EUREC

The Association of European Renewable Energy Research Centres

MYTHS AND REALITIES OF RENEWABLE ENERGY

Editor

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INTRODUCTION

Science shows that **climate change is damaging the environment and hitting food availability and water supply**. There is a growing consensus across many countries that climate change is one of the most serious challenge facing our world today. In the **Paris agreement** 195 countries decided to tackle climate change by limiting global warming to 'well below' 2°C and to pursue efforts to limit it to 1.5°C. A Eurobarometer survey from 2019 found out that 79% of EU population think climate change is a very serious problem and over 80% agree that more public financial support should be given to the transition to clean energy[1].

Most of the emissions of anthropogenic greenhouse gases (GHG) come from burning fossil fuels-coal, natural gas, and petroleum for energy use. Due to the increasing energy demand worldwide, global energy-related CO_2 emissions rose by 1.7% in 2018 to a historic high of 33.1 Gt[2]. Transforming the power, transport and heating & cooling sectors (including industrial processes) to use more renewable energy is necessary to tackle climate change.

The growing share of renewable energy sources (RES) in energy supply entails technical and socio-economic challenges and opportunities of complex nature, which are often not well understood by the general public. This leads to misconceptions about renewable energy. This publication clears up some of the most common misconceptions. For each refutation, research and innovation (R&I) projects from EUREC's members are quoted, showing the importance of R&I to solve complex problems and support a sustainable future.

EUREC
The Association of European
Renewable Energy Research Centres

EUREC IS THE LEADING EUROPEAN ASSOCIATION OF RESEARCH CENTRES AND UNIVERSITY DEPARTMENTS ACTIVE IN THE AREA OF RENEWABLE ENERGY.

The purpose of the association is to **promote and support** the development of **innovative technologies** and **human resources** to enable a prompt transition to a **sustainable energy system.**

EUREC mission is based around the following objectives:

- to coordinate the identification of research needs and R&I related actions for innovative and integrated renewable energy solutions;
- to promote sound policy making in renewable energy R&I;
- to foster collaborative projects and partnerships between research and industrial stakeholders in the area of renewable energy;
- to promote the development of a highly qualified and trained workforce for the renewable energy sector;
- to support international R&I cooperation;
- to communicate renewable energy-related scientific evidence.

[1] Special Eurobarometer 490. Climate change. September 2019. Available at: https://ec.europa.eu/commfrontoffice/publicopinion/index.cfm/survey/getsurveydetail/instruments/special/surveyky/2238. Last time accessed on 07/10/2019.

[2] International Energy Agency. (2019). Global Energy & CO_2 Status Report 2018. Available at: https://webstore.iea.org/global-energy-co2-status-report-2018. Last time accessed on 21 October 2019.

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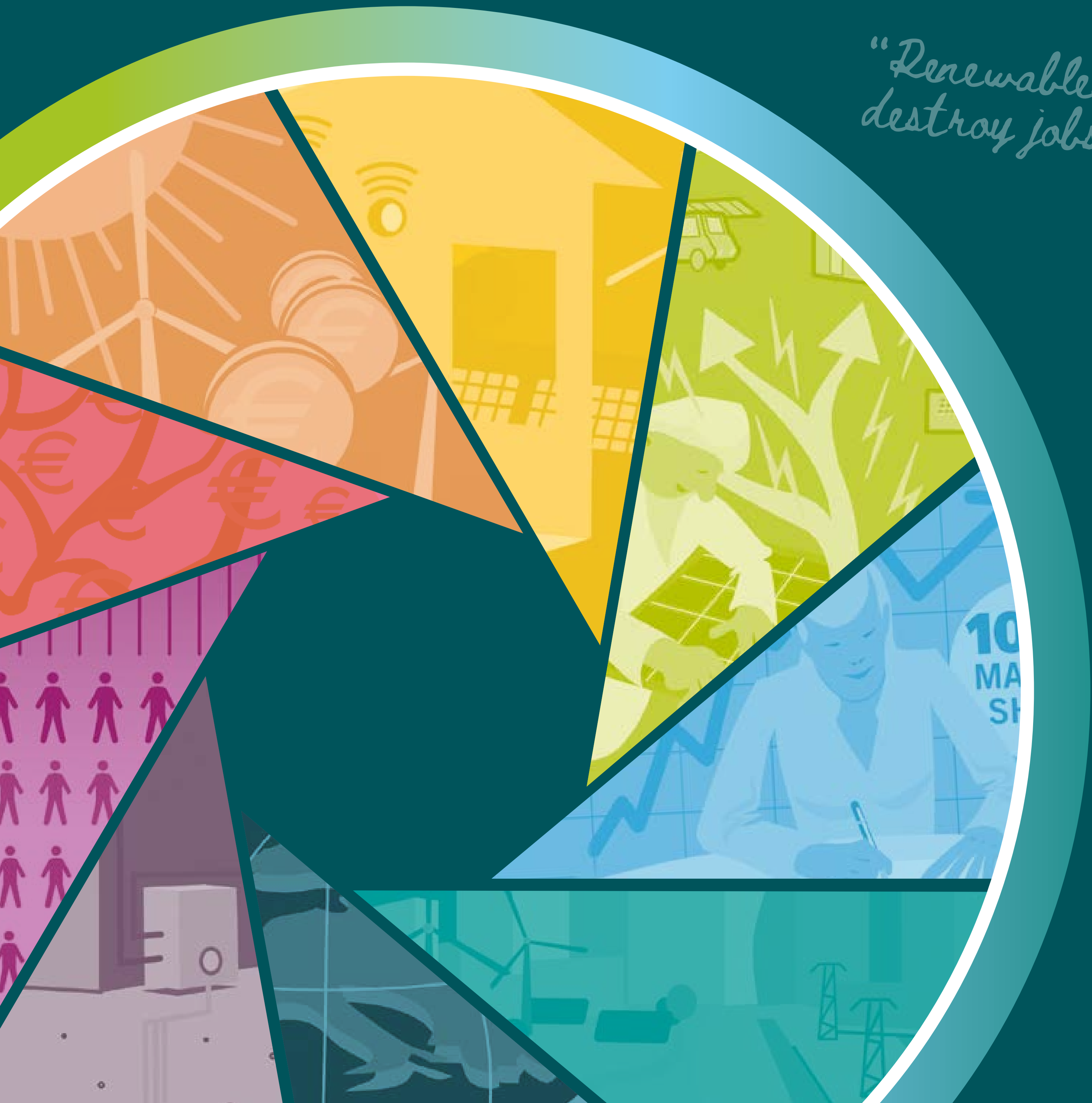
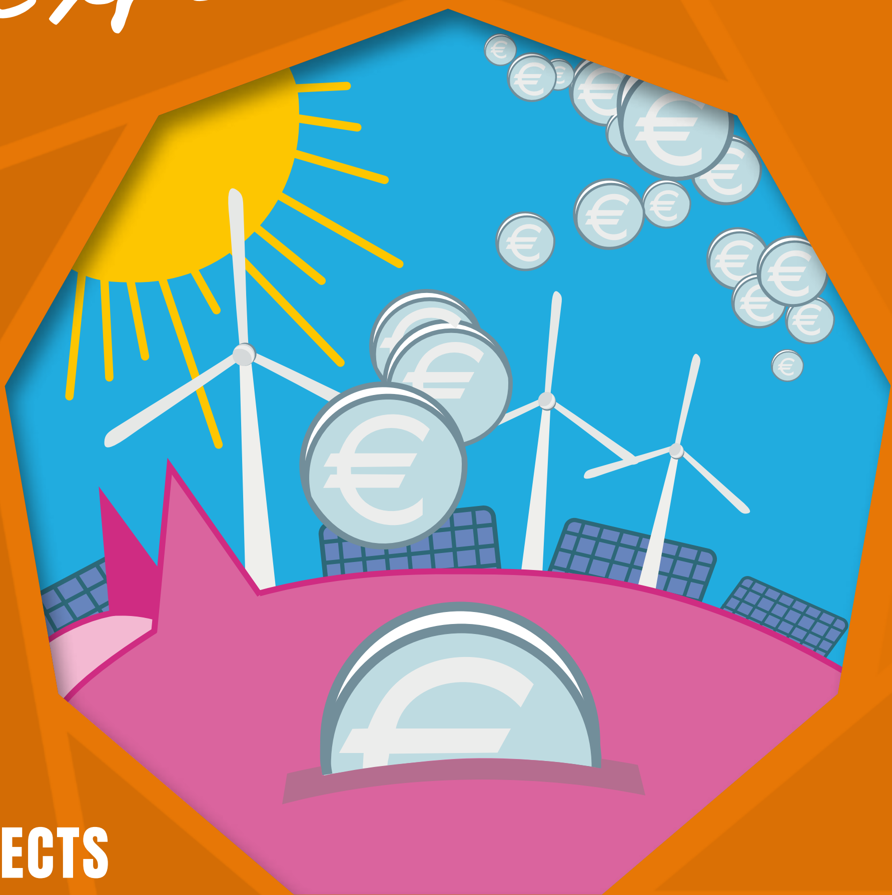
MYTHS AND REALITIES OF RENEWABLE ENERGY

"Renewables destroy jobs"



Myth 1:

"Renewables are too expensive!!!!???"



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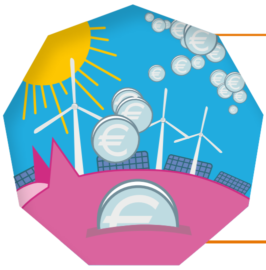


Renewables expensive? On the contrary! Since 2017, most energy from renewable sources has matched the cost of energy from conventional energy sources and will likely have lower generation costs in the coming years.

Twenty years ago, German politician Herman Scheer dreamt of a world where renewable energy is cheap enough to make fossil-fuels obsolete. This would slash CO_2 emissions and help developing countries find a way out of poverty. To get there, a new industry would need to be built, requiring significant subsidies. Starting from 2001, Germany – soon followed by other EU countries - implemented feed-in tariffs and other forms of support. Renewable energy technology was produced and deployed, the volumes increasing year on year. Economies of scale, the expertise built up by the people working in this sector and performance improvements delivered by R&I drove costs down. Since 2017, the cost of a unit of renewable electricity is approximately that of a unit produced from fossil fuels[3] (Figure 1).

Photovoltaics (PV), onshore wind and recently offshore wind, are becoming the cheapest source of electricity in many countries and have the potential to be even cheaper.

Electricity from renewables is soon expected to become cheaper than that of most fossil fuels. By 2020, IRENA expects all currently used renewable power generation technologies to "fall within the fossil fuel-fired cost range, with most at the lower end or undercutting fossil fuels"[4]. The decreasing cost of renewable power, aided by continuous technological innovation, has given it the edge it needs to seize market share. Innovation to boost the performance of different technologies or improve their manufacturability is important for further reducing their cost.

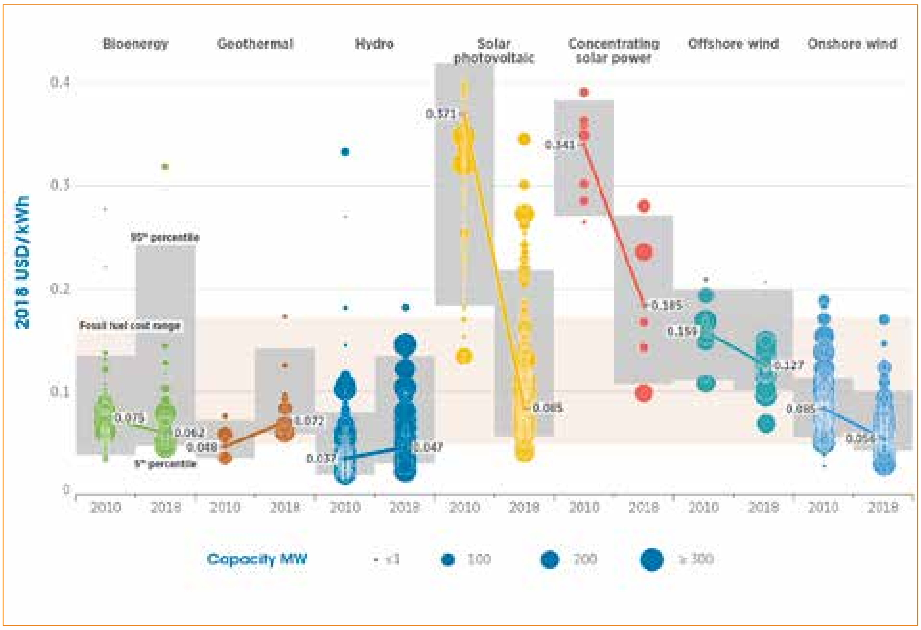


Figure 1 - *Global levelized cost of electricity from utility-scale renewable power generation technologies, 2010-2018. Source: IRENA Renewable Cost Database. (©IRENA, 2018)*

[3] IRENA. (2018). *Renewable Power Generation Costs in 2017*. International Renewable Energy Agency, Abu Dhabi. Available at: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/May/IRENA_Renewable-Power-Generations-Costs-in-2018.pdf . Last time accessed on 08/10/2019.

[4] *Ibid.* p. 15.

Myth 2:

"Renewables are not reliable"

PROJECTS

Although most renewable electricity is generated according to the vagaries of the weather (sunshine or wind), an optimized mix of renewable energy generation, storage technologies, sector coupling, demand side management schemes and smart grid functionalities can guarantee dependable supply.

Adding more and more wind energy or solar PV to a grid can put pressure on an electricity grid. Consider PV, which can only generate during the day. As more and more PV is added to the grid, there is less and less need to use conventional generation during the day. Plotting predictions of PV production on the same a few years into the future on the same chart creates the shape of a duck (Figure 2)[5]. Alternatives to PV are needed to satisfy demand at other times of day (Figure 2).

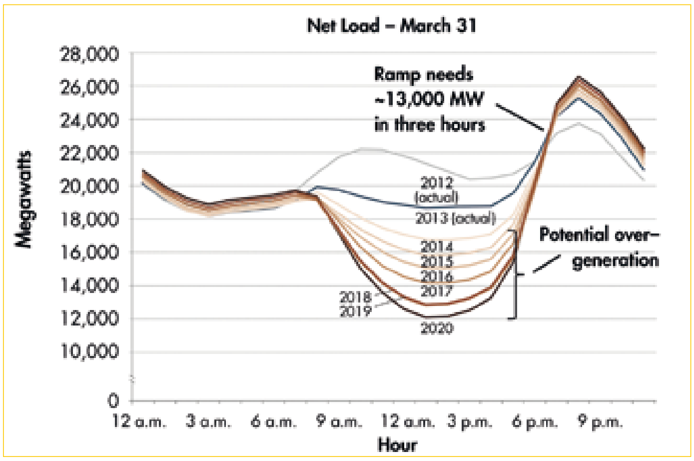


Figure 2 - *The so-called 'duck curve'. As more and more solar PV is added to a grid, the duck's 'belly' gets fatter and fatter as net load (i.e. the part of load not supplied with PV or wind electricity) gets less.*

These alternatives are:

- Energy storage in the grid, including pumped-storage hydroelectricity, batteries, thermal energy storage or Electrical Vehicles (V2G services) etc.
- Demand side management schemes, including demand response within schemes such as microgrids, Virtual Power Plants (VPPs) in energy communities, etc.
- Smart grid functionalities and the operational capabilities and flexibility of power electronics.

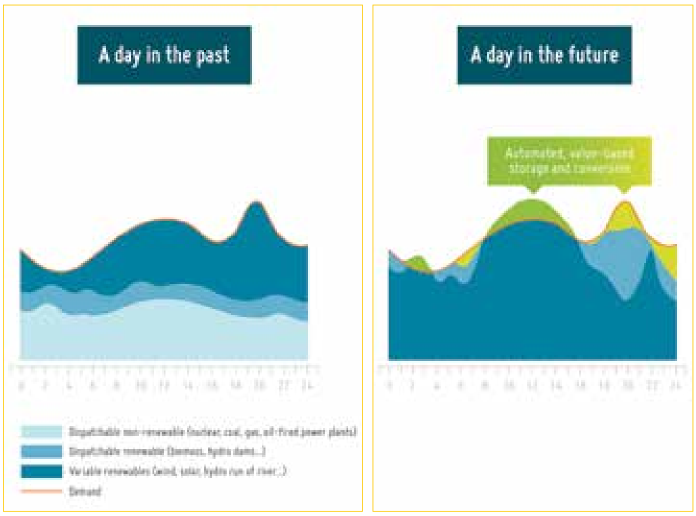


Figure 3 - *A day in the future (ETIP-SNET Vision 2050)*

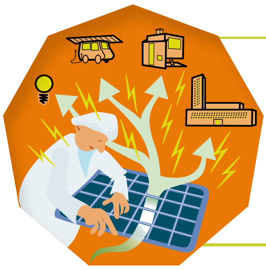
Figure 3 imagines the net-load curve for a day in 2050 with an optimum mixture of RES and storage integrated into the grid. Non-renewable sources are fully substituted by variable renewables, while the remaining demand is covered by dispatchable renewables and stored energy. When generation is higher than demand, such as in the middle of the day, energy is stored thus balancing the grid.

[5] California independent system operator. (2016). *What the duck curve tells us about managing a green grid.* https://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf. Las time accessed on 25 July 2019.

Myth 3:

"Producing renewables consumes more energy that it delivers"

PROJECTS



All renewable energy technologies generate considerably more energy during their lifespan than was used to manufacture them and put them into operation (i.e. their lifecycle energy inputs), with the multiple depending on the technology and the carbon intensity of the energy mix used in manufacture.

"Producing renewables consumes more energy that it delivers"

The relationship between energy input and energy output is known as the energy payback time (EPBT)[6]. The table below summarises an EPBT analysis for the following two hypothetical examples: a silicon multi crystalline PV rooftop system of 3 kW_p and a wind turbine of 2 MW. The primary energy necessary for their materials, manufacturing, transportation and installation was derived from the database Ecoinvent 3.5, whilst the annual electricity output was calculated using the platform Renewables Ninja and considering time series of a decade. Due to the geographic variability of RES, two different locations were considered: Oldenburg (Lower Saxony, Germany) and Freiburg im Breisgau (Baden-Württemberg, Germany). The performance degradation of the systems was neglected, but indeed this might have an effect in the amount of electricity produced by the system in the long term. Other energy inputs during the operation and end of life were also neglected but are in most of cases considered low compared to the material and manufacturing phases and the energy output. The electricity outputs were converted to primary energy employing the average efficiency of public conventional power plants in Europe[7]. The results are that the PV system had an EPBT of around 4.0 years, and the wind turbine 0.7 years.

Description	3 kWp PV Rooftop System		2 MW Wind Turbine	
Primary Energy Input (materials, manufacturing, transportation and installation)[8]				
Primary energy input [MWh]	28		4,634	
Electricity and primary energy output[9]				
Location	Oldenburg	Freiburg	Oldenburg	Freiburg
Electricity Production [MWh/year]	3.28	3.78	5,252.31	2,595.27
Primary energy output [MWh/year], $\eta G = 50\%$	6.56	7.56	10,504.62	5,190.55

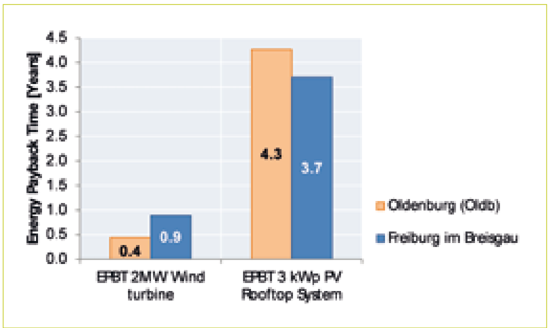


Figure 4 - *Comparison of the energy payback time (EPBT) of a typical 3 kWp PV system and a 2MW*

Given that the lifespan of the conversion devices significantly exceeds these terms (20-25 years in the case of PV systems and 15-20 years in the case of wind turbines), the energy balance is always positive, the amount dependent on available resources at the site of installation. The results for the two technologies in the two locations are given in Figure 4. EPBT is expected to improve. Frischknecht et al. deducted in 2015 that in the near future the EPBT of PV systems could be reduced to 1.2 years[10]. Research and innovation are pivotal to enhance the performance of renewable energy technology, thus further reducing EPBT.

[6] R. Frischknecht, R. Itten, F. Wyss, I. Blanc, G. Heath, M. Raugei, P. Sinha, A. Wade, 2014, Life cycle assessment of future photovoltaic electricity production from residential-scale systems operated in Europe, Subtask 2.0 "LCA", IEA-PVPS Task 12. Available at: http://iea-pvps.org/fileadmin/dam/public/report/technical/Future-PV-LCA-IEA-PVPS-Task-12-March-2015.pdf. Last time accessed on 16 October 2019.
[7] European Environment Agency. https://www.eea.europa.eu/data-and-maps/indicators/efficiency-of-conventional-thermal-electricity-generation-4/assessment-2
[8] Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., and Weidema, B. (2016). The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment, [online] 21(9), pp.1218–1230. Available at: http://link.springer.com/10.1007/s11367-016-1087-8
[9] https://www.renewables.ninja/ Assumptions for PV system: rated power of 3kWp, system loss: 10%, tilt of 36° in Oldenburg and 34° in Freiburg, azimuth of 180°.Assumptions for wind power turbine: rated power of 2,000kW, hub height of 80m, turbine model Vestas V90 2000. Coordinates Oldenburg: 53.187; 8.267. Coordinates Freiburg im Breisgau: 53.187; 8.266
[10] R. Frischknecht, R. Itten, F. Wyss, I. Blanc, G. Heath, M. Raugei, P. Sinha, A. Wade, 2014, Life cycle assessment of future photovoltaic electricity production from residential-scale systems operated in Europe, Subtask 2.0 "LCA", IEA-PVPS Task 12. Available at: http://iea-pvps.org/fileadmin/dam/public/report/technical/Future-PV-LCA-IEA-PVPS-Task-12-March-2015.pdf. Last time accessed on 16 October 2019.

Myth 4:

"Renewables cannot survive without subsidies"

PROJECTS

In many cases renewable energy generation costs are already below the economic full cost of new coal and gas-fired plants[11]. However, the current market system does not allow secure financing. Therefore, new technologies require subsidies at carefully calibrated levels and periods to establish themselves, while mature technologies should compete without subsidies in liberalised markets.

"Renewables cannot survive without subsidies"

Renewables have the stigma that they are heavily subsidised. This representation of reality is not true: historically, subsidies for renewable energies were much smaller than for conventional energies. A study ordered by the European Commission in 2014[12] showed that within the EU the support for coal and nuclear between 1970 and 2007 was around €900 billion (Figure 5), whereas the cumulative interventions for renewable energy in the same period totaled to only 70-150 billion €. Additionally, renewable energy technologies accounted only for about 12% of the public expenditures for R&D, whereas 78% went to nuclear fission and fusion and 10% to coal.

