Zmluva
o poskytnutí finančných prostriedkov na spolufinancovanie
projektu výskumu a vývoja ENIAC č. 296131-2
Časť projektu: „Modelovanie, návrh a charakterizácia pokročilých výkonových prvkov pre stredné a vysoké napätia so zameraním na ich použitie v napäťových meničoch“

Poskytovateľ:	**Ministerstvo školstva, vedy, výskumu a športu SR**
sídlo:	Stromová 1, 813 30, Bratislava
zastúpený štatutárnym orgánom	Doc. PhDr. Dušanom Čaplovičom, DrSc. ministrom
osoba oprávnená rokovať v odborných veciach:	Ing. Róbert Szabó, PhD.
Tel. číslo:	02/59374716
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IČO:	00 164 381
Bank. spojenie:	Štátna pokladnica, č. účtu 7000065236/8180

(ďalej len „poskytovateľ“)

Príjemca:	**Slovenská technická univerzita v Bratislave, Fakulta elektrotechniky a informatiky**
sídlo:	Vazovova 5, 812 43, Bratislava 1
zastúpený štatutárnym orgánom:	prof. Ing. Robertom Redhammerom, PhD. rektorom
osoba oprávnená rokovať v odborných veciach:	prof. Ing. Viera Stopjaková, PhD.
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IČO:	00397687
DIČ:	2020845255
peňažný ústav:	Štátna pokladnica
číslo účtu :	7000133219/8180
Zapísaný:	verejnoprávna inštitúcia zriadená zákonom č. 131/2002 Z. z. o vysokých školách a o zmene a doplnení niektorých zákonov v znení neskorších predpisov ako verejná vysoká škola

(ďalej len „príjemca “)

Preambula

Nariadením Rady (ES) č. 72/2008 z 20. decembra 2007 bol založený spoločný európsky technologický podnik ENIAC (ďalej len „spoločný podnik“) na podporu spoločných európskych výskumných a vývojových aktivít v oblasti nanoelektroniky. Slovenská republika sa prihlásila za člena spoločného podniku listom podpredsedu vlády a ministra školstva SR zo dňa 12. decembra 2008 a zaviazala sa alokovať každoročne v rozpočtovej kapitole Ministerstva školstva Slovenskej republiky prostriedky štátneho rozpočtu Slovenskej republiky vo výške 500 000 EUR za účelom spolufinancovania účasti organizácií výskumu a vývoja v Slovenskej republike v projektoch výskumu a vývoja spoločného podniku (ďalej len „projekt spoločného podniku“).

Na základe dohody o správe č. ENIAC-ED-27-09 uzavretej medzi spoločným podnikom a Ministerstvom školstva SR, ktorá je neoddeliteľnou súčasťou tejto zmluvy v Prílohe 1, sa Ministerstvo školstva, vedy výskumu a športu SR stalo národným financujúcim orgánom, ktorý zabezpečuje poskytovanie prostriedkov štátneho rozpočtu Slovenskej republiky na spolufinancovanie účasti organizácií výskumu a vývoja v Slovenskej republike v projektoch spoločného podniku.

Čl. 1
Predmet zmluvy

1) Poskytovateľ a príjemca uzatvárajú túto zmluvu podľa Čl. 13 ods. 6 písm. b) Štatútu spoločného podniku ENIAC, ktorý je neoddeliteľnou súčasťou Nariadenia Rady (ES) č. 72/2008 z 20. decembra 2007, ktorým sa zakladá spoločný podnik ENIAC (ďalej len „štatút spoločného podniku“).

2) Poskytovateľ a príjemca sa dohodli na predmete zmluvy na základe technickej špecifikácie Technical Anex Energy to Smart Grid (ďalej len „technická špecifikácia“), ktorá bola schválená spoločným podnikom dňa 30. 03. 2012 a je v Prílohe 2 k tejto zmluve, ktorá je jej neoddeliteľnou súčasťou.

3) Predmetom zmluvy je poskytnutie 249 900 EUR (slovom dvestoštyridsaťdeväť tisíc deväťsto EUR) z prostriedkov štátneho rozpočtu Slovenskej republiky poskytovateľom príjemcovi na zabezpečenie spolufinancovania riešenia projektu spoločného podniku s názvom “Energia pre smart siete“, ktorého riešenie bolo schválené na základe výberového konania uskutočneného spoločným podnikom k 4. výzve (Call ENIAC-2011-1) pre verejnú súťaž ním vyhlásenej v roku 2011 a potvrdené technickou špecifikáciou.

4) Doba riešenia projektu spoločného podniku je stanovená v technickej špecifikácií schválenej spoločným podnikom.

5) Poskytovateľ zabezpečuje spolufinancovanie riešenia projektu spoločného podniku počas celej doby jeho riešenia, ktorá je 36 mesiacov.

6) Príjemca sa zaväzuje zabezpečiť riešenie projektu spoločného podniku s názvom: “Energia pre smart siete“ (“Energy to Smart Grid“)

   počas celej doby jeho riešenia od: 01/04/2012 do: 31/03/2015.

7) Špecifikácia projektu spoločného podniku (zoznam riešiteľov a ich kapacít viazaných na riešenie projektu, použitia prostriedkov štátneho rozpočtu Slovenskej republiky

poskytnutých poskytovateľom vrátane charakteristiky, cieľov projektu v jednotlivých rozpočtových rokoch jeho riešenia a výstupov) je uvedená v Prílohe 3, ktorá je neoddeliteľnou súčasťou zmluvy.

Čl. 2
Poskytovanie a použitie prostriedkov

1) Financovanie projektu spoločného podniku sa uskutočňuje podľa Čl. 13 štatútu spoločného podniku.

2) Spoločný podnik podľa Čl. 13 ods. 6 písm. a) štatútu spoločného podniku poskytuje príjemcovi na spolufinancovanie riešenia projektu spoločného podniku prostriedky zo svojho rozpočtu vo výške 16,7 % z celkových oprávnených nákladov na riešenie projektu spoločného podniku.

3) Poskytovateľ poskytuje príjemcovi, ktorý je verejnou vysokou školou podľa zákona č. 131/2002 Z. z. o vysokých školách a o zmene a doplnení niektorých zákonov v znení neskorších predpisov na spolufinancovanie riešenia projektu spoločného podniku prostriedky štátneho rozpočtu Slovenskej republiky vo výške 83,3 % z celkových oprávnených nákladov na riešenie projektu spoločného podniku.

4) Oprávnenými nákladmi na riešenie projektu spoločného podniku, ktoré financuje poskytovateľ z prostriedkov štátneho rozpočtu Slovenskej republiky, sú náklady podľa § 17 ods. 2 až 5 zákona č. 172/2005 Z. z. o organizácii štátnej podpory výskumu a vývoja a o doplnení zákona č. 575/2001 Z. z. o organizácii činnosti vlády a organizácii ústrednej štátnej správy v znení neskorších predpisov v znení zákona č. 233/2008 Z.z. a v znení zákona č. 40/2011 Z.z., a rozpočet projektu spoločného podniku hradený z prostriedkov štátneho rozpočtu Slovenskej republiky je špecifikovaný príjemcom v časti C. Prílohy 3 k tejto zmluve.

5) Poskytovateľ poskytuje prostriedky štátneho rozpočtu Slovenskej republiky na účet príjemcu v jednotlivých rozpočtových rokoch riešenia projektu spoločného podniku podľa rozpisu celkových oprávnených nákladov uvedených v Prílohe 4 k tejto zmluve, ktorá je jej neoddeliteľnou súčasťou.

6) V prvom rozpočtovom roku riešenia projektu spoločného podniku poskytovateľ poskytne prostriedky štátneho rozpočtu Slovenskej republiky na účet príjemcu na základe oficiálneho oznámenia spoločného podniku o ukončení technického rokovania k projektu spoločného podniku.

7) V ďalších rokoch riešenia projektu spoločného podniku poskytovateľ poskytuje prostriedky štátneho rozpočtu Slovenskej republiky na účet príjemcu na základe výsledkov monitorovania a technického auditu projektu spoločného podniku, ktoré vykonáva spoločný podnik a na základe kontroly použitia prostriedkov štátneho rozpočtu Slovenskej republiky poskytnutých príjemcovi v predchádzajúcom rozpočtovom roku, ktorú vykonáva poskytovateľ.

8) Poskytovateľ poskytuje prostriedky štátneho rozpočtu Slovenskej republiky v ďalších rokoch riešenia projektu spoločného podniku na účet príjemcu na základe dodatkov k tejto zmluve.

9) Ak v prvom rozpočtovom roku riešenia projektu spoločného podniku sú prostriedky štátneho rozpočtu Slovenskej republiky poskytnuté poskytovateľom omeškane na účet príjemcu voči termínu začatia riešenia projektu spoločného podniku, ktorý je záväzne stanovený spoločným podnikom v „technickej špecifikácii“, z dôvodu omeškania podpísania zmluvy medzi príjemcom a poskytovateľom alebo medzi príjemcom a spoločným podnikom, môže príjemca na financovanie projektu spoločného podniku použiť vlastné prostriedky, ktoré si potom refunduje z prostriedkov vedených na účte príjemcu.

10) Rovnako v ďalších rozpočtových rokoch riešenia projektu spoločného podniku, ak poskytovateľ poskytne prostriedky štátneho rozpočtu Slovenskej republiky na účet príjemcu omeškane, môže príjemca počas meškania použiť na riešenie projektu spoločného podniku vlastné prostriedky, ktoré si potom refunduje z prostriedkov vedených na účte príjemcu.

11) Príjemca môže prostriedky štátneho rozpočtu Slovenskej republiky poskytnuté poskytovateľom na účet príjemcu použiť iba na stanovený účel.

12) Prostriedky štátneho rozpočtu Slovenskej republiky, ktoré boli určené na čerpanie na obdobie príslušného rozpočtového roka a v tomto období neboli zo závažných preukázaných dôvodov príjemcom, ktorý je verejnou vysokou školou, vyčerpané, môže príjemca použiť v nasledujúcom rozpočtovom roku a to na základe písomnej žiadosti schválenej poskytovateľom podľa §89 ods. 11 zákona č. 131/2002 Z. z. o vysokých školách a o zmene a doplnení niektorých zákonov v znení neskorších predpisov.

13) Príjemca zodpovedá za hospodárenie s prostriedkami štátneho rozpočtu Slovenskej republiky poskytnutými poskytovateľom na účet príjemcu a je povinný pri ich použití zachovávať hospodárnosť, efektívnosť a účelnosť ich použitia.

14) Ak riešenie projektu spoločného podniku vyžaduje zaobstaranie tovarov, služieb a prác, príjemca je povinný v cene pre ich zaobstaranie zohľadniť najlepší pomer kvality a výšky ceny.

15) Príjemca pri zaobstarávaní tovarov, služieb a prác z prostriedkov štátneho rozpočtu Slovenskej republiky vedených na účte príjemcu musí postupovať podľa zákona č. 25/2006 Z. z. o verejnom obstarávaní a o zmene a doplnení niektorých zákonov v znení neskorších predpisov.

Čl. 3
Práva a povinnosti

1) Príjemca a poskytovateľ zodpovedajú za včasné a riadne plnenie si povinností podľa tejto zmluvy.

2) Príjemca je povinný všetky náklady súvisiace s riešením projektu doložiť prehľadom o výške, spôsobe a účele čerpania finančných prostriedkov, vypracovaných podľa

skutočných nákladov na riešenie projektu a platných usmernení a pokynov poskytovateľa v termíne do 31. januára nasledujúceho rozpočtového roka.

3) Príjemca je povinný uchovávať všetky dokumenty a doklady, vrátane účtovných dokladov, týkajúcich sa projektu spoločného podniku najmenej počas piatich rokov nasledujúcich po roku, kedy skončí doba spolufinancovania projektu spoločného podniku poskytovateľom.

Čl. 4
Kontrola

1) Monitorovanie a kontrolu riešenia projektu spoločného podniku vykonáva spoločný podnik podľa Čl. 7 ods. 3 písm. j) a k) štatútu spoločného podniku.

2) Poskytovateľ akceptuje závery vyplývajúce z monitorovacích správ a výsledkov kontroly riešenia projektu spoločného podniku vykonaných spoločným podnikom.

3) Poskytovateľ je oprávnený vykonať pre svoje potreby finančnú kontrolu podľa zákona č. 502/2001 Z. z. o finančnej kontrole a vnútornom audite a o zmene a doplnení niektorých zákonov v znení neskorších predpisov počas trvania zmluvného vzťahu medzi ním a príjemcom ako aj po jeho ukončení, a to aj v prípade odstúpenia od zmluvy.

4) Príjemca je povinný pri výkone kontroly alebo auditu dodržiavať ustanovenia § 14 ods. 2 a § 35 ods. 8 zákona č. 502/2001 Z. z. o finančnej kontrole a vnútornom audite a o zmene a doplnení niektorých zákonov v znení neskorších predpisov.

Čl. 5
Odstúpenie od zmluvy

1) Poskytovateľ má právo odstúpiť od zmluvy, ak
   a) si príjemca neplní povinnosti stanovené v tejto zmluve,
   b) riešenie projektu spoločného podniku má závažné chyby, ktoré zistil spoločný podnik pri monitorovaní a kontrole riešenia projektu spoločného podniku, alebo také chyby, že čas na ich odstránenie by do značnej miery znehodnotil cieľ riešenia projektu spoločného podniku,
   c) spoločný podnik odstúpi od zmluvy medzi ním a príjemcom z ďalších dôvodov stanovených v zmluve medzi ním a príjemcom,
   d) dôjde k zrušeniu spoločného podniku.

2) Ak poskytovateľ odstúpi od zmluvy medzi ním a príjemcom z dôvodov podľa Čl. 5 ods. 1 písm. a) až c) tejto zmluvy, má právo požadovať vrátenie všetkých prostriedkov štátneho rozpočtu Slovenskej republiky ním poskytnutých príjemcovi.

3) Ak poskytovateľ odstúpi od zmluvy medzi ním a príjemcom z dôvodov podľa Čl. 5 ods. 1 písm. d), má právo požadovať vrátenie časti prostriedkov štátneho rozpočtu Slovenskej republiky, ktoré boli použité príjemcom po termíne zrušenia spoločného podniku.

4) Príjemca má právo odstúpiť od zmluvy v prípade, ak si poskytovateľ neplní povinnosti stanovené v tejto zmluve.

Čl. 6
Sankcie

1) Príjemca je povinný prostriedky štátneho rozpočtu Slovenskej republiky neoprávnene použité na iný účel než účel stanovený v predmete zmluvy vrátiť na príjmový účet poskytovateľa.

2) Príjemca je povinný vrátiť na príjmový účet poskytovateľa aj finančné prostriedky štátneho rozpočtu Slovenskej republiky z dôvodov uvedených v Čl. 5 ods. 3.

3) Sankcie za porušenie finančnej disciplíny príjemcom pri hospodárení s prostriedkami štátneho rozpočtu Slovenskej republiky sa riadia § 31 zákona č. 523/2004 Z. z. o rozpočtových pravidlách verejnej správy a o zmene a doplnení niektorých zákonov.

Čl. 7
Vlastnícke práva k predmetu zmluvy

Vlastnícke práva k výsledkom riešenia projektu spoločného podniku sa riadia podľa ustanovení Čl. 23 štatútu spoločného podniku.

Čl. 8
Záverečné ustanovenia

1) Príjemca a poskytovateľ sa zaväzujú bezodkladne navzájom sa písomne informovať o zmenách identifikačných údajov uvedených v zmluve a akýchkoľvek iných zmenách a skutočnostiach, ktoré by mohli mať vplyv na práva a povinnosti vyplývajúce z tejto zmluvy v lehote najneskôr do 30 kalendárnych dní.

2) Zmeny a doplnenia zmluvy môžu byť vykonané len prostredníctvom písomných dodatkov podpísaných obidvoma zmluvnými stranami.

3) Zmluva je vyhotovená v šiestich origináloch, pričom každá zo zmluvných strán obdrží po tri exempláre.

4) Zmluva nadobúda platnosť dňom podpísania oprávnenými zástupcami zmluvných strán a účinnosť dňom nasledujúcim po dni zverejnenia.

5) Prílohy k zmluve sú:
   a) Príloha 1: Dohoda o správe č. ENIAC-ED-27-09 medzi spoločným podnikom ENIAC a Ministerstvom školstva SR
   b) Príloha 2: Technická špecifikácia projektu - Technical Anex Energy to Smart Grid
   c) Príloha 3: Špecifikácia projektu spoločného podniku

d) Príloha 4: Rozpis celkových prostriedkov štátneho rozpočtu Slovenskej republiky na financovanie oprávnených nákladov projektu spoločného podniku v jednotlivých rozpočtových rokoch jeho riešenia.

V Bratislave dňa

....	....
Doc. PhDr. Dušan Čaplovič, DrSc.	prof. Ing. Robert Redhammer, PhD.
minister	rektor

Príloha č.1 k zmluve

Eniac JOINT UNDERTAKING

DOHODA O SPRÁVE MEDZI SPOLOČNÝM PODNIKOM ENIAC

A MINISTERSTVOM ŠKOLSTVA SLOVENSKEJ REPUBLIKY

1. Zmluvné strany

Tento materiál ustanovuje dohodu medzi spoločným podnikom ENIAC (ďalej len „Spoločný podnik“) a Ministerstvom školstva Slovenskej republiky (ďalej len „Národný financujúci orgán“), ktoré ustanovila Slovenská republika v súlade s čl.3 ods. 4 a čl. 12 a ods. 3 štatútu Spoločného podniku, ktorý je prílohou Nariadenia rady (EK) č. 72/2008 z 20. decembra 2007, a ktorým sa zakladá „Spoločný podnik ENIAC[1]“. Dohodou sa stanovujú vzťahy medzi Spoločným podnikom a národnými financujúcimi orgánmi určenými členskými štátmi ENIAC pre administratívne zabezpečenie implementácie projektov a poskytovanie verejných prostriedkov.

2. Rozsah

Táto dohoda detailne stanovuje požiadavky kladené na obidve straty za účelom implementácie projektov vybraných Spoločným podnikom. Je potrebné ju vykonávať v súlade s Nariadením rady (EK) č. 72/2008, ktorým sa zakladá „Spoločný podnik ENIAC“, výzvami Spoločného podniku na predkladanie návrhov projektov, rozpočtovými pravidlami Spoločného podniku podľa potreby a s členstvom Slovenskej republiky v Spoločnom podniku.

Táto dohoda je záväzná pre Spoločný podnik a Národný financujúci orgán ustanovený Slovenskou republikou.

3. Výklad tejto dohody

Národná financujúci orgán je povinná zabezpečiť výklad požiadaviek vyplývajúcich z tejto dohody a konať tak, aby umožnila implementácia projektov a poskytnutie verejných prostriedkov tak, ako je to stanovené v článku 12 odsek 3 štatútu Spoločného podniku.

Na zamedzenie nečestnému konaniu a podvodom je potrebné riadiť sa podľa Nariadenia Rady (EK, Euratom) č. 2988/95 zo dňa 18. decembra 1995 o ochrane finančných záujmov Európskych spoločenstiev[2], Nariadenia Rady (EK, Euratom) č. 2185/96 zo dňa 11. novembra 1996 týkajúceho sa

[1] OJ L 30. 4.2.2008, str. 21

[2] Ú. v. EÚ L 312, 23.12.1995, str. 1

kontrol na mieste a previerok uskutočňovaných Komisiou za účelom ochrany finančných záujmov Európskych spoločenstiev proti podvodom a iným nečestným konaniam[3] a Nariadenia (EK) č. 1073/1999 Európskeho parlamentu a Rady týkajúceho sa prešetrovaní ukončených Európskym úradom pre boj proti podvodom[4].

Výrazy, ktoré sa použijú v tomto materiáli, majú rovnaký význam ako v Nariadení Rady (EK) č. 72/2008, ktorým sa zakladá „Spoločný podnik ENIAC", vo výzvach Spoločného podniku na predkladanie návrhov projektov a v rozpočtových pravidlách Spoločného podniku.

4. Národné zmluvy o grantoch

a) Komunikácia o oprávnenosti národných kritérií

Národný financujúci orgán zabezpečí komunikáciu so Spoločným podnikom ohľadom oprávnenosti národných kritérií a iných zákonných a finančných požiadaviek platných pre každú výzvu na predkladanie návrhov projektov za účelom zostavenia národných zmlúv o grantoch s riešiteľmi projektu. Tieto kritériá a požiadavky budú predložené Spoločnému podniku ešte pred zverejnením výzvy na predloženie návrhov projektov Spoločnému podniku, a do 30 dní od požiadavky výkonného riaditeľa.

Odsúhlasené oprávnené národné kritéria budú v zmysle predchádzajúceho odseku začlenené do výzvy na predloženie návrhov projektov Spoločnému podniku.

Národný financujúci orgán uzatvorí zmluvy o grantoch s riešiteľmi projektov v súlade s vlastnými vnútroštátnymi predpismi s prihliadnutím na:

(a) iba kritériá oprávnenosti, ktoré boli uvedené vo výzve alebo vo všetkých ďalších aktualizáciách výzvy;

(b) iné zákonné a finančné požiadavky na zostavenie národných zmlúv o grantoch, ktoré stanovujú národné zákony a predpisy, a ktoré boli odkonzultované so Spoločným podnikom v uzávierke podľa predchádzajúceho odseku.

b. Výber návrhov projektov

Spoločný podnik je zodpovedný za hodnotenie a výber návrhov projektov a za pridelenie verejných prostriedkov riešiteľom projektu podľa na výzvy na predkladanie návrhov projektov Spoločného podniku.

Predložené návrhy projektov sú posudzované nezávislými odborníkmi.

Rada verejných orgánov schváli zoznam vybraných návrhov projektov, doplnený údajmi o verejných prostriedkoch (Spoločného podniku a/alebo národného financujúceho orgánu) ako aj odporúčaniami na ďalšiu fázu rokovaní. Výkonný riaditeľ Spoločného podniku oznámi jednotlivým žiadateľom a Národnému financujúcemu orgánu tieto výsledky spoločne s bodovým hodnotením, pripomienkami a prípadnými odporúčaniami na zmeny do 15 dní od uskutočnenia výberu.

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[3] Ú. v. EÚ L 295, 15.11.1996, str. 2
[4] Ú. v. EÚ L 139, 31.05.1999, str. 1

Na základe tejto komunikácie a v zmysle zoznamu vybraných návrhov projektov, ktoré schválila Rada verejných orgánov, začne Spoločný podnik v zastúpení výkonným riaditeľom technické rokovania s cieľom schváliť „Technickú špecifikáciu projektu[5]" v rámci limitov vyjednávacieho mandátu a finančných zdrojov na riešiteľa projektu podľa rozhodnutia Rady verejných orgánov.

- V prípade, že boli technické rokovania úspešne ukončené, výkonný riaditeľ predloží ich výsledky spoločne s kompletnou príslušnou dokumentáciou riadiacej rade a Národnému financujúcemu orgánu za účelom vypracovania národnej zmluvy o grante.

- V prípade zmien, ktoré nemôže mandát Rady verejných orgánov vopred predpokladať alebo v prípade neúspešných technických rokovaní, výkonný riaditeľ predloží na schválenie Rade verejných orgánov výsledky rokovaní spoločne zo žiadosťou o zmenu projektu. Rozhodnutie Rady verejných orgánov predloží výkonný riaditeľ riadiacej rade a Národnému financujúcemu orgánu spoločne s kompletnou príslušnou dokumentáciou, aby mohla byť vypracovaná národnej zmluva o grante.

Po ukončení rokovaní predloží Spoločný podnik koordinátorovi zvoleného konzorcia na podpis zmluvu o grante Spoločného podniku a prístupové podklady.

c) Vypracovanie národných zmlúv o grantoch

Po ukončení výberového konania a rokovania, ktoré uskutočnil Spoločný podnik, Národný financujúci orgán vypracuje spoločne s riešiteľmi projektov národné zmluvy o grantoch. Národné zmluvy o grantoch budú zostavované v súlade s pravidlami Národného financujúceho orgánu, aj v prípade, že žiadne národné verejné prostriedky nie sú zabezpečené Radou verejných orgánov predovšetkým, čo sa týka kritérií oprávnenosti a iných nevyhnutných finančných a právnych požiadaviek, okrem prípadov kedy nie je možné vypracovať národnú zmluvu o grante z dôvodu nesplnenia národných kritérií oprávnenosti zo strany riešiteľa projektu alebo iných finančných a zákonných požiadaviek.

Finálna schválená „technická špecifikácia projektu" vyplývajúca z rokovacieho procesu uskutočneného Spoločným podnikom bude rovnaká[6] pre vypracovanie národných zmlúv o grantoch k tomu istému projektu vo všetkých členských štátoch ENIAC.

Dátum začiatku a trvania projektu bude špecifikovaný v „technickej špecifikácii projektu". Národné zmluvy o grantoch stanovujú oprávnené náklady, ktoré budú poskytované odo dňa začatia riešenia projektu nezávisle od dátumu ich podpísania.

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[5] „Technická špecifikácia projektu" predstavuje technický materiál, ktorý čo najjasnejšie a stručne popisuje všetky činnosti, aktivity a úlohy, ku ktorým sa účastníci projektu zaviazali a spĺňajú vedecké a výskumné ciele stanovené v zmluvách o grantoch. Východiskom je popis vedeckých/technologických cieľov a pracovných plánov načrtnutých v návrhu projektu, ktoré sa v priebehu hodnotenia a počas ďalších rokovaní o zmluve eventuálne upravia na základe špecifických odporúčaní externých znalcov. Okrem tejto jej právnej záväznosti „technická špecifikácia projektu" slúži pre príjemcov grantu, Spoločný podnik, Národný financujúci orgán a eventuálne pre externých znalcov ako referenčný údaj, aby mohli efektívne sledovať a kontrolovať napredovanie daného projektu počas celého jeho trvania.

[6] okrem prekladov, ak je to potrebné

Národný financujúci orgán zabezpečí, aby ustanovenia národnej zmluvy o grante boli v súlade s článkom 107 odseku 1 rozpočtových pravidiel ENIAC, ktoré uvádzajú, že ak si riešenie projektu vyžaduje, aby príjemca uskutočnil verejné obstarávanie, musí požiadavku vo výberovom konaní formulovať na základe najlepšej ponúknutej ceny, t.j. vo výberovom konaní ponúkne najlepší pomer ceny a kvality, pričom sa snaží vyhnúť konfliktu záujmov.

Národný financujúci orgán vynaloží maximálne úsilie, aby urýchlil svoje interné postupy na uzatvorenie národných zmlúv o grante. Národná zmluva o grante musí byť podpísaná najneskôr do 30 dní od ukončenia rokovaní, ktoré uskutočnil Spoločný podnik (ENIAC).

Národný financujúci orgán bude informovať Spoločný podnik o podpise národnej zmluvy o grante a kópiu národnej zmluvy o grante predloží Spoločnému podniku do 15 dní odo dňa jej podpisu jej príjemcom.

Následne bude Spoločný podnik informovať Národný financujúci orgán o podpísaní zmluvy o grante medzi Spoločným podnikom a príjemcom a kópiu tejto zmluvy o grante mu predloží do 15 dní odo dňa jej podpisu.

Zmluva o grante Spoločného podniku nadobúda platnosť po pripojení sa minimálne troch neprepojených subjektov, ktoré boli založené v minimálne troch členských krajinách Spoločného podniku v deň pripojenia sa posledného z nich.

d) Technický monitoring

Spoločný podnik je zodpovedný za monitorovanie riešenia projektu v súlade s „Technickou špecifikáciou projektu„.

Konzorcium predloží Spoločnému podniku svoju technickú správu(y)[7] a výstupy v termínoch, ktoré sú na predloženie správ stanovené v „Technickej špecifikácii projektu“ a zmluve o grante uzavretej medzi Spoločným podnikom a riešiteľmi projektu.

Spoločný podnik poskytne technické správy a výsledky technického hodnotenia riešenia projektu ním vykonané Národnému financujúcemu orgánu do 15 dní po ich schválení a potvrdení výkonným riaditeľom.

Technické hodnotenie riešenia projektu vypracované Spoločným podnikom zohľadní v prípade potreby špecifické požiadavky danej krajiny navrhnuté Národným financujúcim orgánom, ktoré Národný financujúci orgán potrebuje pre akceptovanie úhrady nákladov príjemcov grantov.

Národný financujúci orgán nebude požadovať ďalšie dodatočné technické správy okrem tých, ktoré požaduje Spoločný podnik.

Správy, ktoré sú predkladané Spoločnému podniku, sú vyhotovené v anglickom jazyku.

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[7] Technická správa pozostáva z prehľadu o napredovaní prác pre dosiahnutie cieľov projektu, vrátane úspechov a dosiahnutí míľnikov a výstupov stanovených v „Technickej špecifikácii projektu“ a rozdielov medzi očakávanými a skutočne zrealizovanými činnosťami. Technická správa(y) obsahuje aj informácie o riadení (manažovaní) projektu a upravenú verziu plánov pre jeho využívanie a zverejňovanie.

e) **Finančný monitoring/Platby**

Národný financujúci orgán spracuje požiadavky na úhradu nákladov príjemcov grantov v ich vlastnom jazyku podľa vlastných postupov danej krajiny a zohľadní výsledky technického monitoringu, ktorý uskutočnil Spoločný podnik. Zabezpečí, aby boli nároky platné a náklady oprávnené a v súlade s národnou zmluvou o grante. Všetky ostatné potrebné kontrolné činnosti spadajú do kompetencie Národného financujúceho orgánu.

Prípadne Národný financujúci orgán zrealizuje platby z prostriedkov štátneho rozpočtu priamo príjemcom podľa národných zmlúv o grantoch.

Národný financujúci orgán potvrdí Spoločnému podniku výšku akceptovaných nákladov, iných finančných alebo zmluvných oblastí týkajúcich sa plnenia národnej zmluvy o grante a prípadne aj každú platbu uskutočnenú voči príjemcovi grantu. Národný financujúci orgán pošle toto potvrdenie Spoločnému podniku do 15 dní od jeho realizácie. Národný financujúci orgán zabezpečí realizáciu finančného a zmluvného monitoringu výlučne v zmysle národných predpisov a postupov.

Príslušne Spoločný podnik zrealizuje úhradu svojho príspevku príjemcom grantu do 30 dní od dňa prijatia hore uvedeného potvrdenia od Národného financujúceho orgánu.

Národný financujúci orgán bude zabezpečovať evidenciu platieb príjemcom grantov. Národný financujúci orgán obdrží informácie o príslušnom finančnom monitoringu vykonanom Spoločným podnikom.

Spoločný podnik a Národný financujúci orgán súhlasia s poskytovaním si dôkazov o platbách uskutočnených pri plnení príslušných zmlúv o grantoch predložením kópie prevodného príkazu na žiadosť druhej strany.

Každá strana upovedomí druhú stranu o prípade, že dôjde k zdržaniu alebo zníženiu platby v dôsledku neuspokojivého konania príjemcu alebo z iného dôvodu zdržania platby najneskôr do 15 dní od jeho zistenia.

5. Právo na zaplatenie

Každá strana upovedomí písomne druhú stranu hneď ako zistí, že príjemca porušil zmluvu o grante uzavretú s touto stranou ako aj povinnosť použiť prostriedky štátneho rozpočtu na vopred stanovený účel. V prípade grantov, ktoré podliehajú právu na zaplatenie, je nevyhnutné uchovávať dokumenty zodpovedajúce uplatňovaniu tohto práva (napr. dohody a záznamy o platbách) po dobu eventuálneho vymáhania.

6. Dodatky a ukončenie zmlúv o grantoch

Je v zodpovednosti každej strany upozorniť druhú stranu, že považuje jej konanie za neadekvátne a chce v platbách grantov uskutočniť zodpovedajúcu zmenu pre ich pokračovanie na základe dodatku alebo ukončiť zmluvu o grante.

V prípade že je potrebné v „ Technickej špecifikácii projektu“ uskutočniť podstatnú zmenu, Spoločný podnik bude informovať Národný financujúci orgán o účele dodatku. Národný financujúci orgán predloží Spoločnému podniku špecifické požiadavky svojej krajiny najneskôr do 15 dní od získania tejto informácie. Novú „Technickú špecializáciu projektu“ prerokuje Spoločný podnik po zohľadnení všetkých požiadaviek Národného financujúceho orgánu. Spoločný podnik oznámi Národnému financujúcemu orgánu aktualizovanú verziu „Technickej špecifikácie projektu“ do 15 dní od ukončenia tohto rokovania.

Akýkoľvek iný dodatok „Technickej špecifikácie projektu“ prerokuje Spoločný podnik, ktorý oznámi Národnému financujúcemu orgánu zmenu „ Technickej špecifikácie projektu“ do 15 dní od ukončenia tohto rokovania.

Do 15 dní je Spoločný podnik zodpovedný informovať Národný financujúci orgán o akejkoľvek zmene alebo ukončení zmluvy o grante medzi Spoločným podnikom a príjemcom.

Do 15 dní je Národný financujúci orgán zodpovedný informovať Spoločný podnik o akejkoľvek zmene alebo ukončení zmluvy o grante medzi Národným financujúcim orgánom a príjemcom.

7. Audity – kontroly

Spoločný podnik bude u príjemcov verejných finančných prostriedkov Spoločného podniku uskutočňovať kontroly na mieste a finančné audity. Tieto kontroly a audity bude vykonávať buď priamo Spoločný podnik alebo Národný financujúci orgán v mene Spoločného podniku na základe žiadosti Spoločného podniku. Národný financujúci orgán môže na vykonanie kontrol a auditov menovať externý orgán, ktorý tak urobí v jeho mene. Národný financujúci orgán je oprávnený uskutočniť u príjemcov prostriedkov štátneho rozpočtu iné kontroly a audity, v prípade že to považuje za nevyhnutné a Spoločný podnik oboznámi s ich výsledkami.

Obidve strany sa budú vzájomne informovať o začatí ako aj o výsledkoch všetkých kontrol a auditov ustanovených v zmysle predchádzajúceho odseku, a to do 15 dní.

8. Politika práv duševného vlastníctva

Pre účely národných zmlúv o grantoch v rámci tejto zmluvy a bez toho, aby boli dotknuté pravidlá hospodárskej súťaže Spoločenstva, prednosť majú ustanovenia o duševnom vlastníctve schválené Nariadením Rady (EK) č. 72/2008 pred vnútroštátnymi predpismi, pravidlami o poskytovaní grantov alebo projektami súvisiacimi s duševným vlastníctvom.

9. Dôverné informácie

Všetky informácie, ktoré príslušná strana získa v súvislosti s touto dohodou, sa budú považovať za dôverné a každá strana súhlasí, že:

(a) bude dôverné informácie chrániť zodpovedajúcim a adekvátnym spôsobom v súlade s platnými odbornými štandardami;

(b) bude dôverné informácie používať a reprodukovať len na účely stanovené v tejto dohode;

(c) nebude zverejňovať alebo iným spôsobom poskytovať dôverné informácie iným osobám ako tým, ktoré tieto informácie potrebujú na splnenie účelu stanoveného v tejto dohode.

Predchádzajúci odsek sa nebude vzťahovať na informácie,

(a) ktoré sú verejne známe; alebo

(b) ktoré prijímacia strana už pozná;

(c) keď je zverejnenie dôverných informácií požadované národným zákonom.

10. Administratívne záležitosti

Zúčastnené strany tejto dohody si budú uchovávať a aktualizovať zoznam kontaktných osôb zodpovedných za vybavovanie záležitostí týkajúcich sa tejto dohody.

Obidve strany sa budú vzájomne informovať o iných osobách, ktoré sú zodpovedné za príslušnú uzavretú zmluvu o grante.

Kompletná komunikácia medzi stranami sa uskutočňuje v anglickom jazyku[8].

Kompletná písomná komunikácia medzi zúčastnenými stranami tejto dohody bude prípadne uvádzať názov zmluvy a identifikačné číslo (Národného financujúceho orgánu /alebo Spoločného podniku). Každá strana bude druhej strane odpovedať na otázky týkajúce sa tejto dohody najneskôr do 7 pracovných dní. V prípade, že druhá strana nedostane žiadnu odpoveď ani do 15 dní, bude sa to považovať za kladnú odpoveď.

11. Práva kontroly Európskej komisie, OLAF a Dvora audítorov

V súvislosti s touto dohodou zabezpečia obidve strany uplatňovanie kontrolných práv Európskej komisia, Európskeho úradu pre boj proti podvodom a/alebo Dvora audítorov podľa článku 12 odseku 5 a článku 12 odseku 6 Nariadenia rady (EK) č. 72/2008.

12. Riešenie sporov

Súd prvého stupňa alebo odvolací súd, Súdny dvor Európskych spoločenstiev má výlučnú súdnu právomoc pri riešení súdnych sporov medzi Spoločným podnikom a Národným financujúcim orgánom, ktoré sa týkajú výkladu, uplatnenia alebo platnosti tejto dohody.

13. Trvanie dohody

Táto dohoda nadobudne platnosť v deň jej podpísania oboma stranami dohody a bude platná počas obdobia členstva Slovenskej republiky v Spoločnom podniku. Túto dohodu možno kedykoľvek meniť na základne vzájomného písomného súhlasu zúčastnených strán. Táto dohoda nezahŕňa teraz alebo

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[8] V prípade, že je nevyhnutné podpísať pôvodné materiály, ktoré Národná grantová organizácia vyhotovuje v domácom jazyku, Národná grantová organizácia ich predloží spoločne s prekladom do anglického jazyka.

v budúcnosti žiadnu výmenu finančných prostriedkov, ani vytvorenie akéhokoľvek záväzku voči časti akejkoľvek strany na vykonanie úhrady voči inej strane.

Táto dohoda pozostáva z úplnej dohody uzavretej medzi zúčastnenými stranami na stanovený účel a jej úpravy alebo dodatky platia len po uvedení a priložení podpisov obidvoch strán tejto dohody.

Vyhotovené v Bruseli v dvoch kópiách

za Spoločný podnik

vlastnoručný podpis

Dirk Beernaert

dočasný výkonný riaditeľ

za Ministerstvo školstva Slovenskej republiky

vlastnoručný podpis

p. Marta Cimbáková

riaditeľka odboru štátnej a európskej politiky vo vede a technike

Úsek vedy a techniky

ENIAC JOINT UNDERTAKING
Technical Annex

"Energy To Smart Grid"
V1.02
ENIAC Call 01-2011

<u>IMPORTANT NOTE</u>

*From the PO to the FPP, the E2SG consortium agreed to change the Project Coordinator, moving **from STMicroelectronics srl (Italy) to Infineon Technologies AG (Germany)**.*

Following the indication of ENIAC JU, the coordination shift is fully represented in the Technical Annex. However, due to the limit of the EPSS submission systems, this decision may be not fully reflected in the Forms A1 and A2 and in the formal numbered list of partners.

1 ESSENTIALS

Project acronym	**E2SG**
Project full title	**Energy to Smart Grid**
Area/ Sub Programme, Grand Challenge, Results expected, Compliance level	Area/ Sub Programme: Energy Efficiency Grand Challenge 3.3.2: Energy Distribution and Management- Smart grid Results expected: - Optimization of energy consumption by usage of relevant environment and grid information. - Demonstration of new intelligent interface solutions for connection of consumers to Smart Grids. - Introduction of energy efficient high voltage technologies. - Sustainable solutions by intelligent, stable and robust driver circuits.
Area/ Sub Programme, Grand Challenge, Results expected Compliance level	Grand Challenges: Chapter 3.3.3 Reduction of Energy Consumption
Area/ Sub Programme, Grand Challenge, Results expected Compliance level	Secondary Target: Chapter 6.3.3: Design Technology, Design for Reliability and Yield
Version of Technical Annex	*Version 1.02*
Date of Technical Annex	*20th March 2012*
Date of approval of Technical Annex by ENIAC JU	*Not applicable at this stage*
Start Date of Project	*01/04/2012*
Duration of project	**36 M**
Max JU Funding	Not applicable at this stage
Coordinator	**Infineon Technologies AG**
Project coordinator	**Wolfgang Dettmann**
Tel	**+49 (89) 234 - 25249**
Email	**wolfgang.dettmann@infineon.com**

List of participants

#	Participant organisation name	Part. short name	Country	ENIAC member State (Y/N)	Other EU Member State/Ass. Country (Y/N)	National eligibility checked by applicant (Y/N) (2)
1	**STMicroelectronics Italy**	**ST-I**	**I**	**Y**	**N**	**Y**
2	**Centro Ricerche FIAT**	**CRF**	**I**	**Y**	**N**	**Y**
	#3 left consortium before GA					
4	**HERA**	**HERA**	**I**	**Y**	**N**	**Y**
5	**EFFEGI**	**FGE**	**I**	**Y**	**N**	**Y**
6	**METATRON**	**MET**	**I**	**Y**	**N**	**Y**
7	**POLIMODEL**	**PM**	**I**	**Y**	**N**	**Y**
8	**Consorzio Nazionale Interuniversitario per la Nanoelettronica**	**IUNET**	**I**	**Y**	**N**	**Y**
9	**Politecnico di Torino**	**POLITO**	**I**	**Y**	**N**	**Y**
10	**Università di Bologna**	**UNIBO**	**I**	**Y**	**N**	**Y**
11	**Università della Calabria**	**UNICAL**	**I**	**Y**	**N**	**Y**
12	**Università di Catania**	**UNICT**	**I**	**Y**	**N**	**Y**
13	**Austriamicrosystems**	**AMS**	**A**	**Y**	**N**	**Y**
14	**On Semiconductor**	**ONSEMI-B**	**B**	**Y**	**N**	**Y**
15 (C)	**Infineon AG**	**IFAG**	**D**	**Y**	**N**	**Y**
16	**Insta Elecktro GmbH**	**INSTA**	**D**	**Y**	**N**	**Y**
17	**NXP Germany**	**NXP-D**	**D**	**Y**	**N**	**Y**
18	**Telefunken semiconductors**	**TEL**	**D**	**Y**	**N**	**Y**
19	**Fraunhofer IISB**	**FHG**	**D**	**Y**	**N**	**Y**
20	**RWTH Aachen University**	**RWTH**	**D**	**Y**	**N**	**Y**
	#21 left consortium before GA					
22	**IQUADRAT**	**IQU**	**ES**	**Y**	**N**	**Y**
23	**LEITAT**	**LEITAT**	**ES**	**Y**	**N**	**Y**
24	**Centre Tecnològic de Telecomunicacions de Catalunya**	**CTTC**	**ES**	**Y**	**N**	**Y**
	#25 left consortium before GA					
26	**HELIOX**	**HELIOX**	**NL**	**Y**	**N**	**Y**
27	**NXP Semiconductors**	**NXP-NL**	**NL**	**Y**	**N**	**Y**
28	**Philips Consumer Lifestyle**	**PHILIPS-LS**	**NL**	**Y**	**N**	**Y**
29	**Instituto de Telecomunicações**	**IT**	**P**	**Y**	**N**	**Y**
30	**Slovak University of Technology**	**STUBA**	**SK**	**Y**	**N**	**Y**
31	**R-DAS**	**RDAS**	**SK**	**Y**	**N**	**Y**
32	**Enecsys**	**ENECSYS**	**UK**	**Y**	**N**	**Y**
33	**IQE**	**IQE**	**UK**	**Y**	**N**	**Y**
34	**Silvaco**	**SIL**	**UK**	**Y**	**N**	**Y**
35	**University of Sheffield**	**UoS**	**UK**	**Y**	**N**	**Y**

2 HISTORY OF TECHNICAL ANNEX LATER ANNEX 1 TO THE JU GA

Version Number	Date	Main changes / Amendment number	Description
0.98	*17/10/2011*	*Updated FPP after invitation to negotiations and edited proposal to cover ESR.* *Provided at the end of the negotiationphase under the assumption that this FPP version is automatically converted to a TA.*	- *Adaption to communicated available budget* - *Three partners left the consortium:* *- ENEL: will be covered by ST, HERA and IUNET→covered in the version after the kick-off.* *- ADD Semi: no impact on the consortium* *- Tyndall – UCC: no impact on the consortium*
1.0	*10/01/2012*	*End of negotiations*	*Conversion of Updated FPP to TA* - *Chapter 1=Essentials and 2= History added.* - *V0.98 chapter 1, 2, 3... → Chapter 3, 4, 5...* - *Tables (milestones, deliverables) removed to the Excel Table.*
1.01	*13/03/2012*	*No distribution of former ENEL research to the Italian partners ST, HERA and IUNET*	*The in v0.98 announced redistribution of the research, efforts and eligible costs from the former Italian partner ENEL to ST, HERA and IUNET was not approved within the PAB decision in December'11 for E2SG. Consequently the research part is excluded until the efforts are eligible for the former ENEL part.* - *WP4: Page 75: add comment to the ST, HERA, IUNET activities taken from ENEL: will be part of the research after eligibility is approved* - *D4.9: initially planned by ENEL, currently not eligible therefore not in the project (waiting for amendment).* - *M4.3: initially planned by ENEL, currently not eligible therefore not in the project (waiting for amendment).* - *Updated tables for GA regarding that points (del. 4.9/ M4.3 and resources)* *In General: the formerly planned ENEL contribution is not eligible (smart conversion devices and PV distributed generation & test field activities & contribution of data for the demonstrations in the intragrid-related tasks). It is still covered in the TA, since ST, HERA and IUNET wants to take that part over and an amendment will be placed, if funding is available.*
1.02	*20/03/2012*	*Version for JU GA*	*Last update of resources according to the approved budget. Several resource contributions have to be finalized during the kick-off.*
x.y	*dd/mm/yyyy*	*Amendment 1 to the JU GA*	
x.y	*dd/mm/yyyy*	*Version used for Progress Report 1*	
x.y	*dd/mm/yyyy*	*End of project*	

3 PUBLISHABLE PROJECT SUMMARY

The target of the overall E2SG project is to devise and design mechanisms and policies to assemble, monitor and control smart grids, i.e. a set of interconnected nodes whose primary goal is to generate, exchange and consume electrical energy in the most efficient and reliable way by exploiting distributed information that is sensed, transmitted and processed over the same set of nodes and links. From this point of view, E2SG is complementary with respect to ERG that focuses on nodes with generation abilities whose interfaces are the main topic of common interest.

