High-voltage Transmission Studies

Prepared By:

Vibrant Clean Energy, LLC

Dr Christopher T M Clack,

Prepared For:

International Summit on the Electric Transmission Grid

October 24th, 2019

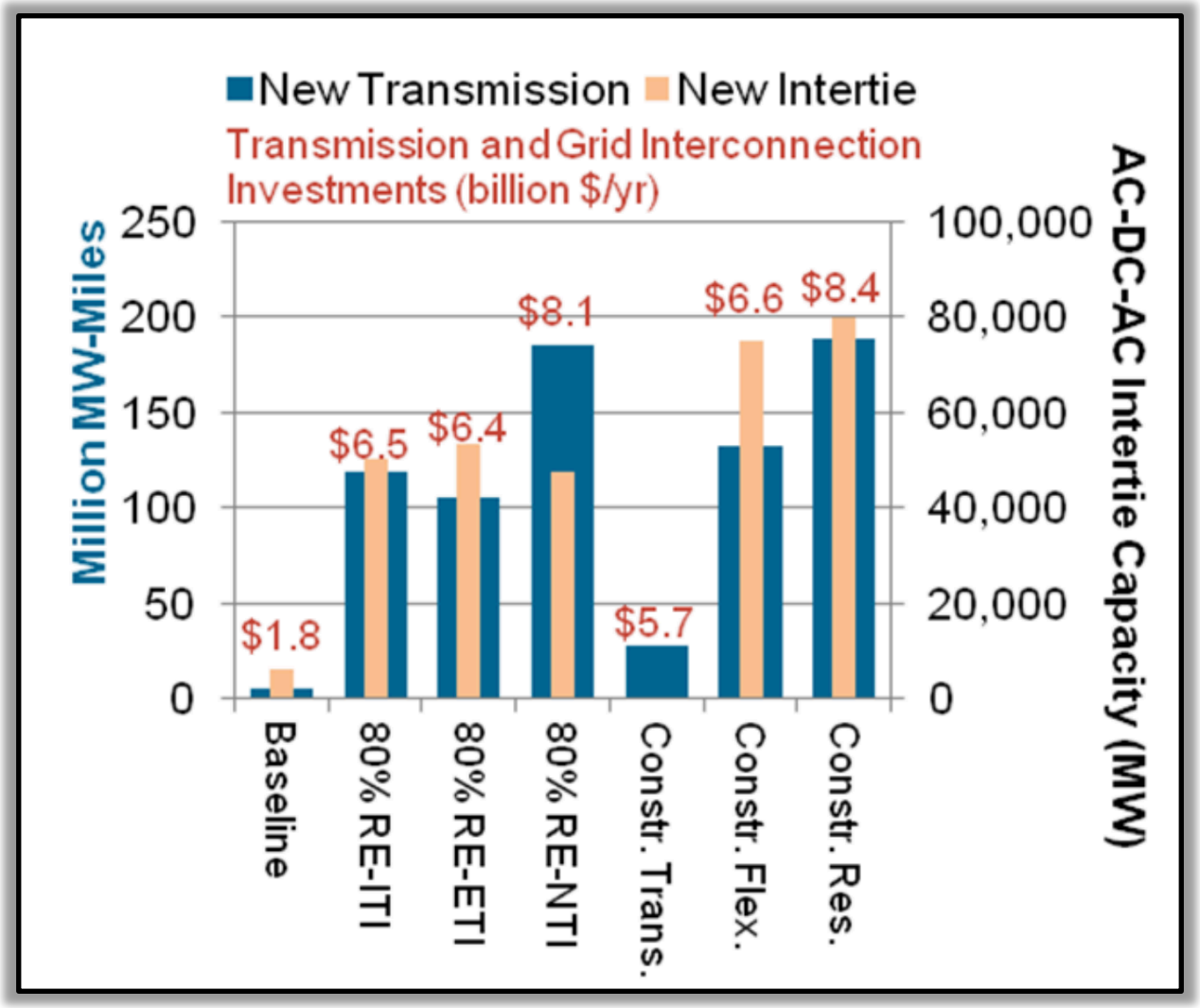
info@vibrantcleanenergy.com

VCE

Recent studies that call for HV transmission

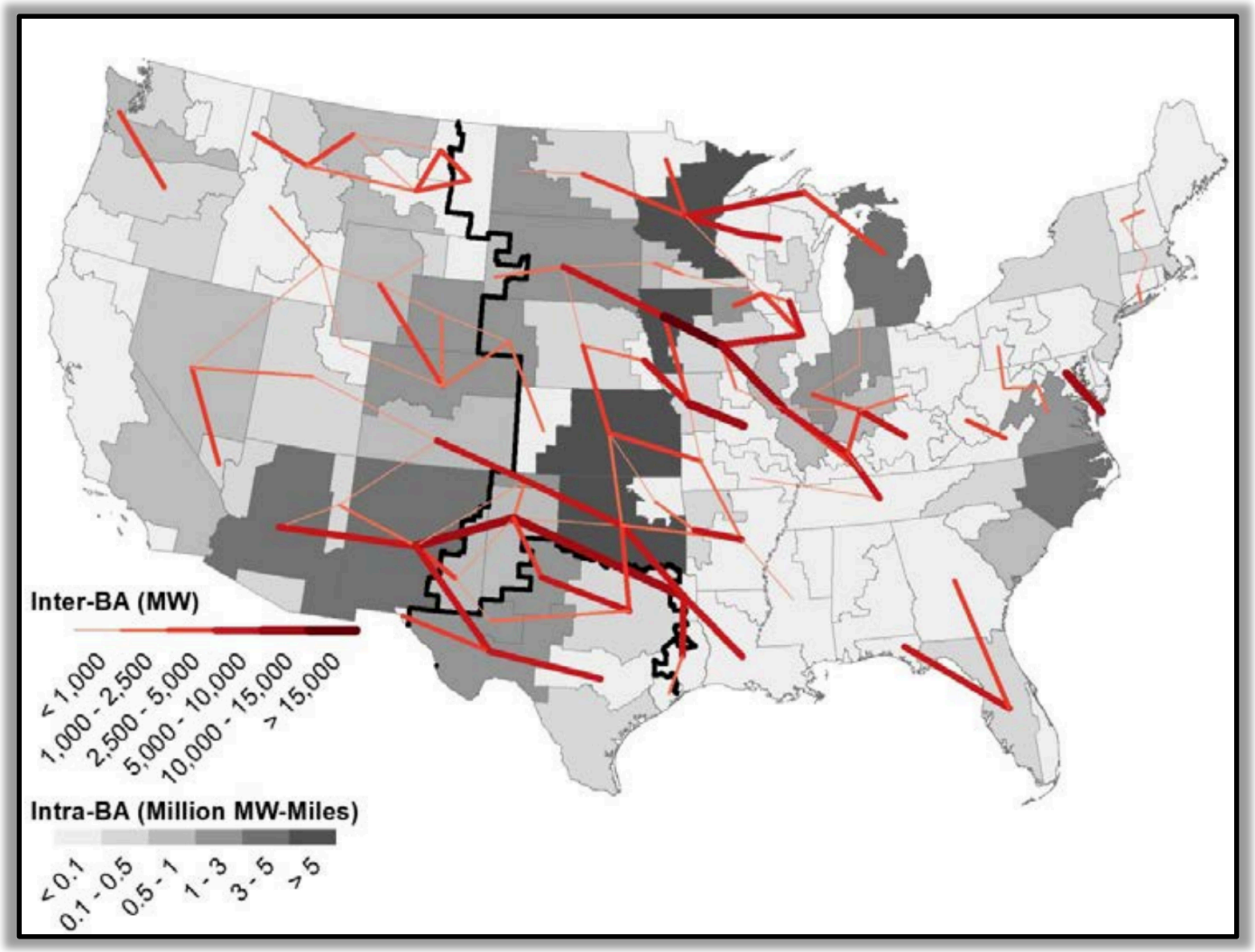
1. NREL REFS report (***2012***) – every scenario required high-voltage transmission upgrades;
2. Peer reviewed "Future Cost-competitive electricity systems and their impact on US CO_2 emissions" Nature Climate Change scientific paper (**2016**) – demonstrated high emission reductions not cost effective without transmission;
3. NREL ERGIS report (***2016***) – reiterated the need for high-voltage transmission as amount of VREs increase, keeping costs down;
