“PVRessQ!”
PV Module Failures Observed in the Field

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Fukushima Nuclear Power Plant Accident and PV

Our government and
nuclear scientists had de
nuclear power plants were safe
and economical for long time.
But people have realized that
the story was a **"myth"**.

Now expectations for PV
have been drastically
increasing
after the accident of
Fukushima Nuclear Power Plant.

Are there any "myths" in PV market? How about "reliability" ?
In Japan, people religiously believe in reliability of PV.

General understandings of PV in Japan

The government and
many PV manufacturers/installers say…

"PV module has **over 20-year expected lifetime** in average."

"PV system is **easy-maintenance** or almost **no-maintenance**."

PV manufacturers and installers have
no legal obligation to check PV systems
with less than 50kW capacity.

They just **recommend** periodic inspection
every four year to PV users.

They provide **10-year warranty**
on **each PV module** for nominal power output.
(Some new comers do 25-year warranty.)

“PVRessQ!” activity

(**PV** – **Re**liable, **S**afe and **S**ustainable **Q**uality**!**)

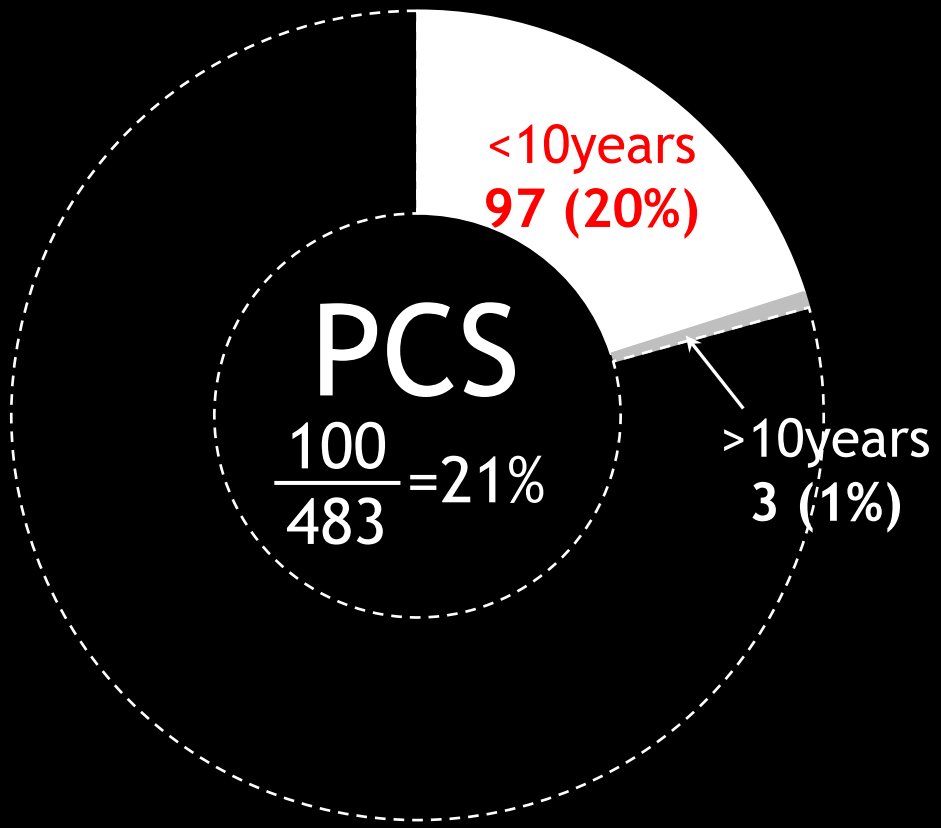
- Started in 2006.
- One from AIST (Kato), others from local installer (not manufacturer)
- Independent research activity supported by donations from the people (always poor because no budget from METI nor AIST)
- Main task
  - Field survey on faults/failures of residential PV systems in operation
  - Statistical survey on PV system reliability
- Goal
  - Proposal of practical maintenance techniques to detect all PV system failures (technical issue)
  - Proposal of inspection system for PV system (social issue)

A statistical survey for PV-user records

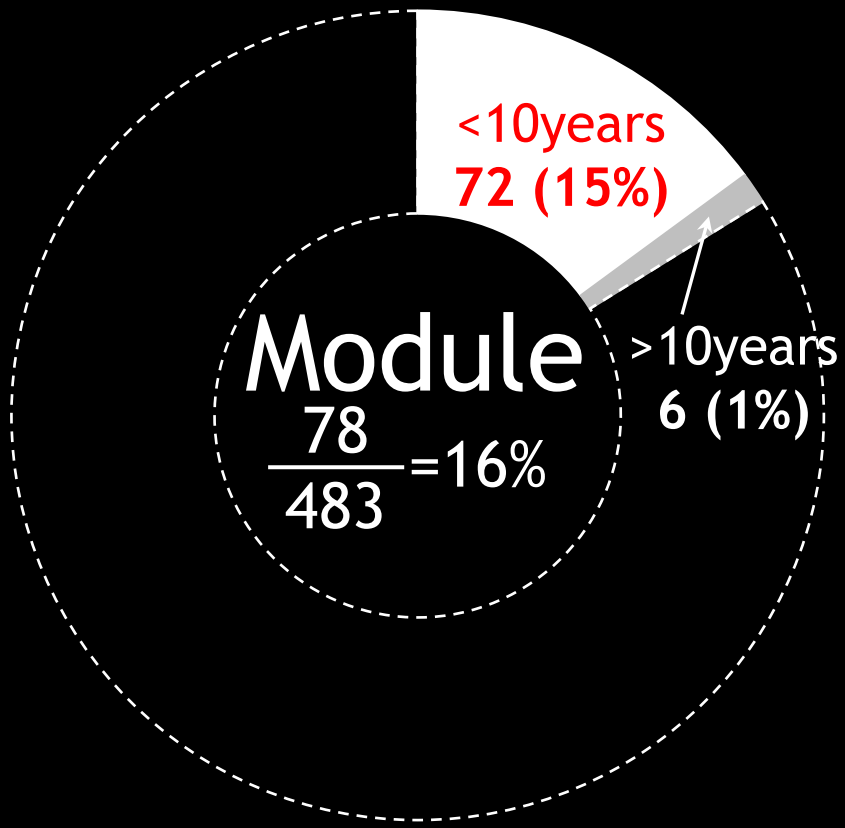
483 residential PV systems installed in 1993-2006

P RessQ!

