FICHTNER

GAF-RE Programme

Workshop for PFIs, Investors & EPC Contractors

Yerevan, March 2026

ENGINEERING ┼ CONSULTING

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1					
2					
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01

Welcome and Opening Remarks

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«PROMOTION OF RENEWABLE ENERGIES AND ENERGY EFFICIENCY»

LOAN PROGRAM

FINANCED BY KFW

GERMAN-ARMENIAN FUND

YEREVAN, 2026

“PROMOTION OF RENEWABLE ENERGIES” PROGRAM

First phase
Y2004 6 Mio. EUR

Second phase
Y2010 18 Mio. EUR

Third phase
Y2012 40 Mio. EUR

Forth phase
Y2019 20 Mio. EUR

Fifth phase
Y2021 40 Mio. EUR

Sixth phase
Y2023 12 Mio. EUR

Seventh phase
Y2024 26 Mio EUR

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"PROMOTION OF RENEWABLE ENERGIES" PROGRAM STATISTICS FOR PHASES 1-6

Within the Program the following projects have been financed:

- 54 SHPP projects with total installed capacity of 143.34 MW;
- 9 up to 1 MW PV stations with total installed capacity of 8,5 MW (EUR 6.5 Mio);
- 24 large-scale (up to 5 MW capacity) PV stations with total installed capacity of 130.18 MW (EUR 61.6 Mio).
- 16,591 small-scale (up to 500 kWh capacity) solar projects and STHs with total capacity of 132.7 MW (EUR 70.7 Mio), out of which 13,208 loans with 35.97 MW capacity were disbursed to physical entities (EUR 34.2 mln.) (from which about 20% were women households).
- 5 MW PVs total CO2 reduction – 55,635.0 t p.a.

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ENVISAGED RE INVESTMENTS WITHIN GAF-REEE-VII

- Investments by households in PV plants up to 150 kW for own consumption (is already closed).
- Investments by legal entities (SMEs) in PV plants for own consumption:
  - Up to 500 kW per PV plant (licensed by PSRC as applicable);
  - Joint operation of several PV plants (up to 150 kW per PV plant; joined to up to 1050 kW in total).
- Up to 5MW per PV plant (licensed by PSRC) for commercial use.

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LENDING CONDITIONS GAF-REEE-VII

- Currency - **AMD**;
- Maturity - up to **10 years**;
- **PV-150 projects**: The refinanced amount should not exceed AMD 80mln, LTV can be 100%, maximum actual interest rate should not exceed 10%, the final beneficiary should be a legal entity and/or a physical person.
- **PV-500 projects**: The refinanced amount should not exceed AMD 200mln, LTV should not exceed 80%, maximum actual interest rate should not exceed 9.5%, the final beneficiary should be a legal entity.
- **PV-1050 projects:** No limitation on the sub-loan amount, LTV should not exceed 80%, maximum actual interest rate should not exceed 9.5%, the final beneficiary should be a legal entity.

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LENDING CONDITIONS GAF-REEE-VII

- **PV-L PV projects:** licensed large-scale up to 5 MW PV projects. No limitation on the sub-loan amount, LTV should not exceed 80%, maximum actual interest rate should not exceed 9.5%. The sub-loan can be disbursed also in foreign currency, in that case maximum actual interest rate should not exceed 5.5%.
- **BESS projects.** The projects will be eligible as an integral part of solar energy solutions both for newly constructed or already built and operating PVs, enhancing the performance and reliability of photovoltaic installations. LTV can be 100%, maximum actual interest rate should not exceed 9.5%, the Beneficiary should be a legal entity or a physical person (being coupled with PV-150 project).
- **Other REPP projects** (wind, biomass, geothermal, etc.): No limitation on the sub-loan amount. LTV can be 80%, maximum actual interest rate should not exceed 9.5%, the final beneficiary can be a legal entity or a physical person.

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IMPORTANT ASPECTS GAF-REEE-VII

- **BESS (Battery Energy Storage Systems)** projects are being considered as an integral part of solar energy solutions, enhancing the performance and reliability of photovoltaic installations – pilot component.
- **Environmental and Social Commitment Plan** and other respective ES requirements, which set clear commitments for both the PFIs as Borrowers and the Final Borrowers.

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CONSULTANCY SERVICES OF GAF-REEE-VII

- Phase 7 has Consulting Services covered by Fichtner with the following tasks:
  - Technical assessment of BESS projects, ground-mounted PV plants and roof-top PV plants from 150KW to 5MW capacity.
  - Training and support to relevant project partners.
  - Training for women sub-borrowers on renewable energy technologies.

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STATISTICS FOR GAF-REEE-VII

Within the Program the following projects have been financed:

- 261 up to 500kW small-scale PVs with total amount of about EUR 3mln and 3.6 MW capacity, out of which 239 loans with total amount of EUR 1.2mln and 2.3MW capacity were disbursed to physical persons (about 33% to women households);

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Thank you!

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02

Programme Overview

Content

1. Welcome and Opening Remarks
2. Programme Overview – Phases IV–VI and Outlook
3. Battery Energy Storage Systems (BESS) – Eligibility, outlook, & regulatory status
4. Updated MTRs for PV and BESS – Practical Walkthrough
5. Application Process – Step-by-Step Guidance
6. Q&A (Part 1) and Break
7. Operational Survey – Key Findings and Lessons Learned
8. Q&A and Open Discussion

03

Battery Energy Storage Systems -

Eligibility, outlook, & regulatory status

BESS: Eligibility, Outlook, & Regulatory Status

Starting Point

- The Armenian legislative framework for BESS licensing and safety standards is still under development
- A government resolution adopting the relevant regulations has not yet been issued
- However, BESS projects are in principle eligible under the GAF-RE Programme
  - Investors and developers should not be deterred from preparing applications for hybrid solar-plus-storage projects.
  - Fichtner has laid the technical groundwork: updated **Minimum Technical Requirements** (MTRs) are designed to accommodate BESS integration once the regulatory framework is in place.

→ **Today's key message: the programme is ready for BESS; developers should start preparing now.**

FEEDBACK

- Has anybody in this room a (pre) developed BESS projects in the drawer?, or
- Are there any other preliminary BESS project experience from the small-scale / own consumption space?

Purpose & Scope

The purpose of this memorandum is to provide an updated overview of the **current Legislative and Regulatory Aspects of BESS technology** in **Armenia**, with a specific focus on **factors influencing the viability** of new BESS projects under the upcoming program phase.

Contents

This presentation covers the following key issues:

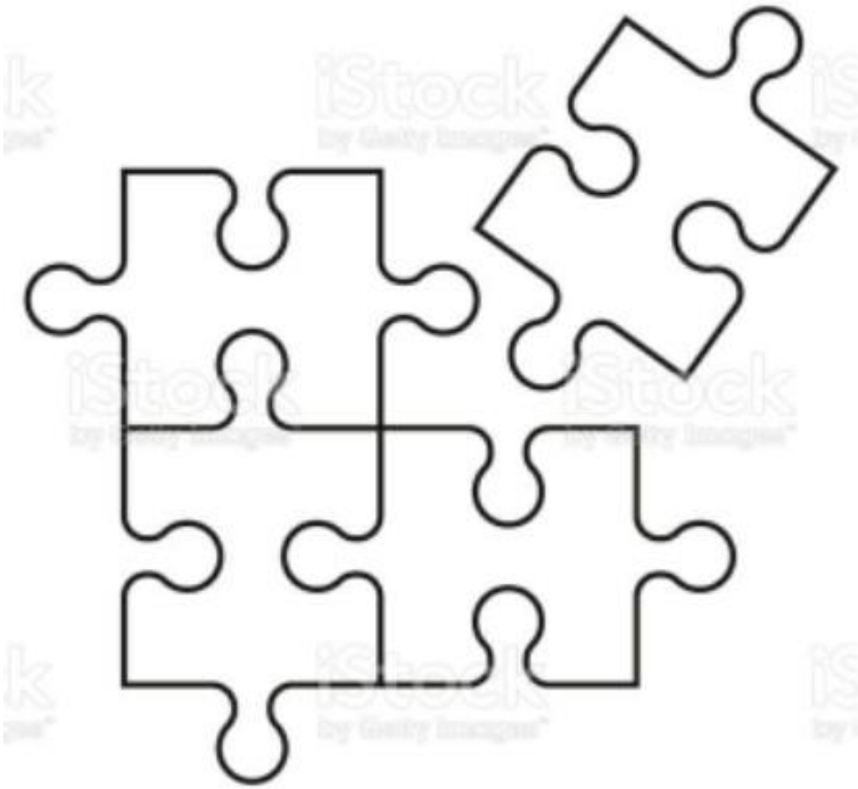
Legal framework gaps

- Definition of electricity storage activity in the legislation
- Licensing requirements for large scale electricity storage facilities
- Environmental impact and classification of BESS in terms of environmental impact
- Safety and Security Standards/Regulation of BESS
- Classification and status of electricity storage companies in the WEM
- The rights and responsibilities of companies involved in electricity storage activity

Factors Driving the Growing Importance of BESS

The growth of renewable energy and the ongoing liberalization of Armenia's electricity market have increased the importance of BESS and created new opportunities for its deployment.

- **No** guaranteed **Feed-in tariffs** → market risk
- **Curtailment** increases uncertainty
- **Grid constraints** + limited hosting capacity
- Growing importance of **BESS**
- **Financing** opportunities (GAF, State Subsidy)
- **Legislative** changes



Absence of Feed-in Tariffs

- FIT still in law but no new quotes planned
- New licenses require selling electricity on the market
- ~200 MW solar under construction despite no FIT

Curtailment Risks & Restrictions

Restricted Producer concept introduced

1,080-hour limit (plants after July 1, 2024)

2,200-hour limit (plants after Apr 12, 2025)

Pre-2024 limit was **87.6 hours**

*The revision of the Curtailment Policy makes the consideration of **BESS** for **Restricted Producer** significantly more **financially justified**.*

Trends & Regulatory Actions

Curtailment rules (1,080 → 2,200 hrs)

Limiting the PPA-backed plants (March 1, 2026)

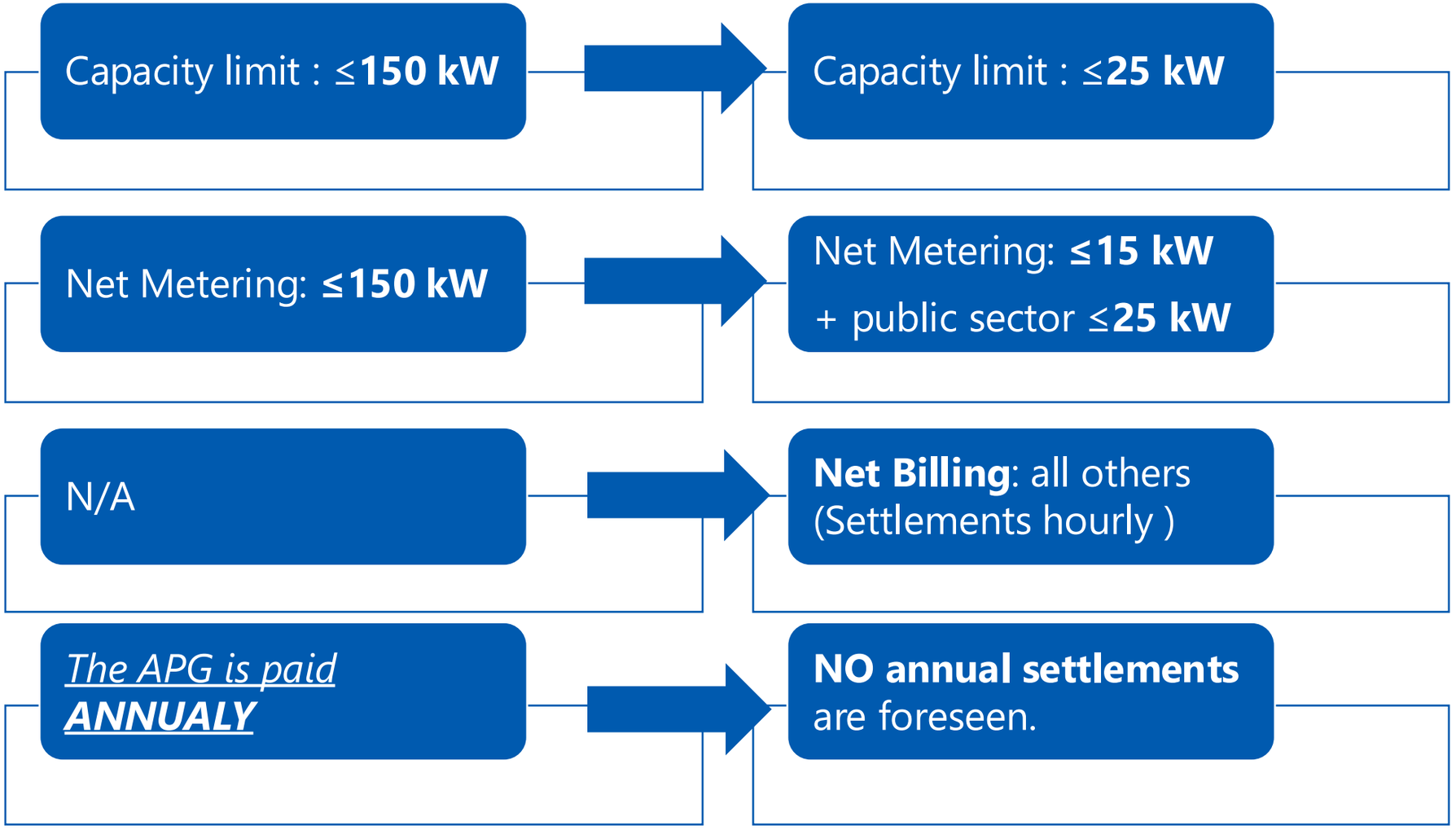
Minimum technical requirements (HV & LV)

Net Metering → Net Billing Transition

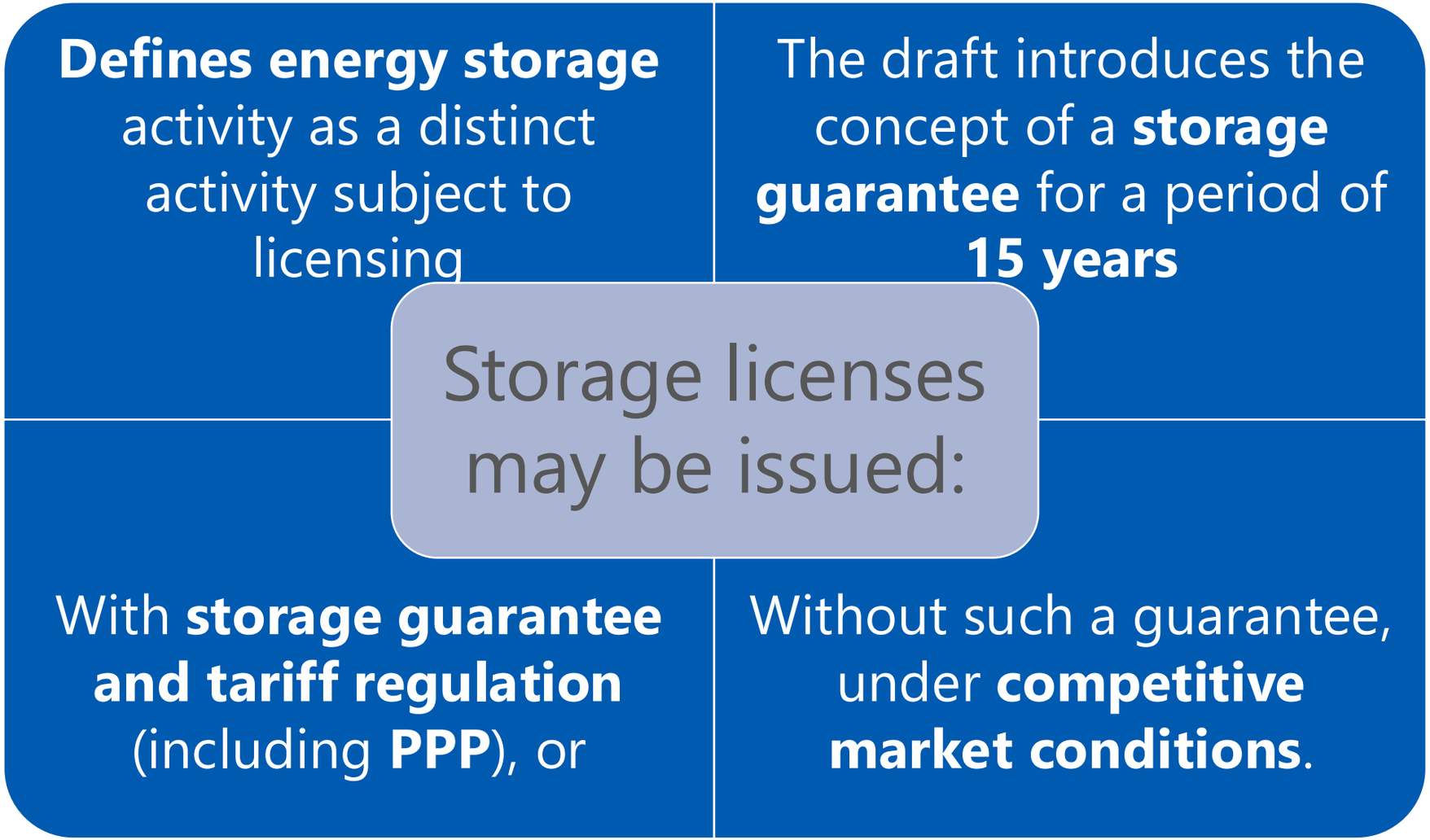
Consideration of state support for PV plants with BESS

Energy Law Amendment (Storage)

Net Metering → Net Billing Transition



Energy Law Amendment



Recommendations - Hybridization

Lack of hybrid plant regulation

The law defines storage and assigns rights to storage licensees, but does not define "hybrid plant" or "hybridisation".

RECOMMENDATION

Hybrid plant (or 'combined generation-storage plant') - a combination of an **electricity generating facility and an energy storage facility**, located **on the same or adjacent land plots,** with a **shared or interconnected control system** and connected to the electric power system through **the same connection point**. A hybrid plant may carry out activities permitted by generation and storage licenses in accordance with the market rules.

Simplified permitting for hybridisation

Hybridisation of existing plants is often blocked by duplicative permits.

EU best practice supports fast-track permitting when:
- **storage is constructed on the same land plot,**
- **no increase of injection capacity occurs.**

The current draft amendment has no such rule.

RECOMMENDATION

Where the construction (reconstruction) of an energy storage facility is carried out **on the same land plot** of an already operating generating plant and **does not lead to an increase in the injection capacity** of the existing plant, the issuance of the licence shall be carried out **through a simplified and accelerated procedure.**

04

Updated Minimum Technical and E&S Requirements (MTRs) for PV and BESS

Updated MTRs for PV and BESS – Practical Walkthrough

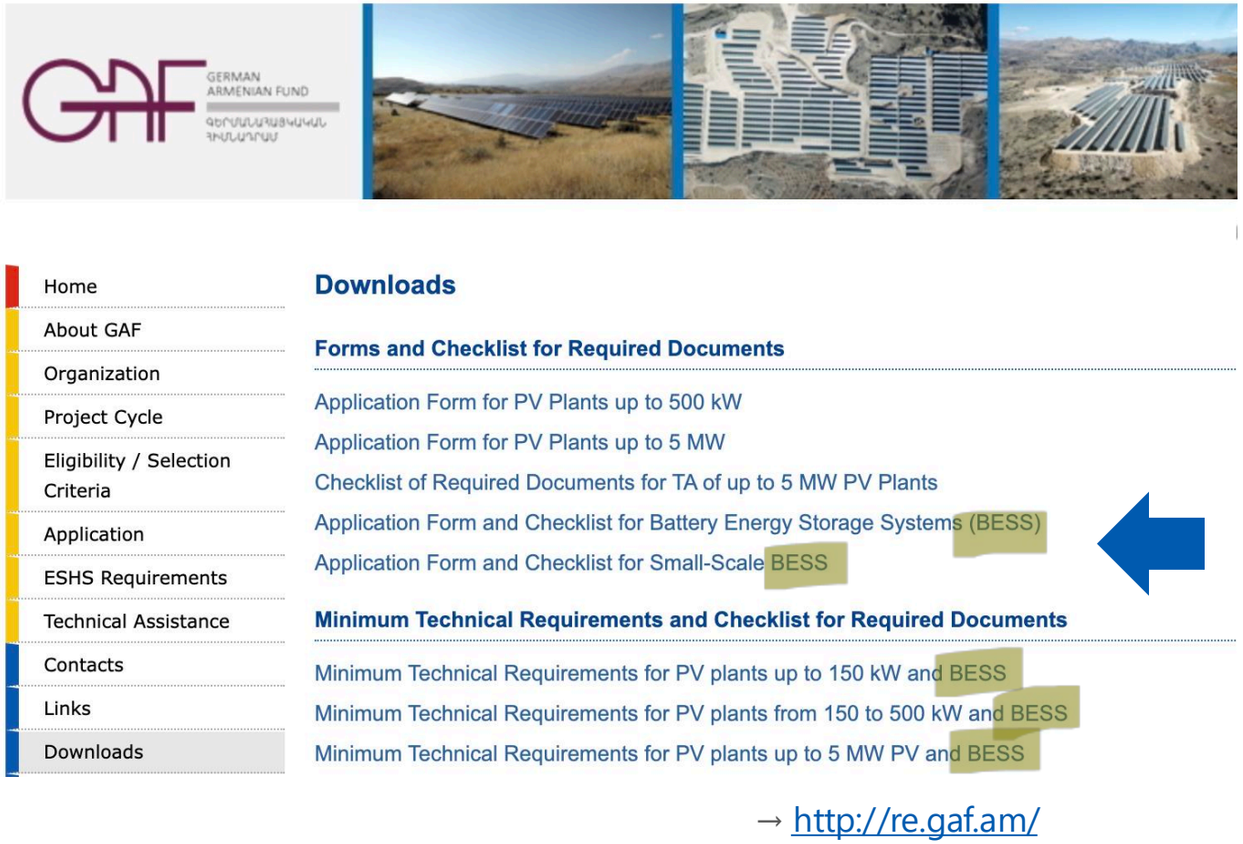
GAF-RE Phase VII | Fichtner

Part A – PV Requirements (Large-Scale, up to 5 MW AC)

- System design, grid interface, ESHS requirements
- PV Modules: technology, efficiency, certifications, warranties
- Inverters: type, efficiency, grid support, cybersecurity
- DC Cabling, Connectors & Combiner Boxes
- Mounting Structures: materials, track record, foundation
- SCADA, I&C & Performance Monitoring

Part B – BESS Requirements (NEW in Phase VII)

- What is BESS eligibility & why does it matter?
- System architecture & key technical requirements
- Warranties, testing & performance guarantees



→ http://re.gaf.am/

Part C – Three-Tier Comparison

- How do requirements simplify for mid-scale (150–500 kW) and small-scale (<150 kW) systems?