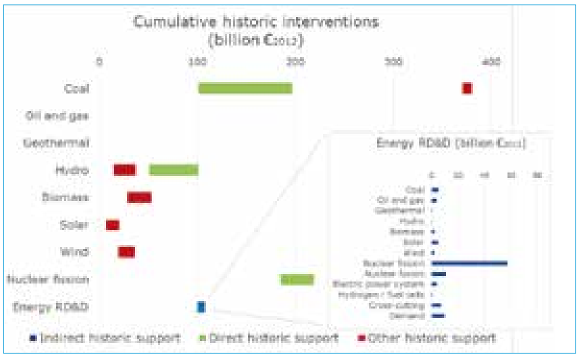


Figure 5 - *Cumulative historic interventions over the period 1970-2007 in billion €2012, expressed as ranges to reflect the uncertainty. Source: (European Commission, 2014)*

A more recent study commissioned by the European Commission[13] recognises that notwithstanding the EU commitment to phase out fossil-fuels subsidies, "these have increased by 3% (+1.4 bn) between 2008 and 2016 to €55 billion". As shown in figure 6, annual subsidies for RES have exceeded those for fossil fuels only since 2013. Subsidies to RES stabilised in the years that followed in, while the installed RES capacity increased.

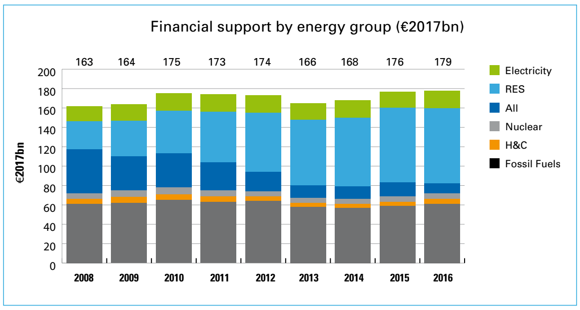


Figure 6 - *Financial support by energy (2008-2016,€2017bn) (European Commission, 2018)*

The current subsidies for coal, oil and gas every year amount to 100 billion US $ only in G7 countries[14], with $333 billion estimated worldwide in 2015[15]. The corresponding number for solar and wind was calculated to be €44 billion[16]. These numbers only include direct subsidies to lower the consumer price. If subsidies covering the external costs due to global warming, environmental damages and local problems like health risks are included, then the worldwide subsidies for coal, oil and gas are an incredible $5.3 trillion, which is 6.5% of world GDP.

A reform of energy subsidies would not only allow market forces to boost renewable energy generation, but also result in savings for the public sector. The freed-up resources could be spent on fixing the legacy of decades of fossil fuel use. As levelised cost of electricity (LCOE) for renewables continue to decrease, the savings due to a reform of energy subsidies will be even larger.

[11] Kost, C., Shammugam, S., Jülch, V., Nguyen, H.T., Schlegl, T. (2018). *Levelized Cost of Electricity- Renewable Energy Technologies, 3rd ed.* Fraunhofer ISE. Freiburg.

[12] European Commission. (2014). *Full dataset on energy costs and subsidies for EU28 across power generation technologies.* Available at: https://ec.europa.eu/energy/en/studies/full-dataset-energy-costs-and-subsidies-eu28-across-power-generation-technologies. Last time accessed on 26 July 2019.

[13] European Commission. (2018). *Study on Energy Prices, Costs and Subsidies and their Impact on Industry and Households.* Available at: https://publications.europa.eu/en/publication-detail/-/publication/d7c9d93b-1879-11e9-8d04-01aa75ed71a1/language-en/format-PDF/source-106971810. Last time accessed on 16 October 2019.

[14] Simon, F. (2018). *100 Milliarden Dollar für Öl, Gas und Kohle - jedes Jahr.* Available at: https://www.euractiv.de/section/energie-und-umwelt/news/100-milliarden-dollar-fuer-oel-gas-und-kohle-jedes-jahr/. Last time accessed on 25 July 2019.

[15] Coady, D., Parry, I., Sears, L., Shang, B. (2015) *How Large Are Global Energy Subsidies?.* IMF Working Paper. Available at: https://www.imf.org/external/pubs/ft/wp/2015/wp15105.pdf. Last time accessed on 16 October 2019.

[16] NERA economic consultants. (2018). *Update on Energy Taxation and Subsidies in Europe: An Analysis of Government Revenues from and Support Measures for Fossil Fuels and Renewables in the EU and Norway.* Report for the International Association of Oil and Gas Producers.

Myth 5:

"Renewables are as harmful for the environment as conventional energy sources"

PROJECTS

Whilst it is undeniable that renewables have an impact on the environment, the environmental benefits of the technologies greatly outweigh the environmental costs.

Reducing the emissions of greenhouse gases often associated with climate change is one of the main goals of renewable energy production and it is this, along with the search for sustainable energy sources, that are the main drivers behind renewable energy's recent and rapid shift from niche to mainstream energy source. However, there are critics of the sector who argue that renewable technologies have a hidden carbon footprint that could negate any environmental benefits associated with their use. One commonly repeated refrain is that it takes more energy to produce a wind turbine than said turbine could ever produce throughout its operational lifetime.

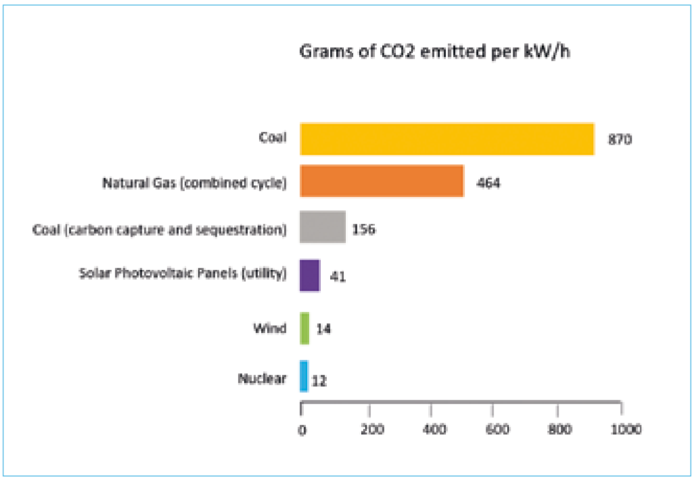


Figure 7 - *Grams of CO_2 emitted per kW/h (Source: Rhodes, 2017)*

In fact, whilst both conventional and renewable power generation technologies result in GHG emissions because of the energy requirements associated with their construction and operation, studies show that the lifetime carbon emissions resulting from renewables are considerably lower than those from fossil-fuel power plants. One study concluded that wind energy produces approximately 14g CO_2/kWh of electricity generated compared with approximately 870g CO_2/kWh for coal and 464g CO_2/kWh for natural gas[17], meaning that coal produces roughly 62 times more CO_2 than wind energy. These figures are backed by a number of other studies that found similar differences in carbon emissions between the two technologies[18 19]. Even the most environmentally friendly coal power plants using cutting-edge carbon capture and storage (CCS) technology are estimated to produce 11 times more CO_2 than wind energy. Other renewable technologies perform similarly well when compared with conventional power sources. For example, solar photovoltaic panels were found to produce, on average, 21 times less carbon per kWh than coal fired power stations, with the best solar technology in the sunniest location performing even better.

Thus, renewable energy sources have much to offer in the fight to reduce emissions, and although they do not represent a complete solution to the energy trilemma, they are an environmentally sound addition to support the energy mix.

[17] Rhodes, J. (2017). *Nuclear and wind power estimated to have lowest levelized CO_2 emissions.* UT Austin's Energy Institute Newsletter. November 2017

[17] Dola, S.L., Heat, G.A. (2012). *Life Cycle Greenhouse Gas Emissions of Utility - Scale Wind Power.* Journal of Industrial Ecology. Vol. 16, Issues 1. Pages S136-S154.

[17] Pehl, M. (2017). *Understanding future emissions from low-carbon power systems by integration of life-cycle assessment and integrated energy modelling.* Nature Energy. Vol. 2. Pages 939–945.

Myth 6:

"Renewables cannot satisfy the growing demand for energy"

PROJECTS

A main criticism is that renewables will never be able to fully replace fossil fuels and cover the total global primary energy demand. However, several studies show that it is both technically feasible and economically viable to develop an energy system entirely based on renewable energy[20].

"Renewables cannot satisfy the growing demand for energy"

Renewable energy technologies are the enabler of the transformation of world's energy system, and their massive deployment will be necessary to meet the ambition of a net-zero-carbon economy by 2050. Recent scenarios developed by the IEA and IRENA predict a renewable energy share in total primary energy supply in 2050 of 46%[21]and 63%[22], respectively. Other scenarios put the share far higher, for instance Finland's LUT University and the Energy Watch Group, which shows that a global transition to 100% renewable energy across all sectors – power, heat, transport and desalination - before 2050 is feasible[23], with the generation mix given in Figure 8. The study highlights that a RES-based energy system is more efficient and cost effective than the current system primarily based on fossil fuels and nuclear. The conclusion of the study is that a successful renewable energy transition is not a question of technical feasibility or economic viability, but one of political will.

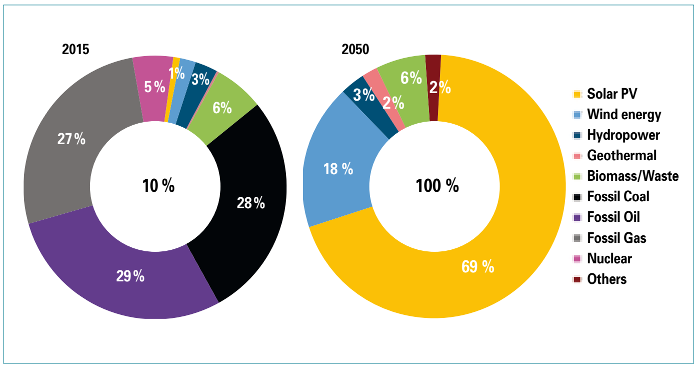


Figure 8 - *Global share of primary energy supply in 2015 and 2050 as predicted by Ram et alia, 2019. This study anticipates significant electrification of the heat and transport sectors and predicts that solar PV and wind will lead the global energy transition (Source: Ram et al., 2019)*

Electricity from RES is already a competitive option across the world, with the highest growth estimated for wind and solar PV. Increasing energy efficiency will contribute to decrease the total energy demand and consistently reduce wastes, thus making an optimal use primary energy. Defossilisation of transport and heavy industry is where the greatest challenges remain[24].

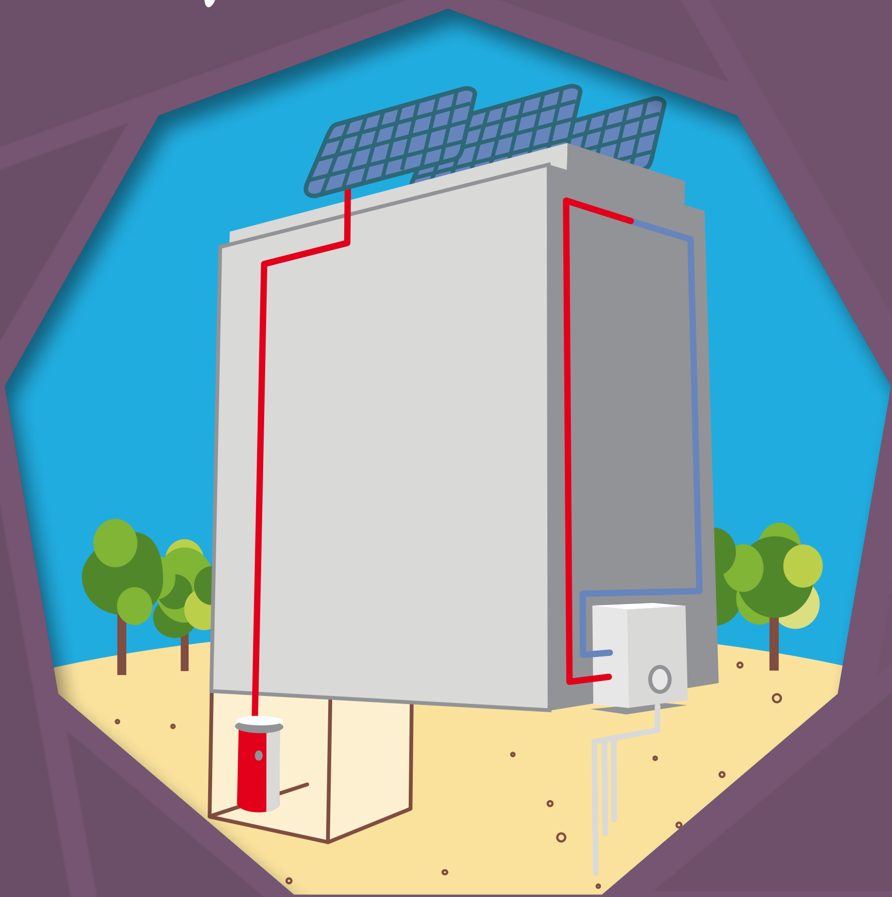
Governments are taking action: Denmark aims to be independent from fossil fuels by 2035 entirely covering power and heat demand with RES. The Austrian Federal Environmental Agency has developed a strategy to fully defossilise its energy system by 2050 with a share of renewables higher than 90%[25]. At the COP22 in November 2016 in Marrakesh, 48 "most vulnerable countries" with respect to the implications of climate change have signed a declaration to transition their energy systems to renewables as soon as possible and latest until 2050[26].

Main pre-requisites for unlocking the full potential of renewable energies are suitable policies and regulatory frameworks creating a level playing field, as well as promoting innovation and technological advances in the fields of renewable energies, energy efficiency, storage technologies, sector coupling and smart energy systems.

[20] Umweltbundesamt. (2013). *Treibhausgasneutrales Deutschland im Jahr 2050. Berlin.*
[21] International Energy Agency. (2018). *Perspectives for the Energy Transition. The Role of Energy Efficiency.* Available at: https://webstore.iea.org/perspectives-for-the-energy-transition-the-role-of-energy-efficiency. Last time accessed on 17 October 2019.
[22] International Renewable Energy Agency. (2018). *Global Energy Transformation. A Roadmap to 2050.* Available at: https://www.irena.org/publications/2019/Apr/Global-energy-transformation-A-roadmap-to-2050-2019Edition. Last time accessed on 17 October 2019.
[23] Ram M. et al. (2019). *Global Energy System based on 100% Renewable Energy – Power, Heat, Transport and Desalination Sectors.* Study by Lappeenranta University of Technology and Energy Watch Group. Available at: http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf. Last time accessed on 17 October 2019.
[24] Gielen, D., Boshell, F., Saygin, D., Bazilian, M.D., Wagner, N., Gorini, R. (2019). *The role of renewable energy in the global energy transformation.* Energy Strategy Reviews. Vol. 24. Pages 38-50. Available at: https://www.sciencedirect.com/science/article/pii/S2211467X19300082. Last time accessed on 17 October 2019.
[25] Umweltbundesamt. (2016). *Szenario Erneuerbare Energie 2030 und 2050.* Available at: https://www.umweltbundesamt.at/fileadmin/site/publikationen/REP0576.pdf. Last time accessed on 17 October 2019.
[26] World Future Council. https://www.worldfuturecouncil.org/48-vulnerable-countries-lead-100-renewables-movement. Last time accessed on 17 October 2019.

Myth 7:

"The importance of thermal renovation of buildings is overrated"



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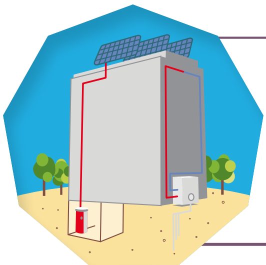


Space heating and cooling and hot water preparation represents about one third of total EU final energy consumption. Since a very large share of the EU building stock has low energy standards, thermal renovation of existing buildings is an essential milestone for the internationally agreed climate target.

"The importance of thermal renovation of buildings is overrated"

The building stock is responsible for approximately 36% of all CO_2 emissions in the European Union (EU)[27]. About 50% of EU's final energy consumption is used for heating and cooling, of which 80% is used in buildings[28]. As shown in figure 9, space heating and cooling and hot water preparation represent more than 30% of the final energy consumption in the EU[29]. The stock of buildings in the EU is relatively old, with more than 40% built before 1960 and 90% before 1990[30]. Most of today's buildings will still be standing in 2050. Without major renovation programmes the building stock will not help to reach Europe's necessary climate targets.

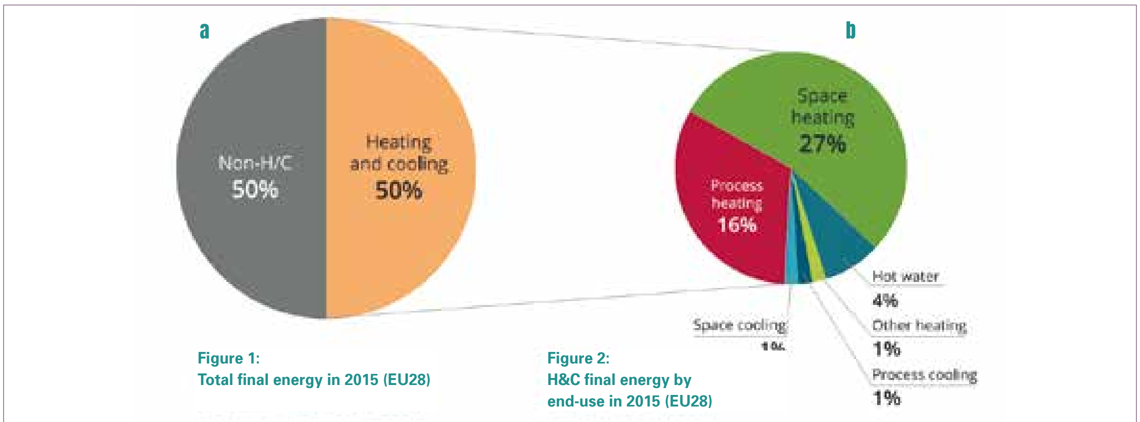


Figure 9 - *(a) Final energy in 2015 (EU28) and (b) Heating and Cooling final energy by end-use in 2015 (EU28)*

Building renovation shall aim to maximise energy efficiency while providing the remaining energy demand from RES, in order to achieve Nearly Zero-Energy Buildings (NZEBs). According to a recent publication of the International Energy Agency[31], end-use energy efficiency alone can deliver 35% of the CO_2 savings required to meet global climate goals, despite a near-tripling of the world economy and a global population that increases by nearly 2.3 billion. At the same time, renewable heating and cooling technologies play an essential role in developing a carbon-neutral building stock in Europe, thus providing a fundamental contribution to the achievement of the EU climate targets. Existing technologies, including bioenergy, geothermal, solar thermal and ambient heat, have an enormous potential to support a carbon-neutral economy; these contribute significantly to the overall portfolio of RES. A variety of technological solutions are already available, and their cost is expected to drop as a consequence of higher market uptake.

The renovation of buildings delivers significant direct benefits to building owners by reducing the energy bill and increasing the property value and living comfort. At macroeconomic level, building renovation contributes to reduce the total amount of materials used, to boosts employment and gross domestic Product (GDP), to reduce energy poverty and to ensure energy security.

[27] Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0844&from=EN.

[27] Ibid.

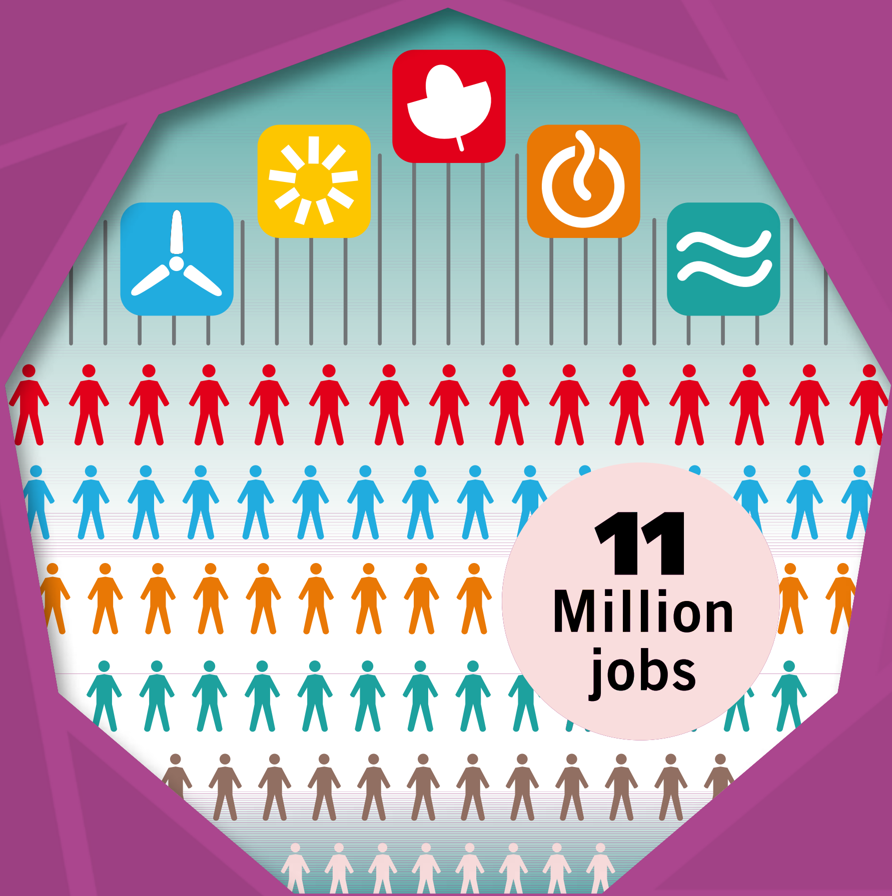
[27] Heat Roadmap Europe project. (2017). Heating and Cooling Facts and Figures. Available at: https://www.euroheat.org/wp-content/uploads/2017/07/29882_Brochure_Heating-and-Cooling_web-1.pdf. Last time accessed on 17 October 2019.

[27] European Parliament. (2016). *Boosting Building Renovation: What Potential and Value for Europe.* Available at: http://www.europarl.europa.eu/RegData/etudes/STUD/2016/587326/IPOL_STU(2016)587326_EN.pdf.

[27] International Energy Agency. (2018). Perspectives for the Energy Transition. The Role of Energy Efficiency. Available at: https://webstore.iea.org/perspectives-for-the-energy-transition-the-role-of-energy-efficiency.

Myth 8:

"Renewables destroy jobs"



PROJECTS

Technological evolution always entails socio-economic changes and renewables are no exception. The energy transition will eliminate jobs in traditional energy technologies, but it will create new ones in renewables. As renewables have a higher labour content, newly created jobs will likely exceed lost jobs. Carefully planning, including retraining the existing workforce, is needed in order to avoid socio-economic disruption.

From the legend of the emperor Tiberius killing an artisan for inventing unbreakable glass, via the English textile workers destroying steam engines, to the recent concerns of job losses caused by artificial intelligence (AI) enabled automation, technological progress has always had its opponents. The changes entailed by the transformation of the energy system will similarly be welcomed by some and resisted by others. Since World War II ubiquitous hydropower plants have been largely replaced by coal, nuclear and finally gas turbines and combined cycle gas turbines power plants. Renewables, such as wind and PV, are simply a more recent page in the story.

