Electricity sector in the Palestinian Territories: The Politico-economical and environmental implications

Seminar , 15 Mars, Geneva

by: Ayman Abu-Alkhair

Centre Universitaire d'Etude des Problèmes de l'Energie (CUEPE)
Université de Genève

Introduction

- Objectives.
- Methodology.
- Palestinian economy.
- GDP/capita (PIB/tête).
- Major problems.
- Current situation.
- Palestinian electrical sector.

Objectives

The construction of an independent Palestinian state requires some sort of independence in the Palestinian energy sector.

This study consists of two parts:

- First: it sheds light on the current situation of the electrical sector in the Palestinian Territories (PT).
- Second: It tries to construct a framework to estimate the recovery period after shock (in particular, war events) and the investment needs. This will be an adequate tool for optimal management of the electrical sectors suffering from fragility and vulnerability caused by political shocks.

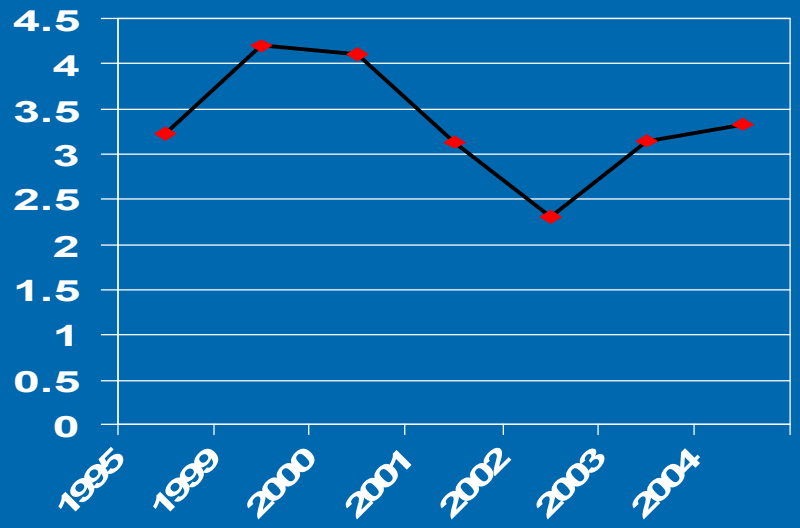
Methodology

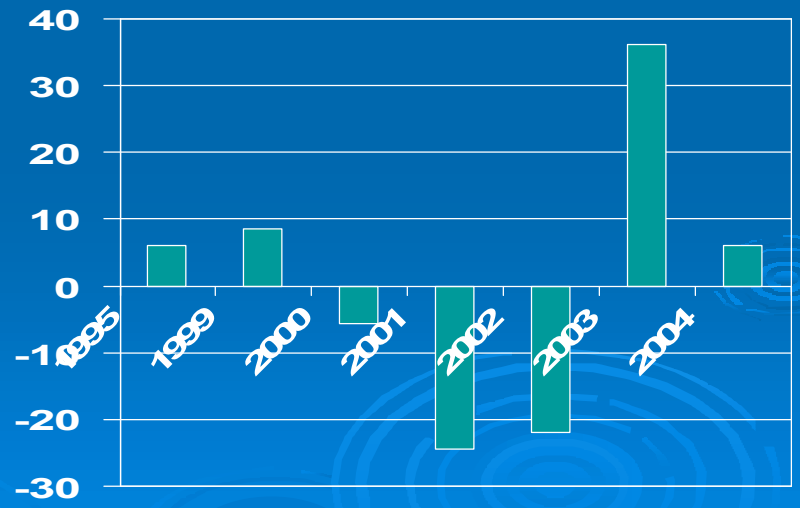
- Our approach for exploring the Palestinian electrical sector consists of an historical retrospective study with a limited series data.
- We made comparisons between the PT and the other countries in the region in order to highlight the electricity consumption gap.
- Finally, we used an econometrical and mathematical model for the analyses of the relationship between electricity consumption and economic growth and for recovery period calculation

Introduction

Palestinian economy

- GDP ≈ $4 Billion (1999)
- 30% of the labour force work in services, compared to 15% in industry
- High vulnerability to political shocks.



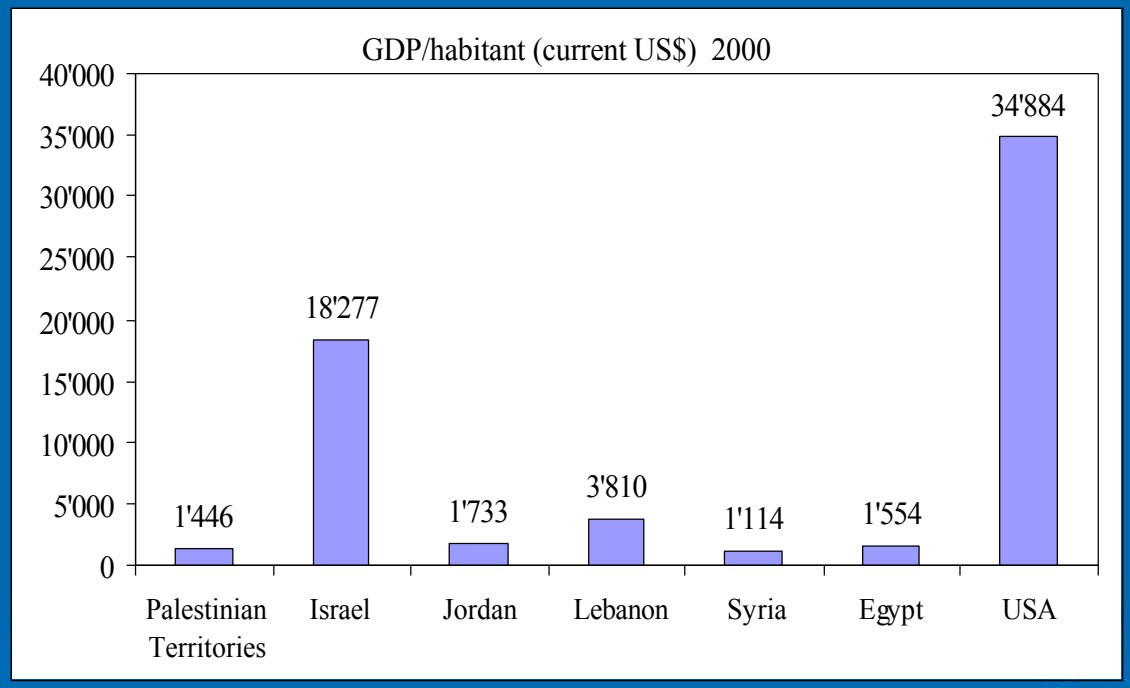


Palestinian Academic Society for the Study of International Affairs (PASSIA), 2004. Palestine facts, economy .

back

GDP/capita (PIB/tête)

- GDP/capita ≈ $1400 (1999)
- Versus nearly $ 18 000/capita in Israel (10 times more).
- And ≈ $1700 in Jordan.



Sources: PCBS, statistical abstract of Palestine no. "4", November, 2003 . www.pcbs.gov.ps. Central Bureau of Statistics of Israel. Statistical Abstract of Israel 2004. USA census depat. http://www.census.gov/, Dpt of commerce US, http://www.bea.gov/ , World Bank http://devdata.worldbank.org/. Middle east dierctor http://www.middleeastdirectory.com/.

Major problems

- As a result of several years of Israeli military occupation of the PT, the **Palestinian economy suffers from major distortions and underdevelopment** *(e.g. dependence upon one single trade partner, disappearance of small industries)*.
- During the Israeli occupation period, the **infrastructures** of the West Bank and Gaza Strip were **largely neglected** by Israeli Authorities.

