

## **Creating Sustainable Buildings in the Middle East**

Mohammed Sanaobar, Dr. Michael Faatz, Wacker Chemie AG, May 12<sup>th</sup>, 2022

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# Agenda

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▶ **Introduction**

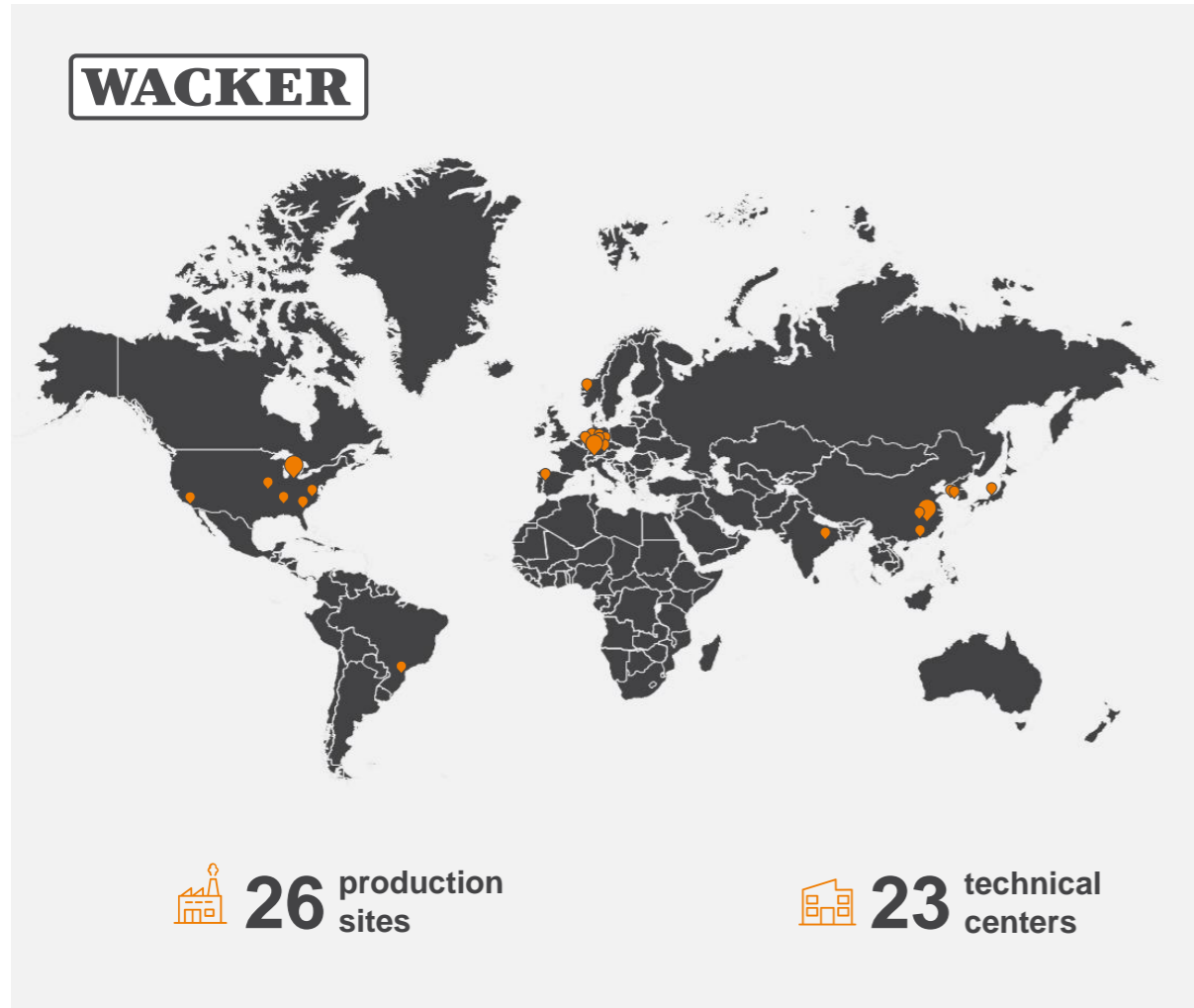
Design of the Sustainability House

Design of the Experiment

Test Results

Conclusion

# Over 100 Years of Success



## Wacker Chemie AG

- ▶ Founded in 1914 by Dr. Alexander Wacker
- ▶ Headquartered in Munich, Germany

## WACKER Group (2021)

- ▶ Sales: €6.21 billion
- ▶ EBITDA: €1,539 million
- ▶ R&D: €164 million
- ▶ Investments: €344 million
- ▶ Employees: 14,406

# Technical Centers and WACKER ACADEMY Sites: Close to Customers' Needs

- ▶ Global coverage via worldwide network
- ▶ Local support for our customers
- ▶ Ideal platform for advanced training and industry-specific networking
- ▶ Promotion of innovations and know-how transfer



