

RAYS OF SUNSHINE

Tales of Sustainable Transitions

SED Report 2017



Destinations



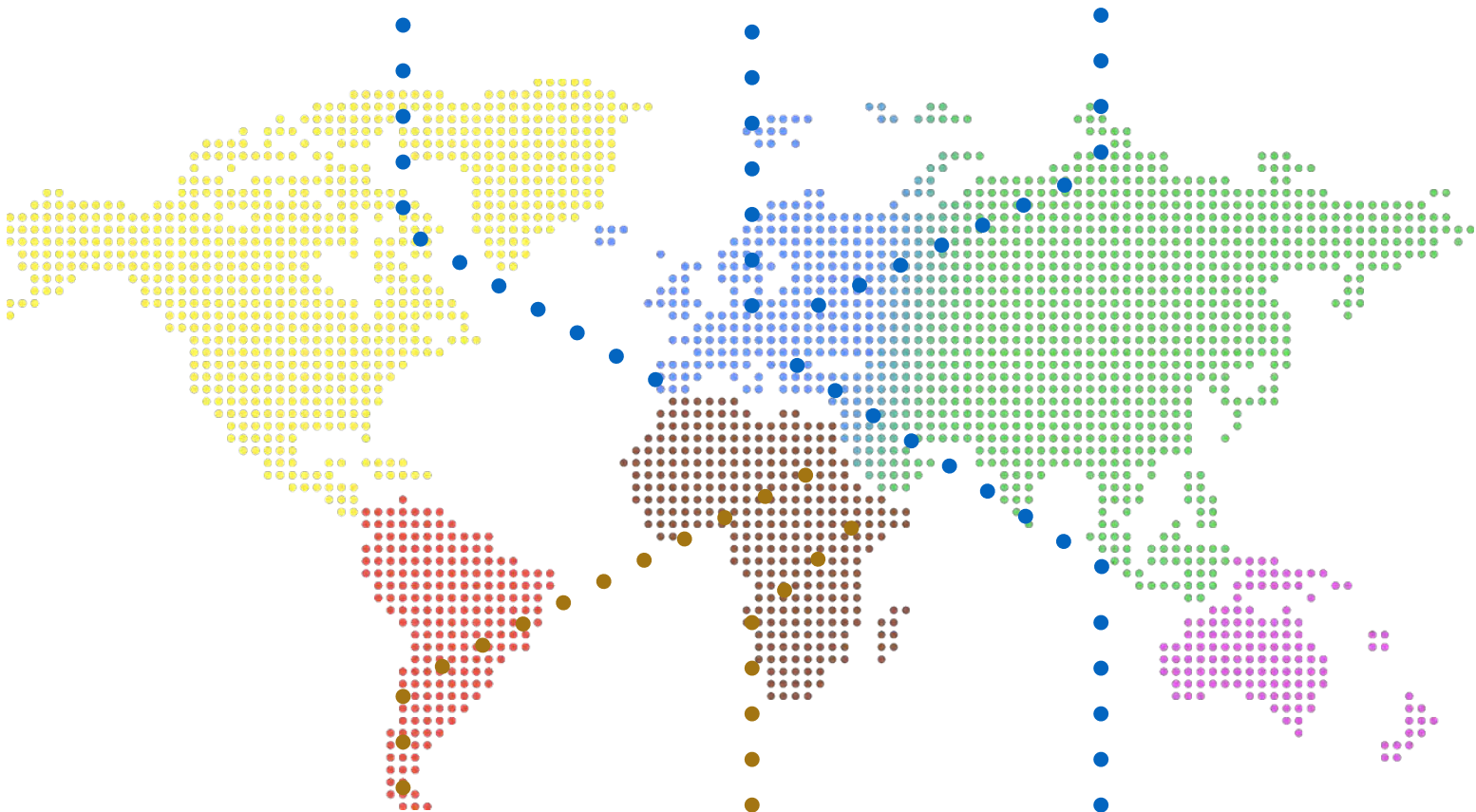
Alentejo, Portugal



Berlin, Germany



Zabrze, Poland



Wonscho, Ethiopia



Nakuru, Kenya



Deva, Romania

This publication should be cited as:

International Institute for Industrial Environmental Economics [IIIEE]. 2017. *Rays of Sunshine: Tales of Sustainable Transitions*. Lund: IIIEE

ISBN: 978-91-87357-28-2

Content

	Introduction	2
	Food for Thought: Developing Horticulture Sustainably in Nakuru County, Kenya Nakuru, Kenya	3
	From Green Beans to Brown Crowns: Building a Climate-Smart Coffee System in Wonsho Wonsho, Ethiopia	15
	A Toast to a Sustainable Future: Guiding a New R&D Agenda for a Changing Climate Alentejo, Portugal	27
	From Wasted Opportunities to Opportunities for Waste: Improving Waste Management in Deva Deva, Romania	39
	It is in the Air: Exploring Cleaner Air Pathways for Zabrze Zabrze, Poland	51
	From Useless Property to Property-less Use: Sharing and Waste Prevention in Berlin Berlin, Germany	63
	Final Remarks	75
	Photo Gallery	76

Introduction

How can we promote development, whilst protecting the environment for the generations that are to follow? This is one of the most difficult challenges that is facing the global population today. Often, the importance of sustaining economic growth overshadows the need to protect the natural resources of our planet. Finding solutions, whereby equitable economic growth can be sustained without compromising the integrity of the environment, is the rationale that underpins the concept of Strategic Environmental Development (SED).

A group of twenty-five graduate students studying Environmental Management & Policy (EMP) travelled to six global destinations to work with regions and communities in order to develop solutions to the problems that they were facing. The teams spent some time researching their respective topics and destinations in Lund, Sweden. This was followed in each case by spending one week engaging with pertinent stakeholders at their respective destinations. This report details each team's experience and main findings.

The students have been working in collaboration with supervisors to produce the reports in this document. These supervisors are researchers at the International Institute for Industrial Environmental Economics (IIIEE) and have considerable experience working with issues of environmental governance, policy, economics and industry. The IIIEE works to advance knowledge on how to catalyse the transition to low-carbon and resource-efficient economies across different levels of governance and management.

This report will present the tale of each team's journey to: Kenya, Ethiopia, Portugal, Romania, Poland and Germany. In a time of global political uncertainty, the Sunshine Batch (Master's class of 2015-2017) hopes that these tales or *Rays of Sunshine* of local actors engaging in sustainable solutions, will interest and inspire you in what is possible in the future.



Photo: IIIEE, Lund, Sweden

Tale of Kenya

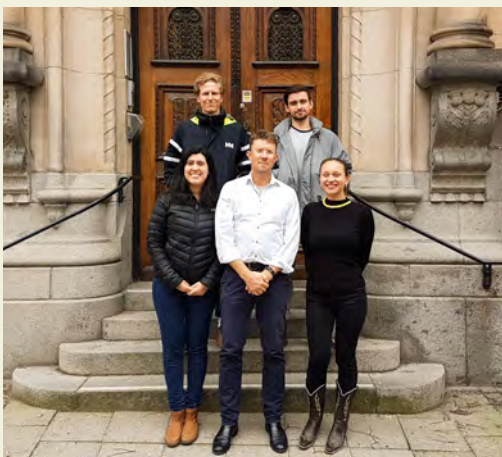


Photo: (from left) Daniela Gutiérrez, Torstein Jystad, Philip Peck (supervisor), Daniel Stewart and Carmen Valache.

Carmen Valache is Romanian and has spent the last six years working as a business journalist covering emerging markets in Southeast Asia, the Middle East, the Caucasus and East Africa. She holds a BA Spanish Literature and International Relations.

Daniel Stewart is from Ireland and has worked with environmental NGOs on activism and research in Brussels, Belgium. He holds a BA Political Science, Sociology, and Spanish.

Daniela Gutiérrez is from Colombia and has worked as a coordination assistant for the World Bank-led WAVES partnership. She holds a BSc Environmental Engineering.

Torstein Jystad is from Norway and has worked for the Norwegian Embassy in Hanoi, Vietnam, and most recently as a policy assistant in Brussels working with the Scandinavian transport sector. He holds a BA Environmental Policy.

Tale of Kenya

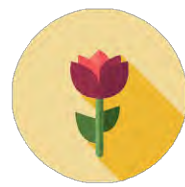


The project to Kenya assisted government authorities in one of the country's 47 counties, Nakuru, with the deployment of their agricultural development projects for 2017/2018. Working as a part of a bigger project on "Operationalising the Green Economy at the Sub-National Level" initiated by UNEP and GIZ, the German development agency, the team identified alternative channels to deploy capacity building to smallholder farmers to support the sustainable intensification of horticulture in the county. Nakuru County is one of the world's epicentres of cut flowers, accounting for a third of the exports of this commodity to the European Union, making horticulture the point of departure for the project. Like much of East Africa, Nakuru County is grappling with climate pressures like drought and social problems, such as rapid population growth, poverty, and hampered access to financial resources and knowledge. Overcoming these obstacles is instrumental to ensure food security and climate resilience in the region. Four development projects linked to the horticulture sector were identified as focus areas, namely the promotion of water harvesting; soil fertility; greenhouses; and agroforestry among smallholder farmers. The project recommended pathways for local agricultural authorities to deploy best practices related to these four areas to smallholder farmers. Furthermore, it showcased examples of capacity building that public authorities can emulate in their efforts to train smallholder farmers and identified opportunities to strengthen the cooperation between the public and private sectors on development projects.

Acknowledgements

The team greatly appreciates the role that Desta Mebratu played in coordinating the project. Ruth Moraa of the GIZ deserves the same thanks for her determined help in organising and facilitating the project from start to finish, not to mention her input throughout. We would also like to thank Joyce Jelagat of the GIZ for her support and critical eye, ensuring that the team was on the right track. We would also like to thank Kevin Ogondi for his wise words and ability to navigate the Kenyan traffic so as to get us to meetings on time as well as Burch's Resort for keeping us comfortable during our week in Nakuru County. We also give thanks to all the informants that took the time to meet and speak to us. Lastly, we would like to extend our gratitude to Philip Peck, our supervisor, for his support and guidance throughout the project, for his anecdotes, words of wisdom and for helping us find simplicity in complexity. As representatives of the IIIIEE, we are honoured to have had the opportunity to learn from and experience the beauty of Kenya.

- Carmen, Daniel, Daniela & Torstein.



Food for thought: Developing horticulture sustainably in Nakuru County, Kenya

Enabling capacity transfer to support smallholder farmers

By Daniela Gutiérrez, Torstein Jystad, Daniel Stewart, Carmen Valache

Introduction

Accelerating the sustainable development of agriculture in sub-Saharan Africa, where smallholder farmers manage 80% of the land [1], is a matter of urgency. The region has sub-average yields and is highly vulnerable to drought. The Population Reference Bureau estimates that by 2050 Africa's population will more than double to 2.4 billion [2].

Even at current demographic levels, agriculture is failing to feed those that depend on it. In 2014, a fifth of the continent's population was undernourished and 47% lived on less than USD 1.9 per day [3].

Environmental degradation (water pollution, desertification, deforestation, soil erosion), political factors (conflict, corruption, land distribution), population growth and poverty are the main threats to food security, quality of life and environmental conservation in Africa. Low yields, land fragmentation and unsustainable agricultural practices are keeping smallholder farmers across the continent trapped in a cycle of subsistence farming.

The dissemination of more *sustainable agricultural practices* can help achieve the double benefit of greater land productivity and environmental protection. Studies

show that switching from business-as-usual to such practices can increase crop yields by up to three times. The most noticeable improvements from changing farming practices are observed in low-yielding, rain-fed regions, which are predominant in sub-Saharan Africa [4].

Working definition - *sustainable agriculture*:

Minimises the use of inputs that damage the environment and human health;

Replaces inputs with natural processes such as crop rotation and biological pest control;

Includes rural stakeholders in problem identification and solutions;

Better use of local knowledge and human resources. Adapted from [4]

Governments, aid and development organisations have sought to facilitate knowledge transfer on best agricultural practices to subsistence farmers for many decades. Despite these efforts, the need for capacity building to empower farmers to better manage their land and surrounding environment remains unsatisfied in many parts of Africa.

The Task

The IIIIE Kenya team was tasked by the UN Environment Programme (UNEP) and the German development agency GIZ (Deutsche Gesellschaft für Internationale

Zusammenarbeit) with assisting in the implementation of the Annual Development Plan (ADP) for 2017/18 in Nakuru, one of Kenya's 47 counties. The county government has been working with UNEP and GIZ to devise development strategies based on green economy principles.

Seeing how the vast majority of Nakuru County's population is engaged in small-scale agriculture, the sustainable development of this sector is the linchpin of the ADP. Many of the projects in the plan have to do with encouraging smallholder farmers to adopt practices like agro-forestry, drought-resistant crops, water harvesting and soil conservation to increase yields.

Large-scale horticultural plantation and non-governmental organisations (NGOs) active in the county are already using and promoting such practices. The project's aim was to find opportunities to incorporate these actors and their know-how in the implementation of the ADP to benefit smallholder farmers.

Like elsewhere in Kenya, the regional agricultural extension office is *the* state institution responsible for training farmers in Nakuru. As such, it is instrumental to the implementation of the ADP and is the subject of many recommendations in this report.

In addition, a handbook on best practices in horticulture was shared with extension officers in Nakuru county and Naivasha sub-county, as per GIZ's request.

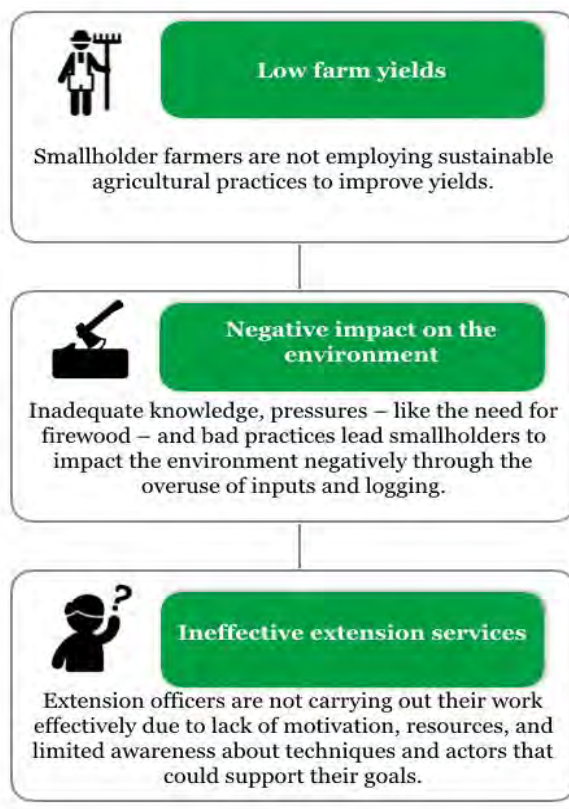
Agricultural Extension Services

A largely government-led rural support service commonly used in Africa and South-east Asia to disseminate scientific innovation and knowledge in order to help smallholder farmers better manage their land, livestock and fisheries [5].

Overview of Findings

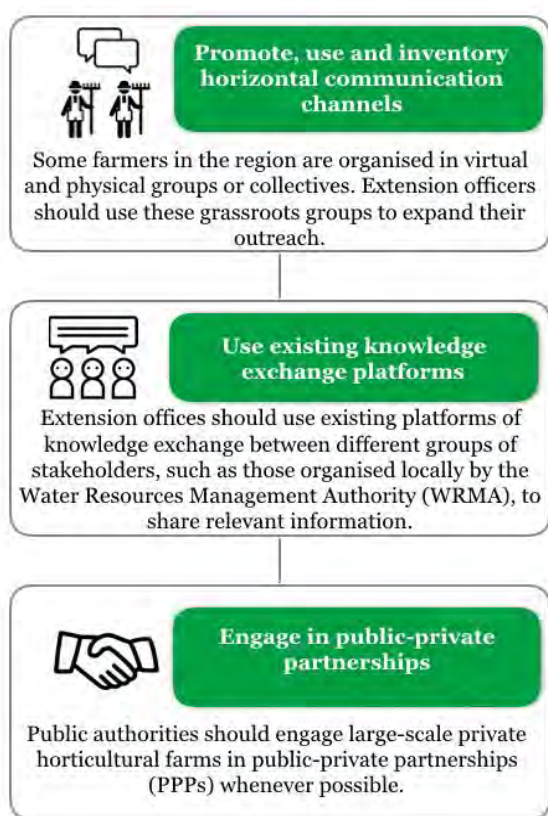
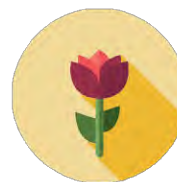
The Issues

The team identified the following deficiencies in information and capacity transfer between county officials, smallholder farmers and other stakeholders involved in regional agriculture.



The Solutions

Addressing these deficiencies prior to and during the ADP implementation would increase the chances of its successful deployment. Improving and expanding extension services are key to addressing the environmental, productivity and capacity-building issues related to horticulture in Nakuru County. The three pathways identified to achieve this are:



After setting the scene, this report expands on the three pathways to communicate expertise at the local level, illustrating them with one case study.

Horticulture in Nakuru

Located north of the capital city, Nairobi, Nakuru is one of Kenya's 47 counties and is home to 1.6 million people [6]. Agriculture is the mainstay of the county's economy. In addition to agriculture, Nakuru boasts a growing tourism sector, two agro-food manufacturing plants and geothermal power generation [7].

Nakuru is the epicentre of flower growing in Africa, accounting for 70% of Kenya's cut flower exports [7]. Kenya is a leading global flower producer, exporting primarily to European markets. The majority of the flower farms in the county surround Lake Naivasha, one of the two freshwater lakes in the country.

Flower farms are generally owned by foreign investors. They work with economies of scale, well-developed supply chains, produce to international quality and sustainability standards, have access to expertise - including some in-house R&D laboratories - and are subject to pressure from customers and markets.



Greenhouse at Oserian farm, Naivasha, Kenya

Since cut flowers are an important source of employment and foreign exchange receipts for Kenya, producers also have leverage over the central government both directly and through lobby organisations. Alongside flowers, Nakuru is also home to a few large fruit and vegetable farms that produce for export markets.

Large-scale horticulture creates an estimated 50,000 jobs in the county and 500,000 nationwide, helping alleviate some of Kenya's skyrocketing unemployment (the official national unemployment rate is 40% and is believed to underestimate the extent of the problem) [8].

Alongside large horticulture, almost 900,000 smallholder farmers in Nakuru grow a mix of food crops - most commonly maize, wheat, vegetables (French beans, potatoes, tomatoes, cabbage, onions) and fruit (passion fruit, strawberries). Some farmers supplement their crops with food and revenues from beekeeping and live-stock rearing.



French bean crops in Naivasha, Kenya

There is no straightforward definition of *smallholder farmer* that is universally applicable [9] but some characteristics of Kenyan smallholder farmers are:

- A reliance on work by household members;
- Production largely for own consumption;
- Plant a variety of vegetables, fruit and cereal on small plots of land;
- A lack of investment, working capital and poor access to finance;
- Need training on sustainable agricultural practices.

The Challenges

Kenya has two short rain seasons. Despite the fact that Nakuru County is semi-humid, receiving over 1.000mm of rainfall per year, *water availability* during the annual dry periods remains the main challenge facing farmers. The shortage of water is further aggravated by the recent drought affecting East Africa [10].

Wealthier farmers and large-scale companies can afford to install boreholes for groundwater extraction. However, that is not an option for farmers with limited resources, who need to be trained in rainwater harvesting to survive the dry spell from November to March.

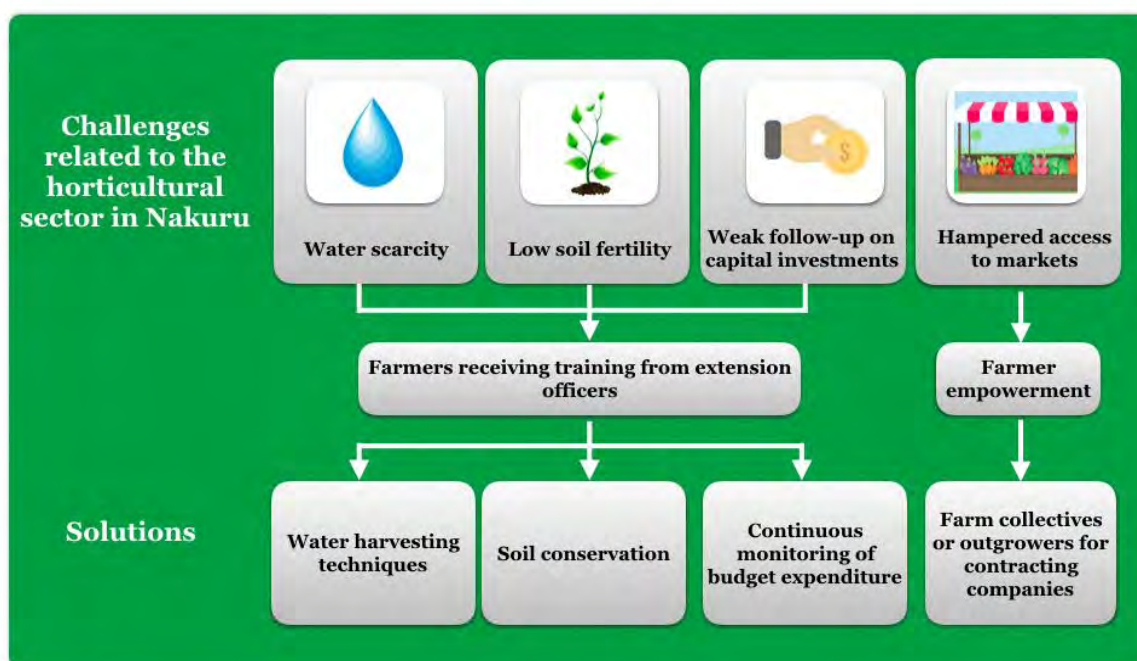
Secondly, while parts of the county have fertile soils (volcanic and clay), a large por-

tion of it has alluvial and lacustrine deposits *with low fertility*. Historically, farmers in the region have overused fertilisers to enhance soil fertility, leading to soil pH and nutrient imbalances, which have resulted in lower yields over time as well as eutrophication in Lake Naivasha.

The third important challenge affecting smallholder farmers in particular is that many horticultural development projects to date have been heavily focused on initial capital investments in structures like greenhouses, but have been *weak on follow-up and monitoring*. Informants have indicated that, without ongoing support from extension officers or other experts, farmers have failed to make the best of such investments.

Lastly, smallholder farmers grapple with *hampered access to local and national markets*. Informants indicated that markets tend to be controlled by cartels of brokers that capture a large share of farmers' profits and block individuals from bypassing their system. As such, prospering off of land cultivation is made more difficult.

Unlike the previous three challenges, which can be overcome by training farmers in water harvesting techniques and soil conservation and by making sure that there is follow-up on capital investments, there are only partial solutions to the last challenge. Cartels of brokers remain a challenge in much of East and Southern Africa. However, some farmers manage to circumvent them by coming together under collectives or by producing for larger exporting companies as part of a system called outgrowing. Neither solution provides a sure access to markets.



Agricultural Extension

The public extension services are the main institution in Kenya tasked with training farmers in best practices, sustainable land management and agricultural innovation. It operates at three levels - national, county, and sub-county - and is run by the agriculture ministry and county governments.

Since its inception in the 1960s, the system has grappled with insufficient funding and inefficiencies at the national and local levels. Until 2010, the central government managed the extension system; agriculture was then devolved to the local level under a new constitution. According to informants, this has led to even more serious underfinancing and understaffing in the extension system.

An e-extension system that the national government launched in 2013, seeking to equip extension workers with laptops and smartphones to make information on best agricultural practices available to farmers, has not received sufficient funding to date

to address the underlying systemic problems plaguing the extension system.

As a result, the extension offices in Nakuru County, just like elsewhere in Kenya, are staffed by ageing employees that are not paid on time and have insufficient budget for operational expenses (e.g.: petrol for vehicles to visit farms). Furthermore, informants estimate that the ratio of extension officers to farmers is on the scale of 1 to 3,000, too low for officers to cover the need for their expertise.

The extension services are the main means for the Nakuru County government to deploy its agriculture development programmes. Numerous ADP projects related to issues like the promotion of rainwater harvesting, installation of greenhouses, agro-forestry and soil conservation and fertility require that farmers be informed and trained in such practices, and this is achieved through extension workers.

Nevertheless, the ADP does not allocate any funding for ongoing training, relying instead on the uncertain “recurrent” (yearly payroll) budget that covers extension officers’ salaries. As such, development projects represent additional responsibilities for extension officers, without granting them further access to resources.

The root of many of these problems are structural in nature. Kenya’s social and political systems are rife with corruption and there is a drain of human resources from rural areas.

Interviews and discussions with extension officers revealed that the chronic lack of funding has become a common excuse to justify a perceived level of apathy and lack of initiative. Development informants noted that outside financing is available for initiatives that bring rural stakeholders together in Africa, from sources like the Bill & Melinda Gates Foundation and the World Bank. However, local authorities must design project proposals for financing and demonstrate the ability to carry them out to secure such funding.

Acknowledging these limiting factors, opportunities exist to enhance the impact of extension services in Nakuru.

The Solutions

Horizontal Communication Channels

A possible solution for extension officers to do more with less and enhance the implementation of the ADP is to *support existing groups of farmers* (dubbed “growers’ groups” locally) to help disseminate good practices and agricultural information through farmer-to-farmer networks.

Such collectives organise regular meetings to exchange information on issues like pest

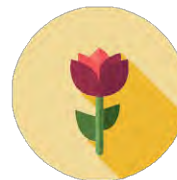
control, diseases, new species, drought, seed and fertiliser programmes. Some organise joint attendance to workshops and conferences. Others use social media, text messages or smartphone applications (primarily WhatsApp) to share news about developments related to their crops or agricultural policies.

WhatsApp for Farming

Technology is revolutionising how farmers cultivate and sell their produce all over the world. Groups of farmers in Africa and other regions are increasingly coming together to exchange best practices through a smartphone application called WhatsApp. Others, like Indian farmers Santosh Kittur and Abhikit Kamath, are using WhatsApp to create virtual markets - in their case, for pesticide-free vegetables. The two received an innovation award from the Dharwad Agricultural Sciences University for their profitable, technology-based, marketing idea [11].

Recommendation:

Tapping into grassroots groups is an obvious and low-cost opportunity for authorities to maximise the outreach of their limited resources and staff, and to increase the development of soft skills that farmers need to better manage their land. The field research found that extension officers in charge of specific areas are familiar with the groups operating locally, but that there is no official inventory of the groups or attempts to work with them in an organised manner. It is recommended that:



The Nakuru County extension office, together with sub-county extension offices, inventory the growers' groups active in the county



Outreach potential associated with such groups be utilised when organising training events to magnify the impact to wider audiences.

IT Solutions to Enhance Extension Services in Kenya

At 89.7% in 2016, Kenya has the highest Internet penetration rate in Africa [12]. Below are some technology-based tools that extension workers could promote in their interactions with farmers to enhance knowledge transfer:

- Farmer group business tools: Farmforce, Farmbook;
- Radio: Farm Radio International;
- Websites: InfoNet-Biovision, FAO, National Farmers' Information Service (NAFIS);
- Video tutorials: Farm Africa on YouTube, digitalGREEN.

Using Existing Knowledge Platforms

Another action for public authorities that can enhance the implementation of the ADP is tapping into local fora and platforms that bring together farmers and other stakeholders in region.

Recommendation:

The representatives of several local organisations expressed their readiness to incorporate representatives of the extension services into their events during interviews and meetings. These organisations include:

- Imarisha Naivasha - a public-private-people partnership created to promote the conservation of Lake Naivasha. The platform brings together different groups of interest around the lake;

- The WRMA and the 12 Water Resource Users' Associations (WRUAs) in Nakuru County, which promote sustainable water use;
- The Lake Naivasha Growers' Group (LNGG), a voluntary organisation that brings together small and large farmers around Lake Naivasha to balance commercial interests with environmental conservation.

Village Knowledge Centres

Village Knowledge Centres (VKC) set up by ClimaAdapt, a joint programme among several Indian research institutes, are rural capacity-building centres that provide access to information and knowledge for nearly 25,000 farmers in India. Indirectly, the VKCs connect more than 75,000 through farmer-to-farmer channels. VKCs host in-person seminars, funded by membership fees, provide daily updates (e.g. on weather or market information) and other services through Internet and mobile [13]. Transforming local extension offices into knowledge centres and thus attracting farmers to come to them is a possible solution for Nakuru County officers to solve the problem of the lack of operational budget.

Public-Private Partnerships (PPPs)

Informants have indicated that the links between large-scale farms and smallholder agriculture in Nakuru County are tenuous at best. This study sought instances where such interactions exist, particularly in the form of knowledge exchanges to explore ways to amplify them.

The two forms of knowledge transmission between large-scale horticulture and smallholder farmers identified were:

Contract farming: large-scale exporters of fruit and vegetables sometimes outsource part of their production to outgrowers that

are smallholder farmers. In such cases, the farmers receive ongoing support in the form of inputs and expertise from agronomists hired by the exporting companies.

Corporate outreach: Some informants (e.g.: Oserian) in the flower sector perceived their role in the immediate community as that of a beacon of best practices. But they do not want to expand their social programmes outside of the area where they operate, stating that large-scale training of farmers are the role of the government.

Vertically Integrating Farmer Groups into Supply Chains

The FAO recommends the formation of farmer groups to exchange information and to enable farmers to access markets as larger business entities. Benefits of vertically integrating farmers' groups into supply chains include: *improved access to credit, training and business services; increased efficiencies and economies of scale; collective knowledge of markets and customers; reduced costs and risks; and collective efforts to overcome shared obstacles* [14].

The study found clear evidence that opportunities exist locally to amplify these schemes. For instance, VegPro, a large-scale horticultural exporter, almost tripled the number of smallholder farmer contractees it works with in the last three years to 4,500.

However, neither platform has the potential to solve the systemic challenges intrinsic to smallholder horticulture to a meaningful extent.

Recommendation:

Extension authorities need to intervene to expand the scope of best practice transfer between large private companies and smallholder farmers. It is recommended

that they do so by creating public-private partnerships (PPPs) whenever possible.

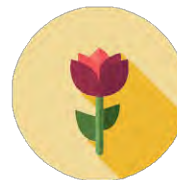
A possible PPP that emerged is with Oserian, a large local flower farm experimenting with biological pest controls. They expressed interest in a PPP to market such products to local farmers. The biological controls or *pests of pests* are of importance to the sustainable development of horticulture in Nakuru due to the abuse of chemical pesticides.

Case Study: Biovision

Noting deficiencies in the extension system, some organisations took it upon themselves to train farmers. One such organisation is Biovision, an NGO active in Kenya, which developed a network of extension officers. An interview with them revealed that, starting in 2005, the organisation rolled out a four-pronged farmer communication programme comprising:



The farmer resource centres, in particular, could be a model of best practices for public extension services. The 15 centres operate like (better-funded) public extension offices, organising workshops, field visits and other activities for farmers. The 29 extension workers on staff are equipped with cameras, laptops and modems, and submit reports on their activities at the end



of every month. In addition to training, the centres operate as platforms where farmers can interact and exchange knowledge. Their offices offer brochures, magazines and meeting areas for farmers.

Biovision works with local partners in different areas of expertise to solve pressing problems facing farmers. In Nakuru County, one of their most important collaborators is the Kenya Organic Agriculture Network (KOAN), a marketing organisation that guarantees smallholder farmers unhindered access to its own markets.

Biovision's other partners include the education and agriculture ministries, private companies (Africa diatomite industry, Juanco) and NGOs (Hand in hand Eastern Africa, Gilgil Environmental and Advocacy Group).

Biovision's Online Database

Biovision's online database on best agricultural practices, Infonet - Biovision, is one of the most comprehensive sources of information specific to East Africa. Their link is: <http://www.infonet-biovision.org/>.

Lastly, Biovision works with 330 growers' groups all over Kenya. Each one of their 29 extension officers is assigned 10 or 11 groups. Normally, one or two representatives of each group attends Biovision's regular workshops; the representatives then share the information with others in their group. The organisation also operates various WhatsApp groups comprising hundreds of members that share news about agriculture. This information is then conveyed to the extension staff on the ground.

While the scale of Biovision's operations is small compared to the number of farmers in Nakuru County, its *modus operandi* could be emulated by public extension of-

fices in Nakuru. Of particular interest is how the organisation is combining technology with horizontal communication channels to maximise its outreach.

Conclusion

Developing horticulture in Nakuru County requires that public extension officers engage with outside stakeholders and apply transferable practices into their training and development efforts. While the shortage of funds and personnel will likely remain obstacles with which they have to grapple, the local extension services need to explore ways to expand and improve their activity in order to successfully deploy development projects.

This report has suggested three pathways for Nakuru County authorities to bring in outside expertise in development programmes: promoting, inventorying and utilising farmer-to-farmer communication channels in extension activities; using existing platforms and fora organised by other institutions for outreach to farmers; and engaging the private sector in PPPs.

The case of Biovision illustrates how great a multiplier effect the use of horizontal communication channels combined with technology can have for extension training. Given how widespread the use of Internet is in Kenya, public development efforts should use such examples to expand their outreach.

Opportunities to develop horticulture sustainably in Nakuru County abound, as do local sources of know-how on best practices. The recommendations in this report can help local authorities overcome the barriers to deploying this knowledge to smallholder farmers in order to promote food security and climate resilience.

References

- [1] FAO. (2012). Smallholders and Family Farmers. Retrieved April 12, 2017, from http://www.fao.org/fileadmin/templates/nr/sustainability_pathways/docs/Factsheet_SMALLHOLDERS.pdf
- [2] Population Reference Bureau. (2013, September). *2013 World Population Data Sheet* (Rep.). Retrieved April 11, 2017, from PRB website: http://www.prb.org/pdf13/2013-population-data-sheet_eng.pdf
- [3] FAO, IFAD and WFP. 2015. The State of Food Insecurity in the World 2015. Meeting the 2015 international hunger targets: taking stock of uneven progress. Rome, FAO.
- [4] Pretty, J. N., Thompson, J., & Hinchcliffe, F. (1996). *Sustainable Agriculture: Impacts on Food Production and Challenges for Food Security* (Rep.). Retrieved <http://pubs.iied.org/pdfs/61061IED.pdf>
- [5] FAO. (2017). Research and Extension. Retrieved April 08, 2017, from <http://www.fao.org/research-and-extension/en/>
- [6] County Government of Nakuru. (2017). Nakuru County. Retrieved April, 2017, from <http://www.nakuru.go.ke/about/>
- [7] GIZ, & UNEP. (2017). *Operationalizing Green Economy Transition in Africa* (Rep.). Nairobi: GIZ.
- [8] CIA World Factbook - Kenya. (2016). Retrieved April 13, 2017, from https://www.cia.gov/library/publications/the-world-factbook/geos/print_ke.html
- [9] Boussard, J. (1992). *The impact of structural adjustment on smallholders*. Retrieved April 13, 2017, from <http://www.fao.org/docrep/t0211e/T0211E03.htm>
- [10] United Nations High Commissioner for Refugees. (2017). Crisis in Horn of Africa. Retrieved April 17, 2017, from <http://www.unhcr.org/crisis-horn-africa.html>
- [11] McColl, S. (2016, Feb 9). *WhatsApp is Changing the Way People in India Grow and Buy Food*. Retrieved April 17, 2017 from <http://www.takepart.com/article/2016/02/09/whatsapp-farming-india>
- [12] Communications Authority of Kenya. *Sector Statistics Report Q2/ 2016/2017*. Retrieved April 17, 2017 from <http://www.ca.go.ke/images/downloads/STATISTI>
- [CS/Sector%20Statistics%20Report%20Q2%20FY%202016-17.pdf](http://www.ca.go.ke/images/downloads/STATISTI/CS/Sector%20Statistics%20Report%20Q2%20FY%202016-17.pdf)
- [13] Dybdal, S. E. (2016, May 11). Innovative platforms for knowledge sharing in India. Retrieved April 17, 2017, from <http://www.nibio.no/nyheter/innovative-platforms-for-knowledge-sharing-in-india>
- [14] FAO. *Good agricultural practices (GAP) on horticultural production for extension staff in Tanzania*. Accessed April 12 from <http://www.fao.org/docrep/013/i1645e/i1645e00.pdf>

List of informants:

John Njenga, Principal Auditor, Kenya Flower Council, March 27th, 2017.

Simeon Otieno Dulo, Senior Lecturer, University of Nairobi, March 28th, 2017.

Fredrik Owino, County Crops Development Officer, Nakuru County, March 28th, 2017.

Elisabeth Barasa, Water Resource Management Authority, March 28th, 2017.

Naivasha Sub-county extension officers (Hannah W. Maine, Sammy M. Magum, Peter M. Njuguna), March 29th, 2017.

Six smallholder farmers, March 29 and 30, 2017.

Hamish Ker, Director, Oserian, March 30th, 2017.

Stephen Musyoka, Farm Comptroller and Head of R&D, Oserian, March 30th, 2017.

Mbogo Kamau, Chief Executive Officer, Imarisha Naivasha, March 31st, 2017.

Marula flower farm representatives, April 3rd, 2017.

Ed Morrison, Sustainability Officer, VegPro, April 3rd, 2017.

Njeri Kinuthia, Outreach Officer, Biovision, April 6th, 2017.

Tale of Ethiopia



Photo: (from left) Håkan Rodhe (supervisor), Julija Skolina, Julia Gause, Tim Forslund and Nanda Noor.

Nanda Noor is from Indonesia and has a management consulting background from both private and public sector, among others from Accenture and the United Nations office for REDD+ coordination. He holds a BA Management and Entrepreneurship.

Julija Skolina is from Lithuania and has professional experience in an international consultancy, working with climate policy and European Structural Investment Funds. She holds an MSc Economics and Business Administration from Aarhus University.

Julia Gause is from Germany and has professional experience with NGOs and marketing. She holds a BA Political Science and History and an MA Global Studies.

Tim Forslund is from Sweden and holds a BSc Environmental Science and has completed exchange studies in the US, Canada, and China. Previously, he has worked as a technical support manager at Uniflex.

Tale of Ethiopia



Ethiopia is the homeland of *coffea arabica*, the world's most consumed coffee variety. In 2014, coffee contributed to around 25-30% of Ethiopia's export earnings, making it one of Ethiopia's key commodities. However, the survival of *coffea arabica* and the livelihood of people dependent on it are threatened by climate change. In response to this threat, the country developed a Climate-Resilient Green Economy Strategy, with the vision of becoming a middle-income country by 2025 while keeping net greenhouse gas emissions on 2010 levels. In line with this strategy, the team was tasked to assist the administration of Wonsho woreda (municipality) in the Sidama zone, in identifying best practices for building a climate-smart coffee production system. A checklist for climate-smart coffee production was developed together with an assessment of Wonsho's current practices. Recommendations based on cross-sectorial synergies and local context were identified in order to improve the coffee system in Wonsho. The project was carried out in cooperation with the UN Environment Programme (UNEP) and the German development agency (GIZ).

Acknowledgements

The team would like to express its appreciation to Desta Mebratu for initiating the project. The students would also like to extend their gratitude to Misgana Kallore from GIZ for her continuous support in facilitating the client engagement and all her valuable inputs. The team thanks Sisay Tadesse, Bemnet Teshome and Tsegaye Bekele for their insights and positive energy. Thanks must also go to Dawit and Yicheneku for their patience and abilities in navigating the bumpy Ethiopian roads. The team is very grateful for the excellent services provided by Aregash Lodge. Thank you to all the informants who invested their time for this project. Last but not least, thank you to Håkan Rodhe for his guidance throughout. The team is honoured to have been given this extraordinary opportunity to learn from and experience beautiful Ethiopia.

- Julia, Julija, Nanda & Tim.



From Green Beans to Brown Crowns

Building a Climate-Smart Coffee System in Wonsho

By Tim Forslund, Julia Gause, Nanda Noor, Julija Skolina

Introduction

Climate change has an increasing impact on agricultural systems, changing the patterns of food production worldwide. More extreme temperatures, prolonged and frequent droughts, and heavier rains are predicted to decrease yields significantly, especially in the global south. This brings additional problems to many developing countries, and concerted mitigation and adaptation measures are needed.

Ethiopia, Coffee & Climate Change

To address this challenge, Ethiopia has developed a Climate Resilience and Green Economy Strategy (CRGE), with the vision of becoming a middle-income country by 2025 while keeping net greenhouse gas (GHG) emissions on a level of 2010. This ambitious target is particularly remarkable considering the country's high dependence on agricultural products, which makes it especially vulnerable to shifting weather patterns. In fact, one of Ethiopia's most important goods is also one of its most threatened: *coffea arabica*, the world's most widely traded coffee variety, is a highly temperature-sensitive crop, and requires very specific growing conditions. While coffee contributed to around 25-30% of the country's export earnings in 2014, many coffee-growing areas might be shifted out of their optimal range already between 2030 and 2050, endangering the country's economic performance [1].



Freshly roasted coffea arabica beans

Coffee in Wonsho

In Wonsho woreda (a district within the Sidama zone), coffee is, from an economic and social perspective, the most important crop [2]. It is mainly grown in agroforestry systems on small garden-like farms, which are usually intensely managed, with regular weeding and application of organic fertilisers. Coffee is mostly intercropped with ensete, a staple food in the region known as false banana. Additionally, different kinds of trees are planted in order to provide shade for the coffee plants. Despite close to ideal local growing conditions, climate change is threatening Wonsho's coffee systems in a tangible way. Thus, Wonsho has begun to address this challenge by translating the national CRGE into an annual development plan, the integrated green economy implementation plan (IGEIP).

Optimal Conditions for coffea arabica

- ✓ annual mean temperature of 20 °C
- ✓ over 1 200 mm of annual rainfall
- ✓ short dry period of less than 40 mm precipitation per month
- ✓ moderate shade

Project Background

The team was asked to assist its client, the local administration of Wonsho woreda, in its efforts to improve coffee growing conditions and increase yields while being affected by climate change.

Explicitly, the task was to

- ✓ assess Wonsho’s coffee production systems with regard to its climate-smartness, and
- ✓ identify possible improvements, and synergies with other prioritised sectors and sub-sectors in the IGEIP.

The project was carried out in cooperation with the UN Environment Programme (UNEP) and the German development organisation Gesellschaft für Internationale Zusammenarbeit (GIZ) as part of a major project on *Operationalizing Green Economy Transition in Africa*.

Approach

In order to carry out the task, the team first developed a checklist of key components of what has been identified to be crucial for a climate-smart coffee production system. This process was inspired by the *Climate-Smart Agriculture* approach developed by

the Food and Agriculture Organisation (FAO), which focuses on increasing productivity and incomes, adapting and building climate resilience, and reducing GHG emissions, while encompassing the three pillars of sustainability: economic, social and environmental (see *Figure 1*). Once the key components were established, Wonsho’s coffee production system was benchmarked against the checklist. For this purpose, a qualitative assessment based on interviews and observations was made. Finally, existing gaps were identified and suggestions for improvement made (see *Table 1*). The main recommendations proposed later in this report took into account both Wonsho’s local conditions and capacity, as well as the Ethiopian context.

The Outcomes

This report provides

- ✓ a holistic checklist on climate-smart coffee production,
- ✓ a benchmark of Wonsho’s coffee production practices and identification of gaps, and
- ✓ a development of strategic and operational recommendations supported by cross-sectoral synergies and illustrations of good practices.

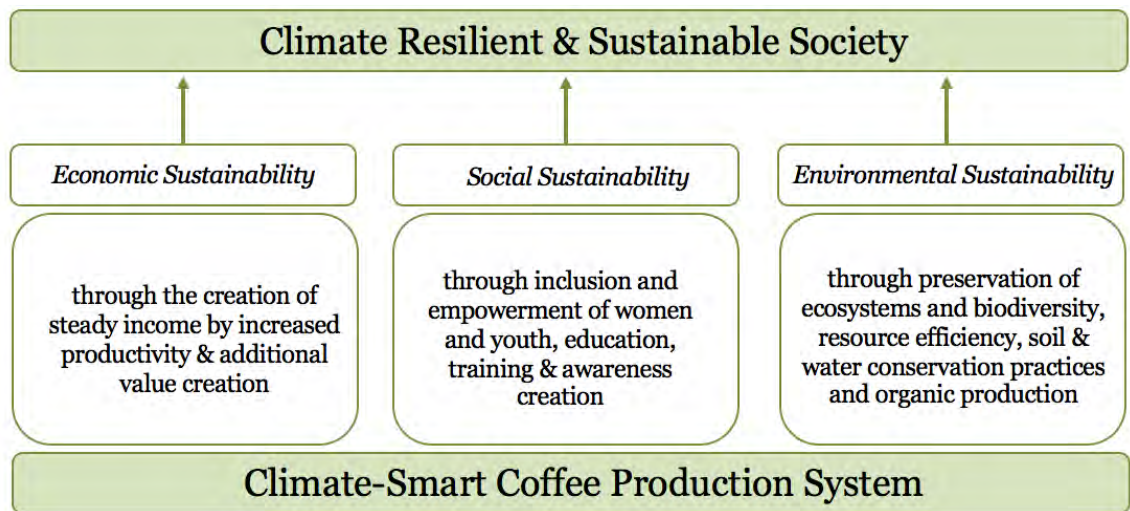






Figure 1 Building a climate resilient and sustainable society













Checklist and Assessment of Wonsho's Coffee System

The key components of the climate-smart coffee production systems are summarised in *Table 1*, together with the main observations and recommendations for Wonsho. The current practices are evaluated based on the team's qualitative assessment from

the field research of how well the woreda has implemented the different components. The assessment is performed with a *three-beans-system*: 3 – *good practice*, 2 – *some potential for improvement*, and 1 – *major potential for improvement*.

#	Observations	Recommendations	Assessment
1	AGROFORESTRY PRACTICES		
	<i>Practices for improved productivity and climate resilience, including shades, intercropping, Soil and Water Conservation (SWC), propagation, planting, pruning & stumping, training and application of organic compost</i>		
	<ul style="list-style-type: none"> o Commitment from the administration to help the farmers to improve their agroforestry practices o Application of shade management o Successful intercropping of ensete with coffee o Successful practice of SWC o Applying organic compost 	<ul style="list-style-type: none"> o Providing continuous support to farmers o Dissemination of already existing knowledge to more farmers 	
2	IMPROVED SEEDS		
	<i>Using seeds with favourable qualities (e.g. increased yield, disease resistance) to improve productivity and build climate resilience</i>		
	<ul style="list-style-type: none"> o Usage and dissemination of improved varieties of coffee (e.g. 74110) o Limited diversity of coffee varieties in the nurseries o More diversity of shade trees and grasses 	<ul style="list-style-type: none"> o Continuous cooperation with researchers on development of improved seeds o Build more awareness of the need for diversity and promote it 	
3	PROTECTING & IMPROVING ECOSYSTEMS		
	<i>Coffee production benefiting from enhanced ecosystem services and biodiversity</i>		
	<ul style="list-style-type: none"> o Ambitious targets of increasing the forest cover o Constraints on ideal forest design o Some different plants in the coffee systems 	<ul style="list-style-type: none"> o Coordinated action still ought to be taken to connect different parts of forests o Develop plant cover in riparian areas and on slopes o Continue developing diverse, mosaic-like coffee systems 	
4	EFFICIENT USE OF RESOURCES		
	<i>Making the most of scarce resources while avoiding waste and minimising impact on the environment</i>		
	<ul style="list-style-type: none"> o Most of the coffee by-products used for composting o Treatment of process wastewater before release 	<ul style="list-style-type: none"> o Use coffee pulp as an input for bio-gas production 	

#	Observations	Recommendations	Assessment
5	DIVERSIFICATION OF INCOME		
	<i>Mitigating the risks of low coffee yields and market fluctuations by generating additional income by offering other activities (e.g. tourism) and products (e.g. honey and fruits)</i>		
	<ul style="list-style-type: none"> ○ Farmers have only some additional sources of income (honey, fruits and vegetables) 	<ul style="list-style-type: none"> ○ Utilise the potential of coffee culture and traditions in the region to promote tourism ○ Potential to grow mushrooms from coffee grounds 	
6	EXPLORING CERTIFICATION POSSIBILITIES		
	<i>Generating a price premium and access to specialty coffee markets</i>		
	<ul style="list-style-type: none"> ○ Main cooperatives are organic and Fair Trade certified 	<ul style="list-style-type: none"> ○ Continue supporting farmers in meeting certification standards 	  
7	IMPLEMENTATION CAPACITY AND TRAINING		
	<i>Enabling smallholders to apply best agronomic practices and incentivise entrepreneurial thinking</i>		
	<ul style="list-style-type: none"> ○ Continuous training on agronomic skills, such as harvesting, stumping or SWC ○ Focus on face-to-face trainings through development agents' (DAs) training model farmers which in turn train other farmers ○ Some manuals and take home materials are available 	<ul style="list-style-type: none"> ○ Inclusion of entrepreneurship and business management in trainings ○ Targeted focus on women and youth, as they are under-represented as model farmers (e.g. in cooperation with the local Office of Women Affairs) ○ Increase usage of different technologies such as radio and internet 	 
8	INCLUSIVE SOCIETY		
	<i>Ensuring that more women and youth are integrated in the coffee production system</i>		
	<ul style="list-style-type: none"> ○ Low participation & inclusion of women & youth in society in general and the coffee sector in particular ○ Progress supported by the efforts of the local offices of Women Affairs & Rural Job Opportunity Organisation 	<ul style="list-style-type: none"> ○ Closer collaboration between cooperatives, DAs and the local government offices to integrate more women and youth 	 
9	FINANCING SCHEMES		
	<i>Providing access to finance</i>		
	<ul style="list-style-type: none"> ○ Cooperatives have made informal small-scale loans available for their members ○ Formalised loans are available through, among others, the OMO Micro-Finance Institution ○ Federal funds are available for implementing the CRGE through the IGEIP, but such funds need to be applied for by submitting proposals 	<ul style="list-style-type: none"> ○ Creating an institution that provides formalised loans, cooperatives could take a leading role in here ○ Ensure that all districts are involved in the micro-financing schemes in an effective manner ○ Ensure that the woreda uses the opportunities presented by the CRGE Fund and submits respective proposals 	 




Legend		
		
Major potential for improvement	Some potential for improvement	Good practice

Table 1 Checklist and assessment of Wonsho woreda's coffee system. Source: Own research based on [3,4,5]



Main Recommendations

This chapter explores biogas production, mushroom cultivation, tourism development, and building implementation capacity. These areas were selected as they present the clearest and most far-reaching synergies between the listed components of climate-smart coffee production. They also build upon the targets for four of the priority sectors found in the IGEIP – agriculture, forestry, energy, and tourism.

From Coffee to Biogas

Observation: Most of the treated by-products from the wet milling process used in Wonsho go to composting, while the waste-water is treated biologically before release. Both solutions are good examples of resource management. However, the by-products could be used more efficiently.

Recommendation #1

Use the coffee by-products from the wet milling process to produce biogas.

Why biogas? Biogas expansion is in line with the IGEIP targets (i.e. increase the number of small-scale biogas units from 67 currently to 500 by 2020) [6]. Currently, most biogas production is run mainly on cattle manure. However, several studies have shown that mixing it with coffee by-products can increase the efficiency significantly, as the coffee cherry is very suitable for methane production. An ideal weight ratio was found at 40% coffee pulp, 40% cattle manure and 20% water [7]. Biogas can also positively impact other aspects, such as energy security and gender equality. Currently, 95% of rural Ethiopia depends on biomass for energy, and in Wonsho, only 5% have access to electricity. Most cooking is done over open fire, posing

serious health problems, especially to women. Small-scale biogas units can help addressing these issues by providing alternative cooking fuel as well as lighting. Women, currently responsible for collecting firewood, can use the gained time to improve their livelihood. Biogas can also positively affect their health as indoor air pollution is reduced.

Case Study #1

Biogas Empowering Women

Tesfanesh Bekele is one of many Ethiopian women who have profited from installing a bio-digester, using coffee by-products. Despite initial scepticism, she soon realised the advantages of biogas: money and time saved, a more efficient fertiliser, and improved health. Since then, she has been able to successfully expand her coffee production as well as to start an apiculture cooperative [8].

Finally, fewer trees will be cut down for fuel, preserving ecosystem services to support the coffee system. Despite these benefits, it needs to be ensured that farmers continue to have access to organic fertiliser, if less coffee by-products are used as composting resource. This challenge can be addressed by using the biogas' slurry as fertiliser. It is a highly suitable substitute as it concentrates the valuable nutrients into less mass than compost. Also, biogas prevents uncontrolled methane emissions which would occur in the composting.



Small-scale biogas unit in Wonsho

Next steps: In order to achieve a change in the minds of people, who have been using coffee by-products as a resource for composting for a long time, training and education are pivotal. This requires concerted cooperation between the woreda and cooperatives, DAs and model farmers. Demonstrating (on model farms) that the slurry is a very suitable fertiliser can help overcome scepticism. In addition, incentives should be created to invest in small-scale biogas units, for instance, by encouraging micro-loans. Cooperatives and local development banks can serve as partners here.

Inspiring Links:

- ✓ Coffee by-product-based biogas project <http://bioinnovate-africa.org/news/ethiopia-project-component-raring-to-produce-mushroom-biogas-and-bio-fertilizer-from-coffee-waste/>.
- ✓ Project demonstrating the relationship between women empowerment and biogas <https://hivos.org/news/biogas-powers-and-empowers-women-coffee-producers-kenyas-highlands>.

From Coffee to Mushrooms

Observation: Hawassa University is currently conducting research on mushrooms, but widespread local practice is yet to follow. Few cooperatives on mushroom growing have been already established [2]. Although much of the coffee by-products in Wonsho are used, spent coffee grounds (often seen as waste rather than a resource) have received little attention.

Recommendation #2

Use coffee grounds to cultivate mushrooms.

Why mushrooms? For more than two decades, scientific studies have shown that coffee grounds are highly useful for cultivating protein-rich mushrooms like oyster, shiitake, and reishi varieties. While conventional mushroom cultivation requires large amounts of steriliser, these can be significantly reduced by applying coffee grounds as fertiliser. Due to the caffeine present in the grounds, the mushrooms grow very fast. Left-overs from the mushrooms can also be used as high-quality animal feed (see *Figure 2*). Feeding waste back into the nutrient cycle simplifies waste management and cuts methane emissions from rotting biomass [9]. Finally, by offering additional jobs and income, farmers are less prone to decrease the forest cover for more farmland, improving biodiversity and climate resilience.

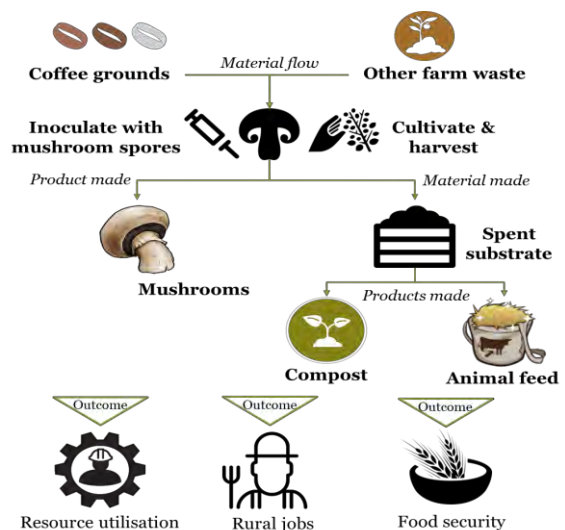


Figure 2 Overview of coffee-to-mushroom approach



Case Study #2

Mushrooms Creating Opportunities

In Zimbabwe, Chido Govera teaches orphan girls how to grow mushrooms using coffee grounds. The girls collect wild mushrooms and use tissue culture techniques to produce the seed stocks. The coffee grounds are then used to cultivate the seeds' growth. With Chido's inspiration, these girls are empowered to build their own livelihood [9]. A similar programme has been realised in Colombia. Today, farmers in more than ten Latin American and African countries are receiving training on similar cultivation.

A programme applying a similar technique has been realized in El Huila & Caldas in Colombia, with over 100 small coffee-to-mushroom companies covering 10 000 farmers [9].

Next steps: Wonsho could initiate a pilot project with model farmers to gradually increase the knowledge in the coffee-to-mushroom technique. Continued close co-operation with Hawassa University is recommended. Coffee grounds needed for this could be collected on a small scale from households in the woreda, as coffee is widely consumed here. After having drawn conclusions from the pilot project, training programmes and written information should be developed, before expanding the technique on a larger scale, as part of the agronomic skill training.

Inspiring Links:

- ✓ Portrait of Ms Chido Govera, the Zimbabwean change agent who has initiated the project mentioned in Case Study #2: <https://vimeo.com/56044701>.
- ✓ Hong Kong-based NGO *The Mushroom Initiative* working on small-scale mushroom cultivation from coffee grounds and other household wastes: <http://ecomushrooms.org/?lang=en>.

From Coffee to Tourism

Observation: Experiencing traditional food culture attracts tourists. However, Wonsho's potential to tap into this trend is largely unexplored, despite Ethiopia's position as the birthplace of coffee, with far-reaching coffee-drinking traditions.

Recommendation #3

Develop tourism in Wonsho using coffee as a vehicle.

Why tourism? Although currently very modest, tourism has a considerable potential in Wonsho, which has also been recognised by the woreda. The administration identified tourism as one of the priority sectors in the IGEIP. It offers job opportunities and a potential for steadier incomes over the seasons. Tourism could also contribute to empowering women and youth through job creation. On a final note, both the efficiency of the coffee system and the demand of Wonsho's coffee would increase, as it would receive even more attention.

Case Study #3

Experiencing Coffee and Culture

A study from northern Tanzania, in Arusha and Moshi, illustrates that tourism can contribute positively to community development with more work opportunities for local women. Developed by a local female entrepreneur, the programme increased local revenues, which are distributed more evenly over the year (less seasonal dependence). This did not only improve livelihoods, but also brought capital to invest in better roads and schools. Remarkably, the coffee systems were also kept tidy and more efficient in order to attract tourists.

Both programmes offered tours of scenic spots and cultural activities with coffee tours, for instance, the *From Bean to Cup* tour in Moshi [10].



Traditional coffee ceremony in Wonsho

Next steps: It is suggested that one of the cooperatives takes a leading role in developing a coffee tourism programme for Wonsho to attract both Ethiopian and international tourists. To implement this programme, one person could be employed full-time. A coffee tour package could also be developed, to allow visitors to immerse themselves in the rich local coffee culture. Visits to coffee farms together with other activities could be offered, including a dinner in a host family, along with coffee ceremonies, or a crash course of how to make your own cup of coffee. Additional incomes can be generated from sales of roasted coffee beans and other related products like *coffee honey* and souvenirs. Cooperation with other funding institutions, tour providers and hotels in southern Ethiopia (e.g. Aregash Lodge) is recommended. Wonsho could explore possibilities of using TripAdvisor or other online platforms to promote the tours.

Inspiring Links:

- ✓ Organic coffee production tours in Tanzania:
<https://visit.org/tanzania/kiliman-cultural-tourism/tanzania-discovery-tour-kilimanjaro-s-organic-coffee-farms>.
- ✓ Coffee tours in Costa Rica:
<https://www.anywhere.com/costa-rica/tours/coffee>.

Building Implementation Capacity

Observation: Wonsho has established an extensive face-to-face training programme in order to disseminate knowledge about agricultural techniques. However, both training content and vehicles could be further developed.

Recommendation #4

Include aspects of business management into the training, and make use of available technologies, such as radio or internet.

Why improved capacity building? Well-structured training does not only help communication and implementation of climate-smart agroforestry practices, but also supports the realisation of the recommendations made in this report. Integrating aspects of business management can trigger entrepreneurial thinking, which is needed to encourage farmers and other stakeholders to make use of previously untapped opportunities. Additionally, in order to reach out to those groups of society that live in more remote places more frequently, using technology could be helpful. As most farmers own radios, the woreda could make use of this channel of communication to disseminate important information. Additionally, the possibility of internet access could help farmers inform themselves about important international market and weather conditions.



Farmers expressed interest in more technology use



Case Study #4

Educating Farmers through Radio

A project in Ghana, carried out by People for Planet, utilised radio programmes as a means of communication. It was found that the radio is a very suitable source of information for farmers, if the programme is broadcasted in the local language and at a time convenient for the target audience. In Ghana, farmers learned about the accurate application of fertiliser, and optimised post-harvest techniques, contributing to higher yields and increased product quality [11].

Next steps: Exploration of opportunities to develop a farmers' radio channel, which can spread information about new opportunities, such as the coffee-to-mushroom practices more quickly and cheaply. Assistance from experienced NGOs could facilitate such a programme. Additionally, centralised internet kiosks equipped with computers should be established, located at co-operatives for instance.

Inspiring Links:

- ✓ NGO *Farm Radio International* develops farmers' programmes in 38 African countries: <http://www.farmradio.org/>.
- ✓ Project description of how to ensure access to internet through internet kiosks in Kenya: <https://www.idrc.ca/en/article/kenyan-farmers-discover-internet>.



Flowering coffea arabica in Wonsho

Conclusion

This report has developed a checklist for climate-smart coffee production, taking into account social, environmental, and economic sustainability. It also reviewed the client's activities in applying climate-smart coffee production, pointing out both strengths and weaknesses. Its value is therefore twofold:

- ✓ It supports further improvement of the coffee production system in Wonsho. While the cultivation practices were found to be exemplary, other aspects could be improved. By looking at coffee production not as an isolated activity but from a systemic perspective, the team highlighted cross-sectoral synergies, which also support the achievement of other targets formulated in Wonsho's IGEIP. As addressed, coffee by-products can be used to grow other agricultural goods, and produce energy and fertiliser at the same time. Additionally, making use of the unique coffee culture in Wonsho is crucial for tourism development. However, to achieve these measures effectively, the outreach to all members of society needs to be ensured. By supporting conventional training with smart technology, both good practices and new ideas can be easier communicated.
- ✓ The lessons learned in Wonsho can be used for spreading good practices to other woredas. The developed checklist can be used as a template for other coffee-growing regions in Ethiopia, to guide them towards a climate-smart coffee production system and to help to fulfil Ethiopia's vision of a climate-resilient green economy.

References

- [1] Deribew, T., Tafere, B., & Gebre-Ab, N. (2011). Ethiopia's Climate Resilient Green Economy - Climate Resilience Strategy: Agriculture and Forestry.
- [2] Bekele, T. (2015). Baseline survey for the project "Operationalizing green economy transition in Africa" - Status of Basic Data and Green Economy Initiatives in Wonsho Woreda, Ethiopia. Hawassa University, Ethiopia.
- [3] Alemu, A., Dufera, E. (2017). Climate Smart Coffee (coffea arabica) Production, *American Journal of Data Mining and Knowledge Discovery*, 2(2), 62-68.
- [4] FAO. (n.d.) FAO Good Agricultural Practices (GAP) Principles. Retrieved March 20, 2017, from http://www.fao.org/prods/gap/home/principles_en.htm.
- [5] Environmental and Coffee Forest Forum. (2015). Coffee: Ethiopia's Gift to the World. Addis Ababa, Ethiopia. Retrieved March 20, 2017, from http://www.naturskyddsforeningen.se/sites/default/files/dokument-media/coffee_-_ethiopias_gift_to_the_world_ecff_2015.pdf.
- [6] Wonsho woreda. (2016). Woreda based Integrated Green Economy Development Planning - The case of Wonsho woreda, Sidama zone, SNNPRS.
- [7] Corro, G., Pal, U., & Cebada, S. (2014). Enhanced biogas production from coffee pulp through deligninocellulosic photocatalytic pretreatment. *Energy Science & Engineering*, 2(4), 177-187. doi:10.1002/ese3.44.
- [8] SNV. (2017). Empowering women through biogas digesters. Retrieved April 16, 2017, from <http://www.snv.org/update/empowering-women-through-bio-digesters>.
- [9] Pauli, G.A.M. (2014). The Blue Economy 2.0: €4 Billion Invested, 188 Projects Implemented, 3 Million Jobs Created. Redwing Book Company.
- [10] Karlsson, H., Karlsson, J. (2009). Coffee Tourism – a community development tool. Bachelor thesis. Baltic Business School, University of Kalmar. Sweden.
- [11] World Food Programme. (2014). How radio programmes can support agriculture and market development. Retrieved April 16, 2017, from <https://www.wfp.org/purchase-progress/news/blog/how-radio-programmes-can-support-agriculture-and-market-development>.
- List of people interviewed
- Mr Björn Almér, Founder of Swedish coffee shop Barista. March 21, 2017, Lund.
- Dr Tsegaye Bekele, Lecturer and Researcher. College of Forestry and Natural Resources, Hawassa University. March 26-27, 2017, Wonsho.
- Mr Toomasi Cororo Bessu, Head of Forestry Office, Wonsho Woreda. March 30, 2017, Wonsho.
- Ms Misgana Kallore, National Coordinator for Green Economy Transition in Africa, Ethiopia, GIZ. March 26, 2017, Addis Ababa; March 27 & 29, 2017, Wonsho.
- Mr Manisa Macho, Head of Rural Job Opportunity Organisation, Ministry of Youth & Sports, Government of Ethiopia. March 30, 2017, Wonsho.
- Dr Desta Mebratu, Associate Professor, Centre for Complex Systems in Transition, School of Public Leadership, Stellenbosch University. March 21, 2017, Lund; Wonsho: March 26-27, 2017, Wonsho.
- Mr Anteneh Mengesha. Staff, Wonsho Woreda Administration. March 27-30, 2017, Wonsho.
- Mr Andreas Missaelides, Manager, Aregash Lodge. March 28, 2017, Wonsho.
- Ms Lowri Rees, Programme Management Officer at United Nations Environment Programme - UNEP: Kenya. March 25, 2017, Wonsho.
- Mr Daniel Remheden, Founder of Swedish coffee shop Love Coffee. March 24, 2017, Lund.
- Ms Wollala Shorde, Head of Wonsho Office, Ministry of Women Affairs, Government of Ethiopia. March 30, 2017, Wonsho.
- Mr Sisay Tadesse, Sector Office Staff, SLMP, Wonsho Woreda. March 27-30, 2017, Wonsho.
- Ms Trunesh Tadesse, Model Farmer. March 30, 2017, Wonsho. March 26-30, 2017, Wonsho.
- Mr Bemnet Teshome, Staff, Ministry of Environment, Forestry and Climate Change, Government of Ethiopia. March 26-30, 2017, Wonsho.
- Mr Thomas Tomole, Staff, Wonsho Woreda Administration. March 30, 2017, Wonsho.

Tale of Portugal



Photo: (from left) Danielle Arzaga, Harry Moncreiff, Jack Fraser and Federica Bertolani.

Harry Moncreiff from Scotland, graduated from Edinburgh University with a BSc Ecological Science. He has a professional background in timber management, ecological surveying and land management.

Jack Fraser from the US, has varied professional experience and holds a BSc Sociology and Environmental Science from Oregon State University, USA.

Federica Bertolani from Italy holds a BA Economics and Management, from Cattolica University in Milan. She is passionate and has professional experience in the textile industry.

Danielle Arzaga from the US holds a BA Public Health. She has previously worked with sustainability issues at the Foundation for Sustainable Development in Nicaragua and for the Living Green Program at UCSF.

Tale of Portugal



Team Alentejo aimed to identify the research gaps of the wine sector in the Alentejo region of Portugal in regard to climatic changes. The project was requested by the regional wine commission of Alentejo (CVRA) in order to ultimately help various stakeholders of the wine industry prepare for the future. Research and interviews conducted prior to the trip focused on impacts of climatic changes on the wine industry and identification of existing research gaps for the sector. Upon arrival in Portugal, additional interviews were conducted in order to confirm what research gaps were important to various stakeholders, such as grape growers, winemakers, agricultural consultants, government officials, researchers and the CVRA. Beyond the main task of identifying key research gaps for the industry, the team collected information regarding relevant research projects, potential partner organisations, and new business opportunities which could help both the CVRA and the regional stakeholders of the wine sector. The project culminated in a presentation from the team, along with a discussion among the CVRA President, CVRA Sustainability Manager, IIIIEE project supervisor, and student team.

Acknowledgements

Team Alentejo would like to first thank Åke Thidell for providing ongoing guidance, feedback, and interview assistance throughout the length of the project. Thank you for dedicated driving and always pointing out how we can become better. We would also like to thank João Barosso, CVRA Sustainability Manager and IIIIEE alumni, for creating such a fantastic schedule of interviews and for his continuous support. Also, thank you for your translation skills and taking us to the beach. Furthermore, we would like to thank the CVRA President for his interest in this project and helping the regional wine sector to prepare for the future. We also thank all those who were interviewed both online and on-site for their kindness and willingness to assist in the project, which would have been impossible without your help. Last of all, we thank all IIIIEE staff and students involved in the review and improvement of the final version of the report.

- Harry, Federica, Jack & Danielle.



A Toast to a Sustainable Future

Guiding a New R&D Agenda for a Changing Climate

By Danielle Arzaga, Federica Bertolani, Jack Fraser, Harry Moncreiff

Introduction

Since before the time of the Romans, the Alentejo region in Southeastern Portugal has cultivated grapes for the production of wine [1]. The region's name comes from its geographic location, being south of the *Tejo* river. It is a region characterised by its unique *montado* landscape, a protected agro-forestry ecosystem widely populated with cork and holm oaks, and a hot and dry climate, that lend themselves to the production of wine with Alentejano style [1].



Figure 1. Map of Alentejo region. Own source.

Alentejo became established as a denomination of origin (DOC), according to the EU-wide quality and classification laws, in 1988 [1]. Today, wines from the Alentejo DOC maintain the largest domestic market quota making up 45% in value and 43% in volume, and the region is the second largest exporting one in Portugal [2]. As a result, the wine industry is one of the most

important economic sectors in the region, currently with 263 producers and over 20 000 hectares of vineyards [3].

Client

The Comissão Vitivinícola Regional Alentejana (CVRA), the regional wine-growing commission, was established in 1989 as the regulating body committed to certifying, controlling and protecting the quality of the wines produced in the Alentejo DOC [3,4]. They provide analysis of the wines produced, and ultimately award an Alentejo DOC label when their standards are met. The CVRA is also responsible for the marketing and promotion of Alentejo wines domestically and internationally [3].



Vineyards in Herdade Malhadinha Nova

Task

The CRVA requested the identification of key research gaps relevant to present and future needs for wine production within Alentejo, specifically those related to shifting climatic conditions. These research gaps were to be derived from both experts and key stakeholders, including grape growers, wine producers, consultants,

technical advisors, policy makers, and researchers within Alentejo, and industry experts internationally. Additionally, the CVRA wished for identification of past and present research from other wine producing regions with similar climates, for both comparative and resource purposes. Finally, the task also included a review of what role the CVRA should play in realising the research goals identified here, along with addressing the needs of the sector.



The team in front of the CVRA offices

Rationale for R&D Agenda

The CVRA aims to be at the forefront of identifying wine sector knowledge gaps and increasing knowledge dissemination, particularly those relevant for Alentejo. Furthermore, it aims to raise interest of potential partners and secure financing through short-term focus on vineyard management, best practices in wine-making, and marketing opportunities. Lastly, longer term focus on vital areas such as grape varieties, soil mapping, water management, and general climate adaptation and mitigation measures are considered useful to increase the competitive advantage of Alentejo.

Methodology

Scope

The R&D proposal specifically applies to the wine sector in Alentejo, keeping in mind its unique climate, weather, resource constraints, and regional traditionality. Prioritisation of the topics proposed in this report is left to the CVRA, as they are one of the key decision-making bodies in the region.

Research & interviews

First, desk research was conducted to determine the effects of climate change on viticulture and winemaking. This was followed by a literature review of articles pertaining to adaptation and mitigation measures pertinent to Portugal and Alentejo. This resulted in an initial list of research gaps, which were further elaborated with interviews with sectoral experts. Lastly, 26 online and on-site semi-structured interviews with the aforementioned industry experts and key stakeholders, were conducted.

Three main themes guided our interviews:

- 1) Knowledge gaps in wine research
- 2) Key R&D areas that a wine sustainability programme should focus on with regards to climate change
- 3) Collaboration opportunities with key stakeholders, and among industry and academia.

In respect to each of our interviewee's area of expertise, more detailed questions were asked. The wide range of stakeholders interviewed built a robust idea of what climate change-related issues exist in Alentejo's wine sector.



Climatic Trends

Rainfall

Annual rainfall is projected to decrease in Alentejo to the extent its eastern areas may become so dry that climatic conditions will become unsuitable for growing grapes [4]. Rainfall will become more concentrated in shorter bursts, reducing the soil's ability to absorb and retain water, while increasing soil erosion and salinity content. Most producers interviewed are already noticing heavy rain events concentrated in short periods (this year in March they experienced from 55 to 75 ml in just 2 days) and less annual total rainfall.

Temperature

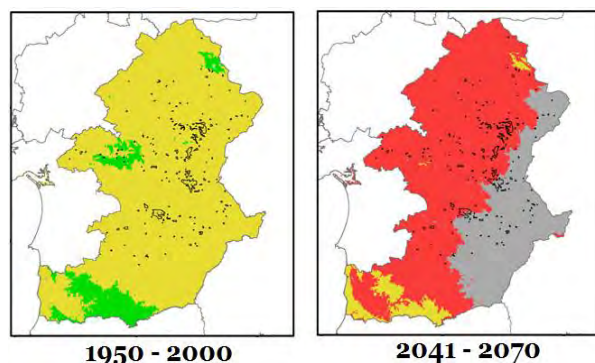


Figure II. Projected re-categorisation of the Alentejo wine region from a temperate (green) and warm (yellow) climate, to very warm (red) and unsuitable for vines (grey) [6, with permission].

Increased warming of summer nights as well as extreme heat events (days over 40°C) are projected in Alentejo [4,5]. The increase in summer night temperatures above 18°C during harvest periods is anticipated to have significant negative impact

on grape quality. Projections indicate up to eight more days per year over 40°C [4] with such temperatures increasing thermal stress and vine damage. Further studies have suggested that increased temperature will result in certain areas becoming unsuitable for grape growing [Figure II]. The increase in temperature is already being felt by producers, with many experiencing more days of extreme heat in recent years. These conditions have forced producers to irrigate more; however, this is only an option for those producers with access to local water reservoirs, with those without being forced to practice dry farming. Producers have also noted concerns over warmer winters. Vines need a minimum period of cold weather for successful leaf bud breaking and a warming of winters can negatively impact the overall yield and quality of the grapes [7].

Phenology

A change in phenological cycles (key seasonal development phases for plants) is projected for many grape-growing areas. In Alentejo multiple interviewees also mentioned that some changes in phenological cycles have already been witnessed. These included a shortening of spring and autumn seasons, as well as earlier harvest periods. Almost all producers had experienced an advance in harvest dates from two to four weeks which many have attributed to the climatic changes. As a result, harvests occurring in hotter periods (early to mid-August) can reduce the quality of the final product.

Yields

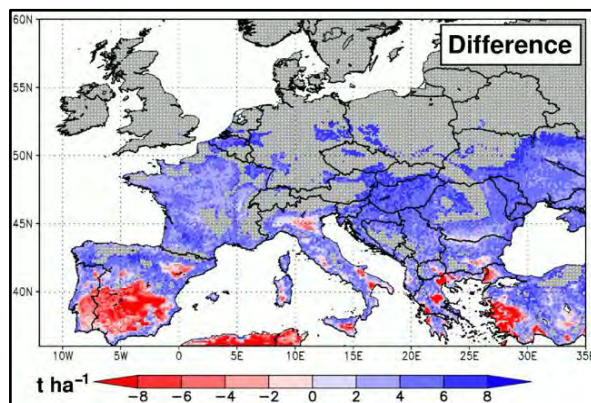


Figure III. Predicted difference in European grape harvest yields from 1980-2005 to 2041-70 [8, with permission]

Because of the mentioned climatic changes, the harvest yields in Alentejo have been projected to decrease by up to 8t/ ha by 2040-2070 [Figure III]. Such a reduction could significantly impact the harvest currently produced by some growers. Furthermore, many of the grape varieties currently grown in Alentejo will no longer be suitable unless climate adaptation measures are used. As a result, Alentejo is projected to be one of the most impacted wine regions in Europe.

R&D Agenda Proposal

Background

The key knowledge gaps identified by stakeholders are highlighted in Figure IV.

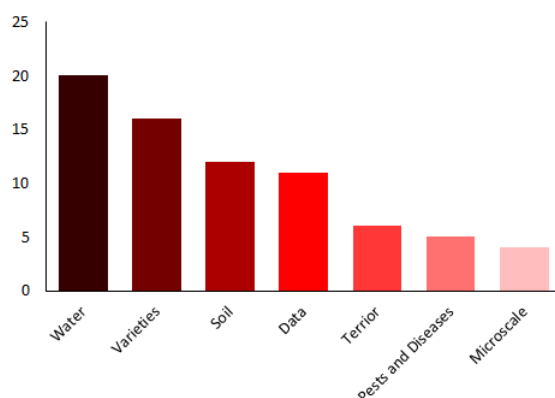


Figure IV. Research gaps mentioned by interviewees.

The following gaps are all related to wine-making in Alentejo. Specific topics were grouped according to general categorisations in order to identify the main themes. The main knowledge gaps identified are recommended for inclusion on the R&D agenda. Water-related knowledge gaps were the most frequently mentioned topics in interviews (72% agreed it requires more research). Genetics of grape varieties (64%), data and monitoring (44%), and soil characteristics (40%), were the next most frequently mentioned knowledge gaps. Additionally, research on terroir, pests and diseases, and winery practices are also needed.

Main Topics

The following sub-themes were the most commonly mentioned within each category by stakeholders. Based on this and further research, these suggestions comprise the proposed topics for the R&D agenda.



WATER

1) *Efficient irrigation* was the most commonly mentioned sub-theme. This includes new and improved techniques for viticultural practices, such as precision irrigation, deficit irrigation, and underground irrigation [6];

2) *Water reuse* was also frequently mentioned. Better knowledge of water use is necessary within the winemaking process. Exploring options to filter and reuse water within the winemaking process could produce financial savings and reduce dependence on an increasingly scarce resource. More research should focus on how to take water used in the winemaking process, and utilise it for cleaning, viticulture, or other activities that use lower quality water [6];



3) *Rain catchment* could warrant more research, since Alentejo receives significant amounts of precipitation in winter months and is increasingly receiving high amounts of rainfall in short time spans. Financial feasibility, capacity, and maintenance required for these systems were concerns of stakeholders.



VARIETIES

1) *Cataloguing indigenous varieties* and studying their behaviour requires more research. Because of changes in market trends and tastes, they could provide an alternative solution considering they are more adapted to higher temperatures. Regional advisors are currently conducting research, and the CVRA could be involved in the creation of an inventory;

2) More investigation should be directed to testing the different tolerance levels of varieties currently suitable for the region. This should serve as preliminary research for actually *combining different varieties* and genotypes, then testing their resistance to variables such as heat or drought;

3) More Research is needed on the different *QTL (Quantitative Traits Locus)*. QTL detection has been used in grapevine for traits such as resistance to fungal diseases, aroma content of berries, or the timing of developmental stages [9]. It would be useful to understand the genetic determinism of climate relevant traits;

4) Another adaptation to new climatic conditions that should be studied is the use of existing and new *rootstock and scion combinations*, that can retain more water and still produce commercial-quality wine.



DATA

1) There is a need to *harmonise data* collected. Currently organisations are collecting this using different methodologies that hinder the integration and comparison. Moreover, the amount of available information is sufficient, but there is a lack of a system (a new platform or the expansion of one already in place) that collects relevant information for producers, such as leaf temperature or sugar content. Producers generally expressed uncertainty in regards of how they collect and use information;

2) Currently most producers have their own weather stations, but the data collected is used mainly for their daily activities. It is necessary to initiate the *collection and analysis* of data that could help in the definition of climatic trends within the region;

3) Researchers also highlighted the need for *dynamic crop modelling*, because they simulate the plant growth and development including phenotype, soil profiles, weather and climate data, and management practices [10]. The suggestion could be to apply crop models under future conditions to assess the impacts of climate changes. The obtained data will be process-based and not just statistical models;

4) More studies on *within-vineyard monitoring systems* that can track the vine status could help growers. For example, field-webcams that can capture digital photographs of the daily grape status could provide more useful information. Within-vineyard sensors could also better track micro-climates. This would help growers better understand current trends and impacts of climatic changes.



1) *Measurement systems* and better tools to assess *soil capability* of water retention could further help growers. Moreover, it would be necessary to track which types of soil retain the most water and prevent runoff and waste of water in this dry region. Tools to better predict fluctuating water supplies and demands from grapevines would also aid growers;

2) *Microbiomes* of soils and characteristics of living soils were also highlighted as potential research areas. For example, how to create anti-fragile soil that can withstand new patterns of extreme weather events and seasonal shifts;

3) One solution for protecting the soil is *cover crops* and *canopy management*, but benefits of these require more research [6]. Reductions in evaporation, shading and cooling, suitability, and potential improvements to soil quality are key areas for further research according to interviewees. Also, determining which plant species are most suitable as cover crops or canopies is an important element;

4) Detailed *soil categorisation* could also help grape growers identify which soils best suit their specific grape varieties and climatic conditions. Soil categorisation research has been carried out in the Dão and Douro regions by growers, but could be further developed in Alentejo. Once such categorisations are established, then better soil management could be the result [6].

Additional Topics



The following points were found to be potentially relevant for the CRVA to investigate further, but were mentioned by fewer interviewees.

1) *Terroir mapping and categorising* were also discussed as potential research areas. Terroir relates to the interaction of soils, climate and geography of an area. Regions of France are conducting terroir research, which Alentejo could mimic and use to identify terroirs with higher tolerances to heat and drought. Terroirs could also be researched for compatibility with grape varieties of higher heat and drought resistance;

2) *Treatments for new diseases and pests* should be researched before the problems become too severe. While some pests and diseases might worsen in certain regions, growers in Alentejo are more worried about new pests and diseases developing in the future. In addition, another key topic would be to investigate any beneficial species.

3) *Winery practices* is another area requiring further attention. Specifically, the discovery and cataloguing of natural yeasts along with a better understanding of the microbiologic components of the wine-making process. An increased understanding of both are useful to better control wine quality. For example, natural yeasts can be used to decrease sugar content, and thus decrease alcohol levels in the final product for consumer preference. This is especially relevant as many producers are experiencing increased sugar levels in grapes, which they attribute to increasing temperatures.



Cellar at Herdade Malhadinha Nova

Role of the CRVA

The need for improved communication, dispersion of information, and network building across stakeholder groups was also mentioned by many interviewees. With this in mind, the CRVA was considered capable of playing three key roles: *Communicator*, *Facilitator*, and *Collaborator*.

The CVRA's leadership role in the region place them in a unique position to increase communication across stakeholder groups. Functions and deliverables could include: 1) Leverage their experience with multi-stakeholder projects to act as middlemen by absorbing and relaying the research needs of industry, and communicating results to producers; 2) Assist in the development of a communication platform that catalogues past and present research to reduce overlap.

As facilitators, the CRVA can help build networking opportunities for stakeholders to meet, exchange ideas and gather new knowledge. Functions and deliverables could include: 1) Facilitate meetings where key stakeholders can connect in an informal setting; 2) Create an annual climate change symposium presenting topics that

are particularly relevant to Alentejo; 3) Utilise their leadership role to engage actors, influence, and educate labour forces.

Finally, the CRVA can also play a vital role as collaborator by participating in and establishing partnerships among key actors both regionally and beyond. Functions and deliverables could include: 1) Advocate for the development of a *Centre of Competence* for viticulture and winemaking in Alentejo; 2) Act as a co-financing body to advance the R&D needs of the region; 3) Build or continue to strengthen collaborative relationships with other actors such as researchers, producers, government agencies, consultants and advisors.

Opportunities

In alignment with Alentejo's strategy (2014-2020) and desire to further develop their competitive advantage as a leading wine producing region on the international market, the risks due to climatic shifts and environmental changes should be viewed as potential opportunities.

As is depicted in the table below, with the realization of this project the CVRA proved to be willing to work towards a *scan of the situation*, both regionally and beyond, and is seeking to *learn from others*.

Strategies to assess the Risks & Opportunities	
Learning from the past	<input type="radio"/>
Developing Customer sensitivity	<input type="radio"/>
Learning from others	<input checked="" type="radio"/>
Scanning	<input checked="" type="radio"/>
Scenario planning	<input type="radio"/>
Seeing the market gaps and change the game	<input type="radio"/>
Create idealised designs and competing in advance	<input type="radio"/>
Developing Market sensitivity	<input type="radio"/>
<input checked="" type="radio"/> Fulfilled in current R&D Agenda <input type="radio"/> Important for future consideration	

Table 1. Risks and Opportunities strategies. Adapted from [11].

With this in mind, some relevant factors to consider from this point forward are: 1) The increased focus on Alentejo due to its high level of risks from climatic shifts, indicate an opportunity to become an industry leader. By *seeing market gaps and changing the game*, while *creating idealised designs and competing in advance* with innovative adaptation measures, Alentejo could showcase their unique and quality products. 2) Increasing the diversity of vines primed for resiliency can help match consumer demand and *develop consumer and market sensitivity*, while also maintaining high levels of productivity and quality increasing marketability. 3) *Learning from the past* with the discovery and increased cultivation of indigenous varieties can help to preserve and enhance the Alentejano style, while creating prestige and new marketing potential. 4) A greater understanding of terroir, microbiology, and the various topics mentioned above can lead to a more precise forecasting of the final product, and more accurate *planning of potential scenarios*.

Global Research Efforts

Along with identifying key research gaps, the client also requested comparison with R&D agendas of other regions experiencing similar climatic conditions. This benchmark would be useful also to buttress our

suggestions. The various R&D agendas are described in the full-page table, including their description and research topics.

Ongoing Research Projects

The following specific projects were identified as being of particular interest to the CVRA, both in terms of results and examples of best practice.

#1 INNOVINE

A four-year multi-state European project aimed to prepare grape plants for climate change adaptation, to improve vineyard practices, and to increase knowledge regarding traits of grape varieties.

#2 VITISMART

Funded by the EU and a partnership of 15 countries, it aims to produce a resilient viticultural system able to recover from biotic and abiotic stresses caused by the climatic change and establish a network of researchers, enterprises, policy-makers.










#3 WINETWORK

Project between 11 partners on Grapevine Trunk Disease and Flavescence Dorce, aiming to research best practices, bond Academia and Industry, increase international exchange, and compile scientific and practical knowledge.

#4 WINE TO WINE CIRCLE

Project that catalogues Portugues and other typical Iberian grape varieties, along with their traits and characteristics in relationship to their geography, climatic conditions, soils and terroir.



Region	Organization	Description	Matching topics
Global 	International Organization for Vine and Wine (OIV)	46 member states providing scientific and technical reference for the wine sector in the form of grape variety lists, best practice guidelines and methods of analysis.	<ul style="list-style-type: none"> • Water consumption management • Vine genomics • Problematic soils • Micro-organisms • New sensory tools • Communication tools • Collective data banks
Australia 	Wine Innovation Cluster (WIC) and the Australian Wine Research Institute (AWRI)	WIC is a national alliance of four Australian grape and wine research agencies. AWRI is industry led grape and wine research organisation and one of the four members of WIC.	<ul style="list-style-type: none"> • Water stress • Soil water retention • Soil water monitoring tools • Vine pests and diseases • Genetic traits • Assessing clone diversity • Reducing environmental and economic of pests and diseases
Australia 	Wine Australia	A national R&D institution funded by producer levies and governmental contributions.	<ul style="list-style-type: none"> • Clonal studies on climate change adaptation • Impacts of reduced irrigation • Micro mapping • Impacts of changing rainfall on vines
South Africa 	Winetech	A R&D association that operates a network of participating individuals and institutions	<ul style="list-style-type: none"> • Efficient irrigation • Reuse of winery wastewater • Terroir research • Clones and new genetics • Cover crops
France 	Institute Français de la Vigne et du Vin (IFV)	Technical and scientific organization serving the wine sector. It has its own R&D Agenda inserted in the “Plan National de Développement Agricole et Rural pour la période 2014-2020”.	<ul style="list-style-type: none"> • Research on varieties • Trunk diseases • Soil and terroir • Market analysis in relation to different grapes • Optimization of the processes • Dissemination of results
Portugal 	Portuguese Environmental Agency (APA)	Public institution that established a climate change adaptation strategy in collaboration with sectoral working groups including viticulture.	<ul style="list-style-type: none"> • Genetics of Varieties • Tolerance of varieties to stress • Adaptability of varieties • Conserving clonal biodiversity • Micro-organisms
Portugal 	Associação para o Desenvolvimento da Viticultura Duriense	Non-profit organization in Douro region that provides technical information on new viticulture and winemaking practices and technologies.	<ul style="list-style-type: none"> • Regional impact of climate change • Microzoning and soil mapping • Varietal biodiversity preservation
California 	California Sustainable Winegrowing Alliance (CSWA)	Non-profit organization that works directly with the wine sector throughout the state of California.	<ul style="list-style-type: none"> • Research on resource efficiency (water, energy) • Sustainable pest management • Soil management
California 	Sonoma County Winegrape Commission	Educational Organization which has drafted a 100-year plan to guide their long-term objectives.	<ul style="list-style-type: none"> • Dissemination of results and education among producers • Understanding consumer perceptions

Summary of Proposal

To assist the CVRA in preparing the Alentejo wine sector for future climatic changes, our results confirmed that the most important issues are: increases in temperature, drought, warmer nights, and phenological shifts. As a result, key research gaps identified were: water, genetics, data and monitoring, and soil.

Although a focused agenda is important, placing all resources in few research topics could be a risk. Thus, engagement of a wide range of stakeholders and partners will be important for the success of the R&D agenda. Specific prioritisation of R&D topics will also be dependent on CVRA budget, capacity of staff and partners, co-financing opportunities and various other factors. A changing climate poses significant risks to winemaking in Alentejo, however the filling of research gaps specific to Alentejo can not only mitigate such risks, but also turn them into opportunities.

References

- [1] CVRA. Website.
- [2] Estratégia para a região dos Vinhos do Alentejo 2014-2020 (translated into English).
- [3] CVRA. Wines of Alentejo - Facts and Figures.
- [4] Fraga, H. et al (2012) Climate Change Projections for the Portuguese Viticulture Using a Multi-Model Ensemble.
- [5] Andrade, C. et al (2013) Climate change multi-model projections for temperature extremes in Portugal.
- [6] Fraga, H. et al. (2013). Very high resolution bioclimatic zoning of Portuguese wine regions: present and future scenarios.
- [7] Malheiro, A.C. (2010). Climate change scenarios applied to viticultural zoning in Europe.

[8] Fraga, H. et al. (2016). Modelling climate change impacts on viticultural yield, phenology and stress conditions in Europe.

[9] Duchene, E. (2016). How Can Grapevine Genetics Contribute To The Adaptation To Climate Change?

[10] Costa, R. et al. (2015). Application Of Crop Modelling To Portuguese Viticulture: Implementation And Added-Values For Strategic Planning.

[11] Befeki, T. et al. (2008). Managing Opportunities and Risks. The Society of Management Accountants of Canada.

List of interviewees

Producers: Nuno Oliveira (Esparao); Pedro Baptista (Cartuxa); Margareth Soares (Herdade Malhadinha Nova); Luis Duarte & colleagues (Herdade dos Grous); Rita Nabeiro & colleagues (Adega Mayor); Duarte Leal da Costa (Adega Ervideira); Dora Simoes (Luis Duarte Vinhos).

Researchers: Antonio Graca (Sogrape Vinhos); Joao Santos; Roger Boulton (UC Davis); Gregory Jones (SOU); Eric Duchene (INRA); Serge Delrot (University of Bordeaux); Stella Grando (FEM); Carlos Lopes (Instituto Superior de Agronomia); Nick Dokoozlian (E&J Gallo Wines; Cornell University); Joao Mota Barroso (University of Evora); Tim Hogg (Lisbon Catholic University); Mondragao Rodriguez (Instituto Politécnico de Portalegre)

Consultancies: Marta Mendes and Rui Almeida (Consulai); José Almeida & colleagues (Tecnica ATEVA)

Government bodies: Jose Paulino and colleagues (APA), Rui Sequeira and colleagues (APA Water Regulation), Maria de Sao and colleague (Direcao-Geral de Agricultura e Desenvolvimento Rural)

Conducted between 15/03/2017-13-04/2017

Tale of Romania



Photo: (from left) Ibrahim Sanchez-Gomez, Christian Clausen, Karen Wulf Diaz, Thomas Lindqvist (supervisor) and Dmytro Kapotia.

Ibrahim Sánchez Gomez from Spain holds a BSc Environmental Science from the University of Malaga. Ibrahim has varied experience including voluntary work in Greece and an NGO in Bulgaria.

Christian Clausen from Denmark, holds a BA Development Studies from Lund University, where he also completed an exchange in Japan. He has varied experience including marketing and logistics.

Karen Wulf Diaz from Chile, holds a BA Business Administration and Commercial Engineering from the Universidad Austral de Chile. She has previous experience as a manager in a private educational institution.

Dmytro Kapotia from Ukraine, holds a BSc Ecology, Environmental Protection and Balanced Natural Resource Management from National University of Food Technologies, Kiev. He has professional experience in eco-labelling.

Tale of Romania



The IIIIE project in Romania took place in Deva, the capital of the Hunedoara County. The project was commissioned by the municipality and sought to assist Deva in developing a waste management system compliant with EU standards. With the recent construction of a modern landfill, Deva and the Hunedoara County were keen to explore additional options for waste treatment, having been very reliant on landfilling in the past, with meagre recycling and recovery numbers. Through consultations with experts in Sweden, the team was able to understand the common challenges faced by a pioneering waste management system, and the various requirements and considerations for the different types of treatments. With this knowledge, the team travelled to Deva to research the local context. The initial research showed that, from the municipality's waste composition, existing infrastructure and need for rapid improvements to recycling, that producing biogas from organic waste would be an ideal path for Deva and Hunedoara. From this observation, the team set out to explore EU funding options for biogas facilities. In addition, the team prepared a set of initial steps to facilitate a smooth transition toward a local and regional biogas system.

Acknowledgements

The team would especially like to thank the Municipality of Deva for their great hospitality and support throughout our time in Romania. We would like to give special recognition to Daniel Crişan for being with us during our time there, facilitating meetings and making sure we were on time, as well as showing us the beautiful city of Deva and its customs. We also like to thank Tiberiu Kadar, our project coordinator who helped us coordinate the mission from start to finish and provided translation during the meetings with the local stakeholders. Also to Doru Sapta, for sharing his knowledge with us, helping us better understand the local context, as well as to everyone that took time to talk to us. Lastly, we would like to express our sincere gratitude to our supervisor, Thomas Lindhqvist for his availability and constant support. His expertise and guidance were crucial for the realisation of the project, and it was a pleasure and an honour sharing long meals and anecdotes with him. Thank you for the IIIIE family for giving us the opportunity to be part of such an interesting project.

- Karen, Dmytro, Christian & Ibrahim.



From Wasted Opportunities to Opportunities for Waste

Improving waste management in Deva

By Christian Clausen, Dmytro Kapotia, Ibrahim Sánchez, Karen Wulf

Introduction

Deva is a small town in the historical region of Transylvania, Romania. With 61,000 inhabitants, it is the capital of the Hunedoara County.

The town currently has a ‘Sustainable Development Strategy 2014-2020’ which outlines its vision for – among others – urban development, energy systems, and waste management. It acknowledges the lack of an adequate waste management system, particularly in rural areas, and the need for a comprehensive and centralised system for waste management. The strategy echoes the EU recycling targets and emphasis on the waste hierarchy, a focus on separate collection and highlighting the need for both prevention and reuse in accordance with the EU Directive 2008/98 EC (Waste Framework Directive, WFD).

An analysis of the current situation of the waste management system in Deva, was performed. The findings show that the current system is still far from compliance with the aforementioned EU Directive. Therefore, the authors’ task was to support Deva Municipality in moving towards a more sustainable system, aligned with the European requirements. A benchmarking analysis was conducted of the good practices developed at the local and regional level



Town of Deva, Romania

in Skåne, Sweden. Its experience in terms of decentralisation and innovative waste management is considered as a good case study for further transposition on Deva.

Deva has a high volume of organic waste and an extensive gas network. Biogas production seems to be a natural and promising starting point for:

1. Enhancing waste management
2. Renewable energy development
3. Development of regional network

This report highlights the features that typically surround a successful biogas system, and which can be addressed prior to the construction of a biogas plant itself. These actions also allow to achieve compliance with the EU legislation.

Waste Management in Romania

In 2014, Romania generated 4.9 tonnes of Municipal Solid Waste (MSW), 82% of which was landfilled [1]. By 2015, the

country was recycling 13% of its waste, combining material recycling and composting, a figure that needs to grow to 50% by 2020 to comply with the EU legislation [2].

Residual (or mixed) waste has traditionally been collected through a door-to-door system, along with a bring-to-site system. Starting in 2004-2006, the country implemented a waste separation system in the form of three bins: metal and plastics, carton and paper, and glass.

In its reports to Eurostat, Romania demonstrates a recycling rate of 13%, figures that seem to be higher on-site. The disparity in the numbers might come from an inefficient reporting system. Contributing to this statistical inaccuracy is the high involvement of the informal sector – mainly comprised of the poorer population in the cities – and the consequent unreported flows of recyclables [13].

The EU funds allowed Romania to launch further development of a new waste management strategy, building modern landfills in compliance with the EU rules. Increasing attention is given to recycling and biological treatment (composting), moving away from the bottom part of the waste hierarchy pyramid.

Goals for waste management in Deva

- ☐ Reduce waste generated
- ☐ Develop an integrated system of collection and transport of waste
- ☐ Reach a 100% collection of municipal waste
- ☐ Increase the number of sorting stations
- ☐ Adapt old landfills to the EU legislation



The waste hierarchy

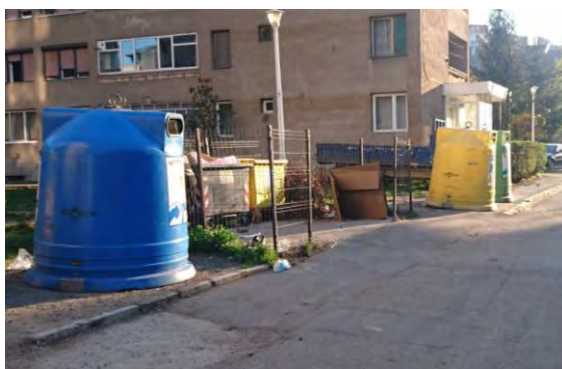
Deva: The Municipal Scale

The county of Hunedoara is developing an Integrated Waste Management System (IWMS) for the region. Deva is one of the better examples in the county in terms of waste management, although it is still in an early stage of development.

Sorting

The current system in Deva for collection has four bins: plastic and metal, paper and carton, glass, and mixed waste. In four years, the separate collection of biodegradable waste will also be mandatory for the town [11].

Awareness of the population is one of the main problems of waste management, and citizens are not very active in the sorting at home, mainly due to lack of education in waste management, lack of enforcement from the local authorities, and a collection system with limited coverage. Thus, the recyclables come mainly from businesses, where sorting is more convenient, and the informal sector that collects waste from the streets, the igloos, or even the landfills, to then sell it to the recycling companies or scrap yards.



Waste igloos in Deva

Collection

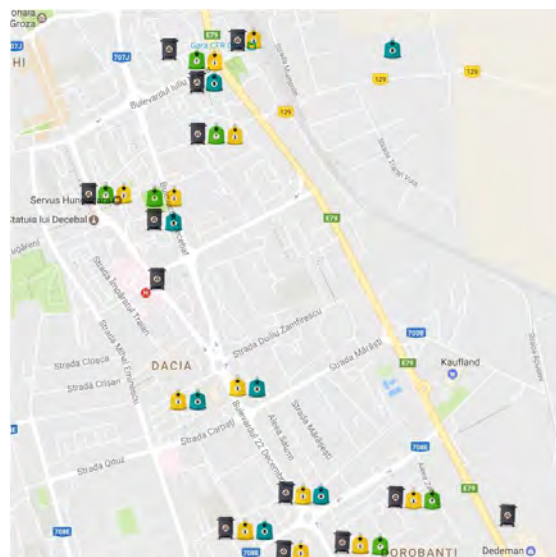
Producer Responsibility Organisations (PROs) expand the local collection system: EcoRom installs “igloo containers” for recyclables, and ECOTIC is responsible for the electronic waste (WEEE), placing bins at local stores. The mixed waste is under the municipality’s control who currently hires a private operator (Salubritate) to manage it.

The containers for separate collection of recyclables are unevenly distributed around the town, which makes it very inconvenient in some areas to get involved in the recycling process.

Treatment

Landfilling is still the most common form of waste treatment in Romania, and Deva is no exception.

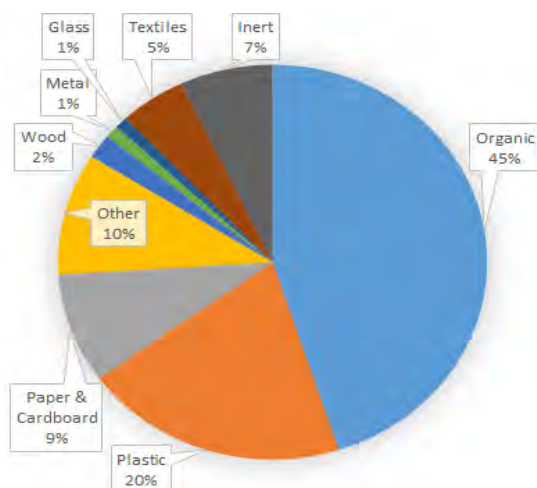
The official recycling rates in Deva are below the national level, with a 2.1% in 2016 [3]. In 2009, the municipality started to work on a new landfill, building it in accordance with all requirements of EU. The project was delayed, being finalised only in 2017, although it is still not functioning due to complexity in the tendering process. For this reason, waste is being deposited in a temporary landfill,



Current collection system in Deva

which has none of the modern capabilities such as capturing methane, and avoiding leachate from seeping into the groundwater.

The new landfill will use Mechanical-Biological Treatment (MBT) as the main treatment option, splitting the waste stream into a wet and a dry fraction, which is then sent for composting and further recycling. However, the compost that comes out of MBT is usually not of very good quality, due to the fact that the organic fraction is mixed with other kinds of waste, leading to contamination of compost with heavy metals and other pollutants.



Waste composition in Deva in 2016. Source: [3]

The imperfect treatment provided by MBT is a missed opportunity, as biological waste has the highest share in the waste stream, with 45% in weight, followed by plastic (20%), paper and cardboard (9%).

Case Study #1— Targu Lapus

Targu Lapus (12.000 inhabitants), located in the region of Transylvania is a good example of how a municipality may apply changes in terms of waste management on the local level. After joining Zero Waste Romania initiative, the mayor of Targu Lapus decided to focus on composting and recycling, instead of incineration. The town managed to divert 50% more waste from going to the landfill than the national average [4].

Using EU funds, they improved their collection system increasing the number of containers and trucks, and they created a system of fines for the households that failed to recycle their waste. Achieving an average of 45% recycling rate in the town, up to 90% for the areas with individual houses, where enforcement was easier [5].

management system. Furthermore, Hunedoara County is a good local example of successful utilisation of the EU funding, with its newly built wastewater treatment facility, and modern landfill.

This proximity of operations helps to streamline the treatment processes, as seen in other examples such as Sysav or NSR in Sweden.

As a capital of the Hunedoara County, Deva benefits from being surrounded by the cities that share their waste management approach. It is a good predisposition for the development of a regional waste treatment network.

Towards Biogas Production

Deva has a number of favourable conditions for the development of a biogas infrastructure: from its high share of biodegradable materials in the waste stream, to a new regional landfill that enables regional cooperation. This new landfill offers a blank slate for the region, and an area to install additional facilities for biogas production to process the organic waste.

In addition, the county of Hunedoara has an extensive coverage of gas-pipes, as well as, expertise in the area of natural gas. This could prove a significant advantage for future introduction of biogas to the grid, and the upgrading for vehicle fuel.

Embracing New Opportunities

Through its EU membership, Romania has access to funds, knowledge, and support for improving the national waste



That said, the town still faces a number of challenges that it will need to overcome in order to implement a working system for biogas. For instance, separate collection of food waste, which is planned to come into place in the near future, remains a crucial piece to this puzzle.

The following sections devoted to the scenario of the waste management system development, based on biogas production.

Pre-requisites

A biogas system depends heavily on a sound waste collection system and the involvement of the citizens in the sorting process. For the case of Deva there are three aspects that need attention:

Accessibility

One of the issues with the current collection system is accessibility. Some areas either lack the infrastructure for recycling, or it is too far away from residential areas. Convenience has proven to be very important as an enhancing factor for recycling in the Swedish case, and it should be a key element of a well-functioning waste management system.

Involvement of the informal sector

The informal sector is currently filling the gap between the waste management company and the PROs in Deva. People from the Romani community actively collect recyclables from the streets, containers and landfills. This informal recycling flow is hard to trace in the current Extended Producer Responsibility (EPR) system.

Collaboration between the two sectors could potentially benefit both actors, and help the town (and country) to improve its recycling rates, especially considering the

stricter targets to come. The use of legal means to formalise their situation could be considered. This does not have to be through formal hiring of the Romani, but simply understanding and the factors that would lead them to use formal channels (i.e. revenue and convenience), and further to provide those channels. For example, a door-to-door collection system could be encouraged in areas where recycling bins are not easily accessible for citizens.

Case Study #2 – The Informal Sector

In a study carried out in Cluj-Napoca, the results showed that the formal sector was achieving a 5% recycling rate, while the informal sector was recycling 8% of the waste [6].

An example of collaboration was seen in Cluj-Napoca, in a building where a chute system was being used by the neighbours to dispose their waste, and the informal sector was sorting a part of the waste before it was collected.

Raising Awareness

Awareness about recycling among the population is insufficient, and sorting of waste is often considered as a chore without any benefits. Thus, it is important to first create a clear communication with the citizens in regard to existing benefits for the society: *What are recyclables being used for? How much has been collected? What is the reduction in GHG emissions?*

This is the case in Sweden, where busses clearly display that they are using biogas as fuel. In this way, the population sees that their sorting at home is creating something tangible, which benefits themselves, society, and the environment.



Bus running on biogas in Lund (Sweden)

Education is key in order to have a well-functioning waste management system, and beginning early is crucial. Children can learn and engage very fast, and become great “*change agents*” for their parents’ and their peers’ behaviour. Organizing leisure activities such as recycling competitions among schools could be a way to get them involved. The general public must also be educated, and informational campaigns are a good way to do so. Another good example can be found looking at Sweden and what some municipalities did to get people involved in the sorting system: it announced a trial period (a few months) to test the recycling system, after which the system would go back to normal. In this way people felt that they were being part of a project without the need to continue after it ends.

Educating the people

- ☐ Involve children at school
- ☐ Inform people about what is being done with the waste
- ☐ Informational campaigns for the community
- ☐ Launch a trial period for waste sorting

Many people decided to give it a try, and once the trial period was over, people had gotten used to it, and they showed willingness to keep the system.

Biogas: Drivers and Benefits

Organic matters

Biogas is formed from the breakdown of organic matter by microorganisms in the absence of oxygen. Many different microorganisms are involved in a complex web of interacting processes, which results in the formation of different compounds, such as methane (CH₄) and carbon dioxide (CO₂), and may have small amounts of hydrogen sulphide (H₂S), ammonia (NH₄⁺) and nitrogen gas (N₂).

With a 45% of organic waste in the waste stream, separate collection of food waste for biogas production would reduce notably the amount of landfilled waste. In four years’ time the new operator will be responsible for collecting separately food waste from households and businesses, which is a key step for biogas generation.

Legislative drivers

The European Waste Framework Directive requires member states to reach 50% recycling by 2020, and reaching this will likely require efforts to recycle both organic and inorganic materials.

If the country fails to comply with the EU recycling targets by 2020, it will result in the fine of EUR 200.000 per day, or EUR 73 million per year [5]. European Council has already fined Greece EUR 10 million for inefficient waste management [7].

Taking into account that Romania does not separate organic fractions from the



municipal solid waste stream, and that the country has difficulties reaching required recycling rates in general, collecting a separate organic fraction may be a logical initial step for further transformation of the waste management system.

Environmental benefits

The largest immediate environmental benefits of a separate organic fraction is the reduction of methane and CO₂ emissions produced by the landfill, and the slower rate of landfill growth. The expected methane emissions from the landfill are 8 million m³ per year, which the operator will capture by using pipes. Nevertheless, this method does not capture all emissions, and often requires a portion of the gases to be flared [8]. At the same time, the potential methane production from food waste in Hunedoara has been estimated to be 22 million m³.

Ultimately, the lifespan of the new landfill is expected to be 7 years. Collecting food waste separately and diverting it from the landfill could greatly increase its longevity.

Economic and social benefits

The production of biogas and the remaining 'digestate' can be a profitable business. Biogas can substitute natural gas, 30% of which is currently being imported from Russia [9]. This means that biogas production yields both greater energy independence and the digestate supports farmers by supplementing soil fertilisers. Based on the price of natural gas and the amount of food waste in the town, it was estimated that Deva alone could save EUR 283.000 annually.

Similarly, the region of Hunedoara could potentially save EUR 1.6 million.

	<i>Deva (EUR)</i>	<i>Hunedoara (EUR)</i>
<i>Food waste</i>	283.000	1.646.000
<i>Wastewater</i>	31.700	245.700
<i>Old landfill</i>	145.200	-
TOTAL	460.000	1.892.000

Potential savings using Biogas. Source: Own elaboration based on [3, 11]

It is worth mentioning that other biogas substrates such as slaughterhouse waste, agricultural crop waste, or manure could not be considered due to lack of data.

Job creation is another positive outcome of this shift to biogas, and typically 1 GWh of biogas production translates into one job [12]. In this case, 8-9 jobs could potentially be created in Deva, while Hunedoara stands to gain 50.

Since biogas production within Romania is very limited, there may be a significant early-mover advantage for Deva. The EU funding is often easier to secure for projects that can also be considered as a 'demonstration'.

Postponing incineration

The pursuit of biogas will allow the region to postpone incineration, which is attractive for a number of reasons. Firstly, it is considered a less desirable option according to the EU waste hierarchy. Second, it will increase the likelihood that incineration capacity will not be excessive. With that said, even reaching high recycling rates, there is always a fraction of the waste that cannot be recycled. Thus,

such waste-to-energy approach remains necessity, as it is a better alternative than landfilling, especially due to the relatively high efficiency of cogeneration of energy and heat.

The Lock-in Effect

Investing in incineration infrastructure is expensive, and once the system is in place, it requires a constant flow of waste to function. This could potentially discourage further actions towards more sophisticated waste treatments. Sweden is an example of this, as an early adopter of incineration, now almost 50% of its waste is treated that way, and the system is reliant on imported waste to keep running at an efficient level.

Funding is a key aspect for the development of an incineration infrastructure, and it involves high investment and operational costs, often resulting in a ratio close to 50/50 [10]. This is worth mentioning, since the EU tends to only cover investment costs (most likely not 100%), in addition to promoting the waste hierarchy when dealing with waste management. Thus, it may be even more difficult to get funding for an incineration project without demonstrating successful undertaking of other recycling measures.

Policy Instruments to Support the Transition

In order to support the transition, environmental policy instruments must be considered in a national and local context. Economic instruments such as the establishment of a landfill tax can disincentivise the use of landfills and allow other waste treatment techniques (e.g. biological) to be relatively more competitive. A landfill tax was planned for

Romania from 2013, however its entry into force has been postponed several times [5] and to date, there is still uncertainty regarding its implementation. Once in place, it will be another driver to choose a different treatment technology.

Similarly, the introduction of a ban on landfilling of organic waste can be considered. This, along with establishing the infrastructure for separate collection and recycling of the organic fraction may incentivise the application of biogas production.

On a local and regional level, administrative instruments, as the inclusion of food waste separation in the waste management plan, is key, along with providing the necessary infrastructure for the citizens to do so. Furthermore, a Pay As You Throw (PAYT) scheme may allow the municipalities/county to levy fines for households for not separating the waste. This financial incentive may increase the proper sorting at source and also generate revenues to be invested in improving the waste management at the local level.

Besides economic and administrative instruments, it is also important to integrate informative instruments. Namely, educational and informative campaigns to improve source sorting and recycling rates. Addressing the community in general with special focus on the educational system. Also, educating other actors in the recycling chain on how to improve efficiency in their operations for a sound waste management.

The situation with the EPR schemes is complex, and requires changes in legislation at the national level. The current system seems to be partially



unbalanced, when one group of actors receives greater benefits compared to another. The Swedish experience also demonstrates that a deposit-refund system might also be a feasible solution – for increasing collection rates and discouraging the informal sector from operating outside the system.

Funding the Future

To fund a project such as a biogas plant, “LIFE”, and the “European Structural and Investment”, specifically the “European Regional Development Fund (ERDF)” together with the “Cohesion Fund” can be considered for funding for the development of waste infrastructure and services based upon the waste hierarchy. Another option is the “European Investment Bank (EIB)”, which offers loans to EU members for projects related to infrastructure, environment and climate, including waste management.

On a smaller scale, there is an “Urban Innovative Actions” programme, which offers funding for the development of innovative solutions to address urban

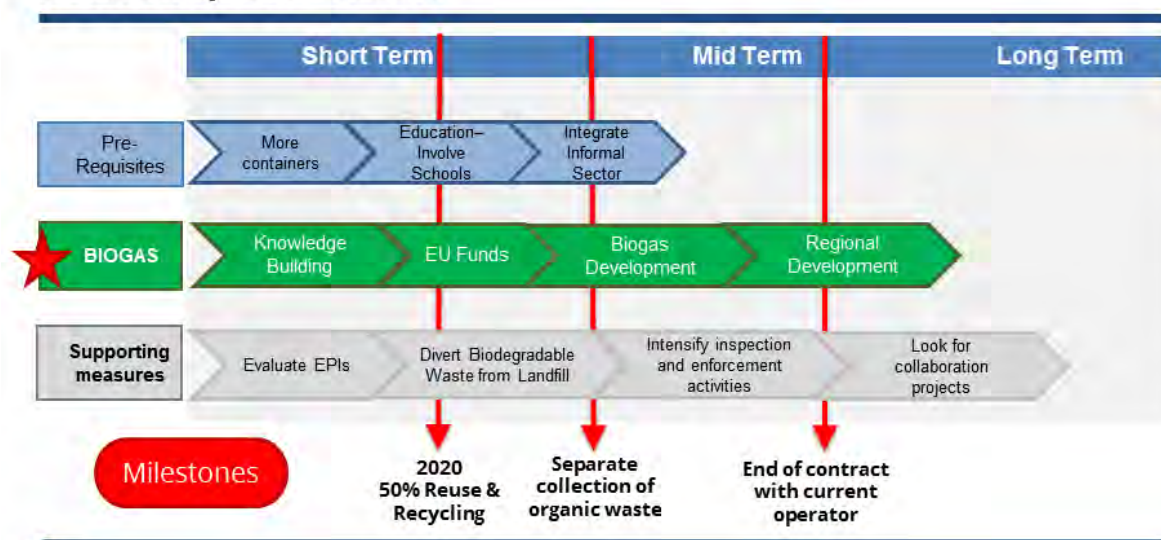
challenges. This programme could be interesting to finance an educational project for the citizens, including the inclusion of the informal sector.

When it comes to developing a new waste strategy, knowledge building is pivotal, and there are funds such as “Interreg Europe”, another program under the ERDF, or the “EEA Grants” for this purpose. While the former finances cooperation projects between two or more EU Member States, the latter aims at facilitating knowledge sharing among different actors, financing conferences, seminars and study visits, among other actions.

Final Remarks

Based on the analysis of the current situation in Deva and considering the know-how developed in the Swedish waste management system, it is suggested to Deva Municipality to pursue Anaerobic Digestion as a treatment technique for biogas production. Given that the municipality is locked in the current contract with the waste operator for the

Roadmap for Action



next 4-8 years, it is recommended first to focus in the short term in the pre-requisites to develop a sound waste collection system: Improving the accessibility to recycling containers; increasing awareness among the population regarding proper separation and recycling and addressing the informal sector. Several drivers and benefits of the development of a biogas infrastructure have been highlighted, which combined with easy access to EU fund, makes biogas the better option against other alternatives. Furthermore, it would help the country get closer to comply with the EU target.

References

- [1] Eurostat (2016). Waste Statistics. Retrieved from: http://ec.europa.eu/eurostat/statistics-explained/index.php/Waste_statistics
- [2] EU (2008). European Directive 2008/98/EC on waste (Waste Framework Directive) Retrieved from: <http://ec.europa.eu/environment/waste/framework>
- [3] Deva Municipality (2014). Sustainable Development Strategy (2014-2020). Retrieved from: <http://www.primariadeva.ro/politici-si-strategii-ale-municipiului-deva/strategia-pentru-dezvoltare-durabila-a-municipiului-deva-2014-2020>
- [4] Rastei, E. (2015) Zero Waste Romania. [Power point slides]. Retrieved from: http://www.humus.hu/sites/default/files/Dokumentumok/programok/2_3_budapest-humus-final.pdf
- [5] Lungu, A. (2016) *Cleaning up Romania*. Retrieved from: <http://www.balkaninsight.com/en/article/cleaning-up-romania-12-07-2016>
- [6] Ioana N. Pop, Călin Baci, Cosmin Briciu, Valentin Tofana, Nicoleta Bican-Brișan (2015). *Informal sector participation in solid waste management – study case: Cluj-Napoca, Romania*. ECOTERRA, Journal of Environmental Research and Protection, Volume 12, Issue 3.
- [7] BBC. (2016). Greece fined €10m for breaking EU waste rules. Retrieved on April, 19, 2017, from: <http://www.bbc.com/news/world-europe-37296789>
- [8] Environmental Protection Agency (2009). Estimates of Methane Recovery in Landfill Gas Flaring and Utilisation. Retrieved from: https://www.epa.ie/pubs/reports/research/climate/CCRP_3_Timoney_MethaneLandfill_web.pdf
- [9] Serbia Energy (2017). Romania: Increase in natural gas imports in 2016. Retrieved from: <https://serbia-energy.eu/romania-huge-increase-natural-gas-imports-2016/>
- [10] Narayan, P. (2001). Analysing Plastic Waste Management in India. Case Study of Polybags and PET Bottles. IIIEE Reports, 11.
- [11] Réka Soós, Environmental Economist, Green Partners. Cluj-Napoca, April, 2017
- [12] Desirée Grahn, Director Biogas Syd. Lund, April 2017
- [13] European Environmental Agency (2016) Municipal waste management - Romania. Retrieved from: <http://wmge.eionet.europa.eu/Municipal>

List of people interviewed

- Caroline Steinwig, Technical Adviser Biological Recycling, Avfall Sverige. Malmö, March 2017
- Carolina Persson, Miljöchef NSR. Helsingborg, March 2017
- Sorin Dumitru, Project Manager, and Lorita Constantinescu, Communication Director, EcoRom (PRO). Deva, April 2017
- Sorin Dănilă, Manager, A sorting station and a newly built landfill. Deva, April 2017
- Mares Cosmin Razvan, Vice-Mayor Deva Municipality. Deva, April 2017
- Jr. Ovidiu Mos, Vice-Mayor Deva Municipality. Deva, April 2017

Tale of Poland



Photo: (from left) Dariya Gavrish, Can Soysal, Nikola Stojmenovic and Elena Talalasova.

Elena Talalasova is originally from Russia, holds a degree in Economics and Finance and has worked with sustainability-related projects in three countries.

Dariya Gavrish, from Russia, holds a BA International Business and Marketing from the Netherlands and has professional background in waste management.

Nikola Stojmenovic, from Sweden, holds a BSc Environmental Science, which resulted in several years of professional experience in environmental consulting.

Can Soysal is originally from Turkey and holds a BSc Political Science. Can has professional experience working with media and export development.

Tale of Poland

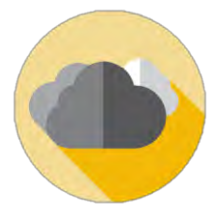


The team was invited by the municipality of Zabrze, which is the partner city to Lund, to work on the problem of air pollution. Zabrze is a town located in southern part of Poland and has some of the highest levels of air pollution in Europe. Through research and interviews with several experts and stakeholders during the study visit, the main sources of air pollution in Zabrze and potential areas of intervention were identified. The project focused on residential heating in Zabrze, as coal based heating systems were identified as the main contributor to air pollution in the city. An alternative heating system scenario based on cleaner sources was suggested and compared to a baseline scenario in terms of cost and emission reduction potentials. Moreover, several enabling measures ranging from better data management to running campaigns to raise awareness and increased stakeholder collaboration was suggested in order to tackle the problem of air pollution.

Acknowledgements

The team wishes to express its gratitude to all those who supported and contributed to this project. We would like to give a special thanks to our supervisor, Mikael Backman, for his guidance and help throughout the project. In addition, we deeply appreciate the hospitality of the representatives of Zabrze municipality and their role in organising meaningful meetings. Lastly, we would like to extend our gratitude to Agnieszka Jama who made our visit to Zabrze productive and pleasant.

- *Dariya, Elena, Can & Nikola.*



It is in the Air

Exploring Cleaner Air Pathways for Zabrze

By Dariya Gavrish, Can Soysal, Nikola Stojmenovic, Elena Talalasova

The team was kindly invited by Zabrze Municipality to work on outdoor air pollution, with a special emphasis on smog. Several expected outcomes were underlined, including a description of the sources of air pollution in the city and potential areas of intervention.

Background

Air pollution is one of the most complex environmental and social issues facing humanity. It is a systemic issue characterised by various types, sources, effects and inter-linkages. The capacity of many pollutants to travel long distances is adding a layer of complexity, requiring coordinated effort.

One type of air pollution is smog. Two types of smog can be distinguished. One is sulfuric smog, formed jointly by sulphur dioxide, light and particulate matter. It is largely caused by the use of coal, which is why it often occurs in winter, during the heating season. The second type is photochemical smog, formed by nitrogen oxides, light and volatile organic compounds. This type of smog can be broadly associated with all types of combustion emissions.

Air pollution causes a variety of environmental and health issues. It negatively affects the health of the Earth's ecosystems, including forests, waterbodies, soils and wildlife. Not surprisingly, one of the species that experience the negative conse-

quences of degrading air quality is humans. Globally, one in nine deaths can be linked to poor air quality [1]. In Europe alone, air pollution is responsible for half a million premature deaths each year, of which 43 000 occur in Poland [2].

These health effects represent a heavy burden for the economy. Increased costs for hospitals, reduced productivity, an increased frequency of sick leave and, most importantly, an increased mortality burden, all contribute to the overall societal bill. OECD suggests that the combined effect of air pollution expressed in costs for the health system can account for up to 4% of the global GDP [3].

Regulatory Framework

Ambient air quality on the European level is regulated by the Clean Air Policy Package. One important policy under the package is the Directive on ambient air quality and cleaner air for Europe. It establishes objectives with regards to the limit values of pollutants in Member States, ensures ambient air quality data are available to the public, and sets out procedures and directions on sampling points, their number and location, among other things.

EU Member States are obliged to follow the requirements laid out in the Directive and transpose it into the national legislation.

As one of the European countries that suffers the most severe consequences of air

pollution, Poland was home to 33 out of Europe’s 50 most polluted cities in 2016 [2]. Poland finds itself in chronic breach of the EU limit values. This brings about attention from the EU, with the European Commission threatening the country with sanctions from the Court of Justice [4].

Urban Air Pollution

Due to high population density and more developed infrastructure, cities usually experience higher levels of pollution than other areas. There is no one-size-fits-all solution for urban air pollution, as there are large differences among the background conditions in different cities. But there is one thing all cities have in common: the urgent need to act, fueled by demands from the citizens, national and regional governments and supranational institutions.

The areas of cities’ activities to tackle the air pollution usually include emission inventory, measurement and modelling, air pollution management and making information available to the public [5].

However, cities usually have limited possibilities to influence the situation, given the transboundary nature of most pollutants and limited regulatory power of local authorities. Many of the most efficient measures require certain changes in national or regional legislation, such as vehicle fuel requirements and bans or industry emission standards.

Air Pollution in Zabrze

Zabrze is a town in the Silesian Voivodship of Poland, with a population of around 190 000. It is part of the largest urban area in

Poland, comprised of 18 cities and a total of 2.5 million inhabitants. Historically, coal mining was the most important industry for Zabrze, with 11 mines spread across the city. Today, only one is operating, putting Zabrze into an exciting yet challenging position of probing new directions for development.

Arguably the most urgent environmental challenge facing the city is air pollution. Together with other cities located nearby, Zabrze is a frequent visitor on the lists of Top 10 most polluted cities in Europe [2].

Levels

Table 1 compares the levels of pollution in Zabrze against the limit values set in the EU Directive, split by the types of pollutants. For some pollutants, the comparison was not possible due to different averaging periods.

Pollutant	Zabrze	EU Directive
PM10 Annual mean; Exceedances	46 g/m ³ ; 93	40 g/m ³ ; 25
NOx Annual mean	36 g/m ³	30 g/m ³
SO2	Not comparable	
CO	Not comparable	
BaP Annual mean	9 ng/m ³	1 ng/m ³
O3	Not comparable	

Table 1. Pollution levels in Zabrze in 2016 [6]

Annual average concentrations of PM10 and benzo(a)pyrene in Zabrze are significantly higher than the limits. The situation was particularly serious in the winter season. With regards to other pollutants, such as NO₂ and SO₂, the concentrations are also either approaching or breaching the limits.



Sources

During numerous preparatory calls and on-site visits, it was pointed out that the main sector responsible for air pollution in Zabrze is residential heating, particularly, coal-fired stoves and furnaces.

Figure 1 describes the main sources of pollutants for the whole Silesian region.

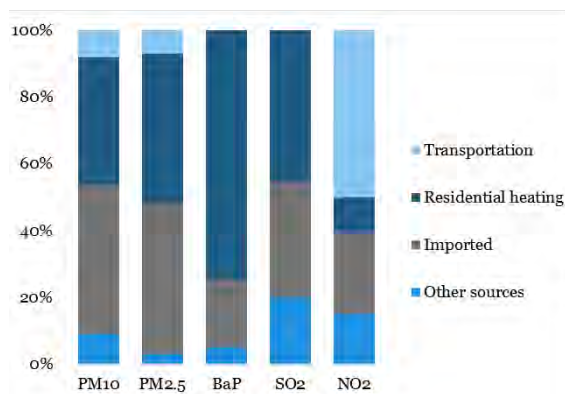


Figure 1. Sources of major air pollutants in Silesian Voivodship [6]

For all pollutants presented, except NO₂, the heating sector is the main contributor, with transboundary pollution following the lead. It must be noted that the data presented in the graph is a yearly average. It can thus be expected that the share of the heating sector in the total mix is even higher during winter. Due to data gaps, it is difficult to measure how the situation in Zabrze differs from the regional picture. However, our general conclusion based on extensive research backed by expert interviews is that the mix is fairly similar.

Effects

It is estimated that 40 deaths can be avoided annually in Zabrze, in addition to 90 visits to hospitals due to respiratory diseases and 75 hospital visits due to cardiac diseases, if the PM₁₀ concentration were reduced to the levels recommended by the WHO [7]. On average, a 5 µg/m³ decrease in annual mean concentration is said to be

associated with 4.9 avoided deaths in Zabrze. Zabrze's own Centre for Heart Diseases recently confirmed that air pollution had severe negative effects on admitted patients with heart problems.

Translating health effects into economic losses, a brief risk burden-based estimation of annual costs from excessive concentrations of NO₂ and PM to Zabrze Municipality returned the result of PLN 116 million, a figure to be considered an absolutely lowest threshold.

PLN **116** mln
Annual unpaid health bill
of air pollution in Zabrze

Many of the non-health-related negative effects described previously could be observed in Zabrze during study visits. For example, an ongoing research undertaken by the Institute of Environmental Engineering showed that air pollution accumulated in Zabrze over years has a detrimental effect on local soils. In addition, facades of many buildings were displaying a black crust from decades of coal soot accumulation.

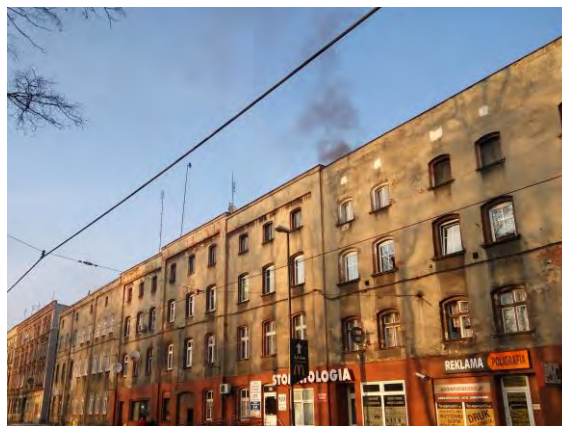


Figure 2. Smoke from the apartments in Zabrze

Scope

Having been given the broad task to look at air pollution in Zabrze, it was necessary to narrow down the scope to arrive at tangible results. As agreed with the city representatives, the report is mostly concerned with outdoor air pollution, while recognising and emphasizing the links between indoor and outdoor pollution and the importance of indoor air quality for human health. Moreover, while looking at all the main pollutant types presented in the European Air Quality Directive, the report focuses on reductions in those pollutants for which the local situation is most critical. Last but not least, given the 2016 report focus on transportation and the moderate contribution of the sector to air pollution in Zabrze in general, the sector falls out of scope of our report.

Approach

Bearing in mind the complexity of the issue, and, at the same time, recognising residential heating as of utmost priority, our report focuses on technical solutions for the heating sector specifically and the enabling measures for air pollution in general.

First, we envisioned two potential directions where the city could go in developing its heating system and discussed their implications for urban air quality and the city in general.

The scenarios range from mostly coal-based in the *Baseline Scenario* to predominantly relying on renewables in the *Alternative Scenario*. The *Baseline Scenario* was developed based on our interpretation of

the direction that the city of Zabrze intends to go. On the contrary, the *Alternative Scenario* is mindful of the declining state of the coal industry in Poland and the rapid development of renewable energy.

As a second step, we described a toolbox of measures (enablers) that, in themselves, do not result in a drastic pollution reduction, but rather act as facilitators. They consist of enhanced collaboration, awareness building, strategic recommendations, data management and nature based solutions.

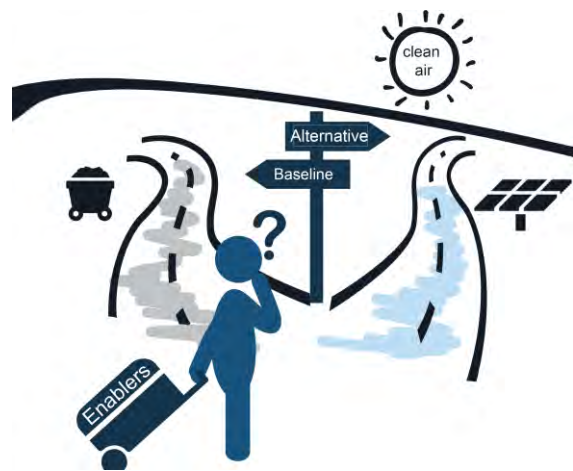


Figure 3. Zabrze at the crossroads

Heating Sector Solutions

Description of Scenarios

For each scenario, the existing housing stock was split between several heating alternatives, bearing in mind that solutions for single-family homes are generally different than solutions for multi-unit dwellings. Both scenarios assumed a change in the number of houses using a particular technology, compared to the current situation. Some technologies suggested under the Scenarios are not currently employed to a large extent.

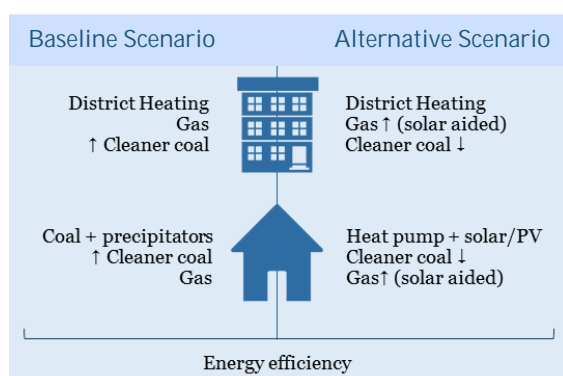


Figure 4. Overview of the heating sector solutions for the two scenarios

The *Baseline Scenario* recognises coal as a main source of heating in Zabrze. The negative effects are minimized mostly through more efficient furnaces, end-of-pipe solutions and developing of higher quality coal.

The *Alternative Scenario* is more committed to preventative approach and suggests a mix of renewable or low air pollution impact solutions. The technologies specific to this scenario are solar panels, heat pumps and solar water heating systems, in various combinations. The feasibility of aforementioned solutions within the local context was tested during study visits as well as extensive research.



Figure 5. Solar panels powering the street lights on Guido coal mine, Zabrze

Despite differences at the core of the two scenarios, they both recognise several important developments that are currently

taking place in Zabrze. First, both scenarios assume that the current efforts to increase energy efficiency of houses in Zabrze will continue. Secondly, the positive role of district heating is recognised. Planned expansion by Municipalities of the district heating network is reflected in both scenarios.

Scenario Comparison

The scenarios were compared based on their investment and operating costs, as well as emission reduction potential and cost effectiveness. Additional considerations were briefly outlined. The estimations were based on several parameters, including efficiency-adjusted annual heat demand for different types of houses, local prices for different types of fuels and different heating and related equipment, infrastructure expansion and energy efficiency investment.

The results of the comparison are presented in Table 2.

Pollutant	Baseline	Alternative
Investment, PLN million	344	482
Total cost over 20 years, PLN billion	3.3	2.7
Emission reduction, % PM10	75	91
Cost-effectiveness, PLN/g	0.3	0.3

Table 2. Scenario comparison

As far as air emission reduction goes, the PM10 reduction potential was used as a proxy. It was estimated that the *Baseline Scenario* can reach a 75% reduction from today's levels, compared to a 91% reduction under the *Alternative Scenario*.

Cost-wise, several parameters were used for comparison. First, the investment costs

were estimated for transforming the heating system. Total investment under the *Baseline Scenario* equaled PLN 344 million, with a figure 40% higher – 482 million for the *Alternative Scenario*. However, due to significant operational savings achieved under the *Alternative Scenario* through the use of renewables, the total cost over 20 years is 15% lower for the *Alternative Scenario*, at PLN 2.7 billion.

Another important angle to look at the situation from was that of cost effectiveness, i.e. the degree to which the aim was achieved vis-a-vis the costs of intervention. In our case, it was expressed by the amount of emissions reduced per zloty spent in investment. For both *Scenarios*, the overall cost-effectiveness is at PLN 0.3 per g of PM10 reduced.

Any heating intervention brings about benefits that go well beyond air pollution reduction. Inevitably, several important trends and factors were not accounted for in the calculations.

One such factor is the potential for job creation. The *Baseline Scenario* will not result in substantial growth in the number of local jobs due to its reliance on the coal industry. Taking into account the declining state of the industry in the city, and in the country in general, the jobs, instead, will be drained elsewhere. The *Alternative Scenario*, however, brings a new industry of renewable technologies into the city, and fosters local employment associated with installation and maintenance of new technologies.

In addition, health effects should be considered. Under the *Baseline Scenario*, the problem of indoor pollution is more likely to prevail, with a higher number of households using coal for heating. Therefore,

health costs will most likely be higher than in the *Alternative Scenario*.

Several private and public benefits stemming from the spread of renewable technologies should also be considered. Among them, increased property value for houses employing solar technologies, increased recreational value of the place and enhanced image of the city.

In such a manner, it is our judgement that the *Alternative Scenario* represents a better, forward-looking option as long as these crucial additional factors are considered. We thus recommend that the funds available are concentrated in the following priority areas:

- Energy efficiency
- Expansion of the district heating network and gradual shift in district heating fuel mix
- Changing to gas boilers within the reach of the gas network
- Solar-based renewable solutions for single family houses

Enablers

The importance of enabling measures has to be underlined due to their high potential in laying the ground for approaching the issue. Apart from fostering technological transition, such measures aim to incorporate the complex social dimension, to avoid problems associated with single-mindedly focusing on technical fixes.

Strategic Approach

Since air pollution is so prevalent in Zabrze, we recommend it to be better incorporated into the City Development Strategy. In the current version of the strategy, air pollution is only mentioned a handful of times under a broader range of environment-related targets. The City Development Strategy is intended to be working across the departments and has a potential



for bringing about cross-departmental collaboration, much needed in the field of air pollution. Including air quality goals in it will help to fix the prevailing fragmentation of the efforts observed in Zabrze.

Among potential quantitative goals it is important to choose indicators for tracking the progress, such as weather-adjusted air pollution concentrations. Regarding qualitative goals, the advice is that air pollution effects should be assessed for every urban development decision undertaken. As a step further, an objective to consider is to ensure that no development decision has a net negative effect on air quality.

Local air pollution goals in Essen, Germany

Essen is Zabrze's German twin city. It is facing many problems that Zabrze is facing, having been an important industrial centre in the 20th century, with blossoming coal and steel industries. The city's Air Quality Strategy focuses on PM10 and NO₂, and has two stages: 2020, by which the levels should be kept below the EU Directive threshold, and 2035, by which WHO guidelines should be consistently met [8]. The strategy has several focus areas, including energy efficiency, mobility, consumer conduct, and industry; and was preceded by an extensive work on establishing a monitoring and measurement network and conducting an emission inventory in order to track progress towards the goals.

Data Management

Monitoring, inventory and modelling are all necessary steps in order to develop a comprehensive urban air quality strategy. One important role of monitoring is to provide input data for inventory, which, in turn, serves as a basis for modelling. Accordingly, modelling allows for estimation of effects of different strategic alternatives.

On a monitoring side, Zabrze could benefit from obtaining accurate data on peak emissions. Such data can help track traffic

emissions load, as well as pollutants emitted in the close proximity to coal heated residential buildings. Recognising costs associated with additional units of measurement equipment, cost effective screening methods such as a mobile laboratories, diffusive sampling and manual techniques are recommended for consideration.

Establishing an emission inventory is our next recommendation. It would help the municipality to manage the issue in a more targeted and thus cost-effective way, by giving a clear picture of where emissions come from and what the potential for reduction looks like. Following the model implemented in Malmö, Sweden, an emission inventory can be realised as a PhD project.

Moving on to modelling, for a smaller city like Zabrze, a well-tailored air pollution modelling system could become a cheaper alternative to expanding the monitoring network, since it requires minimal maintenance. To reduce the costs of modelling, the Katowice urban area could jointly purchase rights for using the model and split the bill.

Nature-Based Solutions

Nature-based solutions is an additional complementary method to tackle air pollution. Among the benefits "green infrastructure" can provide are temporary particle emission capture, temperature reduction, physical barriers for pollution and formation of wind corridors. Interestingly enough, not all trees are equally good for air pollution reduction. During the visit in Zabrze, experts pointed out that, despite a relatively high total area covered by trees, trees contribute little to tackling the issue due to a poor choice of species. At the same time, we could observe that there is limited

understanding of these solutions outside Zabrze academic community.

We thus recommend that carefully designed nature based solutions become part of the urban planning agenda of the city.

- ✓ *Use low VOC emitting trees*
- ✓ *Use low maintenance trees*
- ✓ *Plant trees close to heavily polluted areas*
- ✓ *Use evergreen trees for particle pollution reduction*

Figure 6. General recommendations for nature based solutions

Awareness

One of the crucial enablers, and areas cities are usually most active in, is raising awareness. Several benefits associated with increased awareness can be named, including boosting the pace of adoption of new technologies, as well as the possibility to better manage exposure, decrease negative health effects and associated costs.

We recommend several thematic areas of intervention. First is the broad issue of air pollution, particularly, the causes, sources and effects of it. People should feel the urgency of the problem and the importance of tackling it. Specifically, Zabrze could greatly benefit from locally specified data on air pollution, including spatial dimension of exposure with a breakdown of streets and city areas, based on modelling. Besides, personalised recommendations can be issued for particularly vulnerable groups of citizens. In this respect, higher awareness can help to alter the habits of people, avoid adverse health effects and

eventually even to some extent decrease air pollution.

In addition, information about residential heating alternatives, as well as grants and support available for changing the heating system in houses should be clearly communicated.

Collaboration

To combat the issue of air pollution, the efforts of just one party are not enough. The problem is too complex and fragmented to impose responsibility on a single city department. Rather, involvement and collaboration of multiple stakeholders is necessary. In return, collaboration can boost synergies, facilitate knowledge exchange, help to arrive to a shared vision and increase awareness.



Figure 7. Bringing stakeholders together

The field trip to Zabrze revealed a great potential for enhanced collaboration among a scattered mass of stakeholders. To realise this potential, we mapped out the main stakeholders involved, and identified six main areas for collaboration: data creation, financing, technology transition, job creation, regional collaboration, and public awareness. Figure 8 describes examples of collaboration projects for each of these areas, including the stakeholders involved.

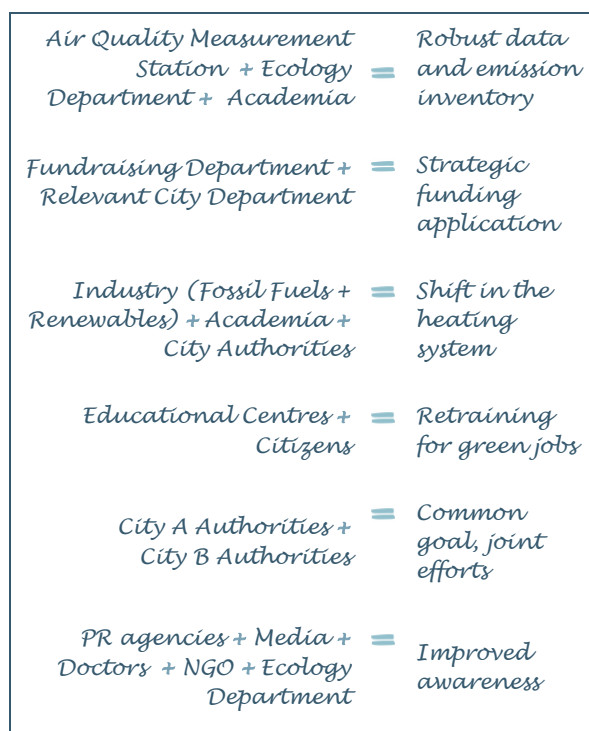


Figure 8. Examples of collaboration projects

Outlook

Air pollution is a complex phenomenon deeply rooted in other issues facing the city. It is thus important to set the right priorities for action, starting with the areas where the most significant effect could be achieved.

Zabrze is standing at a crossroads. Continuing to depend on fossil fuels for heating goes against the prevailing trends in the market, and can therefore not be afforded. Instead, the resources available have to be used wisely in accordance with priority areas identified in the report.

The city of Zabrze has all the potential to become a transformative city, a place that is proud of its industrial past, but is forward-looking and visionary, that transitioned from hitting the charts of the most polluted cities in Poland and Europe to being a role model to follow. To realise this potential, a systematic approach to the is-

sue of air pollution should be applied, one that recognises the importance of both sector-specific technical developments as well as soft measures.

References

- [1] WHO. (2014). 7 million premature deaths annually linked to air pollution. Retrieved from: <http://www.who.int/mediacentre/news/releases/2014/air-pollution/en/>
- [2] EEA. (2016). Air Quality in Europe — 2016 report. Retrieved from <http://www.eea.europa.eu/publications/air-quality-in-europe-2016>
- [3] OECD. (2016). The economic consequences of outdoor air pollution. Policy highlights. Retrieved from <https://www.oecd.org/environment/indicators-modelling-outlooks/Policy-Highlights-Economic-consequences-of-outdoor-air-pollution-web.pdf>
- [4] EEA (2017). European Commission - Press release - Commission warns Germany, France, Spain, Italy and the United Kingdom of continued air pollution breaches. Retrieved from http://europa.eu/rapid/press-release_IP-17-238_en.htm
- [5] EEA. (2013). Air Implementation Pilot - Lessons learnt from the implementation of air quality legislation at urban level — European Environment Agency. Retrieved from <http://www.eea.europa.eu/publications/air-implementation-pilot-2013>
- [6] System monitoringu jakości powietrza ŚLĄSKIE (2016). Retrieved from <http://powietrze.katowice.wios.gov.pl/dane-pomiarowe/automatyczne/stacja/5/parametry/87-92-105-90-94-104-97-106-91-88-93/roczny/2016>
- [7] Kowalski, M., Kowalska, K., & Kowalska, M. (2016). Health benefits related to the reduction of PM concentration in ambient air, Silesian Voivodship, Poland. International Journal of Occupational Medicine and Environmental Health 2016, 29(2), 209–217.
- [8] European Commission. (2015). City of Essen Application to the European Green Capital. Retrieved from http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2015/06/05_Application-EGC-2017_Air-Quality_ESSEN.pdf

List of people interviewed

Adam Kristensson, Deputy lecturer in Aerosol Science and Technology, Lund University, 24/3-17

Aleksandra Wayda, Head of Projects and Realization Department of Zabrze, Zabrze, 28/3-17

Dr. Aleksander Sobolewski, Director of the Institute for Chemical Processing of Coal, Zabrze, 30/3-17

Dr. Krzysztof Klejnowski, Head of Air Protection Department, Institute of Environmental Engineering, Polish Academy of Sciences, Zabrze, 29/3-17

Dr. Sławomir Stelmach, Director of Centre for Technological Research, Institute for Chemical Processing of Coal (IChPW), Zabrze, 27/3-17

Grzegorz Simla, Main Specialist, Institute for Chemical Processing of Coal (IChPW), Zabrze, 30/3-17

Janusz Famulicki, Head of Ecology Department of Zabrze, Zabrze, 27/3-17

Jarosław Gontek, Mayor's Advisor, Zabrze, 27/3-17

Kamila Knap, Smogathon PL, NGO, online, 16/3-17

Lesław Kordys, owner of RAD – Instal (Heating and solar systems), Zabrze, 30/3-17

Lesław Złotorowicz, CEO, Zabrze Enterprise for Thermal Energy (ZPEC), Zabrze, 29/3-17

Magdalena Kozłowska, Polski Alarm Smogowy, NGO, online, 22/3-17

Małgorzata Manka – Szulik, Mayor of Zabrze, 27/3-17

Marcin Lesiak, Head of Strategy Department, Zabrze, 28/3-17

Mårten Spanne, Environmental Engineer Miljöförvaltningen, Malmö, 13/3-17

Mayor's Advisor, City Hall of Zabrze, Zabrze, 27/3-17

Patryk Białas, Katowicki Alarm Smogowy, NGO, online, 24/3-17

Paweł Gorniok, Chief executive officer, Ekolenergia SP. Z.o.o, Zabrze, 30/3-17

Professor Marianna Czaplicka, Executive Director, Institute of Environmental Engineering, Polish Academy of Sciences, Zabrze, 29/3-17

Wojciech Bogacz, Researcher, Silesian University of Technology, Zabrze, 29/3-17

Zbigniew Rau, International Relations Department, Zabrze, 9/3-17

Zenon Rodak, Head of Urban Planning Department, City of Zabrze, 28/3-17

Tale of Germany



Photo: (from left) Nicholas Dehod, Jelena Mnacakanjan, Sophie Schwer, Mathias Lehner (supervisor), Lara Kasnitz and Timothy Millar.

Nicholas Dehod is from Canada and has work experience as a manager in marketing and communications. He holds a BA Sociology from the University of Alberta.

Jelena Mnacakanjan is from Hungary and holds a BA Chinese Studies and an MSc China in Comparative Perspective from the London School of Economics.

Sophie Schwer is from Germany and has previously studied environmental science in Strasbourg, Freiburg and Antwerp. She has experience from NGO work on topics such as deforestation, global timber trade and corruption.

Lara Kasnitz is from Germany and holds a BA Business Economics from the University of Witten/Herdecke. She also participated in an exchange year in Reykjavik, Iceland.

Timothy Millar is from Northern Ireland. He holds a BSc Geography and Geology from The University of Manchester, where he also did an exchange year at the University of Sydney.

Tale of Germany



Team Berlin sought to understand the link between sharing and waste prevention for the Senate Administration for the Environment, Transport and Climate Protection. The trip was in partnership with another team from the IIIIEE researching the Urban Sharing. The research conducted prior to the trip focussed around defining the sharing economy and establishing an observable, measurable impact that it could have on waste prevention. Theoretically, the concept that an increase in sharing of non-perishable goods like electronics, tools and textiles made sense. However, empirical evidence to prove that this was the case was tough to find. The student team also developed a framework, with the aid of the research team that could help describe how municipalities are engaging with the sharing economy. During the trip, both teams met with entrepreneurs who had started sharing platforms, public bodies responsible for implementing waste prevention initiatives and other actors interested in promoting the sharing concept. This culminated in a workshop, which the teams ran to collect the ideas of the local actors interested in sharing for how Berlin municipality could engage with the sharing economy. These ideas, along with some of the recommendations from the student team, were presented to the representatives from the Senate Administration.

Acknowledgements

Team Berlin would like to thank all those who have supported them throughout the project. Thank you to the research team from the IIIIEE for their invaluable guidance during the trip to Berlin. In particular, thank you to our supervisor Matthias Lehner, who always had an open ear to our questions and never lost patience even during critical discussions. In addition, we would also like to thank Herr Schwilling and Frau Schulze from the Berlin Senate, who have made time for our requests. This project has only been possible with their commitment. Thanks must also go to our interview partners, whose input forms the basis for this report.

- *Nicholas, Jelena, Lara, Sophie & Timothy.*



From useless property to property-less use

The Sharing Economy and Waste Prevention in Berlin

By Nicholas Dehod, Lara Kasnitz, Timothy Millar, Jelena Mnacakanjan, Sophie Schwer



Introduction

The Business Innovation Observatory of the European Commission describes the sharing economy (SE) as companies that deploy accessibility-based business models for peer-to-peer markets and its user communities [1]. Research into the SE is not well established and most research initiatives are exploratory in their nature. With this as a backdrop, this project for SED sought to investigate the SE and explore the potential link that sharing has with opportunities for waste prevention. This SED project supplemented a five-year research project on SE being conducted by the IIIIE and included working with Berlin's municipal department responsible for waste prevention, Senatsverwaltung für Umwelt, Verkehr und Klimaschutz (Senate administration for the Environment, Transport and Climate Protection).

Background

Berlin is the capital city of Germany with a population of 3.5 million that is expected to continue to grow posing both opportunities and risks for the municipality [2]. It has a vibrant, entrepreneurial start-up culture, catalysed by a suite of municipality-developed policy measures supporting new businesses and attracting young people. From this has sprung many innovative and creative business sectors including green technology and SE [3].

A growing population poses challenges for how the municipality maintains and advances its agenda for waste management. Household waste currently accounts for 80% of Berlin's municipal waste with the other 20% coming from commercial activities (such as road sweeping) [4]. With an increasing population, it is important for the municipality to consider all opportunities to prevent waste to

comply with EU legislation, national legislation and the trend of decoupling waste generation and economic growth.

The SE includes the sharing and exchange of goods and services rather than the new acquisition of individual products. This holds potential for direct waste prevention since any item that is exchanged prevents the purchase and disposal of a new product.

The rationale for this project follows exploratory research objectives derived from three questions:

1. What is the current status of the SE in Berlin?
2. What is the link between SE and waste prevention?
3. What roles can municipalities play to engage with the SE?

The exploration of these questions was the aim of the team's trip to Berlin. Prior to arriving in Germany, the team conducted a programme of desk research with the aims of: contextualising SE in Berlin; understanding the link between sharing and waste; and understanding how other European cities engage with the SE. During the trip, a series of interviews was conducted with: Berliner Stadtreinigung (BSR); representatives from prominent Urban Sharing Organisations (USOs); the IIIIE research team; interested NGOs; and a team of academics working with sharing from the Institut für Ökologische Wirtschaftsforschung. Interviewees were selected based on a definition of USOs presented later in the paper. In addition, an open workshop was conducted confronting some of the main issues identified throughout the week.

In Berlin, the student team was accompanied by a group of researchers from the IIIIE at Lund University. The two teams worked together, as part of the Mobile

Research Laboratory methodology designed for exploratory research of sharing in cities. This is an approach that combines in-situ data collection with reflexive analysis by an interdisciplinary group of researchers.

The first section of this report covers the theoretical basis for how the SE and sharing platforms can contribute to waste prevention. Then, a summary of the current landscape in Berlin is provided followed by several case studies of how other municipalities are presently working with the SE. Finally, opportunities are identified for the role that Berlin municipality can play in developing the city's SE and improving waste prevention.

Sharing & Waste Prevention

Waste Prevention

Improved waste management is essential to make global economies more resource efficient and prevent adverse effects on the environment. The theoretical basis for improving waste management follows the waste hierarchy as part of Directive [2008/98/EC] of the European Waste Framework [5], shown in Figure 1. It describes preferred waste management strategies, with the most preferred at the top of the pyramid, and the least preferred at the bottom. These are ranked in accordance with the overall environmental effect that each form of disposal has. As is evident from the pyramid, waste prevention is the most preferred strategy environmentally.

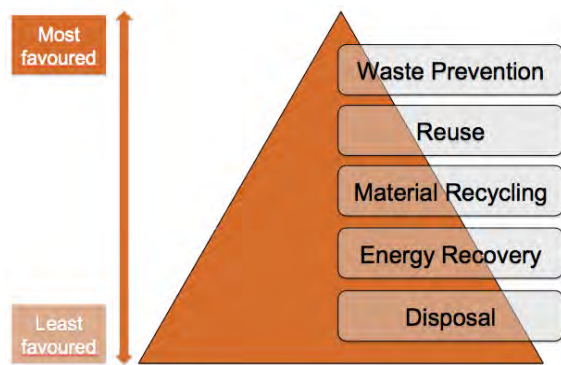


Figure 1. Waste hierarchy

Municipal solid waste production per capita has overall decreased in the EU from 2005 to 2015, although this is not a uniform reduction [6]. Some countries such as Sweden, Germany, and Denmark have seen an increase in the amount of municipal solid waste they have produced during this time. Reducing the amount of waste that consumers produce is especially difficult in the context of economic growth [7]. The SE has been cited as showing potential for reducing waste by changing consumers' consumption patterns [8].

The Sharing Economy

The SE has grown in recent years, with the European Commission estimating that in 2015 the total transactions of the SE amounted to EUR28.1 billion [9]. This is up from total transactions of EUR10.2 billion in 2013. There are several drivers for this growth including increased internet access, urbanisation and cheaper access to goods in the market. [9] These figures reflect the uptake of "sharing" initiatives and show that the SE is growing. It is, therefore, important to understand how to legislate to encourage the benefits from sharing and protect against the negative impacts of sharing.

The best-known sharing enterprises are large and based on commercialised business models, for example, Uber and Airbnb. These platforms have increased market efficiency and consumption and created

knock-on effects that negatively affect infrastructure, industry and create social problems.

For the purpose of on-site research in Berlin, the team analysed Urban Sharing Organisations. For consistency, the student team applied criteria already created by the IIEEE research team for defining what constitutes a USO. This definition describes the platforms that theoretically have the largest waste prevention potential. Under this definition, USOs:

1	share idling physical goods (not consumables or food)
2	are present online/enabled by ICT
3	are rivalrous
4	offer access over ownership
5	enable sharing among strangers
6	ensure peer-to-peer (P2P) transaction, where assets are owned by peers primarily for their personal use and are not put out on the market to generate profits [10].

Although the focus of our meetings in Berlin related to the above criteria, the findings in this report do not strictly focus on sharing related to this definition. This is to accommodate the municipality's interest in waste prevention and include identified opportunities that extend beyond the research team's definition.

What is the link?

The role of the SE in waste prevention is characterised by its potential to decrease resource use and material throughput. Sharing goods and items among a wider number of consumers can reduce consumption levels by satisfying the needs of more consumers with fewer goods. In the long term, it could decrease the waste generated by these consumers. There are additional social benefits such as a sense of community among the individuals involved in sharing goods e.g. tools or books. The SE

can also provide an economic platform for new, business models, potentially stimulating growth and economic development.

There is empirical evidence that suggests more efficient markets for consumer durables such as cars, tools and electronics can reduce material throughput [11, 12]. However, the concept for waste prevention as a direct result of the SE is purely theoretical, following similar logic as described previously. Due to a lack of research surrounding the topic, there is very little empirical evidence to support this claim. Waste prevention is inherently hard to measure. It is difficult to calculate how many goods have been prevented from entering a waste stream, the degree to which overall consumption habits change because of sharing, and if consumption instead increases due to greater access to goods. Yet, as mentioned before, waste prevention is not the only potential benefit of the SE for a city. The municipality can engage with the SE to provide a multitude of benefits for itself and countless other individual actors, creating jobs, building community in neighbourhoods and saving money for municipal governments [13].

Municipalities' Role in Sharing

Peer-to-peer sharing provides cities with another opportunity to counter some of the social, economic, and environmental challenges they face. Given that sharing platforms remain a recent phenomenon, some cities have struggled to establish the right mix of policies to account for the impact being felt by incumbent businesses as well as adopting provisions to protect consumers.

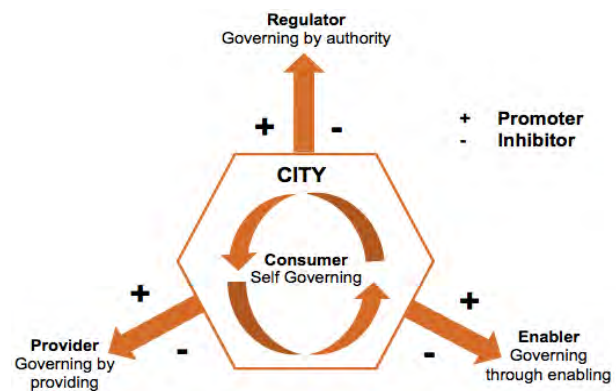






Figure 2. The roles municipality can play [14, 15]

Figure 2 shows a proposed framework based on urban governance models to show how some cities have developed policies to engage with the SE. In the model, cities are understood to have four different roles in the governance of the sharing economy i.e. as a regulator; as a provider; as an enabler; and as a consumer. The roles are explained in the next section followed by case cities, which the team have identified as successful based on how they are engaging with the SE. They highlight potential areas for Berlin municipality to further develop policies for SE engagement.



Municipality Roles

City role	Explanation
<i>Regulator</i> 	<p>Cities that tend towards a more regulatory role develop policies that protect consumers, outline rules for sharing firms, and considerations for challenges faced by incumbent firms. Examples of measures that regulators can take include bans, taxes or any formal documents regulating the establishment and operation of sharing initiatives.</p>
<i>Provider</i> 	<p>Cities that tend towards the provider role work to incorporate sharing into their strategies and provisions. Examples of measures that providers can take include developing their own sharing platform for use by the citizens in the city to promote sharing.</p>
<i>Enabler</i> 	<p>Cities that tend towards the enabler role offer subsidies and grants to help facilitates the growth of sharing organisations locally. In addition, such cities create ways to recognise and share best practices among urban sharing organisations.</p>
<i>Consumer</i> 	<p>Cities that tend towards the consumer role use sharing companies to fulfil their needs or deal with their resource surplus. They can use sharing firms for the provision of city services [14,15].</p>

Case Cities



Amsterdam, the Netherlands

Amsterdam provides one example of the city as a regulator and enabler. The municipality proclaimed itself to be the first *sharing city* in 2015, aided by shareNL [16], a knowledge and networking platform for the SE. This step towards engaging with the SE was made to capitalise on observed potential economic, social and environmental opportunities. Amsterdam, through shareNL, funds sharing initiatives on a project basis [16]. These projects, planned and run by shareNL, distribute funds to specific platforms based on how they can contribute to a certain project's overall goals. There are benefits to this scheme for all actors. The sharing initiatives get funding and recognition for their platform, and the municipality can keep tabs on the sharing initiatives that are currently active in the city allowing them to adapt quicker, and better legislate for, new and upcoming initiatives [17].

Hamburg, Germany

The City of Hamburg acts as an enabler and provider, presenting itself as a hub of the SE and highlighting several initiatives on its official homepage [18]. Their flagship project is the warehouse-project of the “public cleansing service,” “*Stilbruch*” [19]. It forms a cornerstone in the waste prevention efforts of the city. The enterprise is a subsidiary company of the public cleansing service, the business idea is to use the bulky waste that is collected by the city and repair and sell the items that are still of use (around 30.000m³ a year). The income generated by the sales finances 20 furniture trucks that collect the bulky waste and the salaries of the 61 employees in the two warehouse branches in Hamburg [20]. Consumers and donors also can drop off items in person. The warehouse project's objectives are to reduce the waste stream by reusing items from the bulky waste and reduce the need for production of new goods. The City of Hamburg also promotes the concept of Repair-Cafés the same as in Amsterdam, found in almost every district of the city. This concept contributes to waste prevention, longer use phases of the products and provides local communities with a platform for knowledge exchange reinforcing the city as an enabler in achieving set goals.



Malmö, Sweden

The municipality of Malmö provides one example of how the city can act as a consumer. The municipality engages with sharing by incorporating it into its public procurement strategy. An SME called Off2Off offers an online marketplace for public organisations to manage their needs or excess in resources. The platform offers a service that matches the needs of users with functional surplus from within their own organisation or from external actors. This both reduces the organisation's environmental footprint and reduces the purchasing cost of the goods [21].



Berlin and waste prevention

The municipality of Berlin is interested in pursuing strategies to reduce waste. However, interviews with BSR revealed the main obstacle to implementing waste prevention strategies is the waste incineration plants in Berlin are currently operating under capacity and require fuel.

In 2013, the German federal cabinet passed the federal waste prevention programme [22]. The main aim of this programme is to decouple economic growth from the negative environmental and social impacts of waste generation. The German Kreislaufwirtschaftsgesetz (circular economy act): sets targets regarding waste prevention; to present and assess current strategies for waste prevention; and produce recommendations of instruments and measures. Participation in the national programme is not mandatory for federal states, although they will then need to develop an action plan to reach the targets given to them. The federal waste prevention programme analyses different waste-preventing measures on different product lifecycle stages, including approaches touching upon production, product design, retail and use phase. During our interview, the Senate confirmed that, the waste prevention programme is a goal but measures do not yet exist to implement the programme [23].

They also added that new waste management plan with measures will be effective from the next year, putting more emphasis on waste prevention, with a special focus on repair, reuse and separate collection of bio-waste. However, any strategy will continue to compete with the under capacity of Berlin's waste incineration plants.



City of Berlin

Findings in Berlin

To produce the findings in this section, the team conducted interviews with different stakeholders involved in the SE in Berlin, as well as waste prevention public bodies. In addition to individual stakeholder meetings, a workshop was held with interested parties with the goal to discuss opportunities for waste prevention and the potential role of sharing in Berlin, and opportunities for collaboration between the USOs and the municipality.

Sharing Platform Meetings

Interviews were mainly conducted with founding partners of sharing platforms that were selected because they fulfilled USO criteria. The team met with FairLeihen, Frents, Leihbar, Leila and Nebenan.de. Due to the diverse nature of the start-up culture, each platform differed greatly in terms of scale and scope. The following table details the relevant outcomes from those meetings.

Relevant Findings

Lack of financial resources:

Most of the USOs interviewed do not generate revenue, run at break-even, have no employees and are often self-funded or covered by a small transaction fee charged on each exchange. This means these platforms are often run as passion projects on the side of other work communities. This lack of resources also means that money is not allocated to marketing the platforms, making them reliant on word of mouth to grow primarily through word of mouth.

Modest usage rates:

A challenge for USOs growing demand and supply simultaneously for their platform. Moreover, consumers will only engage with the platform regularly if the items they require are online and part of the inventory. Practically, this means that USOs must encourage their users to place their possessions for rent on the platform as well as renting items from the platform. This finding is compounded by the former finding, when there is a lack of resources to promote the online platform.

Link between waste prevention and sharing is weak:

For all USOs, one of the objectives of starting the initiative was to change the consumption habits of USOs by encouraging sharing instead of purchasing new products. However, any environmental benefit of an individual USO is difficult to measure, whether that be in waste prevented or amount of CO₂ mitigated. The USOs believed that environmental benefits are not a tangible value proposition for users. The USOs instead believed individuals were more interested in how convenient it was to access the shared item as well as the social benefits that sharing can provide. However, there was a shared belief that increasing participation levels could have greater potential for environmental benefits.

Sharing in Berlin Workshop

The student team organised an open workshop on SE and waste prevention in which 25 individuals from the SE community in attendance. The group included representatives from environmental groups, USOs, students and local citizens. Past efforts to have Berlin embrace the SE were discussed along with how the city could support sharing organisations moving forward. The findings were collected and presented to the

representatives from the Senate Administration for the Environment, Transport and Climate Protection as recommendations.



Sharing workshop in Supermarkt, Berlin



Recommendations

1. Second-hand warehouse

One area for potential waste diversion is the reestablishment of a second-hand warehouse. Berlin previously had such a space managed by BSR that was closed due to operational challenges however this has been identified across multiple departments in the municipality as something worth reevaluating. Hamburg has demonstrated a successful model that reduces waste and has proven to be profitable. Combining Hamburg's experience with Berlin's large infrastructure of second-hand and social warehouses could be a starting point for developing a new Berlin initiative.

2. Online sharing database

The municipality could benefit from creating an online system for sharing other resources and services among departments. Malmö already has a successful system in place and expertise from this municipality could be tapped to help model and develop a local platform for Berlin.

3. Enabling local initiatives

A common theme among interviews with the urban sharing organisations was a desire for improved communication and exploring opportunities to partner with the city where there was potential to reduce waste. Financial assistance and space were also highlighted as desirable. For the next steps to be successful for all actors, better communication and coordination between local actors and the municipal government to identify areas of collaboration is needed.

Conclusion

This project found the SE in Berlin to be full of active and passionate actors. However, they are underfinanced and would benefit from support of the municipality. The link

between sharing and waste prevention is weak due to lack of empirical evidence. This means that USOs are reluctant to offer waste prevention as a value proposition for users. This report provides a framework for four potential policy strategies for the municipality to engage with the SE. Currently, Berlin is pursuing policies from all four areas of this framework to varying extents. These recommendations will help strengthen existing policy initiatives and provide a clearer strategy for Berlin municipality to engage with the SE.

References

- [1] Business Innovation Observatory - European Commission. (2013). *Business Innovation Observatory - Growth - European Commission*. European Commission. Retrieved 11 April 2017, from http://ec.europa.eu/growth/industry/innovation/business-innovation-observatory_en
- [2] Amt für Statistik Berlin-Brandenburg. (2015). *Die kleine Berlin-Statistik 2015*. Retrieved from https://www.statistik-berlin-brandenburg.de/produkte/kleinstatistik/AP_KleineStatistik_EN_2015_BE.pdf
- [3] Nesta, Accenture & Catapult. (2015). *City Initiatives for Technology, Innovation and Entrepreneurship*. Retrieved from http://citie.org/assets/uploads/2015/04/CITIE_Report_2015.pdf
- [4] Berlin Senate Department for Urban Development and the Environment. (2013). *Municipal Waste Management in Berlin*. Retrieved from http://www.stadtentwicklung.berlin.de/umwelt/abfallwirtschaft/downloads/siedlungsabfall/Abfall_Broschueren_engl.pdf
- [5] European Union. Directive 2008/98/EC on waste (2008). Retrieved from <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008L0098>
- [6] Eurostat. (2017, January 26). *Municipal Waste Statistics*. Retrieved April 17, 2017, from http://ec.europa.eu/eurostat/statistics-explained/index.php/Municipal_waste_statistics
- [7] Sjöström, M & Östblom, G. (2010). Decoupling waste generation from economic growth — A CGE analysis of the Swedish case. *Ecological Economics*. 69, 1545–1552.

- [8] Bachnik, K. (2016). Sustainable Consumption Through the Sharing Economy. *KONSUMPCJA ZRÓWNOWAŻONA STYMULOWANA GOSPODARKĄ WSPÓLNEGO UŻYTKOWANIA.*, (423), 35–44. <https://doi.org/10.15611/pn.2016.423.03>
- [9] PriceWaterhouseCooper. (2016). *Assessing the size and presence of the collaborative economy in Europe*. European Commission.
- [10] Zvolška, L., Lehner, M., Voytenko Palgan, Y., Mont, O. and Plepys, A. (submitted). Urban Sharing in Smart Cities: the cases of Berlin and London. *Local Environment*, Special Issue on Smart Sustainable Cities
- [11] Gavazza, A., Lizzeri, A., & Roketskiy, N. (2014). A Quantitative Analysis of the Used-Car Market. *American Economic Review*, 104(11), 3668-3700. <http://dx.doi.org/10.1257/aer.104.11.3668>
- [12] Rapson, D., & Schiraldi, P. (2013). Internet and the efficiency of decentralized markets: Evidence from automobiles. *Economics Letters*, 121(2), 232-235.
- [13] Cooper, R., and Timmer, V. (2015). *Local Governments and the Sharing Economy: A roadmap helping local governments across North America strategically engage with the sharing economy to foster more sustainable cities*. (1st ed., pp. 1-216). One Earth. Retrieved from http://www.localgovsharingecon.com/uploads/2/1/3/3/21333498/localgovsharingecon_report_full_oct2015.pdf
- [14] Bulkeley, H., & Kern, K. (2006). Local Government and the Governing of Climate Change in Germany and the UK. *Urban Studies*, 43(12), 2237-2259. <http://dx.doi.org/10.1080/00420980600936491>
- [15] Alber, G., & Kern, K. (2008). *Governing Climate Change in Cities: Modes of Urban Climate Governance in Multi-Level Systems*. (1st ed.). Milan: OECD International Conference, Competitive Cities and Climate Change, 2nd Annual Meeting of the OECD Roundtable Strategy for Urban Development.
- [16] shareNL. (2017). *Home. shareNL*. Retrieved 13 April 2017, from <http://www.sharenl.nl>
- [17] van den Eijnden, L. (30 March, 2017). Research Assistant. Interview with shareNL. Skype.
- [18] Nommensen, U. *Teilen, Tauschen, Leihen - Tauschbörsen, Food Sharing, Carsharing: die sharing economy in Hamburg. Hamburg*. Retrieved 11 April 2017, from <http://www.hamburg.de/sharing-economy>
- [19] Stilbruch. (2017). *Stilbruch: Startseite. Stilbruch.de*. Retrieved 11 April 2017, from <http://www.stilbruch.de/>
- [20] Hottgenroth, R. (6 April, 2017). Operations Manager. Interview with Stilbruch-Betriebsgesellschaft mbH. Phone interview.
- [21] Off2off. (2017). *The service - off2off. Off2off*. Retrieved 12 April 2017, from <http://www.off2off.se/en/the-service/>
- [22] Internetseite BMUB. (2017). *Details. Bmub.bund.de*. Retrieved 7 April 2017, from <http://www.bmub.bund.de/service/publikationen/downloads/details/artikel/abfallvermeidungsprogramm>
- [23] Schwilling, T. (2017, 3 April). Representative. Interview with Referat f. Abfallw. In person.

List of people interviewed

- BSR, Herr Söling. 2017.04.03
- Bund für Umwelt und Naturschutz, T. Quast. 2017.04.04
- FairLeihen, Marko Dörre. 2017.04.04
- Frents, Wolf-Ferdinand Mühlhäuser. 2017.04.04
- IÖW, Dr. Gerd Scholl. 2017.04.04
- Leihbar, Andreas Arnold. 2017.04.06
- Leila, Nikolai Wolfert. 2017.04.05
- Nebenan.de, Lena. 2017.04.05
- OuiShare, Thomas Donnerbrink. 2017.04.03
- Referat f. Abfallwirtschaft, Herr Schwilling. 2017.04.03
- shareNL, Lies van den Eijnden. 2017.03.30
- Stilbruch-Betriebsgesellschaft, Roman. 2017.04.06
- SPD, Daniel Buchholz. 2017.04.12

Final Remarks

The world is and will always be complex. Anthropogenic climate change and increasing resource usage are pushing humanity to transform the way it continues to develop. Trends like the growing population and increasing affluence demand more advanced environmental strategies and technologies. In response, the common vision for sustainable development requires multi-sector, inter-generational and cross-cultural collaboration at all levels. Synergistic actions need to be undertaken, encompassing top-down policy instruments and bottom-up changes in behaviour.

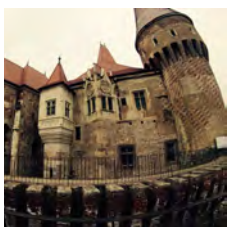
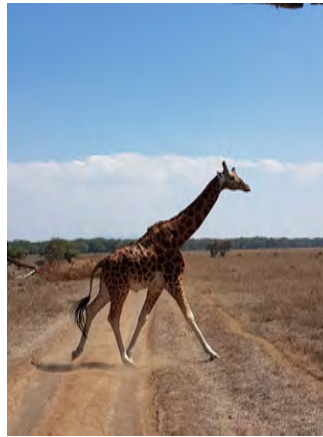
From the global perspective to local practice, a systemic approach to treating environmental issues could be turned into positive opportunities. Despite having their own unique cases, all six SED projects show that adequate institutional capacity building and inclusive engagement measures are the foundation for progress. Improving existing initiatives, expanding current reach and exploring innovative ideas to challenge contemporary norms could be the starting point for building progress. Although the student projects have been completed, the suggestions provided have resulted in feasible directions leading to implementation of each project by the respective clients. Whether it is sectoral issue such as waste prevention and air pollution, or industry cases like resilient agriculture and wineries, integrated work has the potential to be the stepping stone for a focused transition agenda with tangible outcomes.

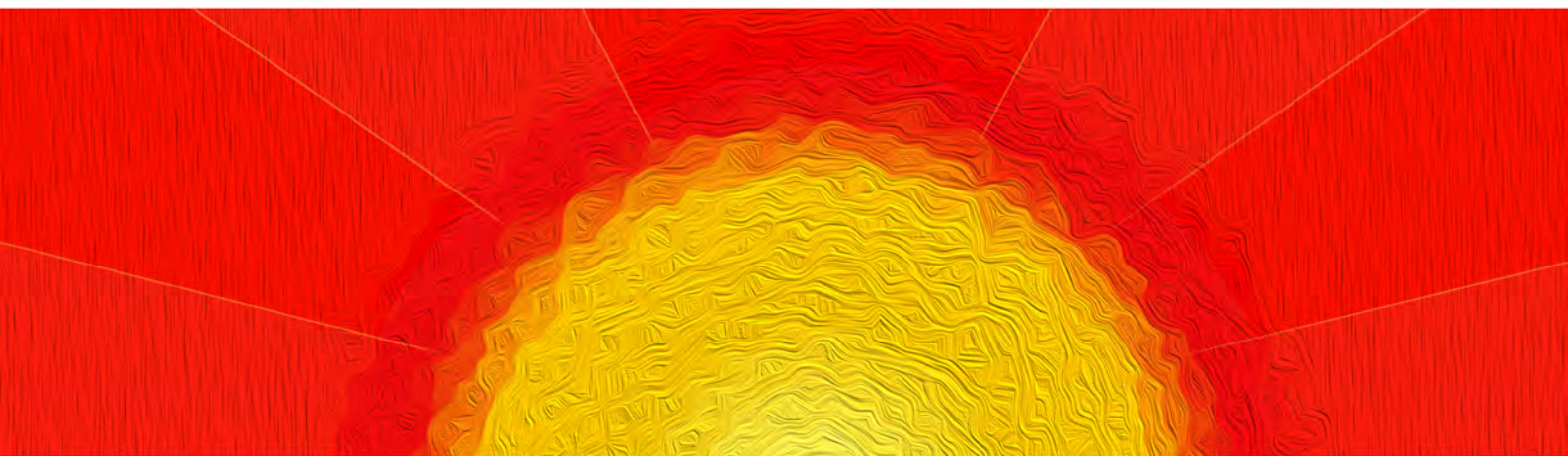
The lessons embedded in this report could contribute to inspiring other stakeholders to create their own smarter, green economy stories. The mission to shift to more sustainable production and consumption patterns would result in a better quality of life for all. Finally, like other tales, the sustainable pathways recommended in this report aim to not only inspire, but also motivate those who read them. And this is just the beginning.



Photo: The Sunshine Batch







iiiee
THE INTERNATIONAL INSTITUTE FOR
INDUSTRIAL ENVIRONMENTAL ECONOMICS

www.iiiee.lu.se
iiiee@iiiee.lu.se

LUND UNIVERSITY

P.O. Box 196, Tegnérplatsen 4
SE-221 00 Lund, Sweden
Tel: +46 46 222 02 00
www.lu.se