SmartReFlex
RENEWABLE DISTRICT HEATING & COOLING

Smart and flexible 100% renewable district heating and cooling systems for European cities

4DH
4th Generation District Heating Technologies and Systems

RES-Heat in Local Energy Planning
Case Study: Tralee, Co. Kerry, Ireland

Co-funded by the Intelligent Energy Europe Programme of the European Union

XD Consulting
Creative Energy Services

SmartReFlex –
Supporting 100% RE District Heating in EU

Comhar, Cabhair, Cairdeas

XD Consulting – Creative Energy Services

Tipperary Energy Agency

PlanEnergi

Dansk Fjernvarme

Regional strategy for DH
Capacity Building
Consultancy and mentoring
Dissemination

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SEAI,2016. Ireland's Energy Targets. Progress, Ambition & Impacts

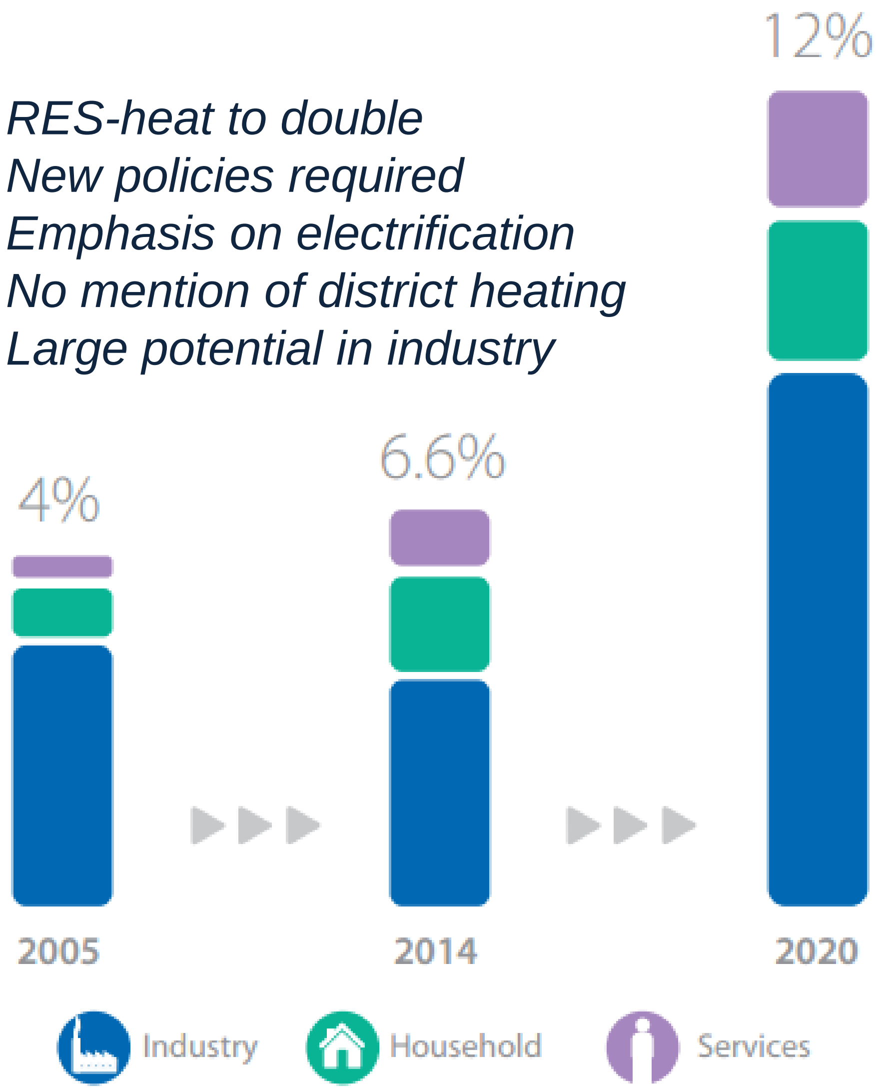
Achievements to date

- Penetration currently about 5% – over 40,000 homes and over 550 businesses using some source of renewable energy for heat – deployed largely through SEAI grant schemes.
- The main technologies are direct combustion of biomass, solar heating and heat pumps.

Future requirements

- New policies and measures are required to bridge the gap to the RES-H 12%.
- The gap to achieving the target is equivalent to about 300,000 homes, 3,000 services/public sector buildings or 200 large industrial sites installing a renewable heating technology – or a mix of installations across each sector.
- Improving energy efficiency greatly assists meeting the heat target. A high proportion of the savings targets in the NEEAP act to reduce the demand for heat energy.
- Potential for accelerating the electrification of heat through technologies such as heat pumps.

- *RES-heat to double*
- *New policies required*
- *Emphasis on electrification*
- *No mention of district heating*
- *Large potential in industry*



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RES-Heat Transition – LOCAL solutions for a national strategy

