



# Solar Cooking as a Sustainable Alternative to Conventional Food Preparation in the MENA Region

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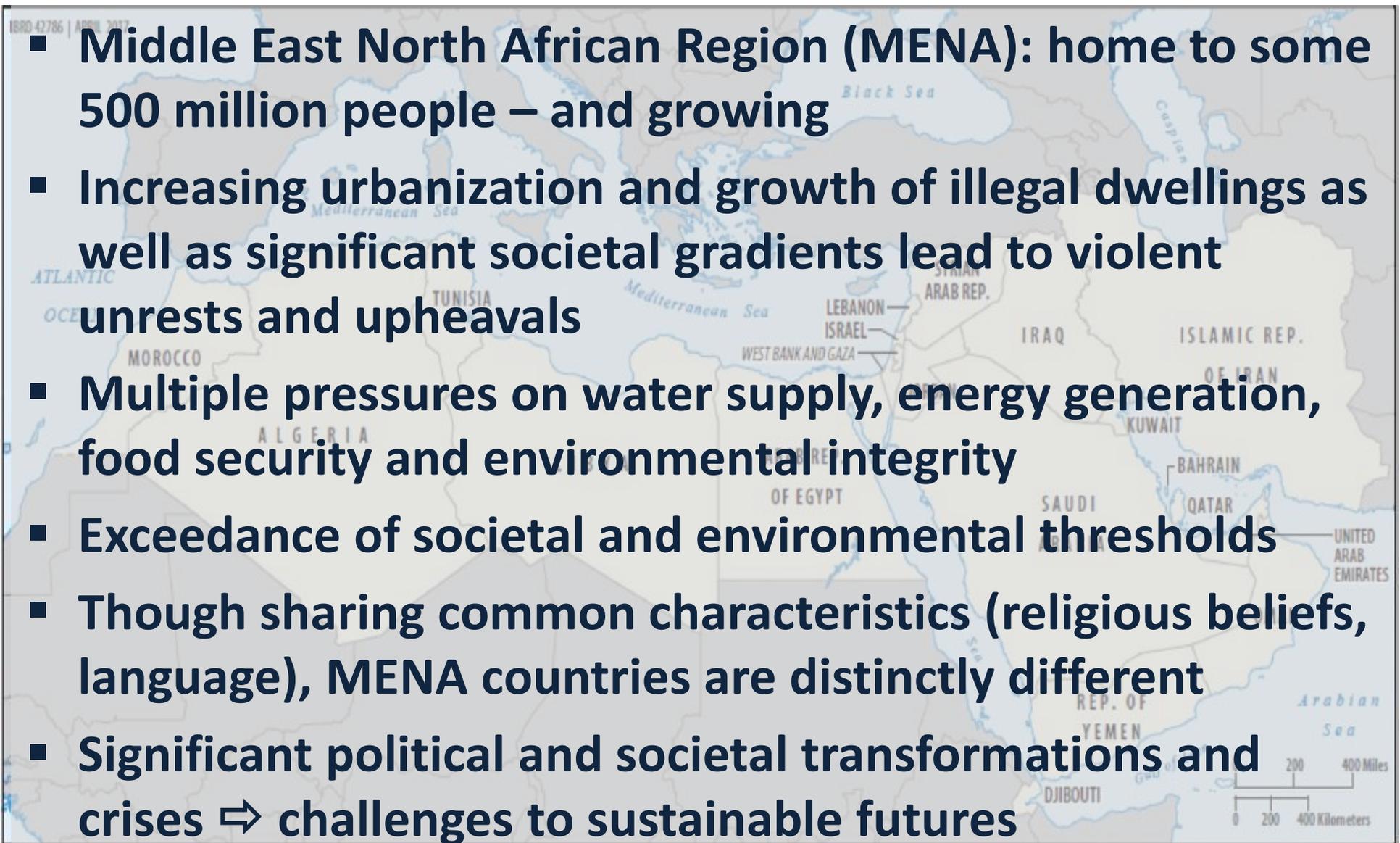
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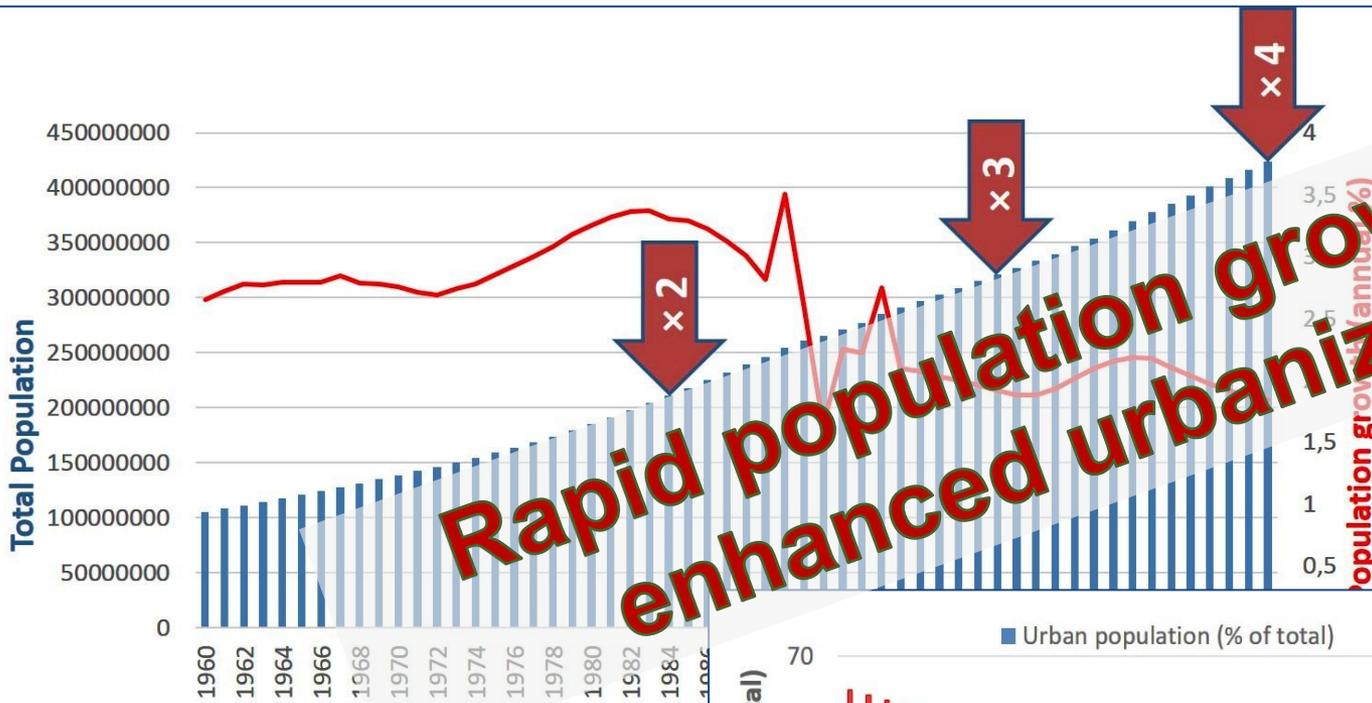
<http://www.futureearth.org/mena-centre>

