



Addressing flexibility and decarbonization of energy systems through TIMES modelling

The case of European Islands

Summer 2021 Semi-Annual ETSAP Meeting

Sophie CHLELA Sandrine SELOSSE Nadia MAIZI

17 June 2021 – Regular Workshop Day 1



THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH & INNOVATION PROGRAM UNDER GRANT AGREEMENT NO 824410

Outline



1: Project Background



2: The interest in islands' energy systems



3: Flexibility of the power system



4: Case Studies



5: Conclusion & lessons learned



6: Annex



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



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 competitiveness of RE,
International commitments*

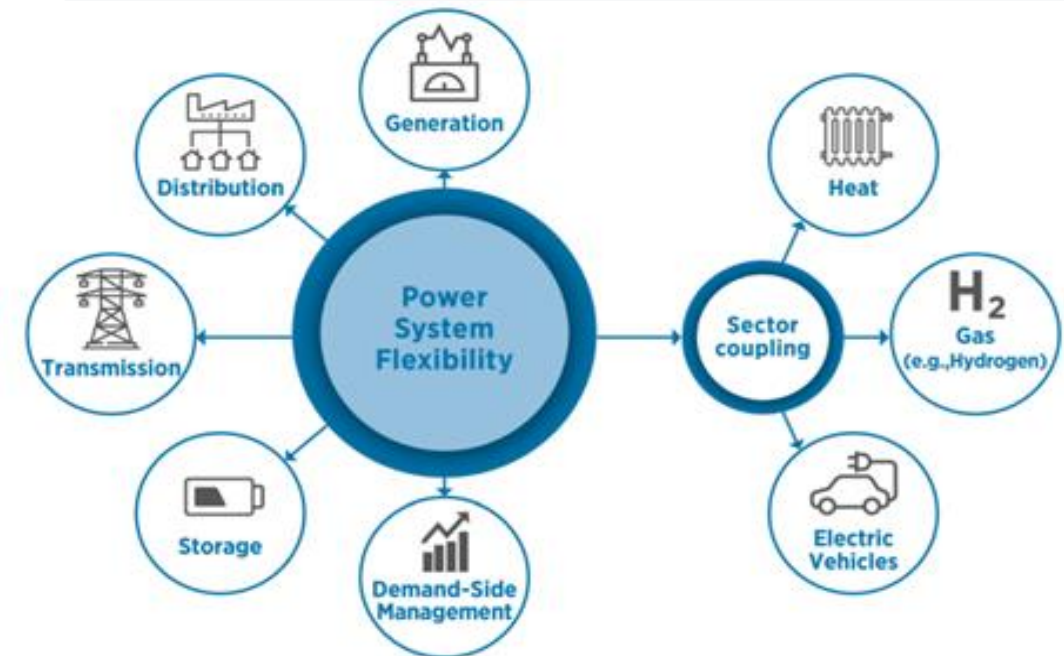
→ **Developing island specific energy system models**

Flexibility of the energy system

- 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

The Demonstration sites

Procida Island (IT)



- *Smallest island in the Gulf of Naples, Area = 4.26 km²*
- *Density = 2449 inhabitants/km²*
- *Challenges: Grid congestions, High seasonality of demand (tourism)*



G I F T

Hinnøya Island Cluster (NO)







- *Fourth largest island in Norway: cluster of large and small islands, Area = 2240 km²*
- *Density = 14.52 inhabitants/km²*
- *Challenges: Limited possibilities of new grid connections, Fish farms using diesel generators*



