

3 FOR 2 BEYOND EFFICIENCY

a research project by

A / S Architecture
and Building
Systems

ETH zürich

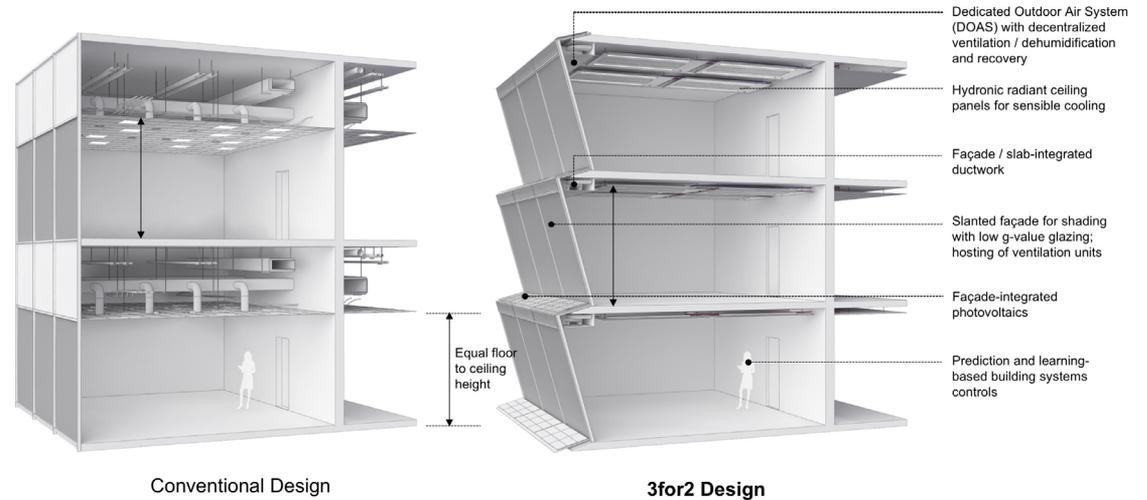
(FCL) FUTURE CITIES
LABORATORY 未来
城市
实验室

in cooperation with

Trox Technik GmbH,
Siemens Building
Technologies and
United World College
of South East Asia

In hot and humid regions, a large portion of building energy consumption is caused by air-conditioning, which additionally requires a large amount of space, volume and materials to be built. The A/S Group developed the 3for2 approach in response, aiming to realize large savings in operational energy and material while increasing the usable / rentable space and investment returns.

Conventional air-conditioning uses large amounts of cold and dry air to achieve thermal comfort. This requires a large amount of energy and extensive ductwork for air distribution, adding up to one third of the floor-to-floor height.



Above: Comparison between the 3for2 concept and a conventional office building design. © A/S Group

3FOR2 RADICALLY CHANGES THE WAY BUILDINGS ARE AIR-CONDITIONED CONCEPT BASED ON THREE MAIN COMPONENTS

To split cooling (sensible cooling) and dehumidifying (latent cooling)

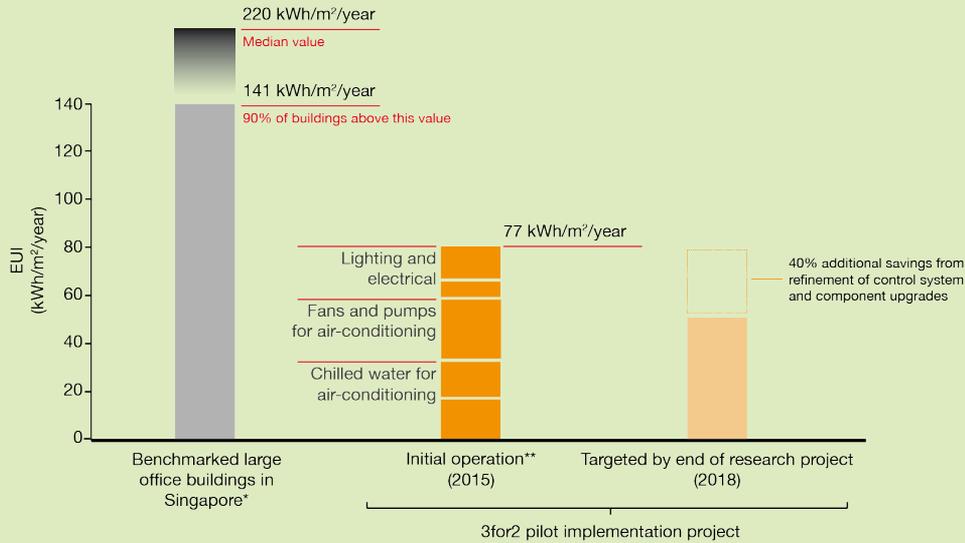
Instead of using cold and dry air for both, 3for2 distinguishes between removing heat from the building interior and removing moisture from the air coming from outside. Separating these functions lowers the amount of electricity required.

