



# CYPRESS CREEK

RENEWABLES

Next Steps to Reduce Resource Uncertainty– Evan Riley

# About Cypress Creek Renewables



- Cypress Creek is a developer and long-term owner of solar power plants with development assets in markets across the United States.
- Our business focus is on 2-20 MW ground mount utility scale solar projects
- Cypress Creek completed 46 MW in 2014 with another 300 MW slated for completion in 2015.
- Cypress Creek has a pipe line of over 1 GW to be deployed in the next 24-36 months.



**First bond issuance back by revenue from a solar farm  
MEHC's 550 MW Plant: A Black & Veatch IE engagement**

## BLACK & VEATCH

- 10,000 person international engineering firm based in Overland Park, KS, founded in 1915.
- Majority of work in energy sector.
- Ranked *Number One in Power* by Engineering News-Record for last two years.
- Significant expertise in solar power:
  - Performance testing, technical due diligence, contract review, construction monitoring, detailed design, policy, integrated resource planning.
  - Independent Engineer for investors financing over 4000 MW of utility scale PV projects.
  - Independent Engineer for investors financing several giant distributed rooftop portfolios, 1000+ MW -- 170,000+ systems!
  - Technical adviser to multiple utilities purchasing utility scale PV plants and energy from PV plants



# Outline



## Solar Resource 101

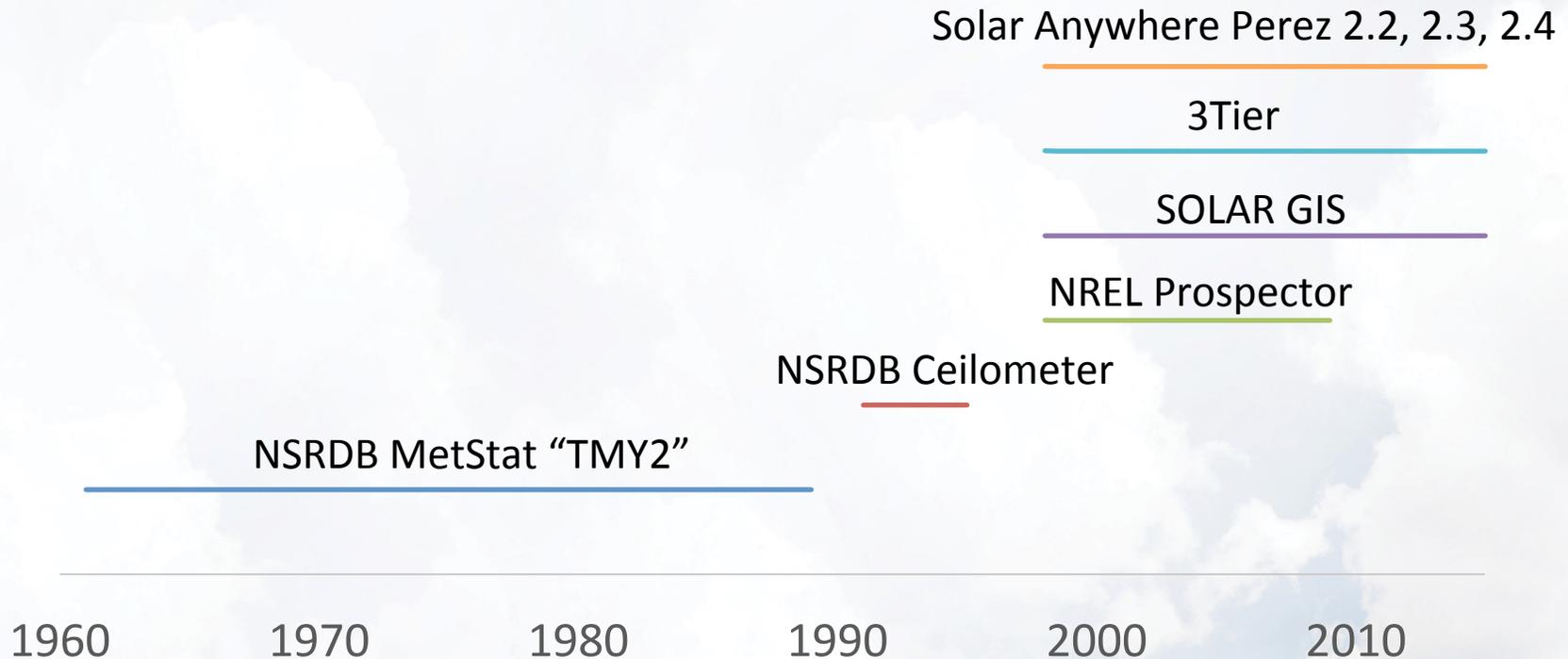