Experienced repair/replacement of PCS

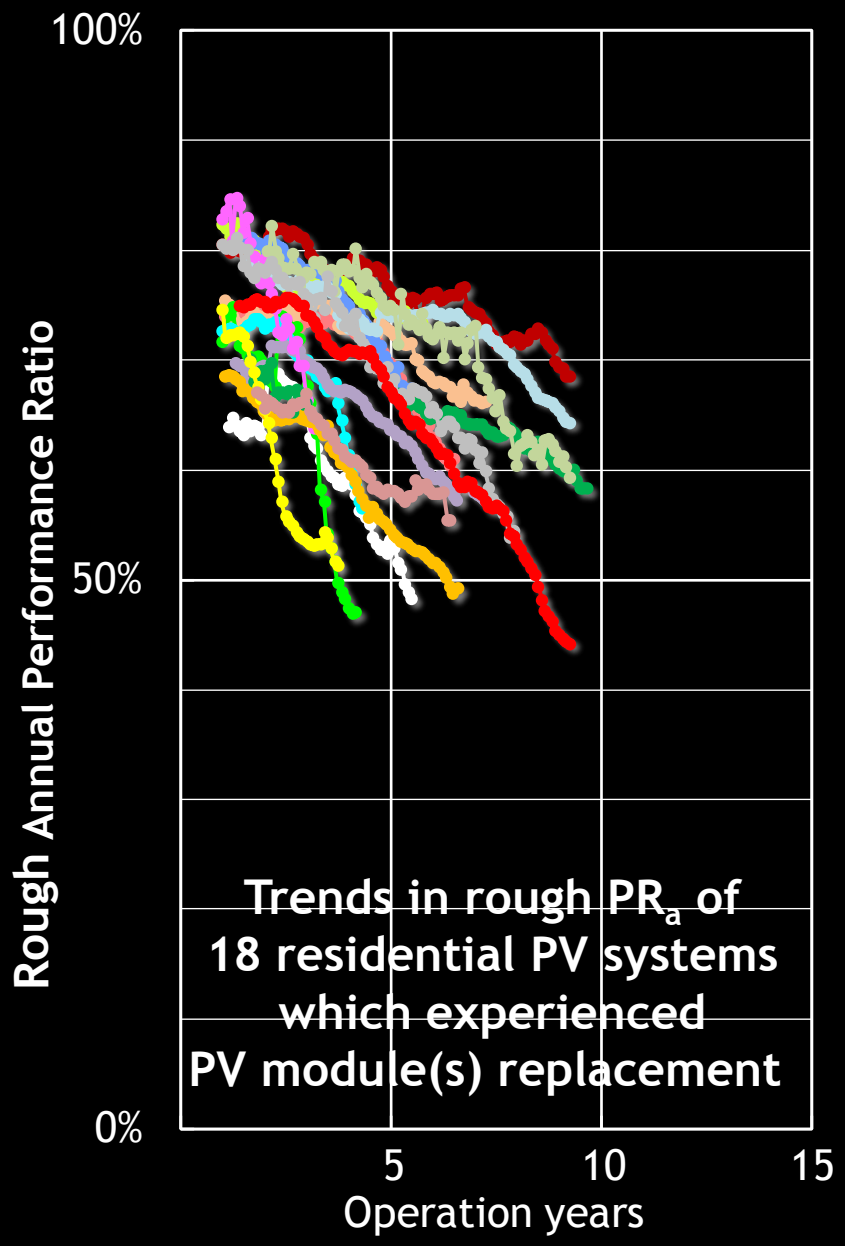


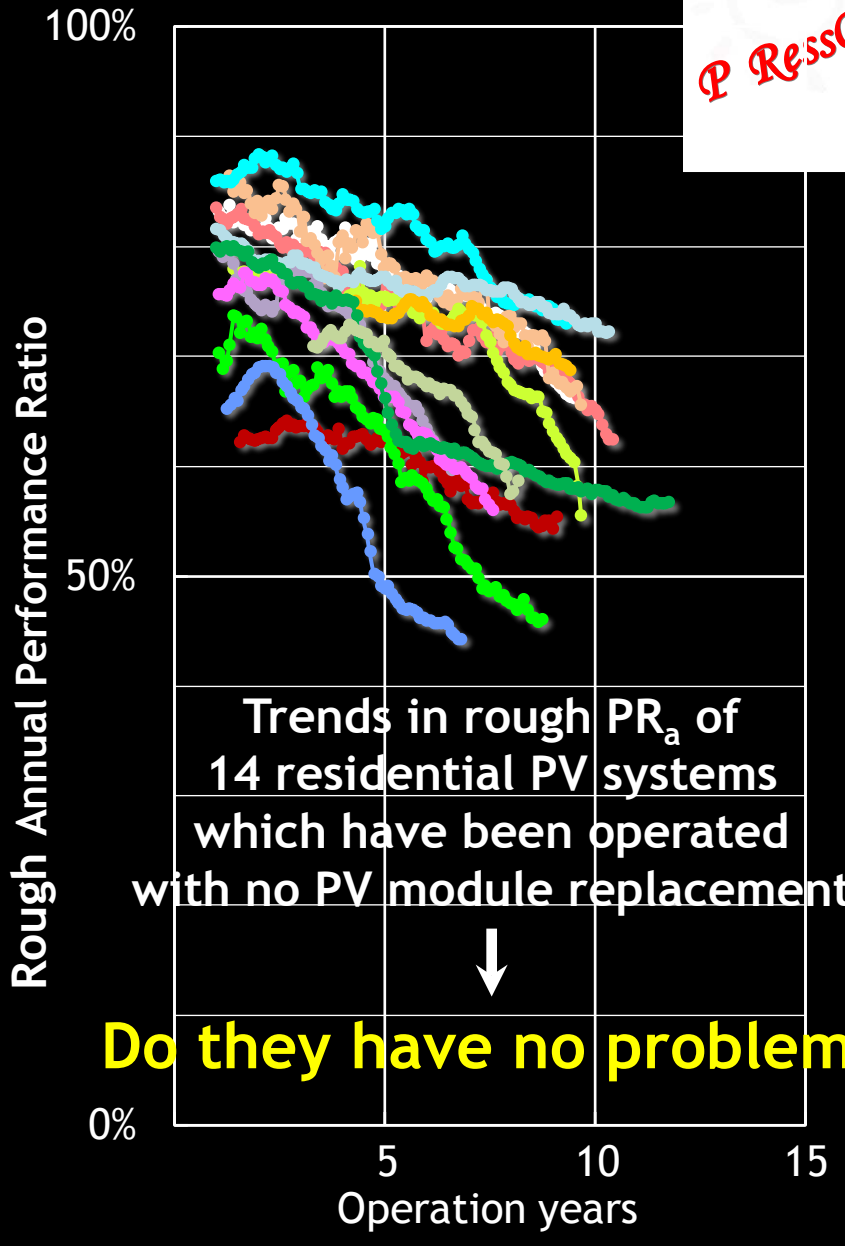
Experienced whole/partial replacement of PV modules



Is PV System Reliable for users ?

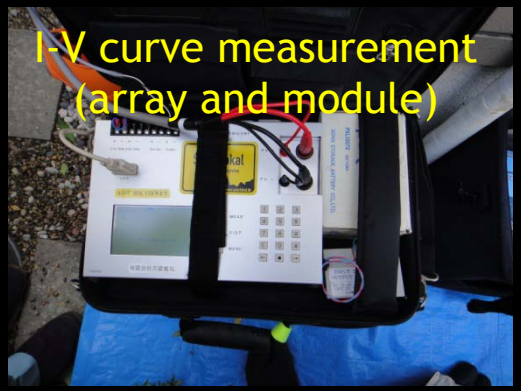
Trends in rough annual performance ratio(PR_a)





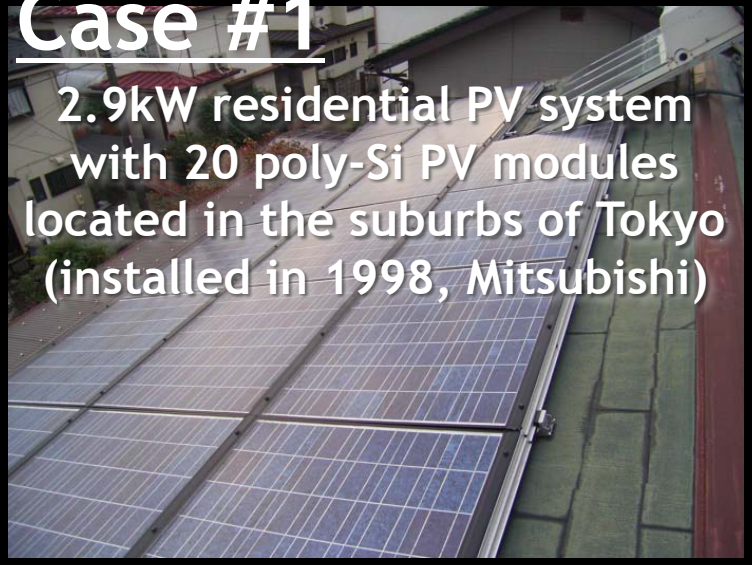
Field Survey for Residential PV Systems

32 residential PV systems have been surveyed so far.

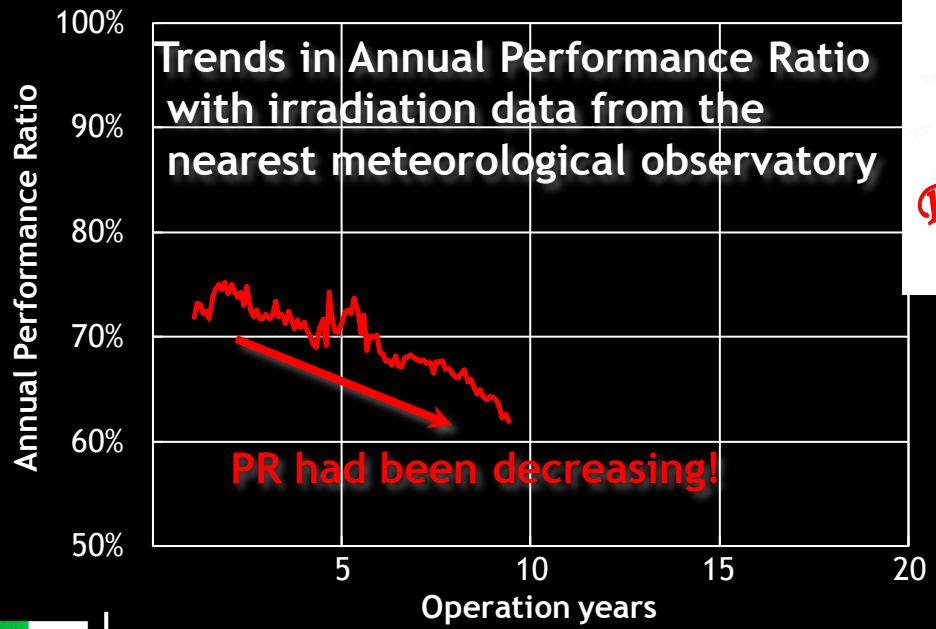


Many failures have been found in PV modules!

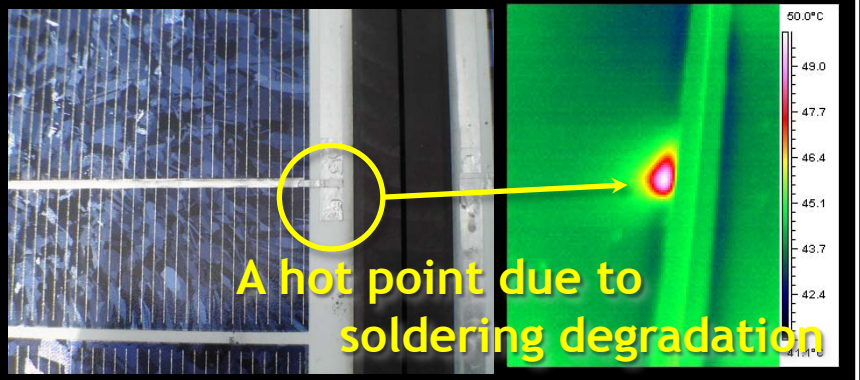
Case #1



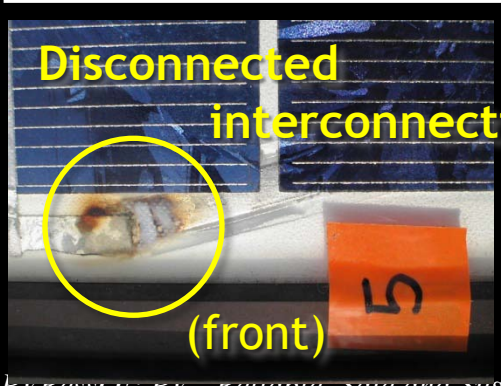
2.9kW residential PV system with 20 poly-Si PV modules located in the suburbs of Tokyo (installed in 1998, Mitsubishi)

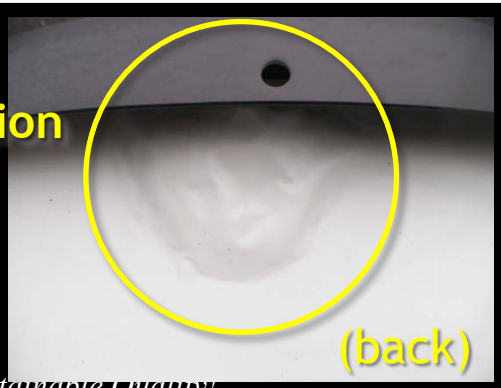


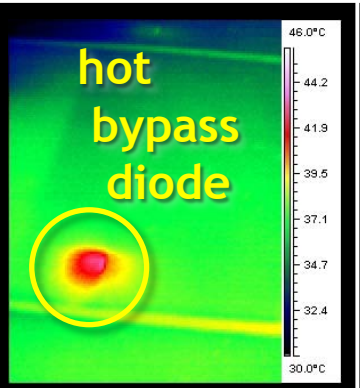
P RessQ!

