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Global Solar and Water Initiative

Iraq Visit Report – 27th July th to 10th August.

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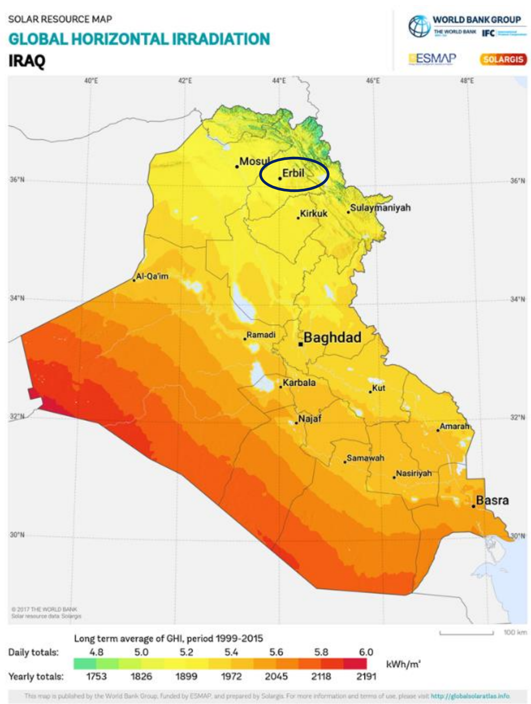
1 - OBJECTIVES OF THE TRIP AND AREA VISITED.

As part of the Global Solar & Water Initiative (see ***Annex A 'Programme Summary'*** for details), a 2-week visit to Erbil area, in the Kurdistan Region of Iraq (KRI) was carried out with the following objectives:

- Engage with WASH cluster coordinators and partners, including Directorate of Water, to understand current context and challenges.
- Raise water stakeholder awareness and technical capacity in design, O&M of solar water projects.
- Visits schemes in the field to assess work practices.
- Evaluate private sector price range and product quality in order to perform price comparisons.
- Produce recommendations and support implementation of steps to ensure quality use of solar pumping solutions.

Map 1: Global Horizontal Solar Irradiation and area visited (circled)



Due to low number of solar water schemes implemented so far in the area, it was possible to visit all of the reported schemes (7 in 5 different locations) within the first week of the trip, including those in refugee camps and in communities within a 2 hour road trip radius from Erbil town. Since UNHCR/UNICEF are solarizing all the remaining water points in refugee camps in the Erbil area, data were collected to extend the techno-economic analysis to these upcoming schemes.

Additionally, Directorate of Water officials in Erbil and Water scheme operators were interviewed in 4 different sites to understand better plans and problems faced when adopting solar water solutions.

Besides, a 3-day technical workshop, counting with the participation of25 engineers from 16 organizations (local and international NGOs, UN agencies and a private contractor) was carried out in Erbil town, with logistic support (meals, venue, IT and others) provided by DRC.

The details of activities carried out during the visit can be found in ***Annex B 'Visit ToR and Training Agenda'.***

Table 1 & 2 – Water points assessed during the visit and Recommendations produced.

