

Zero Net Carbon Homes Pilot Program



Summary Report

This summary report is a condensed version of the Zero Net Carbon Homes Pilot Program evaluation report.

Prepared for Sustainability Victoria by Clear Horizon Pty Ltd

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Executive Summary

The ZNC Homes Pilot Program (the program) was designed to improve the supply of and increase consumer demand for ZNC homes and to pilot As-Build Verification (ABV) methodologies.

The program was delivered from 2017 to early 2021 by Sustainability Victoria (SV) in collaboration with Metricon Homes, SJD Homes, and Stockland.

The program exceeded the original targets, generated substantial interest from other government jurisdictions, volume home builders and land developers throughout Australia. The projects biggest success was the shift in the volume home built market, where prior to the program it was not possible to purchase a zero net carbon home, these are now available to customers. As noted by Metricon Homes:

Through the program we gained an understanding of the customers' expectations for ZNC Homes. We learnt a lot about how to target ZNC promotions to our customers, and we have been successful! This has been a big eye-opener for us (Metricon Homes)

Another fundamental shift was experienced by Stockland, which was the result of work completed in Marketing and Sales workshops:

We are looking at how to make a sustainability standard across our residential developments, so customers would have to opt-out rather than opt-in. We are currently looking at how we bring that proposition to life. That is transformational, we have talked about how to make Stockland more sustainable and appealing to customers, and this is a path that is based on evidence (Stockland)

The interest in Zero Net Carbon (ZNC) homes exceeded expectations and resulted in media news stories which improved the media reach beyond the project expectation. The original reach target of 7000 became a more than 2 million reach and through Sustainability Victoria's own social media alone the interactions and views exceeded 100,000.

The original targets and the achieved results are shown below in figure 1:

Performance Measure	Achieved Outcome	Planned Outcome
ZNC homes built	38	6
ZNC display homes built or in the pipeline	10	6
ZNC home sales to consumers	178	Offer only
ZNC home sales without financial support from SV	140	Offer only
Number of Customer enquiries	812	500
Reach	115,000 (SV channels only)	7,000
Research pieces delivered	7	4

The main achievement of the program was the demonstration beyond a doubt that:

- ▶ ZNC homes are affordable products with an 8 to 10-year payback period (on average) and annual savings of more than 50% on the energy bill.
- ▶ The cost to upgrade to a ZNC home varied between 3.8% to 6.7% and the bigger the home the cheaper the upgrade as a percentage.
- ▶ Most customers want an energy efficient home and a certified product would resolve customer confusion about what is and isn't an efficient or sustainable home.
- ▶ Creating a Zero Net Carbon Home is easy to achieve with today's technology
- ▶ Most homes needed only 5 – 6 KW solar (North, East or West facing) to reach the target.

Achievements and learnings: Zero Net Carbon Homes Pilot Program summary report

Purpose

This report presents the key achievements and learnings from the Zero Net Carbon (ZNC) Homes Pilot Program, summarised from the ZNC Homes Final Evaluation report.

About the ZNC Homes Pilot Program

The ZNC Homes Pilot Program (the program) was designed to improve the supply of and increase consumer demand for ZNC homes and pilot As-Built Verification (ABV) methodologies.

The program was delivered from 2017 to early 2021 by Sustainability Victoria (SV) in collaboration with Metricon Homes, SJD Homes, and Stockland.

As part of the program, SV commissioned the development of a ZNC Homes Design Tool to assess if the builder's Home designs met the 'Zero Net Carbon' criteria, which is 'the home's operational energy use produces no net greenhouse gas emissions'. The tool enabled fast delivery of a zero net carbon rating, which is pass/fail rating rather than a star rating. The ZNC tool was used to assess if homes passed the ZNC rating by uploading into the tool, the home's NatHERS FirstRate5 file and the fixed appliances such as lighting, heating, cooling and cooking appliances and the hot water service. The tool also assumed a plug load for other items such as TVs, computers and so on. The user then added solar PV generation capacity to ensure that the net emissions of the home are zero or below. The tool had the added benefit that it increased builder capacity and understanding regarding the design criteria required to achieve a ZNC rating.

