Evolution of Data Center

Tonya Carter

Sustainable High-Performance Computing

Safety and Health

At Home

- Make sure your workspace is ergonomically sound

- Ensure adequate lighting in the room when you work

- Clean surfaces frequently

- Maintain clear walkways and fire exits

- Have an emergency and evacuation plan in place

On site

- Know locations for fire alarms, extinguishers, emergency exits, defibrillators, and muster points

- Make sure you can hear the fire alarm

- Know what the fire alarm sounds like

On the move

- Do not take this call, or any other call, while driving – ever

- Do not use any hands-free device – Bluetooth, built-in, etc. – whilst driving

- Continue to follow COVID guidelines

- In the event of any kind of emergency, please leave the call – promptly and safely

# High Performance Computing (HPC) Drives Business Value #PoweringProgress

HPC delivers high quality secure, low cost and business optimized HPC solutions to Geophysical Teams and Computational Technologists to enable differentiated geophysical techniques, advanced simulation capabilities and new product discoveries

Seeing deep inside the earth
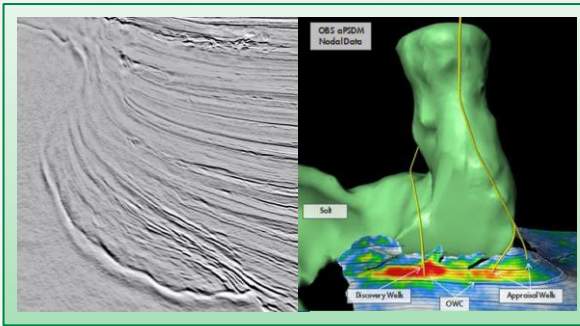
- Shell proprietary, differentiating Subsurface Seismic Imaging algorithms helps Shell maintain its Deep-Water leadership position:
  - "Shell bets big on Brazil"
  - "Shell sweeps 9 of 19 Mexico lease blocks"
  - "Shell makes big deepwater oil discovery in Gulf of Mexico"

Understanding rock properties
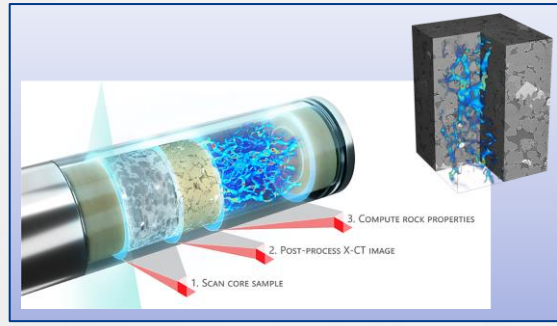
- Digital Rock analysis/simulation
- Calculate Key Rock properties (e.g. porosity, permeability) from digitized images
- Multi-phase multi-component simulations of Pore Chemistry and Flow Dynamics require HPC
- Replaces expensive and time-consuming experiments

Simulating motion & flow

- CFD Fluid flow and reactor engineering
- Modeling the effects of wind, weather & waves on oil and gas facilities
- Modeling fluid flow and chemistry in reactors

Computational Chemistry
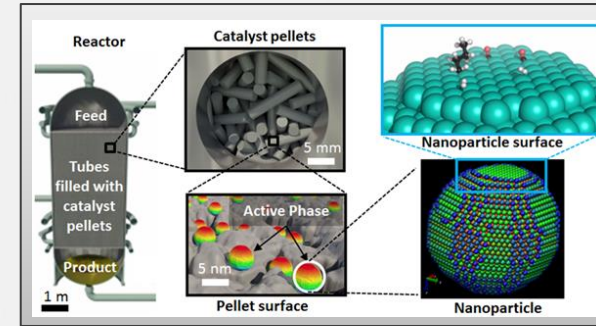
- First-Principles simulations (DFT, MD)
- Predicting the properties of materials from quantum mechanics
- Designing chemicals, catalysts, fuels, lubes
- Shell is a large petrochemical and catalyst manufacturer and continuously improves its products and processes using simulation

Skybox & Shell
BUILDING SHELL'S NET-ZERO, HPC DATA CENTER OF THE FUTURE

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LEGACY CYRUS ONE

- High Cost
- T-Systems managed
- Contract ended Dec-2020
- Power limitations
- Cooling limitations
- Limited ability to grow
- Limited ability to improve Carbon footprint

Better Facilities and Vendor

- Purpose Built HPC Data Center
- Space+Power to grow if needed
- Real-time Data Center Monitoring for great operational insights
- Smart Lighting
- Stronger Floors → heavier equip
- More customer-centric operating model

CARBON AMBITION

- Better built, more efficient building
- Latest in energy efficient support systems
- Advanced Cooling Ready
- We can Renewable Energy Credits (RECs) from a Shell subsidiary (Shell Energy)
- WE are officially CARBON NEUTRAL NOW

Lower Cost

- More affordable $2.5 MM Savings 2021, $5 MM Savings Overall
- Allows for purchase of power from a Shell subsidiary (Shell Energy)
- Texas Sales Tax exemption on power purchase

	Skybox
Input Power	2500 kW
Power Usage Effectiveness (PUE)	1.3
Total Input Power (based on PUE)	3250 kW
Annual Electrical Energy (based on PUE)	28,470,000 kWh
Annual CO2 Footprint	18,904 tons
Equivalency of gas-powered cars	4,168

Sustainable IDT

Crossroads - High Performance Computing and Sustainability

The crossroads of sustainability and high-performance computing (HPC) represent a critical intersection where efforts to achieve high computational performance meet strategies to minimize environmental impact.

Here are key points at this intersection:

- **Energy Efficiency**: Implementing energy-efficient hardware and software solutions to reduce the energy consumption of HPC systems.
- **Renewable Energy Integration**: Increasing the use of renewable energy sources to power HPC facilities, reducing reliance on fossil fuels.
- **Cooling Technologies**: Employing innovative cooling technologies to manage heat generated by HPC systems more efficiently.
- **Lifecycle Management:** Implementing sustainable practices in the lifecycle management of HPC systems, including responsible disposal and recycling of components.
- **Resource Optimization:** Using HPC systems to optimize resource usage in other sectors, such as energy, transportation, and manufacturing, leading to overall sustainability gains.
- **Green Computing:** Developing and utilizing algorithms and software that optimize energy usage and performance in HPC systems.
- **Collaboration and Knowledge Sharing:** Collaborating with industry partners and sharing best practices to drive innovation in sustainable HPC strategies.
- **Policy and Regulation:** Advocating for policies and regulations that promote sustainability in HPC, such as carbon pricing and energy efficiency standards.

Sustainable HPC Computing

Green IT is about more than just power consumption. It incorporates the entire environment impact of technology.

Collaboration with Technology leaders – NVIDIA, GRC, Intel and AMD to promote sustainable practices in the tech industry.

- Intel and Shell efluids teams have signed multi year agreement to test/certify Immersion fluids with Intel technology

- NVIDIA and Shell have signed a three-year R&D collaboration to develop innovative HPC & AI solutions in multiple areas
  - 2024 - Deploying first immersion-cooled HPC & AI Cluster with AMD and NVIDIA H100 accelerated graphics in Bangalore
  - Projected to qualify for Shell's First Top 100 Green Super Compute Clusters, thanks to our implementation of Shell's S3X Immersion Fluid and partnership with NVIDIA.

- Q4 2024 – agreements with GRC and AMD to certify/test Shell Immersion Fluids.

GOAL – to create solutions that will benefit Shell but will support a wider decarbonization of the data center industry.

Benefits:

- Energy Efficiency
- Reduce carbon footprint
- Green Software
- Cost Savings
- Reduce Electronic Waste
- Sustainability
- Improve Brand Image

1 Joint HPC & AI Research

2 Collaborate on Immersion Cooling

3 Partner on Data Center Decarbonization

Green Software

Green IT is about more than just power consumption. It incorporates the entire environment impact of technology.

Green software refers to software that is designed, developed, and implemented with the goal of reducing energy consumption and minimizing its environmental impact. It aims to create applications that emit the **least carbon possible**.

- Carbon Efficiency
- Environmental Impact
- Emerging Discipline
- Resource Conservation
- Sustainability Initiatives

Benefits:
- Energy Efficiency
- Reduce carbon footprint
- Green Software
- Cost Savings
- Reduce Electronic Waste
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Data centre cooling

DEVELOPING AN ECOSYSTEM THAT IS IMMERSION READY

Shell is collaborating with nearly all major OEM's to prepare the industry for immersion ready servers & infrastructure
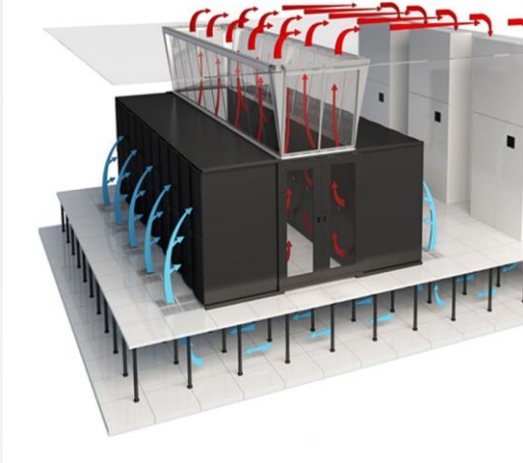
Evolution of Data Center Cooling

Context & Framework Overview

Evolution of data center cooling

Air Cooling

PUE of 1.6 – 2.5

- Most common data center cooling mechanism today
- High noise levels
- Density limit of ~30KW per rack
- Exit temperatures of around 120°F (~50°C)

Direct Liquid Cooling

PUE of 1.2 – 1.5

- Utilizes a water/glycol-based coolant to remove heat from the hottest components, e.g. CPUs & GPUs
- Density limit of ~62KW per rack
- Exit temperatures of around 80°F (~26°C)

Single-phase Immersion Cooling

PUE of 1.04 – 1.1

- Systems are fully immersed in a non-conductive liquid
- Shell deployments:
  - Asperitas system (1) in Amsterdam
  - GRC IceRAQ Duos (6) in Houston
- Density limit of up to 100KW per rack

Immersion Cooling

# Shell Immersion Cooling Fluid S3 X for high-performance and edge computing

Shell Immersion Cooling Fluid S3 X is a synthetic, single-phase immersion cooling fluid designed for the needs of high-performance computing, edge computing and blockchain applications

Benefits:

- **Reduced energy costs and emissions.** High cooling efficiency, flow behaviour and excellent thermodynamic properties mean you need less energy to run your network.

- **Environment agnostic.** Set your network up without worrying about environmental interference, such as hot, humid or dusty locales.

- **Safe and easy to handle.** Can contribute to a safer working environment for your staff.

- **High compatibility.** Suitable for use with almost all computer components.[1]

Properties			Method	Shell Immersion Cooling Fluid S3 X
Colour (Saybolt)	-	-	ASTM D156	>+30
Density	@15°C	kg/m^3	ASTM D4052	808
Flash point	-	°C	ASTM D92	198
Pour point	-	°C	ASTM D97	-42
Kinematic viscosity	@40°C	mm^2/s	ASTM D445	9.9
Kinematic viscosity	@0°C	mm^2/s	ASTM D7042	52.3
Neutralisation value	-	mgKOH/g	IEC 62021-1	<0.01

These characteristics are typical of the research product, variations in these characteristics may occur.
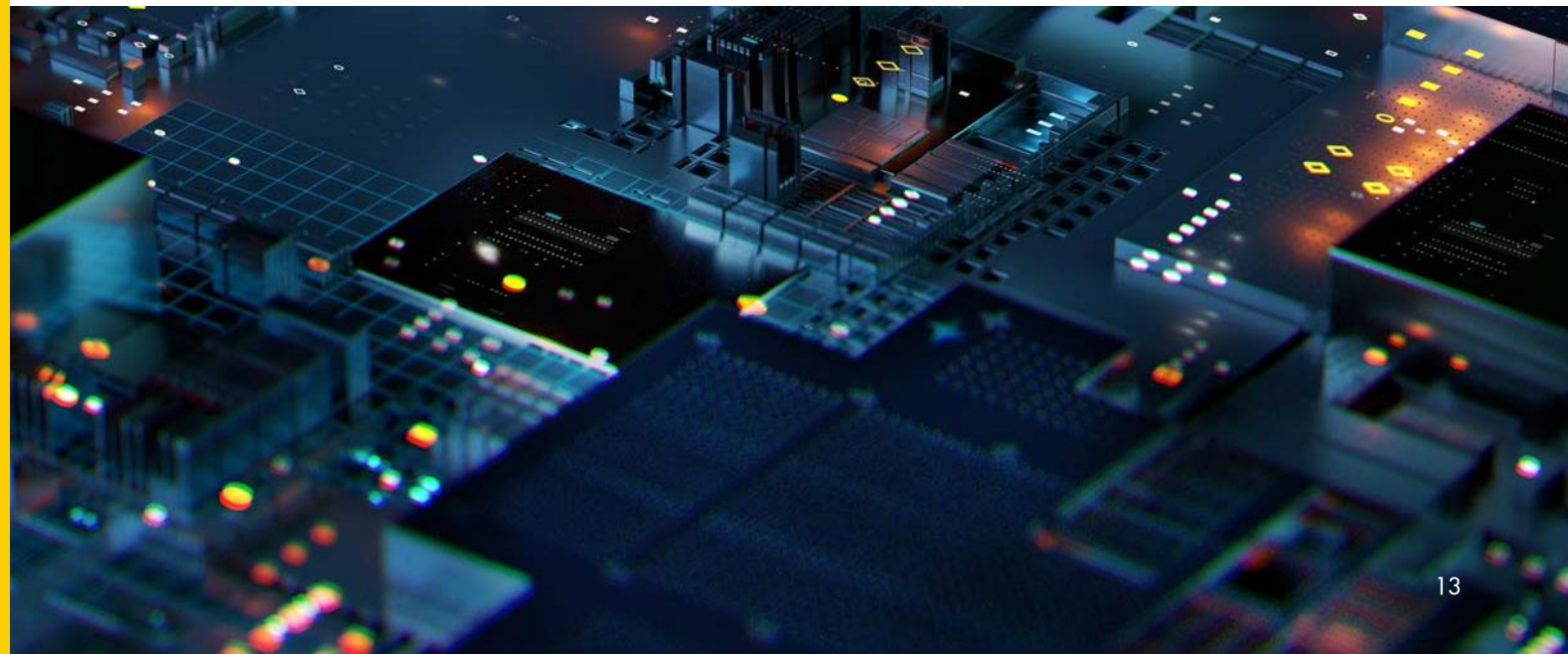
[1]Shell Global. Clean energy solutions. Retrieved April 22, 2021, from www.shell.com/business-customers/trading-and-supply/trading/shell-energy-europe/clean-energy-solutions.html

INTRODUCING SHELL'S RANGE OF IMMERSION COOLING FLUIDS

Specifically developed for use in single-phase immersion cooling systems

Shell's current range of immersion cooling fluids has been specifically developed for use in single-phase immersion cooling systems (pumped and natural convection).

Made from natural gas using Shell's industry-leading gas-to-liquids (GTL) process, Shell Immersion Cooling Fluid S5 X and S3 X have been designed to maximise the energy efficiency and performance of data servers and IT components.

To ensure that we can meet a wider range of immersion cooling needs, we are also developing alternative immersion cooling products that will provide a wider choice of immersion cooling solutions.