

Distributed Energy Resources

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by

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Outline

- I. Distributed Energy Resources: Sources and Systems
- II. CHP – DER Customer Adoption Model
- III. Reliability
- IV. Conclusion

can combined heat and power recover the lost 27%? (cooling!)

can we depend on the macrogrid?

can we make a paradigm shift to a more dispersed power system?

can microgrids be a paradigm for DER deployment?



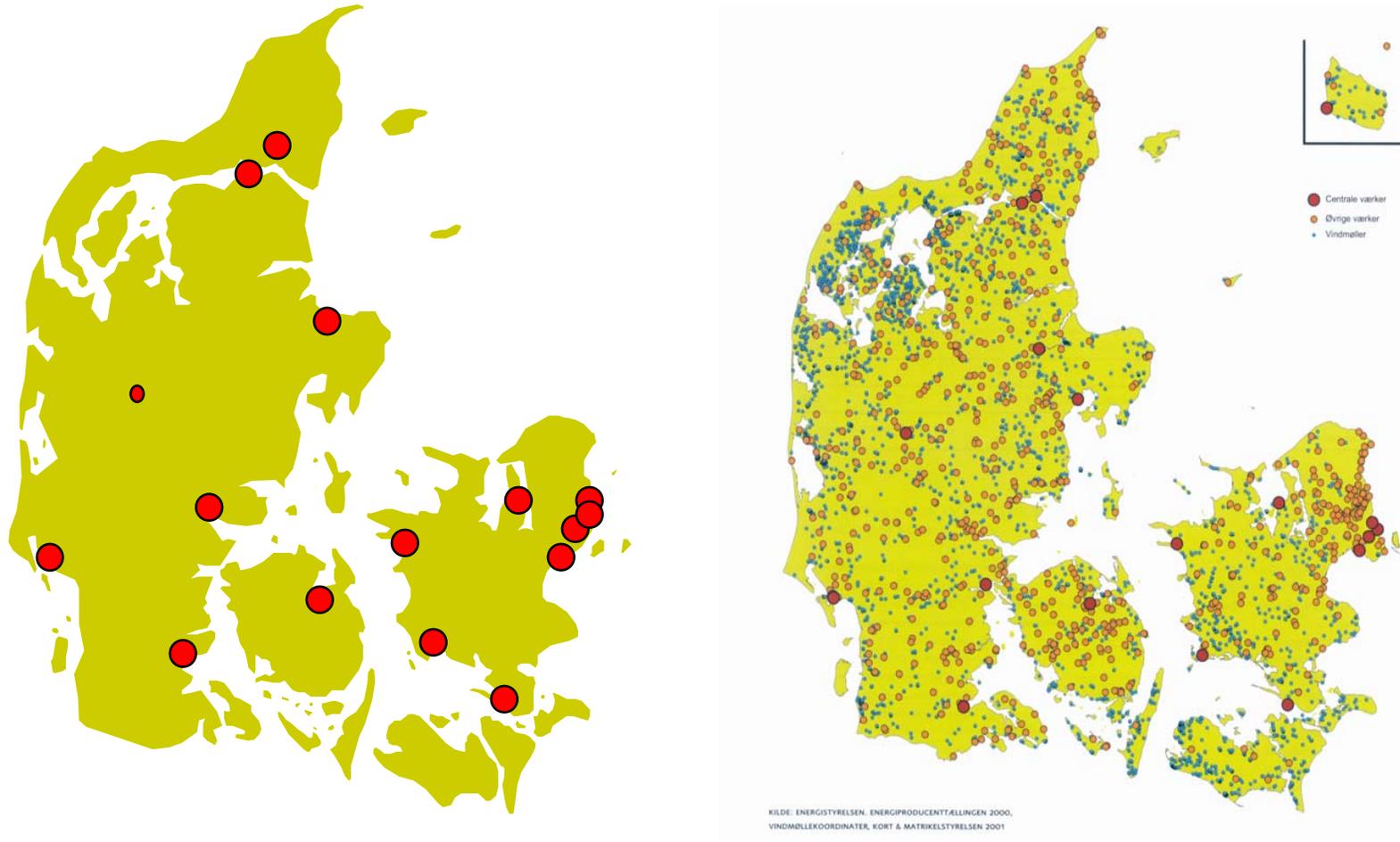
I. Distributed Generation: Sources and Systems



