

Encouraging the Development of Oil Alternatives

EXECUTIVE SUMMARY

February 2011

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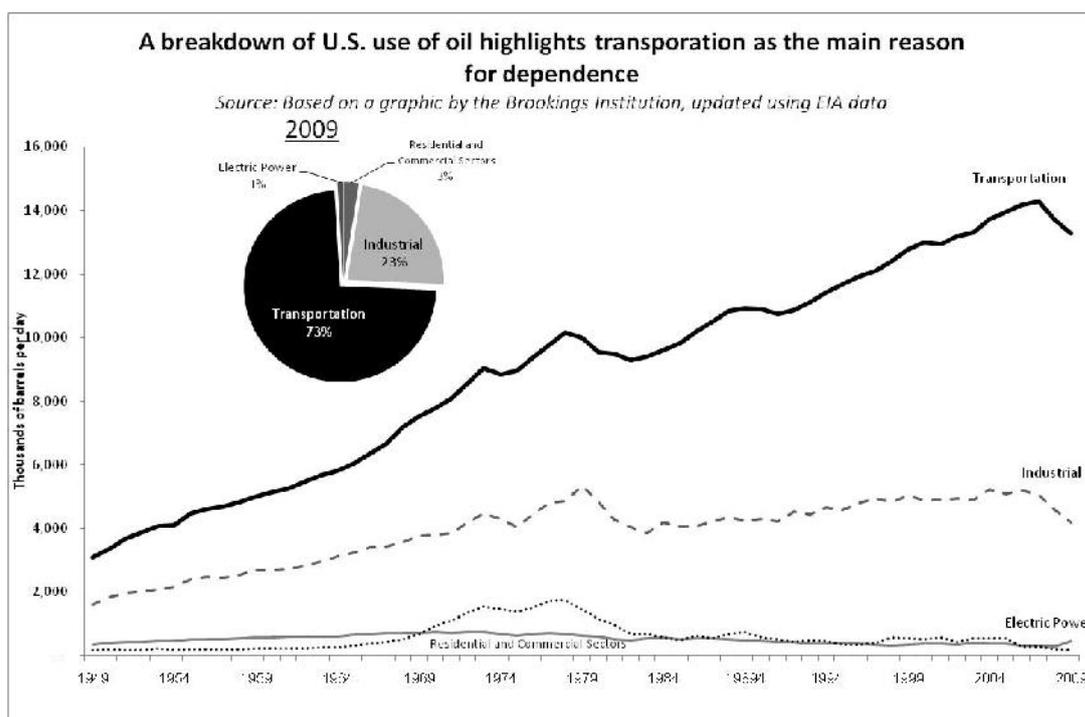
Background

On the 30th January 2011 the National Program to Develop Technologies that Reduce the Global Use of Oil in Transportation ("the Program") was approved by the government of Israel. The government will invest approximately NIS 1.5 billion in the Program over the next decade in basic and advanced research and development ("R&D") that will focus on Oil Alternative technologies, as well as an Oil Alternatives Industry. The decision also provides a mechanism for raising additional substantial funds from non-governmental sources.

Principle Background Points

- **To reduce dependency on oil - global demand for oil must be addressed.** The extent of Israel's oil addiction is of no consequence to global dependence. The characteristics of the global demand for and dependency on oil must be investigated; it is these global needs that must be answered.
- **Oil has a monopoly over global transportation**
 - Transportation represents approximately 80% of the global demand for oil (on a volume basis, per barrel of refined oil).ⁱ
 - Of the energy sources used for global road transportation, the majority (92%)ⁱⁱ is derived from oil.
 - Demand for transportation is more rigid than for other purposes.
 - There is no connection between electricity generation and oil dependence
 - The world barely uses oil to generate electricity.ⁱⁱⁱ Therefore, electricity generation from renewable sources will not influence oil dependence.
- **Global trends of oil dependence (demand)**
 - **The United States** consumes around 20% of the global oil supply. The reduction of a million barrels per day of oil from America's consumption will influence the price of oil more than a reduction elsewhere.
 - **Europe**—in the main - is very dependent on foreign oil. (Europe's North Sea oilfields are waning).
 - **Most of the global demand increase comes from China, India, the Gulf States and Brazil.** One can expect significant growth in oil consumption from these emerging economies in coming decades.
 - **China is leading contender for increasing oil demand**
 - In 2010, China alone represented about 11% of global oil consumption^{iv}
 - In 2010, 18.1 million vehicles were sold in China (compared to 11.6 million in the United States).^v

