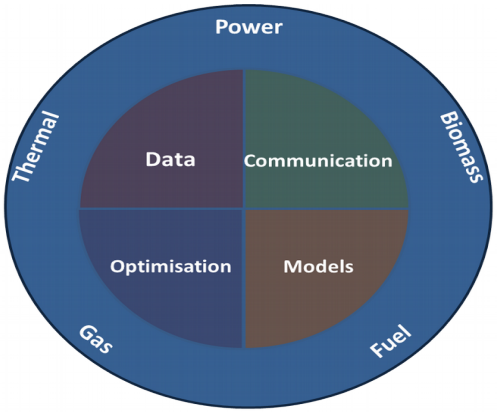
Intelligent and Integrated Energy Systems

Energy Systems in Smart Cities

for the Smart Society



Henrik Madsen

CITIES (smart-cities-centre.org)

Smart City Accelerator (smartcitiesaccelerator.eu)

CITIES Innation Center (citiesinnovation.org)

Zero Emission Neighbourhoods (ntnu.edu/zen)

National Center for Energy Systems Integration (ncl.ac.uk/cesi)

Center Danmark (under development)

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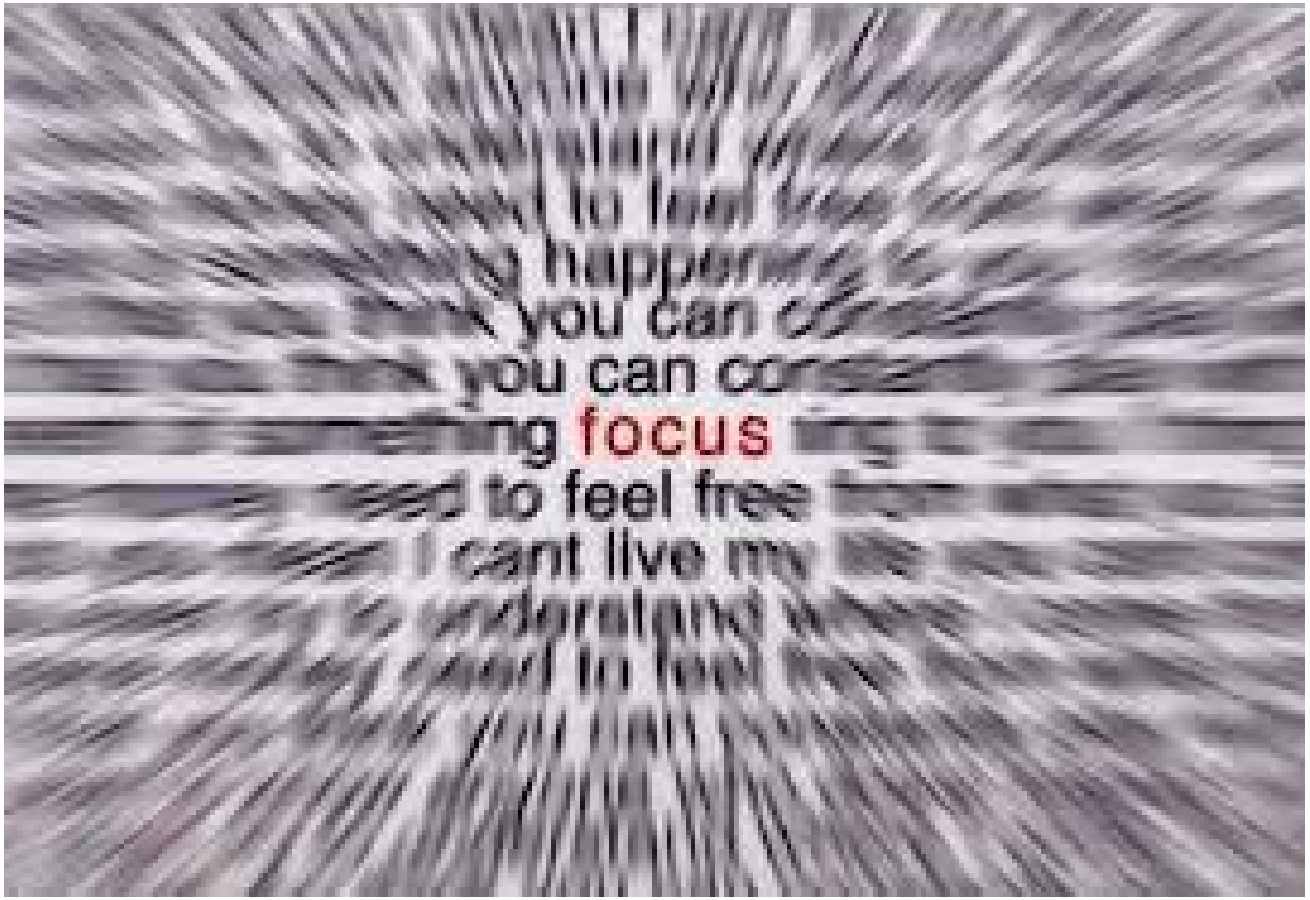
Centre for IT Intelligent Energy Systems

How can we make a difference ?