Three Project Tiers – One Updated MTR Framework

Apply the tier matching your contracted installed capacity

► Large-scale PV & BESS – up to 5 MW(AC)

- Full engineering-grade requirements; utility-scale grid interface; detailed technical assessment by Fichtner/R2E2

► Mid-scale commercial – 150 kW to 500 kW

- Simplified requirements for own-consumption systems; same technology standards but less formal documentation

► Small-scale – up to 150 kW

- Basic checklist-based approach; rooftop or small ground-mount; fund specialist assessment on request

► ALL THREE TIERS: BESS requirements now included in the Minimum Technical Requirements (MTR) for the first time

General System Requirements

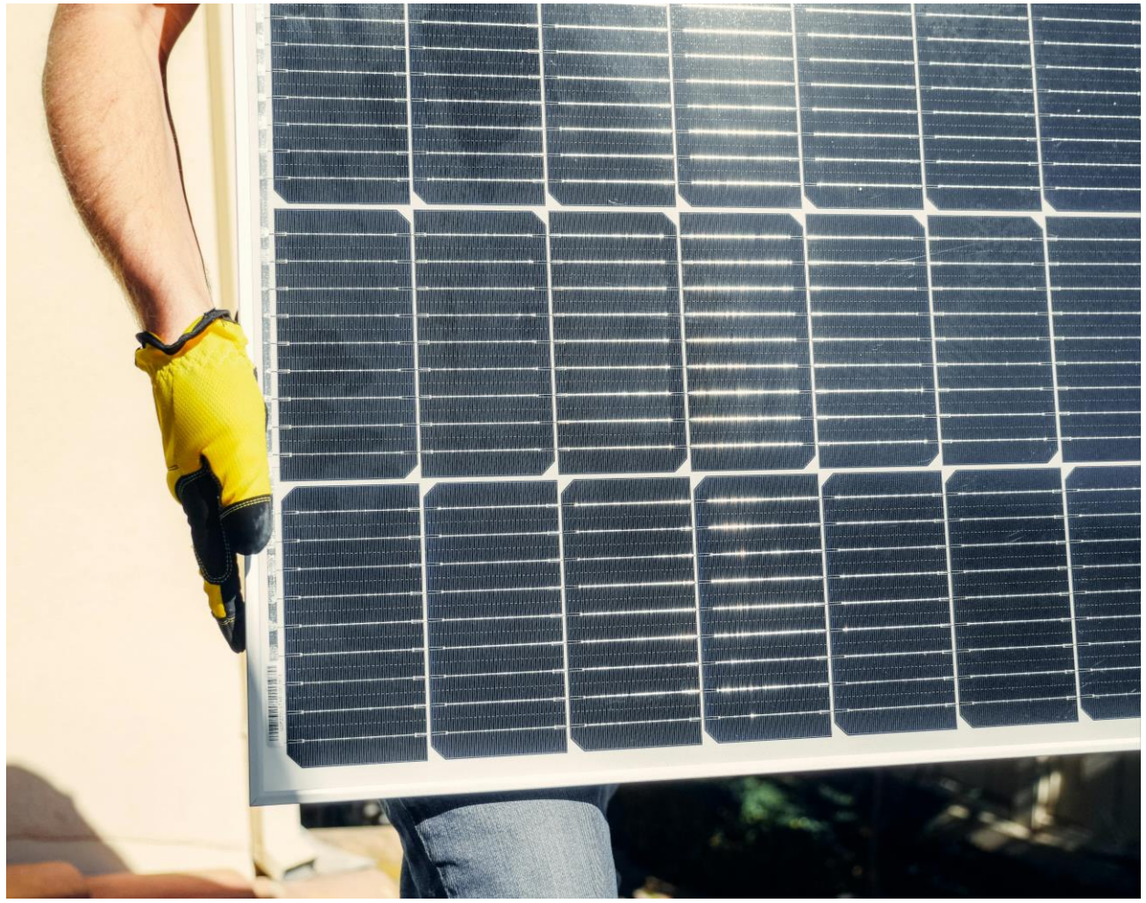
Large-Scale PV Plants up to 5 MW (AC)

- PV plant designed to maximize solar yield under Armenian site conditions
- Overbuilt ratio (DC/AC) per sub-system: not to exceed 1.2
- Installed transformer capacity [MVA] must at least equal installed inverter capacity [kVA]
- Power factor: 0.95 leading to 0.95 lagging at any active power output level
- Continuous reactive power control at the Connection Point (no instability across full operating range)
- Plant must interface with Armenian Load Dispatch Center (LDC / ECC) for Automatic Generation Control (AGC)
- Fixed-tilt or tracked mounting structures both permitted; trackers require weather-adaptive positioning and backtracking
- All safety and warning labels: bilingual Armenian & English; compliant with IEC 60417 / ISO 3864

PV Modules – Quality & Performance Standards

Crystalline silicon (PERC/HJT/TOPCon) or thin-film

- Technology: crystalline silicon (PERC, HJT, TOPCon) or thin-film – proven, commercially available
- Minimum module efficiency: 22% STC (new systems) | 20% STC (systems already in operation at application)
- Maximum 3 power classes and 2 module brands per project; all modules from a single manufacturer
- Market track record: manufacturer must have at least 2 installed reference plants ≥ 10 MW(DC) each; ≥ 50 MW(DC) cumulative
- Certifications required: IEC 61215, IEC 61730, PID test (IEC TS 62804-1), salt mist (IEC 61701), cyclic mechanical load (IEC TS 62782)
- Product warranty: ≥ 10 years | Power output warranty: ≥ 30 years | Max. degradation: 20% over 30 years
- Tolerances: positive only (-0% / +5%)
- Bifacial modules: bifaciality factor to be correctly modelled in yield calculation



Inverters – Efficiency, Grid Support & Cybersecurity

Same type and manufacturer; certified for Armenian grid code

- String inverters (IP 65) or central inverters (IP 54+) – only one type, single manufacturer per project
- Minimum CEC efficiency: 96% (central inverters) | 97% (string inverters)
- Outdoor central inverters: IP 54 minimum; adequate cooling (temperature + moisture control)
- Supports negative pole grounding for PID protection; automatic isolation resistance monitoring (IEC 62109-2)
- Grid support functions required: voltage regulation, frequency support, reactive power control per Armenian Grid Code
- Cybersecurity: IEC 62443 compliance for industrial control systems
- Minimum product warranty: 5 years
- Spare parts availability: the inverter manufacturer must guarantee long-term support

DC Cabling, Connectors & Combiner Boxes

Compatibility and safety in the DC circuit

DC Cables

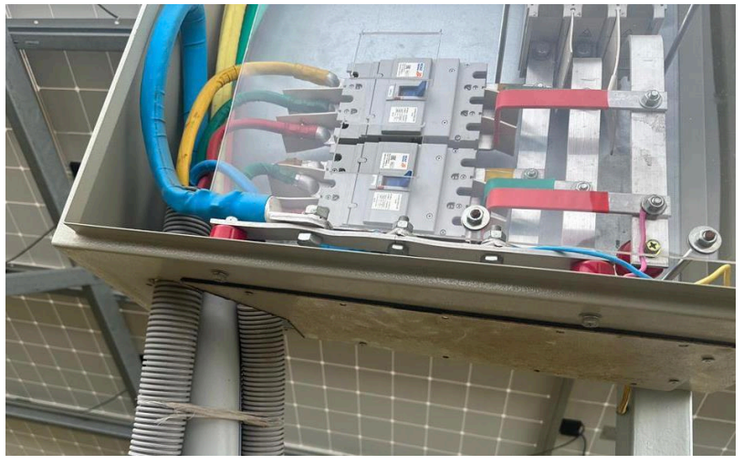
- Single-core, double-insulated; UV-resistant; compliant with EN 50618 / IEC 62930
- All outdoor cables: UV-resistant conduit; properly sealed against water, dust, insects and rodents
- Adequate fixing; respect permissible bending radius; strain relief on all wires

DC Connectors

- **Same** brand and type as required by the PV module manufacturer – **no** mixing of connector brand
- Pairing different male/female connectors from different manufacturers: **not** acceptable

DC Combiner Boxes

- Fuses on each pole; max. fuse rating ≤ PV module maximum fuse/reverse current rating
- All-pole main DC load break switch; capacity sufficient for disconnection under full load
- Overvoltage and lightning protection required
- Protection from direct sunlight or heat mitigation for design lifetime



Mounting Structures – Designed to Last

25-year warranty; proven track record; site-specific foundation design

- Acceptable materials: aluminium alloys (AlMgSi / AlMg), stainless steel, hot-dip galvanized steel, or equivalent (e.g. Magnelis®)
- Black steel with site-applied coating only: NOT acceptable
- Minimum product warranty: 25 years (per RA Construction Standard 22-01-2024)
- Manufacturer track record: ≥ 500 MW(DC) total installed capacity
- PV module manufacturer must confirm structural compatibility with chosen mounting system
- Geotechnical requirement: soil investigation + pile tests (min. 4 per MW DC) for axial and lateral forces before construction
- For tracked systems: weather-adaptive positioning and backtracking algorithms required
- Site preparation: levelling and compaction per hydrological and geotechnical study findings

SCADA, I&C & Performance Monitoring

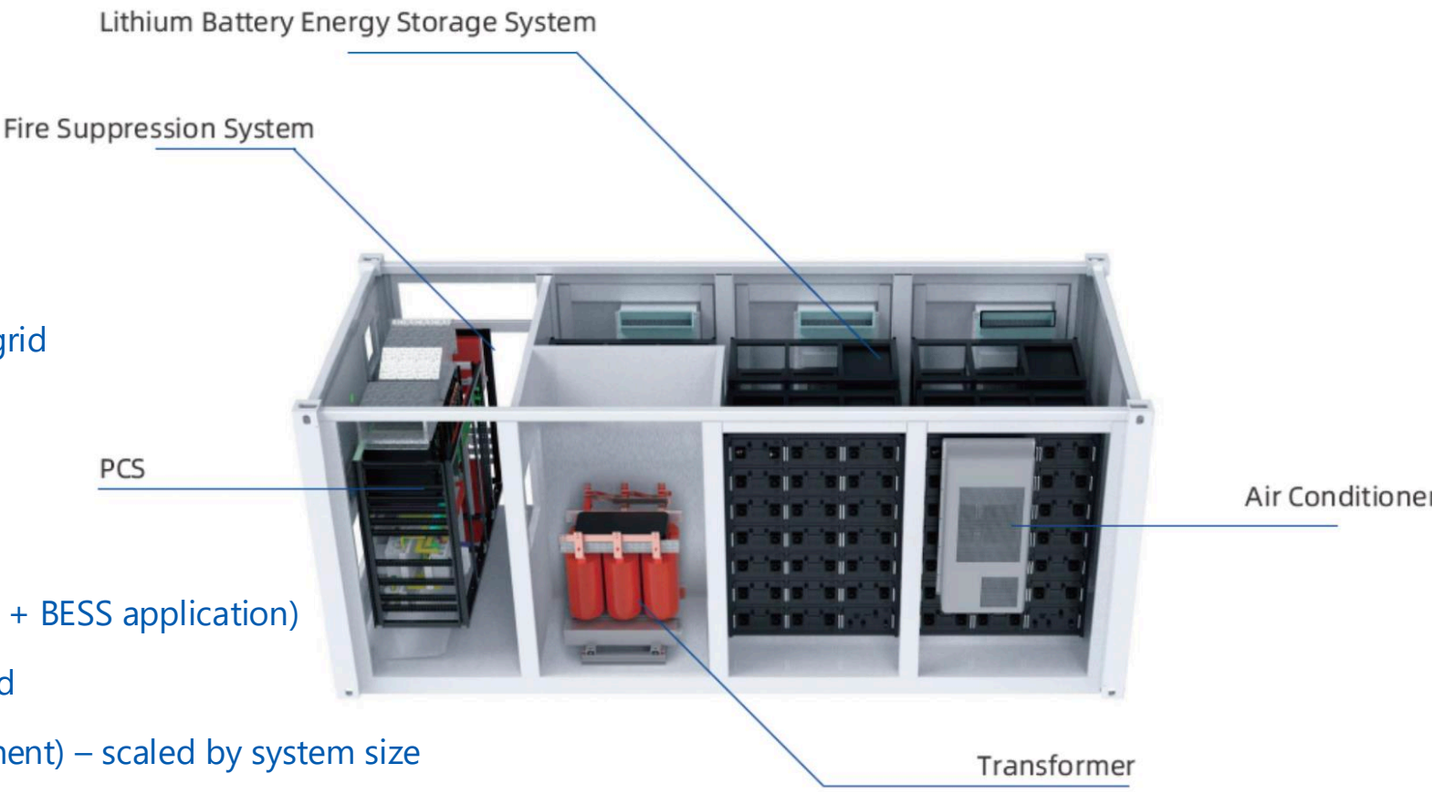
Digital control, grid dispatch & cybersecurity

- Digital Control System (DCS): real-time monitoring per IEC 61724; automated notifications; cloud backup; mobile access
- Minimum weather station equipment: 2 irradiance sensors (GHI + plane-of-array / POA); 2 temperature sensors (ambient + module); wind speed + direction
- SCADA must enable plant control from Armenian Load Dispatch Center (LDC/ECC), including Automatic Generation Control (AGC)
- Single-fault-tolerant design: no single I&C failure shall shut down more than one major plant item or compromise safety
- Cybersecurity: IEC 62443 (industrial systems) and IEC 62351 (data communications)
- Remote diagnostics: secure VPN access for O&M support
- Historical data archive: long-term storage with automated performance analysis

BESS – New Eligibility in Phase VII

Battery Energy Storage Systems: why, what & how

- For the FIRST TIME in Phase VII, Battery Energy Storage Systems (BESS) are eligible under GAF-RE



Why BESS?

- Maximize self-consumption: store excess solar output and use it at night or during low-sun periods
- Peak-shaving: reduce demand peaks and lower grid fees
- Grid frequency support: help stabilize the Armenian power grid
- Backup power: secure supply during grid outages

Key Eligibility Rules

- Must be co-located with the funded PV plant (combined PV + BESS application)
- Commercially proven Li-ion technology (LFP / NMC) required
- Separate MTR requirements apply (Part B of the MTR document) – scaled by system size
- BESS requirements differ by tier: large-scale (full engineering), mid-scale (simplified), residential (basic checklist)

BESS System Architecture

PCS | Battery System | BMS | Controller | Thermal Management

Core BESS Components (Large-Scale)

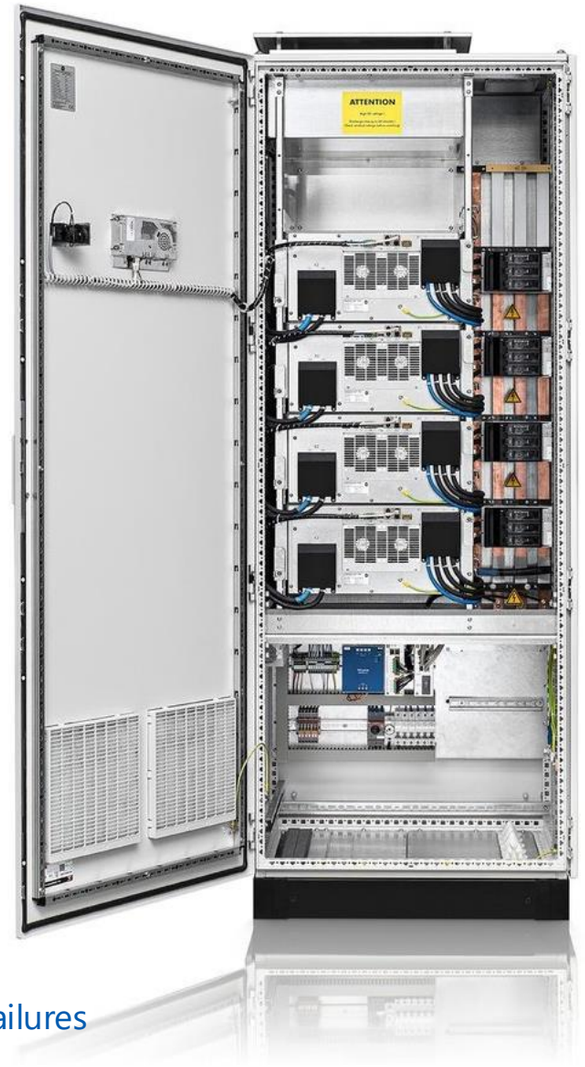
- Power Conversion System (PCS): bi-directional converter (charging & discharging); >97% CEC efficiency; <0.01% idle losses; <3 s to rated power
- Battery System: modular racks; module-level BMS; cell balancing; temperature monitoring; self-discharge <3%/month
- Battery Management System (BMS): monitors SoC, SoH, voltage, current, temperature; controls startup/shutdown; SCADA integration
- BESS Unit Controller: each unit has its own controller (standalone or integrated in PCS/ BMS)
- Thermal Management: active HVAC or liquid cooling to maintain safe temperature range at all times

Design Principles

- Each BESS Unit is IDENTICAL and operates INDEPENDENTLY
  – one unit's failure must not affect others
- Units clearly labelled and separated
  – especially critical for maintenance and emergency response
- System Integration Test (SIT) required: covers startup, fault handling, full functional compliance

BESS Key Technical Requirements (Large-Scale)

PCS | Battery | Cybersecurity | Testing



Power Conversion System (PCS)

- CEC efficiency: >97% at rated power; standby self-consumption <0.01%; transition time to rated power <3 sec
- Surge protection, lockable DC and AC disconnects; IEC 62477-1 and IEC 61000 EMC compliance

Battery System

- Li-ion technology; self-discharge <3%/month; certified per IEC 63056, IEC 62619
- Fire propagation testing: UL 9540A or IEC 62619
- Noise: ≤ 45 dB at nearest sensitive receptor

Cybersecurity

- IEC 62443 (industrial control systems) and IEC 62351 (data communications security)

System Integration Test (SIT)

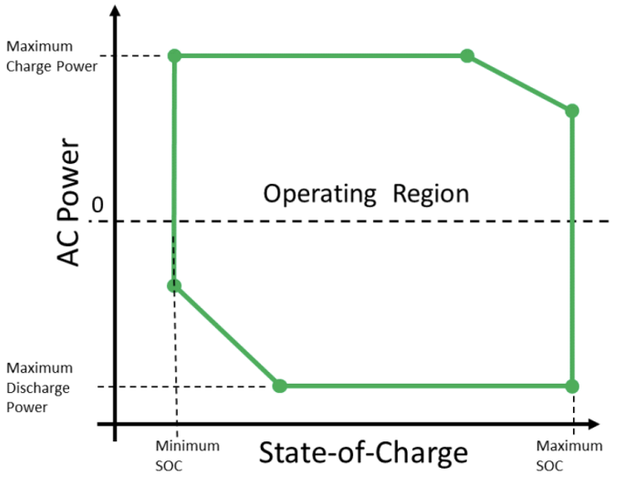
- Factory-level type testing for all equipment unless valid certificates exist
- Site-level SIT: startup, fault handling, full functional compliance – re-testing at contractor's expense for critical failures

BESS Warranties & Performance Guarantees

Large-Scale | Product warranties | Performance warranties | Testing

Product Warranties (Large-Scale BESS)

- Battery system: min. 5-year product warranty (extendable to 15 years); spare parts ≥ 10 years
- Battery system enclosure + BoP: min. 5-year (extendable to 15 years)
- Power Conversion System (PCS): min. 5-year (extendable to 15 years); 10-year spare parts availability
- BESS unit (latent defects): min. 5-year warranty (extendable to 15 years)

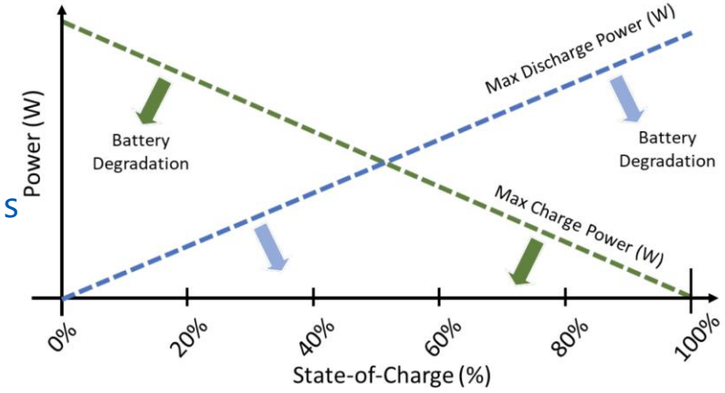


Performance Warranties

- Energy Capacity Warranty: warrants that the BESS delivers its rated energy capacity (tested per IEC 62933-2-1 charge-discharge cycles)
- Availability Warranty: warrants a minimum annual operational availability of the BESS

Performance Testing

- Energy Capacity Test: full charge-discharge cycles at rated power; adjusted for temperature deviations
- Available Energy Estimate Tests: accuracy of SoC/energy predictions (charging and discharging)
- Active & Reactive Power Performance tests: compliance with operational setpoints



Tier Comparison – Key Requirements at a Glance

Requirements scale with project size – same quality foundation for all tiers

Large-Scale
up to 5 MW(AC)

Modules
- Min. 22% efficiency STC (20% if operational)
- Track record: 2 plants ≥ 10 MW; ≥ 50 MW total
- Warranty: 10-yr product / 30-yr power

Inverters
- 96% (central) / 97% (string) CEC efficiency
- 5-year warranty; grid support, cybersecurity

Mounting / Monitoring
- 25-yr warranty; 500 MW manufacturer track record
- Full SCADA + weather station + LDC interface

BESS
- PCS: >97% CEC; <0.01% idle loss; <3 s ramp
- 5-yr warranty (ext. 15); noise ≤ 45 dB

ESHS
- Full ESHS plan; KfW categorization; EIA if required

Mid-Scale
150 kW – 500 kW

Modules
- Min. 22% efficiency STC
- Standard certified modules (IEC 61215 / 61730)
- Warranty: 10-yr product / 25-yr power

Inverters
- 96% (central) / 97% (string) CEC efficiency
- 5-year warranty; IEC compliance

Mounting / Monitoring
- 25-yr warranty; standard market products
- SCADA + monitoring recommended

BESS
- PCS: >95% CEC; pre-commissioned units
- 3-yr warranty (ext. 10); noise ≤ 55 dB

ESHS
- ESHS plan required; EIA generally not required

Small-Scale
up to 150 kW

Modules
- Min. 22% efficiency STC
- Standard certified modules (IEC 61215 / 61730)
- Warranty: 10-yr product / 25-yr power

Inverters
- 97% Euro efficiency; single manufacturer
- Standard IEC compliance

Mounting / Monitoring
- 25-yr warranty; standard products
- Basic monitoring recommended

BESS
- ≥90% round-trip efficiency; LFP preferred
- 5-yr battery / 2-yr PCS warranty; ≤ 40 dB

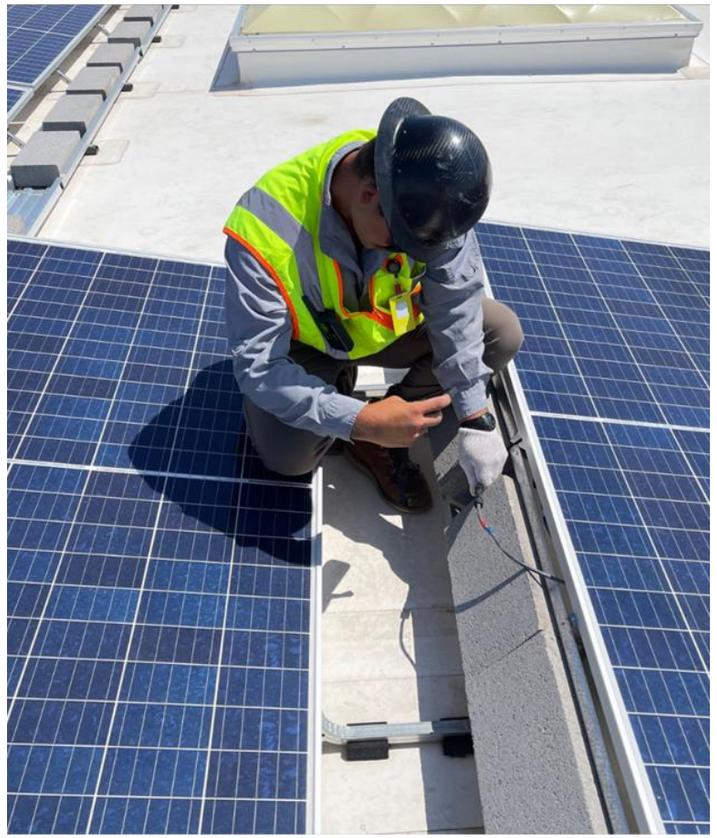
ESHS
- Basic EHS checklist; no EIA required

Smaller-Scale Systems – What Changes?

