AI for Energy Sustainability

Promoting Green Energy Through AI

AI4SB

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Local AI

Source : **2023 report by the Boston Consulting Group (BCG) and Google**

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Local AI

Startup Overview

Our Mission:

❖ Promote Sustainability with the power of AI

Our Background:

❖ motivated Engineers with MSc and PhD studies in the field of Artificial Intelligence

Our Experience:

❖ Awarded and finalized EU funded projects in the field of Sustainable AI

Field	Action	Readiness	Support
Electric Mobility	EV charging network roll-out optimization	TRL7 to TRL9	CNROpt project (funded by i-nergy)
EVs & Energy Consumption	Smart EV charging session planning	TRL7 to TRL9	AI4CS project (funded by Interconnect)
Forest Surveillance	AI based forest health/thickness assessment by drone video	TRL7-TRL9	AI4FS project (funded by ImagineB5G)

Related Work:

❖ AI4CS Project – AI powered EV charging recommendations optimizing AVG waiting time and promoting grid load balance at the same time

Our Presence:

❖ Member of Smart Attica DIH

❖ Supporting the participation of Kalamata in the NetZeroCities EU Mission

SMART ATTICA European Digital Innovation Hub

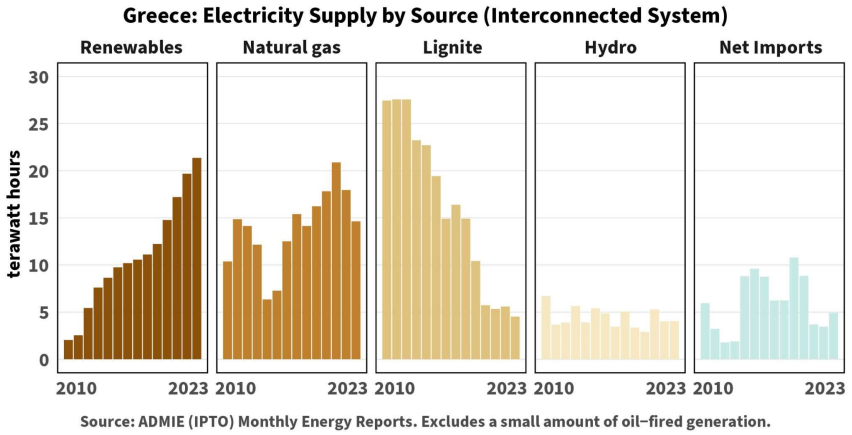
NET ZERO CITIES

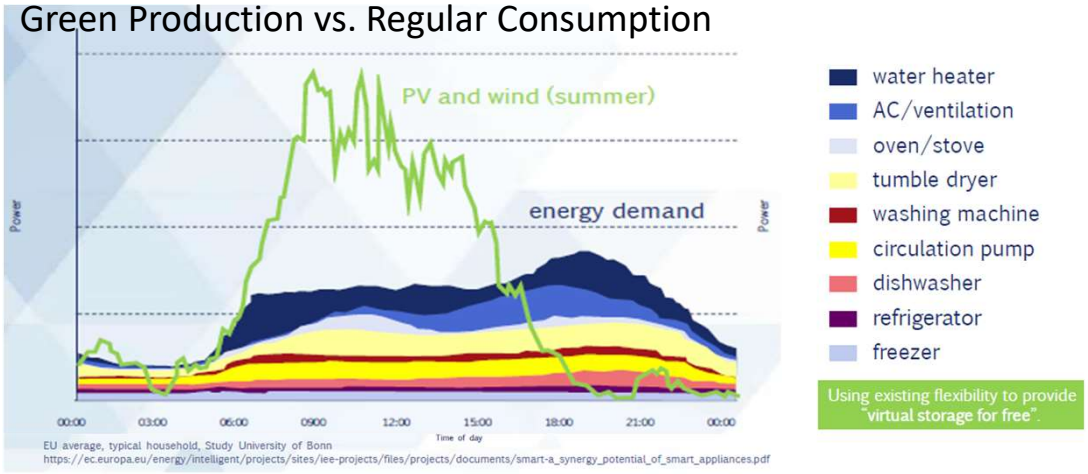
KALAMATA

Challenge: After Reaching 50% Green Electricity the next 50% will require smart real-time energy management from the consumer side

- ✅ -87% generation from lignite (vs. 2005)
- ✅ 2x solar + wind capacity vs. 2019
- ✅ 48% of power from wind + solar (2M 2024)
- ✅ 4th in wind + solar penetration in the EU (2023)
- ✅ 2x investment in grids (vs. 2015-18)
- ✅ 11.3% EV market share (vs. 0.4% in 2019)
- ✅ 250 new electric buses for Athens + Thessaloniki

