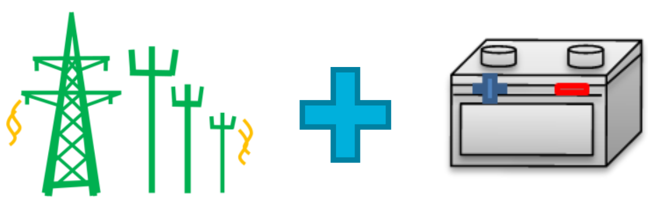
INTEGER
Integration of energy storage in the distribution grid

Grid services for energy storage

Fundamental grid needs

- Power quality
- Thermal limits for current
- Frequency control (stability)
- Phase balancing



Applications

- Alternative to grid re-inforcement for large loads (bottlenecks)
- Balancing of renewable production
- Balancing of power fluctuations
- Islanding/microgrid
- Short circuit performance
- UPS/emergency generator/quality of supply

Usage of batteries

Neutrality challenges

Additional functions possible?

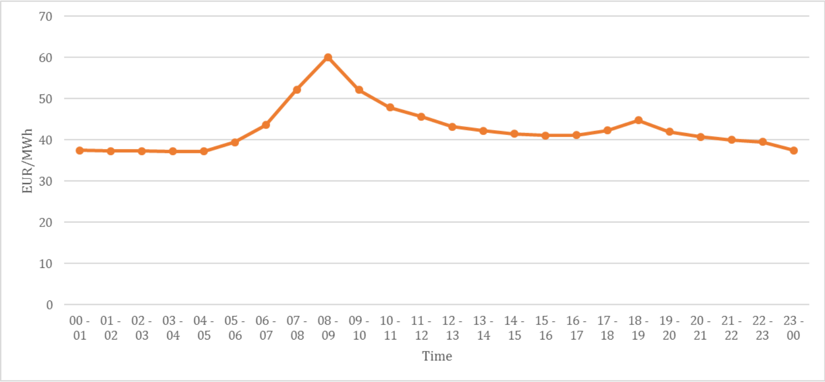
Purpose	How	Market impact	Complementarity
Voltage quality	Reactive power	None	High
	Active power	Some	High
Security of supply	Back up, N-1	None	None
	Emergency power	None	Some
Peak shaving	Bottlenecks	Some	Some
	Optimization	None	Some
Market services	Power trading	High	High
	Balancing market	High	None

None
Some
High

 Source: NVE-report 2-2018: Batterier i distribusjonsnettet. DNV GL and THEMA Consulting Group

Incentives/barriers for energy storage

- Battery prices
- Supportive arrangements, subsidies
- Economic price signals from electricity marked
- Power tariffs
- Arbitration
- Regulatory obstacles to be removed
- Ownership
- The feed-in cost (has been removed in Norway for those under 100 kW)



Source: NordPool (2018)

