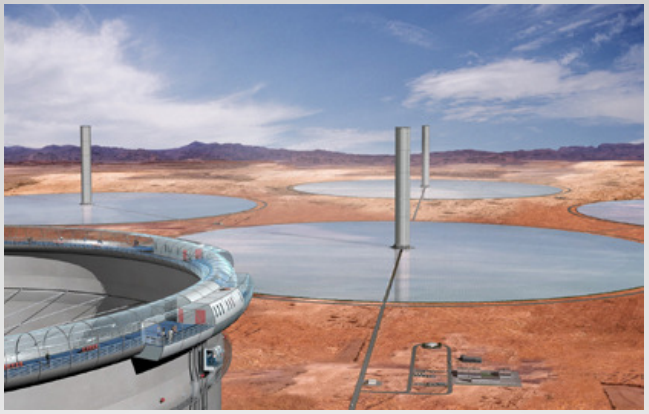

Solar Updraft Towers

CEE 491
Presentation 5
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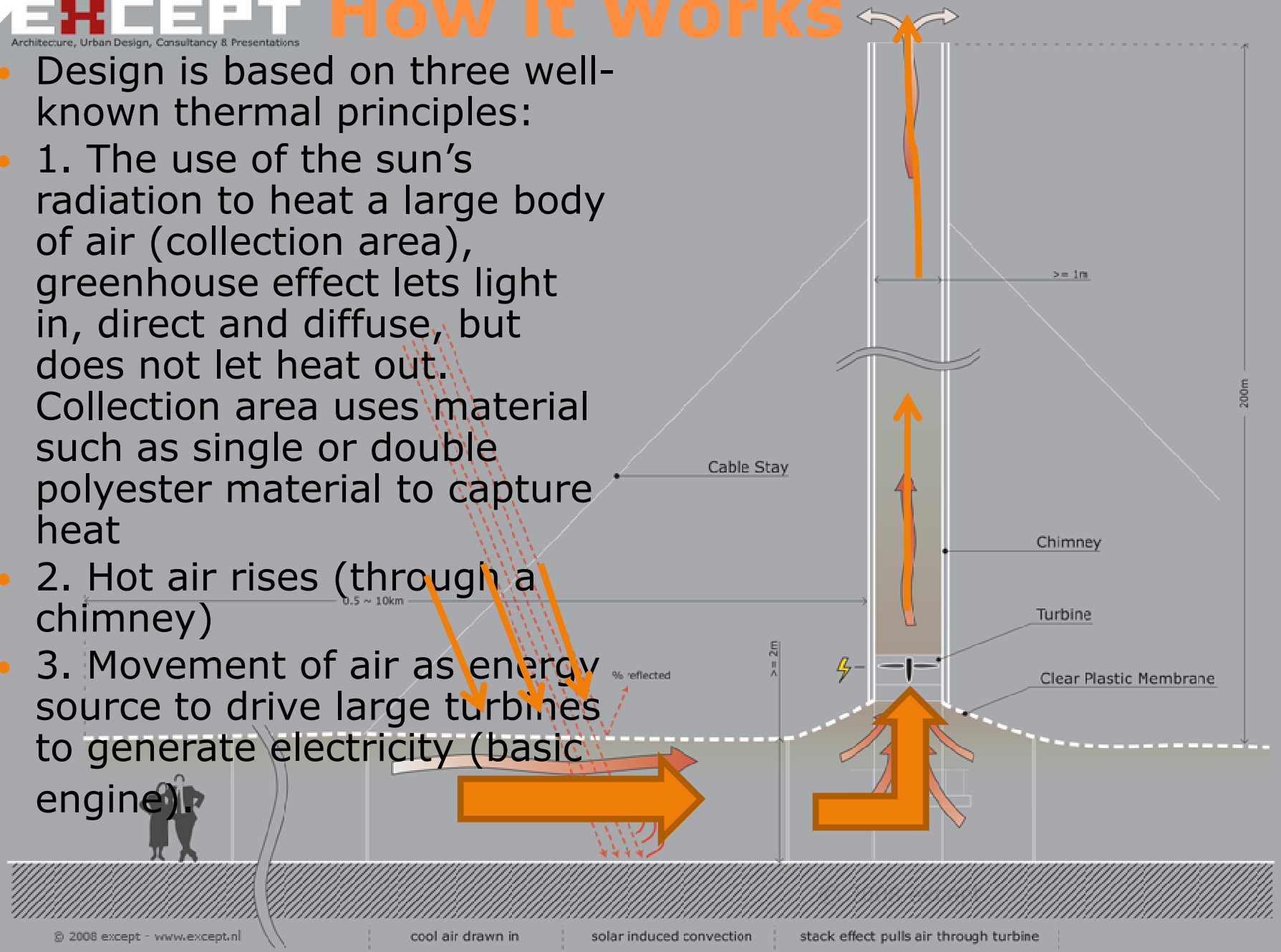
Project Description