Current situation

The current situation has impeded any real growth on the energy front and created **chronic energy problems**:

- There is a ***high unit price*** of energy.
- ***Renewable energy*** has not reached a satisfactory level of utilisation and environmental pollution from conventional resources is potentially threatening.
- The Israel Electric Company ***(IEC) controls the supply of conventional energy*** (electricity and petroleum products);

This monopoly creates:

- Unrealistic price control.
- Energy shortages.
- Energy crises.

back

Palestinian electrical sector

- Introduction.
- Electricity production and supply.
- Electricity network.
- Israeli energy policy in the Palestinian Territories.
- Electricity consumption.
- Electricity prices.
- Transmission losses.
- Substitution effect.
- Political situation and demand for electricity.
- Conflict and electricity consumption.
- Electricity and economic growth.
- Demand curve estimation.
- The notion of recovery analysis.
- Recovery period analysis.
- Investment needs for the PT.
- Conclusions.

Introduction

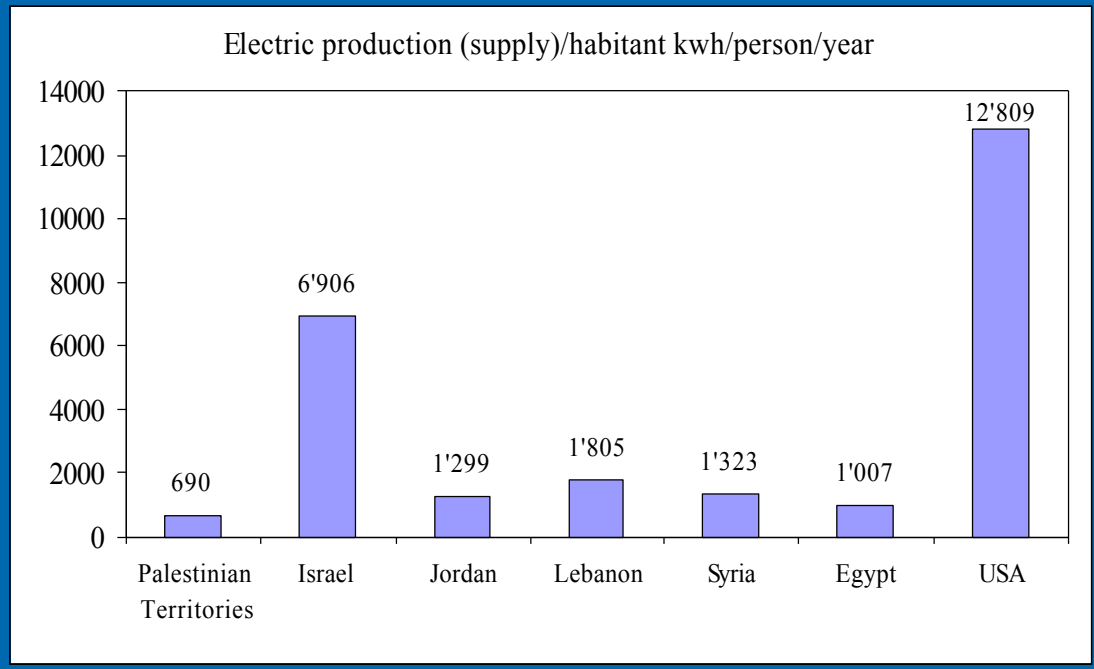
- The electrical sector is characterised by relatively **low electricity consumption**.
- in the **West Bank** electricity consumption was estimated at **890 GWh/year**, with an average consumption of **496 kWh per capita**, while in the **Gaza Strip** it was 47.91 GWh/year (PEC, 1995e), which is considered to be the lowest in the region.
- The Palestinian electrical sector suffers from many problems, such as:

  - High transmission losses.

  - High electric prices per kWh (between $0.1-0.5 per kWh).

Electricity production and supply

- Electricity supply in the PT was ≈ 700 kWh/person (2000), most come from the IEC.
- Versus ≈ 7000 kWh/person in Israel (10 times as superior).
- And 1300 kWh/person in Jordan (twice the consumption of the PT)



source: Eearth Trends http://earthtrends.wri.org/ and National Master http://www.nationmaster.com/, energy statistics. Solar med net http://www.solarmed.net/profile_palestinian.htm, ministry of energy and mineral resources, general indicators, http://www.memr.gov.jo/estatics/general%20inidcators.2.htm, **Energy** Information Administration, http://www.eia.doe.gov/emeu/cabs/egypt.html, World Energy http://www.worldenergy.org/wec-geis/publications/reports/current_cls/ClsELEC.asp

Electricity network

➢ West Bank

161 KV O/HL

161 KV O/HL

161 KV O/HL

Main IEC Feeders supply to West Bank Map source: (Data source: Palestinian Energy Centre, 1995). (Map source: Geography about Library, CIA).http://geography.about.com/library/cia/blcwestbank.htm

➢ Gaza Strip

3. Gaza El-Bahar

2. Jabalya, Beit Lahya, Gaza/Al-Naser

1. Beit Hanon, Jabalya

4. Gaza El-Shaaf

5. Gaza - Bagdad

6. Gaza – El-Quba

7. El-Breige, Al-Nusairat, Al-Magazi, Al-Zawaida, Deir El-Balah

To Israeli settlements

8. Al-Qara, Beni-Suhaila, Abesan Kabera, Abasan Sagira, Khuzaa, Khanyunis

9. Rafah

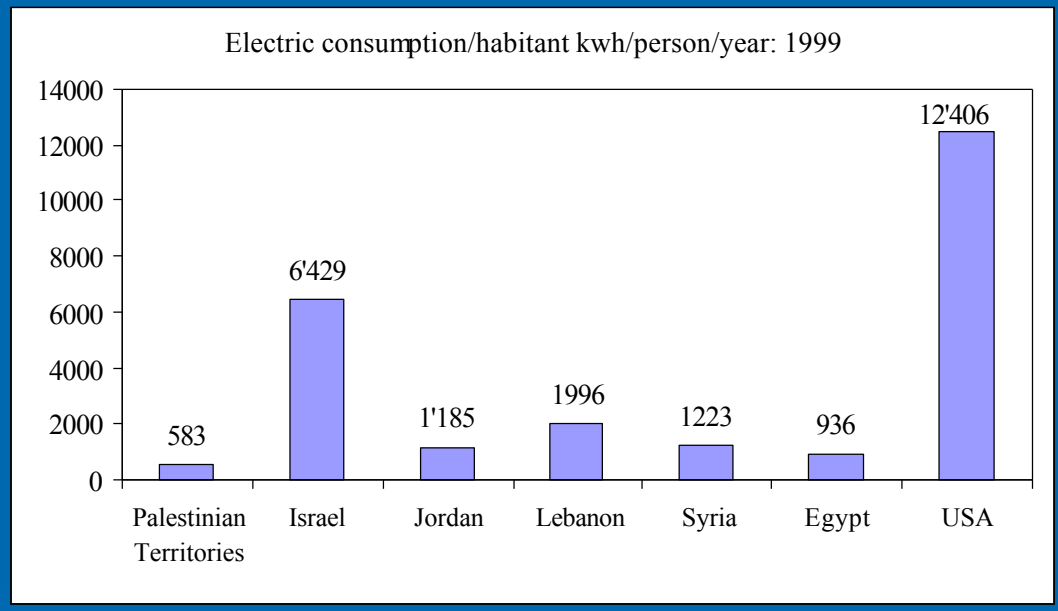
Palestinian Energy Research Centre - Jerusalem, Ministry of planning and International Cooperation Directorate General of Energy Planning, Electrical Energy Status in Gaza Strip, analytical study, Technical department – Electrical Branch, Gaza – January, 1995.
Map Source: http://www.mideastweb.org/mgaza.htm.

Israeli energy policy in the Palestinian Territories

- Service **priority given to the Israeli customer**, resulting in a low voltage at the end of feeder lines.
- IEC supply a limited amount of electrical energy to the Palestinian Territories. **To increase** electricity supply, Palestinian municipalities have to pay **extra fees**.
- Generation and transmission **costs are very high**. Whereas electricity would be less expensive through a national production or importation from a third party.