- **Oil Dependence is projected to rise substantially**
 - Analysis of global oil market trends shows that, without significant change, **global oil dependence- with the United States at the forefront- will grow in the coming decades** (as well as significant increases in the oil price).
- **Transportation is the main market sector in which oil dependency is set to rise the most**
 - The rise in oil demand is an outcome of the existing and growing number of vehicles on the roads, as well as the increase in distances driven.
 - Improvements in fuel usage efficiency have not been sufficient to "put the brakes" on the above trend.
- **Most demand growth will come from "Non-OECD" countries.**^{vi} The particularly high growth rate of China, Indonesia and other countries must be taken into consideration.
- **Oil demand is projected to grow faster than the ability to increase production**
 - Oilfields discovered to date do not sufficiently satisfy demand. It is unclear where the necessitated oil supply would come from. Published data regarding projected future demand and supply shows the issue is problematical.
 - By 2012, excess oil production may disappear altogether. By 2015, there may be an output gap of up to 10 mbd.^{vii}



- **Most global oil reserves are in the hands of OPEC, whose growth is set to increase in the coming years**
 - Most oil reserves are controlled by governments
 - Around 77% of the world's remaining oil is owned by the Organization of the Petroleum Exporting Countries (hereafter: "OPEC").^{viii}
 - The most significant proportion of oil reserves are in the hands of the Gulf States and the existing oil cartel operates in "unfriendly" states. The power of such states is set to increase substantially in the years to come.
 - The United States owns 2% of global oil reserves (and consumes approximately 20% of the global oil supply)
 - Discovery of oilfields and sources of oil in the United States, such as tar sands, have high production costs that will push the oil price up

Developing Oil Alternatives- Which Technologies?

It is neither possible nor desired to project which technologies will be the "winners". Nevertheless, it is possible to give an overview of potential Oil Alternative technologies.

Oil Alternative technologies must be "price disruptive" – that is to say, reduce the cost per km of travel, compared to oil-based transportation. It seems quite clear that only a radically cheap technology portfolio of Oil Alternative Companies (hereafter: "OACs") will succeed in reducing global oil dependence.

In general, Oil Alternative technologies relate to two main areas, the vehicle and the fuel production industry. In addition there are miscellaneous technologies. Technical barriers mainly relate to price and efficiency.

A partial list includes:

- **Applications to Fuel Production**
 - **Development of input sources ("feedstocks") to Oil Alternative Fuels**
 - Based on energy plants (corn, sugar, jatropha, others) and algae
 - Based on waste
 - Based on coal or natural gas (for methanol production for example)
 - Based on other raw materials, including chemicals
 - **Increasing energy density** of the Oil Alternative fuel feedstocks
 - **Increasing conversion process efficiency** from the Oil Alternative feedstocks to fuel
- **Applications to Vehicles**
 - Conversion kits
 - Cheaper batteries are especially critical to the commercial viability of the electric car industry.
 - Besides batteries (and fuel cells), other barriers which improve vehicle efficiency are relevant. Vehicle efficiency improvements reduce battery load (without touching battery chemistry).

- For example: engines, light-weighting, improved driver behavior, reduction of aerodynamic drag and friction.

