E2SWITCH
Energy Efficient Tunnel FET Switches and Circuits

Co-funded by the European Union

E²SWITCH

Energy Efficient Tunnel FET Switches and Circuits

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Contributing partners: LUND, EPFL, IBM

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[1] R = Report, P = Prototype, D = Demonstrator, O = Other

[2] PU = Public, PP = Restricted to other programme participants (including the Commission Services, RE = Restricted to a group specified by the consortium (including the Commission Services), CO = Confidential, only for the members of the consortium (including the Commission Services)

[3] Measured in months from the project start date (M01)

Revision history

Version	Date	Author	Comment
0.1	02-12-2014	Filippo Gander, Kirsten Leufgen (SCIPROM)	First version
1.0	08-12-2014	Adrian Ionescu and Lars-Erik Wernersson	Final revision and approval by AI (coordinator), LEW (dissemination manager)

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Contents

Summary

This deliverable presents the E^{2}SWITCH video introduction. This is a central dissemination product, which has been created according to the DoW, to increase the project visibility and to provide a clear and quick introduction to its central issues.

In the following pages we will present its content, the process that led to its realization, the technical details and other useful information.

1 Introduction

The E^{2}SWITCH video introduction is a central part of the project's dissemination plan.

1.1 Target audience

The E^{2}SWITCH video has been conceptualized in order to address both a specialized and general audience. A special effort has gone in formulating a clear and synthetized text with general information and precise details, reaching out to a large potential audience. This includes other academics, tech transfer units, industrial actors, policy-makers but also individuals interested by the issues raised by the project.

The basic challenge behind the video text is to allow a person without any knowledge in this particular sector to be able to understand at least the basic concept without getting lost in technicalities. At the same time an "expert" viewer should be able to get the technical challenges and the peculiarities of the E^{2}SWITCH project.

1.2 Sources of contributions

The text of this video - approved by the consortium prior to its publication - has been elaborated by LUND and SCIPROM in close collaboration with IBM and EPFL. It has been formulated specifically for the purpose of the video and it closely originates from the Description of Work (DoW), thus ensuring that all the information released to a large audience is agreed upon by both the consortium and the EC.

A non-technical native speaker has been asked to proof-read the whole text, in order to make it "smoother" and to guarantee it is understood by a non-technical audience.

The video sequences used here come from several sources. IBM provided a clean room sequence, a 3D technical rendering (used at 1'08" in the video) and the sequence with people using mobile phones. EPFL provided another clean room sequence, largely used during the central part of the video. The first and last two video sequences (a power counter and a time lapse shoot of a city at night) have been purchased by SCIPROM from a dedicated website.

The different illustrations stem from the DoW and their layout has been adapted to the E^{2}SWITCH visual identity and then animated by SCIPROM.

The audio has been read and recorded by Lars-Erik Wernersson, at the University of Lund.

Video editing (including the creation of the soundtrack) has been done by Filippo Gander, SCIPROM. SCIPROM also uploaded the video on sharing video platforms on the web (Vimeo, Youtube), to facilitate its dissemination and made the video available on the project website.

1.3 Text of the video

The following text serves as the base of the E^{2}SWITCH video:

Solving the energy problem is probably one of the greatest challenges facing our society. World energy resources are limited, but our power consumption constantly increases. Measures need to be taken at all levels, to develop renewable resources but also to more efficiently use our available sources of energy.

A considerable fraction of all power consumed in our society is related to electricity, up to 20% of global consumption has been suggested. Consumer electronic equipment constitutes an important fraction of this use and their energy inefficiency can be as high as 30-40%, depending on the field of use. We all know that lap tops get warm and that battery charges don't last long and their lifetimes are too short. We clearly need to develop new technology to reduce power consumption in all these areas.

Our electronics development includes a wide range of research areas. We explore novel materials, we refine the device architecture and look for new circuit topologies and increased system integration. Innovation in all these areas will be required to reduce power consumption.

In the EU-project E^{2}SWITCH, we in particular develop new devices (TunnelFETs) and circuits to enable more efficient future electronics for various applications from mobile devices to big data centers. . The increasing use of distributed media, saved in the 'cloud', has led to the development of data centres with

significant amounts of power consumption. Portable sensors will enable at the same time personal monitoring of health and well-being. We combine efforts in fabrication, modelling, and characterization to implement the TunnelFETs. It is essential to explore and test new and promising options on the research level prior to their integration into general manufacturing processes. Here our cleanroom facilities within the EU provide important research options that may pave the way for future energy efficient electronics.

We focus on two paths for energy efficiency using either Si-based technology or III-V materials integrated on a Si platform.

The E²SWITCH consortium has been constituted with the ambition to realise a productive synergy between partners' expertise and an exhaustive coverage of the competences needed to deliver an advanced energy efficient switching device.It gathers nine organisations from a total of six different countries. Together they form a unique multidisciplinary network of four universities, one large industrial partner, two research centres and one research-intensive SME, supported by a dedicated management SME.

In E²SWITCH, we target one of the fundamental bottlenecks to power scaling in semiconductor electronics, the transistor drive voltage. For integrated transistors, the ratio between the on-current and the off-current is determined by the drive voltage. This is a balance between performance and static power consumption. To reduce static power consumption, we need to keep any leakage off-current at a sufficiently low level. The balance gives a lower limit to the minimum drive voltage, when we want to maintain performance. In modern transistor technologies, we apply about 1 V, and we foresee a development towards 0.5V over the next decade. By radically reducing the drive voltage towards 0.2V, a 10 fold reduction in energy expenditure may be possible. However, to achieve this goal, innovative new approaches will be needed. In E²SWITCH we utilize a tunneling mechanism in the transistors to realize what is called a 'steep slope.' In fact, this allows the transistors to be turned off more efficiently, to reduce the drive voltage without sacrificing the on-current and thereby balance performance and leakage.

One of the key challenges for these so-called TunnelFETs is the physical implementation of the device architecture, the prime target of E²SWITCH. TunnelFETs rely on Zener-tunneling in a pn-junction. In the on-state, we have a tunneling path for the carriers that we may close with the gate. We may think of this as a tunnel that we may use for transport instead of climbing over the mountain. The benefit is that we avoid thermal injection over any barrier, as occurs in conventional transistors. The challenge is that the tunneling mechanism lowers the current level and accurate design is thus required to obtain sufficient current levels in the transistor.

We focus upon two main applications for energy conservation: digital electronics and sensors. Here power savings will help not only to reduce direct power consumption, but the devices may also need less cooling. TunnelFETs may additionally help reduce power consumption in portable sensors with future applications for health and well-being.

"The aim to achieve power reduction, central to this EU-project, will not only help make Europe more 'green,' but may also provide new services and devices for us, as European citizens and create a market for new components, devices and systems, which will boost these industries in Europe."

2 The video

The E2SWITCH video lasts 5'32". This is an ideal duration for such content as it allows presenting the essential information without a risk of loosing the audience with too much technical and detailed information.

It can be separated in 4 sequences. During the first minute, the general context of the project is briefly presented. The following 2 minutes present the main concepts of E2SWITCH as well as its consortium, followed by another minute and a half in which the video gets into the more technical details of the research carried out within the project. The last sequence presents the two main applications of the project and it ends with a general conclusion about the project outcomes.

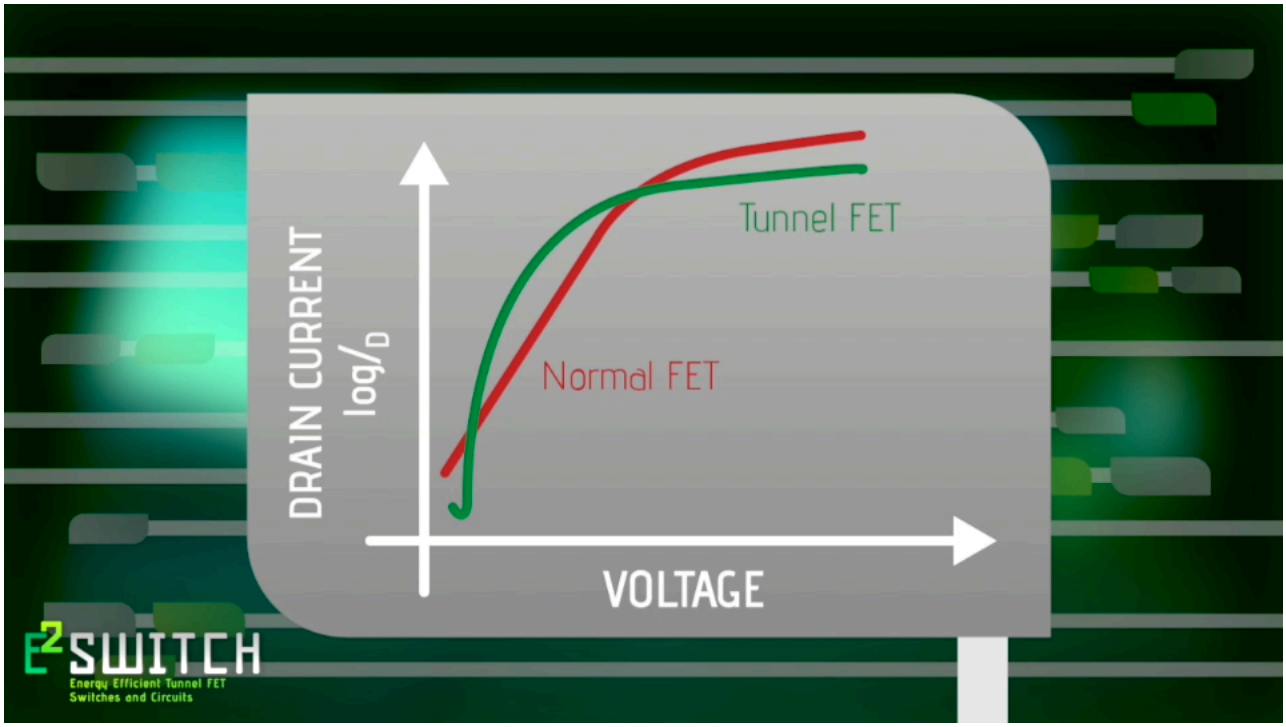

Figure 1: Snapshot of the E2SWITCH video (at 3'24") showing the benefits of TunnelFET technology

3 Technical Implementation

The video has been edited in Final Cut Pro X in a standard HD720p format at 24fps. It would have been possible to generate the video in even higher quality, but the size of the generated file could have compromised its accessibility, especially from mobile devices.

The video presents in a 16:9 aspect ratio, the most common video format, which perfectly fits modern monitors and mobile device screens.

The original soundtrack has been realized with Garageband and offers a good musical background to the text, without disturbing the auditor. Some "ducking" has been added to the background song, reducing its volume when text is being read and turning it up again when the text ends.

All the illustrations have been adapted from the original ones presents in the DoW in order to fit the visual identity of E2SWITCH and to be more appealing for the audience. For the same reasons - and also to make the content even more understandable - all illustrations have been animated, and adapted to the spoken text.

A lack of exploitable footage has been bypassed buying two video sequences from an online photo-repository (http://www.dreamstime.com/). The sparse origin of the different video components caused a certain "heterogeneous" look to the visual side of the video. A subtle photo filter has been added with light-green and yellow tint, proper to the E2SWITCH visual identity. This homogenizes the visual aspect of the movie and positively affects its appearance.

The running video sequence is blurred off each time an animated illustration appears on screen. This created a gentle background to the illustration without distracting from the main message.

4 Dissemination channels

The video has been made available on the E^{2}SWITCH website (on a page specifically designed for the project outcomes, named: "Output").

It has further been published on the online video sharing platform "Vimeo" (http://vimeo.com/112810831) to increase its visibility and facilitate dissemination, eg via social networks. Vimeo has been chosen as online platform as it is generally perceived as a quality platform where only high-definition content-centred videos are posted.

The video is also available on Youtube for distribution to the public at large: http://www.youtube.com/watch?v=QCfw-m2g12s&feature=youtu.be.

5 Conclusions

The E^{2}SWITCH video represents an appealing and useful tool that can increase the project visibility throughout the multimedia channels. It can easily be sent and shared via e-mail, social networks and presentations. Content-wise, its main objective to be appealing both for a scientific and non-scientific audience has been successfully achieved, resulting in a simple yet complete presentation of the core concept of the project.

The video fulfils the requirements described in the preliminary plan for use and dissemination of foreground that is part of the DoW, and has been agreed by all partners of the consortium.

It's now available to the public on the E^{2}SWITCH website and on the online video sharing platforms Vimeo and Youtube.