# WACKER Provides a Diverse Portfolio of Products for the Construction Industry Derived from Two Chemical Platforms

## Polymeric Binders



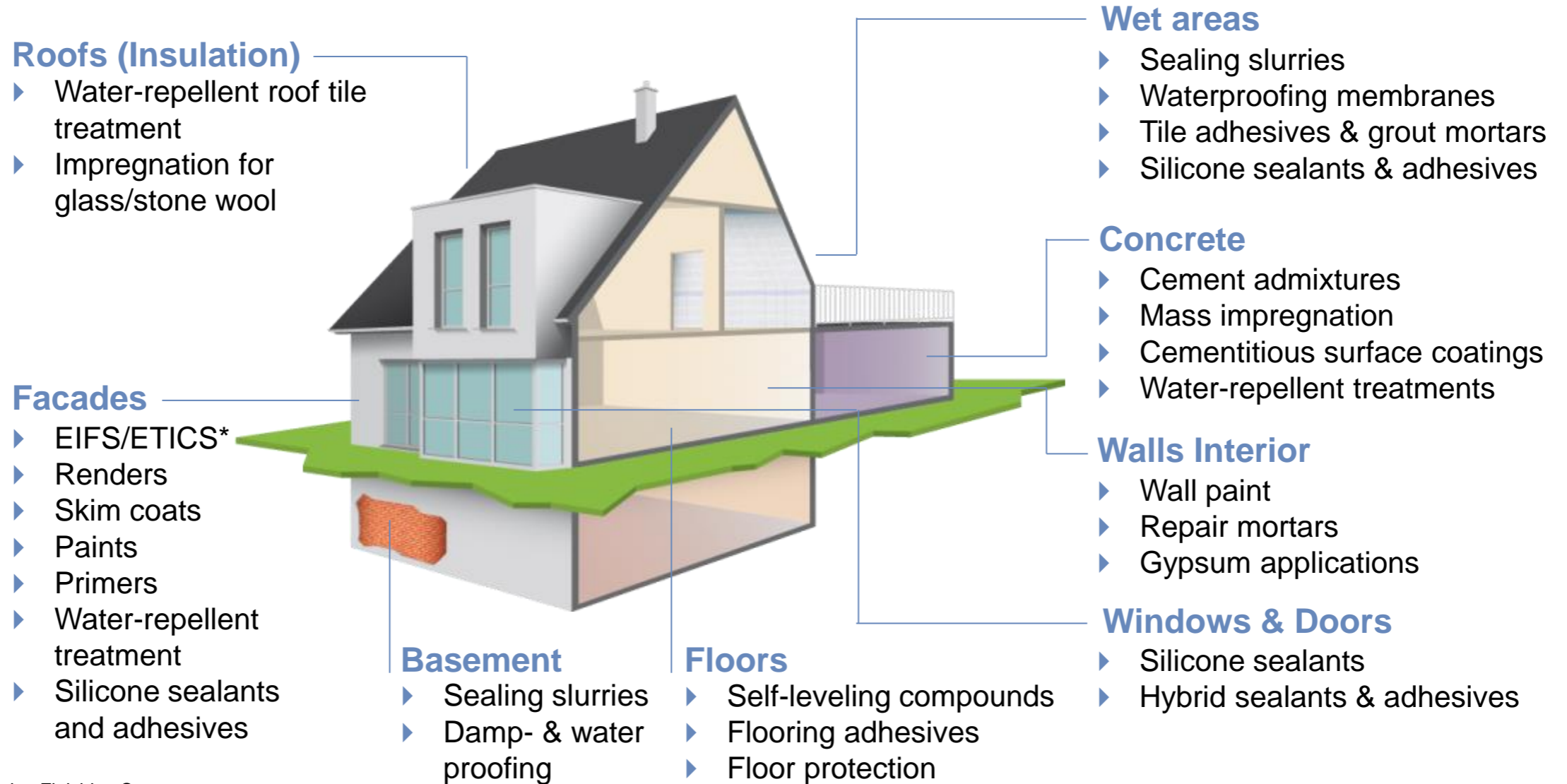
**Products:** VINNAPAS®, ETONIS®, PRIMIS®

## Silanes & Silicones



**Products:** SILRES®, GENIOSIL®, ELASTOSIL®

# WACKER's Construction-Related Solutions



\* EIFS = Exterior Insulation Finishing System  
 ETICS = External Thermal Insulation Composite System

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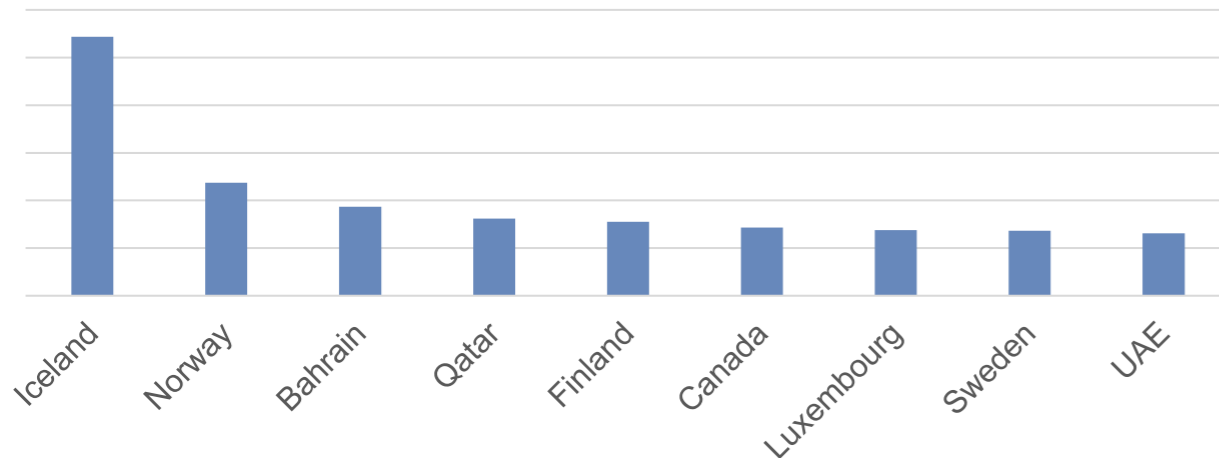


# United Arab Emirates Strives to Become a Global Leader in Sustainable Housing

## United Arab Emirates

- ▶ Second largest economy in the Arab World
- ▶ Growing population comes with an increasing demand for housing, infrastructure, water and energy (power consumption 2012-2021: +5,6%)
- ▶ UAE is among the highest electricity consumers per capita in the world

Energy Consumption per Capita (2017)



## UAE Energy Strategy 2050

- ▶ Launched in 2017
- ▶ UAE's first unified energy strategy

### Strategic Aims

- ↔ combine renewable, nuclear and clean energy sources
- 📈 Increase contribution of clean energy in the total energy mix from 25 to 50% by 2050
- 📉 Reduce carbon footprint by 70%

- ▶ City of Dubai aims to produce 75% of its requirements from clean sources by 2050.

