OFF-GRID SAFARI PARK IRAN

Passive techniques to reduce the energy demand

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PROBLEM STATEMENT

- Off-grid safari park
- Energy needed for facilities

GOAL

Calculate energy demand Negin Safari Park

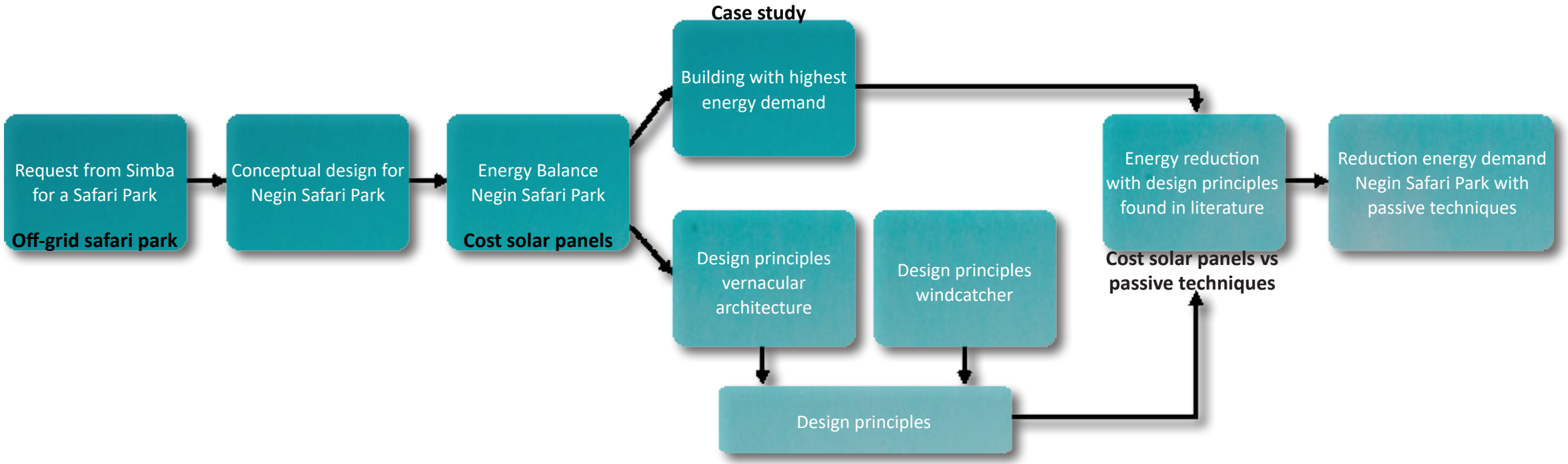
Generate energy on site

Energy balance

Reduce energy demand

RESEARCH

To what extend can passive cooling techniques reduce the energy demand of Negin Safari Park in Iran?



CONCEPTUAL DESIGN
NEGIN SAFARI PARK

LOCATION

Fars region Iran

15-20 minutes from Fīrūzābād

Nearby Qashqai village

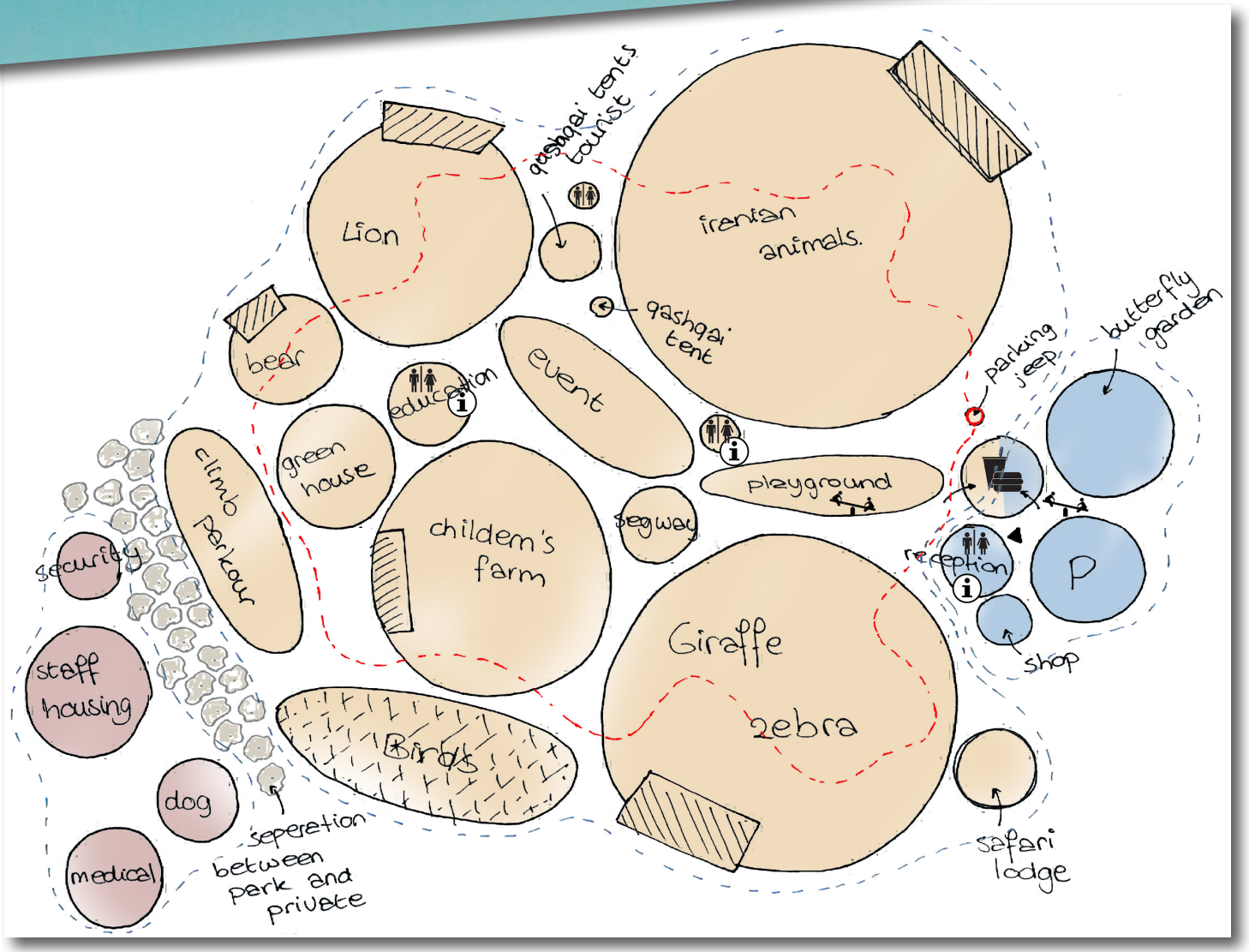
Small to medium sized trees

CONCEPTUAL DESIGN

27.926 day visitors

2.772 night visitors

- Public
- Semi-Public
- Private



CONCEPTUAL DESIGN

- Caged animals
- Facilities for tourist and education

ENERGY
NEGIN SAFARI PARK

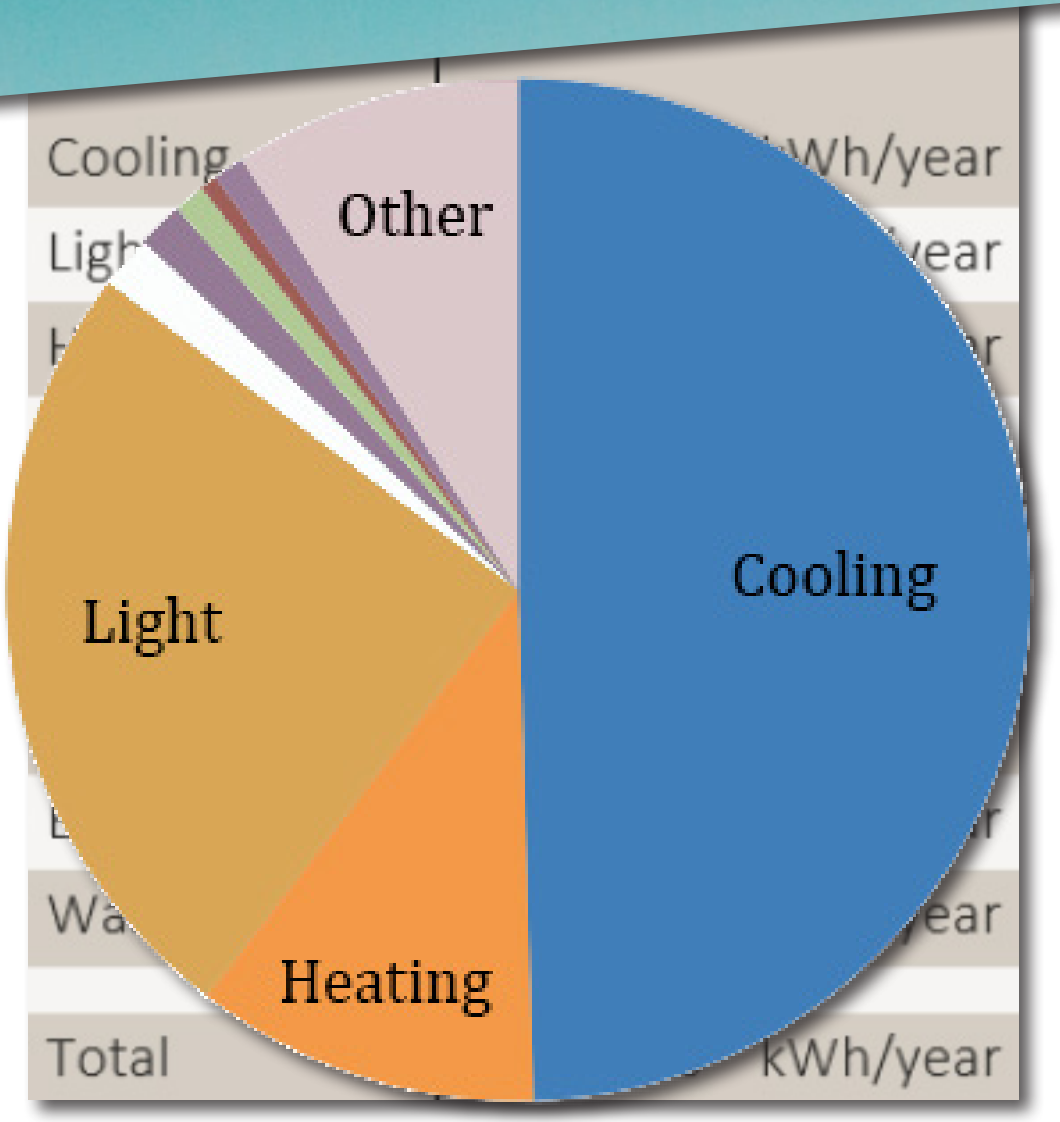
ENERGY DEMAND

		Functions		m^2
1	Heating/cooling, light, cooking, washing and entertainment	Restaurant Tourist Accommodations	Staff accommodation Housing for overnight staff	1150
2	Heating/cooling and light	Butterfly Garden Shop + Weaving area Reception Toilets First Aid Post Information Desk Educational Centre Greenhouse	Quarantine Clinic/medial Area Dog training centre Dog housing Public adoption/rehabilitation Staff office Watch tower and security Administrations office	4200
3	Light and small amount of cooling	Shelter Giraffe, zebra, gazelle Shelter Urial, wild goat, wild ass	Shelter lion Shelter brown bear	3400
4	Light	Small Playground Parking area Event Area	Playground Practice area Paths	12.000

ENERGY DEMAND

Cooling	742.100	kWh/year
Light	372.385	kWh/year
Heating	162.700	kWh/year
Other	136.320	kWh/year
Fridge	24.955	kWh/year
Water heating	21.390	kWh/year
Cooking	14.260	kWh/year
Entertainment	14.260	kWh/year
Washing	7.130	kWh/year
Total	1.495.500	kWh/year

