The design and construction challenges of utility scale PV plants

Abri Stegmann - July 2019

Scatec Solar
Improving our future™

Introduction

My background:

- Stellenbosch studies
- Scatec Solar
  - An Independent Power Producer who develops, designs, builds, owns and operates utility scale PV plants all around the world.
  - ~1 GW of PV in operation
  - Projects in South Africa, Rwanda, Egypt, Brazil, Honduras, Malaysia, Ukraine, Argentina, Mozambique, Jordan, soon Vietnam.
  - Targeting 3.5 GW by 2021

Today I'll speak about:

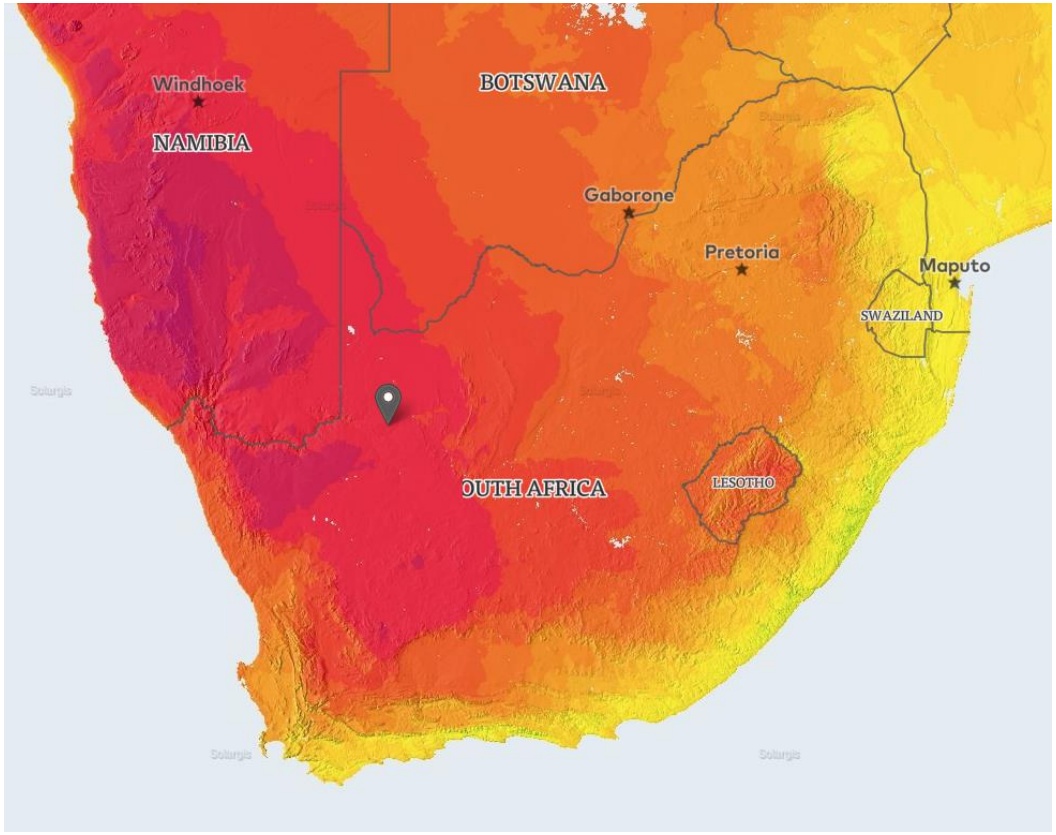
- The typical challenges that we face in the utility scale solar industry.
  - Design challenges
  - Construction challenges
  - Examples
  - 25 min presentation and 5 min for Q&A

Introduction

Snapshot of a Utility Scale PV Plant

REIPPP R4 Upington sites:

- 3 x 86 MWdc plants located in close proximity
- ~700 000 PV modules
- 1 020 000 km of DC cable
- 180 x 1.45 MW inverters
- 60 x 4.7 MW transformers
- 720 x single-axis tracker drive systems
- 130 000 tracker sub-structure posts
- 24 weather stations
- 30 000 SCADA signals
- 600 Ha of land covered



