

Burch Renewable Energy and Sustainability in Germany and the Netherlands Summary

Burch Programs and Honors Study Abroad

Title of Program: Burch Field Research Seminar: A glimpse into our future? Sustainability in Germany and the Netherlands

Faculty Director: Dr. Gregory Gangi, Institute for the Environment and the Curriculum in Environment and Ecology

Program Location(s): Freiburg, Germany
The Hague and surrounding area, The Netherlands
Ruhrgebiet, Germany
Berlin, Germany

Affiliation(s): Innovation Academy, Freiburg, Germany

Program Duration: 6 weeks

Total Credit Hours: 6 credits

Proposed Courses: HNRS 352 The Future of Energy; Instructor: Dr. Gregory Gangi
HNRS 352 Smart Cities; Instructor: Drs. Ing. Cor Rademaker

Contact Hours: Future of Energy: 74
Smart Cities: 118

Burch Seminar in Germany and the Netherlands

A glimpse into our future? Sustainability in Germany and the Netherlands

Summer 2017

Six weeks (First summer session)

Dr. Gregory Gangi

Institute for the Environment and the Curriculum in Environment and Ecology

And

Drs. Ing. Cor Rademaker

Curriculum in Environment and Ecology

I. Introduction

The world is undergoing the largest wave of urban growth in history. More than half of the world's population now lives in towns and cities, and by 2030 this number will swell to about 5 billion. Much of this urbanization will unfold in Africa and Asia, bringing huge social, economic, and environmental transformations. Intensifying urbanization is not only a phenomenon of developing countries but also of developed countries. For example, many of the larger cities in the Benelux region (like Brussels, Antwerp, Rotterdam, and Amsterdam) are experiencing growth rates at or above 2% on annual basis. To put this into perspective that is a doubling rate of 35 years.

Europe has been a global leader when it comes to developing more sustainable living cities. The goal of this program is to visit a few cities in the large and mid-sized

categories that are considered models of sustainable planning. However, Europe is not only a leader in the area of sustainable planning but also in terms of a new movement called the smart cities movement. Most of the world's so-called smartest cities are found in Europe. We will also explore during this Burch program what makes some of the places we visited recognized smart city leaders.

Smart Cities is an emerging approach to utilize state-of-the-art technologies for the purposes of creating evolutionary impacts on urban economic development and sustainability. Smart cities concepts have six cross-cutting dimensions that lend themselves to be addressed through multi-disciplinary research and development. Based on mobility, economic competitiveness, natural resources, quality of life, social and human capital, and governance, smart cities can harness big data and clean technologies to impact a wide range of concerns: energy and water consumption, air pollution, greenhouse gas emissions, public health, creation of quality jobs, vulnerability to extreme events and social equity. For example, by embedding state-of-the-art technologies in our transportation system, energy grids, and infrastructure, individuals, businesses, and governments can identify trends, anticipate hurdles and opportunities, and respond rapidly with participative decision-making.

The other focus of this program will be on the global energy transition. The current global energy transition is one of the most significant events currently taking place in our world. There are plenty of reasons for both optimism and pessimism when it comes to decarbonizing the global economy.

Renewable energy and energy-efficient technologies are evolving at a rapid rate, and Americans have never been more curious about them. The prices for energy sources like solar and wind have fallen precipitously over the past thirty years and now compete with conventional fuels like coal and nuclear in many markets. Experts also expect the price of energy-storage technologies to scale up during the next decade and become an affordable option for utilities, residential consumers, and industry. Meanwhile, advances in information and communication technologies are giving consumers the power to manage their own consumption in a manner that was unfathomable even a decade ago; electric

cars and self-driven cars promise revolution in the way we get around, and a growing number of credible experts talk of a coming “death spiral” for electric utilities. Hence, it is not an exaggeration to state that Joseph Schumpeter’s idea of “creative destruction” is about to play itself out in dramatic fashion around the issues of electricity. In this program, students will take a deep dive into studying today’s electricity issues.

