Horizon2020 Information Days on Public-Private Partnerships

Brokerage event
16 October 2015

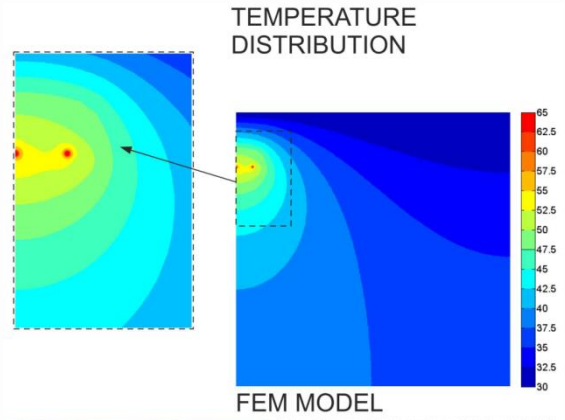
CABLE-SYS

PAWEŁ OCŁOŃ, PHD. ENG.
POCLON@MECH.PK.EDU.PL

SPIRE
Sustainable Process Industry through Resource and Energy Efficiency

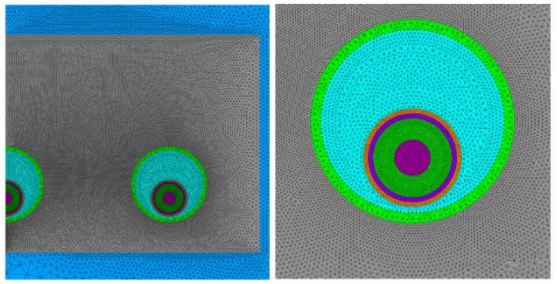
Institute of Thermal Power Engineering

Cracow University of Technology, POLAND

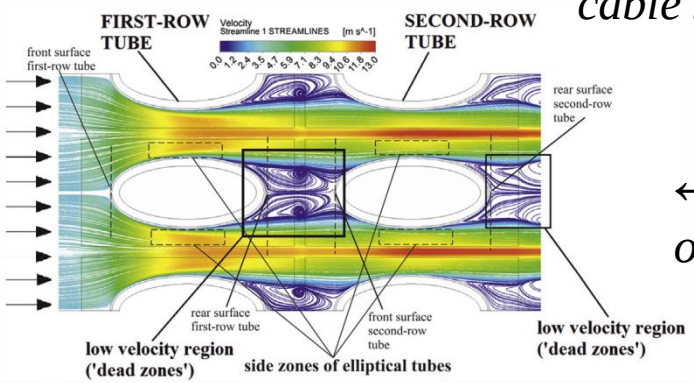


Research area:

- Thermal Power Engineering
- Modern Power Systems
- Structural, heat and flow modelling of (FEM, CFD)
- High pressure power boilers and units
- Underground power cable systems design
- Experimental investigation of heat exchangers
- Flow and heat meters



