LOW-EMISSIONS SOLUTIONS CONFERENCE

#LESC

enel SDSN wbcsd I·C·L·E·I Local Governments for Sustainability

Demand side solutions to renewable integration: Do they scale?

Session Chaired by

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Demand-side and Storage Solutions ….

Storage and Demand-side Solutions

What can we do in near term?

e.g. NYS 50% of electricity from wind/solar in 2030

40% emission reduction using 1990 baseline

ideally cost-effective: 0.67 c/kWh (⇢ \$20/ton co2)

Examples approach

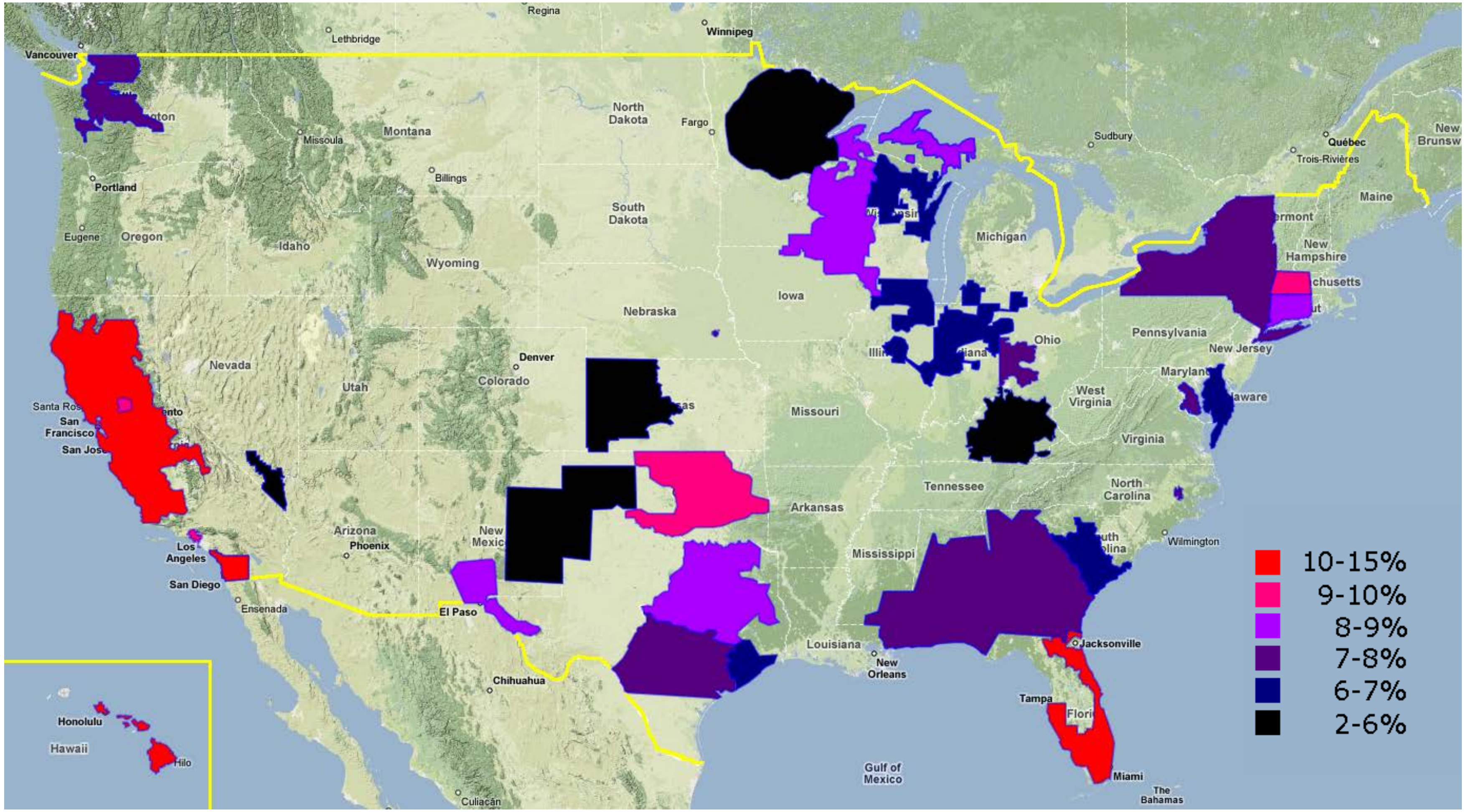
Caveats and parallel opportunities

- What is cost-effective to 40% is in no way to suggest that same approach will be cost-effective to 80%+
- Continued effort on extreme efficiency, especially in buildings and transport
- Modular safe nuclear, CCS
- Electrofuels/chemicals
- Place-specificity in solutions. Demand differentiation is a larger driver, new infrastructure yet to be built

What is certain?

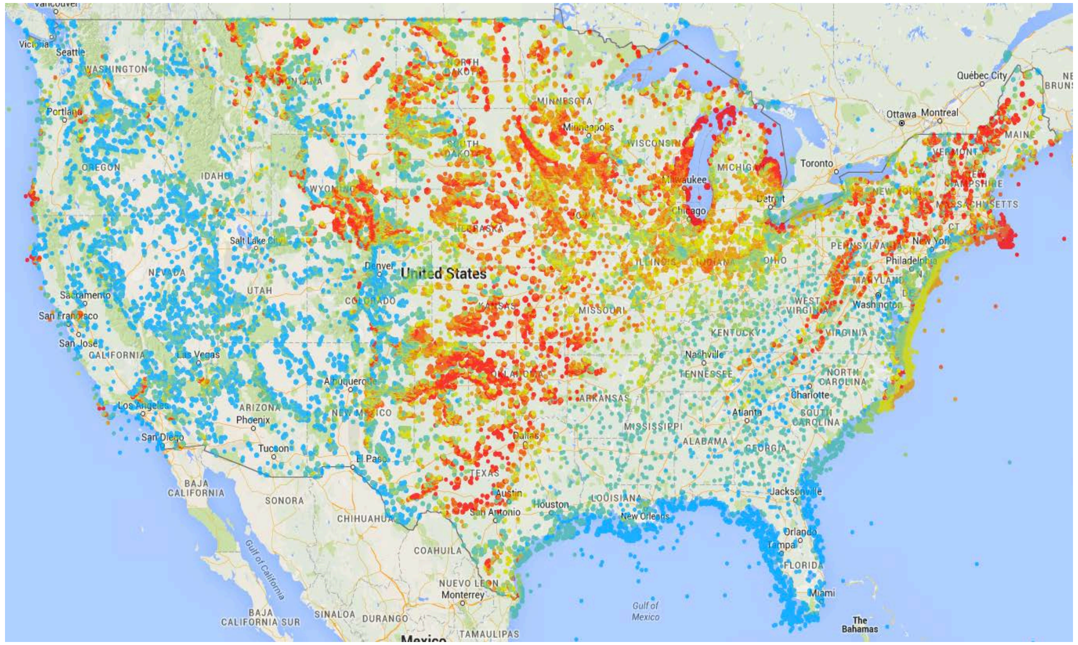
- Grid will be an enabler
- Electrification of transport and heating
- Demand-side management, strategic storage
- Digitization: other ancillary benefits as well
- very likely: Electrofuels/chemicals