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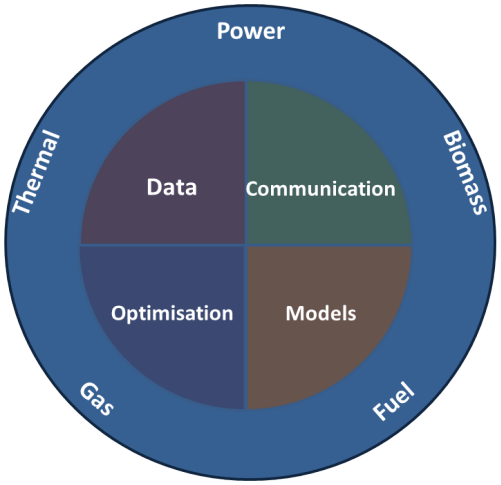
Assumptions, Goals and Methods

CITIES - Hypothesis

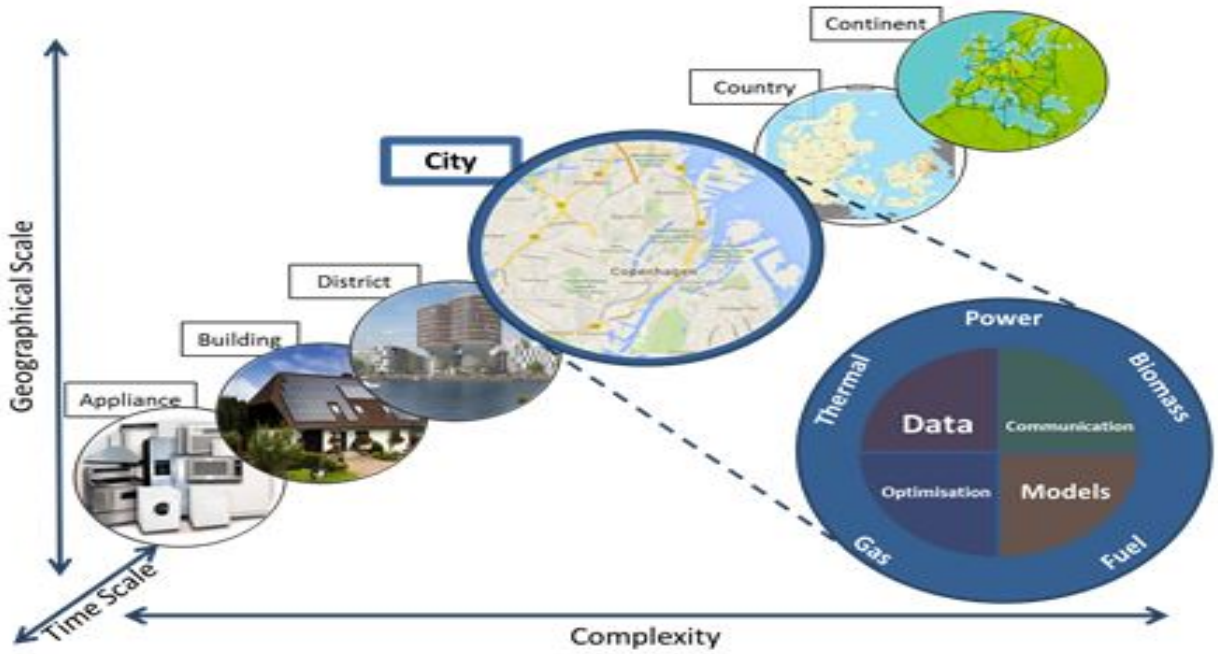


The **central hypothesis** is that by **intelligently integrating** currently distinct energy flows (heat, power, gas and biomass) using **data intelligence** we can balance very large shares of renewables, and consequently obtain substantial reductions in CO2 emissions.

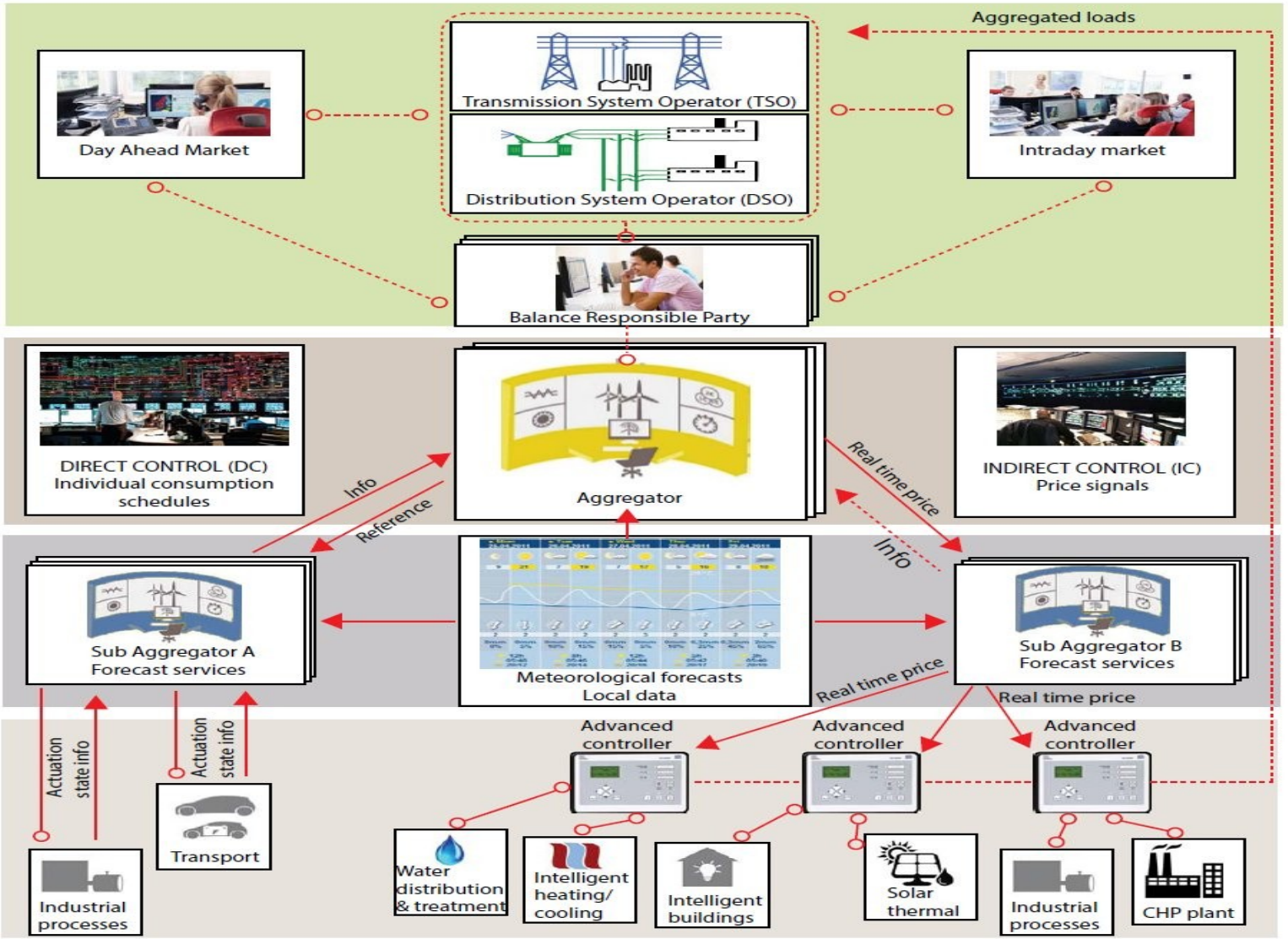
Intelligent integration will (for instance) enable lossless ‘virtual’ storage on a number of different time scales.

CITIES – Research Challenges

To establish methodologies and solutions for design and operation of integrated electrical, thermal, fuel pathways at all scales in Smart Cities



Smart-Energy OS



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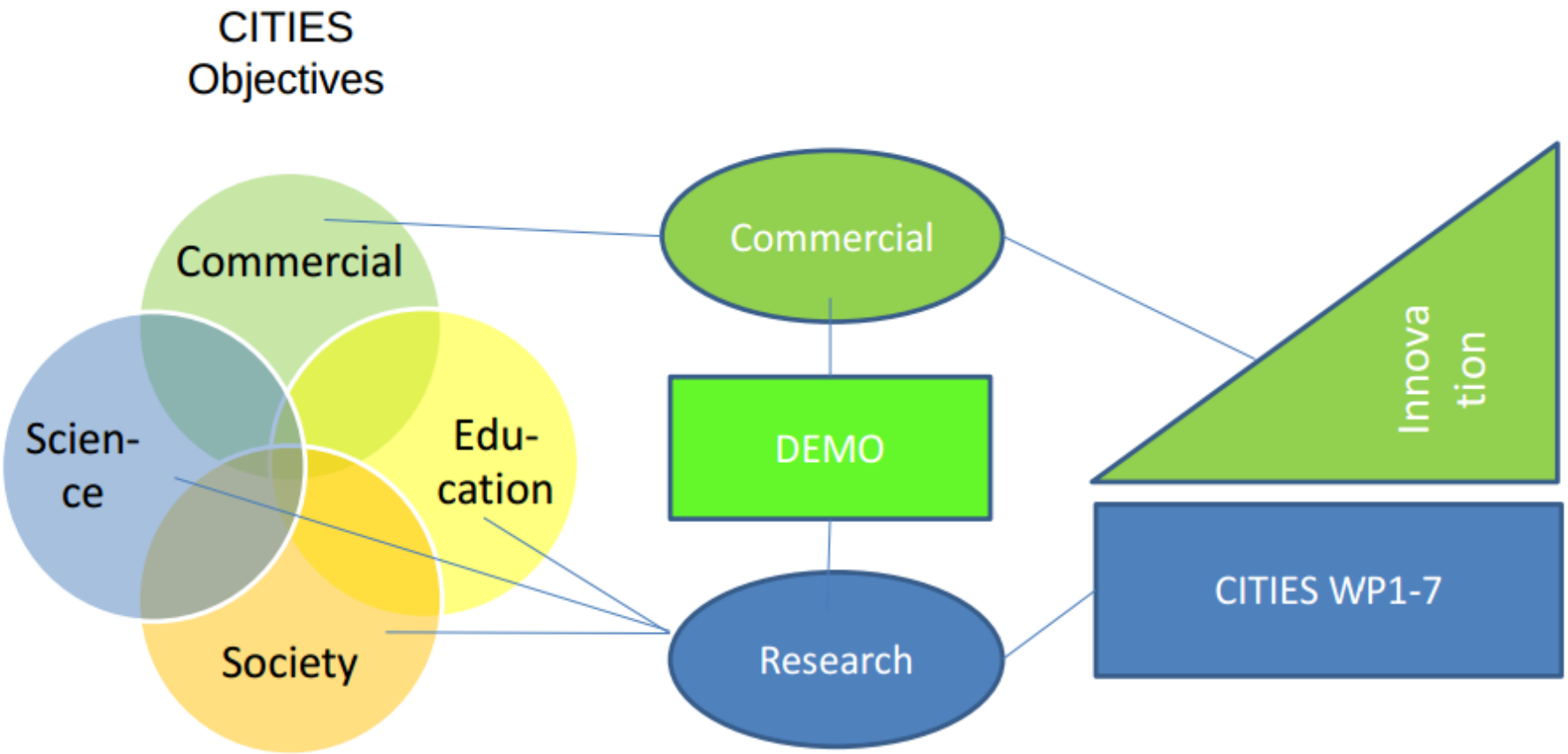
Smart City Nytårskur, Bloxhub, 2018

```
38
39  # Try to parallelize anyway
40  require(multicore)
41  numcores<-multicore:::detectCores()
42  mclapply(
43  ··1:N,·
44  ··function(i,data)·{
45  ····print(paste(i,·"/",·N))
46
47  ····#·Find·the·indices·of·rows·corresponding·to·
48  ····j·<-·which(data$dt_agg·%in%·aggdata$dt[i])
49
50  ····#·Filter·out·those·who·are·NA
51  ····j·<-·j[!is.na(data$last_one_min_power[j])]
52
53  ····#·Count·number·of·readings
    ····aggdata$num_readings[i]·<-·length(j)
```

CITIES Innovation Center



CITIES INNOVATION CENTER
Integrated energy systems powered by intelligent data

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Topics

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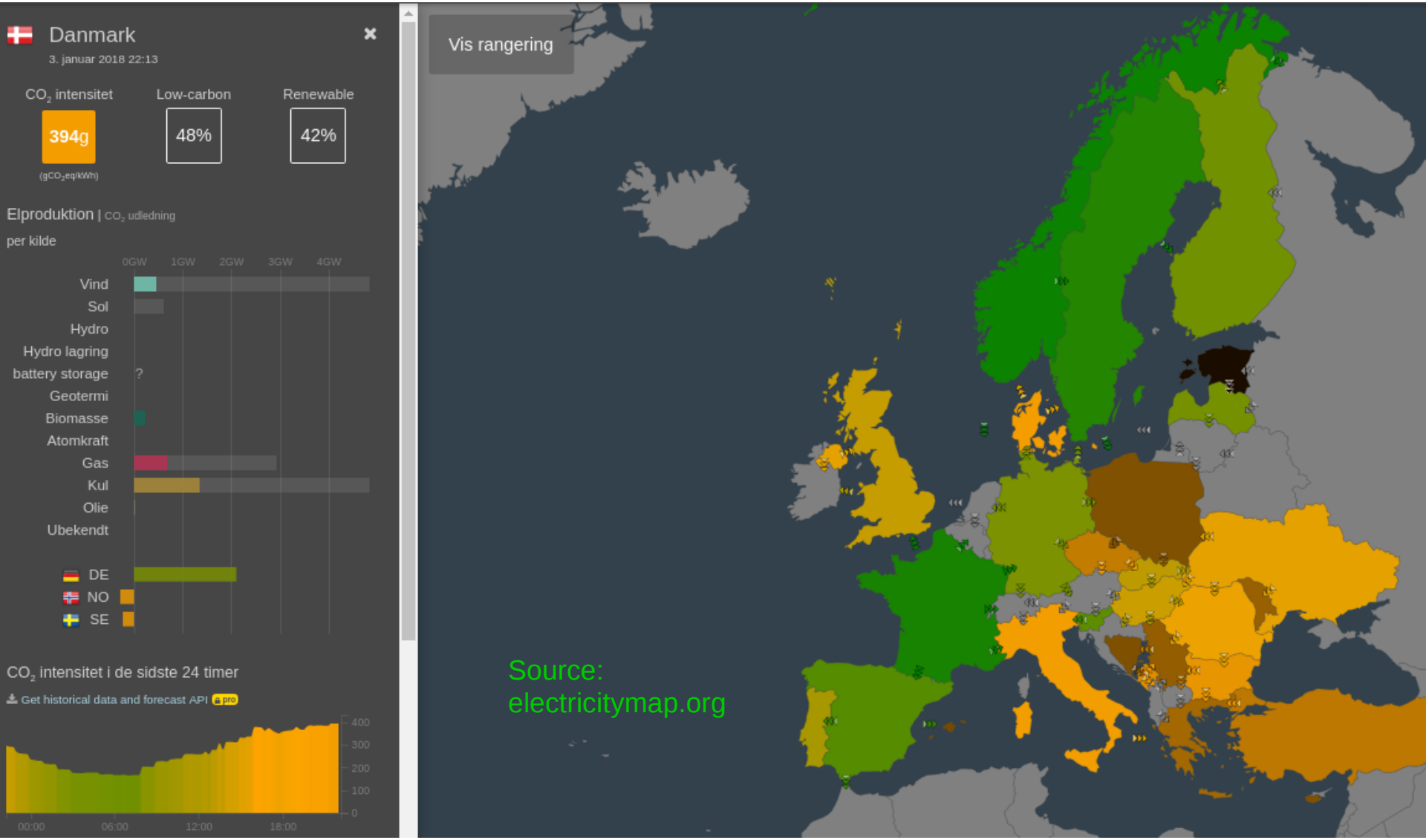
Case study

CO2-based control of heating



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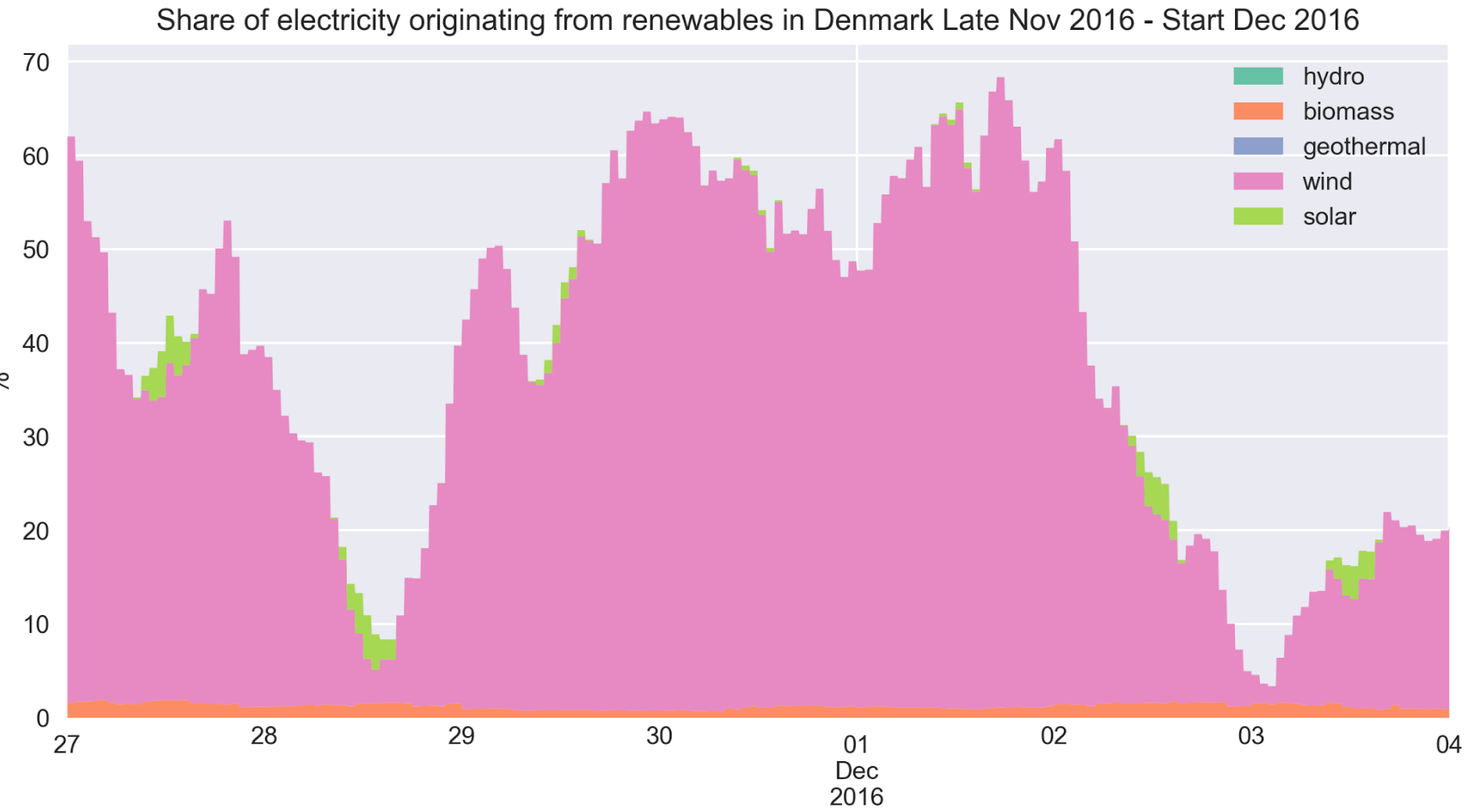

Source: pro.electicitymap.org

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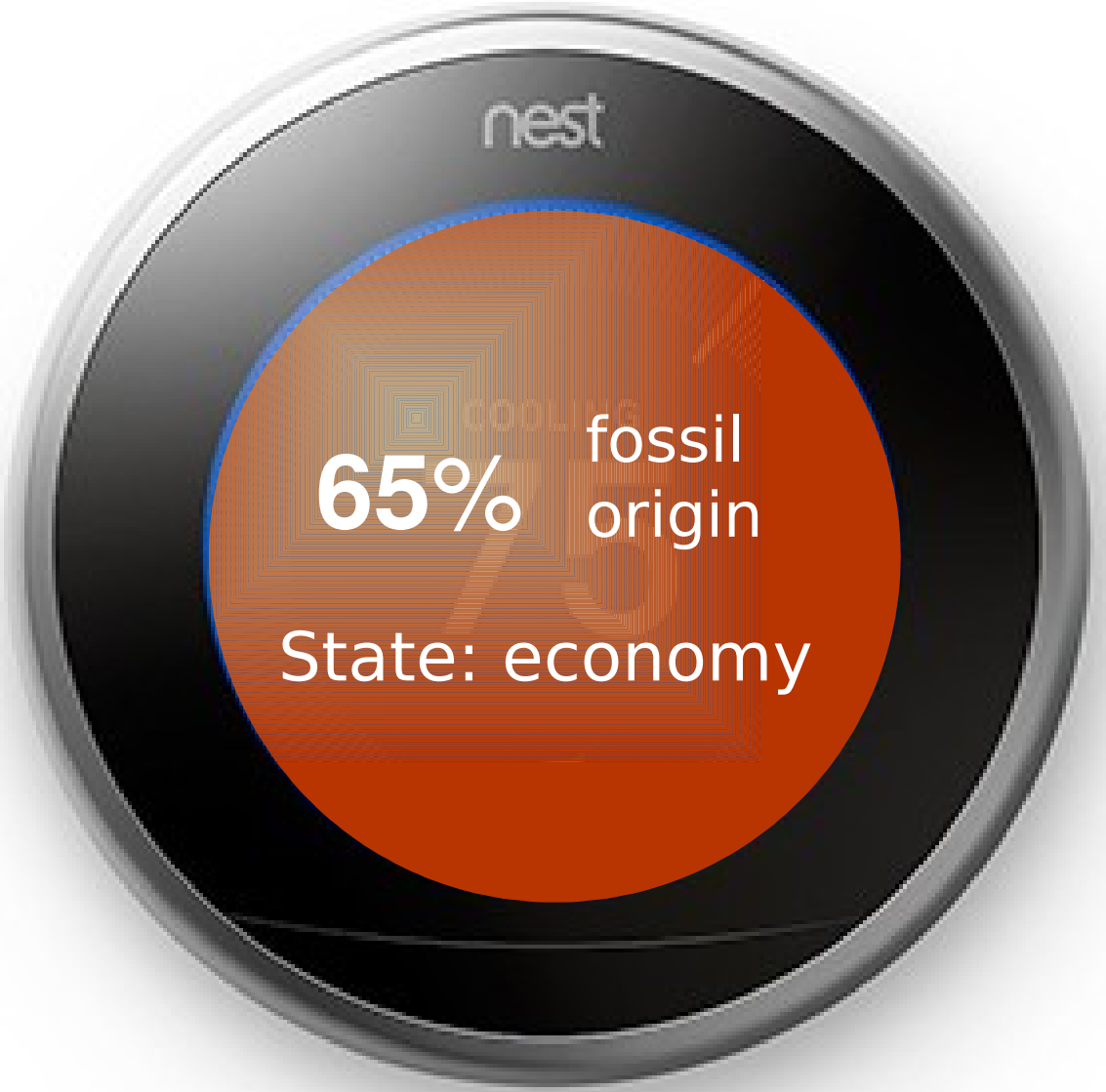
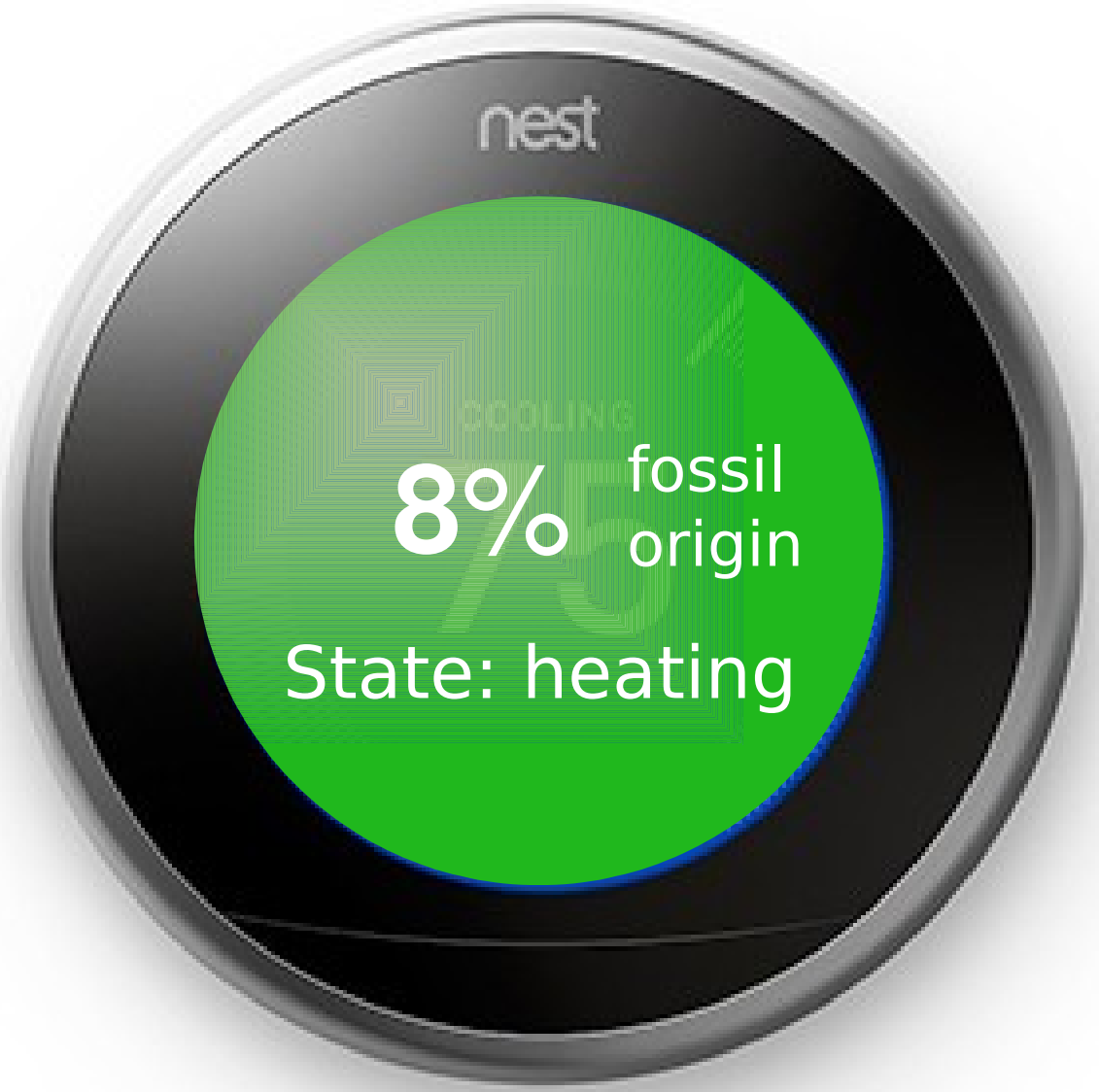


www.co2signal.com



www.co2signal.com

Center Danmark

Intelligent and Integrated Energy Systems in Smart Cities for a Smart Society

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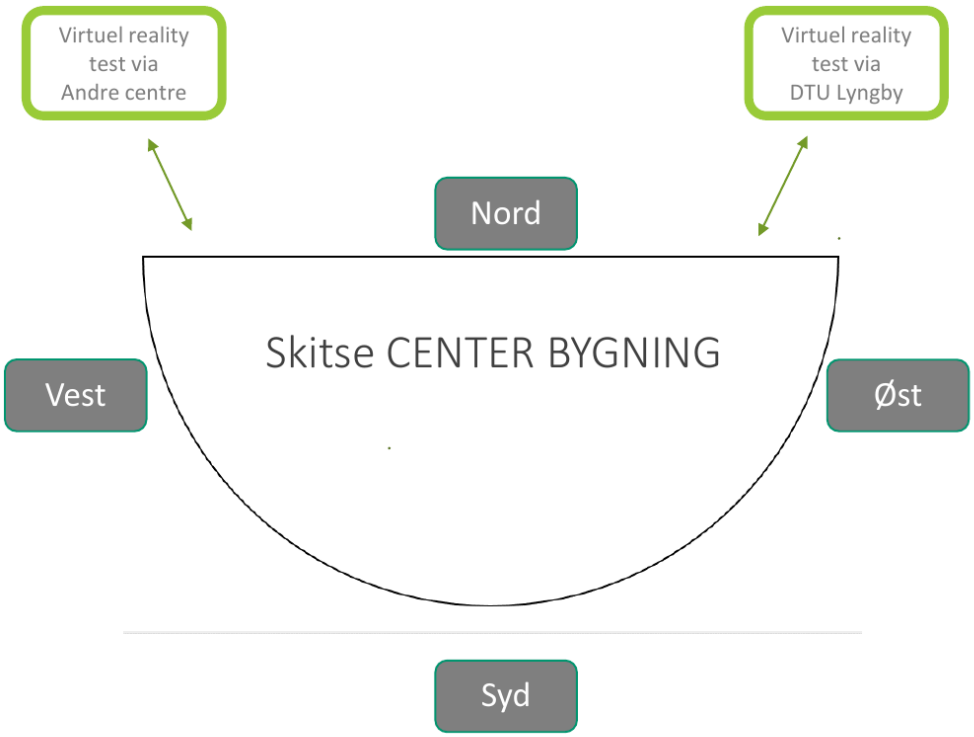
Smart City Nytårskur, Bloxhub, 2018

Center Danmark

- Forskningscenter for studie af intelligente og integrerede energisystemer, samt rammebetingelser
- IKT-løsninger – (big data, IA, IoT, IoS, VR, Securit., Cloud+Fog+Edge Computing, ..)
- Flexible test af rammebetingelser (energiafgifter, energispareordning, energimarkeder, net-tariffer, mv.)
- Forskningscenter med smart by(-del) anno 2030 samt eksisterende (klassisk) bydel
- Samspil mellem bydele og smarte byer
- Kobling til vand- og fødevaresektoren
- Kobling til nationale test faciliteter (PowerLab.dk/SYSLAB, Høvsøre, Østerild, Spildevandscenteret, Danfoss, Grundfos, Green Tech Centeret, Risø Campus, ...)
- Kobling til visse Nationale Labs i USA + centre i Tyskland, Norge, Sver.
- El og Hydrogen - samt gasser generelt
- Testfacilitet for nye løsninger for energisystemer og apparater
- Undervisningsfaciliteter - VR-koblinger til DTU mv.
- Showroom ('Energiens udvikling i Danmark')

Arkitekt: Jan Utzon

Center Bygning



CENTER BYGNING ER BASEN FOR:

- Kontrolcenter overblik samt DATA alle intern og eksterne installationer
- Auditorium 150 Pers
- Møde/undervisnings lokaler 10 pers samt 40 pers.
- Showroom Intelligente Energi Systemer – Overblik og læring via Virtuel reality
- Showroom, læring, gruppearbejde, Spejling med DTU Lyngby
- Klynger til gruppe arbejde – Evt. i forbindelse med Observation
- Laboratorium DTU, (Beskyttede tests, isolering af kontrol og data)
- Laboratorium Andre aktører, (Konverterings teknologier)
- Quick tilkobling eksterne test komponenter fordelt over hele området. Alle installationer er forberedte og ved tilkobling indgår komponenten i det samlede kontrolcenter
- Undervisning / læring ved leg med energien. Byg selv (Lego)
- Indendørs LAGRINGS test Afdeling i sikringsrum
- Overnatningsrum for studerende
- Kontorer samt Køkken
- Udendørs test facilliteter (Containere opkobling m.m.)

Ialt ca. 15.000 m2 under tag + de to smarte bydele (klassisk + smart city anno 2030)

Summary

- A Smart City is a part of a Smart Society
- CO2-based control accelerates the transition to a low carbon city
- CITIES and related projects have established a number of low carbon solutions for smart cities …
- Smart-Energy OS: Focus on Energy Efficiency, Emission Efficiency or Energy Costs
- By intelligent energy systems integration we could rather easily obtain a fossil-free society, however …. we need stronger decision makers.
- We would like to ramp up on the collaboration with innovation clusters
- Intelligent Energy Systems Integration can provide virtual storage solutions (… less need for physical storages)

Thanks for your attention !