Source: Delphi Economic Forum April 2024



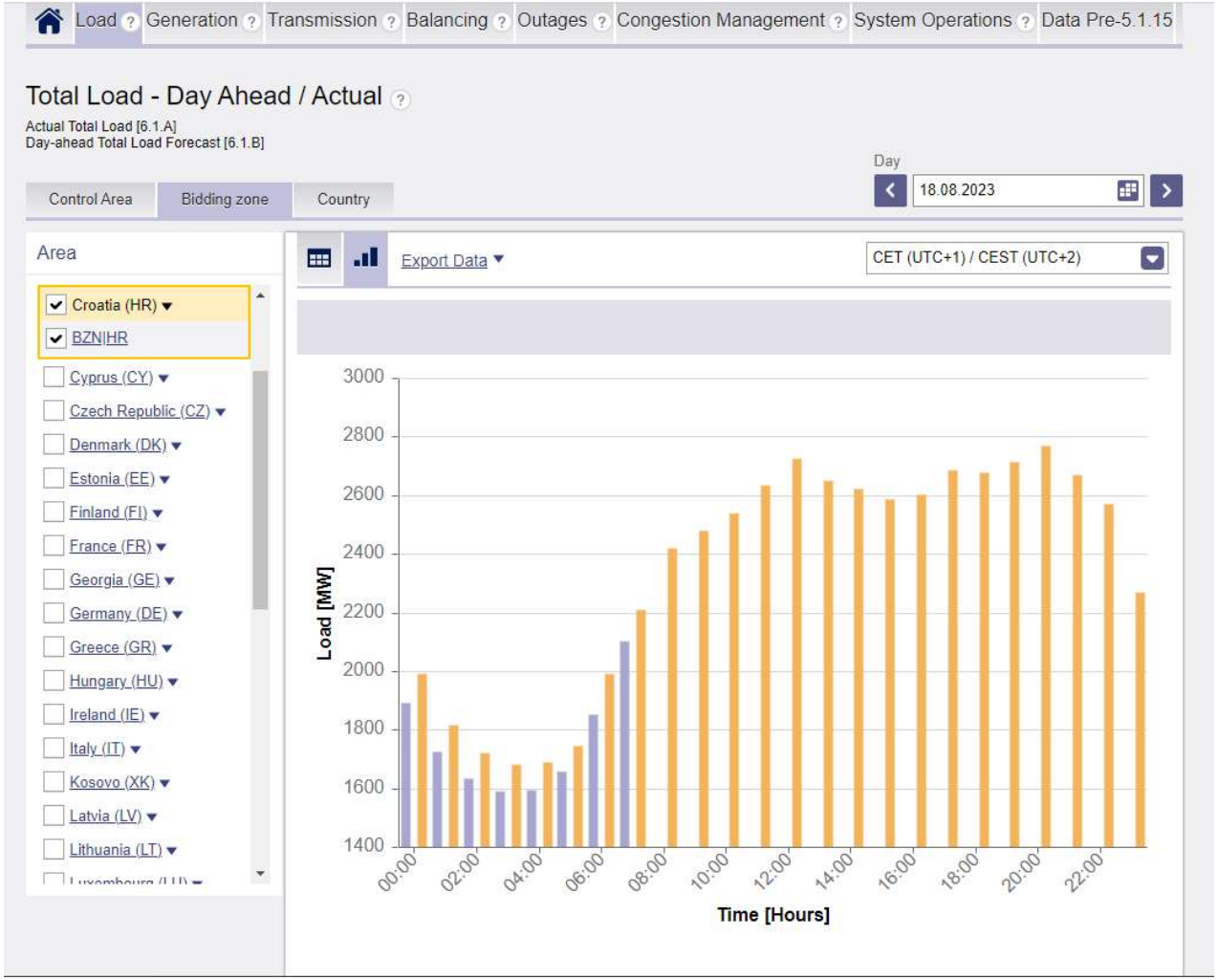


ENTSO-E transparency platform

Data Source

Price & Load Prediction

Already Established Access Via InterConnect

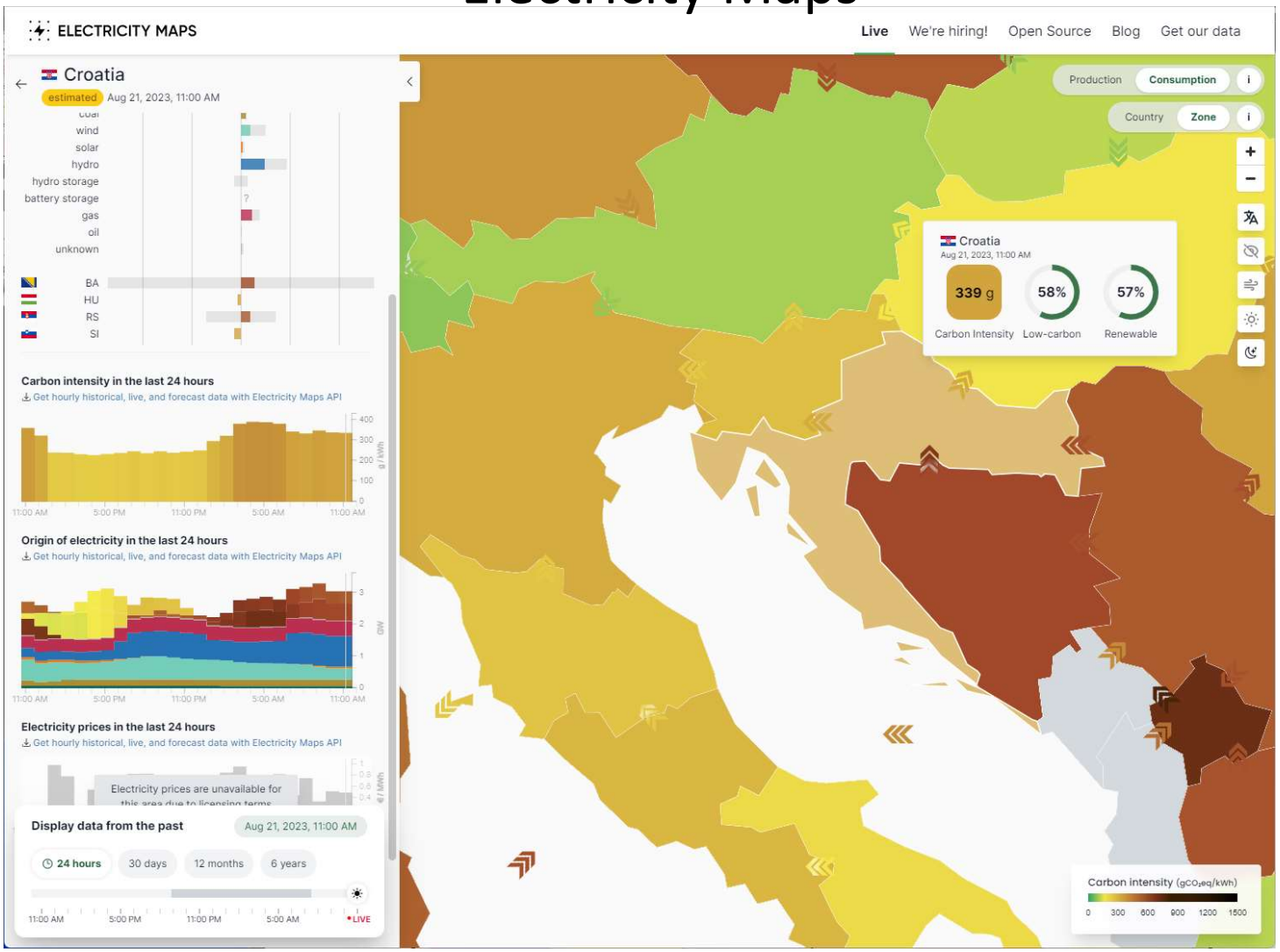


Electricity Maps

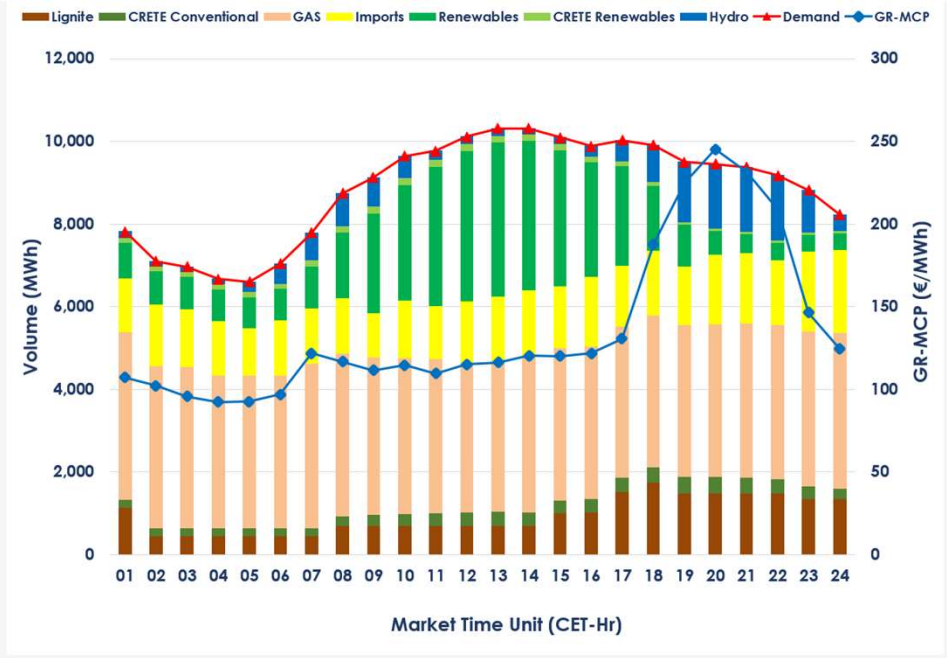
Data Source

Green Production

Already Established Access Via InterConnect



Opportunity: Equip Municipal Buildings with battery storage that can temporarily substitute electricity supply at expensive timeslots



Daily Production – Consumption – Price
Peak price@20:00 is >2x price@04:00
Peak value coincides with minimum Renewables in the Energy Mix

Source : Greek Energy Exchange – enex https://www.enexgroup.gr/

Modelling Electricity Bill Savings Potential in Buildings

Greek Market Attractiveness: >9% Internal Rate of Return* Ranked 4th best in Europe

Standalone Electric Energy Storage System (2h Capacity): 9%-12% IRR

Legal Framework: N129/4.7.2022

Combined PV & 2h EESS	Savings
IRR	>12%
CAPEX	-12% vs. standalone PV
OPEX	-10% vs. standalone PV

Legal Framework: ΦΕΚ 4685/2020

Renewable Energy production 12GW@2024 → 20.6GW @ 2030
Flexibility in the Consumption Side is a Must!