e.g. perfect match of demand/supply

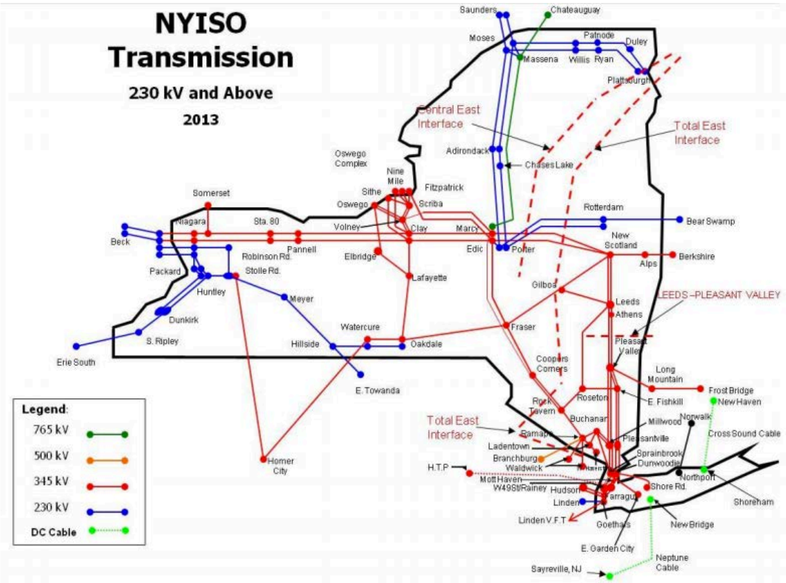


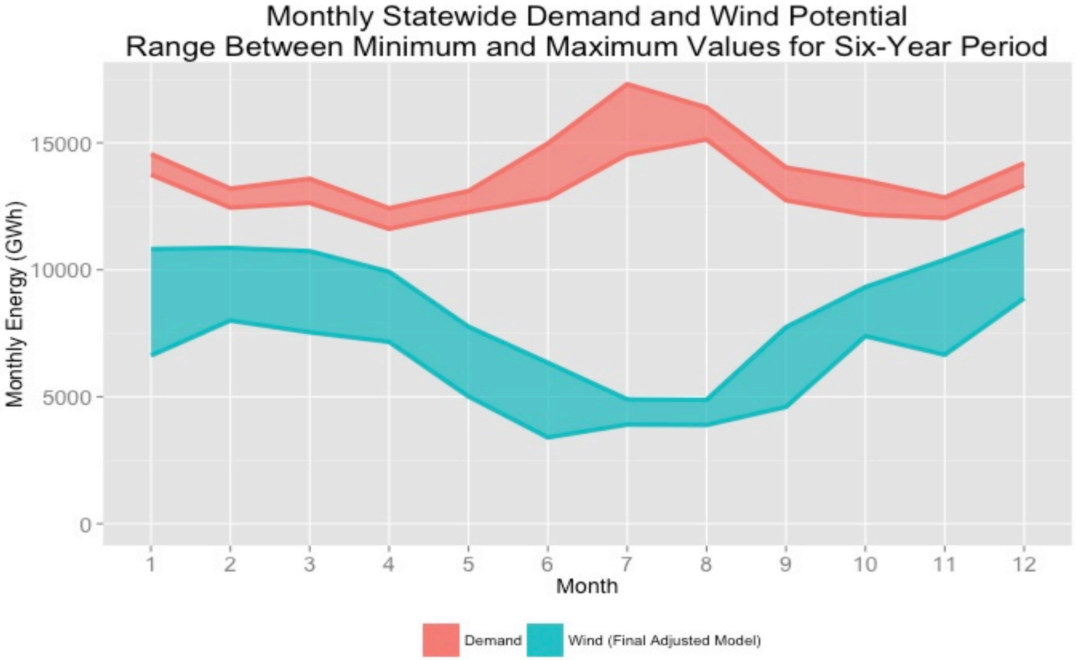
Battery Storage

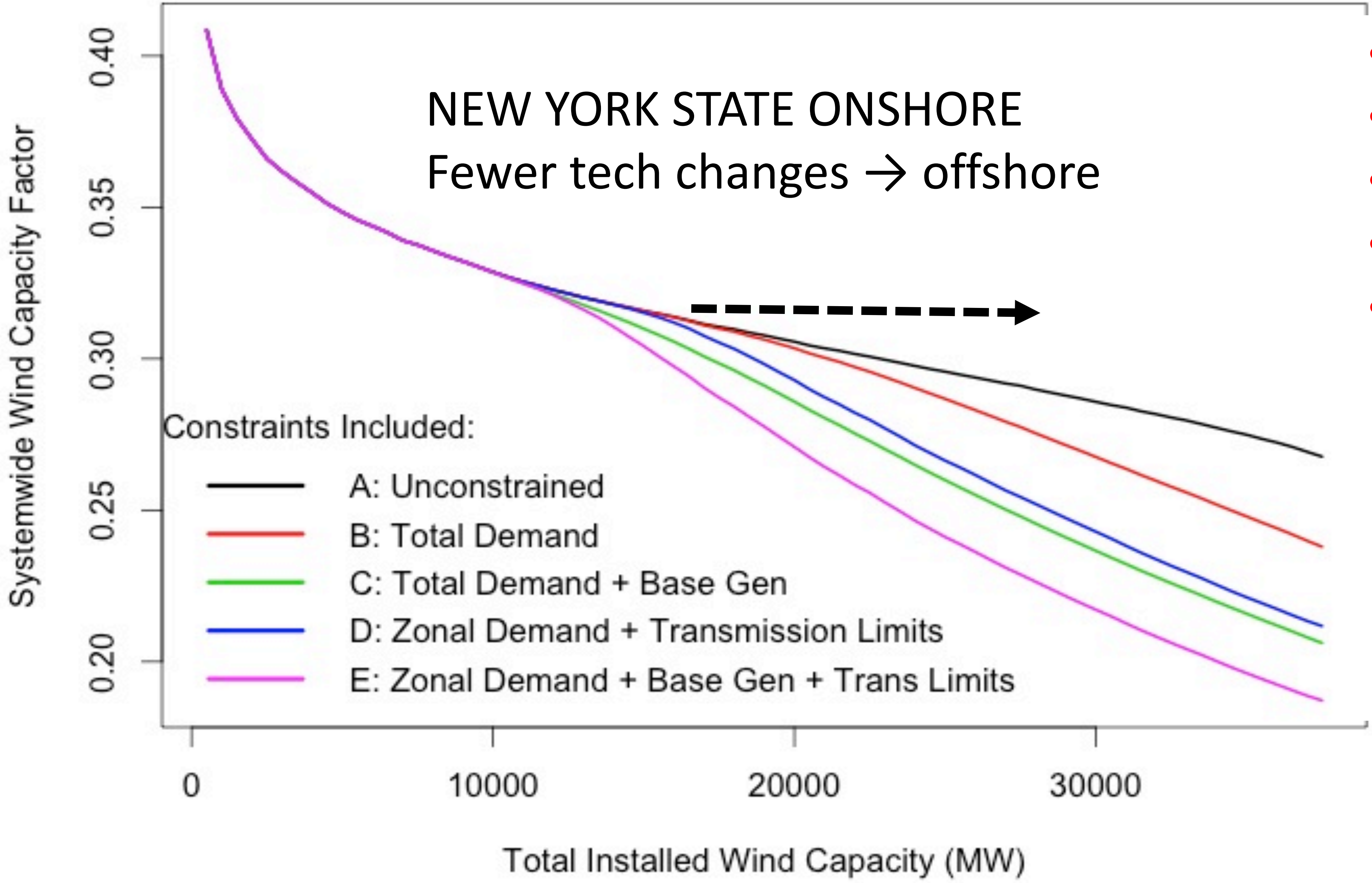
- GOAL: \$100/kWh, 5000 cycles and 80% DoD
- Simplistically
- 200 cycles a year → 5 cents/kWh (hourly/daily cycle)
- 2 cycles a year → \$5/kWh (seasonal storage)
- Extremes to illustrate the opportunity/challenge
- Of capital sitting idle



Modeling 5 min, 6-yrs will all zone loads and transmission- with and w/out electric heating Waite Thesis (2016)







- Store heat/cold
- Hydro dispatch
- Electric vehicles
- Electro-fuels
- Pumps, water