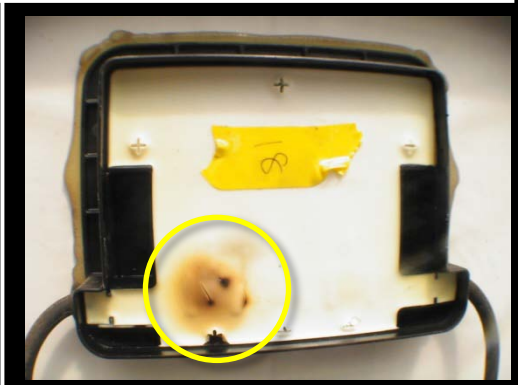


- Inspection by the installer reported "No roblem".
- The survey by PVRessQ! Judged that 10 of 20 PV modules had serious failures.
- The 10 modules were replaced by the manufacturer with no charge in the end.
- The others were not (the manufacturer said they would never have any problems.)



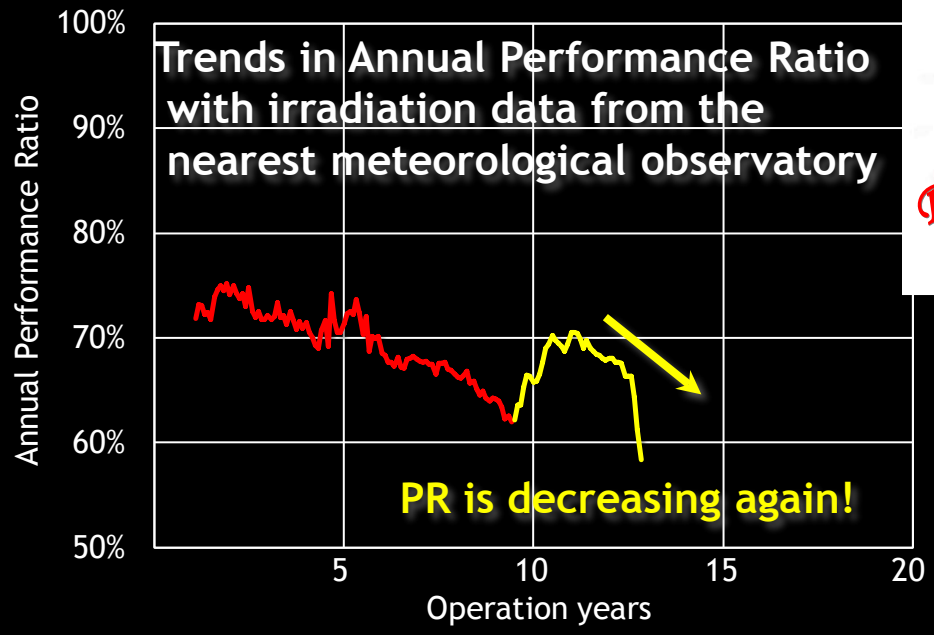


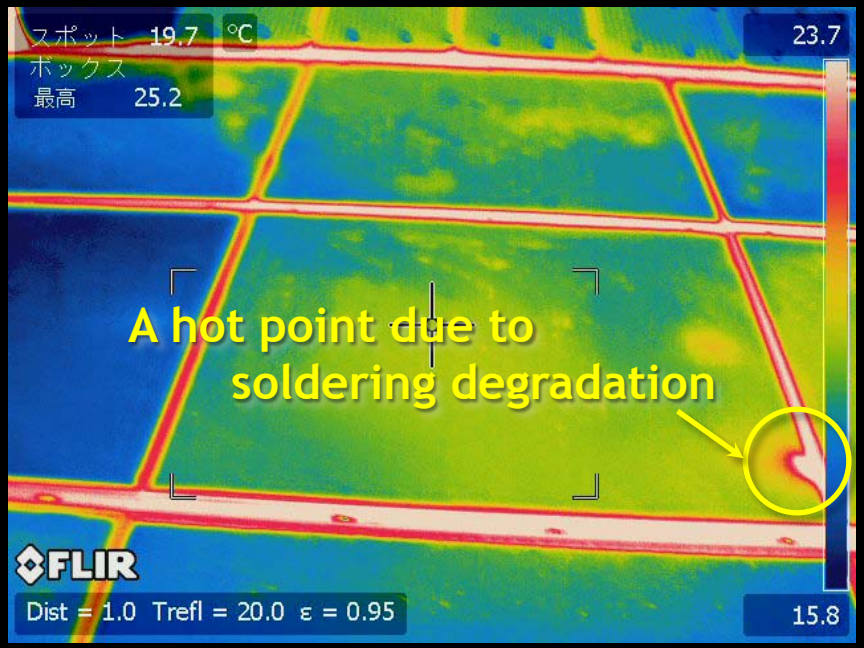


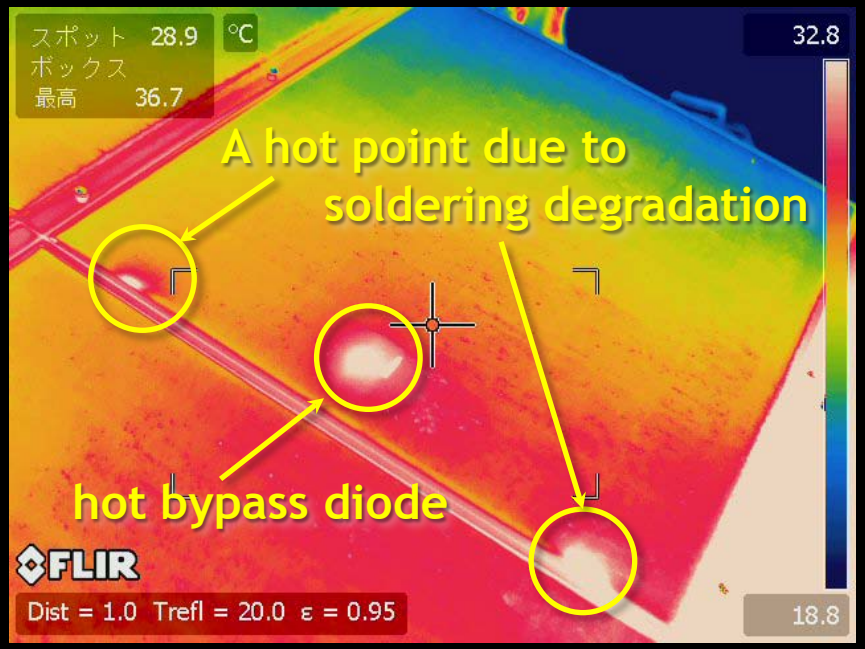


…and three years later

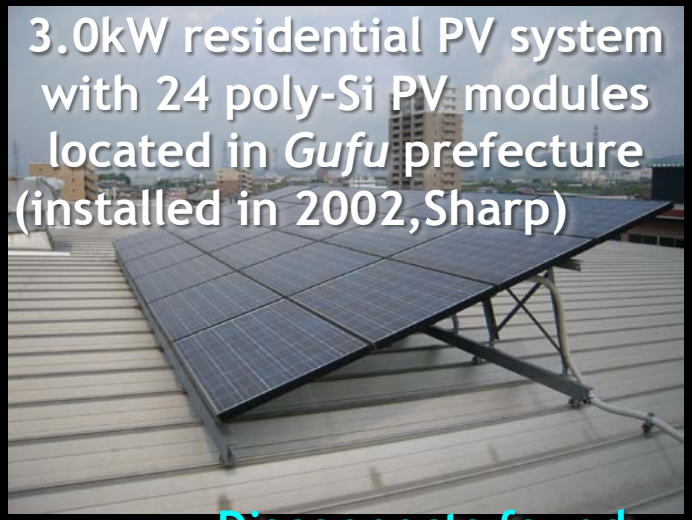
- The same kind of failure as before was found in old 5 modules.
- One of them could not generate voltage due to disconnection of internal circuit.
- The manufacturer replaced all the old modules with no charge, though their warranty period (10 years) was over