Reducing Uncertainty during Prospecting

Reducing Uncertainty during Operations

The Lowest Fruit - Transposition Uncertainty

Resource Uncertainty when Performance Testing

# A History of Solar Resource in the US



- "Measured" long term GHI models include diffuse, method to derive diffuse is often not transparent
- The trade off of long term record vs. more accurate data is not clear anymore
- Most important measure of uncertainty is annual residual of plane of array, which is rarely reported.

# A History of Solar Resource in the US



Typical Years:

- Typical Meteorological Year 2 (TMY2)
- Typical Meteorological Year 3 (TMY3)
- Typical Direct Normal Incident Year (TDY)
- Typical Global Horizontal Year (TGY)
- Wait..... why are we using typical years?

# A History of Solar Resource in the US



## Summary

1. There is no consistent method by which historic resource has been measured
2. Few datasets clearly communicate annual residuals of GHI or POA
3. All predominant datasets include global horizontal incident
4. All predominant datasets include diffuse
5. Few datasets explain how diffuse was derived
6. Most often only typical years are utilized – time of delivery!

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Solar Resource 101

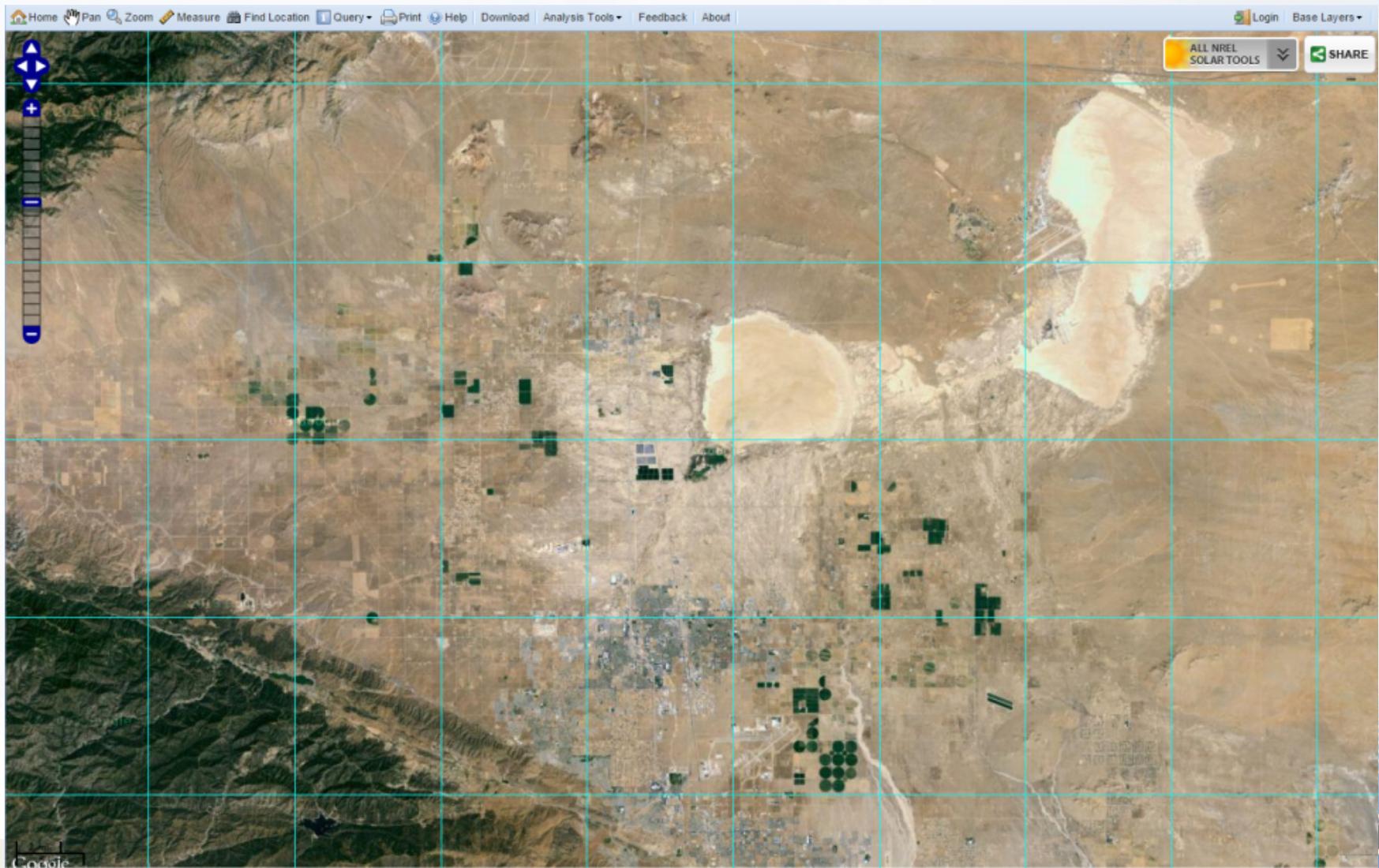
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# Reducing Uncertainty During Prospecting