Exsiting Solar/Grid Systems								
Site Details			Technical Design					
No.	Location	BH ID	Existing/ Proposed Pump	Solar Power Size (Wp)	Daily Output using Solar (m^3/day) in average month	No. of households served (using 200pp/day	Population served @ 5 persons per HH	Comment /Recommendation
1	Ninawa	Sheikhan	Grundfos SP 30	32130	219.0	767	3832.5	The existing PV generator of 32.13kw (Atersa 315Wx102No) is incorrectly sized (this equipment was sized for another site and then transferred to this one). A smaller PV generator of 20.16kW could have been used instead. Pumping rate should be checked against the safe yield to avoid risk of overpumping. The payback period is long and the cost savings low due to PV generator
2	Erbil	Kawrgosk BH 1	Grundfos SP 46-15	Under construction	370.7	1297	6487.3	Solar system was under construction and equipment details were not provided. Stated details are as per own design. Pumping rate should be checked against the safe yield to avoid risk of overpumping.
3	Erbil	Kawrgosk BH 2	Grundfos SP 30-20	32130	276.8	969	4844.0	The exisitng PV generator of 32.13kw (Atersa 315Wx102No.) is correct. Pumping rate should be checked against the safe yield to avoid risk of overpumping.
4	Erbil	Qushtapa BH 1	Grundfos SP 30-20	33075	259.0	907	4532.5	The installed solar PV generator size (Atersa 315Wx105No.) is correct. Pumping rate should be checked against the safe yield to avoid risk of overpumping. Grid power provided for free by govt, but long cut off hours every day. Modules are tilted at 17deg which is not optimal for the latitude of 36deg.
5	Erbil	Qushtapa BH 4	Wilo 30-38	53550	216.1	756	3781.8	The exisitng PV generator of 53.55kw (Atersa 315Wx170No) is incorrectly sized. A bigger PV generator of 70.875kW could have been used instead. Grid power provided for free by govt, but long cut off hours every day.
6	Erbil	Sebarsti Village	0.0	35000	0.0	0	0.0	System was converted from Grid/genset to Grid/solar. No more water shortages since solar was installed. Modules are tilted at 22deg which is not optimal for a latitude of 36deg. Not enough data to do technical and economic analysis.
7	Erbil	Sakrura	SP46-15	33000	0.0	0	0.0	Modules are tilted at 23deg which is not optimal for 36deg. Not enough data to do technical and economic analysis.

Exisiting Grid/Generator Systems								
Site Details			Technical Design					
No.	Location	BH ID	Existing/ Proposed Pump	Solar Power Size Proposed (Wp)	Daily Output using Recommended Solar (m^3/day) in average month	No. of households served (using 200pp/day)	Population served @ 5 persons per HH	Comment /Recommendation
1	Erbil	Kawrgosk BH 3	Grundfos SP 30-24	37800	259.1	907	4534.3	System should be solarised to take advantage of economic gains from fuel savings and shield water supply from power outages
2	Erbil	Kawrgosk BH 4	Grundfos SP 30-20	33075	259.0	907	4532.5	System should be solarised to take advantage of economic gains from fuel savings and shield water supply from power outages Pumping rate should be checked against the safe yield to avoid risk of overpumping.
3	Erbil	Darashakran BH 1	Grundfos SP 17-24	28350	154.8	542	2709.0	System should be solarised to take advantage of economic gains from fuel savings and shield water supply from power outages
4	Erbil	Darashakran BH 2	Grundfos SP 17-24	28350	154.8	542	2709.0	System should be solarised to take advantage of economic gains from fuel savings and shield water supply from power outages
5	Erbil	Darashakran BH 3	Grundfos SP 17-24	28350	154.8	542	2709.0	System should be solarised to take advantage of economic gains from fuel savings and shield water supply from power outages
6	Erbil	Darashakran BH 4	Grundfos SP 17-24	28350	154.8	542	2709.0	System should be solarised to take advantage of economic gains from fuel savings and shield water supply from power outages
7	Erbil	Darashakran BH 5	Grundfos SP 17-24	28350	154.8	542	2709.0	System should be solarised to take advantage of economic gains from fuel savings and shield water supply from power outages
8	Erbil	Basirma BH 1	Grundfos SP 46-15	37800	370.7	1297	6487.3	System should be solarised to take advantage of economic gains from fuel savings and shield water supply from power outages
9	Erbil	Basirma BH 2	Grundfos SP 30-20	33075	276.8	969	4844.0	System should be solarised to take advantage of economic gains from fuel savings and shield water supply from power outages
10	Erbil	Qushtapa BH 2	Grundfos SP 30-20	33075	259.0	907	4532.5	System should be solarised to take advantage of economic gains from fuel savings and shield water supply from power outages. Pumping rate should be checked against the safe yield to avoid risk of overpumping.
11	Erbil	Qushtapa BH 3	Grundfos SP 30-20	37800	226.8	794	3969.0	System should be solarised to take advantage of economic gains from fuel savings and shield water supply from power outages Pumping rate against safe yield should be checked to avoid risk of overpumping

