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data centres' energy demand response analysis

Matti Vilkko, 25.1.2019

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S-o-A – Data Centres' energy research

Lots of efforts have invested to

- decrease energy usage
- decrease environmental impact
- increase energy efficiency
- compensate consumption with renewable sources

i.e. efforts to be “less bad”. However, the question remains how to be good energy citizen

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Intermittent energy source - W

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Intermittent energy source

From Wikipedia, the free encyclopedia

An **intermittent energy source** is any source of energy that is not continuously available for conversion into electricity and outside direct control because the used primary energy cannot be stored. Intermittent energy sources may be predictable but cannot be dispatched to meet the demand of an electric power system.

The use of intermittent sources in an electric power system usually displaces storable primary energy that would otherwise be consumed by other power stations. Another option is to store electricity generated by non-dispatchable energy sources for later use when needed, e.g. in the form of pumped storage, compressed air or in batteries. A third option is the sector coupling e.g. by electric heating for district heating schemes.

The 150 MW Andasol solar power station is a commercial parabolic trough solar thermal power plant, located in Spain. The Andasol plant uses tanks of molten salt to store solar energy so that it can continue generating electricity even when the sun isn't shining.[1]

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How to be good (better)?

Intermittent production creates totally new challenges:

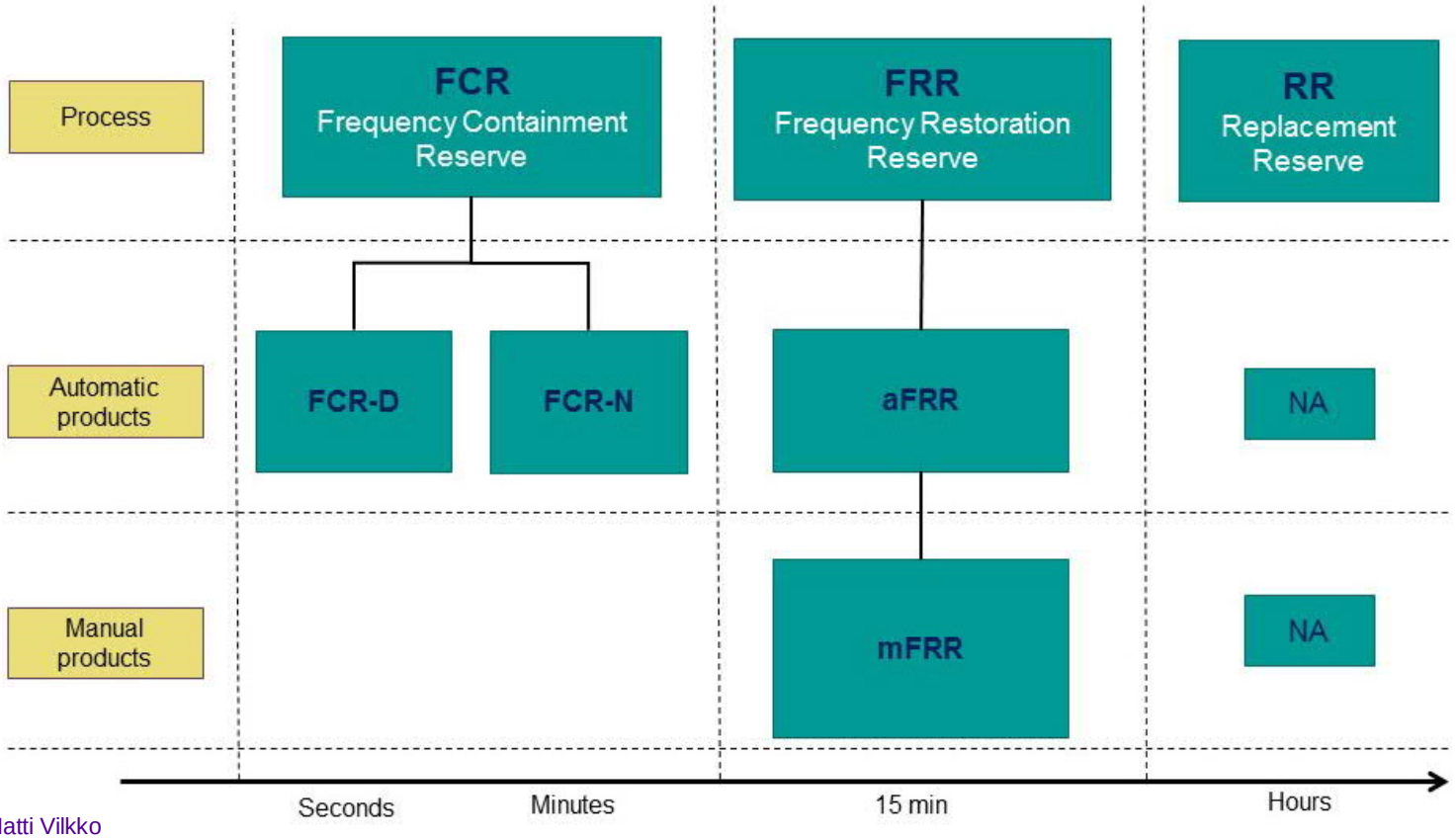
- supply and demand balance
- Reserve requirements