Introduction

Snapshot of a Utility Scale PV Plant

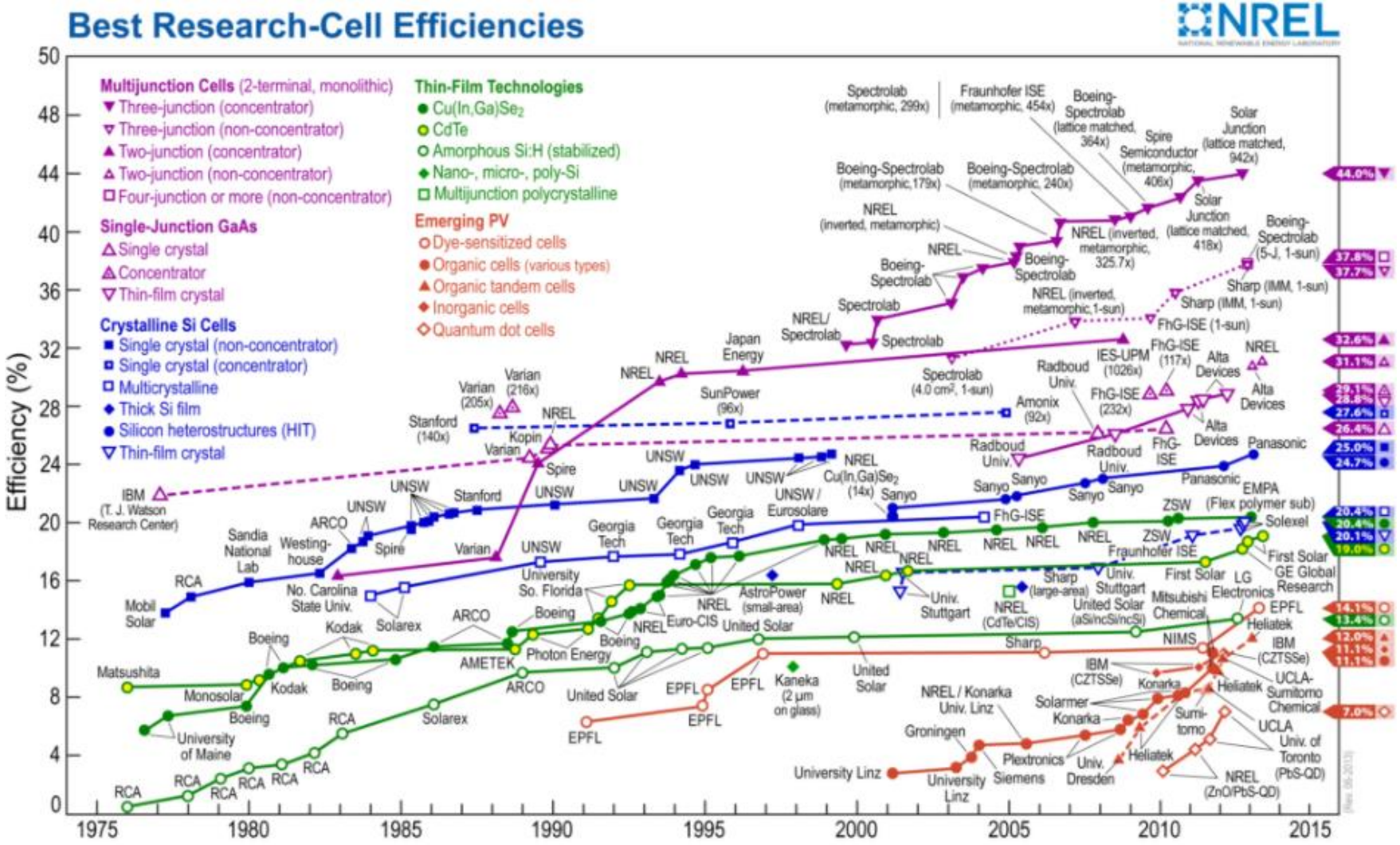
Introduction

Snapshot of a Utility Scale PV Plant

Design challenges

Design challenges

Constantly new technologies: PV Modules



Design challenges

Constantly new technologies: PV Modules

2013 – 240Wp modules
2019 – 410Wp modules

Ordering a module in 2013: Please give me a poly-Si 240Wp module

Ordering a module in 2019: Please give me a mono-Si, PERC, Bi-facial, Double glass, 1 500Vdc rated module with an anti-reflective coating, light reflective film, half cut cell, triple busbar, 1.2m long 4mm^2 string cable with MC4-compatable cable terminations. Don't even specify the watt-class…

Manufacturers have so many options that it is difficult to compare them to each other.