← best

← many options

← transmission

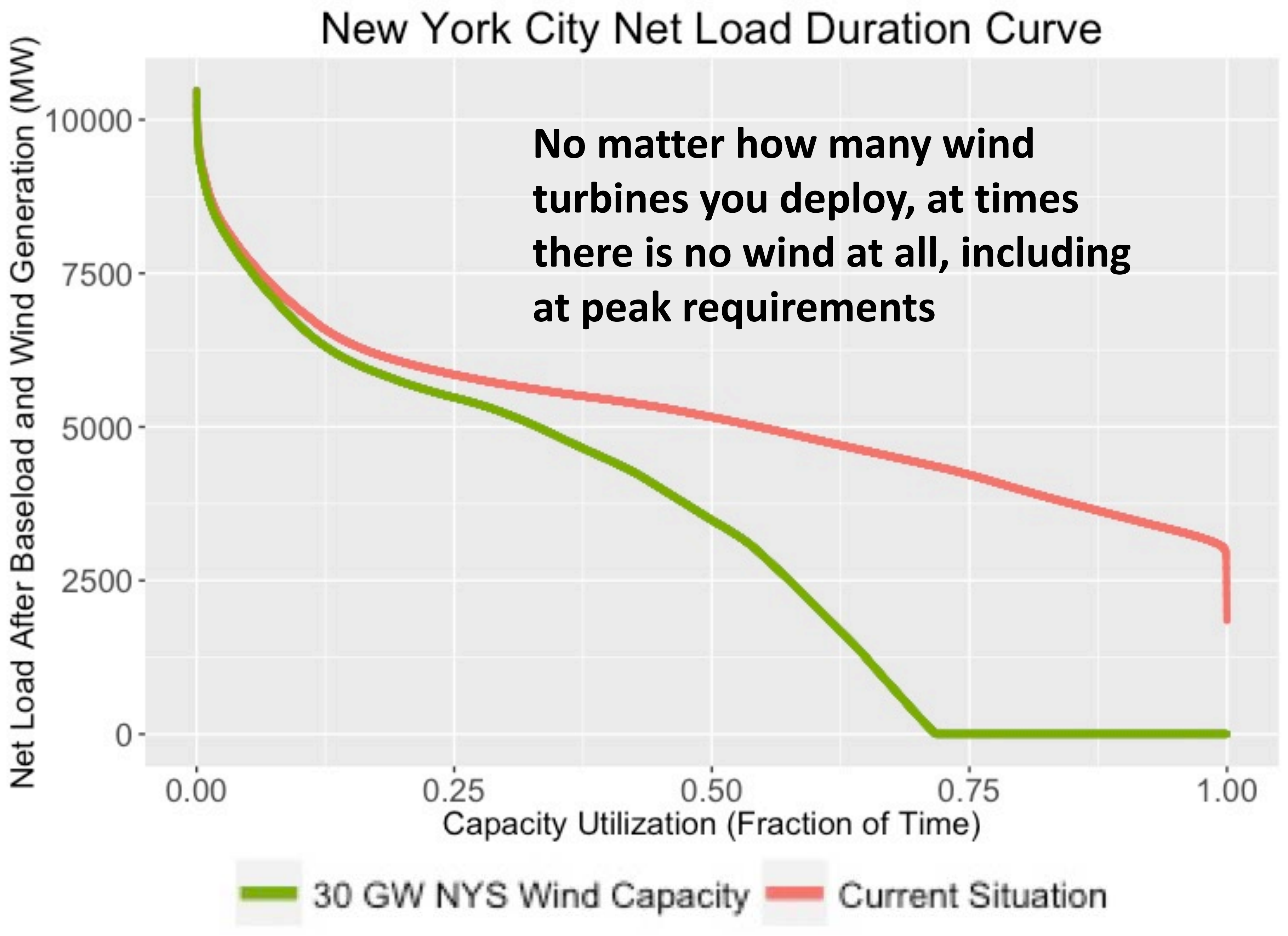
← flex baseload

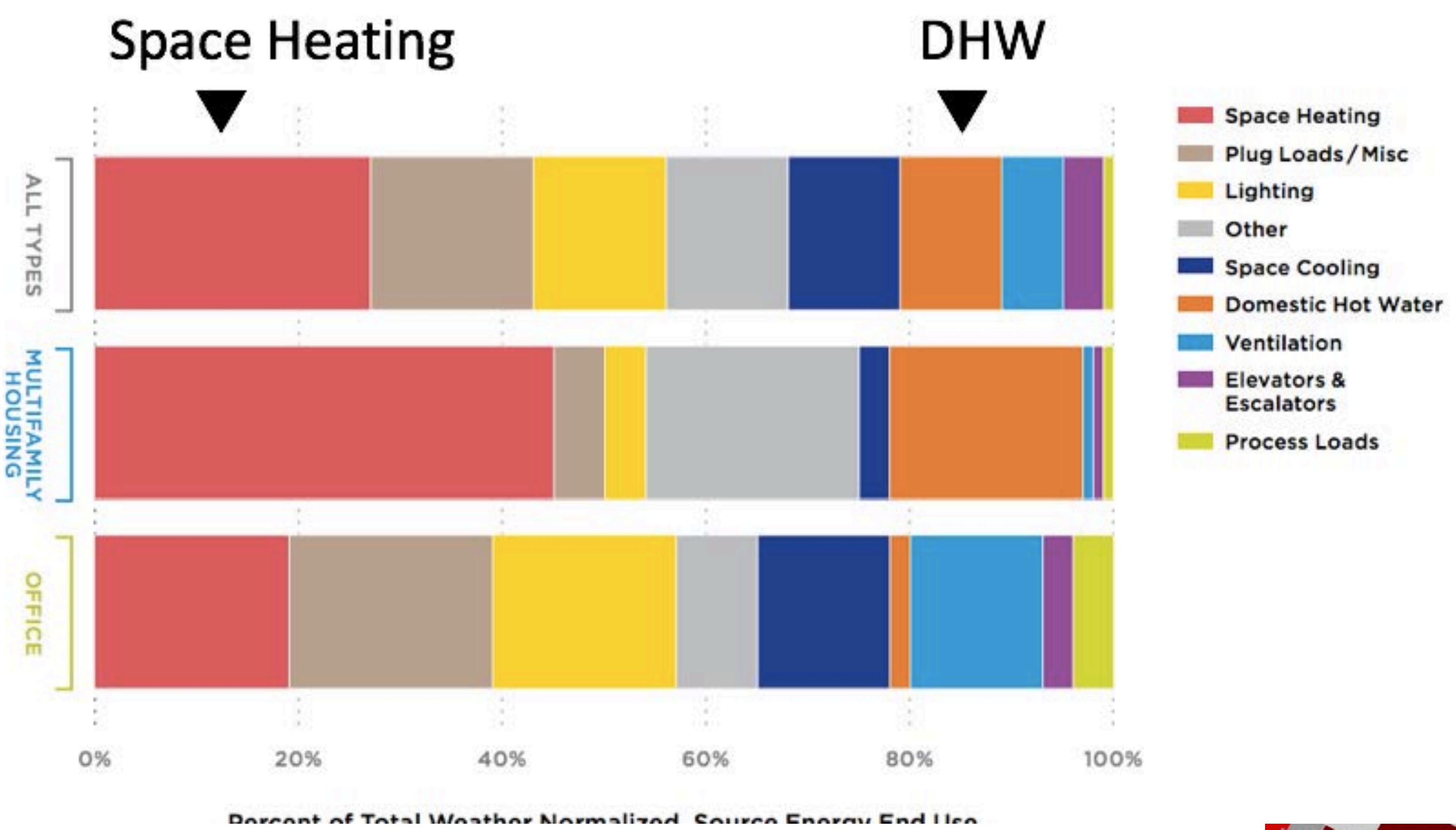
↑ 0%

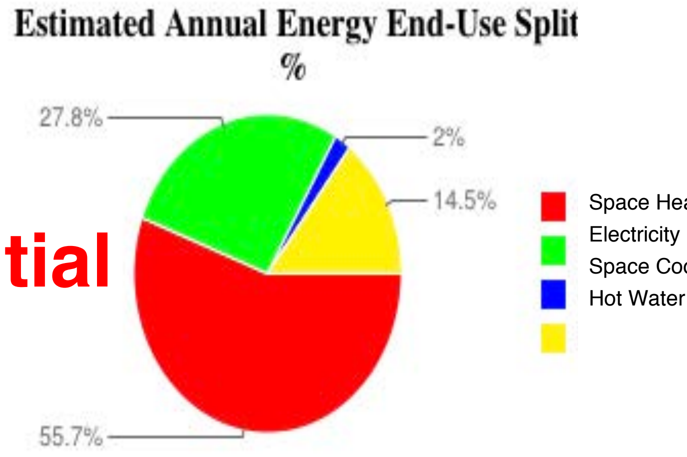
↑ 10%

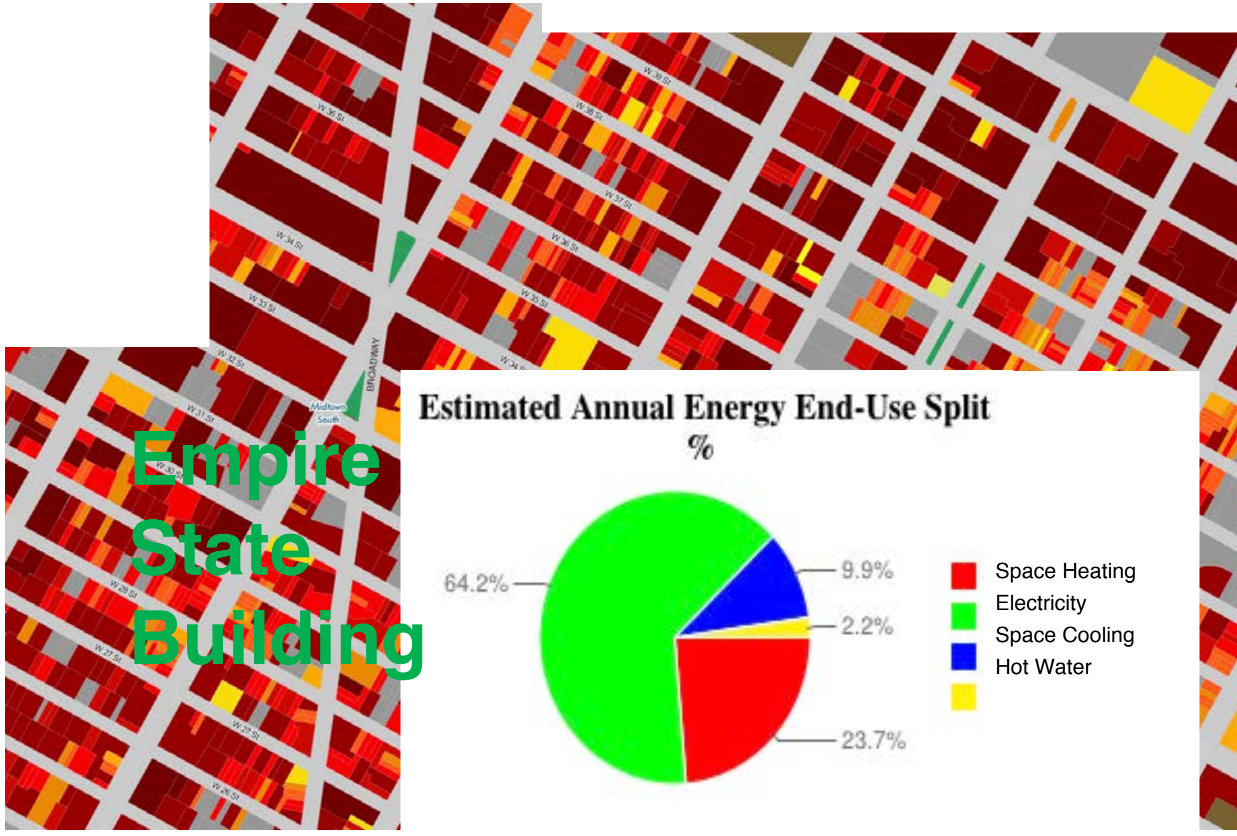
↑ 18%

↑ 31% (% energy from wind)


New York City Net Load Duration Curve