Energy Performance Rate: 86%, Response time <1s

*Reference Data Source : Aurora Energy Research European Battery Markets Attractiveness Report - February 2024

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AI4CS

AI for Charging Stations

AI4CS

Testimonial

Kostas Vlachodimitropoulos
Local AI

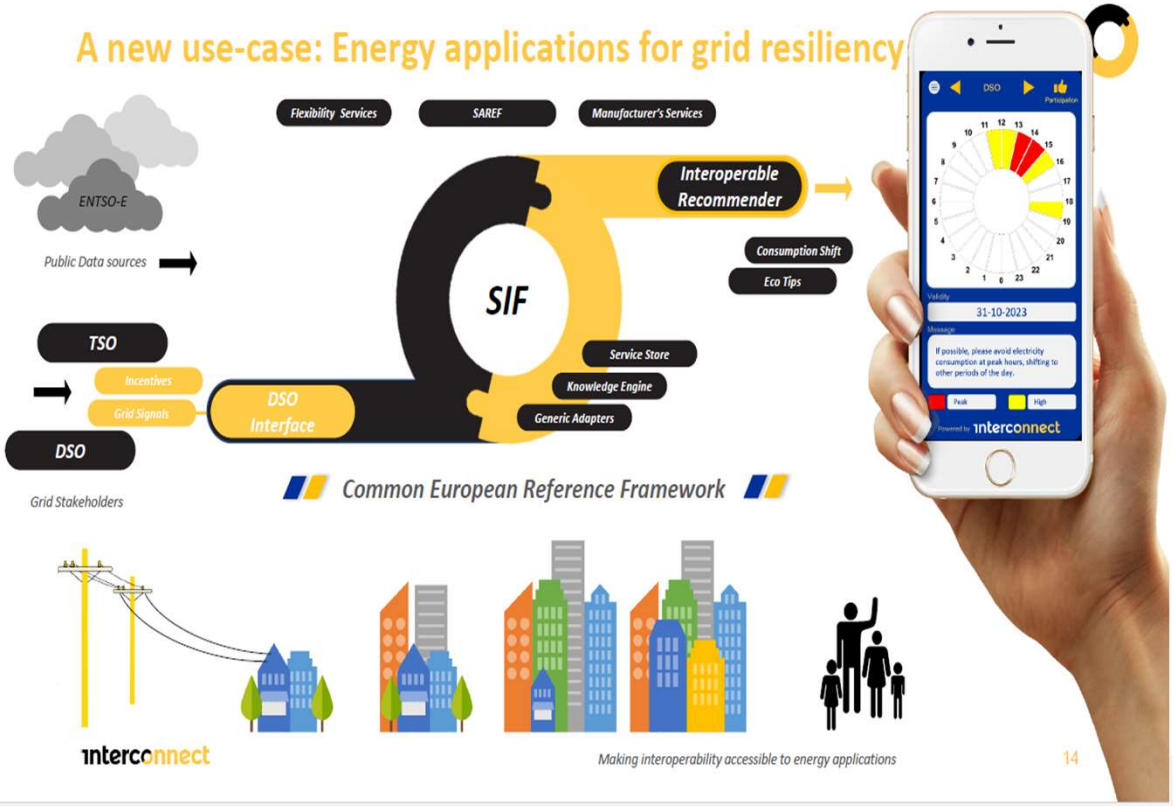
Powered by:
https://interconnectproject.eu/

interconnect

Local AI Experience in AI for Energy

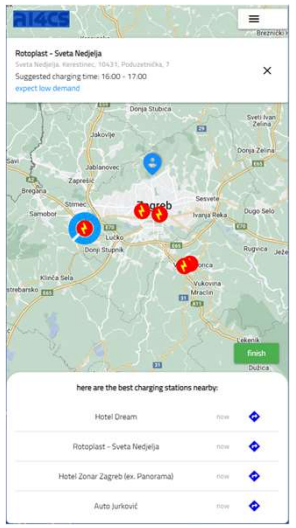
interconnect Project

Connecting European Energy Producers and Consumers
for promoting Energy Sustainability



Our AI for Charging Stations app

Access and knowledge on Prices-Mix-Loads for EU Countries, Intelligent Guidance for EV owners to charge.
Implementation of the AI4CS Use Case for EV Charging Stations piloted Jan-Feb 2024 in Hrvatski Telekom (Deutsche Telecom Group)



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More Info at https://interconnectproject.eu/wp-content/uploads/2023/12/Booklet.pdf

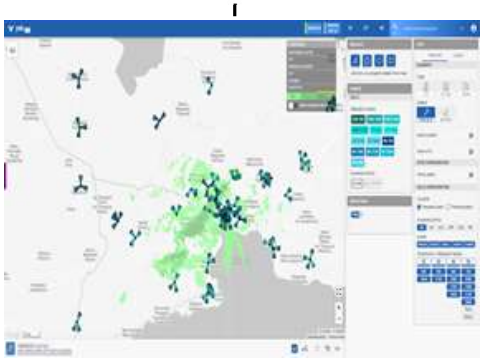
AI4CS Concept

SIF Data:
Grid Load, Green Energy Mix

Data from EV Charging Stations managed

AI4CS Forecast Modelling

Proposed Charging Station to the End User (where and when to charge)