- Produce energy by harnessing simple theory of hot air rises
- Collects hot air and uses it to spin turbines to generate electricity

How it Works

- Design is based on three well-known thermal principles:
- 1. The use of the sun's radiation to heat a large body of air (collection area), greenhouse effect lets light in, direct and diffuse, but does not let heat out. Collection area uses material such as single or double polyester material to capture heat
- 2. Hot air rises (through a chimney)
- 3. Movement of air as energy source to drive large turbines to generate electricity (basic engine).

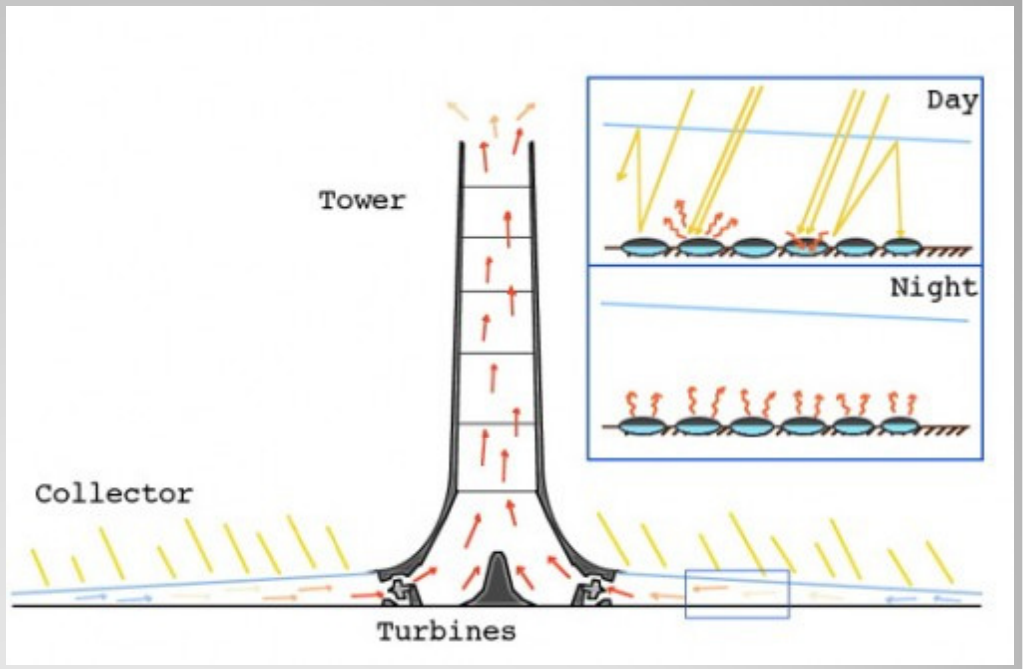


Two Primary Factors

- Size of the Collector Area
  - With a larger collector area, a greater volume of air is warmed to flow up the chimney; collector areas as large as 7 km in diameter have been considered
- Chimney Height
  - With a larger chimney height, the pressure difference increases the stack effect; chimneys as tall as 1000 m have been considered

