Analysis of goals and KPIs in design projects

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PI-SEC

Planning Instruments for Smart Energy Communities

Forord og sammendrag

PI-SEC er et norsk forskningsprosjekt som varer fra april 2016 til mars 2019. Prosjektet er finansiert av Norges forskningsråd. PI-SEC står for "Planning Instruments for Smart Energy Communities", og prosjektet har som mål å utvikle effektive planleggingsinstrumenter for integrering av energispørsmål på områdenivå. Prosjektet vil øke kunnskapen rundt hvilke parametere som er viktige for byer med fokus på smart og bærekraftig energi, samt hvordan disse kan kobles med planlegging, drift og monitorering av nye og eksisterende områder. Forskningspartnerne er NTNU og SINTEF Byggforsk, i samarbeid med Bergen og Oslo kommune og partnerne Standard Norge, FutureBuilt og Norwegian Green Building Council. Bydelene Ådland i Bergen og Furuset i Oslo er pilotområder i prosjektet.

Prosjektet er delt inn i to arbeidspakker (WP), hvor WP1 tar utgangspunkt i utviklingsprosjekter (*bottom-up*), mens WP2 tar utgangspunkt i kommuneplanlegging (*top-down*). Det er videre 4 aktiviteter i hver av arbeidspakkene (tasks).

Denne rapporten er et resultat av den første aktiviteten i WP1; Task 1.1. Målet med rapporten er å samle, strukturere og analysere mål og indikatorer i utviklingsprosjekter; Både internasjonalt samt i pilotområdene Ådland og Furuset. Oversikten i denne rapporten er ment som et utgangspunkt for videre arbeid i prosjektet, hvor nye mål og indikatorer vil foreslås og testes. Resultatene fra Task 2.1 i WP2 beskrives i en parallell rapport, med fokus på å analysere kommunale planleggingsinstrumenter.

Kapittel 2 er en gjennomgang av relevante norske og internasjonale prosjekter. Kapittelet inkluderer en definisjon av smarte byer samt energismarte områder. Videre er det listet en rekke prosjekter som fokuserer på lignende tematikk, samt valgte nøkkelindikatorer (KPIs) i disse prosjektene. Ulike typer indikatorer er beskrevet, og hvordan indikatorene ideelt sett bør være relevante, komplette, tilgjengelige, målbare, pålitelige, forståelige, uavhengige og selvstendige.
Kapittelet oppsummerer indikatorer som blir brukt i andre prosjekter, sortert under relevante temaer som for eksempel energiforbruk, energiproduksjon, CO_2-utslipp og grønn mobilitet. Indikatorer kan listes på ulike nivåer, og eksempler på dette er vist. Også noen få eksempler på ulike verktøy er inkludert, for energiplanlegging på områdenivå.

Kapittel 3 gir en introduksjon til pilotområdene i PI SEC. Pilotområdene Furuset og Ådland er forskjellige på mange måter, men representerer begge norske områder med ambisiøse energi- og klimamål. Dersom det utvikles metoder relevant for disse to pilotområdene så vil disse metodene trolig også kunne benyttes ved utviklingen av en rekke andre områder i Norge.
Kapittelet beskriver videre hvordan rammeverket relevant for energismarte områder er på ulike skalaer, fra land til byer, nabolag til bygg. De generelle nasjonale instrumentene beskrives også i dette kapittelet, fordelt på de ulike skalaene, som for eksempel lovverk, sertifiseringer og støtteordninger. Til slutt inkluderes informasjon relevant for den praktiske implementeringen av ulike indikatorer, og endel tilgjengelige informasjonskilder oppsummeres.

Kapittel 4 er en gjennomgang av pilotområdet Ådland ved Bergen, mens Kapittel 5 er en gjennomgang av pilotområdet Furuset i Oslo. Kapitlene gir en introduksjon til planene og ambisjonene for området. Målet for Ådland er å gjennom året oppnå null utslipp relatert til drift av byggene. Furuset er et forbildeprosjekt i Futurebuilt, med mål om å halvere CO_2-utslippene i området. Videre gir kapitlene en oversikt over det identifiserte rammeverket på ulike skalaer, relevant for områdeutviklingen. Mål og indikatorer for Bergen og Oslo kommune beskrives. Til slutt oppsummeres noen tanker rundt barrierer, lærdommer og gode praksiser.

Kapittel 6 oppsummerer målet med rapporten for Task 1.1, som sammen med rapporten for Task 2.1 er et grunnlag for PI SEC prosjektet videre. I kapittelet listes en del momenter som vil være relevante ved videre valg og testing av mål og indikatorer i Task 1.2. Denne rapporten vil også være grunnlag for Task 2.2, hvor det vil samles erfaringer fra andre prosjekter med lignende mål, utfordringer og drivere.

Summary

"Planning Instruments for Smart Energy Communities" (PI SEC) is a Norwegian research project lasting from April 2016 to March 2019. The project is funded by the Research Council of Norway. The project aims to develop effective planning tools for the integration of energy issues at the property level. The project will increase knowledge about parameters important for cities with a focus on smart and sustainable energy, as well as how these can be connected with the planning, operation and monitoring of new and existing areas. Research partners are NTNU and SINTEF in collaboration with Bergen and Oslo and the partners Standard Norway, FutureBuilt and Norwegian Green Building Council. The districts Ådland in Bergen and Furuset in Oslo are case studies in the project.

The project is divided into two work packages (WPs), where WP1 has a bottom-up approach from building development, while WP2 has a top-down approach from municipal planning. There are four tasks in each work package.

This report is the result of the first task in WP1 (Task 1.1). The aim of the report is to collect, structure and analyze targets and indicators in development projects; Both internationally and in the case studies Ådland and Furuset. The report is intended as a basis for further work in the project, where new targets and indicators will be proposed and tested. The results of Task 2.1 of WP2 is described in a parallel report, focusing on analyzing municipal planning instruments.

Chapter 2 is a review of relevant Norwegian and international projects. The chapter includes a definition of Smart cities and Smart energy cities. Further, a number of projects with focus on similar themes are listed, as well as selected key performance indicators (KPIs) in these projects. Different types of indicators are described, and how the indicators should ideally be relevant, complete, available, measurable, reliable, familiare, non-redundant and independent.
The chapter summarizes indicators used in other projects, sorted under relevant themes such as energy consumption, energy production, CO_2 emissions and green mobility. Indicators can be listed on different levels, and examples are shown. Also a few examples of different tools are provided, for energy planning at district level.

Chapter 3 provides an introduction to the case studies in PI SEC. The case studies Furuset and Ådland are different in many ways, but represent both Norwegian areas with ambitious energy and climate goals. If developing methods relevant for both these two case studies, these methods will probably also be relevant for the development of a number of other areas in Norway.
The chapter describes how the framework relevant to smart energy cities are on different scales, from country to cities, neighborhoods and buildings. The overall national framework and instruments are also described in this chapter, such as legislation, certifications, and support. Finally, information relevant for the practical implementation of various indicators are included, and available sources for further information are listed.

Chapter 4 is a review of the case study Ådland near Bergen, while Chapter 5 is a review of the case study Furuset in Oslo. The chapters provide an introduction to the plans and ambitions for the areas. The aim in Ådland is to achieve zero emissions related to the operation of buildings through the year. Furuset is a model project in FutureBuilt, with the goal to reduce CO_2 emissions in the district with 50%. The chapters give an overview of the identified framework at different scales, relevant for area development in the case studies. Targets and indicators for Bergen and Oslo Municipality are described. Finally, some thoughts around barriers, lessons learned and good practices are summarized.

Chapter 6 repeats the purpose of this 1.1-report, which together with the 2.1-report is a basis for further work in the PI SEC project. Some elements are listed, relevant for the further selection and testing of targets and indicators in Task 1.2. This report will also be the basis for Task 2.2, which will gather experience from other projects with similar goals, challenges and drivers.

English - Norwegian dictionary

In the report, the following translations are used [1]:

English	*Norwegian*
Building applications	Byggesak
Central government land-use plan	Statlig arealplan
Cities of the Future	Fremtidens byer
County master plan	Fylkesplan
District	Fylkeskommune
Energy frame requirements	Energirammekrav
Municipal master plan	Kommuneplan
Plan for land use	Arealplan
Planning and Building Act	Plan og bygningsloven
Prosumers	Plusskunder
Regional master plan	Regional plan
Regulations on technical requirements for building works	TEK / Byggteknisk forskrift
Smart Energy Communities	Energismarte områder
Urban Environment Agreement	Bymiljøavtale
Waterborne heating / cooling	Vannbåren varme/kjøling
White paper on energy policy towards 2030	Energimeldingen
Zoning plan	Reguleringsplan

[1] A general English-Norwegian termlist for the Planning and Building Act is available on https://www.regjeringen.no/no/tema/plan-bygg-og-eiendom/plan--og-bygningsloven/plan/veiledning-om-planlegging/Bokmal-nynorsk-ordliste/ordliste-norsk-engelsk--plan--og-bygning/id462717/

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1. Introduction

Introduksjon – En kort oppsummering av kapittelet

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1.1. About the research project PI-SEC

PI-SEC is a Norwegian research project, lasting from April 2016 to March 2019. The project is funded by the Research Council of Norway.

PI-SEC will deliver efficient planning instruments for integrated energy design at the neighbourhood scale, qualified for Norwegian planning context in cooperation with public stakeholders. The project will provide increased knowledge about what parameters are essential for moving towards smart and sustainable energy use in Norwegian cities and how these can be linked to the planning, operation and monitoring of new or existing neighbourhoods.

The research partners are the Norwegian University of Science and Technology (NTNU) (Project manager and WP2 leader) and SINTEF (WP1 leader), in close cooperation with the municipalities Bergen and Oslo as well as the partners Standard Norge, FutureBuilt and the Norwegian Green Building Council. The project has a European reference group of central institutes and municipality representatives from the European Innovation Platform on Smart Cities and Communities as well as the EERA Joint Programme Smart Cities. Moreover, the project partners participate in IEA ECB Annex 63[2], including also non-European partners such as China and South-Korea.

The main target groups of the project are urban decision makers, municipal planning departments and other stakeholders that are developing targets, criteria, roadmaps and tools for sustainable energy use in Norwegian communities.

[2] International Energy Agency, Energy in Building and Community Systems, Annex 63: "Implementation of Energy Strategies in Communities", project period 2013-2017, Objective to develop recommendations for effective translation of a city's energy and GHG reduction goals to the community scale, develop policy instruments, and models for cooperation and business.

PI-SEC addresses the thematic priority area *Smart Cities and Communities* and the challenge of developing effective planning instruments to improve the energy performance of built environments, and monitor corresponding progress made over time.

The originality of the project lies in the coupling of planning instruments on *different scales* (i.e. building, neighbourhood and city) applying a *multi-disciplinary* approach including *case studies*. The project applies a multidisciplinary approach by analysing ambitious case study projects both from a bottom-up viewpoint (developers and designers) and a top down viewpoint (municipalities). To avoid sub-optimization and ensure that overall goals are met, the planning instruments will be interrelated in a way that makes it possible to transfer and aggregate information from building level, to neighbourhood, city, regional and national levels, and vice versa (see Figure 1.1).

The knowledge developed in PI-SEC will be a catalyst for achieving long-term political goals for reductions in energy use and greenhouse gas emissions (GHG emissions), use of local renewable energy sources, and security of supply. Having specific, agreed upon goals and key performance indicators (KPIs) is important for development of new smart energy services and products by and for the construction industry, as well as for shaping policy and legislation for sustainable development of built environments. This knowledge will also be a basis for standardization, certification and regulations.

Country level ↓ ↑	Energy use per capita, Energy use per unit of GDP, Reserves-to-production ratio, Non-carbon energy share in energy and electricity, Net energy import dependency, Percentage of income spent on energy, Storage capacity, Security of supply, etc.
City level ↓ ↑	Total residential electrical energy use per capita, Energy consumption of public buildings, Percentage from renewables of total energy use, Impact on the electricity network, Air pollution, Charging networks, Intelligent transport systems, Average commuting times, Value of fuel savings, etc.
Neighbourhood level ↓ ↑	Reductions in CO_2-emissions, Life Cycle Costs, Air pollution, Import and export of energy, kWh/m^2 per hours of occupancy, CO_2/travel km, Distance to public transport nodes, Frequency of public transport, Cycling networks, Integration of RES, Intelligent transport facilities, etc.
Building level	Energy demand in kWh/m^2 floor area, Delivered and primary energy in kWh/m^2 floor area, Power demand, CO_2-emissions from materials, construction and operation, Life cycle energy costs, Load match/grid interaction indicators, User interaction, etc.

Figure 1.1 Examples of key performance indicators (KPIs) used at different levels
Note 1: District level and regional/international levels are not included in the figure, for simplicity reasons.
Note 2: The figure only presents examples of typical indicators used at different levels, collected from different sources[3], and is not meant to be a complete list of indicators.

[3] Sources: www.concerto.eu; www.civitas.eu; www.rfsc.eu; www.cityprotocol.org; www.breeam.org; www.usgbc.org www.pub.iaea.org/MTCD/publications/PDF/Pub1222_web.pdf; www.covenantofmayors.eu; www.morgenstadt.de; www.siemens.com/entry/cc/en/greencityindex.htm; ec.europa.eu/regional_policy/en/policy/themes/urban-development

1.2. Main challenges addressed and the project work packages

PI-SEC addresses two main challenges towards smart energy communities:

- Cross-scale indicators for setting goals and measuring progress
- Implementation and integration of these indicators in planning instruments

1) Cross-scale indicators

Smart energy communities require decentralized energy generation with buildings as interactive nodes of larger networks of energy exchange with other buildings and the utility grid; interactions between mobility and energy systems; and enhanced localization and land use planning for smart energy and mobility. However, there is no set of energy indicators that links lower level (buildings, neighbourhoods) to higher level (city, region) indicators. There is insufficient knowledge on how indicators contribute to overall goals of smart sustainable energy use, and how indicators on the different levels are or could be interlinked. There are unsolved questions related to how to set system boundaries for calculating, measuring and aggregating energy credits and GHG emissions with respect to time. Cross-scale indicator sets would help avoid sub-optimization, aid aggregation of results, and improve measurement accuracy at higher levels.

In Norway, most R&D, incentives, standards and regulations on energy efficiency of the built environment have so far emphasised individual buildings. The building code sets requirements with respect to maximum energy demand per m^2 of floor area and minimum requirements regarding renewable energy use. In 2012, the Energy Performance Labelling system was introduced, including benchmarks for delivered energy to buildings. Also, new voluntary standards for low energy and passive house buildings have been introduced. In 2012, the Norwegian Green Building Council introduced *BREEAM-NOR* for new buildings and major renovations, including criteria for energy efficiency, low carbon energy supply, and GHG emissions of materials. The *Research Centre on Zero Emission Building*, *ZEB*, (www.zeb.no) and the *FutureBuilt Program* (www.futurebuilt.no) are currently realising several pilot building projects. These projects have high ambitions with respect to reducing GHG emissions from buildings. On the neighbourhood and district levels, *the Norwegian Green Building Council* is currently adapting *BREEAM Communities* to the Norwegian market, and the international version is being tested in a few pilot projects. On the city level, the national program *Fremtidens byer* (*Cities of the Future*), has developed a set of criteria for pilot projects (Ministry of Environment 2013). The Smart Cities and Communities concept has only recently been introduced in Norway, and has mainly been used by municipalities, electronics and IT-companies. However, overall, there are few and vague common definitions of Smart Cities and Communities, and corresponding energy-related KPIs are not very detailed.

A wide range of European and international research, demonstration and innovation projects deal with smart and sustainable energy use at neighbourhood, city and country scales[4], several with participation by NTNU and SINTEF. The experiences from these projects have not yet been transferred to Norwegian planning practices.

2) Planning instruments for smart energy communities

Smart energy communities require a framework that integrates technical, spatial, regulatory, organisational and socio-economic dimensions, and that is flexible enough to continuously adapt to changing environments to avoid time delays and increased costs (DG IPOL, 2014). There is little empirical evidence to support how working with smart energy communities can be embedded in daily municipal practice, and how the choice of the appropriate indicators can improve overall performances in short and long terms. There are many demonstration projects on (near) zero emission/energy

[4] www.concerto.eu ; www.covenantofmayors.eu; www.civitas.eu ; www.rfsc.eu; www.cityprotocol.org; www-pub.iaea.org/MTCD/publications/PDF/Pub1222_web.pdf; www.siemens.com/entry/cc/en/greencityindex.htm; ec.europa.eu/regional_policy/activity/urban/audit/index_en.cfm

buildings and neighbourhoods, documented for example in the CONCERTO programme[5] and more recent commitments in the European Innovation Platform on Smart Cities and Communities[6], but little evidence to support how a municipality can learn from isolated urban innovations to large-scale, replicable solutions that support a low-carbon transition. A study of Norwegian low energy projects at neighbourhood scale shows they often were the result of specific drivers, persons in the organisation that push a project across departments and shifting project phases and constellations (Narvestad, 2010); this was also the case in the Brøset project (Støa et al., 2014). In the framework of European project Near Zero Energy Neighbourhoods[7], a comparative study between Norway and Sweden indicated that lessons from (renovation) projects are not being transferred into policy decision making processes; in cases where this does happen, early communication, dialogue and information are indicated to be success factors for validation of targets, as well as reference to similar project examples, and follow up after project completion by means of workshops and training (Karlsson and Lindkvist, 2013).

The concept of "smart buildings" is not commonly used in Norway, but has been explored in some research projects by NTNU and SINTEF, e.g. the *Smartbuild* project (Andresen et al., 2007) and the *Intelligent Facade* project (Aschehoug et al., 2005). Here, "smartness" was explored and defined in several ways, including focus on intelligent control systems and building components reacting to users and the environment while optimizing energy performance, and use of intelligence in design processes with cross-disciplinary knowledge. Smart concepts for district and city scales have only recently started to be explored in Norway, for example in Stavanger's *Triangulum*[8] or Trondheim's *Carbon Track and Trace*[9], both European funded projects. PI-SEC includes cooperation with Standards Norway which leads national activities related to European and international standardization work on indicators for sustainable development of buildings and communities, i.e. *ISO/TEC 268 Sustainable development in communities*[10]. NTNU and SINTEF have leading roles in the *EERA Joint Program Smart Cities*[11] (led by Austrian Institute of Technology) in developing KPIs and monitoring methods for comprehensive energy strategies for cities, in cooperation with researchers (KPI Task Force and Symposium[12]) and municipalities (City Advisory Board). The FP7 project cluster *My Smart City District*[13] deals with stationary energy at neighbourhood scale, amongst others with project *ZenN-Nearly Zero Energy Neighbourhoods* aiming to demonstrate the feasibility (technical, financial and social) of innovative low energy renovation processes for buildings at neighbourhood scale. In the *Morgenstadt Initiative*[14], the German Fraunhofer Institute has collected and developed indicator sets for energy, buildings, mobility, water, security, ICT, production and logistics, and governance in 6 cities worldwide. The energy indicator set includes 10 separate indicators ranging from total energy demand to share of renewable energy sources. Phase 2 of the project (currently ongoing) is focusing on how cities can establish new fields of action and new business models for sustainable development together with industry. Other important links include IEA Annex 63[15], the Danish CITIES[16] programme led by DTU, and the European CITYKEYS project[17] led by VTT.

[5] http://concerto.eu/concerto/concerto-sites-a-projects.html
[6] EIP SCC, https://eu-smartcities.eu/sustainable-districts-and-built-environment
[7] FP7 ZenN, http://www.zenn-fp7.eu
[8] Funded by the Horizon2020, SCC1, http://www.triangulum-project.eu/
[9] Funded by the Climate-KIC LoCaL programme, http://www.climate-kic.org/programmes/low-carbon-city-lab
[10] www.iso.org/iso/iso_technical_committee?commid=656906
[11] http://www.eera-sc.eu; http://setis.ec.europa.eu/energy-research/content/eera-jp-smart-cities-establishes-city-advisory-board
[12] EIP SCC, Commitment 7579, https://eu-smartcities.eu/commitment/7579
[13] www.zenn-fp7.eu; http://eu-gugle.eu; http://r2cities.eu/
[14] www.morgenstadt.de
[15] http://www.iea-ebc.org/projects/ongoing-projects/ebc-annex-63/
[16] http://smart-cities-centre.org/
[17] http://www.eurocities.eu/eurocities/news/CITYKEYS-new-smart-cities-project-WSPO-9RUMZU

The work will be organized in 2 work packages that address the 2 main challenges described above:

- Work Package 1: Cross Scale Indicators in Project Planning
- Work Package 2: Planning Instruments for Municipalities

Work Package 1 will take a "bottom-up" approach focusing on the goals and indicators used in the planning and design of buildings and neighbourhood development projects. Work Package 2 will take a "top-down" approach focusing on how the municipalities should design their planning instruments to facilitate the move towards smart energy communities. Together, they will answer the following main research question:

Which targets and KPIs are essential for smart and sustainable energy use in Norwegian cities and how can these be linked to the planning, operation and monitoring of new or renewed neighbourhoods?

The main means to answer this research question will be the analysis of specific case studies in the two largest Norwegian cities (Figure 2). The case study projects have been pre-selected in cooperation with the project stakeholders. They are large (in Norwegian context) ongoing development projects with ambitious goals with respect to energy performance and related Green House Gas (GHG) emissions. Also, the researchers from NTNU and SINTEF are already involved in the planning of these projects, which will facilitate access to information.

Project name and location	**Energy/ environmental goals**	**Type and size of development**	**Time frame**	**Special issues**
Ådland, Bergen	Zero GHG emissions for area, www.zeb.no	600 dwellings and a community centre	2015-2020	Local renewable energy and electro- mobility
Furuset, Oslo	Climate neutral district centre, www.futurebuilt.no	Suburb from 1970's with 9500 inhabitants	2010-2020	Energy strategy plan and GHG accounting analysis

Figure 2: *Case studies in PI-SEC*

The other mainstream methodology in PI-SEC will be interdisciplinary workshops between the researchers, international experts, and professionals from the municipalities and stakeholders in the case study projects:

- National workshops with the representatives from the municipalities and other organizations participating in the project. This will include a kick-off workshop to further specify sub-goals and distribution of work, and 3-4 workshops per year exchanging project results, knowledge and experiences between the researchers and members of the national resource group.
- European workshops in the City Advisory Board (municipal representatives) of EERA Joint Programme Smart Cities, to promote alignment and feedback of Norwegian results with European progress.
- International workshops within *IEA ECB Annex 63: Implementation of Energy Strategies in Communities.*

Each of the main research tasks will be divided into 4 subtasks to answer more specific sub-questions related to the overall research question:

WP 1: **Cross Scale Indicators in Project Planning**	**Task 1.1** Analysis of goals and KPIs in design projects (DP)	**Task 1.2** Preliminary toolkit of goals and KPIs in DP	**Task 1.3** Testing of toolkit in case studies Focus: Project planning	**Task 1.4** Final toolkit and guidelines for design projects
	⬍	⬍	⬍	⬍
WP 2: **Planning Instruments for Municipalities**	**Task 2.1** Analysis of municipality planning instruments (PI)	**Task 2.2** Preliminary toolkit of municipality PI	**Task 2.3** Testing of toolkit in case studies Focus: Municipality practice	**Task 2.4** Final toolkit and guidelines for municipality practices

Figure 3. *Illustration of the work packages and related tasks and work flows.*

1.3. Focus of this report

This report present the results from Task 1.1 and there is a parallel report presenting the results from Task 2.1. The forthcoming paragraphs describes the initial research questions and details for these two subtasks. Also subtasks 1.2 and 2.2 are briefly described, as these are a follow-ups of the initial reports. Information about the later subtasks are available from the project team.

Research Question 1: *What are the main drivers and challenges experienced in the PI-SEC case projects? What is the definition and scope of the PI-SEC case projects, and how are these supported by / embedded in planning instruments? How do the state-of-the-art energy-related targets, planning instruments and KPIs perform on different scales (buildings, neighbourhood, district, city, country)?*

Task 1.1: Analysis of goals and KPIs in design projects

Task 1.1 will collect, structure and analyse existing definitions, targets and KPIs in the case studies to see if they are practical to implement and added value to the transformation process. We will also explore underlying value systems for targets and indicators and analyse technical implementation of the indicators. It also includes analysis of energy-related KPIs, targets and visions of Smart Cities and Communities from documents related to ongoing Norwegian, EU and international projects, including sustainable neighbourhood development projects (worldwide, but focus on Europe), environmental assessment schemes, and standardisation work. The KPIs will be structured according to scale of application (building, neighbourhood, region, city and country), supported values, and alignment with overall Smart Cities and Communities definition(s).

Task 2.1: Analysis of municipal planning instruments

Task 2.1 will perform focus group and individual interviews of municipal and other experts involved in the PI-SEC cases, to identify the main drivers and challenges experienced in the planning and implementation of these neighbourhood projects. Complementary to interviews, document analysis will be performed of PI-SEC case documents such as tenders, meeting minutes and strategic programmes. The outcome will provide an overview of the definition and scope of the PI-SEC case projects, the manner in which these are (not) supported by, and embedded in, municipal planning instruments, and the manner in which this potentially has developed over time. The overview will also make explicit any diverging views and experiences, and potential conflicts, that need to be resolved in Tasks 2.2-2.3.

Research Question 2: *Among RQ1 results, have other Norwegian and international projects experienced similar challenges and drivers, and how were they tackled? Which KPIs, targets and planning instruments are transferable to the Norwegian PI-SEC case projects, and which ones seem most relevant to the researchers and case project partners?*

Task 1.2: Preliminary toolkit of goals and KPIs

The task includes selection and specification of goals and KPIs for testing in Task 1.3. The choices will be made in cooperation between the different experts in the project group and together with city representatives and the international partners.

Task 2.2: Preliminary toolkit of municipal planning instruments

Based on the results of Tasks 1.1 and 2.1, Task 2.2 will collect a reference base of Norwegian and international projects that have similar targets, challenges and drivers, evaluate how they were tackled, and whether these experiences are transferable to Norwegian context, specifically to the PI-SEC case projects. The reference base of Norwegian & international examples will include not only success stories, but also "glorious failures" related to the specific challenges identified in the PI-SEC projects. The most relevant examples and instruments will be selected for testing in PI-SEC cases.

2. Review of relevant Norwegian, EU and international projects

Norske og internasjonale prosjekter – En kort oppsummering av kapittelet

Kapittel 2 er en gjennomgang av relevante norske og internasjonale prosjekter. Kapittelet inkluderer en definisjon av smarte byer samt energismarte områder. Videre er det listet en rekke prosjekter som fokuserer på lignende tematikk, samt valgte nøkkelindikatorer (KPIs) i disse prosjektene. Ulike typer indikatorer er beskrevet, og hvordan indikatorene ideelt sett bør være relevante, komplette, tilgjengelige, målbare, pålitelige, forståelige, uavhengige og selvstendige.
Kapittelet oppsummerer indikatorer som blir brukt i andre prosjekter, sortert under relevante temaer som for eksempel energiforbruk, energiproduksjon, CO_2-utslipp og grønn mobilitet. Indikatorer kan listes på ulike nivåer, og eksempler på dette er vist. Også noen få eksempler på ulike verktøy er inkludert, for energiplanlegging på områdenivå.

2.1. Introduction: Key performance indicators in the PI-SEC project

Key performance indicators (KPIs) define sets of values based on measured data from a project, making it easier to see the building project in relation to other similar projects. The main target groups of the PI-SEC project are urban decision makers, municipal planning departments and other stakeholders that are developing targets, criteria, roadmaps and tools for sustainable energy use in Norwegian communities. For these users, indicators progress over time is important. Thus, the city indicators should be formulated in such a way that they can easily be included in the city's programme for gathering regular statistics and be valuable in the planning processes of the city (CITYkeys, 2016).

Although there are several good indicator systems in place for cities (e.g. Reference Framework for Sustainable Cities or Global City Indicators Facility), there is no broadly accepted indicator system that reflects the "smart city" approach.

Indicators can be set to any field. In PI-SEC the area of focus is energy, and preferable energy indicators that are cross-scale, linking lower level energy use connected to buildings and neighbourhood, to a higher level (city, region).

2.2. Defining Smart City in relation to energy

When searching for relevant indicators one must have a certain clue of where to search. A start can be to find a good definition to what a smart city is in relation to energy. Many projects have tried to define "Smart Energy Cities" (SEC) but there is no consensus on a definition.

CITYkeys made this definition on what they meant is a '*smart city*' (not focusing on energy) (CITYkeys, 2016):

A **smart city** is a city that efficiently mobilizes and uses available resources (including but not limited to social and cultural capital, financial capital, natural resources, information and technology) for efficiently
- improving the quality of life of its inhabitants, commuting workers and students, and other visitors [people]
- significantly improving its resource efficiency, decreasing its pressure on the environment and increasing resiliency [planet]
- building an innovation-driven and green economy, and, [prosperity]
- fostering a well-developed local democracy [governance].

A **smart city project** is a project that efficiently mobilizes and uses available resources (including but not limited to social and cultural capital, financial capital, natural resources, information and technology), and,
- has a significant impact in supporting a city to become a smart city along the four axis of sustainability mentioned above,
- actively engages citizens and other stakeholders,
- uses innovative approaches, and,
- is integrated, combining multiple sectors.

The finished European project Transform (2012-2015) made this definition on a '*smart energy city'* (Transform, 2015):

The Smart Energy City is highly **energy and resource efficient**, and is increasingly **powered by renewable energy sources**; it relies on **integrated and resilient resource systems**, as well as insight-driven and innovative approaches to strategic planning. The application of **information, communication and technology** are common means to meet these objectives.

The Smart Energy City, as a core to the concept of the Smart City, provides its users with a **liveable, affordable, climate-friendly** and **engaging** environment that supports the needs and interests of its users and is based on a **sustainable economy**.

2.3. Sources of information

Several ongoing and finished projects and standards, both nationally and internationally, can give input to the task of finding the best set of categories and related KPIs for Norwegian building community projects.

Table 2.1 presents a summary of relevant sources of information to energy related KPI framework.

Table 2.1 Overview of relevant sources presenting a KPI framework. The list is not complete.

Name	Type/organization	Scale	Source
European projects and initiatives			
CITYkeys	EU R&D project (HORIZON 2020) 2015-2017	City level. Building level.	CITYkeys (2016). Deliverable 1.4: Smart city KPIs and related methodology – final. CITYkeys. Europe, Horison 2020
Transform	EU R&D project Jan 2012 - Aug 2015	City level.	Transform (2013). 2013-Blank-Context-for-Smart-Energy-Cities-Questionnaire_Transform. http://urbantransform.eu/download/download-smart-energy-city/
CONCERTO Premium	EU R&D project	City level.	Stengel, 2012. CONCERTO Premium Indicator Guide
Eurbanlab	European initiative to accelerate innovations for Sustainable Cities in Europe	City level.	Eurbanlab, 2014. Eurbanlab Innovation Case Inventory Template, version 3.4. Peter Bosch (TNO). Roger Toussaint (Utrecht University), Sophie Jongeneel (TNO), Vera Rovers (TNO). Utrecht
EERA Joint Programme Smart Cities	EU Joint Programme	City level.	http://www.eera-sc.eu/events/eera-jpsc-symposium-key-performance-indicators-smart-cities

European Innovation Partnership on Smart Cities and Communities (EIP-SCC)	EU Initiative	City level.	https://eu-smartcities.eu/
Science for Environment Policy: Indicators for Sustainable Cities	In-depth report published by the European Commission's Directorate-General Environment	City level.	http://ec.europa.eu/environment/integration/research/newsalert/pdf/indicators_for_sustainable_cities_IR12_en.pdf
European Green Capital Award	European Commission	City level.	http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2013/02/MDR0763Rp00026_Good-Practice-Report-2015_F01_light.pdf
European Green City Index	Economist Intelligence Unit; Siemens	City level.	http://www.siemens.com/press/pool/de/events/corporate/2009-12-Cop15/European_Green_City_Index.pdf
Urban Ecosystem Europe	International Council for Local Environmental Initiatives (ICLEI); Ambiente Italia	City level.	http://www.silesia.org.pl/upload/berrini.pdf
Cities Statistics (Urban Audit)	Eurostat	City level.	http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-RA-07-016/EN/KS-RA-07-016-EN.PDF
Smarter Together	EU project	City level.	http://smarter-together.eu/
ZenN	EU project	Non-technical (and technical) indicators Building and neighbourhood level	http://zenn-fp7.eu/
SuPerBuildings, VTT	EU project	Non-technical (and technical) indicators Building and neighbourhood level	Sustainability and performance assessment and benchmarking of buildings http://www.vtt.fi/inf/pdf/technology/2012/T72.pdf
IEA projects			
IEA ECB Annex 63, Implementation of Energy Strategies in Communities	IEA ECB	Energy sector. Community level.	http://www.annex63.org
IEA SHC Task 40/EBC Annex 52, Towards Net Zero Energy Solar Buildings	IEA SHC / IEA EBC	Net Zero Energy Solar Buildings. Building level.	IEA. (2012). "IEA SHC Task 40 / EBC Annex 52 "Towards Net Zero Energy Solar Buildings"." from http://www.iea-shc.org/tasks-current
IEA PVPS Task 10, Urban-Scale PV Applications	IEA PVPS	Smart grid. City/region Level.	PVPS, I. (2009). Overcoming PV grid issues in the urban areas, Report IEA-PVPS T10-06-2009

International programs, collaborations, standards and certification			
Greenhouse Gas Protocol	Greenhouse Gas Protocol, related to C40 (network of the world's megacities committed to addressing climate change)	Energy, transportation, waste, industry, agriculture. City level.	GPC (2014). Global Protocol for Community-Scale Greenhouse Gas Emission Inventories. An Accounting and Reporting Standard for Cities, Greenhouse Gas Protocol. http://www.ghgprotocol.org/city-accounting
STAR Community Rating System	Sustainability Tools for Assessing and Rating Communities (STAR)	City level.	http://www.starcommunities.org/rating-system/
Global City Indicators Programme	Global City Indicators Facility	City level.	http://www.cityindicators.org/Deliverables/GCIF%20-%20Web%20User%20Guide%2020130405_5-28-2013-1054298.pdf
EcoDistricts	City collaboration	City level.	EcoDistricts (2016). The Global Performance Standard that Empowers Sustainable Neighborhood- and District-Scale Development v1.1
ISO 37120	ISO standard	City level.	ISO37120 (2014). Sustainable development of communities - Indicators for city services and quality of life, International Standard Organization
BREEAM NOR	Environmental Characterization system	Building level.	NGBC (2012). "BRREAM-NOR ver 1.1." from http://ngbc.no/wp-content/uploads/2015/09/BREEAM-NOR-Norw-ver-1.1_0.pdf
BREEAM Communities	Environmental Characterization system	City level.	BRE (2012). BREEAM Communities Manual 2012 - Technical Manual SD 202 - 1.1.2012
Morgenstadt	Network Initiative led by Fraunhofer	City level	http://www.morgenstadt.de/en.html

The European Commission mentions the importance of finding a common indicator framework in the Strategic Implementation Plan of the European Innovation Partnership on Smart Cities and Communities (2013, p. 16):

"Although there are many good indicator systems in place for cities (…); there is no broadly-accepted indicator system that reflects the 'smart city' approach. Developing one would enable cities to self-evaluate and compare their progress. This will require unambiguous operational definition of the term 'smart city' from which city indicators can be derived, and improved consistency and comparability of urban data among European cities."

Moreover, support for a measuring scheme for the Smart City approach is underlined by pointing out that "measuring a city's progress can raise societal awareness for a low-carbon lifestyle, support industry in identifying new business opportunities, and help city administrations in coordinating and monitoring the transformation process."

EERA JPSC Symposium on Smart City KPIs (which PI-SEC researchers are involved in), will bring together researchers, city government officials, and business people from all over the world working on smart city indicators the next years. The work has just started having a kick-off meeting in November 2015. An official summary from the meeting states that KPI as decision support for policy makers should be made by having these bullet points in mind (EERA JPSC, 2015):

- First develop a vision and define goals, then think of KPIs
- A small numbers of KPIs might be better than having a complex and comprehensive system
- The most useful KPIs are those addressing several field of action at the same time (e.g. CO_2 emissions)
- KPIs should support decision-making, but data-driven government is not desirable.
- Be aware of who is responsible for the implementation of targets, and thus look at the monitoring results

Important knowledge can also be gathered from Smart City Light House Projects (H2020) in the years to come. Cities which already have gathered a lot of experience related to smart communities and energy planning is listed in Table 2.2.

Table 2.2 Selected cities which valuable experience of smart energy communities

City	Why energy "smart"?	More information
Stavanger (Norway) Area: Paradis/Hillevåg	Paradis/Hillevåg will be transformed to a living lab as part of the European Triangulum project: - 100 private homes fitted with integrated solutions and smart generic gateways. Services include heat and light control, innovative video solutions, security/safety features and charging for electric vehicles. - Stavanger municipality will install a renewable energy plant for three major municipal office buildings, making the energy supply for light and heating greener and reducing the CO2 emission. - Further there is a school and a nursing home involved in the project. Through the smart generic gateway developed and installed, they will benefit from innovative video solutions, strengthened energy efficiency, building automation, and smart charging of e-vehicles. - The University of Stavanger will develop a cloud data hub for gathering and analysing big data from the project. - Further the Rogaland County Council, which is in charge of busses in the region, will purchase and test three new battery busses capable of driving approximately 70 000 km annually.	http://triangulum-project.eu/index.php/lighthouse-cities/city-of-stavanger-norway/
Barcelona (Spain)	- Robust and wide-reaching public Wi-Fi infrastructure - Goal of energy self-sufficiency. - Annual Smart City Expo.	http://smartcity.bcn.cat/en
Copenhagen (Denmark)	- Low carbon footprint (two tons per capita and the goal is to go carbon-neutral by 2025) - Large focus on green-building and renewable-resource strategies. - 40% of all commutes within Copenhagen are by bicycle.	http://cc.cphsolutionslab.dk/shortcodes.html

Vienna (Austria)	- More than 400 charging stations throughout its streets - Vienna is breaking new ground in bike and car-share programs. - Open bike system to visitors as well as residents.	https://smartcity.wien.gv.at/site/en/projekte/
Helsinki (Finland)	- 1,200 open data sets (enables start-ups and seasoned scientists to identify new opportunities and create new smart tools). - Many smart solutions, e.g.: Every single residential and commercial spot in the city has a smart meter built into it, and nearly three quarters of the city's commercial properties engage with automated systems that help cut energy use. There's even a move to implement on-demand bus service.	https://smartercitieschallenge.org/cities/helsinki-finland

2.4. Indicator criteria framework

In (CITYkeys, 2016) an overview of the indicator typology were made:

INDICATOR TYPOLOGY **Input indicators:** These indicators refer to the resources needed for the implementation of an activity or intervention, measuring the quantity, quality, and timeliness of resources. Policies, human resources, materials, financial resources are examples of input indicators. **Process indicators:** Process indicators refer to indicators to measure whether planned activities took place. Examples include holding of meetings, conduct of training courses, and distribution of smart meters. **Output indicators:** Output indicators add more details in relation to the product ("output") of the activity, e.g. the number of smart meters distributed, the area of roof that has been isolated and the number of electric busses in the system. **Outcome indicators:** Measuring the intermediate results generated by project outputs. Outcome indicators refer more specifically to the objectives of an intervention, that is its 'results', its outcome. These indicators refer to the reason why it was decided to conduct certain interventions in the first place. They are the result of both the "quantity" ("how many") and quality ("how well") of the activities implemented. Often they are 'coverage indicators' measuring the extent to which the target population has been reached by the project. Example: the outcome of a thermal isolation programme could be the number of well-isolated dwellings as percentage of the total number of dwellings covered by the programme. **Impact indicators:** Measuring the quality and quantity of long-term results generated by programme outputs (e.g. measurable change in quality of life, reduced energy use, reduced air pollutant emissions and (even a more distant impact) improved air quality).

From (CITYkeys, 2016):
" *The primary focus is on impact indicators. Impact indicators are applicable to all kinds of projects in all contexts: For instance, an indicator in the framework could be 'the reduction in greenhouse gas emissions', whether by e.g. introducing electric vehicles or by insulating dwellings. The number of electric vehicles introduced or houses insulated, is then less relevant, making the indicator framework suitable for evaluation of many types of projects in different contexts. Impact indicators also leave room for the cities to find their own solutions to achieve a certain performance, instead of prescribing the way they should reach that or the measures that have to be taken/implemented. The latter ones*

have the risk to lower the possibility for innovative solutions to achieve the same goal, and might be outdated within a few years. The risk with proposing prescriptive input or output indicators (in addition to limiting the measures to be implemented and the risk of being outdated when better technological solutions are found) is that many innovative technological and/or IT-based urban solutions are currently being promoted as "smart city solutions" while it can be questionable if they help to achieve environmentally, socially and/or economically favourable sustainable impacts. To address this issue, CITYkeys will in its testing phase in 2016 evaluate a number of projects, thereby also implementing the ITU-T L.1440 methodology to evaluate the environmental footprint of various smart city solutions. By focusing the indicators on impacts instead of sectors, also cross-sectoral solutions can be easily evaluated. The indicator framework will not implicitly put a focus on isolated, sector specific solutions. The occurrence of double indicators is minimised (for instance the multiple inclusion of an indicator on e.g. final energy use by each sector). A disadvantage of impact indicators is that impacts are only apparent after the project has been implemented and is in full use, which might take a few years. In addition, numerous contextual factors can influence the final impact reached. Nevertheless the impact is the only measure that counts for reaching policy goals. The CITYkeys evaluations will be based on either the projected impacts for planned smart city projects, or on monitoring results for completed projects. "

CITYkeys gives these eight criteria for chose of indicators (CITYkeys, 2016):

1. **RELEVANCE**; Each indicator should have a significant importance for the evaluation process. That means that the indicators should have a strong link to the subthemes of the framework. Further the indicators should be selected and defined in such a way that the implementation of the smart city project will provide a clear signal in the change of the indicator value. Indicators that are influenced by other factors than the implementation of the evaluated project are not suited. Indicators that provide an ambiguous signal (if there is doubt on the interpretation of e.g. an increase in the indicator value) are equally not suited.
2. **COMPLETENESS;** The set of indicators should consider all aspects of the implementation of smart city projects. KPIs can be selected according to the People, Planet, Prosperity and Governance themes (and for project indicators also from the Propagation theme), which framework is fairly comprehensive in describing public policy goals.
3. **AVAILABILITY;** Data for the indicators should be easily available. As the inventory for gathering the data for the indicators should be kept limited in time and effort, the indicators should be based on data that either: - are available from the project leader or others involved in the innovation case that is being evaluated, - or can easily be compiled from public sources, - or can easily be gathered from interviews, maps, or terrain observations. Indicators that require, for instance, interviews of users or dwellers are not suited as the large amounts of data needed are too expensive to gather. The same holds for indicators that require extensive recalculations and additional data, such as footprint indicators, and some financial indicators. The current selection contains, however, a few footprint type indicators that might be expected to become common in the near future (e.g. reduction in indirect CO_2 emissions). A few indicators have been added that score very high on relevance, as they touch upon topics that are high on the political agenda, but for which data availability at the moment is low (e.g. urban food production). They are on the list as 'aspirational' indicators, for which it is expected that the data situation may change soon.
4. **MEASURABILITY;** The identified indicators should be capable of being measured, preferably as objectively as possible. For the majority of indicators in the People, Governance and Propagation themes, quantitative measurability is limited. Social sciences provide approaches to deal with qualitative information in a semi-quantitative way (Abeyasekera, 2005).
5. **RELIABILITY;** The definitions of the indicators should be clear and not open for different interpretations. This holds for the definition itself and for the calculation methods behind the indicator.
6. **FAMILIARITY;** The indicators should be easy to understand by the users. For a large number of indicators we have relied on indicators from existing indicator sets that generally comply

with this requirement. For new indicators a definition has been developed that has a meaning in the context of existing policy goals.

7 **NON-REDUNDANCY**; Indicators within a system/framework should not measure the same aspect of a subtheme.

8 **INDEPENDENCE;** Small changes in the measurements of an indicator should not impact preferences assigned to other indicators in the evaluation. In general we have kept to this principle, but given the political attention for both improving energy efficiency and reducing carbon dioxide emissions, we have included both indicators. As the current energy system is still largely based on fossil fuels, there is a direct relation between a reduction in the use of energy and the reduction of the emission of carbon dioxide. This will lead to a certain extent to double counting the impact.

The in-depth report published by the European Commission's Directorate-General Environment named Indicators for Sustainable Cities gives important considerations to have in mind when choosing indicators (European Commission, 2015):

Important considerations for using indicators

-Without good data, based on monitoring, it is not possible to develop indicators
- Performance measures imply that targets need to be set (i.e against which performance can be compared)
-Different people living in different places have different values. Indicators must therefore be able to take into account different locations, people, cultures and institutions.
- Sets of indicators evolve over time.
-Sets of indicators are seldom, if ever, complete.
Measurement of indicators tends to reduce uncertainty, but does not eliminate it.
-Indicators can play an important role in how human activities influence the environment – changing the indicators will most likely also change the system.

(Source: Food and Agriculture Organization of the United Nations, 2002)

2.5. Indicators

Table 2.3 - Table 2.9 summarize the review on energy related indicators based on the inventory of indicators from existing indicator frameworks assessing smart city projects and smart city performance. Each indicator has been placed in a certain table, one for each category (bold):

- **Energy consumption**
  - Energy consumption, delivered
  - Energy consumption, embodied
  - Energy consumption, total (delivered + embodied)
  - Energy efficient equipment
  - Energy efficient building envelope
  - Load
  - Degree of monitoring
  - Municipal energy consumption
  - Primary energy consumption
- **Energy generation**
- **Mismatch**
- **Carbon emission**
- **Green mobility**
- **Safety of supply**
- **Outdoor lighting**
- **Non-technical**

As an example; BREEAM Communities is included in the table of indicators under Carbon Emissions, since their approach towards energy efficiency is connected to the establishment of an *energy strategy* which gives credit according to the level of reduction in CO_2 emissions (BRE, 2012). The energy strategy related to BREEAM Communities is further explained in Chapter 2.5.

Only one non-technical indicator is presented in the table. The reason is that it was difficult to find good measurable parameters that are not technical. There is also a lack of benchmarking. This is an area in which more research is needed and this can be a topic for further development in PI-SEC.

A topic not included in the tables is **Smart grid.** *Flexibility* and *storage* are some of the topics that could be related to this issue. The report *Overcoming PV grid issues in the urban areas* made by IEA Photovoltaic Power Systems Program from 2009 (IEA PVPS, 2009) gives an overview of possible impacts a large degree of small scale energy production units can have on the grid and could give input to possible indicators judging the level of grid matureness within the region of concern. One of the most important concerns are *voltage control* to make it possible to avoid undervoltage/overvoltage and cope with instantaneous voltage change.

Table 2.3 Summary of reviewed indicators related to "Energy consumption"

Indicator	**Indicator unit**	**Definition**	**Source**	**Possible scale of application**	**Category**
Reduction in annual final energy consumption	% in kWh	Change in annual final energy consumption due to the project for all uses and forms of energy indicated both separately and altogether	CITYkeys; Eurbanlab; CONCERTO; BREEAM NOR	Building, neighbourhood, region, city and country	Energy consumption, delivered
Energy consumption of public buildings per year (core indicator)	kWh/m²		ISO 37120	Region, city and country	Energy consumption, delivered
Total residential electrical energy use per capita (core indicator)	kWh/year		ISO 37120	Building, neighbourhood, region, city and country	Energy consumption, delivered
Total electrical energy use per capita (supporting indicator)	kWh/year		ISO 37120	Building, neighbourhood, region, city and country	Energy consumption, delivered

Tonnes of oil equivalent per inhabitant per year	ton/per yr	Includes: Oil for domestic use, industrial use, the tertiary sector and public spaces	Urban Sustainability Indicator	Building, neighbourhood, region, city and country	Energy consumption
Use of renewable energy	Yes/no	By hiring an energy expert the best renewable energy solution should be found	BREEAM NOR	Building	Energy consumption, delivered
Degree of congruence of calculated annual final energy demand and monitored consumption	%	The ratio of the final energy demand and the final energy consumption over a period of time (year)	CONCERTO	Building, neighbourhood, region, city and country	Energy consumption, delivered
Energy demand divided on sectors	MWh/yr and %	Total energy demand divided on sectors (residential, commercial, industry, retail, public) divided on el and heat	Transform	Building, neighbourhood, region, city and country	Energy consumption, delivered
Improvement of district average zEPI (Energy Use Intensity) score over time	Specified score	Improvement of district average zEPI score over time	EcoDistrict	Neighbourhood, region, city and country	Energy consumption, delivered
Annual final energy consumption	MWh/cap/yr	Annual final energy consumption for all uses and forms of energy indicated both separately and altogether	Eurbanlab; Transform; Citykeys	Building, neighbourhood, region, city and country	Energy consumption, total (delivered + embodied)
Energy efficient cooling	Yes/no	By hiring an energy expert the most	BREEAM NOR	Building	Energy efficient equipment

system		energy efficient cooling system should be found			
Energy efficient lifts	Yes/no	Energy efficient according to specified requirements	BREEAM NOR	Building	Energy efficient equipment
Energy efficient moving staircases	Yes/no	Energy efficient according to specified requirements	BREEAM NOR	Building	Energy efficient equipment
Energy efficient outlet systems in laboratories	Yes/no	Energy efficient according to specified requirements	BREEAM NOR	Building	Energy efficient equipment
Energy efficient ventilation and heating in pools	Yes/no	Energy efficient according to specified requirements	BREEAM NOR	Building	Energy efficient equipment
Energy efficient laboratories	Yes/no	Energy efficient according to specified requirements	BREEAM NOR	Building	Energy efficient equipment
Energy efficient IT solutions	Yes/no	Energy efficient according to specified requirements	BREEAM NOR	Building	Energy efficient equipment
Energy efficient building envelope	Yes/no	Energy efficient according to specified requirements	BREEAM NOR	Building	Energy efficient building envelope
Peak load and load profile of electricity demand	kW	The load profile describes the demand characteristics over time	CONCERTO	Building, neighbourhood, region, city and country	Load
Peak load and load profile of thermal (heat and cold) energy demand	kW	The load profile describes the demand characteristics over time	CONCERTO	Building, neighbourhood, region, city and country	Load
Installation of	Yes/no	Installation of	BREEAM NOR	Building	Degree of

monitoring units		meters on specified load units			monitoring
Percentage of buildings benchmarked and measuring energy performance	% of total building stock	Percentage of buildings benchmarked and measuring energy performance	EcoDistrict	Neighbourhood, region, city and country	Degree of monitoring
Share of renewable generation associated with municipal energy consumption	%	Share of renewable generation associated with municipal energy consumption	Transform	Building, neighbourhood, region, city and country	Municipal energy consumption
Change in primary energy demand	%	Change in primary energy demand, according to a reference year	Transform	Building, neighbourhood, region, city and country	Primary energy consumption

Table 2.4 Summary of reviewed indicators related to "Energy generation"

Indicator	Indicator unit	Definition	Source	Possible scale of application	Category
Increase in local renewable energy production	% in kWh	Percentage increase in the share of local renewable energy due to the project	Eurbanlab; EcoDistricts, CONCERTO; Citykeys	Building, neighbourhood, region, city and country	Energy generation
Renewable energy generated within the city	% of MWh	The percentage of total energy derived from renewable sources, as a share of the city's total energy consumption	ISO 37120; Eurbanlab; Transform; Citykeys	Region, city and country	Energy generation
Renewable energy generated within the city	MWh/yr	Total energy derived from renewable sources generated within the city (also divided between el and heat)	Transform;	Region, city and country	Energy generation

Percentage of buildings connected to a district thermal energy or co-generation system	%	Percentage of buildings connected to a district thermal energy or co-generation system	EcoDistrict	Region, city and country	Energy generation
Identification of available resources of renewable energy	Yes/no	Identification of available resources of renewable energy within the city	Transform;	Region, city and country	Energy generation
Percentage of households connected to district heating	%	Percentage of households connected to district heating	Transform	Region, city and country	Energy generation

Table 2.5 Summary of reviewed indicators related to "Mismatch"

Indicator	**Indicator unit**	**Definition**	**Source**	**Possible scale of application**	**Category**
Maximum Hourly Deficit	MHDx	The maximum yearly value of how much the hourly local demand overrides the local renewable supply during one single hour (by energy type)	Citykeys (taken from IDEAS)	Building, neighbourhood, region, city and country	Mismatch
Supply cover factor (Self-consumption)	% of kWh/h or % of kWh/month	Share of self-consumption of local energy production	IEA Task 40/Annex 52 Towards Net Zero Energy Solar Buildings	Building, neighbourhood, region, city and country	Mismatch
Load cover factor (Self-generation)	% of kWh/h or % of kWh/month	Share of self-generation of total consumption	IEA Task 40/Annex 52 Towards Net Zero Energy Solar Buildings	Building, neighbourhood, region, city and country	Mismatch
Generation Multiple, GM	Factor (kWh/kWh)	Peak local generation relative to peak load (peak generation/peak load)	IEA Task 40/Annex 52 Towards Net Zero Energy Solar Buildings	Building, neighbourhood, region, city and country	Mismatch

Generation Multiple, GM (2)	Factor (kWh/kWh)	Local export relative to import (export/import)	IEA Task 40/Annex 52 Towards Net Zero Energy Solar Buildings	Building, neighbourhood, region, city and country	Mismatch
Dimensioning Rate, DR	Factor	Net export peak/connection capacity	IEA Task 40/Annex 52 Towards Net Zero Energy Solar Buildings	Building, neighbourhood, region, city and country	Mismatch
Degree of energetic self-supply	Factor (kWh/kWh)	The ratio of locally produced energy and the local consumption over a period of time (year)	CONCERTO	Building, neighbourhood, region, city and country	Mismatch

Table 2.6 Summary of reviewed indicators related to "Carbon emissions"

Indicator	Indicator unit	Definition	Source	Possible scale of application	Category
Carbon dioxide emission reduction	% in tonnes	Reduction in direct (operational) CO_2 emissions achieved by the project.	Eurbanlab; CONCERTO; BREEAM Communities; Citykeys	Building, neighbourhood, region, city and country	Carbon emission
Reduction in lifecycle CO_2 emissions	% in tonnes	Reduction in lifecycle CO_2 emissions achieved by the project	Citykeys	Building, neighbourhood, region, city and country	Carbon emission
Total CO_2 emissions	t CO_2/cap/yr	CO_2 emissions in tonnes per capita per year	ISO 37120; Citykeys (taken from Smart city Wheel; SCI; FIN indicators; DESIRE; RFSC; UNECE; European Green Capital Award study; City Protocol; GCIF)	Region, city and country	Carbon emission
CO_2 emissions associated with the	t CO_2/yr	CO_2 emissions associated with the heating of	Transform	Building, neighbourhood, region, city and country	Carbon emission

heating of buildings		buildings			
Carbon emissions related to energy demand divided on sectors	t CO_2/yr and %	Carbon emissions related to energy demand divided on sectors (residential, commercial, industry, retail, public) divided on el and heat	Transform	Building, neighbourhood, region, city and country	Carbon emission, divided on sectors
Emissions from fuel combustion within the city boundary, divided on sectors	t CO_2/yr	Emissions from fuel combustion within the city boundary, divided on sectors (residential, commercial, manufactures, agriculture)	Greenhouse Gas Protocol	Building, neighbourhood, region, city and country	Carbon emission, fuel
Emissions from grid-supplied energy consumed within the city boundary, divided on sectors	t CO_2/yr	Emissions from grid-supplied energy consumed within the city boundary, divided on sectors (residential, commercial, manufactures, agriculture)	Greenhouse Gas Protocol	Building, neighbourhood, region, city and country	Carbon emission, fuel
Emissions from transmission and distribution losses from grid-supplied energy consumption, divided on sectors	t CO_2/yr	Emissions from transmission and distribution losses from grid-supplied energy consumption, divided on sectors (residential, commercial, manufactures, agriculture)	Greenhouse Gas Protocol	Building, neighbourhood, region, city and country	Carbon emission, fuel
Emissions	t CO_2/yr	Emissions	Greenhouse	Building,	Carbon

from energy used in power plant auxiliary operations within the city boundary (industry related)		from energy used in power plant auxiliary operations within the city boundary (industry related)	Gas Protocol	neighbourhood, region, city and country	emission, fuel
Emissions from grid-supplied energy consumed in power plant auxiliary operations within the city boundary (industry related)	t CO_2/yr	Emissions from grid-supplied energy consumed in power plant auxiliary operations within the city boundary (industry related)	Greenhouse Gas Protocol	Building, neighbourhood, region, city and country	Carbon emission, fuel
Emissions from transmission and distribution losses from grid-supplied energy consumption in power plant auxiliary operations (industry related)	t CO_2/yr	Emissions from transmission and distribution losses from grid-supplied energy consumption in power plant auxiliary operations (industry related)	Greenhouse Gas Protocol	Building, neighbourhood, region, city and country	Carbon emission, fuel

Table 2.7 Summary of reviewed indicators related to "Green mobility"

Indicator	Indicator unit	Definition	Source	Possible scale of application	Category
Number of electric vehicle charging stations	Number	Number of electric vehicle charging stations	EcoDistrict	Neighbourhood, region, city and country	Green Mobility

Table 2.8 Summary of reviewed indicators related to "Safety of supply"

Indicator	Indicator unit	Definition	Source	Possible scale of application	Category
Average number of electrical interruptions per customer per year (supporting indicator)	Number per costumer per year		ISO 37120	Building, neighbourhood, region, city and country	Safety of supply
Average length of electrical interruptions (in hours) (supporting indicator)	Hours		ISO 37120	Building, neighbourhood, region, city and country	Safety of supply

Table 2.9 Summary of reviewed indicators related to "Outdoor lighting"

Indicator	Indicator unit	Definition	Source	Possible scale of application	Category
Energy efficient outdoor lighting	Yes/no	Requirements on choice of light bulbs	BREEAM NOR	Building, neighbourhood, region, city and country	Outdoor lighting

Table 2.10 Summary of reviewed indicators related to "Non-technical"

Indicator	Indicator unit	Definition	Source	Possible scale of application	Category
Integrated design in the planning process	This indicator is made of a list of qualitative sub-criteria covering several phases of the planning process of a building, from concept design to operation.	Evaluating project management before, during and after design, involving a multi-disciplinary team, a collaborative and iterative work, aiming at optimising the sustainable performances of the building.	SuPerBuildings, VTT	Building, neighbourhood.	Non-technical

BREEAM Communities

The approach of BREEAM Communities towards energy efficiency is connected to the establishment of an *energy strategy* which gives credit according to the level of reduction in CO_2 emissions. The larger reductions accomplished, the more credits will be given.

The energy strategy should include the following (BRE, 2012):

1. A prediction of the baseline energy demand and associated emissions for a Building Regulations Part L compliant development calculated using approved Building Regulations compliant energy modelling software and other modelling to cover site-wide consumption. This should include:
    - a breakdown of the site wide heating, cooling and electricity demand
    - emissions for both regulated and unregulated energy use
    - emissions associated with street lighting and other electrically powered street furniture
2. Recommendations for reducing energy use and associated emissions beyond baseline levels through implementation of energy efficient measures including:
    - site layout
    - use of topography
    - shading
    - solar orientation
    - use of daylighting
    - wind management
    - use of natural ventilation.
3. Opportunities to further reduce emissions through the use of decentralised energy including:
    - connection to existing or future heat distribution networks
    - installation of site wide communal heating and cooling networks
    - utilisation of combined heat and power (CHP) systems, including any opportunities to extend beyond the site boundary
4. Opportunities to further reduce emissions through the installation of local (on-site or near-site) low or zero carbon (LZC) energy sources including details of the following:
    - energy generated from LZC energy source
    - payback
    - land use
    - local planning criteria
    - noise
    - feasibility of exporting heat/electricity from the system
    - life cycle cost/lifecycle impact of the potential specification in terms of carbon emissions
    - all technologies appropriate to the site and energy demand of the development
    - how any proposed LZC sources will be integrated with and complement any proposed decentralised energy networks
    - reasons for excluding other technologies
5. Summary of the carbon dioxide savings resulting from energy efficient design measures, the use of decentralised energy and the installation of LZC energy sources.

2.6. City level vs building level: Cross-scale indicators

In PI-SEC it is of key importance to find indicators which are cross-scale. CITYkeys describes how that is a difficult task in Deliverable 1.4 (CITYkeys, 2016):

" The indicator selection for evaluating smart city projects has been linked with corresponding indicators on city level. Of the 92 project indicators, there are only 18 that can be quantitatively related (or aggregated) to a corresponding indicator on the city level. For 43 indicators on project level no corresponding city indicator could be found: all the (19) propagation indicators belong to this category, because this theme is only relevant for projects. Also several other indicators are useful for measuring the success of a project, but are too specific to be used on the city level. This means that the possibilities to aggregate quantitatively from project to city level are limited. The majority of these indicators concern energy use, emissions from CO_2 and air pollutants, and waste generation, with some possibilities in the people and prosperity themes. The resulting indicator selection responds to the wishes of cities and citizens for the coverage of their priorities and reflects city goals. Due to the multitude of different smart city projects, the CITYkeys indicator set focuses on impact indicators, as these can be used for all types of interventions. In addition, a limited number of generalised input, output and outcome indicators have been added that reflect the degree of smartness of a city (or a project)."

2.7. How to structure the indicator framework

A report made by United Nation Development Group, *Indicators for Monitoring the Millennium Development Goals (UN, 2003)* illustrates how indicators could be linked to goals and targets (Figure 2.1).

Millennium Development Goals (MDGs)	
Goals and Targets **(from the Millennium Declaration)**	**Indicators for monitoring progress**
Goal 1: Eradicate extreme poverty and hunger	
Target 1.A: Halve, between 1990 and 2015, the proportion of people whose income is less than one dollar a day	1.1 Proportion of population below $1.25 (PPP) per day 1.2 Poverty gap ratio 1.3 Share of poorest quintile in national consumption
Target 1.B: Achieve full and productive employment and decent work for all, including women and young people	1.4 Growth rate of GDP per person employed 1.5 Employment-to-population ratio 1.6 Proportion of employed people living below $1.25 (PPP) per day 1.7 Proportion of own-account and contributing family workers in total employment
Target 1.C: Halve, between 1990 and 2015, the proportion of people who suffer from hunger	1.8 Prevalence of underweight children under-five years of age 1.9 Proportion of population below minimum level of dietary energy consumption
Goal 2: Achieve universal primary education	
Target 2.A: Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling	2.1 Net enrolment ratio in primary education 2.2 Proportion of pupils starting grade 1 who reach last grade of primary 2.3 Literacy rate of 15-24 year-olds, women and men

Figure 2.1 Illustration of how to structure the indicator framework *(UN, 2003)*

Different levels

When making the KPI framework it could be convenient to have several levels or scopes. An example can be studied in *Global Protocol for Community-Scale Greenhouse Gas Emission Inventories* made by Greenhouse Gas Protocol (GPC, 2014). See Figure 2.4 - Figure 2.5.

Scope	Definition
Scope 1	GHG emissions from sources located within the city boundary
Scope 2	GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary
Scope 3	All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary

Figure 2.2 Definition of different scopes in GHG Protocol (GPC, 2014)

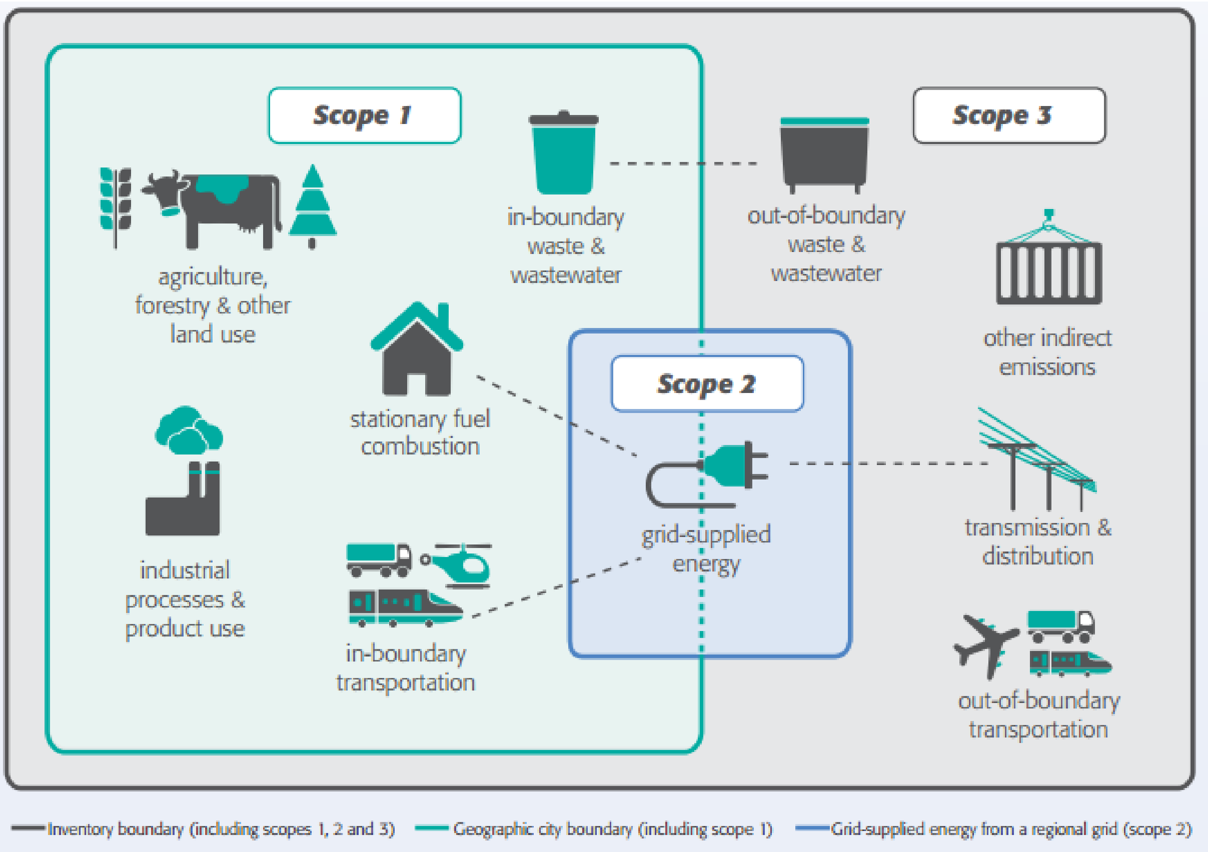


Figure 2.3 Illustration of different scopes in GHG Protocol (GPC, 2014)

Sectors and sub-sectors	Scope 1	Scope 2	Scope 3
STATIONARY ENERGY			
Residential buildings	✓	✓	✓
Commercial and Institutional buildings and facilities	✓	✓	✓
Manufacturing industries and construction	✓	✓	✓
Energy industries	✓	✓	✓
Energy generation supplied to the grid	✓		
Agriculture, forestry, and fishing activities	✓	✓	✓
Non-specified sources	✓	✓	✓
Fugitive emissions from mining, processing, storage, and transportation of coal	✓		
Fugitive emissions from oil and natural gas systems	✓		
TRANSPORTATION			
On-road	✓	✓	✓
Railways	✓	✓	✓
Waterborne navigation	✓	✓	✓
Aviation	✓	✓	✓
Off-road	✓	✓	
WASTE			
Disposal of solid waste generated in the city	✓		✓
Disposal of solid waste generated outside the city	✓		
Biological treatment of waste generated in the city	✓		✓
Biological treatment of waste generated outside the city	✓		
Incineration and open burning of waste generated in the city	✓		✓
Incineration and open burning of waste generated outside the city	✓		
Wastewater generated in the city	✓		✓
Wastewater generated outside the city	✓		
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)			
Industrial processes	✓		
Product use	✓		
AGRICULTURE, FORESTRY, AND LAND USE (AFOLU)			
Livestock	✓		
Land	✓		
Other agriculture	✓		
OTHER SCOPE 3			
Other Scope 3			

✓ Sources covered by the GPC

\+ Sources required for BASIC+ reporting

Sources included in Other Scope 3

Sources required for BASIC reporting

Sources required for territorial total but not for BASIC/BASIC+ reporting *(italics)*

Non-applicable emissions

Figure 2.4 Sectors and scopes covered by the GPC (GPC, 2014)

GPC ref No.	Scope	GHG Emissions Source (By Sector and Sub-sector)
I		STATIONARY ENERGY
I.1		Residential buildings
I.1.1	1	Emissions from fuel combustion within the city boundary
I.1.2	2	Emissions from grid-supplied energy consumed within the city boundary
I.1.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption
I.2		Commercial and institutional buildings and facilities
I.2.1	1	Emissions from fuel combustion within the city boundary
I.2.2	2	Emissions from grid-supplied energy consumed within the city boundary
I.2.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption
I.3		Manufacturing industries and construction
I.3.1	1	Emissions from fuel combustion within the city boundary
I.3.2	2	Emissions from grid-supplied energy consumed within the city boundary
I.3.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption
I.4		Energy industries
I.4.1	1	Emissions from energy used in power plant auxiliary operations within the city boundary
I.4.2	2	Emissions from grid-supplied energy consumed in power plant auxiliary operations within the city boundary
I.4.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption in power plant auxiliary operations
I.4.4	1	*Emissions from energy generation supplied to the grid*
I.5		Agriculture, forestry and fishing activities
I.5.1	1	Emissions from fuel combustion within the city boundary
I.5.2	2	Emissions from grid-supplied energy consumed within the city boundary
I.5.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption
I.6		Non-specified sources
I.6.1	1	Emissions from fuel combustion within the city boundary
I.6.2	2	Emissions from grid-supplied energy consumed within the city boundary
I.6.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption
I.7		Fugitive emissions from mining, processing, storage, and transportation of coal
I.7.1	1	Emissions from fugitive emissions within the city boundary
I.8		Fugitive emissions from oil and natural gas systems
I.8.1	1	Emissions from fugitive emissions within the city boundary

Figure 2.5 Indicators by sectors and sub-sectors divided on scopes (GPC, 2014)

The Morgenstadt initiative, led by Fraunhofer, has divided the indicators into three different levels/categories illustrated in the flowchart in Figure 2.6.

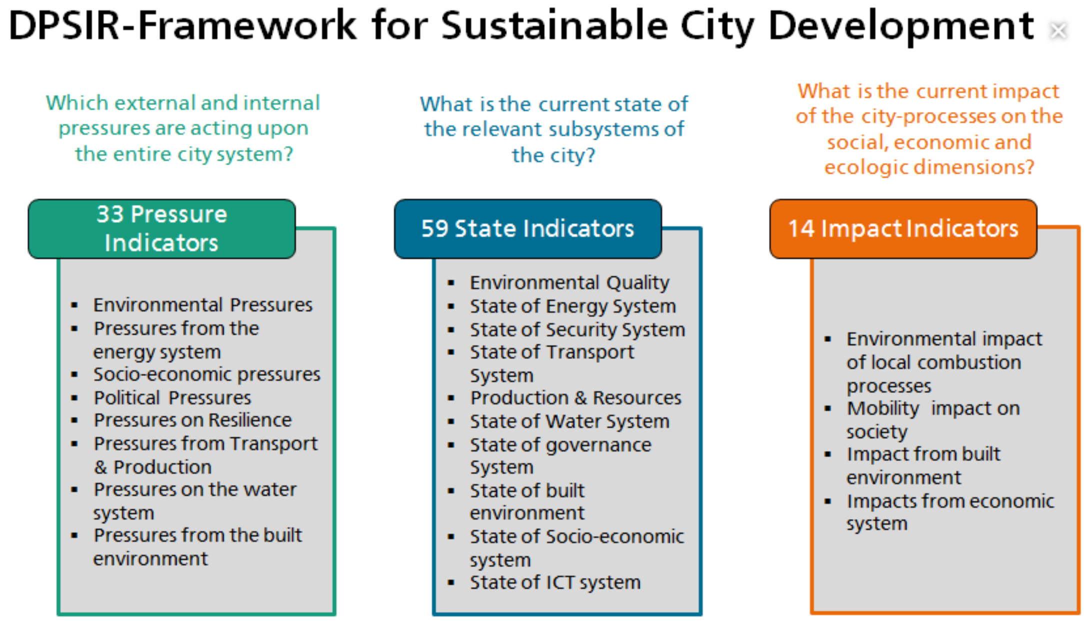
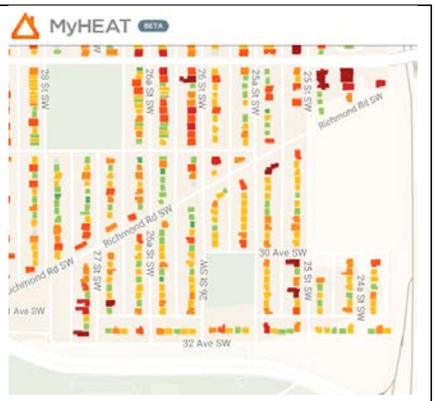


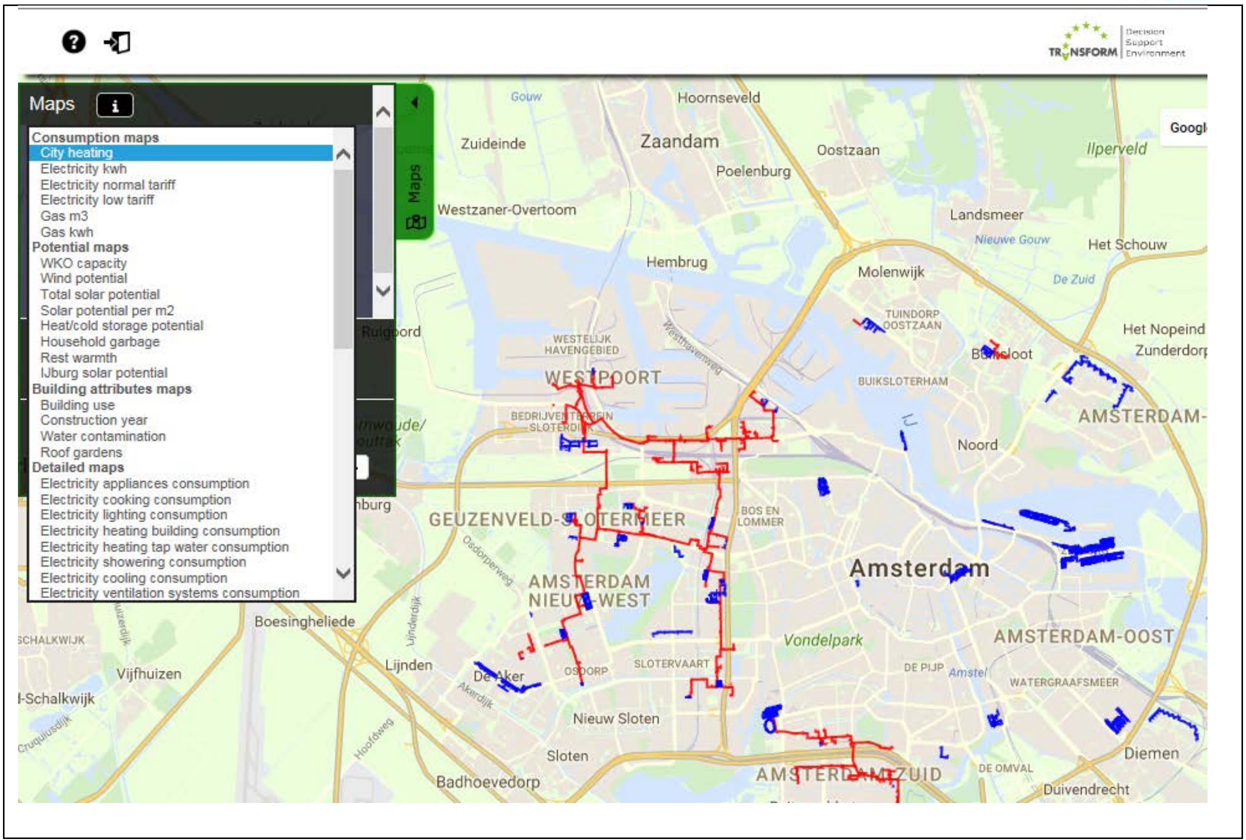
Figure 2.6 Flowchart showing themes and category of indicators in the Morgenstadt initiative.

2.8. Example of tools

Recently, more and more cities have seen the benefit of looking at energy consumption in relation to each specific building presented in a web-based and open tool. Examples of map-based tools are listed in Table 2.11.

Table 2.11 Web-based tools showing energy use in specific buildings

Location	**Webpage**	
Cities in Canada	https://myheat.ca/	
New York	http://qsel.columbia.edu/nycenergy/	
London	https://maps.london.gov.uk/webmaps/heatmap/	
Amsterdam	www.urbantransform.eu/dse (login: user20151204, macomi20151204)	



A possible way of presenting results are shown by The European Green City Index in Figure 2.7.

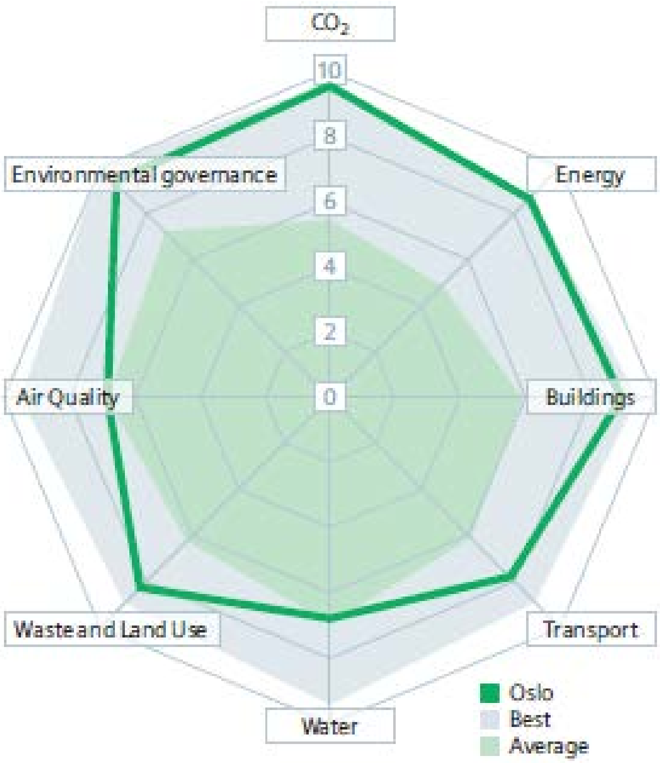


Figure 2.7 Illustration of the results when Oslo was rated by The European Green City Index (Economist Intelligence Unit, 2009)

3. Analysing case studies

Analyse av pilotstudiene – En kort oppsummering av kapittelet

Kapittel 3 gir en introduksjon til pilotområdene i PI SEC. Pilotområdene Furuset og Ådland er forskjellige på mange måter, men representerer begge norske områder med ambisiøse energi- og klimamål. Dersom det utvikles metoder relevant for disse to pilotområdene så vil disse metodene trolig også kunne benyttes ved utviklingen av en rekke andre områder i Norge.
Kapittelet beskriver videre hvordan rammeverket relevant for energismarte områder er på ulike skalaer, fra land til byer, nabolag til bygg. De generelle nasjonale instrumentene beskrives også i dette kapittelet, fordelt på de ulike skalaene, som for eksempel lovverk, sertifiseringer og støtteordninger. Til slutt inkluderes informasjon relevant for den praktiske implementeringen av ulike indikatorer, og endel tilgjengelige informasjonskilder oppsummeres.

3.1. Smart Energy Community case studies

There are two specific case studies in the PI-SEC project, in the two largest Norwegian cities:

- Ådland in Bergen: A new development with 600 to 800 dwellings and a community centre,
- Furuset in Oslo: An upgrading of suburb from the 1970's with 9500 inhabitants.

Even though the case studies are different in most aspects, both represents large ongoing development projects with ambitious goals with respect to energy performance and related GHG emissions. Table 3.1 present some of the main differences in the two case studies. When developing a method relevant for two such different cases, the methods should also be relevant for a number of other communities.

Table 3.1 Main differences in the two case studies in the PI-SEC project

Area	Type	Dimension	Type of owner	Number of owners	Connection
Ådland	New	Smaller	Building owner driven development	One owner	Distance to public transport
Furuset	Existing	Larger	Municipality driven development	Many owners	Public transport hub

The case studies are structured according to scale of application (building, neighbourhood, region, city and country), supported values, and alignment with overall Smart Cities and Communities definition(s).

When analysing the existing definitions, targets and KPIs in the case studies, the information is structured under the themes below (many are the same as in chapter 3.5):

- Carbon emission
- Energy consumption
- Energy generation
- Mismatch
- Energy grid capacity
- Green mobility in the energy system
- Smart energy management
- City environment (e.g. air quality, noise)
- Citizens (stakeholder involvement, involved, engaged and empowered citizens)

3.2. "Smart energy communities" in the national structure

Smart energy communities relate to planning instruments and KPIs on different scales. In this report, such instruments, their goals and indicators are structured according to scale of application. The table structure is shown in Table 3.2. The scales included are building, neighbourhood, city and country. Region is excluded as a scale in the tables, to make the overview more simple and general.

The nationwide instruments / measures are described in Chapter 0, while case-specific instruments / measures for Ådland and Furuset are described in Chapter 4 and 5.

Table 3.2 Table structure for the Case studies in the PI-SEC project

Level	Instruments /measures	Goals	Indicators
Country			
↓↑			
District			
↓↑			
City			
↓↑			
Neighbour-hood			
↓↑			
Building			

3.3. Nationwide incentives, standards and regulations in Norway

Nationwide incentives, standards and regulations are also valid for Smart Energy Communities. On country, city, neighbourhood and building level, existing framework can give both possibilities and obstacles for a Smart Energy Community.

Table 3.3 gives a description of some of the nationwide instruments. The main relevant instruments with related goals and indicators are listed in Table 3.4 (not exhaustive).

Table 3.3 Description of some of the nationwide instruments

Instrument	Description
Prosumer arrangement	Definition of a prosumer by NVE (01.01.17): End user with consumption and production behind connection point, where input power at the connection point at no time exceeds 100 kW. A prosumer cannot have licensable construction behind the connection points or turnover that requires trading license.
Large-scale deployment of smart meters	The installation of measuring systems (AMS) to all electricity customers by 2018 shall make it easier for both consumer and energy supplier to consider measures for better distribution and use of energy.
Elhub	Central datahub for metered data and market processes in the electricity market.
Planning and Building Act	Makes the legal basis for all planning and management within the construction sector in Norway. Includes the national building code.
National planning guidelines for climate and energy planning in municipalities	Guidelines for reduction of greenhouse gas emissions and increased use of environment-friendly energy in Municipalities made by Ministry of Climate and Environment *(Klima - og Miljødepartementet).*
The National building code (TEK)	Regulations on technical requirements for building works. TEK 15 is the current code to follow.
Norwegian district heating regulation	In the current Norwegian district heating regulation, municipalities may impose on buildings an obligation to connect to a district heating system within a defined concession area. Historically, this obligation, along with market conditions and other policy measures, has supported significant growth in district heating.
Energy performance certificates (EPC)	Summarizes the energy status in a building describing energy sources and yearly consumption. Mandatory for all new buildings that are to be sold or rented out.
Funding opportunities, Enova	Enova is a public enterprise that is owned by the Ministry of Petroleum and Energy. Enova gives funding to energy effective and innovative initiatives.
Urban Environment Agreement	An agreement for organizing the collaboration between central, regional and local authorities in major urban areas. The intension is to enable more people to use public transport, cycling and walking.

Table 3.4 Nationwide measures relevant for Smart Energy Communities

Level	Related themes	Instruments /measures	Effectiveness	Main goals	Main indicators
Country	Energy consumption Carbon emission	EU Energy Performance of Buildings Directive	Enforce (if becoming mandatory)	• Improving energy efficiency of buildings • New buildings: Nearly zero-energy by 2020	• Energy use (kWh) • CO_2 emissions
	Energy consumption Energy generation Grid capacity Smart management	White paper on energy policy towards 2030, Meld. St. 25 (2015-2016), Innst. 401 S (2015-2016) (Regjeringen, 2015)	Political goals	• 10 TWh reduced energy use in existing buildings • Flexibility and energy security	• Energy use (kWh) • Grid investment • CO_2 emissions
	Energy consumption Energy generation	Enova funding (Olje- og energidepartementet, 2015)	Encourage	• To trigger private investments in energy efficiency and renewable energy	• kWh triggered • NOK/kWh reduced or generated
	Energy generation	Prosumer arrangement, *Plusskundeordningen* (NVE, 2016)	Enable	• Sale of <100kW el to grid from customers	
	Energy generation	Energy Act	Enforce	• Regulate production, distribution and use of electricity and district heating	
	Energy consumption	Licensing district heating concession areas (NVE)	Enforce Enable	• Regulate district heating	
	Smart management	Large-scale deployment of smart meters	Enforce	• Advanced Metering System (AMS) at all electricity consumers by 2019	• Nr. of AMS
	Smart management	Elhub: Central datahub for metered data and market processes in el. market	Enable	• Simplify processes for all Balance Suppliers and Grid Owners	
	Smart management	White paper on ICT, Meld. St. 27 (2015–2016)	Enable	• Min. 100 Mbit/s available for 90 % of households by 2020	
	City environment	Pollution Control Act	Enforce	• Protect outdoor environment against pollution and to promote better waste management	
	Green mobility	Strategy for charging stations and infrastructure for electrical cars (Enova, 2015)	Encourage	• To trigger private investments in infrastructure for electrical cars	• Nr. infrastructure • NOK/main road covered

↓↑					
District	City environment	Planning and Building Act: Regional and municipal planning	Enforce	Promote sustainable development in the best interests of individuals, society and future generations	
	Green mobility City environment	Development of infrastructure in Regional and County master plan, e.g. transportation	Enforce		
	City environment	Municipal master plan	Enforce	The municipality's overriding governing document, providing framework for development of municipal community and management of land use resources	
↓↑					
City	City environment	Planning and Building Act: Regional and municipal planning	Enforce	• Promote sustainable development in the best interests of individuals, society and future generations	
	Carbon emission Energy consumption	National planning guidelines for climate and energy planning in municipalities (Klima- og miljødepartementet, 2009)	Enforce	• Reduction of greenhouse gas emissions and increased use of environment-friendly energy in Municipalities	• CO_2 emissions • Energy use (kWh)
	Energy consumption	Norwegian district heating regulation	Enforce	• Possibility to impose on buildings an obligation to connect to a district heating system	
	Green mobility	Urban Environment Agreement: Organizing collaboration on passenger transport between central, regional and local authorities in major urban areas	Enforce Enable	• To enable more people to use public transport, cycling and walking	• Public transport use, cycling and walking
	Grid capacity	Regional Power System Studies (NVE / Nettselskaper, 2016)	Enable	• Overview of current grid system and possible future developments and plans	
	City environment	Cultural Heritage Act	Enforce	• To protect archeological and architectural	

				monuments / sites and cultural environments	
	Carbon emission Energy consumption	Pilot cities • Cities of the Future • C40 • Lighting house	Encourage	• Sustainable cities	• CO_2 emissions • Energy use (kWh)
	City environment	Plan for land use	Enforce	Map with written provisions for the use, protection and design of areas and physical surroundings in the whole municipality	
↓↑					
Neighbour-hood	City environment	Planning and Building Act: Zoning plans	Enforce	• Sustainable development in the best interests of individuals, society and future generations	
	Carbon emission Energy generation Energy consumption Mismatch Green mobility Smart management City environment	Research and development-pilot area e.g. within ZEN (Centre for Zero Emission Neighbourhood run by SINTEF and NTNU)	Encourage	• Sustainable neighbourhoods	• CO_2 emissions • Energy use (kWh) • Energy generation (kWh)
	Carbon emission Energy generation Energy consumption Green mobility City environment	BREEAM Communities	Encourage	Sustainable communities	• CO_2 emissions • Energy use (kWh) • Energy generation (kWh)
	Carbon emission Energy generation Energy consumption Green mobility	Futurebuilt-areas	Encourage	• Sustainable communities	• CO_2 emissions • Energy use (kWh) • Energy generation (kWh)
	Carbon emission Energy generation	ISO standards on sustainability	Encourage	• Sustainable communities/cities	• CO_2 emissions • Air quality units • Energy use (kWh)

	Energy consumption Green mobility Smart management City environment Safety of Supply				• Units related to social matters (inhabitants wellbeing)
↓↑					
Building	Energy consumption Energy production	Building code: Regulations on technical requirements for building works (TEK)	Enforce	• To ensure that projects complies with the technical standards for health, safety, the environment and energy	kWh demand/m² floor area Min. % RE heat
	Energy consumption Energy production	Energy performance certificates (EPBD)	Enforce	• Provide information on the energy efficiency of buildings and recommended improvements	kWh delivered/m² floor area
	Carbon emission Energy generation Energy consumption Smart management City environment Citizens	Pilot buildings / voluntary certificates / standards: • Futurebuilt-buildings • ZEB-pilots • BREEAM-NOR • Fyrtårn • Low energy and passive house buildings standards	Encourage	• Sustainable buildings	• CO_2 emissions energy • CO_2 emissions materials • Energy demand (kWh)
	Energy generation Energy consumption Smart management	Funding opportunities: • Enova • Husbanken	Enable	• Investments in energy efficiency and renewable energy	• kWh triggered • NOK/kWh reduced or generated

3.4. Technical implications of indicators

Availability and Measurability are two of the eight criteria for indicators from CITYkeys (2016), listed in Chapter 2.4. The identified indicators should be capable of being measured and data should be easily available. To select and specify indicators will be a focus in the PI-SEC project Task 1.2. However, this chapter describes some of the available sources of information.

Information available from the municipality

Information collected from the municipality is not listed in detail, but is an important source of information. This includes e.g. energy and climate information for municipal buildings, information available in municipal maps, building projects registered with the planning department, etc.

Data availability for climate and energy planning in municipalities

Municipalities should incorporate climate and energy in their planning, as described in the national planning guidelines for climate and energy planning in municipalities (Klima- og miljødepartementet, 2009).

The homepage Miljøkommune.no provides advice on how to develop and revise the climate and energy plan (Miljødirektoratet, 2016a). The homepage gives advice on data sources for emissions accounting. Some of the suggested sources are:

- Energy data: Demand for electricity and district heating
  - Regulation No. 1158 on energy studies (Lovdata, 2012) describes that energy companies upon request from municipalities shall provide (not sensitive) information about the energy supply relevant for municipal climate and energy planning.
- Releases from facilities with permit
  - Norskeutslipp.no (Statistics Norway and The Norwegian Environment Agency, 2016): Releases to air and water as well as transfers of waste from different sectors, both aggregated and at facility level.
- KOSTRA - Key figures on municipal activities
  - Municipalities report information to the state through KOSTRA. The indicators can be used to follow development trends in a municipality or district.
- Statistics Norway (SSB)
  - Norwegian statistics (www.ssb.no)

Data availability for the state and development of the environment

The homepage Miljøstatus.no provides information about the state and development of the environment (Miljødirektoratet, 2016b). The content comes from respective environmental agencies, which includes the Norwegian Environment Agency which is responsible for "Fresh water", "Marine Areas", "Hazardous chemicals", "Climate", "Noise", "Air pollution", "Waste", "Biological diversity" and "Outdoor recreation". A number of institutions supply the website with data. For information on climate gas emissions and local air polution, the sources are Statistics Norway and Norwegian Institute for Air Research.

Other possible sources of information and instruments relevant for Smart Energy Communities

Klimagassregnskap.no is developed by FutureBuilt, for calculating greenhouse gas emissions for buildings and districts.

Elhub will be the central datahub for metered data and market processes in the Norwegian electricity market. Elhubs main functions are automated meter processing, metered data distribution and processing of market processes such as supplier switching, migration and reporting. Elhub will Go Live in 2017.

Prosumers register with the grid operators. Grid operators and maybe also NVE may be able to provide information about installed production capacity in a community.

Investment support information from Enova and municipalities may be available on community-level.

Energy performance certificate information may be available on community-level, from Enova.

Certified BREEAM-NOR projects may be available on community-level, from Norwegian Green Building Council.

4. Case study Zero Village Bergen (Ådland)

Case Ådland, Bergen – En kort oppsummering av kapittelet

Kapittel 4 er en gjennomgang av pilotområdet Ådland ved Bergen. Kapittelet gir en introduksjon til planene og ambisjonene for området, hvor målet gjennom året er å oppnå null utslipp relatert til drift av byggene. Videre gir kapittelet en oversikt over det identifiserte rammeverket på ulike skalaer, relevant for områdeutviklingen. Mål og indikatorer for Bergen kommune beskrives. Til slutt oppsummeres noen tanker rundt barrierer, lærdommer og gode praksiser.

4.1. Introduction to Case study Zero Village Bergen (Ådland)

Zero Village Bergen is a large development project with several types of multifamily residential buildings consisting of 2-4 floors, all together approximately 800 units. The development site is located at Ådland, about 15 km south-east of Bergen, near the airport (Flesland), see Figure 4.1.

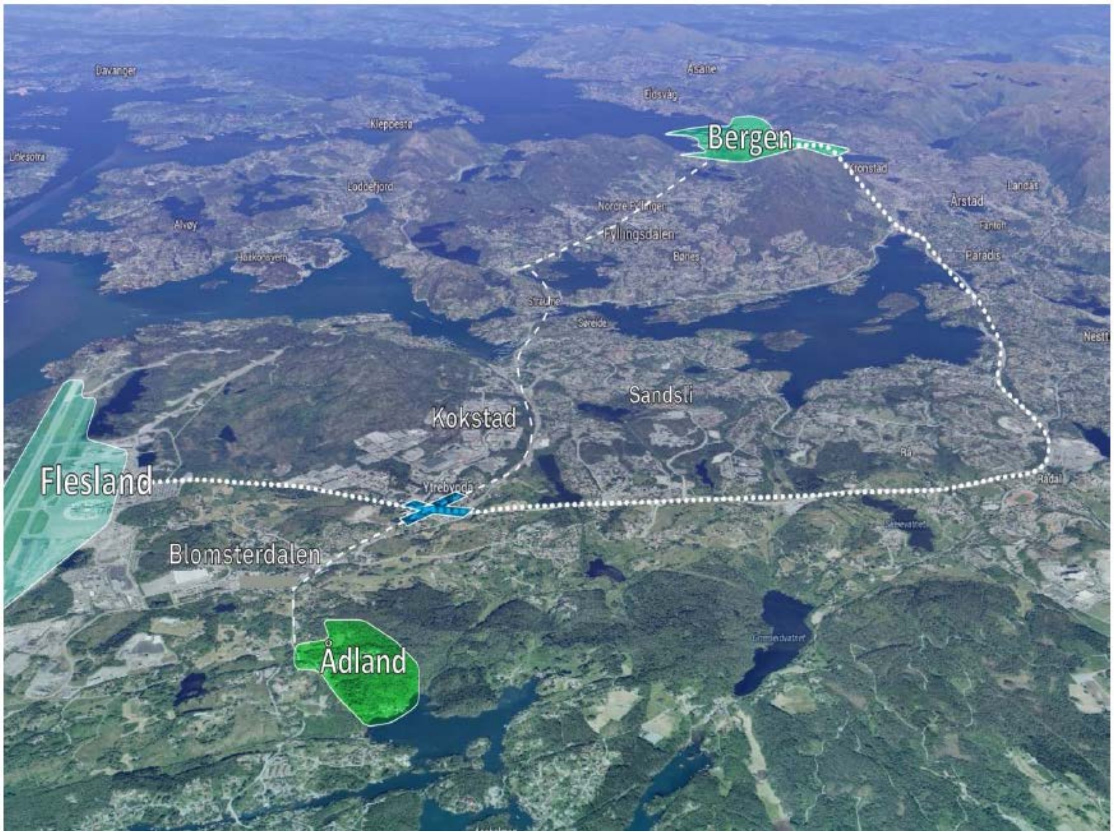


Figure 4.1 Location of Zero Village Bergen (Ådland) (Sartori et al., 2015)

The project is currently in the planning phase and is being developed by the company ByBo AS in close cooperation with the Norwegian research centre on Zero Emission Buildings (www.zeb.no) with partners NTNU, SINTEF, Snøhetta and Multiconsult.

The overall energy ambition of the development is that the greenhouse gas emissions related to the operation of the buildings should be zero on an annual basis. The embodied emissions from construction materials should be accounted for, and for some of the dwellings, the ambition is to also include these in the zero emission balance.

The ZEB definition is characterized by different ambition levels ranging from the lowest (ZEB-O÷EQ) to the highest (ZEB-COMPLETE) depending on what aspects in the building life cycle that are included. The different ambition levels are defined as (Dokka et al., 2013):

1. ZEB-O÷EQ: Emissions related to all energy use in operation "O" except energy use for equipment/appliances (EQ) shall be compensated with renewable energy generation.

2. ZEB-O: Emissions related to all operational energy "O" shall be compensated for with renewable energy generation.

3. ZEB-OM: Emissions related to all operational energy "O" use plus embodied emissions from the materials "M" shall be compensated with renewable energy generation. The M includes the product phase of materials A1–A3, and scenarios for the replacement phase, B4 from the standard EN 15804 (2012), see Figure 4.2.

4. ZEB-COM: Same as ZEB-OM but also taking into account emissions related to the construction phase "C" are included and need to be compensated for. The phases included in the “C” are A4, transport to building site, and A5, construction installation processes, ref EN 15804 (2012), see Figure 4.2.

5. ZEB-COME: Similar to ZEB-COM but emissions related to a scenario for the end-of-life phase “E” have to be included and compensated for C2, transport and C4, disposal phases from the standard EN 15804 (2012), see Figure 4.2.

6. ZEB-COMPLETE: Emissions related to a complete life cycle emission analysis have to be compensated for, namely all the phases, A1–A5, B1–B5, as well as B6- operational energy use and C1–C4, from the standard EN 15804 (2012), see Figure 4.2.

Due to the long time scale of the Ådland development, different ambition levels were specified for different stages in the duration of the development according to the ZEB definition:

• The area as a whole should reach the ZEB-O level

• The lowest performance level for single buildings should be ZEB-O÷EQ

• Within 2 years of project start, the ambition level should be raised to ZEB-OM

• Within 4 years of project start, the ambition level should be raised to ZEB-COM

• For projects with ZEB-O÷EQ level, there should be minimum requirements with regards to emissions from materials

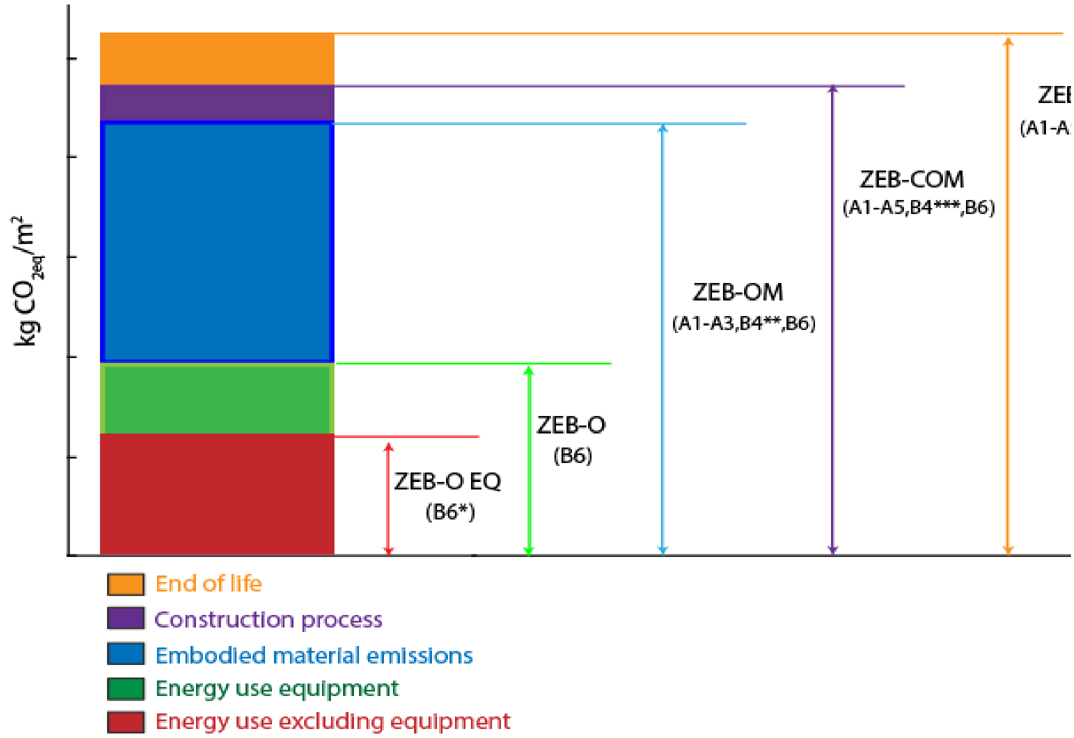


Figure 4.2 Graphical presentation of the ZEB ambition levels.

Figure 4.3 shows the different anticipated construction stages of the development (left), and an indication of the buildings that are designated to reach ZEB-OM level (right).

Figure 4.3 Overview of the Zero Village Bergen development showing left) construction stages and right) the buildings designated to reach ZEB-OM level. Image: Snøhetta.

Previous work has included a preliminary design and analysis of energy concepts for the buildings, as described in Risholt et al. (2014). The preliminary design of the dwellings encompass careful location to account for maximum solar and daylight access, and at the same time provide shielding from noise levels from the nearby airport.

The building envelopes and HVAC equipment are to be constructed according to the Norwegian passive house standard NS 3700 (2013). Two alternative energy supply systems were explored in the concept design phase: 1) A combination of a central ground source heat pump system and building integrated solar thermal collectors and photovoltaics, and 2) A combination of a centrally located biogas cogeneration machine combined with building integrated photovoltaic systems. See Risholt et al. (2014) for a further description.

The energy and load calculations described in Risholt et al. (2014) were limited and simplified in several ways:

The utility grid was basically treated as an infinite capacity battery; surplus electricity was assumed to be exported to the grid and re-imported in periods of net demand. In reality, onsite generation and loads have a temporal mismatch both at seasonal level, i.e. PV generation is concentrated in summer, and at hourly level. This mismatch may be considerable, especially in residential building since the peak demand is usually in the evening while PV generation peaks in the central hours of the day.

Furthermore, the aggregation of loads and PV production from several buildings was not studied. The PV installations in several buildings would peak their generation at approximately the same time due to the geographical proximity. In residential neighbourhoods this peak typically coincides with the time of minimum building load. The result is an aggregated peak of electricity exported to the distribution grid, which might challenge its limits or cause curtailment of the PV generation (Sartori *et. al.,* 2014).

In order to get a more detailed overview of the amount of PV electricity that may be generated, consumed, or exchanged between the buildings and the grid, a more comprehensive analysis needs to be carried out. The load profiles of the commercial buildings in the neighbourhood have been included in the analysis, in order to consider the export of PV electricity to these buildings.

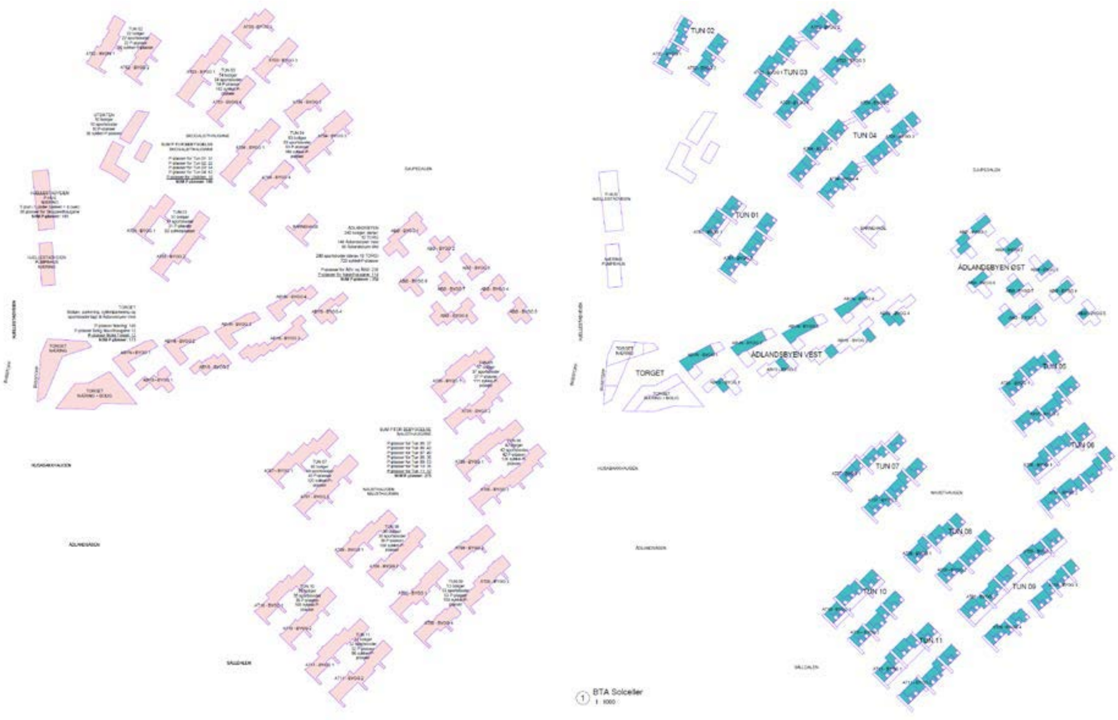


Figure 4.4 Graphical overview of left) floor area of buildings and right) roof area for solar cells. Image: Snøhetta.

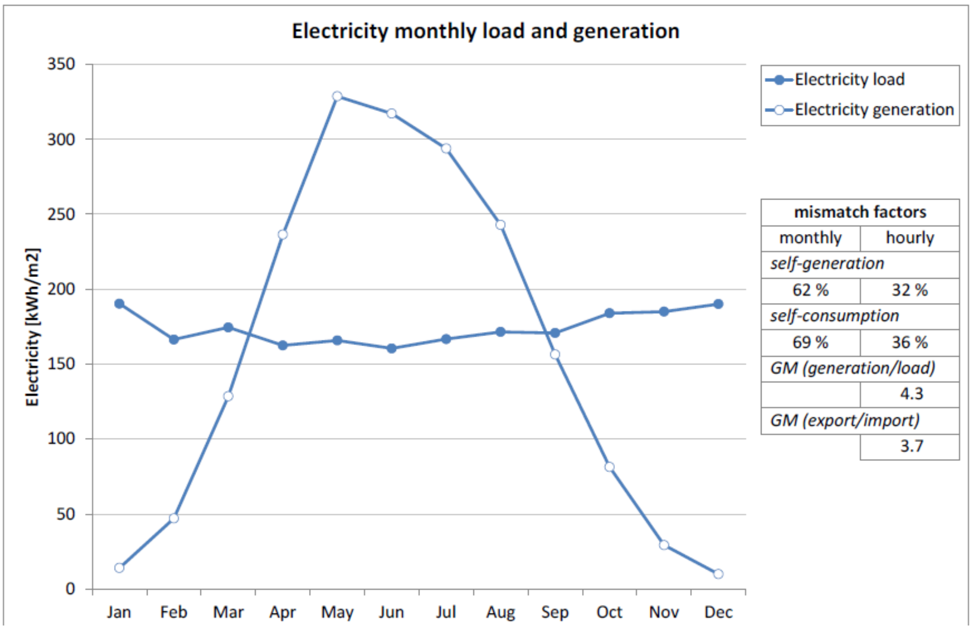


Figure 4.5 Monthly profiles of electric load (filled dots) and PV generation (hollow dots).

The heating system for the Zero Village Bergen is not yet decided. Namely, the two most probable options on the design table are either an all-electric solution with heat pumps in the buildings, or a local district heating system since a city district heating is not available in the area. The analysis of the mismatch between loads and PV generation offers useful insights for the next step in the design phase.

The analysis of alternative solutions for the Zero Village Bergen heating system will be performed in future work, as well as the analysis of the e-vehicles charging load considering different scenarios of e-vehicles penetration. The analysis of the mismatch between aggregated electric load and PV generation presented in this report provide useful insights on how to proceed in the next design step for this pilot project (Sartori et al., 2015).

Figure 4.6 Illustration of how Ådland will look like. Illustration: Snøhetta

Figure 4.7 Map / illustration Ådland

4.2. Analysis of goals and KPIs in Case study Ådland

An overview of the measures are listed in Table 4.1. The table includes the nationwide incentives from Chapter 3.3 (marked in grey).

Table 4.1 Measures relevant for the Smart Energy Community Ådland (national measures are marked in grey)

Level	Related themes	Instruments /measures	Effectiveness	Main goals	Main indicators
Country	Energy consumption Carbon emission	EU Energy Performance of Buildings Directive	Enforce (if it gets mandatory)	• Improving energy efficiency of buildings • New buildings: Nearly zero-energy by 2020	• Energy use (kWh) • CO_2 emissions
	Energy consumption Energy generation Grid capacity Smart management	White paper on energy policy towards 2030, Meld. St. 25 (2015-2016), Innst. 401 S (2015-2016)	Political goals	• 10 TWh reduced energy use in existing buildings • Flexibility and energy security	• Energy use (kWh) • Grid investment • CO_2 emissions
	Energy consumption Energy generation	Enova funding (Olje- og energidepartementet, 2015)	Encourage	• To trigger private investments in energy efficiency and renewable energy	• kWh triggered • NOK/kWh reduced or generated
	Energy generation	Prosumers (NVE, 2016), *Plusskundeordningen*	Enable	• Sale of <100kW el to grid from customers	
	Energy generation	Energy Act	Enforce	• Regulate production, distribution and use of electricity and district heating	
	Energy consumption	Licensing district heating concession areas (NVE)	Enforce Enable	• Regulate district heating	
	Smart management	Large-scale deployment of smart meters	Enforce	• Advanced Metering System (AMS) at all electricity consumers by 2019	• Nr. of AMS
	Smart management	Elhub: Central datahub for metered data and market processes in electricity market	Enable	• Simplify processes for all Balance Suppliers and Grid Owners	
	Smart management	White paper on ICT, Meld. St. 27 (2015–2016)	Enable	• Min. 100 Mbit/s available for 90 % of households by 2020	
	City environment	Pollution Control Act	Enforce	• Protect outdoor environment against	

				pollution and to promote better waste management	
	Green mobility	Strategy for charging stations and infrastructure for electrical cars (Enova, 2015)	Encourage	• To trigger private investments in infrastructure for electrical cars	• Nr. infrastructure • NOK/main road covered
↓↑					
District	City environment	Planning and Building Act: Regional and municipal planning	Enforce	Promote sustainable development in the best interests of individuals, society and future generations	
	Green mobility City environment	Development of infrastructure in Regional and County master plan, e.g. transportation	Enforce		
	City environment	Municipal master plan	Enforce	The municipality's overriding governing document, providing framework for development of municipal community and management of land use resources	
↓↑					
City **Bergen**	City environment	Planning and Building Act: Regional and municipal planning	Enforce	• Promote sustainable development in the best interests of individuals, society and future generations	
	Carbon emission Energy consumption	National planning guidelines for climate and energy planning in municipalities (Klima- og miljødepartementet, 2009)	Enforce	• Reduction of greenhouse gas emissions and increased use of environment-friendly energy in Municipalities	• CO_2 emissions • Energy use (kWh)
	Energy consumption	Norwegian district heating regulation	Enforce	• Possibility to impose on buildings an obligation to connect to a district heating system	
	City environment	Cultural Heritage Act	Enforce	• To protect archeological and architectural monuments / sites and cultural environments	
	Green mobility	Urban Environment	Enforce	• To enable more people to use public	• Public transport use,

		Agreement	Enable	transport, cycling and walking	cycling and walking
	Carbon emission Energy consumption	Green strategy for Bergen, with additions (Bergen kommune, 2016, Bystyret Bergen, 2016)	Political goal	• Fossil-free building sector in Bergen by 2030	• CO_2 emissions • Energy use (kWh)
	Grid capacity	Regional Power System Study for BKK-area (BKK Nett, 2016)	Enable	• Overview of current grid system and possible future developments and plans	
↓↑					
Neighbour-Hood **Ådland**	City environment	Planning and Building Act: Zoning plans	Enforce	• Sustainable development in the best interests of individuals, society and future generations	
	Carbon emission Energy generation Energy consumption Mismatch Green mobility Smart management City environment	Pilot districts / voluntary certificates / standards: • ZEN-pilot	Encourage	• Sustainable neighbourhoods • The greenhouse gas emissions related to the operation of the buildings should be zero on an annual basis. Also, the embodied emissions from construction materials should be accounted for, and for some of the dwellings, the ambition is to also include these in the zero emission balance.	
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Building	Energy consumption Energy production	Building code: Regulations on technical requirements for building works (TEK)	Enforce	• To ensure that projects complies with the technical standards for health, safety, the environment and energy	kWh demand/m^2 floor area Min. % RE heat
	Energy consumption Energy production	Energy performance certificates (EPBD)	Enforce	• Provide information on the energy efficiency of buildings and recommended improvements	kWh delivered/m^2 floor area
	Carbon emission Energy generation Energy consumption Smart management	Pilot buildings / voluntary certificates / standards: • Futurebuilt-buildings • ZEB-pilots • BREEAM-NOR	Encourage	• Sustainable buildings • Very low energy demand for heating •	• CO_2 emissions energy • CO_2 emissions materials • Energy demand

	City environment Citizens	• Fyrtårn • Low energy and passive house buildings standards			(kWh)
	Energy generation Energy consumption Smart management	Funding opportunities: • Enova • Husbanken	Enable	• Investments in energy efficiency and renewable energy • Solar panels (PV)	• kWh triggered • NOK/kWh reduced or generated
	Energy generation	Guidelines for solar energy on the facades	Enable	• Guidelines in line with Planning and Building Act	•

Goals and indicators for Bergen municipality

According to the "Green strategy" document developed in 2016, Bergen municipality states that their greatest challenge is anthropogenic climate change (Bergen kommune, 2016). The Green strategy was adopted by the City Council with some additions September 2016 (Bystyret Bergen, 2016). In order to solve the climate problem this requires efforts from private persons, the business community and the public sector. Sustainable growth in towns is a precondition for reaching Norway's climate targets. Bergen will be an engine for renewable energy and green, sustainable business. City Government's ambition is that Bergen will be the greenest big city in Norway.

Green urban development is the key to a sustainable city. Bergen must cooperate more closely with neighbouring municipalities about new development plans. The rate of expansion must be greatly increased to meet population growth. New development projects that contribute to an increase in transport emissions will, in general, not be approved.

The buildings represent a significant proportion of energy consumption in the city. City council will work to increase the use of more sustainable and space-efficient solutions like passive and energy-positive buildings, green roofs, energy-efficient ventilation and the use of solar energy. The community has a special responsibility to ensure that the public buildings is the most environmentally friendly.

The municipality shall require climate and environmental considerations in tendering processes, and emphasizing innovation. City council wants to improve the municipality's tendering and procurement expertise, and work for better quality control and monitoring of contracts.

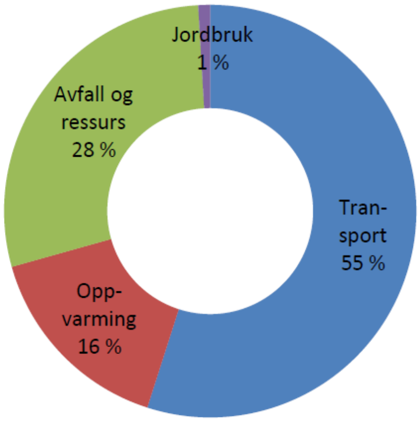
Bergen wants to show the way towards a sustainable planet, and therefore introduce 1.5-degree city in 2050 (Bergen kommune, 2016). The goal is that residents of Bergen will limit their carbon footprint in line with the UN climate treaty. Renewable energy, resource efficiency and recycling economy will help the city to grow without increasing the carbon footprint correspondingly.

The green strategy document states that Bergen municipality shall be a pioneer in environmental, sustainable development and adaptation to climate change. Environmental considerations should be an overarching principle in all its activities and planning. It should be easy to live green in Bergen.

For the goals to be achieved, all parts of the city shall be involved. Businesses, universities and colleges, and citizens of Bergen's major players. Bergen municipality's role as a municipal authority, facilitator and promoter and a good role model as a green business. The document "Green strategy" (Bergen kommune, 2016) shows the clear ambition Bergen has to reduce the contribution to greenhouse gas emissions.

Purchase of emission allowances are not included in the City of Bergen's strategy to become a fossil free society. Bergen will use the resources to create a climate smart society by implementing measures in their own operations and in the city. To achieve good and lasting results, Bergen will learn from others and develop workable solutions by collaborating regionally, nationally and internationally.

In June 2007, the City Council decided to establish a climate fund. A new Climate, Environment and Energy fund was established by conversion of existing climate fund in 2010. From 2015 the Climate, Energy and Environment Fund was replaced by a Climate and Environmental funds. Climate and Environment Fund is continued with NOK 500,000 per year in the budget. Subsidies from climate and environmental fund will contribute to achieve the goals of the "green strategy".



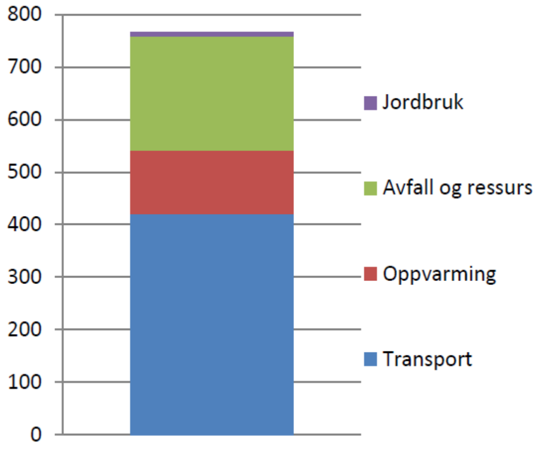


Figure 4.8 Greenhouse gas emission for Bergen in 2013. Agriculture (Jordbruk), Transport (Transport), Heating (Oppvarming) and Waste (Avfall og ressurs).

The reduction up to 2020 will be implemented by phasing out oil-fired heating, technological development that reduces emissions from transport and the effects of increased coordination, walk and bike.

The building sector in Bergen shall be fossil-free in 2030. Energy consumption in new and existing buildings and in street lighting will be streamlined.

- In 2020, fossil fuels shall not be used in homes or as primary energy in larger buildings, and the use of fossil gas should be reduced by 30 percent
- 70 percent of all buildings in Bergen shall have its own energy production in 2030
- District heating in Bergen will be fossil-free by 2025
- By 2030, there will be installed solar production (solar cells and solar collector) equivalent to 200W per capita (totaling 65 MW).
- Use of electricity in Bergen shall not increase until 2030, despite population growth. The phasing out of fossil fuels for heating and increased use of electrical vehicles will result in a reduction of 30 per cent per capita.
- Electricity use of public outdoor lighting in Bergen shall be reduced by 40 percent by 2020 and 80 percent by 2030, and all new lighting installations shall be enabled for power regulation.
- Increased use of environmental classification system such as BREEAM for larger buildings and areas.

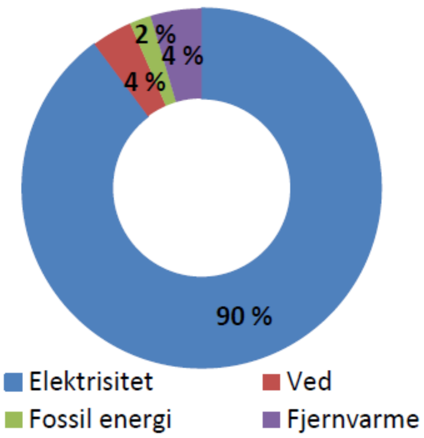


Figure 4.9 Energy use in buildings in Bergen, Electricity (Elektrisitet), Firewood (Ved), Fossile fuels (Fossil energi) and District heating (Fjernvarme).

The city of Bergen has stated that a holistic approach to urban planning and development is crucial for reducing greenhouse gas emissions. The location of the building determines how the transport to and from the building site has to be arranged.

Design and location of the building sets the terms for energy and flexibility. Choice of energy solution will determine the possibility of using renewable energy and sharing with neighbouring buildings. The building materials emit greenhouse gases in the construction process and have implications for energy use for the operation of the building. It is therefore important to have awareness of these factors at an early stage in the design process.

The pilot projects in the five-year government program Cities of the Future have given Bergen municipality valuable knowledge and experience. All pilot projects had as demands to halve greenhouse gas emissions in three areas:

- warming - by building with at least the passive house standard
- building materials -by use of climate-friendly materials
- traffic related to the building - through the localization and mobility planning

The lessons learned from the program show that it is important to achieve a comprehensive planning of areas and that localization and planning for the most climate-friendly mobility is as important as the use of materials and choice of energy source. The Green Strategy document states that it is therefore very important to look at the links between "Transport and mobility" and "Energy in buildings".

The Green strategy document – "Climate and Energy Action Plan for Bergen" discusses the following main strategies for buildings:

1. From fossil fuels to renewable energy
2. Energy efficiency
3. Energy and environmental quality in buildings and areas

This will be achieved by:

- In 2020, fossil fuels should not be used in homes or as primary energy in larger buildings, and the use of fossil gas should be reduced by 30 percent.
- In 2030, there is no use of fossil fuels for heating in Bergen.
- 70 percent of all buildings in Bergen shall have its own energy production in 2030.
- District heating in Bergen will be fossil-free by 2025.
- In Bergen there will be installed solar production (solar cells and solar collectors) equivalent to 200W per capita by 2030 (totalling 65 MW).

MEASURES TO START IN 2016

- Replacement of oil fires in both large and small buildings.
- Inform, facilitate and encourage the installation and use of renewable energy production.
- Requiring energy ratings (report on energy solutions) in relevant plans and develop functional templates for work.
- Cooperate with relevant stakeholders to increase the use of solar panels.

The Green Strategy document states that electricity Use in Bergen will not increase until 2020, despite population growth , the phasing out of fossil fuels for heating and increased use of electrical vehicles. This will provide a 20 percent reduction per capita.

- Energy to public outdoor lighting in Bergen shall be reduced by 40 percent until 2020 and 80 percent by 2030. All new lighting system should have the opportunity for power regulation.

Many of the measures for reducing energy consumption in buildings directed towards settlers. However, there are existing buildings that account for the greatest energy use, and that is where the potential for reducing energy use is highest. It is particularly important to implement energy efficiency measures for building refurbishment projects. This is most profitable, and easier to achieve good results. In addition, it is important to implement measure energy consumption measuring, control, regulation, heat recovery and other clean energy-efficiency measures. Many energy-saving measures are profitable after only a few years.

MEASURES TO START IN 2016

- Energy Portal for housing
- Energy consultancy for private individuals
- Especially focus on cooperatives in partnership with housing associations
- Facilitate own energy production in farm areas
- Focusing on eco-efficient and sustainable building yard among builders in Bergen including by such conferences and by setting requirements for energy assessments and GHG accounting
- Participating in national and international projects to increase awareness of sustainable urban development and implementation capacity
- Help increase knowledge about the use of materials with low CO_2 footprint , for example by developing courses
- Working for the long term to achieve zero emissions in new buildings and the development of new areas - for example, by considering the climatic and environmental consequences of investments and by facilitating emission transportation in new projects
- Encourage the use of environmental classification systems, such as BREEAM, both in developing areas and the construction of individual buildings. The BREEAM classification level should be at least "Very good"
- Consider fossil plant operation - both with regard to buildings and transport

4.3. Barriers and best-practices in Case study Ådland

For Case study Ådland, the following barriers and best-practices have been highlighted:

Barriers: Developing smart energy community in Ådland

- Municipal decisions in relation to the development of the area.
- Uncertainties related to how the site will be developed in the future.

- Ådland is not a priority area for development in the KPA.
- It is not close to the centre, and is not a prioritised densification zone.
- Developing the area will increase the city's "footprint".
- The area lies within a zone of air traffic noise higher than the allowed dB limit and may be health damaging.

- The area is defined as LNF zone. The area use in the zoning plan has to be changed.
- Using this property means that parts of the recreational zones will be repurposed for buildings.
- The collective transport connection is outside of walking distance.
- The development can lead to increased need for transit parking.
- The development will increase the demands on the existing infrastructure.

Lessons learned and Best-practices: Developing smart energy community in Ådland

- Bergen Municipality and ZVB has ambitious energy and climate goals.
- Active and ambitious developer (BYBO).
- The Green strategy was adopted by the City Council in 2016.

- Political determination is important, with common goals and multidisciplinary cooperation.
- Cooperation between agencies, businesses and the government is needed.
- Energy has to be considered from the start of the planning process, along with other infrastructure.

Barriers and best-practices are further described in the report for Task 2.1, which is developed in parallel to this report. In Task 2.1 there has been a number of interviews with stakeholders.

5. Case study Furuset, Oslo

Case Furuset, Oslo – En kort oppsummering av kapittelet

Kapittel 5 er en gjennomgang av pilotområdet Furuset i Oslo. Kapittelet gir en introduksjon til planene og ambisjonene for området, hvor Furuset er e forbildeprosjekt i Futurebuilt med mål om å halvere CO_2-utslippene i området. Videre gir kapittelet en oversikt over det identifiserte rammeverket på ulike skalaer, relevant for områdeutviklingen. Mål og indikatorer for Oslo kommune beskrives. Til slutt oppsummeres noen tanker rundt barrierer, lærdommer og gode praksiser.

5.1. Introduction to Case study Furuset, Oslo

Furuset in the area Groruddalen is an Oslo suburb from the 1970s (Oslo kommune PBE 2014). The development at Furuset was carried out according to municipal planning and included a nursing home, schools, nursery schools, a shopping mall (Furuset senter), commercial buildings, public transport (T-bane, a subway) and walk- and driveways in the whole area. The co-operative building society OBOS was responsible for building approx. 2800 apartments. Following the main development, several minor additional developments have been carried out, such as Furuset Forum in 1998, the extension of Furuset senter in 2001, the Ahmadiyya mosque in 2011 and the building of storage and production facilities along the motorway E6.

The shift from production industry to commerce and service industry has been the most important change in recent years. Oslo is growing rapidly. The population is expected to increase by more than 200 000 inhabitants until 2030. This will also lead to a new period of development for Furuset and Groruddalen.

The largest landowner in the Furuset area is Oslo municipality. The centre of the area is dominated by a few large private landowners whereas the properties in the rest of the area is mostly owned by nine different housing cooperatives. In addition, there are privately owned individual houses (Oslo kommune PBE 2014).

Furuset is served by subway, local busses, express and regional busses. A widespread network of foot- and cycle paths exists. The area is cut through by the motorway E6 with high traffic volume.

Per 1.1.2011 about 9500 people lived in the Furuset district as a whole. The population of Furuset comes from about 140 different nations. Within the boundary for the local development plan, there where per 2014 about 3800 residents and about 1500 jobs.

The district is referred to as a characteristic suburb in need of upgrading. During the "Groruddal campaign", the borough of Alna gave Furuset a boost. During the period of 2007 to 2013 the particular focus had been on improving living conditions in Furuset.

The planning and buildings authority started work on the development plan on Furuset in 2009. In December 2014 a proposal for a climate efficient urban development on Furuset was submitted for political decision (Oslo kommune PBE 2014).

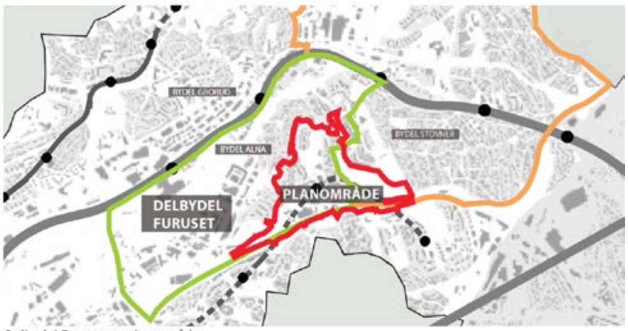


Figure 5.1 Map of Furuset

The purpose of the development plan was to further develop Furuset to become a climate efficient urban area with good public spaces, social spaces, a function blend and diverse neighbourhoods. The proposed plan prepares for a development of new buildings with a gross area of approx. 390 0000 m^2 such as housing, commercial buildings and social infrastructure within the planning area. This could result in building around 1700 apartments. If a lid is built over the motorway E6, the number of new built apartments can increase to around 2300.

Table 5.1 shows todays' situation at Furuset and two possible scenarios for development. Scenario 1 includes a lid over E6, scenario 2 is the planning proposal without a lid.

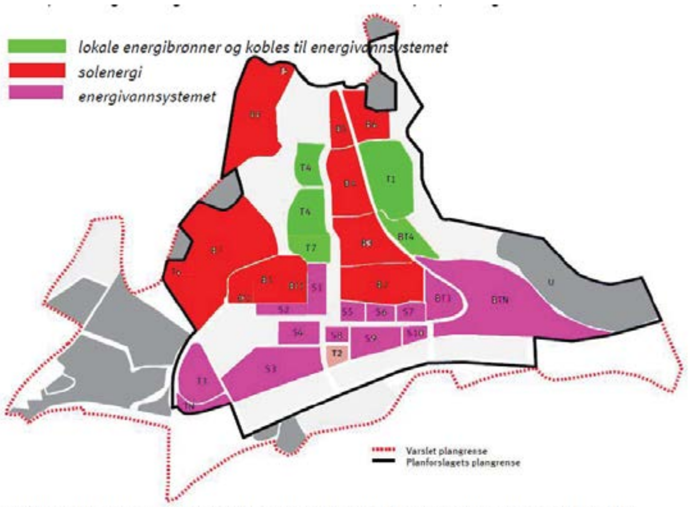
Table 5.1 Facts about the buildings in Furuset (Oslo kommune PBE, 2014b).

	Todays' situation (2014)	Planning proposal incl. lid over E6	Planning proposal without lid
Gross area in total	323 000 m^2	571 000 m^2	571 000 m^2
Housing, gross area	142 000 m^2	373 000 m^2	300 000 m^2
Number of dwellings	1 400	3 700	3 000
Gross area schools, nursery schools, sports facilities, cultural facilities, senior citizens' community centre	68 000 m^2	88 000 m^2	85 000 m^2
Gross area shopping mall	6 500 m^2	15 000 m^2	15 000 m^2
Gross area commercial / service area on ground floor (S1-S10)		15 000 m^2	15 000 m^2
Gross area office / commercial / storage	75 000 m^2	54 000 m^2	130 000 m^2
Number of floors (min-max)	2-9 floors	2-9 floors	2-9 floors

In the Climate and Energy strategy "The green change" (Oslo kommune, 2015) Oslo municipality describes its goal of reducing greenhouse gas emissions by 50 % by 2030 and be fossil-free by 2050.

Furuset is Oslo's designated priority project within the FutureBuilt-programme. The objective of FutureBuilt is to develop climate efficient urban areas and reduce greenhouse gas emissions. The ambition of Oslo municipality is to facilitate a reduction of CO_2 emissions in the area by 50 %. In order to achieve this goal, a sharp reduction in emissions associated with cooling and heating, both in new and existing buildings, is a presumption. One of the main initiatives is to establish a local energy grid at Furuset (Oslo kommune PBE, 2014b).

A micro-energy system consists of a local energy grid that supplies energy to users in the neighbourhood, but also can accept energy from the users (Etterstøl, 2015). Examples could be delivery of heat from a building that has a surplus, hot water from solar collectors or electric energy from solar cells.



Foreslått energiløsninger for byggefelt. Røde felter foreslås å utnytte solenergi. Grønne felter får lokale energibrønner og kobles til energivannsystemet. Rosa felt kobles til energivannsystemet og energibrønner for utveksling av energi mellom bygg med ulike behov. Gravlund, felt U inngår ikke i utkast til energistrategi.

Kilde: Oslo kommune PBE (2014a)

5.2. Analysis of goals and KPIs in Case study Furuset

Oslo and Furuset have developed a number of goals and KPIs. An overview of the measures are listed in Table 5.2. The table includes the nationwide incentives from Chapter 3.3 (marked in grey).

Details and information about the goals and indicators for Oslo and Furuset follow in this chapter and annexes.

Table 5.2 Measures relevant for the Smart Energy Community Furuset (national measures are marked in grey)

Level	Related themes	Instruments /measures	Effectiveness	Main goals	Main indicators
Country	Energy consumption Carbon emission	EU Energy Performance of Buildings Directive	Enforce (if it gets mandatory)	• Improving energy efficiency of buildings • New buildings: Nearly zero-energy by 2020	• Energy use (kWh) • CO_2 emissions
	Energy consumption Energy generation Grid capacity Smart management	White paper on energy policy towards 2030, Meld. St. 25 (2015-2016), Innst. 401 S (2015-2016)	Political goals	• 10 TWh reduced energy use in existing buildings • Flexibility and energy security	• Energy use (kWh) • Grid investment • CO_2 emissions
	Energy consumption Energy generation	Enova funding (Olje- og energidepartementet, 2015)	Encourage	• To trigger private investments in energy efficiency and renewable energy	• kWh triggered • NOK/kWh reduced or generated
	Energy generation	Prosumers (NVE, 2016) , *Plusskundeordningen*	Enable	• Sale of <100kW el to grid from customers	
	Energy generation	Energy Act	Enforce	• Regulate production, distribution and use of electricity and district heating	
	Energy consumption	Licensing district heating concession areas (NVE)	Enforce Enable	• Regulate district heating	
	Smart management	Large-scale deployment of smart meters	Enforce	• Advanced Metering System (AMS) at all electricity consumers by 2019	• Nr. of AMS
	Smart management	Elhub: Central datahub for metered data and market processes in electricity market	Enable	• Simplify processes for all Balance Suppliers and Grid Owners	
	Smart management	White paper on ICT, Meld. St. 27 (2015–2016)	Enable	• Min. 100 Mbit/s available for 90 % of households by 2020	
	City environment	Pollution Control Act	Enforce	• Protect outdoor environment against pollution and to promote better waste management	
	Green mobility	Strategy for charging stations and infrastructure	Encourage	• To trigger private investments in infrastructure for electrical cars	• Nr. infrastructure • NOK/main road

		for electrical cars (Enova, 2015)			covered
↓↑					
District	City environment	Planning and Building Act: Regional and municipal planning	Enforce	Promote sustainable development in the best interests of individuals, society and future generations	
	Green mobility City environment	Development of infrastructure in Regional and County master plan, e.g. transportation	Enforce		
	City environment	Municipal master plan	Enforce	The municipality's overriding governing document, providing framework for development of municipal community and management of land use resources	
↓↑					
City **Oslo**	City environment	Planning and Building Act: Regional and municipal planning	Enforce	• Promote sustainable development in the best interests of individuals, society and future generations	
	Energy consumption	Norwegian district heating regulation	Enforce	• Possibility to impose on buildings an obligation to connect to a district heating system	
	Carbon emission Energy consumption	Oslo Climate and energy strategy (ref. Chapter 5.2)	Political goal	• Reduce climate gas emissions with 50 % within 2020 and 95 % within 2030	• CO_2 emissions • Energy use (kWh)
	Carbon emission Energy consumption	Strategy for more energy efficient and climate neutral buildings in Oslo	Encourage	• More energy efficient and climate neutral buildings in Oslo	• CO_2 emissions • Energy use (kWh) • Energy production
	Carbon emission Energy consumption	Pilot cities • Cities of the Future • C40 • Lighting house application	Encourage	• Sustainable cities	• CO_2 emissions • Energy use (kWh)
	Grid capacity	Power System Study for	Enable	• Overview of current grid system and	

		Oslo (Hafslund Nett, 2016)		possible future developments and plans	
	City environment	Cultural Heritage Act	Enforce	• To protect archeological and architectural monuments / sites and cultural environments	
	City environment	Coordination of digging in the city	Enforce	• Coordinated digging when establishing broad band, electricity, district heating, etc.	
	Energy generation	Guidelines for solar energy on the facades	Enable	• Guidelines in line with Planning and Building Act	
	Green mobility	Oslo Package 3	Enable	• Political agreement and plan for road and public transport infrastructure in the period 2017-2036	
	City environment	Forbidden to burn heavy fuel oil in Oslo and Drammen (Pollution Control Act § 8-4)	Enforce	• Protect outdoor environment against pollution	
	Energy consumption Energy generation	Grants from the Municipal Energy fund (*Energifondet*)	Encourage	• To trigger private investments in energy efficiency and renewable energy	• kWh triggered • NOK/kWh reduced or generated
	Research and Innovation	Research projects, e.g. ZEN, PI-SEC and H2020	Encourage	• Increased knowledge and innovation	
↓↑					
Neighbour-Hood **Furuset**	City environment	Planning and Building Act: Zoning plans	Enforce	• Sustainable development in the best interests of individuals, society and future generations	
	City environment Carbon emission	Furuset goal and indicators: Områderegulering (ref. Chapter 5.2)	Enforce Enable	• 60 % reduction in climate gas emissions	
	Carbon emission Energy generation Energy consumption Mismatch	Pilot districts / voluntary certificates / standards: • Futurebuilt-area • ZEN-pilot • Fyrtårn in Oslo	Encourage	• Sustainable neighbourhoods	

	Green mobility Smart management City environment				
	Research and Innovation	Research projects, e.g. ZEN, PI-SEC and H2020	Encourage	• Increased knowledge and innovation	
↓↑					
Building	Energy consumption Energy production	Building code: Regulations on technical requirements for building works (TEK)	Enforce	• To ensure that projects complies with the technical standards for health, safety, the environment and energy	kWh demand/m² floor area Min. % RE heat
	Energy consumption Energy production	Energy performance certificates (EPBD)	Enforce	• Provide information on the energy efficiency of buildings and recommended improvements	kWh delivered/m² floor area
	Carbon emission Energy generation Energy consumption Smart management City environment Citizens	Pilot buildings / voluntary certificates / standards: • Futurebuilt-buildings • ZEB-pilots • BREEAM-NOR • Fyrtårn • Low energy and passive house buildings standards	Encourage	• Sustainable buildings	• CO_2 emissions energy • CO_2 emissions materials • Energy demand (kWh)
	Energy generation Energy consumption Smart management	Funding opportunities: • Enova • Husbanken	Enable	• Investments in energy efficiency and renewable energy	• kWh triggered • NOK/kWh reduced or generated
	Energy generation Energy consumption	Funding opportunities: • Oslo municipality	Enable	• Investments and loans in energy efficiency, renewable energy and change from fossil fuels	

Municipal planning in Oslo

Under the Planning and Building Act, municipalities are responsible for coordinating the physical, economic, social and cultural development of the areas under their control through an ongoing programme of municipal planning. Meanwhile the county council has responsibility to coordinate central government, county-council and municipal planning activities within the county.

There are national and regional expectations to the municipal planning. In a letter, the County Council is summarizing their expectations to the municipal planning in 2016 (Fylkesmannen i Oslo og Akershus, 2016).

The Municipal master plan is the municipal's overriding governing document, providing framework for development of municipal community and management of land use resources. Oslo Municipal master plan is entitled "Oslo Towards 2030—Smart, Safe and Green" (Oslo Municipality, 2015). Climate and environmental policy has focus in the master plan, as one of in total three priority areas. The master plan is describing how the future Oslo will be a more compact city.

Goals and indicators for Oslo municipality

The ambition of Oslo is to reduce greenhouse gas emissions by 50 % by 2020 and by 95 % by 2030, compared with the level of 1990 (Byrådet Oslo kommune, 2016). These are more ambitious climate goals than published in the Climate and Energy Strategy "The green change", where the goal was to reduce greenhouse gas emissions by 50 % by 2030 and be fossil-free by 2050 (Oslo kommune, 2015). The reduction of 50 % by 2030 was related to the level of 1991 and corresponds to a reduction of 600 000 tonne CO_2. Within 2020, climate budgets and detailed plans of action for the implementation of initiatives for the period 2020-2030, will be in place (Byrådet Oslo kommune, 2016).

The focus of this report are energy related goals and indicators. A complete list of the strategic objectives can be found in the Climate and Energy Strategy "The green change" (Oslo kommune, 2015).

Energy related goals are:

Strategic objective 5. Oslo will facilitate logistics where transport needs are reduced. From 2025 every new car and van in Oslo will be rechargeable hybrid vehicles or run on renewable fuel.

- Important measures to achieve the objectives include the development of infrastructure. Oslo municipality will facilitate and contribute to the establishment of energy stations which ensure access to renewable energy for vehicles (charging stations, hydrogen and sustainable low emission bio fuel).

Strategic objective 9. The use of fossil fuels for heating in Oslo will be replaced by renewable energy sources for heating by 2020.

- To achieve a quicker phase-out of fossil fuels for heating in buildings, Oslo will introduce and enhance incentives for using alternative energy sources for heating. Examples of this could be the use of incentives like support and development schemes in the Climate and Energy Fund, the targeted use of information about the existing fuel tanks, application assistance when applying to Enova, communication and campaigns.

- Oslo municipality will also work to ensure that the Government intensifies its instruments for a quicker phase-out of fossil fuels.

Strategic objective 10. Oslo municipality will work to reduce energy use in buildings by 1.5 TWh by 2020 (compared with the reference forecast). This will be achieved by using national and local measures.

- Achieved energy savings are measured and compared with a projection (reference forecast). This projection is based on a scenario where no measures for energy efficiency are implemented. The targets for energy efficiency will be achieved by a combination of measures like guidance, campaigns and by coordinating policy instruments between Oslo's Climate and Energy Fund and Enova. For municipal buildings, measures will be effectuated to meet Oslo's strategy for energy standards for both new and existing buildings (according to the agreed Strategy for energy efficient and climate friendly buildings). Stricter energy standards like Zero energy buildings or Energy producing buildings will also encourage greater use of solar energy (PV panels or solar collectors).

Strategic objective 11. An overall plan for waterborne energy (heating and cooling plan) for Oslo will be established by 2020.

- Infrastructure for waterborne energy (district heating, cooling and local waterborne energy) will help to ensure flexibility and security of supply of Oslo's energy system. Waterborne energy shall ensure the exploitation of available energy resources that are not utilized, rather than the use of energy resources like electricity, which has high demand. Establishing a Strategic energy plan for waterborne energy (heating and cooling) for Oslo by 2020 will ensure efficient, robust and secure heating supply and a continuing robust interaction between electric and waterborne energy systems.
- Within future energy systems, the transformation of transport into a renewable solution where vehicles make greater use of electrical energy will create a greater demand for electrical energy.
- An overall plan for waterborne energy will also include cooling, as there will be a growing demand for this until 2050. An overall energy plan will ensure that infrastructure for waterborne energy is included in the early phase of urban planning. The energy plan will allow for better utilization of thermal energy, local energy sources and flexibility between electricity and district heating. Future developments in Oslo will have to meet the requirement of waterborne energy for heating and cooling.
- If local energy utilization can be accomplished by ensuring the protection of local environmental needs and resilience of the energy system, then such utilization shall be prioritized.
- FutureBuilt Furuset will be carried out as a beacon project for local energy efficiency and the development of a sustainable micro energy system.
- The energy planning in Oslo will facilitate that the micro energy system will be as robust as the current central systems for electricity and waterborne energy. Security of energy supply is fundamental and has to be prioritized to ensure a well-run society.

Strategic objective 13 (new by Byrådet Oslo kommune (2016)). Oslo municipality will strengthen strategic climate work by integrating climate budgets in the municipal budget process.

Strategic objective 14. Oslo municipality will practice green public procurements. Specific climate related requirements apply to enterprises owned by Oslo municipality.

- Relevant measures could be to prepare procurement standards that promote the development and use of new sustainable technology, and clear framework. Municipal agencies will continuously participate in the development of different clusters to generate innovative solutions and contribute to the development of green and profitable businesses.

Strategic objective 15 (revised by Byrådet Oslo kommune (2016)). Oslo municipality will work closely with citizens, businesses, knowledge institutions, organizations and other public authorities to develop and implement better climate related solutions.

- The residents of Oslo shall be involved in the green change to develop and implement better climate related solutions.
- Oslo municipality will establish joint climate related initiatives together with other major urban areas in Norway and the rest of the greater Oslo area in order to achieve common commitment to greenhouse gas reduction.
- Oslo municipality will seek partnership with academia and industry to ensure that innovation and development is a priority in climate and energy related efforts in the greater Oslo area and in interaction with other cities, nationally and internationally.
- Oslo municipality will establish a system for climate management (planning, execution and reporting of climate efforts in Oslo). An efficient and coordinated organization of the strategic work in this area will also be established. Objectives, planning and performance monitoring for climate efforts will be incorporated in the day-to-day municipal governance. Progress, results and gains are reported annually to Oslo City Council.

Strategic objective 16 (revised by Byrådet Oslo kommune (2016)). Oslo municipality will be a pioneer and carry out beacon projects that may trigger significant emission reductions in the future.

- A. Energy stations: Oslo municipality will contribute to the establishment of energy stations as beacon projects in collaboration with industry. Today's petrol stations will have to be replaced gradually with energy stations supplying renewable fuels such as electricity, hydrogen and sustainable low-emission biofuel.
- B. Micro energy system at Furuset. The development of Furuset suburb is considered a beacon project for the development of micro energy system in a local area with local energy resource utilization. Local waterborne energy distribution (a micro grid) will exploit local low temperature energy resources (geothermal energy, sea, drains etc.). The micro grid can be connected to the central district heating system. It can also exist as a separate entity, which eventually may be linked to the central district heating system.

In addition, the draft of the Climate and Energy Strategy for Oslo (Oslo kommune PBE, 2015a) includes a number of goals and initiatives for various topics. The objectives and measures of the building sector and the sector for energy production and distribution is described in Annex 1 (in Norwegian). The measures are in addition presented with measure number, description and deadline. This information can be found in Annex 2.

Strategy for more energy efficient and climate neutral buildings in Oslo

In 2012, Oslo commissioned Xrgia and Energidata Consulting to draft a strategy for more energy-efficient and climate-neutral buildings in Oslo until 2020 (Ingeberg and Moengen, 2012).

Oslo city council considered the strategy in 2014 (Bystyret Oslo kommune, 2014) and adopted a series of measures to phase out the use of oil burners, support the installation of solar cells and improve the energy efficiency of buildings in Oslo.

1. The City Government is requested to intensify efforts to ensure that measures and subsidies by Enova and the Climate Fund for phasing out oil burners and improvement of energy efficiency of buildings supplement each other.
2. As a minimum requirement, the rehabilitation of public buildings should aim at making the building more environmentally friendly and meet the requirements for passive house, low energy or energy-positive buildings.
3. The City Government is requested to facilitate a measures plan to improve energy efficiency in existing buildings within 2020.
4. A subsidy scheme for the installation of solar cells in buildings shall be prepared through the Climate and Energy Fund.
5. It is requested that the City Government increasingly instruct developers on demands for energy standard for sales or site planning.
6. The City Government is requested to annually report on progress regarding to phase out oil burners, energy efficiency and introduction of passive houses in Oslo.
7. The strategy for energy efficient and climate neutral buildings is taken into consideration.

Power System Study for Oslo

Hafslund has done a Power System Study for Oslo (Hafslund Nett, 2016). The stydy includes the power systems in Oslo, Akershus and Østfold.

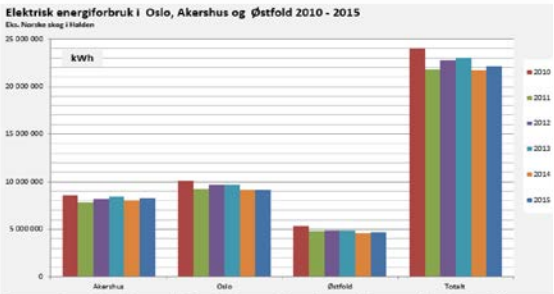
The main goal for the regional grid is to continue a cost-effective development of the grid. In the long term, the goal is that the entire regional grid is changed from the current four voltage levels 33, 50, 66 and 132 kV to 132 kV.

Furthermore, the objective is to see the distribution grid and the regional grid in context. I.e. to choose the most cost effective measures. With that regard, measures in the distribution grid can replace measures in the regional grid and vice versa.

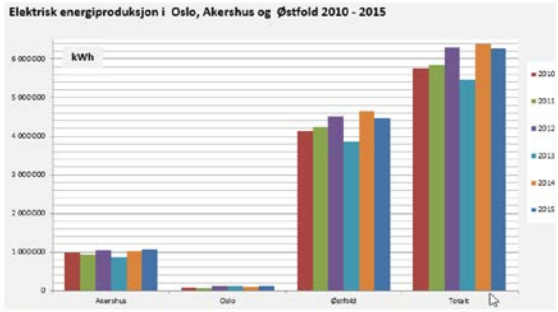
The power grid will be dimensioned based on the highest consumption that can occur every ten years.

The majority of the power in hours with the highest consumption comes from the national grid. The power produced in the planning area is mainly produced in the hydropower plant in Glomma. During an average year, the production is just above 20 percent of the electrical energy used.

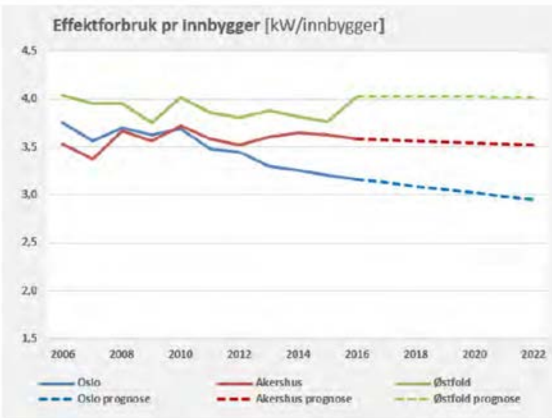
The study describes an increasing interest for PV-installations (solar cells). Per May 2016 about 130 installations are included in Haflund's grid. To be part of the Prosumers arrangement (*plusskundeordningen*), the input has to be less than 0.1 MW. Hafslund evaluates these types of installations to have no or little significance on how the regional grid will be dimensioned within the study period.



Figuren viser elektrisk energiforbruk i de tre fylkene i utredningsområdet de siste 6 årene



Figuren viser elektrisk energiproduksjon i de tre fylkene i utredningsområdet de siste 6 åren



Figuren viser utviklingen av maksimaleffekt pr innbygger for Oslo, Akershus og Østfold

Figuren viser prognoser for utvikling av maksimaleffekt i Oslo og Akershus. Kilde Statnett og Hafslund 2011

Heating is largely based on electricity. Over the last years district heating has increased considerably. In 2015, district heating production in Oslo was about 1.7 TWh. District heating is expected to increase also in the future.

To meet the challenges of increased demand for power in Oslo and Akershus, Statnett has initiated the project "Grid Plan Greater Oslo" (*Nettplan Stor Oslo*) where plans are made for development of the national grid toward 2050.

The Power System Study for Oslo state that the grid at Furuset is in need of upgrading.

Debating changes in the Norwegian district heating regulation

The district heating regulation state that the municipality can impose on buildings an obligation to connect to a district heating system. This is further described in the Municipal master plan in Oslo.

March 2016, Oslo commented on suggested changes in the district heating regulation (THEMA consulting and Norsk Energi, 2015). In the hearing document from Oslo municipality, Oslo is focussing on the following elements:

- It is a central planning tool for Oslo to be able to impose on buildings an obligation to connect to a district heating system,
- Utilizing waste heat in district heating systems should be a premise when discussing district heating, from e.g. waste incineration, buildings and production industry,
- District heating infrastructure is important for energy security and for optimizing energy and power use,
- It is important to see the electricity infrastructure and the district heating infrastructure in context to each other,
- Oslo would like to take over the licensing authority for district heating concession areas in the municipality.

Strategy for waste

Oslo is developing a new strategy for waste, for the development until 2025 (Renovasjonsetaten, 2016). In the strategy, waste is looked upon as a resource, which can be used as an input in local industry. The aim is that all waste will be recycled or reused. To produce energy from waste is a part of this picture.

Other relevant regulations in Oslo

International cooperation and commitments

Oslo har forpliktet seg internasjonalt gjennom The Aalborg Commitments og C40-nettverket. Søknad for å bli utvalgt til den neste European Green Capital er avgitt (Oslo kommune PBE, 2014a).

City environment: Coordination of digging in the city

Oslo municipality has developed guidelines for coordinated digging when establishing broad band, electricity, district heating, etc. (Oslo kommune, 2009). The aim of the process is that the municipality gain insight in existing and planned infrastructure, which makes it possible to initiate cooperation and joint planning of ditches.

Energy generation: Guidelines for solar energy on the facades

Oslo municipality has developed guidelines for solar energy on facades, in line with the Planning and Building Act (Oslo kommune PBE, 2015b). The guidelines describe when a building owner need to apply to PBE before adding a solar energy system to the facade.

Green mobility: Oslo Package 3

Oslo Package 3 is the political agreement and plan for road and public transport infrastructure in the period 2017-2036 (Oslo and Akershus FK, 2016). The objective of agreement is to develop "a transport system that is safe, promotes added value and contribute to the transition to a low-emission society".

Goals and indicators in the Quality programme for Furuset

As part of the area regulation for a climate efficient urban development at Furuset, the Planning and Building Services have developed a Quality programme (Oslo kommune PBE, 2014a). The Quality programme shows the level of ambition, set quality and environmental objectives and standards for Furuset and shows principles for the preparation of public space and infrastructure.

The Quality programme is complimentary to the area regulation, planning map and planning descriptions. The Quality programme provides the municipality, developers and other stakeholders with a common tool for the implementation of projects with a high environmental and quality profile. The Quality programme shall facilitate efficient processes and enable good individual projects. The programme is a guideline for all municipal procedure.

Goals and indicators for FutureBuilt

Oslo is a FutureBuilt area. The aim of the municipality is therefore to carry out a number of individual projects at Furuset, both building and infrastructure projects, within the FutureBuilt programme.

The vision of FutureBuilt is to show that it is possible to develop climate neutral urban areas and architecture with a high standard. Through pilot projects, contribution to innovation and being an international showcase, FutureBuilt will provide good examples.

Different area projects within FutureBuilt have different quality criteria. Areas shall be developed with a long-term goal of greenhouse gas emissions at a lowest possible level. The objective FutureBuilt aims at is a 50% reduction of greenhouse gas emissions compared with current emissions. Furthermore, area projects shall be located close to high frequency public transport hubs for rail transport. A broad public policy system including legal, economic and administrative instruments, will be developed.

The use of a Greenhouse gas protocol

A greenhouse gas protocol shall ensure the documentation of the reduction of greenhouse gas emission and processes for climate-friendly choices. FutureBuilt has developed calculation rules for area and building projects (Klimagassregnskap.no). Calculations for the Furuset area show that by implementing the initiatives provided in the calculation, greenhouse gas emissions from that area can be reduced by 60% compared with today's levels and by 40% compared with the reference scenario. This substantial greenhouse gas cut depends on all individual projects following the intentions of the area regulations.

The greenhouse gas protocol should be prepared at three stages for all individual projects: during the design, in connection with the general application/"as built" and two years after completion. Those stages correspond with the stages in the quality programme and quality monitoring plans. Given that quality monitoring plans and the greenhouse gas protocol should be prepared at the same stage, it is recommended that environment- and quality monitoring, reports on chosen indicators and preparation of the greenhouse gas protocol is considered as a whole. When using BREEAM NOR, a summarizing memorandum on main results and concise explanation/justification of the choices made for transport, energy and material use in line with FutureBuilt documentation requirements (see www.futurebuilt.no) shall be submitted.

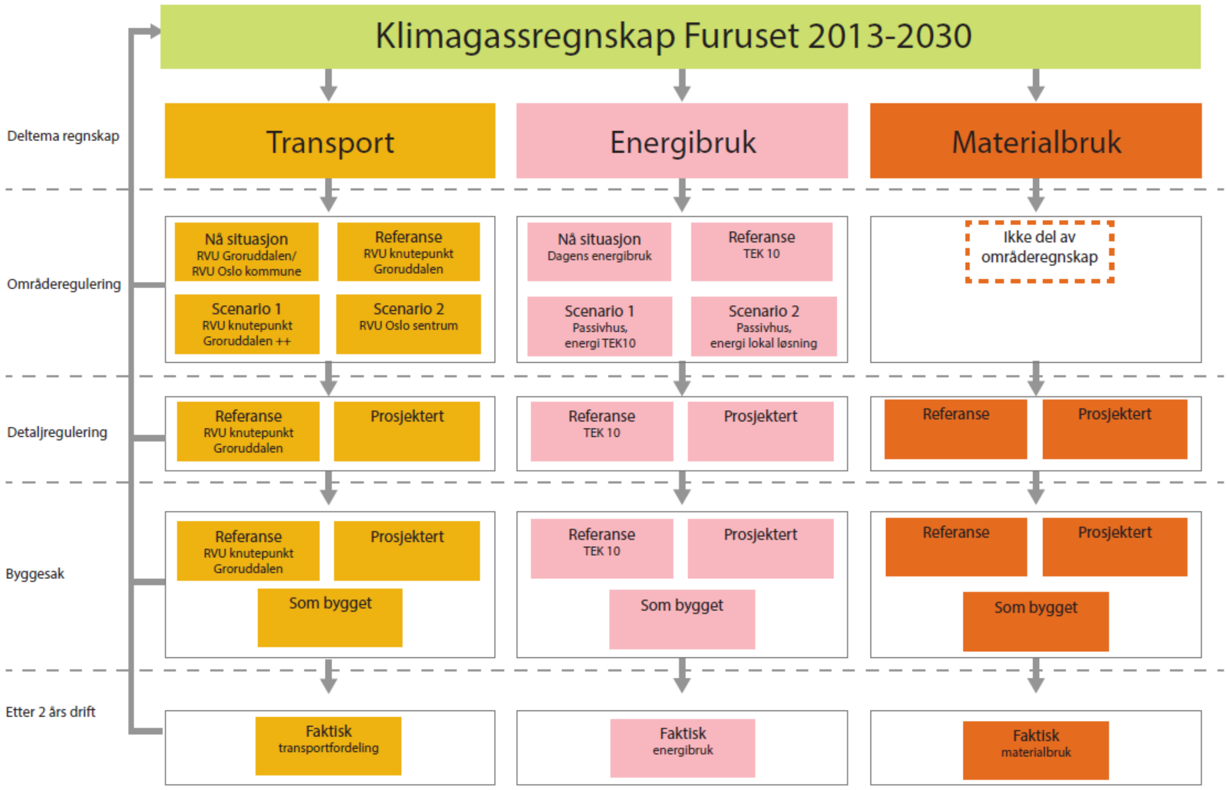


Diagram over oppbygningen for klimagassregnskapet for Furuset: Skjemaet viser oppbygningen av klimagassregnskapet for Furuset etter FutureBuilts regneregler. I områdereguleringen er det utarbeidet en beregning for hele området. Når detaljreguleringer og byggesaker utarbeides og bygg ferdigsstilles utarbeides det mer detaljerte regnskap, som etterhvert rapporteres inn i regnskapet for hele området.

Priority areas for environment and quality

To achieve the vision that Furuset will be a *Smart leading suburb,* it is essential that projects at Furuset aim high in the following areas:

- Urban environment and architecture
- Use of material
- Energy
- Transport

These priority areas correspond with the general objectives in the planning process for Furuset and with the most important quality criteria for individual projects in FutureBuilt. For the latter three targets greenhouse gas emissions is a principal parameter. The aim is 50% reduction in emissions within 2030 compared with today's level and a gradual progress towards climate neutrality.

The objectives for each priority area are described with targets. These are further described in Annex 2. The complete list of goals and indicators can be found in the Quality programme document (Oslo kommune PBE, 2014a).

Within each priority area, a number of initiatives are proposed. Those initiatives could be the basis for achieving the objectives in each priority area. The initiatives list is non-exhaustive and should be considered for each individual building project.

The results of initiatives chosen for each project will be measured through a given set of indicators. Additional indicators can be added.

The focus of this report is energy related goals and indicators. In Annex 2 it is outlined if the indicators for each target is considered relevant to the project PI SEC. This depends on whether the indicator is energy relevant or not.

However, for Smart Energy Communities, also goals and indicators not directly relevant to energy can be important. This is clear when defining Smart City in relation to energy in Chapter 2.2. Examples of such closely related areas in Furuset are:

- Related to Urban environment and architecture, living area efficiency is a goal. This impact the energy use. Also attractive shopping areas within short distances are relevant for the use of transportation, which again effect the energy use.
- For Material use, there is a goal of at least 50% reduction of greenhouse gas emissions from the use of materials in new buildings and rehabilitation, compared with current practice. Materials with lower greenhouse gas emissions also usually have lower energy need during production.
- For Transport, local charging stations for electricity is directly related to the local energy system. Also other change in transportation is affecting the energy use, if it is fossil fuel, biofuels, electricity or hydrogen.

For the priority area **Transport**, especially the following goals are relevant:

- Changes in travel habits and choice of transportation should reduce the greenhouse gas emissions with at least 50 %, compared to the current practise.
- At least 10 % of the parking spaces will have charging facilities for electrical cars.

For the priority area **Energy,** the motivation, goals, measures and indicator from the document Kvalitetsprogram are described below (Oslo kommune PBE, 2014a).

Motivation for the Priority area Energy at Furuset

To achieve the objective of significant cuts in greenhouse gas emissions, there is great potential for a more efficient energy use in buildings and to produce local energy, which will release energy in the electricity supply for other purposes like transportation. In recent years, a great progress in the energy standard of buildings has been made. It is possible to build houses that produce more energy than they use.

In order to cut greenhouse gas emissions from energy use by at least 50 % at Furuset, ambitious energy standards have to apply: preferably at least passive house standard for new buildings and low energy for existing buildings. By establishing a common waterborne energy system, energy can be exchanged between different buildings and be stored in the ground. A common grid will ensure that the system efficiency is increased significantly and that building owners / operators in the area will save considerable expense.

Goals for the Priority area Energy at Furuset

- 50% reduction in GHG emission for energy use at Furuset within 2030.
- High energy standard for all new buildings, at least passive house standard
- Energy standard equivalent low energy for existing buildings

- At least 90% of the demand for heating and cooling shall be met with local, renewable energy sources
- Balanced common waterborne distribution for heating and cooling should be developed to cope with the demand for seasonal storage of energy.
- Effective, dynamic solutions shall be chosen for outdoor (sports)facilities, lighting and infrastructure (incl. possible street heating) in urban spaces.

Suggestions, measures for the Priority area Energy at Furuset

- Integrated energy plan describing stages, investments and actions for reduction of energy use
- Smart Grid for Furuset. The installation of energy meters, which measure consumption of heating energy, cooling energy and electrical energy for each unit in any facility, is to be desired. Energy measurement and preferably a common waterborne energy grid is to be used to optimise cuts in energy consumption and costs.
- Heat pumps and geothermal energy can be used to produce heating/cooling energy and to store excess energy.
- The City Council's decision on passive house standard for public buildings is the minimum standard. In new projects, more ambitious solutions, such as energy-positive buildings, shall be tested.
- Public property managers and developers use energy saving contracts (EPC) in order to reduce energy consumption and energy costs.
- Visualize the energy consumption in the national grid and Furuset at Trygve Lies square/library.
- Detailed planning of the buildings, high quality workmanship and pressure tests as incentive and indicator.
- Organize courses in energy efficiency in existing buildings.
- Use of LED lighting and other modern technologies in outdoor lightning.
- Building integrated solar cells and solar collectors for power/heat production in new buildings and in major redevelopments of existing buildings, e.g. for domestic hot water heating.
- Pilot projects in existing housing cooperatives for change from electrical heating to waterborne heating/cooling.
- Pilot projects in existing housing cooperatives with solar collectors for domestic hot water heating.
- Efficient ventilation systems, possibly natural ventilation, shading and utilization of solar radiation for heating is used.
- Use of www.klimagassregnskap.no and FutureBuilt's calculation methods as planning tool.

Indicators for the Priority area Energy at Furuset

Results from climate gas calculations for stationary energy use on area and project level.
Percentage of buildings with lower energy demand than current standard.
Percentage of the total energy consumption coming from local, renewable energy sources. Percentage of energy supply in existing housing cooperatives coming from solar energy.
System efficiency of the common waterborne distribution grid.
Reporting according to BREAM NOR.

Goals for lighting at Furuset

There are also developed principles for lighting at Furuset, with the following goals:

1. The lighting should emphasize Furuset center, Trygve Lies square, Bygata and Østmarkalmenningen.
2. The lighting shall be energy efficient. Brightness shall be adapted to the seasons and the time of the day.
3. In public places, the lighting will focus on road safety, mobility and safety.
4. The lightning has to operate efficiently but also be a positive aesthetic contribution to the public space.

Low-temperature waterborne energy system

A feasibility study has evaluated the waterborne energy system at Furuset (Etterstøl, 2015). The table below includes entries related to goals from this feasibility study.

In this report, the goals are sorted based on scale; From building level to country-level.

In Annex 4 there are further information from the report, e.g. definitions, preconditions and indicators.

Goals for the micro energy system	Scale of goal			
	Buildings	Neighbour-hood	City	Country
Energy consumption				
Reduced use of energy				
Lower temperatures for the central heating system, to be able to utilize low-temperature heating sources				
Replacing electricity (high exergy) with low-exergy heating sources: Electricity released from heating buildings can be used for other energy needs in eg. green mobility				
Energy generation				
Utilisation of local energy resources				
Local electricity production, eg. from solar cells				
Increased flexibility, using different energy sources				
Using both the local and the central energy resources as sustainable and efficient as possible				
Smart management. Mismatch				
Local energy grid can both deliver and receive energy (el + heat)				

Waterborne heating systems: Flexibility to change to other heating sources when the load on the electricity grid is high				
Reduce the need for upgrading the capacity in electricity grid into the area				
Reduce the need for upgrading the capacity in district heating systems into the area				
Current robustness in the central systems are maintained				
In periods with surplus of electricity production, stationary batteries can store electricity for later use				
Also local production and management of energy can contribute to maintaining a balance with the central energy system, in addition to the traditional responsibility in the central system, ensuring such balance between production and consumption				
Green mobility				
Transportation: Electricity replace fossil fuels				
In periods with surplus of electricity production, batteries in cars and busses can store electricity for later use				

The study of Etterstøl (2015) is based on two previous studies on the energy system in the same area by Cowi in 2012 and Norconsult in 2014. A number of parameters were considered, e.g.

- Available area in square meter
- Composition of different housing
- Population
- Number of persons per household
- Area development
- Energy sources and energy systems in buildings (heating, domestic hot water, ventilation)
- Energy performance certificates
- Measured energy consumption (electricity, district heating, other)
- Power demand
- Share of rehabilitation
    - Other possible measures in existing buildings are listed in the report
- Conversion of energy systems in existing dwellings
- New buildings. TEK, passive house standard
- Distribution high-grad / low-grade energy

The study of Norconsult (2014) is based on a number of calculations for energy consumption based on the following sources:

- Their own energy calculation for typical buildings within the planning area

- Experience from measured energy consumption in selected buildings within the planning area
- Assessment, based on the density of population and area development
- Energy frame requirements (*Energirammekrav*) in TEK 10, energy requirements for passive houses and low-energy houses
- Norconsult's experience data

Based on this, two alternatives were considered:

1. Energy demand without conversion in buildings
   This alternative assumes continued use of electricity for heating. Calculations show that energy consumption for waterborne heating and domestic hot water will increase from today's 22 GWh to about 23 GWh in 2030. This calculation assume that rehabilitation will result in reduced energy demand and reduced demand for electrical heating.

2. Energy demand with conversion in buildings
   This alternative assumes gradual conversion to waterborne heating. The conversion is scheduled for the whole planning period until 2030.

For both alternatives, the energy demand will be reduced from 60 to 50 0000 MWh/year. Alternative 2 will release electricity in the scale of about 7 000 MWh/year.

5.3. Barriers and best-practices in Case study Furuset

For Case study Furuset, the following barriers and best-practices has been highlighted:

Barriers: Developing smart energy community in Furuset

- **High ambitions on behalf of others, which invest in or own buildings, infrastructure and land**
  - Challenge: Large percentage of private buildings. How to influence private owners (balance requirements and inspiration). Measures by private owners (buildings and property) are based on voluntary co-operation.
  - The only driving force at Furuset is Oslo municipality. There are no other commercial driving force. Who can be the First movers? How to make it attractive to private investors?
  - Legal framework: The opportunity to make requirements on private owners is missing. There is an uncertainty, to which terms/requirements the municipality can set in the current legal framework.
  - Property prices at Furuset are rising. However, a conception about low prices is a barrier for investors. It is challenging to motivate private building owners, especially where there are low property prices.
  - Environmental motivated investments and high-quality products may lead to higher investments. They may nevertheless be more lucrative due to lower operating costs. Investors are not always motivated by lower operating costs, but have focus on the investment phase.
  - Complex ownership structures, e.g. housing co-operatives.

- **Agreement needed with company interested in being responsible for energy infrastructure for heating and cooling**
  - Need for a business model for local sales heating / cooling, where local heat is exploited.

- Micro energy system with purchase/sale of low temperature heat. This is not done before in Norway.
    - Smart energy solutions require the integration of waterborne systems and electrical systems and integration between buildings and transport. This has not been done before in Norway.

- **Profitability local electricity production**
    - Sale of electricity is possible as prosumer (*plusskunde*). However, it is more profitable to use the electricity themselves. It is currently not possible to sell electricity locally to other areas or users.

- **Planning Instruments must be adapted to include energy on community scale**
    - Unusual to measure and document effects of energy and GHG emissions on area level.
    - Energy is currently not part of the regular planning system for area development (solved usually by building owners).
    - Transportation: Many major roads require the involvement of many parties. The Norwegian Public Roads Administration (Veivesenet) and others – many decision-makers can complicate and become a barrier.
    - Energy must been seen in context with other important factors (indoor air climate, air quality, transportation etc).
    - New systems for managing risk are needed. The municipality plans for others without taking risks themselves – risk lies with the commercial parties, which is not necessarily willing to take the risk.

- **Choosing the best indicators**
  Oslo municipality has a number of indicators in their planning documents. The next step (WP 1.2): Check whether those are the correct indicators (relevant, complete, available, measurable, reliable, familiar, non-redundant and independent). Should define practical indicators not methods. Probably need to introduce some new indicators, e.g.
    - Energy efficiency in existing building stock and in outdoor constructions and infrastructure. kW/h at area level (electricity and heating). Number of rehabilitated buildings
    - Local heating/cooling supply from buildings to local heating/cooling grid
    - Infrastructure, charging electrical vehicles. Percentage of public transport on electricity/renewable energy
    - Percentage of residents in buildings with lower energy demands than the current standard
    - Percentage of buildings with AMS meters, energy operation systems, own production of electricity, connected to local heating grid, heating supply
    - Number of buildings connected to the local heating grid. Coordination of digging in the city.
    - Lighting: Share with low energy demand
    - Model projects in the area
    - Available roof/façade surfaces for solar energy. Installed solar energy and local power production
    - Number of housing co-operations with environmental/energy measures
    - Number of buildings with energy label A, B, C
    - Innovation. New jobs
    - Interest in energy amongst residents. Is there a change in attitude by the population living there?
    - Financial aspects. Is Sustainable Energy Communities more expensive?

Lessons learned and Best-practices: Developing smart energy community in Furuset

- Oslo Municipality and Furuset has ambitious energy and climate goals, as described in this report.
- Political determination is important, with common goals and multidisciplinary cooperation.
- Cooperation between agencies, businesses and the government is needed.
- Energy has to be considered from the start of the planning process, along with other infrastructure. Energy planning should be coordinated with other areas, such as the new waste strategy.
- The municipality leads the way through ambitious public buildings.
- In Oslo, it is probably best to use "Guiding plan for public space" as a tool rather than the zoning plan (*reguleringsplan*). An "Oslo model" (*Oslomodellen*) is developed with the aim of moving from Municipal master plan to Building applications in an optimal manner.
- FutureBuilt-incentives is introduced: Reduced processing fees and time. Free counselling.
- Dedicated support for private building/house owners in Oslo municipality is introduced.
- Furuset has special opportunities as a Lighthouse. As a Lighthouse, Furuset can test new solutions, e.g. a pilot for charging stations for busses.
- A map for solar energy is under development in Oslo. It may be possible to combine this with a map that shows energy use for the area – combined with info from smart meters/eHub? This could be useful for highlighting and planning, both for inhabitants, private building owners/investors and the municipality.
- Different user groups need different indicators in their daily work. It may be constructive dividing the indicator set in three; one set for the planners, one set for the politicians and one set for the executive officers.
- Realization of actual activities and investments on an early phase, e.g. by first movers, may give positive effects and lead to further activities and engagement.

Barriers and best-practices are further described in the report for Task 2.1, which is developed in parallel to this report. In Task 2.1 there has been a number of interviews with stakeholders.

6. Discussion and further work

Diskusjon og veien videre – En kort oppsummering av kapittelet

Kapittel 6 oppsummerer målet med rapporten for Task 1.1, som sammen med rapporten for Task 2.1 er et grunnlag for PI SEC prosjektet videre. I kapittelet listes en del momenter som vil være relevante ved videre valg og testing av mål og indikatorer i Task 1.2. Denne rapporten vil også være grunnlag for Task 2.2, hvor det il samles erfaringer fra andre prosjekter med lignende mål, utfordringer og drivere.

PI-SEC will deliver efficient planning instruments at the neighbourhood scale, qualified for Norwegian planning context in cooperation with public stakeholders. Task 1.1 has collected, structured and analysed existing definitions, targets and KPIs in the case studies to see if they are practical to implement and adds value to the transformation process.

Barriers and best-practices in the case studies are listed in Chapter 4.3 and 5.3, and these will be relevant in the upcoming Tasks. A summary of other important issues that should be kept in mind when deciding on the set of indicators, are listed below:

- Start with the goals. What do we want to accomplish?
- The indicators should be deeply grounded within the municipalities and should be highly related to the local problems/benefits.
- Start with the structures that are already in place, both indicators and tools. Can energy in district planning become integrated part in current framework?
- Broader view, which includes more topics, might make the process of choosing indicators easier resulting in a more holistic view. However, the set of indicators can never be complete. Try to focus on the most important issues to address.
- Indicators must be possible to measure. Indicators should be relevant, available, measurable, reliable, familiar, non-redundant and independent (ref. Chapter 2.4, from CITYkeys). Start with the parameters where monitoring is already in place.
- How can energy be included in the current planning tools.
- Be aware of the choice of units. Wrong choice of unit can give opposite results than intended.
- Remember who the user is
    - The contact in Oslo Municipality gave the advice of dividing the indicator set in three; one set for the planners, one set for the politicians and one set for the executive officers.
    - Visualizing indicators such as energy use/production can be motivating and useful for different user groups.
- Smart systems for different user groups: Is it possible to develop tools, which can register, analyse and visualize indicators directly? Can use of the tools coordinate development of buildings and infrastructure in communities?
- The definitions of the indicators should be clear and not open for different interpretations.
- Planning systems last for several years, so indicators should be general, not connected to specific technologies, which change quickly.

This report, together with the corresponding report of task 2.1, constitutes the starting point of task 1.2, where appropriate goals and KPI's will be selected, specified and tested towards relevant selection criteria's. Task 2.2 will collect a reference base of Norwegian and international projects that have similar targets, challenges and drivers.

7. ANNEXES

ANNEX 1. Oslo Municipality: Objectives and measures for the building and energy sector

The table shows objectives and measures for the building sector and the sector for energy production and distribution, from Oslo Municipality (Oslo kommune PBE, 2015a).

<table>
<tr><th colspan="2">Byggsektoren</th></tr>
<tr><th>Mål</th><th>Tiltak</th></tr>
<tr><td>Bruk av fossilt brensel til oppvarming av bygg skal fases ut innen 2020</td><td>• Forbud mot bruk av fossilt brensel til oppvarming av bygg innen 2020.
• Innføre/forsterke ulike insentiver for raskere utfasing av fossilt brensel til oppvarming av bygg, slik som økt fyringsoljeavgift, tilrettelegge søknadsprosess for støtte om utfasing av oljefyring fra Enova, intensivere kontroll med nedgravde oljetanker i henhold til Vann- og avløpsetatens register, direkte kontakt med aktørene som har de største oljeanleggene (næringsbygg) samt økt generell kommunikasjon.</td></tr>
<tr><td>Energiforbruket i bygg skal være redusert med 1,5 TWh i henhold til referansebanen i 2020

Energiforbruket i kommunale bygg skal reduseres med 15 prosent innen 2020 i forhold til 2012-nivå</td><td>Alle bygg

• Forsterke insentiver for energieffektivisering gjennom for eksempel bedre veiledning for energieffektivisering i eksisterende bygg, samordnet virkemiddelbruk mellom Oslos klima- og energifond og de statlige støtteordningene som forvaltes av Enova, informasjonskampanjer og raskere saksbehandling og reduserte byggesaksgebyrer ved bygging av nullenergihus/plusshus.
• Arbeide sammen med staten for økt elavgift slik at flere energieffektiviseringstiltak utløses.
• Plan- og bygningsetaten opprettholder gebyrrabatter i gebyrregulativet som et insentiv til økt energieffektivisering i bygg.
• Fremme kompetanseheving i planlegging, bygging og drift av bygg og byområder, slik at ny teknologi blir tatt i bruk i byggebransjen, slik som smartgrid og solenergi.
• Kommunen tilrettelegger for og etterspør naturbaserte løsninger som bruk av vegetasjon for redusert energibehov for enkeltbygg og byområder.
Kommunale bygg

• Utvikle langsiktige finansieringsløsninger som fremmer utbygging av energieffektive løsninger ved nybygging rehabilitering og mindre enøktiltak i eksisterende bygg. Energisparekontrakter (EPC-kontrakter) er en aktuell finansieringsløsning, og det bør vurderes å etablere et kommunalt fond der foretak og etater kan låne midler til gjennomføring av EPC. Lånet kan nedbetales med kostnadsreduksjonen fra drift som EPC-kontrakten utløser. Fondet kan i utgangspunktet oppfinansieres med kommunale midler, og det må i så fall på plass vedtekter som sikrer tilsiktet drift. Denne kommunale markedsutviklingen kan stimulere til at private aktører også øker bruken av energisparekontrakter
• Alle kommunale virksomheter skal vurdere behovet for en EPC-utlysning innen 2017 med sikte på å nå målet om 15 prosent energieffektivisering og ha startet gjennomføringen av tiltak innen 2020
• Grønne leieavtaler benyttes i alle interkommunale leieforhold innen 2020
• Sette krav til energioppfølging og kompetanse til driftsoperatører i bygg kommunen eier og leier.
• Alle kommunale bygg som skal bygges nye eller rehabiliteres skal ha passiv-nullenergi eller plusshusstandard.
• Kommunen kan vurdere å innføre BREEAM eller annen kjent bransjestandard som en del av kravene til bygging av nye kommunale formålsbygg. BREEAMs definerte CO2-faktor på fjernvarme er en utfordring der det er nødvendig at denne tilpasser de lokale forholdene Oslos fjernvarmesystem opererer under, dvs. 0 CO2 fra 2016.
• Aktiv deltakelse i og etablering av forbildeprosjekter i FutureBuilt</td></tr>
</table>

	• Forsterke økonomiske insentiver for energieffektivisering og økt bruk av fornybar energi som for eksempel solenergi. • Prioritere ressurser til å være med i store, internasjonale forskningsprosjekter • Innføre krav til livsløpskostnader som en del av beslutningsgrunnlaget for bygging av kommunale bygg (Reduserer problemet med skillet i investerings- og driftsbudsjett) • Innføre krav til kommunale virksomheter om å søke utrednings- og utbyggingsstøtte fra ENOVA ved nybygging og rehabilitering der det er hensiktsmessig, samt etablere ordninger som sikrer bistand i søknadsprosessen. • Påvirke til bruk av enhetlige beregningsverktøy for vurdering av energibruk og klimagassutslipp. • Innføre krav til kommunale virksomheter om å søke utrednings- og utbyggingsstøtte fra ENOVA ved nybygging og rehabilitering der det er hensiktsmessig, samt etablere ordninger som sikrer bistand i søknadsprosessen.
Oslo kommune skal ha skiftet ut all gatebelysning til energieffektiv gatebelysning innen 2025	• Utarbeide og implementere investeringsstrategi for effektiv belysning av det offentlige rom i hele Oslo med sikte på å redusere energibruken med totalt 12-17 GWh (fra dagens 37 GWh). Dette kan skje ved en overgang til energieffektive pærer og armaturer samt bedre styring og regulering av alle lysene. Denne planen skal gjelde for alle Oslos 70 000 lyspunkter, som hovedsakelig består av gatelys. I dag finnes det en belysningsplan for Oslo sentrum som gjelder ca 4000 lyspunkter.
Innen 2030 skal installert effekt fra solenergi være på minimum 150 MW samlet for solceller og solfangere	• Klima- og energifondet benyttes for å få i gang et marked på solenergi i boliger. • Etablere pilotforsøk på bruk av smarte strøm-målere (AMS) i kombinasjon med leveranse av strøm fra solceller på bygg for å tydeliggjøre muligheter og barrierer. • Informere om muligheten for montering av solceller og solfanger på tak og fasader i forbindelse med kommunal saksgang • Utvikle solenergikart, og lage handlingsplan for bruk av solenergi i Oslo – solceller og solfangere og tilrettelegge for klimavennlig områdeutbygging med solenergi som en alternativ løsning. • Være pådriver for bedre statlige støtteordninger og rammebetingelser, herunder at borettslag får mulighet til å ta del av en plusskundeordning.
Sektor for energi-produksjon og -distribusjon	
Mål	Tiltak
All stasjonær energiproduksjon skal være fornybar i 2020.	Stasjonær bruk • Oslo kommune vil tilrettelegge for lokal fornybar kraftproduksjon og ressursutnyttelse der dette er hensiktsmessig, og vil arbeide med nasjonale myndigheter og energisektoren slik at det etableres gode rammevilkår som muliggjør lønnsomhet i konseptene • Hafslund Varme vil fase ut alle fossile energikilder ved produksjon av energi til fjernvarme. • Utvikling av et fleksibelt energisystem med elektrisitet og vannbåren energi, med kobling mellom lokale og sentrale nett (mikro- og makrosystem) Transport • Oslo kommune vil følge med i utviklingen av skogråvarebasert biodrivstoff, og vil tilrettelegge for utviklingen ved å være etterspørrer av biodrivstoff, hydrogen og biogass til anleggsdrift og godstransport, og ved å tilrettelegge for etablering av Energistasjoner med elektrisk ladning, biogass, hydrogen og biodiesel.
4 piloter med mikroenergisystem utbygget i 2020, med FutureBuilt Furuset som fyrtårn og områdeprosjekt	Konseptutvikling Mikro-Makrosystem • Oslo kommune vil ta initiativ til å etablere en prosess som kan se på organisering og mulige alternative organisasjonsformer for å få til fungerende lokalnett i alternative tilfeller (business case, offentlig – privat samarbeid), med definert funksjon for energiledelse. • Pilotprosjekter for å utvikle og etablere mikro-energisystemer, samt iverksette regulering av og opp mot makroenergisystemet: Oppfølging av tekniske (nettregulering), organisatoriske og regulatoriske forhold, i områder der det er lokal energiproduksjon som i perioder kan leveres ut på hovednett (vannbåren energi og elektrisitet), for å legge til rette for å integrere de ulike energibrukere og produsenter til

	eksisterende makro systemer. FutureBuilt Furuset som fyrtårnprosjekt samt 3 mindre energisystemer. • Videreutvikle konsept for makro- og ev. mikroenergisystemer som ivaretar en fortsatt robust forsyningssikkerhet og fleksibilitet i energisystemet. • Det vil etableres forslag til krav til installasjon av energifleksible termiske systemer med mulighet til å utnytte lavverdige energiformer (lavtemperaturer på vannbåren varme) i nybygg og utvikle Klima- og energifondet til støtte av denne type tiltak. • Det er i dag ikke entydig om det finnes tilstrekkelig hjemmelsgrunnlag for etablering av mikroenergisystemer, og dette vil derfor utredes nærmere for eventuelt å igangsette et arbeid for å påvirke lovgiver til å gi slike hjemmelsgrunnlag. Rammevilkår • Oslo vil bidra i utvikling av rammevilkår og finansieringsmodeller som legger til rette for at vannbåren energi vil bli en del av den samfunnspålagte infrastrukturen på linje med vann, avløp, el. ved etablering av nye utbyggingsområder • Oslo kommune vil være pådriver for å etablere felles regelverk/retningslinjer for varme- og kjøleenergi Områdeutvikling • Oslo vil være en premissgiver og støttespiller som stimulerer til etablering av lokale energisystemer som ivaretar lokal ressursutnyttelse og energiutveksling ved utbygging av nye boområder. • Det avsettes arealer til nødvendige energiformål og utarbeides lokale energiplaner som en del av områdeutvikling. Planer for infrastruktur legges både i tekniske hovedplaner og som krav i planprogram for oppfølging i senere område- og detaljreguleringer, slik at energiutnyttelse og energiplanlegging i større grad blir en del av en helhetlig plan for områdeutviklingen, og det kan legges til rette for energiutveksling og sammenkobling med sentrale energinett.
Strategisk Energiplan for vannbåren energi i Oslo skal være etablert i 2020 Bruk av vannbåren energi i Oslo skal være 2,5 TWh i 2020 og 3,5 TWh innen 2030	• Utvikle en strategisk energiplan for Oslo, for etablering av vannbårne energisystemer til varme og kjøling. Energiplanen skal ivareta en fortsatt robust utvikling av de sentrale distribusjonssystemene for el og fjernvarme. Synergier med Akershus vurderes. • Realisere potensialet for økt bruk av vannbåren energi (varme og kjøling) i Oslo på basis av strategisk energiplan i samspill med varme- og kjølekonsesjonær og reguleringsmyndighet. Teknisk potensial i 2020 er 2,5TWh. • Smart energibruk og effektiv styring for å oppnå redusert effektbehov og sikker energiforsyning. Det vil etableres pilot- og demonstrasjonsprosjekter på Smartgrid-systemer både på distribusjonsnett (makro) og på lokalt nett (mikro).

ANNEX 2. Table of energy and climate measures planned in Oslo Municipality

Measures planned in Oslo Municipality (Oslo kommune PBE, 2015a), with numbers, description and deadline.

7.4. TILTAK I TRANSPORTSEKTOREN

Tiltaks-program	Nr.	Tiltak	2015-20	2020-30	2030-50
Overgang fra individuell biltransport til kollektiv transport, sykkel og gange	T 1.1.	INFRASTRUKTUR Der veiutbygging for personbiltrafikk kommer i konflikt med kollektivutbygging og klimamålsetninger må dette vurderes og håndteres sett i lys av klimaforliket.			
	T 1.2.	Implementere tiltak og tilrettelegge for enklere bruk og bedre fremkommelighet for kollektivtransport bl.a. ved videreføring av prosjektet «Kraftfulle fremkommelighetstiltak».			
	T 1.3.A.	Utvikling av skinnegående løsninger må prioriteres, og ny baneinfrastruktur, ref. KVU-OsloNavet (sentrumstunnel for T-bane og evt. togtunnel), må være etablert innen 2030, for å sikre en byutvikling i henhold til den byutvikling som Kommuneplanen for Oslo legger opp til.			
	T 1.3.B.	Annen nødvendig utvikling og utbygging av baneinfrastruktur, for å håndtere økt befolkningsvekst frem til 2030, så som Fornebubanen, bane til A-hus, generell utvikling av T-banen mm.			
	T 1.4.	Utrede muligheter for redusert trafikk på innfartsårene fra vest, syd og nord. Her bør bl.a. vurderes mulighet for etablering av overgangsterminaler buss/tog ved eksisterende og nye togstasjoner. Innfartsparkeringer bør vurderes der analyser viser at dette er trafikkreduserende for bytrafikken. Inter City-utbyggingen, med evt. nye holdeplasser i Oslo, vurderes i et klima- og byutviklingsperspektiv for Oslo.			
	T 1.5.	Lavutslipp-soner; det etableres pilotforsøk med lavutslipp- soner i gradvis utvidede områder i Oslo sentrum frem til at det kan etableres nullutslipp-soner.			
	T 1.6.	Konseptvalgutredninger (KVU): Plan for byutvikling med areal og mobilitet sett i et klimaperspektiv må bli førende i KVU-prosesser, og KVU-vurderinger integreres i planprosessen hjemlet i plan- og bygningsloven. Rammebetingelser skal alltid settes i henhold til prioriteringen der alt økt persontrafikk som følge av befolkningsøkning skal løses ved gange, sykkel og kollektivtrafikk.			
	T 1.7.	SYKKEL Tiltak for å få økt sykkelandel som utbygging av sykkelveinettet, utvidet bysykkelordning, tilrettelegge arbeidsplasser for sykling til jobb, ref. sykkelstrategien.			
	T 1.8.	REGULATORISKE VIRKEMIDLER Iverksette tiltak for å begrense personbiltrafikken ved			

		parkeringsrestriksjoner, differensierte bompengesatser og ITS (intelligente transportsystemer).			
	T 1.9.	TAXI Tiltak for å redusere energibruk og utslipp fra taxinæringen som vurdering av løyvestruktur, stille miljøkrav ved tildeling av løyver, nullutslipp- soner og anbud som etterspør nullutslipp taxitjenester.			
Grønn varetransport	T 2.1.	BYLOGISTIKK Implementere plan for enklere varetransport ved etablering av 100 losseplasser, omlastingsterminal(er)/samlasting og bedre fremkommelighet.			
	T 2.2.	Gi innspill til plan for nasjonal og regional logistikkløsning for å utvikle hensiktsmessige godsterminalløsninger, bane og havnekapasitet for Østlandet, påvirke for å oppnå økt andel gods fra bil til båt og bane.			
	T 2.3.	VAREDISTRIBUSJON I BYSONER All varetransport gjøres med fossilfrie biler eller ladbare hybridbiler fra 2025 ved trappevis å innføre lavutslipp-soner og deretter nullutslipp- soner og ved å tilrettelegge særskilt ved arealbruk, energistasjoner mm.			
	T 2.4.	Oslo kommune etterspør lavutslipp og nullutslipp transporttjenester.			
	T 2.5.	AVGIFTSREGIME Nasjonalt avgiftssystem utformes slik at det favoriserer klima- og miljøvennlig drivstoff. Oslo kommune skal være en pådriver for utforming av en avgiftsstruktur for å styre godstransport i ønsket retning mht. transportform og drivstoffbruk.			
Innfasing av nullutslippsløsninger for transport	T 3.1.	ENERGISTASJONER Planlegge, tilrettelegge og etablere infrastruktur for fossilfrie drivstoff (energistasjoner) for personbiler og tyngre kjøretøy i Oslo.			
	T 3.2.	Arbeide for et regionalt (i henhold til Hydrogenstrategi for Oslo og Akershus), nasjonalt og nord-europeisk nettverk av energistasjoner (tekniske, regulatoriske og organisatoriske rammebetingelser, standardisering av løsninger).			
	T 3.3.	LOKALE INSITAMENTORDNINGER Implementere og videreutvikle lokale virkemidler for innføring av fornybart drivstoff i individuell- og kollektivtransport - gods og personer, bl.a. bruk av kollektivfelt, miljøfelt, utvidet bruk av bompengeregimet med differensiering av bompengesatser.			
	T 3.4.	Videreføre el-bil satsningen, og utvide denne til å omfatte ladbare hybridbiler og busser og kjøretøy for varedistribusjon.			
	T 3.5.	Være en pådriver overfor staten for innføring av økt engangsavgift og økt drivstoffavgift på fossilbiler.			
	T 3.6.	KOMMUNALE INNKJØP Videreføreinnkjøpsspesifikasjoner for anskaffelser av nullutslipp transporttjenester og kjøretøy.			

	T 3.7.	ELEKTRIFISERING AV FERJER OG HAVN Plan for, og gjennomføring av, elektrifisering (el/hydrogen) av ferjene og videreføring av landstrøm til skip, eventuelt bruk av annen nullutslippsteknologi.	⟷	●	
	T 3.8.	LAVUTSLIPP ANLEGGSDRIFT Lavutslipp anleggsdrift ved å utvikle spesifikasjoner for kjøp av fossilfrie anleggstjenester og maskiner i samarbeid med Staten og Akershus. Gjennomføre pilotprosjekter.	→	●	
Transport-reduserende byplanlegging for attraktive og levende nærområder	T 4.1.	MOBILITET OG BYUTVIKLING Gjennomføre kommuneplanens og Plansamarbeidets forslag til byutvikling i tilknytning til T-bane og jernbanestasjoner	→		●
	T 4.2.	Utarbeide mobilitetsplan for Oslo	→ ●		
	T 4.3.	Bruk av ITS (Intelligente trafikksystemer) for å prioritere ønsket trafikk i byen. Først en utredning og deretter et større investeringsprosjekt.	→	●	
	T 4.4.	Bruk av IKT og fleksible arbeidstidsordninger for å redusere antall reiser, samt bedre utnyttelse av kollektivtransportkapasitet.	→	●	
	T 4.5.	Prosjekt Bilfri! Utvikle bildelingsordninger som sikrer mulighet for mobilitet i en by der ikke alle må eie egen bil	→ ●		
	T 4.6.	Iverksette tiltak for å øke samkjøring i personbiler som for eksempel sambruksfelt forbeholdt kjøretøy med et visst antall personer.	→	●	

7.5. TILTAK I BYGGSEKTOREN

Tiltaks-program	Nr.	Tiltak	2015-20	2020-30	2030-50
Utfasing av fossil energi i bygg	B 1.1.	Innhente hjemmel for og iverksette forbud mot bruk av fossil energi til stasjonær oppvarming i Oslo	➡ ○		
	B 1.2.	Innføre og forsterke ulike insentivordninger for raskere utfasing av fossil brensel til oppvarming av bygg.	➡ ○		
Energieffektivisering	B 2.1.	TILTAK RETTET MOT ALLE BYGG Forsterke insentiver for energieffektivisering i eksisterende bygg gjennom for eksempel bedre veiledning, samordnet virkemiddelbruk mellom Oslos klima- og energifond og de statlige støtteordningene som forvaltes av Enova, informasjonskampanjer og raskere saksbehandling og reduserte byggesaksgebyrer ved bygging av nullenergihus og plusshus. Arbeide med staten for økt elavgift slik at flere energieffektiviseringstiltak utløses	➡ ○		
	B 2.2.	Etablere ordninger for å sikre kompetanseheving slik at ny teknologi blir tatt i bruk i bygge bransjen, som smartgrid, bruk av solceller og solfangere m.v.	➡ ○		
	B 2.3.	Etablere ordninger for naturbaserte løsninger (grønne tak o.l.) for redusert energibehov.	➡ ○		
	B 2.4.	TILTAK KOMMUNALE BYGG Utvikle langsiktige finansieringsløsninger som fremmer utbygging av energieffektive løsninger ved nybygging og rehabilitering. Energisparekontrakter (EPC-kontrakter) er en aktuell finansieringsløsning	➡ ○		
	B 2.5.	Sette krav til energioppfølging og kompetanse til driftsoperatører i næringsbygg kommunen eier og leier.	➡ ○		
	B 2.6.	Alle kommunale bygg som rehabiliteres skal ha passiv-nullenergi eller plusshus standard.	➡	○	
	B 2.7.	Vurdere å innføre BREEAM eller annen bransjestandard ved bygging av kommunale formålsbygg. BREEAMs definerte CO_2-faktor på fjernvarme er en utfordring der det er nødvendig at denne tilpasses de forholdene Oslos fjernvarme-system opererer under, med 0 CO_2-utslipp fra 2016.	➡ ○		
	B 2.8.	Aktiv deltakelse i og etablering av nye forbildeprosjekter i FutureBuilt	➡ ○		

	B 2.9.	«Grønne leieavtaler benyttes i alle interkommunale leieforhold innen 2020 for å utløse investeringsmidler».			
	B 2.10.	Prioritere ressurser til å være med i store, internasjonale forskningsprosjekter			
	B 2.11.	Innføre krav til livsløpskostnader som en del av beslutningsgrunnlaget for bygging av offentlige bygg (redusere skillet i investerings- og driftsbudsjett), og utvikle/ta i bruk enhetlig beregningsverktøy for vurdering av energibruk og totale klimagassutslipp.			
	B 2.12.	Innføre krav til kommunale bygg om å søke utrednings- og utbyggingsstøtte fra ENOVA der det er hensiktsmessig samt etablere ordninger som sikrer bistand i søknadsprosessen.			
	B 2.13.	GATEBELYSNING Utarbeide og implementere investeringsstrategi for effektiv belysning av det offentlige rom i hele Oslo med sikte på å redusere energibruken ihht. Målsetning.			
Solenergi	B 3.1.	SOLENERGI Klima- og energifondet benyttes for å få i gang et marked på solenergi i boliger. Etablere pilotforsøk på bruk av smarte strøm-målere (AMS) i kombinasjon med leveranse av strøm fra solceller på bygg for å tydeliggjøre muligheter og barrierer.			
	B 3.2.	Informere om muligheten for montering av solceller og solfanger på tak og fasader i forbindelse med kommunal saksgang i plan- og byggesaker.			
	B 3.3.	Utvikle solenergikart for byen.			
	B 3.4.	Lage handlingsplan for bruk av solenergi i Oslo.			
	B 3.5.	Pådriver for bedre statlige støtteordninger og rammebetingelser, herunder at borettslag blir en del av plusskundeordningen.			
	B 3.6.	Tilrettelegge for klimavennlig områdeutbygging samt enklere og prioritert saksgang hos Plan- og bygningsetaten.			

7.6. TILTAK I SEKTOR FOR RESSURSUTNYTTELSE

Tiltaks-program	Nr.	Tiltak	2015 -20	2020 -30	2030 -50
Regionalt samarbeid om ressursutnyttelse	R 1.1.	BIOGASS Etablere regionalt samarbeid for å sikre økt biogasstilgang til kjøretøy, herunder se på økt utnyttelse av matavfall og avløpsvann til biogass			
	R 1.2.	REGIONALE PLANER Etablere et regionalt samarbeid for å utnytte ressursene i husholdningsavfall og næringsavfall innenfor det mulighetsrommet som dagens lovgivning og kommunens behov gir.			
	R 1.3.	Utvikle regionale planer for vannforsyning og avløpshåndtering for å oppnå robuste og tilpassede infrastruktursystemer, reduserte infrastrukturkostnader for samfunnet totalt og enhetlig forurensningspolitikk mot fjorden.			
	R 1.4.	Følge opp igangsatt arbeid i regi av Fylkeskommunen i Akershus med utarbeidelse av en plan for håndtering av gravemasser og mineralressurser i Oslo.			
Optimal ressursbruk og energiutnyttelse i egne systemer	R 2.1.	ENERGIUTNYTTELSE Opprettholde og videreutvikle utvinningen av deponigass fra eksisterende deponianlegg			
	R 2.2.	Utrede økt energiutnyttelse av vann og avløp, herunder kjøling, varme og el-produksjon i mikroenergisystemer, i samspill med eiendomsutviklere, planmyndighet og infrastrukturaktører.			
	R 2.3.	Pilot planprosess i ny bydel der kommunens fag- og planetater samarbeider med eiendomsutviklere, infrastrukturaktører og næringsliv for å få smidige løsninger for lokal energiutnyttelse.			
	R 2.4.	MATERIALGJENVINNING Bruke kommunikasjon for å endre brukernes sorteringsatferd for stadig økt utsorteringsgrad av plastemballasje og matavfall. Utredningsprosjekt 70 % materialgjenvinning, i påvente av EU-vedtak; Det må etableres et utredningsprosjekt i samspill med akademia og innovative teknologi- og næringsmiljøer for å utrede hvilke muligheter som kan finnes. Oslo kommunes og næringsaktørers sorteringsanlegg vil tilstrebe BAT-teknologi, slik atman til enhver tid sikrer høy utsorteringsgrad. Oslo kommune vil her være en aktiv pådriver for økt renhetsgrad både på husholdningsavfall og næringsavfall ved optimalisering av innsamlingsløsninger og teknologi for utsortering.			
	R 2.5.	KARBONFANGST FRA AVFALLSBEHANDLING Utrede mulighetene for karbonfangst ved de kommunale energigjenvinningsanleggene. På basis av dette eventuelt etablere anlegg.			

7.7. TILTAK I SEKTOR FOR ENERGIPRODUKSJON/DISTRIBUSJON

Tiltaks-program	Nr.	Tiltak	2015 -20	2020 -30	2030 -50
Fra fossil til fornybar energiproduksjon	E 1.1.	ENERGI TIL STASJONÆR BRUK Tilrettelegge for lokal fornybar energiproduksjon og ressursutnyttelse der dette er mulig og lønnsomt.			
	E 1.2.	Fase ut all bruk av fossile energikilder ved produksjon av energi til fjernvarme			
	E 1.4.	ENERGI TIL TRANSPORT Oslo kommune vil følge med i utviklingen av skogråvarebasert biodrivstoff, og vil tilrettelegge for utviklingen ved å være etterspørrer av biodrivstoff, hydrogen og biogass til anleggsdrift og godstransport, og ved å tilrettelegge for etablering av Energistasjoner.			
Utvikling av et fleksibelt energisystem med elektrisitet og vannbåren energi med kobling mellom lokale og sentrale nett (mikro-/makrosystemer)	E 2.1.	KONSEPTUTVIKLING MIKRO / MAKRO SYSTEMER Oslo kommune vil ta initiativ til å etablere en prosess for å se på alternative organisasjonsformer for å få til fungerende lokalnett (offentlig – privat samarbeid) med definert funksjon for energiledelse			
	E 2.2.	Utvikle konsept som ivaretar forsyningssikkerhet og fleksibilitet i energisystemet. Pilotprosjekter for å utvikle og etablere mikro-energisystemer, samt iverksette regulering av opp mot makroenergisystemet. FutureBuilt Furuset som fyrtårnprosjekt samt 3 mindre energisystemer.			
	E 2.3.	Etablere forslag til krav til installasjon av energifleksible termiske systemer med mulighet til å utnytte lavverdige energiformer i nybygg og utvikle Klima og energifondet til støtte av denne type tiltak.			
	E 2.4.	RAMMEVILKÅR Utvikling av rammevilkår og finansieringsmodeller som legger til rette for at vannbåren energi skal bli en del av den samfunnspålagte infrastrukturen på linje med vann, avløp og el. Oslo kommune skal være pådriver for å etablere felles regelverk/retningslinjer for varme- og kjøleenergi.			

	E 2.5.	OMRÅDEUTVIKLING Oslo skal være premissgiver og støttespiller som stimulerer til etablering av lokale energisystemer som ivaretar lokal ressursutnyttelse og energiutveksling ved utbygging av nye bo-områder.			
	E 2.6.	Avsette arealer og utarbeide energiplan som en del av reguleringsvilkårene som legger til rette for energiutveksling og sammenkobling med sentrale energinett.			
Smart energibruk og effektiv styring for å oppnå redusert effektbehov og sikker energiforsyning	E 3.1.	Utvikle en strategisk energiplan for Oslo for etablering av vannbårne energisystemer til varme og kjøling. Energiplanen skal ivareta en fortsatt robust utvikling av de sentrale distribusjonssystemene for el og fjernvarme. Synergier med Akershus vurderes.			
	E 3.2.	Realisere potensialet for økt bruk av vannbåren energi (varme og kjøling) i Oslo på basis av strategisk energiplan i samspill mellom varme-/kjølekonsesjonær og reguleringsmyndighet.			
	E 3.3.	Gjennom pilotprosjekter gi innspill til utvikling av energitariffene (el og vannbåren energi) for å prise effektbehov i større grad enn i dag i henhold til retningslinjer gitt av NVE.			
	E 3.4.	Etablere pilot- og demonstrasjonsprosjekter på Smartgrid-systemer både i makro- og mikro-nett.			

ANNEX 3. Goals for the 4 priority areas in Oslo Municipality

Goals for the 4 priority areas in Oslo Municipality (Oslo kommune PBE, 2015a): Urban environment and architecture, Material use, Energy and Transport.

Mål Bymiljø og arkitektur

- Furuset skal utvikles til et utstillingsområde for bærekraftig byutvikling. I bærekraftbegrepet ligger både sosiale, økonomiske og miljømessige aspekter.
- Innen 2020 er det bygd minst 5 FutureBuilt-prosjekter i området.
- Fortetting av Furuset skal gjennomføres med fokus på arealeffektivitet, bokvalitet, nyskapende arkitektur og lesbar supplering av bebyggelsen.
- Handelstilbudet på Furuset skal være det som i hovedsak benyttes av de som bor innenfor en radius på 1000 meter fra Furuset sentrum. For dem som har bopel innen 2000 meters radius, skal Furuset være et mye brukt handelssted.
- Bymiljøet på Furuset skal ha attraktive tilbud, gode byrom og tilby opplevelser for lokalbefolkningen og besøkende.
- Bomiljøene skal være skjermet for trafikkstøy og ha god luftkvalitet.
- Blågrønne kvaliteter skal prege både sentrumsområdet og boligområdene. Det skal være lesbar tilgjengelighet til parkområdene og til Østmarka. Det skal være gode forbindelser til Alna miljøpark og til togstasjonsområdene ved Grorud og Haugenstua.

Indikator Bymiljø og arkitektur

Antall forbildeprosjekter som gjennomføres som FutureBuilt-prosjekter.
Andel bosatte innenfor radius på hhv. 1000 og 2000 meter som fra Furuset sentrum som handler dagligvarene sine lokalt på Furuset.
Opphold i sentrale byrom og parker (bylivsundersøkelse).
Dokumentert lokal overvannshåndtering (redusert påslipp til ledningsnett, oppnådd GAF).
Årlig middelkonsentrasjon av PM10/NO2 og antall dager med grenseoverskridelse.

Mål Materialbruk

- Minst 50% redusert klimagassutslipp fra materialbruk ved nybygg og rehabilitering sammenliknet med dagens praksis.
- Ved riving bør minst 80 prosent av hovedkonstruksjonen, samt evt. asfalt gjenvinnes.
- Gjenvinning innenfor utbyggingsområdet skal prioriteres for å unngå unødig transport.
- Gjenvinningsandelen for byggeavfall ved bygging skal være minst 80 prosent av total avfallsmengde eksklusiv betong og asfalt.
- Materialer skal ha levetid tilpasset funksjon og tåle klimaendringer.
- Forvaltning, drift og vedlikehold (FDV) skal inngå i vurderingsgrunnlaget ved valg av alle materialer.
- Materialbruk skal være uten helse- og miljøfarlige kjemikalier eller miljøgifter.

- Nye byggemetoder som fremmer gode eksempler på høy materialkvalitet til fornuftig byggekostnad skal brukes.
- Overflatematerialer, innvendig som utvendig, skal bidra estetisk til det bygde miljøet.

Indikator Materialbruk

Klimagassregnskap for materialbruk ved nybygg og rehabilitering som tilfredstiller Future-Built kriterier (jf. www.klimagassregnskap.no).
Livssyklus-vurderinger av hovedmaterialer (materialer som utgjør 10% eller mer)
Sammenstilling av EPD-er for hovedmaterialer som sammenliknes med erfaringstall f.eks fra prosjekter i FutureBuilt.
Andel av byggematerialer som gjenvinnes/gjenbrukes.

Mål Energi

- 50% redusert klimagassutslipp til energiformål på Furuset innen 2030.
- Høy energistandard, minst tilsvarende passivhusnivå, skal legges til grunn for alle nybygg.
- I eksisterende bygningsmasse skal energistandard minst tilsvarende lavenerginivå legges til grunn.
- Minst 90% av varme- og kjølebehovet skal dekkes av lokale, fornybare energikilder.
- Balansert felles vannbårent distribusjonsnett for varme og kjøling skal søkes utviklet for å håndtere behov for sesonglagring av energi.
- I byrom, utendørs (idretts)anlegg, belysning og infrastruktur (inkludert evt. gatevarme) skal det velges effektive, dynamiske løsninger.

Indikator Energi

Resultater for klimagassregnskap for stasjonær energibruk på områdenivå og for enkeltprosjekter.
Andel bygg med lavere energibehov enn gjeldende standard.
Andel av det totale energiforbruket som kommer fra lokale, fornybare energikilder. Andel av energiforsyning i eksisterende borettslag som kommer fra solenergi.
Systemvirkningsgrad for felles, vannbårent distribusjonsnett.
Rapportering etter BREEAM NOR-systemet.

Mål Transport

- Endringer i reisevaner og transportmiddelfordeling skal resultere i minst 50% redusert klimagassutslipp fra transport i forhold dagens praksis.
- Andelen reiser med sykkel, gange eller kollektivmidler skal være vesentlig høyere enn idag. Dette gjelder både arbeids- og fritidsreiser.
- Kollektivandelen av motoriserte arbeidsreiser for områdebeboere skal utgjøre minst 80%.

- Biltrafikk skal utgjøre mindre enn 20% av alle reiser til, fra og innen området.
- Utvikling av det lokale handels- og servicetilbudet skal bidra til mindre behov for transport.
- Minst 10% av parkeringsplasser skal ha ladestasjon for el-bil.

Indikator Transport

Reisevaneundersøkelse som registrerer reisemiddelfordeling for daglige reiser og arbeidsreiser til/fra/innen Furuset per år med ulike transportmidler.
Andel kjøretøykilometersom foretas med bil drevet av ikke-fossilt drivstoff.
Transportregistrering med ÅDT for biltrafikk på veiene i området, samt gang-/sykkeltrafikk på viktige ferdselsårer for fotgjengere og syklister.
Rapportering etter BREEAM NOR-systemet / klimagassregnskap.

ANNEX 4. Oslo Furuset: The new micro energy system – Information and preconditions

The table list a number of key definitions, preconditions and indicators described in the report (Etterstøl, 2015).

The new micro energy system: Information and preconditions
Energy consumption
Definisjon lavtemperatur varme varme: 15-60°C.
To alternative temperaturnivåer vurderes for Furuset: **Alternativ 1. 70-80 °C turtemperatur** • Krever varmepumpe tilpasset høyere temperaturløft. Gir noe dårligere COP, dvs høyere strømforbruk til varmepumpen • Kan levere hele varmebehovet til byggene i området og kun mindre justeringer på varmesystemet i eksiterende bygg **Alternativ 2 30-50 °C turtemperatur** • Krever heving av temperaturen lokalt for oppvarming av tappevann. Dette kan gjøres for eksempel med elkolber koblet i beredere som hever temperaturen • Kan utnytte standard varmepumper og kan gi lavere temperaturløft og høyere COP • Materialvalg, kvalitet og dimensjonering av rørnett avhenger av temperaturnivå og øvrige forutsetninger. Men for alle nivåer vil infrastrukturen bestå av et rørnett for sirkulering av varmt vann og normalt en varmeveksler i koblingen mellom det felles rørnettet og rørnettet i hvert bygg.
Eksempler, kilder til lavtemperert varme: • Gjenvinning av varme fra kompressorer som leverer kulde til is i Furuset forum samt mulig tilkobling av utvendig isbane • Gjenvinning overskuddsvarme fra kjøling i senter, særlig isvann fra kjøledisker etc. • Gjenvinning av overskuddsvarme fra kjøling av Bakeri • Gjenvinning av overskuddsvarme fra komfort og datakjøling • Gjenvinning av overskuddsvarme fra avløpsvann • Gjenvinning av varme fra ventilasjonsluft i boligblokker der det ikke ligger til rette for balansert ventilasjon • Grunnvarme/borehull • Solfangere
Noen lavtempererte kilder som f.eks solfangere kan levere direkte inn nettet
Ettervarming av tappevann for å hindre legionella (minimum 60-70°C)
Høyere COP, dvs lavere strømforbruk til varmepumpen • I felles varmepumpesentral • I hvert enkelt bygg for å løfte temperaturen
Lade brønnparker over sommeren med solenergi (avhenger av grunnforhold)
Plassering av anlegg slik at overskuddsvarme kan utnyttes. Eks: For en varmpumpeløsning som skal utnytte overskuddsvarme i fra ishallen og levere lavtemperatur kjøling til butikker på senteret er en sentral plassering nært disse en viktig forutsetning
Kjøling distribueres til flere bygg i et felles kjølenett der temperaturnivåene er tilpasset behovet i byggene. Frikjøling kan erstatte elbruk til kompressor

Energy generation
Plusskunder selger strøm
Bedre lønnsomhet av å selv utnytte strøm i forhold til å selge denne tilbake til nettet
Smart management. Mismatch
Infrastruktur for distribusjon av elektrisitet i mikroenergisystem: Lavspent distribusjonsnett (ny 400 V og eksisterende 230V) og intelligente målere (AMS) eid av Hafslund
Energi- og effektbalanse for området: Mindre behov for energi eller effekt inn til område
Utnytting av overskuddsvarme og lagring
Effekt-varighetsdiagram/samtidighet for ulike kilder
Lavere effekttariffer
Mindre belastning på elnettet
Ved intelligent styring og måling av strømbruken vil brukeren ha mulighet til å redusere sitt forbruk nå markedsprisene for el er høye og heller planlegge sitt forbruk til når prisen er lave
Batterilagring i mikroenergisystem, for å redusere effektbehov
Green mobility
Kobling til elsystemet for lading bruk av el til transport
General preconditions
Realisering av felles infrastruktur er en forutsetning
Organisering for å realisere mikroenergisystemet i takt med utbyggingen i området
Finansieringsmodeller må utarbeides
Driftsorganisering må utarbeides
Støttenivå fra eks. Enova

8. References

Andresen, I., Kleiven, T., Ryghaug, M. and Malvik, B. (2007) 'Smarte, energieffektive bygninger', *Smart Energy Efficient Buildings, ISBN 878-82-519-2237-1. Tapir Academic Publishing, Trondheim, Norway.*

Aschehoug, Ø., Andresen, I., Kleiven, T. and Wyckmans, A. (2005) 'Intelligent Building Envelopes - Fad or Future?', *Nordic Symposium on Building Physics, Reykjavik 13-15 June 2005*.

Bergen kommune (2016) 'Grønn strategi: Klima- og energihandlingsplan for Bergen', *Behandlet av Byråd 26. mai. 2016*.

BKK Nett (2016) 'Regional Kraftsystemutredning for BKK-området og indre Hardanger 2016 – 2036'.

BRE (2012) *BREEAM Communities Manual 2012 - Technical Manual SD 202 - 1.1.2012*. Available at: http://www.breeam.com/communitiesmanual/#_frontmatter/breeam_communities.htm%3FTocPath%3D.

Byrådet Oslo kommune (2016) *Tilleggssak til Klima- og Energistrategi for Oslo*.

Bystyret Bergen (2016) 'Saknr 218-16: Grønn Strategi - Klima- og energihandlingsplan for Bergen'.

Bystyret Oslo kommune (2014) *Sak 108 Strategi for energieffektive og klimanøytrale bygg*.

CITYkeys (2016) *Deliverable 1.4: Smart city KPIs and related methodology – final*, Europe, Horison 2020.

DG IPOL (2014) 'Mapping smart cities in the EU', *Directorate-General for Internal Policies, IP/A/ITRE/ST/2013-02*.

Dokka, T. H., Sartori, I., Thyholt, M., Lien, K. and Lindberg, K. B. (2013) 'A Norwegian Zero Emission Building Definition', *In proceedings from Passivhus Norden, 15-17 October2013; Göteborg, Sweden*.

Economist Intelligence Unit (2009) 'European Green City Index: Assessing the environmental impact of Europe's major cities'.

EERA JPSC (2015) *Closing remarks - meeting nov 2015*: EERA JPSC Symposium on Smart City KPIs Available at: http://www.eera-sc.eu/sites/eera-sc.eu/files/attachments/eera_sc_wrap_up.pdf.

Enova (2015) 'Strategi for ladestasjoner og infrastruktur for elbil'.

Etterstøl, A. (2015) 'Rapport - mulighetsstudie for vannbårent energisystem på Furuset (utkast per 28.09.15)'.

European Commission (2015) 'IN-DEPTH REPORT: Indicators for Sustainable Cities'.

Fylkesmannen i Oslo og Akershus (2016) 'Letter: Fylkesmannens forventninger til kommunal planlegging - 2016'.

GPC (2014) *Global Protocol for Community-Scale Greenhouse Gas Emission Inventories. An Accounting and Reporting Standard for Cities*: Greenhouse Gas Protocol. Available at: http://www.ghgprotocol.org/files/ghgp/GPC_Executive_Summary.pdf.

Hafslund Nett (2016) *Kraftsystemutredning 2016 – 2036: Oslo, Akershus og Østfold*. Available at: https://hafslundnett.blob.core.windows.net/files/pdf/om-oss/fakta/kraftsystemutredning/Hovedrapport_Oslo_Akershus_Ostfold_2016_2036.pdf.

IEA PVPS (2009) *Overcoming PV grid issues in the urban areas, Report IEA-PVPS T10-06-2009*.

Ingeberg, K. and Moengen, T. (2012) *STREK-2020: Underlag for Strategi for mer energieffektive og klimanøytrale bygg i Oslo i 2020. Hovedrapport*.

Karlsson, A. and Lindkvist, C. (2013) 'Common barriers and challenges in current nZEB practice in Europe', *D1.1 Report, FP7 ZenN*.

Klima- og miljødepartementet (2009) *Statlig planretningslinje for klima- og energiplanlegging i kommunene*. Available at: https://www.regjeringen.no/no/dokumenter/planretningslinje-klima-energi/id575764/.

Lovdata, energidepartementet, O.o. (2012) *Forskrift om energiutredninger.* https://lovdata.no/dokument/SF/forskrift/2012-12-07-1158.

Miljødirektoratet (2016a) *Lage eller revidere klima- og energiplan*. Available at: http://www.miljokommune.no/Temaoversikt/Klima/Klima-og-energiplanlegging/Klima--og-energiplanlegging/.

Miljødirektoratet (2016b) 'Miljøstatus.no'.

Narvestad, R. (2010) 'Casestudier av norske byutviklingsprosjekter med miljø- og kvalitetskrav', *SINTEF Rapport 58*.

NGBC (2012) *BRREAM-NOR ver 1.1*. Available at: http://ngbc.no/wp-content/uploads/2015/09/BREEAM-NOR-Norw-ver-1.1_0.pdf.

Norconsult (2014) *Energistrategi for Furuset: Analyse av desentralisert løsning for energiforsyning*.

NVE (2016) *Plusskunder*. Available at: https://www.nve.no/elmarkedstilsynet-marked-og-monopol/nettjenester/nettleie/tariffer-for-produksjon/plusskunder/.

NVE / Nettselskaper (2016) *Kraftsystemutredninger*. Available at: https://www.nve.no/energiforsyning-og-konsesjon/nett/kraftsystemutredninger/kraftsystemutredninger-2015-og-2016/ (Accessed: July 20 2016).

Olje- og energidepartementet (2015) 'Oppdragsbrev til Enova SF for 2016'.

Oslo and Akershus FK (2016) *Revidert avtale Oslopakke 3 for 2017-2036*.

Oslo kommune (2009) *Retningslinjer for planer, prosjekter og fremføringstraseer over 40 m samt tverrgravinger*.

Oslo kommune, K.-o. e. (2015) 'Det grønne skiftet: Klima- og energistrategi for Oslo'.

Oslo kommune PBE, P.-o. b. (2014a) 'Områderegulering for klimaeffektiv byutvikling på Furuset. Kvalitetsprogram'.

Oslo kommune PBE, P.-o. b. (2014b) 'Områderegulering for klimaeffektiv byutvikling på Furuset. Planbeskrivelse'.

Oslo kommune PBE, P.-o. b. (2015a) 'Det grønne skiftet - Utkast til Klima- og energistrategi for Oslo'.

Oslo kommune PBE, P.-o. b. (2015b) *Veileder for etablering av solfangere og solcellepanel*

Oslo Municipality (2015) *Municipal master plan: Oslo mot 2030: smart, trygg og grønn*. Available at: https://www.oslo.kommune.no/politikk-og-administrasjon/politikk/kommuneplan/.

Regjeringen, energidepartementet, O.-a. (2015) *Stortingsmelding 25 (2015-2016). Kraft til endring — Energipolitikken mot 2030.* Regjeringen.no.

Renovasjonsetaten, O. k. (2016) 'Avfallsstrategi for Oslo mot 2025 - BLI MED RUNDT (Høringsutkast 29.04.2016)'.

Risholt, B., Thomsen, J., Kristjansdottir, T., Haase, M., Lien, K. M. and Dokka, T. H. (2014) 'Energikonsepter for Ådland boligområde'.

Sartori, I., Merlet, S., Thorud, B., Haug, T. and Andresen, I. (2015) 'Aggregated loads and PV generation profiles (unpublished)', *The Research Centre on Zero Emission Buildings*.

Statistics Norway and The Norwegian Environment Agency (2016) *Totale utslipp til luft i Norge*. Available at: http://www.norskeutslipp.no.

Støa, E., Larssæther, S. and Wyckmans, A. (2014) 'Utopia Revisited. Towards a Carbon-Neutral Neighborhood at Brøset', *Fagbokforlaget (ISBN 978-82-450-1725-0) 355 p*.

THEMA consulting and Norsk Energi (2015) *Konsekvenser av å endre eller fjerne tilknytningsplikten til fjernvarme*. Available at: https://www.regjeringen.no/no/dokumenter/konsekvenser-av-a-endre-eller-fjerne-tilknytningsplikt-til-fjernvarme/id2470559/.

Transform (2015) *Work package 1: Becoming a Smart Energy City, State of the art and ambition*. Available at: http://urbantransform.eu/wp-content/uploads/sites/2/2015/07/WP1-revised-final-report.march-2015.pdf.

UN (2003) *Indicators for Monitoring the Millennium Development Goals*, New York: United Nations Development Group.