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FACULTY OF MECHANICAL ENGINEERING AND NAVAL ARCHITECTURE

DEPARTMENT OF ENERGY, POWER AND ENVIRONMENTAL ENGINEERING

Innovation Fund Denmark

CITIES

"Smart Cities and Smart Islands in Croatia"

Asst. prof. Goran Krajačić, dipl. ing.

CITIES 5TH GENERAL CONSORTIUM MEETING

Fredericia

21/09/2018

- **University of Zagreb**
  - Founded in 1669
  - 73000 students
  - 8000 academic staff
  - 34 Faculties
  - Scimago Institutions Ranking: 9 EE (486)

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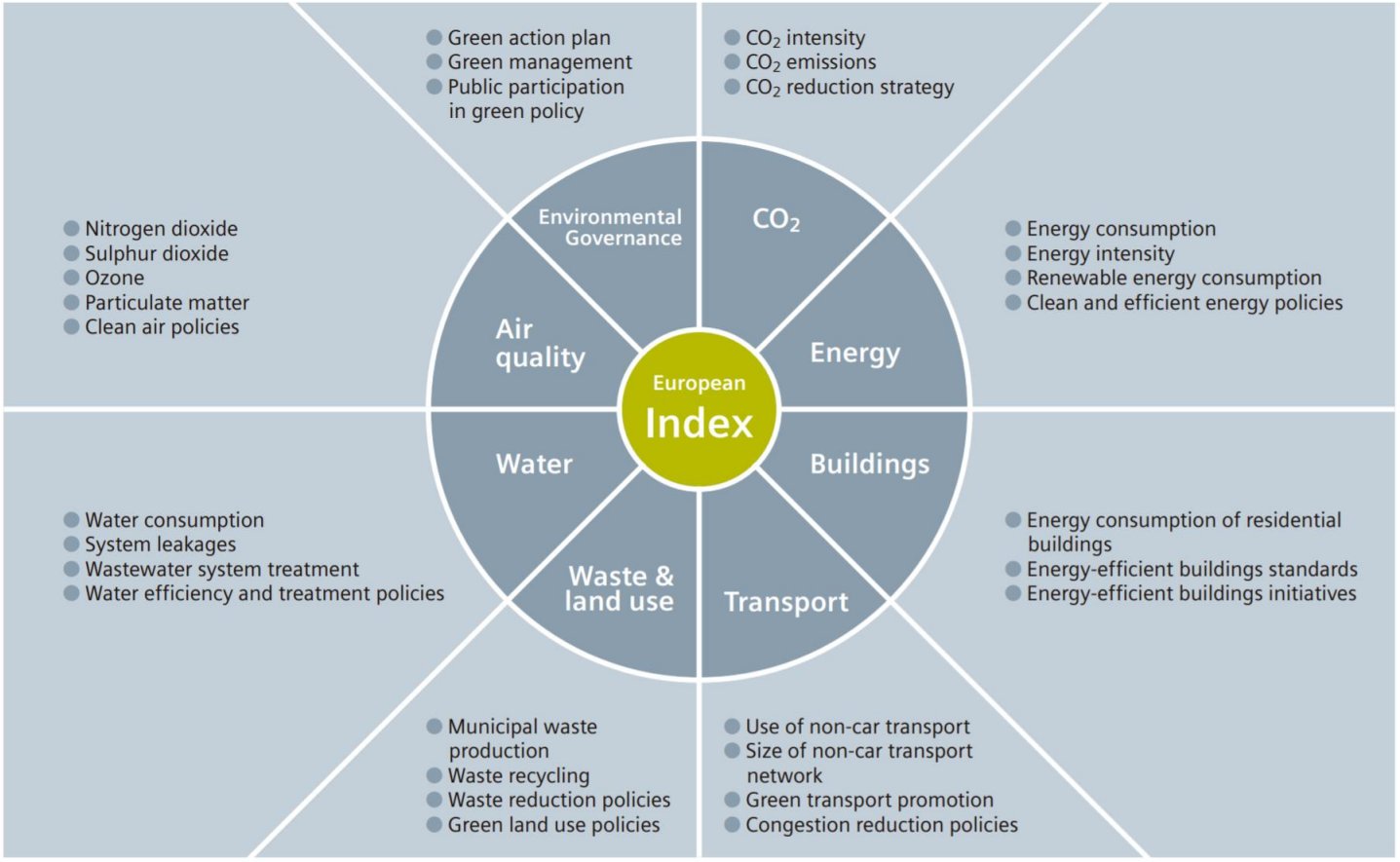
Faculty of Mechanical Engineering and Naval Architecture (UNIZAG FSB)

- 3 Study Programmes
- 14 Departments
- 40 Chairs
- 43 Laboratories
- 74 PhD students
- 234 Researchers
- 2500 Students

Smart phone
Smart TV
Smart Building?
Smart car?
Smart grid?
Smart thermal grid?
Smart gas grid?
Smart transport?
Smart energy system?
Smart city?
Smart politicians?
Smart government?
Smart people?