Requirements simplified but core quality standards maintained

Mid-Scale (150–500 kW) – Simplified, but not relaxed

- Same module efficiency standard (22%) and certifications as large-scale
- Inverter efficiency: same (96% / 97%); warranties: same (5 years)
- Mounting: same standards; but structural justification only if requested by Fichtner / Fund
- Monitoring: SCADA with irradiance & temperature sensors recommended (not mandatory)
- BESS: simplified specs – 95% PCS efficiency, 3-year warranties, pre-commissioned units
- ESHS: ESHS plan required; EIA typically not needed for < 500 kW (confirm with authorities)



Small-Scale (<150 kW) – Checklist-based approach

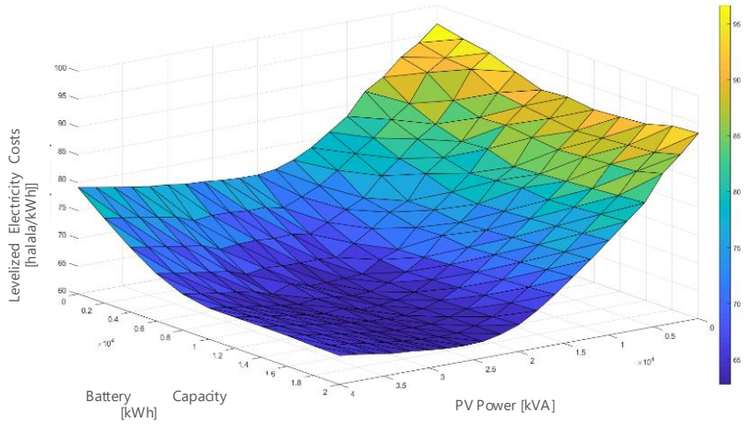
- Same module standards (22% efficiency, IEC certifications, 25-year warranty)
- Inverter: 97% Euro efficiency; same manufacturer throughout
- Structural justification and full earthing justification: only on request by Fichtner / Fund
- Final monitoring only (no interim) for systems < 100 kWp
- BESS: residential/domestic specifications – LFP preferred; 90% round-trip efficiency; 5-year warranty; basic installer certification
- EHS: basic checklist (first aid, PPE, waste management, electrical safety); EIA not required

Optimization within Hybrid power plant

Example: Gold mine in KSA

Technical key figures	
Power Supply	Diesel
Peak load [MW]	17
Annual power consumption [GWh/a]	114.9
Mine lifetime after potential implementation [a]	10 years

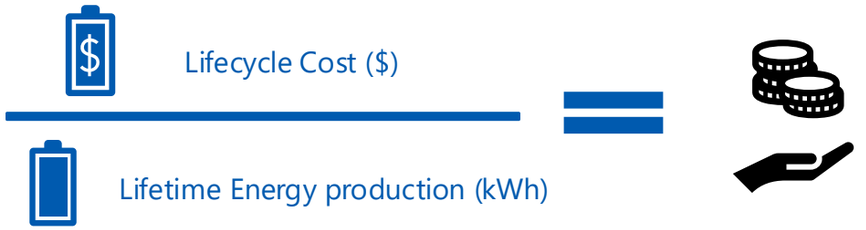
Item	Base Case	Hybrid Optimization
Power Supply	Diesel	Diesel+PV+BESS
PV Size [kVA]	0	26,500
Battery Power [kVA]	0	6,000
Battery Capacity [kWh]	0	12,000
Diesel Generator Power [kW]	28,000	24,000
Diesel Consumption [liters/a]	32,617,508	19,142,477
Levelized Electricity Costs [USDct./kWh]	22.946	16.54
OPEX (Power Supply Costs) [USD/a]	24.7 mio.	15.2 mio.



Levelized Cost of Storage (LCOS)

LCOS for different Energy storage systems

- Is a metric that combines the primary technology cost and performance parameters.
- The LCOS refelects the interal average price at which electricity can be stored for the investment´s net present values to be zero.
- The LCOS approach is utilized to compare storage systems specific among each other.
- Key parameters that affect the LCOS are nominal power capacity, discharge duration, annual cycles and electricity price.



Driver	Reduce LCOS
Battery Costs	Lower capital cost
Asset Lifetime	Longer lifetime
Degradation	Minimal degradation
Round-Trip-Efficiency (RTE)	Higher RTE
Charge Price	Lower charge price
Discount Rate	Lower discount rate

$$LCOS[\frac{\$}{MWh}] = \frac{Invertment\ cost + \sum_n^N \frac{O\&M\ cost}{(1+r)^n}}{\sum_n^N \frac{Total\ amount\ of\ energy\ discharged\ through\ the\ BESS}{(1+r)^n}}$$

Each year of life (n), system lifetime (N), discount rate (r), operation and maintenance (O&M)

Capital and Operational Expenditure of BESS

Composition of CAPEX & OPEX

CAPEX category	Description
System	Mainly driven by the chosen battery chemistry, power and storage duration. ▪ Battery modules ▪ Management systems ▪ Balance of Plant components
Connection	▪ Connection fee ▪ Connection equipment ▪ Energy-management system
Construction	▪ Engineering, procurement and construction (EPC) and developer profits ▪ Labor and equipment costs
Land	Costs associated with acquisition/ leasing of land varies by cases
Other	Permits, advisors, financing, studies, regulatory, tax

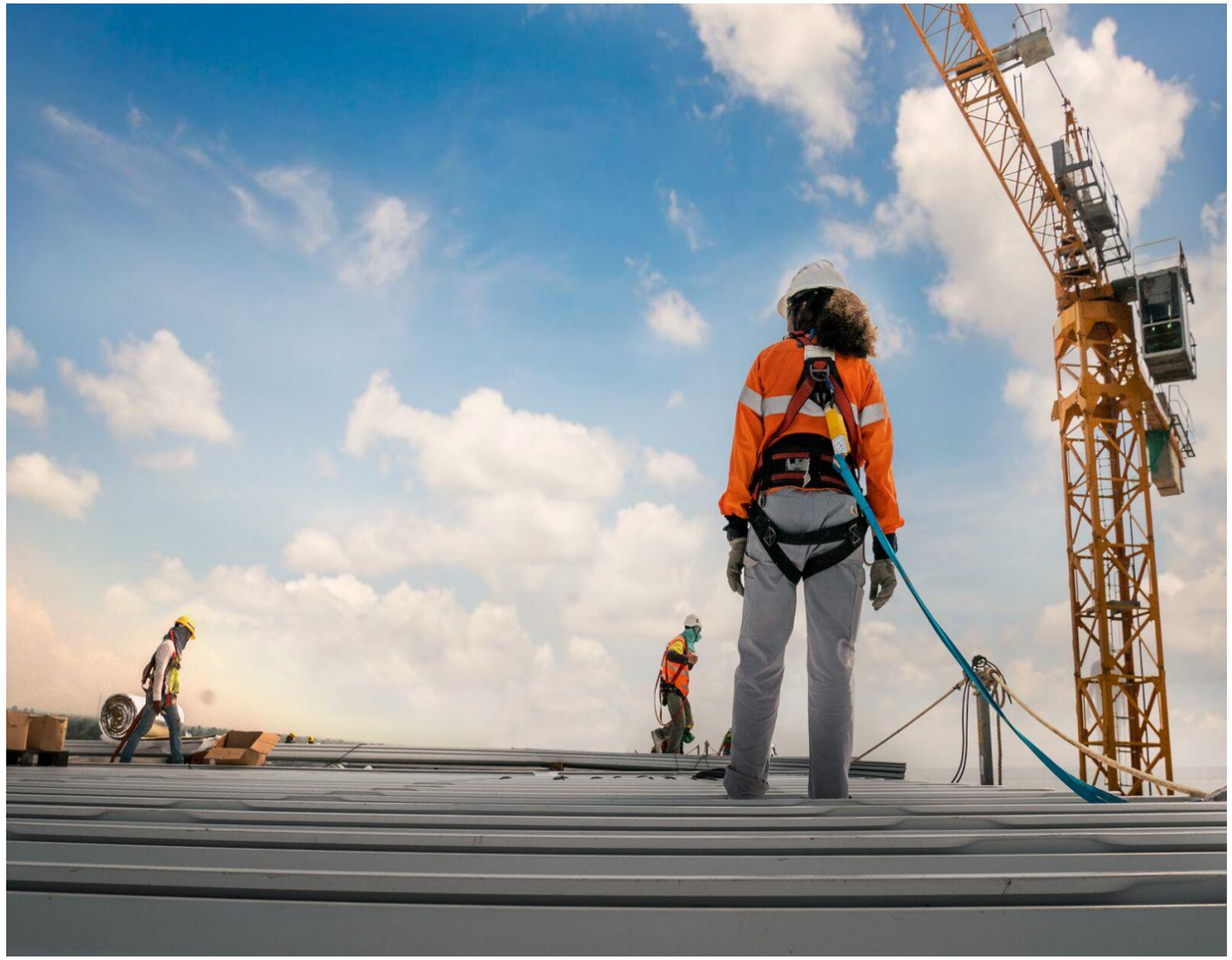
OPEX category		Description
Variable costs	**Operations and maintenance (O&M)**	Includes general, scheduled and unscheduled maintenance; varying degrees of operations services depending on provider.
	Replacement of parts	Replacement of consumable parts.
	Grid fees	Fees paid to transmission and distribution system operators; vary by market and location.
	Electricity costs	Cost of electricity used for charging and operating.
	Optimizer costs	Costs incurred by optimizer
Fixed costs	**Operating labour and monitoring services**	Labor for day-to-day operation of BESS; may come as part of purchase or through optimizer/ O&M.
	Property payments	Property taxes, land lease if applicable.
	Insurance	Insurance for BESS.
	Administrative	Administrative fees and labor.

Source: Unlocking the potential: Navigating key considerations in battery energy storage systems (crai.com)

ESHS – Environmental, Social, Health & Safety

KfW 2024 Guideline | EIA | HSE Plan | Signage requirements

- KfW environmental categorization (2024 Guideline): A (high risk) | B+ (substantial) | B (moderate) | C (low risk)
- Environmental Impact Assessment (EIA): required under RA law if triggered – Positive Conclusion must be submitted before Final Monitoring or risk loan recall
- Comprehensive Construction ESHS Plan and Operation ESHS Plan required from the Developer
- Safety signage: bilingual (Armenian & English); IEC 60417 / ISO 3864; durable, UV-stable; 25-year lifetime
- Worker safety: PPE, electrical safety, safe scaffolding, first aid, fire extinguishers, waste management
- Noise limits: ≤ 45 dB at nearest sensitive receptor (for BESS)
- Complaint mechanism during construction and operation



Health and Safety

Personal Protective Equipment (PPE)

The minimum PPE set shall include

- Safety helmet
- Gloves
- Hi-visibility vest
- Safety shoes (steel cap toe)

During operation

- Hi-visibility vest
- Dielectric gloves
- Dielectric shoes

Other PPE depending on task

- Harness – working at height
- Mask/Respirator – excavation, dusty conditions
- Etc.



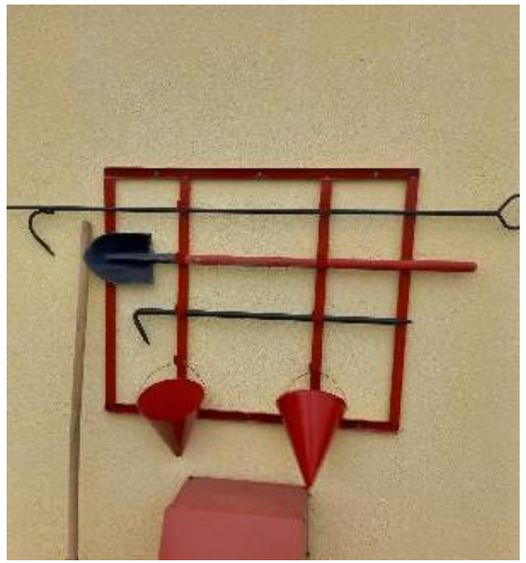



Health and Safety

Fire extinguisher

Fire extinguishers should be available near the transformer, BESS, hazardous waste storage, and flammable materials storage.

Portable extinguishers should also have valid expiry date.



BESS – Environmental Safeguards On Site

What the site operator must provide – not covered by the containerized BESS unit

Soil & Groundwater Protection

- Isolation valves and oil/water separators in site drainage channels; no uncontrolled spill pathway to stormwater or soil
- On-site spill kits (absorbent mats, soda ash/neutralizer); documented site-level environmental emergency response procedure

Waste Management

- Colour-coded, labelled containers: hazardous waste (damaged cells, contaminated PPE) strictly separate from general site waste
- Sealed, ventilated temporary storage on-site; transport only via licensed carrier following UN ADR requirements; waste manifest documentation
- Decommissioning plan with certified battery recycler identified before commissioning – required as part of project documentation

BESS – OHS Requirements for Site Personnel

Site-level safety obligations for personnel working on and around containerized BESS

Electrical Safety

- Lockout-tagout (LOTO) mandatory before any maintenance on BESS circuits; only trained and certified personnel may access high-voltage DC/AC systems; insulated tools rated for system voltage; arc-rated PPE (suit, gloves, face shield)

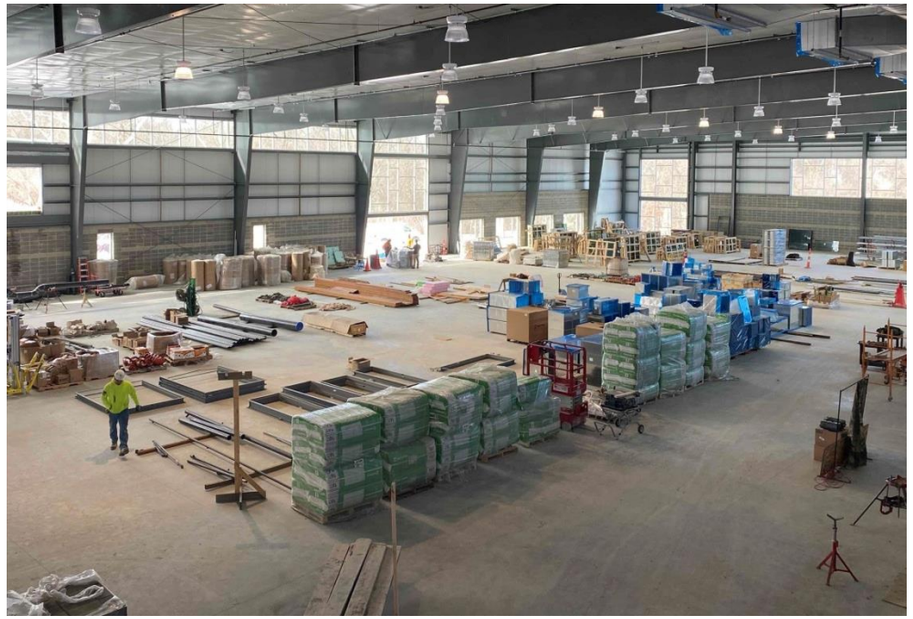
Emergency Response

- Site-specific BESS emergency response plan covering: thermal runaway event, HF gas release, electrolyte spill – including evacuation zones and PPE requirements for each scenario
- Coordinate with local fire service before commissioning; eyewash station and chemical first-aid kit on site; minimum 20 m safety perimeter during thermal events

Signage & Training

- IEC 60417 / ISO 7010 hazard symbols; high-voltage and chemical hazard warnings in bilingual Armenian & English; warning labels on all access doors and electrical panels
- Documented OHS training for all site personnel on lithium-ion specific hazards (IEC 62933-1-1); periodic emergency drills; training records maintained

Good Vs. Bad Housekeeping



Good Housekeeping	Poor Housekeeping
Good storage = less wastages and saving money	Poor storage = excess purchases and wastage
Contained Oil drums	Oil spills, wastage resulting in costs and pollution
Waste sorted and stored appropriately	Fly waste all over property and surrounds
Reduce potential for accident and incidents	Increased potential for accident and incidents
Better moral	No care attitude

ESHS Housekeeping

Best practices for proper housekeeping

Proper housekeeping must be provided on the construction site not only after completion of construction works, but continuously during construction.

Actions	Objective
▪ Periodical removal of trash and debris shall be organized ▪ all types of waste shall be collected and disposed of off site ▪ solid waste shall be kept in a covered container, construction waste shall be collected at a separately allocated area ▪ construction and packaging materials must be collected and stored properly and not be spread on site ▪ construction waste shall be transported from the area (usually it is Contractor's responsibility) and disposed of at the community landfill (landfill, dumpsite) upon written consent of the community head.	**Best practices for proper housekeeping** 

Waste Management On and Off Site

Construction period – hazardous waste

- Hazardous waste is classified in accordance with the Decree of the Minister of Environment N 430 dated 25.12.2006.
- Barrels with transformer oil or diesel should be stored on a waterproof surface and under cover to avoid direct sunlight.
- Secondary containment with a volume of 110% of the volume of drums or oil container shall be provided. The oil barrels/containers shall be properly labelled. The fire extinguisher shall be placed not far from the storage location.

05

Application Process

Application Process - Step-by-Step Guidance

Application Workflow

Duration of the application workflow covering eligibility screening, evaluation of applications, site visits, clarifications and technical assessment depends on the capacity class of the project.

Up to 5MW PV (new or under construction)

STEP 1
Preliminary Screening

IN:
- ✓ Application form
- ✓ First set of docs

OUT:
- ➢ Applicant update
- ➢ Request to provide missing data & clarification of provided info

STEP 2
Full Screening

IN:
- ✓ Missing data
- ✓ Clarifications

OUT:
- ➢ Applicant update
- ➢ Rejection of shortlisting
- ➢ Requesting second set of docs

STEP 3
Evaluation

IN:
- ✓ Second set of docs
- ✓ Clarifications

OUT:
- ➢ Request of additional data (site visit)
- ➢ Evaluation List
- ➢ Qualified for TA (Y/N)
- ➢ Third set of docs (?)

STEP 4
Technical Assessment

IN:
- ✓ Full set of docs
- ✓ Issue List
- ✓ WWF input

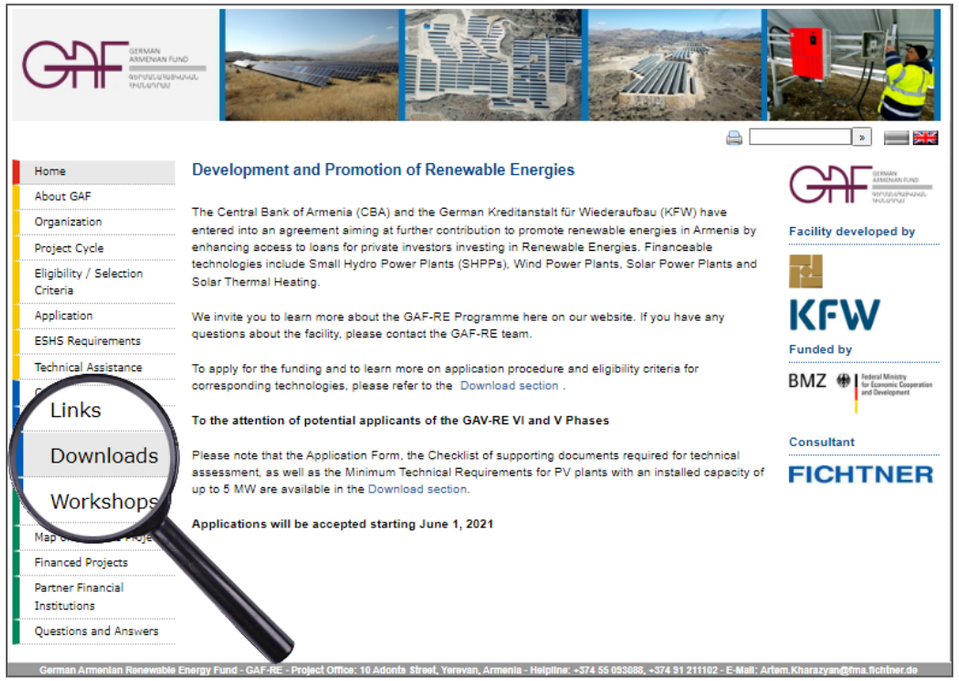
OUT:
- ➢ Formal Applicant notification
- ➢ Issuance of TA Report

Email is the **primary** method of communication and document flow, with the option of clarifying the evaluation and approval procedure or document requirements via video or phone calls with a contact person in Armenia.

Application Process - Step-by-Step Guidance

Application Workflow: Application Forms

Website: re.gaf.am



Downloads

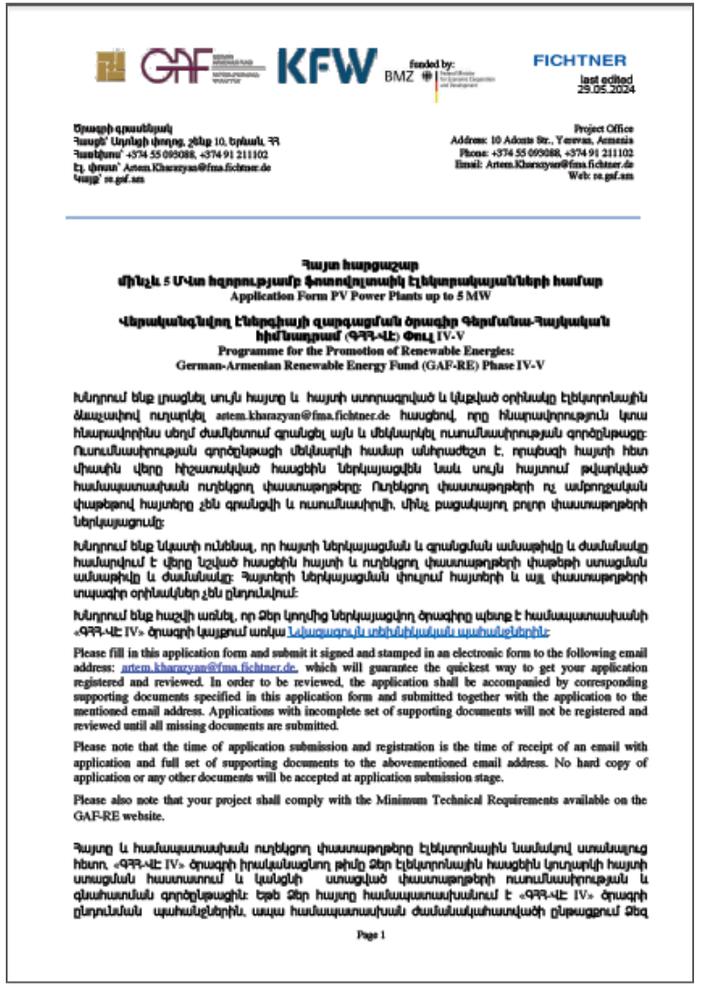
Forms and Checklist for Required Documents

- Application Form for PV Plants up to 500 kW
- Application Form for PV Plants up to 5 MW
- Checklist of Required Documents for TA of up to 5 MW PV Plants
- Application Form and Checklist for Battery Energy Storage Systems (BESS)
- Application Form and Checklist for Small-Scale BESS

Checklists of the required documents for BESS projects are integrated into the corresponding Application Forms!