←Optimization of EHV AC underground power cable systems



←CFD simulations of heat exchangers

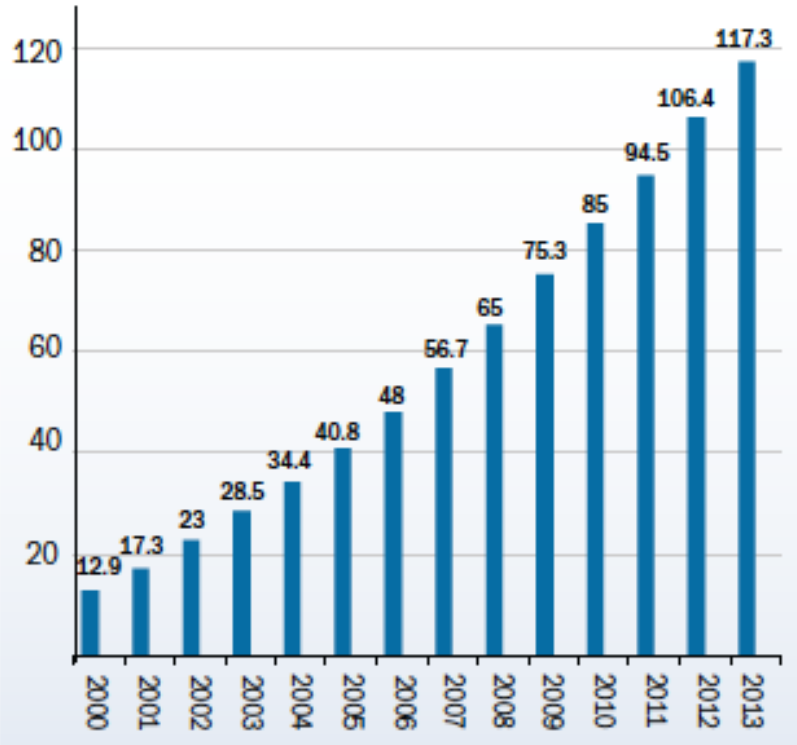
↑Power boilers monitoring systems

MOTIVATION

Wind power installed in EU
by end of 2013 (cumulative)

	Installed 2012	End 2012	Installed 2013	End 2013
EU Capacity (MW)				
Austria	296	1,377	308	1,684
Belgium	297	1,375	276	1,651
Bulgaria	158	674	7.1	681
Croatia	48	180	122	302
Cyprus	13	147	0	147
Czech Republic	44	260	9	269
Denmark	220	4,162	657	4,772
Estonia	86	269	11	280
Finland	89	288	162	448
France	814	7,623	631	8,254
Germany	2,297	30,989	3,238	33,730
Greece	117	1,749	116	1,865
Hungary*	0	329	0	329
Ireland	121	1,749	288	2,037
Italy	1,239	8,118	444	8,551
Latvia	12	60	2	62
Lithuania	60	263	16	279
Luxembourg	14	58	0	58
Malta	0	0	0	0
Netherlands	119	2,391	303	2,693
Poland	880	2,496	894	3,390
Portugal	155	4,529	196	4,724
Romania	923	1,905	695	2,599
Slovakia	0	3	0	3
Slovenia	0	0	2	2
Spain	1,110	22,784	175	22,959
Sweden	846	3,582	724	4,470
United Kingdom	2,064	8,649	1,883	10,531
Total EU-28	**12,102**	**106,454**	**11,159**	**117,289**
Total EU-15	**9,879**	**99,868**	**9,402**	**108,946**
Total EU-13	**2,224**	**6,586**	**1,757**	**8,343**

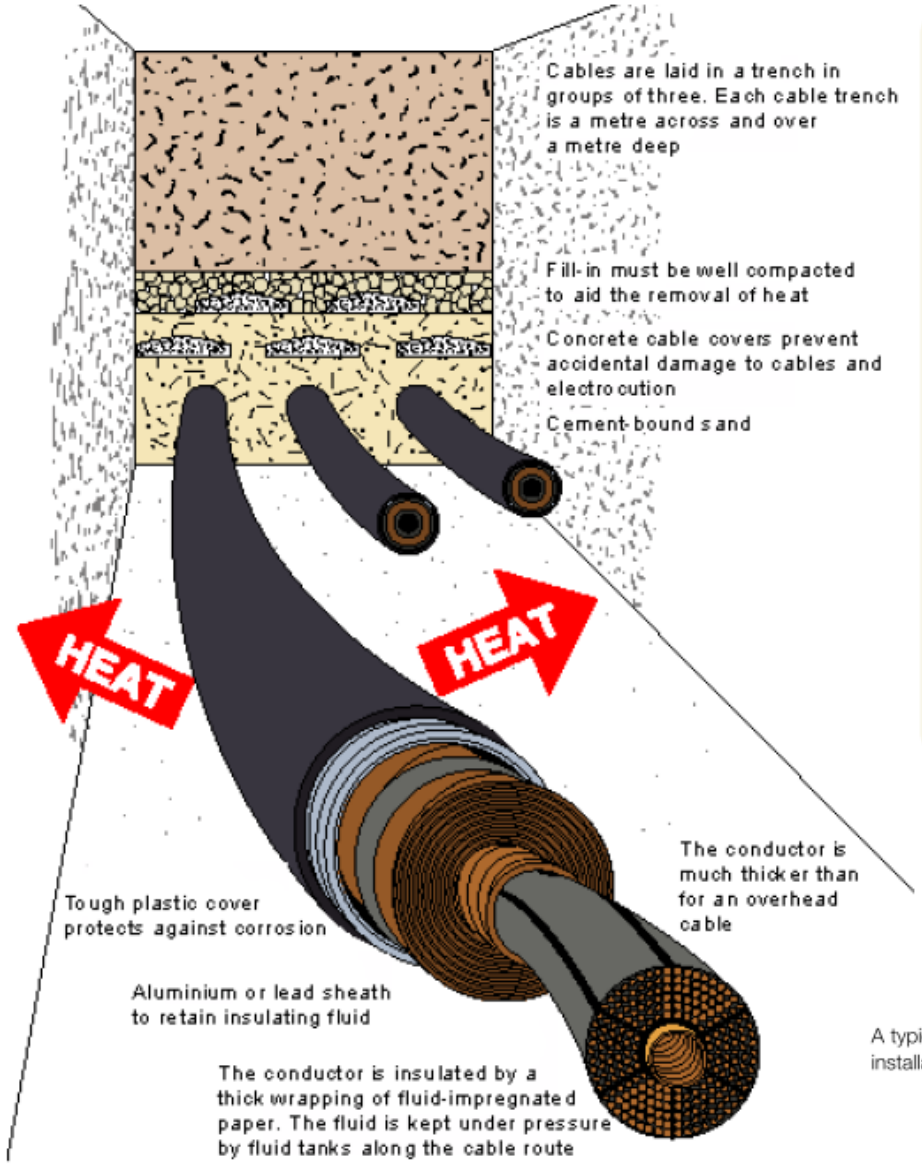
Annual wind power installations in the EU have increased steadily over the past 13 years from 3.2 GW in 2000 to 11 GW in 2013, a compound **annual growth rate of over 10%.**