ENERGY DEMAND



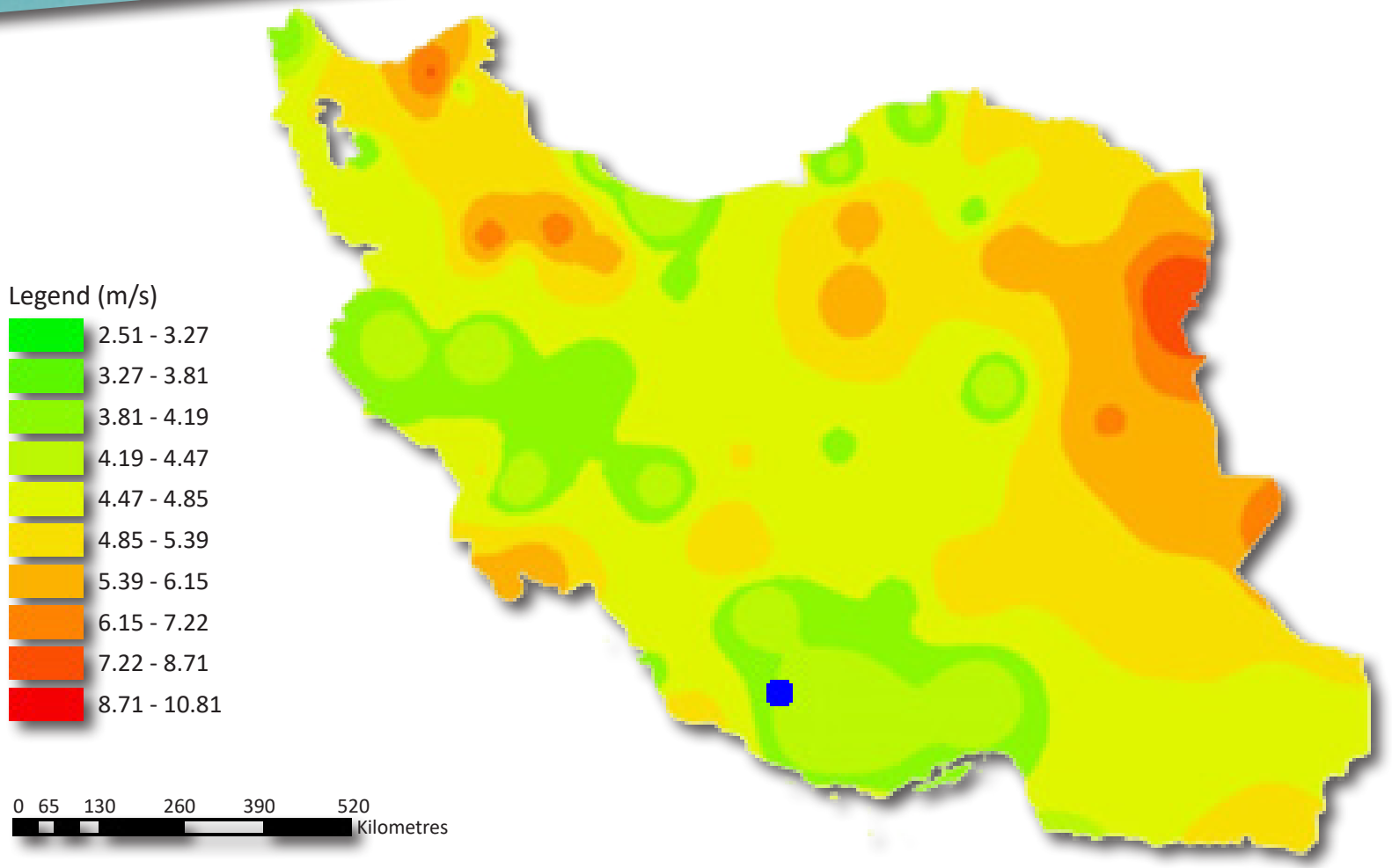
ENERGY PRODUCTION

Wind Energy

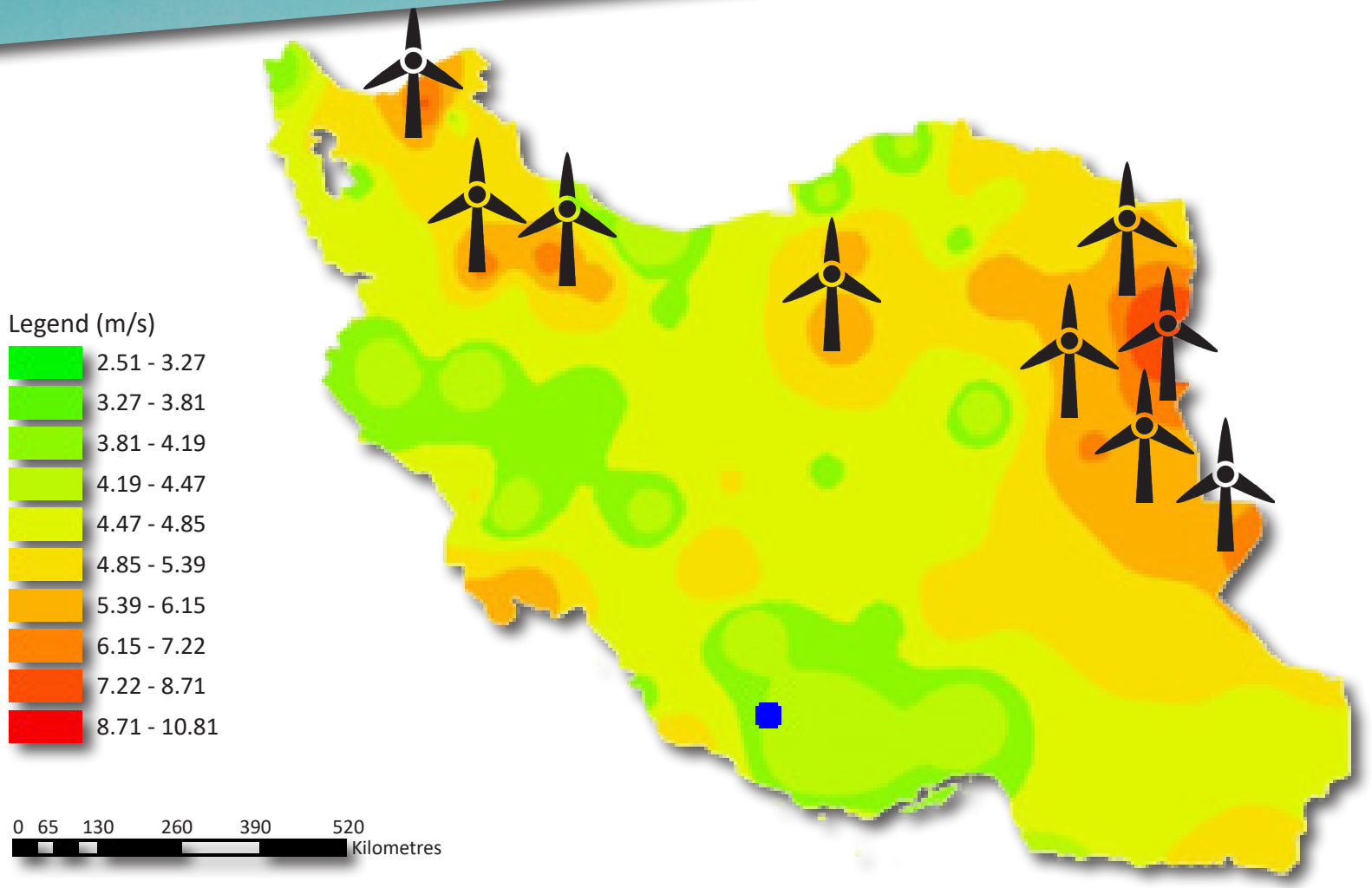
Solar Energy

Biomass

WIND ENERGY


Legend (m/s)
2.51 - 3.27
3.27 - 3.81
3.81 - 4.19
4.19 - 4.47
4.47 - 4.85
4.85 - 5.39
5.39 - 6.15
6.15 - 7.22
7.22 - 8.71
8.71 - 10.81
0 65 130 260 390 520
Kilometres

WIND ENERGY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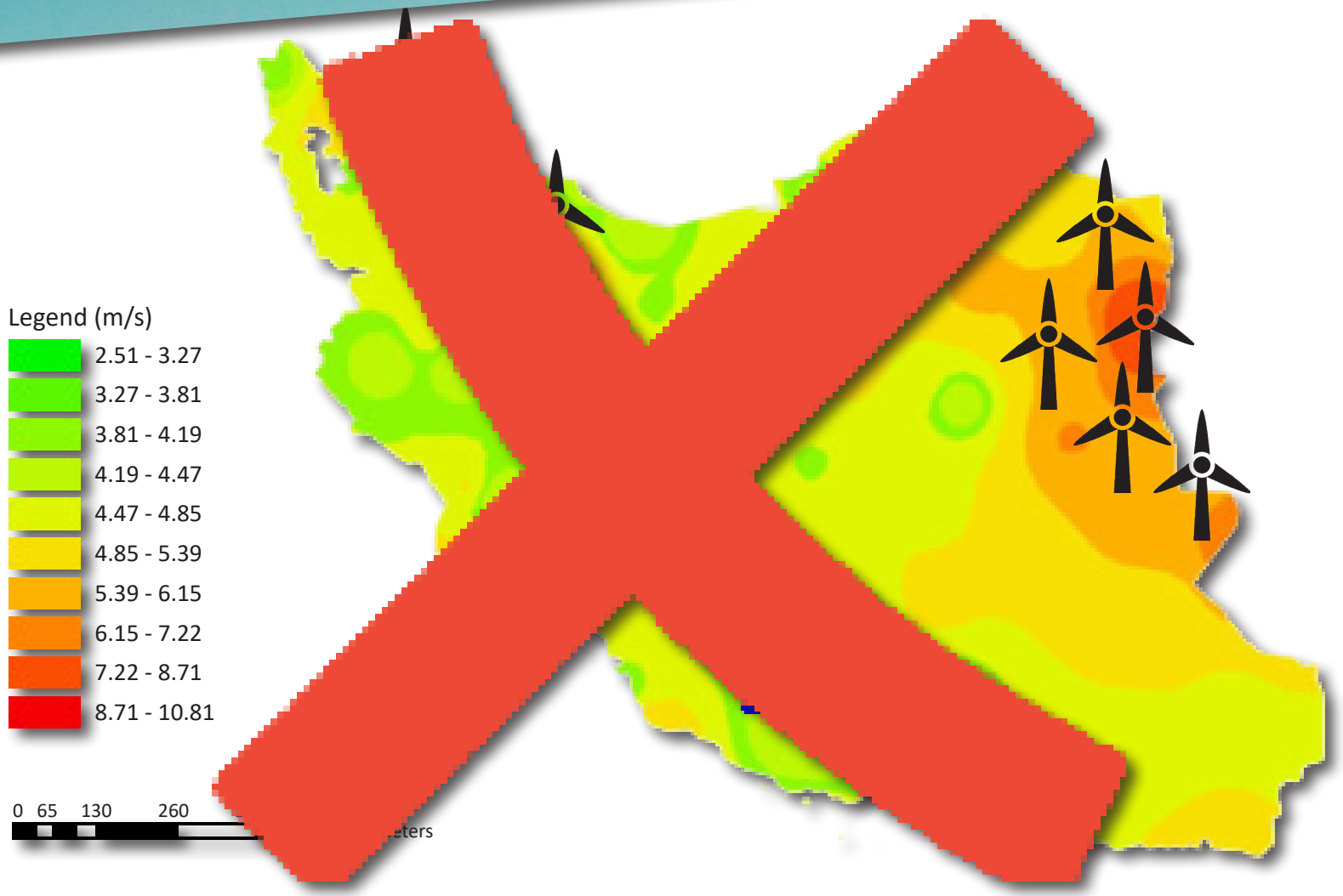
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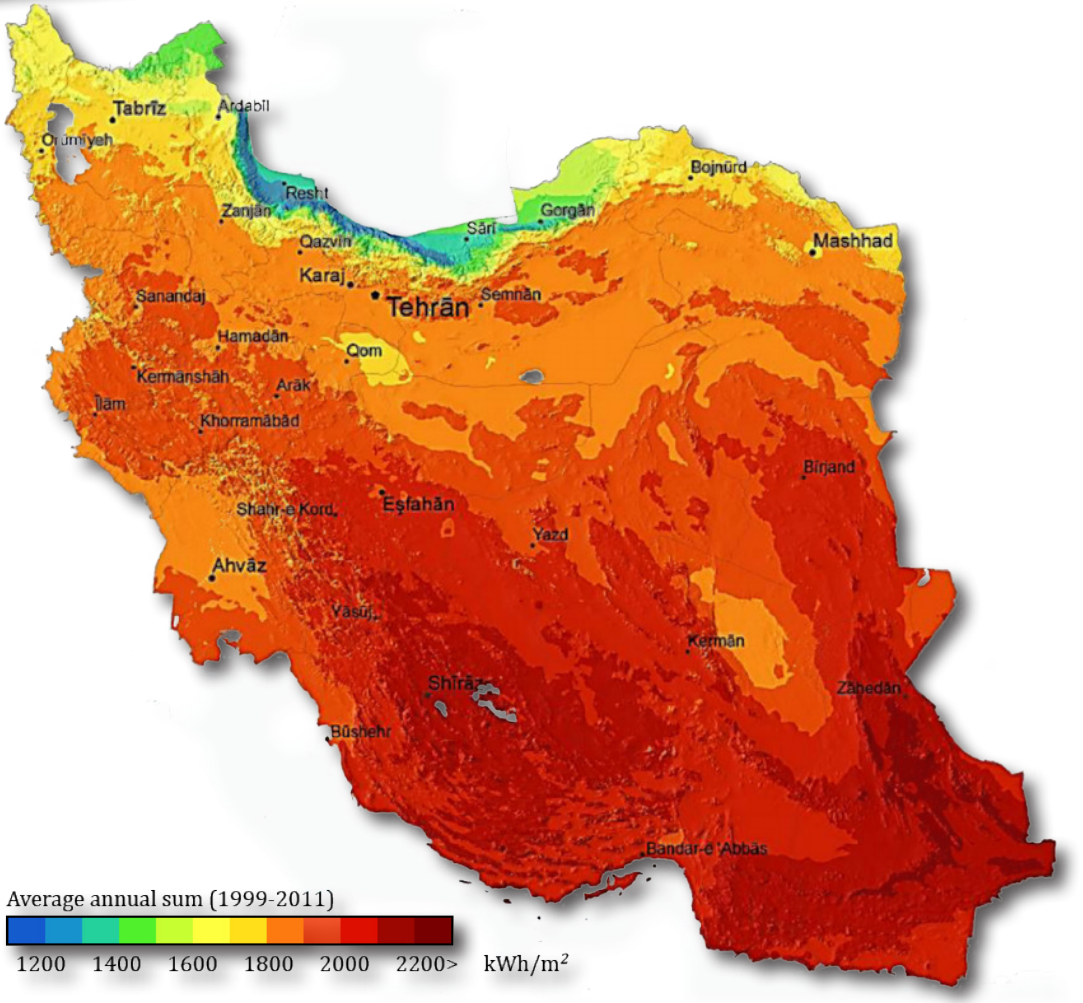
SOLAR ENERGY



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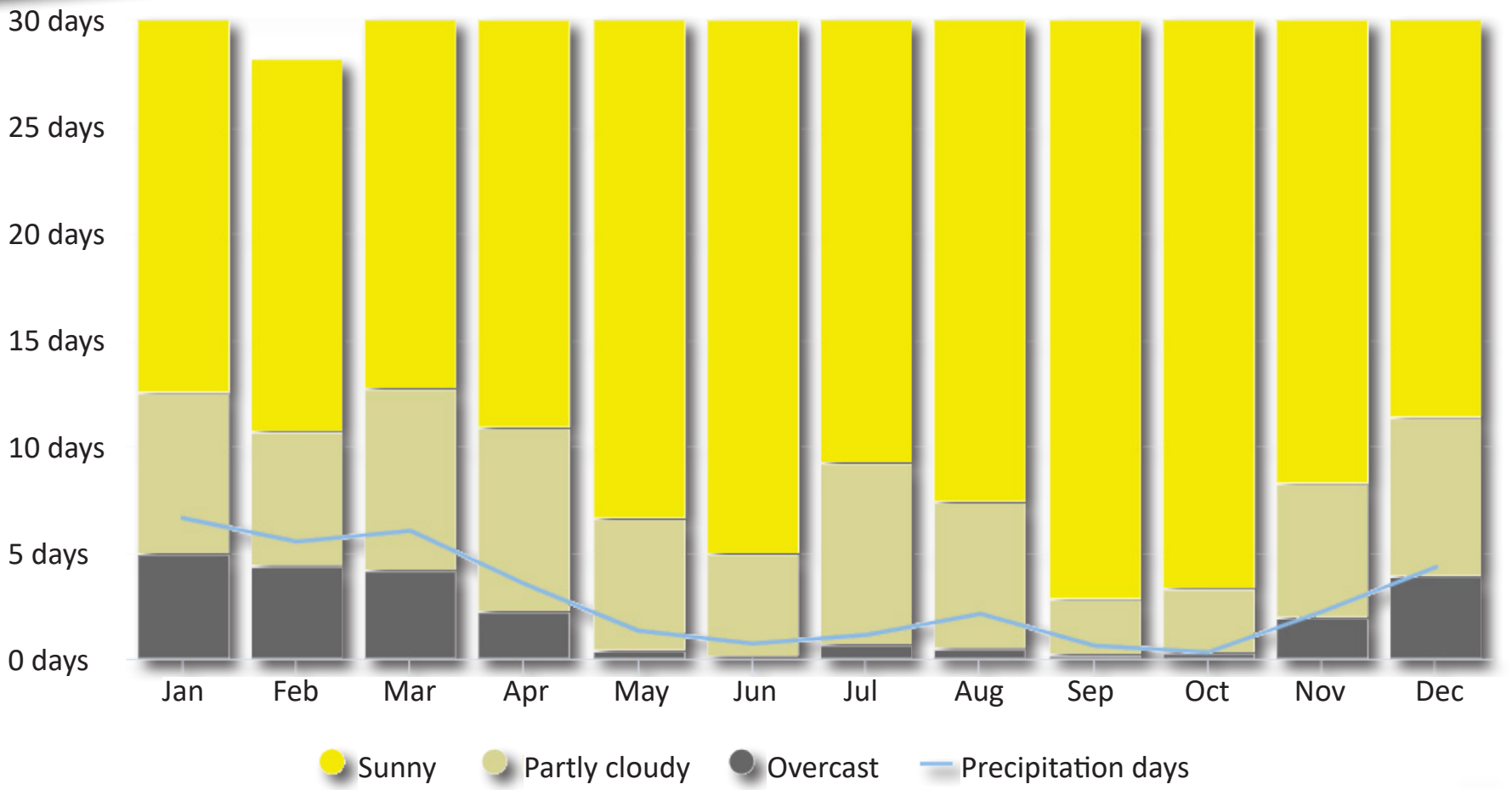