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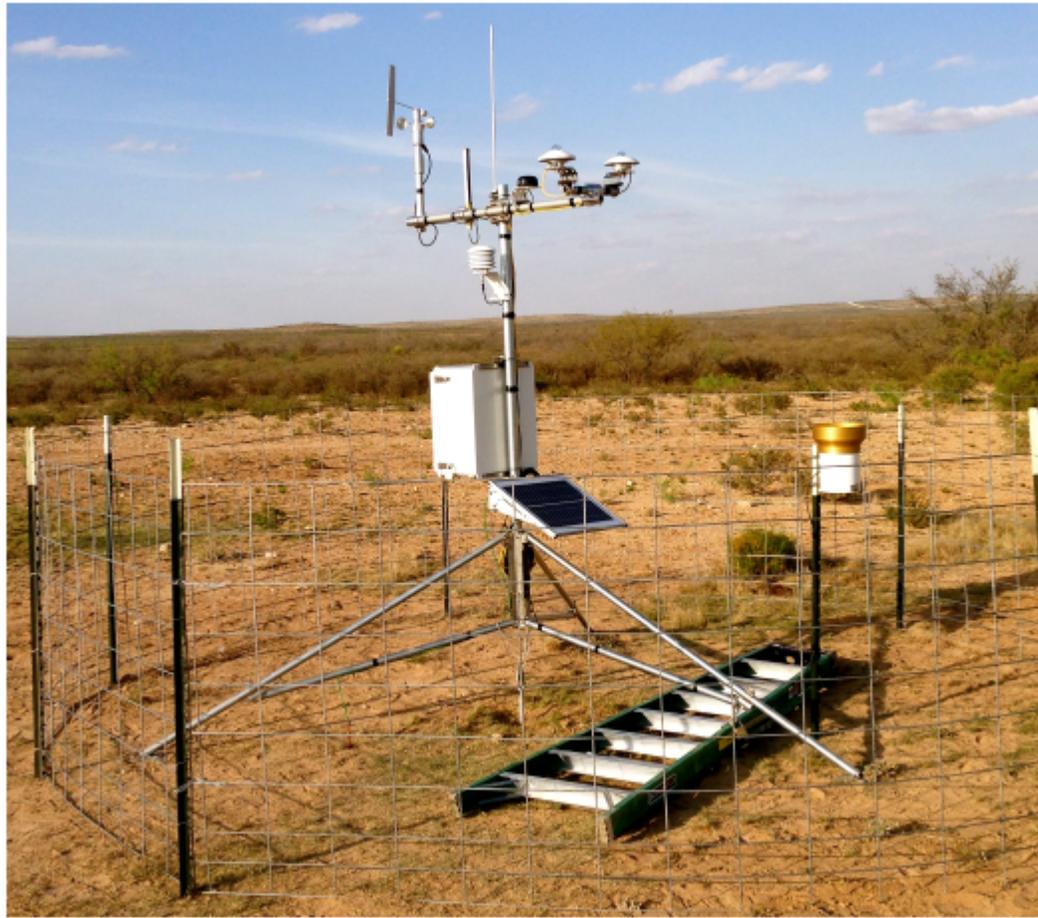