To use water instead of air for heat transport

Water has a greater heat capacity than air, which allows for smaller pipes and more effective cooling components that can be integrated into the construction. Large ductwork and extensive false ceilings become unnecessary.

To use small, decentralized ventilation units instead of a single central unit

Only the required minimum of air is drawn into building and dehumidified efficiently, using a two-stage energy recovery process. The decentralized ventilation units can be integrated into the façade, the minimized air distribution network into the floor slab. The integration of mechanical and electrical components into the construction frees up to one third of the volume of a typical floor.



* Data from BCA Building Energy Benchmarking Report 2015 (<http://www.bca.gov.sg/sustain/sustain.html>)
 ** Aggregation of 18 days of operational data from December 2015 - assumes 252 days of system operation per year; System operates between 7am and 6pm each weekday, with indoor air conditions set to 22.5 °C and 60% relative humidity



Above left: Early benchmarking of the 3for2 pilot implementation project's Energy Use Intensity (EUI) versus top performing office buildings in Singapore. © A/S Group

Above right: Open space office at UWCSEA after completion; ceiling with passive chilled beams. © A/S Group

SAVE ENERGY COSTS AND INCREASE REVENUE IMPLEMENTATION

In 2015, a single-floor 550 m² pilot implementation of the 3for2 concept was designed and constructed in Singapore. The pilot project area sits within the larger 20,000 m² high school building of the United World College of South East Asia and is occupied as a regular office since the beginning of December 2015.

Initial analysis of the building performance shows an aggregate of the building's energy use intensity (EUI) over a month of operation at the end of 2015. According to our measurements the annualized energy consumption of the pilot project space is currently at 77 kWh/m²/year, which is roughly one third of the median EUI of office buildings in Singapore and half of what the best 10% of office buildings consume.

Further optimization will result in approximately additional 40% decrease, making this one of, if not the most energy efficient office in Singapore. In addition, 3for2 allows for significantly more square meters of usable space in the same volume or an increased ceiling height which leads to rent benefits .

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Right: Rendering of a future 3for2 high-rise office building.
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FAQ

RESPONSES TO FREQUENTLY ASKED QUESTIONS REGARDING 3FOR2 AND ITS IMPLEMENTATION

How do you manage operational issues such as condensation and high air flow rates?

The risk of condensation can be easily mitigated. We simply do not circulate water that is colder than the maximum measured dewpoint temperature in the serviced office space. The chilled beam system also allows to satisfy temperature, humidity, and air quality requirements more easily. Avoiding any need to recirculate air in the interior spaces, the total air flow in a 3for2 office is lower than in conventional systems.

If 3for2 outperforms conventional air-conditioning, why has the technology not yet been widely adopted?

The answer is: Design. In the hands of an inexperienced engineer or designer, it is relatively easy to implement 3for2 poorly; the raised concerns would actually materialize. Our ability to execute a sophisticated, elegant system design within the capabilities of the Singaporean construction labour market and in view of the thermal comfort expectations in Singapore, is one of our key strengths.

Is it possible to get a first hand impression of the 3for2 system at work?

For the first 3for2 project at UWCSEA, we have an open-door policy for visitors, which includes presenting performance data, and likewise the UWCSEA has an open-door policy to provide feedback on the system's performance to third parties. We are happy to orchestrate a site visit with any relevant partners to allay concerns.