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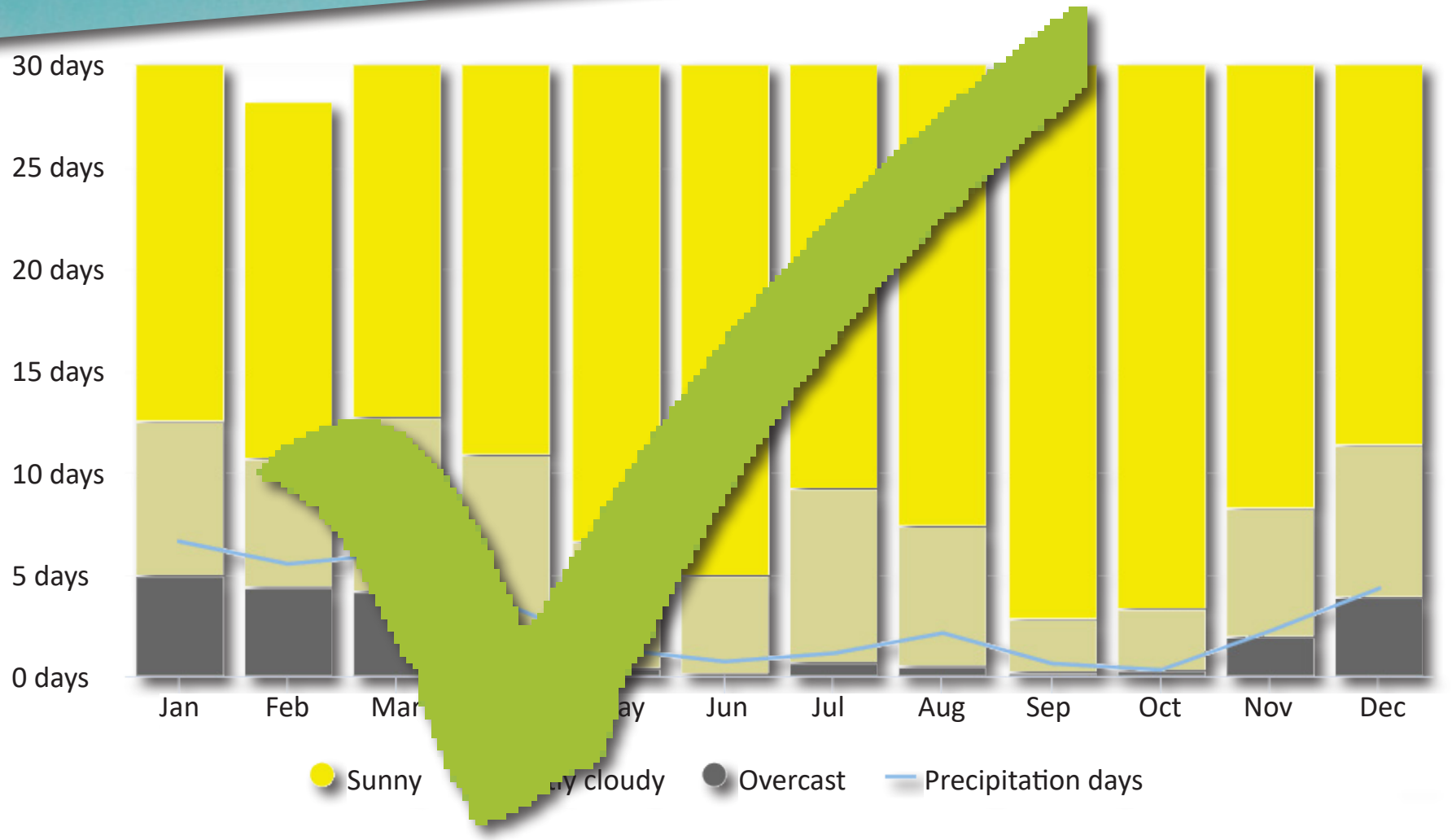
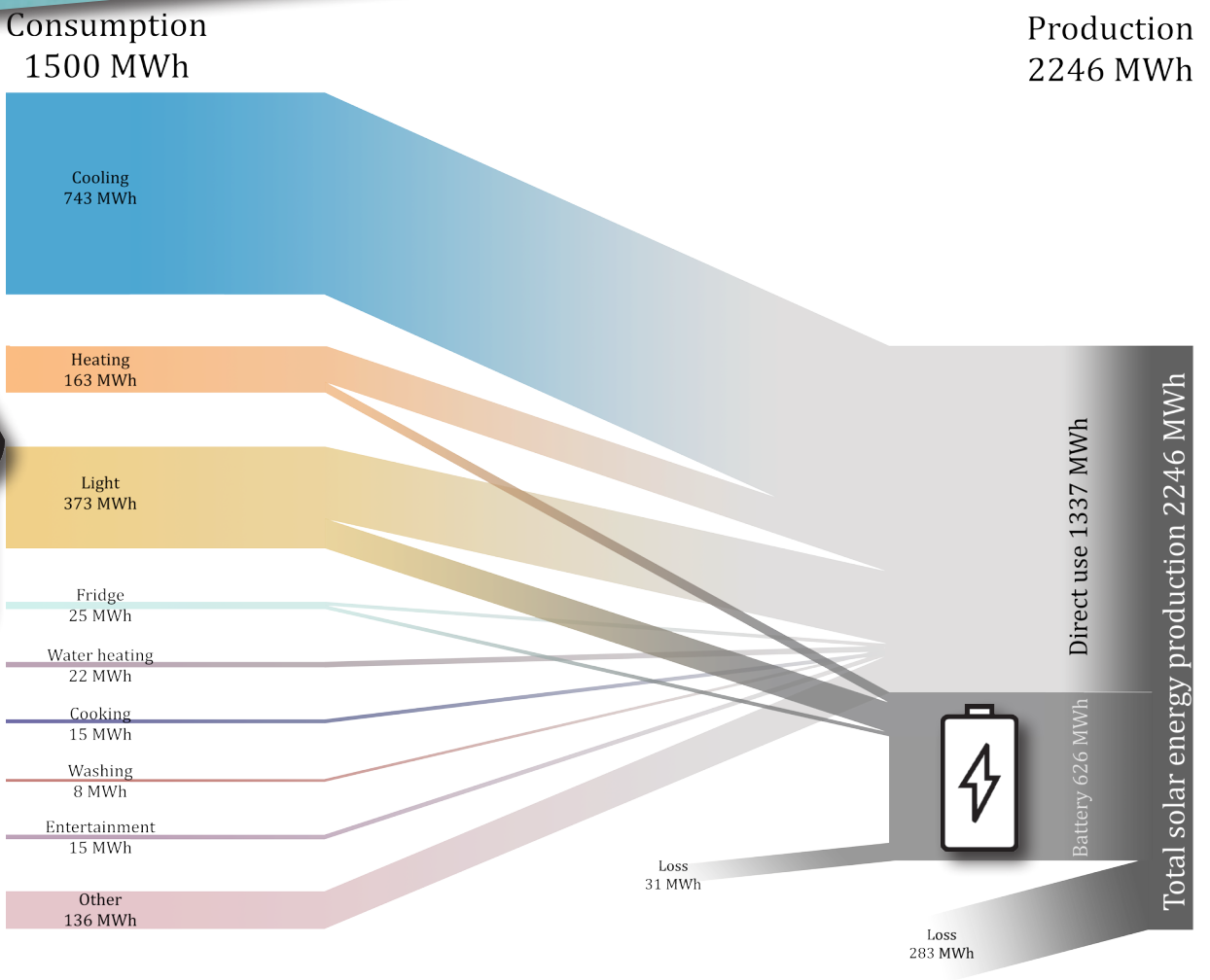
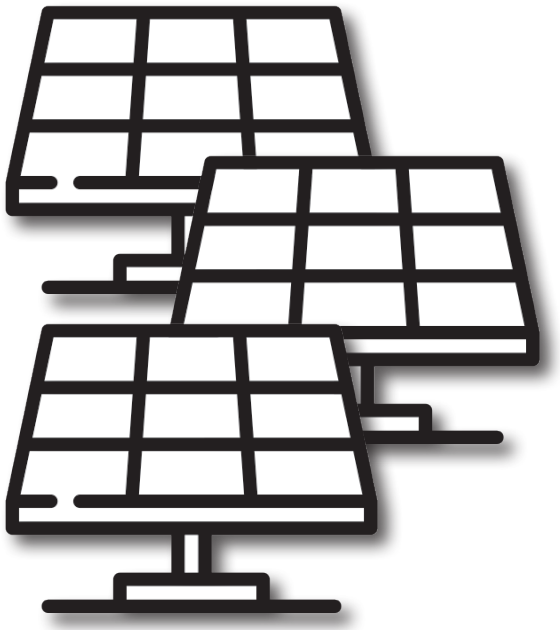


