TAUW

Using non-fossil commercially available PAC

Laboratory tests, costs and sustainability, experiences at full scale

Joost van den Bulk

LEAF

Royal HaskoningDHV
Enhancing Society Together

Witteveen + Bos

Pacas-WWTP's in NL

2016 2021 2022 2023

Almere

Nieuwe waterweg

Katwijk

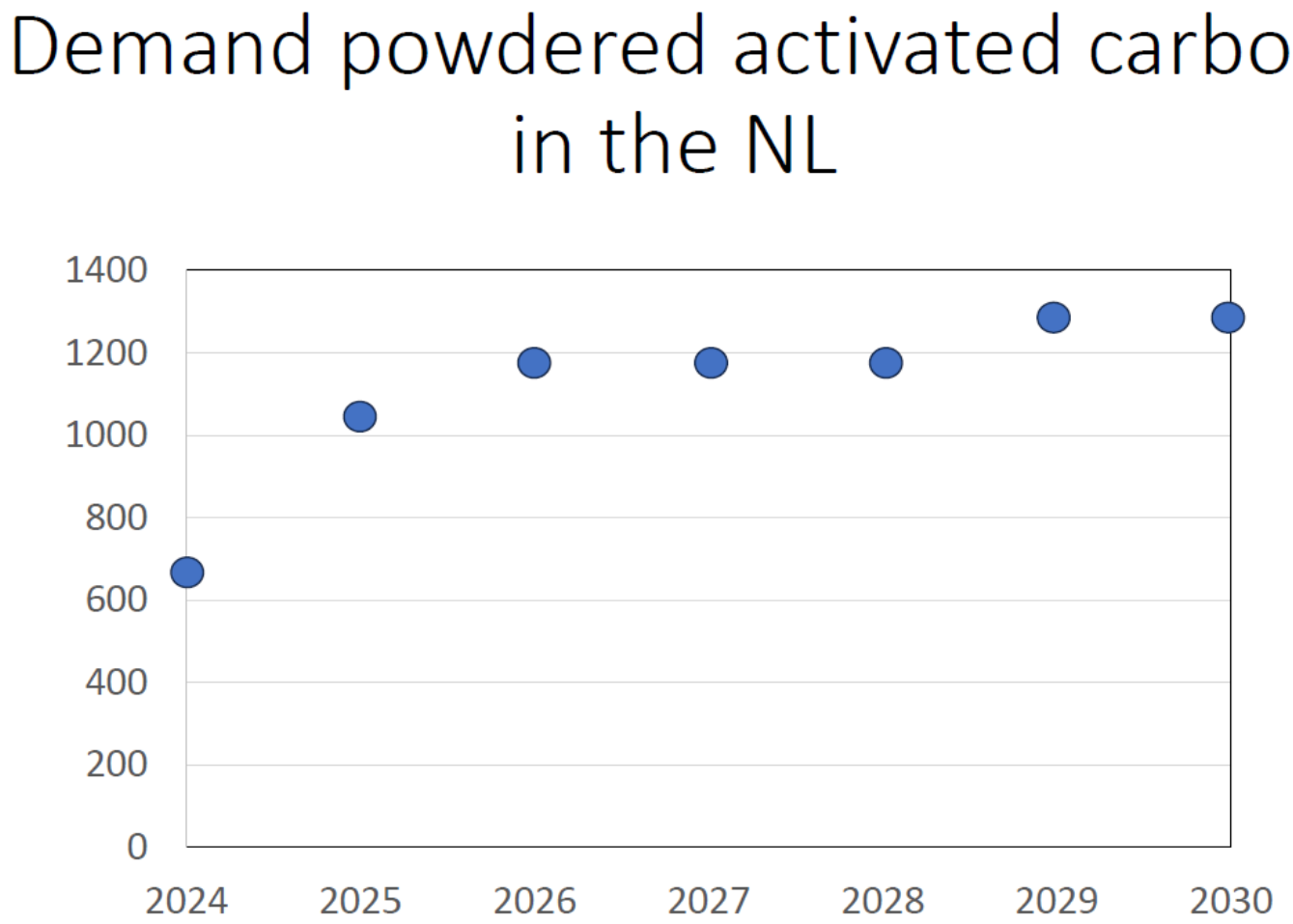
Leiden Zuid-West

Non fossil
PAC

Pacas-WWTP's in NL

Source: Ad de Man, WBL

Demand for PAC at Dutch wwtp's

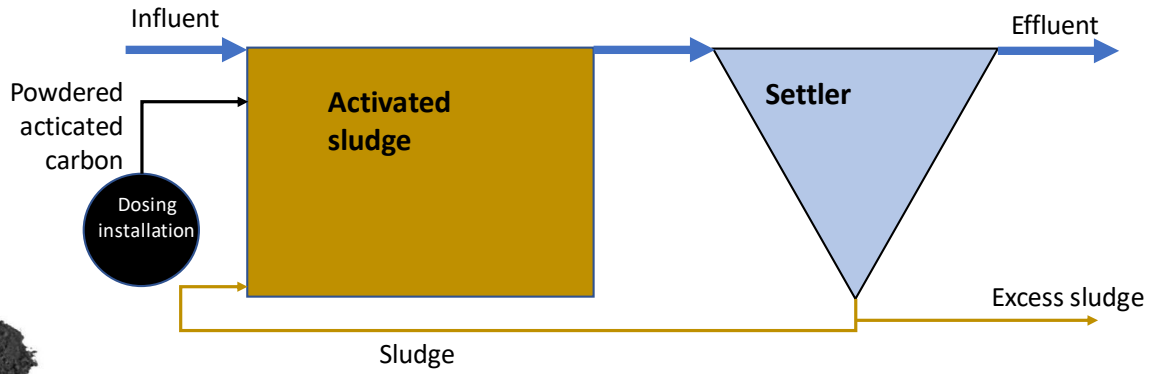


Source: Ad de Man, WBL

Back to 2018

STOWA 2018-02

- Powdered Activated Carbon in Activated Sludge (PACAS)
- Easy to implement
- Cost efficient

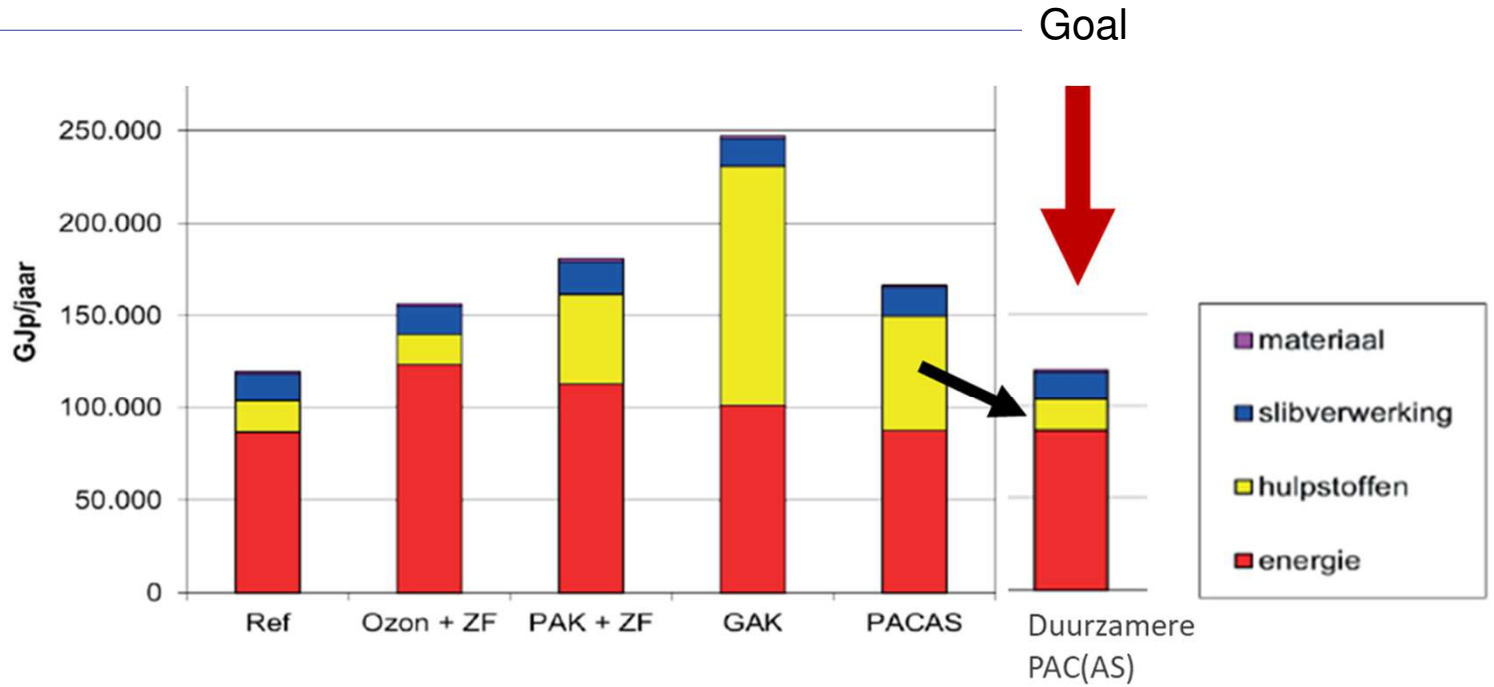


CO_2 footprint…

No recovery of PAC;

High CO_2 footprint

Feasibility study on sustainable alternatives (non-fossil PAC)



Feasibility Study

Tabel 4.1: Longlist: commercieel beschikbare PAK's gemaakt uit hernieuwbaar materiaal en de referentiekool

Naam kool	Leverancier	Indicatieve kosten euro/ton	Grondstof kool	Verwijderings-rendementen micro-verontreinigingen getest?	Activatie methode
Referentie: Pulsorb WP 235	Chemviron	1.950*	Steenkool blend		stoom
Act & sorb product**	Act& sorb	>2.000	MDF afvalhout	v	stoom
PAK C 1000 C	Carbotech	1.410	kokosnoot schillen	v	stoom
MAR-300	Carbon Activated Europe	8.000	hernieuwbaar, onbekend	v	stoom
WOS-PL1000	Carbon Activated Europe	7.750	hout		stoom
WHP-11	Carbon Activated Europe	11.750	hout		chemisch
Acticarbone 2SW	Chemviron	5.100	marine dennen hout		stoom
Acticarbone ENO H	Chemviron	7.250	marine dennen hout		chemisch
C-PURE®	Desotec	4.250	hout		chemisch
C-pure 200-7	Desotec		hout		chemisch
Organosorb 200-1 WB	Desotec	1.940	hout		stoom
Aquasorb G9	Jacobi carbon	2.500	hout	v	?
AquaSorb TM XP-W	Jacobi carbon	Niet bekend	gereactiveerde steenkool (deels)		?
Oxpure 325W-10	Oxbow	vertrouwelijk	hout		stoom
Oxpure 325W-12	Oxbow	vertrouwelijk	hout		stoom
Oxpure 325W-9	Oxbow	vertrouwelijk	hout		stoom
Pyreg kool	Pyreg	Niet bekend			stoom

Reference

Possible sustainable alternatives

STOWA 2020-19

STOWA 2021-24

- Laboratory tests; removal efficiency
- Sustainability
- Costs
- Availability organic waste streams

Laboratory tests

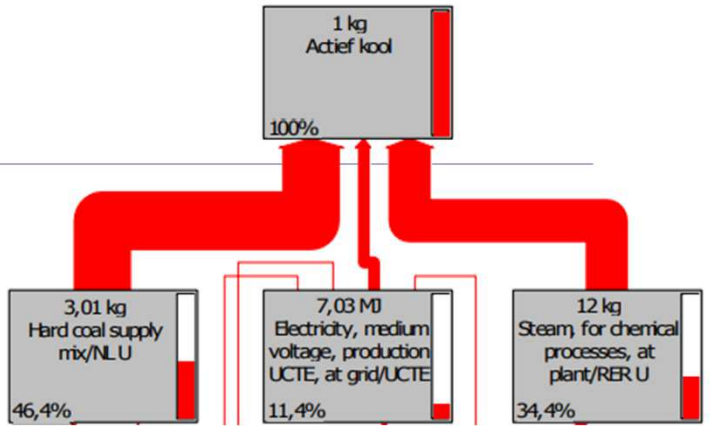
- Removal efficiency for indicator substances
- Both fossil as non fossil PAC

Average removal of indicator substances, dosage 20 mg PAC/l

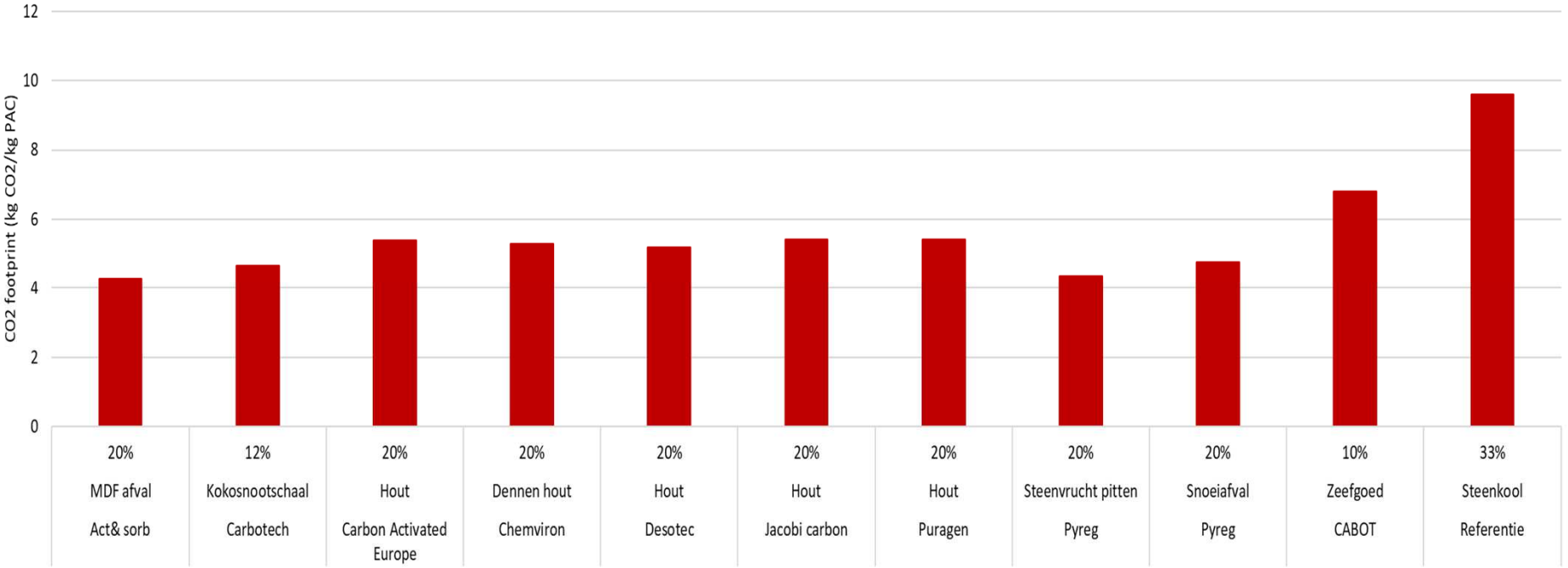
Poederkool	Gemiddelde rendement over alle 19 stoffen (gidsstoffen en	Gemiddelde rendement over de 11 gidsstoffen	Aantal stoffen dat meer of minder presteert dan referentie (meer / minder)
Referentie (Pulsorb wp235)	**86%**	**93%**	**-**
Puragen OxPure	**90%**	**96%**	4 / 0
Chemviron Acticarbone 2SW	**87%**	**94%**	2 / 0
Jacobi Aquasorb G9	**84%**	**90%**	0 / 2
Carbon Activated Europe SMP 1436 MAR 300	**82%**	**89%**	0 / 4
CarboTech PAK C 1000 C	77%	84%	0 / 6
Pyreg	75%	83%	0 / 8
Desotec Organosorb 200-1 WB	63%	72%	0 / 12
geactiveerd zeefgoed Wilp	50%	57%	0 / 18

11 guiding substances: benzotriazol, claritromycine, carbamazepine, diclofenac, metoprolol, hydrochloorthiazide, mengsel van 4- en 5-methylbenzotriazool, propranolol, sotalol, sulfamethoxazol, trimethoprim.

Sustainability



CO_2-footprint



Costs

PAK	PAC prijs	Dosering	Kosten
	€/ton*	g/m^3	€ct/m^3
Referentiekool (Pulsorb WP235)	€ 1.950	15	4,6
Act&Sorb	>€ 2.000	15	>5,8
PAK C 1000 C (Carbotech)	€1.410	20	4,6
Jacobi	€ 2.500	15	5,3
MAR-300	€ 1.600	15	4,2

* bron: STOWA 2020-19

Summary

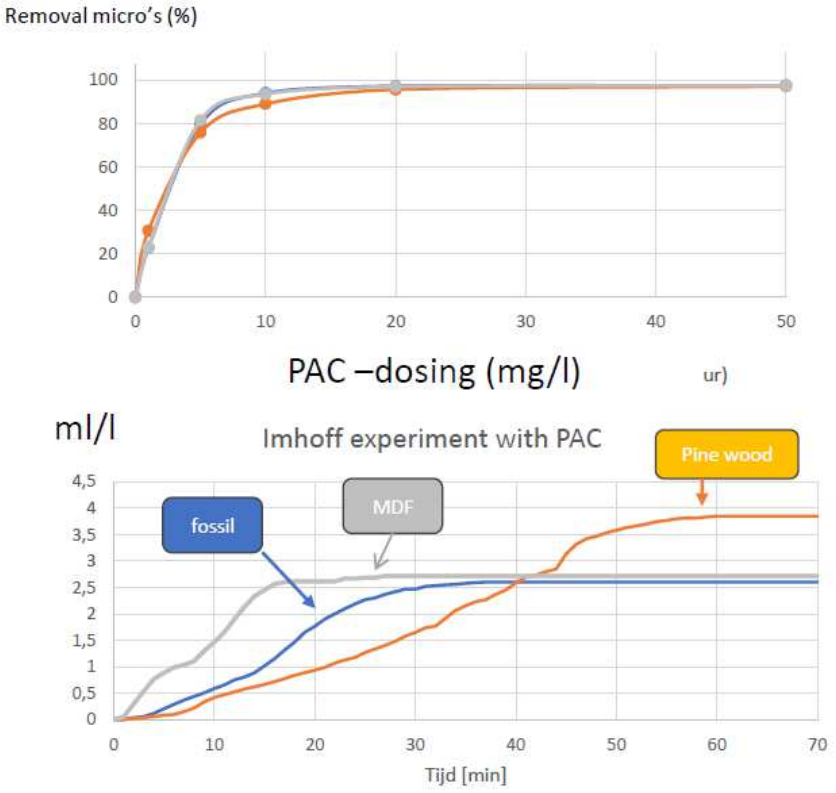
	Unit	PACAS reference (fossil)	PACAS non-fossil
CO_2-footprint	g CO_2/m	122	64 – 127 [1]
Costs	€/m^3	0,05	0,04 – 0,06
Removal of indicator substances	% [2]	70 - 75	70 - 75

[1] CO_2 footprint of commercial available non-fossil PAC ranges from 64 – 103 gram CO_2 / m^3. PAC from finesieve material results in a CO_2 emission of 127 gram because this PAC has a low removal efficiency

Experiments with fossil and non-fossil PAC

Tests at Wwtp Simpelveld and waterboard Rivierenland

	Fossile carbon	Carbon (pine wood)	Carbon (MDF)
Benchscale Efficiency micros	+	+	+
Moisture (%)	96	95	95
Density (kg/m³)	360	230	280
Ash-% 550°C	73	25	14
Ash-% 1000°C	14	2	4



Source: Ad de Man, WBL

Thank you for your attention!

Joost van den Bulk TAUW
joost.vandenbulk@tauw.com

stowa

Tackling Micropollutants in Wastewater
Results of the Dutch Innovation and Implementation Program

November 8 and 9 2023
Aquatech Amsterdam

Ministry of Infrastructure and Water Management