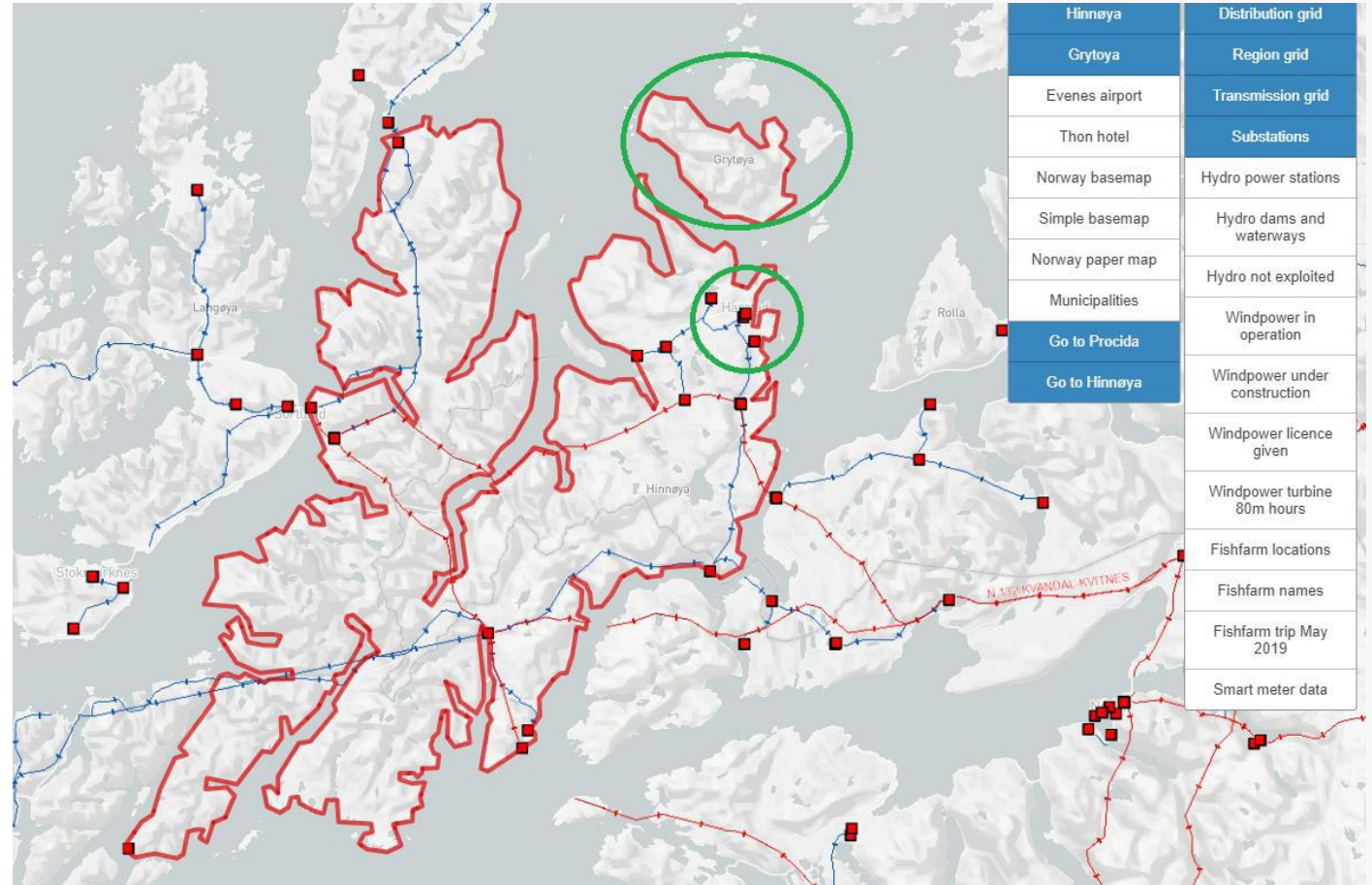
Hinnøya Island Cluster

GIFT Flexibility solutions

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

- Modeled as 3 regions
- 12 seasons
- 2 Weekly
- 24 Daynite

Geographical locations of Hinnøya island cluster



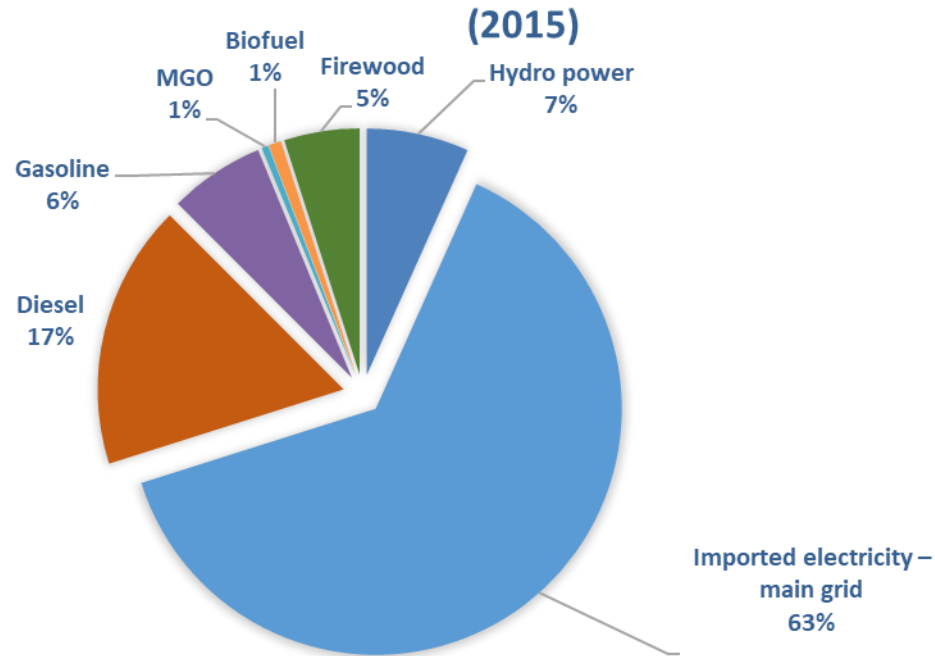
GIFT DigitalTwin, 2019



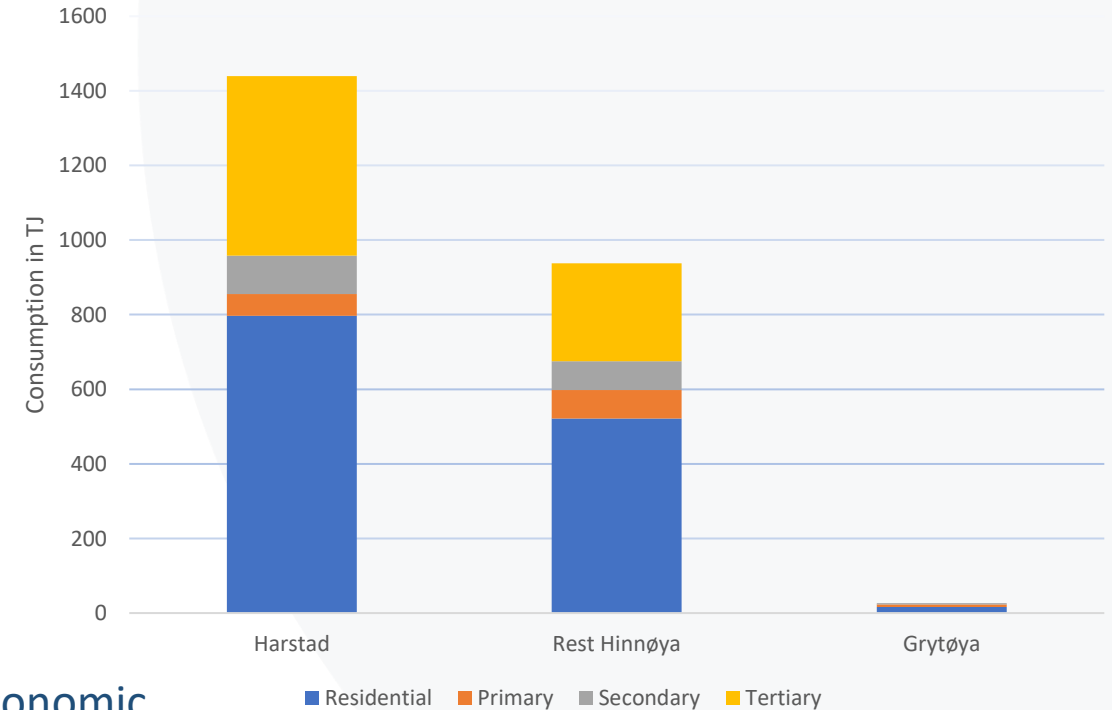


Hinnøya Island Cluster: Energy profile

ENERGY MIX OF HINNOYA ISLAND CLUSTER (%)



Electricity consumption by sector and region



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



G I F T

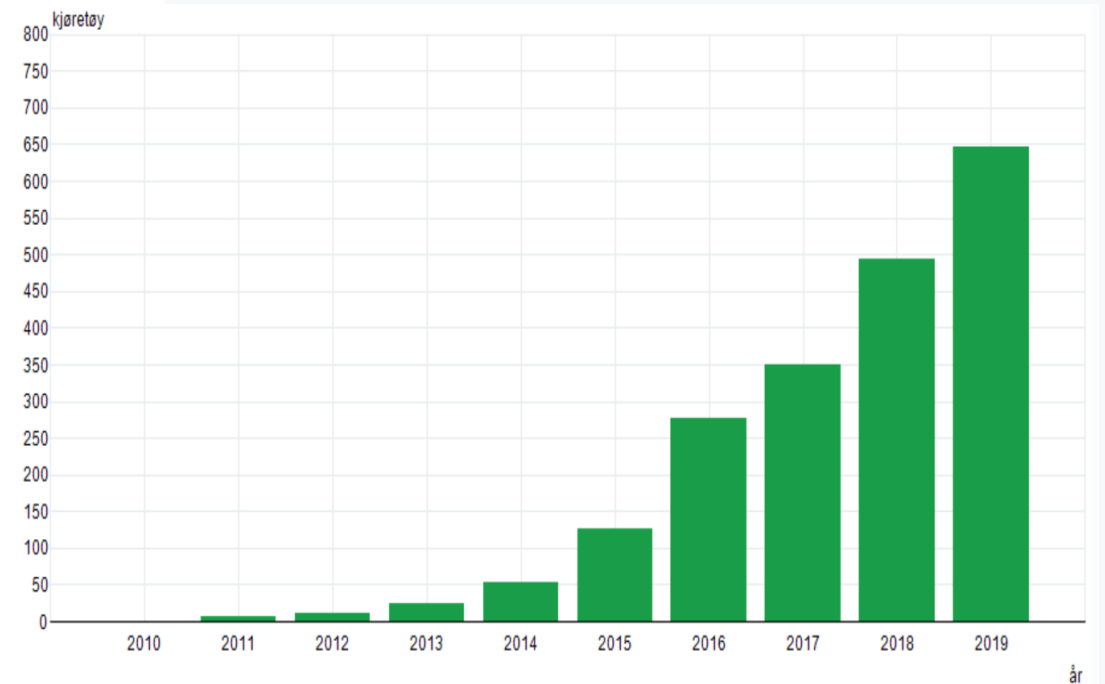


EV deployment on the long-term

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



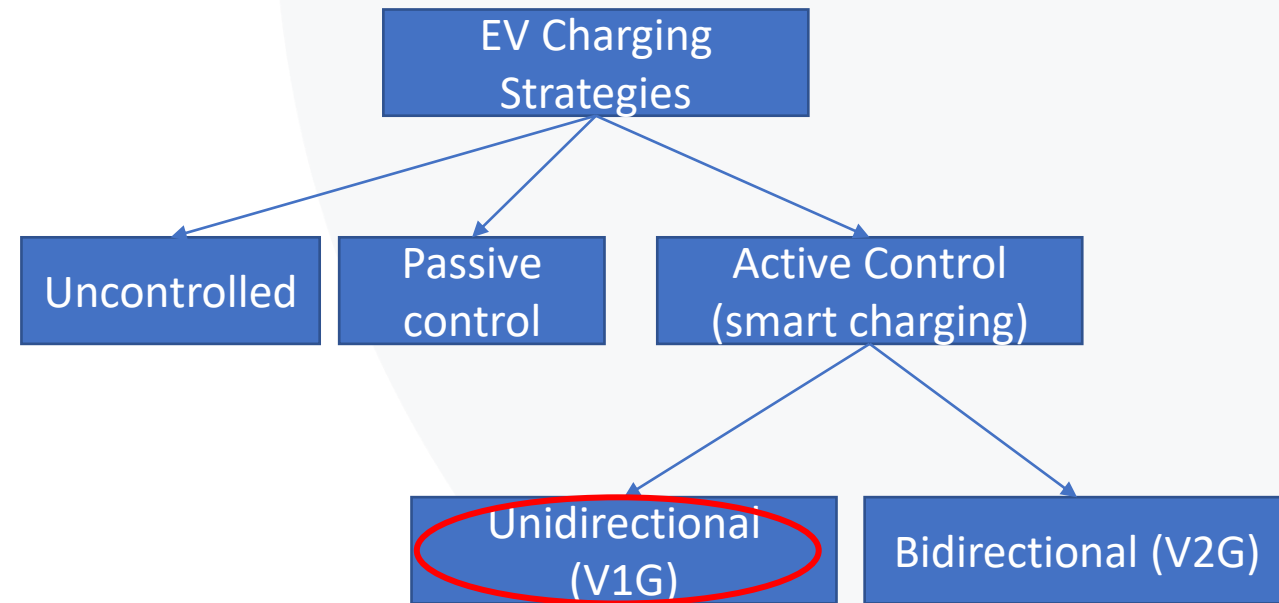
Source: GIFT Deliverable D7.1



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)