Planed energy storage projects in Norway > 500kW

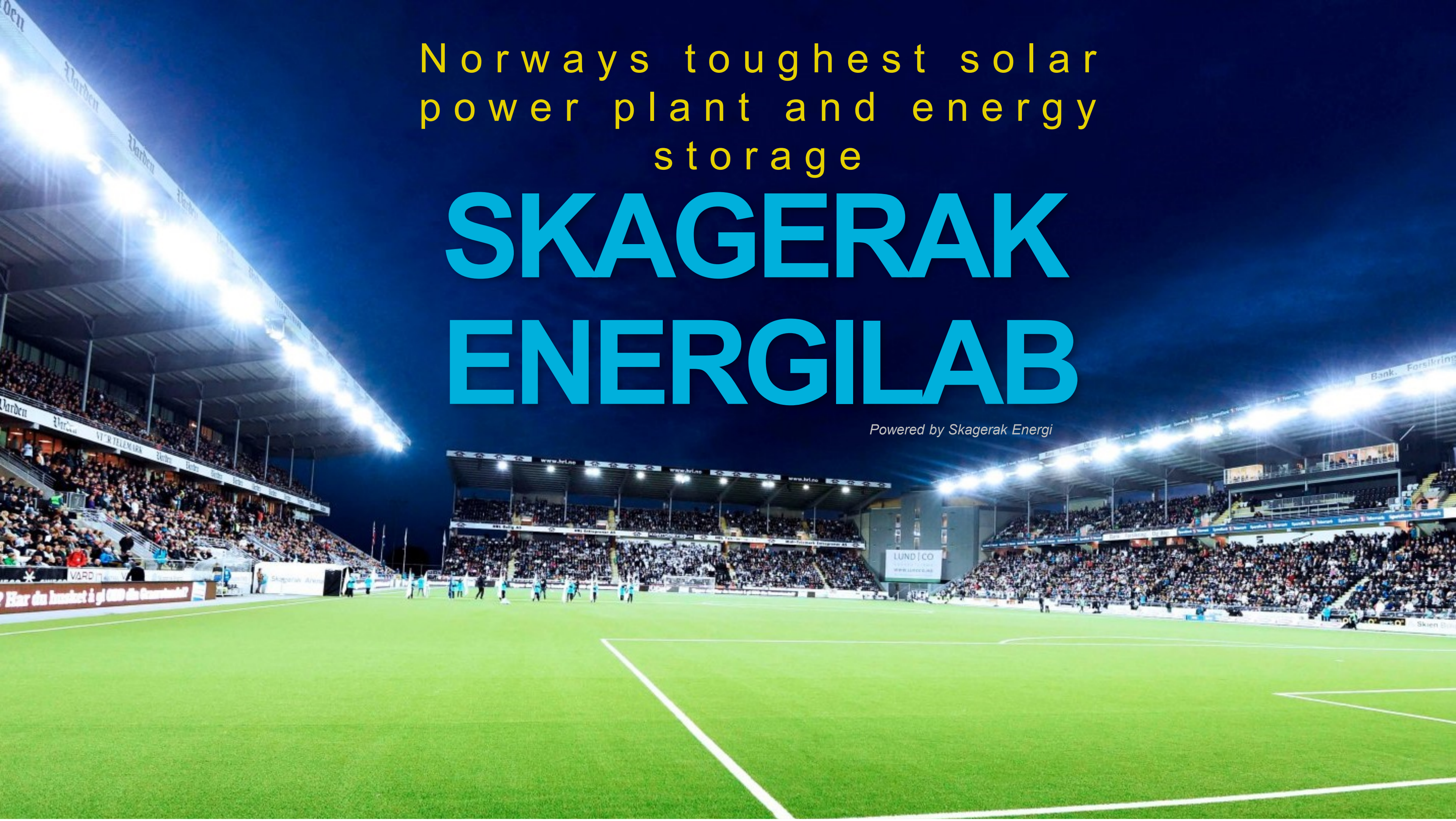
- Stationary Storage
  - Skagerak Energilab, ca. 1 MWh (PV 800 kWp), 2018
  - Powerhouse Brattøra: Trondheim, 2018
  - Yara Birkeland: 7-9 MWh, PILOT-E, 2019
- Offshore Wind
  - Statoil (Hywind Scotland – 1 MWh)
  - Dong Energy (Burbo Bank 2 MW)
- 60 el-ferries by 2021. By year 2030, 2/3 of all ferries
- 53 el-buses in Norway by 2019
- The national target that only zero-emision cars will be sold from 2025