# MENA Region: Major Characteristics

- Middle East North African Region (MENA): home to some 500 million people – and growing
- Increasing urbanization and growth of illegal dwellings as well as significant societal gradients lead to violent unrests and upheavals
- Multiple pressures on water supply, energy generation, food security and environmental integrity
- Exceedance of societal and environmental thresholds
- Though sharing common characteristics (religious beliefs, language), MENA countries are distinctly different
- Significant political and societal transformations and crises ⇒ challenges to sustainable futures

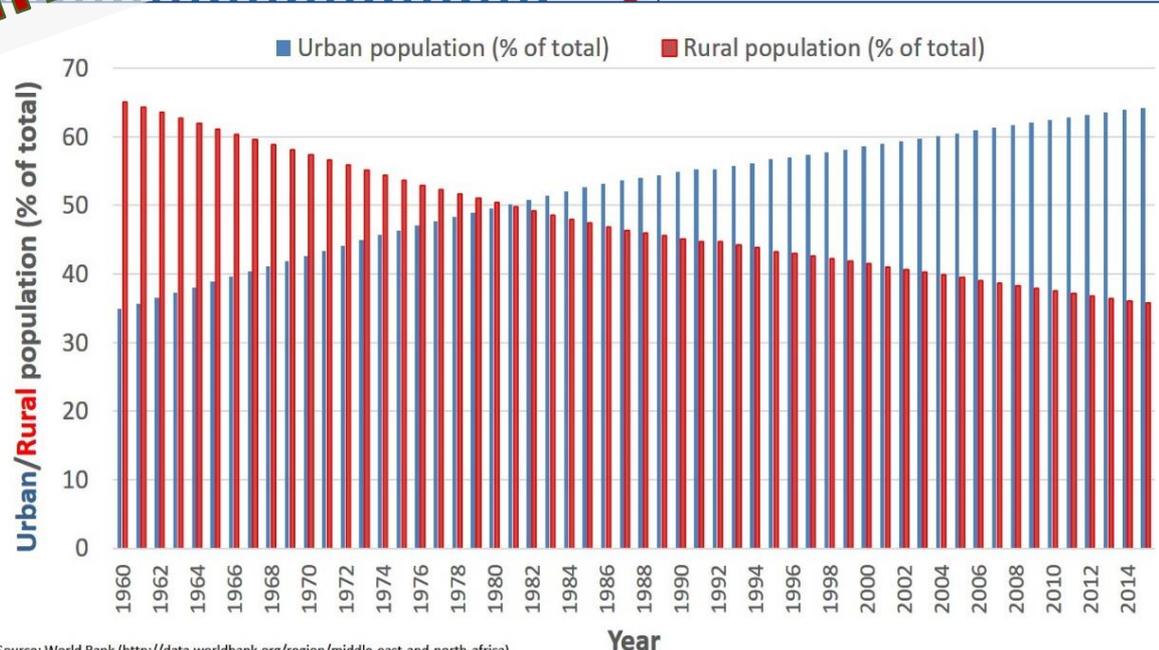


# MENA Region: Demographics



Source: World Bank (<http://data.worldbank.org/region/middle-east-and-north-africa>)

