LEBANESE REPUBLIC
MINISTRY OF ENERGY AND WATER

Hydropower Electricity in Lebanon

Beirut Energy Forum 2014 (Date 17/09/2014)

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Lebanon's Hydrology

- Real Resource unequally spread in time & space
- Undeniable potential of high precipitations

Lebanon's Hydrology: Main River Streams

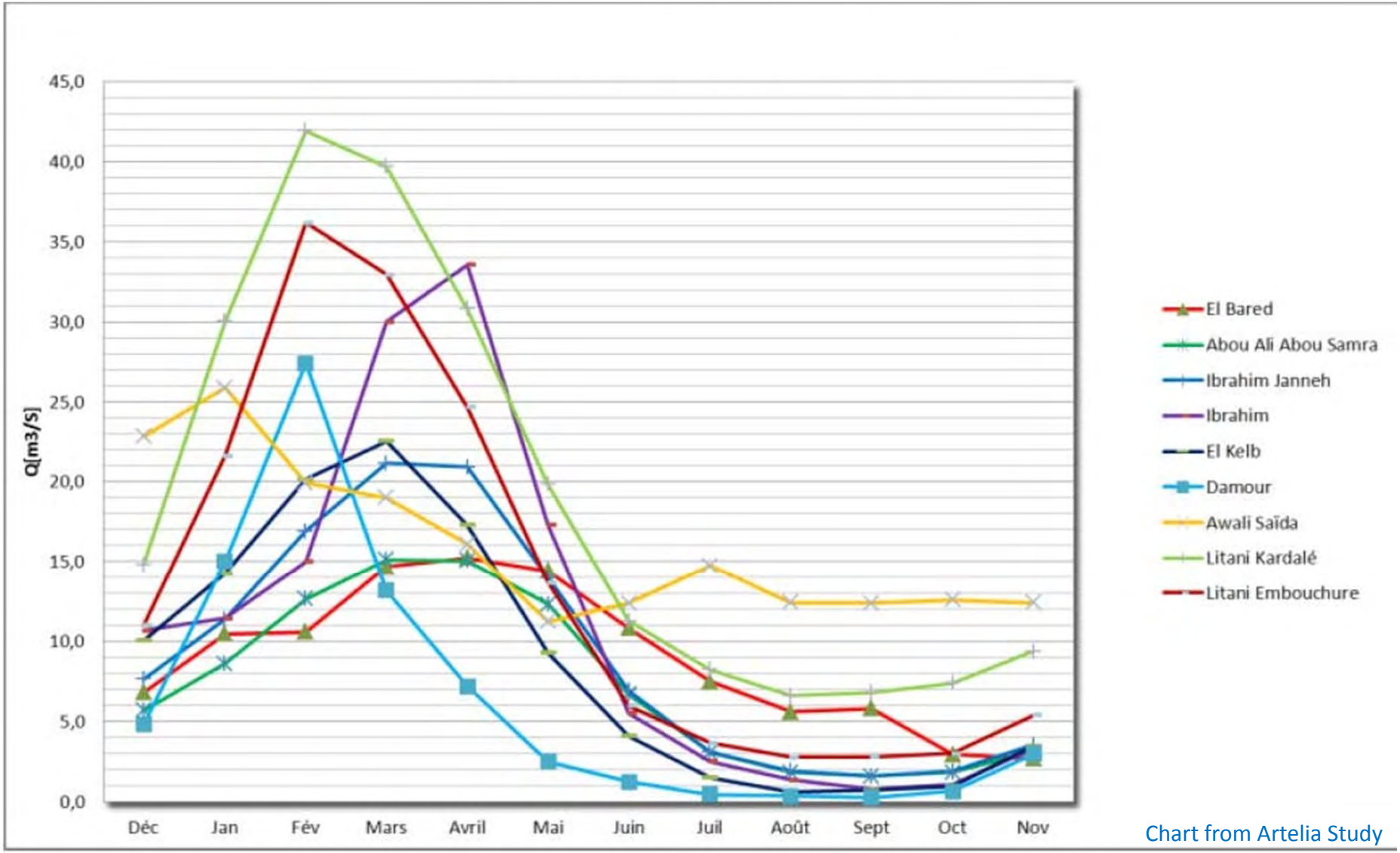


Chart from Artelia Study

Lebanon Hydrology :Priority in Water Use

1- Potable Water

2- Irrigation

3- Hydroelectric Energy

Current Installed Capacity

River Stream	Establishment	No. of Plants	Year	MW	Remarks
LITANI AWALI RIVERS	LITANI WATER AUTHORITY	No. 3 Plants	**1961 - 1967**	**199**	In Service – **Energy production is expected to drop by 60% after the Conveyor 800 Project**
NAHR IBRAHIM RIVER	SOCIETE PHOENICIENE DES FORCES DE NAHR IBRAHIM DES EAUX ET ELECTRECITE	No. 3 Plants	**1951 - 1961**	**32**	In Service - Needs Rehabilitation / Upgrade