No matter how many wind turbines you deploy, at times there is no wind at all, including at peak requirements
Net Load After Baseload and Wind Generation (MW)
10000
7500
5000
2500
0
0.00
0.25
0.50
0.75
1.00
Capacity Utilization (Fraction of Time)
30 GW NYS Wind Capacity
Current Situation

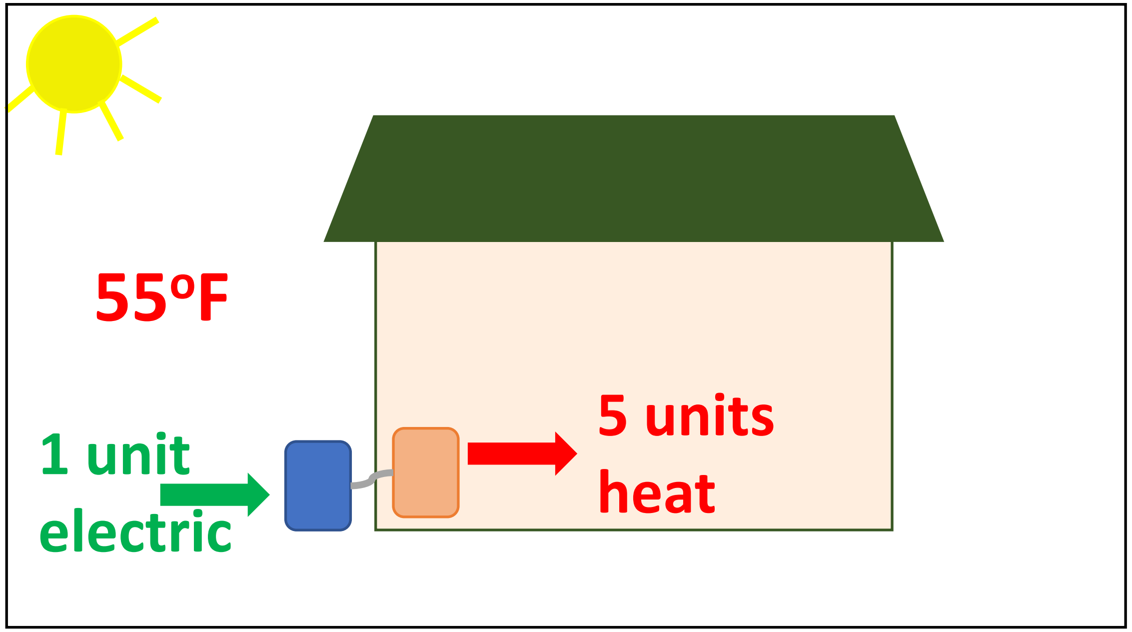

Space Heating
DHW
ALL TYPES
MULTIFAMILY HOUSING
OFFICE
0%
20%
40%
60%