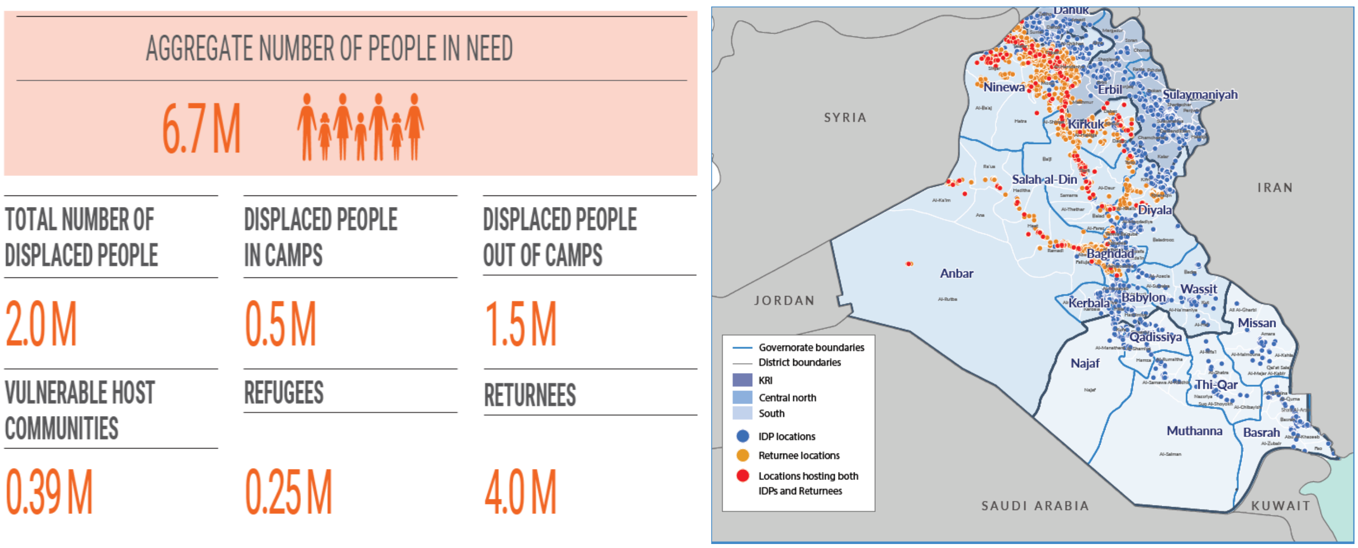
2 - BRIEF HUMANITARIAN, ENERGY AND WASH SECTOR OVERVIEW.

Although the humanitarian context in Iraq has transitioned into a new phase in 2018 after the finalization of the last conflict, vulnerable people continue to face immense challenges. Almost 18% of Iraq's population of 37 million is in need of some form of humanitarian assistance.

Out of an estimated 6.7 million people in need, the humanitarian system will target 1.75 million, a population which includes both in camp and out-of-camp IDPs, returnees, and vulnerable host communities.

Specifically for WASH in Iraq, partners will target 1.2 million people, plus an additional 250,000 refugees.

Figure 1: People in need and its geographical distribution.



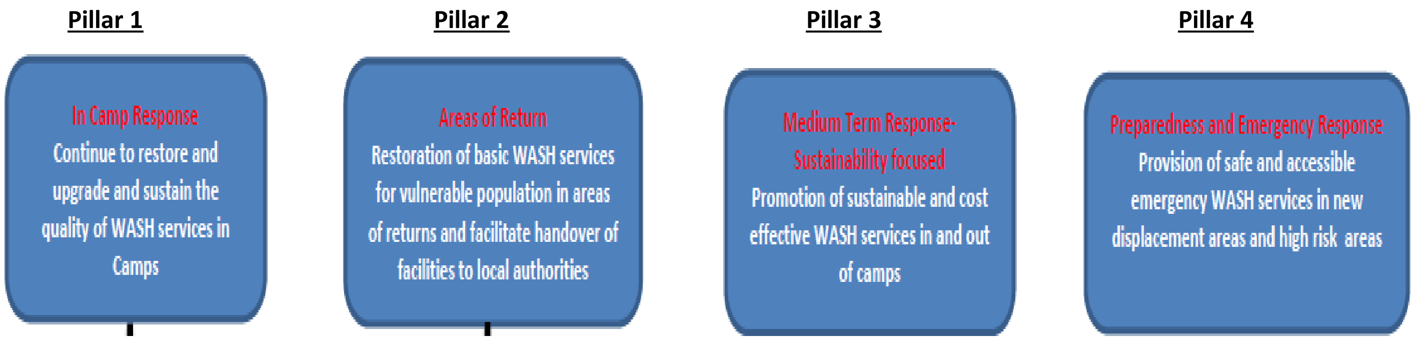
More than a third of the total 1.8 million displaced people and nearly all of the 250,000 Syrians refugees in Iraq continue to seek a place of safety in the Kurdistan Region of Iraq.