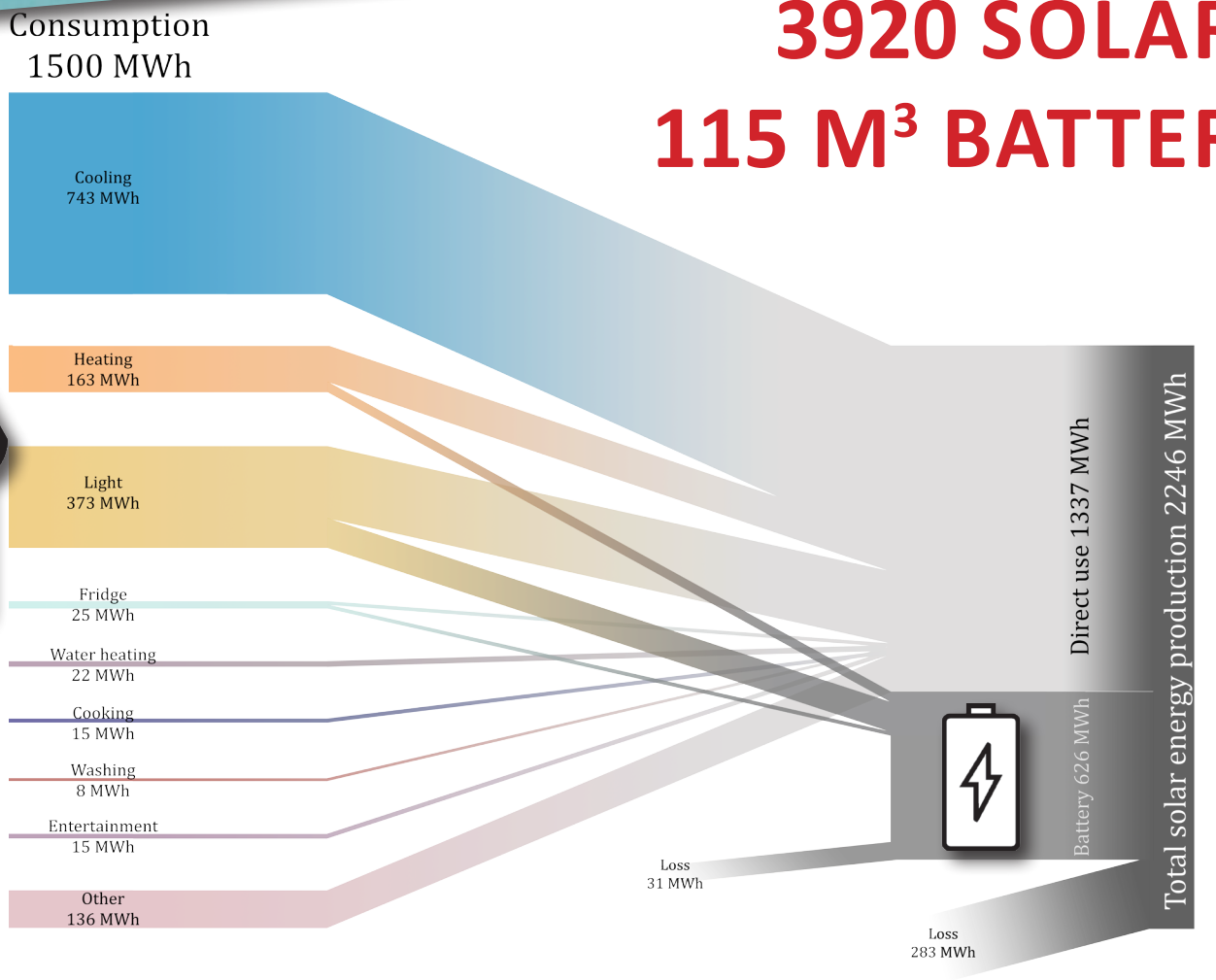
SOLAR ENERGY PRODUCTION

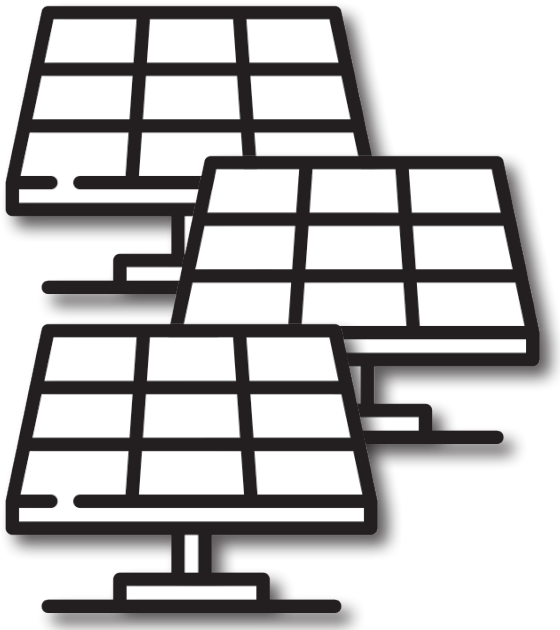




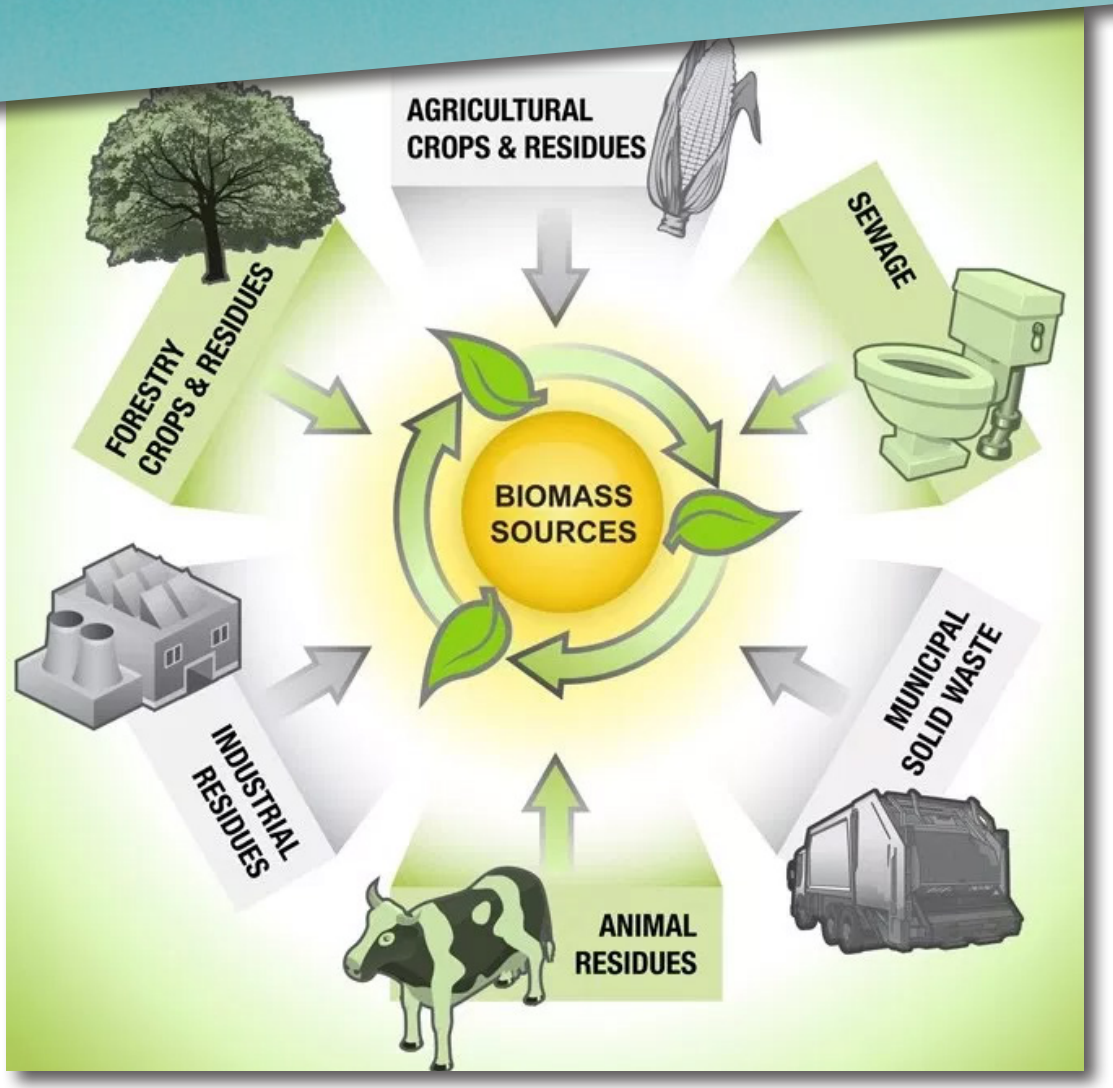
SOLAR ENERGY PRODUCTION

3920 SOLAR PANELS
115 M³ BATTERY STORAGE





BIOMASS ENERGY PRODUCTION



BIOMASS ENERGY PRODUCTION

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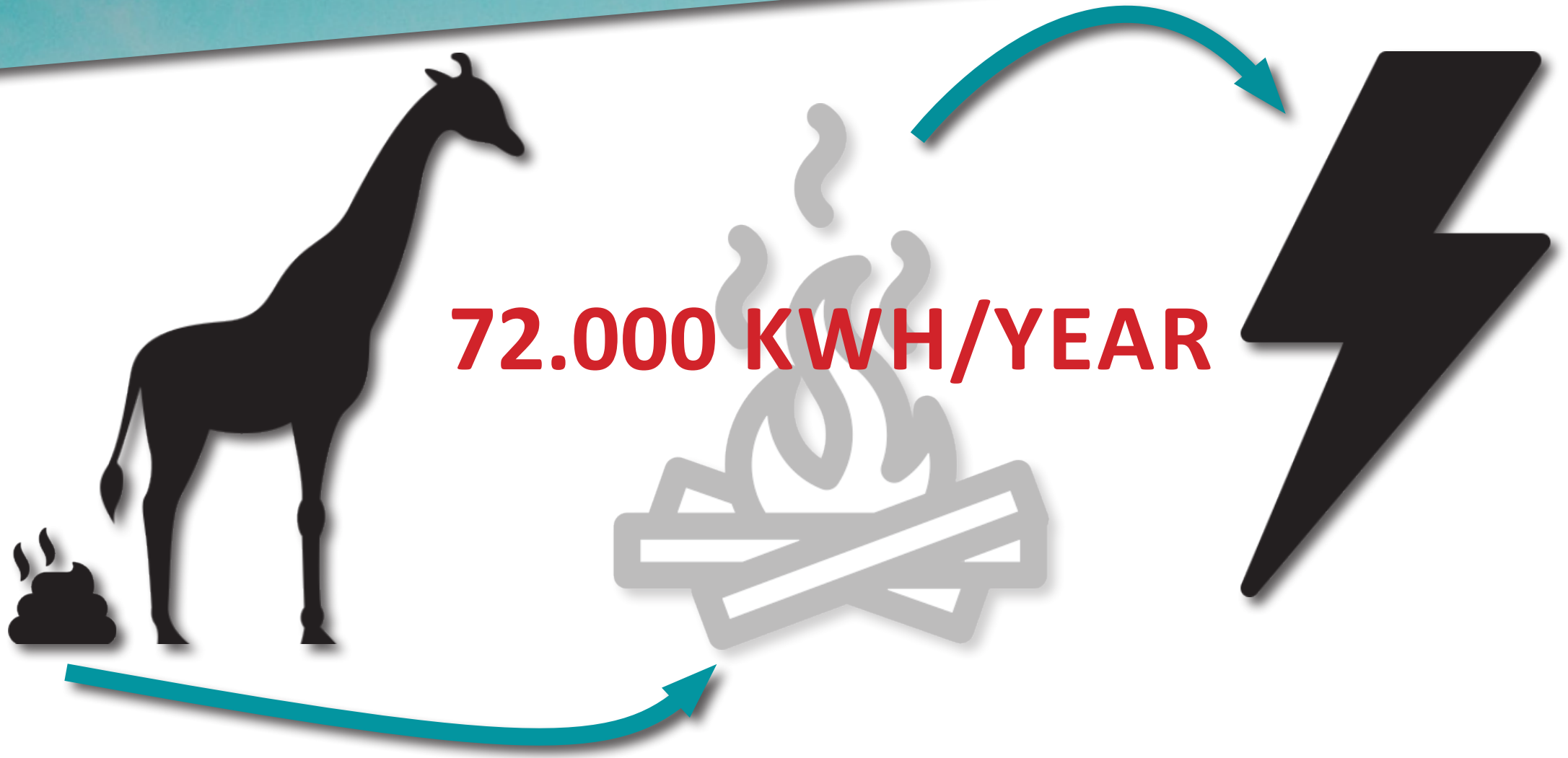
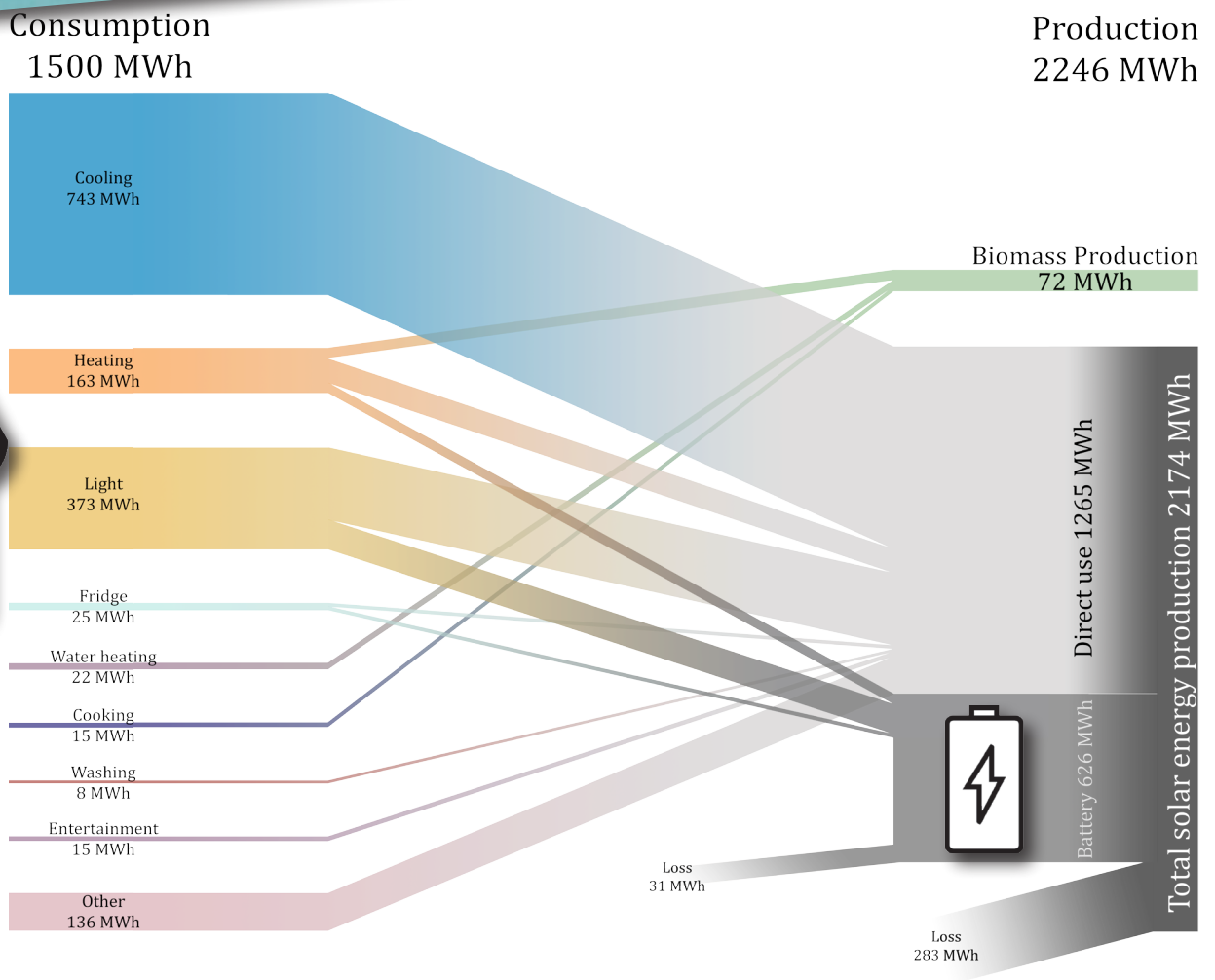
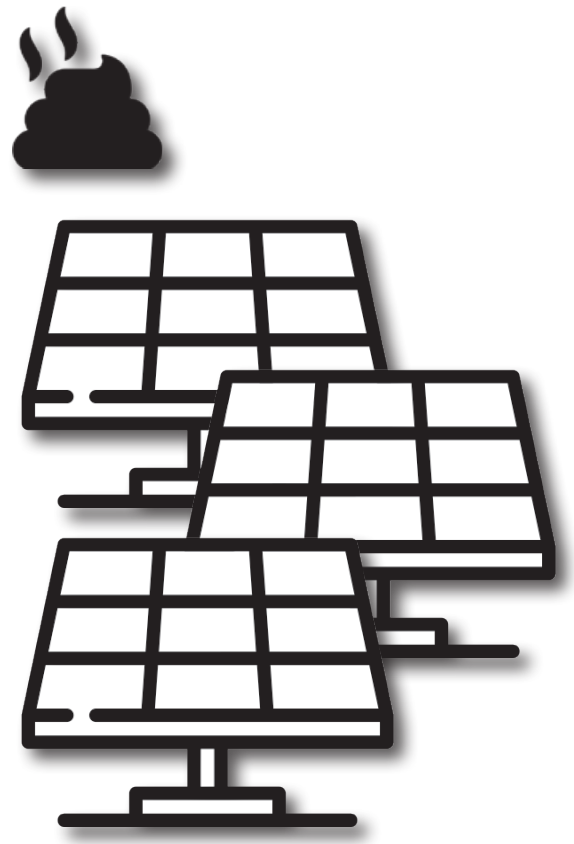


