



SHELL INTEGRATED IMMERSION COOLING SOLUTIONS

Enabling Game-changing Energy Use Reduction At Data Centres

Eduardo David de Azevedo, Product Application Specialist

Sundeep Kamath, Global Marketing Manager

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Agenda

- Introduction
- Integrated Immersion Cooling Solution offerings
- Shell Immersion Cooling Fluid
- Partnership with Asperitas
- ACS and Material Compatibility Workstream
- Q&A

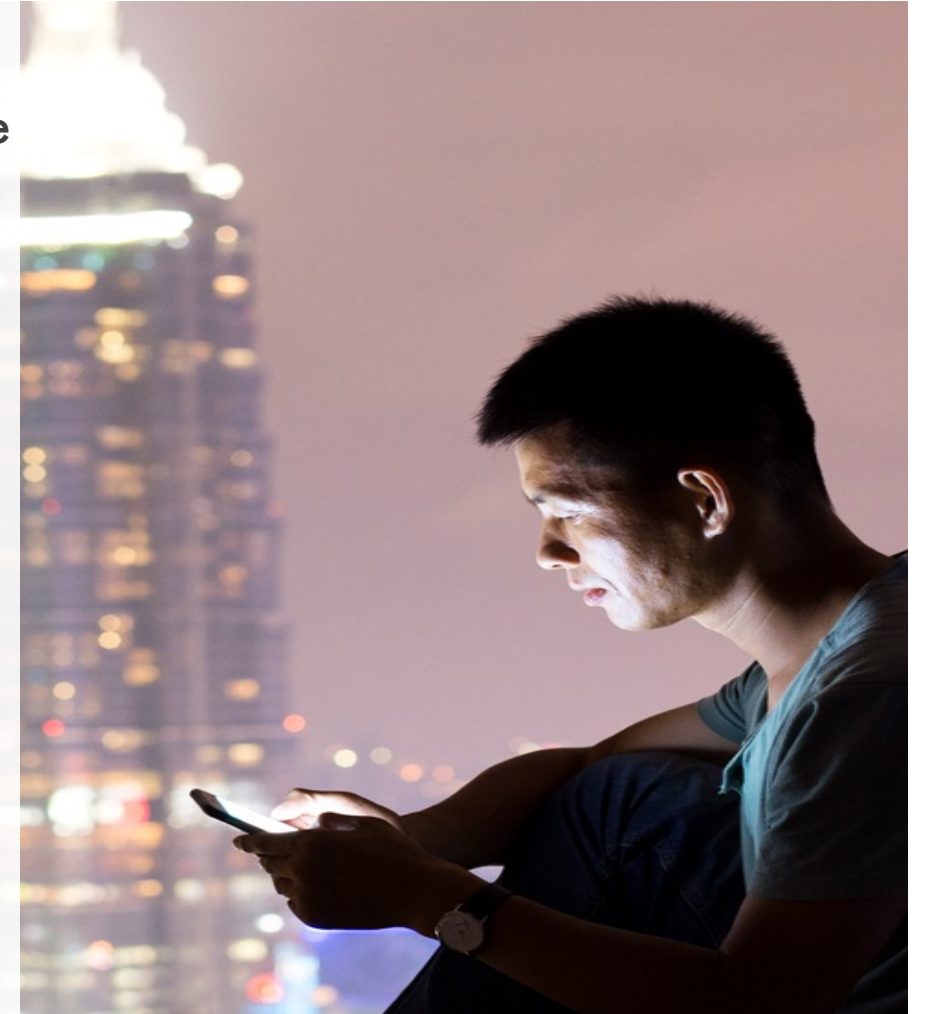
THE BIG CHALLENGE

- **The Internet is a fundamental part of modern life**
- **BUT** it uses an estimated **1% of global electricity** (with half of the carbon emissions as global air travel) **AND** data centres are **expanding by more than 20% a year**¹
- A **30% growth in global population and energy use** is forecast by 2050, yet, to reduce the impact of global warming, **carbon dioxide emissions need to be cut by 50%**²

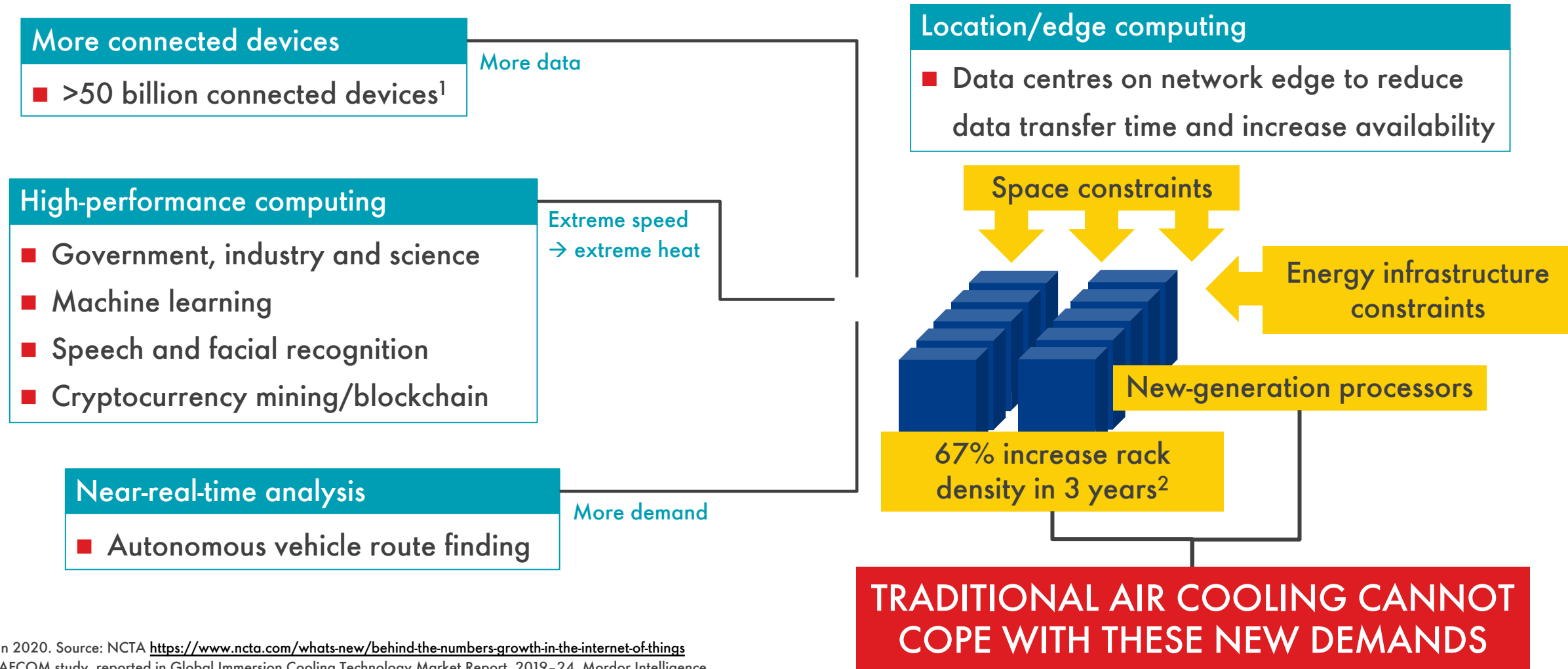
What can WE do to meet this challenge?

¹<https://www.iea.org/commentaries/data-centres-and-energy-from-global-headlines-to-local-headaches>

²<https://www.shell.com/energy-and-innovation/the-energy-future/what-is-shells-net-carbon-footprint-ambition.html>



DO YOU CONTINUE TO RELY ON AIR COOLING?



¹In 2020. Source: NCTA <https://www.ncta.com/whats-new/behind-the-numbers-growth-in-the-internet-of-things>

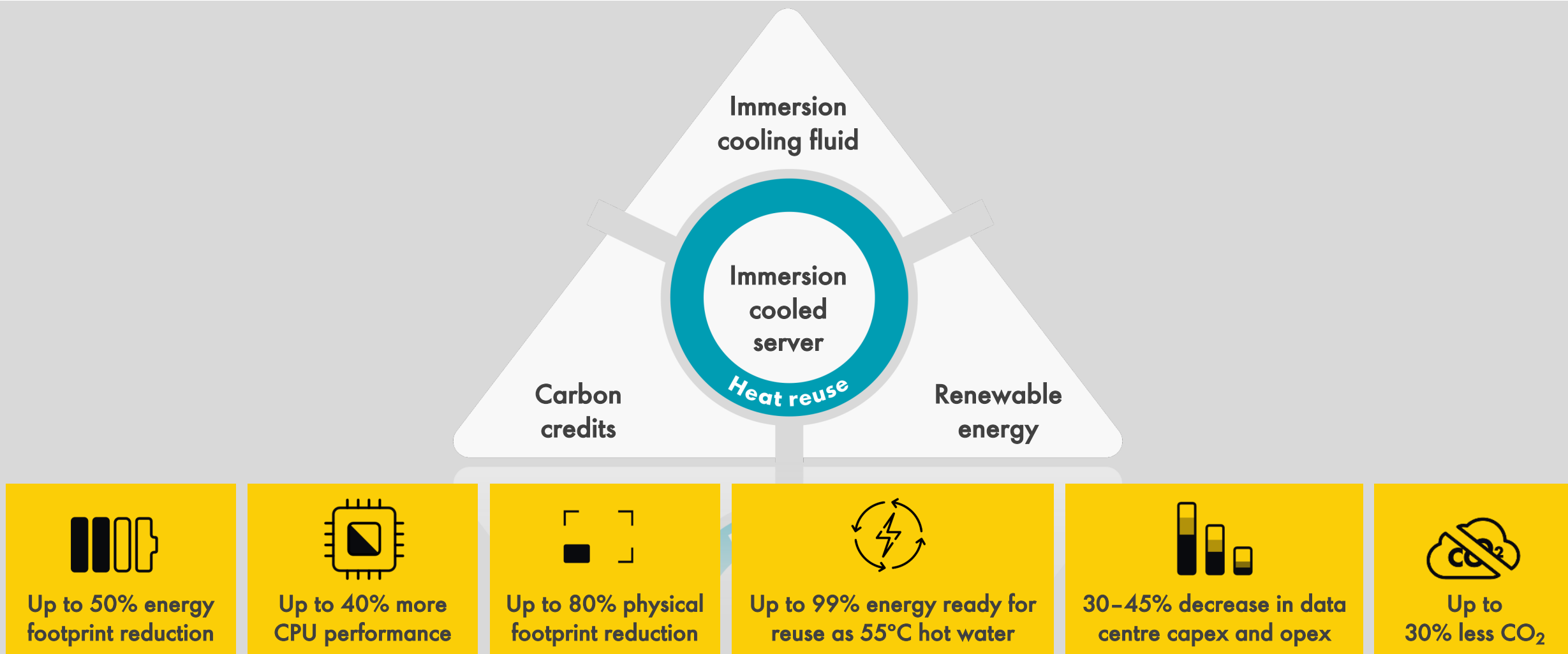
²AFCOM study, reported in Global Immersion Cooling Technology Market Report, 2019–24, Mordor Intelligence



INTEGRATED IMMERSION COOLING SOLUTION

Enabling Game-changing Energy Use Reduction At Data Centres

ARE YOU LOOKING FOR AN INTERGRATED ENERGY SOLUTION?



SHELL ENERGY, YOUR PARTNER TO DELIVER CLEAN ENERGY SOLUTIONS

We can support your business in its decarbonisation journey.



RENEWABLE ENERGY
CERTIFICATES



RENEWABLE POWER



CORPORATE POWER
PURCHASE AGREEMENTS



VOLUNTARY CARBON OFFSETS



COMBINED NATURAL GAS AND
VOLUNTARY CARBON OFFSETS



RENEWABLE GAS

BENEFITS FOR YOUR BUSINESS

**Showcase
climate
leadership**



**Meet your
greenhouse gas
emissions
commitments**



**Create long-term
sustainability
value for
your business**

**Appeal to
your customers
and employees**



To learn more: www.shell.com/see/cleanenergysolutions

2nd December 2020

ONSITE RENEWABLE ENERGY SOLUTIONS FOR DATA CENTRES



Cost reduction



Efficiency and sustainability



Resiliency

Shell Distributed Energy platform

Reuse of heat*

Solar

Combined heat and power and backup

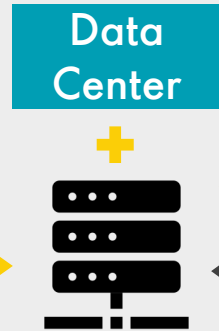
Energy storage

Energy efficiency

Demand response, active load control



* offering under joint development with Asperitas

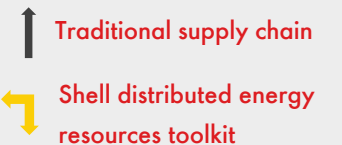


Reuse of heat

Renewable
Grid Power

Solar and Wind

KEY



INTEGRATED BENEFITS – SHELL AND ASPERITAS

Shell Immersion Cooling Fluid S5 X

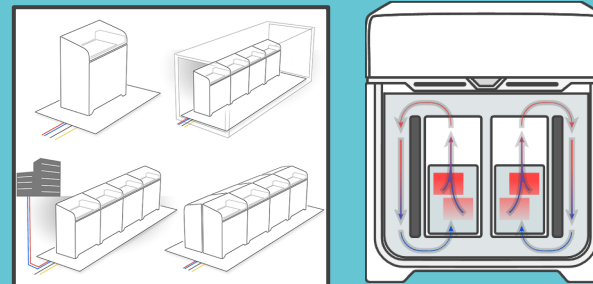
- Specifically developed for immersion computing
- Safety and purity – meets the pharmaceutical purity requirements, non-halogenated, food-grade, free from allergen and extremely low volatility
- Performance – excellent thermodynamic properties, non-evaporating, low density and high flash point
- Protection and reliability – high compositional consistency, very high oxidation and thermal stabilities, virtually no sulphur, nitrogen or aromatics, and non-corrosive

Shell Energy

- Renewable energy
- Heat reuse and energy efficiency
- Combined heat and power, backup and energy storage
- Demand response, active load control
- Carbon credits or nature-based solutions

Asperitas AIC24 immersed cooling system

- Up to 50% less energy¹
- Flexible deployment
- Natural convection (high reliability, low maintenance)
- Climate independent
- Optimised for heat reuse
- Clean and fully contained
- Monitor and control
- Allows for future high-power hardware and performance boosting



¹compared with air cooling



SHELL IMMERSION COOLING FLUID S5X

SPECIFICALLY
DEVELOPED FOR
IMMERSION
COMPUTING

Shell
Immersion Cooling Fluid



SAFETY PURITY

Meets the EU & US pharm.

Food-grade
Non-toxic
Non-flammable
Non-corrosive



PERFORMANCE

Excellent thermodynamic properties

Non-evaporating

Low density

High flash point



PROTECTION RELIABILITY

Chemical consistency

Thermal stability
Oxidation resistance

No sulphur, nitrogen or aromatics

Non-corrosive

Non-corrosive

Compatibility Guide

This is a generic compatibility guideline based on test performed at our laboratories. The components are normally made from different materials and formulations, therefore the compatibility behaviour may differ from each component supplier. For detailed investigation about component compatibility performance, Shell is ready perform detailed compatibility test if the parts are sent to our laboratories.

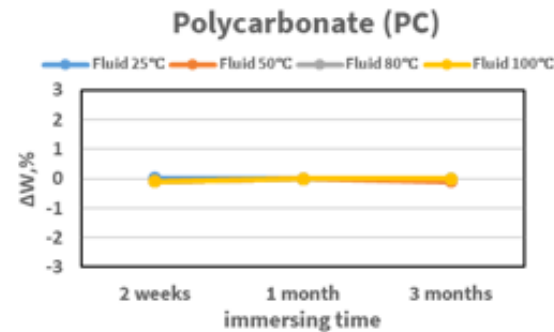
Materials type	Material Description	Component normally used	Compatibility
Metal	Silver	Conductors	Suitable
Metal	Copper	Conductors	Suitable
Metal	Aluminium	Connectors	Suitable
Metal	Steel	Structure parts	Suitable
Metal	Zinc	Coatings	Suitable
Elastomer	FKM /Viton	Cooling tubes / piping	Suitable
Elastomer	CR (Chloroprene)	Sealings	Suitable
Elastomer	MFQ (Fluorsilicone rubber)	Sealings	Suitable
Elastomer	PU (polyurethane)	Connectors	Suitable
Plastic	Polypropylene without plasticizer	Tanks	Suitable
Plastic	HDPE without plasticizer	Cables / wiring insulation	Suitable
Plastic	PTFE (Polytetrafluoroethylene)	Sealings	Suitable
Plastic	Hard PVC without plasticizer	Cables / wiring insulation	Suitable
Plastic	Polyamide	Cooling tubes / piping	Suitable
Plastic	PC (Polycarbonate)	Connectors	Suitable
Plastic	PETG (Polyethylene Terephthalate Glycol-Modified)	Cooling tubes / piping	Suitable
Plastic	POM (Polyoxymethylene)	Connectors	Suitable
Plastic	PS (Polystyrene)	Structure parts	Suitable
Elastomer	EPDM (Ethylene Propylene Diene Monomer)	Sealings / Connections	Not recommended

Material Compatibility Focus

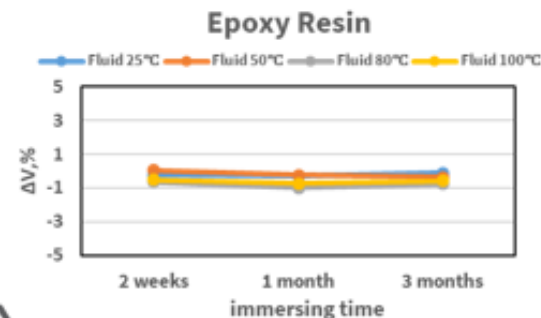
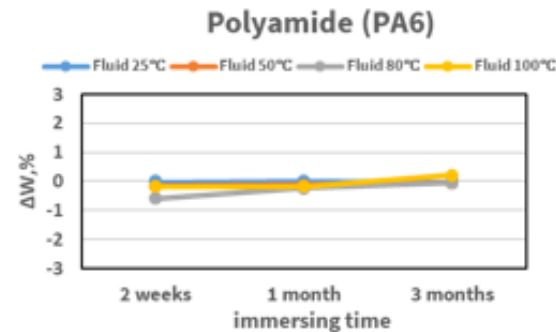
Analysis capabilities need to become available around the world:

Compatibility tests experiments:

- Immersing plastics, elastomers, metals and parts under controlled temperatures (room temp, 50, 80 and 100°C)
- For some weeks or months (accelerated test)
- Measuring component weight & volume behaviour



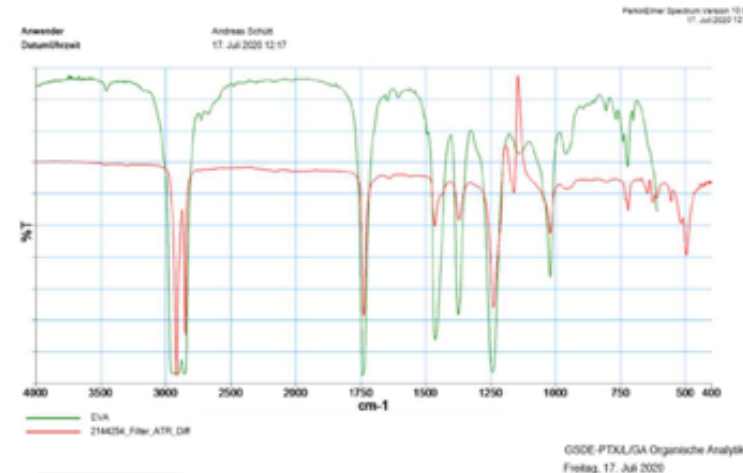
Source: Shell Technology Centres SST/STCHs



Integrated with fluid analytics:

- ICP: Identify metals and elements originally not in the fluid
- FTIR: Materials spectrums comparison / Impurities
- Dielectric breakdown: Thermal Fluid performance

FTIR example – EVA material found in the fluid

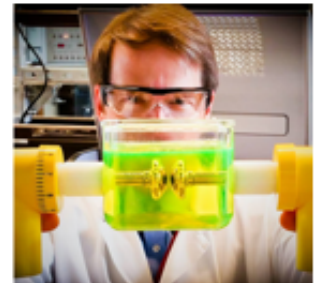


**ADVANCED
COOLING
SOLUTIONS**

ICP

Ag	<1	mg/kg
Al	<1	mg/kg
B	<10	mg/kg
Cr	<1	mg/kg
Cu	<1	mg/kg
Fe	<1	mg/kg
K	<1	mg/kg
Mo	<1	mg/kg
Ni	<1	mg/kg
Pb	<1	mg/kg
Si	30	mg/kg
Sr	<1	mg/kg
Ti	<1	mg/kg
Mn	<1	mg/kg
V	<1	mg/kg
Mg	<1	mg/kg
Ca	<1	mg/kg
Ba	<1	mg/kg
P	1	mg/kg
Zn	<1	mg/kg
Cl	<5	mg/kg
S	<5	mg/kg

Dielectric Breakdown Voltage



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Call to Action

Join the immersion workstream and contribute!

ACS Immersion schedule: Each 3rd Tuesday of the month

Docs:

https://www.opencompute.org/wiki/Rack_%26_Power/Advanced_Cooling_Solutions

Mailing list:

<http://lists.opencompute.org/mailman/listinfo/opencompute-acsimmersion>

Email: Rolf.Brink@OCProject.net, ACS Sub-project: Immersion Lead



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Q&A