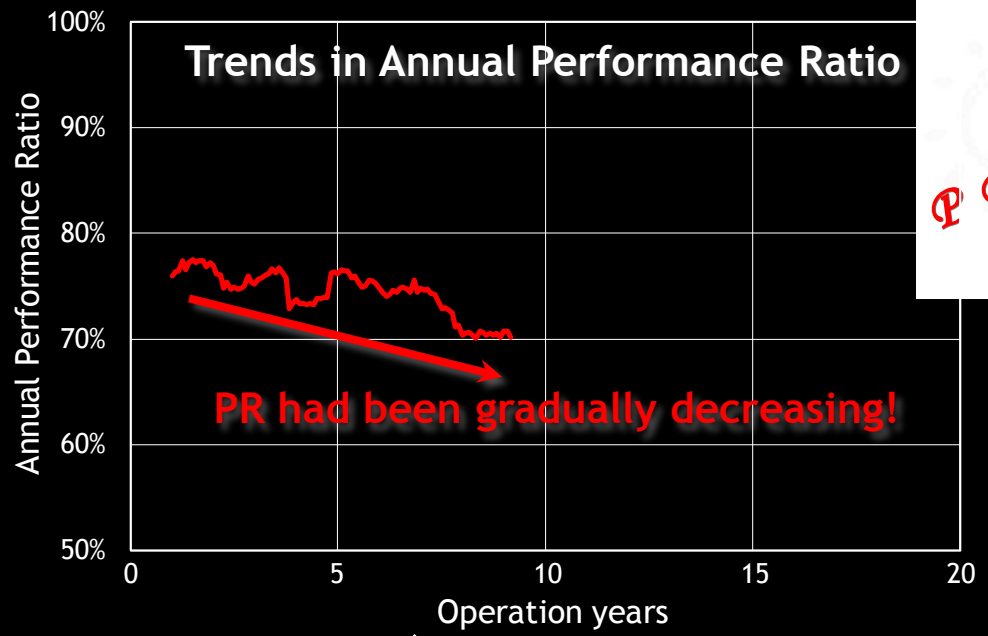


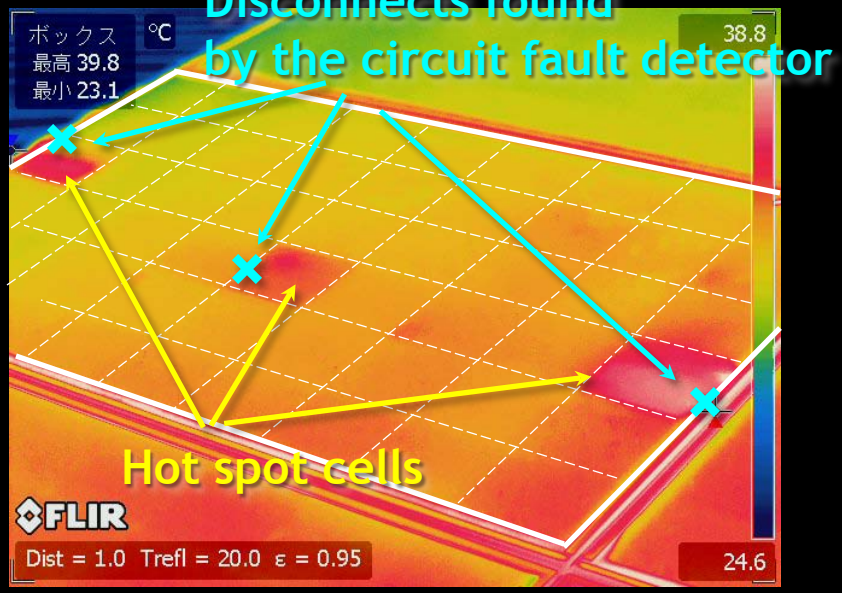


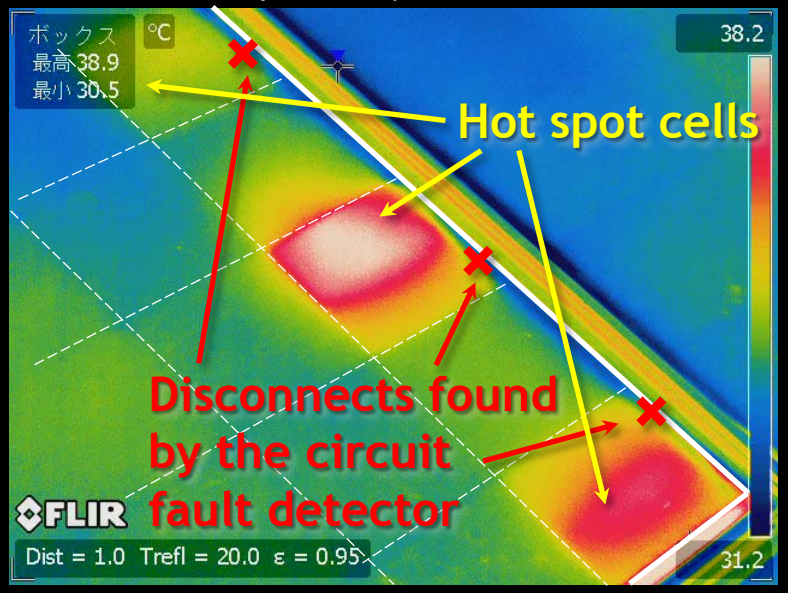


Case #2



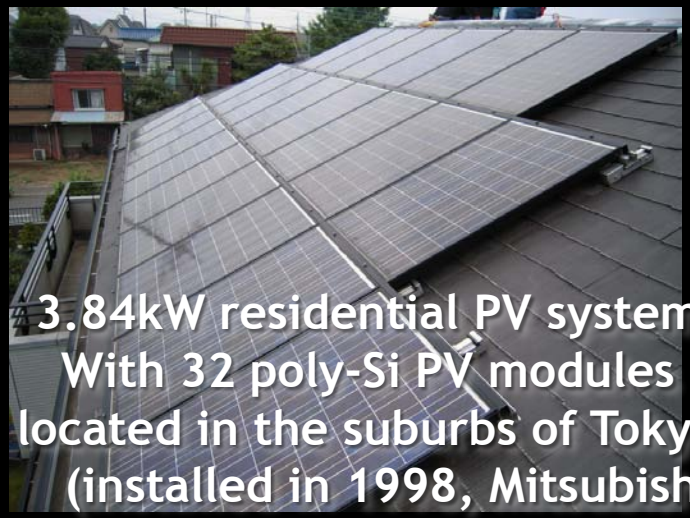




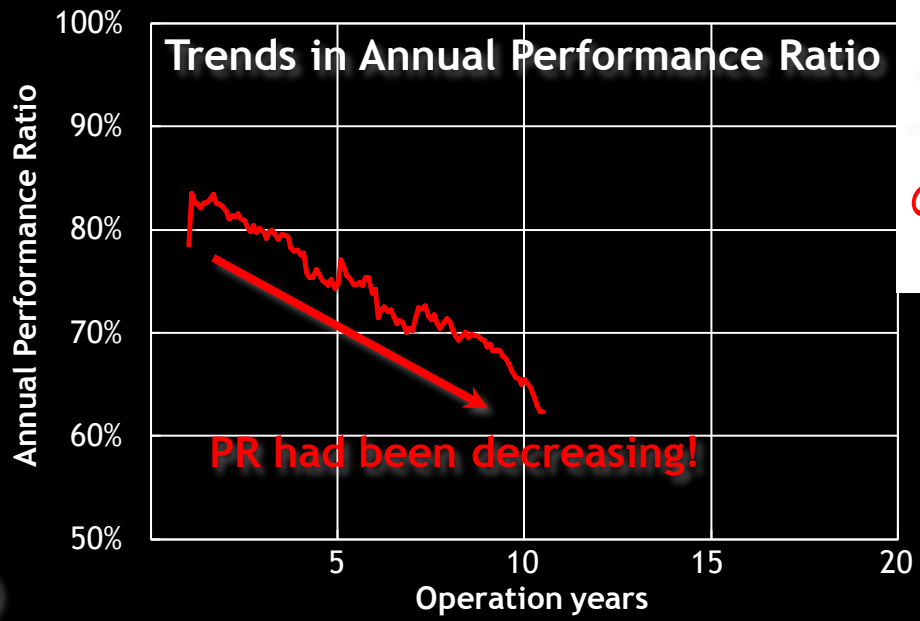


- PVRessQ! survey found failures in many PV modules.
- Discussion about module replacement is in preparation.

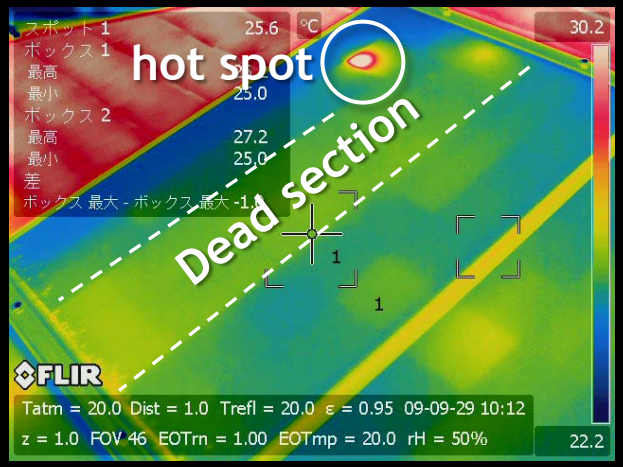
Case #3

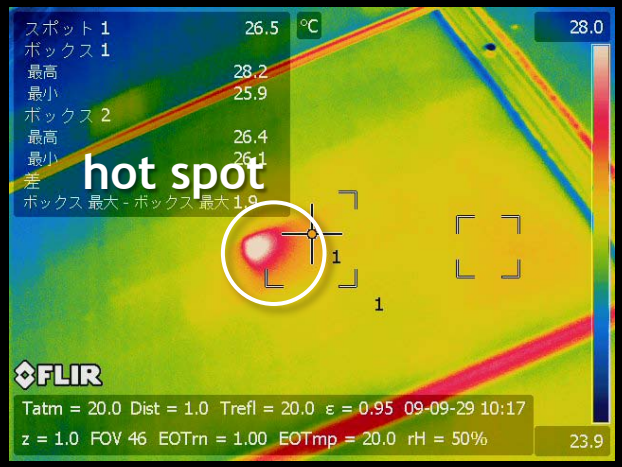


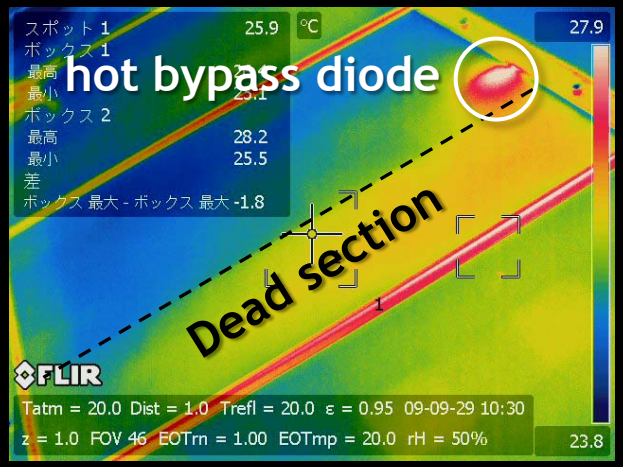
3.84kW residential PV system
With 32 poly-Si PV modules
located in the suburbs of Tokyo
(installed in 1998, Mitsubishi)



P RessQ!

