CITY IN FOCUS
CHEMNITZ, GERMANY

Potential Analysis of Renewable Energy for Targeted Policy Intervention

SUMMARY

A renewable energy (RE) potential analysis allows local governments to develop plans against a theoretical upper boundary of available RE supply, and enables the formulation of possible development strategies or scenarios for the use of RE sources. A successful example of a local government which undertook RE potential analysis can be found in the city of Chemnitz in Germany. In 2008, the city council developed the *Integrated Climate Protection Programme* (*Integriertes Klimaschutzprogramm*). The first focus area in the programme, Climate Protection, gave rise to a comprehensive analysis of RE potentials in Chemnitz, including photovoltaic (PV) systems, biomass energy, wind energy, landfill gas, geothermal energy, and hydropower. The analysis resulted in a holistic overview of the current state of climate change, future trends, and potentials of energy efficiency (EE) and RE. The analysis has been instrumental in informing on-going policy plans, identifying priority measures and key action areas needed to achieve the RE targets and starting consultation processes with relevant stakeholders.

Figure 1: Chemnitz landscape: a historical and modern city.

INTRODUCTION

A METHODOLOGICAL APPROACH TO IDENTIFY RENEWABLE ENERGY POTENTIAL

Analysing and evaluating the RE potential of a given area enables the formulation of possible development paths or scenarios for the use of RE sources. The information from a RE potential analysis can support a local government in its energy-related development strategy (*e.g.* climate change strategy). The resulting information can be a key part of a wider review of the existing local energy mix, which details the energy's origins and its consumption patterns.

By developing the theoretical RE potential from different sources, an alternative composition of the local energy mix can be envisioned. RE sources can be shortlisted according to various cost-benefit assessments (*e.g.* energy potential, investment costs, social acceptance, availability of technology and skills, policy context, etc.). The implementation can be part of a long-term strategy to phase-in RE. A potential analysis can thus be a key part in developing ambitious, yet achievable, RE targets and related implementation strategies. The information can be an important resource for shortlisting locally applicable policies, programmes and initiatives.

A RE potential analysis stands in contrast to other approaches, which develop RE targets, strategies and policies based upon ambiguous information (*e.g.* RE target estimates, pilot projects) or in response to an identified need (*e.g.* public demand for more RE, energy security concerns, national policy). These often lack comprehensive information of what is actually locally available and feasible. Focusing on the theoretical potential allows developing strategies and plans against a theoretical upper boundary of locally available RE supply. The upper RE boundary can change according to the chosen geographical boundary (*i.e.* local, regional, national, etc.) (see text box on the Freiburg region), which in turn can stimulate co-operation amongst local administrative jurisdictions. Local policy makers can base their vision on the available potential. Should the identified potential be limited or insufficient to meet growing energy demands, greater emphasis should be placed on energy efficiency (EE) and conservation measures to achieve sustainable growth.

CONTEXT

ADDRESSING THE CLIMATE CHANGE CHALLENGE IN CHEMNITZ

CITY IN FOCUS:
Chemnitz
Population
243,000 (2011)
Land area
220 km²

Within the context of national and international climate protection activities, the Chemnitz City Council has been addressing the climate challenge since the early 1990s. Chemnitz introduced the *Urban Energy Concept* in 1993 setting the basis for future planning.

To track the progress within the climate change context, the municipality prepared a *Climate Protection Report* every second year between 2000 and 2007. Chemnitz's continued efforts are illustrated with the city council resolution *BA-08/2007* (from 14 March 2007) which outlines an increase in EE, the use of RE in municipally-owned buildings and the development of a contract model for citizens who take the opportunity to install low cost energy from photovoltaic (PV) on public roofs (2008).

As a result of these efforts, the municipality has already introduced a variety of measures to reduce carbon dioxide (CO_2) emissions by using RE and cogeneration as well as energy conservation (*e.g.* solar water heaters, PV systems, wind turbines, landfill gas capturing facilities and the use of geothermal energy). The local government of Chemnitz has also implemented a network on climate and energy-related issues amongst municipal utility companies, city departments, university and research facilities, the housing association and private initiatives.

DESCRIPTION OF ACTIVITIES

CLIMATE AND ENERGY AGENDA, INTEGRATED IN THE CITY DEVELOPMENT STRATEGY

With the local government's regulatory and organisational developments as well as its increasing experience with EE and RE, the local government of Chemnitz set city-wide energy targets in 2009. The resolution *Städtebauliches Entwicklungskonzept – Chemnitz 2020* (*SEKO*) (*Urban Development Strategy/Concept*) is a city development strategy approved by the city council in November 2009. Prior to its approval, it followed a series of consultations within and between the Planning and Environment Committee and the city council. The drafting followed a complex process of involving different departmental working groups, experts and consultancies, as well as public and expert consultations (see figure 2).