Sources: <https://u.ae/en/about-the-uae/economy>; United Arab Emirates, Ministry of Economy, Annual Economic Report 2019; US Energy Information Administration EIA (2017), <https://www.mordorintelligence.com/industry-reports/uae-construction-market>

# Creating New Standards for Sustainable and Energy-Efficient Buildings

## WACKER and Dubai Central Laboratories Join Forces



### Dubai Central Laboratories (DCL)

- ▶ Defines standards and implements quality control for sustainable living.
- ▶ Acts as a stakeholder in establishing green building codes in the region.

### Background

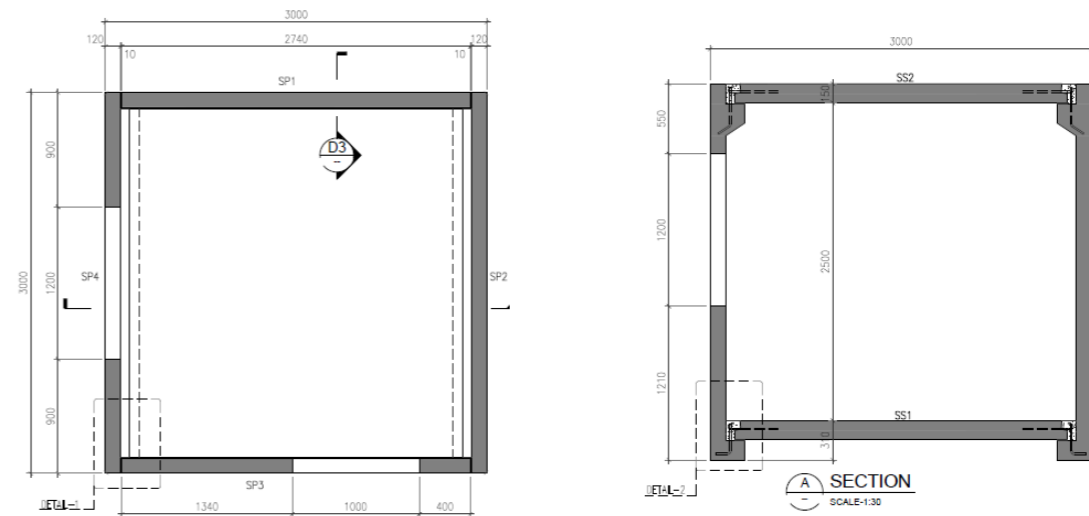
- ▶ Expensive air conditioning is needed to create thermal comfort in interior spaces.
  - ▶ Poorly insulated homes and inefficient building materials impair living quality of homes and raise A/C costs and energy consumption.
- > **In August 2018, WACKER and DCL launch twelve-month model house study.**

**Objective:** Deliver sustainable building solutions for the region.

# Model Houses Provide Comparison Between Conventional and Sustainable Construction Materials

## General Building Design

- ▶ Identical floor plans
- ▶ Foundation walls and roof made of light weight concrete
- ▶ Floor area: 7.5 m<sup>2</sup>, height: 2.5 m
- ▶ Overall volume: ~19 m<sup>3</sup>



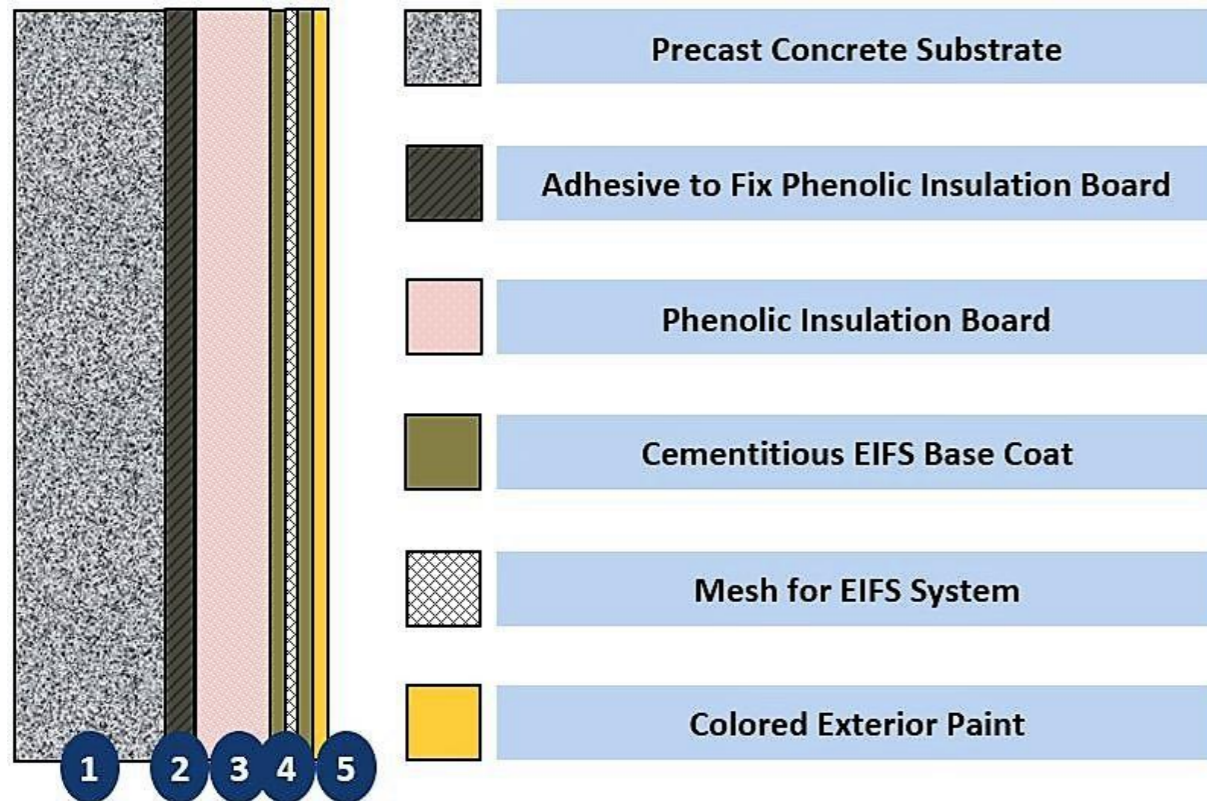
## Real Life Simulation

- ▶ **Two identical** housing model units
- ▶ Sustainable house (left) was insulated with an **External Thermal Insulation Composite System (ETICS)** and built with **WACKER enhanced products**.
- ▶ The other house was uninsulated. It was painted with a commercial paint and fitted with a commercial sealant.