SINTEF Skagerak Energi

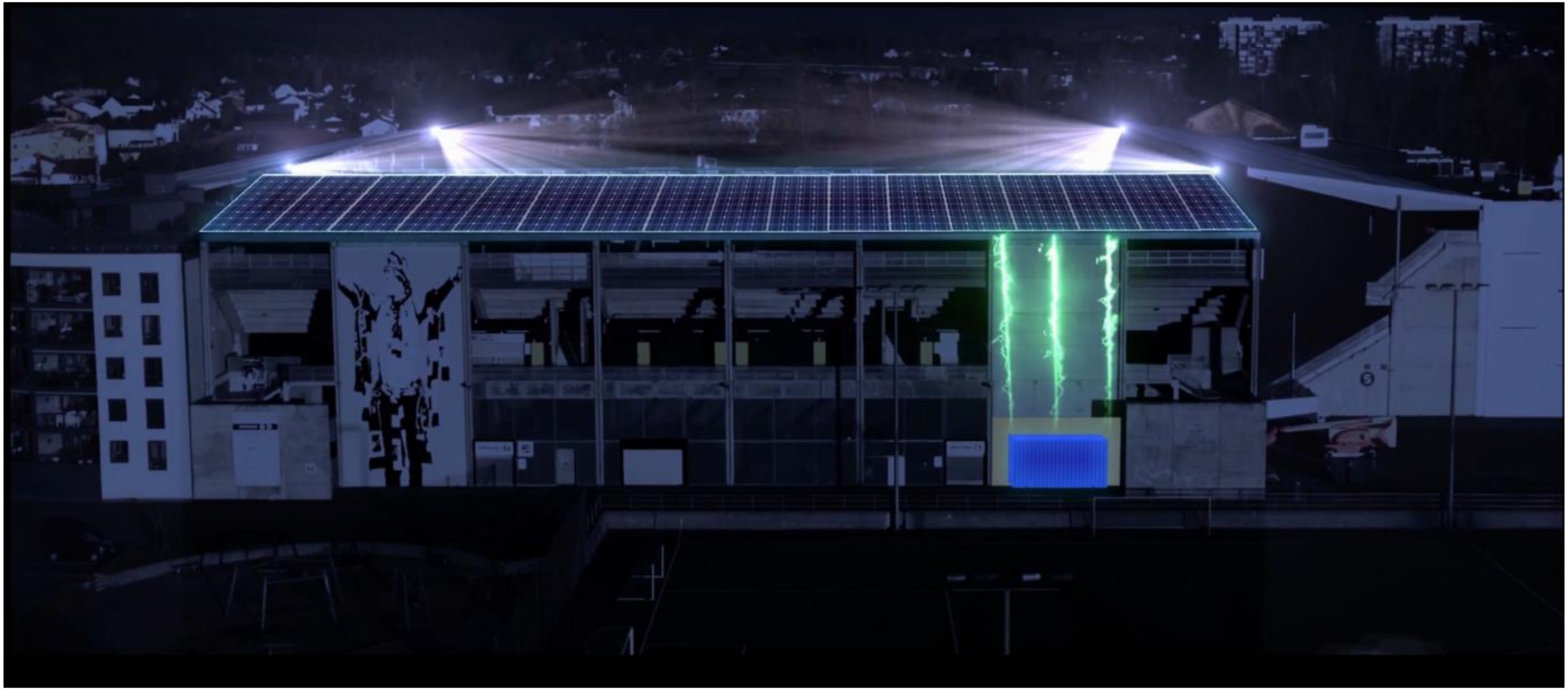
Norways toughest solar power plant and energy storage

SKAGERAK ENERGILAB

Powered by Skagerak Energi



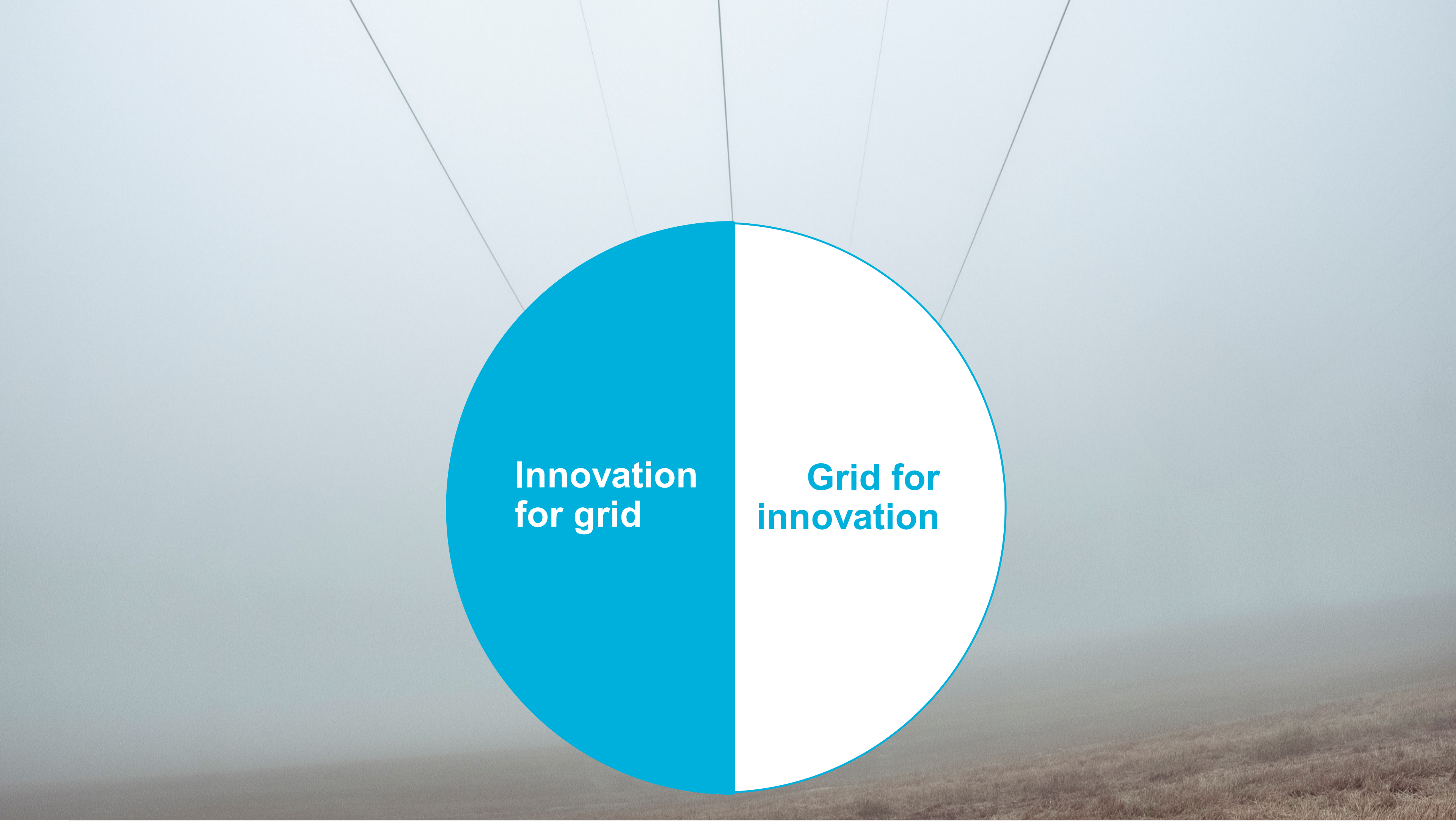
Skagerak Energilab



Skagerak Energi

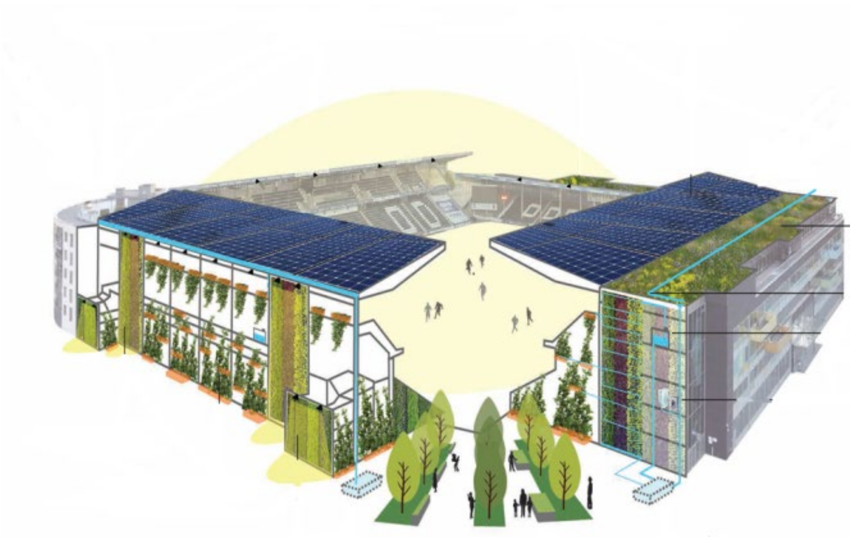
FC ODD: Norways most environmental friendly football club

Sports gets peoples attentions


Innovation for grid
Grid for innovation

Why install three thousand three hundred solar panels and a big battery at a football stadium?

Skagerak Energilab – Numbers



Solar panel

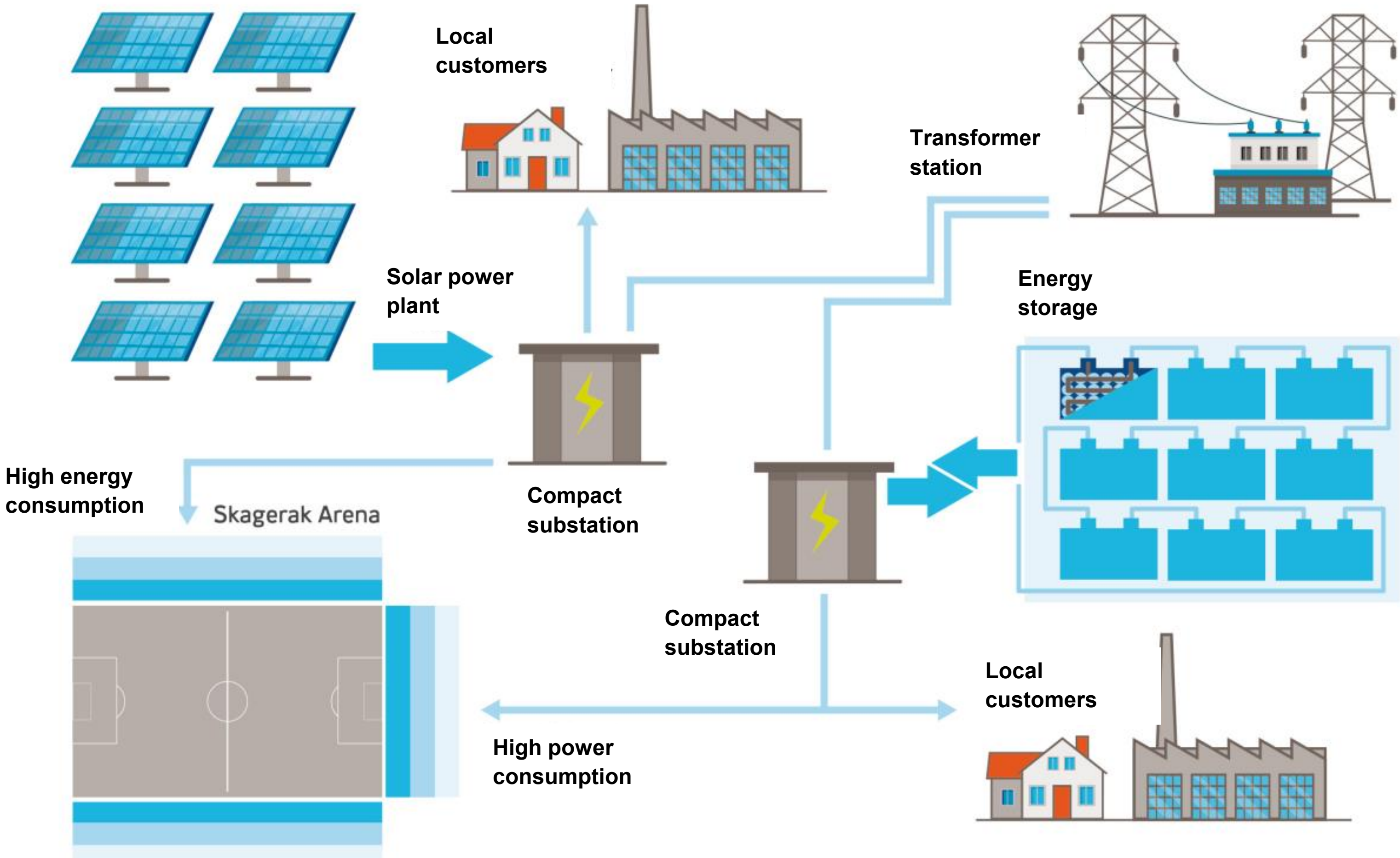
- Size: 5330 m2
- Installed power: 840 kWp
- Estimated production: 660 MWh
- Specific performance: 786 kWh/kWp

