



# CSIR SMART PLACES

Harnessing transformative technologies for smarter buildings, industries, cities and communities – places that are environmentally sustainable and smart about their resource use.



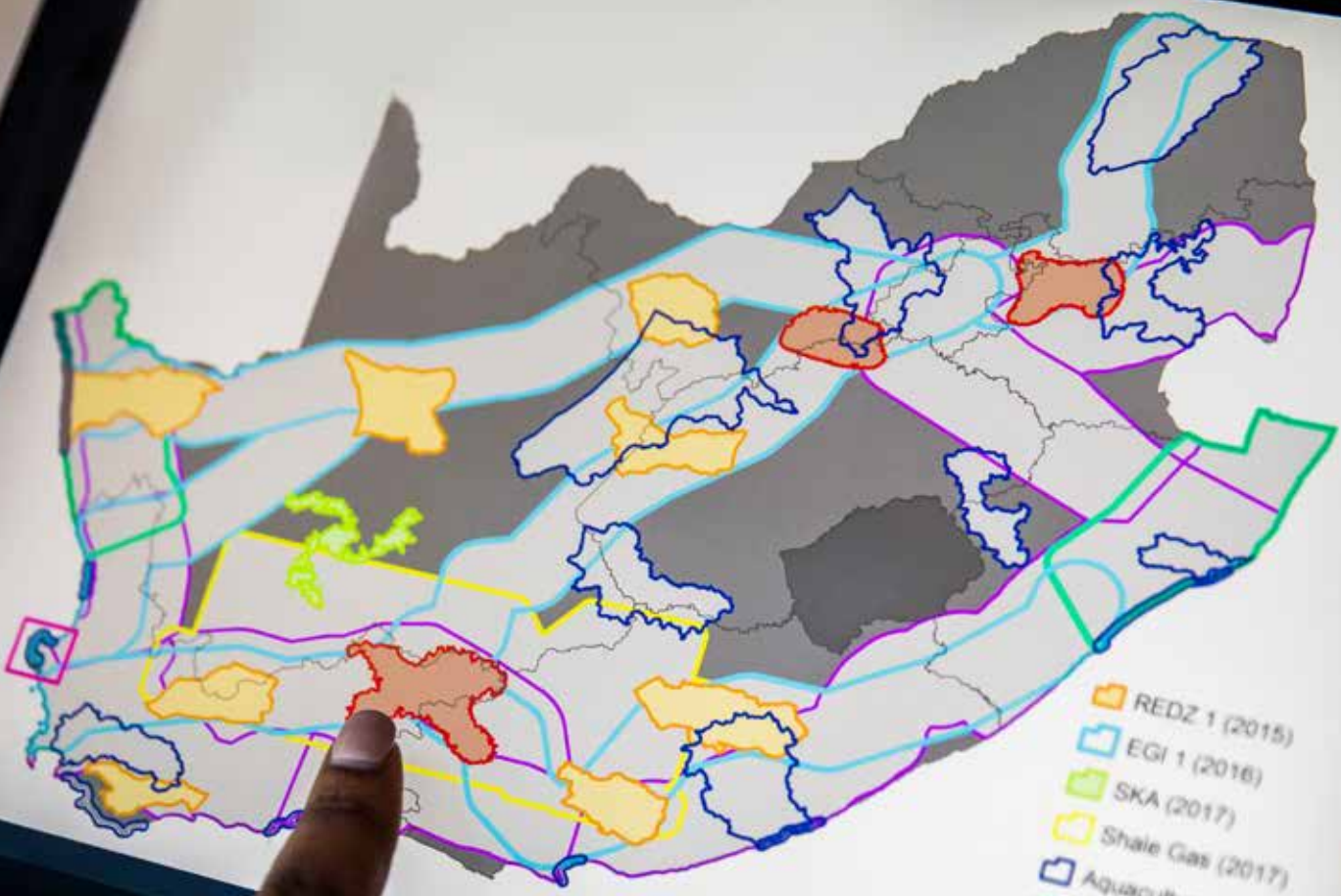
science & innovation

Department:  
Science and Innovation  
REPUBLIC OF SOUTH AFRICA



**CSIR**

Touching lives through innovation



- REDZ 1 (2015)
- EGI 1 (2016)
- SKA (2017)
- Shale Gas (2017)
- Aquaculture (2018)
- EGI 2 (2019)
- Gas pipeline (2019)
- REDZ 2 (2019)
- Saldanha Bay (2019)

# ABOUT THE CSIR

The Council for Scientific and Industrial Research (CSIR) is a leading scientific and technology research organisation that researches and develops transformative technologies to accelerate socioeconomic prosperity in South Africa.