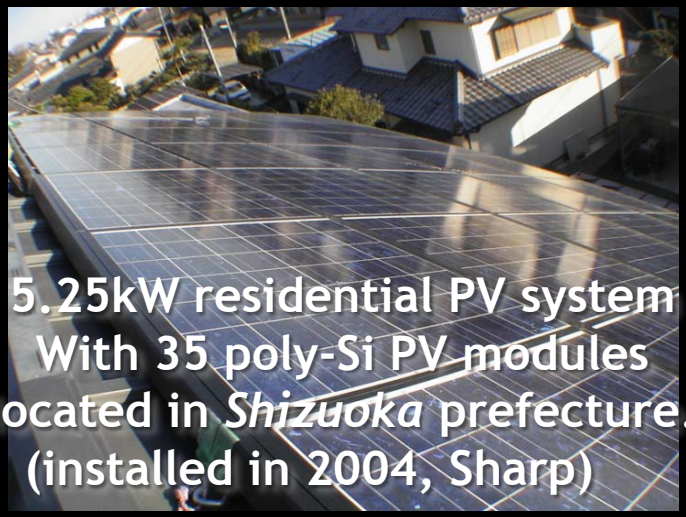




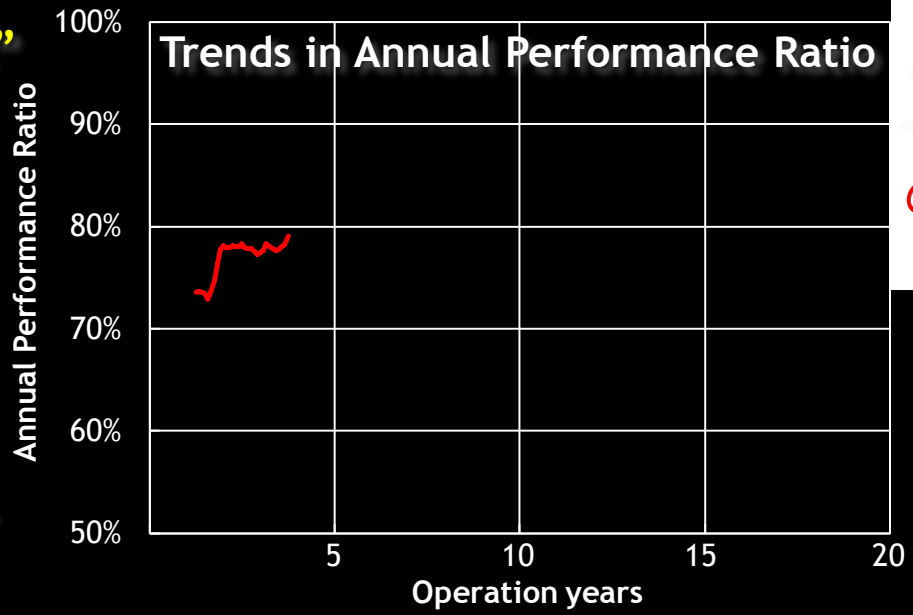


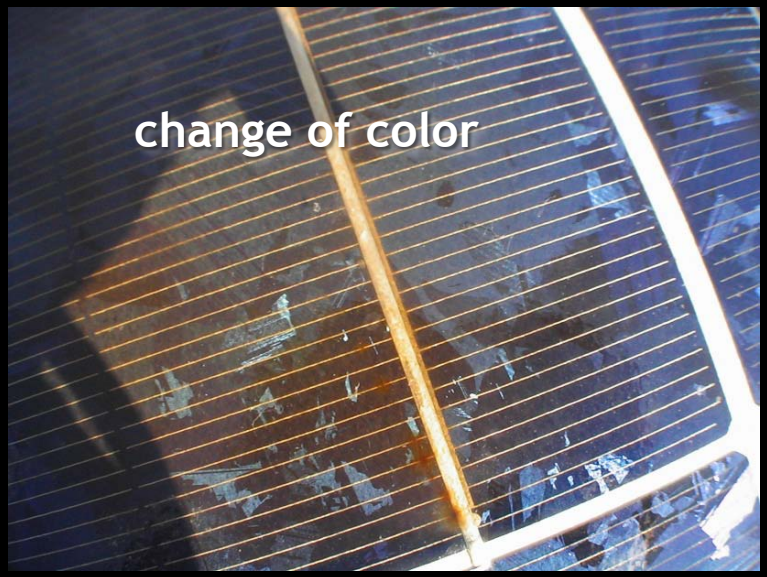
- PVRessQ! survey found 15 PV modules had serious failures.
- Though the warranty period (10 years) was over,
  all the PV modules were replaced with no charge.

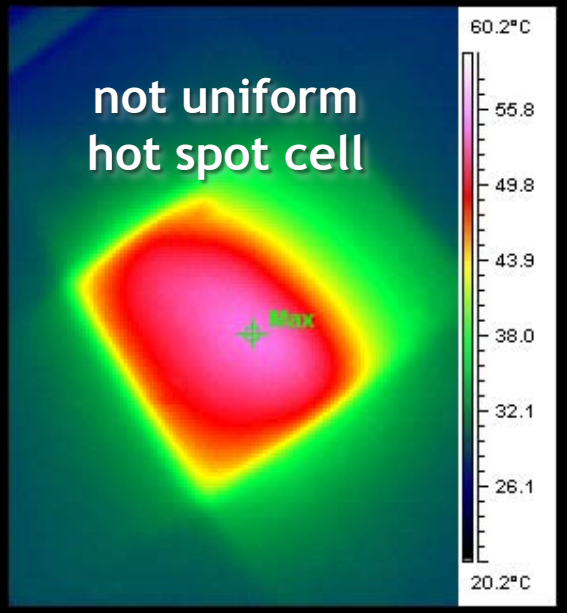
Case #4 "Sharp ND-150AM"



5.25kW residential PV system
With 35 poly-Si PV modules
located in *Shizuoka* prefecture.
(installed in 2004, Sharp)



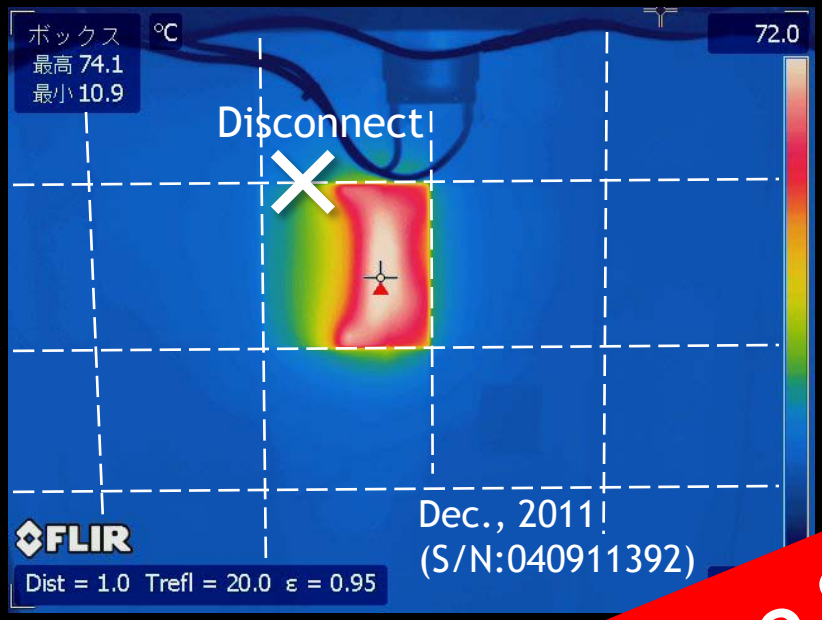


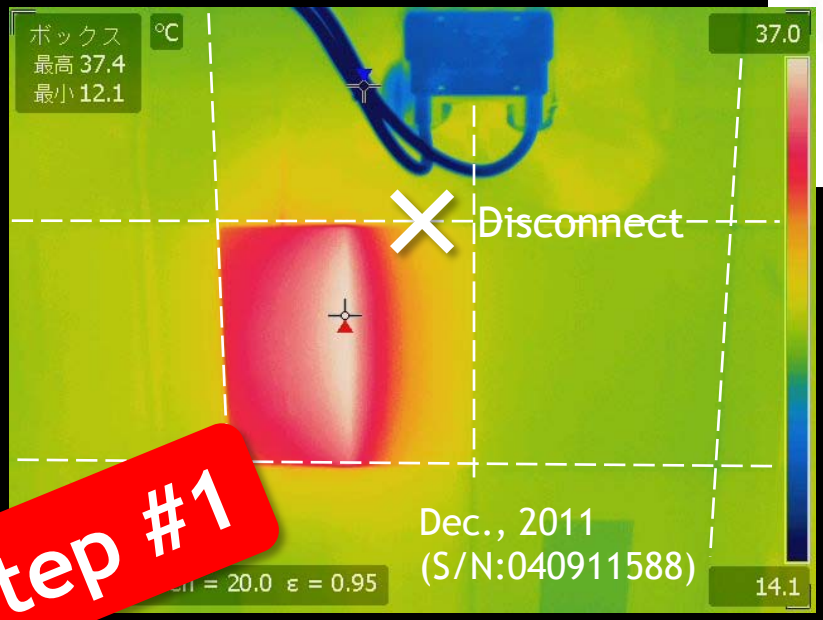


Four PV modules were replaced,
though high performance ratio and short operation years.