The program also offered design and as-built workshops to strengthen the capability of builders in the design and construction of ZNC homes. The As-Built Verification (ABV) methodology and process was then used to verify that the constructed homes had achieved a ZNC rating, and further embedded the builder's learning and development to secure best practice for the installation of insulation for thermal performance and energy efficiency. The program also provided a financial incentive to each builder to offset the costs of upgrading homes to a ZNC standard.

SV undertook market research activities and shared the insights with participants to support program builders drive consumer demand for ZNC Homes. SV also commissioned customer journey mapping workshops and sales workshops that allowed sales teams to map the customer journey and experience and provided them with sales materials.

To further drive consumer interest and industry awareness of ZNC Homes, SV delivered a range of marketing and communications activities, targeted industry engagement and advocacy through promotional opportunities for the program and the builders display homes. The program also investigated establishing a certification for ZNC Homes (Tomorrow Living).

Achievements

The program successfully met and exceeded set KPIs. A total of 38 ZNC Homes were constructed through the program by the three participating builders. This far exceeded the pilot program's target of six homes.

The program resulted in SJD Homes and Metricon Homes offering ZNC Homes in their range with Stockland still considering whether and how they might offer them to customers. The ZNC offers from SJD Homes and Metricon Homes have realised 140 sales beyond the pilot program so far (see Table 1).

SJD Homes also sold more than 125 low-carbon homes during the period of the program.

Table 1 Snapshot of key achievements

Performance Measure	Achieved Outcome	Planned Outcome
ZNC homes built	38	6
ZNC display homes built or in the pipeline	10	6
ZNC home sales to consumers	178	Offer only
ZNC home sales without financial support from SV	140	Offer only
Number of Customer enquiries	812	500
Reach	115,000 (SV channels only)	7,000
Research pieces delivered	7	4
Volume home builders are actively offering ZNC homes	3	3

SJD Homes successfully upgraded homes to a ZNC standard for a low price. This builder was able to upgrade homes to a ZNC standard for approximately \$10,000 and sold 28 of these homes for a \$5,000 upgrade cost to consumers, with the remaining \$5,000 covered by SV.

The National Construction Code is telling us that by 2025 all new Australian homes should be ZNC. I feel we are already there; it is not that hard. (SJD Homes)

Metricon Homes successfully sold ZNC Homes at an upgrade cost higher than \$15,000. This builder sold 21 homes with no subsidy from SV, suggesting that some consumers are willing to pay a larger amount for a ZNC Home without requiring government support.

- ▶ Through the program we gained an understanding of the customers' expectations for ZNC Homes. We learnt a lot about how to target ZNC promotions to our customers, and we have been successful! This has been a big eye-opener for us (Metricon Homes)

Stockland is thinking bigger, the builder is considering offering ZNC Homes across their entire range as a default package, and would require consumers to opt-out of buying a ZNC Home rather than opt-in.

We are looking at how to make sustainability standard across our residential developments, so customers would have to opt-out rather than opt-in. We are currently looking at how we bring that proposition to life. That is transformational, we have talked about how to make Stockland more sustainable and appealing to customers, and this is a path that is based on evidence (Stockland)

Learnings

Through the program SV learned about how to engage with Volume Home Builders (VHB) and about the consumers who purchased ZNC Homes.

Learnings about engaging with VHBs

SV contributed to the program's achievements by supporting builders to improve their capacity to supply and sell ZNC Homes.

Increasing VHB capacity to supply ZNC homes

- › VHBs were able to design, construct, and sell verifiable ZNC homes for a low additional cost. At the commencement of the program some builders were unsure they had the ability to build ZNC Homes cost-effectively; but SJD Homes and Metricon Homes have built and sold homes with less than \$20,000 in additional costs.
- › The design tool facilitated the correct sizing of the solar PV systems to achieve the ZNC standard.
- › Optimising the design before construction substantially decreased the cost of upgrading homes to a ZNC standard. The cost of upgrading homes to ZNC was significantly higher for builders that had not assessed their house design before starting construction.
- › The ABV and design workshops were useful for builders as it increased their capacity to design and construct these types of homes. Delivering ABV workshops in person benefited builders with a single crew, while builders with multiple crews preferred an online format of the workshop that could be accessed on demand at different times and locations.
- › The ABV checks were crucial to improving the knowledge and skills of builders, the verification process and findings provided practical cases for tradespeople to learn from. One builder decided they could not justify the additional cost to the consumer of the ABV testing, and therefore will not include it in their product range after the completion of the program. While they will still offer a low-carbon home, they will not claim it as a ZNC Home.
- › It takes time for builders to sign agreements with the government, design an offer, obtain approvals, construct and sell a home. The larger builders required at least the 3.5 years, approximately the period of funding for the program.
- › There were more VHBs interested in the pilot program than could be included. A further nine VHBs expressed interest in joining the program but were not able to participate because the procurement was through a tender process, which meant that unless the parties had participated in the original tender process, they could not join later.

