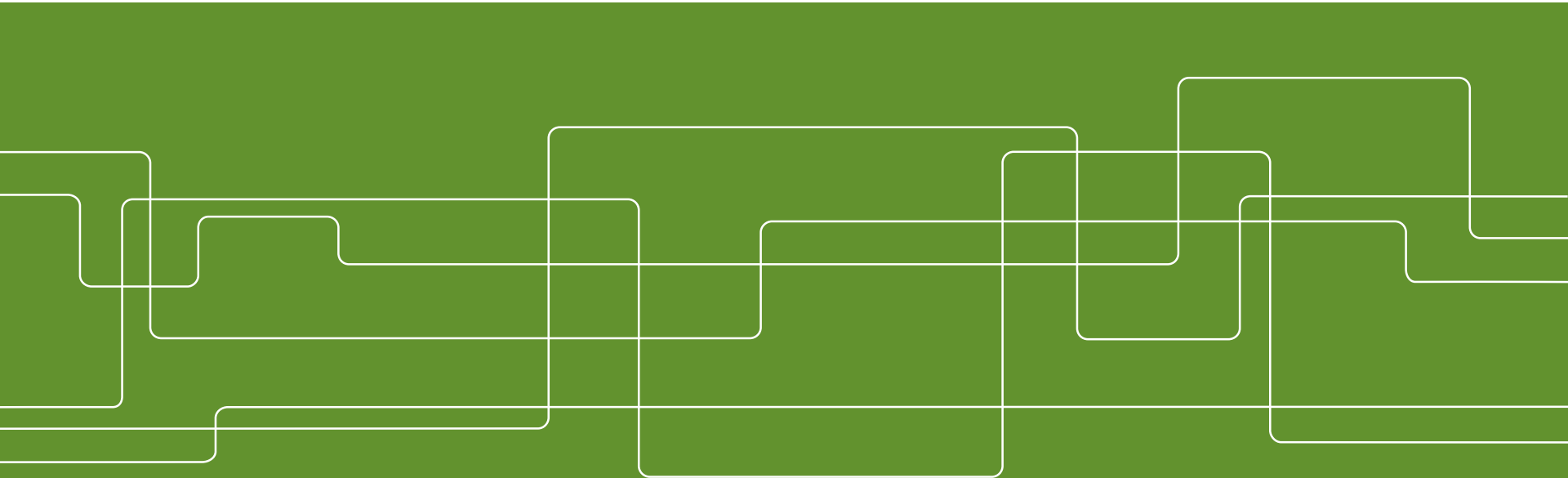




Decarbonisation of the European heating sector: Sweden as a role model for how heat pumps could pave the way and RePowerEU

The Potential for Demand Side Flexibility offered by Smart Heat pumps

Lennart Söder
Professor in Electric Power Systems





Decarbonisation of the European heating sector: Sweden as a role model for how heat pumps could pave the way and RePowerEU

The Potential for Demand Side Flexibility offered by Smart Heat pumps

1) What is "electricity"?



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The Potential for Demand Side Flexibility offered by Smart Heat pumps

- 1) What is "electricity"?**
- 2) Flexibility: On which market?**



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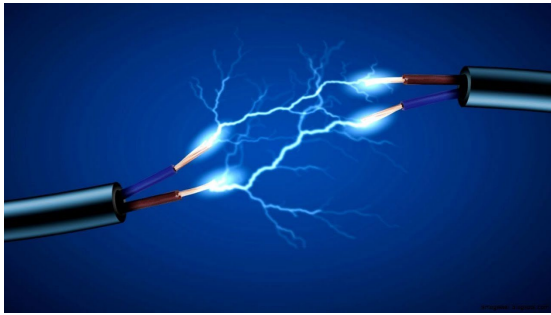
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Decarbonisation of the European heating sector: Sweden as a role model for how heat pumps could pave the way and RePowerEU

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- 1) What is "electricity"?**
- 2) Flexibility: On which market?**
- 3) Flexibility: Who is flexible?**
- 4) Five flexibility examples!**