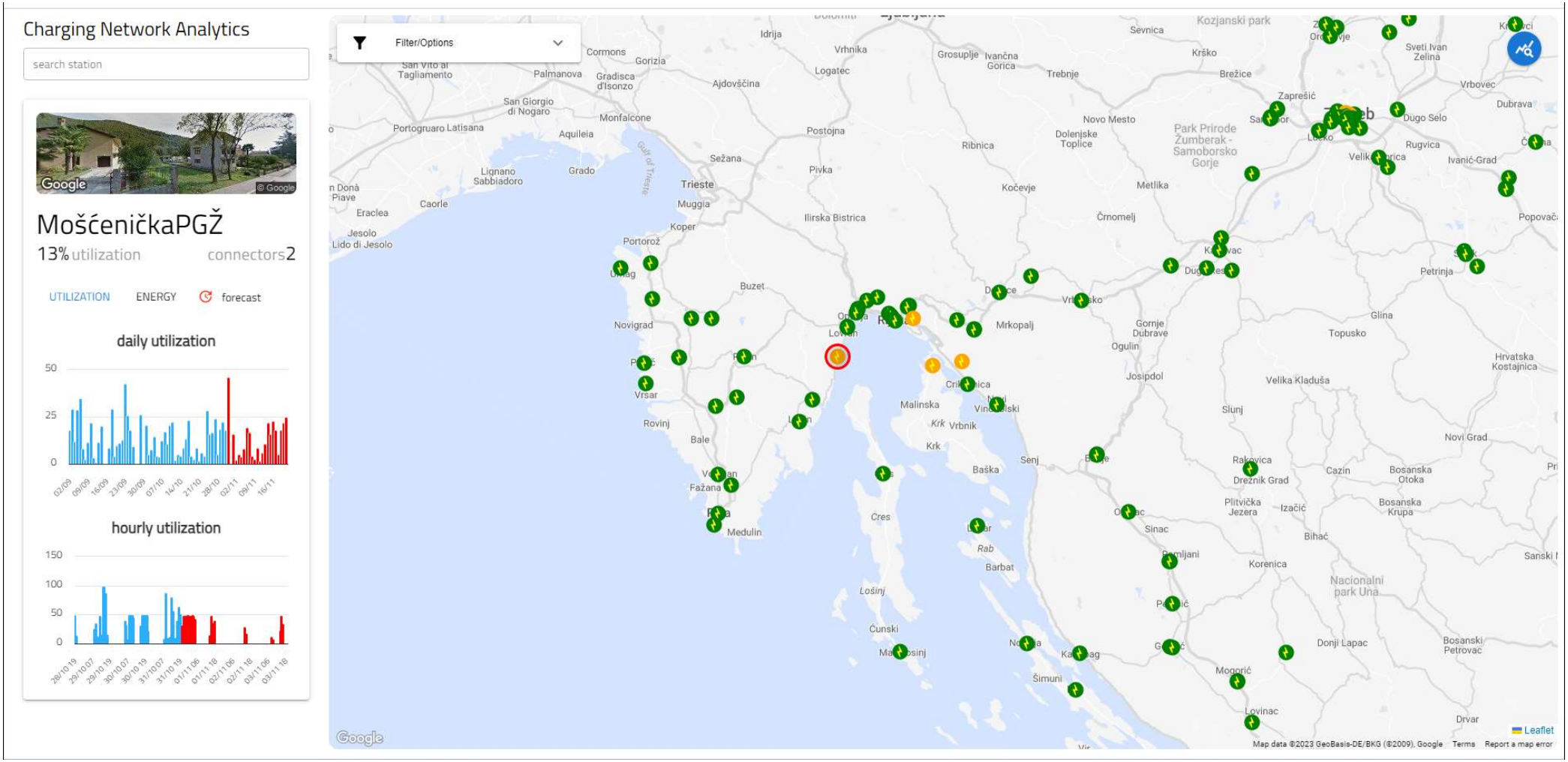


EV Charging Stations Forecasted Availability – Grid Load Forecast

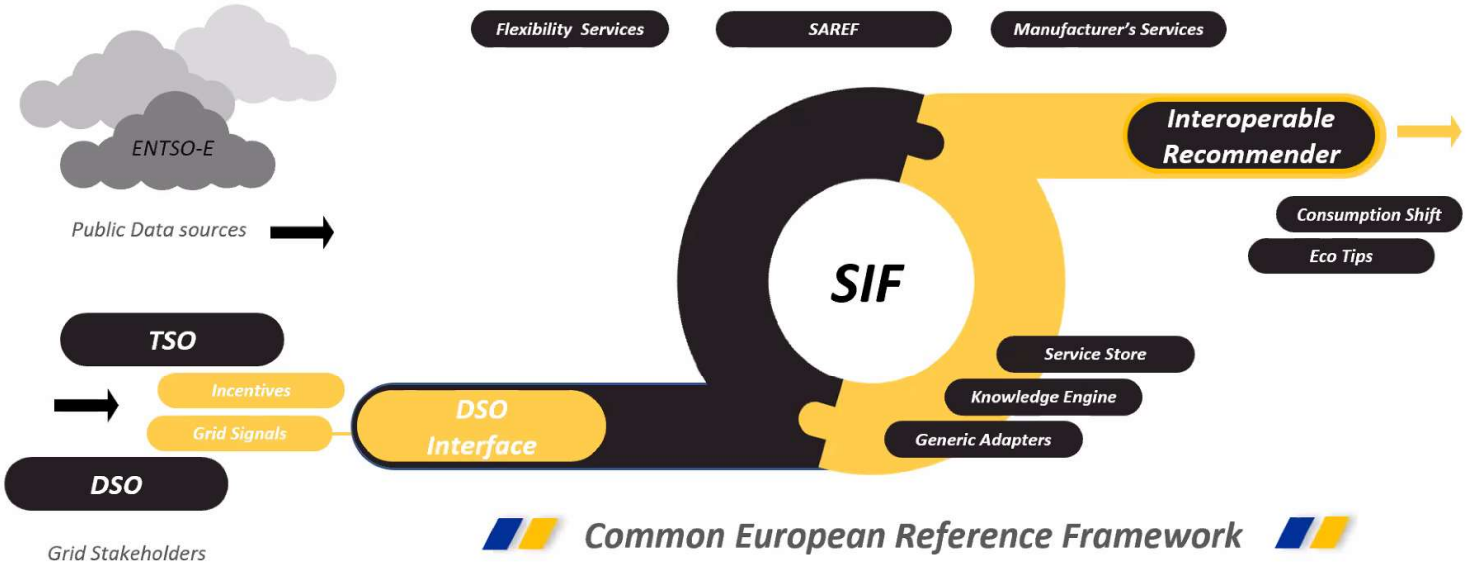
AI powered GeoAnalytics & AI Timeseries Forecasting leading to Optimal Suggestions to EV owners for

- ✓ the best Customer Experience
- ✓ empowerment of EV adoption
- ✓ peak Grid Load avoidance
- ✓ Use of Greener Electricity

Planning Tool – Forecasting Utilisation



Enabling an ecosystem of stakeholders



Common European Reference Framework

interconnect

Current State of the Art Forecasting

The LSTM and Transformers AI Timeseries Forecasting Models currently perform excellent providing precise forecasts, outperforming the baseline ARIMA model:

Charging Station Forecast -ARIMA	Charging Station Forecast - LSTM
Train MSE: 10.55	Train MSE: 0.0224
Test MSE: 13.89	Test MSE: 0.334

Source: Github CNROpt Repo
https://github.com/local-ai-gr/CNROpt/blob/main/Forecasting%20with%20location%20included%20final%20model.ipynb

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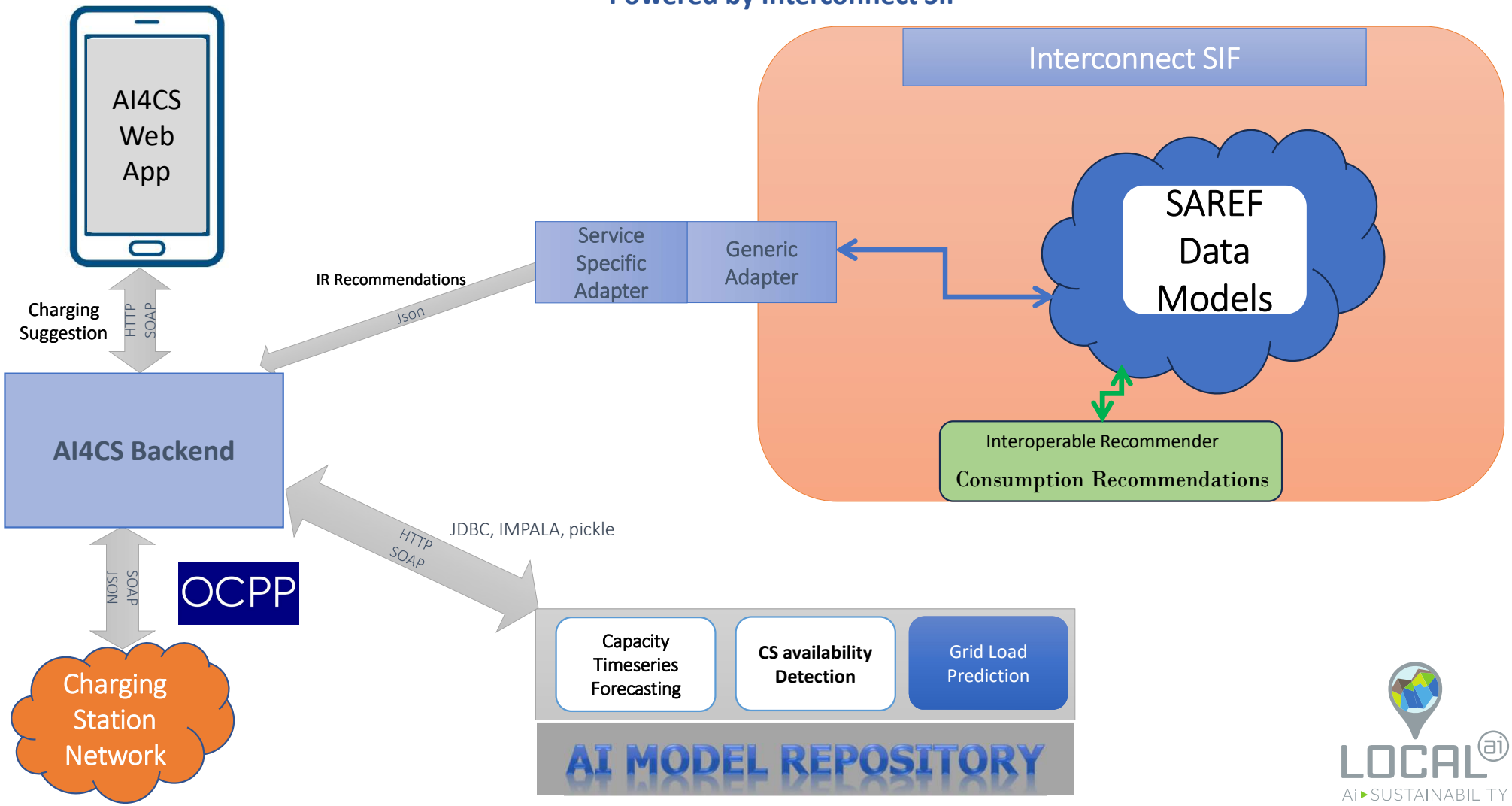
AI for Charging Stations - AI4CS

Powered by Interconnect SIF



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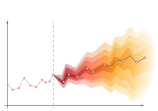
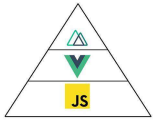
AI4CS Software Stack