WADI KADISHA	LA KADISHA - SOCIETE ANONYME D'ELECTRECITE DU LIBAN NORD S.A.L.	No. 4 Plants	**1924 - 1961**	**21**	In Service - **Rehabilitation / Upgrade Ongoing**
NAHR AL BARED	AL BARED	No. 2 Plants	**1936**	**17**	In Service - Needs Rehabilitation / Upgrade
SAFA SPRING	ELECTRECITE DU LIBAN	No. 1 Plant	**1931**	**13**	In Service - Needs Rehabilitation / Upgrade
TOTAL INSTALLED CAPACITY				**282**	**MW**

Current Share of Hydro Energy

Plant	Net Installed Capacity MW	Yearly Production GWh	Rehabilitated Plant Yearly Production GWh
Zouk	607	1,897	3,164
Jieh	327	1,218	1,704
Deir Ammar	450	2,977	3,275
Zahrani	450	2,984	3,283
Baalbek	64	166	186
Tyr	72	187	209
Hrayche	70	200	364
Total Thermal	**2,040**	**9,629**	**12,185**
Kadisha Hydro	21	72	76
Litani	199	680	775
Nahr Ibrahim	32	92	105
Bared	17	54	62
Richmaya	13	20	23
Total Hydro	**282**	**918**	**1,041**
Total Thermal & Hydro	**2,322**	**10,547**	**13,226**
% of Hydro Energy		**8.70%**	**7.87%**

