Lessons from the European island territory decarbonization:

The role of Flexibility to ensure a High Renewable Energy integration

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Outline

1: Project Background

2: Islands' energy systems

3: Flexibility & the project's solutions

4: Long-term prospective modelling: TIMES modelling

5: Case Studies

6: Conclusion & lessons learned

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Project Goals

The main objective of the GIFT (Geographical Islands FlexibiliTy) project is to **decarbonise the energy mix of islands**.

- ↗ 1: Allow a high level of **local renewable energy** sources penetration
- ↗ 2: Provide visibility of the energy grid to better manage its **flexibility and plan its evolutions**
- ↗ 3: Develop **synergies** between the electricity, heating, cooling, water and, transport networks
- ↘ 4: **Reduce** the use of **hydrocarbon-based energies**
- ↗ 5: Ensure the **sustainability** of the solutions and their **replicability** in other islands

Partners

Demonstration sites

Hinnøya island cluster (NO)

Procida island (IT)

Follower islands

1 Favignana (IT)

2 Evia (GR)

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Why are we interested in energy systems of islands?

Challenges

Energy supply, Economic,

Vulnerability towards Climate Change

Opportunities

Policy support (EU Clean energy for EU islands), Endowment in RE sources, Cost competitivity of RE, International commitments

→ **Developing island specific energy system models**

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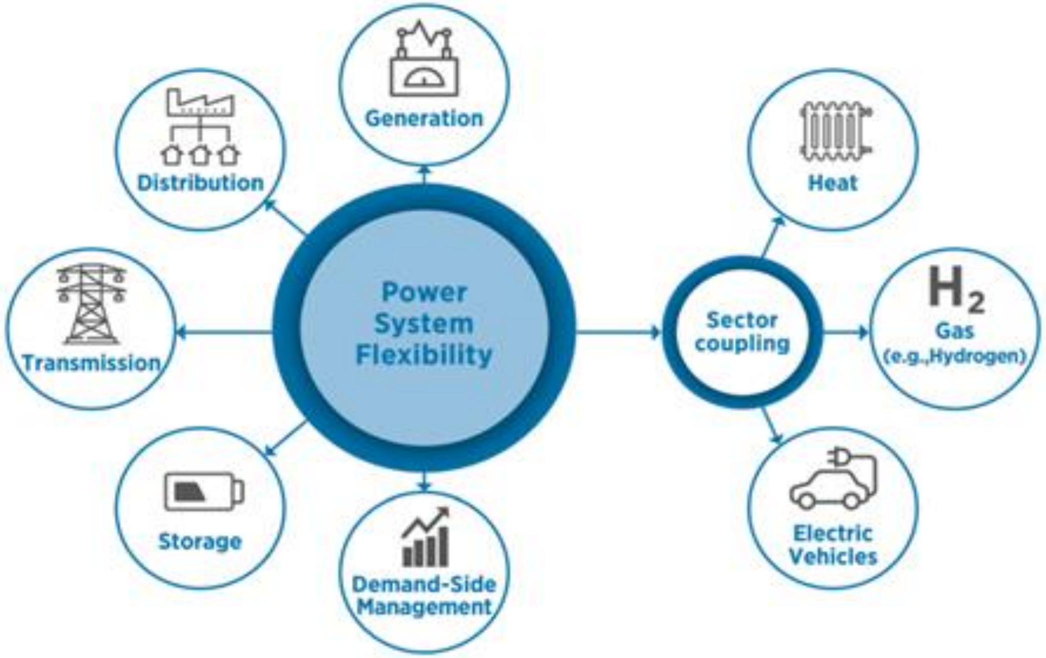
Flexibility of the energy system

Grid flexibility

- Operation of the energy system with instantaneous stability and long-term security of supply
- Reliability and cost-effectiveness
- Management of the variability and uncertainty of renewable energies
- Ensure the balance between supply and demand

→ Develop synergies between the sectors constituting the energy system

Power system flexibility enablers in the energy sector



IRENA, 2018

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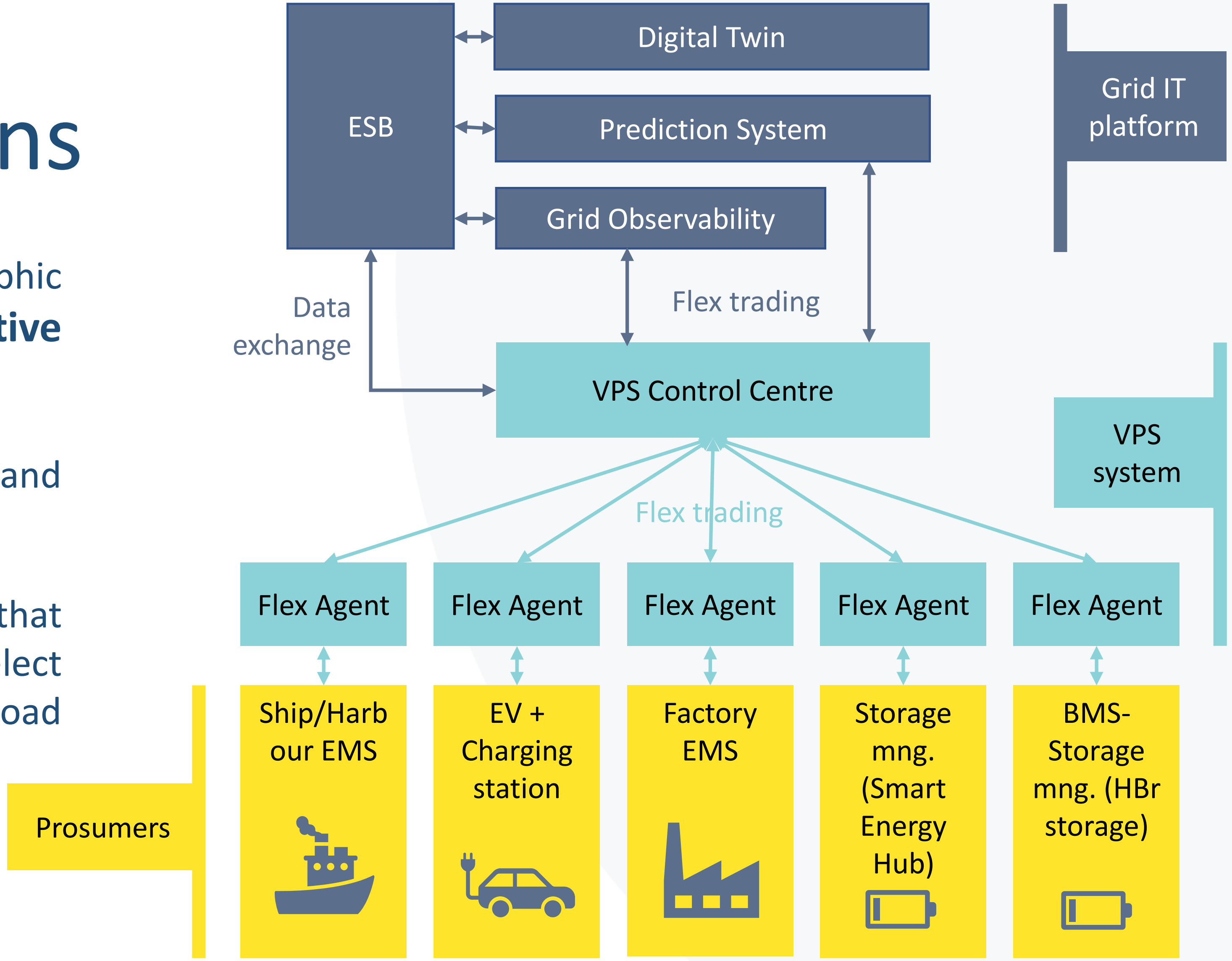
The project's solutions