E2SG aims at addressing most of the challenges entailed in evolving the concept of smart-grid to the level needed by both the industrial players and the society of the next decades, and the uprising environmental awareness which will lead to the increasing exploitation of removable energy sources.

To do so, E2SG aims at developing and demonstrating key enabling technologies in, at least, the following fields

1. node-grid interfaces – especially between generating nodes and the grid
2. grid-sensing/metering – to collect the information needed for management and control
3. over-the-grid communication – to effectively carry sensing and control information where it is needed
4. grid-topology and control – to understand and design connection-induced behaviours improving reliability and to control (local) energy production/distribution by exploiting advanced storage policies and
5. energy routing – to develop flexible and efficient mechanism to transmit energy between nodes, e.g., by properly choosing AC or DC links depending on temporary operating conditions for power consumption.

4 RELEVANCE AND CONTRIBUTIONS TO THE CONTENT AND OBJECTIVES OF THE CALL

4.1 Relevance of the project in relation to the selected Sub Programme targets and Grand Challenges of the AWP

The proposal is presented in order to adequately address Grand Challenge 3.3.2 “Energy Distribution and Management- Smart grid”.

It also addresses some aspects of Grand Challenge 3.3.3 “Reduction of energy consumption” and Grand Challenge 6.3.3 “Design Technology, Design for Reliability and Yield”.

Today, the efficiency of power conversion is a very important topic. Many authorities and governments have approved regulations aiming to guarantee minimum efficiency requirements and have started funding projects to obtain the necessary know-how to reach certain performance targets. Power conversion for sustainable energy production and distribution is one of the most active areas in this context, since efficient power conversion is required at every level of the energy supply chain, from the producer to the consumer. Even more, the demand for energy efficient and reliable power conversion is further strengthened by the current evolution towards intelligent energy networks, i.e. smart grids, which facilitate the pervasive integration and deployment of renewable energy sources. Typical applications in this field of interest are, for instance, photovoltaic (PV) converters, grid-tied inverters, bidirectional dc-dc converters for battery and supercap applications (either for grid support or electric vehicles). On the European level, the 20-20-20 target was put forward to improve the efficiency and performance of the global energy system and supply chain. It is the intention to achieve a 20% increase in energy efficiency, 20% renewable and a 20% decrease in CO_2 emissions by 2020.

The main expected results are:

- Optimization of energy consumption by usage of relevant environment and grid information.
- Demonstration of new intelligent interface solutions for connection of consumers to Smart Grids.
- Introduction of energy efficient high voltage technologies.
- Sustainable solutions by intelligent, stable and robust driver circuits.

Introduction of energy efficient high voltage technologies:

4.2 Contribution of the project to the overall ENIAC JU objectives as listed in the MASP

The proposed project E2SG is following a top down approach, starting from socio-economic challenges, and particularly from the pan-European need of reducing the dependence on fossil-fuel consumption by increasing renewable energy production level and increasing overall energy efficiency. The project focuses on the complex set of hardware and communication needs, which are required in future Smart Power Grids. The objectives will be approached by a combined strategy, starting from existing microelectronic technology, selection of most promising communication medium, following existing and upcoming regulation/standardization aspects, and finishing with the development of missing links for a common platform of linked power nodes. Finally the complete chain of added value will be demonstrated.

The intended results will increase and maintain essentially manufacturing capabilities in Europe and will position European industry partners at a worldwide leading edge for efficient energy grids and interfaces.

5 R&D INNOVATION AND TECHNICAL EXCELLENCE

5.1 Background concepts

The grid infrastructure will face considerable challenges in the near future arising from significant shifts in generation and consumption caused by increasing reliance on renewable energy. The importance of such research to energy security and mitigation of climate change has been evidenced by the $(US) 30 Billion investment in a new generation of energy distribution technology recently launched in the US.

The interest in smart grid issues is confirmed by the considerable amount of initiatives both in the research and industrial domains dealing with such a concept. Indeed, according to Infineon Technologies, the worldwide total investments for upgrading the grid to a Smart Grid (SG) are estimated to reach $3 trillion over the next 20 years.

From a more technical point of view, the IEEE mentions SGs among the leading emergent technologies, dedicates a specific initiative (http://smartgrid.ieee.org) to the building of a strong mixed academic-industrial community addressing related issues, and sponsors the new "IEEE Conference on Innovative Smart Grid Technologies" to become a major vessel of scientific communication and dissemination of technologies and solutions.

In recognition of the fact that the conception of smart-grids has to be addressed with a convergence of energy/power and ICT competences, the National Institute for the Standardization of Technology [1] recently identified a reference model for the definition of SG concepts and challenges. Such a model puts particular emphasis on networking and interoperability issues as well on the role of ICT as a provider of both key enabling devices and of far-reaching paradigm allowing the development of complex interconnected and information-driven systems.

Coherently with this view, nearly 100 standards (either defined or in development by the IEEE) that address this mixture of energy/power and ICT abilities can be identified either supporting or enabling the smart-grid concept. Noteworthy among them:

- the IEEE P2030 Draft Guide for Smart Grid Interoperability of Energy Technology and Information Technology Operation with the Electric Power System (EPS), and End-Use Applications and Loads
- (part of) the IEEE 802 LAN/MAN Standards Series
- the IEEE SCC21 1547 Standards for Interconnecting Distributed Resources with Electric Power Systems
- the IEEE SCC 31 Automatic Meter Reading and Related Services

These very general points of view have concrete implications both in the research and industrial worlds with many occasions of fruitful synergies aiming at applying the most promising innovations to favour sustainable economic growth, climate-friendly energy management, and ultimately, quality of life in the society of the future.

This is why, from a political point of view, in its "Digital Agenda for Europe", the European Commission identifies within the "Seventh Pillar – ICT Enabled benefits for EU Society" the use of ICT as a fundamental tool to achieve a significant reduction of greenhouse gas emissions and improvement in energy efficiency, i.e., by 20 % with respect to 1990 levels, to reduce the carbon footprint (the so-called 20-20-20 goal), and deems *"smart grids essential for the move to a low carbon economy"* [2].

The importance of such topics has been readily received by the academic community. As an example, from the recent conception of the term "smart grid", nearly 2,500 papers focused on that topic have been published in over 40 IEEE journals. Though most of the earlier contribution comes from the power electronic community, more and more ICT related techniques and methodologies are called into play as the complexity and multi-abstraction nature of the issues is revealed. Researchers have begun developing ad-hoc modelling and control methods to deal with the complex-network nature of large-scale smart grids, novel techniques for physical layer communication that can be smoothly integrated with energy exchange, as well as signal-processing strategies that improve energy conversion or metering.

On the industrial side, many major ICT players (both design-oriented and manufacturing-oriented) dedicate a considerable effort in the development and deployment of devices dedicated to smart metering, power-management, and power-close communication (let it be directly powerline communication or wireless communication in high-power environments). Such effort has been paired with the increasing activity by a plethora of energy industry players in the creation/production of more efficient renewable energy sources as well as, by car manufacturers on the design and production of hybrid or electric vehicles.

The scientific and technical purpose of the proposal can be described within the NIST reference model already mentioned.

Such a model partitions a smart-grid into seven interacting domains, each comprising a specialized kind of infrastructure and activities: the bulk generation domain, the transmission domain, the distribution domain, the customer domain, the operations domain, the market domain and the service provider domain.

Such a view is extremely broad and accomplishes various aims and different abstraction and institutional levels. What is most interesting for the purpose of this proposal is the relationship and interaction of the three most customer-centred domains, i.e. related to the Transmission, Distribution and Customers. The Transmission Domain carries bulk electricity **by** power transmission lines over long distances, connecting the bulk generation to the energy consumption centres of the smart grid. It may also connect to energy storage facilities and alternative distributed energy resources at the transmission level. The Distribution Domain distributes the electricity to and from the end customers. The distribution network connects the smart meters and all intelligent field devices; manages and controls them through a two-way wireless or wireline communications network. It may also connect to energy storage facilities and alternative distributed energy resources at the distribution level. The Customer Domain is where the end users (home, commercial/building, and industrial) of electricity are connected to the electric distribution network through proper, possibly two-ways, energy and information interfaces paired with metering devices. Each customer has its own domain comprised of electricity premises and two-way communications networks. It may also generate, store, and manage the use of energy and the connectivity with plug-in-vehicles.

The present proposal aims to address several of the challenges **related to all level of the NIST Smart Grid model.** It will focus on energy (mobile) systems and power grids, and their advanced monitoring and control which takes advantages of ICT techniques at device-level (in designing and implementing more efficient power switches for improving performance of renewable energy extraction circuits/systems) circuit-level (in developing innovative circuits for smart meeting and systems for efficiently assessing the status of each node in a power grid), at the signal and algorithmic levels (that have very recently recognized as necessary to increase the intelligence and responsiveness of the overall system but are not yet fully received by industrial developments) and at the communication and control level (which are the necessary step for both sensing and actuating to achieve optimal grid performance).

5.2 Research topics and objectives

The main idea for the development of advanced energy distribution networks relies on the implementation of the SG which, as seen in the previous section, pairs the power distribution network with an ICT infrastructure and enables forms of sophisticated intelligence in the management of power flows. Such a SG will encompass the distribution network with an interface to the transmission system. Its components will include distributed energy resources, grid interfaces, distribution circuits, smart circuits for measuring energy consumption (smart meters), and an IP-addressable load control architecture that represents the decision support system. In this grid we will see distributed generation sources (such as wind turbines, fuel cells, micro-turbines and photovoltaic panels) closer to the loads; storage technologies including plug-in hybrid and Electric Vehicles (EVs); greater flexibility for islanding and micro-grids; and considerably higher levels of intermittent generation [3,4]. The smart-grid can thus be thought of as a platform where both supply and demand will meet [4]. The new sources of energy such as wind power and solar power have an increasing role, and they can connect both to the transmission and the distribution networks. At the distribution level, they can partially accommodate individual house holders or local communities and, with certain pricing policies, could provide the grid with electricity. Although the reliability and level of supply of renewable sources creates new problems, the challenges are not smaller on the demand side. The installation of intelligent metering for domestic users provides energy producers and distributors with an unparalleled chance to change the way in which electricity is produced, profiled, distributed and consumed. Real time recording of consumption via intelligent metering will enable each domestic user to profile their use to match a pricing policy according to their needs and their capacity to pay.

Already the above scenario identifies some important problems and objectives.

1. At the energy production side, the increasing importance of renewable sources has the important drawback of introducing uncertainties in the energy production level, for both wind- and sun-based generation. For instance, one of the typical problems in Photo Voltaic (PV) panels [5] is the performance loss due to fact that they are masked by shadow, since some of their cells can work in reverse bias, actually performing working as loads and not as power generators. Furthermore, when reverse bias exceeds the breakdown voltage of the shaded solar cell, and the cell will be fully damaged (for example, cell cracking or hot spot formation appears and an open circuit exists at the serial branch where the cell is connected). A well-known solution [6] is that of providing individual solar panels with their individual inverter thus eliminating the problem arising in long panel. This can increase the energy harvest by 20%-30%. Yet, for a product suitable for on field application (especially in isolated power plants), this means that such an inverter should not only be small, efficient and cost effective, but also have an expected lifetime of 25 years whilst being operated in a hostile outside environment behind the solar panel. Providing mains isolation in the inverter will largely increase the ease of installing and the safety of the overall system. Regrettably these types of inverters don’t exist at the moment. Furthermore, even if one refers to commercially available inverters, their efficiency, and therefore the amount of energy which is transferred to the grid, heavily depends on the characteristics of the power switches, whose performance needs to be constantly improved [7].

2. Even excluding the presence of the “random fluctuations” introduced by renewable sources, the behavior of the power grid is extremely difficult to predict in presence of failures of any give source or link. Actually, the network behavior may be so complicated that faults in the wrong place at wrong moment may cause catastrophic black-outs as it was the case in North America and Italy in August and September 2003, respectively. The reason why this is so has not been understood yet, but may be strongly related to the statistically topological features of the network, and several attempts have been made to study it exploiting first nonlinear dynamical systems theory [8] and, more recently, the one of *complex systems* [9]-[11]. Even if some encouraging result, the problem is far from being solved, especially if renewable energy sources come into play, since they may cause the network topology to fluctuate over time, adding a further dimension to the problem of monitoring the state/determining the evolution of the network.

3. Another important challenge is related to the coupling to the grid of EV battery packs [12], which will not only pose additional requirements on the grid load, but if controlled by the SG, will result in the possibility of (large scale) energy storage and eventually energy feedback to the grid. To fully exploit this potential advantage, a bidirectional battery pack charger that is low weight, mains isolated, cost effective, reliable in “under the hood” operating conditions and

compatible to Smart Grid is required. Again, these types of converters don't exist at the moment.

If one pushes the SG vision at a finer level of granularity, one can also imagine an evolution of this concept in which the "grid" is equally involved, for every local community, in the distribution of energy and information, information flows being concerned not only with energy distribution but also with its consumption and its possible local generation as well as with elementary safety monitoring tasks. The environment in which such a hybrid network operates may be that of a building accommodating many families each with its own typical energy needs. We will refer to this network as "***Intragrid***" to signify a local reality that possibly interfaces with an analogous geographic or even worldwide power + information network that we may, in comparison, refer to as "***Intergrid***" (see Figure 3.2.1). The deployment of an Intragrid should help the small community living in the condominium to ease interaction "at energy level" between the members of the community and with the external environment, so to optimize global as well as individual welfare, safety and budget.

A fully developed Intragrid would be the enabling technology for more energy and environment aware and friendly behaviours. Beyond administering energy exchanges between external energy providers and local generators, it also helps optimizing consumption by, for example, automatically scheduling housework or activities that can take place unsupervised, suggesting optimal lighting level given ambient condition, etc. Such an optimization may drive the sizing of the overall power infrastructure far from the worst case (the sum of the maximum powers absorbed by each family in the condominium) and realize significant savings as well as environmental benefits.

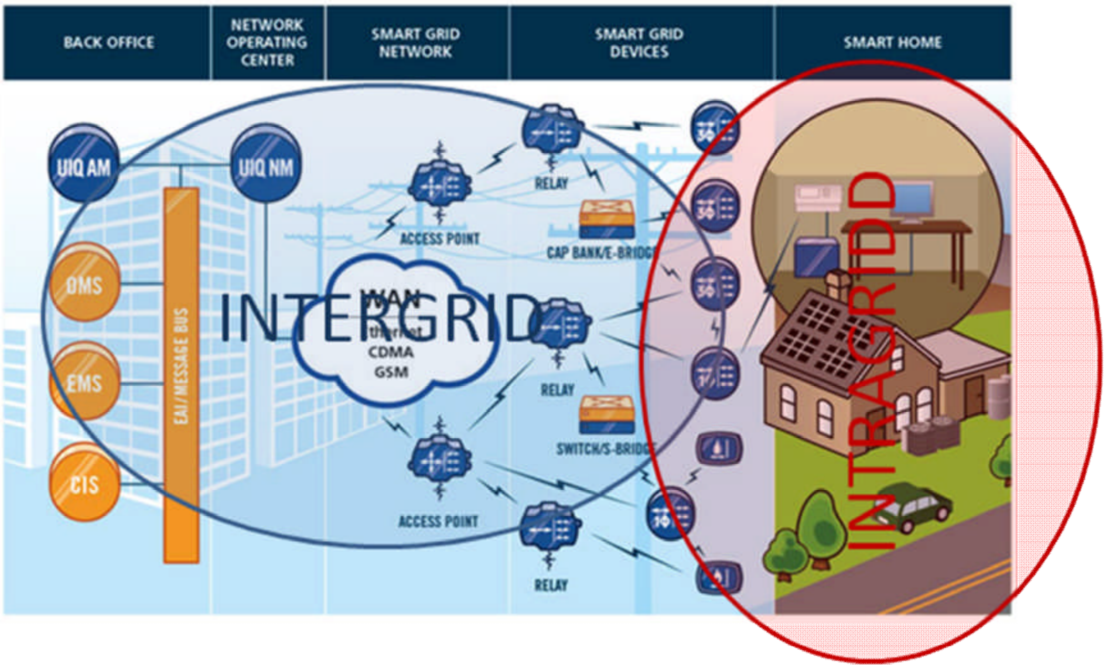

Figure 3.2.1 – Grid scenario.

Nodes of an "*Intragrid*" accept flows both of energy and information and can be of an extremely wide range. They can be classified into few intuitive subsets:

1. Interface points with external energy providers
2. Local co-generators
3. High-power nodes (e.g. heating/cooking appliances)
4. Low-power nodes (e.g. other domestic appliances and lighting devices)
5. Ultra-low to Zero-power nodes (e.g. sensing/computing and interface devices)

To reduce deployment costs, at the physical level, links in the "Intragrid" are common to power and information flows. Connectivity is ensured by the minimum possible number of metal wires by an extensive exploitation of buses, converters/hubs, and wireless links to zero-power nodes.

There are many open areas of research also in the local Intragrid:

1. One of the biggest challenges in a smart grid including local micro-generation of energy via renewable sources is that the supply must meet demand on a very short timescale. In this context, both the voltage and frequency must be maintained on the grid. Failure to maintain the frequency to within +/-0.05Hz will lead to automatic control actions, while larger fluctuations will bring power outages. Moreover, distribution systems are characterized by peculiar design configuration that requires a major effort in order to exploit the available limited means of control of power flows [13].
2. Another fundamental goal to arrive to a proper operation and control of a SG is certainly the introduction of advanced measuring/sensing techniques. One of the quantities which is of paramount importance nowadays to be able precisely monitor in a distributed way in such active distribution networks are the synchronized phasors [14]. As show in the literature [15]-[17], some functions to be implemented in the management system of active distribution networks appear somehow similar those already applied for the operation of transmission networks. In this respect, also the concept of a distributed monitoring system based on phasors measurement units (PMUs) can be one of these functions. As known, PMUs provide the measurements of voltage/current phasors synchronized with high precision time references that, in general, is provided by the UTC-GPS one [15]–[17]. However, the peculiar characteristics of distribution networks compared to transmission ones (such as reduced line lengths and limited power flows) result, in general, into very small phase differences between voltage phasors of different busses. Therefore, very low values of the uncertainty relevant to the phasor-phase estimation is required, hindering the direct utilization of PMUs developed for transmission networks applications, which imposes that innovative solutions must be sought.
3. Conventional power line communication strategies implicitly separate the information signal from the power flow in the frequency domain. To achieve this transformers and filters must be used and special cautions must be paid to ensure that high-frequency components of the power-loaded waveforms do not alter information-bearing signals. This results in constraint on the selectivity of the filters and the characteristic of the transformer, which must be of good quality, thus increasing the cost of the equipment. Of course, in an Intragrid scenario, where all appliances should be linked to a governing “home” authority, the cost of the additional devices should be kept to a minimum, which open the way to study possible alternative solutions for indoor powerline communication.

Other open areas of research appear in several subsystems of both an Inter- and an Intragrid and at several abstraction levels, some of which will indeed be targeted within the E2SG project in addition to those mentioned above. The target of the overall E2SG project is to devise and design mechanisms and policies to assemble, monitor and control smart grids, both at the Intergrid and Intragrid level, i.e. a set of interconnected nodes whose primary goal is to generate, exchange and consume electrical energy in the most efficient and reliable way by exploiting distributed information that is sensed, transmitted and processed over the same set of nodes and links. From this point of view, E2SG is complementary with several other ENIAC and ARTEMIS projects; it is more thoroughly explained in section 3.3.4.

It is worth stressing that, tackling both the Intragrid and the Intergrid scenarios at the same time allows obtaining a kind of cross-layer optimization for the deliverable associated to several tasks,, in a similar way with respect to what is now common practice in communication networks. A typical example is in the determination of the optimal management policies for loads and renewable energy sources, where measuring the state of the power grid via a PMU and receiving information on the smart appliances status via a smart meter, may result in more convenient solutions than trying to solve separately the energy generation and energy consumption problems.

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5.3 Progress beyond the state-of-the-art

Overall E2SG addresses especially the transition from a not in detail and with first order solutions connected grid to a connected one with individual information regarding consumption and sophisticated highly efficient power conversion and bi-directional distribution technologies. The progress beyond the state of the art is therefore in the smart conversion of energy, communication and security technologies within the grid which are the key elements to enable a really smart grid. The research for this progress beyond the state of the art is performed by the partners within the work packages:

- WP1 Smart Conversion
- WP2 Grid-sensing/metering & communication
- WP3 Grid Topology and Control
- WP4 Integration and Demonstration

WP1- Smart Conversion

This work package is concentrated upon the Grand Challenge *Reduction of Energy Consumption* by exploring solutions for intelligent interfacing to SGs, both from the point of view of energy generators/loads and of data transfer. The consortium will develop and implement several innovative microelectronic solutions which will be exploited to define new interfaces between power grids and intelligent power supplies for consumer and industrial applications. The development of these hardware demonstrators covers conversion blocks for high efficient energy usage, control related functions, energy delivery and energy storage options. The security needs for grid connected hardware solutions will be fulfilled by robust designs, covering the reliability for long term usage of future microelectronic products. As the lifetime of sustainable user equipment has to cover functionality for about 20 years, the used technology has to be selected and hardened similarly to automotive requirements.

The WP is divided into 3 main tasks, each of them divided in several sub-tasks. More specifically: T1.1) Optimal power transfer to the SG T1.2) Optimal interfacing of energy generating nodes with synchronous AC grids and T1.3) Intelligent interfaces from customers to smart grid for reducing energy consumption. All tasks are almost equally related to both an Intergrid and an Intragrid.

As already mentioned in section 3.2, “green” energy sources cannot be directly connected to the power grid and need to be interfaced to a suitably designed switching power converter, which not only modifies the raw electrical power into usable one, but which can also maximize its extraction. The main objective is to improve the overall performance of the converters for this specific application. More precisely, this issue will be tackled by:

a) Designing new Si-switches topologies and optimizing their parameters for the specific end-application. In more details, the target is to implement 2 different prototypes of switches, one characterized by a minimum 110V off-state breakdown and a figure of merit Rdson* Qg<157 mΩ.nC, and a second one with off-state breakdown voltage in excess of 600V and Ron*Qg<5400 mΩ.nC. Further improvements of the devices may be obtained if the development of the new technology process in a 200mm Si-substrate will be successful, since this would result in much a more uniform trench etch depths, and hence in tighter electrical distributions on mainly Breakdown and Specific On Resistance.
b) Investigating how power converters for SGs application benefit at most from high-performance silicon semiconductor devices; in particular these switches will assure the degree of reliability mentioned in section 3.2 for coping with shadow effect in PV panel. Reliability verification will also be obtained thanks to automated test equipment developed within the project.

Another important aspect that will be tackled in this WP is the improvement in performance which can be obtained for the inverters connecting a renewable energy source with the AC grid. This goal will be achieved following 3 complementary paths. On the one hand, a completely new methodology will be studied aiming to design the switching waveform driving the inverter by means of an optimization process (instead of a standard PWM), which may be exploited to adapt the converter behaviour to sudden changes in the grid status. On the other hand, one will optimize the performance of the switching converters in terms of EMC. The final goal is to reduce the dimensions of the passive components of the EMI filter without impairing performance. This will be achieved by means of a careful design of the filter layout and by exploiting a spread spectrum technique of the converter control signal of the. The target is a reduction of the dimensions of the filter by a factor 2. Finally, performance improvement of the energy conversion factor of the converter will be sought by exploiting MPPT algorithms in a field prototype.

T1.3 targets the problem of intelligent interfacing to the grid of appliances in an Intergrid scenario. The first goal will be mainly technological and deals with the implementation of an AD/DC controller satisfying requirements for the safe isolation from the primary side (AC, 85-265 VAC) to the secondary side (DC, e.g. 12 V, 5 V, 3,5 V) up to 10 kV or even 20 kV. This goal is very important, since such isolation, in addition to proper communication capabilities, is required to turn all house hold machines, like washing machine, stove, refrigerator, etc. into “user-safe” smart appliances in the US market. Therefore, realizing this prototype may open a potentially very large market to the consortium partners. As a first step, the B6CA (Power Logic Technology) will be exploited for the implementation aiming to extend the isolation from the current 6kV to 10kV. The second step will be based on the results of the first one and combined with investigations on new materials to extend the base isolation initially from 6kV to 10kV and then to 20 kV.

The second goal is to tackle smart resources allocation for appliances in an Intragrid, which will exploit intelligent interface solutions and algorithms to take control of grid nodes and to react by reducing their energy consumption during critical phases of peak requests or high price. This target will be reached in two phase, where the first one defines the specification for the interface which will be implemented in the second one. A final design will be target another important component for and indoor smart grids, such as a low-power AC/DC converter for lighting applications.

Finally, the last important goal of the task is to solve one of the problems mentioned in section 3.2 by implementing EV or PHV to grid intelligent interfaces.

It is finally worth stressing that many (if not all) major silicon players in Europe are contributing to this WP, and that industrial partners contribute overall for over 80% of the entire effort devoted to WP1, while the rest is covered by academic partners and research institutions. This is certainly a guarantee for the strong commitment of silicon industries to the success of the promised hardware demonstrators and of this WP and of the overall project

WP2- Grid-sensing/metering & communication

This work package develops technologies essentially related to the acquisition of data (typically, but not only, data on power flows) at multiple points of the grid, and their communication to a concentrating node in charge of computing some kind of control policy (that is outside the scope of this work package) that, in turn, may be communicated back to the nodes.

Methods for coping with this task in current grids already exist though they may be improved along at least four directions

- Number and density of metering devices
- Scalability, i.e., the ability to grow with the grid
- Rate of data acquisition
- Effectiveness of communication, meaning
    - Limited use of local hardware/power resources
    - Security

Each of the activities of this work package will aim at improving one or more of the above features and will be measured against the corresponding merit figures.

In particular, it can be envisioned that E2SG will develop techniques that allowing the deployment of extremely dense populations of almost autonomous smart meters able to report data concerning power flow and usage, as well as, on environmental characteristic both fixed and transient. This is something impossible with current technology.

Moreover, since this unprecedented massive data flow will need appropriate routing to nodes in charge of higher level policy making, the innovative communication and hierarchical aggregation techniques, as well as data security methods that will be developed, will allow a definite step forward in the deployment of a truly aware energy distribution network.

WP3- Grid Topology and Control

This work package aims to develop techniques and implement hardware demonstrators for estimating the state of electrical power distribution systems by means of the smallest possible number of measurements. The first task aims at tackling the problem from a theoretical point of view and build on the concept of complex networks mentioned in section 3.2. Mixed stochastic-topological indexes will be soughs which are able to (hopefully) easily identify the most critical nodes in the grids, even in relatively fast time-varying configuration. The task is certainly risky, but if successful, this idea could pave the way for a new approach to smart grid state measurement.

A second task will rely on the PMU designed in WP2 (implemented in WP4) and aims to study the possibility to control the short-term (within minutes) and medium-term (with an day or so) behaviour of a smart grid node as a function of the energy cost/availability (i.e. the node will be driven to operate at top performance only in the most convenient conditions). To do so the control problem will be turned into a suitable optimization problem, which will be solved comparing 2 different approached (MILP and Nash Equilibrium of Game Theory). The best performing one will be used in the final demonstrator of a PMU promised in WP4

The third task aims to implement a library of algorithmic elements that will compose the desired distributed application. This approach will be used in order to implement an agent-based control of the energy resources based on broadcasted price signals. It will be based on an high-level GUI and made used to simulated different smart grid control scenarios

The goal of the final task of the WP is to find a possible solution to the problem of use of all the energy storage resources available in the network with particular reference to those associated with the connection of electric vehicles (see section 3.2). The aim of the task is the development of advanced aggregation policies, which implement a kind of virtual power plant, in order to limit the impact of the connection of electric vehicles on the network and try to maximize the available distributed storage for load balancing and frequency regulation.

WP4- Integration and Demonstration

Many of the results in the research and development work packages will be demonstrated with close-to-real-world prototypes or simulations.

Though this is not an innovation per-se, it is a fundamental step in proving that the novel techniques originating in WP1, WP2 and WP4 can result in real products that will benefit both the industrial partners and their customers.

Hence, the activities of WP4 will add to the overall contribution of E2SG to innovation in the field of smart grids a plethora of verifiable and close-to-real proof-of-concepts from which industrial exploitation will follow straightforwardly.

5.4 Measure of Success

The E2SG project aims to deliver several demonstrators and silicon prototypes, most of which are expected to have a great impact on the marked (as described in the market analysis or in the description of the relative task). Despite the consortium will strive to successfully terminate very single task, we here report as measure of success only the most significant ones.

E2SG will be considered successful when:

1. Innovative high voltage (500-800V off-state breakdown values) and medium voltage (100V-200V off-state breakdown values) Si-switches have been implemented, with quality factor Ron*Qg<5400 mΩ.nC and Rdson* Qg<157 mΩ.nC;
2. Critical process on a 200mm substrate has been successfully developed;
3. An innovative AC/DC system controller with safe isolation from AC, 85-265 VAC to DC, (e.g. 12 V, 5 V, 3,5 V) has been implemented and successfully tested and is capable of operating till 10 kV or even 20 kV of voltage difference;
4. The specification for an innovative smart appliances control interface has been decided and the interface has been successfully implemented and tested;
5. A EV or PHV to grid interface has been developed and the algorithm for successfully exploit the electric vehicles batteries as additional storage devices have been tested

6. A prototype for DC powerline communication based on conversion ripple has been successfully implemented and test tested

To these point wise improvements to smart grid technology, E2SG adds other more global goals whose achievement will signify project success.

More specifically, E2SG will be considered successful when it will improve the grid infrastructure for metering, data collection and delivery along these directions

7. Definition of the techniques and methodologies that can lead to increase by at least a factor 2 the density of metering devices deployed on a grid with respect to current implementation. Higher densities are actually foreseeable.
8. Definition of the techniques and methodologies that can lead to increase by at least a factor 2 the number of sensor data that are reported to the policy making nodes, let them be local intragrid controllers or wide-area intergrid authorities.
9. Definition of the techniques and methodologies that can lead to a reduction of at least 30% of the resources (either in term of consumed power or cost additional hardware) needed for communication from and to smart metering modules.
10. Definition of the techniques and methodologies that allow secure communication between metering units and central nodes against all commonly considered attacks and failures.

5.5 Cooperation and interaction with other research activities

As it may be readily understood from what has been reported in Section 3.1 and 3.2, the SG scenario requires the active cooperation of many different players, ranging from researchers to utilities and from electrical, electronics, communication industry to standardization bodies. This is the reason why in the US, NIST has been put in charge of identifying a reference model for the definition of smart-grid concepts and challenges (published in September 2009 and finalized in January 2010) and to create (November 2009) the so-called Smart Grid Interoperability Panel (SGIP), a public-private partnership composed of organizations grouped into 22 stakeholder categories, including multiple kinds of utilities, power equipment manufacturers, standards development organizations, state and local regulators, R&D organizations and academia, and many others. The purpose of the SGIP is to unify the many Smart Grid stakeholders by bringing them together to develop consensus on the approaches to standardization and on the standards themselves. At the same time, and focusing on research, US have recently put extremely significant investments to fund projects in a new generation of energy distribution technology, resulting in a large boost of activity in this area.

Similarly, EC also recognized the use of ICT as a fundamental tool to achieve a significant reduction of greenhouse gas emissions and improvement in energy efficiency to reach the 20-20-20 goal. As such, significant resources were allocated in this research area both in the FP7, ENIAC and ARTEMIS frameworks.

As a result, several projects have already been proposed whose scopes are connected to those of E2SG. In this section we aim to comment on the degree of complementarities/overlapping with E2SG of the following projects which have been identified as the most related ones, namely:

1. ARTEMIS *Internet of Energy for Electric Mobility* (IoE);
2. ENIAC *Trusted Computing for European Embedded Systems* (TOISE)
3. ENIAC *Models, Solutions, Methods and Tools for Energy-Aware Design* (END)

ENIAC *Energy for a Green Society: from Sustainable Harvesting to Smart Distribution, Equipments, Materials, Design Solutions and their Applications* (ERG)

To this aim, let us refer to Figure 3.4.1 where the food-chain of a Smart Grid (i.e. the simplified version of the NIST model [1]) has been schematically represented and conceptually divided into 4 layers:

1. Layer A (L-A), which involves, on the one hand (L-A1), generation of energy from renewable sources, such as photovoltaic or wind plant, as well as development of new energy storage facilities, and, on the other hand (L-A2), structure and behavior of the power distribution grid;
2. Layer B (L-B), which involves circuits/systems (L-B1) for the load- and condition-independent renewable energy extraction, such as optimized switching power converter and related MPPT algorithms, as well as (L-B2) for the power grid status estimation and control, including development of smart meters and PMUs;
3. Layer C (L-C), which involves development of communication protocols and algorithms for assuring a bidirectional flow of data and control signals. This information flow may rely on the Internet or on more traditional and ad-hoc power-line communication paradigms, from/to the power grids and the load. Furthermore, L-C includes the development of security protocols, both at software and hardware level, to assure confidentiality of the transmitted information;
4. Layer D (L-D), which involves the development of models and protocols for optimizing timing and entity of the energy flow to the smart appliances.

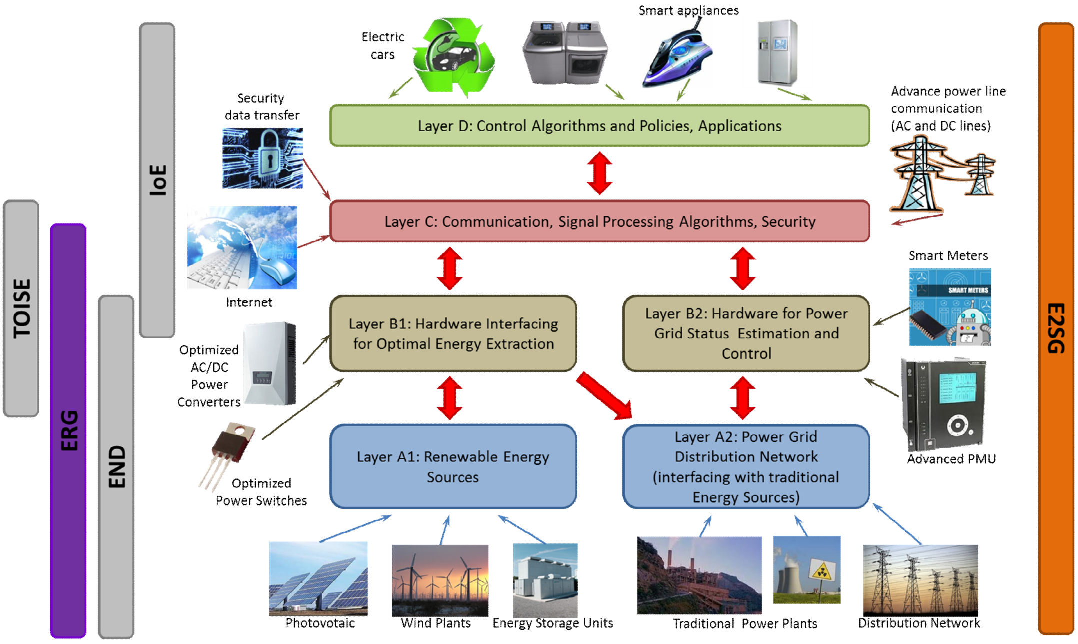


Figure 3.4.1. Positioning of E2SG and related projects with respect to the Smart Grid food-chain

In terms of scope, E2SG has a minimal degree of overlap both with IoE and TOISE, and a marginal one with END. In fact:

a. IoE targets the **middleware** of the Smart Grid food-chain (upper part of L-B2, as well as L-C and L-D) by aiming to combine the Internet and the power network/grid, to exploit the former to obtain a communication network operating in parallel with the electricity grid that distribute data between all elements of the new intelligent grid. The main focus is to develop application and embedded software for controlling the communication processes, for maintain the confidentiality of sensitive data, and for protecting the personal identification, to develop algorithms for achieving security against malicious attacks from intruders, to develop web based architectures for readily guaranteeing information delivery on demand, and to study innovative business models and energy services for accommodating the requirements of all stakeholders (from utilities to SMEs and corporations, research institutes and Public Authorities), so that everyone may have advantages in using energy in the most economically efficient way. On the other hand, only minimal attention is devoted to L-B2 related tasks, since to goals are simply to develop tamper resistant communication blocks and to write new communication software for PCL modems to be integrated in µControllers and FPGA modules;

b. The objective of TOISE is to define, develop and validate trust hardware and firmware mechanisms applicable to embedded devices and platforms in general; here the link to Smart Grids is the fact that they are one of the target applications for the demonstrators (the second one being wireless sensor network for environmental or industrial monitoring). As such, the main focus of TOISE is on the development of secure technologies, from physically unclonable functions to secure crypto-anchors operating at low power, and from secure memories with cryptographic storage, to hardware-software co-design of secure interconnect. As far as Smart Grids are concerned, TOISE targets mainly L-C and (partially) L-B2, i.e. it does not directly develop power-efficient hardware solutions, but targets energy networks guaranteeing secure information flow through software implementation of cryptographic techniques and use of the already developed general-purpose security primitives for guaranteeing privacy of smart meter communications;

c. END main goal is the development of innovative energy-aware design solutions and EDA technologies **of general validity** for next generations' nanoelectronics circuits and systems as the basis for new energy efficient products. Smart Grids are here addressed only in L-A1 and L-B1, since the project aims to design circuits and systems able to exploit heterogeneous energy sources (photovoltaics, vibrational, etc.) and storage devices (batteries, super-capacitors) mainly for autonomous electronic systems (L-A1); in addition, these design solutions are applied to solar energy management systems thought the design and silicon implementation of improved switching power converters (L-B1).

E2SG is, to the best of the knowledge of the consortium's partners, the only project which aims **to target at the same time several aspect of the entire Smart Grid food chain.** In fact, it focuses on the design, optimization and hardware implementation of several building blocks for future Smart Grids. Both L-B1 and L-B2 are targeted, since the project foresees, on the one hand, the implementation of two innovative power switches prototypes, as well as key building blocks for implementing high-efficiency, low-EMI improved inverters optimized for energy extraction from renewable sources thanks to the exploitation of advanced optimization techniques relying on the information on the state of the power energy grid. On the other hand (L-B2), E2SG partner will design and implement hardware prototypes of advanced PMUs and integrated tamper-resistant smart meters. As far as L-C is concerned, the main focus will be on innovative intragrid power-line communication on DC bus (complementing the IoE Internet-based approach) and in developing and implementing communication security algorithms specifically tailored for smart grids applications aiming to keep the resource consumption low and to minimize the impact on the performance of the authentication and communication processes. Layer D tasks target the development of demand-side management algorithms for controlling the behavior of smart appliances/grid nodes based on different decision policies and energy price broadcasting and well as the establishment of advanced energy storage policies to optimize the use of all resources available in the network with particular reference to those associated with the connection of electric vehicles. Finally, E2SG is the only projects which targets also LA-2 by proposing innovative techniques based on advanced mixed statistical and topological indexes allowing to easily identifying, in real time and in presences of time-varying renewable generators and variable smart loads, critical aspects of the power energy grid, i.e., importance of a generation or conversion node, or tendency to islanding.

In a nutshell, with respect to IoE, TOISE and END, E2SG mainly:

1. Focus on hardware/silicon prototypes for smart-grids building blocks, complementing, on the one hand, END which targets the analysis and simulation of innovative devices for renewable Energy Sources and the development of innovative energy aware design techniques and EDA, and, on the other hand, complementing IoE which targets integration at middleware level of Internet and the energy grid;
2. Deals with security issues by developing optimized solution for smart-grids nodes (such as smart meters), complementing the general-purpose security primitives developed in TOISE;
3. Target within the same project different aspects of all Layers of a Smart Grid, which allows to obtain for the deliverable associated to several tasks (such as the determination of optimal management policies for loads and renewable energy sources), a cross-layer optimization between tasks related to Intergrid and Intragrid environments in a similar way with respect to what is now common practice in communication networks.

E2SG and ERG share several complementary aspects; as such the analysis of the scope of the latter deserves more attention, to show how E2SG actually aims to build on and complement the results achievable by it. ERG targets SGs through its aim to enhance the solar energy value-chain by means of a more efficient energy management from high performance PV cells to power conversion and intelligent drive control and interface to smart-grid. As such (see in Figure 3.4.2) ERG targets L-B1 (efficient power conversion by means of suitably designed switching power converter with optimized MPPT algorithms and efficient power switches), L-A1 (by modeling innovative Photovoltaic devices) and, even if more marginally, also L-C (in the implementation of wireless sensor networks, which are only loosely related to the smart grid application). As it can be seen from Figure 3.4.2 in comparison with ERG, E2SG:

- covers much more thoroughly all the layers of the SG model (L-A2, L-B2, L-D and most of L-C)
- does not present overlap in L-A1, since it does not aim to study innovative renewable energy sources
- presents some overlap in L-B1

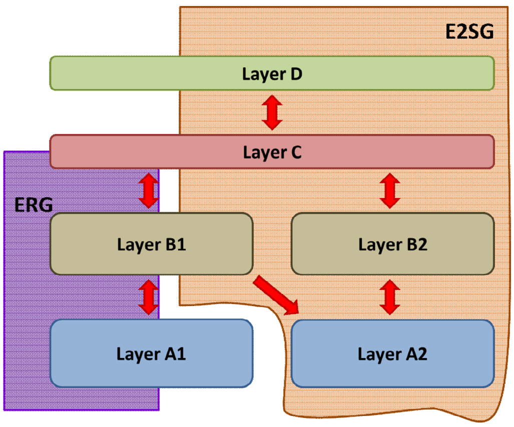


Figure 3.4.1. Comparison between the positioning of E2SG and ERG projects

Yet, we wish to stress that, for the latter point, extreme care has been paid to coordinate the efforts between E2SG and ERG **to both specifically avoid any duplication of activities and, whenever possible, to build on ERG (planned) results**. For instance, one of the activities of ONSEMI both in ERG and E2SG is the design and implementation of innovative, highly efficient power switches. In ERG the device is a split-gate XtreMOS 100V discrete power MOSFET with variants in the 60-80V regime, while in E2SG two new Power MOSFETs will be developed:

1. one based on a derivative idea of what will be developed in ERG, since: it will be a shrink cell layout version, it will have an integrated capacitor, resistor and Schotky diode, it will have variation in the 150-200V regime and it will have a total new concept for hard mask and trench fill. Furthermore the final device will be a semi-super-junction Power MOSFET
2. one based on an high voltage super junction device in the 500-800V range.

Something similar will happen for the activity of UNICT which, in ERG will be in charge to **design** a low-EMI DC/DC converter, while in E2SG it will **implement** and measure the EMI filter for it, in cooperation with IUNET which will support the activity with its experience in signal-processing-based methods for improving EMC in switching power converters.

Finally, it is worth stressing that the presence of partners of E2SG in all project mentioned above in this section, will ensure good knowledge transfer between the projects, exploiting synergy to achieve cross-fertilization of results and harmonization of possible standards developed with any of them.

6 SCIENTIFIC & TECHNICAL APPROACH AND ASSOCIATED WORK PLAN

6.1 Overall strategy and general description

The work in E2SG is organized in 4 Work Packages (WP) and it also includes two service WPs, which are not shown in the Gantt chart and which cover the activities of Management and IPR (WPM1) and Dissemination, Exploitation and Standardisation (WPM2). Interesting enough the 4 technical WPs are coordinated either by Semiconductor Industries, namely ONSEMI (B), IFAG (D), PHILIPS (NL) or by Electricity utilities, namely HERA (I)

6.1.1 WP1: Smart Conversion [WP Leader: ONSEMI]

Work package WP1 aims at providing innovative contributions for the improvement of the performances and the flexibility of the interface between the network and energy sources, storage systems and customers appliances. The interface is in general provided by power electronic converters, the characteristic of which are expected to be significantly improved by high-performance silicon semiconductor devices. The expected results are therefore the development of Si devices characterized by improved parameters with respect to the present best-in-class ones, the development of improved control and communication means, and the specification of standard interfaces.

6.1.2 WP2: Grid sensing, metering and communication [WP Leader: IFAG]

Work package WP2 aims at providing innovative contributions for both the hardware to be applied in communication systems and communication schemes. The hardware activities are focused on the development of low-cost low-power small-volume smart meters with different communications interfaces and on the development of phasor measurement units (PMUs) with performances adequate to provide useful information also when applied to distribution network characterized by low value of power transfers. The results are expected to improve both the energy usage in customer installations (with particular reference to residential buildings) and the flexible and resilient operation of low voltage and medium voltage distribution networks, topic specifically addressed in work package WP3.

