PI-SEC

TOOLKIT TESTING IN THE PLANNING OF SMART ENERGY COMMUNITIES

PI-SEC Report 1.3 / 2.3 :
Municipal practice and project planning

NTNU SINTEF The Research Council of Norway

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Oslo/Trondheim | October 2018

Toolkit testing in the planning of smart energy communities
PI-SEC Report 1.3 - 2.3, Oslo, Oktober 2018

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www.ntnu.edu/smartcities/pi-sec

Design: synlig.no

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Forord

PI-SEC er et norsk forskingsprosjekt 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 om 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 og Loddefjord 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 avslutter Task 1.3 og 2.3 i prosjektet, som handler om uttesting og tilbakemelding på tidlige versjoner av planleggingsverktøy for smarte energisamfunn. Vi presenterer her resultatet fra testing og videreutvikling av verktøyskassa som ble beskrevet i rapportene for task 1.2 og 2.2:

WP 1: Prosjektplanleggingsverktøy: Key perfomance indicators (KPI/ nøkkelindikatorer) og "Indicator tool/ indikator verktøy", nå: "PI-SEC Scenariokalulator".

WP 2: Kommunalt planleggingsverktøy: Planleggingshjul for energismarte samfunn, "PI-SEC Planleggingshjul"

For mer om verktøyene, se rapportene på denne nettsida:
https://www.ntnu.edu/smartcities/PI-SEC/publications

Stor takk til prosjektgruppa for innspill:
Helene Egeland (Plan- og bygningsetaten, Oslo Kommune)
Mathias Carl Mangor Bjornes (Plan- og bygningsetaten, Oslo Kommune)
Elisabeth Sørheim (Klimaseksjonen, Bergen Kommune)
Anders Nohre-Walldén (NGBC)
Miimu Airaksinen (VTT)
Guro Grøtterud (NVE)
Jens Gran (Standard Norge)
Asgeir Tomasgard (NTNU)
Gerhard Stryi-Hipp (Fraunhofer ISE)

Stor takk også til alle informanter som har stilt opp til intervju om verktøyene!

Oslo, Oktober 2018

Norwegian summary

Målene for dette forskningsarbeidet har vært å teste ut planleggingsinstrumentene for energismarte samfunn som ble utviklet i PI-SEC 2016-2017 (Nielsen et al, 2016; Walnum et al., 2017):

- Hvordan fungerer utvalgte mål, nøkkelindikatorer og planleggingsinstrumenter når de blir implementert i norske casestudier av utviklingsprosjekter for nabolag?
- Kan planleggingsinstrumentene forbedres basert på disse resultatene?
- Hvilke mål, nøkkelindikatorer og planleggingsinstrumenter utgjør den beste basisen for utvikling av en felles definisjon og rammeverk for måling av energismarte samfunn i Norge?

Resultatene er basert på kvalitative gruppe- og enkeltintervjuer av mulige brukere av verktøyet, i prosjektmøter og arbeidsverksteder. Lego og spilldesign har også vært brukt som en del av metoden for innsamling av data i arbeidsverkstedene.

Resultater og konklusjoner:

- Utvalgte mål, nøkkelindikatorer og planleggingsinstrumenter passer godt i utvalgte casestudier, og belyser gode måter å jobbe mot klimamålene på. Verktøyene får gode tilbakemeldinger på overordnet plan, men en utfordring kan være å få kommuneansatte til å ta verktøyene i bruk.

- Det er vanskelig å finne ansvarlige og sluttbrukere for verktøy som kartlegger helhetlig energibruk og relaterte utslipp. Det er tidkrevende å samle inn data, og ansvaret for å vurdere helhet i utslipp og hvordan man skal bruke dette er uklart. Selv om kommunene juridisk sett har ansvar for energiforsyning, løser mange kommuner dette gjennom privatiseringsmodeller eller interkommunale selskap som har den praktiske gjennomføringen og kompetansen. Dermed er det gjerne begrenset hva som er igjen av kompetanse og ansvar rundt dette i kommunene. Dette kan enten bety at verktøykassa vår er uegnet, at den ikke er tilpasset, at vi har jobbet med feil nedslagsfelt, eller at anbefalingen fra Annex 63[1] om at hver kommune må ha faste ansatte som har ansvar for dette er sentralt. Sannsynligvis ligger svaret midt i mellom, og vi må

    - forbedre verktøyskassa og spisse den mot behov
    - anbefale bevisst rolleavklaring og plass i planverket rundt tema energismarte nabolag i kommunal planlegging

- Hvis ansvar for energiplanlegging på områdenivå tydeligere plasseres innen kommunen, kan verktøyene ha høyere relevans for kommunene og dermed lettere implementeres i framtidig planlegging av energismarte samfunn.

- Informantene i kommunene ønsker sjekklister og verktøy hvis de oppfattes som relevante og tilpasset plan- og byggesaksbehandling. De ønsker verktøy som oppfordrer til samhandling hvor aktører kan lære fra hverandre og samarbeide mer effektivt og meningsfylt. Dette er i tråd med funn fra ulike andre studier som viser at byplanleggere ikke ønsker mer tidkrevende verktøy, men nettverk for å dele konkrete erfaringer med innovasjon.

- Arbeidet med PI-SEC planleggingshjul viser at beslutningsprosessene avhenger av en god start. Det å få med engasjerte og riktige aktører fra starten, er alfa og omega. Det trengs fortsatt bevisst jobbing i kommunene med å få energiselskaper, utbyggere, eiendomsforvaltere, kommunale planleggere, nasjonale vegmyndigheter, og innbyggere, til å jobbe mer strategisk og på lag. At det utvikles alternative måter å få til strategiske planer (for eksempel strategisk planprogram i Bergen) er et svar på at plansystemet er

[1] https://www.annex63.org/results/volume-1/

for rigid og deler opp aktørene i prosessløp som ikke legger til rette for integrert planlegging. Det er lite kunnskap om energiselskapenes ulike roller og muligheter i kommunene.

- En hovedutfordring med å få PI-SEC scenariokalkulator i bruk i kommunene, er at det er lite fokus på stasjonær energi i kommunal planlegging i dag. De overordnede klimamålene er heller ikke detaljert nok slik at det er mulig å måle CO2 utslipp for å finne ut om man når klimamålene kommunen har satt. Scenariokalkulatoren kan være en hjelp til å øke denne bevisstheten og kompetansen, men det krever også et større eierskap til målene i de ulike kommunale etatene.

- Selv om de største bykommunene bør ha kompetanse til å bruke PI-SEC scenariokalkulator, vil mange mindre kommuner ikke ha det, og være avhengige av hjelp fra konsulenter til å bruke det. Energirådgivere og konsulenter kan være en bedre egnet målgruppe for PI-SEC scenariokalkulator enn kommunen. Hvis kommunene selv skal bruke verktøyet, ønsker de en stor grad av automatisering; en kobling mellom verktøyet og GIS, og at bygninger og energibruk mates automatisk inn i modellen. De ønsker ikke å bruke tid på å legge data inn i verktøyet.

- Et verktøy som PI-SEC Scenariokalkulator er vanskelig å vurdere nytteverdien av uten at potensielle brukere selv tester på egenhånd. En kommuneansatt i en av test-byene sier selv at etter å ha testet verktøyet opp mot et reelt prosjekt hun er involvert i, så ser hun nytteverdien på en helt ny måte. Det å få kommuneansatte selv til å sette seg ned å prøve scenariokalkulatoren har vært noe som har vært fokus i PI SEC lenge, men dessverre har ikke motivasjonen hos kommuneansatte vært stor nok til at flere har testet verktøyet på egenhånd.

- PI-SEC Scenario Kalkulator kan ikke brukes uavhengig av andre verktøy for områdeplanlegging, fordi mål om klimagassreduksjon alltid må ses i sammenheng med andre mål for områdekvalitet.

- Det er også barrierer knyttet til å ta i bruk resultatene fra PI-SEC scenariokalkulator. Ofte vil resultatene demonstrere at energieffektivisering av de privateide bygningene har stor betydning for å få ned CO2-utslippene. Kommunen ser ut til å mangle virkemidler for denne typen prosesser med private boligeiere. Gratis energirådgivning og kreative initiativ til finansiering og støtte vil være avgjørende for å følge opp resultatene verktøyet gir.

English summary

”Planning Instruments for Smart Energy Communities” (PI-SEC) is a Norwegian research project being carried out in the period April 2016 to March 2019. It is funded by the Research Council of Norway and aims to develop effective planning tools for the integration of energy issues at community level. The project will contribute with increased knowledge about parameters that are key to cities focusing on smart and sustainable energy and will provide guidance as to how these cities address issues related to the planning, operation and monitoring of new and existing areas. The project’s research partners are NTNU and SINTEF, in collaboration with the cities of Bergen and Oslo. Standard Norway, FutureBuilt and the Norwegian Green Building Council are reference partners. The districts Ådland and Loddefjord in Bergen, and Furuset in Oslo, are participating in pilot studies as part of the project.
The project is divided into two work packages (WPs). WP1 adopts a bottom-up approach from building project development, while WP2 has a top-down approach from municipal planning. There are four tasks assigned to each work package.

The aims of this research have been to test the planning tools available to energy smart communities developed in PI-SEC 2016-2017 (Nielsen et al, 2016; Walnum et al., 2017):

- How do the selected targets, KPIs and planning instruments perform when implemented into Norwegian neighbourhood development projects?
- Can planning instruments be improved based on these results?
- What targets, KPIs and planning instruments form the best basis for the development of a common definition and assessment framework for smart energy communities in Norway?

The results are based on qualitative group and individual interviews of potential users of the tools, carried out during project meetings and workshops. LEGO and design games were used as a part of workshop data collection approaches.

Results and conclusions:

- The selected aims, key indicators and planning instruments seem to fit well in the context of the selected pilot studies and shed light on the ways in which cities can work towards achieving emissions reduction targets. The tools receive positive evaluations at superior level. However, it remains a challenge to persuade municipal employees to use the tools.

- It is difficult to identify the right employees and end-users for tools that map overall energy use and related emissions. Data collection in connection with the tools is time-consuming, and there is a lack of clarity regarding the responsibility for evaluation of overall emissions, and how this should be applied. Even if the municipalities have a legal responsibility for energy supply, many outsource this by transferring responsibility to private or inter-municipal companies, which are expected to take responsibility for both practice and expertise. This greatly erodes the levels of responsibility and expertise for energy issues within the municipalities themselves. This may mean that the toolbox is inappropriate and unadjusted, that the wrong catchments have been addressed, or that recommendations from Annex 63[2] regarding each municipality’s key duty to employ personnel with responsibility have been ignored. It is probable that the answer is a mixture of these alternatives. In the future, we have to
    - Improve the toolbox and focus it on needs
    - Recommend focused role clarification, and room for energy smart communities as part of municipal planning

[2] https://www.annex63.org/results/volume-1/

If responsibility for community energy planning is defined more clearly within the municipalities, the tools may become more relevant and enable the municipalities more easily to implement them in the future planning of energy-smart communities.

- Informants within the municipalities require checklists or tools, provided that these are perceived as relevant. They want tools that encourage interaction in situations where participating stakeholders are empowered to learn from each other and collaborate more efficiently and meaningfully. This is in line with findings in other studies showing that city planners are inclined to reject new time-consuming tasks but welcome the expansion of networks that enable the sharing of specific experiences, combined with innovation.

- Work with the PI-SEC planning wheel shows that decision-making processes depend on a good start. It is key to obtain appropriate and engaged stakeholders right from the start. There is still a requirement for focused work to encourage energy companies, property developers, property managers, municipal planners, the national highway authorities and residents to work more strategically in teams. The current planning system is too rigid and divides the stakeholders into process directions that are not conducive to effective, integrated planning. One solution to this lies in the development of alternative approaches to strategic planning (for example, as illustrated by Bergen's strategic plan programme). There is a striking lack of knowledge of the energy companies' different roles and opportunities within the municipalities.

- A key challenge to the implementation of the PI-SEC Scenario Calculator within the municipalities is the major current lack of focus on stationary energy in municipal planning. Overall emissions reduction targets are not sufficiently detailed to enable measurement of CO2 emissions, or to find out if a given municipality's targets are met. The Calculator may help to increase awareness and expertise. However, this will require greater commitment to the targets among the various municipal departments.

- Even if the largest city municipalities possess the expertise to apply the PI-SEC Scenario Calculator, many smaller municipalities do not, and are heavily reliant on consultants. Energy and other consultants may represent a more appropriate target group for the Calculator than municipal personnel. Informants state that if the aim is to encourage municipal personnel to apply the tool, they want more automation, a link between the tool and GIS, and the automatic input of building data and energy into the model. They do not want to spend time punching data into the tool.

- It is difficult to assess the usefulness of the PI-SEC Scenario Calculator without testing by potential users. A municipality employee in one of the test cities stated that after testing the tool against a real project, she perceived its usefulness in a completely new way. Persuading municipal personnel to use the Scenario Calculator has remained a challenge that PI SEC has been focusing on for some time. Unfortunately, the motivation of municipal personnel has not been sufficient to encourage more people to test it.

- The PI-SEC Scenario Calculator cannot be used independently of other tools for area planning, because emission reduction targets have to be grouped together with other area quality targets.

- There are also barriers linked to taking results from the PI-SEC Scenario Calculator into account. Results often demonstrate that the energy efficiency of privately-owned buildings has a major impact in reducing CO2 emissions. The municipalities seem to lack instruments that can be applied for these types of processes involving private sector landlords. Free energy consultations and creative initiatives for providing financial help and support will be decisive in following up the results generated by the PI-SEC Scenario Calculator.

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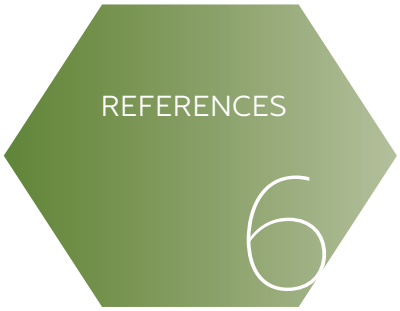


Figures

English - Norwegian Dictionary

In the report, the following translations are used[3]:

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
Key Performance Indicator (KPI)	Nøkkelindikator
Municipal master plan	Kommuneplan
Municipal coordinator	Kommunal saksbehandler
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 (SEC)	Energismarte områder
Urban Environment Agreement	Bymiljøavtale
Waterborne heating / cooling	Vannbåren varme/kjøling
White paper on energy policy towards 2030	Energimeldingen
Zoning plan	Reguleringsplan

[3]A general list of English-Norwegian terms related to the Norwegian Planning and Building Act is available on https://www.regjeringen.no/no/tema/plan-bygg-og-eiendom/plan--og-bygningsloven/plan/veiledning-om-plan-legging/Bokmal-nynorsk-ordliste/ordliste-norsk-engelsk--plan--og-bygning/id462717/

1. INTRODUCTION

Introduksjon – En kort oppsummering av kapittelet
PI-SEC er et norsk forskningsprosjekt som varer fra 2016 til 2019. Prosjektet er delt inn i to arbeidspakker (WP), hvor WP1 tar utgangspunkt i utviklingsprosjekter (nedenfra og opp, 'bottom up'), mens WP2 tar utgangspunkt i kommuneplanlegging (ovenfra og ned, 'top-down').
Denne rapporten oppsummerer utviklingen og testingen av en verktøykasse som skal hjelpe til med planlegging, implementering og evaluering av smarte energisamfunn (SEC).

1.1 About the research project PI-SEC

PI-SEC is a Norwegian research project being carried out in the period 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 neighbourhood scale, qualified for Norwegian planning context in cooperation with public stakeholders. The project will provide increased knowledge about the parameters that are essential for a movement 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.

SEC-definition
A Smart Energy Community is an area containing buildings, infrastructure and citizens that share planned societal services, and where environmental targets are achieved by means of the integration of energy initiatives in planning and implementation processes. A Smart Energy Community aims to reduce its dependency on fossil fuels by becoming highly energy-efficient, and driven increasingly by renewable and local energy sources. Spatial planning and localization also address the reduction of carbon emissions as part of wider regional considerations, by means of the design of energy systems and the inclusion of sustainable mobility initiatives throughout the region. Moreover, it encourages sustainable behaviour by means of its overall design approach – from its building and citizens, to community scale. The application of open information flow, a high degree of communication between the various stakeholders, and the use of smart technology are important factors in meeting these objectives.

The project's research partners are the Norwegian University of Science and Technology (NTNU) (Project manager and WP2 leader) and SINTEF (WP1 leader), in close co-operation with the municipalities of Bergen and Oslo, together with reference partners Standard Norge, FutureBuilt and the Norwegian Green Building Council. The project operates with a European reference group of key institutes and municipal representatives from the European Innovation Platform on Smart Cities and Communities, as well as the EERA Joint Programme Smart Cities. The project partners are also participating in the project IEA ECB Annex 63[4], which also includes non-European partners such as China, Japan, Australia and South-Korea.

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

The project's main target groups are urban decision-makers, municipal planning departments and other stakeholders charged with developing targets, criteria, roadmaps and tools for sustainable energy use in Norwegian communities.

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

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

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 per capita residential electrical energy use; energy consumption of public buildings; percentage from renewables of total energy use; impact on the electricity distribution grid; air pollution; charging networks, intelligent transport systems;, average commuting times; value of fuel savings, etc.
Neighbourhood level ↓↑	Reductions in CO2-emissions, Life Cycle Costs, Air pollution, Import and export of energy, kWh/m2 per hours of occupancy, CO2/travel km, Distance to public transport nodes, Frequency of public transport, Cycling networks, Integration of RES, Intelligent transport facilities, etc.
Building level	Energy demand measured in kWh/m2 floor area; supplied and primary energy measured in kWh/m2 floor area; power demand, CO2 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 the different levels
Note 1: For simplicity, district level and regional/international levels are not included in the figure.
Note 2: The figure only presents examples of typical indicators used at the different levels, collected from different sources[5]. The lists are not meant to be exhaustive.

[5]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

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

1.2 Report context and content

This report addresses tasks 1.3 and 2.3 – toolkit testing in case studies, see figure 1.2. A detailed description of the planning tools for smart energy communities can be found in Reports 1.2 and 2.2 (see Walnum et al., 2017; Nielsen et al., 2016, 2018).

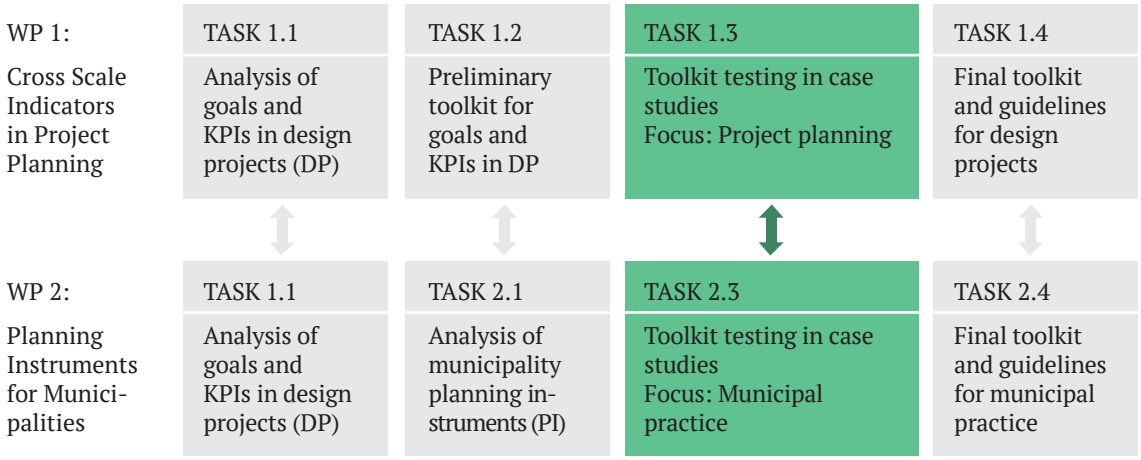


Figure 1.2 Work packages incorporated in PI-SEC. Illustration of work packages, related tasks and work flows.

The research questions for the work described in this report are:

- How do the selected targets, KPIs and planning instruments perform when implemented into Norwegian neighbourhood development projects?
- Can planning instruments be improved based on these results?
- What targets, KPIs and planning instruments form the best basis for the development of a common definition and assessment framework for smart energy communities in Norway?

The planning instruments have been tested on the PI-SEC case studies in feedback meetings with stakeholders involved in these studies, and with stakeholders from other relevant organisations working with smart energy communities. The case studies are presented in the table below. A third case study (Loddefjord, also in Bergen) was included in order to be able to test the tools at a larger scale, and because the Ådland case study is currently on hold (autumn 2018).

PROJECT NAME AND LOCATION	ENERGY/ENVIRONMENTAL GOALS	TYPE AND SIZE OF DEVELOPMENT	TIME FRAME	SPECIAL ISSUES
Ådland, Bergen	Zero GHG emissions for the area, www.zeb.no	600 dwellings and a community centre. Planned new buildings/infrastructure	2015-2020	Local renewable energy and electromobility
Furuset, Oslo	Climate-neutral district centre, www.futurebuilt.no	Existing suburb from 1970's with 9500 residents	2010-2020	Energy strategy plan and GHG accounting analysis
Loddefjord, Bergen	As yet undetermined	Existing suburb from mostly 1970's with about 8500 residents	2018-	Local renewable energy, green mobility

Table 1.1 Case studies/pilot areas

This report views the research results from tasks 1.3 (the PI-SEC Scenario Calculator) and 2.3 (the PI-SEC planning wheel) in combination. The task descriptions are as follows:

Task 1.3: Toolkit testing in case studies
Task 1.3 incorporates data analyses from the case studies as a basis for the validation, optimization, or rejection of the KPIs chosen for task 1.2. A preliminary set of indicators is then tested in the selected neighbourhood development projects (case studies). The case studies are first analysed "as planned", i.e. an analysis of the actual performance indicators, goals and criteria that have been applied by the planners involved. The interview guide covered the following topics, although it should be noted that not all the topics listed were relevant to the respondents:

- What energy performance criteria (KPIs) have been used, and what were the resulting choices with regard to concepts, technologies, energy performance and GHG emissions?
- How do the criteria used relate to higher and lower level criteria (at building, city and regional scales), and how can they be measured and aggregated to higher level criteria?
- How do the criteria contribute to meeting the overall goals of smart sustainable cities?
- Were the criteria easy to understand, measure and communicate?
- How much time has been spent on criteria analysis, and what tools have been used?
- Where should the geographic system boundaries for export/import of energy be defined?
- How much of the life cycle of the project should be included? What about secondary effects?
- What are the appropriate measurement units with respect to time?
- How many indicators should be included?
- How should indicators such as transparency, double counting, synergies, rebounds, etc. be aggregated?
- How should data quality and monitoring procedures, including future scenarios for AMS legislation and the development of Internet of Things, be addressed?

In addition to testing of the PI-SEC Scenario Calculator in the area development case studies, feedback and evaluations were collected during qualitative interviews.

Task 2.3: Toolkit testing of planning instruments using case studies
Task 2.3 has tested how the selected planning instruments perform when implemented in the PI-SEC neighbourhood development project cases. The work was carried out cooperation with PI-SEC researchers and municipalities.

The main tool applied was an action research method involving the co-generation of new information and analysis. The resulting actions generated insight both for researchers and participants with the aim of improving practice (Greenwood and Levin, 1998). Researchers and stakeholders worked together in knowledge development and practical problem solving with the aim of learning lessons and establishing and replicating successful practice both within and beyond the project. Action research is a complex method in that it not only involves the immersion of researchers in their fieldwork, but also requires that they practice reflective examination of their tasks. Researchers from NTNU participated in ongoing processes in the municipalities linked to the development of plans and documents related to the case studies, including secondments/

internships, interviews with stakeholders, testing of tools/approaches and the documentation of analyses designed to coordinate tacit and explicit knowledge. Feedback accumulated from these actions was regularly discussed with project stakeholders, which in turn potentially influenced the course of the project. The work included preparation and adaptation to local contexts, implementation in the PI-SEC cases and the monitoring of results. The results themselves were used to adapt the planning instruments with the aim of obtaining better performance in each PI-SEC case specifically, and in a Norwegian context in general. The outcomes provided a basis for the development of a common definition and assessment framework for smart energy communities in Norway.

Campus Evenstad, Hunton Fiber.

1.3 Current status of the pilot cases

The pilot cases are described in detail in Walnum et al., (2017), and only brief summaries will be given here.

FURUSET, OSLO

KEY FACTS	
Planned function	Multifunctional neighbourhood
Area size (m2)	As yet undecided
Current function	Multifunctional neighbourhood
Construction	Retro-fitting/upgrading and new construction, 1,700 – 2,300 homes and 2,000 – 3,400 jobs (up to 160 000 m2)
Energy sources	District heating and grid-based electricity
Status	Planning of the micro-energy system
Project owner	Oslo municipality
Involved stakeholders	• Oslo municipality (several departments incl. planning, climate change mitigation and property) • Alna urban district administration dept. • Several consultant agencies • 12 housing cooperatives • Private landowners • The public transport company Ruter • The energy utility company Hafslund
Population (1.1.16)	652,940 (Oslo)
Current phase	Planning

Table 1.3: Key facts describing the Furuset case (based on a table taken from the ZEN report "A ZEN Guideline for the ZEN Pilot Areas. Version 1.0". Published in 2018)

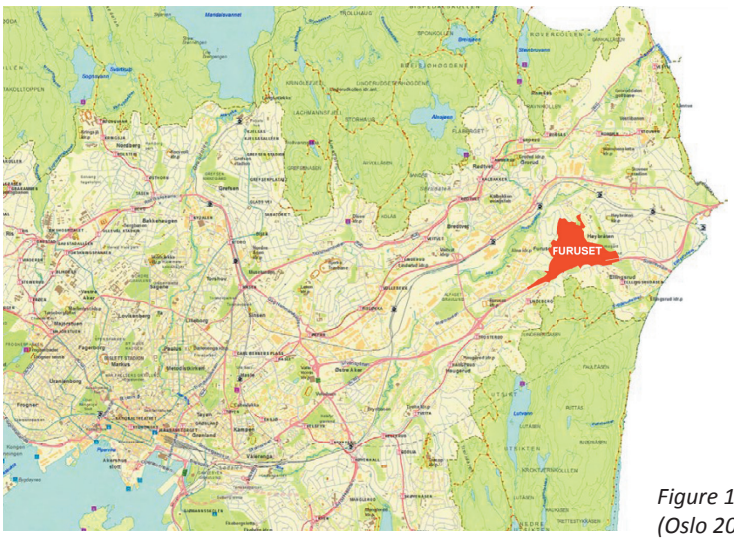


Figure 1.3 Map showing the location of Furuset (Oslo 2014)

Figure 1.4 Furuset today (Oslo 2014)

Figure 1.5 Illustration of the planned future layout of the Furuset area (Oslo 2014)

Furuset in Oslo is a large urban district containing building types of all kinds, both publicly and privately owned. The existing buildings were constructed mainly in the 1970s, and the overall building mass, community areas an infrastructure are in need of renovation.

ZERO VILLAGE BERGEN, BERGEN

KEY FACTS	
Planned function	Residential neighbourhood with a kindergarten and additional service functions
Area size (m2)	378,000
Current function	Green space with a few residential buildings
Construction	New construction, 720 homes (92,000 m2), offices, a kindergarten and additional service functions
Energy sources	Solar panels. The thermal energy system is as yet undecided (district heating, bio CHP and GSHP are under consideration)
Status	Planning phase, waiting for government approval
Project owner	ByBo AS
Involved stakeholders	• ByBo AS • ZEN partners; Multiconsult, Snøhetta, Bergen municipality • Local organisations: BKK and CMR
Population (1.1.16)	252,772 (Bergen)
Current phase	Planning (yet to be approved)

Table 1.4: Key facts describing the ZVB case (based on a table taken from the ZEN report "A ZEN Guideline for the ZEN Pilot Areas. Version 1.0". Published in 2018)

Figure 1.4 Illustration of the planned future layout of Zero Village Bergen (Illustration by architects at Snøhetta) (ZEB 2016)

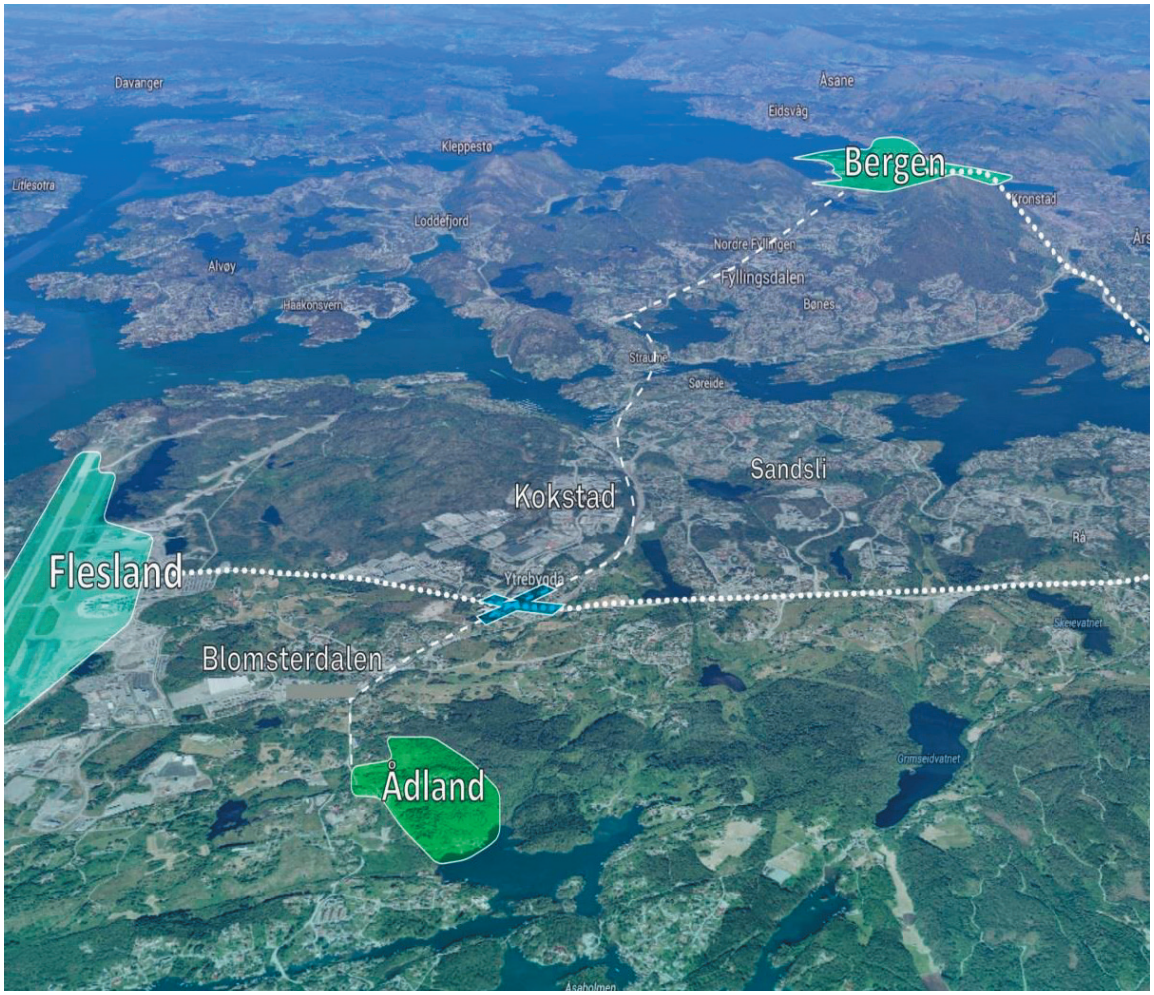


Figure 1.5 Map showing the location of Zero Village Bergen (ZEB 2016)

Zero Village Bergen is a special case in the sense that there are currently no buildings in the area and only one developer involved in project planning. The developer has to a large extent initiated the project itself, with assistance from researchers involved in the Centre of Zero Emission Buildings (ZEB CEER – Centre for Environmentally-friendly Energy Research) who have defined the project's ambitions, including the concept of "a zero emissions community".

A key area of focus linked to Bergen municipality's environment and health targets is to reduce levels of atmospheric emissions and particulates. One of their actions has been to provide incentives for the conversion from oil-burning heating plants to cleaner alternatives. A further key action has been the reduction in city centre vehicle emissions resulting from increasing road tolls at certain times of the day.

LODDEFJORD, BERGEN

Loddefjord is very similar to the Furuset case in Oslo. Many of its buildings originate from the 1970s and require refurbishment. Electricity constitutes the main energy source for heating.

KEY FACTS	
Planned function	Multifunctional neighbourhood
Area size (m2)	As yet undecided
Current function	Multifunctional neighbourhood
Construction	Retro-fitting/upgrading and new construction. Local thermal energy plant.
Energy sources	As yet undecided. A local bio-based thermal energy plant and solar energy have been discussed.
Status	Start-up phase involving planning of the energy system (mainly by the energy utility involved).
Project owner	Bergen municipality
Involved stakeholders	• Several departments in Bergen municipality (planning, climate change mitigation and property) • Urban district administration dept. • Housing cooperatives • Private landowners • The public transport company Skyss • The energy utility company BKK
Population (1.1.16)	Approx. 280,000
Current phase	Planning

Table 1.5: Key facts describing the Loddefjord case.

Figure 1.6 Loddefjord centre today. The large building on the right is the Vestkanten shopping centre. The Vannkanten water park and the Iskanten ice hockey stadium are located outside the diagram (Source: www.google.maps.com)

Figure 1.7 Map showing the size of the Loddefjord case area (Source: Bergen municipality)

2. STARTING POINT – THE PLANNING TOOLS

2.1 PI-SEC Scenario Calculator

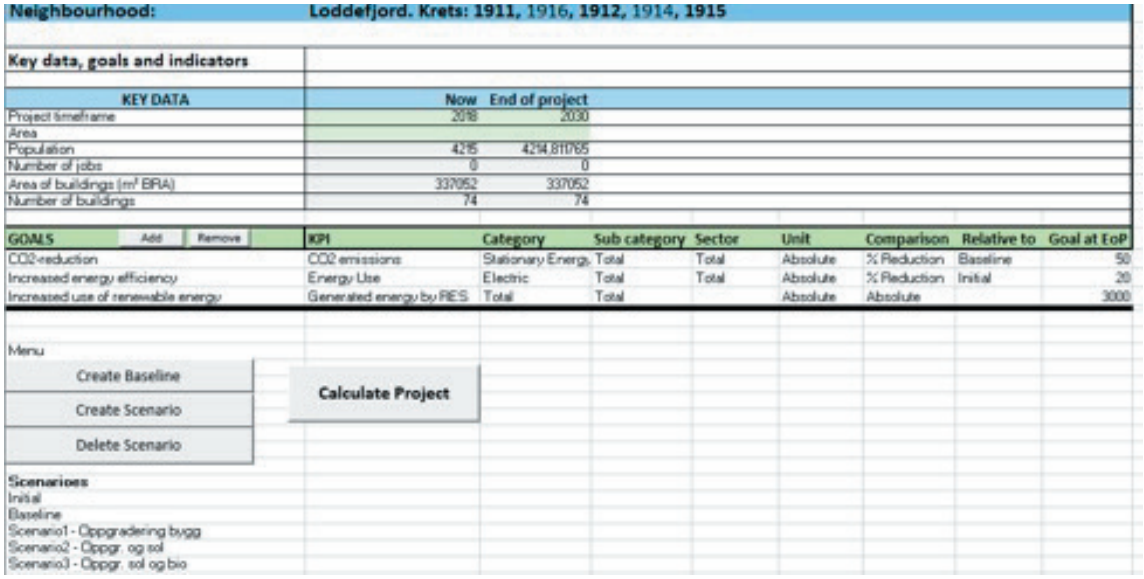
The report from task 1.2 (Walnum et al., 2017) provides a description of the tool to be tested in Task 1.3. The work has focused on an indicator-based toolkit that can meet needs identified in Tasks 1.1 and 2.1.

Based on available literature, a final list of 16 main and relevant key performance indicators (KPIs) was generated by means of a structured selection process. The goals defined by the case projects, and the pilot cities relevant for smart energy communities (SECs), were assembled and structured, and sorted into five main categories:

1. CO2 emissions reduction
2. Increased use of renewable energy
3. Increased energy efficiency
4. Increased use of local energy sources
5. Green mobility

To simplify application of the indicators and link them to goal achievement, an indicator-based planning tool for neighbourhoods was proposed. It was initially called “PI-SEC Indicator Tool”, later changed to the “PI-SEC Scenario Calculator”. The main purpose of the tool is to link specific measures to the degree of goal achievement, thus making it easier for municipalities and developers to see if they have accomplished their goals.

The PI-SEC Scenario Calculator is a decision support tool designed for use by area planners with high levels of ambition in the fields of energy use and emissions reduction.



Neighbourhood: Loddefjord. Krets: 1911, 1916, 1912, 1914, 1915

Key data, goals and indicators

KEY DATA	Now	End of project
Project timeframe	2018	2030
Area		
Population	4215	4214.811765
Number of jobs	0	0
Area of buildings (m² BRA)	337052	337052
Number of buildings	74	74

GOALS (Add / Remove)	KPI	Category	Sub category	Sector	Unit	Comparison	Relative to	Goal at EoP
CO2-reduction	CO2 emissions	Stationary Energy	Total	Total	Absolute	% Reduction	Baseline	50
Increased energy efficiency	Energy Use	Electric	Total	Total	Absolute	% Reduction	Initial	20
Increased use of renewable energy	Generated energy by RES	Total	Total		Absolute	Absolute		3000

Menu

Create Baseline

Create Scenario

Delete Scenario

Calculate Project

Scenarios

Initial

Baseline

Scenario1 - Oppgradering bygg

Scenario2 - Oppgr. og sol

Scenario3 - Oppgr. sol og bio

Figure 2.1 Example of a front page taken from the PI-SEC Scenario Calculator

The PI-SEC Scenario Calculator has been developed to make it easier for municipalities and developers to monitor the achievement of environmental targets in a given area. The calculator links local actions implemented for buildings and transport infrastructure to general energy use and emissions reduction targets by calculating values for the selected key indicators. The targets for any given area are defined based on either current status or a “baseline scenario”, and various user-defined development scenarios can be compared both with each other, and with the defined targets for the area in question. The use of, and results derived from, the scenario calculator may help to increase the understanding of what is required to achieve selected targets, and thus provide the basis for more detailed plans, and the selection of focus areas and incentive schemes.

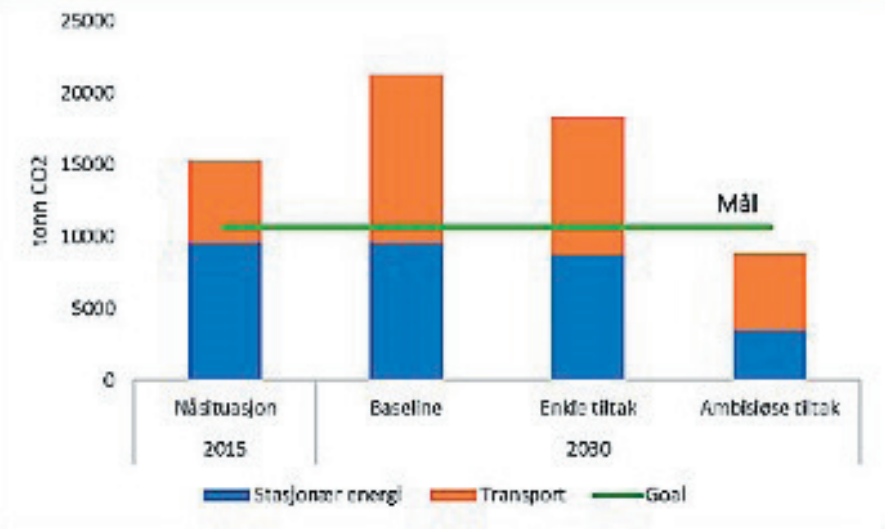


Figure 2.1 Measurement parameters from the PI-SEC Scenario Calculator.

2.2 The PI-SEC planning wheel

The PI-SEC planning wheel offers multiple tools that may be useful for the planning, implementation and evaluation of development actions linked to energy smart communities (Nielsen et al., 2016; 2018). Application of the wheel is an iterative process. Following experience from the IEA/EBC Annex 63 project and feedback from Norwegian municipalities, the following key factors have been identified:

- The planning wheel is based on a logical structure comprising various phases defined on the basis of challenges that users have described as components of their process.
- The order of phases is not prescribed, regardless of needs dependency or the basis for the project. No clear recommendations are provided regarding phase order as a guide to achieving success. For this reason, the municipalities and other stakeholders can use this wheel freely as a source of inspiration to identify their own examples of experiences linked to dealing with process challenges.
- A good process depends heavily on a thorough and collaborative approach to Step 1 in the planning wheel. This requires a vision and the setting of targets. As a result, all subsequent steps should be planned in relation to Step 1.

Thus, for Step 1, the two work packages in the PI-SEC project contribute with decision support tools such as the PI-SEC Scenario Calculator, which help planner set clear target scenarios.

In this project, the Smart Energy Community planning wheel is linked to tools that may be useful for the iterative planning, implementation and monitoring of SECs (Nielsen et al., 2018). The planning toolbox (Nielsen et al, 2018) is subdivided into five different categories, each linked to the steps in the planning wheel;

1. (Tools for) VISION SETTING AND POLITICAL COMMITMENT/APPROVAL
2. (Tools for) TARGET SETTING
3. (Tools for) INTENTION AND FINANCING MODELS
4. (Tools for) ENABLERS AND STAKEHOLDER COMMITMENT
5. (Tools for) MONITORING AND EVALUATION TOOLS

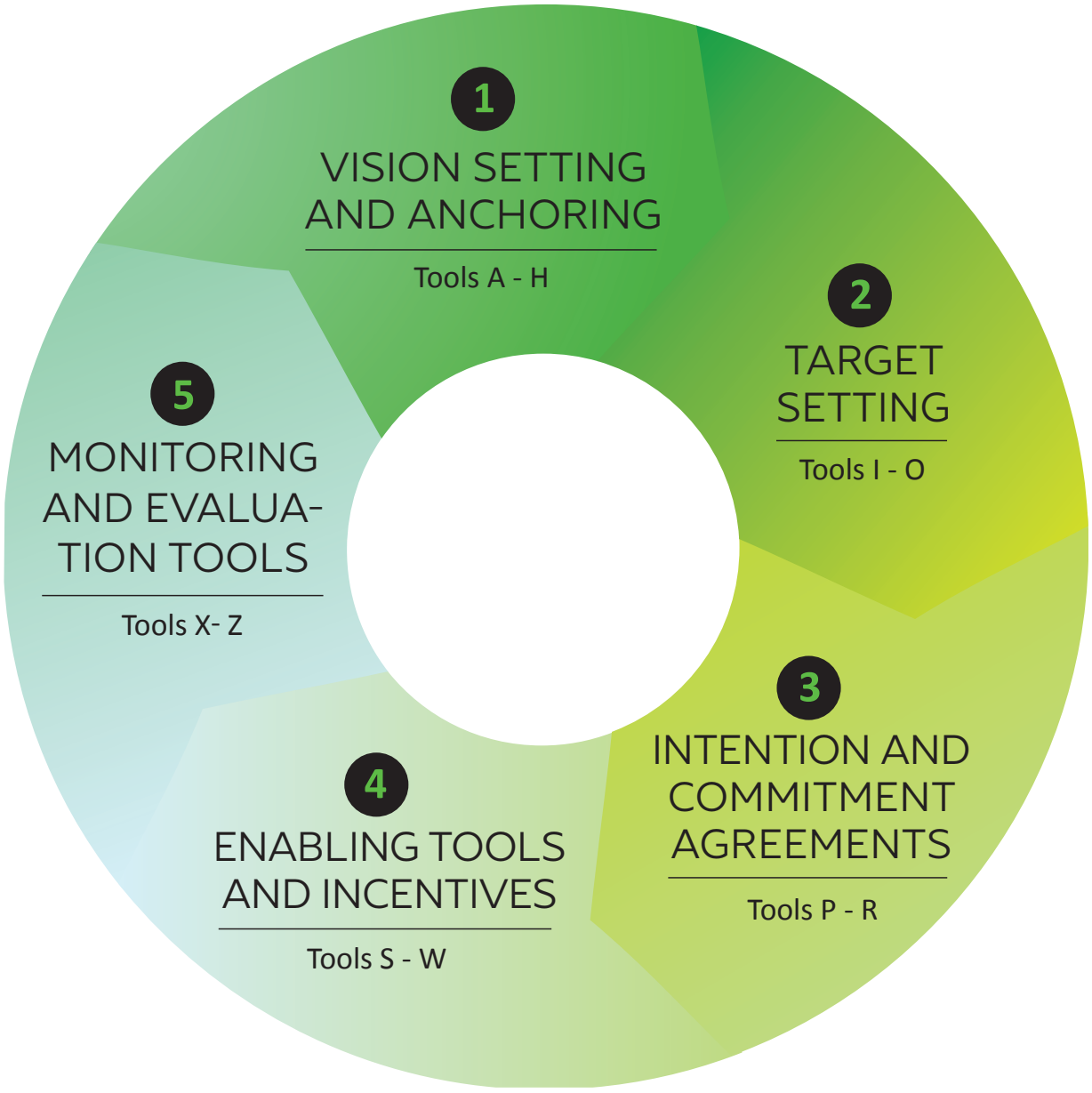


Figure 2.2: The PI-SEC planning wheel

TOOLS:

1 VISION SETTING AND ANCHORING

A: Define Vision holder
B: Evaluate organizational/municipal planning and project baseline
C: Municipal Renewable Energy Strategy (RES)
D: Create a Coordination team
E: Make a plan for citizen inclusion
F: Stakeholder mapping and pathway
G: Create a SEC vision with the help of decision support tools
H: Vision anchoring

2 TARGET SETTING

I: Design the Core of Community (CC)
J: Make a Core of Community Fund (CCF)
K: Define energy demand for buildings
L: Transport systems and energy demand
M: Ensure compliance with requirements in area plans
N: Design energy supply options
O: Decision making and risks

3 INTENTION AND COMMITMENT AGREEMENTS

P: Develop cost roadmap and priorities with stakeholders where the following should be considered
Q: Make Intention Agreements
R: Consider Dispensations and alternative regulation needs:

4 ENABLING TOOLS AND INCENTIVES

S: Ensure and maintain stakeholder engagement
T: Strategic property use/use of role models
U: Consider urban competitions
V: Implement Citizen involvement Actions for the area
W: Increase energy awareness through work with inhabitants

5 MONITORING AND EVALUATION TOOLS

X: Monitoring using PI SEC Indicator Tool
Y: Consider external evaluation or certificates
Z: Did we reach our vision?

Figure 2.3: PI-SEC planning tools for energy smart communities (Nielsen et al. 2018)

2.3 Tools that have guided toolkit design

On the basis of Annex 63, the following reviewed and globally-applied tools were selected based on needs assessment and the planning wheel structure:

- Smart City Guidance Package
- Renewable energy strategy (RES), from Annex 63
- Design game, based on lessons learned from Annex 63
- Municipal assessment tool, from Annex 63
- Final recommendations, from Annex 63
- Jahn Gehl's spatial qualities principles
- BREEAM Communities

In addition, the following tool review from Finland (Hukkalainen, Virtanen et al. 2017) was used as a starting point for the consideration of other tools. This is relevant because the Norwegian and Finnish planning systems are similar, combined with the fact that the Norwegian and Finnish governments have agreed to the same low-carbon emission goals:

Illustrasjon av bomiljø i Ryngetunet. Ill: Snøhetta developer: ByBo AS

TOOL	SCOPE	EXPLOITATION POTENTIAL IN FINLAND	REFERENCE
BREEAM-Community	New development at neighbourhood scale. Buildings and their impacts on transport, land use, economic and social factors.	Potentially suitable, mainly for the evaluation of the final result of new development.	Charoenkit and Kumar (2014), BREEAM (2012)
LEED-ND	Neighbourhood development. Smart growth, urbanism and green building.	Potentially suitable, mainly for the evaluation of the final result.	Charoenkit and Kumar 2014, US Green Building Council (2009)
CASBEE-UD	Assessment method for multiple buildings and other elements on a large-scale site. Developed for the Japanese environment.	Mainly for evaluation of the final result.	Charoenkit and Kumar (2014), Institute for Building Environment and Energy Conservation (IBEC) (2014)
SBTool2012	Designed for different development stages and locations, different sets of criteria and indicators. User weights the criteria.	More complicated to initiate than BREAAM, CASBEE, LEED, but allows for prioritisation at local scale.	Charoenkit and Kumar (2014)
GBI for Township	Sustainable building development in Malaysia.	Completely different climate and environment	Charoenkit and Kumar (2014)
A theoretical model and its practical application	Balance energy consumption of districts and PV potential in districts across an entire city.	Buildings included, but not transportation. Only PV supply is included. No other RES or CHP.	Amado et al. (2016)
Bottom-up energy system optimisation	Supports planning policies to promote RES. Primary energy, power and heat, emissions and end-uses.	Planning of regional (not urban) energy systems. Includes regional CHP.	Cormio et al. (2003)
Evaluation framework & multi-criteria decision analysis	A multilevel decision-making structure using multiple criteria for energy planning and optimal RES at regional level.	Supports decision-making for regional RES, not for urban districts. No transport planning scenarios.	Mourmouris and Potolias (2013)
An land use-transport-energy model for future smart cities	Developed for future smart cities. Uses a spatially explicit land use model. Assesses possible RES implications.	Potential. Developed for Tokyo, focusing mostly on megacity development.	Yamagata and Seya (2013)

Table 2.3: Existing district level sustainability assessment tools and their estimated exploitation potential to support low carbon urban planning in Finland.

While the informants perceive BREEAM Communities[6] mainly as a tool for the evaluation of final results, the PI-SEC project, as described in Hukkalainen et al. (2017), is seeking tools that will help integrate energy efficiency as a planning target at the very beginning of the process. The BREEAM Communities approach involves a total of 40 different criteria sorted into five categories, and offers a holistic framework for sustainable neighbourhood development. Informants in the municipalities expressed a wish to have BREEAM Communities as a part of the PI-SEC approach. BREEAM is a rather flexible approach compared to many other sustainable assessment tools, and avoids being prescriptive in its recommendations for how different solutions should be delivered. However, the tool provides different scores for different issues, and there is a risk that local contexts can be overlooked due to unequal weighting of the various criteria.

The Norwegian Green Building Council (NGBC) has adapted the BREEAM Communities approach to the Norwegian planning context. According to the NGBC, the strengths of the tool are that it offers a holistic toolkit in which different approaches and themes related to sustainable development are considered in relation to each other. Use of the BREEAM Communities approach can thus help the municipalities to direct greater focus on sustainability issues at earlier stages in the planning process (NGBC 2016). The biggest challenge presented by the BREEAM Communities approach is that it has to be adapted to the specific context before application. Furthermore, the certification tools used by municipalities have to be updated during the community development process in order to meet both the present and future circumstances of the area or district in question (Venou 2014).

Selection of the most appropriate criteria to fit both the current Smart Energy Community (SEC) definition, and the municipalities' identified needs, required a careful review of all the 40 BREEAM Communities criteria. These were compared with the current SEC definition and five "hotspots" for tool matching and development were identified. These hotspots had been identified previously in report 2.1 "Planning Instruments for Smart energy Communities" (Nielsen et.al , 2016, p .77-78). The five hotspots for tool matching and development comprise: 1) energy screening and integrative start-up tools; 2) visualization tools; 3) triple-bottom-line scenario building tools; 4) sustainable user behaviour design; and 5) stakeholder/incentive-based understanding of system boundaries. A more comprehensive explanation of the different hot spots can be found in report 2.1 (Nielsen et.al, 2016, p. 77-78). The BREEAM Community criteria that were identified as relevant belong to the categories Governance, Resources and Energy, and Transport and Movement. We selected the following four criteria that were considered most relevant to the PI-SEC project: energy strategy, public realm, consultation plan, and consultation and engagement.

According to the BREEAM Communities approach, all energy strategies should be developed and assessed by an independent energy specialist. The establishment of an energy strategy will assist recognition of the renewable energy potential of the SEC. The strategy should include a visualization tool, such as energy modelling software. Visualization tools that focus on the relationships between energy use, energy production and emissions were one of the municipalities' identified needs as described by Nielsen et al. (2016). According to the BREEAM Communities approach, the energy modelling software should include "a breakdown of the site heating, cooling, and electricity demand; emissions for both regulated and unregulated energy use and emissions associated with street lighting and other electrically powered street furniture." (BRE 2012:23).

One of the five hot spots identified in the PI-SEC report 2.1 was sustainable user behaviour design of buildings and urban areas. The design of urban areas has also been discussed as part of the ZEN CEER project[7]. One of the criteria selected from the BREEAM Communities approach – public realm (meaning public space), is closely related to user behaviour. The properties of public spaces may act to stimulate sustainable user behaviour, such as less use of cars.

Guidance offered in the BREEAM Community approach on Governance, Resources and Energy, and Transport and Movement) in its "consultation plan" and "consultation and engagement" may help municipalities to understand the system boundaries i.e. how stakeholders and incentives can enhance the planning and implementation of SECs. Furthermore, these criteria may support decision makers in the building of triple bottom line scenarios. The four selected BREEAM Communities criteria will be described in more detail in the

[6]https://www.BREEAM.com/discover/technical-standards/communities/
[7]https://fmezen.no/

toolkit report (Nielsen et al., 2018), together with examples of best practice in the application of the BREEAM Communities approach.

2. 4 The PI-SEC Scenario Calculator and planning wheel in combination

The PI-SEC Scenario Calculator and the PI-SEC planning wheel function most optimally when used in combination. The planning wheel is a holistic planning tool, and examples of application of the wheel during the various planning stages are given in the report authored by Nielsen et al, (2018). As figure 2.4 shows, the PI-SEC Scenario Calculator is important in relation both to Step 1 – process start-up and the building of smart community scenarios (KPI planning), and Step 5 – the monitoring of target achievement (KPI monitoring).

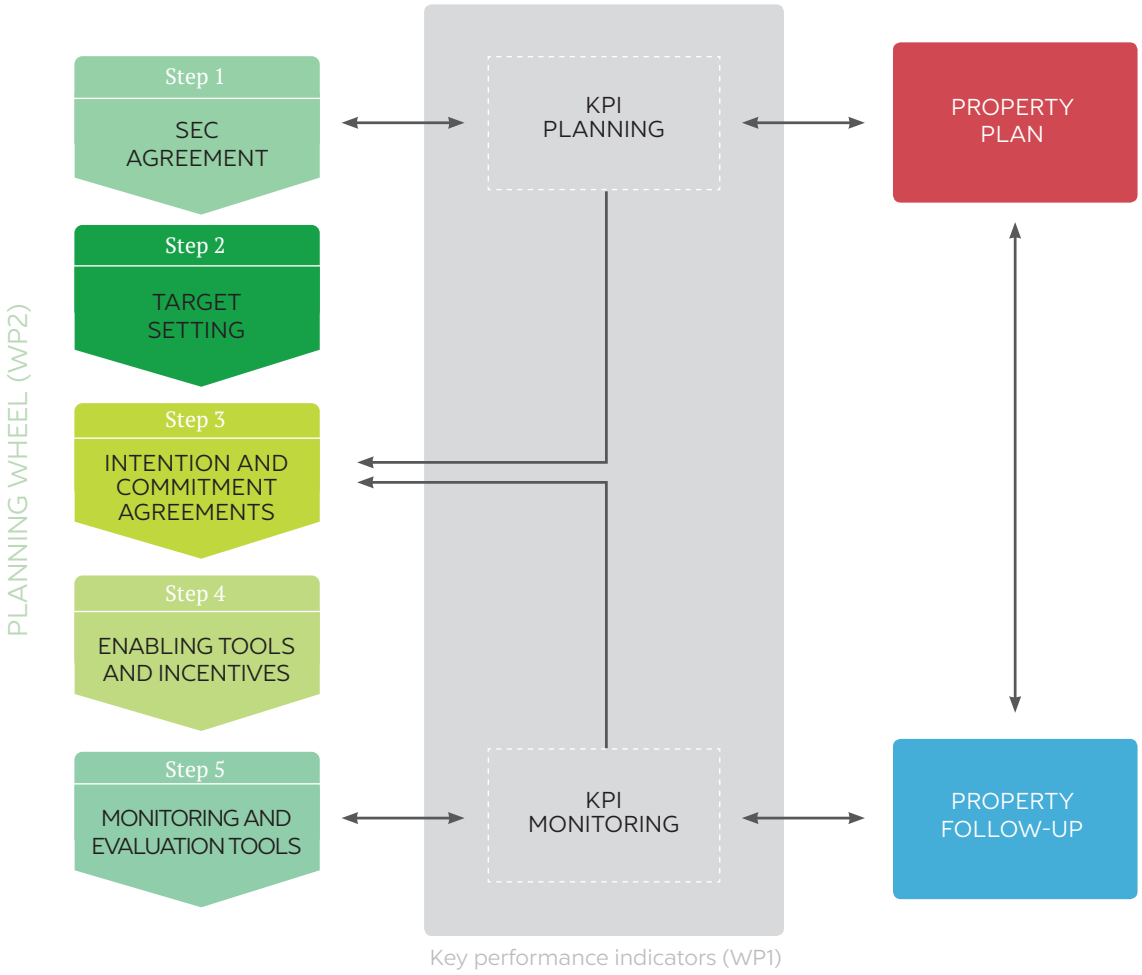


Figure 2.4 Illustration of the combined use of the PI-SEC planning wheel and the PI-Sec Scenario Calculator for KPI planning and KPI monitoring.

3. METHODS

Metode – En kort oppsummering av kapittelet
Dette kapittelet beskriver hvilke metoder som er brukt for å samle inn data om evaluering av verktøyene. I tillegg til at PI-SEC scenariokalkulator er testet ut på faktisk områdeutvikling i pilotområdene (case studiene), er tilbakemeldinger og evalueringer av verktøyene samlet inn gjennom kvalitative gruppeintervju.

3.1 Methodology

The PI-SEC process is based on case study methodology (Yin, 2003), which includes analysis of multiple single cases viewed from different perspectives in their natural setting. The case studies are analysed using both quantitative and qualitative methods such as MCA, computer simulations, interviews, and interdisciplinary analyses carried out in workshops.

Different technological scenarios were analysed and the results compared with KPIs and energy-related targets. Computer simulation tools were used to model energy performance, GHG emissions, energy exchange between buildings and the grid, storage, and the dynamic interactions between stationary energy use and transport (Murphy and Sartori 2014). The case studies were also investigated qualitatively using Focus Group Interviews (Kitzinger, 1995), involving conversations with representatives from all involved participant groups (municipalities, industry partners/consultants) focusing on their use of the KPIs.

3.2 Validity and generalisation

The PI-SEC process is based on research into the planning of pilot projects. This requires a discussion on the transferability of the insights we produce to non-pilot projects.

What makes a pilot project different from other projects? The motivation behind participation in a pilot project may be stronger than that for non-pilot projects. A question that has emerged during the PI-SEC process is what motivates participation in a pilot project. An interesting finding is that even for projects that become dormant or are never implemented, participants tell us that they are very happy with the process and the interactions that have taken place. The main reason for this is that they have learned a great deal. The larger stakeholders have become enabled to apply the innovations they have learned to other projects. In fact, it may be in their interest not to see the project implemented.

Urban planners feel responsible for meeting residents' expectations, and seem to become attached to the final product. The same applies to researchers in connection with pilot projects. However, in a representative situation, who will instigate and own a planning vision, knowing that between 80 and 90 per cent of all urban development projects in Norway are initiated by private stakeholders? Would the levels of interest in participation be equally as high for ambitious stakeholders without the participation of national stakeholders and the fuel of the political spotlight? If stakeholder motivation varies in this way, how can we validate the replication of successful strategies?

Experience shows that motivation within the municipalities is boosted when they are working to procure large-scale funding. However, even if a concept is developed and designed, motivation will decline if funding is not forthcoming and participants withdraw from the project. How can we compete with these financial motivations and still achieve sustainability goals in all projects?
In the light of this, we should interpret our findings in the knowledge that they are based on pilot projects for which there is a strong motivation to succeed. Consideration of the context of case studies enables us to transfer the findings to similar cases.

3.3 The testing process and feedback meetings

The research processes resulted in tools that met the requirements of different stages of the planning of a smart energy community. Since the case studies were/are at different stages of the planning process, the combined toolkit had to be tested stepwise and in the form of individual components.
Tool testing in this project refers to the feedback and iterative remodelling of the PI-SEC Scenario Calculator and Planning Wheel concepts by means of:

- Expert group meetings
- Participatory workshops at which tool probes are tested
- Calculation experiments using the Scenario Calculator
- Identification of gaps based on the findings from (a-c)
- Gap closure by means of a combination of literature sources, international tool review and experience sharing in meetings with other cities.

Feasibility study of a public space in ZEN pilot project Vådan Jl by tegn_3

DATE AND PLACE	PARTICIPANTS	ACTIVITIES	TOOL UNDER EVALUATION
15.09.2017 Trondheim (skype)	Project coordinators, architect and artist (3)	Interview with Gothenburg about its experiences with the Step Up tool and Gugle. Interview with project coordinators, architect and artist.	Planning Wheel
29.09.2017 Stavanger	Oslo municipality (2), Bergen municipality (2), Stavanger municipality (2), International reference group (2) and researchers (5)	Decision-making theatre to improve toolkit.	Planning Wheel and Scenario Calculator
16.10.2017 Trondheim	Annex 63, SINTEF and NTNU experts in urban and energy planning (15), municipalities (2) and researchers (11)	Presentation of toolkit to obtain feedback.	Planning Wheel and Scenario Calculator
15.10.2017 Barcelona	Workshop in Smart City. Participants from the cities of Vienna, Milan, Tel Aviv and Bodø (5)	An alternative/free regulation zone workshop, Knowledge of top-down/bottom-up initiatives and their relationships to international project regulation.	Planning Wheel
17.11.2017 Bergen	Bergen municipality, urban planning and climate change mitigation (3) departments and researchers (2)	Discussion on municipal processes related to project development. Sharing of insights into the importance of area regulations and new directives on impact evaluations.	Planning Wheel and Scenario Calculator
24.11.2017 Oslo	Oslo municipality (2), private sector participants (3) and researchers from PI-SEC and ZEN (6)	Furuset workshop. Municipality assessment in collaboration with ZEN.	Scenario Calculator
10-11.01.2018 Trondheim	Gothenburg, experts in teamwork sustainability (20). Workshop participants (29) and PI-SEC researchers (7)	Experience sharing meeting to discuss inputs to details of the Planning Wheel and Scenario Calculator Design game. The panel debate used as an experience-sharing format received the most positive feedback. Experiences in the use of strategic competition tools were selected from the presentations.	Planning Wheel and Scenario Calculator

DATE AND PLACE	PARTICIPANTS	ACTIVITIES	TOOL UNDER EVALUATION
25.01.2018 Oslo	Norwegian Green Building Council (2) and researchers (4)	Feedback and discussion on how to use the Scenario Calculator as part of a BREEAM communities approach.	Scenario Calculator
02.02.2018 Bergen	Bergen municipality (5) and researcher (1)	Feedback on how to use the Scenario Calculator in municipal planning. Combined with telephone interviews with the participants.	Scenario Calculator
02.02. 2018 Oslo	Asplan Viak (5) and researcher (1)	Feedback on the Scenario Calculator as it relates to energy/climate change consultancy.	Scenario Calculator
09.02.2018 Oslo	Oslo municipality – climate change mitigation dept. (1) and researchers (3)	Feedback on the Scenario Calculator as it relates to the work carried out by municipal climate change mitigation depts.	Scenario Calculator
02.03.2018 Oslo	Oslo municipality – climate change mitigation dept. (approx. 15) and researchers (3)	Presentation of the Scenario Calculator and feedback.	Scenario Calculator
09.03.2018 Bergen	Bergen municipality – Planning and Building Services Agency (3) and researchers (2)	Testing of the Scenario Calculator using the Loddefjord case study. Feedback.	Scenario Calculator and KPIs
22.03.2018 Bergen	Bergen municipality – Planning and Building Services Agency and climate change mitigation dept. (4), researchers (3) and energy utility (2)	Workshop based on results from the Scenario Calculator in the Loddefjord case study.	Scenario Calculator and Planning Wheel
25.04.2018 Trondheim	ZEN researchers (3)	Feedback.	Planning Wheel
26.04.2018 Trondheim	Interview with the artist from Angered (Gothenburg) about resident inclusion in energy renovation projects (X)	Gap closure in toolkit.	Planning wheel
19.06.2018 Bergen	Bergen municipality (4) and researcher (1)	Final meeting with Bergen municipality and participants in the Loddefjord project before the summer. Further testing of the PI-SEC Scenario Calculator.	PI-SEC Scenario Calculator

Table 3.3 provides an overview of the feedback meetings, interviews and workshops held to discuss the PI-SEC tools.

3.4 Methods for testing the PI-SEC Planning Wheel

A design thinking approach was applied during research into the simultaneous design and transformation of the SEC planning process. Design research involves the retrieval of insights during design work, while design thinking involves an iterative, user-centred process. The testing of the planning wheel involved two iterations of redesign, resulting in five broad SEC planning categories or steps. Following these two iterations, more detailed results from approach testing were extracted from the selected literature review with the aim of generating adaptations to the multitude of challenges identified. Limited meetings were held (see overview) in between the design iterations, but it was the results from the design workshops that were fundamental in guiding changes to the design of the planning wheel.

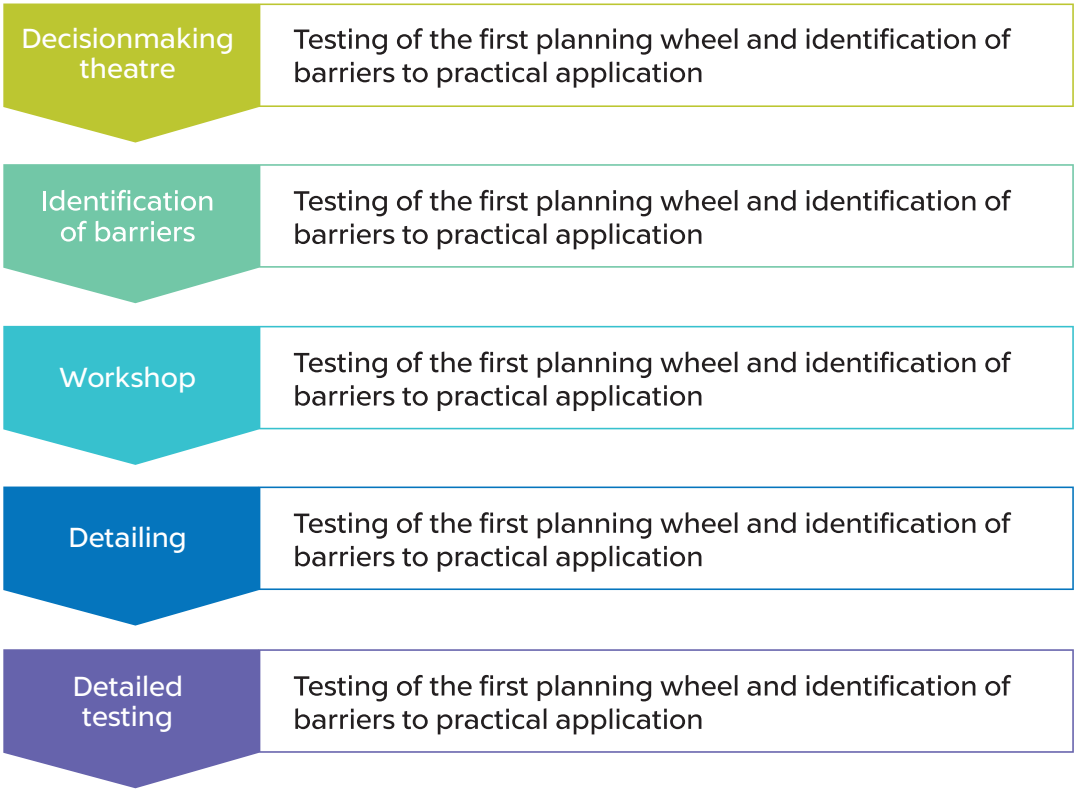


Figure 3.4: The design research process

The first iteration took the form of a so-called "Decision-making theatre" held in Stavanger on 29 September 2017 and called the "tangible decision-making theatre'. Participants were asked to "act out" or represent their planning process using LEGO (LEGO Serious Play-LSP). The inspiration for our choice of the tangible decision-making theatre concept is rooted in the knowledge that such fora are used increasingly in urban planning, and facilitated by LSP. As part of this method, if a user's insight is defined as the main objective, the (urban) designer acts as a facilitator who can intervene as and when needed. The use of a LEGO set-up with figures and building blocks, in front of a GoPro camera, creates an analogue decision-making theatre, within which the participants "act out" the planning process and experiment with the form and content of the decision-making process.

The workshops were set up in a conference room at Stavanger Forum, following the 2017 Nordic Edge Expo[8]. The participants were divided into two groups. Their materials included ten single LEGO figures (arbitrarily represented by pirates, ninjas, nurses, etc.). They were then provided with two large, green, standard LEGO

[8] https://www.nordicedgeexpo.org/conference

base plates, two LEGO Architecture studio kits comprising 1210 transparent and white LEGO components, and two CLASSIC LEGO boxes each containing 29 different coloured blocks with instructions for the construction of an airplane inside the first. It is important to note that the inclusion of LEGO is not regarded as key to the success of a tangible decision-making theatre. However, the use of LEGO is considered to be the easiest way of creating tangible representations in three dimensions. It was also considered relevant to select a medium with which the participants were familiar, so that they would know intuitively how to create something. The design workshops were recorded on both video and audio. The audio was transcribed verbatim, and snapshots of significant video images were inserted into the transcribed text where such illustrations were regarded as containing important information. The data analysis was focused on identifying "aha moments" (Chang, Ziemkiewicz et al. 2009).

Figure 3.5: Photos illustrating 1) a workshop and 2) a decision-making theatre.

Research activities for testing the PI-SEC planning wheel

During the research period, several tools, methods and activities were tested for their suitability for different stages in the SEC Planning wheel. Each of the tools was tested by experienced researchers who had either built the tools themselves, or had obtained instructions in how to test them. Tests were also carried out on the various activities that may support the planning wheel. These are described briefly in the following:

- The Annex 63 municipal assessment tool is able to assess the capacity or readiness of a given municipality to plan for energy efficiency in buildings and communities. It was presented to the various stakeholders participating in the Furuset case study. After a brief introduction to the tool, participants provided their feedback. The tool is beneficial for municipality assessment at large scales. However, participants experienced it as being too generalised and that it would require specific adaptations in order to apply it at the scale of Norwegian municipalities. (Reference: Annex 63, Volume 4[9])

- The Energy Design Game was developed based on the Annex 63 tool by a group of energy and urban planning experts in Denmark. The purpose of the game is to break down energy targets into specific actions promoting renewable energy planning in community contexts. The game can be used during the development and implementation of energy strategies for community projects. The Energy Design Game was tested during a seminar in Trondheim on 11 January 2018. One of the developers of the Annex 63 tool acted as a facilitator during the testing process, and instructed three researchers in how to be become facilitators. The participants (five participants from Norwegian municipalities, one from a Swedish municipality, one from a regional municipality, a grid distributor, and five researchers) were divided into three groups. The groups were asked to select a community case study where the game could be applied.

[9] https://www.annex63.org/results/volume-4/

The game's potential lies in its ability to detect the improvement potential of a given case in a more holistic manner than is permitted by other approaches. More information about the Energy Design Game can be found in Nielsen et al. (2018).

- The EU-funded Nearly Zero Emission Neighbourhoods (ZenN)[10] project was conducted in part by NTNU. The main aim of the ZenN project was to find ways of reducing energy use in existing buildings and neighbourhoods. An NTNU researcher presented and tested the results of one of the work packages on participants during a seminar on 11 January 2018. The research team had generated a set of questions related to non-technical drivers in energy-retrofitting, such as architectural quality, user interaction, economic and management structures, and policies related to energy-efficiency and retrofitting.

- The BREEAM Communities approach offers a set of criteria that can be used for new development projects at neighbourhood scale. These criteria cover a wide variety of aspects related to transport, mobility and land use, and the relationships of these factors to economic and social characteristics. An extensive study was undertaken with the aim of including the application of BREEAM Communities criteria in the planning wheel. Criteria selection was based on gaps identified during the PI-SEC workshops, and questions agreed during meetings with Oslo and Bergen municipalities in November 2017. The SEC definition was also strengthened by the development of so-called Community Criteria. In total, 17 of the BREEAM Communities criteria were found to be relevant and applicable to either one or both cases. From the 17, four criteria were chosen that fitted the identified gaps in both cases. The criteria are described in more detail in the 1.3-2.3 Toolkit report (Nielsen et al, 2018). The BREEAM Communities criteria are best suited for the evaluation of the final results of new development projects and in connection with overlap with regulations in the Norwegian Planning and Building Act.

- The sharing of experiences with energy smart community planners was one of the requirements identified in the PI-SEC project. Experience-sharing events, such as the seminar held in Trondheim in January 2018, can be regarded as a way of bringing together municipalities facing similar goal achievement challenges, and as fora for the discussion of different approaches. This type of event is particularly useful for the discussion of complex issues in which multiple targets and needs have to be addressed and balanced. They also promote greater dialogue between the relevant participants and stakeholders.

- Socio-economic and renewable energy criteria derived from the Annex 63 IEA/EBC project are further explored in relation to the ZEN[11] municipalities. A preliminary finding from the pilot projects is that a stakeholder commitment process may help to close the gaps regarding where and how urban planners can best influence outcomes during the planning of SECs. This issue will be analysed further in the Toolkit review (Nielsen et al, 2018).

3.5 Methods for testing the Scenario Calculator

The PI-SEC Scenario Calculator was tested using ten qualitative group interviews and two workshops. The process involved 28 participant employees from two city municipalities (most from climate change mitigation and planning and building services departments), two scientific experts, ten energy consultants, and two representatives from a public organisation with experts in energy planning.

The group interviews and workshops were conducted between 15 September 2017 and 20 June 2018. Only one of the interviews involved a single informant, while most included around about three. The largest workshops were attended by eight participants from the municipalities and five researchers.

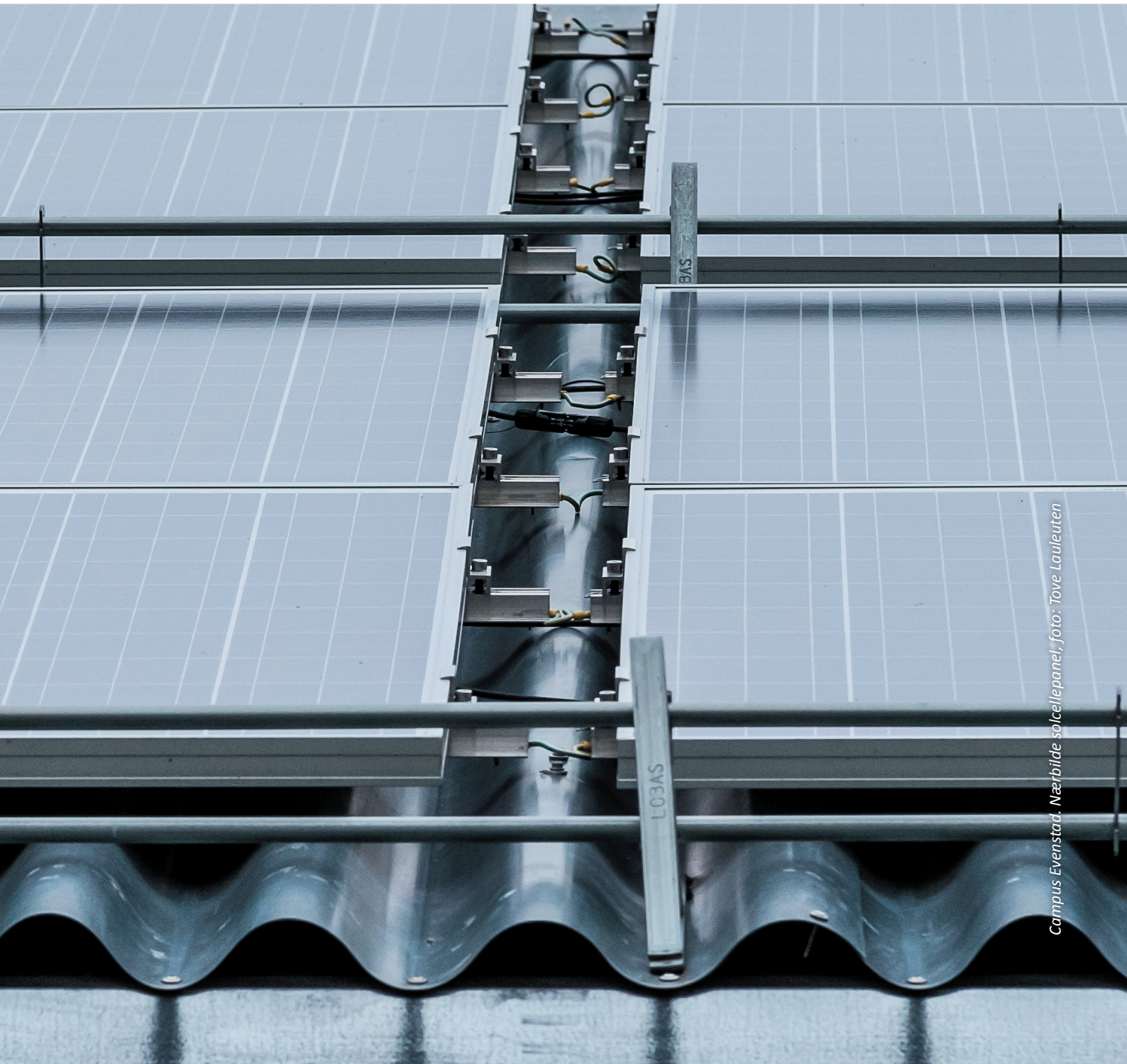
Details of the interviews and workshops are found in Table 3.3.

[10]http://zenn-fp7.eu/
[11]https://fmezen.no/

The interview guide used to obtain feedback on the PI-SEC Scenario Calculator included the following topics (adjusted to the different types of respondents):

- Background: the need for a tool to measure environmental improvement at neighbourhood scale. What tools are in being applied, and what is your evaluation of these tools?
- An evaluation of the KPIs linked to the PI-SEC Scenario Calculator.
- An evaluation of the applicability of the PI-SEC Scenario Calculator as a planning tool.
- Challenges and opportunities related to application of the PI-SEC Scenario Calculator.

Extensive notes were taken during the interviews and workshops, and the discussion that took place during one of the workshops was transcribed. The texts from the interviews were categorised thematically and analysed. Quotations, based mainly on recorded notes, have been used to illustrate findings, and are presented in the results and discussion section.



Campus Evenstad. Nærbilde solcellepanel, foto: Tove Lauleuten

4. RESULTS AND DICUSSION

Resultater og diskusjon – En kort oppsummering av kapittelet
Denne delen av rapporten omhandler resultatene fra testingen av PI-SEC-verktøyene. Evaluering av verktøyene fra ulike grupper av brukere og interessenter er samlet, analysert og diskutert. Resultatene drøftes og presenteres i fire delkapitler:

1. Tilbakemeldinger på PI-SEC planleggingshjul
2. Tilbakemeldinger på PI-SEC nøkkelindikatorer (som brukes som basis for scenariokalkulatoren)
3. Tilbakemeldingar på PI-SEC scenariokalkulator
4. PI-SEC planleggingshjul og scenariokalkulator i sammenheng og videre planer.

Se det norske sammendraget for en oppsummering av disse resultatene.

4.1 Results from tests of the Planning Wheel

Municipal planning challenges were revealed during the design thinking workshops. The tangible decision-making theatre and experience-sharing processes revealed experiences that were relevant to the challenges encountered in the two PI-SEC case studies. We also made detailed enquiries into why “everything depends on the beginning” (Nielsen et al., 2018). The regulatory framework offers few incentives for utility companies and residents to participate in the planning process at the same time as municipal urban planners.
Does the SEC Planning Wheel meet the challenges encountered by the municipalities?

Feasibility study of part of the neighbourhood in ZEN pilot project Ydalir. Ill: tegn_3

The municipalities offered the following general feedback:

- A municipal assessment may be useful for
  - internal reviews of knowledge transfer processes and awareness.
  - providing an opportunity to delegate one person or coordinator the responsibility of conducting the assessment in the form of an interview.

- The questions may be too general and could be better adapted to the needs of Norwegian municipalities

The SEC Planning Wheel was constructed in collaboration with participants involved in the two case studies, and based on interviews carried out with them. As the wheel continues to develop, its relevance to municipal practice is under constant review. The main conclusion here is that even if the tools are well designed, this does not guarantee their implementation or subsequent impact.

The factors influencing outcomes are:

- Responsibilities
- Authority
- Political commitment
- The planning system
- The relationship between the private and public sectors
- The gap between minimum requirements and ambitions

Since, on the whole, implementing stakeholders are private sector organisations, and different from those that design the SEC, it may be difficult to maintain vision and knowledge transfer throughout the development process. This is quite a common problem in all planning processes, and must be afforded careful consideration when approaches are being redesigned.

The planning of SECs is also characterised by aspects related to tradition and practical concerns. The testing process revealed that some divisions in any given municipality believe that other divisions 'perceive' certain work practices to be irrelevant and out of touch with tradition. For example, if a good design requires the inclusion of more stakeholders at the beginning of the concept design phase, there is a perception that more stakeholders will mean more work. Urban planners have commented that this means that any changes must incorporate capacity building and awareness in all affected departments. Even though the Annex 63 report recommends the inclusion of an energy expert, it is not certain that this will solve a problem that requires cross-sectoral awareness, commitment and change.

Furthermore, experience sharing among the municipalities supported the claim that tools that foster collaboration and knowledge transfer related to ambition achievement are the most important factor. Network building and the introduction of joint tasks or projects can make a contribution here.

Everything depends on a good start
The phrase "Everything depends on a good start" was repeated constantly to participants during testing of the planning wheel. The municipalities were unanimous in their opinion that it was a public responsibility to agree on a vision before inviting private sector stakeholders and the utility companies to join the planning process. This is an interesting finding, since it raises the question of how commitment can be achieved when the stakeholders who implement the vision are different from those who define the vision in the first place. The planning wheel does not provide answers to the question of how the common vision can be shared with private sector utility companies, developers, real estate agencies, the national highways authority and residents. One solution is that urban planners should step into the breach as project managers and invite stakeholders to propose their solutions in broader terms, such as the 'strategy plan programme' proposed in Bergen. In any event, the involvement of residents remains a key challenge even when using this type of approach.

There are a number of ways of addressing these challenges:

- The creation of a plan that ensures stakeholder commitment from the start.

- The identification of tools that ensure planner commitment to greater social and environmental ambitions.

- The integration of costs throughout the process by means of:
    - Property regulation. For example, by adding the cost of community infrastructure to the cost of the property.
    - Introducing regulations regarding the building of some social and family housing, etc. as a condition of participation.
    - Subsidies for renovation and rehabilitation must be decided at a conceptual level.

- The use of a municipal assessment tool and an overview of municipal organisation in relation to energy. We identified the need for a municipal assessment tool during the decision-making theatre.

Municipalities find it difficult to identify which departments within their organisations are responsible for SEC planning. The project "Annex 63 Energy in Buildings and Communities"[12] has recently developed a tool for municipality assessment containing a list of criteria for municipalities that intend to develop SECs. It was for this reason that we opted to test this tool in the two case municipalities in the PI-SEC project.

[12]https://www.annex63.org

Addressing municipal organisation and the facilitation of integrated and innovative planning

The decision-making theatre involved the building of many LEGO constructions, and the process generated numerous 'aha' responses from the participants. During and after the workshop, urban planners said that they heard a number of different views on the planning situation during their explanations. They found the acting out of different roles during the interviews relevant, in that it gave them some new ideas about the role of the municipality in question. Planners from a municipality outside the two involved in the PI-SEC case studies also said that they enjoyed, and learned a lot from, the way that the decision-making theatre was structured. They had exchanged ideas on the real meaning of sustainable urban planning. By moving from the building level to the scales of energy systems and residents, they ended up exchanging ideas about what aspects of SECs they could influence as urban planners by means of 'smart participation'.

This snapshot from the text transcription illustrates one of the stories told when the municipal participants were interviewed by other group members:

P1

So this is the problem. The municipality with all its different departments. It has been quite negative to the whole plan because of where it is. But in the end the blame lies with the contractor, and a little on our side. When that happened, the County Governor (fylkesmann) XXX (name removed) sort of put the brakes on it for the time being (lots of laughter).

Figure 4.1: A LEGO illustration of the planning process taken from one of the cases. A multi-headed, multi-armed and poorly coordinated green figure representing the municipality is confronted by a regional manager (pirate) in front of the private sector developer.

The Bergen municipality case included a pirate (representing the County Governor) in confrontation with a multi-headed and poorly coordinated figure (the municipality) that is continuously being shot down. The image of the municipality's inability to coordinate its activities and identify its own role was a new finding and, in her own words, surprised the participant building it. In this case, the County Governor has stopped the project on numerous occasions due to disagreements over legal aspects and the location of the project.

Who finances the 'Core of the Community' that ties a project together?
Questions regarding the financing of different aspects in the correct sequence, and the achievement of sustainable behaviour in an SEC, emerged during the interviews, workshops and all the experience-sharing exercises carried out during testing of the Planning Wheel. During the group interviews involving Oslo municipality at Nordic Edge 2017, discussions centred around the building project and energy design, and the difficulties attached to sequencing everything in such a way that made it possible to finance social aspects alongside private sector interests:

P1 *So what are the main challenges?*

P2 *Mainly the financing, since this has to happen first. This square here. And then it will. It is the City Council for urban planning that proposes the area regulation plan, which is presented together with the Furuset action programme. That was presented last year. It is in there together with the ambitions and the financing… but the City Council is subordinate to the City Council for environment and transport… they simply said that "we haven't heard anything about this". So maybe we shall have to pay for it ourselves. Normally infrastructure is paid for by the private developers. But then the municipality realises that we have to offer something. So, in a way….*

P3 *So, then the question is how?*

P1 *Yes, and how much. How do we make the calculations, and what do we do first? Then we see that there is a parking garage, and that is bound by so many legal constraints, and there will be more in the future, and it is private, so it's very difficult to fix the problem in relation to this public square.*

Figure 4.2: LEGO workshop

Using LSP, the city planners from Bergen, Oslo and Stavanger shared and illustrated in vivid terms the different layers of challenges they faced during the process of building an entire neighbourhood. They explained the visions defined at the start of the early planning phase, in which the public square was seen as key to residents' participation, and their preference for sustainable transport. Later, private sector interests such as the parking garage obstructed the early construction of a public square, and when the utility company and energy system designers arrived with their own requirements, the public square was even further delayed.

Moving between discipline-dependent and multi-layered challenges via intermediaries

The reason for using the tangible decision-making theatre was to find out if this type of tool could act as an intermediary for knowledge transfer between stakeholders. During the workshop, four of the participants said that they were relieved on arrival at the decision-making theatre to find out that it wasn't "just another workshop"'. The LEGO figures and tasks were new to them and they said it was refreshing. They also explained that currently, municipal staff who commonly deal with pilot innovation projects have to participate in a large number of meetings in order to meet participatory process requirements. However, the meetings seldom included tools that presented new and more playful approaches.

An observation from the workshop, and recorded in the transcriptions, is that the LSP stimulated discussions allowed the participants to discuss the interlinkages between urban planning, financing, legal and energy aspects, and emissions reductions. The complex and multiple paths that make up an urban neighbourhood are difficult to explain to researchers. However, the tangible decision-making theatre seemed to be an appropriate setting for the transfer and discussion of this complexity. During the final task within the set-up, the researchers had to explain to the participants how to apply the new decision support tools. While the preliminary toolkit had provided a process designed to improve alignment of conceptual agreement related to aspects such as private stakeholder engagement, the financing of public infrastructure, and suitable incentives for high environmental and social ambitions, the results from the decision theatre indicated that the municipalities totally changed their intentions. It was made clear by all the urban planners and the climate change mitigation department participant, that the need for new approaches was felt most keenly during the early and pre-planning phases. When participants were asked to act out an ideal scenario on the printed SEC Planning Wheel, both groups spent all their time on the first step of the wheel, and even asked for it to be expanded. Urban planners and climate change mitigation department representatives requested a new way of dealing with multi-stakeholder innovation, and to make commitments from the start.

Engaging stakeholders – tangible or digital scenario building?

While GIS and other digital scenario building tools are granted increasing emphasis as decision support tools in smart city research, our 'tangible decision-making theatre' has shown how physical artifacts still have a role to play in complex decision making. It is well known that parallel prototyping and the early testing of ideas result in "better innovation", and the flexibility achieved by utilization of the tactile and visual senses in a non-digital space is accessible to all stakeholders. There is less need for an intermediary, which makes it easy for the participants to present their ideas. This in turn makes the process more flexible and valid because the participants are not "adapting their ideas and knowledge to the restrictions of the prototype". This approach made it possible for researchers from different disciplines to benefit from the process and for the group as a whole to share knowledge on an equal basis, without one or more participants knowing more about the process than the others. During the 'tangible decision-making theatre' process, the previous step-by-step tool was replaced by an expressed need for better conceptual and participatory approaches at the start of the two projects. This led to the new idea of a coordination tool that can be used in-house within the two municipalities, alongside the need for agreement on the project's vision that will ensure stakeholder commitment and also create a timeline for the energy system at an early stage.

Based on these findings, it would be interesting to test the tangible decision-making theatre in conjunction with a digital/augmented reality decision theatre/maker that addresses the planning of a real SEC. Since there is a need for decision support tools that can simplify and improve stakeholder collaboration and engagement in smart city planning, comparing the two during different phases of the planning could provide useful insights into which situations tangible are more useful than digital tools in support of urban decision-making.

Dealing with the regulatory challenges to holistic solutions

A recurring problem that emerged during all interviews and discussions in the decision-making theatre, was that related to the financing of the 'social core' of SECs. Energy ambitious buildings and energy systems place a heavier economic burden on the private developer. Housing costs may increase, and it becomes difficult to find ways to finance social and community aspects. The most relevant example is the financing of the community centre (bydelshus) and the public square 'Trygve Lies plass'.

This problem demonstrates the need to discuss financing early in the planning process, preferably with all the private and public sector participants involved.

In order to close this gap, searches were conducted for experiences recorded in the literature and in interviews conducted during other pilot projects being carried out at the Zero Emission Neighbourhood Research Centre.

Testing the idea of regulation-free zones. In the ZEN pilots[13], four ways were identified for dealing with regulation restrictions on energy-ambitious planning:

1. Adaptation of the design to meet the existing regulations. An example of this is taken from the ZVB case in which the involved stakeholder designed buildings to screen out excessive noise.

2. Apply for exemption from the regulations. In the Evenstad case, the student company owning the flats applied for the right to own and sell the renewable energy produced locally in the community.

3. Bring on board funding partners such as ENOVA in situations where there is no opportunity to transfer the financial burden to the private sector to meet socio-economic targets.

4. A further possibility: it may be possible to establish a coordinating body that bundles applications common to SEC planners.

4.2 Results from testing the PI SEC Scenario Calculator KPIs

During the feedback workshops and meetings, informants commented mostly on the PI-SEC Scenario Calculator (see the next section). However, some of the feedback also addressed the choice of key performance indicators. We refer to the latest version of the indicators in the PI-SEC scenario calculator at https://www.ntnu.edu/smartcities/pi-sec/publications. The issues of mobility and embodied energy in materials were discussed in particular. Bergen municipality provided direct input in terms of what they regarded as redundant and less suitable indicators, and several of the indicators were removed from the list presented in the report of task 1.2 (Walnum et al., 2017) that describes the preliminary toolkit. Some of the indicators retained in the PI-SEC scenario calculator have been rewritten to improve the understanding of their purpose.

Mobility/transport
The municipalities are especially interested in indicators related to mobility. Oslo municipality suggested the inclusion of more indicators related to public transportation and the counting of pedestrians and cyclists.

> *Transport is often an important part of our strategy work. (Municipality)*

> *Now you are addressing a key item. Transport is very expensive, and we have to make it green. This is what governs these plans the most. We only provide very limited terms of reference in terms of buildings. However, we can provide robust guidance on mobility. (Municipality)*

> *Electricity is seen as emissions-free, and mobility is our focus. (Municipality)*

[13]https://fmezen.no/

A developer expressed a wish to use the tool to illustrate the impact of using private- or publically-funded electrical vehicles instead of fossil fuel-driven private cars. Some of the informants from the municipalities stated that they required indicators on mobility:

> *We lack indicators for measuring mobility. This is comprehensive but can be implemented. (Municipality)*

In the light of these inputs, indicators for mobility were implemented in the PI-SEC Scenario Calculator. The model for mobility in the Scenario Calculator is based on the methodology set out on the website klimagassregnskap.no, and travel habit data gathered by Future Built, which in turn obtained the data from the TØI travel habit survey (RVU). It is difficult to assign correct values for mobility, so the figures are generic. Feedback from the municipalities is required to assess whether this is an appropriate way of describing transport. The tool will have to demonstrate the measures that have to be implemented. The most effective action to reduce CO2 emissions is to reduce vehicle volumes. However, it is not the aim to reduce CO2 emissions by keeping people in their homes, and this indicator must be seen in relation to other neighbourhood aims.

Materials

The feedback meetings also included discussions on whether the environmental impact of materials use should be incorporated as an indicator within the tool. Energy consultants evaluating the Scenario Calculator state that:

> *It is essential to include materials. However, it is OK that this the calculation is made outside the tool and is implemented in terms of kgCO2/year. (Energy consultants)*

> *When it comes to reductions, it is also important for Future Built[14] with material use. The amount of materials and what kind of materials. We are increasing our emphasis that it should not be so easy simply to tear down buildings. (Municipalities)*

One option is to implement similar concepts as those applied to energy, using normative data that can be exchanged with more detailed calculations if these become available. However, the disadvantages of implementing "standard" CO2 emissions targets for materials were discussed in a meeting between a public sector organisation and energy planning experts. It emerged that it was too risky to implement these values categorically because they are stereotypical and may have a negative impact on building projects.

Instead, the experts recommended aggregating data related to demolition versus new buildings. This will be useful for many of the stakeholders in their decision-making processes. It is easier to find relevant data on indicators of demolition. For example, a municipality may require an environmental analysis prior to a decision on demolition of a building, in line with the increased focus on circular economy issues. The stakeholders are thus required to evaluate not only economics, but also environmental costs.

In conclusion, as an initial solution, an option to supply emissions data for buildings (rehabilitation or new buildings – representing the total per year of the building's lifetime) has been added to the tool. These is data must be obtained from other calculations.

Emissions factors

Emissions factors linked to the various kinds of energy sources are always a topic of discussion. Electricity and district heating are of particular importance to the conclusive results of the analysis.

This topic was discussed during the feedback workshops and meetings, with an emphasis on data related to waste incineration.

However, this is a tool for which assumptions can be changed according to the goals and interests of the neighbourhood project in question. The PI-SEC Scenario Calculator includes pre-determined values, but if its

[14]https://www.futurebuilt.no/English

users have more detailed data on certain indicators, the pre-determined values can be overwritten. The energy consultants providing feedback on the tool were particularly pleased about the opportunity to adapt values and numbers, and stated that they wanted to introduce their own key numbers:

> *We are positive to openness and the opportunity to adapt indicator values. We wish to use our own key numbers. (Energy consultants)*

4.3 Results from testing the PI SEC Scenario Calculator

The need for the PI-SEC Scenario Calculator and its scope of use
The informants from the municipalities found the tool useful for the planning of specific areas with environmental ambitions.

> *There is a need for this tool in the municipality. (…) It is cool to see a tool that gives you this kind of output. The climate department does not work with this issue today – no one in our municipality works with this. (Municipality)*

> *In general, the climate aims are given insufficient consideration, from the overall climate aims to the individual projects and areas. (Municipality)*

However, as the quotations demonstrate, there is currently little focus on stationary energy as part of municipal planning, and overall CO2 emissions reduction targets are not set out in a way that makes it possible to require reduction measures at this scale. The Scenario Calculator may contribute to developing expertise. One of the international scientific advisers stated that:

- *I think this tool is really nice, and shows really nicely what kind of options you have, and what is really the impact, so I think it is super good. (Scientific adviser)*

Comments indicated that the baseline concept incorporated into the PI-SEC Scenario Calculator is a great advantage, making project sketching easy:

> *I like the fact that there is an opportunity to establish a "baseline", since this provides a good starting point for discussion and the construction of a sketching project. As an early phase tool, it is really good, and it appears to be easy to use. (A public sector organisation with experts in energy planning)*

It appears that the municipality is not planning to construct buildings or infrastructure linked to the Zero Village Bergen (ZVB) area. The project is in the hands of the developers. Bergen municipality have stated that the PI SEC Scenario Calculator is better suited to larger development projects where ambitions are set at area level (such as Furuset in Oslo).

One developer found the tool useful in the sense that it can easily be used to reveal how certain actions related to energy and emissions reduction influence the energy and emissions budget for a given building or neighbourhood. Developers also recognised the benefit of using graphs and data linked to Enova applications as a means of illustrating the impact of certain measures.

The researchers were left with the impression that no clear monitoring scheme exists in Bergen municipality to follow up implemented actions. Monitoring is carried out in a poorly coordinated way by the department that is closest to the issue in question. For example, the department dealing with climate change mitigation issues (Klimaseksjonen) obtains its data on energy indicators from BKK and SSB, while atmospheric emissions data are gathered from checks of the sensors located around the city.

The energy consultants stated that they encounter challenges when looking for useful area planning tools, adding that they may require more detailed tools than the PI-SEC Scenario Calculator:

> *This tool might be helpful. However, it does not solve the problems. We need tools for more detailed analysis. (Energy consultants)*

The energy consultants have developed similar tools themselves, although as yet these are not as comprehensive as the scenario calculator. It is common that such tools are developed by individuals and never generalised or completed. However, the PI-SEC Scenario Calculator has not been developed for detailed analyses, but for planning in the initial phase.

In a meeting with a public sector organisation with experts in energy planning (specifically: expertise in application of the BREEAM Communities approach in Norway), the experts stated that there is currently no tool in Norway that competes with the scenario calculator. They also indicated that such a tool may be required for the recently launched Enova support scheme for "concept investigation":

> *No other tool exists in Norway today that functions in the same way as the PI-SEC Scenario Calculator. Enova's "concept investigation" requires certain pre-defined measurements, but no methodology has been prescribed. So, this tool is really needed. (Public sector organisation with experts in energy planning)*

The PI-SEC Scenario Calculator can also be linked to the BREEAM communities certification (BRE 2012). Informants from the public sector organisation with experts in energy planning stated that the Scenario Calculator meets the requirements for an energy plan (Criteria "RE 01" in the BREEAM Communities Technical Manual (BRE 2012)). Criteria Note 3 (CN3) under RE01 (Approved site-wide energy modelling software) has been removed from the Norwegian version of RE 01, so it is unclear as to which tool is applicable under Norwegian conditions. The PI-SEC Scenario Calculator may be appropriate for this purpose.

> *Up to now, no-one has demanded definite, measurable and replicable data. And if no one demands it, why should the municipalities deliver it? However, BREEAM demands exactly this in "RE 01", and they will need a tool to deliver it. However, the stakeholders may be afraid to use both BREEAM Communities and the Scenario Calculator because they will be afraid to commit themselves to fixed quantitative targets. However, Oslo municipality is currently working with climate budgets, and it is assumed that climate and environmental targets will continue to be more fixed. (Public sector organisation with experts in energy planning)*

As mentioned earlier in this section, the municipalities do not operate with fixed environmental targets at project level, and this was repeated by informants from the public sector organisation with experts in energy planning (above). Use of the PI-SEC Scenario Calculator will require higher levels of expertise and target focus.

An energy plan founded on results from the PI-SEC Scenario Calculator may not only meet BREEAM Communities certification requirements, but also those linked to Enova's concept investigation. A meeting between SINTEF, the public sector organisation with experts in energy planning, and Enova was held at the annual Enova Conference 2018[15] to discuss how the PI-SEC Scenario Calculator might be adopted as an "official" tool for the preparation of the energy strategy required in connection with an application for funding linked to Enova's new energy concepts programme. Enova was interested but wanted to wait to see it in use in a real application. The meeting resulted in an invitation to an energy consultant firm to test the tool in one of its applications.

Digital solution: Excel sheet or web-based?
Should the PI-SEC Scenario Calculator be presented in the form of an Excel worksheet or a web-based tool linked to a database structure? The informants from the municipalities stated that their monitoring of emissions reduction targets is carried out in a poorly coordinated manner by the department that is closest to the issue in question. Since monitoring is thus delegated across different departments, the use of a shared Excel-based file may be problematic in situations requiring information to be filled in from a number of different sources. A web-based version would avoid these problems.

[15]https://www.enova.no/enova-conference-2018/

Planned central street in ZEN pilot project Furuset. Plan- og bygningsetaten, Oslo kommune.

A database structure would also make it much simpler to communicate with other tools and databases, such as "Oslo Solkart"[16], metrical data, and ENOVA's "energimerke"[17] database.

However, an Excel-based solution may be appropriate during a test phase in which small adjustments and additions can be made relatively quickly and easily.

Excel may be more useful than a web-based tool because the worksheets provide the opportunity to adjust the tool structure and all its parameters more directly. This makes the process easier to follow, and the user is in control. Excel is a well-known program, and the tool may be easier to learn for those already familiar with the Excel software.

A web-based version of the tool would require investment and decisions on ownership, development and revision.

User interface and user group
In general, informants from the municipalities are positive to the PI-SEC Scenario Calculator. They find the model perfect for early phase planning. Firstly, they state that they do not think it is too complicated to use. However, both municipalities say that application of the tool appears to be unrealistic. They currently use consultants to obtain results from other tools and systems, and then purchase their reports. Municipality personnel do not feel they have the capacity to fill out the numbers in the Scenario Calculator:

> *Mostly, we use information that we can retrieve directly from maps. When we have to retrieve data from other digital systems, we usually purchase reports. We would normally request analyses from the Scenario Calculator from a consultant. We already request traffic calculations because only a few of us are able to do this ourselves. The consultants have contacts that can retrieve the data from the Road Authorities. It is not traditional practice to make these types of calculations, at least not punch jobs. However, if you get the file punched (pre-filled), and can play with different scenarios, the situation is different (…). If the user threshold is low, perhaps we can try. It would have been perfect if it was possible to increase the number of inhabitants and work locations, and then look into by how much the city would grow. (Municipality)*

> *The Climate department would require extra staff if they were delegated to use the Scenario Calculator. (Municipality)*

Informants from the public sector organisation with experts in energy planning presented other comments to the user group. They said that the target group for the Scenario Calculator must be selected with care. In their opinion, it was too complicated for use by municipal personnel, and that energy consultants might be a more realistic target group for the tool.

> *Is this tool too complicated for municipal personnel to use? Consider the target group again. It might be a tool for energy consultants working on assignments provided by the municipalities. This is an 'engineer world', and area development is about much more than this. I recommend a more informed relationship to the target group. (Public sector organisation with experts in energy planning)*

> *The tool has to be very simple to use, and not too technical for municipal personnel. Do we have to involve an energy specialist? (Public sector organisation with experts in energy planning)*

The energy consultants stated that they liked the methodology and the visual displays of energy scenarios. They found the bar graphs easy and intuitive to understand. In other words, they are a user group ready to use the Scenario Calculator.

However, informants from the municipalities stated that we should expect municipal personnel to be able to use such a tool:

[16]http://od2.pbe.oslo.kommune.no/solkart/
[17]https://www.energimerking.no/no/

> *We should expect that municipal personnel will be able to use this. It is a requirement that, in time, every municipal department must employ a climate coordinator, and they will be forced to learn more about greenhouse gas emissions. Today, emissions calculations are based on data obtained from SSB. The municipal climate strategy is great, but there are some gaps. If you dig deeper, you will find weaknesses. (Municipality)*

Other informants from the municipal departments emphasised the workload involved in collecting data for the tool as the greatest barrier inhibiting its use. They stated that it would be easier to start using it if there existed a system for automatic input of data to the tool:

> *I think that if there was a connection between the GIS system and its function, you could simply generate an area, and if you can mark the area easily, and it is not very hard to input to the system, and if that generates automatically, I think the most of the work is already done. And then you are left with simply deciding which scenarios you want to model. The main people in our department have different tools that they use, and some prefer certain tools rather than others, and I think, if it comes automatically, it is easy for everyone to use this as a base. And then you could review the different scenarios with the rest of your colleagues. (…) The biggest challenge is the data. The original data. If that could be made smart and integrated, it would be much easier. Because filling in the sheets is the most time-consuming aspect. (Municipality)*

The tool might be applicable for large municipalities and cities. However, small municipalities would probably have to work together with energy consultants to apply the PI-SEC Scenario Calculator.

During the final part of the testing period with Bergen municipality, some of the participants tested the PI-SEC Scenario Calculator on their own as part of the analysis of the energy system linked to the Loddefjord project. This experience rapidly generated a more positive impression, as illustrated in the following:

> *You really have to try it out yourself to see the potential of this tool. (Municipality)*

GIS

In both of the workshops and some of the meetings, the municipalities reported that the tool should be web-based and connected to a map system (GIS-based) and other tools already in existence such as Energiportalen.no. Informants from the municipality also stated that visualisation is important, and that the energy labelling of buildings (red or green), or the labelling of buildings worthy of preservation, would make the basis for decision-making clearer. The visualization of energy scenarios in map form would be very valuable. The municipalities also requested the opportunity to extract lists of buildings with energy labels from "energiportalen.no"[18]. The GIS system makes it possible to have a dashboard of layers covering several years and to compare buildings and development from year to year. A web-based GIS tool is convenient because it can link the personnel responsible for monitoring to other departments, thus making work flows easier. Another advantage of connecting the tool to GIS, is the ability to evaluate solar conditions in connection with selected PVA.

> *...but in a future plan, and I would like to geolocate the information and put it on a map. Kind of like to see that… where are the buildings we need to renovate, where are the condemned... (Scientific adviser)*

> *It is really good to visualize it, like from red to green. In the map the city planners use. Only that could be an incentive to do something. I like the red to green colours for the politicians. (…) It would be nice to have this as a layer on the municipality map. It is very nice data, both for planners and politicians, because then they can visualize changes from year to year – "this was the situation 10 years ago, and this is the situation in the city now". (Municipality)*

[18]http://energiportalen.no/

> *I agree that it could easily be integrated with a GIS-tool, then you can easily define the development area, just choose the buildings you wish to develop, and the area you wish to develop, then it would be much easier to just define the area. That would really be a smart solution. And then it could also be a tool for the planners if you connect it to a map, because you could use the map in a meeting with the developers, visualizing it on the map, so that would be nice. (Municipality)*

Participants from the municipality also pointed out that it is easier to get the planners to use tools that are based on GIS and maps:

> *Everything that can easily be retrieved from a map will be easy to get the planners to use. If this was a more commercial tool that private developers could use, then the punch-job would be more manageable. To be able to show some numbers and attach these to the plans would have been good. (Municipality)*

One of the municipalities expressed an intention to invite their own GIS experts to join the project to discuss the opportunities for developing the PI-SEC Scenario Calculator in such a way that it can be used in combination with the tools they are already using today. The municipalities want a larger proportion of the input values to be plotted more automatically, and want to see if their own GIS experts can provide assistance. In any event, the establishment of a link between the PI-SEC Scenario Calculator and GIS requires investment to finance further development, and this in turn will require a plan for future ownership of the Scenario Calculator.

Costs

Informants from the municipalities also stated that it would have been valuable to connect the PI-SEC Scenario Calculator to cost calculations, enabling the computation of cost-benefit analyses. One of the challenges raised by this suggestion is price volatility.

> *Cost calculation is not included. This is not yet a tool for cost optimization. It will possible to add a cost module, and use the tool for cost optimization. But we are not there yet. (Researcher)*

The establishment of a link between the PI-SEC Scenario Calculator and a cost calculation capability will require investment to fund further development, and clarification of ownership.

Technical challenges associated with the PI-SEC Scenario Calculator

The energy consultants evaluating the PI-SEC Scenario Calculator also commented on some technical challenges. They would like to have the opportunity to describe energy exchange between buildings. Energy exchange represents a focus area in connection with smart area development. How can the tool visualise the transfer of surplus energy from one building to another, or from buildings to the heat distribution grid?

> *It is a challenge that power and simultaneousness are not included in the tool. (Energy consultants)*

The inclusion of this feature in the PI-SEC Scenario Calculator at this stage will be too complicated, but can be considered in connection with the future development of a more advanced version.

Challenges associated with the scope of the PI-SEC Scenario Calculator

Another challenge associated with the tool is its limited scope. The tool does not account for “softer architectural values”, such as daylight or sun and wind conditions, etc. However, such factors do not belong to a calculator that is dedicated to CO2 emissions scenarios. It is thus important to keep these limitations in mind when using the tool to inform decision-making processes. One of the informants stated that there is a risk that the tool will be used for sub-optimization – looking for the easiest and cheapest ways of reducing CO2 emissions. The architecture influencing residents’ living conditions must be at the heart of decision-making processes. This is also recognized by informants from the municipalities:

> *The main focus for the municipality is the quality of life and living conditions for our residents. Environmental considerations are a secondary consideration. (Municipality)*

Barriers to the use of PI-SEC Scenario Calculator results in decision-making processes
Even if the PI-SEC Scenario Calculator is used as intended, i.e. to find the best ways of reducing CO2 emissions, there are still barriers to ensuring that the results are fully applied in decision-making processes.

The interviews revealed that one of the greatest barriers to full application of PI-SEC Scenario Calculator results is the lack of ownership of the environmental visions for a given project. Who owns the visions? In the municipalities, environmental targets are often decided by politicians as part of a top-down system. It is thus challenging to implement these visions at lower levels in the hierarchy. It has already been noted that the coordination of achievement of environmental targets in given neighbourhoods remains poor.

> *"Green Strategy" seldom provides the terms of reference for the development of a given area. Coherence between targets and strategy at area level is weak. (Municipality)*

The owners of the visions do not demand fixed quantitative targets for CO2 emissions reductions. So, if no one asks, why provide them? However, this situation may change as the municipalities acquire more expertise, and as a result of Enova's demands for quantitative and fixed data in the energy plans submitted as part of subsidy applications. In addition, some informants from the municipalities note that developers have great ambitions:

> *Often developers have greater ambitions than the municipality, resulting in the municipality acting as a brake on progress. (Municipality)*

> *The climate department has a strategic focus, so we don't have to do the job. We have worked very little with numbers. Last year, we prepared our first climate budget, and discussed how to manage its measurement. Gradually, more data are used. CO2 impact is a simple means of measurement. Then the municipality can document what we do to meet the Paris agreement. Climate departments do not have a mandate to require anything, and no opportunity to enforce sanctions. The requirement the becomes illegitimate. (Municipality)*

Another barrier that influences the use of PI-SEC Scenario Calculator results is the municipalities' lack of ability to influence private housing renovation. The renovation of public buildings is seldom sufficient to achieve environmental emissions targets. The danger here is that this causes public sector stakeholders to lower their ambitions. Some municipalities offer an energy consultant (free of charge) to attend to residents' needs, providing consultations on energy issues for residents interested in renovation. This arrangement opens the door to dialogue on environmental issues with private homeowners. Such arrangements were evaluated by Hauge et al. (2017) and were found to be a good way of increasing awareness among residents for energy renovation initiatives. Oslo and Bergen municipalities do not operate with this type of arrangement, but consideration should be given to finding ways of getting in touch with private homeowners, both in single dwellings and housing cooperatives.

At one of the workshops, the challenges facing the achievement of CO2 reductions targets at Furuset were discussed. It was suggested that the housing cooperatives should be linked to a local district heating plant as a means of meeting environmental targets. However, it emerged that the housing cooperatives would probably find this too expensive. The cooperatives at Furuset have recently been renovated and are described as being in quite good condition. There is no need for immediate renovation. One way to make these housing cooperatives more energy-efficient, is to consider the concept of Energy Performance Contracting (EPC, Hauge et al., 2014). In principle, EPC can make it possible to upgrade buildings without raising rents or shared common costs. This would be a major advantage in housing cooperatives with limited financial resources and rehabilitation needs. An EPC provider will carry out the necessary renovation, and guarantee reductions in energy consumption in the buildings. The costs of the energy saved will finance the renovation work. Examples show that the energy savings linked to heating water and rooms (actual, heating degree-day corrected) are between 10 and 30%. The use of EPC in housing cooperatives may make it easier for residents to adopt simple energy-efficiency measures, but this will entail a number of challenges. Such projects offer only limited energy saving projects to housing cooperatives, focusing mainly on the improvement of technical systems. This has a positive impact in situations where the buildings are in quite good condition, as is the case at Furuset in Oslo.

However, there is a risk that EPC will stand in the way of more extensive structural renovations in situations where the buildings themselves are in need of major upgrades.

4.4 Applying the PI-SEC Scenario Calculator at Furuset

From a researcher's point of view, it is fair to say that the tool has functioned well during its implementation in the three different thermal energy system scenarios. It was interesting to observe its impact and to compare the results with earlier energy system analysis studies.

The PI-SEC Scenario Calculator has been tested as part of a Zero Emission Neighbourhood project (ZEN CEER) workshop in which the main focus was to observe how Furuset could achieve its goal of a 50% reduction in carbon emissions by 2030. The tool demonstrated how useful it can be, how rapidly it is possible to generate scenarios, and how easy it is to play with the different pathways towards achieving emissions targets. There were some hiatuses along the way, but it proved relatively straightforward to fix these problems as they arose. PI-SEC researchers made some interesting findings during testing of the tool in the Furuset project. The overall carbon budget was greatly affected by a transition from electricity-based heating to heating fuelled by waste incineration (a district heating system in which heat is distributed via a microgrid). When this transition was complete, the energy standard in the recently-built buildings was of less importance (TEK10 compared to the Norwegian passive house standard). A question arose related to the weighting factor connected to district heating (11g/kWh) and its relevance. This factor must be investigated further, and seasonal storage must be included as an option.

It also became evident during testing at Furuset that results varied according to the selection of the units in which the emissions targets are expressed. When the carbon budget was studied in absolute terms, it was difficult to achieve the 50% carbon emissions reduction target, but if the emissions were divided proportionately among the residents of the buildings, it was much easier to find ways to achieve the target.

Zero Village Bergen, Ådlansparken. Ill: Snøhetta

5. CONCLUSIONS AND FURTHER WORK

Konklusjoner og videre arbeid – En kort oppsummering av kapittelet
Denne siste delen av rapporten oppsummerer funnene og beskriver hvordan arbeidet med verktøyene vil fortsette i den siste delen av PI-SEC-prosjektet.

Resultatene viser hovedsakelig at brukerne er positive og har kommet med nyttige tilbakemeldinger for videreutvikling. Det er likevel store utfordringer med å få kommunene til å ta verktøyene mer i bruk, og for PI-SEC Scenariokalkulator handler dette mye om at man trenger å prøve verktøyet selv for å virkelig skjønne nytten av det. Resultatene av PI-SEC scenario kalkulator kan heller ikke brukes uten å bli sett i relasjon til andre verktøy som PI-SEC Planleggingshjul refererer til.

5.1 An integrated toolkit

The PI-SEC Scenario Calculator cannot be used in isolation from other tools and planning instruments. One of the informants stated that it is dangerous to plan a neighbourhood based only on the Scenario Calculator because the tool only covers one of many aspects related to sustainability.

> *The Scenario Calculator is first and foremost a theoretical exercise. You should not let the results be the determinant for area development. You have to take other aspects influencing peoples' quality of life into consideration. The houses and their design cannot be completed according to sustainability demands at the sacrifice of quality of life. It is therefore important that the Scenario Calculator is used in interaction with other departments in the municipality. You have to have more than one focus area at the same time. (Public sector organisation with experts in energy planning)*

This argument highlights the importance of viewing the PI-SEC Scenario Calculator and Planning Wheel in relation to each other. The tools have to be used together, and in combination with other smart city planning instruments (Nielsen et al., 2018). It is important to promote collaboration between different municipality departments in order to prevent planning being carried out based on only one sustainability aspect.

As one of the scientific advisers commented, the PI-SEC Scenario Calculator does not provide ready solutions to problems. Nor does it determine who bears the costs. It merely provides a basis for decision-making, and the process as a whole requires other types of input in addition:

> *The problem is that if you have different actors there, they want to know the best combination. Because there may be different investors, saying "ok, I'm already (energy) efficient, so why should I invest more in energy efficiency than the others. (Scientific adviser)*

> *So, we can add some valuable information in such evaluations, but we don't make the decision using this tool. It's just a basis for decision-making. (Researcher)*

One of the major barriers preventing the achievement of overall smart city goals is that the various municipal departments work too much in isolation. In the meetings, municipal personnel expressed a need to work more closely together:

> *Coordinated processes across the departments is key to the accomplishment of common goals. (Municipality)*

5.2 Summary and conclusions

The aim of the research presented in this report has been to test the tools used in the planning of energy smart communities developed in the PI-SEC 2016-2017 project (Nielsen et al, 2016; Walnum et al., 2017):

1. How do the selected targets, KPIs and planning instruments perform when implemented in examples of neighbourhood development projects in Norway?
2. Can the planning instruments be improved based on these results?
3. What targets, KPIs and planning instruments constitute the best basis for the development of a common definition and assessment framework for smart energy communities in Norway?

The results are based on qualitative group and individual interviews with potential tool users carried out as part of project meetings and workshops. LEGO (LSP) and design games were used as a means of acquiring data during the workshops.

In answer to the first research question: The selected aims, key indicators and planning instruments seem to fit well with the pilot studies, and the results shed light on approaches that can be adopted in working towards achieving emissions reduction targets. The tools receive positive high-level evaluations, but it remains a challenge to persuade municipal personnel to use the tools.

It is also easy to provide a positive response to the third research question regarding the planning instrument KPIs. The selected KPIs and targets for the PI-SEC tools functioned well during clarification work linked to the pilot studies in Oslo and Bergen. Both are described in more detail in Nielsen et al. (2016, 2018), and Walnum et al. (2017). Feedback on the KPIs and targets used in the PI-SES Scenario Calculator has been positive. The only major change compared with the original version is the greater focus on mobility. A mobility indicator has now been implemented.

However, the answer to the second research question, addressing how improvement of the tools based on extensive analysis, feedback and evaluation can be achieved during the last phase of the research project, entails a more comprehensive response.

The main challenge is that it is difficult to identify the right employees and end users for tools that map overall energy use and related emissions. The collection of data for use with the tools is time-consuming, and the delegation of responsibility for the evaluation of overall emissions, and how to use these evaluations, is

unclear. This may be an indication that the toolbox is inappropriate or incorrectly adjusted, that we have been focusing on the wrong areas, or that the recommendation of the Annex 63[19] project concerning the need for continuity of employment of personnel with responsibility for these matters is key. It is likely that the answer entails a combination of these factors. As a result, we have to;

- improve the toolbox and direct its focus towards needs, and
- recommend dedicated role clarification and space for SECs as part of municipal planning

It appears likely that if the responsibility for energy planning in communities is more clearly defined within the municipalities, the tools may achieve greater relevance, thus making it easier to implement them in the future planning of SECs.

The informants from the municipalities wanted to see checklists or tools because they perceive these as relevant. They want tools that stimulate interaction in which the various stakeholders can learn from each other and co-operate more efficiently and meaningfully. This is in line with findings from other studies that show that city planners do not want new time-consuming tasks, but more networking to enable them to share their specific experiences related to innovation.

Work with the PI-SEC planning wheel shows that decisionmaking processes depend on a good start. It is key to get the right stakeholders engaged from the beginning of the process. We continue to require dedicated efforts to persuade the energy companies, property developers, property managers, municipal planners, the national highways authorities and residents to work more strategically in teams. The planning system is too rigid and splits stakeholders along process pathways that are not suited to integrated planning. An answer to this is to develop different ways of preparing strategic plans (such as the strategic plan program accomplished in Bergen). We have too little knowledge about the various roles of the energy companies and the opportunities available within the municipalities.

A major challenge facing the implementation by the municipalities of the PI-SEC Scenario Calculator is the relative absence of focus on stationary energy in municipal planning. The overall CO2 emissions reduction targets are not detailed enough to enable measurement, or to establish whether municipal targets have in fact been achieved. The PI-SEC Scenario Calculator may contribute towards increasing awareness and expertise, but we also require a stronger commitment to emissions targets among the various municipal departments. Even if the largest city municipalities become expert in the use of the PI-SEC Scenario Calculator, many of the smaller municipalities do not have this expertise and will be dependent on consultants for its application. In fact, energy and other consultants may represent a more appropriate target group for the PI-SEC Scenario Calculator than municipal personnel. If the intention is for municipal personnel to use the calculator, it is clear that they want a more user-friendly tool that offers a link to a GIS system, and for which data on buildings and energy use can be input automatically to the model. They do not want to spend time punching data into the tool.

It is difficult to assess the usefulness of the PI-SEC Scenario Calculator without potential users testing the tool on their own. An informant from one of the test city municipalities stated that she viewed its usefulness an a new way once she had tested it on a project in which she was directly involved. Persuading municipal personnel to sit down and try out the Scenario Calculator has been an area of focus of the PI SEC project for some time. Unfortunately, the level of motivation among municipal personnel has been too low enable them to test the tool on their own.

The PI-SEC Scenario Calculator cannot be used independently of other tools in connection with area planning because emissions reduction targets have to be viewed together with other area quality targets.
There are also barriers that act to prevent the results from the PI-SEC Scenario Calculator being taken into account. It is common that results demonstrate that the energy efficiency of privately-owned buildings has a major impact in reducing CO2 emissions. The municipalities appear to lack instruments for measuring this process in collaboration with private landlords. Offers of free-of-charge energy consultations with residents, combined with creative initiatives for financing and other forms of support will be decisive factors during the process of further evaluation of the PI-SEC Scenario Calculator.

[19]https://www.annex63.org/results/volume-1/

5.3 Further work with the PI-SEC toolbox

According to the project work plan, research questions linked to the last part of the PI-SEC project will focus on embedding the toolkit in the municipalities, into existing instruments, and its incorporation into other case projects:

Research Question 4. How can experiences from the testing process be embedded into existing Norwegian planning instruments with the aim of creating a better toolkit for use in PI-SEC case projects? Can the results be scaled up and transferred to projects other than those included in PI-SEC?

In WP1, task 1.4 is defined as the development of a final version of the PI-SEC Scenario Calculator, together with user guidelines.

Task 1.4: Final toolkit and guidelines for design projects
This task will encompass a summary of the findings from tasks 1.1 to 1.4, including:

1. Proposed toolkits with KPIs for stationary energy and corresponding mobility at neighbourhood scale, which can be used as a basis for further development by organisations such as Standards Norway.

2. Guidelines for use of the toolkit, including the implementation of corresponding KPIs in Norwegian planning and regulatory instruments.

3. Best practices and benchmarks that will help municipalities and other stakeholders to avoid pitfalls already encountered by others, and facilitate the replicability of the most successful practices.

In WP2, task 2.4 focuses on regulatory and planning implications:

Task 2.4: Regulatory and planning implications for municipalities
Task 2.4 will develop guidelines for embedding experiences from the testing process into existing Norwegian planning instruments with the aim of creating a better toolkit for use in the PI-SEC case projects, and in other Norwegian projects with similar targets. In the case of the latter, sensitivity analysis will be performed to evaluate whether the results can be scaled up and transferred to projects other than those included in the PI-SEC project, and whether these projects will require research support and demonstration project status (with corresponding resources and focus). The guidelines will help urban decision-makers identify opportunities to incorporate smart energy targets, KPIs and planning instruments into existing planning regulations and city-level strategic planning processes, to create measurable targets for the case projects, and to identify the correct organisational process for coordination and implementation across departments and sectors. They will provide experience- and science-based advice on how public-private partnerships can be used to consolidate cooperation between cities, industry, residents and research on issues related to energy targets, and promote the use of mainstream eco-friendly investments such as performance-based contracts, fast-tracked for municipal processes.

Publications and implementations
As part of the next phase, the final versions of the toolkit (PI-SEC Planning Wheel and Scenario Calculator) will be described in detail in separate publications. These will be brief, user-oriented and easy to read, well-designed and colourful. At the same time, the toolkit will be posted on the project website, ready for use: https://www.ntnu.edu/smartcities/pi-sec

During the transition 2018/2019, results from the research project will be published in articles in relevant journals.

The development of a web-based PI-SEC Scenario Calculator is currently under discussion. We have been in contact with a professional firm that works with web tools related to sustainability issues, and discussions are in progress with the GIS department at one of the municipalities with a view to possibly connecting the tool to a GIS system for internal use. Further developments will be decided by the end of 2018.

In combination with further work on the toolkit, a meeting plan will be set up for PED labs in the Norwegian municipalities. This will be carried out in cooperation with the ZEN[20] project with the aim of arranging workshops in Norwegian municipalities based on tools developed by the PI-SEC and ZEN projects, and the results of their application.

In May 2018, the SET-plan Temporary Working Group 3.2 on Smart Cities / Positive Energy Districts will submit its proposal for an implementation plan to the SET-plan Steering Group for approval.
The aim of the implementation plan is to support the roll-out of 100 Positive Energy Districts by 2025, and their subsequent upscaling to Positive Energy Cities.

The overall plan structure is illustrated below:

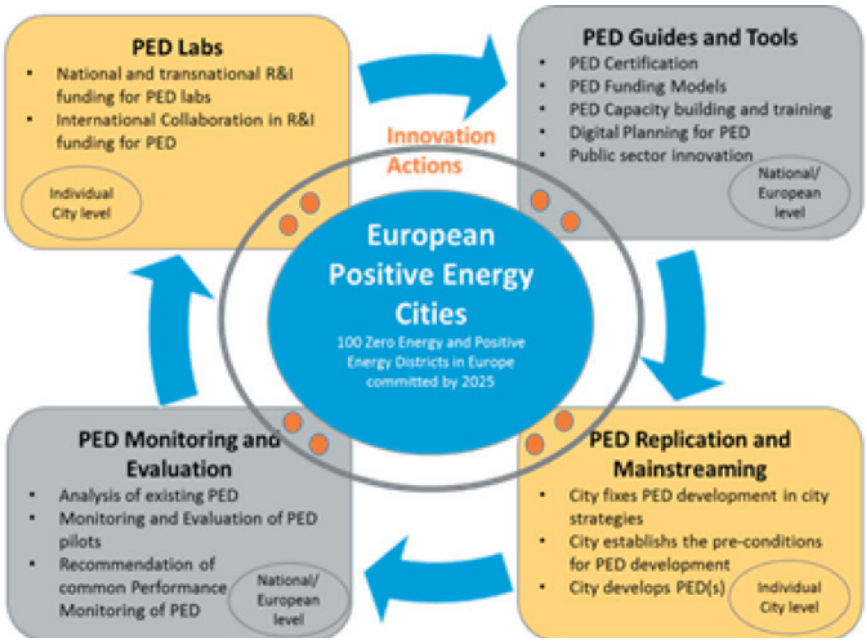


Figure 5.3: Overall plan structure for European Positive Energy Cities

This work will be approved by several European networks and programmes, including JPI UE, ERRIN, EUA-EPUE, EIP SCC and ECTP. The plan itself will be approved by the EERA JP Smart Cities programme, hopefully in cooperation with the EERA Secretariat and other Joint Programmes.

We propose that the EERA JPSC should develop its Work Plan (2018 – 2021) with a view to providing optimal support to this implementation plan as part of its ambition to achieve 100 PEDs by 2025, followed by longer-term upscaling to Positive Energy Cities.

EERA JPSC's planned contributions to the SET-plan 3.2 Implementation Plan:

Towards European Positive Energy Cities:

- To develop and scientifically validate the PED definition and its boundary conditions
- To define, plan and execute the RDI needed to transition from PED to Positive Energy Cities and Societies in line with new knowledge, and ambitions at international, EU and national scales
- To identify the potential for international/global co-operation on PED development (e.g. scoping workshops with JPI UE in China)

[20]https://fmezen.no/

PED Labs:

- To create pockets of excellence within our own networks, and develop “living labs” on our own cities and campuses, and in our own research and work facilities
- To develop a virtual PED lab that will demonstrate how proposed solutions can be integrated and deployed in specific urban contexts, together with a database and data sharing system involving BIM, smart meters, GIS, satellite, cell phones, sensors, etc., in cooperation with the EERA Secretariat and other EERA JPs;
- To create, collect, qualify, compare and analyse data obtained from the 100 PEDs, as a contribution to the virtual PED lab

PED Guides and tools:

- To develop a toolbox of planning instruments for PEDs, including data and metrics, planning and design, investment and business models
- To identify and analyse policy mixes and initiatives for PED transitions. To enable and encourage transfer from research to practical application, as well as co-creation with industry and city partners
- To submit suggestions for revision of the regulatory framework
- To build capacity (by training, education and knowledge exchange initiatives), encourage researcher exchange, and facilitate mobility with the aim of promoting knowledge exchange (involving both young and experienced researchers, industrial and urban networks)

PED Replication and mainstreaming:

- To activate national EERA networks with the aim of engaging with cities for PED planning, deployment and use
- To identify and document the barriers, challenges and opportunities inherent in existing PED projects. What are the main causal mechanisms that enable or inhibit the successful application of PED innovation, systems and policies? How can PED innovations be scaled up both within the EU and beyond?

PED Monitoring and evaluation:

- To define core KPIs for application in PEDs;
- To use defined KPIs to systematically screen existing and new PEDs, and input the results to the Smart Cities Information System

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