Total population and annual rate of population growth in the MENA region between 1960-2016 (above); fraction of urban versus rural population in the MENA region 1960-2016 (right); source: WORLD BANK



Source: World Bank (<http://data.worldbank.org/region/middle-east-and-north-africa>)

# MENA Region: Urbanization

- High population densities and large urban centers prominent in Eastern Mediterranean
- Given current demographic trends: urban centers expected to continuously grow

Population density and urban centres in the Mediterranean basin

Population density, 2008  
Inhabitants per square kilometre



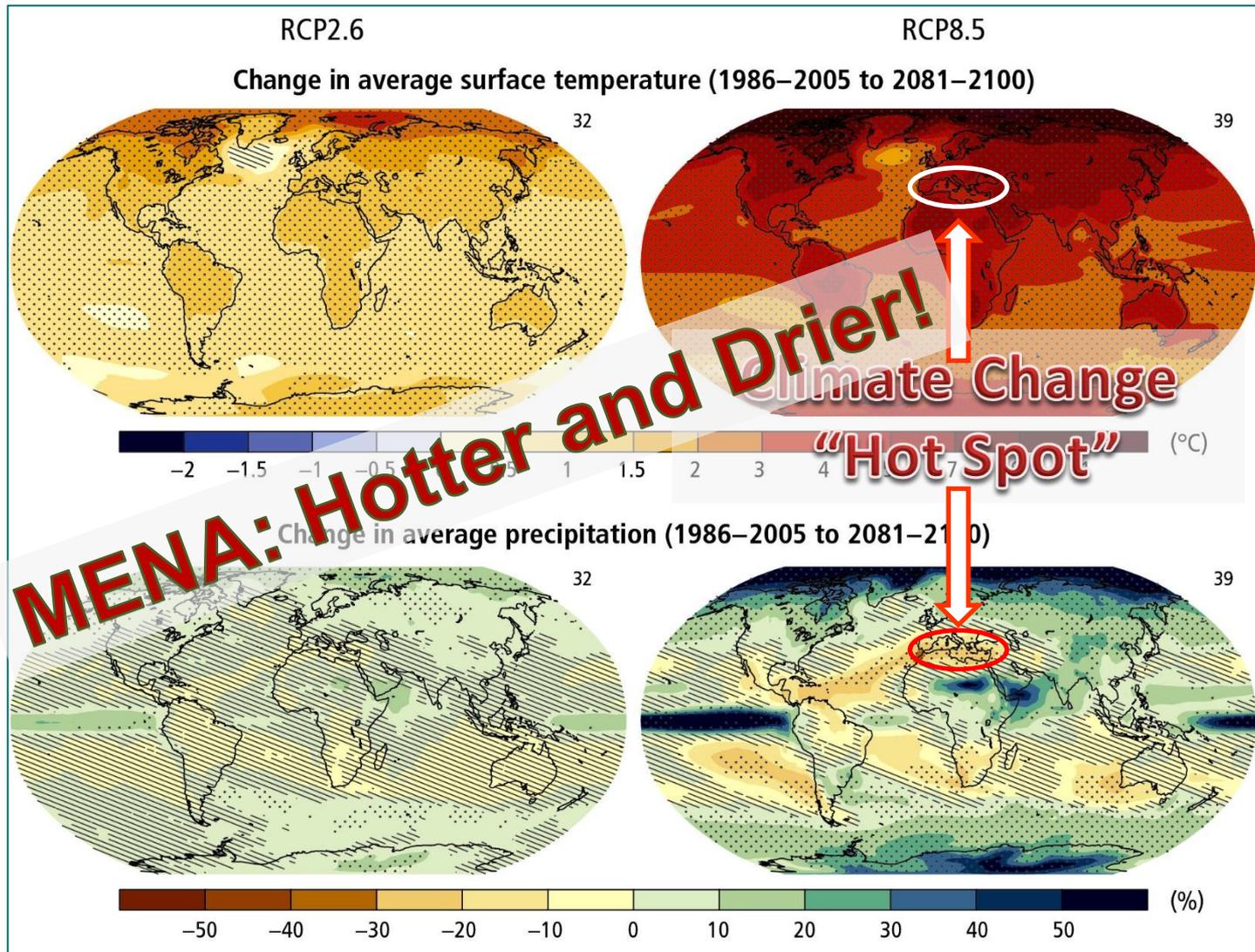
Population in urban centres, 2010  
Millions



Sources: personal communication with Blue Plan, data collected from national sources, 2011; UNDESA, Population Division, online database, accessed in August 2011.