Electricity consumption

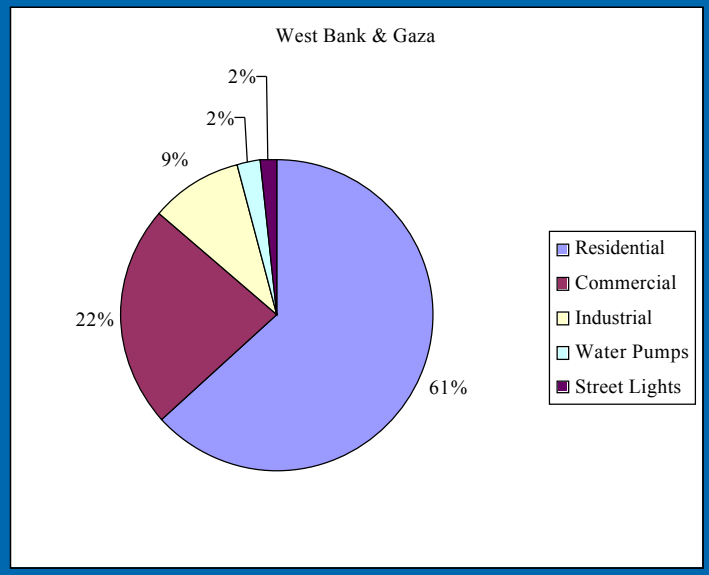
- For the PT: ≈ 600 kWh/capita consumption (lowest in the region)- 2000.
- Vs ≈ 6,400 kWh/capita for Israel (11 times that of PT).
- And ≈ 1,200 kWh/capita for Jordan (twice as superior).
- Explanations for low consumption include:
  1.Insufficient capacity of power sources.
  2.High prices of electricity.
  3.Inadequate quality of electrical energy (high transmission losses).

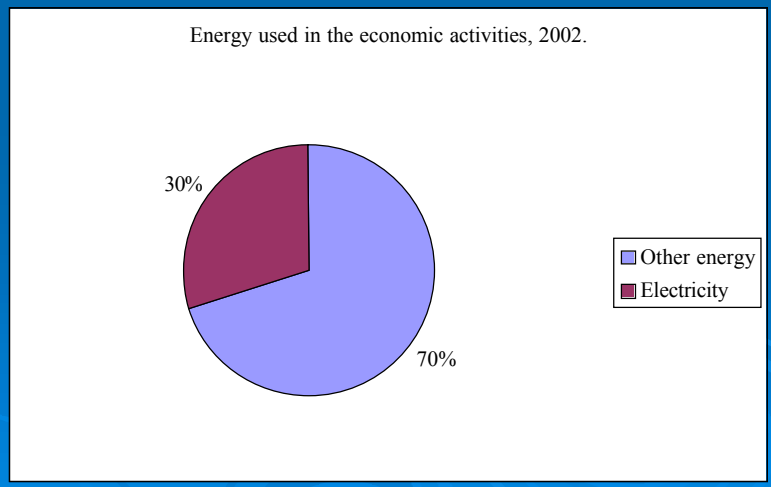


Sources: PCBS, PCBS, statistical abstract of Palestine no. "4", November, 2003. Ramallah - Palestine. 1997 is the base year in US$ million. Data are for 2000. Eearth Trend http://earthtrends.wri.org/, Energy statistics.

Electricity consumption by all sectors

- **Main consumers of electricity:**
  residential (≈ 60%).
  Commercial (≈ 20%).
  industrial (≈ 10%).
- 1/3 of energy used in economic activities comes from electricity.

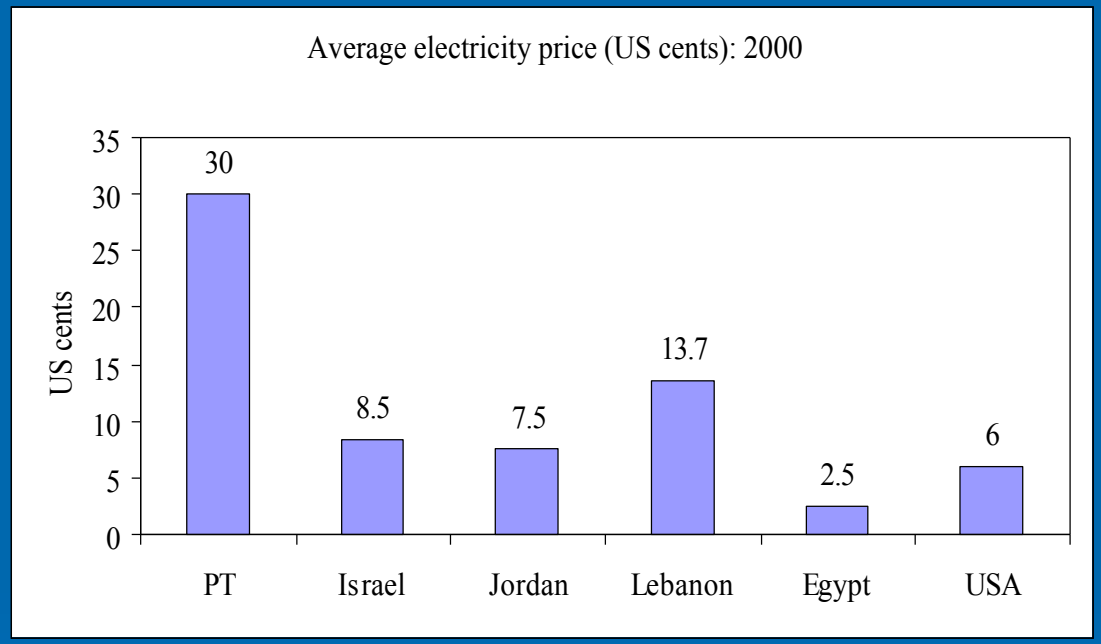




Source: Palestinian Ministry of Energy and Natural Resource and PCBS, Area statistics, natural resource statistics, energy

Electricity prices

- Average price: $0.30/kwh
- 3 times higher than in Israel or Jordan.
- 5 times higher than in the USA.

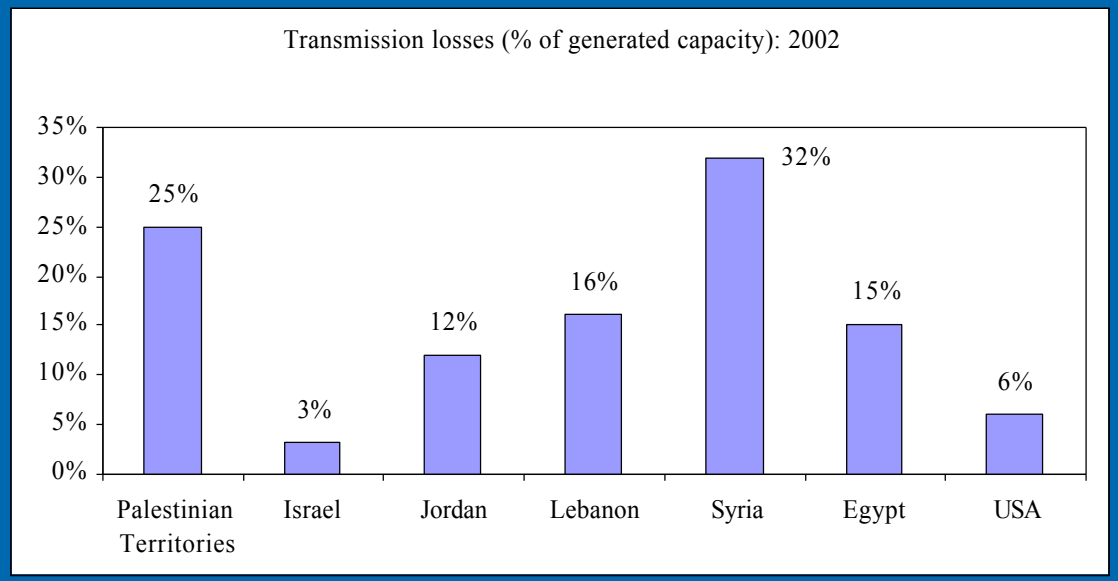


World Energy, http://www.worldenergy.org/, Palnet, http://www.palnet.com/~eigr/menr/cost.htm, solar Buzz, http://www.solarbuzz.com/Solarpricesworld.htm, Energy Information Administration http://www.eia.doe.gov/emeu/cabs/,
Central Bank of Jordan, http://www.cbj.gov.jo/
Palestinian energy research centre (PEC), 1995. The present status of electricity services in the west bank.