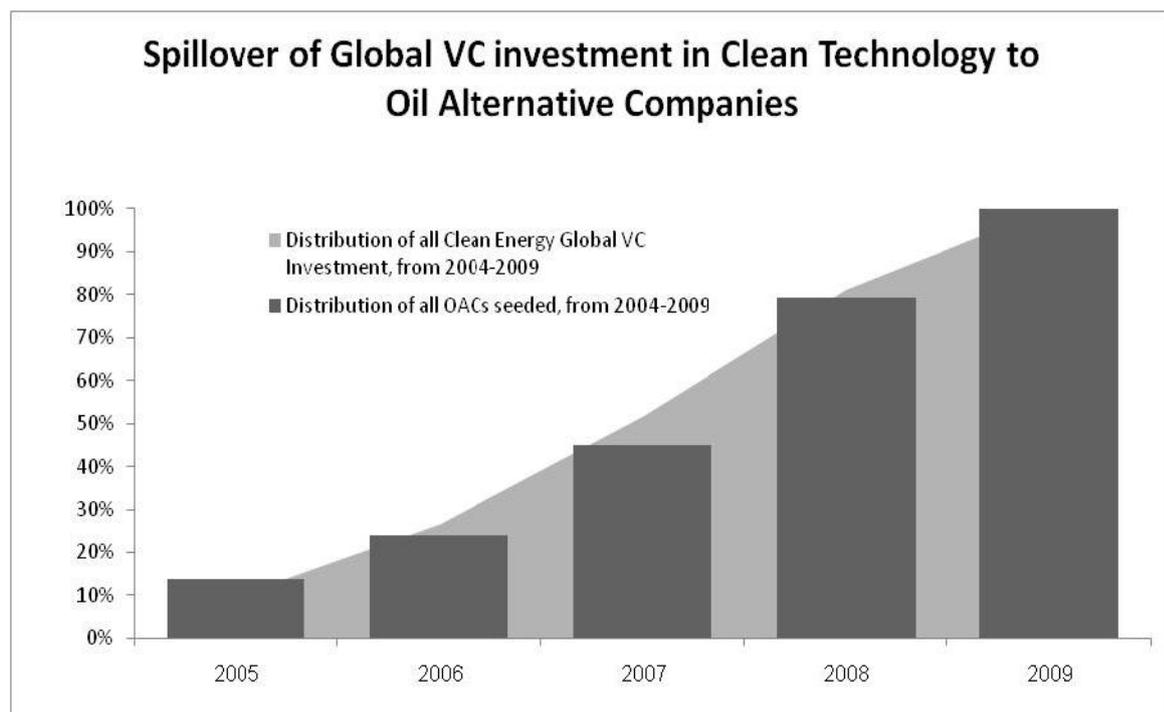
Identification and analysis of 63 Oil Alternative Companies (“OAC”s)

In 2010 the Israeli Institute for Economic Planning led a survey identifying and gaining finance information from Israel’s OACs.

This survey was conducted 'bottom-up' (a systematic general overview followed by a detailed examination of each component) and through interviews of over sixty companies and projects. Through the survey we identified the barriers to business success that these companies face, their financing history and future financing needs.

The growth of the Oil Alternative Companies (OACs)

Israel already boasts a basis of OACs but there is currently no definition which describes the sector in which they operate. Lack of definition creates a situation of invisibility.