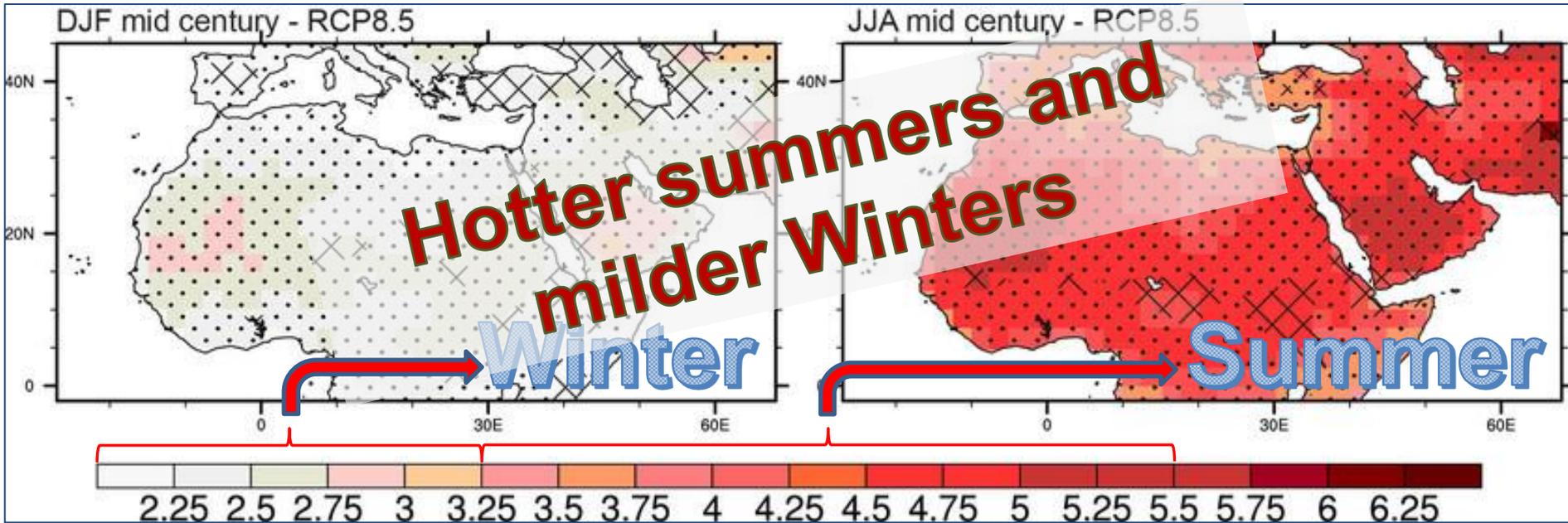
# Future Climate Change: Global



Anomalies of the annual mean temperature (top) and rainfall patterns (bottom) derived from numerical models for 2081-2100 relative to the reference period 1961-1990 for a minimum (RCP 2.6) and a maximum (RCP 8.5) emission scenario; source: IPCC-AR5, 2014

# Future Climate Change: MENA Region

- Regional climate model results for the MENA region

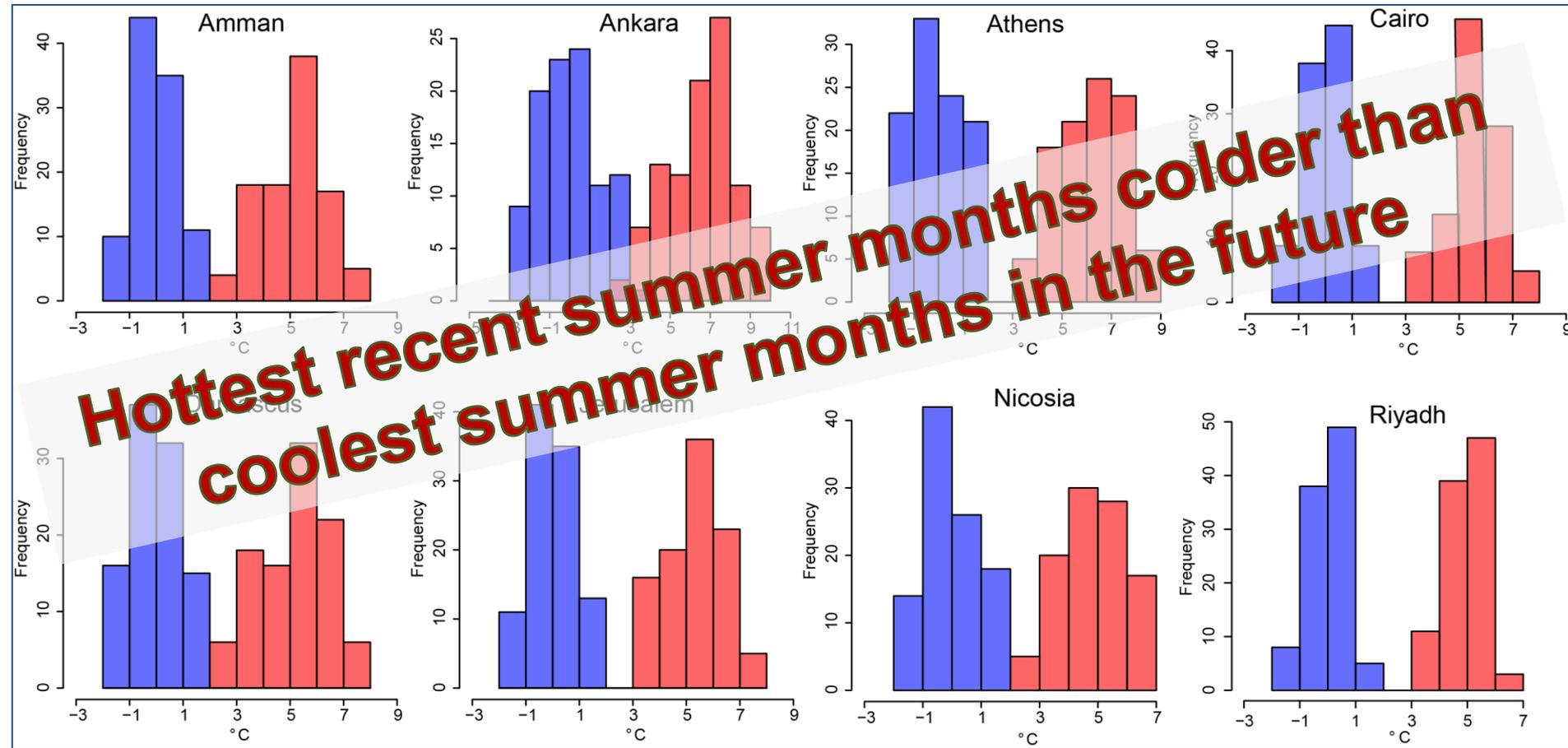


Multi-model mean and robustness (dots: high and cross-hatching: medium confidentiality) for the change in near-surface temperature in degrees K during Dec, Jan, Feb (left) and Jun, Jul, Aug (right) for 2046–2065 (**mid-century**) according to the RCP4.5 emission scenarios (above); source: Lelieveld et al., 2016; Changes in climate extremes in Nicosia (right), source: Lelieveld et al., 2012

Quantity	Total (1961-2000)	2021-2050	2071-2100
Days with $T_{\max} > 35^{\circ}\text{C}$	60	85 (+42%)	120 (+100%)
Tropical Nights with $T_{\min} > 25^{\circ}\text{C}$	75	120 (+60%)	165 (+120%)

# Future Climate Change: MENA Region

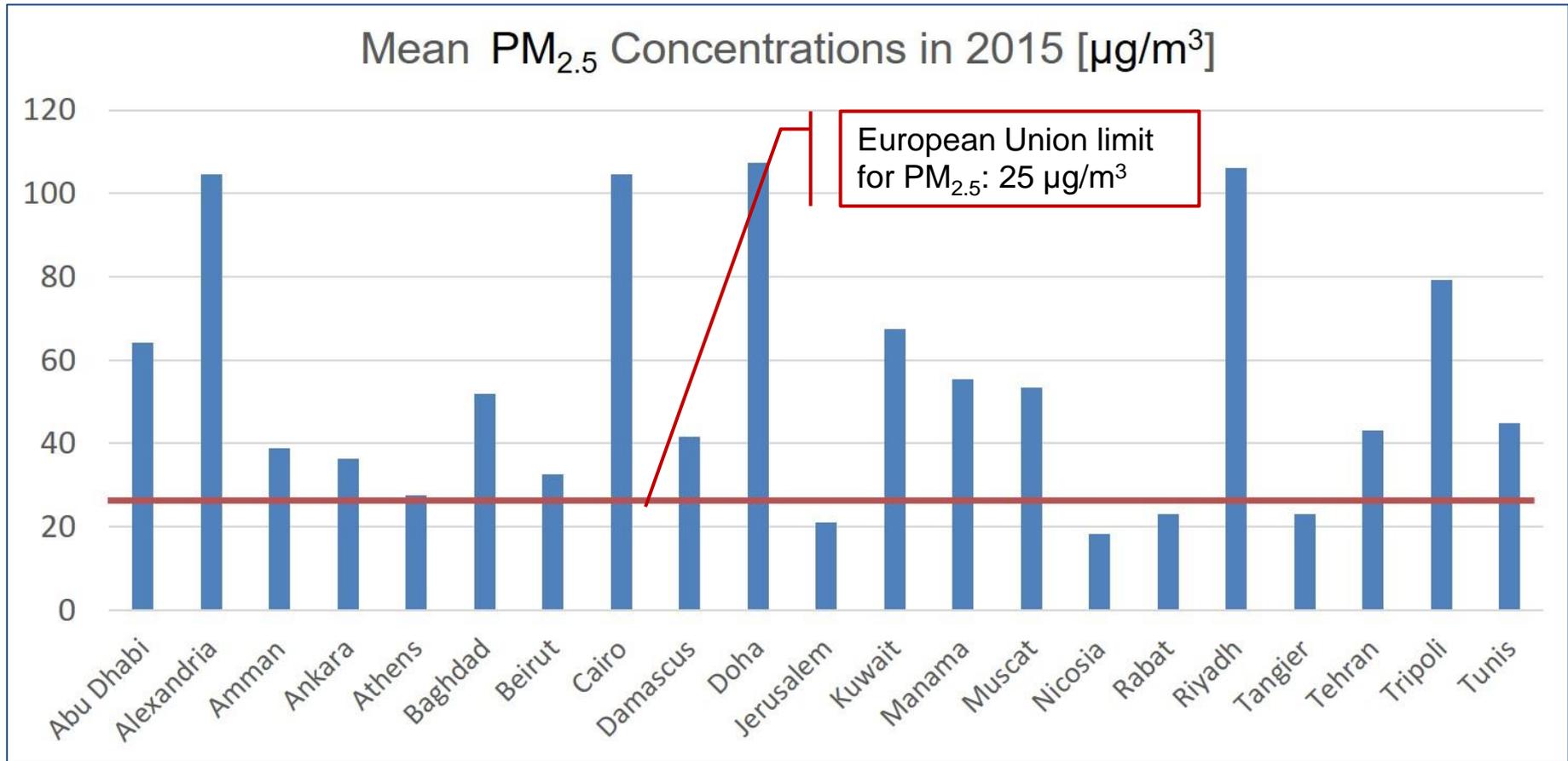
- Regional climate model results: enhanced city heating



