SOLARIS
A CAF GROUP COMPANY

COMMON DIRECTION ›

Changing the image of public transportation

www.solarisbus.com

CAF GROUP

Solaris Urbino 12 hydrogen – product presentation

Romuald Witkowski

COMMON DIRECTION

Company

Solaris Bus & Coach

- **A manufacturer** of buses, trolleybuses and trams
- Solaris is part of **CAF Group**
- The company was founded by **Olszewski Family** in 1996
- **€438 million** annual turnover (2018)
- **2500 employees**
- **17 000** vehicles sold since start of production
- International presence **– 32 countries**

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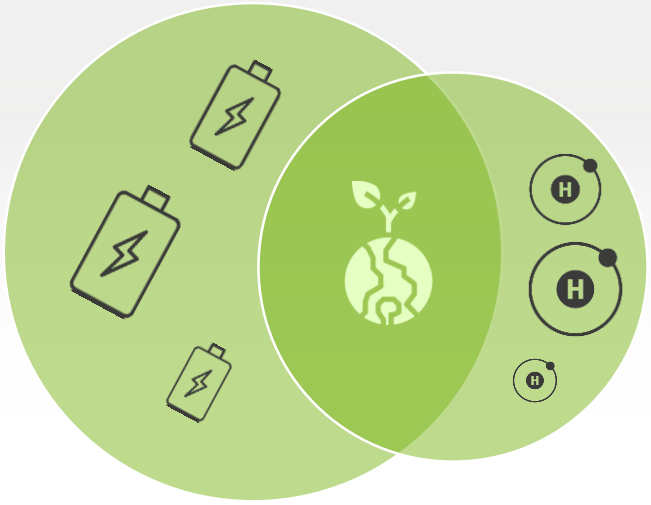
› E-mobility

E-mobility is the future

The synergy of the development of all electro-mobility branches is indispensable to ensure efficient **decarbonisation of transport.**



Hydrogen technology complements battery drives, the two are not competitive.

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› Hydrogen market

When to use hydrogen?

Hydrogen-powered vehicles are best suited for the following applications and requirements:

- long-range requirement
- heavier loads
- routes requiring fast refueling
- a great need for flexibility

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› Hydrogen market

Why to use hydrogen?

- It gives all the advantages of an electric drive
  - compeletely **emission-free** driving
  - extremely **quiet**
  - **it does not generate vibrations**
- **Wide range** – 350 km on routes with different conditions
- **Fast fueling** – about 10 minutes
- Hydrogen fuel cell guarantees **reduction of carbon emissions**, the only by-product of the chemical reaction taking place in the hydrogen cell is **water**

All the advantages of electric drive with increased range and fast refuelling.

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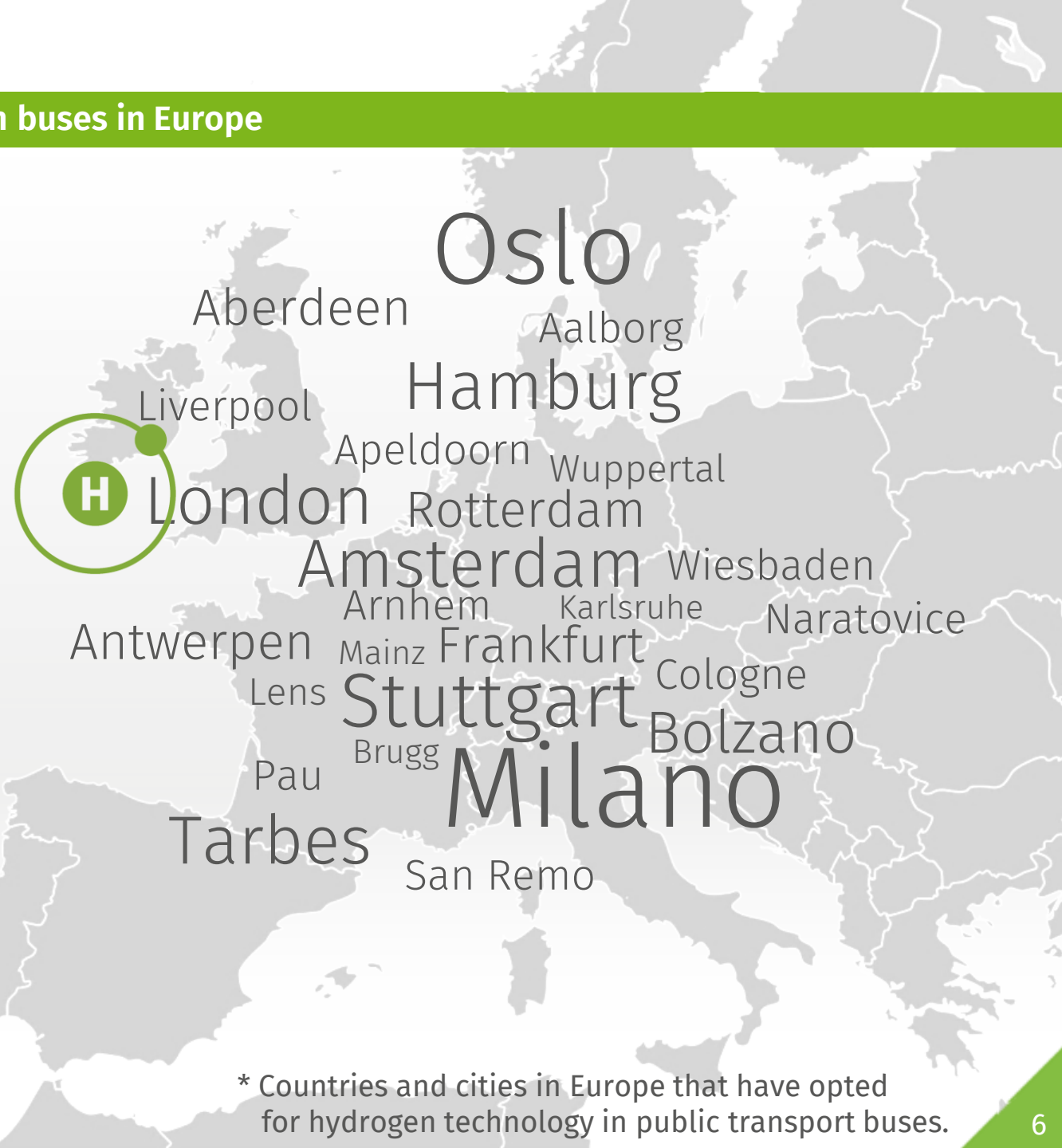
› Hydrogen buses in Europe

European activities promoting hydrogen technologies

In the period between 2010-2019, **187** buses in total were contracted to **30** cities in Europe



* Countries and cities in Europe that have opted for hydrogen technology in public transport buses.

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› Hydrogen experience

Solaris activities as part of the JIVE project

- **HAMBURG** – **2x18,75meter** with hydrogen range extenders
- **RIGA** – **10 trolleybuses** with hydrogen range extender
- **BOLZANO** – contracted **12 hydrogen buses** (JIVE)

JIVE
ZERO EMISSION

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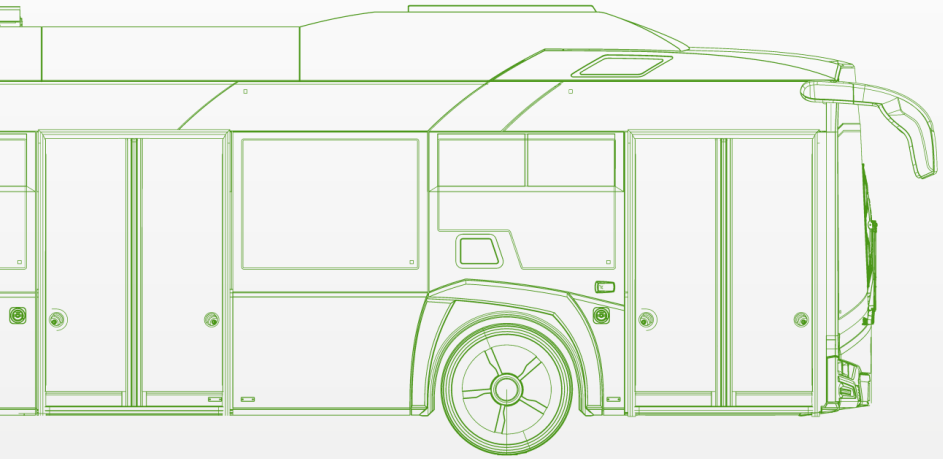
E-mobility ›



700 electric buses

(including buses in production)

Battery

Hydrogen fuel cell

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Urbino 12 Hydrogen

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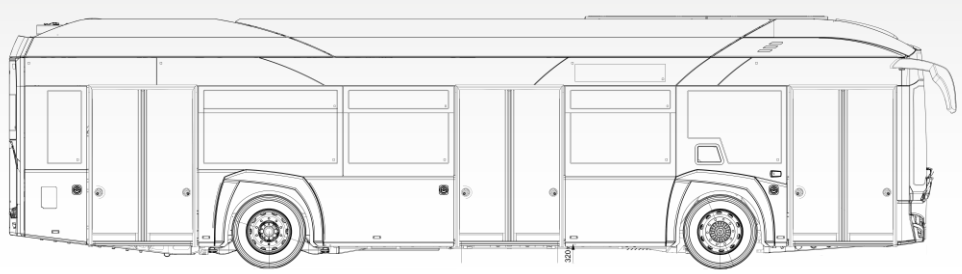
› Product overview

Solaris Urbino 12 hydrogen

- Solaris High Power battery
- Ballard fuel cell – **60 kW**
- Hydrogen tanks **Type 4**, 37.5 kg
- **ZF** Electric drive axle (2 x 125 kW)
- Air conditioning unit with a **CO_2 pump**



GVW
19,200 tonnes

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› Product overview

Solaris Urbino 12 hydrogen

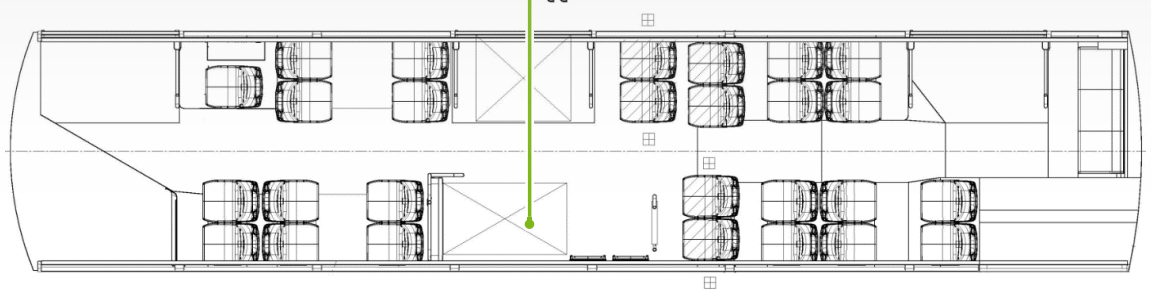
› **33** seats for the 3-door version

› **37** seats for the 2-door version

› **87** people

Highest on the market

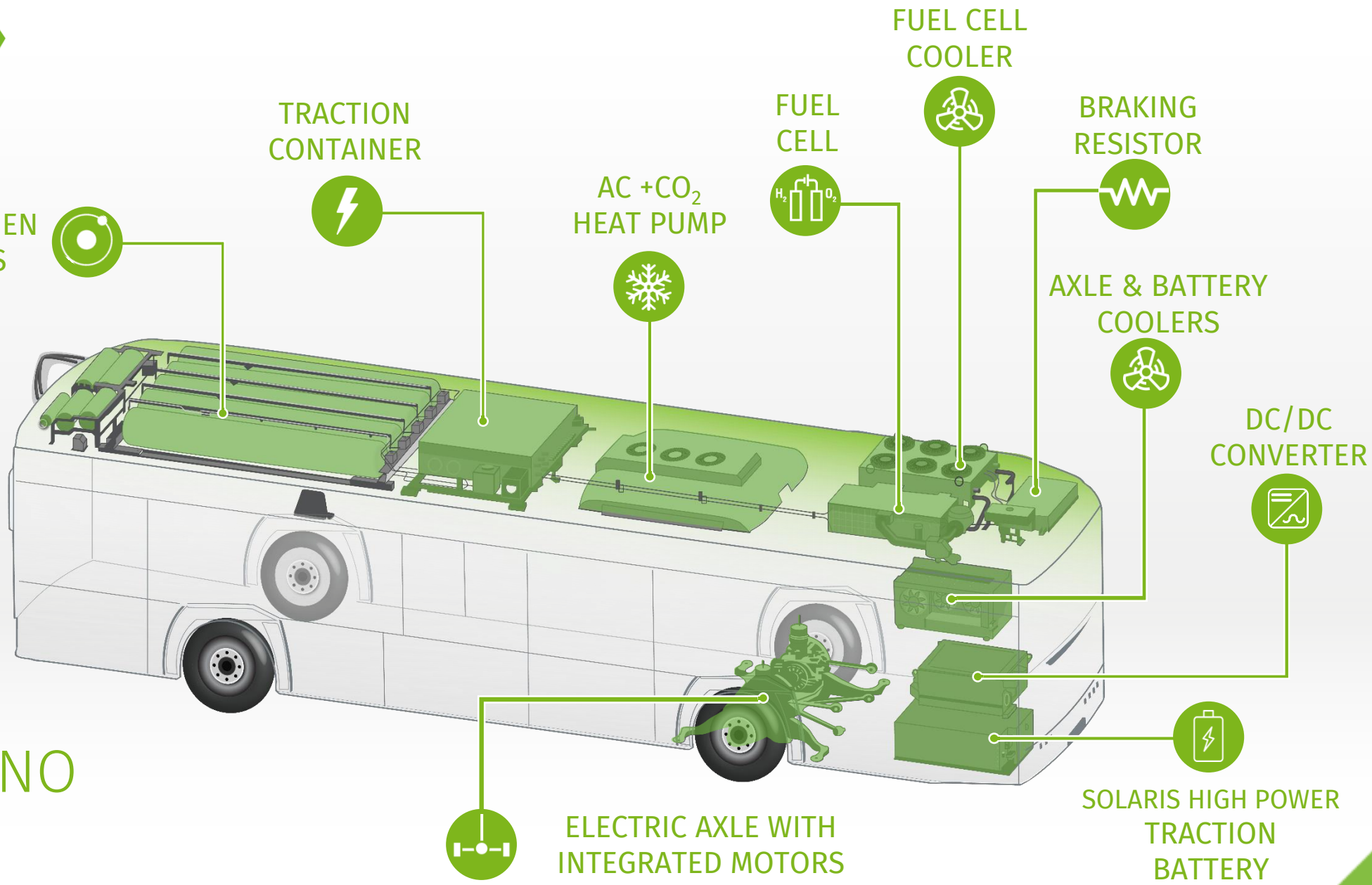
2.000 mm space for a wheelchair



› Product overview

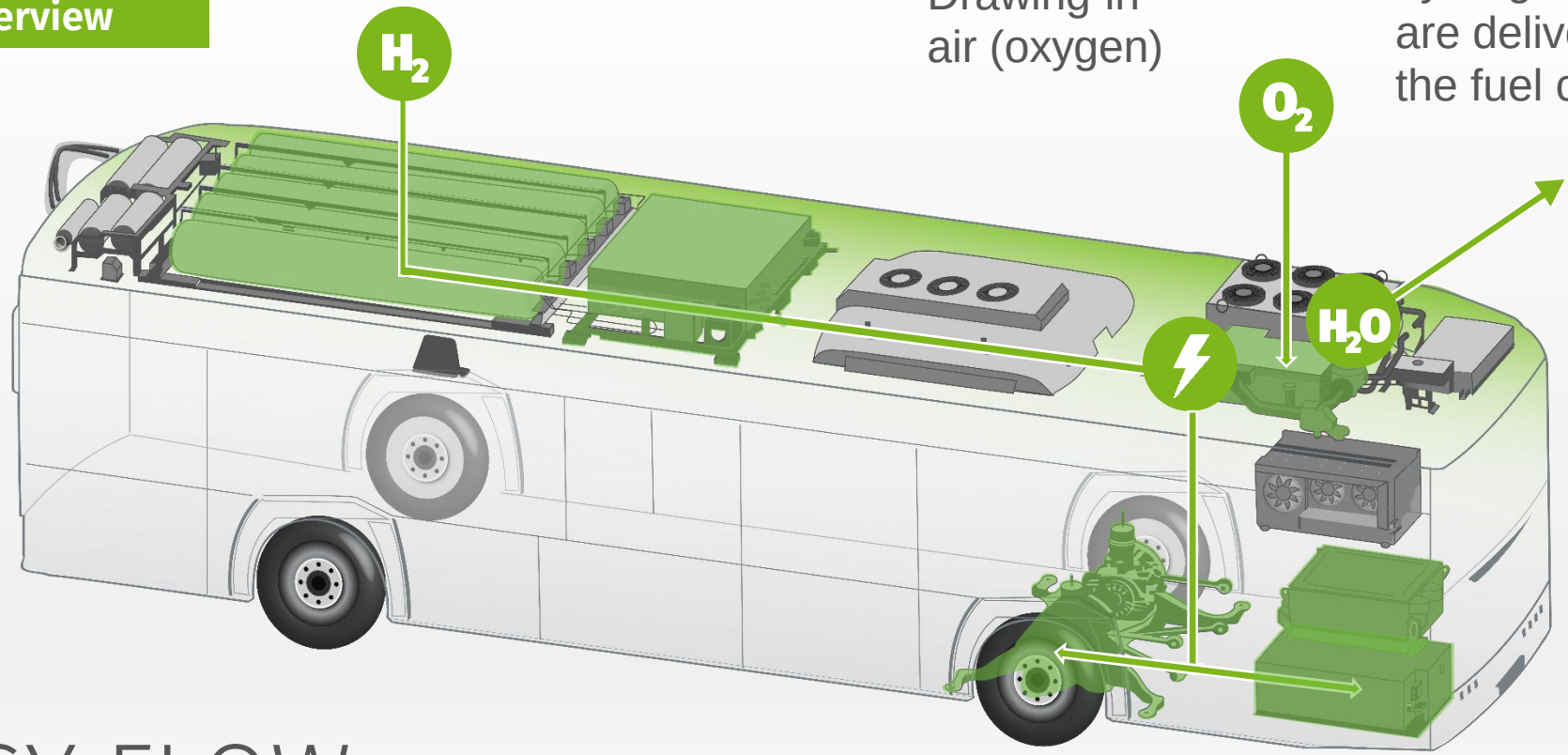
DRIVE SYSTEM

SOLARIS URBINO 12 HYDROGEN



STEP 1
Drawing in air (oxygen)

STEP 2
Oxygen from the air and hydrogen from the tanks are delivered to the fuel cell



STEP 3
Electric power and water are generated as a result of the chemical reaction

ENERGY FLOW

SOLARIS URBINO 12 HYDROGEN

STEP 4
Electricity is fed into the driveline as well as to the battery depending on demand

STEP 5
The engine's power rises, the vehicle is moving

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New solutions

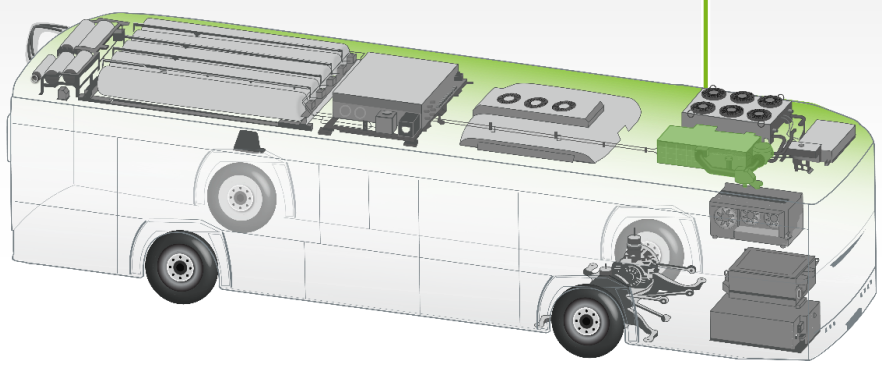
New generation FCmove-HD fuel cell

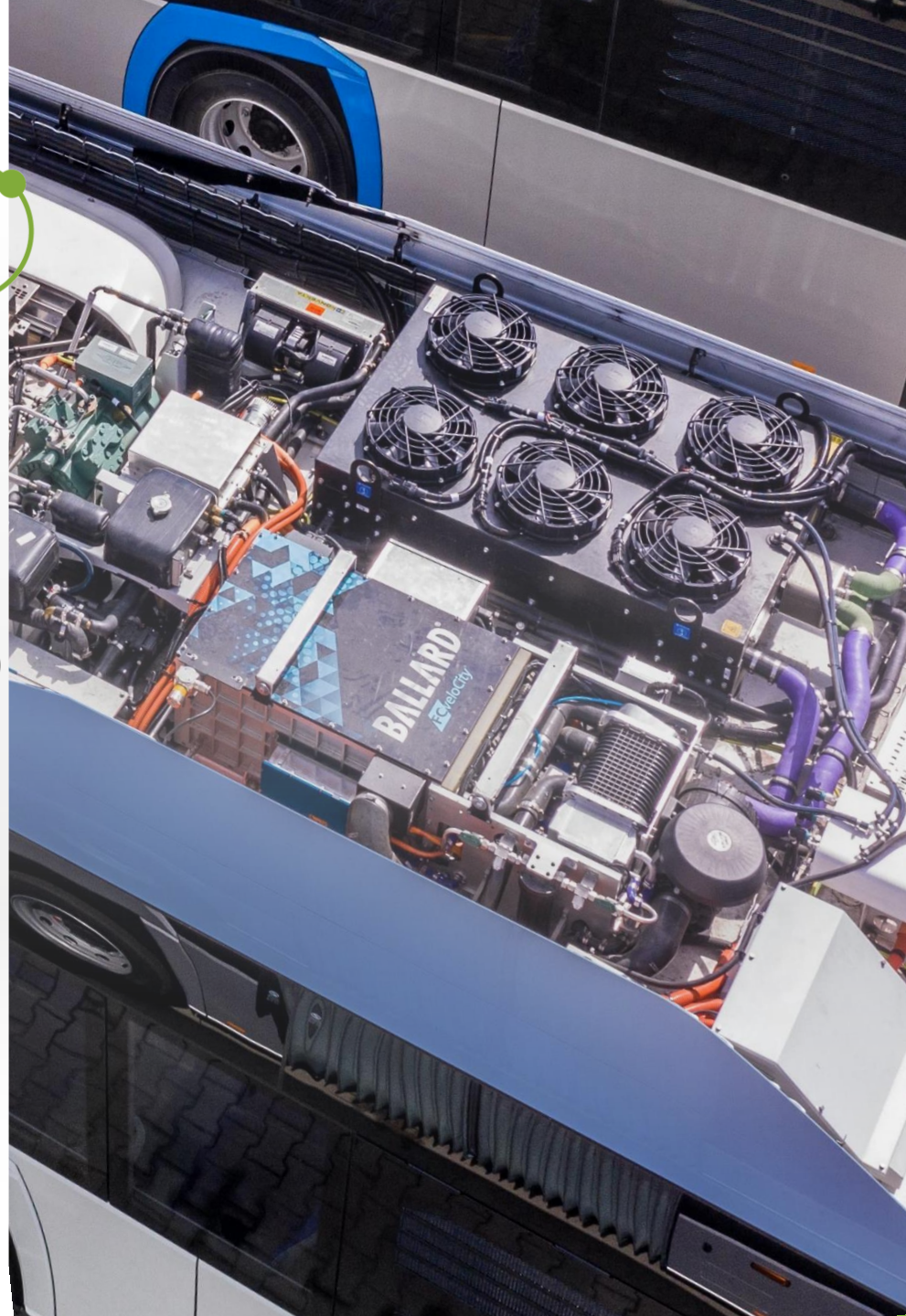
- Rated power **60 kW**
- Maximum efficiency **57%**
- Estimated life time of **>30 000** working hours
- Freeze start from **-25 °C** (no pre-conditioning or external power required over night)
- Stored in temperatures as low as **-40 °C**
- Works in the temperatures ranging from **60 to 80°C**
- No need for external power supply

60 kW

57%

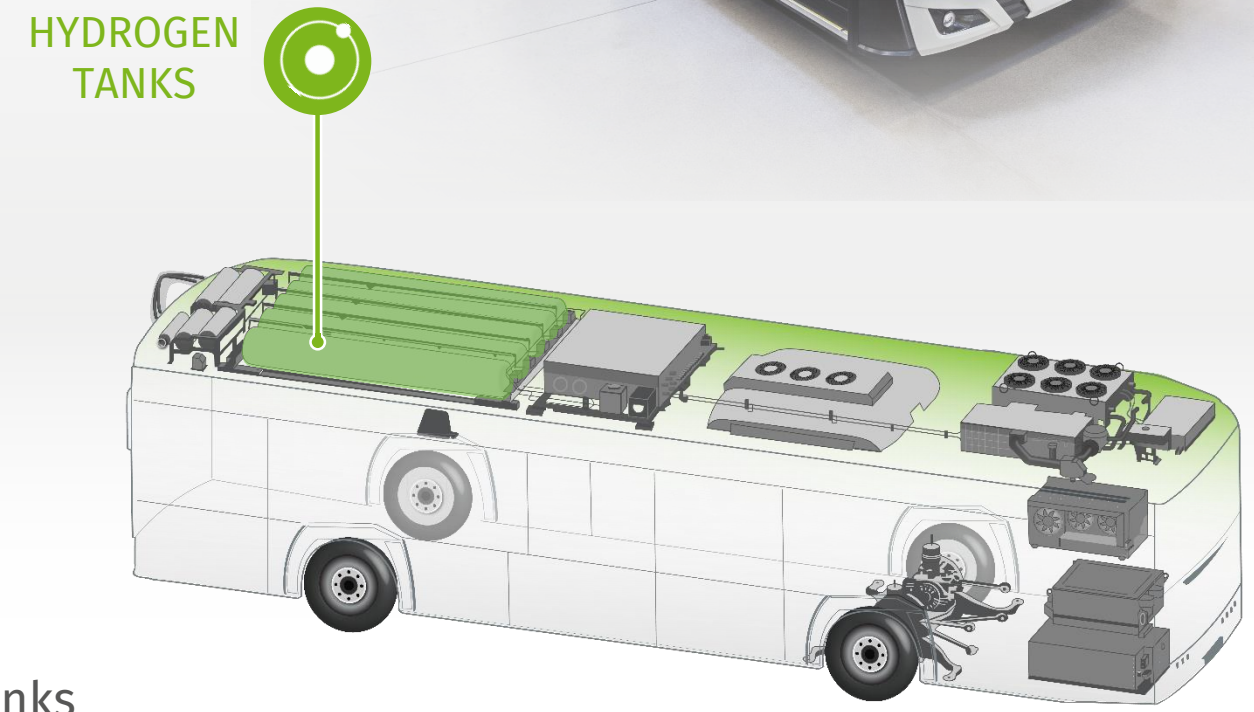
60-80°C





Hydrogen tanks type 4

- **5** cylinders of **Type 4**
- Water capacity: **1,560 l (5 * 312)**
- Total amount of stored hydrogen: **37.5 kg**
- Useful amount of hydrogen: **34.2 kg**
- Working pressure: **350 Bar**

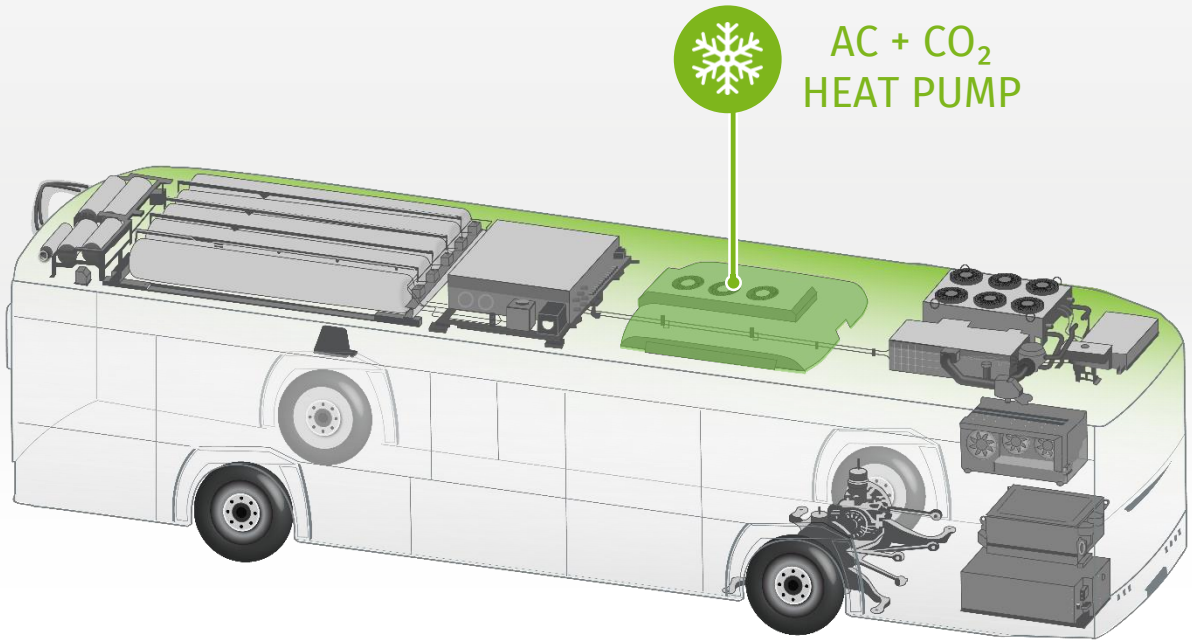


20% lower weight
when compared to the previous generation of tanks

New solutions

Air conditioning with CO_2 heat pump

- CO_2 used as a **refrigerant** (ecological, non-toxic, non-flammable)
- Heat and cold from **outside** used
- **Waste heat** from the fuel cell used to **improve efficiency**
- **20 kW** cooling power



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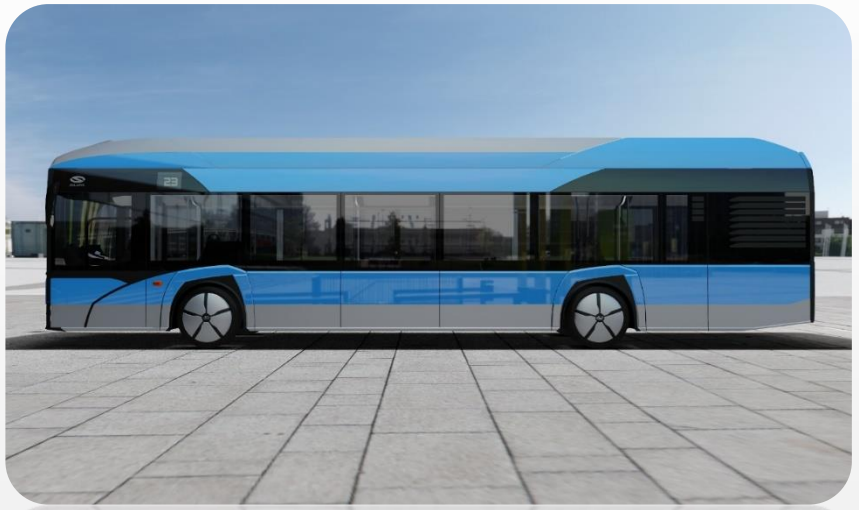
Product range



Solaris E18,75 fuel cell

Solaris T18,75H2

Solaris nE12 hydrogen

Q2 prototype

serial production*

2015 2016 2017 2018 2019 2020 2021 2022

* ramp up volumes set on

10-15 units in 2020
30 units in 2021
100-150 units in 2022

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THANK YOU
FOR YOUR ATTENTION

Romuald Witkowski