Transmission losses

- **Losses:** 25% of electricity injected.
- Key source of **technical losses:** low power factors.
- Sources of **non - technical losses:**

- Illegal ways of accessing the network (theft).
- Unpaid bills.



World Energy, http://www.worldenergy.org/, Palnet, http://www.palnet.com/~eigr/menr/cost.htm, solar Buzz, http://www.solarbuzz.com/Solarpricesworld.htm, Energy Information Administration http://www.eia.doe.gov/emeu/cabs/,
Central Bank of Jordan, http://www.cbj.gov.jo/
Palestinian energy research centre (PEC), 1995. The present status of electricity services in the west bank.

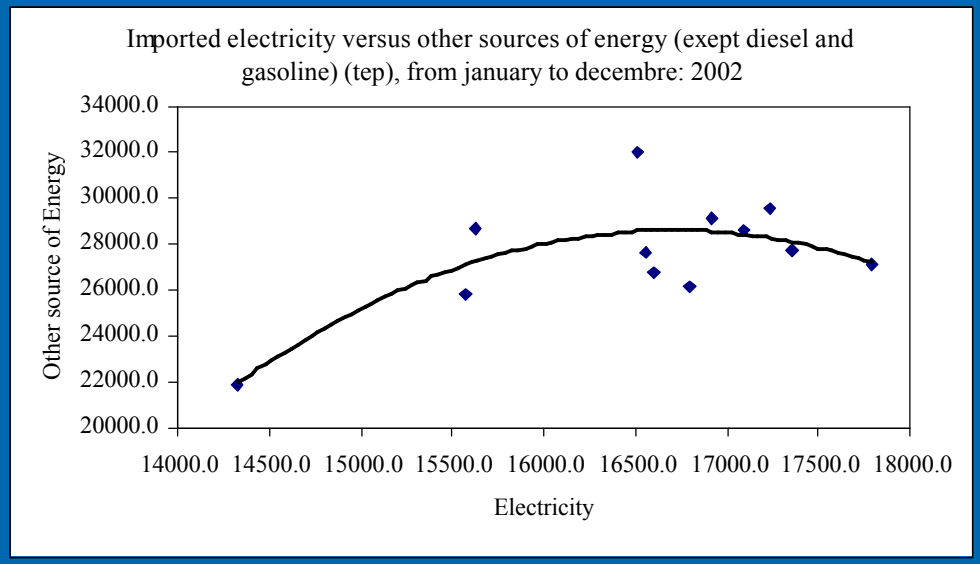
Substitution effect

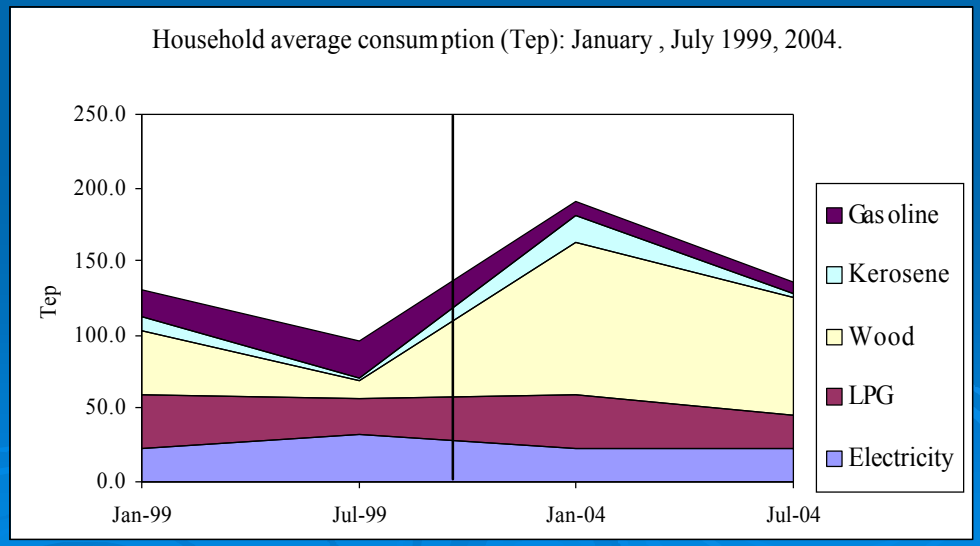
- **Substitution effect:**

1. Substitution between electricity and other energy types.

2. LPG can be considered a substitute for electricity for certain uses.

3. More consumption of wood during the current Intifada

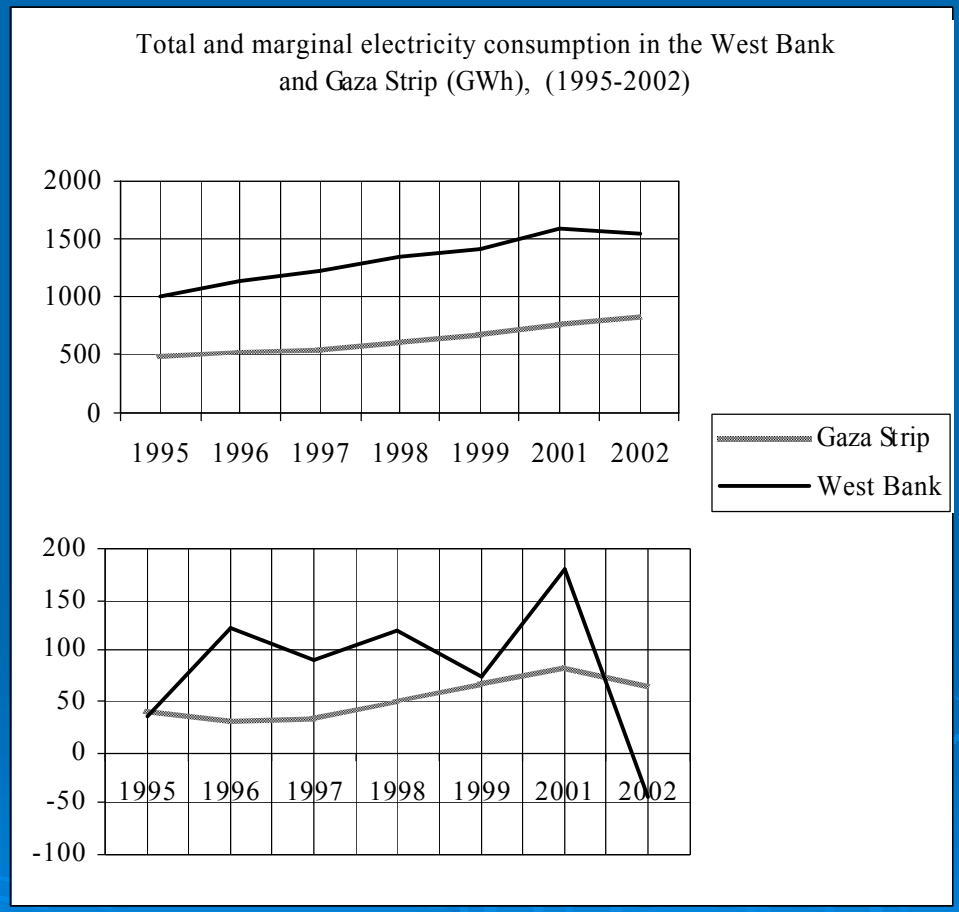




Source: AbuAlkair, Ayman, 2007. The electricity sector in the Palestinian Territories: Which priorities for Development and Peace, Energy Policy, 35, pp2209–2230