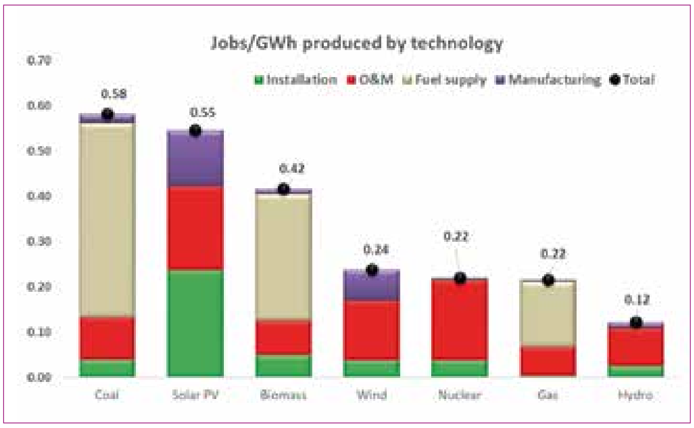


Figure 10 - *Jobs creation by GWh of electricity produced by technology and activity (Source: Fragkos and Paroussos, 2018)*

Renewable power plants need more people for their construction, operation and maintenance than traditional power plants. There are different reasons for this, including the fact that renewable energy installations need more land and material than thermal power plants that produce the same amount of energy. Fragkos and Paroussos compared the labour content of electricity generation by energy source[32]. The analysis shows that all renewables (except for hydro) have a higher employment potential than fossil and nuclear resources with the notable exception of coal, which has the highest labour content per unit of energy produced because of mining.

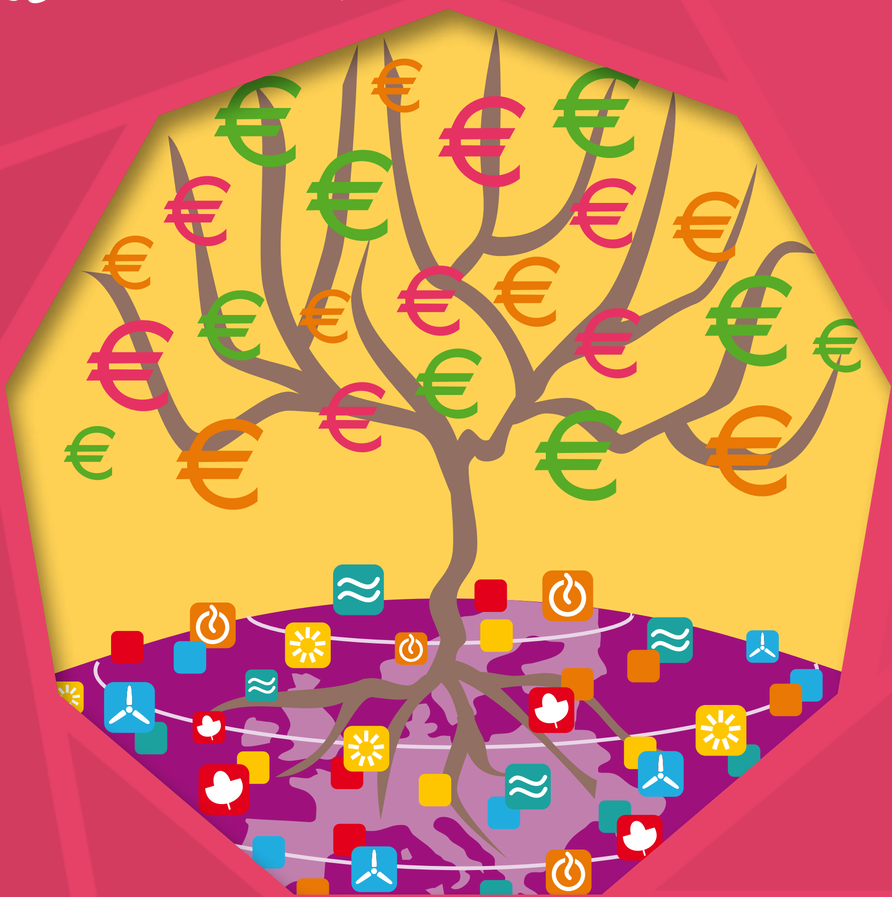
The transformation of the energy system needs support from across society, including from those working in industries that must be closed down. They need compensation packages . The higher labour content of renewables will increase the demand for education and training, and it might be possible for ex-fossil fuel workers to find new jobs in the renewable energy industry.

The International Labour Organisation (ILO) suggests that *"the positive job creation effect of renewable energy is a result of longer and more diverse supply chains, higher labour intensity, and increased net profit margins"*[33]. It continues stating that *"as the demand for energy from renewable sources increases, it is expected that there will be a decrease in demand for oil, coal, and gas. However, recent studies show that renewable energy projects can offset job losses from a decline in extractive industries and can in turn create a net employment gain"*. On the same line, the Organisation for Economic Cooperation and Development (OECD) states that *"well-functioning labour markets are important to achieve a smooth transition and reintegrate workers who lose their jobs"* . It also notes how electricity generation is the sector with the highest responsibility in CO_2 emissions but has also a negligible impact on total occupation. This means that changes in this sector can be easily absorbed by the general labour market. Finally, a complete and up to date review on the labour content of renewable technologies can be found in the IRENA 2019 Annual Report .

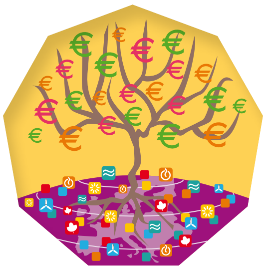
[32] Fragkos, P., Paroussos, L. (2018). *Job creation related to Renewables*. Available at: https://www.researchgate.net/publication/328133354_Job_creation_related_to_Renewables. Last time accessed on 17 October 2019.
[33] International Labour Organisation. *Green jobs and renewable energy: low carbon, high employment*. Available at: https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/publication/wcms_250690.pdf. Last time accessed on 17 October 2019.

Myth 9:

"Renewables will decrease the competitiveness of the EU's economy"



PROJECTS



Although it is true that significant public and private investment is required for the transition from fossil fuel to renewable energy, European companies increasingly see such investments as an opportunity to strengthen their competitiveness by reducing operating costs, to attract capital investments and to enhance their reputation. Overall, the gross value-added deriving from the energy transition is expected to largely offset its cost.

"Renewables will decrease the competitiveness of the EU's economy"

Whilst it could be argued that changing to a renewable energy infrastructure unnecessarily diverts funds away from improving competitiveness, this position neglects the moral, economic and political necessity to address climate change, as well as the insecurity and unsustainability of the existing energy market that endanger the ambitions for future global economic and population growth. It also neglects the potential economic and competitive opportunities that are expected to arise from such a transition.

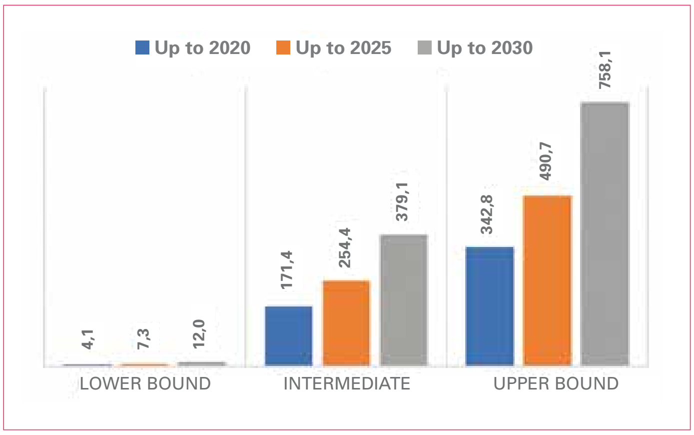


Figure 11 - *Cumulative Gross Value Added (GVA) generated by corporate sourcing of renewable*

The urgent requirement to address climate change and limit the rise in global temperature to well below 2°C above pre-industrialisation levels, is the dominant driver for the energy transition. Therefore, decarbonisation of the energy system is required on a global scale. To achieve this the transition will depend largely on low-carbon technologies and energy efficiency. Electrification with renewable technologies can substantially and immediately begin to have an impact on CO_2 emissions. In fact, this combination is becoming cheaper than fossil fuel alternatives[36]. It is estimated that the savings from avoided subsidies to the existing energy supply and reduced damage to the environment and to human health would be between 3 to 7 times larger than the cost of the transition[37].

Europe will need to be part of the energy transition and with its expertise and experience it could take this opportunity to play a substantial role in the move towards a dominant renewable future. European companies are driven by the need to reduce cost of their energy supplies and demonstrate their corporate social responsibility to both the consumer and investors, in order to gain a competitive advantage and attract capital investment (investors are increasingly concerned about the environmental footprint of their investments). Therefore, European companies increasingly rely on renewables to meet their energy needs, strengthen their competitive advantage and enhance their customer base. Considering corporate sourcing of renewable electricity as an example, a recent study commissioned by the European Commission estimated that the cumulative gross value-added from manufacturing, construction, operation and maintenance in ten selected EU Member States[38] would be between €12 billion and €758 billion by 2030 and it will provide additional full-time employment equivalents of between 4,600 and 221,200 over the same period[39].

To conclude, rather than decreasing the competitiveness of European companies, the transition to renewable energies is becoming an essential part of their strategy to increase their competitive advantage.

[32] Fragkos, P., Paroussos, L. (2018). *Job creation related to Renewables*. Available at: https://www.researchgate.net/publication/328133354_Job_creation_related_to_Renewables. Last time accessed on 17 October 2019.
[33] International Labour Organisation. *Green jobs and renewable energy: low carbon, high employment*. Available at: https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/publication/wcms_250690.pdf. Last time accessed on 17 October 2019.

PROJECTS

EUREC PARTNERS:

Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft

RI.SE

Advanced Biomass Catalytic Conversion to Middle Distillates in Molten Salts

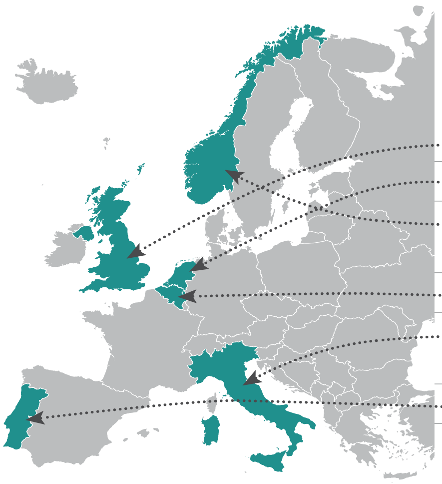
MAIN FEATURES OF THE PROJECT

ABC-Salt validates a novel route to produce sustainable liquid biofuels at laboratory scale by solving a number of technical challenges in biofuels production. The project addresses liquefaction and the subsequent catalytic hydro-pyrolysis of biomass in a molten salt environment, followed by the catalytic hydro-deoxygenation of the vapour phase using suitable catalysts. The aim is to obtain a hydrocarbon product suitable for use as middle distillate biofuel. ABC-Salt will then operate an integrated lab-scale reactor over 100 hours to provide lab-scale validation of the whole process, bringing this technology to readiness level 4.
In addition to technical aspects, the project includes socio- and techno-economic viability studies to foster the future deployment of this technology. These analyses consider sensitive issues, such as substrate availability, supply chains, future end users and the overall economic sustainability of the process. The holistic approach of the project considers the full value chain and includes a promotion and dissemination element to ensure outcomes are effectively communicated. A number of ABC-Salt Summer Schools and open workshops take place across Europe over the project life.

EXPECTED RESULTS

ABC-Salt proposes a novel technology at small lab scale for the conversion of biomass, and particularly waste agricultural residues, to middle distillates. This involves breaking down the complex molecular structure of biomass, which contain significant amounts of bound oxygen, into an oxygen free, low molecular weight product. Catalysts play a major role here and have the function to effectively depolymerize the biomass structure and remove the bound oxygen. In short, ABC-SALT aims to develop both novel processing media, catalysts and integrated technology to make the process as efficient as possible.

For more information: https://www.abc-salt.eu/



OTHER PARTNERS:

- ASTON UNIVERSITY - COORDINATOR (UK)
- BIOMASS TECHNOLOGY GROUP (NL)
- NORGES MILJO-OG BIOVITENSKAPLIGE UNIVERSITET (NO)
- UNIVERSITEIT GHENT (BE)
- UNIVERSITÀ DEGLI STUDI DI ROMA LA SAPIENZA (IT)
- AYMING (PT)

Myth 6: do not satisfy the demand for energy?

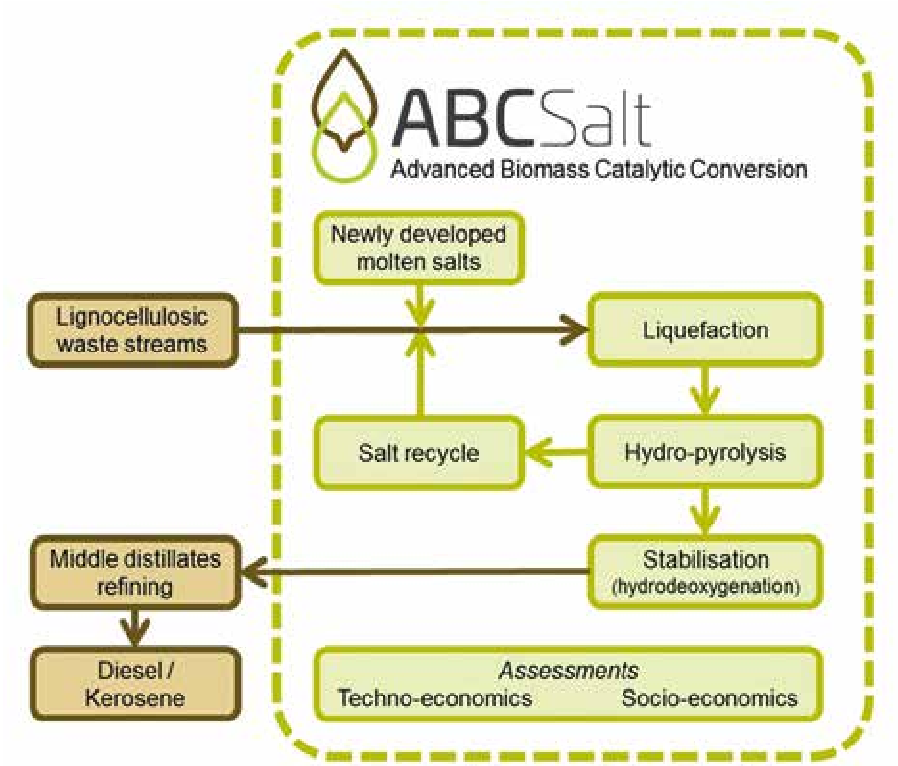


Figure 12 - *ABC SALT concept*

BUDGET:	€ 3 998 025,50	**FUNDING PROGRAMME:**	HORIZON 2020
PERIOD:	From 1 April 2018 .... to 31 March 2022		

EUREC PARTNERS:

Coordinator

Best Practices and Implementation of Innovative Business Models for Renewable Energy Aggregators

MAIN FEATURES OF THE PROJECT

Electricity market liberalisation has enhanced competitiveness in energy production in several EU countries, thereby lowering electricity prices. Renewable energy aggregators act as facilitators between supply and demand in the electricity market bringing small-scale production and consumption to the wholesale market, which is usually accessible only to very large producers and consumers.
BestRES investigated current market barriers and suggested ways of improving the role of renewable energy aggregators. Project partners identified, reviewed and optimised thirteen pioneering business models, eight of which were implemented in real-life conditions in Austria, Belgium, Germany, Italy, Portugal and the United Kingdom (Figure 13). These business models enable energy aggregators to successfully participate in the market by combining renewable energy supply, energy storage, flexible demand and ICT technologies into a commercially viable product. Additionally, the project identified technical, market, environmental and social benefits, as well as legal and regulatory barriers preventing their successful implementation.

EXPECTED RESULTS

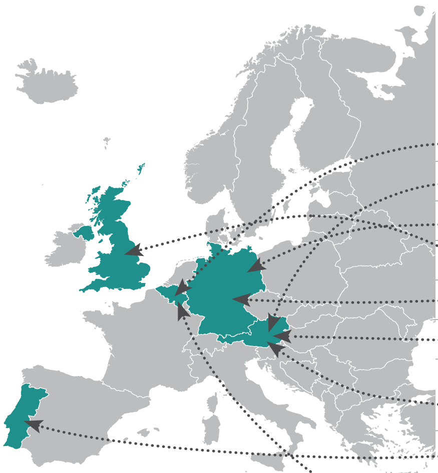
The business models developed in the project have proved to increase the competitiveness of different RES technologies. The UK model shifted the behaviour of domestic electricity consumption through a smart home device connected to a mobile application that shows the energy consumption and cost of each appliance. Its implementation led to a 2% profit in energy bills and demonstrated the benefits of customers' engagement and interaction.

In Austria, BestRES investigated the energy potential of operating photovoltaic (PV) plants on residential multi-dwelling buildings. PV plants showed a significant economic value and allowed exchanging solar energy between the apartments, thus further reducing energy supply cost.

In Belgium, trading of weather-dependent electricity sources, e.g. solar PV and wind, in different power markets was very successful. RES proved to be competitive alternatives leading to significant capacity expansion. The accuracy of wind and solar forecasts contribute increasing the confidence of clients.

Aggregators define a new era for RES, opening avenues to new markets and services for decentralised renewable energy. Importantly, flexibility is the key to allow decentralised power production and the regionalisation of the electricity sector.

For more information: http://bestres.eu/



OTHER PARTNERS:

- 3E (BE)
- TECHNISCHE UNIVERSITAET WIEN (AT)
- STIFTUNG UMWELTENERGIERECHT (DE)
- GOOD ENERGY LIMITED (UK)
- NEXT KRAFTWERKE GMBH (DE)
- OEKOSTROM GMBH FUR VERTRIEB (AT)
- PLANUNG UND ENERGIEDIENSTLEISTUNGEN (AT)
- CNET CENTRE FOR NEW ENERGY TECHNOLOGIES (PT)
- YOURIS.COM (BE)

Myth 1: expensive?

Myth 2: not reliable?

Myth 4: fail without subsidies?

Myth 9: make EU's economy less competitive?

Figure 13 - *BestRES implemented business models*

BUDGET:	€ 1 994 812,50	**FUNDING PROGRAMME:**	HORIZON 2020
PERIOD:	From 1 March 2016 .... to 28 February 2019		

EUREC PARTNERS:

Coordinator

High-Efficiency Bifacial PV Modules and Systems for Flat Roof Applications

MAIN FEATURES OF THE PROJECT

BI-FACE aims to develop innovative bifacial modules and systems for flat roofs. It creates three novel variations for bifacial modules and systems, which are tested in three different climate areas: subtropical (Cyprus), temperate (Austria) and maritime temperate (Netherlands). The ultimate design of these systems is challenging due to the large number of parameters that influence the energy yield (e. g. tilt and distance between modules, reflecting surfaces, shading, cell spacing, materials used and weather conditions).
Bi-FACE recognises that a holistic approach to energy performance needs to take the aspect of standardisation into account. Standardisation is currently lacking for bifacial modules, hindering their market uptake. Therefore, it is critical to identify harmonised performance characterisations of bifacial PV modules and correlate them with outdoor performances. Results will be communicated to the standardisation committees of bifacial modules.
Finally, the layout and mounting design of a bifacial system is critical to achieve the best performance on flat roofs. Construction requirements related to wind load, stability, total weight (incl. ballast) and maximum allowed weight on a roof are directly affected and need to be critically examined.
Ultimately, BI-FACE aims to develop technically and economically feasible bifacial PV systems to exploit the enormous potential of this technology.

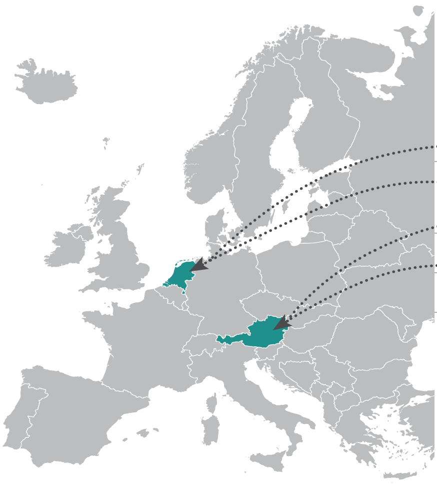
EXPECTED RESULTS

BI-FACE proposes:

- new validated simulation tools for bifacial modules and systems, including simulation of the wind load;
- modelled and validated standards for bifacial modules;
- new high efficiency bifacial modules and systems;
- outdoor performance qualification of bifacial systems in different European climate areas;
- guidelines for flash tester upgrade at the module manufacturer's site.

The newly developed modules should show an increased energy yield and provide a significant reduction of electricity generation costs in BIPV applications.

For more information: https://www.ait.ac.at/en/research-topics/photovoltaics/projects/bi-face/



OTHER PARTNERS:

- TEMPRESS SYSTEMS(NL)
- SOLAR ELECTRICITY DEVELOPMENT BV (NL)
- SILICON AUSTRIA LAB (AT)
- PVP PHOTOVOLTAIK (AT)

Myth 1: expensive?

Myth 3: more inputs than outputs?

Myth 6: do not satisfy the demand for energy?

Figure 14 - *Bifacial PV modules with a suboptimal design presented at the Intersolar exhibition in 2019 and 2019 (left): the junction box/boxes or the frame shades a part of the backside of the bifacial cells. Other products' design was optimized to prevent shading situations (right).*

Figure 15 - *BI-FACE bifacial modules with optimised design. A white painted ground helps to boost the reflected light to the rear side of the modules.*

BUDGET:	€ 1 150 000	**FUNDING PROGRAMME:**	Solar ERA.NET Cofund
PERIOD:	From 1 March 2018 ... to 28 February 2020		

BIOFIT
Bioenergy Retrofits for Europe's Industry

EUREC PARTNERS:

Bioenergy Retrofits for Europe's Industry

MAIN FEATURES OF THE PROJECT

BIOFIT supports bioenergy retrofitting in five industry sectors, namely first-generation biofuels, pulp and paper, fossil refineries, fossil firing power and combined heat and power (CHP) plants. The project investigates the use of technologies such as bioethanol, biodiesel, bio-kerosene, intermediate bioenergy carriers and other advanced biofuels.
BIOFIT will retrofit selected production plants that support bioenergy use. The retrofit measures can result in either using additional biomass as an input to the production plant (primary bioenergy products, process energy) or producing additional output from biomass at the production plant (transport biofuels, intermediate bioenergy carriers, heat and/or electricity).

More specifically, BIOFIT aims to:

- develop ten concrete proposals (Case Studies) for bioenergy retrofitting in collaboration with industry;
- provide a comprehensive catalogue of options for bioenergy retrofitting in the above-mentioned industries, as well as suggestions on the suitable conditions for type of bioenergy retrofit;
- evaluate framework conditions (legal, institutional and political) to identify generic and industry-specific barriers and enablers;
- provide advice to policy makers at national and regional level to serve as input for more informed policies.

SELECTED BIOFIT CASE STUDIES ON TRANSPORT FUELS

First generation biofuels

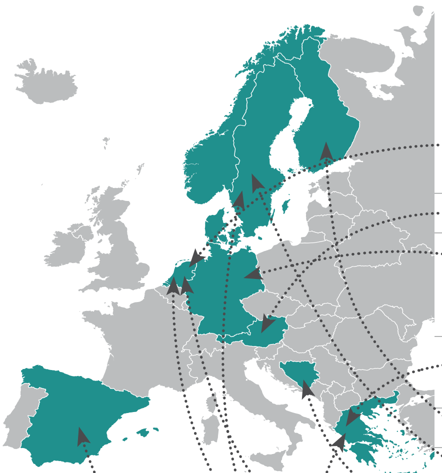
Biocarburantes de Castilla y Leon and CIEMAT will investigate the production of 30 million litres/year of second-generation ethanol from unutilised components of the current feedstocks at the existing cereal-based ethanol production facility in Babilafuente, Spain.