Green Energy

- Unlimited renewable energy source in the sun
- Works 24/7
  - Ground is heated during the day and emits radiation at night to keep turbines running 24/7



- CO_2 only produced during construction of tower

History

- In 1903, Catalan Colonel of the spanish army Isidoro Cabanyes first proposed a solar chimney power plant in the magazine *La energía eléctrica*.
- One of the earliest descriptions of a solar chimney power plant was written in 1931 by a German author, Hanns Günther.
- In 1975, Robert E. Lucier applied for patents on a solar chimney electric power generator
- Between 1978 and 1981 these patents (since expired) were granted in Australia, Canada, Israel, and the USA

Prototype in Spain

- small-scale experimental model of a solar chimney power plant
- Built in 1982 under the direction of German engineer Jörg Schlaich
- Location: 150 km south of Madrid, Spain
- Funding: provided by the German government.
- Chimney Height: 195 meter and Diameter: 10 meters
- Collection area of 46,000 m (about 11 acres, or 244 m diameter)
- Maximum power output: about 50 kW.

Manzanares Solar Tower

Operation

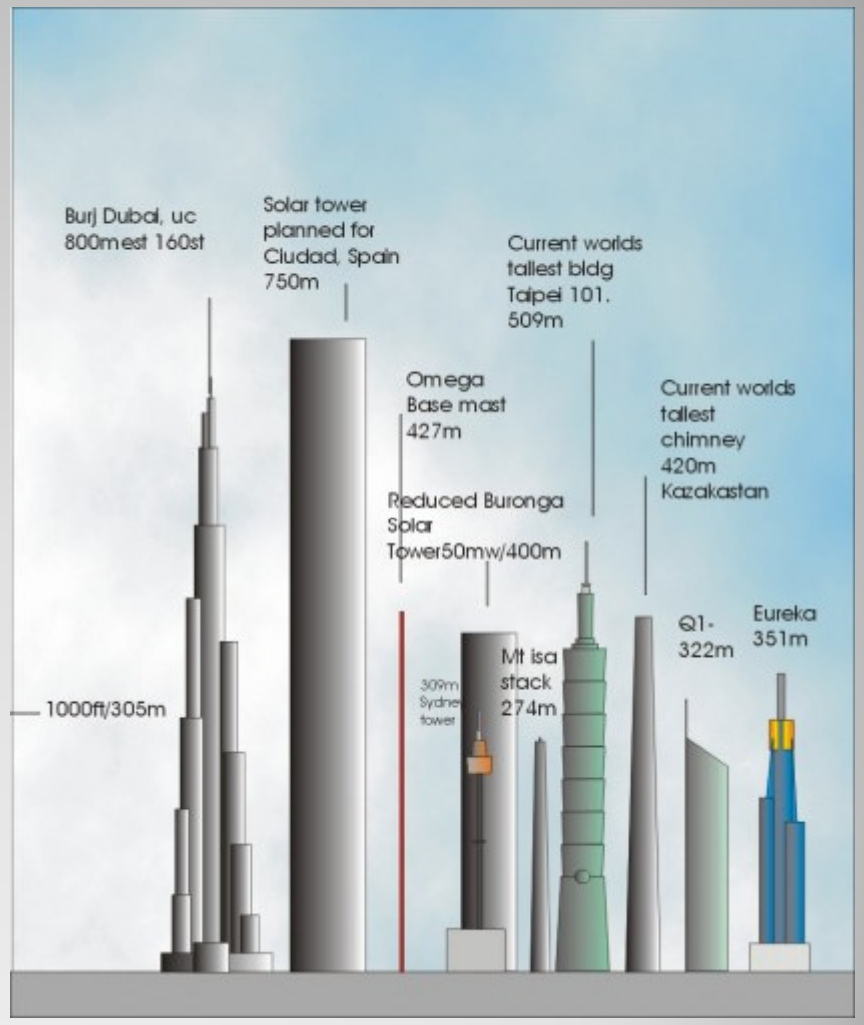
- Experimental setup that was not intended for power generation.
- Test period of three years
- Different materials were used for testing such as single or double glazing or plastic (which turned out not to be durable enough)
- One section was used as an actual greenhouse, growing plants under the glass.
- During its operation, optimization data was collected on a second-by-second basis with 180 sensors measuring inside and outside temperature, humidity and wind speed.