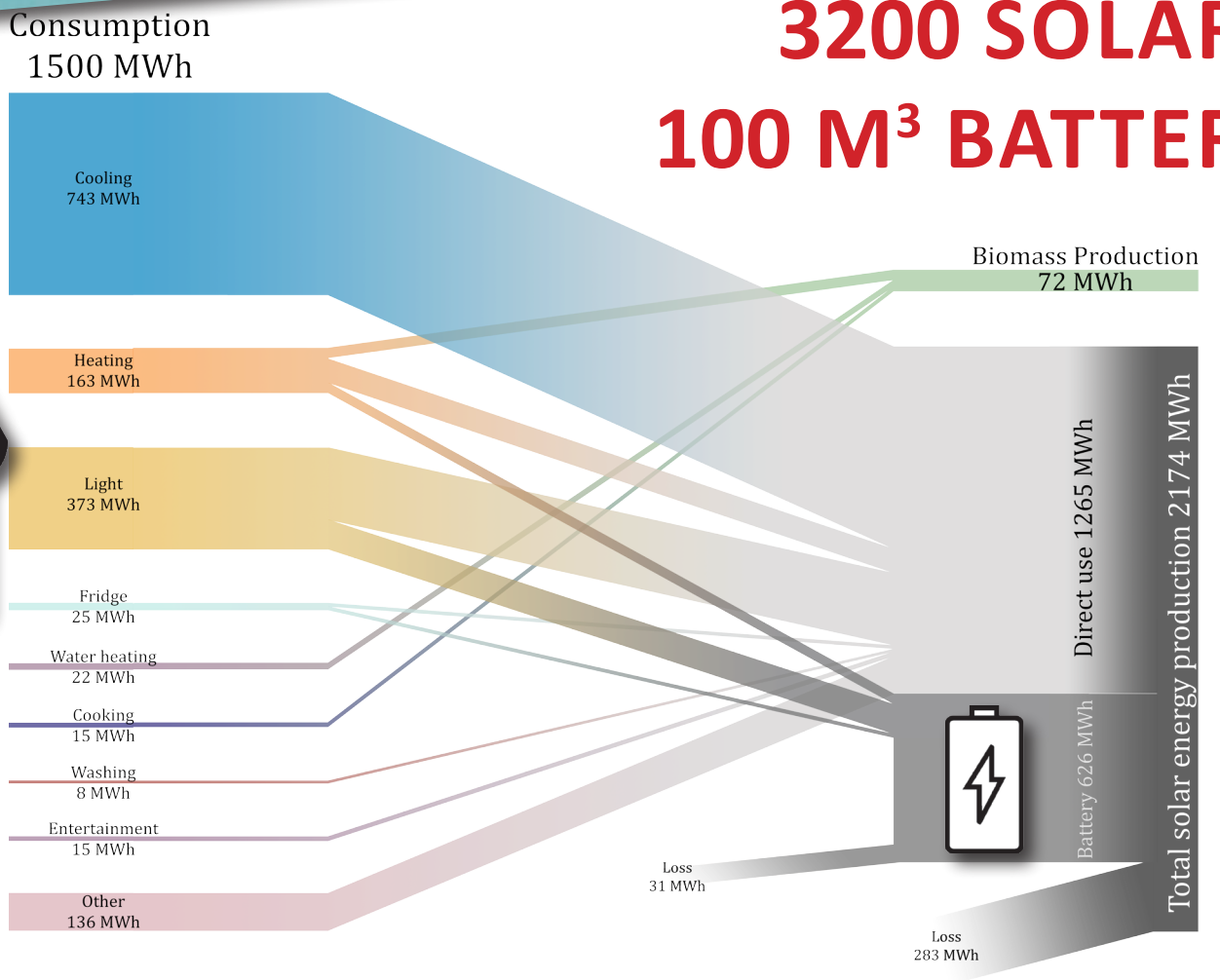
ENERGY BALANCE

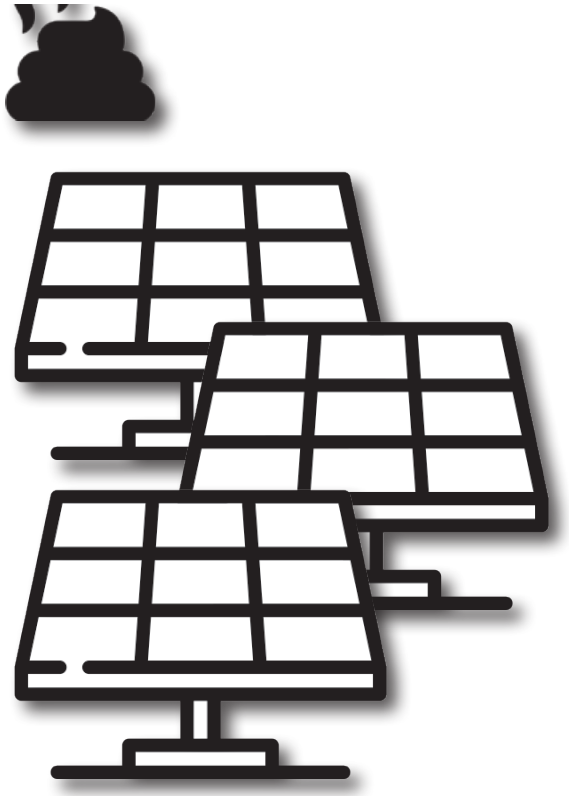




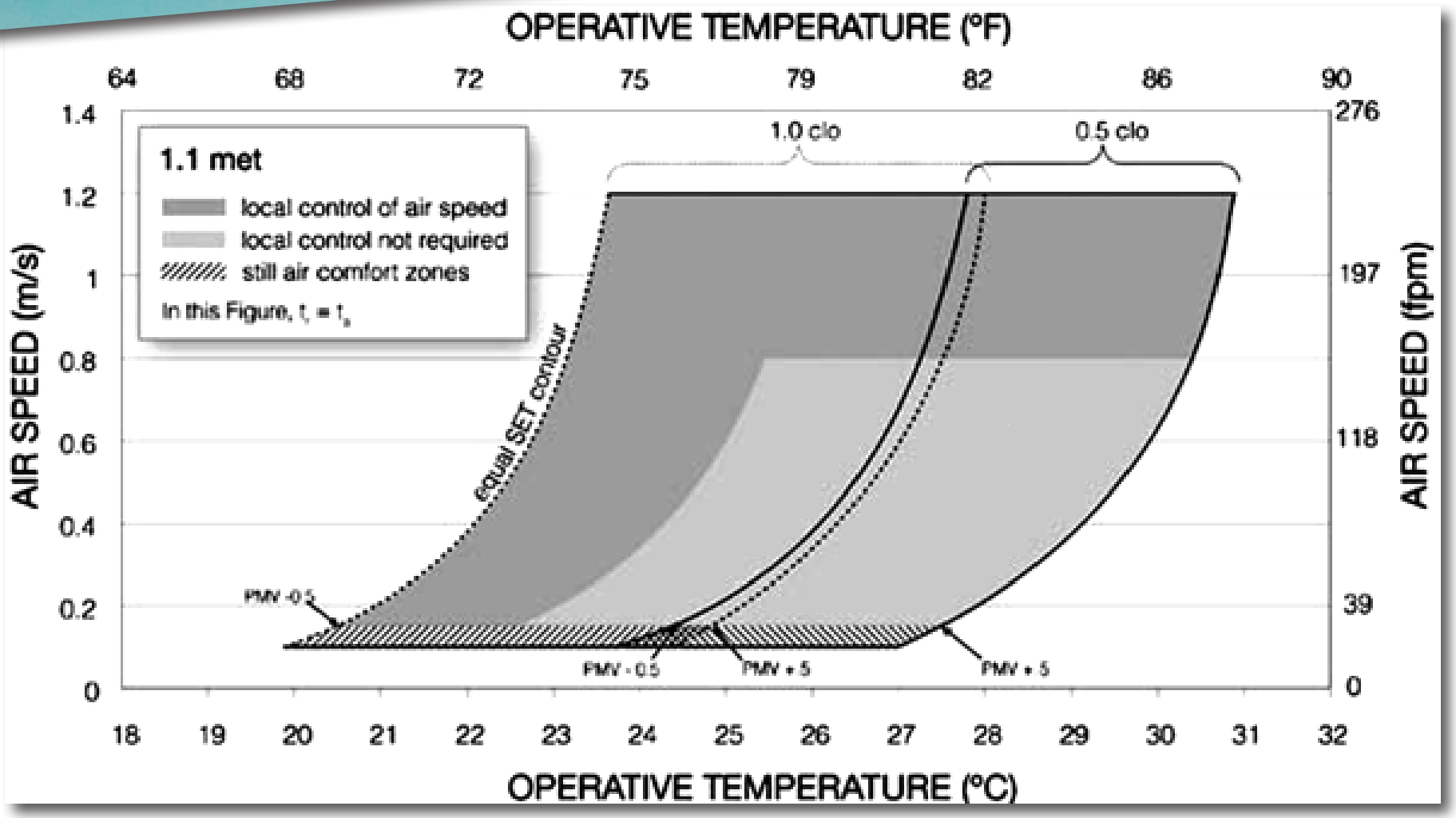
ENERGY BALANCE

3200 SOLAR PANELS
100 M³ BATTERY STORAGE





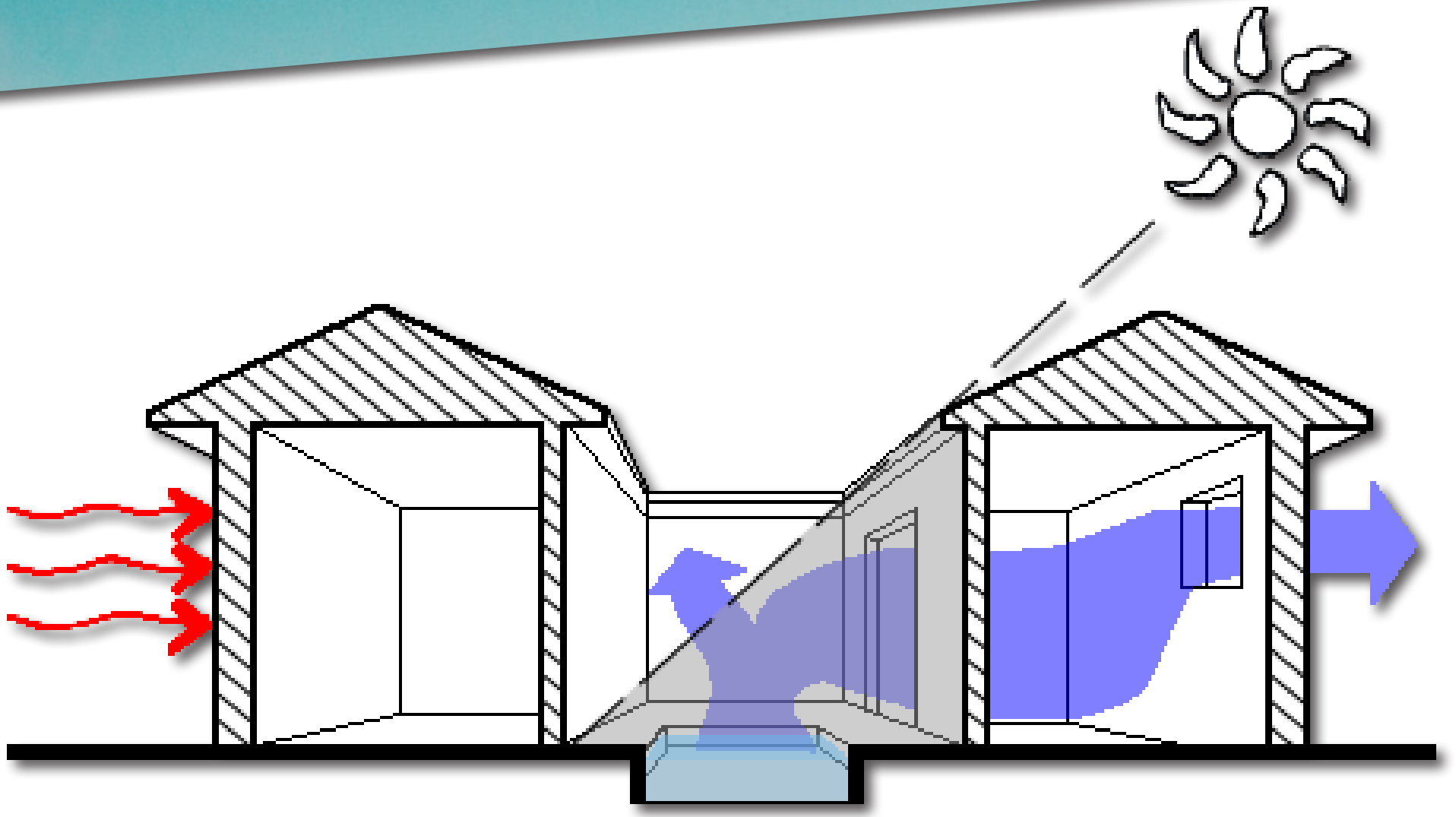
TEMPERATURE BUILDING



VERNACULAR ARCHITECTURE MIDDLE EAST

COURTYARD

COURTYARD



DOMED ROOF

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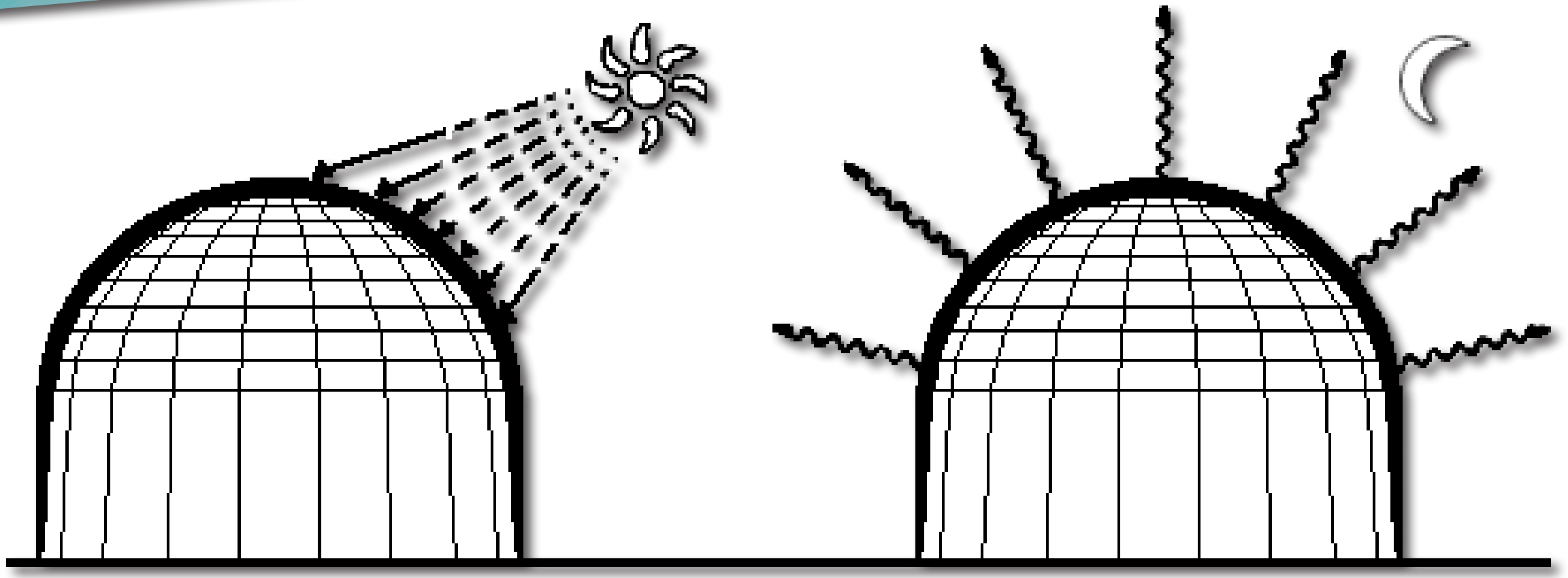
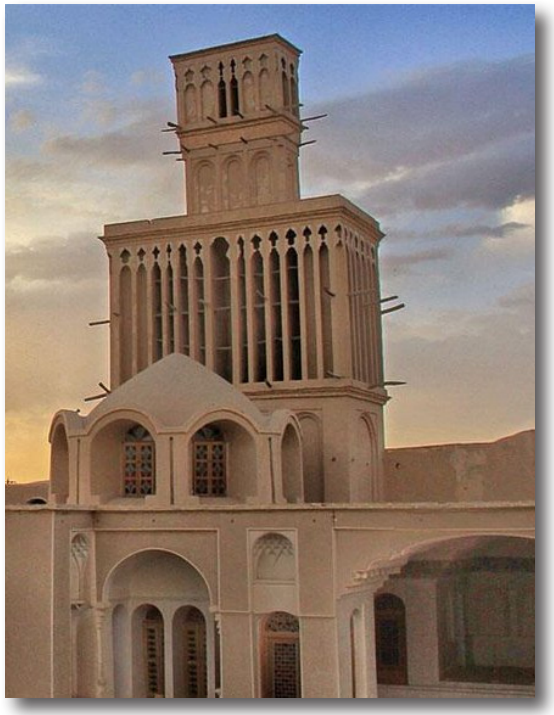
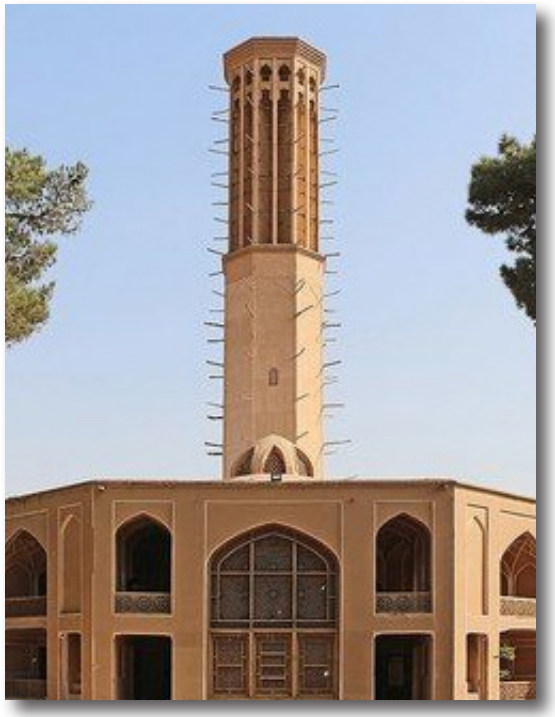


FACADE

WINDCATCHER

WINDCATCHER





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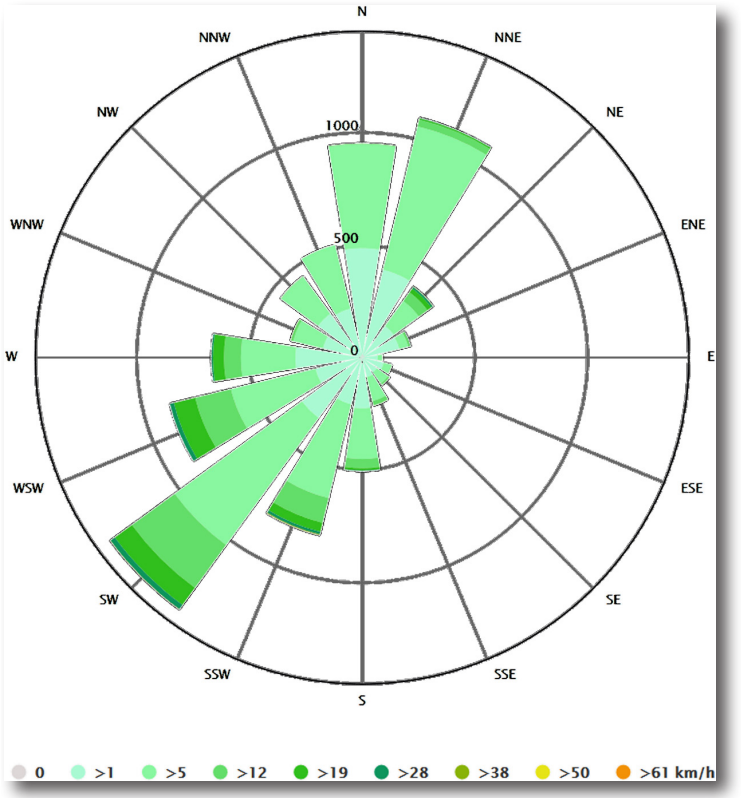
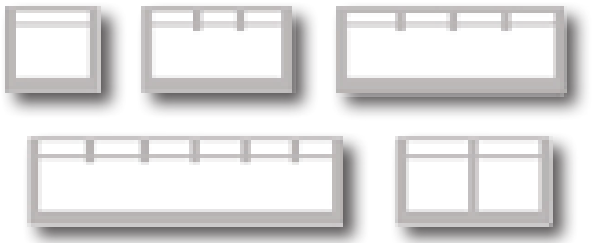
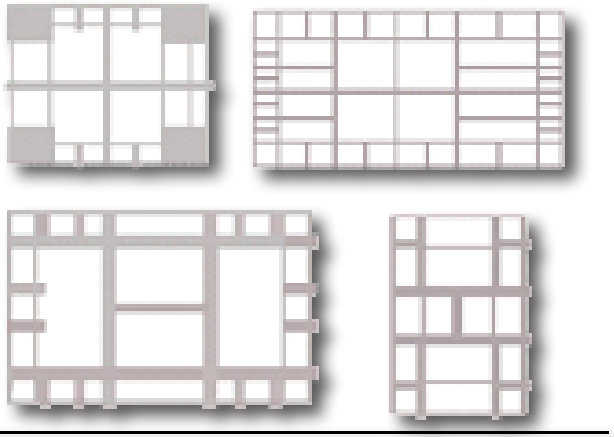


