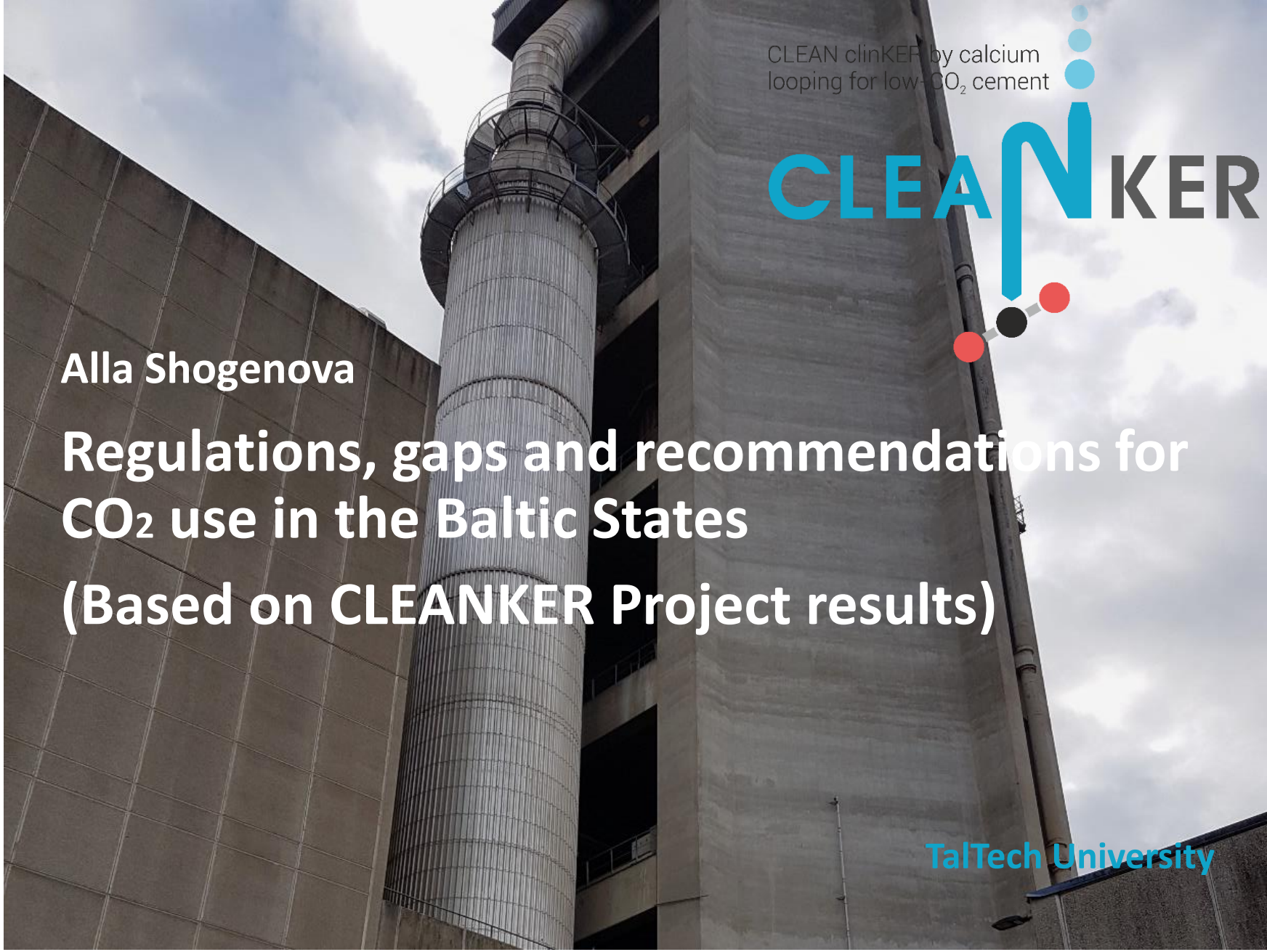

CLEAN clinKER by calcium looping for low-$CO_2$ cement

CLEANKER

Alla Shogenova

# Regulations, gaps and recommendations for $CO_2$ use in the Baltic States

## (Based on CLEANKER Project results)

TalTech University

# EU CCS DIRECTIVE

- Directive 2009/31/EC of the European Parliament and of the Council on the geological storage of carbon dioxide (so-called Carbon Capture and Storage Directive – hereinafter 'CCS Directive') establishes a legal framework for the environmentally safe geological storage of $CO_2$.
- The CCS Directive aims to ensure that there is no significant risk of leakage of $CO_2$ or damage to health or the environment, and to prevent any adverse effects on the security of the transport network or storage sites (EC, 2009a).
- However **CCS Directive does not regulate any CO2 use options**

# EUROPEAN UNION EMISSION TRADING SYSTEM (EU ETS)

- EU ETS was previously known as the EU Emissions Trading Scheme.
- The scheme currently has three operating phases (EU ETS, 2018):
- *Phase I* : 1 January 2005 - 31 December 2007 and was a 'learning by doing phase';
- *Phase II* : 1 January 2008 - 31 December 2012 and includes revised monitoring and reporting rules, more stringent emissions caps and additional combustion sources;
- *Phase III*, 1 January 2013 - 31 December 2020, brings major changes including, harmonised allocation methodologies and additional greenhouse gases and emission sources.

- The EU ETS now operates in **31 countries** (the 28 EU Member States plus Iceland, Liechtenstein and Norway).
- As of 2013 it covers $CO_2$ emissions from **11,000 power plants** and manufacturing installations and slightly over **500 aircraft operators** flying between EEA's airports.
- It covers around **45% of the EU's GHG emissions**.

# EUROPEAN UNION EMISSION TRADING SYSTEM (EU ETS)

- EU ETS works on the "cap and trade" principle.
- This means there is a "cap", or limit, on the total amount of certain greenhouse gases that can be emitted by the factories, power plants and other installations in the system.
- Within this cap, companies receive emission allowances which they can sell to or buy from one another as needed.
- The limit on the total number of allowances available ensures that they have a value.

# EU ETS national data in 2015 (EEA, 2017)

| Country | Fuel consumption (TJ) | $CO_2$ emissions (kt) | Number of registered installations | | | | |
|---|---|---|---|---|---|---|---|
| | | | < 25 000 t $CO_2$-eq | 25 000 – 50 000 t $CO_2$-eq | 50 000 -500 000 t $CO_2$-eq | >500 000 t $CO_2$-eq | In total |
| Estonia | 106 684 | 10996 | 28 | 5 | 8 | 4 | 45 |
| Latvia | 30173 | 1714 | 56 | 4 | 2 | 2 | 64 |
| Lithuania | 99940 | 6028 | 78 | 3 | 6 | 3 | 90 |

# $CO_2$ Emissions from industrial installations as a percentage of the previous year (EU ETS, 2018)

| Country | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|
| Estonia | 94.08 | 79.52 | 112.49 | 109.22 |
| Latvia | 89.67 | 101.03 | 95.78 | 94.87 |
| Lithuania | 91.41 | 99.79 | 90.32 | 101.92 |

# Monitoring and Reporting Guidelines

- **The Monitoring and Reporting Guidelines (MRG) under the ETS Directive (Commission Decision 2007/589/EC and its amendment Commission Decision 2010/345/EU)**
- provide monitoring and reporting guidelines for greenhouse gas emissions from the ***capture, transport and geological storage of $CO_2$***.
- The MRG specify how emissions of the $CO_2$ storage activity have to be accounted for and reported for purposes of the EU ETS (MRG Annexes I (e.g. Section 4.3) and XVIII).
- The following emission sources at a storage site have to be monitored under the EU ETS:
- Combustion emissions at the ***injection site***
- Fugitive emissions and emissions from venting at the ***injection site***
- Emissions from vents and flaring at ***enhanced hydrocarbon recovery***
- ***Leakage from the storage reservoir*** into the water column or atmosphere;

The MRG places emphasis on the verification, accounting and reporting of any emissions (i.e., quantification), the relevant content of which is given below.

In the MRG one of the guiding principles is to minimize the uncertainty in the quantification of emissions.

# INTEGRATION OF EU ETS AND EU CCS DIRECTIVE

- Some monitoring methods used for monitoring under the CCS Directive may be suitable for quantification of any emissions resulting from leakage
- Furthermore, quantification of any leakage will be useful in assessing the significance of the leakage risk as required under the CCS Directive
- ***Monitoring activities and plans need to meet the requirements of the CCS Directive should be extended to meet the requirements of the MRG under the EU ETS***
- It will be more efficient for both the operator and the competent authority of a storage site to set up and manage monitoring on an integrated basis, covering both CCS and EU ETS issues
- Emissions sources at the injection site and from *enhanced hydrocarbon recovery* can be monitored using existing approaches from the MRG
- Combustion emissions at injection can be monitored with approaches from Annex II (stationary combustion), vented emissions at injection and at *enhanced hydrocarbon recovery* with approaches from Annex XII (continuous emission measurement) and fugitive emissions at injection by industry best practice

Co-funded by the Horizon 2020 Framework Programme of the European Union

# REGULATIONS FOR $CO_2$ USE

8 June 2010 EC amended Decision 2007/589/EC to include monitoring and reporting guidelines for *greenhouse gas emissions from capture, transport and geological storage* (EC, 2010).

- Some $CO_2$ use issues are also included in this regulation.
- In the Annex 1 to this decision
- "***enhanced hydrocarbon recovery***" is determined as the recovery of hydrocarbons in addition to those extracted by water injection or other means.
- Where **leakages** from storage complex are identified and lead to **emissions**, **or release of $CO_2$ to the water column,** they shall be included as emissions sources for the respective installation and shall be monitored accordingly as required in Annex XVII.

# Transferred $CO_2$

- **Section 5.7 is replaced by the "5.7 Transferred $CO_2$":**
- Subject to approval by the competent authority,
- the operator may subtract from the calculated level of emissions of the installation ***any $CO_2$ which is not emitted from the installation, but transferred out of the installation:***
- as pure substance
- *or* ***directly used and bound in products or as feedstock***
- or ***to another installation holding a greenhouse gas emissions permit,***
- The respective amounts of **$CO_2$** shall be reported for each installation **$CO_2$ has been transferred to** or **received from** as a **memo item** in the **annual emission report** of the transferring as well as the receiving installation.
-

# Transferred $CO_2$

- In the case of ***transfer to another installation***,
- the ***receiving installation*** must add to its calculated level of emissions the ***received CO2***, unless other requirements as set out in Annexes XVII or XVIII apply.
- Respective **transferring** as well as **receiving installations** shall be notified by Member States to the ***Commission*** pursuant to Article 21 of Directive 2003/87/EC.
- In case of transfer to an installation falling under that Directive,
- the **transferring installation** shall identify the **receiving install**ation in its **annual emission report** by stating the receiving installation's installation identification code as defined by the Regulation pursuant to Article 19 of that Directive.
- The **receiving installation** shall identify the **transferring installation** through the same approach.

Co-funded by the Horizon 2020 Framework Programme of the European Union

# REGULATIONS FOR $CO_2$ USE

## Potential cases of transferred $CO_2$ out of an installation include, inter alia:

- pure $CO_2$ used for the carbonation of beverages
- pure $CO_2$ used as fire extinguishing agent, refrigerant or as laboratory gas
- pure $CO_2$ used as solvent in the food or chemical industry
- $CO_2$ used and bound in products or feedstocks in the chemical, pulp industry (e.g. for urea or precipitated carbonates)
- carbonates bound in spray-dried absorption product (SDAP) from semi-dry scrubbing of flue gases
- $CO_2$ transferred to capture installations
- $CO_2$ from capture installations transferred to transport networks
- $CO_2$ from transport networks transferred to storage sites

# Transferred $CO_2$

- The mass of annually transferred CO2 or carbonate shall be determined with a maximum uncertainty of less than 1,5 %
- In case the amounts of transferred CO2 are measured both at the transferring and at the receiving installation, the amounts of respectively transferred and received CO2 shall be identical.
- If the deviation between measured values is in a range, which can be explained by the uncertainty of the measurement systems, the arithmetic average of both measured values shall be used in both the transferring and receiving installations' emission reports.
- The emission report shall include a statement that this value has been aligned with the value of the respectively transferring or receiving installation. The measured value shall be included as memo item.

Co-funded by the Horizon 2020 Framework Programme of the European Union

# REGULATIONS FOR $CO_2$ USE

## $CO_2$ use for EOR

- The term EOR is not addressed by the CCS Directive.
- The CCS Directive includes Preamble Recital 20:
- “Enhanced Hydrocarbon Recovery (EHR) refers to the recovery of hydrocarbons in addition to those extracted by water injection or other means“.
- EHR is not in itself included in the scope of this Directive.
- However, where **EHR is combined with geological storage of $CO_2$**, the provisions of this **Directive** for the environmentally safe storage of $CO_2$ **should apply.**
- **Pure $CO_2$-EOR operations** involving **incidental storage** (including temporary storage connected with buffering operations) would not qualify as storage under the directive, but an as inevitable and ordinary result of EOR operations: **the directive does not apply.**

# REGULATIONS FOR $CO_2$ USE

## $CO_2$ use for EOR

- Commission decision of 8 June 2010 amending Decision 2007/589/EC as regards the inclusion of monitoring and reporting guidelines for greenhouse gas emissions from the capture, transport and geological storage of carbon dioxide includes

**Annex XVIII "Activity-specific guidelines for the geological storage of $CO_2$ in a storage site permitted under Directive 2009/31/EC.**

- In paragraph 2.3 "Vented and fugitive emissions from enhanced hydrocarbon recovery operations" it is stated:
- The combination of EHR with geological storage of $CO_2$ is likely to provide an additional source stream of emissions, namely the breakthrough of $CO_2$ with the produced hydrocarbons. Additional emission sources from EHR operations include:
- the oil-gas separation units and gas recycling plant, where fugitive emissions of $CO_2$ could occur
- the flare stack, where emissions might occur due to the application of continuous positive purge systems and during depressurisation of the hydrocarbon production installation
- the $CO_2$ purge system, to avoid that high concentrations of $CO_2$ extinguish the flare.

## $CO_2$ use for EOR

- Any fugitive emissions occurring will usually be rerouted in a gas containment system, to the flare or $CO_2$ purge system.
- Any such fugitive emissions or $CO_2$ vented e.g. from the $CO_2$ purge system shall be determined in accordance to Section 2.2 of the Annex.
- Emissions from the flare stack shall be determined in accordance with Annex II, taking into account potential inherent $CO_2$ in the flare gas.
- Monitoring shall start in the case that any leakage results in emissions or release to the water column.
- Emissions resulting from a release of $CO_2$ into the water column shall be deemed to be equal to the amount released to the water column.
- Monitoring of emissions or of release into the water column from a leakage shall continue until corrective measures pursuant to Article 16 of the CCS Directive 2009/31/EC have been taken and emissions or release into the water column can no longer be detected".

# National cases for $CO_2$ use prospects and regulations

## Estonia

- **Hazardous wastes**
- Burning 1 t of Estonian oil shale gives approximately 0.45 t of hazardous alkaline ash (contains up to 50% CaO and 15% MgO) waste.
- Ash alkalinity makes it possible to use it for CO2 mineral carbonation
- Estonia produces around 8.6 mln tonnes of hazardous combustion waste per year (mainly oil shale ash), corresponding to 6600 tonnes of hazardous waste per capita.
- According to Estonian regulation oil shale bottom ash and oil shale flow ash are listed as hazardous waste with codes 10 01 97* and 10 01 98* respectively.
- To simplify the re-usage of oil shale ash, Eesti Energia has created a Material Safety Data Sheet for Oil Shale Thermal Processing Residue with the following specific commercial name: Burnt Oil Shale. Burnt Oil Shale is primarily used in industrial installations for the production of cements and other hydraulic binders. It is also used in soil stabilization and as a fertilizer in agriculture.
- **Prospects for CO2 use**
- Estonian oil shale ash has high CO2 binding properties and has very good prospects to be used in CO2 mineral carbonation process (Uibu et al, 2010).

Co-funded by the Horizon 2020 Framework Programme of the European Union

# National cases for $CO_2$ use prospects and regulations

## Latvia

- **CO2 Use for Enhanced Oil Recovery (CO2 -EOR)**
- Latvia has very small hydrocarbon fields onshore and offshore in the western part of the country, and their capacity for CO2 storage is not estimated.
- However, possibility for CO2-EOR and CO2 storage in the E6 offshore structure was recently proposed (Shogenov et al, 2017, Shogenov and Shogenova, 2017).
- Emissions sources at the injection site and from enhanced hydrocarbon recovery can be monitored using existing approaches from the Monitoring and Reporting Guidelines under the ETS Directive
- Combustion emissions at injection site can be monitored with approaches from Annex II (stationary combustion), vented emissions at injection and at enhanced hydrocarbon recovery with approaches from Annex XII (continuous emission measurement) and fugitive emissions at injection by industry best practice.
- **Prospects for CO2 use**
- CO2 use for EOR is considered be authors of this report as possible useful demonstration of the innovative technology in the Baltic Region (Shogenov et al, 2016, Shogenov and Shogenova, 2017).

Co-funded by the Horizon 2020 Framework Programme of the European Union

# National cases for $CO_2$ use prospects and regulations

## Latvia

- **Renewable Energy (RE)**
- Latvia has not yet reached its ambitious RE 2020 target (40%). Its 2030 RE target is 50% Its 2030 target of RE from total energy and for electricity heating is not available.
- **CO2 Use for Geothermal Energy Recovery (CO2-GER)**
- CO2 has not been used in Latvia for GER, and Latvian installed capacity and heat production from geothermal energy was very low in 2016 and the lowest among the studied countries .
- However, Latvia has geothermal anomalies in the southern part of the western Latvia, and have prospects for higher use of geothermal energy, supported by discussions by research institutes and industry (Skapare et al, 2015).
- **Prospects for CO2 use**
- CO2 use for GER is considered be authors of this report as prospective when used in synergy with other innovative technologies and CO2 storage (Shogenov et al, 2017).
- In case of GER will be implemented, regulations for Renewable Energy and existing approaches from the Monitoring and Reporting Guidelines under the ETS Directive (Commission Decision 2007/589/EC and its amendment Commission Decision 2010/345/EU) could be applied as described in this document for EOR.

# Lithuania

- ***$CO_2$ Use for Enhanced Oil Recovery ($CO_2$ -EOR)***
- According to Minjos Nafta company $CO_2$ use for EOR and $CO_2$ storage in the depleted oil fields is a prospective option for Lithuania. For this case Lithuanian CCS law for $CO_2$ storage and monitoring and could be applied.
- Emissions sources at the injection site and from enhanced hydrocarbon recovery can be monitored using existing approaches from the Monitoring and Reporting Guidelines under the ETS Directive (Commission Decision 2007/589/EC and its amendment Commission Decision 2010/345/EU).
- Combustion emissions at injection site can be monitored with approaches from Annex II (stationary combustion), vented emissions at injection and at enhanced hydrocarbon recovery with approaches from Annex XII (continuous emission measurement) and fugitive emissions at injection by industry best practice.
- ***Prospects for $CO_2$ use***
- $CO_2$ use for EOR is considered be authors of this report as prospective and beneficiary for Lithuania. Cooperation with Estonia is possible.

Co-funded by the Horizon 2020 Framework Programme of the European Union

# National cases for $CO_2$ use prospects and regulations

## Lithuania

- **CO2 Use for Geothermal Energy Recovery (CO2-GER)**
- CO2 has not been used yet for GER, but Lithuanian geothermal resource, lying in the west of the country, has been found to be significant.
- In 2000, the 41 MW Klaipeda Geothermal Demonstration Plant (KGDP) was commissioned and began producing 25% of the heat required by the city of Klaipeda.
- Much work has been undertaken on the thermal waters in Vilkaviskis, a city in the south-western part of the country, with a view to developing balneological uses and also a district heating scheme.
- To date, Lithuania's extensive low-temperature resource has been harnessed for an estimated 1000 ground-source heat pumps, with an installed capacity of 17 MW (WEC, 2018). Installed capacity and production for geothermal electricity and district heating in 2016 is the highest in Lithuania among the studied three Baltic States Table 9.3).
- **Prospects for CO2 use**
- CO2 use for GER we consider as prospective and beneficiary for Lithuania.
- In case of GER will be implemented, regulations for Renewable Energy and existing approaches from the Monitoring and Reporting Guidelines under the ETS Directive could be applied

Co-funded by the Horizon 2020
Framework Programme of the European Union

# Conclusions

- The climate strategic targets should be increased in all the studied countries to reach the Paris climate targets and CCUS technology should be included in the list of technological priorities together with renewables and energy storage in all countries and in the BSR.
- $CO_2$ use options in the studied countries include $CO_2$ use for EOR, GER, mineral carbonation using waste materials, should be used in synergy with $CO_2$ storage and should compose business cases in the Baltic countries.
- **Additional CCUS regulations and political incentives are needed in all the studied countries.**
- Specific laws for $CO_2$ storage and monitoring of emissions at the storage sites should be developed in Latvia and Russia.
- **National, industrial and EU support are needed to start the first full CCUS projects in the Baltic States and Russia.**
- Educational and increasing public awareness activities supported by academic and research institutions and media support to explain benefits of climate change mitigation are needed in the all countries.

# Acknowledgments

**This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement n. 764816**

**This work is supported by the China Government (National Natural Science Foundation of China) under contract No.91434124 and No.51376105**

**www.cleanker.eu**

**Twitter: @CLEANKER_H2020**

**Facebook: CLEANKER project @cleanker**