On Operation Reserves in Electric Energy Systems

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Presentation on WP3.2

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Why study Reserves?

<u>”Markets meet Control”</u>

a) System Operation *requires* Reserves

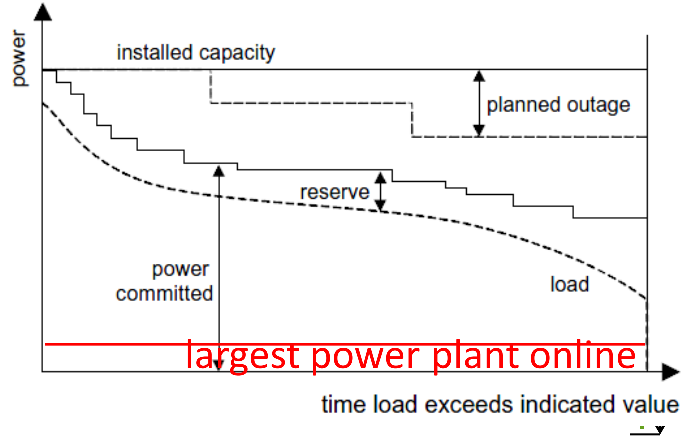
- System Operation is System Control
- Control is challenged – and that will change

b) Reserves are *allocated by* Markets

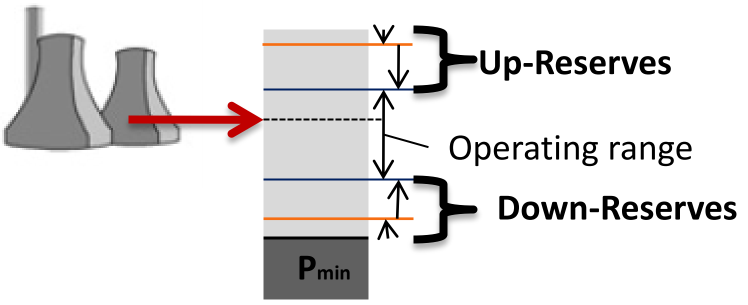
- Investment needs (costs & possible savings)
- Regulation and market structure

What is Control Reserve?

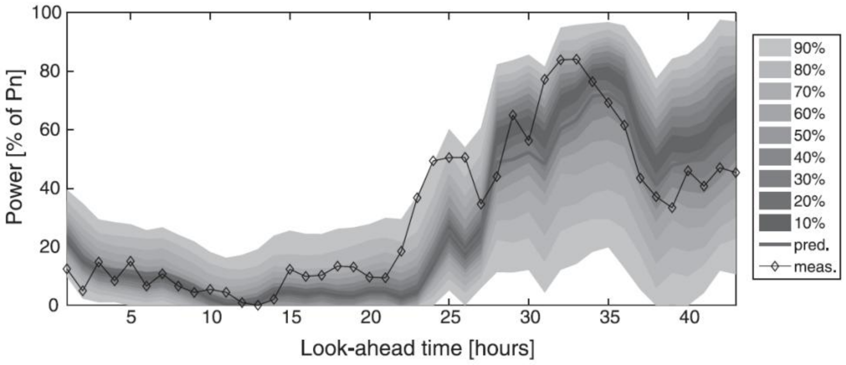
System Perspective (*classic N-1 procurement*)



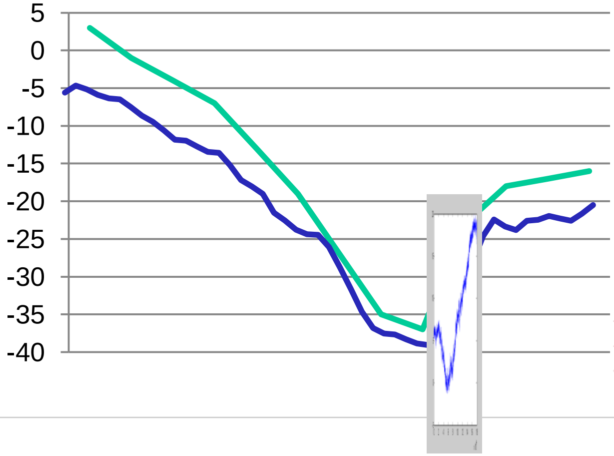
Power Plant Perspective (*committed reserves*)



Prediction Uncertainty



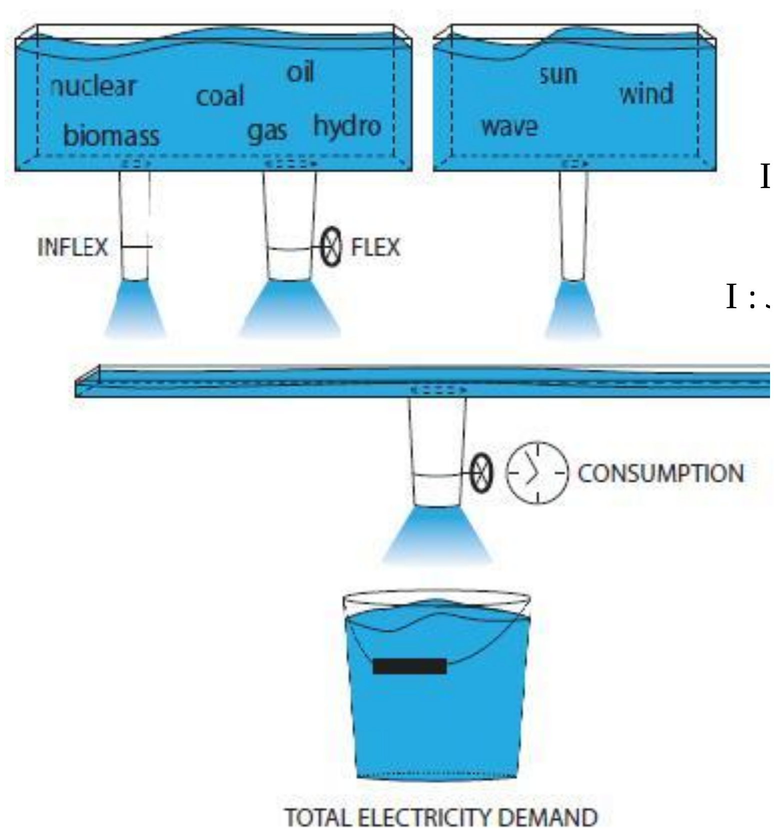
Short-term Variability



Utilization of Reserves in System Operation

Energy Market

(*Schedule* + prediction uncertainty,
unplanned outages, ramping, variation, etc..)



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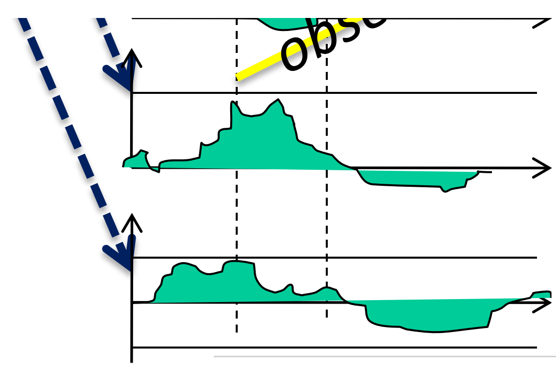

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(updates please!)

Reserve Drivers in CEESA scenarios

2030

A. Central Generation

- **fuel cell CHP** plants, equal to 35-40 per cent of total power plants in 2030,
- Introduce 450 MWe large **heat pumps**

B. Renewable Electricity (uncontrolled)

- Increase **wind power**
  3000 MW to 6000 MW in 2030
  onshore@3000MW, 3000MW offshore)
- 500 MW **wave**; 700 MW **PV**

C. (controllable) Distributed Generation

- Replace natural gas boilers by **microCHP** ~10 per cent of house heating

D. **Electricity Demand** Reduction

- by 50% / 30% in households / industry

E. (controllable) Demand flexibility

- **Flexible electricity demand** (quantification?)

F. Transportation – **V2G**

- 20 % of fuel for road transport by e

2050

A. Central Generation

- ***Replace all CHP by fuel cell***-

B. Renewable Electricity (uncontrolled)

- *Increase **wave power** to 1000 MW*
- ***Wind power** (all offshore)*
  IDA2050: 7000MW //
  IDA2050Biomass: 3000MW //
  IDA2050Wind: 12000MW

C. (controllable) Distributed Generation

- *Convert **micro CHP** systems from natural gas to hydrogen*

D. Electricity Demand Reduction -

E. (controllable) Demand flexibility

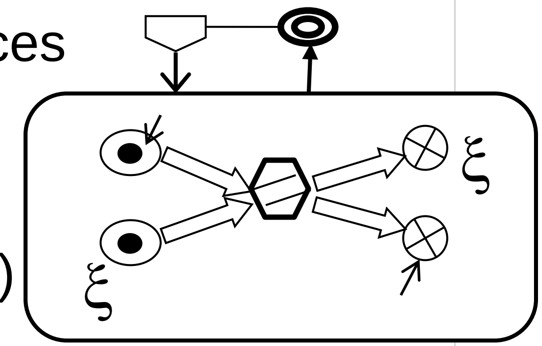
- *3TWh of industrial heat from **heat pumps***

Mix of new reserve drivers:
(more wind / smaller CHP/ less Inertia)

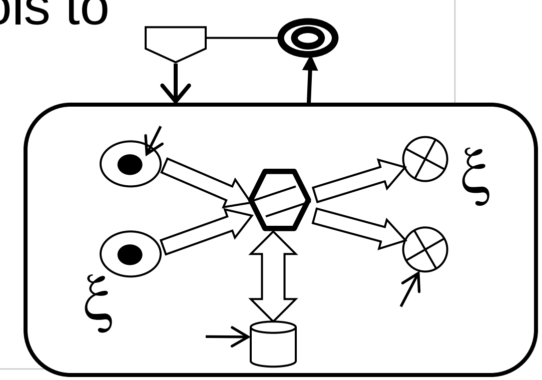
New resources
→ mostly <u>storage</u>-bound!

System Operation Model With Energy Storage

- In current market-based operation models, system operation does not reflect limited-energy resources



- Operation strategies for such systems are more complex, e.g. *anticipate coming situations* (Farø)
- Especially short-term (heat-)energy-storage clusters could provide valuable regulation reserves at low cost.
- Effective utilization requires operator-support tools to ensure (risk-)situation awareness (trade-off): *risk* not balancing the system vs. *cost*,



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System Operation Model *With Energy Storage*

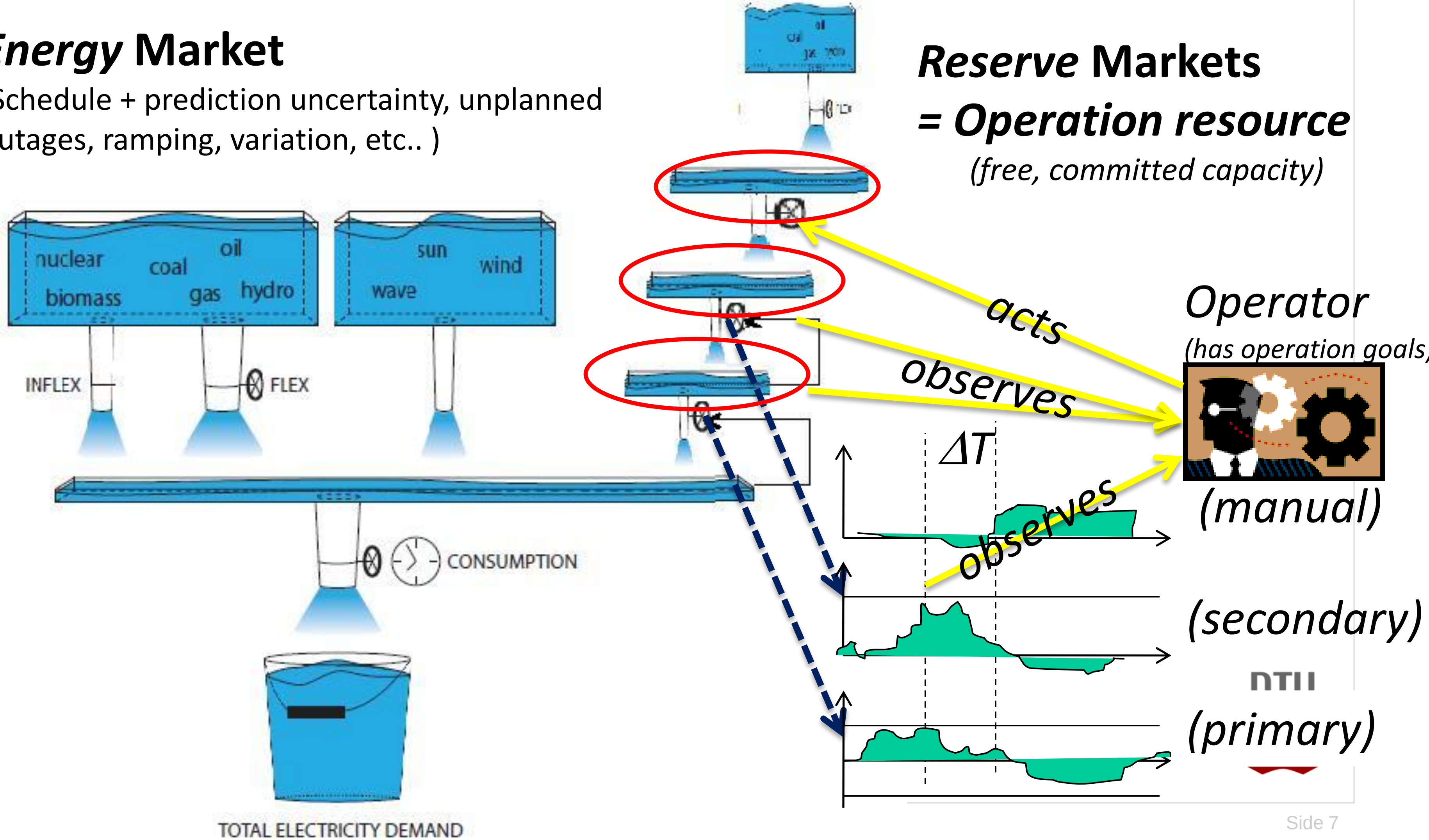
Energy **Market**

(Schedule + prediction uncertainty, unplanned outages, ramping, variation, etc..)

