

# C/CAG

## CITY/COUNTY ASSOCIATION OF GOVERNMENTS OF SAN MATEO COUNTY

*Atherton • Belmont • Brisbane • Burlingame • Colma • Daly City • East Palo Alto • Foster City • Half Moon Bay • Hillsborough • Menlo Park  
Millbrae • Pacifica • Portola Valley • Redwood City • San Bruno • San Carlos • San Mateo • San Mateo County • South San Francisco • Woodside*

### Agenda

#### Resource Management and Climate Protection Committee (RMCP)

**Date:** Wednesday, February 21, 2018

**Time:** 2:00 p.m. to 4:00 p.m.

**Location:** 555 County Center – 5<sup>th</sup> Floor Conference Room 1,  
Redwood City, CA

1. Introductions
2. Public Comment
3. Approval of Minutes from January 17, 2018 Committee meeting  
(Kim Springer – Committee Staff) Action
4. Presentation on Energy Efficiency Program Updates for Member Agencies in San Mateo  
County (Kim Springer – Committee Staff) Presentation
5. Presentation on DNV GL’s Global and Regional Forecast of the Energy Transition to 2050  
(Betty Seto – DNV GL) Presentation
6. Discussion about RMCP Committee priorities for calendar year 2018  
(Kim Springer – Committee Staff) Discussion
7. Review and approve RMCP Committee meeting dates for calendar year 2018  
(Kim Springer – Committee Staff) Action
8. Committee Member Updates
9. Tentative Next Meeting Date: March 21, 2018 or as determined by Committee (Item 7)

# C/CAG

## CITY/COUNTY ASSOCIATION OF GOVERNMENTS OF SAN MATEO COUNTY

*Atherton • Belmont • Brisbane • Burlingame • Colma • Daly City • East Palo Alto • Foster City • Half Moon Bay • Hillsborough • Menlo Park  
Millbrae • Pacifica • Portola Valley • Redwood City • San Bruno • San Carlos • San Mateo • San Mateo County • South San Francisco • Woodside*

### Resource Management and Climate Protection Committee (RMCP)

#### Minutes of January 17, 2018 Meeting

##### **In Attendance:**

Beth Bhatnagar, SSMC Board Member\*  
Pradeep Gupta, South San Francisco City Council\*  
Ortensia Lopez, El Concilio of San Mateo County\*  
Maryann Moise Derwin, Committee Vice Chair, Mayor Portola Valley\*  
Rick DeGolia, Town of Atherton\*  
Adrienne Carr, BAWSCA\*  
Don Horsley, County Supervisor\*  
Kim Springer, County Office of Sustainability  
Michael Barber, Supervisor Pine's Office

##### **Not in attendance:**

Deborah Gordon, Committee Chair, Woodside Town Council\*  
Dave Pine, County Supervisor\*  
Diane Papan, Councilmember, San Mateo\*  
Bill Chiang, PG&E\*  
Robert Cormia, Professor Foothill-DeAnza\*

\* Committee Member (voting)

#### **1. Introductions**

#### **2. Public Comment**

There were no public comments.

#### **3. Approval of Minutes from September 20, 2017 Committee meeting**

Minutes were approved: DeGolia/Bhatnagar

#### **4. Review and approve RMCP meeting dates for calendar year 2018**

Kim Springer presented two possible scenarios for meeting dates, per the staff report for this item. There was a discussion between multiple committee members tied to the possibility of an update to the San Mateo County Energy Strategy or the Governor's Climate Conference, and the potential need for meetings tied to those projects.

PUBLIC NOTICING: All notices of C/CAG Board and Committee meetings are posted at:  
San Mateo County Transit District Office, 1250 San Carlos Ave., San Carlos, CA.

It was proposed to set the meeting at the normal time for February 21, 2018 and reassess future meeting dates based on the discussions for the two potential projects.

There was also a short discussion on changing the meeting time, but traffic concerns eliminated any decision to make a change.

A motion was made to delay decisions concerning future meeting dates to the February meeting and to meet on February 21, 2018.

The motion was approved: Lopez/Gupta

After approval, it was noted that the meeting will be held in Redwood City due to the unavailability of the conference room at 155 Bovet Rd, San Mateo.

## **5. Update on the San Mateo County Energy Watch, Municipal Energy Efficiency Call for Projects**

Kim Springer gave a presentation on the Municipal Energy Efficiency Call for Projects. The Call received 12 proposals and staff will likely be recommending that all 12 proposals be funded, with an increase to the total funding originally proposed for the Call, as there is sufficient budget to fund all projects.

The funding is based on progress payments in two tiers: one for auditing and settling on a set of energy efficiency measures and a commitment of funding to install the projects, the second tier for completing the installation by the end of CY 2018. The effort has been so successful, staff is considering a similar process for school districts across San Mateo County.

Committee members asked about the focus of the Call for Projects and how the savings are being measured. The Call is focused on municipalities' demand side projects, and the actual savings are measured by calculation or deemed savings. The savings to the SMCEW program are not actual measured savings. It was suggested that the program might want to require benchmarking and actual measured outcomes.

## **6. Bay Area Water Supply and Conservation Agency update on current water supply and conservation**

Adrienne Carr provided an update on the current water supply levels, snowpack, and state initiatives.

Though the current snowpack is close to as minimal as it was in 2015, we do not yet know what it will look like at the end of the wet season. In the meantime, the reservoirs are full.

Carr also presented two statewide efforts: the first being "Making Water Conservation a California Way of Life" is an executive order by the Governor requiring permanent changes such that water is used more wisely, statewide. There will be a new framework with urban water use objectives. The state Water Resources Control Board is framing these objectives. BAWSCA has hired a consultant to help sort out the new set of objectives and enforcement.

The committee asked about water storage. Carr explained that Prop 1 funding, over a billion dollars will be for water storage, and some 20 projects applied for those funds. The recipients of those funds will be announced in June 2018.

Michael Barber mentioned the water summit on March 30 at Canada College, will cover the many overlapping issues related to water supply, storage, cleanliness, etc.

Carr added that indoor and outdoor water use standards for water agencies will be enforced by the State Water Board, based on estimations of current water use and an assigned urban water use objective. Agencies have already estimated and submitted water loss data to the State Water Board. Standards will be adopted in 2020. The standard will be based on 55 gallons per capita per day, and GIS surveys of outdoor landscaping. Some agencies are interested in participating in DWR pilot opportunities, which will help them prioritize their conservation efforts. Agencies are using AMI to estimate water loss. Agencies will have to submit plans in 2021 and report annually through 2025.

Based on current water use, most all BAWSCA water agencies will have no issue meeting the expected new targets. New legislation is being developed to support the State's goals, as well provide opportunities for low income customers. Greywater is encouraged and there is opportunity in the county to expand these kind of programs and systems. There is a study going on at Silicon Valley Clean Water with Stanford University, of the Emefcy system.

#### **7. Update on 2017 San Mateo County Energy Watch Program outcomes.**

Kim Springer provided a presentation on progress to date for the calendar year 2016-2018 program cycle of the San Mateo County Energy Watch program.

The SCMEW program is in line to meet its savings goals for the currently program cycle. The program also has ongoing marketing and administration efforts, on a monthly cycle. The charts presented are with savings data through November 2017, and show progress to date.

Under climate action planning, GHG emission inventories for communities for 2014 and 2015 have been completed and are being delivered to cities. Some cities are working on government operations emission inventories. 16 CAPs have been adopted to date, 1 is ready for adoption and 4 are 50% or more through the drafting process. In 2018, we'll be focusing on CAPs as some cities will be amending their CAPS to go out to 2030.

In terms of marketing, the program has a website, an online energy and emissions data portal for cities, and develops two newsletters monthly.

In terms of budget, the program is underspending its budget, so staff are looking at creative ways to make efficient use of remaining funds.

#### **8. Presentation on 2018 program year efforts for next San Mateo County Energy Watch Program cycle, 2019**

The CPUC has been undergoing a Business Planning process, which will affect the SMCEW program. The Planning process was initially meant to launch a 10-year rolling program cycle. The CPUC has called out the local government as its own Public Sector program. This means that the focus of the program post 2018 will be on municipalities, schools, and other public sector

customers, but not to commercial as the SMCEW has been providing services to, since 2009.

The CPUC has also indicated that, of the total funds provided to IOU's from public good charges, the competitively bid portion of those program fund will shift from 20% to 60% over the next 4-6 years. This could affect the amount of money the program receives in calendar year 2019 and beyond.

In addition, the availability of funding climate action planning is uncertain. These Strategic Energy Resources funds are considered by the CPUC as part of the total energy efficiency program cost, which reduces their assessment of the cost-effectiveness of the program.

Springer provided several strategies planned for calendar year 2018 to help smooth the transition to the eventual 2019 program.

#### **9. Committee Member Updates**

There were no committee updates.

#### **10. Next Meeting Date: February 21, 2018**

All presentations for this meeting are posted on the C/CAG RMCP website at:

<http://ccag.ca.gov/committees/resource-management-and-climate-protection-committee/>

# C/CAG AGENDA REPORT

**Date:** February 21, 2018  
**To:** Resource Management and Climate Protection Committee  
**From:** Kim Springer, County staff to RMCP Committee  
**Subject:** Presentation on Energy Efficiency Program Updates for Member Agencies in San Mateo County

(For further information contact Kim Springer at 650-599-1412)

---

## **RECOMMENDATION**

Receive a presentation on energy efficiency program updates for member agencies in San Mateo County.

## **FISCAL IMPACT**

Staff time is paid for by funding under the C/CAG – PG&E Local Government Partnership (LGP) agreement. Additional funding comes from the BayREN program for this initiative.

## **BACKGROUND/DISCUSSION**

The County of San Mateo Office of Sustainability supports energy efficiency through the Bay Area Regional Energy Network (BayREN) and San Mateo County Energy Watch (SMCEW) programs. Bay Area Regional Energy Network (BayREN) is a collaboration of the nine Bay Area counties implementing energy saving programs on a regional level for single family and multifamily property owners, as well as supporting compliance of the California Energy Code. The San Mateo County Energy Watch (SMCEW) is a partnership between PG&E and the City & County Association of Governments of San Mateo County (C/CAG) implementing energy efficiency projects for small businesses, special districts, non-profits, school districts and local government facilities.

Staff working on these two programs developed city-specific program updates for cities, to summarize energy efficiency program accomplishments starting in 2016. The current program updates summarize data from July 2013 through December 2017. The program updates were developed to provide city staff with data specific to their jurisdiction. Data can be used to inform Climate Action Plans and identify additional opportunities for city staff to engage with the County's Office of Sustainability programming.

**ATTACHMENT**

Energy Efficiency Programs Update for Redwood City



## ENERGY EFFICIENCY PROGRAMS UPDATE JANUARY 2018 | YOUR JURISDICTION

The **County of San Mateo Office of Sustainability** supports energy efficiency through the **Bay Area Regional Energy Network (BayREN)** and **San Mateo County Energy Watch (SMCEW)** programs. In San Mateo County, residential, commercial and industrial energy usage accounts for 33.8% of greenhouse gas emissions. By transforming buildings to be more energy efficient, the BayREN and SMCEW programs can help reduce greenhouse gas emissions countywide. The Office of Sustainability is excited to share program accomplishments. Please feel free to forward to your jurisdiction's elected officials and additional stakeholders.

### BAY AREA REGIONAL ENERGY NETWORK



Bay Area Regional Energy Network (BayREN) is a collaboration of the nine Bay Area counties implementing energy saving programs on a regional level for single family and multifamily property owners, as well as supporting compliance of the California Energy Code.