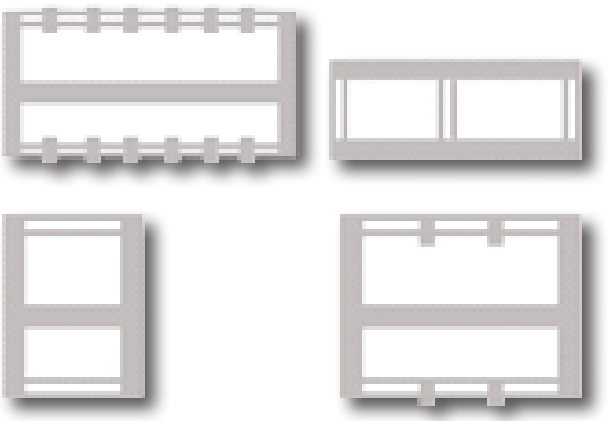
One sided windcatcher



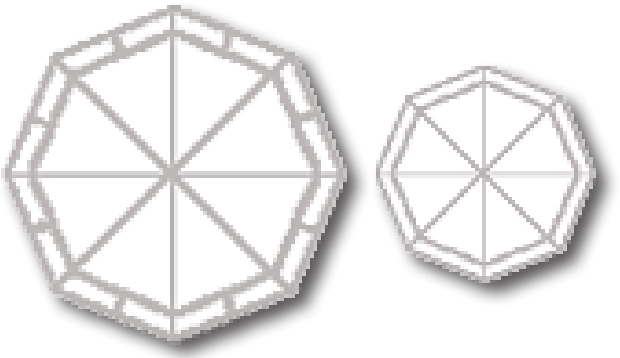
Four sided windcatcher



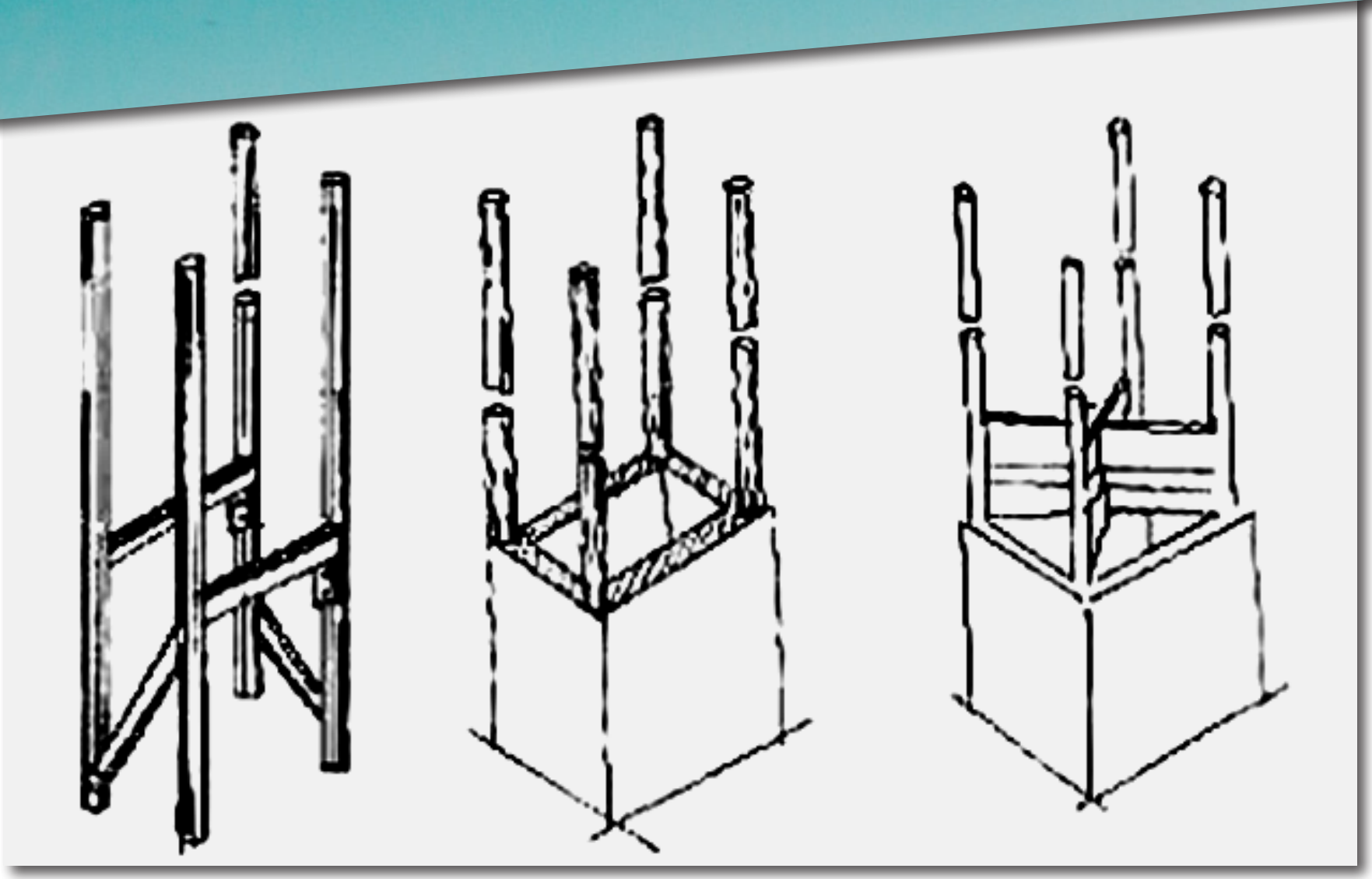
Two sided windcatcher



Eight sided windcatcher

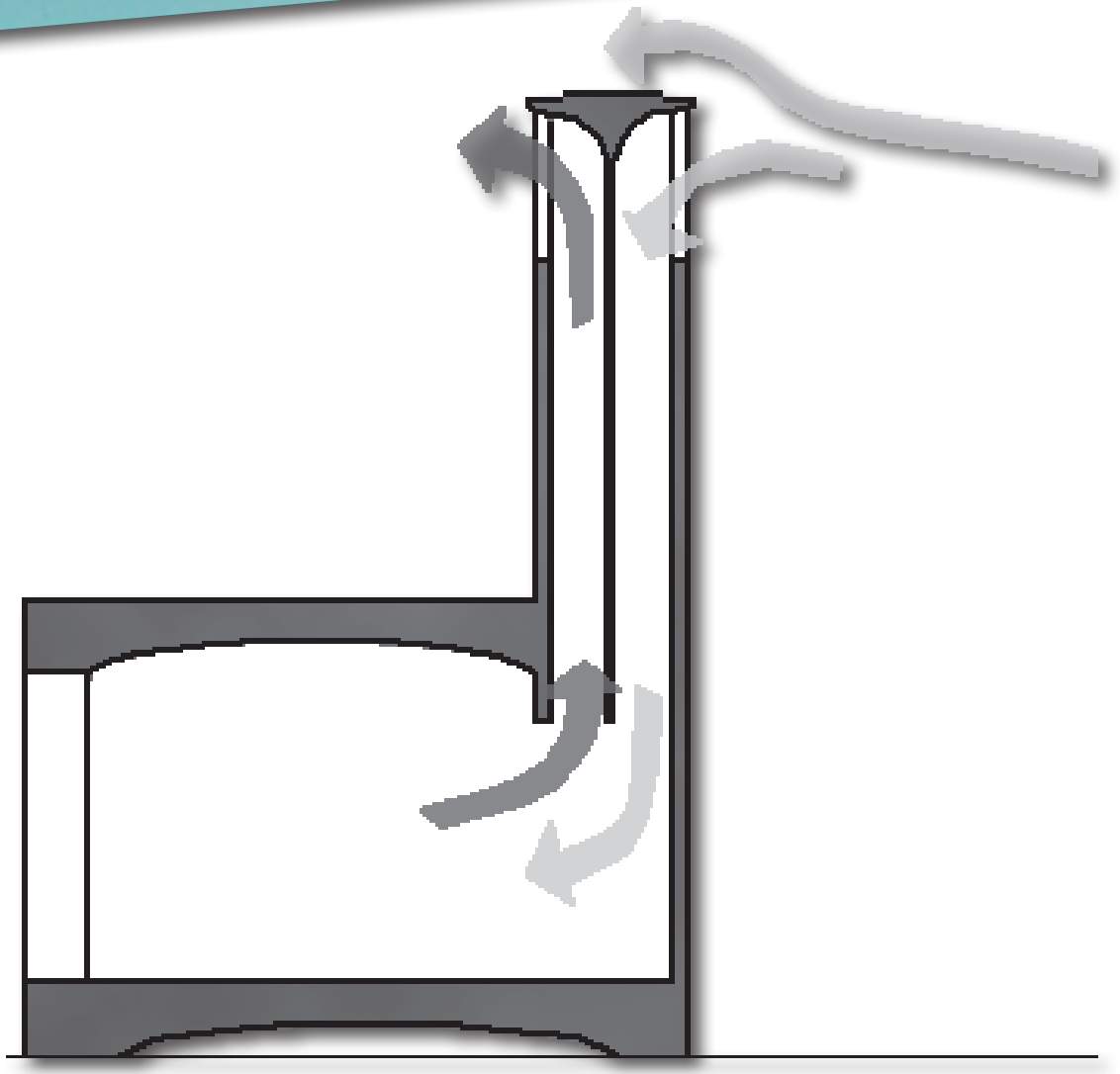


WINDCATCHER STRUCTURE



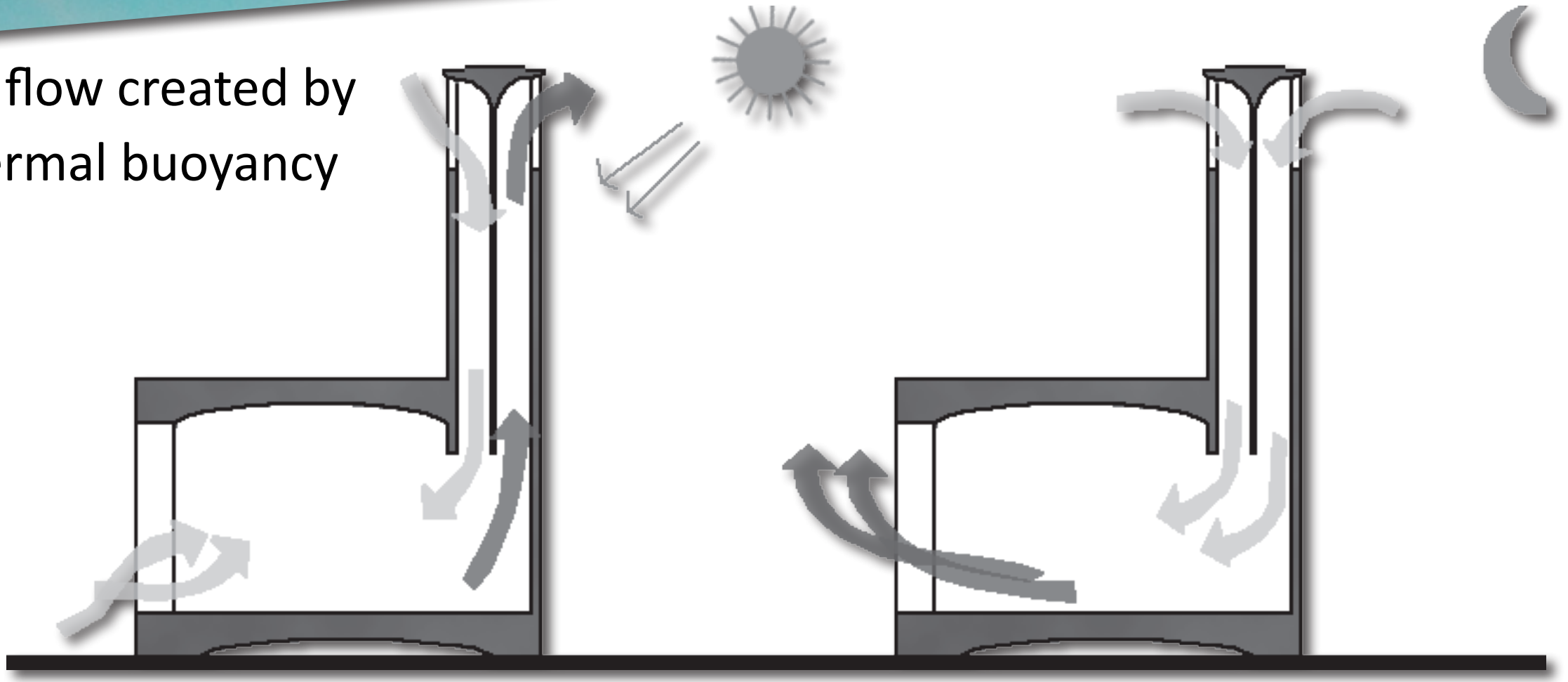
WINDCATCHER

- Positive and negative pressure created by the wind



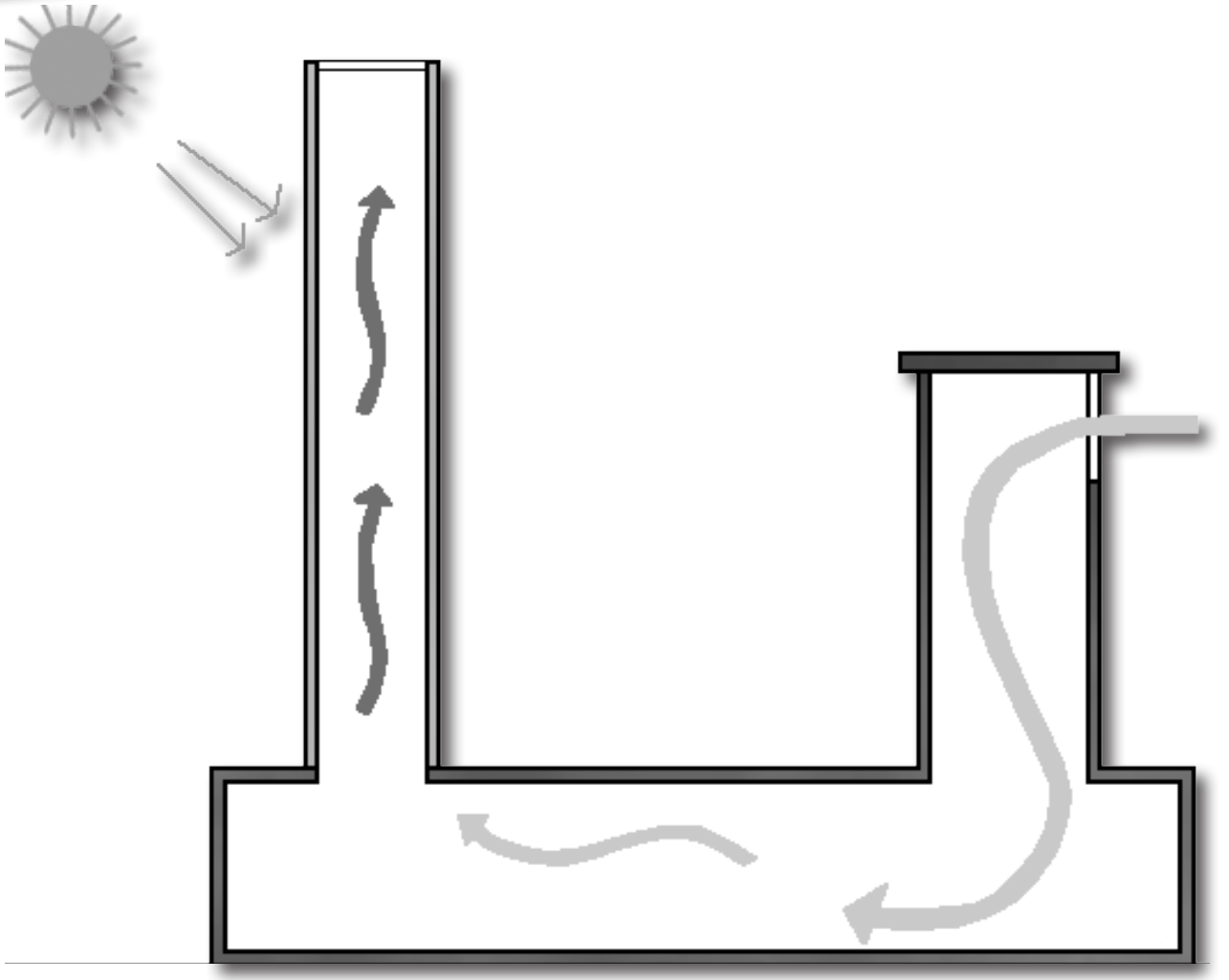
WINDCATCHER

Air flow created by thermal buoyancy

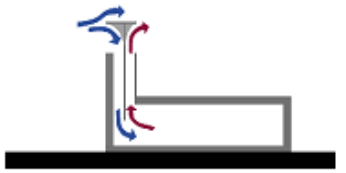
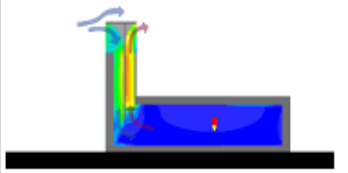
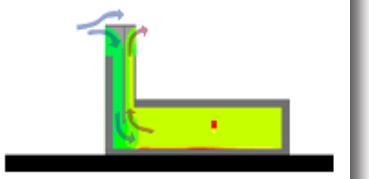
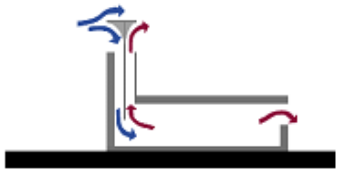
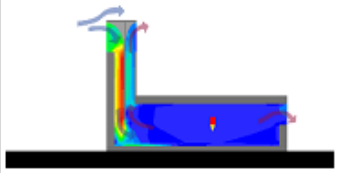
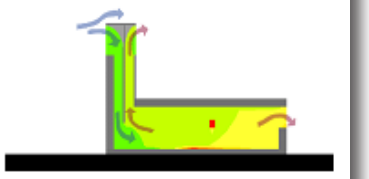
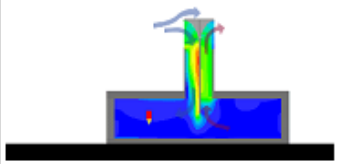
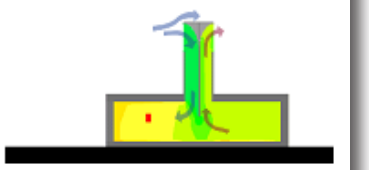
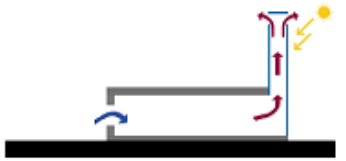
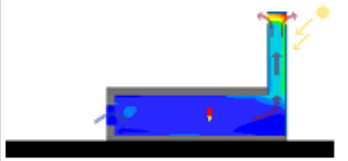
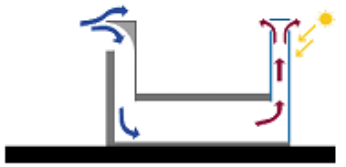
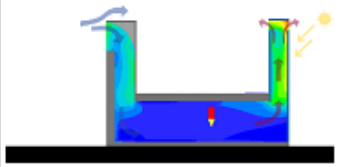
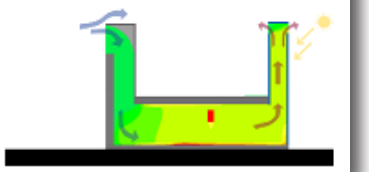