Application Process - Step-by-Step Guidance

Application Workflow: Application Forms for Large-Scale Projects (general requirements)



GAF KFW funded by: BMZ FICHTNER

last edited 29.05.2024

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Email: Artem.Kharazyan@fma.fichtner.de
Web: re.gaf.am

Հայտ հաղորդաշար
մինչև 5 ՄՎտ հզորությամբ ֆոտովոլտային էլեկտրակայանների համար
Application Form PV Power Plants up to 5 MW

Վերականգնվող էներգիայի զարգացման ծրագիր Գերմանա-Հայկական հիմնադրամ (ԳԳՀ-ՎԷ) Փուլ IV-V
Programme for the Promotion of Renewable Energies:
German-Armenian Renewable Energy Fund (GAF-RE) Phase IV-V

Խնդրում ենք լրացնել սույն հայտը և հայտի ստորագրված և կնքված օրինակը էլեկտրոնային ձևաչափով ուղարկել artem.kharazyan@fma.fichtner.de հասցեով, որը հնարավորություն կտա հնարավորինս սեղմ ժամկետում զրանցել այն և մեկնարկել ուսումնասիրության գործընթացը: Ուսումնասիրության գործընթացի մեկնարկի համար անհրաժեշտ է, որպեսզի հայտի հետ միասին վերը հիշատակված հասցեին ներկայացվեն նաև սույն հայտում թվարկված հավելվածում ուղեկցող փաստաթղթերը: Ուղեկցող փաստաթղթերի ոչ ամբողջական փաթեթով հայտերը չեն զրանցվի և ուսումնասիրվի, մինչ բացակայող բոլոր փաստաթղթերի ներկայացումը:

Խնդրում ենք նկատի ունենալ, որ հայտի ներկայացման և զրանցման ամսաթիվը և ժամանակը համարվում է վերը նշված հասցեին հայտի և ուղեկցող փաստաթղթերի փաթեթի ստացման ամսաթիվը և ժամանակը: Հայտերի ներկայացման փուլում հայտերի և այլ փաստաթղթերի տպագիր օրինակներ չեն ընդունվում:

Խնդրում ենք հաշվի առնել, որ Ձեր կողմից ներկայացվող ծրագիրը պետք է համապատասխանի «ԳԳՀ-ՎԷ IV» ծրագրի կայքում առկա Նվազագույն տեխնիկական պահանջներին:

Please fill in this application form and submit it signed and stamped in an electronic form to the following email address: artem.kharazyan@fma.fichtner.de, which will guarantee the quickest way to get your application registered and reviewed. In order to be reviewed, the application shall be accompanied by corresponding supporting documents specified in this application form and submitted together with the application to the mentioned email address. Applications with incomplete set of supporting documents will not be registered and reviewed until all missing documents are submitted.

Please note that the time of application submission and registration is the time of receipt of an email with application and full set of supporting documents to the abovementioned email address. No hard copy of application or any other documents will be accepted at application submission stage.

Please also note that your project shall comply with the Minimum Technical Requirements available on the GAF-RE website.

Հայտը և համապատասխան ուղեկցող փաստաթղթերը էլեկտրոնային նամակով ստանալուց հետո, «ԳԳՀ-ՎԷ IV» ծրագրի իրականացնող թիմը Ձեր էլեկտրոնային հասցեին կուղարկի հայտի ստացման հաստատում և կսկսվի ստացված փաստաթղթերի ուսումնասիրության և գնահատման գործընթացին: Եթե Ձեր հայտը համապատասխանում է «ԳԳՀ-ՎԷ IV» ծրագրի ընտրվելու պահանջներին, ապա համապատասխան ժամանակահատվածի ընթացքում Ձեզ

Page 1

- Filled out as **completely** as possible based on the available data;
- Submitted **signed** and **stamped** in an **electronic** form;
- Submission to: artem.kharazyan@fma.fichtner.de;
- Submission of corresponding **supporting documents** specified in the Application Form and Checklist;
- The **completeness** of information and supporting documents guarantee **quick registration** and **evaluation** of the application;
- Applications with **incomplete** set of supporting documents will **not be registered** until all missing documents are submitted;
- No **hard copy** of application or any other documents are accepted;
- **Compliance** of the project with **MTRs** shall be noted;
- Applicants are **notified** of the **receipt** of the documents via email;
- In case of meeting eligibility requirements the **screening** and **evaluation** process is launched.

Application Process - Step-by-Step Guidance

Application Workflow: Application Form for up to 5MW PV (content)

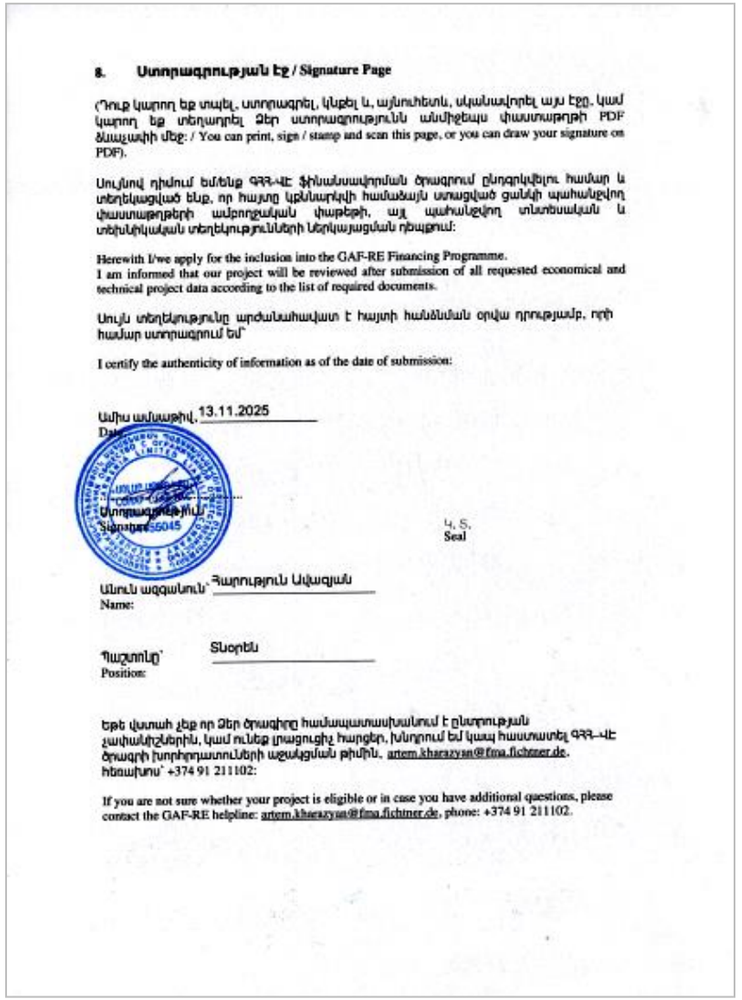
1. Project Name
2. Contact Data
3. Applicant Company Profile
4. Description of the Proposed Project
   - *a. Narrative (status, technology, PV panels, inverters, transformers, support structures, capacity, size, location, interconnection, etc.)*
   - *b. Technical summary*
   - *c. Status of project development*
   - *d. Financial summary*
5) Project Costs and Financing

a) Investment budget

b) Operation and maintenance costs

c) Target capital structure (excluding GAF-RE loan)

6. Information on Environmental Impact Assessment
7. Environmental and Social Sensitivity (WWF Input)
8. Signature Page



8. Ստորագրության էջ / Signature Page

(Դուք կարող եք տպել, ստորագրել, կնքել և, այնուհետև, սկանավորել այս էջը, կամ կարող եք տեղադրել Ձեր ստորագրությունն անմիջապես փաստաթղթի PDF ձևաչափի մեջ: / You can print, sign / stamp and scan this page, or you can draw your signature on PDF).

Սույնով դիմում եմ/ենք ԳՋՀ-ԱԷ ֆինանսավորման ծրագրում ընդգրկվելու համար և տեղեկացված ենք, որ հայտը կքննարկվի համաձայն ստացված ցանկի պահանջվող փաստաթղթերի ամբողջական փաթեթի, այլ պահանջվող տնտեսական և տեխնիկական տեղեկությունների Ներկայացման դեպքում:

Herewith I/we apply for the inclusion into the GAF-RE Financing Programme.
I am informed that our project will be reviewed after submission of all requested economical and technical project data according to the list of required documents.

Սույն տեղեկությունը արժանահավատ է հայտի հանձնման օրվա դրությամբ, որի համար ստորագրում եմ՝

I certify the authenticity of information as of the date of submission:

Ամիս ամսաթիվ, 13.11.2025
Date:

Ստորագրություն՝
Signature:

Կ. Տ.
Seal

Անուն ազգանուն՝ Հայրություն Ավազյան
Name:

Պաշտոնը՝ Տնօրեն
Position:

Եթե վստահ չեք որ Ձեր ծրագիրը համապատասխանում է ընտրության չափանիշներին, կամ ունեք լրացուցիչ հարցեր, խնդրում եմ կապ հաստատել ԳՋՀ-ԱԷ ծրագրի խորհրդատուների աջակցման թիմին, artem.kharazyan@fma.fichtner.de, հեռախոս՝ +374 91 211102:

If you are not sure whether your project is eligible or in case you have additional questions, please contact the GAF-RE helpline: artem.kharazyan@fma.fichtner.de, phone: +374 91 211102.

Application Process - Step-by-Step Guidance

Application Workflow: Checklist for up to 5MW PV - new or under construction (key supporting documents)

First Set of Supporting Docs	Second Set of SD	Third Set of SD
• Land coordinates and ownership • Information Company / Owner • Layout plan of evacuation line • Preliminary TC for grid connection • PSRC license • Solar resource assessment • Energy yield assessment • EIA Report (if applicable) • Design basis report (civil) • Electrical single line diagram • Photos, schedule, costs estimation • Business Plan • Specifications, certificates and purchase agreements of equipment	• Final TC for grid connection • Topographic survey report • Geotechnical study • Structural analysis of mounting structure and foundation • Design basis report (electrical and mechanical • Detailed design of the project and drawings (in PDF format) • Costs estimation (updated) • EPC contract • O&M concept including budget	• Environmental and Social Management Plan for Construction & Operation Phase (if available at the application stage or to be developed upon granting of funds) • Stakeholders Engagement Plant (if requested) • Biodiversity Assessment Report (in case of any special or protected natural areas are engaged - WWF)

Application Process - Step-by-Step Guidance

Application Workflow: Application Form for Battery Energy Storage Systems (BESS)

1. Project Name
2. Contact Data of Applicant
3. Applicant Company Profile
4. Description of the Proposed Project
   a. Narrative (battery cells, battery management system, power conversion system, energy management system, etc.)
   b. Project configuration type:
      - Stand-alone BESS
      - Co-located with existing / new PV plant
      - Hybrid AC/DC-coupled system
   c. Location of the project site
   d. Proximity to other energy facilities
5. Technical Data of the BESS
   a. BESS specifications
   b. Power Conversion System) / Inverter Specifications
   c. Energy Management System (EMS)
   d. Auxiliary Systems
   e. Transformer and Grid Connection
   f. Co-located PV Plant Data (if applicable)
   g. Expected Performance
6. EPC Contractor
7. Project Status and Timeline
8. Financial Data (cost breakdown , financing structure, operating revenue and expenses, project financial indicators, etc.)
9. Environmental, Health, and Safety
10. Grid Integration and Technical Requirements

Application Process - Step-by-Step Guidance

Application Workflow: Checklist for BESS: new, under construction and operational (key supporting documents)

First Set of Supporting Documents (SD)	Second Set of SD	Third Set of SD
• Land coordinates and ownership • Information on Company / Owner • Layout plan of evacuation line • Preliminary TC for grid connection • PSRC license • Grid data assessment (historical load profiles, grid frequency data, voltage stability data) • Solar resource assessment (PV) • BESS performance calculation • PV energy production calculation • EIA Report (if applicable) • Land acquisition plan (if applicable) • Design basis report (civil)	• Final TC for grid connection • Topographic survey report • Geotechnical study • Structural analysis of battery container foundations and mounting structures • Load-bearing capacity analysis for equipment • Fire risk assessment and fire safety plan for battery storage facility • Emergency response plan • Health and safety management plan for construction and operation	• Environmental and Social Management Plan for Construction & Operation Phase (if available at the application stage or upon granting of funds) • Stakeholders Engagement Plant (if requested) • Biodiversity Assessment Report (in case of any special or protected natural areas are engaged - WWF) • Factory Acceptance Test protocol for battery and PCS (before delivery to site) • Site Acceptance Test (after installation)

Application Process - Step-by-Step Guidance

Application Workflow: Checklist for BESS: new, under construction and operational (key supporting documents)

First Set of SD	Second Set of SD
• Electrical single line diagram • Photos, schedule, costs estimation • Implementation schedule • Cost estimation • Business Plan • Detailed financing plan showing equity, debt, and other sources • Specifications and certificates • Battery warranty documentation • Purchase agreements • Supply contract or binding offers • Grid services agreement or PPA • PV plant technical specifications • PV-BESS integration study	• Design basis report (electrical and mechanical) • Detailed design of the project and drawings (in PDF format) • Battery system layout drawings (container arrangement, rack configuration, cooling system, access pathways) • Fire suppression system layout and design drawings • EPC contract or System Integration contract • O&M concept including budget • Insurance certificate or insurance proposal (covering fire, equipment breakdown, business interruption, liability) • Grid code compliance (type test) certificates from equipment manufacturers

Application Process - Step-by-Step Guidance

Assessment of Environmental Sensitivity of Large-Scale Projects (WWF Input into TA Report)

Since July 2021 the collaboration with WWF Armenia has been maintained to evaluate **environmental sensitivity** of up to 5 MW PV projects through the following activities:

- Evaluation of the level of **potential impact** of the project activity and infrastructure to the identified sensitive zones and ecosystems;
- Development of recommendations on suitable **mitigation** activities.

Based on the data available, the WWF concludes if a project is expected or not expected to have negative impact on biodiversity by evaluating distance of a project site for the following sensitive areas: Key Biodiversity Areas (**KBA**), Important Plant Areas (**IPA**), Important Bird Areas (**IBA**), Community Conservation Area (**CCA**) and Emerald Sites. WWF conclusions are **integrated** into TA Reports.

In case of proximity of the project site to the above areas WWF recommends Investors engaging an appropriate **botanist** to assess plants' diversity. In the case of finding any red listed species, a **translocation plan** should be developed by relevant botanists and approved by the state authority.

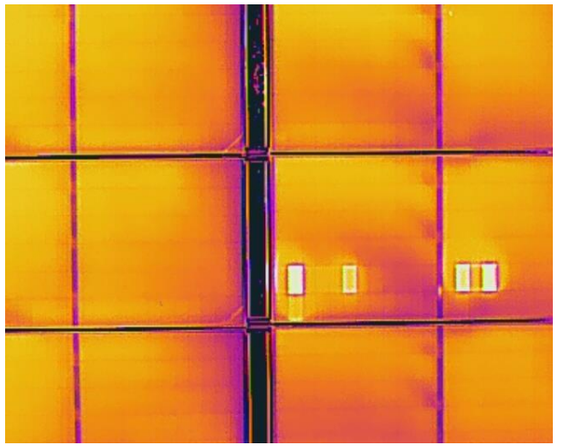
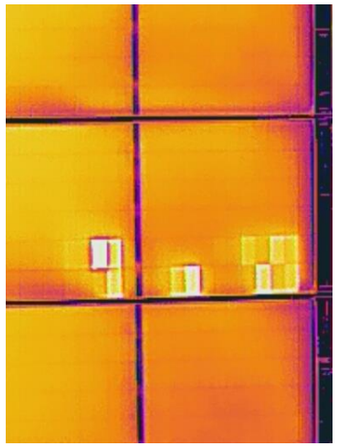
Botanical surveys are to be organized and financed by Investors / Applicants and the results to be **integrated** into the TA Report. **Mitigation measures** are implemented by Investors / Applicants.

Application Process - Step-by-Step Guidance

Additional Data Input and Studies

Depending on the technologies used, the results of the assessment of project documentation and outcomes of monitoring visits, additional data confirming the sustainability of the project may be required during the project implementation process.

For instance a **drone IR-imaging inspection** can be requested.

Depending on the severity level of the detected anomalies, such as multiple hot spot soiling, glass breakage, etc. corresponding mitigation measures shall be taken before the next loan disbursement.

Application Process - Step-by-Step Guidance

Guidance on Document Preparation

The **completeness** and reliability of the information provided significantly impact the speed of project evaluation and approval.

Incompleteness of the application package is the most common cause of evaluation **delay**.

To facilitate the submission process, the following support to applicants is available:

- **Individual consultations** on the format, content and purpose of the required documentation
  (email communication with the Consultant's local or international team);
- Detailed and periodically updated **instructions** in the **"Questions & Answers"** section of the website;

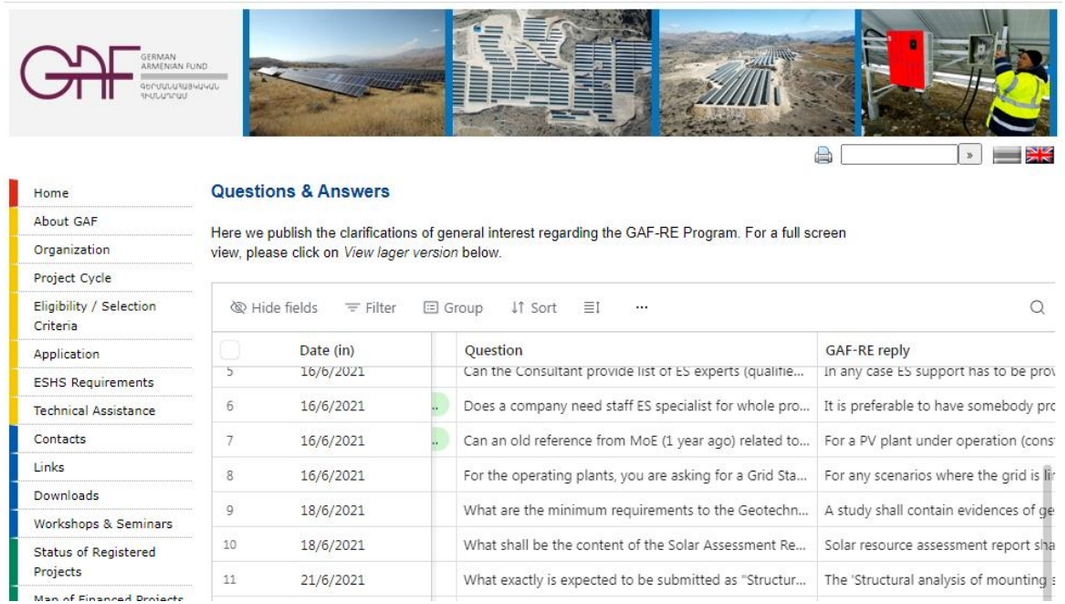
- **Sample documents** from the successfully appraised projects shared with the applicants upon request;

- **Recommendations** on local experts with knowledge and qualifications to prepare documents.

Application Process - Step-by-Step Guidance

Guidance on Document Preparation

Questions & Answers



Question: What is expected to be reported under Design Basis Report?

Answer: The point of Design Basis Report (DBR) is not a repetition of the data sheets and drawings that shall be provided separately anyway, but the explanation of the design approach and assumptions (such as design loads, site conditions, service life, etc.), as well as rationale for selection of specific structural components, mechanical and electrical systems, layout, etc.

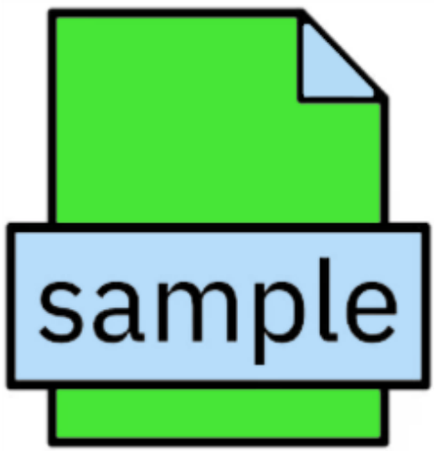
Question: What shall be the content of the Solar Assessment Report?

Answer: Solar resource assessment report shall cover at least the following topics: solar resource (e.g. Solargis), on-site measurements, methodology, determination of global and diffuse horizontal irradiance, inter annual variability, uncertainty of solar resource and conclusions.

Application Process - Step-by-Step Guidance

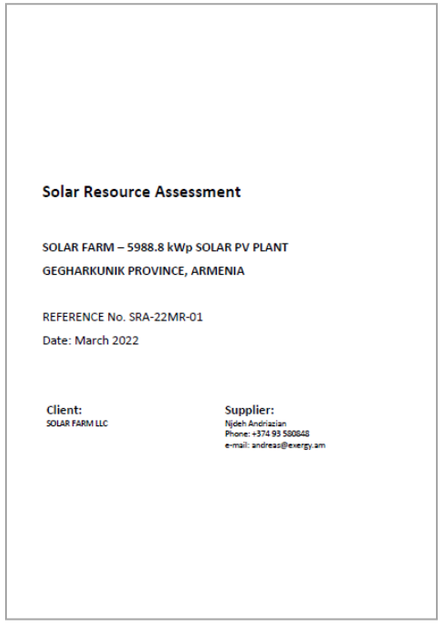
Guidance on Document Preparation

Sharing Sample Documents

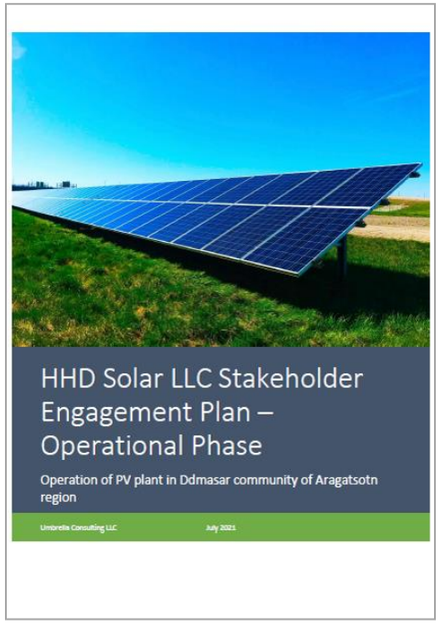


O&M Manual

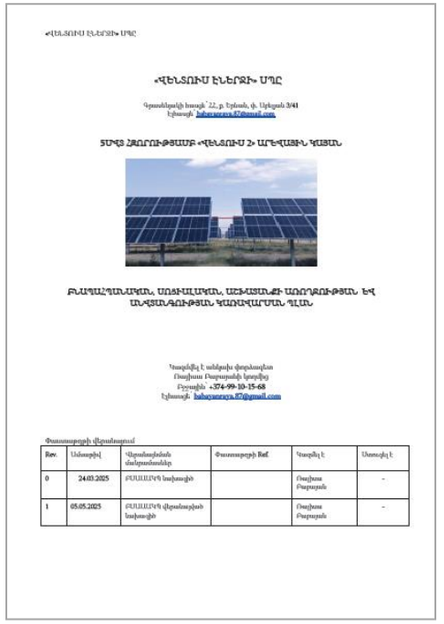
Design-Basis Report



Solar Resource Assessment



Stakeholders Engagement Plan



ESH Management Plan

Application Process - Step-by-Step Guidance

Borrower Corrective Action List of TA Report / Issue List of Monitoring Reports

If, in the course of project evaluation and Technical Assessment of a new project, construction and/or installation work is carried out at the project site, then a **due diligence monitoring visit** is organized to collect information for the report and determine if the work being carried out **complies** with the requirements of the Program.