At KRI, 1.2 million people are in need of humanitarian assistance (721k being IDPs, most of them living outside camp settings), but only 0.5 million will be targeted (347k IDPs). For WASH at KRI, partners will target 300,000 people plus 241,000 refugees living in the region.

In terms of water, groundwater resources are reportedly being depleted due to overuse. The lack of a complete hydrogeological study at KRI make difficult to fully understand the water resource and possible long term mitigation measures.

As a strategic focus, the WASH Cluster continues to advocate for a longer-term improvement of water and sanitation facilities, while strengthening the capacity of local authorities to take ownership of facilities through regular operation and maintenance. Emphasis is on linking humanitarian WASH interventions with recovery/ reconstruction and development partners.

The WASH cluster strategy for 2019 has got 4 pillars of work as detailed below, with pillars 1 and 3 containing the use of solar-water solutions as a key activity.



In terms of energy context, despite abundant fossil fuel reserves and a location ideal for solar generation[1], Iraq currently suffers from a significant deficiency in power generation, with demand far outstripping supply.

Humanitarian activities are carried out against a backdrop of electrical energy insecurity in KRI, and Iraq in general, mostly due to fuel shortages, fleet age, overload of distribution networks, destruction of electrical network, lack of spare parts and equipment outages among others. At KRI, the installed electrical power capacity according to recent figures was about 3,200MW versus a demand of 5,500MW which is a 70% shortfall, with electricity demand growing at double digit rates annually[2].

Many households still experience electricity cut-offs lasting 12 or more hours a day[3]. This cutoffs affects all operations and services, including water supply schemes that always need a second source of power in order to ensure required daily water supply.

3 – ECONOMIC ANALYSIS SOLAR vs DIESEL GENERATOR.

Prices of pumps, generators, solar panels and other components together with government electricity prices were gathered and analyzed during the visits to private sector companies and from quotations to IOM, UNHCR and implementing NGOs.

All the water schemes visited where hybrid grid connected (either solar-grid or generator-grid); electricity from the grid is so far provided for free in refugee camp settings and the cost of kWh when charged outside camps, is heavily subsidized.

In those conditions, economic analysis of solar vs grid solutions is completely unrealistic, and when done showed that solar investment would take 16 years to break even when compared to grid supply for the larger systems (37kW pumps), and even longer for smaller ones. Therefore as things are now, solar would be an unattractive solution to replace grid when strictly considering only economic considerations.

A Present-Worth Life Cycle Cost analysis[4] was performed in order to compare costs for the total or partial replacement of existing diesel generators by solar photovoltaic systems, leaving in both cases grid as a secondary source. Results can be found in table 2 below, showing that in all cases there is a considerable cost reduction over the life time of equipment (average of -50%, ranging from -24% to -65%) when solar solutions are introduced to reduce or eliminate the use of diesel generators, with an average breakeven point on solar investment at 5.3 years.

[1] Erbil annual solar irradiation at 1,950kWh/m2 (higher in provinces outside KRI), with strong difference between summer and winter months, ranging 3.4 to 6.7 PSH.
[2] World Bank's KRG Economic Reform, 2016.
[3] Ministry of Planning Kurdistan Regional Government, 2020 vision.
[4] See Annex C 'Technical Briefing – Cost Analysis' for details in methodology.

Table 3 – Life Cycle Cost Analysis: Solar vs equivalent Generator systems.