Technical Issues

- The plant was decommissioned in 1989.
- Operated for approximately 8 years
- Reason for break down:
  - Chimney guy rods were not protected against corrosion
  - After eight years they rusted through and broke in a storm, causing the tower to fall over.
- Cheap materials were used on purpose to see how they would perform, such as a chimney built with iron plating only 1.25 mm thin and held up with guy ropes.

Technical Issues

- Requires large amount of land
  - Not suitable for areas with high cost/acre
- High construction cost
  - Requires a large amount of initial capital
- Efficiency & Production Cost
  - Cost/kWh is higher than traditional forms of natural gas energy production



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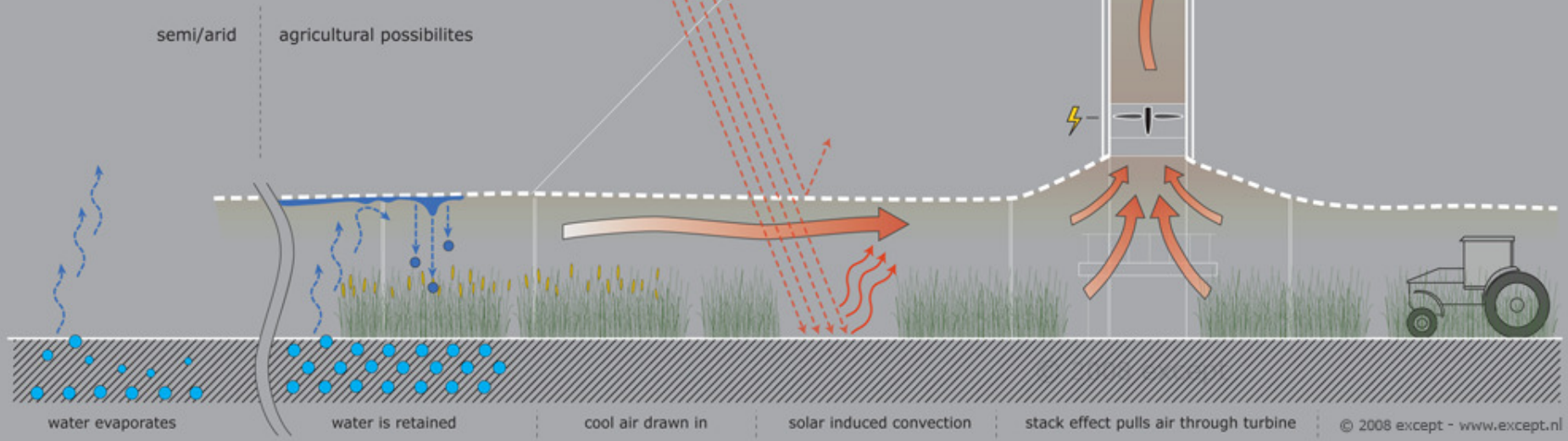
Social & Economical Benefits

- Solar tower built in the desert, instigates plant growth
- Condensation created at night enlivens the soil with moisture
- Transforms the desert into arable land
- Collection areas add water to otherwise unproductive land