Increasing VHB capacity to sell ZNC Homes

- › Consumers were willing to pay the full price for a verified ZNC home with the right promotions. Metricon Homes were able to sell 20 homes with no subsidy, which indicated a sign of consumer demand for ZNC Homes and the role effective promotion plays in selling these homes.
- › The project's marketing research provided insights that were used by both Metricon Homes and SJD Homes when promoting and selling the homes. The research concluded that promoting the greater quality, increased comfort and cost savings attributed to a ZNC Home increased consumer demand more than did promoting the sustainability benefits.
- › Improving the energy efficiency of existing house designs was a preferred option for builders who had already invested heavily in delivering optimised designs their customers want to buy. The original intention was that each builder would only have two ZNC designs, but this was abandoned to meet the builder's preferences, and the ZNC tool was developed to enable builders to upgrade any design in their portfolio to ZNC.



ZNC Certification

- ▶ Builders believed a ZNC certification would be useful for driving consumer demand, however the evolving context and ongoing resourcing required presented challenges to establishing a relevant certification program. For a ZNC certification to be useful, it would need to have at least a state-wide footprint, if not national. In this way, the relevance of a ZNC certification is subject to a rapidly evolving national context which includes planned changes to the National Construction Code (NCC) and the current development of another other similar certification program. Tomorrow Living, the registered Trademark for the certification program would require ongoing resourcing to launch, maintain and promote it to ensure its continuing relevance and market value.

Learning about engaging with consumers and homebuyers

Through participating in the program, builders gained new knowledge and skills to support their consumer engagement and sales strategies for ZNC Homes:

- ▶ Offering ZNC Homes through their website as an add-on package to a standard home design was an effective strategy for engaging buyers
- ▶ Customers with a pre-existing awareness and appreciation of the costs of ZNC Homes were easier to convert to home sales
- ▶ The demand for ZNC Homes largely came from second- and third- home buyers.



Replicating and scaling the program

The program's approach was effective and could be replicated at a similar scale. It has been successfully delivered using the approach of partnering with a small group of VHBs. The program has far exceeded the objectives set out by the Sustainability Fund, and there is interest from other VHBs to participate in similar programs.

While many elements of the program could be scaled, this must be considered within the changing and evolving context presented by the changes to the National Construction Code (NCC) currently under consultation and the work done by the Green Building Council of Australia (GBCA), who are in the process of setting up a residential certification program called Future Homes.

If the NCC raises the minimum carbon standard of homes, it will drive the need for capacity building across industry and create a spike in demand for some elements of the ZNC Homes Program, for example; the ZNC design tool, ABV testing and best practice training. VHBs will need to act to meet the new minimum requirements, and other organisations will seek to provide this capacity building using similar methods to SV.

Individual elements of the program could be used and scaled to support VHBs to build ZNC Homes, and there are many opportunities to improve how this could be done using learnings gained through the program. These include:

- › Publishing the ZNC Homes design tool online to be freely accessed by builders and providing ongoing resources to support its use
- › Scaling up the use of the ABV methodology to support ZNC certification and reduced costs through economies of scale
- › Sharing the marketing insights research that builders have implemented successfully, resulting in home sales.
- › Developing online training to increase build and design capacity that can be accessed by tradespeople around the state.

Conclusion

The program has successfully contributed to ZNC Home sales, increased the capacity of builders to design, build and sell ZNC homes, and contributed to the State Government's 2050 net zero emissions target.

The builders have sold and/or built 178 ZNC Homes, with 38 of these included as part of the program.

SJD Homes and Metricon Homes both developed and offered ZNC Home products to their customers during the program period, and received a strong uptake from home buyers. Stockland is considering an opt-out strategy which is also a key achievement for the pilot program and one of Stockland's participating builders, VCon, is offering a ZNC home design.

The program has piloted the As-Built Verification (ABV) methodology, developed a new best practice standard, built the capability in the VHB industry, however builders believe that the costs of ABV testing remain a challenge.

All builders were provided with ABV testing workshops and learned from test findings conducted on their homes in the program. ABV testing marginally increased the cost of upgrading homes and created a risk of failing the test for the builder but a guarantee that the home met the requirements for the home buyer.

The program recognised that VHBs have distinct needs and successfully adapted the pilot to meet the unique needs of each participating builder. SV initially had planned to deliver the program in a particular way, however research provided customer insights and in-depth discussions with each builder provided an understanding of how each of the builders operates. The different needs of each builder meant that SV had to tailor support to align with the specific needs of each builder. As a result of the tailored approach, builders continued to remain actively engaged throughout the program and it ensured successful delivery of the program beyond the planned outcomes.

The program delivered a new design tool for the building industry, created new learnings and insights about how to increase the supply and demand of ZNC Homes. Many elements of the program had not been trialled in Victoria previously. Through working with three distinctly different VHBs, the program has surfaced new learnings and insights about what works for VHBs of different sizes and types and what works for land developers when improving their capability to supply ZNC Homes to the Victorian market.

As the ZNC Homes program concludes SV has a unique opportunity to collaborate with industry, non-government organisations and other government jurisdictions to leverage the knowledge from the program to lead meaningful change in the VHB sector and the broader building industry. This is very timely given the context of changing national construction code requirements for energy efficiency in the residential construction sector.



Appendix A: ZNC Program NatHERS Design Report

The Program offered Program Builders thermal performance advice via NatHERS assessments, audits and design workshops ensuring that all assessments met the required technical and regulatory standards.

Homes in the ZNCH pilot program achieved house energy ratings ranging from 6.4 to 7.6 Stars, with many homes exceeding the 6.5 Star minimum requirement.

Key findings include:

Timing:

- ▶ Undertaking NatHERS assessments early in the design stage improves design outcomes and reduces added costs of increasing the home's NatHERS rating from 6.0 to 6.5 Stars.
- ▶ Proactive engagement with participating builder's sales and design teams enables design advice to be offered as early as possible in the customer engagement process, resulting in better design outcomes.
- ▶ NatHERS assessment should be undertaken prior to seeking development consent or final client design approval, so that the most cost-effective performance optimisations can be identified for each home.

Orientation:

- ▶ The orientation of a home and its site can make a significant contribution to thermal performance and cost of construction and the program demonstrated that the difference between the best and worst orientation for a dwelling could be greater than 1 Star.
- ▶ Homes with optimal orientation often achieved the minimum 6.5 Star rating with modest specification upgrades.
- ▶ A NatHERS assessment early in the design process can assist homebuyers to take advantage of orientation and moderate the cost of increasing the NatHERS Star rating.

Design:

- ▶ The Program demonstrated how popular design features such as covered outdoor living areas can help or hinder thermal performance, and the influence of housing typology.
- ▶ NatHERS design workshops provided a collaborative space for testing various design options to achieve improved NatHERS ratings.

Quality assurance:

- ▶ NatHERS assessments by external assessors demonstrated considerable variation in modelling accuracy and thermal performance optimisation choices, with the worst errors made by unaccredited assessors.
- ▶ The process of peer review and quality auditing was an important mechanism for detecting errors and revising NatHERS results before ZNC modelling.

Appendix B:

ZNC Program As-Built Verification Report

An As built Verification methodology was tested during the program, to ensure that the homes performed as expected, by ensuring that the insulation was installed correctly and that the home was air-tight. Further to that, a set of criteria was implemented for the program participants to meet, the criteria was identified as best practice through literature review. Key facts for the program were:

As-built Verification Company	Efficiency Matrix
Number of home inspections conducted during the program	35
Number of training workshops delivered	3
Test methods	Blower door test, visual inspection and thermography
Acceptable range for air-permeability	3–6 m ³ /m ² .hr @50 Pa
Range achieved for air-permeability	3.38 – 6.0 (two homes had 10 but were issued exemptions as they had evaporative cooling)
Acceptable tolerance for insulation non-coverage	5%
Range achieved for insulation non-coverage	0.16% – 5%

The ABV resulted in the development of some ABV software, an ABV checklist to assist people on site and to help builders pass the ABV first time in their new builds. Workshops were completed to ensure that builders and the relevant trades were shown on site how to install insulation and what to do to ensure that the home was air-tight.

The key lessons learned were:

The work done by insulation installers at the start of a project, can be significantly tampered with and degraded by the end of the project.

Remediation of issues is not always taken seriously. There is confusion about what is an acceptable standard and what is not.

When the plaster has been installed on the walls, sometimes the plaster is not sealed appropriately before the carpet is installed.

Recessed lighting is inconsistently insulated and batts are sometimes removed completely from their position.

In some cases, ductwork was not connected to outlets.

A full batt or a half batt of insulation was removed to connect the ducted heating register.

Ducted heating returns were always extremely leaky to the roof.

Penetrations behind the kitchen joinery were just awful big holes, and none of the plaster is caulked to the slab.

ABV cannot be done if it is too windy, builders are not necessarily aware of this.

Because wall and eave insulation were common problem areas, we recommend that builders complete an insulation inspection before plastering.

The builder sometimes organised the final inspection before completing key components. Here is a checklist builders [insert link] can use to ensure the final inspection is worthwhile and covers all necessary components.

Appendix C:

Case Study 1 – SJD Home



Timbertop Estate, 290 Newark Place, Officer

Land developer: **Parklea Developments**

Home retail cost: **\$246,000**

ZNC upgrade cost: **\$10,000 (includes EV readiness)**

Annual Energy Cost Savings: **\$2,210**

NatHERS rating: **6.9 Stars**

As-built verified to Zero Net Carbon Homes standard

290 Newark Place was designed to run exclusively on electricity, with energy consumption fully offset by onsite rooftop solar PV. The home was modelled to use 53.6kWh of electricity per year, which is fully offset by a 5kW rooftop solar PV system. Energy bills are modelled to reduce by 77 per cent and annual greenhouse gas emissions by 100 per cent or 8tCO₂-e.

Benefits of the design include lower energy bills due to:

- › North-facing orientation
- › 95% insulation coverage
- › Double glazed windows and sliding doors
- › Energy efficient appliances, including heating and cooling split systems and heat pump hot water
- › 5kW battery-ready PV system with 17 solar panels
- › 4.6 air-changes per hour

Appendix D: Case Study 2 – Metricon Home



Kaduna Park Estate, 4 Mortlake Drive, Officer South

Land developer: **Parklea Developments**

Retail cost: **\$364,265**

ZNC upgrade cost: **\$21,150 (aluminium windows) –
\$28,090 (timber windows)**

Annual energy cost savings: **\$1,522**

NatHERS rating: **6.6 Stars**

Victorian Residential Scorecard: **7**

As-built verified to Zero Net Carbon Homes standard

Designed to run on electricity and gas, the home was modelled to use 1637MJ of energy per year, which is offset by a 6kW rooftop solar PV system. Energy bills are modelled to reduce by 58 per cent and annual greenhouse gas emissions savings by 105 per cent or 7tCO₂-e.

A home designed for comfort

The higher than mandated NatHERS rating produces a more comfortable living environment that is healthier too, due to better indoor environment quality. Modelling has shown that the home, although facing south, will sit within the comfort range of between 18-26 degrees for more hours compared with a 6.0 Star rated home.

Benefits include lower energy bills due to:

- › 95% insulation coverage
- › Increased use of double-glazed windows compared with standard homes
- › Energy efficient appliances
- › 6kW PV system
- › 5.1 air-changes per hour

Appendix D: Case Study 3 – Creation Homes (Stockland)



As-built verified to Zero Net Carbon Homes standard

The Creation Homes Braybrook townhouse achieved an impressive 7 Stars in the NatHERS rating which is above the current minimum 6.0 Star requirement for all new homes. The superior Star rating, along with energy efficient appliances and fixtures improves overall comfort and feel.

The home's attention to design and use energy efficient appliances, reduces heating and cooling loads by 30 per cent when compared with a 6.0 Star rated home. Occupants will enjoy lower heating bills by up to 50 per cent and annual greenhouse gas emissions are reduced by around 4.7tCO₂-e.

Benefits include lower energy bills due to:

- › 99% insulation coverage
- › Increased use of double-glazed windows compared with standard townhouses
- › Energy efficient appliances
- › 3.3kW PV system
- › Extra draught-proofing
- › External shading
- › 4.3 air-changes per hour

Appendix E: Research Report Overview – Consumer Research

A number of research pieces were undertaken to support the Zero Net Carbon Homes program identify and refine effective methods of marketing and selling sustainable homes.

Volume Home Builder Research

This research explored:

- › purchase pathways and consumer motivations
- › design considerations and decisions
- › Research time and strategies
- › Appeal of ZNC features
- › Messaging
- › Exploring package offers

ZNCH Program Name Research

In order to assist in the marketing of the program, research was required to explore consumer perceptions of the ZNCH program name. Previous research by Sustainability Victoria indicated that a name needs to not only convey sustainability, but also luxury and comfort.

The research was conducted with 202 people who had bought a new home in the past 2 years or who were planning to buy a new home in the next 2 years.

The leading option for the program is “Tomorrow Living: Designed and built for efficiency and comfort.” This combination ticks a lot of boxes in terms of eliciting the right types of associations and being clear enough about the issue of sustainability but while also including the concept of comfortable design features and it would be a perfectly acceptable decision for the program.

Customer journey mapping

A customer journey map was co-developed with SJD Homes, Parklea Developments and SV to identify key points in the process of buying a home where ‘selling’ a ZNC home might be effective. Selling points include: ongoing value; quality; ongoing affordability; and comfort.

Four personas were developed to help the sales team to effectively communicate with potential buyers and at the appropriate point in the sales process.

Customer insight mapping

The research tested the potential of a process that presents sustainability features as a standard feature of homes and connects the benefits of sustainability features to the motivations and lifestyle of the homebuyer.

Insights gained included:

- 1 Homebuyers can see how sustainability features can better meet their needs.
- 2 When you make sustainability a consistent part of the conversation, homebuyers will see sustainable and climate conscious decisions as worthwhile.
- 3 When you present sustainability features as relevant, credible and straightforward, homebuyers readily connect with the value and benefits of them.
- 4 Homebuyers are willing to make sacrifices for sustainability features when you navigate these trade-offs with

Appendix F:

Research Report Overview

– 15 Facts about ZNC homes

This report provides a summary of design outcomes of the Zero Net Carbon Homes program. It is based on the designs of 15 homes from the program that were all modelled as a 6 Star NatHERS rated business as usual (BAU) home which were compared with 7 Star NatHERS and ZNC rated homes. The key findings were:

- 1 ZNCH program homes are well orientated for their design
- 2 Insulation and glazing delivered 7 Star NatHERS
- 3 Big homes need more solar
- 4 Fabric plus solar PV = 90% of improvement cost
- 5 ZNC homes don't cost the earth
- 6 ZNC homes give savings from day one
- 7 There is adequate roof space for solar to offset energy use
- 8 Grid emissions intensity matters when using gas
- 9 ZNC homes are more comfortable
- 10 ZNC homes save \$1000+ on energy bills
- 11 Heating improvements and solar PV deliver 80 to 99% of savings
- 12 Solar PV delivers over 75% of emissions reductions
- 13 Gas heating is the main energy user
- 14 ZNC homes help pay your mortgage
- 15 A ZNC home will on average save between 75 tonnes to 150 tonnes of CO₂-e to 2050 (depending on the policy settings).

Six thoughts

- 1 The ZNC homes modelled were better than BAU on every measure included in the research: financial, environmental and social.
- 2 Cumulative impact of ZNC homes for climate change mitigation is a big opportunity given emissions reductions of 75+ tonnes per home to 2050.
- 3 Solar PV provided the largest savings for cost and emissions. Longevity of the building shell, heating, cooling and hot water systems should be considered.
- 4 As the electricity network greenhouse intensity decreases, all electric homes continue to deliver as zero net carbon. This is less clear for mixed fuel homes as the ratios of electricity to natural gas GHG coefficients impact solar PV offsets.
- 5 ZNC homes are more comfortable, however, further work is warranted on thermal comfort impacts for homes as a whole and for different room types and uses. Reducing heat and cold stress for climate resilience should also be considered.
- 6 Verifying the built outcomes through operational data would further strengthen the case for ZNC homes and assist in ongoing predictive modelling.

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