

DESIGNING FOR ZERO EMISSIONS

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Define the problem before solving it.

Find the least-cost means of matching energy demand and renewable supply.

Net Zero Energy is not Zero Emissions.

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Assume the challenge. Challenge the assumptions.

Solutions exist.

Preconceived barriers must be circumvented.

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Seek synergistic passive and active strategies.

Integrated architectural and engineering design is not a process but an outcome.

Closing the professional gap requires overlap.

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Synergy results in higher performance at lower cost.

Life-cycle accounting of O&M is required to determine optimum outcomes but rarely done.

Iterative and integrated design process is helpful but rare.

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The OAA Carbon Neutral Retrofit

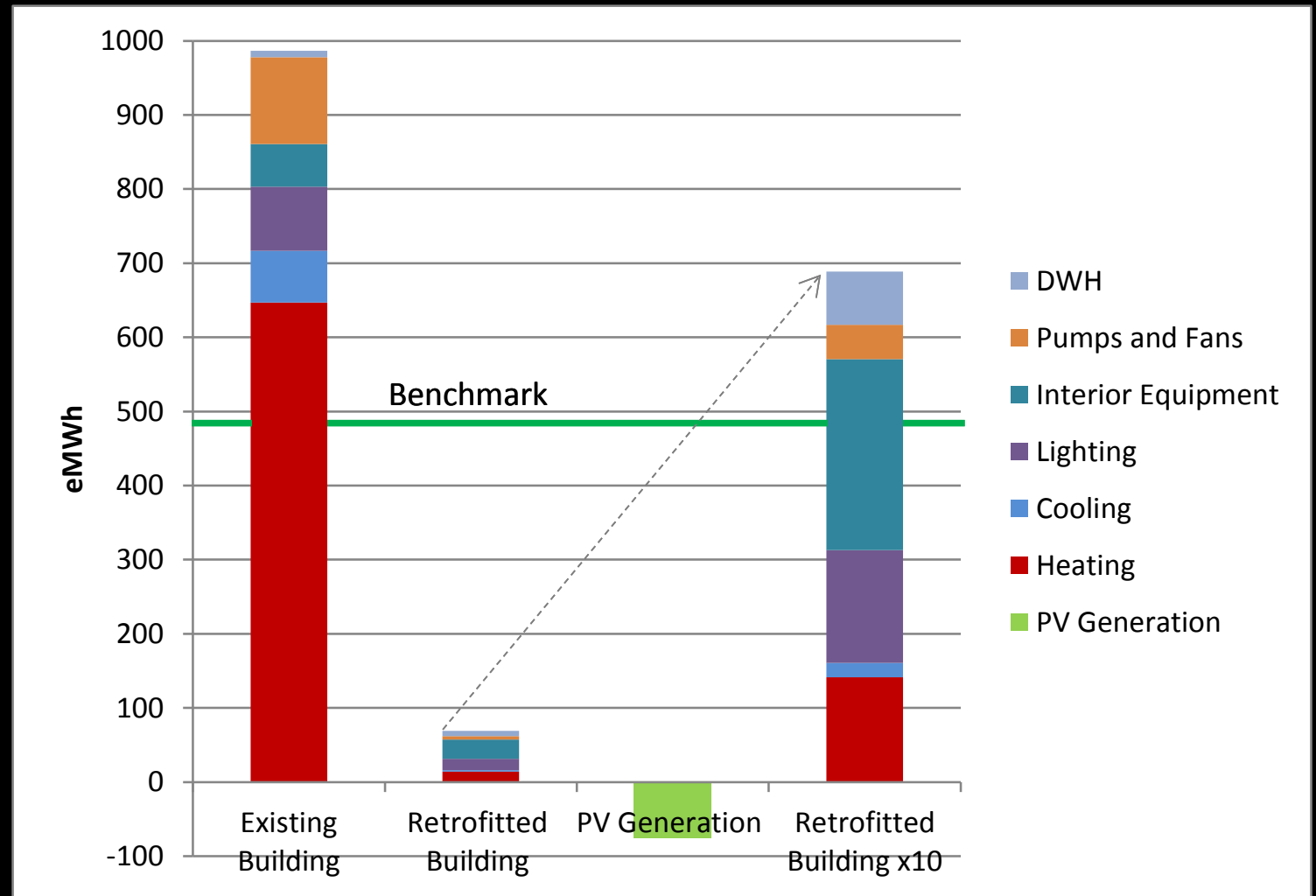
What worked and what didn't.

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What we achieved

93% reduction

More possible



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Thermochromic solar control



Virtual light-shelf using refraction

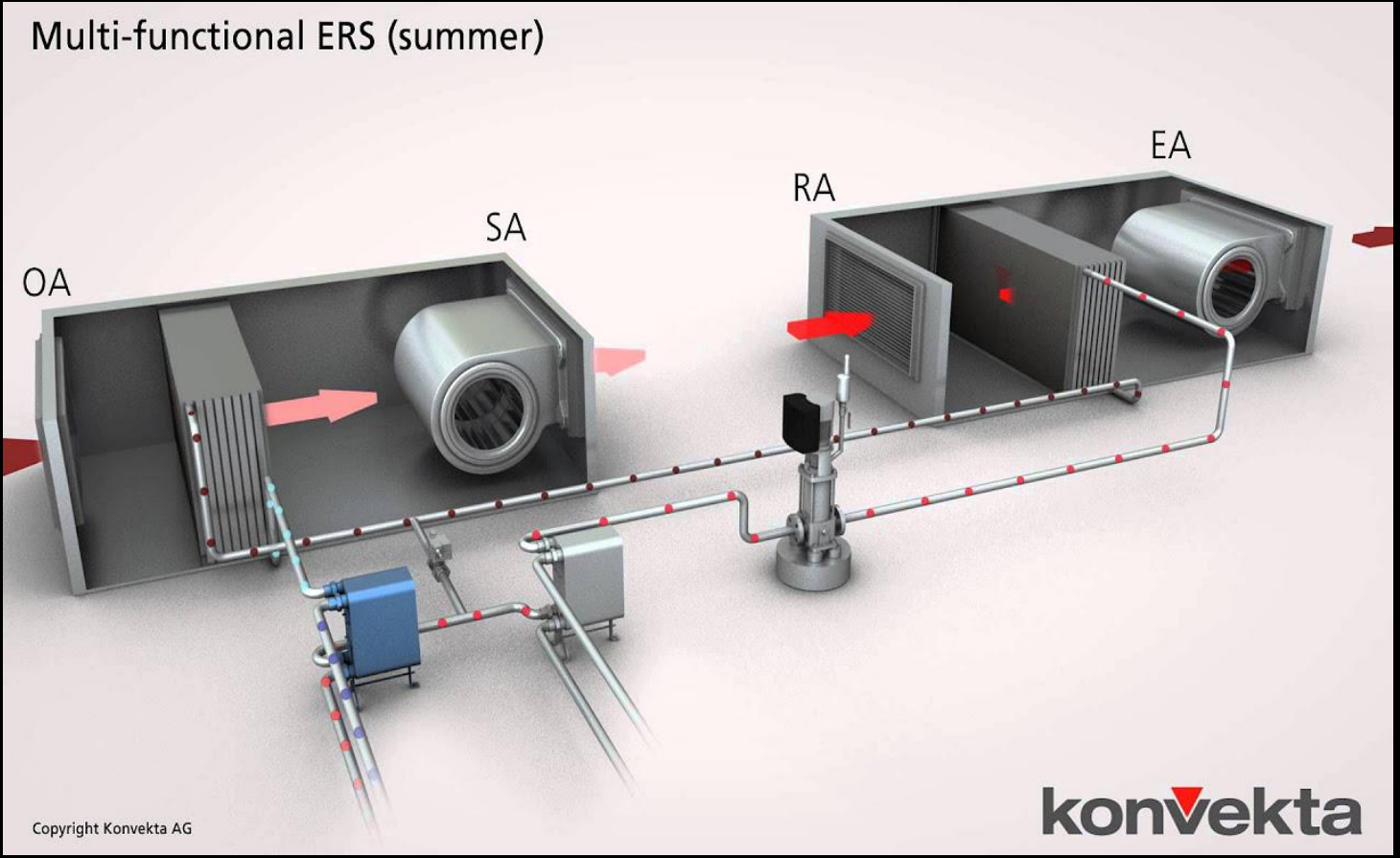


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Runaround coils
with pre-heat and
dehumidification

Low fan power

High effectiveness



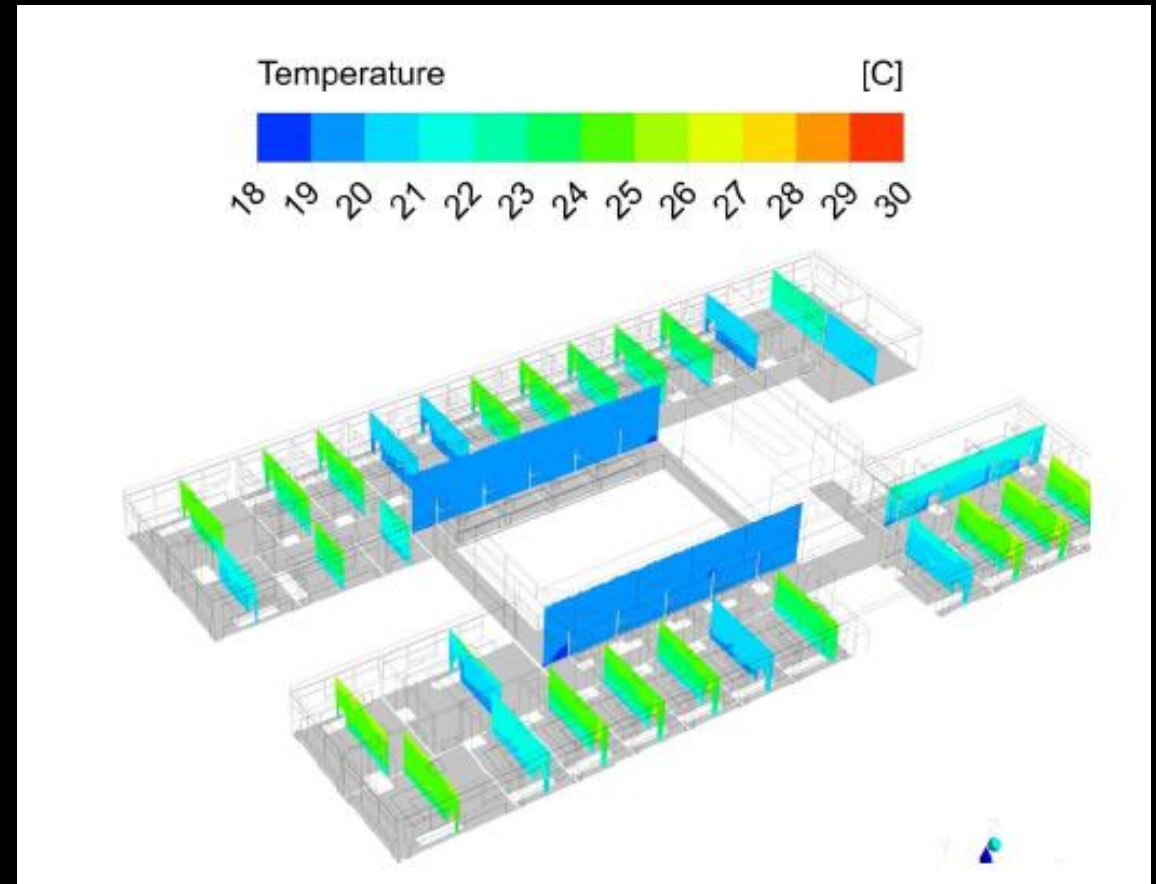
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Ductless DV

Self-regulated delivery

Low cost/low energy

Engineers' comfort zone.



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Acoustic door grilles

A case of crosstalk and sound advice.

Huge cost and energy impact.



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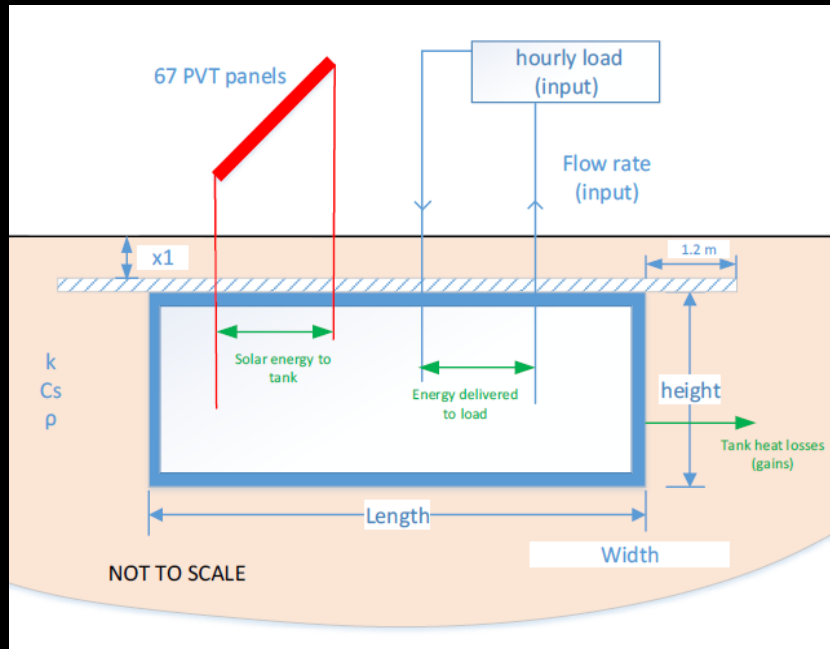
Low $\bar{\epsilon}$ acoustic tile reduces radiant heat transfer to floor and occupants allowing lower displacement ventilation rates.



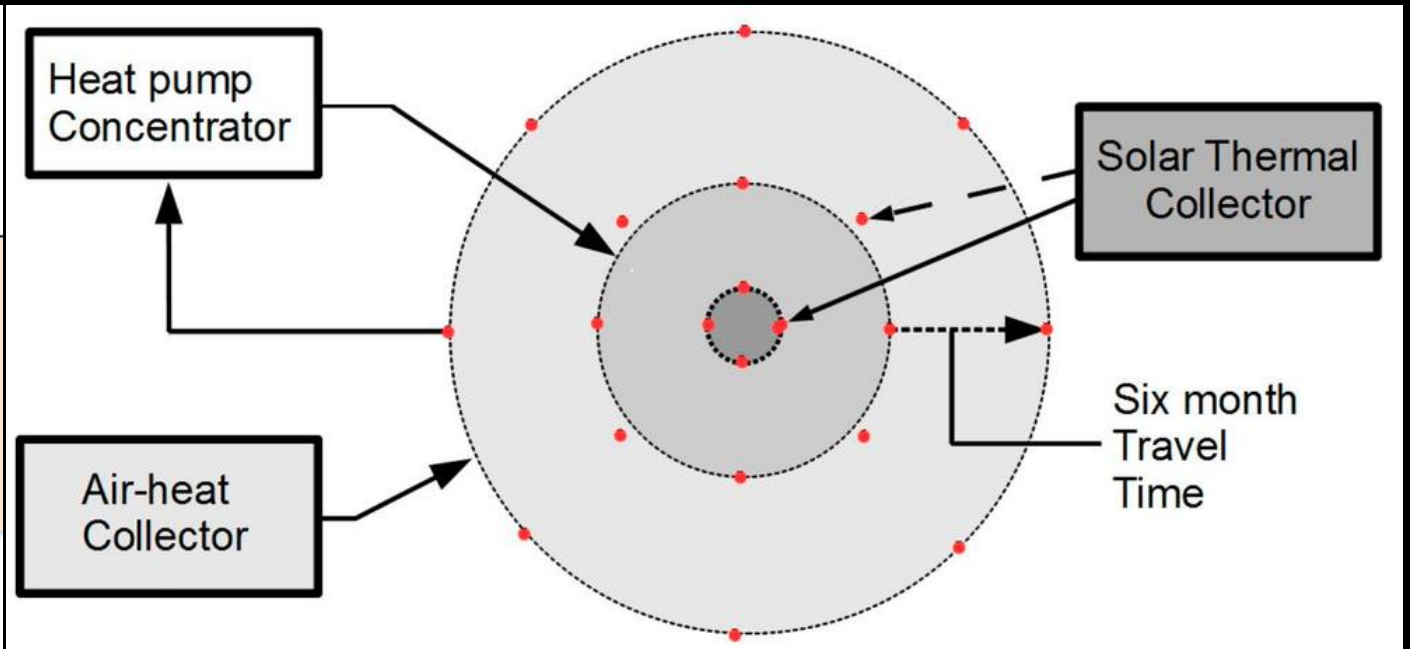
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Seasonal storage options

Annual ice storage



Concentric bore-hole geexchange



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Radiant hydronic walls provide perimeter heating and cooling with insulation backing.

Lowers cost and energy.

Compatible with DV.



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Net Zero Energy on the Roof

Designed for solar



PV-Thermal Hybrid



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Problems Experienced

- Open communication between team and client is essential to good results.
- Innovation to produce better performance at lower cost requires time and investment.
- Design, engineering, modelling, and costing should be integrated and iterative, not linear.
- Money, time, and risk limit good design outcomes.

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Set minimum IRR = borrowing cost.
Separate refurbishing from O&M measures.
4 incentive programs.
Anticipate cap & trade opportunities.

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The global warming tipping point is within a decade.

Compromise is not an option.

Half measures will not fix the problem.

It's the carbon economy, stupid!

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Zero Emissions Residential Retrofit

- Deep retrofit to achieve Passive House Performance
- Radiant ceiling heating and cooling
- Advanced earth storage heat pump with dispatch
- PVT roofing, net metered, earth storage charging, free cooling, ice melting
- Hot water with greywater heat recovery, home-run plumbing, cooling preheat
- Battery and electric vehicle charging when surplus renewables available

Profiting from Zero Emissions

- Generate savings when repairing, extending, and renovating
- Cost of envelope super-retrofit recovered by reduced HVAC cost
- Zero operating cost, carbon credits offset service charges
- High property value for inflation-proof, low O & M housing

Natural Gas is Not Economic

- Gas service connection and service charges are high and avoidable
- Gas infrastructure expansion costs \$30,000/per customer
- District energy infrastructure costs less
- Bio-fuel cogeneration and community exergy storage has lower energy cost
- Dispatched cogeneration returns and avoided landfill of bio-waste makes free heat