



The Green Islands Project

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MIT Portugal Program

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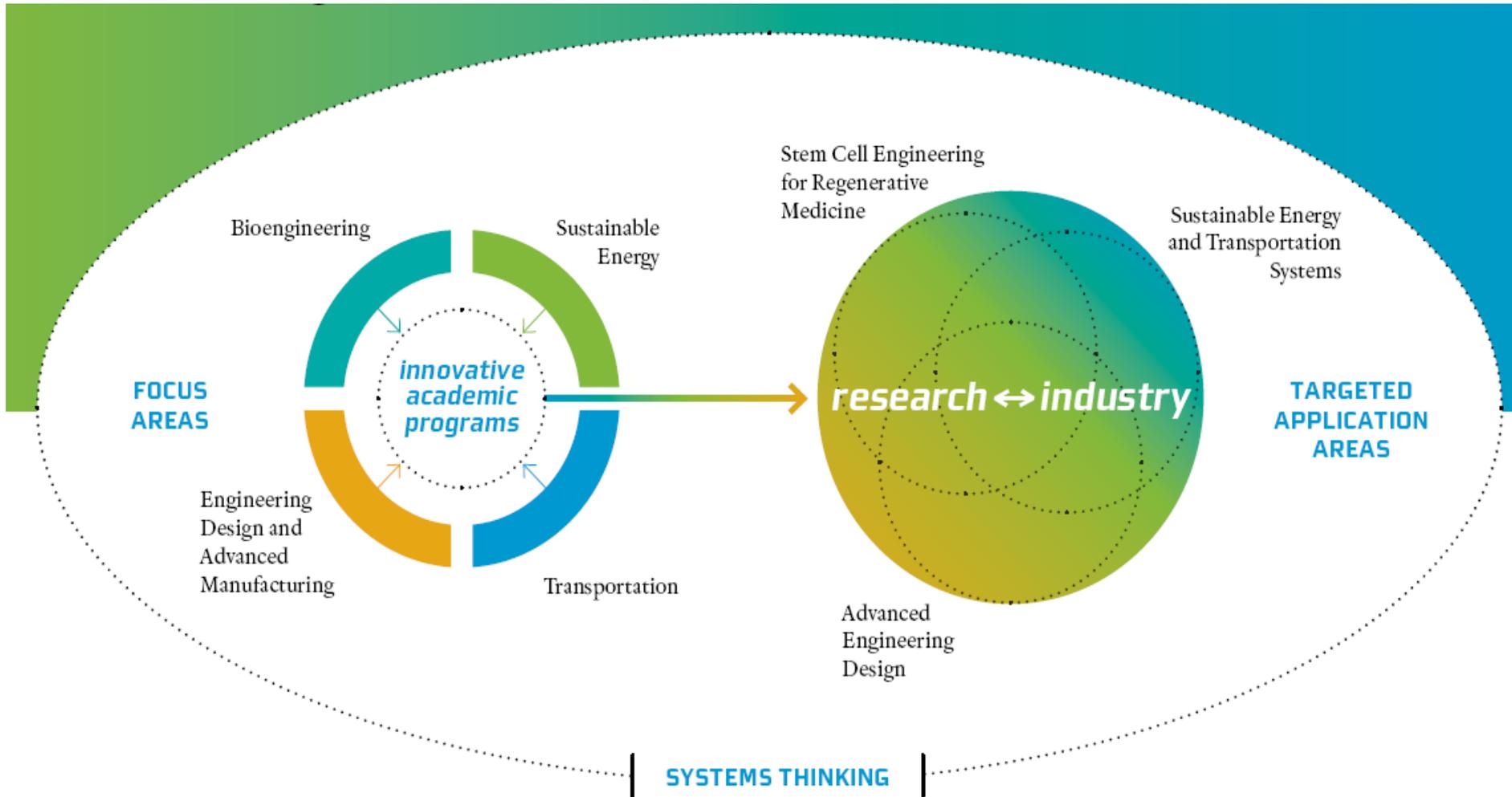
MIT Portugal

**2011 INTERNATIONAL WORKSHOP ON
ENVIRONMENT AND ALTERNATIVE ENERGY**

“Global Collaboration in Sustainable Environmental and
Alternative Energy Strategies”

Noordwijk, The Netherlands – November 15 – 18, 2011

MIT-Portugal - Our knowledge-creation model



- 350 PhD students
- 190 Executive Master Students

Why a Green Island?

“Islands” represent excellent case studies for **developing** and **demonstrating in full scale** new methodologies for the **sustainable and economic transformation** of energy systems based on **renewable energies**.

They allow for testing new **technologies, infrastructures and behavior**, in the context of new challenges such as climate change or energy security.

Living labs!

Which are the Main Challenges ?

The Cost-Effective and Implementable Transition to a “Green Island” Requires...

- **A detailed understanding local energy *resources***

- ... including their daily, seasonal, and inter annual variability

- ... where and when they best fit the current and future energy system

- ... where, when and under what circumstances renewables complement or conflict one another

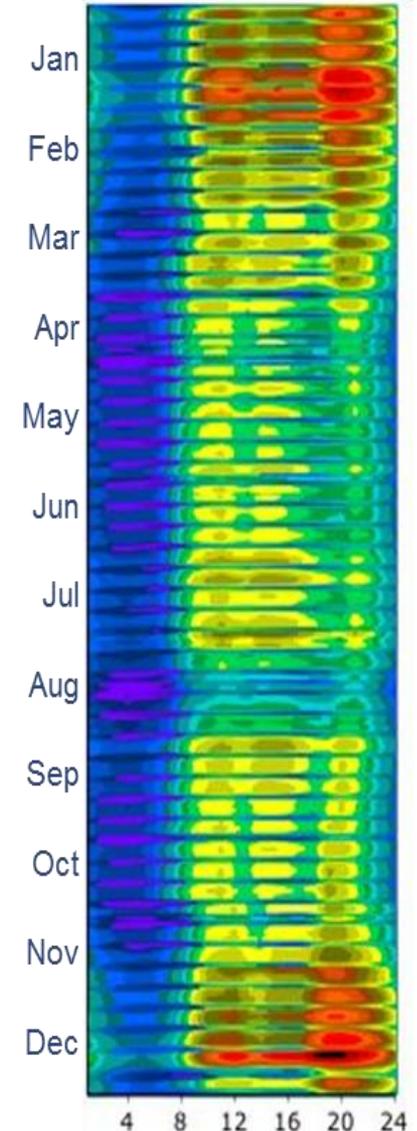
- **A detailed understanding future *energy service needs***

- ... including detailed energy demand patterns, both behavioral and technological

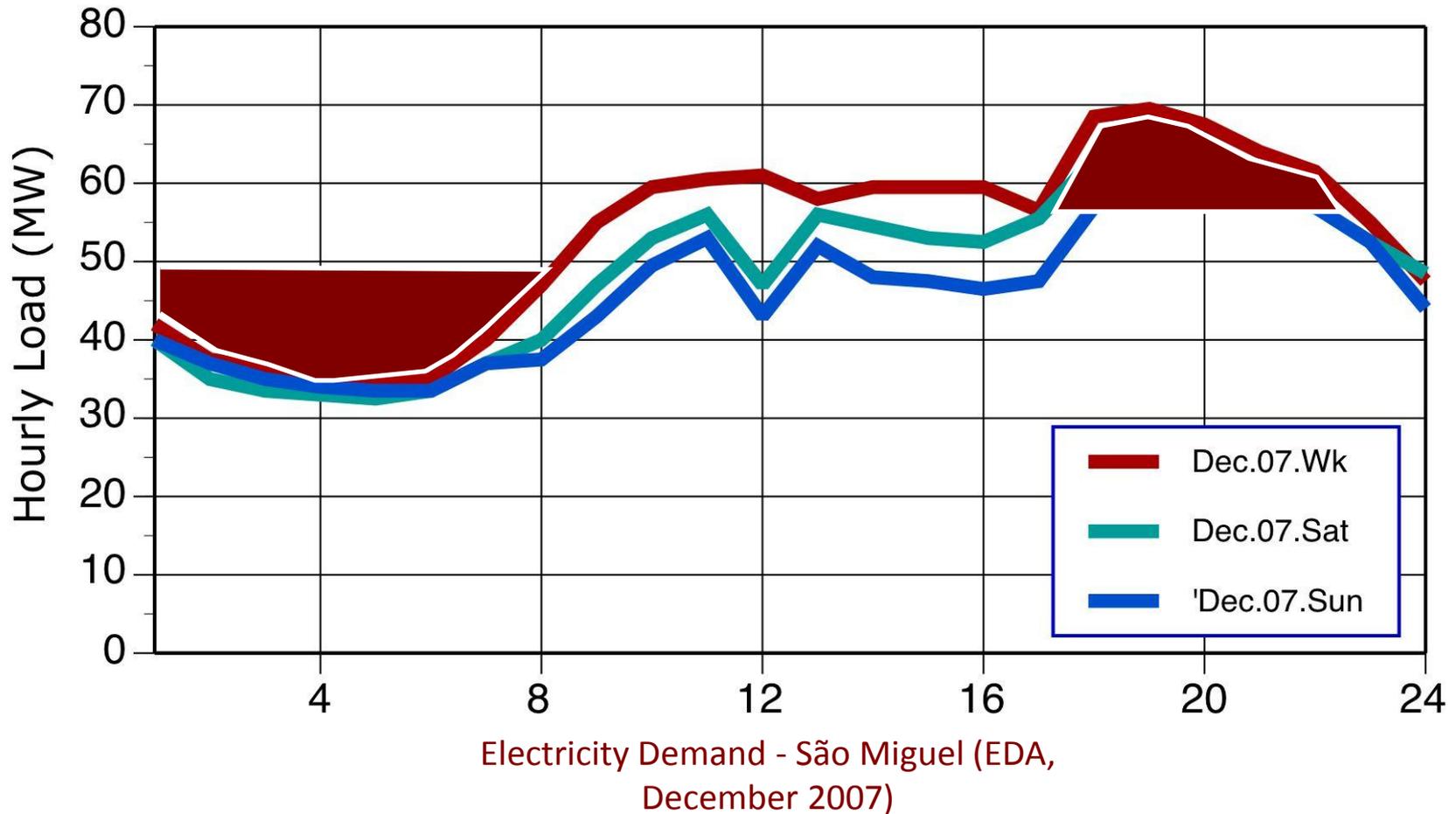
- ... economic, demographic and other trends affecting demand

- ... *not only a question of technologies, people matter!*

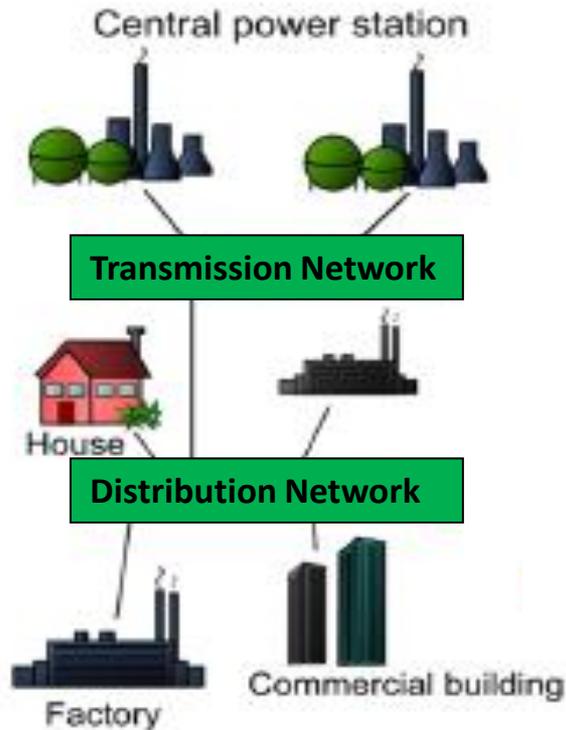
Hourly Electricity Demand



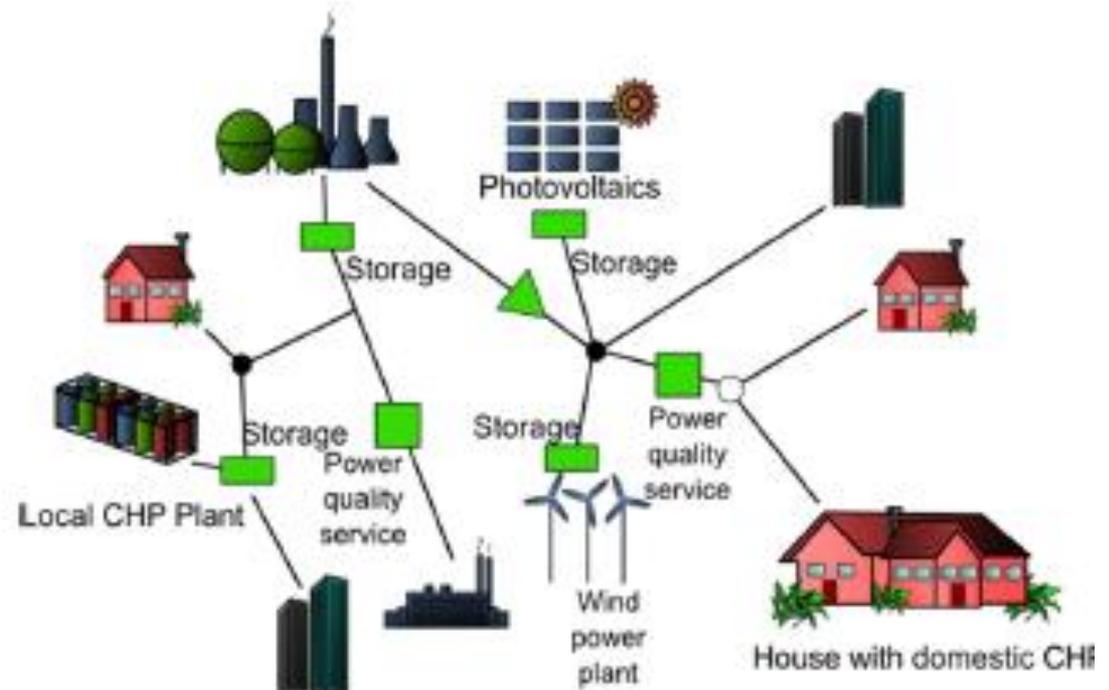
Example for São Miguel: Electricity Storage



Technology transitions

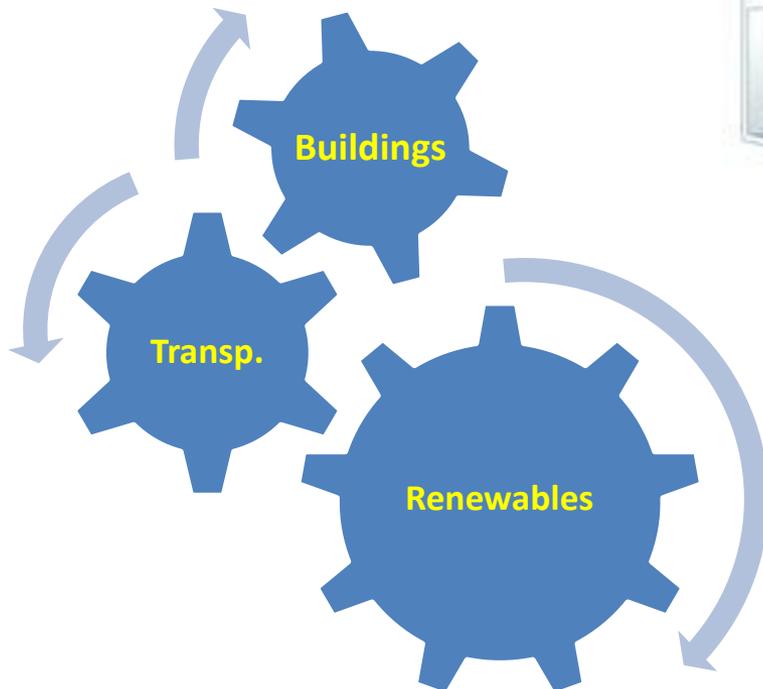
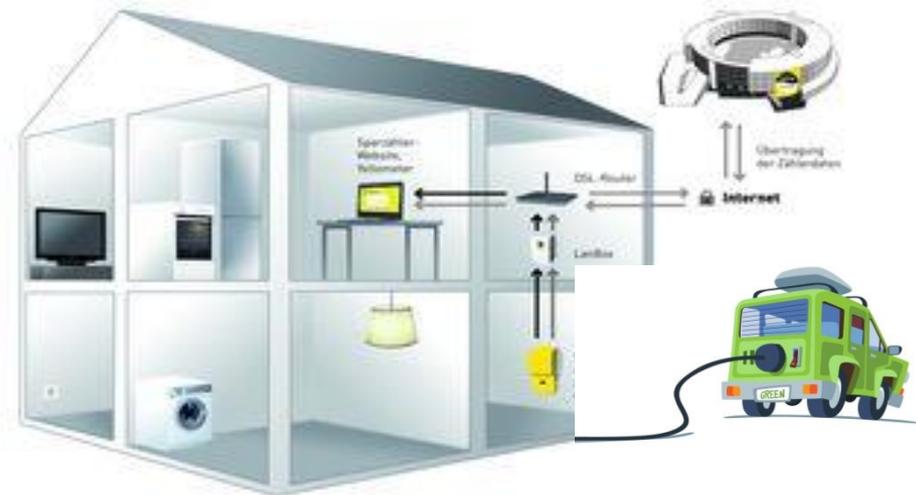


CENTRALIZED PRODUCTION



DECENTRALIZED PRODUCTION

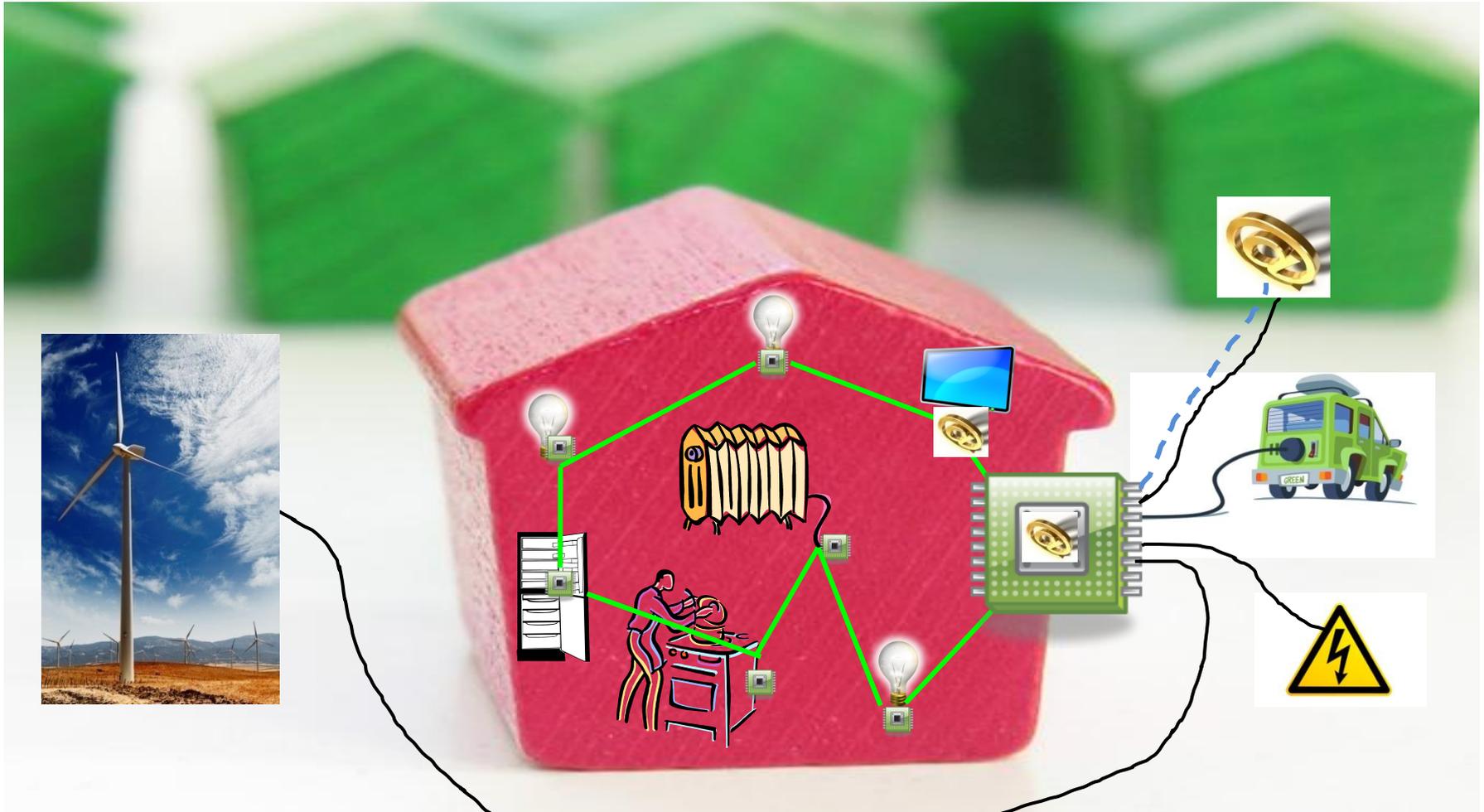
The future – Intelligent Energy Networks, the **energy software revolution**



The “secret” is that they need to cooperate, they are not working alone



The future – Intelligent Energy Networks, the **energy software revolution**



The case study, Azores

The Azores are an archipelago located in the middle of the Atlantic Ocean with 9 islands:

	Population (No.)	Households (No.)	Land Area (km ²)	Total Primary Energy (TJ)	Electricity Production (GWh)	Vehicles (No.)
São Miguel	133.281	40.388	745	9.118,09	428,75	56.520
Terceira	55.844	16.922	400	3.102,35	207,66	27.736
Faial	15.527	4.705	173	1.065,11	52,81	8.491
Pico	14.840	4.497	445	701,31	43,35	7.416
São Jorge	9.492	2.876	244	595,84	26,63	5.099
Santa Maria	5.565	1.686	97	453,20	19,89	2.989
Graciosa	4.879	1.466	61	234,15	13,09	2.231
Flores	4.099	1.242	141	271,18	11,37	2.527
Corvo	479	145	17	21,40	1,22	93
Azores	244.006	73.927	2.322	15.562,62	804,76	113102



Pico



Flores



São Miguel



The Green Islands Project – A living lab

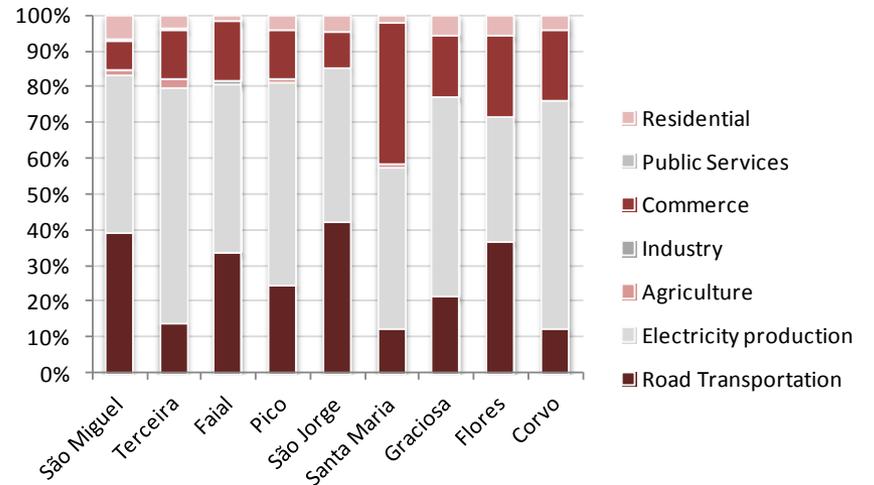
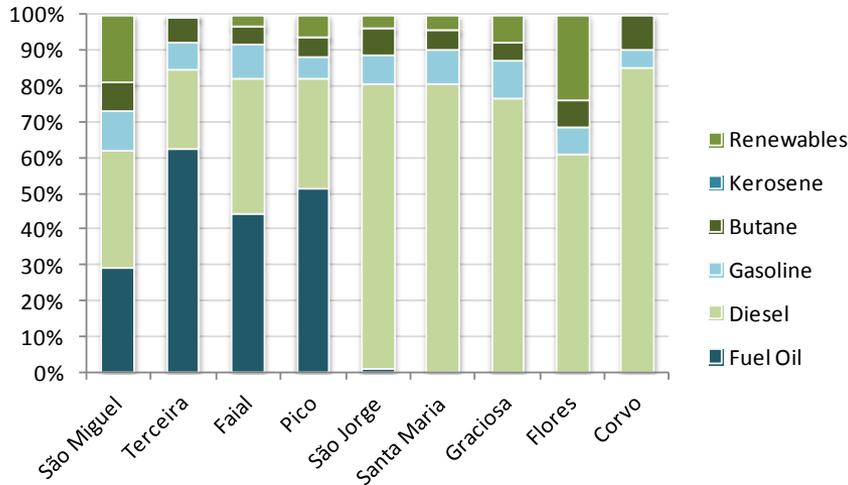
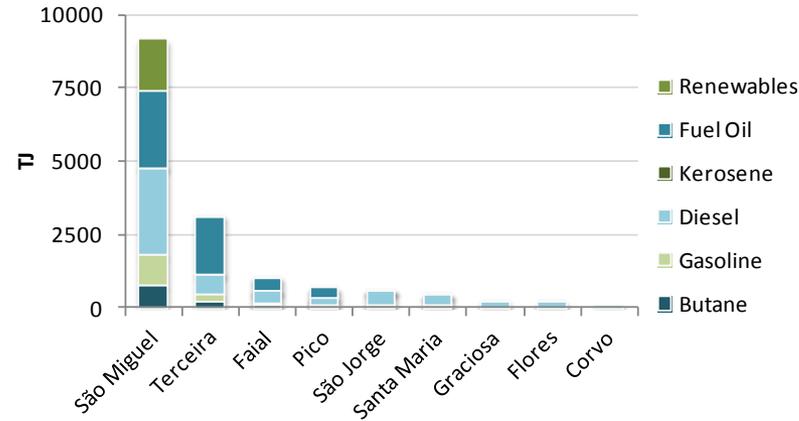
The Regional Government of the Azores defined a **vision** for the future energy system of Azores in 2018 to address the combined challenges of climate change mitigation, energy supply independence and security, and economic and social development challenges:

- **75% of the Electricity is produced from renewable sources;**
- 40% of Total Primary Energy is produced from renewable sources;
- 50% of Total Primary Energy is used in the form of electricity.

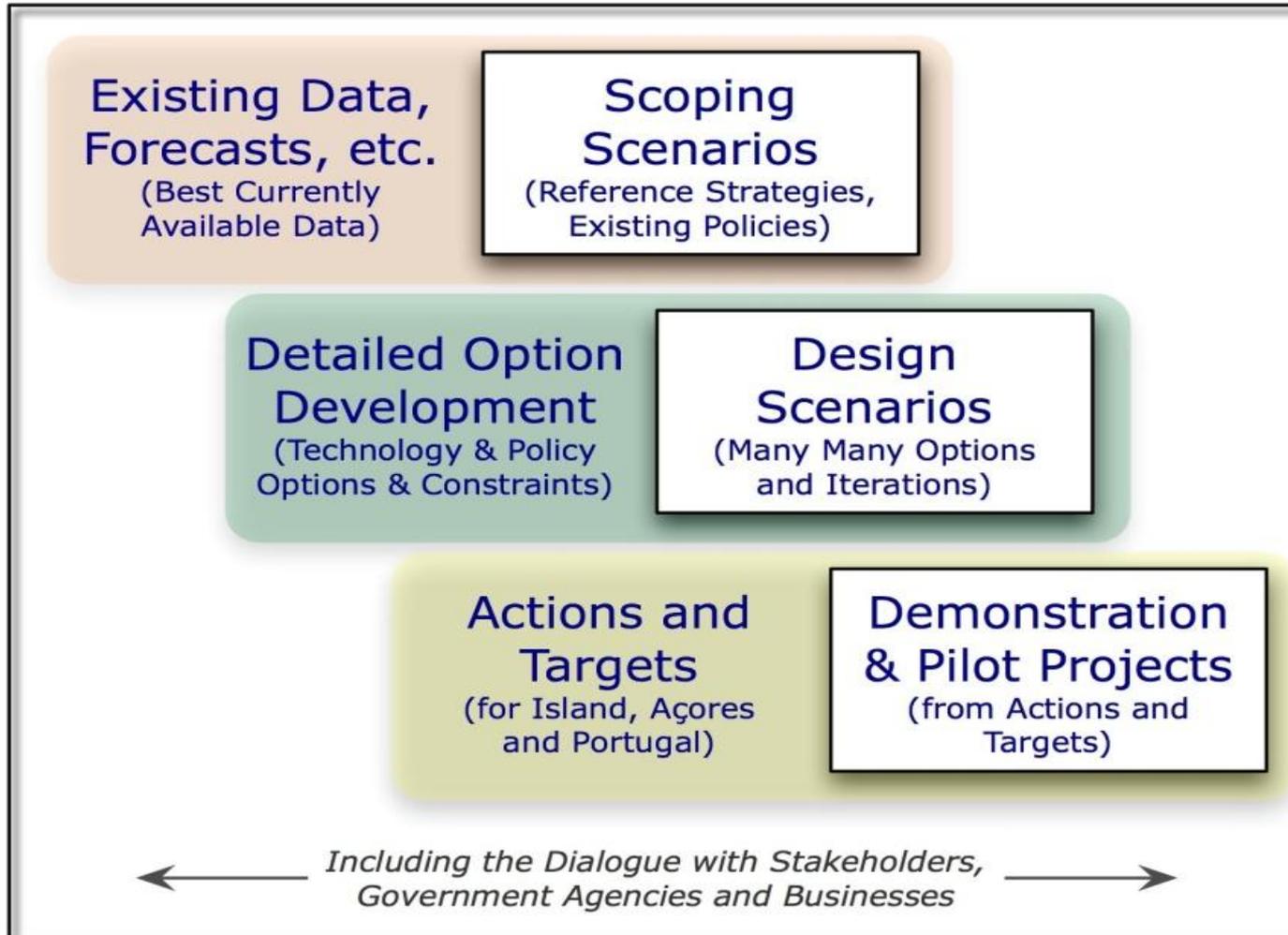
International Universities Partnership

Relevant companies

The Azores Green Islands, Rich diversity



Green Islands, The approach Research Strategy



Scoping Scenarios

**Existing Data,
Forecasts, etc.**
(Best Currently
Available Data)

**Scoping
Scenarios**
(Reference Strategies,
Existing Policies)

**Detailed Option
Development**
(Technology & Policy
Options & Constraints)

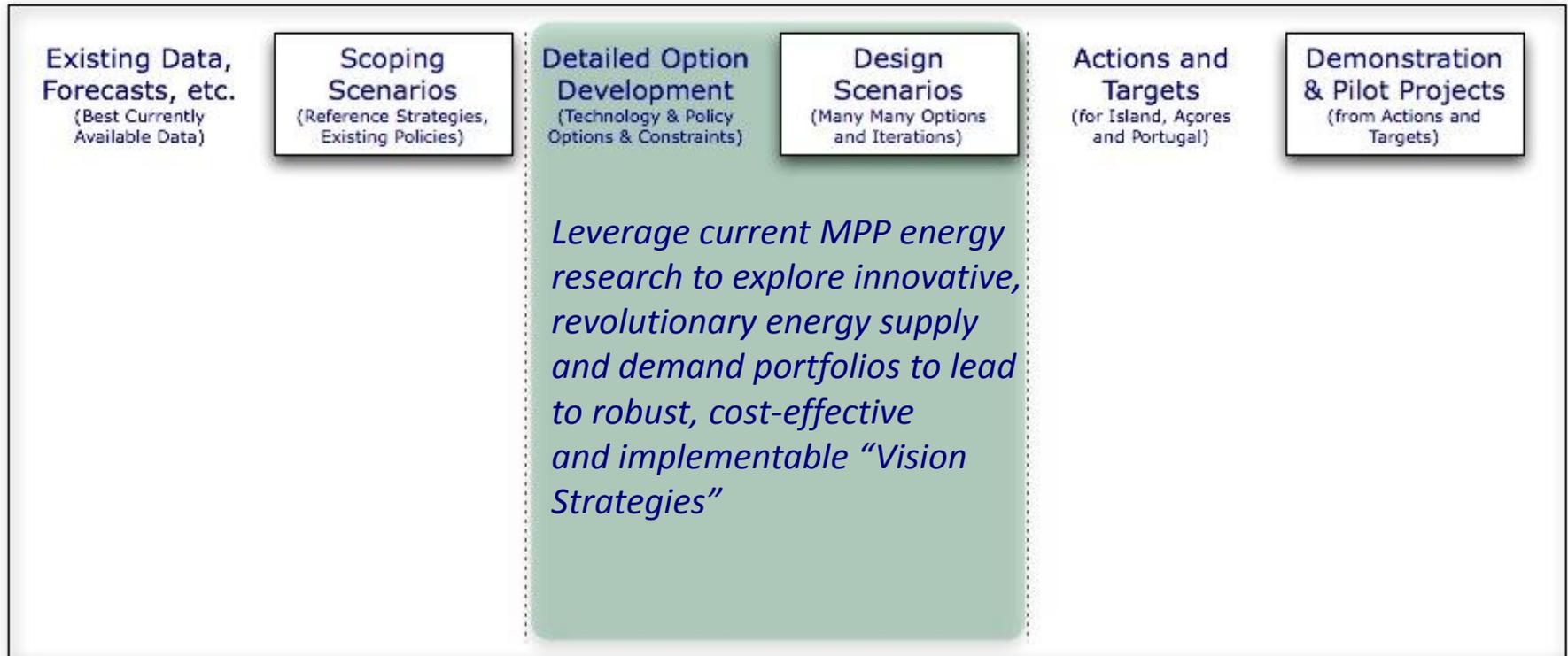
**Design
Scenarios**
(Many Many Options
and Iterations)

**Actions and
Targets**
(for Island, Açores
and Portugal)

**Demonstration
& Pilot Projects**
(from Actions and
Targets)

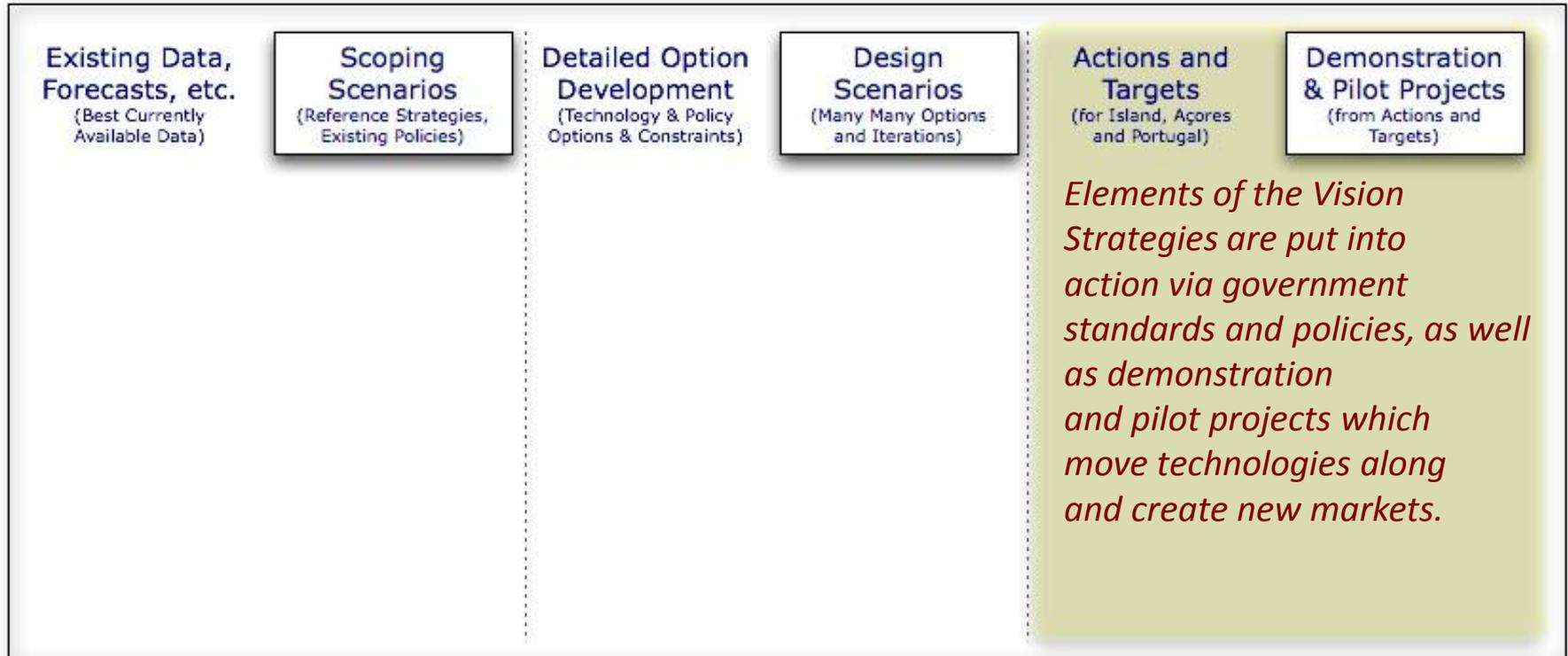
*Use of available data and the
TIMES Model to develop
reference/ evolutionary
scenarios for candidate
islands.*

Design Scenarios



Several stages of “Design Scenarios” research lead to the identification of “robust, cost-effective and implementable Vision Strategies” and their component options.

Implementing Vision Strategies



Partnering with companies and various government agencies across Scoping, Design and Demonstration stages is essential for high quality and relevant Green Islands research.

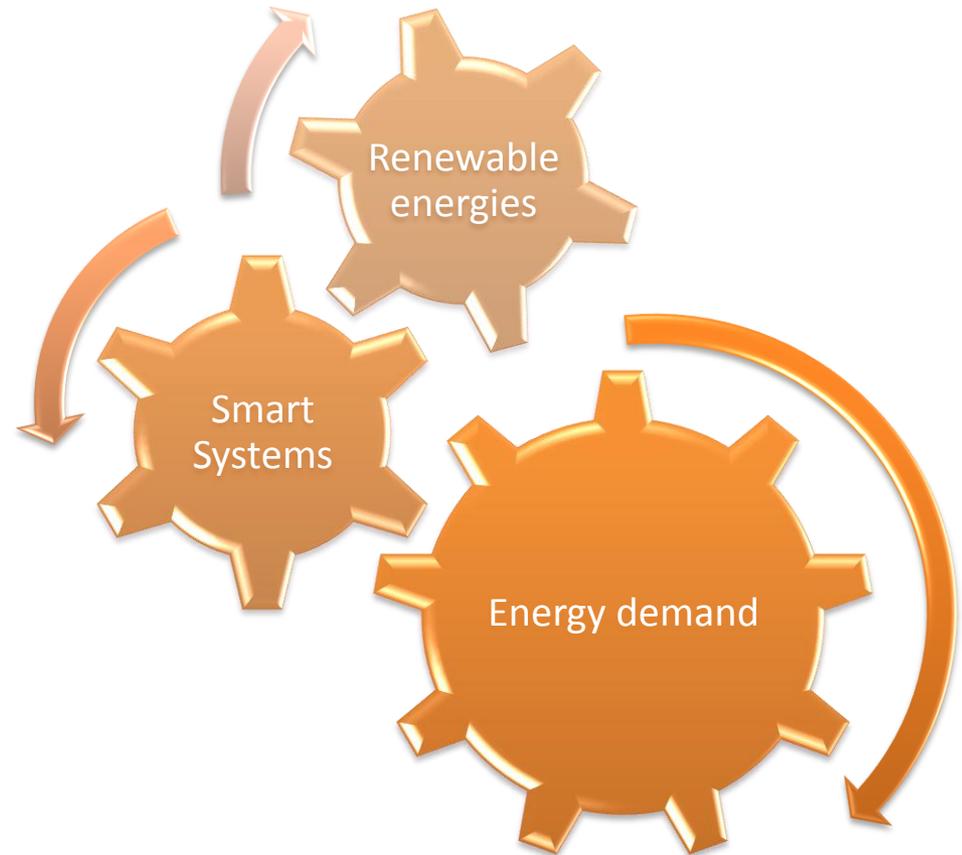
Sample research topics

To increase sustainability and security of supply, several options must be considered:

- Renewable resources
- Energy storage
- Consumer behavior
- Energy efficiency
- Alternative transportation fuels (biofuels, electricity, others)
- Modern networks
- Dynamic energy demand

To effectively design future energy systems, the interactions between the possible options must be accounted for:

- Intermittency of renewable resources
- Evolution of energy consumption
- Impact of energy efficiency policies
- Charging of electric vehicles



Collaboration Projects with the University of Azores

Energy Supply

Green Islands Field Energy Monitoring (GIFEM)

Evaluation of potential energy of the ocean Tidal/Currents and Thermal gradients in the Azores region

Wave Energy Resource in Azores (Wave Atlas)

Use of woody plant biomass for energy production in the Azores Islands

Evaluation of Solar Energy Potential and its Variability in the Azores

Generating energy from municipal and industrial liquid and solid wastes

Collaboration Projects with the University of Azores

Energy Use



Collaboration Projects with the University of Azores

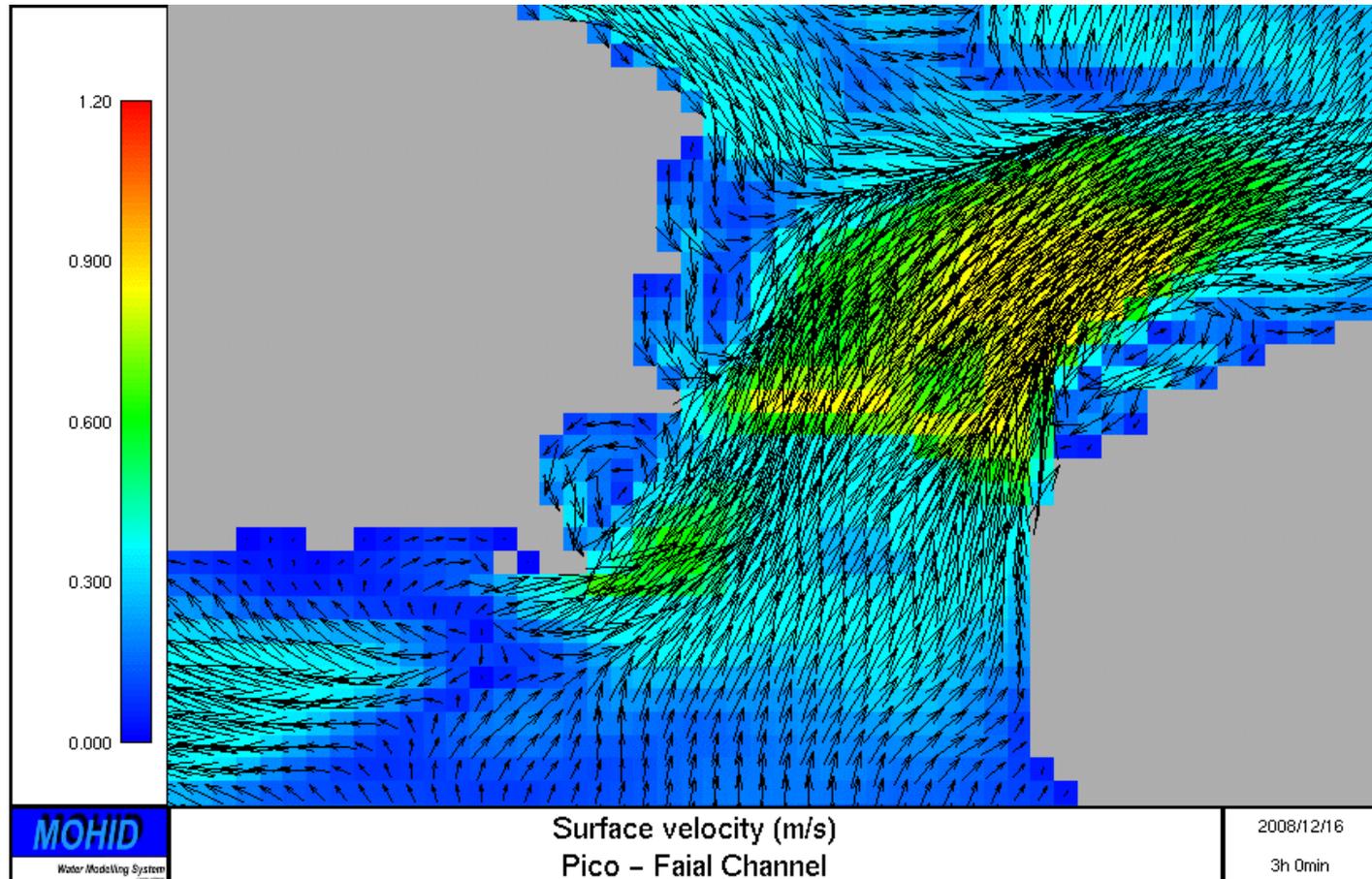
Socio-economic impact

Ecotourism response to Azores Green Islands' outputs (ECOGI)

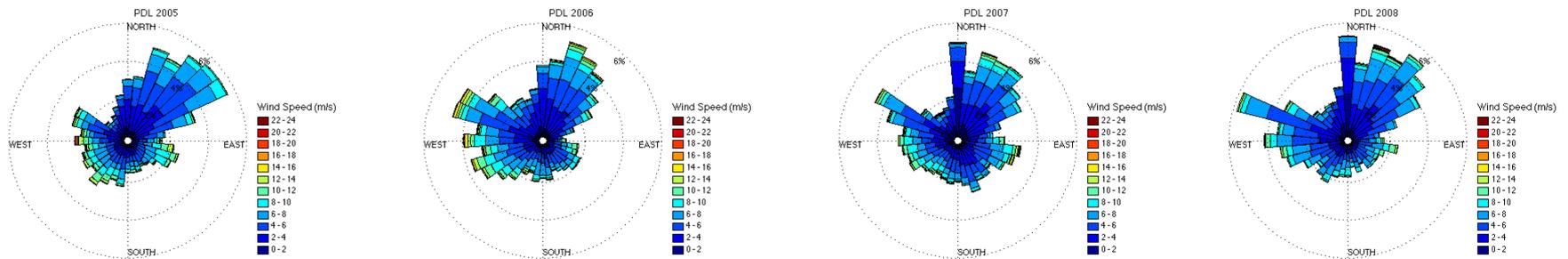
GIBS - Green Islands, Blue Streams

GenARE: Generations of Azoreans and Renewable Energy

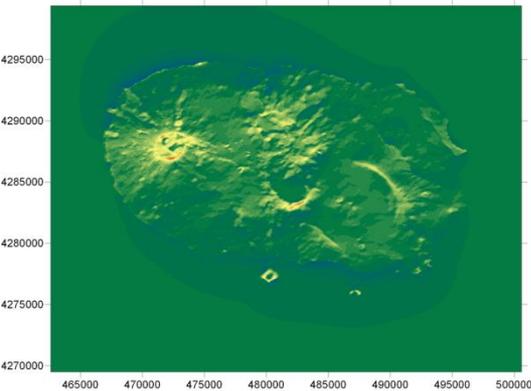
Tides between Pico and Faial



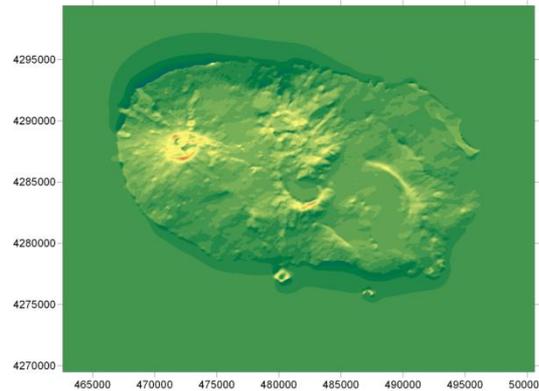
Understanding the wind resource in the islands



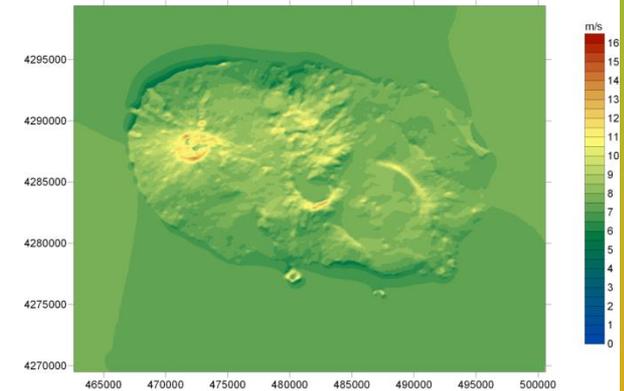
Mean Wind Speed for Terceira island at 10m a.g.l.



Mean Wind Speed for Terceira island at 30m a.g.l.

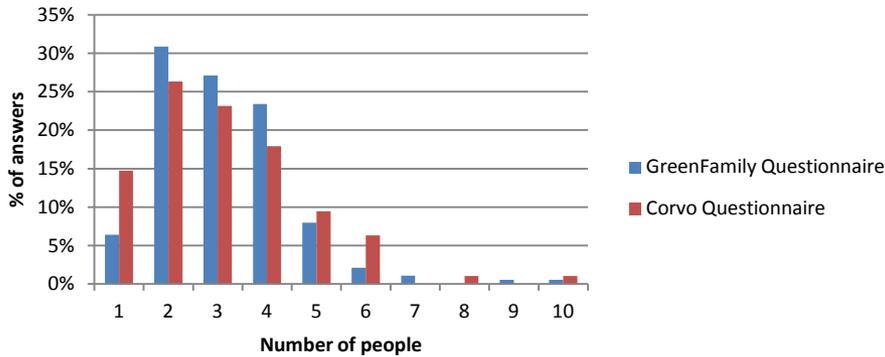


Mean Wind Speed for Terceira island at 50m a.g.l.

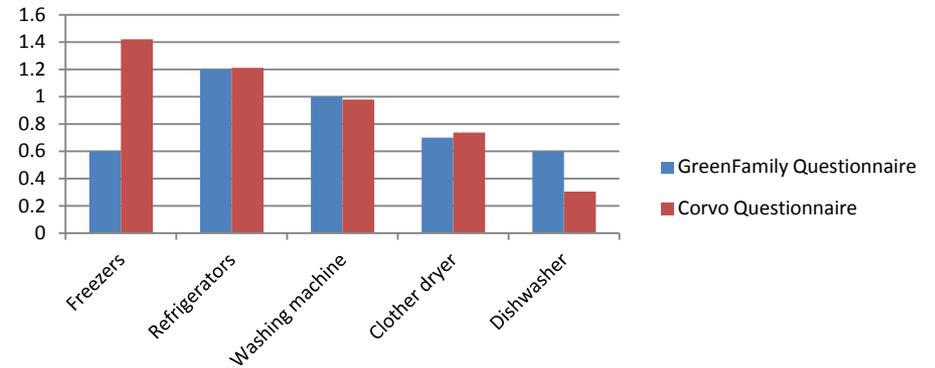


Understading energy consumption in households and the specificities of different islands

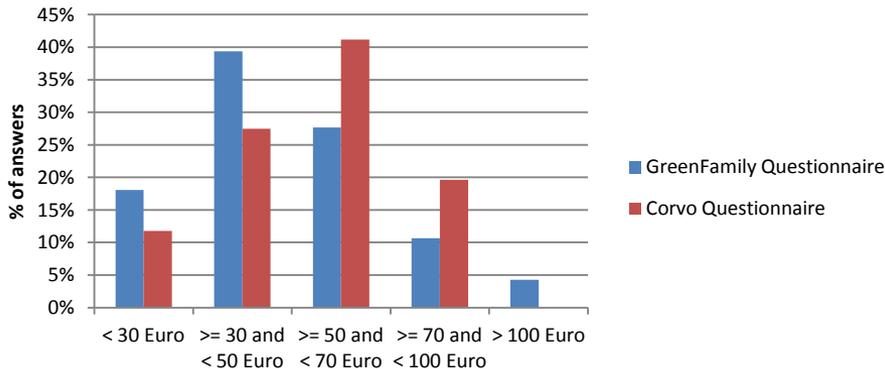
Number of people per household



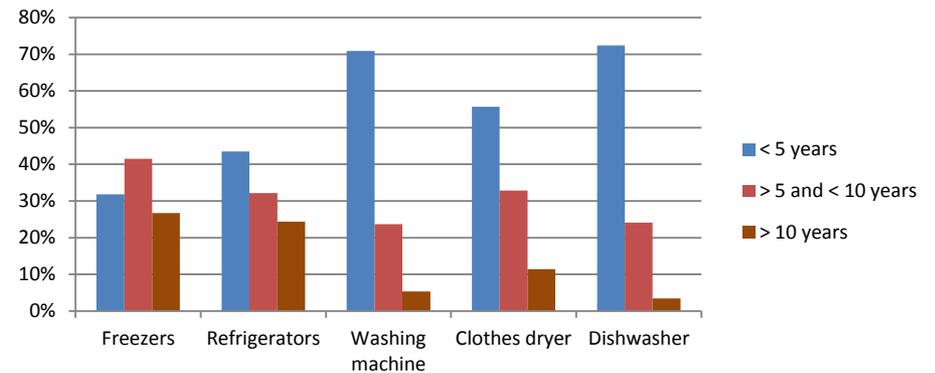
Number of appliances per household



Household electricity costs



Age of the existing appliances in Corvo



Sustainable Corvo

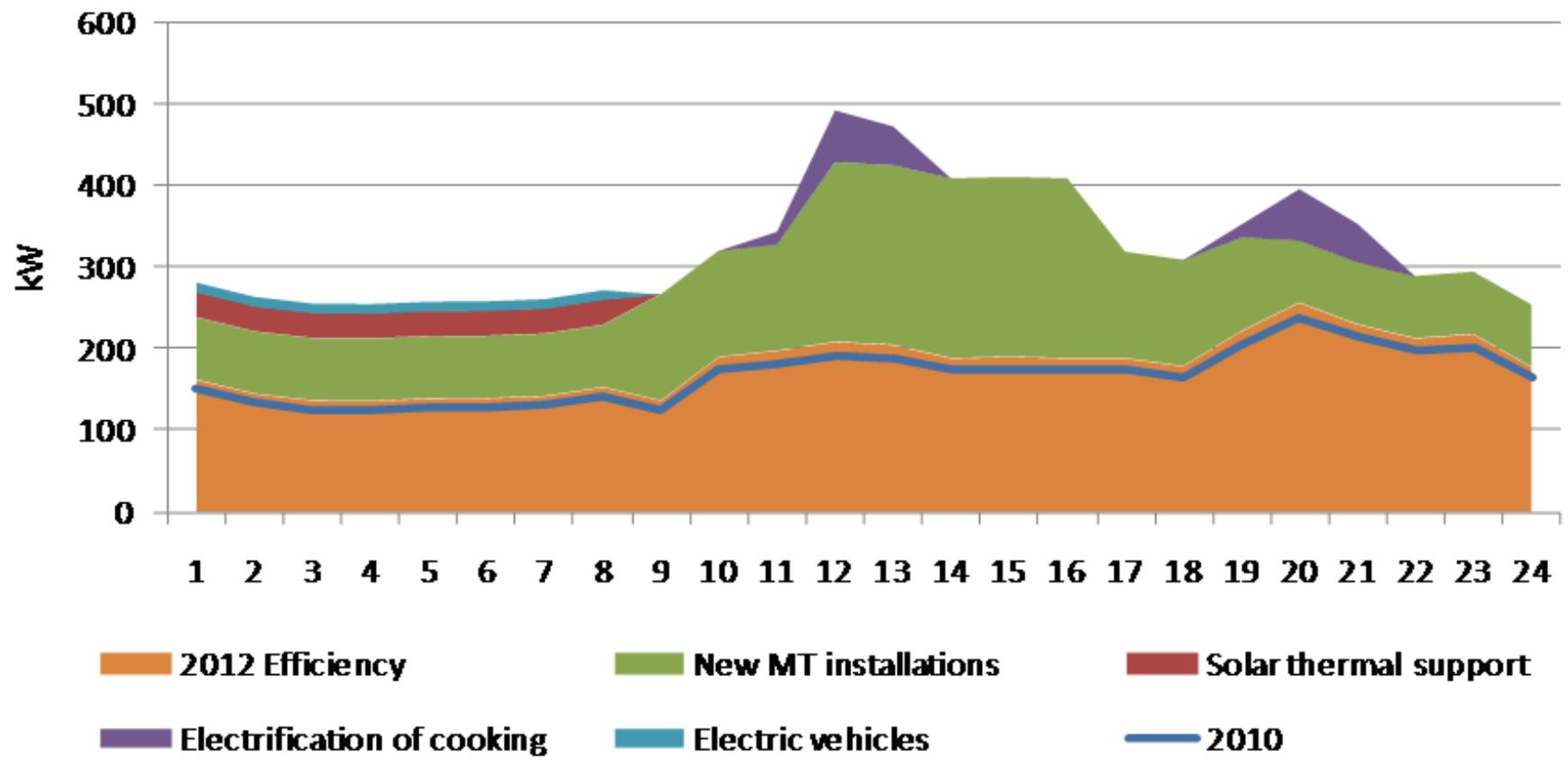
The new paradigm of a sustainable energy system



Land area	17 km ²
Population (2008)	488
Primary energy consumption	21 TJ
Electricity Consumption (2010)	1,4 GWh
Renewables penetration in electricity	0 %
Electricity Generation (4 diesel units)	536 kW
Number of vehicles	93
Number of households	145



Total Load Diagram (after electrification)



Objectives of the Project

- **80% of renewable energy sources** in electricity production
- The island of Corvo as a **living laboratory based on international partnerships** in the area of sustainable energy systems, with the implementation of a myriad of technologies bringing together energy, information and the people.
- Enable the creation of **knowledge in the research institutions and industrial partners** for the development of solutions **towards sustainable energy** systems that can be adopted in other remote regions and elsewhere.

Modeling of the energy system

- Modeling of the system (IST)
- Modeling of the electricity grid (INESC Porto)

Substitution of the consumption of gas

- Solart thermal systems with electric backup for water heating (CMCorvo, Gov. Regional)
- Electrification of stoves and ovens (CMCorvo, Gov. Regional)

Active demand management System

- Development of Energy Boxes and DSM equipments (EFACEC)
- Development of algorithms for the control of the electric backup systems (IST)
- Development of algorithms for the integration of the Energy Boxes with the DSM controller (IST/MIT)
- Forecasting systems for renewable resources and integration with DSM (INESC Porto)

Wind energy (4 X 275 kW_{el}, EDA)

Solar PV (aprox. 250 kW, EDA)

Smart Grid

- Development of Platform for communication with final user (PT)
- Infrastructure for communication and data processing (PT)
- Development of concentrator for the Energy Boxes (EFACEC, PT)

Grid regulation and energy storage systems

- Integrated system for automatic management and control (EDA, INESC Porto, EFACEC)
- Flyweel (EDA)

Electric mobility (V2G – Vehicle 2 Grid)

- Development of algorithms for V2G (INESC Porto)