Solutions

- Adaptation to supply (Spot energy markets)*
- Providing reserves to power network (Reserves and balancing power markets)

* Tapio Niemi, Jukka K. Nurminen, Juha-Matti Liukkonen, Ari-Pekka Hameri: **Towards Green Big Data at CERN**, Future Generation Computer Systems 81 (2018) 103–113

Reserves and balancing power, FINGRID instruments



N – Normal

D - Disturbance

Ref: https://www.fingrid.fi/en/electricity-market/reserves_and_balancing/

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Frequency Containment Reserves (FCR-N, FCR-D), transactions in the yearly markets

	FCR-N price (€/MW,h)	FCR-N volume (MW)	FCR-D price (€/MW,h)	FCR-D volume (MW)
2011	9,97	71	1,48	244,3
2012	11,97	72,7	2,8	346,9
2013	14,36	73,5	3,36	299,8
2014	15,8	75,4	4,03	318,7
2015	16,21	73,6	4,13	297,5
2016	17,42	89	4,5	367
2017	13,00	55,0	4,7	455,7
2018	14,00	72,6	2,8	435,0
2019	13,5	79	2,40	445,6

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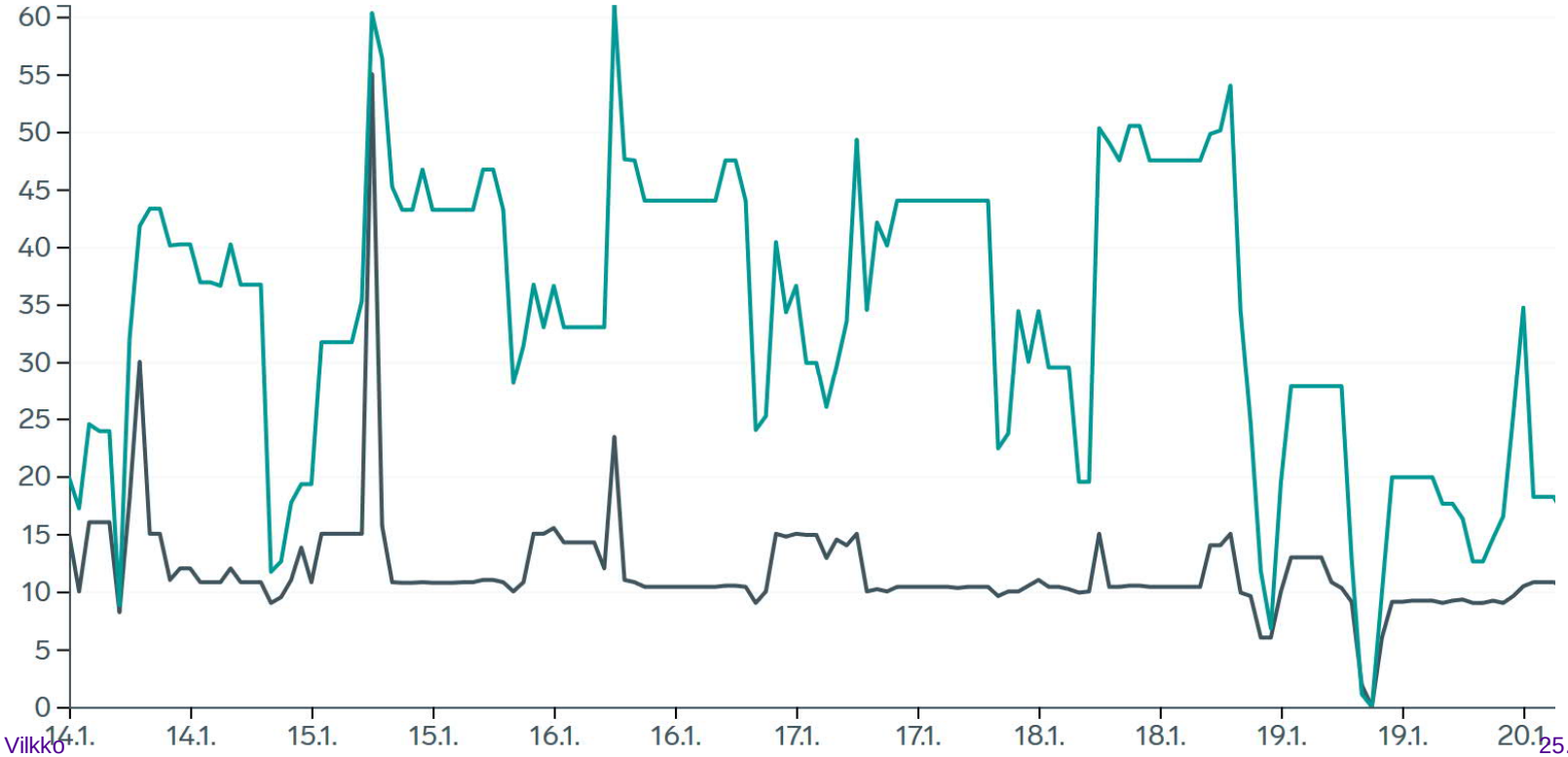
Transactions on the hourly market, FCR-N