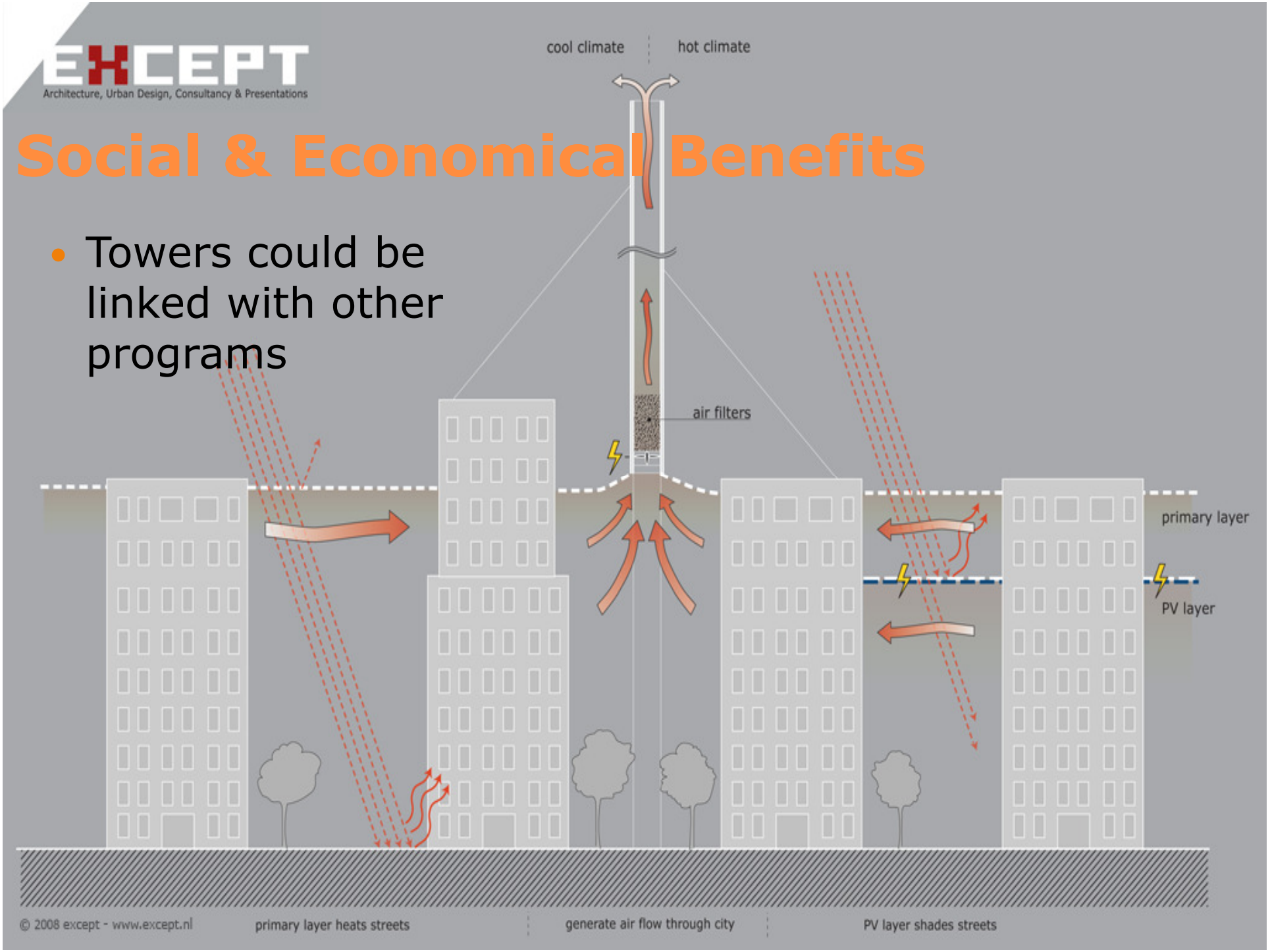
Agricultural Capital

- Clearance height underneath the collector can easily accommodate farm equipment
- Supports for the collector can be far enough apart to allow the working of the land
- Different kinds of crops can be planted depending on the local soil and moisture conditions
- Area near the center will have airflow too strong to allow plant growth.