Deficiencies identified during a monitoring visit and recommended rectifications are outlined in the **Borrower Corrective Action List** to be annexed to the TA Report and to be **implemented** by an applicant as a **pre-condition** for disbursement of the second tranche of the loan.

7 Annex 2: Borrower Corrective Action List

In the course of project evaluation and Technical Assessment, Fichtner performed a site inspection on 25 July 2025 and shared a comprehensive site inspection protocol with the Owner. Derived from that was the following Issue List comprising the immediate corrective action to be taken (UC23_Areg 1 Plant IL_25.07.2025 (Updated on 16.09.25).xlsx). Part of it is already done in the meantime. Items that are still open or ongoing will need to be closed before the disbursement of the final loan tranche of 10%. Fichtner will double check the closed items during the site monitoring visit(s).

N	Category	Issue	Explanation	Action required	Priority	Date commitment	Status	Investor comment	Fichtner reply
1	Electrical	DC LV wire labelling at inverters	Although DC LV cables were labelled/numbered initially, due to improper marking, most of them are not visible or are missing.	DC LV cables are to be fully labelled and numbered at inverter.	1	30/09/2025	closed	DC cables are properly labelled before the committed date.	Photos demonstrating the labels installed on all the DC strings are provided to Fichtner. The results and quality of the rectification will be checked during the next monitoring visit.

Application Process - Step-by-Step Guidance

Borrower Corrective Action List of TA Report / Issue List of Monitoring Reports

The List provides the following information:

- **Category** *(e.g. Electrical)*
- **Issue** *(e.g. Exposed gaps at the end of conduits)*
- **Explanation** *(e.g. Open gaps remain at the conduit ends, some of which are partially filled with degraded PU foam, allowing moisture and dust to enter)*
- **Action required** *(e.g. the gaps should be fully sealed and covered with bituminous sealant; the damaged conduit should be replaced with UV-resistant materials or properly repaired)*
- **Priority level** *(e.g. Immediate)*
- **Date Commitment** *(the deadline for implementation of rectification proposed by an applicant)*
- **Status** *(status of implementation at the moment of submission or report - open, ongoing or closed)*
- **Investor comment:** (*comments of the applicant on implementation of the rectification, i.e. UV-resistant tape will be wrapped around the pipes to prevent cracking and future damage)*
- **Fichtner reply** *(e.g. Please provide photos demonstrating the results of the rectifications, once the work is completed, the results and quality of the rectification will be checked during the next monitoring visit)*

Application Process - Step-by-Step Guidance

Borrower Corrective Action List of TA Report / Issue List of Monitoring Reports

Information on the correction of defects can be provided in **electronic form** (photographs and documents), however, the actual implementation and quality of the work performed is subsequently checked during **monitoring missions**.

DC cable labeling

Safety and information signs

Protection of cable conduits

Application Process - Step-by-Step Guidance

Specific Points for EPC Contractors

The role of **EPC Contractors** in preparing technically accurate and complete design and project documentation is **critical** to ensure timely **acceptance** and **positive evaluation** of applications.

Applications relying on design documents that **do not reflect as-built conditions will not be accepted.**

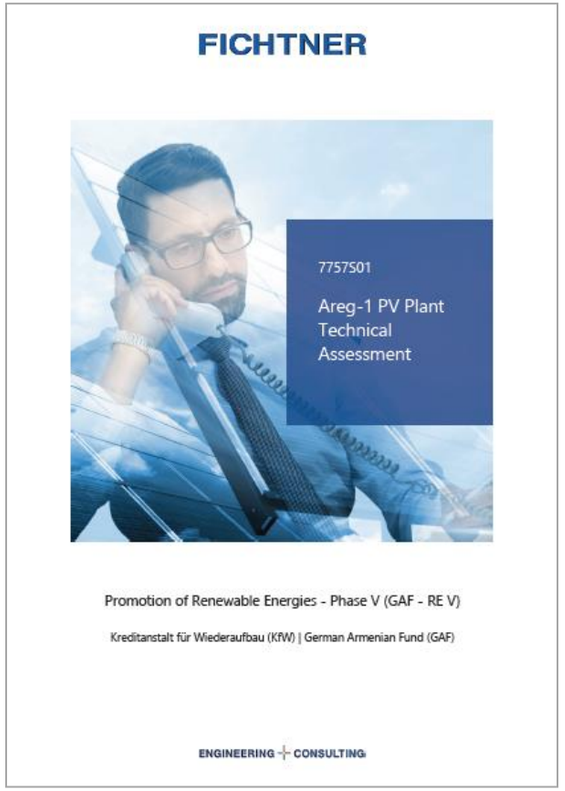
Some key points:

- Provide **complete set of drawings** in line with the requirements, e.g. site plan, single-line electrical diagrams, AC/DC wiring, inverter layout, mounting structure and foundation details, substation and grid connection, cable routing, and structural layouts with clear scales and legends;
- Ensure **site plan accuracy**: show true property boundaries, building footprints, shading obstacles, access routes, orientation (true north arrow), and exact proposed array locations, etc.;
- Verify **as-built conditions**: conduct a field survey and incorporate measured site features;
- Include **detailed equipment specifications**: make/model, datasheets (PV modules, inverters, transformers, combiner boxes, mounting systems, BESS, etc.) warranty terms, and compliance certificates;
- Perform and document **structural assessment**: roof load capacities or foundation design calculations;
- Submit accurate single-line diagram and AC interconnection details;
- Show site **safety** and **access details** and ensure **regulatory** and **standard compliance**.

Application Process - Step-by-Step Guidance

Technical Assessment Report for Large-Scale PV Projects

- Prepared based on the documentation and data **made available** to Fichtner at the time of writing.
- The content of this expert appraisal is **confidential** and intended for the exclusive use of the client.
- Subject to the approval of **GAF** and **KfW**.
- The Report provides:
  - ✓ **Technical Assessment** (permitting and licensing, reviewed documents, findings, risks and mitigations for key components such as PV modules, inverters, transformers, electric works, grid connection, foundation and mounting structure, site security, operation monitoring, etc.).
  - ✓ **Environmental, Social, Health and Safety Analysis** (ESHS Assessment Methodology, WWF conclusion, Environmental and Social Action Plan)
  - ✓ **Recommendations**
  - ✓ **Financial Assessment (**capital structure and financing, bearing capacity of the project, conclusion – loan amount and loan disbursement scheme
  - ✓ **Borrower Commitment Checklist** and **Borrower Corrective Action List**



Application Process - Step-by-Step Guidance

Loan Disbursement Procedure

Up to 5MW PV (new construction or under construction)

I Tranche
Percentage - 50%

Conditions:

- The first tranche can be disbursed immediately after issuance of the TA Report (approved by GAF and KfW)
- Development of ESHMP (2 months)

II Tranche
Percentage - 40%

Conditions:

- Disbursed after completion of the work set forth in the Borrower Corrective Action (Issue) List of TA Report
- Based on the positive Construction Monitoring Report(s) developed after site visit(s) of the Consultant

Final Tranche
Percentage - 10%

Conditions:

- After commissioning and implementation of all rectifications proposed by the Consultant via Issue List
- Based on the positive Final Monitoring Report developed after final site visit of the Consultant

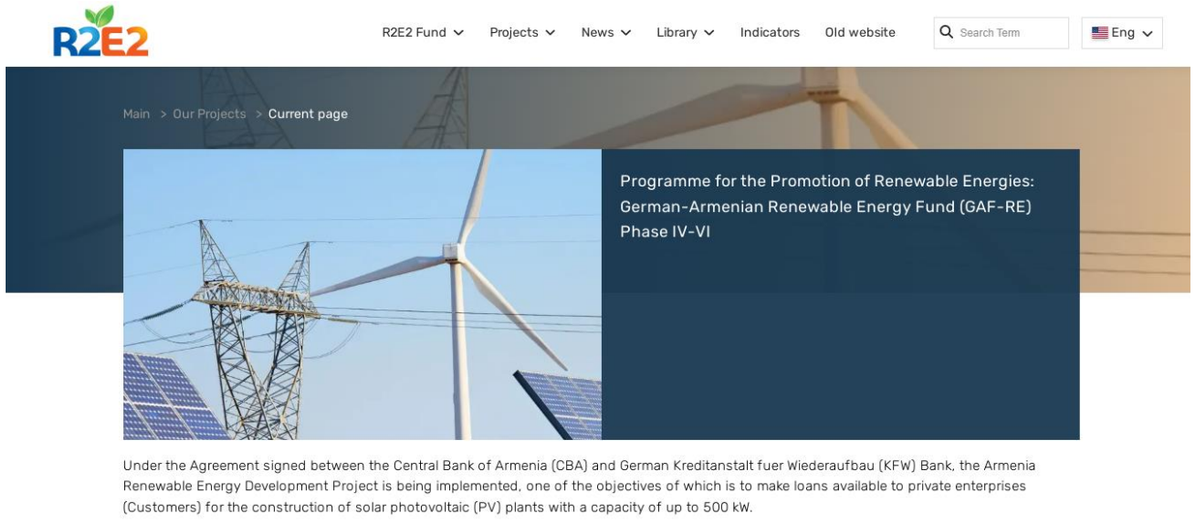
In case the Investor fails to implement the project taking into consideration the requirements and recommendations stated in the respective chapters of the TA Report, the previously disbursed loan will be withdrawn and called back by GAF

Application Process - Step-by-Step Guidance

Application Workflow: Application Forms for Small-Scale PV Projects

Armenia Renewable Resources and Energy Efficiency Fund (R2E2) is Fichtner's subcontractor under the GAF-RE Program in charge of the small-scale PV projects (150 kW - 500 kW)

Website: www.r2e2.am



Location of AFs: Website of R2E2 Fund → Projects → Renewable Energy → GAF-RE

https://www.r2e2.am/contents/newsPress/programme-for-the-promotion-of-renewable-energies-german-armenian-renewable-energy-fund-gaf-re-phase-iv-vi

Application Process - Step-by-Step Guidance

Application Workflow

From 150 to 500 kW PV

No financial assessment

Project Type	From 150 kW to 350 kW	From 350 kW to 500 kW
Rooftop	Assessment by the **R2E2 Fund** under Fichtner's technical and HSE supervision (Rooftop-specific QC aspects to be checked, e.g. load bearing capacity)	
Ground Mounted	Assessment by the **R2E2 Fund** under Fichtner's technical and HSE supervision	Assessment of the projects is carried out by **Fichtner**
Workflow	1. Desktop research-based Report 2. Disbursement of a 100% of loan based on the outcome of the Report 3. Construction works by the Owner 4. Site visit executed by R2E2 Fund 5. Final Report (FR) with Inspection Protocol and Issue List (checked by Fichtner)	1. Site visit upfront or at start of construction 2. Report issued after the site visit 3. Start of construction 4. Disbursement of a 70% of the loan tranche 5. Site inspection at advanced stage of construction 6. End of construction 7. FR with Inspection Protocol and Issue List 8. Disbursement of a 30% of the loan tranche
Requirements	MTRs, HSE and proper and secure connection to LV/MV grid	MTRs, HSE, proper and secure connection to LV/MV grid, load bearing capacity, associated infrastructure, e.g., existing transformer station and switchgear

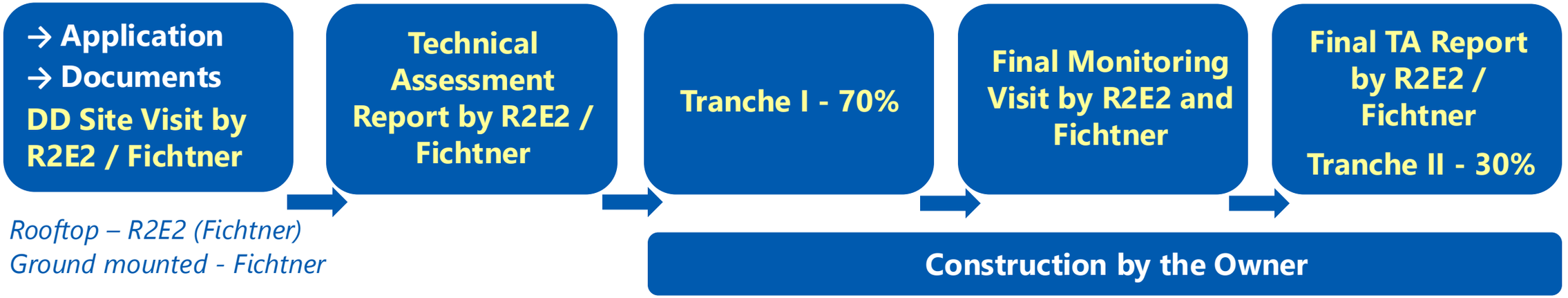
Application Process - Step-by-Step Guidance

Workflow

From 150 to 350 kW PV

R2E2 (Fichtner)

From 350 to 500 kW PV

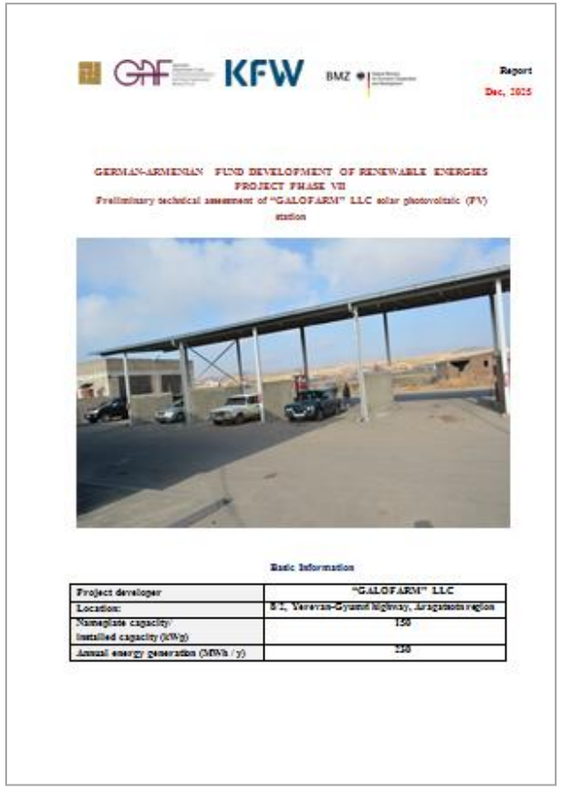


Rooftop – R2E2 (Fichtner)
Ground mounted - Fichtner

Application Process - Step-by-Step Guidance

Technical Assessment Report for Small Scale PV Projects

- Summary information on the proposed project
- Location and climatic parameters
- Installed capacity and disposition of PV panels
- Information on developer / constructor
- Costs and implementation timing
- Photos of the site and available infrastructures
- Bearing / mounting structures
- Connection to the distribution grid (transformer / switchgear)
- Main components of PV station
- Checklist of submitted documents
- Results of site visit
- Environmental and social analysis
- Risk assessment and conclusions


GAF KFW BMZ

Report

Dec, 2025

GERMAN-ARMENIAN FUND DEVELOPMENT OF RENEWABLE ENERGIES
PROJECT PHASE VII
Preliminary technical assessment of "GALOFARM" LLC solar photovoltaic (PV) station

Basic Information

Project developer	"GALOFARM" LLC
Location:	8.2, Yerevan-Gyumri highway, Aragatsotn region
Nameplate capacity:	150
Installed capacity (kWp)	
Annual energy generation (MWh / y)	230

Q&A (Part 1) and Break

06

Operational Survey – Key lessons learned and findings

Agenda

1	Survey Methodology & Grouping of the PV Plants
2	Group 1 – Medium Scale
3	Group 2 – Small Scale
4	Closing

Introduction

Survey Methodology

Phase 1 – Survey Design

- Defined the target audience.
- Developed detailed questionnaires covering performance metrics, operational challenges and failures of key components.
- Requested GAF's assistance as a "door opener" to encourage investor cooperation and participation.

Phase 2 – Data Collection

- Received the completed questionnaires.
- Clarification round was carried out through follow-up questions, site visits, and 1 vs 1 interviews with O&M personnel.

Phase 3 – Data Analysis

- Compared and analysed the received data.
- Gather lessons learned and actionable recommendations, which was the aim of the exercise.
- Compiled findings into report and presentation.

Results

- Complete survey basis.
- Database of **77** PV plants.
- Comprehensive Report.
- Summary Presentation.

Introduction

Survey Methodology

Extensive Sample of PV Plants with 77 in total!

Group 1 – Medium Scale

- 32 Plants
- Utility Scale
- 1 to 5 MVA_{AC}
- Operational from 2018 to as recent as 2022.

Group 2 – Small Scale

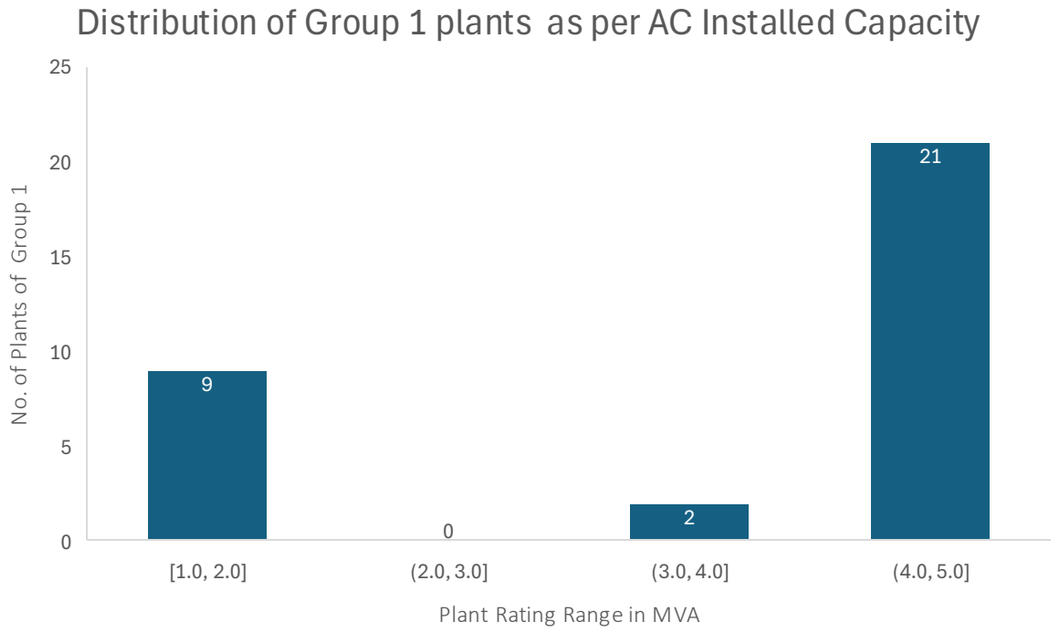
- 45 Plants
- Domestic & Commercial
- 3.3 to 559 kW
- Operational from 2021 to as recent as 2025.

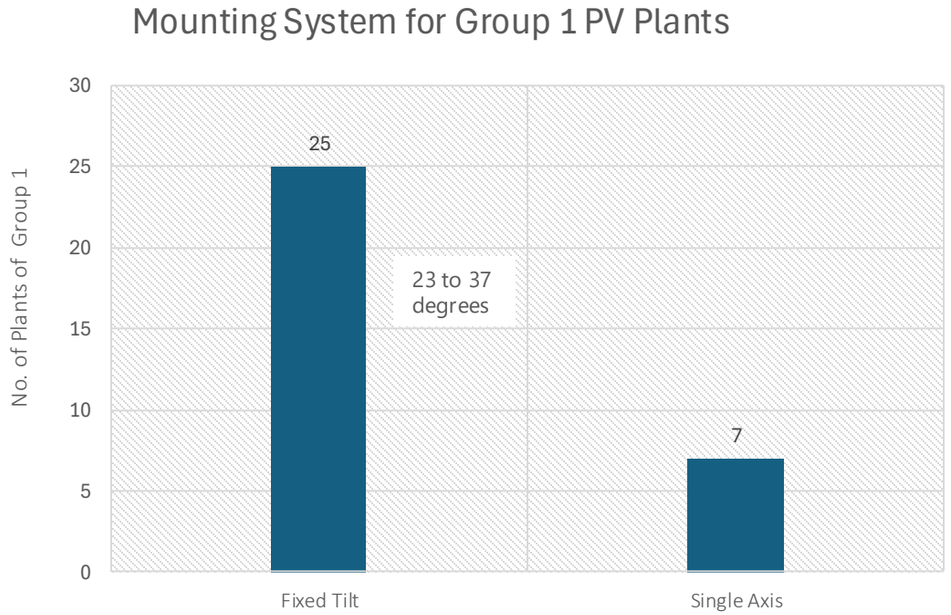
Agenda

1	Survey Methodology & Grouping of the PV Plants
2	Group 1 – Medium Scale
3	Group 2 – Small Scale
4	Closing

Group 1 – Medium Scale

Sample Overview

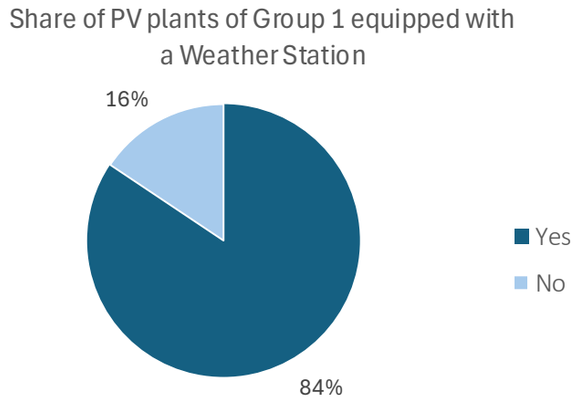




- All OEMs for both module & inverter were **Chinese.**
- Single exception was Ingeteam (Spain) for inverter.
- Tier 1 OEMs selected focusing on reputable suppliers with a long track record.

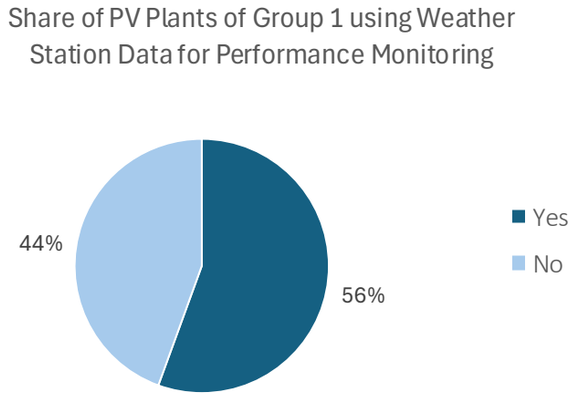
Group 1 – Medium Scale

Weather Station



What they measure

- GHI, Wind Speed/Direction, Amb. T, Humidity → **Typically Measured (85% of the plants)**
- Module T, GII, PM10, PM2.5 and rain/snow → **Rarely Measured (9-15% of the plants)**
  - **E.g. Module T crucial** in detecting operational issues e.g. thermal stress, underperformance, component failure.



Why not used when available?