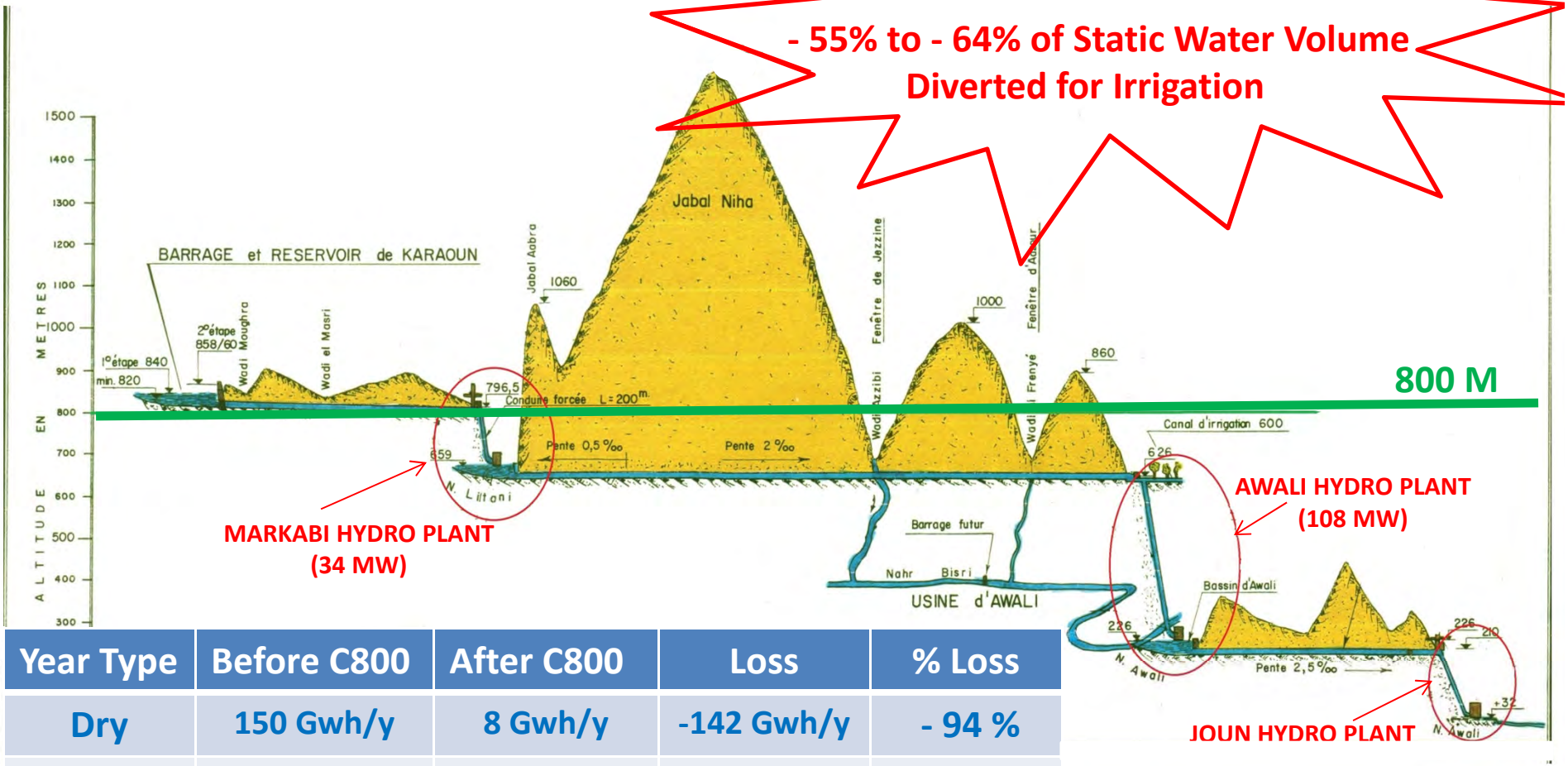
Main Ongoing Projects

- Litani Water Authority Irrigation Projects
- Kadisha Hydro Fleet Rehabilitation & Upgrade
- New Dams : Janneh, Yammouneh, Mseilha, Boqata

Litani Water Authority Irrigation Projects

Litani Water Authority: Conveyors 800 M & 900 M

- 55% to - 64% of Static Water Volume Diverted for Irrigation



Year Type	Before C800	After C800	Loss	% Loss
Dry	150 Gwh/y	8 Gwh/y	-142 Gwh/y	- 94 %
Average	500 Gwh/y	197 Gwh/y	-303 Gwh/y	- 61 %
Rainy	1,000 Gwh/y	705 Gwh/y	-295 Gwh/y	- 30 %

Litani Water Authority Main Ongoing Projects

The Litani Water Authority has 70% of the existing Hydro Fleet installed capacity, however many ongoing projects will significantly curtail its energy production as follows:

- **Conveyor 900 :** Will Divert 10 to 30 Mm3 (4.5 % to 13.6 % of the total static water volume) from the Qaraoun Dam (Total Capacity 220 Mm3) for Irrigation
- **Conveyor 800** : Will divert 110 Mm3 (50% of the total static water volume) from the Qaraoun Dam (Total Capacity 220 Mm3) for Irrigation & Potable water / **New Hydro Unit of 3 MW**
- **Bisri Dam & Conveyor** : Dam Capacity 110 Mm3 – Will divert 70 Mm3 from Joun Hydro Plant / **New Hydro Units of (2 x 5 MW)**
- **Khardali Dam** : Dam Capacity 70 Mm3 / **New Hydro Units 10 MW**
- **Kfarsir Dam** : Dam Capacity 28 Mm3 / **New Hydro Units 6 MW**
- The affected Litani Hydro plant of Awali (108 MW) could be used for **Reactive Energy production**, whereas the plant of Joun (48 MW) could be used as a **Pumped storage** facility (Studies to Confirm)