Political situation and demand for electricity

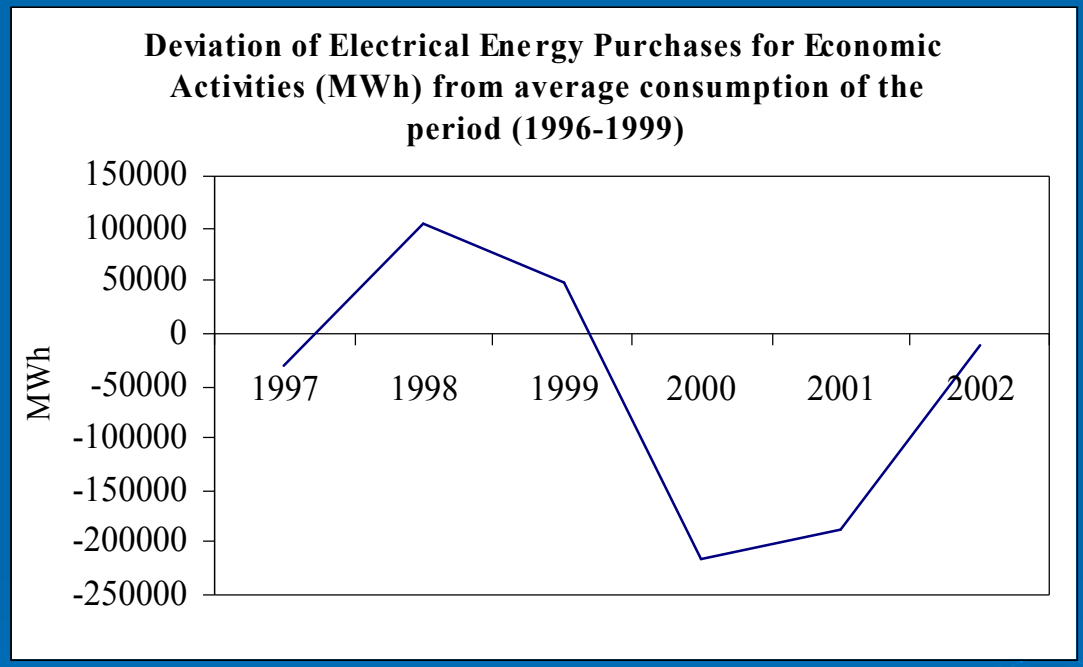
- political instability has two effects on electricity consumption
- First, a deceleration of electricity consumption by the whole economy (at the marginal side)



Source: AbuAlkair, Ayman, 2007. The electricity sector in the Palestinian Territories: Which priorities for Development and Peace, Energy Policy, 35, pp2209–2230

Conflict and electricity consumption

- Second, a strong decrease of the total electricity consumption by **economic activities.**
- Energy purchases level during conflict is lower than the average level in the period with "no conflict".



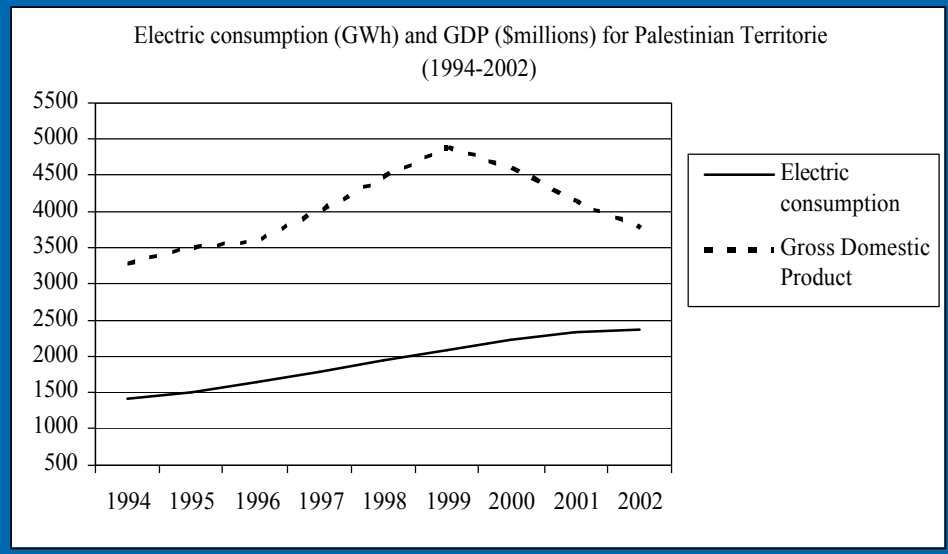
Deviation of electrical energy purchases for economic activities from average consumption of 460156 MWh for the period (1996-1999). Source: AbuAlkair, Ayman, 2007. The electricity sector in the Palestinian Territories: Which priorities for Development and Peace, Energy Policy, 35, pp2209–2230.

Electricity and economic growth

- while GDP suffers from a deep decline during the current crisis, the total electricity consumption trends upwards.
- An aggregated electricity demand function was specified as follows:

$$E = c. Y_t^a . e^{b.t} \quad \text{.....eq. 1}$$

- Where E is the consumption of electricity, Y_t is the Gross Domestic Product (GDP), t is time, while a is the elasticity of consumption with GDP and b is the growth rate with time.

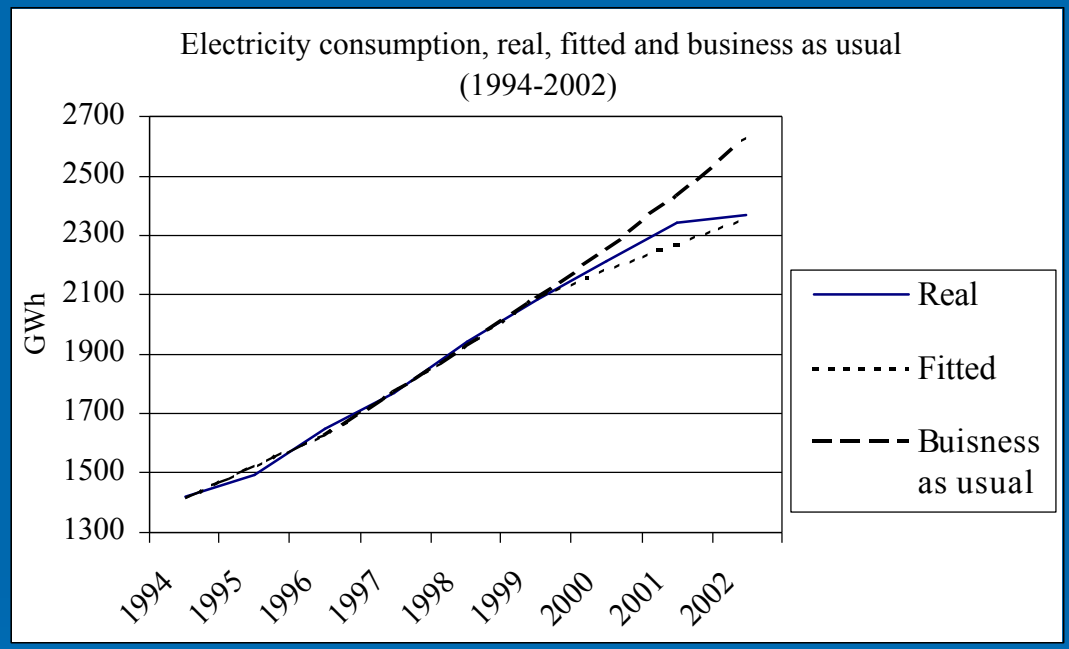


AbuAlkair, Ayman, 2006. The actual status of the energy sector in the Palestinian Territories, with a special focus on the electricity sector, rapport de recherché du CUEPE no 9, Université de Genève, Centre Universitaire d'Etude des problèmes de l'Energie (CUEPE).