- User Interactive Mobile App

Front-End

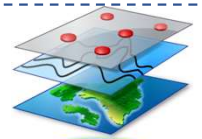


NUXTJS

Leaflet

Back-End

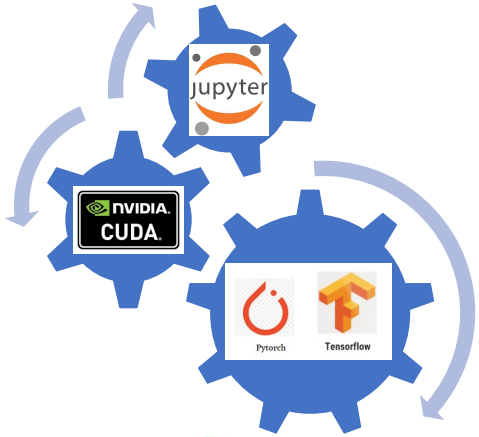


PostGIS
Flask
web development, one drop at a time
OSRM

GraphHopper

Docker
Google Cloud Linux VM

- Model Training
  - Timeseries Forecasting
  - New Location Scoring

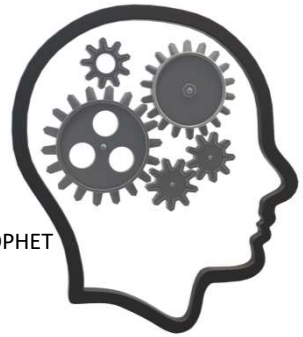


NVIDIA GPU

Google Colab

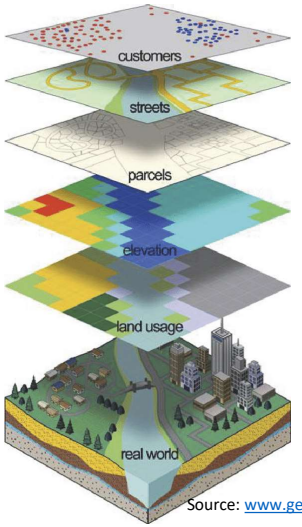
Tested a set of laboratory AI algorithms

- Deep Reinforcement Learning
- LSTM – Transformers – LLMs for Timeseries prediction
- ML techniques tailored for spatiotemporal time series forecasting PROPHET models, Transformers and Recurrent Neural Networks



Open API access Interconnect SIF

Model into Layers



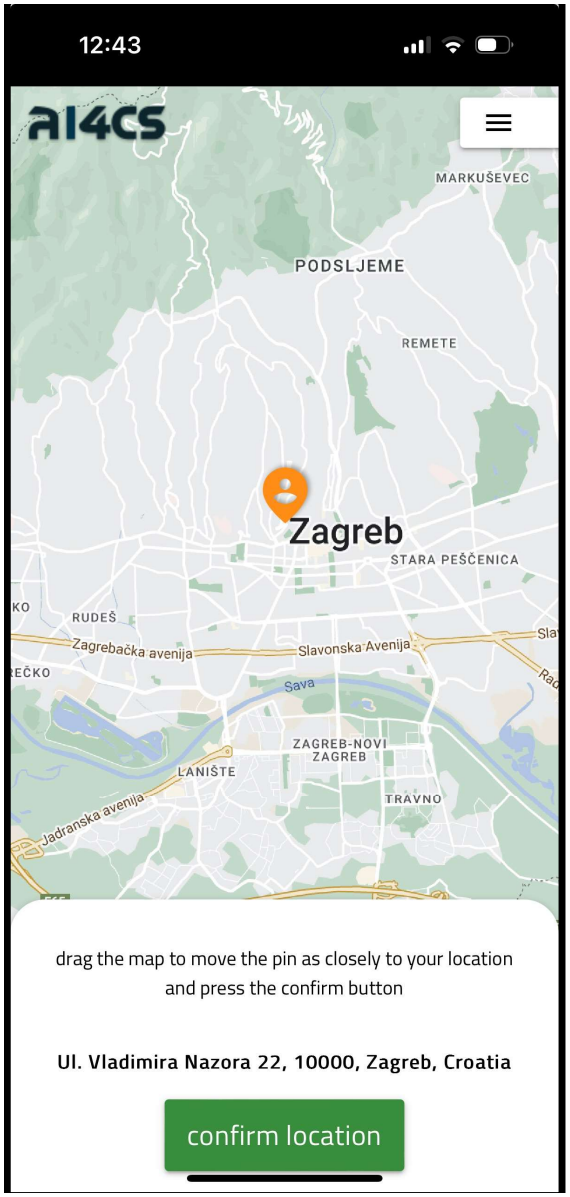
Source: www.gembc.ca

Deployed on cloud infrastructure, container based, using many different containers, one for each micro-service, managed by Kubernetes, enabling fast scalability in the production phase of our operation.

Web App Landing Screen

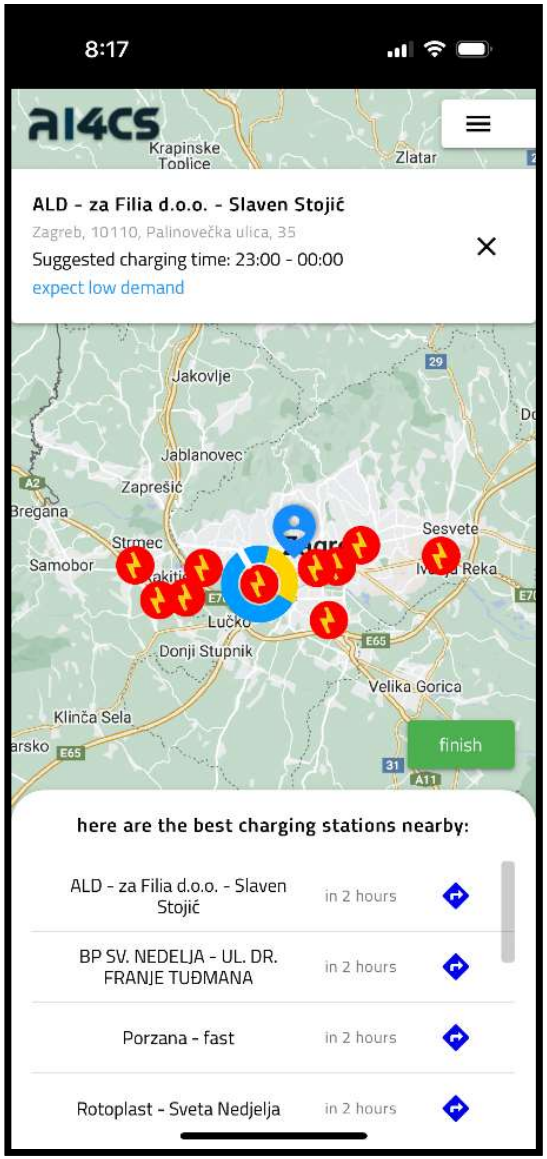
The user is asked for a location (or enable the use of their location)

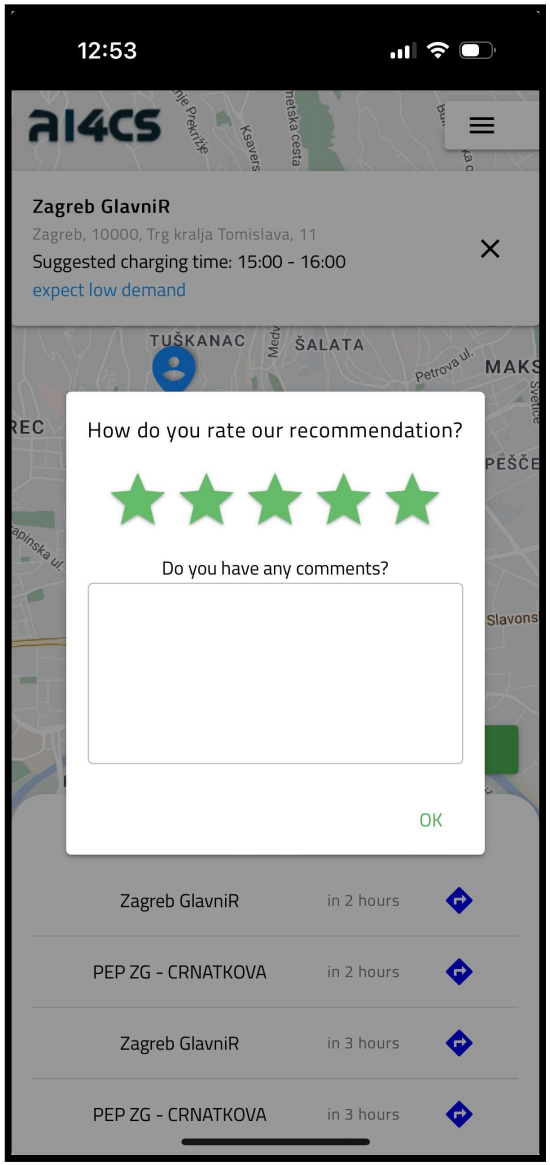
[AI4CS App Demo Video]