No country is more interesting to study and learn from than Germany. Germany’s name for their energy transition is the Energiewende. The Energiewende enjoys huge popular support. Even though Germany is a large industrial economy with global exports almost equal to those of the United States it has moved ahead with the transition relatively fearlessly, at least when compared with debates in the US. Germany currently gets a 1/3 of its electricity from renewable sources and this achievement is made more remarkable by the fact that Germany really is not blessed with good resources for hydroelectric power or solar energy. In the United States, the only state with comparatively poor solar potential is Alaska. Germany is also not blessed with exceptional wind resources. When it comes to energy efficiency, Germany is also at a disadvantage because its building stock is very old. In spite of all these obstacles Germany has managed to emerge as a global leader in the energy transition. The large amount of decentralized energy coming onto the grid has caused a number of shifts to occur in the way that the grid is operated from virtual power plants, the creation of a spot market for energy (European Energy Exchange), new grid infrastructure to move large amounts of wind energy from Northern Germany to the industrialized regions of Southern Germany, and the build-out of the country’s pumped hydro storage capacity. Policy makers in Germany even talk about developing an electric grid that is seventy percent renewable before even introducing any significant new amounts of energy storage to the grid. In spite of German insistence that increased capacity in energy storage is not required to reach a grid that consists of much higher amounts of renewables, Germany has started to incentivize the scaling up of electric vehicle usage and production and the development and deployment of new energy storage capacity. Several large subsidies have been passed or are moving towards passage which will provide a huge boost to both the storage and electric vehicle market. Moving the world’s transportation infrastructure towards clean electric vehicles is a

major step in decarbonizing the global economy and it looks as if Germany is going to also play a significant role in this arena.

Finally, the Energiewende has cost Germans a large amount of money but it has had socially beneficial aspects in that it has turned into a type of redistribution scheme that has brought money from urban areas to rural areas and also created a type of energy democracy that has allowed individuals and grassroots co-ops to play a major role in the transition and take away market share in electric generation from the traditional utilities. It has had such a huge impact on the big four utility companies in Germany, that they are all reducing their stake in fossil fuel generating plants, and the largest utility E.ON has completely gotten out of the fossil fuel business. This is happening against a backdrop by which Germany has made a commitment to also get of the nuclear energy business and is moving to do so rather quickly.

The economic damage suffered by the big four utilities under the Energiewende has been compensated for by the large growth in the number of start-up companies. These new companies that have grown up around the Energiewende are on the one hand a direct product of policy choice and the other hand an innovative ecosystem that is very adept at giving rise to new companies and providing strong support for small and mid-sized enterprises (SMEs) SMEs are referred to collectively in Germany as the Mittelstand and the Germany Mittelstand is not only the backbone of the German economy and its export juggernaut but a globally recognized phenomenon that economists from countries around the world have studied. Countries including Japan, France, Korea, and China have tried to implement elements of what they perceive to be the secret sauce of the German Mittelstand. One of our objectives in Germany will be to examine the impact that the Energiewende has had on the German Mittelstand.

The Netherlands has been and continues to lead the world in water management/engineering. Whether it is dealing with sea-level rise, floods, reclamation of new land, no country is more advanced when it comes to the design and development of appropriate infrastructure. In the wake of hurricane Katrina and super storm Sandy, New Orleans and New York have turned to Dutch expertise to help them prepare so they are

more ready for similar events when they happen in the future. We will spend several days while we are in the Netherlands trying to understand some of the key concepts of Dutch water engineering and examining its global relevance.

This proposal is very similar to the Burch Program I led in Germany, Denmark, and Sweden during 2013. The students on that program were divided into students who were more interested in energy and those who were more interest in city planning. The bulk of the students on this former program will graduate this May or graduated last May. All of the “energy” students have landed very good entry jobs in the renewable energy sector. All of these students describe the Burch program as having had a critical impact on their initial job opportunities and subsequent career trajectory. A list of where these students landed is available upon request.

The lessons of the 2013 Burch Program were the inspiration behind the UNC Clean Tech Summit. Hundreds of students have already participated during the past three years. Students have appreciated the opportunity to interact with entrepreneurs, CEOs, and thought leaders in the clean technology sector. It is now in its fourth year and is becoming a place where companies in the clean technology sector come to find talented students for internships and jobs.