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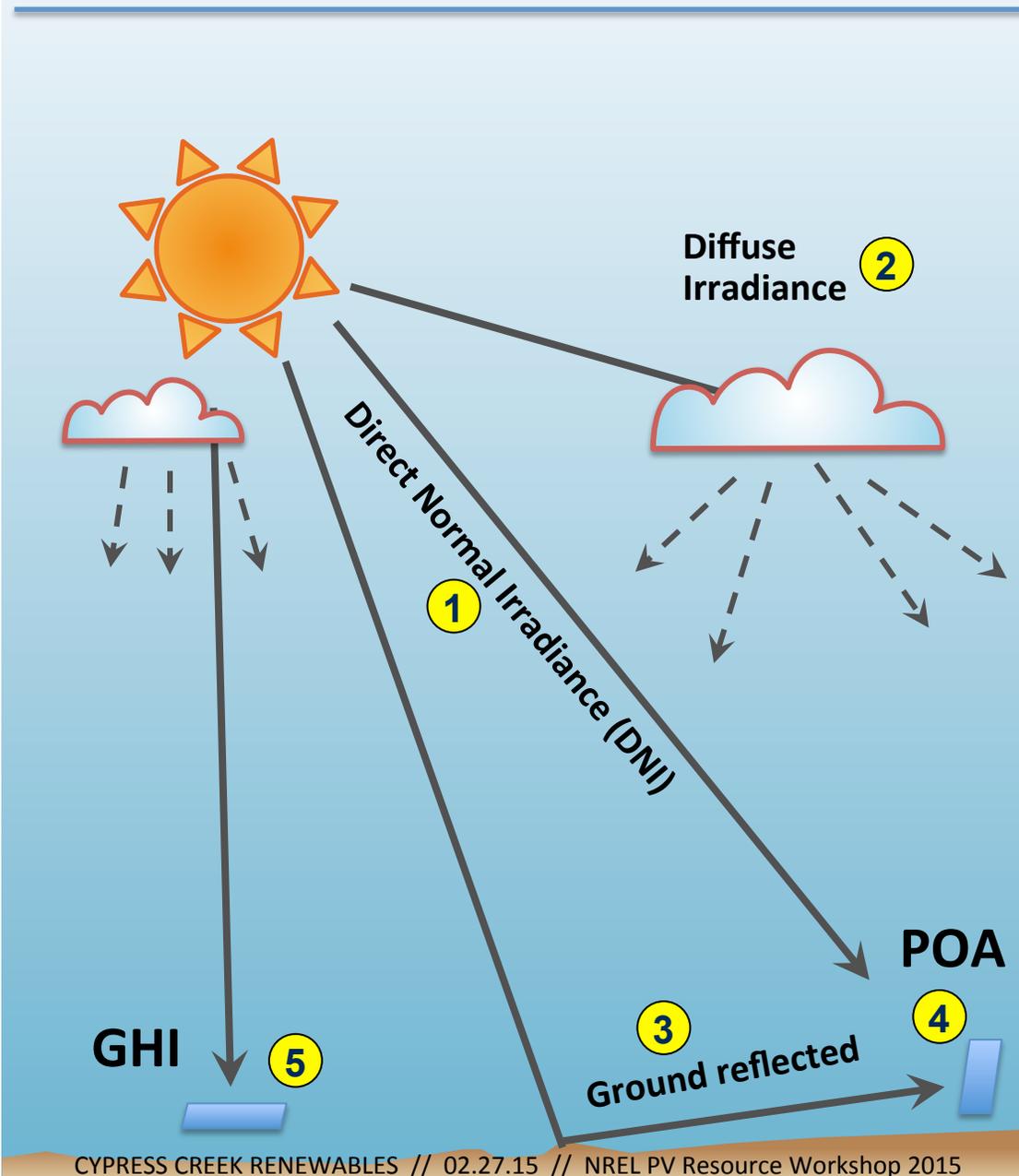
Reducing Uncertainty During Prospecting