The Green City Index

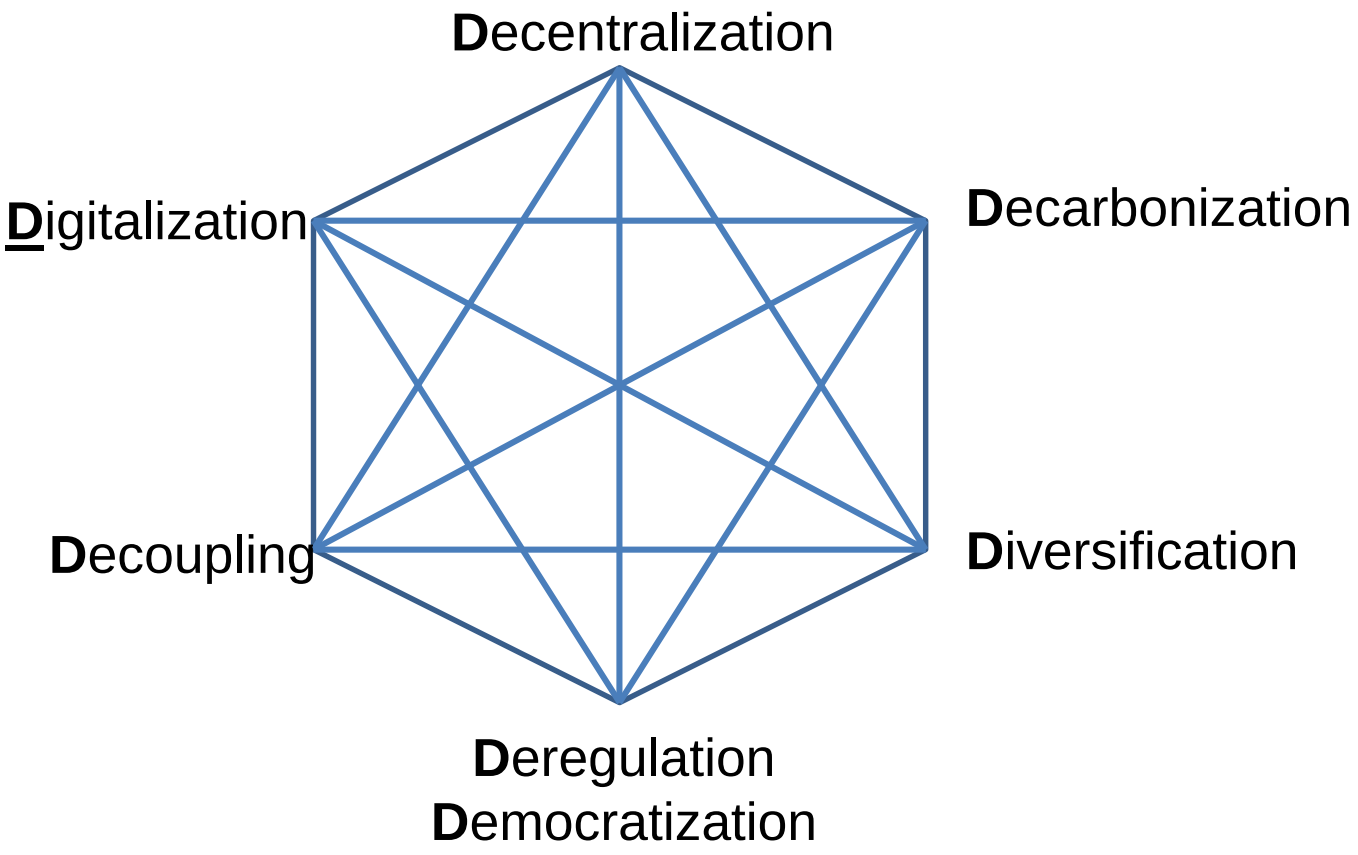


Rank	City	Score
1	Copenhagen	87.31
2	Stockholm	86.65
3	Oslo	83.98
4	Vienna	83.34
5	Amsterdam	83.03
6	Zurich	82.31
7	Helsinki	79.29
8	Berlin	79.01
9	Brussels	78.01
10	Paris	73.21
11	London	71.56
12	Madrid	67.08
13	Vilnius	62.77
14	Rome	62.58
15	Riga	59.57
16	Warsaw	59.04
17	Budapest	57.55
18	Lisbon	57.25
19	Ljubljana	56.39
20	Bratislava	56.09
21	Dublin	53.98
22	Athens	53.09
23	Tallinn	52.98
24	Prague	49.78
25	Istanbul	45.20
26	Zagreb	42.36
27	Belgrade	40.03
28	Bucharest	39.14
29	Sofia	36.85
30	Kiev	32.33

The European Green City Index evaluates 16 quantitative and 14 qualitative indicators. The methodology for Europe was adapted for the other regional Indexes

Source: the Economist Intelligence Unit, sponsored by Siemens

Smart cities support ENERGY TRANSITION



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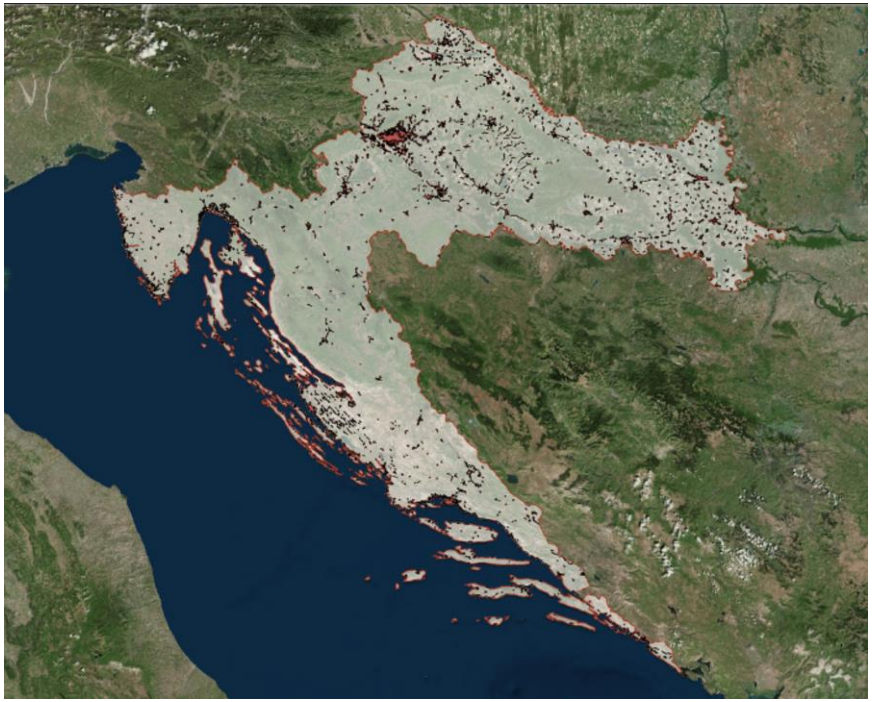

