Impacts of climate change on residential electricity consumption in urban areas and potential adaptation options
Case study: Alexandria Egypt

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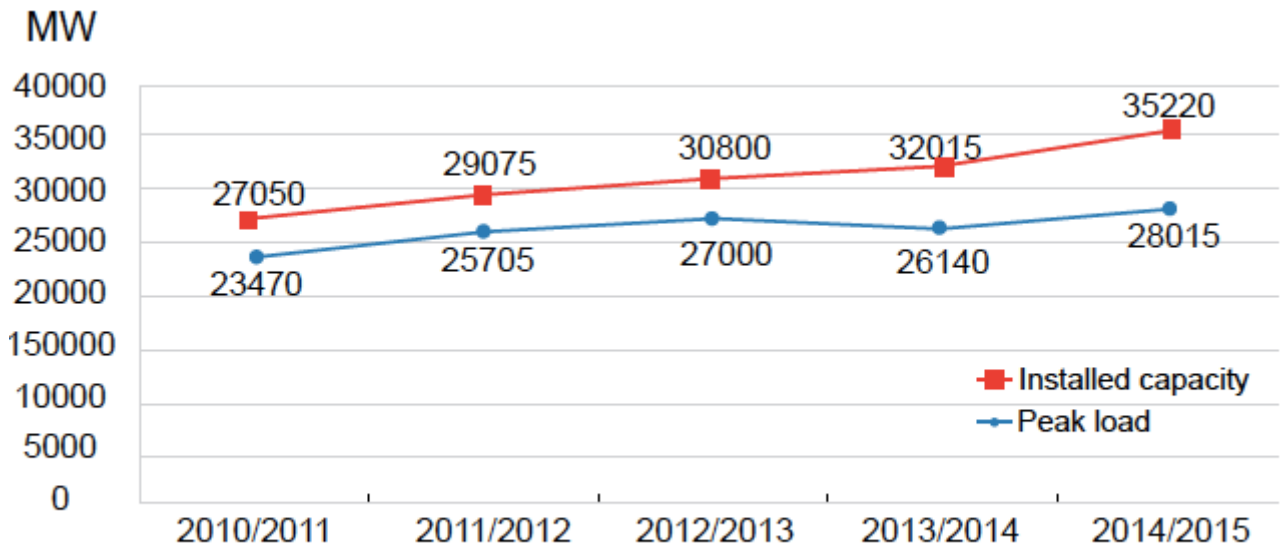
Objectives