- Grid IT platform for KPI visualisation, geographic visualisation, grid observability, **prospective modelling and long-term assessment.**
- VPS system, a decentralised automatic demand response trading platform
- Prosumers or smart energy consumers that postpone energy demanding tasks or select alternate sources for energy to reduce the load on the power grid, thus providing flexibility.



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Long-term prospective modelling

Define an energy plan that ensures a reliable system in the long term

- What type of energy technologies to choose?
- How much capacity should be installed?
- When should new capacities be installed and scrapped?
- Where to install new capacities?

Techno-economic optimization of the energy system over time
+
Environmental, social & political constraints

Long-term prospective modeling of island systems by considering different evolution scenarios

TIMES
The Integrated MARKAL-EFOM System

etsap
ENERGY TECHNOLOGY SYSTEMS ANALYSIS PROGRAM

Advice policy makers and authorities to make knowledge-based decisions in the implementation of their energy planning

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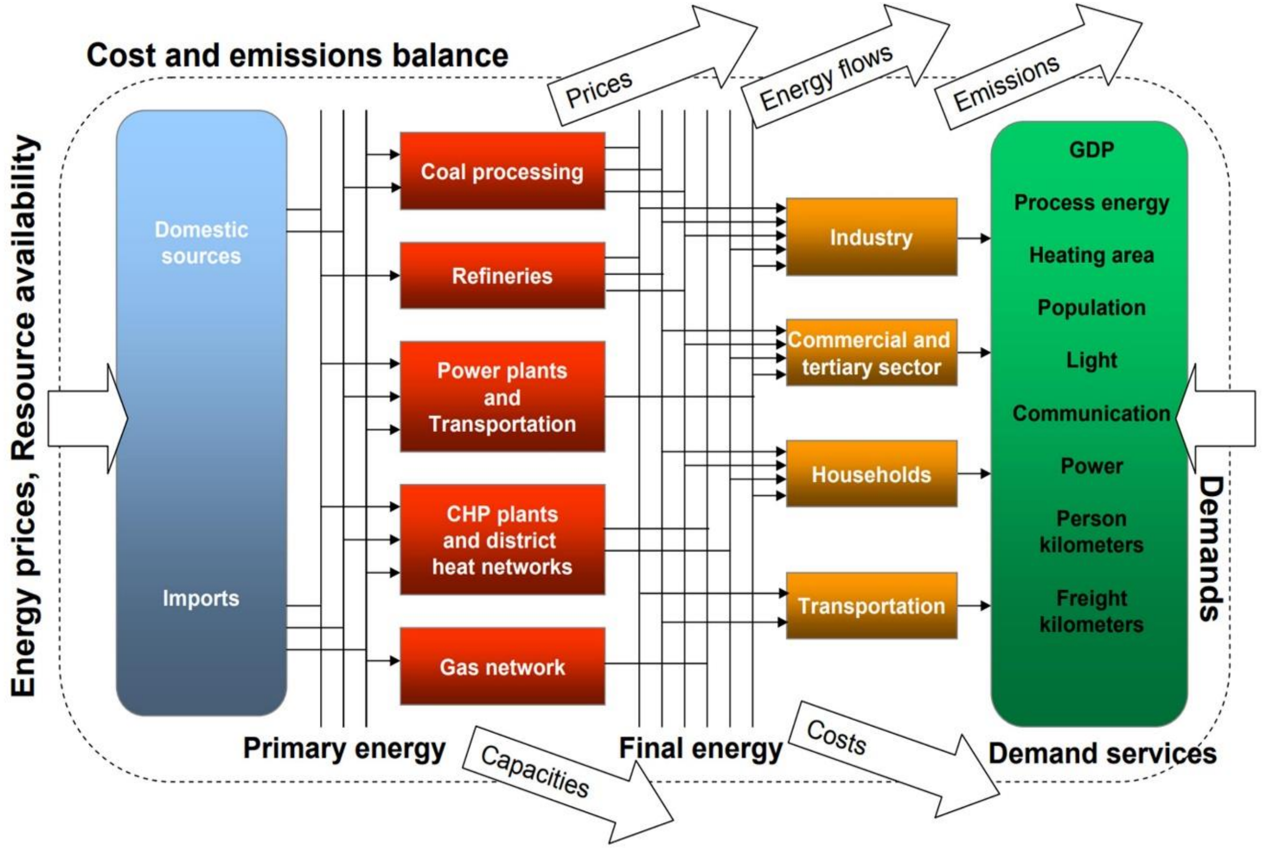
TIMES modelling