Frequencies of summer (JJA) maximum temperature anomalies (%). Blue is the reference period 1961-1990 (centered around 0°C) and red 2070-2099, indicating strongly increasing hot periods; source: Lelieveld et al., 2014

# Air Quality in MENA Cities

- Aerosol concentrations (i.e., PM<sub>2.5</sub>) exceed limit in many MENA cities<sup>1)</sup>



# Biomass Burning for Cooking<sup>1)</sup>

- Around 3 Billion people use biomass (wood, charcoal, kerosene) for cooking in open fire stoves
- This applies to private households as well as to street food vendors in city settings
- Charcoal increasingly replaces wood and kerosene as burning fuel
- Close to 4 million people annually die prematurely from illnesses attributable to household air pollution
- Close to half of deaths due to pneumonia among children under 5 years of age are caused by particulate matter (soot) inhaled from household air pollution

1) Source: WHO; <http://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health>

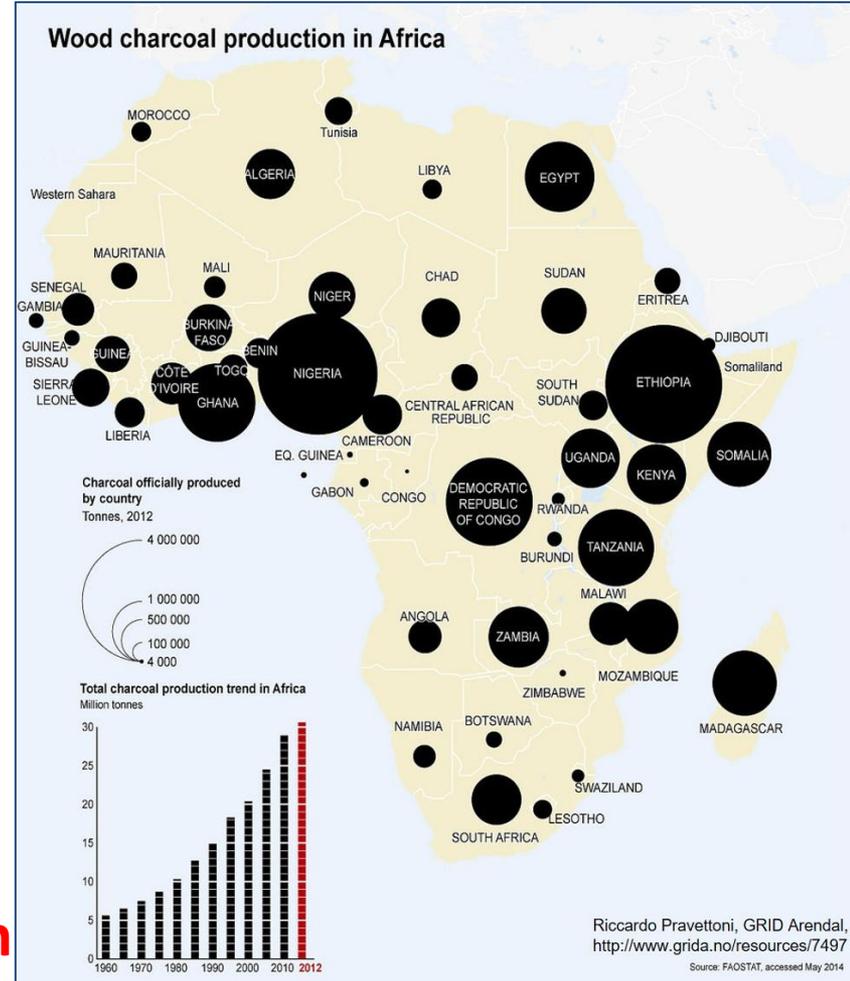


Indoor open fire cooking (top); Charcoal street vendor (center); Street food prepared on open fire (bottom)

# Biomass Burning for Cooking

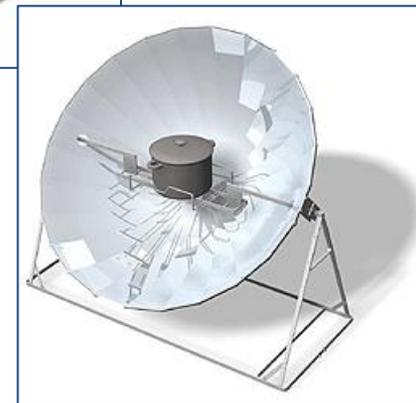
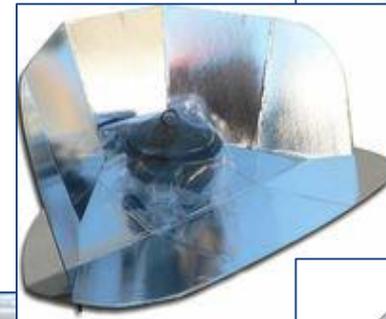
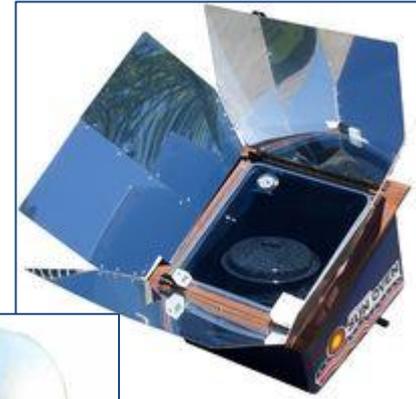
- Charcoal is used the primary source of fuel for cooking in households as well as by city street vendors
- Africans use more than 30 Mill. tons of charcoal every year, making it a multi-billion dollar industry
- 30 Mill. tons of charcoal produced in 2012  $\cong$  150 Mill. tons of wood<sup>1)</sup>
- Up to 90 percent of wood harvested in Africa is used as firewood and charcoal for cooking (UNEP)
- extensive use of renewable resource; adverse consequences for biodiversity and health of forest ecosystems; significant CO<sub>2</sub> emission

1) this assumes an efficiency of turning wood into charcoal of 20%



# Solar Cooking as Sustainable Alternative

- Solar cooking helps reduce the high social, economic, and environmental costs and risks to human health of black soot and fossil fuel emissions from biomass burning
- People who harness free solar energy for cooking breathe cleaner air, drink safe water, and preserve the environment
- Solar cookers work on this basic principle: Sunlight is converted to heat energy, that is retained for cooking
- Many different designs exist<sup>1)</sup>:
  - Box cookers
  - Panel cookers
  - Parabolic cookers
  - (Evacuated) tube cookers