# Sustainable Model House – Exterior Wall

## Exterior Wall Applications



## Exterior Insulation Finishing System

Exterior walls are the single largest source of hot and cold air leaks. An **Exterior Insulation and Finishing System** (EIFS) slashes energy costs significantly.

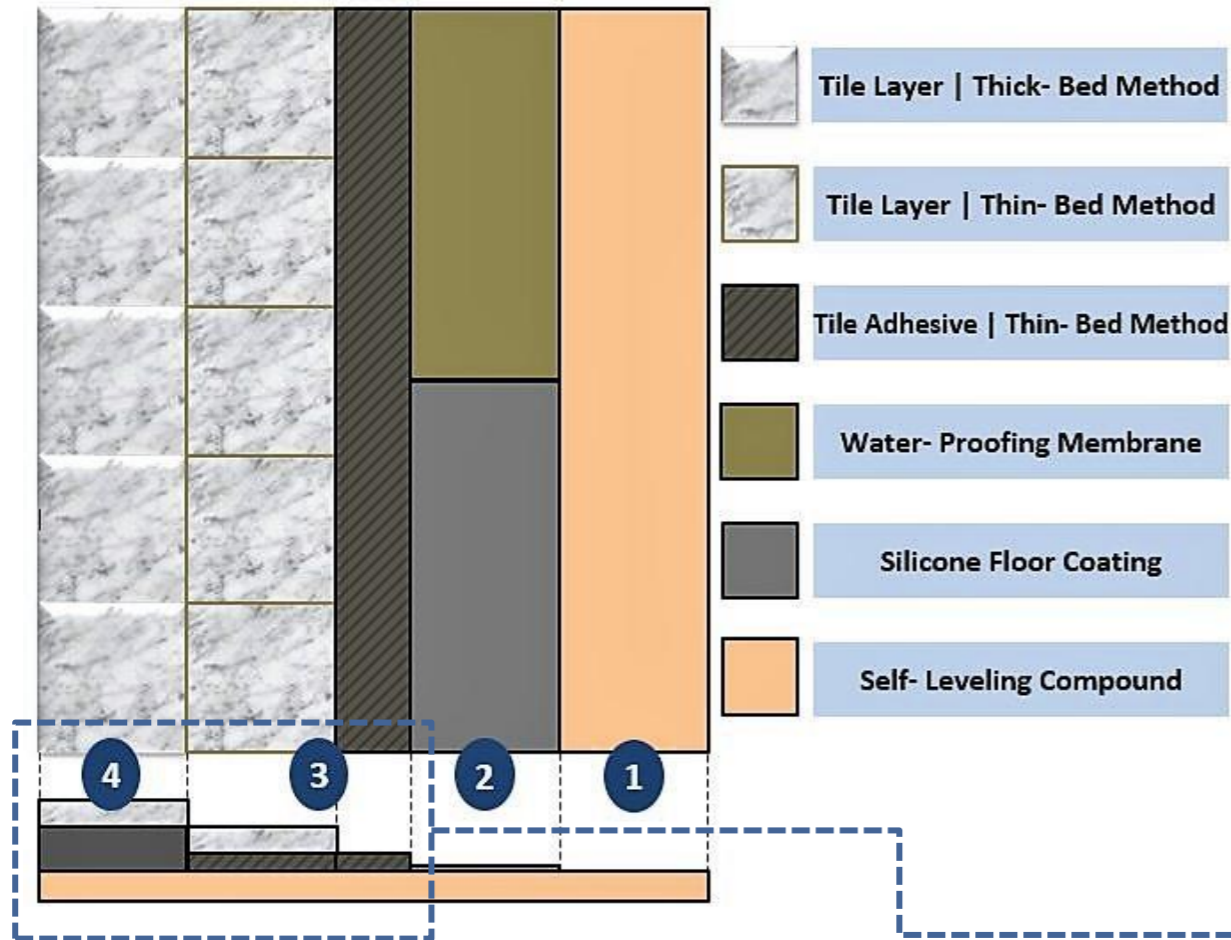
- 2 Insulation board was secured on the wall with an **polymer modified** EIFS adhesive.
  - ▶ Next, the board was covered with a flexible **polymer modified** base coat protecting it against weathering and providing mechanical strength.

## Wall Paint

- 5 Core shell technology PRIMIS<sup>®</sup> protects against moisture, dirt pick-up and chemical/biological attacks.
- 5 Silicone resin emulsion paint SREP<sup>®</sup> is water-repellent, UV-resistant and durable. Due to its water vapor permeability, the wall can “breathe”.

# Sustainable Model House – Floor

## Floor Applications



## Flooring

- 1 Polymer modified self-leveling compound yields void-free, abrasion resistant and smooth surfaces.
- 2 Solvent-free floor coating based on silicone hybrids protects the floor against damage and dirt and acts as a water barrier.
  - ▶ Polymer modified cementitious waterproofing protects floors in wet areas.