4. VCE® MN Smarter Grid report (***2018***) – concluded that to decarbonize of ***whole economy*** of the Eastern Interconnection requires large-scale high voltage transmission to be built;
5. NREL SEAMS study (***2018***) – detailed investigation shows that HVDC is most cost effective as a "macro grid", also shows high voltage transmission integral to high shares of VREs;
6. VCE® National Decarbonization Study (TBD, ***likely 2020***) – confirms that HVDC is most cost effective integration strategy for deep decarbonization of entire economy.

NREL REFS (investments in transmission)



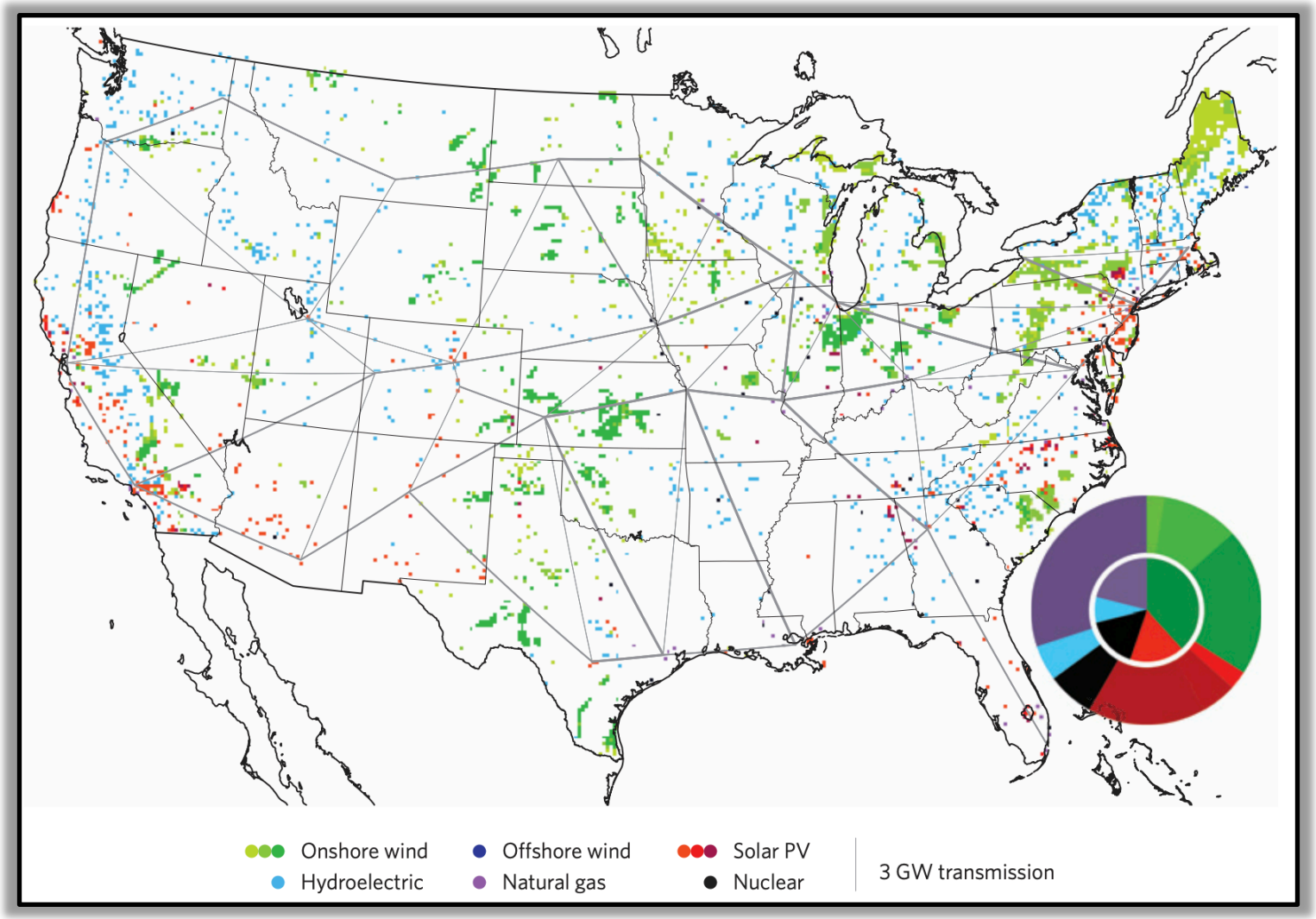
VCE
VIBRANT CLEAN ENERGY

NREL REFS (incremental buildout in HV transmission)