Manufacturer: What do you want? Me: What do you have? Manufacturer: What do you need? Me: I don't know what I need. What do you offer? Manufacturer: We offer whatever you require.

Design challenges

Constantly new technologies: Inverters

2013 – up to 10 kW String and 850 kW Central inverters
2019 – up to 250 kW String and 5 MW Central inverters

Central vs string inverters, battery storage, plant control, DC systems, etc.

Design challenges

Constantly new technologies: Misc.

Floating solar systems
Bifacial systems
Hybrid systems
Etc.

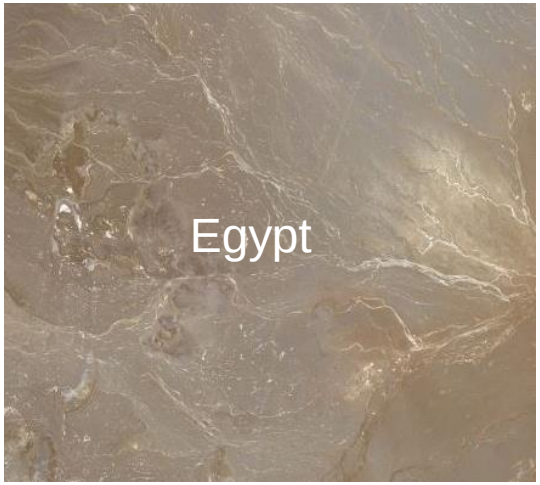
Design challenges

Difficult locations and environments

We've either built or is in the process of designing plants in:

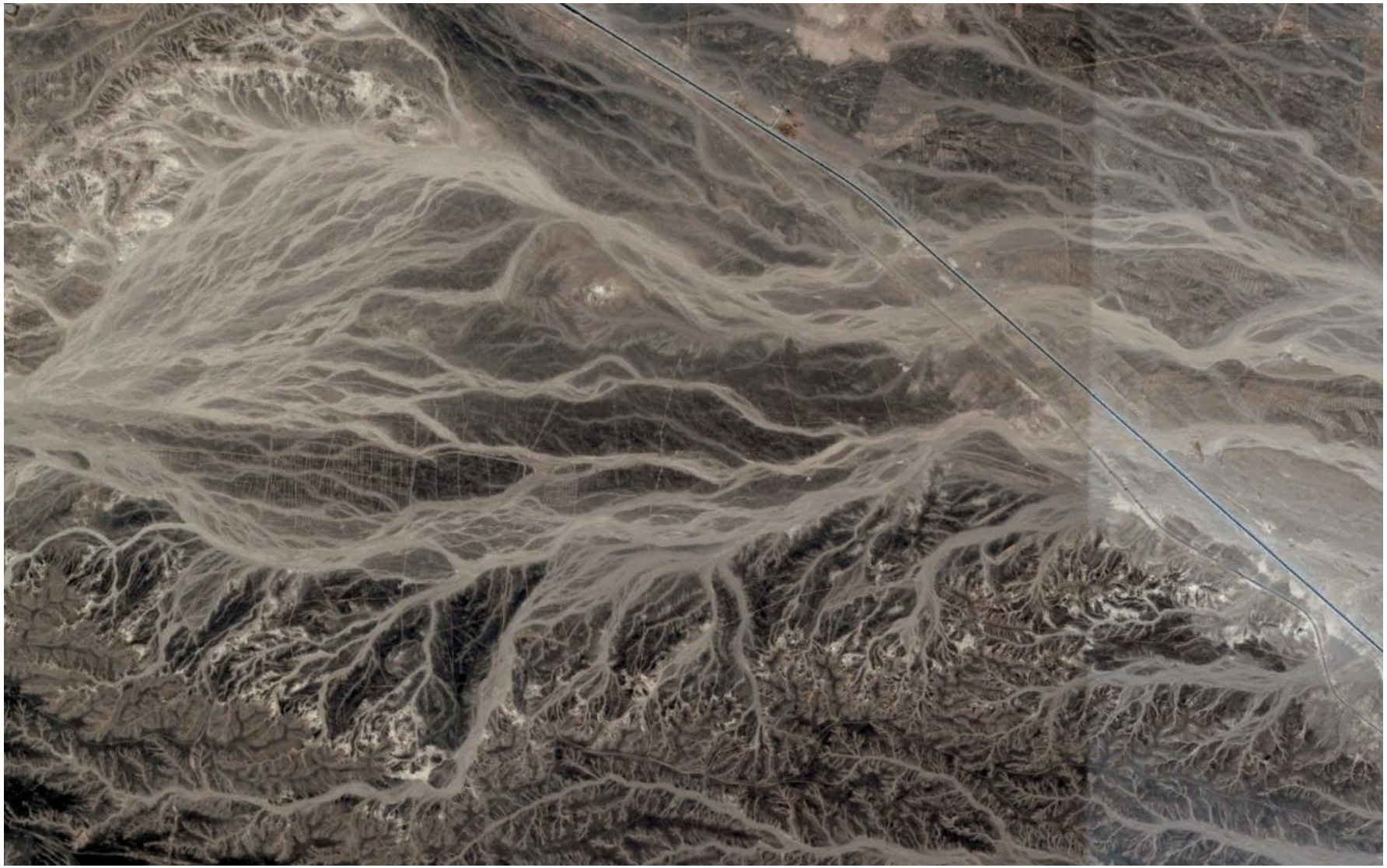
- Bangladesh: Swamp land – Waterlogged areas
- Egypt: Desert – Dry, remote, hot and dusty
- Brazil: Jungle – High vegetation growth, environmentally sensitive
- Malaysia: Monsoon – High rainfall >2.1 m/annum
- Ukraine: Snowfall and sub-zero temperatures
- Rwanda: Remote, weak grid, high lightning area