Reducing Uncertainty by using Ground  
Measurements

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# Transposition – A Review

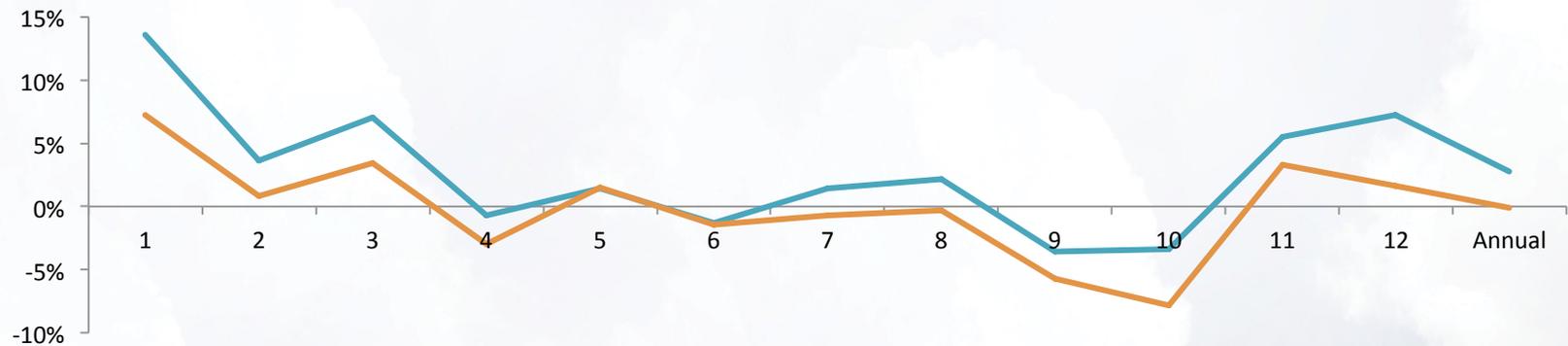


- 1 **Direct radiation:** incident solar radiation direct from the sun, without having been reflected or scattered, measured in the normal plane, (no cosine losses)
- 2 **Diffuse irradiance:** isotropic and forward scattered: incident solar radiation that has been scattered by aerosols such as water droplets or dust
- 3 **Ground Reflected:** incident solar reflected from the ground
- 4 **Plane of Array:** The sum of all incident resource. What is available for conversion.
- 5 **Global Horizontal Incident:** This is the measurement orientation of most historic long term datasets.