VCE
VIBRANT CLEAN ENERGY

Nature Climate Change Paper (HVDC network buildout)

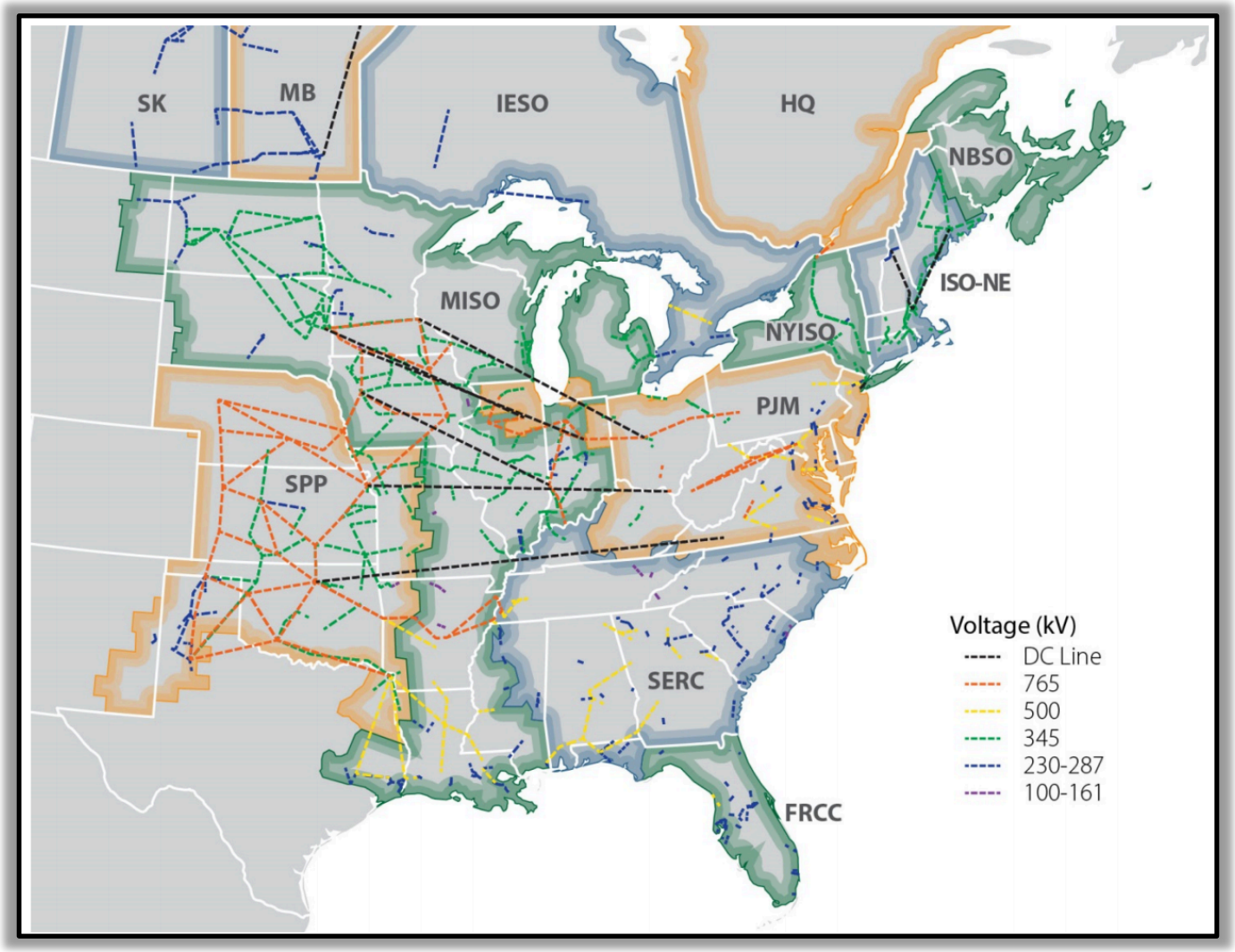


$42 billion / annum saving; 3x cost of building the HVDC network

info@vibrantcleanenergy.com