- South Africa's "Droë" Karoo



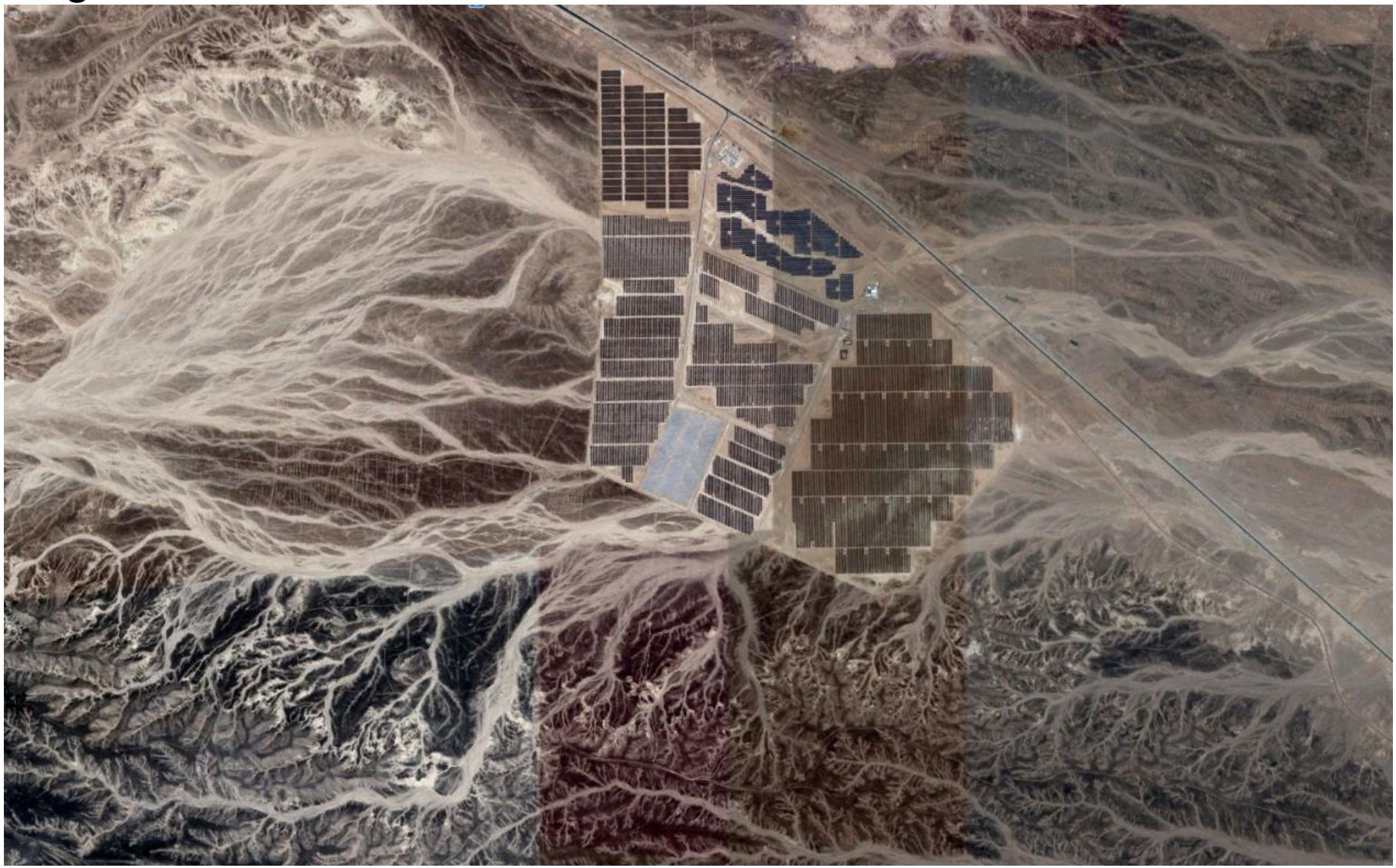
Design challenges

Drainage



Design challenges

Drainage



Design challenges

Difficult locations and environments

Often very limited or bad quality information from site. To assess a potential project site, we have to know as a minimum:

- Geotechnical conditions (sub-soil condition, soil types, earth quakes, etc)
- Environmental conditions (rainfall, irradiation, wind speed, snow, dust, etc)
- Site topography (accurate topo needed to assess shading and sub-structure)
- Grid condition (spare capacity, extensions planned, grid impact study)
- Local legislation, contracts, standards, etc.
- Local expertise (companies, labour, etc)
- Specific local requirements (eg. airports, radio interference locations, etc.)

Design challenges

Customers

Utilities:
- Don’t know how solar works
- Resistant to change and competition
- Inadequate or vague grid codes
- Unstable or unreliable grids
- Old infrastructure and poor maintenance