- Partial equilibrium linear programming, bottom-up, technology rich, and demand driven optimization model
- Minimizes the total discounted system cost or more generally maximizes the social surplus
- Exogenous inputs related to the projection of service demands in the different sectors, one can use the GDP and population growth as inputs to predict future demands

$$\boldsymbol{min(NPV)}$$

$$\boldsymbol{= min(\sum_{r \in R} \sum_{y \in Y} (1 + d_{r,y})^{T_{0-y}} \cdot ANNCOST(r, y))}$$

R. Loulou, G. Goldstein, A. Kanudia, A. Lettila, and U. Remme, 'Documentation for the TIMES Model - Part I'. Jul. 2016

The Demonstration sites

Procida Island (IT)

- *Smallest island in the Gulf of Naples, Area = 4.26 km^2*
- *Density = 2449 inhabitants/km^2*
- *Challenges: Grid congestions, High seasonality of demand (tourism)*

Hinnøya Island Cluster (NO)

- *Fourth largest island in Norway: cluster of large and small islands, Area = 2240 km^2*
- *Density = 14.52 inhabitants/km^2*
- *Challenges: Limited possibilities of new grid connections, Fish farms using diesel generators*

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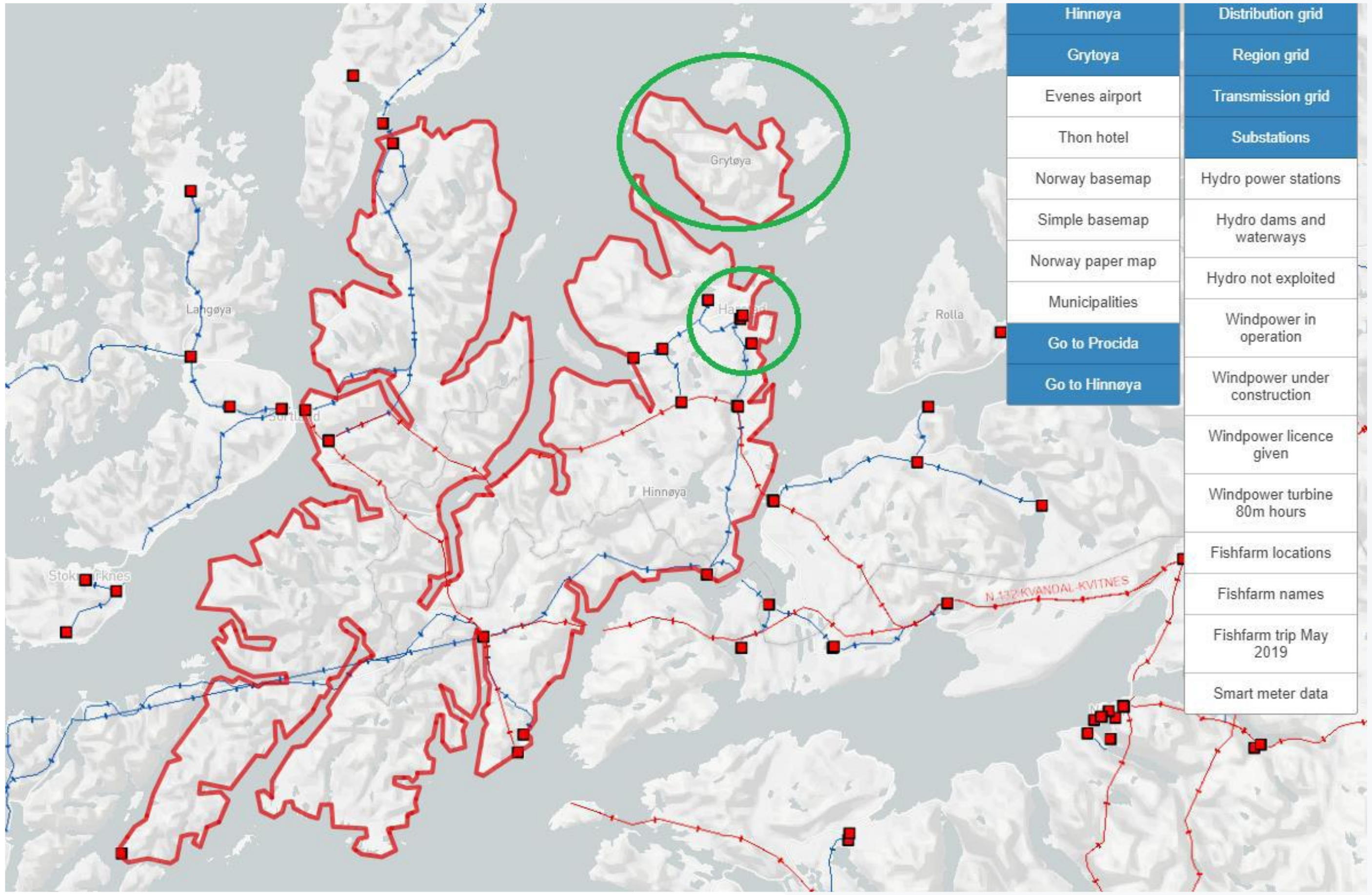
Hinnøya Island Cluster

GIFT Flexibility solutions

Ship/Harbour EMS	EV + Charging station	BMS-Storage mng. (HBr storage)	Factory EMS