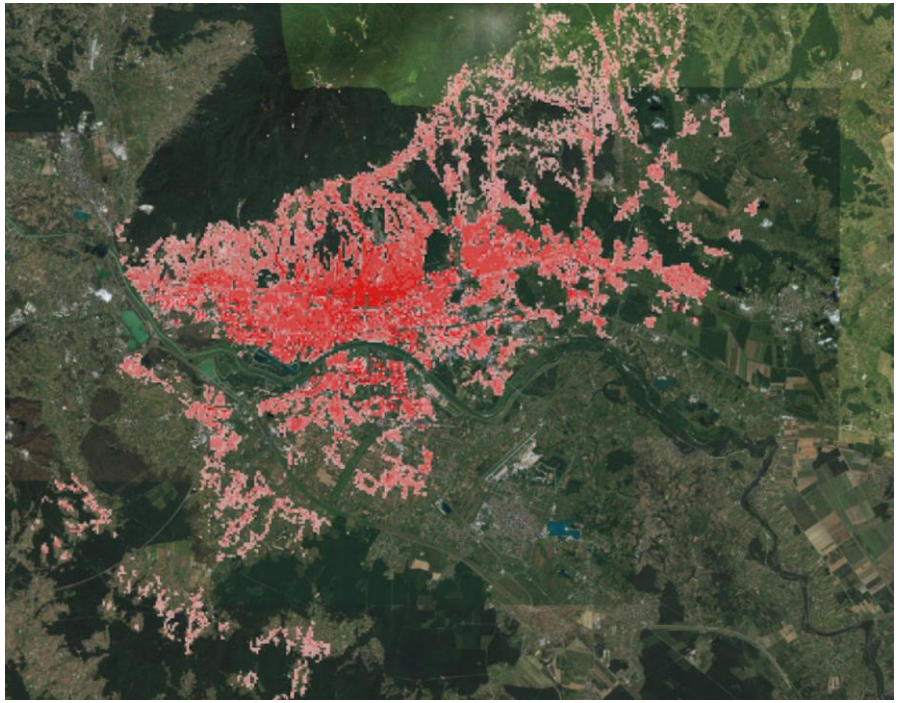

Smart Grid and Smart Cities in Croatia

SINCRO.GRID

- Most inovative project among 18 other in field of electric energy, smart grids
- Provide for more efficient use of existing electricity grid in Croatia and Slovenia
- Enable the existing infrastructure to accept larger quantities of electricity from renewable sources and ensure more reliable electricity supply
- Partners: HEP ODS, HOPS, ELES, SODO
- 79,5 mil. €
- https://www.sincrogrid.eu/en/About-the-project

3Smart

Smart Building – Smart Grid – Smart City

- 01.01.2017. – 30.06.2019.
- Lead partner: Faculty of electrical engineering and computing
- Budget: 3.791.343,41 €
- Technological and legislative setup for cross-spanning energy management of buildings, energy grids and major city infrastructures in the Danube region
- Energy management tool platform
- Manage energy exchange between buildings and distribution grid
- http://www.interreg-danube.eu/approved-projects/3smart

Smart Grid (Koprivnica)

- Siemens and HEP ODS
- First super fast self-renewing grid on a decentrelised system with communication protocol IEC 6185
- Time of grid reconfiguration after fault is less than 0,3 seconds
- Controllers set along the grid communicate in real time and make decisions about grid management without central system
- Siemens system FLISR (Fault Location and System Restoration)
  - Recognises and isolates fault
  - Reconfigures grid and power supply in less than 0,3 seconds
- First step toward completely autonomus systems with artificial intelligence in Smart Grid technologies

Iskrameco and HEP ODS agreement

- Modernization of electricity distribution network
- Smart metering solution
- integration of SEP2W Head-End system for meter data collection and processing into the utilities
- Optimised metering processes enable better monitoring of metering data and allow HEP ODS to perform demand response
- Equip the entire network with smart meters by end of 2030
- http://www.iskraemeco.com/en/news/iskraemeco-and-croatian-hep-ods-join-forces-smart-grid-implementation/

HEP investments in Smart Grid

- European Regional Development Fund Grant Agreement
- 230 million HRK to be invested in Smart Grids by 2022
- digitalization of a part of electricity distribution network in Croatia
- Implementation of advanced measuring infrastructure
- Monitoring of electricity consumption
- Automated medium – voltage network
- http://www.hep.hr/hrk-230-million-to-be-invested-into-smart-grids-by-2022/3356

Smart Lightning

Dubrovnik

- Public lightning control
- more than 100 replaced lighting in the three main streets
- Savings on light up to 90%
- LED lamps

Samobor

- Safer and more effective traffic
- LED lamps on roads and streets
- 1170 new lamps

Smart Mobility

Koprivnica

- CIVITAS DYN@MO
  - 1,48 mil. €
  - Public transport planning
  - Decarbonization
  - Program for public electric vehicle usage
  - http://civitas.eu/content/dynmo

Dubrovnik

- Smart parking application
- People counter and flow tracker
- GreenGoDubrovnik - sharing system for electric vehicles in Dubrovnik
  - 100 electric scooters up to 5 kW in network of 16 stations in city center
  - Zero emissions
- Traffic security and energy efficency

Smart City Decarbonization

Koprivnica

- LOW CARB
  - 221 000 €, 36 months
  - Sustainable mobility education
  - Multimodal station – combines photovoltaic system, energy storadge and electric vehicle charger
  - https://www.interreg-central.eu/Content.Node/LOW-CARB.html

Features of energy planning model for the smart cities

- Capable of analysis of the interdependency between the different layers of the energy system, including the physical-environmental, social, market and data layers