EXCEPT
Architecture, Urban Design, Consultancy & Presentations

Social & Economical Benefits

- Towers could be linked with other programs



Cogeneration Alternatives

- A large office or residential towers could have a solar chimney at their core. Venting the exhaust heat from these additional sources into the solar chimney would increase the updraft current, producing more energy.
- Tower could be fitted with particulate, carbon and other air filters. This would cleanse air rushing through the chimney resulting in urban air quality improvement, while at the same time generating some electricity. Systems like these would be very suitable for highly polluted cities.

Social & Economical Benefits

- One 200MW power station will provide enough electricity for around 200,000 typical households
- will reduce production of over 900,000 tons of greenhouse gases annually

Cost

- Costs lie mainly in construction
- Little operation cost (free ‘fuel', little maintenance and personnel required),
- Cost per energy:
  - largely determined by interest rates and years of operation
  - Varies from 5 eurocent per kWh for 4% and 20 years to 15 eurocent per kWh for 12% and 40 years, (*1 Euro Cent* is 0.6452 *US Cent)*
  - By comparison, a normal gas operated power plant can produce electricity for as little as 5 euroct/kWh

Feasibility

- Requires high capital cost
- Relatively low operating cost
- An inefficient but cheap plant would be ideal for third world countries with lots of space
- The method is inefficient for land use but very efficient economically because of the low operating cost.
- For a commercial plant, a reinforced concrete tower would be a better choice.

Comparison of Variations of Solar Power: Solar Power Tower vs. Solar Updraft Tower

Similarities

- Utilize the sun to create energy
- Require large amounts of land
- Relatively low maintenance cost
- Little to none fuel costs

Differences

- Solar Updraft Tower utilizes hot air to power turbines
- Doesn’t require water or mirrors to operate
- Solar Power Tower utilizes an array of heliostats, flat, movable mirrors to turn water into steam to power turbines

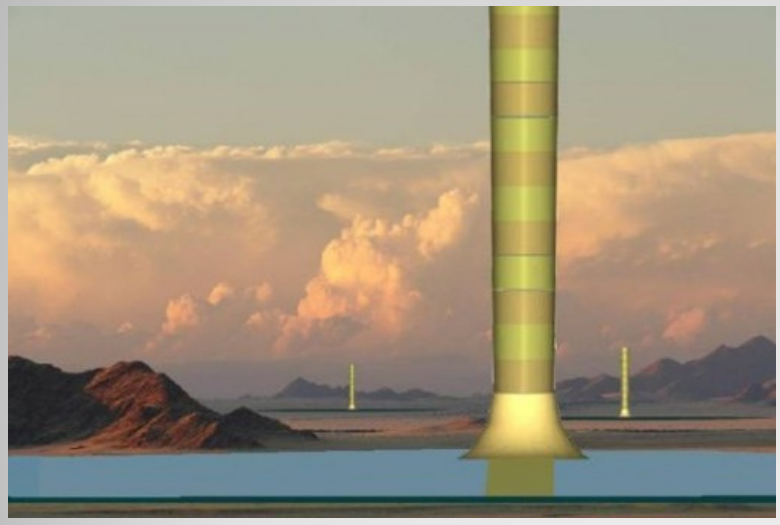
Comparison

- Solar Power Tower

- Solar Updraft Tower

In the Works

- Proposed locations:
  Australia, China, Spain



Australia

- Renewable energy company, EnviroMission set to build tower in Australia
- Australia is a country that is currently powered by cheap coal.
- Collection area: 65m diameter (approximately 6 times larger than central park)
- Energy production: 200 MW

Thank You