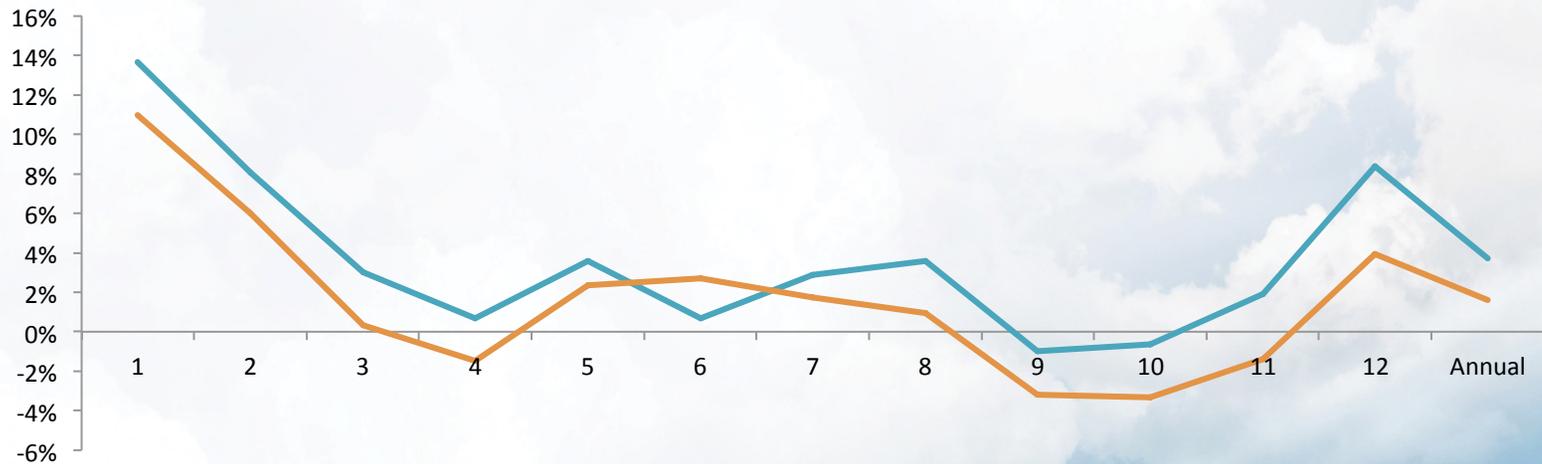
# Transposition Uncertainty



Courtesy of Tejas Tirumalai and Charith Tammineedi of Black & Veatch



— Pvsyst Perez Gain Residual: -2.8%      — Pvsyst Hay Gain Residual: -0.1%

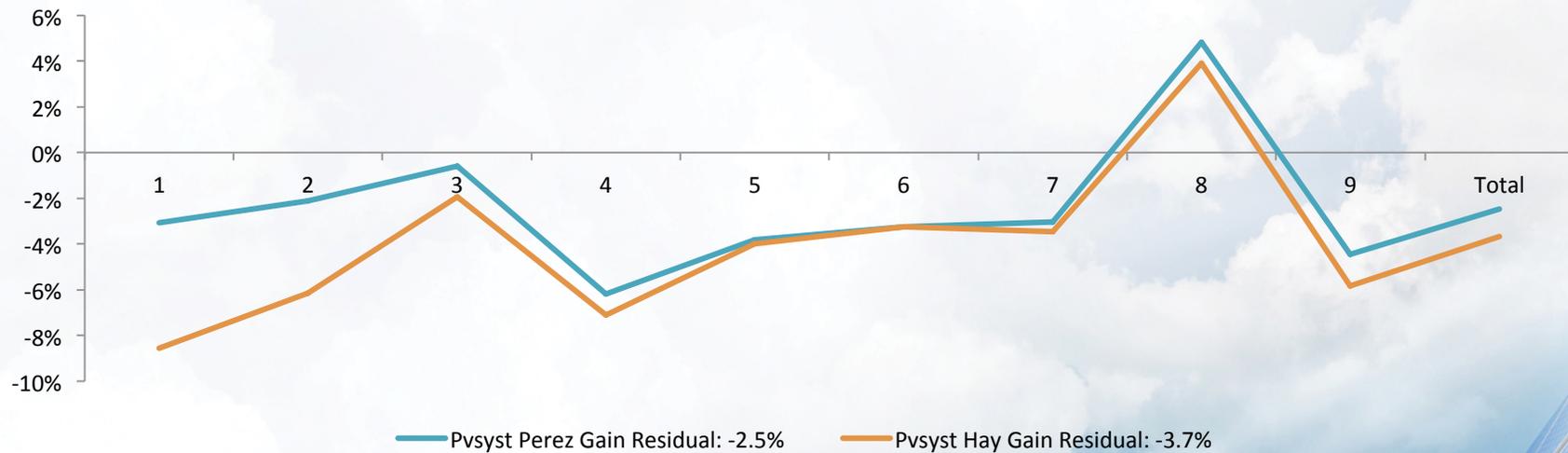
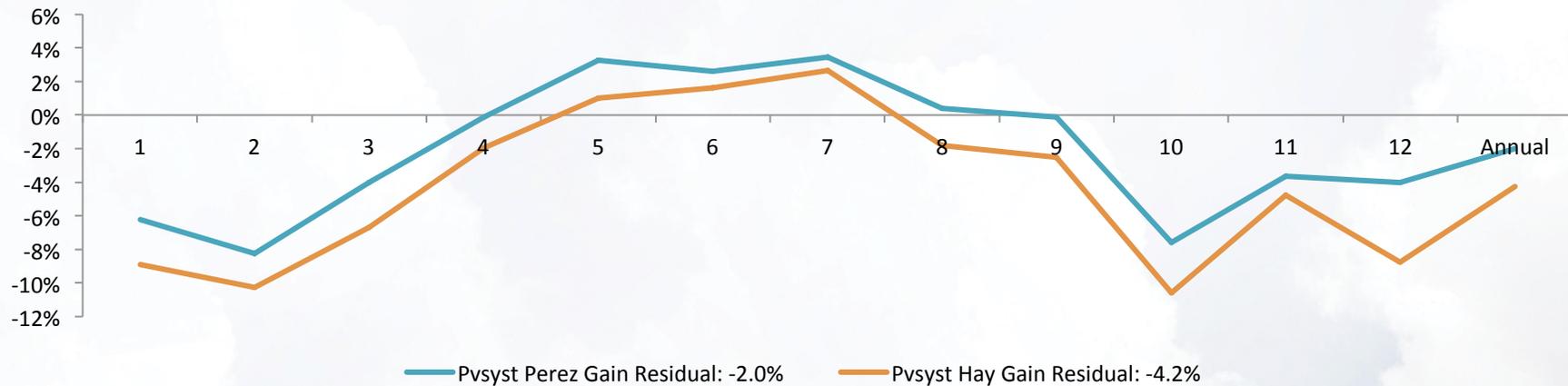


— Pvsyst Perez Gain Residual: 3.7%      — Pvsyst Hay Gain Residual: 1.6%