VCE
VIBRANT CLEAN ENERGY

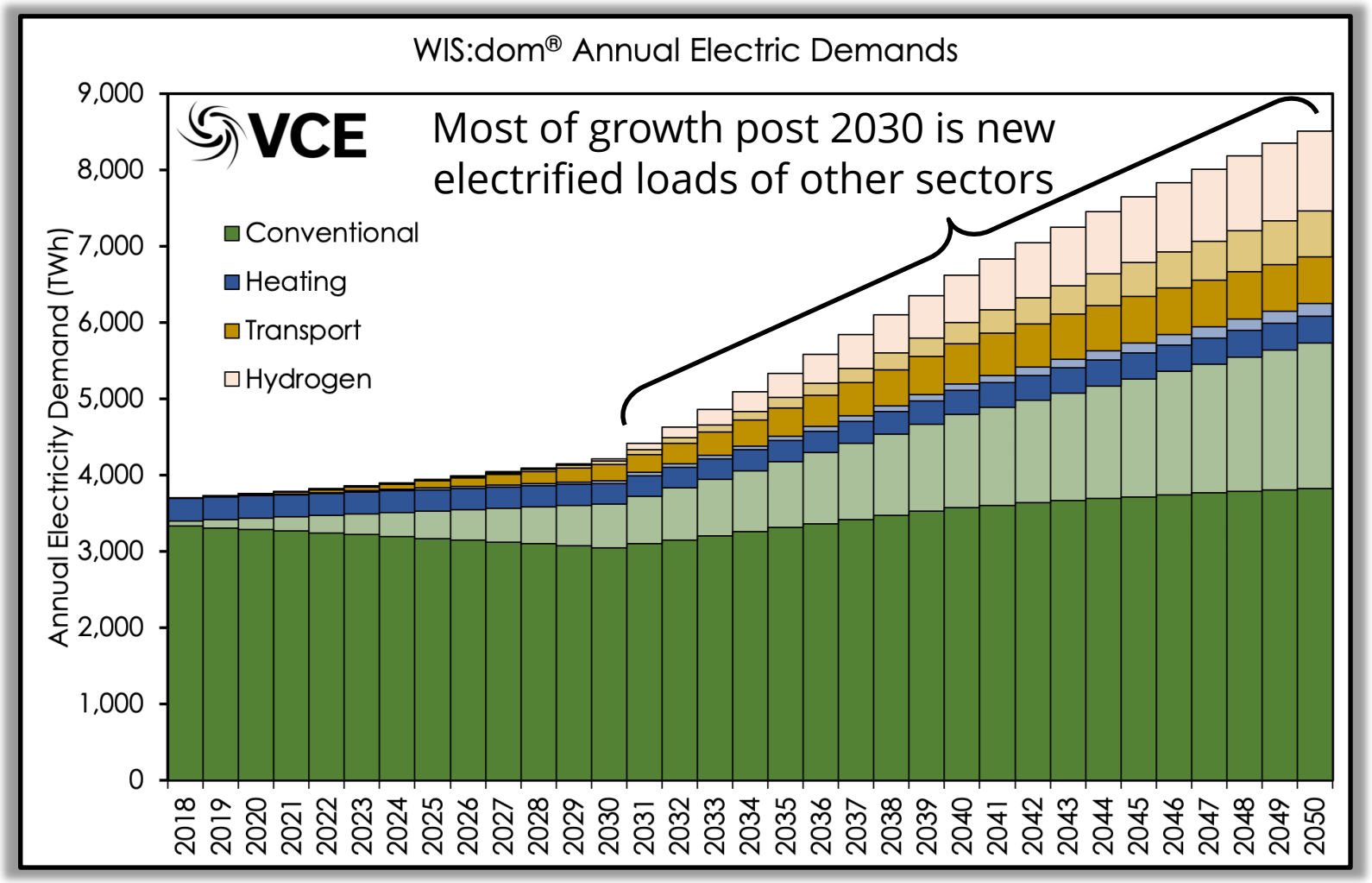
ERGIS (HV Transmission build out)



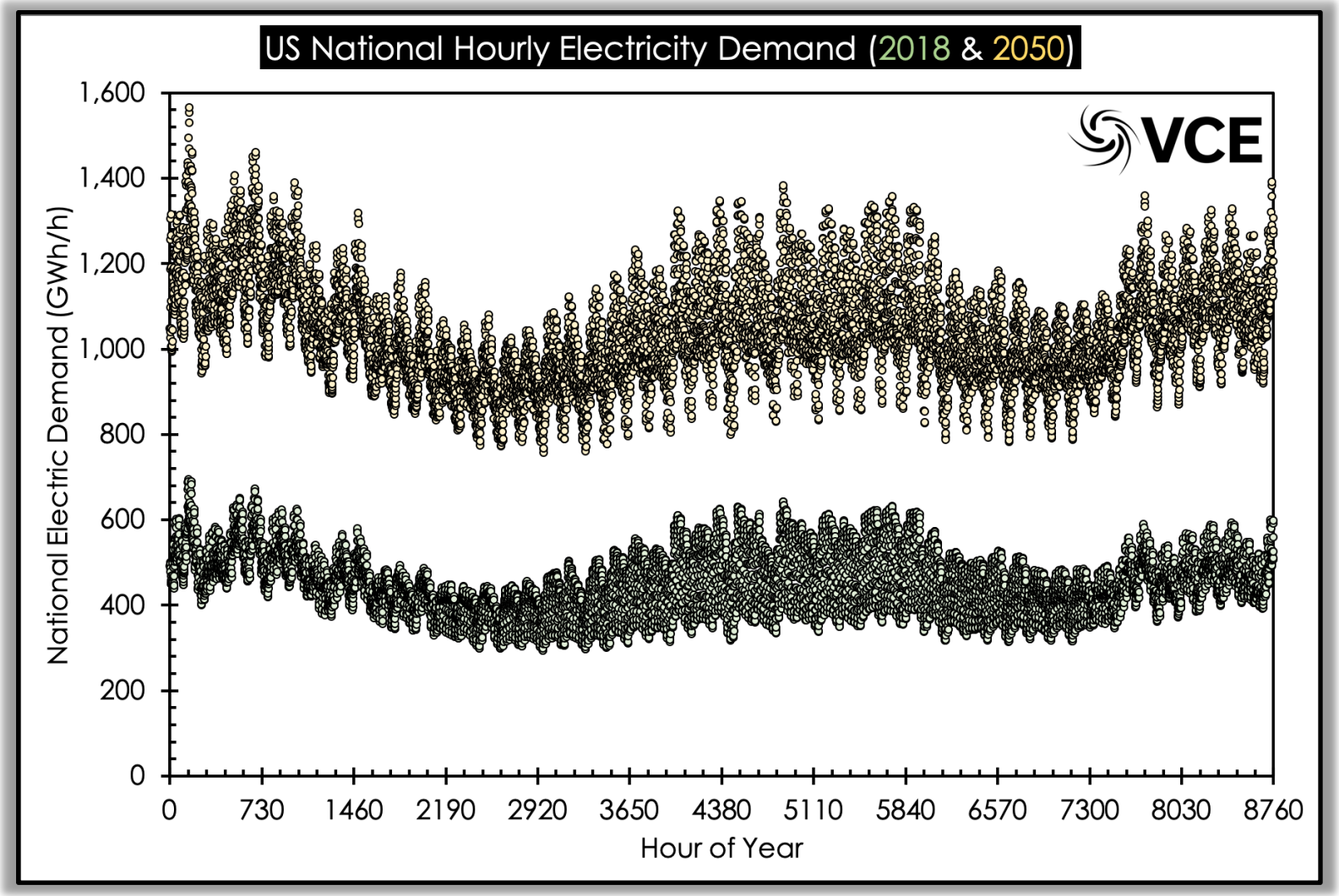
Large-scale build out for 30% VREs by 2030 across EIC