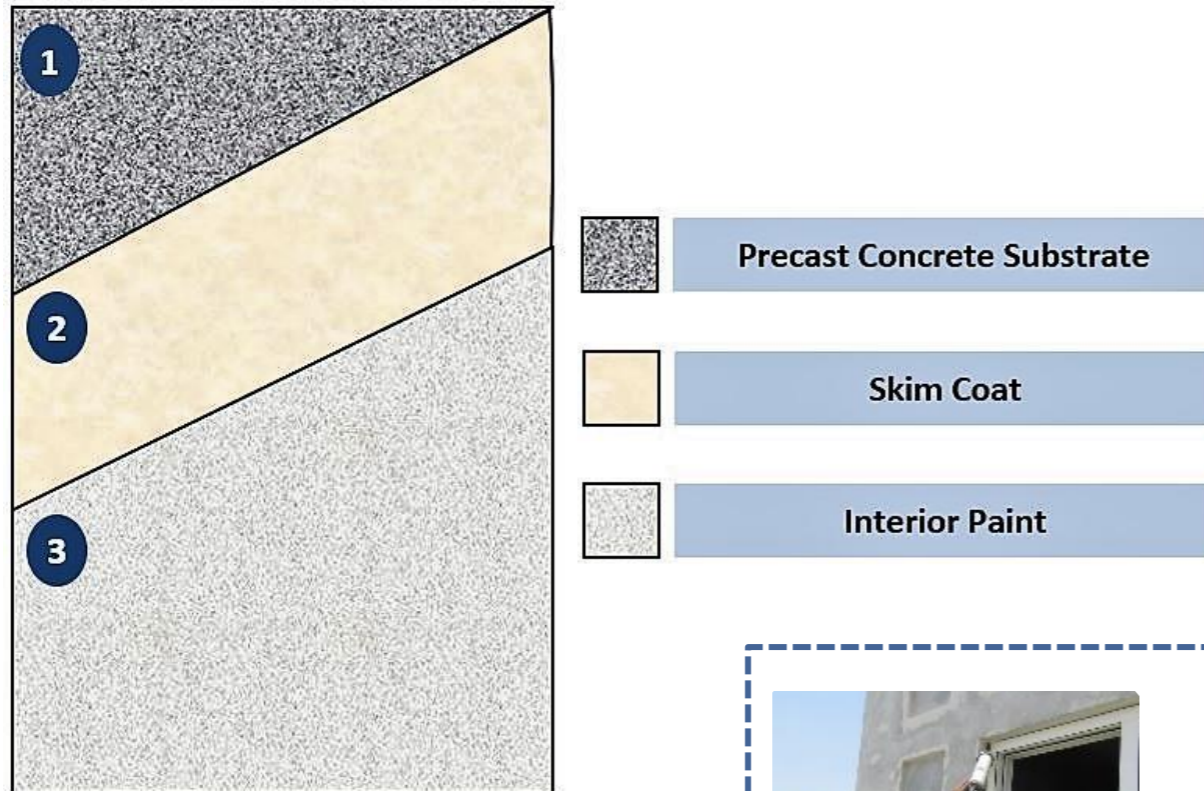
## Tiles

- 3 Polymer modified cementitious tile adhesives ensure crack-free adhesion of tiles and improve waterproofing.

▶ **Thin bed method saves sand and cement compared to conventional thick bed method.**

# Sustainable Model House – Interior Wall

## Interior Wall Applications



## Skim Coat

- 2 Skim coat produces smooth, flawless surface. Polymer binders based on vinyl acetate-ethylene copolymers (VAE) improve adhesion, flexibility and workability of the skim coat.

## Wall Paint

- 3 Low-odor, low VOC\* wall paint based on VAE copolymer binder. The binder is produced without APEO\*\* and is suitable for paints that comply with international eco labels.



## Sealing & Mounting

- ▶ Highly durable, UV and weather resistant silicone sealant for sealing door and window connection joints.
- ▶ Silicone hybrid adhesive for mirror mounting.

\* VOC: Volatile Organic Compound \*\*APEO: alkylphenol ethoxylates

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▶ **Design of the Experiment**

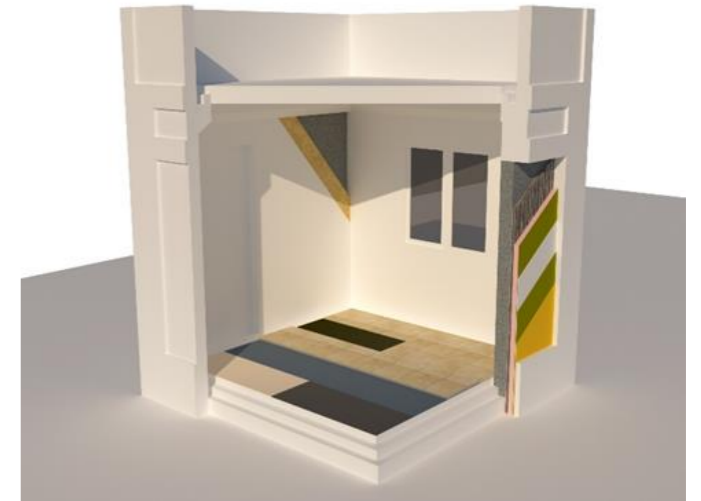
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# Design of the Experiment

## Air Conditioning

- ▶ To maintain the temperature inside the room, air conditioning units were installed in each of the two model houses.
- ▶ Both air conditioners were programmed to run continuously to a preset interior air temperature of 23°C.



## Recorded Data

- ▶ Energy consumption
- ▶ Interior temperature and humidity
- ▶ Atmospheric temperature and humidity
- ▶ Volatile organic compounds (VOC)





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# Results

## Significant Impact Observed by Using Silicone Sealants

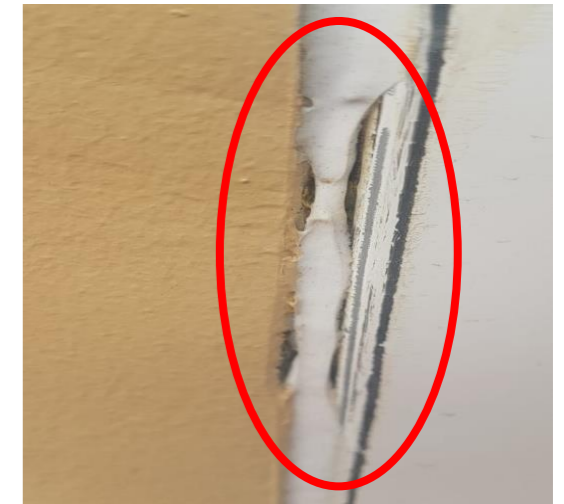
### WACKER Enhanced House

- ▶ Neutral curing silicone sealants used at exterior and interior connection joints were flawless after the twelve-month test.
- ▶ WACKER sealants comply with Green Building Rules (VOC: 37g/l), ASTM C920 and ISO 11600



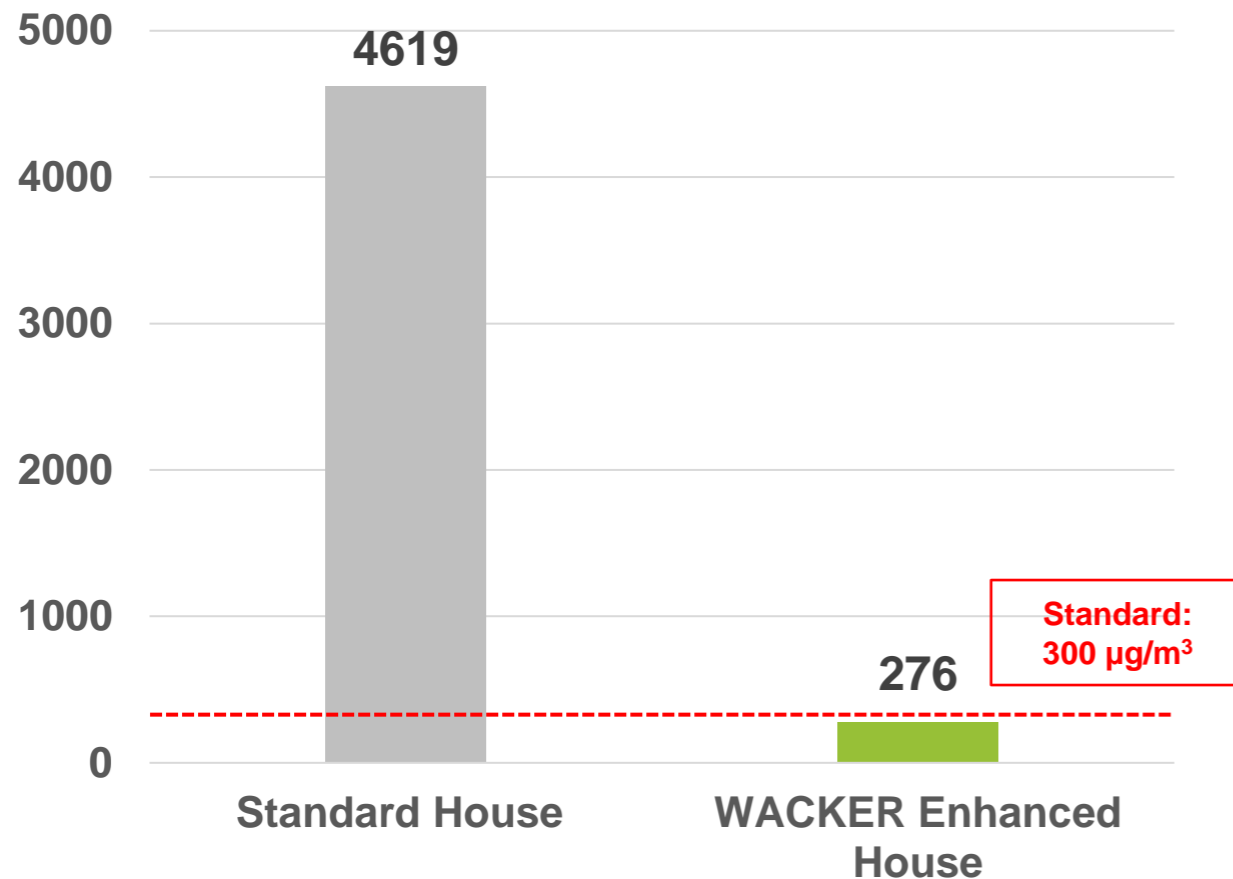
### Standard House

- ▶ Commercial sealants were used to seal the connection joints of windows and doors.
- ▶ After twelve months, the sealants which specify commonly for external use already showed cracks and stains.



# Results – Indoor Air Quality in Model House is Significantly Improved by VAE-Modified Paints and Silicone Sealants

## Volatile Organic Compounds (VOC) $\mu\text{g per m}^3$



### Standard House

- ▶ Water stains on the ceiling and walls due to the conventional materials' inability to cope with precipitation (outside) and condensation (inside)
- ▶ Humidity levels between 40% und 85%
- ▶ Paint and sealant emissions significantly exceed ISO standards for VOC.

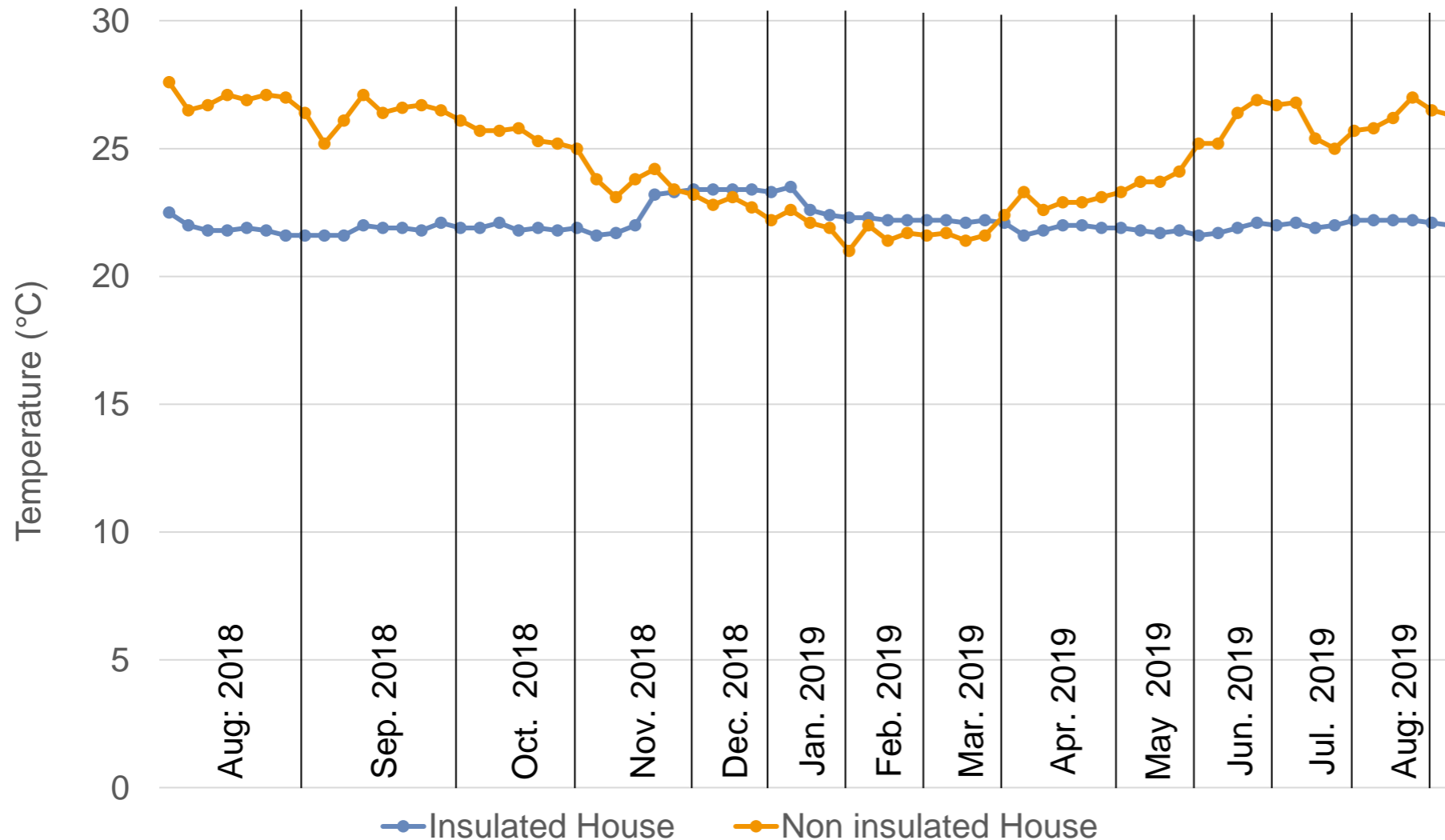
### WACKER Enhanced House

- ▶ VOC of VAE\*-based paint is seven times lower than that of conventional paints
- ▶ Indoor air quality in the **WACKER enhanced model house** fully complies with international standards

\* VAE = Vinyl Acetate-Ethylene Copolomer

# Results

## Indoor Temperature of Insulated vs Non-Insulated House



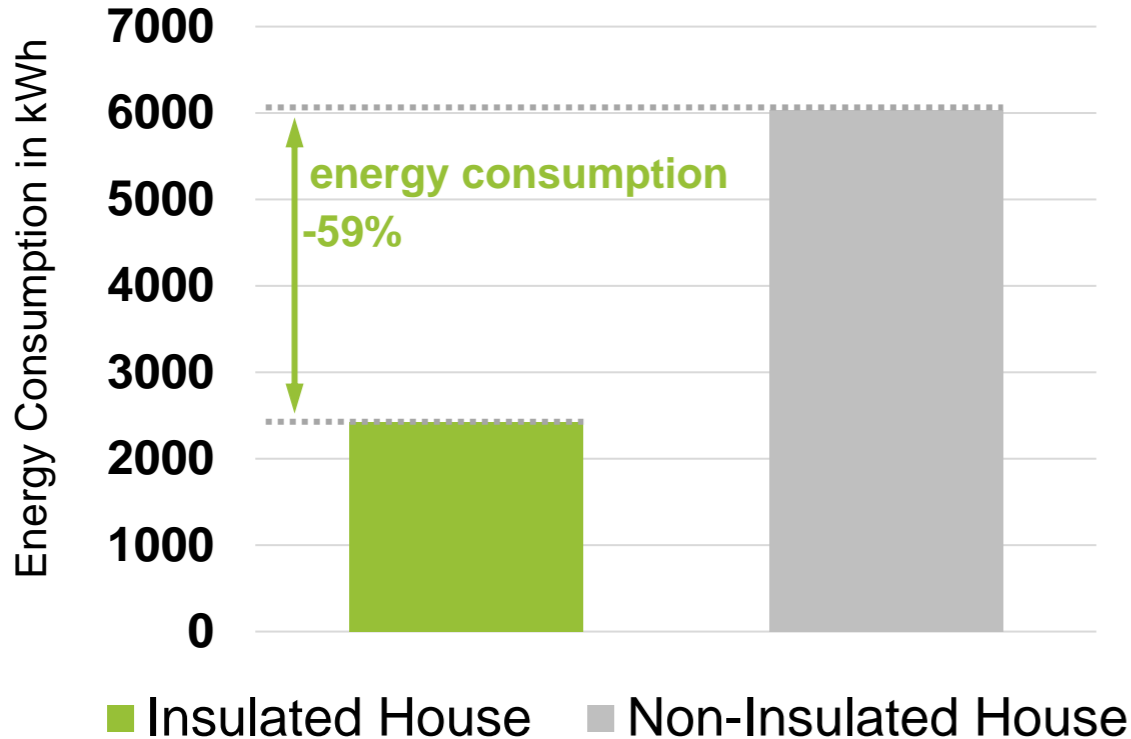
### Indoor Temperature

- ▶ Air conditioners in **both houses** were preset to an interior air temperature of 23 °C.
- ▶ In the **insulated house**, temperature remained **consistent**.
- ▶ The temperature inside the **non-insulated house** repeatedly increased up to 28°C.

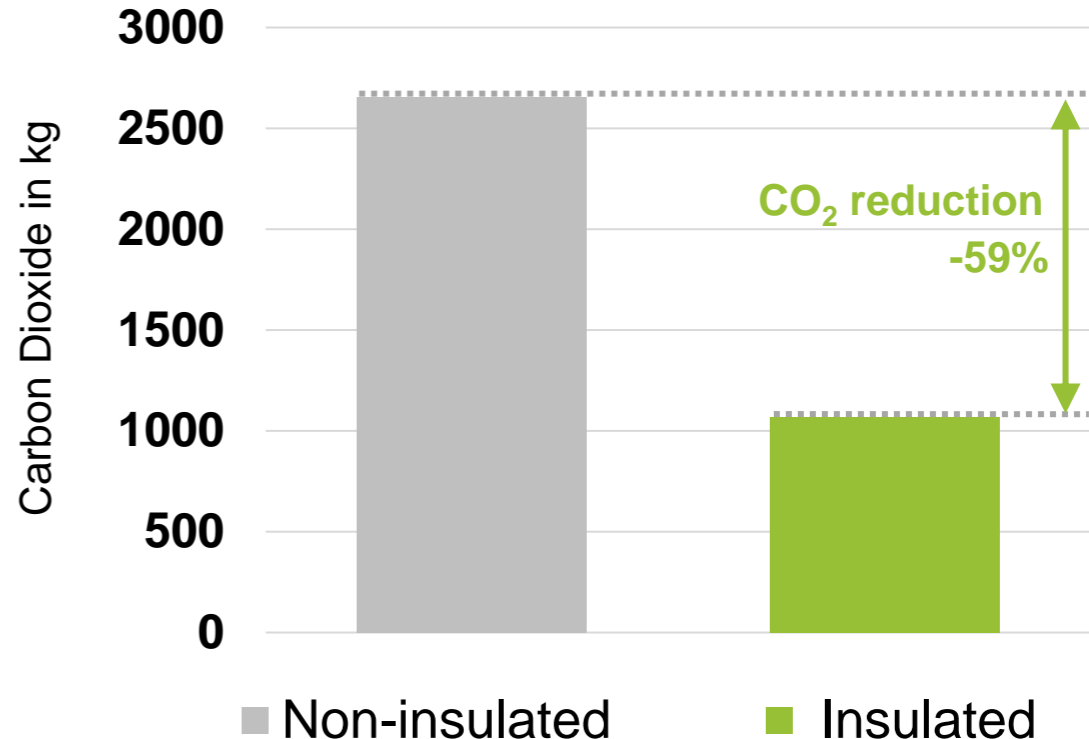
# Results

## Significant Reduction of Energy Consumption & Carbon Footprint

### Total Energy Consumption (kWh)



### Carbon Dioxide Emissions (kg)



► Energy consumption & CO<sub>2</sub> footprint of insulated model house were ~59% lower.

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# Model House Meets Dubai's Green Building Standard Al Safat

Parameter	Test Results	Al Safat Specification
VOC (8 Hour Data) Insulated house	276 µg/ m <sup>3</sup> (0.276 ppm)	300 µg/ m <sup>3</sup> (0.3 ppm)
VOC (8 Hour Data) Non insulated	4619 µg/m <sup>3</sup> (4.619 ppm)	300 µg/ m <sup>3</sup> (0.3 ppm)
Thermal Transmittance 'U' (EIFS)	0.33 W/m <sup>2</sup> K	0.57 W/m <sup>2</sup> K (Silver, Bronze)   0.42 W/m <sup>2</sup> K (Platinum, Gold)
Dry Bulb Temperature	21 - 24°C (Approximately)	22.5 – 25.5°C

<https://www.dm.gov.ae/wp-content/uploads/2021/06/Al-Safat-English-2021.pdf>

## Al Safat

- ▶ New buildings in Dubai are rated based on the implementation of **green building standards**.
- ▶ **Objective:** keep buildings cool inside
- ▶ **Four categories:** platinum, gold, silver and bronze

## WACKER Model House

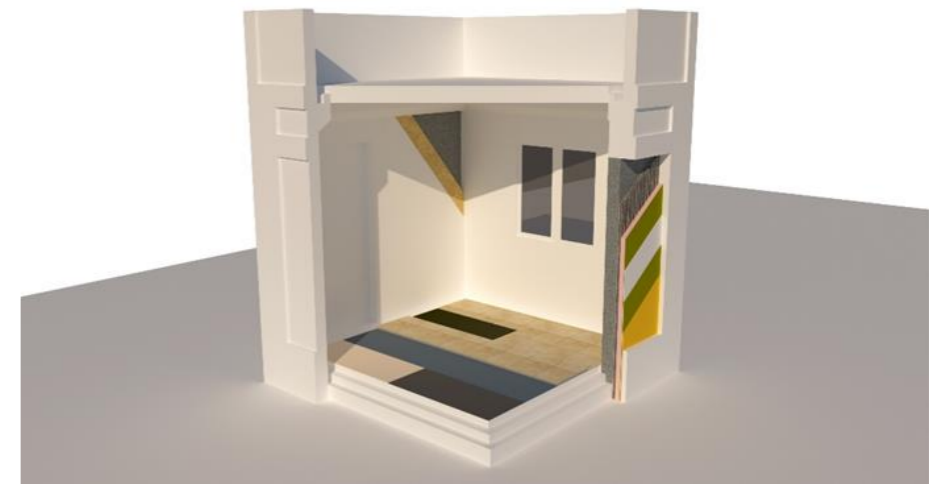
- ▶ **59% less energy consumption** and **carbon dioxide emission** through EIFS compared to the non-insulated model house.
- ▶ **55% less tile adhesive usage** through the thin bed application.
- ▶ **less dirt pick up** due to exterior paint applications based on SREP® and PRIMIS® technology.
- ▶ **lower VOC** with VAE technology compared to paints based on styrene acrylic.

# Summary and Outlook

- ▶ WACKER and DCL joined forces to create new standards for sustainable buildings in the UAE
- ▶ Results show that WACKER enhanced Model House
  - needs less AC
  - reduces power consumption and thus improves carbon footprint
  - fully complies with VOC emission standards and improves indoor air quality

## WACKER Recommendations

- ▶ Register project procedures and copyright study so that it can be used as reference for all stakeholders in the industry.
- ▶ Use the test results as a basis to amend the AI Safat guidelines under the supervision of DCL.
- ▶ Enforce or recommend the practices of saving the energy and improve the indoor air quality in all governmental buildings.





# Creating Sustainable Buildings in the Middle East