### Home Upgrade and Advanced Home Upgrade projects

BayREN is the exclusive administrator of [Energy Upgrade California® Home Upgrade](#) and the [Advanced Home Upgrade Assessment Incentive](#) for single family homeowners in the Bay Area. BayREN provides rebates of up to \$3,150 for Home Upgrade and \$300 for homeowners who have completed an energy assessment through the utility-administered Advanced Home Upgrade program.

	Home Upgrade (up to \$3,150)		Advanced Home Upgrade (up to \$5,500)		TOTAL	
	# projects	\$ rebates paid	# projects	\$ rebates paid	# projects	\$ rebates paid
Your City	11	\$23,350	17	\$4,975	28	\$28,325
Countywide	147	\$327,650	209	\$60,584	356	\$388,234
BayREN Region	5,786	\$13,432,520	2,418	\$696,894	8,204	\$14,129,414

(Data 7/2013 - 12/2017)



## Outreach Events



Office of Sustainability representatives tabling at Maker Fair 2017 in San Mateo, CA.

	Your City	Countywide
<b>Outreach Events</b>	<b>2</b>	<b>88</b>

(Data 7/2013 - 12/2017)

## Home Upgrade Advisor Service

The BayREN Home Upgrade Advisor Service provides technical assistance to homeowners and contractors about energy efficiency and home performance. The Home Upgrade Advisors help homeowners select an appropriate contractor, review project scope, navigate the project from installation to financing processes, and refer to complementary programs.

	Your City	Countywide	BayREN Region
<b>Home Upgrade Advisor accounts</b>	<b>53</b>	<b>921</b>	<b>7,892</b>

(Data 7/2013 - 12/2017)

## Bay Area Multifamily Building Enhancements

The [Bay Area Multifamily Building Enhancements](#) program offers property owners of 5 or more attached units no-cost energy consulting and rebates of \$750 per unit for saving 15% or more of their whole building's energy usage.

	Your City	Countywide	BayREN Region
<b>Completed Units</b>	<b>245</b>	<b>3,136</b>	<b>26,091</b>
<b>Pending Units</b>	<b>12</b>	<b>1,901</b>	<b>15,803</b>

(Data 7/2013 - 12/2017)

## Energy Code Compliance Opportunities for Building Departments

Energy Code trainings are designed to educate building department staff on key aspects of compliance and enforcement of the Energy Code. Since 2013, BayREN has provided **39** trainings in San Mateo County and **209** trainings throughout the Bay Area. For more information on BayREN regional Codes & Standards trainings forums, pilot projects and Zero Net Energy, visit: [www.bayrencodes.org](http://www.bayrencodes.org).

**SAN MATEO COUNTY ENERGY WATCH**



The [San Mateo County Energy Watch](#) (SMCEW) is a partnership between PG&E and the City & County Association of Governments of San Mateo County (C/CAG) implementing energy efficiency projects for small businesses, special districts, non-profits, school districts and local government facilities.

**Small Business Direct Install**

SMCEW Small Business Direct Install Program provides energy efficiency upgrades of lighting and refrigeration systems, with free project management to help local businesses lower their energy bills and boost cash flow. The cost of these projects may be rebated from 30% to 100%.

	Your City	Countywide
<b>Projects</b>	14	359
<b>Total Savings</b>	295,842 kWh 50 kW	11,419,726 kWh 1,597 kW

(Data 7/2013 - 1/2018)

**Municipal Retrofits**

SMCEW assists local governments and special districts in upgrading their facilities and managing their energy use by providing free energy audits, energy efficiency retrofits, rebates and incentives, and benchmarking services.

	Your City	Countywide
<b>Projects</b>	1	70
<b>Total Savings</b>	192,753 kWh - kW	6,142,742 kWh 182 kW

(Data 7/2013 - 1/2018)

**Check It Out! Energy and Water Saving Toolkit**

The [energy and water-saving toolkit](#) is designed for San Mateo County library patrons to save money on their utility bills while conserving vital resources. The toolkit is stocked with tools for patrons to test the efficiency of their home's systems and equipment that patrons can install in their homes and keep. The toolkit is available at libraries in the County Library System and the Peninsula Library System.



	Your City	Countywide
<b>Check-outs</b>	23	397

(Data 4/2017 - 12/2017)

County of San Mateo Energy Efficiency Representatives:

**Andrea Chow**  
650-363-4125  
[achow@smcgov.org](mailto:achow@smcgov.org)

**Rachael Londer**  
650-363-4077  
[rlonder@smcgov.org](mailto:rlonder@smcgov.org)

**Kevin Lu**  
650-363-4698  
[khlu@smcgov.org](mailto:khlu@smcgov.org)

**Resources**

**San Mateo County Energy Watch Newsletter**

San Mateo County Energy Watch publishes monthly newsletters that give you the latest energy efficiency news, local trainings, workshops and webinars. [Join our mailing list!](#)

**Events and Trainings**

Visit our [Online calendar](#) for more classes, events, & conferences!



# C/CAG AGENDA REPORT

**Date:** February 21, 2018  
**To:** Resource Management and Climate Protection Committee  
**From:** Kim Springer, County staff to RMCP Committee  
**Subject:** Presentation on DNV GL's Global and Regional Forecast of the Energy Transition to 2050

(For further information contact Kim Springer at 650-599-1412)

---

## **RECOMMENDATION**

Receive a Presentation on DNV GL's Global and Regional Forecast of the Energy Transition to 2050.

## **FISCAL IMPACT**

None

## **BACKGROUND/DISCUSSION**

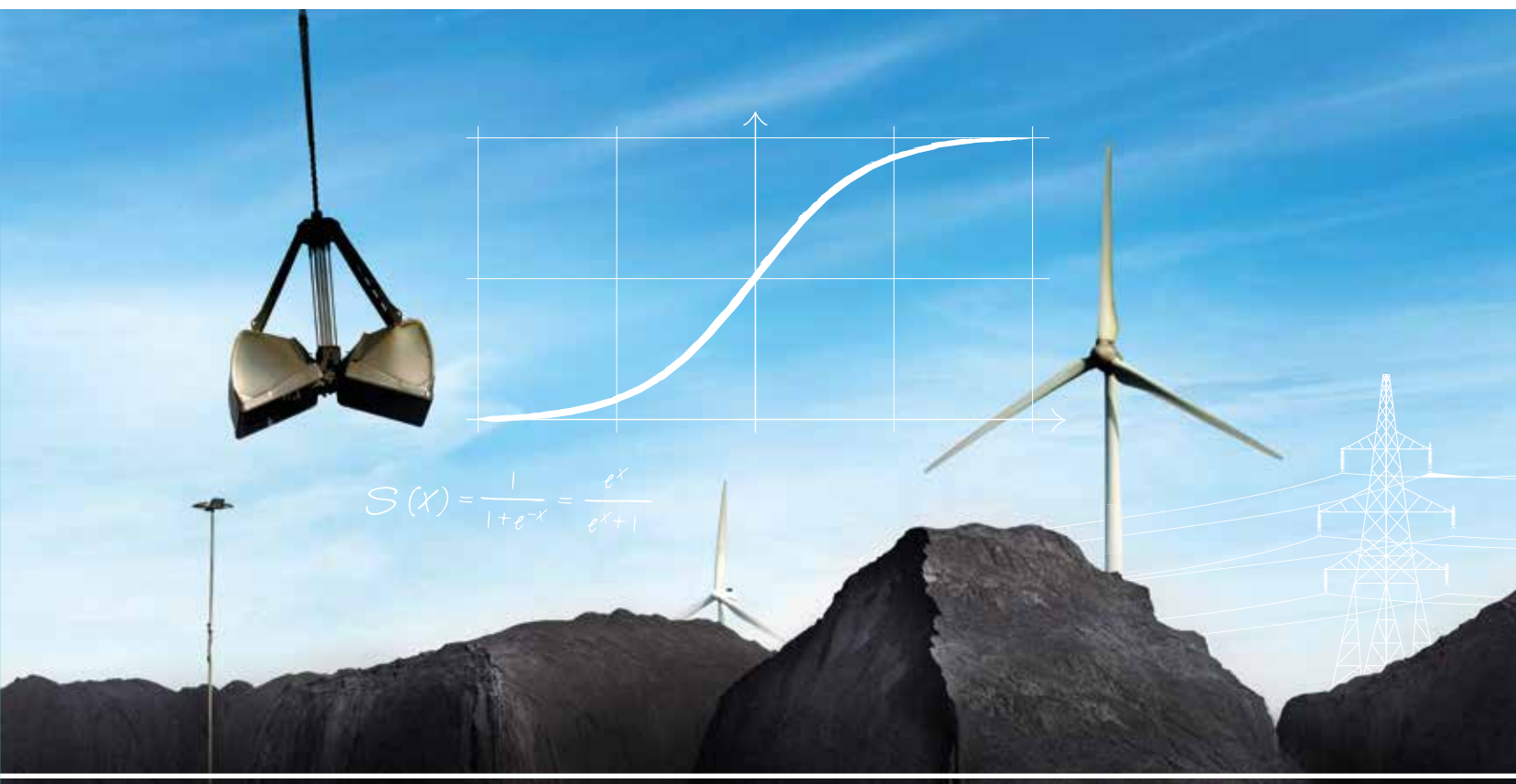
DNV GL is a global organization working on a variety of projects in multiple energy markets. Their motto is: Safer, Smarter, Greener. Recently, DNV GL presented its inaugural Energy Transition Outlook report, which presents their findings on likely developments in the global energy future.

The Report pulls together the collective wisdom of multiple colleagues within DNV GL and was reviewed by outside stakeholders. The Report considers the growing transition to renewable energy, growing population, increasing energy efficiency, the future of energy resources such as coal and natural gas, and other projected energy trends.

Bety Seto, Head of the Department of Sustainable Buildings and Communities at DNV GL, will provide a detailed presentation of the findings. The executive summary of the Report is provided as an attachment to this staff report.

## **ATTACHMENT**

DNV GL Global Energy Forecast Executive Summary



ENERGY TRANSITION OUTLOOK 2017

# EXECUTIVE SUMMARY

A global and regional forecast  
of the energy transition to 2050

## ACKNOWLEDGEMENTS

---

This study was prepared by DNV GL as a cross-disciplinary exercise between three of our business areas – Oil & Gas, Maritime and Energy – co-ordinated by a core research team in our corporate R&D unit. The very many colleagues who contributed are listed on the last page of our main report.

In addition, we wish to thank a wide range of experts from industry and academia for reviewing early drafts of this report. Their comments and suggestions have been of great value, and any remaining errors and deficiencies are our own. Our external collaborators are acknowledged by name in our main 2017 report.

The sources cited in this executive summary are also fully referenced in our main publication, *Energy Transition Outlook, 2017*.

This executive summary is drawn from *DNV GL's Energy Transition Outlook 2017, a forecast to 2050*.

The main publication, and supplementary publications on the industry implications of our forecast, are available for download at:

**[ETO.DNVGL.COM](http://ETO.DNVGL.COM)**

## FOREWORD

---



**REMI ERIKSEN**  
**GROUP PRESIDENT & CEO**  
**DNV GL**



The ingenuity on display will be awesome as the world pursues UN Sustainable Development Goal #7 to ensure access to affordable, reliable, sustainable and modern energy for all

Welcome to DNV GL's inaugural Energy Transition Outlook. As a company, we are highly exposed to the radical changes affecting every part of the energy value chain, and it is critical that we understand the nature and pace of these changes. To the extent that this study does advance understanding, we are proud to offer it as a service to all stakeholders in the transition, present and future.

Scenarios of our possible energy future are coming thick and fast from many quarters, but, in my view, they are not anchored to a base or 'central' case, and that is the aim of this present exercise, which is a forecast, not a scenario. As a world-leading provider of third party and technical advisory services, our customers rely on DNV GL to take an independent view. We also have an equal footing in the fossil and renewable worlds, which we believe helps in striking a balanced perspective when regarding the outlook.

When I requested this forecast, I was keen to involve as wide a cross-section as possible of DNV GL's engineers and technologists – not only to tap into their collective expertise, but also to lift their personal headlights to the possibilities and challenges that await them. I was also curious to see if DNV GL could produce a forecast of the energy future that could come to be regarded as a 'central case'.

At the start of this study, our research team surveyed perceptions of the energy future among their DNV GL colleagues. The survey revealed a good deal of common ground, but also showed that the respondents tended to favour the future importance of 'their' energy source, whether fossil or renewable. My hope is that this outlook – the first in an annual series – will help to build a more unified view of the future, both within DNV GL and externally.



A large number of external experts have been kind enough to review our work, and some, in the politest way possible, have remarked that we give insufficient primacy to “x” energy source (where x could be fossil, renewable or a potential source of disruption like geothermal or hydrogen). In a sense, that indicates that we are on the right track. But it is you, dear reader, who will judge whether we have succeeded in our mission. We welcome your feedback, as we prepare our next (2018) Energy Transition Outlook.

One would think that a ‘central case’ outlook would, per definition, be boring. But the sheer scale of the changes that await the world on the energy front are such that even a middle-of-the-road forecast is anything but boring. The human ingenuity on display will be awesome as the world pursues UN Sustainable Development Goal #7, to ensure access to affordable, reliable, sustainable and modern energy for all. Underpinning that goal is a major shift toward decarbonization, which itself is linked to another great megatrend: energy efficiency.

Advances in both energy storage and renewables will create a highly competitive clean-tech coupling that will drive energy costs downwards, while accelerating energy efficiency. And that will produce a very different world in short order – one where energy decouples from carbon and where the world’s energy use

decreases while the global economy and population continue to grow. A world where energy costs are expected to be relatively low, with available supply exceeding demand.

In these pages, we explain why world primary energy supply is likely to peak before 2030; this will surely be a watershed moment in human history, where collectively we will need less energy to satisfy our energy demand.

The consequences of the decarbonization of the energy mix and of the flattening out of energy demand are substantial, and the implication of this transition, and associated sub-transitions, are highlighted in our industry-focused supplements that accompany this main report.

We forecast that by mid-century, primary energy supply will be split roughly equally between fossil and renewable sources. That presupposes a very substantial growth path for renewable energy, but not enough, we calculate, to bring humanity on track to reduce climate emissions in line with the climate goal agreed in Paris in 2015. That should be a wake-up call to all stakeholders in the energy system. The industry that we know and serve has taken bold steps in the past; even bigger strides are required into the future. I hope our 2017 report makes for stimulating reading and provides food for thought – and action.



REMI ERIKSEN

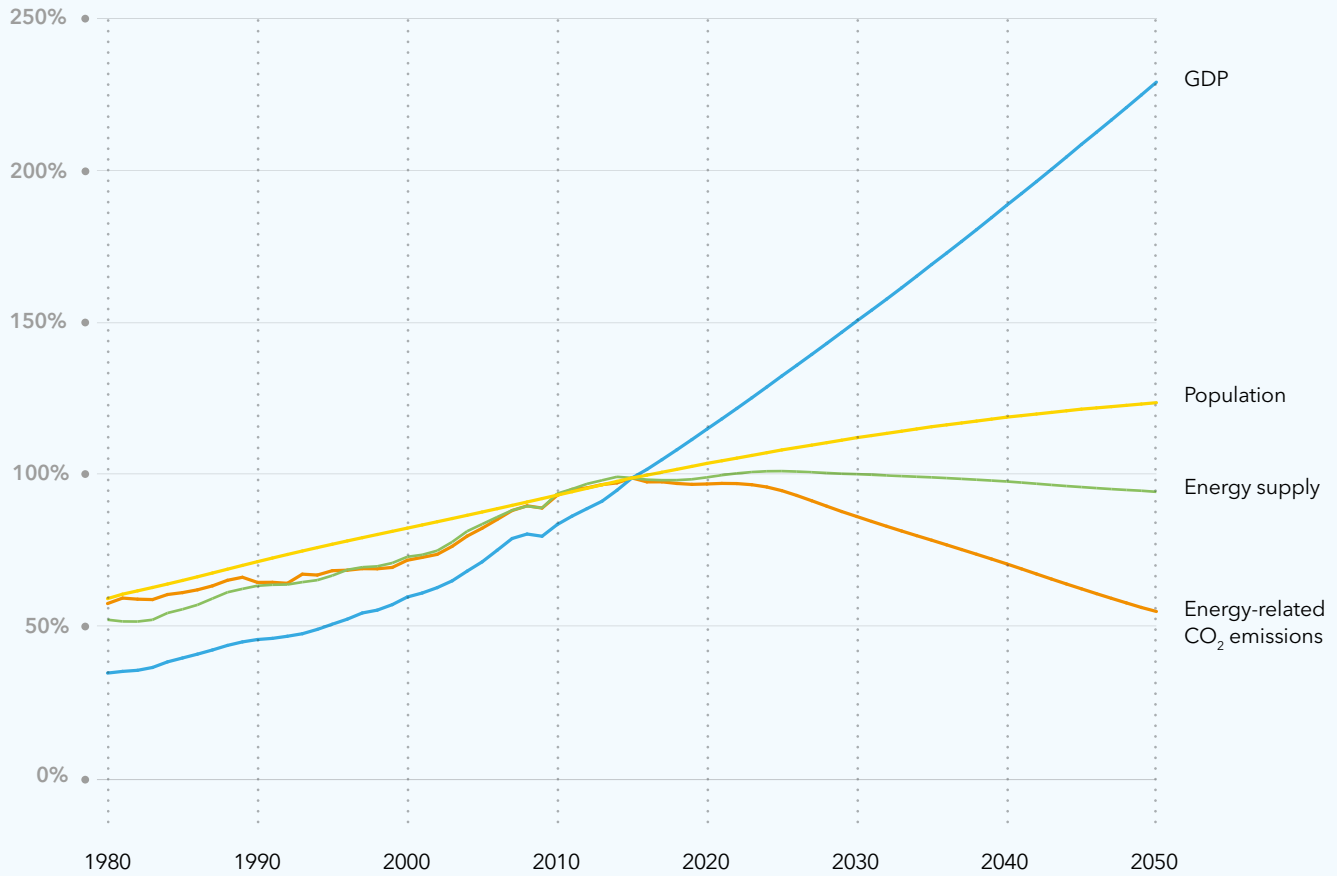
**WORLD PRIMARY  
ENERGY SUPPLY IS  
LIKELY TO PEAK  
BEFORE 2030:**

**THIS WILL SURELY BE  
A WATERSHED MOMENT  
IN HUMAN HISTORY,  
WHERE COLLECTIVELY  
WE WILL NEED LESS  
ENERGY TO SATISFY  
OUR ENERGY DEMAND**

---

**FIGURE 1. THE DECOUPLING OF ENERGY FROM KEY PARAMETERS**

Units: Percentage of 2015 level



**FORECASTED DECOUPLING OF ENERGY SUPPLY FROM EMISSIONS, GDP AND POPULATION TRENDS**

World energy growth has historically gone hand-in-hand with population and economic growth. Not only will energy decouple from carbon in the coming decades, but, in our view, global energy supply will peak and slowly decline in the context of continued (but slowing) population and economic growth.

This is linked to accelerating energy efficiency on a global scale, driven in the main by the growing share of electricity in the energy mix, with losses reduced through the steady uptake of efficient renewable sources.

# HIGHLIGHTS OF OUR OUTLOOK

» The world will undoubtedly experience a rapid energy transition, driven by electrification, boosted by a strong growth of wind and solar power generation, and further decarbonization of the energy system, including the decline in coal, oil, and gas, in that order.

» Coal use has already peaked, oil will peak within the next **10 years** and gas in **20 years**, but gas remains the biggest single source of energy for the world through to **2050**

2015

2020

2025

» The world will manage the shift to a renewable future without increasing energy expenditures; the future energy system will require a smaller share of Gross World Product (GWP) than at present.

» Primary energy supply will peak in **2025**, as electricity grows its share of the energy mix and losses are reduced through the accelerated uptake of efficient renewable sources

» Energy demand will plateau after **2030**, mainly owing to efficiencies in the generation and use of energy – even as the world makes steady progress with UN Sustainable Development Goal (SDG) #7 (ensuring access to affordable, reliable, sustainable and modern energy for all)

» Renewable energy – notably wind and solar PV – holds the most potential for cost-competitiveness. Even so, fossil fuel will still comprise around half of the total energy supply in **2050**

**2030**

» Electric vehicle take-up will be rapid and extensive – by **2033** half of new passenger cars sold globally will be zero emission

**2040**

» The energy transition will be experienced unevenly across the world. Regional energy transitions look very different: e.g. India joining China as a renewable 'superpower'; fossil-fuel dominant regions like the Middle East and Russia experiencing relatively slow transition.

**2050**

» Total energy-related CO<sub>2</sub> emissions in **2050** will be around half of today's level

# EXECUTIVE SUMMARY

Over the next three decades the world’s energy system will decarbonize and change in many other ways. Understanding the energy future is critical for us in DNV GL, and for our stakeholders.

## A STRATEGY TOOL

This outlook, based on our own, independent model of the world’s energy system, was undertaken to aid analysts and decision-makers at our customers’ firms, and other stakeholders in the global energy supply chain. It will also support our own business strategy.

Our findings suggest that there are immense challenges and opportunities in store for the industries we serve, and we explore these further in three ‘industry implications’ supplements to this main publication:

- Oil and Gas;
- Maritime; and
- Renewables, Power, and Energy Use.

Our customers own and operate assets that have a useful life spanning decades. The 33 years between the date of this publication and mid-century will see pivotal changes in the world’s energy system. On the brink of such epochal change, it is wise to take stock of one’s business strategy – the allocation of company resources – and compare existing plans against the kind of energy future we foresee.

## AGENDA 2030

The UN Sustainable Development Goals (SDGs) on Climate Action (#13), Life Below Water (#14) and Life on Land (#15) set the planetary boundaries for all other SDGs. Succeeding with a rapid energy transition that decouples CO<sub>2</sub> emissions from economic development is key to the fulfillment of all the goals that constitute the UN’s Agenda 2030

## AN EQUAL FOOTING

DNV GL has a strong footing in the fossil and renewable energy industries.

We are a world leading provider of risk management, assurance and technical advisory services to customers in more than 100 countries. Around 70% of our business is related to energy in one or other form. This outlook draws on DNV GL's broad involvement across entire energy supply chains, spanning complex offshore infrastructure, onshore oil & gas installations, large- and small-scale wind, solar and energy efficiency projects, and electricity transmission and distribution grids. Two of our main business areas are Oil & Gas and Renewables & Power. As the world's largest ship classification society, energy transportation is also a key topic for us.

DNV GL is a knowledge-led organization, and we typically spend 5% of our revenue on research and innovation. The core model development and research for this outlook was conducted by a dedicated Energy Transition research team in our corporate R&D unit. The team relied on input from around one hundred colleagues across our organization, as well as the dozens of external experts whose contribution we acknowledge in the opening pages of our main report and its companion publications.

