HYDROGEN AS PART OF ENERGY SOLUTION – THE PLASTICS PERSPECTIVE

Tartu Hydrogen Days 2025

TalTech Virumaa College, Allan Niidu

ENERGY CONSUPMTION IN ESTONIA

Mostly imported

Motor fuel

natural gas

Consuption in 2023 a. **63,3 TWh**,

73,6% fossil fuels,

23,5% biofuels,

2,9% other (e.g. wind, solar, hydro).

Final consumption (18,2 TWh) moodustasid diisel ja gaasiõli diesel and gasoil **43,5%**,

gasoline **13,5%**,

NG **10,3%**,

wood **27%**.

TAL TECH

HOW MUCH ENERGY IS PROVIDED

Net (production + import – export) **52 TWh**,

Of which **67,8% fossil fuels**

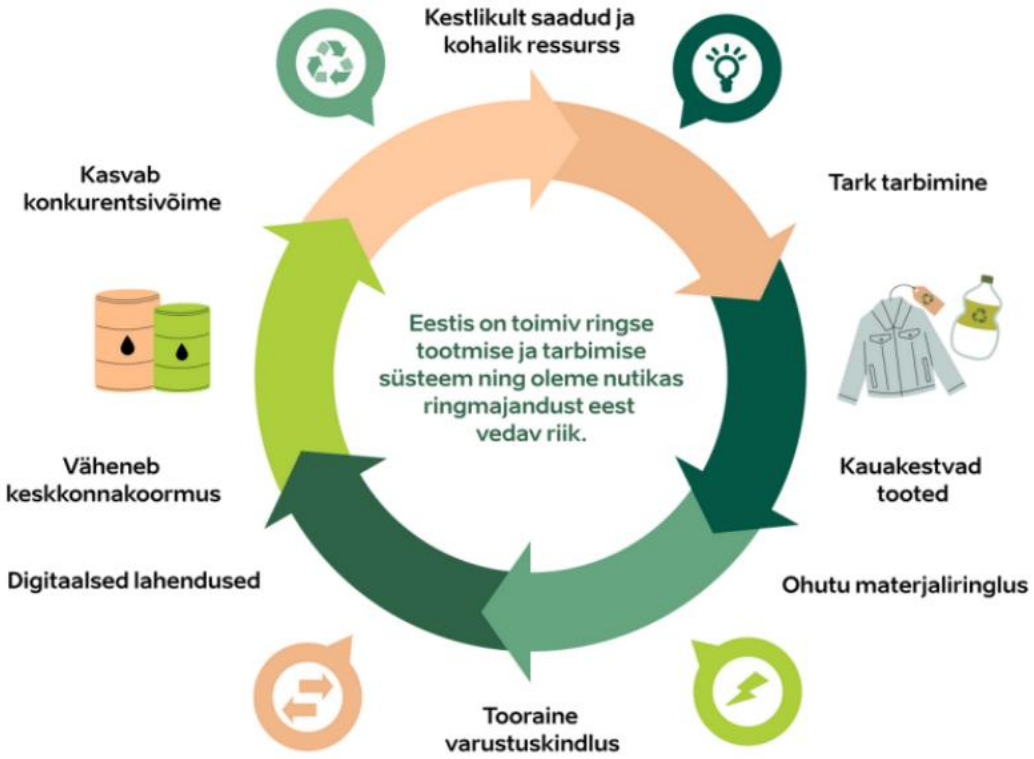
28,6% biofuels.

Energy balance in Baltics ca negative **10 TWh**.

Energia lõpptarbimine=primaarenergia varustatus + muundatud energia tootmine - tarbimine muundamiseks teisteks energialiikideks - energiasektori omatarve - tarbimine tooraineks - kadu.

CIRCULAR ECONOMY AND PLASTICS

CIRCULAR ECONOMY



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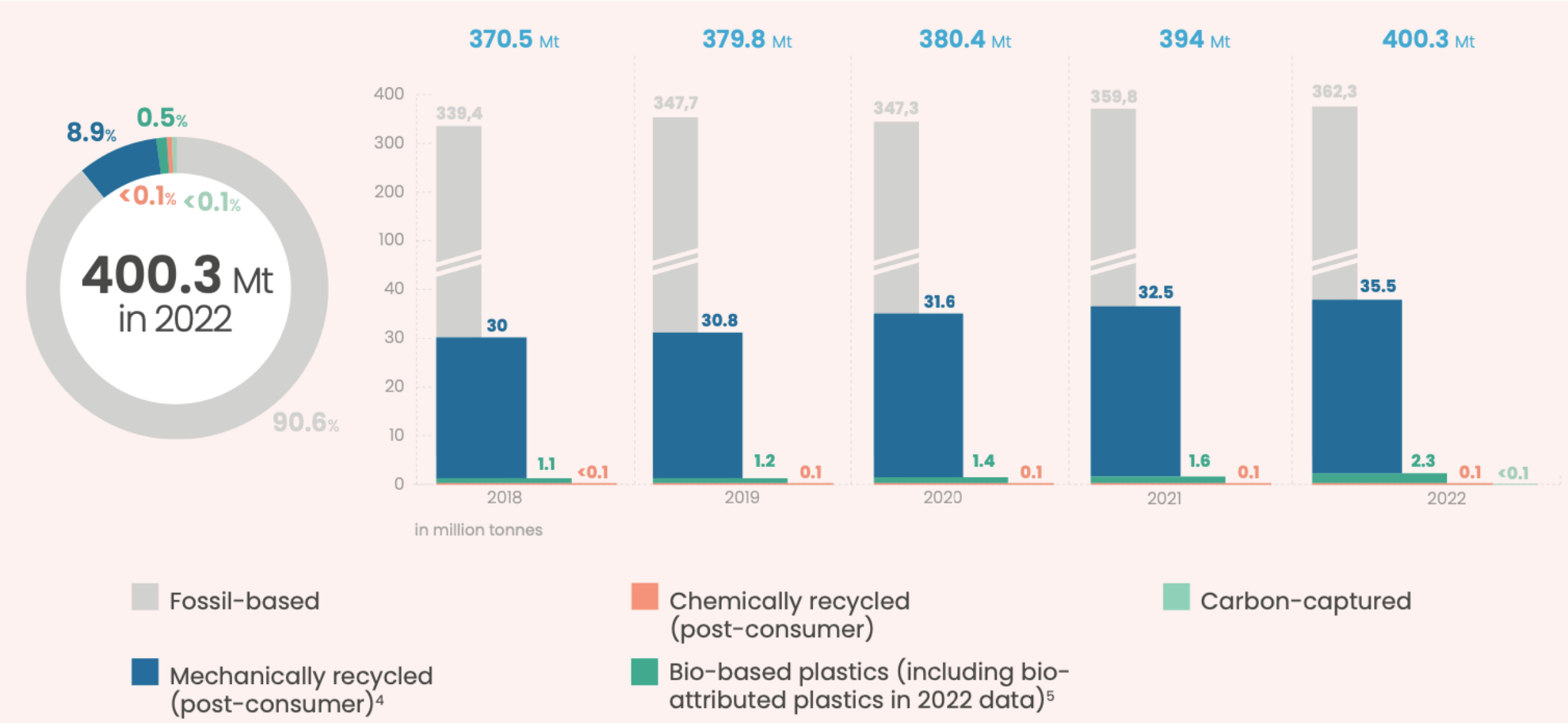
https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits

GLOBAL PLASTICS

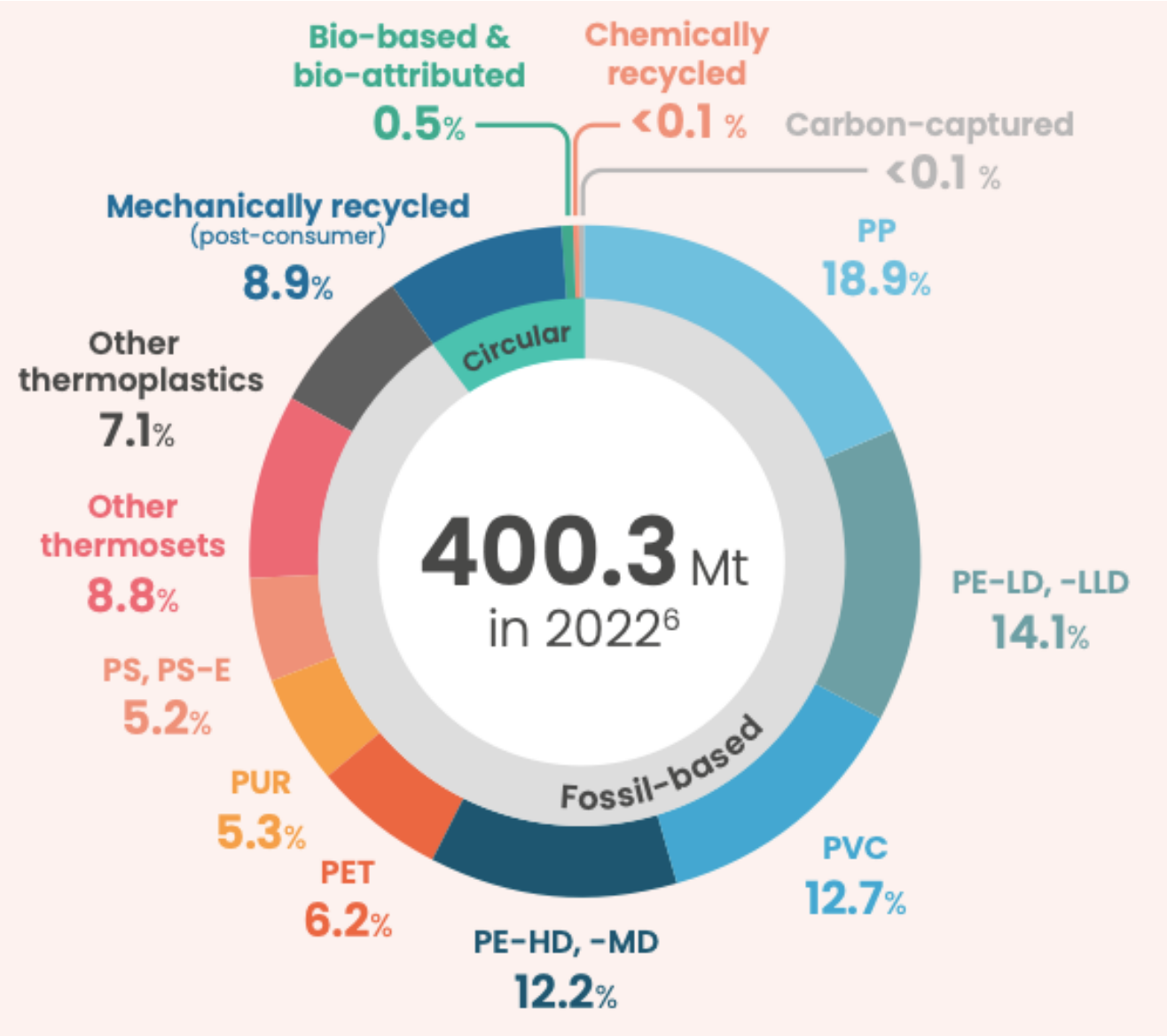


https://plasticseurope.org/wp-content/uploads/2023/10/Plasticsthefastfacts2023.pdf

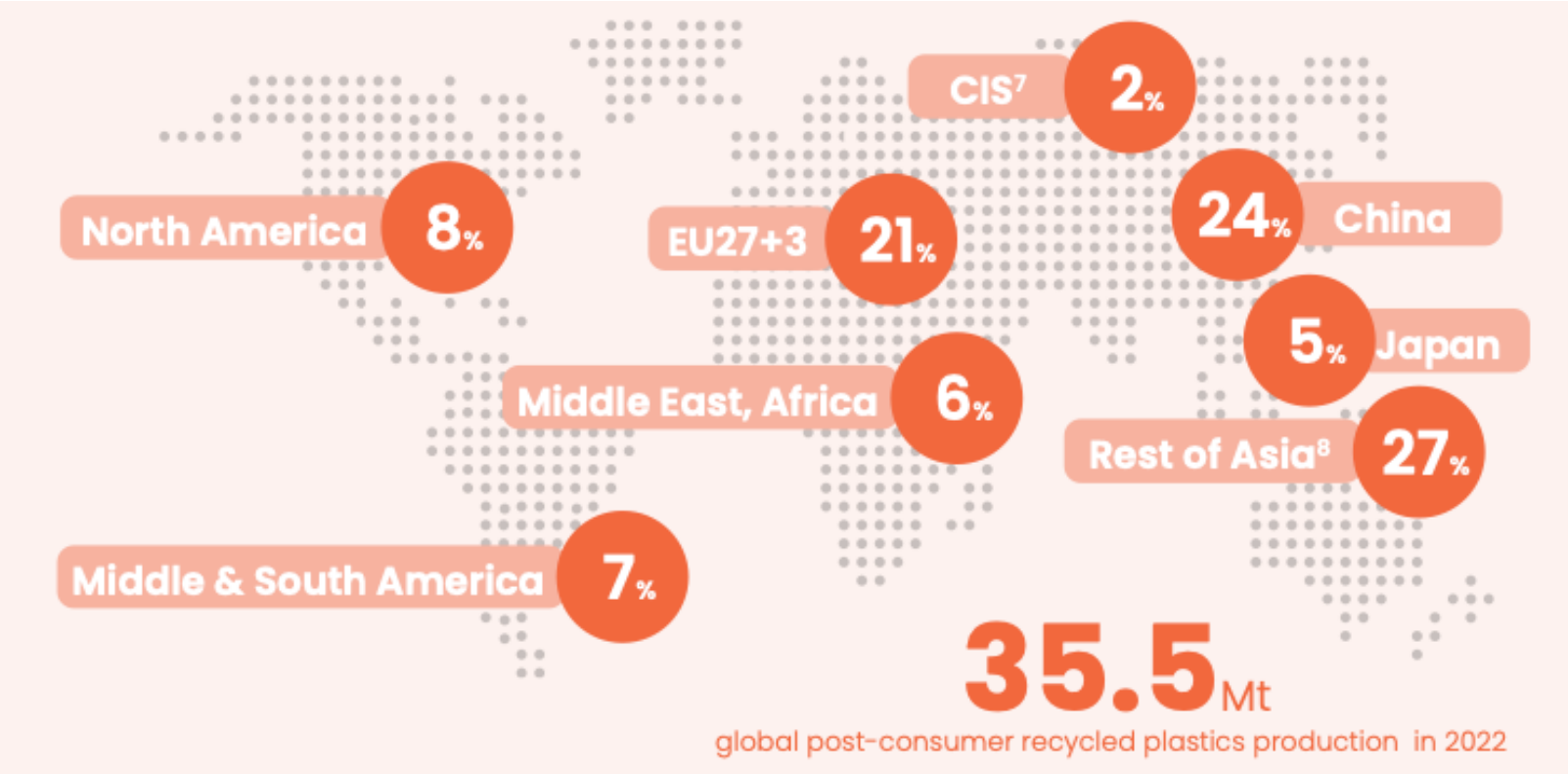
REGIONAL DISTRIBUTION

https://plasticseurope.org/wp-content/uploads/2023/10/Plasticsthefastfacts2023.pdf

BY TYPE


Bio-based & bio-attributed
0.5%
Chemically recycled
<0.1 %
Carbon-captured
<0.1 %
Mechanically recycled (post-consumer)
8.9%
PP
18.9%
Other thermoplastics
7.1%
Circular
Other thermosets
8.8%
400.3 Mt
in 2022[6]
PE-LD, -LLD
14.1%
PS, PS-E
5.2%
Fossil-based
PUR
5.3%
PVC
12.7%
PET
6.2%
PE-HD, -MD
12.2%

RECYCLED PLASTICS



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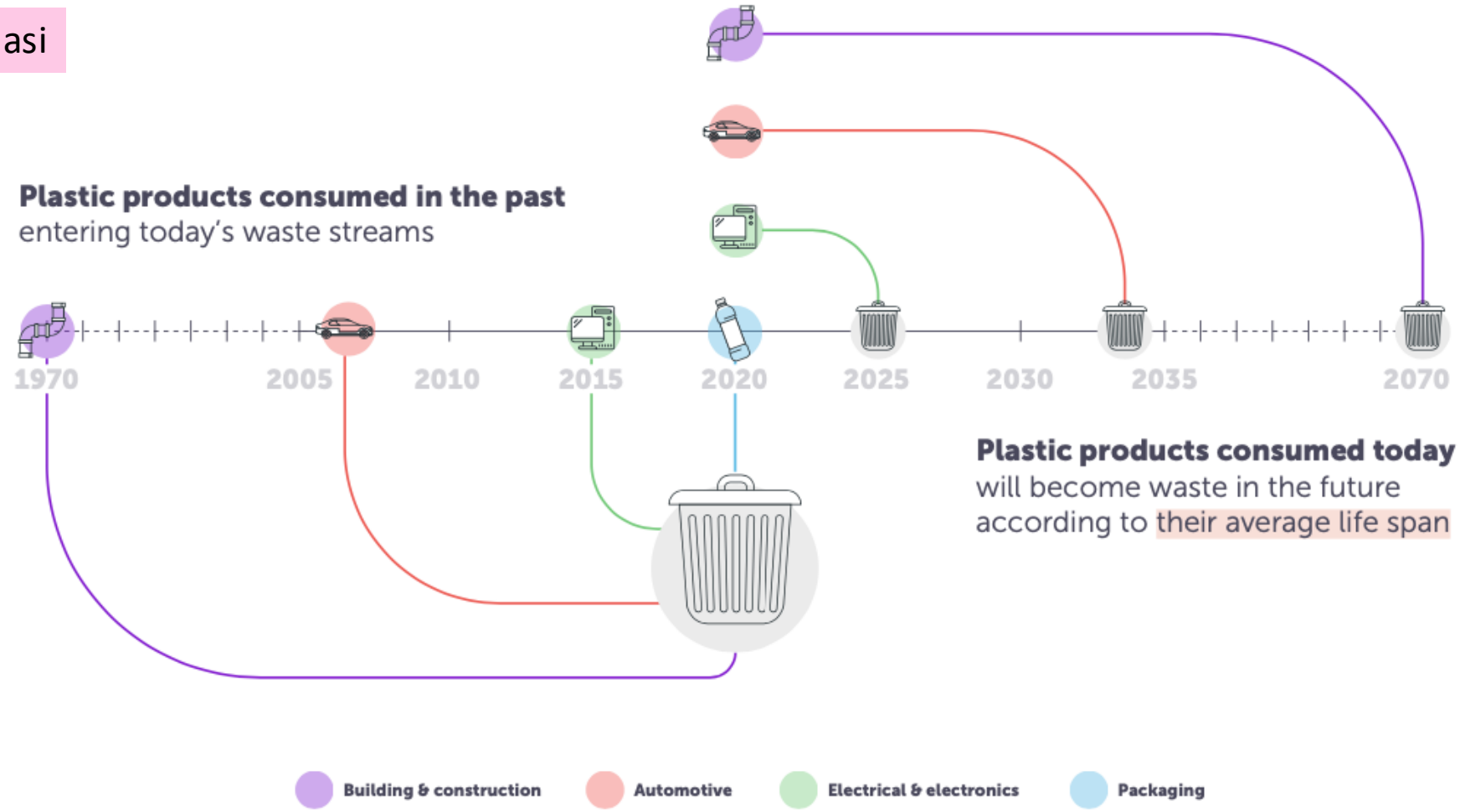
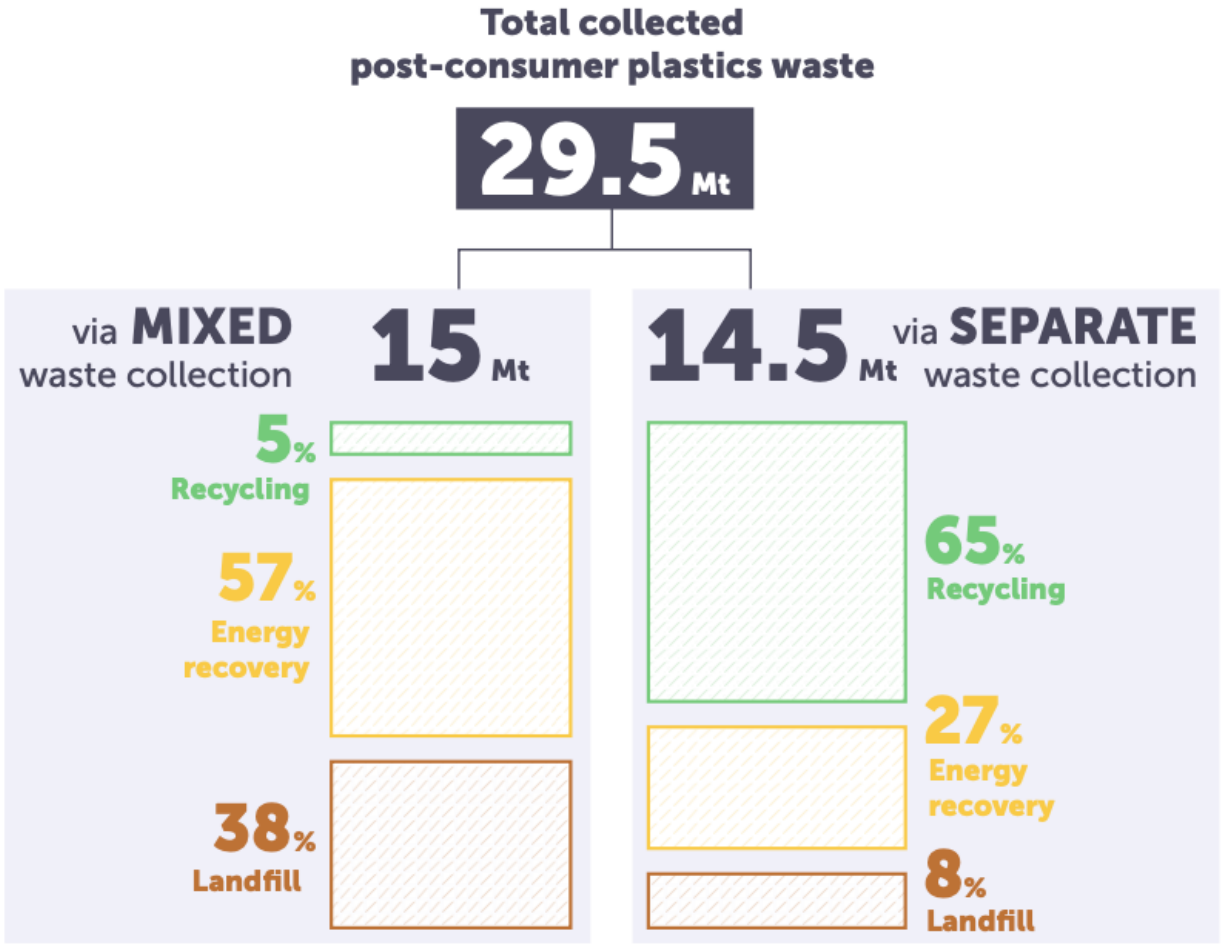
WHEN PLASTICS BECOME WASTE

Vrdl külmik, auto, mänguasi



COLLECTING THE PLASTICS



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HOW CAN WE CONTRIBUTE?

5 KG CAPACITY FAST PYROLYSIS EQUIPMENT

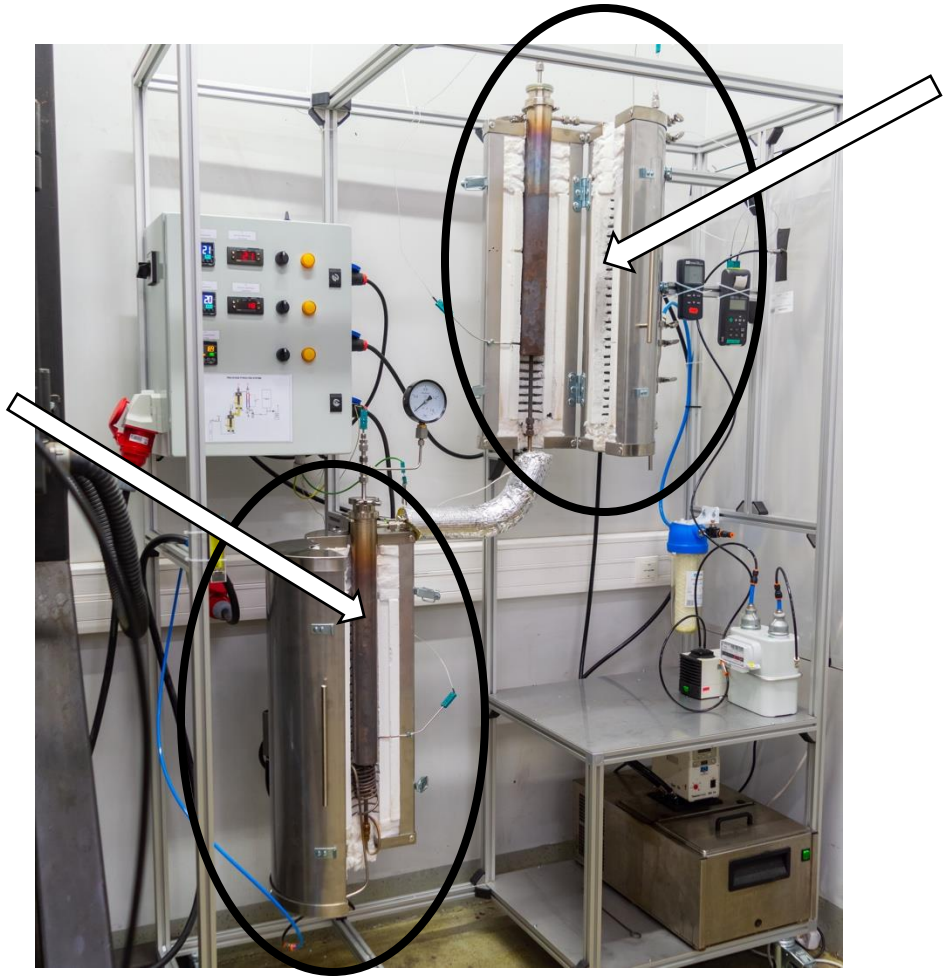
TAL TECH

TWO STAGE PYROLYSIS SYSTEM FOR HYDROGEN PRODUCTION

Pyrolysis reactor

Decomposition of material

Temperature 550°C



Cracking reactor

- Decomposition of hydrocarbons
- Temperature 1000°C

Basic catalysts

- Wood charcoal
- Coconut charcoal

Other catalysts

- Ceramic
- Oil shale semicoke
- RDF semicoke
- Zeolite
- M_xO_y

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Fuel technology science and test laboratory, Virumaa college

Contact olga.pihl@taltech.ee

TWO STAGE PYROLYSIS SYSTEM FOR HYDROGEN PRODUCTION

Syngas composition, % vol.

Compound	RDF	RDF	Bio waste	Wind turbine blade	Sludge
	Empty	*Wood charcoal*	*Catalyst Wood charcoal*	*Wood charcoal*	*Wood charcoal*
H_2	54.6	69.8	35.7	74.2	58.9
CH_4	12.2	5.6	5.2	2.6	0.9
CO_2	0.9	0.9	2.2	0.6	0.5
CO	31.5	23.5	49.4	21.4	39.5
H_2 $m^3/t_{raw\ material}$	**585.5**	**815.6**	**338.7**	**244.8**	**619.7**

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TEXTILE PYROLYSIS

Pyrolysis at 520 °C according to ISO647

Sample	Oil	Semicoke	Water	Gas
Nonwoven material	37.7	16.2	0.2	45.8
Textile	55.6	18.1	2.2	24.1
Porolone	72.9	12.6	5.7	8.8
Latex	87.4	7.3	0.5	4.8
PP + Porolone - 95/5	93.4	1.5	0.0	5.0

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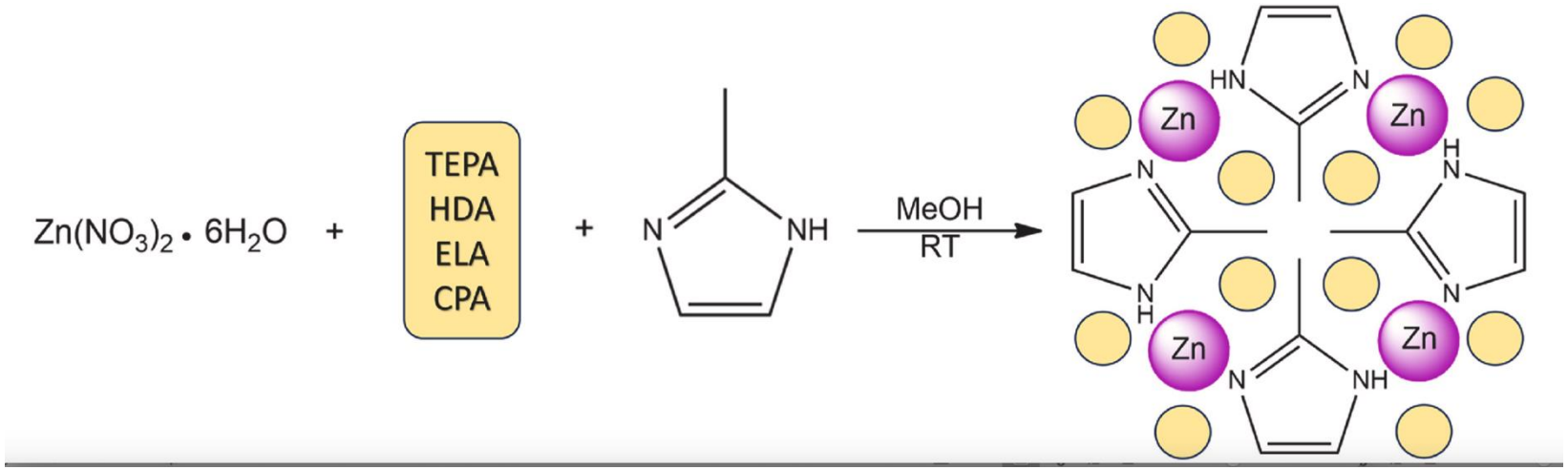
TEXTILE PYROLYSIS

	Nonwoven	Porolone	Fabric	Latex	Textile	Denim
Pyrolysis reactor T, °C	550	550	550	550	550	550
Catalyst	-	-	-	-	-	-
Cracking reactor T, °C	1000	1000	1000	1000	1000	1000
Component, vol. %						
Hydrogen	35.05	53.38	41.67	73.18	43.89	44.99
Methane	10.65	14.43	7.99	18.25	10.4	3.19
CO_2	3.63	3.03	1.92	0.65	2.93	0.68
H_2S	0.08	0.45	0.12	0.35	0.13	0.08
CO	50.16	22.78	47.42	4.44	41.09	50.87
$C_{xn}H_{yn}$	0.44	6.18	0.91	3.11	1.56	3.19
m^3 H_2 / t starting material	192.1	499.9	288.1	608.2	304.8	370.4
m^3 CO / t starting material	274.9	214.3	328.2	36.9	285.3	418.7
HHV, MJ/m^3	15.90	21.56	16.15	23.26	17.60	13.84
LHV, MJ/m^3	14.70	19.50	14.87	20.60	16.11	12.78

ZIF-8



Hexadecylamine was chosen

https://doi.org/10.1016/j.micromeso.2023.112956

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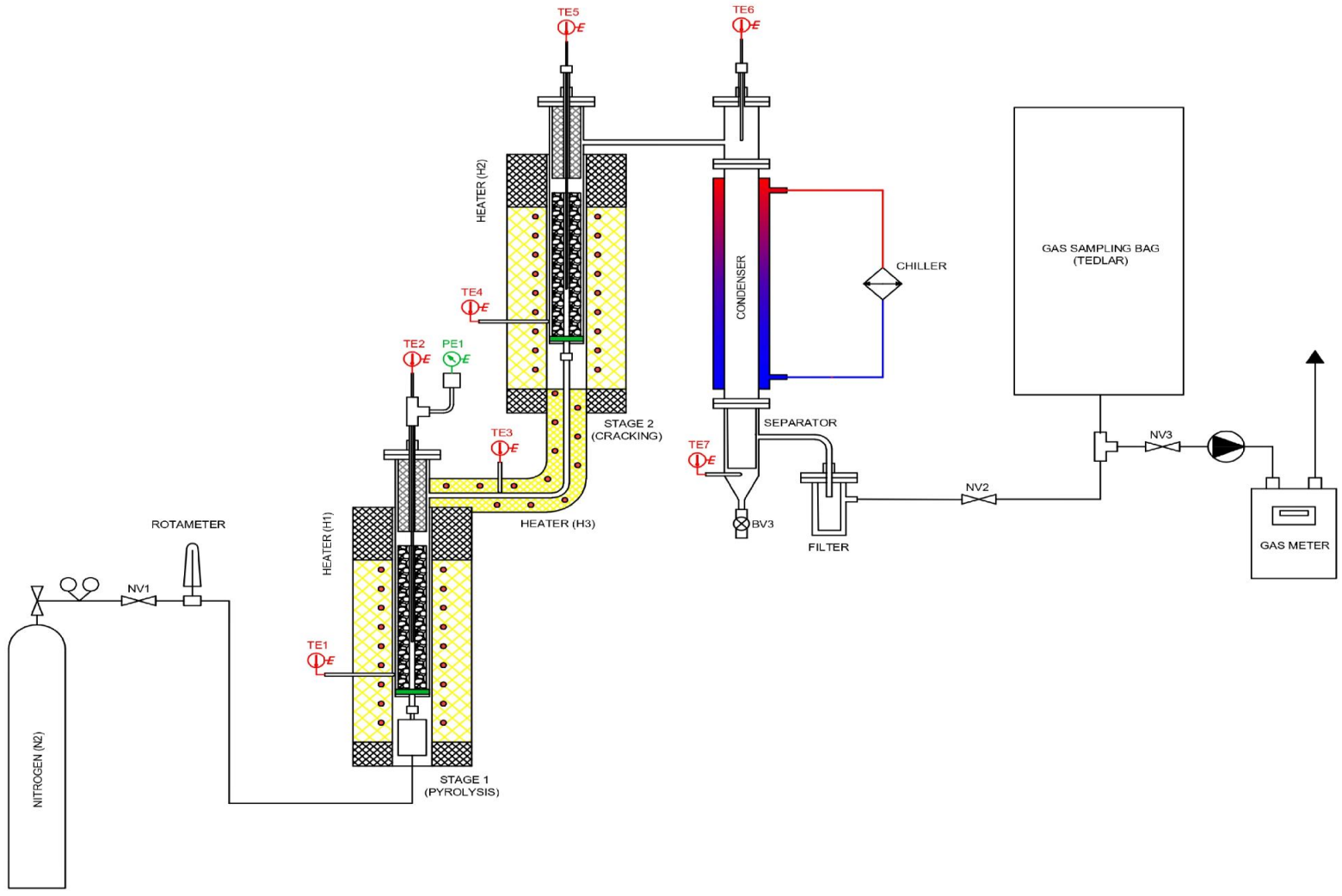
HYDROGEN PRODUCTION

Pyrolysis reactor	Used 5W40 oil + RDF 0,3:0,7	Used 5W40 oil + RDF 0,3:0,7
Temperature, °C	550	550
Cracking reactor	Empty	MOF
Temperature, °C	1000	1000
H_2, vol%	64.6	67.96
H_2S, vol%	0.59	0.14
CO_2, vol%	1.6	0.33
CO, vol%	13.38	18.67
CH_4, vol%	16.84	11.79
$C_{xn}H_{yn}$, vol%	2.99	1.11
m^3 H_2 / t r.m.	543.73	679.6
m^3 CO / t r.m.	112.62	186.7
H_2 : CO	4.83	3.64
HHV, MJ/m^3	22.48	17.74
LHV, MJ/m^3	20.07	15.755



BEFORE WE GO

WHAT WE DO?

People
Moonika Ferschel
Martin Jürisoo
Tanel Mõistlik

PhD students
Bijan Barghi
Viktorija Mironova
Margarita Belova
Anastassia Raag
Ragnar Kauril
Andrea Casagrande
Dmitri Tsõvarev

MOF-s

Oxidation: chemical and photochemical

DoE, kinetics modeling

Adsorption

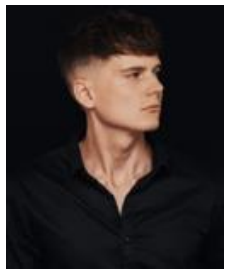
CO2 valorisation: cyclic carbonates, multicarbon compounds

Linker synthesis

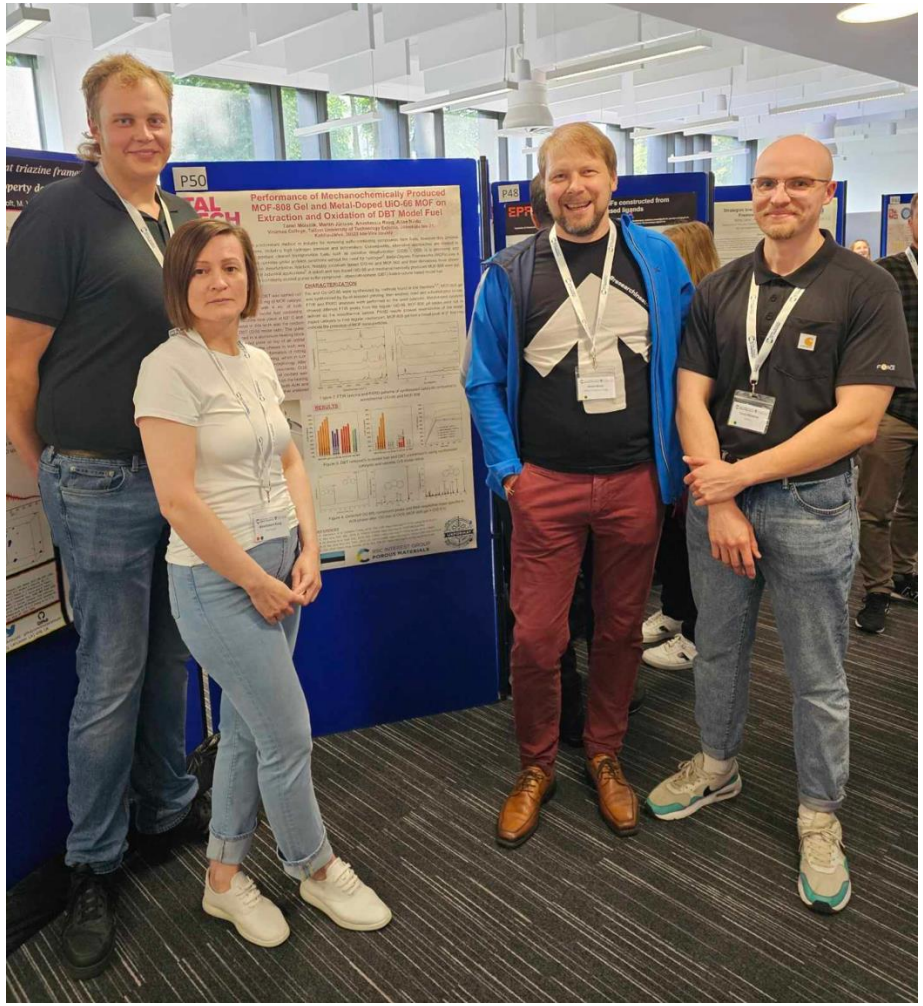
Mechanochemistry – complexation, agrochemicals

Oil shale valorization

TAL TECH



RANDOM PICTURES AT SOME CONFERENCE



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SCIENCE IS COOL

TAL
TECH

H2COVE

H2CoVE
HYDROGEN CENTRES OF VOCATIONAL EXCELLENCE

Co-funded by
the European Union

The Future of Hydrogen Education and Skills

The Hydrogen Centres of Vocational Excellence (H2CoVE) project aims to develop a skilled workforce in the partner regions and across Europe to enable a successful transition to a hydrogen-based economy.

19 partners from 5 countries

D·C TERRA
Eesti Lennuakadeemia Estonian Aviation Academy
Fagskulen Vestland
FJORD BASE GRUPPEN
fen research
fen systems
fh KufsteinTirol
DIE HTL KRAMSACH
Hanze
Western Norway University of Applied Sciences
King Danylo UNIVERSITY
klasse! forschung
SUSTAINABLE ENERGY | NORWEGIAN CATAPULT CENTRE siva
Noorderpoort
New Energy Coalition Drivers of Change
Precarpathian eco-energy cluster
SKYCORP
TAL TECH VIRUMAA COLLEGE
Vestland County Council
TARTU RAKENDUSLIK KOLLEDŽ TARTU VOCATIONAL COLLEGE

Grant number 101143966
ERASMUS+ program

TAL TECH

H2COVE

Goals

Develop **a collaborative, open platform** to connect stakeholders across Europe.

Upgrade and create **tailored education programmes**.

Upskill and reskill the workforce, sharing best practices across the continent.

Ambitions

Training **150 teachers** in "Train-the-Trainer" courses.

Engaging **800 business stakeholders**.

Upskilling or reskilling **1,000 employees**.

Involving **140 students** in challenge-based learning competitions.

Driving **12 thesis projects** tackling real industry challenges.

Follow the project

h2cove.eu

H2CoVe

TAL TECH

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Hydrogen Demo Lab:
Want to know more about our H2 solutions?
https://taltech.ee/virumaa-kolledz/vidrik

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Heiko: heiko.podersalu@taltech.ee

VIDRIK Innovation Centre for Digital and Green Technologies

Increasing the efficiency of energy consumption through smart models and digital systems
Device and system diagnostics, industrial robots, industrial Internet of Things and 5G, artificial intelligence, Internet of Things (IOT), smart grid
Batteries, accumulators, supercapacitors (electrical research), hydrogen technologies and systems
Low carbon technologies CO_2 capture
Smart environmental monitoring, environmentally friendly and self-driving vehicles (including drones)
New business models/e-commerce, digitization of supply chains, 3D printing (at an industrial level)
Creation of remote capacity for occupational health and rehabilitation for heavy and mining industry workers
Demo area of smart city solutions on the example of the college
Recycling of materials, green chemistry

Which partners are you looking for?

- Commercial partners
- Public and Private Financers
- European, national and regional governments.

TALLINNA TEHNIKAÜLIKOOL

Ehitajate tee 5, 19086 Tallinn, Tel 620 2002 (E-R 8.30–17.00)

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