II. Academics

The following two courses will be taught for a total of six credits. Syllabi for both courses are attached.

- HNRS 352 The Future of Energy; Class instructor: Dr. Gregory Gangi
- HNRS 352 Smart Cities; Class instructor: Drs. Ing. Cor Rademaker

Academic schedule

The course will begin in Freiburg, Germany. We will spend the first two weeks in Freiburg and then move on to the Hague/Delft region in the Netherlands. We will return to Germany for the final two weeks spending time in the Ruhrgebiet, Hamburg and we will end the program in Berlin.

III. PROGRAM LOGISTICS

a. Program Affiliations

We will be using some existing connections in Germany that were made during the 2013 (German, Denmark and Sweden) Burch and the 2015 (Spain and Germany) Burch, particularly the Innovation Academy in Freiburg, Germany. The Clean Tech Summit has also brought several Germany energy experts to UNC and they have also expressed their willingness to help us open doors in Germany, particularly in the Berlin region.

Logistics in the Netherlands will be taken care of by Cor Rademaker. He lives for ½ the year in The Hague and has been a lecturer in several Dutch Universities and is at the heart of the Smart Cities movement in the Netherlands.

b. Transportation

Students will fly to Berlin, Germany and then use the train for subsequent travel in Europe. We will utilize a rail pass for travel in Germany and also buy a 30 day ticket for transportation in the Freiburg region.

c. Safety

Germany and the Netherlands are highly developed countries, with low crime rates and excellent health care. However, students should take the same precaution they would take while traveling in major cities in the US. We also aim to reduce risk by setting boundaries on extracurricular travel during free days.

d. Medical Care

Advanced health care facilities are easily available throughout the region. Students will be enrolled in HTH and so have coverage for medical issues and networks while in Germany and The Netherlands.

Faculty Director

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Dr. Gangi has taught a variety of experiential learning courses at UNC. He has taken students on summer programs to Siberia, the Galapagos, and the Sierra Nevada. He also ran the Sierra Nevada, three times as a Burch program (2003, 2004 and 2008). Additionally, he teaches a course on coral reef ecology and takes students every spring for a ten-day trip to the Virgin Islands National Park. Hence he feels extremely comfortable leading students on off-campus programs.

As an undergraduate and graduate student he spent a total of three years in Germany. The idea of taking students to Germany to study environmental policy has been something that germinated in his mind for a long time before implementing a similar program to this proposal in 2013. Two colleagues followed up and offered a spinoff in 2015. He has kept the spirit of this program alive at UNC since 2013 through the development of the annual Clean Tech Summit (<http://ie.unc.edu/cleantech/>). He has also taught a version of his “Future of Energy” class as a Maymester class and included field trips across a vast swath of the eastern half of North Carolina to look at innovations in solar, wind, ocean energy, bio-energy and energy efficiency. He is looking forward to teaching as part of this program as he sees an opportunity to apply his diverse background to have an impact in the rapidly developing and evolving field of sustainability.

Other Course Instructors

1) Drs. Ing. Cor Rademaker

Cor Rademaker is the CEO of Strateq, a company he founded over twenty five years ago on sustainable urban research and design. During his career he has accumulated a wide range of experiences working in government, academia, and the private sector. He is an acknowledged international expert in the area of smart cities with thirty years of experience in urban development and associated econometrics, market research, logistics, and planning. Currently he is helping to develop a UNC-based, regional smart cities hub. He lectures on smart city topics at UNC, as well as at several institutions in Europe. Furthermore, Mr. Rademaker is chairman of the national Dutch Strategic Smart City Advisory Board.

VI. Eligibility and Enrollment

The program aims to enroll 12-16 undergraduate students with at least sophomore status and a GPA of 3.0 or higher. No prerequisites are required but ENEC 201 is strongly recommended.