VCE
VIBRANT CLEAN ENERGY

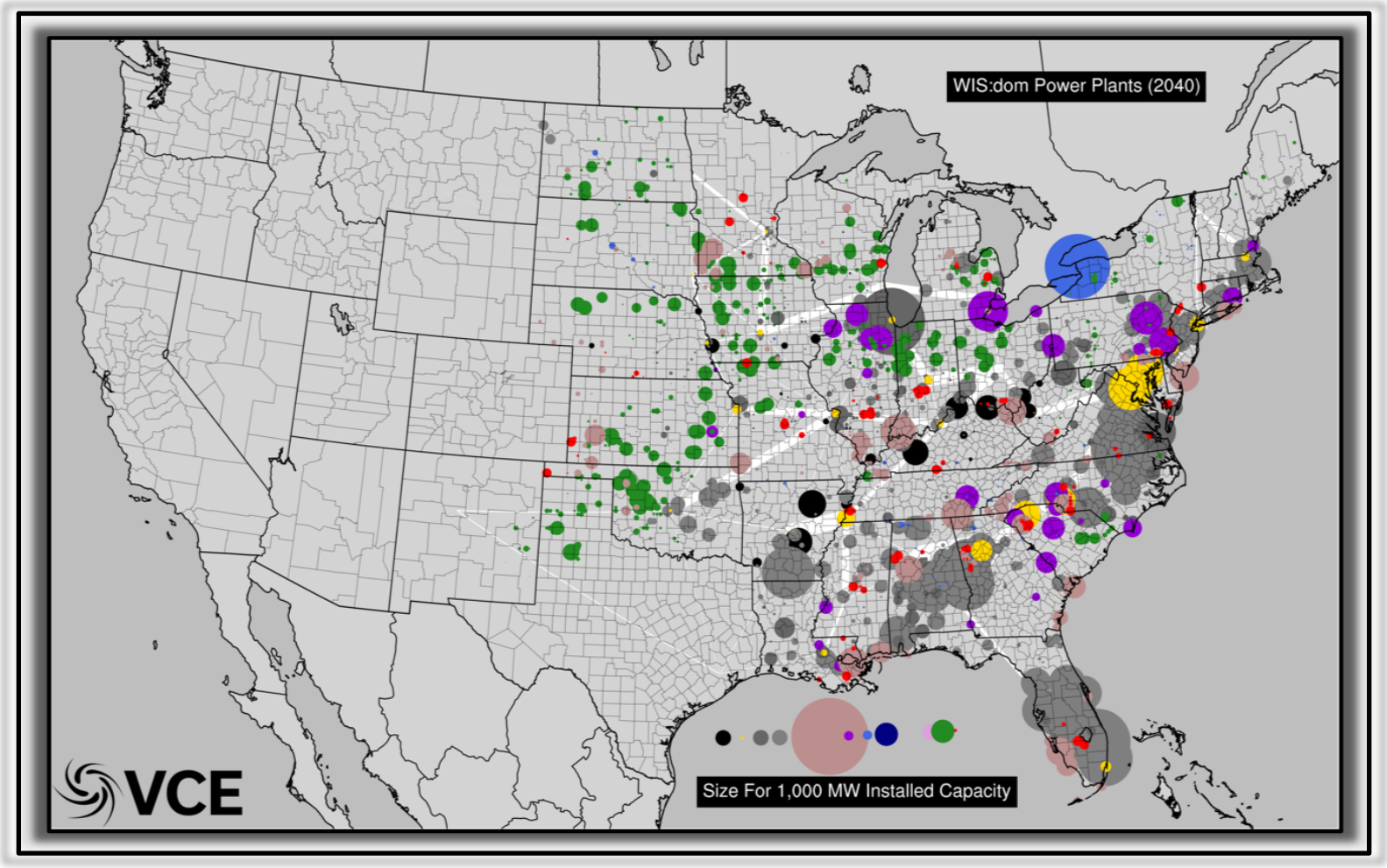
Electrification adds more (not less) requirements for transmission



