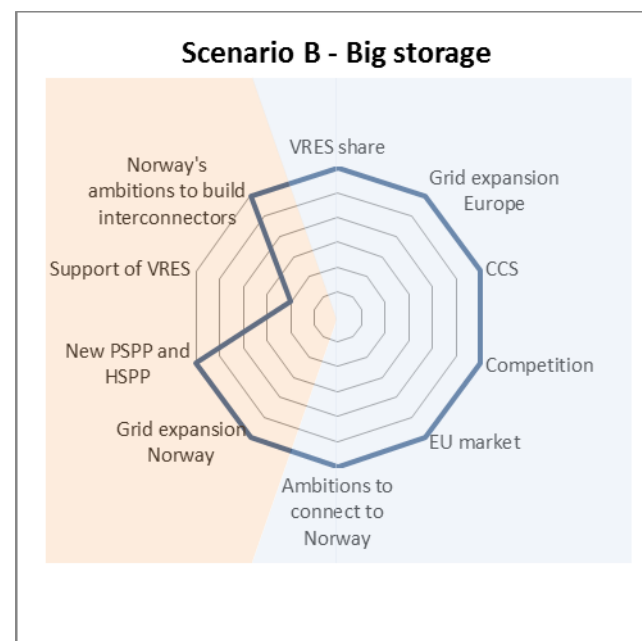
- Middels integrasjon
- Lite volum
- Alle tidshorisonter



# Scenario B – Stor lager

Uncertainties in Future 3	Various flexibility
Technology	
Variable RES share of electricity generation	High
Expansion of European transmission grid	Strong
Deployment of CCS	No
Market	
Competition from alternative flexible technologies	Low
EU regulatory framework and market integration	Fully integrated
Policy	
Ambitions of countries to connect to Norway	Strong
<b>Options in Strategy 1</b>	<b>Active climate policy</b>
Expansion of Norwegian transmission grid	Strong
New and upgrade of existing hydro plants	Strong
Support of variable RES in Norway	Strong
Ambitions of Norway to build interconnectors	Strong

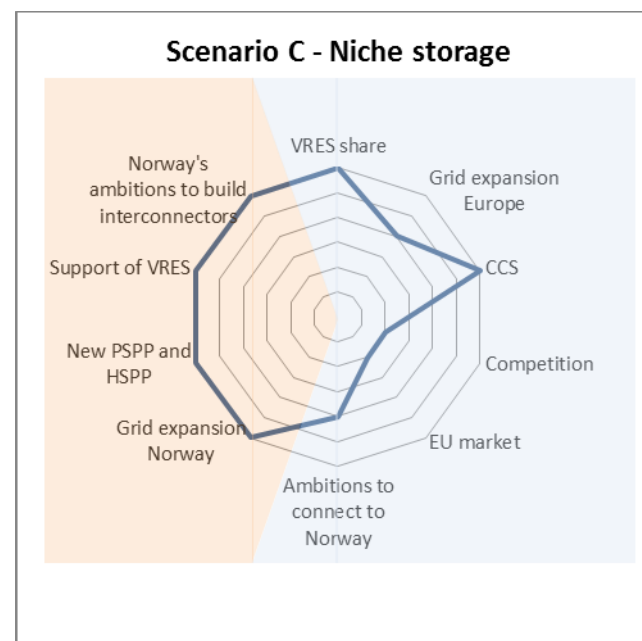
- Høy integrasjon
- Stort volum
- Alle tidshorisonter



# Scenario C – Nisjelager

Uncertainties in Future 2	Niche market
Technology	
Variable RES share of electricity generation	High
Expansion of European transmission grid	Moderate
Deployment of CCS	No
Market	
Competition from alternative flexible technologies	High
EU regulatory framework and market integration	Day-ahead only
Policy	
Ambitions of countries to connect to Norway	Moderate
Options in Strategy 3	Value creation
Expansion of Norwegian transmission grid	Strong
New and upgrade of existing hydro plants	Strong
Support of variable RES in Norway	Limited
Ambitions of Norway to build interconnectors	Strong