80%
100%
Percent of Total Weather Normalized Source Energy End Use
Space Heating
Plug Loads / Misc
Lighting
Other
Space Cooling
Domestic Hot Water
Ventilation
Elevators & Escalators
Process Loads

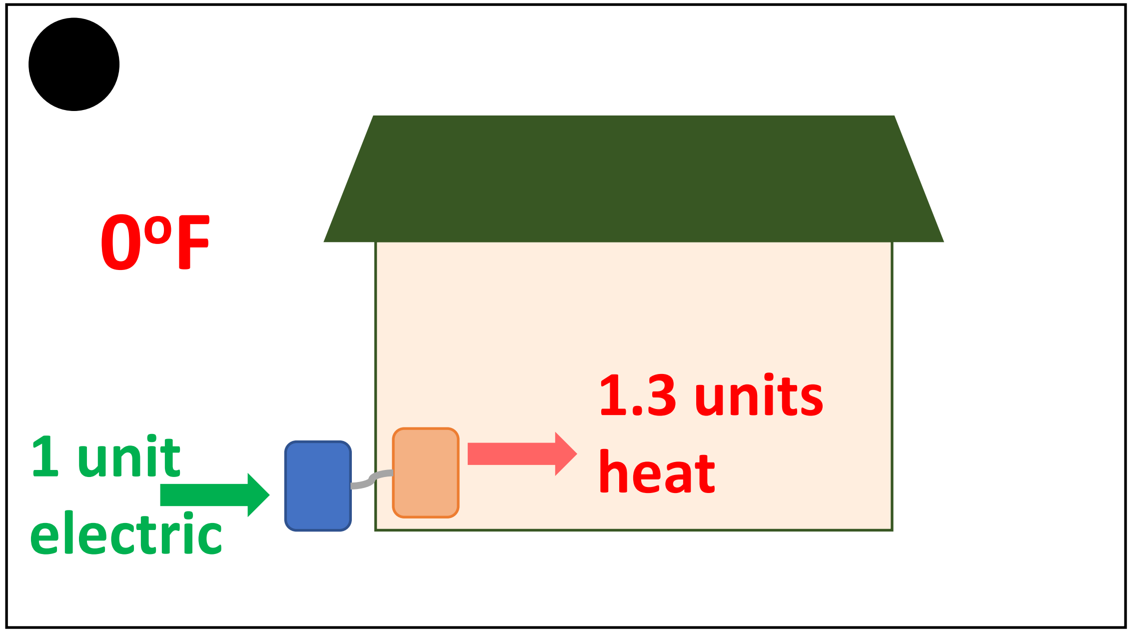

Estimated Annual Energy End-Use Split
%
Residential
27.8%
2%
14.5%
55.7%
Space Hea
Electricity
Space Coo
Hot Water