Electrification changes electricity needs everywhere

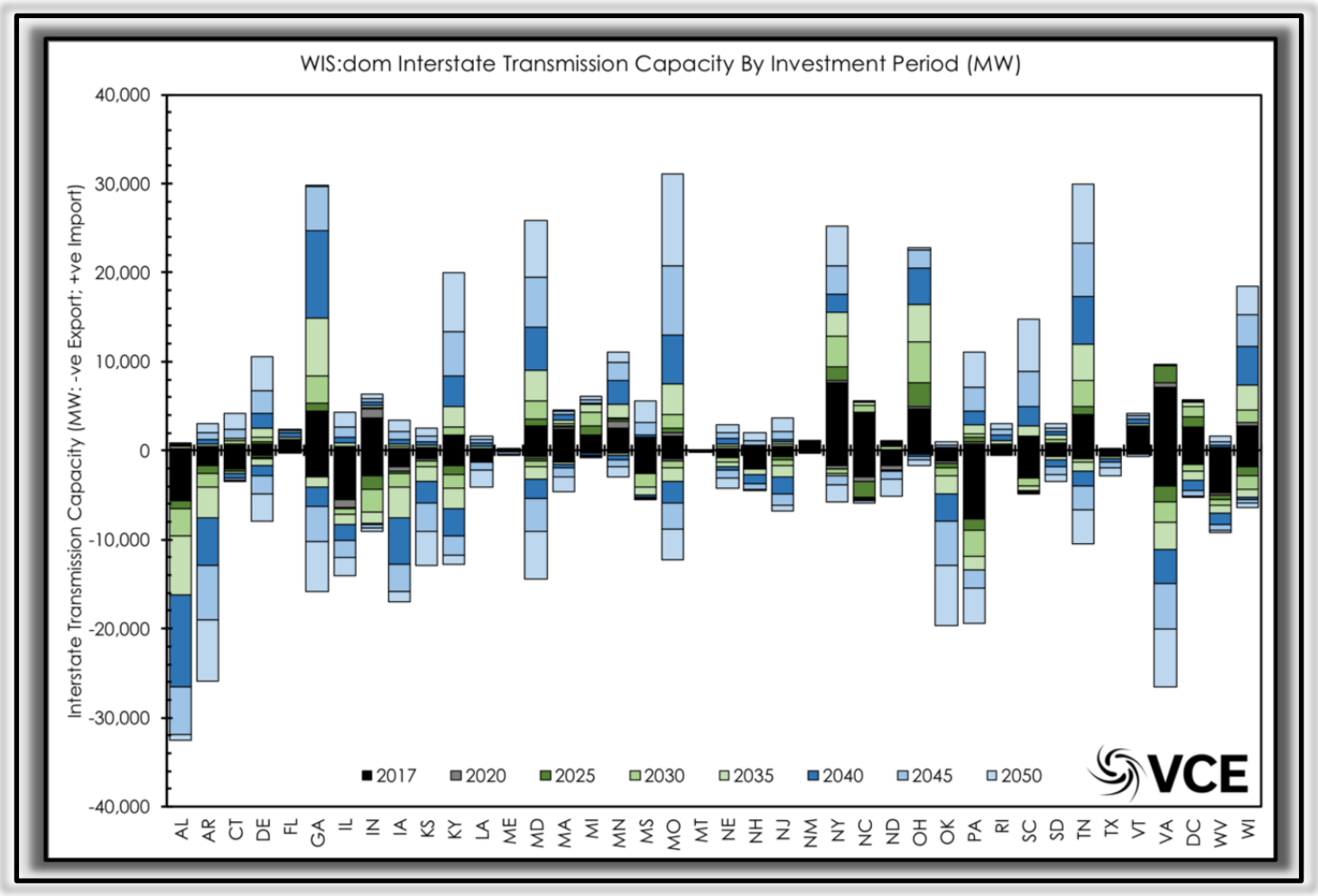


VCE® MN Smarter Grid (HV Transmission build out)



HV transmission critical for deep decarbonization of entire economy of the EIC. Solution was infeasible with no interstate transmission.

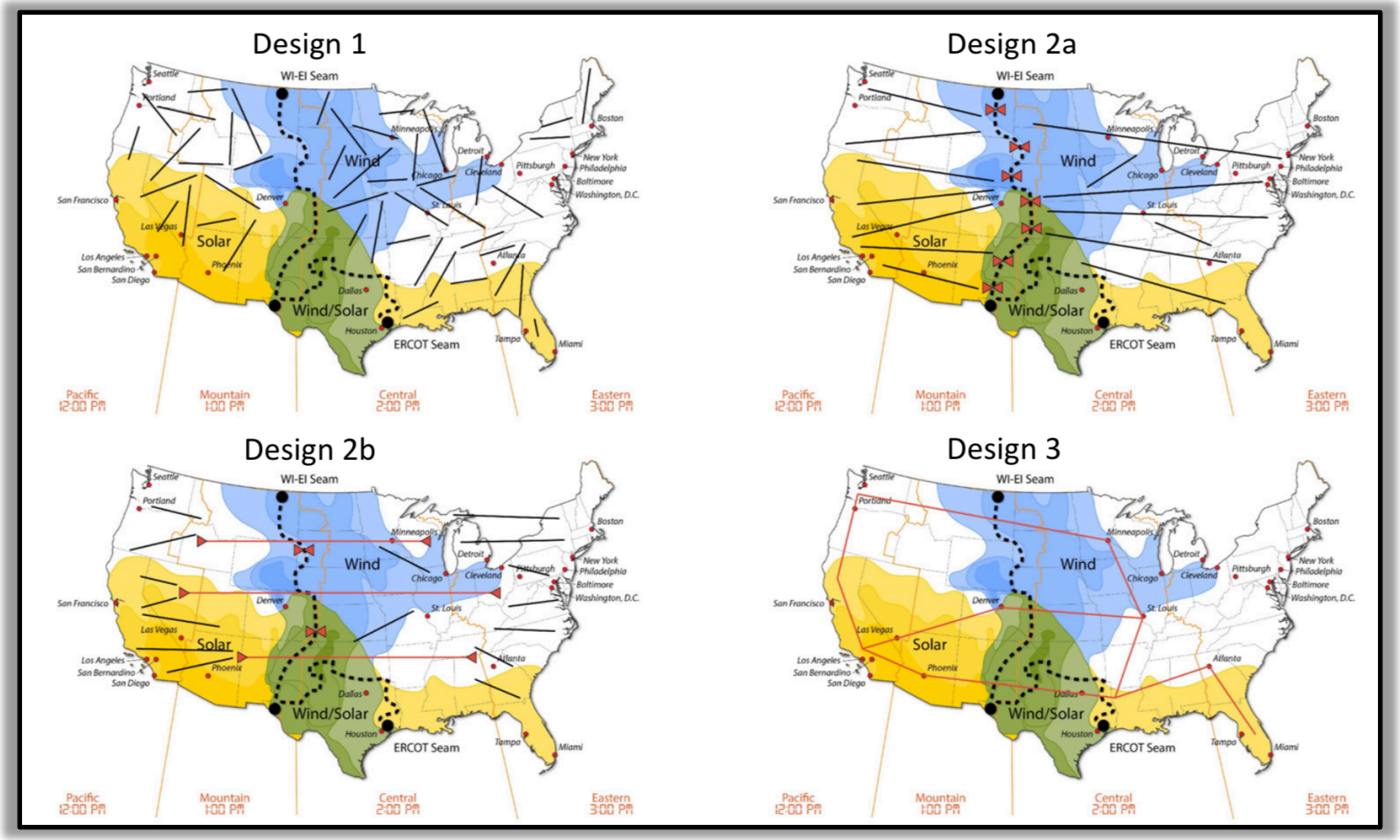
VCE® MN Smarter Grid (HV Transmission build out)



HV transmission critical for deep decarbonization of entire economy of the EIC. Solution was infeasible with no interstate transmission.