VII) Places we will visit and major activities at each location

Freiburg

- 1) Mobility and urban planning in Freiburg** – we will explore the concept of sustainable mobility and look at past and ongoing projects in the City of Freiburg.
- 2) Green design and architecture in Freiburg** – we will visit some of Freiburg's famous green projects including: Sonnenschiff (a large commercial shopping center that gets a large percentage from renewable energy); Vauben (a district of Freiburg where 5000 inhabitants live, it is considered to be one of the greenest large scale residential-commercial areas in the world); Rieselfeld (another famous green district in Freiburg that was built in an area that was once used for processing the cities sludge); we will also visit some large buildings that show

how passive solar features and photovoltaic production of electricity can be incorporated into the design of even relatively large buildings.

- 3) **Renewable Energy Projects in and around Freiburg-** We will visit various photovoltaic and micro-hydro projects in and around Freiburg.
- 4) **Sustainability and Rural development-** We will examine how rural communities are becoming stronger by producing and exporting renewable energy and by focusing on the production of high value organic products for regional urban markets.
- 5) **Green businesses in Freiburg-** We will visit several businesses that focus on the so-called triple bottom line (The triple bottom line focuses businesses not just on the profits they generate but also on the environmental and social value they add or subtract.) At least one of the businesses we visit will be involved in the renewable energy field.
- 6) **Visit with Mittelstand companies in the Black Forest.** Note that another interesting characteristic of German Mittelstand companies is that they are usually family owned and often located in small towns in rural regions.
- 7) **Schönau** - This is a small town (circa 2500 inhabitants) in the Black Forest that became famous in the nineties for challenging the monopoly of the large utility. The citizens of the town ended up buying their grid from the utility and forming a municipal utility. Then when the German grid became deregulated the Elektrizitätswerke Schönau (name of municipal utility) began to expand. Today it serves over 150,000 households with 100% renewable energy.
- 8) **Visit to Fraunhofer Institute for Solar Energy Systems ISE** – The purpose of this trip is to witness first-hand a key component of the German innovation ecosystem. Fraunhofer institutes across Germany in different fields provide important support for the research of small and mid-sized companies and many new companies spin out of the research done by Fraunhofer Institutes. Fraunhofer Institutes are also closely linked to universities and technical colleges. This

particular Institute is not only one of the leading research locations in the world for solar energy but other areas of research include things related to smart grids and charging station technology for electric vehicles. Approximately 1200 people are employed in this particular Fraunhofer.

- 9) **Visit the Solar Information Center-** At first glance the Solar Information Center seems like a business incubator or accelerator. However, it is very different than a typical accelerator in that the companies that are housed in this building do not necessarily seek to grow and leave the information center. Instead it is a collection of small companies in the renewable energy space that share some common infrastructure. This shared infrastructure includes copy and fax machines, sports and recreational facilities and a cafeteria. The shared space and infrastructure brings people together to foster what they call co-opetition. Co-opetition refers to the idea that sometime companies might be in competition with one another but often these companies will join forces when they have complementary skills to go after large projects. When we visited in 2013 we talked with the owner of a company that had joined forces with a colleague from another company to successfully pursue a large project in Oman.

The Netherlands

The Netherlands is a densely-populated country (1057 p sq. mi.) in a strategic position in Europe, highly urbanized and with two third of the country's surface substantially below sea level. It has become be the 16th economy of the world, while being the 131st place area-wise. On education it is ranked 7th, and in the innovation standard 2015 it was ranked 4th, just behind Switzerland, UK, and Sweden, and just ahead of the US.

Forced by its limited area, dense urbanized population, and being below sea level, the Dutch have become famous for their innovations on agriculture, water management, urban planning, land use, energy and transportation.

In fact, Germany, forced by the closure of all their nuclear plants and aged coal industry, has greatly appreciated Dutch innovations on water and energy to fulfill their energy needs for the future.

The intense agriculture in the Netherlands (being the second largest exporter of agriculture in the world, behind the USA), and especially the greenhouse industry, is a large driver for creative new innovations on sustainable energy, water usage and air/water pollution. The Westland area, located between the major cities Rotterdam and The Hague, is one of the most dense and intensified agriculture areas in the world.