Typical DER Equipment



Development of Danish Power System (1980-2000)



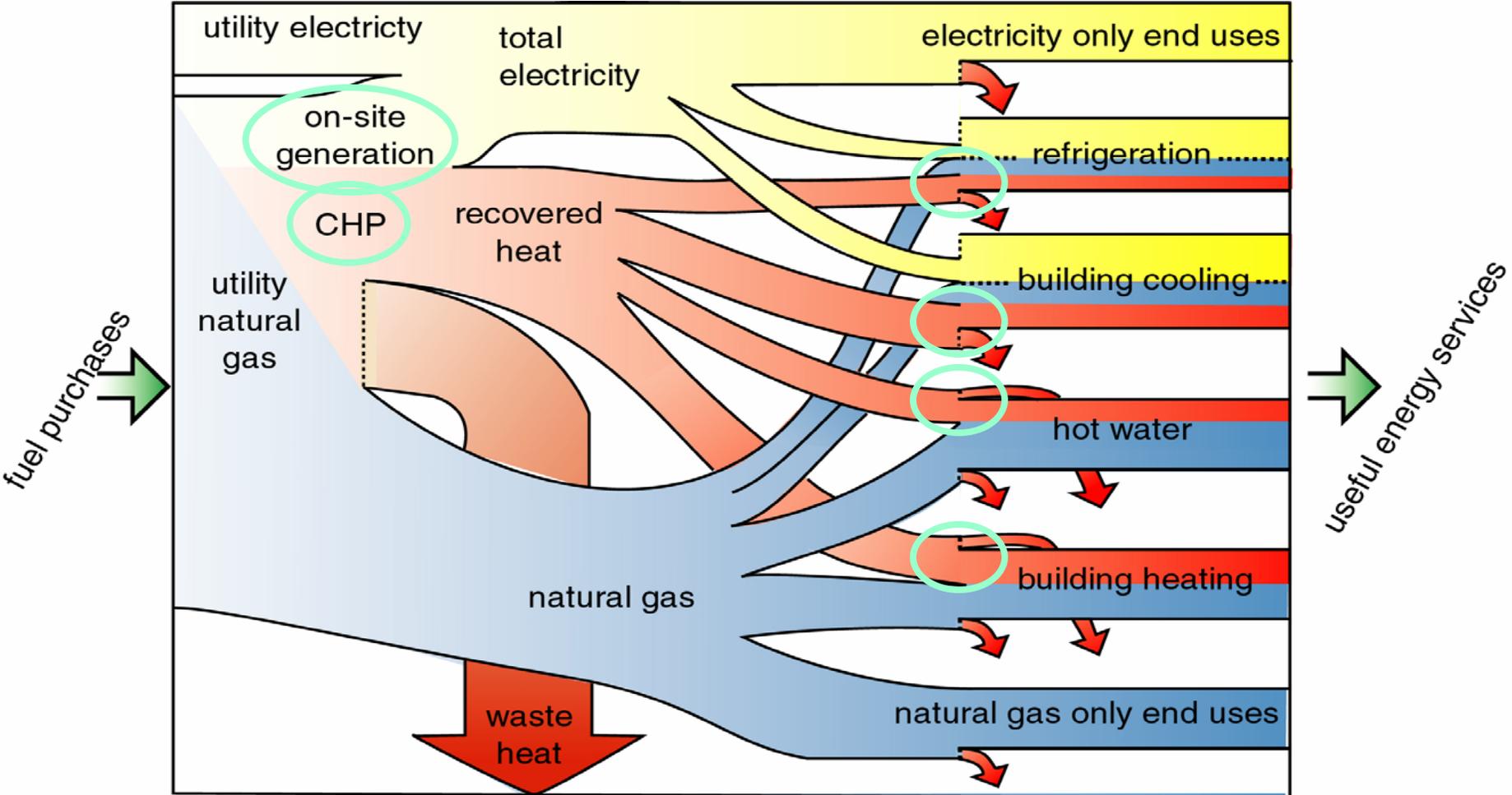
source: Eltra (grid operator of western Denmark)

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II. Distributed Energy Resources Customer Adoption Model (DER-CAM)



Energy Flows Incorporating CHP

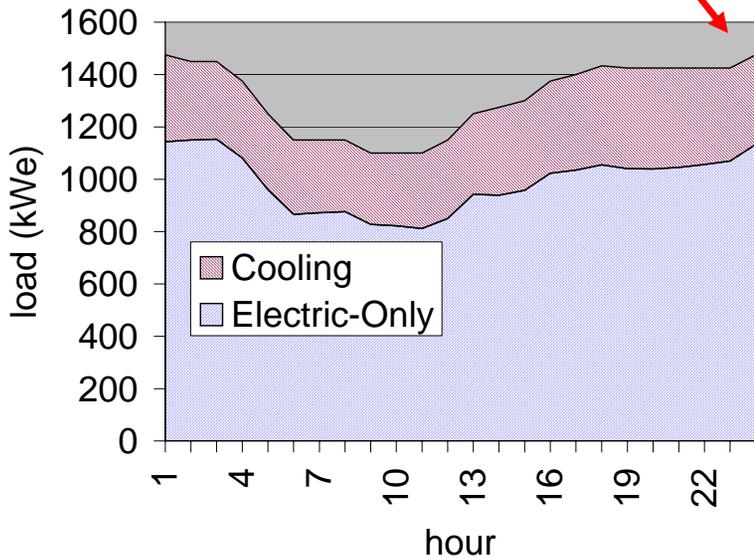


○ technology adoption decisions



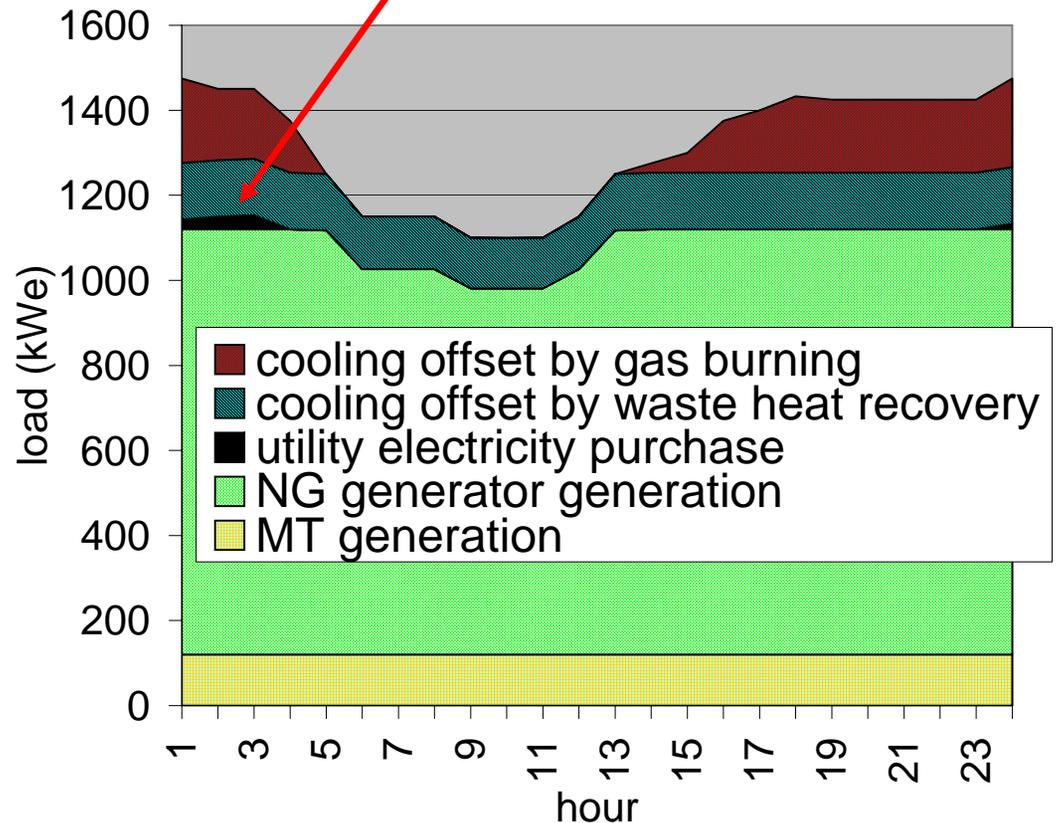
USPS July Weekday Electric Loads

peak load = 1500 kW



site electric loads

peak load = 1150 kW



How site electric loads are met.

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III. Reliability



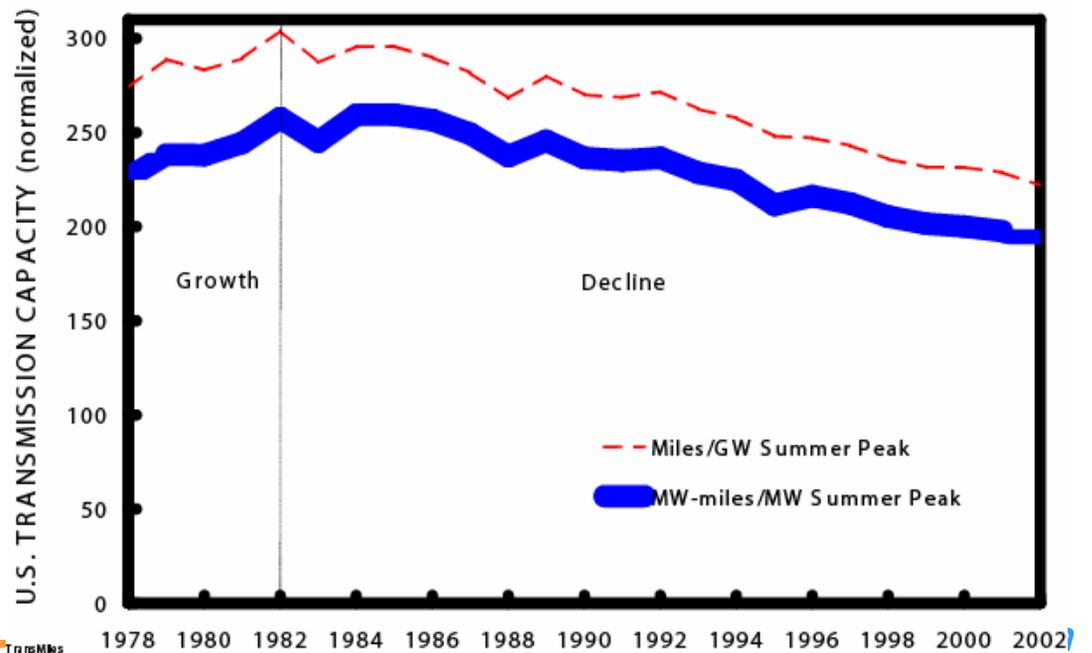
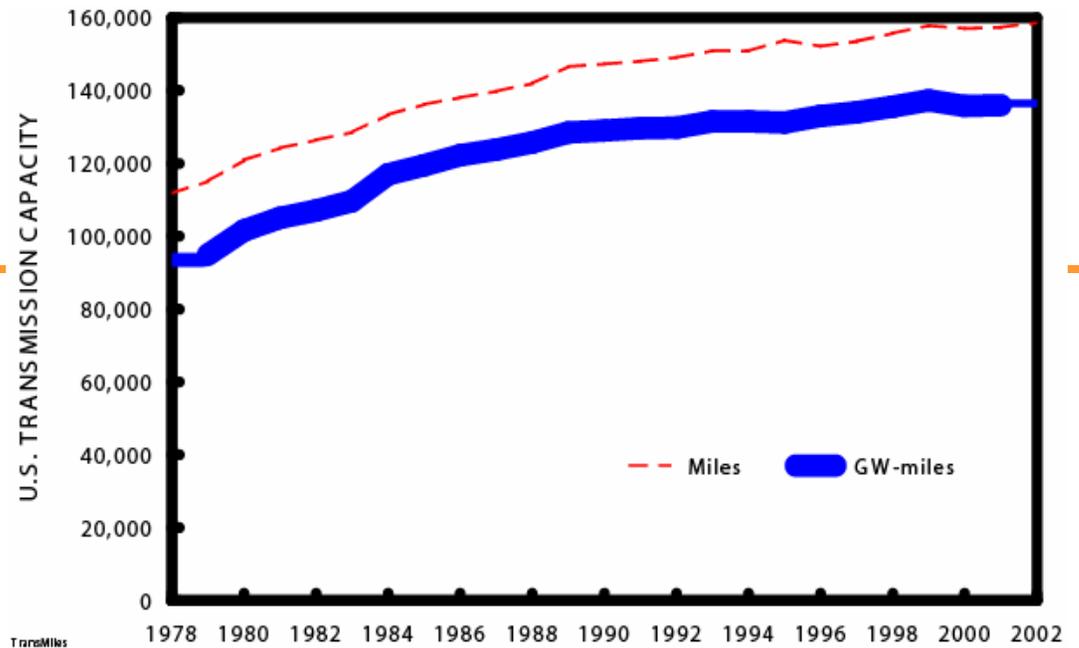
Limits of Current Power System

- volatile bulk power markets
- economics drives operation closer to limits
- insecure system
- centralized power system planning
- restrictions on power system expansion
 - siting, environmental, rights-of-way, etc.
 - declining investment
- multiple infrastructure interdependencies
- roller coaster investment cycle
- heterogeneous power quality and reliability



U.S. Transmission Capacity 1978-2002

[miles and GW-miles (top)
and normalized by summer
peak demand (bottom)]



source: Hirst, Eric, *U.S. Transmission Capacity: Present Status and Future Prospects*, Consulting in Electric Industry Restructuring, Bellingham, WA, June 2004, pg. 6.



Phone System's Weak Link

Storms Cause Greater Outages
 In New Fiber-Optic Networks
 As BellSouth Races to Recover

By PETER GRANT
 Staff Reporter of THE WALL STREET JOURNAL
 September 17, 2004; Page B1



AP/Wide World Photo

CHARLOTTE, N.C. -- Ron Royster stepped out yesterday for only a few minutes from **BellSouth** Corp.'s command center here, where technicians closely monitor the havoc Hurricane Ivan is wreaking on its phone network. But as soon as Mr. Royster, the center's director, returned, he could tell conditions had deteriorated.

Furthermore, because of fiber optics and other new technologies BellSouth has added to upgrade its networks over the past decade, the systems are, ironically, more vulnerable to disasters. The key problem: Many phone networks that used to rely on their own electricity now depend partly on commercial power. That means that when the utility company's power lines go down, the phones may go down, too.

But in the past decade, phone companies added fiber optics and devices known as "digital loop carriers," small file-cabinet-sized pieces of equipment, between central offices and homes. The devices have greatly boosted the capacity of the lines, cutting costs and making new services including high-speed Internet connections possible.

The digital-loop devices also run on electricity from the local power company's network, however. While they are equipped with batteries, that backup lasts only about eight hours -- and less if there's a lot of Internet traffic over the network. Once the batteries run out, phone and Internet service goes dead unless a backup generator can be installed. While some digital-loop carriers have a generator, BellSouth says it would be economically unfeasible to put a generator at all 65,000 of them.

BellSouth executives say that the recovery process still under way in Florida didn't have a major impact on the company's ability to move resources into Ivan's disaster zone. All of the company's 1,100 generators were used to restore phone service knocked out by Frances. But by the time Ivan hit, hundreds of them had been freed up because commercial power had been restored. As of yesterday, BellSouth had reactivated service for all but 50,900 of the customers whose phones went out during Frances.



IV. Conclusions

- expansion of the macrogrid is constrained
- power conversion local to loads in microgrids can deliver cost, efficiency (CHP), and reliability gain
- DER-CAM systemically analyzes building energy systems, i.e. directly considers CHP (& efficiency)
- our understanding of other issues, notably heterogeneous reliability is rudimentary
- interdependent systems create vulnerability
- Can you imagine a power system consisting of weakly interconnected microgrids?