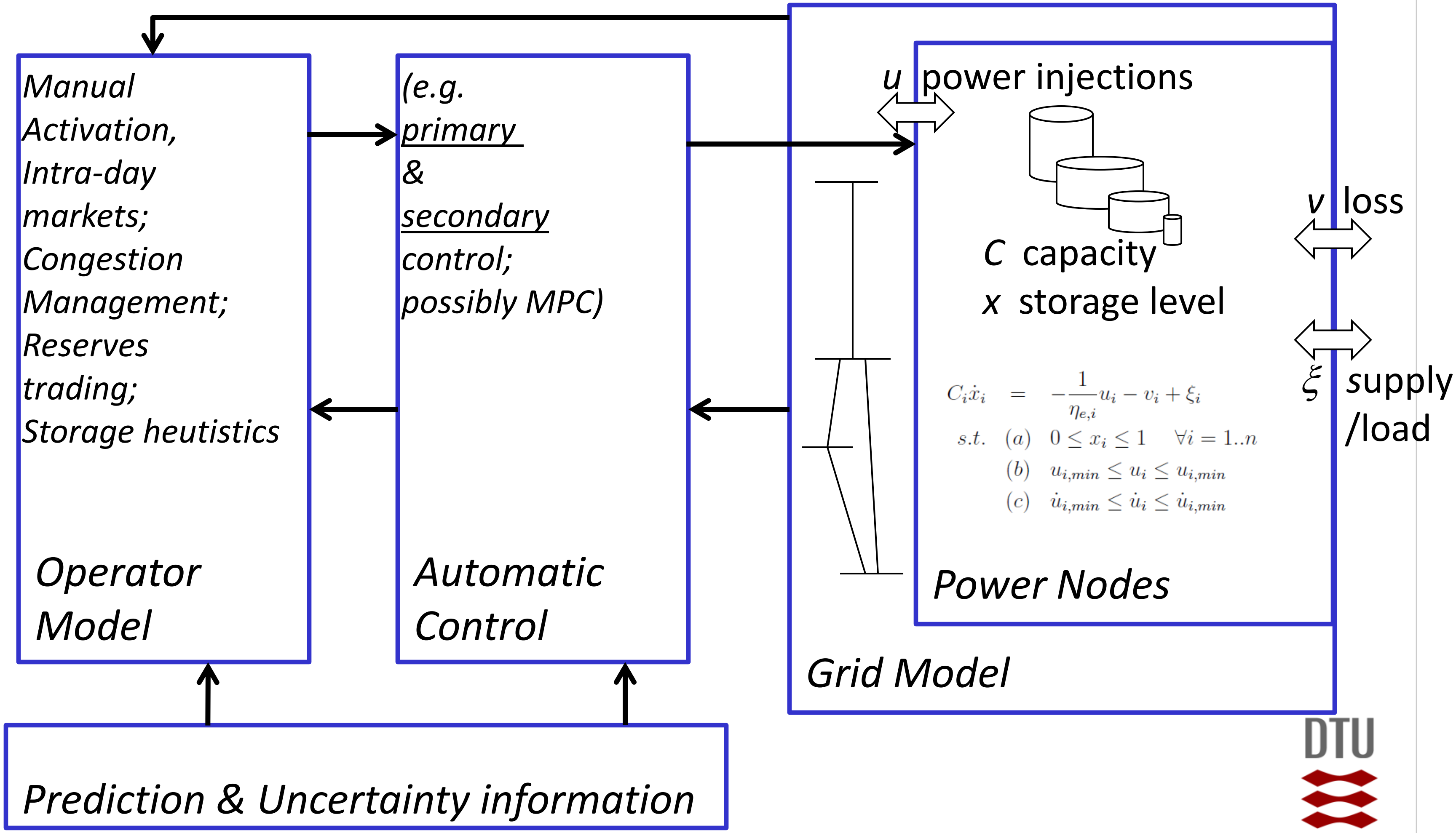
Reserve Markets

= Operation resource

(free, committed capacity)



Power-Nodes Model.



Study Plan: Show Value of operation with ES

- Wind Energy -> Placement, Onshore/Offshore
- Controllable Demand ->
  - Controllable with storage
  - Deferrable demand (washing later)
  - Load shedding
- EVs as storage for different time-scales
- Dispatchable Generators (biomass?)
- Heat Pumps & CHP with shared heat storage
- Electrolysers
- Reserve “trading” need: Generator beyond “border”

Plan til CEESA

- *This* Study (for Grid Model & Analysis):
    - June/July: initial model implementation
    - by August: get input data
    - By September: first study
    - By November: full study result
- Other Reports & Papers
    - *On the Integration of Planning, Operation & Market Perspectives (functional modeling of scenarios)*
    - *Modeling purpose and function of Power System Control Architecture…*

section II

INPUT TO WP4

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Toward future power system operation

- Focus on Dual-use options (such as EV, heat pumps)
- Strengthen DSOs – the front-end to distributed resources
  - Responsibility, Support & Regulation
- Regulation needs to be opened up
- Behavioural aspects
  - Influence possibilities need to be studied;
  - demand flexibility requires new statistics
- Technology incentives: rather don't pick winners

Thanks for your Attention!

Questions? Please!

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