



IDAL

INVEST IN LEBANON

CLEAN TECHNOLOGY

FACT BOOK
2016



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I. GLOBAL OVERVIEW

In 2012, the global clean tech sector had a market size of USD 5.5 Trillion and an estimated growth rate of 4.1% CAGR until 2015/2016¹.

The Clean Tech sector is growing from a niche market to a market that has the potential to impact an array of different sectors, including ICT, Healthcare, Food, and Electronic. An estimated USD 41 billion of venture capital funds have been injected in clean tech startups worldwide from 2009 to 2014, almost double the amount of the previous five years².

The clean tech sector is a driving force for innovation: 6% of all global Patent Cooperation Treaty (PCT) applications filed in 2010 were Environmental technology PCT applications, and these grew at a CAGR of 9% from 1999 to 2010 (OECD, 2011)³.

Switching to a clean tech environment is also favorable for job creation. The International Labor Organization (ILO) estimates that transitioning to a greener

economy could result in 60 million additional jobs⁴. These jobs tend to be more skilled, safer, and better paid than jobs in similar sectors.

Clean technology investment is shifting towards developing economies, and this shift is opening opportunities for entrepreneurs in these regions to take advantage of the sector's growth.

In 2012, investments in the clean tech sector increased by 19% in developing countries reaching USD 112 billion, compared with an overall decline of 12% globally (to USD 244 billion)⁵. Even when excluding China, India, Russia and Middle Income Europe, investments are expected to be over USD 4.1 trillion until 2024⁶ (USD 900 billion should go specifically to MENA region)⁷, with USD 1 trillion of this expected to be accessible to SMEs⁸. Knowledge of local markets, the need for specialization, and lower financial and technical barriers to entry make these activities especially accessible to SMEs.

Clean Tech sector is a growing sector with a market size of

5.5 trillion USD

in 2012



CAGR estimated to

4.1%

until 2015/2016



1 InfoDev /World Bank, 2014

2 The Global Clean Tech Innovation Index 2014, WWF International & the Cleantech Group

3 oecd 2011 in InfoDev /World Bank, 2014

4 ILO, 2013

5 InfoDev /World Bank, 2014

6 (For 15 clean tech sectors in 145 developing countries)InfoDev /World Bank, 2014

7 InfoDev /World Bank, 2014

8 (For 15 clean tech sectors in 145 developing countries)InfoDev /World Bank, 2014

II. CLEAN TECH SECTOR IN LEBANON

Where does the clean tech sector in Lebanon stand? Analyzing the sector will require looking at the various sectors, sub-sectors and activities that involve the use of clean technology such as water and waste water, agriculture, agro food and the environment. Like many countries in the world, Lebanon is suffering from environmental pressures due to climate change, population growth, and urbanization, which require more optimal resource management plans and water and waste management systems.

With the increase of greenhouse gas (GHG) emissions at a rate of 27.66% from 1994 to 2004 (CAGR of 2.77%)⁹ and the presence of a number of natural resources (including wind, solar, and water) Lebanon has been witnessing a surge of high tech companies specialized in clean technologies.

The innovations in the clean tech sector can help Lebanon both preserve its natural resources, as well as benefit from them through renewable energy systems.

1. THE USE OF CLEAN TECHNOLOGY IN WATER AND WASTEWATER MANAGEMENT

While water supply from rivers, springs, storage dams, and groundwater is estimated at 2,000-2,700 million m3 per year, higher than the expected projected water demand of about 1,800 million m3 in 2035¹⁰, widespread pollution and substandard water infrastructure are restricting the Government's ability to meet future water demands. The Ministry of Environment estimated that the total renewable resources (drinking, industrial and irrigation) would be 839m3 per capita per year in 2015¹¹, lower than the international benchmark of 1,000 m3 per capita per year¹².

Globally, the clean tech water sector was generating average profits of 12.9% in 2014¹³. Due to the MENA region's climate, and with a growing population, it is clear that water and wastewater dominate the opportunities in clean tech in this region.

Lebanon possesses a few technologies for water and wastewater management:

► Rainwater harvesting from hill lakes or ground lakes: several hill lakes were constructed in 2008 (mostly in North Lebanon and the Bekaa), with a total capacity of 98,139 m3¹⁴. However, many factors, including the presence of a distribution system, hinder the wide use of this practice.

9 MoE/UNDP/GEF, 2011

10 MOE/UNDP/ECODIT, 2011

11 MOE/UNDP/ECODIT, 2011

12 World Bank 2009

13 Lux Research 2014

14 Green plan 2009 in MoE/URC/GEF, (2012). Lebanon Technology Needs Assessment report for Climate Change.

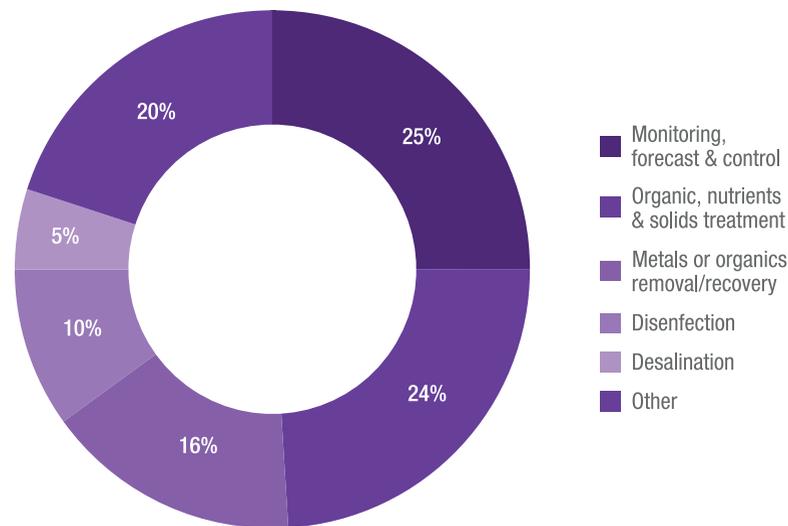
► Use of treated wastewater in irrigation (UTWWI): Several treatment plants have been planned and a number of them are under construction. Municipalities have also taken measures to improve wastewater collection and disposal. However, the absence of specific laws pertaining to the use of treated wastewater, and the lack of a financial mechanism to sustain the treatment plants are some of the challenges that hinder the wide application of this method.

INVESTMENT OPPORTUNITIES

Globally, the clean tech water sector is focusing on a number of different areas, mainly:

- Monitoring, forecasts and process controls: 25% of startups working in the clean tech water sector are focusing on monitoring, forecasts and process controls (through sensors and Internet of Things applications).
- Organic nutrients and solids treatment: 24% of startups globally are working on basic wastewater treatment.
- Metals or organics removal/recovery: 16% of startups globally are working on these technologies.

Share of Startup Technology by Type % | 2014



Source: Lux Research, 2014

2. THE USE OF CLEAN TECHNOLOGY IN THE AGRICULTURE SECTOR

The Agriculture sector generates around 4.7% of Lebanon's GDP¹⁵. It employs roughly 10% of the Lebanese labor force¹⁶, and is the fourth largest employer in the country. Lebanon's moderate climate, rich soil, and abundant water resources provide it with key enablers to stand out in the region as an ideal location for agricultural activity. The country is endowed with the highest proportion of agricultural land¹⁷ in the Middle East. Climate is overall moderate and allows the cultivation of a wide variety of crops that would normally grow in both cold and tropical countries. Major regions for crops, meadows and pastures include the Bekaa plain (where more than 40% of the land is cultivated), and Northern Lebanon.

Due to increasing produce demand, agriculture is suffering from scarcity of land, climate change and environmental issues, and the changing needs of consumers that are demanding healthier and more nutritious products. Agriculture in Lebanon still relies on traditional methods, but a number of Lebanese companies are starting to innovate in this sector.

INVESTMENT OPPORTUNITIES

A number of investment opportunities exist in the Lebanese clean tech agricultural sector:

- The introduction of biotechnology to the agriculture sector: the genetic manipulation of crops to adapt them to certain climate conditions is gaining ground. Crops can be modified to adapt to drought conditions and therefore reducing the need for large amount of irrigation¹⁸. Adapting to climate and selecting suitable varieties can have a 20% increase on yields¹⁹.
- Precision agriculture via hardware innovations: drones are increasingly used as a method of crop surveillance in order to minimize cost and maximize efficiency.
- Precision agriculture via software applications: Agricultural software, i.e. smart irrigation allows to set up an automatic and much more efficient irrigation plan than traditional irrigation methods.

¹⁵ National Accounts

¹⁶ Central Administration of Statistics, Statistical Year book 2009, Green Projects and Agriculture.

¹⁷ As de-fined by the FAO, agricultural areas include arable lands, as well as permanent crops and pastures

¹⁸ Cleantech Group, 2015

¹⁹ MoE/URC/GEF, (2012). Lebanon Technology Needs Assessment report for Climate Change.

CASE STUDY

GREEN STUDIOS

GREEN STUDIOS is a Lebanese company that was able to create a technology that allows it to plant all types of plants including high shrubs, trees and vegetables in the hottest climates due to a fibrous skin layer that allows complete temperature insulation. It works in extreme climate and both indoors and outdoors, horizontally and vertically. The fibrous skin adapts to changing conditions via sensors linked to smart controllers, in order to keep the plants in good health. these technologies.

E2 is a partnership of academics at the American University of Beirut. Their first projects included: (1) A robotic device for use in research (2) an industrial grader for agricultural producers in Lebanon, and (3) a high tech industrial grader for cucumber pickling and packaging with an automated visual measuring system.



ECO INDUSTRIES is a Lebanese company revolutionizing the traditional agriculture sector through hydroponic farming. This technology allows growing crops without soil in a climate controlled environment, and addresses the need for heavier and more regular crops. This method also saves energy and water and land resources. ECO INDUSTRIES' products are currently available on the market.



LIFELAB's founder has created a custom hydroponic system with plans to create a 3,000 m² hydroponic farm in southern Lebanon. LifeLab's hydroponic system can be operated through programmable logic controllers (PLCs), which provide a high degree of automation and the ability to manage the system remotely.

3. THE USE OF CLEAN TECHNOLOGY IN SOLID WASTE MANAGEMENT

Lebanon generates an average of 2.55 million tons of waste annually²⁰. 48% of this waste is landfilled, 29% is openly dumped, 15% is composted, only 8% is recycled²¹. Charges for waste collecting and disposing them in sanitary landfills are higher in Lebanon than in other middle income countries: USD 147/ton compared to USD 100/ton²².

The absence of a proper waste management plan in Lebanon, in addition to the recent trash crisis that has been going on for almost a year, resulted in uncontrolled dumping all over the country, causing in turn a number of environmental and health problems, including water and soil contamination, and increased GHG emissions. The fastest rate of growth of GHG emission in Lebanon occurred in the waste sector²³.

Adopting a zero waste strategy in Lebanon can generate USD 135.7 million over a period of 20 years²⁴.

INVESTMENT OPPORTUNITIES

Clean technology disruptions are urgently needed for waste management solutions. The main opportunities exist in:

- ▶ Web-based recycling platforms: these programs have created online recycling marketplaces where customers can conveniently recycle their waste, allowing consumers to change their behavior towards recycling more easily.
- ▶ Waste to energy technologies: this technology is particularly relevant in Lebanon as it deals with both waste management and energy production.

20-21-22 BlomInvest 2015

23 MoE/UNDP

24 BlomInvest 2015

4. THE USE OF CLEAN TECHNOLOGY IN TRANSPORTATION

GHG emissions from the transport system accounts for 21.41% of Lebanon's total GHG emissions in 2000, 94% of CO₂, 59% NO_x and 66% NMVOC emissions²⁵.

The transportation system relies mainly

on private vehicles, which accounts for around 80% of private passenger cars. Public transport systems are inefficient, and cost-ineffective.

Fuel consumption and CO₂ emissions of end-of-life hybrid vehicles, relative to Lebanese average of 2007 existing cars fleet and to world average of 2005 new cars fleet:

Vehicle type	Fuel consumption on combined cycle (l/100km)	Fuel and CO ₂ savings relative to the world average 2005	Fuel and CO ₂ saving relative to the Lebanese fleet 2007
Sub-compact cars	5.2	35.5%	53.4%
Compact cars	5.3	34.2%	52.4%
Midsize cars	6.7	17.2%	40.1%
Large cars	7.9	2.2%	29.3%
SUV	10.1	-24.6%	9.9%

Fuel efficient vehicles present considerable opportunities of consumption and CO₂ emissions for all vehicle segments. When comparing to the Lebanese consumption

of the passenger car fleet in 2007, these vehicles present savings ranging from 30 to 60%.

INVESTMENT OPPORTUNITIES

Relative to fuel and energy consumption rates, emission savings and cost of different mitigation strategies (that include fuel efficient vehicles, hybrid electric vehicle, plug-in hybrid vehicles, battery electric vehicle, natural gas vehicle, and bus technologies with dedicated lanes), main investment opportunities in the

clean transportation technology sector in Lebanon are²⁶:

- ▶ Bus technologies using diesel and natural gas for revitalizing the public transport
- ▶ Hybrid electric vehicles for renewing the passenger car fleet.
- ▶ Fuel efficient gasoline vehicles for renewing the passenger car fleet.

	Fuel efficient vehicles	Hybrid electric vehicles	Bus technologies (30 passenger / vehicle)
Fuel consumption (l/100 Km.pass)	3.19	2.91	1.27
Total energy consumption (kWh/100km.pass)	29.34	26.81	11.66
PTW CO ₂ saving (%)	48.10	52.00	80.29
WTW CO ₂ savings (%)	26.5	28.6	N/A

Source: MoE/URC/GEF, (2012). Lebanon Technology Needs Assessment report for Climate Change.

5. THE USE OF CLEAN TECHNOLOGY IN ENERGY

Renewable energy accounted for more than half of the new electricity-generating capacity added globally in 2012²⁷, and created 7.7 million jobs in 2014²⁸.

The power sector in Lebanon contributes to around 55% of GHG emissions in Lebanon²⁸, and has been increasing at a very high rate, due to increasing demand of electricity and the expansion of the national grid.

Lebanon is a net energy importing country. Oil imports accounted for 22.7% share of total imports in 2013³⁰. The electricity

sector is dominated by Electricité du Liban (EDL) which controls around 90% of the sector³¹. EDL operates mainly through 7 thermal power plants that function on heavy fuel oil-fired steam turbines, diesel-fired combined cycle gas turbine (CCGT); and diesel-fired open cycle gas turbines (OCGT), depending on the plant. Lebanon's power sector is characterized by intermittences in power supply, as well as power shortages of up to 20 hours per day. Residents are increasingly relying on private generators for electricity supply. Self-generation accounted for 34% of total consumed power in 2009 (WB, 2011)³².

Electric power consumption in Lebanon is high compared to the world and MENA average:

	2006	2010	Electric power consumption (kWh per capita) 2012
LEBANON	2713	3479	3102
WORLD	2731.9	2967.8	3064.5
MENA	2267	2684.5	2813.8

Source: World Bank

In 2009, only 2.9% of Total Primary Energy Supply was produced from renewables³³. In 2015, the maximum net generating capacity of power plants and other installations that use renewable energy sources to produce electricity was of 228

MW³⁴. This number is higher than Kuwait, Qatar, KSA, Jordan, and the UAE³⁵. However, Lebanon has had one of the slowest growth in terms of total capacity from 2006 to 2015.

25 MoE/UNDP/GEF, 2011

26 MoE/URC/GEF, (2012). Lebanon Technology Needs Assessment report for Climate Change.

27 IPCC WGIII on Mitigation, 2014

28 IRENA, 2015

29 Moe / UNDP

30 MoE, 2015

31-32 MoE/URC/GEF, (2012). Lebanon Technology Needs Assessment report for Climate Change.

33 IRENA, Renewable Energy Country Profiles Middle East 2016

34-35 IRENA, Renewable Energy Capacity Statistics 2016

	Total renewable energy 2006 MW	Total renewable energy 2015 MW
Lebanon	221	228
Kuwait	NA	0
Qatar	25 (2011)	28
KSA	19 (2012)	25
Jordan	18	160
Iraq	2225	2513
Iran	6631	12024
UAE	10 (2009)	135

NB: The renewable power capacity data shown in these tables represents the maximum net generating capacity of power plants and other installations that use renewable energy sources to produce electricity.

Source: IRENA, 2016 statistics

The majority of this maximum capacity is due to hydropower, which had a 221 MW capacity in 2015. Wind, solar and bioenergy rank far behind with 1 MW, 4 MW, and 2 MW of capacity respectively³⁶.

In terms of targets, Lebanon is the country with the highest target in terms of renewable energy for 2020 in the Levant

– target at 12% of electricity generation in renewable energy³⁷. This is higher than Jordan and Palestine at 10%, and all GCC countries³⁸.

Contradicting the low presence of renewable energy technologies in the country, Lebanon possesses considerable high renewable energy sources, more than many other countries in the region.

Renewable energy resource	Availability
Wind	High
Hydro	High
Solar	High
Biomass	Medium
Geothermal	Low
Ocean	Low

Source: IRENA, Renewable Energy Country Profiles Middle East 2016

36 IRENA, Renewable Energy Capacity Statistics 2016
37-38 Ernest & Young, MENA Cleantech Survey 2014

INVESTMENT OPPORTUNITIES

Due to the high presence of a number of renewable energy sources in Lebanon, main investment opportunities in the clean tech energy sector for Lebanon are³⁹:

► Energy optimization solutions, mainly in energy storage.

► Hydropower: In the MENA region renewable energy from water appears to be the leader in market potential for clean tech over the next 5 years⁴⁰. Lebanon currently possesses some hydropower plants along the Kadisha river, and it is one of the only clean energy technologies for which local expertise is already available.

► Solar power, in Photovoltaic cells and CSP: Solar technology is also a significant opportunity due to region's abundant solar resources. Solar technologies is in second place after water in market potential for clean tech over the next five years in the MENA region⁴¹. The MENA makes it one of the only regions with large opportunities in CSP, which needs direct sunlight to work. Still in its early phase, the PV technology has been applied in a limited manner by private initiatives or through internationally funded projects (CEDRO) in Lebanon. "Penetration of PV cells in Lebanon is expected to be limited to up to 1MW, with a capacity factor of around 0.2", and this number could lead to a 95% reduction of tons per year⁴².

► Wind power: for the Levant, wind is ranked as the third sub-sector with the highest potential to grow⁴³. According to the Lebanese energy ministry, Lebanon is well suited for wind-generated power, especially in North Lebanon and on the Lebanese slope of Mount Hermon in the southeast, from Chebaa to Rashaya. However, there are only very few windmills in Lebanon operating at a micro level, and the concept of wind farm has never been applied. Wind farms could reduce GHG emissions by 75 times the actual amount, reaching an estimated 1,928 tonnes/year⁴⁴.

► Biomass: this presents an opportunity to deal with waste and energy problems at the same time. NEEAP (MOEW 2012) estimates that waste can generate 15-25 MW of electricity energy very year, and therefore lead to C)2 reductions of 102,492 Tons per year⁴⁵.

39 MoE/URC/GEF, (2012). Lebanon Technology Needs Assessment report for Climate Change 40-41 Ernest & Young, MENA Cleantech Survey 2014

42 MoE/URC/GEF, (2012). Lebanon Technology Needs Assessment report for Climate Change 43 Ernest & Young, MENA Cleantech Survey 2014

44-45 MoE/URC/GEF, (2012). Lebanon Technology Needs Assessment report for Climate Change

CASE STUDY



ENERGY24 is a Lebanese company working on an energy storage solution that allows to store large amounts of electric energy into a specific type of battery in order to power residential, commercial and industrial loads during long power outages. ENERGY24 allows consumers to bypass power interruptions, all the while saving between 50% and 70% on their annual electricity bill.



GREEN TECH manufactures Solar Water Heater systems based on the evacuated tubes technology. Based in Lebanon, it is the largest manufacturing plant in the Middle East to have adopted this technology. Its technology provides an efficient hot water service that reduces carbon emission and considerably reducing the energy bill.



WATER SYSTEM HHO is a local solution to generator efficiency. The device saves the fuel that is usually wasted in generators. The technology is patented in Lebanon, and allows for generators to be 10% to 35% more efficient depending on the size of the generator.



YELLOWBLUE is a renewable energy and energy efficiency EPC company that designs, supplies, and installs clean tech energy solutions including Photovoltaic, and smart solar technologies.

E2 has been working on an energy monitoring device and service aiming to fill the gap in energy audits and reduce energy wastage for large Lebanese institutions including hospitals.



NATIONAL INSTRUMENTS has developed integrated hardware and software platform to develop improved embedded systems for renewable energy applications such as online condition monitoring and grid integration control.



EARTH TECHNOLOGIES specialized in designing and installing top-quality products including LED lighting, solar thermal systems, solar photovoltaic systems, and solar street lighting.

III. LEBANON'S COMPETITIVE ADVANTAGES

1. QUALIFIED AND INNOVATIVE LABOR FORCE AT COMPETITIVE COSTS

► Lebanon's innovative power hinges on its human capital, a well-educated, multi-lingual and creative workforce.

► Universities in Lebanon are increasingly offering environmental courses that cover both engineering and natural sciences. In 2010, there were around 33 environmental courses spread throughout 9 universities, ranging from environmental engineering programs, environmental health, ecosystem management, and environmental sciences⁴⁶.

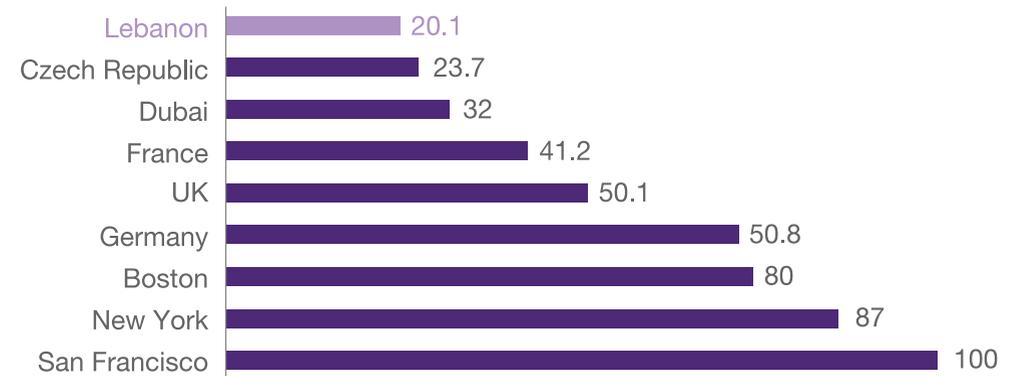
► High tech companies can benefit from human resources with the most competitive technical skills in the region

► It ranks 6th worldwide for the Quality of Math and Sciences Education, and 19th worldwide for the Quality of its Higher Educational System.

► Lebanon is ranked 18th worldwide for the presence of knowledge workers⁴⁷ (source: global competitiveness report 2013-2014) and around 3000 engineers graduate each year and join a labor force currently comprising 1.3 million workers.

at very competitive costs relative to the EU, US and most neighboring countries.

Average annual wages of software engineers in selected countries USD thousands | 2015



Source: Payscale

2. A FLOURISHING SCIENTIFIC COMMUNITY

Lebanon is home to an excellent scientific community, and an exporter of skills and innovation. A growing number of research and training centers are being established mainly in the fields of environmental technologies, medical science and agriculture.

Both private and public sector institutions are working on clean technology and environmental issues through dynamic research programs. There are more than 5 public institutions working on environmental research and issues, including:

► Industrial research institute (IRI)

- Lebanese agricultural research institute
- National Council for Scientific Research (1962)
- Tripoli Environment and Development Observatory (2000)
- Lebanese Center for Energy Conservation (2011)

On the other hand, universities also have a number of research centers working on these issues. There are more than 16 environmental centers and institutes spread across 5 universities.

46 MOE/UNDP/ECODIT, 2011

47 Global competitiveness report 2015-2016

3. RISING REGIONAL DEMAND FOR CLEAN TECH INNOVATION

In the MENA, economic growth, rising population and increased urbanization and industrialization is powering the demand for clean technologies.

There has been an 8.3% surge in MENA energy demand through 2013-2019 (more than 3 times the global average) and there has been a 114% rise in MENA energy

consumption between 2010 and 2050⁴⁷. This shows the need for sustainable energy program, renewable energy appears crucial for the region⁴⁸.

Lebanon's strategic position, located at the crossroads of Europe, North Africa and the Middle East allows it to serve expanding markets.

4. A FAVORABLE INVESTMENT & INNOVATION ENVIRONMENT

Investment incentives:

The Investment Development Authority of Lebanon (IDAL) provides companies engaged in the clean technology sector with a set of fiscal and financial incentives including tax exemptions on corporate income tax along with administrative and facilitation services.

For more information, check out the Incentives for the Technology sector on our website.

Financing schemes:

The Lebanese landscape has recently witnessed the surge of Venture Capital funds offering entrepreneurs seed and growth capital to grow their businesses. Other more traditional sources of financing available include Kafalat and Central Bank loans. The central bank has created low-interest scheme loans for environmentally friendly projects such as renewable energy, waste management, waste water treatment and recycling.

A number of business incubators and accelerators such as BIAT Center, UK Lebanon Tech Hub, and Berytech, also offer financial support along with incubation and training services.

For more information, check out Financing your Business on our website.

IV. MAIN STAKEHOLDERS

Association of Lebanese Industrialists (ALI)
www.ali.org.lb

Ministry of Energy and Water
www.energyandwater.gov.lb

Ministry of Public Works and Transport
www.transportation.gov.lb

Ministry of Environment
www.moe.gov.lb

Ministry of Agriculture
www.agriculture.gov.lb

Lebanese Agricultural Research Institute
www.lari.gov.lb

Council for Development and Reconstruction
www.cdr.gov.lb

Altcity
www.altcity.me

Bader
www.baderlebanon.com

Berytech
www.berytch.org

Beirut Creative Cluster
www.beirutcreativecluster.org

Beirut Digital District (BDD)
www.beirutdigitaldistrict.com

Business Incubation Association in Tripoli (BIAT)
www.biatcenter.org

Endeavor
www.endeavor.org

Investment Development Authority of Lebanon - IDAL
www.investinlebanon.gov.lb

Kafalat
www.kafalat.com.lb

Ministry of Economy and Trade
www.economy.gov.lb

Ministry of Telecommunications
www.mpt.gov.lb

MIT Enterprise Forum Pan Arab Region
www.mitefarab.org

Office of the Minister of State for Administrative Reform
www.omsar.gov.lb

OGERO
www.ogero.gov.lb

South Business Innovation Center (SOUTH BIC)
www.southbic.org



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