Geographical locations of Hinnøya island cluster



GIFT DigitalTwin, 2019

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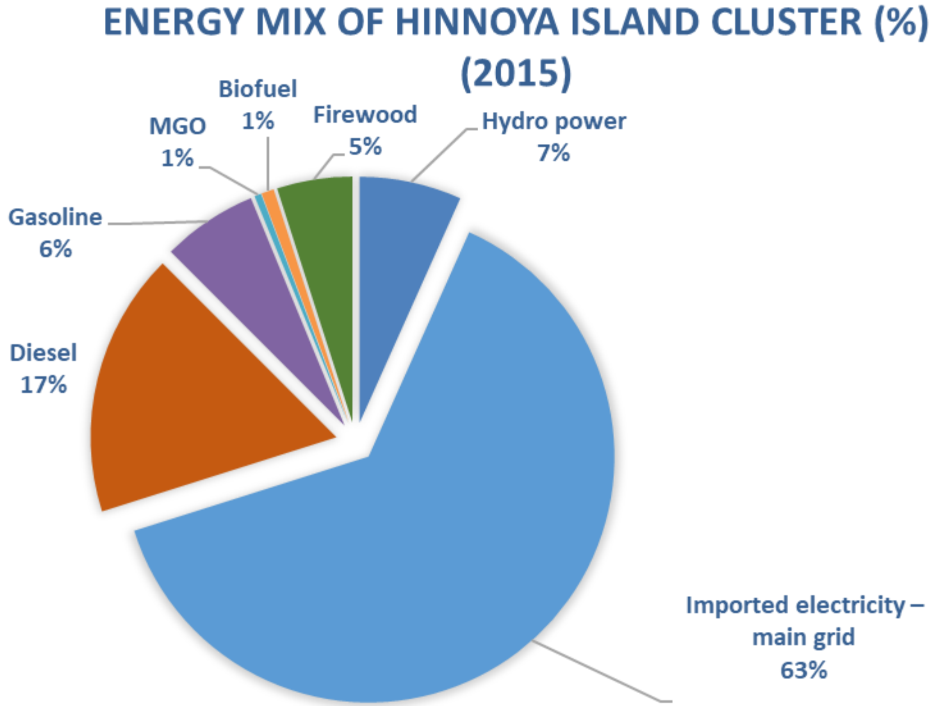
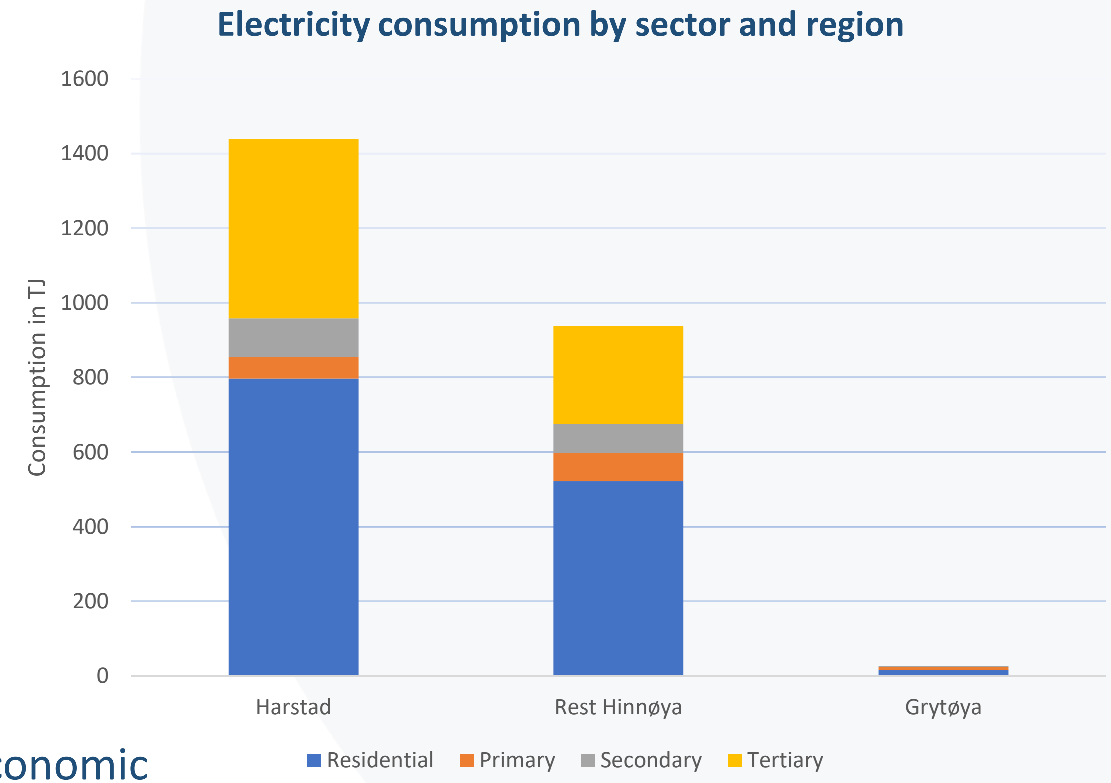
Hinnøya Island Cluster: Energy profile





Electricity in Norway 96% from Hydro, used in the economic sectors except fish farming

High reliance on the transportation in Norway and main source of emission on the island since Fossil fuel is mostly used

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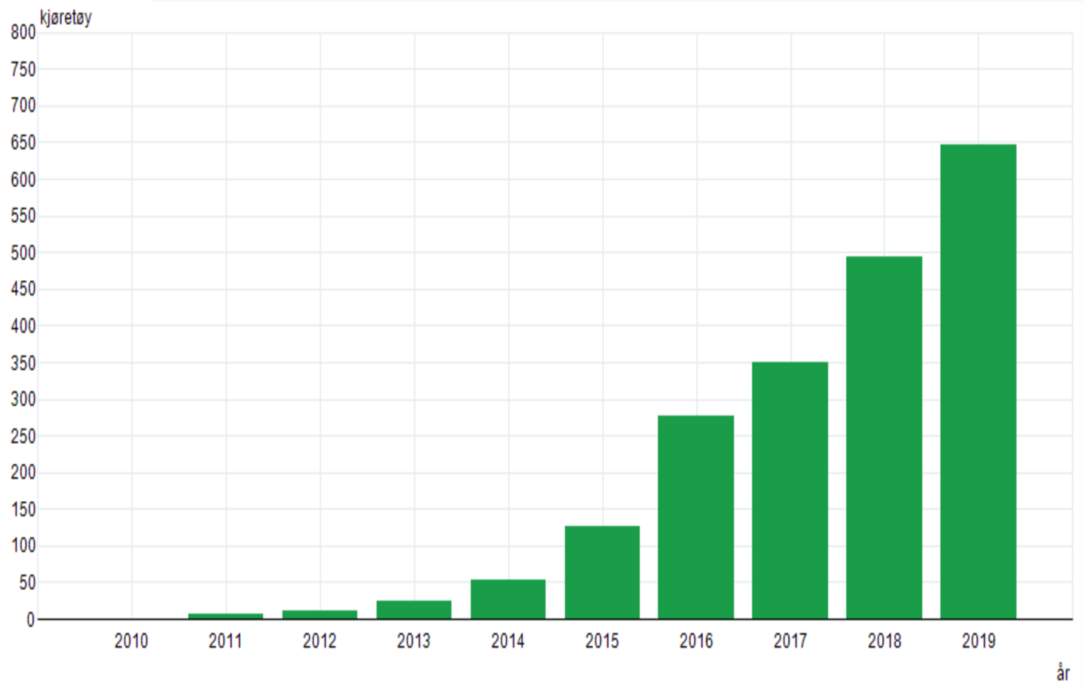
EV deployment on the long-term

1) Policy enablers for EVs in Norway

- Targets to reach 35-40% emission cuts from the transport sector compared to 2005 (*White paper, Meld. St. 41 (2016–2017)*)
- New cars and light vans must be zero emission vehicles by 2025 (*Norway's National Transport Plan, 2018-2019*)
- Incentives like Tax Exemption on registration of the new vehicles, traffic insurance and the re-registration, road usage (*Norway's Fourth Biennial Report 2020, Framework Convention on Climate Change*)
- Gradual increase of taxation on ETS and non-ETS emissions (*White paper Norway's Climate Action Plan (Meld. St. 13 (2020-2021)*))

2) Increasing trend of Electric Vehicles sold in Harstad



Source: GIFT Deliverable D7.1

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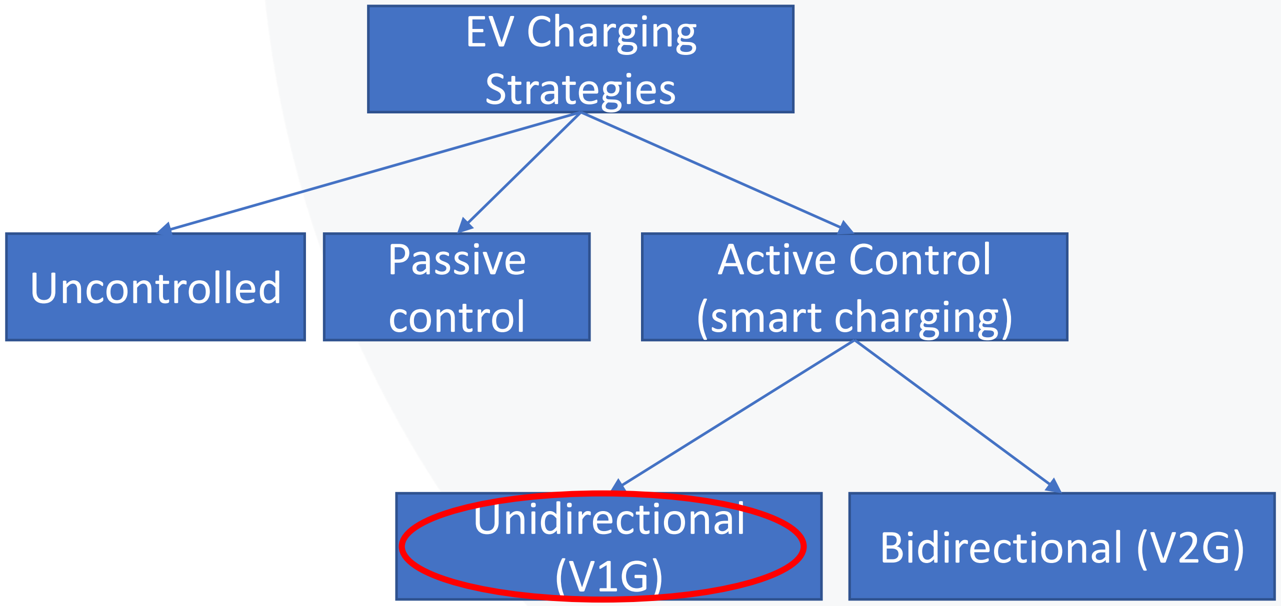
Flexibility in Hinnøya island cluster: EV charging

In GIFT, the flexibility is offered by each individual charging session whose load is shifted from peak hours to off-peak hours to release the stress on the distribution grid (GIFT D7.1)

Classification of possible strategies for EV adoption



(Adapted from Knezovic, 2016)

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Prosumers in Hinnøya: Demand response

Technical parameters of chargers and vehicles, i.e data on their size and operational distance (fuel economy, capital costs, O&M costs and lifetime)

+

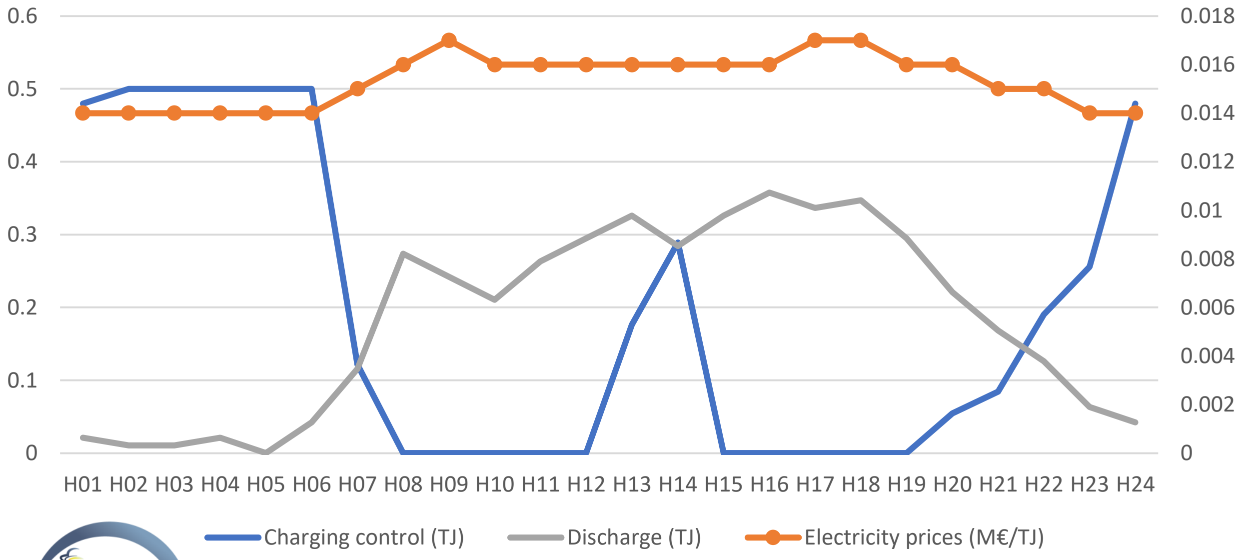
Future transport service demand and mobility demand, based on the national transport model of Norway (NTM) & U.S. Department of Transportation resp. + future electricity prices (NVE forecasts)

+

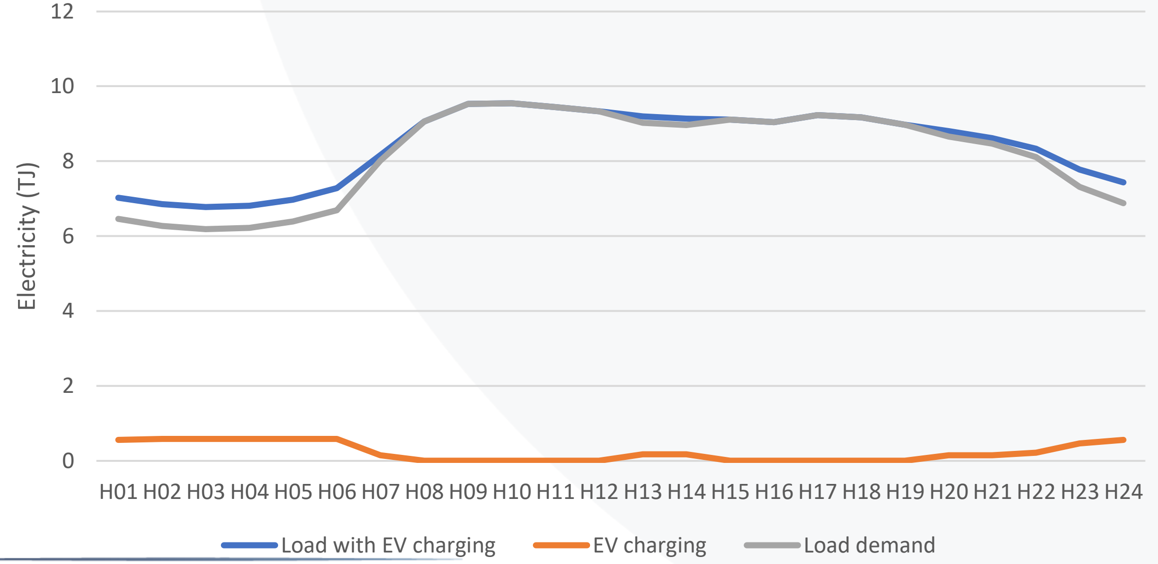
Taxation on transport greenhouse gas emissions (CO2, NOX)

TIMES EV charging strategy

Charging BEVs with respect to electricity prices (2035)



Load demand profile and EV charging (typical winter working day) (2035)



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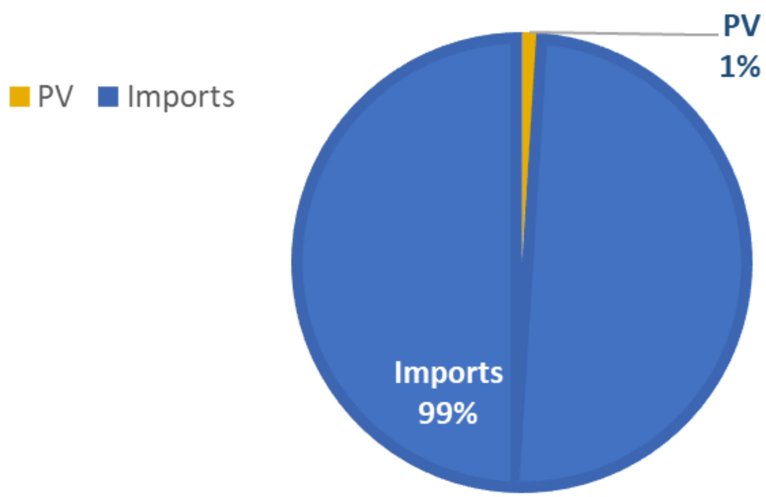
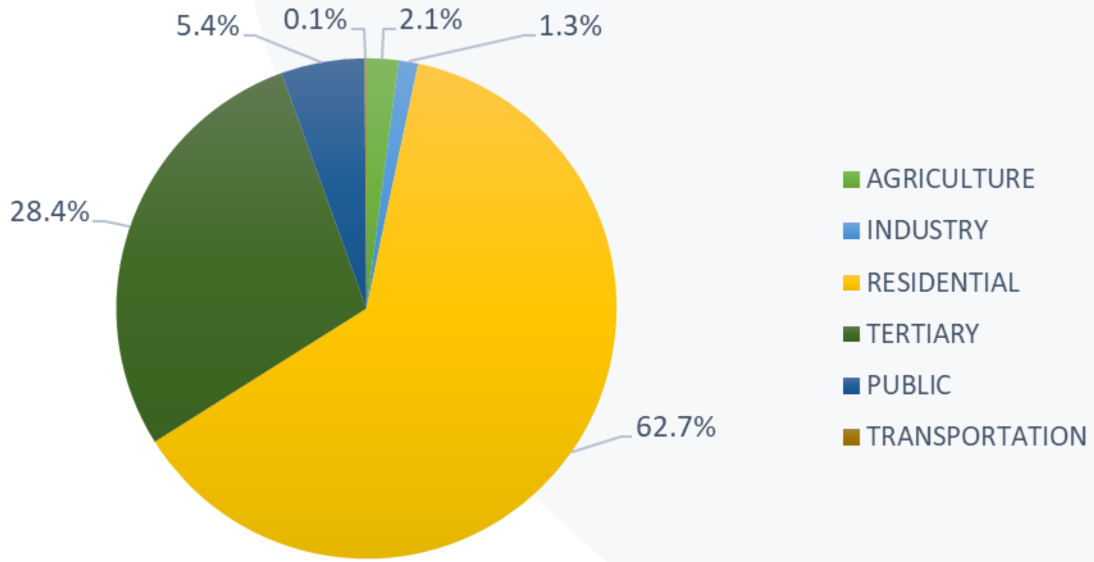
Procida Island: Energy profile

- Main source of energy is electricity from imports
- Solar energy: reduce dependency + decarbonization of sectors

Electricity supply (2018)



Electricity consumption (2018)



Data from E-Distribuzione, 2018

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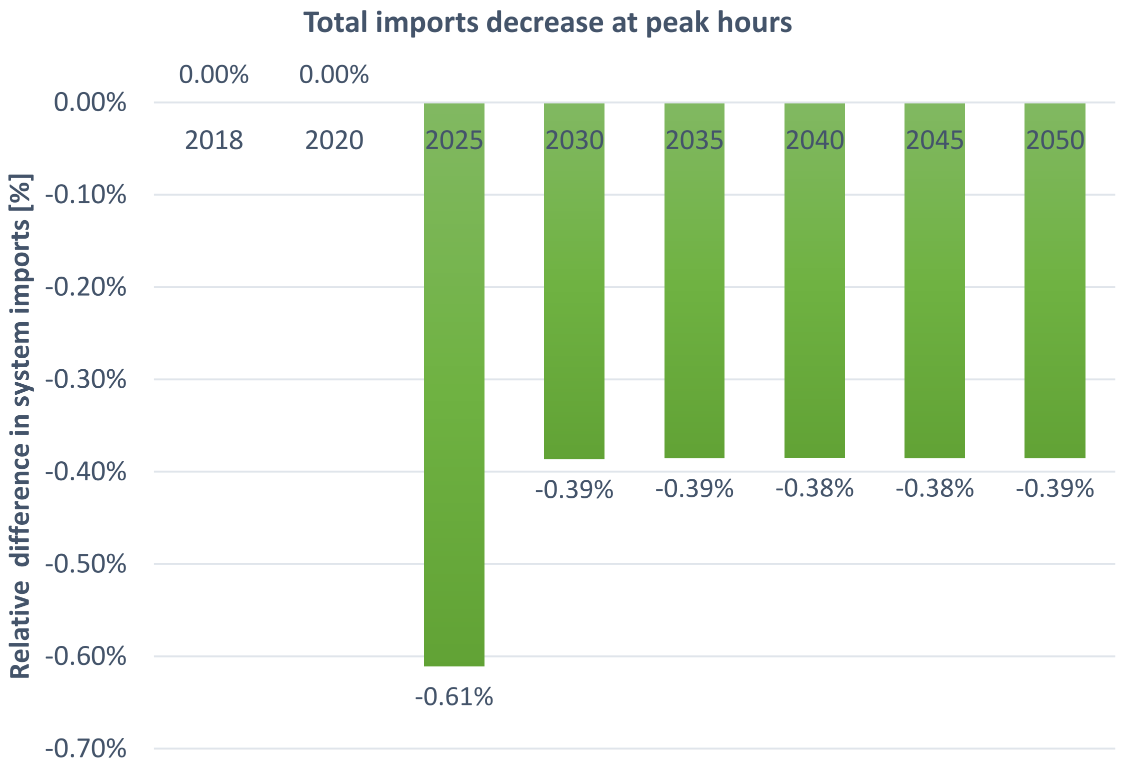
Prosumers in Procida: Self-consumption

Reduction in electricity imports in public buildings >50%

Exploiting Solar energy potential



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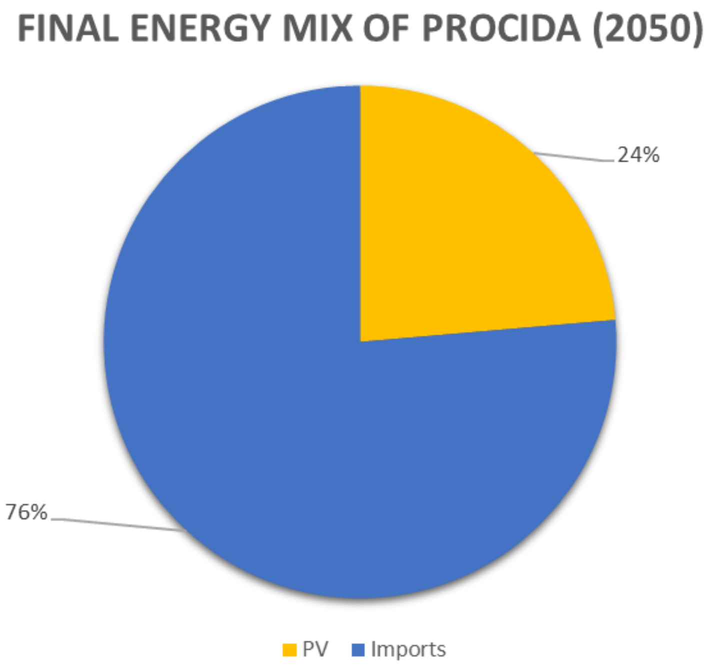
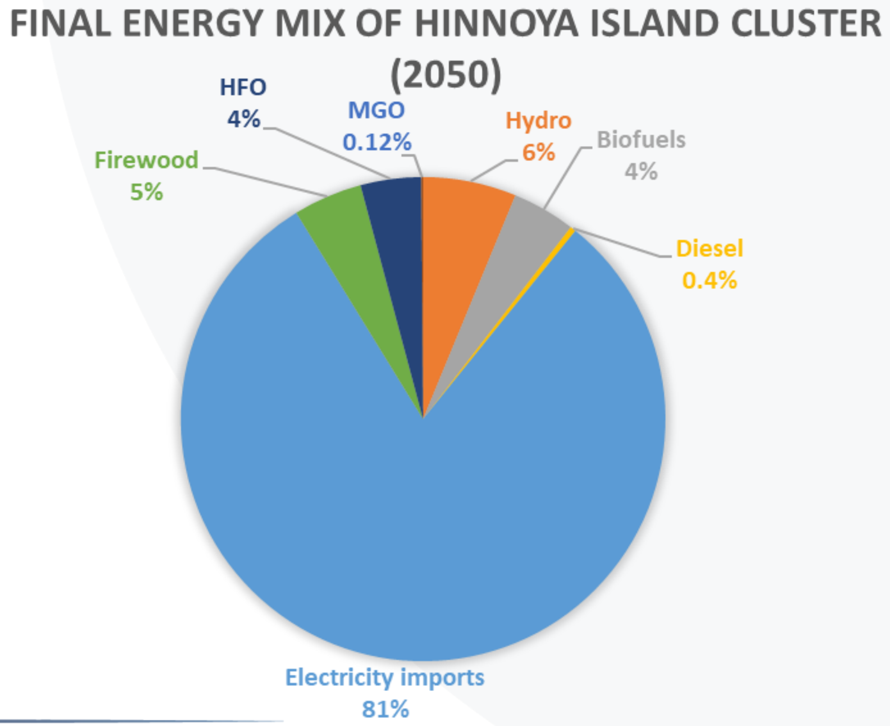
Conclusion & Lessons learned

- Flexibility & RE integration through:
1. Production of electricity on the island
2. Storage technologies

- Cross-sectoral flexibility solutions: Electrification of the transport sector for RE integration and decarbonization *(specific for Norway)*





Conclusion & Lessons learned

Key takeaways:

- Assessing the context of the territory as well as the energy system of the island help in understanding the flexibility needs and identify the suitable solutions
- Flexibility is linked to investment costs and maturity of solutions
- Long term planning supports decision making in new investments in flexibility solutions, but is limited from a grid operation point of view
- Necessity of involvement of the consumers that become “prosumers” thus participating in the energy transition
- Permissible regulatory framework and the use of properly designed systems for information and communication , monitoring and measurement are needed for the sustainability of the solutions

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Thank you for your attention !

Q&A

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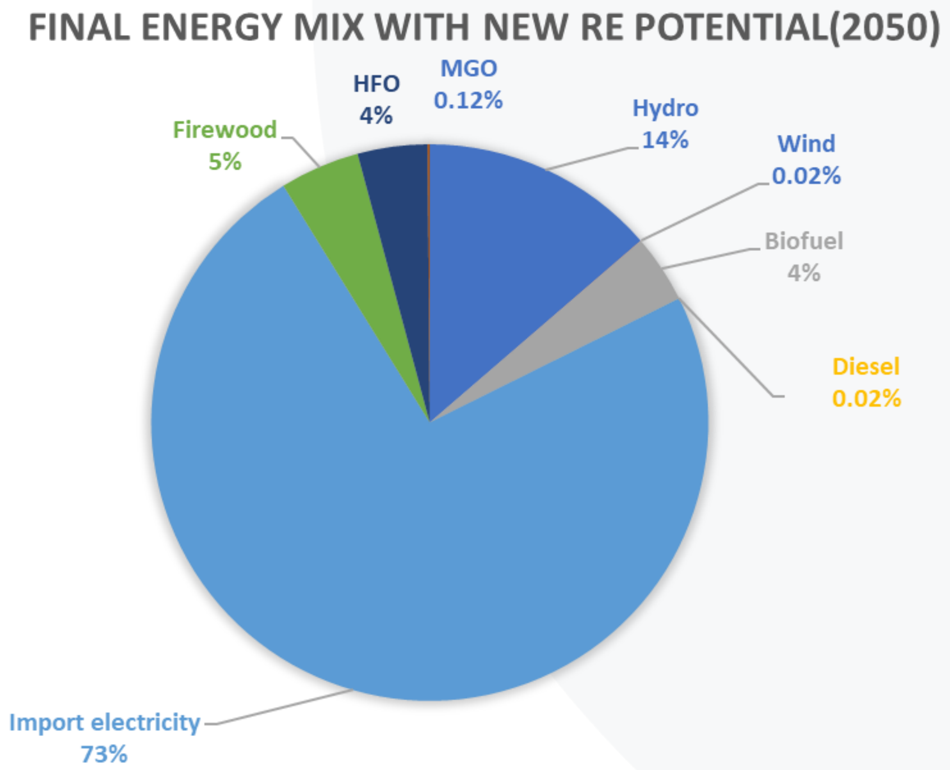
Annex

Energy mix of Hinnoya island cluster, scenario with investment in new Hydro and Wind



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