6.1.3 WP3: Grid topology and control [WP Leader: HERA]

Work package WP3 aims at providing innovative contributions of the management/control of power of distribution systems. The effort is devoted to bring distribution systems to operate more closely to smart grid requirements, although distribution systems are characterized by some peculiar design configurations (e.g. radial configuration) that impose severe limitations to the control of power flows. This is expected to be obtained by the development of state estimation procedures based on the distributed information made available by smart meters and PMUs, the development of improved optimization procedures and the definition of distributed control strategies. In this framework, the adequate management of available energy storage resources, i.e. those related to the use of electrical vehicles, appears to be crucial with particular reference to the exploitation of renewable resources and the operation of the network in islanded mode (i.e. also in the presence of high voltage transmission network blackouts).

6.1.4 WP4: Integration and demonstrations [WP Leader: PHILIPS]

Work package WP4 aims at providing adequate demonstrating environments both for the applications devoted to customers' installations and for the tools and devices developed to improve the operation of the utility distribution systems. several prototyped will be tested: a prototype of inverter for sinusoid synthesis, prototype of ripple-based powerline communication system, prototypes of distributed meters with wireless interfaces and measurements, prototype electric vehicle-to-grid (V2G) interfaces, prototype of building-level control with subsystems, prototype power drivers with new SOI technology, prototype interface between the grid and solar panels, and monolithic controller for solar applications. Moreover an adequate simulation environment will be used to test the use of PMU applied to a real distribution grid configuration, the analysis of the performance of network operation monitoring by means of topological indexes, the simulation of network operation optimized by means of mixed-integer linear programming and a game theory approach, the test of storage optimizing policies.

6.2 WPM2 Management and IPR - Monitoring of the project progress

Since in E2SG several aspects and not only one individual chain in the smart grid and the interfaces to it are under investigation, general reports beside the milestones and deliverables are consolidated.

They are targeted to be available on a yearly basis. The objective is twofold: First to have an overall picture regarding the project, second to secure the transfer of the results from WP1-WP3 to WP4 (Integration and demonstrations). With this approach delays will get obvious and mitigation activities can be implemented.

WP1: Smart Conversion

"…improvement of the performances and the flexibility of the interface between the network and energy sources, storage systems and customers appliances..."

- Si devices characterized by improved parameters
  - Task 1.1: Development of power efficient Si-based switches
- improved control and communication means
  - Task 1.2: Optimal interfacing of energy generating nodes with synchronous AC grid
  - Task 1.3: Intelligent interfaces from customers to smart grid for reducing energy consumption
- specification of standard interfaces.
  - Covered in Task 1.2 and 1.3

Yearly reporting part for WP1 – Task 1.1, 1.2 & 1.3:

- Month 12: short consolidated report on the requirements analysis and first specifications for smart conversion
- Month 24: short consolidated report on concepts and first results for smart conversion

WP2: Grid sensing, metering and communication

" ... low-cost low-power small-volume smart meters with different communications interfaces and the development of phasor measurement units (PMUs) with performances adequate to provide useful information also when applied to distribution network characterized by low value of power transfers..."

- Smart meters
  - T2.1 Advanced network monitoring by means of phasor measurement units (PMU)
  - T2.2 Smart meters design and implementation
  - T2.3 Smart meter integration

- Communication
  - T2.4 Subgrid powerline communication exploiting conversion ripple
  - T2.5 Design and implementation of an architecture for hierarchical data collection, storage, management
  - T2.6 Secure data exchange between grids and consumers

Yearly reporting part for WP2 – Task 2.1, 2.2 & 2.3:

- Month 12: short consolidated report on the requirements analysis and first specifications for the smart metering and sensing segment
- Month 24: short consolidated report on concepts and first results for the smart metering and sensing segment

Yearly reporting part for WP2 – Task 2.2, 2.3 & 2.4:

- Month 12: short consolidated report on the requirements analysis and first specifications for the communication segment
- Month 24: short consolidated report on concepts and first results of the communication segment

WP3: Grid topology and control

"…innovative contributions of the management/control of power of distribution systems..."

- Control and algorithms
  - Task 3.1: Mixed stochastic-topological indexes and state estimation
  - Task 3.2: Optimized control of smart grid nodes
- Mangement of sources
  - Task 3.3: Framework for fast deployment of distributed application
  - Task 3.4: Advanced storage management policies
- specification of standard interfaces.
  - Covered in Task 1.2 and 1.3

Yearly reporting part for WP3 – Task 3.1, 3.2, 3.3 & 3.4:

- Month 12: short consolidated report on the requirements analysis and first specifications for the grid topology and control
- Month 24: short consolidated report on concepts and first results for the grid topology and control

WP4: Integration and Demonstration

"…adequate demonstrating environments both for the applications devoted to customers' installations and for the tools and devices developed to improve the operation of the utility distribution systems..."

- Implementation of E2SG building blocks and mechanisms
- Integration of E2SG building blocks and mechanisms into the demonstrating environments
- Testing and measurements of E2SG technology in realistic scenarios

At the beginning of the third project year the grade of readiness will be evaluated and in case of deviations from the plan mitigation activities for a successful integration will be started.

6.3 Work package description

WORK PACKAGE NUMBER AND TITLE	
1	**Smart Conversion**

WORK PACKAGE PARTNERS
ONSEMI (B), ST (I), CRF (I), FGE (I), IUNET (I), UNICAL(I), UNICT(I), POLITO(I), AMS (A), IFX (D), INSTA (D), NXP-D (D), TEL (D), FHG (D), LEITAT (ES), HELIOX (NL), NXP-NL (NL), PHILIPS (NL), STUBA (SK), RDAS (SK), IQE (UK), SIL (UK).

DESCRIPTION OF WORK

General objectives

The objectives of this work package are threefold:

1: Optimal power transfer to the grid from innovative devices or systems;

2: Optimal interfacing of energy generating nodes with synchronous AC grids;

3: Intelligent interfaces from customers to smart grid for reducing energy consumption;

1. Optimal power transfer to the grid from innovative devices or systems:

Environment friendly energy sources cannot be directly connected to the power grid. Therefore, suitably designed switching power converters which not only modify the raw electrical power into usable one, but which can also maximize its extraction, are required.

The objective is here to improve the overall performance of power converters for smart grids and renewable energy applications from a broader point of view by focusing on several indicators such as reliability, total system cost, power density (converter size), and thermal behaviour.

More specifically we will tackle this issue by:

a) increasing the performance and improving the characteristics of Si-based switching devices and optimization of the device parameter towards the specific end application;

b) optimizing the design parameters of the devices and the target circuit simultaneously;

c) Investigating how power electronic converters for these target applications benefit at most from high-performance silicon semiconductor devices.

2. Optimal interfacing of energy generating nodes with synchronous AC grids:

One of the biggest challenges on a smart grid including local micro generation of energy via renewable sources is that the supply must meet demand on a very short timescale. In this context, both the voltage and frequency must be maintained on the grid. Failure to maintain the frequency to within +/-0.05Hz will lead to automatic control actions, while larger fluctuations will bring power outages. In this particular context, we can exploit our non-negligible experience in the synthesis of waveforms by means of switching systems and pair it to properly designed feedback to devise the algorithms and the systems needed to accurately track and adapt to the common phase of the grid accepting the power. This can be tempted both in a single-phase and in a multiple-phase setting with the additional aim of drastically reducing the size of the reactive components needed to filter the output the inverters as well as that of input capacitors that, in high power environments, are responsible of serious dissipation and reliability issues. The key idea here is to translate the waveform generation problem into a quadratic optimization problem with integral constraints and exploit a mixture of greedy, heuristic and exact algorithms to solve them in pure form or when additional application-specific requirements are posed.

3. Intelligent interfaces from customers to smart grid for reducing energy consumption:

Future energy consuming devices must be able to adapt to smart grids in a most flexible way and enable smart resource allocation. Therefore intelligent interface solutions are recommended in order to take over commands from other intergrid nodes and to react by energy reduction in critical phases — wherever possible.

Studies will be made on power saving strategies, which will cover also intermediate power storage options and intelligent data networks interfaces with low-energy consumption. The developed strategies will be exploited for defining the interface between power grids and intelligent power supplies for consumer and industrial applications. Another target is to develop a model-driven control system of an intragrid, which will be able to analyze energy and power balance by considering the dynamic cost relationship between different sources and smart appliances.

Objectives by partner

ONSEMI (B) will work on the 1st objective and will focus on the following tasks:

- development of Si-based switching devices with optimized device parameters for the specific end application (High voltage and Medium voltage);
- determination of the design parameters of the devices and of the target circuit simultaneously;
- investigation on how switching power converters designed for the above mentioned target applications benefit the most from high performance silicon semiconductor devices.
- Investigation on the possibility to develop the most critical process modules for 200mm production.

ST (I) will work on the 1st objective by developing, implementing and testing several Si-based switching devices with optimized parameters towards for specific application. More specifically, both very low voltage and HV power MOSFETs will be targeted. As far as the testing part is concerned, ST will realize neutron tests on HV power MOSFETs, implementing in situ measurements and evaluations, and reporting on the results. Furthermore, it will design a system architecture (with demonstrator) of an automatic test equipment for power transistors.

CRF (I) will work on the 3rd objective and will cover the design of the interfaces from electric vehicles to the grid, i.e. on-board battery charging units and battery management systems taking care of the power and the digital control board design, the development and the implementation of the mechanical enclosures, and the first functional tests. This will benefit from the technologies developed in WP1 in particular by IFX and NXP-D (power components) and by the technologies developed by ST in WP2 (communication chipsets) and will take care of the existing and the forthcoming standards ISO/IEC in particular for the automotive qualification, the power quality standards and the safety issues.

FGE (I) will work on the 3rd objective and will deal in particular with the setup and the demonstration/prototyping of the devices (battery charger and battery management system) developed by CRF by exploiting advanced, highly-automated, electronic devices assembling techniques.

IUNET (I) will work on the 2nd objective and will cover the optimization-based synthesis of sinusoidal waveforms by means of switching signals. These waveforms are needed to drive the inverters that are the core devices in the power interface between generators and the grid. In cooperation with UNICT, IUNET will also try to pair its knowledge of random modulation for EMI reduction with the accurate design of the EMI filters.

POLITO (I) will work on the 3rd objective and will contribute to the analysis and study of power saving strategies covering intelligent data networks interfaces with low-energy consumption.

UNICAL (I) will work on the 1st objective and more specifically on the modeling and implementation of simulation tools for Si-based switching devices, and in the development of efficient optimization tools. Moreover it will investigate robust methods to address signal synchronization problems arising in grid voltages and currents.

UNICT (I) will work on the 2nd objective and more specifically in the definition of power converters EMI/EMC specifications and in the design of the EMI filters.

AMS (A) will work on the 3rd objective and will develop and provide a smart power technology which is fundamental in the design and implementation of circuits/systems capable of ensuring a safe and reliable transfer of information between domains of the smart grid characterized by very different electric potentials.

IFX (D) will work on the 3rd objective by developing a cost efficient, high data rate capable AC/DC system controller with safe isolation.

INSTA (D) will work on the 2nd objective by contributing to the development to a communication systems to transfer control and measurement signals from/to Photovoltaic modules.

NXP-D (D) will work on the 3rd objective by defining intelligent interfaces from customers to smart grid for reducing energy consumption and with particular emphasis to security and privacy.

TEL (D) will work on the 3rd objective and will provide intelligent driver solutions for interfacing to Smart Grids. For this purpose TEL will bring in a SmartPower SOI technology for high energy efficiency systems, with very low standby losses. The technology is tailored for intelligent power supplies in several applications. For high voltage applications a 700V technology will be available. This technology is actually being developed in the ENIAC project SmartPM and will be re-used here. The technology will be available for project partner RWTH with related design tasks and TEL will offer a MPW (Multi Project Wafer) service also for other concerned partners.

FHG (D) will work on the 2^{nd} and 3rd objective and more specifically:

- on reducing EMI filter volume and improving efficiency for a bidirectional AC/DC converter
- on the development of an integrated energy management system by using information from different communication devices

LEITAT (ES) will work on the 2nd objective by contributing to design and simulate new MPPT (Maximum Power Point Tracking) algorithms.

HELIOX (NL) will work on the 1st objective by investigating the optimal power architecture and topology of a single solar panel Smart Grid coupled inverter with safe mains isolation. This type of setup can improve the energy harvest from a solar panel from 20% to 30%. Next to that, Heliox will investigate the optimum topology and power architecture for a Smart Grid compatible bidirectional Electric Vehicle charger with safe mains isolation. Both investigations will serve as a starting point for demonstrators in WP4.

NXP (NL) will work on the 3rd objective by contributing to the creation of optimal supply architectures for low-power, always-on, grid-connected devices like environment sensors and intelligent light sources.

PHILIPS (NL) will work on the 3rd objective and will contribute to establish the specification for, and to the design of intelligent interfaces from customers to smart grid for optimizing energy usage. This work will be preliminary for the final demonstration of reduction of energy consumption in WP4

STUBA (SK) will work on the 1st objective. More specifically:

- on the design and development of smart power devices and advanced semiconductor structures;
- on the electrical and optical characterization and measurement of the developed power devices and components;
- on the optimization of the characteristics and the parameters of semiconductor devices for improving power converters performance when they are employed for energy transfer from renewable sources.

RDAS (SK) will work on the 3rd objective and will contribute to develop intelligent solutions for smart appliances interface within the “intragrid”. For this purpose, a low-power wireless transceiver will be developed in targeting a standard low cost technology.

IQE (UK) will contribute towards objective 1 and 3, by:

- Providing technical and processing know-how on developing thick and selective epi on 200mm substrates
- Developing energy harvesting PV components for the intragrid smart home applications

SIL (UK) will contribute towards objective 1 by providing his paramount competence in compact modeling of devices and TCAD simulation.

TASK LIST	
T1.1	**Development of power efficient Si-based switches** Leader: ONSEMI Participants: UNICAL, HELIOX, STUBA, IQE, SIL, ST The task is divided into the following sub-tasks:
T1.1.a	**Development of Medium voltage Si-devices** (ONSEMI, UNICAL, STUBA, SIL) The target for this activity is to simulate, develop, process and characterize medium voltage silicon-based devices (in the range of 100V-200V off-state breakdown values) with best-in-class parameters (such as Rdson, gate charge, reverse recovery, operating temperature range) for use in applications in the smart grids and sustainable energy conversion. The best-in-class parameters for a device with minimum 110V off-state breakdown are Rdson=37 mΩ.mm2, Qgd=1.3 nC/ mm2, FOM (figure of merit) Rdson* Qg=157 mΩ.nC. While the on-state resistance determines mainly the efficiency loss at high load currents in voltage converters, the gate charge determines the switching losses at light loads. It is hence important to reduce both at the same time (i.e. to reduce the above FOM). Changing only the area will result in opposite behavior for both parameters, and impacts cost directly. The overall aim is to improve substantially the efficiency of medium- and high-voltage

	applications The focal points of this activity will be: 1) Substantial improvement of the current device parameters like Rdson, gate charge Qg, reverse recovery charge Qrr and body diode forward voltage Vf. This will require considerable process changes, or possibly an architecture change. 2) Bringing part of the application circuit on-chip, by integrating a Schottky-diode and a trench capacitor. This is equivalent to use typical snubber circuits in the application, but without the associated external parasitic elements, which cause power losses. This is typically done in integrated, low-power, low-voltage technologies, and recently in some low-voltage power discrete devices, but has not yet been done in the medium voltage range. 3) Development of a related device with higher off-state breakdown (up to 200V) and still competitive Rdson. It will be investigated whether a pure trench (field-plate) approach or a combined approach with the super-junction principle is appropriate for the targeted applications. ONSEMI will work on the device performance optimization by shrink/cellular layout performing also TCAD mixed mode simulations, while UNICAL will work on accurate device numerical simulations. Finally ONSEMI will work on the integration of Schottky diode and trench capacitor and on the d Development of novel XtreMOS-based transistors with higher breakdown voltage STUBA will assist in the electrical and optical characterization and measurements of the developed power devices and components. The main goal will be to optimize characteristics and parameters of semiconductor devices for power converters performance improvement, when employed for renewable energy extraction. SIL will exploit his competence in compact modeling and TCAD simulations to assist in the device performance optimization phase.
T1.1.b	**Development of High Voltage Si-devices** (ONSEMI, UNICAL, STUBA, SIL) The objective of this activity is to simulate, develop, process, characterize and optimize novel silicon-based devices for high voltage applications (off-state breakdown voltage in excess of 600V). Optimization will be done to achieve maximum power conversion efficiency, with emphasis on applications in the smart grids and sustainable energy conversion. The focus of this activity is on: 1) the area-efficiency by development of a new trench-based termination structure in combination with dry dicing 2) the optimization of the device prime transistor characteristics aiming to obtain maximum performance in circuits for renewable energy conversion, including reduction in conduction losses (gate design), switching losses (shrink) and different voltage rating 3) the reliability improvement so the devices can be operated at higher ambient temperature, resulting in less cooling and a lower system cost 4) the improvement of the avalanche capabilities and overall robustness of both the active cell and the termination, so less protection circuitry is required 5) the co-integration of a Schottky diode 6) the realization of a test-chip layout, as well as the processing and characterization of the devices All activities will be performed by ONSEMI with the cooperation of UNICAL for what mentioned in point 2). The activity of STUBA and SIL will be similar to T1.1.a The tangible objectives are: - concept stretch (500-800V): Shrink for Ron (<18 mΩ.cm2); Novel gate arch (Qg<300 nC/cm2); Ron*Qg<5400 mΩ.nC - Vth tuned for optimum Ron*Qg

	- Eas > 700 mJ, CB imbalance - reliability testing till 150°C - trench termination: Floating SJ trenches and Dry dicing through a SJ trench - component optimized for energy efficiency
T1.1.c	**Circuit optimization and design space exploration** (ONSEMI, UNICAL, SIL) Whereas T1.1.a and T1.1.b focus on the device itself and on the optimization of its design parameters, the goal of this activity is to explore the potential of these devices on the circuit and application level, with emphasis on the domain of renewable energy. We will investigate how power electronic converters for this specific application can benefit from higher-performance devices, and how the circuit can be optimized to achieve maximum system-level performance. The general approach and the phases in which this activity can be broken down can be summarized as follows. 1) Device characterization: the behaviour of the devices is modelled, using manufacturer data as well as measurement results. Test circuits are developed to characterize and compare different components. The characterization results serve as an input for the next phase. 2) Determination of the device potential: It is investigated which target applications and converter topologies benefit the most from high-performance switching devices. 3) Design space exploration and optimization: based on the applications and topologies identified in phase 2), and the device data from phase 1) above, the converter design parameters and the device design parameters are optimized to achieve maximum performance (multi-objective). Particular emphasis is on the interaction between the device and its surrounding components. 4) Test circuits and experimental validation: a practical converter circuit is developed to validate the optimization process of phase 3) above. Whereas the test circuits from the above phase 1) aim to facilitate the measurements and the characterization of the device itself, now the emphasis is on the circuit-level and the exploration of the design space (with variable parameters). All activities will be performed by ONSEMI with the cooperation of UNICAL for what mentioned in phase 3). STUBA and SIL will mainly assist in the optimization of the characteristics and parameters of semiconductor devices for power converters performance improvement.
T1.1.d	**Development of critical processes on 200mm substrates** (ONSEMI, IQE) The first important challenge in this activity is to develop the base layer epi-depositions for both the MV and HV device on 200mm substrates in narrow deep trenches. For the MV device, a dual layer epi is required, with very tight control on the thickness and the doping concentration of both layers. This tight control is required to guarantee the electrical device performance. E.g. the thickness control needs to be better than 5%. The control on doping concentrations needs to be in the 10% range level. Doing this on 200mm will be a challenge. For the HV device, very thick intrinsic epi depositions are required on a highly doped N++ substrate. The required thickness of this intrinsic epi is in the 45 to 55µm range, which is outside the typical epi-thickness range. Linked with T1.1.c, with aim to study also more complex epi-stacks, which contain layers embedded in the epi-stack that can act as stop layers for trench etch. Note that these stop-layers should not have an impact on the electrical behaviour of the MV or HV devices. This approach would result in much more uniform trench etch depths, and hence in tighter electrical distributions on mainly Breakdown and Specific On Resistance.

A second important challenge is the development of trench etch development on 200mm substrates. In fact, both the MV and HV Si4SG device have as important feature a trench in the core of the device, since, in both cases, the characteristics of the trench (depth, profile) have an important impact on the electrical characteristics of the device.

For the MV device, the sidewall roughness after the 1st trench etch is very critical: it should be very smooth, since a critical gate oxide will be grown on this vertical plasma etched surface. Currently on the 150mm toolset, we are using process with a SF6/O2 gas mix to obtain the required surface smoothness. There is no simple formula on how to translate a trench etch recipe on a 150mm process equipment to a trench etch recipe on a 200mm tool. Especially the larger wafer surface will lead to more variation over a wafer, and will necessitate significant process developments. This within wafer variation will need to be brought to the same level on 200 mm as we currently have on 150mm.

Since the MV device is built in a trench, and since the density of these trenches is high, one can have the equivalent of ±60% of the wafer-area that will become a gate-oxide area. All of this area needs to be of gate oxide quality. For integrated technologies, the gate oxide area is typically in the order of a few % of the total wafer-surface.

The profile and depth after the 2nd trench etch for the MV device are also critical for the device performance: the profile should be vertical all over the wafer to guarantee the electrical performance of the transistor. For the HV device, the trench profile should be slightly tapered (±89.5 degrees), and go ±50µm deep.

This excessive polymer formation during trench etch can clog the pumplines which can cause the pump to abort. These polymers can also flake off during the etch process, causing particle issues or incomplete trench etch on the place where the flake drops on the wafer.

Since on 200mm, increased gas flows and power settings of the etch process to accommodate for the larger amount of Si to be etched, will cause high risk for more polymer contamination issues in the chamber. Hence, a process that keeps a good balance between physical characteristics of the trenches and limiting excessive polymer formation in the chamber and the pumplines, will be developed.

Next we will deal with in trench selective Epi depositions for HV device. In the past we have experienced issues that needed to be solved by both process and hardware developments on the epi-deposition system for epi deposition in narrow deep trenches. Since we are unique in the world with our implementation of a super-junction with local charge balance in a trench, requiring selective epi-depositions with very good control in a 50µm deep trench, we cannot rely on experience at the side of equipment vendors nor on publications by research institutes or competition.

The quartz chambers that are typically used in epi-systems are larger for 200mm wafers, so one can expect issues with:

a) Increased mechanical stress on the larger chamber parts. This could result in cracks in the quartz during the harsh processing conditions.

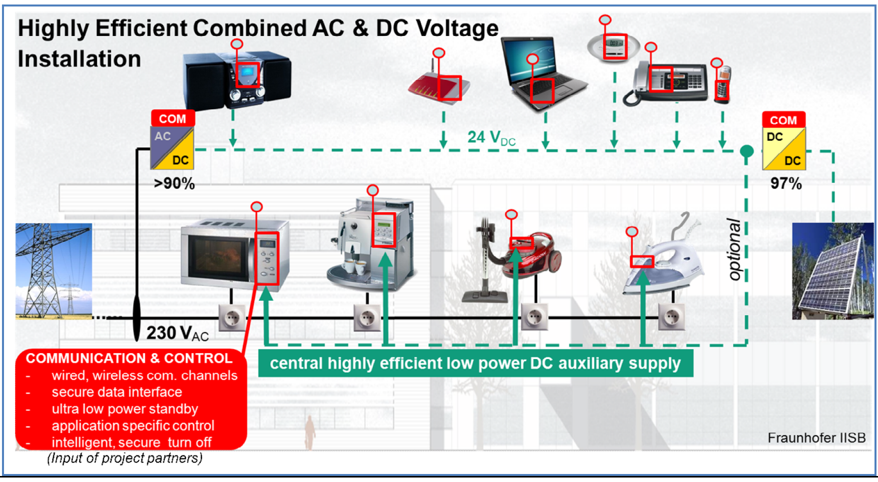
b) Larger volume needs to be pumped when going from atmospheric conditions to reduced pressure.

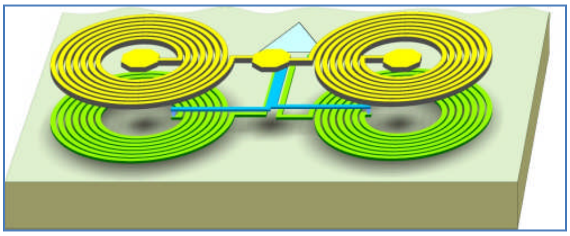
During selective epi-depositions, non-uniformity problems at the edge of the wafer arise due to global loading effects when transitioning from the susceptor (which is flat and has 100% area to be coated) to the wafer (which has trenches and has basically 600% are to be coated with selective epi). We will do basic process developments to minimize this effect from the process side. We also propose to do hardware modifications to the susceptor.

	Finally we will focus on the development of advanced measurement capabilities for in trench process development. More specifically, we plan to develop in fab methodologies for improved measurement of the critical parameters of trench etch and epi deposition processes inside trenches. With the latter we mainly aim at improved measurement capability of deposition processes inside trenches. There are no readily available tools and methods which provide the capability of measuring thickness and doping concentrations of layers that are deposited in trenches. We plan to do basic research into developing such methodologies. We see this as needed for 200mm developments, since these in trench parameters (layer thickness and doping levels) will now need to be guaranteed over a larger wafer-surface. All activities will be performed by ONSEMI, while IQE will assist in all phases by providing its vast experience in processing 200mm epitaxy in large commercial quantities.
T1.1.e	**Optimal, Smart Grid compatible power architectures for a single coupled solar panel inverter and a bidirectional Electric Vehicle charger** (Heliox) Providing individual solar panels with their individual inverter can eliminate the so called “shadow effect” of string arranged panels for a large part. This can increase the energy harvest from 20% up to 30%. To be turned into a product suitable for field applications, such an inverter should not only be small, efficient and cost effective, but also have an expected lifetime of 25 years whilst being operated in a hostile outside environment behind the solar panel. Providing mains isolation in the inverter will largely increase installation easiness and overall system safety. Compatibility with Smart Grid will bring control over the delivered energy. Regrettably inverters with these features don’t exist at the moment. This investigation will yield the optimal power architecture for an inverter fulfilling the above mentioned requirements, and as such serve as a starting point for the realisation of a demonstrator in WP4. The second part of this activity will deal with large scale coupling to the grid of Electric Vehicle battery packs, will not only pose additional requirements on the grid load, but if controlled by Smart Grid, also the possibility of (large scale) energy storage and eventually energy feedback to the grid. As such a bidirectional battery pack charger that is low weight, mains isolated, cost effective, reliable in “under the hood” operating conditions and compatible to Smart Grid is required. Regrettably, these types of converters are nowadays not available. This activity will produce the optimal architecture and topology for such a converter and is a starting point for the realisation of a demonstrator in WP4
T1.1.f	**Development of very low voltage Si-devices** (ST, SIL) The target for this task is to simulate, develop, process and characterize very low voltage silicon-based devices (in the range of 20V-40V off-state breakdown values) with best-in-class parameters (such as Rdson, gate charge,etc.) which will be specifically targeted for smart grid and renewable energy conversion applications, with specific focus to local intergrids. The main target is twofold. On the one hand, we wish to improve the value of the on-resistance (Rdson) by reducing both active and non-active resistive components, which will require considerable process changes, both in the front-end and in the back-end. On the other hand, we want to improve the Gate charge (Qg), which will require an architecture change. ST with the assistance of SIL will perform TCAD process, device and mixed mode simulations which will be the basis for the development of new very low voltage Si-devices with improved FOM (Rdson*Qg). Such devices will then be fully characterized.
T1.1.g	**Advanced testing methods for power MOSFETs for Smart Grid applications** (ST)

	The objective of this activity is twofold. The first one is to implement neutron tests on high voltage power MOSFET devices to evaluate the hardiness technology having in mind its usage in PV applications. In more details, we will focus on a specific MOSFET random failure mode generated by Single Event Burnout (SEB) due to inadequate voltage de-rating of the MOSFET. When the MOSFET is stressed at room temperature to an applied voltage that is close to the real breakdown, some of the devices under stress could have random failures. Furthermore, closer the applied voltage to the breakdown, higher the probability to get failures. SEB as well Single Event Gate Rupture (SEGR) were first documented in Space applications and Avionics, and the related mechanisms are certainly not fully understood in the terrestrial electronics. According to some studies, a certain amount of sea level failures for MOSFETs (as well other high voltage switches) can be attributed to SEB and SEGR. According to previous research, failures were found to fall to zero when the tests were performed 500 feet underground in a salt mine, thus suggesting the most probable cause to be cosmic particles or even more likely, neutrons (that cannot be present in the salt mine). According to the above hypothesis SEB in a MOSFET occurs when heavy ions or neutrons accidentally strike the parasitic bipolar transistor region of the MOSFET. Random failure mechanism specified for MOSFETs as a function of applied voltage stress are not explained by industry standard Arrhenius based models. Arrhenius model, used to predict reliability of power MOSFETs assume, in fact, that failure mechanisms that lead to random failure become worse with increasing temperature while MOSFETs tested at Room Temperature Reverse Bias (RTRB) shows higher failure rate than same devices tested at High Temperature Reverse Bias (HTRB). Furthermore, actual RTRB tests are really stressful for the power MOSFET structure and produce failures INDIPENDENT of technology and Semiconductor Vendor. Devices selection will be done by selecting several key parameters that could have an impact on “SEB ruggedness” (e.g. BVDSS, die size, planar/SuperJunction technology, Fast diode MOSFETs). Scope of the study will be to analyze the failure mode, introduce a theoretical model of the statistic of the failures and evaluate the impact of the failure versus different technologies and breakdown voltage. The second goal of this activity is to realize a fully integrated and automated test procedure. More specifically, we will focus on the study of the study of the power transistors reliability during the HTRB (High Temperature Reverse Bias) test. Normally, this test is performed inserting several devices on a suitable board fed by voltage generators. The test is performed for a duration of 168h without any control. Before and after the tests, main electrical device parameters are measured in order to evaluate the performances degradation of the power transistors. It often happens that, during the 168h of test, inside the thermal camera one or more devices fails, which causes to stop the test performed for the whole evaluated samples set. Therefore, test needs to be restarted from scratch for the rest of the samples. Additionally, it is impossible to evaluate the main reason which caused the device failure, due to the explosion of the package. The scope of this study is to implement a new approach to HTRB testing by realizing a new full automated board where the main parameters of the devices are measured before, during and after the tests in order to analyze the causes of failure, and where data is collected in a txt file each time in which measures are performed.
T1.2	**Optimal interfacing of energy generating nodes with synchronous AC grid** Leader: to be defined during phase to kick-off Participants: IUNET, UNICT, INSTA, FHG, LEITAT, IQE The task is divided into the following sub-tasks:
T1.2.a	**Low-cost communication systems for power monitoring** (INSTA, IQE)

	For monitoring the power generated by individual PV modules data has to be sent to a central node, e.g. to the inverter or a power monitoring unit. INSTA will investigate and contribute a simple, but nevertheless robust and economic approach for a communication system that uses the solar cable rather than wireless connections or additional wires. IQE will perform research in the determination of design concepts for enhanced energy management in CPV solar cell receivers. This will involve thermal management design optimization for cell operating temperature control in conjunction with integrating power and temperature sensing functionality that will be exploited also in WP2. The main goal will be to develop solar cell receivers with improved temperature stability to maximize efficiency and power generator lifetime. The receiver can be used as a test site for the communication system being developed by INSTA
T1.2.b	**Switching synthesis of sinusoidal waveform** (IUNET) The synthesis of sinusoidal waveform by means on switching signals that can be easily implemented by means of inverters can be recast in terms of a filtered-approximation problem, for which both standard signal-processing solutions and innovative mixed-integer optimization based methods will be explored. By means of these approach, it will be possible to pre-compute a set of binary strings encoding the inverter control signals that result in extremely accurate sinusoids for different, finely discretized, phases and amplitudes and, possibly, for the smooth and fast transient between them. This set of strings will be the dictionary of driving signals from which reactive policies can select the one optimizing performance in response to external control messages identifying loss of efficiency or change of load.
T1.2.c	**Reduction of power converters filter components** (UNICT, FHG, IUNET) Power converter stages must comply with Power Quality and EMI/EMC standard. In addition, in Smart Grid application power cables are often used as a net to carry data information in a frequency range among 20-200 kHz, causing interference with power converters operations. A general issue consists in the reduction of the filter components for efficiency, size, weight and cost reasons. On the other hand, the total distortion of the converter output current depends on the value of the output reactance of the converters, as well as on the control algorithm. To face such challenging issues, an integrated approach is necessary in considering high frequency behavior of power converters and filter design. UNICT, using also the high frequency model of the power converter developed in ERG project, will design and test, by simulations, different solutions of filters and converter layout to comply with Power Quality and EMI standards. The experimental activity will be carried out using the anechoic chamber and EMC test equipment of CePTIT-DIEEI EMC lab. The obtained design will be analyzed by IUNET from the point of view of adding a random modulation to the switching waveforms, an approach that has been already proved successful in reducing EMI independently of the filter. A possible synergic approach will be proposed and tested For connecting high-energy efficient local DC grids to a smart grid (see also the scenario shown in the figure below) a bidirectional AC/DC converter is necessary. An important part of the AC/DC converter is the EMI filter toward smart grids nodes. FHG activity will aim to reduce the filter volume by 50 % with respect to a conventional design (what means using less copper and increasing efficiency) by realizing a high frequency converter design based on modern semiconductor technologies and coupled magnetics. After a first analysis phase of filter methods with coupled magnetics, a demonstrator will be realized to verifying functionality, improvement of efficiency and EMI behavior.

	
T1.2.d	**Simulation of MPPT algorithms to optimize energy contribution** (LEITAT) To maximize energy generation in renewable energy sources MPPT systems are needed to match load requirements to available energy generation. LEITAT will investigate algorithms to optimize energy generation and to adapt converters output to AC grid. These algorithms will pursue time efficiency in order to avoid the introduction of distortions and harmonics to the grid.
T1.2e	**Power quality and signal synchronization** (UNICAL) A first step towards a measure of the energy quality is obviously related to a suitable analysis of the electric parameters to establish the required action. This problem is strictly related to the fast and accurate measure of the waveform. Among the intended objectives, it falls within the real-time frequency, amplitude and phase identification problems of sinusoidal signals since it turns out important to the development of power conditioning devices such as UPS, cogeneration systems, grid-connected inverter, synchronization between power system generation and distribution grid. Moreover, the information about frequencies and amplitudes of the grid voltages and currents are necessary for the correct generation of the reference signals and to avoid safety problems on the grid. In this context algebraic identification techniques will be used in order to obtain a fast identification of the unknown parameters of interest. Moreover innovative adaptive schemes of notch filters for frequency-locked-loop will be investigated. A first part of this activity will be dedicated to a theoretical deepening of the existing methods with particular attention to the study of parameters estimation methods of a sinusoidal signal. Among the many techniques present in the literature, particular emphasis will be given to innovative schemes of frequency-locked-loop circuit for the frequency lock and algebraic identification methods for fast estimation, and not asymptotic of stationary and not stationary signals. Another objective is to deepen and integrate some theoretical aspects related to synchronization systems able to lock, autonomously, the signal after a transient phase.
T1.3	**Intelligent interfaces from customers to smart grid for reducing energy consumption** Leader: TEL Participants: CRF, FGE, UNICT, POLITO, AMS, IFAG, INSTA, NXP-D, FHG, NXP-NL, PHILIPS, RDAS, UoS The task is divided into the following sub-tasks:
T1.3.a	**Development of an AC/DC system controller with safe isolation** (<u>IFAG</u>) Requirements for the safe isolation from the primary side (AC, 85-265 VAC) to the

	secondary side (DC, e.g. 12 V, 5 V, 3,5 V) are increasing to 10 kV or even 20 kV in the US. With the connection of all house hold machines, like washing machine, stove, refrigerator, etc. safe isolation to protect users, the equipment and reliable communication is required and opens new market potentials. As a first step **IFAG** will target its B6CA (Power Logic Technology) aiming to extend the safe isolation from 6 kV to 10 kV for coreless transformers.  The second step will be based on the results of the first one and combined with investigations on new materials to extend the base isolation initially from 6kV to 10kV and then to 20 kV. In parallel IFAG's logic technology is investigated regarding the challenges to reach the high safe isolation values in combination with long term reliability, high communication data rates and optimized area for cost efficient availability. For both research directions new materials, new design concepts (area, reliability, life time) will be investigated in several design runs.
T1.3.b	**Specifications of interfaces** (INSTA, TEL, NXP-D, PHILIPS,RDAS, POLITO) **INSTA** will participate to the specification of interfaces from customers to smart grid, in order to prepare for the final demonstration of reduction of energy consumption. **TEL** will contribute to task of specifying intelligent interfaces features from customers to smart grid and will select the best suited technologies of its portfolio. The main focus of this task will be maximizing power saving features. The interface definition will be elaborated in close cooperation with partners working on the wired and wireless communication channels **NXP-D** will make sure that the defined interfaces will possess the necessary level of security to ensure customers' privacy, but also data manipulation (e.g. from customer side). In providing data privacy requirement NXP-D will take current or under development security regulations into account. **PHILIPS** will contribute to activity focusing on interaction via advanced display devices, such as SmartTV, SmartPhones and tables in the home environment. **RDAS** will contribute to the activity by defining the specification for a low-power wireless transceiver, for connecting home appliances within the intragrid via a communication unit. **POLITO** will contribute by helping in giving specifications regarding the implementation of ultra low-power wireless interface components
T1.3.c	**Design of interface to the grid** (TEL, PHILIPS, RDAS, POLITO) Based on the specifications obtained in T.3.b, **TEL** will design the interface to the grid to achieve an optimum connectivity of consumer supply drivers. Again, the highest efficiency is the main goal to reach here. Extended simulation will be performed to ensure a sufficient quality level for the communication to the grid and to reduce power losses for standby activity as far as possible. The use of actual SOI (Silicon On Insulator) technology is the first choice, due to its superior isolation technique and minimum standby losses. The design task will be split up in at least 2 subsequent phases:

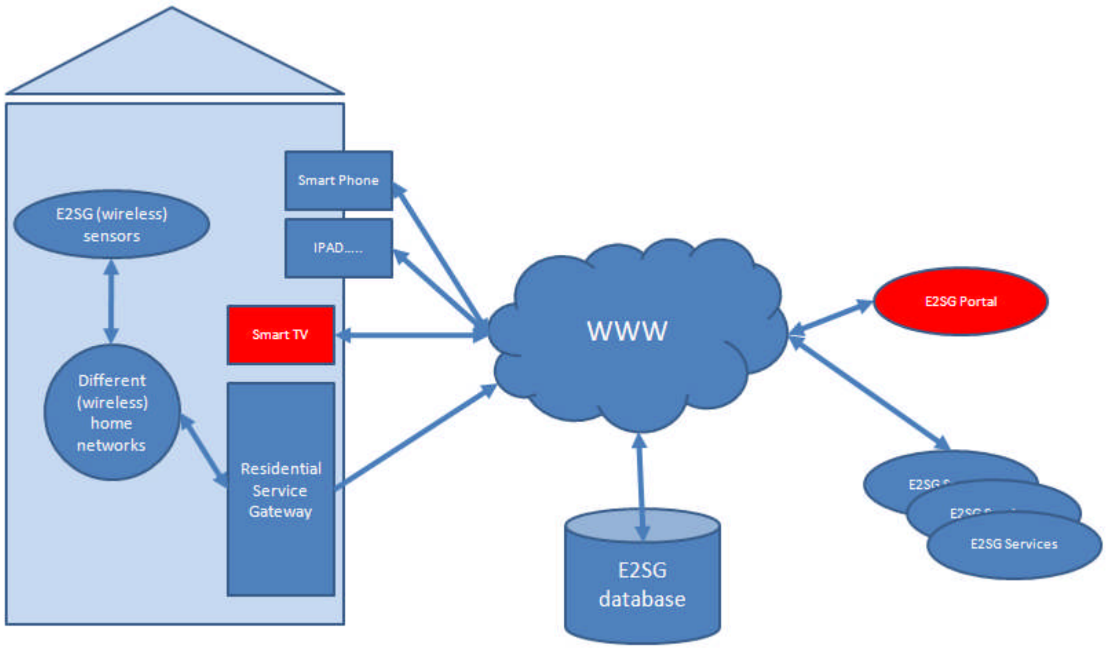
- Exploration of interface blocks
- Combining interface with high power stages for best performance.

Each design phase will be verified by trial runs, resulting in hardware samples. Test campaigns will evaluate the results and compare them with the specifications

In parallel to the evaluation of design blocks, the robustness of elementary groups will be verified in focused experiments by accelerating stress conditions. The aim is to ensure the necessary long term stability of the device to guarantee proper operation for the target power applications. The SOI technology will be explored to provide best stability, especially for applications with high temperature requirements. The experiments will use wafer level reliability (WLR) test setups to analyze the stability under harsh conditions.

The experience of the trial runs will be combined for the demonstration of an intelligent interface solution together with high efficiency power control for industrial and consumer applications. This task will be completed and continued in WP4 for the intended demonstration.

PHILIPS will contribute to the service infrastructure including the residential-gateway architecture as an interface between the networked embedded building system and the outer grid and enables the outer communication (multimedia, tablets or smart phones):



RDAS will contribute to development of intelligent solutions for interfacing the smart grid with respect to the optimal energy consumption. For this purpose, a low-power wireless transceiver, for connecting home appliances within the intragrid via a communication unit, will be developed. The main focus will be paid to low-power design in a standard low cost technology.

T1.3.d **Development of accurate control algorithms** (UNICT, FHG, <u>POLITO</u>)

In Smart Grid applications the estimation of the phase of the grid voltage is a fundamental task for developing accurate control algorithms, especially for single-phase systems. The connection of the distributed generators must not occur in those points of the grid where the voltage waveform is distorted by the presence of harmonics. Moreover, the estimation algorithm should be robust to voltage disturbances, as sags, dips and swells, to avoid the abrupt disconnection of the distributed generators. Many algorithms have been proposed for the estimation of the voltage grid angle; most of them are based

	on Phased-Locked Loop (PLL) techniques. A relevant issue related to these techniques is the presence of an offset in the measured grid voltage. Such an offset is typically introduced by the measurement and data conversion processes. **UNICT** will develop an accurate voltage grid phase estimation algorithm that will guarantee very high noise rejection and dynamic response. Such algorithm will be immune to voltage disturbances, compliant to standard IEC EN 61000, and consequently, it can be used as a basic block from to design suitable control algorithm for the control of distributed generators. The **FHG** will integrate and optimize an energy management system by using information from communication units. Thus a study is done how the communication devices, realized within E2SG, can be used in a scenario similar to what depicted in the figure shown in T1.2.c. Furthermore, methods to connect the power converters (AC/DC and DC/DC converters) with an energy management system will be analysed, and energy management methods will be studied. **POLITO** will contribute in analyzing and studying power saving strategies covering intelligent data networks interfaces with low-energy consumption. In particular, POLITO will focus on the power/energy optimization of the wireless elements of the interface between power grids and intelligent power supplies. Optimizations will be performed taking into account the specific power supply of wireless elements, to ensure best adaptation and provide efficient in-node resource utilization.
T1.3.e	**Development of vehicle to grid interfaces** (<u>CRF</u>, FGE) The forthcoming Electric Vehicles and Plug-in Hybrid Vehicles will have a strong impact on the network and will be a key component of the smart grid. **CRF** together with **FGE** will design and demonstrate innovative EV or PHV to grid interfaces based on novel components developed in the projects and suitable for the automotive market and qualified for the automotive standards.
T1.3.f	**Safe and reliable information transfer between domains of the smart grid which have highly different electrical potentials** (<u>AMS</u>) AMS intends to contribute with speciality silicon process technology variants. In particular we will develop and provide a smart power technology which is capable of assuring a safe and reliable information transfer between domains of the smart grid which have highly different electrical potentials. In a first step a voltage capability of 470Vrms within a lifetime of 15 years is targeted. In this task the extension of this voltage rating will be investigated. Information is transferred via inductive or capacitive coupled transmitters and receivers which are located on a single chip. The electric isolation is accomplished by thick dielectric layers or new materials which will be investigated in this activity. Investigations concerning the long term reliability of these solutions will be a main part of this work and industry standards criteria such as VDE 0884-010 will be the target to reach. The technology will be available for other project partners with related design tasks and AMS will offer a MPW (Multi Project Wafer) -service for interested partners.
T1.3.g	**Development of an AC/DC ultra low power supply** (<u>NXP-NL</u>) NXP-NL contribution will rely on its long-lasting experience with switch mode converter systems for ultra low power supplies and lighting devices. Expertise on topologies and control techniques will enable the design of AC/DC converters and lighting drivers which are either tuned to operate efficiently at very low power levels (<1W) only, or which offer high conversion efficiency at both high (200W) and very low (<5W) load levels. Experience about real-life restrictions like mains fluctuations and EMC performance will be included. **NXP-NL** main goal in this activity is to contribute to the creation of optimal supply architectures for low-power, always-on, grid-connected devices like environment sensors and intelligent light sources. These supplies are intended to operate either autonomously

	or under smart grid control. Simulation models will be provided, as well as hardware prototypes which can be used for measurement data generation.