### A CENTRAL CASE

Our intention, from the outset, has been to construct what we in DNV GL see as ‘a most likely future’ for energy through to 2050. This contrasts with scenario-based approaches. Typically, scenarios are set up to contrast possible futures, for example varying the speed of the transition from the current energy mix to one dominated by renewables. As an organization with equal exposure to both the fossil and renewable energy worlds, our aim has been to produce a objective, balanced view of the future.

DNV GL was founded a little over 150 years ago with the purpose of safeguarding life property and the environment. We have a vision to have global impact for a safe and sustainable future. As such, DNV GL strongly supports the Paris Agreement, and the efforts of almost all the world’s countries to limit global warming from pre-industrial levels to well below 2°C.

As we explain below, and in more detail in the main report, our outlook does not see the world on track to meet the Paris Agreement climate goal. We very much wish that this outlook pointed to a future where the risks and impacts of climate change will be significantly reduced, and where dangerous anthropogenic interference with the climate system is avoided. But our stated aim in building this outlook is to be fact based and to avoid wishful thinking.

### MODEL-BASED

DNV GL has independently designed a model of the world’s energy system, depicting globally interconnected demand and supply of energy, within ten regions, and the transport of energy between those regions. The core of this is a system dynamics feedback model, implemented in Stella software. The model incorporates the entire energy system – from source to end-use – and simulates how its components interact. It includes all the main consumers of energy (buildings, industry and transportation) and all the sources supplying the energy.

By design, the level of detail throughout the model is not uniform. Sectors where DNV GL has strong expertise and large business exposure, like oil & gas

and power, are reflected in more detail than the sectors where we have little exposure, like coal. However, sectors critical to the energy transition, such as road transport, are treated more thoroughly than more marginal sectors.

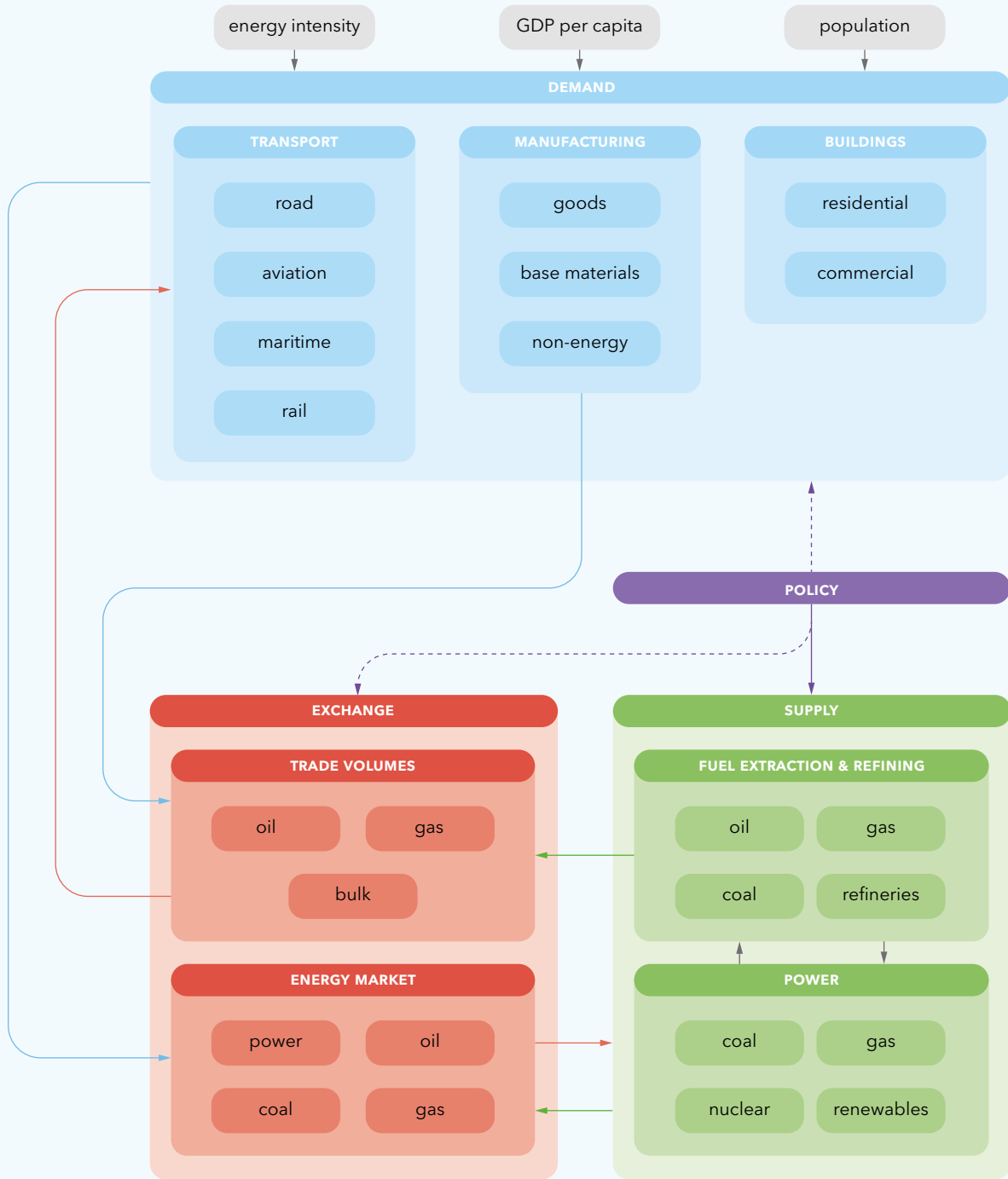
It is important to state what we have not reflected in our model. We have no explicit energy markets with separate demand and supply determining prices; our approach concentrates on energy costs, with the assumption that, in the long run, prices will follow costs. We also do not incorporate political instability or disruptive actions that may revolutionize energy demand or supply, accepting that what constitutes ‘disruption’ is subjective. For example, we assume that the share of electric vehicles (EV) in new light vehicle sales will increase from below 10% to above 90% in a period of less than 10 years in many regions, from varying starting dates. Some industry players are likely to experience this as disruptive, but our main focus is the impact on the energy system, and not so much the impact on its players. While we model both energy demand and supply as mostly endogenously driven, the main exogenous drivers of energy demand in our model are population and productivity.

### BREAKTHROUGH TECHNOLOGIES?

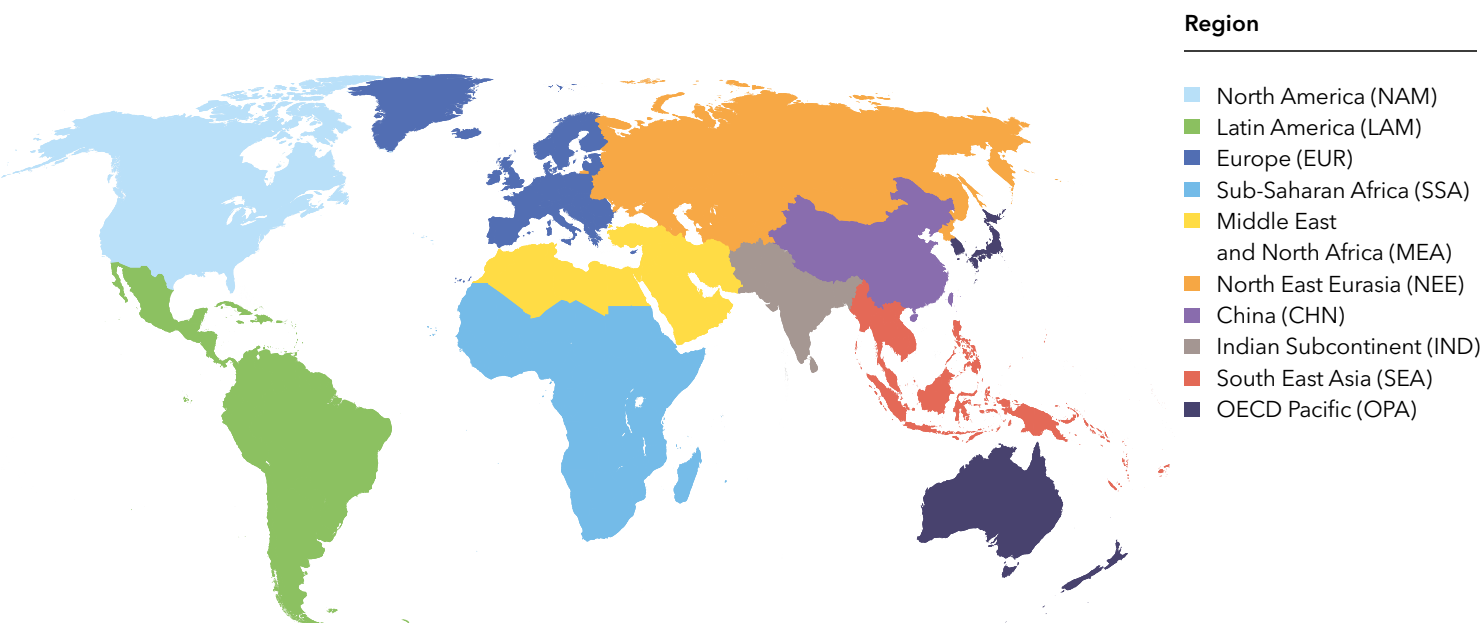
Over the course of the next 33 years, we may see breakthrough technologies – like nuclear fusion, superconductivity, and synthetic fuels – significantly influencing our energy future. While these are not covered by our forecast, we do discuss and consider developments in hydrogen as part of our outlook.



A HIGH LEVEL DEPICTION OF THE DNV GL WORLD ENERGY SYSTEM MODEL



**WE ANALYSE 10 GLOBAL REGIONS**



**REGIONAL OUTLOOKS**

We found it meaningful to produce not just a global outlook, but also to explore regional energy transitions, including inter-regional energy relationships. This provides essential insight for any company which, like our own, operates internationally.

We have divided the world into 10 regions. Countries included in each of the regions generally share some energy characteristics, and geographical contiguity informed our selection of regions in all but one case – our ‘OECD Pacific’ region, which includes Japan, South Korea, Australia and New Zealand.



On a global scale, the energy transition will be dramatic, but it will be experienced unevenly across the world’s regions

**FUTURE ECONOMIC GROWTH**

Future GDP is a function of population and productivity growth.

Energy forecasts often take the number of people as a departure point and commonly rely for their projections on the World Population Prospects published biennially by the UN's Department of Economic and Social Affairs.

The UN has, however, been criticized for not taking country-specific education levels sufficiently into consideration, which matter for future fertility and mortality trends. For that reason, we prefer the approach used by the IIASA/Wittgenstein Centre for Demography and Global Human Capital in Austria, which specifically considers how urbanization and rising education levels are linked to declining fertility.

Taking the IIASA models, but adjusting for a faster rate of population growth in Sub-Saharan Africa which lags other regions in terms of socio-economic development, gives us a global population in 2050 of 9.2 billion, some 6% lower than the 2017 UN median forecasts. In sensitivity tests, we also run our outlook using the UN low and median population forecasts.

As the world's regions develop, they progress first through a phase dominated by primary economic activities (such as agriculture) then an industrialization phase, before the service sector becomes dominant. The potential for productivity improvement diminishes through these stages. Thus, while we see a more prosperous future planet, all regions will experience a slow-down in productivity growth. The dual impact of slower population and productivity growth is that growth in Gross World Product (GWP) growth will also decelerate considerably.