Rehabilitation & Upgrade of Kadisha Hydro Plants

Becharre Hydro Plant

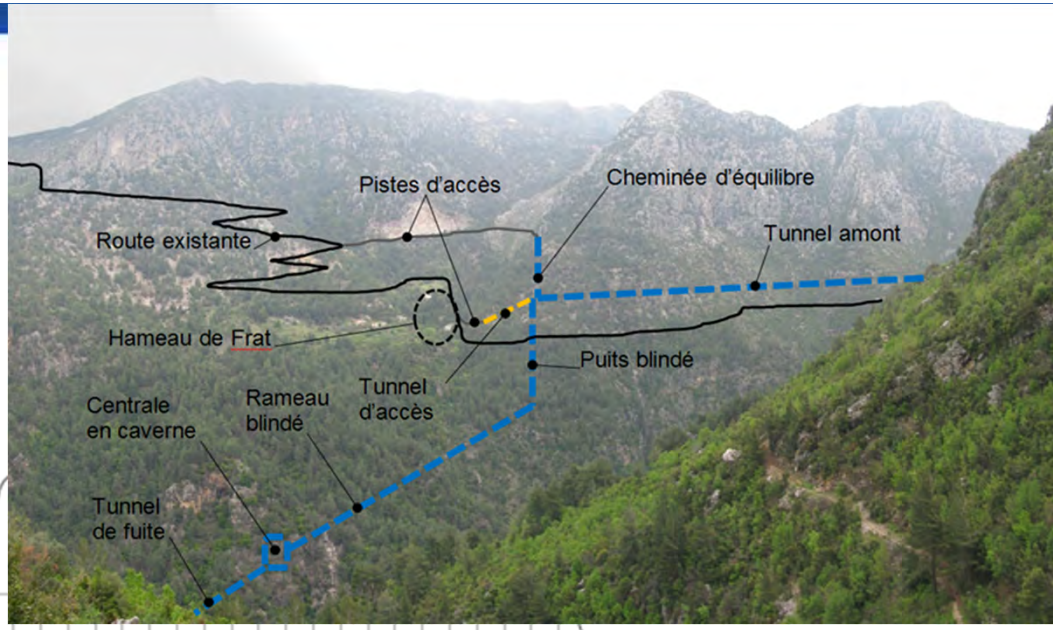
Rehabilitation & Upgrade of Kadisha Hydro Plants

- The Rehabilitation of all civil works including water intakes, penstocks, channels, storage basins, tanks etc…
- **Bechare Hydro Plant** : + 1.8 MW New Unit and Rehabilitation of 2 x 0.8 MW Units (1924) / **+ 0.5 GWh/Year**
- **Abou Ali Hydro Plant** : + 3 MW New Unit and Rehabilitation of a 2.95 MW Unit (1932) / **+ 3.5 GWh/Year**
- **Mar Licha Hydro Plant** : Rehabilitation of 2 x 1.1 MW Units (1957)
- **Blaouza II Hydro Plant** : Rehabilitation of 2 x 2.8 MW Units (1961)

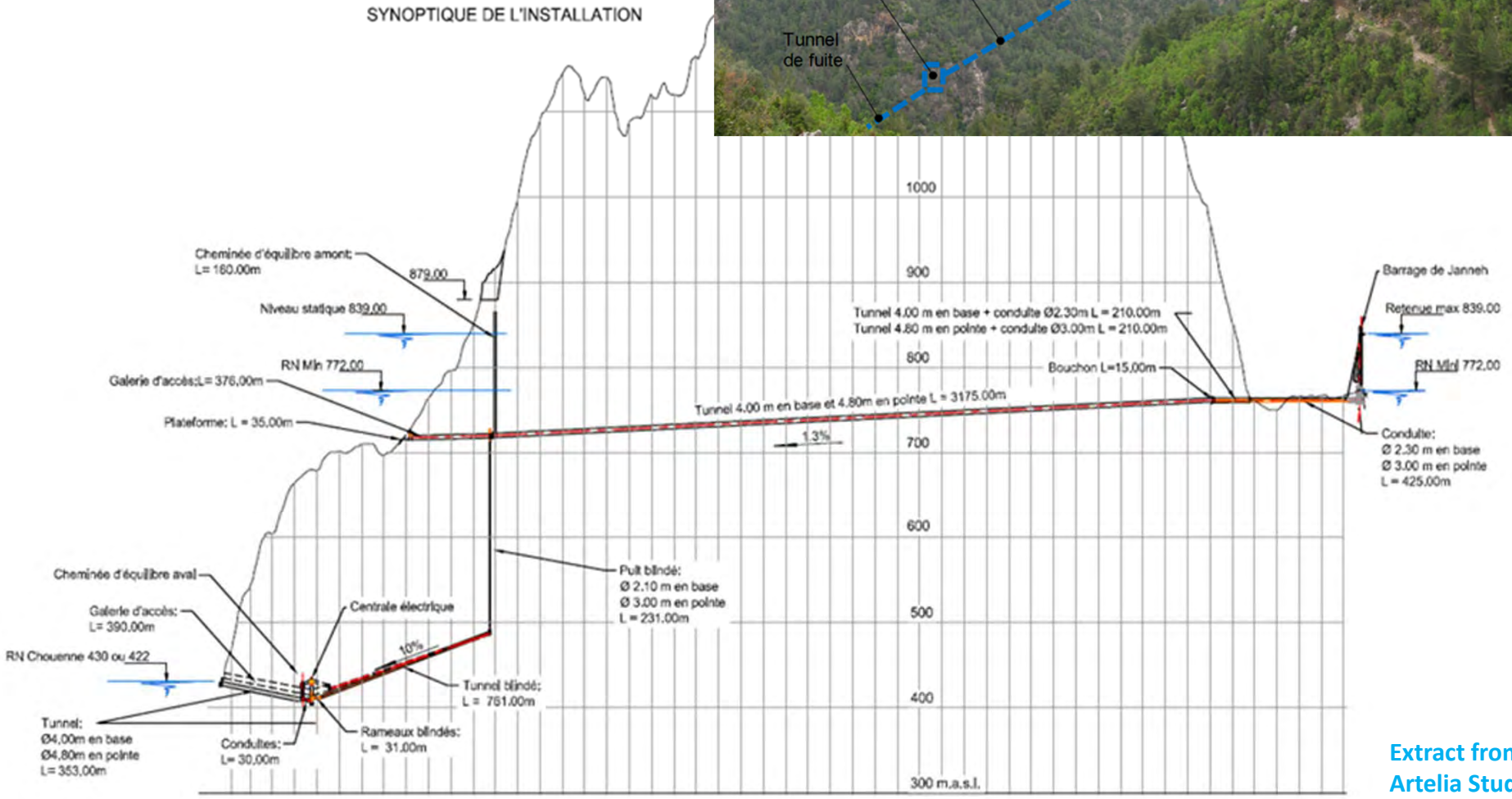
- The Overall Benefits of the Kadisha hydro plants rehabilitation will be an increased reliability of the plants and a **7%** of increase of Energy production or **+ 4 GWh/Year**

New Dams
Janneh Hydroelectric Plant

(54 MW / 100 MW)



SYNOPTIQUE DE L'INSTALLATION



Extract from Artelia Study

New Dams: Janneh Hydroelectric Plant

	Janneh Run of River Scheme	Janneh Peak Load Scheme
Installed Capacity	54 MW	100 MW
Energy Produced	179 GWh/y	199 GWh/y
Project Execution Time	36 Months	40 Months
Project Capex	59 M.$	81 M.$
Cost of Installed Kw	1,100 $/Kw	800 $/Kw
Selling Tariff (16% IRR, 25 years lifetime, 10% Interest)	7 c$/Kwh	8.8 c$/Kwh - Peak
		4.4 c$/Kwh - Base

Hydro Share in Energy Mix after Ongoing Projects Completion

Plant	Net Installed Capacity MW	Rehabilitated / New Plant Yearly Production GWh
Existing Thermal Power Plants (After Rehab)	2,040	12,185
Zouk ICE Power Plant	194	1,552
Jieh ICE Power Plant	78	625
Deir Ammar II CCPP	538	2,811
1500 MW IPP Plants	1,500	11,776
Total Thermal Power Plants	4,350	28,949
Existing Hydro Power Plants (without Litani)	83	266
Litani Hydro (after Irrigation Projects)	228	(From 8 to 705) Avg. 197
Janneh Hydro	100	199
Yammouneh Hydro	4.7	23
Mseilha Hydro	0.6	3
Boqaata Hydro	0.14	1.23
Total Hydro	416	689
Total Thermal & Hydro	4,766	29,638
% of Hydro Energy	8.73 %	2.32 %

Installation of New Hydro Plants – Master Plan

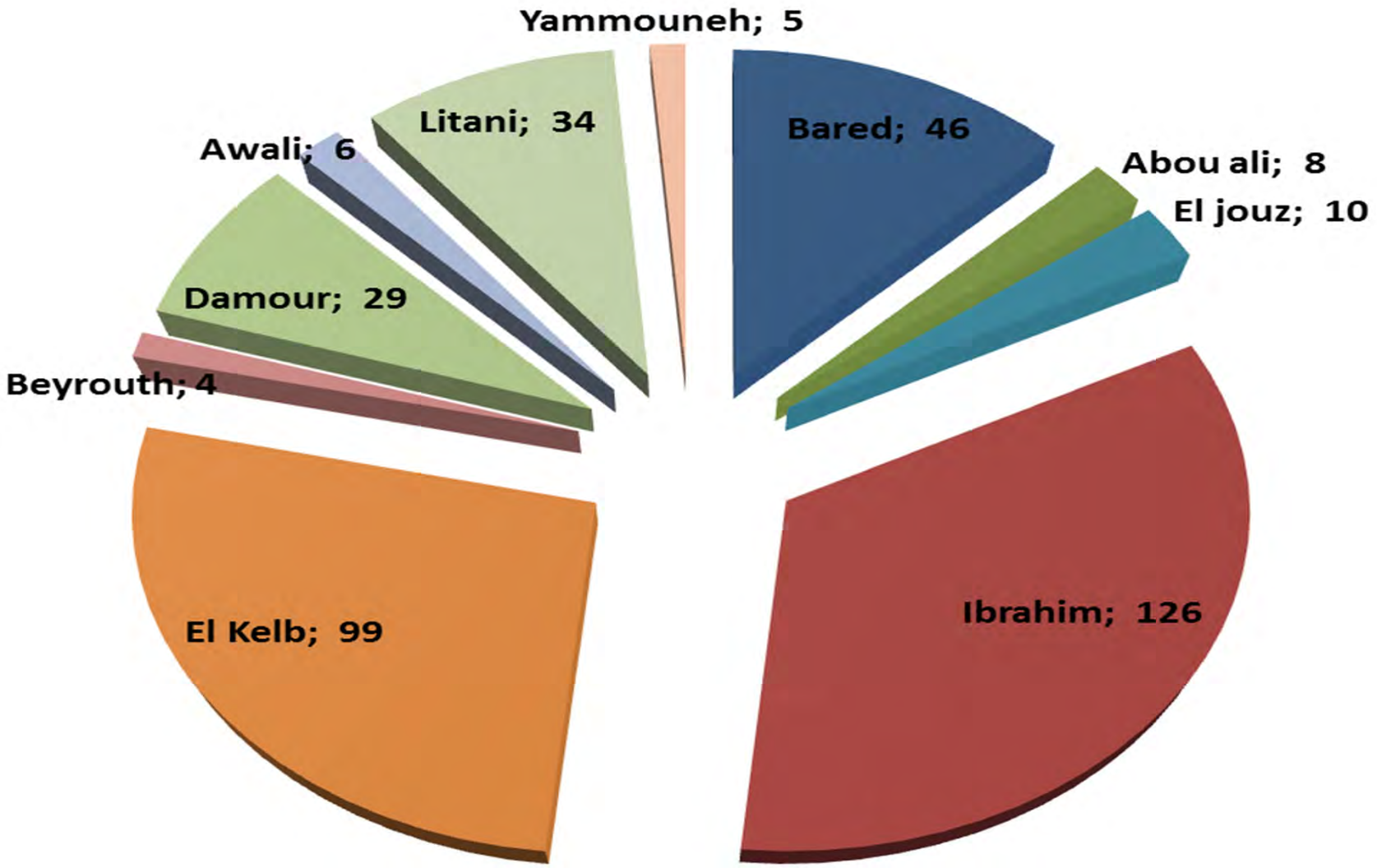
32 new sites ranging from 0.6 MW to 100 MW (average of 13 MW/Site) were identified as follows :

- **263 MW (1,271 GWh/y) with a cost of 667 M.$** in Run of River scheme
- **368 MW (1,363 GWh/y) with a cost of 772 M.$** in Peak scheme

25 sites are economically viable with a Minimum Selling Tariff less than 12 $c/kWh :

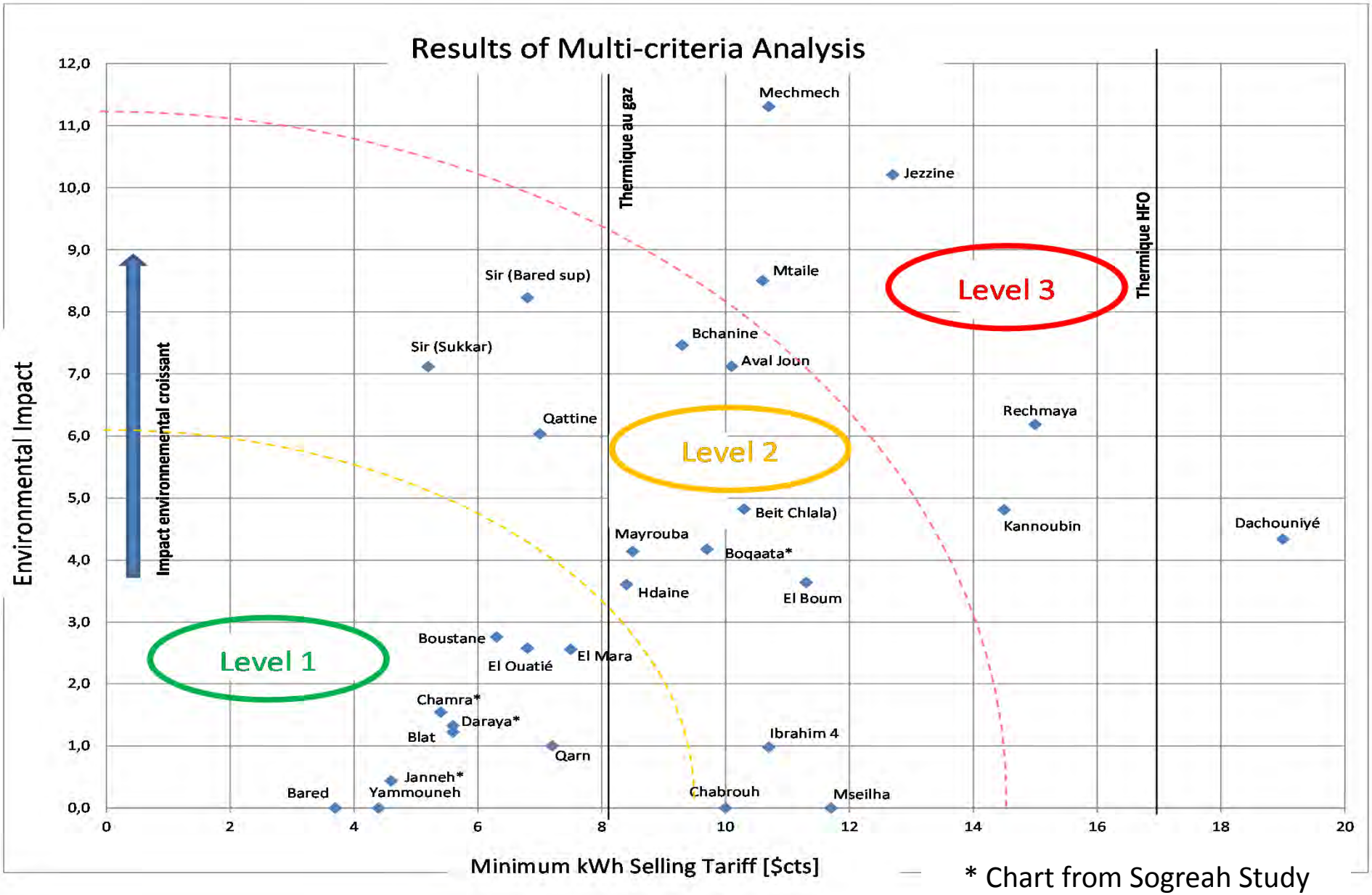
- **233 MW (1,126 GWh/y) with a cost of 560 M.$** in Run of River scheme
- **315 MW (1,217 GWh/y) with a cost of 665 M.$** in Peak scheme

New Hydro 368 MW Capacity Distribution



* Chart from Sogreah Study

New Sites Feasibility Multi-Criteria Chart



* Chart from Sogreah Study

Hydro Share in Energy Mix after Hydro Master Plan Completion

Plant	Net Installed Capacity MW	Rehabilitated / New Plant Yearly Production GWh
Existing Thermal Power Plants (After Rehab)	2,040	12,185
Zouk ICE Power Plant	194	1,552
Jieh ICE Power Plant	78	625
Deir Ammar II CCPP	538	2,811
2500 MW IPP Plants	2,500	19,626
Total Thermal Power Plants	5,350	36,799
Existing Hydro Power Plants (without Litani)	83	266
Litani Hydro (after Irrigation Projects)	228	(From 8 to 705) Avg. 197
Currently Ongoing Hydro Projects	105	226
New Hydro Plants – Level 1	122	541
New Hydro Plants – Level 2	75	323
New Hydro Plants – Level 3	30	138
Total Hydro	643	1,691
Total Thermal & Hydro	5,993	38,490
% of Hydro Energy	12.88 %	4.4 %

Hydro Share in Energy Mix Summary

Plant	Net Installed Capacity MW			Energy Production GWh		
	Current	Medium Term	Long Term	Current	Medium Term	Long Term
Thermal Power Plants	2,040	4,350	5,350	12,185	28,949	36,799
Hydroelectric Power Plants	282 +134MW 416 +227MW 643			1,041 -352Gwh 689 +1,002Gwh 1,691		
Total Thermal & Hydro	2,322	4,766	5,993	13,226	29,638	38,490
% Hydro Share	12.14% -3.41% 8.73% +2% 10.73%			7.87% -5.55% 2.32% +2.08% 4.4%		

Opportunities, Challenges &Risks

Opportunities

- Lebanon's potential of high precipitations constitutes a real natural resource that is not being sufficiently exploited
- There is a Master Plan for the construction of nearly 50 Dams that is under execution for irrigation purposes that constitutes an opportunity for the hydroelectric development
- The irrigation projects that are undergoing can be optimized for hydroelectric production at a micro level
- There is a potential for micro-hydro development in the water distribution networks, the waste water treatment plants and the thermal power plants
- Hydroelectric development with optimized Feed-In Tariff can foster facilities functioning in peak mode, or in pumped storage which represent a particular interest for the grid stability, when this latter will have attained its maturity, in particular in the hypothesis of the future development of other sources of renewable energies (solar, wind, ….)

Natural Challenges

- In many cases the geology of Lebanon is such that the development of hydroelectric facilities is not feasible unless the costs of the Dams construction are not considered as an integral part of the hydroelectric investment
- Water is becoming increasingly scarce over the years whereas the needs for potable water & irrigation are increasing.

Opportunities, Challenges &Risks

Institutional & Legal Challenges

- Most of the existing Hydro concessions of Bared, Kadisha, Nahr-Ibrahim & Litani are close to expiry & are selling the electrical energy produced to EDL at low tariffs. This situation constitutes a major barrier to the investment in the sector.
- The current legal framework gives the exclusive rights on the Water resources to the DGRHE & that on the Electrical resources to EDL.
- There are also other stakeholders involved in the Hydro sector as the Ministry of Agriculture for the storage basins & irrigation channels , & CDR for funded projects.
- The promulgation of the Water Code is necessary for the creation of a legal framework for the PPP's in the water sector.
- The launching of the IPP/PPP Laws & the ERA, as per Law 462 & 181, is necessary in case the development of new projects in the Hydroelectric sector has to be done by the private sector
- In all cases the Hydro development requires the Feed-In Tariff structure of the Electrical energy to be optimized, task which is not possible before restoring the 24h service for the electrical supply

Opportunities, Challenges &Risks

Risks

- The current institutional & legal framework being a handicap for hydroelectric development, if nothing is made the sector will remain at stall
- Introducing the Hydro component to a dam, irrigation channel or other facility becomes difficult & sometimes not feasible at all if not done at the design stage
- If the hydroelectric development does not become a high priority in the near future, we will end up with potable/irrigation/waste water storage & distribution facilities being completed without proper optimization for hydroelectric production

Donors Involvement

- The MoEW will be conducting a study for identifying the legal & administrative barriers to the hydro market development & proposing the most appropriate strategies for overcoming these

- Once the strategy for lifting the barriers is established, it would be beneficial for the sector that the BDL supports a financing mechanism with the local banks for covering the new hydroelectric projects and the rehabilitation of the existing hydroelectric plants

- The next period will require the participation of donors in the sector development

Yahchouch Dam – Nahr Ibrahim

Thank You for your Attention ☺

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