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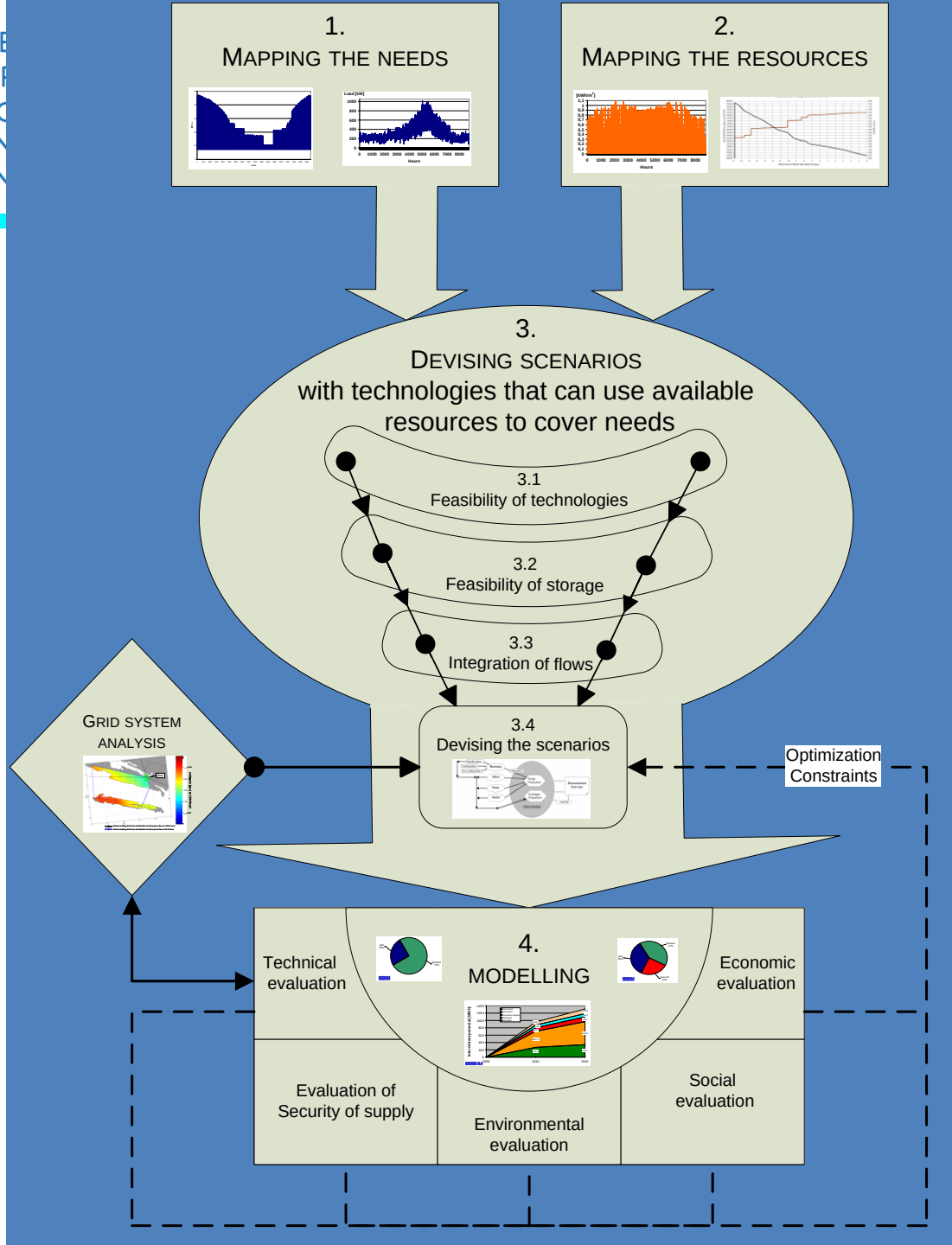
RenewIslands/ADEG METHODOLOGY

1. Mapping the needs
2. Mapping the resources
3. Devising scenaria with technologies that can use available resources to cover needs
4. Modelling the scenaria



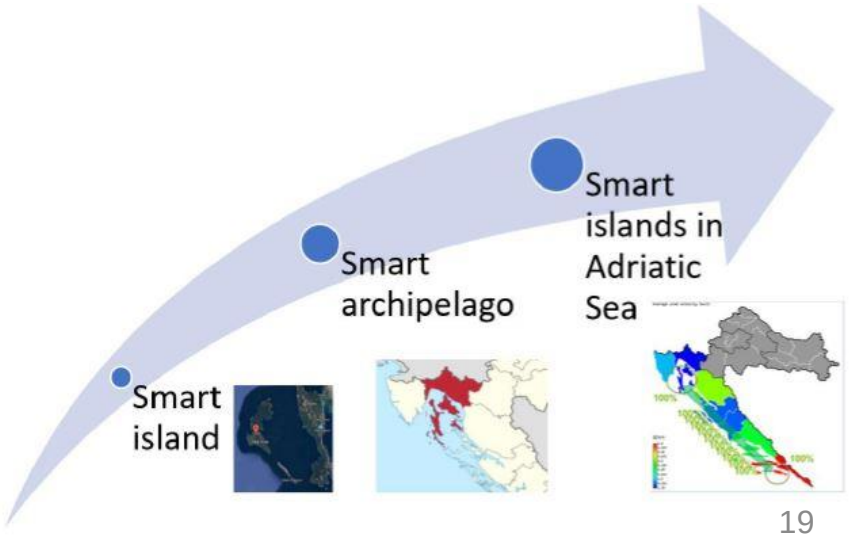
New RenewIslands project financed by HRZZ from 01.09.2018

- Development of method for automatic selection of potential superstructures using programming tool Python
- RenewIslands method implementation
- Analysis and valiadation of indicators for mapping resoruces and needs, technologies, markets and financial mechanisms
- Superstructure optimization in Python
- Valiadation of created method by compering it to existing SE(C)AP scenarios and strategies

Smart Islands in Croatia

Smart Islands Initiative www.smartislandsinitiative.eu

- Take action to mitigate and adapt to climate change and build resilience at local level
- Trigger the uptake of smart technologies to ensure the optimal management and use of our resources and infrastructures
- Move away from fossil fuels by tapping our significant renewables and energy efficiency potential
- Introduce sustainable island mobility including electric mobility