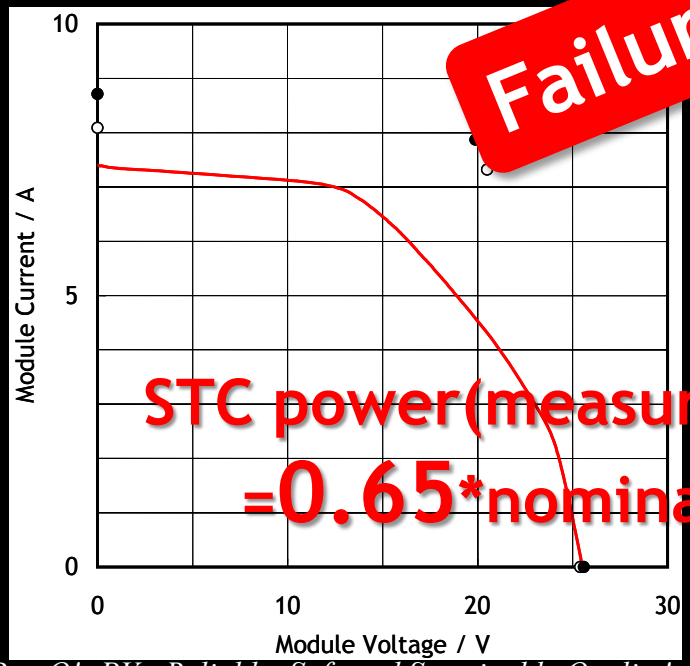
Part of PV installation in AIST

Part of PV installation in AIST

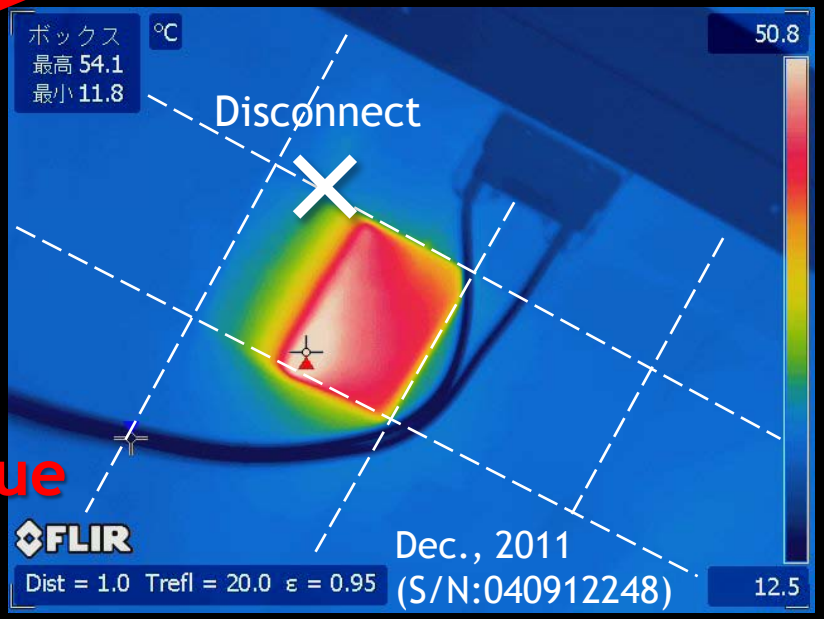




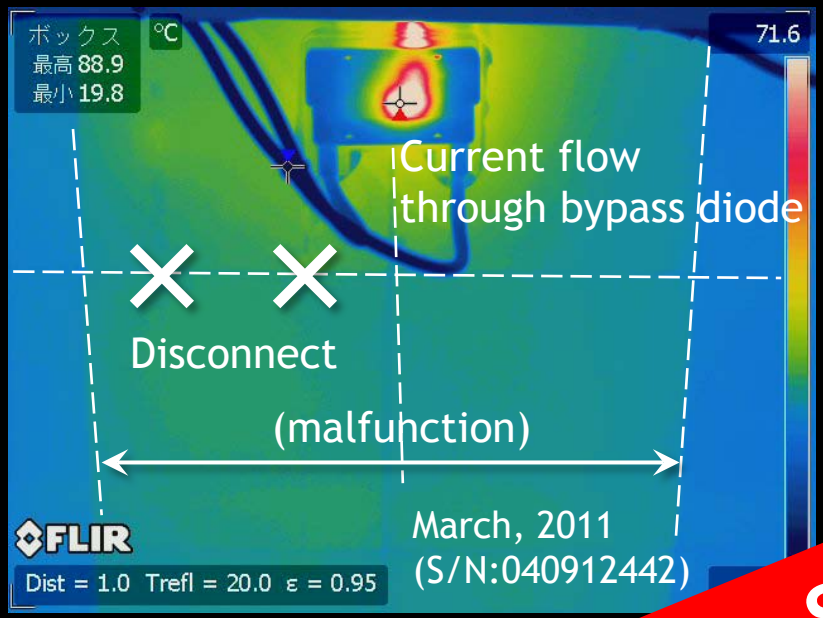
Failure Step #1



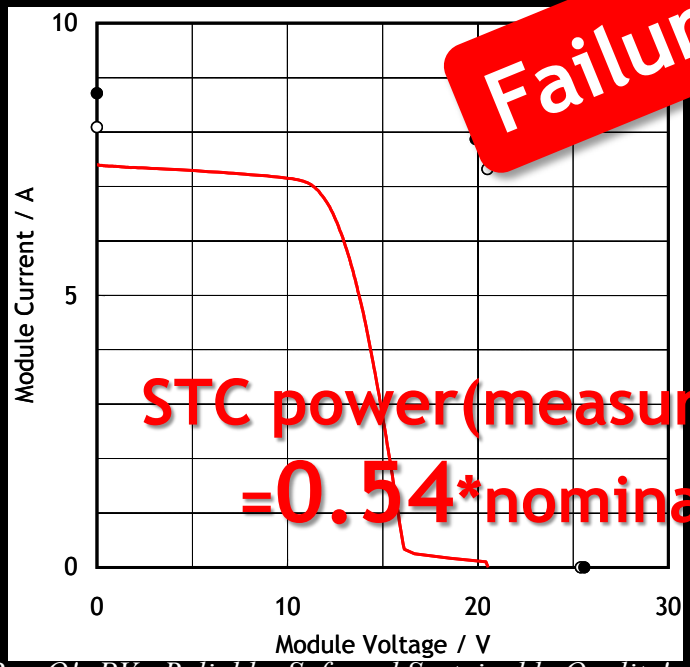
STC power(measured)
=0.65*nominal value



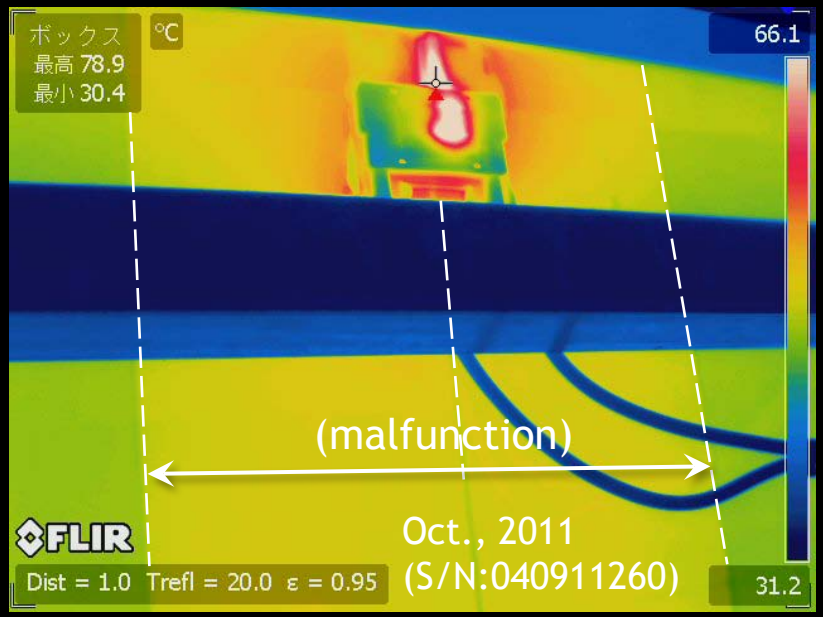
Part of PV installation in AIST



Failure Step #2

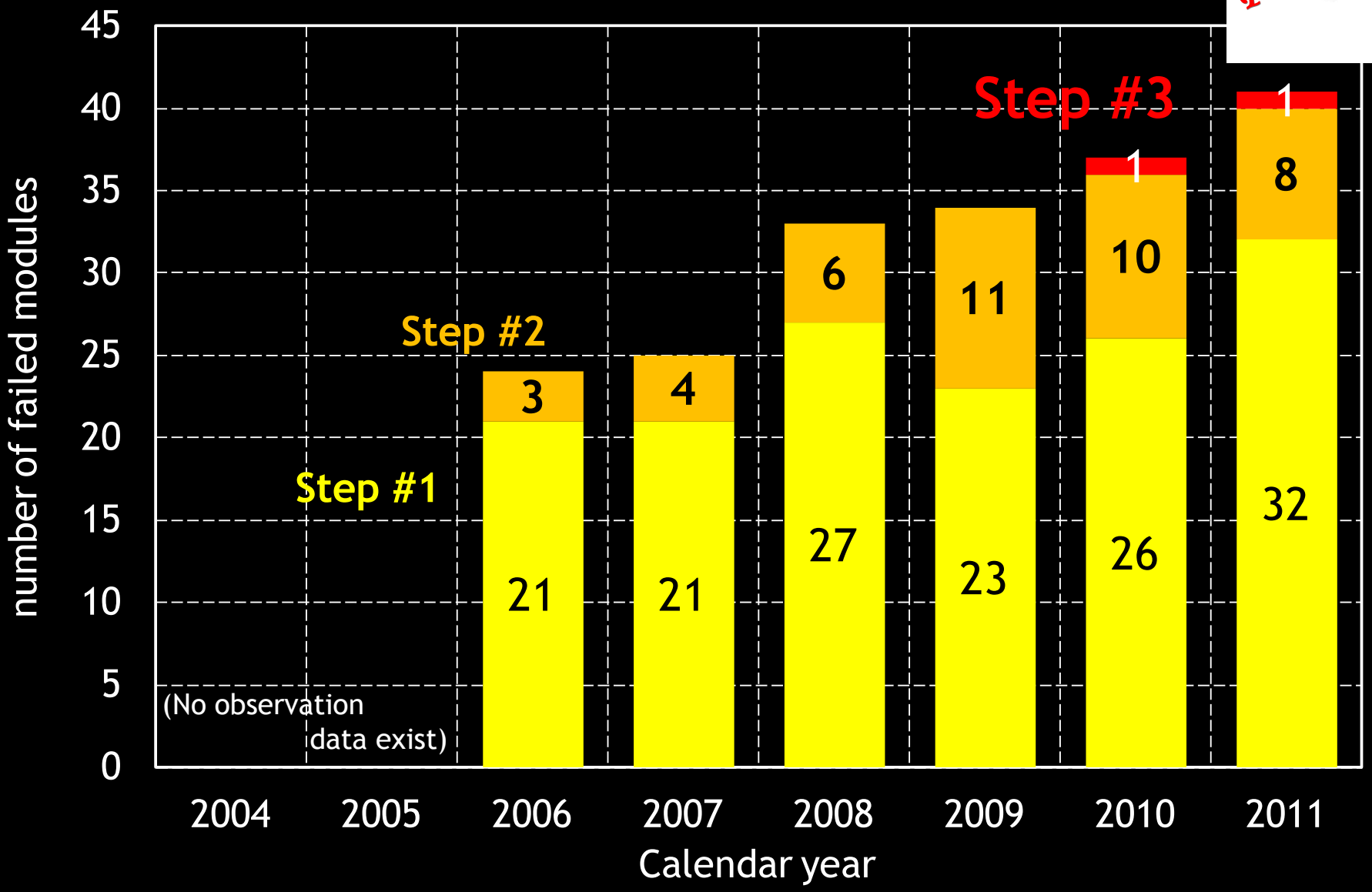


STC power(measured)
=0.54*nominal value

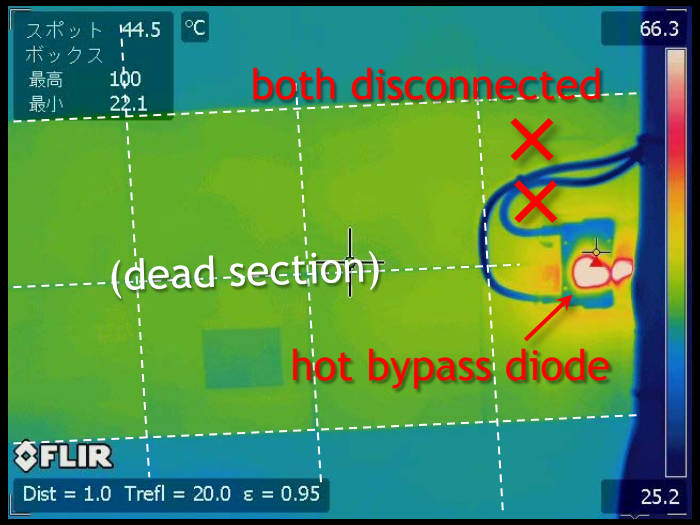


Part of PV installation in AIST

Trend in number of failed modules (out of 1,080 in total)