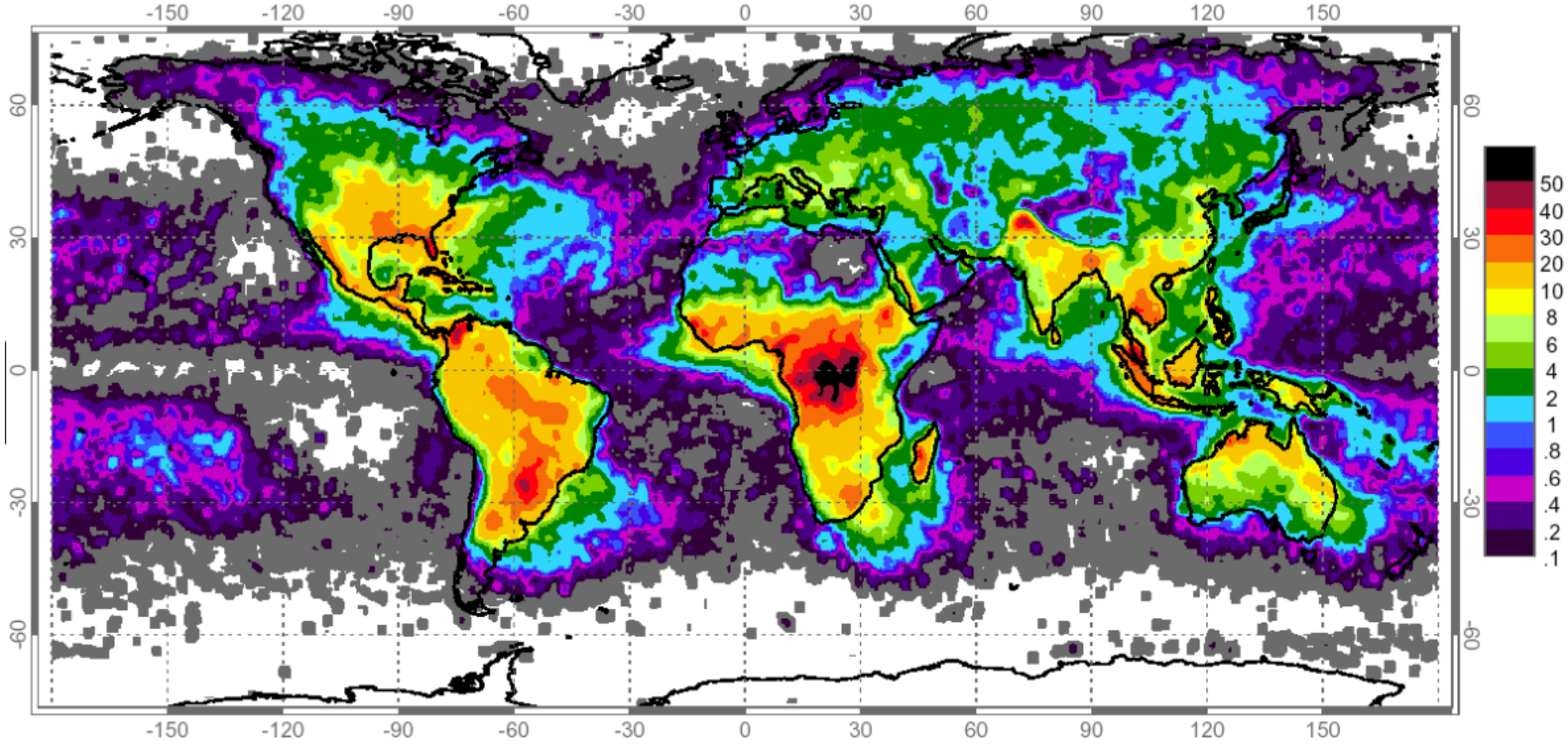
Mines:
- Don’t know their own systems
- Don’t know what they require

Private PPAs:
- Islanded systems or reliance on utilities

Design challenges

Lightning protection for large PV plants

Standards have not kept up with developments in PV. No single clear answer on how to adequately protect free field PV systems, only guidelines.



Construction challenges

Construction challenges

Logistics challenges:

- During peak construction about 60 interlink trucks deliver material to site very day for 2-3 months.
- Warehouse management system has to be in place (FIFO/FILO systems)
- Need the correct materials to arrive at the correct time and location (JIT system)
- Large quantities of people to manage (up to 1200 people on site)
- Fast training programs to equip unskilled labour people
- Communication on site (remote, no cellular network, no radios allowed)

Planning challenges:

- Large quantities of unskilled labour, sometimes constantly changing
- Short construction timelines
- Accurate reporting back from construction personnel
- Multiple contractors and equipment suppliers involved

Construction challenges

Multiple processes running in parallel. Effectively tracking progress is important!

Construction challenges

Quality challenges:

- How to keep a standard of quality across a large site, multiple teams, etc.

Examples:

- Incorrect survey increases bulk earth work quantities by 800 000m^3
- Incorrect fastening of cables resulted in 1 000 000 cable tie replacements
- Incorrect torqueing of bolts results in 3000 modules' cracked glass

Construction challenges

PV construction is handled similarly to a manufacturing operation:

First make a prototype, then automate production.

Small efficiently improvements mean large project time impacts.

Example:

- 1 minute to mount a PV module
- Mounting 700 000 modules would take ~12 weeks*

Shaving off 5 seconds off of the installation time:

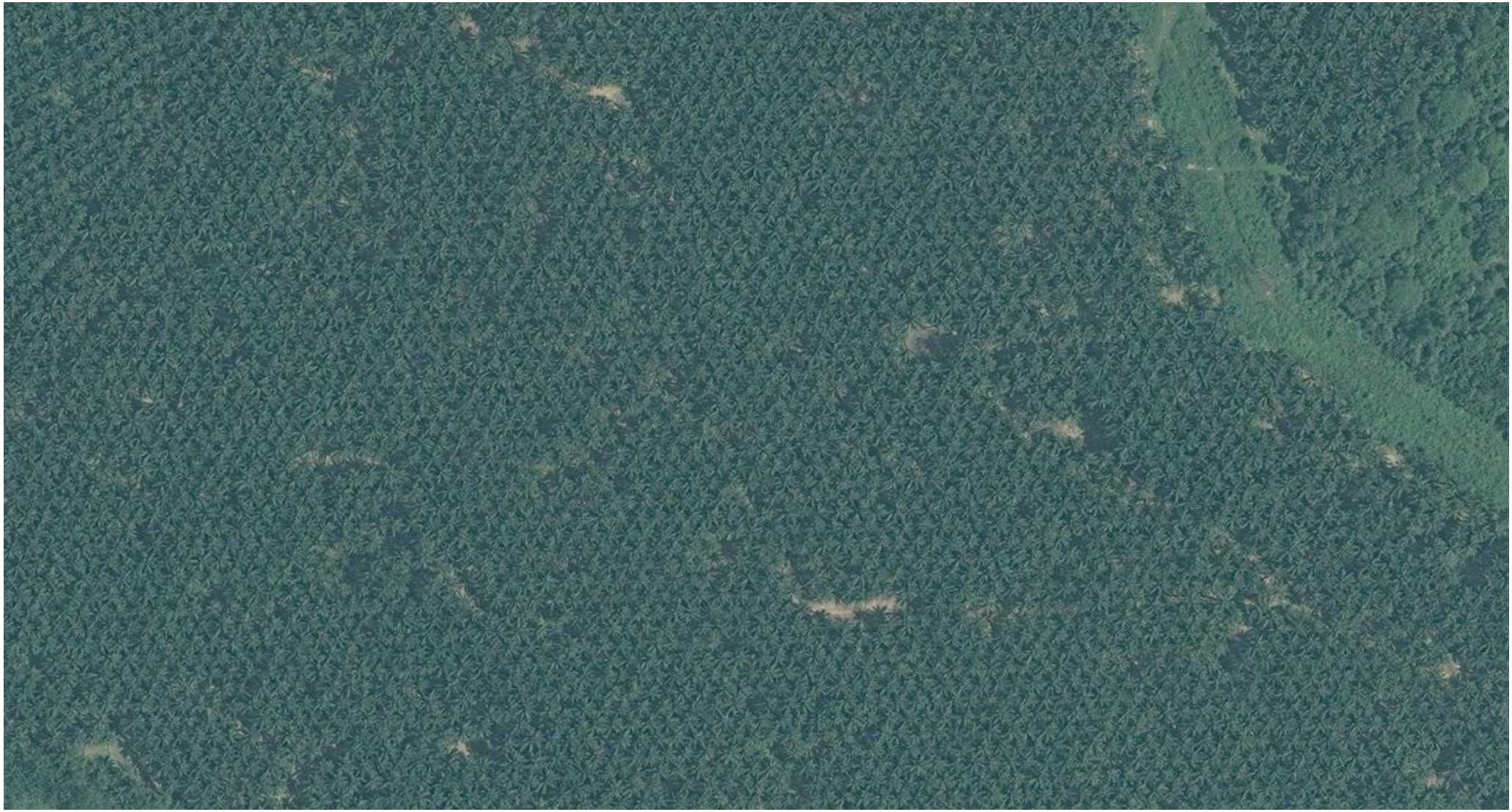
- 55 seconds to mount a PV module
- Mounting 700 000 modules would take ~11 weeks*

Shaving 1 week off installation time. This could be the difference between using a cordless drill versus a spanner to fasten the module's holding bolts.

*Assuming 8 hour work day, 6 day work week, 20 x 2 person teams

Construction challenges

Unique construction tasks: Removing 4 000 palm oil trees.