home

Demand curve estimation

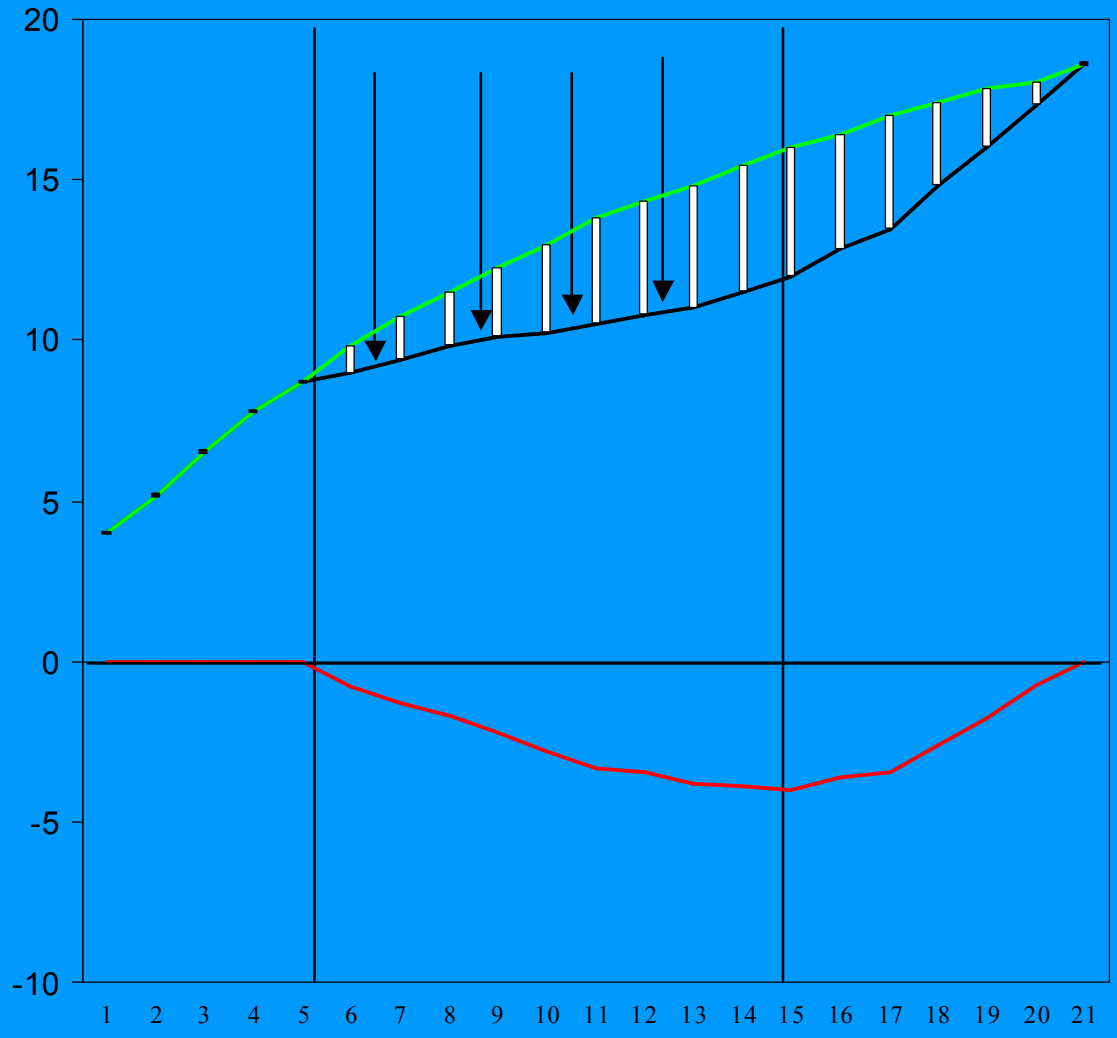
- Electricity consumption increases by 6% with time what ever the GDP.
- Electricity consumption increases by 0.22% when GDP growth is 1% (inelastic demand).



Source: AbuAlkair, Ayman, 2007. The electricity sector in the Palestinian Territories: Which priorities for Development and Peace, Energy Policy, 35, pp2209–2230

The notion of recovery analysis

- war modifies the trajectory of the consumption curve. War compress consumption. For the post-war period this creates a “resilience effect”.
- A significant increase in the post-war electricity consumption allows actual demand to catch up with the reference curve.



“reference curve”.

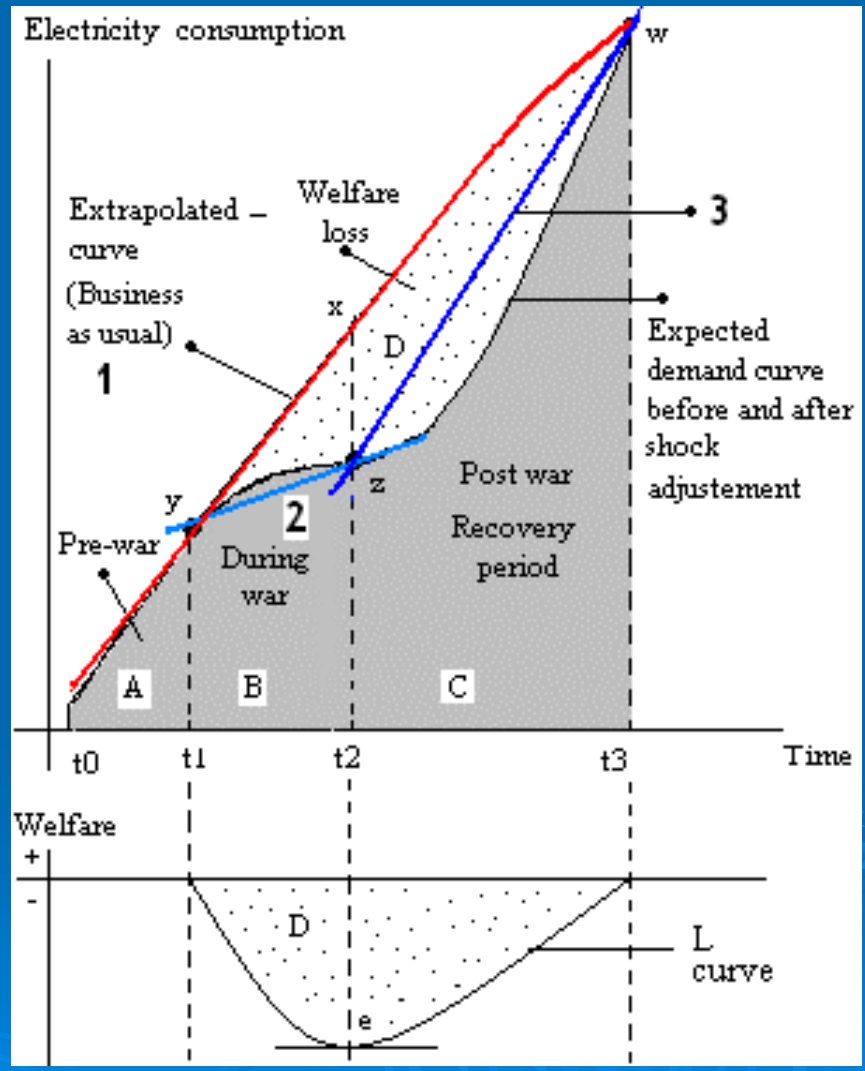
“distorted curve”.

“gap”

Recovery period analysis

- War influences the original demand (compress the consumption, causing a downward dent).
- The reference curve is a simple extrapolation of the historical data.
- Three stages for recovery analysis:

before, during and after period of crises (areas: A, B and C).



Source: AbuAlkair, Ayman, 2007. The electricity sector in the Palestinian Territories: Which priorities for Development and Peace, Energy Policy, 35, pp2209–2230

Recovery period analysis

- Different Electricity consumption demand:

Pre-war: "business as usual" red line curve.

During war: "distorted demand", black one.