The organisation's work contributes to industrial development and supports a capable state. The CSIR is an entity of the Department of Science and Innovation.

The organisation plays a key role in supporting the public and private sectors through directed research that is aligned with the country's priorities, the organisation's mandate and its science, engineering and technology competences.

**The nine high-impact sectors identified by the CSIR to achieve its aims are:**

## Industry advancement clusters



Advanced Agriculture and Food



NextGen Health



Future Production: Chemicals



Future Production: Mining



Future Production: Manufacturing



Defence and Security

## Industry and society enabling clusters



Smart Places



Smart Mobility



NextGen Enterprises and Institutions



# ABOUT CSIR SMART PLACES



CSIR Smart Places aims to contribute to smarter places – smart buildings, cities and regions – underpinned by a sustainable environment – places that are smart about their water and energy use.

The CSIR, with its rich multidisciplinary science, engineering and technology base – in climate change, environmental sciences, energy, water, building science, spatial planning and cleaner production – is ideally positioned to contribute to smarter places, including smart buildings, cities and regions, manufacturing, water use and energy use. Applying these skills to create truly smart places, contributes to improving the lives of South Africans.

The resource focus includes resource efficiency and cleaner production for sustainable industrialisation, and the optimisation of smart infrastructure enables smarter connected resources and infrastructure, revolutionising the way of doing business and delivering services.

CSIR Smart Places also focuses on renewable energy – solar, wind – and thermal storage – and undertakes supply forecasting. Research and development in energy systems focuses on the challenges of introducing more renewables into the energy mix and improving the management of electricity demand during re-industrialisation. CSIR Smart Places has strong knowledge sets on grid planning and energy demand.

In terms of water, expertise extends to water and wastewater treatment technologies, real-time water management systems, water resource monitoring and water resource risk mitigation.

## IMPACT AREAS

- Inclusive Smart Settlements and Regions
- Functional Building Infrastructure
- Sustainable Ecosystems
- Holistic Climate Change
- Water Centre
- Energy Centre
- Smart Places Hosted Industry Support Programmes

## IMPACT

- Lowered cost of infrastructure and construction materials
- The reduced carbon footprint of socio-economic activities, while mitigating and adapting to adverse effects associated with the use of natural resources
- Robust plans and policies
- Improved availability and reduced cost of water and energy

# STRATEGIC CONTEXT

CSIR Smart Places harnesses the opportunities afforded by transformative technologies to support resource trade-off modelling, develop smarter infrastructure and service developments directed towards enabling competitive industrial environments, sustainable ecosystems and economic growth.



## ► CSIR SMART PLACES

- Addresses the unsustainable use of natural resources and mitigates challenges related to the associated adverse effects
- Supports the transformation of built environments to ensure that citizens have equitable access to adequate human settlements, functional services and economic opportunities
- Responds to infrastructure challenges in support of sustainable socio-economic activity
- Supports decision-makers with thought leadership, products and tools to foster robust planning and policy setting



# VALUE CHAIN

CSIR Smart Places focuses on smart maintenance, which is seen as an imperative for sustaining public service offerings and strengthening quality, performance and interactivity through information and communications technology and innovation. Its response covers the full value chain – from resources to services and utilities – and is predicated upon harnessing the opportunities afforded by transformative technologies to develop smarter resource use, infrastructure, and service developments directed towards enabling competitive socio-economic and industrial environments and sustainable natural ecosystems and economic growth.



Resources

Hard Infrastructure

Soft Infrastructure

Services/Utilities



# IMPACT AREAS

## ➤ INCLUSIVE SMART SETTLEMENTS AND REGIONS

The CSIR's Inclusive Smart Settlements and Regions Impact Area provides:

- Socio-economic trends analysis at a high resolution, land-use modelling of cities and inter-settlement population growth modelling
- Evidence-based decision-support to contribute to the development of liveable neighbourhoods, towns and cities and solutions for complex human settlement problems.

### Research groups

- Housing and Urban Studies;
- Urban and Regional Dynamics

## ➤ FUNCTIONAL BUILDING INFRASTRUCTURE

The CSIR's functional building infrastructure impact area is equipped to improve South Africa's building infrastructure performance as a contribution to ensuring sustainable and competitive socio-economic activity. The CSIR promotes and supports contextually cognisant knowledge generation and application of science, technology and innovation in buildings, by leveraging multidisciplinary perspectives.

The focus of the group is on functional building infrastructure planning, construction and operation using innovative building technologies, sustainable materials and the development of decision-support models and tools, as well as building infrastructure assessment and management tools.

### Specifically, the group focuses on:

- Infrastructure innovation;
- Construction materials; and
- Strategic infrastructure management.





## ➤ SUSTAINABLE ECOSYSTEMS

The CSIR's sustainable ecosystems impact area focuses on identifying and addressing risks and opportunities associated with a changing natural environment and the consumption of natural resources to enable sustainable development across the industry sectors of South Africa and the continent. It seeks to provide science-based insights and solutions to environmental challenges. Sustainable development, including sustainable industrial development, and inclusive benefit flows for environmental, social and economic enhancement, are guiding concepts with a key emphasis on providing a robust evidence base to inform development decision-making.

The main types of research, development and innovation (RD&I) solutions developed, include:

- New environmental knowledge and data platforms;
- Decision-support models and tools;
- Assessment, measuring and monitoring approaches and application;
- Development of new guidelines and standards on new methods and approaches;
- Strategic planning support for development in the public and private sectors; and
- Evidence-based policy creation and technology decision support.

Offerings are rooted in the work of four research groups:

- **Biodiversity and Ecosystem Services:** Undertakes research and develops innovative solutions and decision-support tools for public and private industries to assess and mitigate environmental risks and unlock



opportunities stemming from the response to the effects of demographic growth, scarce/overexploited natural resources and environmental degradation in support of on socioeconomic development and poverty alleviation;

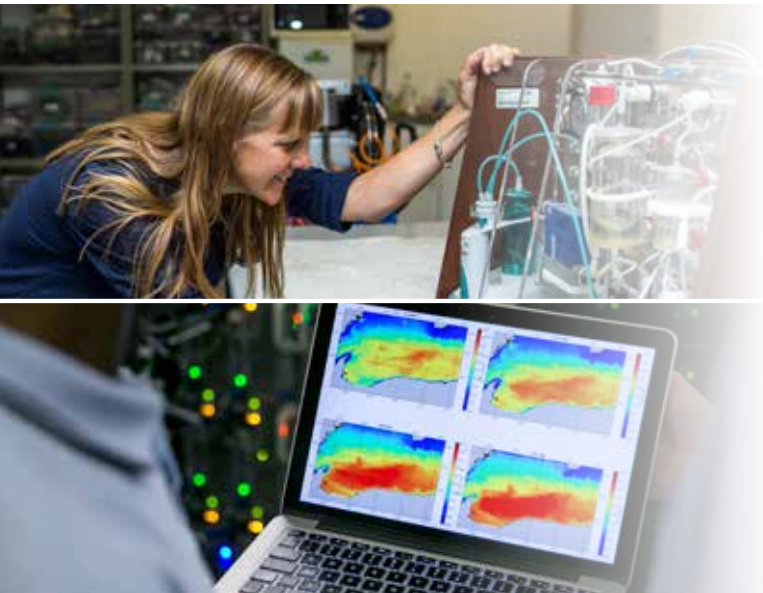
- **Coastal Systems and Earth Observations:** Undertakes research, development and innovation that guide the safe use and sustainable management of coastal resources based on the development and application of methods to identify, quantify and assess the condition of coastal resources and understand coastal processes to inform coastal vulnerability, sustainable exploitation, and the restoration of coastal ecosystems for purposes of future-proofing.
- **Sustainability, Economics and Waste:** Provides scientific evidence and decision support for both public and private sector actors; aimed at integrating sustainability into policy, planning and economic activity; unlocking green and circular economic development opportunities; and supporting a just transition towards a green and circular economy.
- **Environmental Management Services:** Provides environmental assessment and management at a planning, programme and project level, throughout the value chain, from conceptualisation to implementation and monitoring and evaluation, with an emphasis on providing integrated science-based assessments for complex systems to inform decision-making.



# IMPACT AREAS

## ► HOLISTIC CLIMATE CHANGE

The CSIR's holistic climate change impact area offers a unique capability in fundamental science and modelling and interpretation for understanding the African climate system. In particular, the group focuses on the projection of future climate change and climate change impacts currently and into the future at a range of spatial and temporal scales. Researchers apply this knowledge in an integrated manner through the use of application models across key socio-economic sectors. These integrated science, engineering and technology solutions support climate-change responses by the public sector and businesses, in South Africa and across the continent.



### Key strategic objectives

- Advance technological capability to carry out long-term strategic observations and assessments of essential climate parameters to develop a thorough understanding of globally and locally significant earth system components that drive southern African climate.
- Advance the earth systems and application modelling capability to the continuous generation of reliable projections of climate change and seasonal forecasts, and resultant impacts for South Africa and the rest of Africa.
- Transform knowledge generated into information and risk assessment products in support of climate change responses in the primary, secondary and tertiary economic sectors and the public sector in South Africa and across the continent.
- Serve as the national platform for the curation and brokerage of climate-change-related information for the public and private sector.

### Research focus areas

- Climate and air quality modelling;
- Climate services;
- Ocean systems and climate; and
- The Alliance for Climate and Earth Systems Sciences (ACCESS).

# RESEARCH CENTRES

## THE CSIR ENERGY CENTRE

The CSIR's energy research centre provides fact-based expertise and essential research infrastructure to address South Africa's growing energy needs and maximise the associated industrialisation opportunities for new products and services.

The centre provides thought leadership, innovation and capacity building to address the two main energy imperatives of energy efficiency and cleaner energy. The centre responds directly to the challenges identified in the National Development Plan by providing unbiased decision support to solve the long-term sustainable energy needs of South Africa, while concurrently addressing issues such as carbon dioxide emissions, water use, uncertainty, localisation and regional development.

The centre's activities are guided by global trends, contextualised to local realities and focused on developing sustainable energy systems.

### The centre:

- Conducts directed research in emerging energy technologies and system integration;
- Develops and provides proof of concept of emerging energy technologies and systems;
- Demonstrates energy technologies and systems in the South African context and supports their local industrialisation and commercialisation;
- Conducts directed research on how to optimally design, build and operate cost-efficient, reliable and sustainable energy systems;
- Finds optimal pathways for the expansion and operation of energy systems through modelling and simulation;
- Provides policymakers with a scientifically based analysis of market design and regulatory concepts for the integration of new energy technologies;
- Provides support for South African industries on key energy-system-related decisions, and identify and action opportunities for the industrialisation of new products and services; and
- Provides thought leadership on the energy agenda in South Africa and the region.





# RESEARCH CENTRES

## ➤ CSIR ENERGY CENTRE RESEARCH GROUPS

### ENERGY SUPPLY AND DEMAND

The energy supply and demand research group focuses on renewable energy production/supply forecasting, energy efficiency/demand response, and thermal energy optimisation, including thermal energy efficiency, recovery and storage. The techno-economic viability of emerging and existing approaches to energy supply and end-use efficiency are independently assessed to provide impartial advocacy to industry and consumers.

### ELECTROCHEMICAL ENERGY TECHNOLOGIES

Energy and advanced materials derived from abundant South African mineral resources are tailored for portable, mobile and stationary energy storage and conversion users. The industry and government energy storage market requirements inform the product performance and lifetime testing standards. Battery research focuses on lithium-ion, sodium-ion, and zinc-ion battery technologies, as well as supercapacitors. Electrochemical energy technologies focus on membrane technology for fuel cells and electrolyzers.

### ENERGY SYSTEMS

The energy systems research group focuses on establishing future energy systems integrated with electric grids. These future energy systems will be supplied at least cost by two bulk energy sources in South Africa; wind and solar. The energy systems team provides research to guide policy and technology development and to guide national efforts into achieving a net-zero energy system by the year 2050. The focus of this group includes the integration of variable renewable energy generation into the national grid at all voltage levels and scales.

### ENERGY INDUSTRY

The energy industry research group focuses on developing pathways that lead to industrial development in the South African energy value chain. This is done through applying research and development as well as using science-based tools to provide analysis for mapping out various development scenarios. The CSIR is leading the cross-cutting development of a “Just Energy Transition” for South Africa and other African countries.



### SMART UTILITIES PROGRAMME

The smart utilities programme focuses on the sustainable development of the CSIR's Pretoria campus. In addition, the following aspects are studied and implemented: electricity and heat storage, integration of electric and hydrogen-driven vehicles, power-to-liquid and power-to-gas processes, demand-side management and energy-efficiency measures. The other CSIR campuses across the country will gradually become part of the programme, wherein the long-term, supply and demand will be virtually balanced across all campuses as part of a virtual power plant. The Pretoria campus currently has approximately 2 MW of photovoltaic (PV) plants, with a planned 1 MW per year to be acquired in the coming years. The scope of the programme is being expanded to include other utilities such as waste and water to provide a technology demonstration platform.



### ENERGY STORAGE TEST BED PROGRAMME

The energy storage test bed programme provides a platform for energy storage system innovation with interchangeable features (technologies; and/or ancillary equipment) and controlled conditions (environmental; use cases; operational models) and demonstrates energy storage applications for different use cases.

# RESEARCH CENTRES

## THE CSIR WATER RESEARCH CENTRE

The CSIR Water Research Centre contributes to the provision of reliable, efficient and functional water and wastewater service delivery, in the interest of economic development, through the development and refinement of smart water use and infrastructure technologies for the public and private sectors.

The centre addresses shortcomings in South Africa's water planning and accountability; infrastructure operation and maintenance; water treatment technologies and critical domain skills. It also focuses on dwindling water resources, deteriorating water quality, emerging water pollutants and lack of access to alternative water resources.

### The CSIR Water Research Centre objectives

The CSIR invests in the development of technology, software and tools that will improve water resources resilience, thus ensuring the availability of water of high quality against the backdrop of the impact of climate change and other stressors, such as trade-offs within the food-water-energy nexus.

The organisation helps to improve water management systems through its contributions towards policy reviews and the development of tools and techniques that will reduce the cost of water delivery and promote equitable water use. The aim is to ensure improved water testing methods, purification, water and wastewater treatment, and access to alternative water resources (support the water mix).



The CSIR Water Research Centre also contributes towards scarce skills development (human capital development) in the water sector through bursary and internship programmes.

Researchers aim to develop fit-for-purpose technologies for the development and optimisation of smart and robust water use and wastewater infrastructure with concomitant improved operation and maintenance.

**The CSIR Water Research Centre addresses the overall water value chain and guides on:**

- Improvement of the water balance (demand vs availability) by strengthening the resilience of water resources against stressors such as climate change impact, land use and extreme droughts.
- Improvement of water management systems for an inclusive economy through the development of non-conventional, low-cost and sustainable water purification and wastewater treatment technologies, as well analytical methods.
- Improvement of operation and maintenance of water infrastructure through smart design, localisation and optimisation of water purification and wastewater treatment processes.
- Water quality, based on fitness for use.

# RESEARCH CENTRES

## Addressing water-related megatrends through:

- Big data management and use – water quality, quantity, availability, use and impacts.
- Technologies to monitor and acquire data (static and real-time).
- Smart (water) management systems for monitoring, control and operations (individual, local and systems levels).
- Modular (water) technologies – water and wastewater treatment, purification, networks and controls.
- Integrated designs, systems and infrastructure (multiple-use) for enhanced, optimal and sustainable use of water and other natural resources (circular economies, water-energy-food, wastewater treatment and reuse).

## ➤ WATER CENTRE RESEARCH GROUPS:

- **Hydrosciences:** The hydrosciences research group provides research, development and implementation of scientific, engineering and technological solutions to improve water management systems. The group also develops surface and groundwater decision-support tools and assessment techniques that promote smart water use both in private and public sectors.
- **Integrated water assessments and solutions:** The integrated water assessments and solutions research group provides specialised water analysis methods, including analytical methods for emerging and non-conventional water pollutants; persistent organic pollutants, pharmaceuticals and nano-pollutants. The group is also responsible for the development of low-cost water and wastewater treatment technologies and bioremediation approaches to mitigate the impacts of pollutants in water resources. The group further undertake water quality risk-based assessments.





## ➤ WATER AND WASTEWATER INFRASTRUCTURE

### Key focus areas:

- Validation and verification of water infrastructure assets
- Process engineering and design for smart water infrastructure
- Water and wastewater process modelling and simulations
- Smart process integration
- Water infrastructure mapping
- Bulk water distribution network assessment and design
- Hydraulic modelling of water distribution networks
- Water balance modelling
- Water and wastewater treatment process and compliance audits
- Water and wastewater quality management
- Blue Drop and Green Drop implementation support
- Resource recovery from wastewater

### OFFERINGS:

**Smart water use:** Focusing on the provision of knowledge, innovation, skills and services to support the water mix and improve water supply and demand management through effective water resources planning. This also includes improved assessment and testing of water resources, pathways and effluents, and the development of low-cost technology solutions to mitigate water quality challenges.

**Smart water infrastructure:** Focusing on the development of comprehensive water infrastructure lifecycle solutions (design, operation and performance management) with a specific focus on raw water reticulation, potable water distribution networks, wastewater industrial and pharmaceutical) networks and water treatment plants.

**Smart off-grid water and wastewater treatment:** Development of smart decentralised wastewater and point of use/source treatment systems.



# HOSTED INDUSTRY SUPPORT PROGRAMMES

The CSIR hosts numerous programmes that are key in the successful implementation of national strategies. CSIR Smart Places hosts the **National Cleaner Production Centre (NCPC-SA)** and the **National Foundry Technology Network (NFTN)**. The hosted programmes drive industrial development by providing technology and enabling support to the private sector.

**The NCPC-SA** is a national support programme that drives the transition of South African industry towards a green economy through appropriate resource-efficient and cleaner production interventions.

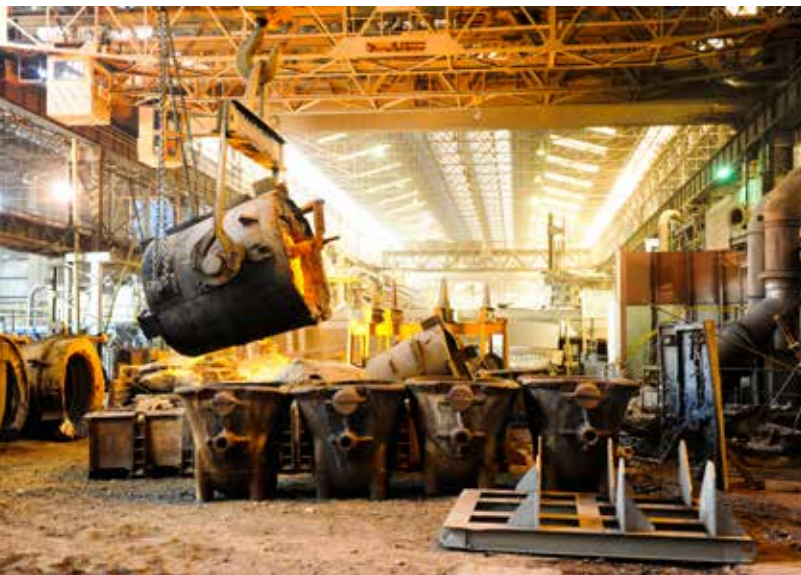
The **NCPC-SA's** mission is to drive resource-efficient and cleaner production in industrial and selected commercial and public sectors by equipping them to operate in an efficient, sustainable and competitive manner, contributing to a low carbon and green economy.

The mission is achieved through projects and programmes using energy, water and materials efficiency, life cycle management, industrial symbiosis, eco-innovation and circular economy principles. Services are offered to industry, partners and government in three areas:

- Technical support industry to adapt to the transition to a green economy through Resource Efficient and Cleaner Production (RECP) interventions and tools;
- Skills and capacity building through training in skills required for a green economy; and
- Advisory and awareness-raising, demonstrating the impact and potential benefits of RECP.

The **NFTN** is a catalyst for the improvement of the foundry industry, to enable all members of the industry to be competitive and self-sustainable. Interventions are identified through assessments within the foundry industry and are packaged to provide solutions with optimum impact, resulting in technology or know-how transfer, skills development, and, potentially, job retention or creation.







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