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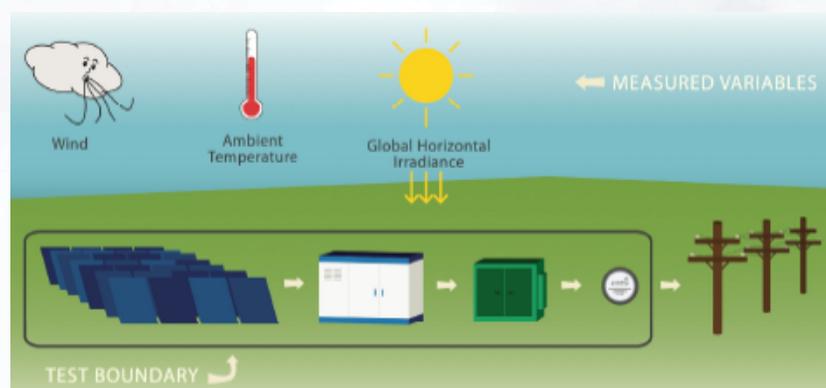
# Resource Uncertainty when Performance Testing



1. Nobody wants it
2. Everybody ends up taking it when it is not well understood, measured and parsed

Goal: Consistency with forward looking energy forecast using historic data

Challenges: Want most accurate measurement that is consistent with historic measurement methodology





Thank you!