The Netherlands have a long history of urban planning, water management and land use, and wind energy. In fact the old city of Amsterdam, as other cities, have been the result of urban planning and design.

Current urban growth, rising sea level, climate change and river/delta water discharges and flooding have put extreme stress on urban systems worldwide. Due to dense populated high urbanized areas in The Netherlands and based on a long history of urban planning (the old city of Amsterdam is completely planned), water management (God created the earth, the Dutch created the Netherlands) and (wind-) energy these problems have forced the Netherlands to be a pioneer on innovatively countering climate change effects, urban growth, and innovative energy, water and transportation management.

That all came together in the terminology Smart Cities, where the newest technological innovations meet with a well-educated and highly informed urban population creating effective and efficient solutions on today's urban problems, sustaining social and economic urban development.

In our visit to the Netherlands we will focus on the different aspects coming together in a well livable, smart organized city with an overall high quality of life for its inhabitants.

We will learn about how climate change, population growth and increasing need for water quality, flood control and healthy food supplies has been implied in our urban developments in centuries old city centers, in contrast with newly developed cities. We

will see how urban governments stimulate population involvement mixing bottom up approaches with top down regulation.

The cities efforts on becoming smart and resilient cities, with interesting innovative techniques and a whole system approach will show students new ways and insights to be used in their future careers.

The environmental influences by urban systems, the relation between geology, geography, land use and urban impact, and the current effects on climate change, all affects the way the Dutch manage the urban atmosphere, using the latest technical innovations and IT solutions.

Interesting for environmental students is how the Dutch approach to deal with natural hazards and today's climate change has moved from building impressive engineered structures towards an approach of using natural processes to create future resiliency against natural hazards partly caused by climate change effects.

Our trip will include the smart and resilient cities of The Hague (seat of government), Amsterdam (Capital) and Rotterdam (2nd largest harbor city in the world), but also mid-sized university cities as Delft (Technical University Delft, Green city), Groningen (Rijks University Groningen, resilience water and earth quakes), Eindhoven (technical University Eindhoven, voted Europe's most innovative city, home to world leading companies such as Philips and ASML), We will visit the new town of Almere (250,000 inhabitants), new claimed land areas such as Flevoland and older 'polders'. And we will look at the Dutch defense to ocean rise and river hazards, both in a massive engineered approach (Deltawerken, Deltaworks) and a natural approach (sand motor, natural retention basins), old and new dyke systems, The Hague coastal defense, stepwise pumping systems (by windmills, steam and modern powerless structures), an ocean windfarm, energy neutral housing areas, modern urban transportation solutions integrating different modes, urban farms, and visiting the Westland where intensive agriculture has put mind-shifting innovations on energy and water in place. We learn a bit about waste management, turning it into energy, and from an environmental standpoint we will visit 2 very special huge wetlands: the Biesbosch (with a demand for a tidal mix

of ocean and fresh water, reset the way the Dutch were thinking of the Delta works) and the Waddenzee (the world's unique ocean that falls dry at low tide, stretching from Holland all the way to Denmark), the biological richness, the stress by rising sea level and the urge to preserve both this and the 6 islands in the north.

On the way we will look at energy coming by tidal turbines, controlled wind flyers, bio burners, river flows, rainwater and the exchange between salt and fresh water (chemical reactions triggering energy dismissions).

We will have great presentations and classes by the technical University on energy, water, and an organic waste-neutral village currently being built, the green campus, future energy, and by the major cities on their (different) views on Smart and Resilient Cities.

To brighten ideas on entrepreneurship we will visit some buildings and projects that help start-up young entrepreneurs replacing the current office structures. The Dutch cities are struggling with enormous amounts of empty office space. One of the first was the Caballero factory in The Hague, the RDM wharf in Rotterdam, and the Shell office building in Amsterdam.

One of the things that the Netherlands has been pioneering when it comes to smart cities is the integration of top down and bottom up approaches to come up with more effective city planning policies.

APPENDIX: Excursions

The Hague

While we are in the Netherlands, we will rely on The Hague to be our home base. The Netherlands is rather small so most of our destinations will typically involve no more than a 30-minute train ride from The Hague.