Site Details			Water Output	Economic/Life Cycle Analysis					
				Generator stand alone		Equivalent Solar stand alone or Hybrid		Hybrid/Solar vs Diesel Comparison	
No.	Location	BH ID	Solar (m^3/day) in average month	Initial cost (USD)	Cost over Life Cycle (USD)	Initial cost (USD)	Cost over Life Cycle (USD)	Reduction of expenses Hybrid/Solar vs Genset	Break-even point
1	Ninawa	Sheikhan	219.0	0	87,138	47,994	66,506	-24%	**11.6 years**
2	Erbil	Kawrgosk BH 1	370.7	0	173,651	57,923	80,567	-54%	**4.6 years**
3	Erbil	Kawrgosk BH 2	276.8	0	161,783	50,567	72,217	-55%	**4.4 years**
4	Erbil	Kawrgosk BH 3	259.1	0	184,287	58,991	81,635	-56%	**4.4 years**
5	Erbil	Kawrgosk BH 4	259.0	0	156,634	51,786	73,436	-53%	**4.7 years**
6	Erbil	Darashakran BH 1	154.8	0	123,312	44,363	62,875	-49%	**5.4 years**
7	Erbil	Darashakran BH 2	154.8	0	123,312	44,363	62,875	-49%	**5.4 years**
8	Erbil	Darashakran BH 3	154.8	0	123,312	44,363	62,875	-49%	**5.4 years**
9	Erbil	Darashakran BH 4	154.8	0	123,312	44,363	62,875	-49%	**5.4 years**
10	Erbil	Darashakran BH 5	154.8	0	123,312	44,363	62,875	-49%	**5.4 years**
11	Erbil	Basirma BH 1	370.7	0	175,581	58,510	81,155	-54%	**4.7 years**
12	Erbil	Basirma BH 2	276.8	0	161,783	51,650	73,300	-55%	**4.5 years**
13	Erbil	Qushtapa BH 1	259.0	0	157,756	53,148	74,798	-53%	**4.8 years**
14	Erbil	Qushtapa BH 2	259.0	0	157,756	52,058	73,709	-53%	**4.7 years**
15	Erbil	Qushtapa BH 3	226.8	0	136,035	57,428	79,078	-42%	**7.4 years**
16	Erbil	Qushtapa BH 4	216.1	0	305,707	81,446	107,245	-65%	**3.4 years**
17	Erbil	Sebarsti Village	_	Not enough data to do technical and economic analysis.					
18	Erbil	Sakrura	_	Not enough data to do technical and economic analysis.					

Adding the costs on the table above, a total investment of 843,000USD to solarize schemes would lead to a total saving of 1.3 million USD over the life time of the equipment.

The wide variations in return on investment periods and cost reduction from system to system would show that if funds are restricted, a good prioritizing for schemes to be solarized (new or existing ones) would be important in order to maximize the investment.

While the results shown in the table above are valid for Erbil town and surrounding area (less than 2 hours car trip), these could be extrapolated to other parts of the country taking into account that diesel costs are higher in remote regions where delivery of diesel is more expensive, however solar cost of water will be consistent among all sites, no matter how remote.

Finally, and contrary to a still widespread belief, this analysis proofs once more the fact that solar solutions can be cost effective in countries were diesel cost are low (0.5USD/l at the point of use for Erbil area).

4 - PRESENTATION OF MAIN FINDINGS.

Despite the mentioned energy problems, the high solar potential in Iraq in general and in KRI in particular and the cost reduction and sustainability potential from solar solutions, **Solar Water Pumping (SWP) is in its infancy at KRI**. Out of the 35 WASH partners contacted, only 4 (UNHCR, UNICEF, IOM and Wind Peace Japan) had used the technology in a handful of water schemes (7 in total).

Directorate of Water officials expressed awareness and interest to solarise 25% of the water schemes under their area of influence, but no existing supporting documents (policy, assessments, workplan, budget) were found to support this statement, hinting again that use of SWP solutions is also at an early stage at government level.

The same comment can be applied to private sector companies in Erbil. While **high quality components and knowledgeable companies are found in town**, these are relatively new, have installed a low number of SWP systems or, as it is the case for the Grundfos supplier, just learnt and received their first SWP training from their matrix company in the last month.

