Façade Integrated Solar Cooling Systems

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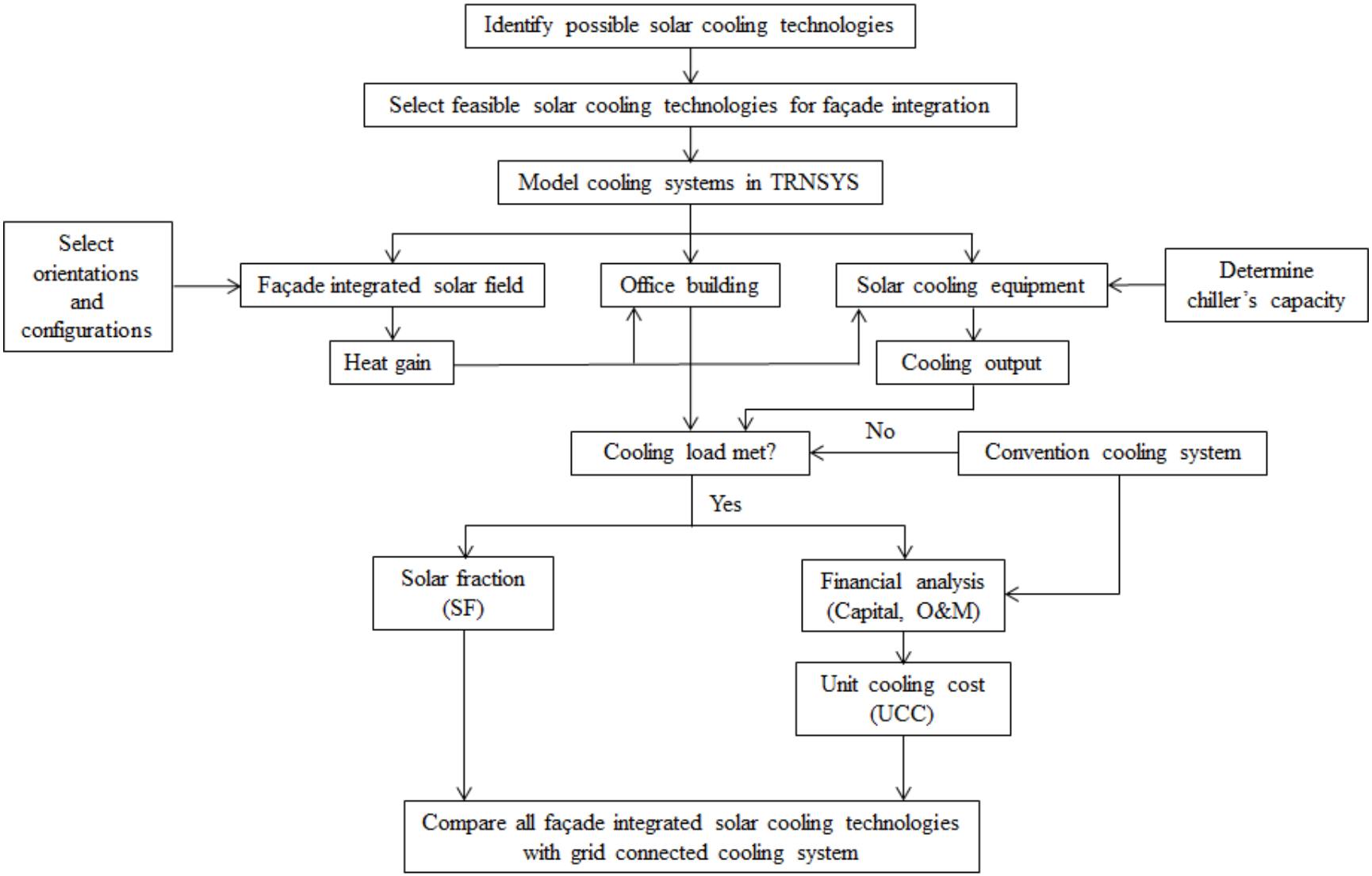
Research aim and objectives

Aim: to develop an integrated system to enhance the function of façades to utilise solar energy for cooling in office buildings

- To develop façade integrated solar collection systems for cooling generation for commercial office buildings;
- To develop simulation models which can quantify the system performance (e.g. energy gain from solar, cooling load, power output, cooling generation, overall system efficiency);
- To construct an experimental rig for validation of the simulation models for the system developed;
- To optimise the system design and operational parameters for minimum life cycle cost.