The world is, however, still on track to more than double the size of its economy by mid-century. But, compared with the last five decades, in which GWP has grown six-fold, our 130% growth forecast for GWP represents a marked deceleration.

By mid-century, even today's rapidly growing emerging economies will experience significantly slower growth as their economies de-industrialize and become more service orientated.

Our forecast for GWP is in line with recent projections by McKinsey and PWC. The International Energy Agency (IEA) and BP predict higher global economic growth towards 2050, and their projections for growth in energy use are consequently higher.



## ENERGY AT SCALE: EXAJOULES, TERAWATT-HOURS AND MTOE

The oil and gas industry normally presents its energy figures in millions of tonnes of oil equivalents (Mtoe), while the power industry uses terawatt-hours (TWh), to describe large amounts of electrical energy. The SI system’s main unit for energy, however, is joules, or rather exajoules (EJ) when it comes to national or global energy statistics, which is also the unit we have chosen in this outlook.

So what is a joule? Practically one could think of a joule as the energy needed to lift a 100g smartphone 1 metre vertically; or the amount

of electricity needed to power a single watt LED-bulb for 1 second (1 Ws). In other words, a joule is a very small energy unit, and when talking about global energy we use EJ, being  $10^{18}$  J, or a billion billion joules.

In this outlook, we will use J or EJ as the main unit of energy. The conversion factors we use are:

$$1 \text{ EJ} = 23.88 \text{ Mtoe}$$

$$1 \text{ EJ} = 277.8 \text{ TWh}$$

### 1EJ = A BILLION BILLION JOULES

# 1,000,000,000,000,000,000 J

### LEARNING CURVE EFFECTS

The premise behind the notion of ‘learning curves’ is that the cost of a technology decreases by a constant fraction with every doubling of installed capacity, owing to the growth in experience, expertise and industrial efficiencies associated with market deployment and ongoing R&D.

Wind and solar photovoltaics (PV) have shown significant cost reductions and market growth in recent years. For wind, the historical cost learning rate is 18%, and we expect this to decline slightly to 16%. In addition, we factor in significant, but regionally uneven, public sector subsidies of new capacity at least through the next decade. For PV, the rate is 18% historically and we expect this to continue and to drive down the cost of new installations, accepting that as installed capacity mushrooms, the rate of doubling as a function of time will slow along with cost reductions. Notably, for systems dominated by variable renewables, which will be the case for several regions after 2040, storage

capabilities will be crucial. We account for this in our forecast by adding storage costs to the renewables installations as they begin to dominate, which happens towards 2050 in several regions.

There are critical learning curves at play also beyond renewables. These include electric vehicles (EVs) – a sector with potential to keep doubling output in coming years, such that by 2022 we expect strict vehicle price/performance parity between internal combustion engine vehicles (ICEVs) and battery electric vehicles (BEVs) while incentives for EV infrastructure, and for wind and PV generation will continue – albeit at steadily reducing levels – for a decade or two.

After a decade or two, depending on the region, we see the energy transition gaining a self-reinforcing momentum. This will be the main consequence of interacting cost and technology dynamics that enable low-carbon solutions to stand on their own feet.



In the coming decades, we see a mix of forces at play. There will be diverse political frameworks and policy measures to achieve climate or other policy goals and energy system change depending on the resource endowments, existing energy system structures, and available technology. A cursory look at the history of carbon pricing is enough to show countervailing forces at work, and, indeed, our forecast assumes that the implementation of carbon pricing schemes will remain difficult, and hence prices are likely to generally remain low and not exceed 60 USD/tonne CO<sub>2</sub> (in today's money) in any region before 2050.

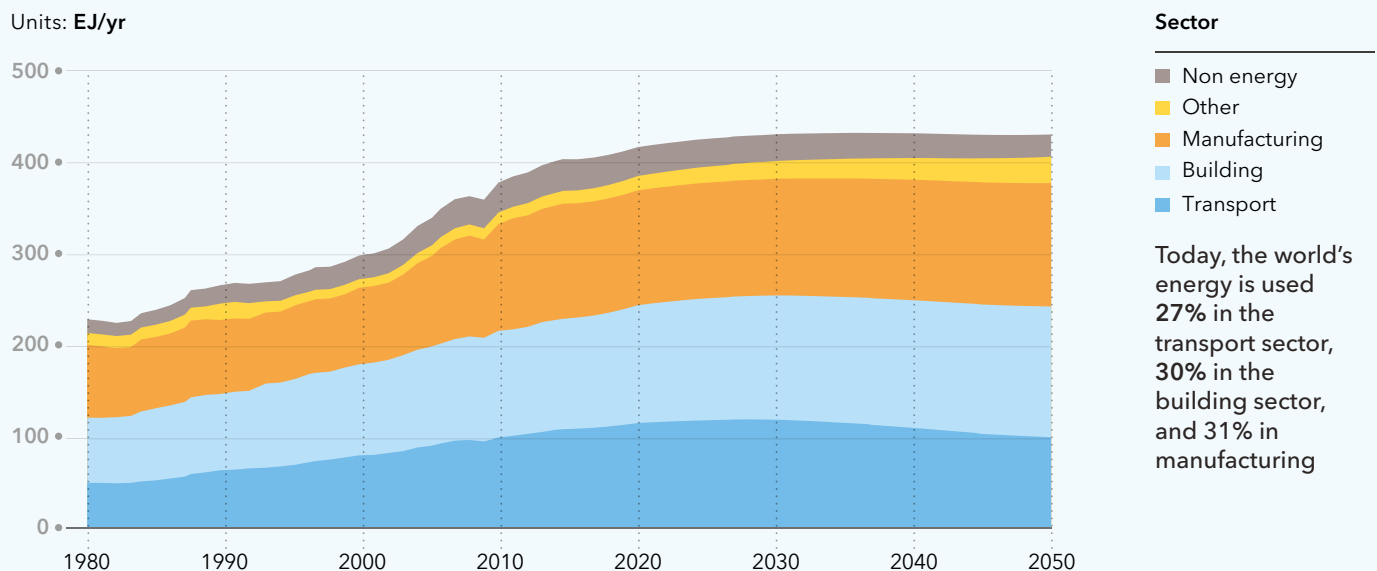
#### **DEMAND**

We estimate total final energy demand by mid-century at 430 exajoules (EJ), up from 400 EJ in 2015. All of the increase will take place in the years prior to 2030, following which demand flattens. This, relatively modest, 7% increase contrasts with the 35% rise in global energy demand that has occurred over the last 15 years. The slow-down in demand growth is related to decelerating population and productivity growth, to faster improvements in energy efficiency, and to electrification, e.g. in heating and transport.

#### **ENERGY AND YOU: HOW MUCH DO YOU NEED?**

Another way of understanding joules is in terms of the energy needed per person. The amount of energy used per person today averages 78 gigajoules (GJ) annually. Shell (2016) estimates that 100 GJ of primary energy per person per year is needed to support a decent quality of life to which people naturally aspire. In the much more efficient energy system of the future, we think 100 GJ is not needed; as an example, we forecast Europe's' average primary energy use to be 76 GJ per person per year by 2050.

**FIGURE 2. WORLD FINAL ENERGY DEMAND BY SECTOR**



At first glance, the final energy demand chart (Figure 2) looks deceptively stable across major categories of demand. Transport shows initial growth, but then declines as electrification of the road sub-sector materializes. Our analysis indicates that uptake of EVs will follow an S-shaped curve, resembling the fast transition seen, for example, with digital cameras.

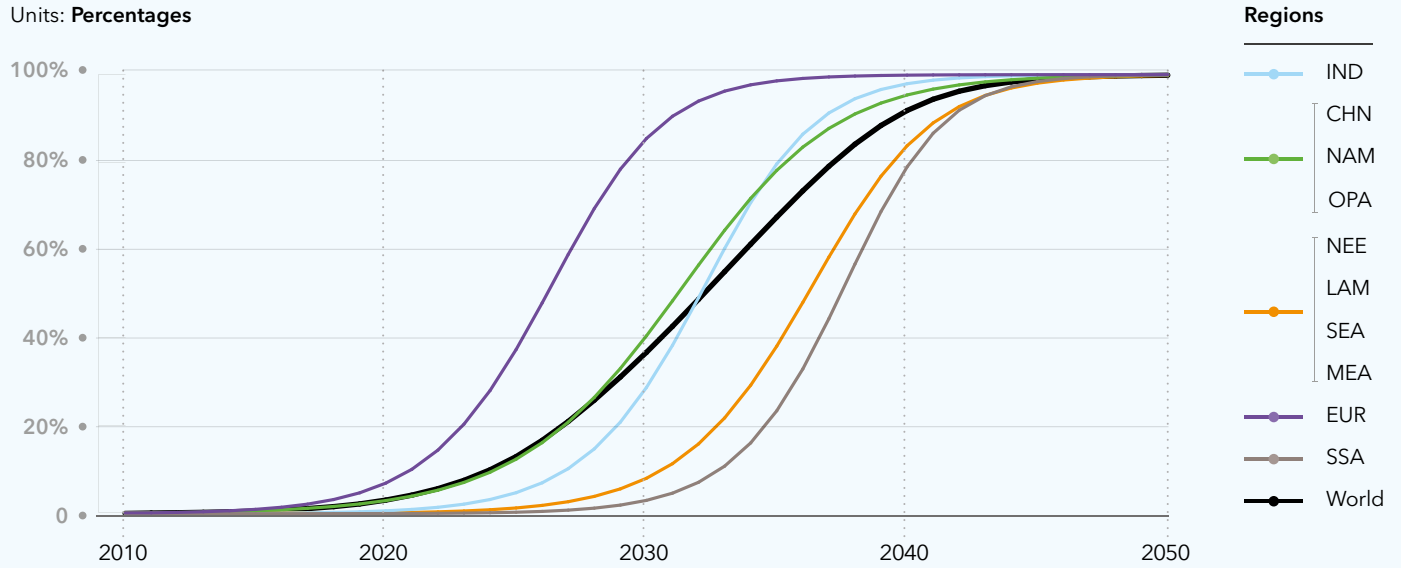
The point where half of all new cars sold are EVs will be reached just after 2025 for Europe, 2030 for North America, OECD Pacific, China and Indian Subcontinent, and 2035 for the rest of the world. The buildings and industry/manufacturing sectors both retain a stable share of about 30% of demand through the forecast period. The remaining 12% is split between agriculture, forestry, other smaller categories and the non-energy use of fossil fuels (e.g. as feedstock for lubricants, asphalt, and petrochemicals).

From the perspective of where the energy is sourced, the demand picture is more dramatic. Although total energy demand is almost flat, there are big changes in its composition. In 2015, electricity represented 18% of the world's final energy demand: by 2050, its share will be 40%, growing from 73 EJ/yr to 170 EJ/yr. Electricity replaces both coal and oil in the final energy demand mix, and the trend of electrification is clear in all regions.

“ We estimate total final energy demand by mid-century at 430 EJ, up from 400 EJ in 2015. All of this increase will take place in the years prior to 2030, following which demand flattens.