Cumulative Wind Power Installations in EU, *GW*

According to: EWEA Annual Statistics 2013

Installation technique



A typical cable installation method.

In designing a cable system, if the electrical performance of the cables is not to be compromised, it is important that the physical environment of the cable enables:

- heat dissipation to prevent overheating and subsequent reduction in cable rating (capacity for carrying current);
- physical protection so that the cable does not become damaged or become a potential danger to third parties whilst in service; and
- proper access to the cables to ensure efficient inspection, repairs or replacement.

Cable line failure

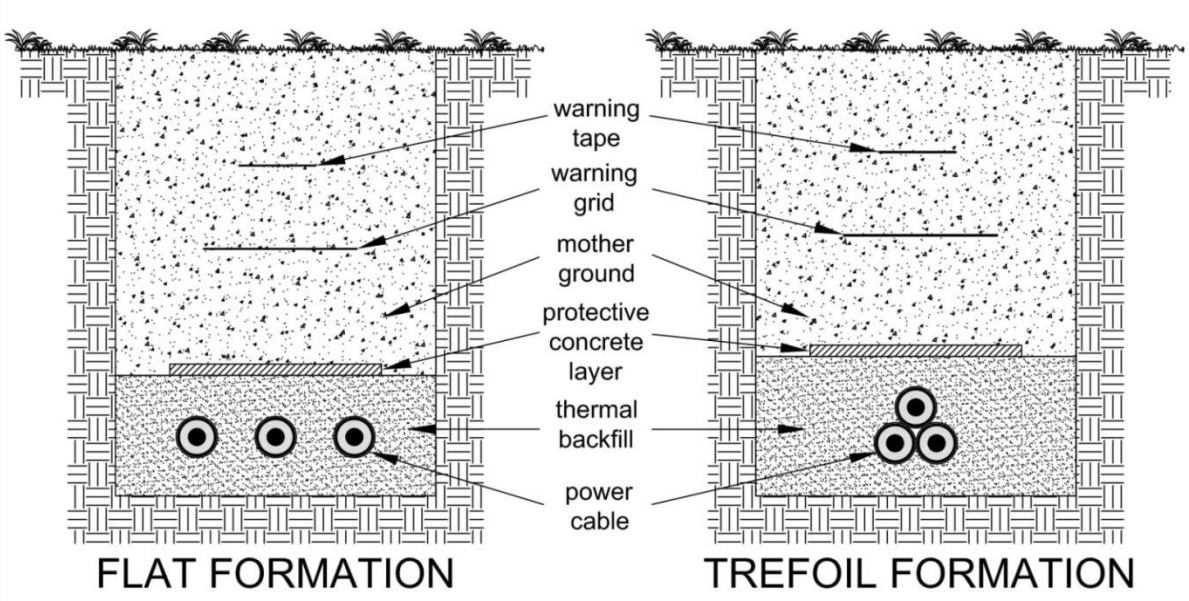
Cable line failure.