VCE
VIBRANT CLEAN ENERGY

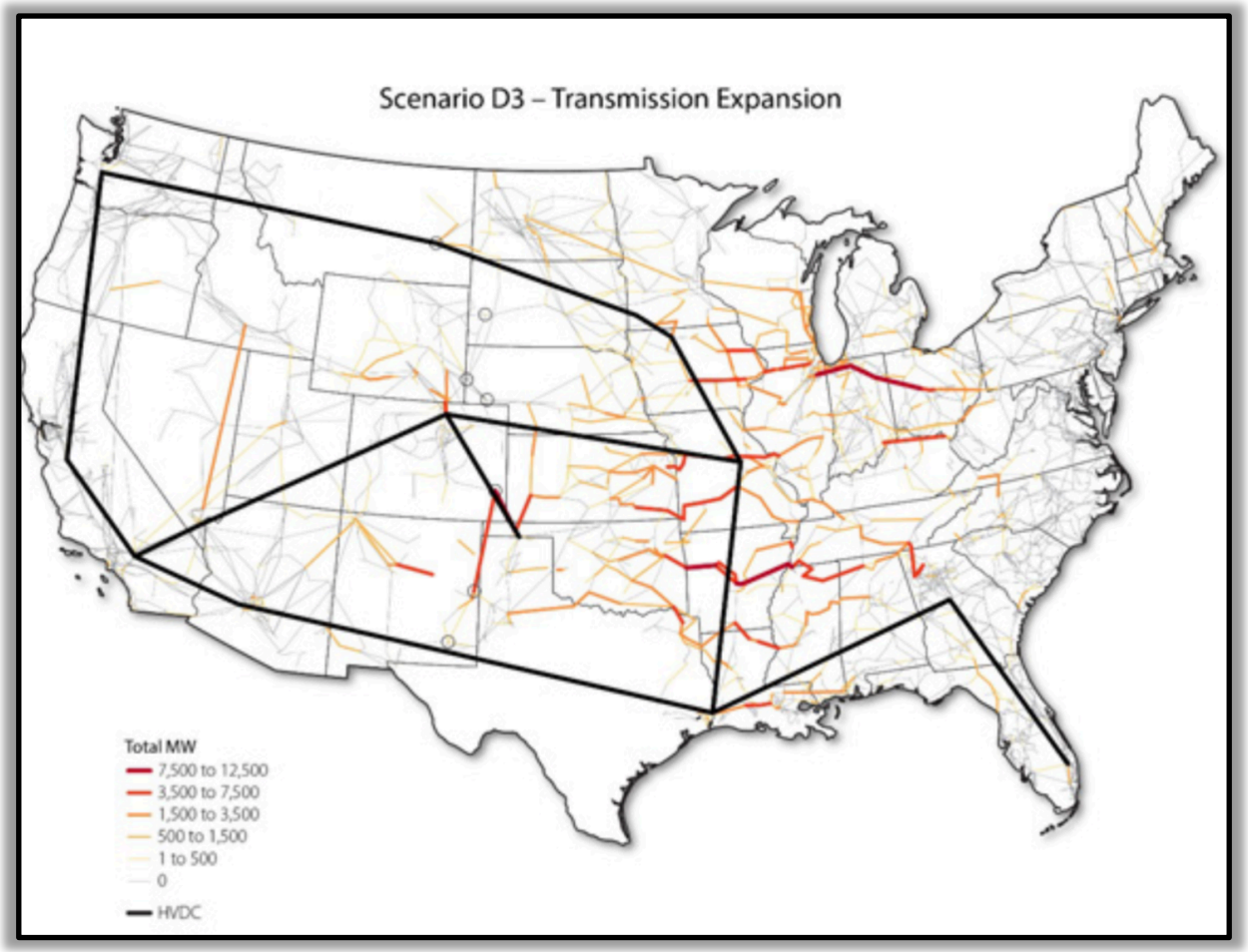
NREL SEAMS Study (HV Transmission scenarios)



SEAMS investigated four HV transmission build outs in detail. The most effective (for all metrics) was the “HVDC macrogrid” (design 3).

VCE
VIBRANT CLEAN ENERGY

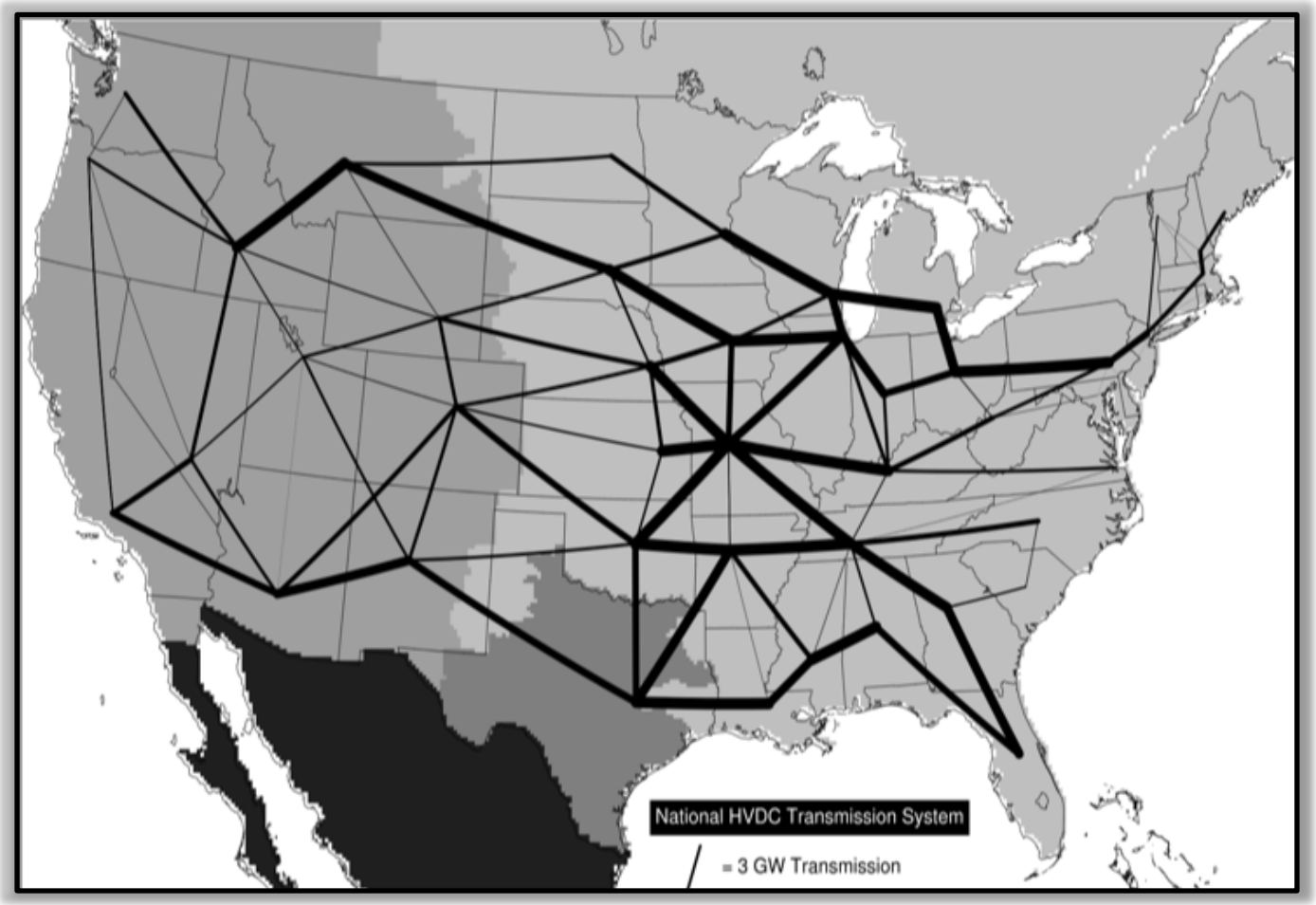
NREL SEAMS Study (Macro grid buildout)



