section II

ACTIVITIES IN WP3.3

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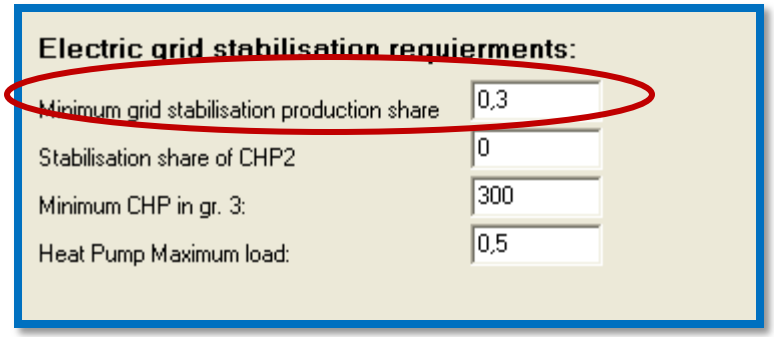
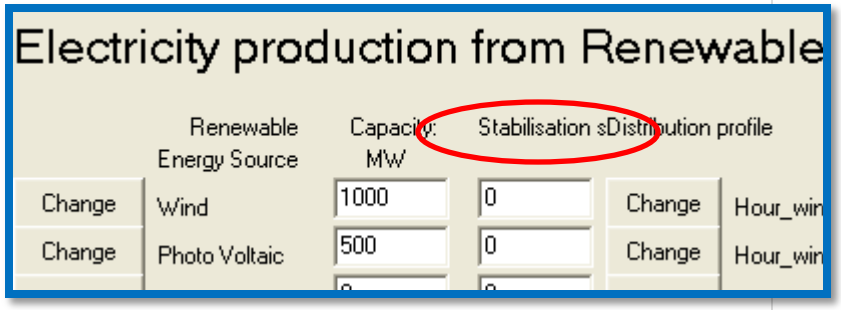
Integration with EnergyPlan

- EnergyPlan adresses some grid requiremnts
- Required *"stabilization share"* (connected large synchronous generation):
  - Estimated 30% according to experience from system operators
  - CEESA calcualtes with 0%
  - *Theoretical minimum* unknown
- stabilizing contribution from renewable energies
  - Possible, to be investigated...





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Discussion toward including operation-requirements in EnergyPLAN

I. Requirements for system ”stability” / ”Operational Requirements”.

a) For Interconnected Areas (inertia&primary control shared)

OPTION: trading of ancillary services.

b) For islanded systems

II. Generalized/relevant device-properties

Energy storage, response time, availability, ”distributedness”, ...

III. ”Services” to be recognized by EnergyPLAN

Active Power Reserves, Non-active power requirements (voltage control etc.) *(?)*

IV. List of devices(now and future) modeled in EnergyPLAN, their properties and mapping to the respective ”services”.

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Stability Requirements for EnergyPLAN

- discussing extension to Energyplan:
  - Revision of “stability” requirements
  - to include capacity reserve for intra-hour variation
  - Document *different requirements* for islands and interconnected systems

- *ideally* should follow from WP3.1 and 3.2, but does require additional simulation studies.

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What is in the scenarios? (IDA 2030 / *2050*)

A. Central Generation

- Replace future power […] by fuel cell CHP plants, equal to 35-40 per cent of total power plants in 2030, (individual house heating →district heating CHP)
- Introduce 450 MWe large heat pumps
- *Replace all CHP and power plants by fuel cell-based or biogas or biomass gasification*

B. Renewable Electricity (uncontrolled)

- Increase wind power
  3000 MW to 6000 MW in 2030
  onshore@3000MW, 3000MW offshore)
- 500 MW wave; 700 MW PV
- *Increase wave power to 1000 MW*
- *Wind power (all offshore)*
  IDA2050: 7000MW //
  IDA2050Biomass: 3000MW //
  IDA2050Wind: 12000MW

C. (controllable) Distributed Generation

- Replace natural gas boilers by microCHP, ~10 per cent of house heating
- *Convert micro CHP systems from natural gas to hydrogen*

D. Electricity Demand Reduction

- … by 50 per cent in private households
- …by 30 per cent in industry

E. (controllable) Demand flexibility

- Flexible electricity demand in order to integrate wind power and CHP better in the energy system. (quantification?)
- *3TWh of industrial heat from heat pumps*

F. Transportation – V2G

- 20 per cent of fuel for road transportation by electricity (and 20 per cent by biofuels)
- *Stabilise the transportation demand at the 2030 level*

Mapping to Electricity perspective

1. Generation Units ←*more renewables, less inertia?*
2. Grid Design ← *transmission network, components?*
3. Balancing Control ←*Intermittency*
    1. Controllability issues
    2. Balancing resources (time scales/ volume)
4. Network Control (Operational stability) ←*Changing flows*
    1. Voltage Control
    2. Distributed inputs
    3. Reactive flows and congestion management
5. (Protection Systems)

Measures / Tech. Areas	A. Central Generation	B. renewable Electricity	C. Distributed Generation	D. Demand reduction	E. Demand Flexibility	F. Transportation	WP3.1	WP3.2
I.	X	x		-	-	-	?	?
i.	X	x	x	?				
II.	X	X		x	X	X	X	X
i.	x	X		?	X	X	X	X
ii.		X	X		X	X		X
III.		x	X	-	X	?	X	x?
i.		x			X		?	x
ii.			X		X		X	x
iii.	X				x	x	x	
IV.	?	?		-	?		X?	?
X – major, x – minor, ? – unclear, - – none								

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Initial comments / Apparent challenges

- The fundamental (frequency-forming) unit of power systems is the *synchronous generator*.
  Introduction of *fuel-cell CHP plants* means to remove stabilizing system inertia.

  →complete replacement of CHP plants by fuel cells seems most radical system change

- All measures are stated with reference to Ref2030 scenario*
  →scenario descriptions are only relative changes.
  A “business as usual” power system model does not exist. Further, a power system for the whole of Denmark is not available for us, neither tractable.