Source: Bloomberg New Energy Finance, IEP Database

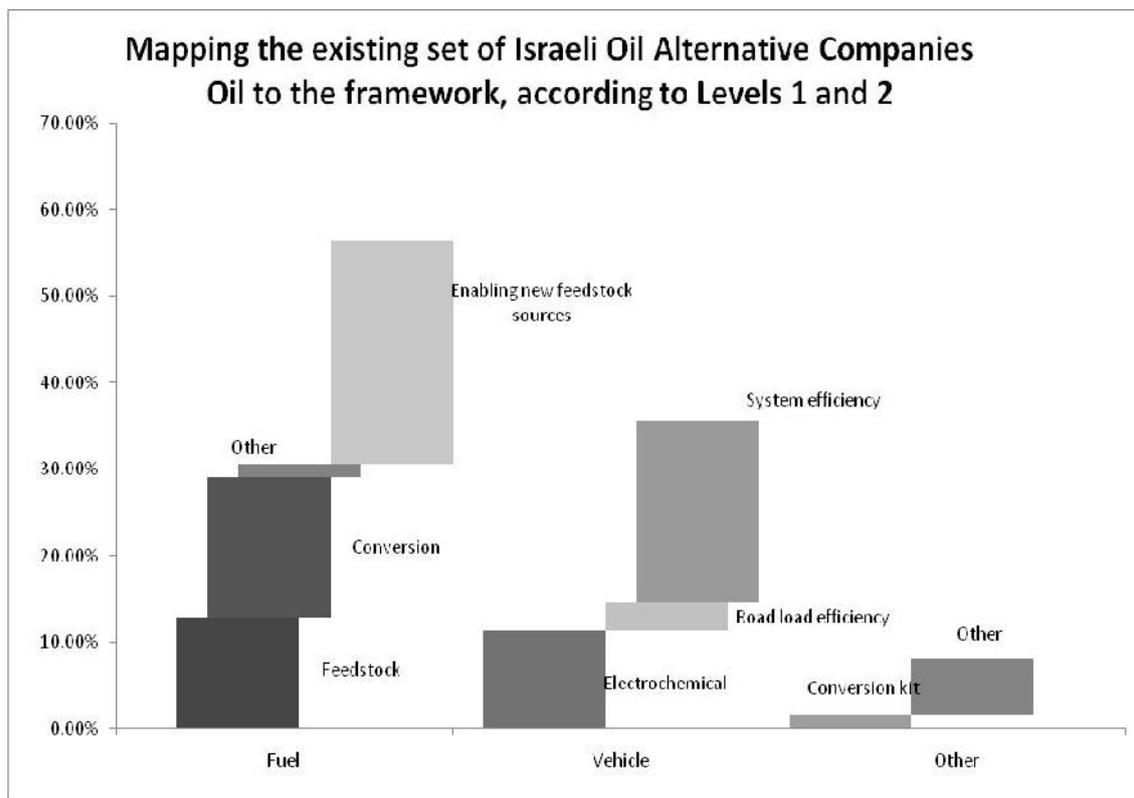
From 2007 to 2010, 25 OACs were established. This is quite a sizeable number when compared to the size of start-up industries in the United States. For example:

- In 1999, in the early days of the industry, 33 American biotechnology companies succeeded to raise Seed financing (the first round of finance); in 2009 this figure had risen to 112.

- In 2010, 35 American companies under the category "Energy Industrial" succeeded to raise Seed financing (the first round of finance)^{ix}

Moreover in Israel, when the first Yozma fund was established in the early 1990s a negligible number of start-ups were in existence.

The global CleanTech investment surge created favorable conditions that supported the existing OACs.



The OACs are mostly characterized by:

- Their multi-disciplinary scientific profile
- High quality of scientific personnel
- Prior training from some of the most esteemed military institutions worldwide
- Expertise from a wide range of industries in Israel (for example, chemicals and defense)

It was revealed that around half of the OACs received some kind of government support- mostly from the Office of the Chief Scientist or the Ministry of Infrastructure.

Fundamental Barriers Development of the Oil Alternative Companies (OACs)

Through interviews, data was collected and a picture of the barriers that OACs face emerged.

After examination it was decided to focus on the significant barriers that were repeatedly raised as substantial obstacles. There is considerable concern that if not addressed, these barriers may jeopardize the Program.

These primary barriers are: **difficulty in financing at specific stages**, **cumbersome bureaucracy** (permits) and **lack of information sharing** (information “imbalances” or “asymmetries”).

- **Finance and available amounts of funding** provided from government sources are stated as the main problem amongst the companies.
 - According to representatives of the companies, the current budget is too small compared to demand and is not comparable to international standards. In addition, the criteria embodied in the Law for Encouragement of Industrial Research and Development 1984 (and subsequent changes to the law since) creates obstacles which prevent some OACs from receiving government support.
- **Bureaucracy**- the second obstacle cited in interviews is the existence of cumbersome bureaucracy and lack of transparency by the authorities.
- **Failure to coordinate and share information from all parties involved**

Finance

- **Funds raised to date**
 - We estimate \$213 to \$436 million has been raised by the Oil Alternative Companies to date.
 - Most foreign capital was invested in Series A (the second round). 5 out of ten of the Top Ten Global Clean Technology Venture Funds invested in Israel- of these, 4 invested in OACs.
 - The principle difficulty is raising finance for Seed and Series A (first and second financing rounds).
- **Survey results**

Most OACs are to raise Series A, next round.

 - \$441 million is required to get to Series A over the entire data-set, not accounting for failure rates. (For every company that wishes to raise finance, a proportion will fail, even if there is good capital availability, due to technology or other risk factors).
 - To take failure rates and other market variables into account the IEP Finance Model ("IFM") was created (see next section).
 - In the opinion of the Israeli Institute for Economic Planning, \$102 to \$128 million would be reached by the current OACs reach financing stage of Series A, taking into account failure rates.

Required Future Finance- the IFM Model

- The IFM Model was created by the Israeli Institute for Economic Planning to project the necessary finance required for companies in the area of Oil Alternatives. For analysis of the so-called Meta Scenarios, the Institute used market variables and results from various studies.
- The IFM Model aggregates the existing financial demands of the OACs and future financing needs of the OACs that will be established. Five principle variables are used:
 - The number of OACs that are raising finance
 - The annual growth rate
 - The amount required for each finance round
 - Array of failure rates, between finance stages
- The Israeli government must support the Oil Alternatives Industry in a manner that ensures its long term growth. In our humble opinion, the need for the security of the State of Israel and for reducing global oil dependence obligates the highest level scenario of the IFM model.

In order for this scenario to be put into action, \$ 4.5 billion must be raised and allocated as follows:

- ~55% to Seed Financing Stage (the first financing round)
- ~25% to Series A Financing Stage (the second financing round)
- ~20% to Series B Financing Stage (the third financing round)

The National Program to Reduce Oil Dependency Increases Competitiveness

The National Program relies on Israel's relative advantages:

- **Science and Innovation** –two principle areas in which Israel's relative advantage advances; in these Israel is ranked tenth and first in the world (Innovation- Ranked 6 out of the world according to the GCI for the year 2010-2011)

Discipline =>	Multi disciplinary Studies	Materials Science	Chemistry	Engineering	Biology and Biochemistry	Agricultural Sciences	Micro biology	Molecular Biology and Genetics	Physics
Global ranking for quotes per publication	1	2						3	

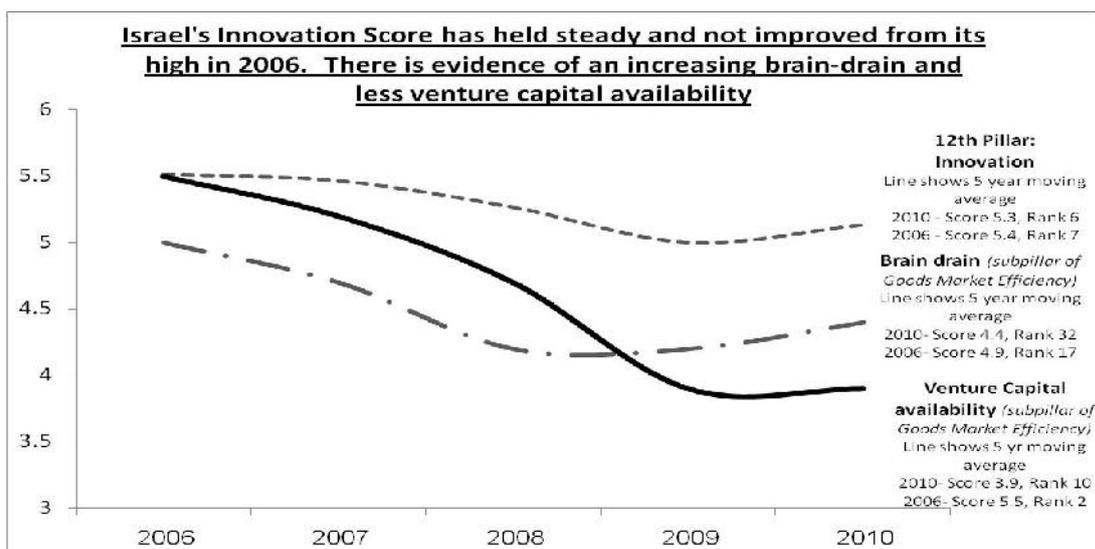
Source: Science, Technology and Innovation Indicators in Israel: An International Comparison; Neaman Institute, Central Bureau of Statistics, 2007 update