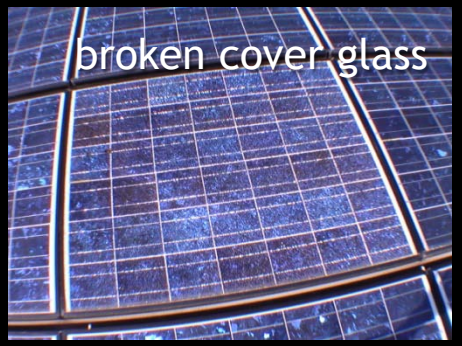
Part of PV installation in AIST



Observed in March 2010

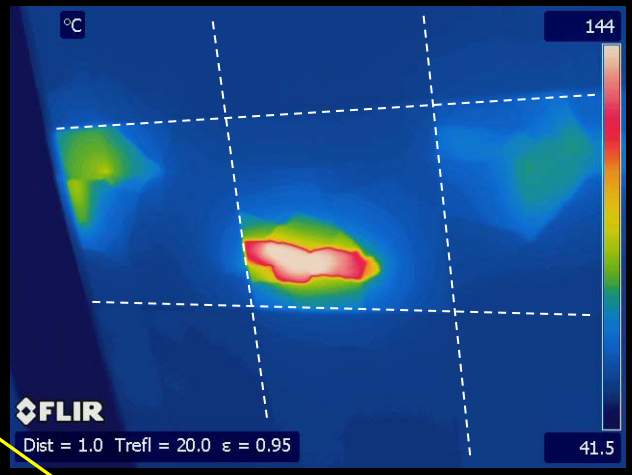
"Step 2"

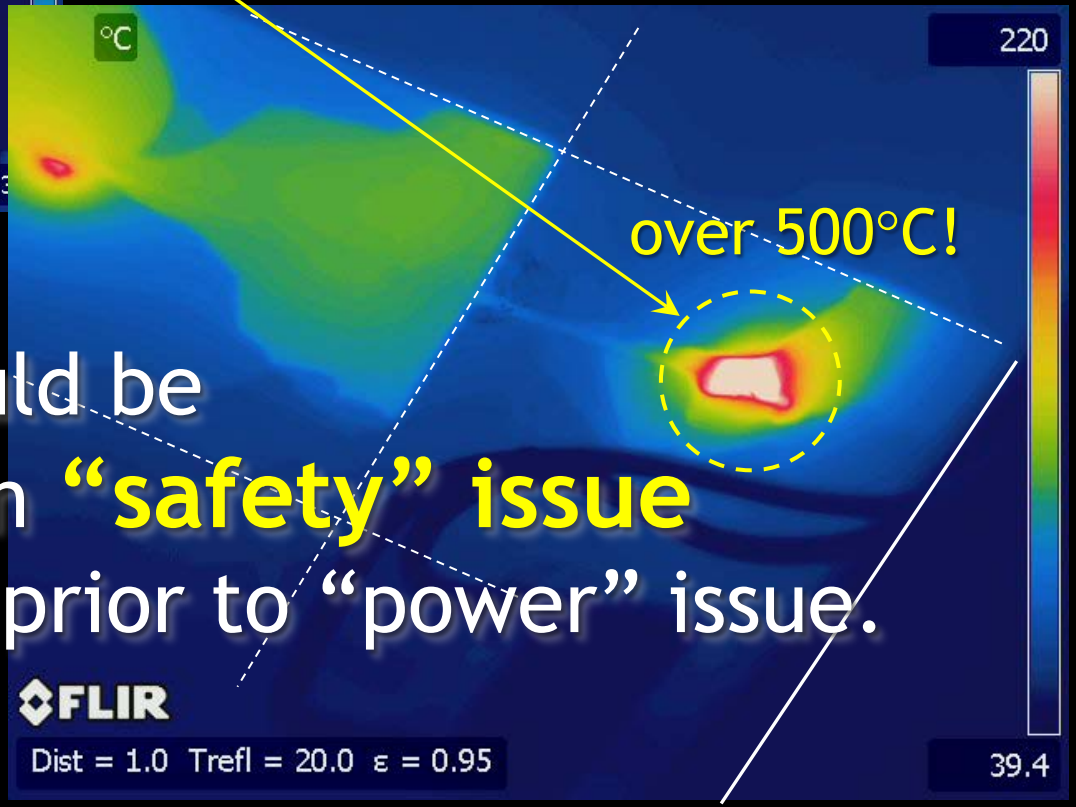
New situation observed in June 2010

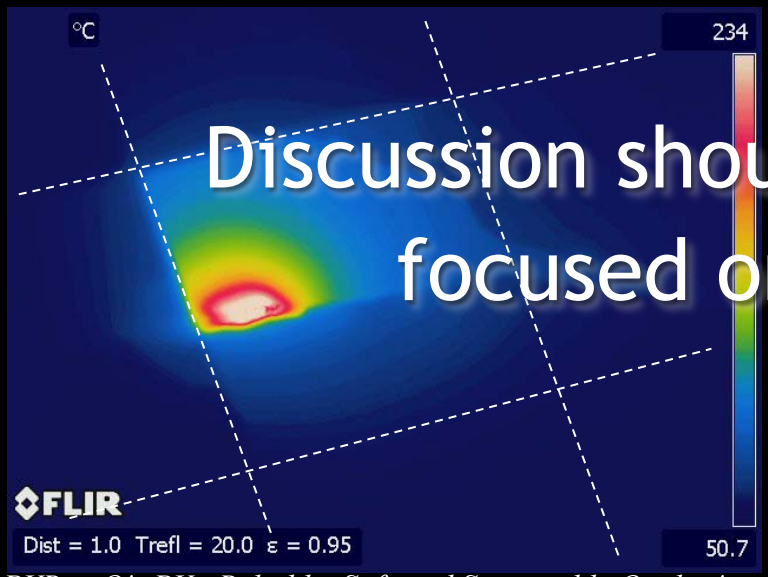


Part of PV installation in AIST

IR images from back side

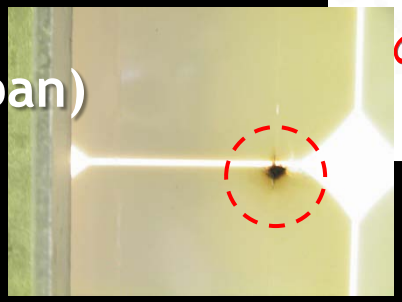


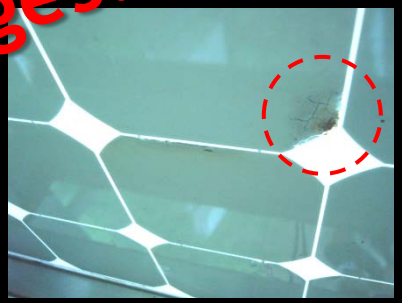


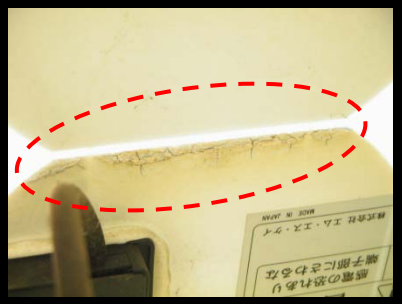


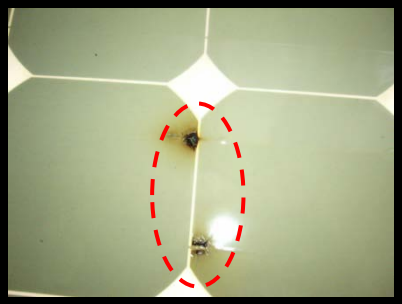
Discussion should be focused on **"safety" issue** prior to "power" issue.