- Middels integrasjon
- Middels volum
- Lange tidshorisonter

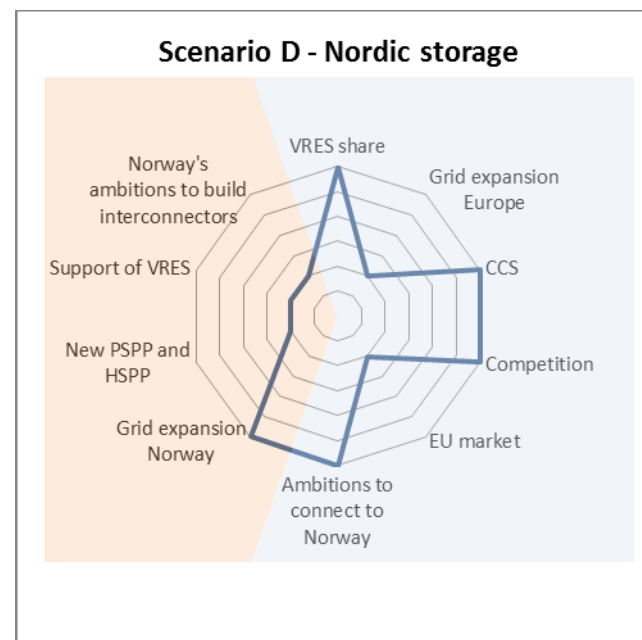




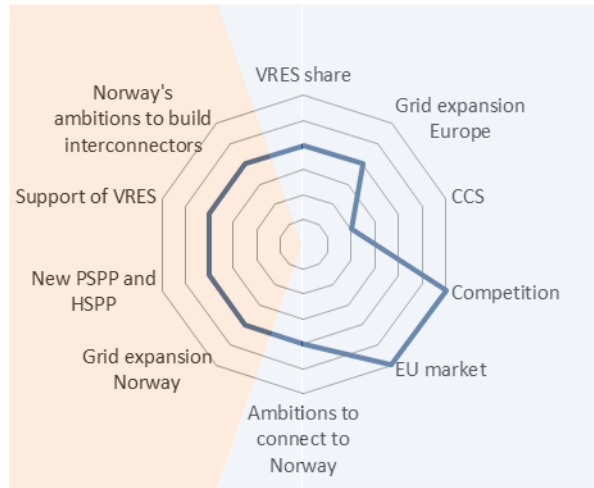
# Scenario D – Nordisk lager

Uncertainties in Future 4	Critical supply
Technology	
Variable RES share of electricity generation	High
Expansion of European transmission grid	Limited
Deployment of CCS	No
Market	
Competition from alternative flexible technologies	Low
EU regulatory framework and market integration	Day-ahead only
Policy	
Ambitions of countries to connect to Norway	Strong
Options in Strategy 4	Nordic only
Expansion of Norwegian transmission grid	Strong
New and upgrade of existing hydro plants	Limited
Support of variable RES in Norway	Strong
Ambitions of Norway to build interconnectors	Weak

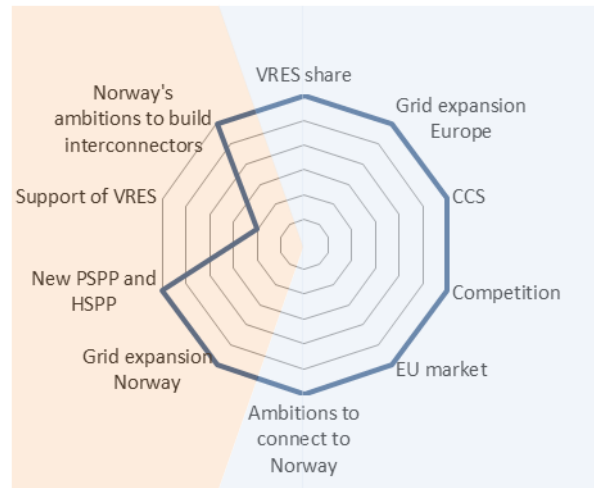
- Lite integrasjon
- Lite volum
- Alle tidshorisonter