The “macro grid” creates $48 billion in savings and costs $19 billion to construct giving a benefit cost ratio of 2.5. The macro grid could pay for itself with fuel costs savings alone.

VCE
VIBRANT CLEAN ENERGY

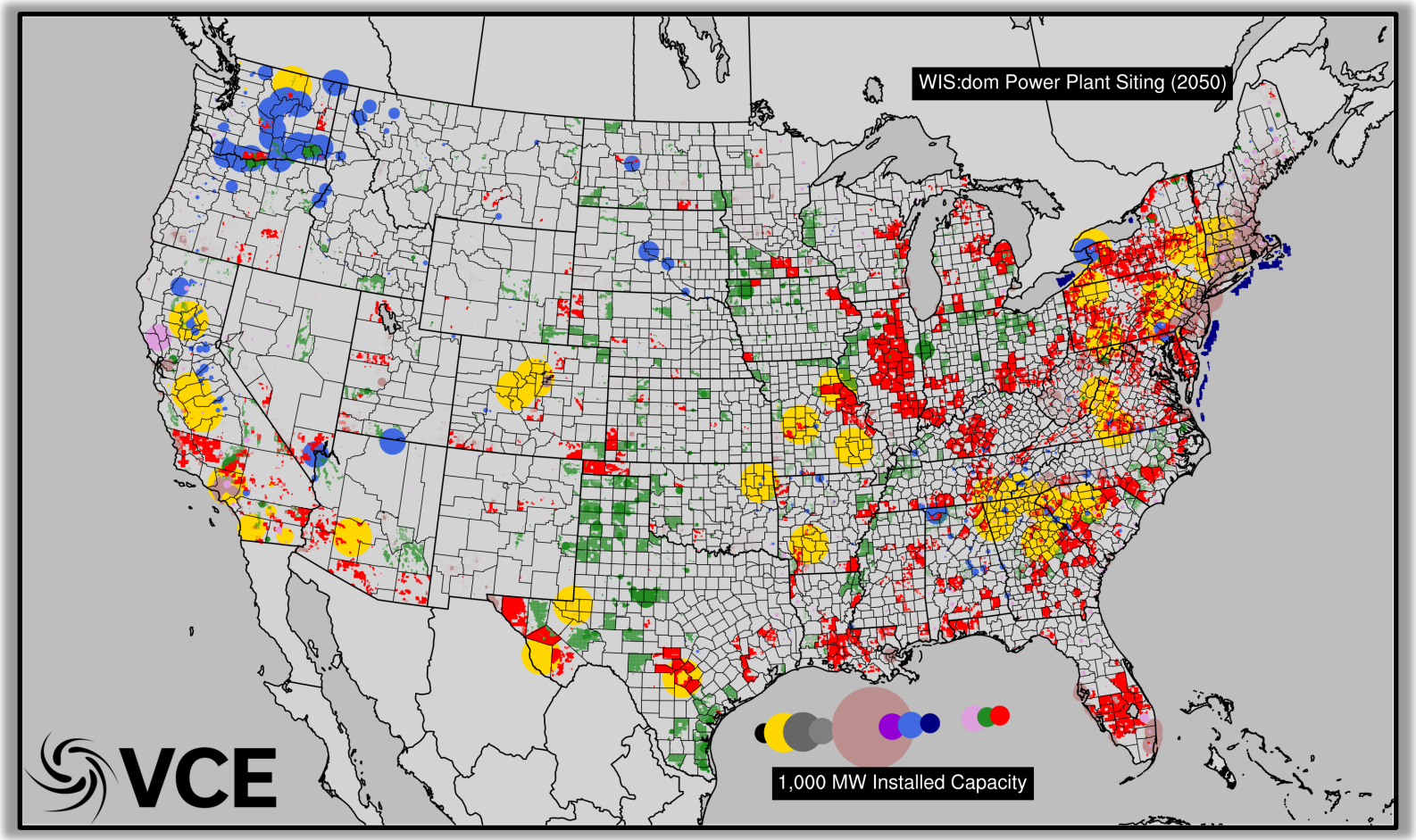
VCE® National Decarbonization Study (TBD)



WIS:dom® constructed HVDC super grid. All states connected and have access the the market.

VCE
VIBRANT CLEAN ENERGY

VCE® National Decarbonization Study (TBD)



WIS:dom® constructed HVDC super grid saves **$353 billion** annually compared with using HVAC. Interties with Canada are expanded, allowing more hydro-balancing. Reduces curtailment by **50%.**

info@vibrantcleanenergy.com

VCE
VIBRANT CLEAN ENERGY

Conclusions

1. There are now a multitude of recent studies that show that HV transmission is essential to:
   a) Decarbonization;
   b) Electrification;
   c) Reduced costs;
   d) Reliability enhancements;
   e) Market expansion;
   f) Curtailment mitigation.

2. The best technology for doing all the above is HVDC in a national super grid format. It saves the most money, reduces emissions more aggressively, increases resilience, enables electrification across the country and is technology agnostic from a generation perspective.

3. The issue with siting could be mitigated with ungrounding the transmission along transportation corridors (roads and railways). This can be done at similar costs to overhead. The network will need to be state-to-state connective to reap the greatest benefits

Thank You

Dr Christopher T M Clack
CEO Vibrant Clean Energy, LLC

Telephone: +1-720-668-6873
E-mail: christopher@vibrantcleanenergy.com
Website: VibrantCleanEnergy.com