# Notes on: RAMBØL - ANCILLARY SERVICES FROM NEW TECHNOLOGIES

**1 - Preface**

Electricity grid inertia/robustness are provided primarily from rotating masses in generators and motors.

European TSO’s – ENTSO-E and ENTSOG

Reference document for ancillary technologies: Behovsvurdering for systemydelser 2020” [4] from Energi Net

Technology Data Catalogues from the Danish Energy Agency: ref [6]

Western Denmark is part of Central Europe synchronous area , Eastern Denmark is part of Nordic synchronous area.

**3 - TECHNICAL REQUIREMENTS FOR ANCILLARY SERVICES**

Primary services (5 min to full load, short duration):

* FCR (frequency containment reserve)
* FCR-N
* FCR-D

Secondary services (15 min to full load, medium duration):

* aFRR (automatic frequency restoration reserve) capacity in DK1 is +/-90 MW (page 26)

Tertiary services (15 min to full load, continuous duration):

* mFRR (manual frequency restoration reserve) approx. 500 MW for DK1

**4 - Ancillary services from new technologies**

4 categories:

* Generation Plants
* Demand plant
* Power to X
* Energy storage

**5- Generation plants**

Technology: wind turbines

* Cannot offer regulation when wind is below 4-6 m/s
* Can offer down (and sometimes up) regulation when wind is above 4-6 m/s

Technology: Photovoltaics

* Control is possible but is only in the testing phase. No implementations yet.

Renewable Energy Generation plants can provide auxiliary services to some extend by down regulating their produced power.

Consider CHP plants

Synkronkompensatorer

**6- Demand plants**

Technology: Large Scale Heat Pumps

* FCR-N regulation capacity
* Technology: Electric boilers
* Can provide all auxiliary services with 100% of capacity

Technology: Industrial cooling

* Experiments have been conducted, but inertia in cooling systems appear to be to low, and therefore cooling is not considered a good candidate

Afbrydelighed

**7 – Power to X**

Technology: Biogas plants

* Currently no efforts are done in terms of providing auxiliary services with biogas plants electricity consumption.

Technology: Solid Oxide Electrolyser Cell

* Research and development phase
* Has good qualifications to provide auxiliary services (fast up and down regulation)

Generally good possibilities for auxiliary services from power to x technologies. Most technologies are however only in development stage

**8 – Energy Storage**

Technology: Battery storage

LiIon

* Can provide primary services easily (FCR-N)
* Capacity may limit the ability to deliver secondary and tertiary services
* High TRL level (TRL 7-8)

Electric Vehicle batteries

* Can deliver FCR
* Trouble with two low fleet size, therefore not capable of making minimum bid
* Rambol concludes that EV batteries will be a potential auxiliary service in future

Technology: Hybrid power plants (plants combining wind turbines and batteries)

**Summary and conclusion**

**Ideas for technology facts:**

TRL level

% of capacity available as FRR/FCR etc.

LCOS

The TRLs in Europe are as follows:[15]

TRL 1 – Basic principles observed

TRL 2 – Technology concept formulated

TRL 3 – Experimental proof of concept

TRL 4 – Technology validated in lab

TRL 5 – Technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)

TRL 6 – Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)

TRL 7 – System prototype demonstration in operational environment

TRL 8 – System complete and qualified

TRL 9 – Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)