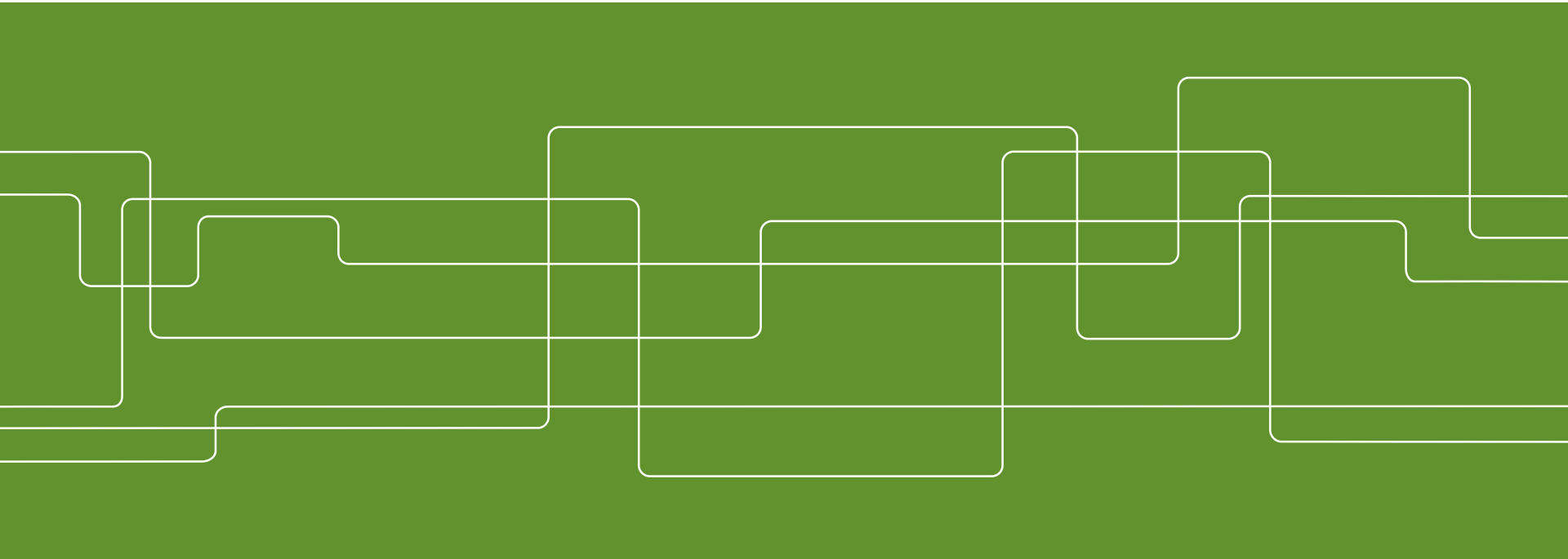


Electricity

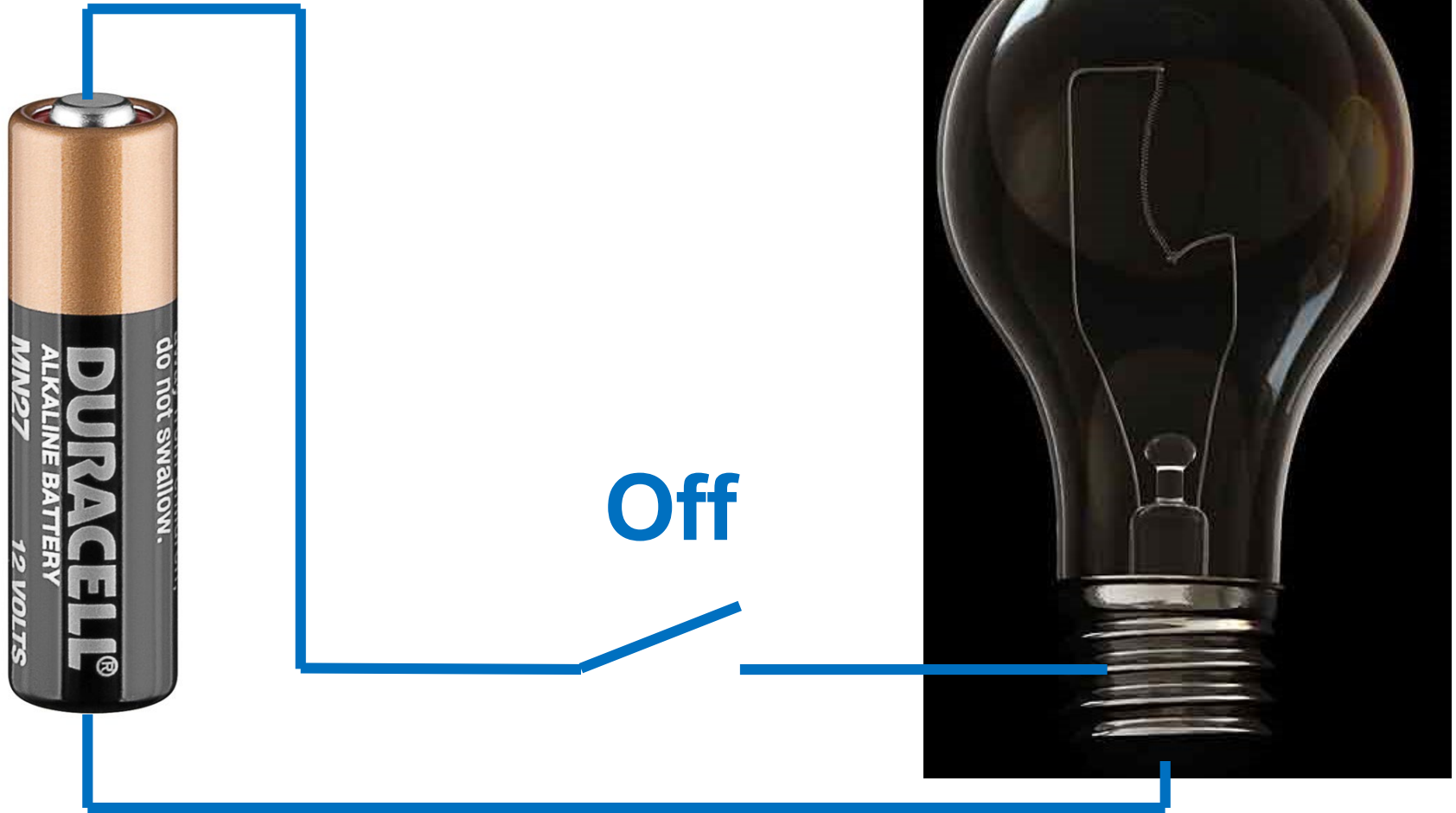
May 26, 2023



by Lennart Söder
Professor Electric Power Systems, KTH

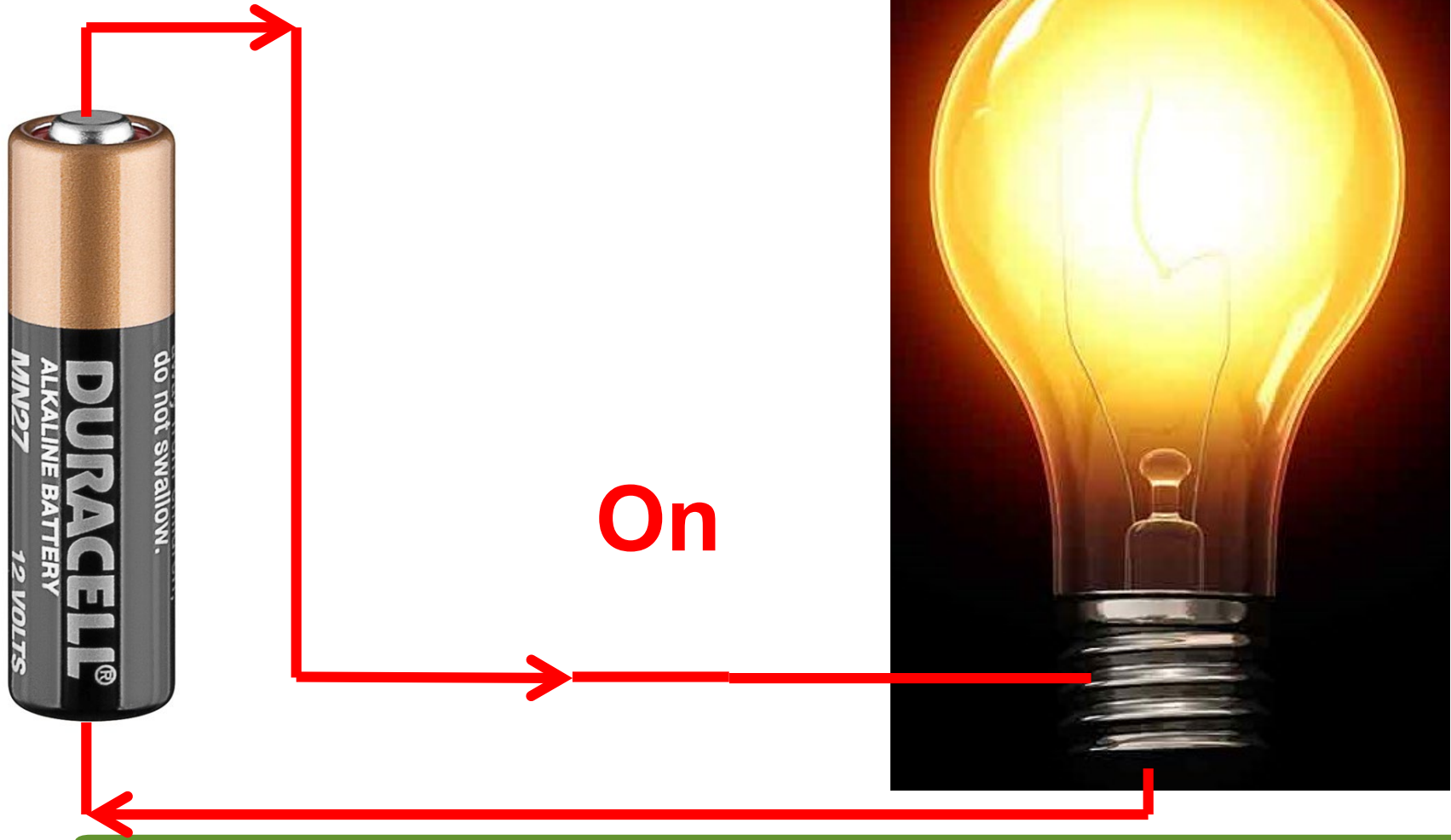


Electricity comes with the speed of light



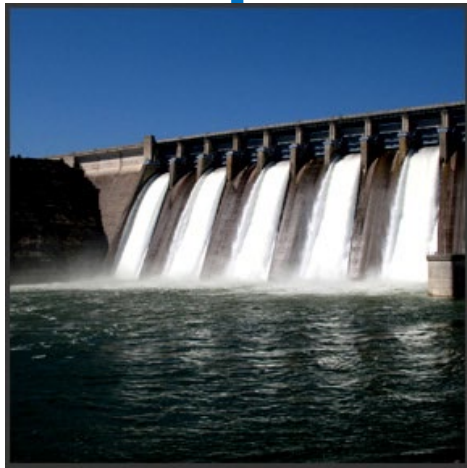


Electricity comes with the speed of light





Electricity comes with the speed of light

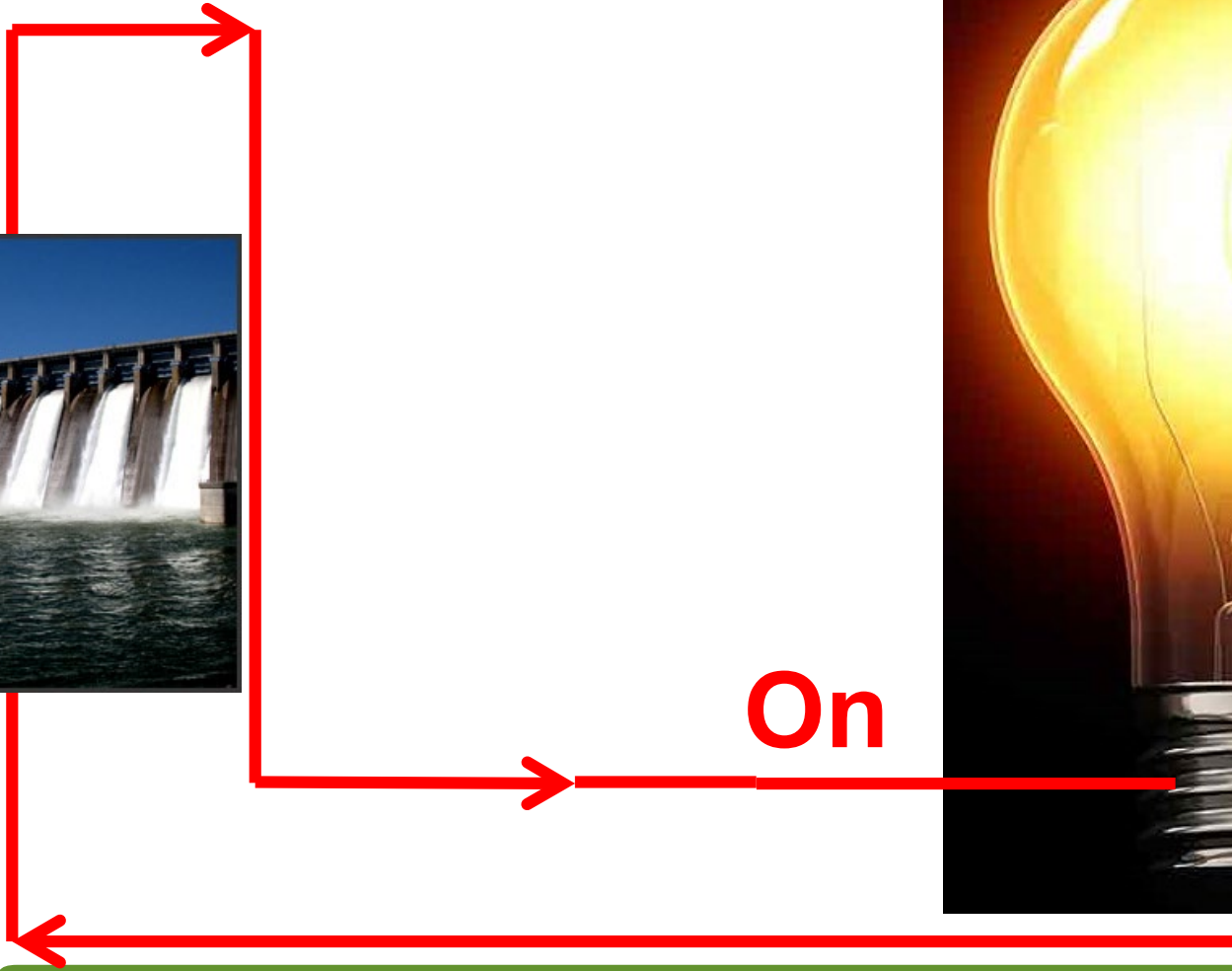
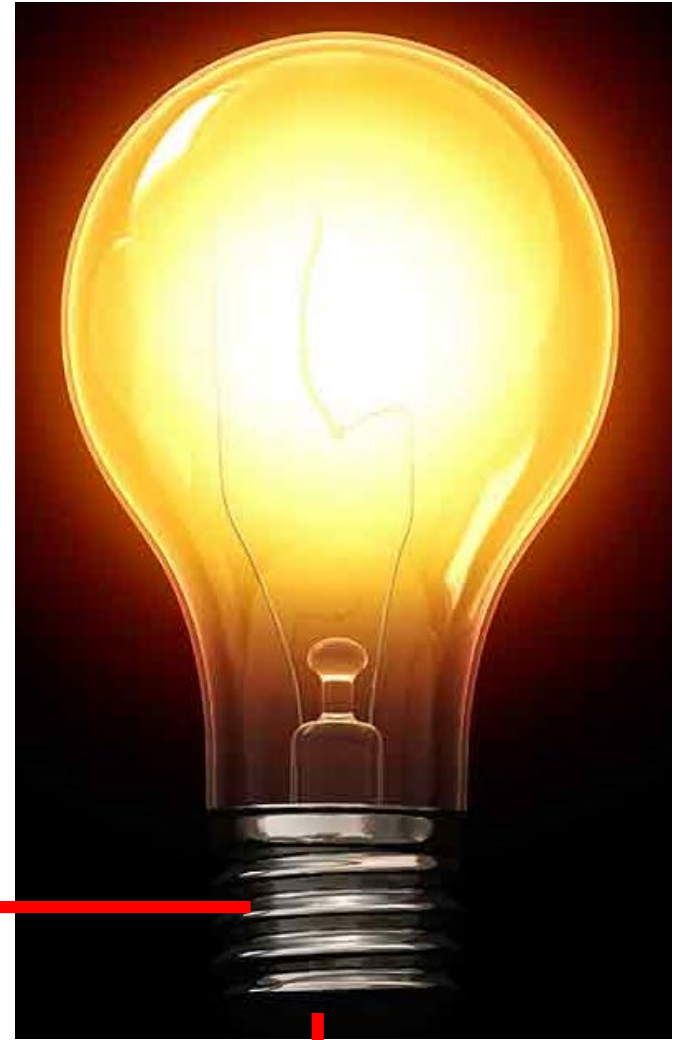


Off





Electricity comes with the speed of light

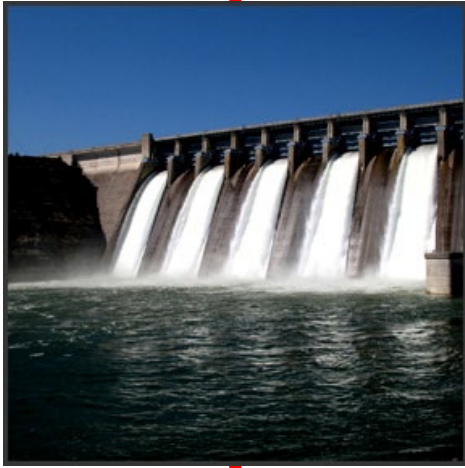


On

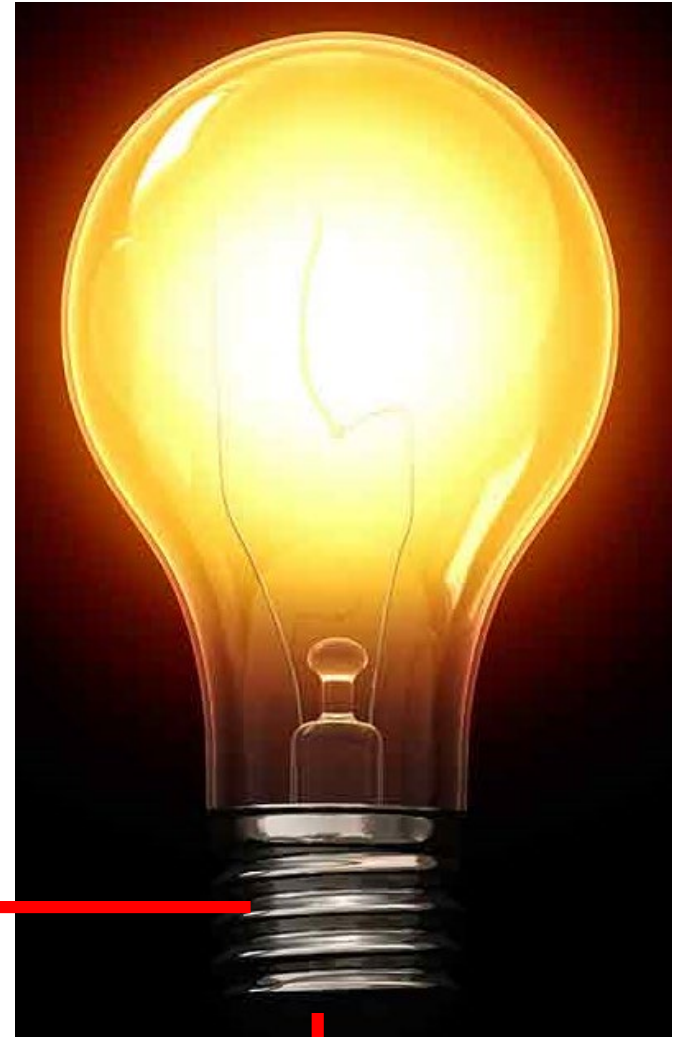
Electricity comes with the speed of light

During 1/100 second

- **Light** travels 3000 km = Stockholm – Madrid
- **Sound** travels 3 m.



On





The Potential for Demand Side Flexibility offered by Smart Heat pumps

Which markets?

Day-ahead: **Trade** of hourly energy for all single hours. Decision noon, day before

Intra-day: **Trade** of hourly energy. Deadline: Bids up to one hour before true trade.

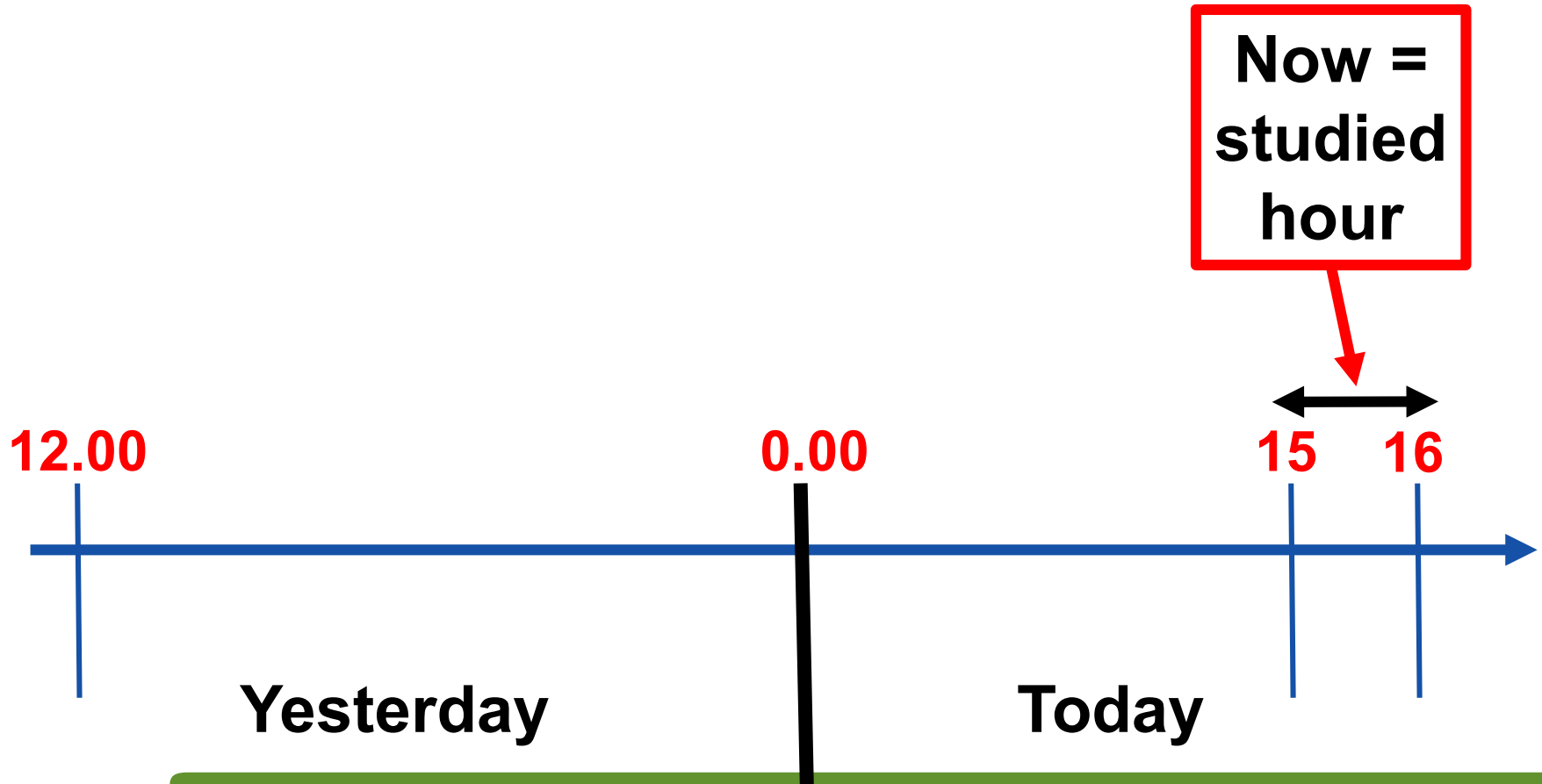
Reactive day-ahead: At take-and-pay contract: **React** when prices are set.

System services: React at order **within each hour**.



The Potential for Demand Side Flexibility offered by Smart Heat pumps

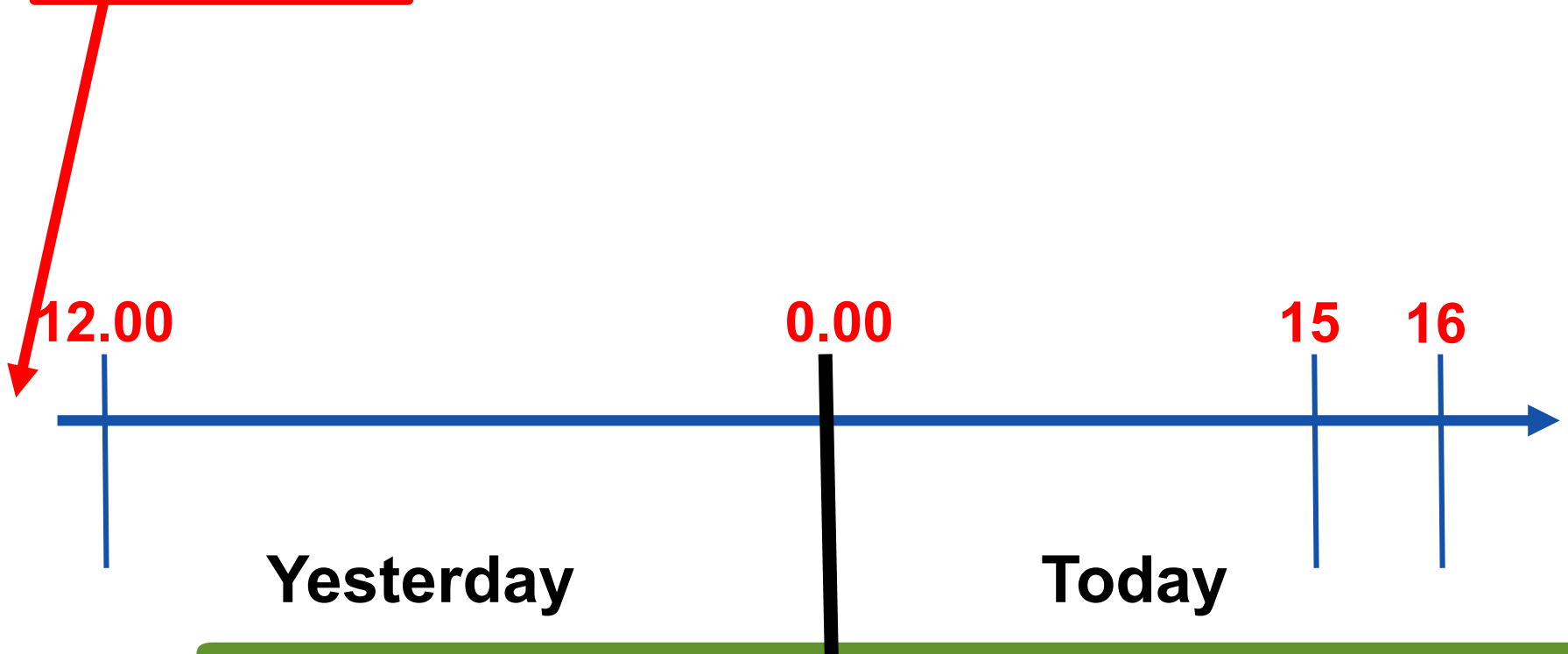
Which markets?





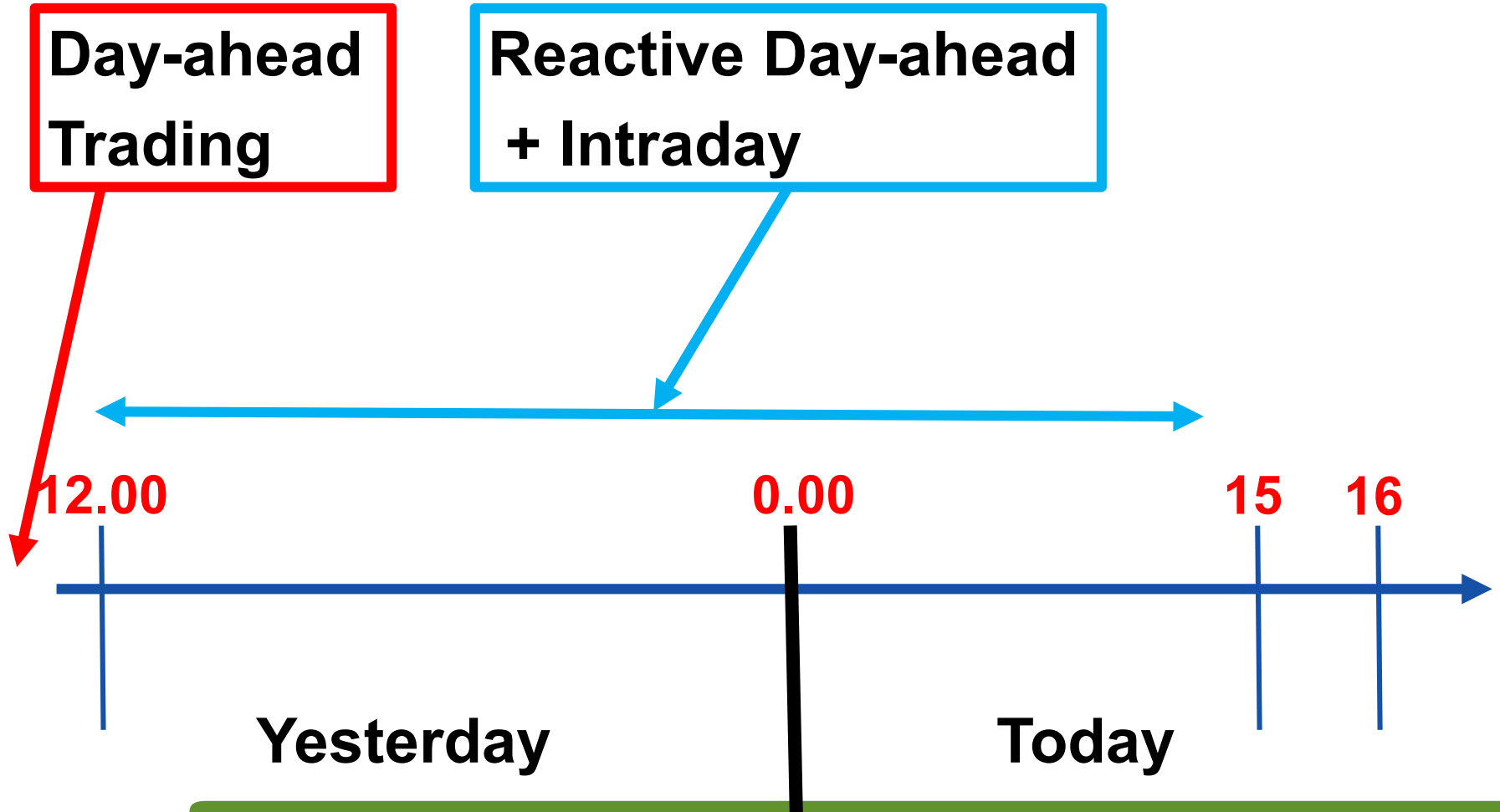
The Potential for Demand Side Flexibility offered by Smart Heat pumps

Day-ahead Trading



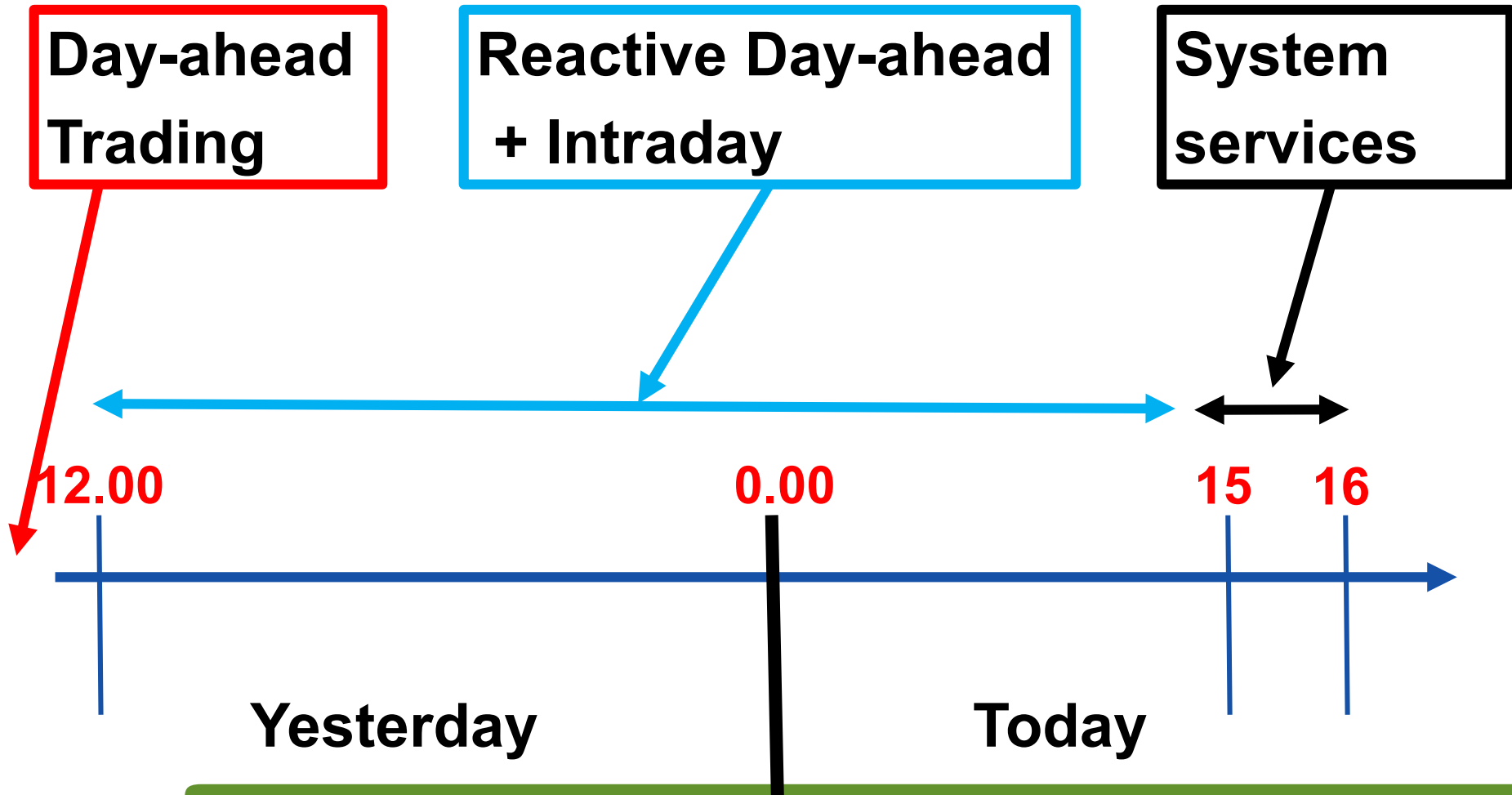


The Potential for Demand Side Flexibility offered by Smart Heat pumps





The Potential for Demand Side Flexibility offered by Smart Heat pumps





The Potential for Demand Side Flexibility offered by Smart Heat pumps

Who will trade?

HP owner - 1: Market actor can put bids on the different markets, and consider flexibility concerning use of heat pumps.

HP owner - 2: With take-and-pay contract. Can react on prices when they are seen

Aggregator: Can bid in resources on markets.

Retailer with controllability: Considers the controllability in the market purchase bidding + system services.

HP flexibility example – 1



Data:

- Lennart Söders heat pump
- He purchases power at hourly prices (Nordpool) from a retailer
- The contract is take-and-pay
- 8.8 kW heat.

Flexibility:

- The heat pump is connected to Nordpool
- At high price: Indoor temperature is decreased with 1°



HP flexibility example – 2

Data:

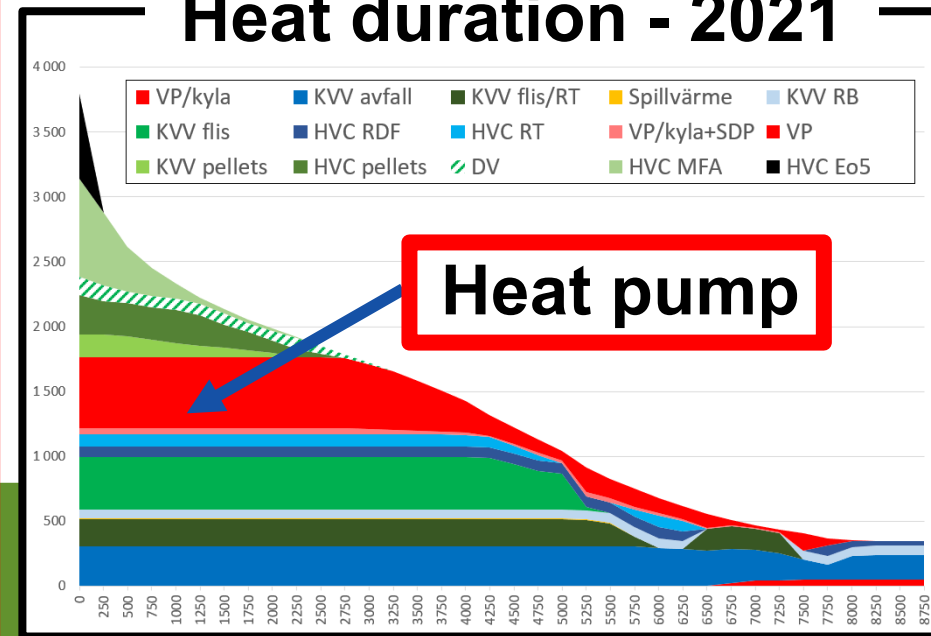
- **Stockholm Exergi** heat pump
- They put bids on Nordpool for power purchase and selling for the whole system.
- Day-ahead + intra-day
- **HP: More than 500 MW** district heating.



Flexibility:

- The heat pumps are only used at low prices,
- CHP used at high prices (heat + electricity generated)
- Plans for battery for combined HP-battery fast system services.

Heat duration - 2021



HP flexibility example – 3



Data:

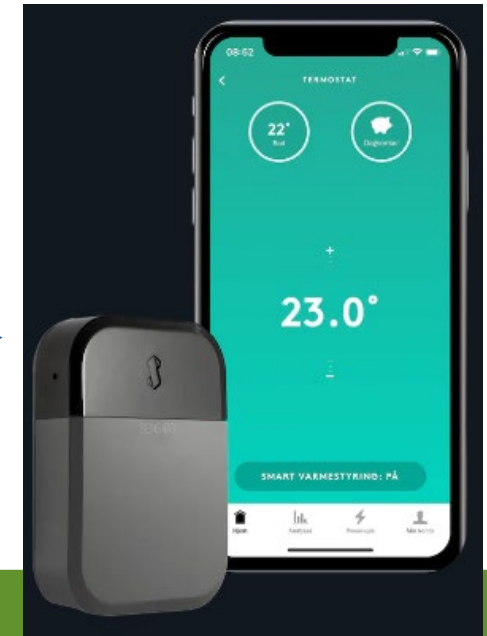
- **Tibber**: a retailer which has online communication with consumers.
- They put bids on Nordpool for power purchase and also with TSO for system services.

EVs and other loads



Flexibility:

- Their costumers can individually control consumption via their system **Sensibo**
- Or be controlled directly by Tibber: cloud to cloud via HP company.



HP flexibility example – 4

Data:

- **Ngenic**: a technology provider of "smart control". Ngenic Tune
- They are also active on some local markets: **SthlmFlex**, **Coordinet** and **Switch** + grid optimization

Flexibility:

- Their customers can use **Ngenic Tune**, which uses temperatures + prices etc, to optimize performance.
- Or be controlled coordinated for system services, peak shaving, grid problems

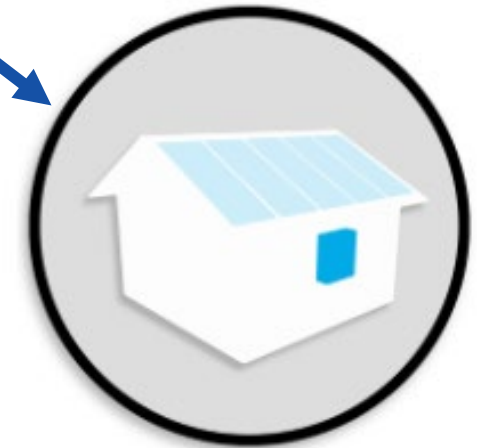
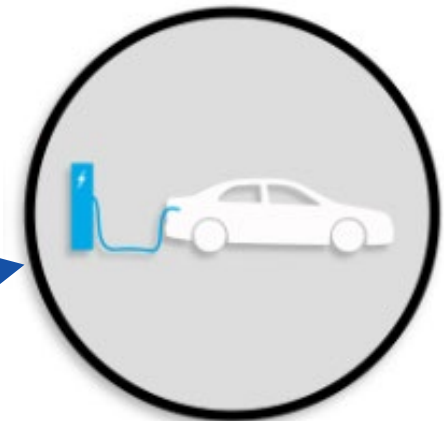
 The logo for GRIDTUNER, featuring the word "GRIDTUNER" in a stylized, yellow, italicized font on a dark purple background.

Data:

- **CheckWatt**: an aggregator of "controllable demand".
- They are active on day-ahead but mainly on the system service market.

Flexibility:

- CheckWatt installs a local controller for each customer, which changes consumption depending on system frequency change.
- In some cases coordinated control.
- Plans to include HP control






System impact

- Swedish current peak: \approx **26 GW**
- Heat Pumps for heating of single and multi-family houses \approx **3-6 GW** in 2030
- Plus Heat pumps in district heating (e.g. Stockholm area \approx **0.2 GW**)

→ HP flexibility certainly interesting for a stable power supply



Värmepumpars påverkan på effektbalansen
-idag och i framtiden

Profu, 2018

Denna rapport redovisar resultaten från ett forskningsprojekt om värmepumparnas samlade effektbehov i Sverige, idag och i framtiden. Inom ramen för projektet har effektbehovet av el för uppvärmning kvantifierats och relaterats till en framtid med ökande andel icke styrbar elproduktion.

Detta projekt har tillkommit som ett resultat av en dialog mellan Svenska Kyl & Värmepumpföreningen (SKVP) och utförare i projektet Värmemarknad Sverige. Finansiering har skett via Energimyndighetens och Svenska kyl- och värmepumpföreningens samverkansprogram Effsys Expand samt Kylbranschens samarbetsaffärs (KYS).

I projektet har vi ökat kunskapsnivån kring effektbehovet för uppvärmning samt kring möjligheter och begränsningar med att förskjuta detta effektbehov i tid för en bättre anpassning till den ökade variabiliteten på elmarknaden. Arbetet bidrar med underlag till följande två av Värmemarknad Sveriges temanområden, Värmepumpsmarknaden och Framtidens värmeförsörjning.

Värmemarknad Sverige

Profu, 2018

Värmemarknad Sverige