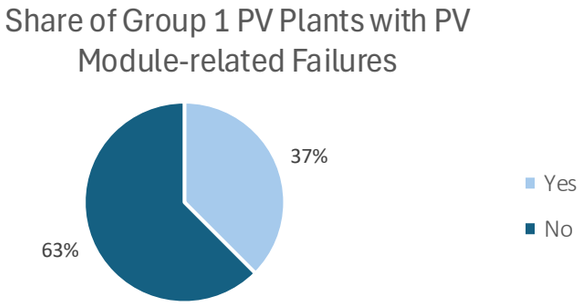
Potential added value not fully exploited

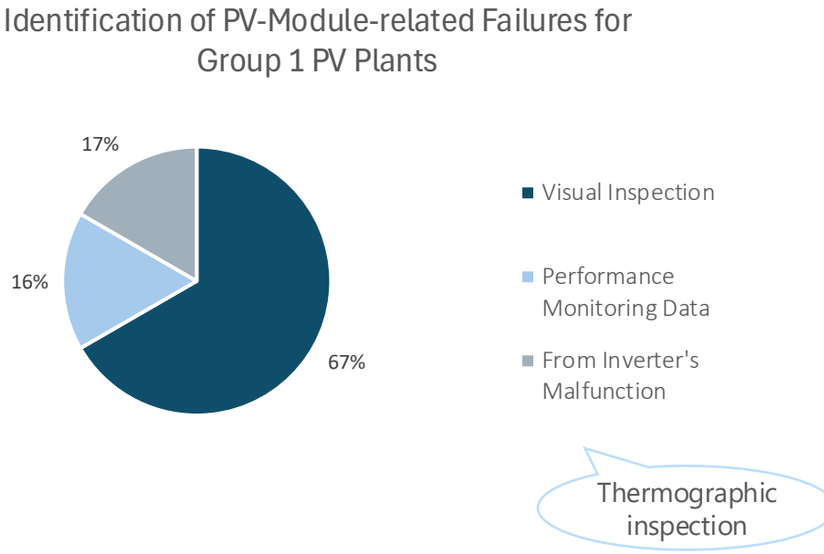
- Higher uncertainty due to reliance on satellite data → Risk of masking operational issues.
- Reduced ability to detect underperformance linked to environmental factors (e.g., soiling, shading, abnormal temperature effects).
- Weakened foundation for predictive maintenance strategies.

PM: Particulate Matter, GHI: Global Horizontal Irradiation, GII: Global Inclined Irradiation.

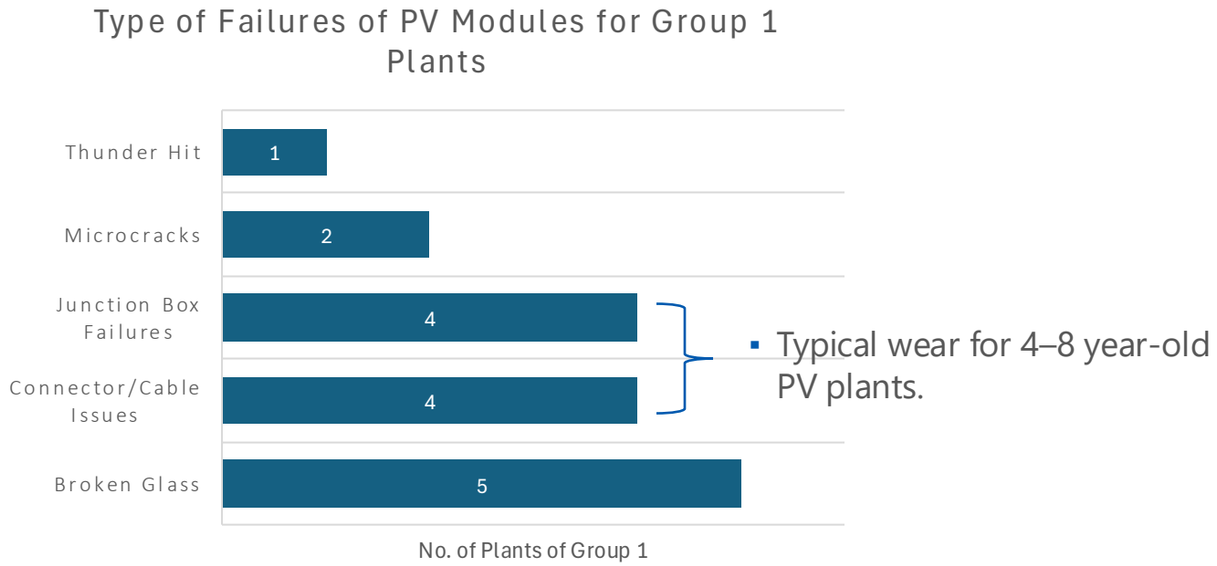
Group 1 – Medium Scale

Failures of PV modules





- **No deviation** from industry experience for 4-8 year old plants.
- No detailed diagnostics shared in most of the cases→ the severity of failures cannot be precisely assessed.



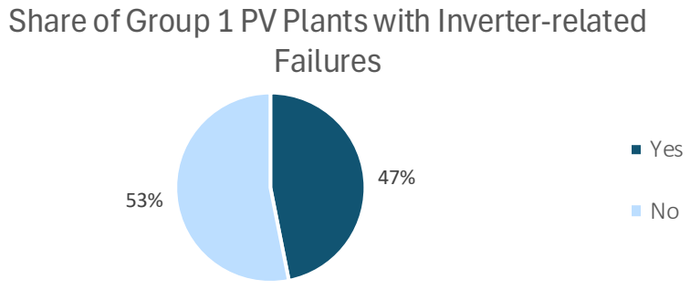
- Typical wear for 4–8 year-old PV plants.

Broken glass & microcracks potential causes:

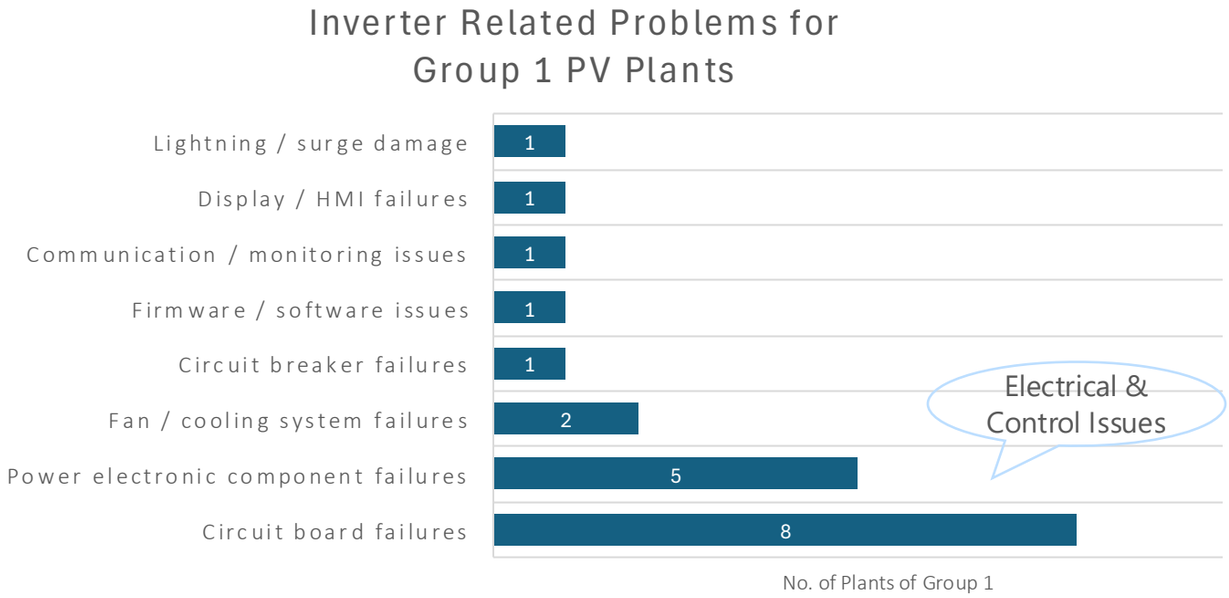
- ❑ Weather related (e.g. hail, snow)
- ❑ Improper handling & installation
- ❑ Aging (glass becomes brittle)
- ❑ Manufacturing defects (propagation of microcracks).

Group 1 – Medium Scale

Failures of Inverters



- Not an unexpected failure ratio, capturing transition from early-life to mid-life reliability.
- Average Downtime of 12.2 days (**high criticality of inverters**).



Potential Causes:

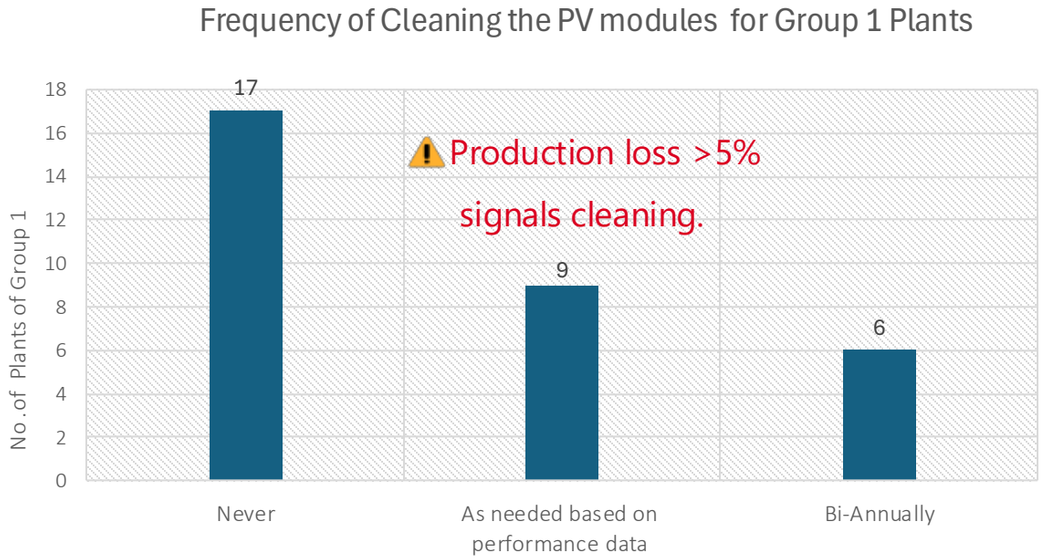
- **Design Problems**
  - Insufficient thermal management & ventilation.
  - Incorrect sizing.
- **Component selection**
  - Not fully certified for local climatic conditions.
  - Models with limited track record.
- **O&M**
  - Incorrect or delayed preventive maintenance.
  - Delayed corrective maintenance.

✓ 14 /15 affected plants replaced failed components from own spare-parts inventory.

✓ In all case, OEMs warranties were fully honoured (response time between 2-60 days, avg. 27 days).

Group 1 – Medium Scale

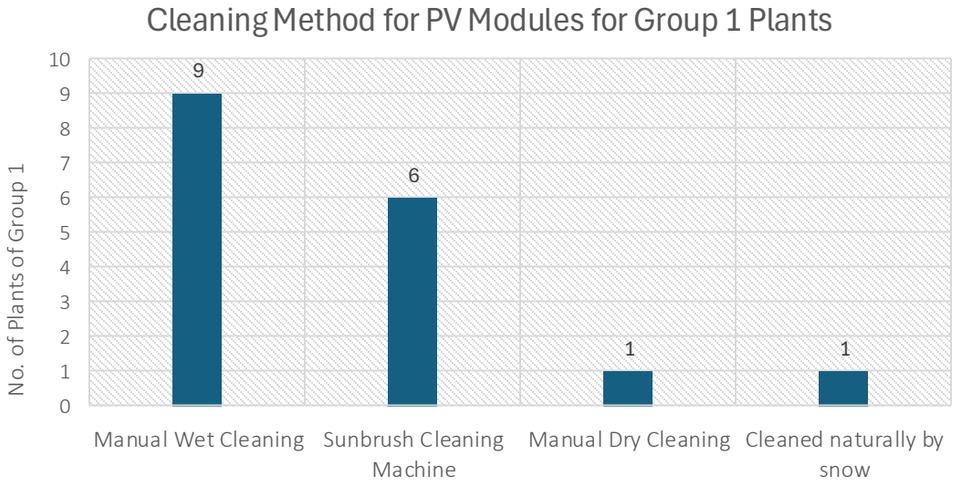
Maintenance 1



- 52% the PV plants do not clean the modules.
- Soling losses typically are between 1-5% of the production.
- Cleaning either wet or dry is an easy and quick task.

Recommended Annual Cleaning Frequency

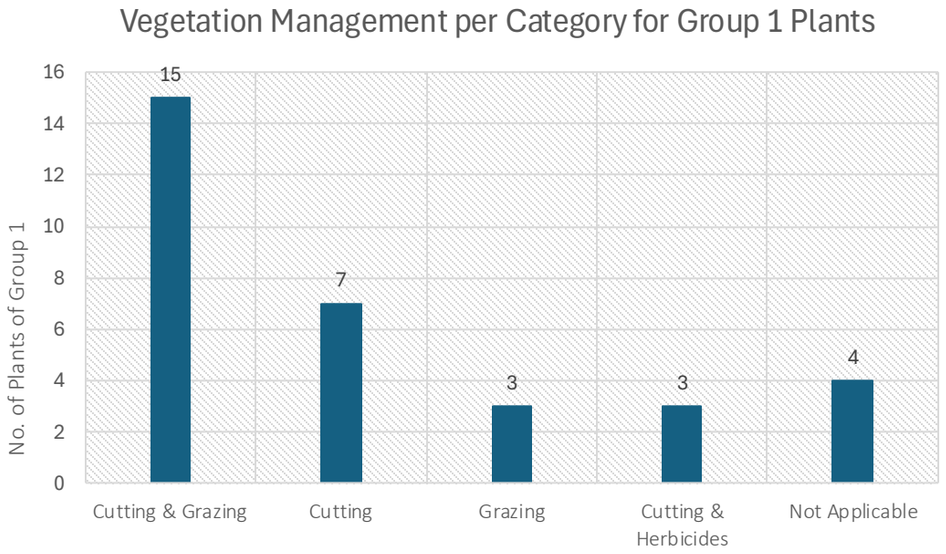
- Clean 2 to 4 times.
- For higher-dust areas (common in Armenia) 4 to 6 times.
- More often near construction, unpaved roads or farmland.
- Less often in rainy region due to natural cleaning.
- Snow melts on its own, but heavy snow adds weight load.

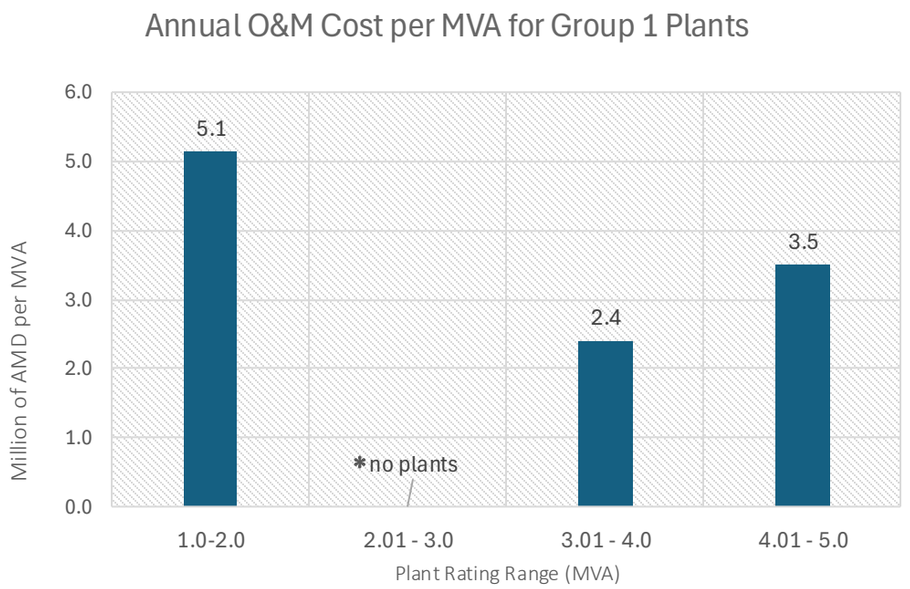


- Cleaning need to be done always with caution.
- Wet cleaning not ideal if there is water scarcity.

Group 1 – Medium Scale

Maintenance 2





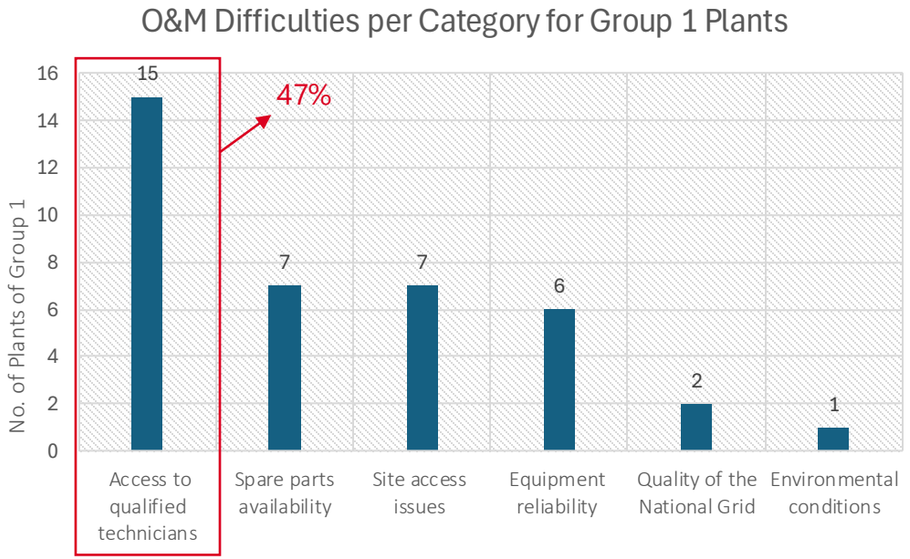
- All PV plants manage vegetation. ✓
- Preventing shading, hotspots and promoting safety (no dry vegetation during summer months that can cause fire ignition).
- Average frequency 2.2 times annually generally in line with good practices (but always location specific).

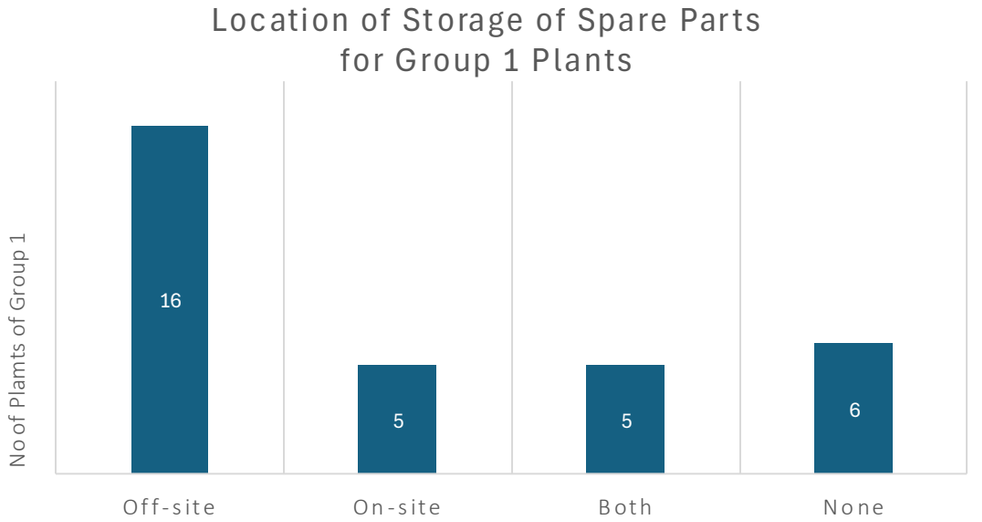
- Larger plants lower O&M costs (economies of scale).
- All plants (with a single exclusion) claimed O&M costs in line with the expectation.

*Group 3.01-4.0 MVA incl. only 2 plants → non trustable results.

Group 1 – Medium Scale

Maintenance 3





- Lack of qualitied technicians.
- Spares availability.
- Site access issues.
- Equipment reliability.

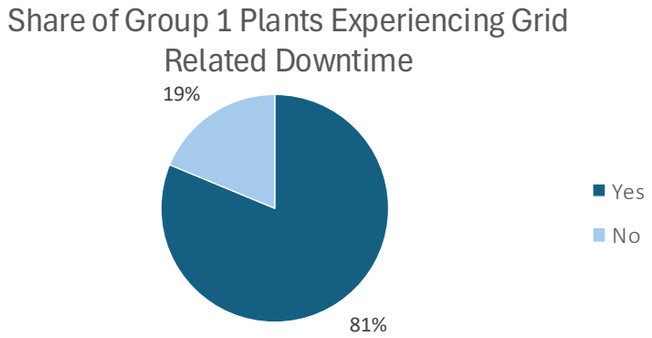
→

- Increase workforce & training.
- Proper O&M planning.
- Adequate & accessible spares.
- Reputable OEMs.

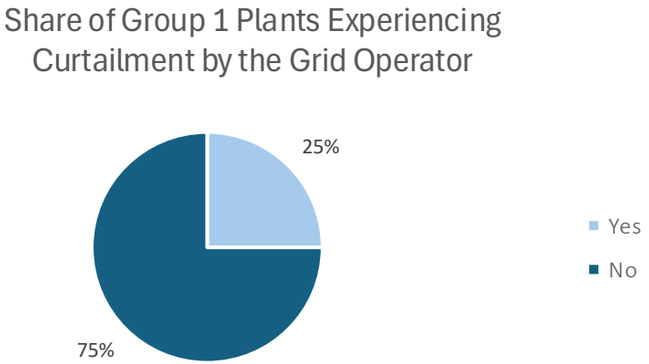
- Storing offsite is not a problem, if however nearby (less than ~25 km).
- However, 8 PV plants store at distanced > 50 km → delay of corrective maintenance.
- When O&M outsourced, no spares storage is not uncommon → must be offset by strong LTSA contract.

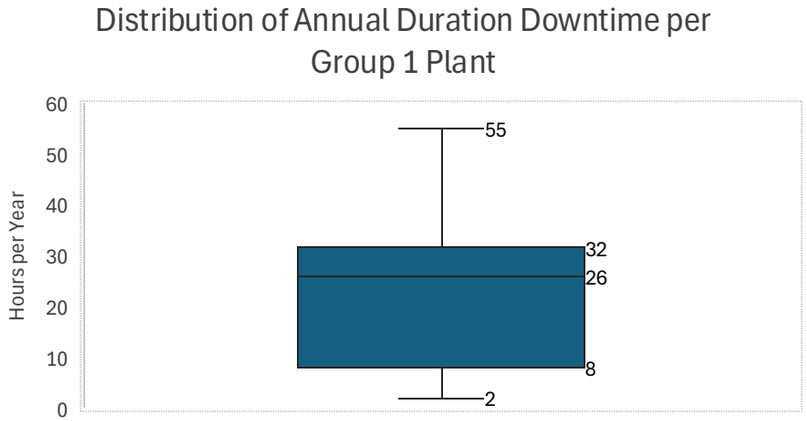
Group 1 – Medium Scale

Grid Availability & Curtailment



- Only 8 plants experienced curtailment.
- Minor curtailment 0.54%-1.23%.