There is also a **proliferation of low quality solar products** due to lack of control in importation and unawareness on potential users, making quality product knowledge a key point for implementing organizations. Having said this, the presence of good quality installations in the field show that good quality contractors and materials are indeed available and that with proper know-how, WASH partners can get efficient and performant water schemes.

As mentioned above, the unreliability of the grid made necessary the use of hybrid systems (grid-generator) to ensure water provision in each of the 18 water systems visited. Despite cheap fuel prices, operation and maintenance of **generators are reportedly expensive and cumbersome when compared to solar**, especially in some rural areas and refugee camps.

Positive existing experience: the first solar water scheme was installed in KRI by UNHCR (33kWp, 2016 in Quastapha refugee camp). According to UNHCR engineer and solar pioneer in the region, Mr Yahya Kawa, the scheme has been functioning daily without any technical issue since its installation as the solar investment is some months away to break even. Learning from their experience, UNHCR together with UNICEF decided in 2019 to solarize the rest of water schemes supplying refugee camps, a work currently under way.

Given the unreliability of the grid, the difficulty to properly manage its operation and maintenance and the remoteness and/or lack of regular access to sites together with the high and constant solar radiation in the area, **SWP solutions are ideal in the development of new points or conversion of old diesel powered ones** if greater cost-efficiency and sustainability want to be achieved, especially at long term camp settings and rural host communities.

It is believed as well that in line with the approach from WASH cluster, SWP adoption would represent a good opportunity to link humanitarian WASH interventions with recovery/ reconstruction and development partners and donors. Together with it, adoption of SWP solutions could alleviate an overload grid through grid-tie connections that could act at the same time as cash crops for host communities. It seems however that at least at KRI, there is no legislation or initiatives to look into these opportunities.

In terms of management models, all partners adopting SWP solutions turn to government water offices for them to handle operation and maintenance of the systems. Salaried operators where found taking care of schemes. Good maintenance routines were implemented in all SWP schemes visited, and all schemes were found functional (=water at tap at time of visit), showing that the model works well for everything that has to do with onsite maintenance; however since all SWP are new from 2016 or later and none have reportedly gone through any major technical fault, the capacity from these offices to timely respond and repair SWP schemes is untested and remain to be seen.

Since the **exit strategy of WASH partners** in and outside camps pass by handing water schemes to local authorities, training of their personnel and agreeing on roles and responsibilities at sector level is essential to ensure long term sustainability and functionality of SWP schemes.

The table below summarize the main factors specific to Erbil area context that are for and against a quality mainstreaming of solar water pumping solutions.

Factors for solar pumping mainstreaming	***Policy & Institutional***	***Technical***	***Financial***	***Social***	***Environmental***
Positive/ Favorable	Government, UN, NGOs started using solar solutions for water supply	Presence of high quality solar products in Nigerian Market Existence of knowledgeable private sector companies Quick access to spare parts and knowledgeable companies feasible Good maintenance practices observed at existing solar schemes Lack of reliable electricity grid	Lifecycle costs lower for solar when compared to diesel Water cost cheaper to users	High acceptance of solar solutions by beneficiary community Low risk of theft or vandalism Water offices at government level willing to take O&M of systems from humanitarian actors	Reduction noise and air pollution High solar radiation in KRI most of the year
Challenging/ Need improvement	Lack of guidelines, best practices, lessons learnt, framework or policy	Lack of expertise among stakeholders Low quality products and unsafe layouts used in installations Lack of regular training opportunities in-country Low involvement and training of Water committees in proper operation and management	Low or lack of payment by most users when systems are converted to solar	Wrong water-for-free perception when solar provided Untested capacity by government water technicians to solve technical issues as solar schemes handed over are too new	High winds and dusty environment difficult maintenance of solar systems

The single most important barrier towards a quality solarization of water points in the area visited is the technical expertise of WASH stakeholders involved in the design, implementation, operation and maintenance of solar pumping projects; this despite the use of solar solutions is mentioned in 2 of the 4 strategic pillars of the WASH cluster.

Short-term training opportunities for WASH engineers are not available at the country yet, with no place or plan in sight to cover this gap. The large expression of interest by WASH stakeholders and high turnover for the training provided during this visit shows the willingness and need to strengthen technical knowledge if the current and planned solar conversions are to be implemented and maintained successfully.