Suggestion to the User

The optimal CS within x km driving distance is displayed along with its name and distance and driving directions to it. The suggested time is close to the desired one but may be ±2 hours from the desired time for avoiding peak grid load and/or getting greener electricity





Pilot - Demonstration in the field

Pilot in Collaboration with Hrvatski Telekom 16/1-20/2/2024

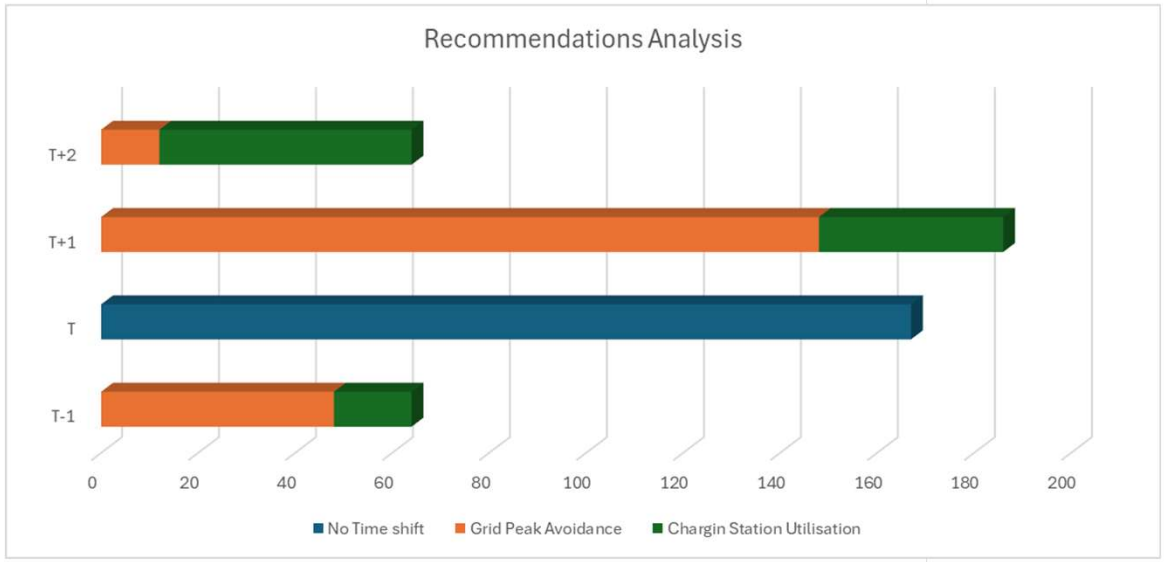
- Addressed 112 Friendly Users from HT subscribers
- Engagement of consumers and usage of app
- Collection of App Logs – Calculation of KPIs
- Collection of User Feedback for Experience Evaluation
- Preparation of Final Evaluation (Consumers/Grid/CO_2 emissions)
- HT: Potential Price Motivation for avoiding peaks

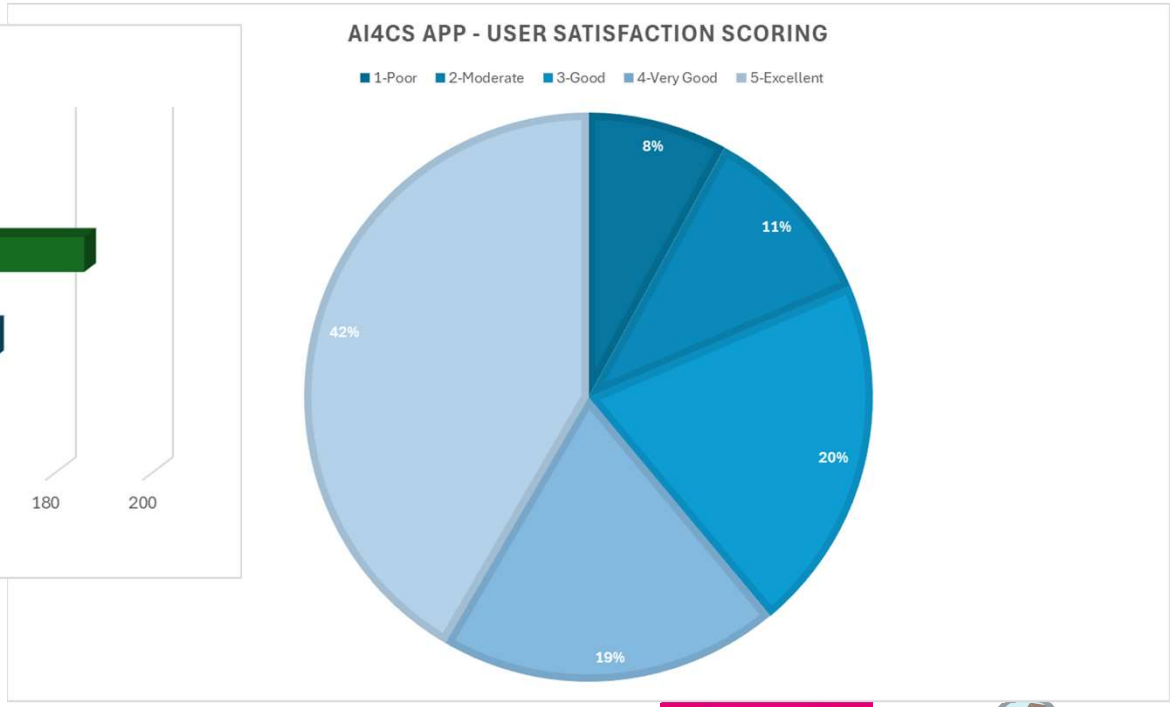
AI4CS Pilot Key Results

Demonstration Project Key Performance Indicators		
Users Engagement	112 users	480 Recommendations
User Satisfaction	MOS Score 3.8	1:bad, 2:poor, 3:OK, 4:very good, 5:excellent
NPS score	7.5	1:Not Recommend at all – 10:Strongly Recommend
Avoidance of Grid Peak Load	130 Recommendations to avoid Grid Peak Load (based on Interoperable Recommender)	2.1% Contribution Reduction
CO_2 emissions reduction	Increase of Green Electricity Usage	2% Increase (est.)

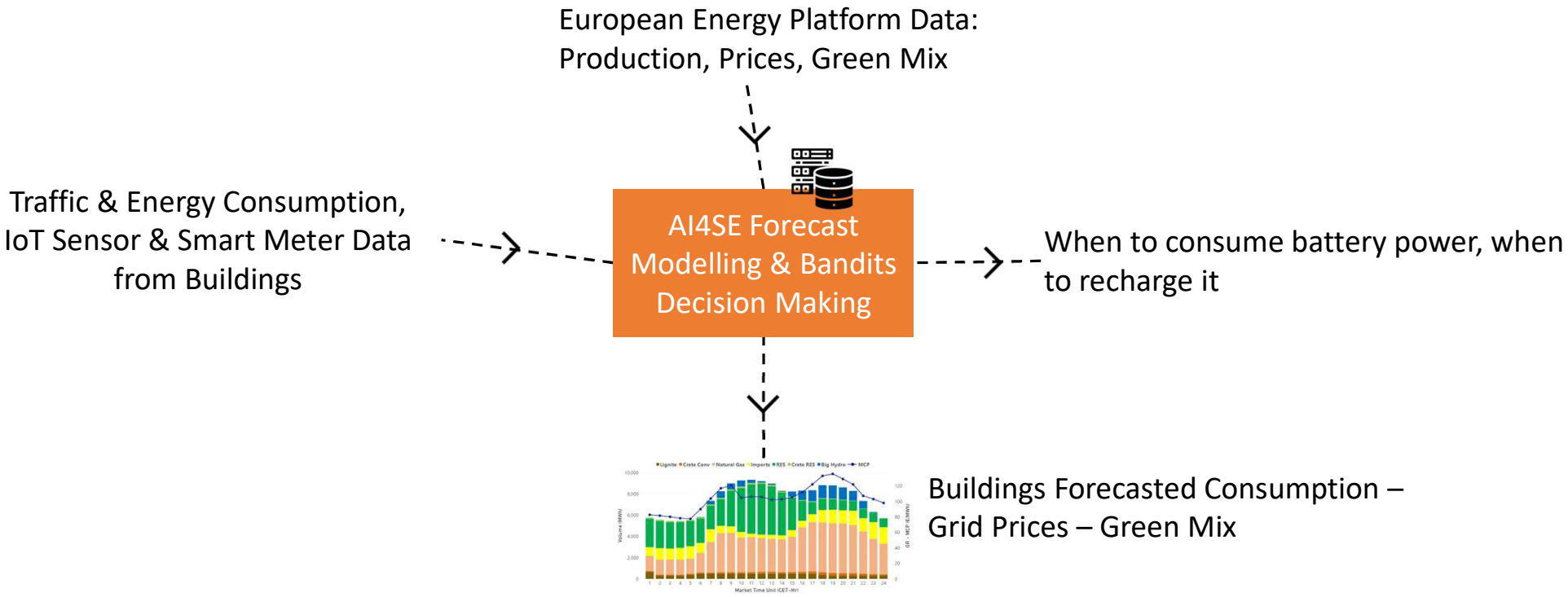
AI4CS Pilot Key Results - Analysis

Shifting the time of EV charging to avoid Grid Load based on Interoperable Recommender Insights