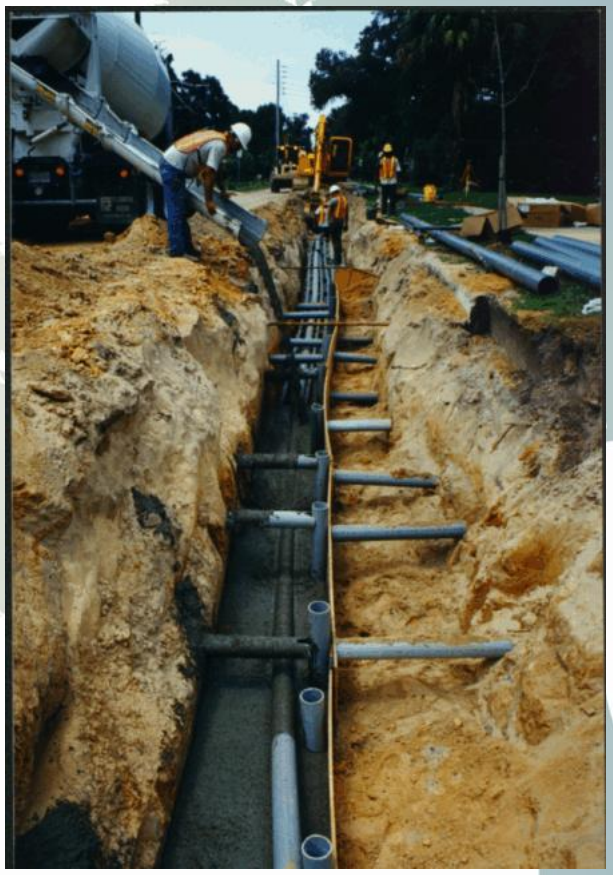
An overheated connector in a failed cable joint.

The conductor connector appears to be the weak spot of the wind farm collector circuits.

Cable joint designs suffer from high thermal stress and cable overheat that occur in the harsh loading environment.

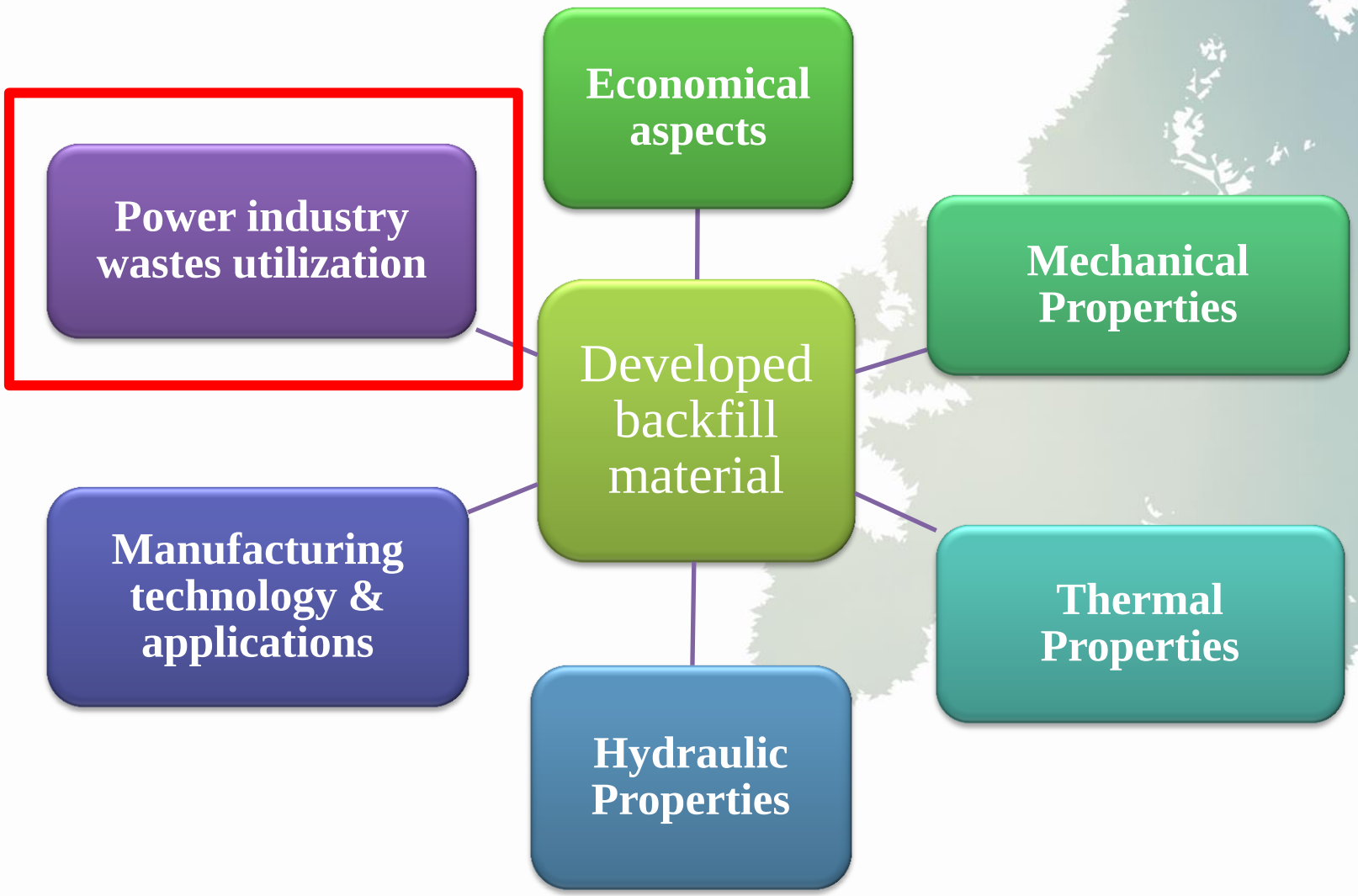
Installation technique



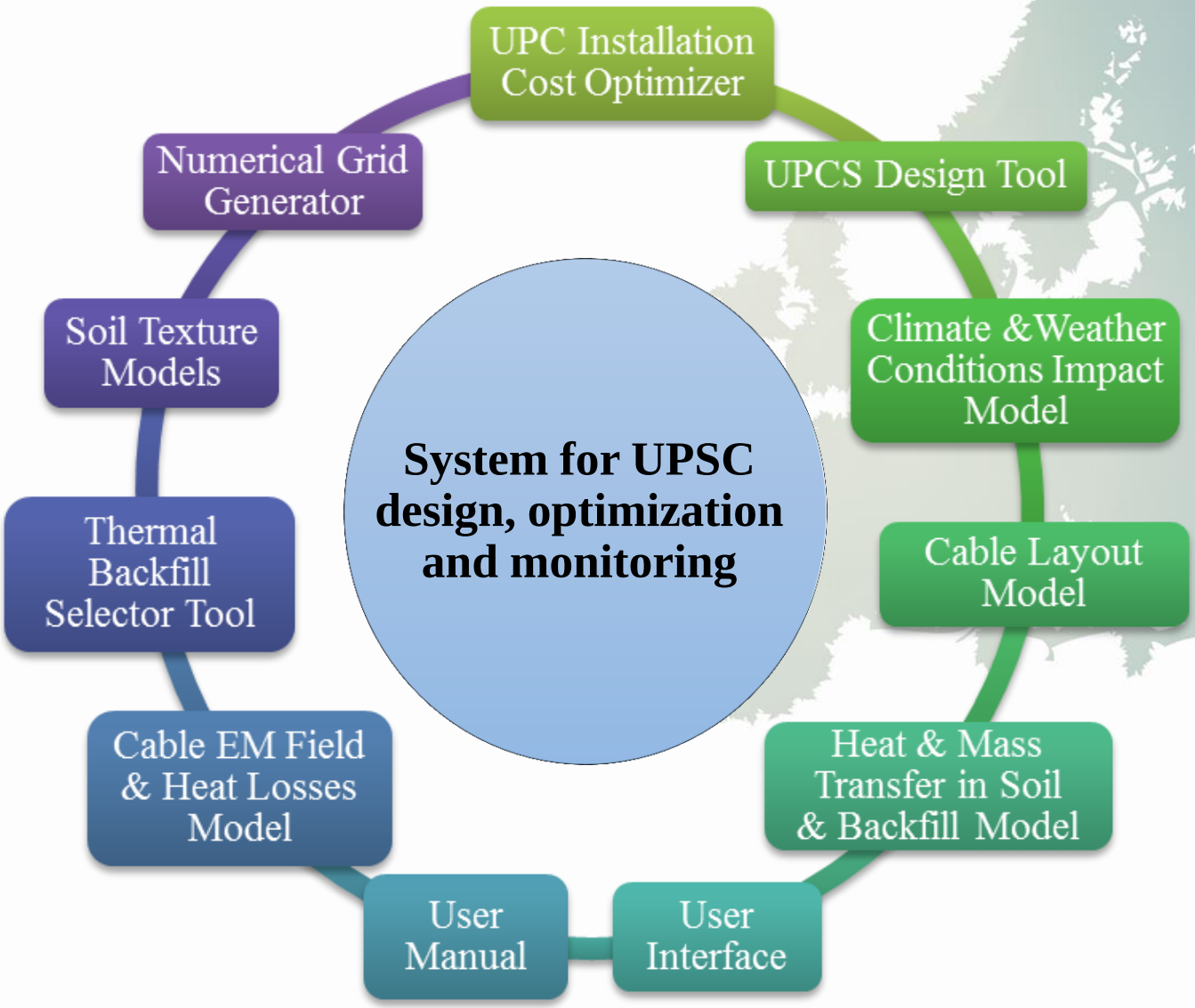


The power cables laying technique, involving the use of the FTB bedding, is the most traditional method of protecting the underground transmission line from overheating.

PROJECT IDEA



PROJECT IDEA



PROJECT OBJECTIVES

- Development of novel **geopolymer-based** thermal backfill material to protect cables from overheating
- Development of the CAD software for designing and optimization of underground power cable systems.
- Development of correlation equations to obtain thermal properties for backfill materials.
- Optimization of cable selection for improved customer service.
- Improvement and application of numerical models for electromagnetic transmission and coupled heat and mass balance for cable systems.
- Experimental validation of proposed computational models.
- **Development of a monitoring system for underground power cables operation.**

EXPECTED IMPACT

Materials*	**Novel material ~ € 40 /ton**
	Fine aggregate (sand) max. ~ **€ 4 /ton**
Preparation*	**~ € 14 /m³ (7%$_{mass}$ Novel material + sand)**
Transportation* + Installation*	**~ € 7 /m³**
Total unit cost*:	**~ € 21 /m³**

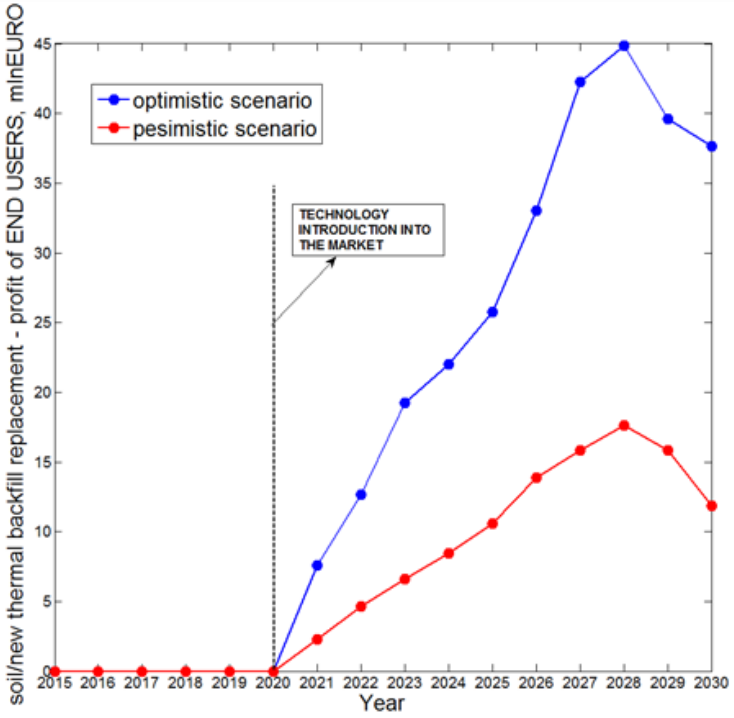
*** unit prices assesed for Poland region**

Total unitary cost of backfill material in U.S.:

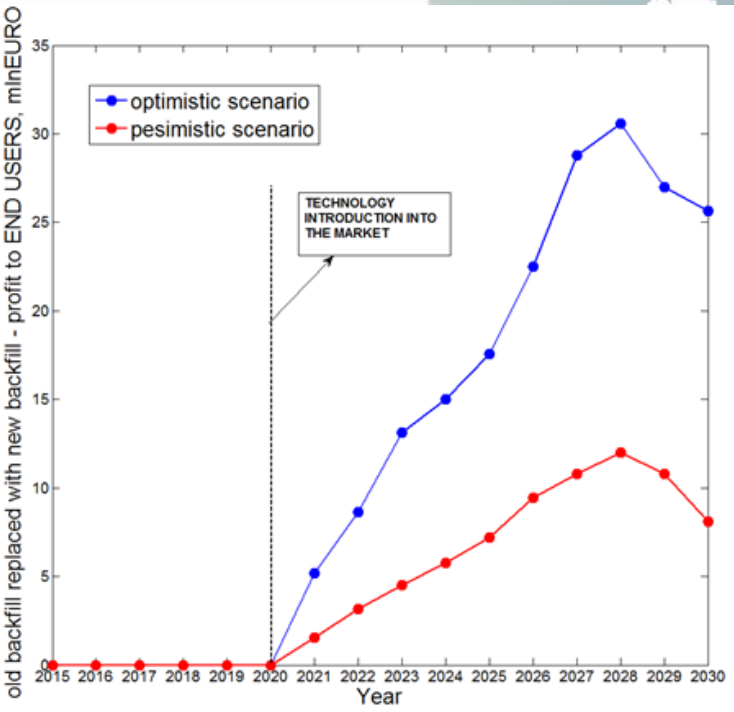
~ €130 / m³

According to:
Rosen B., Davis M., Maples T.: *Cost Saving Approaches to Wind Farm Design* (2010)
http://www.burnsmcd.com/TechBriefs/Article

EXPECTED IMPACT



Yearly profit of technology when End Users replace the soil by new thermal backfill materials developed during the project



Yearly profit of technology when End Users replace the soil by new thermal backfill materials developed during the project

Replacement of native soil with new (geopolymer based) **thermal backfill material**: European energy distributors savings: 220 000 EURO per 1 km of cable line	**Replacement of old type backfill with new** (geopolymer based) **thermal backfill material**: European energy distributors savings: 175 000 EURO per 1 km of cable line

Geopolymers will be made from Energy Industry wastes

EXISTING PROJECT CONSORTIUM

Cracow University of Technology
ENDESA
TAURON Polska Energia S.A.
NEXANS
Heidelberg Cement Group
ENERGOPROJEKT Kraków S.A.
Institute of Sustainable Technology – Polish National Research Institute
Institute for Applied Physics of Italian National Research Council
University of Bologna
Georg-August University of Göettingen
University of Modena
Sapienza University of Rome
Aalborg University
Chemnitz University of Technology
University of Belgrade
PC-Progress
Madrid Research Institute
VERTECH Group

LOOKING FOR PARTNERS

- RES Companies (wind farm designers),
- Automation and monitoring systems developers for HV and EHV underground transmission lines,
- Fiber optics on-line measurements of cable core temprature,
- Institutions specialised in climate and weather changes modelling and simulation (climate models for cable lines installation locations).

CONTACT DETAILS

Cracow University of Technology

Institute of Thermal Power Engineering

PhD. Eng. Paweł Ocłoń

poclon@mech.pk.edu.pl