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)



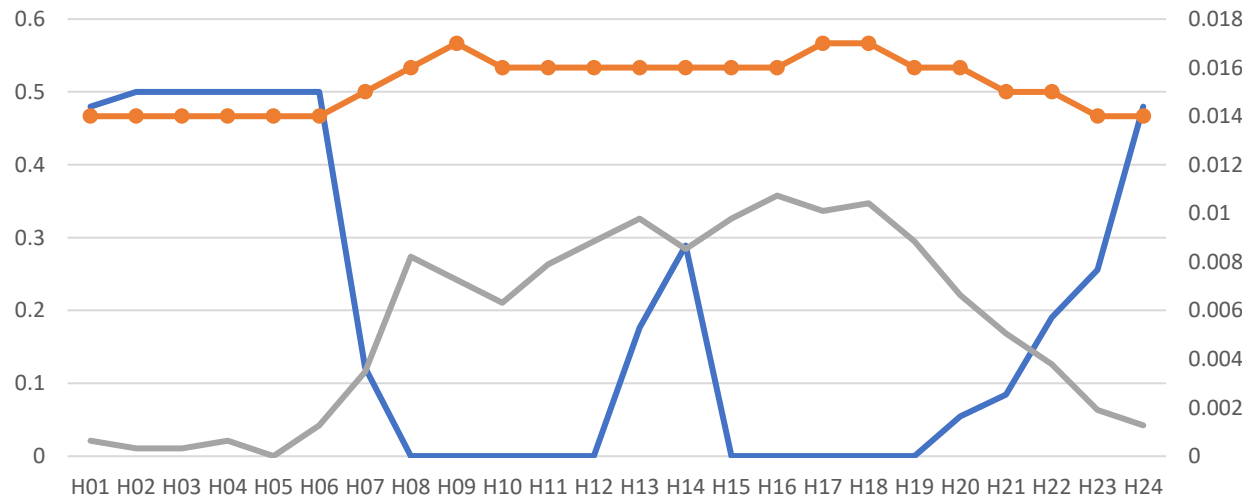
Future transport service demand and mobility demand, based on the national transport model of Norway (NTM) & U.S. Department of Transportation resp. + future electricity prices (NVE forecasts)



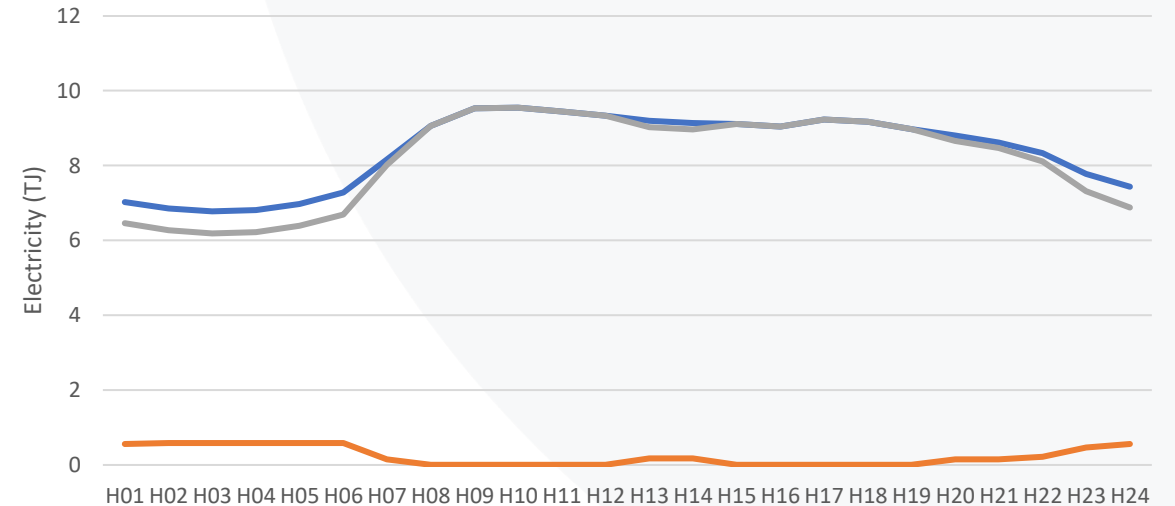
Taxation on transport greenhouse gas emissions (CO₂, NO_x)

TIMES EV charging strategy

Charging BEVs with respect to electricity prices (2035)



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



GIFT

— Charging control (TJ) — Discharge (TJ) — Electricity prices (M€/TJ)

— Load with EV charging — EV charging — Load demand

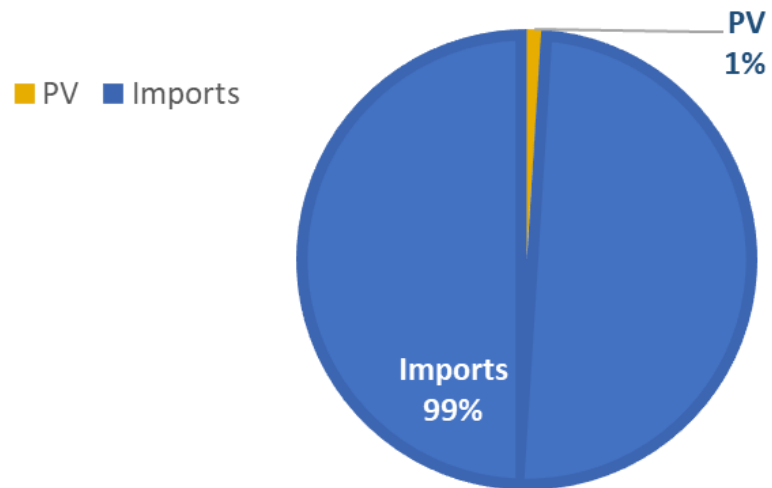




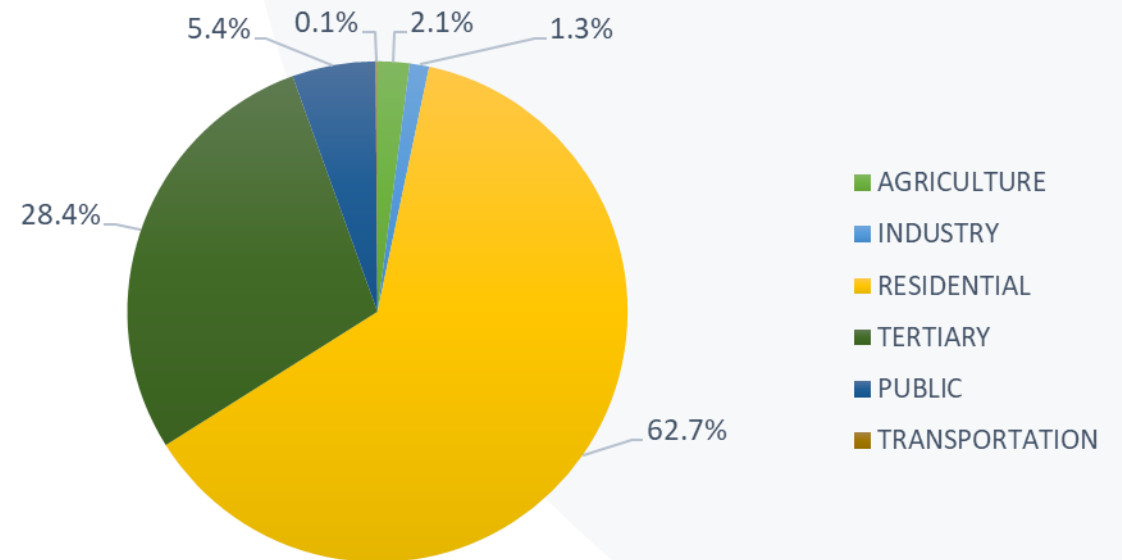
Procida Island: Energy profile

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

Electricity supply (2018)



Electricity consumption (2018)



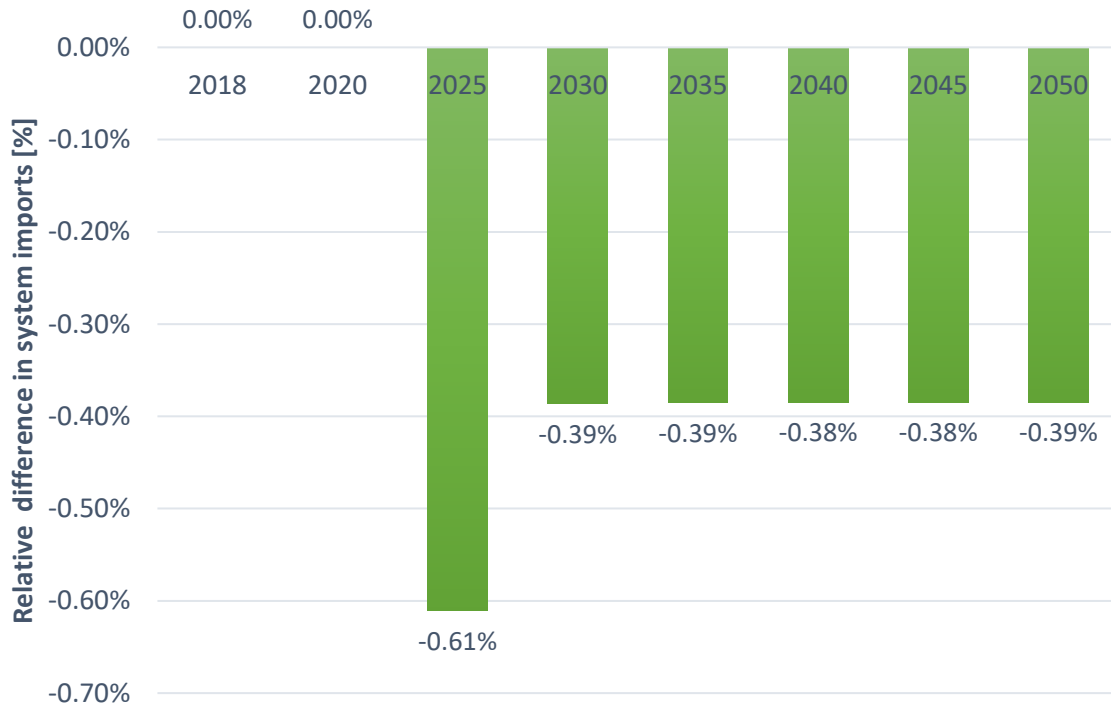


Prosumers in Procida: Self-consumption

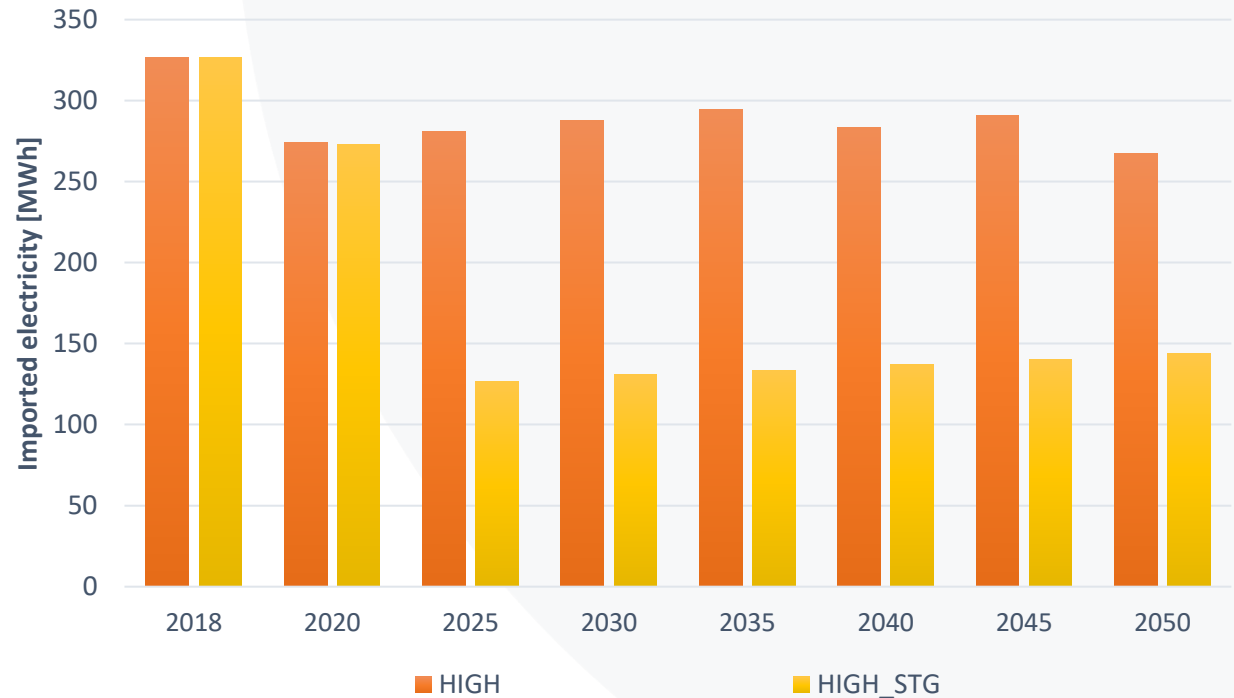
Exploiting Solar energy potential

Reduction in electricity imports in public buildings >50%

Total imports decrease at peak hours



Electricity imports to public buildings



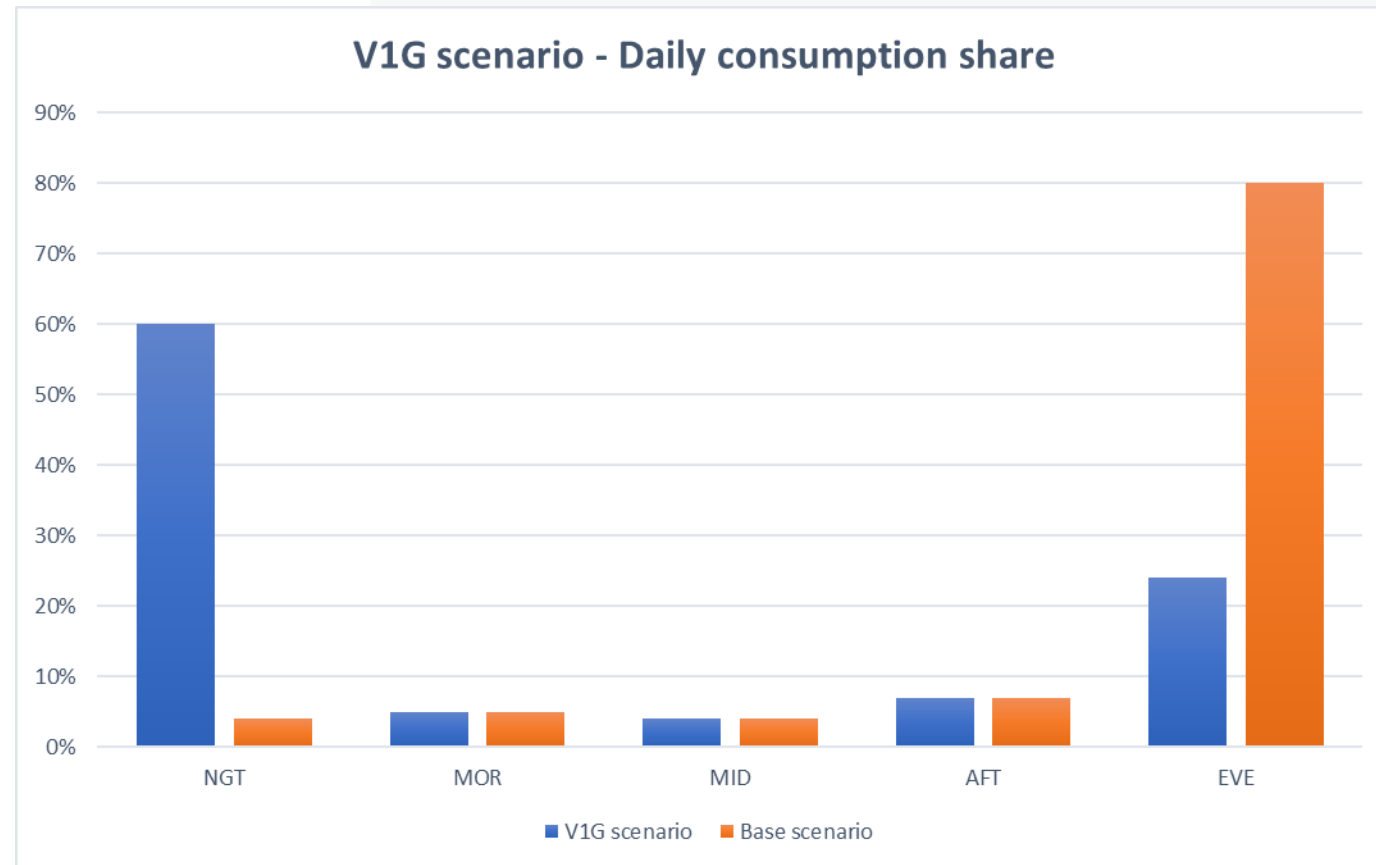
Source: Giulia Grazioli



Prosumers in Procida: Electric vehicles

Used as additional electricity demand

- No investment costs or fixed O&M
- Load depends on the fleet dimension, technical parameters and behavioural attitudes
- Fleet evolution in time is based on the Italian strategic plan for the energy system (PNIEC): need of number of vehicles deployed to calculate the electricity demand
- 80% charging at peak hours



G I F T

Conclusion & Lessons learned

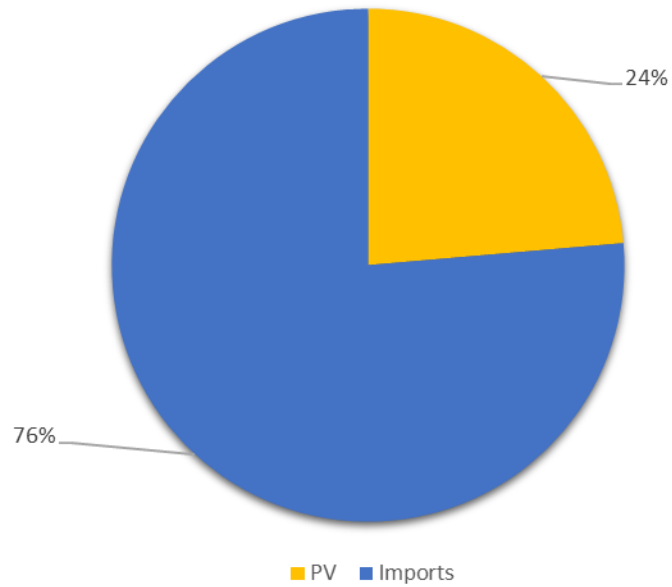
- Flexibility & RE integration through:
 1. Production of electricity on the island
 2. Storage technologies



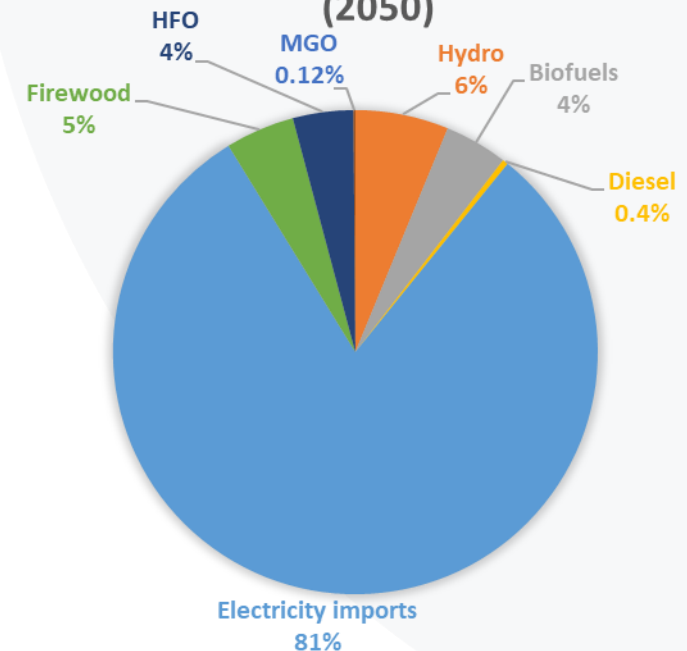
- Cross-sectoral flexibility solutions: Electrification of the transport sector for RE integration and decarbonization (*specific for Norway*)



FINAL ENERGY MIX OF PROCIDA (2050)



FINAL ENERGY MIX OF HINNOYA ISLAND CLUSTER (2050)



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

REFERENCES 1

1. <https://www.gift-h2020.eu/>
2. GIFT Deliverable D7.2 <https://www.gift-h2020.eu/delivrables/>
3. “TIMES-HINNOYA” Norwegian University of Science and Technology (NTNU), 2020
4. R. Loulou, G. Goldstein, A. Kanudia, A. Lettila, and U. Remme, ‘Documentation for the TIMES Model - Part I’. Jul. 2016. <https://iea-etsap.org/>
5. EUROPEAN COMMISSION DG ENERGY. (2017, octobre 20). Clean energy for all Europeans package [Text]. Energy - European Commission. https://ec.europa.eu/energy/topics/energy-strategy/clean-energy-all-europeans_en
6. IRENA. (2018). Power system flexibility for the energy transition. /Publications/2018/Nov/Power-System-Flexibility-for-the-Energy-Transition. /publications/2018/Nov/Power-system-flexibility-for-the-energy-transition
7. IEA, ‘Status of Power System Transformation 2019’, p. 32, May 2019.

REFERENCES 2

1. Knezovic, K. (2016) 'Active integration of electric vehicles in the distribution network - theory, modelling and practice', Ph.D. Thesis, DTU.
2. M. of C. and Environment, 'Meld. St. 41 (2016–2017)', *Government.no*, Jun. 16, 2017.
<https://www.regjeringen.no/en/dokumenter/meld.-st.-41-20162017/id2557401/> (accessed May 17, 2021).
3. Norwegian Ministry of Transport and Communications, 'National Transport Plan 2018-2029'.
<https://www.regjeringen.no/contentassets/7c52fd2938ca42209e4286fe86bb28bd/en-gb/pdfs/stm201620170033000engpdfs.pdf> (accessed May 03, 2021).
4. Norway's Fourth Biennial Report 2020, Framework Convention on Climate Change,
https://unfccc.int/sites/default/files/resource/Norway_BR4%20%282%29.pdf
5. White paper Norway's Climate Action Plan (Meld. St. 13 (2020-2021))
<https://www.regjeringen.no/en/aktuelt/heilskapeleg-plan-for-a-na-klimamalet/id2827600/>
6. Norwegian Water Resources and Energy Directorate (NVE), Long-Term Power Market Analysis (Langsiktig kraftmarkedsanalyse 2019-2040)(in Norwegian). 2019, NVE.
7. Fuel taxation <https://www.skatteetaten.no/en/business-and-organisation/vat-and-duties/excise-duties/about-the-excise-duties/mineral-product/>

Thank you for your attention !

Q&A

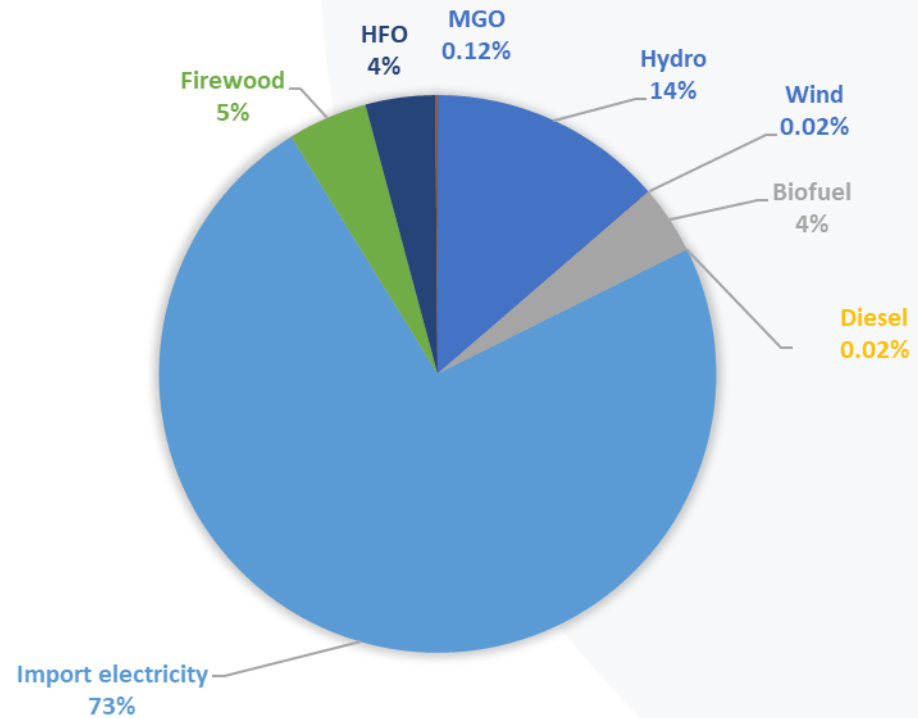
e-mail: sophie.chlela@mines-paristech.fr



Annex

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

FINAL ENERGY MIX WITH NEW RE POTENTIAL(2050)



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.