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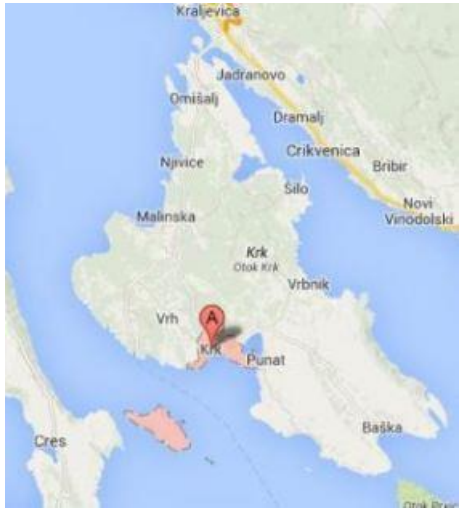
The formal signing of the Smart Islands Declaration in the EU Parliament on March 28, 2017

REGIONALNA ENERGETSKA AGENCIJA KVARNER

The Krk Island



- Krk in numbers:
  - 19 383 inhabitants
  - City of Krk joinned Covenant of Mayors in 2011
  - CO2 reduction target of the city is 20% by 2020
  - CO2 free island by 2030
- Forseen activites in the next 20 years:
  - Installation of about 36.8 MWp of new PVs on rooftops
  - 4 MWp of PV on the ground
  - 25.2 MW of wind power
  - 250 kWel in biogas plants

- Smart Island Krk

The island of Mljet

- Finished projects on Mljet
  - Charging statitons for the electric vehicles
  - Electric vehicles
  - PHEV
  - Electric bikes
  - Two electric trains
  - Energy independent tourist block
- Future projects
  - 41,5 photovoltaic rooftop system
  - Charging stations on the docks
  - 3 electric boats (PV)

iCat
INTEGRATED SOLUTIONS

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F +385 1 5506473

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Decarbonising energy systems of geographical Islands

Horizon 2020
Call: H2020-LC-SC3-2018-2019-2020
(BUILDING A LOW-CARBON, CLIMATE RESILIENT FUTURE: SECURE, CLEAN AND EFFICIENT ENERGY)
Topic: LC-SC3-ES-4-2018-2020
Type of action: IA
Proposal number: SEP-210510484
Proposal acronym: INSULAE
Deadline Id: H2020-LC-SC3-2018-ES-SCC

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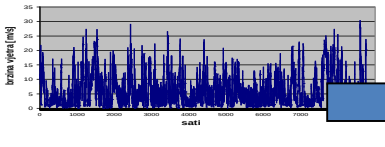
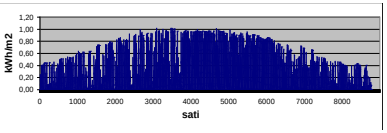
H_2RES MODEL v2.8

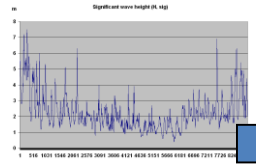
Developed by:

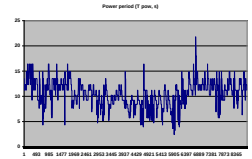
FSB

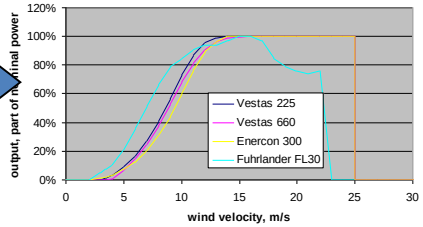
INSTITUTO SUPERIOR TÉCNICO





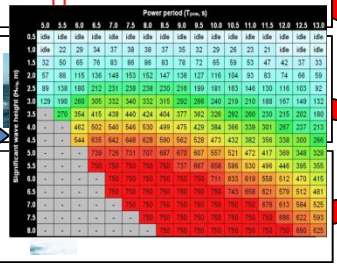






GRID

SOLAR



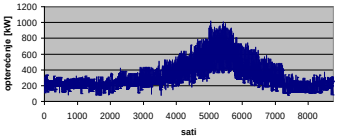
GEO-THERMAL

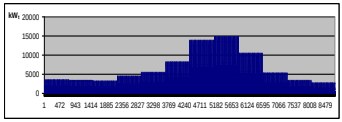
BIOMASS

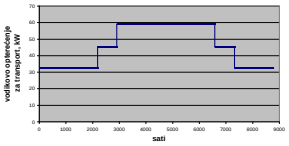
FOSSIL FUELS

LOAD

- Power
- Hydrogen
- Water
- Heat



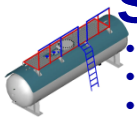




DESALINATION

STORAGE

- Hydrogen
- Reversible hydro
- Batteries
- Heat



Unije

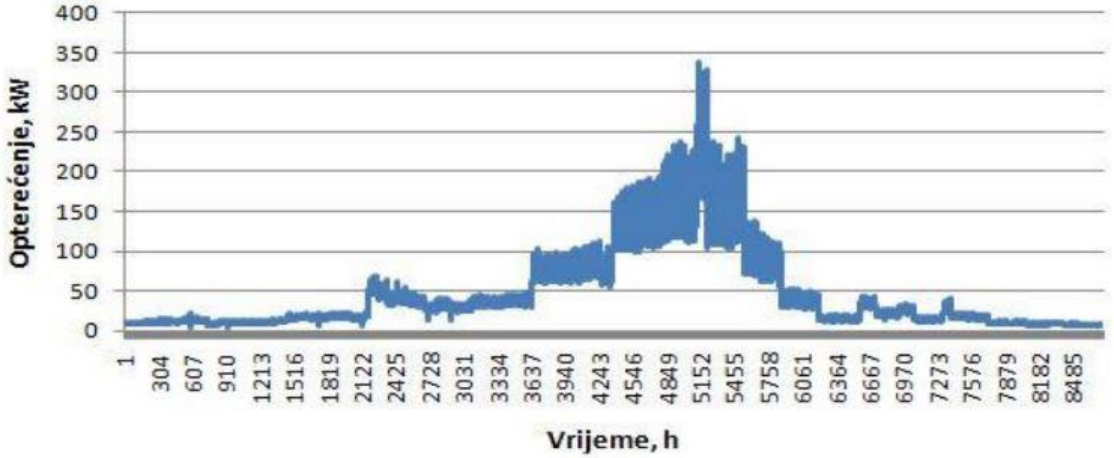
- Pilot project of Unije first energy independet island in the Adriatic Sea
  - Key activities:
    - Solar PV Plant 1 MW – source of electric energy for desalination
    - Energy-efficient public lightning
    - Thermal solar collectors on buildings
    - The biogas plant
    - Desalinization plant with its own photovoltaic system

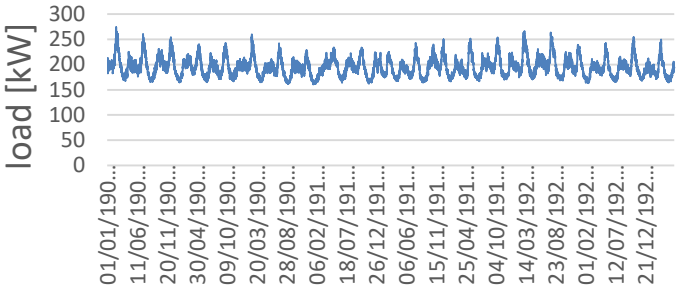
Electricity consumption on the Island of Unije
kWh

Year	Public lighting	Services and municipal sector	Households	Telecomunication	Total
2010	48125	93374	410985	36104	552484
2017	14886	57177	371745	51011	443808

		Specific electricity consumption	Electricity consumption
Goats	Milk production	0,1 kWh/l	35000 kWh
	Chees production	5,6 kWh/t	28 kWh
Sheeps	Chees production	300 kWh/t	1500 kWh
Beef	Meet production	250 kWh/t	1250 kWh
Olives	Oil production	8 kWh/l	560000 kWh
		Total	**597778 kWh**

Unije – Power System Load



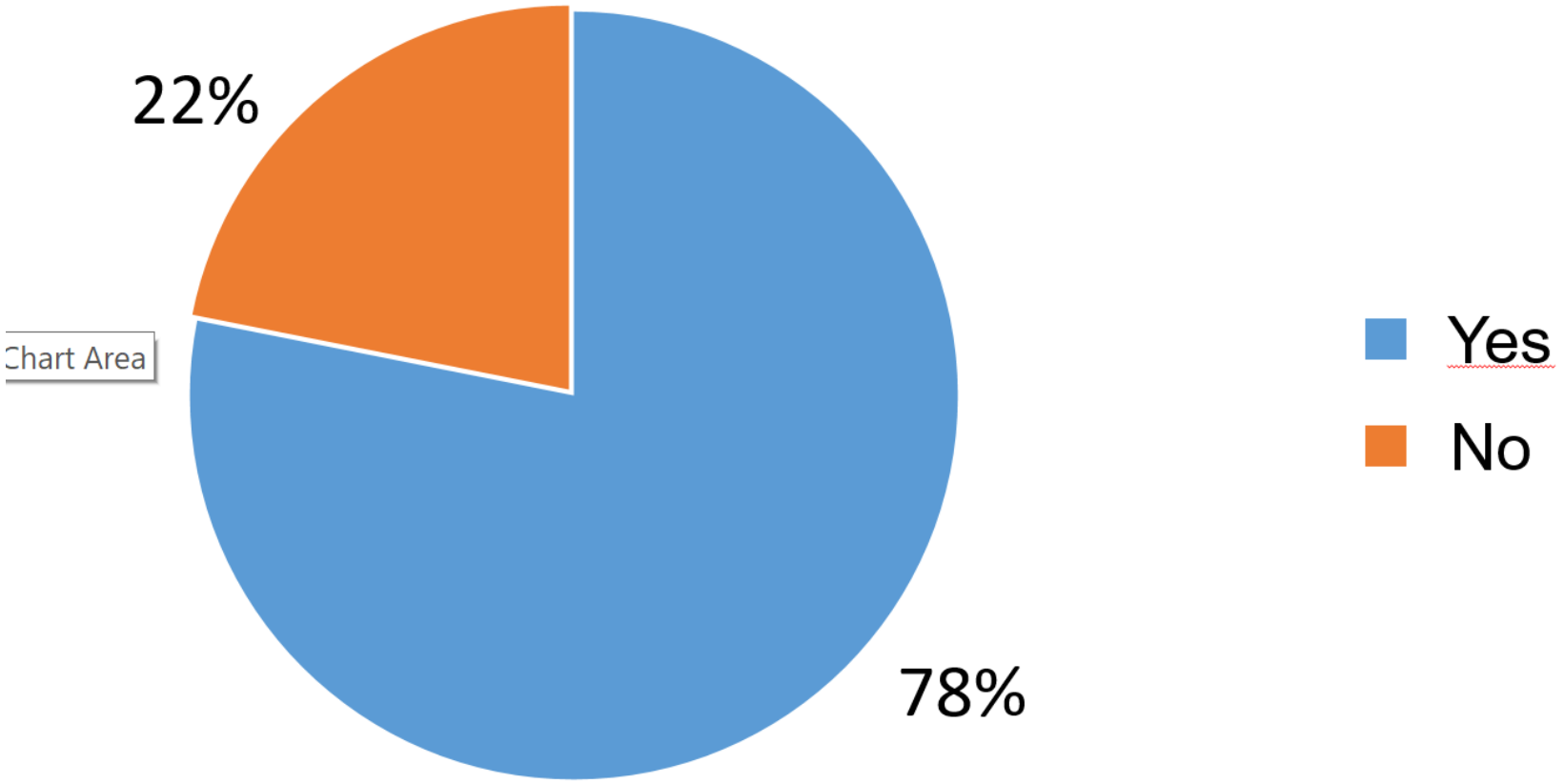


- Scenario „100% RES” in 2030
  - Solar heat: 192 kW
  - Hot water storadge: 45 m^3
  - PV: 3 MW
  - Batteries: 5 MWh
  - Wind: 500 kW

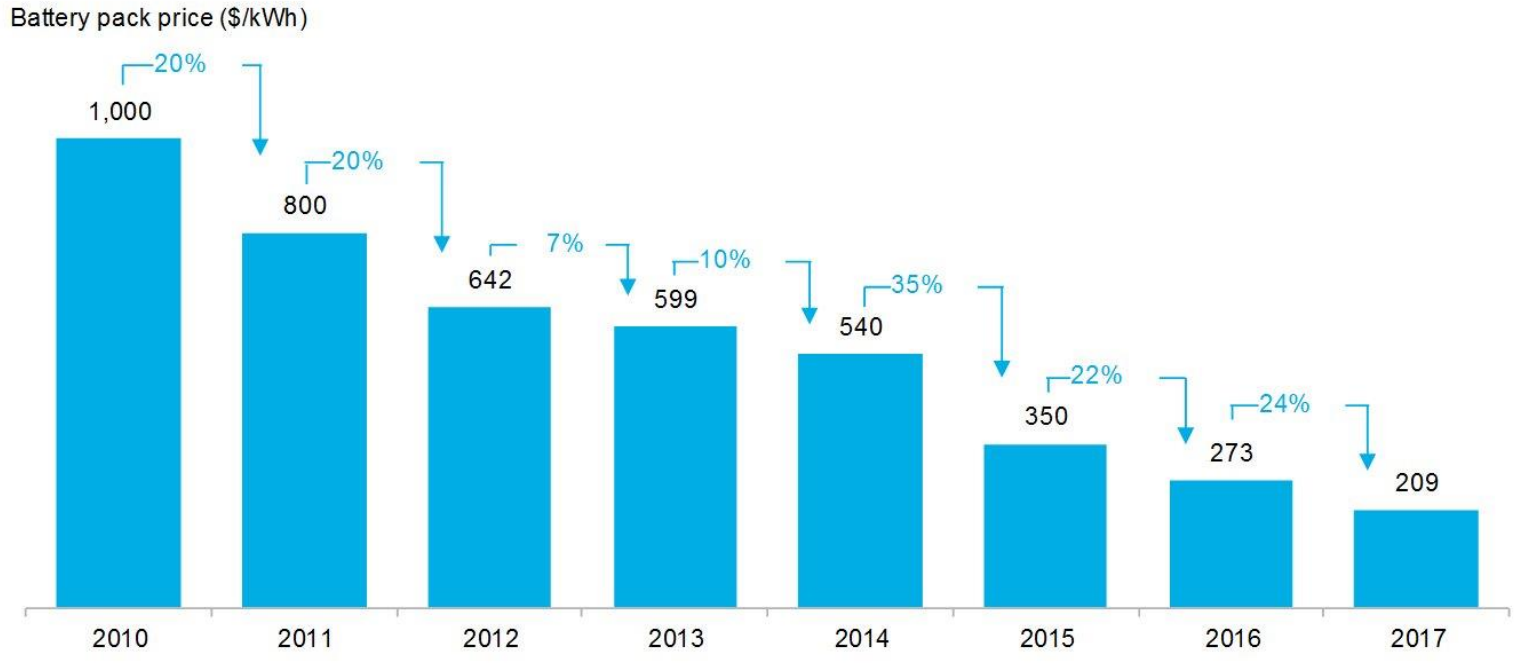
Unije – PV +wind scenario

Year	RES capacity			RES share	
	PV , kW	Solar heat, kW	Wind, kW	Electricity, %	Heat for DHW, %
2011	27	26,4	0	6	25
2020	42	33,6	50	12	25
2030	67,5	33,6	150	19	21

The island of Unije „Interestead for Energy production in an energy cooperative”?



BNEF EV lithium-ion battery pack price survey results



Source: Bloomberg New Energy Finance. Pack level pricing. Weighted average of BEV and PHEV packs

Battery cost to move 1 kWh from noon to midnight?

Capacity	1 kWh	
Cost	209	$/kW
Lifetime	10	year
Capital cost	5%	
Yearly cost	27.07	$
Daily 1 kWh	365	kWh
LCOE for 1 kWh	0.07	$/kWh
LCOE for 1 kWh	0.48	kn/kWh

year	2017	2018	2019	2020	2021	2022	2023	2024	2025
$/kWh	209	167	134	107	86	68	55	44	35
$/kWh	0.07	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01

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ERICSSON

Ericsson Nikola Tesla d.d.