BROADWAY
Empire State Building
Estimated Annual Energy End-Use Split
%
64.2%
9.9%
2.2%
23.7%
Space Heating
Electricity
Space Cooling
Hot Water

Observation

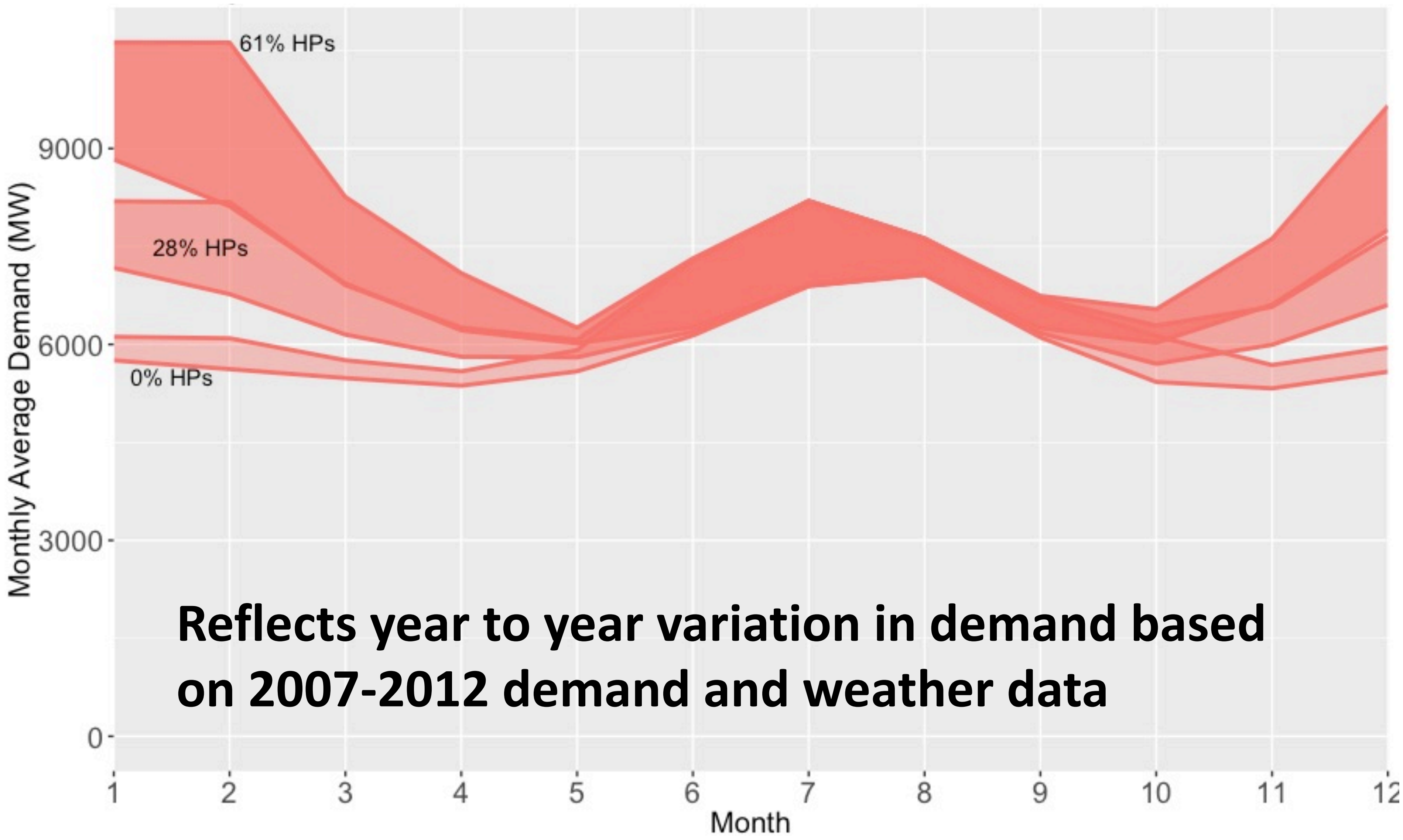
1. Space heating, the dominant source of GHG emissions in many areas, typically relies on burning on-site fossil fuels
2. Wide agreement that this will be addressed by electrification of heating via Heat Pumps (HP).





