Sustainable power systems and green grids

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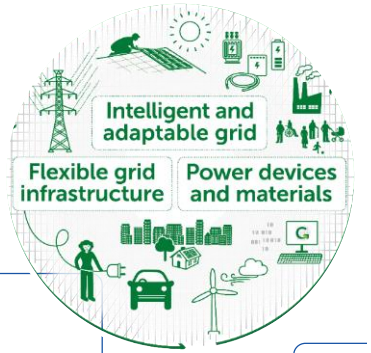
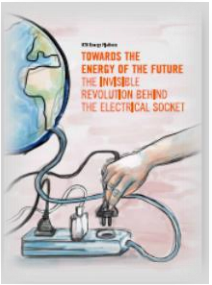


EEM23 Conference, LUT University, Lappeenranta, June 6, 2023, Finland

Thanks & Welcome to KTH – we provide science and knowledge for a sustainable society

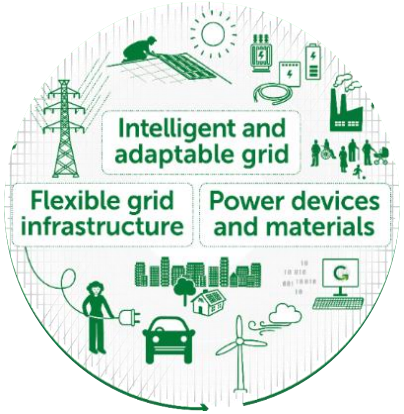


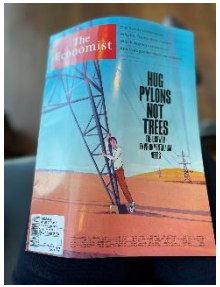
KTH Energy Dialogue 2023, 30 November – inclusive platform for energy dialogues

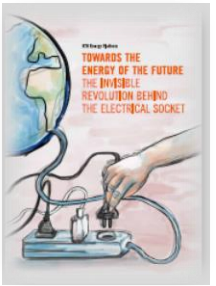
More information: www.kth.se/energy

Key Messages

- Global targets for sustainable developments and energy independence in Europe
- Challenges from the electricity grid's perspective:
  - need for flexibility
  - capacity shortage
  - new market solutions with prosumer
  - circular economy
- Example GreenGrids-Flex
- Engagement and continued dialogues!







We need power grids and engagement!

The Economist, April 2023


DAGENS NYHETER.

EKONOMI

Hon vill vara den sansade i energidebatten: ”Det vore bra att försöka lösa problemet i stället för att bråka”

UPPDATERAD IGÅR 05:18 PUBLICERAD 2022-09-21

Lina Bertling Tjernberg tycker det hade varit bättre om hushållen fick stöd för energieffektiviserande investeri

Foto: Elin Åberg

DN, September 21, 2022

SvD , April 23, 2023

Sustainable power grids developments

- ✓ Goals for reduction in use of fossils fuels and of fossil emissions
  - ❑ *Huge increase in electricity generated from wind and solar*
  - ❑ *Electrification of transportation sector and industrial processes*
- ✓ Smart grid technologies and integration of intermittent electricity generation
- ✓ Local electric generation and energy storage solutions (PV and EV integration)
- ✓ Nuclear power and use of Small Nuclear Reactors (SMR)

Sustainable power grids developments

- European Green Deal Call: €1 billion investment to boost the green and digital transition (launched 22 Sept. 2020)
- boost the efficient use of resources by moving to a clean, circular economy restore biodiversity and cut pollution
- The plan outlines investments needed and financing tools available. It explains how to ensure a just and inclusive transition.

Sustainable power grids developments

sweden 2023.eu

SVERIGES RIKSDAG

Draft programme

Challenges and opportunities for the EU's future energy supply

23–24 April 2023

The Riksdag, Stockholm
The Former Second Chamber

Version as of 18 April 2023

Interparliamentary conference hosted by the Riksdag Committee on Industry and Trade

Interparlimentary conference on energy hosted by the Swedish Parliament

Lina Bertling Tjernberg moderates a panel on solutions for future sustainable energy supply - research, development and innovation

Sustainable power grids
Interconnected power grid in Europe

- Urgent request by Ukrenergo and Moldova for emergency synchronization due to the war
- TSOs of Continental Europe agreed to start on 16 March 2022 the trial synchronisation of the Continental European Power System with the power systems of Ukraine and Moldova.

➢ contribute to a stable and efficient electricity supply in the Ukrainian power grid.

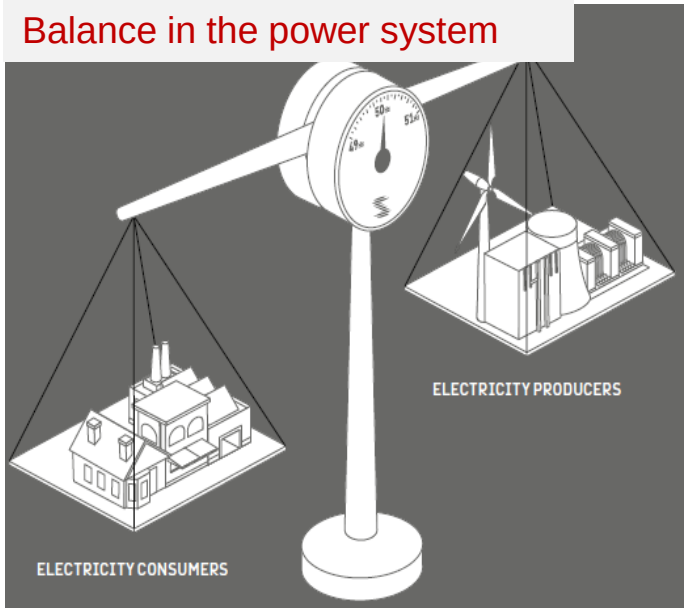
Sustainable power grids - RePowerEurope

REPowerEU: Joint European Action for more affordable, secure and sustainable energy, May 18, 2022.

- objective of breaking away from Russian energy ASAP.
- Member State interventions, whether fiscal or regulatory, will be necessary in order to secure affordable prices for end consumers and to prevent energy poverty
  - care must be taken not to discourage investments by energy companies in low-carbon solutions.
- A versatile energy palette must be used in order to secure energy supply to European households and businesses. It is important to make use of the wide variety of low-carbon energy, that fit economically and ecologically within an energy system.
  - need to remove unnecessary administrative barriers in order to accelerate rollout of renewables.

Sustainable power grids

Balance in the power system



Grid Capacity

Sustainable power grids

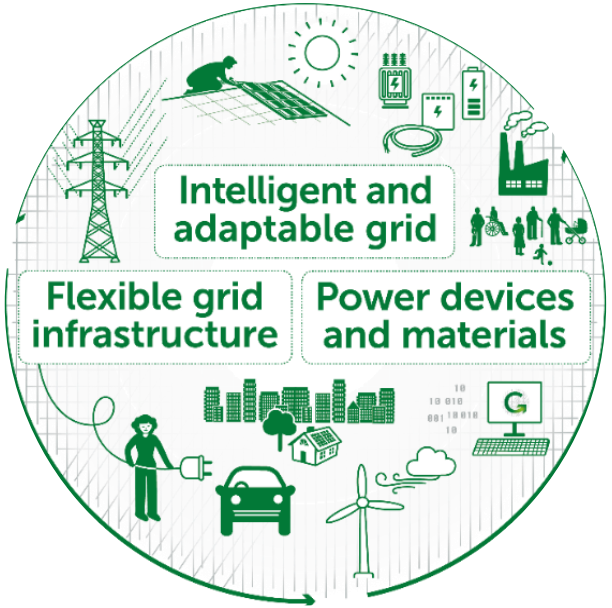
Interconnected power grid in Europe

- ENTSO-E is the European association for the cooperation of transmission system operators (TSOs) for electricity
- A much deeper coordination between operators close to real-time is needed to integrate more renewables into the grid and reduce carbon emissions cost-effectively and in all security.

Sustainable power grids

Developing technologies and trends

I. An intelligent and adaptable grid - ***Digitalization***
II. A flexible grid infrastructure, with local generation, electrical vehicles (EV) and storage. - ***Electrification***
III. Improved power devices and materials - ***Circular economy***



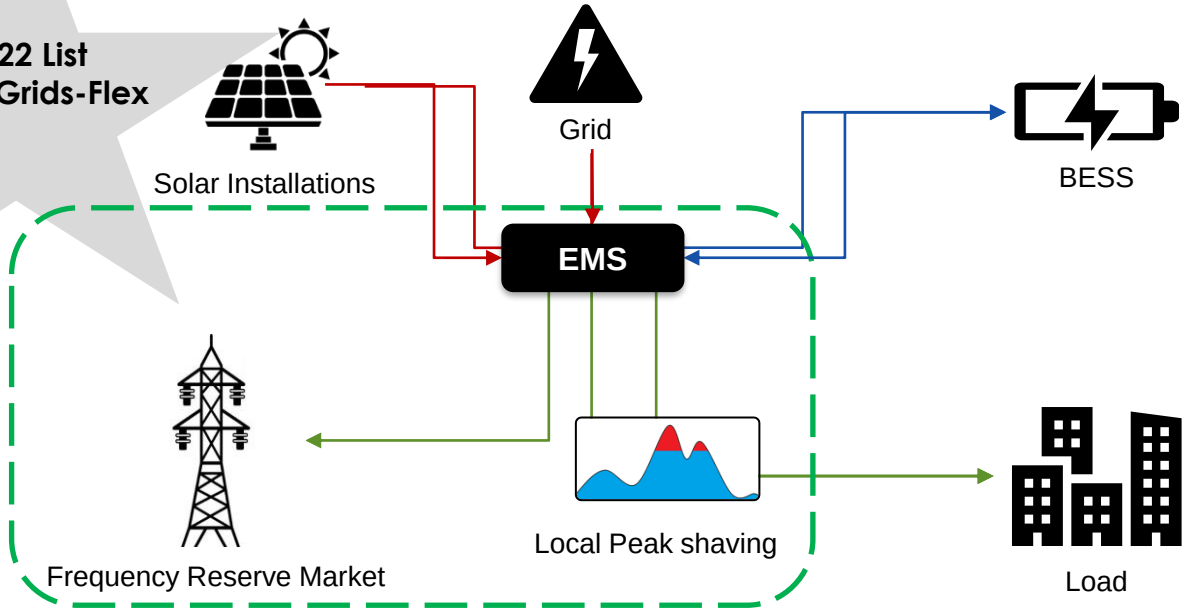
GreenGrids initative
@LinaBertlingTjernberg

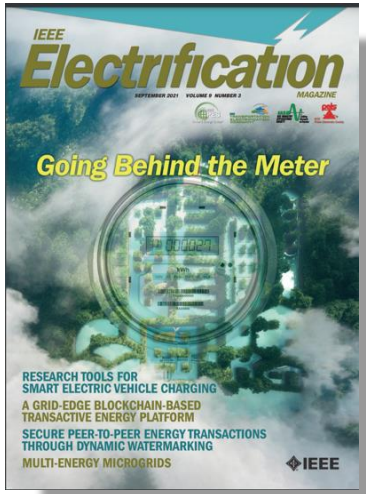
Bertling Tjernberg, L. (2022). The sustainable electrical grid In F. Brounéus & C. Duwig (Eds.), Towards the energy of the future – the invisible revolution behind the electrical socket. (pp. 23-31). www.energiantologi.se

Sustainable power grids

Example: local generation and battery storage

IVA 2022 List
GreenGrids-Flex





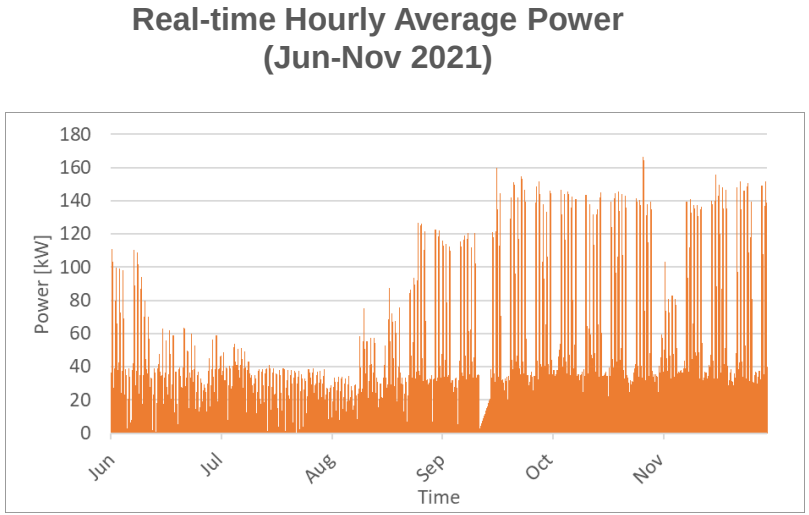
***EMS:**
Energy Management System

***BESS:**
Battery Energy Storage System

H. Shafique *et al.*, "Behind the Meter Strategies Energy management system with a Swedish case study," *IEEE Electrification Magazine*, vol. 9, no. 3, s. 112-119, 2021.

Sustainable power grids

Example: Sinntorp school (400 students)



Solar PV peak power (DC) production
= 300 kW

Max Inverter rating
= 60 kW

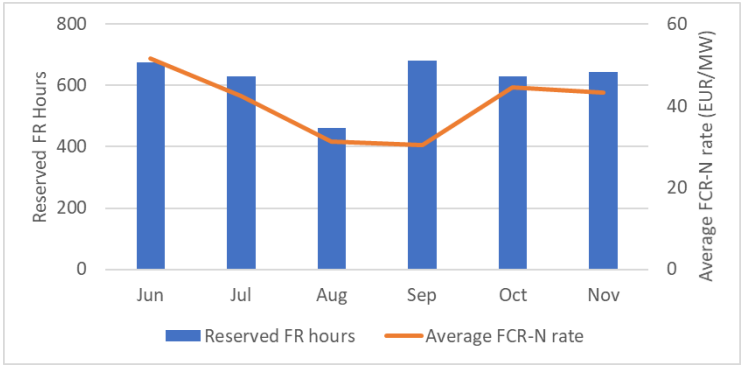
Useable BESS Capacity
= 75 kWh

H. Shafique, D.-E. Archer , R. Eriksson, L. B. Tjernberg, Real-time Operation Model for Energy Management System of Battery Energy Storage System - Case Study: The School of Sinntorp, In proceedings of the International Conference on Probabilistic Methods Applied to Power Systems (PMAPS), Manchester, UK, June 2022.

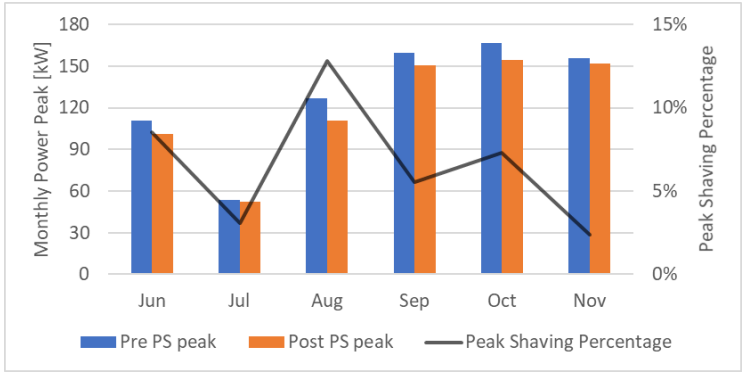
Sustainable power grids

Example: Sinntorp school (400 students)

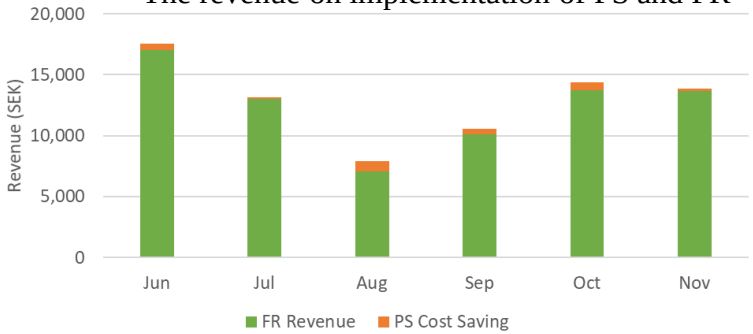
Frequency Regulation performance summary



Peak Shaving performance summary



The revenue on implementation of PS and FR

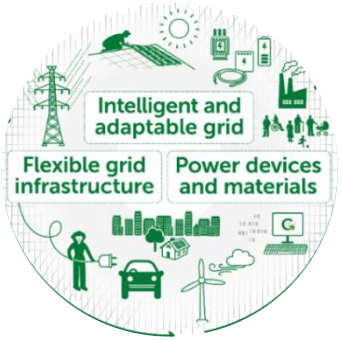


Peak power reduction of 6.62%

620 hours of BESS capacity reserve for FCR-N

22% Return on Investment Of the System

Summary



- Overall targets for the sustainable developments – SDGs and an urgent need for energy supply independence – speed up the energy transition and smart grid developments
- Solutions with European Green Package and Green Grids
- Key trends and technology areas:
  I. Intelligent (software) – access to data e.g. condition monitoring, cyber security, internet of things
  II. Flexible (hardware) –integration of storage, EVs, PV,..
  III. Circular economics with recycling of material and second life time usage
- Long term energy agreement needed and engagement.