**FIGURE 3. MARKET SHARE OF ELECTRIC VEHICLES IN NEW LIGHT VEHICLE SALES**

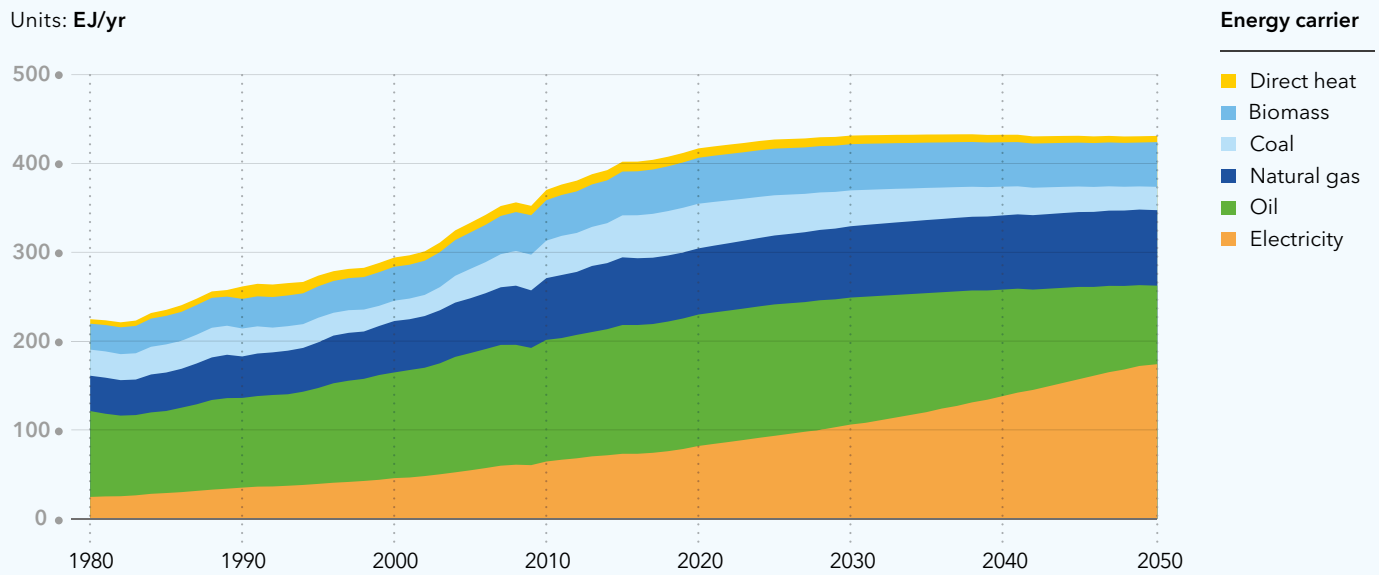
Units: Percentages



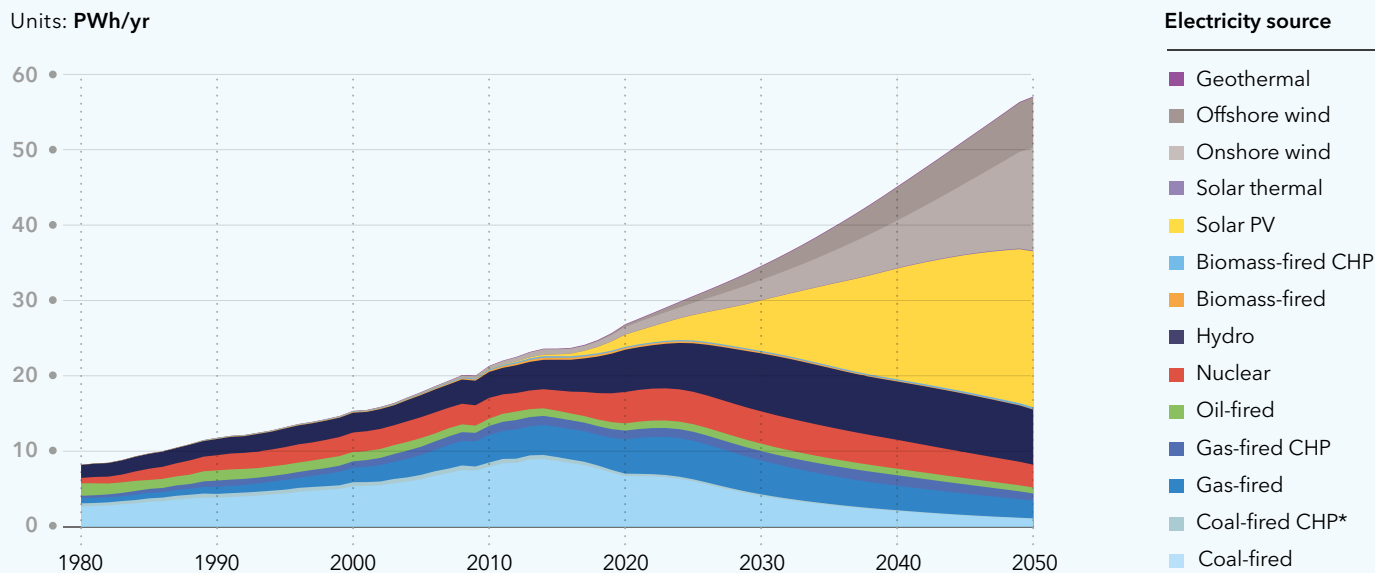
See region map on page 14

**FIGURE 4. FORECAST WORLD FINAL ENERGY DEMAND BY ENERGY CARRIER**

Units: EJ/yr



**FIGURE 5. WORLD ELECTRICITY GENERATION BY SOURCE**



**SUPPLY**

Our forecast shows a more dynamic transition on the supply side of the equation, with renewable energy growth leading the charge. Other rapid changes include shifts in shale gas and falling coal demand in China and several developing countries.

But the key feature is rapid changes within the electricity mix. To satisfy the 170 EJ demand in 2050, electricity generated will amount to 206 EJ, some 18% higher than the final electricity demand owing to losses in transmission and distribution and the power used by the sector itself.

Our model allows all potential electricity sources to compete on price, which means that electricity from renewable energy sources also compete with each other. Renewables will increasingly dominate world electricity generation – with solar PV and wind each having a 36% share, and two-thirds of wind power coming from onshore by 2050. With this high amount of variable power, the stability of the system will

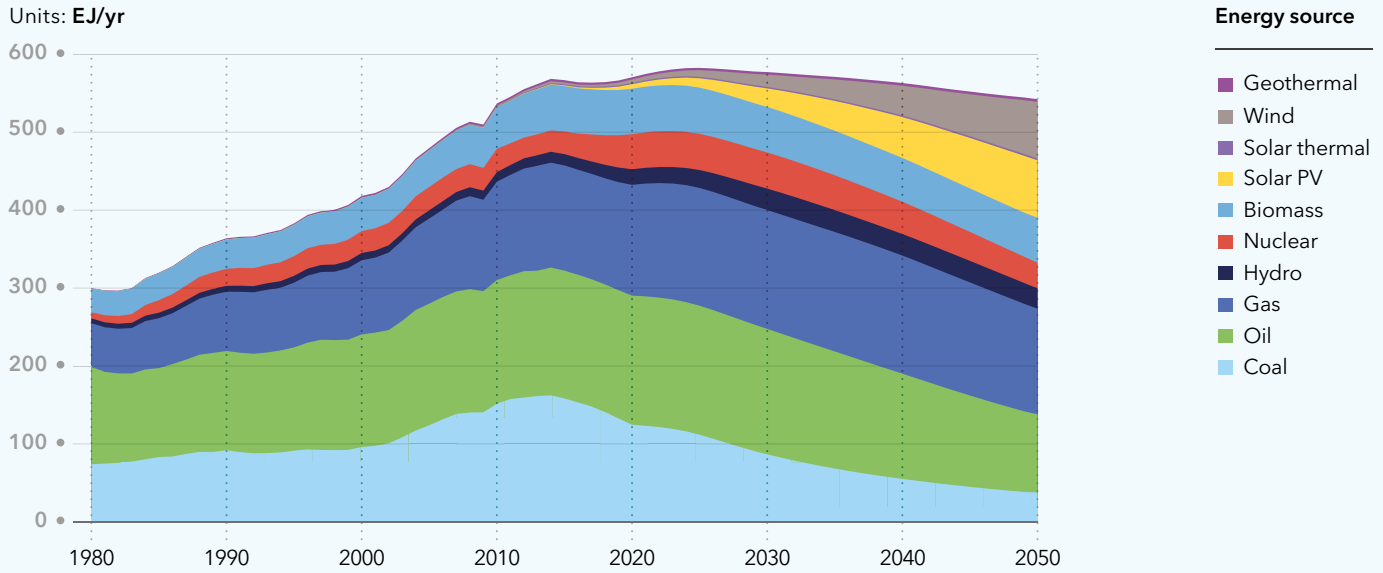
become crucial – a topic we address extensively in the *Renewables, Power & Energy Use* supplement to this main publication.

Looking beyond the electricity sector to the energy system as a whole, we foresee large shifts in the supply of primary energy. Oil and coal currently provide 29% and 28% respectively of the world’s global energy supply. By 2019, coal will be overtaken by gas, and in 2034, gas will surpass oil to become the largest energy source. The fossil fuel share of the world’s primary energy mix will decline from 81% currently to 52% in 2050. Hydropower, nuclear, and biomass will remain flat, while PV and wind will grow rapidly, and represent 13% and 14% respectively of the world’s primary energy supply in 2050.

A key result from our model is that while demand flattens, the global primary energy supply required to satisfy it will peak within our forecast period. The arbiter of this shift is rising energy efficiency.



**FIGURE 6. FORECAST WORLD PRIMARY ENERGY SUPPLY BY SOURCE**



**UNCERTAINTIES**

Our forecast combines past data with our best judgment to provide expected values for variables, without quantifying uncertainties. We do, however, present sensitivity analyses, which highlight issues that are both uncertain and important. We also analyse uncertainties associated with assumptions that place our outlook at odds with other forecasts.

For example, should the UN medium case for population growth prove correct, then the global population will be 6.5% higher in 2050 than we have assumed. Our model suggests that energy demand will consequently rise by slightly less (6%) than population growth, split fairly evenly between all energy sources, though oil and biomass benefit more than others. We find a similar sensitivity to productivity assumptions, where higher or lower growth rates do not produce considerable changes in the pace of transition or in the energy mix. Likewise, changes to carbon prices cause only moderate changes in energy outcomes, but significant changes in emissions.



**Significant capacity additions are still needed for oil and gas, to satisfy forecast demand**

The most dramatic changes in energy use come from improvements in energy efficiency. The largest changes in the energy mix come from improved cost learning rates for renewables. Behavioural changes affecting, for example, the rate of uptake of electric vehicles and the electrification of buildings, are also important and can shift the pace of transition considerably.

None of the sensitivities discussed, however, alter the main conclusion that the world will undoubtedly experience a rapid energy transition, driven by electrification boosted by a strong growth of wind and solar power generation, and also further decarbonization of the energy system, including the decline in coal, oil, and gas, in that order.

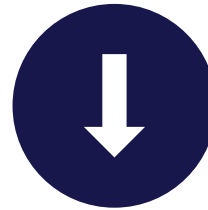
**ENERGY EFFICIENCY**

Our outlook shows that the world’s energy system is highly sensitive to changes in energy efficiency. The world’s energy intensity (units of energy per units of GDP) has been declining on average by 1.4% per year for the last two decades. We find that this rate will almost double to an average annual 2.5% decline.

The main reason for this is the accelerating electrification of the energy system. Simply put, electricity use is much more efficient with less heat losses than is the case for fossil fuels. This effect is accentuated by ever-more solar and wind generation capacity being added, with only inconsequential energy losses. The efficiency trend will be further boosted by the mainstreaming of EVs, which typically consume only a quarter of the energy used by comparable gasoline-powered vehicles.

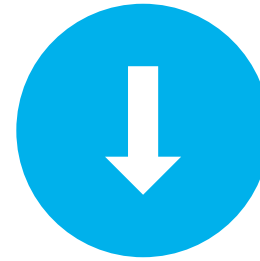
There are lower efficiency improvements in aviation and maritime, due to the continued use of internal combustion engines for propulsion.

**THE DECLINE IN THE WORLD’S ENERGY INTENSITY WILL ACCELERATE**



**-1.4%**

PAST 20 YEARS



**-2.5%**

FORECAST TO 2050

Nevertheless, we anticipate improvement rates of 2.0%/yr per passenger-trip and 0.8%/yr per tonne-mile, respectively. Our forecast ramp-up of efficiency also relies on automation and digitalization, which enables a host of efficiency enhancements, for example in manufacturing efficiencies and in the energy-efficient design and operation of buildings.

**ACHIEVING SDG #7:**



— Ensuring access to affordable, reliable, sustainable and modern energy for all

The future we forecast is one where humanity’s energy demand flattens after 2030. We foresee this happening even as the world makes steady positive progress with SDG #7, addressing the energy poverty that afflicts more than one billion people today. Energy demand flattens mainly because the energy intensity of economic activity is decelerating. Less energy is required per person.

We forecast that the third target in UN Sustainable Development Goal No.7 – to double the rate of improvement in energy efficiency by 2030 – will be met. More specifically, we see energy efficiency doubling from an average of 1.3%/yr over the period 2000-2015 to 2.7%/yr in 2015-2030.

### THE EFFICIENCY OF RENEWABLE ENERGY

Fossil power plants convert only a portion of their input energy to electricity, as much of the input energy is lost as heat. Though combined heat and power (CHP) plants capture some of this heat for useful purposes, globally such heat losses are enormous. In the case of renewable power generation, electricity is generated directly from wind, solar irradiance, and from running or elevated water. Although 100% of the input is not converted into electricity, the electricity generated is considered primary energy according to the *physical energy content method* (as explained in section 4.2 of our main report), and the wind, sun or water not captured is never counted as part of the energy system. Hence, with a growing proportion of renewable power generation in the energy mix, losses to heat in the production of energy will decline. This is a major reason why the world's primary energy supply will peak before 2030.



### ENERGY FINANCING

Given the scale of change, there may be concerns that the energy transition will place an unbearable financial burden on society.

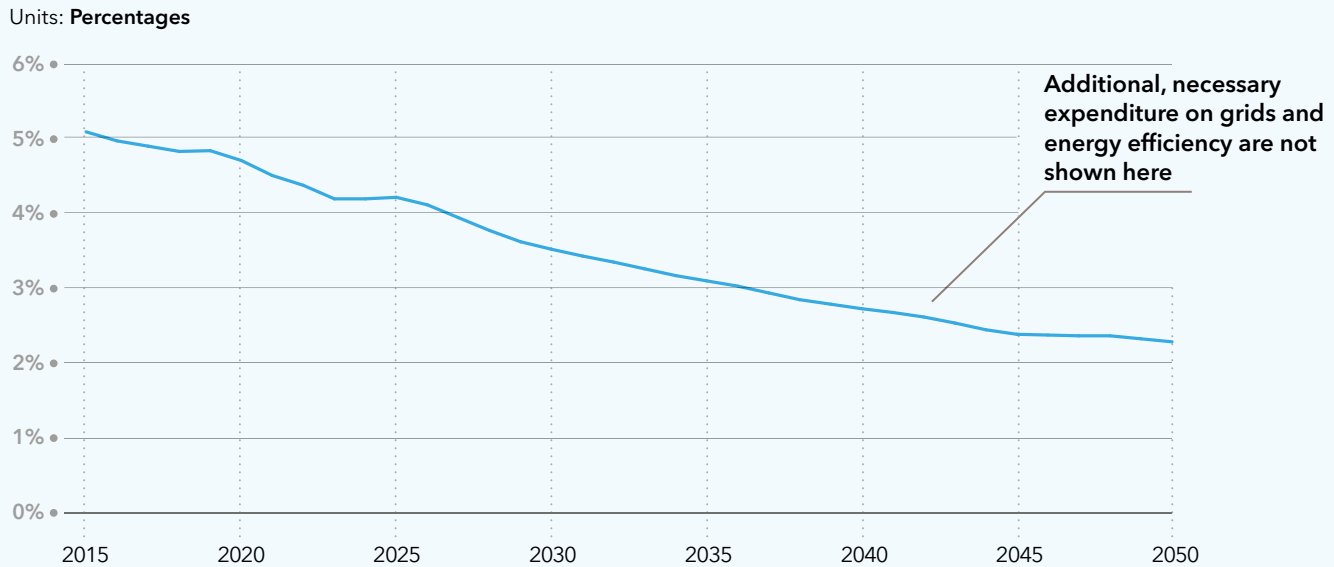
Looking at overall energy financing needs, we calculate investment in fossil fuels by considering upstream and power-related investments for oil, gas and coal. We estimate that, globally, expenditures for fossil fuels will drop by more than half from around USD3,400 billion/yr today to USD1,500 billion/yr in 2050, while non-fossil energy expenditures show the reverse trend, increasing fivefold from around USD500 billion/yr today to USD2,700 billion/yr in 2050.

Shifting to renewables, where capital expenditure (capex) is mostly upfront, implies a shift from an energy system with a 60/40 split between opex and capex to one with the inverse split of 40/60.

In dollar terms, global opex will decline from about USD2,000 billion/yr in 2015 to USD1,500 billion/yr in 2050. Conversely, capital expenditure increases from USD1,800 billion/yr in 2015 to USD2,600 billion/yr in 2050. The energy transition can be undertaken without a significant increase in overall energy expenditures, which will stay approximately constant over time. With Gross World Product (GWP) increasing by 130% over the next 33 years, total energy expenditure is forecast to fall to less than half of its current share of GWP – from 5% to a little over 2% of GWP.

The energy transition may still be challenging from a financial perspective, given the heavier capex load from renewables. Yet the forecasted transition is unlikely to prove financially disruptive, and if we maintain the fraction of GWP going to energy expenditure, there is ample scope to accelerate the pace of change.

**FIGURE 7. GLOBAL ENERGY EXPENDITURE AS A FRACTION OF GROSS WORLD PRODUCT**



**CLIMATE IMPLICATIONS**

This outlook is one of the few we know of that predicts that humanity will collectively start using less energy in the coming decades. Even so, the emissions associated with our forecast will not bring the planet within the so-called 2 °C target – the maximum level of warming above pre-industrial levels agreed upon in Paris, 2015.

CO<sub>2</sub> will continue to be emitted to the atmosphere long after 2050. Simple extrapolation suggests that the first emission free year will only occur in 2090. This produces an overshoot, beyond the so-called 2 °C carbon budget (see fact box), of some 700 Gt CO<sub>2</sub>. Inevitably, with an overshoot of such magnitude, the question arises: what level of global warming is associated with our forecast?

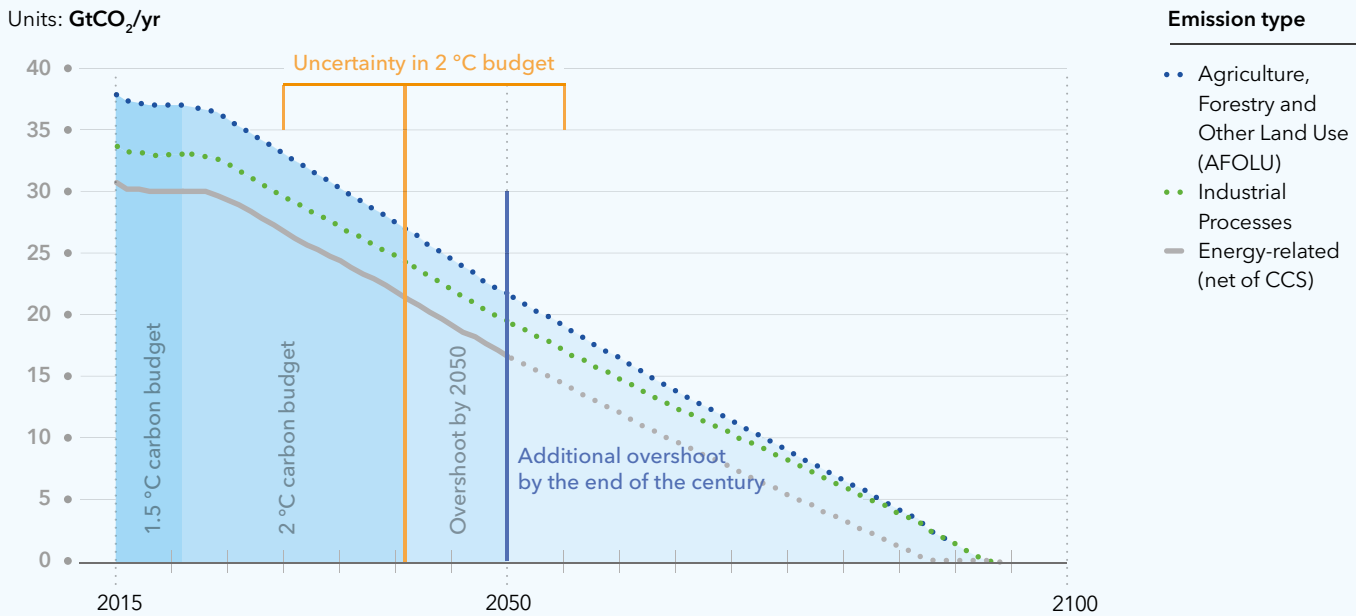
While we can confidently conclude that our outlook does not place the world on the path contemplated by the Paris Agreement, we have reservations about

**CARBON BUDGET DEPLETION**

The carbon budget is an expression of how much carbon can be emitted to the atmosphere while staying within a certain temperature threshold. With climate emissions calculated from our forecast, the 2 °C carbon budget will be emptied by 2041. The 1.5°C carbon budget will be depleted in only 4 years from now, by 2021.

It must be stressed, as we explain more fully in our outlook, that there are considerable uncertainties involved in estimating carbon budgets. Our estimated remaining carbon budget for a 2 °C warming future – 850 Gt CO<sub>2</sub> – is an average value for which there also is significant uncertainty.

**FIGURE 8. CARBON EMISSIONS AND CARBON BUDGET**



citing a definitive warming figure because there are considerable uncertainties associated with such calculations, both energy-related uncertainties (including the inherent uncertainties in our forecast) and non-energy related. Issues such as future agriculture, forestry and other land use (AFOLU) emissions, unknown climate tipping points and other non-linear earth system reactions, e.g. methane stored in permafrost, are beyond the scope of this outlook.

We nevertheless hazard an estimate that our forecast points towards 2.5 °C planetary warming by the end of the century. We also explore ways to ‘close the gap’ between our forecast and the kind of future envisioned by the parties to the Paris Agreement. For example, a much higher carbon price may stimulate a greater carbon capture and storage effort, or further policy support could boost the growth of renewable energy.

However, our main conclusion is that ‘closing the gap’ will require a mix of extraordinary measures working in synchrony. This is very much in line with the conclusion of the flagship report by the Energy Transitions Commission, (ETC, 2017) setting out an achievable pathway to limit global warming to well below 2 °C.

“ The energy transition is affordable: the share of Gross World Product (GWP) represented by energy expenditure will go down

**IMPLICATIONS FOR INDUSTRY**

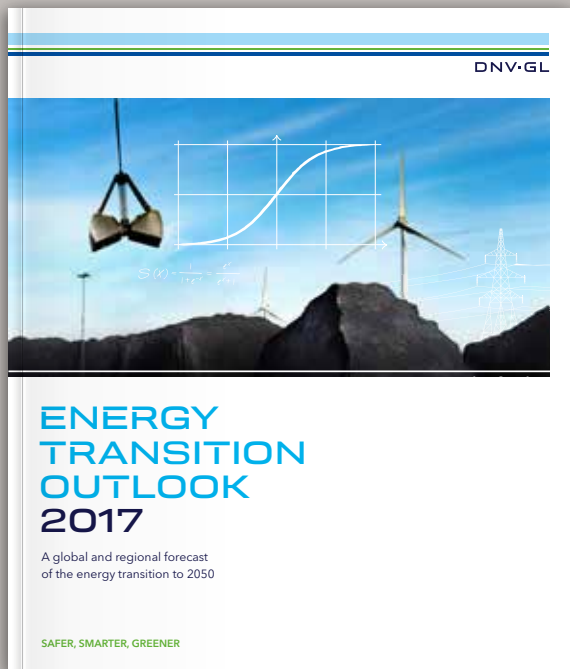
Our forecast has major implications for the oil and gas industry, as well as for renewables, power, and energy intensive industries. A full discussion of our forecast and its ramifications for these sectors is the subject of dedicated supplements to this report.

Suffice it to say here that some of the most important implications for oil and gas over the long term are as follows:

- Oil and gas will retain an important role in the energy mix, together accounting for 44% of world primary energy supply in 2050, compared with 53% today. Continued investments will be needed for new production capacity offshore and onshore.
- In an energy future with more intensive competition and reduced oil demand (mainly driven by rapid EV uptake), the oil and gas industry will intensify its focus on cost efficiency to remain competitive over the forecast period. Tools to achieve this include digitalization, technology innovation, standardization and collaboration.
- Gas will be the largest energy source by 2034, and will hold this position through to 2050, even though its share of the energy mix will start to decline from 2040 onwards. There are large opportunities for gas to co-develop with other energy sources and to add flexibility to the expanding electricity system.

The key trends that we predict for power, renewables and energy use are that:

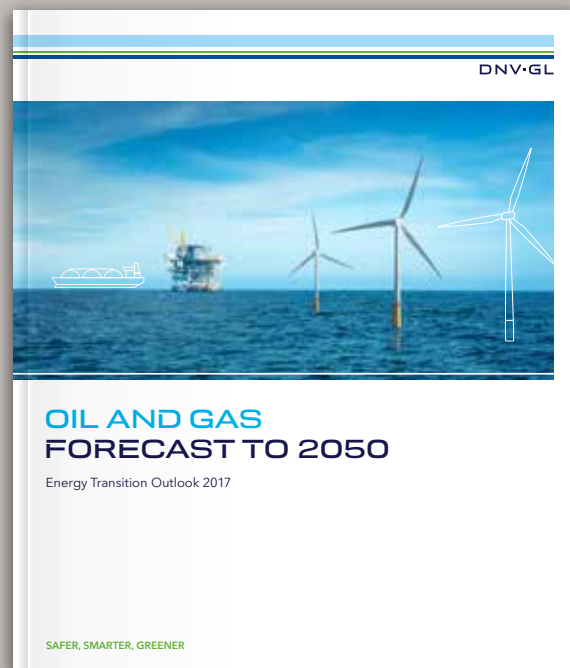
- Exponential growth in renewables and electrification of energy demand contrasts with the peaking of oil and later of gas. This will significantly alter the energy industry landscape.
- Consumer-scale technologies such as solar PV systems and EVs will become increasingly cost-competitive, and deployment will accelerate dramatically.
- Portfolios of network projects, some as small as home installations, could become more significant than large utility scale generating plants. Investment horizons will shrink, and investors and insurers will need a new understanding of what they are financing and covering. Change will also embrace investments at residential, commercial and industrial scale, such as battery storage, or energy efficiency measures.
- Digitalization will lead to better connectivity of all elements in the power system. This will optimize the design, planning and operations of assets in wind, solar, transmission, distribution and the use of electricity in society.



## ENERGY TRANSITION OUTLOOK

Our main publication deals with our model-based forecast of the world's energy system through to 2050. It gives our independent view of what we consider 'a most likely future', or a central case, for the coming energy transition. The report covers:

- Our main assumptions, on population, productivity, technology, costs and the role of governments
- The model behind our forecast results
- Our findings on global energy supply, demand and each of the energy carriers – and a sensitivity analysis
- Energy forecasts for each of our 10 world regions
- Issues to watch in the next 5 years
- The climate implications of our outlook
- Highlights from our supplementary reports

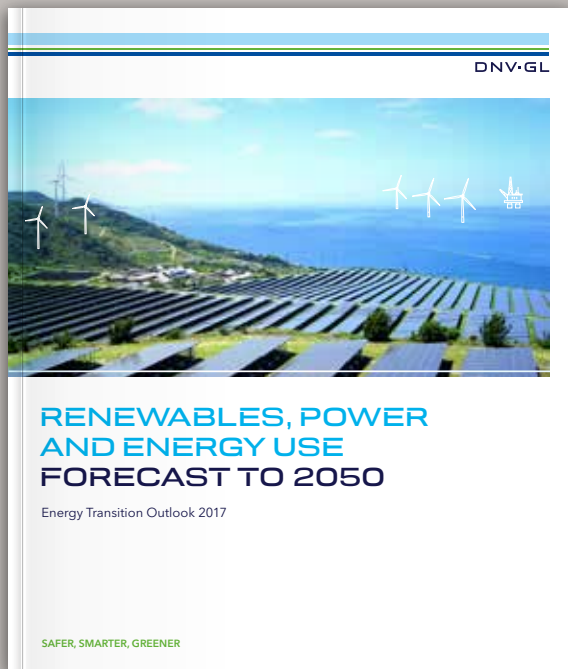


## OIL AND GAS FORECAST TO 2050

Oil and gas will be crucial components of the world's energy future. While renewable energy will increase its share of the energy mix, oil and gas will account for 44% of world energy supply in 2050, compared to 53% today.

In our oil and gas report, we have translated the energy requirements of key demand sectors into the trends we expect to see across the value chain. We discuss how the oil and gas energy system will meet this demand from existing and new production capacity. We also consider implications for LNG and pipelines, and the roles digitalization and emerging technologies will play across the value chain.





## RENEWABLES, POWER AND ENERGY USE FORECAST TO 2050

This report presents implications of our energy forecast for key stakeholders including electricity generation, including renewables; electricity transmission and distribution; and energy use. The report covers:

- Key conclusions from our model
- Key technologies and systems, focusing on results from the model and on the expected key developments. The technologies and systems considered include: onshore and offshore wind; solar; hydropower; biomass; nuclear; coal; transmission grids and system operation; distribution grids; off-grid and micro-grids; electrification of energy use; buildings and their energy efficiency; energy efficiency in manufacturing industry; and storage.
- Takeaways for specific types of stakeholders
- Important issues to monitor over the next five years



## MARITIME FORECAST TO 2050

*Forthcoming:* our Maritime energy outlook will be published towards the end of 2017. It will explore the implications of our forecast for the shipping industry. The expected focus areas include the contribution of shipping to the decarbonization of the world's energy system and the impact of shifts in the energy mix on the demand and usage of vessel types and trading patterns. The forces driving this shift are not limited to emission regulations and physical risks to assets, but also changes in consumer preferences, new technologies, and the supply of energy, all of which will have an impact on shipping.





**HEADQUARTERS:**

**DNV GL AS**

NO-1322 Høvik, Norway  
Tel: +47 67 57 99 00  
[www.dnvgl.com](http://www.dnvgl.com)

DNV GL is a global quality assurance and risk management company. Driven by our purpose of safeguarding life, property and the environment, we enable organizations to advance the safety and sustainability of their business.

We provide classification, technical assurance, software and independent expert advisory services to the maritime, oil & gas, power and renewables industries. We also provide certification, supply chain and data management services to customers across a wide range of industries.

Combining technical, digital and operational expertise, risk methodology and in-depth industry knowledge, we empower our customers' decisions and actions with trust and confidence. We continuously invest in research and collaborative innovation to provide customers and society with operational and technological foresight.

With origins stretching back to 1864 and operations in more than 100 countries, our experts are dedicated to helping customers make the world safer, smarter and greener.

[eto.dnvgl.com](http://eto.dnvgl.com)

# C/CAG AGENDA REPORT

**Date:** February 21, 2018  
**To:** Resource Management and Climate Protection Committee  
**From:** Kim Springer, County staff to RMCP Committee  
**Subject:** Discussion about RMCP Committee priorities for calendar year 2018  
(For further information contact Kim Springer at 650-599-1412)

---

## **RECOMMENDATION**

Participate in a discussion about RMCP Committee priorities for calendar year 2018.

## **FISCAL IMPACT**

Funding for the RMCP Committee comes from C/CAG Congestion Relief Funds

## **BACKGROUND/DISCUSSION**

At the January 17, 2018 RMCP Committee meeting, during the item on future meeting dates, there was a discussion about potential future projects for the Committee to work on. Among the projects mentioned was a suggestion in support of an update to the original San Mateo County Energy Strategy 2012 document, and a mention of the Governor's Climate Summit, scheduled for September 2018. Another consideration, not mentioned, is the possibility of an Energy Summit, in the same spirit as the Water Summit being held March 30, 2018.

Staff would like the Committee to engage in a discussion about these or other potential projects, and decide on next steps. With direction, staff will begin work on objectives established by the Committee. Links to the San Mateo County Energy Strategy and the Global Climate Summit are provided as attachments to this staff report.

## **ATTACHMENT**

Links to:

- A. San Mateo County Energy Strategy: <http://ccag.ca.gov/wp-content/uploads/2014/05/Energy-Strategy-Complete.pdf>
- B. Governor's Global Climate Action Summit: <https://globalclimateactionsummit.org/>

# C/CAG AGENDA REPORT

**Date:** February 21, 2018  
**To:** Resource Management and Climate Protection Committee  
**From:** Kim Springer, Committee Staff  
**Subject:** Review and approve RMCP Committee meeting dates for calendar year 2018  
(For further information contact Kim Springer at 650-599-1412)

---

## **RECOMMENDATION**

Review and approve RMCP Committee meeting dates for calendar year 2018.

## **FISCAL IMPACT**

None

## **SOURCE OF FUNDS**

Funding for the RMCP Committee comes from C/CAG Congestion Relief Funds.

## **BACKGROUND/DISCUSSION**

At the change of each calendar year, the Committee reviews and approves the meeting dates for the following calendar year. At the January 17, 2018 meeting, the Committee postponed a decision on 2018 meeting dates, due to a need for further discussion on Committee priorities in 2018.

The RMCP Committee will continue to meet on third Wednesdays from 2:00 to 4:00 p.m. Two meeting dates are proposed for the fourth Wednesday (June and November) due to holiday or event conflicts. Staff may cancel a meeting or shift a meeting date with notice to the committee and the public. Meetings will continue to be held at the 155 Bovet Rd., San Mateo location for 2018 unless the ground-floor meeting room is unavailable, in which case the meeting will most likely be held at County Center in Redwood City.

The following dates are the potential meeting dates for the RMCP Committee in 2018. The Committee will review and approve the dates for 2018. Once approved, staff will update the C/CAG RMCP Website and provide Committee members appropriate calendar appointments.

March 21	August 15
April 18	September 19
May 16	October 17
June 27 (4 <sup>th</sup> week due to SEEC Forum)	November 28 (4 <sup>th</sup> week due to Thanksgiving)
July 18	December 19

## **ATTACHMENTS**

None