AI4SB Overview

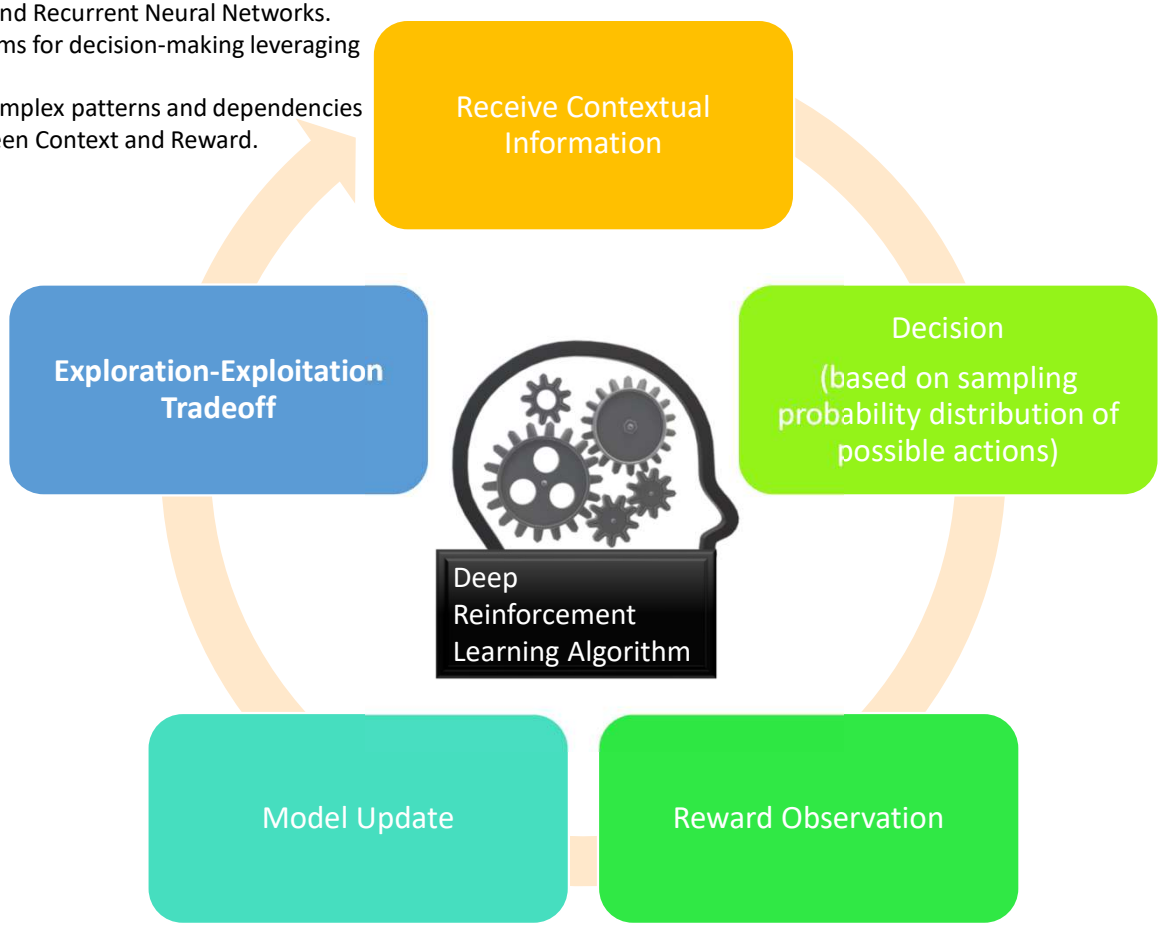


AI powered Analytics, AI Timeseries Forecasting and Neural Bandits Algorithms leading to Optimal Suggestions to Municipality Stakeholders for

- ✓ Energy Bill Savings
- ✓ Use of Greener Electricity

Decision Making based on Neural Bandits AI algorithms

- Deep Reinforcement Learning techniques tailored for time series forecasting models, Transformers and Recurrent Neural Networks.
- Neural Contextual Bandits Algorithms for decision-making leveraging Neural Nets.
- Neural Network used to capture complex patterns and dependencies in the data - the relationship between Context and Reward.



Model Building Energy Consumption and Grid Energy characteristics using Neural Nets

AI

Find the best switch on & off times from the Grid, Maximizing savings

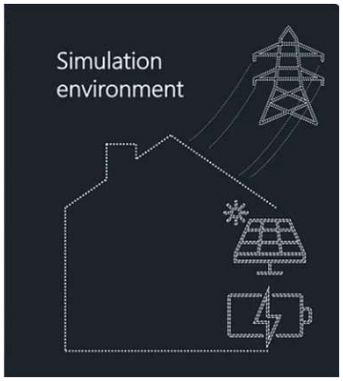
Source: https://towardsdatascience.com/contextual-bandits-and-reinforcement-learning-6bdfeaece72a

AI4SB Technologies

Deep Learning AI models

Energy decision making powered by Deep Reinforcement Learning

Creating a digital representation of the real physical environment where our RL agent learns the policy optimizes the household costs based on:



- Forecasted hourly energy market prices
- PV energy production (if applicable)
- Battery specifications (if applicable)
- Baseload of the household
- User preferences

Gymnasium

OpenAI

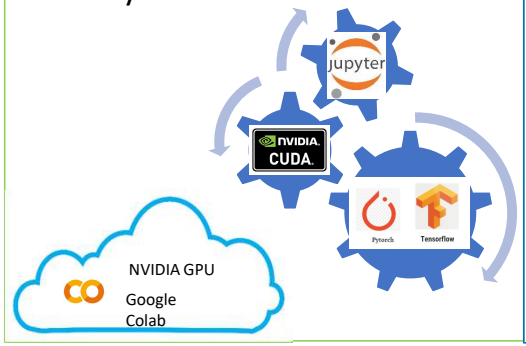
Example decisions of the energy agent

	Hour	Day-ahead (€)	Afrr-up (€)	Baseload (kWh)	PV (kWh)	Action	SoC (kWh)
	20	33 €	84 €	9	1	bat_idle	13
1	21	33 €	84 €	9	1	bat_afrr_up	6
	22	31 €	81 €	11	3	bat_afrr_up	1
	23	28 €	60 €	11	2	bat_from_grid	6
	0	23 €	82 €	9	0	bat_afrr_up	1
	1	4 €	0 €	1	0	bat_from_grid	13
	2	6 €	0 €	1	0	bat_to_home	12
2	3	14 €	0 €	1	0	bat_to_grid	1
	4	1 €	0 €	1	0	bat_from_grid	13
	5	13 €	0 €	2	0	bat_to_grid	1
	6	7 €	0 €	2	0	bat_from_grid	13
	7	13 €	0 €	1	0	bat_to_home	12