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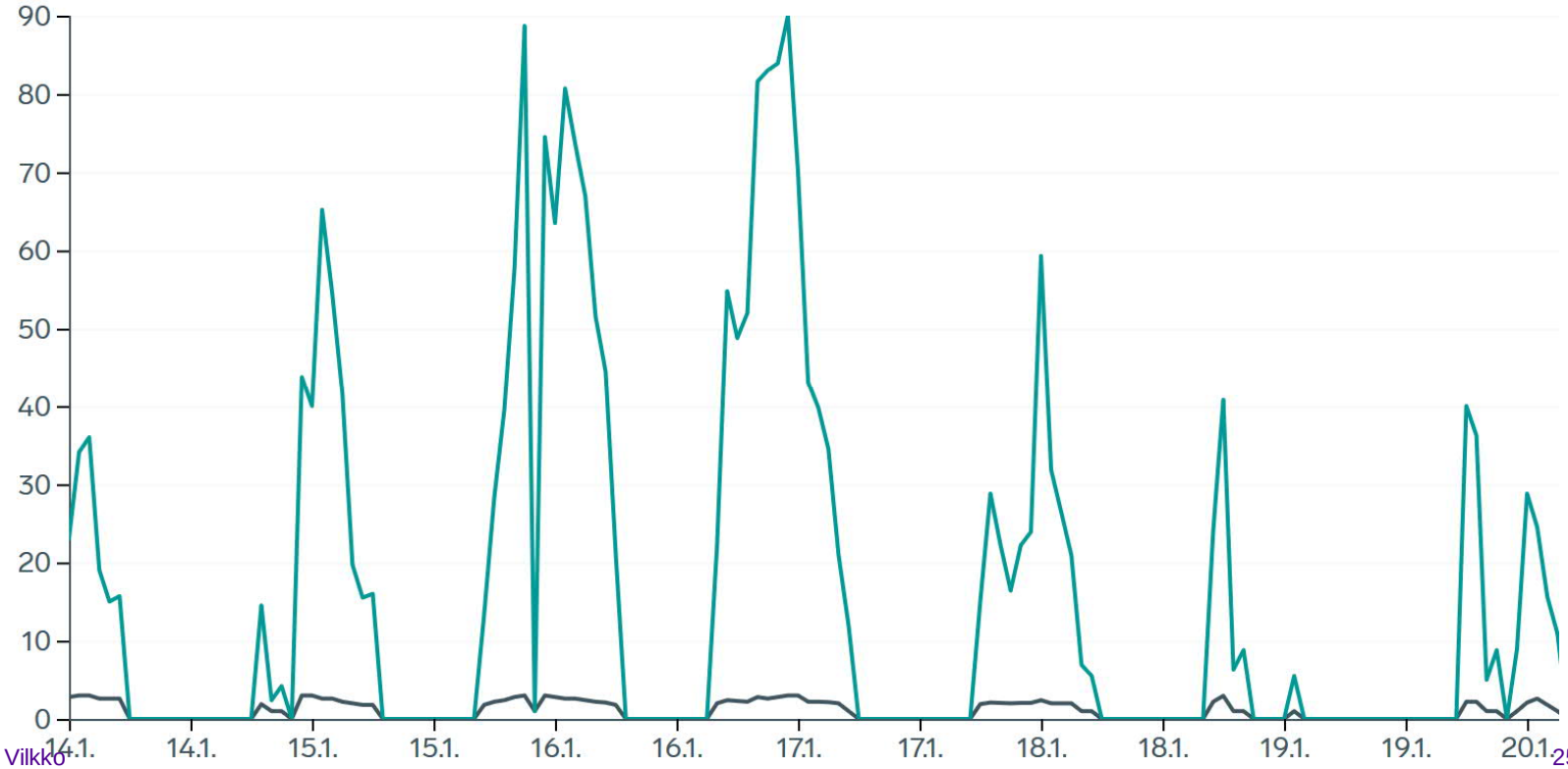
Transactions on the hourly market, FCR-D



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DEACT

Business Finland funded
Co-Creation project

- Towards Co-Innovation
- 100 k€, 6 months

Goal:

Business Finland funded
Co-Innovation project

- 2-4 M€
- 2 years
- 3-4 companies with own project
- +10 companies in steering group

Co-Creation funding

Funding for developing a research idea and for building cooperative networks

Co-Innovation funding

Funding for R&D projects by companies and research organisations, in which they *jointly* develop new knowledge and innovations for new business needs.

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Basic Concept

Computing load

Heat demand

Renevable intermittent generation

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SENECC – Smart Energy Systems

http://www.senecc.fi/

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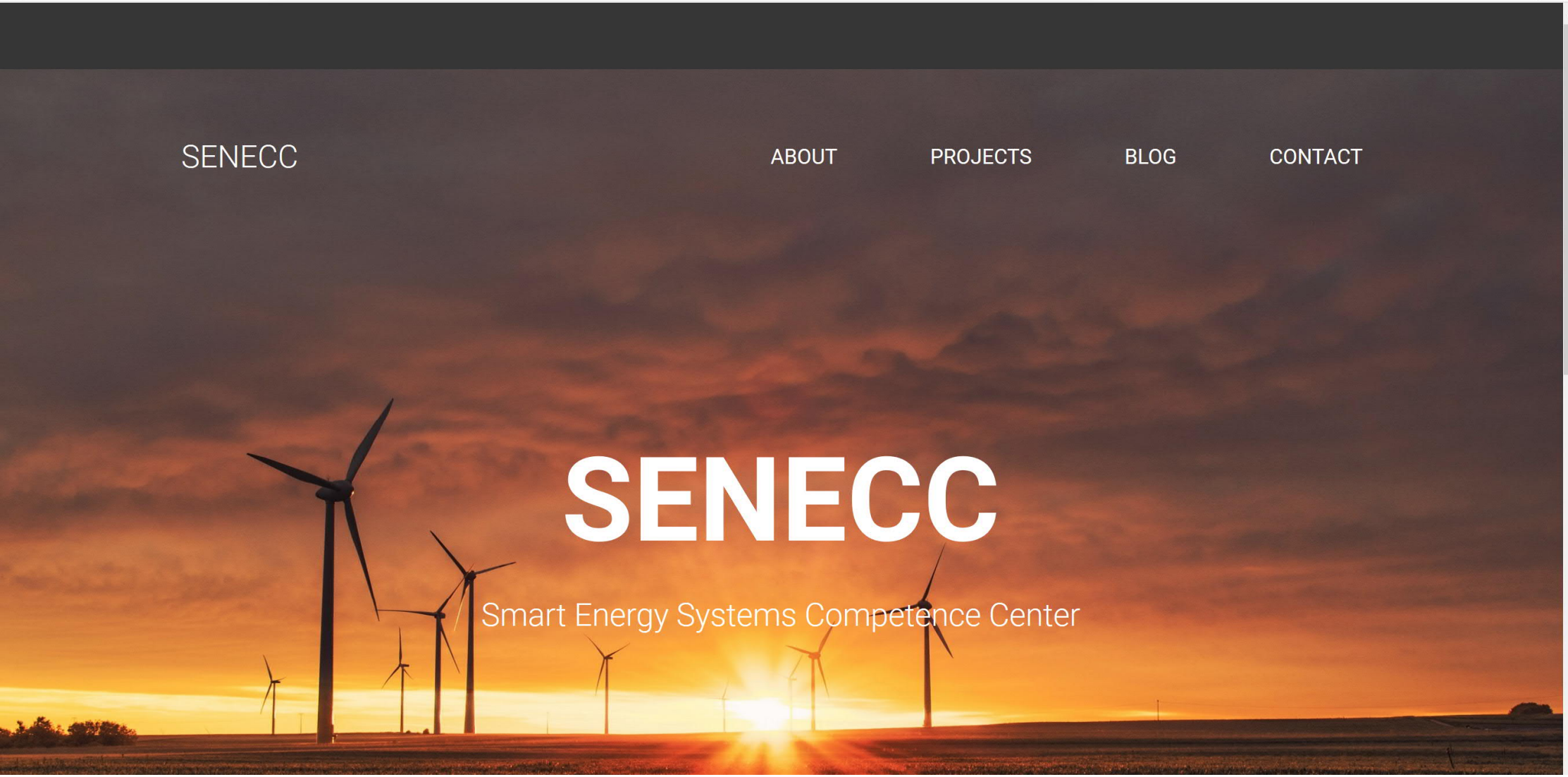
SENECC