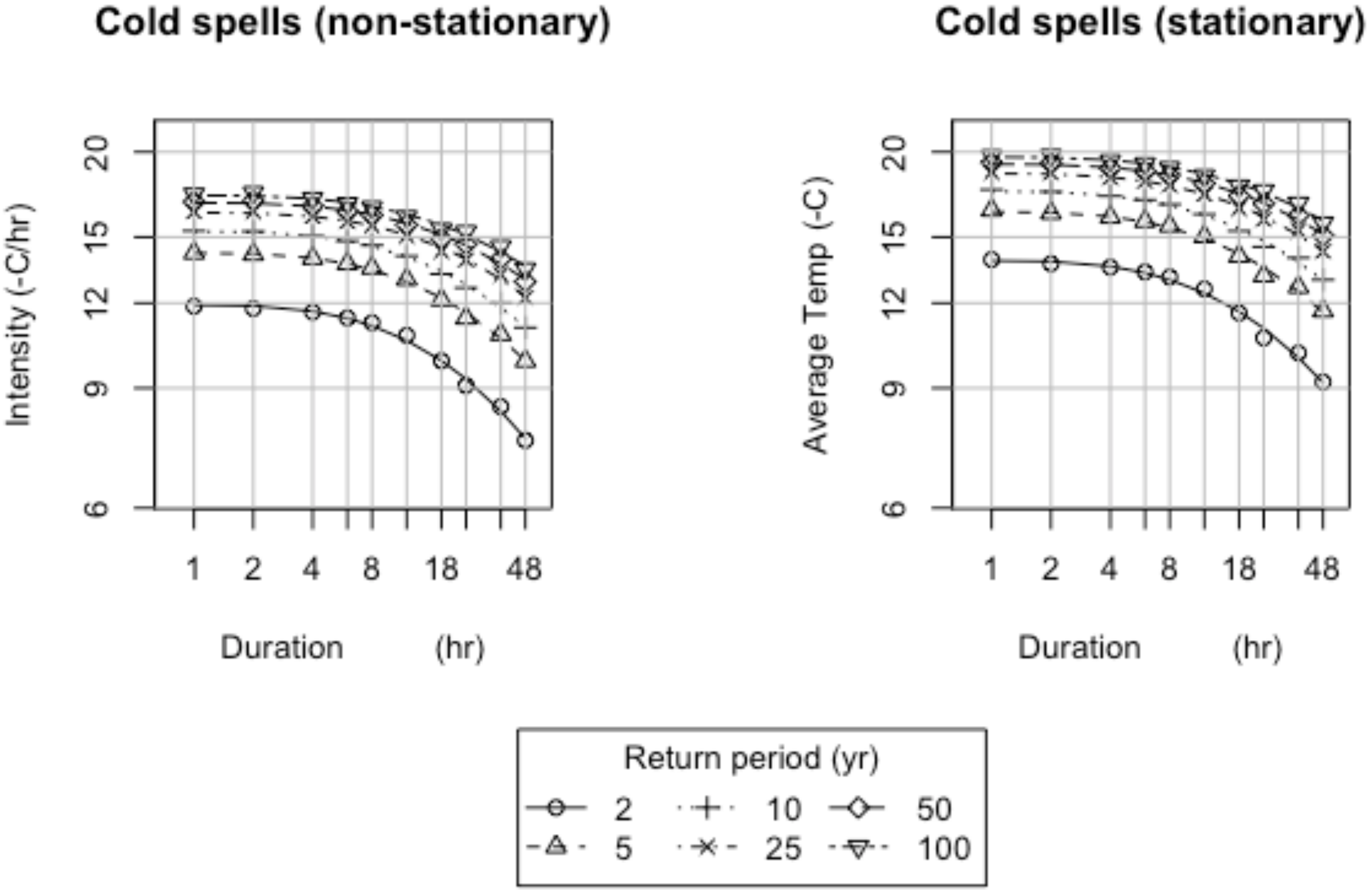
>>> What happens to demand curve with increasing HP?

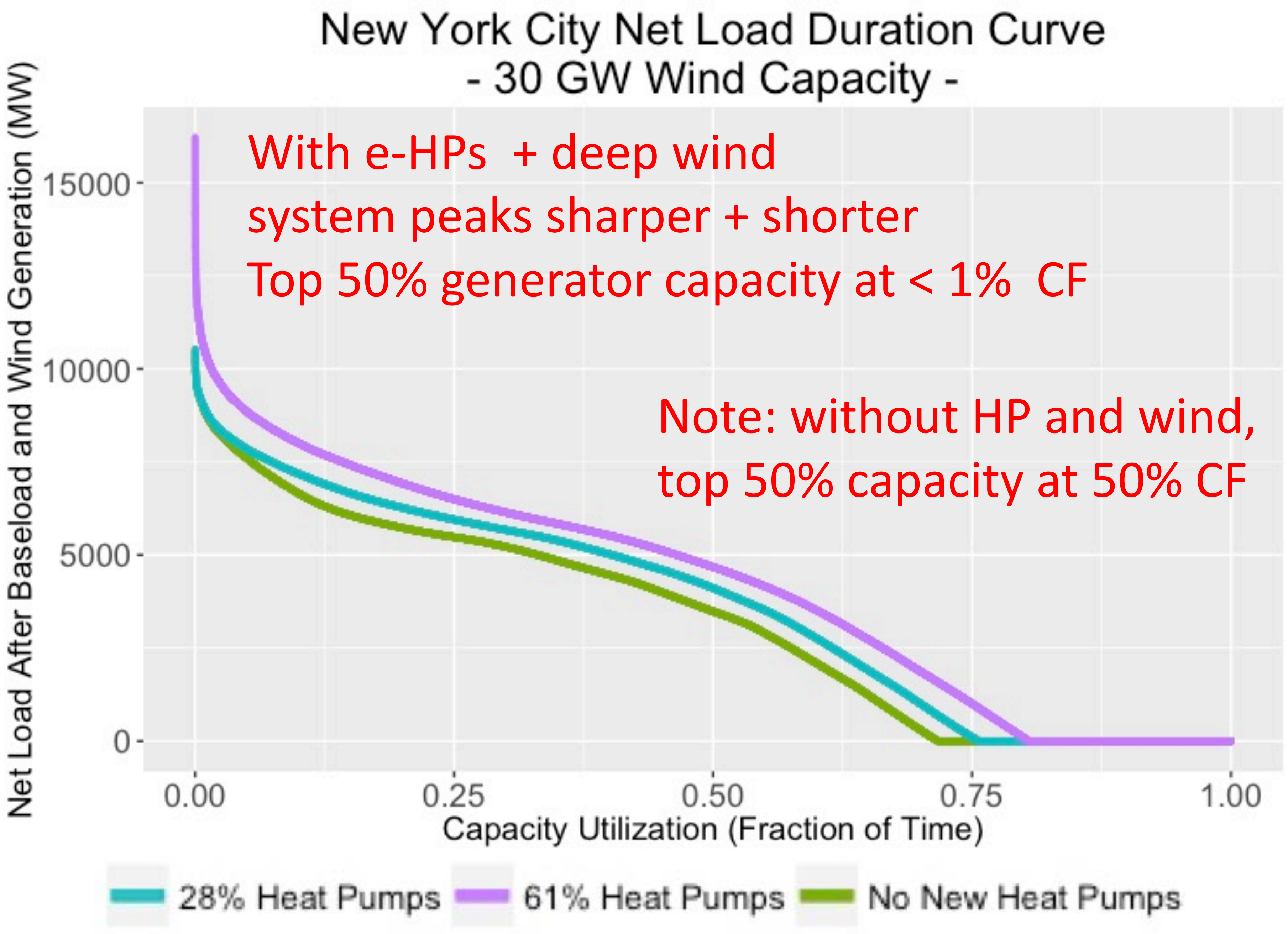
28% of elec heating: utilizes unused grid capacity



