#### On the road to dispatchable variable resources

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#### Who Are We: Vibrant Clean Energy (VCE<sup>®</sup>)





#### Purpose of Vibrant Clean Energy, LLC:

- Reduce the cost of electricity and help evolve economies to near zero emissions;
- Co-optimize transmission, generation, storage, and distributed resources;
- Increase the understanding of how Variable Generation impacts and alters the electricity grid and model it more accurately;
- Agnostically determine the least-cost portfolio of generation that will remove emissions from the economy;
- Determine the optimal mix of VG and other resources for efficient energy sectors;
- Help direct the transition of heating and transportation to electrification;
- License WIS:dom<sup>®</sup> optimization model and/or perform studies using the model;
- Ensure profits for energy companies with a modernized grid;
- Assist clients unlock and understand the potential of high VRE scenarios, as well as zero emission pathways.



#### **VRE Power Data Incorporated**

Wind

**Solar PV** 

VIBRANT CLEAN ENERGY



#### **Potential Siting Screening**





#### **VRE Power Data Incorporated**





#### Cost Projections Used ✓ NREL ATB 2019







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## **Objective & Optimization**

- ✓ Minimize the total annualized costs;
- ✓ Meet the prescribed load exactly each 5-minutes for all of the five years;
- ✓ Enforce self-discharge, charging losses, discharging losses, and state of charge metrics for the electric storage;
- Compute the amount of power able to be produced by scaling by the available land for construction;
- ✓ Determine the LCOE-baseload, \$/kW-baseload, reserves (hours), baseload capacity.



# Levelized Cost of Electricity (Baseload)







## **Range of LCOE for Baseload VREs**





## Capital Costs (\$/kW-baseload)





#### **Reserves Available (hours)**





## **Baseload Generation Capacity (MW)**





		Last .
Input widgets		
Solar costs, \$/kW (utility-scale single-axis tracking)	_	
0	550	1,200
Wind costs, \$/kW (100m hub height)		
0	1,000	2,000
Storage costs \$/kWh (energy)	0	
		400
Storage costs, \$/kW (power) 0 75		250
Ō		
Investment Tax Credit (%)	-	
0		30
Pick a county:		
CO I Weld		•















#### **Release Timeline**

- 1. The WIS:dom<sup>®</sup>-B results will be released and open source with all accompanying data (county-level).
- 2. VCE<sup>®</sup> will be writing a report based on the results.
- 3. The WIS:dom<sup>®</sup>-B will match any input load profile shapes.
- 4. The timeline is early 2020 (Q1 or Q2).



#### **Overview (2030)**





#### **Overview (2050)**





#### Conclusions

- 1. VRE hybrid systems coming down in cost, soon will be cheaper than anything else;
- 2. They will be more reliable than baseload generation from thermal because of the ability to hold "reserves" at all times;
- 3. The places with greatest resource do not have the demand to use it;
- HVDC transmission (underground) in a super grid is likely most economically efficient means to move the low-cost electricity over the continent;
- 5. These systems can become energy centers to produce  $e^-$ ,  $H_2$ ,  $CH_4$ ,  $NH_3$ ,  $CO_2$  capture.
- 6. As our electricity needs grow, there will be a greater acceptance that we should use all the energy we can with fewest resources, that is reduce curtailment via other technologies.



# Thank You

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