Smart Energy Systems Competence Center



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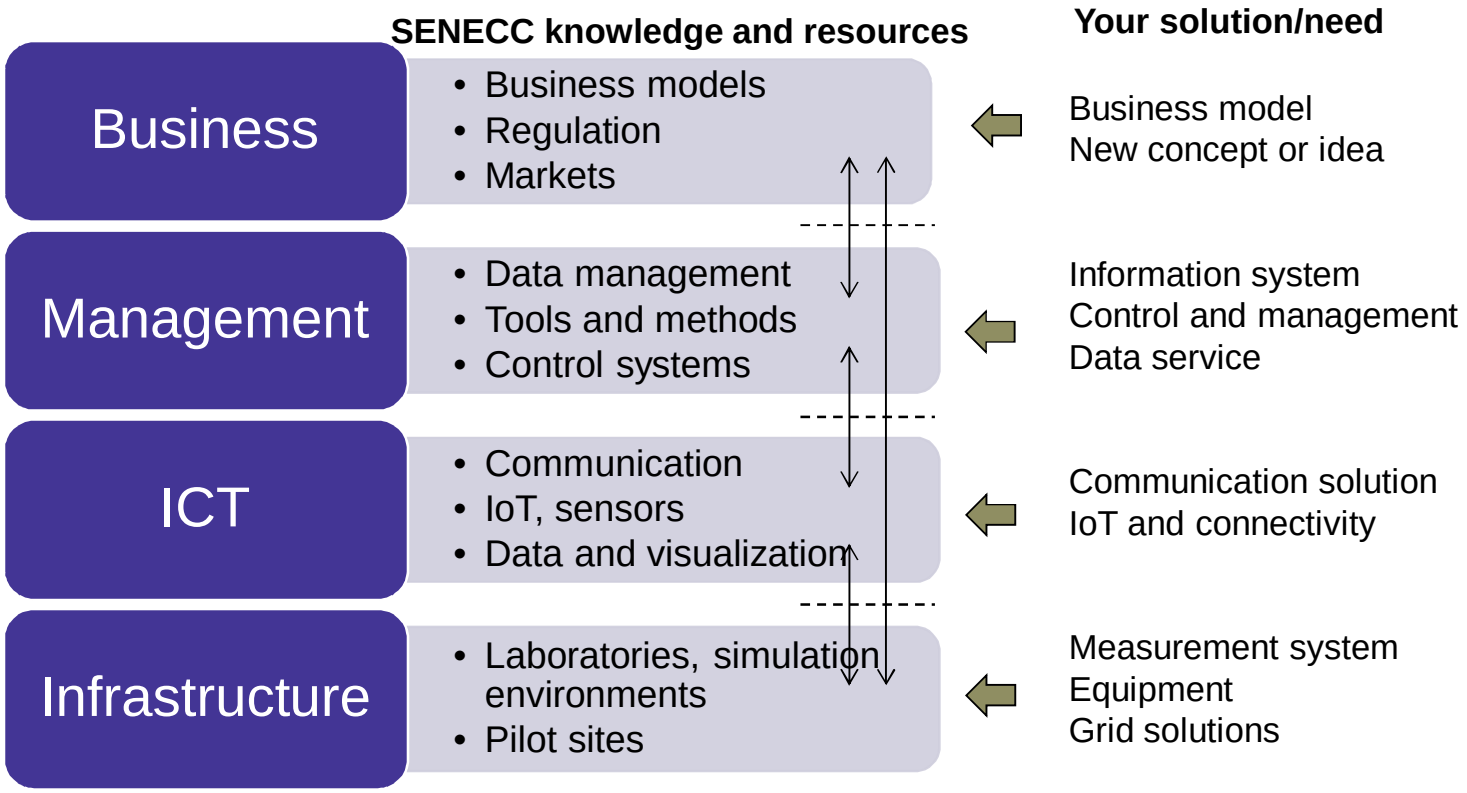
Co-creating horizontally and vertically



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DEACT 1st steps

Goal: Feasibility analysis

- Operation
  - Computing load, properties
  - Power demand, properties
    - Computing, cooling, other
  - Heat loads, properties
    - Local, district heating
- Technology, systems
  - Renewable sources
  - Power grid, components
  - Cooling systems
  - Measurements
- Tier 1(&2) Centers
  - Same parameters

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DEACT – Datakeskukset energiajärjestelmän aktiivisina toimijoina – Data Centers Energy Demand Response Analysis

- Business Finland
  - DEACT (Co-Creation) prepares DEACTPlus (Co-Innovation)
- Data centres use 1-2 % electric power globally, share is increasing
- In the future, power grids require more controlling power and flexible power use
  - Needed to compensate unpredicted fluctuations in wind and solar power generation
- DEACTPlus research and innovate how Data Centres can act as flexible user
  - Goal is that Data Centres support stability of electric power grid
- DEACT, Coordinated by Tampere University, integrates
  - Electric power grid device manufactures
  - Cooling equipment manufactures
  - System integrators
  - Data Centre equipment manufacturers
- DEACTPlus demonstrates solutions in CERN