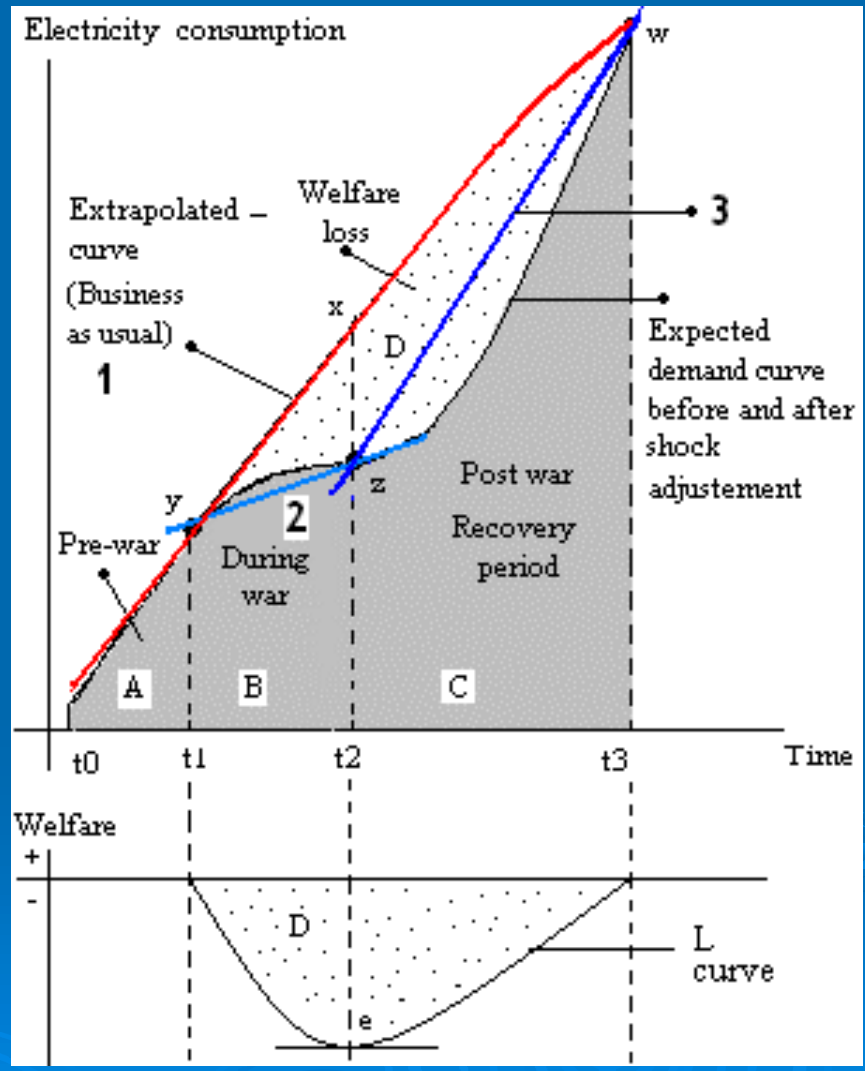
Post-war period: "resilience effect" : "recovery curve", curve3. demand will increase significantly.

- We want to estimate the time necessary for the "recovery demand" curve to catch up with the "reference curve" at point (w).
- The "abnormal demand" (Ei) is composed of different demand curves.

$$E_i = c_i \cdot Y_t^{a_i} \cdot e^{b_i t} \quad \text{.....eq. 2}$$

Where i = 1,2,3

home

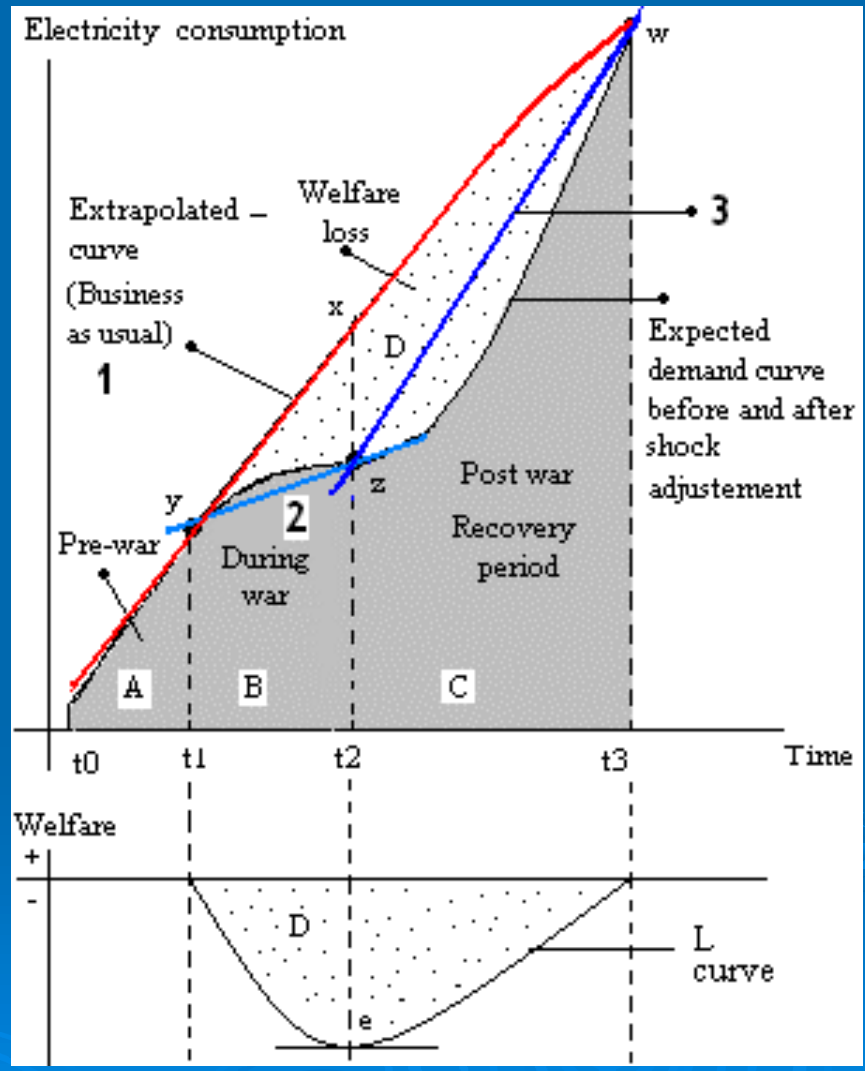


Source: AbuAlkair, Ayman, 2007. The electricity sector in the Palestinian Territories: Which priorities for Development and Peace, Energy Policy, 35, pp2209–2230

Recovery period analysis

- **It allows to estimate the following:**

1. **Time needed for recovery.**
2. "magnitude" of crisis (the surface of area D/All surface under reference curve).
3. Post-war investment estimations.