Construction challenges

Unique construction tasks: Fast growing vegetation

Construction challenges

Unique construction tasks: Complex civil works (water, sand, organic material)

66 MWp plant in Malaysia

Construction challenges

Unique construction tasks: Hard ground

Construction challenges

Unique construction tasks: Irregular shapes

Construction challenges

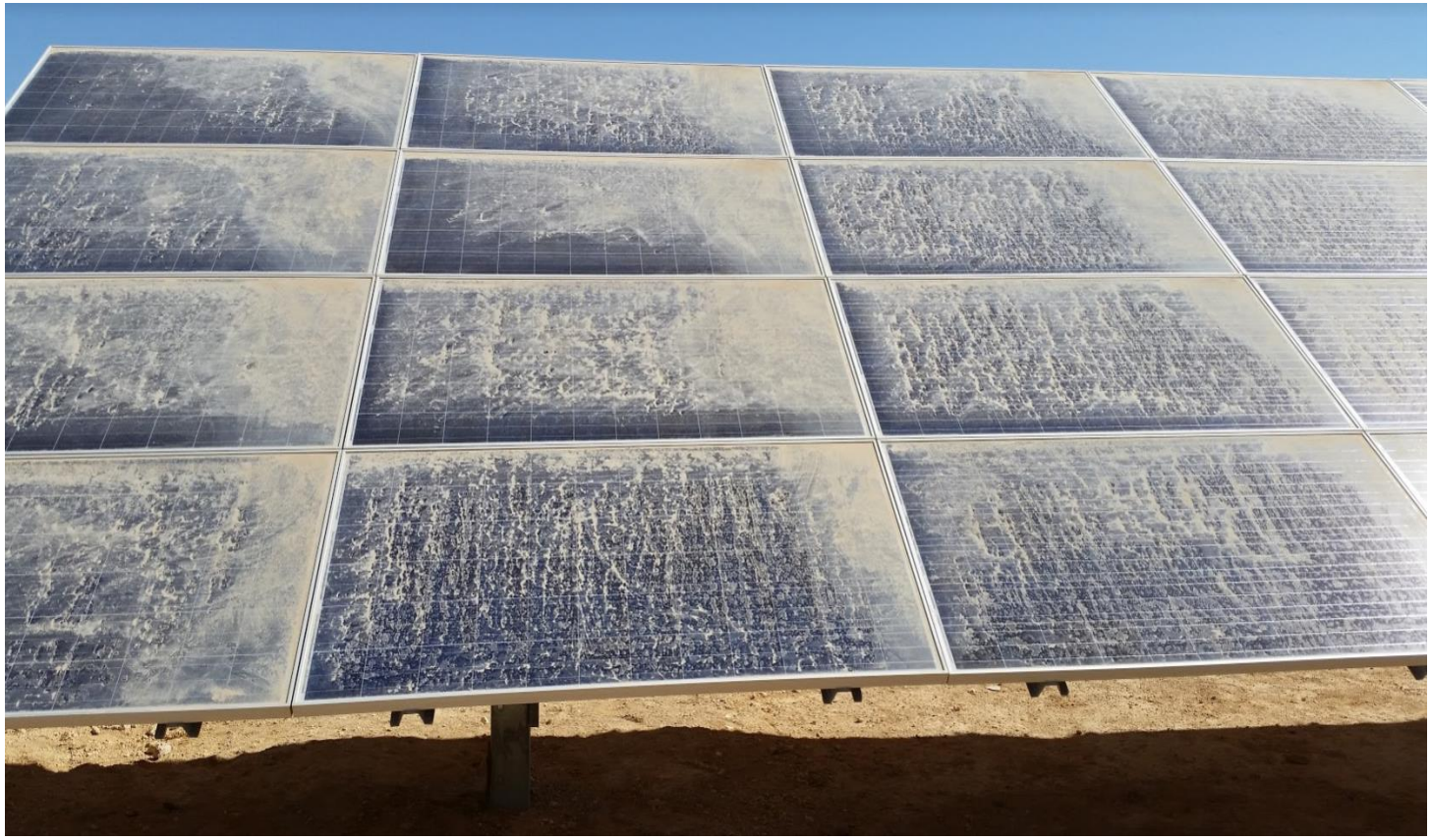
Commissioning and plant testing:

- Multiple parties on site during commissioning
- 1000V vs 1500Vdc system change – Testing technology behind
- Some tests are weather dependent.
- Testing with a utility can be “painful” but is unavoidable
- Explaining to stakeholders how the plant operates and that it is healthy

- My personal favorite:
  - Explaining to stakeholders what reactive power is

Construction challenges

Unique construction tasks: Soiling of PV modules



Conclusion

PV industry has many challenges,
but they all can be overcome.

Thank you

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The End

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Questions?

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