Energy storage

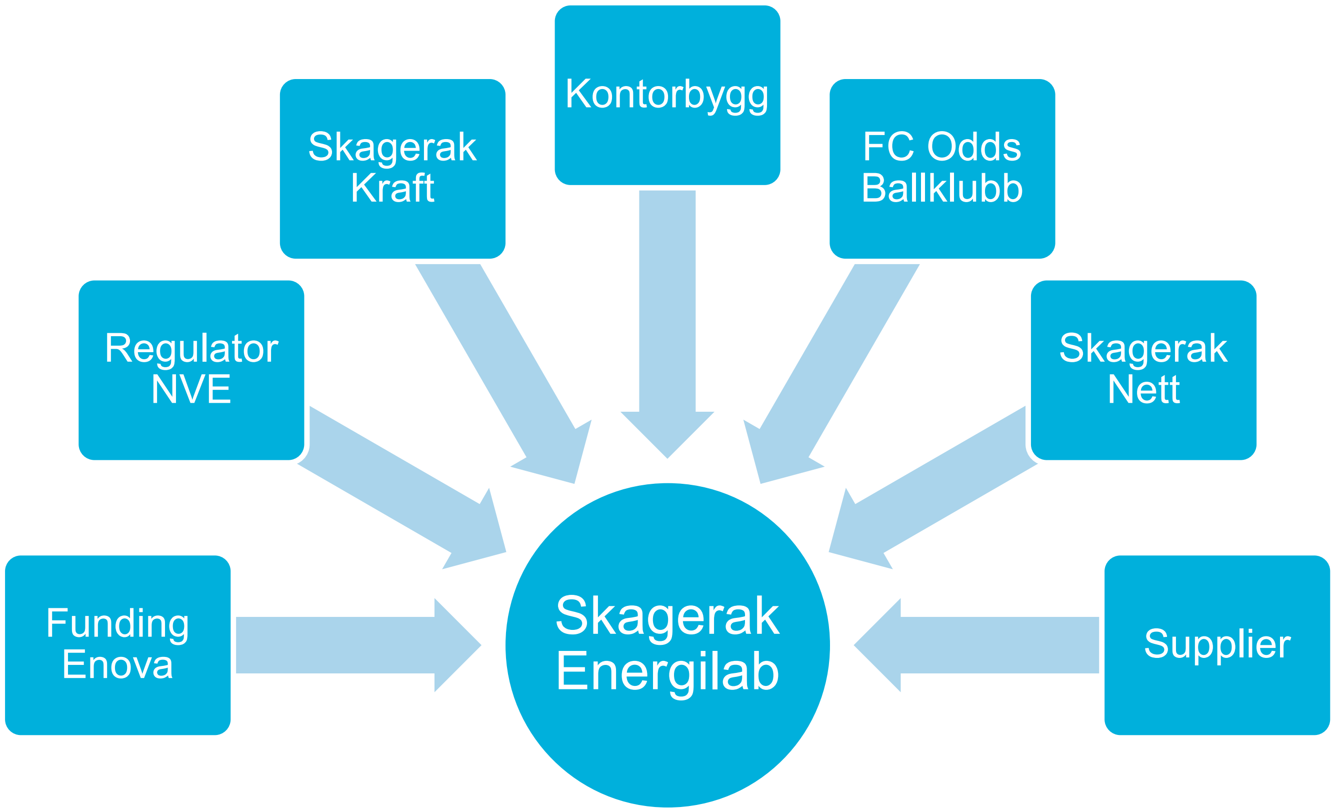
- Capacity: 1 MWh
- Power: 800 kW

 Bildet fra ODD

Skagerak Energi

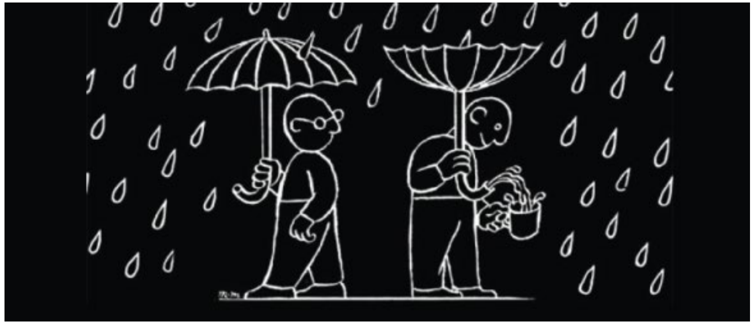

Local
customers
Transformer
station
Solar power
plant
Energy
storage
High energy
consumption
Skagerak Arena
Compact
substation
Compact
substation
Local
customers
High power
consumption

Cooperation



Skagerak Energi

Integer and Skagerak Energilab
Key exploitable results, lessons learned and recommendations



- Technologies
  a) Local production
  b) Local energy storage
  c) Interaction between distributed energy resources
- Stakeholders
  1) From DSO perspective
  2) From commercial (power company) perspective
  3) From customer perspective
  4) Fra regulators perspective
- Lessons learned and recommendations
  I. Feasibility of combining local resources
  II. Service stacking
  III. Ownership, regulation and business model
  IV. Commercial cooperation

Thank you

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