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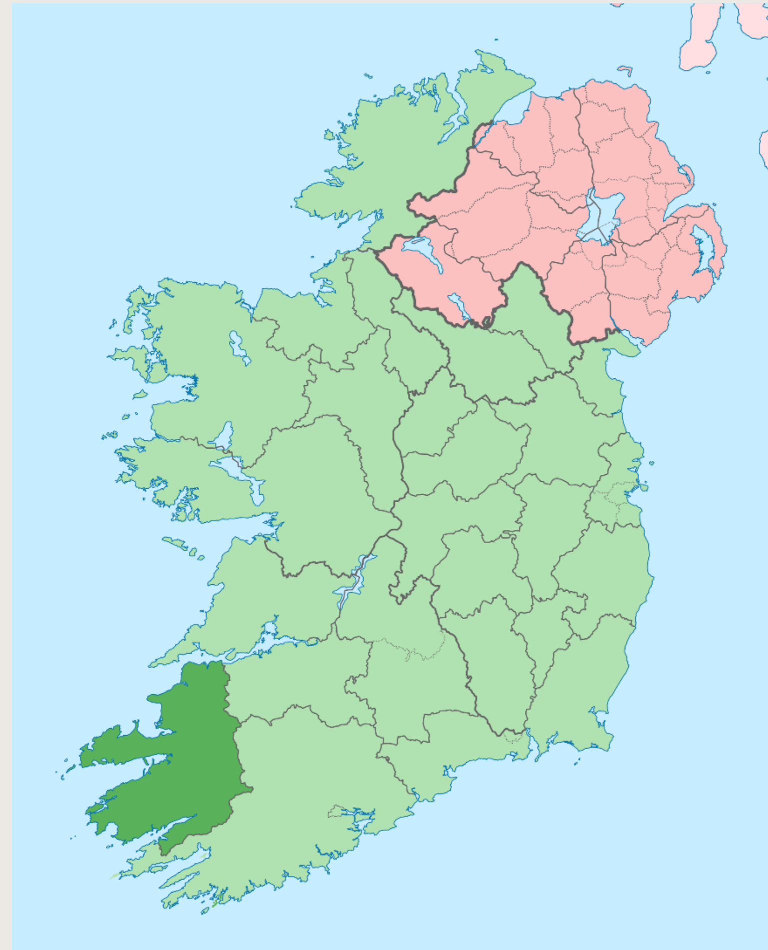
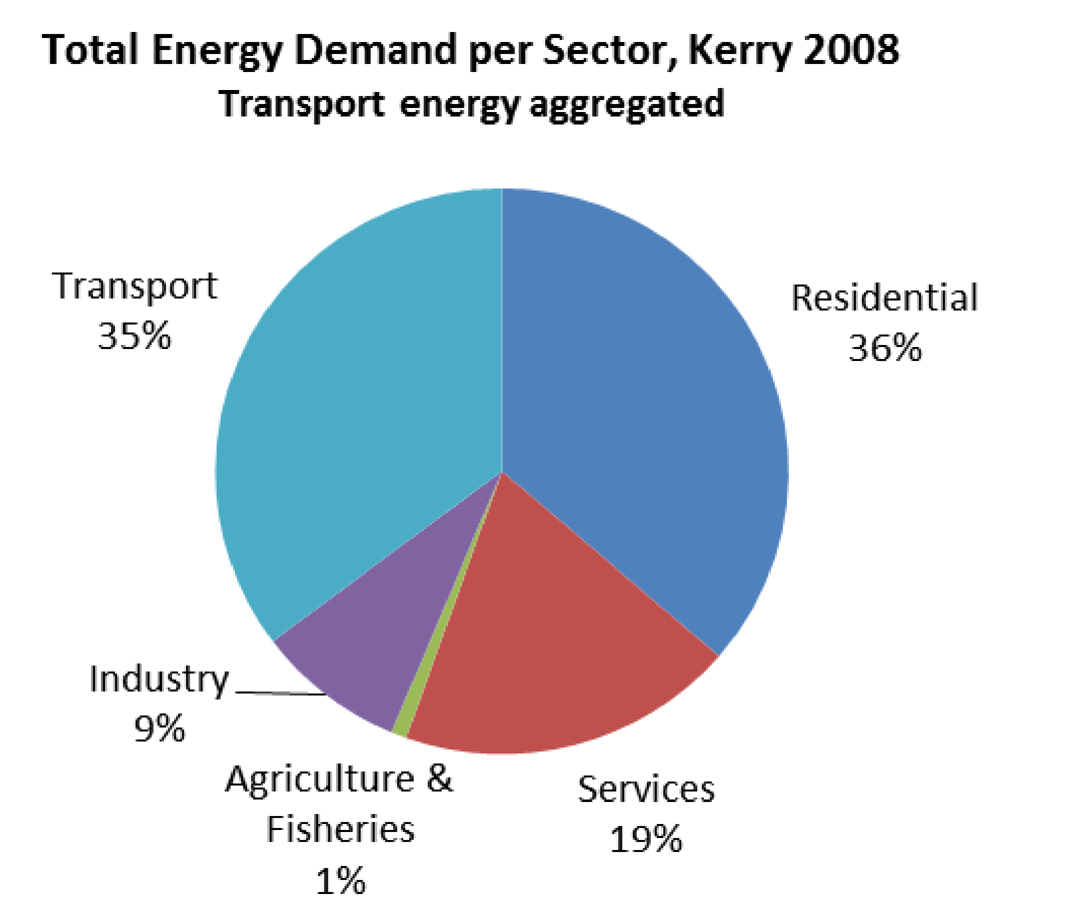
Kerry