The Hague has been an important contributor to modern-day democracy. The roots of democracy go all the way back to 1229 (Binnenhof). In the medieval governmental buildings, one can see the emergence of a federal structure and constitution very much

like what developed later in the USA. The Hague is also home to some first rate museums that contain the greatest quantity of paintings by Rembrandt, Vermeer, Fabricius, Steen, Potter etc.

Places we will visit in the Netherlands:

Smart City Projects:

- Cleantech Delta projects, RDM campus (Rotterdam/Delft area), Green Campus, Green Village (TU Delft)
- Ocean heat used to warm public houses. (The Hague), Greenhouse solutions (The Hague/Westland area)
- Amsterdam Smart City (PPS Amsterdam, Industry), AMS (PPS Amsterdam, Industry, Universities (IE. MIT))
- Construction of Amsterdam metroline, issues with peatland, historic 17th century buildings, floating Central Station.

Energy

- TNO, the leading public research institute on technical innovations, CleanTech also.
- New Energy Coops in many appearances.
- Latest generation windmills (Flevoland)

Transportation

- Transportation facilities, like multimodal hubs (reopened 7 last year after decade of work), Randstadrail, Rotterdam harbor (2nd in the world) and Betuwelijn (Rail freight from Rotterdam to Rhine/Ruhr Metropolitan).
- First bicycle highways paved with solar

Water management

- Sandmotor, a manmade peninsula of sand replenishes the dune structures along the entire coastline in a natural way using ocean currents.

- Deltaworks (Zealand), Roosevelt Academy (Middelburg), Harbour doors Rotterdam.
- Deltares, the world leading water management institute, with Dutch waterworks in scale to test implications
- Flow and tide management systems in the larger rivers, more natural solutions today.
- And off-course some impressive dyke structures...ancient and the latest ones.

Urban food

- Urban Farming exists since the early 20th century, visit some of the new and old ones.

New Economy

- New ways of working together, on creative design of ideas. The Caballero factory, the Red Elephant (former Exxon European HQ), the Bink (all The Hague), RDM wharf Rotterdam, Shell tower, NDSM wharf Amsterdam.

Urban development

- Almere as new town, Amsterdam 16th century urban planning, Rotterdam as newly defined center after WW2, The Hague as independent city, in the republican times and today.

Environmental protection

- Pressure on nature, Expanding Amsterdam closing in on one of Europe's finest wetlands Naardermeer, building transportation tunnel systems under a 23 sq. km nature resort.
- Nature works, visits to Biesbosch (largest salt/sweet water wetland, Wadden (oceanfloor falls dry at low tide, Veluwe (Europe's largest National Nature Park), New Wilderness

RUHR AREA Germany: Facing the End of an industrial era.

We will see revitalized city areas, visit parks on industrial waste, getting acquainted with the areas great public transportation networks. We will visit Germany's main Research Institute on Sustainability and Energy and we will visit Bayer's exhibition on Science for a better life.

In the federal union of Germany Nord-Rhein Westphalia is one of the most important states and includes the RUHR-area. More energy is used and converted in this state than in any other German state.

The RUHR area, along the river Rhine, was and is Germany's highest industrialized area. The area was also the largest mining area (mostly Braun kohl, the kind with the highest fine particles and carbon dioxide pollutants). Industry in this region was very dated and consumed energy in an extremely inefficient manner. The Ruhr area and Rotterdam are closely linked because Rotterdam evolved into the large port city from which the industrial production of the Ruhr area was shipped beyond Europe. Rotterdam was the largest port in the world for more than fifty years. It was just recently surpassed by Shanghai. The area stopped mining around 2000 and shut down the 3 nearby nuclear plants at 2010, but it still has a great demand for energy so this energy demand is being met in new ways.

Coal mining powered Germany's industrial revolution in the 19th century and helped spawn the country's oldest political party, the Social Democrats. Although mining has been in decline for decades here as in other western European countries, successive governments have propped it up with heavy subsidies to preserve jobs and communities.

The Ruhr industrial region that was once crowded with pit heads and the smoking chimney stacks of coking plants and steel mills, has been transforming itself for years, turning power stations into leisure parks, slagheaps into parkland, gas storage tanks into exhibition halls and disused mines into museums.

It is also a very dense and highly urbanized area, with a couple of Germany's largest cities amongst them. The Rhine-Ruhr metropolitan is home to more than 11 million citizen, and includes major cities as Cologne, Dortmund, Bochum, Essen, Duisburg, Monchengladbach, Wuppertal, Leverkusen and Dusseldorf in one major constructed area.

The area is the economic backbone of Germany and is still home to major companies like Thyssen-Krupp and Bayer AG, and major energy companies like E-ON and RWA. But many new and modern companies sprawl through the region, with many young millennial professionals settling in and changing the profiles of the cities.

The demand for energy remained, and it will be interesting to see new green energy initiatives. However E-ON and RWA invest in new energy they still remain exploiting large coal energy plants, in Germany and in the surrounding countries. They have lately done some cosmetic steps to change, they both split the respective companies in a totally green company and in a fossil fuel energy one, under a different name. Both stay however under the same umbrella of a holding.

We will be explore how the Energiewende in the Ruhrgebiet is driven by these 5 principles:

- Measures and steering methods at the local and regional level
- Regional economic development policy
- Networking local and regional infrastructures
- New culture of innovation and living
- Sustainable district development

Places we will visit:

- 1) We will visit the Energie agentur NRW (see: <http://wupperinst.org/en/topics/changing-cities/nrw/>) and learn from their sustainability research for Nord Rhein-Westphalia (The state the Ruhr area is

located). We will learn about the new ways the Area is producing, re-using and store energy, and heat.

- 2) We also will visit Chem Park in Leverkusen to learn about modern industrialization and visit Bayer's exhibition center Science for a better Life Tour (<http://www.bayer.com/en/bayer-lifescience-center.aspx>). While there we will also discuss with an expert from Bayer the system they have developed for accelerating technological innovation.
- 3) We will visit the Ruhr University in Bochum for a lecture on how the region has been able to kick its dependency on coal and come to rely on 50% green energy. We will finish with a tour in the hanging railway of Wuppertal, a prewar solution to traffic congestion.

Hamburg

- 1) Sustainability tour of the city including the Harbor District, which is an internationally recognized model of sustainable development. We will also visit some of the cutting edge buildings and redevelopment projects that were constructed as part of the 2013 International Building Exhibition. Among these famous building is the famous algae house.
- 2) Visit to B.A.U.M - The German Association for Environmental Management has operated under the acronym BAUM since 1984. With its membership of over 500 companies, BAUM is largest corporate network for sustainable economic activity in Europe.

Berlin

Our visit in Berlin will center on energy policy and exploring what is being done in Berlin to create a more innovative environment. Berlin will provide us with a good comparison with Eindhoven. Berlin and Eindhoven are considered to be two of the leading centers of innovation in Europe.

- 1) Visit to Bundestag and hopefully meet with someone associated with the Bundestag to discuss German energy policy.
- 2) Policy visits to the Heinrich Boll Stiftung (a Green Party think tank), and BMWi (Federal Ministry for Economic Affairs and Energy)
- 3) Visit to IASS in Potsdam (the Institute for Advanced Sustainability Studies) <http://www.iass-potsdam.de/en> (brief train ride from Berlin)
- 4) Exploration of the Berliner startup scene. We will examine why a growing number of experts are pointing to Berlin and describing it has an emerging European Silicon Valley.
- 5) Specifically visit with some small clean tech companies in the Berlin region.

VIII) Structure of a typical day:

On a typical day we will leave for our visits at 9:00 AM. Breakfast will be offered at the places where we are staying. Time for lunch will be built into our program. On most days we will return around 3:00 to our home base. At all of the places we are reserving there is meeting space we can utilize. We will then allocate 75 minutes for each class, to discuss our activities and to deliver a mixture of lecture and seminar style discussion. Students will be on their own for dinner during the evening.