Besides, **theft and vandalism at SWP schemes level is almost unreported**, which together with the impossibility to mismanage fuel for operation since this is not needed, ensure high cost-efficiency and reliability of solar solutions.

At community level, the users of all water schemes visited but 1 were getting water for free, with users having direct access to government employees to act on repairs when necessary. While this can foster better acceptance of refugees and IDP presence in the areas where host communities live, it might also pose a future challenge when NGOs retreat their support and paying for water become again necessary, as it was before the emergency.

Discussion on oversized solar designs: In Erbil the 12 solar pumping systems by UNICEF and UNHCR had design changes between the moment of tendering and the installation, reportedly due to increasing water demand and/or lowering of static water levels. Designs of solar pumping schemes should be made having into account future water demands and lowest drawdown of the year (end of dry season). It is not common practice to oversize a PV generator for the future demand and this should not be encouraged; among others cause changing to a bigger pump might imply as well change of invertor and layout of panels. In fact modular design should be such that more modules can be added in the future when demand increases thus keeping the current Capex low, rather than incurring all the cost now. Modules are the most "modular" part of the whole system after all.

In general, WASH emergency partners face a range of common challenges when using solar pumping solutions for which it would make sense to look at those in a unified, coordinated way. While it is difficult to have engineers with good solar knowledge in all +20 WASH operating organizations all the time, coordination to provide reference material, regular in-country technical support, accessible technical helpline and/or a platform where to share common challenges and agree on best practices as a sector seem lacking.

5 – RECOMMENDATIONS AND WAY FORWARD.

Solar pumping technology is deemed an appropriate solution for some areas in Iraq. Primarily, off-grid WASH focused areas and long term camps (refugee camps and some IDP camps) are contexts where solar would be best suited to ensure water supply in a cost effective and sustainable way. In the medium term, existing water schemes working for the longest time on diesel generators can be replaced by solar in order to maximize financial investment.

However a stronger focus on technical aspects and capacity building of implementing partners and water state actors will be needed in order to ensure proper functioning and maximization of resources.

The main recommendations from this visit are detailed below.

***For NGOs and implementing organizations*:**

- Seek for options to build technical capacity of wash engineers in order to know what designs, products, qualities and layouts are the best suited for every water scheme.
- Invest in after-sale support of solar systems by making provision to support DoW/ communities in budget for stock/purchase of critical spare parts and/ or provide rapid technical support when needed.
- Ensure training and basic tools are provided at field base to water operators in order to properly operate and basic maintain solar equipment.
- Quality components: Ensure certified quality materials are provided by suppliers. Ask for reputed brands and/ or certification documents during tendering and quotation process.

For coordinating organizations:.

- Further involve and support government officers by building understanding of solar benefits and what approaches are necessary for sustainability. E.g. Sheikhan community has 13 pump operators who are all illiterate, challenging O&M and sustainability of the systems.

- Policy environment for solar technology: work to influence government/donor change of policy so that there is a framework for the mainstreaming of solar technology. Collective bargaining to donors at sector level would help for more allocations to SWP.
- Need for guidelines at the national or sector level to provide standards for use/ installations. A solar working group/ recruitment of a focal solar WASH expert at the sector level can provide a road map to this.
- Articulate capacity building of WASH engineers through workshops and tapping on private sector knowledge, who are ready to provide training.

For Government/ Donors:

- Favor SWP projects that include provisions for after-sale service and visions on long term operation and maintenance.
- Build stronger linkages with recovery and reconstruction efforts and support government partners in prioritizing solar-WASH solutions in its national developmental plans.
- Develop a regulatory framework and an investment plan to provide solar and power capacity for connection with the grid so that it can be used as well as a cash crop for users.
- Support **establishment of a solar training center** at University level, as the one existing in Nairobi, that would serve as a reference for regular training of both government, NGO, UN technical staff as well as for private sector actors.

Action points for the Global Solar&Water Initiative team:

- Follow up visit in beginning of 2020. Organization of new solar training with priority to those in waiting list.
- Available for remote technical support at solarquery@iom.int