Population: 145,500
Population density: 30.7 inh/km2
Households: 53,300

Heat in Kerry



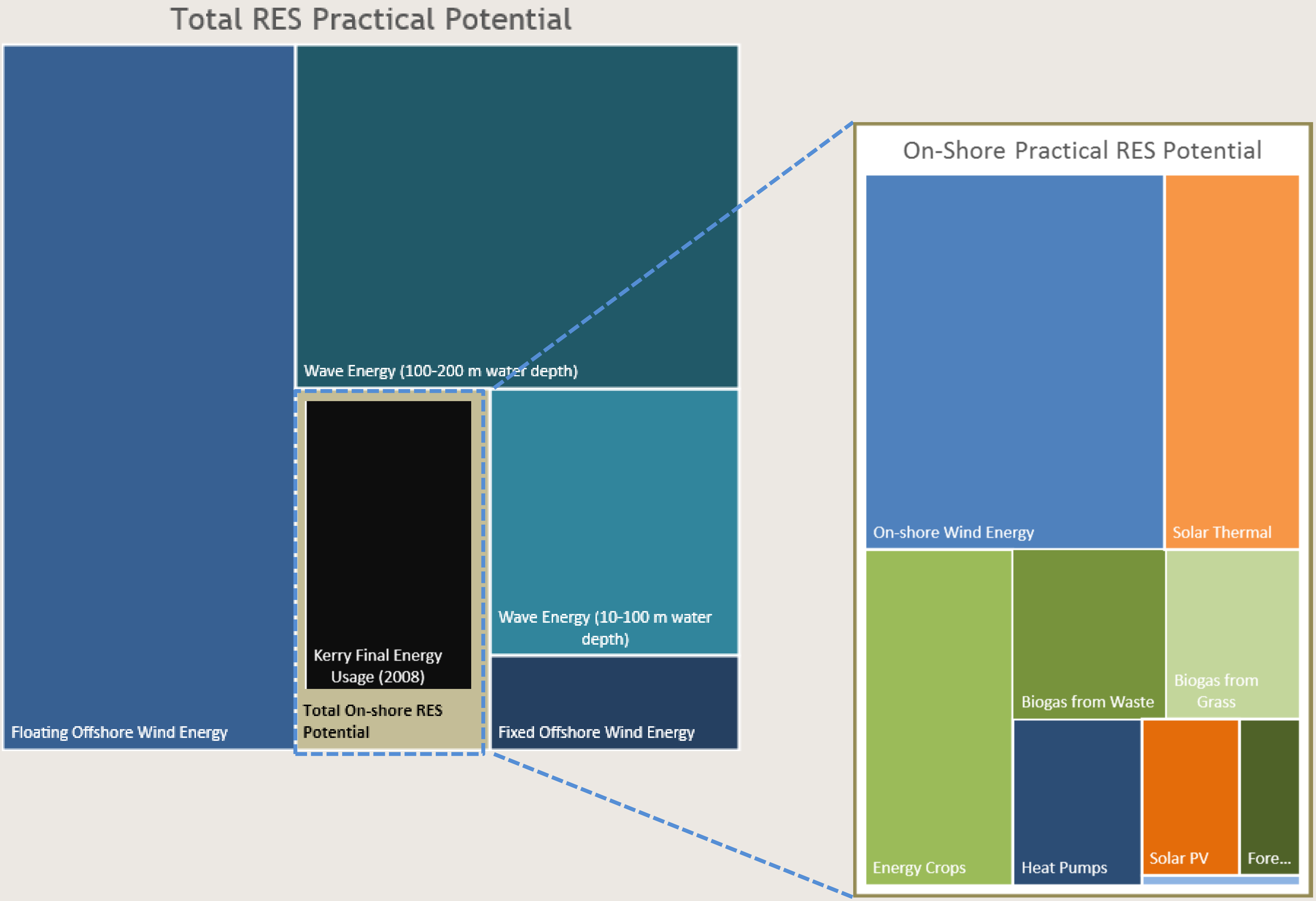
Source: Kerry Community RE Roadmap

Heat = 46% of total final energy use

40% of heat demand is in urban centres

115 Mio€/year spent on heat

Potential 45 Mio€/year market for DH



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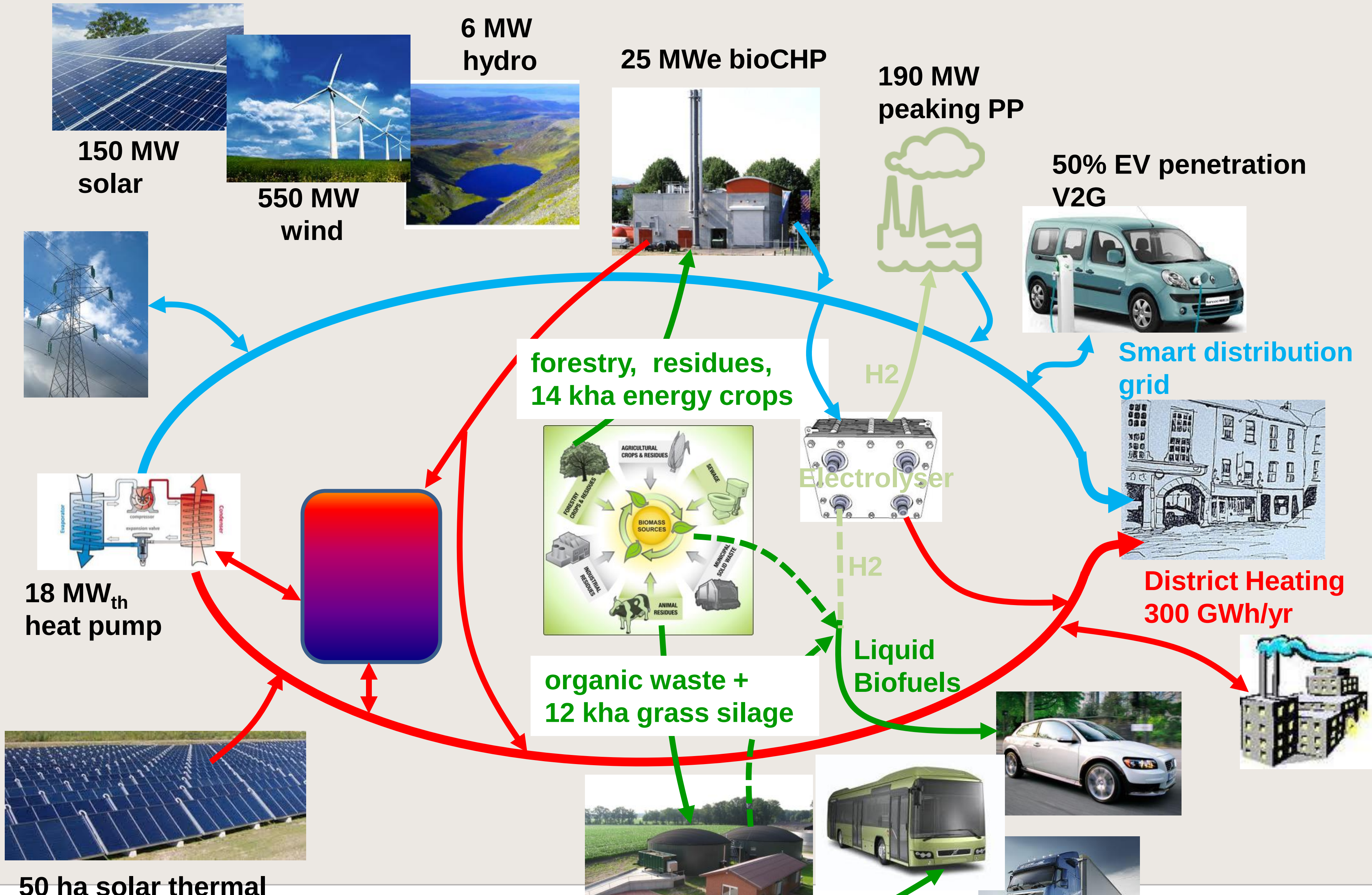

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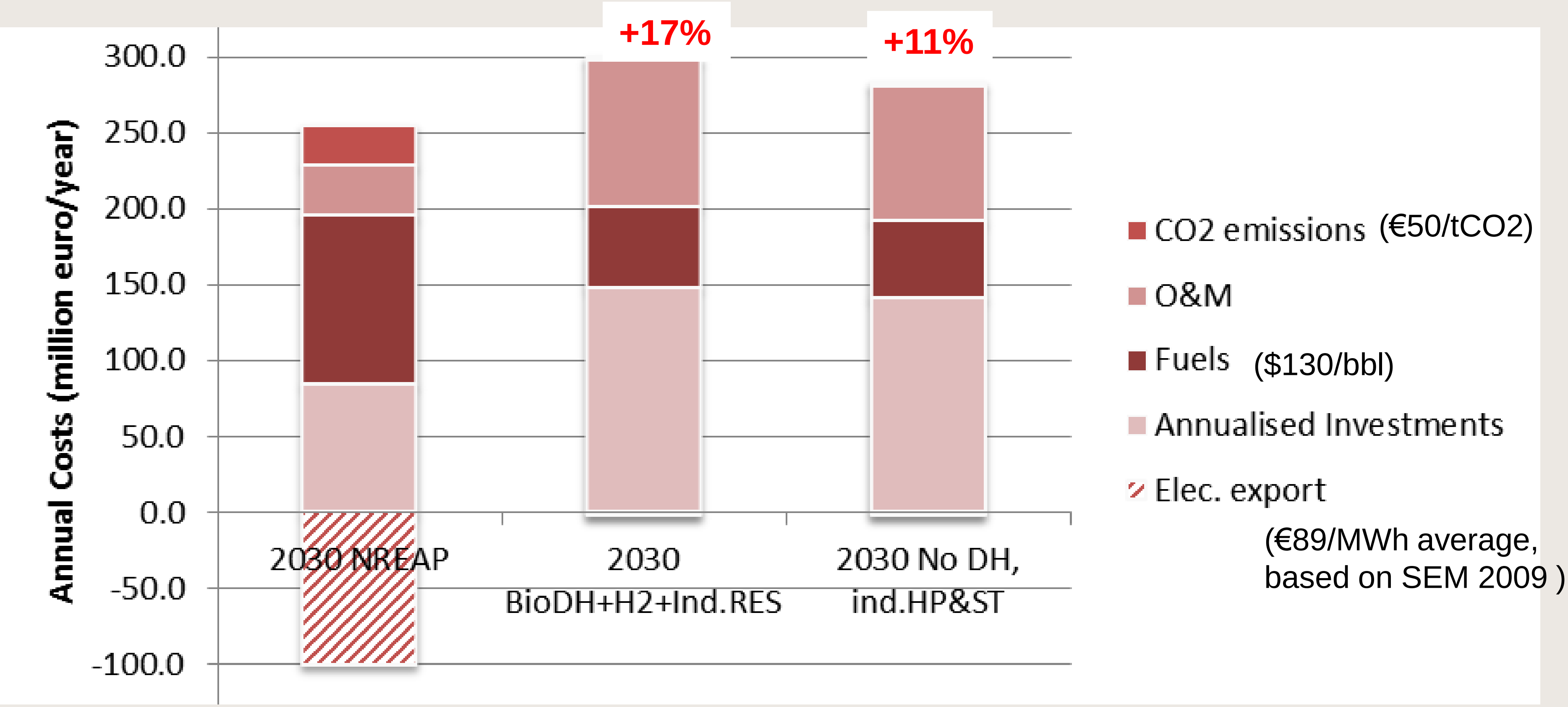
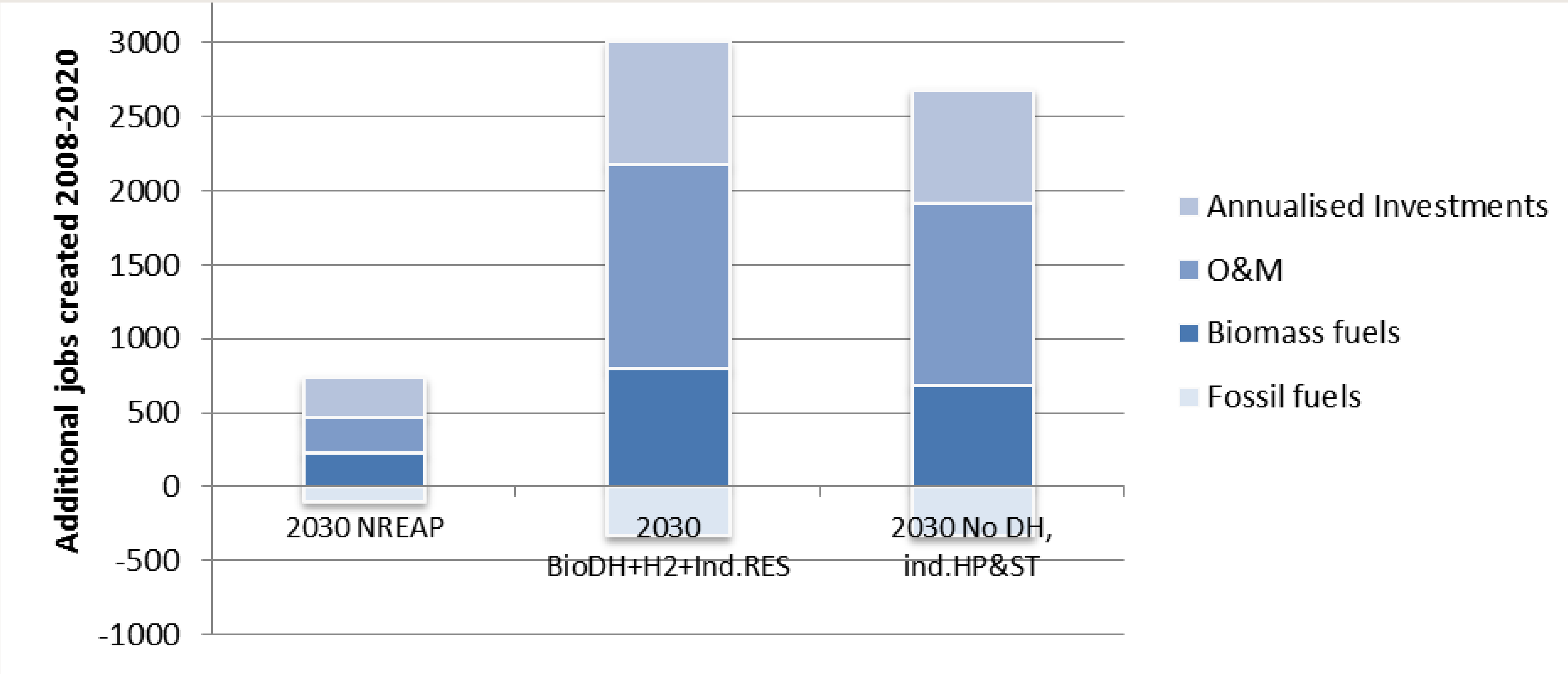
Annualised costs of energy system scenarios 2030.



- Additional mio€64/year annualised investment
- Major redirecting of balance of payment to local economy

Job Creation Potential



+2700 local jobs created!

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Tralee’s Heat Plan

Population: 23,700

Area: 16 km2

Households: 9520

Population density: 1480 inh/km2

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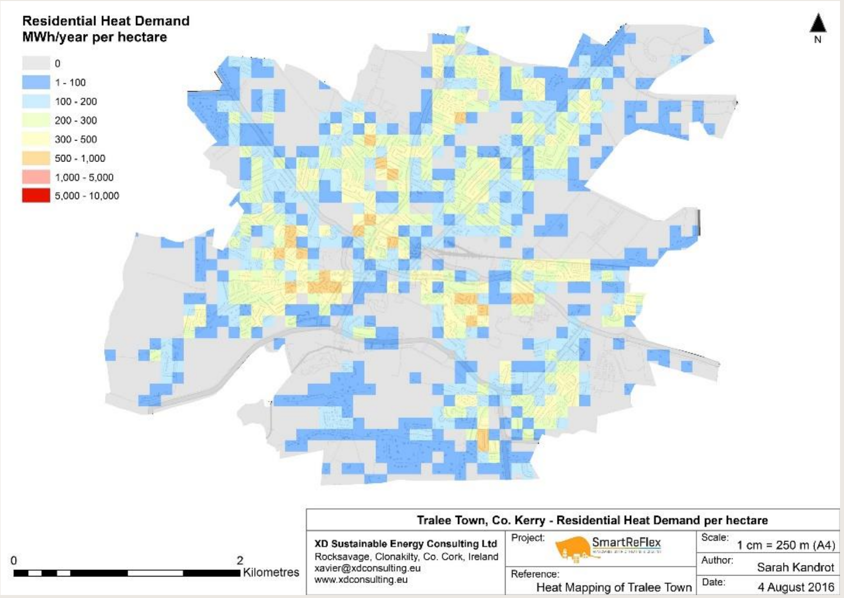
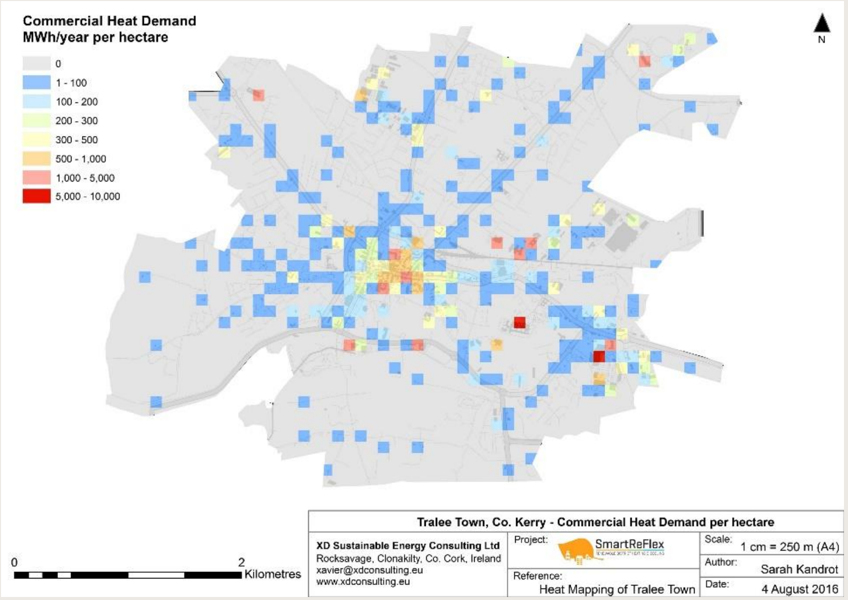
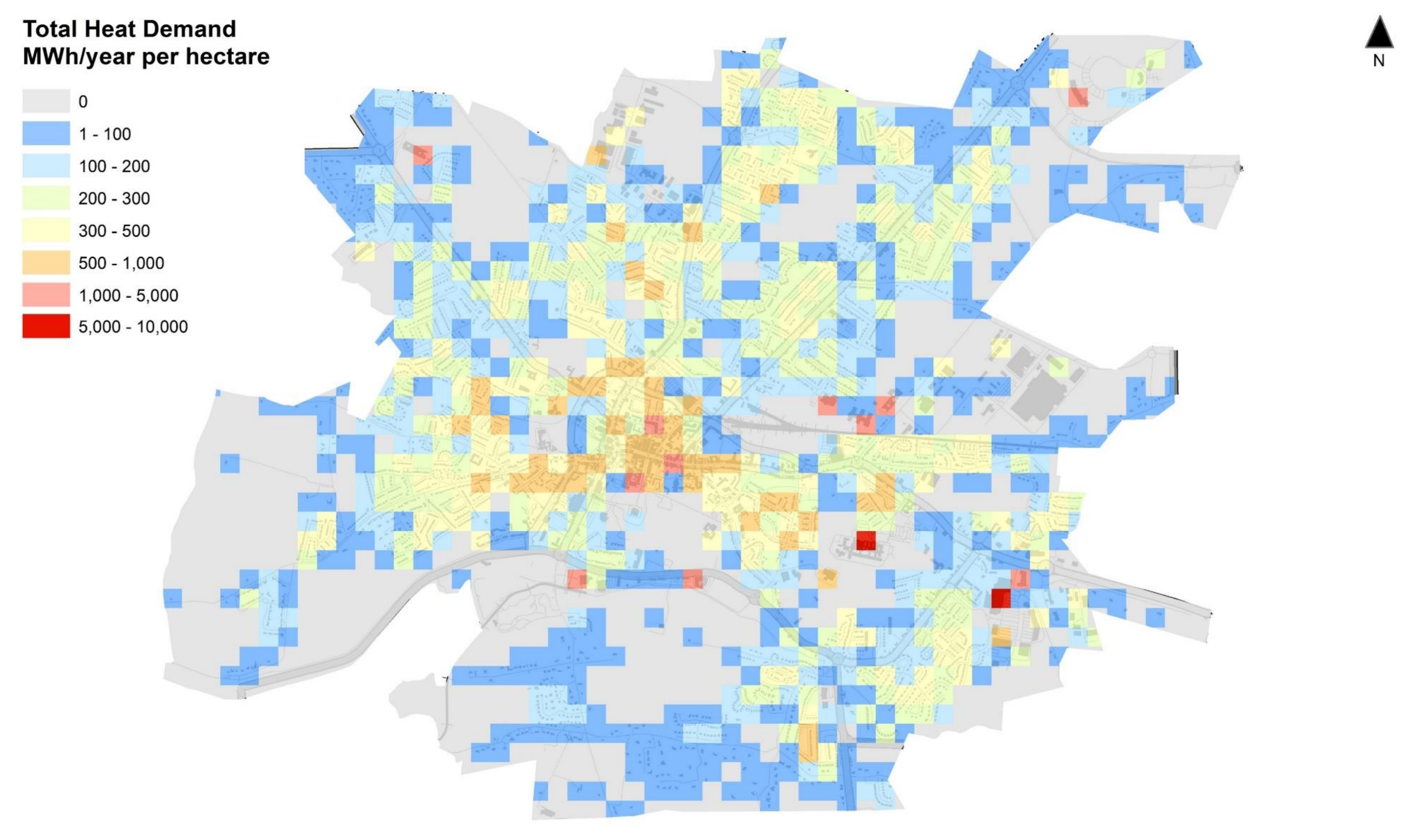
Tralee Heat Density Mapping





Residential: 150 GWh/year

Services/small industry: 68 GWh/year



0 2 Kilometres

Tralee Town, Co. Kerry - Total Heat Demand per hectare		
XD Sustainable Energy Consulting Ltd Rocksavage, Clonakilty, Co. Cork, Ireland xavier@xdconsulting.eu www.xdconsulting.eu	Project: SmartReFlex RENEWABLE DISTRICT HEATING & COOLING Reference: Heat Mapping of Tralee Town	Scale: 1 cm = 250 m (A4) Author: Sarah Kandrot Date: 4 August 2016

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Where is DH competitive?

- For each 100 x 100 m square, we know heating requirement (heat density) & number of buildings
- Calculate specific heat distribution cost:
  - Capital cost of DH pipelines based on heat density (Persson & Werner, 2011)
  - Heat interface unit cost (DEA unit price estimates)
  - Operation & Maintenance Costs, incl. pumping (DEA)
  - Consider heat loss factor of 15% across the network
- Calculate heat production cost:
  - Central DH Plant (DEA and Sunstore/SDH estimates)
  - Individual heating systems
- Allow for a 20% cost differential for ‘customer switch’

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Heat distribution cost calculation based on Urban Persson, Sven Werner, 2011(*) and Stratego/EU Heat Roadmap (**)

$$C_d = \frac{a \cdot I}{Q_s} = \frac{a \cdot (C_1 + C_2 \cdot d_a)}{\left(\frac{Q_s}{L}\right)} \quad (€/GJ)$$

$$d_a = 0.0486 \cdot \ln(Q_s/L) + 0.0007 \quad (m)$$

$$w = 61.8 \cdot e^{-0.15} \quad (m)$$

a : annuity factor
C_1 : construction cost constant (€/m)
C_2 : construction cost coefficient (€/m2)
d_a : average pipe diameter (m)
L : total trench length (m)
Qs/L : linear heat density (GJ/m,a)

w : effective width (m) = A_L/L
e : plot ratio = A_B/A_L
A_B : building floor area
A_L : land area

Linear heat density: $Q_s/L = Q_s \times w / A_L$

(*) Persson U, Werner S, 2011. Heat distribution and the future competitiveness of district heating. Applied Energy 88 (2011) 568-576.
(**) Bernd Möller, Sven Werner, 2016. WP2, Background Report 6. Quantifying the Potential for District Heating and Cooling in EU Member States.

Relation between pipe diam. & cost of distribution pipes

Area characteristics	Plot ratio (e)	C_1 (€/m)	C_2 (€/m^2)
Inner city areas (A)	$e \geqslant 0.5$	286	2022
Outer city areas (B)	$0.3 \leqslant e < 0.5$	214	1725
Park areas (C)	$0 \leqslant e < 0.3$	151	1378

Persson U, Werner S, 2011

Excluding HIU, pumping, O&M

Bernd Möller, Sven Werner, 2016

C1 = 220

C2 = 4410

W = 65 m

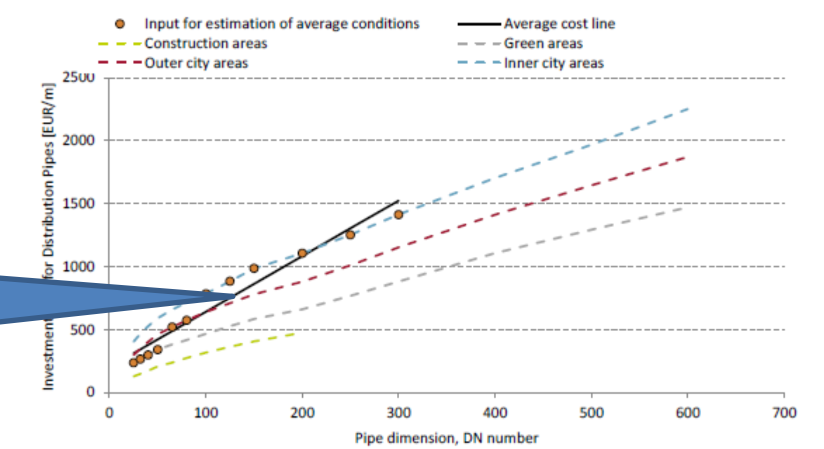

Figure 2: The investment cost for distribution pipes per trench length by pipe dimension and ground conditions based on Swedish experiences for the 2014 cost level. Conversion to EUR from SEK was based on the conversion rate of 9.1 SEK/EUR.

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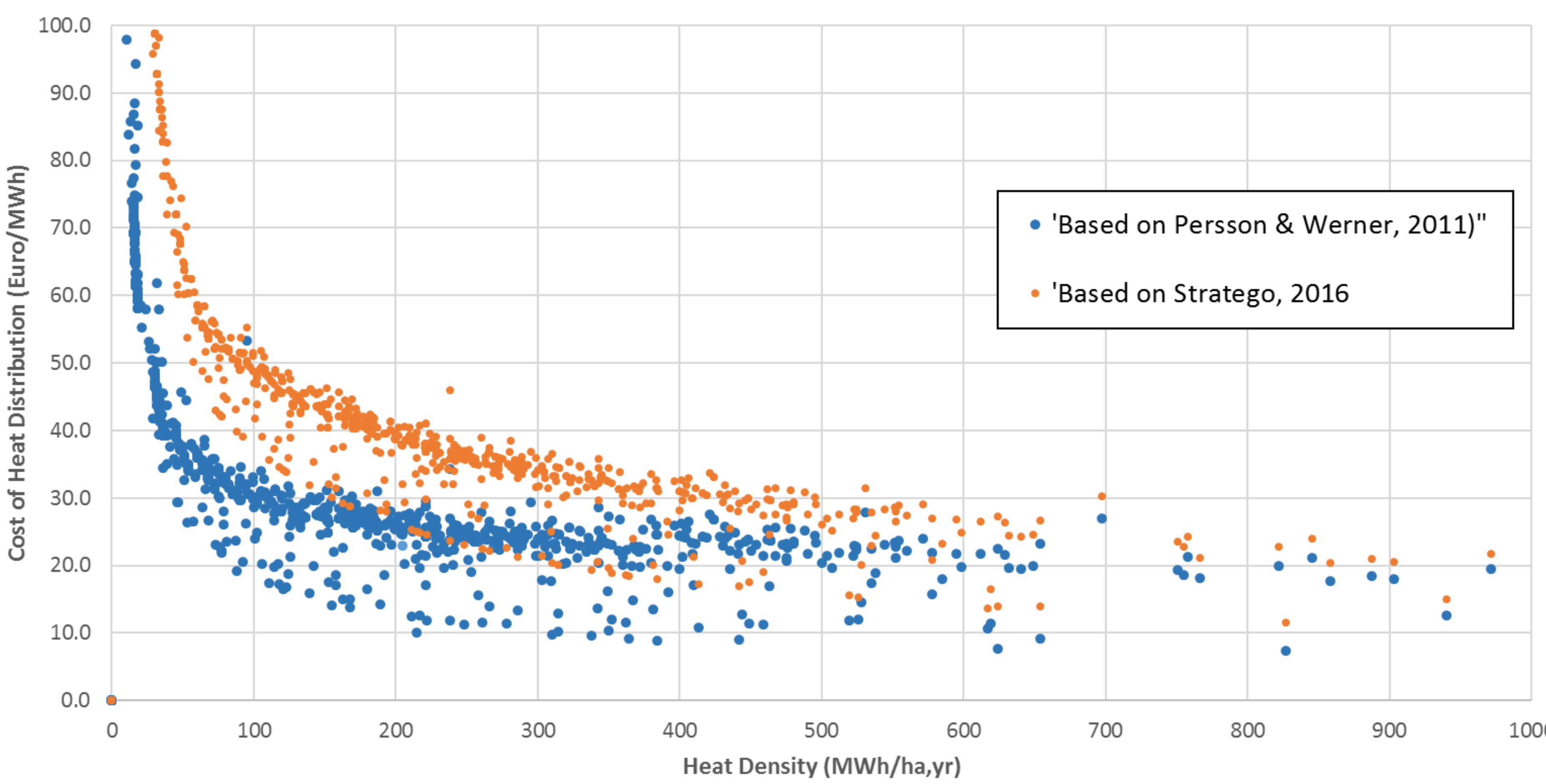
Relation heat density & heat distribution cost



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Benchmarking against individual heating systems (LCOE)

Individual Heat production options:	Cost of heat sold	-20% ‘discount’
	(€/MWh)	(€/MWh)
Oil Boiler	**103**	**83**
Pellet Boiler	131	105
Electrical Heating	155	124
ASHP	96	77
DH heat production options:	Cost of heat sold	≠ce with individual oil boiler – 20% discount
	(€/MWh)	(€/MWh)
Biomass Boiler	50	**33**
Heat Pump + Peak Oil	66	**17**
Biomass CHP + Peak Oil	34	**49**
Biomass Boiler + 20% Solar Thermal	52	**31**
Biomass Boiler + geothHP +solar (50%)	54	**28**

Maximum heat distribution cost for DH to be a compelling option

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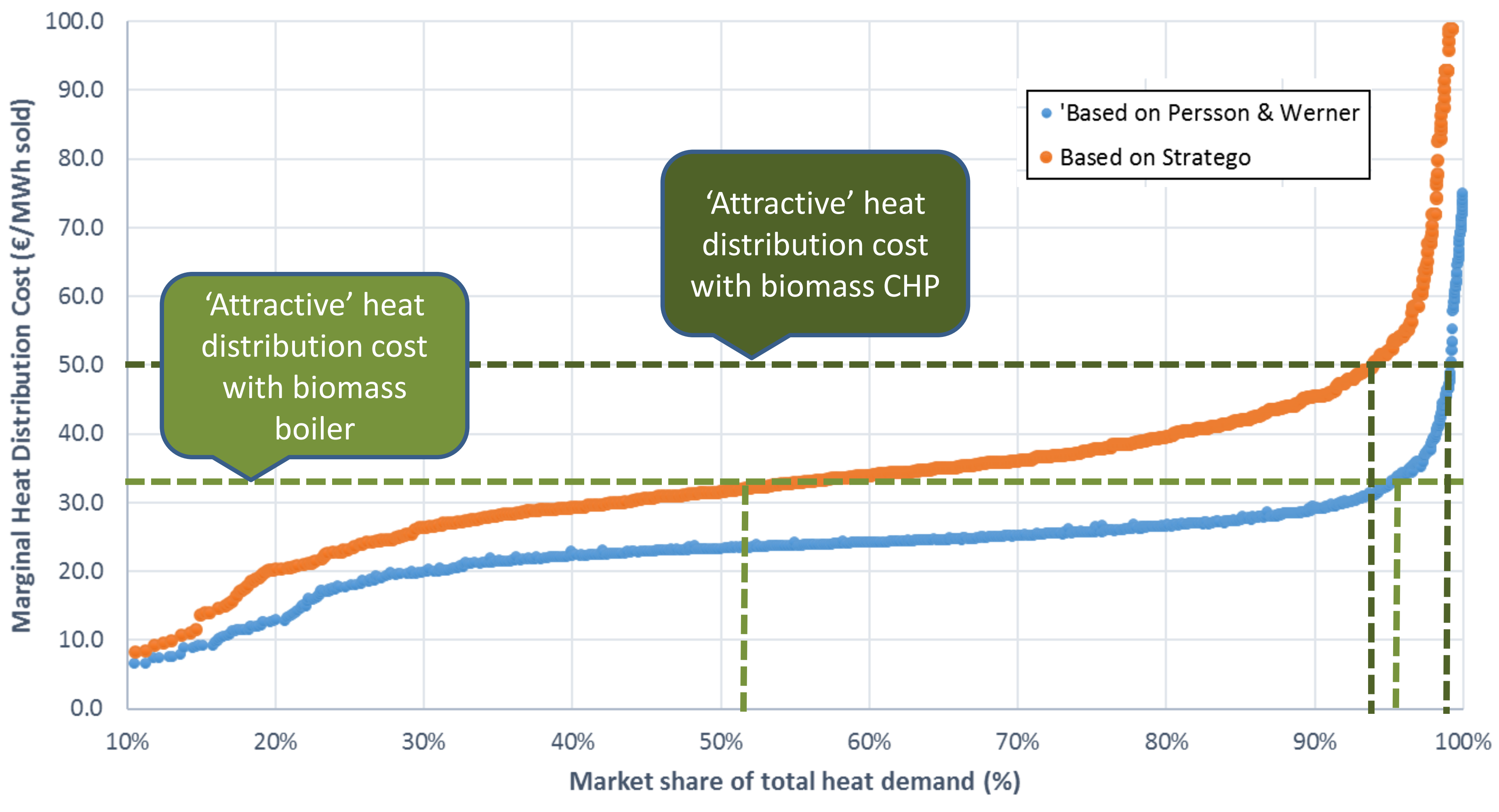
Potential for DH deployment



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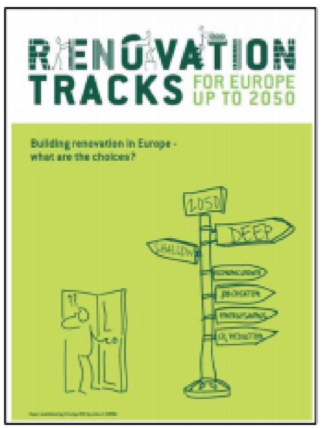
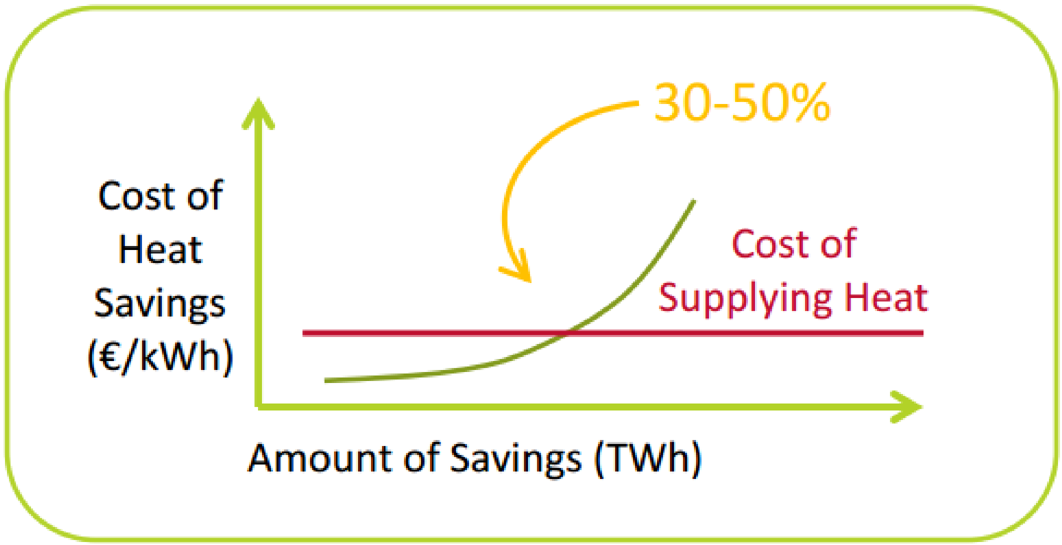
How Much Should We Save?

- We should implement heat savings until the price of sustainable supply is less than the marginal price of additional savings