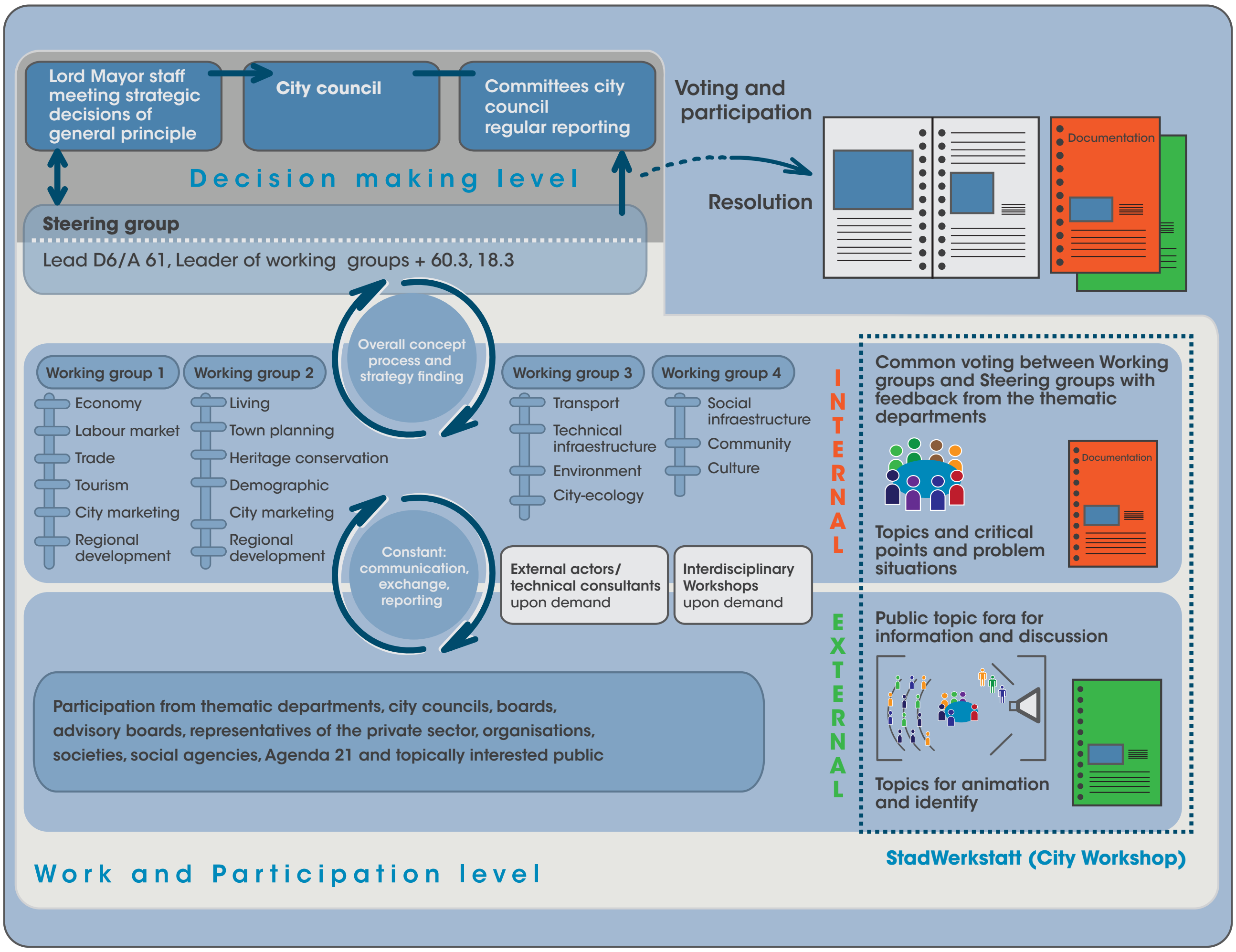
In the chapter *Energy and Climate*, *SEKO* stipulates the following intermediate energy targets:

- » 30% of total electricity generation and 14% of total heat generation should be produced from RE by 2020.
- » EE should be improved by 20% by 2020.

SEKO also aims to improve the heating network through consolidation and re-building. The overall long-term target (without a clear timeline), according to Chemnitz' commitment to the *Klimabündnis* (*Climate Alliance*), is to reduce greenhouse gas (GHG) emissions to a sustainable level. This was identified as 2.5 tonnes CO_2 equivalent (tCO_2e) per capita per year. Currently, it is 7.8 tCO_2e per capita.

Energy and the climate change agenda, a dedicated programme. In 2008, the city council decided with the resolution *BA-02/2008* to develop a climate protection programme. The *Integrated Climate Protection Programme* (*Integriertes Klimaschutzprogramm*) took into account any advocated international and national climate targets, as well as available global and regional climate change science. It was adopted by the city council in December 2012.

Figure 2: Organisation structure of SEKO process



Source: City of Chemnitz citing the Büro für Urbane Projekte, 2008

The *Integrated Climate Protection Programme* addresses three main fields (or focus areas): *climate protection* (climate change mitigation), *climate change* (concerned with climate trends), and *climate impact* (concerned with adaptation). For these fields, different expertise and contributions were brought together including the *Klimaschutz Initiative* (*Climate Protection Initiative*) from the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), C&E Consulting and Engineering GmbH, and Ingenieurgesellschaft für Datenverarbeitung und Umweltschutz mbH (IDU mbH) (Society of Engineers for Data Processing and Environmental Protection), although the Chemnitz Environment Department maintained a leading role.

Climate Protection focused on which GHG emissions could be reduced in Chemnitz. This field examined available data and developed measures to increase EE and RE. *Climate Change* addressed the question of how the climate in Chemnitz would change by analysing trends and preparing projections. Meanwhile, *Climate Impact* explored the potential impact of climate change and available adaptation measures. The preparation of the two latter fields was strongly linked.

Potential and feasibility analysis under the *Climate Protection Programme*. The first focus area in the *Climate Protection Programme*, *Climate Protection*, gave rise to a holistic and comprehensive analysis of RE potentials in Chemnitz. The analysis began in 2009 and was conducted in liaison with the other two fields of the programme (which focused on trends, impacts and adaptation needs) to account for the impacts on energy demand and production, amongst others. This was done in collaboration with a variety of city departments and other data provision sources.

The energy needs of the city were predicted up to 2050, with the aim of planning and effectively managing energy supply. The prediction concluded that climate change, together with other factors (*e.g.* economic growth, improving living standards) will lead to a higher future energy demand, even though heating needs are expected to decrease.

To identify and test the feasibility of reaching the *SEKO* targets, various energy options had to be considered. This was done though a RE potential analysis, including the following RE options: PV systems, biomass energy, wind energy, landfill gas, geothermal energy, and hydropower. The main results of the potential analysis are listed in the following section.

RESULTS

The analysis of RE potentials provided key data to inform and test the on-going policy plans (*SEKO*) as well as to determine key action areas to achieve the RE targets. The main results and strategy for implementation are detailed in the final *Integrated Climate Protection Programme*. The analysis has been instrumental in providing the necessary information for identifying priority measures detailed in the *Integrated Climate Protection Programme*, which was approved by the city council in December 2012. Despite some limitations in the RE options available in Chemnitz, the outlook still shows potential.

Solar energy provides the greatest potential for electricity and heating. Over half of the 30,000 residential roofs are directed towards the south and are therefore ideally placed to collect solar radiation, forming a cumulative suitable area of 1.7 million m^2. To heat the water with solar energy for 60% of the households in Chemnitz would only require 15% of the available suitable roof area. The remaining 1.4 million m^2 roof areas could be used for electricity production using PV. With the current technology (10 m^2/kW peak), a potential of 140 Megawatt (MW) peak is possible, which is comparable to the electricity capacity of the city's largest existing thermal power plant of 195 MW. However, installations need to consider land-use conflicts where there are large area requirements, as well as impacts on landscaping and stability (*e.g.* snow load on building roofs during winter).

The *Solar Atlas* (*Solarfibel*), published by the local government in 2004 for homeowners wishing to know more about solar energy on rooftops, can be used as part of an awareness campaign to provide practical advice to landlords and developers on the suitability of sites, including economic and legal considerations.

Potential of biomass energy not fully exploited. In addition to existing combined heat and power stations, the local energy utility service is interested in building an energy plant to use the approximate 35,000 tonne/year bio-waste, given that green waste is already being collected in the City of Chemnitz. The bio-waste-to-energy potential is about 5 GWh to 6 GWh per year (electric energy), which can be fed to the main grid. Pilot projects for biomass collection systems and combustion already exist, such as plans to increase the percentage of wood chips used in communal heating systems.

Landfill gas fully used with some increases in efficiencies of facilities is possible. In Chemnitz, there are two large landfill sites for municipal waste. Once a landfill site has been closed (accounts indicate that this is already the case for one of the landfill sites in Chemnitz), the amount of methane produced decreases. Therefore, effective landfill gas collection systems and efficient gas engines are needed. The area of the landfill site can also be used for solar energy installations.

Geothermal energy in the form of heat pumps is increasingly used, especially from surface-near groundwater in the city centre. The potential output of the surface-near heat flow in the region of Chemnitz is relatively high, with huge potential to extend this usage. Surface

Table 1: Overview of solar potential in Chemnitz

	Estimated Value	**Unit**
Average annual solar energy production	350	kWh/m²/yr
Available roof area suitable for solar installations in Chemnitz	1,685,626	m²
Maximum theoretical solar energy potential	589,969	MWh
Hot water demand	152,139	MWh
Required solar energy production to cover 60% of hot water demand	91,283	MWh
Roof area requirement to cover 60% of hot water demand	260,809	m²

Source: SEKO 2009

geothermal systems can effectively help heat or cool building temperatures. However, the region of Chemnitz is not within the recommended areas for the deployment of deep geothermal power stations (depth >1000 m) in the State of Saxony.

Wind energy potential is restricted by the specifics of the locality, but extension and modernisation of existing facilities offers potential. The results showed a shortage of sites suitable for wind energy generation. All sites with high potential are affected by one or more negative criteria (topography and wind direction, environmental protection, ecosystem corridors of wildlife (*e.g.* bats), development zones, etc.). In most cases, the proximity of residential buildings or infrastructure prohibits new installations. The most suitable sites are already in use by the existing wind power stations. Potential locations were identified and cited within the context of regional plans, as well as city land-use and development plans.

Figure 3: Chemnitz city center showing many unused roof surface areas

New hydroelectric plants excluded due to high urban flood risks. Hydro power needs to be in compliance with the legal framework (*e.g.* fishery, nature and soil protection, landscaping, recreational areas, impact of damned water on ecology) and should take into account the high urban flood risk. Given the high flood risk, this was not an option in Chemnitz.

Long-term impact of acquired knowledge. The RE potential analysis and draft of the *Integrated Climate Protection Programme* was completed in 2011. The local government of Chemnitz, led by its Environment Department, presented the draft for public hearing in the first half of 2012 and it was approved in December 2012. The final *Integrated Climate Protection Programme* provides the necessary specification of the targets set out in the *SEKO*. It will be used to discuss how to realise all necessary measures to achieve the emission target of 2.5 tCO_2 per person per annum. Conclusions and decisions reached in the *Integrated Climate Protection Programme* are likely to lead to revisions in the city development strategy.

Planned local government actions. The *Integrated Climate Protection Programme* sets out a number of local government actions, including:

- Consistent alignment of the city development plan with the climate protection goals.
- Maintenaining and strengthening the compact city structure as a basis for EE.
- Securing resources for RE, in particular solar, wind and biomass including bio-waste.
- Increasing EE and a gradual transition to RE with all local government constructions and renovations.
- Supporting a systematic change toward climate friendly mobility.
- Consistent use of sustainable and climate friendly produced goods.

» Gradual transition to RE and reduction in energy consumption in accordance with the guidelines provided by the Advisory Council on Environment (Sachverständigenrates für Umweltfragen).

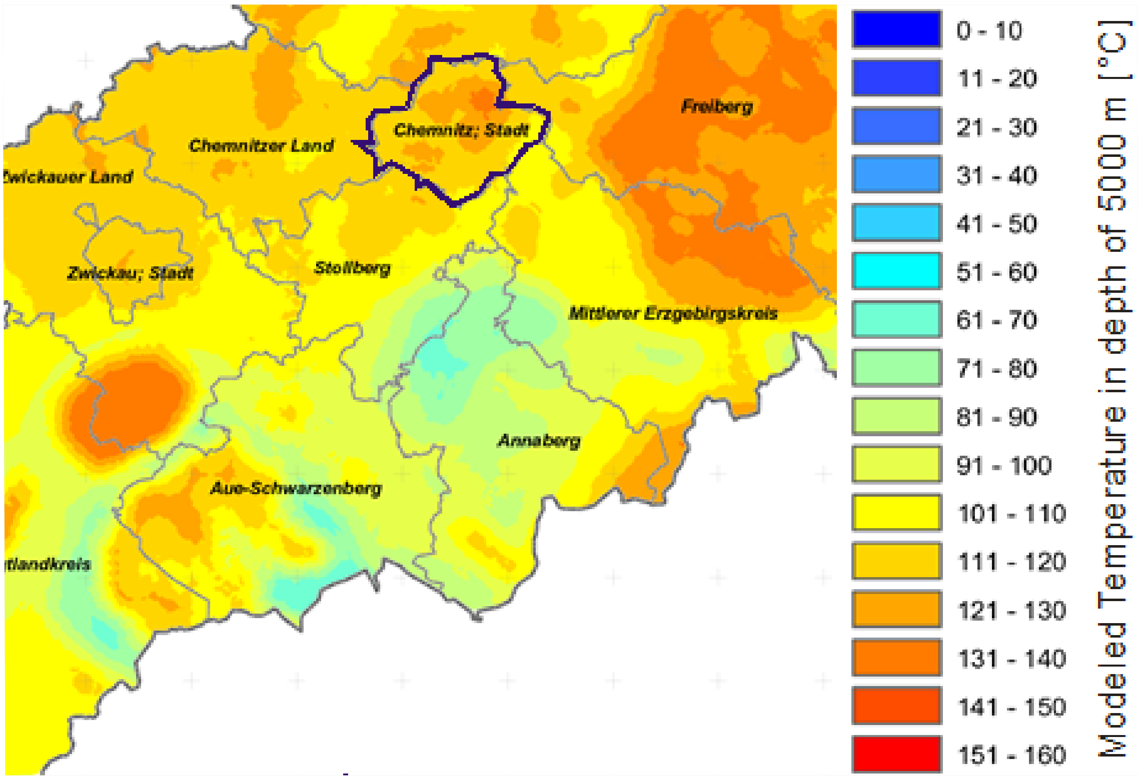
LESSONS LEARNT FOR REPLICATION

Potential Programme as part of a bigger picture. During the development of the *Integrated Climate Protection Campaign*, a complex process was put in place to include and assess all relevant information; especially those related to the *SEKO* that directly impact the energy agenda. The Environment Department worked closely with other relevant departments and the climate change agenda was a key driving force behind the process. The result is a holistic and comprehensive overview of the current state of climate change, future trends, and potentials of EE and RE. This allowed the local government to discuss key actions with relevant stakeholders and to set up consultation processes.

Implementing potential is dependent upon local support. Political decisions should be made in such a way that these are supported by citizens, and tailored for the community. Potentials have to be matched by tools and policies that allow for their realisation. A working group, with its own funds and organisational structures, which reports directly to the mayor and collaborates with all departments, and is managed by the Environment Department, could be an option, as was the case in Chemnitz. This also gives the possibility of raising awareness to inform and acquire broader local support.

Every city is unique. One city's potential and feasibility analysis cannot be simply transferred to another city. Each community's current status and outlook can be very different, as can local legislation and regulations, the history of urban energy and climate projects, existing initiatives and technologies. In addition, the geographic and environmental conditions vis-a-vis the urban fabric are always unique. Variations in climate conditions, historic infrastructure, building stock, level of affluence, culture, population density, rate of urbanisation, transport modes, hinterland characteristics and geographical size are some of the parameters that make every community unique. Strategies need to account for the opportunities and challenges that come along with these unique conditions.

Figure 4: Deep geothermal energy analysis for the state of Saxony and area around Chemnitz.



Source: C&E GmbH (2005)

Region Of Freiburg, Germany (Population 0.6 Million)

In the region around Freiburg, a 222,000 ha area was considered to assess whether a regional 100% RE target could be achieved using the potentials of wind, hydro, solar, geothermal, biomass, wood and energy conservation. The analysis concluded that the region as a whole could meet a 100% target, if at least a 50% reduction in energy consumption could be achieved. It was discovered that rural districts can achieve a 100% target, while the City of Freiburg is dependent upon the imports of RE. The greatest potentials were identified in wind and PV for electricity, and biomass and solar thermal for heat production. Wood, as a result of the large surrounding forests, offered a particularly attractive economic opportunity. The potential analysis concluded that individuals and companies have to act in unison, with a region-wide strategy and would need to put strategies in place to explore financial investments.

Source: Energieagentur Regio Freiburg (2012)

Further readings:

See additional relevant case studies at www.iclei.org/casestudies

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For further information or for provision of feedback, please contact Dr. Rabia Ferroukhi, IRENA, Policy Advisory Services and Capacity Building Directorate (PACB), C67 Office Building, Khalidiyah Street, P.O.Box 236, Abu Dhabi, United Arab Emirates; Email: RFerroukhi@irena.org. ICLEI contact details: urban.research@iclei.org.
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