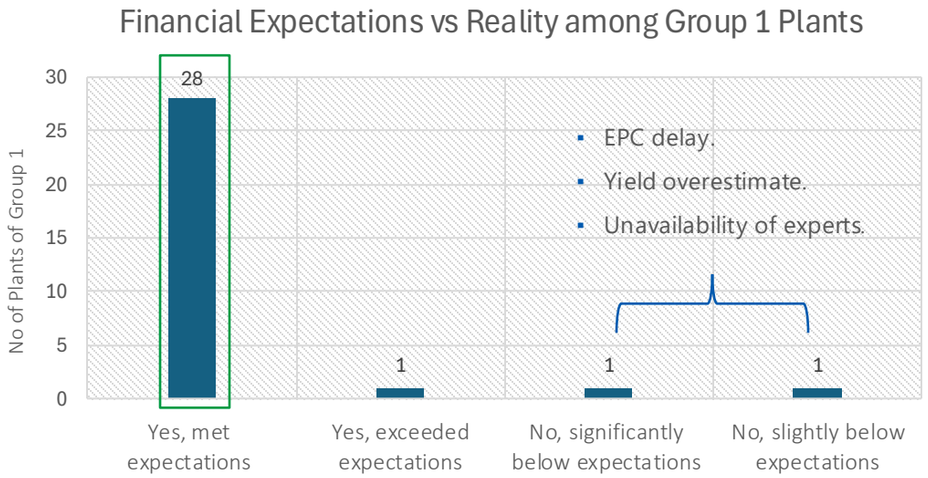
- 4 out of 5 plants experience grid unavailability.
- However, 50% of the plants had a downtime of 8-32 h, mean value being 26h.
- Availability always> 99.3% →in line with European standards → strong grid.

	Reason for Curtailment	No of Plants
General Grid Challenges	Planned grid maintenance	7
	Unplanned grid outages	3
	General grid congestion / weak local grid	3
RE Integration	Grid congestion during renewables peak production hours	3

- Room for more RE integration in the Armenian grid.
- To be backed by BESS to balance supply & demand and ensure flexibility.

Group 1 – Medium Scale

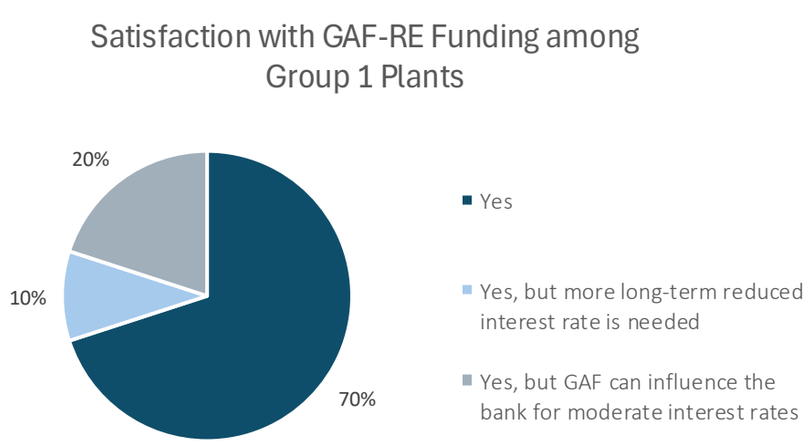
Financing



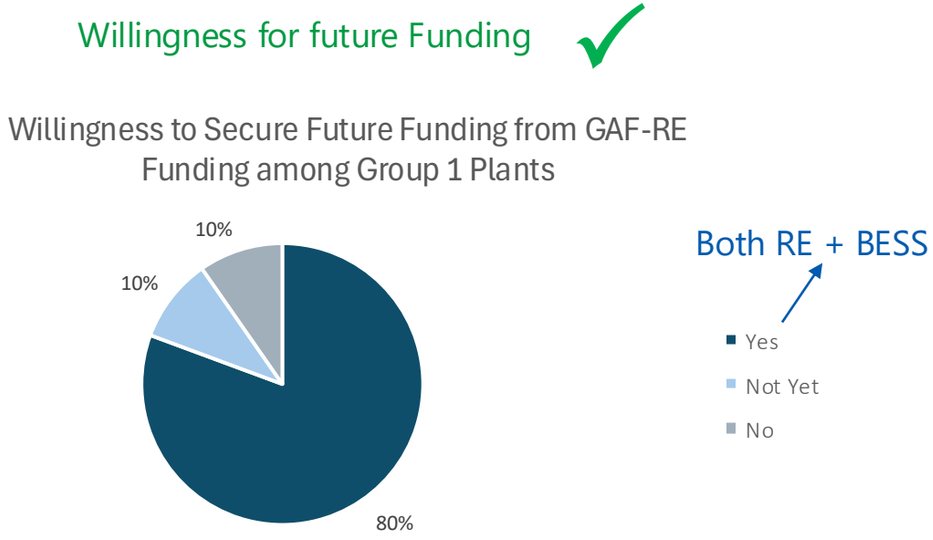
Financing program improvement suggestions:

- ❑ faster decision-making → process acceleration (5 plants)
- ❑ lower interest rates (8 plants).

Satisfaction ✓



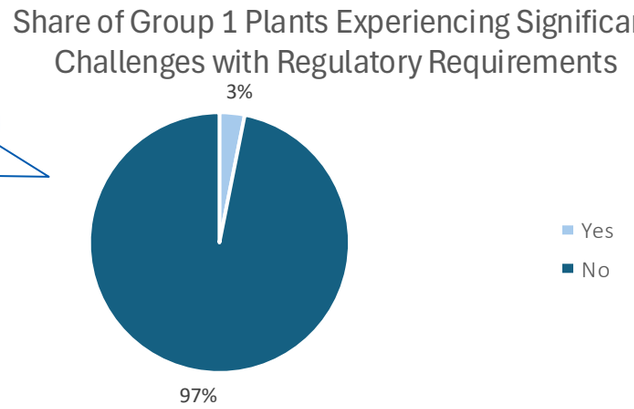
Willingness for future Funding ✓



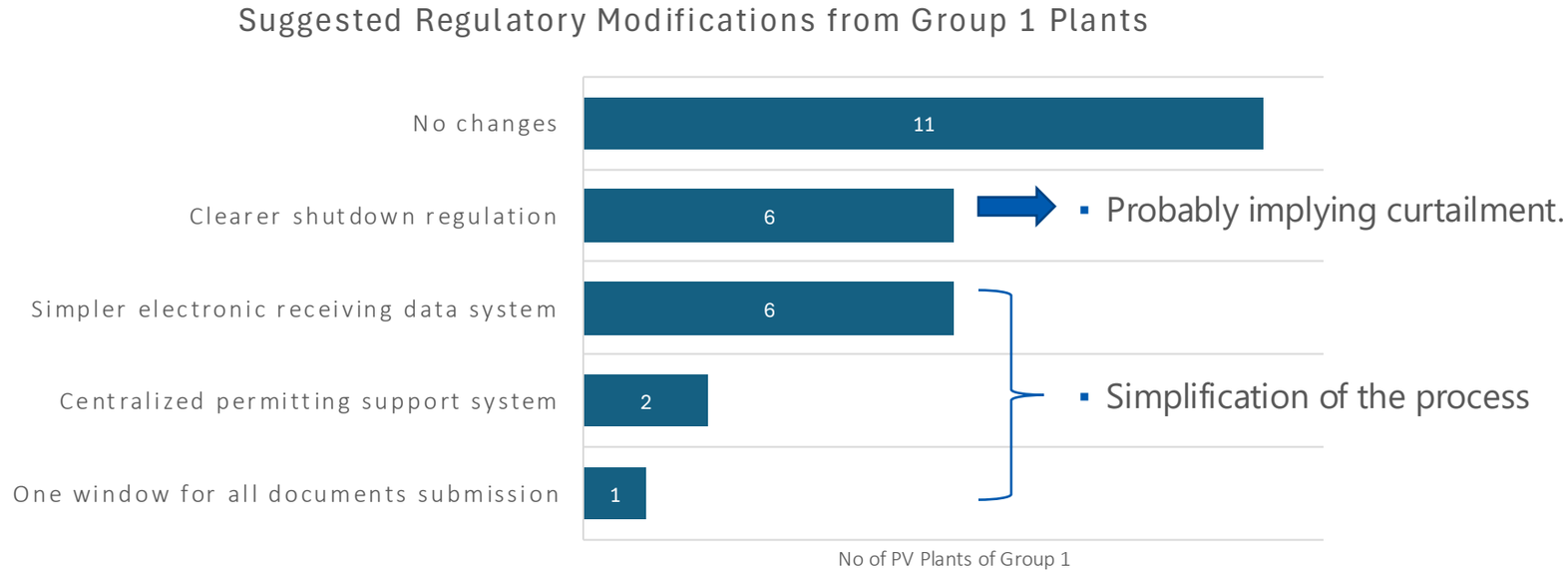
Group 1 – Medium Scale

Regulatory Environment

- land permit
- category classification
- grid access



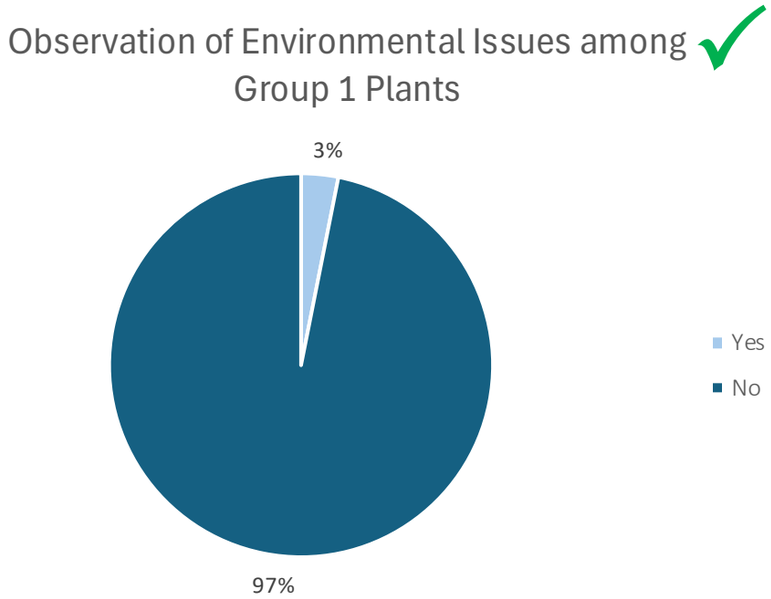
- Quite positive experience in total for a typical project bottleneck.
- Only a single case seriously struggling due to prolonged process.

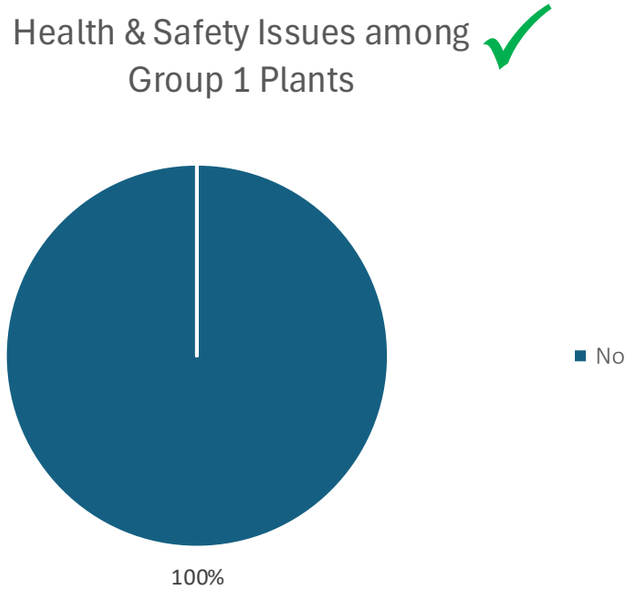


- Probably implying curtailment.
- Simplification of the process

Group 1 – Medium Scale

Health, Safety & Environment



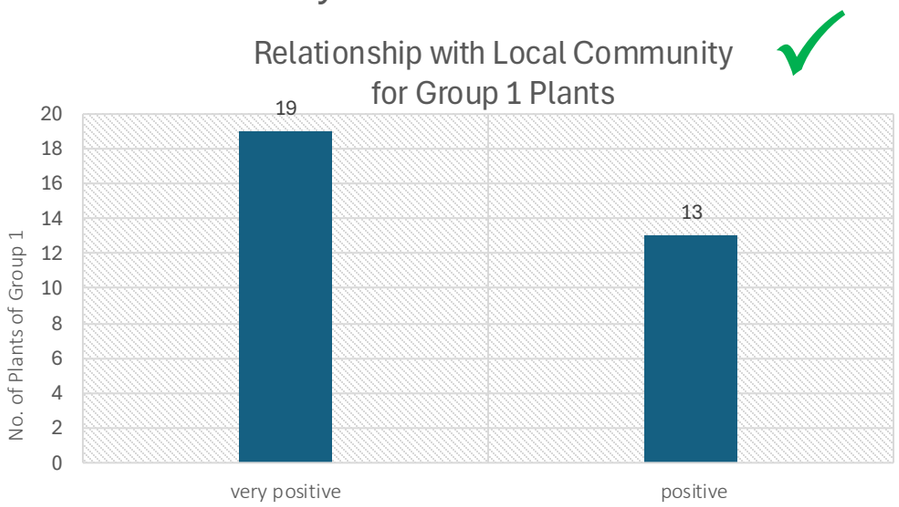


- Only once → soil erosion → addition of gravel.
- Very positive, indicating effective and thorough environmental assessment prior to construction.

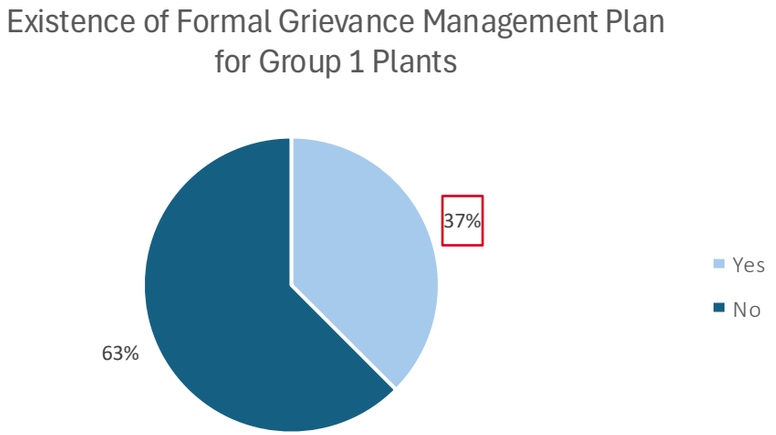
- No issues at all for a topic of outmost importance.
- All plants have a HSE Plan, implemented without challenges.

Group 1 – Medium Scale

Local Community



- Reflecting high social acceptance of solar energy.
- Although, only 3 plants tried to engage communities:
  - Construction of buildings (2)
  - Panels donation for a school (1)



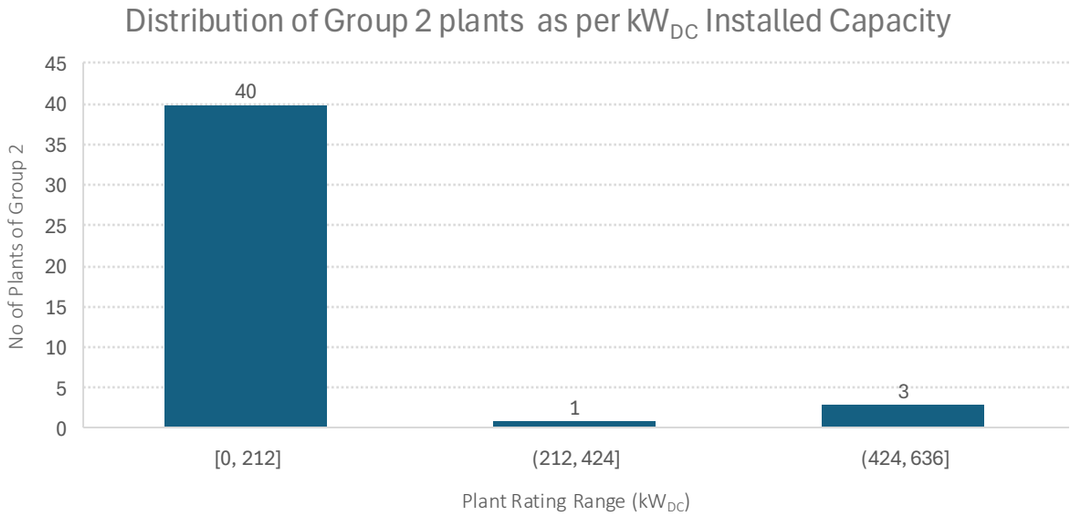
- **Shall be expanded** to all plants to address and resolve complaints fairly.

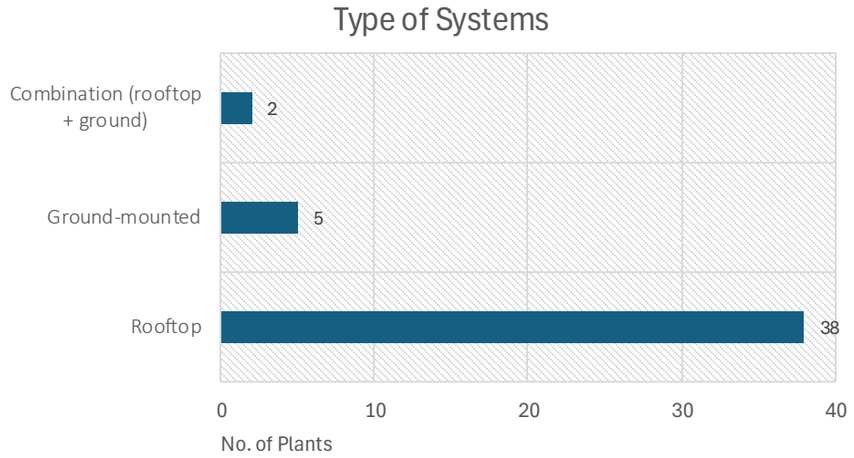
Agenda

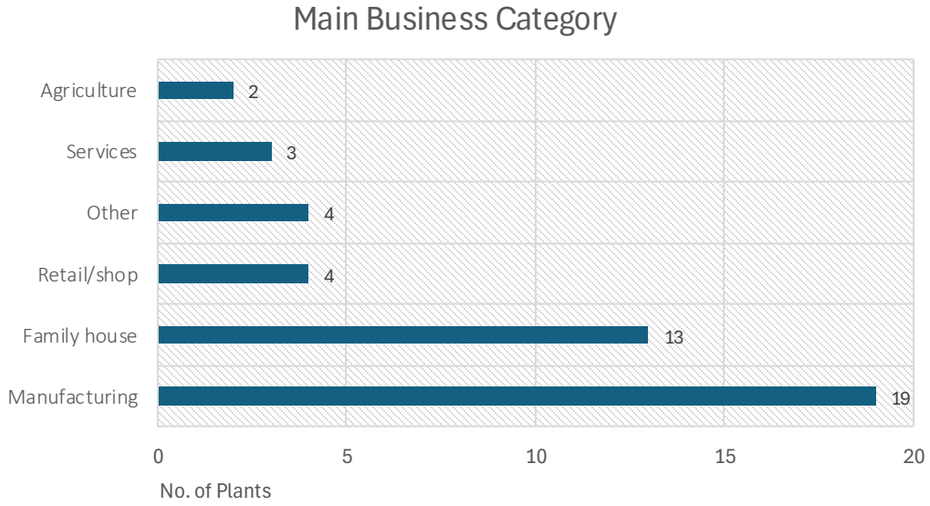
1	Survey Methodology & Grouping of the PV Plants
2	Group 1 – Medium Scale
3	Group 2 – Small Scale
4	Closing

Group 2 – Small Scale

Sample Overview



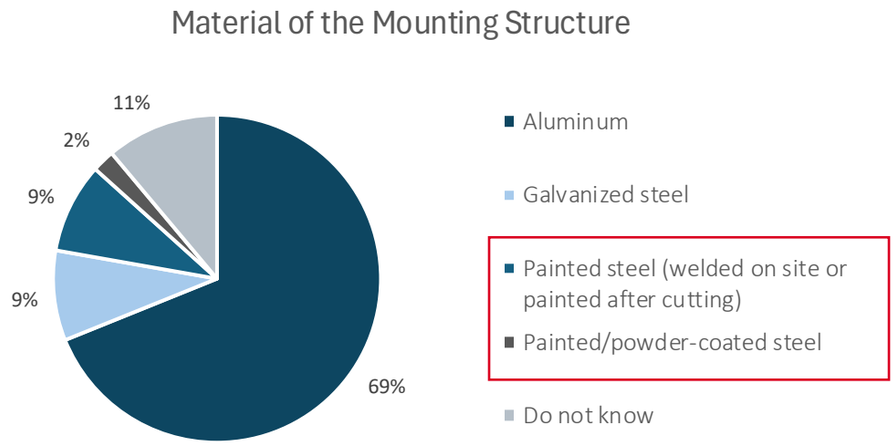




Group 2 – Small Scale

Material of the Mounting Structure

HDG: hot dip galvanized



- 11 % in total of steel cases.
- All these were rooftop systems.

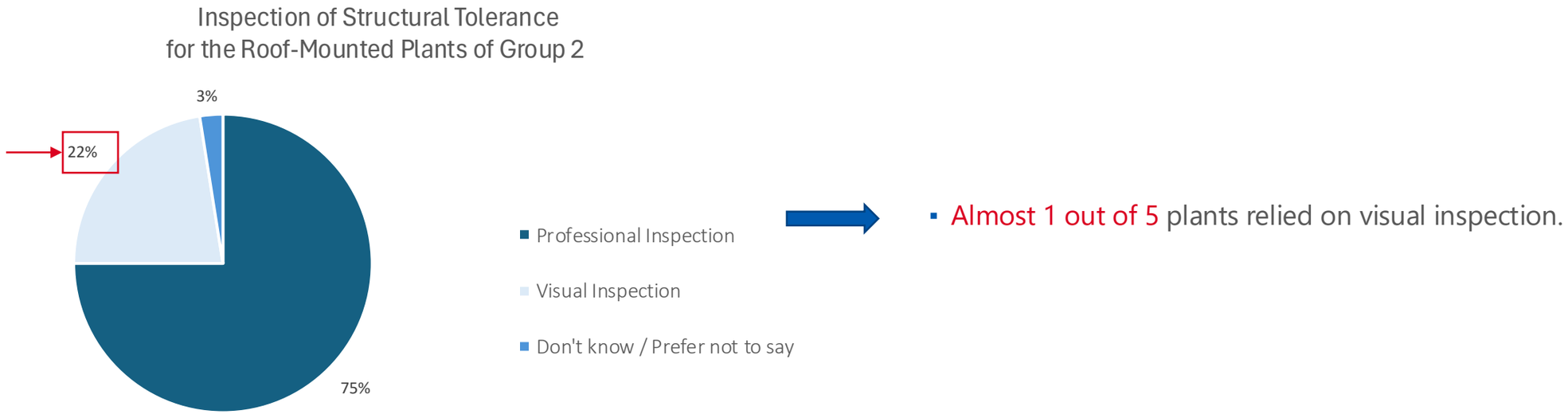
✓ Aluminium is naturally corrosion resistant and lightweight.

✓ HDG steel offers sufficient cathodic Zinc protection, a bit heavier however so not that common for roofs.

✗ Painted or powdered steel offers only surface level protection, if compromised, **corrosion** begins **quickly**.

Group 2 – Small Scale

Structural Tolerance of the Roof-Mounted Plants



- Almost 1 out of 5 plants relied on visual inspection.

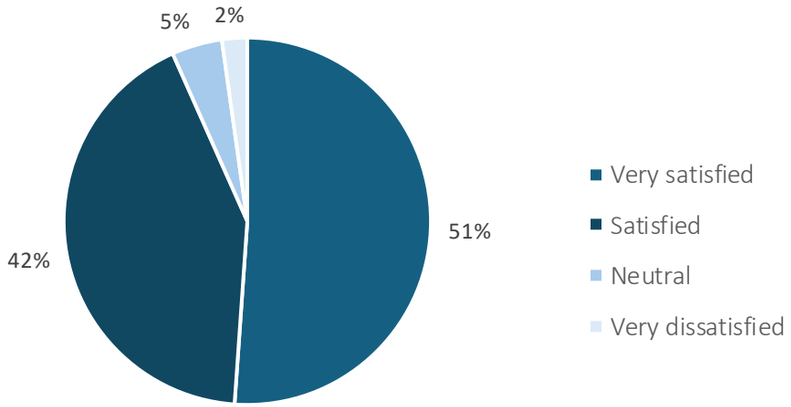
Suggested Engineering Practice:

- Structural calculations (dead load + wind load + snow load).
- Review of original structural drawings of the building.
- Load comparison with building code requirements.

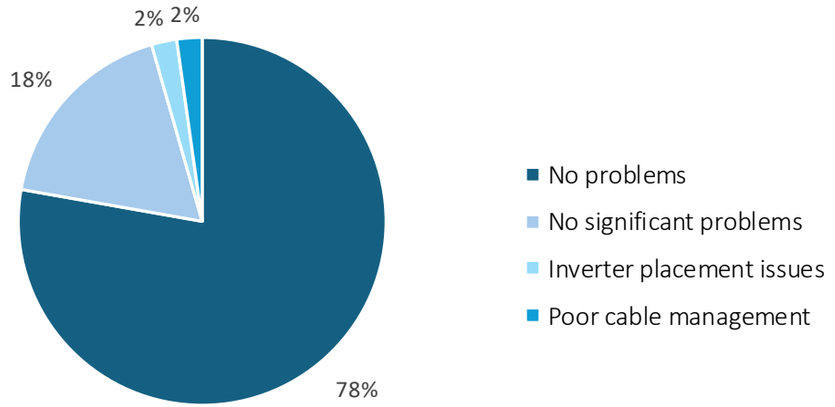
Group 2 – Small Scale

Installation Experience

Satisfaction with the Installation Company among Group 2 Plants



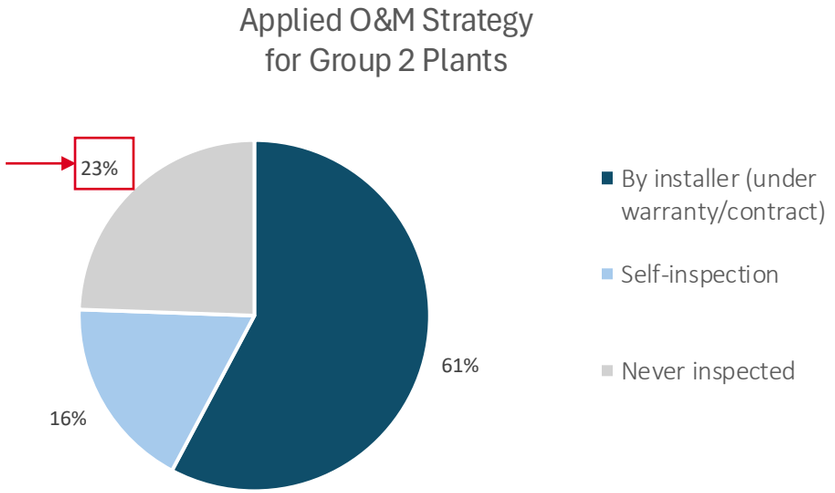
Problems with the Installation of Group 2 Plants

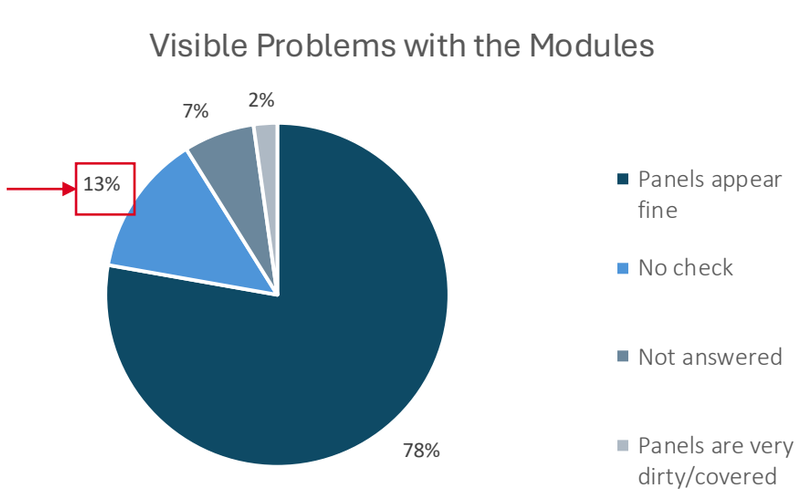


- High overall satisfaction, with 93% of respondents reporting being very satisfied or satisfied.
- Smooth installation process, with only 4% reporting issues.
- 25 different installation companies were reported in the survey, providing a broad selection and competitive pricing.

Group 2 – Small Scale

General O&M Strategy

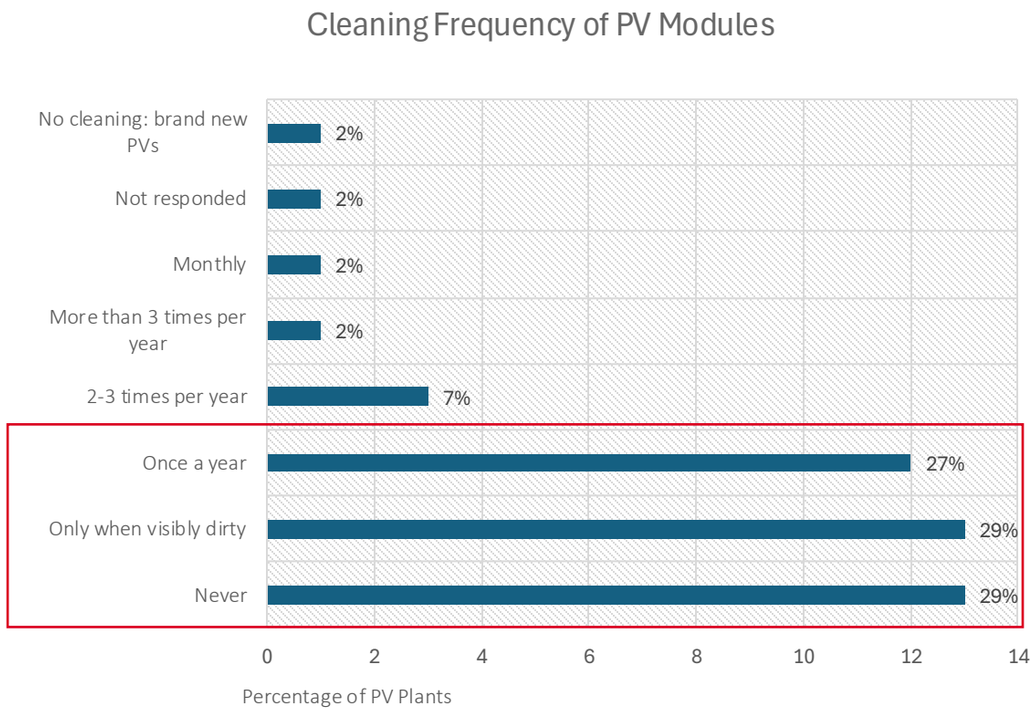


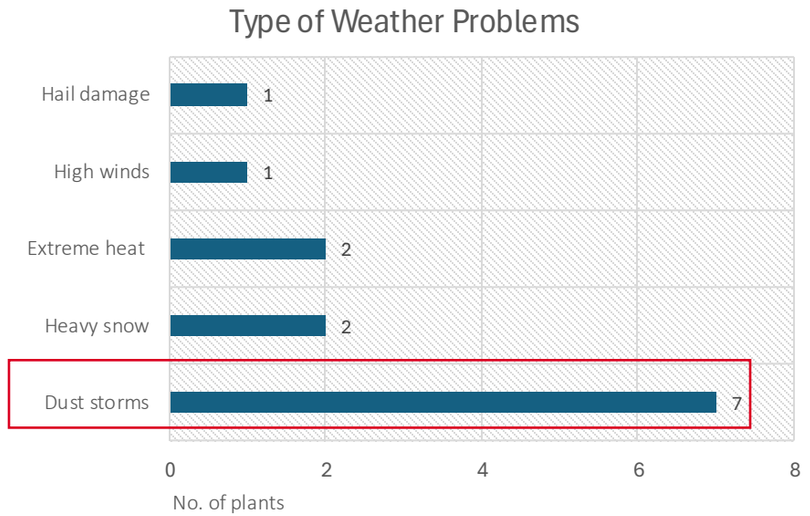


- Clear tendency to outsourcing.
- Nearly one quarter of the plants has never been inspected.
  - COD of these plants earliest Mar 2021 and latest Dec 2024.
  - At least 1 year operational until the survey.
- Raises serious concerns about proper operation throughout the entire lifetime.
- Inform the owners about the need and importance of regular inspection.

Group 2 – Small Scale

PV Modules Maintenance



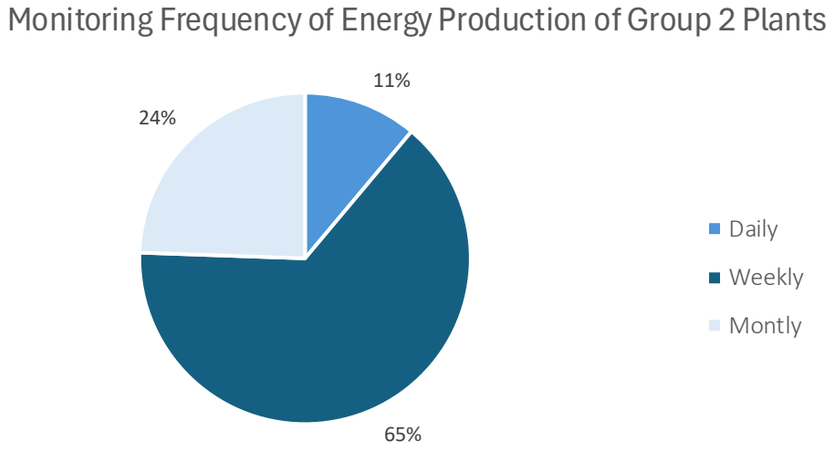


- 29% never clean the modules.
- When dirty is a subjective methodology.
- No regular cleaning applied in general.
- Dust storms most common weather problem.

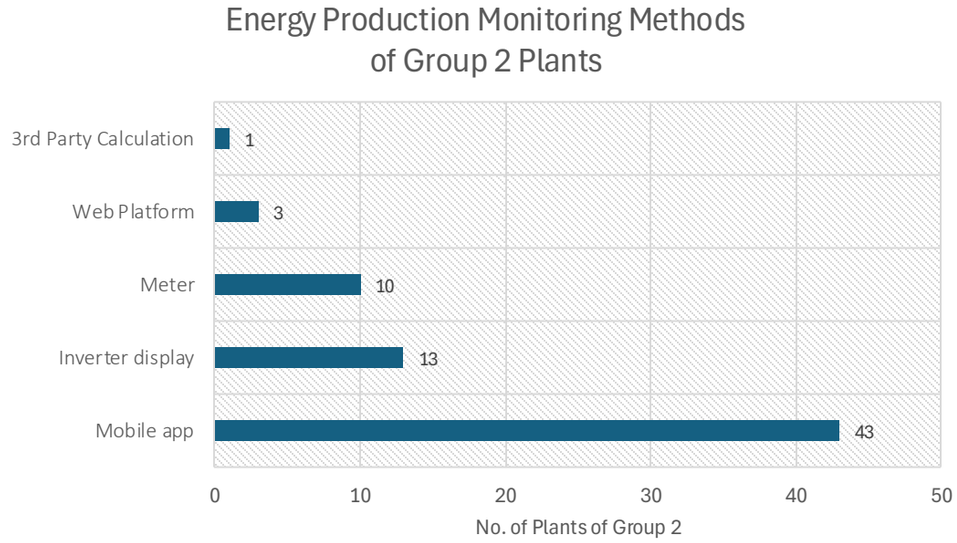
- Apply regular cleaning and educate the plant owners
- Good practices as described for Group 1 Plants.

Group 2 – Small Scale

Performance Monitoring



- Daily monitoring is only 11% among the plants.
- Ideally, there is room for improvement.
- Early problem identification → prompt resolution.



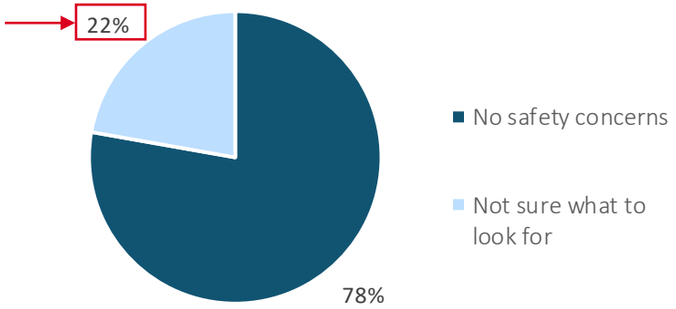
- Preference for user-friendly monitoring.
- Mobile app is simple & quick → appropriate for such small scale users.
- Proper training needed to ensure correct data interpretation.

Group 2 – Small Scale

Safety

Monitoring

Experience of Safety Issues for Group 2 Plants



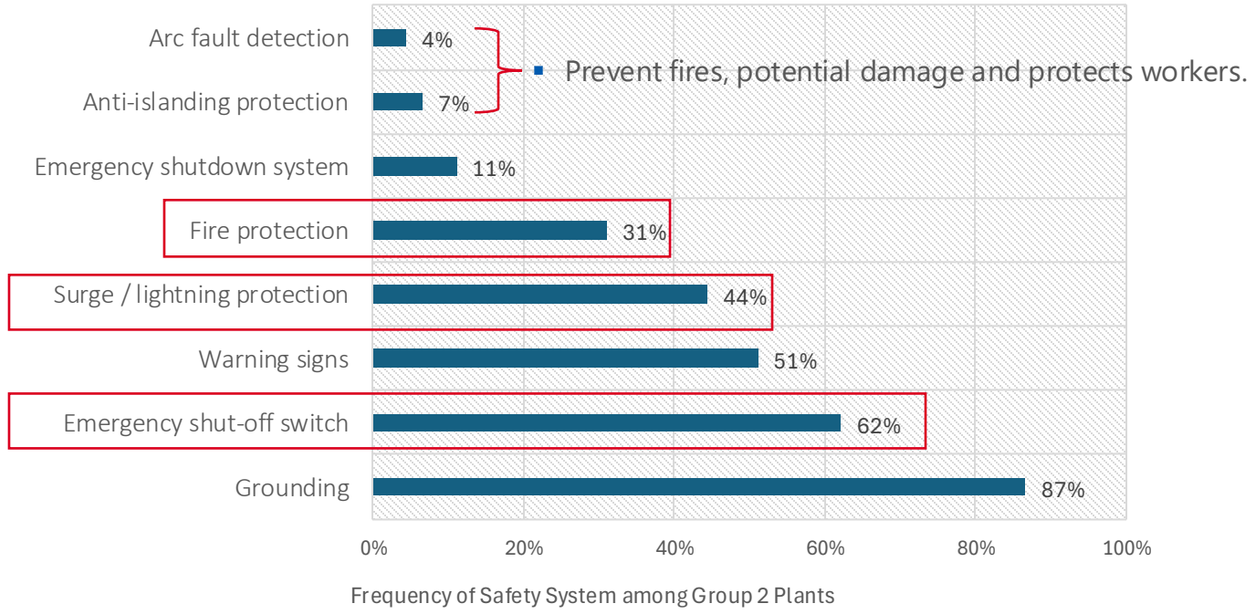
Questionnaire points

- Exposed el. terminals
- Burn marks or melted components
- Hot spots
- Unusual smells
- Sparking or buzzing noises
- Rust

- Lack of awareness → better training and clear maintenance guidelines needed

Design

Adoption Rate of Safety Systems Among Group 2 Plants

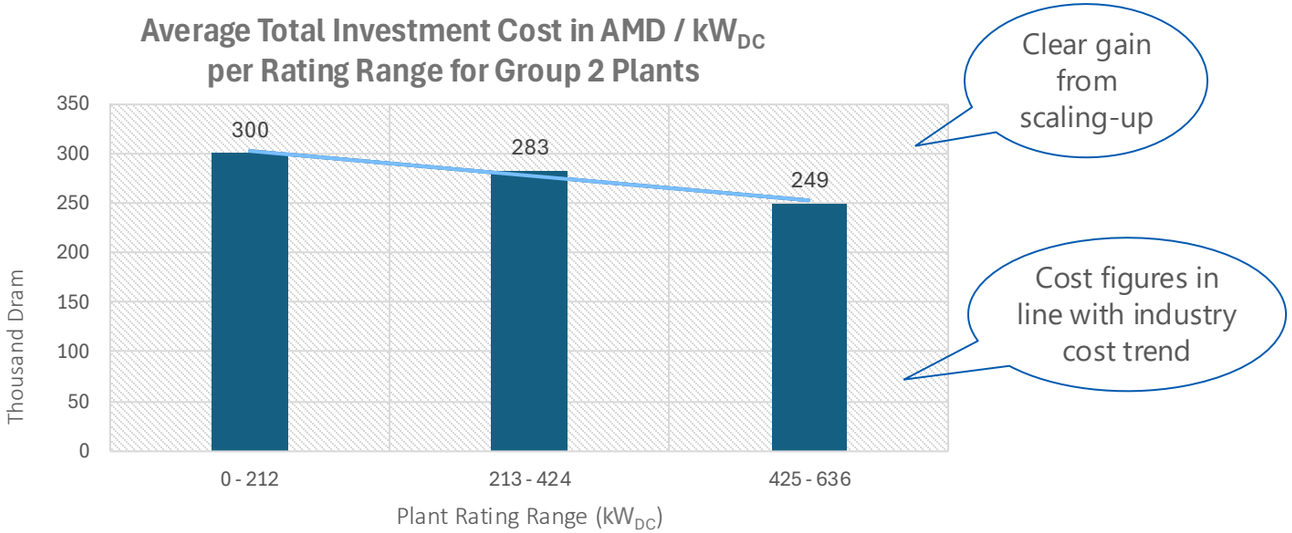


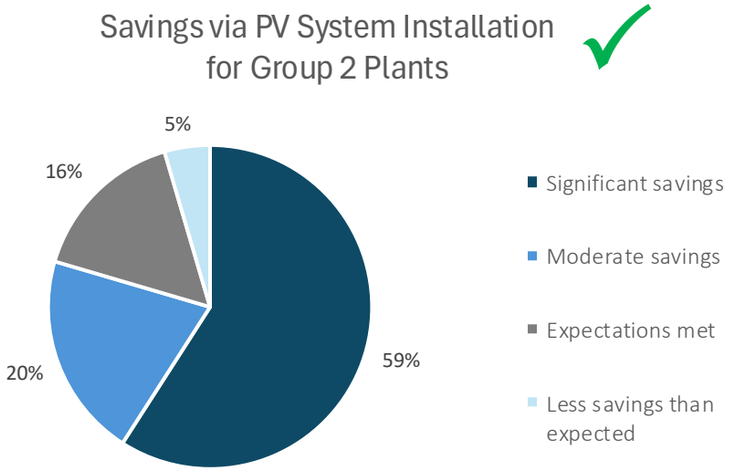
- Prevent fires, potential damage and protects workers.

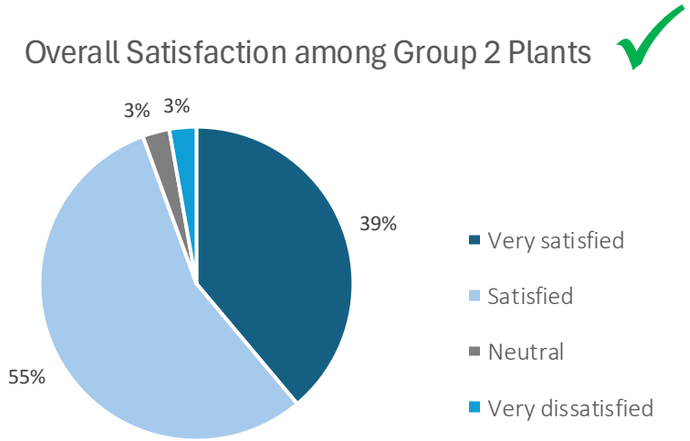
- Worrying finding, that should be looked into carefully to improve the most critical element, safety.

Group 2 – Small Scale

Investment and Savings







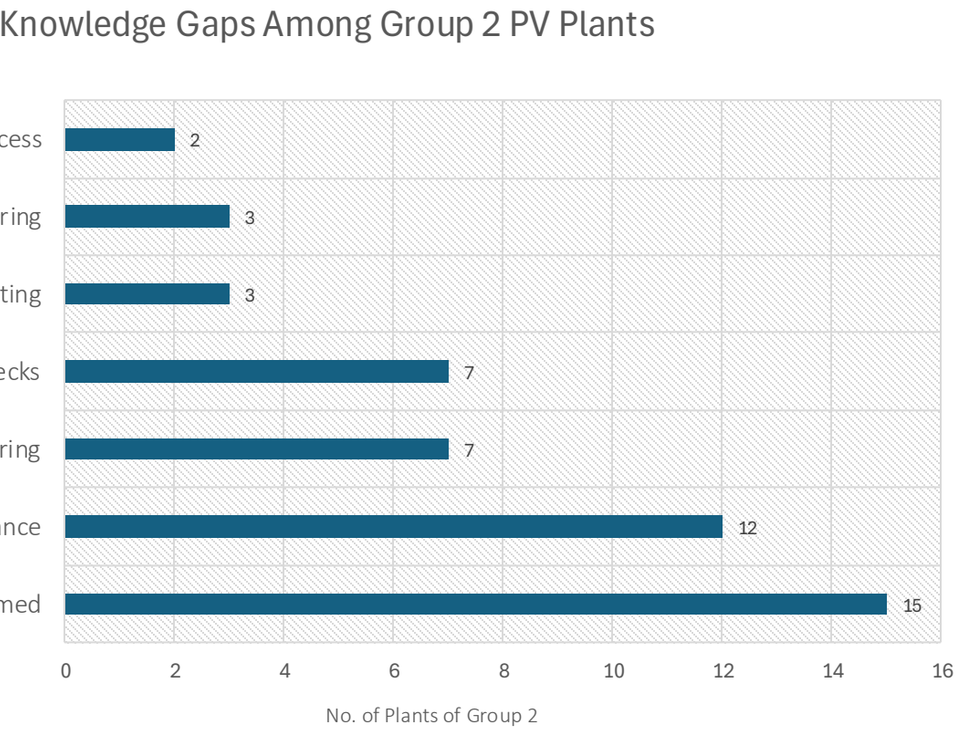
Savings led to satisfaction

- 95% of the plants had savings.
- 3 out of 5 plants had significant savings.
- Only two plants had less savings than expected.
- Clear savings making the financial investment reasonable.

Group 2 – Small Scale

Knowledge Gaps

- Organizational Aspects.
- Operation & Maintenance.



- Information gaps **strongly on O&M** processes.
- **In line** with the previous survey findings e.g. insufficient module cleaning, identification of safety issues.
- Addressing these gaps will be essential for improving the performance and long-term development of the sector

Agenda

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Agenda

Thank you for your attention!

Q&A

07

Q&A and Open Discussion

Thank you for your attention