VERIFICATION OF THE RESULTS

For the most critical tasks we will give here additional details on the methodologies for the verification of the main results of the WPs

T1.1 Development of power efficient Si-based switches

T1.1.a Development of Medium voltage Si-devices

- final Silicon will be delivered between M30 and M36
- intermediate results will be available after each cycle of learning (3 cycles)
- intermediate and final reports will be on parameter optimization; TCAD; integration of diodes/capacitors and resistors/ Novel Super Junction transistor

T1.1.b Development of High Voltage Si-devices

- final Silicon will be delivered between M30 and M36
- intermediate results will be available after each cycle of learning (3 cycles)
- intermediate and final reports will be on trench termination / device optimisation / reliability improvement/ diode-co integration

T1.1.c Circuit optimization and design space exploration

- reporting on in-situ device characterization (devices from T1.1.a and T1.1.b)
- reporting on potential for smart grid
- report and demonstration of design space exploration
- report and demonstration of experimental validation

T1.1.d Development of critical processes on 200mm substrates

- demonstration and reporting will be available on: Base EPI layer development / Trench Etch Development / In trench selective EPI development / Advanced in-trench measurements (M36)

T1.1.e Investigation of solar panel and Electric Vehicle coupled converters

- a detailed report will be available on the optimal power architecture of a solar panel coupled inverter and a bidirectional Electric Vehicle charger
- the design and simulation tools and results of the mentioned converters will be delivered
- an hardware verification of the critical subsystems of both power architectures will be performed

T1.1.f Development of very low voltage Si-devices

- TCAD process, device and mixed mode simulations will be performed for comparing the different solutions. At the end a report will be available characterizing the best new very low voltage Si-devices obtained with improved Rdson*Qg product.

T1.1.g Advanced testing methods for power MOSFETs for Smart Grid applications

- evaluation of best HV power MOSFET technology in PV inverter applications will be performed by implementing suitable Neutron tests and reporting the results of tests performed on samples implemented in specific technologies
- for the implementation of full automated bench to realize engineering reliable tests on power transistors, we will design and realize the automated test system architecture and we will perform several test-bench, reporting on the results

T1.2 Optimal interfacing of energy generating nodes with synchronous AC grids

T1.2.a Economical communication system for power monitoring

- the demonstration of the communication system is planned
- the report will be available on the design of a single cell CPV receiver module with enhanced thermal management performance incorporating temperature sensing functionality. Particular emphasis will be given on accelerated thermal storage and cycling tests in association with reliability/failure analysis and inspection to evaluate reliability and identify possible failure modes.

T1.2.b. Switching synthesis of sinusoidal waveform

- a report will be available for a new optimization-based technique for the generation of optimal switching waveform for driving power converters interfacing renewable sources. This will be starting point for a demonstrator planned in Wp4

T1.2.c Reduction of filter components

- demonstration and reporting on different filters and converters layout, as well an on the impact of using randomly jittered switching waveforms
- report on an hardware demonstrator of a bidirectional AC/DC converter with reduced filter volume

T1.2.d Simulation of MPPT algorithms to optimize energy contribution

- reporting and demonstration of the developed innovative MPPT algorithms.

T1.2.e Power quality and signal synchronization

- a report will be available on the exploration of the different phase- and frequency- locked loop systems;
- a report will be available on the characteristics of notch and quasi-notch adapted filters for sinusoidal tracking;
- a report will be available on the algebraic derivative methods in frequency domain for fast frequency estimation.

T1.3 Intelligent interfaces from customers to smart grid for reduction of energy consumption

T1.3.a Development of an AC/DC system controller with safe isolation

- report on specification, requirements analysis (M12)
- report on 10 kV safe isolation in power logic technology (M12)
- report on investigation & research in reaching 20 kV safe isolation (M33)
- report on research in logic technology (M33)

T1.3.b Specifications of interfaces

- a report on the different specification and requirements of the interface will be available

T1.3.c Design of interface to the grid

- a report will be available on the exploration of the different interface blocks/ high voltage stages / high power stages which will be studied
- a report will be available on the test results on hardware samples (as a result of several trial runs)
- a report will also be available describing the robustness of the design blocks
- intelligent interface solutions will be also demonstrated on field

T1.3.d Development of accurate control algorithms

- a report will be available of a new network phase estimation algorithm with high noise rejection
- a report will be available on the integration and optimization of an energy management system by using information from communication units for intragrid applications

RISK ANALYSIS

Being highly silicon driven and involving development of new process, we estimate that the main risks in WP1 will be related to the technological process development and to the hardware implementation of the silicon demonstrators. We here aim at highlighting the most critical tasks from this point of view and providing for them an further description in addition to what was provided above

Main risks (and control/actions) of T1.1.a/b/c/d:

- optimized devices have serious reliability issues or are limited by power density.

  control: regular fast reliability checks on COL's (cycles of learning)
- Integrated components do not have enough benefit (efficiency, ringing, …) in the applications of Task 1.1.c (e.g. because of too high parasitic contributions).

  control: many other topologies are present in the 'regular' 42V conversion market.

  control: feedback from task 1.2 (mixed mode TCAD) should identify those topologies, and upfront indicate the good parametric range.
- Novel devices (100-200 V) become too complicated and expensive in processing.

  Control: for verification in Task 1.1.c, the devices can be used.

  Control: before making the choice between different options, cost should be taken into account.

  It turns out the above devices do not show benefit in the topologies of Task 1.1.c

  Control: Other markets for stand-alone discrete components exist. Devices can be tested in-house in different topologies.

  The main risk for 200 mm implementation (T1.1.d) is in the field of trench etch and epi-depositions, where mutual process developments and hardware improvements will be needed to prove that the processes can be set up on 200mm with the required process output parameters.

  Special attention will be paid during the development on meeting the specifications all over the larger wafer surface. Also here we envisage process development and hardware improvements to come to the required process outputs.

  Specific attention will need to be paid to wafer-edges on the 200mm substrates.

  A fourth risk is in getting the substrates with their multilayer or thick epi-stack developed with good quality on 200mm. ONSEMI has no in house experience with 200mm epi-processes, so this is a capability that needs to be developed.

  A fifth risk is related to the "in trench layer thickness and doping concentration measurements". We will first need to go through a "proof of concept" phase for this work to define the most promising techniques and layout of test-structures. This needs to be followed by developments of measurements and data extraction techniques to minimize the effect of parasitics, and to guarantee good accuracy in e.g. the extracted doping levels

Main risks (and control/actions) of T1.1.e

- The expected operational lifetime of the solar panel inverter does not reach to 25 years. In this case solution will have to be found in more expensive substrate technologies.
- The cost effective realisation of the bidirectional behaviour of the EV charger is not achieved. In this case the usage of additional power semiconductors will have to be allowed.

Main risks (and control/actions) of T1.2

Devices may not meet the specifications as required by the circuit design optimization. At the device level, this can be due to:

- The device is not meeting the voltage requirement. This is the highest and most important risk as the circuit might have to be redesigned to work with lower voltage rated devices.

- The device is not meeting the Ron specification. In this case the device will need to be overdesigned leading to a higher cost. In addition, the gate charge will increase, see the next bullet point.
- The device is too slow (too large capacitance). The circuit will have to work at a lower frequency, and the trade-off to the overall circuit performance and efficiency will have to be evaluated.
- The device reliability is not sufficient: device operating temperature will have to be de-rated, having implication on the total system solution.
- Avalanche robustness is too low: in this case one might have to include a protection element, adding total system cost.

	RESOURCE ALLOCATION																										
	ONSEMI	CRF	FGE	IUNET	POLITO	UNICAL	UNICT	AMS	IFAG	INSTA	NXP-D	TEL	FHG		LEITAT		HELIOX	NXP-NL	PHILIPS	STUBA	RDAS	IQE	SIL	UoS	ST	**Total**
T1.1	13					25											58			39		6	40		118	699
T1.1.a	09					6														13			10			138
T1.1.b	45					6														18			10			179
T1.1.c	1					6														8			10			75
T1.1.d	08																					6				114
T1.1.e																	58									58
T1.1.f																							10		24	34
T1.1.g																									94	94
T1.2				2			14			12			30		14							16				166
T1.2.a										12												16				50
T1.2.b				0																						20
T1.2.c							14						30													46
T1.2.d															14											50
T1.2.e						7																				7
T1.3		8	8		20		12	71	93	2	5	124	18					36	24		36					580
T1.3.a									93																	96
T1.3.b					2					2	5	9							6		3					30
T1.3.c					18							115							18		33					231
T1.3.d							12						18													30

T1.3.e		8	8																							86
T1.3.f								71																		71
T1.3.g																		36								36
Total	13	8	8	2	20	25	26	71	93	14	5	124	48		14		58	36	24	39	36	22	40		118	1445

It is worth stressing that Industrial partners contribute for over 80% of entire effort devoted to WP1, being the rest covered by academic partners and research institutions

DELIVERABLE LIST		
ID	**Task**	**Name, Kind and Due Date**
D1.1	T1.1.a	Process + analysis report enhanced devices (shrink + cell), D, M18
D1.2	T1.1.a	Process + analysis report extra components & Novel MV devices, D & R, M36
D1.3	T1.1.b	Tape-out of the COL2 devices (first pass of the optimized HV devices), D, M18
D1.4	T1.1.b	COL3 samples submitted to research partner, D, M33
D1.5	T1.1.b	Final report on robustness, reliability and trench termination, R, M36
D1.6	T1.1.c	Test circuit for in-situ device characterization and measurement results, R, M12
D1.7	T1.1.c	Design space exploration and optimization, R, M24
D1.8	T1.1.c	Experimental validation and design guidelines, R, M36
D1.9	T1.1.d	Base Epi Layer deposition on 200mm substrates: process developed for MV and HV Si4SG devices, R, M18
D1.10	T1.1.d	Trench etch development on 200mm for MV and HV Si4SG device, R, M30
D1.11	T1.1.d	Development of stopping layer in epi-stack on 200mm, and assessment of trench etch stopping capability in this stopping layer, R, M36
D1.12	T1.1.d	Process development on 200mm of “in trench selective Epi depositions” for HV Si4SG device, R, M36
D1.13	T1.1.e	Report on optimal power architecture investigation of single panel coupled solar inverter and design of bidirectional EV battery pack charger, R & D, M24
D1.14	T1.1.f	Report on the characterization of new very low voltage Si-devices with improved FOM, R, M24
D1.15	T1.1.g	Fully integrated and automated procedure for HTRB testing of power MOSFETs, R & D, M24
D1.16	T1.1.g	Report on neutron test characterization of high-voltage power MOSFETs and statistical modeling of induced failures, R & D, M36
D1.17	T1.2.a	Communication system for power monitoring, R & D, M18
D1.18	T1.2.b	Report on Switching synthesis of sinusoidal waveform, R, M24
D1.19	T1.2.c	Designs & test of different solutions of filters & converters Report on realization of a hard ware demonstrator, R&D, M36
D1.20	T1.2.d	Report on MPPT algorithms, R & D, M30
D1.21	T1.2.e	Innovative scheme for a low-harmonic distortion, reduced switching frequency inverter, R, M12
D1.22	T1.3.a	Specification & requirements analysis for AC/DC system controller, R, M18
D1.23	T1.3.a	10kV safe isolation in power logic technology, R, M18
D1.24	T1.3.a	Report on investigation in 20kV safe isolation and on safe isolation in logic

		technology, R, M33
D1.25	T1.3.b	Specification on smart grid interfaces, R, M12
D1.26	T1.3.c	Designs of interfaces to the grid, R, M18
D1.27	T1.3.c	Report on test results on hardware samples, R & D, M24/30
D1.28	T1.3.d	Accurate voltage grid phase estimation algorithm, R, M18
D1.29	T1.3.d	Report on integration and optimization of an energy management system by using information from communication devices, R & D, M36
D1.30	T1.3.e	Design and demonstration of vehicle to grid interfaces, R & D. M18
D1.31	T1.3.f	Technology development and design techniques for smart power technology capable of assuring a safe operation with highly different electric potentials, R, M18
D1.32	T1.3.f	Report on reliability investigation of high-differential voltage smart power technology, R & D, M33
D1.33	T1.3.g	Simulation models and hardware prototype of an AC/DC ultra low power supply, R & D, M24

MILESTONE LIST		
ID	**Task**	**Name, Kind and Due Date**
M1.1	T1.1.a	Decision on Novel Device (100-200V) architecture, R, M18
M1.2	T1.1.b	Delivery of COL3 HV samples for application testing in T1.1.c, D, M33
M1.3	T1.2	Optimal interfacing of generating nodes with synchronous AC grids, M36
M1.4	T1.3.e	Smart Vehicle to grid interfaces built and tested for functionality, R & D, M18
M1.5	T1.3	Intelligent interfaces from customers to smart grid for reduction of energy consumption; including: 'in situ' power supply, ultra-low power standby and intelligent robust drivers. Demonstration of an ultra Low Power supply, R & D, M36
M1.6	T1.3.f	Specification and requirements for smart power technology capable of assuring a safe operation with highly different electric potentials, R, M12

WORK PACKAGE NUMBER AND TITLE	
2	**Grid-sensing, metering and communication**

WORK PACKAGE PARTNERS
IFAG (D),IUNET (I), PHILIPS (NL), ST (I), CRF (I), UNIBO (I), UNICAL (I) NXP-D (D), RWTH (D), UoS (UK), IQE (UK), SIL (UK), TYN-UCC (IR) , LEITAT (ES), RDAS (SK), STUBA (SK) , CTTC (ES)

DESCRIPTION OF WORK

General objectives

Six different objectives in two segments – hardware and over the grid communication - are targeted:

Segment 1: Metering

1: Advanced network monitoring by means of phasor measurement units (PMU)

2: Smart meters design and implementation

3: Smart meter integration

Segment 2: Over the grid communication

4: Subgrid powerline communication exploiting conversion ripple

5: Design and implementation of an architecture for hierarchical data collection, storage, management

6: Secure data exchange between grids and consumers

Segment 1: Metering

1. Advanced network monitoring by means of phasor measurement units (PMU)

Phasor measurement units (PMUs) provide the measurements of node voltage and/or branch current phasors synchronized with a common time reference (typically UTC-GPS). The increasing use of data provided by PMUs in the real-time operation of power systems, the availability of accurate timing devices, advanced signal processing techniques and telecommunication infrastructures have resulted in the development of PMUs characterized by increasing accuracy levels. The projects aims at developing an improved synchrophasor estimation algorithm for the application in distribution networks in order to achieve:

(i) low values of synchrophasors estimation uncertainties

(ii) high rejection of harmonic components different from the fundamental one

(iii) maintain uncertainty levels to values which are not modified by the dynamic behavior of frequency-varying phasors.

2. & 3. Smart meters design, implementation and integration

Smart meters are a core element in the collection of actual power consumption data. Key elements are the measurement interface, the connection to the network for the data exchange and the security and integrity of the measured data. We aim to develop low-cost and small-volume smart meters with different communication interfaces, ranging from twisted pair, to radio link and power line communication for ease of deployment in commercial, residential and industrial settings. The research of the partners addresses the three different aspects with innovations in low power data transfer, integration, application and security.

To do so, we will leverage on the extreme low-cost low-power microcontrollers and radios made available by recent advances in micro/nanoelectronics, and the emergence of open communication standards. Smart-meters will also collect environmental information from zero-power nodes to allow analysis of intra-grid efficiency by the energy provider, and output energy usage and environment data to zero-power consumer interfaces to encourage active control of energy consumption by the consumer.

Segment 2: Over the grid communication

4. Subgrid powerline communication exploiting conversion ripple

The feasibility of a communication scheme that applies a modulation to the switching signals of power converters so to embed information in the ripple that is superimposed to the DC voltage level will be demonstrate both from the theoretical point of view and by means of realistic simulations taking into account the various disturbance sources such as load variations, further switching converters at the receivers, non-ideality and dispersion along the wires. Within limits that will be carefully ascertained, such a scheme will allow powerline communications with minimal hardware overhead. Its effectiveness will possibly be shown by measurements on simple prototype systems.

5: Design and implementation of an architecture for hierarchical data collection, storage, management.

This part will be constituted by the definition of the hierarchical architecture, the definition of the functions of the various gateways at the different levels, the algorithms that characterize their behaviour and the data exchanged.

6: Secure data exchange between grids and consumers

To be entirely confident that a smart meter is functioning properly at all times, there needs to be a trusted component in (absolute) control of the meter device, which has to be placed into the core of the system. Since any kind of trusted computing is based on the authentic and integral reporting of a device's configuration, a major ingredient is the strong and secure authentication of devices and peripherals, whilst maintaining high performance, though with minimal consumption of resources. All the options for lightweight and fast authentication and communication protocols will be studied, ranging from classical authentication schemes using public key cryptography (such as RSA and ECC) to non-standard solutions such as coupon-based authentication and similar. The main focus here will be the tailoring of the schemes, key sizes used and security measures needed for device authentication and communication in order to minimize the consumption of physical resources like chip size and power consumption, whilst maximizing performance. Especially, in order to resist side-channel analysis and fault injection attacks, innovative lightweight measures will be needed in order to keep the resource consumption low and minimize the impact on the performance of the authentication and communication processes. The final step is then to provide a prototype proving the concept, i.e., implementing an example application of device authentication and communication optimized for all the parameters: performance, security, physical resource consumption.

Objectives by partner

POLITO

will explore power and energy management features at the architectural level, enabling the adaptation of power consumption to the current needs dictated by the activity of the nodes.

UNIBO

will work on smart meters.

The goal of UNIBO in WP2 is to integrate an advanced metering system that collects and monitors total energy consumption data of a multi apartment building. The system is capable of providing usage information on a continuous basis and supports functionality related to energy use management, procurement, and operations.

UNICAL

will work on smart meters.

The UNICAL contribution will focus on the design of new distributed smart meters based on WSAN (Wireless Sensors and Actuators Networks) at the smart home intra-grid side.

IFAG

will work on smart meters & secure data protocols

Special knowledge at design and implementation and especially secure and tamper proof semiconductor technology will be developed and applied to ensure data privacy, data integrity (digital signing) and platform integrity for the smart meter. For protecting the metering mechanism itself and the stored data together with the processing algorithm inside the smart meters special care has to been taken against attackers from the outside (via the network) as well as against local or inside attackers which have physical access to the smart meter device.

NXP-D

will work on smart meters design, implementation and integration and on objective 6 : Secure data exchange between grids and consumers.

NXP will work on the investigation and implementation of hardware solutions for secure interfaces between consumers and energy provider, securing the integrity and authenticity of data to prevent cybercrime, terrorism and manipulation. To ensure data privacy within the communication over the grid crypto mechanisms with low power consumption will be defined and demonstrated by NXP-D. Special focus will be on the data integrity of smart meter devices. An according concept prototype will be provided by the end of the project.

RWTH

will work on smart meters.

A smart meter communication interface has to ensure a secure and reliable connection within a building or neighborhood. A sufficient link budget at low power consumption calls for an implementation using a frequency band below 1GHz. The research focus of the RWTH Aachen University will be the integration of a low power RF transceiver supporting OFDM modulation schemes with a high peak to average ration.

LEITAT

will participate in development smart meters for any ambient who can be powered via energy harvesting with communication based on low-power systems like Zig-Bee or 6Lowpan (low power IP).

PHILIPS.

will work on the 2nd objective & 6th objective: smart meter & integration

Philips will contribute to the specification of wireless communication (including powerline) in the home environment and will work on the integration of a first prototype with different sensors and will contribute to the specifications of data exchange from outside □ inside home environments.

STUBA

will work on smart meters.

STUBA will contribute to development of low-cost small-volume smart meters with different communication interfaces that will be dedicated for residential use. Such meters should offer active control of energy consumption by the user/customer.

RDAS

will contribute to segment 1,objectives 2 and 3, where smart meter will be developed and integrated. The developed meter will be dedicated for residential use, therefore, it should help control and optimize the energy consumption by the user. To keep the meter cost low, a proper low-cost low-power microcontrollers will be employed.

IQE

will work on the optimization and manufacture of low cost, high efficiency group IV photovoltaic cells optimized for indoor lighting conditions and use with self powered RF smart meters.

ST

Development of a system on chip platform integrating different smart metering functions in a single chip.

The architecture is conceived as scalable platform to meet different application requirements, with a mix of programmable digital engines and HW accelerators to achieve the best trade off trade-off among flexibility, technology integration and costs.

UoS

will contribute to the 2nd objective: smart meter.

A communication interface has to be reliable and be available under all conditions. Hence demonstration of an autonomous wireless system operating at frequency band less than 1 Ghz has many attractions. The research focus will be investigation of the design and testing of a low power transceiver (available off-the-shelf or in collaboration with partners) powered by indoor PV which will transmit a set of data to a smart meter. The work will include optimisaton and testing of cells.

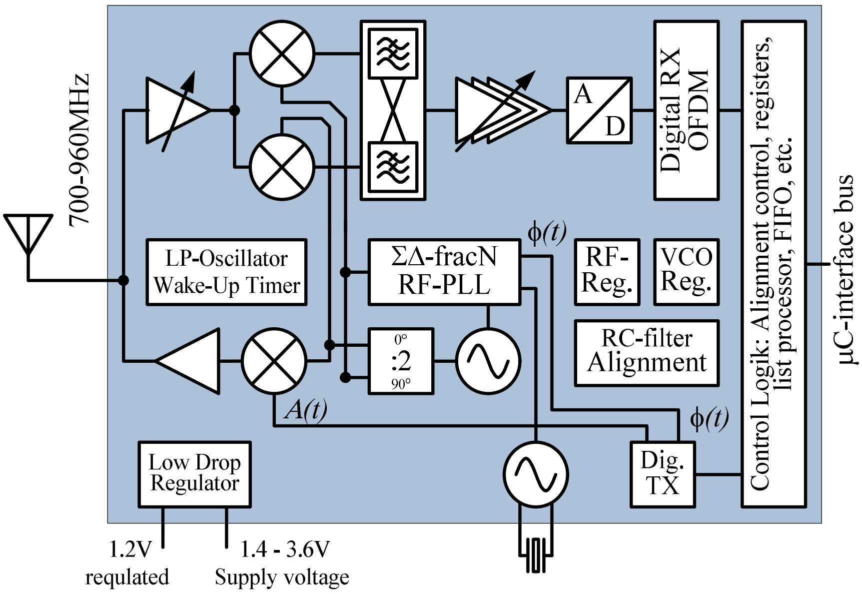
SIL

will contribute towards compact model and circuit design software as well as performing large matrix simulations to optimise the performance of indoor PV device circuits. Various illumination and deployment scenarios can be investigated and optimised. Designs will utilise mixed mode and available compact models to accurately reflect the performance of the designed PV devices in circuit configurations.

CTTC

will develop (T2.2b) a WSN network and a web application for monitoring in-home energy consumption. The implementation will be focused on reliable communication between sensor nodes and a collection node. Real time data will be available from the web page as well as a profile of the consumption of the sensed space.

TASK LIST	
T2.1	Advanced network monitoring
T2.1.a	Advanced network monitoring by means of phasor measurement units (PMU) One of the main challenges for operation and control of smart grids are certainly the introduction of advanced monitoring/sensing techniques. We here aim at filling this gap by designing and implementing an advanced phasor measurement unit (PMU) which will be able to monitor the current state of the network at each node, whose position will be clearly defined trough GPS data or when not available as in closed rooms by storing them at installation time. Once implemented, this unit will be the key element in devising adaptive distributed control algorithms, which, taking into account forecast for renewable energy production for short (minutes) and long (from few hours to 24 hours) periods, will allow to optimize energy production/need, thus making it possible an intra-day or day-ahead intelligent scheduling.
T2.2	Smart meters design and implementation
T2.2.a	Low power transceiver RF subsystem for a wireless metering SoC A smart meter communication interface has to ensure a secure and reliable connection within a building or neighborhood. A sufficient link budget at low power

	consumption calls for an implementation using a frequency band below 1GHz. Increasing the over the air bit rate will lead to a low duty cycle protocol, which is a key factor in achieving the required low power operation. As only small chunks of spectrum are available in the highly occupied UHF band an OFDM-based system, as targeted in the new IEEE 802.15.4 standard, is needed to provide a high data rate within a narrow RF bandwidth. The research focus of the RWTH Aachen University will be the integration of a low power RF transceiver supporting OFDM modulation schemes with a high peak to average ration. Available low power transceivers for wireless metering are suited for constant envelop modulation schemes and will therefore not support OFDM. Polar modulation architectures have been adopted over the years for cellular communications systems starting with narrow band systems like the EDGE mode of GSM. For wideband systems like UMTS first feasible solutions have been published achieving the stringent requirements of cellular systems. Within the E2SG project the transceiver will adopted to the system specific tradeoffs required by the smart metering application.  Low power metering circuits will require an adaptive low power AC to DC converter in order to assure power efficiency in the standby as well as in the active mode of the application. A solution requiring a low additional effort would be preferred. The research will focus on two general approaches. The first and secure approach is the use of Telefunken's SmartPower SOI technology to realize a separate AC/DC supply chip. The second approach exploits the idea of using a capacitive voltage divider to generate first a low voltage, which can be handled by the CMOS SoC directly. The RWTH will carry out an investigation on ultra low power AC/DC conversion for an independent supply of smart metering subsystems. Activities will extend to the development smart meters for any ambient who can be powered via energy harvesting, for example by indoor PV cells. These modules will integrate low power wireless communication based on 802.15.4 standard (preferably 6LoWPAN).
T2.2.b	Intra-GRID controlling system based on WSAN

	The research activity aims at creating a framework based on wireless sensor and actuator networks (WSAN) to audit buildings and control equipments. Designing such framework based on WSAN represents a viable and more flexible solution than traditional building monitoring and actuating systems (BMAS) that require retrofitting the whole building and therefore are difficult to implement in existing structures. In contrast, solutions based on WSAN for monitoring buildings and controlling equipments, such as electrical devices/appliances, and heating, ventilation and cooling (HVAC) systems, can be installed in existing structures with minimal efforts. This would enable monitoring of space usage and energy (electricity, gas, water) in apartment and office buildings while facilitating the design of techniques for intelligent device actuation. The main objectives of the Intra-Grid Management Framework (IGMF) are: (1) Management of a range of cooperating wirelessly internetworked entities able to sense and actuate the building environment; (2) Profiling of the energy spent in the building; (3) Development of applications for controlling the energy consumption in buildings and profiling the consumers' behaviours; (4) Definition of intelligent actuation techniques based on intelligent agents that can interact with the SmartGrid. The IGMF is an effective and useful tool for the Intra-SmartGrid to provide users and energy providers with real-time information about building energy saving and wasting and consumers' behaviours in exploiting energy
T2.2.c	Exploration of power and energy management features To ensure low-power operation of the nodes, POLITO will explore power and energy management features at the architectural level, enabling the adaptation of power consumption to the current needs dictated by the activity of the nodes (i.e. sensing frequency, data rate, radio link quality). To this purpose, node's activity monitors will be exploited to extract information about power consumption of the various on-chip and on-board components (radio interface, microcontroller, sensors) and battery status where present. Power management orchestration will be developed relying to this information. In order to enable the energy-aware simulation of GRID-monitoring infrastructure, POLITO will develop power and energy models of GRID-sensing nodes. Simulation models will support the optimization of node's lifetime and reduce their impact on overall power budget.
T2.2.d	Development of a Smart Metering system-on-chip platform The goal is to design, diffuse and validate a high integrated, programmable silicon platform for several smart metering functions integration in a single chip (Smart Meter SoC). The architecture will be conceived as scalable platform to meet different application requirements, with a mix of programmable digital engines and HW accelerators to achieve the best trade off trade-off among SoC flexibility, technology integration and costs. The work flow will include the device definition in terms of specification, the

	selection and the design of the IPRs, the integration of the system and the verification in simulation, the layout, the diffusion and the validation of some part of the device and finally of the whole system. After the understanding of compatibility in smart grid environment of the available IPs, through the realization of a basic system and benchmarking of competition, the work flow will be done according with the following list of actions: 1. Understanding the design requirements. Partition of the whole design into blocks for a deeper analysis 2. Compile design specification and define the reusability of existing IPs. 3. Acquisition/design of the not available IPs 4. Writing the RTL code for the digital section, design of the analog blocks 5. Modeling of the target device in to Hardware model (i.e. using FPGA) 6. Synthesis of the RTL code 7. Simulation of the behaviour of the single blocks and of the overall digital design. 8. Mixed analog and digital simulation 9. Layout 10. Post-layout simulation 11. Mask generation 12. Silicon debug 13. Design fix (repeat step 6 to 12) In parallel to this work a testing program has to be done. Definition of validation and characterization strategy. After this first stage the aim is to obtain a prototype of the SoC, the following steps will be run 1. prototype realization: wafer diffusion and assembling of the entire system or part of the same 2. characterization of the prototypes through dedicated instrumentation 3. ATE validation of the prototypes 4. reliability 5. in-system validation with a dedicated board
T2.3	Security and integrity
T2.3.a	Requirements and specifications for secure smart meter IC A detailed requirements and specification analysis for a secure smart meter IC will be conducted. The special knowledge in the design for secure and tamper proof semiconductor technology is basis to reflect the requirements versus the research objectives. Requirements are derived to achieve the protection of the metering mechanism itself and the stored data together with the processing algorithm inside the smart meters. Special care has to been taken against attackers from the outside (via the network) as well as against local or inside attackers which have physical

	access to the smart meter device.
T2.3.b	Concept for a specific, high security metering IC including crypto algorithms and protection Concepts for the trusted implementation and data integrity measurement of the platform and integrity attestation have to be developed. The last developments on integrated trust and trust anchors from the Trusted Computing Groups standardization has to be included. Research on the implementation approach against the expected threats together with low power consumption requirements.
T2.3.c	Secure smart meter IC including trusted computing components IC hardware and software research will be performed in parallel and based on the specifications and concept evaluation. Following aspects have to be considered: • Low power computing accelerators for cryptographic operations, esp. but not only for elliptic curves which have clear advantages for in this use case • Integrity measuring of the nodes and security policy enforcement for networking which is offered by the Trusted network Connection (TNC) protocol in addition to the standard IPSec networking. • Privacy functionality based on the trusted platform technology for fulfilling the new requirements from the national data protection officers and the EU Art. 29 group. • Secure and protected storage of data and especially key and certificates together with strong authentication protocols for access to the meter functions • Trusted operating system technologies for safe and reliable operation • Privacy architecture which exploits the security architecture to ensure confidentiality of personal data and which allows to adapt the level of confidentiality of data according to external conditions such as consumption, physical presence, user behavior and similar.
T2.4	Integration of an advanced metering system
T2.4.a	Integration of an advanced metering system that collects and monitors total energy consumption data of a multi apartment building. The goal is to integrate an advanced metering system that collects and monitors total energy consumption data of a multi apartment building. The system is capable of providing usage information on a continuous basis and supports functionality related to energy use management, procurement, and operations. The advanced metering system proposed here is a complete energy monitoring solution from the low level metering devices that will be designed by other partners to a host of user interfaces and data display options including smart data processing unit and communication channel. Bidirectional data communication will be supported and different options evaluated, including wired (Power line communication) and wireless (Zigbee IEEE 802.15.4) protocols. All these communication protocols will be developed on hardware modules that will be designed by other partners working in WP2. The proposed metering system will have enough computing power to support algorithms able to optimize power consumption profiles.
T2.4.b	Integration of a first prototype with different sensors

	This task will be a joint effort by several partners and will consist of the following steps: a. Selection of appropriate sensors b. Provision of schematics and parts list for the sensor and interface circuits to contribute to the grid sensing-metering hardware platform and support the following tasks c. Definition of the specification for the hardware platform and related system and architecture d. Design and test of the hardware platform e. Deployment of the hardware platform and integration with component/hardware technology platforms from Telefunken, NXP & R-DAS in WP1 f. Render compatible with smart systems developed by partners such as Philips g. Render compatible with wireless sensor network protocols, architectures, cognitive systems developed by other partners
T2.5	Over the grid communication
T2.5.a	Specifications Specifications for the planned coordinated demonstrators and contributions to WP4.
T2.5.b	Subgrid powerline communication exploiting conversion ripple Conventional powerline communication strategies implicitly separate the information signal from the power flow in the frequency domain. To achieve this transformers and filters must be used and special cautions must be paid to ensure that high-frequency components of the power-loaded waveforms do not alter information-bearing signals. In particular areas of the power grids, most notably in the domestic framework but also in the distribution to small complexes or groups of neighbouring facilities, the power-loaded waveforms are heavily dependent on the switching activity of converters. A typical distribution in a movie theatre, for example, would entail a cascade of AC/DC and DC/DC converters. The ripple that is superimposed to power levels is a periodic signal of small amplitude whose frequency (and, consequently, amplitude) modulation is possible without impairing the power transfer (actually, often improving Electro Magnetic Compatibility of the overall system). The idea is to exploit such a modulation to offer a simple way to transport information which would be very cost-effective with respect to classical power-line communication solutions.
T2.5.c	Design and implementation of an architecture for hierarchical data collection, storage, management What is proposed here is the definition of an architecture and the prototyping of a system allowing real-time hierarchical collection of information on power consumption and profiling of single users. The system will include aggregation and synthesis of data at the higher levels of complete buildings, districts, up to the whole city. The architecture will be structured on hierarchical levels (user, building, district, city), each based on a different type of gateway. Each level gateway will collect

	process and aggregate information at one level and present it at a higher level gateway. The architecture derive concepts and software infrastructure (CoMo) used for monitoring computer networks in large testbed deployments such as Planetlab.
T2.5.d	Secure data exchange between grids and consumers To be entirely confident that a smart meter is functioning properly at all times, there needs to be a trusted component in (absolute) control of the meter device, which has to be placed into the core of the system. As the grids network transmission capabilities depend on a lot of different factors like different media, timing, protection and threat level as well as possible dynamic configurations a transmission independent trust and secure component is required which is able to offer a security level which is sufficient for all possible network configurations. According to the current standards the gateway will connect several metering devices with the network and deliver also the security and trust mechanism. To implement this security functionality we will base our work also on trusted and secure implementation standards like the new developments of the embedded systems workgroup from the TCG which probably offers standards for all required security mechanisms. Our main focus is the implementation according to the newest state of the art and the extension of it during the development process. A major ingredient is the strong and secure authentication of devices and peripherals, whilst maintaining high performance, though with minimal consumption of resources. We will take special care on: • Robustness of protocols and specific security terms like authentication and nonrepudiation. • Middleware and protocol parts for security configurations, secure protocols for routing and key distribution etc.. • Trusted network Connection (TNC) protocol for enhanced node integrity verification and security policy enforcement. • Strong access protocols and physical resistance against tampering. • Error resistant trusted OS against internal errors as well as intelligent attacks via the networks. • Seamless integration of nodes stemming from different administrative domains. • End to end security in a variable environment which integrates heterogeneous communications technologies • Studies on various options for lightweight and fast authentication and communication protocols, ranging from classical authentication schemes using public key cryptography (such as RSA and ECC) to non-standard solutions such as coupon-based authentication and similar. • lightweight measures in a way that resource consumption is kept low and the impact on the performance of the authentication and communication processes is minimized, whilst maximizing performance is guaranteed

VERIFICATION OF THE RESULTS
This workpackage develops technologies essentially related to the acquisition of data (typically, but not only, data on power flows) at multiple points of the grid and their communication to a concentrating node in charge of computing some kind of

control policy (that is outside the scope of this workpackage) that, in turn, may be communicated back to the nodes.

Methods for coping with this task in current grids already exist though they may be improved along at least four directions

- Number and density of metering devices
- Scalability, i.e., the ability to grow with the grid
- Rate of data acquisition
- Effectiveness of communication, meaning
    - Limited use of local hardware/power resources
    - Security

Each of the activities of this workpackage will aim at improving one or more of the above features and will be measured against the corresponding merit figures.

RISK ANALYSIS

The risk in this workpackage concentrates in activities designing and fabricating ICs, let them be a wireless transceiver, a SoC smart meter or a communication module embedding trusted computing principles.

Actually, the corresponding tasks see the commitment of major industries like ST, PHILIPS, NXP-D, IFAG and SIL whose experience and history of successful implementation of innovative designs will help minimizing a risk of failure.

	IUNET	RWTH	LEITAT	UNICAL		POLITO	NXP-D	IFAG	UNIBO	PHILIPS		STUBA	RDAS	ST	SIL	UoS	IQE	CTTC
T2.1.a	11																	
T2.2.a		82	25										6		20	51	20	
T2.2.b				20														29
T2.2.c						85												
T2.2.d													12	130				
T2.3.a							3	6										

T2.3.b							4	8										
T2.3.c							36	60										
T2.4.a									55	6								
T2.4.b										4								
T2.5.a							3	3		1								
T2.5.b	10																	
T2.5.c	21																	
T2.5.d							17	59		2								
	42	82	25	20		85	63	136	55	13		18	10	130	20	51	20	29

DELIVERABLE LIST		
ID	**Task**	**Name, Kind and Due Date**
D2.1.a	T2.1.a	Principle description and design of a PMU, R, M18
D.2.2.a	T2.2.a	Integration of low-power wireless transceiver, P + R, M36
D2.2.b	T2.2.b	Implementation of an IGMF, P + R, M36
D2.2.c	T2.2.c	Simulator of grid monitoring infrastructure, P + R, M30
D2.2.d	T2.2.d	SoC Smart Meter, P + R, M36
D2.3.a	T2.3.a	Report on requirements for secure smart meter IC, R, M6
D2.3.b	T2.3.b	Description of the concepts for high-security ISs for metering, R, M18
D2.3.c.1	T2.3.c	Secure smart meter IC, P + R, M30
D2.3.c.2	T2.3.c	Test of secure smart meter IC, R, M36
D2.4.a.1	T.2.4.a	Advanced metering system suitable for multi apartment building, P + R, M30
D2.4.a.2	T.2.4.a	Preliminary tests on the system in D2.4.a.1
D2.4.b	T2.4.b	Integration of a meter with other sensors, P + R, M36
D2.5.b	T2.5.b	Design and simulation of ripple-based communication, R, M36
D2.5.c	T2.5.c	Design and implementation of hierarchical data collection, storage and management, P + R, M36
D2.5.d	T2.5.d	Design and simulation of secure data exchange between grid and consumer, P + R, M36

MILESTONE LIST		
M2.4.a	T2.4.a	Specifications for advanced metering systems for buildings
M2.5.a	T2.5.a	Specifications for the coordinated demonstrators planned in WP4

WORK PACKAGE NUMBER AND TITLE	
3	**Grid topology and control**

WORK PACKAGE PARTNERS
HERA (I), CTTC (ES), IQU (ES), IT (PT), IUNET (I), POLITO (I), ST (I), UNIBO (I), UNICAL (I), UNICT (I), UoS (UK)

DESCRIPTION OF WORK

General objectives

The WP aims at providing techniques for the state estimation of electrical power distribution systems by means of a reduced number of distributed measurements and the identification of mixed stochastic-topological indexes. The state estimation is then used for the definition of optimization procedures and agent based control of the smart grid. In particular, a general framework will be developed composed by a collection of basic algorithmic elements and graphical GUI environment. The developed tools are expected to provide the characteristics of management strategies that will allow optimizing the use of all the energy storage resources with particular reference to electric vehicles connected to the grid.

A brief description of the objectives of the WP and the partner involved are listed here below:

1 mixed stochastic-topological indexes and state estimation

The objective is to provide synthetic parameters that adequately describe the network and to find techniques to estimate the internal state of interconnected dynamical systems by means of a reduced number of distributed measurements

2 Optimized control of smart grid nodes

The objective is to provide the definition of optimization problems by a MILP (Mixed integer linear programming) formulation. The objective is also to provide the definition of the interdependencies between different optimization objectives and different decision makers.

3 Framework for fast deployment of distributed application

The objective is to provide a library of algorithmic elements that will compose the desired distributed application. The approach will be used in order to implement an agent-based control of the energy resources based on broadcasted price signals.

4 Advanced storage management policies

The objective is to provide the characteristics of management strategies to optimize the use of the available distributed storage with also reference to that provide by connected electric vehicles. The objective is also to propose a suitable control strategy for the power converters also in islanded conditions.

Objectives by partner

HERA (I) will contribute to objectives 1, 2 and 4 by giving access to the topology of portions of the actual power distribution network and interacting with researchers analyzing such a topology by means of suitably defined indexes. Moreover, it will provide information and direct experience on the performances and functionalities of its state of the art distribution management system. Hera will contribute to the activity relevant to the test of control functions and advanced storage management functions.

CTTC (ES) will focus on demand side management algorithms (objective 2): interaction between users and energy providers is needed to guarantee a flat consumed energy profile. Electricity resource can be assigned to the different users according to allocation protocols based on game-theoretic results and/or (not necessarily convex) optimization tools.

IT (PT). The task of IT is relevant to objective 2. optimized control of smart grid nodes. In particular, to the development of tools for demand-side management (DSM). DSM is a designation which refers to programs implemented by utility companies to control energy consumption at the customer side of the meter. An incentive based energy consumption scheduling scheme for the future smart grid can be considered. In the proposed framework different energy providers and consumers interact in a communications network and by means of smart devices which intelligently schedule energy consumption in customer's premises. A game theoretic approach can be followed with the objective of minimizing the energy consumption in the systems. Also, deregulation of the market allow smaller utilities, namely from renewable energy, to supply customer demands. The benefits are obvious: introduction of clean and renewable sources of energy, reduction in energy bill and on CO2 emissions. Nevertheless, the design of proper game theoretic algorithms which can be implemented in the grid, for such a huge number of nodes (energy sources and users) is a challenging aspect.

IQU (ES). The tasks that will be carried out by IQU refer to objective 2 for optimized control of smart grid nodes and objective 3 framework for fast deployment of distributed application. For objective 2, IQU will contribute to the development of optimization techniques. Indeed, with the spatial and temporal measurements availability, the system performance can be optimized through convex and linear programming techniques, where several objectives can be targeted, with energy saving being a major one of them. For objective 3, IQU will propose a general framework to control the system available resources in order to save the employed energy and to study the interactions between the different parameters.

IUNET (I) will contribute to all the objectives: For objective 1 the aim is the extension the concept of topological indexes to networks whose links are characterized by, for example, a capacity and a failure probability, as power-grids. For objective 2, the effort will be focused on the development of a MILP model for the search of the minimum losses configuration of the network. For task objective 3 a collection of pre-defined, parametric library blocks will be provided for the different application environment. Each block will mask all underlying details (hardware dependent codes and mapping information), still allowing for proper configuration through available parameter setting. This general setting will be then specified for the smart grid scenario by introducing local energy distribution/generation algorithms based on pricing policies which will be spread to run the distributed intelligent agents in the network. For objective 4, the aim is the development of a dynamic model of a distribution system that could be used for the characterization of the impact and benefit of distributed storage resources and the assessment of performances of different control strategies.

POLITO (I). The effort of POLITO will be devoted to distributed control of GRID-sensing nodes energy consumption (objective 2), required to ensure the optimization of the power spent for the monitoring infrastructure. Reliability of the sensing network lifetime will be pursued for radio-link based sensors. Distributed control will rely on wireless or over-the-grid communication infrastructure. POLITO will exploit network-wide information in order to keep under control the power status of single nodes leveraging on architectural support provided in WP2. POLITO will also develop network-wide simulation models for estimating the energy savings and the lifetime autonomy of the GRID-monitoring infrastructure.

ST (I) will contribute to objective 2, in which it will optimize control of smart grid nodes through a novel solution based on Game Theory and Mobile Agents Systems. This novel algorithm operates based on the idea that supply must always follow demand. In a setting in which the individual homes, within a smart grid, receive a continually varying real-time price for the electricity that they consume, we would show that it is possible to calculate the system's equilibrium state. In particular, with the advent of Smart Meters that can monitor and control devices in the home, it is now possible to envisage that smart software agents could be installed on these devices. These agents would then be able to optimize the usage and storage profile, using information from various sources: weather data to predict energy and hence heating costs or price plan data from suppliers.

ST will also contribute to objective 3 for the development of software library for communication grid infrastructure. This multi-layer library will ensure requirements and robustness needed for the application in smart grid system. ST will carry out a specific study and evaluation of power management algorithms based on statistical analysis of consumption and will develop of a software library for the analysis and management of network appliances in a multi agent system.

UNIBO (I) will develop a software low-level interface for metering-device integration in the agent-based system (building/home control unit). This activity is related to objective 3.

UNICAL (I) will carry out research in T3.2 on the analysis, application and design of the intra-grid/smart home system, developed in WP2, for energy monitoring, profiling and automatic energy control. Moreover, it will contribute to T3.3 through wireless sensor and actuator networks in the context of intra-grid frameworks for fast deployment of distributed applications.

UNICT (I) will contribute to develop innovative control strategies for DG converters which allow full exploitation of the DG power capability in both grid-connected and islanded-mode operations (objective 4). The proposed technique consists of a robust hierarchical control strategy, based on a narrowband communication among contiguous DGs. The main idea is to implement independent operation of the DGs in order to obtain a reduction of the distribution losses and other ancillary functions based on reactive power control, such as voltage and frequency support, that are normally devoted to the grid. According to such a control strategy, the global efficiency increases as smart-grids will switch automatically from grid-connected to islanded mode operation.

TASK LIST

T3.1

Mixed stochastic-topological indexes and state estimation

Leader: IUNET Participants: HERA,

Synthetic parameters that subsume significant properties of the nodes of a network of dynamical nodes (modeling, in this case, power distribution at various space scales) will be developed targeted to the identification of critical aspects of power grids, i.e., importance of a generation or conversion node, tendency to islanding, etc. This will be done either by modifying topological measures already presented in the literature, so that they can cope with links with various capacities and probabilities of activation, or defining new ones tailored to specific features.

We will also explore the possibility that the implementation of policies based on the computation of these indexes will rely on techniques to estimate the internal state of interconnected dynamical systems by means of a reduced number of distributed measurements. In particular we aim to develop innovative techniques which are based on the extension of compressive sensing (CS) methodologies to measure the state of a distributed network. CS is a new paradigm for the acquisition/sampling of signals that violates the intuition behind the theorem of Shannon. In fact, CS theory states that, around the under surprisingly broad conditions it is possible reconstruct certain signals or images using far fewer samples or measurements than they are used with traditional methods. To enable this, compressive sensing is based on two concept/principles. On the one hand, the signal to measure must be sparse, i.e. its “information rate” must be much less than what is suggested by his bandwidth, or, for a discrete-time signal, that the number of its degrees of freedom must be much smaller than its time length. On the other hand the sampling waveforms must be incoherent with the signal to acquire, which practically result in random sampling of the signal to acquire. In this framework, we will extend this technique to reconstruct distributed signals, i.e. those measuring the state of a smart grid, trough the collection of **only a small number of samples**. To do so, will study the relationship between the number of incoherent data transmissions and the probability of correctly reconstruct the information of the smart grid state and determine in which settings of the smart grid this technique can be successfully exploited. We wish to stress that, if successful, this technique will have a great impact, on the one hand, on the next generation of smart meters which will be expected to be much more energy efficient due to the reduced requirement in terms of number of transmissions of the state of the grid node and, on the other hand, on the efficiency of any distributed energy shaping profile mechanism, which may run on the basis of a very often updated information of the grid state (thanks to the small number of samples needed to determine it) and thus may be able to efficiently capture the network dynamics and more efficiently optimize the energy production and consumption.

The ability of the resulting methodology in capturing significant features of the grid interconnections and state will be shown with reference either to true connectivity data and grid state measurements provided by HERA. In alternative we will refer to synthetically produced networks with statistical properties analogous to those of real ones and to data collected from system-level simulators of the smart grids.

<table>
<tr><td>T3.2</td><td>

Optimized control of smart grid nodes

Leader: CTTC

Participants: HERA, IT, IQU, IUNET, POLITO, ST, UNICAL

Initially the aim of this activity is to define the problem of controlling the behavior of a smart grid node as a suitable optimization problem. By doing so we will also provide the definition of the interdependencies between different optimization objectives and different decision makers.

We will compare 2 possible approaches:

- the first is based on a MILP (Mixed integer linear programming) formulation.
- the second is based on a new algorithm which uses the integration of Nash Equilibrium of Game Theory and Multi Agents System. The algorithm is designed to distribute electricity from a small number of large generators to millions of consumers and following the idea that supply must always follow demand.

The final aim of the optimization process is to improve the exploitation of the distributed energy and control resources. These tools are expected to be integrated in the distribution management system of the distribution system operator.

In particular, increased efficiency can be realized through dynamically reconfiguring the electrical distribution network on a time-of-day basis in order to follow the load variations. Although additional investment and operational costs are needed for the automated control and monitoring system of remotely operated the switches, the installation of embedded generation that frequently use renewable fluctuating energy resources calls for an improved ability to quickly adapt the configuration in order to facilitate the proper network operation and to reduce network losses. Moreover, optimal reconfiguration is a key procedure in the restoration process of a distribution system after a fault.

The problem has been addressed in the literature by using various approaches, by exploiting specific heuristics and sensitivities, or by applying genetic algorithms and other meta-heuristic search methods, integer programming approaches and hybrid techniques. The performances of modern Mixed Integer Linear Programming (MILP) solvers based on the integration between branch-and-bound and cutting-plane algorithms have been significantly improved also by the implementation of local search techniques and effective heuristics in order to find of a first feasible solution. Therefore, an enhanced MILP model that allows the adequate representation of the optimal configuration problem also in the presence of embedded generation is expected to be of practical use. This task will develop a MILP model of the reconfiguration problem that directly incorporates the typical operating constrains of distribution networks, namely radiality constraints, branch ampacity limits and limited bus voltage deviations with respect to the reference value, taking into account the presence of embedded generation. In order to assess its performances the approach is applied to test networks with elevated number of sectionalizing switches that have been already analyzed in the literature so that the optimal solution is known.

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<tr><td>T3.3</td><td>

Framework for fast deployment of distributed application

Leader: IQU

Participants: HERA, IUNET, ST, UNIBO, UNICAL

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</table>

	The main aim of this task is the implementation of a library of algorithmic elements that will compose the desired distributed application. This approach will be used in order to implement an agent-based control of the energy resources based on broadcasted price signals. A general framework for the deployment of distributed-applications for monitoring and control will be developed, in addition to a graphical GUI and environment. The framework includes a proper set of model-based library algorithmic elements, rich enough to constitute a collection of basic algorithmic elements which, once properly connected, will compose the desired application.
T3.4	**Advanced storage management policies** Leader: UNICT Participants: HERA, IUNET The task is expected to provide the characteristics of management strategies that will allow optimizing the use of all the energy storage resources available in the network with particular reference to those associated with the connection of electric vehicles. The aim of the task is the development of advanced aggregation policies, which implement a kind of virtual power plant, in order to limit the impact of the connection of electric vehicles on the network and try to maximize the available distributed storage for load balancing and frequency regulation. The aggregation policy will take into account that smart-grids are expected to contain local loads and distributed generators (DGs) based on standard and renewable energies. The interface of DGs with the grid is normally obtained using two conversion stages. The first stage is based on ac/dc or dc/dc converters and connects the energy source to the dc link, the second one interfaces the dc link and the grid and it is normally based on single- or three-phase inverters. Regarding the energy flows, two operating modes must be considered for the DGs. In grid-connected operation mode, the utility feeds part of the power consumed by the smart-grid and ensures voltage and frequency stabilization, as for traditional distribution grids. The function of the DGs is to feed energy from alternative energy sources into the grid as close as possible to the loads, thus reducing the distribution losses. On the contrary, in islanded operation mode the smart-grid performs autonomously. Thus, the load power is entirely fed by the DG units and available storage systems. In this scenario, voltage and frequency stabilization falls completely under the responsibility of the power converters. The task aims to propose a suitable control strategy for the power converters also in islanded conditions.

VERIFICATION OF THE RESULTS
T3.1: Mixed stochastic-topological indexes and state estimation The expected result is twofold. On the one hand, we will present a list of synthetic parametersm whose ability in capturing significant features of the grid interconnections will be shown with reference either to true connectivity data provided by (HERA) or to synthetically produced networks with statistical properties analogous to those of real ones. On the other hand, we will determine the configuration of the smart grid in which the distributed signal characterizing its state can be determined through a reduced number of samples. Also in this case, the validity of the approach will be shown in relation to real data set produced by HERA or those obtained by a grid generator.

T3.2: Optimized control of smart grid nodes

The expected results are two optimization frameworks: one based on MILP and one on Game Theory. The characteristics of these optimization techniques will be compared with those already presented in the literature and with those already included in the distribution management systems presently used by the utilities operators.

T3.3: Framework for fast deployment of distributed application

The achievement of the task results will be assessed by the characteristics of the developed library of algorithmic elements and of the general framework for the deployment of distributed-applications for monitoring and control.

T3.4: Advanced storage management policies

The results will be assessed by the performances of the developed control strategy for the power converters also in islanded conditions and the management of the energy storage resources.

RISK ANALYSIS

T3.1: Mixed stochastic-topological indexes and state estimation

The main risk is that the provided synthetic parameters will not be sufficient to efficiently describe the network or too complex to be used. To mitigate the risk, the work will be carried out by a continuous exchange of information with the partner involved in energy distribution (HERA). Another risk is that the implementation of index-based policy cannot be successful if based on a substantially reduced set of information about the nodes. With respect to this, we wish to stress that in addition to the fact that compressive sensing is a very recent area of research in the scientific community,its **distributed** version is only at a very embryonic stage. As such this activity must be considered at very high risk, but also potentially extremely disruptive in case of success for its impact on the design of low-power smart meters and on the development of improved energy profile algorithms for the smart grid. One of the main risks is that the state estimation will work only with redundant available information provided by smart metering devices too costly to be installed in distribution network. Moreover, the state estimation should be fast enough to catch the dynamic changes in the network conditions, due both to the change of the load level and distributed generation. Moreover, the state estimation should provide a result both in normal and unusual operating conditions of the network. In order to mitigate these issues, the developed approach will be tested (out of line) by using the measurement data already available at the distribution management systems of network operators.

T3.2: Optimized control of smart grid nodes

For what concern the solution of the MILP model the main risk is associated to the time required by the solution and the inaccuracy introduced by the linearization of non linear constraints, such as those relevant to the power flow equations in the network. Regarding the Game Theory model, the main risk is associated to Nash Equilibrium solution efficiency, in terms of Pareto optimal solution for the developed model.

T3.3: Framework for fast deployment of distributed application

The main risk sits in the possibility that the library of primitives deployed is not sufficient to implement all the possible sensing/communication/processing tasks required in the nodes of a smart grid with a satisfactory power and performance efficiency.

T3.4: Advanced storage management policies

The main risk is associated to the cost of the developed power converters and the energy storage resources to be adopted. The cost will be compared with those of the components and techniques now available in the market.

RESOURCE ALLOCATION

	HERA	CTTC	IQU	IT	IUNET	POLITO	ST	UNIBO	UNICAL	UNICT		**Total**
T3.1	15		0		10							25
T3.2	25	70	35	32	10	42	26		10			250
T3.3			38		11		18	10				113
T3.4	14				12					16		42
Total	54	70	73	32	43	42	44	10	10	16		430

DELIVERABLE LIST

ID	**Task**	**Name, Kind and Due Date**
D3.1	T3.1	List description and use of the synthetic parameters, R, M18
D3.2	T3.1	State estimation procedure, R, M24
D3.3	T3.2	MILP and Game Theory models for resource optimization and network reconfiguration, R & D, M32
D3.4	T3.3	Library of algorithmic elements and software modules for metering device, R & D, M24
D3.5	T3.4	Dynamic model of the system including DGs and energy storage devices, R, M30
D3.6	T3.4	Control strategies for smart grid converters, R & D, M36

WORK PACKAGE NUMBER AND TITLE	
4	**Integration and Demonstration**

WORK PACKAGE PARTNERS
PHILIPS (NL), ST (I), CRF (I), UNIBO (I), TEL (D), FHG (D), RWTH (D), IFAG (D), NXP-D (D), INSTA (I), HELIOX (), METATRON (I), POLIMODEL (I), UNICAL (I), STUBA (SK)

DESCRIPTION OF WORK

General objectives

This workpackage is devoted to the development of two general demonstrating environments into which technologies and methods developed in the previous workpackages will be plugged-in and put to work to demonstrate their effectiveness and possible synergies.

The effectiveness of the technologies developed within E2SG that cannot be integrated in these coherent environments will be anyway demonstrated by the achievement of individual milestones listed in the corresponding workpackages.

The demonstrating environments will be

- a collection of groups of properly connected intragrid nodes. The configuration of each group of nodes will exemplify one of the main issues in mid-to-low voltage distribution within a medium-size building hosting both residential and business users and featuring local generation capabilities. Nodes will be as close as possible to their real-world implementation though actual energy exchange may be performed at reduced power levels when this does not compromise the demonstration of the key concept. Wherever possible, groups of nodes will be implemented and run in the facility provided by INSTA.

- a simulation environment modeling an intergrid serving nodes and clusters of nodes featuring intragrids. The topological configuration and main electrical features are taken from that of a real-world geographical grid and will be provided by the Italian partners.

Interaction between the intergrid and intragrids will be addressed in the second environment.

Activities will be carried out in three stages and along two parallels paths, one for each demonstrating environment: the first stage will concern, when needed, the individual implementation of the techniques and methods resulting from the research and development workpackages, the second stage will concern the integration of these implementation into the demonstrating environment, the third stage will concern testing and measurement.

The completion of a stage will materialize a global milestone for this workpackage.

Stage 1: Implementation of E2SG building blocks and mechanisms

This is the interface point between the research and development workpackages of the project and the demonstration activities in this workpackage. Partners will concretize the results of their efforts to produce two sets of first individual implementations aimed at taking their place in one of the two demonstrating environments. Namely

Intragrid environment

- An implementation of optimal MPPT-like algorithm(s) developed for innovative green energy sources, as studied in 1.a. The implementation will be either in MATLab/Simulink or in power systems simulation tools such as PSCAD and EMTP-RV, but the control algorithm part will be designed with a microcontroller or FPGA realization in mind.
- An implementation of one or more optimization-based algorithms for the synthesis of sinusoids by means of filtered switching signals which guarantee high accuracy in the control of frequency and phase of the current delivered to a smart grid node.
- An implementation of algorithms identifying energy consumption or generation profiles from the observation of data coming from intragrid meters and of the algorithms allowing predictive control of smart appliances to optimize energy consumption and maintain power balance between (renewable) energy sources while also deciding whether it is convenient or simply needed to acquire energy from the global intergrid.
- The implementation of a low energy wireless transceiver for smart meters compliant with the new IEEE 802.15.4 standard and their integration into smart meters unit with “glue and play” capabilities.
- The implementation of a V2G interface and of a battery management system into a demonstrator including one or more plug-in hybrid vehicle like a city car or a sport-car.
- The implementation of a smart, building-level control module taking into account consumption data provide by distributed sensors to compute the profile of power/energy requirements of the building and to forecast needs to optimize energy consumptions.
- Integration of interfaces and power handling block in SOI technology.

Intergrid Environment

- An implementation of an improved synchrophasor estimation algorithm for the application in distribution grids.
- An implementation of both the procedure to compute the node and link indexes previously developed and a procedure to evaluate the actual importance of a node or a link by simulating its failure in a given grid and trying to restore the power flow towards the consumers.
- An implementation of algorithm for intergrid control based on the formulation and solution of instances of mixed-integer linear programming problems, possibly addressing different optimization objectives and the interaction between multiple decision makers.

- An implementation of the algorithms optimizing the use of all the energy storage resources available in the network with particular reference to those associated with the connection of electric vehicles.

Stage 2: Integration of E2SG building blocks and mechanisms into the demonstrating environments

This is the point at which most individual implementations are coordinated to take their place into the corresponding demonstrating environment. In particular

Intragrid environment

i. algorithm in stage 1.i will be implemented by means of a microcontroller or an FPGA and coupled with a proper generator (either the real plant or its hardware emulation)

ii. the switching policies resulting from the applications of the algorithms in stage 1.ii will be implemented in a real inverter and connected to a load.

iii. a prototype of powerline communication exploiting conversion ripple will be implemented. The system will consist of a bus driven by a master converter (DCDC or ACDC) loaded by appliances featuring a further DCDC conversion. Communication will be tested from the master to the loading devices.

iv. One or more prototype systems representing metering units whose data are collected at a central node are built, possibly integrating wireless transceivers developed within E2SG.

v. Implementation of a grid-compatible solar panel inverter and a bidirectional EV storage converter.

Intergrid Environment (only partial the research is covered since former part of ENEL is at the time of the GA not eligible, plan is to distribute the research to ST/HERA/IUNET)

vi. results achieved by milestones from stage 1.viii to stage 1.xi will be coordinated to work on the same grid (or grids in case more than one real-world instance if available), whose topology and main electrical features will be provided by HERA.

Stage 3: Testing and measurements of E2SG technology in realistic scenarios

This is where the two demonstrating environments developed in the first two stages are configured and put to work to reproduce, emulate or simulate one or more realistic scenarios. This will allow to demonstrate

Intragrid environment

i. The advantages of the algorithms in stage 1.i and stage 2.i in finding and tracking the best power transfer conditions from sources such as solar cells or other renewable alternatives.

ii. The advantages in terms phase accuracy and fast response to phase control stimuli of waveform generation such as those in stage 1.ii and stage 2.ii

iii. The possibility of effectively communicate over powerlines exploiting conversion ripple, thus avoiding all the devices (e.g., transformers) needed to separate power waveforms from information signals on the same wire (stage 2.iii)

iv. The possibility of effectively exploiting new techniques and methodology for the deployment of low power metering unit, possibly exploiting wireless transceiver in stage 1.iv and stage 2.iv to extensively deploy meters whose data are collected to reconstruct the state of the grid nodes.

v. The effectiveness of improved V2G interfaces and battery managements systems in optimizing the coupling between the distribution grid and a plug-in hybrid vehicle.

vi. The effectiveness of the newly implemented building-level control modules in modeling and forecasting energy needs and optimizing building energy performance (collects stage 1.iii and stage 1.vi).

vii. The effectiveness of newly built SOI-based devices in improving the performance of power interfaces.

viii. The efficiency of the newly designed grid-compatible inverter to transfer energy from solar panels to storage units through the distribution grid.

Intergrid Environment

ix. The improvement in phasor measurements due to the application of the techniques in stage 1.viii when they are applied to real-world intergrids.

x. The effectiveness of the node and link indexes in stage 1.ix in identifying the importance of an element in a real-world distribution grid, i.e. the fact that in case of a failure the grid is exposed to a substantial degradation in performance and eventually to discontinuation of service or islanding.

xi. the effectiveness of mixed-integer linear programming implemented in stage 1.x in determining the optimization policies to apply to a real-world grid, possibly taking into account different optimization objectives and the interaction between multiple decision makers.

xii. The effectiveness of the algorithms implemented in stage 1.xi to optimize the use of all the energy storage resources available in the grid, with particular reference to those associated with the connection of electric vehicles.

Objectives by partner

PHILIPS

WP4 leader; Demonstrate/Test/Validate the use cases in the Home Environment.

HELIOX

A demonstrator of a single solar panel coupled, smart grid compatible inverter will be build. This inverter will be based on the architecture and topologies as outcomes of WP1. The design will be translated into (realistic) available components, bread boarded and as such validate the work done in WP1. After evaluation on key functionality (Smart Grid compatibility, mains isolation, MPPT, thermal and EMI behavior), also the mechanical casing of the inverter will designed and realized. This will be fine tuned with the detailed PCBA design in order to achieve optimal functionality when combined. The software controlling the system will be generated and tested. Finally the complete system will be tested in the field in

Smart Grid environment scenarios as described above.

-Also a demonstrator on a bidirectional EV charger will be realized. This demonstrator will be based upon the selected architecture and topology results from T1.1.f The smart grid compatible bidirectional will be implemented in “real life” boundary conditions, thus validating the results from WP1. Special attention will (have to) be given to EMI, cooling and mains isolation of the converter. The software that controls the converter will be generated and evaluated. Finally the bidirectional charger will be tested in Smart Grid environment scenarios.

Both demonstrators will use the results of the other partners to implement and achieve appropriate communication with the Smart Grid.

Remark regarding the initially planned ENEL contribution, which is at GA time (March’12) not eligible:

In the submitted FPP originally ENEL proposed a contribution in the research work in the areas on field experimental activity and modeling activity to scale up results and simulate long time module and string operation.

During the negotiation phase ENEL stepped out of the project and the technically speaking, the activity and tasks formerly in charge of ENEL are not covered within the budget decision in December 2011: If they are seen as eligible (Italian and ENIAC JU approval not given until GA), they are planned to be moved to:

1- ST Italy: power device tuning and field test

2- IUNET: device qualification and field test.

3- HERA: electric utility scenario of smart grid mngt and work load statistical profiling

Since during the negotiation phase and until the GA this is not finalized the preparation of the contributions of ST-Italy, IUNET and HERA will be clarified during the course of the project.

CRF

The activities are aimed to the integration of the outcomes of the project, and in particular the developed V2G interfaces and battery management systems, into one or more Plug-in hybrid vehicle demonstrators for the final validation and the real usage testing. In particular up-to-date the envisioned platforms for the demonstration are expected to be

- A city car
- A sport-car

CRF will also take care of the vehicle harnesses and in particular the physical layer of the power V2G connection for a better integration with the infrastructure, also with the option of including inductive charging systems. This in compliance with all the present and forthcoming ISO/IEC standards.

ST

will design and develop a smart building-level control module. It will take into account all consumption data provided by the distributed sensors and compute a detailed profile of the power/energy requirements of the building, as well as a forecast of possible improving actions in order to optimize energy consumption at different hierarchical levels. These levels represent the counterpart of the modular nature of the control module, which has to be able to interact with other similar modules so that energy management can be applied to single units (homes) as well as structured systems (entire buildings).

ST will also contribute to investigate how switching power converters for renewable energy conversion can msotly benefit from high performance silicon semiconductor devices/switches as modeled and characterized in WP1. To reach this goal ST will implement a prototype of DC-DC converter in a proprietary BCD technology for microgeneration application.

ST will develop a monolithic controller, realized in a proprietary BCD technology, specially designed for high-volume consumer market and optimized to provide integrated power supply solutions for both ON-grid and OFF-grid solar applications. This integrated solution greatly simplifies the design procedure and offers significant saving in terms of cost and development time of the application board realization. It allows developing high efficient PV systems as embeds a MPPT algorithm to maximize the energy provided from DC input supply unit (such as a concentrated PV panel) to output. The IC will support SPI interface for configuration purpose and communication.

The IC has to be able to provide a set of control signals, over-voltage, over-current and over-temperature protections and drive functions to successfully manage operations for a PWM controlled DC-DC converter based on 2-phase interleaved flyback operating in transition mode. The advanced control techniques is aimed mainly to high efficiency and low EMI, reducing input decoupling capacitor size. Thanks for these features the IC will be perfectly tailored to advanced microgeneration application as well innovative technologies, such as microinverter and power optimizers.

UNIBO

will cover the development and implementation of energy sources models and the statistical characterization of sub-domain consumption profiles. More precisely sources are solar-driven energy converters (both thermal and photovoltaic) and geothermal equipments. These models have to strike the right trade-off between precision and computational complexity so that they match the resources of the advanced metering system developed in WP2.

METATRON

will test and validate on the bench the BMS and theV2G interface developed by CRF and EFFEGi elettronica in WP2 towards the qualification on the basis of the automotive constraints and standards. Metatron as the final supplier of the system will also prepare the subsystems for the final industrialization.

SILVACO

Will perform large matrix simulations to optimise the performance of indoor PV device circuits. Various illumination and deployment scenarios can be investigated and optimised. Designs will utilise mixed mode and available compact models to accurately reflect the performance of the designed PV devices in circuit configurations.

POLIMODEL

will enter in the final part of the project and will integrate the outcomes (and in particular a bidirectional V2G module) on an advanced EV platform for urban use which will also include on-board photovoltaic generation features.

TEL

TELEFUNKEN Semiconductors (TEL) will contribute a demonstrator with focus on intelligent interfacing to the smart grid and effective energy handling. On base of the specification and design tasks in WP1, the resulting interface and power handling blocks will be taken over and will be combined to an integrated prototype demonstrator. As preferred technology, chosen from the existing portfolio, will be a SOI technology, which is tailored for lowest standby power consumption. The resulting layout will comprise explored building blocks for interfacing and power handling from WP1 experiments. A full mask set is produced and a final wafer processing will provide hardware for the final test and characterization campaign.

TEL will demonstrate intelligent, robust prototype drivers for products like motors, energy buffers or lighting. Beside highest efficiency the secure data exchange between grids and consumers will be demonstrated. The resulting efficiency of power interfaces will be evaluated in a measurement campaign and the results will be compared to the state of the art. The goal is to optimize the total power consumption by strategic and technological measures by 15 to 20%.

LEITAT

Demonstration of smart meters modules for either power generation or consumption metering. These modules will integrate low power wireless communication based on 802.15.4 standard (preferably 6LoWPAN). Special attention will be paid to easy installation according to the concept “glue and play” to ensure a good market acceptance.

Leitat will also contribute by integrating these smart meter modules in the proposed demonstrators and scenarios.

RWTH

will support the development of the demonstration hardware based on the smart meter wireless transceiver compliant to the IEEE802.15.4.g standard. The RF section will be developed in close cooperation with the partner INSTA. An ultra low power AC/DC power supply subsystem will be developed and demonstrated within the hardware framework provided by the other partners.

INSTA

INSTA will bring in specifications for product relevant applications and will demonstrate energy optimized solutions which are based on partner’s contributions.

To demonstrate and validate E2SG concepts, INSTA will develop two functional prototypes of devices which will be defined in the course of the project, both in software and hardware. INSTA will assist in the proof of concept in the Intragrid, based on the two demonstrators developed especially for E2SG and existing devices. Besides existing KNX or wireless products which are under development, also devices with the newly established “Leditron” Standard will be used.

INSTA will evaluate ultra-low power standby power supplies to reduce the standby-consumption significantly. This work will be performed in order to get general design guidelines and expertise in ultralow power supplies rather than developing a power supply for one special application. Nevertheless, the proof on concept will be done using one demonstrator defined in the course of the project together with the partners. Furthermore, INSTA will develop at least one prototype of driver of LED light sources based on the intelligent, robust drivers...

On the software side INSTA plans to implement system power management functionality into an existing platform. Therefore, without need of new components, Intragrid concepts can be tested and optimized.

To validate the results of E2SG on a system level the INSTA development centre in Lüdenscheid, Germany will be used. The building was built in 2009 and is equipped with about 1500 state-of-the-art home automation nodes, fully connected via KNX-TP1, KNX-IP and DALI. Complementary to this home automation network, an Ethernet-Test network is available throughout the building. The building uses a passive heating and cooling system with a large number of sensors, practically all of which are accessible via network. For the proof of concept this system can be extended by functional prototypes developed for Milestone 5a. The energy management software can be implemented on one of the embedded PC platforms, which are already available in the system and which are today used predominantly as User Interfaces.

IFAG

Infineon will integrate and make available the results from WP2 (hardware - metering platform as functional prototype based on the security metering chip) and integrate it together with the other parts (especially the gateway security component from WP2 “over the grid communication”) into an functional demonstrator which could be interfaced to the other relevant building blocks (e.g. networking components, management equipment and institutions, testbed and environment).

We will test and verify especially the security and privacy protocols within the system.

Infineon will contribute to the integration of the provided building blocks into a demonstration environment and test the functional and esp. security interoperability with the overall demonstrator environment. Infineon will participate in the definition and implementation of the test scenarios and the processing of the results.

NXP-D

Integration of E2SG building blocks and mechanisms in Software and Hardware:

NXP-D will provide according building blocks (trusted module) for smart meter security as defined in WP2 (incl. needed software libraries).

In order to show the functionality NXP will integrate the software to a smart card device

(native or Java card) to provide the following functions to the system:

- Mutual authentication between requesting reading entity and the smart grid node based on PKI cryptology
- Emulation of interfacing (e.g. I2C) to adapt to target architecture
- Ensure the integrity of data by the means of hashing and signing the data.
- Manipulation detection by the using:
    - Challenge response schemes to check the integrity of critical elements in the system (with active communication)
    - Make use of hardware intrinsic security (unique keys not stored in the memories of the security device

The demonstration will be built on an existing security device in order to be as close as possible to a real system which needs to undergo a common criteria security certification.

Integration of the E2SG mechanics and solutions in the demonstrator environment (selected usage scenarios): NXP-D will support the integration of the provided building blocks into common demonstrators and ensure the interoperability with other building blocks within the demo environment.

Testing: E2SG scenarios: NXP-D will support the definition of the scenarios for smart meter implementation and will participate in the evaluation and test of the demonstrators.

HERA

Will provide information on the topology of real distribution grids to be used in demonstrating the effectiveness of E2SG technologies in T4.9 and T4.10.

IUNET

Will be mainly involved in T4.1, T4.2, T4.8 and T4.9, and T4.11 since these demonstrations concern technologies in which IUNET is heavily committed responsible. Interactions with demonstrators of analogous kind will take place in T4.3 and T4.7.

UNICAL

UNICAL will provide building blocks (simulation programs and/or real software modules) both for smart conversion devices and for distributed smart metering as defined in WP2 (incl. needed software libraries). In order to show the functionality UNICAL will integrate a WSAN platform with the Smart Grid platform provided by the Project Industrial Partners and the implemented demonstrator will show real-time profiling of building/home energy expenditure and, possibly, intelligent actuation strategy to save energy.

UNICAL will support the integration of the provided building blocks into common demonstrators and ensure the interoperability with other building blocks within the demo environment.

Finally, UNICAL will contribute to the definition of the scenarios for smart meter implementation and will participate in the evaluation and test of the demonstrators.

STUBA

will provide a demonstrator of a developed smart meter module with different wireless communication interfaces, dedicated for residential use.

STUBA will also contribute to the integration of the developed building block in the proposed demonstrators and scenarios.

TASK LIST	
Tasks are transversal to stages and concern the development of single demonstrations up to stage 3.	
T4.1	Demonstration of accurate sinusoidal synthesis by means of inverters

T4.2	Demonstration of powerline communication exploiting conversion ripple
T4.3	Demonstration of innovative metering systems for distributed deployment
T4.4	Demonstration of improved V2G interfaces and battery management for hybrid vehicles
T4.5	Demonstration of building level control for energy optimization
T4.6	Demonstration of SOI-based devices for power interfaces
T4.7	Demonstration of interfaces between the grid and solar panels
T4.8	Demonstration of high-accuracy PMU
T4.9	Demonstration of criticality discovery by network topological indexes
T4.10	Demonstration of grid control based on mixed-integer linear programming
T4.11	Demonstration of storage optimization by exploiting electric vehicles
T4.12	Demonstration of IC for smart power conversion

VERIFICATION OF THE RESULTS

The availability of working prototypes is the main indicator of success of the tasks from T4.1 to T4.7.

Beyond that, all the deliverables of this work package are intrinsically measurable since they refer to prototypes or to simulation of realistic systems for which quantitative performances can be given. In particular, whenever a “classical” solution can be identified, the reports included in the deliverables will describe it and compare its performance with what is obtained by observing the prototype or the simulator in operation. Increase of performance figure with respect to “classical” situations will be a clear mark of success.

RISK ANALYSIS

Beyond the generic risk associated to research and development activities, there are two risk-classes in this work package.

The first concerns the tasks committed to produce hardware prototypes, the second includes tasks dealing with simulation of real systems.

Hardware prototypes will contain both digital and analog parts.

To mitigate the risk of incorrect implementation of an analog block, the partners will try to design systems by maximizing the recourse to existing circuitry. Analog components that are object of direct development in E2SG (e.g. the wireless transceivers for metering systems) will thus remain in the highest-risk blocks.

Digital hardware usually presents less implementation problems though a software-based emulation will be used as a backup option in all those cases in which the digital part is the keystone of the overall demonstrator.

Software demonstrators usually incur in a complexity-risk, i.e. they work only either at the expense of an unreasonable amount of computing resources or they are able to take into account only reduced-size models of the true systems. This risk can be partially mitigated by obtaining information on the minimum size of the system allowing realistic considerations at the earliest stage of development and by driving the development so that it may focus separately on specific aspects of the grid operations rather than trying a general, overly complete, simulation.

RESOURCE ALLOCATION

	INSTA	LEITAT	ST	CRF	IUNET	UNIBO	TEL	UNICAL	RWTH	IFAG	NXP-D	PHILIP		SIL	HERA	HELIOX	MET	PM	STUBA
T4.1					9											4			
T4.2					9					4	3	10							
T4.3	32	20						2	24	20	12								6
T4.4				40													30	25	
T4.5	24	10	40			40		2		11	3	24							2
T4.6							66					10							
T4.7								2				12		42		50			
T4.8					8														
T4.9					8										4				
T4.10															4				
T4.11					5														
T4.12			55																
	56	30	95	40	39	40	66	6	24	35	18	56		42	8	54	30	25	8

DELIVERABLE LIST		
ID	**Task**	**Name, Kind, and Due Date**
D4.1	T4.1	Prototype of inverter for sinusoid synthesis + measurements, P+R, M36
D4.2	T4.2	Prototype of ripple-based powerline communication system + measurements, P+D, M36
D4.3	T4.3	Prototypes of distributed meters with wireless interfaces è measurements, P+R, M36
D4.4	T4.4	Prototype V2G interfaces + measurements, P+D, M36
D4.5	T4.5	Prototype of building-level control with subsystems + measurements, P+R, M36
D4.6	T4.6	Prototype power drivers with new SOI technology + measurements, P+R, M36
D4.7	T4.7	Prototype interface between the grid and solar panels + measurements, P+R, M36
D4.8	T4.8	Simulator of PMU applied to a real distribution grid, R, M36
D4.9	T4.9	(not eligible at GA, former part of ENEL): Simulator of network operation monitoring by means of topological indexes, R, M36
D4.10	T4.10	Simulator of network operation optimized by means of mixed-integer linear programming, R, M36
D4.11	T4.11	Simulator of storage optimizing policies, R, M36
D4.12	T412	Monolithic controller for solar applications, P + R, M36

MILESTONE LIST		
The completion of each of the stages described above will materialize a global milestone for this work package.		
ID	**Task**	**Name, Kind, and Due Date**
M4.1	NA	Individual implementation of selected methods and technologies
M4.2	NA	Integration in the demonstrating environments
M4.3	NA	Testing and measurements of the methods and technologies under conditions as close as possible to the real ones. → not included until funding is available for ST, HERA, IUNET (former ENEL task)

WORK PACKAGE NUMBER AND TITLE	
WPM1	Dissemination, exploitation and standardization

WORK PACKAGE PARTNERS
IFAG (D), ST-I,(I), HERA(I), FGE(I), MET(I), PM(I), IUNET(I), POLITO (I), UNIBO (I), UNICAL(I), UNICT(I), AMS(A), ONSEMI-B (B), INSTA(D), NXP-D(D), TEL(D), FHG(D), RWTH(D), IQU (ES), LEITAT (ES), CTTC (ES), HELIOX (NL), NXP-NL (NL), PHILIPS (NL), IT (P), STUBA (SK), RDAS (SK), ENECSYS (UK), IQE (UK), SIL (UK), UoS (UK)

DESCRIPTION OF WORK

General objectives

The goal of the present work Package is to maximize the impact of the project in the scientific, technical and commercial life of the EU and possibly outside EU. This goal will be pursued in three ways

- Dissemination of E2SG activities and results
- Standardization
- Exploitation

Objectives by partner

The purpose of this WP is three-fold. First, it deals with all the issues related to the dissemination of the project progress and achieved results to a wide audience, including designers, engineers and scientists from industry and SMEs, as well as researchers, instructors and students from educational institutions and research centers. Different dissemination means will be adopted for achieving this objective, including the set-up and maintenance of a lively, user-friendly and easily-accessible web-site. The activities regarding web-site maintenance and dissemination in a broad sense are concentrated in Tasks M1.1 and M1.2, respectively. The second goal of this WP concerns the necessary definition of Standards related to the Smart Grids and the Energy Distributions. The last piece of work in this WP regards the fundamental task of project result exploitation. Task M1.4 covers the exploitation activities, which include also market analysis. Exploitation comprehends the advertisement and promotional activities for awareness creation about the outcomes of the project, as well as the preparation of the exploitation plans by the individual partners and by the Consortium as a whole. Market analysis is an important building brick towards the maximization of the impact of the project and they will pave the way to best commercial exploitation of the achieved results.

Each partner will contribute to the execution of the four tasks in this WP. Following each own nature and mission Industries will be majorly biased to the exploitation of the

results and the Academies and research centers to the dissemination. The coordinator will place the major effort in the project web site set-up and maintenance but all partners will contribute building the content.

TASK LIST	
M1.1	Set-up and maintenance of the project web-site The objective of this Task is the set-up and maintenance of a public web-site that will constitute the main point of collection of the project information, including public deliverables, summary of major scientific achievements, advertisement, dissemination and training activities. Maintenance and incremental updates will take place monthly, major revisions and restructuring will occur every six months. The web-site will be mastered by partner IFAG. The site will link CIRCA (http://circa.europa.eu), see task M1.1, for the communication with the ENICA JU and the reviewers. Only after evaluation of CIRCA for the purpose of internal communication, a link to a private, password-protected section of the web-site might be reserved for communication internal to the E2SG Consortium.
M1.2	Dissemination The partners of the E2SG Consortium will disseminate the project results through various means, including scientific presentations at international conferences and workshops, publication of papers in international journals, magazines and conferences, participation to activities such as tutorials, panels, round tables and seminars in international events. It is expected that the project will generate a large amount of innovative, scientifically sound research results, which could lead to several publications. A measure of success of the scientific impact that the project will have is certainly the number and quality of the papers published jointly by the partners. Given the size of the Consortium, the scientific excellence of the partnership and the broad range of innovative topics covered by the project, we predict that no less than 30 conference and 10 journal papers will be published within the project lifetime (or immediately after project conclusion). A dissemination plan will be prepared and issued at the beginning of the project, and updated at month M18. It will serve as reference for the execution of the dissemination activities. Single partners dissemination activities are described in section 2.1
M1.3	Standardization The standardization activities will start at the very beginning of the project as they are simultaneously driver and outcome of the project activities. The Standards panels to be targeted are described in section 5.3. The task foresees an initial plan to be delivered at month six and updated at month 20. At month 18 and 36 the first report andd final report of the achievements of the projects with respects to the standards definition and contributions are planned. Detailed description of each partners contribution to the standardization activities can be found in section 2.2
M1.4	Exploitation The exploitation of the project results is the final step which is required to make

	the E2SG project a success from the point of view of both industrial and societal impact. In order to implement a successful exploitation strategy, the partners of the E2SG project, as well as the Consortium as a whole, must take the appropriate actions and measures already during the project lifetime to prepare for this target. The planned activities in this Task include the advertisement and promotion of the E2SG outcomes following well established strategies based on participation to fairs and exhibits in the key areas of electronics (between others) design, offering of on-site presentations and demos to potential customers, licensing trial versions of the tools to interested partners, set-up joint marketing and distribution agreements to enhance the visibility of the new technologies, especially outside Europe. All the E2SG partners will prepare result exploitation plans, indicating in detail what market and business opportunities will be favored by the development of the new technologies made in E2SG. A preliminary plan, jointly compiled by the Consortium as a whole and by each individual partner will be delivered at M18. The exploitation plan will then be finalized at the end of the project. Instrumental to the implementation of effective preparatory actions to result exploitation is the market surveying activity, which is part of this task. Market surveying will be a continuous effort, spanning the entire duration of the project. Three updates of a market survey document will be delivered by the partners at months M6 and M30. Single partners exploitation activities are described in section 2.1

VERIFICATION OF THE RESULTS
The results of the present work package will be measured in the quality of the Deliverables listed below.

RISK ANALYSIS
Given the scientific, industrial and commercial proven experience of the partners in the Consortium we do not foresee any risk in the present work package unless there will be a lack of technical results. So the risk are related to the technical risks related in the other work packages,

RESOURCE ALLOCATION					
	M1.1	M1.2	M1.3	M1.4	**TOTAL**
IFAG	0,5	0,5	2	1	4
INSTA	0	2	1	3	6
NXP-D	0	0,5	1	0,5	2
TEL	0	1	0	1	2
FHG	0	3	1	2	6
RWTH	0	3	1	2	6
ST	0	2	1	3	6
CRF	0	2	1	3	6
HERA	0	2	1	3	6
FGE	0	2	1	3	6
MET	0	2	1	3	6
PM	0	2	1	3	6
IUNET	0	3	1	2	6
POLITO	0	8	1	1	10
UNIBO	0	1	0	0	6
UNICAL	0	3	1	2	6
UNICT	0	3	1	2	6
AMS	0	2	1	3	6
ONSEMI-B	0	2	1	3	6
IQU	0	2	1	3	6
LEITAT	0	3	1	2	6
CTTC	0	3	1	2	6
HELIOX	0	3	1	2	6
NXP-NL	0	2	1	3	6
PHILIPS	0	2	1	3	6
IT	0	3	0	0	3
STUBA	0	3	1	2	6
RDAS	0	3	1	2	6
ENECSYS	0	3	1	2	6
IQE	0	3	1	2	6
SIL	0	3	1	2	6
UoS	0	3	1	2	6
TOTAL	3	86	35	86	210

DELIVERABLE LIST		
ID	**Task**	**Name, Kind and Due Date**
DM1.1.1	M1.1	Set-up of the Public E2SG Web-Site; M1
DM1.1.2	M1.1	First Report on Web-Site Accesses and Performed Updates; M18
DM1.1.3	M1.1	Final Report on Web-Site Accesses and Performed Updates ; M36
DM1.2.1	M1.2	Press Release: Launching the E2SG Project; M1
DM1.2.2	M1.2	Initial Dissemination Plan; M3
DM1.2.3	M1.2	First Report on Dissemination Activities; M18
DM1.2.4	M1.2	Final Report on Dissemination Activities; M36
DM1.3.1	M1.3	Standards :first plan ; M6
DM1.3.2	M1.3	Standards first report; M12
DM1.3.3	M1.3	Standards final report; M24
DM1.3.4	M1.3	Standards Final report : M36
DM1.4.1	M1.4	First Release of Market Survey Document; M6
DM1.4.2	M1.4	Preliminary Exploitation Plan; M18
DM1.4.3	M1.4	Final Release of Market Survey Document; M30
DM1.4.4	M1.4	Final Exploitation Plan; M36

MILESTONE LIST; expected date and mean of verification		
MM1.a	Review of standardization, exploitation, dissemination activities; M18	The Milestone shall be achieved by the achievements of the following Deliverables: DM1.1.1, DM1.1.2, DM1.2.1, DM1.2.2, DM1.2.3, DM1.3.1, DM1.3.2, DM1.4.1, DM1.4.2
MM1.b	Final Review of standardization, exploitation, dissemination activities; M36	The Milestone shall be achieved by the achievements of the following Deliverables:DM1.1.3, DM1.2.4, DM1.3.3, DM1.3.3, DM1.3.4, DM1.4.3, DM1.4.4

WORK PACKAGE NUMBER AND TITLE	
WPM2	**Management and IPR**

WORK PACKAGE PARTNERS
IFAG (D), ST-I,(I), HERA(I), FGE(I), MET(I), PM(I), IUNET(I), POLITO (I), UNIBO (I), UNICAL(I), UNICT(I), AMS(A), ONSEMI-B (B), INSTA(D), NXP-D(D), TEL(D), FHG(D), RWTH(D), IQU (ES), LEITAT (ES), CTTC (ES), HELIOX (NL), NXP-NL (NL), PHILIPS (NL), IT (P), STUBA (SK), RDAS (SK), ENECSYS (UK), IQE (UK), SIL (UK), UoS (UK)

DESCRIPTION OF WORK

General objectives

- *Technical and Administrative Project Management*
- *IPR Management*
- *ENIAC JU rules compliance*
- *Communication with Eniac JU and reviewers*

Objectives by partner

The goal of WPM2 is to ensure that the overall objectives of the E2SG project, as outlined in the proposal, will be achieved within the foreseen time and budget. This requires a permanent and close contact with all partners in order to enable the project coordinator to act as interface and catalyst for the project within ENIAC JU rules. The work to be performed in this WP includes: Set-up and implementation of all the project management structures, as described in Section 2.1; organization of the project kick-off meeting and of the periodic management and technical meetings; execution of day-by-day project administration and monitoring of work progress; technical steering of the project; identification of potential risks and definition of appropriate recovery plans; monitoring of the performance of the Consortium partners; implementation of corrective actions to cope with possible misbehaviors of some partners; definition of standards, procedures and conventions regarding matters such as documentation and review procedures; preparation and delivery to the ENIAC JU of the required documents and reports; organization and preparation of the project review meetings; preparation of the Consortium Agreement document which, among other matters, will set-up proper policies and guidelines for intellectual property protection, internally and externally to the Consortium, and it will set-up and manage the IPR management database.

The project Coordinator, IFAG, as primus inter pares will lead all tasks and be the unique executor of the first. All partners will collaborate in the other tasks because only with a proactive and committed team such an ambitious project can be successful. The partners shall actively provide their inputs for the projects and deliverables reports and support the

IPR management activities in shaping the EPCA. IFAG as project coordinator will work in the present work package with effort of 18 pm (not funded!) and all the other partners will collaborate with 1 pm each.

TASK LIST	
M2.1	Implementation of project management structures In this task, the project coordinator will set-up and implement the necessary project management structures, in accordance with the schemes described in Section 6.2. In addition, the project coordinator will convene the E2SG project kick-off meeting no later than one month since the official start date of the project
M2.2	Project Management In this task, the project coordinator and all the partners will perform the due project management activities, as described in Section 3.1 of this proposal. Such activities are comprehensive of technical, strategic, administrative and financial actions, all devoted to an efficient, on-time execution of the project work and the delivery of the corresponding results. Key tool for project management will be CIRCA (http://circa.europa.eu). It will be used as a repository for communication and documentation exchange among the partners and ENIAC JU. It will be linked from the project public web-site developed and maintained in the context of Task M1.1 (WPM1). Part of the project management is the duty of the project coordinator to be the primary contact point to the ENIAC JU and the reviewers for all the matters, technical and administrative, concerning the execution, progress and management of all project activities. Any action concerning communication to the ENIAC JU and the reviewers, as well as the exchange of material, technical, administrative and legal documents occurs in the context of this task.
M2.3	IPR management This task concerns the establishment of appropriate policies and rules for the management of background and foreground IP for the technologies developed within E2SG. As common practice in the recent past ENIAC JU funded projects the activity will converge in the EPCA (Eniac Project Consortium Agreement) in which the partners shall define the guidelines for information exchange of pre-existing know-how and within its annexes there will be the Initial release of the IPR Management Database. IPR management will be a continuous activity covering the entire project lifetime, collecting a list of reusable and non-reusable pre-existing know-how available at the start of the project, and new know-how generated by the R&D activities during the project.

VERIFICATION OF THE RESULTS
The Management activities will be measured through the punctuality in releasing the deliverables listed below within the timescales set by the proposals and the ENIAC JU regulations.

RISK ANALYSIS

These generalized risks are particularly likely in projects requiring the interaction of several industrial partners operating in similar business sectors (thus potentially competing for the same market) and the participation of SMEs to the R&D/innovation-related activities. However, this potential conflict can evolve into strength if the parties clearly specify the work to be done and the respective expectations, resulting in mutual benefits. Although E2SG may present some of these risks, the commitment of the partner Consortium to the ENIAC JU program and the management structures of WPM2 guarantee an appropriate precautionary contingency plan.

The work in E2SG will be performed in a distributed environment (the project has 35 partners). In spite of the large number of partners, this is no source of risk: modern working protocols have demonstrated that distributed work is the key for success, as this approach facilitates concentration in small groups or sites of very focused and homogeneous competence, thus minimizing the burden of handling and coordinating huge teams. Communication technologies help in keeping the work synchronized; cutting away redundancies that may arise when the group at work is too large. Obviously, each site should offer enough resources to allow the performance of self-contained portions of the development. This is definitely the case of the project management structures we have defined, together with state-of-the-art resource and financial control policies will favor, on one hand, a synergic approach to the solution of the problems targeted by on the other hand, they will reduce to a minimum duplication of work and promote chaining of results.

Considering the issues related to competition between the industrial partners of the Consortium, it can be noted by looking at the work-plan that appropriate policies for IPR management will be set-up in the Consortium Agreement, to be signed before the project actually starts, and that IPR management will continuously be on the project agenda, according to the procedures planned in this WPM1

Strictly related to the management aspect, the major companies in the project and ST-I in particular (as the project lead) have long lasting experience in funded projects. Academies have put a good plan in place to minimize any risks related to dissemination activities. Any risks related to IP conflicts will be mitigated through the EPCA and by putting in place a clear management structure.

The Project Management Structure described in section 2.1 is well experienced and proven to be successful.

	M2.1	M2.2	M2.3	**TOTAL**
IFAG	1	10	7	18
INSTA	0	0	0	0
NXP-D	0	0	0	0
TEL	0	0.5	0.5	1
FHG	0	0.5	0.5	1
RWTH	0	0.5	0.5	1
ST	0	0.5	0.5	1
CRF	0	0.5	0.5	1
HERA	0	0.5	0.5	1
FGE	0	0.5	0.5	1
MET	0	0.5	0.5	1
PM	0	0.5	0.5	1
IUNET	0	0.5	0.5	1
POLITO	0	0.5	0.5	1
UNIBO	0	0.5	0.5	1
UNICAL	0	0.5	0.5	1
UNICT	0	0.5	0.5	1
AMS	0	0.5	0.5	1
ONSEMI-B	0	0.5	0.5	1
IQU	0	0.5	0.5	1
LEITAT	0	0.5	0.5	1
CTTC	0	0.5	0.5	1
HELIOX	0	0.5	0.5	1
NXP-NL	0	0.5	0.5	1
PHILIPS	0	0.5	0.5	1
IT	0	0.5	0.5	1
STUBA	0	0.5	0.5	1
RDAS	0	0.5	0.5	1
ENECSYS	0	0.5	0.5	1
IQE	0	0.5	0.5	1
SIL	0	0.5	0.5	1
UoS	0	0.5	0.5	1
TOTAL	1	27	24	52

DELIVERABLE LIST		
ID	**Task**	**Name, Kind and Due Date**
DM2.1.1	M2.1	Project Management Handbook; M3
DM2.2.1	M2.2	First Periodic Project Report on Progress, Use of Resources and Financial Statement; M12
DM2.2.2	M2.2	Second Periodic Project Report on Progress, Use of Resources and Financial Statement
DM2.2.3	M2.2	Third Periodic Project Report on Progress, Use of Resources and Financial Statement; M36
DM2.2.4	M2.2	Final Publishable Summary Report ; M36
DM2.3.1	M2.3	IPCA and Annex IPR Management Database: Pre-Existing Know-How ; M3
DM2.3.2	M2.3	IPR Management Database Table: Intermediate Release ; M18
DM2.3.3	M2.3	IPR Management Database Table : Final Release; M36

MILESTONE LIST; Month and mean of verification		
MM2.a	Project Management Setup; Month 3	Availability and quality of DM2.1.1, and DM2.3.1, Kick – Off Meeting Minutes available.
Mm2.b	Activities, Intermediate Review : Month 18	Availability and quality of Deliverables DM2.2.1 DM2.3.2.and Midterm Review meeting Minutes.
MM2.c	Project Management Activities, Final Review; M36	Availability and quality of Deliverables DM2.2.2, DM2.2.3, DM2.2.4, DM2.3.3

6.4 Description of milestones and demonstrators

For each milestone, a brief description is provided and well as the indication of the expected results and methods in order to assess the achievements of the milestone.

WP1: Smart Conversion

Main contributors: ONSEMI, IUNET, FHG, PHILIPS, TEL

Description of milestone 1.a): optimal power transfer to the grid from innovative devices or systems.

The high-level objectives of this project are situated in the synergy between the silicon device and circuit of power switching for sustainable energy and smart grid applications. Bringing together the unique skills of both device development engineers and circuit application specialists, together with the access to a semiconductor production facility opens the way to tune the device's electrical targets (voltage rating, on-resistance, switching characteristics, avalanche robustness, high temperature operation and reliability, reverse recovery, …) to obtain maximum overall circuit performance (efficiency, cost, form factor, …). Hence, this task will focus on increased performance of the devices as well as the circuit, and on the interaction between both:

- Increased performance of switching devices (primary target: higher efficiency). From the optimization of the circuit, or from choosing other topologies, the device targets might change (e.g. more emphasis on Qgd than on Ron, higher required voltage, higher required avalanche capability, etc…).
- Combined optimization of device and circuit design parameters for better overall performance in sustainable energy and smart grid applications. The results will be: a roadmap with typical topologies and applications for further research and optimization; an optimization tool, which must lead to the optimal design parameters for a certain application or topology, both on the device-level and on the circuit-level; demonstration circuits for validation of the optimization and design tools developed in the framework of this project.

Description of milestone 1.b): optimal interfacing of generating nodes with synchronous AC grids

One or more optimization-based algorithms for the synthesis of sinusoids by means of filtered switching signals will be formalized, which guarantee high accuracy in the control of frequency and phase. The advantages of the adoption of these algorithms on the size of the reactive components needed to filter the output the inverters as well as that of input capacitors will be determined. The spectral features of the generated waveform will be measured in a suitably designed prototype system.

Description of milestone 1.c): intelligent interfaces from customers to smart grid for reduction of energy consumption.

Intended demonstration applications are:

- ‘in situ’ power-supply,
- ultra-low power standby,
- intelligent, robust drivers for products like motors, energy buffers and light sources.

FHG will provide an existing hardware platform in his new application centre “Efficient Power Electronics for Local DC Grids” including local low power DC grids, power electronics as well as local power generation and energy storage. Project partners can use the platform to demonstrate their new and innovative ideas. The IISB will support the project partners by implementing their communication devices into the given hardware platform.

For the model-driven control system of a multi-apartment building, UniBo will cover the development and implementation of energy sources models and the statistical characterization of sub-domain consumption profiles. More precisely sources are solar-driven energy converters (both thermal and photovoltaic) and geothermal equipments. These models have to strike the right trade-off between precision and computational complexity so that they match the resources of the control unit. ST will design and develop the control module. It will take into account all consumption data provided by the distributed sensors computing a detailed profile of the power/energy requirements of the building has to be generated, as well as a prevision of possible improving actions in order to optimize energy consumption at different hierarchical levels. These levels represent the counterpart of the modular nature of the control module, which has to be able to interact with other similar modules so that energy management can be applied to single units (homes) as well as structured systems (entire buildings).

WP2: Grid-sensing, metering and communication

Main contributors: IUNET, PHILIPS, ST, CRF, UNIBO, NXP-D, IFX, FHG, RWTH, CTTC.

<u>Description of milestone 2.a: Advanced network monitoring by means of phasor measurement units (PMU)</u>

Phasor measurement units (PMUs) provide the measurements of node voltage and/or branch current phasors synchronized with a common time reference (typically UTC-GPS). The increasing use of data provided by PMUs in the real-time operation of power systems, the availability of accurate timing devices, advanced signal processing techniques and telecommunication infrastructures have resulted in the development of PMUs characterized by increasing accuracy levels. The projects aims at developing an improved synchrophasor estimation algorithm for the application in distribution networks in order to achieve: (i) low values of synchrophasors estimation uncertainties, (ii) high rejection of harmonic components different from the fundamental one; (iii) maintain uncertainty levels to values which are not modified by the dynamic behavior of frequency-varying phasors.

<u>Description of milestone 2.b. Smart meters design and implementation</u>

A smart meter communication interface has to ensure a secure and reliable connection within a building or neighbourhood. A sufficient link budget at low power consumption calls for an implementation using a frequency band below 1GHz. Increasing the over the air bit rate will lead to a low duty cycle protocol, which is a key factor in achieving the required low power operation. As only small chunks of spectrum are available in the highly occupied UHF band an OFDM-based system, as targeted in the new IEEE 802.15.4 standard, is needed to provide a high data rate within a narrow RF bandwidth. The research focus will be the integration of a low power RF transceiver supporting OFDM modulation schemes with a high peak to average ratio. Within the E2SG project the transceiver will adapted to the system specific tradeoffs required by the smart metering application. Figure 5 shows the scheme of a low power transceiver RF subsystem for a wireless metering SoC.

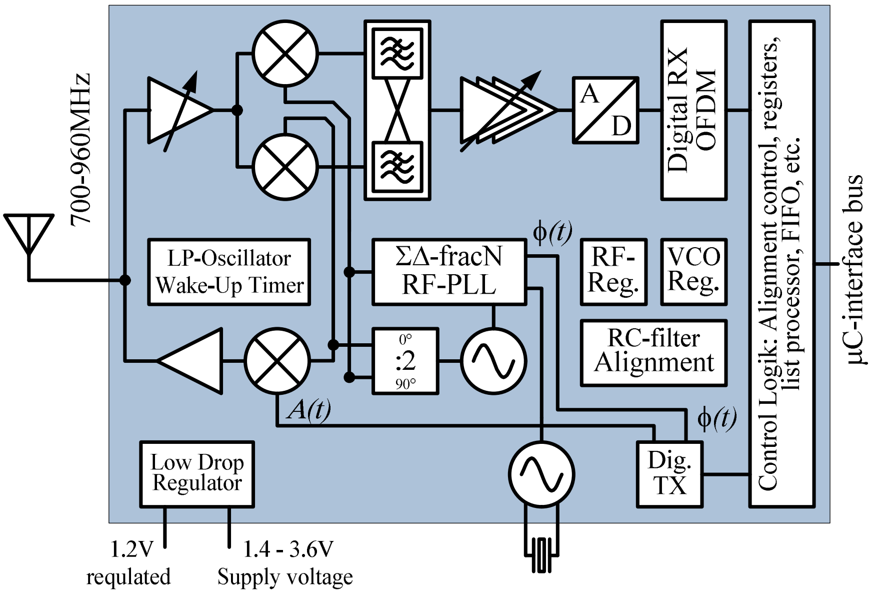


Figure 5 – Scheme of a low power RF transceiver.

Low power metering circuits will require an adaptive low power AC to DC converter in order to assure power efficiency in standby as well as in active mode. A solution requiring a low additional effort would be preferred. The research will focus on two general approaches. The first and most straightforward approach is the use of Telefunken's SmartPower SOI technology to realize a separate AC/DC supply chip. The second approach exploits the idea of using a capacitive voltage divider to generate a low voltage that can be handled by the CMOS SoC directly.

Telefunken will provide to RWTH its SmartPower SOI technology. as MPW (Multi Project Wafer) –service.

<u>Description of milestone 2.c: Subgrid powerline communication exploiting conversion ripple</u>

The feasibility of a communication scheme that applies a modulation to the switching signals of power converters so to embed information in the ripple that is superimposed to the DC voltage level will be demonstrated both from the theoretical point of view and by means of realistic simulations taking into account the various disturbance sources such as load variations, further switching converters at the receivers, non-ideality and dispersion along the wires. Within limits that will be carefully ascertained, such a scheme will allow powerline communications with minimal hardware overhead. Its effectiveness will possibly be shown by measurements on simple prototype systems.

Description of milestone 2.d: *Design and implementation of an architecture for hierarchical data collection, storage, management*

The milestone will be constituted by the definition of the hierarchical architecture, the definition of the functions of the various gateways at the different levels, the algorithms that characterize their behaviour and the data exchanged.

Description of milestone 2.e: secure data exchange between grids and consumers

To be entirely confident that a smart meter is functioning properly at all times, there needs to be a trusted component in (absolute) control of the meter device, which has to be placed into the core of the system. Since any kind of trusted computing is based on the authentic and integral reporting of a device's configuration, a major ingredient is the strong and secure authentication of devices and peripherals, whilst maintaining high performance, though with minimal consumption of resources. All the options for lightweight and fast authentication and communication protocols will be studied, ranging from classical authentication schemes using public key cryptography (such as RSA and ECC) to non-standard solutions such as coupon-based authentication and similar. The main focus here will be the tailoring of the schemes, key sizes used and security measures needed for device authentication and communication in order to minimize the consumption of physical resources like chip size and power consumption, whilst maximizing performance. Especially, in order to resist side-channel analysis and fault injection attacks, innovative lightweight measures will be needed in order to keep the resource consumption low and minimize the impact on the performance of the authentication and communication processes. The final step is then to provide a prototype proving the concept, i.e., implementing an example application of device authentication and communication optimized for all the parameters: performance, security, physical resource consumption.

WP3: Grid topology and control

Main contributors: ST, UNIBO, RWTH, PHILIPS, IUNET, CTTC

Description of milestone 3.a: mixed stochastic-topological indexes

Synthetic parameters that subsume significant properties of the nodes of a network of dynamical nodes (modelling, in this case, power distribution at various space scales) will be developed targeted to the identification of critical aspects of power grids, i.e., importance of a generation or conversion node, tendency to islanding, etc. This will be done either by modifying topological measures already presented in the Literature so that they can cope with links with various capacities and probabilities of activation, or defining new ones tailored to specific features. The ability of these indexes in capturing significant features of the grid interconnections will be shown with reference either to true connectivity data provided by partners involved in energy distribution or to synthetically produce networks with statistical properties analogous to those of real ones.

Description of milestone 3.b: parsimonious space-time sensing of the state of dynamical interconnected nodes.

Techniques to estimate the internal state of interconnected dynamical systems by means of a reduced number of distributed measurements will be developed by applying compressive sensing schemes both in time and space. The performance of the developed algorithms will be shown with reference either to true connectivity data provided by partners involved in energy distribution or to synthetically produce networks with statistical properties analogous to those of real ones.

Description of milestone 3.c: optimized control of smart grid nodes.

The milestone is provided by the definition of the optimization problems by a MILP (Mixed integer linear programming) formulation. The milestone will also provide the definition of the interdependencies between different optimization objectives and different decision makers.

Description of milestone 3.d: framework for fast deployment of distributed application.

The milestone will be constituted by the implementation of the library of algorithmic elements that will compose the desired distributed application. The approach will be used in order to implement a agent-based control of the energy resources based on broadcasted price signals.

Description of milestone 3.e: advanced storage management policies.

The milestone is expected to provide the characteristics of management strategies that will allow optimizing the use of all the energy storage resources available in the network with particular reference to those associated with the connection of electric vehicles.

WP4: Integration and demonstrations

Main contributors: ST, CRF, UNIBO, TEL, RWTH, IFX, NXP-D, PHILIPS, IUNET

The main goal of this work package is to demonstrate the key concepts of the E2SG project via concrete use cases.

Through real-life field trials, the objective is to show E2SG principal innovations, applicability of generic E2SG concept in different usage scenarios, easy deployment and seamless integration of E2SG services, coexistence, in harmony, of different stakeholders (thus enabling a successful horizontal market).

Description of milestone 4.a: Integration of E2SG building blocks and mechanisms in Software and Hardware.

At software level, the following modules will be developed:

- Simulation blocks (either in MATLab/Simulink or in power systems simulation tools such as PSCAD and EMTP-RV) implementing the optimal MPPT-like algorithm(s) developed for innovative green energy sources, as studied in 1.a
- Simulation block describing one or more optimization algorithms for the synthesis of sinusoids by means of filtered switching signals which guarantee high accuracy in the control of frequency and phase of the current delivered to a smart grid node, as studied in 1.b

- Plug-in block to optimize energy and power balance between (renewable) energy sources, characterized via predictive mathematical models and smart appliances. The block will run suitable optimization procedure to decide whether it is convenient or simply needed to acquire energy must from the global Intergrid (see 1.b)

At hardware level, the following modules will be developed:

- A low energy wireless transceiver for smart meters compliant with the new IEEE 802.15.4 standard for Intergrid in 65nm CMOS technology (see 1.c)
- An advanced PMU which will be able to monitor the current state of the network at each node, whose position will be clearly defined trough GPS data or when not available as in closed rooms by storing them at installation time.

Description of milestone 4.b: Integration of the E2SG mechanics and solutions in the demonstrator environment (selected usage scenarios).

We will integrate several of the building blocks defined above with several of the results of the other milestones to obtain demonstrator for:

- An high energy efficient smart meter relying at least of the wireless transceiver developed in 5.a as well as other solutions considered in 2.b
- A complete smart building level control module relying on the software block developed in 5.a
- A compete PMU relying on the hardware developed and the software optimization algorithms developed in 5.a
- An Intragrid powerliner communication prototype exploiting conversion ripple developed in 3.a

Description of milestone 4.c: Testing: E2SG scenarios.

Aim of this task is to test the demonstrator developed in 5.b in several realistic scenarios with parameter defined by the industrial partners for the case of a local Intragrid (for the case of the smart building control module and the powerline communication prototype) and for the case of both for a local Intragrid and the global Intergrid (for the PMU and the smart meter).

WPM1: Dissemination, exploitation and standardisation

The dissemination, exploitation, standardisation and project web-site maintenance are part of this WP. These are continuous activities. As such, they span the entire duration of the project (M1-M36).

The WPM1 Milestones are all under the Project coordinator leadership

Milestone M1.a: *First Review of standardization, exploitation, dissemination activities; M18*

The Milestone shall be achieved through the achievements of the following Deliverables: DM1.1, DM1.1.2, DM1.2.1, DM1.2.2, DM1.2.3, DM1.3.1, DM1.3.2, DM1.4.1, DM1.4.2

Milestone M1.b: Final *Review of standardization, exploitation, dissemination activities; M36*

The Milestone shall be achieved through the achievements of the following Deliverables: DM1.1.3, DM1.2.4, DM1.3.3, DM1.3.3, DM1.3.4, DM1.4.3, DM1.4.4

WPM2: Management and IPR

All project management aspects, such as scientific, technical, administrative, financial, Intellectual Property management are concentrated in WPM2, which obviously runs for the entire project lifetime.

The WPM2 Milestones are all under the Project coordinator leadership

The mean of their verifications is the following:

Milestone M2.a Project Management Setup Month 3: Availability and quality of DM2.1.1, and DM2.3.1, Kick – Off Meeting Minutes available.

Milestone M2b. Management Activities, Intermediate Review: Month 18: Availability and quality of Deliverables DM2.2.1 DM2.3.2.and Midterm Review meeting Minutes.

Milestone M2.c Project Management Activities, Final Review: Month 36: Availability and quality of Deliverables DM2.2.2, DM2.2.3, DM2.2.4, DM2.3.3

The summary of effort for each partner of this 36-months project is presented in the annex table.

7 MARKET INNOVATION AND IMPACT

7.1 Impact

As already state in section 4.1, one of the major challenges Europe will face in the near future is related to the need to move to a low-carbon economy, to reduce greenhouse gas emissions by relying more and more on renewable energy sources, and to improve overall energy efficiency. This will have a strong impact on the power grid infrastructure, which, with ICT devices and techniques becoming pervasive, will indeed evolve into a fully developed smart grid.

This transformation will certainly represent a big improvement in quality of life for European Society, and is a result of paramount importance per-se. Yet the deep economic and social impact of the innovation required for this transformation needs not to be underestimated, since it will offer a tremendous opportunity of scientific and economic growth. Smart grids are, in fact, seen as “the digitization of one of the last major analogue-based industries,” (Bernard Meyerson, IBM Fellow and CTO of IBM Systems & Technology Group) and represent a further aspect of everyday private and public life in which ICT, on the one hand, and pervasive usage of electric vehicles and renewable energy sources, on the other hand may deliver huge benefits.

As just an example of the forthcoming revolution, one may simply consider that an ever increasing number of houses, agricultural and industrial sites are becoming completely energy autonomous (even if they remain grid connected for various reasons, such as access to incentives, electricity trading, redundancy in power sources, etc). Micro photovoltaic installations with an integrated battery pack is an example in this direction becoming particularly popular in that a house can become autonomous form the electricity grid adding to the photovoltaic panel an extra cost of only 10-15%. This category of energy users and producers approach the grid in a completely new way thanks to the expected bi-directionality of the energy flow. Interesting enough, by 2020 the grid will have to be interfaced with about 100millions of new power sources-facilities (of which 30-40 million will be electrical vehicles), which can operate bi-directionally.

The evolution of electric vehicles is also astonishing. To see this, one may consider that in the year 2000, Light Electrical Vehicles LEVs (bicycles, scooters, tricycles, mopeds and quad-cycles) accounted for a global production in the order of 100.000 per year, while in the 2010's they are expected to be produced in several tens of millions per year. To support these developments there is an on-going replacement of lead-acid batteries with much more efficient and cleaner Li-ion ones. China and Japan are rolling out large scale production, addressing manufacturing cost issues. The European sales of e-bikes are expected to reach about 1.5 Millions in 2010, representing an incredible growth from the 2009 sales. LEVs are now evolving to micro-cars and conventional mid-sized cars. Electrification of conventional cars will follow a step by step approach starting with the smaller ones while covering at most urban mobility. Electrical mobility in an urban environment offers new solutions to the difficulties encountered by thermal engines (Clean Internal Combustion Engine

Vehicles –ICEV- requires costly and complex catalytic architectures and their radical downsizing implies a reduced overall efficiency. As a consequence it is difficult to design new clean, safe and low cost small vehicles). Responding to evolving customer demands is fundamental for the success and viability of EVs. The market will evolve step by step now moving to large scale implementation of affordable, safe, ergonomic and clean micro- and mini-cars.

European companies will then be exposed to a novel vertically organized supply chain supported by large nations where regulations are made by fast acting Governmental Institutions. This is having, and will have, an ever increasing impact on the relations amongst Tier1-2 suppliers and OEMs, which is likely to be reflected on heavy industrial restructuring. European industries are then faced with managing the effects caused by this radical change of the supply chain, adopting quickly and properly sized competing instruments that could avoid the move of the European production to the new high tech countries.

Noticing that the empty so-called *quadcycle* weight all of about 350kg it can be deduced and already demonstrated in PMOB that their e-counterpart can be produced with a range of about 150km in an NEDC (to speed 120kmh) while keeping the weight below 500kg.

Figure 5.1.1 below shows how the number of Kilometres run in urban mobility is likely to shift from heavy and polluting vehicles to e-vehicles of much lower weight, reflecting both the concern on energy and raw materials and new people demand

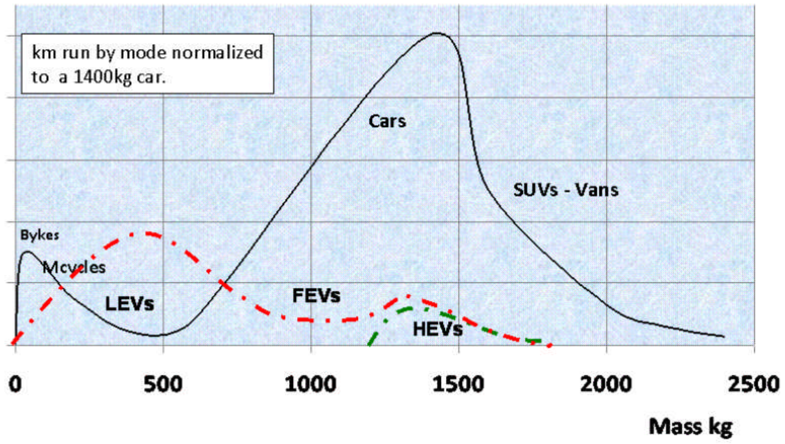


Figure 5.1.1

In quantitative terms in Europe by 2020 we can estimated several millions of new e-vehicle typologies. The economic impact is than very vast. In E2SG exactly the basis for the smart efficient conversion of energy, metering and information exchange in a connected infrastructure is developed. The impact therefore on new applications and infrastructure models is very high since in the estimations for the new mobility the support by the infrastructur is not considered yet. A better prepared infrastructure as targeted in E2SG will even boost this new markets.

A far as the other side for the market is concerned a few initial steps have been made already been made towards "a smart grid revolution" for ICT

A few initial steps have been made already in this direction with STMicroelectronics already offering a first generation of devices dedicated to several aspects of smart-grid deployment ranging from integration of renewable energy, advanced transmission, smart metering, and efficient energy conversion, Fairchild Semiconductor recently introduced devices dedicated to consumption optimization in various fields (LED lighting, solar energy, automotive systems, etc.) and advanced information transmission, while Philips Dynalite offers building automation systems that can link smart grids with building energy management and National Semiconductor's Solar Magic technology is designed to optimize photovoltaic energy harvesting and exchange with evolved grids. NXP Semiconductors is producing several million reader devices and cards which are sold by into pre-paid power metering schemes mainly in non-European markets. For European metering schemes component/application system packages are also offered, however, as of today, with only partial reliability.

Another important segment of the "smart grid market" is the provision of services for energy management to utilities, and businesses and citizens. Here, the market is still in its infancy, but an important sign of vitality is the huge interest of venture capital (VC) investors both in the US and in Europe.

Several companies have entered the smart grid arena with services based on proprietary technology for energy management in residential and commercial buildings, and in critical applications such as data centres, attracting significant VC funding.

Notable mentions are the US company Gridpoint, which has received as of now 262 M$ in VC funding. Gridpoint provides utilities with a platform and distributed resources for controlling energy consumption, local generation of renewable energies, and storage. In Europe, the size of VC investments is smaller but still appreciable. Alertme, for example, has gathered 28 M$ in VC funding by providing a complete solution for energy management aimed at residential users and public utilities, based on Zigbee networks of smart meters and a dedicated internet-based platform.

According to the Nomura report (see also the Table 5.1.1 below which show the estimated investments in smart grid systems estimated in the 20 years from 2010 to 2030) "Smart Grids (2) – IT for electric power networks – a new global battleground" from November 2010, the smart grids are moving from idea to reality. Nomura reports that *"Smart grid investment is likely to be substantial over a long time frame, but given the ongoing technology standardization and various types of testing, it could take several years to get fully under way, except in areas such as advanced metering infrastructure (AMI)"*, which is exactly one area which is addressed within E2SG by the planned research and standardization activities.

2. Estimated investment in smart grid systems in the US, Japan, and Europe (2010–30) ($bn)

	US	Europe	Japan	Total
Smart meters	19	14	6	39
EE/DR	66	50	20	137
Storage batteries	356	355	60	771
Inverters	40	42	37	119
Superconducting cable	81	61	25	167
Voltage regulation	6	6	6	18
Total	567	529	154	1,251
Annual total	28	26	8	63

Source: Nomura

Table 5.1.1: Estimated Investments in smart grid systems.

Furthermore, it is worth stressing that systems in the focus of research for the E2SG project (such as smart meters, energy efficiency/demand response (EE/DR), inverters and voltage regulation) cover ¼ of the estimated investment by Nomura.

From the above analysis it is immediate to conclude that **the potential impact both in terms of economic growth and market expansion is impressive and E2SG aims to achieve scientific and technical results to enable important leap forwards in this direction**.

As just a first example, one can easily foresee an huge market opportunity for the **low-energy, low-cost wireless transceivers** developed within E2SG. Such circuits are in fact the heart for the pervasive devices acquiring the data necessary to devise an optimized distributed energy consumption policy. The fact that such transceivers will be potentially sold in huge quantities is easy to predict, even more so if one takes into account that they will be necessary in almost any smart appliance to guarantee fulfilment of the EU “zero emission buildings” policy for offices to be implemented by 2019.

A second important example is related to **smart metering**. Here, one can foresee a huge potential market. In fact, while in 2008 there were 1.698 million electricity meters installed in the world, growing at an annual rate of about 13%, it is expected that such rate with grow to 22% in 2012 (average for the entire world), with a peak of 28% in Europe. These figures may result to be even larger if national government and public utilities will, as expected, push for the rapid adoption of advanced metering systems. Figure 5.1.2 shows the Predicted annual meter demand in Germany both in terms of economic value of the marked and number of installed meters.

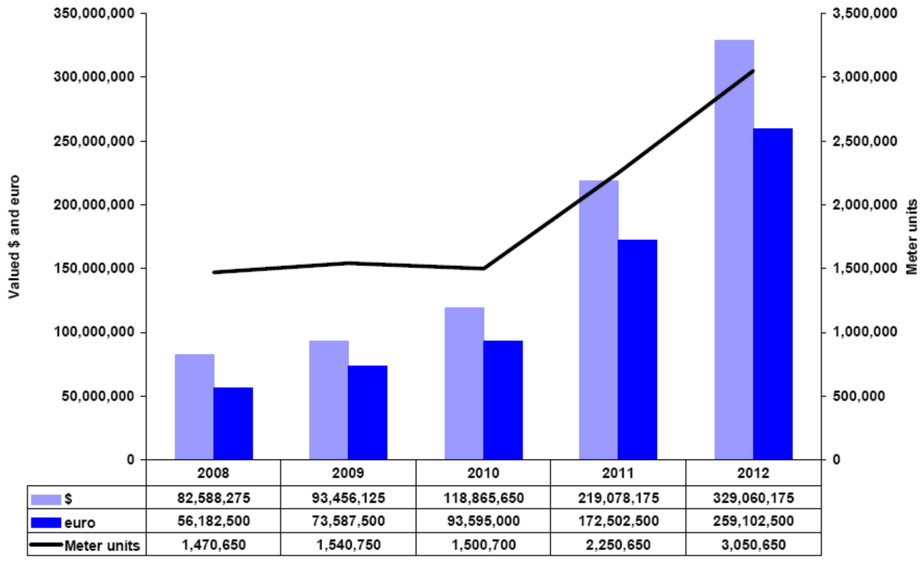


Figure 5.1.2

European manufacturers can win a significant share of this new segment, if they will be able to enter the market in a short term with a convincing solution. From this point of view, the results to be achieved within E2SG will be of paramount importance to lay the according ground for that success.

A further important point for assessing the actual potential smart meter market is related to what they need to measure. In fact, it should be noted that, in some cases, the supplier offers electric energy only and meters are therefore installed to measure electricity energy consumption only (e.g. in Italy – Enel –, in Sweden, and in USA – Southern California Edison). In other cases, national standards are now being developed for electricity and gas meters (and water and heat meters in some cases)

Examples are: EnergieNed, NTA specifications, Dutch Smart Meter Requirements in the Netherlands; OMS (Open Metering System) in Germany; ERA (Energy Retail Association), SRSM (Supplier Requirements for Smart Meters), LAN and WAN committees, Govt. Dept. DECC (was BERR) in the UK. EU meters need to conform to MID (Measuring Instruments Directive) for metrology.

A third important aspect is related to the power **management circuits and systems**, those markets are expected to grow at least till 2014 as shown in Figure 5.1.3.

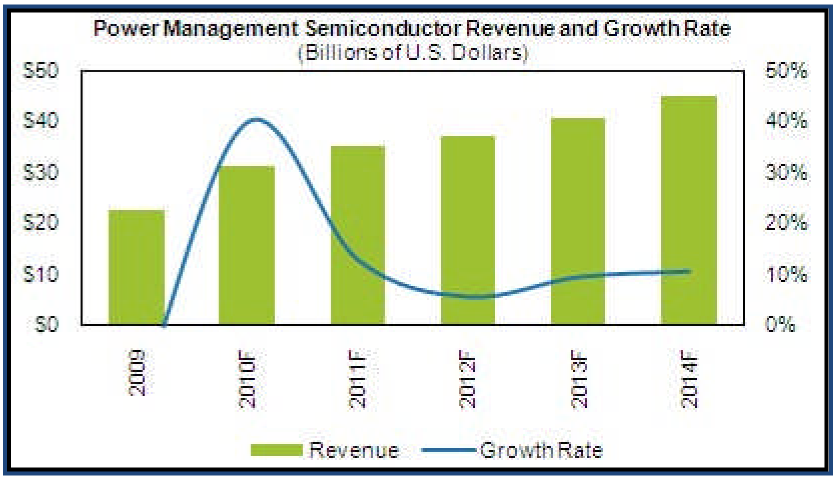


Figure 5.1.3

According to M. Vukicevic - Principal Analyst, Power Management at iSuppli, a market research firm, "Over the next five years, a good part of growth in power management semiconductors will derive from the vibrant alternative energy market, which will bring inverters to the attention of many suppliers. The need for inverters—devices that convert direct current to alternating current—will stem from applications in the automotive, solar and wind turbine markets. Revenue is expected to more than double by 2014, reaching $7.2 billion, compared to $2.9 billion in 2009.

Power management semiconductors as a whole are expected to grow about 15 percent, driven mainly by the notebook market, server infrastructure replacement and alternative energy requirements issuing from hybrid and electric vehicles, wind and solar energy and grid upgrades.

Furthermore, observable improvements in the efficiency of electronics products and processes that make use of the semiconductors—everything from power tools to forklifts, from trains to cars—can be considered an emerging trend for power management, iSuppli believes"

Also in this case, results achieved within E2SG are expected to have a great impact. E2SG also aims to develop high efficient power drivers in silicon and to compare solutions at medium voltage (± 100 V) and at high voltage (in excess of 800V). The market up to 100 V is important for low-voltage power conversion and regulation. These are typically applications in which the voltage is converted from 12-25V down to 1.8, 3.3 or 5V. The market segment at 600V is basically covering the power conversion market for applications that directly go into the main supply (power conversion from 400-600V down to 12-25V).

A last important consideration is related to the **improvement in energy efficiency** for the power converters exploited in the implementation of a smart grid. In a typical converter currently available in the market, about 75% of all energy passing through power supplies is in active mode, while 25% is due to standby power loss. As such, due to the different stages of power conversion and system partitioning (from 480V down to 220V down to 12V down to 1.8V), for every 100W load (power to run the CPU), an average of over 200W is required. Increasing the efficiency of every power conversion step through more efficient power drivers will result in a tremendous saving in power losses, hence much less input power will be required for the same load. In this way, innovation in power semiconductors will contribute to a large extent to the world wide quest for reduction in energy waste. The exploitation of these innovative devices in power conversion will be tackled within E2SG, both for high voltage as well as for medium voltage power conversion.

Substantial market opportunities are at the horizon for the exploitation of these novel power semiconductor devices in power conversion, as regulatory organizations are imposing new and challenging targets for energy efficiency which can absolutely not be met with the current device topologies. Devices not meeting the specifications of these regulations (including Japanese *Top Runner Program* **-** developing the world's best energy efficient energy appliances**-**, Japanese *Eco Mark Program*, Australian *Greenhouse Office Program*, Korean *e-standby Program*, European *COC*, and US *Energy Star Program*") will just not be allowed on the market.

To summarize the market impact highlights:

- E2SG provides infrastructure which can even boost the enormous growth of light electric vehicles and smart meter market since new business models will be applicable
- E2SG performs research on the privacy protection and integrity which enables the acceptation of the new business models etc. by the customers and vendors
- Bi-directional effect: the growing markets enable the research for new technologies as developed in E2SG and on the other side the developments in E2SG are enabler for the new applications in this domain
- Overall the energy efficiency targets are only achievable with intelligent connected distribution, handling and metering of electrical energy, since this opens a huge potential for global addressed savings

7.2 Dissemination and exploitation

Dissemination and exploitation of the project results are important objectives of the E2SG Consortium as a whole, as well as of the partners individually. The difficulty in designing and integrating complex and heterogeneous Energy Harvester and Energy consumer is becoming an obstacle towards their deployments, and it will get more and more critical with the advances in technology and requirements of additional supported domains and functionalities. Consequently, the ability of mastering the complexity of the simulation and design of future Smart Grid will offer a decisive market advantage. Besides project partners, this will translate into a benefit for European companies at large, which lead the market and the innovation in this sector.

The E2SG Consortium will directly address both the semiconductor and the Energy consumer device markets, since both are relevant to the objectives of the project. The Energy Consumer Device market has a very high leverage if compared to the semiconductor market. Only the availability of advanced smart devices that can interact with the Smart distribution grid will guarantee the Energy Saving Success. For example, the power management segment alone, one of the hottest areas in analog, is expected to grow 9% over the next several years, from $22 billion in 2009 to $32 billion in 2014. There are other growth markets that will fuel analog demand, including automotive, displays, LEDs, medical and others. There is ongoing demand for analog oriented chips for sensors, hybrid cars and electric vehicles. " [Source: http://www.analog-eetimes.com/ Oct. 19, 2010]

In summary, the E2SG Consortium targets important markets in which the capabilities developed in this project will be a key to future success. In this way, the project will stimulate the extension of the market share not only of the project partners, but also of the European consumer and semiconductor industry. It will help to consolidate the role of European semiconductor companies as specialist of the future Green and Sustainable Economy.

The exploitation strategy will utilize the diverse perspectives of the individual participants on exploitation for maximum effectiveness. The exploitation path of the **semiconductors vendors** and **system companies** involves applying the design developed in the project to the design of future Smart Grids and Components and their application to complex products. These partners will benefit from the project results by increasing their capabilities to produce competitive Energy Efficient Systems that will be directly reflected in a market advantage and, therefore, sales success.

The exploitation will not start before the end of the project. However, the E2SG Consortium will already act during the project lifetime to plan and prepare for this phase. An important and proven means for the preparation of the exploitation are *demonstrations at customers' sites and at industry relevant trade shows*. Such demonstrations help to validate the market, detail requirements and stimulate interest. Analysis of the technical state-of-the-art as well as the market is another effective way to prepare for the exploitation phase. Smart Grid technology involves fields such as semiconductors and materials that are highly dynamic and innovation driven markets. In that respect, being updated on the research innovation will be essential for maximizing the leverage gained from the project results.

Research in E2SG is more focused on the medium-long term (3-10 years), to provide the technological and system base knowledge for upcoming product generations. For example, Infineon will bring to market first the 10kV safe-isolation within power technologies and only in a second step a high voltage capable logic technology with the safe-isolation capabilities. According to current plans for security in the smart grid new TPM modules based on research results and cooperative approach within E2SG will be developed. Key elements are here as well the standardization activities in this area – first alignment within the standardizations in parallel to the research in the technology and second exploitation of highly innovative products in the midterm period. A software tools vendor like Silvaco with strategic long term interest in photovoltaic applications will implementing new Verilog A and compact models for photovoltaic applications and thus improves its offer to the design industry.

Public Utilities will exploit project results internally, as a way to deliver energy and services at a lower overall cost and with improved reliability. Their primary advantage will be an accurate quantitative assessment of the benefits related to distributed generation layout optimization and integration in smart grids, which will guide future investment in smart grid equipment, infrastructure, and services to maximize return on investment.

HERA, a public utility that provides electricity, water & gas to 3.1 million customers spread over the entire territory of the Emilia-Romagna region, will equip over 95% of its electricity customers with electronic meters that includes communication capability (first generation smart meters) with the objective to replace the entire set of electromechanical measurement systems now in use (around 270.000) by the end of 2012. This is a major investment effort. Therefore, it is a strategic objective of HERA to exploit the information provided by the new measurements systems in order to improve the distribution system performances (nominal operation, power quality and reliability) and to enable the active participation of customers in shaping their energy profile. The old concept of demand side management will be renewed by the capability (expected to be provided by the results of the project) to implement management/control strategies of the customer appliances on the basis of the information provided by the smart metering systems and communication means. Moreover, HERA has started an internal project in order to anticipate the effects and the possible advantages of the foreseen increased use of electric vehicles in highly-populated urban areas. The results of the project relevant to the mitigation of the impact of this particular type of load in the network are expected to avoid huge investments for the network capacity improvement, which would otherwise be required.

For **research and education partners**, the most important exploitable project outcome is knowledge, which will be exploited internally by training personnel and students, and externally to promote the partners' reputation and standing. To realize a Green World is not only a matter of enabling technologies but also a **cultural shift** in the way we use energy and we design the energy consumer devices hence, in this case, *the dissemination is also a first step toward exploitation.* In an increasingly competitive international environment both of these aspects are highly important to secure the institutes' existence as drivers of Europe's high-tech industry. Both imply a dissemination of the generated knowledge. In the form of intellectual property, this knowledge will have a commercial implication that the research partners may consider exploiting indirectly by making agreements with third parties – preferably with partners of this Consortium.

Dissemination plays an important albeit less directly revenue related role for the Consortium: First and foremost, it generates visibility and underlines the partners' expertise in the area, thus promoting their standing. Furthermore, this also fuels interest in the topic as such, and the partners' methodologies and tools. Last, but not least, dissemination helps to drive the convergence of the technical state-of-the-art. This, in turn is a mandatory pre-requisite for a commercially exploitable market.The dissemination activities will combine complementary actions in research, business partner support within the technical community and end users. Partner semiconductor companies will handle this project as an integrated part of their smart grid marketing concept, communicating results with brochures, customer addressing and public talks. Participation to ICT cluster events and European meetings, the participation in workshops and conferences organized by ICT, and other important international organization is planned to increase the dissemination impact. Moreover great emphasis will be given to the links which are already active among the project partners.

Scientific results of the project will be promoted in the form of scientific publications at international conferences and journals, and will transfer knowledge to the community at large and serve to foster the birth of new research streams.

7.3 Contribution to standards and regulations

Semiconductor components and systems companies within the E2SG consortium are actively involved in the definitions of standards related to smart-grid products.

Infineon is actively participating at CEN, in the IEEE P2030 Draft Guide for Smart Grid Interoperability of Energy Technology and Information Technology standardization and the IEEE SCC 31 Automatic Meter Reading and Related Services group. Infineon contributes also to the German BMWi/BSI and other government protection profile working group for defining certification standards for smart meters as well as gateways. Infineon will transfer the results of these standardization activities to the project group and will also bring the result of the project back into standardization.

NXP Semiconductors - is in a leading position also from this point of view, since it is actively participating in the International Electrotechnical Commission (IEC). As member of the ESIA (European Semiconductors Industry Association) NXP is involved in the EU Expert group #2 of the so called “Smart Grid Task Force”. in the EU “smart grid” expert group as member of ESIA (European Semiconductors Industry Association)and actively supports the Gateway PP (protection profiles) initiative of the German BMWi/BSI.

Telefunken has no activities in standardization groups, but will support the consortium with technical input.

7.4 Management of intellectual property

IPR Management in E2SG will rely on the detailed definitions of the Eniac project Consortium Agreement (EPCA), which will be legally signed among all the parties at the start time of the contract grant. The EPCA will be based on the ENIAC template. In this respect the purpose of the EPCA is also to specify with respect to the project, the relationship among the parties, in particular concerning the organization of the work between the Parties, the management of the project and the rights and obligations of the parties concerning cross-liability, access rights and dispute negotiation and resolution.

Within the project, some confidential information will be handled between partners; the conditions of how such exchange will take place will be defined in the EPCA.

E2SG will aim at a strategy for the management of knowledge and IPR, ranging from technology characterization to device, circuit and architectural design, models, tools and methodologies.

Such a strategy is intended to be open between the partners, yet it will ensure that commercially relevant information will remain within the project and the respective owner(s). This implies that each dissemination or project output will have to be authorized on behalf of the partners. Any public output will be classified as official deliverable of the project and, as such, will be subject to evaluation of its exploitation potential. Thus, every deliverable is likely to be qualified in terms of:

- **Background:** Brought by the owner as a starting IP necessary to generate the new result;
- **Foreground**: Shall be owned by the Parties who carried out the actual work generating the new result, or on whose behalf such work was carried out.
- **Exploitation**: The strategy for the access and exploitation of the result.

The detailed terms, responsibilities and rights of the partners in terms of IPR management will be defined in the Consortium Agreement as well.

Means and tools for knowledge management and IP protection will be adopted, specifically on the issue of protecting and/or sharing background and foreground intellectual property in an appropriate manner. In this respect, a key role will be played by the *Exploitation Manager,* who will be appointed on the initial stage of the project, whose function is that of coordinating and supervising the set-up of the measures and procedures for effectively handling IPR.

7.5 Synergies with other domains

As it has been already stated in section 3.4 (please see that section of a more detailed analysis), E2SG fits very well the overall picture of collaborative applicative R&D at the European level in the domain of Energy Efficiency, as its activities are complementary to those performed (or planned) in other projects from the ENIAC and ARTEMIS. There are several collaborative projects that have links and relations to E2SG; common denominator to most of such projects is that they have a core group of partners, including ST, IFAG, NXP and some other key players, one more proof of the strong commitment of major European Semiconductor Industries in the Energy Saving for a Green Society. This ensures high synergy across the various projects and the optimization of human and financial resources.

In the same Grand Challenge, within ENIAC call2, ST in coordinating the END project, where also NXP is participating which targets the development of innovative energy-aware design solutions and EDA technologies for next generations' nanoelectronics circuits and systems, and the related energy generation, conversion and management systems. The ultimate objective of the END project is that of bringing such solutions and technologies into the product development processes of the industrial partners of the Consortium, thus enabling the design and manufacturing of the electronic circuits that will be at the basis of the green information society of the future. The E2SG is also linked to ERG within ENIAC call 3. The ERG project focuses on the solar energy supply chain, starting form solar cells and proceeding along with innovative energy harvesting techniques and high efficiency power conversion.

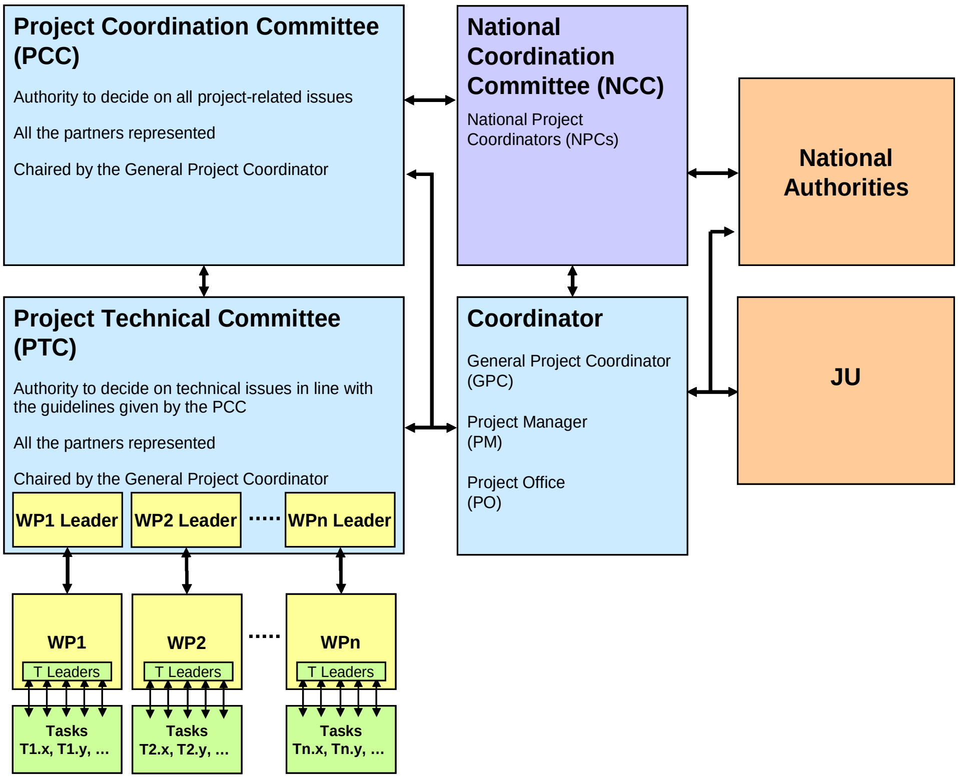
Under the broad range vision of the future smart-grid, E2SG can leverage some valued synergies with the project ARTEMIS IoE accepted for funding in ARTEMIS call 2010, whose objective is to develop the architecture, software and middleware for seamless, secure connectivity and interoperable convergence between Internet and the energy grids. The IoE project aims to implement the real time interface between the power network/grid and Internet. Most of the big partners of E2SG (including the electric utility) are also contributing to IoE, augmenting in this way the opportunity for a shared vision and a larger capability to take up research into real products and new market opportunity.

8 QUALITY OF CONSORTIUM AND MANAGEMENT

8.1 Management structure and procedures

The management approach for the E2SG project builds upon the structures and procedures of former EU-funded projects (e.g., FP6 "CLEAN", FP6 "NANOCMOS", FP6 "PullNANO", FP6 "COMSON", ENIAC Call 1 "MODERN", ENIAC Call 2 "END", ENIAC Call 3 "ERG") which have successfully completed or which are currently running. The management scheme adopted in such projects has proven to be adequate for handling large consortia; in addition, the past experience has shown that the proposed management procedures allow to efficiently and quickly responding to any changes and threats to the project. As a consequence, they will be applied to the ERG project as well.

The project management will consist of the following structures and functions, whose interaction is shown in Figure 3:



- General Project Coordinator (GPC).
- Project Coordination Committee (PCC).
- Project Technical Committee (PTC).
- Project Manager (PM).
- Exploitation Manager (EM)
- Work-Package Leaders (WPLs).
- Task Leaders (TLs).
- Project Office (PO).
- National Coordination Committee (NCC).

- National Project Coordinators (NPCs).

Figure 8 - E2SG project management structures.

The project is coordinated by the General Project Coordinator (GPC). The Project Coordination Committee (PCC) includes the GPC, the Project Manager (PM) and the Project Office (PO). The PCC nominates the Exploitation Manager (EM) and decides on all organizational project-related issues, whereas the Project Technical Committee (PTC) decides on all technical project-related issues. Both will be assisted by the PO, which is located at the GPC site. Each project Work-Package (WP) will be coordinated by the corresponding Work-Package Leader (WPL). Each project Task (T) will be coordinated by the corresponding Task Leader (TL). The GPC is the main interface to the JU. The liaison of the GPC to the National Authorities is provided by the National Coordination Committee (NCC), which consists of one National Project Coordinator (NPC) per country which is represented in the project.

8.2 Individual partners

1. ST

Company Profile

STMicroelectronics is the world's fifth largest semiconductor company with net revenues of US$ 8.51 billion in 2009. According to the latest industry data from iSupply, ST holds market leadership in many fields. The Company is the leading producer of application-specific analog chips and power conversion devices. It is the #1 supplier of semiconductors for the Industrial market, set-top box applications, and MEMS (micro-electromechanical systems) chips for portable and consumer devices, including game controllers and smart phones. ST also occupies leading positions in fields as varied as automotive integrated circuits (#3), chips for computer peripherals (#3), and the rapidly expanding market for MEMS overall (#5). ST aims to be the leader in multimedia convergence and power applications, offering one of the world's broadest product portfolios, including application-specific products containing a large proprietary IP content and multi-segment products that range from discrete devices to high-performance microcontrollers, secure smart card chips and MEMS devices.

The Company provides solutions for a wide array of Digital Consumer applications, with a particular focus on set-top boxes, digital TVs and digital audio, including radio. In the Computer Peripherals arena, ST provides leading solutions in data storage, printing, visual display units, power management for PC motherboards, and power supplies. A wide range of ST's ASSPs (Application Specific Standard Products) power sophisticated Automotive systems such as engine control, vehicle safety equipment, door modules, and in-car infotainment The Company also supplies industrial integrated circuits (IC) for factory automation systems, chips for lighting, battery chargers and power supplies, as well as chips for advanced Secure Access applications. ST pioneered and continues to refine the use of platform-based design methodologies for complex ICs in demanding applications such as mobile multimedia, set-top boxes and computer peripherals.

Since its creation, ST has maintained an unwavering commitment to R&D and is one of the industry's most innovative companies. In 2009, ST spent US$2.37B in R&D, which is approximately 28% of the Company's 2009 revenues. ST's process technology portfolio includes advanced CMOS (Complementary Metal Oxide Semiconductor) logic including embedded memory variants, mixed-signal, analog and power processes. ST has a worldwide network of front-end (wafer fabrication) and back-end (assembly and test and packaging) plants.

ST has established a worldwide network of strategic alliances, including product development with key customers, technology development with customers and other semiconductor manufacturers, and equipment- and CAD-development alliances with major suppliers. These industrial partnerships are complemented by a wide range of research programs conducted with leading universities and research institutes around the world, in addition to playing a key role in Europe's advanced technology research programs such as CATRENE (Cluster for Application and Technology Research in Europe on NanoElectronics), a successor to MEDEA+, and industry initiatives such as ENIAC (European Nanoelectronics Initiative) and ARTEMIS (Embedded Computing Systems Initiative).

ST is also active in numerous collaborative research projects worldwide. At the regional level STMicroelectronics participated on following European projects relevant to SMAC: FP5: EASY; PERLA, FP6: CLEAN; MORPHEUS; SYMTECO (Marie Curie); COMSON (Marie Curie); FP7: THERMINATOR, SeemPubs (PPP), MAnON, PROPHET (the last two both are Marie Curie) and ENIAC MODERN, END, ERG. The Italian Government is currently contributing to the MODERN, END and ERG projects.

Role in the project

Within the scientific scope of E2SG, ST is participating with many teams principally based within IMS R&D and Systems Lab. Each group has strong experience in the related sector of activity, spanning from semiconductor technologies to innovative materials and from analog and digital ICs to complex power electronics systems.

Key Staff Members Profile

Francesco Gennaro graduated cum Laude in 1996 at the University of Catania in Electrical Engineering and pursued the Ph.D. in Electrical Engineering in 2000 at the same University. Currently he is Team Manager of “Power Converters” inside Systems Lab, the Application Laboratory for Industrial and Multisegment, Sector developing system solutions in several application field of power electronics and energy management.

Giuliana Gangemi IMS CAD and Design Services Department Transfer of Knowledge and Research Programs manager. Giuliana graduated cum Laude in 1992 at Catania’s University in Applied Mathematics and, during the same year, joined STMicroelectronics as EDA engineer in a digital design team, whose projects were large 32bits SoCs and where she ended up having the responsibility of CAD Support and Development Manager. Since June 2007 Giuliana has joined the IMS CAD and Design Services Department in and in the current role she is technical Work Package leader or Project Manager in many projects where the group is involved. Giuliana has recently been invited to be part of the Advisory Board of the ERAMIND FP7 project

Salvatore Rinaudo, Director of CAD & Design Services Department of Industrial and Multisegment Sector of STMicroelectronics. He received the Laurea degree in nuclear engineering from the University of Palermo, Italy, in 1989. Since 1991, he has been with STMicroelectronics, Catania. He was involved in numerical simulation of semiconductor devices with emphasis on optimization and parameter extraction techniques for process and device design. Since 2000, he has been responsible of Design Methods Developments, covering also Process, Device and Physical Modeling across technologies, designs and data management, Design Services and Knowledge Management. In 2008, he joined the IEEE Library Advisory Council for the term 2008-2009.

Roberto Zafalon, EU Projects Director - Italy, is in charge to foster and leverage the link between ST technology groups and the R&D cooperative EU programs. Until June 2007 he has been the head of the Competence Center for Low Power System Design at the Advanced System Technology R&D group in STMicroelectronics, Agrate Brianza (Milano), Italy. In his current capacity since July 2007, he elaborates the vision and roadmap, seeks for project financing and drives industrial R&D teams to pursue innovative solutions in the field of embedded systems and nanolectronics, for corporate product divisions and labs. He is an active member of ARTEMIS’s and ENIAC’s WG’s and he currently is, and has been in the past, General Project Manager and Coordinator of major Integrated Projects under FP6, FP6 and JTI 2nd call. He contributed to over 66 international scientific publications so far, including conferences, Journals/Transactions, invited papers and books. He holds 8 international patents, four European, three USA and one Japanese, in the field of low power design, processors and computing architectures. He has been elected Senior Member IEEE in 2006.

2. CENTRO RICERCHE FIAT

Company Profile

Centro Ricerche Fiat was established in 1976 to fulfil the innovation, research and development needs expressed by FIAT Group. With a full-time workforce of more than 850 highly trained professionals, CRF offers a wide range of technical competencies and is equipped with state-of-the-art laboratories for the testing of powertrains, electro-magnetic compatibility, experimental noise and vibration analysis, driving simulation and virtual reality, in addition to facilities for the development of new materials and manufacturing processes, opto-electronics and micro-technologies, environmental stress test and screening (HALT/HASS).

CRF uses innovation as strategic lever and attributes value to its results by promoting, developing and transferring the innovative content which raises product competitiveness and distinctiveness. Hence, CRF provides vital technological support for growth to Fiat Group and its partners by focusing on the development of vehicles with new architectures and powertrain, innovative materials and advanced solutions for process control.

In the Powertrain Research & Technology business line, which refers to Fiat-Powertrain-Technologies (FPT), in the field of automotive electronics a large experience has been developed on embedded systems architecture design and mixed ASIC ICs with processing capabilities onboard.

Main tasks attributed in E2SG:

- Specification of vehicle to grid and communication devices
- Demonstration of V2G devices
- Integration

Previous experience relevant to tasks: In the field of HEVs, in the last fifteen years CRF has developed specific solutions at vehicle and powertrain level to support Fiat Auto, IVECO-Altra, Magneti Marelli and other companies not belonging to the Fiat Group. Moreover CRF, in the pure electric and hybrid traction field, has participated, amongst others, to the following EU funded projects: Rita, Optelec, ICAPU, Elmas, Himrate, SUVA, HYSIS, HICEPS, E^3CAR, POLLUX, P-MOB, CASTOR

Key Staff Members Profile

Ing. Marco Ottella Ph.D. received his degree in Electronic Engineering in 1996 and his Ph.D in Electrical Engineering in 2001, at the Politecnico of Torino. He has been working at CRF since 1997 mainly focused on high level simulation of electromechanical drives in automotive application by means of CAE techniques applied on electrical, hybrid and fuel cells cars. In 2007 he joined the Hardware Design and Development Department of the Powertrain R&T business line participating in numerous projects on the design of power electronics for hybrid and electrical powertrain (Kinetic Energy Recovery Systems, SmallHybrid,…), also being active in the preparation and the management of international projects and in various EU initiatives (ARTEMIS, ENIAC, EPoSS, EUCAR) He is co-author of a consistent number of patents and international papers on electrical drives, being also a member of IEEE. He is currently coordinating the ARTEMIS-JU POLLUX project.

Ing. Riccardo Groppo graduated in Electronics Engineering at the Politecnico of Torino and joined CRF in Oct.1989; further academic background was provided by attending a post-degree course at M.I.T. (USA, Boston, rif. Prof.J.Kassakian) focused on Power Electronics. He was a member of the CRF team which developed the first automotive common rail system being in charge of the technological transfer to R.Bosch until the start of production on the Alfa Romeo 156 (1997). Since that period he has been involved in several large powertrain programs where automotive electronics was playing a key role. He was the program manager of the joint CRF-MOTOROLA SPS team (1998-2001) focused on the development of advanced embedded micro controller and ASIC ICs specifically designed for engine control systems. Since 2002 he is the Head of the HW Design and Development Dept. at CRF-Powertrain R&T. He owns more than 20 several patents in the field of automotive electronics and embedded systems, most of which are currently in production on passenger cars (e.g. Multijet, Multiair).

3. ENEL: stepped out in negotiation phase

4. HERA

Company Profile

Established in 2002 from the union of eleven public utility companies in Emilia Romagna, Hera group has continued its territorial growth over the years, acquiring AGEA of Ferrara in 2004 and closing, with Meta, the first Italian merger between publicly traded multi-utility companies in 2005. Hera realized in 2006, 2007 and 2008 al lot of other M&A activities to expand its core business. In 2009, Hera was the first Italian multiutility in Waste business in terms of waste collected and treated (above 5.7 million tons treated), the second one in Water business in terms of Ebitda (142 ml€ in 2010) and of volumes sold (251 million mc of water), the fourth player in the Italian Gas business in terms of gas sold (2,914 million mc of gas) and the 8th player in the Italian Electricity business in terms of electricity sold (7,744Gwh). Hera's goal is to be the best multiutility in Italy for its customers, workforce and shareholders. It aims to achieve this through further development of an original corporate model capable of innovation and of forging strong links with the areas in which it operates by respecting the local environment. The HERA Group distributes electricity to the users connected to the distribution network serving the municipalities of Imola and Mordano (Province of Bologna), Sant'Agata sul Santerno, Massalombarda and Bagnara di Romagna (Province of Ravenna), and the municipality of Modena and 18 municipalities of the Province of Modena. The group also operates in electricity sales to customers in its territory of reference and, thanks to liberalization, throughout the north-eastern Italy market. Although it is not historically defined as a producer of electricity, the Group has for some time implemented activities aimed at producing energy from renewable or assimilated sources through energy recovery linked to the development of plants associated with its own production processes such as cogeneration (district heating service), waste-to-energy and recovery of biogases from landfills (environmental hygiene service), recovery of biogases from municipal waste water purification plants (integrated water cycle), natural gas turboexpansion (natural gas distribution service), and significant shareholdings in plants started up in Campania totalling 1,200 MW of installed power.

Key Staff Members Profile

Marco Venturi graduated in electrical engineering (with honors) at the University of Bologna Italy in 1981. He has been working at Nuovo Pignone now GE and since 1992 in META, now HERA, the electricity distribution utility in Modena (Italy). He is now the head of the electricity distribution division of Hera.

Franco Sami graduated in civil engineering. He has attended courses at Politecnico di Milano and LUISS in Rome, as well as at the business management school of Luigi Bocconi University in Milan in 2000. In 2002, he was appointed head of networks at Hera Forlì - Cesena S.r.l., and became COO of Hera Imola - Faenza S.r.l. the following year. In 2006, he became head of special projects and vice chairman of Hera Modena S.r.l. Since 2008, he has reported directly to the COO with responsibility for operations as director of the fluids distribution division, which includes: gas distribution, water cycle, laboratories and remote control of fluids.

8. IUNET

Organisation profile

The “Consorzio Nazionale Interuniversitario per la Nanoelettronica” (IUNET, Italian Universities Nano-Electronics Team), is a non-profit, private Organization, which has been created with the initial aim aim to lead and coordinate the effort of the major Italian University Teams in the field of Silicon Based Nanoelectronic Device Modeling and Characterization. After this initial phase, several other groups have joined IUNET, bringing competences in analog, mixed-mode and digital IC design, electronic systems, and algorithms for signal processing

Current Members of IUNET are the Universities of Bologna, Calabria, Ferrara, Modena e Reggio Emilia, Padova, Pisa, Roma “Sapienza”, Udine, and the Politecnico of Milano. They offer renown and complementary expertise in the field of modeling, simulation, design, characterization of CMOS-based nanometer-size electronic devices as well as in the development of algorithms and architectures for signal and information processing and power generation.

Main role in the project
IUNET will contribute to WP1, WP2 WP3 and WP4. Its key contributions will be in the Modeling of the distribution grid and microgrid by using the EMTP-rv simulation environment and the analysis of the regulation and dynamic behavior of the microgrid in islanding conditions (i.e. when separated from the rest of the electrical power network).
IUNET will also be involved in developing of innovative subgrid powerline communications exploiting conversion ripple and in the study of the main features of topology of a intergrid, as well as of methods to sense its state by a reduced set of measures. Finally it will contribute to the automatic management of storage resources in isolated microgrids.

Key Staff Members Profile

Enrico Sangiorgi is a Full Professor of Electronics at the University of Bologna. From 2005 to 2010 he is the Director of IUNET. Since 1994 he is Editor of IEEE Electron Device Letters. He has been a member of the following Conference Technical Committees: IEDM ('91-96; '04-'06), ESSDERC ('99-present), INFOS ('95-'03), ULIS ('00-'07), etc. Enrico Sangiorgi coauthored 33 papers presented at the IEDM, and overall more than 160 papers on journals and conference proceedings. He is a Fellow of the IEEE and he has been involved in managing European Projects of the 5th, 6th, and 7th FP. Since 2007 he is a member of the Strategic Board of the AENEAS Association.

Riccardo Rovatti teaches nonlinear electronics and advanced statistical signal processing at the University of Bologna. His current research activities focus on the application of statistical methods to the processing of signals in electronic systems. He also performed extensive research on application of nonlinear complex dynamics to signal processing and telecommunications, pattern recognition, and fuzzy logic. He co-authored several international publications. For his research activities he received several recognition among which the 2004 "Darlington Award", for the best paper bridging the gap between theory and applications in the IEEE Transactions on Circuits and Systems - Part I and Part II.

Carlo Alberto Nucci was born in Bologna, Italy, in 1956. He received the M.Sc.degree (with hons.) in electrical engineering from the University of Bologna, Bologna, in 1982. He is currently in the Department of Electrical Engineering, University of Bologna, where he was a Researcher in the Power Electrical Engineering Institute in 1983 and was a Full professor and the Chair of Power Systems in 2000. Since January 2010, he has been an Editor-in-Chief of the Electric Power System Research journal, Elsevier. He is the author or coauthor of more than 200 scientific papers published on reviewed journals or presented at international conferences. His research interests include power systems transients and dynamics, with particular reference to lightning impact on power lines, system restoration after blackout, and distributed generation. Prof. Nucci is a member of the IEEE Working Group "Lightning performance of distribution lines." He was the Chairman of the Study Committee C4 "System technical performance" in the International Council on Large Electric Systems (CIGRE). He is also a Fellow of the IEEE.

Alberto Borghetti was born in Cesena, Italy, in 1967. He received the M.Sc. degree (with hons.) in electrical engineering from the University of Bologna, Bologna, Italy, in 1992. Since 1992, he has been in the Power System Group, Department of Electrical Engineering, University of Bologna, where he was a Researcher in 1994 and an Associate Professor of electric power systems in 2004. His current research interests include power system analysis, with particular reference to voltage collapse, power system restoration after blackout, electromagnetic transients, and optimal generation scheduling.

Gianluca Setti received the Dr. Eng. and Ph.D. degree in Electronic Engineering from the University of Bologna. He held visiting position of the University of California San Diego and the University of Washington (Seattle). He is currently Professor of Circuit Theory and Analog Electronics at the School of Engineering at the University of Ferrara, Italy, and faculty member of ARCES, University of Bologna. His research interests include statistical signal processing, electromagnetic compatibility and BIST for analog circuits. In 2006-2007 he was the Editor-in-Chief of the He was Associate Editor of the IEEE Transactions on Circuits and Systems – Part II and, in 2008-2009 of the IEEE Transactions on Circuits and Systems – Part I. In 2010 he was the President of the IEEE CAS Society. He is also a Fellow of the IEEE and a co-recipient of the 2004 IEEE CAS Society Darlington Award.

13. AMS

Organisation profile

Austriamicrosystems is a global leader in the design and manufacture of high performance analogue/RF and analogue-intensive mixed-signal integrated circuits (ICs) tailored to meet specific customer applications. Austriamicrosystems provides the unique benefits of a vertically integrated, full-service supplier including research & development, design, process development, mask making, wafer production, assembly, and testing for customers in the strategic markets Automotive, Communications, Industry&Medical and Full Service Foundry. Austriamicrosystems offers highly integrated analogue/RF and analogue mixed signal process technologies (CMOS, HV-CMOS, BiCMOS, and SiGe).

The strengths are built up by process extensions like analog, HV functions and sensor implementations. Research in advanced technology developments is very often pursued by research co-operations with leading universities and research institutes throughout Austria, but also in international projects supported with European funding.

Main role in the project

Austriamicrosystems AG intends to contribute with speciality silicon process technology variants. Within this project, austriamicrosystems AG will develop and provide a smart power technology which is capable of providing a safe and reliable information transfer between domains of the smart grid which have highly different electrical potentials. In one variant this galvanic isolation will be realised as a single chip solution. In a second, more cost effective variant, this will be realised as a two chip solution. Investigations concerning the long term reliability of these solutions will be a main part of this work. Criteria which are published in industry standards such as VDE 0884-010 will be the target to reach. The technology will be available for other project partners with related design tasks and austriamicrosystems will offer a MPW (Multi Project Wafer) -service for concerned partners.

Key Staff Members Profile

Dr. Hubert Enichlmair has received his Masters degree in physics from the University of Graz. He worked as an associate professor at the Montanuniversität Leoben, Austria and received his Ph.D. at the Technical University of Linz, Austria. He is currently working in the TCAD and device R&D group of austriamicrosystems AG, where he is focussing on the development high voltage devices with special interest in their reliability aspects.

Ing. Andreas Wagner received his degree in technical informatics in 2009. He joined austriamicrosystems in 2006. He is currently working in the ESD/EMV group specialised on ultra high voltage ESD- , and EMV- measurements.

14. ON Semiconductor Belgium BVBA

Company Profile

With its global logistics network and strong product portfolio, ON Semiconductor is a preferred supplier of efficient power solutions to customers in the power supply, automotive, communication, computer, consumer, medical, industrial, mobile phone, and military/aerospace markets. The company's broad portfolio includes power, analog, DSP, mixed-signal, advance logic, clock management and standard component devices. Global corporate headquarters are located in Phoenix, Arizona. The company operates a network of manufacturing facilities, sales offices and design centers in key markets throughout North America, Europe, and the Asia Pacific regions.

ON Semiconductor has a strong presence in Europe and the Belgian legal entity, comprises manufacturing facilities and design centers. A large R&D effort is dedicated to analogue and high voltage devices, process technology and reliability, innovative design and test techniques and new circuit concepts. Engineers from ON Semiconductor in Belgium have co-operated with many European partners in the frame of IST and EUREKA projects.

Web page: www.onsemi.com

Main role in the project

ONsemi will mainly contribute in WP1 in which one will develop, characterize and demonstrate two advanced energy efficient Power MOSFETS: one for medium and one for high voltage applications. In order to have impact on future Smart Grid applications, it is mandatory to be able to offer competitive energy efficient silicon switches. Besides the development of these switches, it is important to have switches that are developed for best efficient applications. Therefore the development of these silicon switches is directed towards most efficient application, and not necessarily towards best device specifications. Finally it is important to prepare future volume production, it will be researched if the advanced super junction silicon switches, can be processed on 200mm substrates for critical processes. ONsemi will take the coordination lead as workpackage leader for WP1

Key Staff Members Profile

Peter Moens received a M.Sc. and a Ph.D. in solid state physics from the University of Gent, Belgium, in 1990 and 1993 respectively. In 1996, he joined ON Semiconductor, where he was involved in the technology and device development for smart power applications, and the related reliability aspects. Since 2008 he is responsible for the development of 600+V discrete power devices, both in silicon as well as in wide band gap materials. He is author or co-author of over 120 papers in international scientific journals and in international conference proceedings, and has issued over 15 patents in his field of application. Dr. Moens is member of the technical program committee of ISPSD, IRPS, IRW, ESREF and the ESD/EOS Symposium, and served as the chair of the HV reliability subcommittee of IRPS. He also served as the technical program chair of ISPSD2009, and will be the general chair of ISPSD2012. He is Guest Editor of IEEE Transactions on Devices and Material Reliability.

Filip Bauwens holds a M.Sc. degree in applied physics from the University of Gent, Belgium (1995). In 2000, he received a Ph.D. in nuclear physics from the same university. In 2001, he started his career in microelectronics when joining ON Semiconductor. He manages a team of device engineers that are mainly involved in the prestudy of new smart power technologies and discrete power devices, including process specification, assessment of electrical and degradation behaviour, and detailed TCAD studies. He is author or co-author of over 20 international journal papers or conference proceedings.

Paul Colson received a M.Sc Ing. in chemistry from the KIHO of Gent in 1980. In 1983 he started as a process engineer in MIETEC NV– later Alcatel Microelectronics, AMI Semiconductor, and presently ON Semiconductor Belgium. He was involved in process module R&D, and mastered a large experience in plasma chemistry and lithography. He authored and co-authored several papers and patents in semiconductor processing, and cooperated continuously in European and National development programs. Since 2003 he is program manager in Corp. R&D, with a large experience in program coordination activities.

15. IFAG - coordinator

Company Profile

Infineon Technologies AG, Neubiberg, Germany, offers semiconductor and system solutions addressing three central challenges to modern society: energy efficiency, mobility, and security. In the 2010 fiscal year (ending September 30), the company reported sales of Euro 3.295 billion with approximately 26,650 employees worldwide.

Infineon has long years of experience in semiconductor solutions for automotive and industrial applications and develops, manufactures and markets innovative semiconductor products and complete SoC solutions. Infineon is market leader in automotive semiconductors (sensors, power semiconductors and microcontrollers) in Europe and worldwide. Infineon is worldwide one of the leading companies in power electronics as with the CoolMos technology, the IGBTs and the SiC technology and No 2 worldwide as manufacturer of high power IGBT modules. Research activities have been conducted on Catrene / ENIAC level like HotCar, SPOT-2 or SmartPM, on national (BMBF) level like INGA, SIC_JFET or Super-junction BE and on EU FPx security like OpenTC, TECOM, SecFutur and SEPIA. Infineon is the major European driver in the Trusted Computing standardisation Group and market leader for high security controllers e.g. for smartcards (esp. banking and government applications).

Main role in the project

Infineon will provide the key expertise in power technologies and core less transformers for safe isolation and in security elements to enable a secure, safe, cost and power efficient communication chain, as cornerstone in the interfacing to the grid at home. The seamless integration of advanced security and trust technology will prohibit that wide and open communication links can be exploited by any attacking adversaries, Very low standby losses, safe communication and low costs for the high volume mass production together with easy product implementation capabilities in the exploitation phase are parts of the objectives, where Infineon performs the research within the project.

Key Staff Members Profile

Wolfgang Dettmann, studied physics at the Technical University Munich. In 1999 he obtained his Ph.D. in biophysics at the Ludwig Maximilians University Munich with an analysis of single receptor-ligand binding forces and cell-cell interactions, measured with an atomic force microscope. Since 2000 he has been working for the Infineon Technologies AG. He has been leading the development of alternating phase shift masks for optical enhancement technologies in wafer lithography and later on the 70nm photo mask technology development in the Infineon Mask House until 2004. As a member of the project office for product development in the area of wireline and wireless communications he obtained a profound knowledge within IC development for DSL and 3G/HSPA applications, risk and structured project management. Since 2009 he is responsible for collaborative projects on European and national level and covers within this function the area of smart energy related cooperative research.

Hans Brandl, studied Electrical Engineering (majoring in communication and data processing) at University of applied sciences and following Technical University Munich and finished with Dipl-Ing. degree (corresponds to master) in 1977. After developing crypto systems for government applications he changed to the semiconductor company Infineon Technologies AG. Since that time he contributed in different positions at Technology, Innovation, Sales and Marketing to technological and product advances on all sorts of high security ICs like for smartcards, secure USB-Token, specific cryptographic and security ICs. Since the last years he is active also on Trusted Computing technology, where he is responsible for technological advances and technical marketing issues. Many of his presentations and publications about Trusted Computing, advanced security and privacy at different congresses and fairs can be found in the internet. He serves as member of the board of directors and chair of workgroups in the Trusted Computing Group standardization organization.

16. INSTA

Organisation Profile

Insta was founded by three well-known companies of the installation sector, companies Berker, Gira and Jung in 1970. As electronics technology centre with 500 employees Insta develops and fabricates modules, components and systems for the lighting industry, for intelligent electric installation of buildings and other fields. Insta's development centre with more than 80 engineers designs innovative products with focus on:

- LED luminaires and LED lamps
- Light management systems and light control devices
- Lamp ballasts and electronic transformers
- Radio technology (433Mhz, 868 MHz and 2.4 GHz)
- Safety technology, including presence, motion detectors and biometric systems
- OEM development and fabrication

Insta offers a wide range of high-quality, economic serial products in the field of lighting electronics and is constantly working on customer-specific solutions, with regard to development, fabrication and even customer-requested packaging.

Main role in the project (divided to the tasks involved)

Insta will cover the end user domain and will investigate application, system concepts and certain components needed for E2SG. With strong links to two major players in the market of home installation, companies Gira and Jung, and various other companies, Insta provides access to the market and knowledge of the installation sector. Using the background in the field of devices for home automation Insta is capable of solving some of the technical challenges regarding the last few meters to the electrical consumer.

Key Staff Members Profile

Harald Mundinger was born in 1963 and studied computer engineering at the University of Applied Science Furtwangen from 1984 to 1988. From 1988 to 1992 he worked as design engineer and later as a team leader for control systems and advanced user interfaces for high end injection moulding machines. In 1996 he received a Dipl.-Ing. degree in Electrical Engineering from the University of Paderborn and then worked there as research assistant in power electronics. In 2001 he joined Insta. He leads a team of three engineers, reports to the CTO and is responsible for technology scouting, evaluation of new technologies, coordination of research projects and cooperation with Universities and research institutes.

Friedhelm Holtz was born 12th May 1960 in Mönchengladbach, Germany. He studied electrical engineering at the University of Duisburg from 1981 to 1988, when he received a Dipl.-Ing. degree. After eight years of work in the field of digital video predevelopment at Thomson Multimedia in Hannover he joined in 1996. He took over the responsibility for the product development of dimmers, motion detectors, shutter controls etc. From 2009 on he is responsible for the product development of the whole complete Insta product range including components of wired and wireless bus systems as well as LED luminaires.

17. NXP-D

Organisation profile

NXP Semiconductors provides High Performance Mixed Signal and Standard Product solutions that leverage its leading RF, Analog, Power, Digital Processing and manufacturing expertise. These innovations are used in a wide range of automotive, industrial, consumer, lighting, medical, computing and identification applications. Headquartered in Europe, the company has about 28,000 employees working in more than 25 countries and posted sales of USD 3.8 billion in 2009. News from NXP is located at www.nxp.com.

NXP-D has an outstanding position in automotive semiconductors and is market leader in contact-less identification solutions with the business unit for automotive and identification (BU A&I) in Hamburg. NXP is a top global supplier of chips in eGovernment applications, such as electronic passports, ID cards, or health cards. The activities of NXP Germany comprise design, development and marketing of leading edge RFID, e-government and automotive sensor devices. With over four billion chips sold to date NXP the world's leader in the design of contact-less chips used in secure smart cards and electronic identification schemes.

Main role in the project

NXP Germany will firstly explore and study all the options for lightweight and fast authentication and communication protocols, ranging from classical authentication schemes using public key cryptography (such as RSA and ECC) to non-standard solutions such as coupon-based authentication and similar.

The final step is then to provide a prototype proving the concept, i.e., implementing an example application of device authentication and communication optimized for all the parameters: performance, security, physical resource consumption.

Key Staff Members Profile

Georg Menges, Govt. Relation & Projects and member of the identification innovation group organizes and manages the participation of NXP Germany in nationally as well as internationally funded projects. Georg Menges owns an engineering diploma in electronics (Dipl. Ing.) from the Technical University Braunschweig. After a short intermezzo at PC Manufacturer Compaq this led him to join Philips Semiconductors in Hamburg. Within more than 25 years with Philips, today NXP Semiconductors, he was able to build up experience in such different areas as chip design, application, project management and product marketing. Before moving back to Hamburg he has been managing marketing groups acting in as different market segments as identification, displays, audio and MEMS technology. Those assignments also gave him the opportunity to work and live abroad in e.g. Taiwan, England and the Netherlands.

18. TEL

Organisation profile

Telefunken Semiconductors with headquarter in Heilbronn, Germany has special and long-term knowledge in the design and production of high performance RF and power technologies and corresponding circuits. One focus of Telefunken is on mixed signal circuits with supply voltages up to 80 Volt and switched currents of 1 Ampere. For example the application areas body control, ABS and Airbag systems in the car industry are covered by products of our customers, as well as keyless entry and IR/RF data control. For this application field a special technology line has been developed and is in production in the Heilbronn facility. This line includes Smart Power technologies on Bulk and SOI substrate material. A special focus is on high temperature (200°C) applications for automotive and industrial usage and on integration of non volatile memory (EEPROM) cells. Telefunken is supporting worldwide customers with its foundry service and is offering own products for selected market segments.

Main role in the project

Telefunken will provide intelligent driver solutions for interfacing to Smart power Grids. For this purpose Telefunken will bring in a SmartPower SOI technology for high efficiency systems, with very low standby losses, tailored for intelligent power supplies in several applications. The technology is available for other project partners with related design tasks and Telefunken will offer a MPW (Multi Project Wafer) -service for concerned partners.

Telefunken will finally contribute a demonstrator with focus on effective energy supply systems and high voltage capability.

Key Staff Members Profile

Volker Dudek received the degree in physics in 1988 from the Technical University of Darmstadt. He worked in his diploma thesis on VLSI multilayer metallization systems at the Electrical Engineering Department. He joined the Institute for Microelectronics Stuttgart in 1988, where he was active in quality, reliability and process integration departments. From 1992 to 1999 he was the Front-End Processing manager at IMS. He got the PHD from the Mechanical Engineering Department of the University of Stuttgart for his work titled “Lithography independent MOS-Transistors with channel-length below 100nm”.In 1999 he joined Atmel-Heilbronn as the leader of the Smart-Power BCD process integration group. Since 2004 he is the Technology Development Director of Atmel-Cooperate. Since 2005 he was also the Director of the Foundry Business Unit. Since 2009 he is responsible as VP and CTO for technology developments and foundry business in Telefunken Semiconductors. Winfried Rabe received the Dipl.-Ing. degree in 1977 from the Ruhr University Bochum. He joined Telefunken, located in Heilbronn, Germany and developed discrete and integrated RF circuits in several technologies. In these activities he worked out several publications and patents. After management of RF development groups and departments, he was appointed as a project manager and was responsible for R&D-projects of Atmel Germany. He actually is a manager with responsibility for innovation management in Telefunken Semiconductors.

Uwe Gieselmann received his Dipl.-Ing. (FH) in 1994 from the Fachhochschule Osnabrück. He joined Siemens HL in Villach, Austria and developed ASICs for automotive and smart power applications. 1996 he changed to Sican/Sci-worx in Hannover and continued the development of ASICs and ICs for smart power applications for different customers and with several technologies. 2009 he joined Telefunken and is the Manager of IC Architecture in the Design Center in Hannover.

19. FHG

Organisation profile

The Fraunhofer Gesellschaft is the leading organization of institutes for applied research in Europe, undertaking contract research on behalf of industry, the service sector and the government. At present, Fraunhofer maintains more than 80 research establishments at more than 40 locations throughout Germany. A staff of some 17000, predominantly qualified scientists and engineers, works with an annual research budget of about 1.5 billion Euros. Of this sum, more than one billion Euros are earned through contract research. The Fraunhofer Microelectronics Alliance VµE coordinates the activities of the ten Fraunhofer institutes working with about 2500 people in the fields of micro- and nano-electronics. Among these, the Fraunhofer Institute of Integrated Systems and Device Technology (Institut für Integrierte Systeme und Bauelementetechnologie IISB) in Erlangen is dedicated to front-end process simulation and development, and power electronic systems.

Main role in the project

Energy management and Energy conversion. In the field of power electronics, the “Power Electronic Systems” department of IISB involved in the project is specialized on system integration of power electronics, especially into thermally and geometrically demanding target applications. The staff has a broad experience in power and control electronics for integrated power converter systems, especially in automotive hybrid traction applications and renewable energies. System engineering is done based on software tools for thermal, thermo-mechanical, and electro-magnetic analysis, and for circuit and system simulations. Facilities necessary for thermal and electrical characterizations are available; the same applies regarding equipment for reliability tests and failure analysis. The respective expertise was contributed to the European projects HOPE and e3Car.

Key Staff Members Profile

Dr. Martin März, Head of the “Power Electronics Systems” department at the Fraunhofer IISB. Mr. März, born in 1962, received his PhD in electrical engineering in 1995. After 5 years in industry (Infineon) he built up the power electronics department at the Fraunhofer IISB. In 2005 he established the “Center for Automotive Power Electronics and Mechatronics (ZKLM)”, a subsidiary of the Fraunhofer IISB in Nuremberg. His focus is on high power density and highly efficient power converters, on system integration of power electronics, and thermal management. He is inventor on more than 35 granted and submitted patents, and author of more than 75 publications.

Dr. Vincent Lorentz obtained the Dipl.-Ing. Degree in physics from the National High School for Higher Education in Physics of Strasbourg (ENSPS) in 2003, and a Master Degree in microelectronics from the University of Strasbourg in the same year. He received his Ph.D. Degree in Electronic Engineering under joint supervision of the University of Erlangen-Nuremberg in Erlangen, Germany, and of the University of Strasbourg, France, in 2008. He joined the Fraunhofer IISB in Erlangen, Germany, in 2003 and since 2010 he is Group Manager of the “Energy Management” Group in the “Power Electronics” department. His activities are in the area of hardware and software for power management and power conversion, especially for battery driven electric vehicles and energy storage systems for renewable energies.

Dr. Stefan Zeltner has studied communications engineering at the Georg Simon Ohm University of applied sciences Nuremberg and electrical engineering at the Friedrich Alexander University Erlangen. Since 2001 he is a research associate of the power electronics division at the Fraunhofer Institute of Integrated Systems and Device Technology. Since 2007 he is head of the advanced circuit engineering group and his research interest is focused on ultra-high power-density systems.

20. RWTH

Organisation profile
RWTH Aachen University is the largest university of technology in Germany and one of the most prestigous technical universities in Europe. It currently has around 31,000 enrolled students, most of them in the field of engineering. RWTH Aachen
University was founded as a polytechnical institute (Polytechnikum) in 1870 by an industrial initiative. RWTH Aachen University has a long history of close and wide-ranging co-operation with national and international research centers and industries; continuously contributing to the development of the German economy and increasingly extending this role within the European Union. 400 professors with 2,000 researchers offer more than 100 courses of studies. The Faculty of Electrical Engineering and Information Technology consists of 23 chairs, 2 additional research departments and 5 junior professorships each with its own research area.
Throughout its long history, RWTH Aachen has always focused its efforts on combining its expertise with the industry and help students to develop innovative skills. The chair supports the Wireless Research Center of the Faculty in the areas of circuit design, system concepts and design methodology for on-chip RF sub-systems. Current research includes a S-Band Ship Radar System (RASKEL, SAM Electronics and FGAN-FHR), an UWB LNA for sensing and localisation (Ukolos Halos, DFG), Software Defined Radio (Infineon Germany), a Single-Chip FM radio, a combined GPS/Glonass/Galileo receiver (Shared RF), Sigma-Delta Converters (DAAD), Novel Receiver and Transmitter Architectures for Nanoscale CMOS Integration (4 x UMIC, BMBF), DC/DC-Converters (pathfinder) and readout circuits for MEMS (proposal). A major task in the current research is located in the cluster of excellence of the German government Ultra High Speed Communication and Information (UMIC) with 8 researchers.
RWTH IAS currently has a staff of 1 acting manager, 14 PhD students, 1 laboratory engineer, 14 student workers, 2 technicians, 1 mechanics, 2 apprentices and 2 secretaries. IAS is equipped with more than 40 PC/SUN workstations, multiprocessor computing servers with an adequate number of MATLAB, Cadence, Mentor, ADS, RFDE licenses. The chair has an RF measurement lab including an on-wafer prober, vector network analyzers up to 50 GHz, three 6 GHz vector signal generators, a 40 GHz signal generator, and a 40 GHz signal analyzer.

Main role in the project
The research focus of the RWTH Aachen University will be the integration of a low power RF transceiver supporting OFDM modulation schemes with a high peak to average ration. This work will be carried out in close cooperation with Infineon Technologies.
The RWTH will additionally carry out an investigation on ultra low power AC/DC conversion for an independent supply of smart metering subsystems.

Key Staff Members Profile

Prof. Dr. Stefan Heinen received Diplom-Ingenieur Degree in 1988 as well as his Dr.-Ing. Degree in 1992 from Gerhard- Mercator University Duisburg. Dr. Heinen started his career 1992 as RF IC designer in the Siemens semiconductor group. He has been responsible for various commercial R&D programmes in the RF area covering cellular as well as cordless applications. He founded the RF group in the Duisburg Design Center of Infineon Technologies (former Siemens Semiconductor), which has a world leading record in RF SoC integration. The Bluetooth single chip and the first GSM single chip have been developed in that group. In 2002 Dr. Heinen accepted a full professorship at RWTH Aachen University and founded the Chair of Integrated Analog Circuits and RF Systems. Prof. Heinen is an IEEE fellow since 2007.

Dr. Ralf Wunderlich received the Diplom-Ingenieur Degree in 1997 at the Technical University Dortmund, Germany (TUD). Ralf Wunderlich joined the RWTH IAS in 2002 after completing his Ph.D. at the TUD on the topic of an integrated CMOS only Hall sensor system for precision length measurement. Currently he is involved in the described research activities, in teaching and in student concerns. He is leading the chairs power management and sensor group. As an acting manager he is responsible for all organizational and professional affairs.

21. ADD – stepped out during negotiation phase

22. IQU

IQUADRAT has been founded in 1997 and has a focused business plan specifically intent on delivering a “new generation of research tools for system level evaluation of wireless cognitive systems”. The company includes a “radio access group” with extensive know-how in system level simulation methodologies for Radio Access Technologies that include 802.11, WiMax, and Long Term Evolutionary RAN. Besides the main stream in development, IQUADRAT also acts as a consulting company for the planning of wireless networks, being currently involved in projects with the mobile operators, and several public authorities.

IQUADRAT participated in the CELTIC project LOOP targeting the integration of heterogeneous wireless systems for which it is developing a simulation tool for evaluating cognitive protocols for future emerging technologies. IQUADRAT improved the functionalities of the custom made simulator by including new radio technologies and new functionalities. Moreover, IQUADRAT is participating in the CATRENE project HERTZ for the design of energy efficient wireless home gateways for the control of the energy consumption at home. In addition, IQUADRAT designs an application for smart phones for remotely monitoring the home gateway and the energy consumption at home. IQUADRAT has been subcontracted by the Cypriot operator MTN S.A. for the FP7-ICT project Hurricane for which IQUADRAT designed and evaluated efficient handover algorithms that take into account both the users´ and the operator´s satisfaction.

Key Staff Members Profile

Nizar Zorba is an experienced researcher and has participated in several R&D European projects under ICT-FP7 program through PHYDYAS and HURRICANE projects; ICT-FP6 program through NoE NewCom, CELTIC program through HERTZ and LOOP projects; MEDEA program through MARQUIS and PLANETS projects and European Space Agency through MIMOSAT project. Dr. Zorba has published a lot of scientific papers in terms of journal and conference papers, edited and participated in several books and presented 5 international patents. In addition Dr. Zorba has the relevant experience in IQUADRAT´s research topics and he can carry out the proposed work.

David Boixadé Vilà received his Information Systems Engineering degree from Universitat d‘Enginyeria La Salle, part of the Universitat Ramon Llull, Barcelona. Prior to Iquadrat, he was employed by Asertel, one of the first ISPs in Spain. As an Internet Project Manager he was responsible of the ISP creation for the Logic Control Company. Later he co-founded Iquadrat in 1997, with the goal of carrying out bigger telecommunications and information technologies projects. David is CEO and co-founder of Iquadrat with responsibility for Product Development. He is currently participating in the CATRENE project HERTZ while he served as a WP Leader in the LOOP project.

23. LEITAT

Organisation profile

LEITAT is a Technological Centre specialized in production technologies. LEITAT develops R+D activities in the areas of materials sciences, nanohealth and security, environment, biotechnologies and biomedicine, smart systems, new production process and renewable energies with deep knowledge and experience on the technological transfers to several industrial sectors.

LEITAT has a strong experience in the field of the promotion of the innovation, developing its activities in terms of raising awareness and spreading existing information and communication technologies and identifying new software methodologies of innovation, design and implementation of them.

LEITAT takes part each year in many projects financed by the regional and national government, participates in projects co-funded by the European Commission; that gives to LEITAT a very valuable experience in the management of European projects under different European funding schemes. Besides, LEITAT develops private R&D projects funded by industrial partners, and LEITAT has a wide portfolio of SMEs specialized in several areas of expertise.

Furthermore, LEITAT is member of several Technological platforms, including Smart Systems Integration (EPOSS), EU Platform for Industrial Safety (Industrial Safety), EU Technology Platform for the Future of Textiles and Clothing (Textile), the Spanish technological platform on Health, Welfare, and Social cohesion, (eVIA), and the Spanish platform of Digital Home (Hogar Digital).

The Smart Systems division of LEITAT which will participate in tasks of E2SG project has interest in:

- Thermoelectricity: Specific applications design and prototyping, Custom made thermoelectric modules development, Thermal requirements calculation and simulation
- Medical devices: Custom made portable devices, Bio-parameter monitoring devices, Bio-sensors
- Energy harvesting: Renewable energy sources, Self-powered devices, Energy harvesting modules design and development
- Smart Systems: Sensors and actuators integration, Wireless communications, Firmware development
- Energy storage: Li-ion batteries, Super Capacitors
- E-Textiles: Electronic integration in Smart Textiles, Electronics on flexible substrates, Flexible and stretchable conductive materials
- Prototype development: Renewable energies applications, Electronics applied to high performance sports, New commercial products, Small production series custom-made devices.

Main role in the project

LEITAT contribution to the project is related to: simulation of new algorithms for smart conversion and implementation of smart meters for sensing and its communication within the network with two assumptions: low-power and low-cost.

LEITAT will contribute to WP1, WP2, WP4 and also to dissemination and exploitation tasks of WPM2.

Key Staff Members Profile

José Sáez is graduated in Industrial Technical Engineering specialized in Electronics at the Polytechnic University of Catalonia (UPC). He has carried out postgraduate studies in Robotics in the Foundation CIM, belonging to the Polytechnic University of Catalonia. Throughout his professional career José Alberto Sáez has worked in different companies as electronic engineer carrying out tasks of design as well as of management. Nowadays, he works in the R&D Department of the Technological Center Leitat. He takes part in the development of prototypes in R&D&I projects, being specialized in design and integration of the electronic devices used on these prototypes. He takes also part in the tasks of prospecting and evaluation of the used technologies.

Laura Pérez works as a technical industrial engineer, specialized in industrial electronics and in Electronic Engineering with deep knowledge of bioelectronics and the environment. After various collaborations with the University in order to carry out research on the final positioning of mobile robots in interior spaces with the help of ultrasonics, she has spent her career focussing on renewable energies.Currently she is working at LEITAT Technological Center where she is responsible of the laboratory of renewable energies. On the other hand, she coordinates tests on heat and the characterization of photovoltaic modules, materials and devices for generating electric current according to international standards for the homologation and certification. Furthermore, she helps to carry out testing and projects on working with electron charge.

24. CTTC

Organisation profile

CTTC is a non-profit research centre, from a public initiative and with a high degree of self-financing, open to the participation of other public and private bodies, as well as to partnership with the industrial and business sectors. CTTC has a professional scientific management, a critical mass of

researchers and projects, real possibilities of growing and establishing durable links with the industrial and business sectors, and the capacity of leading technological projects, both national and international. The expertise accumulated at CTTC makes us one of the primary addresses for Spanish telecom industry, as well as one of the leading European institutions for research at physical, access and network layers in telecommunications.
CTTC's core activity is the conception, design and implementation of research and development projects, which have to produce innovative results in all their development phases, in both scientific and engineering terms. The acquisition of an international reputation in its scientific and technological activity, shaped in terms of scientific production, will favour CTTC's mission of becoming an Excellence Centre.
CTTC aims at fostering innovation potential by making new scientific knowledge accessible and supporting its implementation. In this way, CTTC significantly contributes to consolidating Barcelona's position as an important centre of technology, besides helping expand Spain's role within the European telecommunications research community and industry.
Finally, CTTC contributes to the economic growth of the Catalan industrial context, by becoming a partner of solid reputation in research and technological development, as well as a provider of knowledge and human resources for the industrial research.

25. Tyndall-UCC stepped out during negotiation phase

26. Heliox.

Organisation profile

Heliox is a fast growing Dutch SME specialised in the research, design, manufacturing and delivery of high performance power conversion products. Heliox is a “head-to-tail” company with a strong focus on R&D. Manufacturing is located in as well The Netherlands, Eastern Europe as Asia.
The R&D department from Heliox is mainly located in Best, The Netherlands and currently contains 16fte’s. Heliox is mainly active on the high end consumer market, the medical market and the automotive market. Heliox is specialised in the design of power conversion modules for a variety of products and applications: ranging from high efficient audiophile quality Class D amplifiers and multichannel audio systems, to long lifetime compact power supplies and from medical grade power conversion systems to solar inverters and high power automotive inverters and chargers. Products are typically characterised by a high degree of innovation, high efficiency and long lifetime. The R&D and manufacturing process are strongly related in an ever ongoing drive for higher product and process quality.
Heliox has long and extensive expertise in R&D and manufacturing of high quality power conversion modules. Heliox has strong know-how on not only conceptual but also on practical implementations, suitable to be operating in the field on a safe, reliable and long lifetime manner. As such Heliox will contribute to a strong link from innovation to practical solutions, improving short term European economical advantages

Key Staff Members Profile.

Dr. Ir. Frank van Horck was born in The Netherlands in 1967. He has received his Ir. degree in electronics from the Technical University of Eindhoven. He worked at the Technical University of Eindhoven, doing research on Electro Magnetic Interference. He received his Ph.D. on this subject at the Technical University of Eindhoven, The Netherlands. He is currently working in the R&D department of Heliox as Power System specialist, focussing on high efficient power conversion. Next to that he contributes to the research program and is active as a teacher at the Technical University of Eindhoven.

27. NXP-NL

Organization profile

NXP Semiconductors provides High Performance Mixed Signal and Standard Product solutions that leverage its leading RF, Analog, Power Management, Interface, Security and Digital Processing expertise. These innovations are used in a wide range of automotive, identification, wireless infrastructure, lighting, industrial, mobile, consumer and computing applications.

NXP Semiconductors has operations in more than 25 countries, with about 3000 employees active in R&D. The company has approximately 14000 issued and pending patents.

NXP's Power and Lighting business line creates AC/DC power supply and lighting solutions. Power supply solutions include highly efficient flyback and resonant converters, in the range of 250W down to less than 1W, with integrated power switches in the lower power ranges. NXP's lighting solutions drive every existing lamp type, from several fluorescent types to LEDs. Technologies for RF-controlled LED and CFL lamps are avaliable. The R&D department contributing to E2SG is located in Nijmegen, The Netherlands.

Proprietary high voltage silicon-on-insulator based IC technology enables the integration of mentioned power and control functions, withstanding up to 750V. So far, 750 million products using this high voltage SOI technology have been shipped.

Main role in the project

In E2SG WP1, NXP-NL will contribute to the creation of optimal supply architectures for low-power, always-on, grid-connected devices like environment sensors and intelligent light sources. These supplies are intended to operate either autonomously or under smart grid control. Simulation models will be provided, as well as hardware prototypes which can be used for measurement data generation and use in WP4.

Key Staff Members Profile

Ing. Hans Halberstadt received his ing. degree from the HTS Amsterdam in 1986 and started working at Philips/NXP in 1986, where he received a post HBO degree on IC design aspects. He worked several years as designer of analog and mixed signal IC's for switch mode power systems. Later he focused on system architecture and worked on various system aspects within the field of shavers, battery management, VRM, adapters for notebook computers, power supplies for TV, PC desktop and worked on topics like Buck, Flyback and bidirectional Flyback and resonant power conversion. This work resulted in over 30 issued or pending patents.

Ir. Wouter Groeneveld was born in The Netherlands in 1962. He has received his Ir. degree in electronics from the Technical University of Delft. He worked at Philips Research in the areas of high-resolution digital to analog conversion and EMI, and at Philips Semiconductors, NXP Semiconductors and ST-Ericsson on power conversion systems for mobile applications. Currently, he leads the innovation team at NXP Semiconductors' power and lighting organization, focusing on new technologies for AC/DC converters and drivers for fluorescent and LED lamps.

28. Philips Consumer Lifestyle – PLC, Netherlands

Company Presentation: Royal Philips Electronics of the Netherlands is a diversified Health and Well-being company, focused on improving people's lives through timely innovations. As a world leader in healthcare, lifestyle and lighting, Philips integrates technologies and design into people-centric solutions, based on fundamental customer insights and the brand promise of "sense and simplicity". Headquartered in the Netherlands, Philips employs approximately 133,000 employees in more than 60 countries worldwide. With sales of EUR 27 billion in 2007, the company is a market leader in cardiac care, acute care and home healthcare, energy efficient lighting solutions and new lighting applications, as well as lifestyle products for personal wellbeing and pleasure with strong leadership positions in flat TV, male shaving and grooming, portable entertainment and oral healthcare.

The following tasks will be performed in the project:

- Interface for the interactive control of a smart home
- PCL will contribute to intelligent metering and remote control solutions able to capture energy consumption statistics in the home (like (e.g. hotels)) environment (e.g. monitoring and control

IP-based photo frame, tablets, smart phone or NetTV). Based on detailed analysis of the consumption patterns, the home owner will be able to interactively monitor the consumption of all the energy hungry elements, including lighting (lighting occupies one of the largest percentages of energy consumption). PCL will contribute to innovative E2SG activities related to (-) supervisory control of the system, (-) energy consumption forecast, (-) optimization of HVAC systems and (-) Service Oriented Architecture. As technology provider, PCL will provide an open, distributed SoA platform.

29. IT

Company Profile

IT is a private, non--profit organisation owned by the Technical University of Lisbon, University of Aveiro, University of Coimbra, Portugal Telecom Inovação, S.A and Siemens Portugal. IT mission is to create and disseminate scientific knowledge in the field of telecommunications in order to both improve higher education and training, both at graduate and postgraduate levels, and to improve the competitiveness of Portuguese industry and Telecommunications operators. The research unit has been evaluated by an expert panel selected by "Fundação para a Ciência e a Tecnologia" (the national agency for research), in 1996 and 1999: as a result of this evaluation IT has been selected in 2001 by the Portuguese Government to hold the distinction of the Government Associate Laboratory in the area of Telecommunications. The Aveiro pole of IT currently has about 28 PhD researchers (many of which also holding teaching positions at the University of Aveiro), plus 78 other researchers, with expertises on radio and microwave, optical, networks and circuit design. IT has been involved since its foundation in several projects in the area of wireless either at a national or European level, namely in the ACTS and IST programmes (e.g. SAMBA, ASILUM, MOBYDICK, MATRICE, 4MORE, DAIDALOS, 4MORE, ORACLE, UNITE, HURRICANE, WHERE, and PEACE) Networks of Excellence (ACE, TARGET, EuroNGI, E-PHOTON, and CRUISE). The 4TELL team within IT is currently coordinating the ICT C2POWER (Call4) and COGEU (Call4) project, and partner of ICT HURRICANE, ICT-SEC PEACE and ICT WHERE 2.

Main role in the project

IT being a key international player on green communications and coordinating several European project on this area plan to exploit their know-how towards delivering ICT solutions for evolving the concept of smart grids. More specifically, IT´s role will be mainly in "T3.2: Optimized control of smart grid node" and willl address the application of game theorectical approaches (integration of Nash Equilibrium of Game Theory and Multi Agents System) to optimize the distribution of electricity from a small number of large generators to millions of consumers following the idea that supply must always follow demand. The characteristics of the technique will be compared with those already presented in the literature and with those already included in the distribution management systems presently used by the utilities operators.

Key Staff Members Profile

Dr. Jonathan Rodriguez received his Masters degree in Electronic and Electrical engineering and Ph.D from the University of Surrey (UK), in 1998 and 2004 respectively. Since 2005, he became a Senior Researcher at the Instituto de Telecomunicações, Pólo de Aveiro (Portugal) and team leader of the 4TELL wireless communication research team. In 2008 he became an invited lecturer at the University of Aveiro. He is author of several conference and journal publications, and has carried out consultancy for major manufacturers participating in DVB-T/H and HS-UPA standardisation. His research interests include Cooperative Radio Resource Management, and cross-layer design.

Alberto Nascimento received the Licenciatura, MSc. and Ph.D degrees, from the University of Aveiro (Portugal) in 1994, 1999 and 2010, respectively, in Electronics and Telecommunications Engineering. Complementing his academic career, he was working with TMN Lisbon and Nokia Netherlands as a cell planning and optimization engineer for 3G and 2.5G mobile networks.

Moreover, he was a consultant for pre-sales and technical support at the mobile communications group at Siemens in Lisbon. Since 2003 he became an academic staff member within the Department of Mathematics and Engineering of Madeira University, Funchal (www.uma.pt), and in 2010 a member of the 4TELL research group at the Instituto de Telecomunicações – Aveiro His main research interests include B3G and 4G networks WiMAX and LTE), namely in the MAC layer, resource allocation and optimization, cross-layer optimization, energy consumption optimization and game theory application to radio resource optimization in wireless networks and smart grids.

Joaquim Bastos has received his Licenciatura* and Masters degree in Electronics and Telecommunications Engineering from the University of Aveiro (Portugal), in 1997 and 2006 respectively. From 1998 to 2002, he was a development manager at Philips – Portugal where he participated in national collaborative research projects in communication systems. In 2003, he became a researcher at the Instituto de Telecomunicações – Aveiro, and participated in international research projects, such as FP6-IST's MATRICE, 4MORE, ORACLE, and as WP leader in FP7-ICT's WHERE and WHERE2, and in Celtic's MOBILIA. He is author of several conference publications, and his main research interests include: digital signal processing for OFDM and MC-CDMA, location-based communications optimization, cognitive radio systems, multiuser detection, and energy efficient cooperation strategies..

30. STUBA

Organization profile

Slovak University of Technology in Bratislava (STUBA) consists of 7 faculties, is attended by almost 18 000 students and belongs to leading universities in microelectronics education and R&D activities in the New Member States of EU. The Microelectronics Department of Slovak University of Technology in Bratislava is active in fields of microelectronics, IC design, optoelectronics and sensors. Its membership in EUROPRACTICE provides access to advanced TCAD modeling and simulation as well as IC design tools (Synopsys, Cadence). Structure and device characterization and failure analysis either by electrical (I-V, C-V, DLTS measurements in a wide temperature range with optional magnetic field, microwave characterization) or analytical tools (SEM, EBIC, CL, AES, AFM, SIMS, micro-Raman spectroscopy) is another strong field of department activities. The comparison and good correlation of experimental and simulated results is used for physical models calibration, physical interpretation of obtained experimental results and prediction of the properties of new semiconductor devices and IC's. The solved projects comprise the thin film sensors and subsequent signal processing for healthcare and environmental applications, analogue and mixed signal design, smart power MOS device design and characterization, GaN based devices, organic semiconductor transistors and LED's, diamond and carbon nanotubes growth. The well equipped laboratories, expertise and enthusiasms of department staff ensure the successful project solution. They are about 40 teachers and researchers and more than 20 PhD students at the department. They actively participated in projects in 5th, 6th and 7th FP projects as well as ENIAC-JU, NATO and COST projects. More than 20 projects funded by national authorities and/or within bilateral international collaboration are being solved at the department yearly.

Main role in the project

STUBA has expertise and could contribute to PV solar energy generation by offering precise structural analysis of the physical geometry, morphology of materials and structures by FE SEM (SE, EDS, EBIC, CL), ION-TOF SIMS, AFM and microRaman spectroscopy combined with optical and electrical characterization performed in a wide temperature range. This analysis is essential to the development InGaN/Si structures for optimization of design of solar cells giving efficiency of around 30%. This include nanoscale structural analysis of materials and structures by Field Emission Gun Scanning Electron Microscope (FE-SEM- SE, EDS, EBIC and CL modes), Time-of flight secondary ion-mass spectrometer (ION-TOF SIMS), AFM technique (PARK XE-100) in different modes and micro-Raman spectra and mapping (LabRam) to analyze the effect of strain on continuous films of III-Nitrides with low strain and low dislocation density.

STUBA has also an expertise in various methods of electrical and optical characterization of optoelectronic devices. The complex electrical (I-V, photocurrent) and optical detection spectroscopy will be realized to optimize the device structure and properties as well as measurements of electrical and optical parameters stability and degradation of structures and devices by I-V (Agilent sources& semiconductor parameter analyzer), C-V, DLTS methods (80-450 K) and optical spectroscopy methods (15-300 K).

STUBA also offers 2D and 3 D process and device modeling & simulation (ISE TCAD), with focus on electrical and thermal properties (UIS, ESD), mechanical and thermal properties, and non-standard effects that might be very useful and supporting for development of power devices and structures.

Key Staff Members Profile

Prof. Daniel Donoval received his M.S. and PhD degrees in Electronics from Slovak University of Technology (STU) in Bratislava, Slovakia, in 1976, and 1981, respectively. He has been working as a Head of Department of Microelectronics STU Bratislava for 16 years. As a professor he is involved particularly in physics, technology and characterization of advanced semiconductor structures and devices supported by modeling and simulation. In the years 1997 – 2003 he was a member and chairman of the Scientific Grant Agency of Slovak Ministry of Education. He was a referee of the projects submitted within 5th, 6th, and 7th FP of European Union. Currently he is a member of the Education & Training Coordination Board and management team of the Scientific Community Council of ENIAC Technology Platform. He is the Slovak representative in Public Authorities Board and governing Board of ENIAC JU. He is a coordinator of many R&D projects supported by national and international agencies. He authored and co-authored more than 150 papers published in international scientific journals and conference proceedings. To stimulate the technology transfer to industrial partners he organizes many conferences, workshops and participates in scientific program and steering committees of many international conferences.

Prof. Viera Stopjaková received her M.S. and PhD degrees in Electronics from Slovak University of Technology (STU) in Bratislava, Slovakia, in 1992, and 1997, respectively. From October 1997 to September 2003 she was an assistant professor at Microelectronics Department, FEI STU in Bratislava. Since October 2003 she has been an associate and currently a full professor at the same department. She has been involved in several EU funded research projects such as Tempus, ESPRIT, Copernicus, Inco-Copernicus, 5th EU Framework project REASON, 7th FP project IDESA, ENIAC-JU projects END and MAS. Currently, she is a co-ordinator of 2 grants funded by the Slovak Ministry of Education and the European Social Fund project NANOSYS. She has published over 70 papers in various scientific journals and conference proceedings; and she is a co-inventor of two US patents. Her main research interests include IC design and test, on-chip current testing, design and test of mixed-signal circuits and systems, biomedical monitoring, and smart sensors.

31. RDAS

Organization profile

R-DAS, ltd., (**R**esearch - **D**evelopment **A**pplications **S**ervices), was founded in order to transfer results of research and development as well as the latest technology knowledge and know-how, mainly in microelectronics, into practice. It is a small spin-off firm closely related to the university. The company has been established with intention to apply innovations of the newest, modern products in the area of microelectronics and nanoelectronics, biomedical engineering, healthcare, RFID, smart sensor systems, miscellaneous RF communication systems, and especially, IC design. The company has excellent scientists, research workers and IC design experts as well as experienced management and technical support, providing altogether high quality research potential. The main activities are research and development of smart modern electronic systems and their IC integration in several fields of microelectronics. Moreover, company deals with solutions to the general social issues such as quality of life, healthcare, wellness, etc.

Main role in the project

R-DAS can offer an expertise in several fields that include ASIC development and prototyping, low-power systems, integrated solutions for RF receivers and wireless communication systems, PCB development and testing, measurement and test, smart sensors, and others. The company has developed microelectronic systems for diverse application domains such as low-voltage low-power applications, biomedical monitoring, healthcare, smart sensors, contactless cards, ultra-wideband RF receivers, and communication systems.

Within the E2SG Project scope-frame, R-DAS could contribute “Advanced Monitoring” and/or “Advanced control” by development of dedicated and specific metering ASICs needed for precise and advanced monitoring and control systems that will be inevitably employed in E2SG project.

R-DAS might also partially contribute to new solutions, suitable for communication part of E2SG project.

Key Staff Members Profile

Dr. Libor Majer received his M.S. and PhD degrees in Electronics from Slovak University of Technology (STU) in Bratislava, Slovakia, in 2004 and 2010, respectively. Afterwards, he has been working at Microelectronics Department of the same university as a researcher in microelectronics especially, in the area of RF, analog and mixed IC design and testing, systems on chip, biomedical circuits, application software, and hardware design of the programmable ICs, microcontrollers and signal processing. He has participated in several EU projects such as 5th FP Project REASON, European Social Fund project, ENIAC-JU Project MAS and many others. He is the author or co-author of more than 30 papers presented at international conferences or published in journals.

In the last two years, he has been managing a research project running by R-DAS, and he focused his activities towards transferring of research results and know-how into practice.

32. ENECSYS

Organisation Profile

Enecsys designs, manufactures and markets micro-inverter systems with comprehensive monitoring to the level of individual modules. The systems maximize the harvested energy from photovoltaic solar modules, delivering up to 30% more power. This is achieved by optimizing the performance of each solar module and minimizing the impact of shadows and other factors that impact conventional PV system performance.

33. IQE Silicon Compounds

Organisation Profile

IQE Silicon Ltd. is part of IQE PLC and provides advanced silicon, SiGe and germanium epitaxy services to industry. IQE PLC is headquartered in Cardiff UK and employs >400 persons worldwide with eight manufacturing facilities located in USA, Singapore and UK. The group turnover for 2010 was €83.5million. IQE Silicon Ltd has continuously extended its epitaxy capabilities to include strained silicon, strained silicon on insulator (sSOI) and germanium on insulator (GeOI), The company has also developed and patented Intellectual property in epitaxial growth of lattice matched junctions used in low cost high efficiency multi junction solar photo voltaic technology .

Main role in the project

IQE will provide University of Sheffield with epitaxial growth services aimed specifically at high efficiency photovoltaics optimised for indoor light conditions.

IQE Silicon has an engineering group dedicated to the development of advanced photovoltaic structures on group IV bulk substrates and SOI. There is an installed base of single wafer ASM Epsilon 2000 reactors and supporting metrology tools to characterize complex epitaxy structures. IQE Silicon continuously develops leading edge engineered substrates. including epitaxially grown multi junction SiGe photovolatics on GaAS and Silicon bulk substrates. IQE is also experienced in the use of new silicon precursors that enable lower temperature processing thereby providing additional scope to deposit materials with improved TCR. Process expertise has been developed on SOI with respect to slip line optimization (made difficult by emissivity differences at the wafer edge of SOI wafers) and in-situ doping of the active silicon layer of the SOI.

Key Staff Members Profile

Robert Harper (M) received his BSc(hons) in Chemistry from University College Swansea in 1983 and his MSc (dist) in Advanced Semiconductor Processing and Manufacturing Technologies from the University of Southampton in 2006. The title of his final project was The Development of Strained Silicon Direct on Insulator for UTBSOI CMOS Applications. He worked for Inmos and ST Microelectronics as a process integration engineer before joining IQE in 2001 as technical sales manager. He has >20 years experience of working in advanced CMOS integration and new materials development. He has many years experience of leading teams in new product and process introductions.

Aled Morgan (M) graduated from Cardiff University in 1991 2.1 BEng (hons) in Electrical and Electronic Engineering and has spent 18 years working in semiconductor manufacturing environments. He started his career as a process engineer at EPI (now IQE) for 5 years working on the growth and characterisation of III/V custom epitaxial semiconductors. He then moved to ESM (European Semiconductor Manufacturing) where he spent 5 years as senior process engineer. He returned to IQE 7years ago and is now technology manager and responsible for all SiGe qualifications with particular focus on R&D.

Moz Fisher (M) graduated in 1978 from Salford University with a degree in Physical Electronics, he has twenty seven years of working in the semiconductor industry. He began his career with Mullards as a product engineer in the companies advanced silicon manufacturing plant in Southampton for three years. He moved to National Semiconductor and held several positions from Process Engineer to Process and Equipment Engineering Manager in a period of eight years with the company. On moving to Plessey he became Fab and Manufacturing Manager for a period of eleven years before joining IQE Silicon Compounds eight years ago as Operations Manager.

34. SIL

Organisation Profile

SILVACO Europe Ltd is a leading supplier of Technology Computer Aided Design (TCAD) software, and a major supplier of Electronic Design Automation (EDA) software for circuit simulation and design of analog, mixed-signal and RF integrated circuits. Silvaco is a major research and development company with 70% of the staff linked to the R&D activities. Silvaco supports leading photovoltaic producers in Europe and shares and sponsors collaboration and development with many universities and academic institutes in this area. Silvaco is already involved in a number of national and European collaborative projects.

Main role in the project

Silvaco will participate in WP1 and WP4 by contributing compact model and circuit design software as well as performing large matrix simulations to optimise the performance of indoor PV device circuits. Various illumination and deployment scenarios can be investigated and optimised. Designs will utilise mixed mode and available compact models to accurately reflect the performance of the designed PV devices in circuit configurations.

Key Staff Members Profile

Ahmed Nejim obtained his PhD in 1990 in Ion-Solid interaction. A wide experience in ion implantation and semiconductor processing was obtained in 17 years of research in material science, semiconductor physics and microelectronic design. Experience in lecturing, mentoring and facility management. 10 years of technical project management, European multinational projects, Liaison research fellow. Since 2001 he has been working at Silvaco supporting users in the photonic and photovoltaic community.

Lincoln Moult has a BEng(Hons) in Electronic Engineering 1986 and MSc(Eng) in Control Systems 1993 both from Sheffield University. 25 years experience in Semiconductor design, distribution and support for Communications, Consumer, Medical, Video Broadcast Distribution, Power, RF, Analog / Mixed-Signal ICs in Scientific and Commercial industry markets. The last 14 years have been concentrated on Electronic Design Automation (EDA) software applications and support. Since 2009 Lincoln has been a Lead Applications Engineer at Silvaco Europe for their EDA tools, specializing in Front-End Analog, Mixed-Signal and RF circuit design tool support for both customers and industrial partners.

Slobodan Mijalkovic received the PhD degree in computational microelectronics from University of Nis, Yugoslavia, in 1991. From 1991 until 1998 he has been appointed at the same university as Assistant and Associate Professor of Physical Electronics. In 1998 he joined the Delft Institute of Microelectronics and Submicron Technology (DIMES) in the Netherlands, working as a Senior Researcher in process simulation, model-order reduction and compact transistor modelling. Since 2006 he is with Silvaco as a Senior Development Engineer working on compact transistor modelling.

35. UoS

Organisation Profile

This work will be carried out at the Department of Electronic and Electrical Engineering (EEE), one of the top rated departments in the UK. The department has State-of-the-art facilities and expertise for growth, fabrication, modelling and characterisation of materials including III-V and Group III Nitrides at the EPSRC funded national Centre for III-Vs. Facilities and software are also available for electrical characterisation, and modelling of solar cells including stability measurements.

Main role in the project

University of Sheffield will contribute 58 men month to WP2 to carry out optimisation of contacts and windows for solar cells designed for indoor PV applications, circuit modelling, design and testing. Tradeoffs associated with performance versus cost of cells suitable for low power transmission will be investigated.

Key Staff Members Profile

Prof. Maria Merlyne De Souza, FInstP, FIET holds a Chair in Microelectronics at the EEE department, University of Sheffield since ‘07. Prior to that she was Chair in Electronics and Materials (‘03) De Montfort University (1995-2007). She received her PhD from Cambridge University Engineering Department (’94). She has authored/co-authored over 200 articles in journals and conferences, delivered invited talks to leading semiconductor industry. She is Associate Editor of IEEE-Trans Nanotechnology ('09-) and technical member of IEEE-IRPS (03-). Sheffield will work on devices and technologies for indoor PV applications as part of this project.

8.3 Consortium as a whole

8.3.1 Third Parties

The “Consorzio Nazionale Interuniversitario per la Nanoelettronica” (IUNET, Italian Universities Nano-Electronics Team) is a non-profit, private organization, aimed at leading and coordinating the efforts of the major Italian university teams in the field of silicon-based nano-electronic device modelling and characterization. Current members of IUNET are the Universities of Bologna, Calabria, Ferrara, Modena e Reggio Emilia, Padova, Pisa, Roma “Sapienza”, Udine, and the Politecnico di Milano. As such it qualifies as “Grouping” under the definition given in Article II.14.2.B of the “Guide to Financial Issues relating to FP7 Indirect Actions”, and therefore as third party carrying out part of work and entitled to funding, since it can be considered among: “associations, federations, or other legal entities composed of members (in this case, the Grouping is the beneficiary and the members contributing to the project should be listed).”

The partners of IUNET involved in E2SG are the following: Università di Bologna, Università di Ferrara, Università di Pisa, and Università di Udine.

The specific competences and expertise brought to the project are related to advanced signal processing techniques, EMI reduction, design and implementation of non-conventional mixed-mode circuits, RF circuits design, power energy systems and smart grids, and is testified by the very large number of relevant papers published in international journals, the long-standing collaboration with leading industries in the field and the extremely significant recognition at international level of all the involved team members, as it can be deduced by their CVs.

Allocation of Person-months among the IUNET partners:

	WP1	WP2	WP3	WP4	WPM1+WPM2	TOTAL
IUNET					1	1
Università di Bologna		11	10	10	2	33
Università della Calabria			12			12
Università di Ferrara	22	10	10	19	2	63
Università di Pisa		21		10	2	33
Università di Udine			11			11
TOTAL	**22**	**42**	**43**	**39**	**7**	**153**

Budget (estimated costs in euros):

	WP1	WP2	WP3	WP4	WPM1+WPM2	TOTAL
IUNET					0	0
Università di Bologna		90,838	82,581	82,581	0	256,000
Università della Calabria			96,000			96,000
Università di Ferrara	181,770	82,623	82,623	156,984	0	504,000
Università di Pisa		173,420		82,580	0	256,000
Università di Udine			88,000			88,000
TOTAL	**181,770**	**346,881**	**349,204**	**322,145**	**0**	**1,200,000**

8.4 Small and Medium size Enterprises

A small but aggressive and quality driven group of SME complements the Industry and Academic participation to the Consortium. Among them INSTA (LED technology), IQE (Silicon compounds), IQUADRAT (software), EFFEGI, METATRON and POLIMODEL.

Príloha 3

Špecifikácia projektu spoločného podniku

A. 1 Základné informácie o projekte		
Názov projektu	**Energia pre smart siete *(Energy to Smart Grid)*** Časť projektu: „Modelovanie, návrh a charakterizácia pokročilých výkonových prvkov pre stredné a vysoké napätia so zameraním na ich použitie v napäťových meničoch“	
Akronym projektu	E2SG	
Odbor výskumu a vývoja[1]	20207 Mikroelektronika	
Charakter projektu	Aplikovaný výskum a vývoj	
Doba riešenia projektu	Od: 1. 4. 2012	Do: 31. 3. 2015
Celkové náklady na projekt (v EUR)	300 000 EUR	
Výška spolufinancovania projektu z prostriedkov MŠVVaŠ SR (v EUR)	249 900 EUR	
Podiel spolufinancovania z prostriedkov MŠVVaŠ SR na celkových oprávnených nákladoch (v %)	83,3 %	
Zodpovedný riešiteľ projektu (meno, priezvisko, tituly, č. telefónu, e-mail)	Viera Stopjaková, prof., Ing., PhD. 02 602 91 149 viera.stopjakova@stuba.sk	

A. 2 Zodpovedná organizácia	Základné údaje o zodpovednej organizácií
Názov organizácie	Slovenská technická univerzita v Bratislave, Fakulta elektrotechniky a informatiky
Skrátený názov	STUBA
Adresa	Vazovova 5 Bratislava 1 812 43

[1] Podľa smernice č.27/2006-R z 21. decembra 2006 o sústave odborov vedy a techniky a číselníku odborov vedy a techniky

Samosprávny kraj	Bratislavský
IČO	00397 687
Príslušnosť k rezortu	Ministerstvo školstva, vedy, výskumu a športu SR
Typ organizácie	verejná vysoká škola
Odvetvie podľa OKEČ (odvetvová klasifikácia ekonomických činností)	72.1 Výskum a experimentálny vývoj v oblasti prírodných a technických vied
Štatutárny zástupca (meno, priezvisko, tituly)	Robert Redhammer, prof., Ing., PhD.

A. 3 Zoznam riešiteľov						
Zoznam riešiteľov priamo sa podieľajúcich na riešení projektu						
Meno a priezvisko	Tituly	Pracovné zaradenie	Dátum narodenia	IČO organizácie	Počet hodín	Podpis*
Viera Stopjaková	Prof. Ing. PhD.	Profesor, vedúca oddelenia	[redacted]	00397 687	1200	
Daniel Donoval	Prof. Ing. DrSc.	Profesor, riaditeľ ústavu		00397 687	800	
Aleš Chvála	Ing. PhD.	Vedecký pracovník		00397 687	1800	
Juraj Marek	Ing. PhD.	Vedecký pracovník		00397 687	1800	
Marián Molnár	Ing.	Vedecký pracovník		00397 687	2000	
Patrik Príbytný	Ing.	Vedecký pracovník		00397 687	4000	
Jozef Mihálov	Ing.	Vedecký pracovník		00397 687	1600	
Daniel Arbet	Ing.	Výskumný pracovník, Doktorand		00397 687	4000	
Gábor Gyepes	Ing.	Výskumný pracovník, Doktorand		00397 687	4000	

- Ja vyššie podpísaný v zmysle zákona č. 428/2002 Z. z. o ochrane osobných údajov, súhlasím so spracovaním osobných údajov Ministerstvom školstva, vedy, výskumu a športu SR počas doby archivácie údajov a to v rozsahu uvedenom v zmluve. Zároveň sa zaväzujem, že pri akejkoľvek zmene údajov uvedených v zmluve budem informovať Ministerstvo školstva, vedy, výskumu a športu SR o týchto zmenách a to v lehote do 30 dní. Osobné údaje môžu byť spracovávané a archivované najviac po dobu 10 rokov po skončení poskytovania prostriedkov štátneho rozpočtu Slovenskej republiky.

A.4 Zoznam riešiteľov		
Ostatní riešitelia	Celkový počet ostatných osôb	2
	Súhrnná kapacita ostatných osôb v hodinách	600
Spolu	Celkový počet zamestnancov	11
	Súhrnná kapacita zamestnancov v hodinách	21800

B. Ciele, harmonogram a výstupy projektu

Anotácia projektu

Uvedený projekt je riešený v rámci európskeho technologického podniku ENIAC a správa sa podľa Nariadenia Rady (ES) č. 72/2008 z 20. Decembra 2008, ktorým sa zakladá spoločný podnik ENIAC a Štatútu spoločného podniku ENIAC, ktorý je prílohou tohto Nariadenia. STU Bratislava je spoluriešiteľom projektu, ktorého koordinátorom je Infineon Technologies AG Nemecko.
Aplikovaný výskum v projekte E2SG je orientovaný na tzv. smart grid – inteligentné elektrické rozvodné siete, a to počnúc od návrhu mechanizmov a stratégií ich zriadenia a zavedenia, až po ich monitorovanie a kontrolu. To znamená, že budú vytvorené spojené body elektrických rozvodných sietí, ktoré majú generovať, distribuovať, vymieňať a riadiť spotrebu elektrickej energie z dôrazom na jej úsporu. V rámci tohto cieľa je potrebné vyriešiť niekoľko úloh, akými sú napr. rozhranie bodov, metódy merania/inteligentné elektromery, komunikácia cez rozvodnú sieť, topológia a riadenie siete, rozvod energie medzi bodmi a ďalšie.
Zámerom projektu E2SG je teda rozvíjať koncept smart sietí do takej úrovne, ktorá bude v nasledujúcich dekádach potrebná nielen z hľadiska požiadaviek priemyslu, ale aj spoločnosti ako takej. Projekt chce taktiež prispieť k zvyšovaniu všeobecného spoločenského povedomia o dôležitosti zavádzania a rozvoja obnoviteľných zdrojov energie.
Konzorcium partnerov zúčastnených na riešení vyššie spomenutých úloh a pre dosiahnutie stanovených cieľov bude využívať komplementárne metódy, procesy a expertízu partnerov a riešiteľských inštitúcií. Komplexný prístup k výskumu bude potrebný hlavne v oblasti návrhu a modelovania nových výkonových vysoko-napäťových spínacích prvkov využiteľných v napäťových meničoch, a pri ich optimalizácii prostredníctvom komplexných charakterizačných metód a techník.

Kľúčové slová

Smart siete, úspora energie, konverzia energie, vysokonapäťové výkonové prvky, výkonové spínače, napäťové meniče, inteligentné elektromery, komunikácia cez sieť, monitorovanie siete, rozhranie bodov smart siete, distribúcia energie, modelovanie a simulácia, charakterizácia

Ciele projektu
Hlavným cieľom projektu E2SG je hľadanie komplexných inovatívnych riešení pre výskum a vývoj smart rozvodných sietí, ktoré ponúkajú individuálne informácie o jednotlivých prepojených bodoch siete a to hlavne o spotrebe, vysoko účinnej konverzii energie a obojsmerných distribučných technológiách. Tento zámer si však vyžaduje splnenie čiastkových cieľov projektu, ktorými sú hlavne inteligentná konverzia energie, inteligentné monitorovanie a riadenie smart sietí, a komunikácia cez smart sieť a jej bezpečnostné aspekty. Hlavné ciele E2SG projektu budú dosiahnuté prostredníctvom inovácií, vývoja, experimentálnych aktivít a rozvoja pokročilých technológií v týchto čiastkových oblastiach: • Vývoj rozhraní zdroj energie–smart sieť. • Monitorovanie/meranie smart sietí – meranie a zber informácii pre efektívne riadenie sietí. • Komunikácia cez rozvodnú sieť – prenos dát a informácií. • Topológia a riadenie siete – návrh konkrétneho riešenia v závislosti od prepojenia a správania sa siete a lokálne riadenie výroby/distribúcie energie prostredníctvom pokročilých metód uchovania energie. • Distribúcia energie – návrh flexibilných a účinných mechanizmov distribúcie energie medzi bodmi siete, napr. vhodným výberom AC alebo DC liniek v závislosti od aktuálnej spotreby energie. Výskum a aktivity smerom k splneniu stanovených cieľov budú vykonané prostredníctvom vzájomnej spolupráce partnerov participujúcich na projekte v rámci týchto technických pracovných balíkov: 1. Inteligentná konverzia 2. Monitorovanie/meranie siete a komunikácia 3. Topológia a riadenie siete 4. Integrácia a demonštrácia Hlavným cieľom STU ako partnera v tomto medzinárodnom projekte je modelovanie, vývoj a charakterizácia nových polovodičových prvkov, hlavne výkonových spínačov pre vysoké napätia, ktoré budú mať vylepšené vlastnosti z hľadiska ich použitia v napäťových konvertoroch a rozhraniach medzi smart sieťou a zdrojmi energie. STU sa bude podieľať taktiež na výskume a vývoji inteligentných elektromerov, s bezdrôtovým prenosom nameraných údajov, ktoré budú prispievať k optimalizácii spotreby energie v domácnostiach. STU sa v projekte podieľa na riešení viacerých úloh rozvrhnutých v rámci troch pracovných balíkov. Jednotlivé úlohy/etapy v rámci projektu ako aj harmonogram ich riešenia sú uvedené nižšie.

Harmonogram riešenia projektu		
Názov etapy	Začiatok	Koniec
Výskum a vývoj elektrofyzikálnych modelov energeticky efektívnych výkonových prvkov/spínačov na báze kremíka	04/2012	03/2013
Verifikácia a kalibrácia parametrov elektrofyzikálnych modelov výkonových spínačov pre stredné a vysoké napätia	10/2012	12/2013
Rozvoj a aplikácia analytických a elektrických metód charakterizácie vlastností navrhnutých a zrealizovaných výkonových prvkov	08/2013	12/2014

Meranie a charakterizácia vybraných vlastností vyvinutých výkonových spínačov a optimalizácia ich parametrov a vlastností z hľadiska použitia v napäťových meničoch	12/2013	03/2015
Výskum, vývoj a implementácia obvodových blokov inteligentného elektrometra s bezdrôtovým prenosom údajov vhodného pre domácnosti vo viacbytových domoch	09/2012	03/2014
Integrácia vyvinutých častí elektromera do výsledného systému pre demonštrátor, komunikácia s ostatnými snímačmi	04/2014	03/2015
Prezentácia dosiahnutých výsledkov, využitie a ochrana duševného vlastníctva - 1. etapa	09/2012	12/2013
Prezentácia dosiahnutých výsledkov, využitie a ochrana duševného vlastníctva - 2. etapa	01/2014	03/2015
Manažovanie projektu	04/2012	03/2015

Očakávané výstupy riešenia							
Kategória	Výstupy	Rok 2012	Rok 2013	Rok 2014	Rok 2015		
Publikácie	Publikácie v karentovaných časopisoch			1			
	Publikácie v recenzovaných vedeckých časopisoch a zborníkoch konferencií		1	1	1		
	Publikácie v nerecenzovaných časopisoch a zborníkoch konferencií		1	1			
Aplikačné výstupy	Model a laboratórna vzorka inovovaných výkonových spínačov		1	1	1		
Vzdelávanie a popularizácia vedy a techniky	Počet diplomantov, ktorých práce súviseli s riešeným projektom		1	1	1		
	Počet doktorandov, ktorých práce súviseli s riešeným projektom	2	2	1	1		
	Popularizačné aktivity - prezentácia výsledkov na výstave (napr. týždeň slovenskej vedy)		1		1		
	Organizovanie vedeckých konferencií a seminárov			1			
Pridaná hodnota	Novovytvorené pracovné						

riešeného projektu výskumu a vývoja	miesta (post-doktorandské miesta)	1	2	2	1		
	Vytvorené partnerstvo medzi akademickým a podnikateľským sektorom	1		1			
	Vyvolané projekty výskumu a vývoja		1				

C. Rozpočet projektu					
Rozpočet projektu pre zodpovednú organizáciu (v eurách)					
Rok	2012	2013	2014	2015	Suma
Bežné priame náklady	36000	73500	76000	22750	208250
Mzdové náklady	25000	47800	49600	14400	136800
Zdravotné a sociálne poistenie	8200	15600	16200	4700	44700
Cestovné výdavky	1200	3300	3300	1850	9650
Materiál	600	2400	2400	1400	6800
Odpisy	0	2000	2000	0	4000
Služby	1000	2400	2500	400	6300
Energie, vodné, stočné a komunikácie	0	0	0	0	0
Bežné nepriame náklady	7200	14700	15200	4550	41650
Bežné výdavky	43200	88200	91200	27300	249900
Kapitálové výdavky	0	0	0	0	0
Výška spolufinancovania projektu z prostriedkov MŠVVaŠ SR (v eurách)	43200	88200	91200	27300	249900
Výška vlastných prostriedkov žiadateľa	0	0	0	0	0

D.Čestné vyhlásenie štatutárneho zástupcu	Zodpovedná organizácia

Ja, dole podpísaný prof. Ing. Robert Redhammer, PhD., štatutárny zástupca záväzne vyhlasujem, že:

- Všetky údaje obsiahnuté v dokumentácii projektu sú pravdivé, projekt bude realizovaný v zmysle predloženého obsahu
- Zodpovedná organizácia súhlasí s pravidelnou finančnou kontrolou projektu
- Zodpovedná organizácia bude archivovať všetky účtovné dokumenty súvisiace s realizáciou projektu po dobu 5 rokov po skončení jeho financovania Ministerstvom školstva, vedy, výskumu a športu SR
- Dávam súhlas na výkon kontroly príslušným kontrolným orgánom Ministerstva školstva, vedy, výskumu a športu SR
- Zodpovedná organizácia bude dodržiavať legislatívu Európskej únie a platnú legislatívu SR

Som si vedomý možných následkov a sankcií, ktoré vyplývajú z uvedenia nepravdivých alebo neúplných údajov. Zaväzujem sa bezodkladne písomne informovať o všetkých zmenách, ktoré sa týkajú uvedených údajov a skutočností.

Podpis štatutárneho zástupcu príjemcu a pečiatka

....

Miesto: Bratislava

Dátum:

Príloha 4

Rozpis celkových prostriedkov štátneho rozpočtu Slovenskej republiky na financovanie oprávnených nákladov projektu E2SG č. 296131-2 spoločného podniku v jednotlivých rozpočtových rokoch jeho riešenia (v EUR)

Deň/mesiac/rok	1 / 4 / -31/12/ 2012	2013	2014	1/1 - 31 / 3 / 2015
výška prostriedkov v EUR	43 200	88 200	91 200	27 300

Podpis štatutárneho zástupcu príjemcu a pečiatka

....

Miesto: Bratislava

Dátum: