Datacenter location to minimize CO2 emissions

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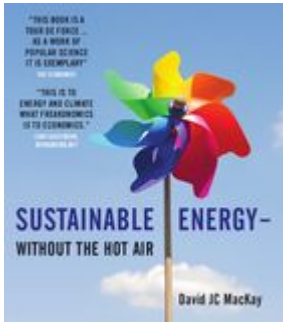
Introduction

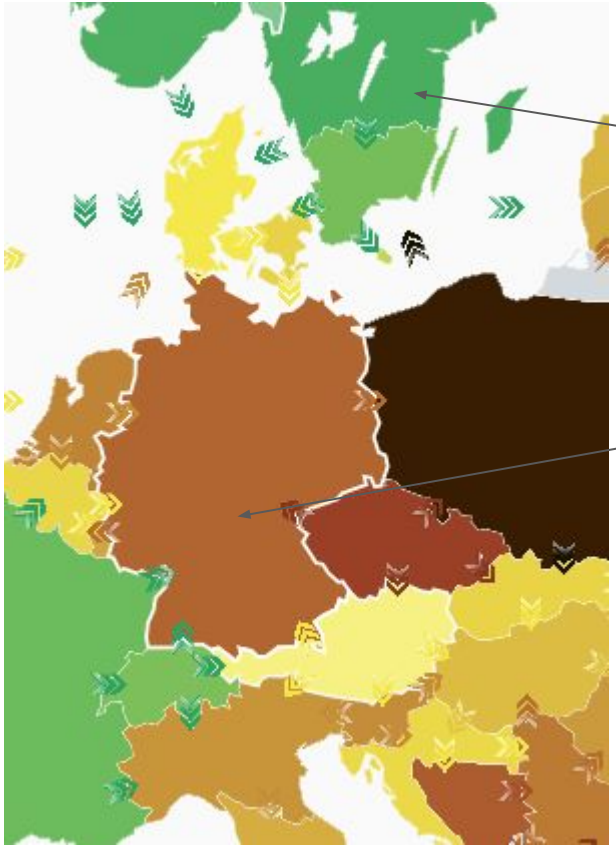


- 100% renewable power grid solves the problem
  - but too late, ~20yrs? What can we do now?
- “Every BIG helps” (David MacKay: retro html)
  - few % here and there, or even everywhere, does not solve the problem
  - to stop and reverse climate change, need close to 100% reduction in CO2 emissions,
- Free to choose the location with renewable power?
- Compare 1MW of compute in Germany and Sweden
- Effect of interconnected Grids
- Conclusion

Are we free to choose a location? Technically.

- Computing Grid lets us locate computing anywhere
  - good connectivity
  - decision to not put everything at CERN finally pays off
- Non-grid user access, e.g. direct batch submission
  - latency not a problem
  - file systems should be local
  - lxbatch-like

1MW Compute (& Storage)



https://app.electricitymaps.com

1MW compute consumes 1MW electricity, produces 1MW heat and 1MW*intensity CO2

Assume same optimizations can be done in both locations, e.g. PUE

#1 mitigation - Waste heat replaces

- natural gas: 200g/kWh heat
- heat pump (SCOP=5), DE: 400/5=80g/kWh heat

1MW compute in high or low carbon intensity grid

scenario	Germany kg C02/MWh	Reduction	Sweden kg CO2/MWh	Reduced CO2 emissions by
	400		20	95%
heat replaces gas (SW too)	400-200=200	50%	20 (20-200=-180)	90% (190%)
Replace heat pump (SW too)	400-80=320	20%	20 (20-20/5=16)	94% (95%)

Get close to 100% reduction of CO2 emission : BIG
Heat with heat pumps not Datacenter resistive heating

Interconnected Grids

If renewable power could be transmitted to datacenter, then location not critical

Spoiler: it can't!

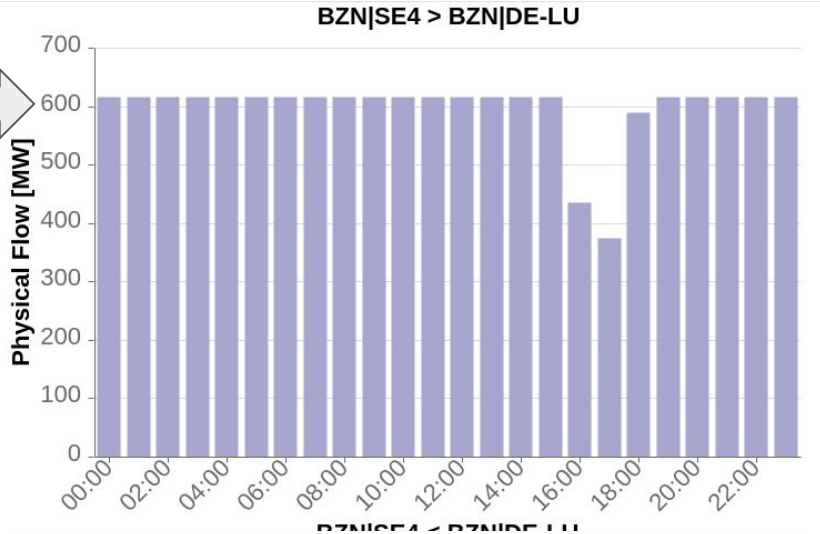
Needs investment and O(10) years

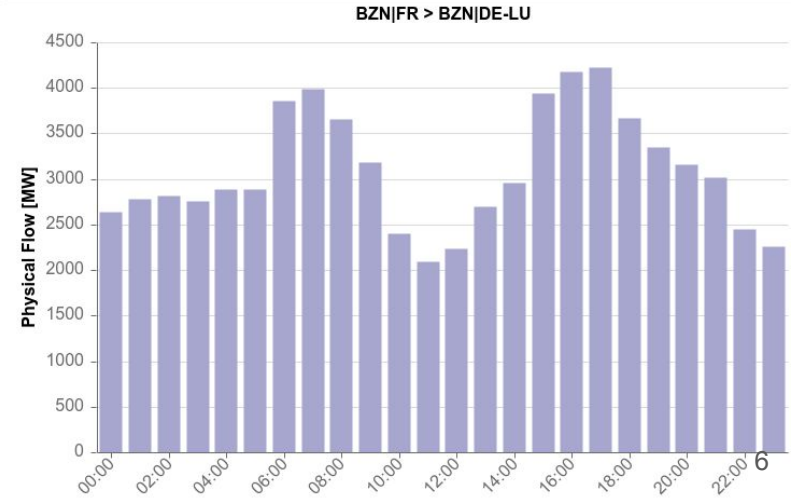
Multiple regions in SE: N-S interconnect 7GB

Valuable capacity for balancing and storage, not base loads.

Reduced load in FR, reduces DE coal generation(potentially)

1% DE





https://transparency.entsoe.eu

Reasons not to

- Financial
  - ‘free’ stuff: machine room, electricity, manpower, network
    - not actually free, but costs hidden
    - CERN ~3ct/kWh bears no relation to cost of nuclear power plus transmission
- local money for local compute resources
  - Political will, as imposed by national funding bodies
    - already fund HW outside country for good reason, e.g. LHC, exascale HPC
  - dedicated uni resources(local users), control, recognition, training/expertise
    - plugging cables and swapping disks or rather Grid service operation
- Need to disentangle some of these non-physical factors
  - the climate does not care - it’s the CO2, stupid

The Narrative

Pending greening of local electricity grid - production, network, storage, interconnect - O(20) years …

- Temporarily put new compute and storage at location with plentiful renewable electricity - WLCG investment made this possible!
  - Multiple HW generations(~5 years) before local grid greened, then retire and put locally
  - Easier for compute than steel, chemicals, manufacturing - #jobs! Political cover/motivation.
- Funding bodies & universities pool (existing) money
  - Partner site with existing infrastructure. Strong steering committee
  - largely remote admin team for all services: batch, CE, SE
  - share of WLCG pledge, HS23s, PB allocated to Uni/Country

Conclusions

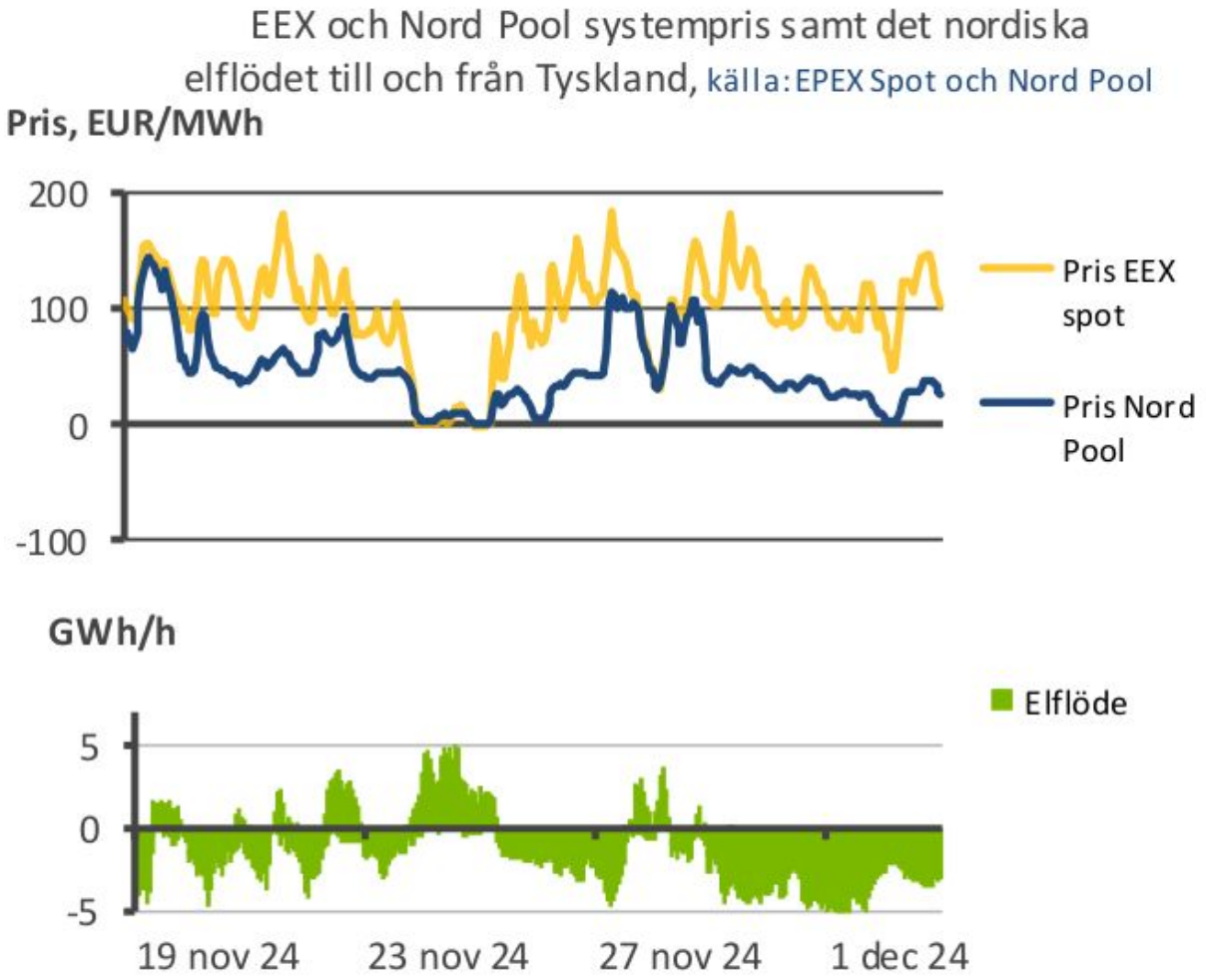
- Datacenter has a large and flat power consumption
  - free to locate where power is 100% renewable
- Given current HW location, every few % efficiency improvement is welcome
  - they are just not BIG, and we can do way better, i.e. 95% less CO2
- New compute and storage can and should be located optimally for climate
  - low CO2 intensity & plentiful electricity, connected, infrastructure, manpower
  - Sweden, Norway, Iceland obviously renewable and not interconnected to central Europe
  - Scotland, northern Germany, France depends on interconnect details. Morocco?
- Challenge to overcome reasons not to
  - acknowledge good reasons: T0 farm, T1 tape for repro
  - call out bad reasons: fake finance, politics, empire

Backup

From Mattias:

Price difference implies saturation of interconnect, but could be North-South within Nordic countries.

Nordic to/from Germany



CERN did a lot!

3.15ct/kWh

PV roofs and car parks: ROI>35yrs

10% tertiary power

“PPA is a must towards better management of energy costs …” - Serge Claudet.