DISTRICT ENERGY IN COMPREHENSIVE ENERGY PLANNING

Anna Chittum

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IDEA 2015
Campus + City
Workshop

CHANGE THE CONTEXT

- District energy systems seen as:
  - One-off solutions for particular campus/area of city
  - Thermal only, so only relevant to thermal issues
  - Fossil fuel-based
  - Based on old technologies
- In reality we know:
  - District energy is a family of solutions
  - District energy can include *and support* electric resources
  - District energy increases efficiency of fossil fuels + leverages renewable resources
  - District energy is the foundation for the integration of new technologies as they develop
- District energy is a system optimization strategy

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WE HAVE PROBLEMS

- Rising Renewable Energy Portfolio goals
- Wind and solar resources located far from load centers
- Constrained transmission systems
- No market signals for energy and capacity services in some areas
- Retirement of coal-fired fleet
- Disconnect between electric utilities' economic interests and that of consumers
- Lack of context for valuing waste heat
- Piecemeal renewable energy solutions on building-by-building basis

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WE HAVE PROBLEMS

- Pacific Northwest:
  - Facing a need for system flexibility it never needed before
  - Overgeneration
  - No new hydro being built
  - Increasing deployment of renewables, especially wind
- PJM:
  - Issued “problem statement” on capacity resources
  - Identified fact that current economic incentives/signals not sufficient to “ensure that operational reliability will be maintained through all seasons”
  - Emphasized concurrent peaks of natural gas and electricity during Polar Vortex of the winter of 2014

VISUALIZING AN OPTIMIZED SYSTEM

- Fundamental question:

  What is highest and best use of our resources?

- Aalborg University's Smart Energy System approach: https://www.youtube.com/watch?v=eiBiB4DaYOM

EnergyPLAN

INPUT

Demands
Electricity
Cooling
District Heating
Individual Heating
Fuel for Industry
Fuel for Transport

RES
Wind
Solar Thermal
Photovoltaic
Geothermal
Hydro Power
Wave

Capacities & efficiencies
Power Plant
Boilers
CHP
Heat Pumps
Electric Boilers
Micro CHP

Storage
Heat Storage
Hydrogen Storage
Electricity Storage
CAES

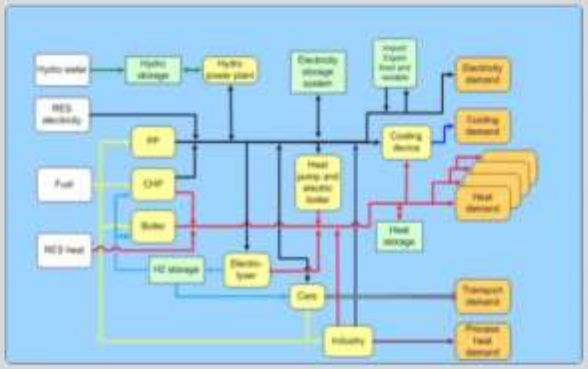
Transport
Petrol/Diesel Vehicles
Gas Vehicles
Electric Vehicles
V2G Electric Vehicles
Hydrogen Vehicles
BiofuelVehicles

Distribution data
Electricity Demand | DistrictHeating | Wind | Hydro | Wave | Waste
Solar thermal | Photovoltaic | Geothermal | Individual Heating
IndustrialCHP | Transportation | MarketPrices

Regulation
Technical Limitations
Choice of Strategy
CEEP Strategies
Transmission Cap.
External Electricity Market

Fuel Cost
Types of fuel
CO2 Emission Factor
CO2 Emission Costs
Fuel Prices

Cost
Variable Operation
Fixed Operation
Investment
Interest Rate



Either: **Technical regulation strategies**

1) Balancing heat demand
2) Balancing both heat and electricity demand
3) Balancing both heat and electricity demand (reducing CHP even when partially needed for grid stabilisation
4) Balancing heat demand using triple tariff

Or: **Electricity market strategy**

Market simulation of plant optimization based on business economic marginal production costs.

And: **Critical Excess Electricity Production**

Reducing wind
Replacing CHP with boiler or heat pump
Electric heating and/or bypass

OUTPUT

Results
(Annual, Monthly and Hourly Values)

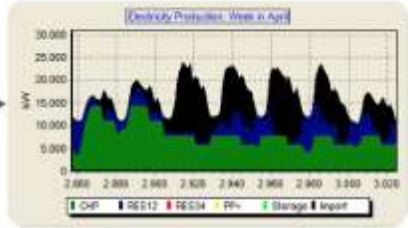
Electricity Production
Electricity Import/Export
electricity Excess Production

Import Expenditures
Export Revenues

Fuel Consumption

CO2 Emissions

Share of RES



WHAT IS POSSIBLE?

- Skagen, Denmark
  - CHP plant + electric boiler + thermal storage
  - CHP plant can ramp up and down based on electricity prices
  - Interruptible gas customer
  - Wind → heat
  - Makes its capacity available in regulating power market

Image courtesy COSPP magazine

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WHAT IS POSSIBLE?

- Heat pumps, CHP, thermal storage
- Denmark: active markets for energy, capacity, ancillary services

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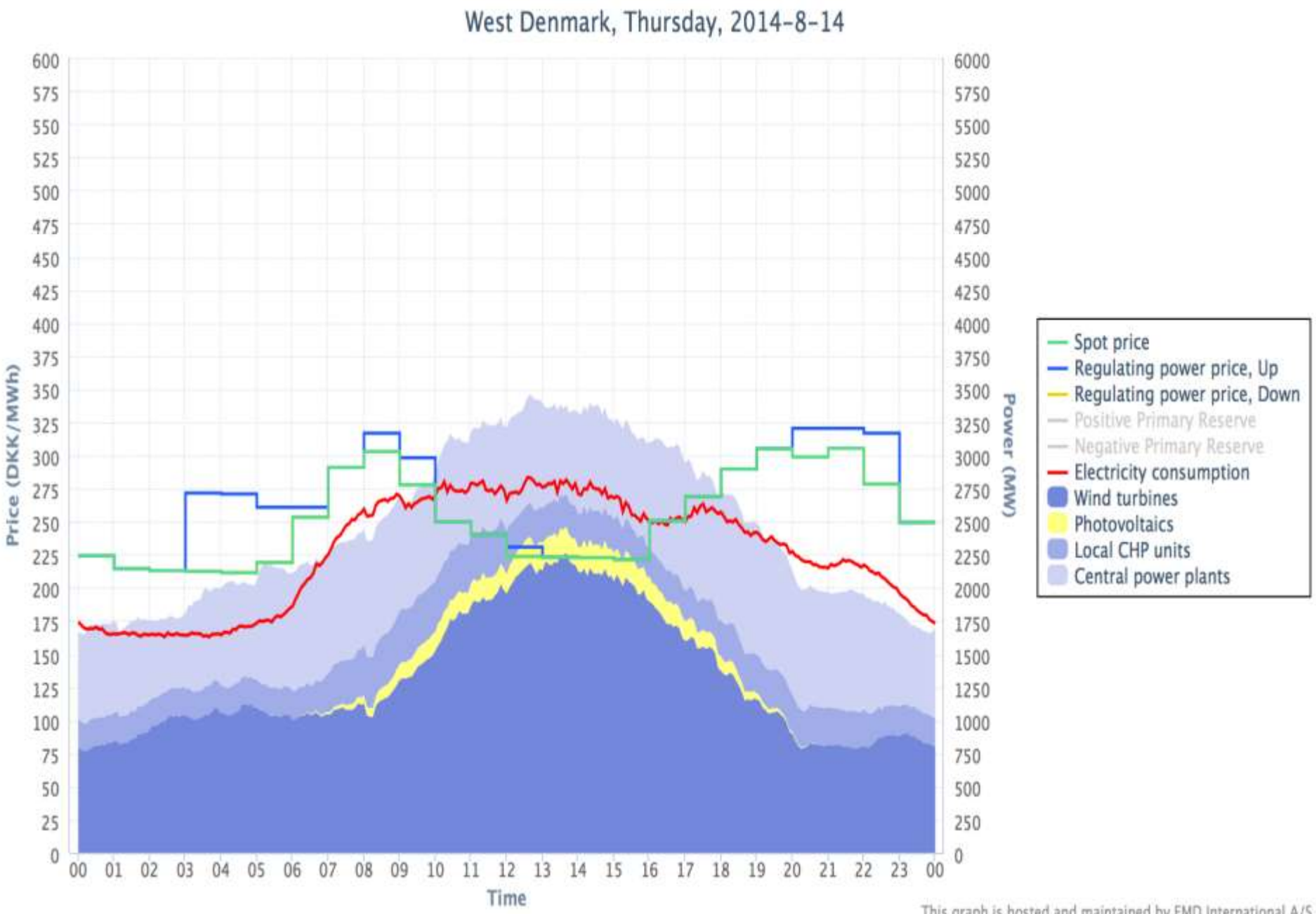
West Denmark, Thursday, 2014-8-14
Price (DKK/MWh)
Power (MW)
Time
Spot price
Regulating power price, Up
Regulating power price, Down
Positive Primary Reserve
Negative Primary Reserve
Electricity consumption
Wind turbines
Photovoltaics
Local CHP units
Central power plants
This graph is hosted and maintained by EMD International A/S

WHAT WE KNOW

- As an industry we have solved these problems
- What works on a micro scale is relevant to macro scale
- Technology is mature
- Cost-effectiveness is good
- This is a policy, regulatory, market, and planning issue
- District energy is an aggregator of tools to solve problems

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WHAT ARE OUR OPPORTUNITIES?

- Clean Power Plan
  - http://www.districtenergy.org//assets/pdfs/111d/111d-Toolbox-v10.pdf
- Resiliency banks and programs
- Transmission and distribution constraints
  - FERC Order 1000: Regional transmission planning and cost allocation
- Other greenhouse gas goals affecting natural gas and electric utilities
- Better market signals for resiliency as well as greenhouse gas reductions
- Research arms of ARPA-e, BPA, etc: we need system flexibility and we need to work on storage and renewable integration

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THANK YOU

Anna Chittum
Manager, Strategic Initiatives, IDEA
Founder, Gridkraft
Portland, OR

503-292-0902
anna@gridkraft.com