Technical and financial analysis



Available options

Solar field	Cooling equipment	Transport
Photovoltaic (PV)	Vapour compression cycle	~~Air~~
~~Flat plate collector (FPC)~~	Organic Rankine cycle + vapour compression cycle	Water
Evacuated tube solar collector (ETSC)	Absorption chiller (1 stage)	
~~Parabolic trough collector (PTC)~~	~~Absorption chiller (2 stage)~~	
	Adsorption chiller	
	~~Desiccant~~	

System overall efficiencies

PV panel (0.15) + VCC (4) = ~0.6

ETSC (0.5) + ORC (0.1) +VCC (4) = ~0.2

ETSC (0.5) + one-stage absorption chiller (0.7) = ~0.35

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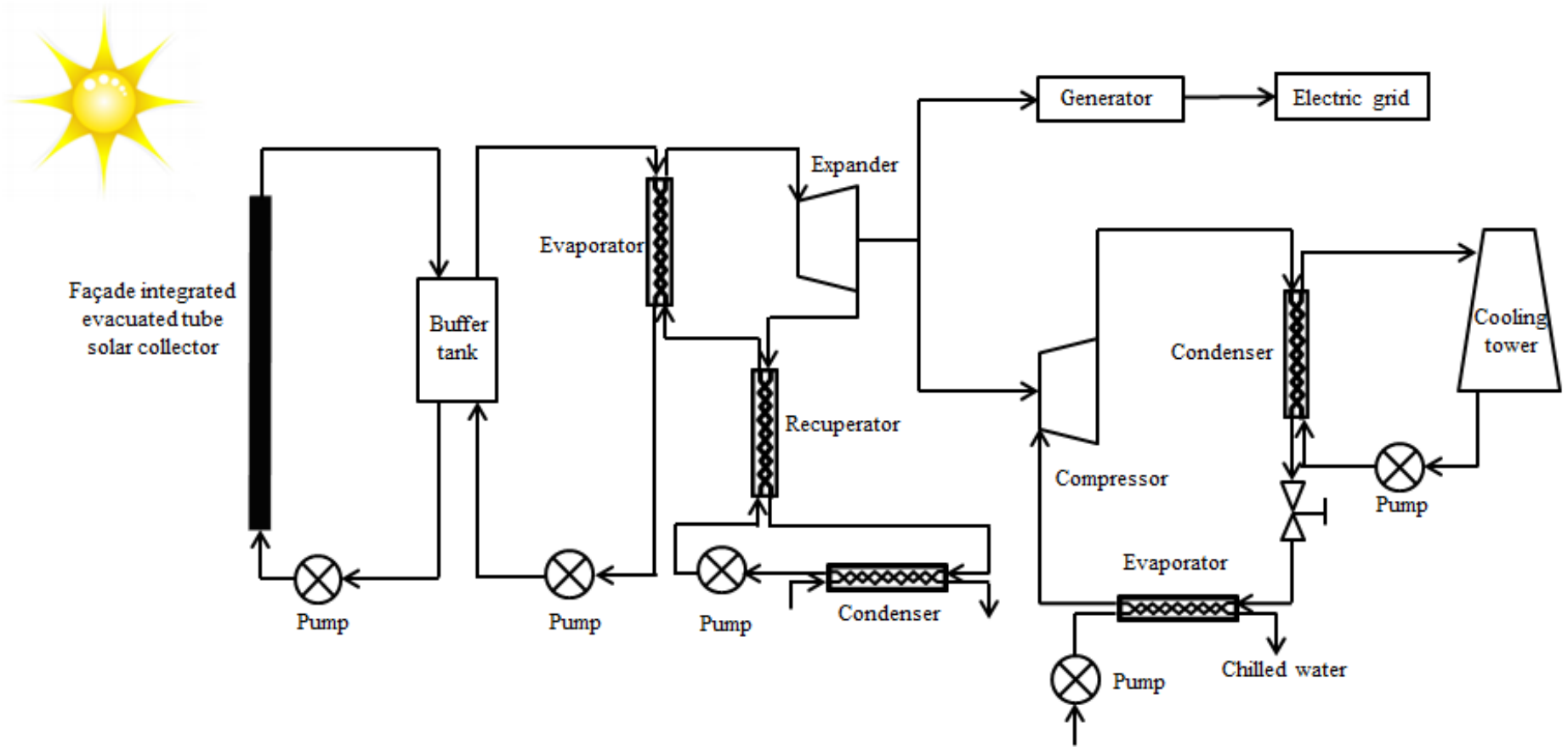
Schematic diagram of the system



Simulations

TRNSYS

- Building, weather data, façade integrated evacuated tube solar collector, pumps and buffer tank;
- Estimating transient cooling load;
- Coupling with GenOpt through interface TRNOPT for optimisation.

Engineering Equation Solver (EES)

- Organic Rankin cycle and vapour compression cycle;
- Thermodynamic model (for working fluid selection);
- Component model (for optimisation studies).

Conclusion: working fluid selection

- To achieve the highest overall efficiency, the optimal hot thermal fluid temperature for ORC is recommended to be 95ºC;
- In terms of pressure aspect, R134a and R500 are the best fluids;
- RC318 has the most moderate pressure ratio;
- Expander outlet volume flow rate favours R290 the most;
- From an efficiency point of view, R152a with superheating is the most efficient one.

Fluid	Superheating (°C)	η_{th} (%)	η_{Π} (%)	$\dot{I}_{tot}$ (kW)	$\dot{V}_4$ (m^3/h)
R134a	0	6.85	41.69	1.612	6.66
R290		6.59	41.73	1.716	6.00
R227ea		7.15	43.12	1.505	9.55
R152a		7.27	43.09	1.465	6.97
R134a	5	7.29	43.88	1.456	6.09
R290		7.05	43.93	1.541	5.47
R227ea		7.59	45.27	1.363	8.76
R152a		7.78	45.70	1.305	6.36