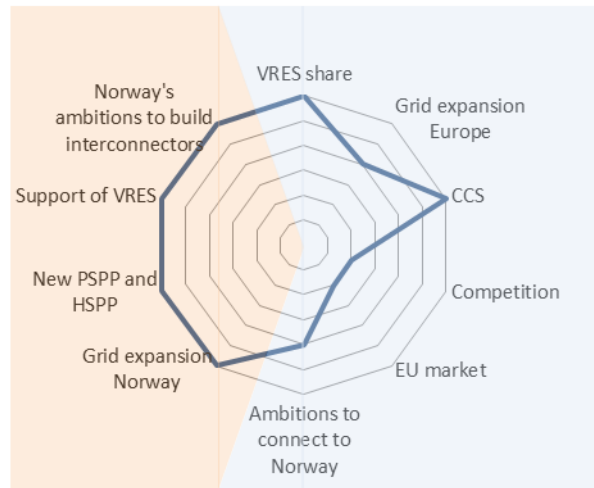
### Scenario A - Small storage



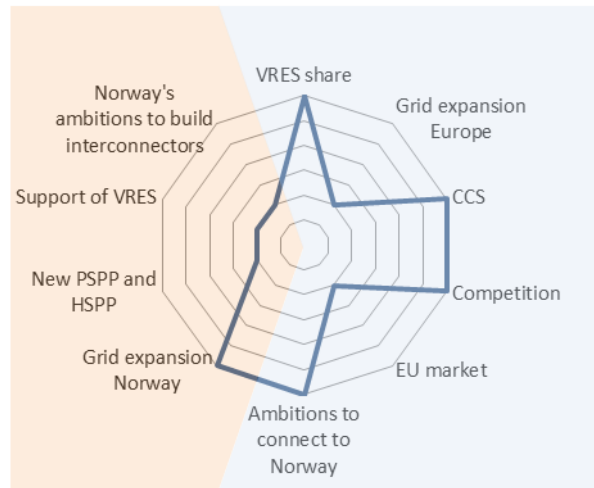
### Scenario B - Big storage



### Scenario C - Niche storage

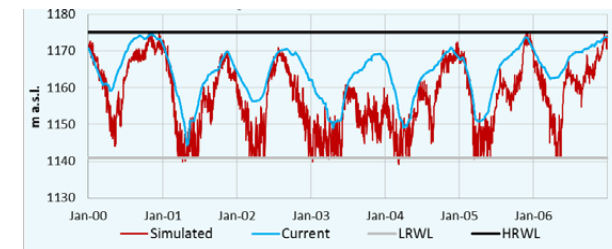
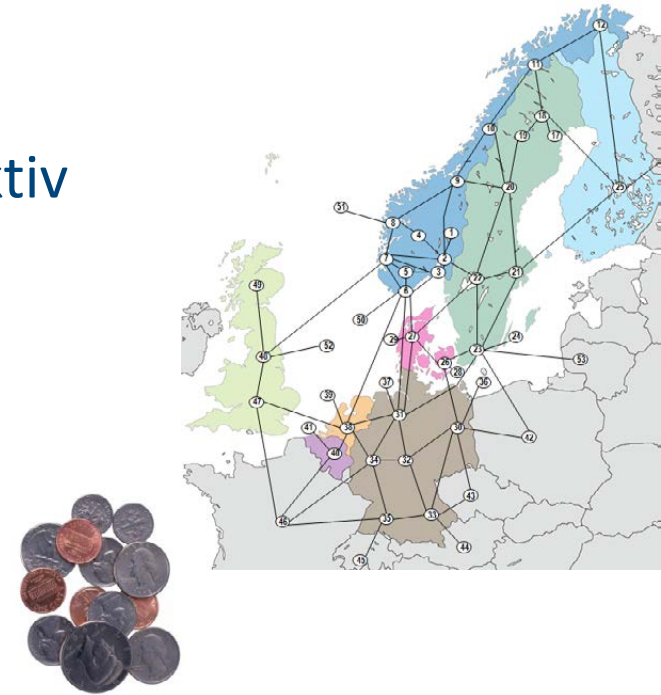


### Scenario D - Nordic storage



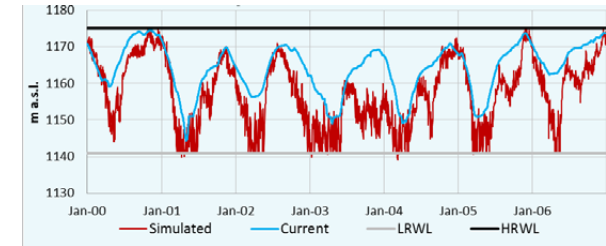
# Bruk av scenarioene

- Energisystemmodellering – systemperspektiv
  - El-markedmodell
  - Balansekraftbehov
  - Alternative teknologier
- Forretningsmodeller – perspektiv fra en kraftprodusent
  - El-markedmodell
  - Simuleringer for spesifikke case



# Bruk av scenarioene

- Endrete driftsmønstre: effekter av hurtigere og hyppigere vannstandsendringer på fiskepopulasjoner
  - Sammenheng mellom miljøeffekter og magasintype, klima, vassdrags-karakteristikk
  - Virkninger av regulering på fisk så langt
  - Virkninger av fremtidig regulering
- Regulatorisk rammeverk og samfunnsaksept
  - Regelverk i ulike land (NO, GB, DE)
  - Syn blant stakeholdere
  - Stakeholder intervjuer: kommunisere ulike fremtidsbilder





# Takk for oppmerksomheten!



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