WINDCATCHER

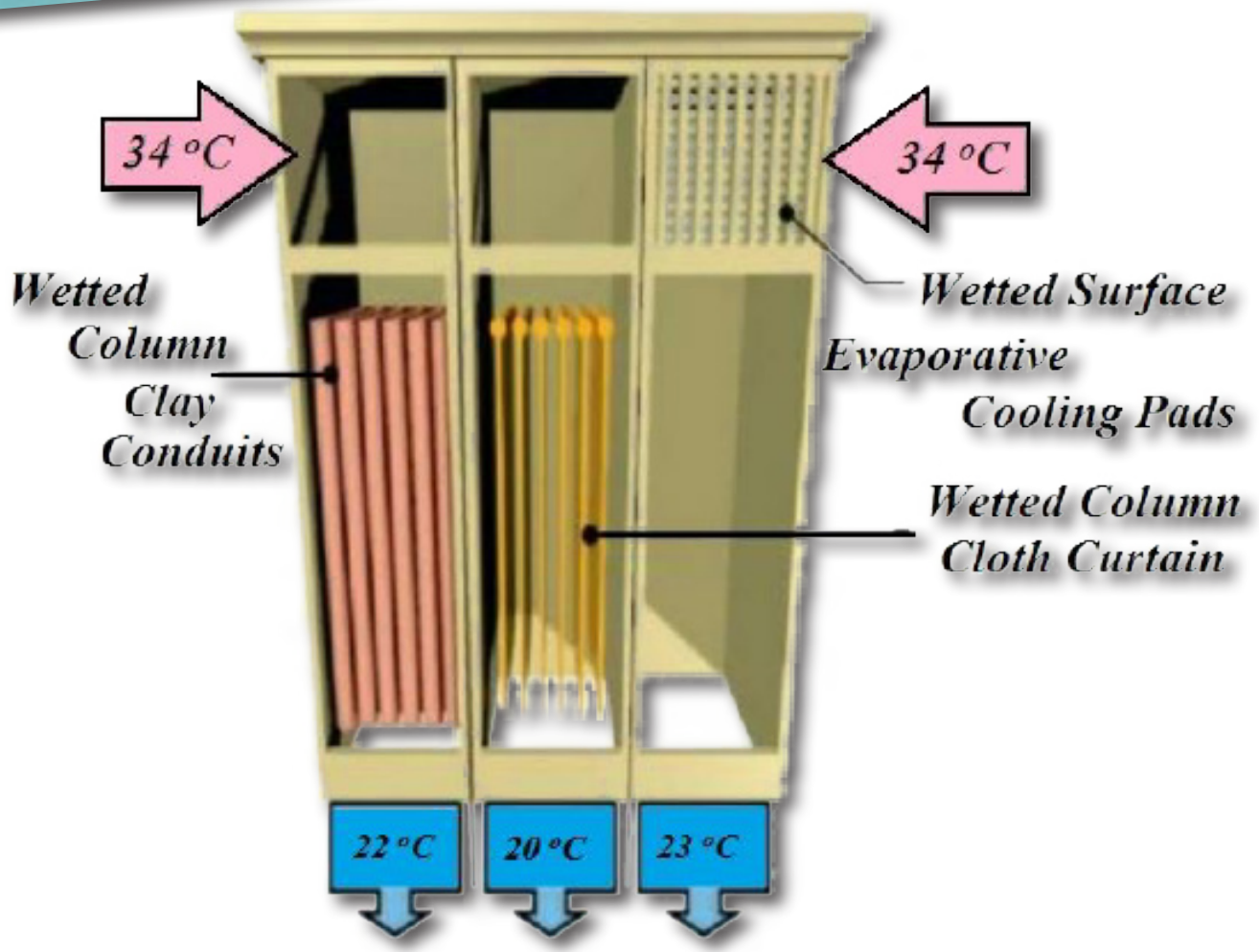
Combination of pressure difference by the wind and thermal buoyancy



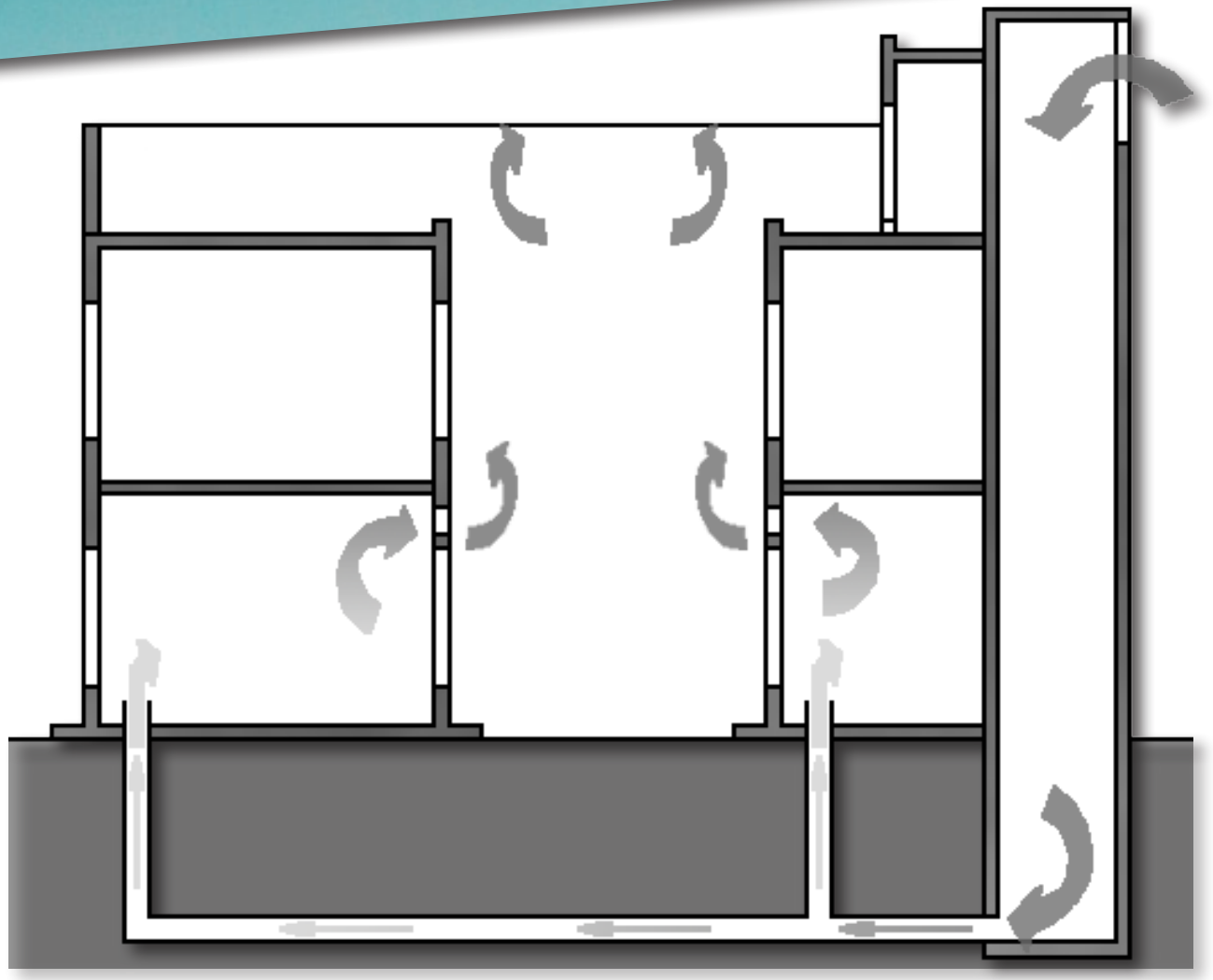
CFD STUDY

Building Type	Velocity [m/s]		Temperature [°C]	
	0,5 m/s		38°C	
	0,6 m/s		37°C	
	0,4 m/s		39°C	
	0,7 m/s		40°C	
	0,7 m/s		38°C	

EVAPORATIVE COOLING

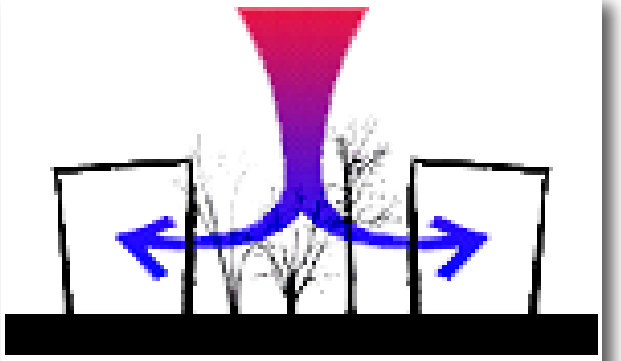


UNDERGROUND COOLING



DESIGN PRINCIPLES

Courtyard



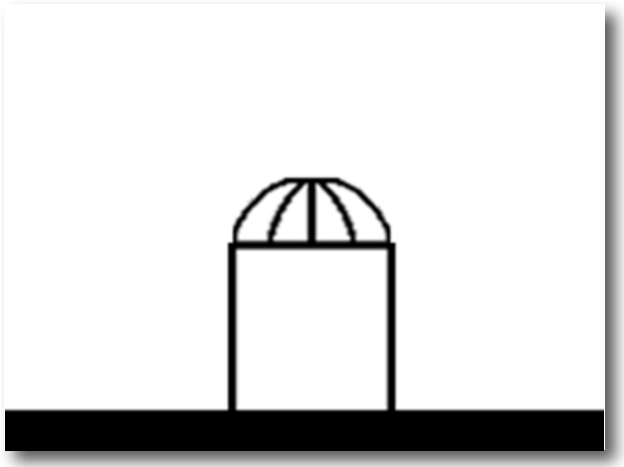
Internal courtyard

External courtyard

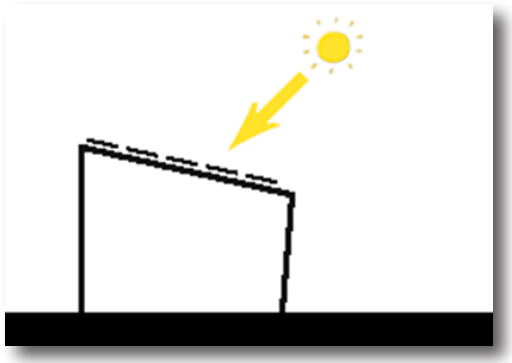
Courtyard used for evaporative cooling

DESIGN PRINCIPLES

Roof

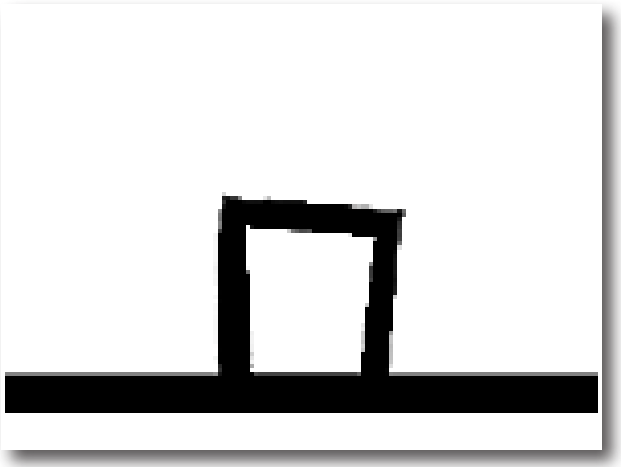


Roof adjusted for solar panels



DESIGN PRINCIPLES

Facade



Natural material like mud or adobe

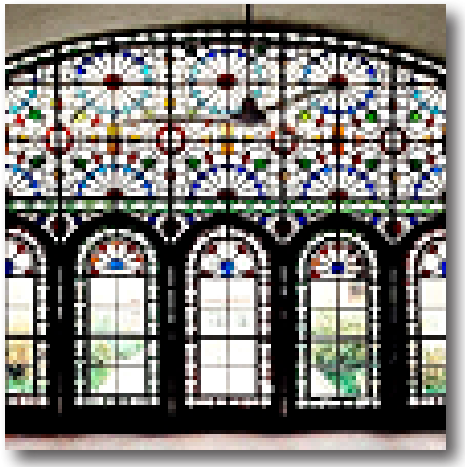
Thermal mass, walls up to 1 meter

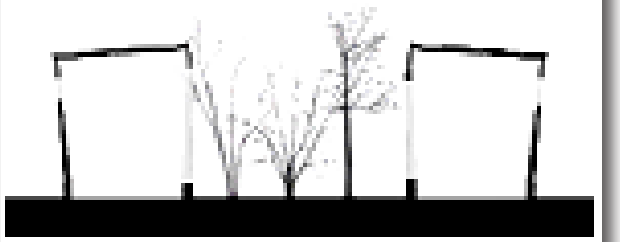
Light coloured surfaces

Less solar heat gain

DESIGN PRINCIPLES

Openings





Openings faced north and east

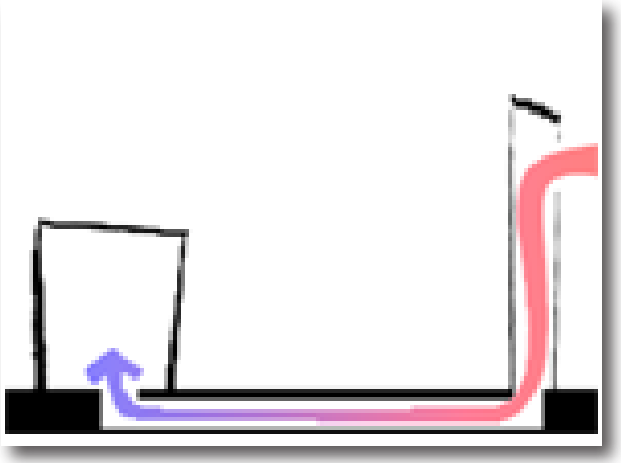
Small openings high in the wall exterior

