INDICATOR SELECTION FOR SMART ENERGY COMMUNITIES

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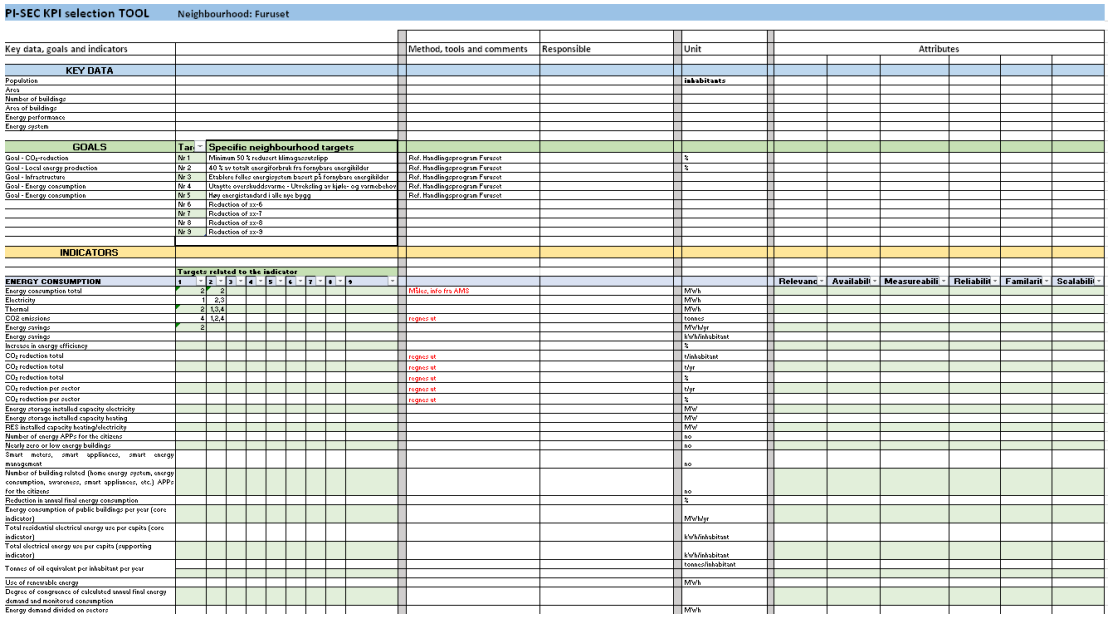
Smart Energy Community – a definition

A Smart Energy Community is an area of buildings; infrastructure and citizens sharing planned societal services, where environmental targets are reached through the integration of energy aspects into planning and implementation. The Smart Energy Community aims to become highly energy efficient and increasingly powered by renewable and local energy sources and lowered dependency on fossil fuels. Its spatial planning and localization considers reduction of carbon emissions also through its relationship with the larger region, both through the design of energy systems and by including sustainable mobility aspects of the larger region; it further encourages sustainable behaviour through its overall design from building and citizen scale to community scale. The application of open information flow, large degree of communication between different stakeholders and smart technology are central means to meet these objectives.

Task 1.2 : Preliminary toolkit of goals and indicators

1. Find relevant goals and targets – linked to a set of indicators
   - Develop an overview with relevant goals and targets
   - Sort indicators from literature review
   - Link indicators to goals and targets

2. Create tool for indicator follow-up
   - Select/Set goals and target for a specific project
   - Generate list of relevant indicators
   - Select indicators
   - Analyze the project based on chosen indicators



PI-SEC KPI selection TOOL Neighbourhood: Furuset

Key data, goals and indicators			Method, tools and comments	Responsible	Unit	Attributes					
KEY DATA											
Population					**inhabitants**						
Area											
Number of buildings											
Area of buildings											
Energy performance											
Energy system											
GOALS	**Tag**	**Specific neighbourhood targets**									
Goal - CO_2-reduction	Nr 1	Minimum 50 % reduksjon klimagassutslipp	Ref. Handlingsprogram Furuset		%						
Goal - Local energy production	Nr 2	40 % av totalt energiforbruk fra fornybare energikilder	Ref. Handlingsprogram Furuset		%						
Goal - Infrastructure	Nr 3	Etablere felles energisystem basert på fornybare energikilder	Ref. Handlingsprogram Furuset								
Goal - Energy consumption	Nr 4	Utnytte overskuddsvarme - Utvikling av kjølv- og varmebehov	Ref. Handlingsprogram Furuset								
Goal - Energy consumption	Nr 5	Høy energistandard i alle nye bygg	Ref. Handlingsprogram Furuset								
	Nr 6	Reduction of xx-6									
	Nr 7	Reduction of xx-7									
	Nr 8	Reduction of xx-8									
	Nr 9	Reduction of xx-9									
INDICATORS											
	Targets related to the indicator										
ENERGY CONSUMPTION	**1**	**2** **3** **4** **5** **6** **7** **8** **9**				**Relevanc**	**Availabili**	**Measureabili**	**Reliabilit**	**Familarit**	**Scalabili**
Energy consumption total	2	2	Miljø, info fra AM3		MVh						
Electricity	1	2,3			MVh						
Thermal	2	1,3,4			MVh						
CO2 emissions	4	1,2,4	regnes ut		tonnes						
Energy savings	2				MVh/yr						
Energy savings					kVh/inhabitant						
Increase in energy efficiency					%						
CO_2 reduction total			regnes ut		t/inhabitant						
CO_2 reduction total			regnes ut		t/yr						
CO_2 reduction total			regnes ut		%						
CO_2 reduction per sector			regnes ut		t/yr						
CO_2 reduction per sector			regnes ut		%						
Energy storage installed capacity electricity					MV						
Energy storage installed capacity heating					MV						
RES installed capacity heating/electricity					MV						
Number of energy APPs for the citizens					no						
Nearly zero or low energy buildings					no						
Smart meters, smart appliances, smart energy management					no						
Number of building related (home energy system, energy consumption, awareness, smart appliances, etc.) APPs for the citizens					no						
Reduction in annual final energy consumption					%						
Energy consumption of public buildings per year (core indicator)					MVh/yr						
Total residential electrical energy use per capita (core indicator)					kVh/inhabitant						
Total electrical energy use per capita (supporting indicator)					kVh/inhabitant						
Tonnes of oil equivalent per inhabitant per year					tonnes/inhabitant						
Use of renewable energy					MVh						
Degree of congruence of calculated annual final energy demand and monitored consumption											
Energy demand divided on sectors					MVh						

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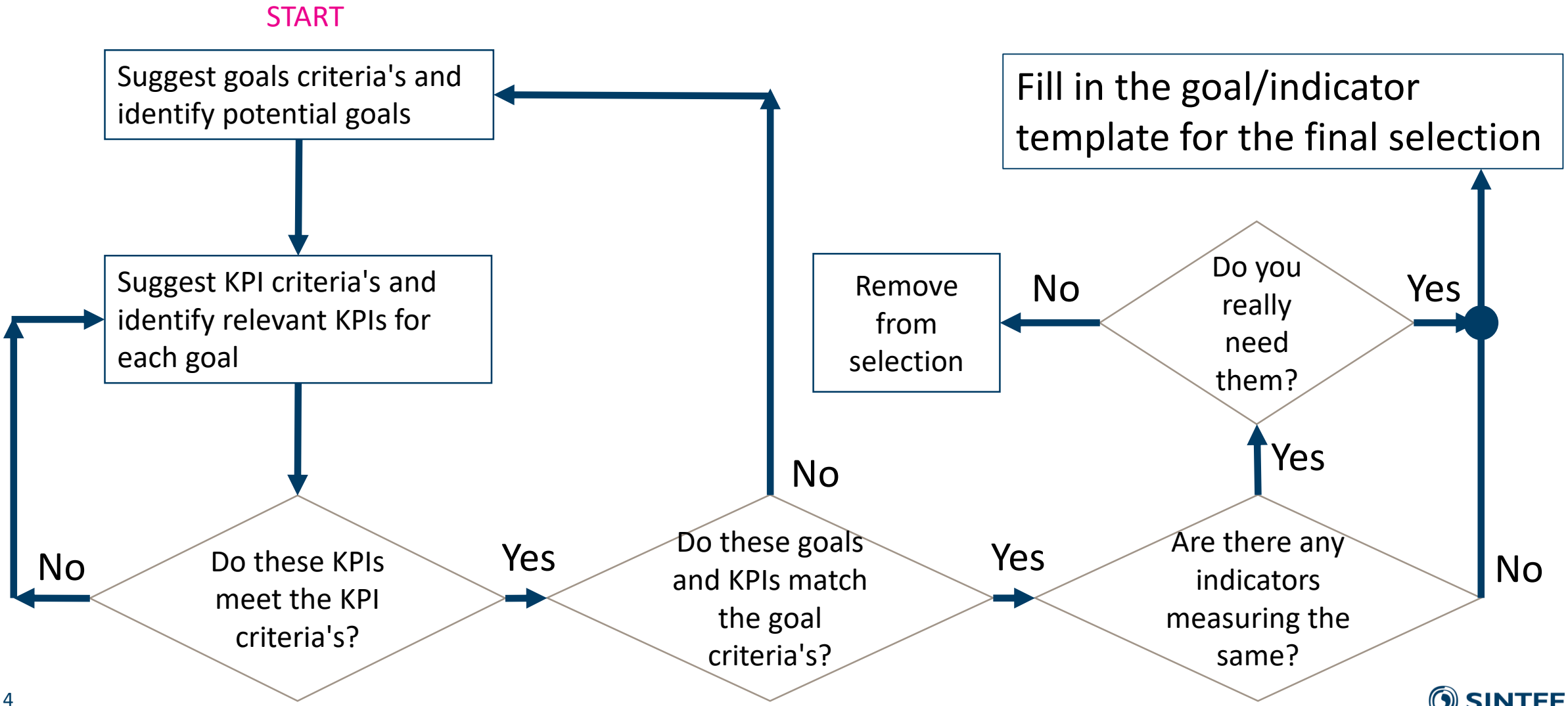
Process to select goals and Indicators

KPI = Key Performance Indicator



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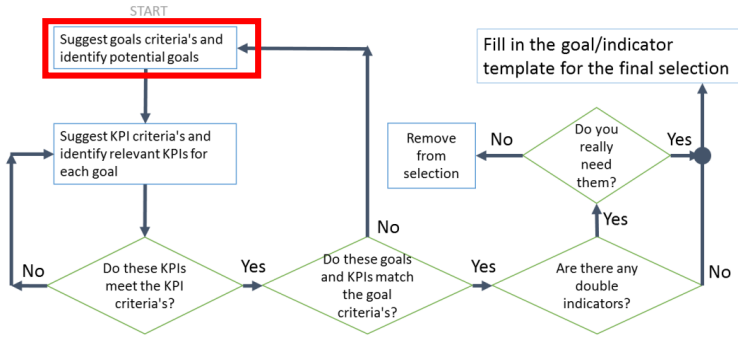
Goals and Targets



- Goals are defined as the overall objectives
  - Goals can be more general
  - General goals should be broken down to one or several specific targets
- Targets are more specific/concrete
  - Targets should be measurable → related to indicator

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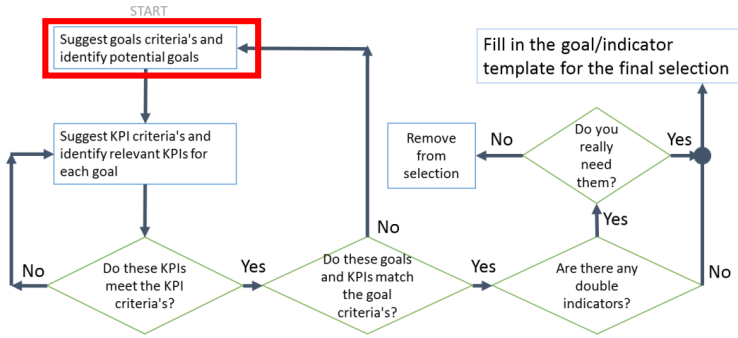
Typical goal criteria



- Address policy/governmental goals
- Address the specific challenges for the area
- Realistic and achievable

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Finding common goals based on pilot cases ZVB and Furuset

- City/project policy programs gave input to 5 general goals related to energy >>>>

City/Area	Reference
Oslo	Klimabudsjett Oslo kommune (www.oslo.kommune.no)
Furuset	Handlingsprogram Furuset (www.arkitektur.no/furuset)
Bergen	Grønn Strategi Bergen (www.bergen.kommune.no)
ZVB	ZVBs nettside (www.zerovillage.no)

Nr	Goal
1	CO_2-reduction
2	Increased use of renewable energy
3	Increased energy efficiency
4	Increased use of local energy sources
5	Green mobility (reduced CO2 emissions and better air quality)

Goal	Specific neighbourhood targets	Reference
No 1	Minimum 50 % reduced greenhouse gas emissions	Ref. Action plan Furuset
No 1	Phase out all oil boilers used for heating in buildings	Ref. Climate budget Oslo municipality
No 1	Reduce the use of fossil gas by 30 %	Ref. Green strategy Bergen
No 1	Fossil-free district heating	Ref. Climate budget Oslo municipality
No 1	CO2-capturing at waste plants	Ref. Climate budget Oslo municipality
No 1	Increased utilisation of landfill gas	Ref. Climate budget Oslo municipality

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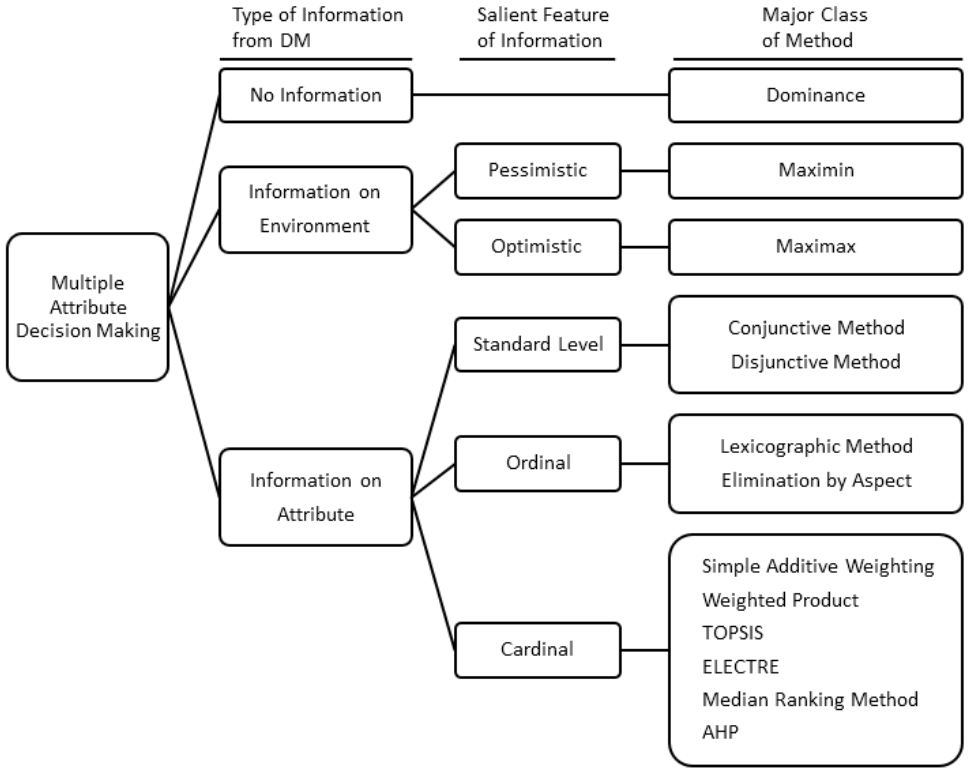
KPI selection – Multiple Attribute Decision Making (MADM)

Selecting the best alternative based on attributes/criteria

- MADM processes can be split into three phases:
  - ***Generating attributes:***
    - *The term "attributes" can be referred to as "criteria".*
    - *To establish a foundation for the decision making, the relevant attributes needs to be identified.*
    - *The set of attributes should represent all the important parameters relevant for the decision.*
    - *Ranking the attributes*
  - ***Attribute rating:***
    - *All the alternatives must be rated against all attributes.*
    - *Quantification of qualitative attributes*
  - ***Applying the MADM methods:***
    - *The MADM methods are classified based on the available information.*
    - *More than one method can be applied*

- *Example: Buying a new car*



Classification of MCDM methods (Yoon and Hwang, 1995)

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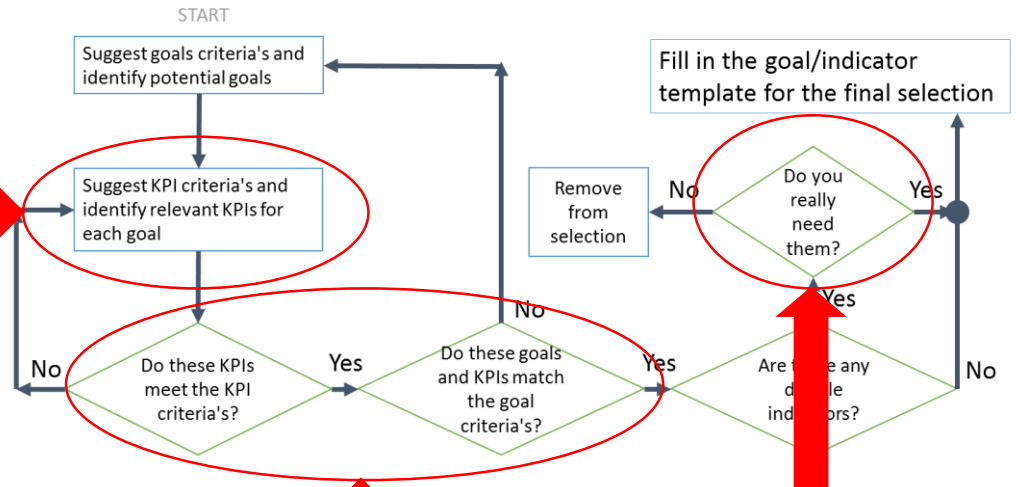
KPI selection – MADM in PI-SEC

- Generating attributes
- Attribute rating



- Applying the MADM methods
  - ***Conjunctive method***
  - ***Lexicographic sequential elimination method***

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Developing a prelimenary KPI set

- Initial screening of the total number of indicators from the literature survey (task 1.1)
- Indicators were chosen or rejected based on ranking criterias/attributes (table)

Ranking	Attributes	Comment
1	Relevance	Relevance in defined as the most important attribute in the selection process. If an indicator is not relevant for the project goals, it is not necessary to include.
2	Availability	Availability is important to reduce the workload in data gathering and processing. However, it must be evaluated in relation to other attributes. One can accept lower availability for a highly relevant indicator, compared to a less relevant indicator.
3	Measurability	Measurability is an important attribute, as it is necessary for evaluating the KPIs. However, it is also an attribute that is in continuous evolvement (instrumentation, AMI). One should therefore be careful to discard indicators based on todays situation.
4	Reliability	Reliability is challenging to rate, as the indicators have different target groups with different background and foundation for understanding the indicator. To increase the level of reliability it is important to carefully define the scope and objective for each indicator and how it is to be measured.
5	Scalability	Cross-scale applicability is defined as an important attribute in the PI-SEC project
6	Familiarity	Familiarity is an important attribute in dissemination of the results, but it is challenging to rate, as the indicators have different target groups with different background and foundation for understanding the indicator
7	Phase applicability	The PI-SEC project focuses on planning instrument, and the indicators should therefore be applicable in the planning phase. To be able to follow up the influence of the planning on the actual development, it is important that indicators also are applicable in the planning phase.

Goal	Target	KPI	Relevance	Availabilty	Measureability	Reliability	Fa
Goal - CO_2-reduction	Fossilfri byggeplass	# zero emission construction sites	2	3	2	1	
		% of construction sites with zero emission	2	3	2	1	
		CO2 emission from construction sites	4	3	2	3	
		# construction sites utilizing district heating	5	3	3	4	
		# construction sites utilizing local electricity production (eg. PV)	4	3	3	4	
Goal - Energy consumption	40/80 % reduksjon i elektrisitetsbruk fra offentlig utebelysning innen 2020/2030	Electricity consumption from outdoor lighting	5	4	3	5	
		% of lighting with low energy bulbs	4	4	3	4	
		% of lighting with energy control system	4	4	3	4	
Goal - CO_2-reduction	Fossilfrie ferger	CO2 emissions from ferries	2	2	3	3	
		# ferries fossil free ferries	2	2	3	3	
		% fossil free ferries	2	2	3	3	
Goal - Mobility	Utbredt infrastruktur for fornybare drivstoffer (el, hydrogen, bio)	# filling stations with RES fuel / area/innh.	5	4	5	5	
		Average distance between fuel stations	4	3	3	4	
Goal - Mobility	Tilby landstrøm for alle skip innen 2020	CO2 emissions from moored ships	4	2	2	3	
		% of berths with power connection	3	3	4	3	
		% of berths with district heating connection	3	3	2	3	
Goal - Mobility	Alle nye biler skal være utslippsfrie fra 2025	% fossil free cars of new cars registered	5	3	3	4	
		# sold fossil free cars	2	3	3	4	
Goal - Mobility	Doble passajerer per bil i rushtrafikken innen 2020	Average number of passenger per journey in rush hours	4	2	2	3	
		# journeys with more than one passenger	4	2	2	3	
Goal - Mobility	Redusere antall biler per husoldning til 1 innen 2025	# cars	3	3	3	4	
		# households with more than one car	4	3	3	4	

Prelimenary KPI set : from 220 to 21 indicators

- **CO_2 emissions**
- **Energy Use**
- % of buildings with Energy Certificate at each of the grades
- Installed capacity of RES
- Generated energy by RES
- Buildings with installed RES
- Use of secondary heat
- Buildings connected to district related thermal energy source
- Peak Load Production
- Peak Load Consumption
- Identification of available resources of renewable energy
- Number of registered oil tanks
- % of buildings with a benchmark and with measure of energy performance
- % of different kinds of RES in district heating
- Use of energy related incentive (for both single and multiple buildings)
- Energy Storage
- # fossil free construction sites (machines and transportation)
- Modal Split
- # filling stations with RES fuel
- % fossil free cars of new cars registered
- % of berths with power connection

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KPI	Goals	Sub-categories		Sectors	Unit
CO_2 emissions	CO_2-reduction	Stationary Energy	Electricity Biofuel Fossil fuel District heating	Public buildings Residential buildings Private buildings Infrastructure	Tonnes CO_2 eqv. /yr
		Mobility		Private cars Taxi Public transport Goods transport Freight transportation Construction machines	
		Materials		Public buildings Residential buildings Private buildings	
Energy Use	Increased energy efficiency	Electric	Buildings	Public buildings Residential buildings Private buildings	MWh/yr
			Infrastructure	Outdoor lighting Transport Other	
		Thermal	Solar Biofuel Oil Gas District heating	Public buildings Residential buildings Private buildings Infrastructure	

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KPI	Goals	Sub-categories		Sectors	Unit
% of different kinds of RES in district heating	Increased use of renewable energy	Electricity Heat pump Solar Biofuel Waste			%
% of buildings with Energy Certificate at each of the grades	Increased energy efficiency	Certificate A Certificate B Certificate C Certificate D Certificate E Certificate F Certificate G Not registered		Public buildings Residential buildings Private buildings	%
Use of energy related incentive (related to both single and multiple buildings)	Increased energy efficiency	Futurebuilt Enova Bream Communities Local		Public buildings Residential buildings Private buildings	#
% of buildings with a benchmark and with measure of energy performance	Increased energy efficiency			Public buildings Residential buildings Private buildings	%
# fossil free construction sites (machines and transportation)	Total CO2 emissions Increased use of renewable energy	Construction Machines Energy production		Public buildings Residential buildings Private buildings	#

KPI	Goals	Sub-categories		Sectors	Unit
Modal Split	Green mobility	Fossil free Cars Fossil fuel Cars Fossil free Public transport Fossil fuel Public transport Lorries Bicycle Foot			%
# filling stations with RES fuel	Green mobility	Electric Hydrogen Biofuel			#
% fossil free cars of new cars registered	Green mobility	Electric Hydrogen			%
% of berths with power connection	Green mobility				%
Installed capacity of RES	Increased use of local energy sources Increased use of renewable energy	Electric Thermal	Solar Geothermal Hydro Power Wind Power CHP Waste CHP Biomass		kW
Generated energy by RES	Increased use of local energy sources Increased use of renewable energy	Electric Thermal	Solar Geothermal Hydro Power Wind Power CHP Waste CHP Biomass		MWh
Buildings with installed RES	Increased use of local energy sources	Electric Thermal	Solar Geothermal Hydro Power Wind Power		%

KPI	Goals	Sub-categories		Sectors	Unit
	Increased use of renewable energy		CHP		
Use of secondary heat	Increased use of local energy sources				MWh
Buildings connected to district related thermal energy source	Increased use of local energy sources Increased use of renewable energy				%
Identification of available resources of renewable energy	Increased use of local energy sources Increased use of renewable energy		PV, Solar Thermal, Biomass, Geothermal, Hydro Power (Waste heat, energy from waste)		MWh
Number of registered oil tanks	Increased use of renewable energy Total CO2 emissions				#
Peak Load Consumption	Increased use of local energy sources	Electric Thermal			kW
Peak Load Production	Increased use of local energy sources	Electric Thermal			kW
Energy Storage	Increased use of local energy sources Increased use of renewable energy	Electric Thermal			MWh

And now?

- Testing on two very different case studies
- Further implementation into PI SEC planning tool (excel and web)

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