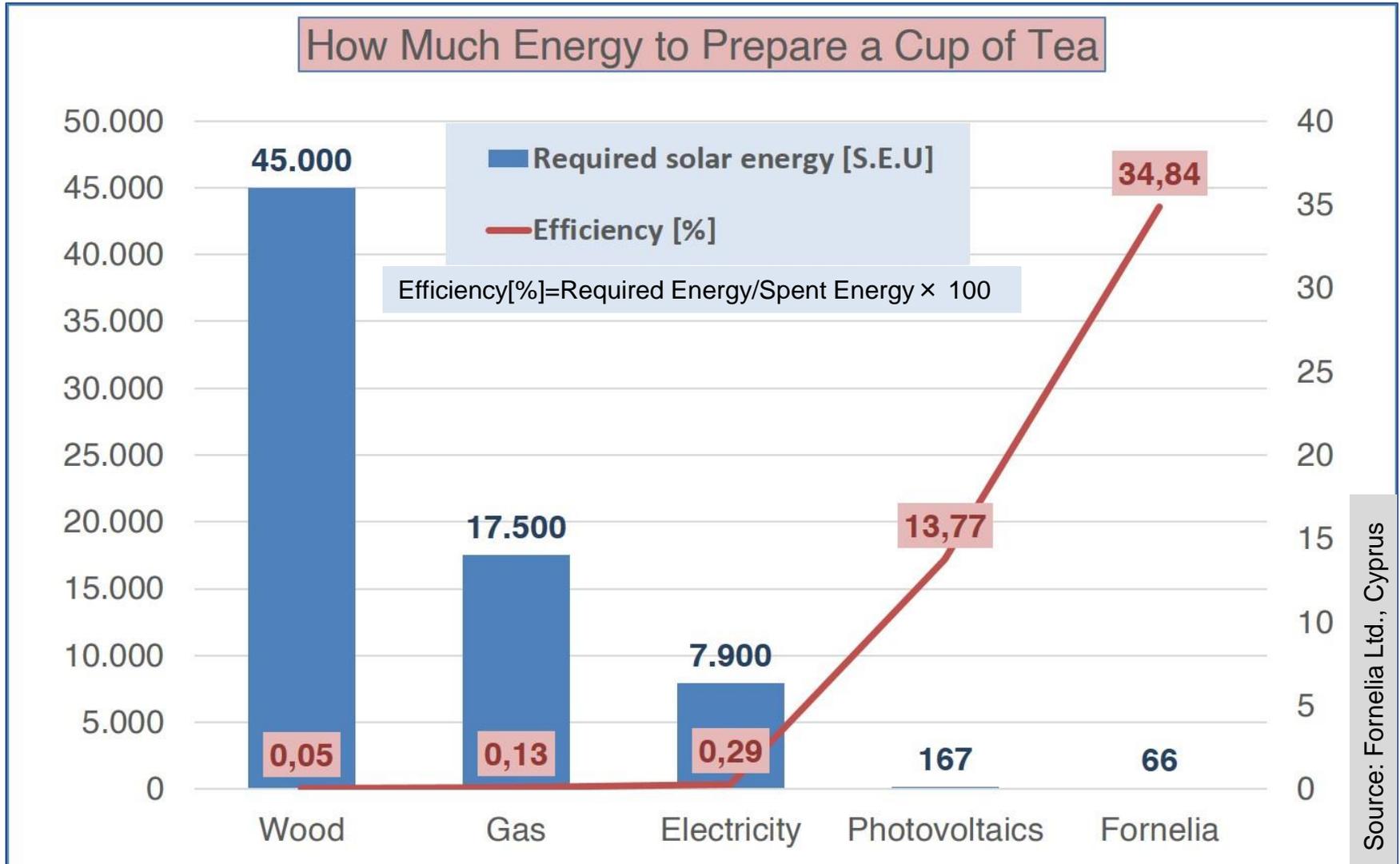
1) Source: Solar Cookers International;  
[http://solarcooking.wikia.com/wiki/Introduction\\_to\\_solar\\_cooking](http://solarcooking.wikia.com/wiki/Introduction_to_solar_cooking)

# Solar Cooking as Sustainable Alternative

- A particularly innovative type of a tube cooker has been designed and built by Savvas Hadjixenophontos of Fornelia Ltd., Cyprus (<https://fornelia.com/>)
- Different models exist; they are easily set up and operated<sup>1)</sup>
- Current retail price: € 600 per oven
- Goal: install one product assembly line in 10 developing countries over the next 3 years



# Solar Cooking as Sustainable Alternative



# Solar Cooking as Alternative?

- A number of reasons lead to still low acceptance and to the slow spread of solar cooking including:
  - High cost of solar cookers compared to firewood with a 3-stones cooking place ☹️
    - ☀️ *However, solar cookers be introduced at selected places and possibly with either government or foreign assistance. Introduction of solar cookers as a **gradual and longer-term transition process***
  - Charcoal is a massive economic sector in the region that will fight hard to remain in place ☹️
    - ☀️ *However, this completely leaves out the aspects of the overall environmental costs of using charcoal instead of solar power, which should have some weight*

# Solar Cooking as Alternative? Cont.'d

- Charcoal and firewood are “homely” to many people ☹️
  - ☀️ *However, solar power is there to use for free and does not require any collection or purchasing of wood or charcoal; this is a matter of informing and convincing people*
- Smoke leads to respiratory diseases, but helps keeping mosquitoes away ☹️
  - ☀️ *However, while this argument might not be so easily refuted, the best alternative may be other forms of mosquito repellents; such repellents provide a much more economical alternative to treating an increasing number of malaria patients*
- Low efficiency biomass stoves are certainly appreciated for providing some warmth in higher areas where the evenings are cold ☹️
  - ☀️ *However, this might be relevant primarily only seasonally*

# Conclusions

- The MENA Region is experiencing rapid population growth and significant urbanization
- Anticipated climate change and increasing pollution enhance health risks for urban citizens
- Biomass burning in open fire stoves still dominant way of producing food for African households and street vendors
- Charcoal production and use implies rapid deforestation and increasing CO<sub>2</sub> emissions
- Solar cooking offers sustainable, affordable and easy to use alternative
- The Fornelia tube cooker represents particularly innovative development

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