Swedish Biofuels and DBFZ will explore the possibility to use Swedish Biofuels ATJ technology to produce up to 100,000 ton/year of bio-kerosene (ATJ-SPK), which can be blended up to 30% with conventional kerosene following the requirements of ASTM D7566.

TFMC and BTG will investigate the co-feeding of pyrolysis oil in the Fluid Catalytic Cracker (FCC) of a fossil refinery. Pyrolysis oil is a liquid bioenergy carrier produced from lignocellulose material. The retrofit could result in 20,000 tons of 2G transport fuels.

Hellenic Petroleum, CERTH and TFMC will investigate the integration of new equipment for the production of hydrotreated vegetable oil (HVO) into the Aspropyrgos refinery of Hellenic Petroleum in Greece. The expected production capacity is 56,000 tonnes of biofuel.

For more information: https://www.biofit-h2020.eu/



OTHER PARTNERS:

- BIOMASS TECHNOLOGY GROUP - COORDINATOR (NL)
- BIOENERGY 2020+ GMBH (AT)
- DEUTSCHES BIOMASSEFORSCHUNGSZENTRUM GEMEINNUTZIGE GMBH (DE)
- ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS (EL)
- TEKNOLOGIAN TUTKIMUSKESKUS VTT OY (FIN)
- ENERGIKONTOR SYDOST AB (SE)
- JAVNO PREDUZECE ELEKTROPRIVREDA BOSNE I HERCEGOVINE DD (BA)
- TECHNIP BENELUX BV (NL)
- STICHTING WAGENINGEN RESEARCH (NL)
- SWEDISCH BIOFUELS AB (SE)
- ELLINIKA PETRELAIA AE (EL)
- BIOCARBURANTES DE CASTILLA Y LEON (ES)

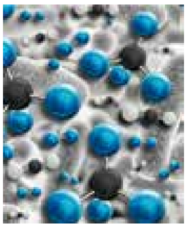
Myth 3: more inputs than outputs?

Myth 5: environmentally harmful?

Myth 6: do not satisfy the demand for energy?

BUDGET:	€ 2 626 237,50	FUNDING PROGRAMME:	HORIZON 2020
PERIOD:	From 1 October 2018 ...... to 30 September 2021		

BioP2M



EUREC PARTNERS:

Coordinator

Hanze University of Applied Sciences Groningen

Biomethane from Hydrogen and Carbon Dioxide

MAIN FEATURES OF THE PROJECT

Biogas is a mixture of about 50% methane and 50% carbon dioxide, generated from biomass via anaerobic digestion. Either as such or in the form of green gas, i.e. upgraded biogas that meets the specifications of the gas grid, biogas will contribute to the energy transition. BioP2M aims to generate more methane from biomass with the addition of green hydrogen from electrolysis. It is the biological equivalent of the well-known chemical Sabatier reaction: with the help of particular micro-organisms methane is formed from hydrogen and carbon dioxide. The bioP2M approach can use any carbon dioxide and may develop into one of the alternatives for short-circle, carbon-neutral cycling of carbon dioxide. The biological route is considered an attractive alternative to the chemical route, since it is more easily established at smaller scales. It also does not depend on sensitive chemical catalysts and can cope with less pure input streams. This way, the BioP2M approach contributes to tackling the limited biomass supply.

The feasibility of BioP2M process has been analysed from a technical, economic and environmental perspective to evaluate the sensitivity and sensibility of this approach. The reactor type (trickle bed/CSTR) and technological set-up, either in situ (i.e. adding the hydrogen directly to the biogas reactor) or ex situ (i.e. using two different reactors in parallel), the startup protocol and the method and speed of hydrogen addition, determine robustness, efficiency and yield. More recalcitrant biomass that is difficult to convert to biogas may require additional pretreatment procedures.

MAIN RESULTS

The project showed that BioP2M approach is feasible on a laboratory scale at ambient temperature and pressure, and that it allows to generate twice as much methane from any given amount of biomass. Modelled at farm-scale, BioP2M reduces greenhouse gas emissions by over 80% compared to natural gas. The potential of BioP2M approach is currently limited by the cost of green hydrogen; however, analyses show that farm-scale set-ups may become economically interesting upon implementation of carbon pricing. Moreover, BioP2M process may be effectively employed for energy and carbon storage.

For more information: https://www.hanze.nl/eng/research/strategic-themes/energy/bio-p2g

OTHER PARTNERS:

ALL IN NL

- BIOCLEAR EARTH
- DIRKSE MILIEU TECHNIEK
- ENEXIS
- ENKI ENERGY
- GASTERRA
- NEDERLANDSE GASUNIE
- NEW ENERGY COALITION
- UNIVERSITY OF GRONINGEN
- WAGENINGEN UNIVERSITY & RESEARCH

Myth 2: not reliable?

Myth 3: more inputs than outputs?

Myth 5: environmentally harmful?

Myth 6: do not satisfy the demand for energy?

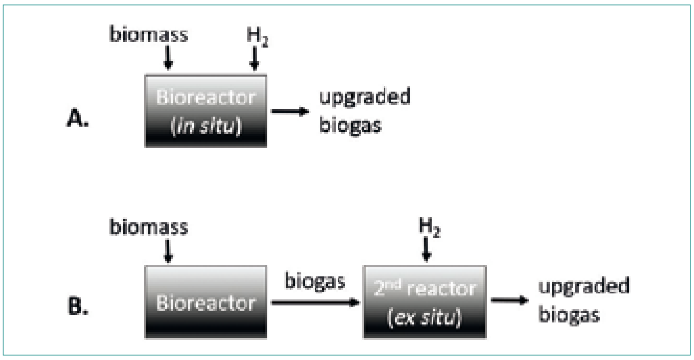


Figure 16 - *Reactor concepts for bioP2M combined with biogas. A. The in situ system, in which hydrogen gas is directly added to a biogas reactor; B. The ex situ system, in which biogas (or only carbon dioxide) is led into a second reactor to which hydrogen gas is added.*

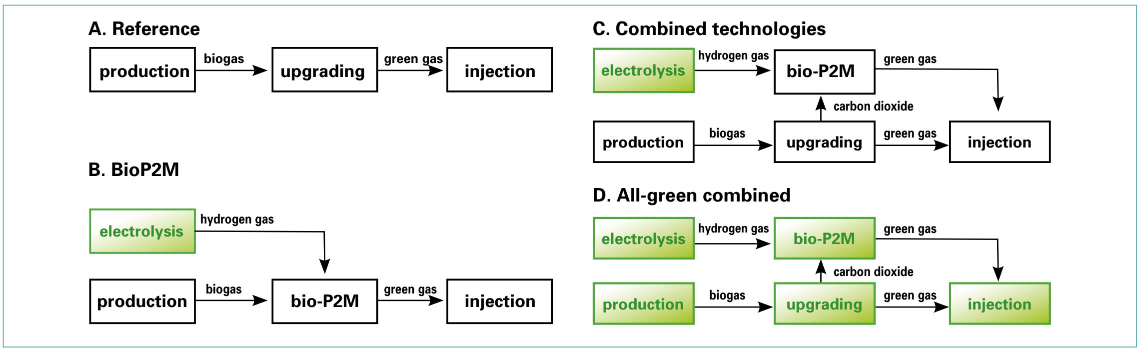


Figure 17 - *BioP2M scenarios considered for economic feasibility and viability. Each scenario is given as a sequence input-to-output transformation blocks. A green block indicates that all electricity used is renewable (solar, wind). Otherwise, the energy is from fossil origin. The production and injection blocks are identical in all four scenarios. (A) The reference scenario. (B) The bio-P2M block involves an ex situ trickle-bed reactor; the electrolysis block involves a PEM electrolyser. (C) A combination of A and B, in which the carbon dioxide obtained after membrane separation is fed into an ex situ bio-P2M trickle-bed reactor. (D) Same as C, but now all the electricity used is renewable. All calculations are based on an average Dutch biogas plant on farm-scale. More details and all quantitative data will be detailed elsewhere.*

BUDGET:	€ 1.049.000	**FUNDING PROGRAMME:**	Sia RaakPRO program (NL)
PERIOD:	From 1 September 2015 ...... to 31 August 2019		

CHEETAH

Cost-Reduction through Material Optimization and Higher Energy Output of Solar Photovoltaic Modules

EUREC PARTNERS:

Coordinator: ECN (part of TNO)

Fraunhofer

JÜLICH FORSCHUNGSZENTRUM

AIT AUSTRIAN INSTITUTE OF TECHNOLOGY

Loughborough University

KAΠE CRES

imec

MAIN FEATURES OF THE PROJECT

CHEETAH aims to solve specific R&D issues as outlined in the EERA-PV Joint Program, overcoming the fragmentation of European PV R&D in Europe and intensifying the collaboration between R&D providers and industry. The objective of the project is threefold:

- generating more power with less materials by developing new concepts and technologies for wafer-based crystalline silicon PV (modules with thin cells < 100 micron), thin-film PV (advanced light management) and organic PV (very low-cost barriers);
- fostering long-term European cooperation in the PV R&D sector, by sharing knowledge, organising workshops, training researchers inside and outside Europe, efficiently using infrastructures, promoting best practices and standards;
- Accelerating the market uptake of innovative PV technologies.

MAIN RESULTS

The main results of CHEETAH can be summarised as follows:

- Wafer based crystalline Si: epitaxial growth of (ultra) thin crystalline silicon wafers up to 80 micrometer and successful development of heterojunction (HJ) and back contact cell and module manufacturing processes for thin devices down to 80 µm (best x-Si HJ cell with 4 busbars: 21.2% efficiency for 97 µm);
- Thin film PV: advanced light management solutions and modelling for micro concentrator CIGS cells and thin film Silicon based on Liquid Phase Crystallization of thin film Silicon. A 22.5 % CIGS micro concentrator was achieved under concentrated light for sub-mm² cell using innovative approaches;
- Organic PV: improvement of the intrinsic stability of organic PV via fullerene free acceptors and development of cost efficient flexible organic and inorganic protective films.

Technology developments within CHEETAH led to the realisation of innovative and competitive PV concepts with a significant reduction in the cost of materials and increased overall performance. These developments will likely boost the European PV industry, so that Europe can regain and build up own manufacturing capacity across the entire value chain.

For more information: http://www.cheetah-project.eu/

OTHER PARTNERS:

35 PARTNERS FROM ITALY, BELGIUM, FRANCE, NETHERLANDS, SPAIN, FINLAND, TURKEY, UNITED KINGDOM, SWITZERLAND, GREECE, PORTUGAL, GERMANY, AUSTRIA, ESTONIA, NORWAY, DENMARK, FINLAND

Myth 1:
expensive?

Myth 9:
make EU's economy
less competitive?

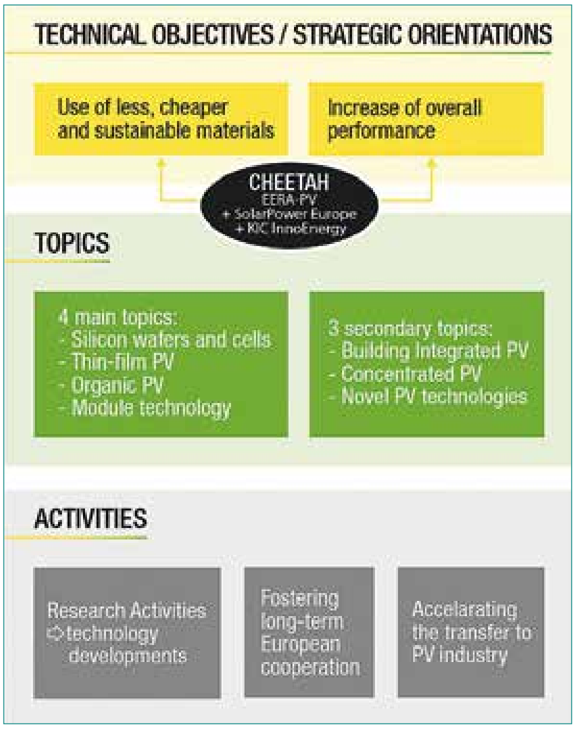


Figure 18 - *CHEETAH's objectives, focus topics and activities(D) Same as C, but now all the electricity used is renewable. All calculations are based on an average Dutch biogas plant on farm-scale. More details and all quantitative data will be detailed elsewhere.*

BUDGET:	€ 13 282 037,27	**FUNDING PROGRAMME:**	FP7
PERIOD:	From 1 January 2014 .... to 31 December 2017		

COMSYN

EUREC PARTNERS:

DLR Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft

Compact Gasification and Synthesis Process for Transport Fuels

MAIN FEATURES OF THE PROJECT

COMSYN's aim is to develop a new biomass-to-liquid (BTL) production concept that will reduce biofuel production cost up to 35 % compared to alternative routes. This means < 0,80 €/ l production cost for diesel. The production concept is based on distributed primary conversion of various kinds of biomass residues to intermediate liquid products with small-to-medium scale units (10-50 kt/a Fischer-Tropsch products) located close to biomass resources. The primary conversion will be integrated to local heat and power production resulting in 80% energy efficiency in biomass utilization. The FT products will be refined to high quality drop-in liquid transport fuels at existing oil refineries. The novel gasification technology will enable the use of wider feedstock basis. In addition to woody residues, the process makes use of straw and other agricultural residues, as well as various waste-derived materials. Moreover, it creates new job opportunities and stimulate the economy close to the production sites.

MAIN RESULTS SO FAR

Production of biofuel by gasification of biomass residues was successfully validated in two 80 hours tests run campaigns in September 2019. The focus of the test was to study and verify the performance of the gas cleaning train, and especially the entire synthesis process, with real wood-derived gasification gas. The first validation test successfully demonstrated the efficiency of the compact gasification and synthesis process concept, and the production of FT-products, waxes and other hydrocarbons. Based on the achieved results, industrial-scale plants in the range of 25.000-50.000 tn/a will be designed. The ultra-clean syngas was compressed and led to VTT's mobile synthesis unit called MOBSU, which utilizes the innovative compact Fischer-Tropsch technology of INERATEC. Two products, the FT- wax and FT-oil streams, were collected and will be further refined to high-quality transport fuels by UniCRE, the Unipetrol Centre for Research and Education. Techno-economic and environmental assessments and business case studies will be also carried out during the project lifetime.

For more information: https://www.comsynproject.eu/

OTHER PARTNERS:

- TEKNOLOGIAN TUTKIMUSKESKUS VTT OY (FIN) - COORDINATOR
- INERATEC GMBH (DE)
- GKN SINTER METALS FILTERS GMBH (DE)
- UNIPETROL VYZKUMNE VZDELAVACI CENTRUM AS (CZ)
- AMEC FOSTER WHEELER ITALIANA SRL (IT)
- AF-CONSULT OY (FIN)

Myth 1: expensive?

Myth 3: more inputs than outputs?

Myth 5: environmentally harmful?

Myth 6: do not satisfy the demand for energy?

Myth 8: destroy jobs?

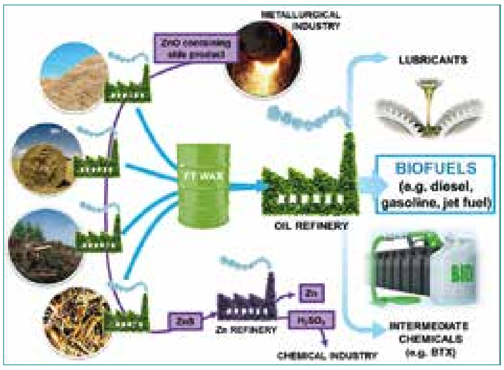


Figure 19 - *COMSYN concept*

Figure 20 - *Crushed bark (woody raw material for gasification), FT liquid product and FT wax.*

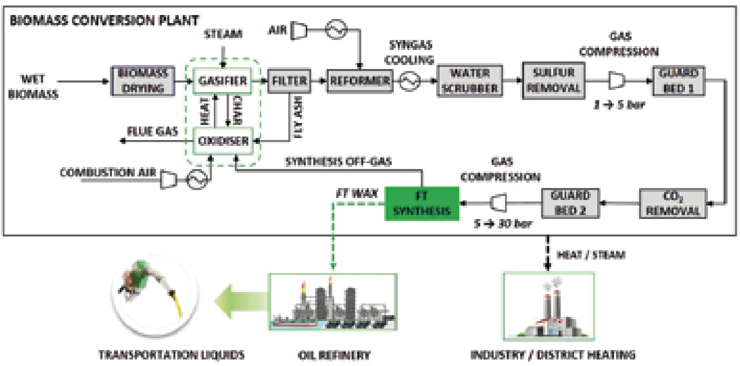


Figure 21 - *Techical configuration of the COMSYN process from gasification to FT synthesis*

BUDGET:	€ 13 282 037,27	**FUNDING PROGRAMME:**	HORIZON 2020
PERIOD:	From 1 May 2017 .... to 30 April 2021		

CREATE

EUREC PARTNERS:

Coordinator

AEE INTEC

AIT AUSTRIAN INSTITUTE OF TECHNOLOGY

Compact Retrofit Advanced Thermal Energy storage

MAIN FEATURES OF THE PROJECT

In Europe, the building sector accounts for the largest share of energy consumption. Harvesting, converting and storing seasonal solar energy in the building sector is therefore essential to achieve the goal of an energy-neutral built environment by 2050. CREATE aims to tackle this challenge by developing a compact thermal energy storage system able to provide renewable heat over the entire year. The CREATE system is an advanced thermal storage system based on Thermo-Chemical Materials (TCMs) that enables economically affordable, compact and loss-free storage of heat in existing buildings. The system consists of several storage modules containing salt, which is hydrated (charged) in summer and dehydrated (discharged) in winter.

This heat battery allows for better use of available renewables in two ways:

- bridging the gap between supply and demand of renewables; and
- increasing the efficiency in the energy grid by converting electricity peaks into stored heat to be used later on, thus increasing the flexibility of the grid

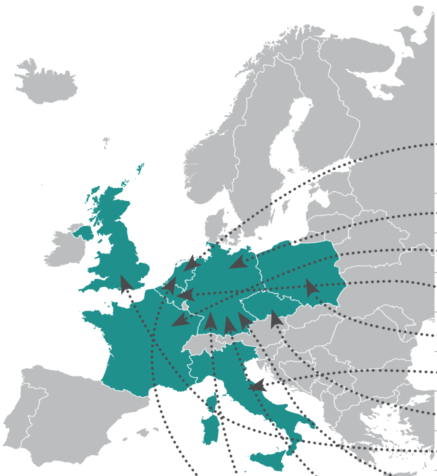
The CREATE concept is to develop stabilised storage materials with high storage density, improved stability and low price, and package them in optimized heat exchangers, using optimized storage modules. Full scale demonstration is done in a real building, taking into account regulatory, normative and economic boundaries.

EXPECTED RESULTS

By developing a storage system based on stable and compacts materials (energy density of more than 1.5 GJ/m3) and affordable technology, CREATE aims to achieve the following targets:

- 15% net energy reduction by using a 2,5 m^3 storage system for seasonal storage of solar heat;
- energy density on module level of 128 kWh/m^3;
- building's solar fraction of 32% with a very limited collector area of 12.5 m^2.

For more information: http://createproject.eu/



OTHER PARTNERS:

- TECHNISCHE UNIVERSITEIT EINDHOVEN (NL)
- VAILLANT GMBH (DE)
- ÉLECTRICITÉ DE FRANCE (FR)
- TESSENDERLO CHEMIE (BE)
- MOSTOSTAL WARSZAWA SA (PL)
- RINA CONSULTING SPA (IT)
- FENIX TNT SRO (CZ)
- LUVATA UK LIMITED(UK)
- DOW WOLFF CELLULOSICS GMBH (DE)
- DOW DEUTSCHLAND ANLAGENGESELLSCHAFT GMBH (DE)
- CALDIC NETHERLAND BV (NL)
- POLAR KALTETECHNIK GMBH (DE)

Myth 2: not reliable?

Myth 7: thermal renovation overrated?

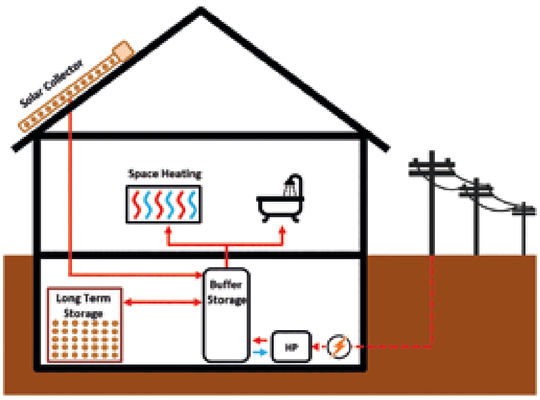


Figure 22 - *Concept of the CREATE system installed in a single family building*

Figure 23 a and b - *Modular storage system manufactured (left) and final installation in Container (right)*

BUDGET:	€ 1 616 545,50	**FUNDING PROGRAMME:**	HORIZON 2020
PERIOD:	From 1 October 2015 .... to 30 June 2020		

EUREC PARTNERS:

Coordinator

WIP RENEWABLE ENERGIES

Unleashing the Potential of Crowdfunding for Financing Renewable Energy Projects

MAIN FEATURES OF THE PROJECT

CrowdFundRES intended to accelerate the growth of renewable energy in Europe by unleashing the potential of crowdfunding for financing renewable energy projects. To achieve this purpose, CrowdFundRES focused on:

- gaining a deep understanding of the public's perception of crowdfunding and of the challenges faced by the application of crowdfunding to renewable energy projects in Europe;
- developing and applying guidelines that support easier, more effective and wider accepted practices in crowdfunding renewable energy projects;
- improving the market and regulatory framework as a whole;
- promoting crowdfunding and its advantages among those who could contribute or raise funds.

EXPECTED RESULTS

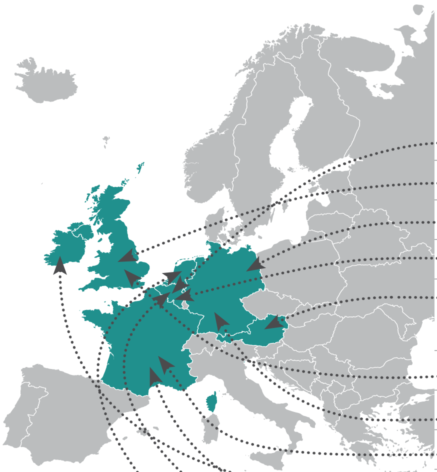
CrowdFundRES performed a qualitative and quantitative analysis on perceptions about crowdfunding for renewable energy, taking into consideration the point of view of citizens, crowdfunding platforms and RES developers. This analysis offered a unique insight on the elements of crowdfunding that are positively or negatively received by the public. It also highlighted how the results of this analysis change depending on geographical or other socioeconomic classifications of the public.

CrowdFundRES also reviewed existing crowdfunding regulations and RES market developments, providing a detailed overview of the fast-changing regulatory conditions in EU-28. The insight collected during the project resulted in a set of three guidelines providing guidance to crowdfunding platforms, project developers and investors.

Among the most noticeable achievements of CrowdFundRES is an unprecedent cross-border collaboration between two crowdfunding platforms based in France and Netherlands respectively, which allowed to gather 800.000 euros to finance a solar park in France notwithstanding some issues related to cross-border investments.

Finally, CowdFundRES developed concrete recommendations to improve market and regulatory framework conditions for crowdfunding renewable energy projects in Europe.

For more information: http://www.crowdfundres.eu/index.html



OTHER PARTNERS:

- EUROPEAN CROWDFUNDING NETWORK (BE)
- UNIVERSITY OF DUNDEE (UK)
- OSBORNE CLARKE ANWALTSSOZIETAT (DE)
- YOURIS.COM (BE)
- GLOBAL 2000 UMWELTSCHUTZORGANISATION (AT)
- ABUNDANCE INVESTMENT LTD (UK)
- GREEN CROWDING GMBH (DE)
- LUMO (FR)
- BNRG RENEWABLES LIMITED (IE)
- VALOREM SAS (FR)
- EPIA SOLARPOWER EUROPE (BE)
- ONEPLANETCROWD INTERNATIONAL BV (NL)

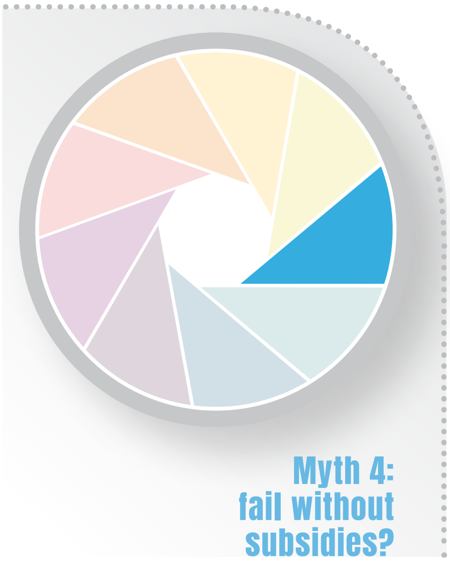


Figure 24

BUDGET:	€ 1 994 915	**FUNDING PROGRAMME:**	HORIZON 2020
PERIOD:	From 1 February 2015 .... to 31 January 2018		

EUREC PARTNERS:

Coordinator

AEE INTEC

Prefabricated Façade Elements with Maximum Integrated HVAC Components and Systems for Refurbishment of Existing Buildings

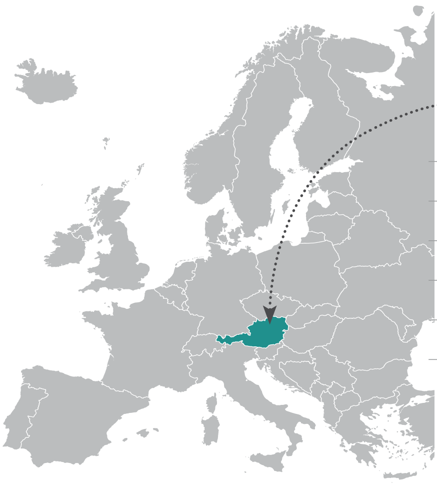
MAIN FEATURES OF THE PROJECT

Façade elements with a high level of insulation are a very promising technology for large-scale buildings. They can be prefabricated to a high degree, allowing for quick installation and excellent quality of implementation. One option for substantially reducing costs and simplifying the renovation processes is to integrating more functionality into traditional curtain walls, e.g. using the surfaces as energy conversion areas or for energy storage and/or integrating into the prefabricated component mini heat pumps, ventilation elements, distribution lines for heat, water, air or disposal of waste water. HVACviaFACADE explores all these options.
As a first step, twenty-four energy supply concepts allowing for the integration of HVAC into prefabricated curtain walls were defined. The considered technologies belong to five broad technology groups: solar thermal, photovoltaics, heat pumps, ventilation technology, water heaters and heat transmission systems. Most concepts consisted of a combination of technologies or hybrid systems. Three system concepts were selected. They were simulated in detail for a reference multi-storey building with 12 apartments and for 2 different thermal insulation standards (heating demand 30 and 15 kWh/m²a).
All system concepts integrate active as well as passive HVAC elements, such as ascending pipes, descending wastewater pipes, ventilation pipes, etc., into the façade. At the same time, it was possible to optimize the current construction technique for wood curtain walls, reducing the overall cost by 30%.

MAIN RESULTS

The simulations showed that implementing heat pumps alone reduces the primary energy demand by 40-50% compared to the reference renovation scenario, while adding a PV system increases this number to 65-70%. Electric heating via infrared elements without photovoltaics does not lead to any advantages in terms of primary energy demand, compared to the reference renovation. In order to keep up with the primary energy demand of the heat pump systems, it requires huge array areas which cannot fit onto a building anymore.

Another important aspect of the project was the dynamic cost calculation of the entire renovation concepts over the whole life cycle, from the construction to the demolition and removal of the building. After calculating the heat generation costs over the whole life cycle, it became clear that the heat pump systems not only achieve lower primary energy demand but also lead to lower life cycle costs than the reference renovation (using conventional thermal insulation systems and gas boilers). The cost reduction potential of the electric heating system via infrared heating depends heavily on the thermal insulation level. Heat demand 15 allows for cost advantages over the reference scenario while heat demand 30 does not.



OTHER PARTNERS:

ALL FROM AUSTRIA

- B KUMLER HOLZBAU GMBH
- VAILLANT GMBH
- TECHNISCHES BÜRO HAMMER GMBH
- ARCHITEKT NUSSMÜLLER ZT-GMBH
- ENNSTAL SG
- TU-GRAZ, LABOR FÜR BAUPHYSIK

Myth 1: expensive?

Myth 3: more inputs than outputs?

Myth 5: environmentally harmful?

Myth 7: thermal renovation overrated?

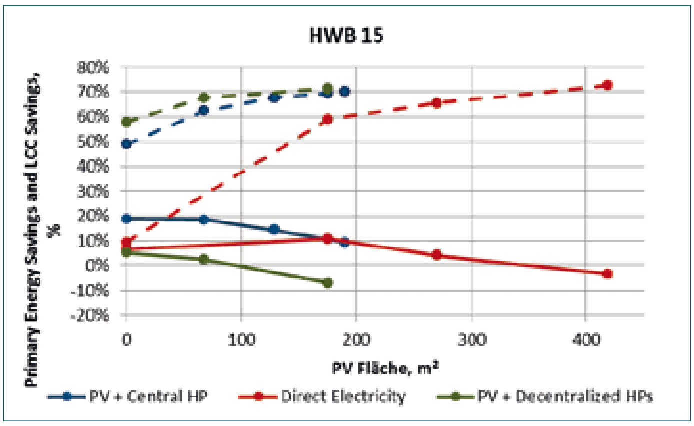


Figure 24 - *Primary energy savings (dotted lines) and savings in life cycle costs (full lines) for three system concepts (central heat pump, decentralized small-scale heat pumps, electric heating system) compared to the reference retrofit space heating demand)*

Figure 25 - *Prefabricated HVAC façade (source: Kulmer)*

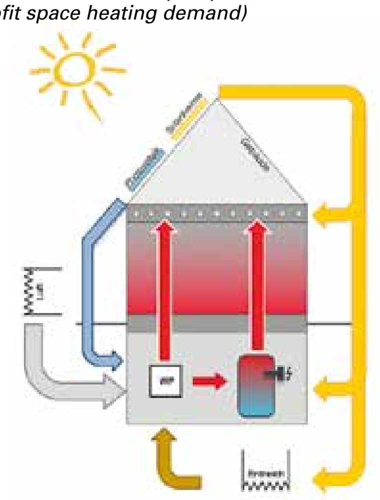


Figure 26 - *HVACviaFACADE concept*

BUDGET:	€ 775.436	**FUNDING PROGRAMME:**	Energy Mission Austria (AT)
PERIOD:	From 1 April 2014 .... to 31 March 2017		

EUREC PARTNERS:

Coordinator: eurac research

WIP Renewable Energies

Adaptable and Adaptive RES Envelope Solutions to Maximise Energy Harvesting and Optimize EU Building and District Load Matching

MAIN FEATURES OF THE PROJECT

EnergyMatching aims to maximise RES harvesting in the built environment by developing and demonstrating robust solutions to efficiently capture on-site available renewable sources through adaptive active building skin technologies, and to effectively use the locally produced energy within buildings and/or districts. The EnergyMatching concept is based on three pillars: (i) overall methodological framework and business vision; (ii) robust active skin technologies to efficiently harvest local RES; (iii) building and district energy hub to effectively use the produced energy on site through load matching strategies.

EnergyMatching focuses on the renovation of EU residential buildings, which hold a huge potential to meet the EU policy goals of nearly Zero Energy Buildings (nZEBs). The main goals of EnergyMatching are to:

- define adaptive and adaptable envelope solutions for energy harvesting at building level;
- integrate the energy harvesting solutions into building and district energy concept;
- geo-cluster solutions and replication potential.

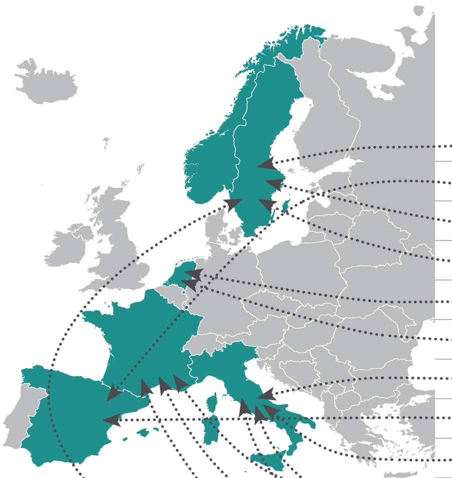
These objectives will be achieved through the following building blocks: i) versatile click&go substructure for different cladding systems; ii) solar window package, iii) modular appealing BIPV envelope solutions; iv) RES harvesting package to heat and ventilate; v) building and district energy harvesting management system. Such solutions are integrated into energy efficient building concepts for self-consumers connected in a local area energy network (energyLAN). EnergyMatching optimisation tool enables the best matching between local RES-based energy production and building load profiles and simplifies energy demand management for the energy distributors.
EnergyMatching solutions will be demonstrated in three demo cases, which have a large replication potential in diverse climatic conditions, law and regulation framework, buildings' architectural features and socio-cultural environment. The three demo cases are located in Italy, France and Sweden.

EXPECTED RESULTS

Main expected impacts of EnergyMatching include:

- reduced cost of manufacturing, installation and operation of renewable energy harvesting technologies at building and district scale;
- demonstrated replicability that will result in the acceleration of RES integration into residential buildings and districts;
- cost-effective solutions supported by advanced economic and business models for investors;
- maximisation of RES generation, demand coverage and optimal integration of RES in energy grids;
- market penetration of effective, modular, robust and easy-to-integrate energy harvesting solutions;
- revitalization of the EU building sector.

For more information: https://www.energymatching.eu/



OTHER PARTNERS:

- HOGSKOLAN DALARNA (SE)
- FUNDACION TECNALIA (ES)
- FERROAMP ELEKTRONIK AB (SE)
- NIBE AKTIEBOLAG (SE)
- TULIPPS BV (NL)
- PLASTICA PLAAT BV (NL)
- EUROFINESTRA SAS DI ECOSISTEMA SRL (IT)
- ONYX SOLAR ENERGY SL (ES)
- PELLINI SPA (IT)
- SOLARWALL EUROPE (FR)
- BOUYGUES CONSTRUCTION (FR)
- R2M SOLUTION SRL (IT)
- CASA SPA (IT)
- LUDVIKAHEM AKTIEBOLAG (SE)
- OFFICE PUBLIC DE L'HABITAT DU DEPARTEMENT DE LA SEINE MARITIME (FR)

Myth 1: expensive?

Myth 2: not reliable?

Myth 6: do not satisfy the demand for energy?

Myth 7: thermal renovation overrated?

Myth 9: make EU's economy less competitive?

Figure 28 - *Map of EnergyMatching Demo sites*

Figure 29 - *EnergyMatching Demo Sites' description*

BUDGET:	€ 6 889 765,63	**FUNDING PROGRAMME:**	HORIZON 2020
PERIOD:	From 1 October 2017 .... to 31 March 2022		

factory microgrid

EUREC PARTNERS:

CENER
ADItech

Electric Vehicles to Grid, Renewable Generation and Zn-Br Flow Battery to Storage in Industry

MAIN FEATURES OF THE PROJECT

The main objective of Factory Microgrid was to demonstrate that microgrids are the most suitable solutions for electricity generation and management in industrial sites in terms of environmental impact. The proposed approach involved the installation of an industrial microgrid at Jofemar's factory in Peralta (Navarra, Spain) with a near 80% share of electricity. In this site, Factory Microgrid aimed to:

- implement an innovative system in a real operating environment;
- test and validate energy management strategies capable of using or storing all the renewable energy generated, while reducing energy consumption by managing dispatchable loads up to 100kW; and
- transfer the acquired knowledge to stakeholders by means of targeted education and dissemination strategies.

Initially, a microgrid based on 300 kWh Zn-Br flow batteries was built. In a second stage, another Zn-Br flow battery module was added to increase storage capacity (+ 200kWh). Moreover, the microgrid was integrated with prototypes of 610kW bidirectional charging points, six electric vehicles (EVs) to allow vehicle-to-grid (V2G), and a 50kW fast charging point. Parameterization and monitoring activities allowed to evaluate results for future replications.

MAIN RESULTS

Factory Microgrid demonstration showed that the system is strong and reliable. The following results can be highlighted:

- 230.000 kWh/year renewable electricity generated through photovoltaic panels (40 kWp) and a 120 kW wind turbine;
- 73 tonnes of CO_2 emissions were avoided thanks to the management of dispatchable loads and the use of the EVs fleet integrated into the microgrid;
- several energy management strategies were tested and validated to ensure that all the renewable energy generated was either used or stored for later use;
- there was a significant reduction of peak energy consumption due to the energy management of about 100 kW of dispatchable loads;
- the microgrid capacity as voltage and frequency control contributed to the stability of the network and to reduce generation reserve capacity.

For more information: http://www.factorymicrogrid.com/en/index.aspx

OTHER PARTNERS:

JOFEMAR CORPORATION – COORDINATOR (ES)

Myth 2: not reliable?

Myth 5: environmentally harmful?

Myth 9: make EU's economy less competitive?

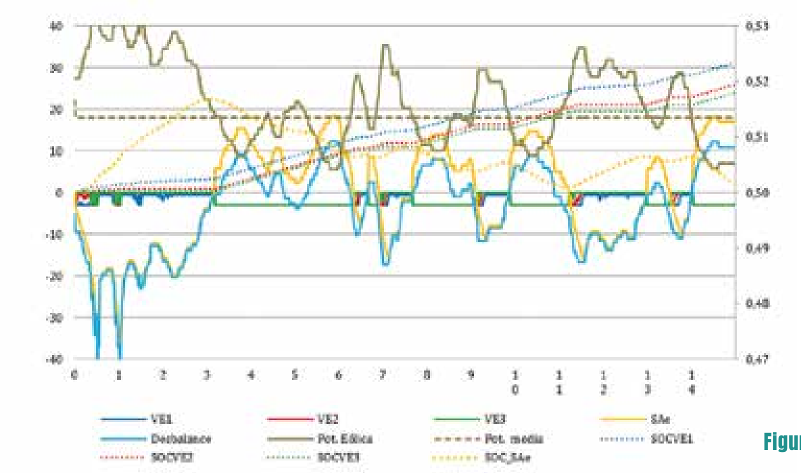


Figure 30 - *Figure 1. Hourly operation of the plant (- EV 1; - EV2; - EV3; - Battery; - Wind power; - Energy Misbalance; … EVs and Battery State of Charge (SOCs) and average power)*

Figure 31 - *Factory Microgrid at Jofemar's factory in Peralta (Navarra, Spain)*

BUDGET:	€ 6 889 765,63	**FUNDING PROGRAMME:**	LIFE
PERIOD:	From 1 July 2014 .... to 30 December 2017		

FLEXCHX

EUREC PARTNERS:

Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft

Flexible Combined Production of Power, Heat and Transport Fuels from Renewable Energy Sources

MAIN FEATURES OF THE PROJECT

FLEXCHX proposes a flexible and integrated hybrid process that combines electrolysis of water with gasification of biomass and catalytic liquefaction. This process produces heat, power, and an intermediate energy carrier, namely Fischer-Tropsch (FT) wax, which can be refined to transportation fuels using existing oil refining equipment. FLEXCHX plants can be integrated with various combined heat and power (CHP) production systems, including industrial CHP plants and communal district heating units.

In the summer season, renewable fuels are produced from biomass and hydrogen; the hydrogen is produced from water via electrolysis that is driven by low-cost excess electricity from the grid. During the dark, winter season, the plant is operated with just biomass, in order to maximize the production of heat, electricity and FT wax. Most of the plant components are in full use throughout the year; only the electrolysis unit is operated seasonally.

Bringing this type of flexible and integrated production concept to the energy production market requires the development of new conversion technologies, which is the focus of FLEXCHX. The new pressurized staged fixed-bed gasifier followed by catalytic reformer can be operated with a wide range of biomass residues and waste-derived feedstocks. Innovative recycling of carbon dioxide and tail gas from the FT unit enables flexible operation with and without electrolysis hydrogen. Another key innovation of the project is the use of compact and highly efficient FT technology, which can be economically realized at 10- to 50-megawatt biomass input.

EXPECTED RESULTS

The following five key enabling technologies will be developed to TRL5: i) gasification; ii) hot gas filtration; iii) reforming; iv) final gas cleaning; and v) compact FT synthesis.

The experimental development will be carried out using a 0.5 MW, pressurized, fixed-bed gasification pilot plant (SXB-Pilot) located at VTT's piloting Centre Bioruukki, Finland. At first, the existing air-blown gasification plant was modified to allow operation at elevated pressure and with various ratios of gasification agents. The gasifier was equipped with a special hot filter unit followed by a catalytic reformer, where tars and hydrocarbon gases are reformed to H2 and CO. Pilot tests started in autumn 2019 using various wood residues as feedstocks. Simultaneously, the FT technology was optimized at Ineratec's facilities in Karlsruhe, Germany. Validation tests for the whole FLEXCHX concept is expected to be carried out in 2020. Then FT hydrocarbons will be produced from wood residues, agro-biomass and demolition wood. The experimental development is supported by technical, economic and environmental feasibility studies.

The process will be ready for industrial demonstration in 2021. Potential production sites in Lithuania and Finland, where biomass-based district heating plays an important role, is being assessed.

For more information: www.flexchx.eu

OTHER PARTNERS:

- VTT - COORDINATOR (FINLAND)
- LITHUANIAN ENERGY INSTITUTE (LITHUANIA)
- ENERSTENA (LITHUANIA)
- JOHNSON MATTHEY (UK)
- NESTE ENGINEERING SOLUTIONS (FINLAND)
- KAUNO ENERGIJA (LITHUANIA)
- HELEN (FINLAND)
- INERATEC (GERMANY)
- GRÖNMARK (FINLAND).

Myth 2: not reliable?

Myth 5: environmentally harmful?

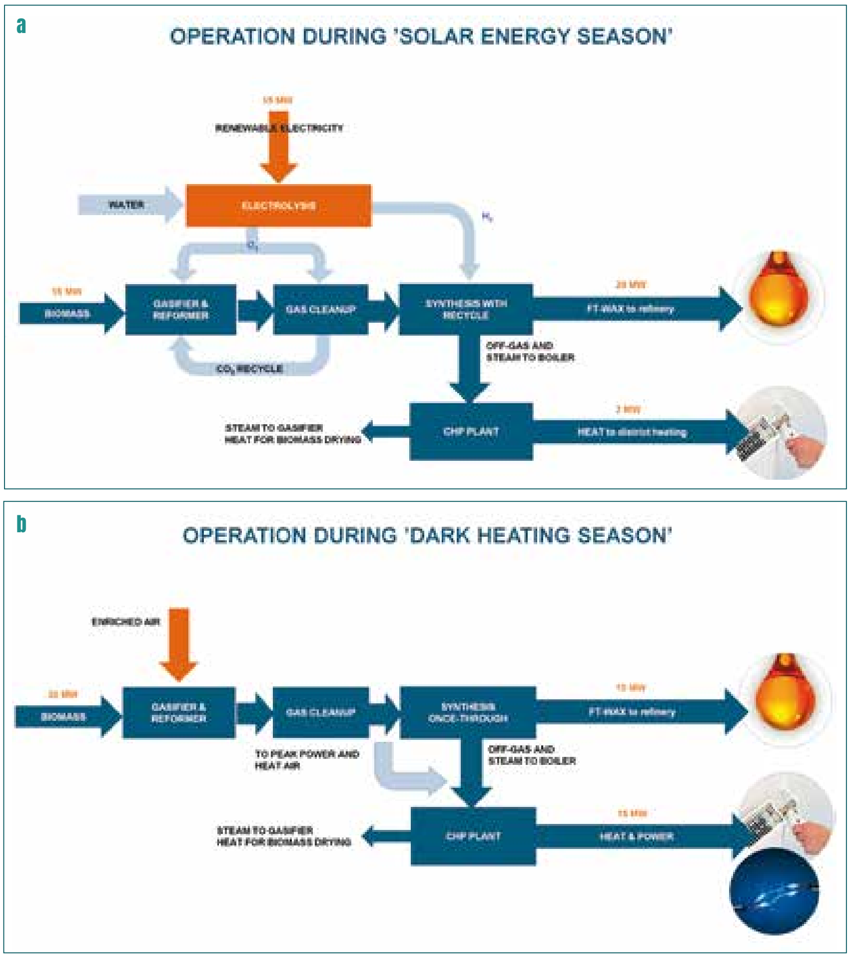


Figure 32 - *FLEXCHX operation mode in the summer (a) and winter (b) season*

BUDGET:	€ 6 889 765,63	**FUNDING PROGRAMME:**	HORIZON 2020
PERIOD:	From 1 March 2018 .... to 28 February 2021		

EUREC PARTNERS:

Coordinator

Fostering Sustainable Feedstock Production for Advanced Biofuels on Underutilised Land in Europe

MAIN FEATURES OF THE PROJECT

FORBIO developed a methodology to assess the sustainable bioenergy production potential of available "underutilised lands" in Europe (contaminated, underutilised and marginal land) at local, site-specific level. Based on this methodology, the project produced multiple feasibility studies in selected locations in three countries (Italy, Germany, Ukraine). FORBIO investigated economic and non-economic barriers to sustainable bioenergy deployment and produced roadmaps for the sustainable growth of bioenergy. Furthermore, awareness raising and capacity building events were organised to promote and facilitate the creation of partnerships between farmers, bioenergy producers and local institutions, and to share good practices and lessons learnt.

MAIN RESULTS

The sustainability assessment of the three bioenergy value chains in the case study regions not only showed that bioenergy production on marginal, underutilised and contaminated land does not harm the environment, but also that it can have a positive impact.

In Italy, the value chain consisted of planting giant reed for ethanol production on contaminated land in Sulcis, Portoscuso. The environmental assessment showed that:

- the GHG performances of lignocellulosic ethanol would lead to at least 64% reduction when compared to petrol;
- soil quality, such as erosion and soil organic carbon content, is positively impacted by the production of biomass for advanced biofuels generation;
- biomass production contributes to reduce pollutants in water bodies;
- biodiversity is also positively impacted by the production of biomass for advanced bioenergy in the target area.

In Germany, the value chain consisted of planting lucerne and sorghum in a crop rotation system for biogas production on lignite reclamation sites in Brandenburg. The environmental assessment showed that:

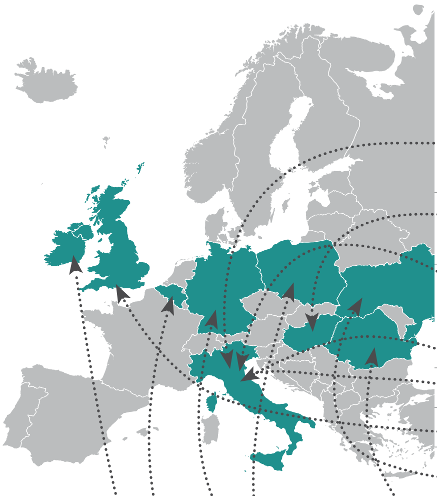
- if leaking is not factored the fuel could save some 80% emissions per unit of energy when compared to natural gas;
- given the highly organic fertilization regime proposed, the biomass value chain contributes to enhancing SOC content in the soil;
- water performances of the biomethane value chains are positive.

In Ukraine, the value chain consisted of willow plantation for ethanol production on underutilised marginal land in Ivankiv region. The environmental assessment showed that:

- the GHG performances of lignocellulosic ethanol leads to at least 57% reduction when compared to petrol;
- soil organic matter increases by 314 kg/ha/yr if the current underutilized lands are cultivated with willows for biomass production;
- biodiversity is positively impacted by the production of biomass for advanced bioenergy in the target area.

Moreover, FORBIO shows that the establishment of new bioenergy value chains boosts local green economy and job creation.

For more information: https://forbio-project.eu/



OTHER PARTNERS:

- FOOD AND AGRICULTURE ORGANISATION OF THE UNITED NATIONS (IT)
- GEONARDO ENVIRONMENTAL TECHNOLOGIES LTD (HU)
- CONSIGLIO PER LA RICERCA IN AGRICOLTURA E L'ANALISI DELL'ECONOMIA AGRARIA (IT)
- INGEG SRL (IT)
- BLACKSMITH INITIATIVE (UK)
- NAUKOVO-TEHNICHNII CENTAR BIOMASA LLC (UA)
- CENTRUL PENTRU PROMOVAREA ENERGIEI CURATE SI EFICIENTA IN ROMANIA ENERO ASOCIATIEI (RO)
- FORSCHUNGINSTITUTE FUR BERGBAUFOLGELANDSCHAFTEN EV (DE)
- POLSKIE TOWARZYSTWO BIOMASY POLBIOM (PL)
- EUROPEAN LANDOWNERS ORGANISATION (BE)
- UNIVERSITY OF LIMERIK (IE)

Myth 5: environmentally harmful?

Myth 8: destroy jobs?

Figure 33 - *Italy case study (Sulcis, Portoscuso)*

Figure 34 - *Germany case study (Brandenburg region)*

Figure 35 - *Ukraine case study (Ivankiv region)*

BUDGET:	€ 1 941 581,25	**FUNDING PROGRAMME:**	HORIZON 2020
PERIOD:	From January 2016 ... to 31 December 2018		

gigaTES

EUREC PARTNERS:

AEE INTEC

Giga-Scale Thermal Energy Storage for Renewable Districts

MAIN FEATURES OF THE PROJECT

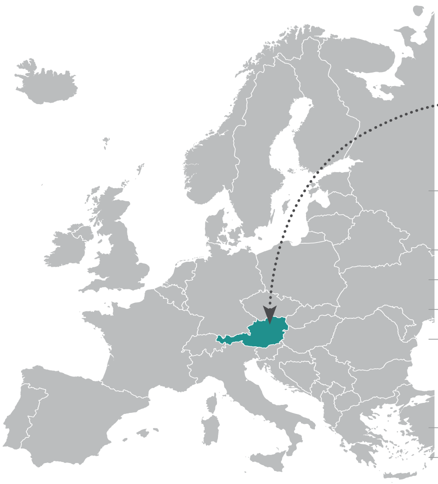
The goal of giga_TES is to develop novel materials, components and construction technologies for giga-scale thermal energy storages, which allow to rapidly increase the share of renewable and flexible sources in district heating networks. To this end, innovative polymer liner materials, novel concrete formulations and novel materials and construction methods for floating lids will be developed. This will enable the cost-effective design and operation of water based thermal energy storages from 50,000 to more than 2,000,000 m3 volume at elevated storage temperatures. The development will be optimised with the help of numerical simulation techniques at different levels.

EXPECTED RESULTS

Giga_TES aim to achieve the following goals:

- categorized and prioritized requirements, challenges and benefits of giga-scale heat storages for at least three Austrian locations representing possible archetypes;
- technology concepts for large and deep storage pits within five typical construction grounds (rock/soils, with/without ground water), as well as designs and process technologies for multilayer structures for the bottom, the wall and the cover of giga-scale TES;
- novel liner, concrete and metal-sandwich materials with improved temperature capability and lifetime, as well as optimized multi-functional property profiles according to the component specific requirements;
- detailed 3D TES model accounting for different ground layers, ground water flow, complex geometries, moisture transport and convection in multi-layer structures at the bottom, the wall or the cover;
- simulation framework, application scenarios and operating windows for district heating systems with integrated giga-scale TES.

For more information: https://www.gigates.at/index.php/en/



OTHER PARTNERS:

ALL FROM AUSTRIA

- S.O.L.I.D. GESELLSCHAFT FÜR SOLARINSTALLATION UND DESIGN M.B.H.
- AGRU KUNSTSTOFFTECHNIK GESELLSCHAFT M.B.H.
- UNIVERSITÄT INNSBRUCK
- SMART MINERALS GMBH
- UNIVERSITÄT LINZ
- INSTITUTE OF POLYMERIC MATERIALS AND TESTING GABRIEL-CHEMIE GESELLSCHAFT M.B.H.
- STEINBEIS INNOVATION GGMBH - SOLITES
- FORSCHUNGSINSTITUT FÜR SOLARE UND ZUKUNFTSFÄHIGE THERMISCHE ENERGIESYSTEME PLANENERGI
- INGENIEURBÜRO STE.P ZT-GMBH
- GEOLOGIE UND GRUNDWASSER GMBH
- LENZING PLASTICS GMBH & CO KG
- GVT VERFAHRENSTECHNIK GMBH
- BILFINGER VAM ANLAGENTECHNIK GMBH
- PORR BAU GMBH HTTP://WWW.PORR.AT
- SALZBURG AG FÜR ENERGIE, VERKEHR UND TELEKOMMUNIKATION
- METAWELL GMBH

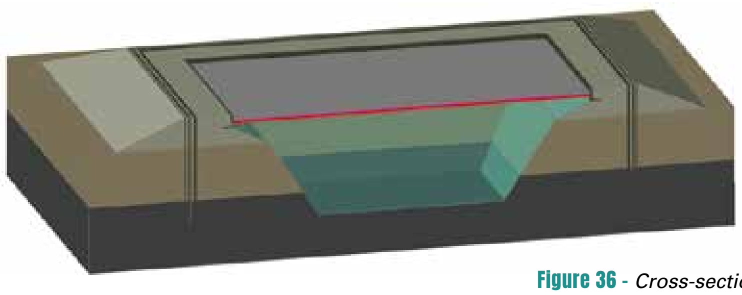


Figure 36 - *Cross-section of one possible geometry for a giga_TES storage, with diaphragm wall to cut off groundwater from the storage, elevated dam structure and floating lid (Source: Ingenieurbüro ste.p)*

Figure 37 - *Holder for several novel polymer liner material to be tested for durability in a test chamber (Source: JKU Linz)*

BUDGET:	€ 4 400 000	**FUNDING PROGRAMME:**	Klima- und Energiefonds (Austria)
PERIOD:	From 1 January 2018 .... to 31 December 2020		

goflex-community.eu

EUREC PARTNERS:

FOSS Research Centre for Sustainable Energy

Generalized Operational Flexibility for Integrating Renewables in the Distribution Grid

MAIN FEATURES OF THE PROJECT

GOFLEX innovates, integrates, further develops and demonstrates a series of electricity smart-grid technologies, enabling the cost-effective use of demand-response strategies in distribution grids, increasing the grids' adaptation capacity and safely supporting a higher share of renewable electricity generation. The GOFLEX smart grid solutions deliver general (across different loads and devices) and operational (solving specific local grid problems) flexibility. GOFLEX enables active use of distributed sources of load flexibility to provide services for grid operators, balance electricity demand and supply, and optimize energy consumption and production at local level.

Building on existing, validated technologies, GOFLEX enables flexibility in automatic trading of general, localized, device-specific energy, as well as in trading aggregated prosumer energy. Generalized demand-response services are based on transparent aggregation of distributed, heterogeneous resources to offer virtual-power-plant and virtual-storage capabilities. The sources of load flexibility include thermal and electric storage (including electric vehicles charging/discharging). A backbone data-services platform offers localised estimation and short-term predictions of market and energy demand/generation, thus supporting effective data-driven decisions. Smart-grid technologies allowing increased observability and congestion management, contribute to strengthen the platform.

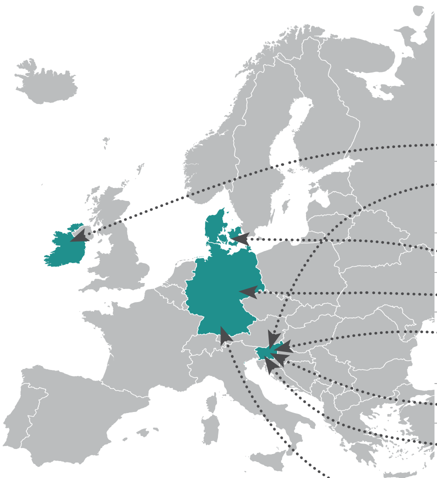
MAIN RESULTS

GOFLEX contributes to strengthen the energy system by:

- introducing dynamic pricing of energy through automatic demand-response trading by prosumers;
- augmenting demand-response capabilities through energy storage;
- adapting prosumer demand response for creating virtual energy reservoirs in prosumer processes and devices;
- integrating optimized and balanced demand-response energy management system;
- integrating grid users from the transport sector though charging/discharging station management systems;
- improving observability and manageability of distribution grid for demand-response management;
- providing cloud (SaaS) based data and forecasts provision service platform for energy market and weather forecasts data.

Overall, GOFLEX provides solutions to enhance the reliability of the energy system, to support high shares of RES and to develop new business models. Through the proposed demand-response schemes and integrated storage solutions the security of energy supply is ensured. A high penetration of RES in the grid is allowed, whereas flexible demand can secure that RES and storage can accommodate all energy needs. In addition, a competitive market of demand-response is created through different approaches and tools, making prosumers viable actors of the energy transition and reducing the need for subsidies.

For more information: https://goflex-project.eu/



OTHER PARTNERS:

- IBM IRELAND LIMITED (IE)
- INFORMATIZACIJA ENERGETIKA AVTOMATIZACIJA DOO (SI)
- AALBORG UNIVERSITET (DK)
- TECHNISCHE UNIVERSITAET DRESDEN (DE)
- ETREL SVETOVANJE IN DRUGE STORITVE DOO (SI)
- ROBOTINA DOO (SI)
- POFJETJE ZA INZ ENIRING, MARKETING, TRGOVINO IN PROIZVODNJO (SI)
- B.A.U.M. CONSULT GMBH (DE)
- ARCHI ILEKTRISMOU KYPROU (CY)

Myth 2: not reliable?

Myth 4: fail without subsidies?

Myth 6: do not satisfy the demand for energy?

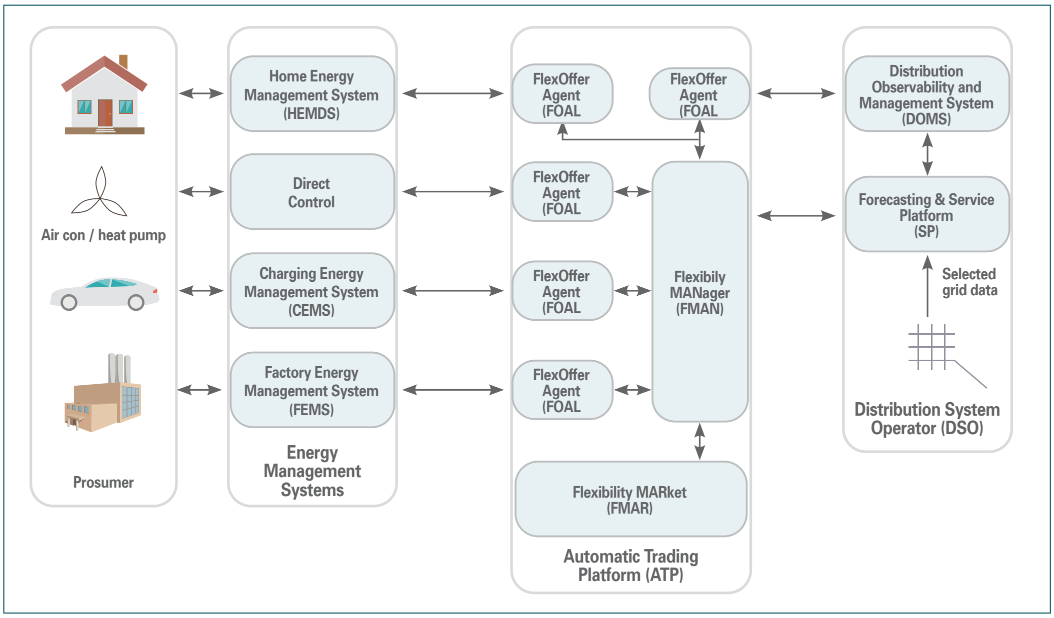


Figure 38 - *GOFLEX concept*

BUDGET:	€ 11 234 125	**FUNDING PROGRAMME:**	HORIZON 2020
PERIOD:	From 1 November 2016 .... to 29 February 2020		

EUREC PARTNERS:

Comprehensive Plan for Virtual Power Plants in European Markets

MAIN FEATURES OF THE PROJECT

Hybrid-VPP4DSO investigates the concept of a hybrid virtual power plant to provide services for distribution grid operators, grid customers and balancing markets. For this, a coordination scheme between the DSO and the hybrid-VPP operator was developed using a traffic light concept: in grid sections marked in green market participation is possible without restrictions. When the state is marked in yellow a grid section is close to its limits (voltage or current) and market participation for the hybrid-VPP is restricted. Finally, if a grid section is marked in red, meaning it faces some potential voltage or overloading problems, the grid demands active support from the hybrid-VPP. To realize this traffic light system, enhanced interaction between the different stakeholders is required. Figure 39 shows the required interactions for one of the investigated use cases.

MAIN RESULTS

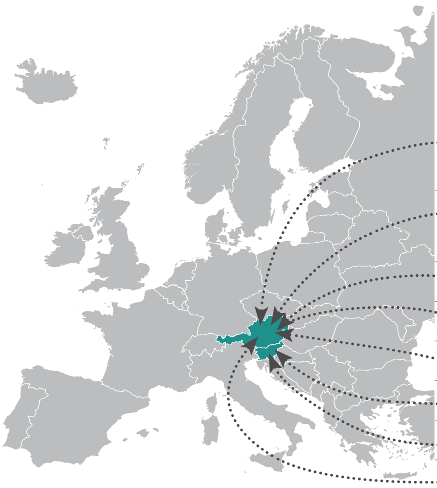
The project successfully demonstrated the potential of a hybrid-VPP to support DSOs in parallel to the active participation on a national market for tertiary control. The applicability of the hybrid-VPP depends on the grid topology, the connection points, the capacity and the type of available flexibility. The simulations showed that a pool with units that are diverse in location and include demand side management, as well as different types of (renewable) generators, is needed to successfully support the distribution grid operation throughout the whole year.

The added value of a hybrid-VPP is mainly related to the multitude of different use cases (e.g. the reduction of investment costs for new users who connect to the grid and the prevention/deferral of grid investments of DSOs), which can be realized using the same hybrid-VPP platform.

Regulatory barriers for the integration of the hybrid-VPP were identified, especially for the remuneration of grid-friendly flexibility operations. Two promising solutions for the configuration of the hybrid-VPP operator were identified: i) the aggregator as hybrid-VPP-operator and ii) the DSO as market facilitator.

The Traffic Light System will be further developed in the Integrid project, recently funded by the EU's HORIZON 2020 program.

For more information: http://www.hybridvpp4dso.eu/front_content.php



OTHER PARTNERS:

- GEA GRAZER ENERGIEANGENTUR GES.M.B.H (AT)
- TU WIEN INSTITUT FÜR ENERGIESYSTEME UND ELEKTRISCHE ANTRIEBE (AT)
- ENERGIE STEIERMARK KUNDEN GMBH (AT)
- ENERGIENETZE STEIERMARK GMBH (AT)
- CYBERGRID GMBH (AT)
- ELEKTRO ENERGIJA D.O.O (SI)
- ELEKTRO LJUBLJANA D.D. (SI)
- ENERGETIC SOLUTIONS (AT)

Myth 2: not reliable?

Myth 4: fail without subsidies?

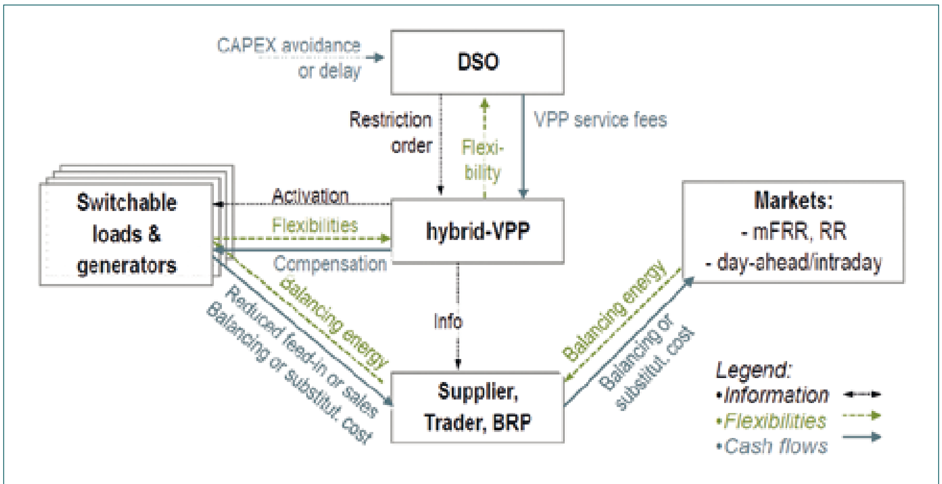


Figure 39 - *Main interactions between the stakeholders in the grid driven hybrid use case*

BUDGET:	€ 11 234 125	**FUNDING PROGRAMME:**	Klima+ energie fonds (AT)
PERIOD:	From 1 November 2016 ... to 29 February 2020		

EUREC PARTNERS:

КАПЕ
CRES

Demonstration of Good Practices to Minimize Impacts of Wind Farms on Biodiversity in Greece

MAIN FEATURES OF THE PROJECT

Despite the benefits of wind energy, the siting and operation of wind farms in sensitive ecological areas is a source of concern for biodiversity. WINDFARMS & WILDLIFE demonstrates and promotes state-of-the-art methods and approaches to improve the compatibility of wind farms with the EU biodiversity conservation targets, and to develop guidelines that will enable Greek state authorities and wind farm project owners to effectively plan, implement and regularly evaluate the performance of mitigation technologies.
The project implements integrated approaches for the mitigation of impacts on biodiversity (birds and bats) during the operation of wind farms, using available modern methods and technologies. The main site for the demonstration of technologies and methods is the 3MW Demonstration Wind Farm, Park of Energy Awareness (PENA), in Keratea, Attica. Demonstration actions are also implemented in other areas of Greece.

MAIN RESULTS

Modern technologies and best practices can help to avoid and/or to reduce to a tolerable level the impacts of the wind farms on the biodiversity during design, construction and operation. An important issue during the operation of wind farms is the use of the so called "early warning systems", such as ornithological radars, video surveillance systems, thermal cameras and bio-acoustic monitoring systems. These systems, along with traditional methods of data collection (e.g. optical observations) and information on the responses of birds to wind turbines, can help to reduce the impact on biodiversity during the operation stage, as well as significantly improve biodiversity data on space use.

For more information: https://www.windfarms-wildlife.gr/

OTHER PARTNERS:

- NATURE CONSERVATION CONSULTANTS LTD, GREECE

Myth 5: environmentally harmful?

Figure 40 - *A pilot installation of three different models of automated ultrasound recording systems on wind turbines was carried out within the project, in order to examine their ability to record bat activity at the rotor height and to determine the possible need for curtailment of wind turbine operations. For this purpose, the microphone of each system was mounted on the nacelle of the wind turbines. The picture shows one of the bat detectors microphone at VESTAS V47/660kW wind turbine of CRES demonstration wind farm, PENA (GR).*

Figure 41 - *Installation of an autonomous video-based bird monitoring and dissuasion system on the nacelle of a wind turbine at CRES demonstration wind farm, PENA (GR). The system detects/records movements of flying objects in the area, assesses them and makes decisions to trigger bird collision mitigation measures (sound emission, wind turbine stopping) in real time, depending on the risk of impact.*

BUDGET:	€ 894,784.00	**FUNDING PROGRAMME:**	LIFE
PERIOD:	From 1 October 2013 ... to 31 December 2018		

EUREC PARTNERS:

Building-integrated photovoltaic technologies and systems for large-scale market deployment

MAIN FEATURES OF THE PROJECT

Building-integrated photovoltaics (BIPV) is currently a growing market, mainly supported by the increasingly demanding legislation on the energy performance of buildings. However, market uptake has been hindered by the lack of holistic solutions that comply with key requirements and end users' needs. The main objective of PVSITES is to contribute towards a larger market deployment of BIPV technology by:

- identifying and addressing the main BIPV market barriers and challenges;
- demonstrating (TRL 5 to TRL 6-7) an ambitious portfolio of BIPV solutions in terms of flexible design, architectural integration, functionality, simulation of performance, cost-effectiveness, grid integration, energy management, LCA, training and awareness; and
- defining business models that support the commercialization of BIPV technologies.

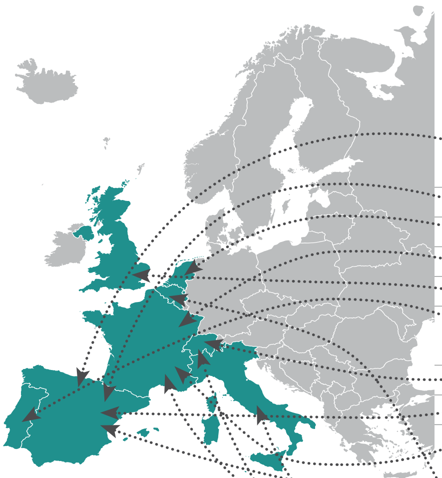
MAIN RESULTS SO FAR

At time of publication, PVSITES has:

- successfully tested crystalline silicon-based solutions and CIGS BIPV modules, and demonstrated their compliance with PV and construction standards;
- developed two new inverter technologies to improve the integration of the electricity generated in the grid: a silicon carbide (SiC)-based inverter CSI prototype and a low-cost 10 kW DC-coupled storage inverter were validated according to relevant standards;
- created a smart building energy-management system using software that predict the influence of solar technology on a building's energy performance;
- released a pre-commercial version of PVSITES software (BIM-integrated): this BIM-compatible suite is designed to ease the integration of BIPV systems in buildings at the design stage, covering the electrical, thermal and optical domains in real operating conditions.

PVSITES BIPV technologies have be installed on seven real buildings in five different European locations and climate conditions: a single family residential house in Stambruges, Belgium; an apartments building (social housing) in Wattignies, France; the prestigious Swiss École Hotelière de Genève and two carports in Zurich, Switzerland; an industrial building in Barcelona, and an office building in San Sebastián, Spain.

For more information: https://www.pvsites.eu/



OTHER PARTNERS:

- FUNDACION TECNALIA RESEARCH & INNOVATION (ES)
- ONYX SOLAR ENERGY SL (ES)
- BEAR HOLDING BV (NL)
- NOBATEK INEF 4 (FR)
- FILM OPTICS LTD (UK)
- CENTRO TECNOLOGICO DA CERAMICA E DO VIDRO (PT)
- FLISOM AG (CH)
- CRISTALES CURVADOS SA (ES)
- COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES (FR)
- ACCIONA CONSTRUCCION SA (ES)
- BUREAU D'ARCHITECTES FORMAT D2 SPRL (BE)
- VILOGIA SA (FR)
- R2M SOLUTION SRL (IT)
- CADCAMATION KMR SA (CH)

Figure 42 - *Single house in Stambruges*

Figure 43 - *TECNALIA office in San Sebastian*

Figure 44 - *PVSITES carport in Zurich*

Figure 45 - *Crystalline silicon photovoltaic skylight by Onyx Solar*

Figure 45 - *16 kW BIPV glass-glass curtain wall (ONYX Solar) at Balenciaga storefront*

BUDGET:	€ 8 490 472,50	**FUNDING PROGRAMME:**	HORIZON 2020
PERIOD:	From 1 January 2016 .... to 30 June 2020		

REstable PROJECT

EUREC PARTNERS:

Coordinator

ARMINES

Fraunhofer

Improvement of Renewables-based System Services Through Better Inter-action of European Control Zones

MAIN FEATURES OF THE PROJECT

REstable intended to develop new technologies to allow RES to provide ancillary services to the grid without the need of storage or other investments. REstable builds on the results of the project "Kombikraft-werk II" and is based on the concept of a Virtual Power Plant (VPP) able to control diverse renewable resources (photovoltaic, wind) in several regions (atlantic, continental, mediterranean).

The project tested the ability of a Virtual Power Plant (VPP) to provide the following five ancillary services:

- Frequency Containment Reserve (FCR);
- Automatic Frequency Restoration Reserve (aFRR);
- Manual Frequency Restoration Reserve (mFRR);
- Replacement reserve (RR);
- Voltage Support.

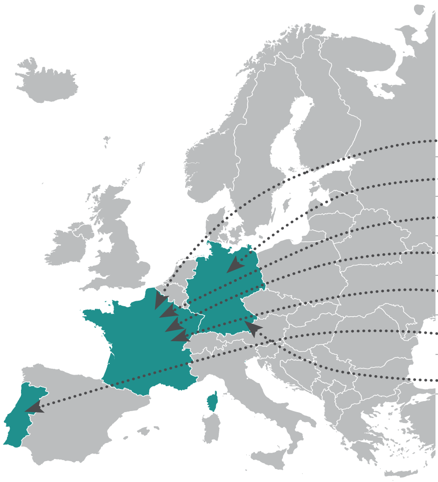
For each service a meaningful number of tests was carried out. In each test, a procedure similar to the one requested by the TSOs for the pre-qualification of a provider for the provision of each ancillary service was repeated. In the case of FCR there was also a test with reaction of the VPP to a real frequency deviation signal.

REstable also proposed an approach to accelerate the response of the VPP, developed strategies for multiple bidding in energy and ancillary services markets, issued tools to forecast the capacity of renewable plants to provide ancillary services and carried out a study of the needs of ancillary services on the European grid in the medium to long term.

MAIN RESULTS

REstable developed several solutions at different levels of technology readiness level (TRL). Some of them such as the VPP control system or the bidding tool are commercialised by the partners, others needs further refinement. The financial benefit for a renewable producer of providing ancillary services and energy instead of only energy has been estimated in the region of 4-8%. REstable will be followed by a second project, REgions (2019-2022) building on these results to demonstrate the provision of ancillary services - such as voltage support and congestion management - at local level.

For more information: https://www.restable-project.eu/



OTHER PARTNERS:

- FARTELYS (FR)
- ENERCON (DE)
- ENGIE (FR)
- HYDRONEXT (FR)
- HESPUL (FR)
- INESC TEC (PT)
- SOLAR WORLD (DE)

Figure 47 - *Map of the VPP highlighting the physical assets and the control centre*

BUDGET:	€ 3,500,400	**FUNDING PROGRAMME:**	ERA-Net Smart Grids Plus
PERIOD:	From 1 April 2016 .... to 31 March 2019		

EUREC PARTNERS:

Coordinator

Self Consumption of Renewable Energy by hybrid Storage systems

MAIN FEATURES OF THE PROJECT

SCORES aims to develop and demonstrate a building energy system including new compact hybrid storage technologies, optimising supply, storage and demand of electricity and heat and increasing self-consumption of local renewable energy in residential buildings.

SCORES develops several key-technologies in parallel, ie. second-life Li-ion batteries, compact thermal storage by Phase-Change Materials (PCM), high performance hot-water heat pump supplied by hybrid photovoltaic and solar collectors (PVT), Chemical Looping Combustion heat storage (seasonal storage). These technologies are integrated through a smart Building Energy Management System (BEMS) and demonstrate in a hybrid energy system.

Demonstration of the integrated hybrid energy system will take place in two real buildings in Austria and France that are representative of different climate and energy system configurations.

MAIN RESULTS SO FAR

Preliminary results from the Austrian demo case show:

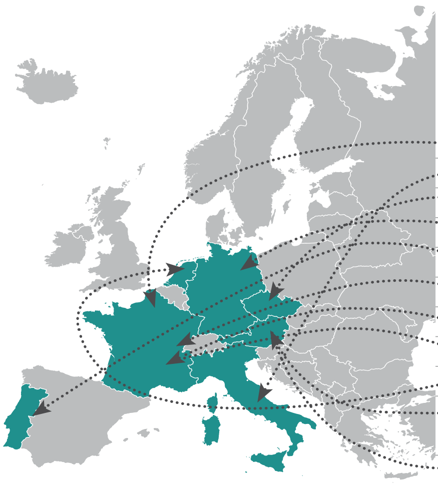
- cost savings of 50% per year compared to a conventional gas boiler system;
- a payback period of 18 years;
- 30% gain in energy savings.

The French demo case shows the following preliminary results:

- cost savings of 47 % compared to standard electric heaters;
- a payback period of 7 years;
- 50% gain in energy savings.

More generally, SCORES provides efficient solutions for mid- and long-term storage of surplus (and cheap) heat and electricity, thereby avoiding (expensive) peak-loads and improving the resilience of the grids. If more SCORES systems are implemented in an electricity and thermal (sub)grid, a higher level of regularization and stabilization of the grids can be achieved.

For more information: http://www.scores-project.eu/



OTHER PARTNERS:

- ELECTRICITE DE FRANCE (FR)
- RINA CONSULTING SPA (IT)
- FENIX TNT SRO (CZ)
- KONIG METALL GMBH & CO KG (DE)
- INSTITUTO POLITECNICO DE SETUBAL (PT)
- FORSEE POWER (FR)
- HELIOPAC (FR)
- CAMPA (FR)
- SIEMENS NEDERLAND NV (NL)
- SALZBURG AG FUR ENERGIE, VERKEHR UND TELEKOMMUNIKATION (AT)
- STADTWERKE GLEISDORF GMBH (AT)

Myth 1: expensive?

Myth 2: not reliable?

Myth 7: thermal renovation overrated?

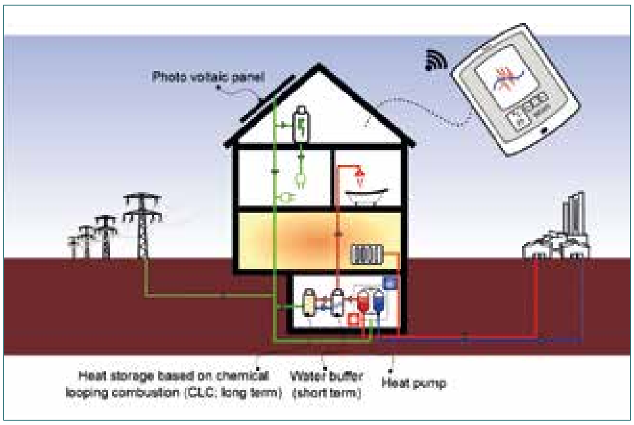


Figure 48 - *Schematic of complete installed SCORES system for the Austrian demonstration case.*

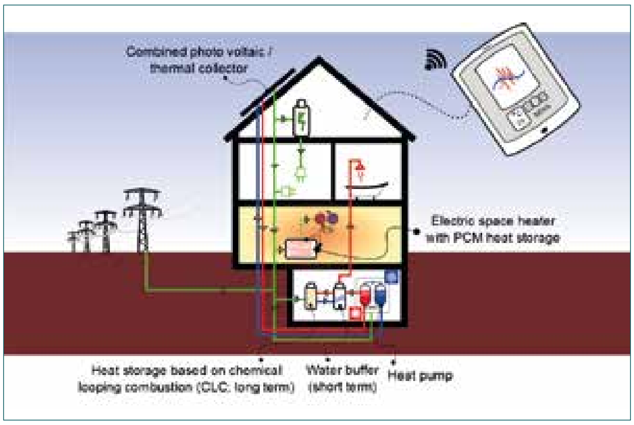


Figure 49 - *Schematic of complete SCORES system for the French demonstration case.*

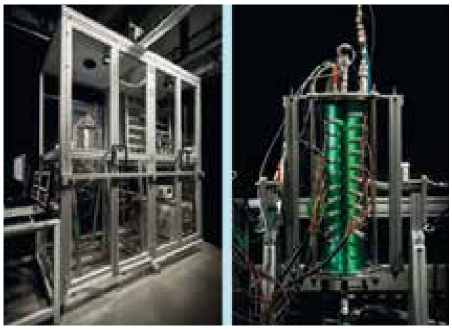


Figure 50 - *Test rig of innovative CLC storage*

BUDGET:	€ 5 998 598,75	**FUNDING PROGRAMME:**	HORIZON 2020
PERIOD:	From 1 November 2017 .... to 31 October 2021		

SmartPV

EUREC PARTNERS:

Coordinator

FOSS Research Centre for Sustainable Energy

Smart Net Metering for Promotion and Cost-Efficient Grid-Integration of PV Technology in Cyprus

MAIN FEATURES OF THE PROJECT

SmartPV focused on optimizing household electricity consumption via smart net-metering and application of dynamic electricity tariffs for all interested parties, including consumers, distribution and supplier networks. The project aimed to highlight the impact of smart net-metering implementation on prosumer billing options, prosumer energy-related behaviours and cost-benefit implications for network owners and operators. The energy behaviour of 300 prosumers in Cyprus was monitored through smart meters. Based on the collected datasets, an optimum Time-of-Use tariff scheme was developed and approved for pilot implementation. This was the first time a time-varying electricity tariff was applied for residential prosumers in Cyprus.

Among the results achieved is the awareness raising of the general public on smart net-metering and demand side management (DSM) concepts and the development of an optimization software to identify cost-efficient time-varying electricity tariff schemes based on varying RES penetration in the energy mix. An optimized mix of RES generation along with a price-based DSM scheme will eventually reduce the wholesale electricity prices over time and guarantee reliability of electricity supply in terms of balancing production with demand. Additionally, the pilot network and the valuable large database can be exploited as a testbed for benchmarking and energy policy formation.

MAIN RESULTS

The analysis performed shows that prosumers became more aware of their energy consumption patterns. As a result, the load factor was increased, while the percentage of total consumption measured during peak hours was reduced by 3.19%, 1.03% and 1.40% in summer, middle and winter respectively. Moreover, average energy consumption was reduced by approximately 2.18%. Overall, two third of participants benefitted from reduced electricity bills.

These encouraging results convinced the DSO to invest in a full AMI rollout and to commit to replace at least 80% of conventional meters with smart meters by the end of 2028. Moreover, the DSO proceeded with the implementation of a Two Rate Domestic Use Tariff. Project results and lessons learned helped in establishing a clear and transparent regulatory framework.

For more information: http://www.smartpvproject.eu/index.php

OTHER PARTNERS:

- EELECTRICITY AUTHORITY OF CYPRUS
- REGULATORY AUTHORITY OF CYPRUS
- MINISTRY OF AGRICULTURE NATURAL RESOURCES AND ENVIRONMENT – ENVIRONMENT DEPARTMENT
- DELOITTE LIMITED

Figure 51 - *Time-of-use tariff scheme implemented in SmartPV*

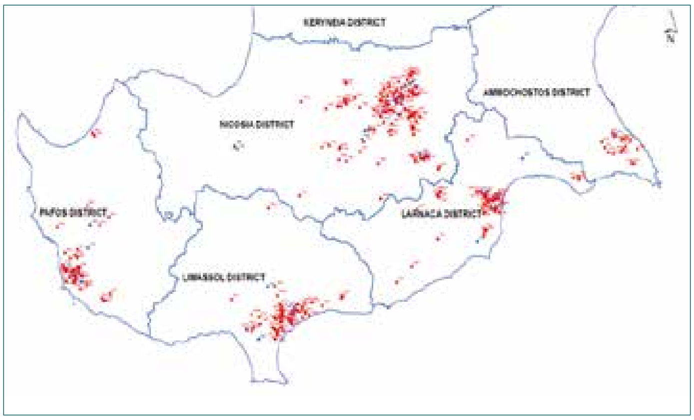


Figure 52 - *Geo-localisation of smart meters installed in SmartPV*

BUDGET:	€ 1,219,838.00	**FUNDING PROGRAMME:**	LIFE
PERIOD:	From July 2013 .... to 1 March 2017		

EUREC PARTNERS:

Coordinator

Fostering Social Innovative and Inclusive Strategies for Empowering Citizens in the Renewable Energy Market of the Future

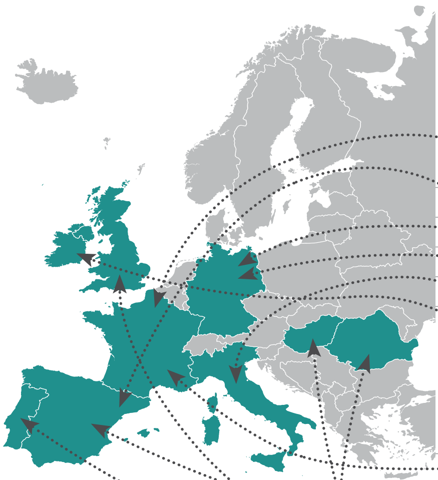
MAIN FEATURES OF THE PROJECT

SocialRES aims at closing non-technological research gaps that impede the widespread uptake of social innovation business and service models in the European energy sector. SocialRES will set the basis for a better understanding of the socio-economic, socio-cultural, socio-political and gender factors that influence the behaviour of consumers in the energy system. On this basis, SocialRES will foster the development of new cooperation models among the key enabling actors for energy democracy: cooperatives, energy aggregators and crowdfunding platforms.

EXPECTED RESULTS

SocialRES will provide a better understanding of socioeconomic, gender, sociocultural, and socio-political factors and their interrelations with technological, regulatory, and investment-related aspects. To complement our research, we will provide policy makers with recommendations to create a more favourable legal and regulatory framework for social innovation. This will encourage the uptake of social innovation and the empowerment of consumers as responsible actors in the clean energy transition. Innovative techniques will be employed, such as a Peer to Peer (P2P) crowd-investing for renewable energy sources projects, P2P lending and P2P virtual photovoltaic electricity platform for aggregators. The innovative P2P photovoltaic virtual platform will be developed as a pilot software application in off-line mode and will facilitate the understanding about existing barriers within current electricity markets and policies. Experience will be accumulated related to the main issues with the common access for energy trades between different actors on the market: prosumers, consumers, balancing responsible party and distributed photovoltaic generators.

For more information: http://socialres.eu/



OTHER PARTNERS:

- ECOLE SUPERIEURE DES TECHNOLOGIES INDUSTRIELLES AVANCEES (FR)
- FUNDACION CARTIF (ES)
- BODENSEE STIFTUNG (DE)
- ADELPHI RESEARCH GEMEINNUTZIGE GMBH (DE)
- FONDAZIONE ICONS (IT)
- THE PROVOST , FELLOWS, FOUNDATION SCHOLARS & THE OTHER MEMBERS OF BOARD OF THE COLLEGE OF THE HOLY & UNDIVIDED TRINITY OF QUEEN ELIZABETH NEAR DUBLIN (IE)
- I-ENER (FR)
- ENERGETICA S COOP (ES)
- POWER PARTY LDA (PT)
- ABUNDANCE INVESTMENT LTD (UK)
- REGIONALNA EGIONALNA ENERGETSKA AGENCIJA SJEVEROZAPADNE HRVATSKE (HR)
- TRACTABLE ENGINEERING SA (RO)

Myth 4: fail without subsidies?

Myth 9: make EU's economy less competitive?

Figure 53 - *4.8MW ground mounted solar park developed by Abundance in collaboration with Swindon Borough Council (UK)*

Figure 54 - *Križevci Solar Roof: P2P crowdfunding investment model to finance an installation of a 50kW PV system on the rooftop of a business centre owned by the city Krizevci (HR)*

BUDGET:	€ 2 444 198,75	**FUNDING PROGRAMME:**	HORIZON 2020
PERIOD:	From 1 May 2019 .... to 31 August 2022		

EUREC PARTNERS:

Coordinator

AEE INTEC

High solar fraction by thermally activated components in an urban environment

MAIN FEATURES OF THE PROJECT

One way to increase the heat storage capacity of a building is to make use of the thermal capacity of construction components. All solid components such as ceilings, walls and foundations can be used as sensible heat storage elements, i.e. by increasing their temperature. This process is called thermal activation. In combination with solar-thermal or solar-electric systems, a high level of solar coverage of the building's energy needs can be achieved, enabling a far-reaching supply with renewable energy. For several years, this approach has been followed by individual pioneers in the construction industry and has already been implemented in several promising construction projects.

The goal of solSPONGEhigh was to perform a detailed analysis of this approach. Based on numerical models and several case studies the project contributes to better understanding the energy-related processes and the design of such systems. Several system concepts for heating and domestic hot water preparation have been developed for three prototype buildings, namely a one-family house, an apartment building and a manufacturing hall. In addition to small buffer storage tanks, the concepts mainly include thermally activated components (storey ceilings) for heat storage and heat dissipation. The energy source is provided by building-integrated solar-thermal or solar-electric systems combined with heat pumps. The system concepts are numerically modelled in different configurations and supplemented with control strategies.

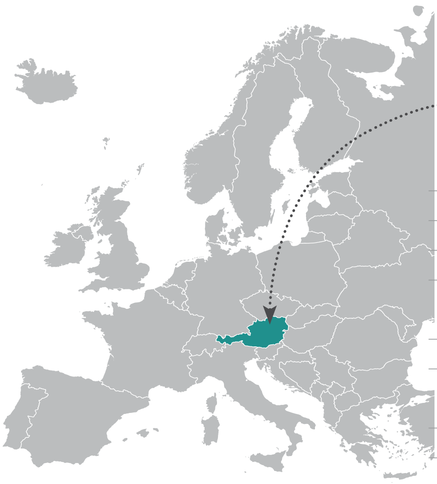
MAIN RESULTS

Due to the storage capacity of the storey ceilings, a single-family house in low energy level can achieve a solar fraction of approximatively 50% even with the smallest considered collector area (20 m²) and a small buffer storage (1.5 m³). By means of other improvements, such as reduction of heat consumption to the level nearly zero energy, solar overheating and covering of the entire roof area and the entire south façade with thermal collectors, the solar fraction is 91%. Thus, over 90% of the heat demand can be covered by locally available RES and the heat pump contributes to less than 10% of the total thermal energy supply.

In multi-family building the heating demand is slightly lower, due to the higher compactness of the building. However, in relation to the heated volume significantly fewer external surfaces are available for solar use. Therefore, the achievable solar fraction is lower than in single-family houses: with a compact energy storage (30 l/m² collector area) and the smallest considered collector area (25 m²) a solar fraction of approximatively 25% can be achieved. Exploiting all considered options for improvement leads to a maximum achievable solar fraction of approximatively 75%.

Finally, in the manufacturing hall a solar fraction of 73% can be achieved with a compact energy storage unit (30 l/m² collector surface) and the smallest considered collector area (200 m²). The exploiting the full range of options a solar fraction of 95% may be achieved.

Several additional parameters were analysed for the considered scenarios. Regarding the costs of the system concepts, high additional investment costs were observed. However, even small collector areas lead to a significant reduction of the energy demand and the operating costs.



OTHER PARTNERS:

ALL FROM AUSTRIA

- INSTITUT FÜR WÄRMETECHNIK DER TU GRAZ
- EAM SYSTEMS GMBH
- UPONOR VERTRIEBS GMBH
- ENERGETICA INDUSTRIES GMBH
- VEREINIGUNG DER ÖSTERREICHISCHEN ZEMENTINDUSTRIE
- GASOKOL GMBH
- DIEHAUSTECHNIKER TECHNISCHES BÜRO GMBH
- OCHSNER WÄRMEPUMPEN GMBH

Myth 1: expensive?

Myth 7: thermal renovation overrated?

Figure 53 - *building renovation*

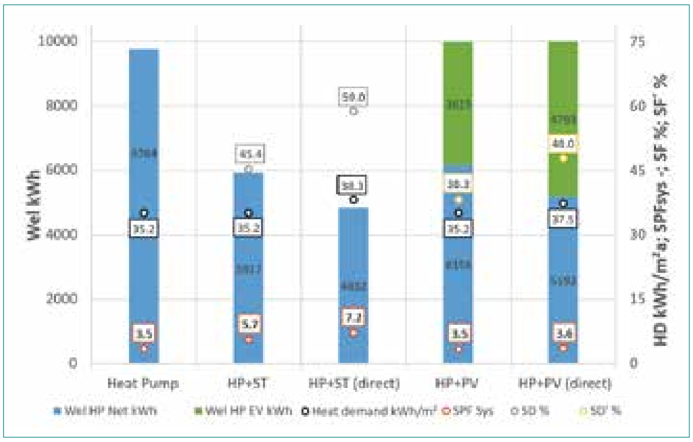


Figure 54 - *technical system comparison for the multifamily house (LEB) with 125 m² ST (PV) and 3.75 m³ storage volume*

BUDGET:	€ 728.210	**FUNDING PROGRAMME:**	City of Future (Austria)
PERIOD:	From 1 May 2014 .... to 30 November 2016		

Holistic and Integrated Urban Model for Smart Cities

EUREC PARTNERS:

Coordinator
CENER
ADItech

eurac research

MAIN FEATURES OF THE PROJECT

STARDUST serves as smart connector bringing together advanced European cities and citizens of Pamplona (ES), Tampere (FI) and Trento (IT) - with the associated follower cities of Derry (UK), Kozani (GR) and Litomerice (CZ). These six cities collaborates with relevant industrial partners, academia and research centres, to implement smart energy initiatives, deploy intelligent integration measures, test and validate technical solutions and innovative business models, and deliver blueprints for replication throughout Europe and abroad.

The objective of STARDUST is to pave the way towards the transformation of the carbon supplied cities into smart, high efficient, intelligent and citizen oriented cities, developing urban technical green solutions and innovative business models, integrating the domains of buildings, mobility and efficient energy through ICT, testing and validating these solutions to enable their fast roll out in the market.

The core idea of the STARDUST is the demonstration of different "innovation islands" as urban incubators of technological, social, regulatory and market solutions which, once validated, could contribute to transform our cities into Smart Cities. The integrated approach of STARDUST is based on the combination of technological solutions with citizens' involvement in decision making, economic constraints, citizens' governance, etc. The STARDUST Smart City concept has been designed to enhance the integration of all these aspects to define a new urban metabolism.

EXPECTED RESULTS

Smart districts and buildings:

- deep energy rehabilitation of selected buildings taking nearly-Zero-Energy-Buildings (nZEB) as reference;
- energy performance active metering, monitoring and demand side management by setting-up an online monitoring and data management concept;
- co-opportunities and co-benefits from smart district and buildings development by using the Smart and Sustainable District Energy Project concept (SSEDP);
- overcoming the barriers to the implementation of smart district and smart buildings by finding solutions to strengthen business planning for public-private partnerships.

Energy generation and use:

- high efficiency district heating and cooling systems. STARDUST approach will involve: i) the integration of Organic Rankine Cycle (ORC) on large scale Combined Heat and Power (CHP) district heating; ii) renewable energy integration on high-efficient District Heating & Cooling (DHC); iii) free-cooling from lake; iv) heat waste recovery from industry to supply district heating; v) demand response/big data control;
- smart grid: integration of batteries, new energy management strategies in combined systems, definition of clear value propositions for this new "prosumer" role of hybrid smart grids.
- Smart lighting with novel high-efficient technology;

E-mobility:

- last Mile transportation solutions for goods or people;
- cost efficient E-Vehicle charging technology;
- new incentives for e-vehicles.

OTHER PARTNERS:

31 PARTNERS FROM SPAIN, ITALY, FINLAND, UK, GREECE, CECH REPUBLIC, ROMANIA AND BELGIUM

Myth 1: expensive?

Myth 7: thermal renovation overrated?

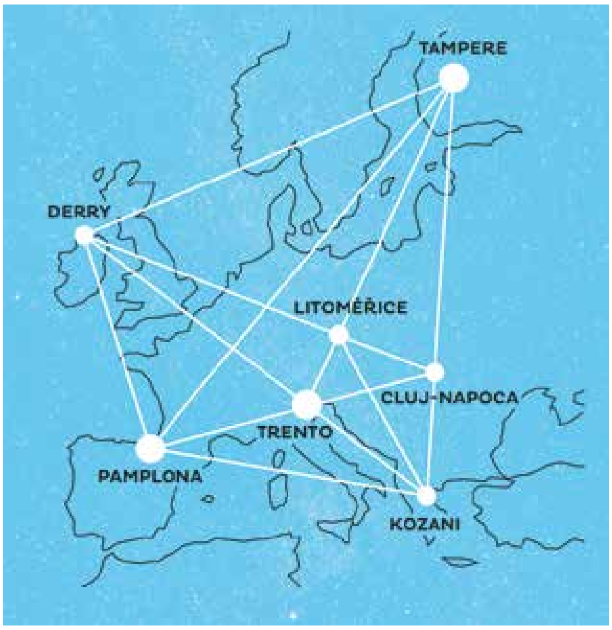


Figure 57 - *Map of STARDUST demonstration and follower cities*

BUDGET:	€ 20 988 954,18	**FUNDING PROGRAMME:**	HORIZON 2020
PERIOD:	From 1 October 2017 .... to 30 September 2022		

EUREC PARTNERS:

Added Value of Storage in Distribution Systems

MAIN FEATURES OF THE PROJECT

The main objective of STORY is to show the added value storage can bring for a flexible, secure and sustainable energy system. This will be achieved by showing the inter-relations between technologies and stakeholders, as well as the potential and impact of policy and regulation.

The future European grid must serve a diverse and mixed landscape of users in a situation of mixed rules and responsibilities. Challenges include high penetration of renewables, bi-directional flows of different energy vectors, growing number of users and requirements for higher security. The advances in ICT technology, intelligent control algorithms, inverter and storage technologies provide strong tools to cope with these challenges.

STORY focuses on providing relevant and wide-covering demonstrations that serve as input for a thorough and transparent analysis on the impact of energy storage. Storage is considered as a means, while not neglecting other competing technologies that could provide a similar or complementary functionality.

In short, STORY first developed viable storage and ICT solutions for seven demonstration sites. Secondly, it has analysed the impact of these technologies and the effect of policies and regulations on their uptake.

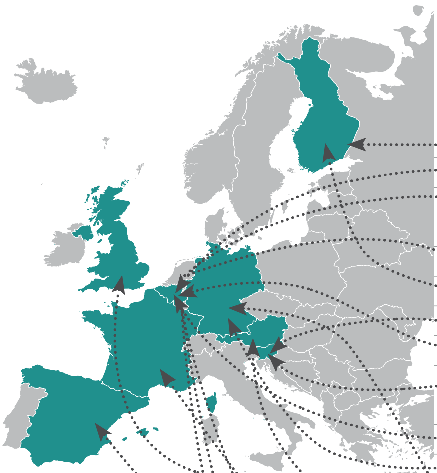
MAIN RESULTS SO FAR

STORY demonstrates and quantifies the added value of energy storage and its contribution to tackle several grid challenges caused by high RES shares in the distribution networks. Through a synergetic approach considering technical, economic and social aspects, STORY provides a comprehensive overview of the main barriers to RES and storage technologies deployment and proposes solutions and recommendations to overcome them.

In terms of technology, STORY has identified the weaknesses of some technologies and proposed necessary improvements (more development on CAES and ORC, better synergies between electric and thermal energy management, more reliability of Li-ion batteries and power electronics including EMS, etc.).

Most challenges faced along the project have been solved by means of alternatives approaches and new research issues have been identified not only at technical level, but also regarding regulation and market design.

For more information: http://horizon2020-story.eu/



OTHER PARTNERS:

- TEKNOLOGIAN TUTKIMUSKESKUS VTT OY (FIN)
- TH!NK E (BE)
- VLAAMSE INSTELLING VOOR TECHNOLOGISCH ONDERZOEK N.V. (BE)
- VLERICK BUSINESS SCHOOL (BE)
- BASEN OY (FIN)
- UNIVERZA V LJUBLJANI (SI
- BENEENS JOZEF EN ZONEN BVBA (BE)
- ELEKTRO GORENJSKA PODJETJE ZA DISTRIBUCIJO ELEKTRICNE ENERGIJE DD (SI)
- VIESSMANN BELGIUM (BE)
- HAWKER GMBH (DE)
- B9 ENERGY STORAGE LTD (UK)
- LOPTA FILM GMBH (DE)
- JOANNEUM RESEARCH FORSCHUNGSGESELLSCHAFT GMBH (AT)
- ACTILITY SAS (FR)
- PROSPEX INSTITUTE (BE)
- EXPOSICION Y CONSERVACION DE ALIMENTOS SA (ES)
- UC LEUVEN (BE)
- ABB OF ASEA BROWN BOVERI (BE)

Figure 58 - *Li-ion battery deployed in one demonstration case in Spain*

BUDGET:	€ 15 337 875,98	**FUNDING PROGRAMME:**	HORIZON 2020
PERIOD:	From 1 May 2015 .... to 30 April 2020		

SUPER PV

EUREC PARTNERS:

WIP RENEWABLE ENERGIES

AIT AUSTRIAN INSTITUTE OF TECHNOLOGY

CoSt redUction and enhanced PERformance of PV systems

MAIN FEATURES OF THE PROJECT

Photovoltaics (PV) deployment growth is an unmatched success story in the energy sector over recent years. In just 12 years the world's cumulative solar capacity increased by over 7,600% - from merely 6.6 GW in 2006 to 505 GW by the end of 2018. Today PV is becoming the cheapest unsubsidized form of electricity, with emerging business models based primarily on levelized cost of electricity (LCOE) estimations. To succeed in this very competitive PV market, European PV manufacturers are facing the need for innovations addressing not only technology but also business models based on data management solutions;

SUPER PV proposes a combined solution addressing both product technological quality and business operation, targeting a significant reduction of LCOE. This reduction will be achieved through demonstration of a careful selection of innovations.

EXPECTED RESULTS

Introducing superior quality PV systems will create the right conditions for accelerating large scale deployment of PV in Europe for both utility (non-urban) and residential scenarios. It will also help EU PV industry to regain leadership and competitiveness on the global market.

To achieve ground-breaking impact on cost reduction, the project focuses on three main segment of the value chain strongly influencing PV's LCOE:

- module: Introducing and combining five PV module innovations applied to c-Si based bifacial modules and CIGS modules;
- power electronics: ensuring higher power output, performance monitoring and data collection on string level, as well as long term stability of operation;
- PV system integration and process innovation: developing a new digital and holistic process (PIM: PV information Modelling/Management).

For more information: https://www.superpv.eu/

OTHER PARTNERS:

26 PARTNERS FROM LITHUANIA, GERMANY, FRANCE, SWITZERLAND, SPAIN, MOROCCO, NORWAY, SLOVENIA, BELGIUM, TUNISIA

Myth 1: expensive?

Myth 9: make EU's economy less competitive?

Figure 59 - *SUPER PV methodology*

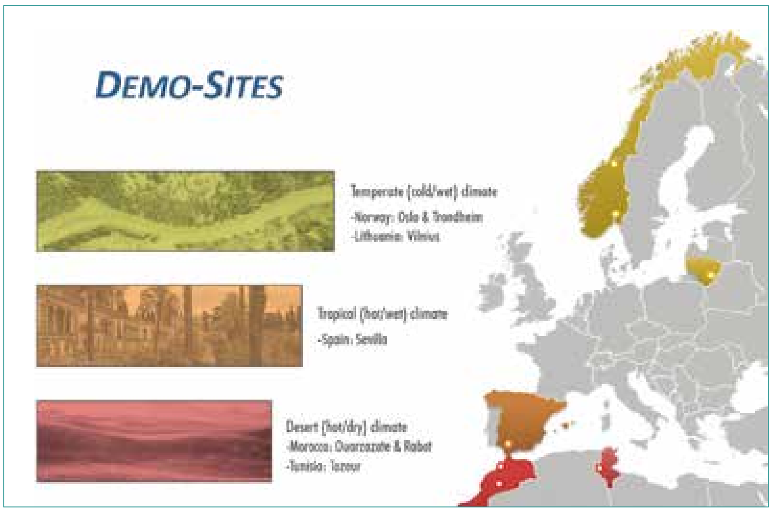


Figure 60 - *SUPER PV Demo sites*

BUDGET:	€ 11 616 850	**FUNDING PROGRAMME:**	HORIZON 2020
PERIOD:	From 1 May 2018 .... to 30 April 2022		

4RinEU

EUREC PARTNERS:

Coordinator eurac research

Robust and Reliable Technology Concepts and Business Models for Triggering Deep Renovation of Residential Buildings in EU

MAIN FEATURES OF THE PROJECT

4RinEU aims to define robust, cost-effective, tailorable deep renovation technology packages supported by usable methodologies, feeding into reliable business models. The project will minimize failures in design and implementation, manage different stages of the deep renovation process (from the preliminary audit up to the end-of-life) and provide information on energy, comfort, users' impact, and investment performance.

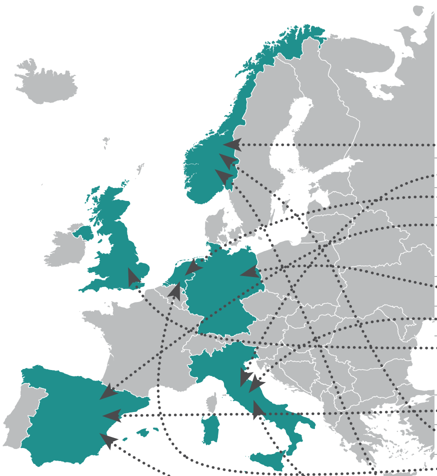
The 4RinEU deep renovation strategy is based on 3 pillars: (i) technologies to decrease net primary energy use (60 to 70% compared to pre-renovation), allowing a reduction of life cycle costs over 30 years (15% compared to a typical renovation) (ii) methodologies to support the design and implementation of the technological solutions through improved information flows and knowledge sharing among stakeholders to sustain participative design, (iii) business models to enhance the level of confidence of deep renovation investors, increasing the EU building stock transformation rate up to 3% by 2020.

EXPECTED RESULTS

The expected results for each project pillar are:

- technology: to reduce ENERGY demand (Prefab Multifunctional Façade, Comfort Ceiling Fan), to improve energy efficiency (Plug&Play Energy Hub, Objective-based RES Implementation), to improve building operations (Sensible Building Data Handler), and to reduce construction waste (Strategies for Components End-Of-Life);
- methodology: to accurately understand renovation issues and potentials (Cost-Optimal Energy Audit), to ensure an effective and participated design (Investor and Building User-Oriented Design Tool and Method based on BIM), to reduce construction time and failures (Deep Renovation Implementation Management);
- business model: to identify the level of risk of renovation processes and to enable well-founded investments supported by tailor-made financial tools (Cost-effectiveness Rating System).

Myth 7: thermal renovation overrated?



OTHER PARTNERS:

- STIFTELSEN SINTEF (NO)
- ADERMA SRL (IT)
- TRECODOME BV (NL)
- SISTEMES AVANCATS DE ENERGIA SOLAR TERMICA SCCL (ES)
- GUMPP & MAIER GMBH (DE)
- THERMICS ENERGIE SRL (IT)
- INTEGRATED ENVIRONMENTAL SOLUTIONS LTD (UK)
- ACCIONA CONSTRUCCION SA (ES)
- OSLO KOMMUNE (NO)
- STICHTING WOONZORG NETHERLAND (NL)
- AGENCIA DE L'HABITATGE DE CATALUNYA (ES)
- R2M SOLUTIONS SRL (IT)
- SINTEF AS (NO)

Figure 59 - *A building before (a) and after (b) 4RinEU renovation*

BUDGET:	€ 4 630 949,49	**FUNDING PROGRAMME:**	HORIZON 2020
PERIOD:	From 1 October 2016 .... to 30 June 2021		

KNOW RES
KNOWLEDGE CENTRE
FOR RENEWABLE ENERGY JOBS

EUREC PARTNERS:

Coordinator
EUREC

circe
CENTRO DE INVESTIGACIÓN DE RECURSOS Y CONSUMOS ENERGÉTICOS

Hanze
University of Applied Sciences
Groningen

Knowledge Centre for Renewable Energy Jobs

MAIN FEATURES OF THE PROJECT

In the transition to a RES-based society, new areas of expertise will emerge while some others will disappear or change to adapt to the fast-evolving energy environment. Identifying areas where new skills are needed is crucial to avoid skills shortage in the future. Moreover, identifying emerging needs in the energy sector is important to ensure social inclusion.

KnowRES carried out an analysis of the skills needed by the industry and created an online platform to provide job intelligence to companies, research institutions and training organisations. Moreover, the results of the project are instrumental for training providers to tailor-made their educational offer to the sector's needs. More precisely, KnowRES performed:

- an analysis of the currently requested skills, as well as a forecast of the industry needs in terms of competences. The analysis also identified a set of skills that can be easily transferred from traditional sectors (e.g. oil and gas, nuclear, chemicals, pharmaceutical, etc.) to the growing renewable energy industry. A Renewable Energy Jobs Barometer summarises the collected information, while presenting the most wanted job profiles in the renewable energy sector;
- an analysis of the competences currently offered in the renewable energy job market. As a result, a thorough candidates' database was set up;
- an analysis of the existing gaps between the skills requested by the industry and the existing competences, which led to the identification of areas where further training should be developed.

MAIN RESULTS

While many studies assess the global employment trends per sector, KnowRES focused on concrete recruitment needs of companies, highlighting the critical skills and competencies that renewables need. The project concludes that the number of people working in the renewable energy sector is expected to raise significantly in the coming year, due to the strong political mandate included in the Paris agreement. The most needed profiles include mechanical engineers, business developers and research engineers (biomass); drilling engineers, project managers and plant managers (geothermal); structural and R&D engineers (ocean); electrical engineers, field technicians and technology researchers (PV); technical salesmen and field service technician (small hydropower); marketing officers and O&M technicians (solar thermal). Skills and expertise needing further development include language and sales skills, hydrogeologic and chemical know-how, multitasking and problem solving and legal expertise. All sectors show a medium to high level of skills transferability from traditional sectors.

For more information: http://www.knowres-jobs.eu/en/

OTHER PARTNERS:

- GREENFISH (BE)
- EUROPEAN BIOMASS ASSOCIATION (BE)
- EUROPEAN GEOTHERMAL ENERGY COUNCIL (BE)
- EUROPEAN SOLAR THERMAL ELECTRICITY ASSOCIATION (BE)
- OCEAN ENERGY EUROPE (BE)
- ASSORINNOVABILI (IT)

BUDGET:	€ 840 922,36	FUNDING PROGRAMME:	PROGRESS
PERIOD:	From 1 October 2014 .... to 30 April 2016		

Annexes

ABBREVIATIONS

BIPV: Building-Integrated Photovoltaics

BTL: Biomass-to-liquid

CCS: Carbon capture and storage

CHP: Combined Heat and Power

CO_2: Carbon dioxide

EPBT: Energy Payback Time

EV: Electric Vehicles

GDP: Gross domestic product

GHG: Greenhouse gas

HVAC: Heating, Ventilation and Air Conditioning

kW: Kilowatt

kWp: Kilowatt-peak

LCoE: Levelised Cost of Electricity

MW: Megawatt

NEZBs: Near Zero-Energy Buildings

ORC: Organic Rankine Cycle

P2P: Peer-to-Peer

PV: Photovoltaics

R&I: Research and Innovation

RES: Renewable Energy Sources

RHC: Renewable heating and cooling

TCMs: Termo-Chemical Materials

VPP: Virtual Power Plant

V2G: Vehicle-to-grid

DEFINITIONS

Ancillary services: ancillary services are the services necessary to support the transmission of electric power from seller to purchaser given the obligations of control areas and transmitting utilities within those control areas to maintain reliable operations of the interconnected transmission system. Ancillary services are the specialty services and functions provided by the electric grid that facilitate and support the continuous flow of electricity so that supply will continually meet demand. The term ancillary services is used to refer to a variety of operations beyond generation and transmission that are required to maintain grid stability and security. These services generally include, frequency control, spinning reserves and operating reserves. Traditionally ancillary services have been provided by generators, however, the integration of intermittent generation and the development of smart grid technologies have prompted a shift in the equipment that can be used to provide ancillary services.

Building-Integrated Photovoltaics: photovoltaic materials or components that are used in place of traditional building components or materials, especially in building features such as facades, roofs or skylights, and provide solar power for the building. Considered as ancillary and, at times, a primary electrical power source, they provide other advantages over conventional building materials. The initial cost involved in building integrated photovoltaics can be offset by the reduction in the labor charges involved and the quantity of building materials involved; furthermore, they are eco-friendlier.

Combined Heat and Power: combined heat and power or cogeneration is the use of a heat engine or power station to generate electricity and useful heat at the same time. Trigeneration or combined cooling, heat and power refers to the simultaneous generation of electricity and useful heating and cooling from the combustion of a fuel or a solar heat collector.

Energy payback time: the time, measured in years, required for a complete energy generation system to compensate for the use of energy for its production.

Feed-in Tariffs: policy mechanism designed to accelerate investment in renewable energy technologies. It achieves this by offering long-term contracts to renewable energy producers, typically based on the cost of generation of each technology. Rather than pay an equal amount for energy, however generated, renewable energy technologies are offered a higher price, reflecting costs that are higher at the moment and allowing a government to encourage development of one technology. In addition, feed-in tariffs often include "tariff degression", a mechanism according to which the price (or tariff) ratchets down over time. This is done in order to track and encourage technological cost reductions. The goal of feed-in tariffs is to offer cost-based compensation to renewable energy producers, providing price certainty and long-term contracts that help finance renewable energy investments.

Final energy: energy delivered in a form ready to be used by the end user, e.g. the electricity available through the user's socket. Due to the many ways it can be used, final energy comes in many forms: e.g. electricity, thermal energy, mechanical energy. Final energy is but a mere fraction of the initial primary energy, once it is transformed into secondary energy, stored, transported and finally distributed to the end user. In a short production/distribution circuit, e.g. an individual solar water heater, the quantity of final energy is closer to the quantity of primary energy.

Greenhouse gas: any gas that has the property of absorbing infrared radiation (net heat energy) emitted from earth's surface and reradiating it back to earth's surface, thus contributing to the greenhouse effect. Carbon dioxide, methane, and water vapour are the most important greenhouse gases. To a lesser extent, surface-level ozone, nitrous oxides, and fluorinated gases also trap infrared radiation. Greenhouse gases have a profound effect on the energy budget of the earth system despite making up only a fraction of all atmospheric gases. Concentrations of greenhouse gases have varied substantially during earth's history, and these variations have driven substantial climate changes at a wide range of timescales.

Load: the total electrical power being removed by the users of the grid. Baseload is the minimum load on the grid over any given period, peak demand is the maximum load.

Near Zero-Energy Buildings: buildings with a very high energy performance. According to the EU Directive on energy performance of buildings (EPBD, Directive 2010/31/EU) the nearly zero or very low amount of energy required should be covered to a very significant extent from renewable sources, including energy from renewable sources produced on-site or nearby. While the Directive includes this general definition of the NZEB, it is up to the EU Member States to set up a detailed national application of this definition.

Net load: the difference between forecasted load and expected electricity production from variable generation resources.

Primary energy: an energy form found in nature that has not been subjected to any human engineered conversion process. It is energy contained in raw fuels, and other forms of energy received as input to a system. Primary energy can be non-renewable or renewable.

Vehicle-to-grid: a system in which plug-in electric vehicles, such as battery electric vehicles (BEV), plug-in hybrids (PHEV) or hydrogen fuel cell electric vehicles (FCEV), communicate with the power grid to sell demand response services by either returning electricity to the grid or by throttling their charging rate. V2G storage capabilities can also enable EVs to store and discharge electricity generated from renewable energy sources such as solar and wind, with output that fluctuates depending on weather and time of day.

Virtual power plant: a network of decentralized, medium-scale power generating units such as wind farms, solar parks, and Combined Heat and Power (CHP) units, as well as flexible power consumers and storage systems. The interconnected units are dispatched through the central control room of the Virtual Power Plant but nonetheless remain independent in their operation and ownership. The objective of a Virtual Power Plant is to relieve the load on the grid by smartly distributing the power generated by the individual units during periods of peak load. Additionally, the combined power generation and power consumption of the networked units in the Virtual Power Plant is traded on the energy exchange.

Notes

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