Big openings facing courtyard

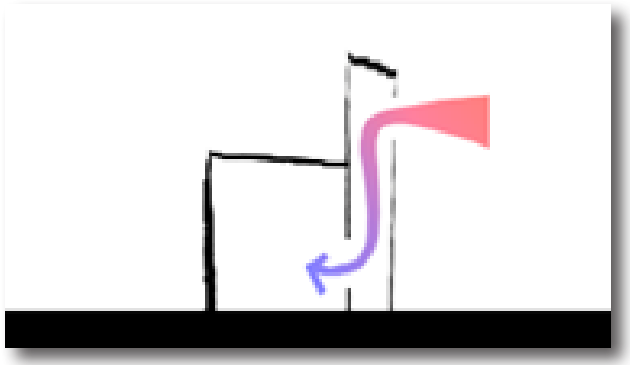
Less solar heat gain

DESIGN PRINCIPLES

Windcatcher



Windcatcher for natural ventilation



ENTRANCE BUILDING
NEGIN SAFARI PARK

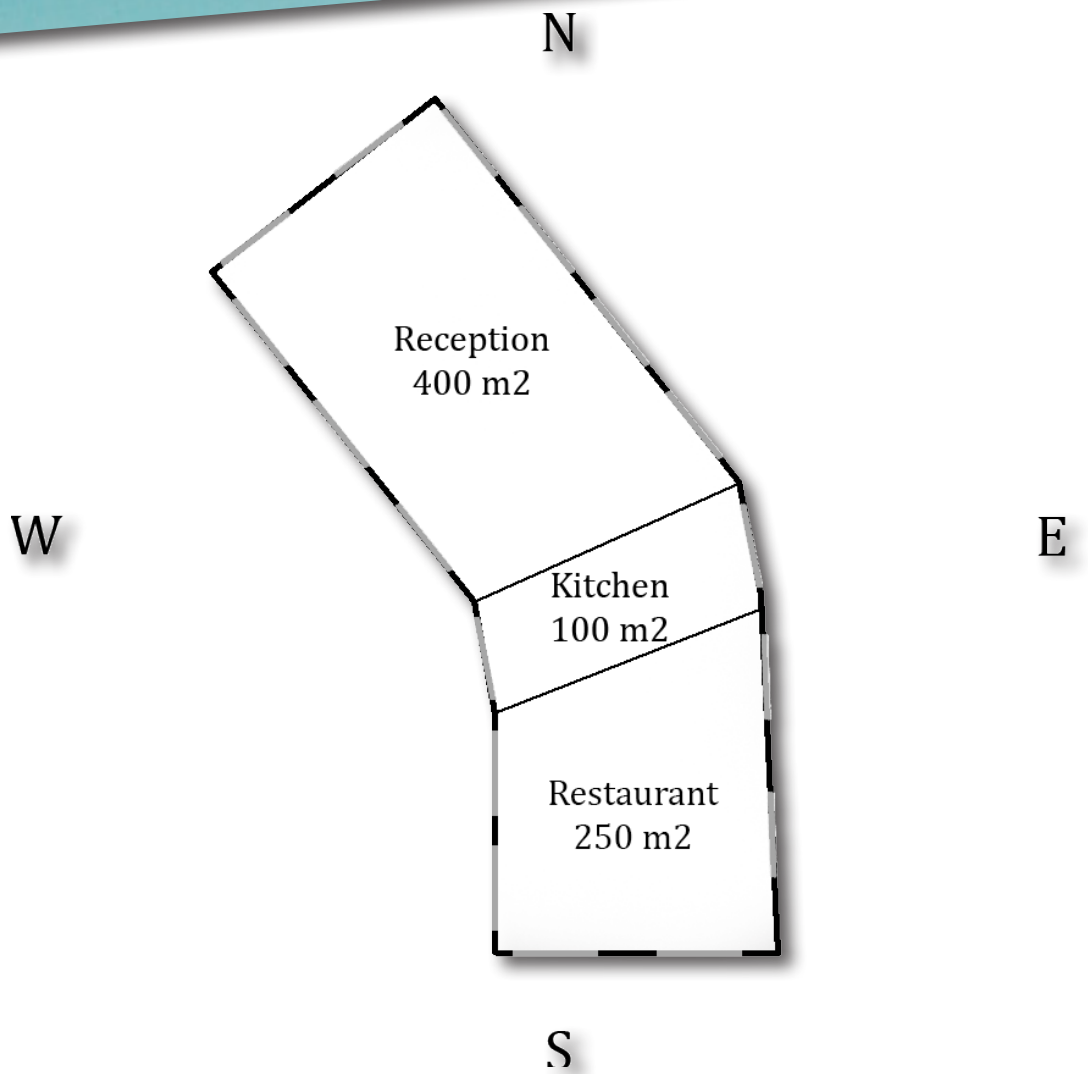
ENTRANCE BUILDING

Building Information:

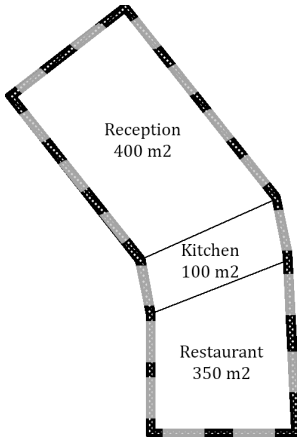
Reception:	400 m^2
	35 people
Kitchen:	100 m^2
	10 people
Restaurant:	250 m^2
	70 people

Wall thickness 500 mm

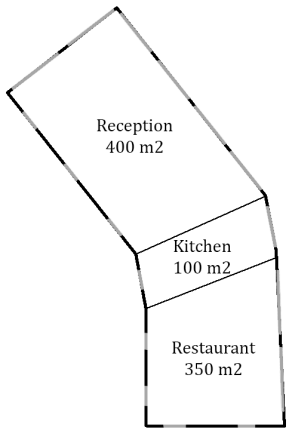
Windows are the same size (30% glazing)



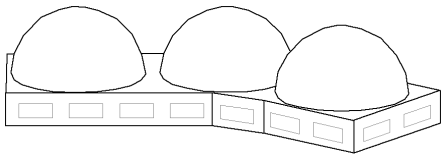
ENERGY REDUCTION

	Building Information	Energy reduction	Increase cost
	**Increase of mass** • Walls and roof 1000 mm thick • Walls and roof 1500 mm thick • Windows are the same size (30% glazing)	1000 mm mass -10% 1500 mm mass -15%	+450 m^3 material +5% +900 m^3 material +10%

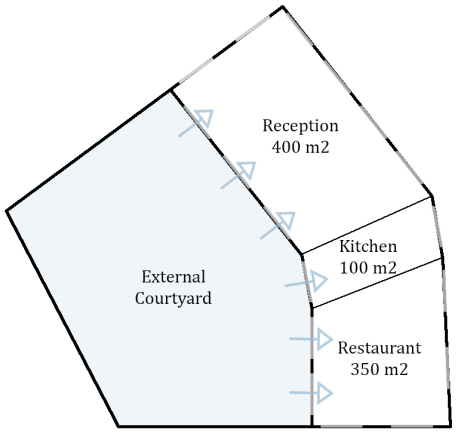
ENERGY REDUCTION

	Building Information	Energy reduction	Increase cost
	**Openings** • Small openings south and west (8% glazing high in the walls) • Big openings north and east (40% glazing)	-10%	window surface equal

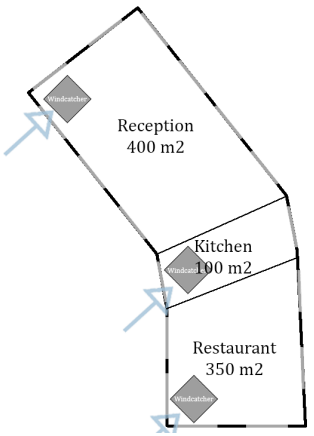
ENERGY REDUCTION

	Building Information	Energy reduction	Increase cost
	**Domed roof** • Minimize heating during the day • Maximize cooling during the night	-5%	+40%

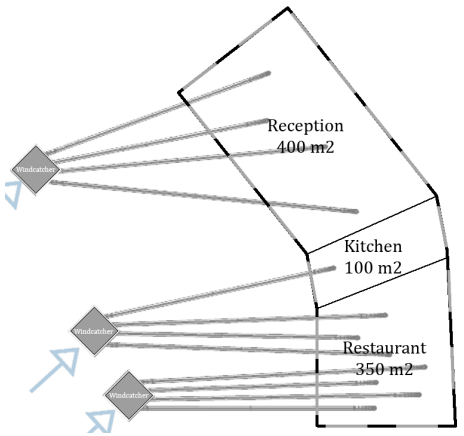
ENERGY REDUCTION

	Building Information	Energy reduction	Increase cost
	**Courtyard** • Lower air temperature • Natural ventilation through courtyard	-15%	200 m^3 material +5%

ENERGY REDUCTION

	Building Information	Energy reduction	Increase cost
	**Windcatcher** • No evaporative cooling • Higher winds, cooler air • Building heats up to 37 degree instead of 40 degree	-10%	10.000 euro/windcatcher +50%

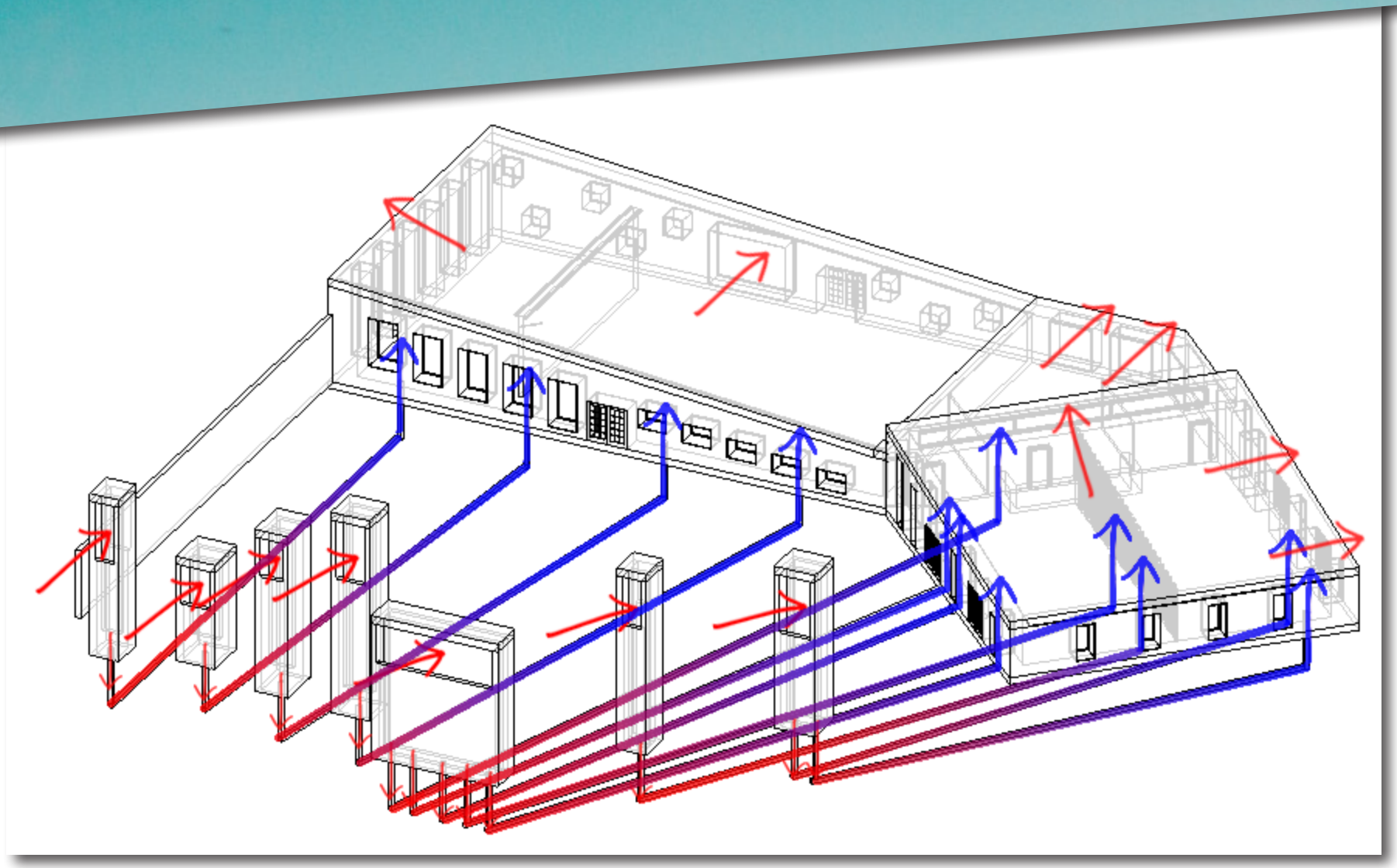
ENERGY REDUCTION

	Building Information	Energy reduction	Increase cost
	**Ducts** • Windcatcher combined with ducts • 12 ducts for the building • Provide a temperature of 26 degree	No cooling in summer -90%	5000 euro/duct +150%

DESIGN PROPOSAL

DESIGN PROPOSAL

VENTILATION



COST CALCULATION

Standard Building	
Energy use:	188.600 kWh/year
Building cost:	€ 52.500

Module cost	76696	EUR
Battery cost	180411	EUR
Regulator cost	17400	EUR
Transport/Fitting	130501	EUR
Total investment	**405009**	**EUR**
Annuities	16200	EUR/yr
Maintenance costs	45103	EUR/yr
Total Yearly cost	**61303**	**EUR/yr**
Energy cost	**0.37**	**EUR/kWh**

Investment solar panels:	€ 405.000
Yearly cost solar panels:	€ 61.000
Investment for 25 years:	€ 1.940.000
Building cost for 25 years:	€ 2.000.000

Improved Design	
Energy use:	91.865 kWh/year
Building cost:	€ 200.000

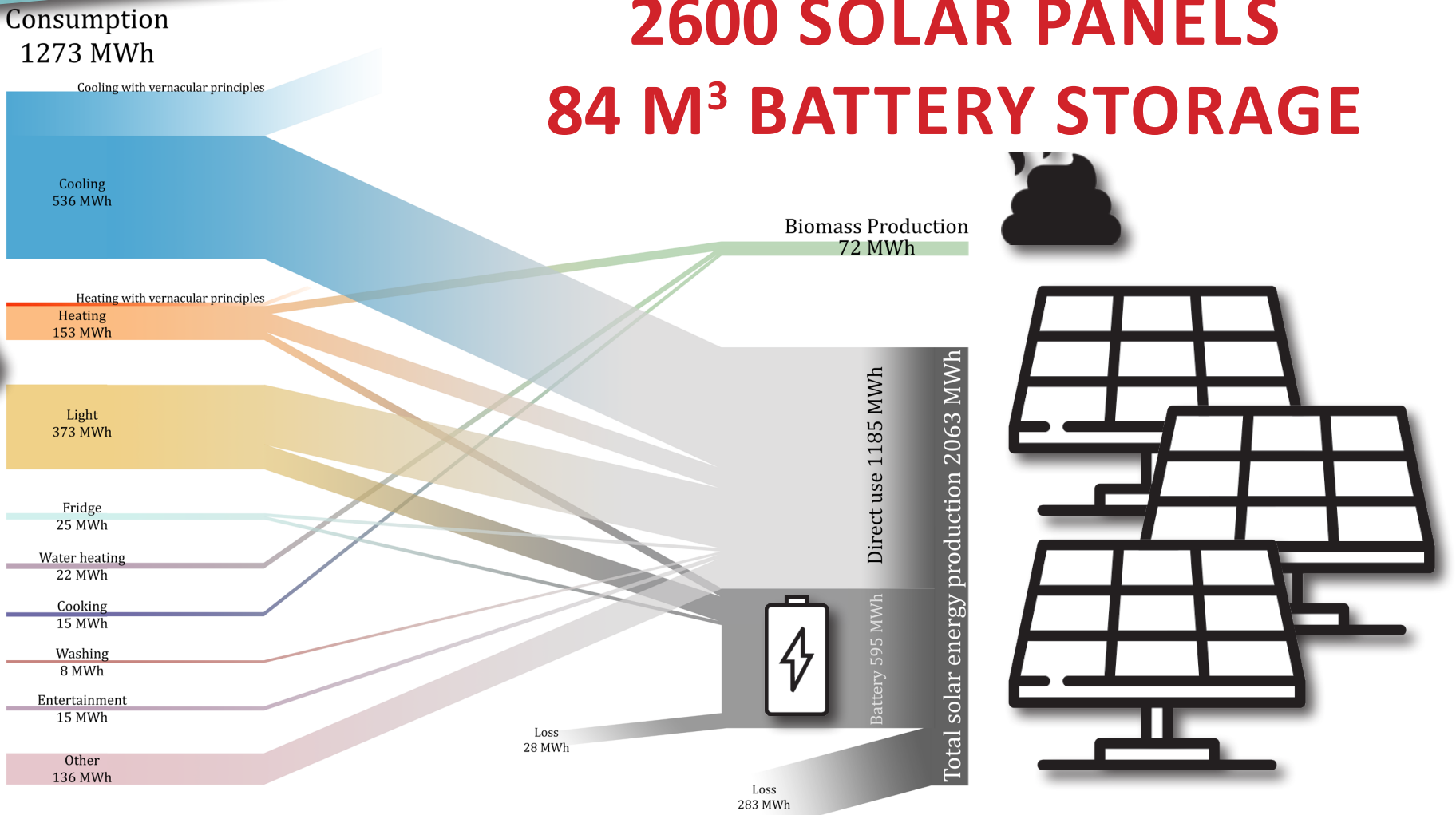
Module cost	57378	EUR
Battery cost	88647	EUR
Regulator cost	12397	EUR
Transport/Fitting	92976	EUR
Total investment	**251398**	**EUR**
Annuities	10056	EUR/yr
Maintenance costs	22162	EUR/yr
Total Yearly cost	**32218**	**EUR/yr**
Energy cost	**0.34**	**EUR/kWh**

Investment solar panels:	€ 251.000
Yearly cost solar panels:	€ 32.000
Investment for 25 years:	€ 1.056.000
Building cost for 25 years:	€ 1.300.000

IMPROVED DESIGN

ENERGY BALANCE

2600 SOLAR PANELS
84 M³ BATTERY STORAGE



- To what extend can passive cooling techniques reduce the energy demand of Negin Safari Park in Iran?

FUTURE RESEARCH

- Maintenance cost buildings
- Price / maintenance solar panels Iran
- Large scale energy storage
- Exact build form in the Park

QUESTIONS??