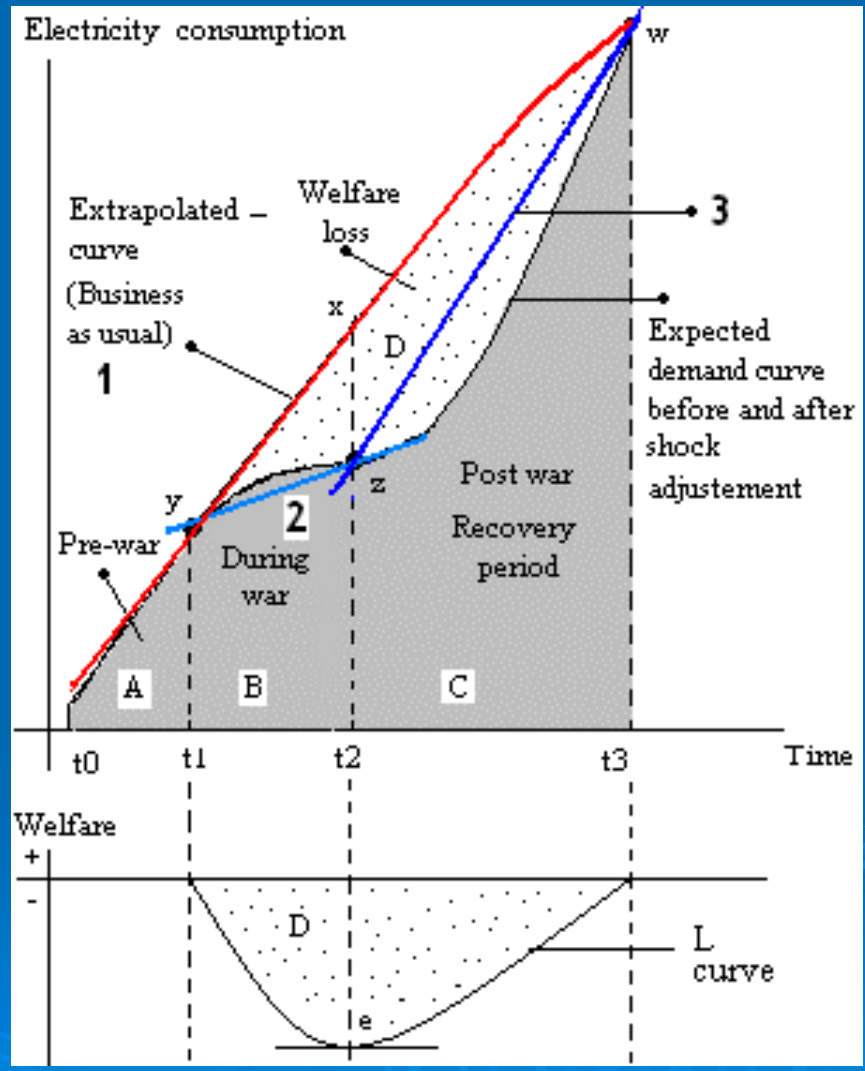


Source: AbuAlkair, Ayman, 2007. The electricity sector in the Palestinian Territories: Which priorities for Development and Peace, Energy Policy, 35, pp2209–2230

Recovery period analysis

- From (eq. 1 & 2), by solving for t_2 and t_3 we can find the time required for after-war recovery (Rt):

$$Rt = \left[\frac{\ln\left(\frac{c_2}{c_1}\right)}{(b_1-b_2)} - \frac{\ln\left(\frac{c_0}{c_2}\right)}{(b_2-b_0)} \right] - \left[\frac{\alpha\,(a_2-a_0)}{(b_2-b_0)} - \frac{(a_1-a_2)}{(b_1-b_2)} \right] \cdot \ln(Y_{t2}) \quad \text{.....eq. 3}$$



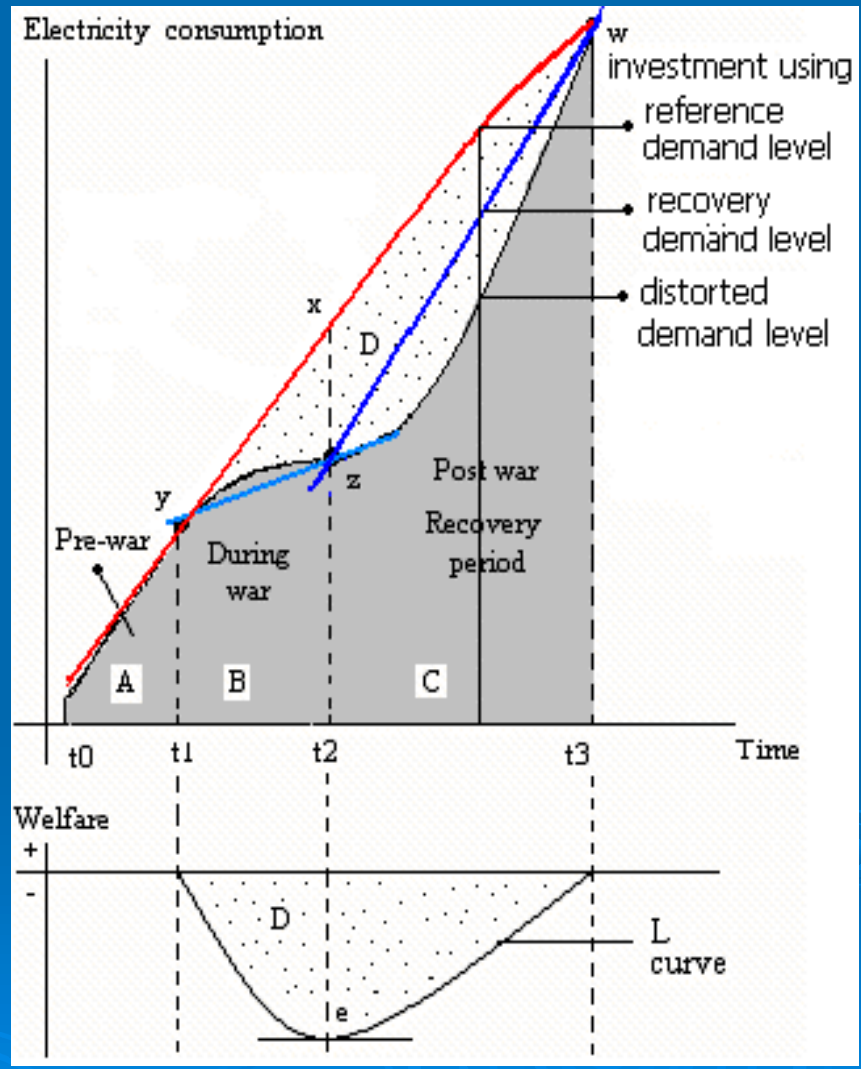
- From the last equation:

1. Recovery period was estimated at between 7 and 10 years.
2. The "magnitude" of crisis (the surface of area D/All surface under reference curve) = **8%.**

Source: AbuAlkair, Ayman, 2007. The electricity sector in the Palestinian Territories: Which priorities for Development and Peace, Energy Policy, 35, pp2209–2230

Investment needs for the post-war

- Recovery Period concept is useful for estimating the investment requirements for the post-war reconstruction needs.
- The post-war period investment needs vary depending on the type of demand curve used to make the estimations.
- Using the distorted demand estimation results in the underestimation of investment needs.



Investment needs for the PT

- Investment needs for Palestinian electricity sector include:
- Network.
- Rebuilding the direct destruction by the Israeli Army
- Rural electrification
- Building generation capacity
- The difference between investment estimations based on the distorted curve compared to the reference demand is nearly 30%.

Indicator	Scenarios for the electricity demand		
	Distorted demand (E_0)	Recovery Demand (E_2)	Reference demand (E_1)
Demand projections for the PT in 2010	675 MW (3783 GWh)	756 MW (4238 GWh)	848 MW (4754 GWh)
investment in 2010 (prices of 2006) (No diesel cost)	$1,043 Million	$1,197 Million	$1,373 Million
Average diesel purchases per year (59% of investment from historical data)	$382 Million	$440 Million	$506 Million
investment (2010) (including diesel)	$1,425 Million	$1,637 Million	$1,879 Million
Investment difference with the distorted demand	-	$212 Million	$454 Million
Percentage to the distorted demand	-	15%	32%

Source: AbuAlkair, Ayman, 2007. The electricity sector in the Palestinian Territories: Which priorities for Development and Peace, Energy Policy, 35, pp2209–2230

Conclusions

- The level of electric services provided by the IEC is inadequate: Constituting a handicap for the economy.
- Electricity problems consist of:

High transmission losses.

Electricity services limited in quantity and quality.

Lack of investment in the electricity sector.

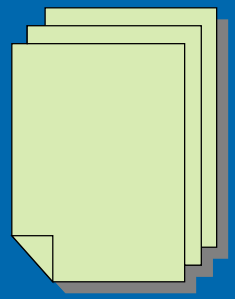
High prices.

- The Palestinian electric sector shows a high vulnerability to political shocks.

Conclusions

- The end of collective punishment policies and a well functioning economy are key factors for the electricity demand recovery.
- Palestinian electricity consumption appears to be inelastic.
- The use of reference period is useful for qualitative electricity services and future investment planning.
- The creation of independent power plants in the PT must be studied along with other scenarios of electricity importation.

For more details see



- AbuAlkair, Ayman, 2007. The electricity sector in the Palestinian Territories: Which priorities for Development and Peace, Energy Policy, 35, pp2209–2230.
- AbuAlkair, Ayman, 2006. The actual status of the energy sector in the Palestinian Territories, with a special focus on the electricity sector, rapport de recherché du CUEPE no 9, Université de Genève, Centre Universitaire d'Etude des problèmes de l'Energie (CUEPE).