KTH VETENSKAP OCH KONST

KTH Industriell teknik och management

2nd International Conference on Smart Energy Systems and 4th Generation District Heating
Aalborg, 27-28 September 2016

The Challenge to Integrate the Growing Fluctuating RES-E Power at Different Vertical Entries in the Energy System

Knut Bernotat

AALBORG UNIVERSITY DENMARK

4DH
4th Generation District Heating Technologies and Systems

The Challenge to Integrate the Growing Fluctuating RES-E Power at Different Vertical Entries in the Energy System

4DH
4th Generation District Heating Technologies and Systems

Knut Bernotat

Department of Industrial Economics
Royal Institute of Technology
Stockholm, Sweden
++ 46 (0)8-790 9663
Knut@kth.se
http://www.indek.kth.se

AALBORG UNIVERSITY
DENMARK

2nd International Conference on Smart Energy Systems and
4th Generation District Heating, Aalborg, 27-28 September 2016

KTH VETENSKAP OCH KONST

KTH Industriell teknik och management

“Market Potential”

- According to the research firm IHS, the energy storage market is set to “explode” to an annual installation size of 6 GW in 2017 and over 40 GW by 2022 - from an initial base of only 0,34 GW installed in 2012 and 2013.

- An IMS Research report expects the market for storing power from solar panels – which was less than $200 million in 2012 – will catapult to $19 billion by 2017.

- In Sweden around 2 TWH will be dumped annually in the future

Overview

- Introduction
- Grid Extension vs. DSM
- Current Situation
- Vertical Integration
- Storage Systems
- Results
- Discussion
- Conclusions

Introduction

- European goals of reducing greenhouse gas emissions
- Shift in energy supply and power sector
- Increase of distributed RES-E mainly wind and solar power
- Increase started with WP in Denmark
- Later the FIT in Germany resulted in a massive increase of capacity and a price decrease of WP and PV
- Result: RES-E is competitive and abundant
- Current increase of RES-E on a European and international level
- Next generation WP 8 MW and PV at 19% efficiency
- Increasing number and size of peaks in the future grid

Grid Extension vs. DSM

4DH
4th Generation District Heating Technologies and Systems

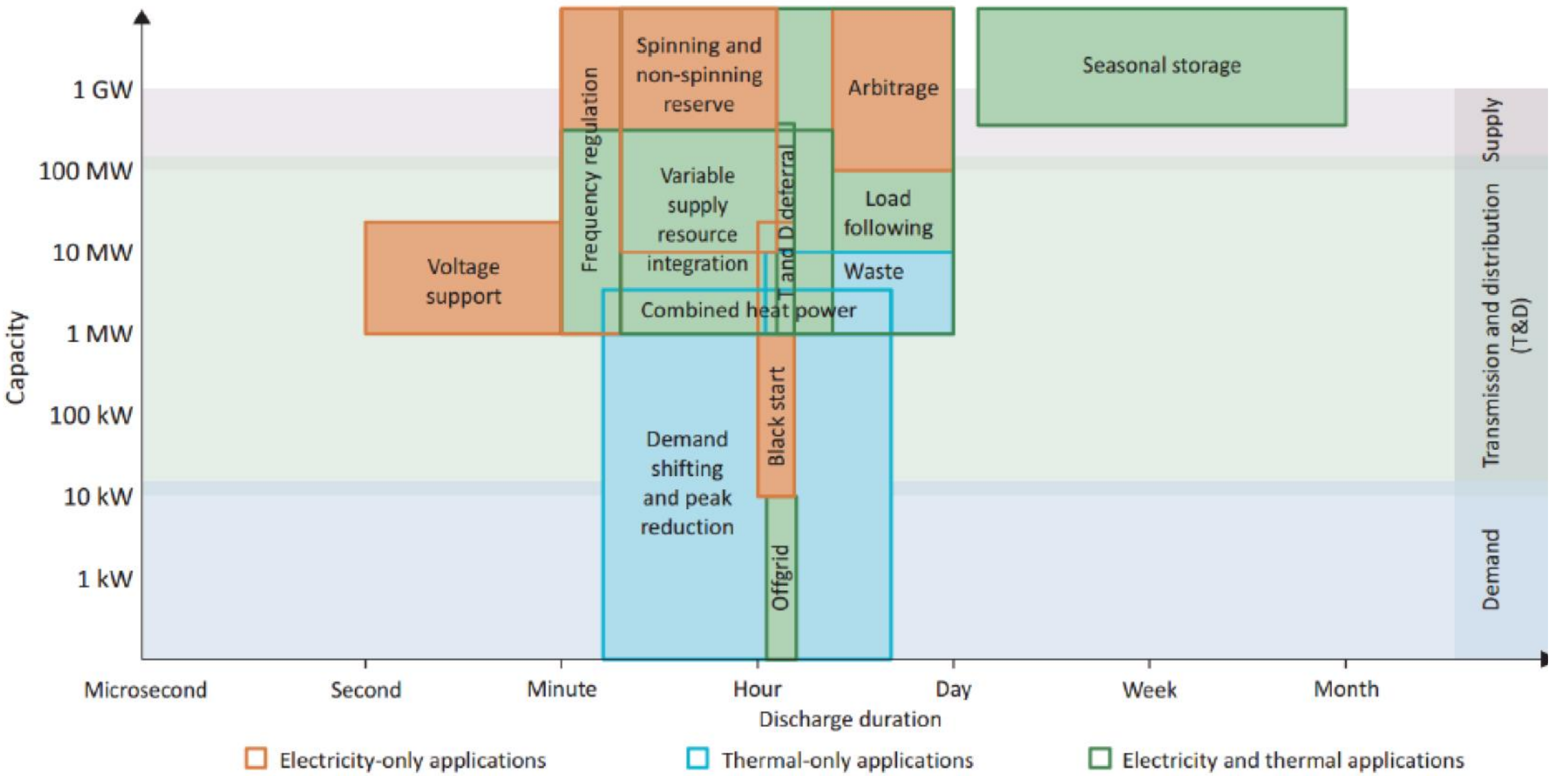
- **Different solutions**
- **Different stake holders**
- Power grid extension – shift in place
- DSM integration in the smart energy system of tomorrow shift in time

AALBORG UNIVERSITY
DENMARK

KTH VETENSKAP OCH KONST

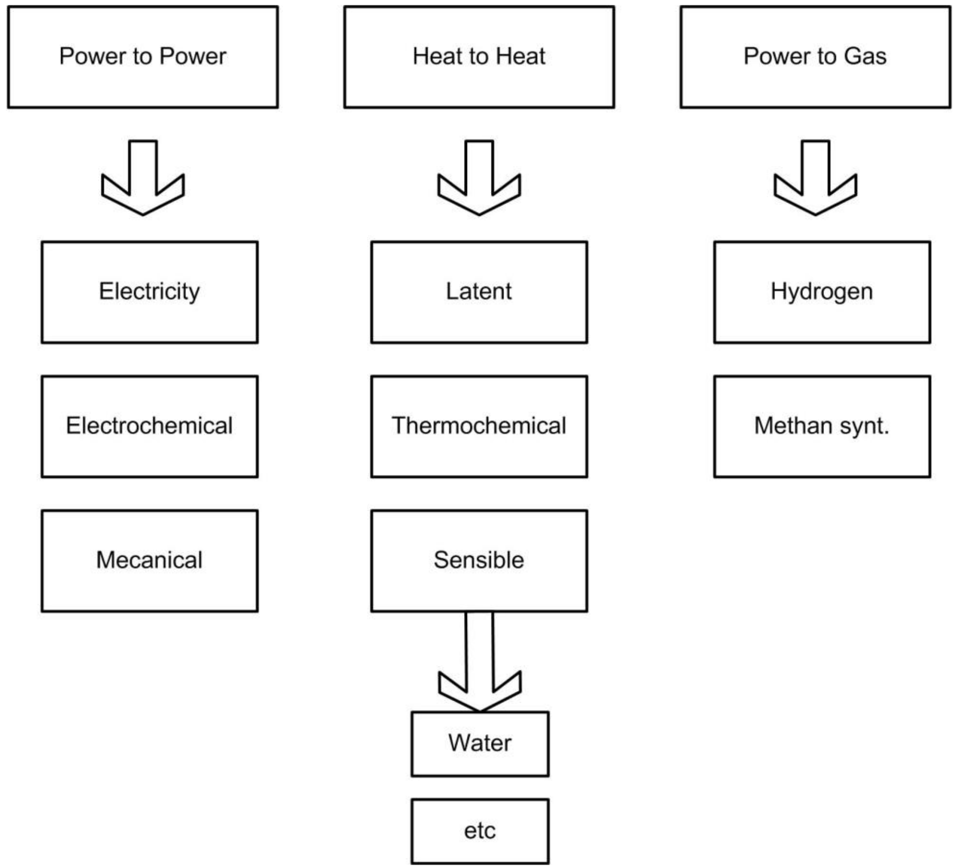
KTH Industriell teknik och management

Current Focus on Power

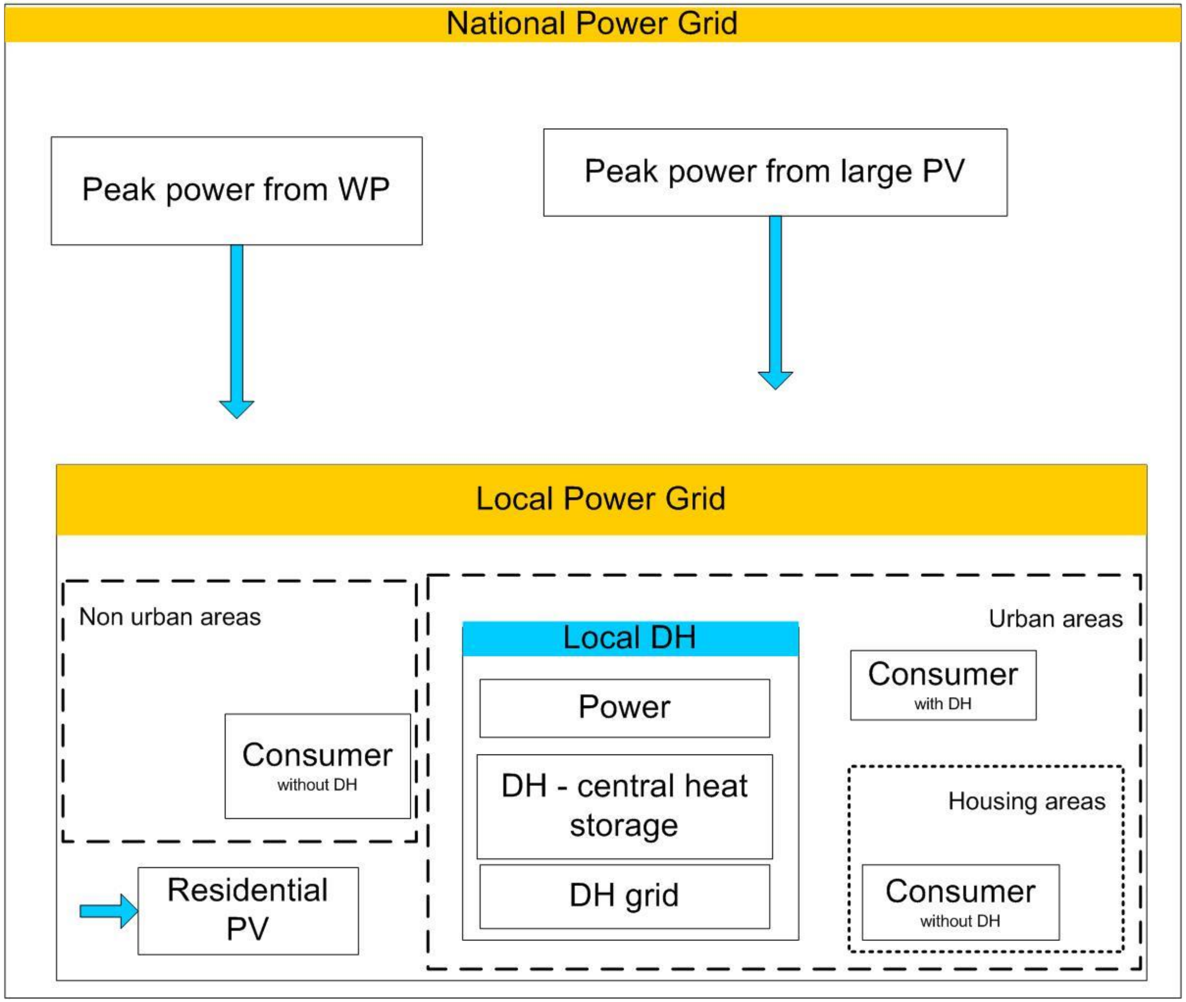


Source: STEM, IEA, Energy Technology perspective 2014, with changes from EASE (European Association for Storage of Energy)

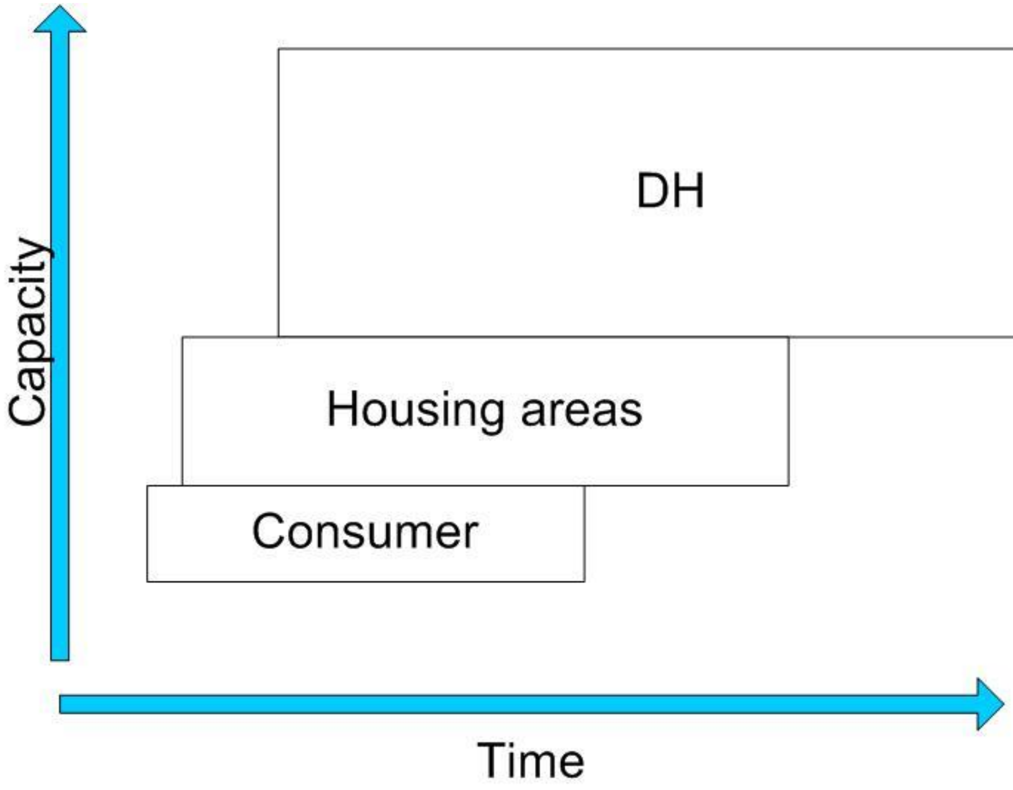
Future Focus



Vertical integration



Vertical integration



Storage Systems

- Who will
  - develop it
  - at what level in the system
  - in which system: heat or power
- This could be done by the
  - DH company
  - Housing owners, the developer of the area, or
  - TSO

Storages in DH Systems

4DH
4th Generation District Heating Technologies and Systems

- Storages are commonly available in DH systems
- The DH grid often acts as a storage itself
- Different ways to load storages:
  - Electrical boilers are common (cheap but less efficient)
  - HP is already available in a number of places (+100; Stockholm 480 MW) mainly in Norway , Sweden, Denmark
  - HPs are large investments and a free heat source must be available
  - Currently HPs compete with DH scheduling - availability at the “right” time
  - Free storage capacity at what time and what level in the system

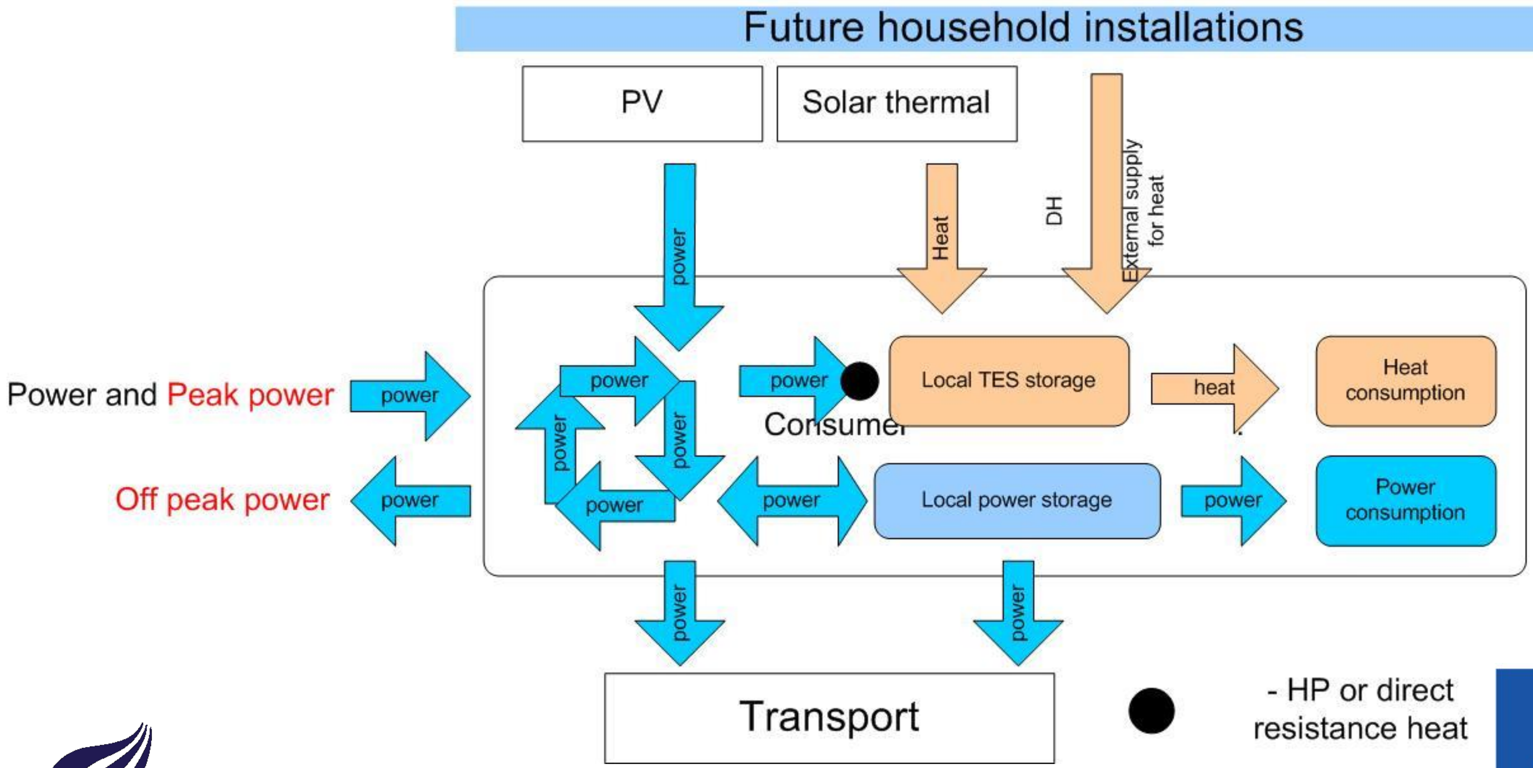
Storages within Housing Areas

4DH
4th Generation District Heating Technologies and Systems

- Development of battery storages within housing areas for PV
- Local Thermal Energy Storages (TES)
- Sequential heating with TES

- Pro/ Cons
  - Currently mainly electricity storages
  - Cluster efficiency - close to consumer
  - Responsibility
  - Pricing dependent on national regulation and system level
  - Mainly power storages

Final Consumer – Smart Home



AALBORG UNIVERSITY DENMARK

2nd International Conference on Smart Energy Systems and
4th Generation District Heating, Aalborg, 27-28 September 2016

KTH Industriell teknik och management

Storages at the Final Consumer

4DH
4th Generation District Heating Technologies and Systems

- In a Smart Energy System these features can develop in smale and large scale systems
- HP with TES (single houses - single house areas without DH)
- Boilers with TES or building mass as storage
- PV and battery storages in single houses
- Additional HP with TES in regions when FIT is running out
- HP without TES but with battery storages (German case)

Storages at the Final Consumer Pros/Cons

4DH
4th Generation District Heating Technologies and Systems

- Easy to adapt to national regulations
- Hard to predict a European development, local markets
- Different national PV developments
- Share of HP heating differs within Europe
- Low power prices and high volumes of HP
- Low energy buildings (LEB) foster HP

AALBORG UNIVERSITY
DENMARK

KTH VETENSKAP OCH KONST

KTH Industriell teknik och management

Results

- The heat demand in the building sector has large capacities and the ability to shift power to heat and in time.
  - Via DH
  - Via HP and TES
- Fluctuation and storage not always in the same grid/TSO (Stocklholm HP)
- High and Low voltage grid issues (WP, PV and residential PV)
- Residential PV and storage heat and power will grow

- DH can take fluctuative power
- Single houses with ICT (clusters) can make use of fluctuative power as well
- Heat storages with DSM can reduce investment in grid expansion

Discussion

- When is DH getting to complex?
- Legal framework for power and heat storages
- Real time tarifs
- Future development of RES-E
  - Temporary fuctuation
  - Power curtailment
  - Ramping issues
- Future HP with storage and ICT for peak power

Conclusions

- Large potential for integrating Power in the building sector
- Urban areas via DH
- Non urban areas directly with HP and TES
- Smart grid necessary
- National differences responsible for local development

Thanks