What happens as you go from 28% to 61%

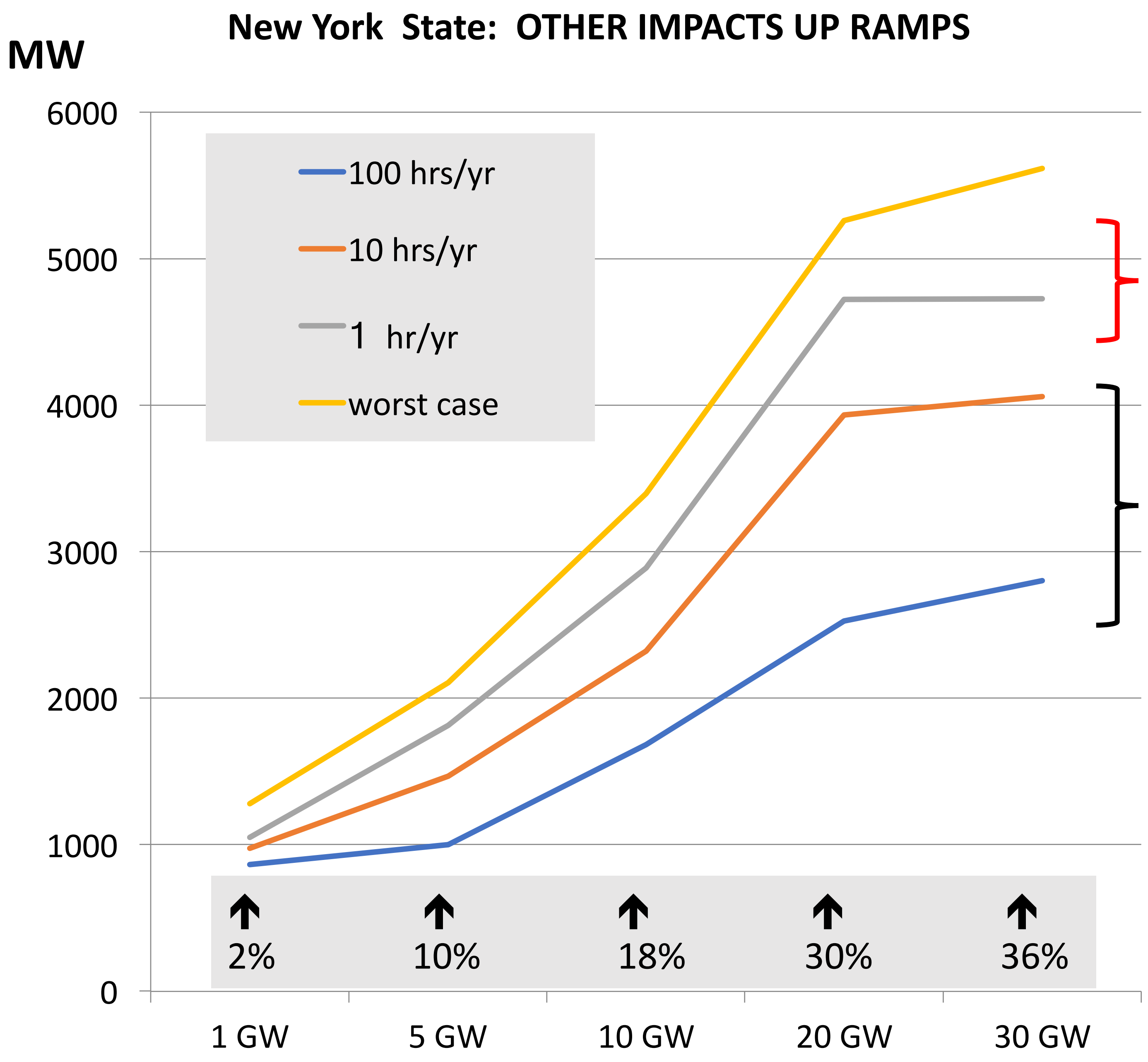
Cold Spell Frequency- extremes will matter




New York City Net Load Duration Curve
- 30 GW Wind Capacity -
With e-HPs + deep wind
system peaks sharper + shorter
Top 50% generator capacity at < 1% CF
Note: without HP and wind,
top 50% capacity at 50% CF
Net Load After Baseload and Wind Generation (MW)
15000
10000
5000
0
0.00
0.25
0.50
0.75
1.00
Capacity Utilization (Fraction of Time)
28% Heat Pumps
61% Heat Pumps
No New Heat Pumps

So might need low capex techs for a couple of hundred hours a year. Local gas-based gen. Interesting twist to the phrase fuel switching

also adds resilience



Worst case:
5 min in 6 yrs

Rare: DSM,
Regulation or
Spin reserves

Less rare but
very low duty
cycle

New Ideas: ?
Where
What kind
What cost
How controlled

Current model for grid is changing

- Increasing fractions of Solar/wind (cannot be dispatched)
- Prosumers, Bidirectional
- Flexible (multiple ways)
- Optimization and real-time control
- Transactional (ideally without the overhead) + Prosumers
- Ancillary Services

Enablers of flexibility

- Improved forecasting,
- Wider geographic area of integration
- Scheduling loads (e.g. HVAC, irrigation)
- Appliances (grid smart)
- Power electronics (appliance, inverter, feeder level volt-var)
- Real time pricing
- Differentiated reliability
- Energy storage (batteries, pumped hydro, microgrids)

Cost-effective deployment needs identifying more immediate opportunities that can nibble at scale

e.g. BQDM in New York

Low and Middle Income countries

Lack of legacy systems, full electricity access and poor reliability offer win-win opportunities for tech and economic development

DIGITIZATION of UTILITY will be KEY

Flexibility- examples, Low-Middle Income

- Hydro → adjustable speed, dispatch
- Irrigation (huge potential in India), pumps
- Appliances (operate over wider voltages)
- AMI/ low-cost meters, driver: non tech losses
- Distribution auto (new + low cost deploy)
- Existing grid: overlay and augment
- Renewables and storage for access or reliability
- Thermal storage and New electric vehicles

e.g. INDIA, Avg losses of the power sector: $10 Billion/yr Digitization will have multiple benefits

Accumulated DISCOM losses & debt have ballooned in the last few years

Accumulated Loss ~ Rs. 3.8 lakh crore (Mar 15) - Total Loss in last 6 years – Rs. 3.66 lakh crore

Source: Audited DISCOM Accounts * 2014-15 figure is a projection based on provisional reporting by States

Flexibility through scheduling load: