EMBODIED ENERGY, COSTS AND TRAFFIC IN DIFFERENT SETTLEMENT PATTERNS – EE SETTLEMENT

Prosjekt i BYFORSK, 2017 - 2020

Finansiert av Norges Forskningsråd

Bakgrunn

- Ulike bosettingsstrukturer påvirker
  - Energibehov for bygninger i drift
  - Energibehov for å bygge hus og infrastruktur (veier, p-plasser, strømledninger, vann, kloakk …)

    > "innebygd"/"bundet" energi
  - Behov for trafikk og tilknyttet energi
  - Arealbehov
  - Kostnader for å bygge infrastruktur
  - Kostnader og energi for drift av infrastruktur og tjenester
- Utfordringer for kommuner og regioner

Prosjekt: EE Settlement –
Bundet energi, kostnader og trafikk ved ulike bosettingsmønstre

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- Vi vet lite om energibruk til infrastruktur
- Østerrike: Infrastruktur har enorm andel av total energi

  > klimagassutslipp ingen tenker på
- Vi trenger grunnlagsdata for Norge spesielt for dette
- Data for bundet energi gir grunnlag for vurdering av totale klimagassutslipp (LCA)
- Helhetlig vurdering av konsekvenser for ulike utbyggingsalternativer

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Prosjektet skal …

- Skaffe fram **grunnlagsdata** for bundet energi ved **typiske bygninger og bosettingsstrukturer**, **inkludert** utomhusanlegg og infrastruktur
- Analysere **investerings-/driftskostnader**, **energi** i drift, generert **trafikk**
- Analysere **rammebetingelsene** som påvirker folks boligpreferanser og kommunale beslutninger om boligutvikling
- Utvikle et nettbasert **verktøy** som viser konsekvenser i et helhetlig bilde
- Utvikle **veiledning** med anbefalinger for myndigheter og fagfolk

Consortium and expertise (1)

- SINTEF Building and Infrastructure (SINTEF) – buildings, infrastructure, LCA
  – project leader, work package leaders
- The Norwegian Institute for Urban and Regional Research (NIBR) – research on housing and regional development
  – framework, recommendations; work package leader
- The Institute of Transport Economics (TØI) – transport research
  – generated traffic, energy needs for transport; task leader

NIBR
Norwegian Institute for Urban and Regional Research
OSLO AND AKERSHUS UNIVERSITY COLLEGE OF APPLIED SCIENCES

toi
Institute of Transport Economics
Norwegian Centre for Transport Research

Consortium and expertise (2)

- Kristiansand municipality – A city with challenges and experience
  – provides case studies and data
- BYLIVsenteret – Advice and guidance to local municipalities on sustainable urban development
  – provides professional advice and guidance to the assessment of needs and to the development of recommendations
- Akaryon – Research based Austrian SME, environmental informatics, leader of former ZERsiedelt project
  – tool development; work package leader (subcontractor)
- Institute of Spatial Planning and Rural Development (IRUB) at University of Natural resources and life sciences (BOKU) in Vienna, leader of former ELAS project
  – Case studies in Austria; knowledge sharing

KRISTIANSAND KOMMUNE

BYLIV SENTERET
Senter for bærekraftig by- og tettstedsutvikling

BOKU

IRUB

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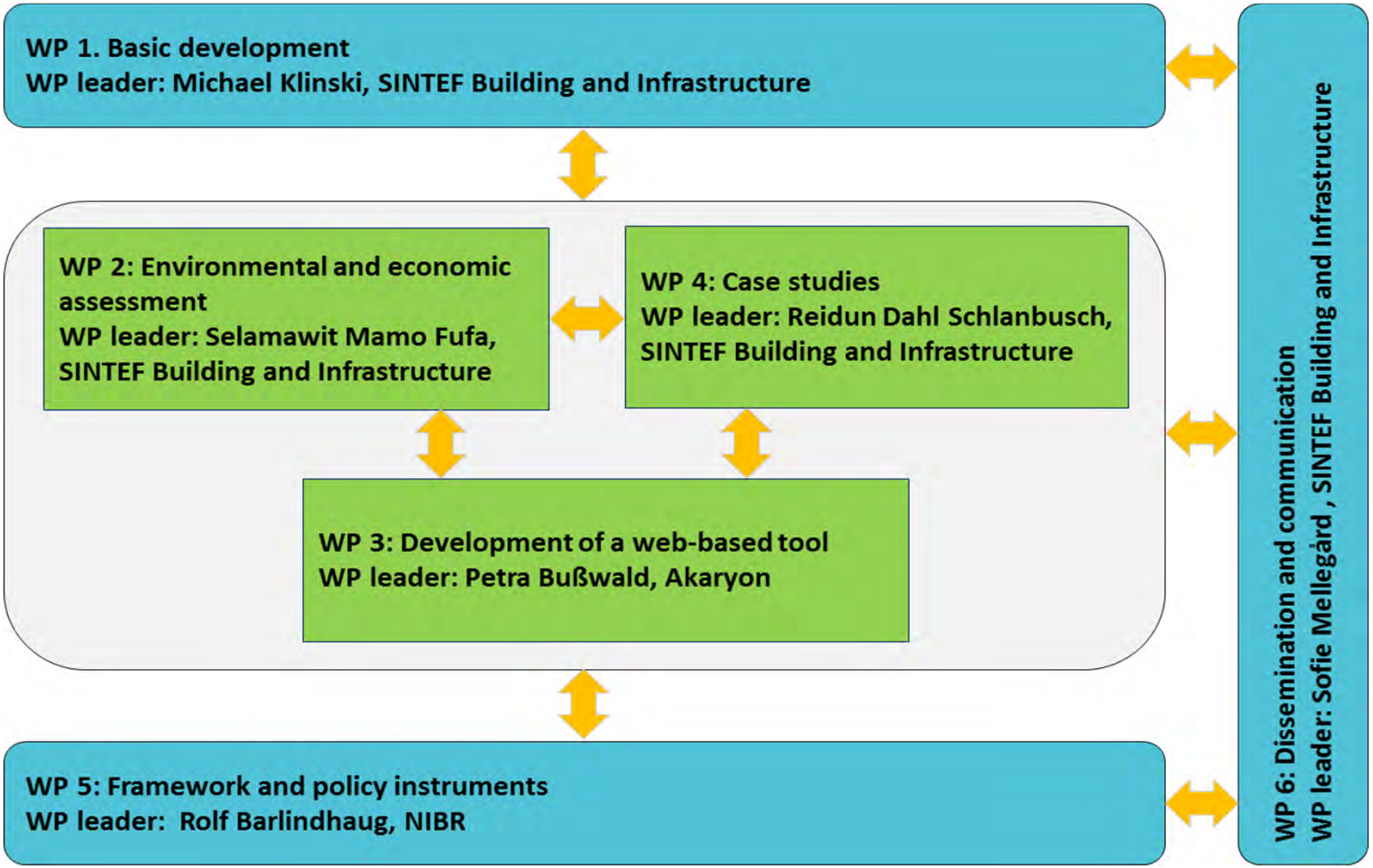
Project organization and implementation



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Time line

Assessment
Development
Basis Guidelines
Final dissemination

	Activities and milestones	Contribution	2017		2018				2019				2020	
			3	4	1	2	3	4	1	2	3	4	1	2
	Start-up, status and closure meetings with advisory board	All	■			■		■		■		■		■
WP1	**Basic development**													
	Task 1.1: State of the art	All	■	■										
	Task 1.2: Assessment of needs			■	■									
	Task 1.3: Modelling of typical buildings, sites / settlements, infrastructure				■	■								
WP2	**Environmental and economic assessment**													
	Task 2.1: Calculation of embodied energy and operating energy	SINTEF, TØI				■	■	■	■	■				
	Task 2.2: Calculation of investment and operating costs for infrastructure					■	■	■	■	■				
	Task 2.3: Estimation of energy demand and operating costs for services					■	■	■	■	■				
	Task 2.4: Estimation of residents' energy needs for transport					■	■	■	■	■				
WP3	**Development of a web-based tool**													
	Task 3.1: Development of a generic model that can be used in several countri	Akaryon, SINTEF					■	■	■	■	■	■		
	Task 3.2: Adaptation to Norwegian conditions and needs						■	■	■	■	■	■		
WP4	**Case studies**													
	Task 4.1: Apply the tool to case studies from Kristiansand municipality	All						■		■	■			
	Task 4.2: Apply the tool to case studies from further municipalities							■		■	■			
	Task 4.3: Apply the tool in a city in Austria							■		■	■			
WP5	**Framework and policy instruments**													
	Task 5.1: Factors affecting individuals' and houshold's housing demand	NIBR (all)				■	■	■	■	■	■	■		
	Task 5.2: Instruments that municipalities and governing authorities should de							■	■	■	■	■		
	Task 5.3: Guidelines for policy makers					■			■		■	■	■	
WP6	**Dissemination and communication**													
	Task 6.1: Workshops	All		■						■				
	Task 6.2: Presentations and publications				■	■	■	■	■	■	■	■	■	■
	Task 6.3: User/public-oriented communication and publications				■	■	■	■	■	■	■	■	■	■

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To prosjekter i Østerrike

- Analyser
- Anbefalinger
- Verktøy

ELAS

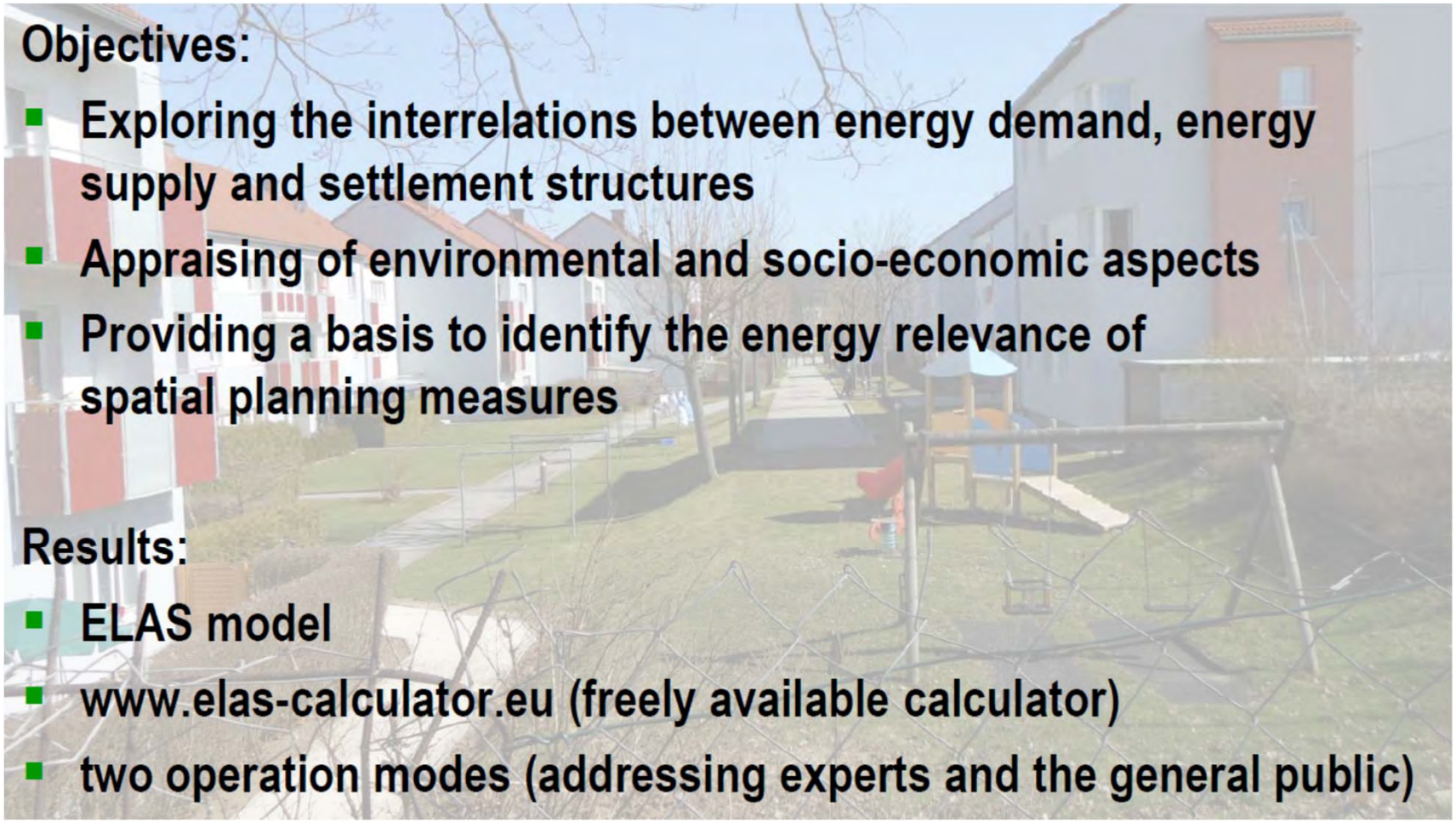
Energetic Long Term Analysis of Settlement Structures

ZERsiedelt

Zu EnergieRelevanten Aspekten der Entstehung und Zukunft von Siedlungsstrukturen und Wohngebäudetypen in Österreich

www.zersiedelt.at NEUE ENERGIEN 2020 Projekt 822099

ELAS



Objectives:

- Exploring the interrelations between energy demand, energy supply and settlement structures
- Appraising of environmental and socio-economic aspects
- Providing a basis to identify the energy relevance of spatial planning measures

Results:

- ELAS model
- www.elas-calculator.eu (freely available calculator)
- two operation modes (addressing experts and the general public)

ELAS results

University of Natural Resources and Life Sciences, Vienna
Department of Landscape, Spatial and Infrastructure Sciences

- **Overall environmental appraisal**
  - **Cumulative energy demand**
  - **Lifecycle CO_2 emissions**
  - **Ecological footprint as Sustainable Process Index**
- **Socio-economic appraisal**
  - **Regional economic input-output analysis**
    comprising estimations of
    turnover, value added, imports induced as well as jobs created with the construction, renovation, operation and maintenance of settlements

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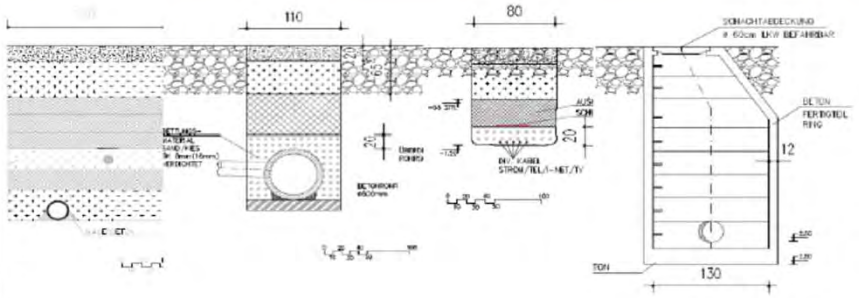
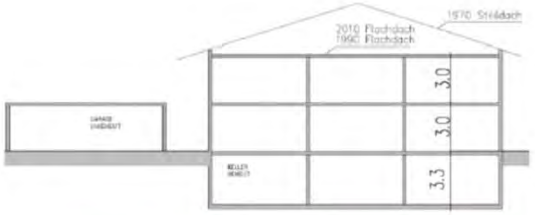
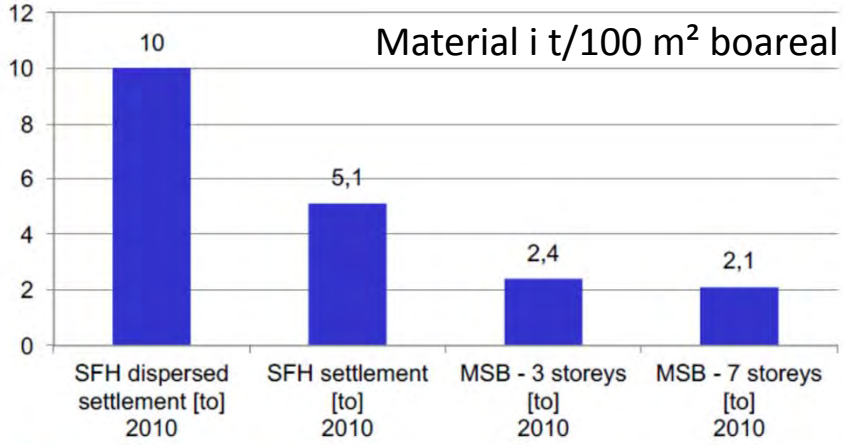
Physical modeling of buildings and infrastructure

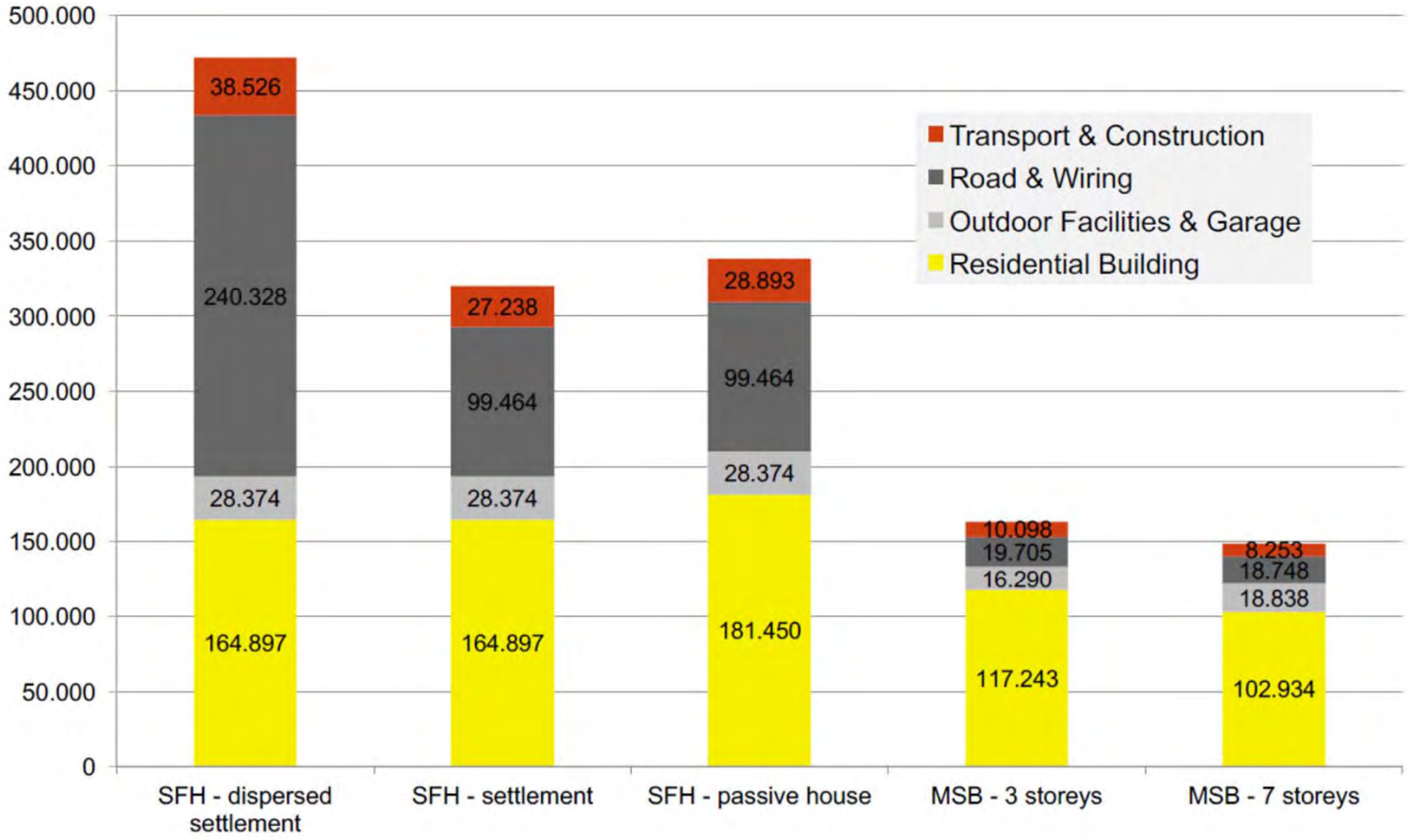
	SFH dispersed settlement	SFH settlement	MSB - 3 storeys	MSB - 7 storeys
area of property	1200 m2	800 m2	10816 m2	3150 m2
GFA living area	176 m2	176 m2	100 m2	100 m2
amount of apartment	1	1	132	54
street width	4 m asphalt 2 m gravel	5 m	18 m	10,5 m
street length	100 m	25 m	244 m	90 m
collecting road	10 m	10 m	30 m	30 m





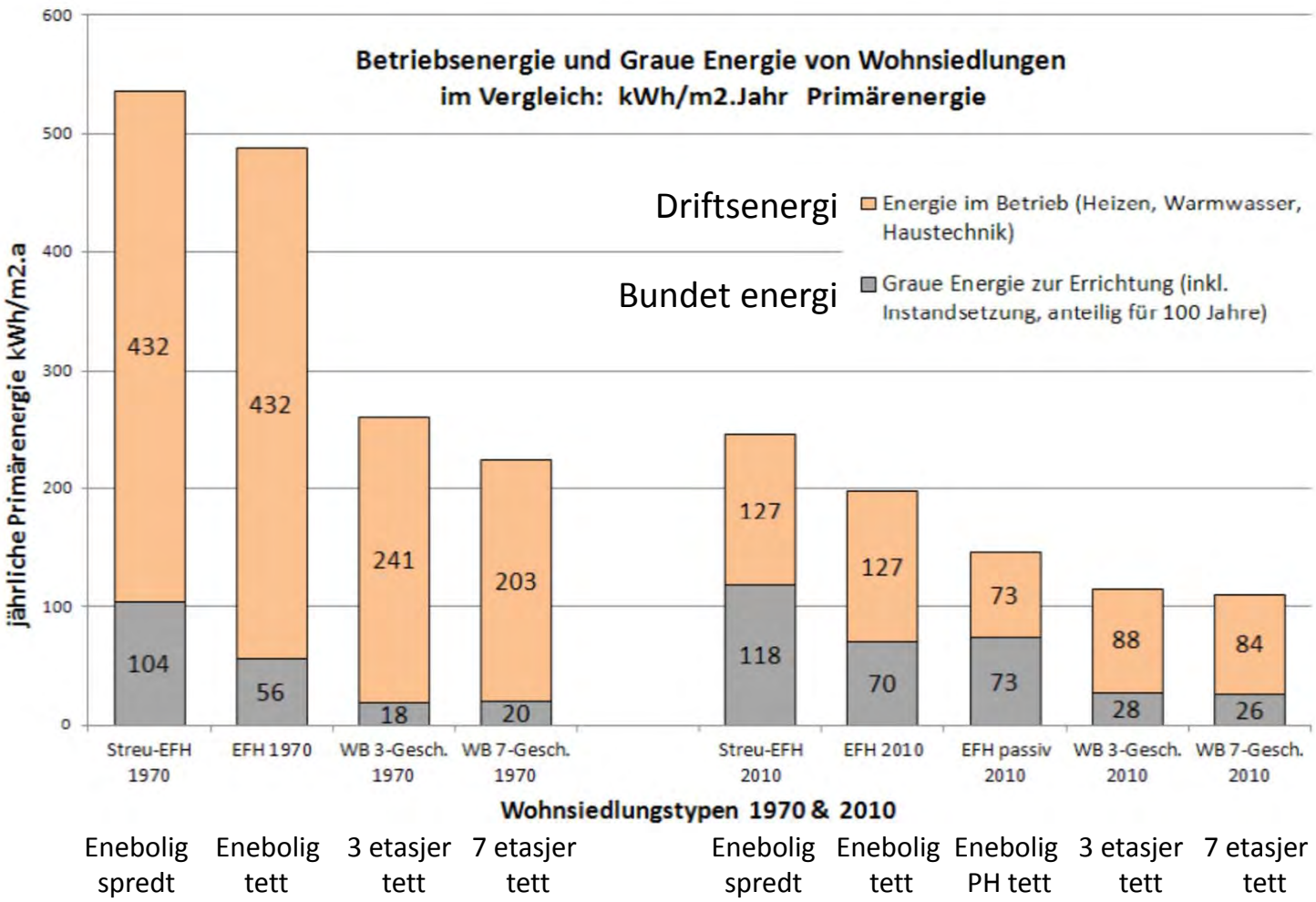


Embodied Energy in Construction of Buildings and Infrastructure – kWh per 100 m² Gross Floor Area, 2010



ZERsiedelt
klima+ energie fonds
Zu EnergieRelevanten Aspekten der Entstehung und Zukunft von Siedlungsstrukturen und Wohngebäudetypen in Österreich
www.zersiedelt.at NEUE ENERGIEN 2020 Projekt 822099
a ÖGUT FCP TU Graz ÖKOLOGIE INSTITUT
SINTEF

ZERsiedelt: Driftsenergi og bundet energi



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Verktøy tilgjengelig på nettet

- www.elas-calculator.eu/
  - Tysk og engelsk
- www.zersiedelt.at/
  - Sammendrag og verktøy tysk og engelsk, andre publikasjoner bare tysk

Resultater ELAS

As-is-analysis

Category	Result
Energy Consumption	117,528 kWh
Ecological Footprint (SPI)	9,327,621 m^2
CO_2 Life Cycle Emissions	37,742 kg
Turn over	52,891 €
Value added	24,562 €
Imports	8,549 €
Jobs	0.2

Planning based on As-is-analysis

Category	Result
Energy Consumption	161,657 kWh
Ecological Footprint (SPI)	13,708,444 m^2
CO_2 Life Cycle Emissions	54,532 kg
Turn over	85,588 €
Value added	39,823 €
Imports	13,680 €
Jobs	0.4

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CO_2 life cycle emissions, As-is-analysis

Result area	Result	Distribution
Space heating, hot water supply	**4,306** kg	11.0 %
Electricity	**11,150** kg	28.5 %
Municipal services	**2,002** kg	5.1 %
Mobility (every day)	**13,158** kg	33.7 %
Mobility (leisure/vacation)	**8,463** kg	21.7 %
Total	**39,080** kg	**100** %

Ecological Footprint (SPI), As-is-analysis

Result area	Result	Distribution
Space heating, hot water supply	**1,143,922** m^2	12.3 %
Electricity	**3,670,187** m^2	39.3 %
Municipal services	**580,381** m^2	6.2 %
Mobility (every day)	**2,258,743** m^2	24.2 %
Mobility (leisure/vacation)	**1,674,388** m^2	18.0 %
Total	**9,327,621** m^2	**100** %

- Samme for planlegging

Dessuten:

- Regional-økonomiske effekter
- Endringer med grønn scenario mot 2040

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How much grey energy is in housing and infrastructure?

Deutsch

scattered settlement

Length of the access road / channel etc 50 [m]

Resultater ZERsiedelt

Results [kWh primary]

⊙Overview ○ Building comparison only initial ○ Building comparison with maintenance for 100 years ☑ operating energy ☑ Display access road

	[kWh]	[kWh/100m^2]	%	with maintenance [kWh/100 years]	[kWh/100m^2/100 years]	%
Access road	949 200	949 200	80	2 793 000	2 793 000	84
building	110 993	110 993	9	176 580	176 580	5
outdoor facilities	12 737	12 737	1	48 749	48 749	1
garage	0	0	0	0	0	0
development	107 463	107 463	9	316 208	316 208	9
Total Grey Energy	**1 180 393**	**1 180 393**	**100**	**3 334 536**	**3 334 536**	**100**
operating energy	**21 400**	**21 400**	**2**	**2 140 000**	**2 140 000**	**64**
Grey Energy : operating energy	**55.2 : 1**			**1.6 : 1**		

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Teknologi for et bedre samfunn