• **Industry- Established and with Expert Knowledge**

Industry	Relevance to National OA Program
Chemicals	29% of 2008 “Hi Tech” exports. 30,000 employees. World’s leading generic companies. Proprietary, relevant chemical synthesis knowledge, intellectual capital.
Engineering	Multi-faceted, multi-disciplinary capability over a broad spectrum of applications
Defense /Military	Applications include:- project integration, execution; laboratories- chemical synthesis; know-how in chemistry, physics, engineering; specialized in areas in industry– miniaturization, light-weighting, propulsion technologies, fuel cells. ^x
Automobile Parts	The "high tech of low tech", generated revenues of \$800 million in 2008. Resources, business networks, contacts, industry know-how.
Electronics	Electronics is Israel's largest export sector – (more than \$15 bn annual sales). Expertise can be applied to propulsion and battery management technologies. Global automotive electronics is a huge sector (annual turnover of ~22 billion EUR ^{xi}) and there is a shortage of engineers. ^{xii}
Metal & Industrial Equipment	Represents 20% of overall industrial production in the country and 25% of exports. Manufacturing capabilities in machinery, electrical and electro-mechanical parts

- **Strong Venture Capital (VC) sector** Funding as a percentage of GDP is amongst the highest in the world. (Source: OECD).

- **Business sophistication** Ranked 26th in the world, (GCI 2010-2011).



Source: Global Competitive Index, IEP records 2010-2011

- **The Program will preserve existing competitive strengths**
 - Allocation of funding to academia will maintain and build up Israel's innovation and education. Funding to start-ups will increase the national innovative output.
 - The program may trigger the inflow of international funds towards Oil Alternatives and may increase FDI ("Foreign Direct Investment").
 - The program will increase economic wealth through trade.
- **The Program will positively influence "weak" areas (education, research, bureaucracy)**
 - Our recommendation for tackling bureaucracy ("One Stop Shop") will yield an improvement in the existing low rating for bureaucracy. In addition, this recommendation will increase the likelihood of the new Oil Alternatives Industry succeeding, which would deliver the benefits noted above.
 - Our recommendation (increasing funding to academia) would create a demand pull on the system and might bring about a rise in education standards for mathematics and science, in which Israel is commonly ranked at a low level. In addition, how recommendation will enhance Israel's human capital in the long term.

The Program faces opportunities and challenges ahead

- **Opportunities**
 - **The size of the oil market- opportunity for far-reaching economic growth-** The size of the oil market is proven; Oil Alternative technologies that are cheaper than the oil benchmark have high profit potential. In addition, oil demand is projected to increase significantly given global economic growth and particularly when the growth rate of emerging markets is taken into account.
 - **Optimization of intellectual capital** - the Steering Committee of the National Program to Develop Technologies that Reduce the Global Use of Oil in Transportation, commissioned by the Prime Minister and chaired by Professor Apeloig, former president of the Technion, found that Israel has high academic potential and significant existing resources that are required for the creation of a local Oil Alternatives Industry.
 - **OACs are characterized by a multi-disciplinary nature-** The key strategic advantage for such fields is density of intellectual capital, which Israel has.
 - **Significant contribution to the environment-** Around 40% of carbon dioxide emissions by energy source are from oil. Despite international awareness of the importance of reducing the very high oil consumption, not enough efforts are directed to correct the problem. The contribution toward the reduction of environmental damage caused by oil is a great opportunity.

- **Nevertheless, there are a number of serious challenges to Israel's Oil Alternatives industry:**
 - **Oil price volatility destabilizes research and development ("R&D")** Oil price volatility causes governmental budgets assigned to R&D funding to be erratic, with a detrimental effect on scientific research. Similarly, oil price volatility is destructive to Oil Alternative Companies as it makes their cash-flow and therefore profitability unstable. Consistent funding of Oil Alternative R&D -with a long term outlook –has been neglected due to oil price volatility.
 - **Systemic resistance** - incumbents resist changes to the status quo and make efforts to disrupt processes that threaten their commercial interests.
 - **Significant economic interests working against Oil Alternatives development** – clearly, the commercial oil interests have an interest to make it difficult for R&D to meaningfully disrupt the existing oil paradigm (the "status quo"). This is understandable given that it is in their commercial interests are at stake.
 - **Uncertainty and constant change in target markets** The constant change and uncertainty in the target markets (automobile, oil alternative fuel industry) can be challenging and non-trivial for entrepreneurs and support institutions.

Summary

- The long term funding commitment, the existing industries, the general absence of institutional oil interests and the density and strength of intellectual capital have the potential to enable **Israel to exploit its relative advantages and establish itself as a "hub" for Oil Alternatives technologies.**
- The global setting creates a **window of opportunity**: undesired growing dependency on oil; negative strategic implications; anticipated shortage and increasing prices; a vast role for innovation, creative ideas and scientific research; massive growing demand on behalf of the huge rising economies.
- Gaining an "early foothold" in the Oil Alternatives industry through the establishment of R&D related products - **is set to be most profitable in the near future.**
- **Our goal is that the domain of development of Oil Alternative technologies will be the source of growth and innovation much like the "Hi Tech" industry.**



The Israeli Institute for Economic Planning is a non-profit organization, working to change the Israeli economy into a free market, competitive modern economy

The Institute's research focuses on the problems that prevent the Israeli economy from reaching its full potential. The Institute's main goal is to offer practical solutions for such problems.

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ⁱ When oil is extracted in its crude form, heavier and lighter oil molecules are separated according to their boiling point in a refining column. As a result, for every barrel of oil, different types of oil are extracted, for use in different industries. Based on oil refined product in volume terms from a barrel of oil, at least 80% is used by the transportation sector.

ⁱⁱ World Bank, 2007 data: of the total recorded energy consumption for the road sector, 92% is attributed to diesel and gasoline.

ⁱⁱⁱ Petroleum liquids and petroleum coke contributed to less than 1% of all electricity generated in 2010 (in MWh). For the United States, see <http://tinyurl.com/2d7pqjp> Source: US Energy Information Agency (EIA)

^{iv} See International Energy Agency Oil Market Report; in 2010 the China consumed 9.3 million barrels per day out of a global total of 87.7 million barrels per day

^v The China Association of Automobile Manufacturers (CAAM)- 18.06 million vehicles were sold in 2010. See also: <http://tinyurl.com/6ciyojn>

^{vi} World Energy Outlook 2010

^{vii} DOD, Joint Operating Environment, 2010 report <http://tinyurl.com/6xmqj2t>

^{viii} Source: British Petroleum Statistical Review of World Energy June 2010 <http://tinyurl.com/273vzqs>

^{ix} Source: PriceWaterhouse Coopers MoneyTree

^x (cf start-ups Given Imaging emerged from electro-optics technologists at the defense contractor Rafael

^{xi} <http://tinyurl.com/6edtzw> page 3

^{xii} <http://tinyurl.com/6ksakkx> Page 19. OEMs must increase their electronics R&D personnel by 2010/2015. Gap between the existing and targeted profile of engineers

See also <http://tinyurl.com/6778urj> Page 33- Roland Berger Consultants see room for cost reductions in the electronics of the vehicle.