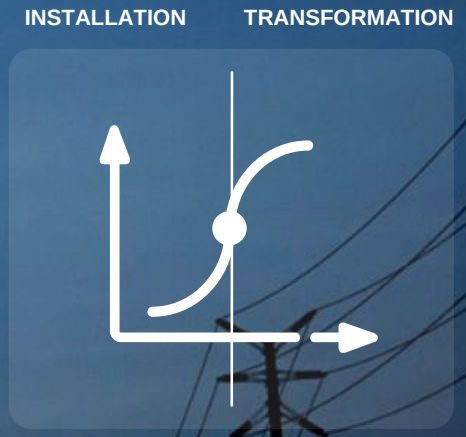
Future is here …

TECHNOLOGIES BEHIND SMART ISLANDS

At an inflection point

5G + IoT + Cloud

The 5th technological revolution



5G – The Networked Society Platform

CONVERGED INFRASTRUCTURE

Hiding heterogeneity and complexity

Combined radio, transport and compute

AUTOMATED & PROGRAMMABLE

Bootstrapping a slice within minutes

Programmability at all layers

5G

INTEGRATED MACHINE INTELLIGENCE

Powering network and external applications, within low-latency control loops

PERFORMANCE FEATURES THROUGHOUT THE SYSTEM

Supporting highly diverse and demanding application requirements

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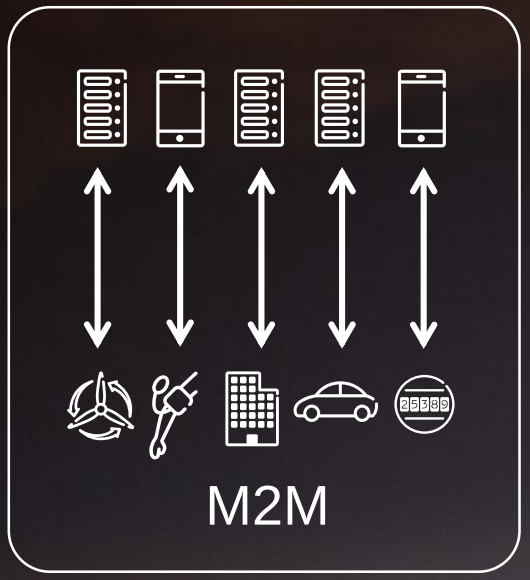
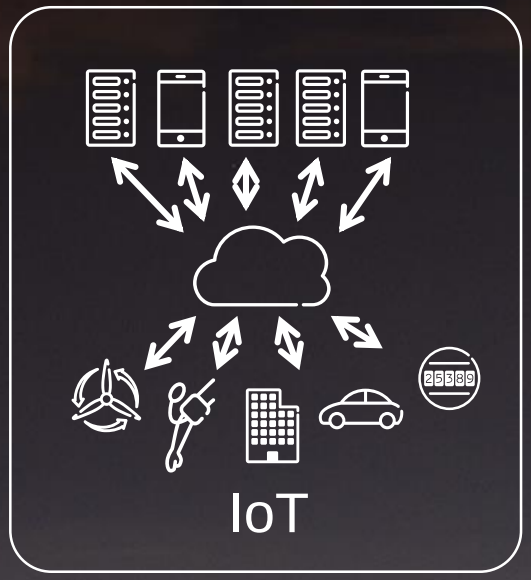
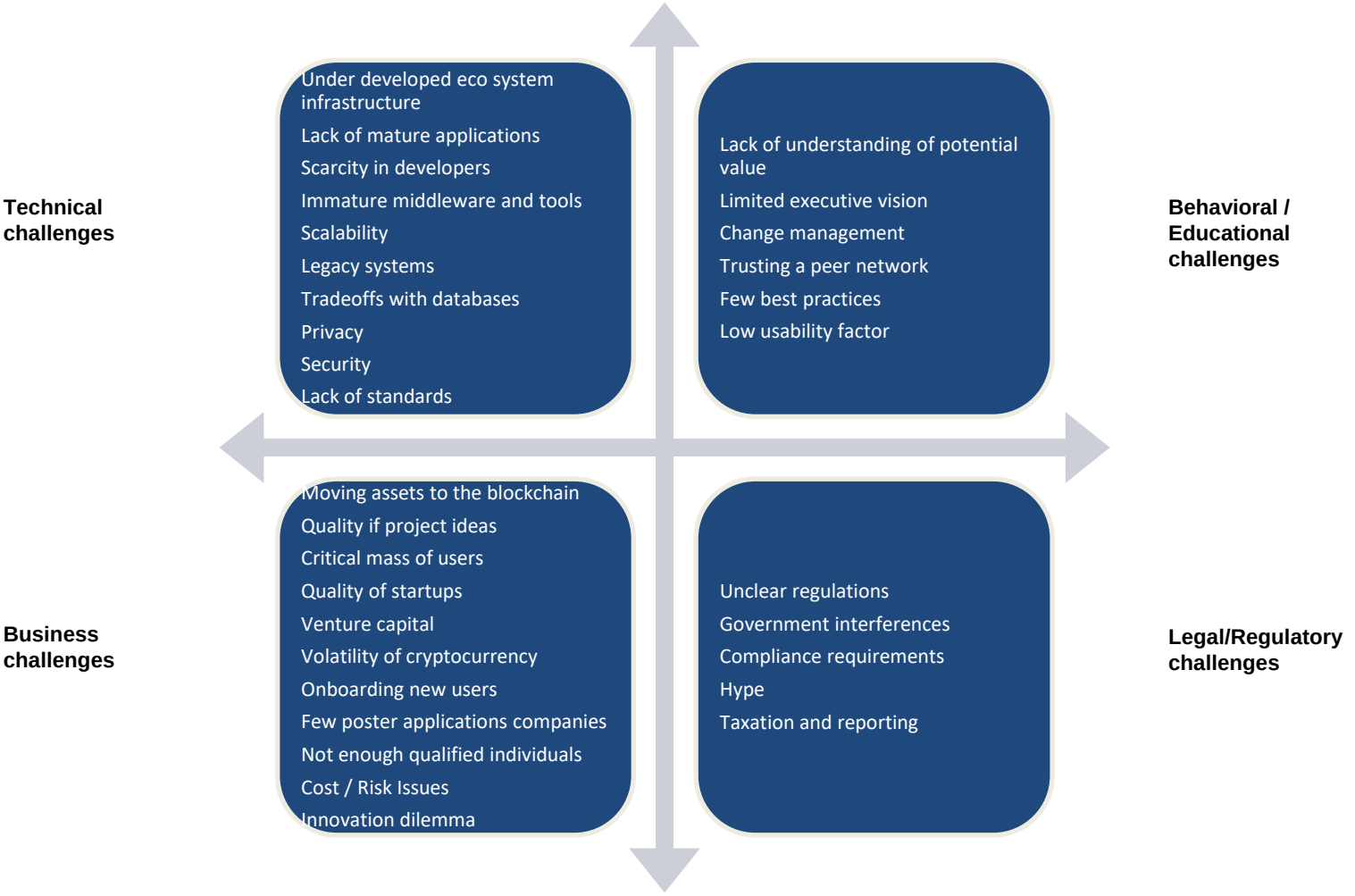
Transformation within IoT





- Horizontal platform for vertical applications
- Open environments
- Data centricity
- Easy access as a Service
- Business focused innovation

Blockchain Matrix, adaption of needs – Smart Islands Case



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UNIVERSITAS STUDIORUM ZAGRABIENSIS MDCLXIX

13th sdewes Conference Palermo 2018

September 30 - October 4
Palermo, Italy

14th sdewes Conference Dubrovnik 2019

October 1 - 5, 2019
Dubrovnik, Croatia

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THANK YOU FOR YOUR ATTENTION!

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Other projects

http://het.hr/

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CoolHeating.eu

Beyond Energy Action Strategies BEAST

2050 Heat Roadmap Europe A low-carbon heating and cooling strategy

Bin2GRID

AGROCYCLE for a circular economy

fosterREG

Interreg Mediterranean PRISMI

KeepWarm – Improving the performance of district heating systems in Central and Eastern Europe

Phoenix Project (H2020-MSCA-RISE-2015)