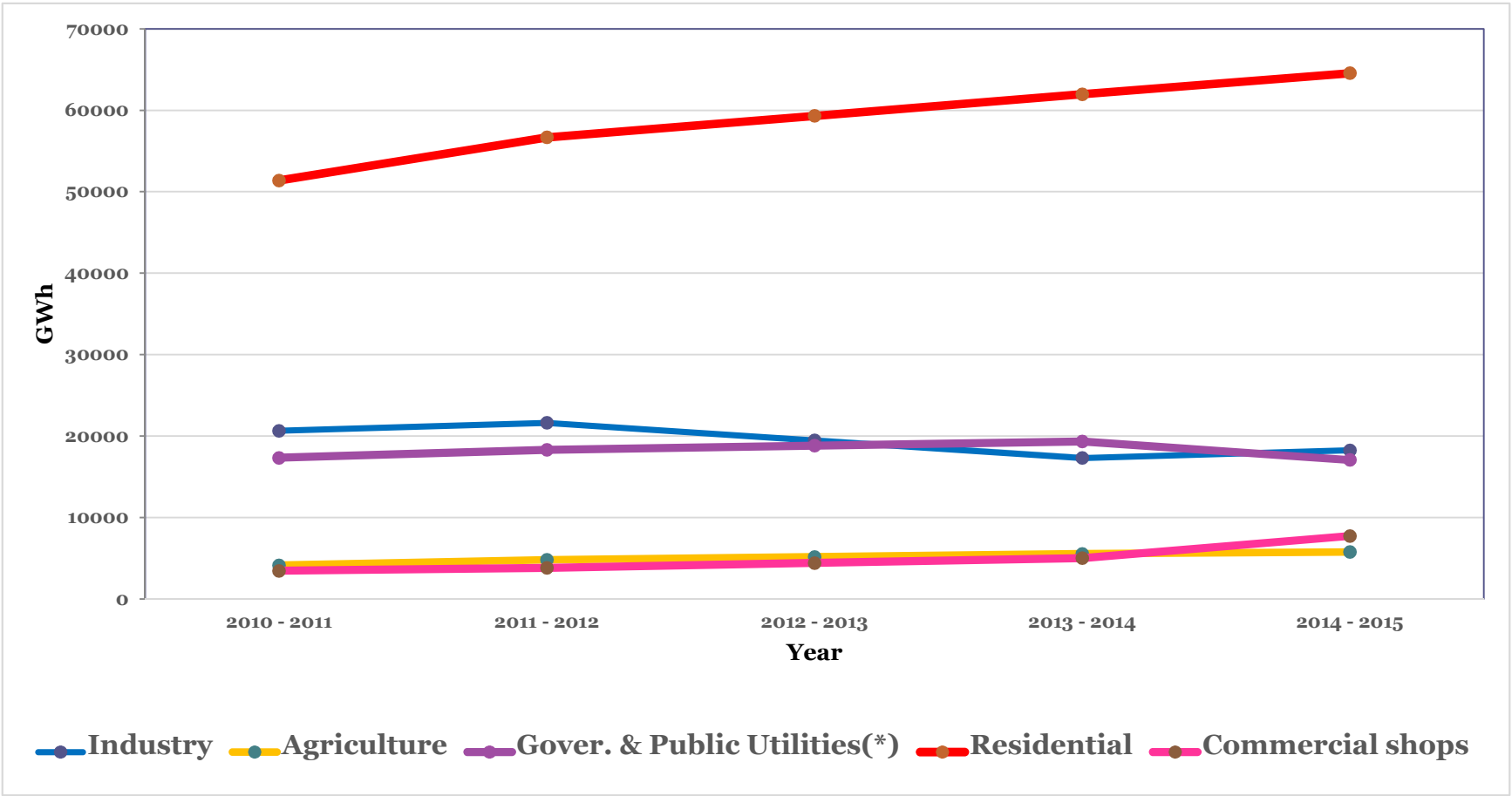
- To assess the impact of increasing temperature and humidity attributed to climate change on seasonal residential electricity consumption in Alexandria city, Egypt.

- To explore potential soft and hard actions to adapt to such impacts are considered.

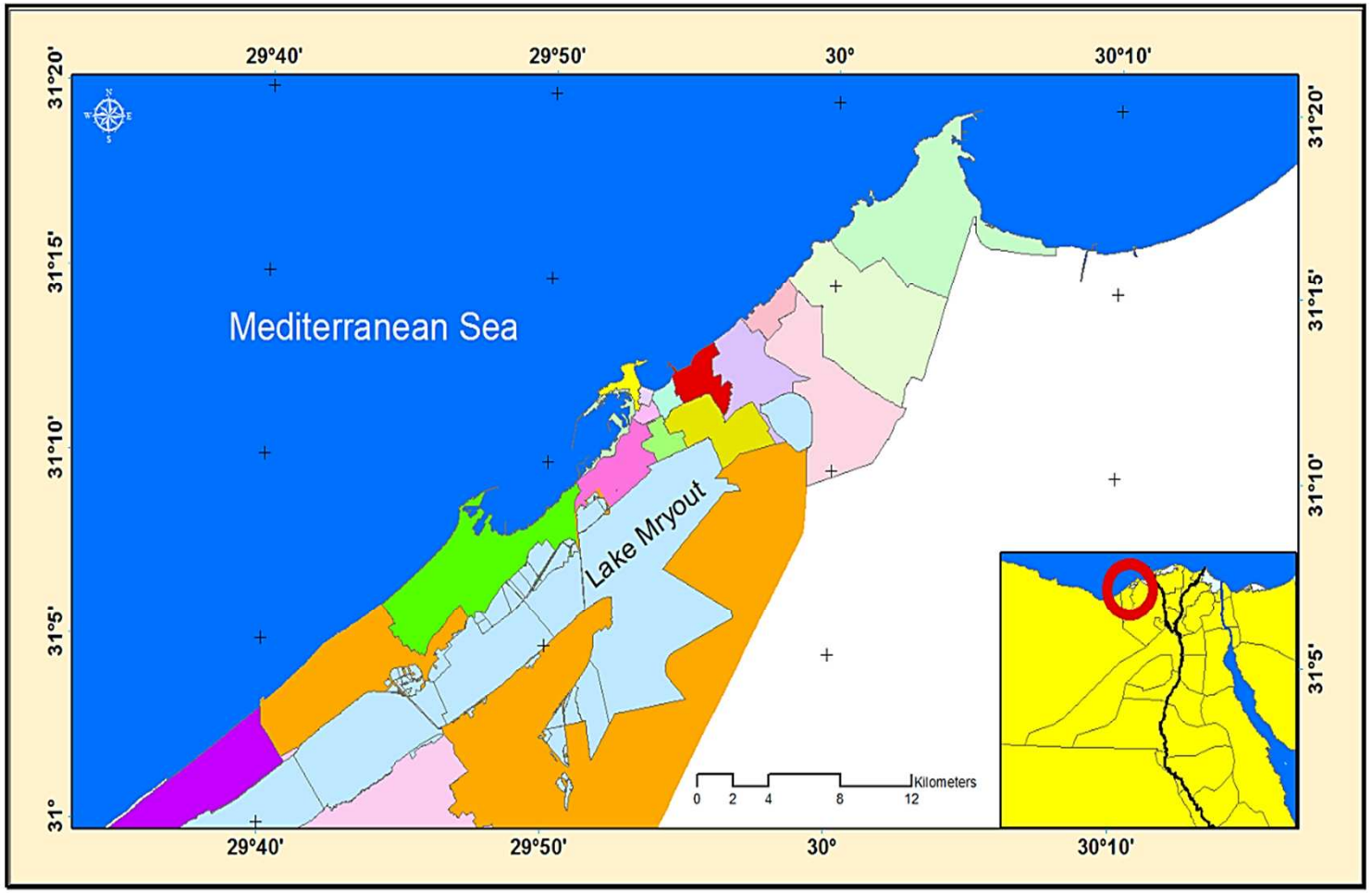
Development of peak load and installed capacity in Egypt during the period 2010-2015



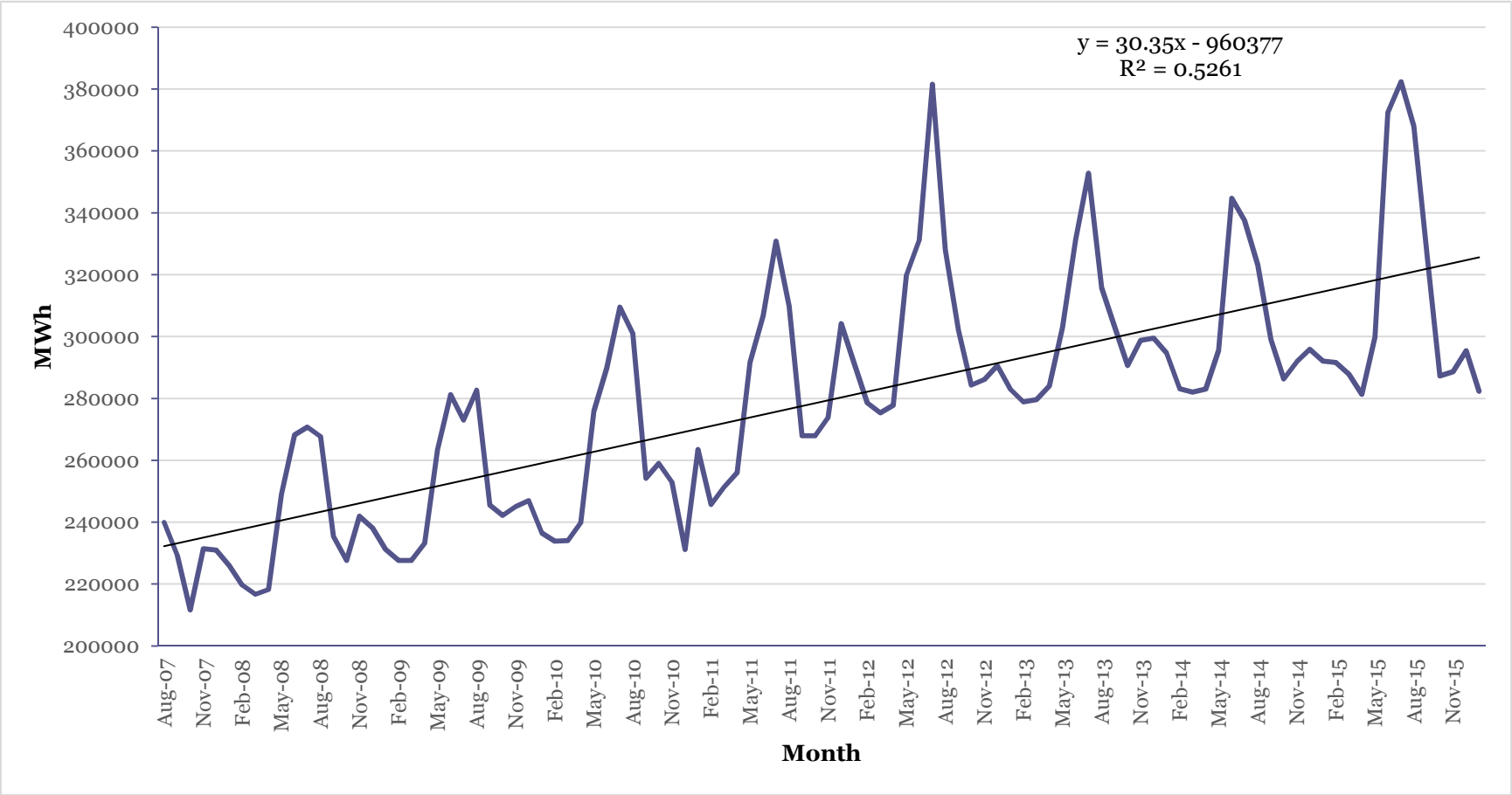
Electricity consumption by sector in Egypt



Alexandria city



Residential electricity consumption in Alexandria (2007 - 2015)



Estimating driving forces on seasonal electricity consumption: Regression analysis

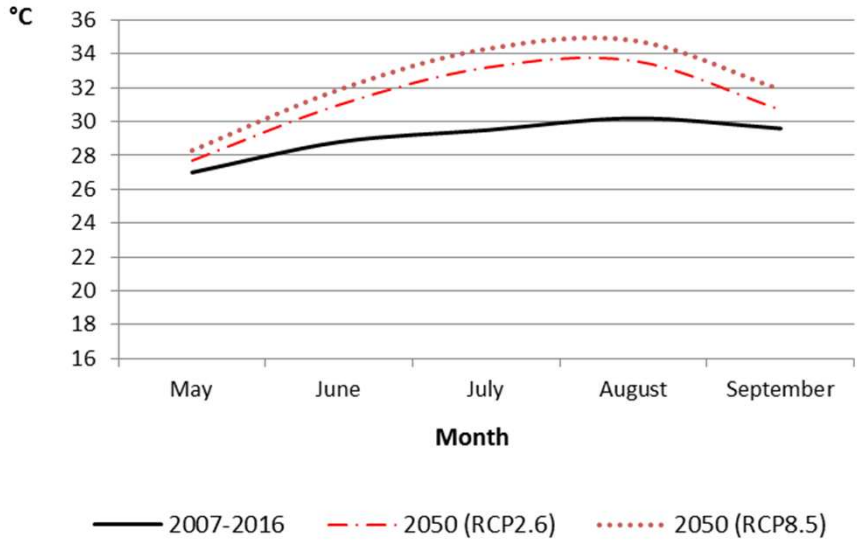
$$\mathcal{Y}_{it} = \beta_0 + \beta_1 \mathcal{X}_{1it} + \beta_2 \mathcal{X}_{2it} + \beta_3 \mathcal{X}_{3it} + \beta_4 \mathcal{X}_{4it}$$

where:
$\mathcal{Y}_{it}$: is residential electricity consumption for district i and over time t;
$\mathcal{X}_{1it}$: is maximum monthly temperature for district i and over time t;
$\mathcal{X}_{2it}$: is relative monthly humidity for district i and over time t;
$\mathcal{X}_{3it}$: is population size for district i and over time t;
$\mathcal{X}_{4it}$: is GDP per capita for district i and over time t

$$Elect.con = -34978.63 + 259.51\, Temp + 0.08157\, Pop + 2.2667\, GDP\ per\ capita$$

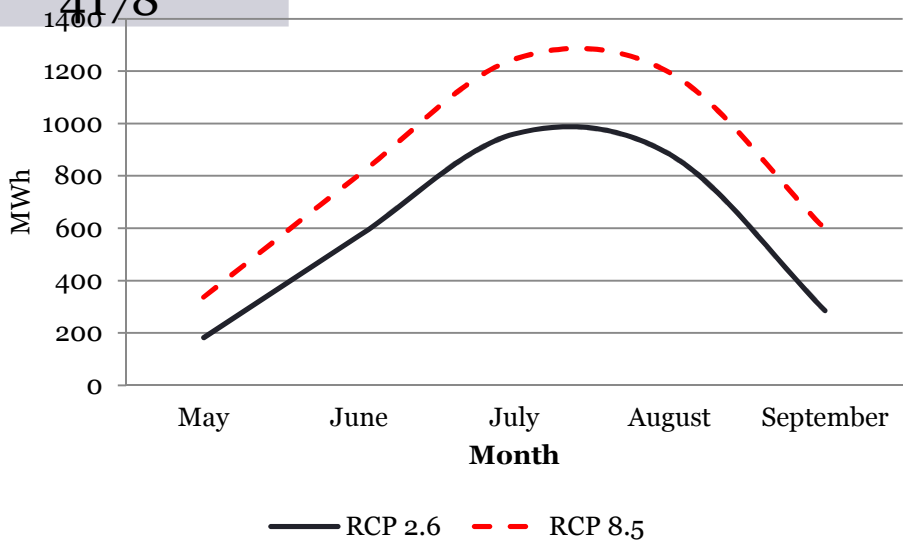
Current and expected temperature

Month	Maximum temperature (°C)		
	2007-2016	2050 (RCP 2.6)	2050 (RCP 8.5)
May	27.0	27.7	28.3
June	28.8	31	31.9
July	29.5	33.2	34.3
August	30.2	33.6	34.8
September	29.6	30.7	31.9



Climate change impacts on electricity consumption

Month	Electricity consumption change MWh	
	2050 (RCP 2.6)	2050 (RCP 8.5)
May	182	337
June	571	804
July	960	1246
August	882	1194
September	285	597
Total	2880	4178



Dense high buildings in Alexandria

Potential adaptation options

- Hard options:
  - Construction of additional electricity generation and upgrading electricity network capacities in order to cope with increasing residential demand for electricity.
  - involve massive spending to meet both initial capital investments as well as operational costs.
- Soft options:
  - Using economic instruments (e.g. price mechanisms)
  - Introduction of more stringent electricity efficiency standards for air conditioning equipment.
  - Enforcement of urban planning and designs could as well improve internal housing environments and thus reducing the need for air conditioning.
- Hard options typically involve significant investments that would involve high opportunity cost, particularly in a developing country like Egypt.

Environmental/economic impacts valuation

- Valuation of emissions (carbon emission markets)
- Opportunity cost of funds to be invested in electricity generation.

- Hard to value aspects may include for instance discomfort due to reduced use of air conditions.

Thank you