Source: EU Stratego project & http://www.heatroadmap.eu/

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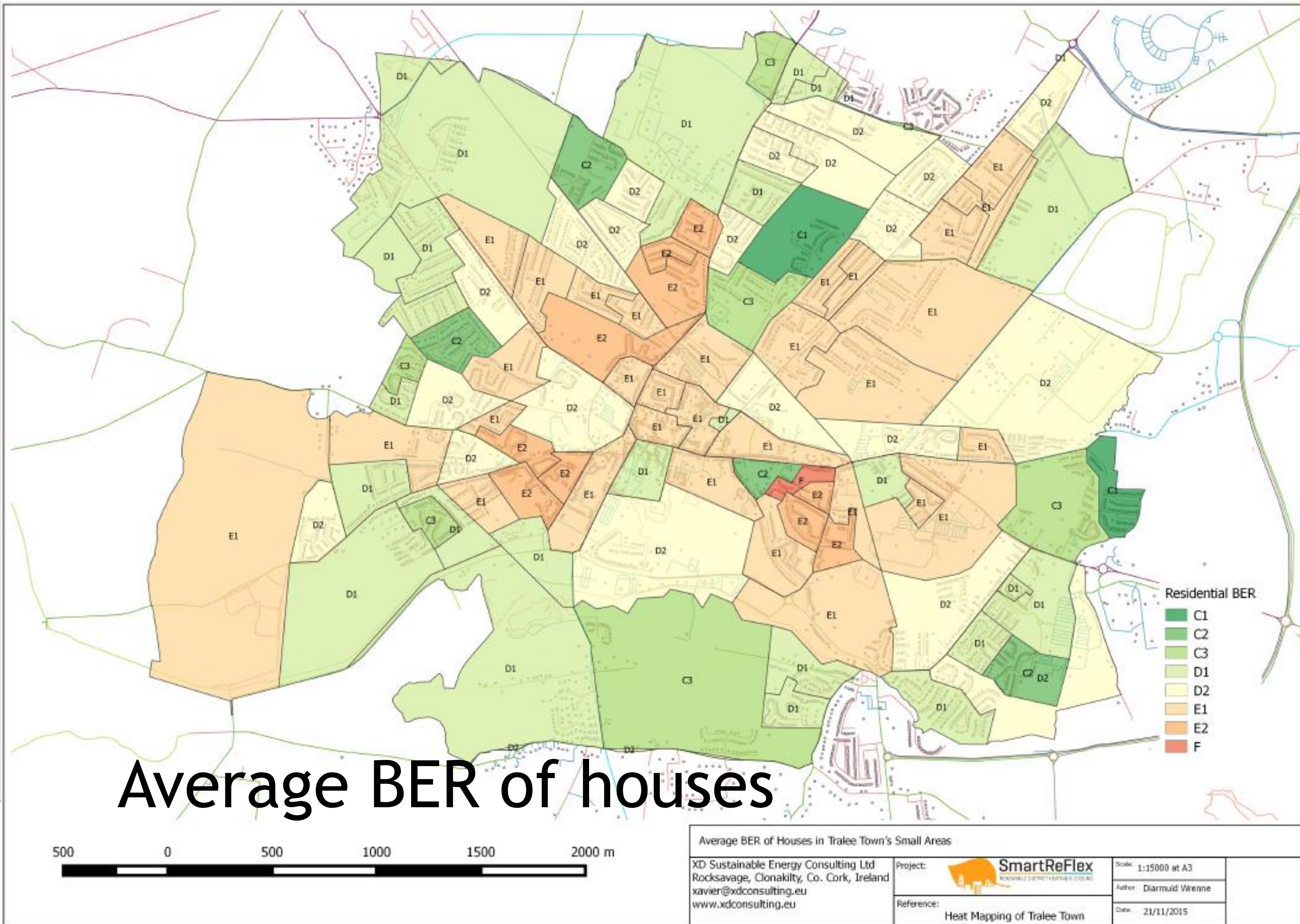
Average BER of houses

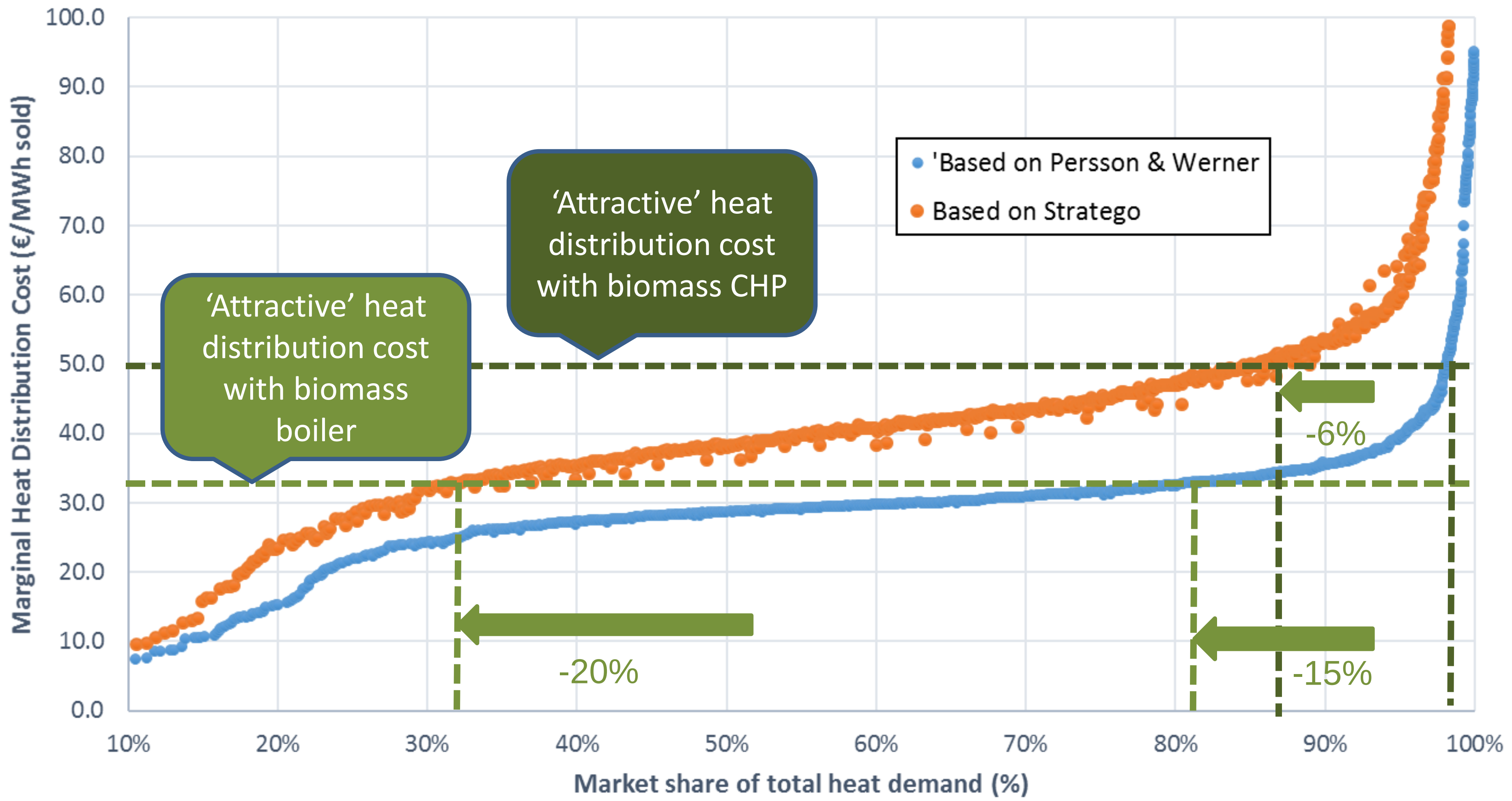


Cost of heat demand reduction

2.5 x more expensive than DH

Level of retrofit	**Shallow**	**Medium**	**Deep**
Levelised cost of heat demand reduction (cumulative)	73 euro/MWh	67 euro/MWh	195 euro/MWh
Potential for heat demand reduction (cumulative)	-14%	-22%	-33%
Retrofit Measures	Wall insulation (0.28) Roof insulation (0.15) Airtightness	Shallow retrofit + Efficient DHW cylinder Heating controls Pipework insulated	Medium retrofit + Windows (0.9) Doors (1.5) Walls (0.15) Efficient ventilation

Impact of 22% heat demand reduction



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Next Steps

- Spatial analysis of:
  - Heat demand reduction potential
  - RES-heat resources
  - Potential location of DH plants
- Design DH network for 3 scenarios of deployment levels

➢ Verify heat distribution costs

- Model RES-heat production systems with EnergyPRO

➢ Verify heat production costs

- Model different pathways to 100% RES system in Tralee

➢ Define 100% RES-heat deployment plan for Tralee

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Xavier Dubuisson Eng. MSc.
Managing Director
Tel: +353 86 0476124
Email: xavier@xdconsulting.eu
xavier.dubuisson

www.smartreflex.eu

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