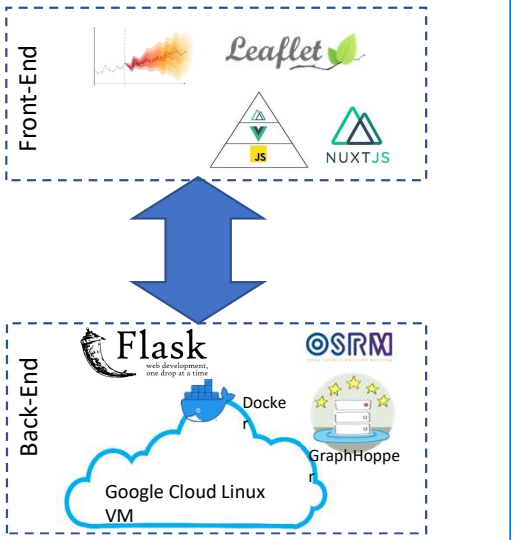
Example - Our agent can carry out the arbitrage between different market prices

Deep Reinforcement Learning algorithms:

- Neural Bandits
- Deep Inventory Management
- Deep Q Networks
- Policy Gradient Methods

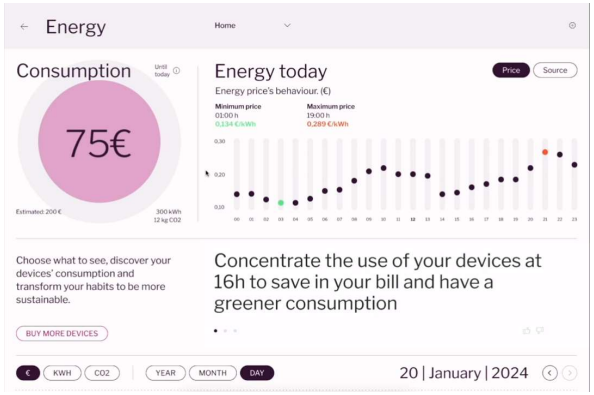


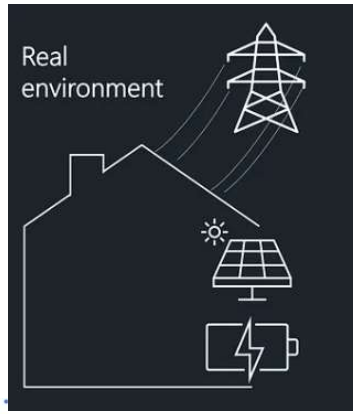
User Interactive Mobile App

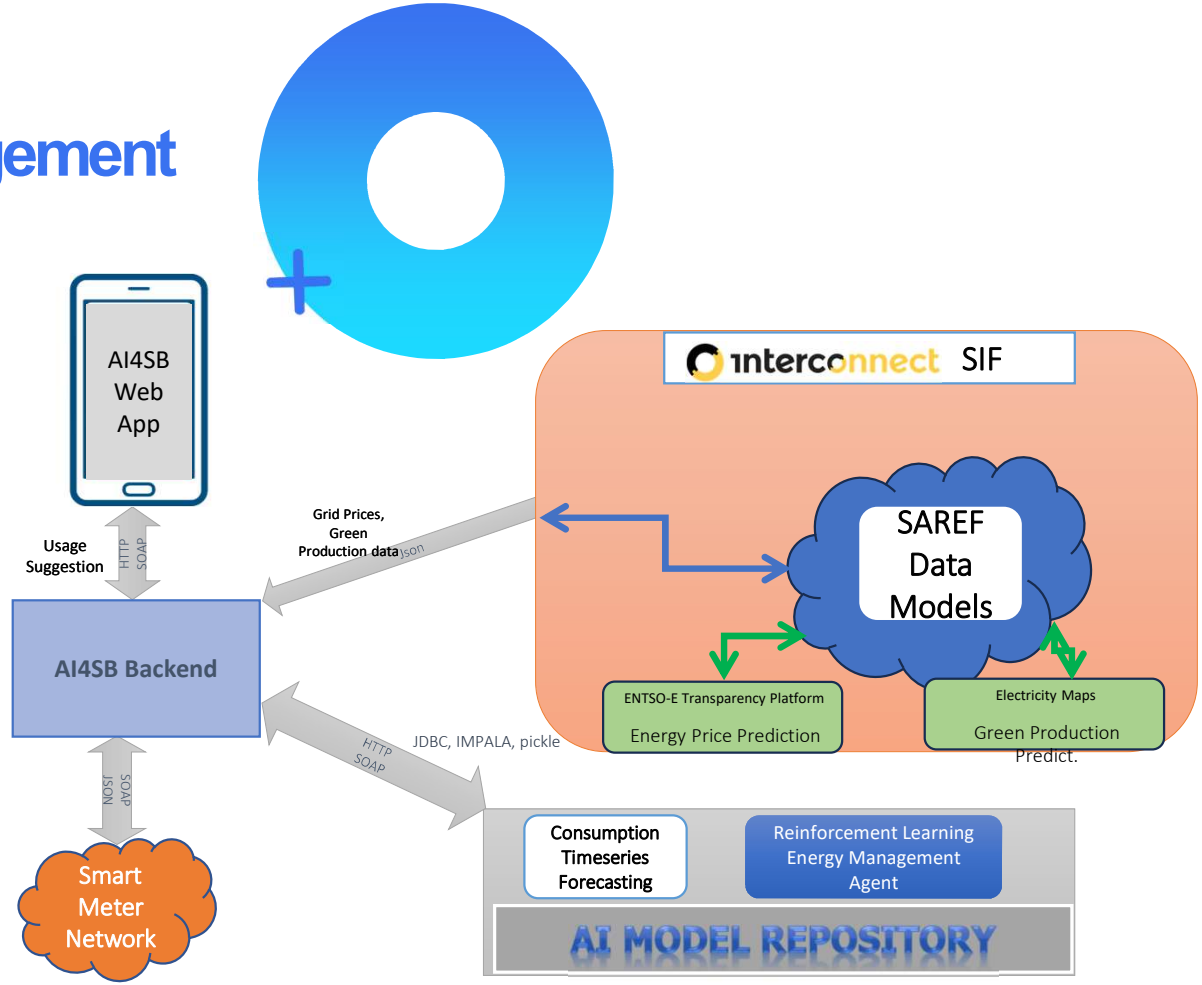


AI for Smart Buildings

Household Energy Management

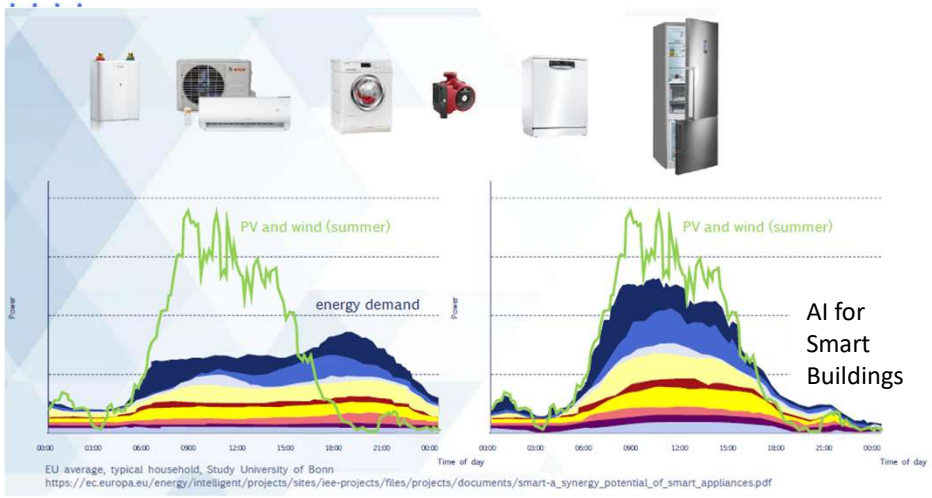






AI 4Smart Buildings : a Value-Added Service

Bringing Energy Cost Savings & Reducing CO_2 Footprint



AI for Smart Buildings

- water heater
- AC/ventilation
- oven/stove
- tumble dryer
- washing machine
- circulation pump
- dishwasher
- refrigerator
- freezer

Using existing flexibility to provide "virtual storage for free".

Enabling the transition towards the "Smart Energy Management"

- End User Managing the "Orange" Energy Subscription
- Leveraging new Opportunities – Production & Storage
- Enabling the **Prosumer** Model
- AI is the key enabler to unlock its full potential
- Futureproof for "Smart Energy Appliances"

TEAM

Local AI

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Thank you!

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Video Testimonial:

Play Video