Another Module Failure occurring in AIST

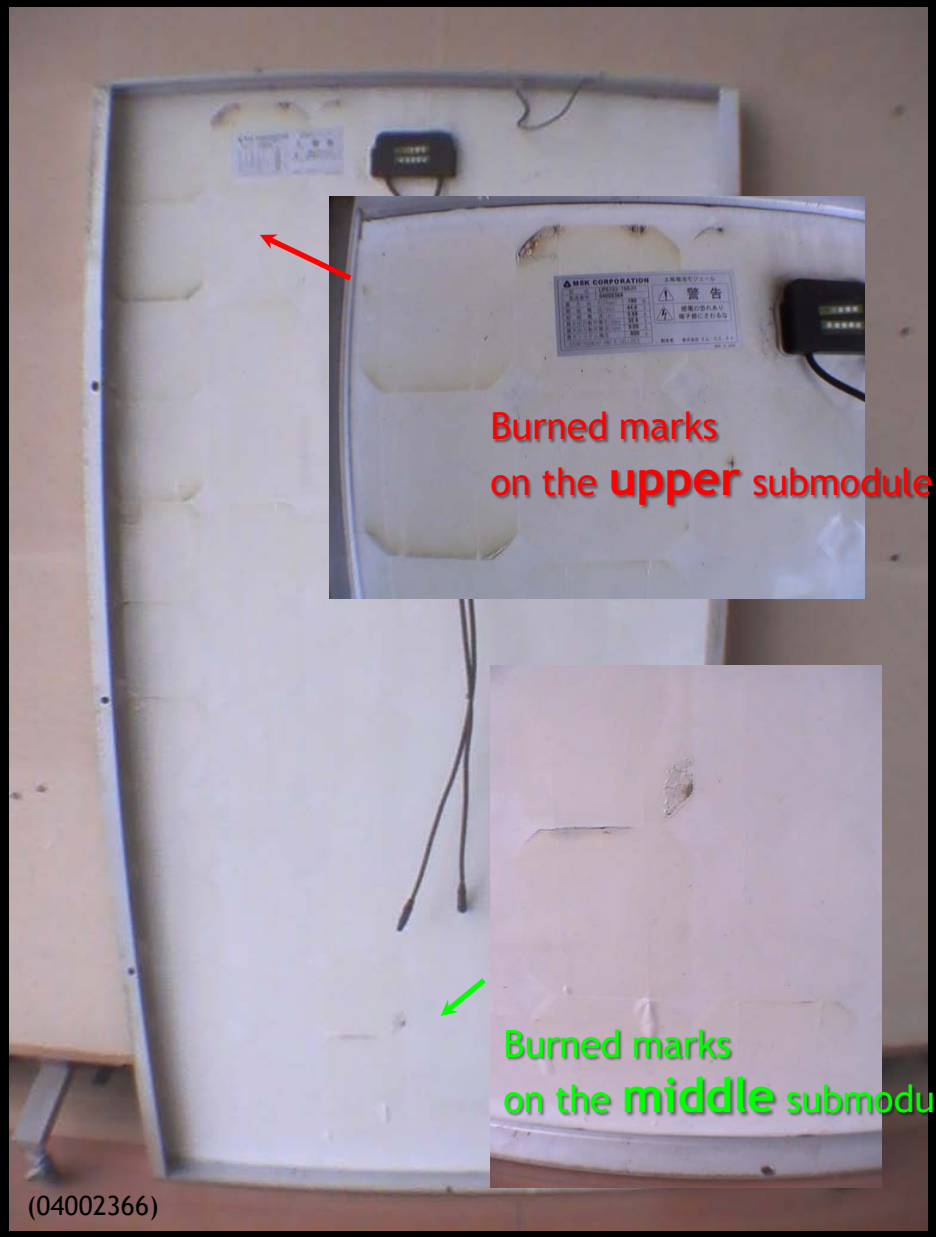


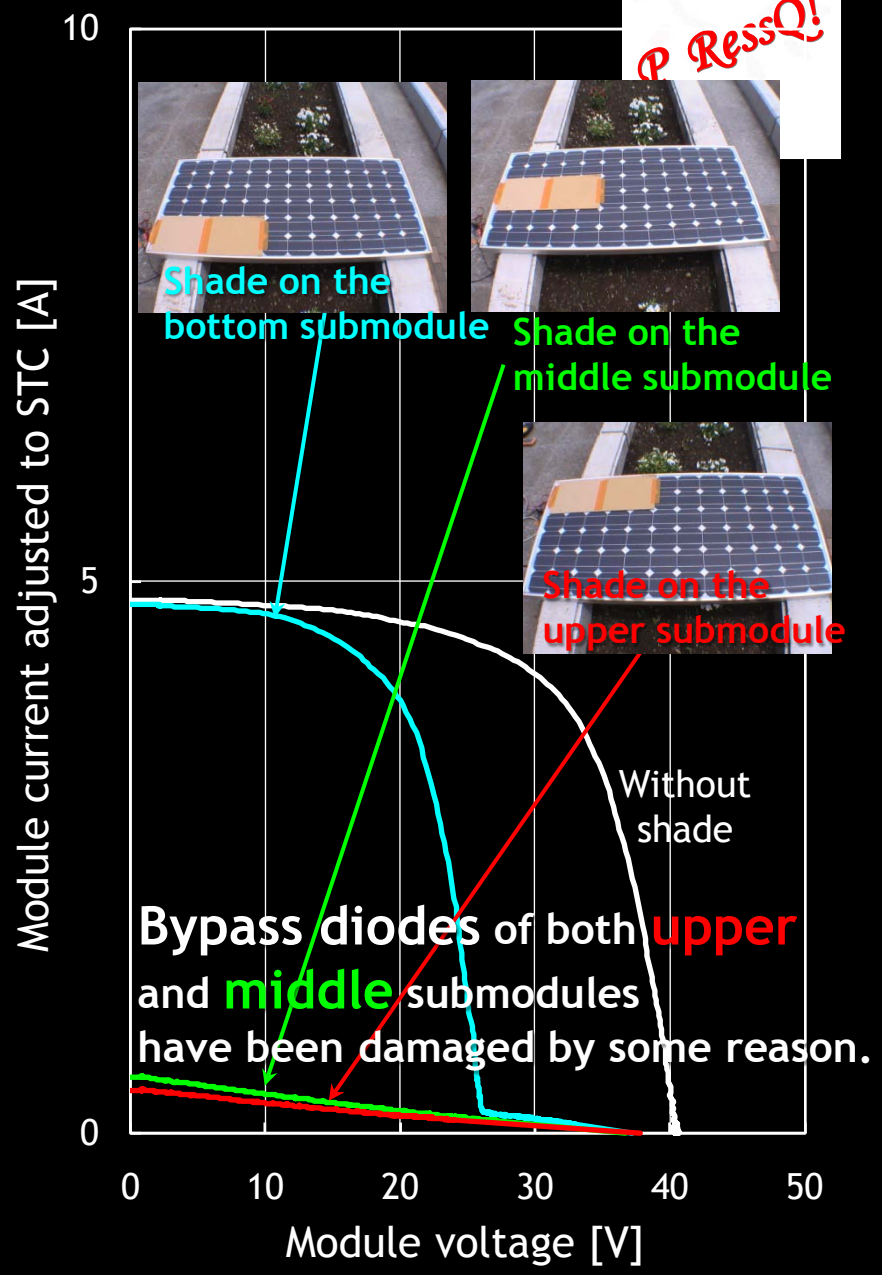






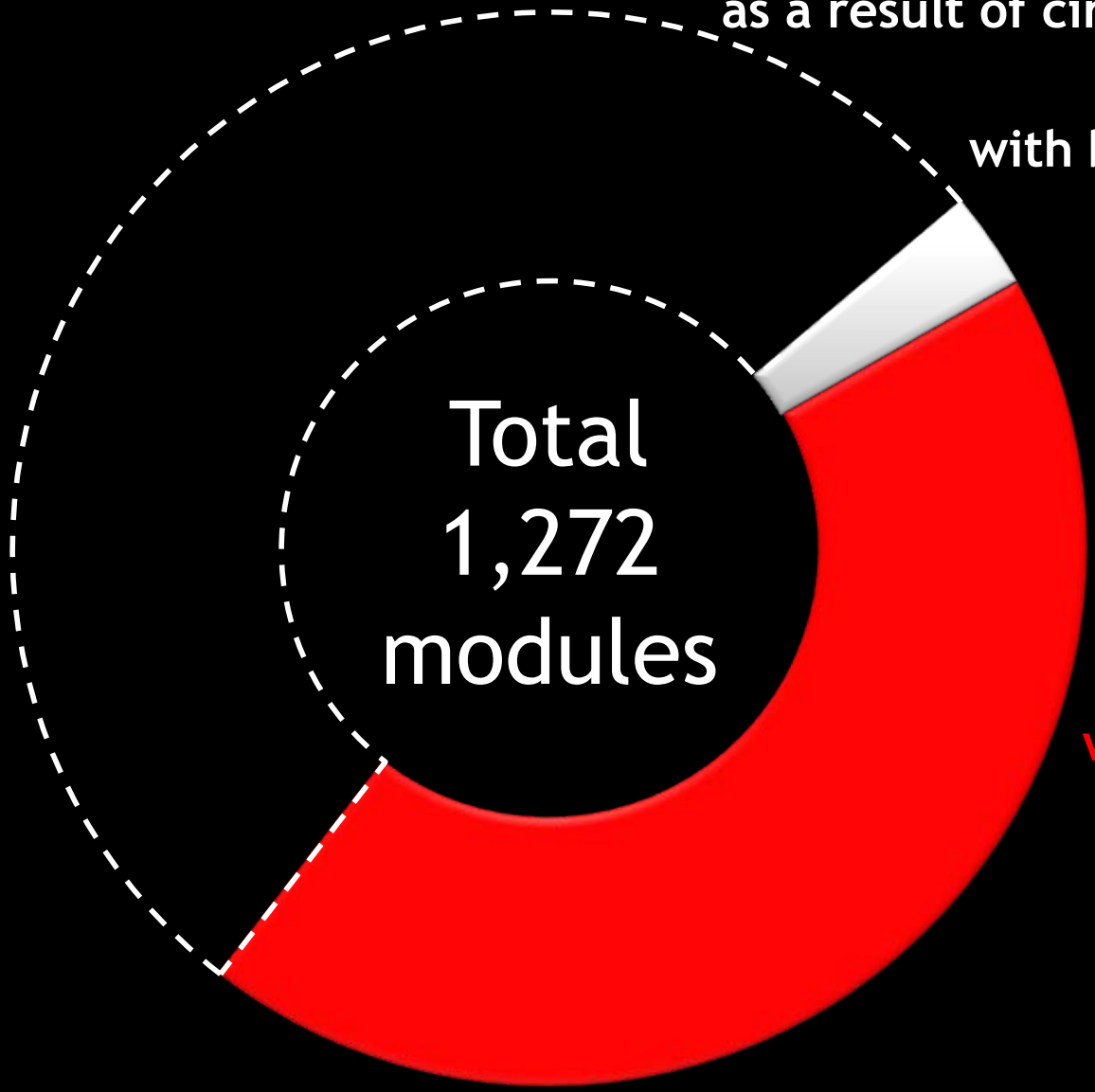
Another Module Failure occurring in AIST





Another Module Failure occurring in AIST

Fraction of PV modules in which bypass diodes do not work as a result of circuit fault check.



PVRessQ! tackling thin-film PV modules now

No experience, no info, no instrument…no solution.

Some remarks from PVRessQ!

- PV module failures are often invisible.
  - -Visual inspection has less effect for casual field survey. Failures always hidden behind backdrop.
- What is “reliability” of PV module?
  - “Degradation” and “failure” must be discussed, respectively.
  - Harmless degradation damages nothing, but people might be injured with PV module failure.
  - long-term “Safety” is one important perspective of reliability, of course.
- What is “lifetime” of PV module?
  - A light bulb with 50% decrease in luminous flux may be not worth to use, but a harmless PV module with 50% drop in efficiency still can give you good-quality electricity.
  - Only power drop is not the indicator of lifetime of PV module.
- Higher quality must be required of PV module as an “industrial product”. But quality assurance without valid maintenance has less effect than your expectation.

We should pay attention to maintenance issue!

In conclusion…Back to Fukushima…

Some audience may think and laugh…

"You are only talking about PV modules with past and old-fashioned technologies."

But, remember…

Fukushima nuclear power plant started its operation 40 years ago! And nobody could make decision to stop it before this accident.

Another "China Syndrome" might be waiting for us…